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Standard Repair Procedures for Honeywell Avionics Equipment Instruction Manual

Part Number

CAGE

SOPM20-00-03

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Part No. SOPM20-00-03

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TRANSMITTAL INFORMATION

TO HOLDERS OF STANDARD REPAIR PROCEDURES FOR HONEYWELL AVIONICS EQUIPMENT INSTRUCTION MANUAL ATA No. 20-00-03 ISSUED FOR USE IN SUPPORT OF THE FOLLOWING:

Table TI-1 shows the applicable components.

Table TI-1. Applicable Components

Component PN	Nomenclature
SOPM20-00-03	Standard Repair Procedures for Honeywell Avionics Equipment Instruction Manual

Revision History

Table TI-2 shows the revision history of this instruction manual.

Table TI-2. Revision History

Revision Number	Revision Date
0	10 Jan 1992
1	1 Apr 1994
2	12 Jun 1996
3	10 Feb 1997
4	1 Nov 2000
5	15 May 2003
6	15 Nov 2004
7	1 Feb 2008
8	21 Jun 2013
9	26 Feb 2020
10	20 Jan 2022

This revision is a full replacement. All changed pages have a new date, as identified in the List of Effective Pages. Revision bars identify the changed data. A revision bar adjacent to the Fig./Item column identifies changes in the Detailed Parts List. See Transmittal information for history of revisions to this instruction manual.

Remove and discard all pages of the manual and replace them with the attached pages. Write the revision number, revision date, and replacement date on the Record of Revisions page.

The table of highlights tells users what has changed as a result of the revision. The table consists of three columns.

The Task/Page column identifies the blocks of changed information, such as a task, subtask, graphic, or parts list, and the page on which that block starts. The block of information often includes the MTOSS code. Revision marks, when provided, identify the location of the change within the block.

The Description of Change column tells about the change or changes within each block. The description of change is often preceded by a paragraph or figure reference that applies to the block of information.

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The Effectivity column tells the user the part number(s) to which the block of information applies. The default value for this column is "All." "All" means that the block applies to all parts.

Table of Highlights

Task/Page	Description of Change	Effectivity
TRANSMITTAL INFORMATION	Global Change: Changed the content and format to agree with the Honeywell processes in effect at the time of the release of this revision.	All
TRANSMITTAL INFORMATION	Global Change: The editorial changes and data that were moved or reformatted are not identified with revision bars.	All
INTRODUCTION (Page INTRO-9)	Figure INTRO-3. Updated the illustrations from "M409148 Rev D" to "M409148 Rev F".	All
REMOVAL AND APPLICATION OF CCA/ECA/PWB COATINGS (Page 3-25)	Paragraph 3.A. Step (1). Revised the document revision of EB7020465 from "Revision C" to "Revision F" in the procedure.	All
REMOVAL AND APPLICATION OF CCA/ECA/PWB COATINGS (Page 3-26)	Figure 3-4. Updated the illustrations from "EB7020465, Rev C" to "EB7020465, Rev F".	All
HARNESS, CABLE, LEAD SET, AND CONNECTOR REPAIR (Page 7-2)	Paragraph 1.B. Step (3). Revised the source from 'Commercially available' to 'CAGE: 11536' for item 11X0152.	All

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RECORD OF REVISIONS

NOTE: Refer to the Revision History in the TRANSMITTAL INFORMATION section for revision data.

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RECORD OF TEMPORARY REVISIONS

Instructions on each page of a temporary revision tell you where to put the pages in your manual. Remove the temporary revision pages only when discard instructions are given. For each temporary revision, put the applicable data in the record columns on this page.

Definition of Status column: A TR may be active, incorporated, or deleted. "Active" is entered by the holder of the manual. "Incorporated" means a TR has been incorporated into the manual and includes the revision number of the manual when the TR was incorporated. "Deleted" means a TR has been replaced by another TR, a TR number will not be issued, or a TR has been deleted.

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* The initial H in this column shows Honeywell has done this task.

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INTRODUCTION

1. How to Use This Manual

A. General

- (1) The instructions in the Standard Repair Procedures for Honeywell Avionics Equipment Instruction Manual (manual) gives the data necessary to do standard maintenance procedures on Honeywell avionics equipment.
- (2) The processes defined in this manual are recommended for use during the repair and modification of Honeywell avionics equipment. These processes are used by manufacturing to ensure high reliability and performance of Honeywell avionics equipment. Other industry standards or internal processes that align with the processes in this manual are acceptable.
- (3) Warnings, cautions, and notes in this manual give the data that follows:
 - A WARNING gives a condition or tells personnel what part of an operation or maintenance procedure, that if not obeyed, can cause injury or death.
 - A CAUTION gives a condition or tells personnel what part of an operation or maintenance procedure, that if not obeyed, can cause damage to the equipment.
 - A NOTE gives data, not commands. The NOTE aids personnel when they do the related instruction.
- (4) Warnings and cautions go before the applicable paragraph or step. Notes follow the applicable paragraph or step.
- (5) All personnel who operate equipment and do maintenance specified in this manual must know and obey the safety precautions.

B. Symbols

- (1) The symbols and special characters are in agreement with IEEE Publication 260 and IEC Publication 27. Special characters in text are spelled out.
- (2) The signal mnemonics, unit control designators, and test designators are shown in capital letters.
- (3) The signal names followed by an "*" show an active low signal.
- (4) Some figures in this manual incorporate standard geometric characteristic symbols. Refer to Figure INTRO-1 for the geometric characteristic symbols.

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CHARACTERISTIC SYMBOLS

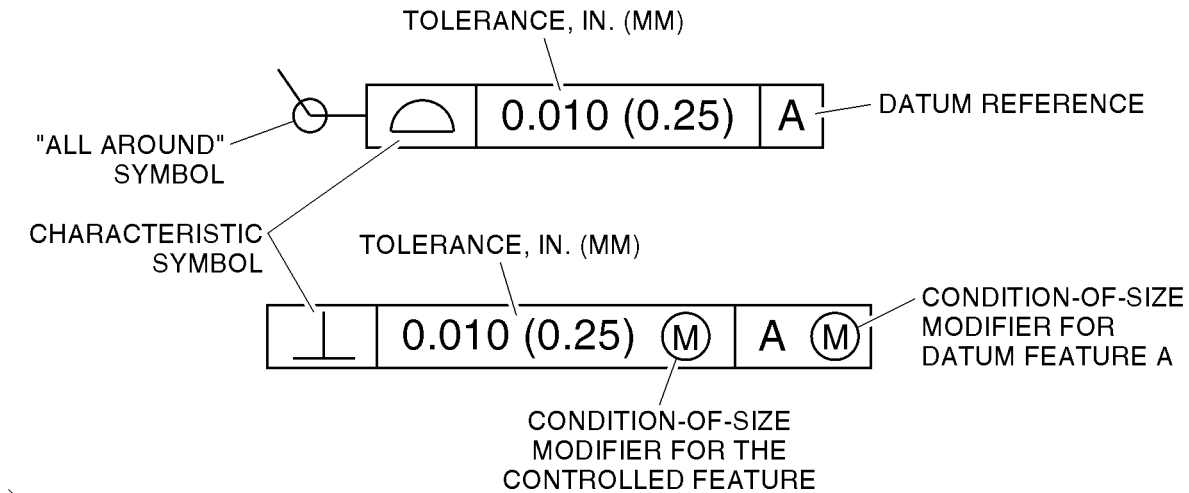
	FLATNESS		PERPENDICULARITY
	STRAIGHTNESS		PARALLELISM
	CIRCULARITY		ANGULARITY
	CYLINDRICITY		CIRCULAR RUN OUT
	PROFILE OF A SURFACE		POSITION
	PROFILE OF A LINE		SYMMETRY
	CONCENTRICITY		

MODIFYING SYMBOLS

- MAXIMUM MATERIAL CONDITION (MMC)
- REGARDLESS OF FEATURE SIZE (RFS)
- PROJECTED TOLERANCE ZONE

OTHER SYMBOLS

- DIAMETER
- NEGATIVE NOTATION

FEATURE CONTROL FRAME

EXCEPT WHEN THE DATUM(S) OR CONTROLLED FEATURE IS A PLANE SURFACE, A MODIFIER IS REQUIRED PER GENERAL RULE 1 OR MAY BE USED TO ALTER GENERAL RULE 2

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Figure INTRO-1. (Sheet 1 of 2) Geometric Tolerance Symbols

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GENERAL RULES

1. POSITION ($\oplus$) TOLERANCES AND THEIR RELATED DATUMS APPLY AT MMC OR RFS AS SPECIFIED IN THE FEATURE CONTROL FRAME.
2. EXCEPT FOR POSITION ($\oplus$), ALL TOLERANCES AND THEIR RELATED DATUMS APPLY RFS UNLESS OTHERWISE SPECIFIED.
3. ALL GEOMETRIC TOLERANCES ARE SPECIFIED AS TOTAL VALUES (TOTAL DIAMETER, TOTAL THICKNESS, TOTAL WIDTH, OR TOTAL ON RADIUS).
4. WHEN TWO DATUM FEATURES ARE REFERENCED IN HYPHENATED FORM,

A-B

, A SINGLE DATUM IS ESTABLISHED BY THE TWO FEATURES.
5. WHEN TWO OR THREE DATUMS ARE REFERENCED IN SUCCEEDING FRAMES,

A	B	C
---	---	---

, THE ORDER OF PRECEDENCE IS LEFT TO RIGHT.

SAMPLE INTERPRETATIONS

-A-

 THIS IS DATUM FEATURE A WHICH IS USED TO CREATE DATUM A IN THE PROCESSING EQUIPMENT.

	0.010 (0.25)
---	--------------

 THIS SURFACE MUST BE FLAT WITHIN 0.010 IN. (0.25 MM) TOTAL (MEETING EITHER SYSTEM WILL ACCEPT THE PART).

	0.010 (0.25)	B
-C-		

 THIS IS DATUM FEATURE C AND, RFS MUST BE PARALLEL TO DATUM B, RFS, WITHIN 0.010 IN. (0.25 MM) TOTAL.

	0.0005 (0.013)	A-B
---	----------------	-----

 EACH CIRCULAR ELEMENT OF THIS FEATURE, RFS, MUST NOT RUN OUT MORE THAN 0.0005 IN. (0.013 MM) FIM, WITH RESPECT TO THE DATUM ESTABLISHED BY FEATURES A AND B, BOTH RFS.

$\oplus$	$\varnothing$ 0.010 (0.25)	$\textcircled{M}$	A	B	$\textcircled{M}$	C	$\textcircled{M}$
----------	----------------------------	-------------------	---	---	-------------------	---	-------------------

 THE AXIS OF THIS FEATURE, WHEN THIS FEATURE IS AT MMC, MUST BE LOCATED WITHIN 0.010 IN. (0.25 MM) DIAMETER OF THE TRUE (BASIC) LOCATION ESTABLISHED IN RELATION TO THE PRIMARY SURFACE DATUM A, SECONDARY DATUM B AT MMC, AND TERTIARY DATUM C AT MMC.

	$\varnothing$ 0.010 (0.25)	$\textcircled{M}$	A
0.500 (12.7)	$\textcircled{P}$		

 THE AXIS OF THIS FEATURE, WHEN THIS FEATURE IS AT MMC, MUST BE PERPENDICULAR TO DATUM A, RFS, WITHIN A 0.010 IN. (0.25 MM) DIAMETER TOLERANCE ZONE PROJECTED 0.500 IN. (12.7 MM) ABOVE THE SURFACE.

	
---	---

 THE ANGULAR ORIENTATION OF THIS FEATURE NEED NOT BE CONTROLLED WITH RESPECT TO ANY OTHER FEATURE.

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Figure INTRO-1. (Sheet 2 of 2) Geometric Tolerance Symbols

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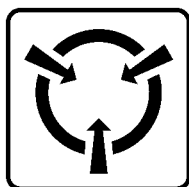
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- (5) The symbols in Figure INTRO-2 are used to identify ESDS and moisture sensitive devices.



ESDS



MOISTURE SENSITIVE

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Figure INTRO-2. Symbols

C. Weights and Measurements

- (1) Measurements, weights, temperatures, dimensions, and other values are expressed in the USMS followed by the appropriate SI metric units in parentheses. Some standard tools or parts such as drills, taps, bolts, nuts, etc. do not have an equivalent.

D. Standard Shop Supplies

- (1) The procedures contained in this manual refer to items which are considered standard shop supplies, and are not listed in the equipment and materials table of the applicable sections. Some examples of these items, which are locally available, are as follows:
- Cotton swabs
 - Tongue depressors
 - Soft-bristled brush
 - Hard-bristled brush
 - Erasers
 - Knife
 - No. 180 and No. 360 sandpaper
 - Deionized water.

2. Customer Support

A. Honeywell Aerospace Online Technical Publications Website

- (1) Go to the Honeywell Online Technical Publications Website at (<https://aerospace.honeywell.com>).
- To download or see publications online
 - To order a publication
 - To tell Honeywell of a possible data error in a publication.

B. Honeywell Aerospace Contact Team

- (1) If you do not have access to the Honeywell Technical Publications Website, or if you need to speak to personnel about non-Technical Publication matters, the Honeywell Aerospace Contact Team gives 24/7 customer service to Air Transport & Regional, Business & General Aviation, and Defense & Space customers around the globe.



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- Telephone: 800-601-3099 (Toll Free U.S.A./Canada)
- Telephone: 602-365-3099 (International).

3. References

A. Honeywell Publications

- (1) This manual is written in accordance with the Honeywell engineering specifications that follow:
 - M4091484, Manufacturing Specification for Soldered Electrical and Electronic Assemblies
 - M4091485, Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies
 - EB7020465, Application and Removal Guidelines for 11A8978, 11A8578, and 11A8878 Moisture Barrier Coatings
 - Refer to Figure INTRO-3 for Specification M4091484. Refer to Figure INTRO-4 for Specification M4091485. Refer to Figure 3-4 for EB7020465.

B. Other Publications

- (1) These publications are standard references:
 - The United States GPO Style Manual (available at <http://www.gpo.gov/fdsys/pkg/GPO-STYLEMANUAL-2008/content-detail.html>)
 - IEEE Std 260.1, Standard Letter Symbols for Units of Measurement (available from the American National Standards Institute at <http://www.ansi.org>)
 - ASME Y14.38, Abbreviations for Use on Drawings and Related Documents (available from the American National Standards Institute at <http://www.ansi.org>)
 - ASME Y14.5, Dimensioning and Tolerancing (available from the American National Standards Institute at <http://www.ansi.org>)
 - ANSI/IEEE Std 91, Graphic Symbols for Logic Functions (available from the American National Standards Institute at <http://www.ansi.org>)
 - CAGE codes and manufacturers' addresses are available at <https://cage.dla.mil>.
 - IEEE 315/ANSI Y32.2, Graphic Symbols for Electrical and Electronics Diagrams (available from the American National Standards Institute at <http://www.ansi.org>)
 - MIL-HDBK-263, Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric) (available from any military standards database)
 - MIL-STD-1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric) (available from any military standards database).
- (2) The publications that follow are joint industry and IPC standards that are referenced in the Honeywell Specifications, M4091484 (Figure INTRO-3) and M4091485 (Figure INTRO-4):
 - IPC/EIA J-STD-001, Requirements for Soldered Electrical and Electronics Assemblies
 - IPC-HDBK-001, Handbook and Guide to Supplement J-STD-001

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- IPC/EIA J-STD-002, Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires
- J-STD-003, Solderability Tests for Printed Boards
- J-STD-004, Requirements for Soldering Fluxes
- J-STD-005, Requirements for Soldering Paste
- J-STD-006, Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications
- IPC/JEDC J-STD-033, Standard for Handling, Packing, Shipping and use of Moisture/Reflow Sensitive Surface Mount Devices
- IPC-T-50, Terms and Definitions for Interconnecting and Packaging Electronic Circuits
- IPC-A-610, Acceptability of Electronic Assemblies
- IPC-7711/7721, current revision, Rework of Electronic Assemblies/Repair and Modification of Printed Boards and Electronic Assemblies
- IPC/WHMA-A-620, Requirements and Acceptance for Cable and Wire Harness Assemblies

4. Acronyms and Abbreviations

A. General

- (1) The abbreviations are used in agreement with ASME Y14.38.
- (2) Acronyms and non-standard abbreviations used in this publication are as follows:

Table INTRO-1. List of Acronyms and Abbreviations

Term	Full Term
ANSI	American National Standards Institute
AO	American Optical
ARINC	Aeronautical Radio, Inc.
ASME	American Society of Mechanical Engineers
ATA	Air Transport Association
AWG	American Wire Gage
BCD	binary coded decimal
CAGE	commercial and government entity
CCA	circuit card assembly
CMM	component maintenance manual
CTE	coefficient of thermal expansion
CCCC	complete customer care center
dB	decibel
DIP	dual inline package
ECA	electronic component assembly
ESD	electrostatic discharge

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Table INTRO-1. List of Acronyms and Abbreviations (Cont)

Term	Full Term
ESDS	electrostatic discharge sensitive
FP	fine pitch
FR	free-running
IC	integrated circuit
ID	inside diameter
IEEE	Institute of Electrical and Electronics Engineers
in-lb	inch-pounds
in-oz	inch-ounces
IPC	illustrated parts catalog
IPL	illustrated parts list
kPa	kilopascal
LCC	leadless chip carrier
LSI	large scale integration
MELF	metalized electrode face
Nm	Newton meter
OD	outside diameter
PLCC	plastic leaded chip carrier
PTH	plated-through hole
PWB	printed wiring board
S.I.	International System of Units
SIP	single inline package
SL	self-locking
SM	surface mount
SMC	surface-mounted component
SMD	surface-mounted device
SMT	surface mount technology
SO	small outline
SOIC	small outline integrated circuit
SOL	small outline large
Std	standard
TBD	to be determined
TBS	to be supplied
THC	through-hole component

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Table INTRO-1. List of Acronyms and Abbreviations (Cont)

Term	Full Term
VHSIC	very high-speed integrated circuits
VLSI	very large scale integration

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Figure INTRO-3. (Sheet 1 of 6) Manufacturing Specification for Soldered Electrical and Electronic Assemblies, M4091484, Rev F (R)

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TITLE: MANUFACTURING SPECIFICATION FOR SOLDERED ELECTRICAL AND ELECTRONIC ASSEMBLIES

1. SCOPE

This specification provides requirements and acceptance criteria for assembling and soldering of printed board assemblies (PBAs), electronic component assemblies (ECAs), and other electrical connections.

2. APPLICABLE DOCUMENTS

2.1 Documents

The following specifications, standards and guidelines, of the issue in effect on date of invitation for bids or request for proposal, form part of this specification to the extent specified herein.

IPC

IPC-T-50	Terms and Definitions for Interconnecting and Packaging Electronic Circuits
IPC-A-610	Acceptability of Electronic Assemblies

HI

M4089108	Manufacturing Specification for Product Identification and Marking Requirement
M4091485	Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies
EB4091488	Miscellaneous Materials
HPS1009	Soldered Electrical and Electronic Assemblies

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Figure INTRO-3. (Sheet 2 of 6) Manufacturing Specification for Soldered Electrical and Electronic Assemblies, M4091484, Rev F (R)

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2.2 Precedence of Documents

When a requirement of an applicable specification is in conflict with one specified herein, the requirement given in this specification shall apply. When a requirement of a Contract, Purchase Order, applicable Drawing or Engineering Bulletin invoked on the Drawing is in conflict with one specified herein, the requirement given on the Contract, Purchase Order, Drawing or Engineering Bulletin shall apply. This specification shall apply for clarification of the intended criteria, contained in accepted Industry Standards and HI soldering requirements. Nothing in this document however supersedes applicable Laws and Regulations.

2.3 Definitions

Terms and definitions unless otherwise specified shall be as stated in IPC-T-50.

2.3.1 Clarification

PBAs may be referred to as Circuit Card Assemblies (CCAs) or Printed Circuit Assemblies (PCAs) in other documentation.

2.3.2 Side A

Side A is the HI designate for the solder source side. The source side is that side of the PB to which solder is applied. The solder source side is normally the secondary side of the PB when wave, dip or drag soldering are used. The solder source side may be the primary side of the PB when hand soldering operations or additive solder processes on surface mount pads are used.

2.3.3 Side B

Side B is the HI designate for solder destination side. The solder destination side is that side of the PB that the solder flows toward. The destination side is normally the primary or top side of the PB when wave, dip or drag soldering are used. The destination side may be the secondary side of the PB when hand soldering operations are conducted.

2.3.4 HI

HI shall be used to reference Honeywell International Inc.

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Figure INTRO-3. (Sheet 3 of 6) Manufacturing Specification for Soldered Electrical and Electronic Assemblies, M4091484, Rev F (R)

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3. REQUIREMENTS

3.1 General

Unless otherwise specifically stated in this section, soldered electrical and electronic assemblies shall be in accordance with HPS1009.

3.2 Materials and Processes

3.2.1 Miscellaneous Materials

Miscellaneous materials specified in EB4091488 may be used as required in addition to the part list, in accordance with applicable instructions, to aid in the component positioning, protection, holding, locating, etc.

3.3 Components

3.3.1 Component Mounting

The components shall be mounted on the PB in accordance with HPS1009 and this specification.

If a boss or seating plane is not integral to the component, a mounting pad may be installed under the component to meet the radial leaded components mounting requirement in HPS1009.

Glass beads may be installed to achieve minimum spacing required for radial leaded capacitors and resistors (2 or 3 leads).

Other optional spacers (water washable, etc.) may be used to facilitate mounting of components to aid in processing.

If drawing does not specify applicable mounting materials, the mounting materials shall be in accordance with EB4091488.

3.3.2 Unclinched Leads, Unsupported Holes

When straight-through leads are used on a single-sided PB, (unsupported holes) the leads shall extend 0.020 inch minimum to 0.060 inch maximum from the surface of the foil.

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Figure INTRO-3. (Sheet 4 of 6) Manufacturing Specification for Soldered Electrical and Electronic Assemblies, M4091484, Rev F (R)

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3.4 Solder Connections - General Requirements

3.4.1 Surface Mount Solder Connection Acceptance Criteria

3.4.1.1 Jumper Wires - Gull Wing.

The Class 3 acceptance criteria of IPC-A-610 shall be used for the addition of wires to Gull Wing components with the following exceptions. If the soldered termination is parallel to the component lead, then the minimum requirement is 50% of "L" or 0.050 inches, whichever is less. The soldered termination may be placed parallel to any of the three edges as long as it is a minimum of 50% of the pad/land length or 0.050 inches, whichever is less and does not violate any other wiring or spacing requirements.

3.4.1.2 Jumper Wires - J-Leads.

The Class 3 acceptance criteria for the addition of wires to J-Leaded components shall be IPC-A-610. The acceptance criteria shall be used with the following exceptions. If the soldered termination is parallel to the component lead, then the minimum requirement is 50% of "L" or 0.050 inches, whichever is less. The soldered termination may be placed parallel to any of the three edges as long as it is a minimum of 50% of the pad/land length or 0.050 inches, whichever is less, and does not violate any other wiring or spacing requirements.

3.4.1.3 Quad Flat Packs (QFPs).

QFPs shall meet all the Class 3 acceptance criteria of IPC-A-610 with one exception. The 160, 208 and 240 pin QFPs need only meet the Class 2 requirements for heel fillets. The target is Class 3 for heel fillets but will except Class 2 if all other Class 3 requirements have been met.

This condition is not desirable but acceptable. Objective evidence shall be available for review to demonstrate that the components were to print, met the solderability requirement and the coplanarity requirement. Documented evidence of the processes and product profile shall be available for review also, prior to initiating any design investigation to alleviate this condition.

3.5 Touch-up and Resoldering (PBAs and Components)

Touch-up or resoldering shall be permitted, if necessary, to only correct defective solder connections (e.g. to remove icicles or solder bridges or to add solder to the conductive circuit and component terminal area). Touch-up and resoldering for cosmetic purposes is not permitted. Reliability shall not be compromised by touch-up.

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Figure INTRO-3. (Sheet 5 of 6) Manufacturing Specification for Soldered Electrical and Electronic Assemblies, M4091484, Rev F (R)

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3.6 Marking

3.6.1 The markings and marking requirements shall be per M4089108.

3.7 Rework and Repair

3.7.1 Rework and repair shall be per M4091485.

4. PACKAGING

Assemblies shall be placed in individual bags or compartmented boxes during transit or storage to prevent contamination, mechanical damage, and/or electrical damage.

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Figure INTRO-3. (Sheet 6 of 6) Manufacturing Specification for Soldered Electrical and Electronic Assemblies, M4091484, Rev F (R)

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Figure INTRO-4. (Sheet 1 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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**TITLE: MANUFACTURING SPECIFICATION FOR REWORK, REPAIR AND/OR
MODIFICATION OF SOLDERED ELECTRICAL AND ELECTRONIC ASSEMBLIES**

1. SCOPE

1.1 INTENT

This Specification covers the requirements and acceptance criteria for the rework, repair and modification of printed board assemblies, electronic component assemblies, electronic components and all other electrical connections to restore the functional capability, appearance and/or uniformity of a defective or damaged assembly to the initial or current design parameters. The techniques used shall not affect the form, fit or function or in any way degrade the assembly to a point of non-compliance to the current design requirements established by the drawing or other fabrication/build specifications.

1.2 PURPOSE

- 1.2.1 This Specification establishes requirements and criteria for reworking, repairing or modifying assemblies per the procedures and guidelines in IPC-7711/21.
- 1.2.2 The assemblies shall be processed, soldered and handled per the requirements of M4091484 and/or IPC/EIA J-STD-001.
- 1.2.3 The acceptability of the reworked assemblies shall be per the criteria established in M4091484 IPC/WHMA-A-620, IPC/EIA J-STD-001 and/or IPC-A-610.
- 1.2.4 The target for acceptability of the repaired or modified assemblies shall be the same as those for reworked assemblies, except other documentation and/or authorization may be needed to establish additional guidelines/requirements and acceptance criteria.
- 1.2.5 This specification shall be used in conjunction with AP-1456 to define Supplier (ECM, MRO and/or OEM) specific requirements that are applicable in the rework, repair and/or modification of printed board assemblies (PBAs).
- 1.2.6 The use of this Specification to flow down requirements to an ECM, MRO and/or OEM is predicated on there being objective evidence, viewable upon request by the OEM, AERO, COO or FAA, of, at a minimum, the criteria that follows:
- Certification that operators were trained to IPC/EIA J-STD-001 by a certified trainer..
 - Certification that inspectors were trained to IPC-A-610 by a certified trainer.
 - There is a documented training program in accordance with IPC-7711/21.
 - There is a documented procedure requiring only trained and certified operators/inspectors shall work on AERO product.

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Figure INTRO-4. (Sheet 2 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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- There are proper handling and storage practices and capabilities in place for all product in process.
 - All designated processes have Process Control Plans and if applicable Variation Reduction Programs and are actively monitored by the ECM, MRO, OEM and AERO ISC using MES and other data tool sets.
 - All designated processes have been approved or are in the process of being approved for inclusion in MSDs, SSPs or this specification.
 - All reflow processes that have been used to rework, repair or modify the assemblies, shall be per their individual product profiles and process parameters.
 - All other soldering processes shall be documented, controlled and monitored.
 - All products has a traveler or ERF and router profile and/or ITA Tag which contains documented rework, repair and modification activities and buy-off data for those procedures.
 - And all changes to materials or processes must have prior written approval from the OEM, AERO, COO or FAA as applicable.
- 1.2.7 Deviations to these requirements that are not already addressed in 1.2.5 shall be per a document of higher order of precedence in accordance with 1.7; through a flow-down requirement via the ISC; or AABUS.
- 1.3 Performance Classification**
- 1.3.1 Printed board assemblies (PBAs) reworked or repaired per this specification shall be in accordance with the soldering acceptance criteria and the parametric definitions for the validation activities to the requirements of M4091484 or, at a minimum, to Class 3 requirements of J-STD-001 and IPC-A-610.
- 1.3.2 Deleted.
- 1.3.3 Deviations to these requirements shall be per a document of higher order of precedence in accordance with 1.7.

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Figure INTRO-4. (Sheet 3 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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1.4 Definition of Terms

Terms and definitions shall be in accordance with IPC-T-50 or as specified herein.

1.4.1 Clarification

Printed board assemblies (PBAs) may be referred to as circuit card assemblies (CCAs) or printed circuit assemblies (PCAs) in other documentation.

1.4.2 Specifications

1.4.2.1 For ease of use, IPC/EIA J-STD-001 will be referred to as J-STD-001. In all cases, unless specifically stated otherwise, any reference to IPC documentation will be for the requirements of Class 3 hardware or the highest reliability classification/rating of that specification.

1.4.2.2 For use in this specification all AERO Manufacturing Specifications will be listed as they appear in other documentation (M4091484, etc.). The reference to or invocation of M4091484 reflects requirements that may or may not be unique to AERO, but at a minimum reflects the requirements for the Aerospace Industry and all the IPC documents referenced in this specification.

1.4.3 IPC

IPC Association Connection Electronic Industries is a trade association in the electronic Interconnect industry.

1.4.4 JEDEC

JEDEC is an acronym for Joint Electronic Device Engineering Council.

1.4.5 ANSI

ANSI is an acronym for American National Standards Institute.

1.4.6 ESD

ESD is an acronym for Electrostatic Discharge Association.

1.4.7 EIA

EIA is an acronym for Electronics Industry Association.

1.4.8 Side A

Side A is the AERO designate for the solder source side. The source side is that side of the PB to which solder is applied. The solder source side is normally the secondary side of the PB when wave, dip or drag soldering is used. The solder source side may be the primary side of the PB when hand soldering operations or additive solder processes on surface mount pads are used.

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Figure INTRO-4. (Sheet 4 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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1.4.9 Side B

Side B is the AERO designate for solder destination side. The solder destination side is that side of the PB that the solder flows toward. The destination is normally the primary or top side of the PB when wave, dip or drag soldering is used. The destination side may be the secondary side of the PB when hand soldering operations are conducted.

1.4.10 AERO

AERO shall be used to designate Honeywell International Inc. and more specifically Aerospace Electronic Systems (AES).

1.4.11 ISC

ISC is the acronym for Integrated Supply Chain.

1.4.12 MRO

MRO shall be used to designate any entity performing maintenance or repair work on systems, components, assemblies or parts where such work or parts must meet regulatory airworthiness requirements.

1.4.13 ERF

ERF is the acronym for Electronic Router File.

1.4.14 ITA

ITA is the acronym for Inspection Test Assembly.

1.4.15 MRB

MRB is the acronym for material review board. It is generally used to mean a formal review of materials or processes to establish acceptability and verifying such via approved signature requirements.

1.4.16 Modification

The revision of the functional capability of a product in order to satisfy new acceptance criteria. Modifications are usually required to incorporate design changes, which can be controlled by drawings, change orders, etc. Modifications shall only be performed when specifically authorized and described in detail on controlled documentation.

1.4.17 Rework

The act of reprocessing non-complying articles, through the use of original or equivalent processing in a manner that assures full compliance of the article with applicable drawings or specifications.

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Figure INTRO-4. (Sheet 5 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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1.4.18 Repair

The act of restoring the functional capability of a defective article in a manner that precludes compliance of the article with applicable drawings or specifications. Repairs are generally changes to an unacceptable end product to make it acceptable in accordance with the original functional requirements. The control of repaired products shall be by means of MRB, or its equivalent. The MRB, with technical support, should define the mutually acceptable repair method to be used and take the action necessary to ensure that all applicable procedures are adhered to.

1.4.19 ECM

ECM is the acronym for Electronic Contract Manufacturer. The term shall be used to refer to all Suppliers who build/rework electronic assemblies for AERO.

1.4.20 COO

COO is the acronym for Current Owner/Operator. The term shall be used for all Airlines or spares provisioning depots.

1.4.21 FAA

FAA shall be used to designate Federal Aviation Authority.

1.4.22 MSD

MSD shall be used to designate publications by the design approval holder that provide acceptable methods, techniques and practices for performing maintenance, preventative maintenance and alterations. They include, but are not limited to maintenance manuals, restoration/overhaul manuals, ICAs, Component Maintenance Manuals, Structural Repair Manuals, service bulletins, letters or other similar information.

1.4.23 SSP

SSP shall be used to designate Standard Shop Practice.

1.4.24 ICA

ICA shall be used to designate instructions for continued airworthiness. They reflect that the information contained in the MSDs are acceptable to the FAA.

1.4.25 MES

MES is an acronym for a Manufacturing Execution System. It is part of the AERO CASper database, but it will function in any equivalent Oracle database system

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Figure INTRO-4. (Sheet 6 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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1.5 Precautions

This specification shall apply for clarification of the intended criteria contained in accepted Industry Standards and AERO requirements. Nothing in this specification however supersedes applicable Laws and Regulations.

1.6 Revision Level Changes

Revision changes to this specification will automatically include the new requirements created by the revision of any or all of the applicable documents. A revision to any of the applicable documents without a revision change to this specification does not mandate an incorporation of those potentially new requirements. Deviations to, or the invocation of those new requirements shall be per a document of higher order of precedence in accordance with 1.7 or AABUS.

1.7 Precedence of Documents

When a requirement of an applicable specification is in conflict with one specified herein, the requirement given in this specification shall apply. When a requirement of a Contract, Purchase Order, Drawing or other AERO Engineering Documents invoked on the Drawing is in conflict with one specified herein, the requirement given on the Contract, Purchase Order, Drawing or Engineering Document shall apply.

The hierarchy of precedence is as follows:

- Contract
- Purchase Order
- Drawing
- Engineering Document
- This Specification
- Reference Documents

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Figure INTRO-4. (Sheet 7 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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2. APPLICABLE DOCUMENTS

2.1 Documents

The following specifications, standards and guidelines of the issue in effect on date of order, invitation for bids or request for proposal, form part of this specification to the extent specified herein.

Joint Industry Standards

IPC/EIA J-STD-001	Requirements for Soldered Electrical and Electronics Assemblies
IPC/JEDEC J-STD-033	Standard for Handling, Packing, Shipping and use of Moisture/Reflow Sensitive Surface Mount Devices
IPC/JEDEC J-STD-020	Moisture/Reflow Sensitivity Classification for Plastic Integrated Circuit Surface Mount Devices
ANSI/ESD-S-20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment

IPC

IPC-T-50	Terms and Definitions for Interconnecting and Packaging Electronic Circuits
IPC-A-610	Acceptability of Electronic Assemblies
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards
IPC-7711/21	Rework, Repair and Modification of Electronic Assemblies
IPC/WHMA-A-620	Requirements and Acceptance for Cable and Wire Harness Assemblies
IPC-HDBK-001	Handbook and Guide to Supplement J-STD-001

AERO

M4091484	Manufacturing Specification for Soldered Electrical and Electronic Assemblies (A09-1100-004, Table Intro-1)
AP-1456	Aerospace Materials Engineering Supplier Agreements (MESAs)

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Figure INTRO-4. (Sheet 8 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3. REQUIREMENTS

3.1 General

The reworking, repairing and/or modifying of the assemblies, component parts, wires and hardware shall be in accordance with the applicable Drawing, Engineering Documentation, IPC-7711/21, J-STD-001, M4091484 and this specification. No damage shall result, nor shall the functionality of the soldered assembly be impaired, by improper assembly practices. The processes shall not degrade the as designed or current functionality of the components, hardware, wires, PBs or PBAs.

- 3.1.1 All assemblies of the same part number shall be reworked, repaired and/or modified such that they are similar in workmanship, appearance, and functional characteristics.
- 3.1.2 All wires, components and assemblies shall still meet the as received condition defined in their individual drawings, after the completion of the rework, repair and/or modification, unless otherwise specified in a document of higher order of precedence in accordance with 1.7.
- 3.1.3 All PBs shall meet the requirements defined in their respective manufacturing specifications after the completion of the rework, repair and/or modification.
 - 3.1.3.1 All controlled impedance PBs shall not be reworked, repaired or modified per this specification until authorization has been established by a formal MRB process if the rework or repair alters or modifies the original/current as designed circuitry.
 - 3.1.3.2 All Teflon or non-FR4 PBs shall not be reworked, repaired or modified per this specification unless so directed by a formal MRB process.
 - 3.1.3.3 All PBs, which have a glass transition temperature of less than 150 degrees C., shall have the rule of six invoked. No one spot on the PB shall be subjected to more than six thermal excursions. One excursion happens each time the PB or localized area on the PB is exposed to heat greater than the glass transition temperature of the laminate. No further rework or repair will be allowed per this specification unless so authorized by a formal MRB process.
- 3.1.4 All processes shall be in compliance with the intent of the applicable ICAs.

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Figure INTRO-4. (Sheet 9 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.2 **Materials and Processes**

The materials and processes used shall be in accordance with the requirements of current engineering documentation, M4091484, J-STD-001 and this specification, unless otherwise specified by a document of higher order of precedence in accordance with 1.7. Any changes to a material or process shall not be allowed without the prior written approval from the OEM, AERO or COO.

3.2.1 **Materials**

3.2.1.1 Flux

3.2.1.1.1 Flux shall be in accordance with the requirements of M4091484 and J-STD-001.

3.2.1.1.2 The use of flux not approved per the requirements of 3.2.1.1.1 shall not be allowed without prior written approval from the OEM, AERO or COO or so stated in a document of higher order of precedence in accordance with 1.7.

3.2.1.2 Solder

3.2.1.2.1 The solder alloy shall be in accordance with the requirements of M4091484 and J-STD-001.

3.2.1.2.2 Flux that is part of Flux-cored solder wire shall meet the requirements of 3.2.1.1.

3.2.1.2.3 Other alloys may be used if they meet all other conditions of M4091484 and J-STD-001 and objective evidence of this is available for review.

3.2.1.2.4 The use of solder not approved per the requirements of 3.2.1.2.1 shall be not allowed without prior written approval from the OEM, AERO or COO or so stated in a document of higher order of precedence in accordance with 1.7.

3.2.1.3 Solder Paste

3.2.1.3.1 The solder paste shall be in accordance with the requirements of M4091484 and J-STD-001.

3.2.1.3.2 The paste shall also be in accordance with 3.2.1.1 and 3.2.1.2.

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Figure INTRO-4. (Sheet 10 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.2.1.4 Processing Materials

PBs, parts, wires and markings shall not be damaged by any of the processing materials used. Materials, such as cleaning solvents, temporary maskants and soluble spacers, shall cause no degradation of the finished assembly. The compatibility of the processing materials with the parts being processed shall be determined by testing, periodic sampling, and quality audit. Objective evidence of this compatibility shall be maintained and available for review by the OEM, AERO, COO or FAA. The approved materials shall be per the requirements of M4091484, IPC-7711/21, J-STD-001 and IPC/WHMA-A-620.

3.2.1.5 Miscellaneous Materials

Miscellaneous materials as specified per the requirements of M4091484, IPC-7711/21, J-STD-001 and IPC/WHMA-A-620 may be used in addition to those items listed on the drawing as required, in accordance with applicable instructions, to aid in the component positioning, protection, holding, locating, etc.

3.2.2 Approved Processes

Only processes specified in M4091484, IPC-7711/21, J-STD-001, IPC/WHMA-A-620 and this specification shall be used for the rework, repair and/or modification of PBAs and other electrical connections. Process control methodologies shall be developed and implemented to support the requirements of this specification. IPC-HDBK-001 may be used to clarify or further define the requirements. Objective evidence of these processes and controls shall be made available to the OEM, AERO, COO or FAA upon request. Once a process has been qualified by the OEM, AERO, COO or FAA no major changes are allowed to that process without prior written approval from the applicable authorizing agency.

3.2.2.1 Manual/Hand (Nonreflow) Soldering

All hand soldering shall be in accordance with the requirements of M4091484, J-STD-001, IPC/WHMA-A-620 and this specification. Only trained and certified operators are allowed to perform hand-soldering operations using controlled temperature soldering irons. Objective evidence of the training and certification of operators, as well as, the care and maintenance of the solder stations shall be made available to the OEM, AERO, COO or FAA upon request.

The approved materials for this process shall meet the requirements of 3.2.1. The use of other materials shall not be allowed without prior written approval from the OEM, AERO or COO or so stated in a document of higher order of precedence in accordance with 1.7.

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Figure INTRO-4. (Sheet 11 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.2.2.2 Machine (Nonreflow) Soldering

The soldering process shall be in accordance with the requirements of M4091484, J-STD-001 and this specification. For each assembly reworked, repaired and/or modified, the ECM or MRO shall establish an individual product profile, if one does not already exist, which meets the minimum set of criteria established in M4091484, J-STD-001 and this specification. Objective evidence of this must exist and be maintained by the ECM or MRO and made available to the OEM, AERO, COO or FAA upon request. Machine soldering should be employed for reworking, repairing and/or modifying assemblies where automatic mass soldering of lead terminations is necessary. This may include flow soldering, selective soldering or soldering with a solder bath.

3.2.2.2.1 The solder for this process shall meet the requirements of 3.2.1.2.

3.2.2.2.2 The flux for this process shall meet the requirements of 3.2.1.1

3.2.2.3 Machine (Reflow) Soldering

The soldering process shall be in accordance with the requirements of M4091484, J-STD-001 and this specification. For each assembly reworked, repaired and/or modified, the ECM or MRO shall establish an individual product profile, if one does not already exist, which meets the minimum set of criteria established in M4091484, J-STD-001 and this specification. Objective evidence of this must exist and be maintained by the ECM or MRO and made available to the OEM, AERO, COO or FAA upon request. Because of the intensive nature of this process, all alternatives should be explored before implementation.

3.2.2.3.1 The solder paste for this process shall meet the requirements of 3.2.1.3.

3.2.2.4 Manual (Reflow) Soldering

A hot air reflow pencil may be used if all other requirements of 3.2.2.3 have been met and objective evidence of this is available for review.

3.3 Components and PBs

3.3.1 Component Preparation

PBs and components shall meet the requirements of M4091484 and J-STD-001.

3.3.2 Solderability

Electronic/mechanical components, wires and PBs to be soldered shall meet the solderability requirements of M4091484, J-STD-001 and IPC/WHMA-A-620 or equivalent. Prior to acceptance of parts for storage or use, the ECM or MRO shall ensure that the parts to be soldered have been solderability tested in accordance with a sampling plan and conform to the requirements of the applicable solderability specifications. If a pre-tinning and inspection operation is performed as part of the documented rework, repair and/or modification process, that operation may be used in lieu of solderability testing (see 3.3.2.2).

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Figure INTRO-4. (Sheet 12 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.3.2.1 Moisture and Environmental Controls

All components and PBs shall be stored and handled per IPC/JEDEC J-STD-033 to maintain solderability, cleanliness and acceptable levels of moisture absorption. Verification that the PBs or moisture sensitive parts are acceptable for use shall be established prior to subsequent processing. All classification and processing shall be in accordance with the requirements of IPC/JEDEC J-STD-020

3.3.2.2 Solderability Maintenance

The ECM or MRO shall ensure that all components, parts, leads, wiring, terminals and PBs that have met the requirements of 3.3.2 are solderable at the start of hand and/or machine soldering operations. Any components failing to meet this requirement shall be solder coated with solder which meets the requirements of 3.2.1.2 and retested to the requirements of M4091484, J-STD-001 and IPC/WHMA-A-620.

3.3.3 Component Mounting

The components shall be mounted on the PB in accordance with the requirements of M4091484, IPC-7711/21, J-STD-001, IPC/WHMA-A-620 and this specification.

3.3.3.1 Components shall be mounted such that any subsequent removal shall not damage nor cause removal of any other component. Components shall be mounted as near as their construction will permit to the base laminate of the PB, unless otherwise specified.

3.3.3.2 All parts dissipating one watt or more shall be mounted so that the body of the part is not in direct contact with the PB laminate surface unless a clamp or a thermal plane, or both, is used.

3.3.3.3 Components, which weigh 7 or more grams per lead, or have unique (large) body to lead diameter ratios, shall be bonded or mechanically restrained to prevent damage during vibration. The drawing or other engineering documentation shall state the appropriate methodology.

3.3.3.4 Components referenced as "heat sensitive" on the drawing, or components, which may suffer damage from heat as a result of processing, shall be protected against such damage.

3.3.3.5 Components referenced as "static sensitive" or "ESD sensitive" on the Engineering drawings; components which may suffer damage from ESD as a result of processing; and all semiconductor devices shall be stored, handled and processed per the requirements of ANSI/ESD-S-20.20, M4091484, J-STD-001 and IPC/WHMA-A-620.

3.3.3.6 Radial leaded components (3 thru 10), shall not be mounted flush to the PB circuitry. They must be installed 0.010 minimum from the base laminate.

3.3.3.7 Other optional spacers (water washable, etc.) may be used to facilitate mounting of components to aid in processing. The approved materials shall be in accordance with the requirements of M4091484, IPC-7711/21, J-STD-001 and IPC/WHMA-A-620.

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Figure INTRO-4. (Sheet 13 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.3.3.8 Radial leaded capacitors and resistors (2 or 3 leads), which have glass beads required by the drawing, do not require them after the soldering process if the 0.010 minimum spacing is maintained.

3.3.4 Unclinched Leads, Unsupported Holes

When straight-through leads are used in conjunction with single-sided PBs (unsupported holes), the leads shall extend 0.020 inch minimum to 0.060 maximum from the surface of the foil. Exposed copper is permissible on trimmed leads.

3.3.5 Unclinched Leads, Supported Holes (PTHs)

When unclinched leads are used in conjunction with plated-through holes, the lead shall have a maximum protrusion of 0.060 inch from base laminate. Minimum requirement is that the lead shall be flush to circuitry and discernible in the solder connection. If the lead is not clearly discernible on side A, but has an acceptable solder connection when viewed from side B, it shall not require additional rework, and shall be accepted on the basis of the side B connection. Exposed copper is permissible on trimmed leads.

3.3.6 Clinched Leads

Clinched leads shall be bent as close as practical onto the terminal area, or terminal area and conductor, so that contact is made on the side of the PB opposite the component. The clinched lead shall not extend beyond the edge of the terminal area by more than 0.030 inch, providing a minimum 0.015 inch clearance to adjacent runs is maintained. After soldering the angle between the clinched lead and the plane of the PB shall not exceed 30 degrees.

3.4 Wires

All wires and lead assemblies to be soldered per this specification shall also meet the requirements of M4091484 and IPC/WHMA-A-620.

3.5 Cleanliness Requirements

Cleaning, if required, shall be per the applicable requirements of M4091484, IPC-7711/21, J-STD-001 and IPC/WHMA-A-620.

3.5.1 Verification

Cleanliness of PBAs shall be checked in accordance with resistivity of solvent extract per the requirements of M4091484 and J-STD-001.

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Figure INTRO-4. (Sheet 14 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.6 Solder Connections

3.6.1 General Requirements

Solder connections shall be free from scratches, roughness, sharp edges, dullness, looseness, or blistering. There shall be no evidence of dirt, chips, or other foreign matter. Solder connections shall indicate evidence of wetting and adherence where the solder blends to the soldered surface forming a small contact angle. Smooth clean voids or unevenness on the surface of the solder connection shall be acceptable. A line of demarcation or transition zone where applied solder blends with the solder coating, solder plate, or other surfaces shall be acceptable provided wetting is evident. The general outline of leads at termination points shall be visible.

3.6.2 Acceptance Criteria

The acceptance criteria for all solder connections shall be in accordance with the requirements of M4091484, J-STD-001, IPC-A-610 and IPC/W HMA-A-620, unless otherwise specified in a document of higher order of precedence in accordance with 1.7.

3.6.3 Surface Mount Acceptance Criteria

All surface mount acceptance criteria shall be in accordance with the requirements of M4091484, J-STD-001 and IPC-A-610. There is conditional acceptance criteria contained in M4091484 and IPC-A-610, but the goal of procedures defined in this specification is to meet the target requirements of IPC-A-610, unless otherwise specified in a document of higher order of precedence in accordance with 1.7.

3.7 Touch-up/Resoldering

Touch-up or resoldering shall be permitted, if necessary, only to correct defective solder connections (i.e. to remove icicles or solder bridges or to add solder to the conductive circuit and component terminal area). Touch-up and resoldering for cosmetic purposes is not permitted. Reliability shall not be compromised by touch-up.

3.7.1 Flow Solder

Flow soldering per 3.2.2.2 is the preferred method for resoldering PBAs which have many PTH areas needing touch-up.

3.7.2 Hand Soldering

Hand soldering per 3.2.2.1 may be used to touch-up or resolder PBAs. Only individuals who have demonstrated the highest proficiency in soldering should be used to touch-up or resolder components on PBAs. The damage that may occur to the PB or Components as a result of improper hand soldering techniques will potentially reduce product quality and long term reliability.

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Figure INTRO-4. (Sheet 15 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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3.7.3 Other Soldering

Selective soldering or use of a solder bath per 3.2.2.2 may be used to touch-up components, wires and other electrical connections if so directed by appropriate documentation (MSDs, SSPs, etc.).

3.7.4 Fluxing

Surfaces to be soldered shall be coated with flux that conforms to 3.2.1.1.

3.7.5 Acceptance Criteria

All solder connections that have been formed by touch-up or resoldering shall be in accordance with the acceptance criteria defined in 3.6.1, 3.6.2 and 3.6.3.

3.7.6 Cleaning

Cleaning after touch-up or re-soldering shall be in accordance with the requirements of 3.5.

3.8 Marking

3.8.1 The markings and marking acceptance criteria shall be in accordance with the requirements of M4091484 and J-STD-001.

3.8.2 The marking shall be sharply defined and legible, and in no way degrade the electrical or physical requirements of the PBA. Marking shall be applied to the laminate surface or on approved labels, unless otherwise specified on a document of higher order of precedence in accordance with 1.7.

3.9 Rework and Repair

3.9.1 Rework and repair shall be initiated, completed and dispositioned in accordance with the requirements of M4091484 and J-STD-001.

3.9.2 Rework and repair shall be in accordance with the requirements of IPC-7711/21 and this specification.

3.9.3 Rework and repair shall be in compliance/alignment with the requirements of the OEM, AERO, COO, MRO and FAA as defined in the applicable MSDs, SSPs and ICAs.

3.9.4 Minor corrections required as a result of processing during rework or repair shall be permitted on assemblies provided the techniques used do not in any way degrade the assembly below the requirements of the drawing, this specification or applicable ICAs.

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Figure INTRO-4. (Sheet 16 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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4. QUALITY ASSURANCE PROVISIONS

Sufficient inspection, testing and process control shall be maintained to insure that the finished product meets the requirements of this specification and other applicable Engineering/Regulatory documentation. Required tests shall be performed on the PBAs, or as applicable, on specified test specimens processed in accordance with the rework, repair and/or modification procedures.

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Figure INTRO-4. (Sheet 17 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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5. STORAGE AND HANDLING

5.1 The site/facility that is doing the rework/repair shall have an established storage and handling procedure which insures at a minimum the following:

- Ample protection of the assemblies/components against damage during rework and repair.
- Use of individual bags and/or compartmented boxes during transit to prevent contamination, mechanical damage, and/or electrical damage.
- Use of proper packaging during storage to prevent contamination, mechanical damage, and/or electrical damage.
- Use of proper packaging that is compliant with the environmental storage conditions (controlled atmosphere, relative humidity, etc.).
- Use of proper packaging that is compliant with the requirements of ANSI/ESD-S-20.20.
- Use of proper packaging that is compliant with the requirements of IPC/JEDEC J-STD-033.

5.2 Additional packaging requirements shall be established by the OEM, AERO and/or COO.

5.3 Deviations to these requirements shall be in accordance with 1.2.7.

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Figure INTRO-4. (Sheet 18 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

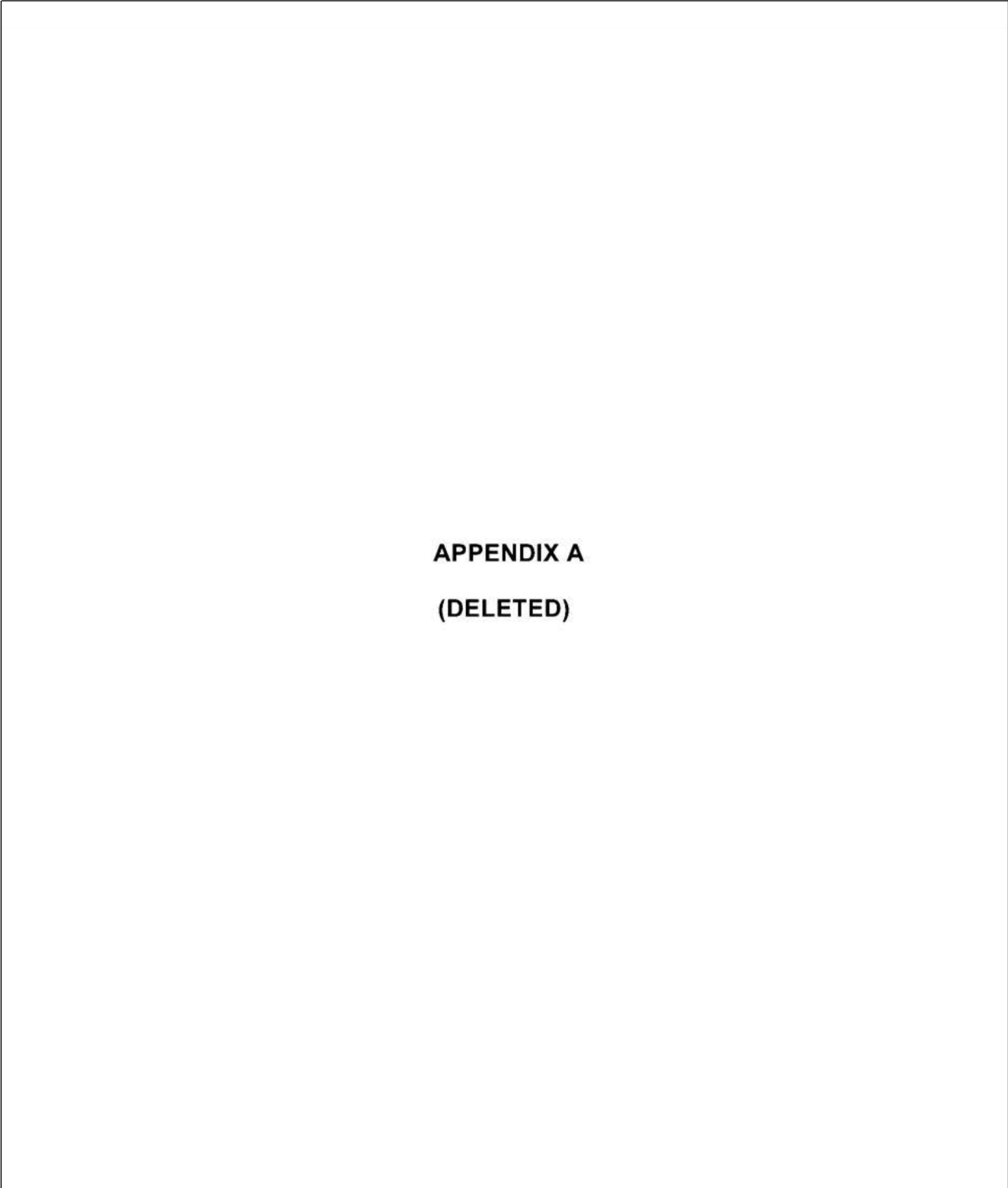
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APPENDIX A
(DELETED)

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Figure INTRO-4. (Sheet 19 of 19) Manufacturing Specification for Rework, Repair and/or Modification of Soldered Electrical and Electronic Assemblies, M4091485, Rev A (R)

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SECTION 1 – PERSONAL SAFETY

1. Overview

A. General

- (1) This section covers shop practices for personal safety in the shop environment.

B. Equipment and Materials

- (1) Refer to Table 1-1 for equipment.
(2) No materials are necessary.
(3) Equivalent alternatives are permitted for equipment.

Table 1-1. Equipment for Personal Safety

Item	Description	Source
Eyeware, protective	Polycarbonate lenses, 54 or 58 mm diameter clear or gray lenses, side shields and brow guards (ANSI Z87.1-1989 Standard) - American Optical (AO). Refer to Table 1-2 for AO or WWG number.	Commercially available
Glasses and goggles, laser vision	Maximum light transmission, withstands a direct hit from a specific laser for 10 seconds or 100 pulses; glasses: 110° field of vision, goggles: 120° field of vision; glasses provide sideshields and eyebrow protectors; goggles fit over personal eyeglasses, and provide UV stabilizers, and top and side air vents. Refer to Table 1-3 for LaserVision number.	Commercially available
Goggles, impact	Top and bottom venting, soft pliable nonglare frame, elastic head band, fits over eyeglasses (ANSI Z87.1-1989) - Uvex No. S372	Commercially available
Goggles, chemical	Top and bottom adjustable venting, soft PVC frame, Uvex4-c coated polycarbonate coated lenses to provide antifog, antistatic dust, and UV ray protection, elastic head band, fits over eyeglasses (ANSI Z87.1-1989) - Uvex No. S375	Commercially available
Goggles, welding	Soft vinyl frames, indirect ventilation, fits over eyeglasses, 2 X 4 in. shade, five lenses (ANSI Z87.1-1989) - Sellstrom No. 86550	Commercially available

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Table 1-1. Equipment for Personal Safety (Cont)

Item	Description	Source
Helmet, welding	Thermoplastic resin, drop-down ratchet headgear, front loading no-gasket Sel-snap lenses retention system, 2 X 4.5 in. lift front plate retainer, includes No. 10 shade plate (ANSI Z87.1-1989) - Sellstrom No. 2930110	Commercially available
Plates, replacement	Polycarbonate, impact resistant, 2 X 4.5 in., No. 10 shade (ANSI Z87.1-1989) - Sellstrom No. 16610	Commercially available
Shield, face	Acetate (impact and scratch resistant), propionate (impact, scratch, and water resistant), polycarbonate (impact, water, heat, and common chemical resistant), wire mesh (molten-metal splashes), when worn with safety glasses, all face shields in Table 1-4 meet ANSI Z87.1-1989, pinlock or ratchet headgear	Commercially available

Table 1-2. Protective Eyewear

Frame Color	54 mm Clear Lenses		58 mm Clear Lenses		54 mm Gray Lenses		58 mm Gray Lenses	
	AO No.	W.W.G. No.	AO No.	W.W.G. No.	AO No.	W.W.G. No.	AO No.	W.W.G. No.
Brown	90090-54	4T844	90900-58	4T854	90905-54	4T849	90905-58	4T859
Slate	90901-54	4T845	90901-58	4T855	90906-54	4T850	90906-58	4T860
Red	90903-54	4T846	90903-58	4T856	90908-54	4T851	90908-58	4T861
Blue	90902-54	4T847	90902-58	4T857	90907-54	4T852	90907-58	4T862
Purple	90904-54	4T848	90904-58	4T858	90909-54	4T853	90909-58	4T863
NOTE: W.W.G. is CAGE: 0ZPR9.								

Table 1-3. Laser Vision Glasses and Goggles

Glasses No.	Goggles No.	Type	Wavelength (nm)	Optical Density	Lumens Transfer
Narrowband Spectrum					
RA-11248	RA-11255	Neodymium-YAG	1050-1064	5.5	82%
RA-11249	RA-11256	Excimer	193-380	6+	90%

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Table 1-3. Laser Vision Glasses and Goggles (Cont)

Glasses No.	Goggles No.	Type	Wavelength (nm)	Optical Density	Lumens Transfer
RA-11250	RA-11257	Double YAG, --- Argon	532 --- 458-514.5	8+	35%
RA-11251	RA-11258	Carbon Dioxide	10,600	10+	90%
Broadband Spectrum					
RA-11252	RA-11259	Excimer --- Helium Neon --- Diode/Gallium --- Arsenide --- Neodymium-YAG --- Carbon Dioxide	193-310 --- 633 --- 750-1050 --- --- 1064 --- 10,600	6+ --- 1-2 --- 6+ --- --- 8+ --- 5	55%
RA-11253	RA-11260	Diode --- Neodymium-YAG --- Erbium/Holmium YAG --- Carbon Monoxide/ Carbon Dioxide	900-1050 --- 1050-1400 --- 1400-2200 --- 5000/ 10,600	4+ --- 6+ --- --- 5+	72%
RA-11254	RA-11261	Neodymium-YAG --- Double Harmonic YAG --- Excimer and Argon	1050-1064 --- --- 193-532	8+ --- --- 8+	27%
NOTE: If any laser eyewear other than what is shown is necessary, send for the laser safety eyewear brochure, Catalog No. RA-8932.					

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Table 1-4. Face Shields

Complete Shield Catalog No.	Extra Window Catalog No.	Shield Color	Shield Size (WxLxThk) (in.)	Shield Sweatband Material	Shield Crown	
					Height (in.)	Material
Acetate Shields/Pinlock Headgear						
5481T28	5481T32	Clear	8x12x0.040	--	3.5	Opaque Plastic
5481T35	5481T34	Dark Green	8x12x0.040	--	3.5	Opaque Plastic
5481T27	5481T31	Clear	8x16x0.040	--	3.5	Opaque Plastic
5481T39	5481T33	Dark Green	8x16x0.040	--	3.5	Opaque Plastic
Acetate Shields/Ratchet Headgear						
10335T31	10335T34	Clear	8x16x0.040	Vinyl	3.0	Poly-Carbonate
10335T32	10335T35	Dark Green	8x16x0.040	Vinyl	3.0	Poly-Carbonate
Propionate Shields/Ratchet Headgear						
56505T1	56505T11	Clear	8x13x0.060	Vinyl	3.5	Opaque Plastic
56505T2	56505T21	Dark Green	8x13x0.060	Vinyl	3.5	Opaque Plastic
5488T41	5488T44	Clear	8x15.5x0.055	Foam	4.0	Opaque Plastic
5488T51	5488T54	Medium Green	8x15.5x0.055	Foam	4.0	Opaque Plastic
5488T52	5488T55	Dark Green	8x15.5x0.055	Foam	4.0	Opaque Plastic
5488T81	5488T44	Clear	8x15.5x0.055	Foam	7.0	Opaque Plastic
5488T82	5488T54	Medium Green	8x15.5x0.055	Foam	7.0	Opaque Plastic
5488T83	5488T55	Dark Green	8x15.5x0.055	Foam	7.0	Opaque Plastic
Polycarbonate Shields/Ratchet Headgear						
56505T3	56505T31	Clear	8x13x0.060	Vinyl	3.5	Opaque Plastic
56505T4	56505T41	Dark Green	8x13x0.060	Vinyl	3.5	Opaque Plastic

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Table 1-4. Face Shields (Cont)

Complete Shield Catalog No.	Extra Window Catalog No.	Shield Color	Shield Size (WxLxThk) (in.)	Shield Sweatband Material	Shield Crown	
					Height (in.)	Material
Wire Mesh Shields/Ratchet Headgear						
10335T33	5488T36	--	8x16	Vinyl	3.0	Opaque Plastic
5488T61	5488T62	--	8x15.5	Vinyl	4.0	Opaque Plastic
5488T71	5488T62	--	8x15.5	Vinyl	7.0	Opaque Plastic
Acetate Shields/Ratchet Headgear with Crown and Chin Guard						
5482T23	5482T25	Clear	7x19x0.040	Vinyl	3.5	Opaque Plastic
5482T24	5482T26	Dark Green	7x19x0.040	Vinyl	3.5	Opaque Plastic
10495T51	10495T57	Clear	7x16.75x0.04	Vinyl	3.0	Poly-Carbonate
10495T52	10495T58	Dark Green	7x16.75x0.04	Vinyl	3.0	Poly-Carbonate

2. Details

A. Eye Protection for Different Environments

- (1) Table 1-5 gives a list of different environments in which eye protection is necessary, and it gives the type of protection that must be used.

Table 1-5. Eye Protection for Different Environments

Location/Operation	Eye Protection	Comments
All machine shops	Protective eyewear or impact goggles	Make sure the side shields and brow guards are attached.
All drill rooms	Protective eyewear or impact goggles	Make sure the side shields and brow guards are attached on the protective eyewear.
Laser laboratory and assembly areas	Laser eyewear	WARNING: TO PREVENT EYE DAMAGE, CHECK WITH YOUR LASER SAFETY OFFICER TO MAKE SURE WHAT TYPE OF GLASSES SHOULD BE USED WITH THE LASERS BEING USED.
Gas, arc, or spot welding shop(s)	Welding goggles or helmet	

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Table 1-5. Eye Protection for Different Environments (Cont)

Location/Operation	Eye Protection	Comments
Heat, smoke, vapor, or fumes	Face shield and chemical goggles	WARNING: THESE GOGGLES ARE FOR PROTECTION OF THE EYES ONLY AND SHOULD BE USED WITH SOME FORM OF FACE OR SKIN PROTECTION.
Grinding or chip producing machinery	Protective eyewear or impact goggles	Make sure the side shields and brow guards are attached on the protective eyewear.
Chemicals: Solvents, adhesives, paints, etc.	Face shield and chemical goggles	WARNING: THESE GOGGLES AND FACE SHIELD ARE FOR EYE AND FACE PROTECTION ONLY AND SHOULD BE USED WITH SOME FORM OF SKIN PROTECTION.
Compressed gases	Face shield	---
Soldering pot or seal-up operation	Wire mesh face shield	The wire mesh face shield provides good protection from product and heat, as well as good air circulation.
Snipping or lead trimming	Protective eyewear or impact goggles	Make sure the side shields and brow guards are attached on the protective eyewear.
Belt sanding	Protective eyewear, impact goggles, or face shield	Make sure the side shields and brow guards are attached on the protective eyewear.
Woodworking	Protective eyewear, impact goggles, or face shield	Make sure the side shields and brow guards are attached on the protective eyewear.
Plating and dipping operations	Face shield and chemical goggles	WARNING: THESE GOGGLES AND FACE SHIELD ARE FOR EYE AND FACE PROTECTION ONLY AND SHOULD BE USED WITH SOME FORM OF SKIN PROTECTION.
Degreasing or cleaning operations	Face shield and chemical goggles	WARNING: THESE GOGGLES AND FACE SHIELD ARE FOR EYE AND FACE PROTECTION ONLY AND SHOULD BE USED WITH SOME FORM OF SKIN PROTECTION.
Cathode ray tube testing	Face shield and impact goggles	Both forms of protection can be worn together to protect eyes and face.

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Table 1-5. Eye Protection for Different Environments (Cont)

Location/Operation	Eye Protection	Comments
Handling or transferring of chemicals	Face shield and chemical goggles	WARNING: THESE GOGGLES AND FACE SHIELD ARE FOR EYE AND FACE PROTECTION ONLY AND SHOULD BE USED WITH SOME FORM OF SKIN PROTECTION.
Electrical component testing	Face shield and chemical goggles	Both forms of protection can be worn together to protect eyes and face.

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SECTION 2 – EQUIPMENT SAFETY AND HANDLING

1. Overview

A. General

- (1) This section gives data on the safety and handling of equipment and materials in order to prevent an electrostatic discharge (ESD) event.

B. Equipment and Materials

- (1) Refer to Table 2-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 2-2 for materials.
(3) Equivalent alternatives are permitted for equipment and materials.

Table 2-1. Equipment for Equipment Safety and Handling

Item	Description	Source
Air blower	Ionizing — 3 M Model 909	Commercially available
Air gun, ionizing	Simpco Model ES2A4	Commercially available
Bag, plastic (ESD protection)	2, 4, 6 mil thick — Honeywell Specification P8506536	Commercially available
Bag, static shielding	Extended shelf life	Commercially available
Bag, static shielding	Limited shelf life	Commercially available
Box, tote	Divided, electrically conductive, carbon impregnated conductive component, wall thickness = 1.25-in. (33 cm), 1.25-in. (2.6 cm) side wall slot spacing, meets EIA-541 with cover installed (Faraday cage) — 3M PN as shown in Table 2-3	Commercially available
Cart, static-sensitive (ground strap from cart to floor)		Commercially available
Clips, shunt,	PWB, antistatic, polyolefin, carbon-loaded — 3M PN 5020, Velostat	Commercially available
Cover, connector, circular	Conductive polyethylene composite, permanently volume conductive, carbon black particulate free, noncorrosive, low outgassing — 3M PN and size in Table 2-4	Commercially available

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Table 2-1. Equipment for Equipment Safety and Handling (Cont)

Item	Description	Source
Cover, connector, D-type	Subminiature, conductive polyethylene composite, permanently volume conductive, carbon black particulate free, noncorrosive, low outgassing — 3M PN and size in Table 2-5	Commercially available
Cover, tote, insert	Fits inside ridge of tote box, Velostat conductive material, makes a Faraday cage when used with conductive tote box — 3M PN in Table 2-6	Commercially available
Cover, tote, snap-on	Snaps over ridge of tote box, Velostat conductive material, makes a Faraday cage when used with conductive tote box — 3M PN in Table 2-7	Commercially available
Dividers	Slip-in, conductive Velostat, locking dividers — 3M PN in Table 2-8	Commercially available
Floor mat, conductive	3M 8200 series	Commercially available
Gloves, ESD		Commercially available
Labels, caution, ESD	2 x 3-In., BLK on YEL, Fasson R-130 or 3M 467 adhesive — Honeywell Specification P8254385-18	Commercially available
Strap, ground (ESD)	Spiedel Fred Style, 5-ft accordion cord — Small, 3M PN 2245; Medium, 3M PN 2246; Large, 3M PN 2247	Commercially available
Strap, shoe grounding (ESD)	1 MΩ, No. CP711, Charles Waters 1 MΩ, 3M PN 2045	Commercially available
Strap, wrist (ESD)	1 MΩ, 3M PN 2064	Commercially available
Floor treatment, static	Statguard	Commercially available
Floor treatment, static sensitive	Staticide	Commercially available
Flooring, static conductive	VPI vinyl - conductible	Commercially available
Floor strap tester		Commercially available
Meter, electrostatic	3M PN 718	Commercially available
Monitor, workstation	Continuous — 3M PN 720	Commercially available
Table mat, static control	3M PN 8210	Commercially available
Tabletop, conductive	3M PN 1872	Commercially available
Work surface, conductive	Micastat laminate	Commercially available

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Table 2-2. Materials for Equipment Safety and Handling

Item	Description	Source
60A9476	Finger cots, black, rolled, antistatic, 3 mils thick	Commercially available

Table 2-3. Tote Boxes

3M PN	Length in. (cm)	Width in. (cm)	Depth in. (cm)
4415A	9.125 (23.2)	6.625 (16.8)	6.0 (15.2)
4423A	14.375 (36.5)	9.125 (23.2)	3.5 (8.9)
4425A	14.75 (37.5)	9.125 (23.2)	6.0 (15.2)
4428A	14.75 (37.5)	9.125 (23.2)	8.0 (20.3)
4432A	20.25 (51.4)	15.25 (38.7)	12.0 (30.5)
4435A	20.875 (53.0)	15.75 (40.0)	5.0 (12.7)
4438A	20.875 (53.0)	15.75 (40.0)	8.0 (20.3)

Table 2-4. Connector Covers (Circular)

3M PN 4270-	Dimensions (in.) (MS90376)			
	Diameter of Face	Body Length	Body ID	Body OD
4R	0.670	0.500	0.250	0.336
5R	0.670	0.500	0.313	0.99
6R	0.670	0.500	0.375	0.461
8Y	0.670	0.625	0.413	0.483
8R	0.740	0.500	0.480	0.540
9R	0.750	0.500	0.500	0.586
10Y	0.750	0.625	0.530	0.595
10R	0.840	0.500	0.605	0.665
12Y	0.860	0.625	0.655	0.715
12R	0.970	0.500	0.720	0.775

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Table 2-4. Connector Covers (Circular) (Cont)

3M PN 4270-	Dimensions (in.) (MS90376)			
	Diameter of Face	Body Length	Body ID	Body OD
14Y	1.031	0.625	0.785	0.845
14R	1.125	0.500	0.850	0.905
16Y	1.125	0.500	0.893	0.963
16R	1.220	0.500	0.973	1.035
18Y	1.250	0.625	1.028	1.088
18R	1.330	0.562	1.093	1.155
19R	1.400	0.562	1.125	1.213
20Y	1.406	0.625	1.150	1.215
20R	1.465	0.562	1.231	1.301
22Y	1.500	0.625	1.270	1.340
22R	1.590	0.562	1.340	1.410
24Y	1.640	0.625	1.390	1.460
24R	1.700	0.562	1.463	1.533
25Y	1.610	0.625	1.540	1.580
28Y	1.875	0.625	1.645	1.718
28R	1.950	0.562	1.715	1.790
32Y	2.125	0.625	1.890	1.970
32R	2.220	0.562	1.965	2.040
36Y	2.340	0.625	2.140	2.210
36R	2.435	0.600	2.215	2.290
40Y	2.600	0.625	2.380	2.450
40R	2.660	0.600	2.440	2.530
44Y	2.875	0.625	2.630	2.700
44R	2.960	0.600	2.720	2.812
48Y	3.125	0.625	2.880	2.950
48R	3.225	0.600	2.960	3.050
NOTE: ID = inside diameter; OD = outside diameter				

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Table 2-5. Connector Covers (D-Type)

3M PN 4270-	Dimensions (in.)							
	Barrel ID Width	Barrel OD Width	Face Width	Barrel OD Height	Barrel ID Height	Height of Face	Barrel Length (w/face thickness)	Barrel Length (from back of face)
50P	2.112	2.179	2.279	0.636	0.536	0.469	0.280	0.249
50S	2.049	2.116	2.216	0.574	0.474	0.407	0.280	0.249
37P	2.216	2.283	2.383	0.530	0.430	0.363	0.280	0.249
37S	2.143	2.210	2.310	0.462	0.362	0.259	0.280	0.249
25P	1.568	1.635	1.735	0.530	0.430	0.363	0.280	0.249
25S	1.495	1.562	1.662	0.462	0.362	0.295	0.280	0.249
15P	1.040	1.107	1.177	0.512	0.436	0.369	0.280	0.249
15S	0.955	1.022	1.122	0.462	0.362	0.295	0.280	0.249
9P	0.682	0.775	0.849	0.512	0.434	0.367	0.280	0.249
9S	0.627	0.694	0.794	0.462	0.362	0.295	0.280	0.249
NOTE: ID = inside diameter; OD = outside diameter								

Table 2-6. Tote Box Covers (Insert)

3M PN	Mating Tote Box
4225	4423A, 4425A, 4428A
4235	4432A, 4435A, 4438A
4236A	4432A, 4435A, 4438A
4215	4415A

Table 2-7. Tote Box Covers (Snap-On)

3M PN	Mating Tote Box
4252A	4423A, 4425A, 4428A
4253A	4432A, 4435A, 4438A
4254A	4432A, 4435A, 4438A
4251	4415A

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Table 2-8. Tote Box Dividers

3M PN	Fits Tote Box No.	Function	Product No.	Fits Tote Box No.	Function
4321	4415A	Length	4328A	4435A	Length
	4425A	Width			
4322	4415A	Width	4329	4435A	Width
4323	4425A	Length	4330	4423A	Length
4324A	4428A	Length	4331	4423A	Width
4325	4428A	Width	4332A	4432A	Length
4326	4438A	Length	4333A	4432A	Width
4327	4438A	Width	--	--	--

2. ESD Prevention

A. Introduction

- (1) What is ESD?
 - (a) Electrostatic discharge, also known as ESD, is defined as the "equalization of static charge between two surfaces." An example is the small shock you receive when you walk across a carpet and then touch a metal object, such as a TV or doorknob. This small shock is exactly the same as the large bolts of lightning that can be seen during a thunderstorm. This ESD event (damage) measures between 12,000 and 40,000 volts. The common threshold level a human can feel a shock is between 3,000 and 4,000 volts.
- (2) How Can ESD Damage Electronics?
 - (a) Modern electrical components contain very small conductors that are electrostatic discharge sensitive (ESDS). Some conductors are only 0.000005-inch (0.000127 mm) in diameter, smaller than a speck of dust. These conductors melt and/or vaporize when an ESD event occurs.
 - (b) Sometimes an ESD event causes a hidden or latent failure. An ESD event can cause damage to a part that will not show up until the part is in normal service; this means that the failure will not show up in test. In normal service, the part is subjected to overstress, such as continuous on/off cycles or power transients. This overstress will cause the ESD weakened part to fail completely.
- (3) What Causes Static Charges?
 - (a) There are many ways to damage ESDS components. The most common way to make a static charge is by rubbing or sliding two different materials together. This is called triboelectric charging; tribo means to rub. The size of the charge depends on the types of surfaces being rubbed together. Materials that make a large amount of static are plastics and glass. Air moving through an area can also become charged. One item that causes the worst static charge is tape. Unrolling a 6-inch (152 mm) piece of tape can make a static charge of between 3,000 and 5,000 volts.

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B. ESD Event Prevention

WARNING: MAKE SURE YOU ARE NOT CONNECTED DIRECTLY TO A HARD GROUND. CONNECTION TO GROUND MUST BE MADE THROUGH A CURRENT LIMITING RESISTOR TO MAKE SURE YOU ARE SAFE.

(1) Grounding

(a) Wrist Straps

- 1 Put on a snug fitting ESD wrist strap that is grounded to the work surface, and do as follows:
 - a Make sure the wrist strap always touches the skin; do not let it dangle freely.
 - b Do not wear a wrist strap inside out or over clothing, and do not just hold it in your hand.
- 2 Check your wrist strap daily at the beginning of the shift. If the wrist strap fails the daily check, do as follows:
 - a Apply approved lotion to the area where the wrist strap touches the skin, then test again.
 - b If the wrist strap fails again, get a new wrist strap and do the test again.
- 3 If continuous monitors are used, check the monitor to make sure it is correctly connected and it works.

(b) Foot Straps

- 1 If the ESD wrist strap is inconvenient or not possible to wear when you work, wear a pair of ESD foot straps and do as follows:
 - a Make sure you use foot straps on both feet; one foot strap is not sufficient for ESD protection.
 - b Stand on a conductive floor surface.
 - c Do a check of your foot straps daily at the beginning of the shift.
- 2 You must also wear a wrist strap if you sit down and handle ESDS items.

(c) Gloves, Finger Cots, and Smocks

- 1 Make sure the gloves and finger cots are made of conductive material, and on the approved list of materials.
- 2 When you put on and take off your smock, make sure you stand away from the ESD workstation. Make sure the smock is on the approved list of materials.



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CAUTION: DO NOT USE COLORLESS POLYETHYLENE CUSHIONING MATERIAL TO PACKAGE OR PROTECT ESDS MATERIAL, UNITS, OR COMPONENTS.

CAUTION: CLEAN ALL ESDS POUCHES, BAGS, AND OTHER CONTAINERS REGULARLY BEFORE USE TO MAKE SURE CONTAMINATION WILL NOT CAUSE AN ESD EVENT.

(2) Material Handling

(a) Use a Faraday cage static shielding enclosure when you store or move ESDS materials. Some examples of Faraday cages are as follows:

- Static shielding bags that have been sealed with an ESD caution label or ESD approved tape with the proper symbol on the bag
- Ziploc-type static shielding bags
- Covered conductive tote boxes.

(b) For temporary storage or if you leave the workstation, keep the ESDS unit or material protected in ESD containers.

(c) Remove ESDS units from the ESD containers only at ESD workstations.

CAUTION: DO NOT USE GROUNDED CARTS ON NONCONDUCTIVE FLOORING.

(d) If you use carts to move units, do as follows:

- 1 Make sure you wear ESD foot straps when you move the grounded cart on conductive flooring.
- 2 Clean the drag bar periodically to make sure the cart is grounded correctly.

CAUTION: COMPONENTS THAT HAVE BEEN INSTALLED ON A CCA OR ANY OTHER NEXT HIGHER ASSEMBLY OR END ITEM ARE STILL SUBJECT TO ESD DAMAGE.

(3) Material Storage

(a) Components

- 1 Put the components in an approved static shielding container or bag and seal the container or bag with an approved static caution label, or use a Ziploc type static shielding bag.
- 2 Put the applicable paperwork outside of the sealed container or bag.

(b) Dual Inline Packages (DIPs)

- 1 Put the DIPs in a tube, then put the tube inside an approved static shielding container or bag.

NOTE: A DIP tube cannot be considered a Faraday cage because it is not completely sealed.

- 2 Seal the container or bag with an approved static caution label.
- 3 Put the applicable paperwork outside of the sealed container or bag.



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(c) Circuit Card Assemblies (CCAs)

- 1 Put the components in an approved static shielding container or bag and seal the container or bag with an approved static caution label, or use a Ziploc type static shielding bag.
- 2 For storage of several CCAs, put the sealed CCAs in individual cells of a divided conductive tote box, and then cover the box.
- 3 Put the applicable paperwork outside of the sealed container, bag, or tote box.

(d) End Item Units

- 1 For partially completed end item units, put the components in an approved static shielding container or bag and seal the container or bag with an approved static caution label, or use a Ziploc type static shielding bag.
- 2 For completed end item units, make sure all covers are installed, with conductive protective covers on all connectors.
- 3 Do not put the paperwork inside the box; it must be kept outside the Faraday cage.

CAUTION: ALL ELECTRICAL EQUIPMENT USED AT THE ESD WORKSTATION MUST BE WELL GROUNDED AND CONNECTION TO ITS POWER SOURCE MADE THROUGH A THREE PRONG PLUG.

CAUTION: ENGINEERING DRAWINGS, OTHER DOCUMENTATION, VISUAL AIDS AND ANY OTHER SUCH DOCUMENTATION THAT IS PRINTED ON PAPER OR ANY OTHER KIND OF NONANTISTATIC MATERIALS MUST BE PREVENTED FROM COMING INTO CONTACT WITH ESDS MATERIALS OR UNITS EITHER BEFORE OR AFTER INSTALLATION IN SUBASSEMBLIES, ASSEMBLIES, OR EXPOSED ESD BOXES.

CAUTION: ANY DOCUMENTATION STORED IN CLEAR PLASTIC ENVELOPES MUST BE REMOVED FROM THE ENVELOPE BEFORE THE DOCUMENTATION IS USED AT OR NEAR AN ESD WORKSTATION OR AREA.

CAUTION: ALL OVENS, VAPOR DEGREASERS, CLEANING TRAYS, OR SIMILAR EQUIPMENT USED IN AN ESD AREA MUST BE GROUNDED.

(4) Workstation/Work Area

- (a) Handle ESDS units or materials at certified workstations only.
- (b) Make sure all electrical equipment used at the workstation is grounded correctly. Make sure that the only tools on the work surface are necessary.
- (c) Make sure you wear your wrist strap, and that it is attached to the grounding jack at all times.
- (d) Make sure items that cause static charges, such as paper and plastic, are kept at a minimum of 12 inches (305 mm) away from the ESDS unit or material.
- (e) Make sure all ESD-safe areas and workstations are labeled.

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- (f) Make sure the ESD workstation is correctly grounded and is certified.

NOTE: A certified workstation must be identified with an ESD label.

NOTE: Workstations must be certified yearly, or whenever they are moved to a new location.

- (g) Make sure the conductive mat is grounded correctly.

1 Use an approved cleaner to keep the mat clean.

2 Use a topical antistat solution for preservation of the dissipative qualities of the mat.

- (h) Use ionizing fans to help remove the build-up of charges on plastics at the workstation (two examples of plastics are tool handles and some types of tape used in the assembly process).

1 Make sure the ionizing fans are calibrated and at a minimum of 12 to 15 inches (305 to 381 mm) away from the ESDS material.

2 Hold the plastic items in the ionizing fan air stream for approximately 5 seconds before you use them.

- (i) Make sure personal non-ionizing fans do not blow across the ESD workstation or across any ESDS material.

CAUTION: DO NOT COMB HAIR NEAR ESDS MATERIAL. IT CAN CAUSE STATIC ELECTRICITY WHICH CAN DAMAGE ANY ESDS ITEM.

- (j) Do personal grooming at least three feet away from the ESD workstation or area.

- (k) Make sure all personal items and clothing are removed from the ESD workstation, and the operator's chair and personal stereos, radios, or tape machines are kept a minimum of 12 inches (305 mm) away from the work surface or unit. No food or drink is permitted at an ESD workstation.

- (l) Visitors to an ESD area must follow the same precautions to prevent an ESD event as the people who work in that area. Anyone without an ESD certification sticker must be informed that the area is an ESD protected area and they must be escorted.

C. ESD Event Prevention Checklist

- (1) Table 2-9 is an ESD event prevention checklist. Use this checklist when you examine the ESD workstation or area to aid in the prevention of an ESD event.

Table 2-9. ESD Event Prevention Checklist

Action	Pass	Fail
Only ESD certified personnel handle ESDS units or material.		
ESDS materials and units are unpackaged, handled, and packaged only at an ESD workstation.		
All items that cause static charges are removed from the ESD workstation and area.		



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Table 2-9. ESD Event Prevention Checklist (Cont)

Action	Pass	Fail
All ESDS materials and units are packaged in a Faraday cage when the operator is not present unless the unit is under test.		
Hair, paper, or clothing do not touch the ESDS material or unit.		
Sweaters, coats, smocks, etc., do not hang from the back of the operator's chair at the ESD workstation.		
Paper does not insulate the material or unit from the conductive work mat.		
Only work-related items are on the work area (conductive work mat or conductive flooring).		
Wrist straps are checked for proper fit at the beginning of each work shift or before using the ESD workstation.		
ESD shoes or foot straps and conductive flooring are used in place of ESD wrist straps.		
Problems with materials, equipment, or conditions that can cause an ESD event are reported to the area supervisor.		
A coworker who fails to follow the proper ESD precautions is coached on the correct ESD procedures and precautions.		

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SECTION 3 – REMOVAL AND APPLICATION OF CCA/ECA/PWB COATINGS

1. Overview

A. General

- (1) This section gives data on how to remove and apply conformal coating and moisture barrier coating. The coatings protect circuit card assemblies (CCA)s, electronic component assemblies (ECA)s, and printed wiring boards (PWB)s and their electrical components from different environmental conditions.

NOTE: In this section CCAs and ECAs are referred to as assemblies, unless specified differently.

B. Equipment and Materials

- (1) Refer to Table 3-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 3-2 for materials.
- (3) Equivalent alternatives are permitted for equipment and materials.
- (4) When the equipment specified in Table 3-1 is not available, some conformal coatings can be replaced by an aerosol conformal coating as follows:
- Replace 98C1878 with aerosol 98A1478
 - Replace 98A2578 or 98P6478 with aerosol 98C0678.

Table 3-1. Equipment for Conformal and Moisture Barrier Coating

Item	Description	Source
Hanger	Part No. T3028508-1	Honeywell International Inc. Aerospace Electronic Systems 21111 N. 19th Ave. Glendale, AZ 85027-2708 U.S.A. (CAGE 58960)
Moisture barrier dip tank	Part No. T3078222 (vertical tank)	
Moisture barrier dip tank	T336287 (horizontal tank)	
Rubber boot	Part No. T3030816-1 or T3030816-3	
Black light (UV light source)	Spectroline Model Q - 225, long wave UV - white light 115 V, 600 Hz, 0.36 amperes	Spectronics Corp, Westbury, NY (CAGE 20772)
Conformal coating dip machine	Single station type	J and R Mfg Co, Chandler, AZ
Gloves, vinyl	Not powdered, no sulfur added, fits either hand - Multi-flex No. 2D7852	CAGE: 2H934

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Table 3-1. Equipment for Conformal and Moisture Barrier Coating (Cont)

Item	Description	Source
Ionized air		Commercially available
Pressurized, deionized water		Commercially available
Paper filters	Fisher Part. No. 09-832L	Commercially available
No. 2 Zahn cup	Viscosity measure device	Commercially available
Oven NOTE 1.	Adjustable to 170 °F ±10 °F (77 °C ±5.5 °C), temperature limited to 90 °F (120 °F)	Commercially available
Spray gun	Pot pressure of 8 to 10 psi, atomization pressure of 15 to 50 psi - Model MBC, E tip and needle, air cap No. 765	Commercially available
Thickness test coupon	3 by 9 by 0.025-inch (76 by 229 by 0.64 mm) plane PWB material	Locally fabricated
Timer	Standare Electric Model S1	Commercially available
Vapor degreaser tank		Commercially available
Label, polyamide	0.25 by 0.90 inch (6.4 by 22.9 mm) - Part No. 7006940-39	Commercially available
Label moisture barrier	Part No. 7006940-43	Commercially available
NOTE: 1 The oven must be vented to an outside source of dry air, if it is used to dry assemblies that use moisture barrier film. If the oven is not vented, moisture can be absorbed and then trapped when the moisture barrier film is applied.		

Table 3-2. Materials for Conformal and Moisture Barrier Coating

Item	Description	Source
1112378 NOTE 2.	Solvent, toluene, technical grade per A-A-59107 (certified to contain 1 percent or less benzene)	
1115078	Thinner, polyurethane - Cytec Type S-8	Commercially available
1113678	Isopropanol, Technical, per MIL TT-I-735, Grade B	Commercially available
111C678	Defluxer/cleaner semiaqueous, terpene — BIOACT EC-7R	Commercially available
1130778	Solvent — Isopropyl alcohol (99%), semigrade	Commercially available
1145278	Mask, flexible solder — TC-530 Pink Hi-Temp (de-ammoniated)	Commercially available

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Table 3-2. Materials for Conformal and Moisture Barrier Coating (Cont)

Item	Description	Source
1170178	Humiseal Thinner 701	Commercially available
11A8578 NOTE 3.	Film, fluorocarbon barrier film, NyeBar, Type Q	Commercially available
11A8678 NOTE 3.	Fluorosolvent, NyeBar 504	Commercially available
11X1486	Solvent, alkaline (contains 60% methanol and 1% - 8% potassium hydroxide) (MIL-R-83213A, Type I) — URESOLVE 411	Commercially available
29P7620	Tape, polyester, adhesive, X/X-inch wide — No. P-232	Commercially available
6006776	Kimwipes, wipers, No. 34155	Commercially available
60A1260	Paper cups, 8-oz, hot and cold — No. HP508	Commercially available
60A1676	Gloves, assembly (cotton blend), unhemmed, ladies Size No. 8810; mens Size No. 8812; or jumbo Size No. J27	Commercially available
60A9476	Finger cots, rolled, static dissipative — No. 8C-800	Commercially available
9824678	Insulating compound, electrical (MIL-I-46058, Type UR) — Conathane CE 1155A/1155B	Commercially available
9824778	Conformal coating, epoxy (MIL-I-46058) — PC12-00M	Commercially available
9862078 NOTES 4., 5., 6.	Coating, conformal, acrylic, low VOC (MIL-I-46058, Type AR) No. 1B31-LOC	Commercially available
98A0378 NOTES 5., 6.	Coating, conformal, polyurethane, high humidity resistance — Type 1A27	Commercially available
98A1378	Coating, conformal, polyurethane, high humidity resistance (MIL-I-46058) — Type 1A33	Commercially available
98A1478 NOTES 5., 6.	Coating, conformal, acrylic, aerosol can (MIL-I-46058, Type AR) — Humiseal No. 1B73	Commercially available
98A1978	Coating, conformal, polyurethane, high humidity resistance (MIL-I-46058) — Type 1A20	Commercially available

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Table 3-2. Materials for Conformal and Moisture Barrier Coating (Cont)

Item	Description	Source
98A2578 NOTES 5., 6.	Coating, conformal, acrylic (MIL-I-46058, Type AR) — No. 1B31-66	Commercially available
98A2878	Coating, conformal, acrylated urethane, ultraviolet cure, single component, multicure (MIL-I-46058, type AR) — No. 29911 (984-LVF anti-foaming agent)	Commercially available
98A3778 NOTES 5., 6.	Coating, conformal, acrylic (MIL-I-46058, Type AR) — No. 1B73	Commercially available
98C0678	Acrylic conformal coating, MS-475N, Type AR (aerosol pack) per MIL-I-46058	Commercially available
98C1878	Insulating compound, electrical (MIL-I-46058, Type AR) — Conap CE-1170	Commercially available
98P6478 NOTES 5., 6., 7.	Coating, conformal, acrylic (MIL-I-46058, Type AR) — No. 1B31	Commercially available
98P7978 NOTES 5., 6.	Coating, conformal, silicone (MIL-I-46058, Type SR) — No. 1-2577	Commercially available
98S0178	Embedment/conformal coating, polyurethane resin., highly flexible, room temperature curing — Conathane EN-2	Commercially available

NOTES:

- Deleted.
- Use toluene only to remove conformal coating or for hand (cold) cleaning applications.
- Honeywell has discontinued the factory use of type K fluorocarbon barrier film (11A8178) and solvent 506 (11A7878).
- Conformal coating (9862078) is used where local environmental regulations require low volatile organic compound contents.
- Conformal coating 1B31 (9862078, 98A1378, 98A2578, 98P6478) and 1B73 (98A1478, 98A3778) are compatible and interchangeable. 1B31 and 1B73 can be used on top of 1A27 (98A0378), but, 1A27 can not be used on top of 1B31 or 1B73.
- Conformal coating 1- 2577 (98P7978) is a soft silicone coating, used on some radar products, that is applied thicker than other coatings. It can be used on top of 1A27, 1B31, and 1B73 but, they can not be used on top of 1-2577.
- Conformal coating (98P6478) can only be used for brush coating touch-up repairs.

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2. **Procedure for Conformal Coating**

WARNING: CONFORMAL COATINGS, TOLUENE, THINNERS, AND SOLVENT CAN BE IRRITATING TO THE OPERATOR. AVOID CONTACT WITH SKIN AND WORK IN A WELL VENTILATED AREA. USE PROTECTIVE CLOTHING INCLUDING SOLVENT RESISTANT GLOVES AND APRON WHEN WORKING. WASH IMMEDIATELY AFTER HANDLING AND BEFORE SMOKING OR EATING.

WARNING: WORK IN A WELL VENTILATED AREA. CONFORMAL COATING, TOLUENE, AND THINNER VAPORS AND MISTS ARE HARMFUL. AVOID PROLONGED BREATHING OF VAPORS OR MISTS.

WARNING: CONFORMAL COATING, TOLUENE, AND THINNERS ARE HARMFUL OR FATAL IF SWALLOWED. DO NOT INDUCE VOMITING BUT GET HELP IMMEDIATELY.

WARNING: THE CONFORMAL COATINGS, SOLVENT, TOLUENE, AND THINNERS PRESENT A FIRE AND AN EXPLOSION HAZARD AT NORMAL TEMPERATURES. KEEP THEM AWAY FROM HEAT, SPARKS, AND OPEN FLAME. DO NOT SMOKE WHILE USING THEM.

CAUTION: USE CARE WHEN YOU HANDLE THE CCA. HANDLE BY THE EDGES OF THE PWB AND WITH APPROVED GLOVES WHEN POSSIBLE. USE COTTON GLOVES TO HANDLE A CCA UNLESS OTHERWISE INSTRUCTED TO PROTECT THE CCA FROM OIL AND CONTAMINATION FROM SKIN. USE VINYL GLOVES AS INSTRUCTED UNLESS A COMPONENT OR ASSEMBLY IS SUSCEPTIBLE TO ELECTROSTATIC INDUCED DAMAGE.

CAUTION: MAKE SURE YOU REMOVE ALL SOLDER RESIDUE AND FOREIGN CONTAMINATION BEFORE YOU APPLY THE CONFORMAL COATING.

CAUTION: DO A CHECK OF THE COMPONENTS BEFORE YOU APPLY SOLVENTS OR THINNERS BECAUSE THEY CAN CAUSE DAMAGE TO SOME COMPONENTS. IF NECESSARY, REMOVE ANY COMPONENTS BEFORE YOU BEGIN REPAIR.

CAUTION: DO NOT EXPOSE THE CCA OR COMPONENTS TO SOLVENT (11X1486) FOR MORE THAN 15 MINUTES MAXIMUM. OVEREXPOSURE WILL DISSOLVE ALL MARKINGS ON THE CCA AND COMPONENT(S) IN THE AREA WHERE IT IS APPLIED. THE URETHANE PORTION OF THE CCA OR COMPONENT BODY THAT IS PUT INTO THE SOLVENT FOR A LONG PERIOD WILL DISSOLVE.

CAUTION: IF THE ASSEMBLIES CONTAIN ESDS ITEMS, USE PROTECTIVE PROCEDURES.

A. General Warnings, Cautions and Comments About Removal and Application of Conformal Coating Procedure

- (1) The warnings and cautions that precede this paragraph apply to all conformal coating procedures.
- (2) Use the procedures in conjunction with the applicable manufacturers instructions to remove and apply the moisture barrier film. When the manufacturers instructions and the Honeywell instructions are not the same, use the Honeywell instructions.



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- (3) Some conformal coated assemblies are also coated with a nearly invisible moisture barrier film, such as 11A8578. These assemblies are identified with a moisture barrier identification label. Refer to paragraph 3. for moisture barrier procedures.
- (4) Conformal coating 1B31 (9862078, 98A1378, 98A2578, 98P6478) and 1B73 (98A1478, 98A3778) are compatible and interchangeable. 1B31 and 1B73 can be used on top of 1A27 (98A0378), but 1A27 can not be used on top of 1B31 or 1B73. Conformal coating 1- 2577 (98P7978) can be used on top of 1A27, 1B31, and 1B73, but, 1A27, 1B31, and 1B73, can not be used on top of 1-2577.

B. Initial Cleaning of an Assembly

WARNING: SOLVENT AND THINNER VAPORS ARE HARMFUL; A POSITIVE FRESH AIR VENTILATION SYSTEM IS NECESSARY. AN ALTERNATIVE IS AN AIR SUPPLIED HOOD OR CHEMICAL CANISTER FACE MASK. AVOID PROLONGED BREATHING OF VAPORS AND MISTS. CALL A PHYSICIAN IF THE OPERATOR HAS PERSISTENT COUGHING WHILE OR AFTER USING THE VAPOR DEGREASER MACHINERY.

WARNING: AVOID CONTACT WITH SKIN OR EYES WITH VAPORS OR LIQUID CLEANER SUBSTANCE.

WARNING: DO NOT SWALLOW THE VAPORS, MIST, OR THE LIQUID USED IN THE CLEANING PROCESS. THEY ARE HARMFUL OR FATAL IF SWALLOWED. CALL A DOCTOR IF THESE SUBSTANCES ARE SWALLOWED. DO NOT INDUCE VOMITING.

- (1) Clean the assemblies and their PWBs with an applicable cleaning solvent or thinner. This will remove residual greases or fluxes before you apply the conformal coating.

C. Removal of Conformal Coating from the Complete Assembly

- (1) Before you remove any conformal coating, find and record the areas that are necessary to mask to prevent conformal coating from being applied to them. Some typical areas include: CCA board edges, board mounted connectors, select integrated circuits (IC)s and other select components.
- (2) Do a visual check of the assembly for shiny surfaces (coated) or dull surfaces (not coated), or use a black light and look for fluorescence (coated) or lack of fluorescence (uncoated) surfaces. Record the areas and components that do not fluoresce. These surfaces or components will have to be masked before conformal coating is applied again to the assembly.
- (3) If an exposed thermo pad or thermo conductive compound is used on a heat sink, remove the thermo pad or compound before the conformal coating is removed.
- (4) Do a check of the assembly for a label that states what conformal coating was used. Do the applicable procedure that follows.
 - (a) If conformal coating 98A2878 or 9824678 was used, put the complete assembly in solvent (11X1486) for 15 minutes maximum.
 - (b) If conformal coating other than 98A2878 or 9824678 was used or if there is no label present, do as follows:
 - 1 Put the complete assembly in toluene (1112378) for approximately 15 minutes.

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- 2 Let the stripped assembly air dry.
- 3 If the coating is not removed, flush the toluene from the subassembly and put the complete assembly in solvent (11X1486) for 15 minutes maximum.
- (5) Remove the assembly from the toluene or the solvent with the card edge connector up (if present) on the PWB.
- (6) Spray the assembly with toluene or solvent as you remove it from the bath to flush conformal deposits around pins and from the connector(s) body or pins.

D. Removal of Conformal Coating from a Selected Area

- (1) Before you remove any conformal coating, find and record the areas that are necessary to mask to prevent conformal coating from being applied to them. Some typical areas include: CCA board edges, board mounted connectors, select ICs and other select components.
- (2) Do a visual check of the assembly for shiny surfaces (coated) or dull surfaces (not coated), or use a black light and look for fluorescence (coated) or lack of fluorescence (uncoated) surfaces on the assembly. Record the areas and components that do not fluoresce. These surfaces or components will have to be masked before conformal coating is applied again to the assembly.
- (3) Apply toluene or solvent on the area where you want to remove the conformal coating. Do not let the toluene or solvent stay on the area for more than 15 minutes.
- (4) Put a Kimwipe (6006776) on top of the area where you will remove the coating.
- (5) Use a stiff-bristle brush soaked in toluene or solvent on the area on top of the wipe. Let the wipe soak up the dissolved coating completely.
- (6) Continue this procedure until the conformal coating has been completely removed and the area or assembly is clean.

CAUTION: AFTER YOU CLEAN THE ASSEMBLY OR PWB, AND BEFORE YOU APPLY THE CONFORMAL COATING, WEAR CLEAN COTTON GLOVES OR FINGER COTS WHEN YOU HANDLE THE ASSEMBLY. IF THE SKIN TOUCHES THE CLEANED ASSEMBLY SURFACE, IT CAN CAUSE CONTAMINATION TO THE ASSEMBLY SURFACE.

E. Preparation of Conformal Coating

- (1) The aerosol conformal coatings do not need preparation. They are ready to use as received.
- (2) The ultraviolet cure conformal coating (98A2878) does not need preparation. It is ready to use as received.
- (3) Refer to Table 3-3, for conformal coatings that do need preparation.

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Table 3-3. Preparation and Cure Time for Conformal Coating

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
9824678	10 parts component A to 7 parts component B by weight 5 parts component A to 4 parts component B by volume Use 10/20% thinner No. S-8 (1115078) as necessary. Higher dilutions make thinner film applications.	5 to 7 days @ 78° ± 10° 3 hrs @ 155 ± 10° 1 hr @ 212° ± 10°	6 hr @ 77° (additional 8 hrs with 10% or more thinner)	Mix the components together thoroughly by hand. Air bubbles introduced in mixing will normally dissipate in a few minutes.
9824778	100 parts component A to 80 parts component B	Dipping: First coat, drain 15 minutes @ 167° ± 10° Following coats, drain 15 minutes @ 77° ± 10° then drain 15 minutes @ 167° ± 10° Brushing: Drain 15 minutes @ 167° ± 10° Final coat (after Dipping or Brushing): 2 hrs @ 167° ± 10° 4 hrs @ 150° ± 10°	2 hrs @ 77°	
9862078	Spraying: Thin approximately 50 percent to 100 percent by volume using 701 thinner (1170178) or as necessary to achieve a 20-23 second viscosity using a No. 2 Zahn cup.	In accordance with instructions in Section 3.		
98A0378	Spraying: 1 part base to 1 part solvent (Humiseal No. 521) Dipping: 10 parts base to 1 part solvent (Humiseal No. 503). This ratio can be varied from 10:1 to 4:1 as necessary.	4 to 6 days @ 170° 20 hrs @ 190°	1 year	
98A1378	Spraying: 1 part base to 1 part solvent (Humiseal No. 521) Dipping: 10 parts base to 1 part solvent (Humiseal No. 503). This ratio can be varied from 10:1 to 4:1 as necessary.	4 to 6 days @ 170° 20 hrs @ 190°	1 year	
98A1478	The aerosol conformal coating does not need preparation. It is ready to use as received.	24 hrs @ 78° ± 10° or 30 minutes @ 155° ± 10°		
98A1978	Spraying: 5 parts base to 2 parts solvent (Humiseal No. 521) Dipping: 10 parts base to 1 part solvent (Humiseal No. 503). This ratio can be varied from 10:1 to 4:1 as necessary.	4 to 6 days @ 170° 20 hrs @ 190°	6 months	
98A2578	Spraying: 1 part base to 1 part solvent (Humiseal No. 521) Dipping: 10 parts base to 1 part solvent (Humiseal No. 503). This ratio can be varied from 10:1 to 4:1 as necessary. NOTE: When work is done in a field shop not equipped to correctly coat the components or CCA with 98P6478, use 98A1478, Humiseal 1B73, aerosol can.	24 hrs @ 77° 4 to 6 hrs @ 170°	1 year	

Table 3-3. Preparation and Cure Time for Conformal Coating (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
98A2878	The ultraviolet cure conformal coating (98A2878) does not need preparation. It is ready to use as received.	Primary cure: UV cure with a 365 NM UV light source as follows: 30 seconds @ 100 mW/cm 5 seconds @ 300 mW/cm 1 second @ 2000 mW/cm Secondary cure: After the primary cure, if there is any area where the UV source can not reach (e.g., under components etc.), bake the assembly at 212° for 1 hour maximum.		
98A3778	See manufacturers instructions	24 hrs @ 78° ± 10° or 30 minutes @ 155° ± 10°	See manufacturers instructions	
98C0678	The aerosol conformal coating does not need preparation. It is ready to use as received.	24 hrs @ 78° ± 10° or 30 minutes @ 155° ± 10°		
98C1878	Use conformal coating as received or thin with thinner No. S-8 (1115078) Spraying: 1 part base to 1 part thinner. Thin the coating material with thinner while maintaining a viscosity of 15 to 17 seconds with a No. 2 Zahn cup. Dipping: 10 parts base to 1 part thinner. This ratio can be varied from 10:1 to 4:1 as necessary. For dipping and brushing: Thin the coating material with thinner while maintaining a viscosity of 70 to 85 seconds with a No. 2 Zahn cup.	24 hrs @ 78° ± 10° or 30 minutes @ 155° ± 10°	See manufacturers instructions	
98P6478 UP46426	Use conformal coating as received or thin with thinner No. 701 (1170178). Spraying: 1 part base to 1 part thinner. Thin the coating material with thinner while maintaining a viscosity of 15 to 17 seconds with a No. 2 Zahn cup. Dipping: 10 parts base to 1 part thinner. This ratio can be varied from 10:1 to 4:1 as necessary. For dipping and brushing: Thin the coating material with thinner while maintaining a viscosity of 70 to 85 seconds with a No. 2 Zahn cup.	24 hrs @ 78° ± 10° or 30 minutes @ 155° ± 10°	See manufacturers instructions	
98S0178	100 parts A to 90 parts B by weight 1 part A to 1 part B by volume	3 to 5 days @ 77° 8 minutes @ 95° 5 minutes @ 113° 3 minutes @ 140° 1.5 minutes @ 176° 1 minute @ 212°	@ 77°, Viscosity = 12 in 10 minutes 25 in 20 minutes 55 in 25 minutes 4000 in 31 minutes	



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F. Application of Conformal Coating Using a Brush, an Aerosol Spray, or a Spray Gun**(1) Brush or Aerosol Spray Application**

- (a) Mask the applicable area with tape. Use a black light to make sure that all unmasked areas are free of conformal coating.

Examples of items that should be free of conformal coating are:

- Test points/terminals
- Variable potentiometers/resistor screw
- Connectors
- Ejector holes
- Spacers/standoffs
- Goldfingers
- Mounting holes
- Sockets
- PWB edges (as necessary).

- (b) Put the assembly in a position so the new coating will not flow to surrounding areas that must not be coated.

CAUTION: IF YOU USE AN AEROSOL SPRAY TO APPLY THE CONFORMAL COATING, MAKE SURE YOU GROUND THE ASSEMBLY OR OTHER ITEM TO PREVENT STATIC CHARGES.

- (c) Do the procedure that follows to apply the conformal coating:

- 1 Use a brush or spray to apply one or more coats to the whole assembly or specific area being coated.
- 2 Let each coat air dry for 5 minutes.
- 3 Repeat this procedure until you get a correct thickness, a dry film thickness of 0.003 to 0.005 inch (0.08 to 0.13 mm) on a flat surface.
- 4 Measuring coating thickness in reworked areas is difficult. Operators may use adjacent original coating thickness as a guide and apply rework coating to approximately the same thickness.
- 5 Let the final coat air dry for 10 minutes.

- (d) Cure the conformal coating in accordance with Table 3-3.

- (e) Remove all masking material and clean the assembly with an approved cleaning solvent.

(2) Spray Gun Application

- (a) Mask the applicable area with tape. Use a black light to make sure all unmasked areas are free of conformal coating. Examples of items that should be free of conformal coating are the same as if using a brush or spray.

- (b) Preheat boards in oven for 30 minutes at 170 °F (77 °C).

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- (c) Set spray gun air pressure to 25-35 PSI.
- (d) Remove boards from oven.
- (e) Spray one coat of conformal coating while the boards are still hot. Position spray gun at approximately 45 degrees, 6 to 8 inches (152 to 203 mm) from the boards. Rotate boards at 90 degree increments and spray conformal coating between all components until the boards have been rotated 360 degrees.
- (f) Set boards aside to air cure for 10 minutes.
- (g) Oven cure for 10 minutes at 170 °F (77 °C).
- (h) Remove boards from oven.
- (i) Spray a second coat of conformal coating while the boards are still hot. Position spray gun at approximately 45 degrees, 6 to 8 inches (152 to 203 mm) from the boards. Rotate boards at 90 degree increments and spray conformal coating between all components until the boards have been rotated 360 degrees.
- (j) Set boards aside to air cure for 10 minutes.
- (k) Oven cure for 10 minutes at 170 °F (77 °C).
- (l) Remove boards from oven and repeat steps 2.F.(2)(g) thru 2.F.(2)(l).
- (m) Oven cure for 30 minutes at 170 °F (77 °C).
- (n) Remove masking.
- (o) Use a black light to ensure applicable conformal coating coverage.

G. Setup and Maintenance of the Conformal Coating Dip Machine

- (1) Refer to Table 3-3 for conformal coating mix ratio.
- (2) Set up the dip machine as follows:
 - (a) Set the immersion speed of the dip machine to 3.25 ±0.25 inches/minute (82.6 ±6.4 mm/minute).
 - (b) Set the dwell time of the dip machine to 15 ± 5 seconds.
 - (c) Set the initial withdrawal rate to 2.25 ± 0.25 inches/minute (57.2 ± 6.4 mm/minute), and then reset as specified in the applicable procedures.
 - (d) Set the operational temperature of the oven to 170 ± 10 °F.
 - (e) If present, set the oven over temperature limit switch to 190 °F.
- (3) Make sure the viscosity and thickness of the conformal coating in the dip machine is correct.
 - (a) Do a check of the viscosity as follows:

NOTE: There must be a sufficient quantity of conformal coating in the dip machine tank so that the assemblies do not touch the bottom of the tank or cause the coating material to spill out of the tank.

 - 1 Remove the cover from the dip tank.

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- 2 Add conformal coating, if necessary, until the level is approximately one inch (25.4 mm) from the top of the tank.
- 3 Use a tongue depressor to stir the conformal coating in the dip tank thoroughly. Make sure the bubbles go away before you continue.
- 4 The viscosity of the conformal coating solution in the dip tank must be 75 to 85 Zahn seconds. Do a check as follows:
 - a Use a No. 2 Zahn cup and timer, and slowly submerge the cup in the conformal coating as shown in Figure 3-1.
 - b As soon as the bubbles go away, pull the cup straight up from the tank and hang above the tank.
 - c Start the timer when the cup rim breaks the surface of the conformal coating. Stop the timer when the stream of coating material that comes out of the bottom of the cup breaks.
- 5 If the viscosity measurement is less than 75 Zahn seconds, let the dip tank stay uncovered until sufficient solvent evaporates to bring the viscosity up to specification of 75 to 85 Zahn seconds.

NOTE: Fresh coating can have a viscosity of below 75 Zahn seconds. It is permitted to run the dip machine at this time only if the necessary minimum thickness on the test coupon is met. Once you add thinner to the coating, this exception does not apply and the 75 to 85 Zahn second range of viscosity must be maintained.

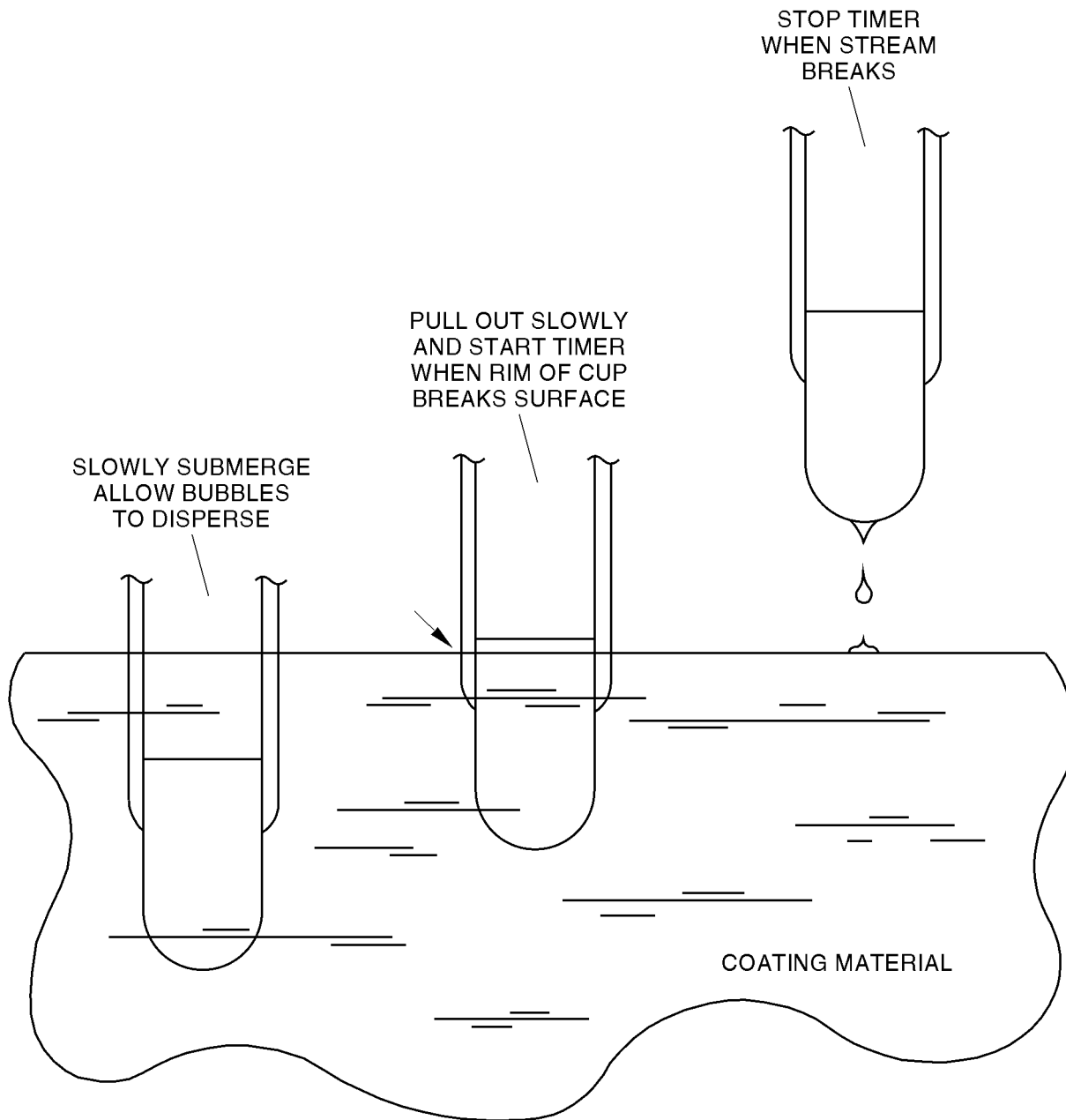
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Figure 3-1. Viscosity Check Setup

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- 6 If the viscosity measurement is greater than 85 Zahn seconds, do as follows:
 - a Add approximately 6 ounces of thinner.
 - b Stir thoroughly with a tongue depressor and make sure the bubbles go away before you continue.
 - c Repeat the steps in paragraph 2.G.(3)(a) and continue to add thinner as directed until viscosity measurement is within specification.

CAUTION: YOU MUST DO A CHECK OF THE THICKNESS IF CONFORMAL COATING OR THINNER HAVE BEEN ADDED TO THE DIP TANK.

- (b) Do a check of the conformal coating thickness as follows:
 - 1 Clean the test coupon thoroughly and let it dry completely.
 - 2 Use a hanger, Part No. T3028508-1, to hang the test coupon from the dip machine cross bar.
 - 3 Remove any film that is on the surface of the conformal coating before you put the assembly in the coating material. Use a tongue depressor to push the film to either side of the tank to prevent contamination of the assembly.
 - 4 Set the toggle switch to START position and then push the CYCLE START button. The down arrow will light and the cross bar containing the test coupon and hanger will start to move down into the dip tank.
 - 5 The test coupon will stop in the dip tank when the lower circular stop on the control rod is struck by the cross bar. The dip machine will dwell for 10 to 20 seconds and then the test coupon will start to withdraw from the dip tank.
 - 6 After the test coupon is removed from the dip tank, let the excess conformal coating drip from the assembly. Do not brush unwanted coating from the test coupon because it will prevent an equal coating thickness.
 - 7 Put the test coupon in the oven and set the oven to 70 °C for 30 minutes. Remove the test coupon from the oven and let it cool.
 - 8 Measure the coating thickness of the test coupon. It must be between 0.001 and 0.003 inch (0.3 to 0.8 mm) on each side. If not, repeat paragraph 2.G.(3)(a).

- (4) Put the conformal coating solution through a filter once a month as follows:

NOTE: Use a spare dip tank supplied by the manufacturer during this process.

- (a) Make sure the spare tank is clean and free from any contamination before you proceed.
- (b) Remove the top panel in the front of the dip tank. Slide the tank forward and put the clean spare tank in its position.
- (c) Use paper clips to hang two to three paint filters from the dip machine crossbar.

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- (d) Use paper cups to scoop the conformal coating from the dirty tank and pour the coating into the paint filters. Let the filtered coating drain into the clean dip tank.
- (e) After the coating is filtered, remove the empty dirty dip tank and clean it for future use.
- (f) If necessary, add new conformal coating to the dip tank. Use the procedure in paragraph 2.G.(3)(a) to adjust the viscosity.
- (g) Install the top panel of the dip machine.

WARNING: USE A CONTAINER THAT IS APPROVED BY NATIONAL AND LOCAL HAZARDOUS MATERIAL HANDLING REQUIREMENTS FOR STORAGE AND/OR DISPOSAL OF DIRTY CONFORMAL COATING. THE APPROVED CONTAINER WILL PREVENT DAMAGE TO THE OPERATOR AND THE ENVIRONMENT.

WARNING: THE APPROVED CONTAINER GIVEN IN THE FOLLOWING STEPS IS FOR CONTAINMENT, STORAGE, AND/OR DISPOSAL OF THE DIRTY CONFORMAL COATING IN ACCORDANCE WITH NATIONAL AND LOCAL HAZARDOUS MATERIAL HANDLING REQUIREMENTS TO PREVENT DAMAGE TO THE OPERATOR OR THE ENVIRONMENT.

- (5) Replace the conformal coating solution every 3 months as follows:

NOTE: Use a spare dip tank supplied by the manufacturer during this process.

NOTE: Make sure the spare tank is clean and free from any contamination before you do the procedure that follows.

- (a) Put an approved container below the dip tank drain and open the drain valve. When all of the conformal coating has drained from the dirty dip tank, close the drain valve and seal the approved container.
- (b) Remove the top panel in the front of the dip tank and slide the dirty tank forward. Put the clean tank in its position.
- (c) Remove the empty dirty dip tank, then clean for future use.
- (d) Fill the clean dip tank with new conformal coating until the level is approximately one inch (25.4 mm) from the top of the tank.
- (e) Use a tongue depressor to stir the conformal coating in the dip tank. Make sure the bubbles go away before you continue.
- (f) Do a check and adjust the conformal coating viscosity in accordance with paragraph 2.G.(3)(a).

NOTE: Fresh coating can have a viscosity of below 75 Zahn seconds. It is permitted to run the dip machine at this time only if the necessary minimum thickness on the test coupon is met. Once you add thinner to the coating, this exception does not apply and the 75 to 85 Zahn second range of viscosity must be maintained.

- (g) Install the top panel of the dip machine.



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H. Application of Conformal Coating Using the Dip Machine

- (1) Prepare and mask the assembly as follows:
- (a) Remove any electrostatic shields, parts not to be dipped, and the hardware that attaches from the assembly. Move it to the side for assembly after repair.
- CAUTION:** USE GLOVES OR FINGER COTS AND TOUCH ONLY THE EDGES WHEN YOU TOUCH OR MOVE THE ASSEMBLY AFTER CLEANING.
- (b) Use isopropyl alcohol to fully clean the assembly.
 - (c) Mask the assembly for conformal coating as shown in the related maintenance manual, the related engineering drawing, or Figure 3-2. Use a pink liquid mask and polyester tape as specified.
 - (d) Bake the assembly to cure the pink liquid mask and dehumidify the assembly as follows:
 - 1 Put the assembly on a wire hook as shown in Figure 3-3.

NOTE: Make sure the hook is made from heavy wire (Honeywell Part No. T3028508-1). It must be strong enough to hold 2 pounds.
 - 2 Hang the hook that contains the assembly on oven cross bars.
 - 3 Bake the assembly at 70 °C for 45 ± 15 minutes.
 - 4 Remove the assembly from the oven and let it cool to room temperature while it hangs on the hook.



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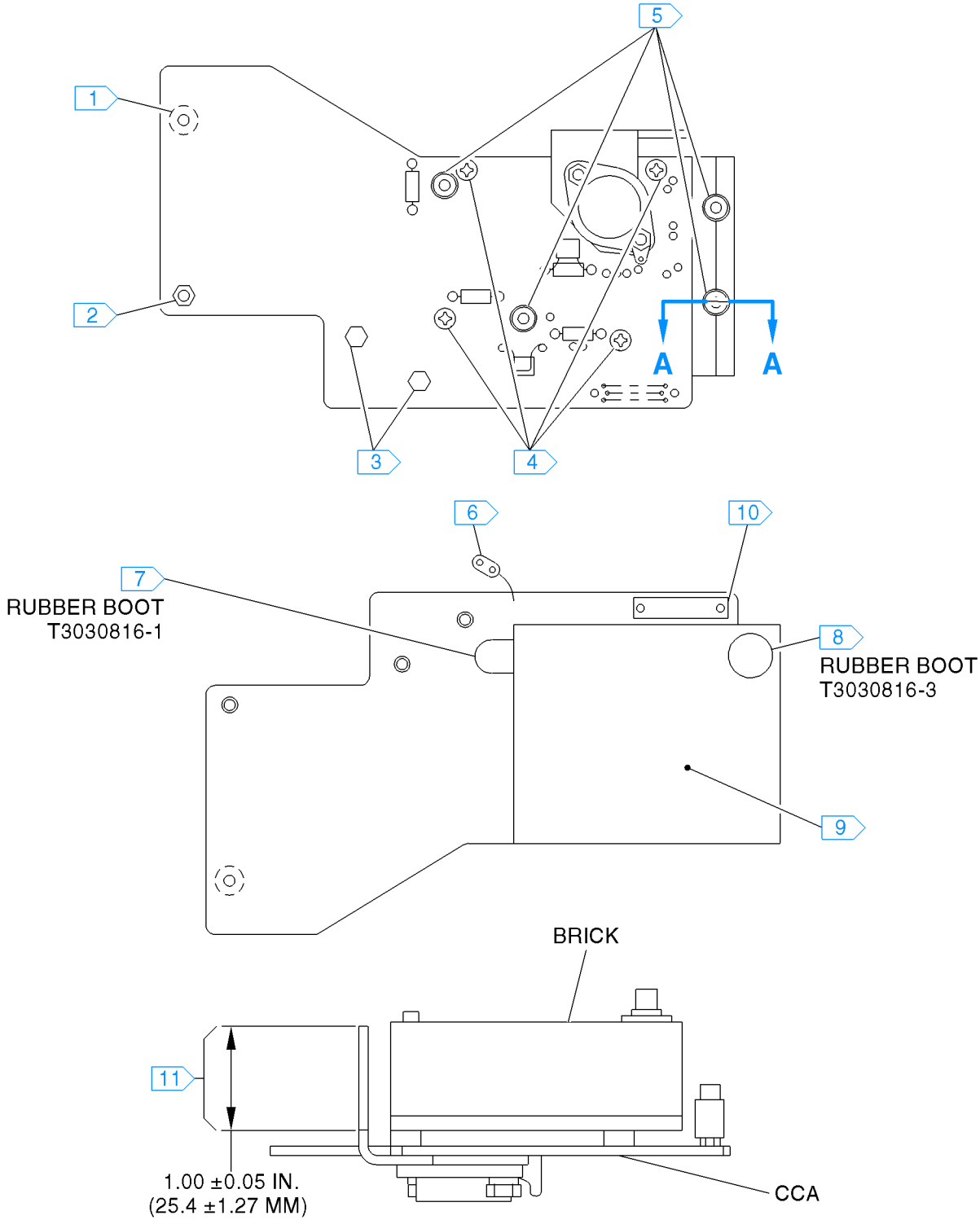
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- NOTES:**
- 1 Do not apply conformal coating on the hole found on both sides of the PWB. Make sure the distance is approximately 0.32 inch (8 mm) diameter around each hole.
 - 2 Do not apply conformal coating on the screw found on Side A only of the PWB. Make sure the distance is approximately 0.32 inch (8 mm) diameter around the screw.
 - 3 Do not apply conformal coating on the holes found on both sides of the PWB. Make sure the distance is approximately 0.25 inch (6.4 mm) diameter around each hole.
 - 4 When necessary, mask screw slots with pink liquid mask.
 - 5 Make a plug of pink liquid mask in the brick holes as shown in View A-A.
 - 6 When necessary, use the pink liquid mask to fully coat the lug.
 - 7 For rubber boot, PN T3030816-1, install the rubber boot as shown, then apply a bead of pink liquid mask around the bottom of the boot to make a seal. Make sure you apply the bead equally so it will peel off uniformly.
 - 8 For rubber boot, PN T3030816-3, install the polyester tape (refer to NOTE 9.), then do the procedure in NOTE 7.
 - 9 Use polyester tape to mask the surface as shown.
 - 10 Apply pink liquid mask around the base of the connector as shown. Wind a piece of polyester tape completely around all four sides of the connector with an overlap. Pinch the top edges of the tape together to form a complete seal. This complete seal is very important so you don't get the conformal coating on connector pins.
 - 11 Use polyester tape to mask both sides of the metal bracket (if present) to the dimension shown.

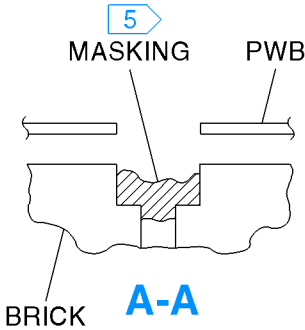
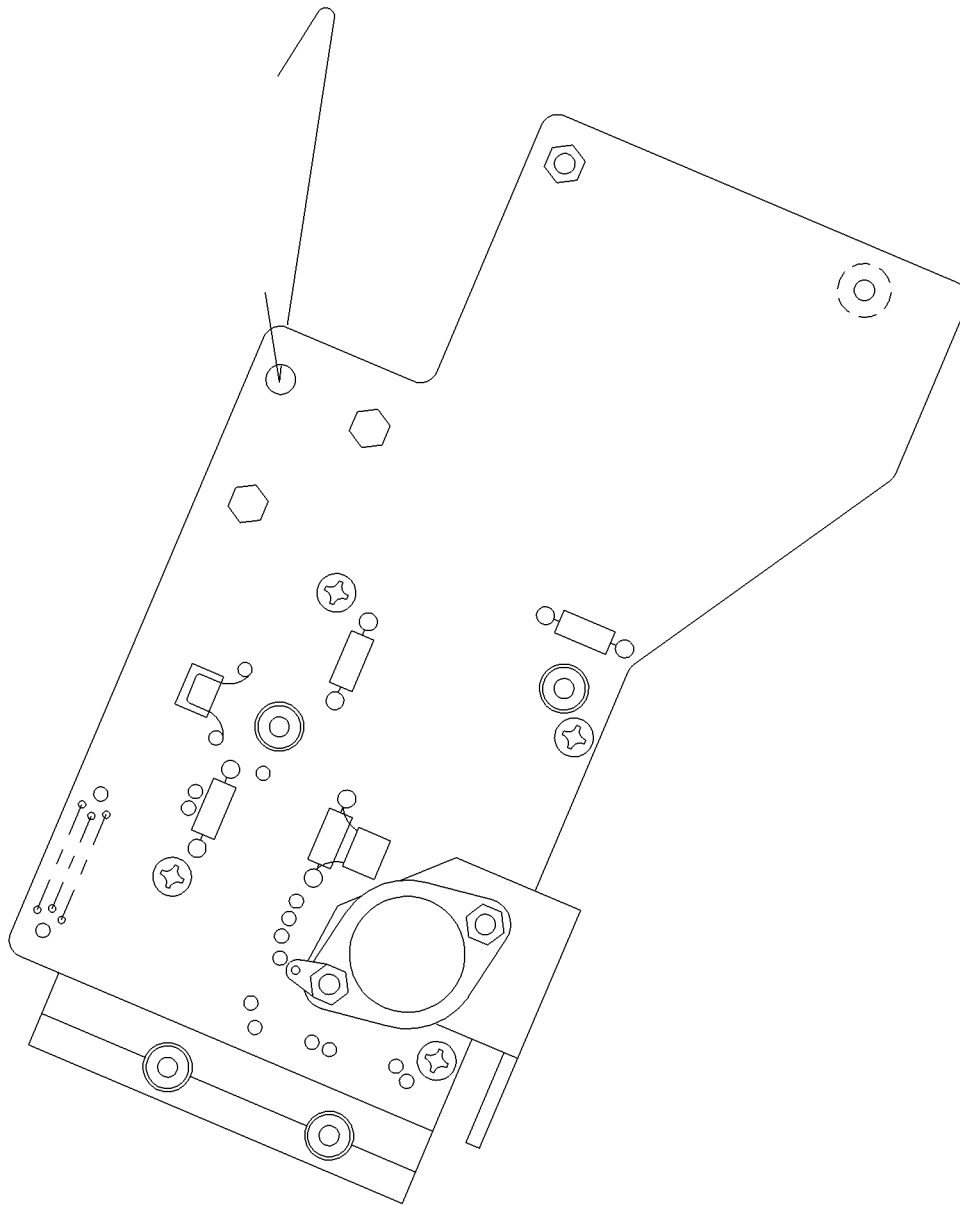


Figure 3-2. Typical Assembly Masking Layout

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Figure 3-3. Typical Assembly Wire Hook Placement

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- (2) Apply the first coat on the assembly as follows
- (a) Adjust two circular stops on the control rod of the dip machine to set the travel. Make sure the assembly is fully in the dip tank.
 - (b) Set the withdrawal rate of the assembly from the dip machine to 2.25 ± 0.25 inches/minute (57.2 ± 6.4 mm/minute).
 - (c) Hang the hook that contains the assembly on the dip machine with the brick pointed away from the operator, as shown in Figure 3-3.
 - (d) Remove any film that is on the surface of the conformal coating before you put the assembly in the coating material. Use a tongue depressor to push the film to either side of the tank to prevent contamination of the assembly.
 - (e) Set the toggle switch to the START position and then push the CYCLE START button. The down arrow will light, and the cross bar that contains the assembly and the hook will start to move down into the dip tank.
 - (f) The assembly will stop in the dip tank when the lower stop on the control rod is struck by the cross bar. The dip machine will dwell for 10 to 20 seconds, and then the assembly will start to withdraw from the dip tank.
 - (g) After the assembly is completely withdrawn from the dip tank, let the excess conformal coating drip from the assembly for 45 to 60 seconds, then brush off excess coating from only the bottom edges of the assembly. Let the assembly air cure for 30 minutes.
 - (h) Use a black light to do a check of the assembly for bubbles or voids after it is air cured. If necessary, use a brush dipped in conformal coating to touch up bubbles and voids. Use toluene, if necessary, to carefully remove excess coating.
- NOTE:** If it is necessary to further touch up the conformal coating on the assembly, do it after you remove the assembly from the oven, and before you start the one hour air cure.
- (i) Put the assembly in the oven and set to 70°C for 30 minutes. Remove the assembly from the oven and let it air cure for 1 hour.
- (3) Apply a second coat on the assembly as follows:
- (a) Repeat the steps in paragraph 2.H.(2) with the exception of changing the withdrawal rate in step 2.H.(2)(b) to 2.75 ± 0.25 inches/minute (69.9 ± 6.4 mm/minute).
- (4) Apply a third coat on the assembly as follows:
- (a) Repeat the steps in paragraph 2.H.(2) with the exception of changing the withdrawal rate in step 2.H.(2)(b) to 3.25 ± 0.25 inches/minute (82.6 ± 6.4 mm/minute).
 - (b) Remove the rubber boots from the assembly as follows:
 - 1 Use a razor blade to carefully cut a round circle around the base of the masking fillet.
 - 2 Pull off the boots; you will see the remaining clean round circles.
 - (c) Remove the pink mask and polyester tape from all areas on the assembly. Carefully touch up any ragged edges or areas with conformal coating.

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(d) Use a black light to check for unwanted conformal coating on all connectors. Use toluene and a brush to remove any unwanted coating.

(e) Put the assembly in the oven and set to 70 °C for 30 minutes. Remove the assembly from the oven.

NOTE: If a large amount of touch-up is necessary, air-dry the assembly for 30 minutes before you continue.

(f) Touch up the conformal coating on the assembly, if necessary.

(g) Put the assembly in the oven and set to 70 °C for two hours. Remove the assembly from the oven and let it return to room temperature before you continue.

I. Reference Data for Operation of the Conformal Coating Dip Machine

(1) General Data About Dip Machine Settings

(a) The dip machine settings in this section were established to produce acceptable conformal coating. The study that established these settings was conducted during the period of December 1982 thru January 1983.

(2) Thickness Test Coupon

(a) All thickness checks were made using a test coupon made of plain PWB material with the dimensions of 3 by 9 by 0.025 inches (76 by 229 by 0.64 mm). The average of three readings was used, taken on the sample (coupon) 1 inch (25.4 mm) from the side alternating 1.5, 3.0, and 4.5 inches (38, 76, and 114 mm) from the bottom coating edge. Coating thickness typically varied from bottom to top; thickest at the bottom. The coating flows down toward the bottom edge.

(3) Thickness Compared to Viscosity

(a) Thickness checks were performed at viscosities in the range of 60 to 100 Zahn seconds. The maximum variation in thickness was approximately 0.0005-inch (0.013 mm) per side. Increased viscosity increases thickness of coating, all other variables being fixed.

(4) Viscosity Compared to Flow

(a) Viscosities over 80 to 85 Zahn seconds did not flow evenly, leaving streaks and irregularities. Also, bubble dispersion was difficult.

(5) Viscosity

(a) The viscosity of the conformal coating as received is specified by the manufacturer as 220 centipoise per FED-STD-141, Method 4287. In practice, a Zahn cup is used to establish conformal coating viscosity because it is easy to use. It is important to note that there is no exact conversion from centipoise to Zahn seconds existing. The conversion is dependent on material, temperature, and so forth.

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- (b) A range of 75 to 80 Zahn seconds has experimentally been established as the ideal viscosity. Viscosity is a measurement of the material flow characteristics and solids content. If viscosities over 85 Zahn seconds are used, it is difficult to disperse bubbles trapped in the coating. Values below 75 may affect coating thickness although not substantially.
 - (c) The viscosity of coating fresh from the can will be less than 75 Zahn seconds. The value will depend on the temperature, etc. The coating can be used at this level if the 0.001 to 0.003-inch (0.003 to 0.008-mm) thickness requirement is achieved.
- (6) Immersion Speed
 - (a) The immersion speed is set at 3.25 ± 0.25 inches/minute (82.6 ± 6.4 mm/minute). Faster speeds generate and trap more air bubbles. Slower speeds are not detrimental but increase the production costs and exposure time of components and masking materials to the coating.
- (7) Dwell Time
 - (a) The dwell time was arbitrarily set at 15 ± 5 seconds. The purpose of the dwell time is to prevent any bubbles formed during immersion to disperse.
- (8) Withdrawal Speed
 - (a) The withdrawal speed is critical. It is set at the speeds specified in this subsection. The value of 2.25 ± 0.25 inches/minute (57.2 ± 6.4 mm/minute) will produce an average single dip coating thickness of approximately 0.0015-inch (0.038 mm) per side. Withdrawal speed is the single most critical parameter affecting coating thickness. Slower speeds reduce thickness, and faster speeds increase thickness. Increased thickness increases toluene-caused bubbles and affects curing.
- (9) Bubbles
 - (a) Bubbles can be caused by entrapped air or evaporation of toluene in the coating. Immersion speed, dwell time, withdrawal speed, viscosity, component density, coating thickness, and curing cycle all have an impact on bubbles forming in the coating. The coating "films" rapidly, making curing- versus toluene-caused bubbles dependent on the withdrawal speed.
- (10) Filtering
 - (a) All material added to the dip tank requires filtering to remove contamination. In addition, the tank is cleaned and the conformal coating is filtered once a month. This filtering is to remove insoluble contamination.
- (11) Coating
 - (a) The conformal coating in the dip tank is changed every 3 months. This is required because the coating becomes contaminated with soluble materials, which cause voids to appear after curing.
- (12) Voids
 - (a) Voids are caused by contamination on the assembly due to improper cleaning, handling, and soluble or insoluble substances in the coating material in the dip tank.

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3. Procedure for Moisture Barrier Film Coated Assemblies**A. General**

- (1) Refer to Figure 3-4 for the application and removal guidelines for the 11A8578, 11A8878, and 11A8978 moisture barrier coatings. Figure 3-4 is based on Honeywell EB7020465, Revision F. References to Honeywell production data have been removed from Figure 3-4.

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 - 10.4.2 MOISTURE BARRIER TYPES P, L AND Q APPLIED OVER UV LIGHT SENSITIVE CONFORMAL COATINGS**
 - 10.4.3 MOISTURE BARRIER COATING TYPE LV (HMN 11A9178) OR V (HMN 11A8878)**
 - 10.5 TRAINING AND PROCESS AUDITS**

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Figure 3-4. (Sheet 1 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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14.	DATA RIGHTS NOTATIONS

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Figure 3-4. (Sheet 2 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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STANDARD REPAIR PROCEDURES FOR HONEYWELL AVIONICS EQUIPMENT INSTRUCTION MANUAL
Part No. SOPM20-00-03**TITLE: APPLICATION AND REMOVAL GUIDELINES FOR MOISTURE BARRIER COATINGS****1. SCOPE**

This Engineering Bulletin (EB) provides application and removal guidelines for moisture barrier coatings with Honeywell Material Numbers (HMN) 11A8978, HMN 11A8578, HMN 11A8878 and HMN 11A9678. Line Replaceable Units (LRU's) and sub-assemblies with warning labels Honeywell Part No. 7006940-44 have been treated with HMN 11A8978, HMN 11A8578, HMN 11A8878 and HMN 11A9678 moisture barrier coating to reduce susceptibility to moisture problems.

2. REFERENCED DOCUMENTS

- M7010975 Manufacturing Specification for the Application of MIL-I-46058 Type AR Conformal Coating
- MEB AV-7066 Conformal Coating Repair/Rework Procedure
- MEB AV-7078 Cleaning of Motherboard Assemblies to Remove Contaminants
- A09-1100-004 Standard Repair Procedures for Honeywell Avionics Equipment Instruction Manual

NOTE: A09-1100-004 is listed for reference purposes only. It applies to authorized Repair Stations operating under Part 145 only, and must not be used in any manufacturing facility or any supplier to a manufacturing facility operating under Part 21.

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Figure 3-4. (Sheet 3 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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3. MATERIALS

3.1 Sundry Materials

7006940-44 Moisture barrier warning label; Honeywell International Inc.

HMN 1111978 Solvent, Acetone, technical grade (Federal Specification O-A-51); Optional source

HMN 1112378 – Solvent, toluene, technical grade per A-A-59107 (certified to contain 1 percent or less benzene); Optional source

HMN 1113678 – Isopropanol, Technical, per MIL TT-I-735, Grade B (99%); Optional source

HMN 1130778 – Solvent, Isopropyl alcohol, (99%), semigrade – Grade A; Optional source

HMN 11A8578 – Film, Fluorocarbon barrier film, NyeBar Type Q; Nye Lubricants Inc, Fairhaven, MA (CAGE 98354)

HMN 11A8678 – Fluorosolvent, NyeBar 504; Nye Lubricants Inc, Fairhaven, MA (CAGE 98354)

HMN 11A8878 – Film, Fluorocarbon barrier film, (with ultraviolet (UV) light sensitive dye), NyeBar Type V; Nye Lubricants Inc, Fairhaven, MA (98354)

HMN 11A8978 – Film, Fluorocarbon barrier film, NyeBar Type L; Nye Lubricants Inc., Fairhaven, MA (CAGE 98354)

HMN 11P0678 – Glass cleaner, modified ammonia, no phosphorus – Windex Glass Cleaner with Ammonia D – S. C. Johnson and Son Inc, Drackett Professional Div, Cincinnati, OH (CAGE 85234)

HMN 6006776 – Wipers, Kimwipes, No. 34155; Kimberly-Clark, Neenah, WI (CAGE 85100)

HMN 60A9476 – Finger cots, rolled, static dissipative, - No. 8C-800; QRP Inc, Industrial Div, Tucson, AZ (CAGE 0J2R7)

HMN 60D3817 – Scotchlok Masking Paper 3M Part Number 05 1131 0671 8 – 3M, Industrial Tape and Specialties Div, St. Paul, MN (CAGE 52152)

HMN 98P6478 – Coating, conformal, acrylic (MIL-I-46058, Type AR) – No. 1B31 – Columbia Chase Corp, Humiseal Div, Woodside, NY (CAGE 99109)

HMN 11A9678 - Film, Fluorocarbon barrier film, NyeBar Type P; Nye Lubricants Inc., Fairhaven, MA (CAGE 98354)

HMN 11A9078 - Nye Solvent 509; Nye Lubricants Inc, Fairhaven, MA (CAGE 98354)

HMN 29P9020 - Tape, polyester, adhesive - No. 1280 - 3M, Industrial Tape Division, St. Paul, MN (Cage 26066)

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Figure 3-4. (Sheet 4 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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Brush, antistatic; optional source

Cotton tipped swabs, antistatic; optional source

Gloves – vinyl, antistatic, not powdered, no sulfur added; optional source

Measuring cup or spoon, aluminum, 1/8 to 1/4 cup; Optional source

Paper filters – Fisher Part. No. 09-832L; Fisher Scientific, Hinsdale IL, (CAGE 08889)

NOTE 1: Moisture barrier type K (HMN 11A8178), type Q (HMN 11A8578) and type L (HMN 11A8978) are no longer available from Nye Lubricants Inc. When the design data specifies type K (HMN 11A8178), type Q (HMN 11A8578) or type L (HMN 11A8978), type L (HMN 11A8978) or type P (HMN 11A9678) may be used.

NOTE 2: Solvent 506 (11A7878) is intended for use with moisture barrier type K (11A8178) only. Solvent 506 (11A7878) can not be used with moisture barrier type L (HMN 11A8978), type Q (HMN 11A8578) or type V (HMN 11A8878). Honeywell has discontinued the use of solvent 506 (HMN 11A7878).

NOTE 3: Solvent 504 (HMN 11A8678) can be used to strip moisture barrier type K (HMN 11A8178), type L (HMN 11A8978), type Q (HMN 11A8578) or type V (11A8878).

NOTE 4: Moisture barrier type V (HMN 11A8878) and Type LV (HMN 11A9178) are no longer available from Nye Lubricants. Where the design data specifies Type V or Type LV, use Type V, Type LV or Type P (HMN 11A9678). Type P does not have the UV luminescent properties. See section 10.4 for Inspection instructions.

NOTE 5: Solvent 509 (HMN 11A9078) can be used to strip moisture barrier type P (HMN 11A9678).

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Figure 3-4. (Sheet 5 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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3.2 Tools

Equivalent substitutes for any of the following are acceptable:

T3028508-1: Hanger

T3078222: Moisture barrier dip tank (vertical tank)

T3078255: Washtub, with pressurized de-ionized water.

T336287: Moisture barrier dip tank (horizontal tank)

Airbrush, Paasche Type H; Optional Source

Black light (UV light source) – Spectroline Model Q – 225, long wave UV – white light 115V, 60Hz; Spectronics Corp, Westbury, NY (CAGE 20772)

Dionized water, pressurized; optional source.

Ionic Air Gun, Model AFC-2 controller and PG-5 gun; Static Control Services

Oven – Adjustable to 225 ± 10 °F (110 ± 5 °C), vented to outside source of dry air; Optional source

Syringe, antistatic; optional source

Totes, antistatic; optional source

Tote cover, antistatic; optional source

Vent Hood – Optional Source

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Figure 3-4. (Sheet 6 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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4. GENERAL WARNINGS, CAUTIONS, AND INSTRUCTIONS

WARNING 1: THE MOISTURE BARRIER AND SOLVENT CAN DAMAGE YOUR SKIN AND EYES. USE ANTISTATIC VINYL FINGER COTS OR GLOVES FOR PROTECTION. GOGGLES ARE REQUIRED IF HANDLING MOISTURE BARRIER IN LIQUID FORM. IF CONTACT OCCURS, WASH WITH SOAP AND WATER. WASH IMMEDIATELY AFTER HANDLING AND BEFORE SMOKING OR EATING. DO NOT EAT, DRINK, OR SMOKE IN THE AREA.

WARNING 2: THE MOISTURE BARRIER LIQUID AND SOLVENT VAPORS CAN REDUCE THE AMOUNT OF OXYGEN AVAILABLE FOR BREATHING. OVEREXPOSURE TO HIGH CONCENTRATIONS CAN CAUSE CENTRAL NERVOUS SYSTEM DEPRESSION WITH EFFECTS RANGING FROM DIZZINESS TO UNCONSCIOUSNESS, NARCOSIS, COMA, RESPIRATORY FAILURE AND DEATH. AVOID PROLONGED BREATHING OF FUMES. CONDUCT WORK UNDER A VENTILATION SYSTEM APPROVED BY THE SITE HEALTH, SAFETY AND ENVIRONMENT (HSE) REPRESENTATIVE.

WARNING 3: THE MOISTURE BARRIER AND SOLVENT ARE HARMFUL OR FATAL IF SWALLOWED. DO NOT INDUCE VOMITING BUT GET HELP IMMEDIATELY.

WARNING 4: THE LIQUID MOISTURE BARRIER AND SOLVENT ARE NOT COMBUSTIBLE. HOWEVER, THERMAL DECOMPOSITION MAY PRODUCE DANGEROUS GASES SUCH AS HF. KEEP LIQUID MOISTURE BARRIER AND SOLVENT AWAY FROM SPARKS AND OPEN FLAME. DO NOT SMOKE WHILE YOU USE THEM.

WARNING 5: CONSULT THE APPLICABLE MATERIAL SAFETY DATA SHEETS (MSDS) FOR ADDITIONAL SAFETY AND HANDLING INFORMATION.

CAUTION 1: THE MOISTURE BARRIER RUBS OFF THE ASSEMBLY IF IT IS TOUCHED. DO NOT TOUCH THE COATED AREA WITH FINGERS OR OBJECTS. HOLD THE ASSEMBLY ONLY BY THE EDGES, THE HANDLES, THE UNCOATED SURFACES, OR BY WIRE HOOKS THROUGH THE DATUM HOLES. DO NOT LAY THE COATED SURFACES ON WORK SURFACES. IF A MOISTURE BARRIER COATED ASSEMBLY IS TOUCHED, CONTAMINATED, OR LAID DOWN ON A WORK SURFACE, IT MUST BE WASHED IN DEIONIZED WATER AND THEN RECOATED WITH MOISTURE BARRIER.

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Figure 3-4. (Sheet 7 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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- CAUTION 2:** SALTS FROM HUMAN SKIN CAUSE CORROSION. DO NOT TOUCH ASSEMBLIES THAT ARE MOISTURE BARRIER COATED OR ARE TO BE COATED. USE CLEAN, UNCONTAMINATED FINGER COTS OR GLOVES. THIS CAUTION APPLIES TO BOTH COATED AND UNCOATED SURFACES OF THE ASSEMBLIES, AND WORK SURFACES IN THE AREAS WHERE COATING IS PERFORMED.
- CAUTION 3:** IF ASSEMBLIES CONTAIN ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) ITEMS, USE ESDS PROTECTIVE PROCEDURES.
- CAUTION 4:** THE TABLE TOP IN THE CCA DRYING AREA IS CONTAMINATED WITH MOISTURE BARRIER. DO NOT SET OBJECTS DOWN IN THIS OR OTHER CONTAMINATED AREAS.
- CAUTION 5:** UNCURED, HOT, OR SOFT ACRYLIC CONFORMAL COATING TYPE AR (HMN 98P6478) WILL CONTAMINATE THE MOISTURE BARRIER DIP TANK. IF USED, MAKE SURE THE CONFORMAL COATING IS FULLY HARDENED AND AT ROOM TEMPERATURE BEFORE THE MOISTURE BARRIER FILM IS APPLIED.
- CAUTION 6:** MOISTURE BARRIER REPELS OILS AND OTHER LUBRICANTS. DO NOT ALLOW MOISTURE BARRIER TO COME IN CONTACT WITH LUBRICATED PARTS OR BEARINGS, INCLUDING FAN BEARINGS, RACE LANDS, RACE SEPARATORS, BALLS OR BALL GROVES.
- CAUTION 7:** DO NOT APPLY MOISTURE BARRIER TO CONNECTORS EXCEPT AS SPECIFIED BY THE HONEYWELL PRODUCT DESIGN DATA. MOISTURE BARRIER APPLIED TO FEMALE CONNECTORS CAN WICK UP INTO THE BARRELS BY CAPILLARY ACTION AND CAN CAUSE INTERMITTENT CONNECTIONS IN LOW CONTACT FORCE CONNECTORS. DO NOT ALLOW THE MOISTURE BARRIER TO WICK INTO THE CONTACT AREA THROUGH THE BACK OF OPEN CONNECTORS.
- CAUTION 8:** MOISTURE BARRIER HAS NOT BEEN QUALIFIED FOR USE IN SOCKETS FOR SURFACE MOUNT PARTS. ITS RELIABILITY IN SUCH APPLICATIONS IS UNKNOWN.
- CAUTION 9:** AN ASSEMBLY WITH MOUNTING SURFACES USED FOR THERMAL (HEAT SINK) TRANSFER REQUIRES SPECIAL HANDLING. DO NOT COAT THE MOUNTING SURFACE OF THE HEAT SINK THAT IS NORMALLY COATED WITH THERMAL (SILICONE) LUBRICANT (OR COVERED WITH A THERMAL PAD) WITH THE MOISTURE BARRIER FILM. DO NOT LET THE SILICONE LUBRICANT CONTAMINATE THE DIP TANK.

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Figure 3-4. (Sheet 8 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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NOTE 1: If the amount or types of materials used changes notify the Health, Safety and Environment (HSE) Representative so that the site Air Permit can be reviewed to determine if a minor modification to the permit is required.

NOTE 2: Health, Safety, and Environment (HSE) must approve (sign the Change Order and Engineering Release) changes to this Engineering Bulletin.

- A. The warnings, cautions, and notes that precede this paragraph apply to all moisture barrier procedures.
- B. Assemblies that have a warning label Honeywell Part No. 7006940-44 have been coated with moisture barrier Honeywell material code 11A8978, 11A8578, 11A8178, 11A8878 or 11A9678.
- C. Use these procedures in conjunction with the applicable manufacturer's instructions to remove and apply the moisture barrier. When the manufacturers instructions and the Honeywell instructions are not the same, use the Honeywell instructions. An example of this is: The manufacturer instructions recommend coating connectors. Honeywell does not generally coat circuit card connector contacts because the moisture barrier, when present in sufficient amounts in the female contact area of low contact force connectors, has been shown to be a cause of intermittent connections.
- D. Honeywell product design data requirements take precedence over both these procedures and the manufacturers instructions.
- E. Three methods of moisture barrier coating are described:
 - Dip method
 - Pour method
 - Spray method
- F. The dip method, where it can be used, is the preferred method of moisture barrier application. The dip method is the best method to get the material under components and into small areas. When possible, use the dip method to apply the moisture barrier if:
 - The assembly is not yet installed in the chassis, is easily removed from the chassis, or needs to be removed,
 - The assembly can be reinstalled in the chassis without touching the coated surfaces, or can be touched up after assembly,
 - Location of connectors, heatsinks, fans, and other keep out areas does not prevent the use of the dip method.
- G. The pour method is second choice.
- H. Spray is third choice. It should only be used for touchup/rework. It is most often used for motherboard and other assemblies that are difficult to remove from or install into the rack or a higher level assembly. Such assemblies can be sprayed while they are in the rack or higher level assembly.

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Figure 3-4. (Sheet 9 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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- I. For many assemblies, a combination gives the best coverage:
- Most common is a partial dip, with the pour method subsequently used to get coverage in the areas that can not be submersed.
 - For some assemblies, the dip, the dip-pour, or the pour method is used first. The assembly is then put into the rack or higher level assembly and sprayed. This is most often applicable to assemblies where only one side can be sprayed after it is installed in the rack or higher level assembly, or where it is difficult to install without touching the assembly.
 - In cases where it is not possible to spray an assembly after it is installed in the rack, it may be necessary to touch up a coated assembly after it is installed by using a brush, syringe, cotton tipped swap, or other suitable applicator.

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Figure 3-4. (Sheet 10 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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5. PREPARATION FOR APPLICATION OF MOISTURE BARRIER FILM

5.1 Disassemble, Inspect, and if Necessary Pre-Clean:

5.1.1 **Assemblies:**

- A. Remove all covers and plug-in subassemblies.
- B. Inspect for dirt, contaminants etc.
- C. New production (Part 21) CCA assemblies that have been handled in a manner that avoids contamination by salts or other materials do not require pre-cleaning prior to coating with moisture barrier, and the dionized wash (section 5.2) can be skipped.
- D. If the assembly is contaminated with salts or other substances that can be removed by a dionized water wash, then see section 5.2. All rack assemblies must be washed in dionized water prior to moisture barrier coat application. Part 21 (production) assemblies contaminated during repair etc. must be washed. Part 145 (field) assemblies must be washed.
- E. If the assembly is contaminated with materials that will not be removed by the dionized water wash, then an additional pre-clean is necessary. Use toluene (HMN 1112378), acetone (HMN 1111978), isopropyl alcohol (HMN 1130778) or other solvent appropriate for the material to be cleaned. A brush, cotton swap, wiper (HMN 6006776), or other appropriate aide to mechanical removal of the dirt may also be required. After precleaning, wash the assembly in dionized water as described in paragraph 5.2.
- F. If the assembly uses conformal coating, apply the conformal coating prior to application of the moisture barrier coating.

5.1.2 **Socketed Parts:**

- A. If an assembly with socketed parts is to be cleaned with dionized water remove the socketed parts and clean them separately.
- B. If socketed parts or sockets are contaminated with salts or other substances that can be removed by a dionized water wash, remove the socketed parts and clean them and the sockets. See also section 5.2.
- C. If necessary, use toluene (HMN 1112378) to clean the leads of socketed parts and sockets. In Part 145 field shops that can not use toluene, acetone (HMN 1111978) may be used.
- D. Socketed through hole integrated circuits may be coated while the socketed parts are in the sockets. Otherwise, consult the product design documentation for instructions.

5.2 Dionized Water Wash:

Salts (from human skin and other surfaces) and other contaminants cause corrosion. The purpose of the dionized water wash is to remove salts and other contaminants, including those deposited by touching the assembly during manufacture, transport, or repair. The dionized water wash also prevents contamination of the moisture barrier material in the dip tank.

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Figure 3-4. (Sheet 11 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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- A. If the assembly contains a fan or other lubricated assembly remove the lubricated assembly or protect it. Do not spray the fan or other lubricated parts with the dionized water. Use a plastic shield or some other suitable method to protect them.
- B. Use a clean washtub such as T3078255 or equivalent.
- C. Vigorously spray pressurized dionized water on all sides of the item to be cleaned.
- D. Blow out water with an ionized air hose.
- E. Also wash the totes etc. that will be used to transport the clean sub assemblies.

CAUTION: DO NOT TOUCH THE WASHED ITEMS WITH BARE HANDS OR CONTAMINATED GLOVES OR FINGER COTS OR LAY THEM ON A CONTAMINATED WORK SURFACE AFTER THEY ARE WASHED AND BEFORE THEY ARE COATED WITH MOISTURE BARRIER. IF YOU DO, THE ITEMS ARE CONTAMINATED AND THEY MUST BE WASHED AGAIN.

5.3 **Bake and Inspect the Items as Follows:**

CAUTION 1: THE OVEN MUST BE VENTED WITH AN OUTSIDE SOURCE OF DRY AIR. IF THE OVEN IS NOT VENTED, MOISTURE WILL BE ABSORBED AND TRAPPED WHEN THE MOISTURE BARRIER IS APPLIED.

CAUTION 2: MOISTURE OR SOLVENTS TRAPPED UNDER THE MOISTURE BARRIER (IN ACRYLIC CONFORMAL COAT OR ELSEWHERE) MAY CONTRIBUTE TO BUBBLING IN THE CONFORMAL COAT DURING HIGH TEMPERATURE CYCLING OR MAY CONTRIBUTE TO CORROSION.

CAUTION 3: VENTED ELECTROLYTIC CAPACITORS AND OTHER COMPONENTS CAN BE DAMAGED BY EXCESS HEAT. DO NOT BAKE ASSEMBLIES OR COMPONENTS AT TEMPERATURES IN EXCESS OF THEIR MANUFACTURER RATINGS UNLESS ALLOWED BY HONEYWELL PRODUCT DESIGN DOCUMENTATION.

- A. Bake assemblies with components that are manufacturer rated to 125 °C in a vented oven for 2 hours at 220 ± 10 °F (104 ± 5 °C) or per the Honeywell design documentation.
- B. Bake assemblies with components that are not manufacturer rated to 125 °C per the Honeywell design documentation.
- C. Let the items cool at room temperature for a minimum of 2 hours, or until room temperature is reached, whichever is longer.
- D. Insert socketed integrated circuits into associated sockets.
- E. Go to paragraph 6 or 7 as applicable.

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Figure 3-4. (Sheet 12 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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6. APPLICATION OF MOISTURE BARRIER FILM USING A DIP TANK OR PAN

6.1 Apply Warning Label

Attach a warning label, Part No. 7006940-44 to the assembly. If possible, the label should be readable when the sub-assembly is installed in a next higher assembly. If possible, apply the label to the assembly extractor handle. Clean the area and attach the label. If applied over the top of conformal coating and if necessary, apply conformal coating over the label. Allow sufficient time for the conformal coating to completely cure.

6.2 Mask

- A. Mask areas that must be well protected from contamination by moisture barrier.
- B. Use polyester tape HMN 29P7620 or other suitable material.
- C. Masking is not generally required for sockets with through hole integrated circuits in them.
- D. Mask the exposed thermal contact surfaces of heatsinks.
- E. Mask fans and other items with bearings or lubricated parts.
- F. If masking will not adequately protect an item (such as a fan) and it can be removed, remove the item. Re-install after coating.
- G. Keep out areas that are not in danger of contamination by moisture barrier coating may not need to be masked. For instance, on assemblies to be dipped components above the dip line do not generally need to be masked.

6.3 Decide Dip vs. Pour:

There are multiple ways to use the dip tank or pan:

- A. Dip the assembly into the tank or pan.
Use the dip method if:
 - The assembly fits in the tank or pan without submerging the connectors or surface mount style components that are socketed or heat sink contact surfaces or fans or bearings or lubricated parts or masked areas or other areas that can not be dipped.
 - The assembly has through hole style components that are plugged into sockets or are soldered.
 - Do not use the dip method if the assembly can not be submerged or partially submerged without submerging areas that can not be dipped.
- B. Hold the assembly above the tank or pan and pour the moisture barrier over the applicable areas of the assembly.
Use the pour method if:
 - The assembly is too large to fit into the dip tank or pan.
 - The assembly can not be dipped without submerging the connectors or other areas that should not be dipped.

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Figure 3-4. (Sheet 13 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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C. A combination of the above methods may be used.

6.4 General Instructions:

- A. The moisture barrier is expensive. More moisture barrier can be lost to evaporation than is used to coat the assemblies.
 - Do not leave the dip tank or pan uncovered longer than necessary.
 - Have the assembly or assemblies prepared for moisture barrier application and immediately available before you remove the dip tank or pan cover.
 - Dip each assembly in succession.
 - Close (and latch, if applicable) the tank or pan cover immediately after the moisture barrier is applied.
- B. When the tank or pan is first uncovered and before each assembly is dipped, inspect the moisture barrier solution in the tank or pan. Skim the surface to remove any floating contaminants. If necessary, filter the solution in the tank or pan as described in paragraph 11.
- C. Keep the tank or pan cover clean. Do not set it down in a contaminated area.

CAUTION: UNCURED OR HOT TYPE AR CONFORMAL COATING (HMN 98P6478) CONTAMINATES THE MOISTURE BARRIER SOLUTION DIP TANK. IF TYPE AR CONFORMAL COATING IS USED, MAKE SURE THE CONFORMAL COATING IS FULLY HARDENED AND AT ROOM TEMPERATURE BEFORE THE MOISTURE BARRIER FILM IS APPLIED.

6.5 Detailed Instructions:

- A. Wear clean uncontaminated ESD safe vinyl gloves or finger cots during moisture barrier film application.
- B. Thoroughly spray all sides of the assembly with the ionic air source to remove dust.
- C. If the assembly is to be dipped, insert the hooked ends of wire hangers into the assembly datum holes. For assemblies with connectors that can not be dipped that are along one edge of the assembly, use the holes on the edge of the board near the connectors, so that the connectors are at the top. Do not submerge connectors unless the product design documentation allows it. During dipping, handle the assembly only by the wire hangers.
- D. For assemblies that get a partial dip or pour, it is often easier to hold the assembly by an uncoated surface than it is to suspend them from wire hangers. After the assembly is coated, if necessary touch up the area where the assembly was held.
- E. Open the cover on the moisture barrier dip tank T-3078222, tank T-336287, pan, or equivalent.
- F. Dip the assembly in the moisture barrier or use a scoop to pour moisture barrier over the applicable areas of the assembly.

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Figure 3-4. (Sheet 14 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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- G. For shallow tanks such as T-336287 or where a pan is used, it may be easiest to position the assembly in the tank or pan first, and then pour moisture barrier into the tank or pan up to the appropriate depth.
- H. Do not let the moisture barrier touch connector pins or socketed surface mount style component pins or the contact portion of heatsinks or other keep out areas.
- I. Do not let the moisture barrier wick into connectors.
- J. Submerge the assembly at a rate of speed slow enough to avoid trapping air bubbles under components etc.
- K. While submerged, shake and bump or tap the assembly gently to remove any air bubbles that might become trapped under components etc.
- L. Avoid touching the T-3078222 (vertical) tank with the assembly.
- M. Gently remove the assembly from the dip tank or pan at a rate of speed slow enough to minimize trapping moisture barrier under components etc.
- N. Hold the assembly over the tank or pan long enough to allow the excess moisture barrier to drip back into the tank or pan.
- O. If necessary, use the ionic air gun to blow out any moisture barrier that may have inappropriately collected in connector barrels.
- P. Use wire hangers to hang the assembly up to dry.
- Q. The liquid moisture barrier has a very high rate of evaporation. Do not leave the tank or pan uncovered longer than necessary. If the tank or pan has a lid, cover the tank or pan as soon as practical.
- R. If the tank or pan is not designed for long term storage of the material, empty the tank or pan as soon as practical:
 - Pour the used moisture barrier solution into a clean marked glass storage container through a paper filter (Fisher Part No. 09-832L or equivalent).
 - Put a cap on the container.
 - Keep the used moisture barrier solution in a separate container from the one that has new moisture barrier solution. Mark the container appropriately.
 - The used moisture barrier solution can be used again in a dip tank or pan, but not in an airbrush (because the airbrush can become clogged with contaminants).
- S. Let the assembly dry for 5 minutes minimum.
- T. After the assembly is dry:
 - Remove the masking materials.
 - If necessary inspect the assembly (see section 10.4.3). Touch it up as needed.
 - And then immediately assemble it into the rack or next higher assembly. Do not set it down on work surfaces.
 - Inspect the assembly again and touch it up as needed.

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Figure 3-4. (Sheet 15 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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7. APPLICATION OF MOISTURE BARRIER FILM USING THE SPRAY METHOD

- A. Attach a warning label, Part No. 7006940-44 to the assembly to be coated. If possible, the label should be readable when the sub-assembly is installed in a next higher assembly. If possible, apply the label to the assembly extractor handle. Clean the area, attach the label, and if necessary, apply conformal coating over the label. Allow sufficient time for the conformal coating to completely cure.

- B. Mask areas that must be well protected from contamination by moisture barrier, including:

- connectors (especially low contact force female connectors),
- surface mount sockets and socketed surface mount parts.
- heat sink thermal contact surfaces,
- LRU painted surfaces,
- fans, rack hold down mechanisms and other lubricated parts or parts with bearings.

Use masking paper HMN 60D3817 for large areas that are not ESD sensitive, such as the outside of an LRU. Use polyester tape HMN 29P7620 or other suitable material for smaller areas and to secure the masking paper.

- C. Thoroughly spray all sides of the assembly with the ionic air source to remove dust.

- D. Hold the nozzle of the airbrush approximately 3 inches from the board surface. Spray the component side of the assembly with smooth length wise strokes. Where possible each stroke should overlap the previous stroke by 50%. Where possible repeat using width-wise strokes. The two stroke directions should be perpendicular. Repeat the process for the backside of the assembly. Do not spray into the connectors.

- E. Spray and flow material from multiple sides of the components as necessary to assure that shadowing does not occur. Use sufficient moisture barrier to completely wet down, around, and under components, connectors, wire wrap pins, printed wiring board surfaces, etc. Deposit sufficient liquid on the board near the components so that the liquid runs under the components. Repeat this process from different angles so that IC pins and other obstructions to material flow do not cause areas of no coverage.

- F. On some assemblies containing connectors (such as motherboards), it is not possible to hold the airbrush 3 inches from the board surface without getting moisture barrier into the connectors. Hold the airbrush as close as necessary to avoid getting the moisture barrier into the connectors. Where possible coat under connectors, but do not let moisture barrier wick into connectors.

- G. Wires, wire harnesses and ribbon cables should generally be thoroughly coated along their entire length where reasonable to do so. This improves resistance to water condensing on/in the assembly and then migrating to less benign locations. The ends (approximately the last ½ inch) of all insulated wires and wire harnesses must be thoroughly coated. The interiors of wire harnesses more than approximately 1/2 inch from the ends need not be fully coated.

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Figure 3-4. (Sheet 16 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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- H. Hang the assembly up to dry.
- I. Let the assembly dry for 5 minutes.
- J. After the assembly is dry:
 - Remove the masking materials.
 - If necessary inspect the assembly (see section 10.4.3). Touch it up as needed.
 - And then immediately assemble it into the rack or next higher assembly. Do not set it down on work surfaces.
 - Inspect the assembly again and touch it up as needed.
- K. If necessary clean keep out areas with an appropriate solvent. Painted surfaces (such as the external surfaces of an LRU) can be cleaned with glass cleaner (HMN 11P0678 or equivalent).
- L. Clean the airbrush after each group of assemblies is complete. To clean the airbrush, rinse it with solvent type 509 (HMN 11A9078) and spray the solvent through the airbrush.

8. ATTACH WARNING LABELS TO THE LRU

The LRU documentation should specify that two moisture barrier warning labels Part No. 7006940-44 are necessary on the outside of the LRU. One is located in a prominent location on the body of the LRU. The second label is typically applied across the cover and the body of the LRU to make a seal that is broken when the cover is removed.

9. REMOVAL OF MOISTURE BARRIER FILM

- A. Before you change an assembly that is coated with moisture barrier, the moisture barrier must be removed from the area you change.
- B. To remove the moisture barrier, use solvent 509 (HMN 11A9078).
- C. If the assembly has conformal coating under the moisture barrier, remove the conformal coating after the moisture barrier film is removed.
- D. For small areas, toluene (HMN 1112378) can be used to remove both moisture barrier and type AR conformal coat (HMN 98P6478) simultaneously.
- E. For connectors or where moisture barrier is mixed with conformal coat or other contaminants, repeated application of solvent 509 and then a conformal coat solvent may be necessary. Agitation and use of a brush, kimwipes, etc. may be necessary.

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Figure 3-4. (Sheet 17 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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10. INSPECTION OF MOISTURE BARRIER FILM

10.1 Minimum Thickness Requirement

When applied to a flat non-porous surface the dry moisture barrier coating is only a few molecules thick - too thin to measure using mechanical methods. Therefore, there is no minimum inspectable thickness of the dry coating.

10.2 Visual Appearance

The moisture barrier coating is very difficult to see with the naked eye. On a flat surface in white light, if the incident light angle (the angle between the light beam and a line perpendicular to the surface of the item) is sufficiently large, a slight rainbow effect can sometimes be seen due to the refraction of the light. The effect is similar to that seen on an oily window. The effect is very faint, and can not be used to inspect for quality of the coverage.

10.3 Verification of Coverage During Application

Verify coverage during application by visually confirming that all surfaces to be covered are thoroughly wetted with the liquid moisture barrier:

- In the dip tank: Visually confirm depth of dip and release of any air bubbles.
- Pour and spray methods: Visually confirm that the liquid liberally flows over, under, and around the surfaces to be covered.

10.4 Ultraviolet (UV) or Blacklight Inspection Considerations

10.4.1 Moisture Barrier Coating Types P (HMN 11A9678), L (HMN 11A8978) and Q (HMN 11A8578)

- Moisture barrier types P, L and Q do not contain ultraviolet light sensitive dye.
- The product design documentation should specify moisture barrier Type P where it is necessary to apply moisture barrier over a conformal coat that contains a UV light sensitive dye.
- Ultraviolet light inspection techniques cannot be used to inspect moisture barrier types P, L and Q coverage.

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Figure 3-4. (Sheet 18 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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10.4.2 Moisture Barrier Types P, L and Q Applied Over UV Light Sensitive Conformal Coatings

When a dip tank is used to apply moisture barrier type P, L or Q over conformal coatings that use a UV sensitive dye, care must be exercised when subsequently inspecting the conformal coat using UV light:

- The solvents used as the carrier for the type P, L or Q moisture barrier in liquid form leaches the UV sensitive dye out of type AR (acrylic) conformal coat (HMN 98P6478).
- After a sufficient number of assemblies coated with HMN 98P6478 have been dipped in moisture barrier type P, L or Q, the moisture barrier in the tank will contain UV sensitive dye.
- The UV sensitive dye in the moisture barrier dip tank may be deposited on assemblies subsequently dipped. Connectors and other non-flat or complex shaped surfaces that "trap" a large quantity of moisture barrier material may show a UV response if the moisture barrier material contains a sufficient amount of UV dye.
- The dye is generally too dilute to interfere with conformal coat inspection using the UV light.
- When inspecting conformal coat using UV light, visually confirm that conformal coat keep out areas that are moisture barrier coated are not UV light sensitive. If they are, then closer examination is necessary to determine whether the UV response is due to conformal coat or if it might be due to dye in the moisture barrier coat. If the UV light response is due to dye in the moisture barrier coat then UV light can not be used to inspect the conformal coat.
- UV light inspection techniques are not a reliable method for distinguishing between type AR conformal coat and fluorocarbon film moisture barrier on or in connectors and other non-flat (complex-shaped) surfaces.

10.4.3 Moisture Barrier Coating Type LV (HMN 11A9178) or V (HMN 11A8878)

- Moisture barrier coating type LV (HMN 11A9178) or V (HMN 11A8878) contains UV light sensitive dye.
- The product design documentation may specify moisture barrier type LV or V for applications where it UV inspection was required.
- Ultraviolet light can be used to inspect for coverage of previous applications of moisture barrier type LV or V.

10.5 Training and Process Audits

- A. The Health, Safety, and Environment (HSE) organization and Quality Engineering shall establish training and process audit requirements.
- B. See also section 11.D.

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Figure 3-4. (Sheet 19 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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11. KEEP THE MOISTURE BARRIER TANK CLEAN

- A. When the tank is first opened and before each assembly is dipped, inspect the moisture barrier solution in the tank. Skim the surface to remove any floating contaminants. If necessary, filter the solution in the tank as described below.
- B. The moisture barrier solution in the tank must be filtered periodically. Filtering is done by pouring the tank contents through a paper filter such as Fisher Part No. 09-832L and into a clean glass jug. Then return the solution to the tank.
- C. Completely replace the moisture barrier material in the T3078222 vertical dip tank after approximately 225 full size CCA's are dipped.
 - Maintain a log to track the total number of dipped CCA's since the last time that the tank contents have been replaced. Keep the log near the dip tank.
 - Also make a log entry when the material in the tank is completely filtered.
 - A full size CCA is one that largely fills the tank.
 - Smaller CCA's can be tracked as full size CCA equivalents. For instance, two CCA's that are approximately $\frac{1}{2}$ the size of a full size CCA can be counted as one full size CCA.
 - Do not track fractional counts. Round to the nearest whole number.
- D. The moisture barrier material from the dip tank should be audited for NaCl contamination at intervals to be determined by Quality Engineering.
- E. Moisture barrier may be added to the tank as necessary to replace consumed material.

12. KEEP THE AIR BRUSH CLEAN

Clean the airbrush after each group of assemblies is completed using solvent 509 (HMN 11A9078). Spray the solvent through the airbrush and then clean the outside of the airbrush.

13. MATERIAL CONCENTRATION AND SOLVENTS

- A. Use type V (HMN 11A8878), type L (HMN 11A8978), type Q (HMN 11A8578) and type P (HMN 11A9678) liquid moisture barrier in 1.0% concentration (1.0% moisture barrier, 99% liquid carrier).
- B. Type Q and L moisture barrier (HMN 11A8578 and 11A8978) may be purchased as 1.0% concentration, or it may be purchased in higher concentration and diluted using solvent 504 (HMN 11A8678).
- C. Type V moisture barrier (HMN 11A8878) must be purchased as 1.0% concentration. There is no commercially available solvent that can be used to dilute higher concentrations.

NOTE: Solvent 504 (HMN 11A8678) can be used to strip either moisture barrier material, but not dilute type V material. The reason is that solvent 504 will not dissolve the UV light sensitive dye in the type V material. The concentration of the dye is low enough that it does not affect material removal by the solvent.

- D. Type P moisture barrier (HMN 11A9678) may be purchased as 1.0% concentration, or it may be purchased in higher concentration and diluted using solvent 509 (HMN 11A9078).

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Figure 3-4. (Sheet 20 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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14. DATA RIGHTS NOTATIONS

The use of fluorinated film moisture barrier in Honeywell products is a proprietary/trade secret. Use appropriate data rights notations on all documents including design data and service bulletins. See page CR-1 of this document for an example data rights statement.

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Figure 3-4. (Sheet 21 of 21) Application/Removal Guidelines for Moisture Barrier Coatings

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SECTION 4 – CCA/ECA/PWB REPAIR AND COMPONENT REPLACEMENT

1. Overview

CAUTION: DO NOT USE THE PROCEDURES IN THIS SECTION TO REPAIR PWBS THAT USE SURFACE MOUNT TECHNOLOGY (SMT). REFER TO SECTION 13, SURFACE MOUNT TECHNOLOGY.

A. General

- (1) This section includes instructions to repair single-sided, double-sided, or multilayered circuit card assemblies (CCA)s, electronic component assemblies (ECA)s, and printed wiring boards (PWB)s. It also includes instructions for component installation and preparation.
- (2) If you have CCAs or ECAs with PWB laminate damage, do not try to repair them. Contact Honeywell for an applicable procedure to discard them.

B. Equipment and Materials

- (1) Refer to Table 4-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 4-2 for miscellaneous materials. Refer to Section 6, SOLDERING AND WIRE-WRAP, for approved soldering and wire-wrap materials.

- (3) Equivalent alternatives are permitted for equipment and materials.

Table 4-1. Equipment for CCA/ECA/PWB Repair and Component Replacement

Item	Description	Source
Desolder equipment	STA-TEMP Desolder System with appropriate replaceable tip cartridges	CAGE: 47882
Solder equipment	STA-TEMP Model STSS-002 Solder System with appropriate replaceable tip cartridges	
Brush	Gold plating equipment	Commercially available
Repair kit	Master Track, Part No. 2570-4000, automated	CAGE: 57216
Brush	Soft natural-bristle (MIL-S-43871)	Commercially available
DIP insertion tool	Pliers-type	
Crimp tool	Snap-in (optional)	
Solder pot		

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Table 4-2. Miscellaneous Materials for Standard Repair

Item	Description	Source
1112378	Solvent, toluene, technical grade per A-A-59107 (certified to contain 1 percent or less benzene)	Commercially available
1113678	Isopropanol, Technical, per MIL TT-I-735, Grade B	
11P1478	Epoxy thinner, T-262A	Commercially available
2010814	Tape, flat braided for lacing and tying, 0.XXX-inch wide and 0.YYY-inch thick (A-A-52081, - polyester yarn, finish C - impregnated with synthetic rubberized polyester, size ?)	Commercially available
20A0114	Tape, black, lacing and tying, flat braided, 0.XXX-inch wide and 0.YYY-inch thick (A-A-52080, Type I - nylon yarn, finish C - impregnated with synthetic rubber, size ?)	Commercially available
2914532	Tubing, flexible TFE (AMS 3654), NATURAL color, inside diameter = X.XXX (size Y)	Commercially available
2932532	3M sleeving, nonrigid, insulation, crosslinked, flexible, polyolefin, heat shrinkable, electrical, CLR (flammable), 0.XXX-inch inside diameter (MIL-I-23053/5, Class 2)	Commercially available
57002XX	Wire, uninsulated, soft, tin-coated, electrical hookup, [Federal Specification QQ-W-343, Type H (Part No. QQW343HXXS1T, AWG = XX) even gauges only]	Commercially available
57C01XX	Wire, kapton-insulated, special, AWG XX — Part No. H32015-YY	CAGE: 17217
57P29XX-C	Wire, extruded PTFE with fluorocarbon/polyimide tape insulation, solid conductor, AWG XX, YYY	CAGE: 17217
6008676	Lint free cloth - Bluewipes, No. TX 512	Commercially available
60A1676	Gloves, assembly (cotton blend), unhemmed, ladies Size No. 8810; mens Size No. 8812; or jumbo Size No. J27	Commercially available
60A9476	Finger cots, rolled, static dissipative — No. 8C-800	Commercially available

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Table 4-2. Miscellaneous Materials for Standard Repair (Cont)

Item	Description	Source
95C0878	Ink, flat WHT, epoxy base resin and amine-type catalyst (FED-STD-595 color 37875) - No. 50-041886, REV B with catalyst No. 20 (95P4874)	Commercially available
95P1978	Ink, black marking, epoxy base resin and amine-type catalyst (FED-STD-595 color 37038) - No. 50-710-R black CAT-L-INK with catalyst No. 20	Commercially available
95P3778	Marking ink, black, Markem No. 6817 per A-A-208	Commercially available
95P4578	Marking ink, black, Markem No. 7261 per A-A-208	
95P4678	Catalyst No. 2 per P695852	CAGE:1RXP5
95P4778	Catalyst No. 9 per P695852	
95P4878	Catalyst No. 20 per P695852	
95P5678	Marking ink, white, Markem 7224 FRS per TT-I-1975, Type I, color per Fed STD-595, 17875	Commercially available
95P6078	Marking ink, vivid orange, Markem 7224 FRS per TT-I-1975, Type I	
95P6678	Marking ink, white, Markem 6817 per P2597605-434 (Markem 6811 and 6819 discontinued)	
9702878	Adhesive, epoxy (Federal Specification MMM-A-134, Type I) — A-1177B (two parts)	Commercially available
97A0978	Adhesive, solventless, rapid room-temperature curing (MIL-A-46050, Type II - ethyl-2-cyanoacrylate, Class 2 - medium viscosity) — Loctite Superbond 414	Commercially available
97A2578	Curing accelerator (MIL-A-46050, Type IIA) — No. 710 Tak-Pac Accelerator	
97C2578	Chip bonding adhesive, Loctite No. 360 Chipbonder	Commercially available
97C3778	Adhesive, paste, two-part, A-1273-B per MMM-A-132, Type I, class 3, form P, group 1.	Commercially available
97C4478	Adhesive, epoxy resin, Loctite No. 348 Chipbonder	Commercially available

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Table 4-2. Miscellaneous Materials for Standard Repair (Cont)

Item	Description	Source
97P4378	Adhesive, epoxy — LCA-4LV/BA-9 (NATURAL)	Commercially available
NOTES: 1 Deleted. 2 Deleted.		

2. Procedure

CAUTION: PRODUCTION CRITICAL:

USE THE ILLUSTRATED PARTS LIST OF THE APPLICABLE CMM TO IDENTIFY THE PRESENCE OF A CORRECT CRITICAL PART ON THE CCA. THIS FULFILLS ANY PRODUCTION CRITICAL REQUIREMENT.

CAUTION: USE COTTON GLOVES AND/OR STATIC DISSIPATIVE FINGER COTS TO PREVENT STATIC DISCHARGE DAMAGE OR CONTAMINATION FROM OILS OR PARTICLES ON THE SURFACES OF THE PWB.

A. General Cautions and Data About CCA/ECA/PWB Repair and Component Replacement Procedure

- (1) The cautions that precede this paragraph apply to all procedures in this section.
- (2) Unless specified differently, when a PWB is referred to in this procedure, it also applies to CCAs and ECAs.
- (3) If applicable, make sure the conformal coating is removed from the complete PWB, or the area on the board or assembly before you start the repair.
- (4) Refer to the applicable maintenance manual or engineering drawings for component location and maximum lead protrusion.

B. Repair of Socketed Parts, Parts Mounted on Pin Receptacles, and Removable Bus Bars

- (1) Electrical components are often mounted in sockets, or in pin receptacles with no socket body. In the paragraphs that follow, the term socketed part is used to indicate both mounting methods. The term pin receptacles is used to indicate only pin receptacles with no socket body.
- (2) If a socketed part is removed from a socket or from pin receptacles, inspect the barrels of the socket or pin receptacles for damage or foreign material before the socketed part is installed again. Inspect the socketed part and, if necessary:
 - Clean or replace the socket or pin receptacles
 - Clean and straighten the leads of the socketed part.
- (3) For all end items listed in Table 4-3, except as specified in the exceptions column, use any of the techniques that follow to make a field repair:
 - Replace the socket or pin receptacles.

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- Remove the socket, solder the component directly to the PWB.
 - If the pin receptacle is not necessary to let a heatsink pass under a component, remove the receptacle and solder the component directly to the PWB.
 - Solder the component into the socket or pin receptacle. This can be done one time. For subsequent repairs the components, socket, and pin receptacles can not be used again.
- (4) For all end items given in Table 4-3, the bus bars can be soldered to the pins if:
- The subassembly locations are not specified in the exceptions column
 - The end item uses removable bus bars, such as Honeywell Part No. 7005971-var.

Table 4-3. End Items for Socketed Parts Repair

End Item Model Number	End Item Part No.	Exceptions
SG-600/601/603/700/800/801/802/803	7003400-var	
SG-610/611/810/811	7004544-var	
PZ-800	7004609-var	
MG-600/603/800/803	7007061-var	
MG-610/611/810/811	7007321-var	
SG-820	7007356-var	
FC-880	7007484-var	
SG-884	7008570-var	
MG-820	7009289-var	
SG-605/705/805	7011672-var	Except at subassembly, Part No. 7013670-var, location U83 and subassembly Part No. 7011449-708, location U76
MG-605/805	7011673-var	Except at subassembly, Part No. 7013670-var, location U83 and subassembly Part No. 7011449-708, location U76
SG-815/816/817/818	7011764-var	
MG-815/816/817/818	7011765-var	
SG-806	7013788-var	Except at subassembly, Part No. 7013670-var, location U83 and subassembly Part No. 7011449-708, location U76
IZ-501	7020480-var	

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C. Preferred Repair of Circuit Run Breaks Larger Than 0.25 Inch (6.4 mm)

- (1) This procedure is optional for circuit run breaks less than 0.25 inch (6.4 mm).
 - (a) Fully clean the area with an approved solvent (1113678) and let the PWB air dry.
 - (b) Remove any solder from the area where you will make the repair.
 - (c) Cut the damaged run from the PWB surface so that any deformation of the run is also removed with the damaged run.
 - (d) Fully clean the area where the run was removed with an approved solvent (1113678). Let the PWB air dry.
 - (e) Clean the conformal coating and other contamination back 0.125 inch (3.18 mm) from the cut along the remaining run on both ends of the missing run with an approved cleaning solvent (1113678), and let the PWB air dry.
 - (f) Cut a pretinned replacement run from the sheet stock supplied in the Master Track Repair Kit, A.P.E. Corp. Part No. 2570-4000, so the replacement run is 0.25 inch (6.4 mm) longer than the area to be replaced.
 - (g) Place the pretinned replacement run so both ends overlap onto the initial run by 0.125 inch (3.18 mm). Lap solder both joints between the initial and replacement runs.
- NOTE:** Be careful when you clean flux residue from the replacement run.
- (h) Clean the flux residue from the solder connections, PWB base material, and below the replacement run.
 - (i) Bond the replacement run to the PWB base material with Super Bonder 414 adhesive (97A0978).

NOTE: TAK PAK accelerator (curing accelerator, 97A2578) can be used with Super Bonder 414 to decrease the curing time of the adhesive.

D. Minimum Repair of Circuit Run Breaks

- (1) For circuit run breaks of 1/4 or less, do as follows:
 - (a) Fully clean the area with an approved solvent (1113678) and let it air dry.
 - (b) Remove any solder from the area where you will make the repair.
 - (c) Cut an AWG 26, 28, or 30 insulated bus wire 0.25 inch (6.4 mm) longer than the break in the run.
 - (d) Solder the wire ends to the run on both sides of the break. Fully apply the epoxy adhesive (97P4378) to the connection.

NOTE: It is not necessary to apply adhesive coating on the bus wire if the run break is 0.25 inch (6.4 mm) or less.
- (2) For circuit run breaks greater than 0.25 inch (6.4 mm), do as follows:
 - (a) Fully clean the area with an approved solvent (1113678) and let it air dry.
 - (b) Remove any solder from the area where you will make the repair.

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- (c) Cut an AWG 30 (or other size wire as specified) insulated bus wire 0.25 inch (6.4 mm) longer than the break in the run.
- (d) If possible, put the bus wire under the components then attach and solder to the component leads. If not possible, solder the wire ends to the run and fully apply the epoxy adhesive (97P4378) to the connection.
- (e) If the bus wire is longer than 2.0 inches (51 mm), attach it to the PWB with epoxy adhesive (97P4378) every 2.0 inches (51 mm).

NOTE: If it is necessary to solder any of the adjacent circuit points and components, make sure you keep them away from the bus wires.

E. Replacement of Missing or Damaged PWB Terminals/Pads

- (1) Use the procedures in paragraph 2.C. to replace a missing or damaged PWB terminal/pad.

F. Repair of Double-Sided PWBs with Plated Through-Holes

- (1) Use the procedures in paragraphs 2.C. or 2.D.(1) to repair circuit runs of 0.25 inch (6.4 mm) or less.
- (2) Use the procedures in paragraph 2.D.(2) to repair circuit runs of more than 0.25 inch (6.4 mm).

NOTE: When possible, make sure bus wires are terminated in plated feed through holes or on component leads.

NOTE: If it is necessary to solder any of the adjacent circuit points and components, make sure you keep them away from the bus wires.

- (3) If a plated through-hole is present, make sure the repaired pad has continuity as follows:
 - For holes without components installed, install a clinched Z-shaped wire.
 - For holes where component leads are to be installed, install an eyelet of correct ID to fit the component lead ID.

G. Repair of Multilayer PWBs

- (1) Use the procedures in paragraphs 2.C. or 2.D. to repair the two outside layers only.
- (2) Circuit breaks in the inner layers have no standard repair procedures; these damaged PWBs must be discarded. Contact Honeywell for an applicable procedure to discard them.
- (3) A nonfunctional pad is one which has no circuitry attached. It is permitted to have up to a maximum of six missing nonfunctional pads per PWB because of repair, modification, or rework, as long as the plated through hole is in position and the pad on the reverse side of the PWB is not lifted or missing. If the damaged PWB has more than six missing nonfunctional pads, contact Honeywell for an applicable procedure to discard them.

H. Repair of PWBs With Lifted Runs or Terminal Areas/Pads

- (1) This procedure is applicable to PWBs that have runs or terminal areas/pads which lifted from the PWB during maintenance; do not use this procedure for anything other than as specified. The definition of a lifted run, terminal area, or pad is a gap of 0.004 inch (0.102 mm) or the thickness of the run, whichever is greater.

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- (2) Use this procedure for PWBs with 12 or less lifted runs, terminal areas/pads. If there are more than 12 lifted runs, contact Honeywell for an applicable procedure to discard the PWB.

- (a) Fully clean the terminal area with an approved solvent. Let the area air dry.
- (b) Apply a sufficient amount of Super Bonder 414 adhesive (97A0978) to cover the complete area and overlap onto the PWB. Let the PWB air dry.

NOTE: TAK PAK Accelerator (curing accelerator) (97A2578) can be used with Super Bonder 414 to reduce curing time of the adhesive.

I. Repair of Broken, Damaged, or Disconnected Bus (Jumper) Wires

- (1) General Data About Bus Wires

- (a) The list that follows gives data applicable to all bus wires.
- Do not repair broken, damaged, or disconnected bus wires, or try to reconnect them to their initial connection or terminal. You must replace them.
 - A maximum of two wires is permitted at any termination except dip component leads.
 - Make sure wires are not attached to the mating contact surfaces of connectors.
 - Use the shortest route possible when you route the wires.
 - Keep the quantity of wire crossings to a minimum.
 - Do not let wires that are added to the solder side of the PWB go across the component mounting holes.
 - Make sure all wires more than 0.50 inch (12.7 mm) long are insulated.
 - Make sure all wires that are over or near any conductive surface are insulated.
 - Unless specified differently, wires that are soldered immediately to a PWB run must be a minimum of 0.050 inch (1.27 mm) from the terminal area.

- (2) Procedure

- (a) Examine the length, routing, and special characteristics of the wire that you will replace.
- (b) Remove the wire and clean the area of flux and residue.
- (c) Cut a new wire the same length as the one you replace, plus a sufficient length to do two more repairs after initial installation.
- (d) Remove the initial insulation, or install sleeving to insulate the wire. Tin ends of the wire to prepare them before you solder.
- (e) Install the new wire.

J. Repair of Holes or Slots That are Too Large or Not Correct in the PWB

- (1) Fully clean the area around the hole or slot with an approved solvent, and let it air dry.

NOTE: If the location or the shape of the slot is not correct, you can drill a series of holes. Start with the two end holes first.



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- (2) Use a drill bit that is larger than the initial hole or slot, and drill a hole or slot in the PWB where the deformation is located. A No. 50 drill bit is recommended.
- (3) Prepare and apply A-1177B epoxy adhesive (9702878) in the drilled hole as follows:
 - (a) Mix epoxy adhesive as specified in Section 9, Mixing Adhesives, Sealants, and Compounds, and in the manufacturer's instructions.
 - (b) Apply nonstatic tape over one side of the new hole.
 - (c) Fill the drilled hole with the mixed epoxy adhesive. Let the adhesive set momentarily, then remove the tape.
 - (d) Cure the adhesive.

CAUTION: MAKE SURE YOU DRILL THE NEW HOLE OR SLOT IN THE CENTER TO PREVENT THE DRILL FROM GOING INTO RUNS AND PADS.

- (4) Put the drill bit in the center of the filled area and drill a new hole or slot. A recommended size for this operation is a No. 70 drill bit.

K. Repair of Shorts at Plated Through-Holes on Multilayer PWBs

- (1) Remove the components and/or wires as necessary.
- (2) Use a minimum drill bit to drill out the plated through-hole. Repeat this on the pad at the opposite end of the run if necessary.
- (3) Do a check to see if the short circuit is removed. If not, use a drill with a bigger drill bit and check again.
- (4) Prepare and apply A-1177B epoxy adhesive (9702878) in the drilled hole as follows:
 - (a) Mix epoxy adhesive as specified in Section 9, Mixing Adhesives, Sealants, and Compounds, and in the manufacturer's instructions.
 - (b) Apply nonstatic tape over one side of the new hole.
 - (c) Fill the drilled hole with the mixed epoxy adhesive. Let the adhesive set momentarily, then remove the tape.
 - (d) Cure the adhesive.

CAUTION: MAKE SURE YOU DRILL THE NEW HOLE OR SLOT IN THE CENTER TO PREVENT THE DRILL FROM GOING INTO RUNS AND PADS.

- (5) Put the pilot drill bit in the center of the filled area and drill a new hole or slot. Drill out the pilot hole with a drill bit approximately the same diameter of the ID of the initial plated hole.
- (6) Clean out the new hole with an approved cleaning solvent.
- (7) If necessary, replace any bus wires as specified in paragraph 2.I.
- (8) Install the components and/or wires that were removed in step (1) as necessary.
- (9) Do a check to make sure the continuity of all components and bus wires that were installed again has been reestablished.

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L. Repair of Shorts at Other Than Plated Through-Holes on Multilayer PWBs

- (1) Use a minimum drill bit when you drill on the PWB. Identify an area that will let you drill through the board and cut the shorted run.
- (2) If a drill can not be used, carefully mill to the depth in the PWB to clear the short.
- (3) Do a check to see if the short circuit is removed. If not, drill or mill again, then do one more check.
- (4) Prepare and apply A-1177B epoxy adhesive (9702878) in the hole as follows:
 - (a) Mix epoxy adhesive as specified in Section 9, Mixing Adhesives, Sealants, and Compounds, and in the manufacturer's instructions.
 - (b) Apply nonstatic tape over one side of the new drilled hole.
NOTE: Tape is not necessary on the milled hole.
 - (c) Fill the new hole with the mixed epoxy adhesive. Let the adhesive set momentarily, then remove the tape.
 - (d) Cure the adhesive.
- (5) If necessary, replace any bus wires as specified in paragraph 2.I.

WARNING: PLATING IS HARMFUL TO THE OPERATOR. DO NOT LET IT TOUCH THE SKIN. USE GLOVES AND AN APRON.

WARNING: PLATING VAPORS AND FUMES ARE HARMFUL. DO NOT BREATHE THE VAPORS OR MISTS FOR A LONG PERIOD OF TIME. WORK IN AN AREA THAT IS SUFFICIENTLY VENTILATED.

CAUTION: MAKE SURE THERE IS NO DAMAGE TO COMPONENTS ON THE CCA OR THE PWB BECAUSE OF ELECTRICAL CURRENT USED DURING THE PLATING PROCESS.

M. Repair of Gold Plate on Printed Contacts

- (1) Missing PWB printed contacts have no standard repair procedures. If the PWB with the contact needs to be replated, contact Honeywell for an applicable procedure to discard the damaged PWB.
- (2) Although it is not recommended, the procedure that follows gives instructions to refurbish or replace gold plating.
 - (a) Apply heat as necessary to melt and remove any solder that is present.
 - (b) Remove remaining solder residue with an abrasive equipped electric eraser. When you replace damaged or missing gold on PWB contacts, remove the gold in the same way.
 - (c) Clean the area with an approved solvent.
 - (d) Use locally available brush plating equipment to plate the area. Refer to the instructions supplied with the equipment.



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CAUTION: THE UNIT OR EQUIPMENT CAN CONTAIN ITEMS THAT ARE ELECTROSTATIC DISCHARGE SENSITIVE. IN THE ILLUSTRATED PARTS LIST OF THE APPLICABLE CMM, THESE ITEMS ARE IDENTIFIED AS ESDS. IF YOU DO NOT OBEY THE NECESSARY CONTROLS, A FAILURE OR UNSATISFACTORY OPERATION OF THE UNIT CAN OCCUR FROM ELECTROSTATIC DISCHARGE. USE APPROVED INDUSTRY PRECAUTIONS TO KEEP THE RISK OF DAMAGE TO A MINIMUM WHEN YOU TOUCH, REMOVE, OR INSERT PARTS OR ASSEMBLIES.

CAUTION: CLINCHED OR OTHER COMPONENT LEADS THAT PROTRUDE THROUGH THE PWB AND ARE NOT SUPPORTED BY A SUFFICIENT SOLDER FILLET ARE NOT ACCEPTABLE. IF YOU BEND THIS TYPE OF LEAD WHEN YOU MOVE IT, IT CAN SHORT WITH NONCOMMON TRACES.

N. Replacement or Installation of Discrete Components With Round Leads

(1) General Data About Discrete Components With Round Leads

- (a) The procedures in this section are for a component with round cross-sectional leads. Use other procedures for components such as dual inline packages (DIPs), single inline packages (SIPs), flat packs, trim pots, etc.
- (b) Look at how a component is installed and write notes and draw sketches. This will help when you install the new component. Contact Honeywell if there is not an applicable procedure for the removal of a component.
- (c) The list that follows gives data that is applicable to discrete components.
 - Component leads must not have any grease, dirt, paint, mold flash, and other contaminations.
 - Components with gold plated leads must be pretinned before the solder operation.
 - DIPs must lie flat on the PWB or thermal plane as near as their construction will allow.
 - Components with flexible leads supported by hardware must be dressed with a small amount of slack. However, make sure no exposed portion of the lead can creep to a position that violates specified minimum spacing requirements.
 - Wirewrap leads and wires must be mechanically attached to their terminals before the soldering operation begins.
 - Components that have identification bands, dots, or other designations must be mounted so all markings are visible and can be read in one direction, unless polarity or other functional requirements will not allow it.
 - Clearance between the end of any insulation and the solder connection must be as follows:

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- Minimum clearance - The insulation must not be imbedded in the solder joint. The contour of the conductor must be visible at the end of the insulation.
- Maximum clearance - The clearance between the end of the insulation and the solder joint must be less than two wire diameters or 0.060 inch (1.52 mm), whichever is larger.
- Component leads that must be clinched before the soldering operation must be bent so the angle between the PWB and the lead does not exceed 45 degrees and the air-gap between conductive materials (component lead and noncommon traces) is a minimum of 0.020 inch (0.51 mm).

CAUTION: IF THE EQUIPMENT HAS MOISTURE-SENSITIVE COMPONENTS, USE THE SPECIAL STORAGE PROCEDURES THAT FOLLOW FOR PROTECTION OF THESE COMPONENTS.

(2) Storage of Moisture-Sensitive Components

- (a) All plastic leaded chip carrier (PLCC) components with 28 leads or more are moisture sensitive. The components are moisture sensitive because they can absorb moisture during shipping and storage. When you install the components, the heat caused by the flow-solder procedure can make the moisture expand. When moisture expands, it can make the component defective.
- (b) Do the applicable procedures that follow when you use moisture-sensitive components:
 - 1 Install all moisture-sensitive components within 2 days after you remove them from the sealed bag.
 - 2 If you remove components from the sealed bag but do not use them within 2 days, do the applicable step that follows:
 - Put the components in a new bag, with new desiccant, and seal the bag.
 - Put the components in storage where the relative humidity is less than 25%.
 - 3 If the relative humidity increases to 30% or more and/or the date on the bag has expired before assembly to a board, do the applicable step that follows:
 - Bake individual components for 24 hours at 257 °F (125 °C).
 - Bake components that are taped on a reel at 113 °F (45 °C) to 11% moisture by component body weight.

(3) Removal of Discrete Components

- (a) If a component is present, apply heat as necessary to melt the solder and remove the component lead(s) from the PWB. Discard the component.

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- (b) Remove any remaining solder residue.
- (c) Bend the leads of the replacement component as shown in Figure 4-1 thru Figure 4-4. Refer to Table 4-4 for component lead formation bend radius.

CAUTION: MAKE SURE THE COMPONENT LEADS OF THE PIGGY-BACKED COMPONENT ARE SOLDERED TO THE APPLICABLE AREA OF THE HOST COMPONENT LEADS AS NECESSARY WHERE THE INITIAL COMPONENT WAS REMOVED. THIS WILL MAKE SURE THE MECHANICAL QUALITY OF THE SOLDER BOND IS CORRECT. (SEE FIGURE 4-5 AND FIGURE 4-6.)

CAUTION: DO NOT SOLDER THE LEADS TO THE BEND PART, WELDMENT, OR ON THE LEAD BETWEEN THE COMPONENT BODY AND WELDMENT. THIS WILL PREVENT ANY STRESS-RELATED FAILURES TO THE SOLDER JOINT.

- (4) Recommended Mounting for Discrete Components
 - (a) If necessary, install a clinch and solder individual discrete components.
 - (b) If necessary, install other components piggy-back, as shown in Figure 4-6. Refer to Table 4-4 for component lead formation bend radius.
- (5) Optional Mounting Procedures for Discrete Components
 - (a) Cut away the section of the PWB run that is longer than the component body.
 - (b) Bend the leads of the component as shown in Figure 4-1. Make sure that a minimum of 0.125 inch (3.18 mm) of the end of the component lead touches the PWB run surface. Also, the end of the component lead must be a minimum of 0.050 inch (1.27 mm) from the nearest terminal pad.
 - (c) Solder the component leads to the run on both sides of the cut as shown in Figure 4-7 and put epoxy adhesive (97P4378) on the connection.

CAUTION: MAKE SURE ANY COMPONENT BODY THAT IS NOT MOUNTED FLAT OR HANGS LOOSE IS ATTACHED WITH AN APPROVED ADHESIVE OR IS SPOT TIED TO THE PWB OR ANOTHER COMPONENT. THIS WILL KEEP THE COMPONENT MOUNTED CORRECTLY.

 - (d) Attach any component body that does not mount flat on the board surface to the PWB with epoxy adhesive (97P4378) as shown in Figure 4-7, or spot tie to the PWB or another component.

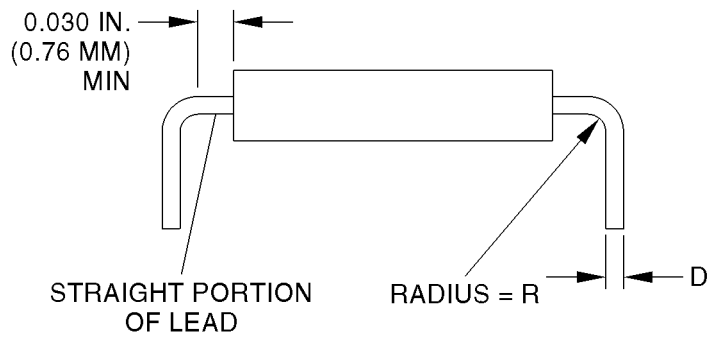
Table 4-4. Component Lead Formation Bend Radius Chart

Lead Diameter (D)	Minimum Lead Bend Radius (R)
≤ 0.027 inch (0.69 mm)	1.0 X diameter
0.028 to 0.047 inch (0.71 to 1.19 mm)	1.5 X diameter
≥ 0.048 inch (1.22 mm)	2.0 X diameter
NOTE: Use these dimensions in Figure 4-1, Figure 4-2, Figure 4-3, and Figure 4-4.	



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Figure 4-1. Axial Component Lead Formation

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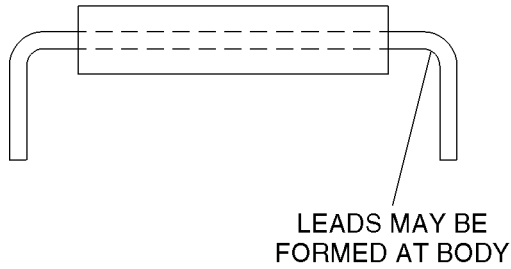
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NOTE:

Zero ohm resistors may be marked with one black band or may not be marked at all.

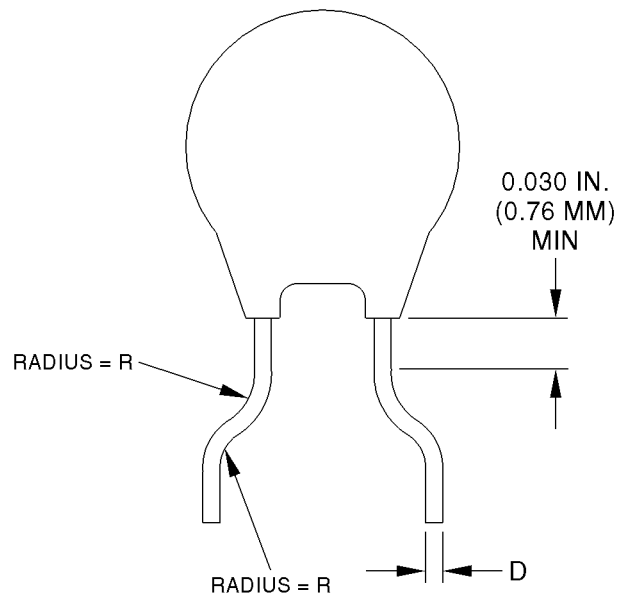
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Figure 4-2. Zero Ohm Resistor Axial Component Lead Formation



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Figure 4-3. Radial Component Lead Formation

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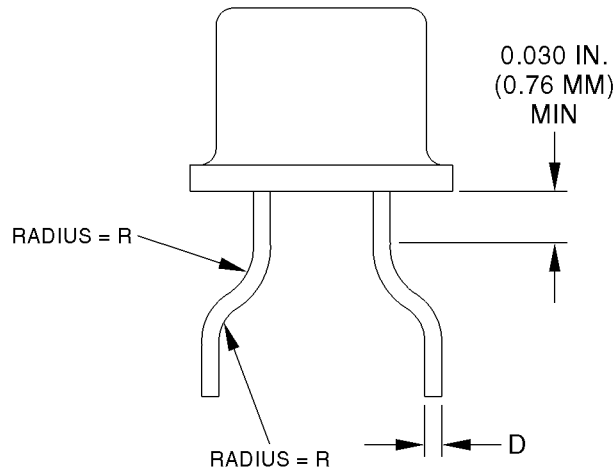
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Figure 4-4. Transistor/Microcircuit Component Lead Formation

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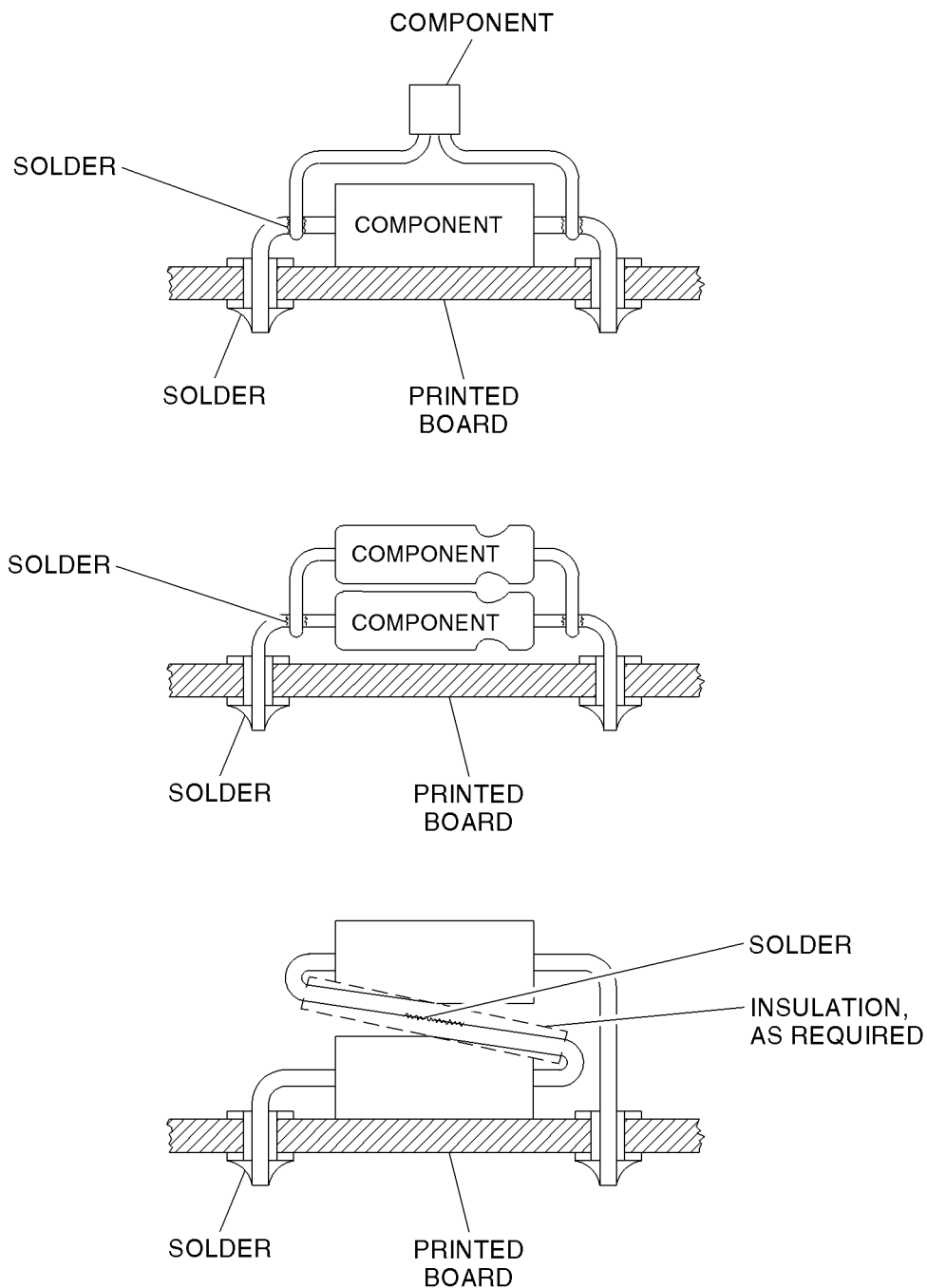
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Figure 4-5. Discrete Component Piggy-Back Installation

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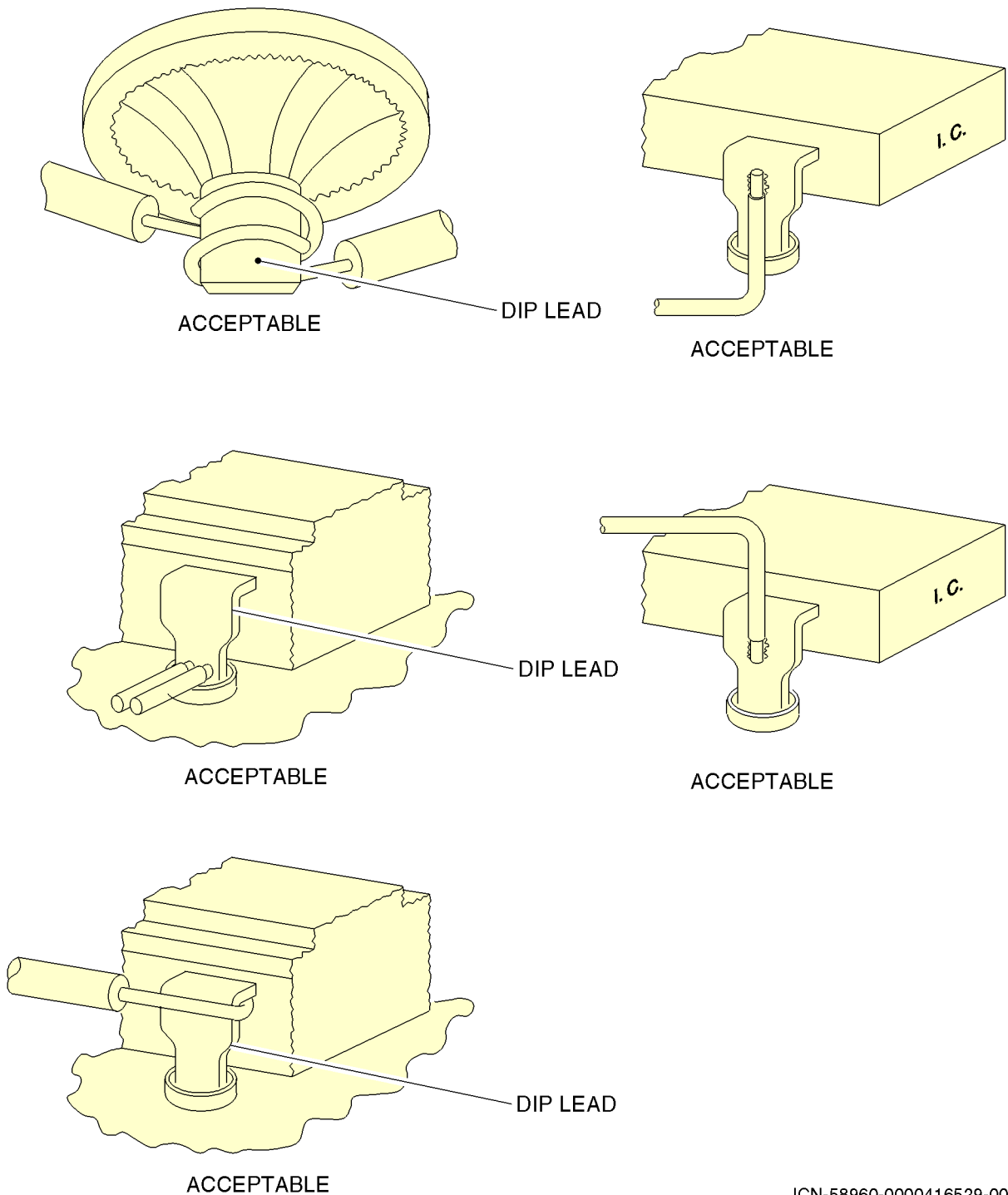
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Figure 4-6. DIP/IC Component Piggy-Back Installation

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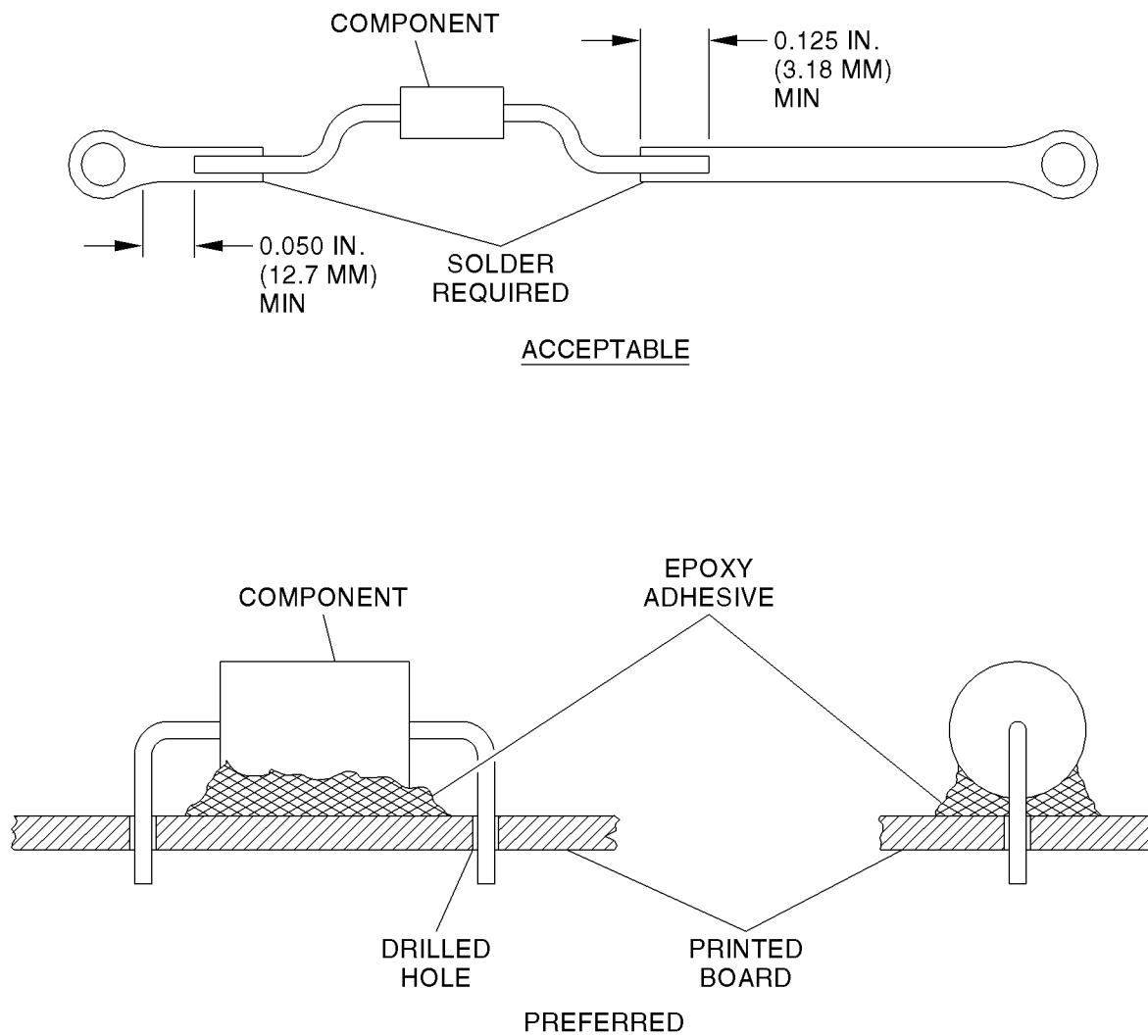
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Figure 4-7. Discrete Component Optional Mounting

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O. Connector Preparation

(1) General

These instructions describe how to prepare connectors for installation.

(2) Procedure

CAUTION: TAKE CARE NOT TO NICK PINS ADJACENT TO THOSE BEING CUT.

(a) Cutting

- 1 Snip off designated number of pins. Trim flush to 0.050 inch (1.27 mm) maximum protrusion.
- 2 Start at correct end to correspond with side that will be marked, which is side opposite to that which has vendor markings.

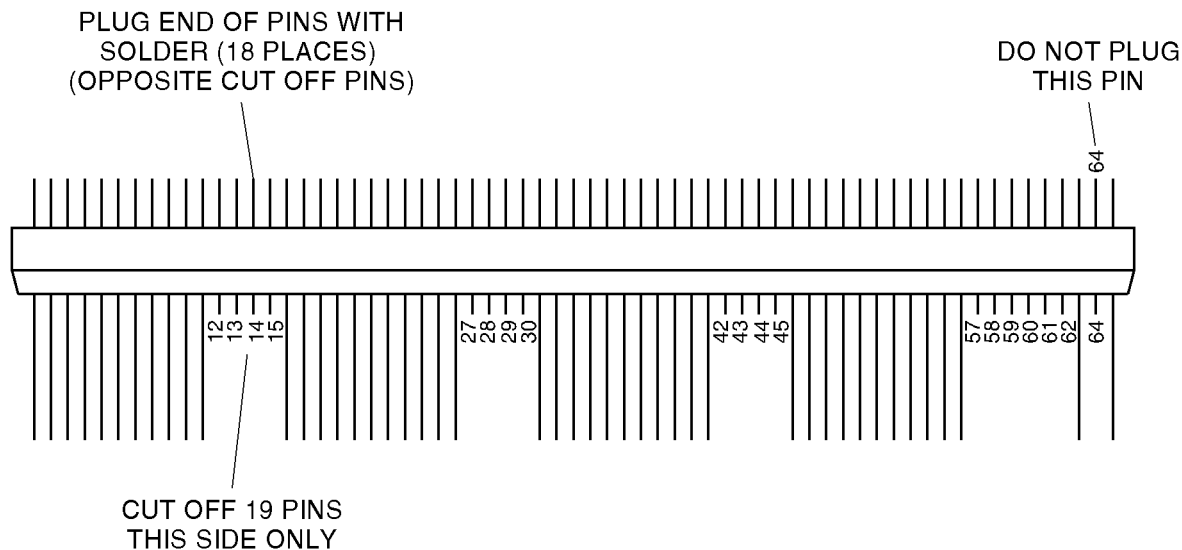
(b) Solder Filling

- 1 Fill in designated cut-off pins with solder to exactly match previous part. A typical example is shown in Figure 4-8.



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Figure 4-8. Typical Connector Diagram

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P. Tinning Connector Leads

(1) General

These instructions describe how to tin connector leads.

(2) Procedure

- (a) Remove any hardware from the connector and mask the mating leads.
- (b) Dip the connector leads into a solder pot as shown in Figure 4-9. Do not allow solder to contact the plastic connector body.
- (c) Clean the connectors with toluene (1112378) and isopropanol (1113678) and replace the hardware.

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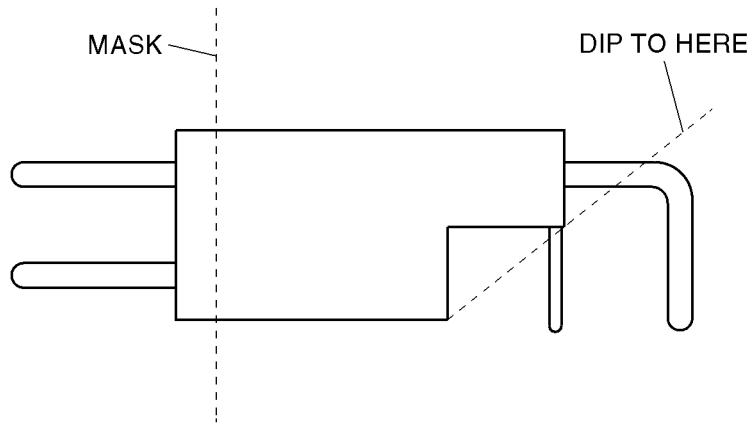
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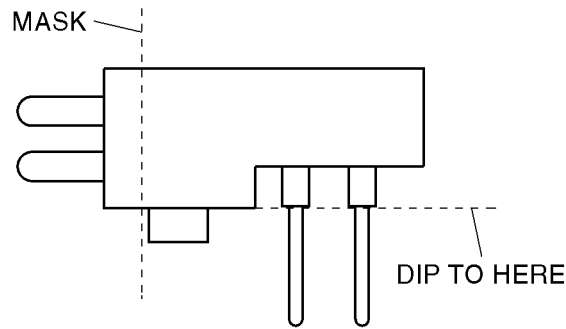
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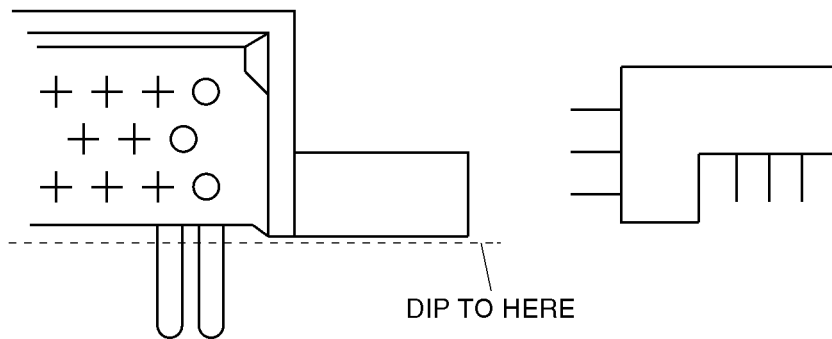
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EXAMPLE 1



EXAMPLE 2



EXAMPLE 3

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Figure 4-9. (Sheet 1 of 2) Masking and Dipping

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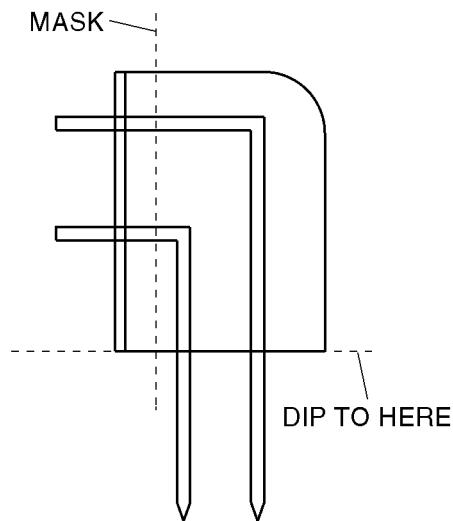
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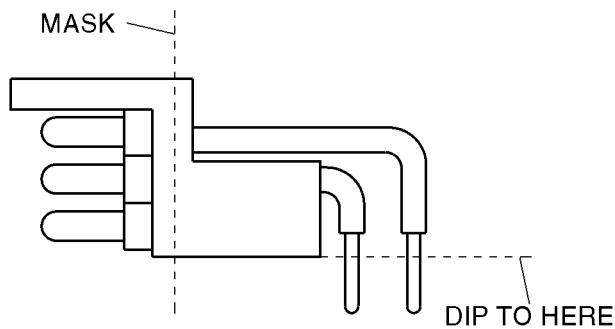


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EXAMPLE 4



EXAMPLE 5

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Figure 4-9. (Sheet 2 of 2) Masking and Dipping

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Q. Radial Lead Preparation

(1) General

These instructions describe how to prepare leads for installation of radial lead components.

(2) Procedure

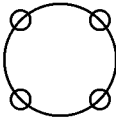
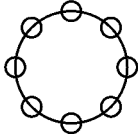
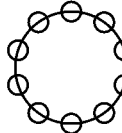
Refer to Figure 4-10 when checking acceptable lead patterns and dimensions.

CAUTION: WHEN PERFORMING THIS OPERATION, THE OPERATOR MUST BE GROUNDED BY MEANS OF A WRIST STRAP. ALL TOOLING MUST BE LOCATED AT A GROUNDED WORK STATION OR PROTECTED BY AN IONIZED AIR BLOWER OR STATIC NEUTRALIZER.

CAUTION: PRECAUTIONS MUST ALSO BE TAKEN WHEN TRIMMING HYBRID LEADS. WHEN PERFORMING THIS OPERATION, THE OBSERVANCE OF PRECAUTIONS ARE EXTREMELY CRITICAL. ALWAYS HANDLE HYBRIDS WITH A MAGNETIC HANDLING TOOL. DO NOT TOUCH THE LEADS WITH FINGERS. DO NOT BEND THE LEADS AT THE COMPONENT BODY.



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TYPE	PATTERN
STRAIGHT	 0.100 IN. (2.54 MM)
STRAIGHT	 0.200 IN. (5.08 MM)
STRAIGHT	 0.200 IN. (5.08 MM)
STRAIGHT	 0.200 IN. (5.08 MM)

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Figure 4-10. (Sheet 1 of 8) Lead Patterns and Dimensions

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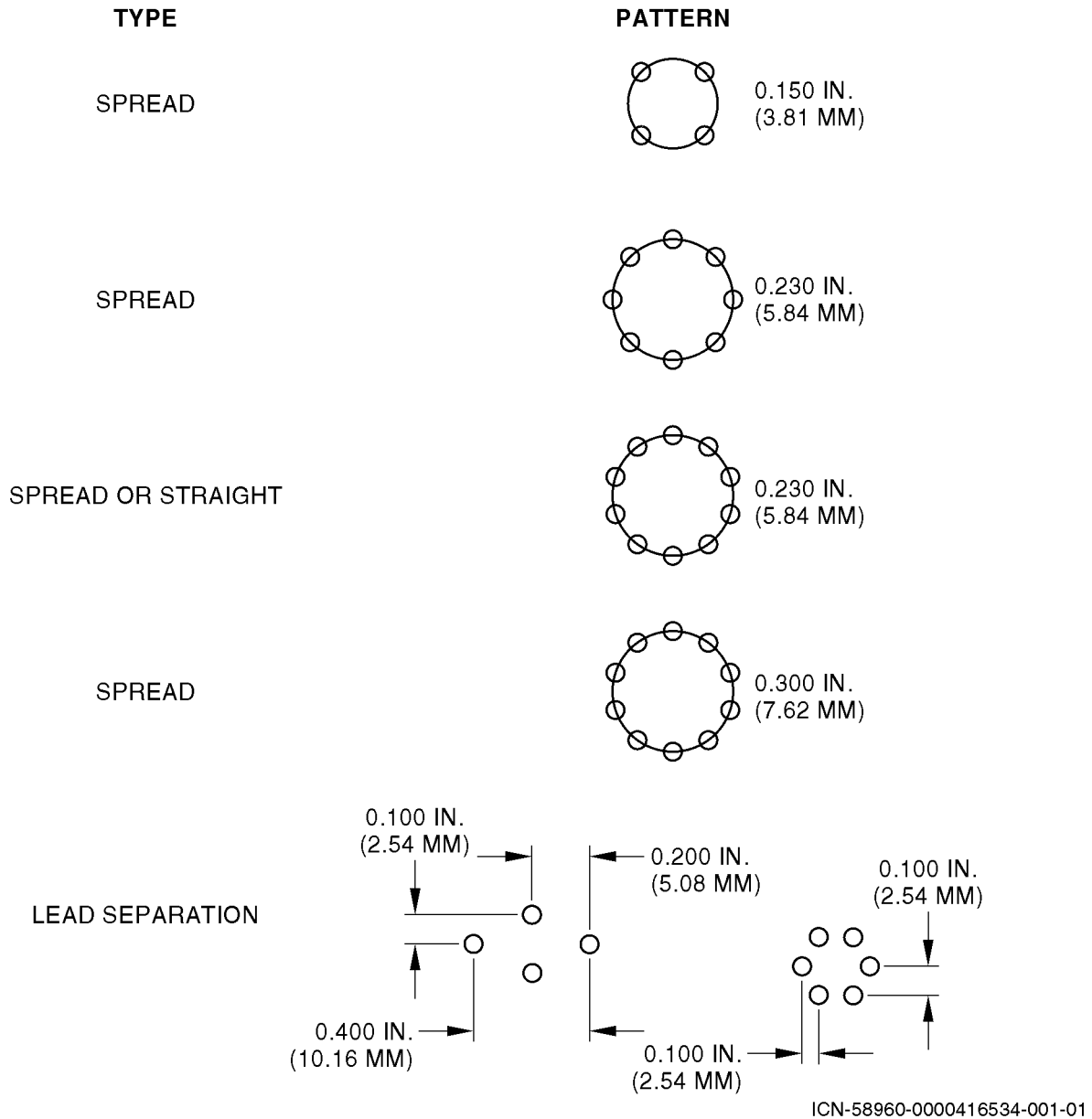


Figure 4-10. (Sheet 2 of 8) Lead Patterns and Dimensions

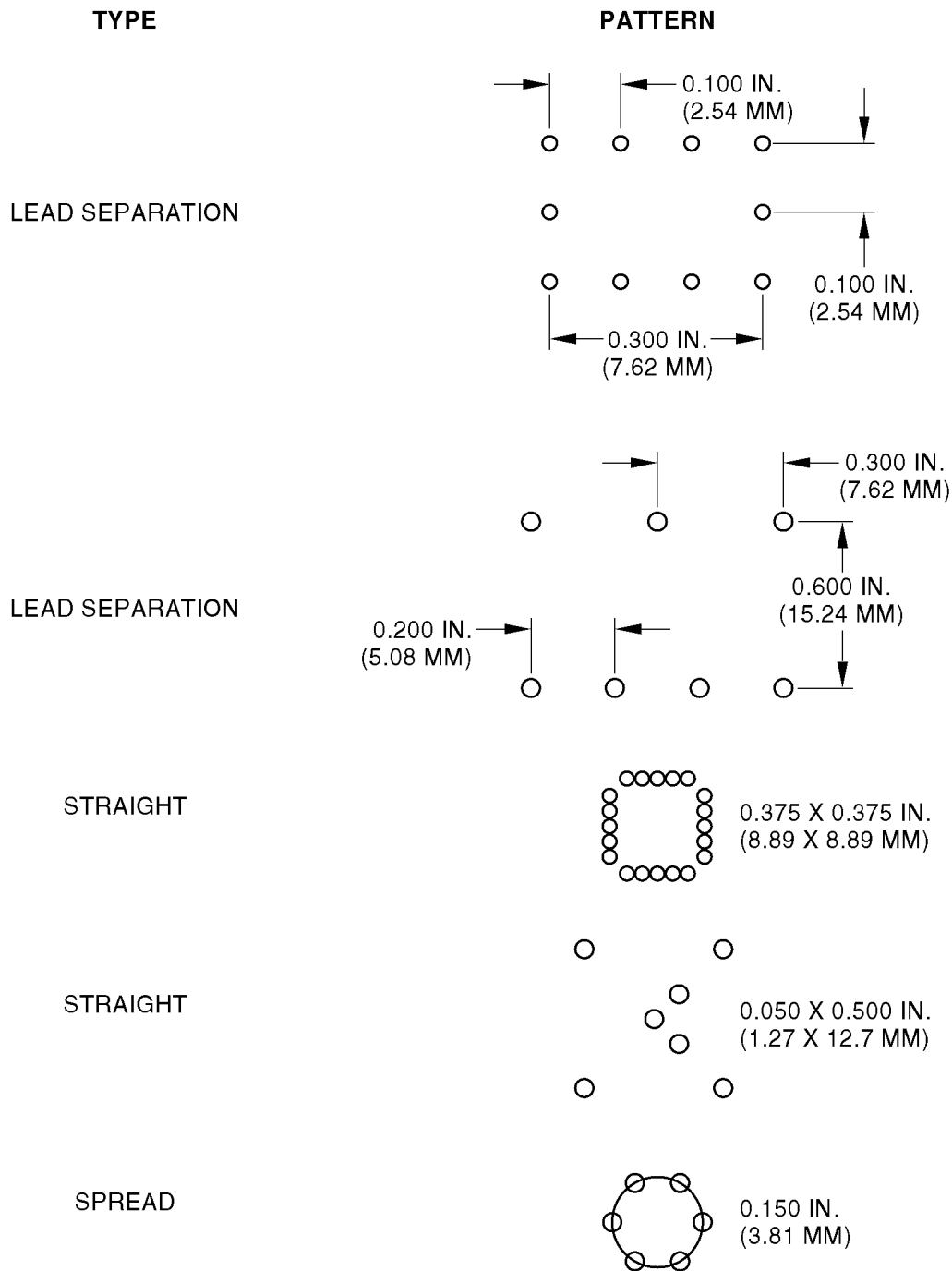
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Figure 4-10. (Sheet 3 of 8) Lead Patterns and Dimensions

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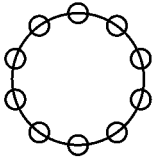
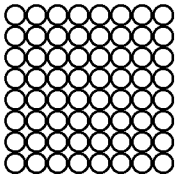
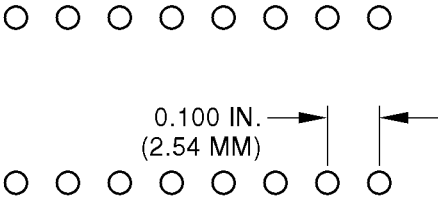
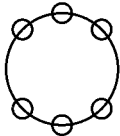
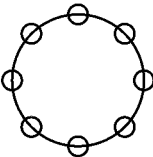
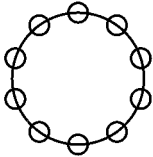
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TYPE	PATTERN
SPREAD OR STRAIGHT	 0.250 IN. (6.35 MM)
STRAIGHT	 0.700 X 0.700 IN. (17.78 X 17.78 MM)
PITCH	 0.100 IN. (2.54 MM)
SPREAD	 0.175 IN. (4.45 MM)
SPREAD	 0.300 IN. (7.62 MM)
SPREAD	 0.300 IN. (7.62 MM)

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Figure 4-10. (Sheet 4 of 8) Lead Patterns and Dimensions

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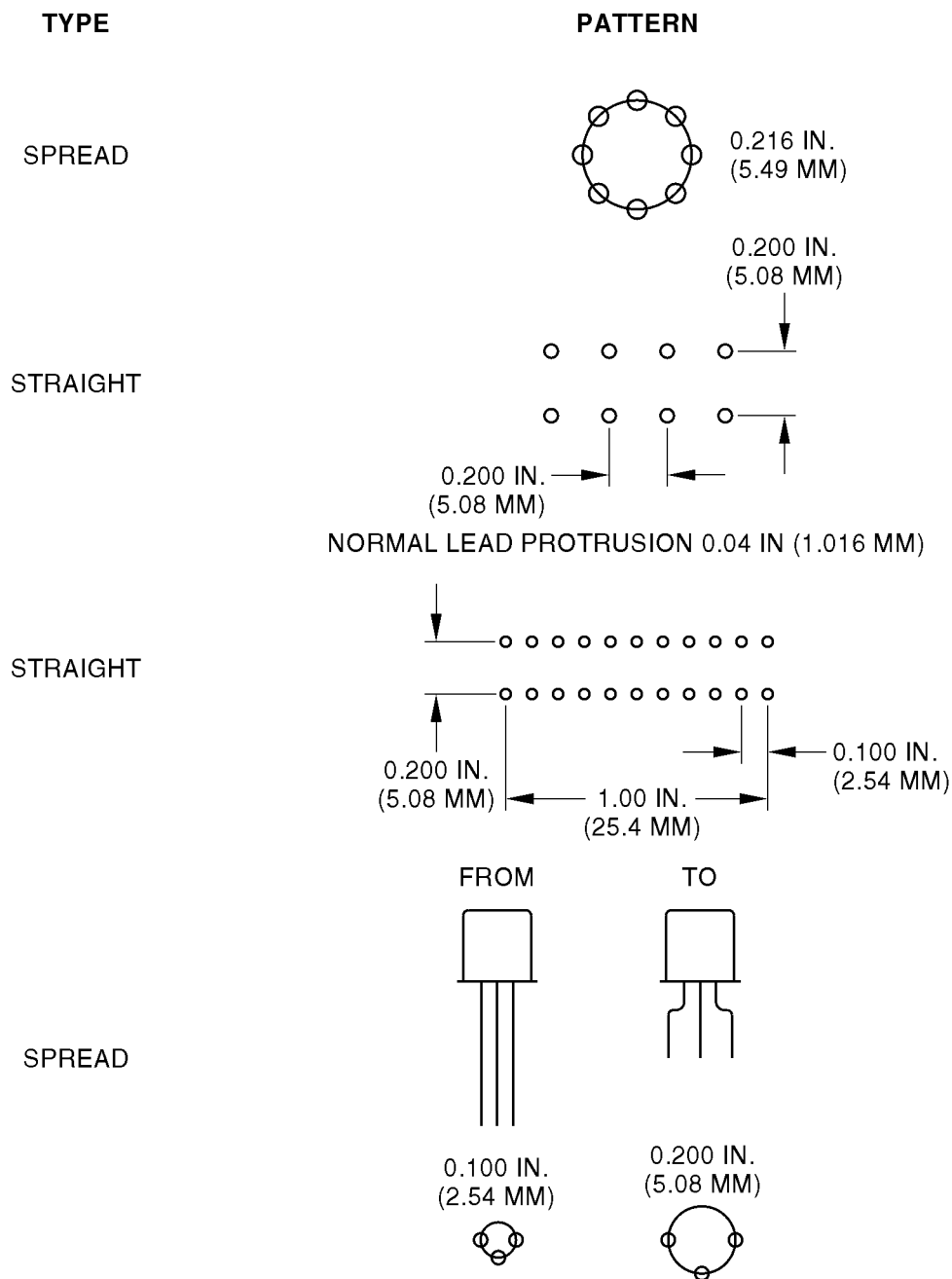
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Figure 4-10. (Sheet 5 of 8) Lead Patterns and Dimensions

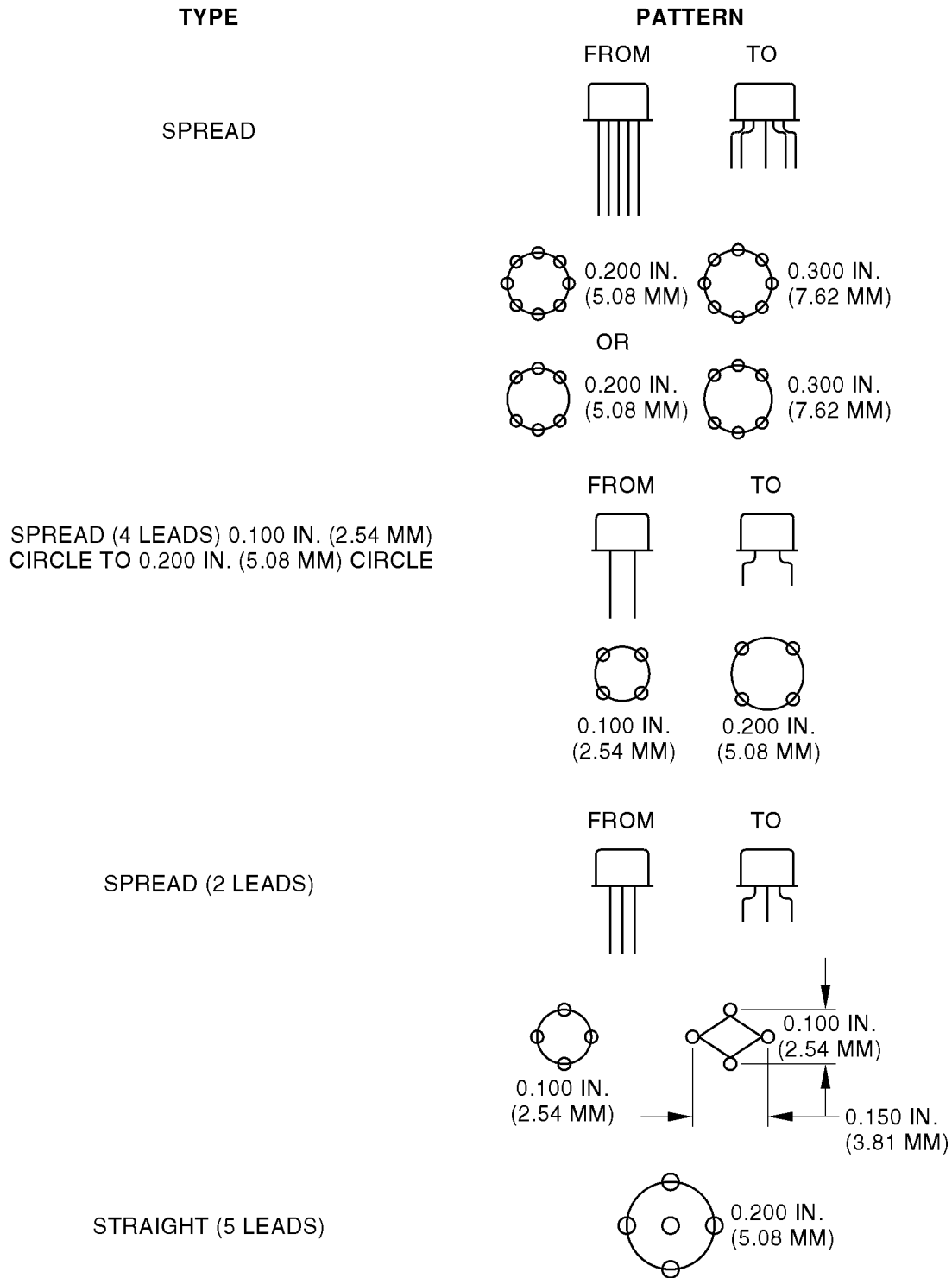
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Figure 4-10. (Sheet 6 of 8) Lead Patterns and Dimensions

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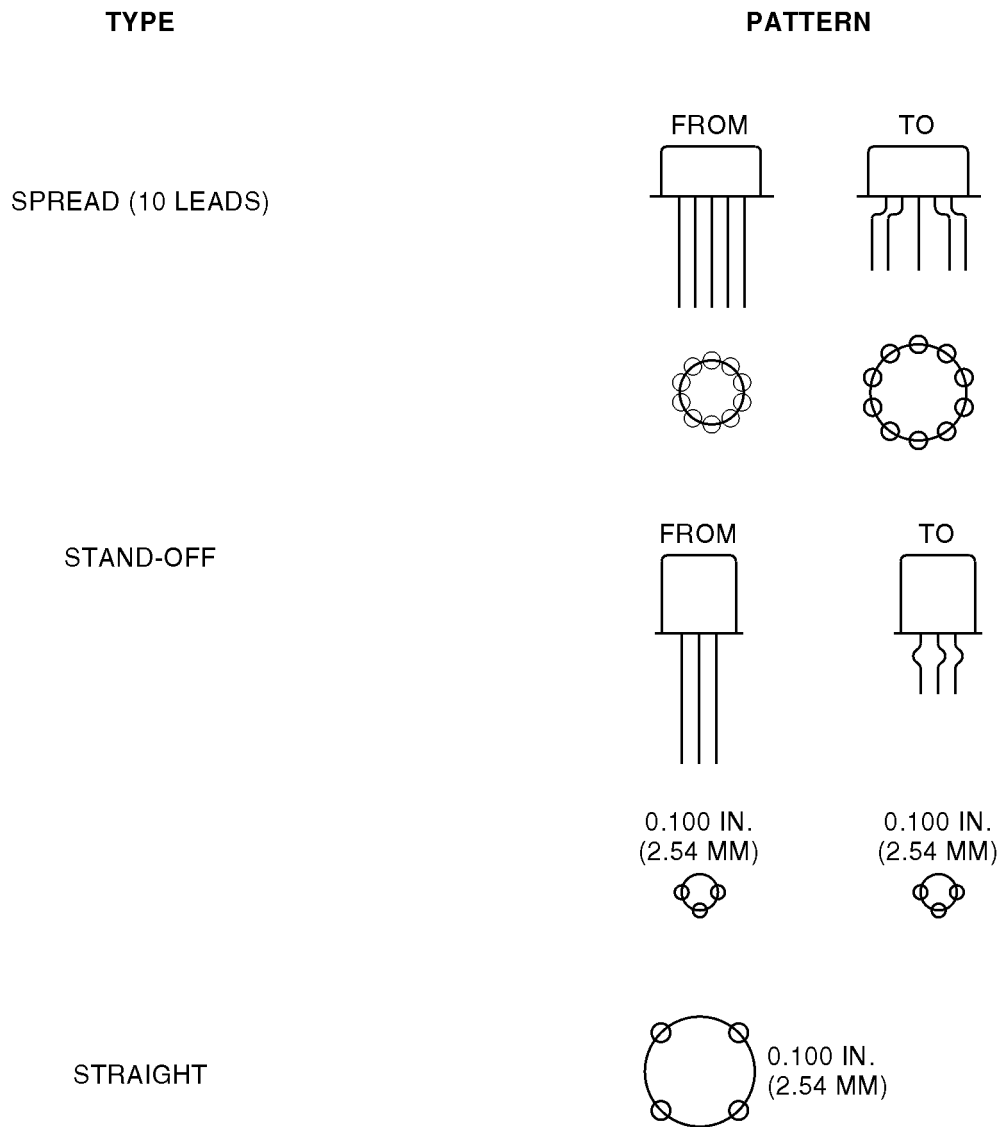
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NOTE:

Use pliers to form the 0.230 inch (5.842 mm) bolt circle to a 0.350 inch (8.89 mm) bolt circle.

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Figure 4-10. (Sheet 7 of 8) Lead Patterns and Dimensions

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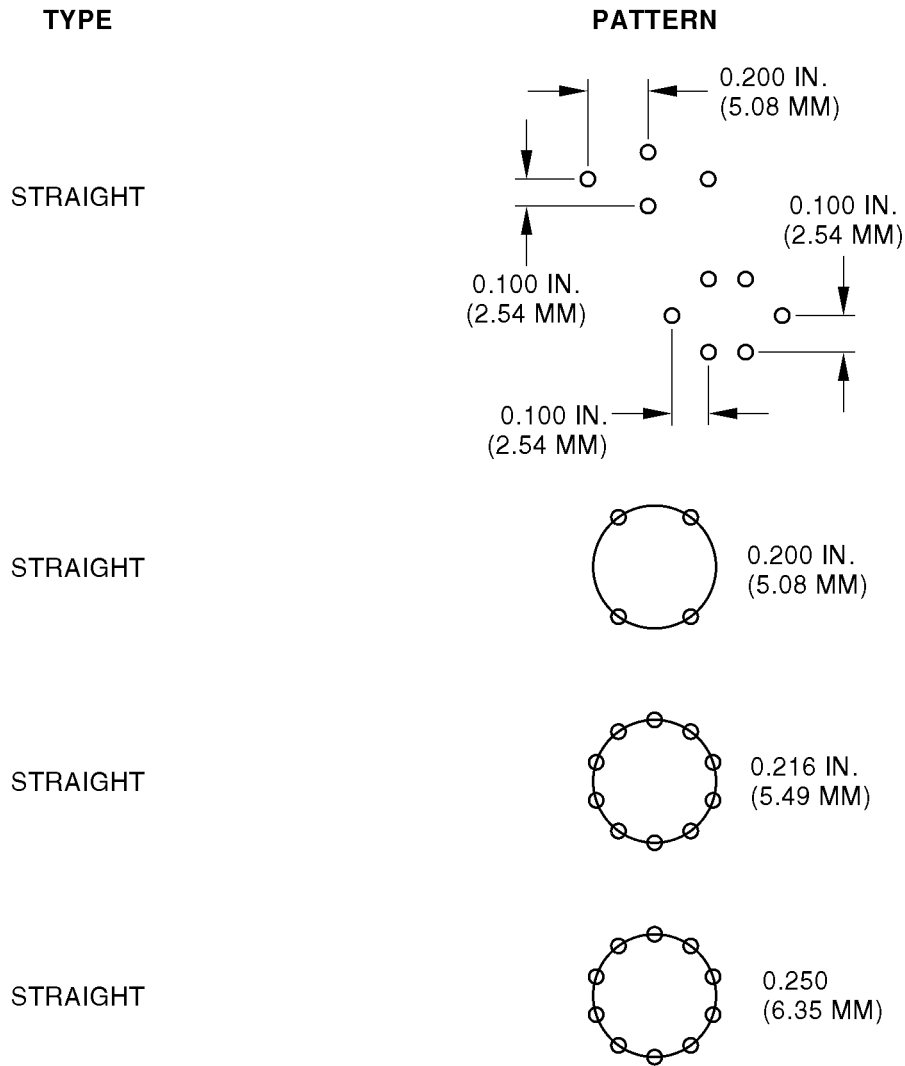
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Figure 4-10. (Sheet 8 of 8) Lead Patterns and Dimensions

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R. Hand Cutting of Leads

(1) General

These instructions describe how to cut leads by hand. Operator technique in hand cutting leads is very important. Acceptable use of these cutters on CCAs should result in flat leads parallel to the board surface, no fractured joints, and a 0.040 inch (1.02 mm) lead protrusion (unless a shorter protrusion is specified in the CMM).

(2) Procedure

All components to be hand prepped should be cut with available hand cutters.

Resultant lead protrusion should be 0.040 +0.020, -0.010 inch (1.02 +0.51, -0.25 mm), unless specified otherwise in the CMM.

S. Hand Preparation of Components

(1) General

These instructions describe how to prepare components for installation.

(2) Procedure

NOTE: All drawings for the figures listed in the description of this section are for reference only.

Use the PWB from the parts kit or a template to establish the proper center distance for forming.

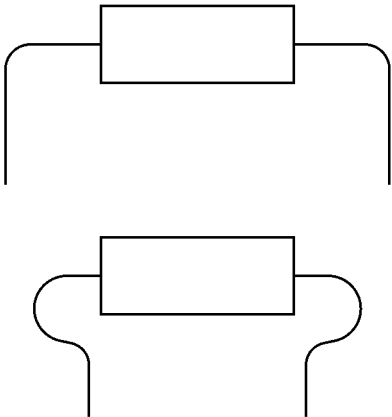
Use Figure 4-11 thru Figure 4-19 to hand-form the components to match the appropriate figures shown in the CMM.

Apply sleeving over component body and shrink with heat gun.

CAUTION: HEAT GUN MUST BE USED WITH CARE TO AVOID DAMAGE TO SLEEVE OR COMPONENT.



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Figure 4-11. Component Diagrams (Radial)

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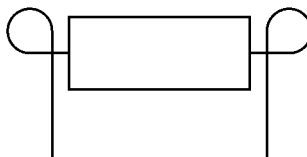
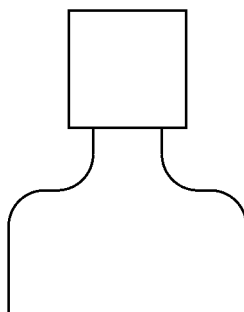
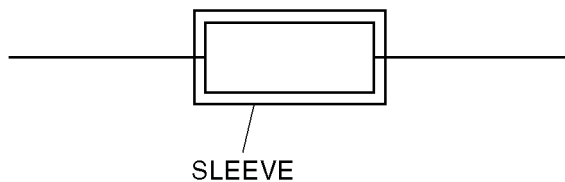
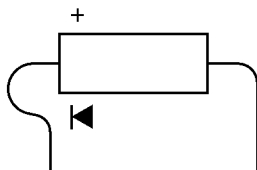
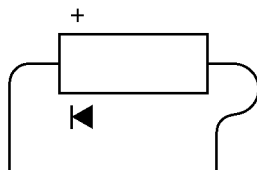
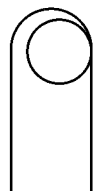
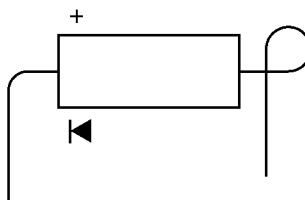
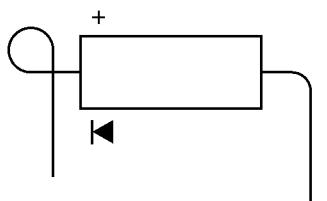


Figure 4-12. Component Diagrams (Lead Forming)



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Figure 4-13. Component Diagrams (Cylindrical)

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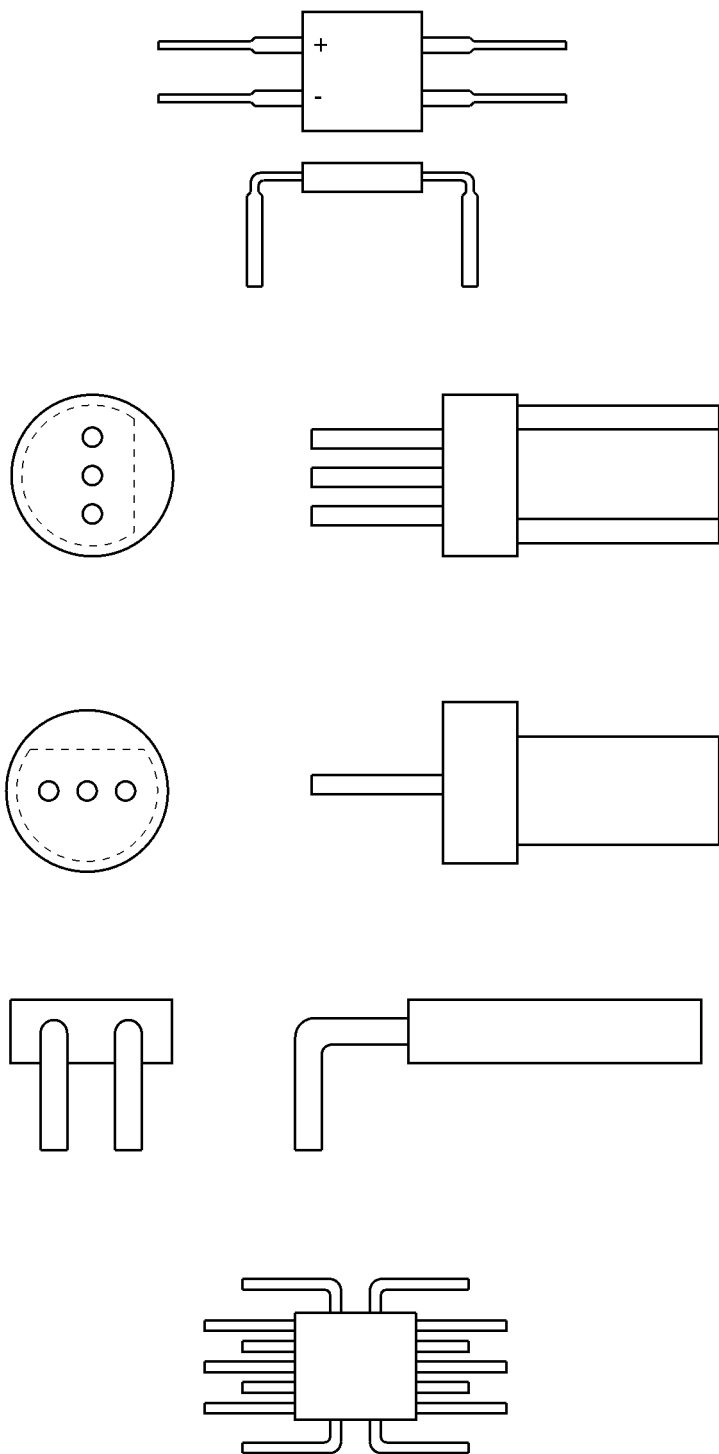
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Figure 4-14. Component Diagrams (Flat Packs)

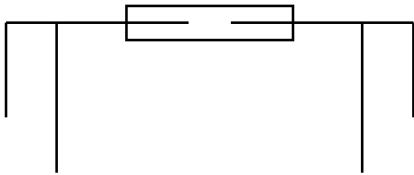
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Figure 4-15. Component Diagram (Flat Pack Side View)



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Use CCA as a template to determine lead length.

Most DIPs will be prepped to a 0.030 to 0.040 inch (0.76 to 1.02 mm) final lead protrusion. Some specifications have a 0.030 inch (7.62 mm) maximum lead protrusion. The DIPs on these reassemblies will be prepped to a 0.020 to 0.030 inch (0.51 to 0.76 mm) lead protrusion.

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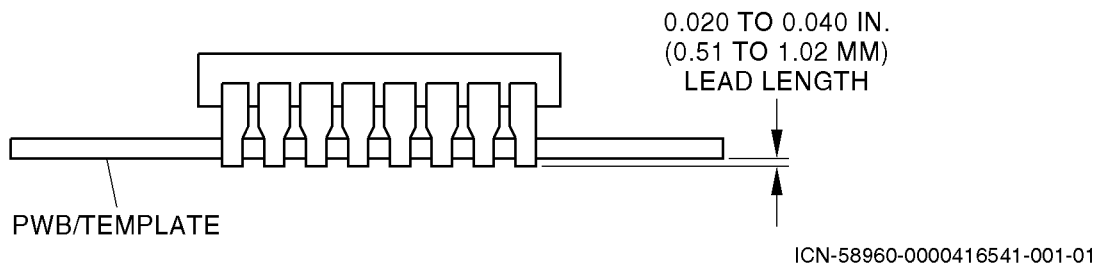


Figure 4-16. Hand Cutting Dual In-Line Parts (DIPs or ICs)

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NOTE: This figure will primarily be used to prep the 0.400 and 0.600-inch (10.16 to 15.24 mm) center spacing DIPs only.

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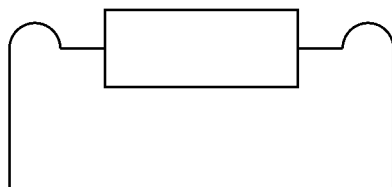
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Figure 4-17. Hand Cutting of Individual Leads

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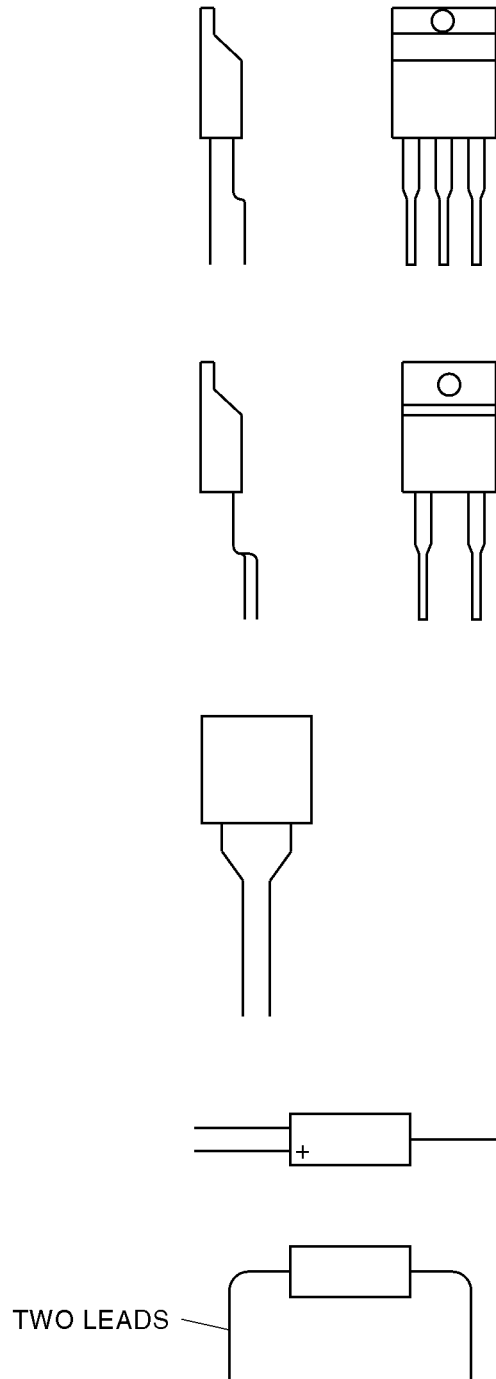
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Figure 4-18. Hand Cutting of Individual Leads on Dual In-Line Packages (DIPs or ICs)

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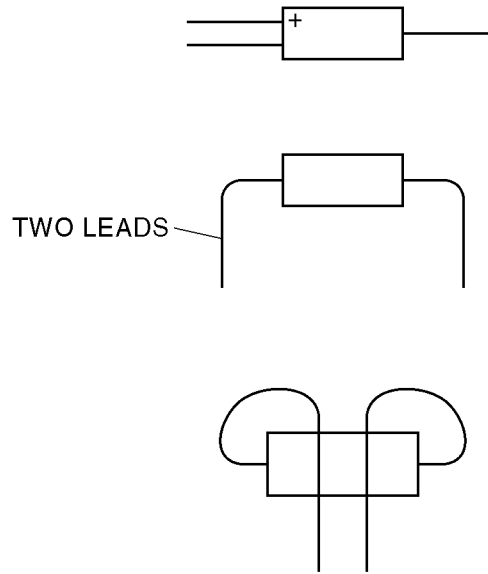
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Figure 4-19. Hand Cutting of Individual Leads (Radial)

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T. Installation of Components by Hand

(1) General

These instructions describe how to install components by hand.

(2) Procedure

Examples of hand insertion of components into a PWB are shown in Figure 4-20.

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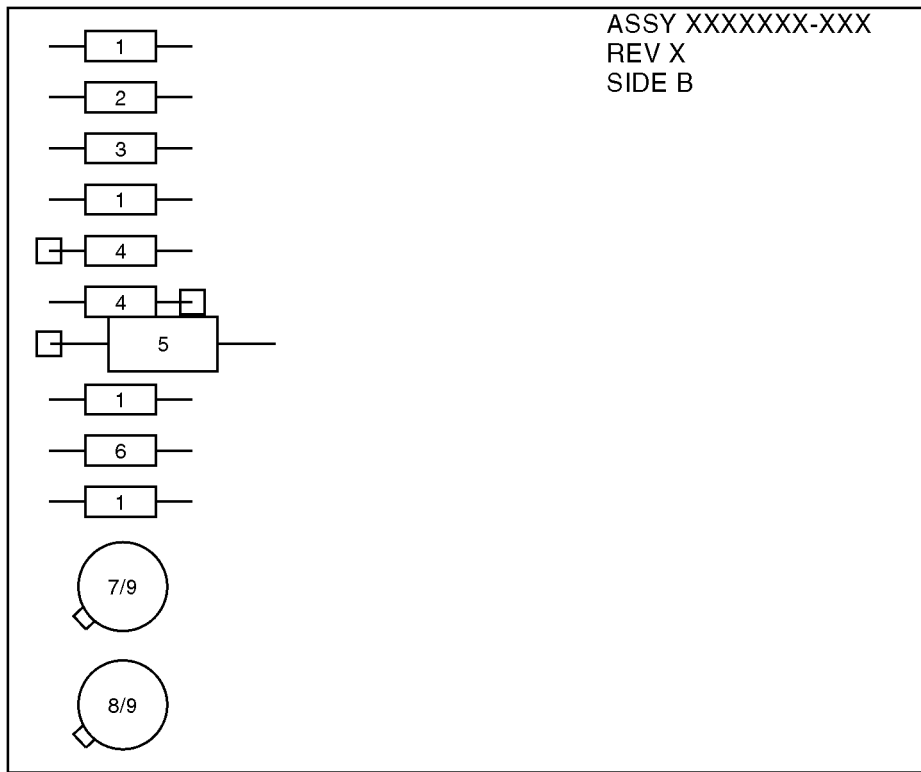
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Figure 4-20. Orientation of Components on PWB

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(a) PWB Orientation

Orient PWB on bench as shown in Figure 4-20.

(b) DIPs

Place DIP components on the surface of the bench, leads down, with cut outs in the component bodies all oriented in the same direction. Pick up the DIP in the jaws of the plier-type insertion tool. This will compress the component leads slightly, causing them to align with the hole pattern in the board. Install the component leads into the PWB, making sure the cut out end of the DIP is at tab (terminal 1) end of hole pattern. Release the handle of the insertion tool to release the component. Check to see all leads are installed properly into the hole pattern, and that the DIP is seated properly. If the DIP appears to be tipped or not seated, press on it until it is fully seated.

(c) Axial Components

CAUTION: TAKE CARE TO AVOID BENDING THE LEADS AT THE COMPONENT BODY. FORCING THE COMPONENTS INTO POSITION ON THE BOARD COULD RESULT IN DAMAGE.

Locate and install axial components as shown in Figure 4-20. Unless otherwise specified, the component body shall be parallel to and flush with the PWB surface. Leads must have clearance from other component leads and from circuitry. The use of spacers or other special mounting information will be specified in the IPL in the CMM. Polarized components such as diodes and certain capacitors must be installed exactly as indicated in Figure 4-20.

(d) Radial Components

Locate and install as shown in Figure 4-20 and follow any other special mounting information in the CMM. If the component case has a locating tab, this tab must be aligned with the unique pad shown on the PWB (transistors, op-amps, and certain relays and diodes).

Unless the CMM specifies otherwise, radial components shall be spaced approximately 0.031 inch (79 mm) above the PWB surface. Components that do not have a built-in stand-off must be installed with an insulator, spacer, or glass beads under it.

(e) Modules

Locate and install the modules as shown in Figure 4-20. Modules sometimes plug into sockets which have been installed and flow soldered into the PWB, or they may be installed into the PWB without sockets. Split O-rings, one around each corner terminal, are used to space the module approximately 0.070 inch (1.78 mm) above the PWB surface.

Using a snap-in crimp tool will hold the component in and at approximately 0.050 inch (1.27 mm) off the board. Using this tool takes about the same amount of time as it takes to use glass beads.

(f) Vertical Components

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Locate and install vertical components as shown in Figure 4-21. On a single-sided PWB, the component body may be mounted directly against the PWB. On a double-sided PWB, spacing must be provided, usually by the use of glass bead spacers. If the leads are prepared correctly, the orientation of the components for polarity and readout will have been determined at the preparation stage.

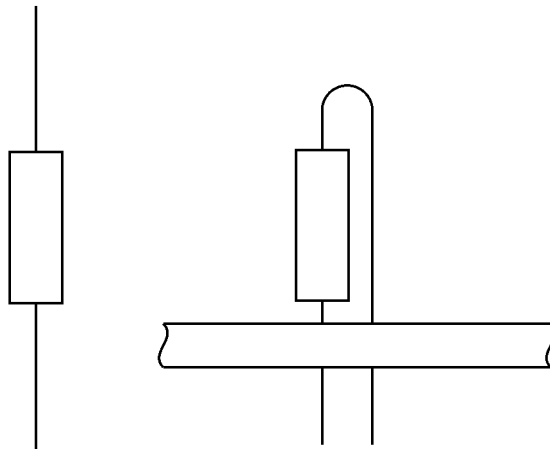
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Figure 4-21. Vertical Component Installation

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U. Marking

(1) General

These instructions describe how to apply markings to the CCAs.

(2) Procedure

This section gives instructions on various methods of marking CCAs, ECAs, and PWBs.

(a) Hand Lettering

1 Description

This covers application of variable dash numbers, revision letters, serial numbers or shop numbers, and MOD letters. The CMM specifies which of these markings are required. Use contrasting color ink where ink color is not called out in the CMM.

Locate the individual markings as follows:

Dash number: ASSY. XXXX - var

Revision letter: REV

Serial number: SER. NO.

Shop number: Locate in any easily visible location on PWB unless a specific location is called out in the CMM.

Modification number: MOD A B C D E F or MOD. If modification letters are already located on board, remove or mark over applicable letters per the CMM.

If modification letters are not on the PWB and a MOD status is required, add applicable letters.

2 Procedure

a Clean all surfaces to be marked with Isopropanol.

b Apply marking.

c Use characters approximately the same size as the existing markings.

d Parts may be handled after air drying for 1 hour. The ink will dry hard in 72 hours at room temperature. The ink will dry hard in 1 hour at 200 to 250 °F (93 to 121 °C).

(b) Rubber Stamp, Stencil, and Hand Lettering

1 This covers application of variable dash numbers, revision letters, serial numbers or shop numbers, and MOD letters. The CMM specifies which of these markings are required. Use contrasting color ink where ink color is not called out in the CMM.

Locate the individual markings as follows:



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Dash number: ASSY. XXX -var

Revision letter: REV

Serial number: SER. NO.

Shop number: Locate in any easily visible location on PWB unless a specific location is called for in the CMM.

- 2 Clean all surfaces to be marked with Isopropanol.
- 3 Apply marking. The CMM will specify stamp, stencil, or screen print, and character size.
- 4 Bake 90 minutes at 175 ± 10 °F (79 ± 5 °C), or 45 minutes at 225 ± 0 °F (107 ± 5.5 °C).

NOTE: The ink will not air cure.

(c) Hand Lettering or Rubber Stamping

- 1 Same as in the previous paragraph, except use materials listed above, unless the CMM specifies otherwise.
- 2 Apply marking. The CMM specifies hand lettering or stamp and character size.
- 3 Bake 1 hour at 260 ± 20 °F (127 ± 11 °C).

(d) Marking Labels

- 1 Apply polyester adhesive-backed nameplate. The CMM specifies the location.
- 2 Clean all surfaces to be marked with Isopropanol.
- 3 Remove liner.
- 4 After positioning nameplate, press firmly with roller or other means to eliminate air pockets.

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SECTION 5 – MECHANICAL REPAIR

1. Overview

A. General

- (1) This section gives procedures to repair mechanical or electromechanical parts.

B. Equipment and Materials

- (1) Refer to Table 5-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 5-2 for materials.
(3) Equivalent alternatives are permitted for equipment and materials.

Table 5-1. Equipment for Mechanical Repairs

Item	Description	Source
Holding fixture	Part No. T3024038	CAGE: 58960
Flaring tool and block	Part No. 1, PT35-A	CAGE: 72794
Keensert threaded insert	Refer to Table 5-3 and Table 5-4	CAGE: 0CBU7
Tangless threaded insert	Refer to Table 5-5 thru Table 5-8	CAGE: 0YC40
Tanged insert	Refer to Table 5-9 thru Table 5-11	
Clinch nut (captive nut assembly) removal and installation equipment		Specified by device manufacturer
Screw thread insert removal and installation equipment	See Figure 5-12 and Figure 5-13	Specified by device manufacturer
Rivet removal and installation equipment		Specified by device manufacturer
Brush	Soft natural-bristle (MIL-S-43871)	Commercially available
VAR insulator	Thermally conductive	
Torque screwdriver	Inch-ounces	
Torque screwdriver	Inch-pounds	
Rotary electric grinder	Use with drum sander or cylindrical grinding stone	
Anvil		
Anvil adapter		

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Table 5-1. Equipment for Mechanical Repairs (Cont)

Item	Description	Source
Die		
Riveting tool		
Toggle press		
Punch		
Eyeletter		
Roller		
Holding clamp		

Table 5-2. Materials for Mechanical Repairs

Item	Description	Source
1112378	Solvent, toluene, technical grade per A-A-59107 (certified to contain 1 percent or less benzene)	Commercially available
1113678	Isopropanol, Technical, per MIL TT-I-735, Grade B	
11P1478	Epoxy thinner, Kop-Coat T-262A	Commercially available
6008676	Lint free cloth — Bluewipes, No. TX512	Commercially available
9702878	Adhesive, epoxy (Federal Specification MMM-A-134, Type I) — A-1177B (two parts)	Commercially available
9730078	Retaining compound, BLU — 7526F [(BLU) Glyptal]	Commercially available
9730378	Retaining compound BLU, (MIL-S-22473, grade C) — Grade C	Commercially available
9731178	Primer for retaining compound, ready-to-use, quick (MIL-S-22473, grade T, form R) — Locquic Grade T	
97C3778	Adhesive, paste, two-part (MMM-A-132, Type I, class 3, group 1)	Commercially available
97P5778	RTV silicone, No. 3145, translucent, per MIL-A-46146, Group II, Type I military designation M4614621XTN.	Commercially available

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2. Procedure

CAUTION: DISCARD AND REPLACE ANY UNIT OR SUBASSEMBLY THAT CONTAINS CAST OR WELDED PARTS THAT ARE DAMAGED. IF YOU TRY TO MAKE REPAIRS TO THE UNIT OR SUBASSEMBLY, IT CAN CAUSE DAMAGE TO THE ADJACENT ELECTRICAL AND MECHANICAL PARTS.

A. General Caution About Mechanical Repair Procedure

- (1) The caution that precedes this paragraph applies to all procedures in this section.

B. Replacement of Dzus Fasteners

- (1) Removal of the Fastener

- (a) Carefully cut and remove the top of the fastener housing.
- (b) Remove the spring and screw.

CAUTION: DO NOT REMOVE THE PANEL MATERIAL WHEN YOU DRILL OUT THE FASTENER. THE FASTENER WILL NOT FIT IN AN OVERSIZED HOLE.

- (c) Use a drill or reamer and carefully drill the flared portion of the fastener from the rear of the unit panel.
- (d) Remove the remaining portion of the fastener from the panel.

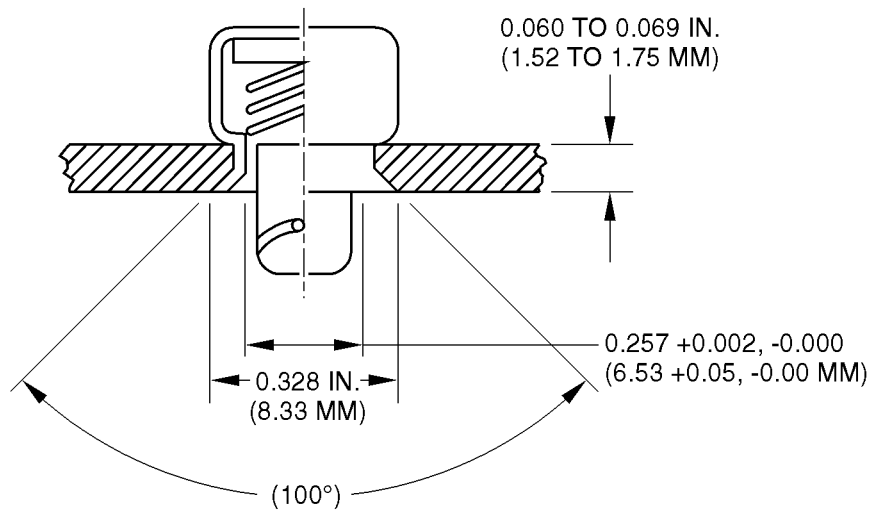
- (2) Installation of the Fastener

- (a) Insert a new Dzus fastener from the front of the panel.
- (b) Flare from the rear of the panel as shown in Figure 5-1 with the flaring tool and block, Part No. 1, PT35-A.



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Figure 5-1. Dzus Fastener Flare

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CAUTION: ANY CLINCH NUT THAT MOVES A LARGE AMOUNT OF METAL IS NOT REPAIRABLE. THE METAL THAT IS MOVED WILL NOT HOLD A REPLACEMENT CLINCH NUT.

C. Replacement of Clinch Nuts

(1) Tighten Loose Clinch Nuts

- (a) Remove the loose device from the parent material.
- (b) Prepare and apply the epoxy adhesive as follows:
 - 1 Mix epoxy adhesive as specified in Section 9, Mixing Adhesives, Sealants, and Compounds, and in the manufacturer's instructions.
 - 2 Apply the adhesive to the ID of the hole in the initial material of the cover, chassis, or assembly, and to the OD of the device body.
- (c) Push the device into the hole in the initial material and let the epoxy adhesive cure.

(2) Installation of New Clinch Nuts

- (a) Use a drill bit the same size or smaller than the initial size of the hole that contains the device, and carefully drill out the body of the device.
- (b) Use a pair of tweezers, awl, or a small diameter punch to remove the residue of the device.

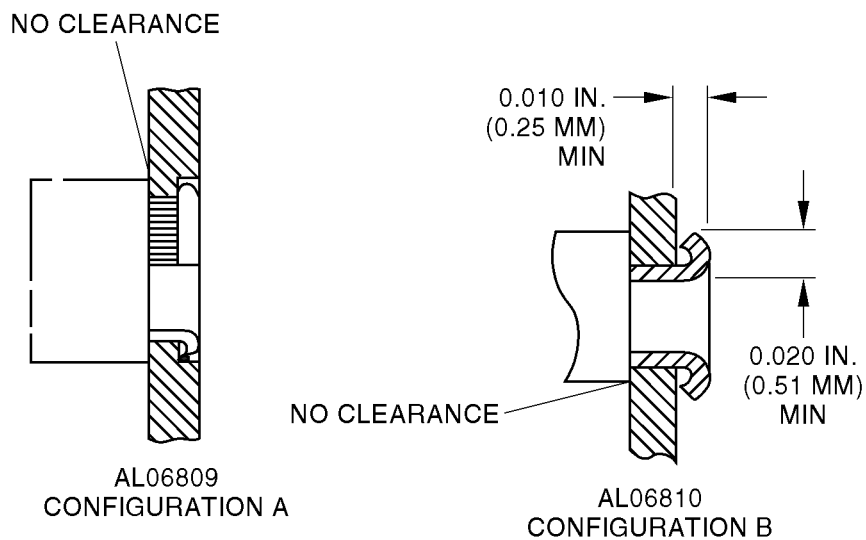
NOTE: Do not chamfer, break, or deburr the edge of the hole on the side that the clinch nut enters the device. The material around the hole will help hold the device once it is installed.
- (c) Use the installation equipment specified by the manufacturer to install a new clinch into the drilled hole.
- (d) Flare, peen, drive, or deform the device as necessary. Use recommended manufacturer's tooling with a force of sufficient magnitude to cause penetration of device into the initial material of the cover, chassis, or assembly.

(3) Replaceable Clinch Nuts

- (a) The rolled-clinch clinch nut (Figure 5-2) is installed flat against the panel or work surface with a rolled clinch on the opposite side of the panel from the nut element. The nut element design can change with the nut manufacturer.



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Figure 5-2. Rolled-Clinch Clinch Nut Details

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- (b) The flat-flange clinch nut (Figure 5-3) is installed with the flange flat against the panel or work surface. The nut element design can change with the nut manufacturer.

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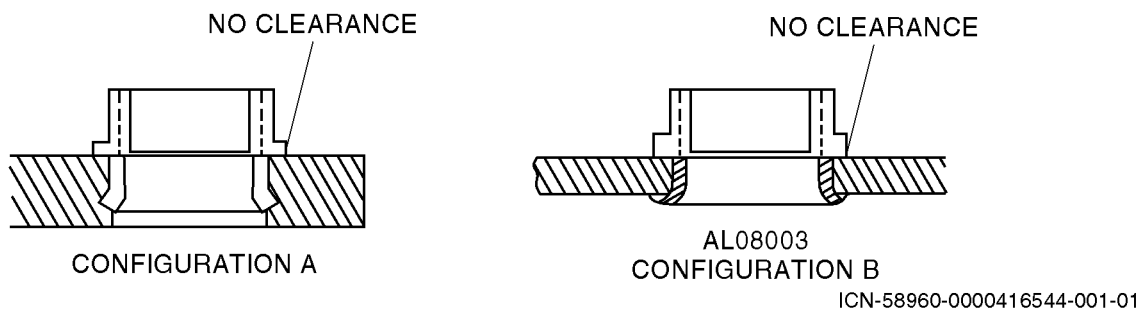


Figure 5-3. Flat-Flange Clinch Nut Details

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- (c) The flared-shank clinch nut (Figure 5-4) is installed flat against the panel or work surface with the shank flared in a countersunk hole. The countersunk hole is on the opposite side of the panel from the nut element. The nut element design can change with the nut manufacturer.

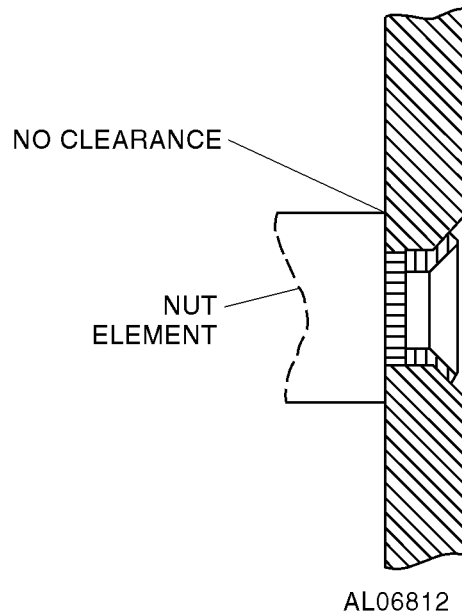
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Figure 5-4. Flared-Shank Clinch Nut Details



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- (4) Nonreplaceable Clinch Nuts
 - (a) The splined-shoulder clinch nut (Figure 5-5) has a splined shoulder. Sufficient driving force is applied to the shoulder to embed the splined surface of the nut 0.015 inch (0.38 mm) minimum into the panel or work surface for a full 360 degrees. The splined surface cannot protrude through the opposite side of the panel or work surface when the nylon ring bottoms out on the work surface. The nut element design can change with the nut manufacturer.

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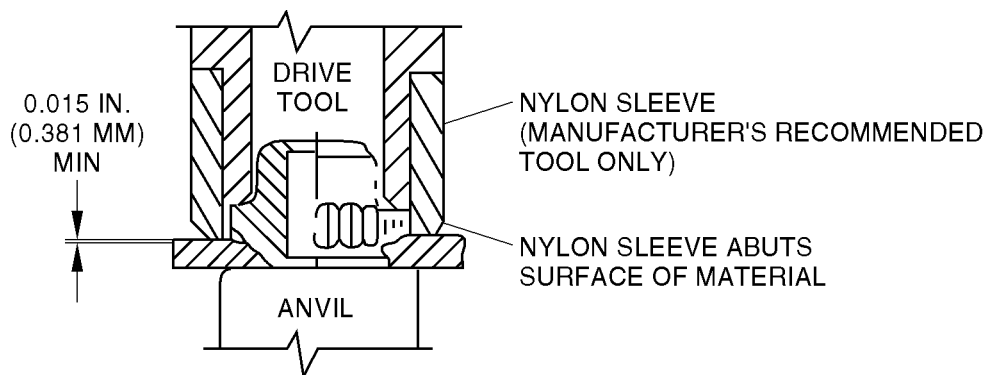
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Figure 5-5. Splined-Shoulder Clinch Nut Details

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- (b) The hex-flange clinch nut (Figure 5-6) is a fastener with a hex driving flange that is pressed in flush with the material surface in the panel or work surface. The fastener can include parts that protrude, as shown in configuration B. The nut element design can change with the nut manufacturer.

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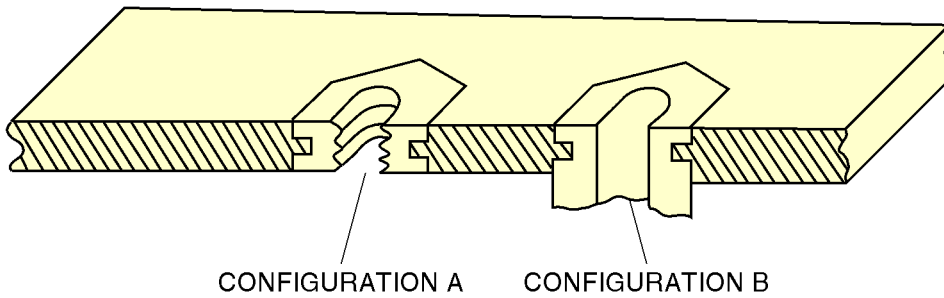
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Figure 5-6. Hex-Flange Clinch Nut Details



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- (c) The serrated-ring clinch nut (Figure 5-7) has a shank that fits in the installation hole, a serrated clinch ring that is embedded in the panel or work surface, and a shoulder that is pressed flush to the work surface. The clinch ring must be embedded in the work surface for a full 360 degrees. The nut element design can change with the nut manufacturer.

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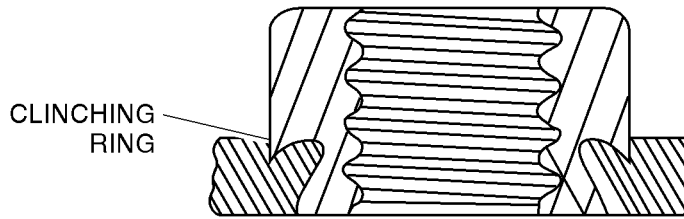
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Figure 5-7. Serrated-Ring Clinch Nut Details

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- (d) The serrated-shoulder clinch nut (Figure 5-8) has a serrated driving shoulder that is embedded flush in the panel or work surface. Care must be taken to apply force to the driving shoulder and not the body of the nut. The nut element design can change with the nut manufacturer.

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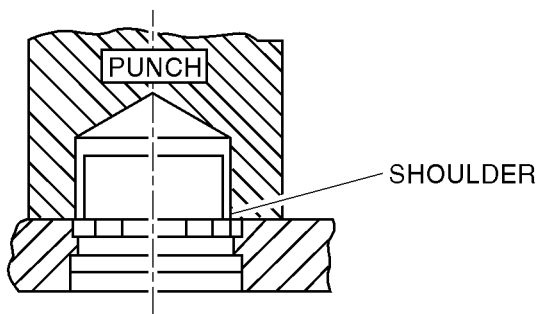
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Figure 5-8. Serrated-Shoulder Clinch Nut Details

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CAUTION: FOR EQUIPMENT MANUFACTURED BY HONEYWELL, DO NOT REPLACE ANY SCREW, BOLT, ETC., WITH ONE OF A DIFFERENT SIZE IF THE SCREW OR MATING HOLE THREADS ARE DAMAGED. YOU MUST REPLACE THE PART OR ASSEMBLY, OR INSTALL AN APPLICABLE INSERT.

CAUTION: BEFORE YOU CONTINUE, MAKE SURE THERE IS SUFFICIENT MATERIAL IN THE BOSS OR AREA AROUND THE DAMAGED TAPPED HOLE TO DO THE WORK. AN INSUFFICIENT QUANTITY OF MATERIAL WILL MAKE THE INSERT DEFECTIVE AND NOT ABLE TO HOLD IN THE MATERIAL. THIS CAN CAUSE DAMAGE TO THE PART OR ASSEMBLY.

D. Replacement of Keensert Screw Threaded Inserts

(1) General Data About Keensert Inserts

- (a) The threaded inserts referred to in this paragraph have a trademark name of Keensert. Alternative brand name inserts can be used if they are equivalent.
- (b) The threaded inserts installed in this paragraph can be used when the hole is too large, and the wire-form threaded inserts can not be used. Use Figure 5-9 and Figure 5-10 as aids for the installation and insertion of inserts.

(2) Removal of a Keensert Insert

- (a) Use a drill bit as specified in Table 5-3 to remove the threaded insert material between the threads in the insert hole.
- (b) Bend or move the threaded insert in the hole and break off.
- (c) With an easy-out type tool, remove the insert.

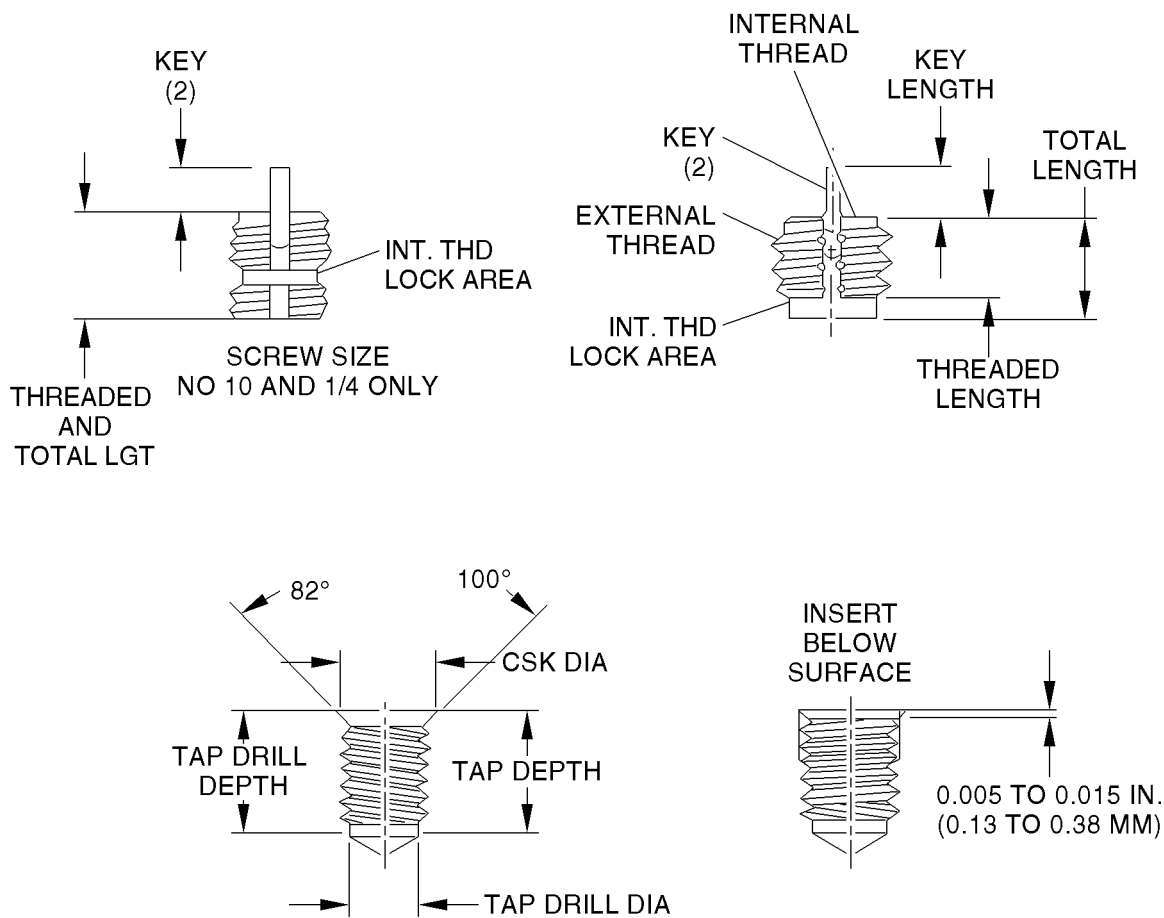
(3) Installation of a Keensert Insert

- (a) Select the correct threaded insert from Table 5-4.
- (b) Use a drill bit specified in Table 5-3 and carefully drill out the threads in the hole where you will install the threaded insert.
- (c) Countersink the drilled hole for 82 to 100 degrees countersink, 0.005 to 0.015 inch (0.13 to 0.38 mm) deep as shown in Figure 5-9.
- (d) Use the tap size specified in Table 5-4 and tap the hole for the threaded insert.
- (e) Use the insertion tool specified by the manufacturer in Table 5-4 and install the threaded insert (see Figure 5-10).



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Figure 5-9. Keensert Installation Data

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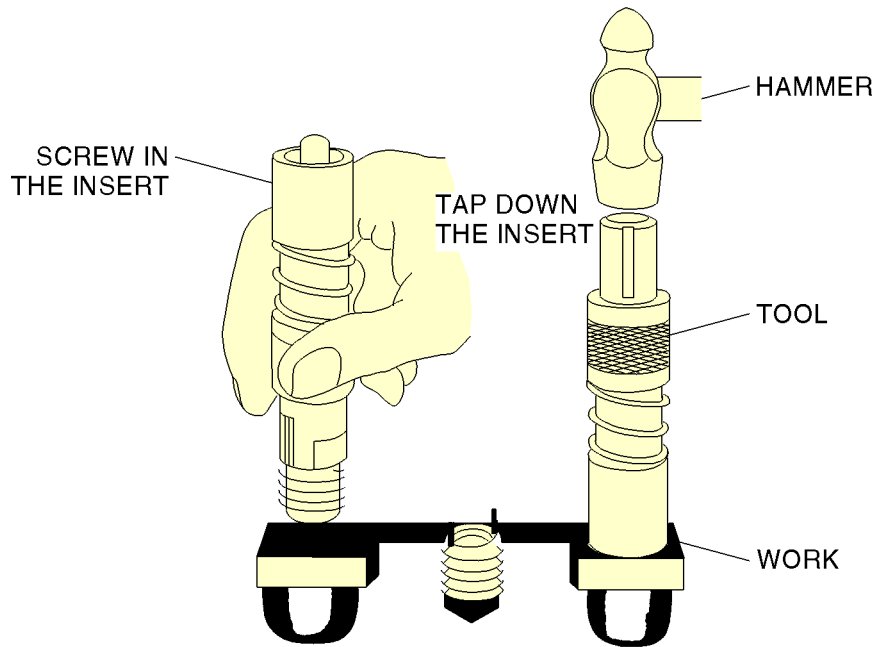
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Figure 5-10. Keensert Insertion Tool

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Table 5-3. Keensert Insert Drill Bit Data

Vendor Part No. (Honeywell Part No.)		Installation Data					Removal Data	
Nonlocking	Locking	Tap Drill Size	Countersink Diameter	Thread Tap		Install Tool Part No.	Drill	
				Size UNF-2B	Depth (Min)		Size	Depth
KNC0080J (None)	None (None)	0.120	0.140)	6-40	0.130 (3.30)	TKNC 008	No.38 (0.101)	0.625
KNCC0256J (None)	KNCC0256J (2500362-4)	0.120	0.140	6-40	0.130 (3.30)	TKNCCL 02	No.38 (0.101)	
KNCA0256J (None)	KNCA0256J (None)	0.134	0.166	8-32	0.140 (3.56)	TKNC 02	No.33 (0.113)	
KNCA0440J (None)	KNCA0440J (2500362-1)	0.161	0.194	10-32	0.160	TKNC 04	No.29 (0.136)	3/32
KNC0632J (None)	KNCL0632J (2500362-5)	0.187	0.220	12-28	0.160	TKNC 06	No.21 (0.159)	
KNCA0832J (None)	KNCA0832J (2500362-6)	0.228	0.255	1/4-28	0.210	TKNC 08	No.8 (0.199)	1/8
None (None)	KNL1032J (2500362-7)	0.272	0.323	5/16-18	0.370	TD1032L	7/32 (0.219)	5/32
None (None)	KNL428J (2500362-8)	0.332	0.385	3/8-16	0.430	TD428L	9/32 (0.281)	3/16
NOTE: All dimensions are in inches (mm).								

Table 5-4. Keensert Insert Dimensions

Vendor Part No. (Honeywell Part No.)		Dimensions					
Nonlocking	Locking	Nominal Screw Size	Internal Thread Size	External Thread Size	Key Length (2 Each)	Total Insert Length	Total External Thread Length
KNC0080J (None)	None (None)	No. 0	0-80 UNJF-3B	6-40 UNF-3A	0.06	0.10	0.085
KNCC0256J (None)	KNCC0256J (None)	No. 2	2-56 UNJC-3B	6-40 UNC-2A	0.06	0.10	0.085
KNCA0256J (None)	KNCA0256J (None)	No. 2	2-56 UNJC-3B	8-32 UNF-2A	0.06	0.12	0.088

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Table 5-4. Keensert Insert Dimensions (Cont)

Vendor Part No. (Honeywell Part No.)		Dimensions					
Nonlocking	Locking	Nominal Screw Size	Internal Thread Size	External Thread Size	Key Length (2 Each)	Total Insert Length	Total External Thread Length
KNCA0440J (None)	KNCAL0440J (2500362-1)	No. 4	4-40 UNJC-3B	10-32 UNF-2A	0.08	0.17	0.125
KNC0632J (None)	KNCL0632J (2500362-5)	No. 6	6-32 UNJC-3B	12-28 UNF-2A	0.08	0.17	0.125
KNCA0832J (None)	KNCAL0832J (2500362-6)	No. 8	8-32 UNJC-3B	1/4-28 UNF-2A	0.10	0.22	0.175
None (None)	KNL1032J (2500362-7)	No. 10	10-32 UNJF-3B	5/16-18 UNC-2A	0.16	0.31	None
None (None)	KNL428J (2500362-8)	1/4 in.	1/4-28 UNJF-3B	3/8-16 UNC-2A	0.19	0.37	None
NOTE: All dimensions are in inches.							

CAUTION: FOR EQUIPMENT MANUFACTURED BY HONEYWELL, DO NOT REPLACE ANY SCREW, BOLT, ETC., WITH ONE OF A DIFFERENT SIZE IF THE SCREW OR MATING HOLE THREADS ARE DAMAGED. YOU MUST REPLACE THE PART OR ASSEMBLY, OR INSTALL AN APPLICABLE INSERT.

CAUTION: BEFORE YOU CONTINUE, MAKE SURE THERE IS SUFFICIENT MATERIAL IN THE BOSS OR AREA AROUND THE DAMAGED TAPPED HOLE TO DO THE WORK. AN INSUFFICIENT QUANTITY OF MATERIAL WILL MAKE THE INSERT DEFECTIVE AND NOT ABLE TO HOLD IN THE MATERIAL. THIS CAN CAUSE DAMAGE TO THE PART OR ASSEMBLY.

E. Replacement of Tangless Coil Threaded Inserts**(1) General Data About Tangless Inserts**

- (a) The threaded inserts referred to in this paragraph have a trademark name of Tangless. Alternative brand name inserts can be used if they are equivalent.
- (b) Use Figure 5-11 and Figure 5-12 as aids for the removal and installation of inserts.

(2) Removal of a Tangless Insert

- (a) Put the removal mandrel into the installed threaded insert (Figure 5-11) and turn approximately three to four times after the removal pawl engages the top notch of the insert. There will be a click sound.
- (b) Turn the mandrel in the opposite direction and remove the threaded insert out of the tapped hole.
- (c) Push the pawl hook and turn and pull the insert at the same time to release the threaded insert from the mandrel.

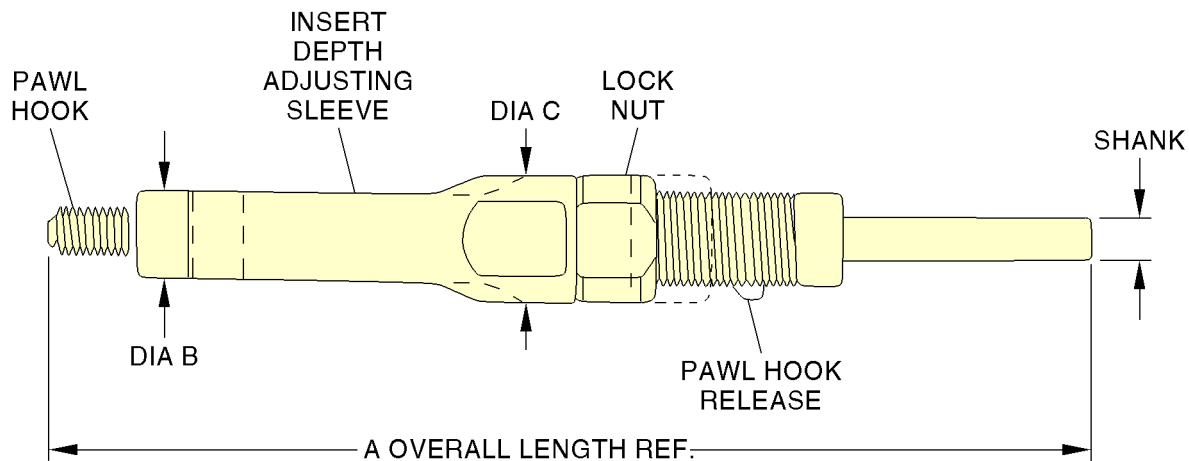
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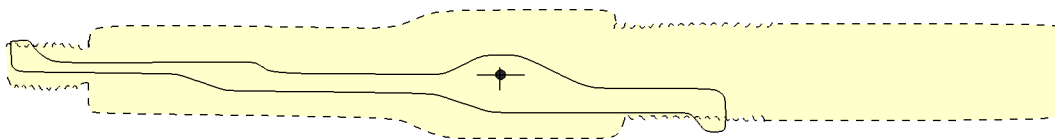
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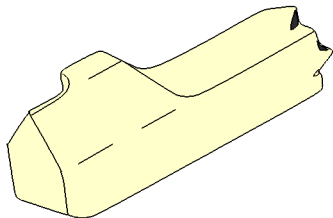


REPLACEMENT PAWLS

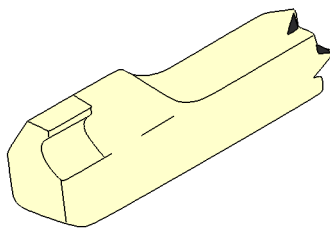


PAWL TIP DETAILS

INSTALLATION



REMOVAL



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Figure 5-11. Tangless Insert Installation/Removal Tools

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(3) Installation of a Tangless Insert

- (a) Make a selection of the correct threaded insert from Table 5-5.
- (b) Use a drill bit specified in Table 5-6 and carefully drill out the threads in the hole where you will install the threaded insert.

CAUTION: MAKE SURE YOU COUNTERSINK THE HOLE TO REMOVE ANY BURRS BEFORE YOU TAP IT. IF THE ENTRANCE OF THE HOLE IS BLOCKED BY THE BURRS, THE INSERTS WILL NOT BE INSTALLED CORRECTLY.

- (c) Countersink the drilled hole for 82 to 100 degrees countersink, 0.005 to 0.015 inch (0.13 to 0.38 mm) deep as shown in Figure 5-12.
- (d) Use the tap size specified in Table 5-6 and tap the hole for the threaded insert.
- (e) Install the threaded insert as follows:
 - 1 Make a selection of the pawl and mandrel specified by the manufacturer (refer to Table 5-7 and Table 5-8).
 - 2 Align the threaded insert, mandrel, and pawl over the hole. Make sure the mandrel is perpendicular to the work surface.
 - 3 Turn the mandrel clockwise, but do not use downward pressure, until the threads engage.
 - 4 Continue to turn the mandrel until the plastic tip touches the work surface.
 - 5 Turn the mandrel counterclockwise to remove it from the threaded insert.

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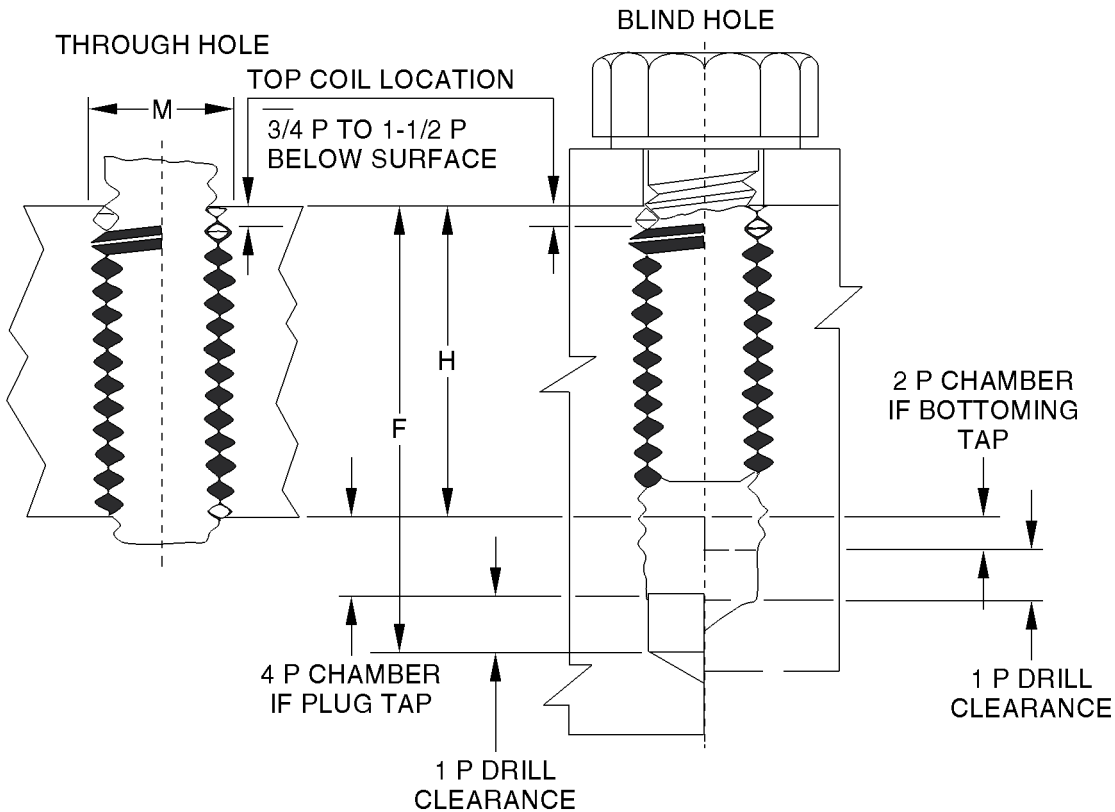
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**NOTES:**

1. P = Pitch (teeth).
2. Diameter " M " is for top of counter sink.

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Figure 5-12. Tangless Insert Installation Data

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Table 5-5. Tangless Insert Dimensions

Thread Size	Length (in.)			Coil Thread Part No.	National Aerospace No. (Honeywell Part No.)	Equivalent Mil-Std No.
	1	1.5	2			
NOTES:						
1 FR = free-running series, SL = self-locking series.						
2 For coil thread part numbers:						
- The material type for the inserts, unless otherwise specified, is Type 304 S.S.(MIL-I-8846) and AS724S, surface texture (ANSI B46.1). - If there is no lubricant or finish requirement, leave first suffix off (e.g., 2TLC-06C-0207_). - If a dry film lubricant (MIL-L-46010) is needed, add a W as the first suffix in the coil thread Part No. (i.e.; 2TLC-06C-0207W). - If a cadmium finish [QQ-P-416, type I (max thickness = 0.0001)] is needed, add a Y as the first suffix in the coil thread Part No. (e.g., 2TLC-06C-0207Y). - If a bulk quantity of the inserts is needed, add nothing as the second suffix to the Part No. (e.g., 2TLC-06C-0207W_). - If the inserts are needed in a strip feed packaging format, add an SF as the second suffix to the coil thread Part No. (e.g., 2TLC-06C-0207WSF).						
3 All dimensions are in inches.						
UNIFIED NATIONAL COARSE						
FR)2-56 (0.086)	0.086	--	--	2TNC-02C-0086	NAS1130-02-10 (7024420-1)	MS122095
SL)2-56 (0.086)	0.086	--	--	2TLC-02C-0086	NAS1130-02L-10 (7024420-101)	MS21209-C0210
FR)2-56 (0.086)	--	0.129	--	2TNC-02C-0129	NAS1130-02-15 (7024420-3)	MS122135
SL)2-56 (0.086)	--	0.129	--	2TLC-02C-0129	NAS1130-02L-15 (7024420-103)	MS21209-C0215
FR)2-56 (0.086)	--	--	0.172	2TNC-02C-0172	NAS1130-02-20 (7024420-5)	MS122175
SL)2-56 (0.086)	--	--	0.172	2TLC-02C-0172	NAS1130-02L-20 (7024420-105)	MS21209-C0220
FR)4-40 (0.112)	0.112	--	--	2TNC-04C-0112	NAS1130-04-10 (7024420-7)	MS122076
SL)4-40 (0.112)	0.112	--	--	2TLC-04C-0112	NAS1130-04L-10 (7024420-107)	MS21209-C0410

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Table 5-5. Tangless Insert Dimensions (Cont)

Thread Size	Length (in.)			Coil Thread Part No.	National Aerospace No. (Honeywell Part No.)	Equivalent Mil-Std No.
	1	1.5	2			
FR)4-40 (0.112)	--	0.168	--	2TNC-04C-0168	NAS1130-04-15 (7024420-9)	MS1221161
SL)4-40 (0.112)	--	0.168	--	2TLC-04C-0168	NAS1130-04L-15 (7024420-109)	MS21209-C0415
FR)4-40 (0.112)	--	--	0.224	2TNC-04C-0224	NAS1130-40-20	MS122156
SL)4-40 (0.112)	--	--	0.224	2TLC-04C-0224	NAS1130-04L-20 (7024420-111)	MS1209-C0420
FR)6-32 (0.164)	0.138	--	--	2TNC-06C-0138	NAS1130-06-10 (7024420-13)	MS122078
SL)6-32 (0.164)	0.138	--	--	2TLC-06C-0138	NAS1130-06L-10 (7024420-113)	MS1209-C0610
FR)6-32 (0.164)	--	0.207	--	2TNC-06C-0207	NAS1130-06-15 (7024420-15)	MS122118
SL)6-32 (0.164)	--	0.207	--	2TLC-06C-0207	NAS1130-06L-15 (7024420-115)	MS21209-C0615
FR)6-32 (0.164)	--	--	0.276	2TNC-06C-0276	NAS1130-06-20 (7024420-17)	MS122158
SL)6-32 (0.164)	--	--	0.276	2TLC-06C-0276	NAS1130-06L-20 (7024420-117)	MS21209-C0620
FR)8-32 (0.164)	0.164	--	--	2TNC-2C-0164	NAS1130-08-10 (7024420-19)	MS122079
SL)8-32 (0.164)	0.164	--	--	2TLC-2C-0164	NAS1130-08L-10 (7024420-119)	MS21209-C0810
FR)8-32 (0.164)	--	0.246	--	2TNC-2C-0246	NAS1130-08-15 (7024420-21)	MS122119
SL)8-32 (0.164)	--		0.328	2TLC-2C-0328	NAS1130-08L-20 (7024420-123)	MS21209-C0820
FR)8-32 (0.164)	--	--	0.328	2TNC-2C-0328	NAS1130-08-20 (7024420-23)	MS122159
FR)8-32 (0.164)	--	--	0.328	2TLC-2C-0328	NAS1130-08L-20 (7024420-123)	MS21209-C0820
FR)10-24 (0.190)	0.190	--	--	2TNC-3C-0190	NAS1130-3C-10 (7024420-25)	MS122080

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Table 5-5. Tangless Insert Dimensions (Cont)

Thread Size	Length (in.)			Coil Thread Part No.	National Aerospace No. (Honeywell Part No.)	Equivalent Mil-Std No.
	1	1.5	2			
SL)10-24 (0.190)	0.190	--	--	2TLC-3C-0190	NAS1130-3CL-10 (7024420-125)	MS21209-C1-10
FR)10-24 (0.190)	--	0.285	--	2TNC-3C-0285	NAS1130-3CL-15 (7024420-27)	MS122120
SL)10-24 (0.190)	--	0.285	--	2TLC-3C-0285	NAS1130-3CL-15 (7024420-127)	MS21209-C1-15
FR)10-24 (0.190)	--	--	0.380	2TNC-3C-0380	NAS1130-3C-20 (7024420-29)	MS122160
SL)10-24 (0.190)	--	--	0.380	2TLC-3C-0380	NAS1130-3CL-20 (7024420-129)	MS21209-C1-20
FR)1/4-20 (0.250)	0.250	--	--	2TNC-4C-0250	NAS1130-4-10 (7024420-37)	MS122081
SL)1/4-20 (0.250)	0.250	--	--	2TLC-4C-0250	NAS1130-4L-10 (7024420-137)	MS21209-C4-10
FR)1/4-20 (0.250)	--	0.375	--	2TNC-4C-0375	NAS1130-4-15 (7024420-39)	MS122121
SL)1/4-20 (0.250)	--	0.375	--	2TLC-4C-0375	NAS1130-4L-15 (7024420-139)	MS21209-C4-15
FR)1/4-20 (0.250)	--	--	0.500	2TNC-4C-0500	NAS1130-4-20 (7024420-41)	MS122161
SL)1/4-20 (0.250)	--	--	0.500	2TLC-4C-0500	NAS1130-4L-20 (7024420-141)	MS21209-4C-20
UNIFIED NATIONAL FINE						
FR)10-32 (0.190)	0.190	--	--	2TNF-3C-0190	NAS1130-3-10 (7024420-31)	MS124655
SL)10-32 (0.190)	0.190	--	--	2TLF-3C-0190	NAS1130-3L-10 (7024420-131)	MS21209-F1-10
FR)10-32 (0.285)	--	0.285	--	2TNF-3C-0285	NAS1130-3-15 (7024420-33)	MS124695
SL)10-32 (0.285)	--	0.285	--	2TLF-3C-0285	NAS1130-3L-15 (7024420-133)	MS21209-F1-15
FR)10-32 (0.380)	--	--	0.380	2TNF-3C-0380	NAS1130-3-20 (7024420-35)	MS124735

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Table 5-5. Tangless Insert Dimensions (Cont)

Thread Size	Length (in.)			Coil Thread Part No.	National Aerospace No. (Honeywell Part No.)	Equivalent Mil-Std No.
	1	1.5	2			
SL)10-32 (0.380)	--	--	0.380	2TLF-3C-0380	NAS1130-3L-20 (7024420-135)	MS21209-F1-20
FR)1/4-28 (0.250)	0.250	--	--	2TNF-4C-0250	NAS1130-4F-10 (7024420-43)	MS124656
SL)1/4-28 (0.250)	0.250	--	--	2TLF-4C-0250	NAS1130-4FL-10 (7024420-143)	MS21209-F4-10
FR)1/4-28 (0.375)	--	0.375	--	2TNF-4C-0375	NAS1130-4F-15 (7024420-45)	MS124696
SL)1/4-28 (0.375)	--	0.375	--	2TLF-4C-0375	NAS1130-4FL-15 (7024420-145)	MS21209-F4-15
FR)1/4-28 (0.500)	--	--	0.500	2TNF-4C-0500	NAS1130-4F-20 (7024420-47)	MS124736
SL)1/4-28 (0.500)	--	--	0.500	2TLF-4C-0500	NAS1130-4FL-20 (7024420-147)	MS21209-F4-20

Table 5-6. Tangless Insert Drill Bit Data

Thread Size	II Size		Minimum Drill Depth for Taps [F]						Minimum Tapping Depth [H]			Counter-sink Diameter (120 ± 5 included angle) [M]	
			Plug Tap			Bottoming Tap			Diameter				
	Alu-minum	Steel, Plastic, and Magne-sium	1	1.5	2	1	1.5	2	1	1.5	2	Min	Max
UNIFIED NATIONAL COARSE													
2-56 (0.086)	3/32 (0.0938)	No. 41 (0.0960)	0.236	0.279	0.322	0.157	0.200	0.243	0.10	0.15	0.19	0.09	0.11
4-40 (0.112)	No. 31 (0.1200)	No. 31 (0.1200)	0.318	0.374	0.430	0.212	0.268	0.324	0.14	0.19	0.25	0.14	0.17
6-32 (0.138)	No. 26 (0.1470)	No. 25 (0.1495)	0.394	0.464	0.532	0.263	0.332	0.401	0.17	0.24	0.31	0.18	0.21

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Table 5-6. Tangless Insert Drill Bit Data (Cont)

Thread Size	II Size		Minimum Drill Depth for Taps [F]						Minimum Tapping Depth [H]			Counter-sink Diameter (120 ± 5 included angle) [M]	
			Plug Tap			Bottoming Tap			Diameter				
	Alu-minum	Steel, Plastic, and Magne-sium	1	1.5	2	1	1.5	2	1	1.5	2	Min	Max
8-32 (0.164)	No. 17 (0.1730)	No. 16 (0.1770)	0.434	0.516	0.598	0.289	0.371	0.453	0.20	0.28	0.36	0.20	0.23
10-24 (0.190)	13/64 (0.2031)	No. 5 (0.2055)	0.535	0.630	0.725	0.375	0.452	0.547	0.23	0.33	0.42	0.24	0.27
1/4-20 (0.250)	Size H (0.2660)	Size H (0.2660)	0.675	0.800	0.925	0.450	0.575	0.700	0.30	0.43	0.55	0.31	0.34
UNIFIED NATIONAL FINE													
10-32 (0.190)	No. 7 (0.2010)	13/64 (0.2031)	0.472	0.568	0.662	0.315	0.410	0.505	0.22	0.32	0.41	0.23	0.26
1/4-28 (0.250)	Size G (0.2610)	6.7 mm (0.2638)	0.589	0.714	0.839	0.393	0.518	0.643	0.29	0.41	0.54	0.29	0.32
NOTES:													
1 There are more sizes available. However, use the sizes in this table with the Tangless inserts specified in Table 5-5.													
2 Letters [F], [H], and [M] are related to Figure 5-12.													
3 All dimensions are in inches.													

Table 5-7. Tangless Insert Installation/Removal Tool Data

Thread Size	Installation Tool	Removal Tool	Replacement Pawl Kit		Prewind Hand Install Tool
			Installation	Removal	
2-56 (0.086)	CT16002-02	CT16002R-02	CT16402-02K	CT16402R-02K	--
4-40 (0.112)	CT16002-04	CT16002R-04	CT16402-04K	CT16402R-04K	--
6-32 (0.138)	CT16002-06	CT16002R-06	CT16402-06K	CT16402R-04K	--

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Table 5-7. Tangless Insert Installation/Removal Tool Data (Cont)

Thread Size	Installation Tool	Removal Tool	Replacement Pawl Kit		Prewind Hand Install Tool
			Installation	Removal	
8-32 (0.164)	CT16002-2	CT16002R-2	CT16402-2K	CT16402R-2K	--
10-24 (0.190)	CT16002-3	CT16002R-3	CT16402-3K	CT16402R-3K	--
10-32 (0.190)	CT16003-3	CT16003R-3	CT16403-3K	CT16403R-3K	TCIF-3
1/4-20 (0.250)	CT16002-4	CT16002R-4	CT16402-4K	CT16402R-4K	--
1/4-28 (0.250)	CT16003-4	CT16003R-4	CT16403-4K	CT16403R-4K	TCIF-4
NOTES: 1 The replacement pawl kit contains an installation or removal pawl, two pins, and two springs. 2 The 1/4-28 size prewind hand installation tool is available in the prewinder hand tool and air-driven types only. 3 All dimensions are in inches.					

Table 5-8. Tangless Mandrel

Thread Size	Overall Length [A]	Plastic Mandrel Tip [B]	Adjusting Sleeve [C]	Shank Dimension
2-56 (0.086)	2.80	0.240	0.370	0.164
4-40 (0.112)	2.90	0.240	0.370	
6-32 (0.138)	3.00	0.360	0.440	
8-32 (0.164)	3.15	0.360	0.440	
10-24 (0.190)	3.00	0.370	0.440	
10-32 (0.190)	3.00	0.370	0.440	
1/4-20 (0.250)	3.00	0.370	0.440	

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Table 5-8. Tangless Mandrel (Cont)

Thread Size	Overall Length [A]	Plastic Mandrel Tip [B]	Adjusting Sleeve [C]	Shank Dimension
1/4-28 (0.250)	3.00	0.370	0.440	
NOTES: 1 Dimensions B and C are ± 0.020 in. 2 Letters [A], [B], and [C] are related to Figure 5-11. 3 All dimensions are in inches.				

CAUTION: FOR EQUIPMENT MANUFACTURED BY HONEYWELL, DO NOT REPLACE ANY SCREW, BOLT, ETC., WITH ONE OF A DIFFERENT SIZE IF THE SCREW OR MATING HOLE THREADS ARE DAMAGED. YOU MUST REPLACE THE PART OR ASSEMBLY, OR INSTALL AN APPLICABLE INSERT.

CAUTION: BEFORE YOU CONTINUE, MAKE SURE THERE IS SUFFICIENT MATERIAL IN THE BOSS OR AREA AROUND THE DAMAGED TAPPED HOLE TO DO THE WORK. AN INSUFFICIENT QUANTITY OF MATERIAL WILL MAKE THE INSERT DEFECTIVE AND NOT ABLE TO HOLD IN THE MATERIAL. THIS CAN CAUSE DAMAGE TO THE PART OR ASSEMBLY.

F. Replacement of Tanged Coil Threaded Inserts

- (1) General Data About Tanged Inserts
 - (a) Use Figure 5-13 and Figure 5-14 as aids for the removal and installation of inserts.
- (2) Removal of a Tanged Insert
 - (a) Make a selection of the applicable insert extraction tool specified in Table 5-9 (see Figure 5-13).
 - (b) Put the insert extraction tool blade in the top of the insert.
 - (c) Use a hammer to lightly tap the tool.
 - (d) Turn the tool counterclockwise until the insert completely comes out of the hole.
- (3) Installation of a Tanged Insert
 - (a) Select the correct insert from Table 5-10.
 - (b) Use a drill bit specified in Table 5-11 and carefully drill out the threads in the hole.

CAUTION: MAKE SURE YOU COUNTERSINK THE HOLE TO REMOVE ANY BURRS BEFORE YOU TAP IT. IF THE ENTRANCE OF THE HOLE IS BLOCKED BY THE BURRS, THE INSERTS WILL NOT BE INSTALLED CORRECTLY.

 - (c) Countersink the drilled hole for 82 to 100 degrees countersink, 0.005 to 0.015 inch (0.13 to 0.38 mm) deep.
 - (d) Use the tap size specified in Table 5-11 and tap the hole for the insert.

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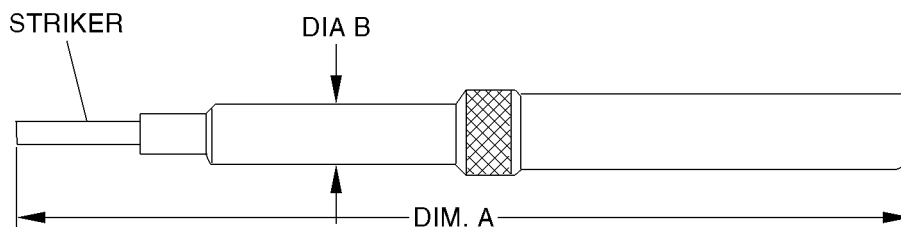
- (e) Install the tanged insert as follows:
- 1 Make a selection of the insertion tool specified by the manufacturer in Table 5-11 (see Figure 5-14).
 - 2 Align the tanged insert and insertion tool over the hole. Make sure the tool is perpendicular to the work surface.
 - 3 Turn the tool clockwise, but do not use downward pressure, until the threads engage.
 - 4 Continue to turn the tool until the top of the insert is $3/4$ to $1-1/2$ pitch below the work surface.
 - 5 Turn the tool counterclockwise to remove it from the insert.
- (f) Use one of the procedures that follow to remove the tang from the insert.
- Twist off with a pair of needle nose pliers.
 - Select the correct tang break-off tool as specified by the manufacturer in Table 5-9 and shown in Figure 5-13. Insert the punch of the tang break-off tool into the installed insert and push down on the tool barrel (body). The tang will quickly and cleanly break away from the insert.

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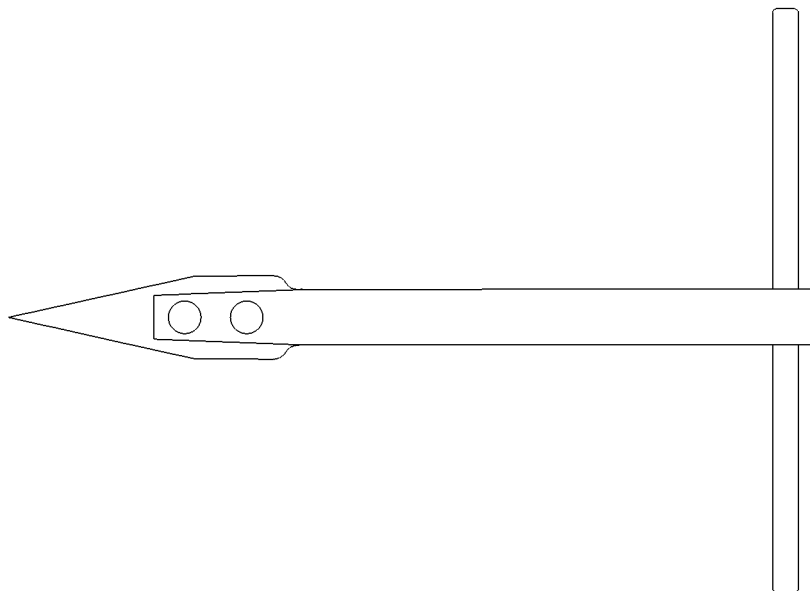
Part No. SOPM20-00-03

TANG BREAK-OFF TOOL

THIS TOOL IS USED TO REMOVE THE DRIVING TANGS OF COIL THREAD OR COIL LOCK INSERTS AFTER THEY HAVE BEEN INSTALLED.

**INSERT EXTRACTING TOOL**

COIL THREAD INSERTS ARE DESIGNED FOR PERMANENT INSTALLATION. IF, HOWEVER, THEY SHOULD BE REMOVED FOR ANY REASON, THIS EXTRACTING TOOL SIMPLIFIES REMOVAL.



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Figure 5-13. Tanged Insert Break-Off and Insert Extracting Tools

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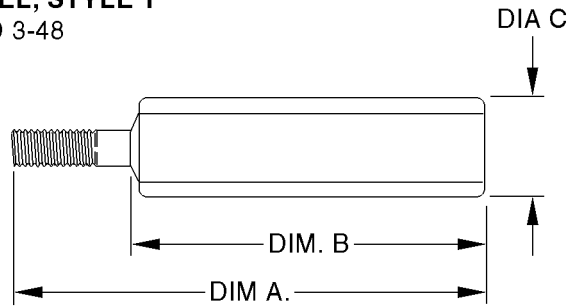
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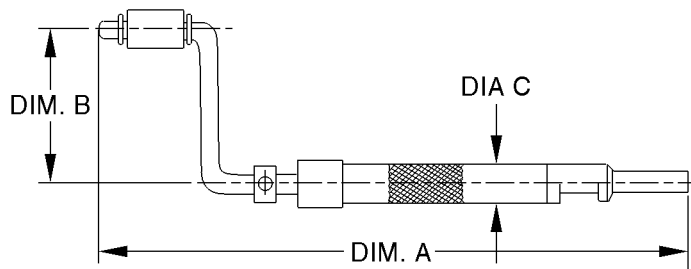
Part No. SOPM20-00-03

THREADED MANDREL, STYLE 1

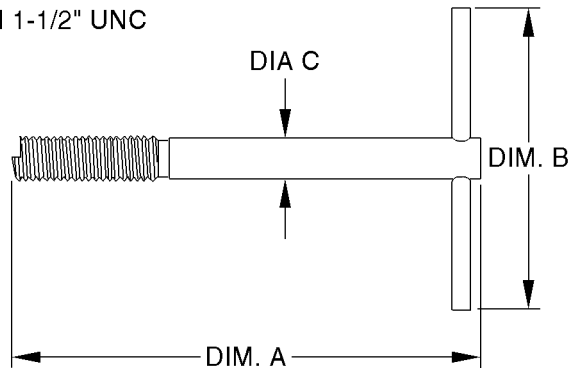
FOR SIZES 2-56 AND 3-48

**PREWINDER, CAPTIVE SLEEVE TYPE, STYLE 2**

FOR SIZES #4 THROUGH 1/2" UNC, AND FOR #3 THROUGH 1/2" UNF

**THREADED MANDREL, STYLE 3**

FOR SIZES 9/16" THROUGH 1-1/2" UNC

**NOTE:**

A prewinder, noncaptive sleeve type insertion tool, Style 4, is available for sizes 9/16" through 1-1/2" UNF, but is not covered in this procedure.

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Figure 5-14. Tanged Insert Hand Insertion Tools

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Table 5-9. Tanged Insert Break-Off and Insert Extracting Tool Data

Nominal Thread Size	Tang Break-Off Tool Part No.	Dimensions		Insert Extracting Tool Part No.
		[A]	[B]	
UNIFIED COARSE				
2-56 (0.086)	CAB-02	5-11/32	3/8	CET-02
4-40 (0.112)	CAB-04	5-13/32		CET-06
6-32 (0.138)	CAB-06	5-15/32		CET-06
8-32 (0.164)	CAB-2	5-17/32		CET-06
10-24 (0.190)	CAB-3	5-21/32		CET-6
1/4-20 (0.250)	CAB-4	5-23/32		CET-6
UNIFIED FINE				
10-32 (0.190)	CAB-3	5-21/32	3/8	CET-6
1/4-28 (0.250)	CAB-4	5-23/32		CET-6
NOTES:				
1 There are more sizes available. However, use the sizes in this table with the tanged inserts specified in Table 5-10.				
2 Letters [A] and [B] are related to Figure 5-13.				
3 All dimensions are in inches.				



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Table 5-10. Tanged Insert Dimensions

Thread Size	Length For Diameter			Coil Thread Part No.	National Aerospace No.	Mil-Std No.
	1	1.5	2			
NOTES:						
1 FR = free-running series, and SL = self-locking series.						
2 For coil thread part numbers:						
- The material type for the inserts, unless otherwise specified, is Type 304 S.S.(MIL-I-8846) and AS724S, surface texture (ANSI B46.1). - If there is no lubricant or finish requirement, leave first suffix off (e.g., TLC-06C-0207_). - If a dry film lubricant (MIL-L-46010) is needed, add a W as the first suffix in the coil thread Part No. (i.e.;TLC-06C-0207W). - If a cadmium finish [QQ-P-416, type I (max thickness = 0.0001)] is needed, add a Y as the first suffix in the coil thread Part No. (e.g., TLC-06C-0207Y). - If a bulk quantity of the inserts is needed, add nothing as the second suffix to the Part No. (e.g., TLC-06C-0207W_). - If the inserts are needed in a strip feed packaging format, add an SF as the second suffix to the coil thread Part No. (e.g., TLC-06C-0207WSF).						
3 All dimensions are in inches.						
UNIFIED NATIONAL COARSE						
FR)2-56 (0.086)	0.086	--	--	TNC-02C-0086	NAS1130-02-10	MS122095
SL)2-56 (0.086)	0.086	--	--	TLC-02C-0086	NAS1130-02L-10	MS21209-C0210
FR)2-56 (0.086)	--	0.129	--	TNC-02C-0129	NAS1130-02-15	MS122135
SL)2-56 (0.086)	--	0.129	--	TLC-02C-0129	NAS1130-02L-15	MS21209-C0215
FR)2-56 (0.086)	--	--	0.172	TNC-02C-0172	NAS1130-02-20	MS122175
SL)2-56 (0.086)	--	--	0.172	TLC-02C-0172	NAS1130-02L-20	MS21209-C0220
FR)4-40 (0.112)	0.112	--	--	TNC-04C-0112	NAS1130-04-10	MS122076
SL)4-40 (0.112)	0.112	--	--	TLC-04C-0112	NAS1130-04L-10	MS21209-C0410
FR)4-40 (0.112)	--	0.168	--	TNC-04C-0168	NAS1130-04-15	MS1221161

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Table 5-10. Tanged Insert Dimensions (Cont)

Thread Size	Length For Diameter			Coil Thread Part No.	National Aerospace No.	Mil-Std No.
	1	1.5	2			
SL)4-40 (0.112)	--	0.168	--	TLC-04C-0168	NAS1130-04L-15	MS21209-C0415
1FR)4-40 (0.112)	--	--	0.224	TNC-04C-0224	NAS1130-40-20	MS122156
SL)4-40 (0.112)	--	--	0.224	TLC-04C-0224	NAS1130-04L-20	MS21209-C0420
FR)6-32 (0.164)	0.138	--	--	TNC-06C-0138	NAS1130-06-10	MS122078
SL)6-32 (0.164)	0.138	--	--	TLC-06C-0138	NAS1130-06L-10	MS21209-C0610
FR)6-32 (0.164)	--	0.207	--	TNC-06C-0207	NAS1130-06-15	MS122118
SL)6-32 (0.164)	--	0.207	--	TLC-06C-0207	NAS1130-06L-15	MS21209-C0615
FR)6-32 (0.164)	--	--	0.276	TNC-06C-0276	NAS1130-06-20	MS122158
SL)6-32 (0.164)	--	--	0.276	TLC-06C-0276	NAS1130-06L-20	MS21209-C0620
FR)8-32 (0.164)	0.164	--	--	TNC-2C-0164	NAS1130-08-10	MS122079
SL)8-32 (0.164)	0.164	--	--	TLC-2C-0164	NAS1130-08L-10	MS21209-C0810
FR)8-32 (0.164)	--	0.328	--	TNC-2C-0328	NAS1130-08-15	MS122119
SL)8-32 (0.164)	--	0.328	--	TLC-2C-0328	NAS1130-08L-20	MS21209-C0820
FR)8-32 (0.164)	--	--	0.378	TNC-2C-0378	NAS1130-08-20	MS122159
FR)8-32 (0.164)	--	--	0.378	TLC-2C-0378	NAS1130-08L-20	MS21209-C0820
FR)10-24 (0.190)	0.190	--	--	TNC-3C-0190	NAS1130-3C-10	MS122080
SL)10-24 (0.190)	0.190	--	--	TLC-3C-0190	NAS1130-3CL-10	MS21209-C1-10

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Table 5-10. Tanged Insert Dimensions (Cont)

Thread Size	Length For Diameter			Coil Thread Part No.	National Aerospace No.	Mil-Std No.
	1	1.5	2			
FR)10-24 (0.190)	--	0.285	--	TNC-3C-0285	NAS1130-3CL-15	MS122120
SL)10-24 (0.190)	--	0.285	--	TLC-3C-0285	NAS1130-3CL-15	MS21209-C1-15
FR)10-24 (0.190)	--	--	0.380	2TCN-3C-0380	NAS1130-3C-20	MS122160
SL)10-24 (0.190)	--	--	0.380	TLC-3C-0380	NAS1130-3CL-20	MS21209-C1-20
FR)1/4-20 (0.250)	0.250	--	--	TNC-4C-0250	NAS1130-4-10	MS122081
SL)1/4-20 (0.250)	0.250	--	--	TLC-4C-0250	NAS1130-4L-10	MS21209-C4-10
FR)1/4-20 (0.250)	--	0.375	--	TNC-4C-0375	NAS1130-4-15	MS122121
SL)1/4-20 (0.250)	--	0.375	--	TLC-4C-0375	NAS1130-4L-15	MS21209-C4-15
FR)1/4-20 (0.250)	--	--	0.500	TNC-4C-0500	NAS1130-4-20	MS122161
SL)1/4-20 (0.250)	--	--	0.500	TLC-4C-0500	NAS1130-4L-20	MS21209-4C-20
UNIFIED NATIONAL FINE						
FR)10-32 (0.190)	0.190	--	--	TNF-3C-0190	NAS1130-3-10	MS124655
SL)10-32 (0.190)	0.190	--	--	TLF-3C-0190	NAS1130-3L-10	MS21209-F1-10
FR)10-32 (0.285)	--	0.285	--	TNF-3C-0285	NAS1130-3-15	MS124695
SL)10-32 (0.285)	--	0.285	--	TLF-3C-0285	NAS1130-3L-15	MS21209-F1-15
FR)10-32 (0.380)	--	--	0.380	TNF-3C-0380	NAS1130-3-20	MS124735
SL)10-32 (0.380)	--	--	0.380	TLF-3C-0380	NAS1130-3L-20	MS21209-F1-20
FR)1/4-28 (0.250)	0.250	--	--	TNF-4C-0250	NAS1130-4F-10	MS124656

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Table 5-10. Tanged Insert Dimensions (Cont)

Thread Size	Length For Diameter			Coil Thread Part No.	National Aerospace No.	Mil-Std No.
	1	1.5	2			
SL)1/4-28 (0.250)	0.250	--	--	TLF-4C-0250	NAS1130-4FL-10	MS21209-F4-10
FR)1/4-28 (0.375)	--	0.375	--	TNF-4C-0375	NAS1130-4F-15	MS124696
SL)1/4-28 (0.375)	--	0.375	--	TLF-4C-0375	NAS1130-4FL-15	MS21209-F4-15
FR)1/4-28 (0.500)	--	--	0.500	TNF-4C-0500	NAS1130-4F-20	MS124736
SL)1/4-28 (0.500)	--	--	0.500	TLF-4C-0500	NAS1130-4FL-20	MS21209-F4-20

Table 5-11. Tanged Insert Hand Insertion Tool and Drill Bit Data

Nominal Thread Size	Tool Style	Tool Part No.	Dimension		
			[A]	[B]	[C]
UNIFIED NATIONAL COARSE					
2-56 (0.086)	1	CIC-02	2-3/4	2-1/8	5/16
4-40 (0.112)	2	CIC-04	7-5/16	1-3/4	7/16
6-32 (0.138)		CIC-06			
8-32 (0.164)		CIC-2			
10-24 (0.190)		CIC-3			
1/4-20 (0.250)		CIC-4	7-7/8	2	1/2
UNIFIED NATIONAL FINE					
10-32 (0.190)	2	CIF-3	7-5/16	1-3/4	7/16
1/4-28 (0.250)		CIF-4	7-7/8	2	1/2

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Table 5-11. Tanged Insert Hand Insertion Tool and Drill Bit Data (Cont)

Nominal Thread Size	Tool Style	Tool Part No.	Dimension		
			[A]	[B]	[C]
NOTES:					
1 There are more sizes available. However, use the sizes in this table with the tanged inserts specified in Table 5-10.					
2 Letters [A], [B], and [C] are related to Figure 5-14.					
3 All dimensions are in inches.					

G. Replacement of Damaged Rivets

(1) General Data About Rivets

(a) Types of Rivets

1 Rivets are identified by the shape of their body and head as follows:

- Rivet Body
 - Solid
 - Tubular
 - Semitubular
 - Blind
 - Locked
- Rivet Head
 - Button
 - High button head acorn
 - Cone
 - Pan
 - Flat countersunk
 - Oval countersunk

(b) Identification of Defective Rivets

1 Defective rivets are identified by the conditions that follow:

- Countersunk rivets are not flush to 0.010 inch (0.25 mm) below the work surface
- Rivets have an insufficient curl or clinch
- Rivets are not curled evenly
- Rivets are not set tightly enough



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- Rivet heads are not seated properly
- Rivet body is buckled in work
- Rivets are not installed per specification (rivet holes must be other than 90 degrees to the work surface)
- The structure next to the rivet is marred, deformed, or separated (caused by rivet installation).

(c) Conditions for Replacement of Rivets

- 1 If it necessary to replace a rivet, make sure the applicable conditions occur:
 - The replacement rivet diameter is at least 93 percent of the hole diameter. If the hole is bigger than this or if the hole is not round, the component or panels that will be riveted must be replaced.
 - Any new rivet that is installed must have a length equal to the total of the work thickness plus 60 to 70 percent of the rivet diameter.
 - The combined rivet hole repairs and oversize countersink repairs must be limited to no more than 20 percent of the rivets or 10 rivets in a single rivet pattern, whichever is less.
 - Replacement of more than half of the rivets in any 10 inch (254 mm) length of pattern with oversized rivets is not allowed.
 - Replacement of more than two adjacent oversized rivets is not allowed.

(2) Replacement of Defective Generic Rivets (Solid, Tubular, Semitubular)

- (a) Use a drill to remove the rivet body out of the hole in the work surface. Be careful not to cause damage to the hole or area around the work surface.
- (b) Remove all chips, burrs, and foreign material from the mating surfaces.
- (c) Insert the new rivet into the hole the same as the other rivets. Use the equipment and data specified by the manufacturer to install the rivets.

NOTE: You can get the data on the type of rivet, manufacturer part number, and installation equipment from a local supplier or from the manufacturer.

- (d) After you replace the rivet, make sure the applicable conditions occur:
 - Any gap between a raised or countersunk rivet head and the work surface must not be more than 0.002 inch (0.05 mm). The gap must include 40 percent or less of the head circumference.
 - Any countersunk rivet that is set during installation must not be more than 0.015 inch (0.38 mm) above and below the work surface.

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- Any gap between nut plates, connectors, and panel fasteners must not be more than 0.005 inch (0.13 mm). Make sure that some part of the plate touches the work surface and the gap tilt is not caused by the nut plate tilt.
- If two flat plates or sheets are attached by rivets, make sure the sheet separation is less than 0.002 inch (0.05 mm) and a feeler gage does not touch a rivet shank.

(3) Replacement of Defective Blind Locked Spindle Rivets (Cherrylock)

- Use a carbide drill to remove the defective rivet until the locking ring is free.
- Push out any remaining unwanted material from the center piece.
- Use a drill to remove what is remaining of the rivet body from the hole in the work surface. Do not cause damage to the hole or the work surface around it.
- Remove all chips, burrs, and foreign material from the mating surfaces.
- Use the equipment and procedures specified by the manufacturer to install the new rivet.

NOTE: You can get the data on the type of rivet, manufacturer part number, and installation equipment from a local supplier or from the manufacturer

- After you replace the rivet, make sure the applicable conditions occur:
 - Any gap between a raised or countersunk rivet head and the work surface must not be more than 0.002 inch (0.05 mm). The gap must include 40 percent or less of the head circumference.
 - Any countersunk rivet that is set during installation must not be more than 0.015 inch (0.38 mm) above and below the work surface.
 - Any gap between nut plates, connectors, and panel fasteners must not be more than 0.005 inch (0.13 mm). Make sure that some part of the plate touches the work surface and the gap tilt is not caused by the nut plate tilt.
 - If two flat plates or sheets are attached by rivets, make sure the sheet separation is less than 0.002 inch (0.05 mm) and a feeler gage does not touch a rivet shank.
 - When the rivet is installed correctly, the spindle will break at the break notch flush with the rivet, within 0.020 inch (0.51 mm) above and 0.010 inch (0.25 mm) below.
 - When the rivet is installed correctly, the stem protrusion must be flush with the rivet top, +0.020 inch (0.51 mm), -0.010 inch (-0.25 mm).
 - Collar flash (deformation of collar) that is caused by pressure necessary to drive the collar is acceptable from flush to 0.020 inch (0.51 mm) above the rivet head.
 - When the collar is installed correctly, the locking collar is pushed into the locking recesses in the rivet sleeve and the spindle. If the spindle breaks off flush or below the rivet head, make sure it is between the limits given in Table 5-12.

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Table 5-12. Cherrylock Rivet Collar Flushness

Rivet Diameter	Protrusion Allowed Below Rivet Head
0.125	0.01
0.156	0.020
0.187	0.025
0.250	0.030
NOTE: All dimensions are in inches.	

H. Installation of Extractors

(1) General

These instructions describe how to assemble and install the extractors.

(2) Procedure

NOTE: Radial cracks existing only in the flared funnel that have no loose or burred edges are acceptable.

CAUTION: DO NOT OVER-PEEN THE RIVETS. THE EXTRACTORS SHOULD NOT BE DEFORMED OUT OF PARALLEL BY THE RIVETS. THE EXTRACTOR HANDLES MUST MOVE FREELY.

CAUTION: COATING ON THE CCA MUST BE THOROUGHLY CURED BEFORE EXTRACTORS ARE INSTALLED.

(a) Use roll pins provided with extractors. Disassemble extractors if necessary. See Figure 5-15 thru Figure 5-18.

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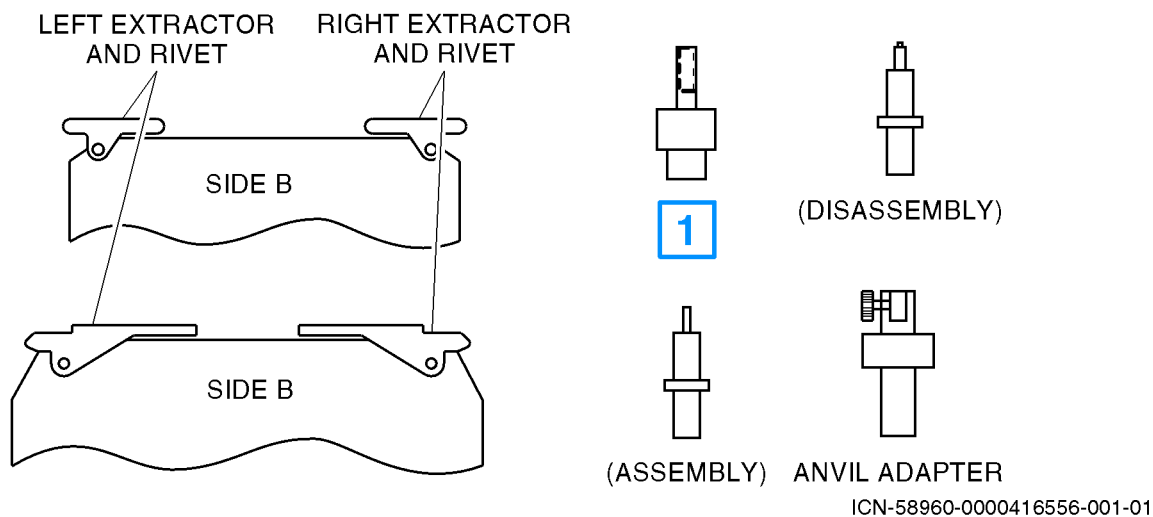


Figure 5-15. Assembly of Ejector Handles with Rivets

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- (b) Flare the rivet on side A.

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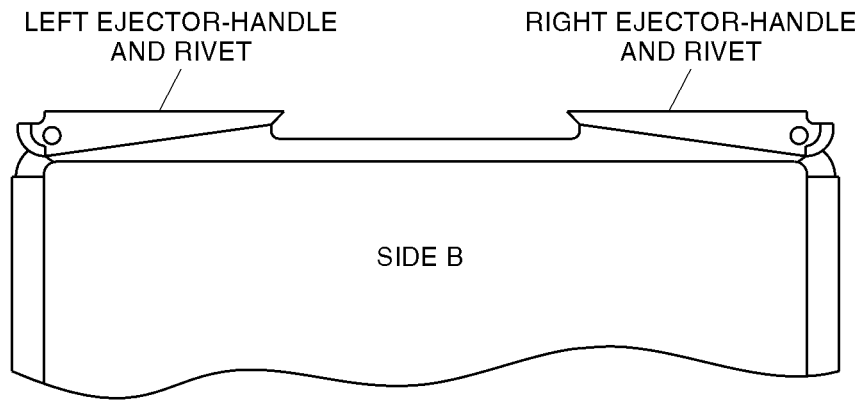
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Figure 5-16. Ejectors with Rivets

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CAUTION: DO NOT OVER-PEEN THE RIVETS. THE EXTRACTORS SHOULD NOT BE DEFORMED OUT OF PARALLEL BY THE RIVETS. THE EXTRACTOR HANDLES MUST MOVE FREELY.

CAUTION: COATING ON THE CCA MUST BE THOROUGHLY CURED BEFORE EXTRACTORS ARE INSTALLED.

(c) Adjust the anvil set screw until the pivot pin is supported in the anvil to a depth of the pivot pin flange.

(d) Readjust the gap as required to produce the following results.

NOTE: The extractor must move freely but the washer may not be loose.

NOTE: Avoid splits or cracks in the flared pin.

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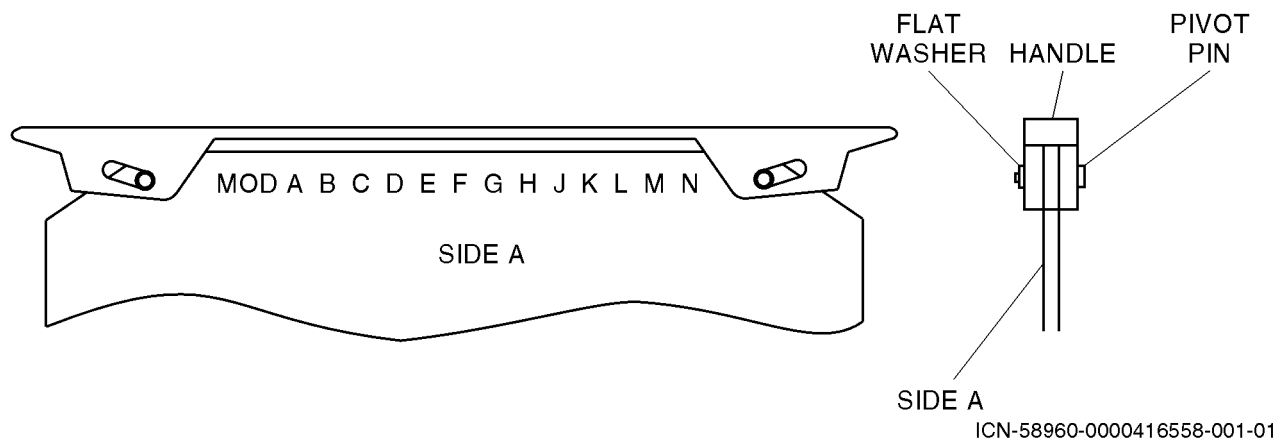


Figure 5-17. Adjust Tooling and Attach Handle to PWB with Pivot Pin and Flat Washer

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CAUTION: DO NOT OVER-PEEN THE RIVETS. THE EXTRACTORS SHOULD NOT BE DEFORMED OUT OF PARALLEL BY THE RIVETS. THE EXTRACTOR HANDLES MUST MOVE FREELY.

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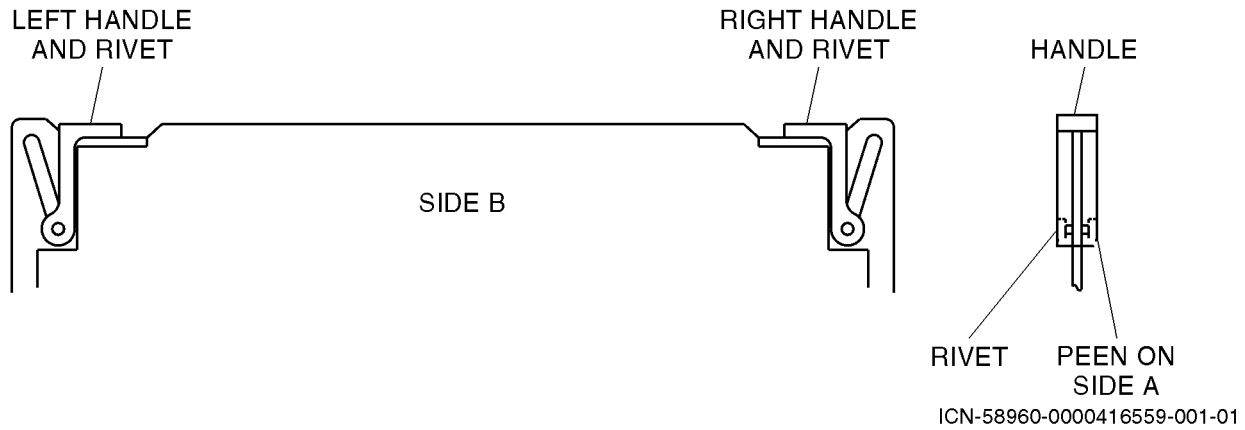


Figure 5-18. Attach Handle to PWB with Rivet

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I. Terminal Installation

(1) General

These instructions describe how to install terminals on the PWB.

(2) Procedure

NOTE: The IPL in the CMM indicates on which side of the board the terminal is to be installed.

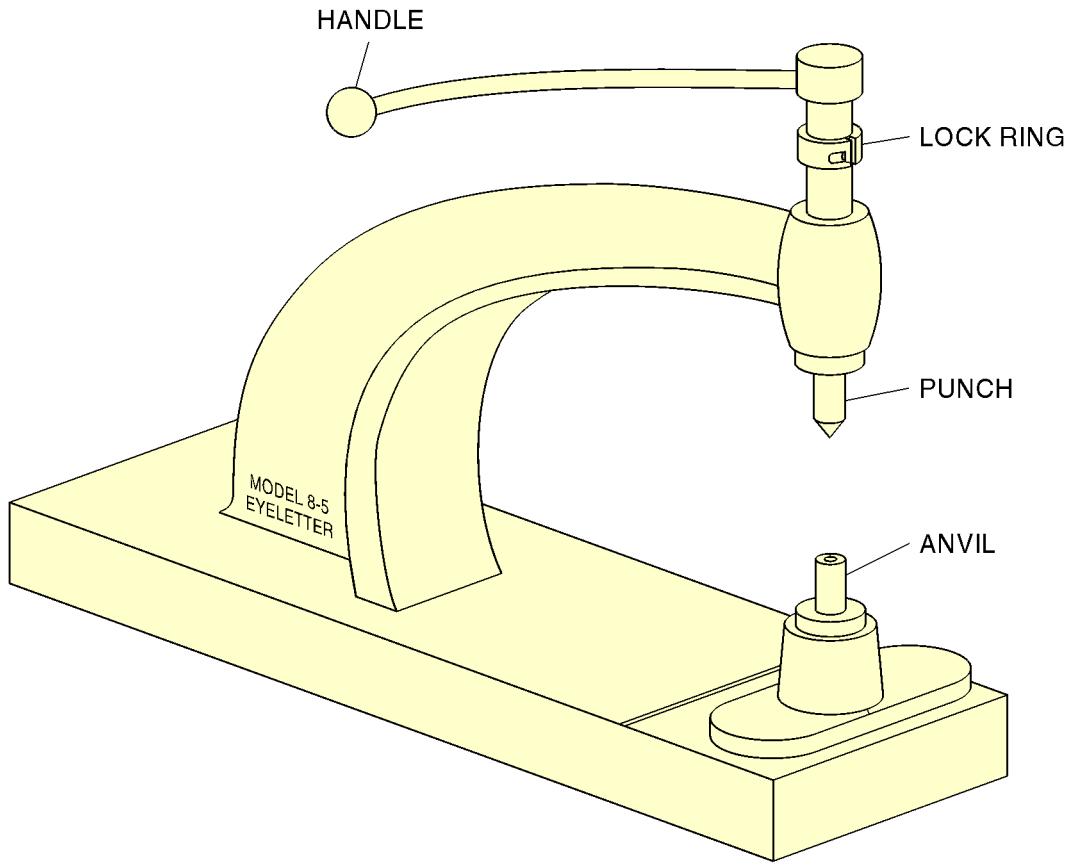
NOTE: All terminals shall be set sufficiently snug to prevent movement during board handling and subsequent soldering. Radial cracks which exist only in the flared funnel are acceptable.

(a) Place terminal in anvil. Align terminal hole of PWB over terminal and hold board level with bed of press. See Figure 5-19.

(b) Rotate press handle clockwise until terminal is correctly flared. When correct press travel is established, secure lock-ring on eyeleter.

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Figure 5-19. Anvil and Punch

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J. Installing Thermally Conductive Insulators

(1) General

These instructions describe how to install thermally conductive insulators.

(2) Procedure

(a) Installation

- 1 Use No. 2 Phillips bit. Assemble bit to driver.
- 2 Set driver to 4 in-lbs or 64 in-oz (0.45 Nm) torque.
- 3 While holding nut stationary with standard nut driver, torque screw to required torque.

(b) Insulator Repair (if required)

After assembly and cleaning, the edges of the insulator may begin to crumble or separate. Repair as follows.

CAUTION: AVOID CUTTING OR MARRING THE SURFACE OF THE BOARD OR HEAT SINK. CUT WITH A STRAIGHT DOWN MOTION ONLY. DO NOT CUT WITH A SLICING ACTION.

- 1 Using a sharp cutting blade, cut away the excess insulator material around the transistor. Use a straight-down cutting motion only.
- 2 Clear away insulator debris.
- 3 Check to see the insulator is intact under the edges of the transistor. If the insulator is split underneath the transistor or is otherwise damaged, it must be replaced.

K. Stiffener Installation

(1) General

These instructions describe how to install stiffeners on the PWB.

(2) Procedure

- (a) Install stiffener on side B of PWB with ridge toward connector. See Figure 5-20.
- (b) Bend leads on side A in alternating directions.



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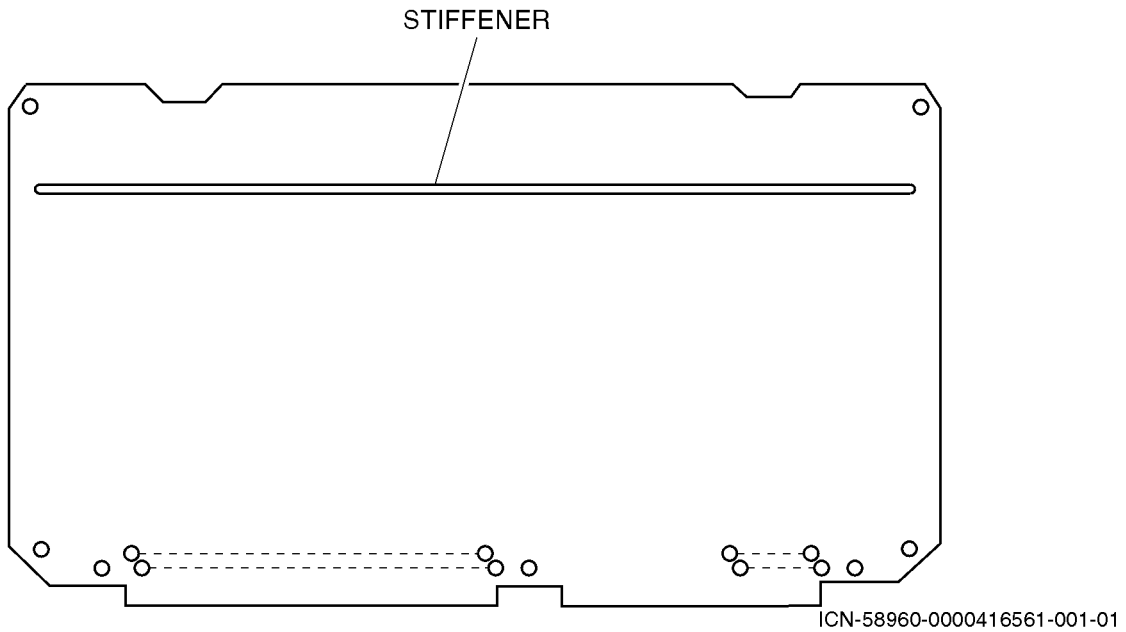


Figure 5-20. Stiffener Location

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L. Assembly of Bumpers

(1) General

These instructions describe how to install bumpers on the CCA.

(2) Procedure

(a) Side A/Side B Bumper Installation

- 1 Assemble bumper to side B and bumper to side A as shown in Figure 5-21.
- 2 Apply thread sealant to screw threads if specified in CMM.
- 3 Secure with screw inserted from side A.

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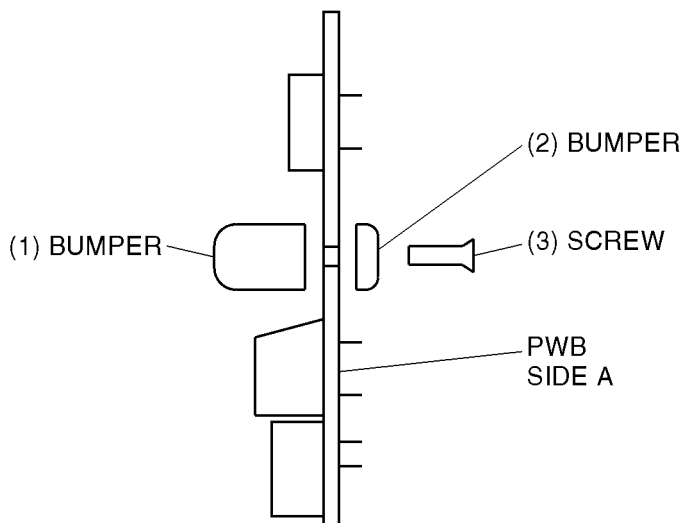
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Figure 5-21. Side A/Side B Bumper Installation

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(b) Side B Bumper Installation

- 1 Assemble bumper to side B as shown in Figure 5-22.
- 2 Apply thread sealant to screw threads if specified in CMM.
- 3 Secure with screw inserted from side B and flat washer, lock washer and nut.

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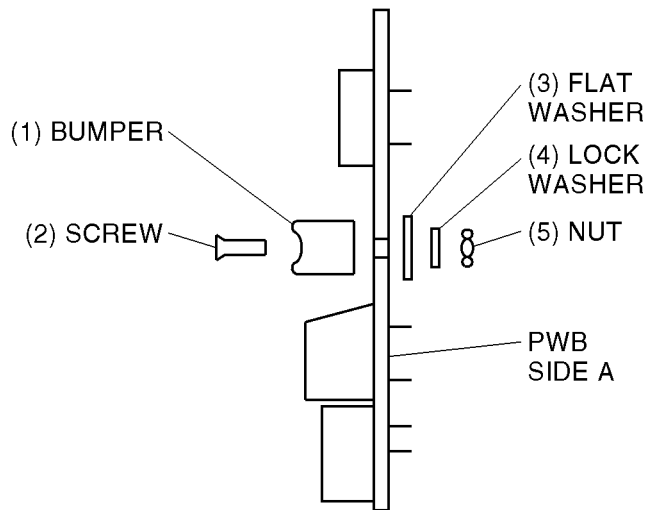
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Figure 5-22. Side B Bumper Installation

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(c) Side A Bumper Installation

- 1 Assemble bumper to side A as shown in Figure 5-23.
- 2 Apply thread sealant to screw threads if specified in CMM.
- 3 Secure with screw inserted from side A, and flat washer, lock washer and nut.

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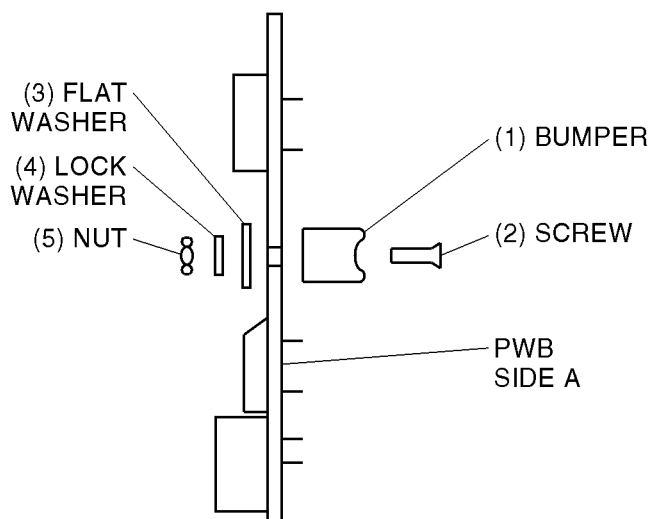
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Figure 5-23. Side A Bumper Installation

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(d) Transformer CCA Bumper Installation

- 1 Assemble bumper to side A as shown in Figure 5-24.
- 2 Apply thread sealant to screw threads if specified in CMM.
- 3 Secure with screw inserted from side A threaded into inductor.

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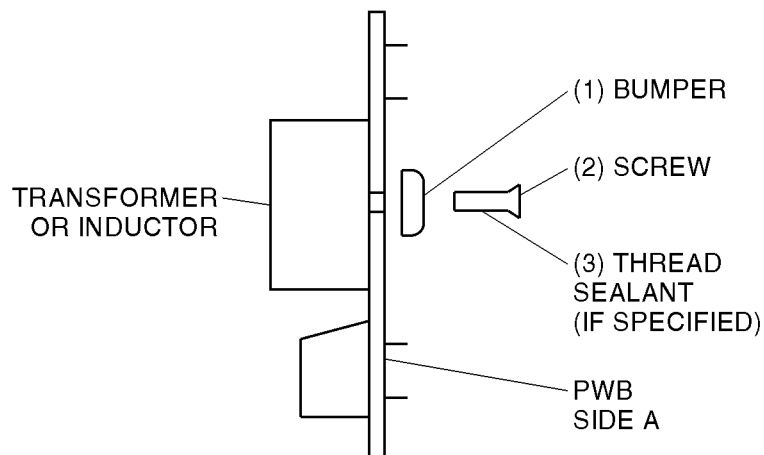
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Figure 5-24. Transformer CCA Bumper Installation

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M. Bonding of Channel Guides

(1) General

These instructions describe how to apply bonding to channel guides.

(2) Procedure

(a) Bonding of Channel Guides

CAUTION: CEMENTING FIXTURE MUST BE COMPLETELY CLEAN OF ALL TRACES OF ADHESIVE RESIDUE.

- 1 Clean surfaces to be bonded using isopropanol (1113678).
- 2 Prepare adhesive (9702878) according to paragraph 2.O.
- 3 Apply thin film (approximately 0.003 inch (0.08 mm) thick) of adhesive (9702878) to banking surfaces. See Figure 5-25.
- 4 Place channel guides over edges of PWB, place assembly into cementing fixture component side down.
- 5 Assemble pusher block to fixture and apply spring pressure to back edge of board. Check to be sure connector end of assembly is in the full depth and parallel with fixture.
- 6 Adjust four wing nut clamps to secure rails against outside edge of fixture.
- 7 Tighten knurled studs of clamping bars two places.
- 8 Cure according to paragraph 2.O.
- 9 Remove fixture from oven, allow to cool to room temperature, and remove assembly from fixture.
- 10 Clean fixture thoroughly to remove all traces of adhesive (9702878) residue.

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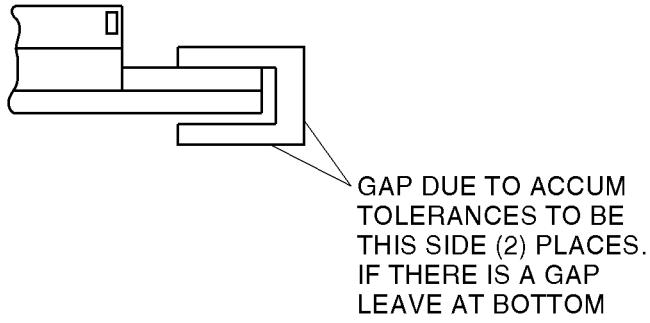
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Figure 5-25. Cementing Channel Guides

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(b) Bonding of Short Channel Guides

CAUTION: CEMENTING FIXTURE MUST BE COMPLETELY CLEAN OF ALL TRACES OF ADHESIVE RESIDUE.

- 1 Clean surfaces to be bonded using isopropanol (1113678).
- 2 Prepare adhesive (9702878) according to paragraph 2.O.
- 3 Apply thin film (approximately 0.003 inch (0.08 mm) thick) of adhesive (9702878) to banking surfaces. See Figure 5-26.
- 4 Place channel guides over edges of PWB. Centralize short channel guide over the edge of the PWB opposite connector. See Figure 5-26 for orientation of marking. Place assembly into cementing fixture, component side down.
- 5 Assemble pusher block to fixture and apply spring pressure to short channel guide. Check to be sure connector end of assembly is in the full depth and parallel with fixture.
- 6 Tighten knurled studs of clamping bars in two places.
- 7 Cure according to paragraph 2.O.
- 8 Remove fixture from oven, allow to cool to room temperature, and remove assembly from fixture.
- 9 Clean fixture thoroughly to remove all traces of adhesive (9702878) residue.

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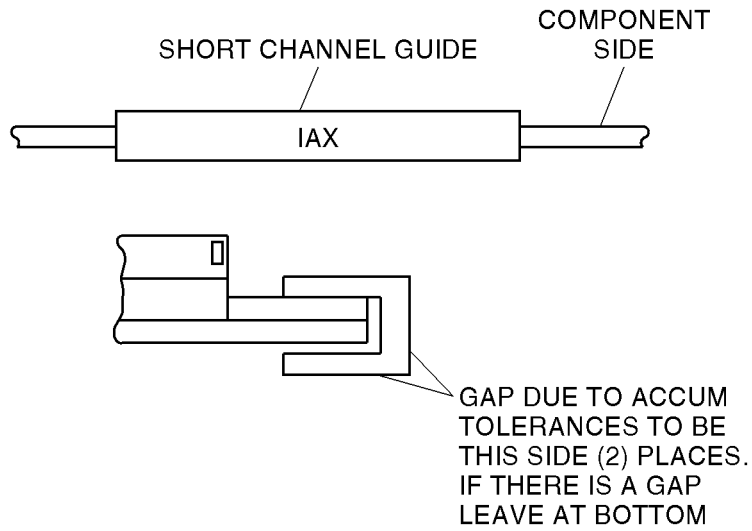
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Figure 5-26. Cementing Short Channel Guides

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(c) Bonding of Spring (Rails) to PWB

CAUTION: CEMENTING FIXTURE MUST BE COMPLETELY CLEAN OF ALL TRACES OF ADHESIVE RESIDUE.

- 1 Clean surfaces to be bonded using isopropanol (1113678).
- 2 Prepare adhesive (9702878) according to paragraph 2.O.
- 3 Check CMM for position of spring. Mark lightly on edge of PWB.
- 4 Apply thin film (approximately 0.003 inch (0.08 mm) thick) of adhesive (9702878) to banking surfaces. See Figure 5-27.
- 5 Hold spring full length against side edge of PWB with top edges of spring contacting heat sink on B side of PWB. Snap bottom of spring into position. (Recheck dimension.)
- 6 Position assembly into fixture T3024038 component side up.
NOTE: Fixture will hold three assemblies maximum. Springs should contact sides of fixtures their entire length.
- 7 Cure according to paragraph 2.O.
- 8 Remove assembly from oven to cool to room temperature and remove from fixture.

NOTE: Springs are slightly bowed near the center, lengthwise.

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BEVELED END TOWARD CONNECTOR

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Figure 5-27. Cementing Spring

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N. Application of Identification Plates

(1) General

These instructions describe how to apply identification plates.

(2) Procedure

NOTE: See service bulletin list (SBL) section of CMM for location of plate on PWB.

- (a) Clean mounting surface with isopropanol (1113678) and wipe dry.
- (b) Remove paper backing from identification (ID) plate.
- (c) Position plate on PWB per sketch in CMM and roll smooth with roller. Check edges for good bond.

O. Preparation and Application of Adhesives

(1) General

These instructions describe preparing and applying adhesive to components and CCAs.

(2) Procedure

(a) Adhesive Preparation

The adhesive (9702878 or 97C3778) consists of two components separately packaged and identified as Part 1 and Part 2. Refer to Table 9-2 for mix ratio and prepare as follows:

- 1 Squeeze out a ribbon of any convenient length from a Part 1 tube on a small, clean, plastic bag.
- 2 Lay a ribbon of equal length of Part 2 alongside.
- 3 Mix the two ribbons together with a wooden stirrer until the entire amount is evenly and thoroughly mixed.

(b) Adhesive Application

- 1 Apply approximately a 0.001 to 0.003-inch (0.03 to 0.08 mm) thickness to each mating surface to be bonded. Apply as a fillet along component body between component and PWB. Apply as a fillet at each end of the component body.
- 2 Cure 1 hour minimum at room temperature then cure 1 hour at 165 ±10 °F, (73.9 ±5.5 °C) or cure 16 hours at room temperature. Using adhesive very sparingly, install pins into connector. Be sure that pins bottom out in holes. Do not allow trapped air to push pin away from bottom of hole. Using adhesive sparingly, install keying pin on connector pin. Bond jumper wires to PWB at 1 inch (25.4 mm) intervals and corners using a spot of adhesive to encapsulate the wire or wire bundle.



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- 3 Apply RTV adhesive (97P5778-003) (Translucent) as a fillet along component body between component and PWB approximately 0.015 inch (0.38 mm) thick.
 - 4 Cure at room temperature one to three days. Parts may be handled after 8 hours of cure.
- (c) Bond retainer to heatsink
- 1 Roughen mating surface of retainer, spacer, and heat sink with electric hand grinder. Assure the surface finish is completely removed.
 - 2 Clean surface with isopropanol (1113678).
 - 3 Apply adhesive (9702878) and install alignment screws.
 - 4 If retainer is longer than 3 inches (76.2 mm), gently clamp it at the center using a holding clamp.
 - 5 Cure one hour minimum at room temperature then cure 1 hour at 165 ± 10 °F (73.9 ± 5.5 °C) or cure 16 hours at room temperature.
 - 6 Remove screws and holding clamp.
- (d) Blue Glyptal Application
- CAUTION:** GLYPTAL WILL CRAZE OR CRACK MOST PLASTICS SUCH AS ACRYLICS, POLYSULFONES, POLYSTYRENES, ALLULOSICS, POLYCARBONATES, AND RIGID VINYLs. THIS MATERIAL SHOULD ONLY BE USED FOR METAL-TO-METAL STAKING.
- 1 Apply by any suitable means (e.g., brushing, dipping, prefilled tube) a full, wet coat of the Glyptal (9730078) to the thread of the screw. The thickness should be approximately 0.005-inch (0.13-mm) thick.
 - 2 While the Glyptal is still wet, engage the screw to the desired position.
 - 3 Cure 24 hours at room temperature.
- (e) Thread Locking Compound Application
- 1 Cleaning
Applicable surfaces shall be cleaned free of grease, oil, dust, etc. by wiping with isopropanol (1113678).
 - 2 Primer Application
Apply a thin coat of primer (9731178-6) to surfaces which are 10 minutes minimum. Once activated, the surface will remain active for one week if kept clean and dry. When dry, apply the staking compound as the following outlines.
 - 3 Compound Preparation
Compound (9730378-25) is ready for use as received. Pour into a shallow dish or apply directly from a plastic squeeze bottle.
 - 4 Compound Application

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Just prior to assembly, apply the compound (9730378-25) to the part. On threaded parts, application to approximately the first 20 percent of the threaded area usually will be sufficient. Shake off excess before assembly. After assembly, wipe off excess compound with a rag dampened with isopropanol (1113678).

NOTE: Since the liquid compound will creep on exposed surfaces, removal of excess material is critically important near moving parts.

5 Curing

Cure for 30 minutes at room temperature or 1 hour at 180°F (82°C).

NOTE: Do not use metal containers. They cause premature hardening.

P. Torque Requirements for Screws and Threaded Fasteners

- (1) Threaded fasteners must be torqued to the values specified in the CMM. If torque values are not specified in the CMM and if other acceptable industry torque standards are not available, refer to the instructions that follow:
 - (a) Tighten fasteners installed through elastic boundaries (sealed by means of a diaphragm or similar elastomeric gasket) equally to get a pressure tight seal.
 - (b) Tighten fasteners installed through non-elastic boundaries as follows:
 - 1 Tighten fasteners to remove visible clearance between the parts.
 - 2 Refer to Table 5-13 and tighten to the final torque.

Table 5-13. Torque Data

Fastener Size	Torque in Inch-pounds (Nm)	
	Steel	Aluminum or Brass
2- 56 UNC	2.0 to 3.0 (0.23 to 0.34)	1.0 to 2.0 (0.11 to 0.23)
4- 40 UNC	5.0 to 6.0 (0.56 to 0.68)	3.0 to 4.0 (0.34 to 0.45)
6-32 UNC	9.0 to 12.0 (1.02 to 1.36)	5.0 to 7.0 (0.56 to 0.79)
8-32 UNC	12.0 to 15.0 (1.36 to 1.69)	8.0 to 12.0 (0.90 to 1.36)
10-24 UNC	20.0 to 25.0 (2.26 to 2.82)	12.0 to 19.0 (1.36 to 2.15)
10-32 UNF	25.0 to 30.0 (2.82 to 3.39)	19.0 to 25.0 (2.15 to 2.82)
1/4-20 UNC	60.0 to 87.0 (6.78 to 9.83)	40.0 to 60.0 (4.52 to 6.78)
5/18-18 UNC	155.0 to 170.0 (17.51 to 19.21)	65.0 to 90.0 (7.34 to 10.17)
3/8-24 UNF	260.0 to 285.0 (29.38 to 32.20)	125.0 to 150.0 (14.12 to 16.95)

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SECTION 6 – SOLDERING AND WIRE-WRAP

1. Overview

A. General

- (1) This section gives general solder and wire-wrap data.

B. Equipment and Materials

- (1) Refer to Table 6-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 6-2 for materials.
(3) Equivalent alternatives are permitted for equipment and materials.

Table 6-1. Equipment for Soldering and Wire-Wrap

Item	Description	Source
Desolder equipment	STA-TEMP Desolder System with appropriate replaceable tip cartridges	CAGE: 47882
Solder equipment	STA-TEMP Model STSS-002 Solder System with appropriate replaceable tip cartridges	
Wire-wrap gun	SP Model 6021, 110 V ac	Commercially available
Wire-wrap gun	SP Model 6311, 230 V ac	
Wire-wrap bit, size AWG 24	SP No. 52424 for AWG 24 wire	
Wire-wrap bit, size AWG 26	SP No. 52624 for AWG 26 wire	
Wire-wrap bit, size AWG 28	SP No. 52822 for AWG 28 wire	
Wire-wrap bit, size AWG 30	SP No. 53140 for AWG 30 wire	
Wire-wrap sleeve, AWG 24	SP No. 60440	
Wire-wrap sleeve, AWG 26, 28, 30	SP No. 60343	
Wire-unwrap hand tool, AWG 28-32)	SP Model 682	
Wire-unwrap hand tool, AWG 20-26)	SP Model 680	



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Table 6-1. Equipment for Soldering and Wire-Wrap (Cont)

Item	Description	Source
Unwrap tool, wire, hand, left and right hand	Type UW-2, AWG 20 to 26, terminal Dia: 0.070 In., terminal length: 1.000 In. Catalog No. 112, Stock No. 10F7661	Commercially available
Unwrap tool, wire, hand, left and right hand	Type UWD-93-93, AWG 24 to 32, terminal Dia: 0.038 In., terminal length: 1.000 In. Catalog No. 112, Stock No. 10F7665	

Table 6-2. Materials for Soldering and Wire-Wrap

Item	Description	Source
1102978	Flux, Kester 197, Type ROL1, per J-STD-004	Commercially available
1103078	Flux, liquid rosin, Type R (MIL-F-14256, Type R) — Kester No. 135	Commercially available
112C978	No-Clean flux, NC-264-5; Flux activity, Lo	Commercially available
1130778	Solvent — Isopropyl alcohol (99%), semigrade	Commercially available
11A7078	Flux, Alpha 615-25	Commercially available
11C0778	Flux, Kester 197 per MIL-F-14256, Type RMA	Commercially available
11C1678	Flux, Alpha 5003 per MIL-F-14256, Type R	Commercially available
11D2078	Flux, Liquid Rosin, Alpha 611F, Per MIL-F-14256, Type RMA	Commercially available
11G1178	Flux, Kester 197, per MIL-F-14256, Type RMA	Commercially available
8900311	Solder, rosin cored, flux no. 282, per QQ-S-571, comp SN60, WRMAP3	Commercially available
8900811	Solder, solid, 63/37 per QQ-S-571, comp SN63WS	Commercially available
8902376	Solder Anode (drill and tap for standard Anode hook), 63/37 per QQ-S-571, COMP SN63BS	Commercially available
8902908	Solid solder bar, ultra pure 63/37 per QQ-S-571, SN63BS	Commercially available
8902711	Solder, rosin cored, flux 285, per QQ-S-571, comp SN63, WRMAP3	Commercially available

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Table 6-2. Materials for Soldering and Wire-Wrap (Cont)

Item	Description	Source
89A0211	Solder, rosin cored, comp SN60 WRMAP3 (Federal Specification QQ-S-571) - ALMIT KR-19RMA	Commercially available
89A0611	Solder, rosin core (QQ-S-571, comp SN62/PB36/AG2, WRMAP3)	Commercially available
89A0811	Solder, rosin cored, Almit KR-19RMA	Commercially available
89A1478	Solder paste, Ultraprintt 78, No-clean	Commercially available
89C0578	Solder cream, 63SN/37PB, RMA 390DH, 90-2-M11 (SN63 PRMA- per QQ-S-571 and IPC-SP-819)	Commercially available
89C0678	Fine pitch solder paste, 63SN/37PB RMA 390DH, 90-3-M13 (SN63 PRMA Per QQ-S-571 and IPC-SP-819)	Commercially available
89C0778	Fine pitch solder paste, 63SN/37PB RMA R-229-25, (SN63 PRMA per QQ-S-571 and IPC-SP-819)	Commercially available
89C1378	Solder paste, NC-SMQ92J, no clean, SN63 W/ROL0 Flux per IPC/J-STD-005	Commercially available
NOTE:		
1 For manual/hand soldering refer to Table 6-3.		

2. General Data About Solder and Soldering

CAUTION: BECAUSE RESIDENT OXIDES CAN NOT BE REMOVED, IT IS NOT ACCEPTABLE TO SOFT SOLDER ON MOST GRADES OF ALUMINUM.

A. Approved Solder and Flux

- (1) The approved solder and flux are for manual/hand (nonreflow) soldering are given in Table 6-3.

Table 6-3. Approved Solder and Flux for Manual/Hand (nonreflow) Soldering

Material	Description	Specification	Comments
1103078	Flux, R	J-STD-004	This flux can be used for hand soldering if instructed by other documentation.
11C0778	Flux, RMA	J-STD-004	This flux can be used for hand soldering if instructed by other documentation.
11C1678	Flux, RMA	J-STD-004	
8900311	Solder, rosin cored, SN60/PB40, WRMAP3	J-STD-006 J-STD-004	

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Table 6-3. Approved Solder and Flux for Manual/Hand (nonreflow) Soldering (Cont)

Material	Description	Specification	Comments
8900811	Solder, solid, 63/37	J-STD-006	
8902711	Solder, rosin cored, SN63, WRMAP3	J-STD-006 J-STD-004	This solder is the standard approved material for all hand soldering of electrical connections. If no solder is stated, this is the default material.
89A0211	Solder, rosin cored, SN60 WRMAP3 (no clean)	J-STD-006 J-STD-004	This flux can be used for hand soldering if instructed by other documentation. This is a cleanable no-clean solder and does not need to be cleaned. It can be cleaned just prior to final assembly.
89A0611	Solder, rosin core, SN62/PB36/AG2 WRMAP3	J-STD-006 J-STD-004	
89A0811	Solder, rosin cored, SN63 WRMAP3 (no clean)	J-STD-006 J-STD-004	This flux can be used for hand soldering if instructed by other documentation. This is a cleanable no-clean solder and does not need to be cleaned. It can be cleaned just prior to final assembly.

(2) The approved solder and flux for machine (nonreflow) soldering are given in Table 6-4.

Table 6-4. Approved Solder and Flux for Machine (nonreflow) Soldering

Material	Description	Specification	Comments
1102978	Flux, RMA	J-STD-004	
11C0778	Flux, RMA	J-STD-004	
11D2078	Flux, RMA	J-STD-004	
11D4578	Flux, RMA, Alpha 615	J-STD-004	
11G1178	Flux, RMA	J-STD-004	
8900811	Solder, solid, 63/37	J-STD-006	
8902376	Solder, solid	J-STD-006	
8902908	Solder, solid	J-STD-006	

(3) The approved solder and flux for machine (reflow) soldering are given in Table 6-5.

Table 6-5. Approved Solder and Flux for Machine (reflow) Soldering

Material	Description	Specification	Comments
112C978	Flux	J-STD-004	
11A7078	Flux	J-STD-004	
11D4578	Flux, RMA, Alpha 615	J-STD-004	

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Table 6-5. Approved Solder and Flux for Machine (reflow) Soldering (Cont)

Material	Description	Specification	Comments
89A1478	Solder paste	J-STD-005	
89C0578	Solder cream, 63SN/ 37PB, RMA	J-STD-005	
89C0678	Solder paste, 63SN/ 37PB, RMA	J-STD-005	
89C0778	Solder paste, 63SN/ 37PB, RMA	J-STD-005	
89C1378	Solder paste	J-STD-005	

B. Description of Solder

- (1) Solder is a fusible alloy of two or more metals, composed predominately of tin and lead. The percentage of tin is always stated first (i.e., 63/37 solder is 63 percent tin and 37 percent lead). The introduction of other metals into the solder changes the working characteristics. Generally, when solder is used, it goes through three stages as heat is applied: solid, plastic, and liquid. The 63/37 solder is called an eutectic composition and has the lowest melting point of both tin and lead.
- (2) The 63/37 solder, when heated, goes from solid to liquid with no plastic state as shown in Figure 6-1. Note that other compositions have various temperature ranges when in the plastic state.

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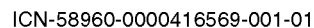


Figure 6-1. Tin/Lead Fusion Table



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- (3) Solder forms a mechanical and chemical bond between the metals being joined at a temperature well below the melting point of either metals. The process can be best illustrated by reviewing the combining of water and salt. The melting point of salt is approximately 1400°F (760°C), but when water is added to the salt, it becomes a solution at a much lower temperature. Solder, in a liquid state (as with water), when combined with some of the base metal (like salt), are joined to form a new alloy (such as a water and salt solution). This process when soldering is called inter-metallic solvent action. The completed connection forms a continuous piece of metal.
- (4) For maintenance purposes Honeywell specifies 63/37 solder which provides the best results when properly used. Less heat needs to be applied to reach the liquid state of the solder. Lower heat means less chance of heat damage to electrical parts. The soldering range must be higher than the melting point of the solder used.
- (5) After a solderable surface has been established and flux applied, the next step is to apply the correct amount of heat. Heat is necessary to:
 - Change solder from solid to liquid states
 - Reduce surface tension to provide mobility of metal flow
 - Make thermal solvent action (soldering) to take place.

CAUTION:

DO NOT USE FLUX TO REMOVE CONTAMINATION OTHER THAN OXIDATION. CONTAMINATION MUST BE REMOVED WITH A SOLVENT OR AN APPLICABLE CLEANING METHOD. FLUX WILL NOT REMOVE:

- CONFORMAL COATING
- RESIDUE FROM CHEMICAL FUMES
- DIRT
- DUST
- ADHESIVES
- FINGER PRINTS
- MARKINGS
- OILS.

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CAUTION: MAKE SURE YOU USE THE FLUX AND PROCEDURES SPECIFIED BY THE SOLDER MANUFACTURER OR HONEYWELL. IF YOU USE THE WRONG FLUX, YOU WILL GET A BAD CONNECTION.

CAUTION: DO NOT USE SOFT SOLDER FLUX AT A HIGH TEMPERATURE (APPROXIMATELY 750°F (399°C)) FOR LONG PERIODS OF TIME. SOFT SOLDER FLUX IS NOT STABLE AT THAT TEMPERATURE.

C. Flux and Soldering

(1) Description of Flux

- (a) The intermetallic solvent action that takes place during the soldering operation makes it absolutely vital that the surfaces to be bonded be clean and free of contamination, dirt and normal oxidation. All metals including the ones being soldered together form an oxide of some kind. The oxide forms a barrier that actually prohibits the metal to metal contact required for the soldering process to take place. Since oxidation takes place on all metals, we must be able to remove it to accomplish a good solder connection. The use of flux is the common answer to overcome oxidation during the soldering process.
- (b) Ever since the first of the 20th century, a search has been conducted for a flux that would allow the soft soldering of generally all aluminum. In recent years a flux has been developed by The Aluminum Company of America that removes aluminum oxides at low temperature and otherwise functions in the manner of conventional flux allowing the soft soldering of purer or higher grades of aluminum such as 2S, 3S, and 4S grades. Soft soldering of all other grades is still not recommended.
- (c) The joint to be soldered must be completely covered because the flux will not follow heat like solder does. The oxidation is dissolved by the flux as the soldering temperature is approached. Once the oxides are dissolved, they are suspended in the flux body allowing the pure base metals being soldered to make contact. If a portion of the area or joint to be soldered is not coated with flux, oxidation in that area will increase resulting in a contaminated joint.

NOTE: The wetting action seen as a soldered joint is being completed indicates all the oxides are completely removed and there is metal to metal contact. This action indicates a good solder connection.

NOTE: Solder paste, cream, or paint is a consistent mixture of pre-alloyed solder powder in a viscous flux vehicle which is used if multi-lead or SMT components are being worked on. It is not specified by Honeywell for use with discreet electrical components, wires, or sheet stock type surfaces being joined.

CAUTION: DO NOT USE CHLORIDE AND ORGANIC FLUXES WHEN SOLDERING IN OR AROUND ELECTRICAL CIRCUITRY. THESE FLUXES CAN PROMOTE CORROSION AFTER THE SOLDERING OPERATION IS COMPLETE.

(2) Classifications of Flux

- (a) Flux is grouped into three general classifications:
 - Chloride (acid)



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- Organic
 - Rosin or resin.
- (b) Chloride and organic fluxes do a very thorough job of cleaning the areas being soldered, but are very corrosive. Honeywell specifies the use of rosin or resin fluxes only.
- (c) R, RMA, and RA fluxes can be used under certain conditions. R and RMA fluxes, when used with approved procedures and processes, are for the most part considered noncorrosive.
- (d) All fluxes are corrosive during the soldering operation. The advantage of resin is that it becomes active when heated to soldering temperatures but it is inactive at normal temperature. Resin is initially corrosive but it becomes noncorrosive after the resident solvents have boiled off during the soldering process.

D. Cleanliness and Soldering

- (1) The base metal (mating surfaces) that will be soldered must be clean. Any oxidation or contamination on mating surfaces must be removed before soldering is accomplished. The solder must make contact with the base metal of all items to be soldered to make a complete and correct mechanical connection (bond). This is accomplished only when all of the oxides are removed normally by the application of flux.
- (2) It is impossible to complete a good solder connection if any member of the connection is contaminated. Types of contaminations that will prevent a good solder connection are:
- Conformal coating
 - Residue from chemical fumes
 - Dirt
 - Dust
 - Adhesives
 - Finger prints
 - Markings
 - Oils.

3. Procedure for Soldering

CAUTION: DO NOT USE THIS SOLDERING PROCEDURE TO REPAIR SURFACE MOUNT TECHNOLOGY (SMT) ASSEMBLIES, SUBASSEMBLIES, OR COMPONENTS. REFER TO SECTION 13, SURFACE MOUNT TECHNOLOGY, FOR THE CORRECT PROCEDURES.

CAUTION: WHEN SOLDERING ON A PWB, REMEMBER THERE IS A DIFFERENCE BETWEEN HEAT AND TEMPERATURE. THE PWB WILL BE DAMAGED BY THERMAL ABSORPTION OF THE OPERATION, NOT THE SOLDER TEMPERATURE. QUICK HIGHER TEMPERATURE SOLDERING WILL DO LESS DAMAGE THAN LOWER PROLONGED OPERATIONS.

A. General

- (1) If heat is not applied correctly, it will cause cold solder joints, porosity, inadequate flow, etc. When all the variables are considered, the best temperature, called equilibrium temperature, is 525 to 575 °F (274 to 302 °C).

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B. Hand Soldering

- (1) For solid core solder with flux already applied to work surface, place the heated iron or tool on item to be soldered. Put the solder wire on upper face of iron near point and let the solder flow down the face of the iron onto work surface. Move iron along work surface if necessary.
- (2) For flux core solder, put the heated iron or tool on item to be soldered. Put the solder wire on the face of the tool to help solder flow. Move the solder wire to a position so the solder and heat are being applied to the same point simultaneously.
- (3) If necessary, clean the soldered area with approved cleaning solution(s).

C. Machine Soldering

- (1) If you use a solder dip pot, bath, or solderwave machine, follow the operation instructions for that equipment.

4. Procedure for Wire-Wrap**A. General Data**

- (1) The used piece of the wire that is wrapped around a terminal must not be reused. The used piece must be cut off and the new end used. Usually enough length is built into each lead for two or three repair efforts.
- (2) Wire can be wrapped on the same section of the terminal that the original wire was removed as long as the original cross sectional shape is retained, it is not bent, twisted, corroded, and the plating is intact.

B. Removal of a Wire-Wrap Wire

- (1) Remove the existing wire-wrap connections from the terminal post with an unwrapping tool (unwrapper).
- (2) Cut the deformed portion from the wire(s).

C. Installation of a Wire-Wrap Wire

CAUTION: DO NOT CAUSE DAMAGE TO OR CUT INTO THE NEW WIRE(S) END(S) WHEN YOU STRIP INSULATION. THE DAMAGED WIRE WILL MAKE AN INCORRECT WIRE-WRAP OR WILL CAUSE A PREMATURE FAILURE IN THE CONNECTION.

- (1) Strip the insulation from the end(s) of the wire(s) to be wire-wrapped. Refer to Table 6-6 for wire stripping lengths. There are two types of stripping tools:
 - Automatic stripper (recommended)
 - Hand blade-type stripper (optional).
- (2) Select the correct wire-wrap bit, sleeve for the American wire gage (AWG) size of the wire to be attached, and install them on the wire-wrap gun.
- (3) Insert the stripped end of the wire to be installed in the wire-wrap bit until it bottoms out. Bend the wire so the insulated part of the wire fits into the notch of the bit sleeve.
- (4) Insert the wire-wrap bit and wire over the post or terminal and squeeze the gun trigger. The wire will wrap around the post or terminal. Remove the gun from the connection.



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- (5) Check the wire-wrap connection for turns, connection, and general workmanship requirements given in Table 6-7 and Figure 6-2.

Table 6-6. Wire Stripping Lengths

Terminal Size (square in.)	Wire Size (AWG)	Strip Length (approx in.)
0.015	34	0.466
0.025	30	1.062
0.025	28	1.062
0.025	26	0.875
0.025	24	0.750
0.045	30	1.625
0.045	28	1.562
0.045	26	1.375
0.045	24	1.312
0.045	22	1.312
0.045	20	1.250
0.045	18	1.218

Table 6-7. Minimum Wire-Wrap Turns

Wire Size (AWG)	Terminal Size (square) (in.)	Minimum Number of Turns	
		Modified Connection	Conventional Connection
24	0.025	5 uninsulated plus 1/2 insulated	5 uninsulated
26	0.025	6 uninsulated plus 1/2 insulated	6 uninsulated
28	0.025	7 uninsulated plus 1/2 insulated	7 uninsulated

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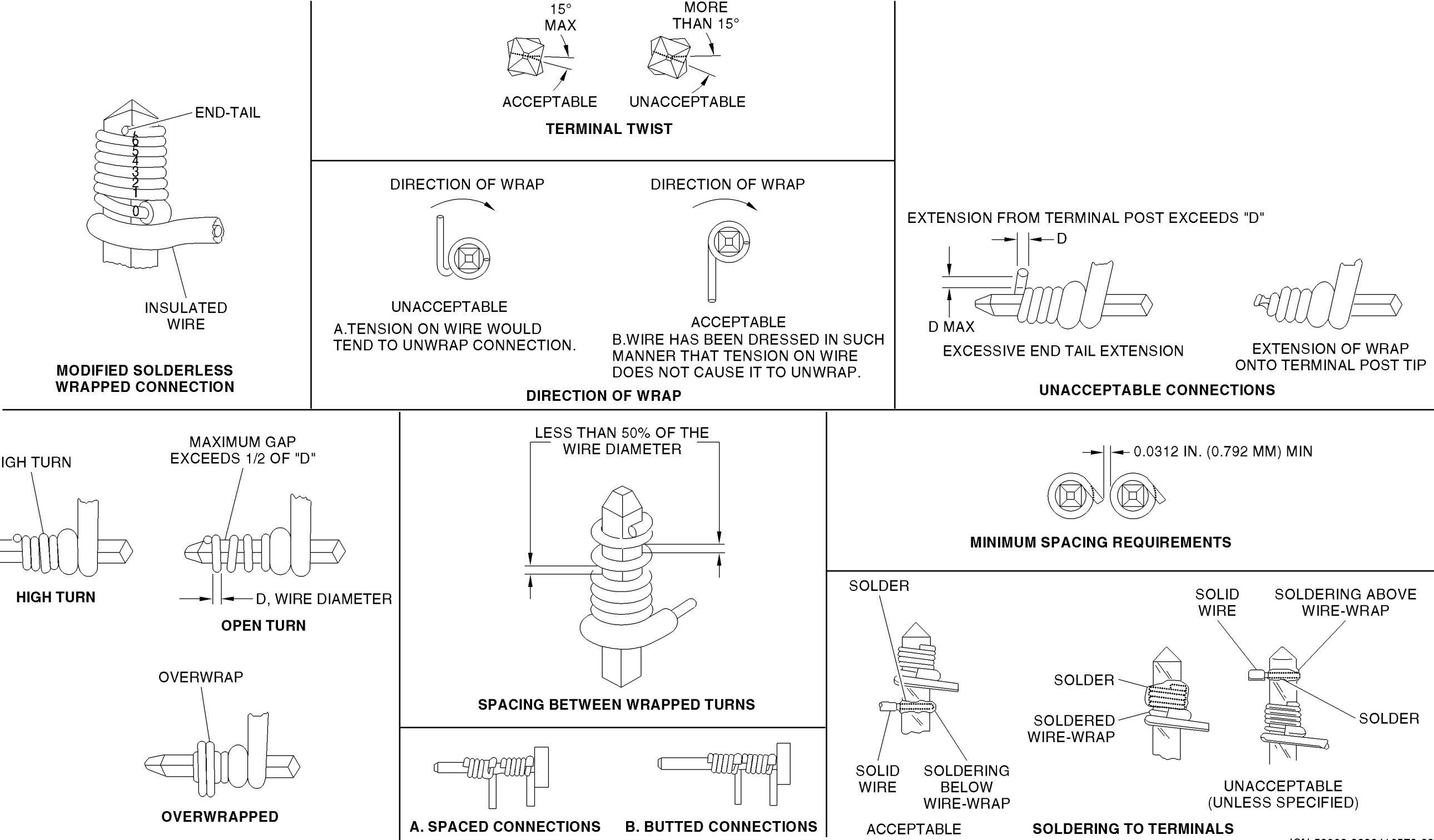


Figure 6-2. Wire-Wrap Workmanship Requirements



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SECTION 7 – HARNESS, CABLE, LEAD SET, AND CONNECTOR REPAIR

1. Overview

A. General

- (1) This section gives shop practices for the correct repair of a unit harness, cable, lead set, and connector(s).

B. Equipment and Materials

- (1) Refer to Table 7-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 7-2 for materials.

- (3) Equivalent alternatives are permitted for equipment and materials.

Table 7-1. Equipment for Harness, Cable, Lead Set, and Connector Repair

Item	Description	Source
Desolder equipment	STA-TEMP Desolder System with appropriate replaceable tip cartridges	CAGE: 47882
Solder equipment	STA-TEMP Model STSS-002 Solder System with appropriate replaceable tip cartridges	
Crimping tool gage set	T3008994-VAR (Refer to Table 7-18)	CAGE: 13130
Reamer blank	List No. 902 (Refer to Table 7-18)	
Drill stock and drill rod	Refer to Table 7-19.	
Plastic	Polycarbonate, clear, 11/32 in. rod — LEXAN	CAGE: 0B609
Storage box	6 x 4 x 3 in.—LI-0 6	CAGE: 29697
Connector contact, wire, and crimper/locator tooling	Refer to Table 7-19.	CAGE: 00779 CAGE: 29247 CAGE: 4F300 CAGE: 02660

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Table 7-1. Equipment for Harness, Cable, Lead Set, and Connector Repair (Cont)

Item	Description	Source
Connector contact, wire, and crimper/ locator tooling	Refer to Table 7-19.	CAGE: 84462 CAGE: 12783 CAGE: 11851 CAGE: 17419 CAGE: 54592 CAGE: 0EU87 CAGE: 71468

NOTES:

- 1 The tools necessary to do the work described in Table 7-19 are listed in that table. The tool suppliers are also listed in the notes for that table.
- 2 Parts used to fabricate the tools shown in Figure 7-4 thru Figure 7-18 are listed in the notes for each figure, or shown in an applicable table.

Table 7-2. Materials for Harness, Cable, Lead Set, and Connector Repair

Item	Description	Source
1113678	Isopropanol, Technical, per MIL TT-I-735, Grade B	Commercially available
1130778	Solvent — Isopropyl alcohol (99%), semigrade	
11C1878	Cleaner, lens cleaner, #1 K-Lens-M-Lens, MIL-C-43454, Type 1	Commercially available
11X0152	Cleaner, optical, thin film-TFC	CAGE: 11536
11X2586	Cleaner, glass, ALG/CR215	Commercially available
6008676	Lint free cloth — Bluewipes, No. TX512	Commercially available
6502017	Thermoplastic polystyrene, rigid, transparent (clear) sheet stock — per Honeywell specific P692357-1	Commercially available
65A1117	Foam, electroabsorbent, BLK, glossy, flexible, sheet, X/X-inch thick — Eccosorb LS26	Commercially available
9519478	Ink, black marking, epoxy base resin and amine-type catalyst (FED-STD-595 color 17038) — No. 50-700-R black CAT-L-INK with catalyst No. 20	Commercially available
9702878	Adhesive, epoxy (Federal Specification MMM-A-134, Type I) — A-1177B (two parts)	Commercially available

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Table 7-2. Materials for Harness, Cable, Lead Set, and Connector Repair (Cont)

Item	Description	Source
Wet/dry antistatic sachet	Visial antistatic instrument sachet, ALG/CR215	Commercially available
MC7777-01	Adhesive, epoxy-polyamide, unfilled	CAGE: 94580
NOTE: 1 Materials used to fabricate the tools shown in Figure 7-4 thru Figure 7-18 are listed in the notes for each figure, or shown in an applicable table.		

2. Procedures

A. Procedure for Cable and Wire Harness Assemblies

- (1) Refer to IPC/WHMA-A-620, Requirements and Acceptance for Cable and Wire Harness Assemblies.
- (2) Refer to STANDARD PRACTICES MANUAL, ATA NO. 20-00-02/70-00-01, Section D – Method No. 413D for Wiring Harness Assembly Repair.

CAUTION: CONNECTORS MOUNTED TO THE PWBS THAT USE SURFACE MOUNT TECHNOLOGY (SMT) SHOULD NOT BE REPAIRED USING THE PROCEDURES THAT FOLLOW. AN ATTEMPT TO USE THESE PROCEDURES WITH SMT COMPONENTS COULD DAMAGE BOTH THE CONNECTOR AND PWB BEYOND REUSE. REFER TO SECTION 13, SURFACE MOUNT TECHNOLOGY, FOR SMT PROCEDURES.

B. Procedure for Connectors

- (1) General Data About Connectors
 - This procedure covers the repair of connectors used to connect electrical circuits internally in avionics equipment or externally from the equipment to other aircraft or test equipment.
 - Conformal coating, if specified, must be removed from the complete CCA, PWB, ECA, or the area on the board or card around the damaged connector before connector work is performed.
 - Discard, do not attempt to repair, damaged connectors or pins in connectors with filters, glass, or sealed headers.
 - Connectors with serious damage to the housing/shell must be replaced or discarded. Contact Honeywell for an applicable procedure to discard them.
 - Figure 7-2 is a typical hand-held pneumatic crimper/locator, used for connector contact installation.
 - Figure 7-3 shows typical methods of wire stripping and contact fit. Preferred, acceptable, and incorrect methods are shown.
 - Table 7-3 gives the applicable resident connector shell or mating contact for specific Honeywell part number contacts.
 - The tools in Figure 7-4 thru Figure 7-18 are specified by part number in Table 7-19.
 - Table 7-19 and Table 7-20 are foldout tables that are located at the end of this section.

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- Table 7-19 gives the applicable tooling and conditions to install specific contacts.
- Table 7-20 gives the applicable tooling and conditions to install specific lugs, pins, studs, sockets, and terminals.

(2) Replacement of Typical Crimp-Type Connector Contacts

- (a) Remove the defective contact from the connector body with an applicable extraction tool.
- (b) Cut the damaged contact from the end of the wire.
- (c) Remove enough insulation from the end of the wire so that the new contact will fit as indicated in the preferred or acceptable illustrations in Figure 7-3.
- (d) Use the tool specified in Table 7-3 to install a new connector contact on the end of the wire.
- (e) Install a new contact as follows:
 - 1 Put the new contact on the bare end of the wire.
 - 2 Crimp the contact and wire together with a crimping tool. See Figure 7-2 for an illustration of a typical crimper, and Figure 7-3 for a typical wire stripping and contact fit.
- (f) Push or pull the new terminal into the correct connector body hole until it is fully seated.

C. Standard Repair Procedure for ARINC 600 Connectors

(1) General

- This procedure is for repair of damaged ARINC 600 connector contact(s) cavity. Maximum allowable contacts to be repaired are 5 per connector block.

(2) Procedure

- (a) Remove the damaged contact(s) from the connector cavity, ensuring the retaining clip within the cavity does not impede the insertion of replacement contact.
- (b) Clean the replacement contact with isopropyl alcohol and dry.
- (c) Insert the ARINC connector into a fully loaded (male contacts) mating ARINC connector to further align repaired contact(s).
- (d) Apply Adhesive MC7777-01 around the circumference of contact, staying within 0.25 inch (6.35 mm) of wire wrap side only of contact shoulder. Refer to Figure 7-1.

NOTE: Adhesive on the shoulder itself is permissible.
- (e) Insert the contact into the cavity and locate in proper position. Make sure there is no adhesive on outside portion of connector block.
- (f) Orientate the connector being repaired during the adhesive cure cycle so that the wire wrap portion faces upward at all times.



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- (g) Cure 6 hours at room temperature, then 170°F (77°C) for 2 hours or 24 hours at room temperature.

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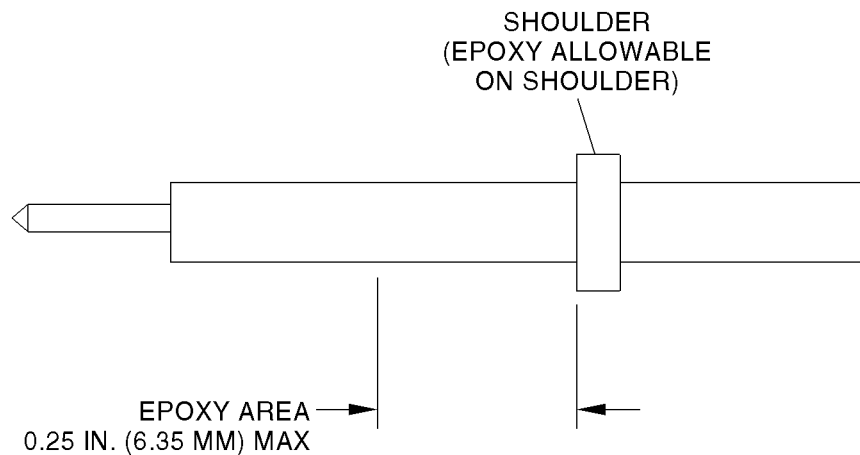
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Figure 7-1. Epoxy Application on Contact

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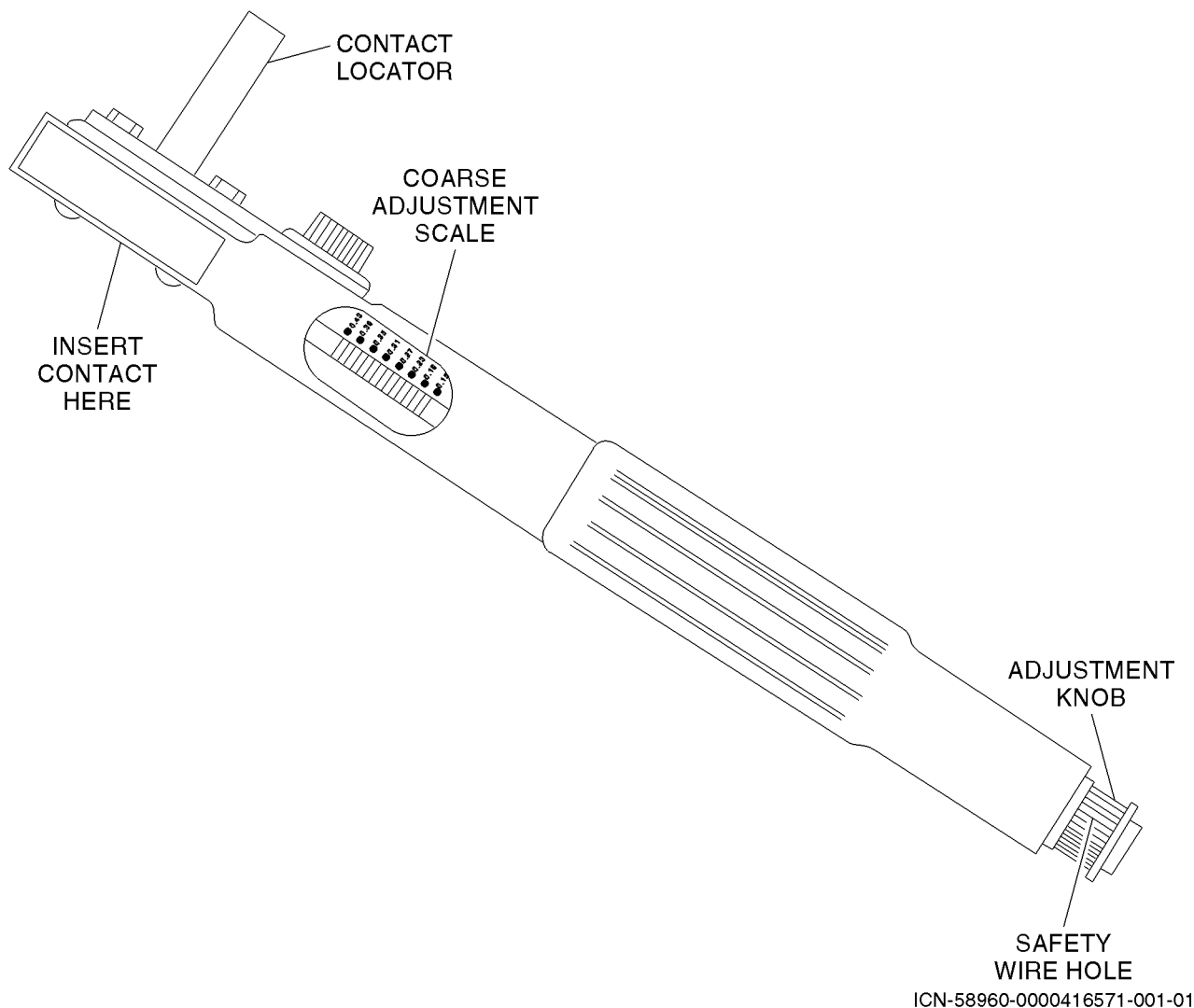


Figure 7-2. Typical Hand-Held Crimper/Locator, T3008300-3

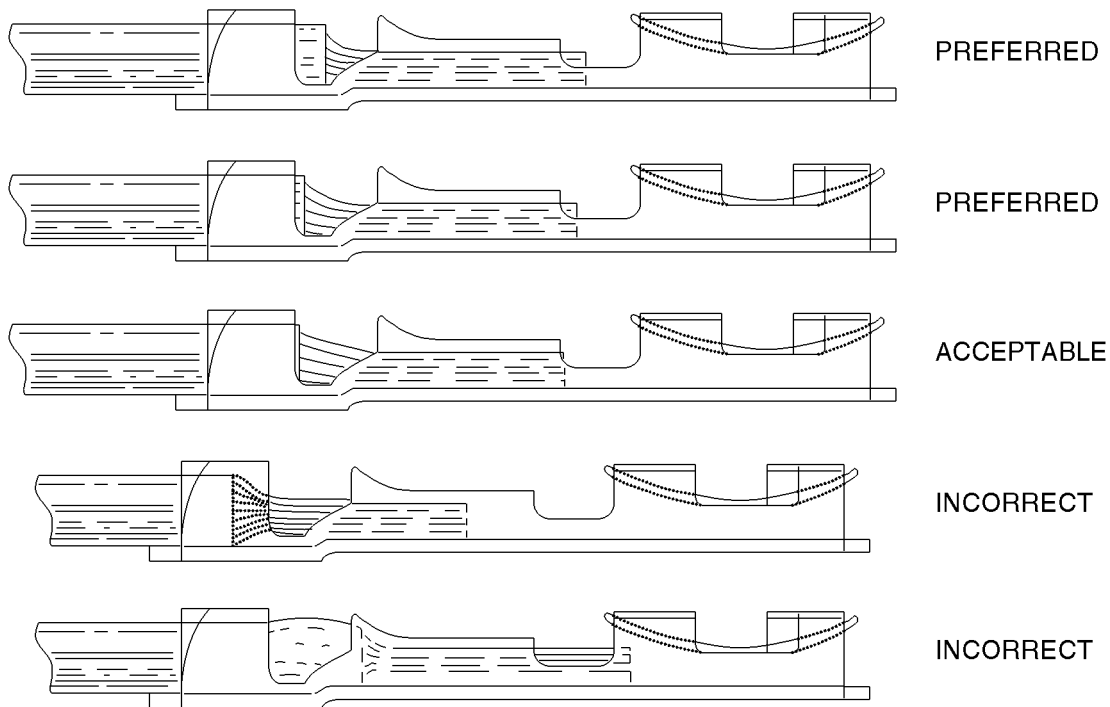
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NOTES:

1. The preferred examples show the wrap-around grippers holding the insulation, the insulation extending beyond the grippers, and the wire ends visible in the inspection window.
2. The acceptable view shows the insulation trimmed so that the grippers are almost at the end of the insulation and the wire end is just visible in the edge of the inspection window.
3. The top incorrect view shows more insulation trimmed from the wire than needed and the wire not inserted far enough into the contact barrel.
4. The bottom incorrect view shows not enough insulation trimmed from the wire and more wire inserted into the contact barrel than needed.

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Figure 7-3. Typical Wire Stripping and Contact Fit



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Table 7-3. Contact/Connector Mating Relationship

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
NOTES: - Under the Mating Contact heading: - The Honeywell Part No. column lists the part number and can contain notes that are related to the part number. - The Military/ARINC Part No. column lists the military or Aeronautical Radio, Inc. (ARINC) part number for the Honeywell part number. - The Contact Gender column indicates whether the part number is female (F) or male (M). - Under the Mating Connector heading: - The Honeywell Part No. column lists the part number (if available) of the connector the referenced contact can be installed in or the contact that it mates with. This column can contain notes that are related to the part number. - The Military/ARINC Part No. column lists the military or ARINC part number for the Honeywell part number (if available) for the mating contact or resident connector body. - Some entries in the table refer to the mating connector contact instead of the mating connector.				
1715213-1	---	F	Mates with 0.025 X 0.002 in. square pin	---
1715213-2				
1715213-3				
1715215-1	---	F	7002851	---
1715215-3				

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
2387050-16 Same as 2503959-2	M39029/31-229	M		MIL-C-26482, Type I, MIL-C-26500, MIL-C-26518
2387050-112 Same as 2503959-1 and 4030483-20	M39029/31-234			
2387050-120 Same as 2503959-1 and 4030483-20	M39029/31-240			
2387050-160	M39029/31-223			
2387050-212	M39029/32-253			
2387050-220	M39029/32-259			
2387050-260	M39029/32-247			
2500137-1 Same as 2500163-2	---	F	2500122, 2501523, or other ARINC 404 connectors	ARINC 404
2500137-2			2500122, 2501523	
2500137-3 Same as 2500163-1			2500122, 2501523	
2500137-4 Same as 2501512-1			2500122, 2501523	
2500163-1 Same as 2500137-3	---	F	2500097	
2500163-2 Same as 2500137-1				
2500202 Same as 3718697-21	---	M	2500208, 2500485, 2500750, 2500900	

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
2500205 Same as 3718679-22	---	F	2500204, 2500484	
2500237-1 Same as 2500979-1	---	F	2500249	
2500239-1	---	M		
2500322-1	M39029/34-22	M	2500320, 2500374	
2500323-1	M22520/2-01	F	2500311	
2500325-1 or 2500325-2	---	F	2500333	---
2500438-1	---	F	2500441, 2500443	
2500439-1	---	M	2500440, 2500442	
2500527-1	---	M	---	MS3122, MS3126
2500926-12 Same as 4007689-12	M39029/58-365	M	2500949, 2500982	
2500926-16 Same as 4007689-16	M39029/58-364			
2500926-20 Same as 4007689-20	M39029/58-363			
2500926-22 Same as 4007689-22	M39029/58-362			
2500926-221 Same as 4007689-221	M39029/58-361			
2500926-222 Same as 4007689-222	M39029/58-360			

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
2500937-12	M39029/57-12	F	2500970, 2500981, 4007979, 4016916, 4008114, 4030061	
2500937-16	M39029/57-16			
2500937-20	M39029/57-20			
2500937-22	M39029/57-22			
2500937-221	M39029/57-22M			
2500937-222	M39029/57-22D			
2500978-1	M39029/64-369	M	(Contact) 2500979-1	M39029/63-368
2500978-2	M39029/58-360		(Contact) 2500979-2	M39029/57-354
2500979-1 Same as 2500237-1	M39029/63-368	F	(Contact) 2500978-1	M39029/63-368
2500979-2	M39029/57-354		(Contact) 2500978-2	M39029/57-354
2501339-20 Same as 4002087-20	NAS1662-20	M	2501352	
2501433-22	MS90460-23-22	F	2501436	
2501434-22	M39029/47-22	M	2501281, 2501435	
2501512-1 Same as 2500137-4	---	F	2501523	
2501663-1		M		
2501663-2				
2501663-3				
2501663-4				

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
2501678-1 Same as 2501678-2 (-2 = SPOOL)	---	F	2501658, 2501679, 2501660, 2501682	
2501678-3 Same as 2501678-4 (-4 = SPOOL)				
2503528-1	---	M	2504778, 2504914	
2503528-2				
2503528-3				
2503528-4				
2503959-1 Same as 2387050-120 and 4030483-20	MS3192-20A	M	2503941	
	MS3192-16A	M	2503941	
2504450-1	---	M	2504428, 2504429, 2504473	
2504520	---	M	2504519	
2504521		F		
2504842-1 Same as 2504843-1 and 4069506-1	MS24254-20P	M	---	MIL-C-26500
2504842-2 Same as 6229599-2				
2504842-3	---	M		MIL-C-26500

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
2504843-1 Same as 2504842-1 and 4069506-1		F		
2504843-2 Same as 6229600-2				
2519857-*	MIL-N-46026	M	General Connector/ Electronic Assembly	---
2519857-1				
2519857-2				
2519857-3				
2519857-4				
2519857-5				
2519857-6				
2519857-7				
2519857-8				
2519857-9				
2519857-10				
2519857-11				
2519857-12				
2519857-13				
2519857-14				
2519857-15				
2519857-16				
2519857-17				
2519857-18				
3718679-21 Same as 2500202	---	M	2500208, 2500485, 2500750, 2500900	
3718679-22 Same as 2500205		F	2500204, 2500484	
3718866-1				
3718866-6				

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
3718919-101				
3718919-102				
3719005-101, -103, -104, and -113		F		
3719005-102		M		
3719005-105				
3719005-106				
3719005-107				
3719005-108		F		
3719005-109		M		
3719005-110		F		
3719005-111		M		
3719005-112		F		
4000808-12	---	F	4000811	
4000808-16				
4002086-12	---	F	4001747	
4002086-16				
4002086-20				
4003087-12	---	M	4001531	
4003087-16				
4003087-20				
4003074-12	M39029/01-12	M	Switch Part No. 4000332	
4003074-16	M39029/01-16			
4003074-20	M39029/01-20			
4003074-21	M39029/01-21			
4003074-22	M39029/01-22			

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4007689-12 Same as 2500926-12	M39029/58-365	M	2500949, 2500982, 4006911	MIL-C-39029/58
4007689-16 Same as 2500926-16	M39029/58-364			
4007689-20 Same as 2500926-20	M39029/58-363			
4007689-22 Same as 2500926-22	M39029/58-362			
4007689-221 Same as 2500926-221	M39029/58-361			
4007689-222 Same as 2500926-222	M39029/58-360			

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4007795-12 Same as 4011587-12	M29029/57-359	F	2500926-12, 4007689-12	(Contact) MIL-C-39029/58
4007795-16 Same as 4011587-16	M29029/57-358		2500926-16, 4007689-16	
4007795-20 Same as 4011587-20	M29029/57-357		2500926-20, 4007689-20	
4007795-22 Same as 4011587-22	M29029/57-356		2500926-22, 4007689-22	
4007795-221 Same as 4011587-221	M29029/57-355		2500926-221, 4007689-221	
4007795-222 Same as 4011587-222	M29029/57-354		2500926-222, 4007689-222	

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4011587-12 Same as 4007795-12	MS27491-12	F	4008766, 4008769, 4011587	
4011587-16 Same as 4007795-16	MS27491-16			
4011587-20 Same as 4007795-20	MS27491-20			
4011587-22 Same as 4007795-22	MS27491-22			
4011587-221 Same as 4007795-221	MS27491-221			
4011587-222 Same as 4007795-222	MS27491-222		4008766, 4008769, 4011588	
4011588-12	MS27494-12	M	4008767, 4008768, 4011587	
4011588-16	MS27494-16			
4011588-20	MS27494-20			
4011588-22	MS27494-22			
4011588-221	MS27494-22M			
4011588-222	MS27494-22D			
4012291-1	---	F	Switch Conn Block Part No. 4011595	
4012291-2				
4015220-12	MS27494-12	M	4008767, 4008768, 4009062	40M38277
4015220-16 Same as 4015221-16	MS27494-16			
4015220-20	MS27494-20			
4015220-22	MS27494-22			
4015220-221	MS27494-221			
4015220-222	MS27494-222			

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4015221-12	MS27492-12	F	4008766, 4008769	
4015221-16 Same as 4015220-16	MS27492-16			
4015221-20	MS27492-20			
4015221-22	MS27492-22			
4015221-221	MS27492-22M			
4015221-222	MS27492-22D			
4015819-1	M39929/50-340	F	4015823	
4015821-12	M39029/4-110	M	4015822	M39029/4-
4015821-16	M39029/4-111			
4015821-20 Same as 4015824-20	M39029/4-113			
4015822-12	M39029/4-			
4015822-16	M39029/4-	F	4015821	M39029/4-110
4015822-20	M39029/4-			M39029/4-111
				M39029/4-113
4015824-12	M39029/4-115	F	4015826	
4015824-16	M39029/4-116			
4015824-20 Same as 4015820-20	M39029/4-118			
4015826-12				
4015826-16		M	4015924	M39029/4-115
4015826-20			4015824	M39029/4-116
			4015824	M39029/4-118
4018337-12	M39029/18-180	M	4018264	MIL-C-0081511/41
4018337-16	M39029/18-179			
4018337-20	M39029/18-178			
4018337-22	M39029/18-177			
4018337-28	M39029/18-176			
4018847-1	---	M	4018852	
4018847-2				

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4018847-3	---		4018852	
4018847-5	---			
4018847-7				
4018847-9				
4018847-11				
4018847-13				
4024886-1		M	4017518, 4017519	
4024886-2				
4024886-3				
4024886-4				
4024886-5				
4027009-1	M39029/17-171	F	4026740, 8002177	MIL-C-81511, SERIES 3
4027009-2	M39029/17-172			
4027009-3	M39029/17-173			
4027009-4	M39029/17-174			
4027009-5	M39029/17-175			
4029091-10	M39029/56-527	F	4029004, 4029005, 8503000, 8503009, 8503912	MS27467, MS27505, M38999/42, M38999/44, M38999/46
4029091-12	M39029/56-353			
4029091-16	M39029/56-352			
4029091-20	M39029/56-351			
4029091-22	M39029/56-350			
4029091-221	M39029/56-349			
4029091-222	M39029/56-348			
4030483-20 Same as 2387050-120 and 2503959-1	MS3192A20-20A	M	4030514	
4032151-1 - or - 4032151-11 (-11=AUTO TOOLING)	---	F	4031996, 4060016	---

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4032151-2 - or - 4032151-12 (-12=AUTO TOOLING)				
4032151-3 - or - 4032151-13 (-13=AUTO TOOLING)				
4032151-51 - or - 4032151-61 (-61=AUTO TOOLING)				
4032151-52 - or - 4032151-62 (-62=AUTO TOOLING)				
4032151-101 - or - 4032151-111 (-111=AUTO TOOLING)				
4032151-102 - or - 4032151-112 (-112=AUTO TOOLING)				
4032151-103 - or - 4032151-113 (-113=AUTO TOOLING)				
4038175	---	M	4037989	

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
4038176	---	M	4037989	
4045070-12	---	M		ARINC 404 or ARINC 600
4045070-16				
4045070-20				
4045070-22				
4049711-1	---	F	4049710-1	
4053139			4053137, 4053138	
4069506-1 (crimp) Same as 2504842-1 and 2504843-1	MIL-C-39029/31	M	2504389, 2500191	MIL-C-26500
4069506-2 (wire wrap)	---			
6229599-2 Same as 2504842-2				
6229600-2 Same as 2504843-2				
7002730 Same as 1715213-1 and 7002730-3	---	F	7002851	---
7002730-1 Same as 1715213-3 and 7002730-2				
7002730-2 Same as 1715213-3 and 7002730-1				

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Table 7-3. Contact/Connector Mating Relationship (Cont)

Mating Contact			Mating Connector	
Honeywell Part No.	Military/ARINC Part No.	Contact Gender	Honeywell Part No.	Military/ARINC Part No.
7002730-3 Same as 1715213-1 and 70002730-1,-2				
7002730-4				
7002730-5 Same as 7002730-6				
7002730-6 Same as 7002730-5				
7002730-7				
7002730-8				
7007466-1	---	M	7002851	---
7007466-2				
7007466-3				
7007472-9				
7007472-11				
7007466-1				
7008004		M	7007737	---
7009203-1	---	M	7000759-2	
7009203-2				
7009314-1	---	F	7009312	---
7017632				
7018408	---	M	4017770, 7000759, 7004612	---

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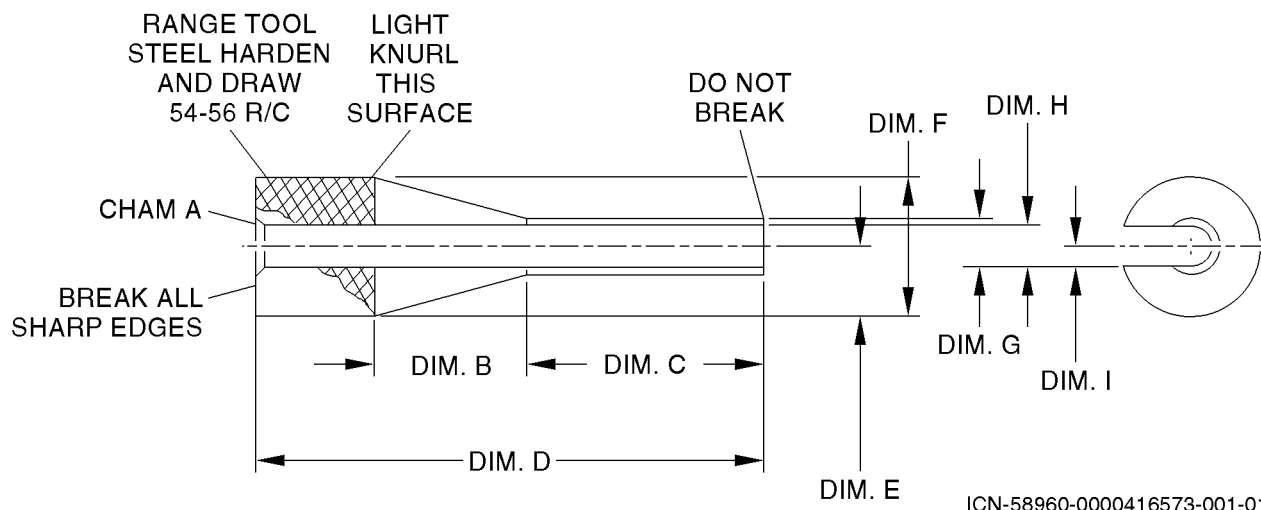
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Figure 7-4. Contact Removal Tool, T3005573

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Table 7-4. Key to Figure 7-4

Dimension	Value in Inches (Millimeters)
A	0.016 (0.41)
B	0.250 (6.35)
C	0.375 (9.53)
D	0.813 (20.95)
E	0.109 (2.77)
F	0.219 (5.56)
G	0.088 +0.00, -0.03 (1.73 +0.00, -0.03)
H	0.069 +0.001, -0.00 (1.75 +0.03, -0.00)
I	0.0345 ±0.001 (0.876 ±0.03)

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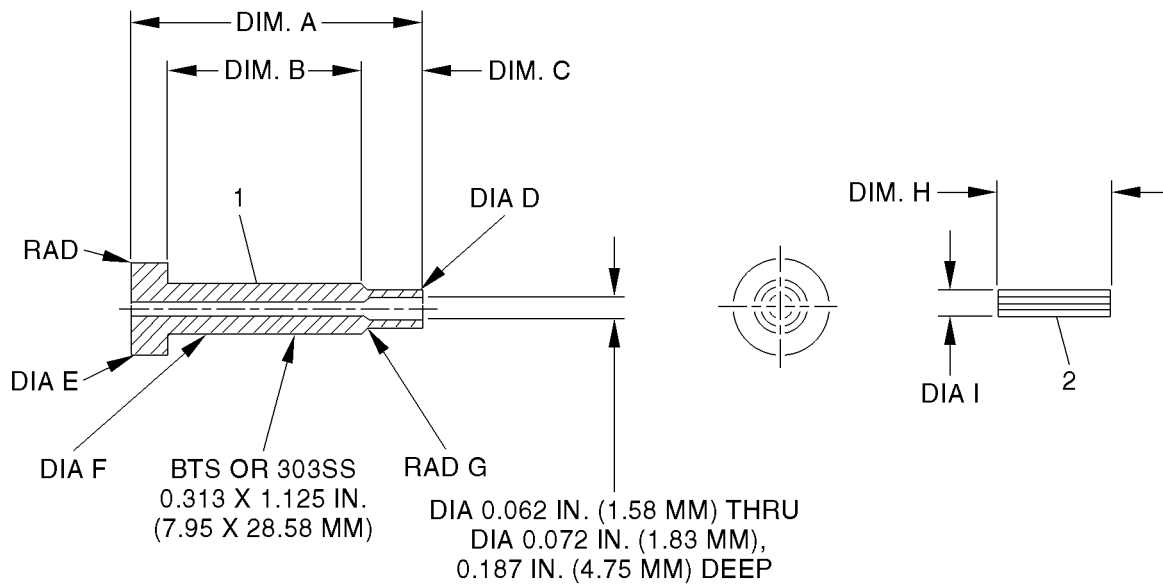
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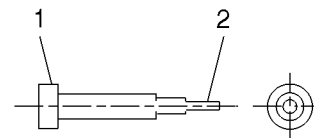
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DETAIL 2 CONSTRUCTION

1. MATERIAL = 0.072 IN. (1.83 MM) DX 0.010 IN. (0.25 MM) WALL SS TUBE
2. CUT TUBING TO 0.438 IN. (11.13 MM) LENGTH
3. DRILL THRU NO. 53 DRILL
4. REAM 0.062 IN. (1.58 MM) DIA HALF WAY THROUGH
5. TURN PART END FOR END
6. REAM 0.062 IN. (1.58 MM) DIA HALF WAY THROUGH
7. LOCTITE DET 1 TO DET 2

ASSEMBLED
TOOL

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Figure 7-5. Contact Extraction Tool, T3008017

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Table 7-5. Key to Figure 7-5

Dimension	Value in Inches (Millimeters)
A	1.093 (27.76)
B	0.75 (19.1)
C	0.218 (5.54)
D	0.125 (3.18)
E	0.305 (7.75)
F	0.187 (4.75)
G	0.063 (1.60)
H	0.437 (11.10)
I	0.072 (1.83)

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NOTE:

Purchase crimping tool, PN T3008128, as:
Cannon crimping tool, PN CCT--CTA
(Commercially available)

ICN-58960-0000731948-001-01

Figure 7-6. Crimping Tool Contact Adapter, T3008128

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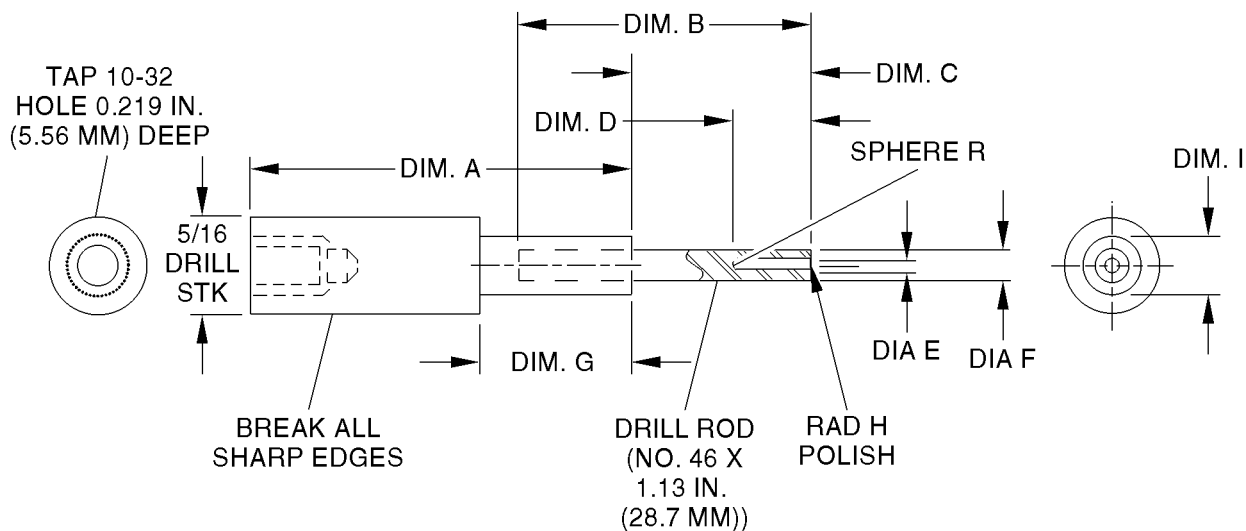
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ICN-58960-0000416576-001-01

Figure 7-7. Contact Seating Inspection Kit Contact Adapter, T3009406-3

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Table 7-6. Key to Figure 7-7

Dimension	Value in Inches (Millimeters)
A	1.250 (31.75)
B	1.000 (25.40)
C	0.588 ±0.005 (14.96 ±0.13)
D	0.208 +0.000, -0.015 (5.28, +0.00 -0.38)
E	0.048 +0.002, -0.000 (1.22 +0.05 -0.00)
F	0.078 +0.000, -0.002 (1.98 +0.00, -0.05)
G	0.500 (12.70)
H	0.010 +0.000, -0.005 (0.25 +0.00, -0.13)
I	0.188 (4.78)

EFFECTIVITY

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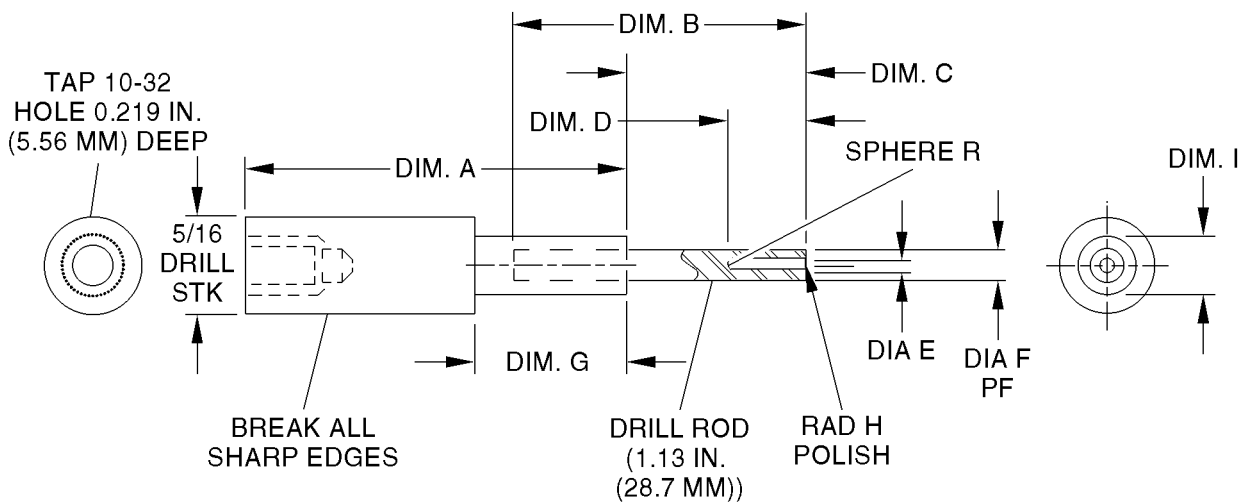
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ICN-58960-0000416577-001-01

Figure 7-8. Contact Seating Inspection Kit Contact Adapter, T3009406-4

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Table 7-7. Key to Figure 7-8

Dimension	Value in Inches (Millimeters)
A	1.250 (31.75)
B	1.063 (27.006.84 +0.00 -0.13)
C	0.663 +0.000, -0.005 (16.84 +0.00, -0.13)
D	0.266 +0.000, -0.002 (6.76 +0.00, -0.05)
E	0.0.068 +0.000, -0.002 (1.73 +0.00, -0.05)
F	0.076 +0.000, -0.002 (1.93 +0.00, -0.05)
G	0.500 (12.70)
H	0.010 +0.000, -0.005 (0.25 +0.00, -0.13)
I	0.188 (4.78)

EFFECTIVITY

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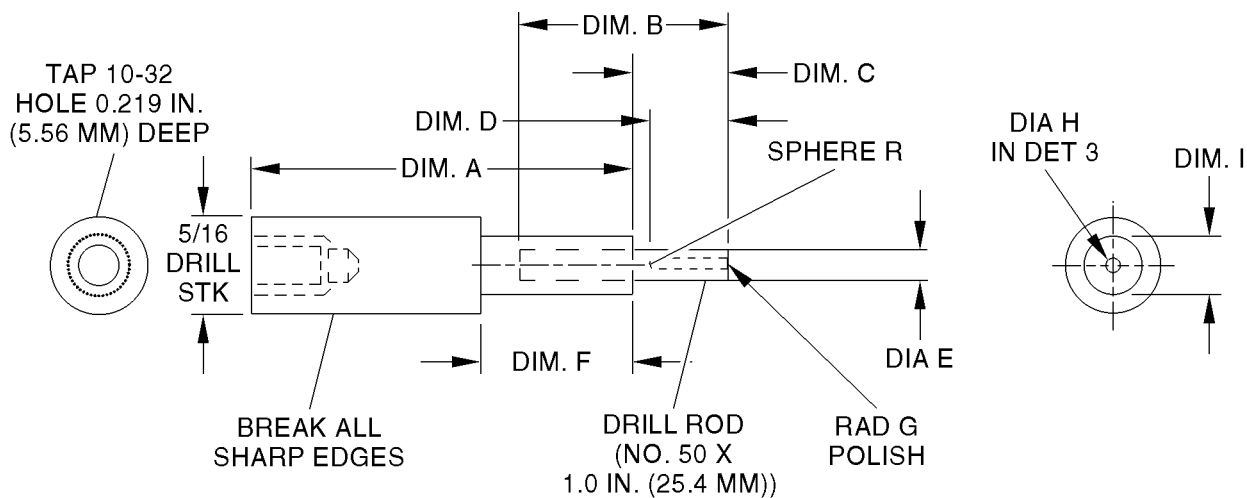
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ICN-58960-0000416578-001-01

Figure 7-9. Contact Seating Inspection Kit Contact Adapter, T3009406-5

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Table 7-8. Key to Figure 7-9

Dimension	Value in Inches (Millimeters)
A	1.250 (31.75)
B	0.750 (19.05)
C	0.200 +0.000, -0.010 (5.08 +0.00, -0.25)
D	0.187 +0.000, -0.010 (4.75 +0.00, -0.25)
E	0.068 +0.000, -0.003 (1.73 +0.00, -0.08)
F	0.500 (12.70)
G	0.010 +0.000, -0.005 (0.25 +0.00, -0.13)
H	0.043 +0.003, -0.000 (1.09 +0.08 -0.00)
I	0.125 (3.18)

EFFECTIVITY

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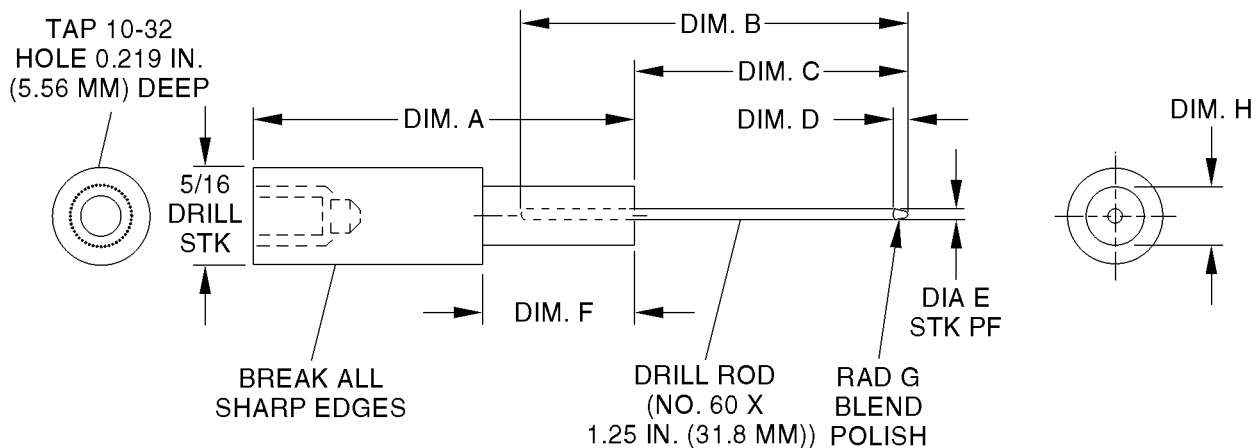
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ICN-58960-0000416579-001-01

Figure 7-10. Contact Seating Inspection Kit Contact Adapter, T3009406-6

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Table 7-9. Key to Figure 7-10

Dimension	Value in Inches (Millimeters)
A	1.250 (31.75)
B	1.125 (28.58)
C	0.691 +0.000, -0.010 (17.56 +0.00, -0.25)
D	0.018 to 0.022 (0.46 to 0.56)
E	0.040 (1.02)
F	0.500 (12.70)
G	0.003 to 0.006 (0.08 to 0.16)
H	0.188 (4.78)

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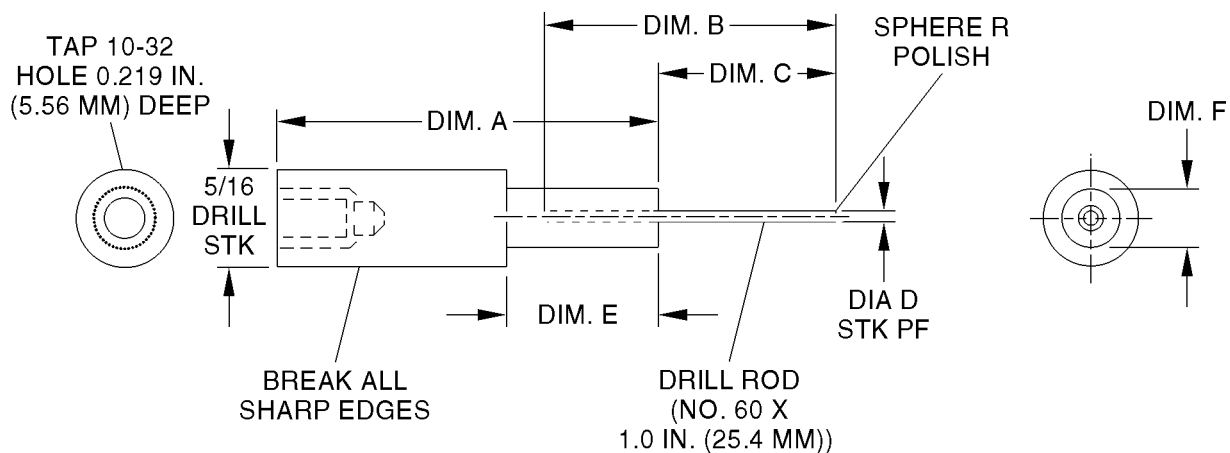
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Figure 7-11. Contact Seating Inspection Kit Contact Adapter, T3009406-7

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Table 7-10. Key to Figure 7-11

Dimension	Value in Inches (Millimeters)
A	1.250 (31.75)
B	0.875 (22.23)
C	0.358 +0.000, -0.010 (9.09 +0.00, -0.25)
D	0.040 (1.02)
E	0.500 (12.70)
F	0.188 (4.78)

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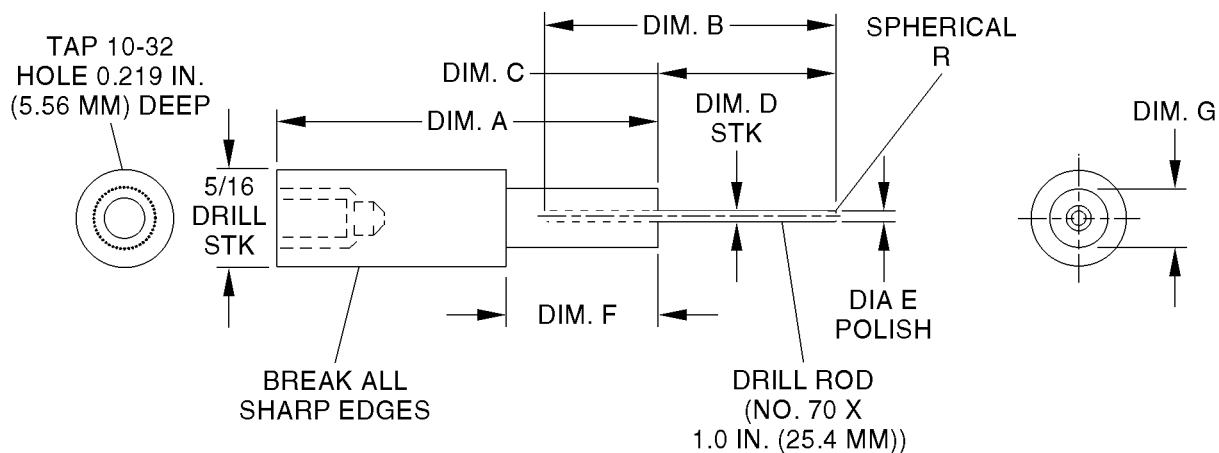
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Figure 7-12. Contact Seating Inspection Kit Contact Adapter, T3009406-8

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Table 7-11. Key to Figure 7-12

Dimension	Value in Inches (Millimeters)
A	1.250 (31.75)
B	0.875 (22.23)
C	0.480 +0.000, -0.005 (12.19 +0.00, -0.13)
D	0.028 (0.71)
E	0.028 (0.71)
F	0.500 (12.70)
G	0.188 (4.78)

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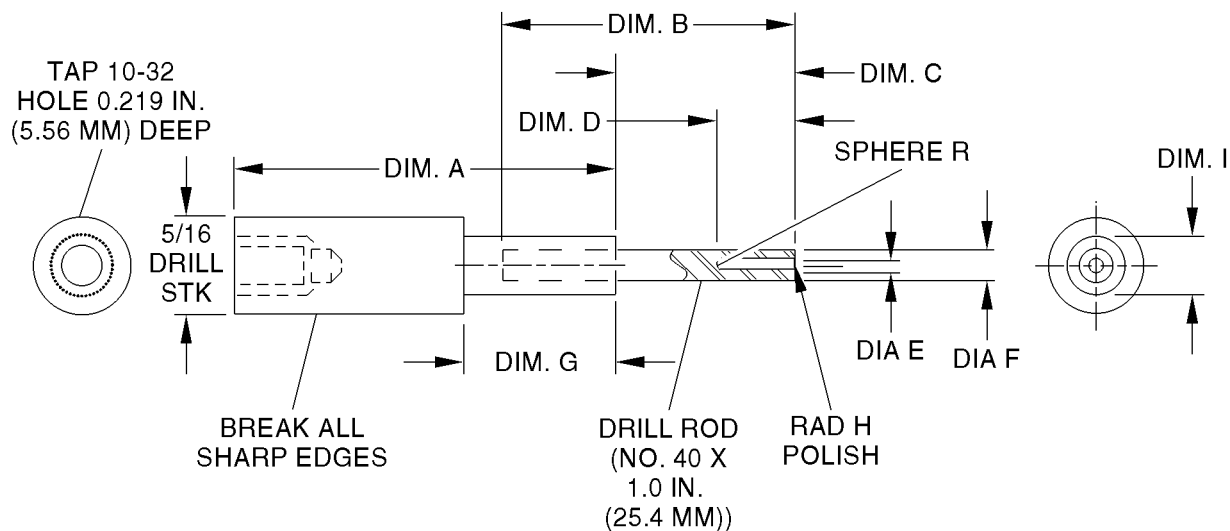
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Figure 7-13. Contact Seating Inspection Kit Contact Adapter, T3009406-11

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Table 7-12. Key to Figure 7-13

Dimension	Value in Inches (Millimeters)
A	1.250 $\pm$ 0.005 (31.75 $\pm$ 0.13)
B	0.500 (12.70)
C	0.125 $\pm$ 0.005 (3.18 $\pm$ 0.13)
D	0.093 +0.000, -0.015 (2.36 +0.00, -0.33)
E	0.048 +0.000, -0.002 (1.22 +0.00, -0.05)
F	0.078 +0.002, -0.000 (1.22 +0.05, -0.00)
G	0.500 (12.70)
H	0.010 +0.000, -0.005 (0.25 +0.00, -0.13)
I	0.125 (3.18)

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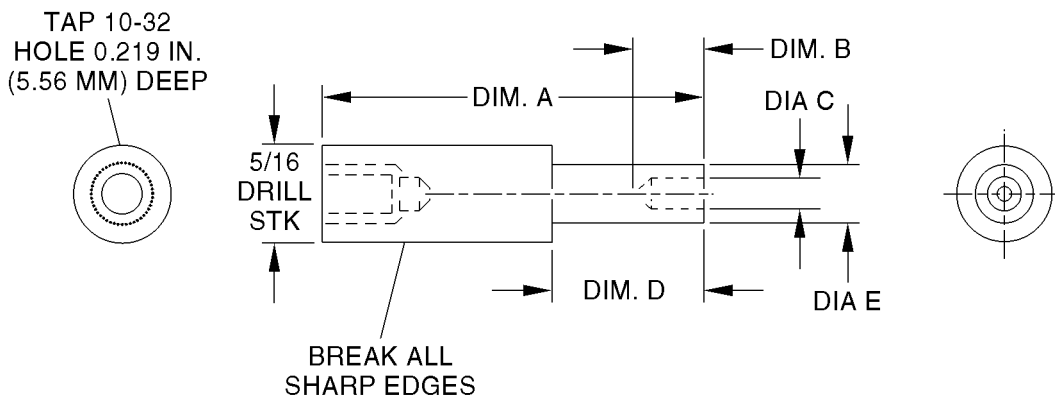
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Figure 7-14. Contact Seating Inspection Kit Contact Adapter, T3009406-12

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Table 7-13. Key to Figure 7-14

Dimension	Value in Inches (Millimeters)
A	1.250 (31.8)
B	0.187 (4.75)
C	0.109 +0.003, -0.000 (2.77 +0.08, -0.00)
D	0.500 (12.70)
E	0.135 +0.000, -0.003 (4.43 +0.00, -0.08)

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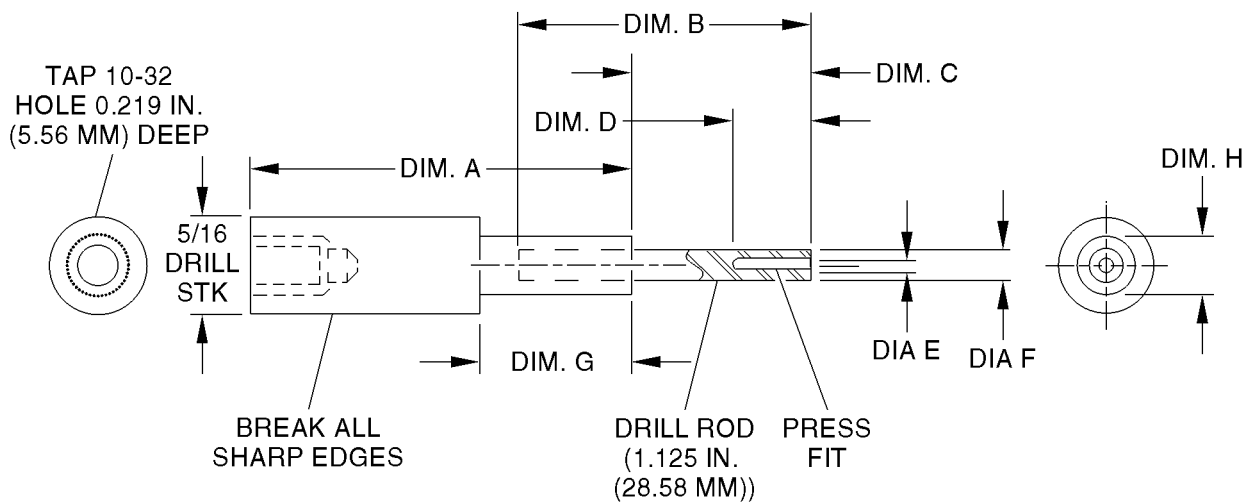
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Figure 7-15. Contact Seating Inspection Kit Contact Adapter, T3009406-13

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Table 7-14. Key to Figure 7-15

Dimension	Value in Inches (Millimeters)
A	1.250 (31.8)
B	1.063 (27.00)
C	0.663 +0.00 -0.05 (16.84 +0.00 -0.13)
D	0.187 (4.75)
E	0.068 +0.00, -0.05 (1.73 +0.00, -0.05)
F	0.106 +0.00, -0.05 (2.69 +0.00, -0.05)
G	0.500 (12.70)
H	0.188 (4.78)

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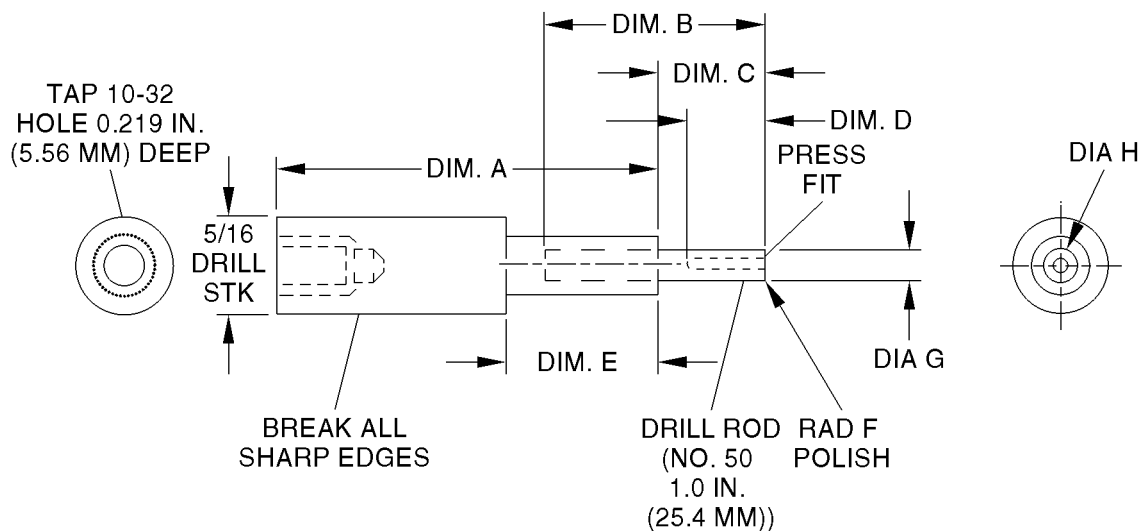
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Figure 7-16. Contact Seating Inspection Kit Contact Adapter, T3009406-14

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Table 7-15. Key to Figure 7-16

Dimension	Value in Inches (Millimeters)
A	1.250 (31.8)
B	0.750 (19.05)
C	0.200 +0.000, -0.010 (5.08 +0.00, -0.25)
D	0.125 +0.000, -0.010 (3.18 +0.00, -0.25)
E	0.500 (12.70)
F	0.010 (0.25)
G	0.068 +0.000, -0.003 (1.73 +0.00, -0.08)
H	0.043 +0.003, -0.000 (1.09 +0.08, -0.00)

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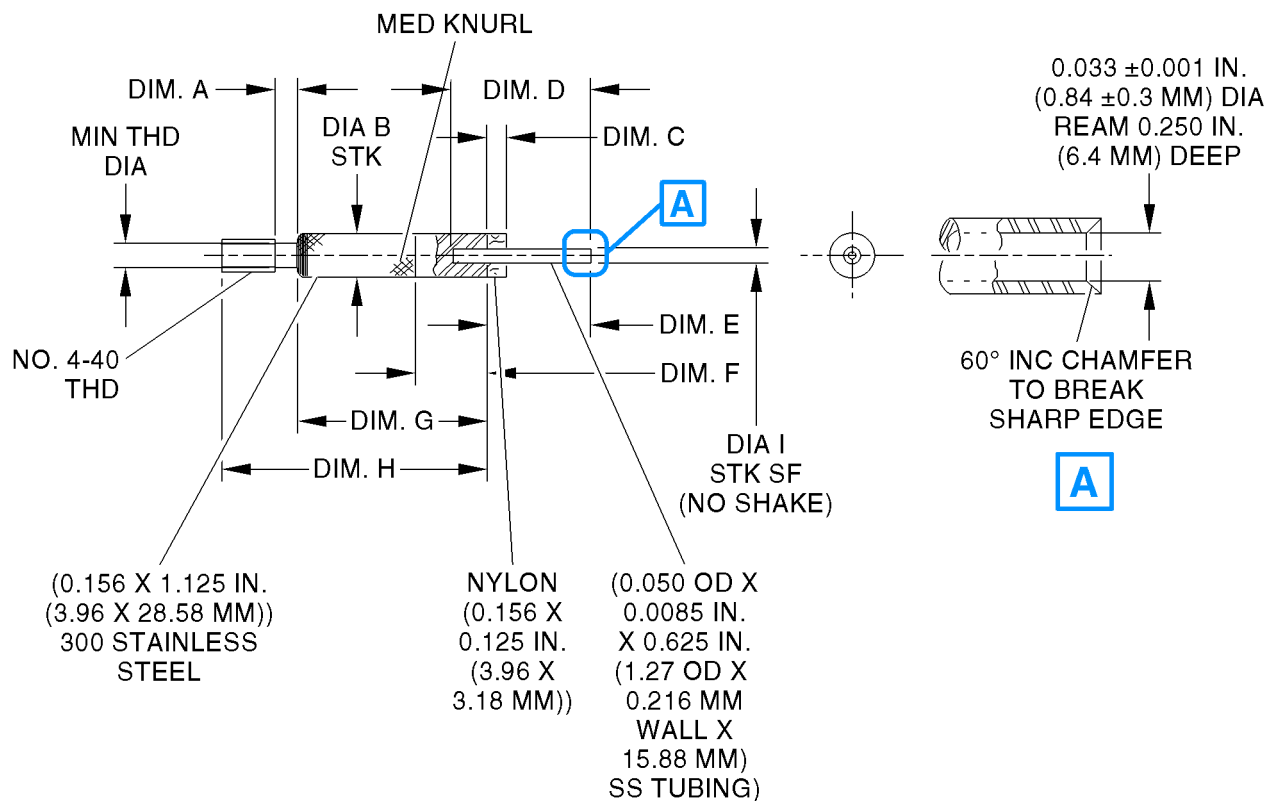
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NOTE:

Tool handle by ITT Cannon, PN 204-9500-000.

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Figure 7-17. Contact Removal Tool, T3008770

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Table 7-16. Key to Figure 7-17

Dimension	Value in Inches (Millimeters)
A	0.063 (3.96)
B	0.156 (1.60)
C	0.063 (3.96)
D	0.500 (12.70)
E	0.359 (9.12)
F	0.250 (6.35)
G	0.656 (16.67)
H	0.906 (23.01)
I	0.050 (1.27)

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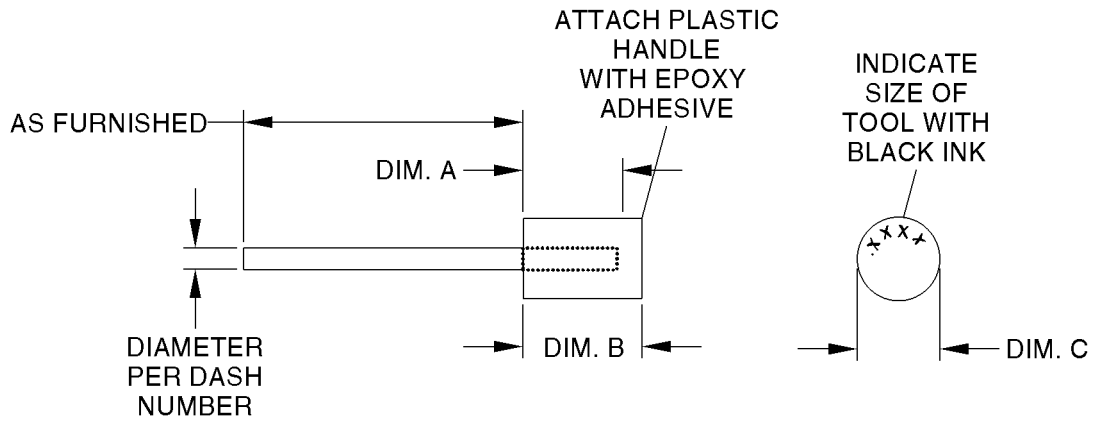
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Figure 7-18. Crimping Tool Gage Set, T3008994-VAR

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Table 7-17. Key to Figure 7-18

Dimension	Value in Inches (Millimeters)
A	0.250 (6.35)
B	0.375 (9.53)
C	0.344 (8.74)

Table 7-18. Specifications for Crimping Tool Gage Set, T3008994-VAR

Part No. T3008994	Diameter in Inches (Millimeters)
NOTES: - The equipment and materials that follow are necessary to build this tool. Refer to Table 7-1 to contact the tool manufacturers. - Reamer blank - Plastic, clear polycarbonate - Storage box - Thermoplastic polystyrene (6502017), black marking ink (9519478), and adhesive (9702878). - You can buy the complete crimping tool gage set from Cleveland Twist Drill Co. - Make sure the tool diameter at the end away from the handle agrees with this list.	
-1	0.0135 (0.342)
-2	0.0145 (0.368)
-3	0.0156 (0.396)
-4	0.0160 (0.406)
-5	0.0180 (0.457)
-6	0.0200 (0.508)
-7	0.0210 (0.533)
-8	0.0225 (0.572)
-9	0.0240 (0.610)
-10	0.0250 (0.635)
-11	0.0260 (0.660)
-12	0.0280 (0.711)
-13	0.0292 (0.742)
-14	0.0310 (0.787)
-15	0.0320 (0.813)
-16	0.0330 (0.838)
-17	0.0350 (0.889)

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Table 7-18. Specifications for Crimping Tool Gage Set, T3008994-VAR (Cont)

Part No. T3008994	Diameter in Inches (Millimeters)
-18	0.0360 (0.914)
-19	0.0370 (0.940)
-20	0.0380 (0.965)
-21	0.0390 (0.991)
-22	0.0400 (1.016)
-23	0.0410 (1.041)
-24	0.0420 (1.067)
-25	0.0430 (1.092)
-26	0.0465 (1.181)
-27	---
-28	---
-29	0.0520 (1.321)
-30	0.0550 (1.397)
-31	0.0595 (1.511)
-32	---

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
NOTES for Table 7-19												
NOTES:												
1	The Honeywell Part No. column under the Contact title can also contain notes relating to the listed part number being explained.											
2	The AWG column under the Contact title states the AWG size of the contact barrel for installation of wire or cable.											
3	The Type column indicates whether the part number is female (F) or male (M).											
4	In the Wire Type/Quantity, the entries (i.e., solid/1, strand/1, etc.) are as follows: - Strand/1 = one single stranded wire - Strand/2 = two stranded wires - Strand/3 = three stranded wires - Solid/1 = one solid wire - Solid/2 = two solid wires - Solid/3 = three solid wires.											
5	In the Wire Type/Quantity column, the entry fill* after a solid/1, strand/1, or any similar statement, indicates a filler as specified is required because the wire OD is not big enough to completely fill the contact ID.											
6	When a contact seating inspection kit, contact adapter, Part No. T3009406-VAR, is specified in this table, a 10-pound push meter containing a 5/16 in. ram with 10-32 in. threads is also required.											
7	Gages, holders, and/or handles required to use other than specified in NOTE: 6 should be ordered at the same time the tool is ordered.											
8	Tool manufacturers are listed, where applicable, along with tool part or catalog numbers in this table. In most cases, the tools can be obtained from a local distributor.											
9	Tools required by this table should be ordered by their M, MS, or NAS numbers if listed. If the supplier does not sell them in this manner, the vendor name and part number should then be used.											
10	Refer to Table 7-1 to contact the tool manufacturers. A second source, if available, is the Thomas Register.											
11	Tool numbers proceeded by the letter T are tools peculiar to Honeywell. In most cases, a drawing is provided to make the tool. If the tool is required and a drawing is not present, contact Honeywell, Phoenix, AZ, Attention: Methods Engineering Dept.											
12	When drill stock or drill rod is specified for the tools required in this table, it can be obtained locally or from Cleveland Twist Drill Co.											

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
1712316-301	20	M	20	strand/1 solid/1	5/32	Buchanan 612768 - or - 612118	Buchanan 613326 - or - 613234	0.043	ITT Canon CIET-20-HDL	ITT Canon CIET-20-HDL	---	T3008994-25
			22	strand/1 solid/1	5/32			0.039				
			24	strand/1 solid/1	5/32			0.029				
1712316-302	20	F	20	strand/1 solid/1	5/32	Buchanan 612768 - or - 612118	Buchanan 613326 - or - 613234	0.043	ITT Canon CIET-20-HDL	ITT Canon CIET-20-HDL	---	T3008994-25
			22	strand/1 solid/1	5/32			0.039				
			24	strand/1 solid/1	5/32			0.029				
1712316-303	20	F	20	strand/1 solid/1	5/32	Buchanan 612768 - or - 612118	Buchanan 613326 - or - 613234	0.043	ITT Canon CIET-20-HDL	ITT Canon CIET-20-HDL	---	T3008994-25
			22	strand/1 solid/1	5/32			0.039				
			24	strand/1 solid/1	5/32			0.029				
1712316-304 UP46426	20	F	20	strand/1 solid/1	5/32	Buchanan 612768 - or - 612118	Buchanan 613326 - or - 613234	0.043	ITT Cannon CIET-20-HDL	ITT Cannon CIET-20-HDL	---	T3008994-25
			22	strand/1 solid/1	5/32			0.039				
			24	strand/1 solid/1	5/32			0.029				
1715213-1 Same as 7002730-1 and 7002730-2	2	F	22	strand/1 solid/1	5/32	Dupont HT-95	Hand	---	Hand	---	---	---
			24		5/32		Hand	---	Hand	---	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
				strand/1 solid/1		Dupont HT-95						
			26	strand/1 solid/1	5/32	Dupont HT-95	Hand	---	Hand	---	---	---
1715213-3 Same as 7002730 and 1715213-1	28, 30, 32	F	22	strand/1 solid/1	5/32	Dupont HT-95	Hand	---	Hand	---	---	---
			24	strand/1 solid/1	5/32	Dupont HT-95	Hand	---	Hand	---	---	---
			26	strand/1 solid/1	5/32	Dupont HT-95	Hand	---	Hand	---	---	---
2387050-16 (MS39029/31-229) Same as 2503959-2	16	M	18	strand/1	5/32	57	58	(5) 0.045/0.050	11-7401-16 (Bendix) Hamilton-Avnet ----- Replacement Tip 11-7929-16	11-7880-16 (Bendix) Hamilton-Avnet	T3009406-4	T3008994
			24	strand/1 solid/1	3/16	57	58	(5) 0.045/0.050				
			22	strand/1 solid/1	3/16 fill*							
	16	M	26	strand/1	3/16	57	58	(6) 0.052/0.077				
			20	strand/1	3/16 fill*							
UP46426 2387050-120 (M39029/31-240) (Color Bands = RED/YEL/BLK) Same as 2503959-1 and 4030483-20	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	(MS24256A20) Amphenol-Borg 294-88 - or - Coast Air Inc ATB-1067	(MS24256R20) Amphenol-Borg 294-89	T3009406-3	T3008994
			22	strand/1	3/16	57	58	(4) 0.039/0.044				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			24	strand/2	3/16	57	58	(5) 0.045/0.051				
			24	strand/3	3/16	57	58	(6) 0.052/0.057				
			26	strand/2	3/16	57	58	(4) 0.039/0.044				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			30	solid/1	3/16	57	58	(4)				
			24	strand/1	3/16 fill*			0.039/0.044				
2387050-160 (M39029/31-223) (Color Bands = RED/RED/GRY)	16	M	16	strand/1	5/16	57	58	(5) 0.045/0.050	11-7401-16 (Bendix) Hamilton-Avnet ----- Replacement Tip 11-7929-16	11-7880-16 (Bendix) Hamilton-Avnet	T3009406-4	T3008994
2387050-220 (M39029/32-259) (Color Bands = RED/GRN/WHT) UP46426	20	M	20	strand/1	3/16	12 with - or - 57 with	13	(4) 0.0440/0.050 - or -	(MS24256A20) Amphenol-Borg 294-88 - or - Coast Air Inc ATB-1067	(MS24256R20) Amphenol-Borg 294-89	T3009406-3	T3008994
							58	(6) 0.052/0.050				
			22	strand/1	3/16	57	58	(5) 0.045/0.050				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			24	strand/2	3/16	57	58	(5) 0.045/0.050				
			24	strand/3	3/16	57	58	(6) 0.052/0.050				
			26	strand/2	3/16	57	58	(4) 0.039/0.044				
			28 24	strand/1 strand/1	3/16 3/16 fill*	57	58	(4) 0.039/0.044				
			28 26	strand/1 strand/1	3/16 3/16 fill*	57	58	(6) 0.052/0.057				
			30 24	strand/1 strand/1	3/16 3/16 fill*	57	58	(4) 0.038/0.045				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2387050-260 (M39029/32-247) (Color Bands = RED/YEL/VIO)	16	F	16	strand/1	3/16	57	58	(5) 0.045/0.050	11-7401-16 (Bendix) Hamilton-Avnet ----- Replacement Tip 11-7929-16	11-7880-16 (Bendix) Hamilton-Avnet	T3009406-7	T3008994
			20	strand/1	3/16	57	58	(5) 0.045/0.050				
	16	F	22	strand/1	3/16	57	58	(8) 0.068/0.073				
			22	strand/1	3/16	57	58	(5) 0.045/0.050				
			26	strand/1	3/16	57	58	(6) 0.052/0.057				
			20	strand/1	3/16 fill*							
2500137-1 Same as 2500163-2 UP46426	16	F	16	strand/1	9/32	57	58	(6) 0.052/0.057	ITT Cannon CET-16-9 (plastic)/ CRIMPER M22520/1-01	M22520/1-02	T3009406-6	T3008994
			18	strand/1	9/32	57	58	(5) 0.045/0.050		M22520/1-02		
			20	strand/1	9/32	57	58	(6) 0.052/0.057		M22520/1-02		
			22	strand/1	3/16	57	58	(6) 0.052/0.057				
			26	strand/1	3/16 fill*							
			24	strand/1	3/16	57	58	(5) 0.045/0.050				
			22	strand/1	3/16 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500137-2	20	F	20	strand/1	3/16	1	47	N/A	ITT Cannon CIET-20-HDL CRIMPER M22520/2-01	ITT Cannon CIET-20-HDL - or - T3005573	T3009406-6	T3008994
			22	strand/1	3/16	1 with - or - 57 with	47 58	N/A - or - (5) 0.045/0.050				
			24	strand/1	3/16	1	47	N/A				
			26	strand/1	3/16	57	58	(1) 0.028/0.032				
2500137-3 Same as 2500163-1	20	F	22	strand/1	3/16	57	58	(4) 0.039/0.044	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20-8	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-7	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	3/16	12 with - or - 36 with	13 37	(2) 0.032/0.039				
			26 26	strand/1 strand/1	5/32 5/32 fill*	12 with - or - 36 with	13 37	0.038/0.045				
2500137-4 Same as 2501512-1 UP46426	22	F	22	strand/1	5/32	59 with - or - 3 with	64 43	(6) 0.030/0.035 - or - 0.032	ITT Cannon CIET-20-8	ITT Cannon CIET-20	T3009406-6	T3008994
			24	strand/1	5/32	59 with - or - 3 with	64 43	(4) 0.026/0.031 - or - 0.028				
			24	strand/1	5/32	3	43	0.031				
			24 28	solid/1 strand/1	5/32 5/32 fill*	3	43	0.036				
			24 28	solid/1 solid/1	5/32 5/32 fill*	3	43	0.035				
			26	solid/2	5/32	59	64	(6) 0.030/0.035				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			26	strand/1	5/32	59 with - or - 3 with	64 43	(4) 0.022/0.027 - or - 0.024				
			28 24	solid/1 solid/1	5/32 5/32 fill*	3	43	0.032				
			28 26	strand/1 solid/1	5/32 5/32 fill*	3	43	0.029				
2500163-1 Same as 2500137-3	20	F	20	strand/1	3/16	57	58	(5) 0.045/0.050	(NAS 1664-20) Deutsch Co. - or - ITT Cannon CIET-20	(NAS 1664-20) Deutsch Co. - or - ITT Cannon CIET-20	T3009406-7	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			22	strand/1	3/16			(4) 0.039/0.044				
			24	strand/1	3/16	12 with - or - 36 with	13	(2) 0.032/0.039				
			26 26	strand/1 strand/1	5/32 5/32 fill*		37	0.038/0.045				
2500163-2 Same as 3718679-21	16		16	strand/1	5/32	MS3191-1						
			18	strand/1	5/32	MS3191-1						
			20	strand/1	5/32	MS3191-1						
2500202 Same as 3718679-21	22	M	22	strand/1	1/10	3			ITT Cannon Handle = 204-9500-000 Tip = 323-9510-001-24	T3008770	----	T3008994
			24			2 with - or - 3 with - or - SPC 11412						T3008994
			24			T3008128						---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
UP46426			26			4 with - or - 3 with - or - SPC 11412 - or - 2 with - or - T3008128	24 27 --- 24 ---	0.026 - or - 0.026 - or - 0.026 - or - 0.026 N/A				T3008994
			26	solid/1	1/8	3	27	0.033				
			26	strand/1	1/8 fill*							
			28	strand/1	1/10	T3008128	---	N/A				
			26	strand/1	1/10 fill*							
			28	strand/1	1/10	3	27	0.033				
			26	strand/1	1/10 fill*							
			28	solid/1	1/8	3	27	0.033				
			26	strand/1	1/8 fill*							
2500205 Same as 3718679-22	22	F	28	strand/1	1/8	3	27	0.032	ITT Cannon Handle = 204-9500-000 Tip = 323-9510-001-24	ITT Cannon Handle = 204-9500-000 Tip = 324-9501-000	T3009406-6	T3008994
			26	strand/1	1/8 fill*							
			30	solid/1	1/8	3	27	0.035				
			26	strand/1	1/8 fill*							
			32	strand/1	1/10	T3008128	---	N/A				
			26	strand/1	1/10 fill*							
			32	strand/1	1/10	3	27	0.0225				
			32	strand/1	1/10 fill*							
			26	strand/1	1/10 fill*							
			32	strand/1	1/10 fill*							
			22	strand/1	1/10	3	25	0.035				
			24	strand/1	1/10	3	25	0.033				
			26	strand/1	1/10	3 with - or - SPC1141 - or - T3008128	25 --- ---	0.0292 - or - 0.0292 - or - N/A				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			26	strand/1	1/10	2	26	0.026				
			28	strand/2	1/10	3	25	0.034				
			28	strand/1	1/10	T3008128	---	N/A				
			26	strand/1	1/10 fill*							
			30	solid/1	1/10	T3008128	---	N/A				
			28	strand/1	1/10 fill*							
			32	strand/1	1/10	T3008128	---	N/A				
2500237-1 Same as 2500979-1 UP46426	20	F	26	strand/1	1/10 fill*				(M24308/18-2) AMP Inc 91067-2 - or - ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ- 070151-0000 - or - Burndy Corp RTM20-17	(M24308/18-2) AMP Inc 91067-2 - or - ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ- 070151-0000 - or - Burndy Corp RX20-36 - or - T3005573	T3009406-7	T3008994
			32	strand/1	1/10 fill*	3	25	0.0225				
			22	strand/1	3/16 - or - 5/32	3	19	0.039				
			24	strand/1	3/16 - or - 5/32	2 with - or - 3 with	18 19	0.032 0.035				
			26	strand/1	3/16 - or - 5/32	2 with - or - 3 with - or - ITT Cannon CBT-460	18 19 ---	0.038 - or - 0.039 - or - 0.032				
			24	strand/1	3/16	3	19	0.041				
			26	strand/1	- or - 5/32 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500239-1	20	M	20	strand/1	5/32	3	19	0.043	(M24308/18-2) AMP Inc 91067-2 - or - ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ- 070151-0000 - or - Burndy Corp RTM20-17	(M24308/18-2) AMP Inc 91067-2 - or - ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ- 070151-0000 - or - Burndy Corp RX20-36 - or - T3005573	T3009406-7	T3008994
			22	strand/1	5/32	3	19	0.035				
			24	strand/1	5/32	2 with - or - 3 with	18 19	0.035				
			26	strand/2	5/32	3 with - or - 4 with - or - ITT Cannon CBT-460	19 18 ---	0.035 - or - 0.037 - or - (4) 0.032				
2500322-1 UP46426	22	M	22	strand/1	1/8 - or - 1/10	3		0.0465	Continental Conn 2558	T3008017	T3009406-14	T3008994
			24	strand/1	1/8 - or - 1/10	2 with - or - 3 with		0.041 - or - 0.041				
			26	strand/1	1/8 - or - 1/10	2 with - or - 3 with		0.036 - or - 0.036				
			26	strand/1	1/8 - or - 1/10	3		0.0465				
			26	solid/1	1/8 - or - 1/10	3	9	0.038				
			28	strand/1	1/8 - or - 1/10	3	9	0.040				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	solid/2	1/8 - or - 1/10	3	23	0.043				
			30	solid/1	1/8 - or - 1/10	3	9	0.037				
			32 26	strand/1 strand/1	3/16 - or - 5/32 fill*	3	19	0.043				
2500323-1 Same as 8001436-1 UP46426	22	F	22	strand/1	1/8 - or - 1/10	3	23	0.043	Continental Conn 2558	T3008017	T3009406-8	T3008994
			24	strand/1	1/8 - or - 1/10	4 with - or - 3 with	22 23	0.041 - or - 0.043				
			24	solid/1	1/8 - or - 1/10	3	23	0.040				
			24 28	solid/1 solid/1	1/8 - or - 1/10 fill*	3	23	0.039				
			26	strand/1	1/8 - or - 1/10	3 with - or - 4 with	23 22	0.037 - or - 0.039				
			26	solid/2	1/8 - or - 1/10	3	23	0.039				
			26	strand/2	1/8 - or - 1/10	3	23	0.039				
			26	solid/1	1/8 - or - 1/10	3	23	0.038				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			26	solid/1	1/8 - or - 1/10 fill*	3	23	0.041				
			28	solid/1	1/8 - or - 1/10 fill*	3	23	0.039				
			30	solid/1	1/8 - or - 1/10 fill*	3	23	0.043				
			28	solid/3	1/8 - or - 1/10 fill*	3	23	0.043				
2500323-1 Same as 8001436-1 (cont)	22		28	solid/1	1/8 - or - 1/10	3	23	0.042	Continental Conn 2558	T3008017	T3009406-8	T3008994
			28	solid/1	1/8 - or - 1/10	3	23	0.039				
			28	solid/1	1/8 - or - 1/10 fill*	3	23	0.039				
			30	solid/1	1/8 - or - 1/10	3	23	0.039				
			30	solid/2	1/8 - or - 1/10	3	23	0.043				
2500325-2 UP* = size of 0.076 by 0.016 in.	**	F	24	strand/1	1/8	51	---	A/7	Hand	AMP Inc 91017-3	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500438-1	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	AMP Inc 91039-1 ----- Replacement Tip 126117-1	AMP Inc 91040-1 ----- Replacement Tip 126118-1	T3009406-6	T3008994
			22	strand/1	3/16	57	58	(4) 0.033/0.044				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			26	strand/2	3/16	57	58	(4) 0.039/0.044				
2500439-1 UP46426	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	AMP Inc 91039-1 ----- Replacement Tip 126117-1	AMP Inc 91040-1 ----- Replacement Tip 126118-1	T3009406-3	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			22	strand/1	3/16	57	58	(4) 0.039/0.044				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			26	strand/2	3/16	2 with - or - 57 with - or - ITT Cannon CBT-460	20 - or - 58 - or - ---	0.041 - or - 0.036/0.041 - or - (5) 0.036				
			28 26	solid/1 solid/1	3/16	57	58	(2) 0.032/0.037				
			28 26	strand/1 strand/1	3/16 3/16 fill*	57	58	(2) 0.032/0.037				
2500527-1	20	F	26	strand/1	3/16	57	58	(4) 0.038/0.044	(MS24256A20) Amphenol-Borg 294-88 - or - Coast Air Inc ATB-1067			T3008994

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500439-1	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	AMP Inc 91039-1 ----- Replacement Tip 126117-1	AMP Inc 91040-1 ----- Replacement Tip 126118-1	T3009406-3	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			22	strand/1	3/16	57	58	(4) 0.039/0.044				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			26	strand/2	3/16	2 with - or - 57 with - or - ITT Cannon CBT-460	20 - or - 58 - or - ----	0.041 - or - 0.036/0.041 - or - (5) 0.036				
			28	solid/1	3/16	57	58	(2) 0.032/0.037				
			26	solid/1								
			28	strand/1	3/16	57	58	(2) 0.032/0.037				
2500527-1 UP46426	20	F	26	strand/1	3/16	57	58	(4) 0.038/0.044	(MS24256A20) Amphenol-Borg 294-88 - or - Coast Air Inc ATB-1067			T3008994
2500848 (*For RU-188/U and RG-174/U)	----	--	*	----	----	Daniels M22520/5-01 - or - Buchanan 612783	----	----	----	----	----	----
2500848-1 (*For RG-196/U and RG-178/U)	----	--	*	----	----	Daniels M22520/5-01 - or - Buchanan 612783	----	----	----	----	----	----

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500848-2 (*For RG-188/U and RG-174/U)	---	--	*	---	---	Daniels M22520/5-01 - or - Buchanan 612783	---	---	---	---	---	---
2500926-12 Same as 4007689-12	12	F	12	strand/1	1/4	57	58	(7) 0.059/0.064	MS3191-4	MS3191-9T	T3009406-13	(MS22520/3-1) Daniels Mfg G125
			14	strand/1	1/4	57	58	(7) 0.059/0.064	MS3191-4	MS3191-9T	T3009406-13	(MS22520/3-1) Daniels Mfg G125

UP46426

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500926-16 Same as 4007689-16	16	F	16	strand/1	1/4	57	58	(7) 0.059/0.064	(MS27534-16) Amphenol-Borg 294-109 - or - Deutsch Co. M-15570-16 - or - ITT Cannon CIET-16 - or - (MS27495-A16) Burndy-Corp RTM-16-4	(MS27534-16) Amphenol-Borg 294-109 - or - Deutsch Co. M-15570-16 - or - ITT Cannon CIET-16 - or - (MS27495-A16) Burndy-Corp RX-16-9	T3009406-13	(MS22520/3-1) Daniels Mfg G125
			20	strand/1	1/4	57	58	(6) 0.052/0.057				
			22	strand/1	1/4	57	58	(5) 0.045/0.050				
2500937-221 UP46426	22M	F	22	strand/1	3/16	59	63	(6) 0.030/0.035	Bendix Corp 11-8674-24 - or - Burndy Corp RTM24-3 - or - ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-2) AMP Inc 91067-2	Bendix Corp 11-8674-24 - or - Burndy Corp RTM24-3 - or - ITT Cannon CIT-22M-KJ- 070155-0000 - or - Astro Tool Co. MS27495-R22M - or - (M24308/18-2) AMP Inc AMP91067-2 - or - (MS27509R22M) Plastic Tool	T3009406-5	T3008994
			24	strand/1	3/16	59	63	(5) 0.026/0.031				
			26	strand/1	3/16	59	63	(4) 0.022/0.027				
2500937-222	22D	F	22	strand/1	1/8	3	54 - or - 29	0.033	Bendix Corp 11-8674-24 - or -	Bendix Corp 11-8674-24 - or -	T3009406-5	T3008994

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			24	strand/1	1/8	3	54 - or - 29	0.026	Burndy Corp RTM24-3 - or - ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-2) AMP Inc 91067-2	Burndy Corp RTM24-3 - or - ITT Cannon CIT-22M-KJ-070155-0000 - or - Astro Tool Co. MS27495-R22M - or - (M24308/18-2) AMP Inc AMP91067-2		
			24	solid/1	1/8	3	54 - or - 29	0.026				
			26	solid/1	1/8	3	54 - or - 29	0.024				
			28	solid/1	1/8	3	54 - or - 29	0.018				
			30	solid/1	1/8	3	54 - or - 29	0.016				
2500978-1 (M39029/64-369) (Color Bands = ORN/BLU/WHT) UP46426	20	M	20	strand/1	3/16	3	19	0.043	(M24308/18-2) AMP Inc 91067-2 - or - ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ-070151-0000 - or - Burndy Corp RTM20-17 - or - Bendix Corp 11-8674-20	(M24308/18-2) AMP Inc 91067-2 - or - ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ-070152-0000 - or - Burndy Corp RX20-36 - or - T3005573	T3009406-5	T3008994
			22	strand/1	3/16	3	19	0.037				
			24	solid/1	3/16	3	19	0.033				
			24	strand/1	3/16	3	19	0.042				
			26	strand/1	3/16 fill*	3	19	0.035				
			28	solid/1	3/16	3	19	0.032				
			26	strand/1	3/16 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500978-2 (M39029/58-360) (Color Bands = ORN/BLU/BLK)	22D	M	22	strand/1	5/32	3 with - or - 59 with	53 - or - 62	0.032 - or - (6) 0.030/0.035	(M24308/18-2) AMP Inc 91067-2 - or -	Bendix Corp 11-8674-24 - or - Burndy Corp RX24-3 - or - ITT Cannon CIT-22M-KJ- 070156-0000 - or - Astro Tool Co. MS27495-R22M - or - AMP Inc AMP91067-2	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	5/32	3 with - or - 59 with	53 62	0.028 - or - (5) 0.026/0.031	ITT Cannon CIET-20-HDL - or - ITT Cannon CIT-20-KJ- 070151-0000 - or - Burndy Corp RTM20-17 - or - Bendix Corp 11-8674-20			
			28	solid/1	5/32	3 with - or - 59 with	53 62	0.021 - or - (3) 0.019/0.024				
2500979-1 (M39029/63-368) (Color Bands = ORN/BLU/GRY) Same as 2500237-1 UP46426	20	F	20	strand/1	5/32	3	19	0.043	(M24308/18-2)	(M24308/18-2)	T3009406-7	T3008994
			22	strand/1	5/32	3	19	0.039	AMP Inc 91067-2	AMP Inc 91067-2		
			24	strand/1	5/32	3	19	0.033	- or -	- or -		
			24	solid/1	5/32	3	19	0.0292	ITT Cannon CIET-20-HDL	ITT Cannon CIET-20-HDL		
			24	strand/1	5/32	3	19	0.038				
			28	strand/1	5/32 fill*							
			26	strand/2	5/32	3	19	0.033	- or -	- or -		
			26	solid/2	5/32	3	19	0.033	ITT Cannon CIT-20-KJ- 070151-0000	ITT Cannon CIT-20-KJ- 070152-0000		
			26	solid/1	5/32	3	19	0.039	- or -	- or -		
			26	strand/1	5/32 fill*				Burndy Corp RTM20-17	Burndy Corp RX20-36		
			26	strand/1	5/32	3	19	0.032	- or -	- or -		
			28	solid/1	5/32 fill*				Bendix Corp 11-8674-20			
			28	solid/2	5/32	3	19	0.033				
			28	strand/1	5/32	3	19	0.036	- or -	- or -		
			26	strand/1	5/32 fill*							
			28	solid/1	5/32	3	19	0.032				
			26	solid/1	5/32 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500979-2 (M39029/57-354) (Color Bands = ORN/GRN/YEL)	22D	F	22	strand/1	5/32	3 with - or - 59 with	54 63	0.032 - or - (6) 0.030/0.035	Bendix Corp 11-8674-24 - or - Burndy Corp RTM24-3 - or - ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-2) AMP Inc 91067-2	Bendix Corp 11-8674-24 - or - Burndy Corp RX24-3 - or - ITT Cannon CIT-22M-KJ- 070156-0000 - or - Astro Tool Co MS27495-R22M - or - (M24308/18-2) AMP Inc AMP91067-2	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	5/32	3 with - or - 59 with	54 63	0.028 - or - (5) 0.026/0.031				
			26	strand/1	5/32	3 with - or - 59 with	54 63	0.025 - or - (4) 0.022/0.027				
			26	strand/2	5/32	59	53	(5) 0.026/0.031				
			28	solid/1	5/32	3 with - or - 59 with	54 63	0.021 - or - (3) 0.019/0.024				
2501339-20 Same as 4002087-20 (Use only TEFLON tools) UP46426	20	M	22	strand/1	3/16	57	58	(4) 0.039/0.044	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-3	T3008994
			26	strand/2	3/16	57	58	(4) 0.039/0.044				
2501433-22 (MS90460-23-22)	22	M	24	strand/1	5/32	59	5	(5) 0.026/0.031	Amphenol Borg 294-278	Amphenol Borg 294-278	T3009406-TBS	T3008994

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2501434-22	22	M	22	strand/1	1/4	3	48	0.032	Amphenol Borg 294-278	Amphenol Corp 294-278	T3009406-11	T3008994
			22	solid/1	1/4	3	48	0.033				
			24	strand/1	3/16	3	48	0.032				
			26	strand/1	3/16	3	48	0.026				
			26	strand/2	1/4	3	48	0.033				
2501512-1 Same as 2500137-4	22	F	24	strand/1	5/32	3	43	0.031	ITT Cannon CIET-22 (plastic)	ITT Cannon CIET-22 (plastic)	T3009406-8	T3008994
			26	strand/1	5/32	3 with - or - ITT Cannon CBT460	43	0.033 - or - (1) 0.022				
			26	solid/1	5/32	3	43	0.033				
			26	strand/1	5/32 fill*							
2501663-1 NOTES: *; 1=KAPTON 2=TEFLON	20	M	24	strand/1	1/8	44 - or - 45	w/crimp	(1)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
							w/crimp	(*)				
			26	strand/1	1/8	44 - or - 45	w/crimp	(1)				
2501663-2 NOTES: *; 1=KAPTON 2=NYLON	20	M	24	strand/1	5/32	46	w/crimp	(*)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
			26	strand/1	5/32	46	w/crimp	(*)				
2501663-3 NOTES: *; 1=KAPTON 2=TEFLON	20	M	24	strand/1	1/8	44 - or - 45	w/crimp	(1)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
							w/crimp	(*)				
			26	strand/1	1/8	44 - or - 45	w/crimp	(1)				
2501663-4	20	M	24	strand/1	1/8	46	w/crimp	(B6)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
			26	strand/1	1/8	46	w/crimp	(B5)				
	20	F	24	strand/1	3/16	45	w/crimp	(*)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
			26	strand/1	1/8							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2501678-1 NOTES: *; 1=KAPTON 2=TEFLON Same as 2501678-2 (-2=AUTO SPOOL)						44 - or - 45	w/crimp w/crimp	(2) (1)				
2501678-2 NOTES: *; A7=KAPTON A6=TEFLON Same as 2501678-1	20	F	24	strand/1	1/8	46	w/crimp	(*)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
			26	strand/1	1/8	46	w/crimp	A7				
2501678-3 NOTES: *; A7=KAPTON A6=TEFLON (DON'T USE AWG 24 TEFLON) Same as 2501678-4 (-4=AUTO SPOOL)	20	F	24	strand/1	1/8	44 - or - 45	w/crimp w/crimp	(2) - or - (*)	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
			26	strand/2	1/4	44 - or - 45	w/crimp w/crimp	(2) - or - (3)				
2501678-4 NOTES: *; 1=KAPTON 2=TEFLON Same as 2501678-3	20	F	24	strand/1	1/8	46	w/crimp	B/6	AMP Inc 91042-1	AMP Inc 91042-1	T3009406-5	---
			26	strand/1	1/8	46	w/crimp	B/6				
2503528-1	16	M	16	strand/1	1/4	57	58	(6) 0.052/0.057	Hand	ITT Cannon CIET-16-9 (plastic)	T3009406-4	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			18	strand/1	1/4	57	58	(5) 0.045/0.050				
			20	strand/1	1/4	57	58	(4) 0.039/0.044				
			22	strand/1	1/4	57	58	(6) 0.052/0.057				
			22	strand/2	1/4	57	58	(6) 0.052/0.057				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
UP46426			24	strand/3	1/4	57	58	(6) 0.052/0.057				
			24	strand/2	1/4	57	58	(6) 0.052/0.057				
			24 26 20	strand/1 strand/1 strand/1	1/4 1/4 1/4 fill*	57	58	(7) 0.059/0.064				
			24 20	strand/1 strand/1	1/4 1/4 fill*	57	58	(6) 0.052/0.057				
			26	strand/2	1/4	57	58	(5) 0.045/0.050				
			26 20	strand/2 strand/1	1/4 1/4 fill*	57	58	(6) 0.052/0.057				
			26 20	strand/1 strand/1	1/4 1/4 fill*	57	58	(6) 0.052/0.057				
			26 20	solid/2 strand/1	1/4 1/4 fill*	57	58	(7) 0.059/0.064				
			26 30 22	solid/1 solid/1 strand/1	1/4 1/4 1/4 fill*	57	58	(6) 0.052/0.057				
			28 22	solid/1 strand/1	1/4 1/4 fill*	57	58	(6) 0.052/0.057				
			30 22	solid/2 strand/2	1/4 1/4 fill*	57	58	(6) 0.052/0.057				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2503528-2			20	strand/1	3/16	3 with - or - 59 with	19 60	0.038 - or - (7) 0.034/0.039	ITT Cannon CIET-20-HDL (plastic)	ITT Cannon CIET-20-HDL (plastic) - or - T3005573	T3009406-3	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			22	strand/1	3/16	4 with - or - 3 with - or - 59 with	18 19 60	0.037 - or - 0.040 - or - (6) 0.030/0.035				
			22 26	strand/1 solid/1	3/16 3/16 fill*	3	19	0.040				
			24	strand/1	3/16	4 with - or - 3 with - or - 59 with	18 19 60	0.032 - or - 0.032 - or - 0.032				
			24	solid/1	3/16	3	19	0.031				
			24 26	solid/1 solid/1	3/16 3/16 fill*	3	19	0.033				
			26	strand/1	3/16	59 with - or - ITT Cannon CBT-460	60 ---	(4) 0.022/0.027 - or - (2)				
			26	strand/1	3/16	3 with - or - 4 with - or - ITT Cannon CBT-460	19 18 ---	0.038 - or - 0.036 - or - (4) 0.032				
			26 24	strand/1 strand/1	3/16 3/16 fill*	57	58	(5) 0.045/0.050				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			26 28	solid/1 solid/1	3/16 3/16 fill*	3	19	0.032				
2503528-3	20	M	22	strand/2	3/16	3	19	0.041	Hand	T3009406-3	T3009406-3	T3008994
			24	strand/1	3/16	57 with - or - ITT Cannon CBT-460	58 ---	(2) 0.032/0.037 - or - (4) 0.032		(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20		
			26	strand/1	3/16	57 with - or - ITT Cannon CBT-460	58 ---	(1) 0.028/0.033 - or - (3) 0.028				
			26	strand/1	3/16	3	21	0.028				
			26 26	strand/1 solid/1	3/16 3/16 fill*	57 with - or - ITT Cannon CBT-460	58 ---	(4) 0.039/0.044 - or - (6) 0.04				
2503528-4 UP46426	22	M	22	strand/1	1/8	59 with - or - 3 with	64 43	(6) 0.030/0.035 - or - 0.032	ITT Cannon CIET-22	ITT Cannon CIET-22	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	1/8	59 with - or - 3 with	64 43	(5) 0.026/0.031 - or - 0.028				
			26	strand/1	1/8	59 with - or - 3 with	64 43	(4) 0.022/0.027 - or - 0.024				
			28 24	solid/1 solid/1	1/8 1/8 fill*	3	43	0.035				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28 24	strand/1 solid/1	1/8 1/8 fill*	3	43	0.036				
2503959-1 (MS3192A20-20A) Same as 2387050-120 and 2530483-20	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	(MS2425R20) Amphenol Borg 294-88	(MS2425R20) Amphenol Borg 294-89	T3009406-3	T3008994
			22	strand/1	3/16	57	58	(4) 0.043/0.050				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			26	strand/1	3/16	57 with - or - ITT Cannon CBT-460	58 ---	(4) 0.039/0.027 (5) 0.036				
2503959-2 (MS3192-16A)	16	M	16	strand/1	3/16	57	58	(2) 0.032/0.037	(MS2425R20) Amphenol Borg 294-88	(MS2425R20) Amphenol Borg 294-89	T3009406-3	T3008994
2504450-1	22	M	26	strand/1	3/16	57	58	(3) 0.038/0.041	Bendix Corp Insertion Pliers 11-6782 CE Adapter 11-7771-5	Bendix Corp Removal Handle 11-6900 plus Tip	T3009406-5	T3008994
2504520	22	M	26	strand/1	1/10	59	68	(4) 0.022/0.027	Amphenol Borg 294-123	Amphenol Borg 294-205 Adapter Bit 294-1300	T3009406-11	---
2504521	22	F	26	strand/1	1/10	59	68	(4) 0.022/0.027	Amphenol Borg 294-123	Amphenol Borg 294-205 Adapter Bit 294-1300	T3009406-8	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2504842-1 (MS24254-20P) (Color Band = RED) Barrel same as 2504843-1 or 4069506-1 for crimping	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	(MS2425A20) Amphenol Borg 294-88	(MS2425R20) Amphenol Borg 294-89	T3009406-3	T3008994
			22	strand/1	3/16	57 with - or - ITT Cannon CBT-460	58 ---	(4) 0.039/0.044 - or - (7)				
			22	strand/2	3/16	57	58	(3) 0.038/0.041				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			24	strand/2	3/16	57	58	(2) 0.032/0.037				
			26	strand/2	3/16	57	58	(4) 0.039/0.044				
			28	strand/2	3/16	57	58	(2) 0.032/0.037				
			28	strand/2	3/16	2	20	0.035				
			28 28	strand/1 strand/1	3/16 3/16 fill*	57	58	(2) 0.032/0.037				
2504842-2 (MS24254-16P) (Color Band = BLU) Same as 6229599-2	16	M	16	strand/1	1/4	1 with - or - 57 with	31 58	N/A - or - (7) 0.059/0.064	11-7401-16 (Bendix) Hamilton Avnet	11-7401-16 (Bendix) Hamilton Avnet	T3009406-4	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
2504842-3 (Color Band = BLK)	20	M	20	strand/1	1/4	1 with - or - 57 with	31 58	N/A - or - (7) 0.059/0.064	11-7401-16 (Bendix) Hamilton Avnet	11-7880-16 (Bendix) Hamilton Avnet	T3009406-4	T3008994 - or - (MS22520/3-1) Daniels Mfg G125

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2504843-1 Barrel same as 2504842-1 or 4069506-1 for crimping	20	F	20	strand/1	1/4	1 with - or - 57 with	31	(5) 0.045/0.050	(MS24256A20) Amphenol Borg 294-88 - or - Coast Air Inc ABT-1076	(MS24256R20) Amphenol Borg 294-89	T3009406-6	T3008994
			22	strand/1	3/16	57	58	(4) 0.039/0.044				
			22	strand/2	3/16	57	58	(4) 0.039/0.044				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			24	strand/2	3/16	57	58	(5) 0.044/0.050				
			26	strand/2	3/16	57 with - or - ITT Cannon CBT-460	58 ----	(4) 0.039/0.037 - or - (3) 0.036				
			28	strand/2	3/16	57	58	(2) 0.032/0.037				
			28 28	strand/1 strand/1	3/16 3/16 fill*	57	58	(2) 0.032/0.037				
2504843-2 Same as 6229600-2 UP40026	16	F	24 22	strand/1 strand/1	1/4 1/4 fill*	57	58	(6) 0.052/0.057	11-7401-16 (Bendix) Hamilton Avnet -- Replacement Tip 11-7929-16	11-7880-16 (Bendix) Hamilton Avnet	T3009406-6	----
2519857 (0.030 x 0.830 in.)	---	M	---	strand/ solid	1/4	---	---	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil	---	---
2519857-1 (0.030 x 0.860 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-2 (0.030 x 1.015 in.)	---	M	---	strand/ solid	1/4	---	---	---				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2519857-3 (0.030 x 0.995 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-4 (0.030 x 0.700 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-5 (0.030 x 1.355 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-6 (0.030 x 0.750 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-7 (0.030 x 0.890 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-8 (0.030 x 0.760 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-9 (0.030 x 0.800 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-10 (0.030 x 0.200 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-11 (0.030 x 0.350 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-12 (0.030 x 1.260 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-13 (0.030 x 1.562 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-14 (0.030 x 1.875 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-15 (0.030 x 2.500 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-16 (0.025 x 1.000 in.)	---	M	---	strand/ solid	1/4	---	---	---				
2519857-17 (0.020 x 1.000 in.)	---	M	---	strand/ solid	1/4	---	---	---				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
3718679-21 Same as 2500202	22	M	22	strand/1	1/10	3	27	0.033	ITT Cannon Handle = 204-9500-000 Tip = 323-9510-001-24	T3008770	---	T3008994
			24	strand/1	1/10	2 with - or - 3 with - or - SPC 11412	24 27 ---	0.026 - or - 0.029 - or - 0.031				T3008994
			24	solid/1	1/10	T3008128	---	N/A				---
			26	strand/1	1/10	4 with - or - 3 with - or - SPC 11412 - or - 24 2 with - or - T3008128	24 27 --- 24 ---	0.026 - or - 0.026 - or - 0.026 - or - 0.026 N/A				T3008994
			26 26	solid/1 strand/1	1/8 1/8 fill*	3	27	0.033				
			28 26	strand/1 strand/1	1/10 1/10 fill*	T3008128	--	N/A				
			28 26	strand/1 strand/1	1/10 1/10 fill*	3	27	0.033				
			28 26	solid/1 strand/1	1/8 1/8 fill*	3	27	0.033				
			28 28	strand/1 strand/1	1/8 1/8 fill*	3	27	0.032				
			30 26	solid/1 strand/1	1/8 1/8 fill*	3	27	0.035				
			32 26	strand/1 strand/1	1/10 1/10 fill*	T3008128	---	N/A				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			32	strand/1	1/10	3	27	0.0225				
			32	strand/1	1/10 fill*							
2500926-20 Same as 4007689-20	20	F	20	strand/1	1/4	T3007339	69	(6) 0.030/0.035	Bendix Corp 11-6874-20 - or - Burndy Corp RTM20-17 - or - ITT Cannon CIT-20-KJ 070151-0000 - or - M24308/18-2) AMP Inc 91067-2	Bendix Corp 11-6874-20 - or - Burndy Corp RX20-17 - or - ITT Cannon CIT-20-KJ 070151-0000 - or - (M24308/18-2) AMP Inc 91067-2 - or - T3005573	T3009406-5	T3008994
			22	strand/1	1/4	T3007339	69	(5) 0.026/0.031				
			28 26	solid/1 solid/1	1/4 1/4 fill*	3	41	0.036				
2500926-21 Same as 4007689-21			22	strand/1	1/4	59	69	(5) 0.026/0.031	Bendix Corp 11-8674-20	Bendix Corp 11-8675-20	T3009406-5	T3008994
			28 26	solid/1 solid/1	1/4 fill*	3	41	0.036	- or - Burndy Corp RTM20-17 - or - ITT Cannon CIT-20-KJ- 070151-0000 - or - (M24308/18-2) AMP Inc 91067-2	- or - Burndy Corp RX-20-36 - or - ITT Cannon CIT-20-KJ- 070152-0000 - or - (M24308/18-2) AMP Inc 91067-2 - or - T3005573		
2500926-22	22	F	22	strand/1	5/32	59	62	(5) 0.026/0.031	Burndy Corp RTM-22-1	Burndy Corp RX-22-1	T3009406-5	T3008994

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
Same as 4007689-22			24	strand/1	5/32	59	62	(4) 0.022/0.027	- or - Bendix Corp	- or - Bendix Corp		- or - (MS22520/3-1)
			26	strand/1	5/32	3	38	0.024	11-8674-22 - or - T3022740	11-8675-22		Daniels Mfg G125
2500926-221 Same as 4007689-221	22M	M	24	strand/1	5/32	3	53	0.022/0.027	Bendix Corp 11-8674-24 - or - Burndy Corp RTM24-3 - or - ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-2) AMP Inc. 91067-2	Bendix Corp 11-8674-24 - or - Burndy Corp RX24-3 - or - ITT Cannon CIT-22M-KJ- 070156-0000 - or - Astro Tool Co. MS27495-R22M - or - (M24308/18-2) AMP Inc. AMP91067-2	T3009406-5	T3008994
			26	strand/1	5/32	3	53	0.024				
			28	solid/2	5/32	3	53	0.029				
			28	strand/1	5/32	3	53	0.018				
2500926-222 Same as 4007689-222 UP46426	22D	F	22	strand/1	5/32	59	62	(5) 0.026/0.031	Bendix Corp 11-8674-24 - or - Burndy Corp RTM24-3 - or -	Bendix Corp 11-8674-24 - or - Burndy Corp RX24-3	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	5/32	59	62	(4) 0.022/0.027				
			26	strand/1	5/32	3	53	0.024				
			28	solid/2	5/32	3	53	0.024				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	strand/1	5/32	3	53	0.018	ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-2) AMP Inc. 91067-2	- or - ITT Cannon CIT-22M-KJ-070156-0000 - or - Astro Tool Co. MS27495-R22M - or - (M24308/18-2) AMP Inc. AMP91067-2		
2500937-12	12	F	12	strand/1	5/32	MS22520/1-01	MS22520/1-04	---	M81969/8-09	M81969/8-10	---	---
			14	strand/1	5/32	MS22520/1-01	MS22520/1-04	---	M81969/8-09	M81969/8-10	---	---
2500937-16	16	F	16	strand/1	5/32	MS22520/1-01	MS22520/1-04	---	M81969/8-08	M81969/8-08	---	---
			18	strand/1	5/32	MS22520/1-01	MS22520/1-04	---	M81969/8-08	M81969/8-08	---	---
2500937-20 UP46426	20	F	20	strand/1	5/32	MS22520/1-01	MS22520/1-04	---	M81969/8-08	M81969/8-08	---	---
			20	strand/1	1/4	3	41	0.0465	(M24308/18-2)	(M24308/18-2)	T3009406-7	T3008994
			26	strand/1	1/4	3	41	0.036	AMP Inc 91067-2	AMP Inc 91067-2		
			22	strand/1	1/4	3	41	0.040	- or - ITT Cannon	- or - ITT Cannon		
			24	strand/1	1/4	59	69	(6) 0.031/0.036				
			28	solid/1	1/4	3	41	0.035	CIET-20-HDL	CIET-20-HDL		
			26	strand/1	1/4 fill*				- or - ITT Cannon CIT-20-KJ-070151-0000 - or - Burndy Corp RTM20-17 - or - Bendix Corp 11-8674-20	- or - ITT Cannon CET-20-KJ-070152-0000 - or - Burndy Corp RX20-36 - or - T3005573 (See fig. 808)		

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
2500937-22	22	F	26	solid/1	5/32	3	54 - or - 29	0.024	Burndy Corp RTM-22-1 - or - Bendix Corp 11-8674-22 - or - T3022740	Burndy Corp RX-22-1 - or - Bendix Corp 11-8675-22	T3009406-8	T3008994
3718679-22 Same as 2500205 UP46426	22	F	22	strand/1	1/10	3	25	0.035	ITT Cannon Handle = 204-9500-000 Tip = 323-9510-001-24	ITT Cannon Handle = 204-9500-000 Tip = 324-9501-000	T3009406-6	T3008994
			24	strand/1	1/10	3	25	0.033				
			26	strand/1	1/10	3 with - or - SPC1141 - or - T3008128	25 --- ---	0.0292 - or - 0.0292 - or - N/A				
			26	strand/1	1/10	2	26	0.026				
			28	strand/2	1/10	3	25	0.034				
			28 26	strand/1 strand/1	1/10 1/10 fill*	T3008128	---	N/A				
			30 28	solid/1 strand/1	1/10 1/10 fill*	T3008128	---	N/A				
			32 26	strand/1 strand/1	1/10 1/10 fill*	T3008128	---	N/A				
			32 32	strand/1 strand/1	1/10 1/10 fill*	3	25	0.0225				
3718866-1	18, 20	--	18	strand/1	---	---	---	---	---	---	---	---
			20	strand/1	---	---	---	---	---	---	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
3718866-2	16-20	--	16	strand/1	----	Amphenol Borg 90180-2 - or - 90171	Self Adjust	---	---	---	---	---
			18	strand/1	----							
			20	strand/1	----							
3718866-3	14-18	--	14	strand/1	----	Amphenol Borg 90226-1	Self Adjust	---	---	---	---	---
			16	strand/1	----							
			18	strand/1	----							
3718866-4	14-18	--	14	strand/1	----	Amphenol Borg 90226-1	Self Adjust	---	---	---	---	---
			16	strand/1	----							
			18	strand/1	----							
3718866-5	22, 24	--	22	strand/1	----	Amphenol Borg 59528	Self Adjust	---	---	---	---	---
			24	strand/1	----							
3718866-6	18-22	--	18	strand/1	----	Amphenol Borg 59528	Self Adjust	---	---	---	---	---
			20	strand/1	----							
			22	strand/1	----							
3718919-101	---	F	22	strand/1	----	---	---	---	Hand	Hand	---	---
3718919-102	---	M	22	strand/1	----	---	---	---	Hand	Hand	---	---

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
3719005-101, -103, -104, -113	22	F	22	strand/1	0.130/ 0.110	ITT Cannon 995-0001-584	ITT Cannon 995-0002-015	(3)	ITT Cannon (metal) 070256-0000 (plastic) CIT-DPXMA-22-1 - or - ITT Cannon 980-004-804 w/Metal Tip	ITT Cannon (metal) 070317-0000 (plastic) CIT-DPXMA-22 - or - ITT Cannon 980-004-804 w/Metal Tip	---	---
			24	strand/1	0.130/ 0.110			(3)				
			26	strand/1	0.130/			(4)				
3719005-102	22	M	22	strand/1	0.130	ITT Cannon 995-0001-584	ITT Cannon 995-0001-604	(3)	ITT Cannon (metal) 070256-0000 (plastic) CIT-DPXMA-22-1 - or - ITT Cannon 980-004-804 w/Metal Tip	ITT Cannon (metal) 070317-0000 (plastic) CIT-DPXMA-22 - or - ITT Cannon 980-004-804 w/Metal Tip	---	---
			24	strand/1	0.130			(3)				
			26	Strand/1	0.130			(4)				
3719005-105	22	M	20	strand/1	0.167	ITT Cannon 995-0001-584	ITT Cannon 995-0001-604	---	ITT Cannon CIT-20D - or - CIET-20HDL	ITT Cannon CIT-20D - or - CIET-20HDL	---	---
			22	strand/1	0.167							
			24	strand/1	0.167							
3719005-106	20	M	20	strand/1	0.167	ITT Cannon 995-0001-584	ITT Cannon 995-0001-604	---	ITT Cannon CIT-20D - or - CIET-20HDL	ITT Cannon CIT-20D - or - CIET-20HDL	---	---
			22	strand/1	0.167							
			24	strand/1	0.167							
3719005-107	16	M	16	strand/1	0.270	ITT Cannon 995-0001-585	ITT Cannon 995-0001-736	---	--	ITT Cannon CET-16-9	---	---
			18	strand/1	0.270				ITT Cannon CIT-20D - or - CIET-20HDL	ITT Cannon CIT-20D - or - CIET-20HDL		
			20	strand/1	0.270	ITT Cannon 995-0001-584	ITT Cannon 995-0001-604					
3719005-108	16	F	16	strand/1	0.270	ITT Cannon 995-0001-585	ITT Cannon 995-0001-736	---	--	ITT Cannon CET-16-9	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			18	strand/1	0.270				ITT Cannon CIT-20D - or - CIET-20HDL	ITT Cannon CIT-20D - or - CIET-20HDL		
			20	strand/1	0.270	ITT Cannon 995-0001-584	ITT Cannon 995-0001-604					
3719005-109	12	M	12	strand/1	0.270	ITT Cannon 995-0001-585 - or - MS3191-1	ITT Cannon 995-0002-027	---	---	---	---	---
			14	strand/1	0.270							
3719005-110	12	F	12	strand/1	0.270	ITT Cannon 995-0001-585 - or - MS3191-1	ITT Cannon 995-0002-027	---	---	---	---	---
			14	strand/1	0.270							
3719005-111	5	M	--	RG-58C	--	T&B WT-410	---	---	---	ITT Cannon CET-C8	---	---
3719005-112	5	F	--	RG-58C	--	T&B WT-410	---	---	---	ITT Cannon CET-C8	---	---
4000808-16	16	F	20	strand/1	1/4	57	58	(5) 0.045/0.050	(MS27534-16) (plastic) ITT Cannon CIET-16 Deutsch Co. M-15570-16 Amphenol-Borg 294-109 (was NAS 1664-16)	(MS27534-16) (plastic) ITT Cannon CIET-16 Deutsch Co. M-15570-16 Amphenol-Borg 294-109 (was NAS 1664-16)	T3009406-6	T3008994 (See fig. 803
4002086-20 (Use plastic insert/ extract tool only)	20	F	24	strand/1	3/16	57	58	(4) 0.033/0.044	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	T3009406-8	---
4002087-12	12	M	12	strand/1	3/16	MS3191-1	---	---	NAS1664	NAS1664	---	---
4002087-16	16	M	16	strand/1	3/16	MS3191-1	---	---	NAS1664	NAS1664	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4002087-20 Same as 2501339-20 (Use plastic insert/ extract tool only)	20	F	24	strand/1	3/16	57	58	(2) 0.032/0.037	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	T3009406-5	T3008994
			26	strand/1	3/16	57	58	(4) 0.039/0.044				
4003074-12 (M39029/01-12)	12	M	12	strand/1	3/16	MS3191-4	MS3191-3T	---	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	T3009408-4	T3008994
4003074-16 (M39029/01-16)	16	M	16	strand/1	3/16	MS3191-4	MS3191-3T	---	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	T3009408-4	T3008994
4003074-20 (M39029/01-20) UP46426	20	M	26	strand/1	3/16	57	58	(4) 0.039/0.044	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	T3009408-4	T3008994
			26	solid/1	3/16	3	53	0.033				
4003074-22 (M39029/01-22)	22	M	22	solid/1	3/16	MS3191-4	MS3191-3T	---	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	(NAS 1664-20) (plastic) ITT Cannon CIET-20 Deutsch Co. M-15570-20	T3009408-4	T3008994

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4007689-12 (39029/58-360) (Color Bands = ORN/BLU/GRN) Same as 4011588-12	14	M	14	strand/1	1/4	57	58	(6) 0.052/0.057	MS27495-A12 (plastic)	MS27495-A12 (plastic)	T3009406-13	---
			22 14	strand/1 strand/1	1/4 1/4 fill*	57	58	(5) 0.045/0.050	MS27495-A12 (plastic)	MS27495-A12 (plastic)	T3009406-13	---
4007689-16 (39029/58-364) (Color Bands = ORN/BLU/YEL) Same as 4011588-16	16	M		strand/1 strand/1	/4 1/4 (fill*)	57	58	(6) 0.052/0.057	MS27495-A16 (plastic)	MS27495-A16 (plastic)	T3009406-13	---
4007689-20 (39029/58-363) (Color Bands = ORN/BLU/ORN) Same as 4011588-20	20	M	20	strand/1	5/32	57	58	(4) 0.039/0.044	MS27495-A20	MS27495-A20	T3009406-5	---
			22	strand/1	5/32	57	58	(2) 0.032/0.037				
			24	strand/1	5/32	57	58	(1) 0.032/0.039				
			26 26	strand/1 strand/1	3/16 3/32 fill*	57	58 (red)	(4) 0.039/0.044				
			28 26	solid/1 strand/1	5/32 5/32 fill*	57	58 (red)	(1) 0.032/0.039				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4007689-22 (39029/58-362) (Color Bands = ORN/BLU/RED) Same as 4011588-22	22	M		strand/1	5/32	MS3198-1	MS3198-8P	---	MS27495-A20	MS27495-A20	---	---
				strand/1	5/32	MS3198-1	MS3198-8P	---				
				strand/1	5/32	MS3198-1	MS3198-8P	---				
4007689-221 (39029/58-361) (Color Bands = ORN/BLU/BRN) Same as 4011588-221	22M	M	24	strand/1	5/32	3	53	0.024	MS27495-A22M	MS27495-A22M	T3009406-5	T3008994
			24	solid/1	5/32	T3007339	49 - or - 62	(4) 0.022/0.027				
			26	solid/1	5/32	T3007339 - or - 9	49 62	(2) 0.016/0.021 - or - (2) 0.016/0.021				
			26	strand/1	5/32	3	53	0.020				
			28	solid/1	5/32	59	49	(3) 0.019/0.024				
			28	strand/1	5/32	3	53	0.018				
			28	solid/2	5/32	3	53	.029				
4007689-222 (39029/58-360) (Color Bands = ORN/BLU/BLK) Same as 4011588-222	22D	M	22	strand/1	5/32	59	62	(5) 0.026/0.031	MS27495-A22D	MS27495-A22D	T3009406-5	T3008994
			24	strand/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	62 53 8 8	(4) 0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026				T3008994 - or - (MS22520/3-1) Daniels Mfg G125

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			24	solid chrome/ aluminum duplex- 58P75/1	5/32	59	62	(1) 0.013/0.018				
			24	strand/1	5/32	59	62	(4) 0.022/0.027				
			24	strand/1	5/32	3	53	0.024				
			26	strand/1	5/32	59	62	(2) 0.016/0.021				
			26	solid/2	5/32	59	62	(3) 0.019/0.024				
			26	strand/2	5/32	59	62	(3) 0.019/0.024				
			26	solid/2	5/32	3 - or - 4 with - or - 6 with	53 8 8	0.033 - or - 0.033 - or - 0.033				
4007689-222 (39029/58-360) UP46426 (Color Bands = ORN/BLU/BLK) Same as 4011588-222 (cont)	22D	M	26	solid/1	5/32	59	62	(3) 0.019/0.024	MS27495-A22D	MS27495-A22D	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			26	strand/1	5/32 fill*	59	62	(4) 0.022/0.027				
			30	solid/1	5/32 fill*	59	62	(5) 0.026/0.031				
			28	strand/1	5/32	3 with - or - 4 with - or - 6 with	53 8 8	0.018 - or - 0.018 - or - 0.018				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
UP46426			28	solid/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	62 53 8 8	(2) 0.016/0.021 - or - 0.033 - or - 0.018 - or - 0.018				
			28	solid/2	5/32	3	53	0.026				
			28	solid/3	5/32	3	53	0.026				
			28	solid/2	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	62 53 8 8	(4) 0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026				
			28	solid/3	5/32	3 with - or - 4 with - or - 6 with	53 8 8	0.026 - or - 0.026 - or - 0.026				
			28	solid/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	62 53 8 8	(4) 0.022/0.027 - or - 0.0292 - or - 0.0292 - or - 0.0292				
			26	solid/1	5/32 fill*							
			28	solid/1	5/32	59	62	(4)				
			28	strand/1	5/32 fill*			0.022/0.027				
4007689-222 (39029/58-360) (Color Bands = ORN/BLU/BLK) Same as 4011588-222 (cont)	22D	M	28	solid/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	62 53 8 8	(4) 0.022/0.027 - or - 0.0292 - or - 0.0292 - or - 0.0292	MS27495-A22D	MS27495-A22D	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	strand/1	5/32	59	62	(4)				
			28	strand/1	5/32 fill*			0.022/0.027				
			28	solid/1	5/32	3	53	0.028				
			30	solid/1	5/32 fill*							
			30	solid/1	5/32	59 with	62	(4)				
			26	strand/1	5/32 fill*	- or - 4 with	8	0.022/0.027 - or - 0.027				
4007795-12 (M39029/57-359) (Color Bands = ORN/GRN/WHT) Same as 4011587-12 UP46426	12	F	30	solid/1	5/32	59	62	(4)				
			20	strand/1	5/32 fill*			0.022/0.027				
			32	strand/1	5/32	59	62	(4)				
			28	strand/2	5/32 fill*			0.022/0.027				
			20	strand/3	1/4	12	56	(7) 0.066/0.073				
			24	strand/1	5/32	12	56	(7)				
4007795-16 (M39029/57-358) (Color Bands = ORN/GRN/GRY) Same as 4011587-16	16	F	18	strand/1	5/32 fill*			0.066/0.073				
			16	strand/1	1/4	57	58	(6) 0.052/0.057				
			18	strand/1	1/4	57	58	(5) 0.045/0.050				
			20	strand/1	1/4	57	58	(4) 0.039/0.044				
			22	strand/1	1/4	57	58	(2) 0.032/0.037				
			16	strand/1	1/4	57	58	(6) 0.052/0.057				
			18	strand/1	1/4	57	58	(5) 0.045/0.050				
			20	strand/1	1/4	57	58	(4) 0.039/0.044				
			22	strand/1	1/4	57	58	(2) 0.032/0.037				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4007795-20 (M39029/57-357) (Color Bands = ORN/GRN/VIO) Same as 4011587-20	20	F	20	strand/1	5/32	57	58	(4) 0.039/0.044	Astro Tool Co. MBX 1072 Bendix Corp 11-8674-20 Burndy Corp RTM20-17 ITT Cannon CIT-20-KJ-070151-0000	Bendix Corp 11-8675-20 Burndy Corp RX20-36 ITT Cannon CIT-20-KJ-070152-0000	T3009406-8	---
			22	strand/1	5/32	57	58	(2) 0.039/0.044				
			24	strand/1	5/32	57	58	(2) 0.039/0.044				
4007795-22 (M39029/57-356) (Color Bands = ORN/GRN/BLU) Same as 4011587-22	22	F	22	strand/1	5/32	57	58	(2) 0.039/0.044	Astro Tool Co. MBX 1072 Bendix Corp 11-8674-20 Burndy Corp RTM20-17 ITT Cannon CIT-20-KJ-070151-0000	Bendix Corp 11-8675-20 Burndy Corp RX20-36 ITT Cannon CIT-20-KJ-070152-0000	T3009406-8	---
4007795-221 (M39029/57-355) (Color Bands = ORN/GRN/GRN) Same as 4011587-221 UP46426	22M	F	24	solid/1	5/32	T3007339 - or - 59 with	49 63	(4) 0.022/0.027 - or - (4) 0.022/0.027	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8674-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	T3009406-8	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	5/32	T3007339 - or - 3 with	49 54	(4) 0.022/0.027 - or - 0.028				
			26	strand/1	5/32	3	54	0.018				
			26	strand/1	5/32	3	54	0.020				
			28	solid/1	5/32	3 with - or - T3007339	54 49	0.018 - or - (2) 0.016/0.021				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	strand/1	5/32	T3007339 - or - 3 with	49 54	(2) 0.016/0.021 - or - 0.024				
			28	solid/2	5/32	3	54	0.0292				
			28 28	solid/1 strand/1	5/32 5/32 fill*	3	54	0.0292				
4007795-222 (M39029/57-354) (Color Bands = ORN/GRN/YEL) Same as 4011587-222 UP46426	22D	F	22	strand/1	5/32	59 with - or - 4 with - or - 6 with	63 8 8	(5) 0.026/0.031 - or - 0.027 - or - 0.027	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	T3009406-8	T3008994
			24	solid/1	5/32	3	54	0.024				
			24	strand/1	5/32	3 with - or - 4 with - or - 6 with	54 8 8	0.026 - or - 0.026 - or - 0.026				
			26	solid/3	5/32	3	54	0.033				
			26	solid/2	5/32	3	54	0.033				
			26	solid/1	5/32	3	54	0.024				
			26	strand/1	5/32	3	54	0.024				
			26	solid/1	5/32	3	54	0.024				
			28	strand/1	5/32 fill*							
			26	solid/1	5/32	3	54	0.0292				
			28	strand/1	5/32 fill*							
			26	solid/1	5/32	3	54	0.028				
			30	solid/1	5/32 fill*							
			28	solid/3	5/32	3	54	0.031				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	strand/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	63 54 8 8	(2) 0.016/0.021 - or - 0.018 - or - 0.018 - or - 0.018				
4007795-222 (M39029/57-354) (Color Bands = ORN/GRN/YEL) Same as 4011587-222 (cont) UP46426	22D	M	28	solid/2	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	63 54 8 8	(4) 0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	T3009406-8	T3008994
			28	solid/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	63 54 8 8	(2) 0.016/0.021 - or - 0.018 - or - 0.018 - or - 0.018				
			28	solid/1	5/32	3	54	0.018				
			28	solid/1	5/32	3	54	0.027				
			26	strand/1	5/32 fill*							
			28	solid/1	5/32	3 with - or - 4 with - or - 6 with	54 8 8	0.026 - or - 0.026 - or - 0.026				
			28	strand/1	5/32 fill*							
			30	solid/1	5/32	3	54	0.026				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4007795-222 (M39029/57-354) (Color Bands = ORN/GRN/YEL) Same as 4011587-222 (cont)	22D	M	30	solid/1	5/32	59	63	(4)	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	T3009406-8	T3008994
			20	strand/1	5/32 fill*			0.022/0.027				
			30	solid/1	5/32	3	54	0.026				
			26	strand/1	5/32 fill*							
			30	solid/1	5/32	59 with	63	(4)				
4011587-12 (MS27491-12) (Color Bands = ORN/GRN/WHT) Same as 4007795-12	12	F	28	strand/1	5/32 fill*	- or - 3 with - or - 4 with - or - 6 with	54	0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026				
			30	solid/1	5/32	3	54	0.024				
			28	solid/1	5/32 fill*							
			30	solid/2	5/32	3 with	54	0.027				
			28	strand/1	5/32 fill*	- or - 59 with	63	- or - (5) 0.026/0.031				
4011587-12 (MS27491-12) (Color Bands = ORN/GRN/WHT) Same as 4007795-12	12	F	20	strand/3	1/4	12	56	(7) 0.066/0.073	---	---	---	---
			24	strand/1	5/32	12	56	(7)				
			18	strand/1	5/32 fill*			0.066/0.073				
			16	strand/1	1/4	57	58	(6) 0.052/0.057				
			18	strand/1	1/4	57	58	(5) 0.045/0.050				
			20	strand/1	1/4	57	58	(4) 0.039/0.044				
			22	strand/1	1/4	57	58	(2) 0.032/0.037				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4011587-16 (MS27491-16) (Color Bands = ORN/GRN/GRY) Same as 4007795-16	16	F	16	strand/1	1/4	57	58	(6) 0.052/0.057	---	---	---	---
			18	strand/1	1/4	57	58	(5) 0.045/0.050				
			20	strand/1	1/4	57	58	(4) 0.039/0.044				
			22	strand/1	1/4	57	58	(2) 0.032/0.037				
4011587-20 (MS27491-20) (Color Bands = ORN/GRN/VIO) Same as 4007795-20	20	F	20	strand/1	5/32	57	58	(4) 0.039/0.044	Astro Tool Co. MBX 1072 Bendix Corp 11-8674-20 Burndy Corp RTM20-17 ITT Cannon CIT-20-KJ-070151-0000	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ-070155-0000	T3009406-8	---
			22	strand/1	5/32	57	58	(2) 0.039/0.044				
			24	strand/1	5/32	57	58	(2) 0.039/0.044				
4011587-22 (MS27491-22) (Color Bands = ORN/GRN/BLU) Same as 4007795-22	22	F	22	strand/1	5/32	57	58	(2) 0.039/0.044	Astro Tool Co. MBX 1072 Bendix Corp 11-8674-20 Burndy Corp RTM20-17 ITT Cannon CIT-20-KJ-070151-0000	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ-070155-0000	T3009406-8	---

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4011587-221 (MS27491-22M) (Color Bands = ORN/GRN/GRN) Same as 4007795-221	22M	F	24	solid/1	5/32	T3007339 - or - 59 with	49 54	(4) 0.022/0.027	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ- 070155-0000	T3009406-8	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			24	strand/1	5/32	T3007339 - or - 3 with	49 54	(4) 0.022/0.027 - or - 0.028				
			26	strand/1	5/32	3	54	0.018				
			26	strand/1	5/32	3	54	0.020				
			28	solid/1	5/32	3 with - or - T3007339	54 49	0.018 - or - (2) 0.016/0.021				
			28	strand/1	5/32	T3007339 - or - 3 with	49 54	(2) 0.016/0.021 - or - 0.024				
			28	solid/2	5/32	3	54	0.0292				
			28 28	solid/1 strand/1	5/32 5/32 fill*	59 with - or - 4 with - or - 6 with	63 8 8	(5) 0.026 - or - 0.027 - or - 0.027				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.					
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage		
4011587-222 (MS27491-22D) (Color Bands = ORN/GRN/YEL) Same as 4007795-222	22D	F	22	strand/1	5/32	59 with - or - 4 with - or - 6 with	63 8 8	(5) 0.026/0.031 - or - 0.027 - or - 0.027	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ- 070155-0000	T3009406-8 T3009406-8	T3008994 T3008994		
			24	solid/1	5/32	3	54	0.024						
			24	strand/1	5/32	3 with - or - 4 with - or - 6 with	54 8 8	0.026 - or - 0.026 - or - 0.026		Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000				
			26	solid/3	5/32	3	54	0.033						
			26	solid/2	5/32	3	54	0.033						
			26	solid/1	5/32	3	54	0.024						
			26	strand/1	5/32	3	54	0.024						
			26 28	solid/1 strand/1	5/32 5/32 fill*	3	54	0.024	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000					
			26 28	solid/1 strand/1	5/32 5/32 fill*	3	54	0.0292						
			26 30	solid/1 solid/1	5/32 5/32 fill*	3	54	0.028	ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1					

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	solid/3	5/32	3	54	0.031	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000			
			28	strand/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	63 54 8 8	(2) 0.016/0.021 - or - 0.018 - or - 0.018 - or - 0.018				
4011587-222 (MS27491-22D) (Color Bands = ORN/GRN/YEL) Same as 4007795-222 (cont) UP46426	22D	F	28	solid/2	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	63 54 8 8	(4) 0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ-070155-0000	T3009406-8	T3008994
			28	solid/1	5/32	59 with - or - 3 with - or - 4 with - or - 6 with	63 54 8 8	(4) 0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026				
			28	solid/1	5/32	3	54	0.018				
			28	solid/1	5/32	3	54	0.027				
			26	strand/1	5/32 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	solid/1 strand/1	5/32 5/32 fill*	3 with	54	0.026	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1			
			28			- or - 4 with - or - 6 with	8 8	- or - 0.026 - or - 0.026				
			30	solid/1	5/32	3	54	0.026	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000			
4011587-222 (MS27491-22D) (Color Bands = ORN/GRN/YEL) Same as 4007795-222 (cont) UP 4426	22D	F	30	solid/1	5/32	59	63	(4)	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ-070155-0000	Bendix Corp 11-8675-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ-070155-0000	T3009406-8	T3008994
			20	strand/1	5/32 fill*			0.022/0.027				
			30	solid/1	5/32	3	54	0.026				
			26	strand/1	5/32 fill*							
			30	solid/1 strand/1	5/32 5/32 fill*	59 with	63	(4)				
			28			- or - 3 with - or - 4 with - or - 6 with	54 8 8	0.022/0.027 - or - 0.026 - or - 0.026 - or - 0.026				
			30			3	54	0.024				
			28	solid/1	5/32 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			30 28	solid/1 strand/1	5/32 5/32 fill*	3 with - or - 59 with	54 63	0.027 - or - (5) 0.026/0.031	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1			

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4011588-12 (MS27494-12) Same as 4007689-12			12	strand/1	5/32	MS3191-4	MS3198-8P	---	MS27495-12	MS27495-12	---	---
			14	strand/1	5/32	MS3191-4	MS3198-8P	---				
4011588-16 (MS27494-16) Same as 4007689-16			16	strand/1	5/32	MS3191-4	MS3198-8P	---	MS27495-12	MS27495-12	---	---
			18	strand/1	5/32	MS3191-4	MS3198-8P	---				
			20	strand/1	5/32	MS3191-4	MS3198-8P	---				
4011588-20 (MS27494-20) Same as 4007689-20			20	strand/1	5/32	MS3198-1 - or - MS3191-4	MS3198-9P - or - MS3191-9T	---	MS27495-12	MS27495-12	---	---
			22	strand/1	5/32	MS3198-1 - or - MS3191-4	MS3198-9P - or - MS3191-9T	---				
			24	strand/1	5/32	MS3198-1 - or - MS3191-4	MS3198-9P - or - MS3191-9T	---				
4011588-22 (MS27494-22) Same as 4007689-22			22	strand/1	5/32	MS3198-1	MS3198-8P	---	MS27495-12	MS27495-12	---	---
			24	strand/1	5/32	MS3198-1	MS3198-8P	---				
			26	strand/1	5/32	MS3198-1	MS3198-8P	---				
4011588-221 (MS27494-221) Same as 4007689-221			24	strand/1	5/32	MS3198-1	MS3198-8P	---	MS27495-12	MS27495-12	---	---
			26	strand/1	5/32	MS3198-1	MS3198-8P	---				
			28	strand/1	5/32	MS3198-1	MS3198-8P	---				
4011588-222 (MS27494-222) Same as 4007689-222	22D	M	22	strand/1	5/32	MS3198-1	MS3198-8P	---	Bendix Corp 11-8674-24 Burndy Corp RTM24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	Bendix Corp 11-8674-24 Burndy Corp RX24-3 ITT Cannon CIT-22M-KJ- 070155-0000 - or - (M24308/18-1) AMP Inc 91067-1	T3009406-5	T3008994
			24	strand/1	5/32	MS3198-1	MS3198-8P	---				
			26	strand/1	5/32	3	53	0.024				
			28	strand/1	5/32	MS3198-1	MS3198-8P	---	MS27495-12	MS27495-12		---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4012291-1 (M22885/80-50)	20	F	20	strand/1	5/32	3	19	0.044	Hand	T3017504	T3009406-8	T3008994
			22	strand/1	5/32	3	19	0.035				
			24	strand/1	5/32	3	19	0.032				
			24	strand/1	5/32	3	19	0.038				
			24	strand/2	5/32	3	19	0.040				
			26	strand/2	5/32	3	19	0.038				
			28	strand/1	5/32	3	19	0.031				T3008994
4012291-2 (M22885/80-51)	20	F	26	strand/1	5/32	1	47	N/A	Hand	T3017504	T3009406-8	T3008994
4015220-12 Crimp Barrel Dimensions same as 4015221-12	12	M	14	strand/1	1/4	57	58	(7) 0.059/0.064	(MS27495-A12) Burndy Corp RTM12-4	(MS27495-R12) Burndy Corp RX12-9	T3009406-12	---
			22 14	solid/1 strand/1	1/4 1/4 fill*	57	58	(8) 0.068/0.073	(MS27495-A12) Burndy Corp RTM12-4	(MS27495-R12) Burndy Corp RX12-9		
4015220-16 Crimp Barrel Dimensions same as 4015221-16 UP46426	16	M	16	strand/1	1/4	57	58	(6) 0.052/0.057	(MS27495-A16) Burndy Corp RTM16-4 - or - ITT Cannon CIET-16 - or - Deutsch Co. M-15570-16 - or - Amphenol Borg 294-109	(MS27495-A16) Burndy Corp RTM16-4 - or - ITT Cannon CIET-16 - or - Deutsch Co. M-15570-16 - or - Amphenol Borg 294-109 - or - Bendix Corp 11-8675-16	T3009406-13	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4015220-20 Crimp Barrel Dimensions same as 4015221-20	20	M	20	strand/1	1/4	M22520/2-01 - or - M22520/1-01	M22520/2-10 - or - M22520/1-04	---	MS27495	MS27495	---	---
4015220-22 Crimp Barrel Dimensions same as 4015221-22	22	M	22	strand/1	1/4	M22520/2-01	M22520/2-09	---	MS27495	MS27495	---	---
4015220-221 Crimp Barrel Dimensions same as 4015221-221	22M	M	22	strand/1	3/16	M22520/2-01	M22520/2-09	---	MS27495	MS27495	---	---
4015220-222 (MSFC 40M38277, NLS-CP-22D) Crimp Barrel Dimensions same as 4015221-222 UP46426	22D	M	22	strand/1	3/16	3	53	0.033	Bendix Corp 11-8674-24 - or - Burdny Corp RTM24-3 - or - CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1 - or - Astro Tool Co. MS27495-A22D	Bendix Corp 11-8674-24 - or - Burdny Corp RX24-3 - or - CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1 - or - Astro Tool Co. MS27495-A22D	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			26	strand/1	3/16	3	53	0.025				
			26	strand/2	3/16	59	63	(5) 0.026/0.030				
			28	solid/1	3/16	3	53	0.020				
			28	strand/1	3/16	3	53	0.020				
			30	solid/1	3/16	3	53	0.016				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4015221-16 Crimp Barrel Dimensions same as 4015220-16	16	F	16	strand/1	1/4	12	56	(5) 0.052/0.059				
			16	strand/1	1/4	57	58	(6) 0.052/0.057	(MS27495-A16) Burndy Corp RTM16-4 - or - ITT Cannon CIET-16 - or - Deutsch Co.	(MS27495-A16) Burndy Corp RX16-9 - or - ITT Cannon CIET-16 - or - Deutsch Co.	T3009406-7	T3008994
			20	strand/1	1/4	12	58	(4) 0.045/0.051				
			20	strand/1	1/4	57	54	(6) 0.045/0.050				
			28	solid/1	3/16	3	54	0.020				
			28	solid/2	3/16	3	54	0.026	M-15570-16 - or - Amphenol Borg 294-109	M-15570-16 - or - Amphenol Borg 294-109 - or - Bendix Corp 11-8675-16		T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			28	solid/1	3/16	3	54	0.028				
			26	strand/1	3/16 fill*							
			8	solid/1	3/16	3	54	0.026				
			30	solid/1	3/16 fill*							
			30	solid/1	3/16	3	54	0.016				
4015221-20 Crimp Barrel Dimensions same as 4015220-20	20	F	20	strand/1	3/16	M22520/2-01 - or - M22520/1-01	M22520/2-10 - or - M22520/1-04	---	MS27495-A20	MS27495-R22D	---	---
4015221-22 Crimp Barrel Dimensions same as 4015220-22	22	F	22	strand/1	3/16	M22520/2-01	M22520/2-06	---	MS27495-A20	MS27495-R22D	---	---
4015221-221 Crimp Barrel Dimensions same as 4015220-221	22M	F	22	strand/1	3/16	M22520/2-01	M22520/2-06	---	MS27495-A20	MS27495-R22D	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4015221-222 (MSFC 40M38277, NLS-CS-22D) Crimp Barrel Dimensions same as 4015220-222	22D	F	22	strand/1	3/16	3	54	0.033	Bendix Corp 11-8674-24 - or - Burndy Corp RTM24-3 - or - CIT-22M-KJ-070155-0000 - or - (M24308/18-1) AMP Inc 91067-1 - or - Astro Tool Co. MS27495-A22D	Bendix Corp 11-8674-24 - or - Burndy Corp RX24-3 - or - CIT-22M-KJ-70156--0000 - or - (M24308/18-1) AMP Inc 91067-1 - or - Astro Tool Co. MS27495-R22D	T3009406-5	T3008994 - or - (MS22520/3-1) Daniels Mfg G125
			26	strand/1	3/16	--	54	0.025				
4015819-1 (M39029/50-340) (Color Bands = ORN/YEL/BLK)	12 shld	M	28	solid/1 (cable M17/094-RG179)	-/-	Burndy Corp M10S-1	Burndy Corp M10S-1	0.025 ± 0.001	T3016352-7	T3016352-8	T3009406-14	N/A
			28	strand/1 (cable M17/094-RG179)	1/4	1 (non-adjust)	11	0.025 ± 0.001				
4015821-12 (M39029/4-113) (Color Bands = BRN/BRN/ORN) Same as 4015824-12	12	M	14	strand/1	9/32	57	58	(7) 0.059/0.064			T3009406-5	---
			16 20	strand/1 strand/1	9/32 9/32 fill*	57	58	(8) 0.068/0.073				
			20	strand/2	9/32	57	58	(7) 0.059/0.064				
			20 16	strand/1 strand/1	9/32 9/32 fill*	57	58					

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
								(8) 0.068/0.073	(NAS-1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20 - or - CIT-20-KJ- 070151-0000 - or - Bendix Corp 11-8674-20 - or - Burndy Corp RTM20-17	(NAS-1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20 - or - CIT-20-KJ- 070151-0000 - or - Bendix Corp 11-8674-20 - or - Burndy Corp RTM20-17		
			20 20	strand/1 strand/1	9/32 9/32 fill*	57	58	(7) 0.059/0.064				
			22 20	strand/2 strand/1	9/32 9/32 fill*	57	58	(8) 0.068/0.073				
			26 20	strand/1 strand/1	9/32 9/32 fill*	57	58	(6) 0.052/0.057				

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4015821-16 (M39029/4-111) (Color Bands = BRN/BRN/BRN) Same as 4015824-16	20	M	18	strand/1	5/32	12	13	(6) 0.052/0.057	(NAS-1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20 - or - CIT-20-KJ-070151-0000 - or - Bendix Corp 11-8674-20 - or - Burndy Corp RTM20-17	(NAS-1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20 - or - CIT-20-KJ-070151-0000 - or - Bendix Corp 11-8674-20 - or - Burndy Corp RTM20-17	T3009406-5	---
			22	strand/1	5/32	13	13	(4) 0.044/0.051				
4015821-20 (M39029/4-110) (Color Bands = BRN/BRN/BLK) Same as 4015824-20 UP46426	20	M	20	strand/1	5/32	12	13	(4) 0.044/0.051	Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-5	---
			20	strand/1	5/32	57	58	(5) 0.045/0.050				
			22	strand/1	5/32	57	58	(4) 0.039/0.044				
			22	strand/1	5/32	36 with - or - 12 with	37 13	(3) 0.038/0.045 - or - (3) 0.038/0.045				
			22	strand/1	5/32	57	58	(3) 0.036/0.041				
			24	strand/1	5/32	12 with - or - 36 with	13 37	(2) 0.032/0.039 - or - (2) 0.032/0.039				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			24	strand/1	5/32	57	58	(2)				
			24	strand/1	5/32 fill*			0.032/0.037				
			24	strand/1	5/32	57	58	(4)				
			26	strand/1	5/32 fill*			0.044/0.050				
			26	solid/1	5/32	57 with - or - 36 with	58 37	(1) 0.028/0.033 - or - (1) 0.0285/0.0335				
4015821-20 (M39029/4-110) (Color Bands = BRN/BRN/BLK) Same as 4015824-20 (cont) UP46428	20	M	26	strand/1	5/32	57	58	(3)	Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-5	---
			26	strand/1	5/32 fill*			0.036/0.041				
			26	strand/1	5/32	57	58	(4)				
			26	strand/1	5/32 fill*			0.039/0.044				
			28	strand/1	5/32	12	13	(1)	Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-5	---
								0.028/0.035				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	solid/1 strand/1	5/32 5/32 fill*	57 with	58	(5)				
			22			- or -	37	0.045/0.050				
						36 with	13	- or - (5) 0.045/0.050				
								- or - (4) 0.044/0.051				
			28			57	58	(6)				
			22				(red)	0.052/0.057				
4015824-12 (39029/5-118) (Color Bands = BRN/BRN/GRY) Same as 4015821-12	20	F	16	strand/1	9/32	57	65	(6) 0.052/0.057	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20 CIT-20-KJ-070151-0000 - or - Bendix Corp 11-8674-20 - or - Burndy Corp RTM20-17	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20 CIT-20-KJ-070151-0000 - or - Bendix Corp 11-8674-20 - or - Burndy Corp RTM20-17	T3009406-5	----

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			20	strand/1	9/32	57	58	(4)	(NAS 1664-20)	(NAS 1664-20)	T3009406-5	---
			20	strand/1	9/32 fill*			0.039/0.044	Deutsch Co.	Deutsch Co.		
			26	strand/1	9/32	57	58	(7)	M-15570-20	M-15570-20		
			16	strand/1	9/32 fill*			0.059/0.064	- or -	- or -		
									ITT Cannon	ITT Cannon		
									CIET-20	CIET-20		
4015824-16 (M39029/5-116) (Color Bands = BRN/BRN/BLU) Same as 4015821-16 UP46426			18	strand/1	5/32	12	13	(6)	(NAS-1664-20)	(NAS-1664-20)	T3009406-8	---
								0.058/0.065	Deutsch Co.	Deutsch Co.		
			20	strand/1	5/32	12	13	(6)	M-15570-20	M-15570-20		
								0.058/0.065	- or -	- or -		
									ITT Cannon	ITT Cannon		
									CIET-20	CIET-20		
			24	strand/1	5/32	12	13	(5)	(NAS-1664-20)	(NAS-1664-20)		
			20	strand/1	5/32 fill*			0.052/0.059	Deutsch Co.	Deutsch Co.		
									M-15570-20	M-15570-20		
									- or -	- or -		
									ITT Cannon	ITT Cannon		
									CIET-20	CIET-20		

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4015824-20 (M39029/5-118) (Color Bands = BRN/BRN/BLU) Same as 4015821-20	20	F	20	strand/1	5/32	12	13	(4) 0.044/0.051	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-8	---
			22	strand/1	5/32	36 with - or - 12 with	37 13	(3) 0.038/0.045 - or - (3) 0.038/0.045				
			24	strand/1	5/32	12 with - or - 36 with	13 37	(2) 0.032/0.039				
			26	solid/1	5/32	36	37	(1) 0.0258/0.0316				
			26 26	strand/1 strand/1	5/32 5/32 fill*	57 with - or - 36 with - or - 12 with	58 37 13	(3) 0.038/0.045 - or - (3) 0.038/0.045 - or - (3) 0.038/0.045				
			26 28	strand/1 strand/1	5/32 5/32 fill*	57	58	(3) 0.036/0.041				
			28 22	solid/1 strand/1	5/32 5/32 fill*	12 with - or - 36 with - or - 57 with	13 37 58	(4) 0.044/0.051 - or - (5) 0.045/0.050 - or - 0.045/0.050				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4018337-12 (M39029/18-180) (Color Bands = BRN/GRY/BLK)	12	M	12	strand/1	3/16	M22520/1-01	M22520/1-09	---	MS3160-12	MS3160-12	---	---
			14	strand/1	3/16			---				
4018337-16 (M39029/18-179) (Color Bands = BRN/VIO/WHT)	16	M	16	strand/1	3/16	M22520/1-01	M22520/2-15	---	MS3160-16	MS3160-16	---	---
			18	strand/1	3/16			---				
			20	strand/1	3/16			---				
4018337-20 (M39029/18-178) (Color Bands = BRN/VIO/GRY)	20	M	20	strand/1	3/16	M22520/1-01	M22520/2-14	---	MS3160-20	MS3160-20	---	---
			22	strand/1	3/16			---				
			24	strand/1	3/16	57	65	(4) 0.022/0.027	(MS3160-20) Deutsch Co. 81515-20	(MS3160-20) Deutsch Co. 81515-20	T3009406-5	---
			26	strand/2	3/16	57	65	(3) 0.019/0.024				
			26	strand/1	3/16	57	65	(6) 0.030/0.035				
			28	strand/1	3/16	57	65	(2) 0.016/0.021				
4018337-22 (M39029/18-178) (Color Bands = BRN/VIO/GRY)	22	M	22	strand/1	3/16	M22520/1-01	M22520-2-13	---	MS3160-22	MS3160-22	---	---
			24	strand/1	3/16			---				
			26	strand/1	3/16			---				
			28	strand/1	3/16			---				
4018337-28 (M39029/18-176) (Color Bands = BRN/VIO/BLU)	28	M	28	strand/1	3/16	M22520/2-01	M22520/2-13	---	MS3160-28	MS3160-28	---	---
			30	strand/1	3/16			---				
			32	strand/1	3/16			---				
4018847-1	---	F	18	solid/1 - or - strand/1	1/8	55	---	N/A	Hand	ITT Cannon CET-DL	---	---
			20	solid/1 - or - strand/1	1/8	55	---					
			20		3/16	55	---					

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			22	solid/1 - or - strand/1	1/8	55	---			T3911000-7		
			24	solid/1 strand/1	1/8	55	---			ITT Cannon CET-DL		
			26	solid/1 - or - strand/1	1/8	55	---					
			28	solid/1 - or - strand/1	1/8	55	---					
			30	solid/1 - or - strand/1	1/8	55	---					
			32	solid/1 - or - strand/1	1/8	55	---					
4018847-2	---	M	22	strand/1	1/8	ABT-500 (auto tape feed)	901-113	Self Adjust (0.003 RD A)	Hand	ITT Cannon CET-DL	---	---
			24	strand/1	1/8							
			24	strand/1	3/16	55	w/crimp	N/A	---	---		
			26	strand/1	1/8	ABT-500 (auto tape feed)	901-113	Self Adjust (0.003 RD A)	Hand	ITT Cannon CET-DL		
4018847-3	---	M	18	solid/1 - or - strand/1	1/8	55	ITT Cannon CET-DL	N/A	Hand	ITT Cannon CET-DL	---	---
			20	solid/1 - or - strand/1	1/8	55						
			22	solid/1 - or - strand/1	1/8	55						

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			24	solid/1 - or - strand/1	1/8 - or - 1/4	55		N/A - or - 24 thru 28		ITT Cannon CET-DL - or - T3911000-7		
			26	solid/1 - or - strand/1	1/8 - or - 1/4	55		N/A		ITT Cannon CET-DL		
			28	solid/1 - or - strand/1	1/8	55						
			30	solid/1 - or - strand/1	1/8	55						
			32	solid/1 - or - strand/1	1/8	55						

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4018847-5	---	M	18	solid/1 - or - strand/1	1/8	ITT Cannon CCT-DL-3 - or - 995-0001-903	ITT Cannon CET-DL	N/A	Hand	ITT Cannon CET-DL	---	---
			20	solid/1 - or - strand/1	1/8							
4018847-7	---	M	24	solid/1 - or - strand/1	1/8	ITT Cannon CCT-DL-3 - or - 995-0001-903	ITT Cannon CET-DL	N/A	Hand	ITT Cannon CET-DL	---	---
			26	solid/1 - or - strand/1	1/8							
4018847-9	---	M	20	solid/1 - or - strand/1	1/8	ITT Cannon CCT-DL-3 - or - 995-0001-903	TT Cannon CET-DL	N/A	Hand	TT Cannon CET-DL	---	---
			22	solid/1 - or - strand/1	1/8							
4018847-11 UP46426	---	M	18	solid/1 - or - strand/1	1/8	ITT Cannon CCT-DL-3 - or - 995-0001-903 ITT Cannon CCT-DL-3 - or - 995-0001-903	TT Cannon CET-DL	N/A	Hand	TT Cannon CET-DL	---	---
			20	solid/1 - or - strand/1	1/8							
4018847-13	---	M	28	solid/1 - or - strand/1	1/8	ITT Cannon CCT-DL-3 - or - 995-0001-903	TT Cannon CET-DL	N/A	Hand	TT Cannon CET-DL	---	---
			32	solid/1 - or - strand/1	1/8							
4020030-1	30	---	30	coax/1	5/32	59	T3027179		---	---	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
								(3) 0.021				
4020050	28	---	28	triax/1	1/8	T3027177 (set)	T3027177 (set)	---	---	---	---	---
4024886-1 CAUTION: USE PLASTIC INSERT/ EXTRACT TOOLS ONLY	22	M	22	strand/1	3/16	Buchanan No. 612118	Buchanan No. 613703	---	M15570-22-1	M15570-22-1	---	---
			24	strand/1	3/16							
			26	strand/1	3/16							
4024886-2) CAUTION: USE PLASTIC INSERT/ EXTRACT TOOLS ONLY	16	M	16	strand/1	3/16	57	58	(6) 0.052/0.057	(plastic) ITT Cannon CIET-16 - or - Deutsch Co. M-15570-16 - or - Amphenol Borg 294-109	Bendix Corp (plastic) MS27509R22	T3009406-4	(MS22520/3-1) Daniels Mfg G125
			18	strand/1	3/16	57	58	(5) 0.045/0.050				
			20	strand/1	3/16	57	58	(4) 0.039/0.044				
			22	strand/2	3/16	57	58	(6) 0.052/0.057				
			26 20	strand/1 strand/1	3/16 3/16 fill*	57	58	(6) 0.052/0.057				
UP46426 4024886-3 CAUTION: USE PLASTIC INSERT/ EXTRACT TOOLS ONLY	20	M	20	strand/1	3/16	57 with - or - 59 with	58 60	(4) 0.039/0.044 - or - (7) 0.034/0.039	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	(NAS 1664-20) Deutsch Co. M-15570-20 - or - ITT Cannon CIET-20	T3009406-5	(MS22520/3-1) Daniels Mfg G125
			22	strand/1	3/16	57 with - or - 59 with - or - T3007339	58 60 60	(3) 0.036/0.041 - or - 0.030/0.035 - or - (6) 0.030/0.035				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			24	strand/1	3/16	57 with - or - 59 with	58 60	(2) 0.032/0.037 - or - (5) 0.026/0.031				
			26	strand/1	3/16	57 with - or - 59 with	58 60	(1) 0.028/0.033 - or - (4) 0.022/0.027				
4024886-4	12	M	14	strand/1	3/16	M15500-12-7	---	---	M15570-12	M15570-12	---	---
			12	strand/1	3/16	M15500-12-7	---	---				
4024886-5	8	M	8	strand/1	3/16	M20399	---	---	M15515-103	M15515-103	---	---
4027009-1 (M39029/17-171) (Color Bands = BRN/VIO/BRN)	28	F	28	strand/1	5/32	3	71	0.016	T3911000-6	T3911000-6	T3009406-5	T3008994
4027009-1 (M29029/17-171) (Color Bands = BRN/VIO/BRN)	23	F	28	strand/1	5/32	22520/2-01	M22520/2-16	---	M81969/16-04	w wire = M81969/16-04 w/o wire = M81969/30-01	---	---
4027009-2 (M39029/17-172) (Color Bands = BRN/VIO/RED)	22	F	22	strand/1	5/32	3 with - or - 4 with - or - 6 with	71 80 80	0.033 - or - 0.033 - or - 0.033	T3911000-6	T3911000-6	T3009406-5	T3008994
			26	strand/1	5/32	3 with - or - 4 with - or - 6 with	71 80 80	0.021 - or - 0.021 - or - 0.021				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			26	solid/2	5/32	3 with - or - 4 with - or - 6 with	71 80 80	0.032 - or - 0.032 - or - 0.032				
			28	solid/1	5/32	3 with - or - 4 with - or - 6 with	71 80 80	0.020 - or - 0.020 - or - 0.020				
			28	solid/2	5/32	3 with - or - 4 with - or - 6 with	71 80 80	0.024 - or - 0.024 - or - 0.024				
			28	strand/1	5/32	3	71	0.016				
			30	solid/1	5/32	3 with - or - 4 with - or - 6 with	71 80 80	0.016 - or - 0.016 - or - 0.016				
UP46426 4027009-3 (M39029/17-173) (Color Bands = BRN/VIO/ORN)	20	F	20	strand/1	5/32	M22520/2-01 - or - M22520/7-01	M22520/2-18 - or - M22520/7-03	----	M81969/16-1	Wired= M81969/16-01 Unwired= M81969/30-02	----	----
4027009-4 (M39029/17-174) (Color Bands = BRN/VIO/YEL)	16	F	16	strand/1	5/32	M22520/2-01 - or - M22520/7-01	M22520/2-18 - or - M22520/7-03	----	M81969/16-2	Wired= M81969/16-02 Unwired= M81969/30-03	----	----
4027009-5 (M39029/17-174) (Color Bands = BRN/VIO/YEL)	12	F	12	strand/1	5/32	M22520/1-01	M22520/1-01	----	M81969/16-03	M81969/16-04	----	----

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4029091-10 (M39029/56-527) (Color Bands = GRN/RED/VIO)	10	F	10	strand/1	1/4	M22520/1-01	M22520/1-01	---	M819678-TBD - or - M81969/14-04	M819678-TBD - or - M81969/14-04	---	---
4029091-12 (M39029/56-353) (Color Bands = ORN/GRN/ORN)	12	F	12	strand/1	1/4	57	58	(8) 0.068/0.073	(MS27495-A16) Astro Tool Co. tweezer type for AWG16 contact	(MS27495-R16) Astro Tool Co. tweezer type for AWG16 contact	T3009406-7	---
			14	strand/1	1/4	57	58	(7) 0.059/0.064				
			16	strand/1	1/4	57	58	(6) 0.052/0.057				
4029091-16 (M39029/56-352) (Color Bands = ORN/GRN/RED)	16	F	16	strand/1	1/4	12	56	(5) 0.052/0.057	(MS27495-A16) Astro Tool Co. tweezer type for AWG16 contact	(MS27495-R16) Astro Tool Co. tweezer type for AWG16 contact	T3009406-7	---
			18	strand/1	1/4	12	56	(6) 0.058/0.065				
			20	strand/1	1/4	12	56	(5) 0.052/0.057				
			24	strand/1	1/4	57	58	(6) 0.052/0.057				
			22	strand/1	1/4 fill*		(blue)					
			24	strand/1	1/4	12	56	(6) 0.052/0.057				
			22	strand/1	1/4 fill*		(blue)					
			24	strand/1	1/4	12	56	(3) 0.022/0.027				
			26	strand/1	1/4 fill*							

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Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4029091-20 (M39029/56-351) (Color Bands = ORN/GRN/BRN)	20	F	20	strand/1	1/4	12	56	(3) 0.036/0.041	(MS27495-A16) Astro Tool Co. tweezer type for AWG16 contact	(MS27495-R16) Astro Tool Co. tweezer type for AWG16 contact	T3009406-7	---
			22	strand/1	1/4	12	56	(3) 0.036/0.041				
			24	strand/1	1/4	12	56 (red)	(2) 0.032/0.037				
			24	strand/2	1/4	57	58 (red)	(2) 0.032/0.037				
4029091-22 (M39029/56-350) (Color Bands = ORN/GRN/BLK)	22	F	10	strand/1	1/4	M22520/2-01 - or - M22520/7-01	M22520/2-01 - or - M22520/7-01	---	M81969/8-03	M81969/8-03	---	---
4029091-221 (M39029/56-349) (Color Bands = ORN/YEL/WHT)	22M	F	22	strand/1	1/4	M22520/2-01 - or - M22520/7-01	M22520/1-07 - or - M22520/7-05	---	M819678-01 - or - M81968/14-01	M819678-02 - or - M81968/14-01	---	---
4029091-222 (M39029/56-348) (Color Bands = ORN/YEL/GRY) UP46426	22D	F	22	strand/1	3/16	59	73	(5) 0.026/0.031	(MS27495--A16) Astro Tool Co. tweezer type for AWG16 contact	(MS27495--R16) Astro Tool Co. tweezer type for AWG16 contact	T3009406-7	---
			24	strand/1	3/16	59	73	(4) 0.022/0.027				
			26	strand/1	3/16	59	73	(4) 0.022/0.027	Bendix Corp 11--8674--20 -- or -- Burndy Corp RTM20--17 -- or -- ITT Cannon CIT--20--KJ-- 070151--0000	Bendix Corp 11--8675--20 -- or -- Burndy Corp RX--17 -- or -- ITT Cannon CIT--20--KJ-- 070152--0000	T3009406--8	---
			26	strand/2	3/16	59	73	(3) 0.019/0.024				
			26 26	solid/1 strand/1	3/16 3/16 fill*	59	73	(3) 0.019/0.024				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4030483-20 Same as 2387050-120 (MS3192A20-20A) and 2503959-1	20	M	28	solid/1	3/16	59	73	(4)				
			26	strand/1	3/16 fill*			0.022/0.027				
			28	solid/1	3/16	59	73	(4)				
			28	strand/1	3/16 fill*			0.022/0.027				
			32	strand/1	3/16	59	73	(4)				
			28	strand/2	3/16 fill*			0.022/0.027				
UP46426			20	strand/1	3/16	12	13	(4) 0.044/0.051	(MS24256A20) Amphenol-Borg 294-88 - or - Coast Air Inc ABT-1067	(MS24256R20) Amphenol-Borg 294-89	T3009406-3	T3008994
			22	strand/1	3/16	12	13	(3) 0.038/0.045				
			24	strand/1	3/16	12	13	(2) 0.032/0.039				
			24	strand/2	3/16	12 with - or - 57 with	13 58	(4) 0.044/0.051 - or - (5) 0.045/0.051				
			24	strand/3	3/16	57	58	(6) 0.052/0.057				
			26	strand/1	3/16	12	13	(3) 0.038/0.045				
			30	solid/1	3/16	12	13	(3)				
4032151-1 Standard Pressure (-11=AUTO TOOL)	--	F	27 to 30	strand/1	5/32	AMP Part No. 90417-1 or 90358-1	---	---	Hand	AMP Part No. 91052-1	---	---
			24	strand/1	5/32	90	With Crimp	(2) (Insulation only)				
4032151-2 Standard Pressure (insulation setting only, on-adj wire crimp) (-12=AUTO TOOL)	--	F	26	strand/1	5/32	90	With Crimp	(2) (Insulation only)	Amp Inc 90418-1	---		

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4032151-3 Standard Pressure (-13=AUTO TOOL)	--	F	20 to 24	strand/1	5/32	AMP Part No. 90202-2 or 90345-1	---	---	Hand	AMP Part No. 91052-1		
4032151-51 Inter Pressure (-61=AUTO TOOL)	--	F	27 to 32	strand/1	5/32							
4032151-52 Inter Pressure (-62=AUTO TOOL)	--	F	20 to 24	strand/1	5/32							
4032151-53 Inter Pressure (-63=AUTO TOOL)	--	F	22 to 26	strand/1	5/32							
4032151-101 High Pressure (-111=AUTO TOOL)	--	F	27 to 32	strand/1	5/32							
4032151-102 High Pressure (112=AUTO TOOL)	--	F	20 to 24	strand/1	5/32							
4032151-103 High Pressure (113=AUTO TOOL)	---	F	22 to 26	strand/1	5/32							
UP46426 XXXXXXX For Connector Part No. 4032580	22D	F	24	strand/1	3/16	3	70	0.026	Deutsch Co. 81515-23	Deutsch Co. 81515-23	---	---
			26	strand/1	3/16	3	70	0.021				
			26	solid/1	3/16	3	70	0.021				
			28	strand/1	3/16	3	70	0.020				
			28 26	solid/1 strand/1	3/16 3/16fill*	3	70	0.026				
4038175	16	M	20	strand/1	1/4	74	---	---	AMP Inc 200893-2	AMP Inc 305183	T3009406-4	N/A
4038176	12	M	26 20	strand/1 strand/1	1/4 1/4 fill*	75	---	---	Hand	AMP Inc 305183-8	T3009406-3	N/A

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4049711-1	22	F	22	---	---	---	---	---	---	---	---	---
			24	---	---	---	---	---	---	---	---	---
			26	---	---	---	---	---	---	---	---	---
4045070-12	12	F	12	strand/1	1/4	57	58	N/A	Hand	T3031542 - or - T3008300-83	T3009406-12	T3008994 --- --- ---
			16	strand/1	1/4	1	32	N/A				
			20	strand/1	1/4	1	32	N/A				
			22	strand/1	1/4	36 with - or - 57 with	37 58	(6) 0.059/0.064 - or - (7) 0.059/0.064				
			24	strand/1	1/4	57	58	(6) 0.052/0.057				
4045070-16 (Color Bands = ORN/BLU) UP46426	16	F	16	strand/1	1/4	57	58	(7) 0.059/0.064	Hand	---	---	---
			20	strand/1	1/4	57	58	(6) 0.052/0.057				
			22	strand/1	1/4	36 with - or - 57 with	37 58	(5) 0.052/0.057 - or - (6) 0.052/0.057				
			22 26	strand/1 strand/1	1/4 1/4 fill*	57	58	(4) 0.039/0.044				
			24 24	strand/1 strand/1	1/4 1/4 fill*	57	58	(6) 0.052/0.057				

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
4045070-20 (Color Bands = ORN/RED)	20	F	20	strand/1	3/16	57	58	(4) 0.039/0.044	---	---	---	---
			22	strand/1	3/16	57	58	(3) 0.036/0.041				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			26	strand/1	3/16	57	58	(1) 0.028/0.033				
4045070-22	20	M	22	strand/1	5/32	59	64	(6) 0.038	---	---	---	---
			26	strand/1	3/16	59	64	(4) 0.022/0.027				
4053139	22	M	22	strand/1	9/64	AMP Part No. 90418-1	N/A	----	Hand	AMP Part No. 90152-1	----	----
			24	strand/1	9/64							
			26	strand/1	9/64							
4069506-1 Barrel same as 2504842-1 or 2504843-1 for crimping UP46426	20	M	20	strand/1	3/16	57	58	(5) 0.045/0.050	(MS24256A20) Amphenol Borg 294-88 -or- Coast Air Inc ATB-1067	(MS24256R20) Amphenol Borg 294-89	T3009406-3	T3008994
			22	strand/1	3/16	57 with - or - ITT Cannon CBT-460	58	(4) 0.039/0.044 - or - (7) 0.059/0.064				
			22	strand/2	3/16	57	58	(3) 0.038/0.041				
			24	strand/1	3/16	57	58	(2) 0.032/0.037				
			24	strand/2	3/16	57	58	(2) 0.032/0.037				
			26	strand/1	3/16	57	58	(3) 0.038/0.041				
			22	strand/1	3/16 fill*							
			26	strand/2	3/16	57	58	(4) 0.039/0.044				
			26	strand/1	3/16 fill*							

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	T y p e	AWG	Type/ Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
			28	strand/2	3/16	2	20	0.035				
			28	strand/2	3/16	57	58	(2) 0.032/0.037				
			28 28	strand/1 strand/1	3/16 3/16 fill*	57	58	(2) 0.032/0.037				
7002730 Same as 1715213-1 and 7002730-3	22/ 24/ 26	F	22	strand/1 solid/1	5/32	T3077444	Dupont HT-208A (hand)	N/A	Hand	---	---	---
			24	strand/1 solid/1	5/32							
			26	strand/1 solid/1	5/32							
7002730-1 Same as 1715213-2 and 7002730-3	22/ 24/ 26	F	22	strand/1 solid/1	5/16	Dupont HT-95 (hand)	---	---	---	---	---	---
			24	strand/1 solid/1	5/16							
			26	strand/1 solid/1	5/16					T3030490		
			28	strand/1	5/32					---		
			30	strand/1	5/32							
			32	strand/1	5/32							
7002730-2 Same as 1715213-1 and 7002730-3	---	M & F	24	strand/1	5/32	85	With Crimp (B2) With Crimp (B2)	N/A	---	T3030490	---	---
			26	strand/1	5/32	85					---	---
7002730-3 Same as 1715213-1 and 7002730-2	---	M & F	22	strand/1	5/32	PE4792	With Crimp	N/A	---	T3030490	---	---
			24	strand/1	5/32							
			26	strand/1	5/32							
7002730-4	---	F	22/ 24/ 26	strand/1	5/32	Dupont HT-25 - or - HT-208	Hand	N/A	---	T3030490	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
7002730-5 Same as 7002730-6	---	F	22	strand/1	---	Dupont HT-25 - or - HT-208	Hand	N/A	---	T3030490	---	---
			24	strand/1	---							
			26	strand/1	---							
7002730-6 Same as 7002730-5	---	F	22	strand/1	5/32	Dupont PV-250 - or - QL-740	Automatic	N/A	---	T3030490	---	---
			24	strand/1	5/32							
			26	strand/1	5/32							
7002730-7	---	F	18/ 20	strand/1	5/32	Dupont HT-25 - or - HT-208	Hand	N/A	---	T3030490	---	---
7002730-8	---	F	18/ 20	strand/1	5/32	Dupont HT-25 - or - HT-208	Hand	N/A	---	T3030490	---	---
7007466-1	---	M	22	strand/1	5/32	Dupont HT-102	Hand	---	Hand	DuPont HT-80	---	---
			24	strand/1	5/32							
			26	strand/1	5/32							
7007466-2	---	M	22	strand/1	5/32	Dupont HT-102	Hand	---	Hand	DuPont HT-80	---	---
			24	strand/1	5/32							
			26	strand/1	5/32							
7007466-3 UP46426	---	M	28	strand/1	5/32	Dupont HT-102	Hand	---	Hand	---	---	---
			30	strand/1	5/32							
			32	strand/1	5/32							
7008004	20	M	14 thru 20	strand/1	5/32	AMP Part No. 90124-2	Hand	---	Hand	---	---	---
7009203-1 Material = ALUMEL (AL)	---	M	22	strand/1	5/32	M22520/2-01	M22520/2-23	---	MS3156-22	MS3156-22	---	---
7009203-2 Material = CHROMEL(CH)	---	M	22	strand/1	5/32	M22520/2-01	M22520/2-23	---	MS3156-22	MS3156-22	---	---
7009314-1	---	F	---	---	---	ELCO	06-78-87-1	---	---	---	---	---

Table 7-19. Connector Contact, Wire, and Crimper/Locator Tooling Information (Cont)

Contact			Wire			Crimper/Locator T3008300-(Dash No. or Alternate Vendor)			Associated Tool Part No.			
Part No.	AWG	Type	AWG	Type/Quantity	Strip Length (in.) (Notes)	Crimper Dash No.	Locator Dash No.	(Setting No.) Dimensions (in.)	Insertion	Removal	Seating Inspection	Crimp Depth Gage
7017632-1		F	18	strand/1	1/4	57	58	(5) 0.045/0.050	---	---	---	---
7018408 CAUTION: METALLIC EXTRACTION TOOL MUST BE AS SPECIFIED, METALLIC TOOLS WILL NOT EXPAND TO FIT OVER CRIMP PORTION OF CONTACT BECAUSE CONTACT IS LARGER IN DIAMETER THAN STD SIZE 22 CONTACT.	22	M	20	strand/1	5/32	M22520/2-01	M22520/2-23	---	Hand	M81969/14-01	---	---
			22	strand/1	5/32							
			24	strand/1	5/32							
			26	strand/1	5/32							

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Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
NOTES for Table 7-20						
1	The Honeywell Part No. column under the Lug/Pin/Stud/Socket/Terminal heading lists the part number and notes relating to the part number.					
2	The Description column is used to name the part number.					
3	The Contact Gender column indicates whether the part number is female (F) or male (M).					
4	The Significant Details/Size/No. column is used to describe the mounting hole size of a lug, panel, or board thickness, physical relationship, and other relative information about the mating of the part number.					
5	The Installation, Location, or Other column lists the installation tool, installation equipment, describes the size of attaching hardware, and contains appropriate installation notes.					
6	The Removal, Extraction, or Other column lists the removal tool, extraction tool, or action required.					

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Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
7003047-2	Electrical Contact (P.W.B.)	M/M	Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.549 in. Tip of Pin Below Bottom Surface of Board = 0.310 in.	---	ELCO Part No. 06-7741-01	Arbor Press Punch and Anvil
7003047-3			Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.698 in. Tip of Pin Below Bottom Surface of Board = 0.317 in.			
7003047-4			Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.423 in. Tip of Pin Below Bottom Surface of Board = 0.057 in.			
7003047-5			Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.320 in. Tip of Pin Below Bottom Surface of Board = 0.316 in.			
7003047-6			Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.250 in. Tip of Pin Below Bottom Surface of Board = 0.316 in.			
7003047-7			Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.386 in. Tip of Pin Below Bottom Surface of Board = 0.057 in.			
632523-10	Fanged Spade Lug NOTE: Replace with ring tongue lugs whenever possible.	F	Stud Hole Dia. = 0.191 in.	16/14	AMP No. 49513 ETC No. RTH-4150	Cut From End of Wire
632523-11	Ring Tongue Lug	F	Stud Hole Dia. = 0.110 in.	26/22	AMP No. 48070-1	Cut From End of Wire

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
632523-12			Stud Hole Dia. = 0.110 in.	22/16	AMP No. 49512 ETC No. RHT-4050	
632523-13			Stud Hole Dia. = 0.110 in.	16/14	AMP No. 49513 ETC No. RTH-4150	
632523-14			Stud Hole Dia. = 0.138 in.	26/22	AMP No. 48070	
632523-15			Stud Hole Dia. = 0.138 in.	22/16	AMP No. 49512	
632523-17			Stud Hole Dia. = 0.138 in.	12/10	AMP No. 59054 ECT No. RHT-4200	
632523-21			Stud Hole Dia. = 0.164 in.	12/10		
632523-25			Stud Hole Dia. = 0.190 in.	12/10		
632523-33	Fanged Spade Lug	F	Stud Hole Dia. = 0.086 in.	26/22	AMP No. 49512	Cut From End of Wire
632523-34	NOTE: Replace with ring tongue lugs whenever possible.		Stud Hole Dia. = 0.086 in.	22/18		
632523-56	Ring Tongue Lug	F	Stud Hole Dia. = 0.086 in.	26/22	AMP No. 48070-1	Cut From End of Wire
			Stud Hole Dia. = 0.164 in.	22/16	AMP No. 49512 ECT No. RHT-4050	
			Stud Hole Dia. = 0.190 in.	22/16		
			Stud Hole Dia. = 0.138 in.	22/16		
			Stud Hole Dia. = 0.110 in.	22/16		
839118	Insulated Terminal Stud	M	---	---	4-40 UNC-2B X 0.156 in. Min. Screw	Remove Screw
839118-2						
847509-4	Stud-Turret Terminal	M	Panel Thickness = 1/16 in.	---	Arbor Press Punch and Anvil, Hand Punch	Drill, Hand Punch
847509-5			Panel Thickness = 3/32 in.	---		
847509-6			Panel Thickness = 1/32 in.	---		
872053-1	Insulated Terminal Stud	M	Panel Thickness = 0.050 in.	---	Arbor Press Punch and Anvil	Hand Punch
872053-2		M	Panel Thickness = 0.050 in.	---		
872053-3		M	Panel Thickness = 0.050 in.	---		
872053-4		M	Panel Thickness = 0.050 in.	---		
872053-5		M	Panel Thickness = 0.050 in.	---		
872053-6		M	Panel Thickness = 0.050 in.	---		
872053-9		M	Panel Thickness = 0.050 in.	---		
872053-10		M	Panel Thickness = 0.050 in.	---		
872053-11		M	Panel Thickness = 0.050 in.	---		
872053-12		M	Panel Thickness = 0.050 in.	20/18		

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
938321-8	Insulation Support Terminal	F	Mating Lug Size = 0.020 X 0.187 in., (HPN 942970-23, -50, -56)	24/20	Ratchet Type Crimping Tool	Cut From End of Wire
938321-13		F	Mating Lug Size = 0.020 X 0.187 in., (HPN 942970-23, -50, -56)	20/18 or 24/20	Ratchet Type Crimping Tool	Cut From End of Wire
942970-23	Terminal Lug (90°)	M	Mating Lug Size = 0.058 X 0.220 in., (HPN 938321-8, -13	20/18 or 24/20		
942970-50			Mating Lug Size = 0.058 X 0.220 in., (HPN 938321-8, -13	20/18 or 24/20		
942970-56			Mating Lug Size = 0.058 X 0.220 in., (HPN 938321-8, -13	20/18 or 24/20		
1712987-3	P.C. [Board (P.W.B.)] Connector Pin	M	Board Thickness = 0.060 in. Mounting Hole Dia. = 0.034 in. Pin Above Board = 0.433 in. Pin Below Board = 0.045 in.	---	Soldering Iron, Arbor Press Punch and Anvil	Soldering Iron, Arbor Press Punch and Anvil
1712987-4			Board Thickness = 0.060 in. Mounting Hole Dia. = 0.032 in. Pin Above Board = 0.640 in. Pin Below Board = 0.045 in.			
1712987-5			Board Thickness = 0.060 in. Mounting Hole Dia. = 0.032 in. Pin Above Board = 0.750 in. Pin Below Board = 0.045 in.			
1712987-6			Board Thickness = 0.060 in. Mounting Hole Dia = 0.032 in. Pin Above Board = 0.270 in. Pin Below Board = 0.045 in.			
1712987-7			Board Thickness = 0.060 in. Mounting Hole Dia. = 0.032 in. Pin Above Board = 0.470 in. Pin Below Board = 0.355 in.			

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
1712987-8			Board Thickness = 0.060 in. Mounting Hole Dia. = 0.032 in. Pin Above Board = 0.515 in. Below Board = 0.381 in.			
1712987-9			Board Thickness = 0.060 in. Mounting Hole Dia. = 0.032 in. Pin Above Board = 0.520 in. Pin Below Board = 0.045 in.			
1712987-10			Board Thickness = 0.060 in. Mounting Hole Dia. = 0.032 in. Pin Above Board = 0.235 in. Pin Below Board = 0.045 in.			
1751197-1	Tip Jack (White)	M/F	Mounting Hole Dia. = 0.172 in. With 0.195 in. by 60° Csk	----	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
1751197-2	Tip Jack (Red)					
1751197-3	Tip Jack (Blue)					
1751197-4	Tip Jack (Yellow)					
1751197-5	Tip Jack (Green)					
1751197-6	Tip Jack (Brown)					
1751197-7	Tip Jack (Gray)					
1751197-8	Tip Jack (Orange)					
1751197-9	Tip Jack (Black)					
1751197-10	Tip Jack (Violet)					
UP464261751856-1	Tip Jack (White)	M/F	Max. Panel Thickness = 0.130 in. Mounting Hole Dia. = 0.172 in. With 0.195 in. by 60° Csk	----	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
1751856-2	Tip Jack (Red)					
1751856-3	Tip Jack (Blue)					
1751856-4	Tip Jack (Black)					
1751856-5	Tip Jack (Green)					
1751856-6	Tip Jack (Yellow)					
751856-7	Tip Jack (Orange)					
751856-8	Tip Jack (Gray)					
751856-9	Tip Jack (Brown)					
751856-10	Tip Jack (Violet)					

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
1752361-1	Sub-Miniature Insulated Feed-Thru Terminal (Violet)	M	Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.130 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
1752361-2	Sub-Miniature Insulated Feed-Thru Terminal (Yellow)					
1752361-3	Sub-Miniature Insulated Feed-Thru Terminal (Red)					
1752361-4	Sub-Miniature Insulated Feed-Thru Terminal (Blue)					
1752806-1	Insulated Feed-Thru Terminal	M	Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.075 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
1752806-2			Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.100 in.			
1752806-3			Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.100 in.			
1752806-7			Mounting Hole Dia. = 0.148 in. Panel Thickness = 250 in.			
1752806-8			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.			
UP46426 1752806-9			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.			
1752806-10			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.110 in.			
1752806-11			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.110 in.			
1752806-12			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.120 in.			
1752806-13			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.132 in.			
1752806-14			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.160 in.			

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
1752806-15			Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.			
1752806-19			Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.105 in.			
1752806-20	Insulated Feed-Thru Terminal	M	Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.160 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
1753802	Insulated Feed-Thru Terminal	M	Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
2503188	Terminal Stud	M/F	---	---	2-56 UNC-2B X 0.156 in. Screw	Remove Screw
2503222	Feed-Thru Terminal Pin	M	Mounting Hole = 0.040 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvi
2503521-1	Insulated Terminal Stud (White)	M	Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
2503521-2	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.132 in.			
2503521-3	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.089 in.			
2503521-4	Insulated Terminal Stud		Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.100 in.			
2503521-8	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.250 in.			
2503521-9	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.			
2503521-10	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.			
2503521-12	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.132 in.			
2503521-13	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.125 in.			
2503521-15	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.100 in.			
2503521-16	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.090 in.			
2503521-17	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.165 in.			

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
2503521-18	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.090 in.			
2503521-19	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.093 in. Panel Thickness = 0.105 in.			
2503521-20	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.165 in.			
2503521-21	Insulated Terminal Stud (White)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.			
2503521-22	Insulated Terminal Stud (Black)		Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.125 in.			
2503543-1	Insulated Feed-Thru Terminal	M/M	Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.110 in.	----	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
2503543-2	Insulated Feed-Thru Terminal		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.100 in.			
2503543-3	Insulated Feed-Thru Terminal		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.100 in.			
2503543-4	Insulated Feed-Thru Terminal		Mounting Hole Dia. = 0.125 in. Panel Thickness = 0.165 in.			
2504561-1	Insulated Terminal Stud (Black)	M	Mounting Hole Dia. = 0.148 in. Panel Thickness = 0.100 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
2504561-2	Insulated Terminal Stud (Brown)					
2504561-3	Insulated Terminal Stud (Red)					
2504561-4	Insulated Terminal Stud (Orange)					
2504561-5	Insulated Terminal Stud (Yellow)					
2504561-6	Insulated Terminal Stud (Green)					
2504561-7	Insulated Terminal Stud (Blue)					
2504561-8	Insulated Terminal Stud (Violet)					

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
2504561-9	Insulated Terminal Stud (Gray)					
2504561-10	Insulated Terminal Stud [(White), Natural Teflon]					
2504814-1	Stud Terminal	M	Mounting Hole Dia. = 0.040 in. Panel Thickness = 1/32 in.	---	Arbor Press Punch and Anvil, Hand Punch	Drill, Hand Punch
2504814-2			Mounting Hole Dia. = 0.040 in. Panel Thickness = 1/16 in.			
2504814-3			Mounting Hole Dia. = 0.040 in. Panel Thickness = 3/32 in.			
2504814-4			Mounting Hole Dia. = 0.040 in. Panel Thickness = 1/32 in.			
2504814-5			Mounting Hole Dia. = 0.040 in. Panel Thickness = 1/16 in.			
2504814-6			Mounting Hole Dia. = 0.040 in. Panel Thickness = 3/32 in.			
2504814-8			Mounting Hole Dia. = 0.058 in. Panel Thickness = 1/32 in.			
2504814-9			Mounting Hole Dia. = 0.058 in. Panel Thickness = 1/16 in.			
2504814-10			Mounting Hole Dia. = 0.058 in. Panel Thickness = 3/32 in.			
UP46426 2504814-13			Mounting Hole Dia. = 0.058 in. Panel Thickness = 1/16 in.			
2504814-14			Mounting Hole Dia. = 0.058 in. Panel Thickness = 1/16 in.			
2504814-16			Mounting Hole Dia. = 0.040 in. Panel Thickness = 1/16 in.			
2504814-20			Mounting Hole Dia. = 0.040 in. Panel Thickness = 1/8 in.		Ratchet Type Crimping Tool	

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
3200648-2	Pre-Insulated Ring Tongue Solderless Terminal-Lug (Yellow)	F	Stud Hole Size = 0.093 in.; No. 2 Bolt	26/22	Ratchet Type Crimping Tool	Cut From End of Wire
3200648-3	Pre-Insulated Ring Tongue Solderless Terminal-Lug (Yellow)		Stud Hole Size = 0.118 in.; No. 4 Bolt	26/22		
3200648-4	Pre-Insulated Ring Tongue Solderless Terminal-Lug (Yellow)		Stud Hole Size = 0.145 in.; No. 6 Bolt	26/22		
3200648-11	Pre-Insulated Ring Tongue Solderless Terminal-Lug (Red)		Stud Hole Size = 0.093 in.; No. 2 Bolt	22/18		
3200648-13	Pre-Insulated Ring Tongue Solderless Terminal-Lug (Red)		Stud Hole Size = 0.145 in.; No. 6 Bolt	22/18		
3718866-1	Push-On Tab Terminal	M	Mating Lug Size = 0.187 X 0.020 in.	22/18	Ratchet Type Crimping Tool	Cut From End of Wire
3718866-2		F	Mating Lug Size = 0.187 X 0.020 in.	20/16		
3718866-3			Mating Lug Size = 0.250 X 0.032 in.	14/18		
3718866-4			Mating Lug Size = 0.250 X 0.032 in.	18/14		
3718866-5			Mating Lug Size = 0.110 X 0.020 in.	24/22		
3718866-6			Mating Lug Size = 0.110 X 0.020 in.	22/18		
3718867-1	Quick Disconnect Terminal	M	Mounting Hole Dia. = 0.052 in.	---	Arbor Press Punch and Anvil	Pliers
3718867-2		F	Mating Tab Size = 0.196 x 0.020 in.	---	Ratchet Type Crimping Tool	Cut From End of Wire
3718867-3		M	Mounting Hole Dia. = 0.052 in.	---	Arbor Press Punch and Anvil	Pliers
3718867-4						
3718940-1	Lug Terminal	F	Mounting Hole Dia. = 0.044 in.	---	Arbor Press Punch and Anvil	Pliers

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
4001727-1	Tip Jack (White)	M/F	Max. Panel Thickness = 0.050 in. Mounting Hole Dia. = 0.107 in. With 0.131 in. by 60° Csk	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
4001894-102	Ring Tongue Terminal Lug	F	Stud Hole Size = 0.865 in.; No. 6 Bolt	22/18	Ratchet Type Crimping Tool	Cut From End of Wire
4001894-103			Stud Hole Size = 0.910 in.; No. 10 Bolt	22/18		
4001894-145			Stud Hole Size = 0.855 in.; No. 6 Bolt	26/24		
4001894-147			Stud Hole Size = 0.855 in.; No. 10 Bolt	26/24		
4001894-148			Stud Hole Size = 0.755 in.; No. 4 Bolt	22/18		
4001894-149			Stud Hole Size = 0.910 in.; No. 8 Bolt	22/18		
4001894-152			Stud Hole Size = 0.774 in.; No. 4 Bolt	16/14		
4001894-153			Stud Hole Size = 0.910 in.; No. 8 Bolt	16/14		
4001894-156			Stud Hole Size = 1.120 in.; No. 8 Bolt	12/10		
UP46426 4005526-11	White Insulated Electrical Contact (One Wire)	F	Mounting Hole Dia. = 0.0725 in. P.W.B. Thickness = 0.080 in. Hole Pattern = 0.100 in. Grid NOTE: The female insulator must be seated firmly before contact is installed.	30	Arbor Press Punch and Anvil NOTE: To ensure proper seating, boil insulators in distilled water for approximately 20 minutes. After dry, install.	Arbor Press Punch and Anvil
4005526-12	White Insulated Electrical Contact (One Wire)	F	Mounting Hole Dia. = 0.0725 in. P.W.B. Thickness = 0.080 in. Hole Pattern = 0.100 in. Grid NOTE: The female insulator must be seated firmly before contact is installed.	30	Arbor Press Punch and Anvil NOTE: To ensure proper seating, boil insulators in distilled water for approximately 20 minutes. After dry, install.	Arbor Press Punch and Anvil
4005526-13	Red Insulated ElectricalContact (One Wire)					

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
4005526-21	White Insulated Electrical Contact (One Wire)					
4005526-22	Black Insulated Electrical Contact (One Wire)					
4005526-23	Red Insulated ElectricalContact (One Wire)					
4005526-31	White Insulated Electrical Contact (One Wire)					
4005526-32	Black Insulated Electrical Contact (One Wire)					
4005526-33	Red Insulated Electrical Contact (One Wire)					
4005526-61	White Insulated Electrical Contact					
4005526-62	Black Insulated Electrical Contact					
UP46426 4005526-63	Red Insulated Electrical Contact					
4012667-1 (MIL P/N SE12X001)	Non-Insulated Stud Terminal	M	Max. Panel Thickness = 0.062 in. Mounting Hole Dia. = 0.072 in.	---	Arbor Press Punch and Anvil, Hand Punch	Drill, Hand Punch
4012667-2 (MIL P/N SE12X002)			Max. Panel Thickness = 0.094 in. Mounting Hole Dia. = 0.072 in.			
4012667-4 (MIL P/N SE12X002)			Max. Panel Thickness = 0.062 in. Mounting Hole Dia. = 0.090 in.			
4012667-5 (MIL P/N SE12X005)			Max. Panel Thickness = 0.094 in. Mounting Hole Dia. = 0.090 in.			
4012667-7 (MIL P/N SE12X007)			Max. Panel Thickness = 0.112 in. Mounting Hole Dia. = 0.072 in.			

Table 7-20. Terminal Lug, Pin, Stud, Socket Installation/Removal Information (Cont)

Lug/Pin/Stud/Socket/Terminal					Tooling	
Honeywell Part No.	Description	Contact Gender	Significant Details/Size/No.	AWG	Installation, Location, or Other	Removal, Extraction, or Other
4012667-8 (MIL P/N SE12X008)			Max. Panel Thickness = 0.112 in. Mounting Hole Dia. = 0.072 in.			
4012667-12 (MIL P/N SE12X008)			Max. Panel Thickness = 0.047 in. Mounting Hole Dia. = 0.112 in.			
4012667-13 (MIL P/N SE12X0013)			Max. Panel Thickness = 0.125 in. Mounting Hole Dia. = 0.090 in.			
4048113-3	Solderless Wrap Lead Socket	M/F	Max. Panel Thickness = 0.046 in. Mounting Hole Dia. = 0.055 in. Socket Will Accept 0.019 and 0.150 in. Dia. Wire	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
7007472-8	Electrical Contact (P.W.B.)	M/M	Mounting Hole Dia. = 0.033 in. Tip of Pin Above Bottom Surface of Board = 0.315 in. Tip of Pin Below Bottom Surface of Board = 0.210 in.	---	ELCO Part No. 06-7741-01	Arbor Press Punch and Anvil
7007472-9	Un-Insulated Ring Tongue Solderless Terminal	M/M	Stud Hole Size = 0.093 in.	---	AMP No. 49935	Cut From End of Wire
7007472-11			Stud Hole Size = 0.145 in.			
7008205-1	Un-Insulated Terminal	M/F	Mounting Hole Dia. = 0.055 in. P.W.B. Thickness = 0.062 in.	---	Arbor Press Punch and Anvil	Arbor Press Punch and Anvil
7008205-2						
7008205-3						
7008205-4						
JP46426 7017563-2	Un-Insulated P.W.B. Pin	M	Mounting Hole = 0.035 in. P.W.B. Thickness = 0.062 in.	---	Arbor Press Punch and Anvil, Hand Punch	Arbor Press Punch and Anvil
7500033-1	Test Point Terminal	F	Mounting Hole = 0.053 in. P.W.B. Thickness = 0.150 in.	---	Arbor Press Punch and Anvil	Pliers
8982998-2	Terminal Lug	---	---	---	AMP Part No. 9275	---



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SECTION 8 – COATING PREPARATION AND APPLICATION

1. Overview

A. General

(1) This section gives data on the preparation and application of coatings (paints).

B. Equipment and Materials

(1) Refer to Table 8-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

(2) Refer to Table 8-2 for materials.

(3) Equivalent alternatives are permitted for equipment and materials.

Table 8-1. Equipment for Coating Preparation and Application

Item	Description	Source
Spray gun	Pot pressure of 8 to 10 psi, atomization pressure of 15 to 50 psi — Model MBC, E tip and needle, air cap No. 765	CAGE: 3D332
Oven	Adjustable to 250 ± 10 °F (120 ± 5.5 °C)	Commercially available
Compressed air	Low pressure, 20 psi	Commercially available

Table 8-2. Materials for Coating Preparation and Application

Item	Description	Source
Sponge		Commercially available
Spray bottle		Commercially available
Sand paper	80 and 360 grit	Commercially available
110C878	Sherwin Williams, CATALYST V66V29, PER SPEC P4061999-4	Commercially available
110C978	Reducer, polyurethane — No. R7K84	Commercially available
1112378	Solvent, toluene, technical grade per A-A-59107 (certified to contain 1 percent or less benzene)	Commercially available

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Table 8-2. Materials for Coating Preparation and Application (Cont)

Item	Description	Source
11P0778	Methyl Isobutyl Keton, 99% MIBK, 0.10% water maximum (ASTM D1153)	Commercially available
91P0478	Coating, conversion, chemical for aluminum or aluminum alloys (MIL-C-81706; Class 3 - protection against corrosion where low electrical resistance is required; form II - powder; methods A, B, or C - spray, brush, or immersion)	Commercially available
9460078	Primer, coating, epoxy, low VOC (MIL-P-23377, Type I, Class 2)	Commercially available
94XXX78	Coating, Polane 2.8TPLUS polyurethane - various	Commercially available
Sand-blasting	Sand-blasting machine	Commercially available

2. Procedure

WARNING: MAKE SURE YOU HAVE SUFFICIENT VENTILATION FOR PROTECTION AGAINST FUMES AND VAPORS.

WARNING: USE HAND CREAM AND GOGGLES OR A FACE MASK FOR PROTECTION FROM THE COATING. IT CAN CAUSE DAMAGE TO YOUR SKIN AND EYES.

CAUTION: DO NOT MIX PRIMER OR COATING COMPONENTS FROM DIFFERENT VENDORS OR SUPPLIERS.

CAUTION: DO NOT PUT FRESH COATED SURFACES IN AIRTIGHT AREAS UNTIL THE COATING IS DRY.

A. General Warnings and Cautions About Coating Preparation and Application Procedure

- (1) The warnings and cautions that precede this paragraph apply to all procedures in this section.

B. Preparation of the Surface for Coating

- (1) Remove all the dents and deformations on the surface to be coated.

CAUTION: ALWAYS SAND PARALLEL TO THE AXIS OF THE PART. IF YOU SAND LATERAL TO THE AXIS OF THE PART, IT CAUSES DAMAGE TO THE FINISH.

- (2) Sand with 180-grit paper, or sand-blast per SIL-0576 the area first, and finish with a 360-grit paper.

C. Application of Conversion Coating

- (1) Use this procedure only if necessary.
- (a) Clean the area to be conversion coated with a clean cloth moist with solvent.

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- (b) Rinse the area with water. The water will bead if the area is sufficiently clean.
- (c) Apply a thin coat of the premixed conversion coating (91P0478) to the wet surface with a wet sponge or spray.
- (d) Continue to apply thin coats until you get a result of a light gold to tan color.
- (e) Rinse the area with water to stop the chemical reaction.

CAUTION: DO NOT TOUCH, PAINT, OR LET THE COATED AREA GET TO A TEMPERATURE OF MORE THAN 140 °F (60 °C) WHILE IT CURES. THE COATED AREA IS SOFT AND CAN BE EASILY DAMAGED.

- (f) Dry the area with a clean cloth or an air blast and let it cure at room temperature before you continue.

D. Preparation and Application of Polyurethane Primer Coating

- (1) Fully mix the individual components A and B in their individual containers.
- (2) Mix a 1:1 ratio by volume of component A and B as follows:
 - (a) Slowly mix the container that contains one part of component A at the same time you add one part of component B.
 - (b) Mix fully.

NOTE: The pot life of the mixed primer is 8 hours.

- (3) Make the mixed primer more liquid by mixing a 1.5:2 ratio by volume of toluene thinner (1135778) to the mixed primer as follows:

NOTE: A mixture of equal parts, by weight, of toluene (1112378) and methyl isobutyl ketone (11P0778) can be used as an alternative to toluene thinner.

- (a) Mix 1.5 parts by volume of thinner to two parts of mixed primer.
- (b) Mix fully.
- (4) Apply a thin layer (0.03 ±0.006 inch (0.75 ±0.15 mm) when dry) of the prepared primer.
- (5) Let the primer air dry for a minimum of 1 hour and a maximum of 4 hours before you apply the top coat.

E. Preparation of Polyurethane Base Coating

- (1) Fully mix the base (94xxx78) and the catalyst (110C878) in their individual containers.

CAUTION: ALWAYS ADD THE CATALYST TO THE BASE RESIN. NEVER ADD THE BASE RESIN TO THE CATALYST BECAUSE IT CAN CAUSE THE COATING TO DRY TOO FAST AND PRODUCE LUMPS IN THE COATING.

CAUTION: THE MIXTURE RATIO MUST BE ±2 PERCENT.

- (2) Mix a 6:1 ratio by volume of base to catalyst as follows:
 - (a) Stir the container that contains the six parts base at the same time you slowly add one part catalyst.

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- (b) Make sure you mix this fully.

NOTE: The pot life of the mixed coating is 6 hours maximum when catalyzed and reduced to 4 hours maximum when catalyzed for textured finish.

- (3) Make a reduced mixture for first coat application as follows:

- (a) Mix three parts of mixed coating, by volume, to one part reducer (110C978).

- (b) Make sure you mix this fully.

NOTE: The ratio for the reduced mixture can be varied to achieve spraying viscosity to match applicable color chip.

F. Application of Polyurethane Base Coating to Large Areas

- (1) For a smooth top coating, do as follows:

- (a) Do the procedures in paragraphs B. thru E. as necessary, to prepare the surface and the coating.
- (b) Use a spray gun and pot pressure of 8 to 10 psi (55.2 to 69.0 kPa) to apply the paint.
- (c) Set the atomization pressure of 40 to 50 psi (275.8 to 344.7 kPa).
- (d) Apply a reduced mixture first coat.
- (e) Apply a second, unreduced, wet coat. Make sure the total thickness is (0.06 ±0.012 inch (2.0 ±0.3 mm) when dry.

- (2) For a textured top coating, do as follows:

- (a) Do the procedures in paragraphs B. thru E. as necessary, to prepare the surface and the coating.
- (b) Use a spray gun and pot pressure of 8 to 10 psi (55.2 to 69.0 kPa) to apply the paint.
- (c) Set the atomization pressure of 15 to 25 psi (103.4 to 172.4 kPa).
- (d) Apply one wet coat for a total dry film thickness of 0.04 ±0.008 inch (1.0 ±0.2 mm).

NOTE: Only reduce first coat mixture for texture coating if necessary.

- (e) Apply the textured coat (clear, 94A2678 or 94A2778) for a total finish thickness of 0.14 inch (3.6 mm).

G. Cure Time of Polyurethane Top Coating

- (1) To air dry 77°F (25°C), 50% relative humidity) the top coating, do as follows:

- (a) Apply the first coat and let it air dry 20 to 30 minutes to flash-off.
- (b) If necessary, air dry the second coat as specified in Table 8-3.

Table 8-3. Top Coating Air-Dry Time

Requirement	Time (minimum)
To touch	45 minutes

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Table 8-3. Top Coating Air-Dry Time (Cont)

Requirement	Time (minimum)
To handle	2 hours
To package	Overnight
Ultimate hardness	7 days
NOTE: The time stated is in addition to the first coat drying time.	

- (2) To bake dry a smooth top coating, do as follows:
- (a) Let each coat flash-off for 15 minutes before you apply the next coat.
 - (b) After you apply the final coat, bake dry as specified in Table 8-4.

Table 8-4. Smooth Top Coating Bake-Dry Time

Temperature	Time (minimum)
130°F (50°C)	40 minutes
185°F (85°C)	30 minutes
250°F (121°C)	15 minutes
NOTE: The time stated is in addition to the first coat drying time.	

- (3) To bake dry a textured top coating, do as follows:
- (a) Bake dry the first coat as specified in Table 8-5.
 - (b) After you bake the first coat, apply a clear textured coat.

Table 8-5. Textured Top Coating Bake-Dry Time

Temperature	Time (minimum)
130°F (50°C)	10 minutes
185°F (85°C)	5 minutes
250°F (121°C)	5 minutes

H. Application of Polyurethane Top Coating to Small Areas (Touch Up)

- (1) For a smooth top coating, do as follows:
- (a) Do the procedures in paragraphs B. thru E. as necessary, to prepare the surface and the coating.
 - (b) Apply the coating with a soft-bristled brush.
 - (c) To air dry, let the coated surface set for 1 hour at 77°F (25°C), 50% relative humidity to get a tack-free finish, or overnight for a complete cure.
 - (d) To bake dry the coated surface, heat for 15 minutes at 150°F (65°C).

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- (2) For a textured top coating, do as follows:
- (a) Do the procedures in paragraphs B. thru E., as necessary, to prepare the surface and the coating.
 - (b) Apply the first coat with a soft-bristled brush.
 - (c) Apply a clear coat of polyurethane (clear, 94A2678 or 94A2778) over the first coat.
 - (d) To air dry, let the coated surface set for 1 hour at 77°F (25°C), 50% relative humidity to get a tack-free finish, or overnight for a complete cure.
 - (e) To bake dry the coated surface, heat for 15 minutes at 150°F (65°C).

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SECTION 9 – MIXING ADHESIVES, SEALANTS, AND COMPOUNDS

1. Overview

A. General

- (1) This section gives data to mix adhesives, sealants, and compounds in quantities other than what is initially specified by the manufacturer.

B. Equipment and Materials

- (1) No equipment is necessary.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 9-1 for materials.
(3) Equivalent alternatives are permitted for equipment and materials.

Table 9-1. Materials Necessary to Mix and Cure

Item	Description	Source
9702478	Adhesive- sealant, thixotropic, highly filled, two part — LCA- 1	Commercially available
9702578	Adhesive, silver filled epoxy — ECCOBOND 56- C (kit containing one jar of Eccobond, one tube of catalyst No. 9 and one tube catalyst No. 11)	Commercially available
9702678	Adhesive, epoxy — Resiweld FE- 7002	Commercially available
9702878 NOTE 3.	Adhesive, epoxy (Federal Specification MMM- A- 134, Type I) — A- 1177B (two parts)	Commercially available
970P378	Adhesive, epoxy, semiflexible, two-part — Isochembond 303 IMP, Part A and B	Commercially available
9711778	Adhesive, high viscosity, mineral filled, two- part — LCA- 4/BA- 9	Commercially available

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Table 9-1. Materials Necessary to Mix and Cure (Cont)

Item	Description	Source
9712478	Sealant, fungus resistant, nonnutrient, room temperature curing, thixotropic, polysulfide liquid polymer compound, contains soluble cromate, two component (MIL- S- 8802, Class B- 2 - sealing material suitable for application by extrusion gun and spatula, application time of two hours minimum, Type I - 90 percent nonvolatile content by weight) — PR- 1422	Commercially available
971P478	Compound, rubber, silicone, RTV, high strength, high elongation, tear resistant, two- part — RTV- 700 (WHT- ivory), Beta 1 catalyst (BLU- GRN)	Commercially available
971P578	Compound, rubber, silicone, RTV, high strength, high elongation, tear resistant, two- part — RTV- 700 (WHT- ivory), Beta 2 catalyst (RED)	Commercially available
971P678	Compound, rubber, silicone, RTV, high strength, high elongation, tear resistant, two- part — RTV- 700 (WHT- ivory), Beta 4 catalyst (BLU- GRN)	Commercially available
971P778	Compound, rubber, silicone, RTV, high strength, high elongation, tear resistant, two- part — RTV- 700 (WHT- ivory), Beta 5 catalyst (RED)	Commercially available
9720778	NOTICE: NO LONGER MANUFACTURED OR SUPPLIED AFTER JANUARY 1, 1994. NO REPLACEMENT IS DESIGNATED.	
9722878	Sealing compound, temperature-resistant, high- adhesion, two component, polysulfide synthetic rubber (MIL- S- 8802, Type I - dichromate cured sealing materials, Class B1/2 - spreadable) — PR- 1422 (base and accelerator)	Commercially available
97A0778	Epoxy, rigid, BLK (MMM- A- 134, Type I, modified to BLK)	Commercially available
97A2078	Adhesive- sealant, epoxy, two- part, 100 percent solid filled, optically CLEAR, NATURAL color — Epoxy- Patch, General Purpose No. 0151 Kit	CAGE: 12405

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Table 9-1. Materials Necessary to Mix and Cure (Cont)

Item	Description	Source
97A3278	Adhesive, heat conductive, electrically insulating — ECCOBOND 285 with catalyst No. 9	Commercially available
97A3378	Adhesive, instant drying [modified ethyl cyanoacrylate (CA)] — Loctite No. 410	Commercially available
97C0178	Adhesive, epoxy, silver filled, thixotropic paste — EPC- TEX H20E	Commercially available
97C3778	Adhesive, paste, two-part, A-1273-B per MMM-A-132, Type I, class 3, form P, group 1. Hysol EA 9394 and Megabond 6388-3	Commercially available
97D0378	Sealing compound, polysulfide rubber (MIL- S- 83430, class B- 1/2) — PRC 1750, Class B	Commercially available
97D0678	Adhesive, epoxy, semirigid, black — Eccobond 45, Black	Commercially available
97D0878	Retaining compound — Loctite Assure No. 425 surface curing threadlocker	Commercially available
97D1478	Adhesive, epoxy, thixotropic, silver-filled — Epo- Tek H20E	Commercially available
97G1178	Adhesive, epoxy, high- viscosity, putty- like, two- part — EA 921 NA	Commercially available
97G2578	Adhesive, epoxy, unfilled, CLEAR, variable flexibility (rigid, semirigid, flexible) — Eccobond 45 (CLEAR) catalyst No. 15	Commercially available
97G2678	Adhesive, epoxy, filled, black, variable flexibility (rigid, semirigid, flexible) — Eccobond 45, Black, catalyst No. 15	Commercially available
97G2778	Adhesive, epoxy, amber, unfilled, electric wire impregnation compound, kit form — Sterling E- 203- 25 (- 25 = catalyst) Thermopoxy Compound kit [formerly Sterling U- 500/25 (/25 = catalyst No. 25)]	Reichhold Chemicals Inc, Sterling Div, Sewickly, PA
97P0578	Adhesive- sealant, epoxy- patch kit — No. 1- C epoxy kit	Commercially available

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Table 9-1. Materials Necessary to Mix and Cure (Cont)

Item	Description	Source
97P0678	Adhesive- sealant, epoxy- patch kit, 100 percent solid filled, contact pressure mating — Epoxy Patch Kit No. 3X	Commercially available
97P4478	Adhesive, epoxy, mineral filled — LCA-4LV/BA-5	Commercially available
97P5078	Adhesive, inert partial- epoxy, silver-coated — No. 72- 00002	CAGE: 07700
97P5178	Adhesive, cement, optical, epoxy (MIL- A- 3920) — HE- 80 (base resin and catalyst) optical cement	Commercially available
97P5678	Adhesive, epoxy — Epoweld 8173 DOUBLE/BUBBLE	Commercially available
97P5878	Adhesive, epoxy, Skydrol 500A hydraulic fluid resistant — C- 1 Epoxy resin and Activator A.	Commercially available
97P6278	Rubber, silicone, compound, RTV, room temperature vulcanizing, low volatile — RTV- 566A/B	Commercially available
97P6378	Adhesive, epoxy, refined pure silver, electrically conductive — Tra- Duct BA2902, Silver/Epoxy Adhesive	Commercially available
97P7578	Base, epoxy — A8- 4219 (replaced by AE- 4219) Base	Commercially available
97P7678	Hardener, epoxy — H- 3404 (replaced by HD- 3404) Hardener	Commercially available
97P8278	Adhesive, epoxy, flexible, self- curing, structural bonding, GRA — 3M No. 2216 B/A (GRA)	Commercially available
97P9178	Adhesive, epoxy, silver filled, thixotropic paste — EPC- TEK H20E	Commercially available
97S0378	Adhesive, epoxy (Federal Specification MMM- A- 134, Type I) — A1177B (two parts)	Commercially available
97S0478	Adhesive, epoxy, silver filled, flexible, electrically conductive — Tecknit No. 72- 00008	CAGE: 07700
97S1078	Adhesive, high viscosity, mineral filled, NATURAL color — LCA-4/BA-9	Commercially available
97S1178	Adhesive, high viscosity, mineral filled, GRN color — LCA-4LV/BA-5	Commercially available

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Table 9-1. Materials Necessary to Mix and Cure (Cont)

Item	Description	Source
97S1278	Adhesive, epoxy, silver filled, electrically conductive — Eccobond 69/Catalyst No. 9	Commercially available
97S1378	Adhesive, epoxy, silver filled, electrically conductive — Eccobond 69/Catalyst No. 11	Commercially available
980P278	Primer, epoxy, lacquer base, modified — Denflex 1169A/B	Commercially available
980P478	Silicone rubber compound, RTV, highly thermo conductive — ECCOSIL 4954	Commercially available
980P578	Silicone rubber compound, transparent, low viscosity, easily pourable — RTV 615	Commercially available
9830478	Adhesive, epoxy, filler, heavy consistency compound (MIL- C- 24176, Type II) — Devcon F	Commercially available
9851878	Compound, epoxy, colored, flexible — Eccogel 1265- H (Parts A and B)	Commercially available
9853378	Adhesive, epoxy resin., thixotropic — Epoxy coating	CAGE: 21109
9854278	Embedment, resin., rubber, silicone, RTV, pink or black — 3M SCOTCHCAST No. 247	Commercially available
9859678	Insulating compound, reversion resistant silicone, embedding, electrical (MIL- I- 81550, Type I) — Sylgard No. 184 Resin	Commercially available
9859878	Coating, silicone, resin., transparent, moisture resistant, flexible, good damping quality — Sylgard No. 182 Resin	Commercially available
98A0278	Compound, rubber, silicone, transparent RTV, potting, encapsulating — RTV 615 (Parts A and B)	Commercially available
98A0578	Encapsulant, silicone, rubber, two-part — Sylgard 567 (Parts A and B)	Commercially available
98A0778	Encapsulant, silicone, RTV rubber, two- part — RTV No. 12	Commercially available

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Table 9-1. Materials Necessary to Mix and Cure (Cont)

Item	Description	Source
98A1178	Encapsulant, silicone, RTV rubber, two- part — Sylgard 527 (Parts A and B) silicone dielectric gel	Commercially available
98A2178	Coating, conductive (anti- static), epoxy, graphite based, carbon black, two- part — XA- 147A (No. 2320- B- 8 base, No. 2821- C- 4 catalyst)	Commercially available
98A2978	Potting compound, silicone, two- part, highly filled, low density, very high thermal conductivity, RED — ECCOSIL 5954	Commercially available
98C0278	Potting compound, silicone rubber, RTV condensive cure, two- part, highly filled, low density, very high thermal conductivity, RED — ECCOSIL 4954, Catalyst No. 50	Commercially available
98C0978	Sealant, corrosion inhibitive (MIL- S- 81733, Type II- 1/2 - for extrusion application in the time of 1/2 hour) — Pro- Seal 870B- 1/2	Commercially available
98C1078	Sealant, corrosion inhibitive (MIL- S- 81733, Type II- 1/2 - for extrusion application in the time of 1/2 hour) — Pro- Seal 870A- 1/2	Commercially available
98C1278	Encapsulant, silicone, two- part, transparent, solventless (MIL- I- 81550, Type I modified for use in hard vacuums) — No. 93- 500 Space- grade encapsulant	Commercially available
98C1778	Epoxy resin kit, CLEAR — Eccogel 1365- 0 CLEAR Epoxy Resin Kit (A/ B)	Commercially available
98P6878	Filler, plastic — Dynalite, No. 494 (gallon), No. 492 (quarts)	Commercially available
98P7178	Silicone rubber compound, including dibutyl tin dilaurate catalyst — RTV 11	Commercially available
98P7378	Potting compound, epoxy, low viscosity, low weight — Stycast 1090SI Base/24LV Catalyst	Commercially available

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Table 9-1. Materials Necessary to Mix and Cure (Cont)

Item	Description	Source
98P8078	Encapsulant, epoxy, 100% solid filled, medium viscosity, semiflexible — 3M SCOTCHCAST No. 241 Parts A and B)	Commercially available
98P8878	Coating/lubricant, PTFE, resin-bonded, phenolic, abrasion and corrosion resistant — Emralon 313	CAGE: 70079
98P9778	Molding compound, urethane, flexible — Flexane 80	Commercially available
98S0478	Potting compound, epoxy, resin., two-part, specify black, thermally-conductive — Stycast 2850 FT/catalyst 24LV, specify black	Commercially available
98S0578	Potting compound, epoxy, resin., two-part, black, thermally-conductive — Stycast 2850 FT/catalyst 24LV, specify black	Commercially available
NOTE: 1 When black pigment (97A1078) is added to this adhesive, 9702878 becomes 97A0778.		

2. Procedure

WARNING: DO NOT LET THE RESIN MAKE CONTACT WITH THE EYES, OR FOR MORE THAN A FEW MINUTES WITH THE SKIN. IF SKIN IRRITATION OCCURS, WASH WITH SOAP AND WATER AND THEN GET MEDICAL HELP.

WARNING: USE GLOVES OR CREAMS FOR PROTECTION WHEN YOU WORK WITH THE ADHESIVE. BE CAREFUL TO PREVENT CONTAMINATION OF THE SURFACES WITH THE CREAM.

WARNING: USE AN EXTERNAL VENTILATION SYSTEM IF A LARGE QUANTITY OF ADHESIVE IS APPLIED DAILY. SMALL QUANTITIES CAN BE USED IN A CORRECTLY VENTILATED ROOM WITHOUT AN EXHAUST SYSTEM.

A. General Warnings About Mixing Adhesives, Sealants, and Compounds Procedure

- (1) The warnings that precede this paragraph apply to all procedures in this section.

B. General Data About Mixing Adhesives, Sealants, and Compounds Procedure

- (1) Table 9-2 gives instructions for component mix ratios, cure times, and pot life for multicomponent adhesives, sealing compounds, coatings, embedments, potting compounds, insulating compounds, etc. that are shown in Table 9-1. The materials are used in the maintenance and repair of Honeywell equipment. Use these instructions to mix quantities of the multicomponent items other than specified by the manufacturers or suppliers. Use them along with, and not to replace, the manufacturers instructions about how to mix, evacuate air, or do other processes to successfully put together the necessary components.

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- (2) The list that follows gives general data that is applicable to adhesives, sealants, and compounds when you mix them.
- When you clean the surface, make sure there is no contamination in the solvent.
 - Make sure you do the work immediately after you mix the epoxy adhesive. The adhesive will begin to harden after 3 to 5 minutes.
 - Do not pour adhesive back into the initial container. Discard any adhesive that you do not use.
 - Make sure you fully clean the container before you use it again.

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Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
9702478	0.7 parts activator to 50 parts resin by weight. Optional: (black coloring) - Carbon black color indicator: 1 part of carbon black to 3 parts Lesamite by weight. - Adhesive-sealant/carbon black color indicator: 0.009 ± 0.003 parts by weight to original mixture at initial mixing.	For bonding: 4 Hr/190° ± 5.0 ° For filling: 8 Hr/190° ± 5.0 °	25 minutes maximum	
9702578	With catalyst No. 9 = 40 parts adhesive to one part catalyst by weight With catalyst No. 11 = 20 parts adhesive to one part catalyst by weight [example: One gram of adhesive to one drop of catalyst]	Catalyst No. 9 = 1 Hr @ 150° ± 10° Catalyst No.11 = 1 Hr @ 250° ± 10°	Not Available	
9702678	1 part component A to 2 parts component B by weight	16 hrs @ 77° 2 hrs @ 165° ± 10 °	Not Available	
9702878	1 part component A to 1 part component B by weight NOTE: When black pigment (97A1078) is added to this adhesive (9702878), it becomes 97A0778.	16 hrs @ 68° 4 hrs @ 120° 1 hr @ 165° 30 minutes @ 220° 15 minutes @ 250°	2 hrs maximum	
970P378	5 parts base to 7 parts catalyst by weight 2 parts base to 3 parts catalyst by volume	24 hrs @ 77° 1 hrs @ 150° ± 10 °	1 hr minimum @ 75°	
9711778	100 parts adhesive to 4.2 parts activator by weight	17 hrs @ 77° 8 hrs @ 165° ± 10 ° 4 hrs @ 185° ± 10 ° 2 hrs @ 200° ± 10 °	5 minute maximum use time at 77° . Store mixed adhesive at -40 °F. Use several times after mixing until more than moderate hand pressure is required to spread adhesive.	
9712478	10 parts base to 1 part catalyst by weight or volume	24 hrs @ 80° 12 hrs @ 100° 6 hr @ 120° 3 hr @ 140° 1.5 hr @ 160° 45 minutes @ 180°	2 hrs	
971P478	10 parts base resin to 1 part catalyst by weight	24 hrs @ 77°	1 to 5 hrs @ 77°	Mold strip time: 18 hrs @ 77°
971P578	10 parts base resin to 1 part catalyst by weight	24 hrs @ 77°	3 hrs maximum @ 77°	Mold strip time: 3 hrs @ 77°
971P678	10 parts base resin to 1 part catalyst by weight	24 hrs @ 77°	1 to 5 hrs @ 77°	Mold strip time: 24 hrs @ 77°
971P778	10 parts base resin to 1 part catalyst by weight	24 hrs @ 77°	1 to 5 hrs @ 77°	Mold strip time: 18 hrs @ 77°
9720778	100 parts sealant to 10 parts activator by weight	16 hrs @ 77° 2 hrs @ 77° then 1 hr @150° ± 10 °	30 minutes	

Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
9722778	100 parts base to 13.3 parts catalyst by weight or volume	48 hrs @ 80° 24 hrs @ 100° 12 hrs @ 120° 6 hrs @ 140° 3 hrs @ 160° 1.5 hrs @ 180°	Not available	
97A0778	Mixture A (rigid) small amount: Mix fully equal amounts of Part A and Part B of 9702878 by weight or volume, and 2 to 3% by weight of pigment (97A1078). Mixture B (flexible) small amount: 1 Mix 0.2 grams of pigment to 5.0 grams of activator (Part A). Mix fully into a homogenous mixture. 2 Add 12.75 grams of resin (Part B) and mix fully into a homogenous mixture. Mixture C (flexible) larger amount: 1 Mix four parts of pigment by weight to 100 parts of activator (Part A) by weight. Mix fully into a homogenous mixture. 2 Add one part by weight of mixture to 2.45 parts of resin (Part B) by weight. Mix fully into a homogenous mixture. Outgas in a vacuum tank for 3 to 5 minutes after mixing the epoxy at an absolute pressure of 5mm Hg.	16 hrs @ 68° 4 hrs @ 120° 1 hr @ 165° 30 minutes @ 220° 15 minutes @ 250°	2 hrs maximum	
97A2078	Tube Kits: Equal length ribbons of both Part A and Part B. Foil Packs: Completely empty both compartments of foil pack (one time use) Bulk: • 2.7 parts A to one part B by volume. • 100 parts A to 33 parts B by weight.	6 to 8 hrs @ 77° (handling strength) 3 days @ 77° (full cure)	50 minutes @ 77°	
97A3278 UP4642	With catalyst No. 9 = 100 parts base to 3 or 4 parts catalyst by weight With catalyst No. 11 = 100 parts base to 4 or 5 parts catalyst by weight	With catalyst No. 9: 24 hrs @ 80° 6 hrs @ 100° 4 hrs @ 165° 0.5 hr @ 258° With catalyst No. 11t: 8 hrs @ 180° 2 hrs @ 120° 20 minutes @ 375°	Catalyst No. 9 = 45 minutes Catalyst No. 11 = 4 hours	
97A3578	This product comes in a premeasured kit and is to be mixed only as directed. Do not attempt to mix individual small portions.	See kit instructions	See kit instructions	

Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
97C0178	1 part resin to 1 part hardener by weight or volume	12 hrs @ 122° 30 minutes @ 176° 15 minutes @ 248° 5 minutes @ 302° 45 seconds @ 347°	4 days minimum @ 77°	
97C3778	Mixture A (Hysol EA 9394): 100 parts Part A to 17 parts Part B Mixture B (Magnabond 6388-3): 100 parts Part A to 26 parts Part B	24 hrs @ room temperature 1 hr @150° ± 10° 24 hrs @ room temperature 1 hr @ 260° ± 10° 2 hr @ 225° ± 10°	90 minutes @ room temperature 60 minutes @ room temperature	
97D0378	10 parts base to 1 part curing compound by weight 100 parts base to 82 parts curing compoung by volume	10 hrs (tack free) 30 hrs (cure to shore)	30 minutes	
97D0678	100 parts resin to 100 part catalyst by weight or volume	8 hrs @ 77° 30 minutes @ 160° 15 minutes @ 200°	2 hrs @ 77°	
97D1078	100 parts Part A to 33 parts Part B by weight	36 hrs @ 77°	30 to 50 minutes	
97D1478	1 part A to 1 part B by volume	12 hrs @ 122° 90 minutes @ 176° 15 minutes @ 248° 5 minutes @ 302° 1 minute @ 347°	Long time	
97G1178	4 parts A to 1 part B by weight	48 hrs @ 77° 2 hrs @ 140° 1.5 hrs @ 165° 1 hrs @ 180°	Approximately 45 minutes	
97G2578	Rigid: 100 parts resin to 100 parts catalyst Semirigid: 100 parts resin to 200 parts catalyst Flexible: 100 parts resin to 300 parts catalyst	30 hrs @ 77° 8 hrs @ 77° then 2 hrs @ 160°	Rigid formulation: 2 minutes Semirigid formulation: 2.34 minutes Flexible formulation: 2.67 minutes	
97G2678	Rigid: 100 parts resin to 50 parts catalyst Semirigid: 100 parts resin to 100 parts catalyst Flexible: 100 parts resin to 150 parts catalyst	30 hrs @ 77° 8 hrs @ 77° then 2 hrs @ 160°	Rigid formulation: 2 minutes Semirigid formulation: 2.34 minutes Flexible formulation: 2.67 minutes	
97G2778	100 parts base (E-203) to 86 parts catalyst (No. 25) by weight	1 hr @ 302° then 8 hrs @ 356°	5 to 7 days @ 77°	
97P0578	1 part epoxy-patch resin to 1 part hardener by volume (equal length ribbons)	24 hrs @ 77° 1 hr @ 140°	55 minutes @ 77°	
97P0678	1 part epoxy-patch resin to 1 part hardener by volume (equal length ribbons)	24 hrs @ 77° 1 hr @ 140°	45 minutes @ 77°	

Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
97P4378	100 parts to 4.2 parts by weight	16 hrs @ 77° 8 hrs @ 165° 4 hrs @ 185° 2 hrs @ 200°	3.5 hrs @ 77°	
97P4478	100 parts to 4.2 parts by weight	16 hrs @ 77° 8 hrs @ 165° 4 hrs @ 185° 2 hrs @ 200°	3.5 hrs @ 77°	
97P5078	1 part Part A to 1.4 parts Part B by weight or volume	24 hrs @ 77° 30 minutes @ 212°	30 minutes @ 77°	
97P5178	100 parts resin base to 2.5 parts catalyst by weight	7 days @ 77° 24 hrs @ 122° 4 hrs @ 158°	4 to 8 hrs	
97P5678	100% part A to 100% part B by volume or weight NOTE: The adhesive shall be furnished only in what the manufacturer describes as the “DUBBLE/BUBBLE” convenience package. To add black color, add 1% (.04 gram) by weight of 94P0678, Hysol black dispersion to the thoroughly mixed adhesive.	24 hrs @ 77° 1 hr @ 100° 30 minutes @ 150° 10 minutes @ 200°	3 to 5 minutes minimum	
97P5878	100 parts of C-1 resin to 8 parts activator A by weight	24 hrs @ 77° 4hrs @ 77° (tack free) 2 hrs @ 165°	30 minutes or less	
97P6278	100 parts to 0.1 part by weight	6 to 24 hours (full bond strength will be established after approximately 168 hours (7 days) at 77 °F)	None. Material sets in air quickly. Skin formation indicates partial set-up. Useful working time: 1 hr	
97P6378 JP46426	100% part 1 to 100% part 2 by volume or weight NOTE: The adhesive shall be furnished only in what the manufacturer describes as a convenience package.	24 hrs @ 77° 2 hrs @ 149° 1 hr @ 212°	60 minutes	
97P7578 97P7678	97P7578 (AE-4319) and 97P7678 (H-3404) are available from the manufacturer in kit form. NOTE: The kit produces an epoxy adhesive with 100 percent solids, low viscosity, and unfilled.	7 days @ 77° 24 hrs @ 77°, then 2 hrs @ 140°, then 4 hrs @ 257°, then 2 hrs @ 140°	40 minutes @ 77° for a 100 gram mass	
97P8278	5 parts base to 7 parts accelerator by weight 2 parts base to 3 parts accelerator by volume	7 days @ 77° 2 hrs @ 149° 5 minutes @ 149° 40 seconds @ 347°	90 Minutes @ 77° for a 100 gram quantity	
97P9178	1 part resin to 1 part hardener by weight or volume	30 minutes minimum @ 338°	4 day minimum @ 77°	

Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
9S0378	1 part component A to 2 parts component B by weight	24 hrs @ 77° 2 hrs @ 149° 1 hr @ 167° 30 minutes @ 194° 30 minutes @ 248°	2 hrs maximum	
97S0478	1 part A to 1.4 parts B by weight	24 hrs @ 77° 45 minutes @ 199.4° 30 minutes @ 212°	30 minutes @ 77°	
97S1078	100 parts A (LCA-4) to 4.2 parts B (BA9) by weight	16 hrs @ 77° 8 hrs @ 165° ± 10 ° 4 hrs @ 185° ± 10 ° 2 hrs @ 200° ± 10 °	60 minutes @ 77°	
97S1178	100 parts A (LCA-4LV) to 4.2 parts B (BA5) by weight	16 hrs @ 77° 8 hrs @ 165° ± 10 ° 4 hrs @ 185° ± 10 ° 2 hrs @ 200° ± 10 °	90 minutes @ 77°	
97S1278	40 parts A to 1 part B by weight	2 hrs ± 10 minutes @ 129° ± 41° 10 minutes ± 2 minutes @ 158° ± 41°	1 hr minimum	
97S1378	30 parts A to 1 part B by weight	8 hrs ± 20 minutes @ 147.6° ± 41° 1 hrs ± 5 minutes @ 228.6° ± 41°	2 hrs minimum	
980P278	10 parts A to 9 parts B by weight 10 parts A to 10 parts B by volume (use 980P378 thinner as necessary)	7 days @ 77° 60 minutes @ 149°	Approximately 24 hours (not thinned)	
980P478	100 grams resin to 0.1 to 0.4 grams catalyst	Initial: overnight @ 77° or 3 to 4 hrs @ 150° Full: 5 to 6 days @ 77°	15 minutes to 1 hr, depending on how much catalyst used	
980P578	10 parts A to 1 part B by weight	24 hrs @ 77° (tack free) 6 to 7 days @ 77° 4 hrs @ 149° 1 hr @ 212° 45 minutes @ 257° 15 minutes @ 302°	4 hrs @ 77°	
9830478	9 parts Devcon F to 1 part Devcon F hardener by weight 5 parts Devcon F to 1 part Devcon F hardener by volume	72 hrs @ 77° (hand sand in 4 hrs)	Not available	
9833778	100 parts A to 34 parts B by weight	x hrs @ 77°	Not available	
9851878	Clear: 100 parts A to 100 parts B by weight Colored: 50 parts A to 42 parts B, 9 parts green concentrate (95P4478), and 1 part yellow dye (95P4378), by weight	48 hrs @ 125° ±10° 16 hrs @ 150° ±10°	Not available	

Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
9853378	Clear: 100 parts A to 8.25 parts B by weight Colored: 100 parts A to 8.25 parts B, and 1 part of epoxy dispersion pigment [(PMS Consolidated Red No. 1450), Ferro Corp, Plainfield, NJ, No. CI-108], by weight	75% Cure Time: 10 hrs @ 77° 4 hrs @ 130° 2 hrs @ 165° 100% Cure Time: 5 days @ 77° 2 days @ 130° 1 day @ 165°	30 to 45 minutes @ 77° for a 75 gram batch	
9854278	Plain: Equal parts A to B by weight Black: Add 5 parts 945198 (Claremonte PX-3165) to mixture of parts A and B after they are mixed together	2 to 2.5 hrs @ 157.5° ± 17.5° Over night @ 77°, then 1 hr @ 201° ± 10°	8 hrs @ 75°	
9859678	10 parts resin to 1 part curing agent by weight	24 hrs @ 78° 4 hrs @ 150° 1 hr @ 212° 15 minutes @ 302° NOTE: Full cure will take 7 days	2 hrs minimum @ 75°	
9859878	10 parts resin to 1 part curing agent by weight	4 hrs @ 150° 1 hr @ 212° 15 minutes @ 302°	Approximately 8 hrs minimum @ 75°	
98A0278	10 parts A to 1 part B by weight	6 to 7 days @ 77° 4 hrs @ 149° 1 hr @ 212° 45 minutes @ 257° 15 minutes @ 302°	4 hrs @ 77°	
98A0578	1 part A to 1 part B by weight or volume	4 hrs @ 176° 3 hrs @ 212° 2 hrs @ 302°	96 hrs @ 77°	
98A0778	20 parts A to 1 part B by weight	72 hrs @ 176° 1 hr @ 212°	30 minutes @ 77°	
98A1178	1 part A to 1 part B by weight or volume	4 hrs @ 149° 1 hr @ 212° 15 minutes @ 302°	13 hrs @ 77°	
98A1478				
98A2178	1 part base to 1 part catalyst by weight or volume	4 days @ 77° (total cure) 4 to 6 hrs @ 77° (touch) 4 hrs @ 180°	8 hrs @ 77°	
98A2978	1 part A to 1 part B by weight and volume	1 to 4 hrs @ 149° 20 minutes @ 301°	Not available	
98C0278	100 parts A to 0.1 part B by weight or volume	24 hrs @ 77° 2 to 4 hrs @ 149°	15 minutes to 1 hr @ 77° x minutes @ 77°	

Table 9-2. Mixing Instructions for Adhesives, Sealants, and Compounds (Cont)

Material	Mix Ratio	Cure Time (Temperature in °F)	Pot Life (Temperature in °F)	Other
98C0978	100 parts base to 77 parts catalyst by weight 100 parts base to 13.85 parts catalyst by volume	14 days @ 77° 16 hrs @ 77° (tack free) 30 hrs @ 77° (handling time) 48 hrs @ 77°, then 24 hrs @ 120.2°	30 minutes to 1 hr not refrigerated. Refrigeration will extend pot life.	
98C1078	100 parts base to 77 parts catalyst by weight 100 parts base to 13.85 parts catalyst by volume	14 days @ 77° 16 hrs @ 77° (tack free) 30 hrs @ 77° (handling time) 48 hrs @ 77°, then 24 hrs @ 120.2°	30 minutes to 1 hr not refrigerated. Refrigeration will extend pot life.	
98C1278	10 parts encapsulant to 1 part curing agent by weight	7 days @ 77° (full cure) 24 hrs @ 77° (permit handling) 4 hrs @ 150° 1 hr @ 212° 15 minutes @ 302°	2 hrs @ 77°	
98C1778	In accordance with manufacturers kit instructions	3 to 7 days @ 77° 24 hrs @ 110° 8 hrs @ 150° 2 hrs @ 200°	Not available	
98P6878	1/2 can filler to 1/2 can hardener 1/4 can filler to 1/4 can hardener 1.75 inch diameter ball filler to 1 inch ribbon hardener	Cheese grade: 12 minutes Sand with 80 grit sandpaper: 20 minutes	4 to 5 minutes @ 77°	
98P7178	100 parts silicone rubber to 0.5 parts catalyst by weight	6 to 24 hrs @ 77° 75% reduction in curing time @ up to 199.5°	1 hr @ 77°	
98P7378	100 parts Stycast to 23 parts catalyst by weight	24 hrs @ 77°	30 minutes @ 77°	
98P8078	2 parts base to 1 part catalyst by weight 69 parts base to 31 parts catalyst by volume	15 to 20 hrs @ 167° 6 to 8 hrs @ 203° 2 to 3 hrs @ 250°	Less than 22 minutes @ 250°	
98P8878	33 parts white component A to 100 parts black component B by weight	60 minutes @ 302° 10 minutes @ 356° 8 minutes @ 401° 4 minutes @ 500°	24 hrs	
98S0478	100 parts Stycast with 6.5 to 7.5 parts catalyst	12 minutes @ 77° 2 minutes @ 150° ± 10°	30 minutes @ 77°	
98S0578	100 parts Stycast with 6.5 to 7.5 parts catalyst	12 minutes @ 77° 2 minutes @ 150° ± 10°	30 minutes @ 77°	



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SECTION 10 – SAFETY WIRE AND HARDWARE RETENTION

1. Overview

A. General

- (1) This section gives data and illustrations for safety or locking wire of standard parts common to Honeywell avionics equipment, and wire application for hardware retention.
- (2) Safety or lock wiring is done to lock together two or more parts with wire so that if a part is loosened it will cause the wire to tighten. This gives torque maintenance and prevents disengaged parts.
- (3) Hardware retention wiring is done to prevent loss of the part, and is not safety or lock wiring.

B. Equipment and Materials

- (1) No equipment is necessary.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 10-1 for materials.
- (3) Equivalent alternatives are permitted for equipment and materials.

Table 10-1. Materials for Safety Wire and Hardware Retention

Item	Description	Source
45D0211	Wire, nickel-copper alloy N04400 (Monel 400), 0.XXX-inch diameter (MS20995-NCXXX) (XXX = 0.020, 0.032, or 0.040)	Commercially available

2. Procedure

A. General Data About Safety Wire and Hardware Retention Procedure

- (1) Do a check and record data about the safety or retention wire routing, group of parts to be wired, method of wiring (single wire or double twist), and location of pigtails before you remove the initial wire.
- (2) The procedures and figures that follow are for safety wiring fasteners that have right-hand threads. For fasteners that have left-hand threads, do the opposite direction of all instructions.

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B. Installation of a Double-Twist Safety Wire (Lock Wire)

(1) General Data About Double-Twist Safety Wires

- (a) The double-twist method is used as the typical method of safety wiring (see Figure 10-1 thru Figure 10-4). When you install double-twist safety wires, do as follows:
- Make sure there is no more than three fasteners in a series when you wire widely spaced groups (4 to 6 inches (102 to 152 mm) apart).
 - When you wire a closely spaced multiple group that has the maximum number of fasteners, make sure the wire is not longer than 24 inches (610 mm).
 - Make sure each fastener has the correct torque, and that the safety wire holes are in a position so they will not loosen.
 - Make sure you cut, remove, and discard all applicable used wire.

(2) Installation of a Double-Twist Safety Wire to Two Fasteners

- (a) Use the double-twist method when you install a new safety wire (45D0211) to two fasteners. See Figure 10-1 and do the procedure that follows.

- 1 Step 1 - Insert the wire through the hole in the first fastener head so that approximately equal lengths protrude on each side of the head.
- 2 Step 2 - Hold the left hand end of the wire and bend it clockwise around the head and under the other wire end.

CAUTION: MAKE SURE THAT THE BRAID IS NOT TOO LONG SO THAT YOU CAN PULL IT TIGHT BETWEEN THE TWO FASTENERS. IF IT IS TOO LONG, DISCARD IT. DO NOT USE THE WIRE AGAIN BECAUSE IT BECOMES WEAK WHEN YOU UNTWIST IT.

- 3 Step 3 - Hold both ends of the wire, pull the wires so the loop is tight around the fastener head, and at the same time twist the wires around each other in a clockwise direction to form a braid. Continue to twist the wires in the direction of the second fastener until the end of the braid is almost to the fastener hole.
- 4 Step 4 - Use a pliers to hold the wire at the end of the braid and pull it tight. Continue to pull as you twist the braid in a clockwise direction until the braid is stiff.
- 5 Step 5 - Insert the end of the top wire through the hole in the second fastener head. Use the pliers to pull the wire through until the braid is tight.
- 6 Step 6 - Move the end of the bottom wire around the second fastener in a counterclockwise direction and under the wire end that protrudes from the fastener.
- 7 Step 7 - Use the pliers to pull the loop tight, and at the same time make sure that the wire is kept down around the fastener head diameter.
- 8 Step 8 - Bend the twisted wire ends counterclockwise around the second fastener head.



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- 9 Step 9 - Cut off all but three to six twists of the unwanted wire. Make sure the ends are not sharp and do not protrude.

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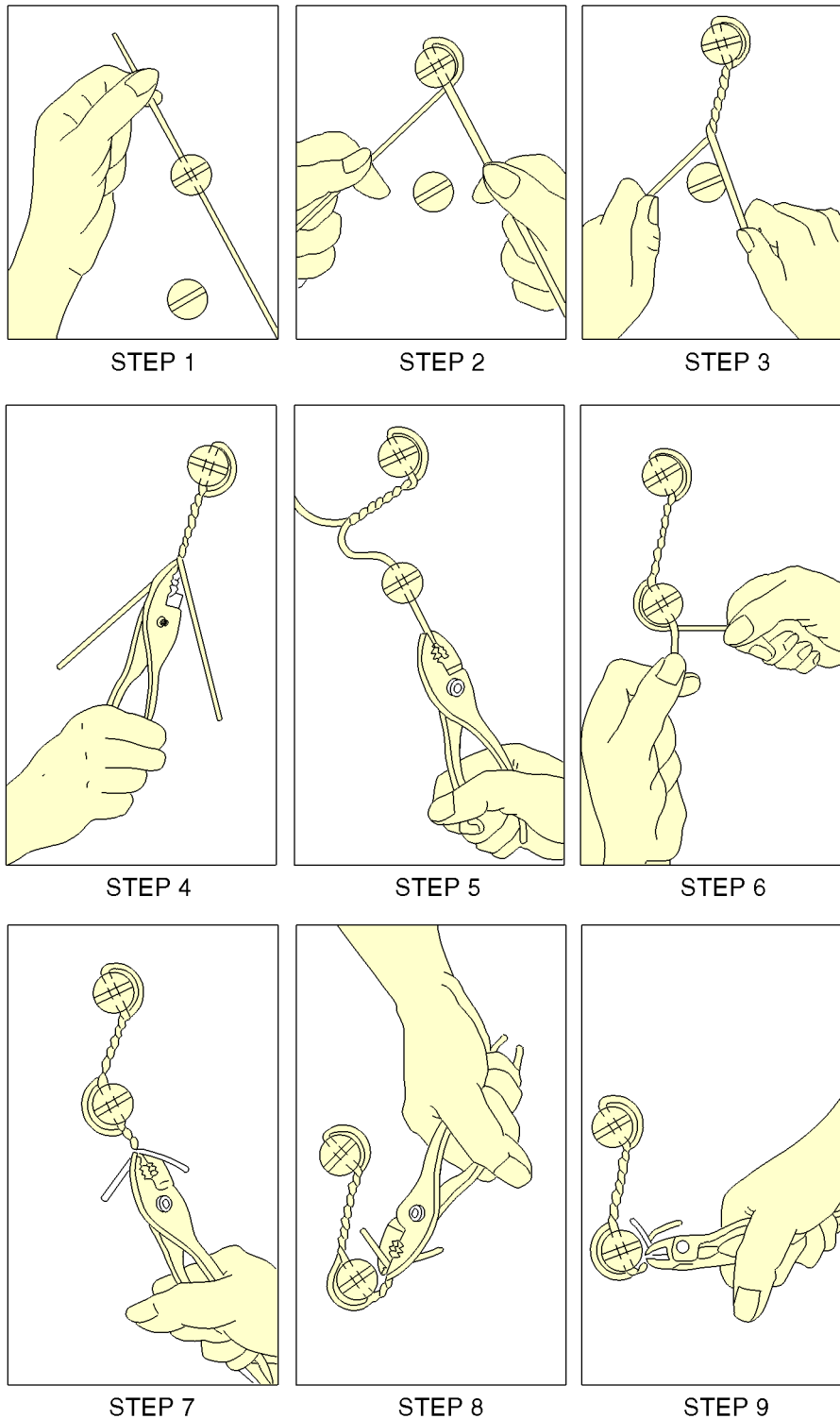
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Figure 10-1. Double-Twist Method of Safety Wiring Two Fasteners

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(3) Installation of a Double-Twist Safety Wire to Three Fasteners

- (a) Use the double-twist method to install a new safety wire (45D0211) to three fasteners. See Figure 10-1 (applicable steps), Figure 10-2, and do the procedure that follows.

- 1 Insert the wire through the hole in the first fastener head so that approximately equal lengths protrude on each side of the head.
- 2 Hold the left hand end of the wire and bend it clockwise around the head and under the other wire end.

CAUTION: MAKE SURE THAT THE BRAID IS NOT TOO LONG SO THAT YOU CAN PULL IT TIGHT BETWEEN THE TWO FASTENERS. IF IT IS TOO LONG, DISCARD IT. DO NOT USE THE WIRE AGAIN BECAUSE IT BECOMES WEAK WHEN YOU UNTWIST IT.

- 3 Hold both ends of the wire, pull the wires so the loop is tight around the fastener head, and at the same time twist the wires around each other in a clockwise direction to form a braid. Continue to twist the wires in the direction of the second fastener until the end of the braid is almost to the fastener hole.
- 4 Use a pliers to hold the wire at the end of the braid and pull it tight. Continue to pull as you twist the braid in a clockwise direction until the braid is stiff.
- 5 Insert the end of the top wire through the hole in the second fastener head. Use the pliers to pull the wire through until the braid is tight.
- 6 Move the end of the bottom wire around the second fastener in a counterclockwise direction and under the wire end that protrudes from the fastener.
- 7 Use the pliers to pull the loop tight, and at the same time make sure that the wire is kept down around the fastener head diameter.

CAUTION: MAKE SURE THAT THE BRAID IS NOT TOO LONG SO THAT YOU CAN PULL IT TIGHT BETWEEN THE TWO FASTENERS. IF IT IS TOO LONG, DISCARD IT. DO NOT USE THE WIRE AGAIN BECAUSE IT BECOMES WEAK WHEN YOU UNTWIST IT.

- 8 Hold both ends of the wire, pull the wires so the loop is tight around the fastener head, and at the same time twist the wires around each other in a counterclockwise direction to form a braid. Continue to twist the wires in the direction of the third fastener until the end of the braid is almost to the fastener hole.
- 9 Make sure the wires of the second fastener are still in position and tight. Use a pliers to hold the wire at the end of the braid and continue to pull as you twist the braid in a counterclockwise direction until the braid is stiff.
- 10 Insert the end of the bottom wire through the hole in the third fastener head. Use the pliers to pull the wire through until the braid is tight.

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- 11 Move the end of the top wire around the third fastener in a counterclockwise direction and under the wire end that protrudes from the fastener.
- 12 Use the pliers to pull the loop tight, and at the same time make sure that the wire is kept down around the fastener head diameter.
- 13 Bend the twisted wire ends counterclockwise around the third fastener head.
- 14 Cut off all but three to six twists of the unwanted wire. Make sure the ends are not sharp and do not protrude.

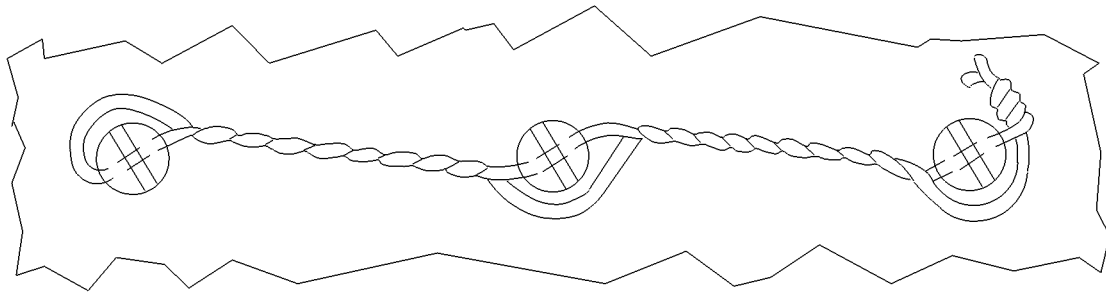
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Figure 10-2. Double-Twist Method of Safety Wiring Three Fasteners

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- (4) Installation of a Double-Twist Safety Wire to a Stationary Member and One Fastener
- (a) Use the double-twist method to install a new safety wire (45D0211) to a stationary member and one fastener. See Figure 10-1 (applicable steps), Figure 10-3, and do the procedure that follows.
- 1 Insert the wire through the hole in the stationary member so that approximately equal lengths protrude on each side of the head.
- CAUTION:** MAKE SURE THAT THE BRAID IS NOT TOO LONG SO THAT YOU CAN PULL IT TIGHT BETWEEN THE TWO FASTENERS. IF IT IS TOO LONG, DISCARD IT. DO NOT USE THE WIRE AGAIN BECAUSE IT BECOMES WEAK WHEN YOU UNTWIST IT.
- 2 Hold both ends of the wire, pull the wires so the loop is tight around the fastener head, and at the same time twist the wires around each other in a clockwise direction to form a braid. Continue to twist the wires in the direction of the second fastener until the end of the braid is almost to the fastener hole.
 - 3 Use a pliers to hold the wire at the end of the braid and pull it tight. Continue to pull as you twist the braid in a clockwise direction until the braid is stiff.
 - 4 Insert the end of the top wire through the hole in the fastener head. Use the pliers to pull the wire through until the braid is tight.
 - 5 Move the end of the bottom wire around the fastener head in a counterclockwise direction and under the wire end that protrudes from the fastener.
 - 6 Use the pliers to pull the loop tight, and at the same time make sure that the wire is kept down around the fastener head diameter.
 - 7 Bend the twisted wire ends counterclockwise around the second fastener head.
 - 8 Cut off all but three to six twists of the unwanted wire. Make sure the ends are not sharp and do not protrude.

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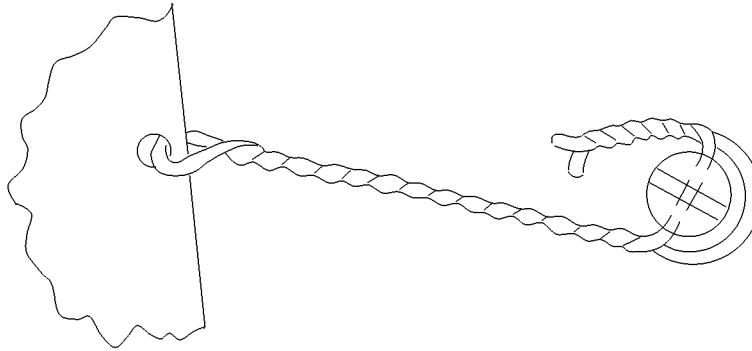
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Figure 10-3. Double-Twist Method of Safety Wiring One Fastener

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- (5) Installation of a Double-Twist Safety Wire to Castellated or Slotted Nuts
- (a) Use the double-twist method to install a new safety wire (45D0211) to castellated or slotted nuts. See Figure 10-1 (applicable steps), Figure 10-4, and refer to the applicable procedure for fasteners, paragraphs (2), (3), or (4). When you install double-twist safety wires to castellated or slotted nuts, do as follows.
- Make sure you use the double-twisted wire method.
 - If there is a torque requirement, torque the nut to the low side of the torque range then tighten as necessary to align the slot in the nut and hole for the wire.
 - In the fastener procedure, the wire that usually loops around the fastener head will loop around the part of the stud that protrudes above the castellated segments of the nut as shown in Figure 10-4.

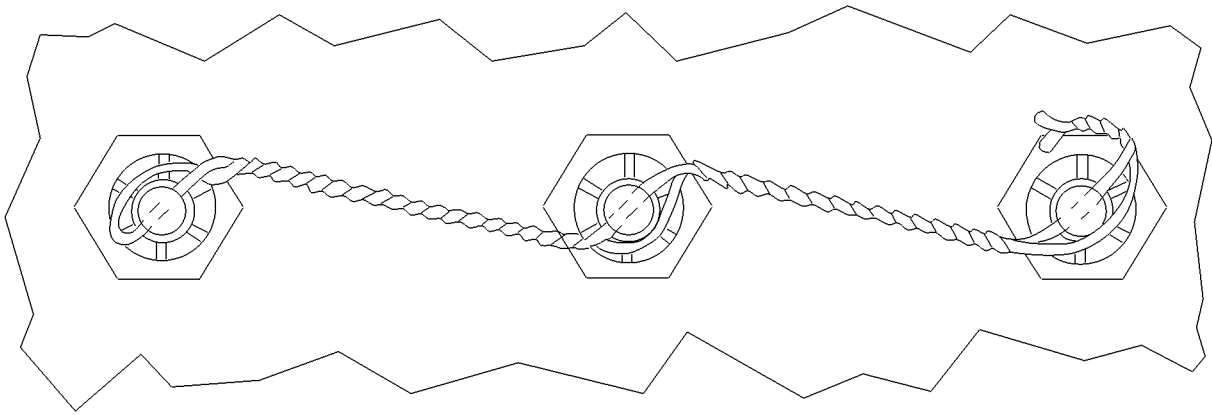
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Figure 10-4. Double-Twist Method of Safety Wiring Castellated or Slotted Nuts

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C. Installation of a Single-Twist Safety Wire (Lock Wire)

(1) General Data About Single-Twist Safety Wires

- (a) The single-twist method is used in a closely spaced closed geometrical hole pattern (2 inches (51 mm) or less between fastener centers) such as a triangle, circle, or rectangle (see Figure 10-5 thru Figure 10-8). When you install single-twist safety wires, do as follows:
- Use the single-wire method when you cannot use the double-twisted method.
 - When you wire a closely spaced multiple group that has the maximum number of fasteners, make sure the wire is not longer than 24 inches (610 mm).
 - Make sure each fastener has the correct torque, and that the safety wire holes are in a position so they will not loosen.

(2) Installation of a Single-Twist Safety Wire to Two Fasteners

- (a) Use the single-twist method when you install a new safety wire (45D0211) to two fasteners. See Figure 10-5 and do the procedure that follows.
- 1 Step 1 - Insert the wire through the hole in the first fastener head so that approximately equal lengths protrude on each side of the head.
 - 2 Step 2 - Hold the left hand end of the wire and bend it clockwise around the head and under the other wire end.
 - 3 Step 3 - Hold both ends of the wire and insert the top wire end through the hole in the second fastener head. Use the pliers to pull the wire through until the braid is tight.
 - 4 Step 4 - Move the end of the bottom wire around the second fastener head in a counterclockwise direction and under the other wire end that protrudes from the fastener. Use the pliers to bend the twisted wire ends counterclockwise. Wrap the twisted pigtail counterclockwise around the second fastener head. Cut off all the excess wire except three to six twists. Avoid sharp or projecting ends.

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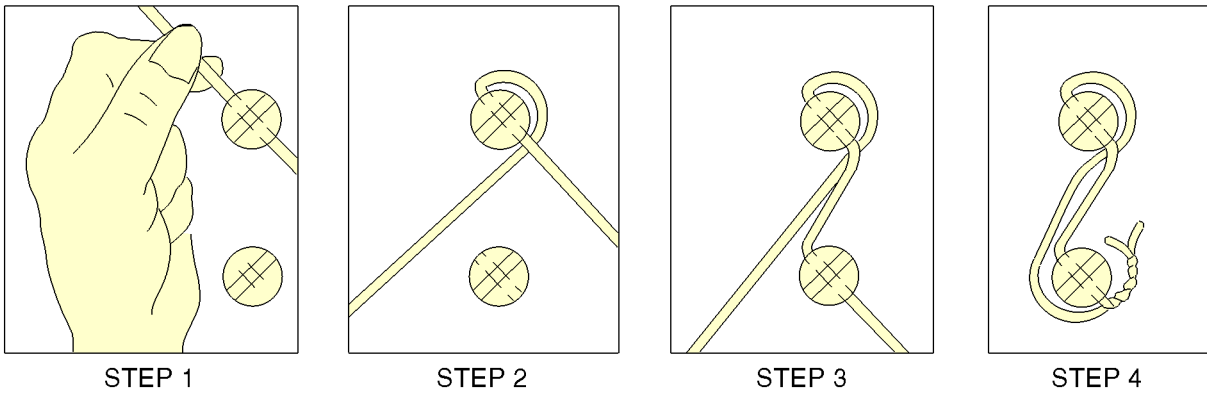
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Figure 10-5. Single-Twist Method of Safety Wiring Two Fasteners

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- (3) Installation of a Single-Twist Safety Wire to Multiple Fasteners
 - (a) Use the single-twist method when you install a new safety wire (45D0211) to multiple fasteners. See Figure 10-6, Figure 10-7, and Figure 10-8, and refer to the procedure for fasteners, paragraph (2).

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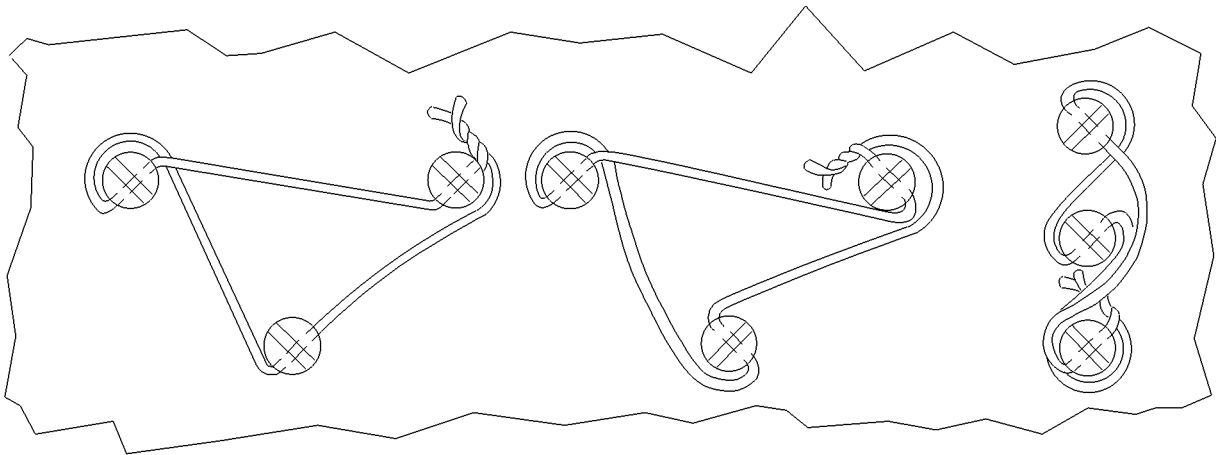
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Figure 10-6. Single-Twist Method of Safety Wiring Three Fasteners

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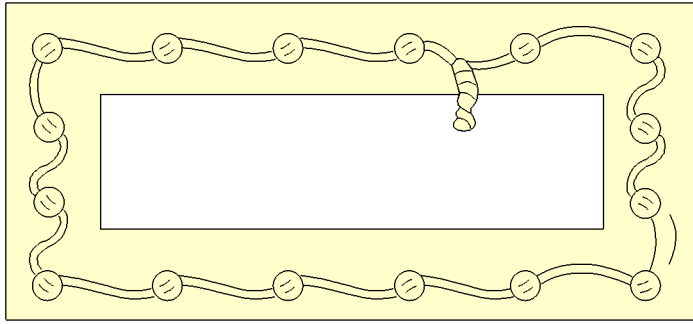
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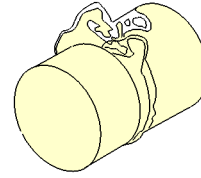


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SMALL SCREWS IN CLOSELY SPACED,
CLOSED GEOMETRICAL PATTERN



EXTERNAL SNAP RING
SINGLE WIRE METHOD

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Figure 10-7. Single-Twist Method of Safety Wiring Closed Pattern and Snap Ring

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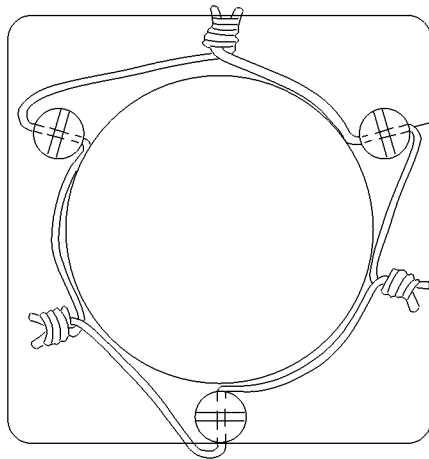
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LOCKWIRE INSERTED IN SCREW HOLE PRIOR TO TORQUING OF SCREW AND ENDS TWISTED TOGETHER AS SHOWN AFTER TORQUING.

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Figure 10-8. Single-Twist Method of Safety Wiring With Adjacent Structure

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D. Hardware Retention Wiring

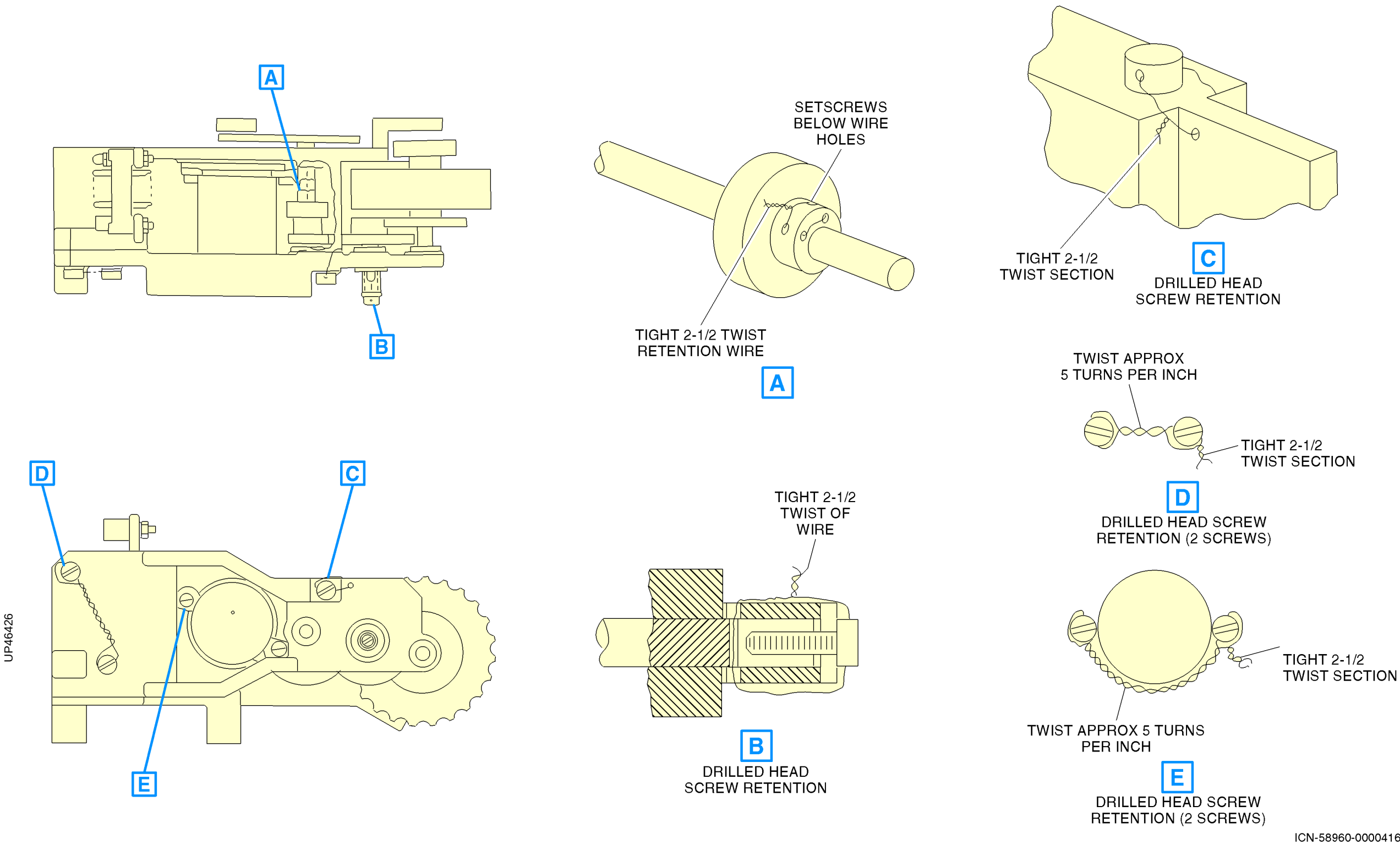
- (1) Cut, remove, and discard all applicable used wire.
- (2) Install new wire (0.020-inch (0.51 mm) minimum diameter) as shown in Figure 10-9.
- (3) Terminate the wires by making a tight pigtail twist of 2-1/2 turns.
- (4) Bend the pigtail so that it does not become a snag.

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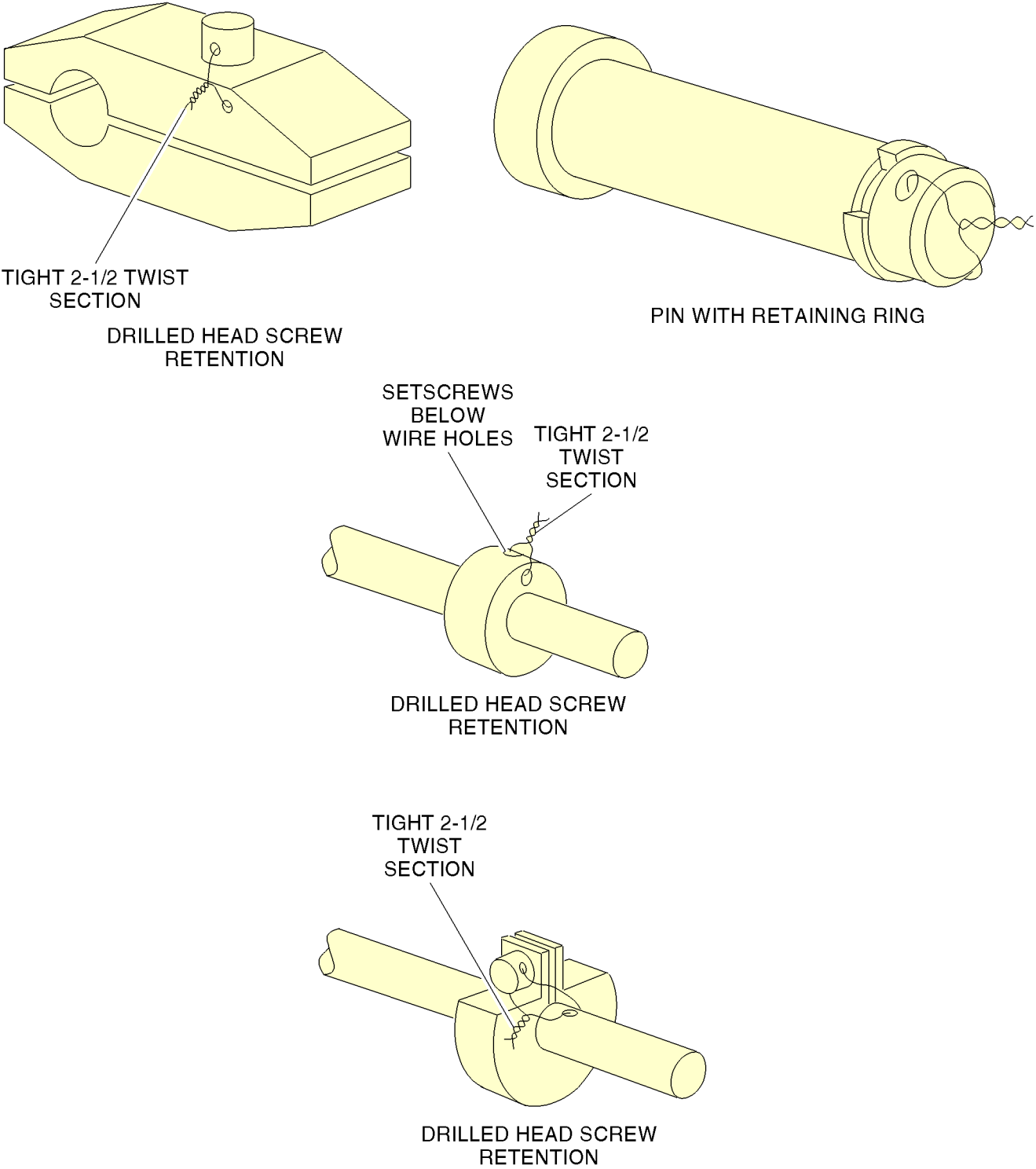
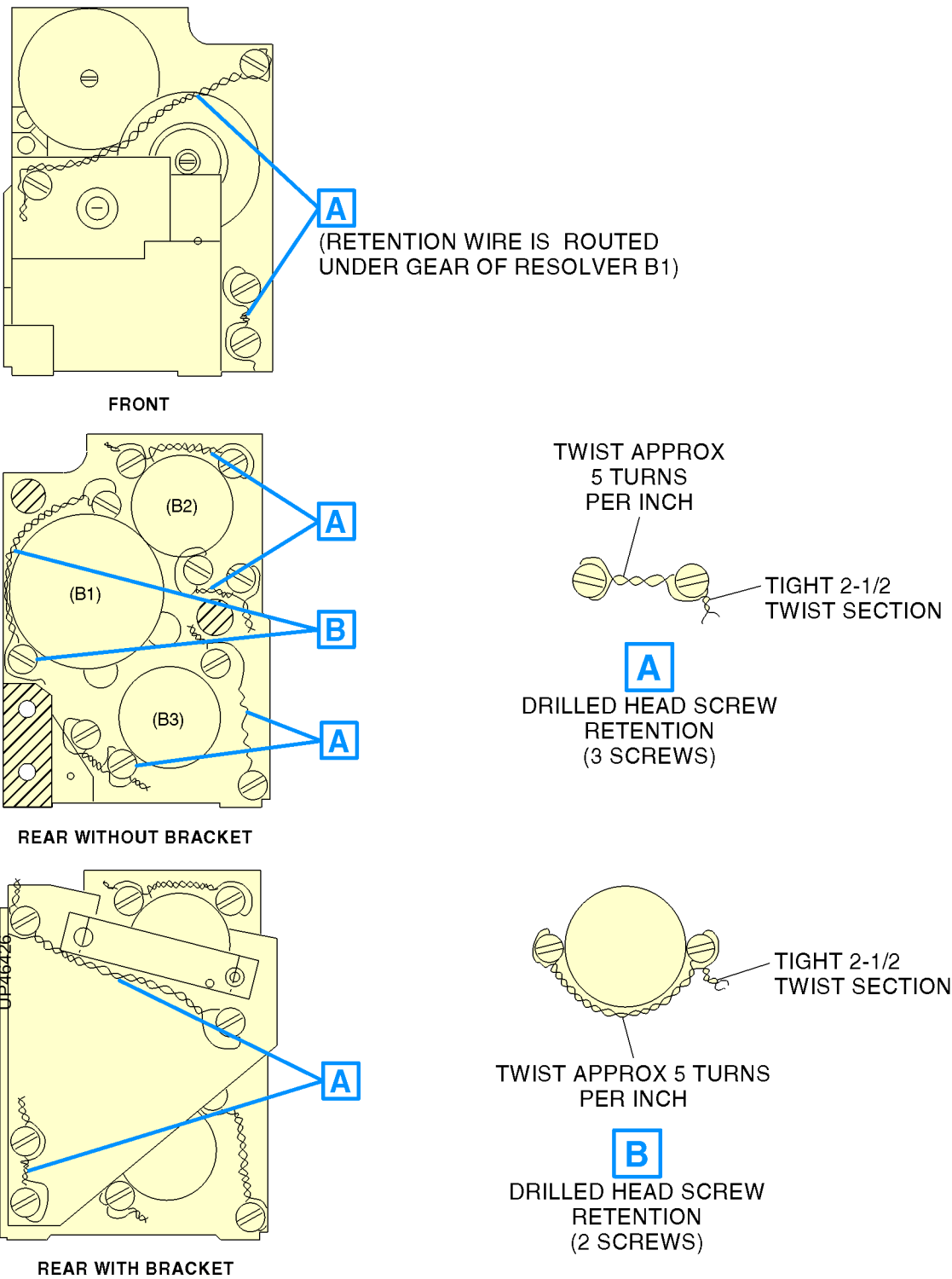


Figure 10-9. (Sheet 2 of 2) Installation of Wire for Hardware Retention

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SECTION 11 – REFERENCE INFORMATION

1. Overview

A. General

- (1) This section gives data to use as an aid when you do standard repair procedures in this manual.

B. Equipment and Materials

- (1) No equipment is necessary.
(2) No materials are necessary.

2. Details

A. Wire and Cable Color Codes

- (1) Use the data in Table 11-1 to find or specify the color codes for wire and cable.

Table 11-1. Wire and Cable Color Codes

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
001	Black			
002	Brown			
003	Red			
004	Orange			
005	Yellow			
006	Green			
007	Blue			
008	Violet			
009	Gray			
010	White			
011	Clear			
012	White	Black		
013	White	Brown		
014	White	Red		
015	White	Orange		
016	White	Green		
017	White	Blue		
018	White	Violet		
019	White	Black	Black	
020	White	Black	Brown	

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
021	White	Black	Red	
022	White	Black	Orange	
023	White	Black	Green	
024	White	Black	Blue	
025	White	Black	Violet	
026	White	Brown	Brown	
027	White	Brown	Red	
028	White	Brown	Orange	
029	White	Brown	Green	
030	White	Brown	Blue	
031	White	Brown	Violet	
032	White	Red	Red	
033	White	Red	Orange	
034	White	Red	Green	
035	White	Red	Blue	
036	White	Red	Violet	
037	White	Orange	Orange	
038	White	Orange	Green	
039	White	Orange	Blue	
040	White	Orange	Violet	
041	White	Green	Green	
042	White	Green	Blue	
043	White	Green	Violet	
044	White	Blue	Blue	
045	White	Blue	Violet	
046	White	Blue	Green	
047	White	Violet	Violet	
048	Black	Brown		
049	Black	Red		
050	Black	Orange		
051	Black	Yellow		
052	Black	Green		

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
053	Black	White		
054	Black	Blue		
055	Brown	Red		
056	Brown	Orange		
057	Brown	Yellow		
058	Brown	Green		
059	Brown	Blue		
060	Brown	White		
061	Red	Orange		
062	Red	Yellow		
063	Red	Green		
064	Red	Blue		
065	Red	Gray		
066	Red	White		
067	Orange	Green		
068	Orange	Blue		
069	Orange	Gray		
070	Orange	White		
071	Orange	Violet		
072	Yellow	Green		
073	Yellow	Blue		
074	Yellow	Gray		
075	Yellow	Violet		
076	Green	Gray		
077	Green	White		
078	Green	Violet		
079	Blue	Gray		
080	Blue	White		
081	Gray	Violet		
082	White	Yellow		
083	White	Black	Yellow	
084	White	Brown	Black	

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
085	White	Brown	Yellow	
086	White	Red	Black	
087	White	Red	Brown	
088	White	Red	Yellow	
089	White	Orange	Yellow	
090	White	Green	Black	
091	White	Green	Brown	
092	White	Green	Red	
093	White	Green	Yellow	
094	White	Blue	Black	
095	White	Blue	Brown	
096	White	Blue	Red	
097	White	Blue	Orange	
098	White	Yellow	Green	
099	White	Yellow	Blue	
100	Natural			
101	Blue	Red	White	
102	Yellow	Black		
103	White	Gray		
104	Brown	Violet		
105	Brown	Gray		
106	Orange	Black		
107	Orange	Brown		
108	Orange	Red		
109	Yellow	Brown		
110	Yellow	Red		
111	Yellow	Orange		
112	Green	Brown		
113	Green	Red		
114	Green	Orange		
115	Green	Yellow		
116	Green	Blue		

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
117	Blue	Brown		
118	Blue	Red		
119	Blue	Orange		
120	Blue	Yellow		
121	Blue	Green		
122	Gray	Brown		
123	Gray	Red		
124	Gray	Orange		
125	Gray	Yellow		
126	Gray	Green		
127	Gray	White		
128	White	Black	Gray	
129	White	Brown	Gray	
130	White	Red	Gray	
131	White	Orange	Black	
132	White	Orange	Red	
133	White	Orange	Gray	
134	White	Yellow	Black	
135	White	Yellow	Brown	
136	White	Yellow	Violet	
137	White	Yellow	Gray	
138	White	Green	Orange	
139	White	Green	Gray	
140	White	Blue	Yellow	
141	White	Blue	Gray	
142	White	Violet	Gray	
143	Green	White	Brown	
144	White	Gray	Red	
145	Violet	Red		
146	Pink			
147	White	Gray	Green	
148	White	Gray	Blue	

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
149	White	Orange	Brown	
150	Not Used			
151	Brown	Black		
152	Red	Black		
153	Orange	Yellow		
154	Blue	Black		
155	Violet	White		
156	White	Yellow	Red	
157	White	Yellow	Orange	
158	Gray	Black		
159	Yellow	White		
160	Green	Black		
161	Violet	Black		
162	Violet	Yellow		
163	Gray	Blue		
164	White	Black	Brown	Red
165	White	Black	Brown	Orange
166	White	Black	Brown	Yellow
167	White	Black	Brown	Green
168	White	Black	Brown	Blue
169	White	Black	Brown	Violet
170	White	Black	Brown	Gray
171	White	Black	Red	Orange
172	White	Black	Red	Yellow
173	White	Black	Red	Green
174	White	Black	Red	Blue
175	White	Black	Red	Violet
176	White	Black	Red	Gray
177	White	Black	Orange	Yellow
178	White	Black	Orange	Green
179	White	Black	Orange	Blue
180	White	Black	Orange	Violet

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
181	White	Black	Orange	Gray
182	White	Black	Yellow	Green
183	White	Black	Yellow	Blue
184	White	Black	Yellow	Violet
185	White	Black	Yellow	Gray
186	White	Black	Green	Blue
187	White	Black	Green	Violet
188	White	Black	Green	Gray
189	White	Black	Blue	Violet
190	White	Black	Blue	Gray
191	White	Black	Violet	Gray
192	White	Brown	Red	Orange
193	White	Brown	Red	Yellow
194	White	Brown	Red	Green
195	White	Brown	Red	Blue
196	White	Brown	Red	Violet
197	White	Brown	Red	Gray
198	White	Brown	Orange	Yellow
199	White	Brown	Orange	Green
200	White	Brown	Orange	Blue
201	White	Brown	Orange	Violet
202	White	Brown	Orange	Gray
203	White	Brown	Yellow	Green
204	White	Brown	Yellow	Blue
205	White	Brown	Yellow	Violet
206	White	Brown	Yellow	Gray
207	White	Brown	Green	Blue
208	White	Brown	Green	Violet
209	White	Brown	Green	Gray
210	White	Brown	Blue	Violet
211	White	Brown	Blue	Gray
212	White	Brown	Violet	Gray

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
213	White	Red	Orange	Yellow
214	White	Red	Orange	Green
215	White	Red	Orange	Blue
216	White	Red	Orange	Violet
217	White	Red	Orange	Gray
218	White	Red	Yellow	Green
219	White	Red	Yellow	Blue
220	White	Red	Yellow	Violet
221	White	Red	Yellow	Gray
222	White	Red	Green	Blue
223	White	Red	Green	Violet
224	White	Red	Green	Gray
225	White	Red	Blue	Violet
226	White	Red	Blue	Gray
227	White	Red	Violet	Gray
228	White	Orange	Yellow	Green
229	White	Orange	Yellow	Blue
230	White	Orange	Yellow	Violet
231	White	Orange	Yellow	Gray
232	White	Orange	Green	Blue
233	White	Orange	Green	Violet
234	White	Orange	Green	Gray
235	White	Orange	Blue	Violet
236	White	Orange	Blue	Gray
237	White	Orange	Violet	Gray
238	White	Yellow	Green	Blue
239	White	Yellow	Green	Violet
240	White	Yellow	Green	Gray
241	White	Yellow	Blue	Violet
242	White	Yellow	Blue	Gray
243	White	Yellow	Violet	Gray
244	White	Green	Blue	Violet

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Table 11-1. Wire and Cable Color Codes (Cont)

Color Code No.	Background Color	Primary Tracer	Secondary Tracer	Tertiary Tracer
245	White	Green	Blue	Gray
246	White	Green	Violet	Gray
247	White	Blue	Violet	Gray
248	White	Yellow	Yellow	
249	White	Gray	Black	
250	White	Gray	Orange	
251	White	Gray	Yellow	
252	White	Violet	Black	
253	White	Violet	Brown	
254	White	Violet	Red	
255	White	Violet	Orange	
256	White	Violet	Yellow	
257	White	Violet	Green	
258	White	Violet	Blue	
999	Used when color is NOT APPLICABLE, for items such as: uninsulated conductors, braids, armors, and metallic sheaths. Also used when color is not variable as for cabled conductors without an overall covering.			

B. Resistor Value Color Codes

(1) The industry standard resistor value color codes are given in Table 11-2.

Table 11-2. Resistor Value Color Codes

First (Left) Band Color (First Significant Digit)	Second Band Color (Second Significant Digit)	Third Band Color (Number Of Zeros)	Fourth Band Color (Tolerance)
Black (BLK) = 0	Black (BLK) = 0	--	--
Brown (BRN) = 1	Brown (BRN) = 1	Brown (BRN) = 0	--
Red (RED) = 2	Red (RED) = 2	Red (RED) = 00	--
Orange (ORN) = 3	Orange (ORN) = 3	Orange (ORN) = 000	--
Yellow (YEL) = 4	Yellow (YEL) = 4	Yellow (YEL) = 0000	--
Green (GRN) = 5	Green (GRN) = 5	Green (GRN) = 00000	--
Blue (BLU) = 6	Blue (BLU) = 6	Blue (BLU) = 000000	--
Violet (VIO) = 7	Violet (VIO) = 7	--	--
Gray (GRY) = 8	Gray (GRY) = 8	--	--

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Table 11-2. Resistor Value Color Codes (Cont)

First (Left) Band Color (First Significant Digit)	Second Band Color (Second Significant Digit)	Third Band Color (Number Of Zeros)	Fourth Band Color (Tolerance)
White (WHT) = 9	White (WHT) = 9	--	--
--	--	Gold (GLD) = X 0.1	Gold (GLD) = $\pm 5\%$
--	--	Silver (SLV) = X0.01	Silver (SLV) = $\pm 10\%$
--	--	--	No 4th Band = $\pm 20\%$

C. Exponential Expressions

- (1) Decimal equivalents and prefixes for exponential expressions are given in Table 11-3.

Table 11-3. Exponential Expressions

Exponential Expression	Decimal Equivalent	Prefix Name	Symbol
10^{12}	1 000 000 000 000	tera	T
10^9	1 000 000 000	giga	G
10^6	1 000 000	mega	M
10^3	1 000	kilo	k
10^2	100	hecto	h
10^1	10	deca	da
10^{-1}	0.1	deci	d
10^{-2}	0.01	centi	c
10^{-3}	0.001	milli	m
10^{-6}	0.000 001	micro	μ
10^{-9}	0.000 000 001	nano	n
10^{-12}	0.000 000 000 001	pico	p
10^{-15}	0.000 000 000 000 001	femto	f
10^{-18}	0.000 000 000 000 000 001	atto	a

D. Temperature Conversions

- (1) Temperature conversion formulas are given in Table 11-4. Temperature equivalents for Celsius and Fahrenheit are given in Table 11-5.



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Table 11-4. Temperature Conversion Formulas

Celsius $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \div 1.8$ $^{\circ}\text{C} = ^{\circ}\text{K} - 273.16$ $^{\circ}\text{C} = 5/9 (^{\circ}\text{R} - 491.67)$	Kelvin $^{\circ}\text{K} = ^{\circ}\text{C} + 273.16$ $^{\circ}\text{K} = 5/9 (^{\circ}\text{F} - 32) + 273.16$ $^{\circ}\text{K} = 5/9 (^{\circ}\text{R} - 491.67) + 273.16$
Fahrenheit $^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32$ $^{\circ}\text{F} = ^{\circ}\text{R} = 459.67$ $^{\circ}\text{F} = 9/5 (^{\circ}\text{K} - 273.16) + 32$	Rankine $^{\circ}\text{R} = ^{\circ}\text{F} + 459.67$ $^{\circ}\text{R} = (^{\circ}\text{C} \times 9/5) + 491.67$ $^{\circ}\text{R} = 9/5 (^{\circ}\text{K} - 273.16) + 491.67$

Table 11-5. Celsius and Fahrenheit Equivalents

$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$	$^{\circ}\text{C}$	$^{\circ}\text{F}$
-100	-148	+50	+122	+200	+392
-95	-139	+55	+131	+205	+402
-90	-130	+60	+140	+210	+410
-85	-121	+65	+149	+215	+419
-80	-112	+70	+158	+220	+428
-75	-103	+75	+167	+225	+437
-70	-94	+80	+176	+230	+446
-65	-85	+85	+185	+235	+445
-60	-76	+90	+194	+240	+464
-55	-67	+95	+203	+245	+473
-50	-58	+100	+212	+250	+482
-45	-49	Boiling		+255	+491
-40	-40	+105	+221	+260	+500
-35	-31	+110	+230	+265	+509
-30	-22	+115	+239	+270	+518
-25	-13	+120	+248	+275	+527
-20	-4	+125	+257	+280	+536
-15	+5	+130	+266	+285	+545
-10	+14	+135	+275	+290	+554
-5	+23	+140	+284	+295	+563
0	+32	+145	+293	+300	+572
Freezing		+150	+302	+305	+581
+5	+41	+155	+311	+310	+590

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Table 11-5. Celsius and Fahrenheit Equivalents (Cont)

° C	° F	° C	° F	° C	° F
+10	+50	+160	+320	+315	+599
+15	+59	+165	+329	+320	+608
+20	+68	+170	+338	+325	+617
+25	+77	+175	+347	+330	+626
+30	+86	+180	+356	+335	+635
+35	+95	+185	+365	+340	+644
+40	+104	+190	+374	+345	+653
+45	+113	+195	+383	+350	+662
+355	+671	+420	+788	+480	+896
+360	+680	+425	+797	+485	+905
+365	+689	+430	+806	+490	+914
+370	+698	+435	+815	+495	+923
+375	+707	+440	+824	+505	+941
+380	+716	+445	+833	+500	+932
+385	+725	+450	+842	+510	+950
+390	+734	+455	+851	+515	+959
+395	+743	+460	+860	+520	+968
+400	+752	+465	+869	+525	+977
+405	+761	+470	+878	+530	+986
+410	+770	+475	+887	+535	+995
+415	+779				

E. Number System Equivalents

(1) Octal and Binary Equivalents

- (a) Number system equivalents for octal and binary number systems are given in Table 11-6. Conversion from octal to any other system must be done from octal through binary to the desired system. Conversion to octal from any other system must be done from the original system through binary to octal.

Table 11-6. Octal and Binary Equivalents

Octal	Binary
0	000
1	001

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Table 11-6. Octal and Binary Equivalents (Cont)

Octal	Binary
2	010
3	011
4	100
5	101
6	110
7	111
10	1000
12	1010
13	1011
14	1100
15	1101
16	1110
17	1111
20	10000
21	10001
22	10010
23	10011
24	10100
25	10101
26	10110
27	10111
30	11000
40	100000
50	101000
60	110000
70	111000
77	111111
100	1000000
110	1001000
111	1001001
120	1010000
140	1100000
170	1111000

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Table 11-6. Octal and Binary Equivalents (Cont)

Octal	Binary
177	1111111
200	10000000
240	10100000
270	10111000
277	10111111
300	11000000
340	11100000
370	11111000
377	11111111

(2) Decimal, Binary, BCD, and Hexadecimal Equivalents

- (a) Number system equivalents for the decimal, binary, binary coded decimal (BCD), and hexadecimal numbering systems are given in Table 11-7. Conversion from octal to any system other than binary must be done from octal through binary to the desired system. Conversion to octal from any system other than binary must be done from the original system through binary to octal.

Table 11-7. Decimal, Binary, BCD, and Hexadecimal Equivalents

Decimal	Binary	BCD	Hexadecimal
0	000	0000 0000	0
1	100	0000 0001	1
2	010	0000 0010	2
3	011	0000 0011	3
4	100	0000 0100	4
5	101	0000 0101	5
6	110	0000 0110	6
7	111	0000 0111	7
8	1000	0000 1000	8
9	1001	0000 1001	9
10	1010	0001 0000	A
11	1011	0001 0001	B
12	1100	0001 0010	C
13	1101	0001 0011	D
14	1110	0001 0100	E
15	1111	0001 0101	F

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Table 11-7. Decimal, Binary, BCD, and Hexadecimal Equivalents (Cont)

Decimal	Binary	BCD	Hexadecimal
16	10000	0001 0110	10
17	10001	0001 0111	11
18	10010	0001 1000	12
19	10011	0001 1001	13
20	10100	0010 0000	14
21	10101	0010 0001	15
22	10110	0010 0010	16
23	10111	0010 0011	17
24	11000	0010 0011	18
25	11001	0010 0101	19
26	11010	0010 0110	1A
27	11011	0010 0111	1B
28	11100	0010 1000	1C
29	11101	0010 1001	1D
30	11110	0011 0000	1E
31	11111	0011 0001	1F
32	100000	0011 0010	20
64	1000000	0011 0100	40
96	1100000	1001 0110	60
99	1100011	1001 1001	63

(3) Binary and Decimal Conversion Formulas

(a) Refer to Table 11-8 for binary and decimal conversion formulas.

Table 11-8. Binary and Decimal Conversion Formulas

Binary to Decimal	Decimal to Binary
$\begin{array}{r} \underline{1\ 0\ 0\ 1\ 1} \\ 1 \times 2^0 = 1 \\ 1 \times 2^1 = 2 \\ 0 \times 2^2 = 0 \\ 0 \times 2^3 = 0 \\ 1 \times 2^4 = \underline{16} \\ = 19 \end{array}$	$\begin{array}{r} \underline{19} \\ 19/2 = 9 + 1 \\ 9/2 = 4 + 1 \\ 4/2 = 2 + 0 \\ 2/2 = 1 + 0 \\ 1/1 = 1 + 1 \\ = 1\ 0\ 0\ 1\ 1 \end{array}$

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F. Decibel Definition

- (1) The decibel (dB) is a unit that is used to measure two different signals using a logarithmic scale. The gain of amplifiers (Table 11-9) and sensitivity of receivers (Table 11-10) are expressed in dB.

NOTE: The dB defines the ratio between two signal levels and not the absolute value of the signals.

- The power of a signal at the input of an amplifier (P_{IN}) and the power of the signal at the output of the amplifier (P_{OUT}) is expressed as:
 - $dB = 10 \text{ LOG } (P_{OUT}/P_{IN})$
- The difference between the voltage (V_{IN}) and current (I_{IN}) at an amplifiers input and the voltage (V_{OUT}) and current (I_{OUT}) is expressed as:
 - $dB = 20 \text{ LOG } (V_{OUT}/V_{IN})$
 - $dB = 20 \text{ LOG } (I_{OUT}/I_{IN})$

Table 11-9. Amplifier Gain

dB	Negative (-)		Positive (+)	
	Voltage or Current Ratio	Power Ratio	Voltage or Current Ratio	Power Ratio
0	10000	10000	10000	10000
1	0.8913	0.7943	1.1220	1.2589
2	0.7943	0.6310	1.2589	1.5849
3	0.7079	0.5012	1.4125	1.9953
4	0.6310	0.3981	1.5849	2.5119
5	0.5623	0.3162	1.7783	3.1623
6	0.5012	0.2512	1.9953	3.9811
7	0.4467	0.1995	2.2387	5.0119
8	0.3981	0.1585	2.5119	6.3096
9	0.3548	0.1259	2.8184	7.9433
10	0.3162	0.1000	3.1623	10.000
20	0.1000	0.0100	10.000	100.00
30	0.0316	0.0010	31.632	1000.0
40	0.0100	0.0001	100.00	10000.00
50	0.0032	0.00001	316.23	100000.00
60	0.0010	1×10^{-6}	1000.00	1×10^{-6}
70	0.0003	1×10^{-7}	3162.30	1×10^{-7}



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Table 11-9. Amplifier Gain (Cont)

dB	Negative (-)		Positive (+)	
	Voltage or Current Ratio	Power Ratio	Voltage or Current Ratio	Power Ratio
80	0.0001	1×10^{-8}	10000.00	1×10^{-8}
90	0.00003	1×10^{-9}	31623.00	1×10^{-9}
100	0.00001	1×10^{-10}	100000.00	1×10^{-10}

Table 11-10. Receiver Sensitivity

dBm	Power (mW)	Units
10	10,000000	10 mW
0	1,000000	1 mW
-10	0.100000	100 μ W
-20	0.010000	10 μ W
-30	0.001000	1 μ W
-40	0.000100	100 nW
-50	0.000010	10 nW
-60	0.000001	1 nW

NOTE: Receiver sensitivity is often expressed in dB with respect to 1 mW.

G. Logic Symbols and Functions

- (1) The ANSI/IEEE standard logic symbols used on schematics are given in Figure 11-1. Functional descriptions of the logic symbols are given in Figure 11-2.

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Symbol	Description
General Qualifying Symbols	
&	AND gate (function)
$\geq$	OR gate (function). The symbol was chosen to indicate that at least one active input is needed to activate the output.
= 1	Exclusive OR. One and only one input must be active to activate the output.
=	Logic identity. All inputs must stand at the same state.
2k	An even number of inputs must be active.
2 k+1	An odd number of inputs must be active.
1	The one input must be active.
$\triangleright$ or $\triangleleft$	A buffer or element with more than usual output capability (symbol is oriented in the direction of signal flow).
Π	Schmitt trigger; element with hysteresis
X/Y	Coder, code converter (DEC/BCD, BIN/OUT, BIN/7-SEG, etc.)
MUX	Multiplexer/data selector
DMUX or DX	Demultiplexer
Σ	Adder
P-Q	Subtractor
CPG	Look-ahead carry generator
π	Multiplier
COMP	Magnitude Comparator
ALU	Arithmetic logic unit
$\square$	Retriggerable monostable
1 $\square$	Nonretriggerable monostable (one-shot)
$\square$ G	Astable element. It is optional to show a waveform.
$\square$ IG	Synchronously starting astable
$\square$ G!	Astable element that stops with a completed pulse
SRGm	Shift register. m = number of bits

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Figure 11-1. (Sheet 1 of 4) Logic Symbols

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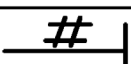
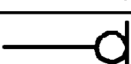
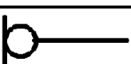
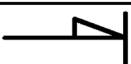
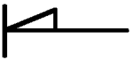
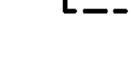
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Symbol	Description
CTRM	Counter. m = number of bits; cycle length = 2 to the power of m
CTR DIVm	Counter with cycle length = m
RCTRM	Asynchronous (ripple-carry) counter; cycle length = 2 to the power of m
ROM	Read only memory
RAM	Random-access read/write memory
FIFO	First-in, first-out memory
1 = 0	Element powers up cleared to 0 state
1 = 1	Element powers up set to 1 state
Φ	Highly complex function; 'gray box' symbol with limited detail shown under special rules.
Qualifying Symbols for Inputs and Outputs	
	Nonlogic connection. A label inside the symbol will usually define the nature of this pin.
	Input for analog signals (on a digital symbol).
	Input for digital signals (on an analog symbol).
	Logic negation at input. External 0 produces internal 1.
	Logic negation at output. Internal 1 produces external 0.
	Active-low input. Equivalent to 'Logic negation at input' in positive logic.
	Active-low output. Equivalent to 'Logic negation at output' in positive logic.
	Active-low output in the case of right-to-left signal flow.
	Active-low output in the case of right-to-left signal flow.
	Signal flow from right to left. If not otherwise indicated, signal flow is from left to right.
	Bidirectional signal flow
	Dynamic input. The transition from the external 0-state to the external 1-state produces a transitory internal 1-state. At all other times the internal logic state is 0.

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Figure 11-1. (Sheet 2 of 4) Logic Symbols

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Symbol	Description
	Dynamic input with negation. The transition from the external 1-state to the external 0-state on the input produces a transitory internal 1-state. At all other times the internal logic state is 0.
	Dynamic input with polarity symbol. The transition from the H-level to the L-level on the input produces a transitory internal 1-state. At all other times the internal logic state is 0.
	Internal connection. 1-state on left produces 0-state on right.
	Negated internal connection. 1-state on left produces 0-state on right.
	Dynamic internal connection. Transition from 0 to 1 on left produces transitory 1-state on right.
	Internal input (virtual input). It always stands at its internal 1-state unless affected by an overriding dependency relationship.
	Internal output (virtual output). Its effect on an internal input to which it is connected is indicated by dependency notation.
	Common control block outline
Symbols Inside an Outline	
	Postponed output (of a pulse-triggered flip-flop). The only change is when input initiating change (e.g. a C input) returns to its external state or level.
	Bi-threshold input (input with hysteresis)
	NPN open-collector or similar output that can supply a relatively low-impedance L level when not turned off. Requires external pull-up. Capable of positive-logic wired-AND connection.
	Passive-pull-up output is similar to NPN open collector output but is supplemented with a built-in passive pull-up.
	NPN open-emitter or similar output that can supply a relatively low-impedance H level when not turned off. Requires external pull-down. Capable of positive-logic wired-OR connection.
	Passive-pull-down output is similar to NPN open-emitter output but is supplemented with a built-in passive pull-down.
	3-state output

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Figure 11-1. (Sheet 3 of 4) Logic Symbols

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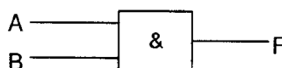
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Symbol	Description
	Output with more than usual output capability (symbol is oriented in the direction of signal flow).
	Enable input: When at its internal 1-state, all outputs are enabled. When at its internal 0-state, open-collector and open-emitter outputs are off, three-state outputs are in the high-impedance state, and all other outputs (e.g., totem-poles) are at the internal 0-state.
J, K, R, S, T	Usual meanings associated with flip-flops (e.g., R = reset, T = toggle).
	Data input to a storage element equivalent to
	Shift right (left) inputs, m = 1, 2, 3, etc., If m = 1, it is usually not shown.
	Counting up (down) inputs, m = 1, 2, 3, etc., If m = 1 it is usually not shown.
	Binary grouping. m is highest power of 2.
	The contents-setting input, when active, causes the content of a register to take on the indicated value.
	The content output is active if the content of the register is as indicated.
	Input line grouping. Indicates two or more terminals used to implement a single logic input.
	Fixed-state output always stands at its internal 1-state

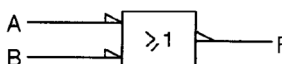
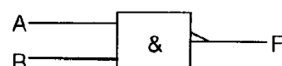
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Figure 11-1. (Sheet 4 of 4) Logic Symbols

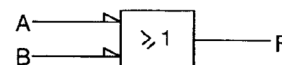
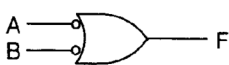
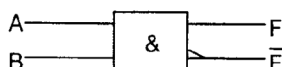
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AND/NAND LOGIC**AND function**

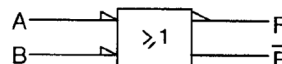
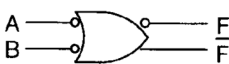
A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

**ANSI / IEEE****NAND function**

A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

**ANSI / IEEE****AND/NAND function with complementary outputs**

A	B	F	$\bar{F}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

**ANSI / IEEE**

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Figure 11-2. (Sheet 1 of 7) Logic Functions

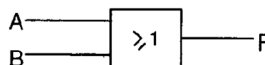
EFFECTIVITY

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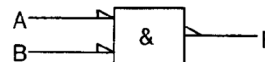
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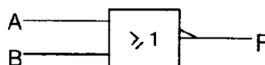
Part No. SOPM20-00-03

OR/NOR LOGIC**OR function**

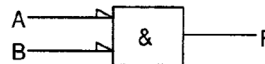
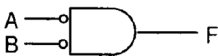
A	B	F
0	0	0
0	1	1
1	0	1
1	1	1



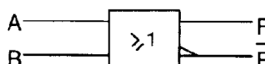
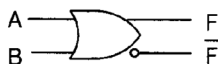
ANSI / IEEE

NOR function

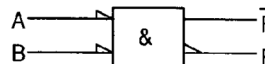
A	B	F
0	0	1
0	1	0
1	0	0
1	1	0



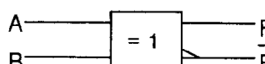
ANSI / IEEE

OR/NOR function with complementary outputs

A	B	F	$\overline{F}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0



ANSI / IEEE

Exclusive OR/NOR function with complementary outputs

A	B	F	$\overline{F}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

ANSI / IEEE

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Figure 11-2. (Sheet 2 of 7) Logic Functions

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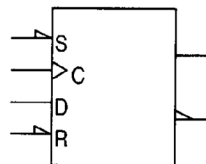
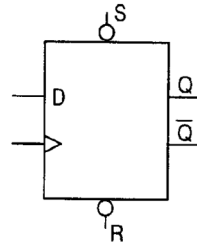
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FLIP-FLOP/LATCH

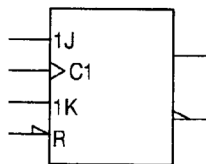
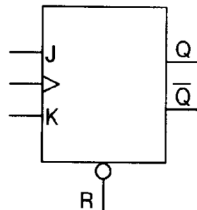
Clocked D flip-flop



ANSI / IEEE

@tn	@tn+1	
D	Q	$\bar{Q}$
L	L	H
H	H	L

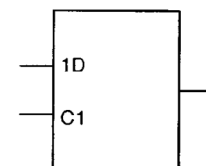
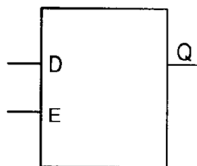
Clocked JK flip-flop



ANSI / IEEE

@tn		@tn+1	
J	K	Q	$\bar{Q}$
L	L	Q_0	$\bar{Q}_0$
L	H	L	H
H	L	H	L
H	H	TOGGLE	

D-type latch



ANSI / IEEE

D	E	Q
L	H	L
H	H	H
X	L	Q_0

Key to truth tables

- H = high voltage level
- L = low voltage level
- X = high or low level (immaterial)
- t_n = bit time before clock pulse
- $t_n + 1$ = bit time after clock pulse
- Q_0 = same output level that existed before the steady-state input change
- TOGGLE = each output changes to the complement of its previous level on each clock transition

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Figure 11-2. (Sheet 3 of 7) Logic Functions

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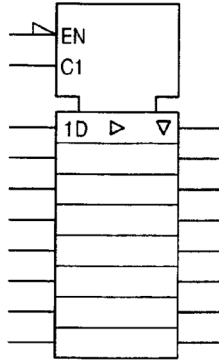
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MULTIPLE D FLIP-FLOP

Symbol and truth table



TRUTH TABLE			
INPUTS			OUTPUT
EN	C1	1D	
L	L to H	L	L
L	L to H	H	H
L	L	X	Q_0
H	X	X	Z

Device operation

Two inputs control the octal D flip-flop shown above:

- C1 = data clock input
- EN = output enable/inhibit input.

If EN is true (low), the state of each data input (1D) moves to the output at the rise of the next clock pulse.

Function symbols

The symbols shown in the first flip-flop element identify internal functions:

- Right-pointing triangle shows the direction of data flow inside the element at the clock transition
- Downward-pointing triangle shows a 3-state output with a high impedance (Z) state. The high-Z state isolates the external connections from the outputs.

Primary use

Multiple D flip-flops are used to synchronize the movement of data and addresses in processor-based circuits.

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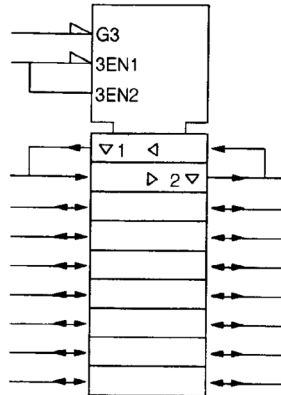
Figure 11-2. (Sheet 4 of 7) Logic Functions

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BUS TRANSCEIVER

Symbol and truth table



TRUTH TABLE		
CONTROL INPUTS		PORT CONDITION
G3	3EN1/3EN2	
L	L	Right to Left
L	H	Left to Right
H	X	High Z

Device operation

Two inputs control the multiple line driver/receiver (transceiver) shown above:

- G3 = data transfer gate enable
- 3EN1/3EN2 = transmit/receive control input.

Data flows in each transceiver when gate G3 is pulled low. A high at G3 inhibits data flow and puts all ports in the high-Z state. The state of control input 3EN1/3EN2 sets the direction of data flow.

Primary use

Tri-state transceivers are used to connect logic devices to a shared bus. Two or more transceivers may be controlled in parallel to serve buses larger than 8 bits.

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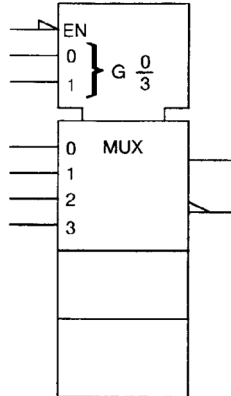
Figure 11-2. (Sheet 5 of 7) Logic Functions

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MULTIPLEXER

Symbol and truth table



TRUTH TABLE			
CONTROL INPUTS			EACH TRUE OUTPUT
EN	G ₀	G ₁	
L	L	L	I ₀
L	H	L	I ₁
L	L	H	I ₂
L	H	H	I ₃
H	X	X	L

Output subscripts 0 thru 3 indicate which data input is transferred to the output.

Device operation

Two inputs control the three logic elements shown above:

- EN = device enable input
- G₀/G₁ = 2-bit data select input.

Each logic element has four data inputs and two complementary outputs. The 2-bit code at the control G input determines which data input goes to the output. A high at the EN input forces all true outputs low.

Primary use

A multiplexer (MUX) is used as a line selector. The number of MUX elements and the number of inputs per element are the primary variables. For example:

- A quad 2-input MUX acts as a 4-pole, 2-position switch. A single bit at the G input toggles the switch position.
- An 8-input MUX acts as an 8-position switch. A 3-bit G input is necessary to select 1 of 8 positions ($2^3 = 8$).

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Figure 11-2. (Sheet 6 of 7) Logic Functions

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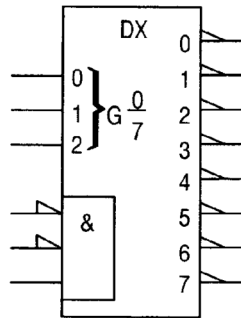
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DECODER/DEMULTIPLEXER

Symbol and truth table



TRUTH TABLE										
INPUTS			OUTPUTS							
G ₀	G ₁	G ₂	0	1	2	3	4	5	6	7
L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H
L	H	L	L	H	H	H	L	H	H	H
H	H	L	L	H	H	H	H	L	H	H
L	L	H	L	H	H	H	H	L	H	H
H	L	H	L	H	H	H	H	L	H	H
L	H	H	L	H	H	H	H	H	L	H
H	H	H	L	H	H	H	H	H	H	L

Device operation

The enable inputs in the AND (&) block make the device operate as decoder or demultiplexer:

- **Decoder Operation:** The binary code at select inputs G₀ thru G₂ activates one of eight output lines, 0 thru 7, when the enable inputs are true (one high and two lows). When the enable inputs are not true, all outputs are high.
- **Demultiplexer Operation:** Data is applied to one of the enable inputs and the data strobe to another enable input. The state of the select input G₀ thru G₂ directs the input data to one of eight outputs when the data strobe occurs.

Primary use

The device is used to perform address or function decoding (decoder mode), or to move data from the strobe input to one of several outputs (demultiplexer mode).

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Figure 11-2. (Sheet 7 of 7) Logic Functions

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SECTION 12 – CLEANING**1. Overview**

CAUTION: DO NOT USE THE PROCEDURES IN THIS SECTION TO CLEAN PWBS THAT USE SURFACE MOUNT TECHNOLOGY (SMT). REFER TO SECTION 13, SURFACE MOUNT TECHNOLOGY.

A. General

- (1) This section gives cleaning procedures for equipment manufactured by Honeywell. Contact the applicable customer or product engineer at Honeywell for cleaning procedures not given in this section.

B. Equipment and Materials

- (1) Refer to Table 12-1 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 12-2 for materials.
- (3) Equivalent alternatives are permitted for equipment and materials.

Table 12-1. Equipment for Cleaning

Item	Description	Source
Parts cleaner, drum mounted (CFC cleaning replacement)	Aqueous-based (semiaqueous) solutions (thermoplastic tub) - Model DH 336 (same as SG 336)	Commercially available
Parts cleaner, self supporting (CFC cleaning replacement)	Aqueous-based (semiaqueous) solutions (thermoplastic tub) - Model PH-522 Handi-Kleen (supported by a four-legged stand containing a work shelf). The tank contains an internal parts shelf.	CAGE: 26023
Printed circuit board cleaning system (CFC cleaning replacement)	Controlled agitation (18 cfm air flow) uses alcohols, semi- aqueous solutions or water - Jetclean Model 1500	Commercially available
Zahn cup, No. 2		Commercially available
Brush	Natural-bristle, soft, Mil-B-43871	Commercially available

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Table 12-2. Materials for Cleaning

Item	Description	Source
11-0A1-78	Rust remover, EVAPO–RUST	Commercially available
1113678	Isopropanol, Technical, per MIL TT-I-735, Grade B	Commercially available
111C678	Defluxer/cleaner semiaqueous, terpene — BIOACT EC-7R	Commercially available
111C778	Defluxer/cleaner, semiaqueous, terpene — BIOACT EC-Ultra	Commercially available
11A7378	Cleaner and degreaser, SIMPLE GREEN	Commercially available
11C1878	Cleaner, K-Lens-M-Lens per A-A-59199, Type I	Commercially available
11X0152	Cleaner, optical, thin film — TFC	CAGE: 11536
11X2586	Cleaner, glass ALG/CR215	Commercially available
6008676	Lint free cloth — Bluewipes, No. TX512	Commercially available
Wet/dry antistatic sachet	Visial antistatic instrument sachet, ALG/CR215	Commercially available

2. Procedure

WARNING: CLEANING SOLVENTS CAN BE DANGEROUS. WEAR AN APRON, A PAIR OF GLOVES, AND GLASSES OR A FACE SHIELD FOR PROTECTION.

WARNING: MAKE SURE YOU DO THE WORK IN A WELL VENTILATED AREA. THIS WILL GIVE YOU PROTECTION FROM BREATHING VAPORS AND FUMES FROM THE CLEANING SOLVENTS.

CAUTION: MAKE SURE ANY COMPONENTS NEAR THE AREA YOU WILL CLEAN HAVE PROTECTION FROM CLEANING SOLVENTS.

CAUTION: DO NOT CLEAN ALL COMPONENTS THAT HAVE CONTAMINATION. DISCARD AND REPLACE THE CONTAMINATED COMPONENTS THAT FOLLOW:

- COMPONENTS THAT WERE NOT IN A PROTECTIVE CASE
- COMPONENTS THAT WERE NOT ENCAPSULATED IN A COMPOUND, SUCH AS CONFORMAL COATING OR POTTING COMPOUND
- COMPONENTS THAT CAN BE COMPROMISED BY THE CLEANING SOLVENT.

A. General Warnings, Cautions, and Data About Cleaning Procedure

- (1) The warnings and cautions that precede this paragraph apply to all procedures in this section.
- (2) In this procedure, the defluxer/cleaner and cleaner and degreaser are referred to as cleaner.

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B. Cleaning with a JetClean Parts Cleaner

(1) General Data

- (a) The JetClean Model 1500 Parts Cleaner is used to remove dirt, grime, contamination, and conformal coating from PWBs and CCAs. Procedures to operate the JetClean are supplied with the unit. The procedures that follow are for maintenance and initial startup for the JetClean.

(2) JetClean Liquid Maintenance

(a) Liquid Level

- 1 The liquid level in the tanks must be maintained approximately 1 inch (25.4 mm) above the top ports in the cleaning and rinsing chambers. This will prevent air from aerating the solutions. The top ports are the fluid return ports from the pumps.

(b) Liquid Replacement

- 1 The liquid must be replaced when it becomes significantly contaminated with foreign particles or the color changes. Replace the liquid as follows:
- a Remove the pipe plug from the drain valve.
 - b Attach the hose supplied with the unit.
 - c Get an approved waste container and ground it to the unit housing.
 - d Open the drain valve.
 - e After the liquid has completely drained, flush the tank to remove any remaining contamination.
 - f Close the drain valve.
 - g Remove and store the hose.
- (1) Install the pipe plug in the drain valve.

(3) JetClean Filter Maintenance

- (a) Clean the JetClean filter bowls as follows:

CAUTION: THE INNER ASSEMBLY OF THE JETCLEAN IS ATTACHED BY THE DRAIN HOSE TO THE OUTER CONTAINMENT VESSEL. DO NOT LIFT THE INNER ASSEMBLY TOO HIGH BECAUSE THE CONTAINMENT VESSEL COULD BE PULLED OUT OF POSITION OR THE DRAIN HOSE DAMAGED. USE TWO PERSONS TO LIFT THE INNER ASSEMBLY.

- 1 With two people, grasp the corners on the side of the inner assembly and lift vertically approximately one foot (enough height to let the inner assembly turn slightly).
- 2 Turn the inner assembly approximately 30 degrees clockwise and put it on top of the outer vessel at three points as shown in Figure 12-1.

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- 3 Clean the filter screen as follows:
- a Shake the loose unwanted material from the screen.
 - b Put the screen in a container of cleaner, and lightly shake it.
 - c Wash the screen in water.
 - d Carefully remove any remaining unwanted material as necessary from the screen.

CAUTION: BE CAREFUL WHEN YOU SEAT THE O-RING. IT CAN GET DAMAGED IF YOU PINCH IT.

- 4 Put the O-ring in the seat, then install and hand tighten the bowl in the housing. Do not pinch the O-ring.
- 5 Do a check of the air line moisture filters and drain as necessary.
- 6 Do a check of all connections and hoses to make sure there is no damage.

EFFECTIVITY

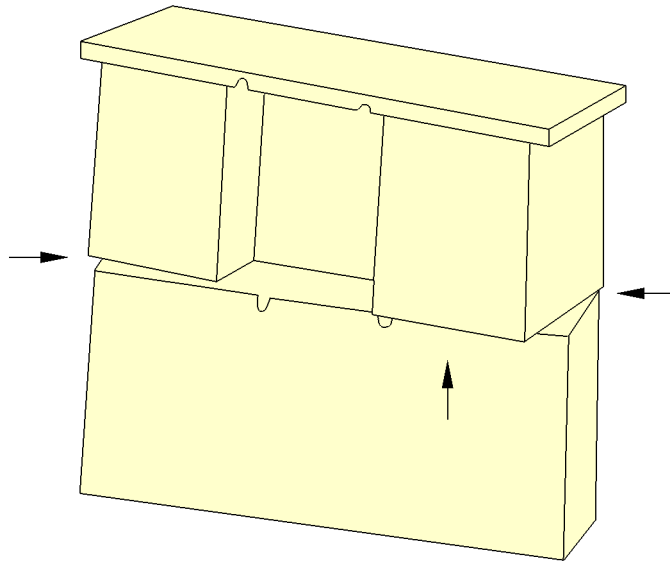
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Figure 12-1. JetClean Inner Assembly Three-Point Support for Maintenance

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- (4) JetClean Initial Startup
- (a) Make sure the drain valve is closed.
 - (b) Make sure the plug is tightened sufficiently.
 - (c) Make sure the fluid chamber is filled with approximately two gallons of clean defluxer and cleaner (111C678 or 111C778) to a level above the return port (minus the volume of fluid displaced by the PWB or CCA).
 - (d) Close the lid of the JetClean.
 - (e) Turn the valve lever to the ON position. A pulsing pump action will start and the fluid will begin to shake in the cleaning chamber with some bubbling action. This bubbling will continue until all the air is purged from the pump.
 - (f) Momentarily lift the lid and feel an air flow.
- NOTE:** An underfilled chamber will bubble the same as a full one will; the pump will not be damaged, but the cleaning action will not take place.
- (g) Turn the valve lever to the OFF position.
 - (h) Verify the liquid level is as specified. The JetClean is now ready to use.

CAUTION: USE ONLY NONFLAMMABLE, WATER-BASED CLEANING SOLVENTS WITH A PH OF LESS THAN 12.5 IN THE GRAYMILLS. DO NOT USE SOLVENTS, GASOLINE, ALCOHOL, MINERAL SPIRITS, ETC. EVEN A SMALL AMOUNT OF FLAMMABLE MATERIALS CAN BE A DANGEROUS FIRE HAZARD.

CAUTION: DO NOT OPERATE THE GRAYMILLS IF THE FUSIBLE LINK IS BROKEN OR BLOWN. FOR SAFETY REASONS, IT IS SET TO BLOW AT 165 DEGREES FAHRENHEIT (74 DEGREES CELSIUS).

CAUTION: DO NOT ATTEMPT TO CHANGE THE THERMOSTAT SETTING OF 115 DEGREES FAHRENHEIT (46 DEGREES CELSIUS) SET BY THE MANUFACTURER. A HIGHER TEMPERATURE WILL DAMAGE THE PUMP.

CAUTION: MAKE SURE THE HEATER IS OFF AND THE LID IS CLOSED WHEN THE GRAYMILLS IS IDLE FOR A LONG PERIOD (OVERNIGHT OR WEEKEND). THIS WILL HELP DECREASE FLUID EVAPORATION.

C. Cleaning with a Graymills Parts Cleaner

- (1) General Data
- (a) The Graymills Model DH-336 and Model PH-522 parts cleaners are used to clean grit, grime, contamination, and conformal coating from a PWB, CCA, or other electrical or mechanical assembly that is too big for the JetClean, but can fit in a 36 by 22 by 9 inch (914 by 559 by 229 mm) pan, or a 31 by 22 by 17 inch (813 by 559 by 229 mm) pan.
 - (b) Procedures to operate the Graymills parts cleaner are supplied with the unit. The procedures that follow are for maintenance of the Graymills. Do the procedures as specified to make sure that the operator is safe, and the equipment does not get damaged.



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- (2) Maintenance of the Reservoir and Strainer Basket
 - (a) Do a daily check of the reservoir to make sure it has the correct fluid level.
 - (b) Do a daily check of the strainer basket. Remove and correctly discard the solid waste.
- (3) Maintenance of the Heating Coil
 - (a) Inspect the heating coil weekly.

CAUTION: A DIRTY HEATING COIL WILL CAUSE A PREMATURE FAILURE.

 - (b) If necessary, clean the heating coil.
- (4) Maintenance of the Fluid and the Filter

CAUTION: WHEN YOU ADD FLUID, MAKE SURE THE POWER CORD ON THE PARTS CLEANER IS UNPLUGGED AND THE HEATER COIL IS COOL.

 - (a) Replace the fluid frequently. It may be necessary to replace the fluid daily if the cleaner is used regularly.
 - (b) Replace the filter when necessary. It may be necessary to replace the filter frequently if the cleaner is used regularly.

D. Cleaning Areas of PWBs, CCAs, Subassemblies, Assemblies, and Units

- (1) Use the procedures that follow to clean areas of PWBs, CCAs, subassemblies, assemblies, and units.
 - (a) Mask off the area around the contamination. Use tape or a similar material that is resistant to cleaner and degreaser. Remove any components that can be damaged by cleaners and degreasers.
 - (b) Apply cleaner to the contaminated area. Let the cleaner stay for a sufficient period of time to soften or loosen the contamination from the surface.
 - (c) Wipe the area clean. If you can not remove the contamination easily, use a stiff bristle brush moist with the cleaner to scrub the contaminated surface.
 - (d) Flush the cleaned area with deionized water until all remaining contamination and cleaner is removed.
 - (e) Air dry the cleaned area with warm air to remove all moisture.
 - (f) Replace any components you removed to do the cleaning.
 - (g) Apply conformal coating, if applicable, as specified in Section 3, Removal and Application of CCA/ECA/PWB Coatings.

E. Cleaning Optical Glass Coatings

- (1) General Data

The glass on the central display unit (CDU) and display unit (DU) has a high-quality optical coating that is easily damaged. Do not touch it with bare skin and do not press excessively hard on the glass. Use correct shop procedures to clean the glass. Remove oil, grease, dust, and dirt that collects on the surfaces. Usually, only minimal cleaning is necessary. Clean in a manner that keeps abrasion to a minimum.



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(2) Procedure

NOTE: The glass can be cleaned using steps 2.E.(2)(b)1, 2, and 6 or steps 3, 4, 5, and 6.

WARNING: BEFORE YOU USE A MATERIAL, KNOW THE HAZARD CODE AND GET THE NECESSARY PROTECTION. REFER TO THE PAGE ON HAZARD CODES FOR MATERIALS IN THE FRONT OF THIS MANUAL.

CAUTION: THE GLASS HAS A HIGH-QUALITY OPTICAL COATING THAT IS EASILY DAMAGED. DO NOT TOUCH THE GLASS WITH YOUR BARE SKIN.

CAUTION: CLEAN IN A MANNER THAT KEEPS ABRASION OF THE COATING TO A MINIMUM. DO NOT APPLY A CLEANER DIRECTLY TO THE SURFACE OF THE SCREEN. APPLY TO A TISSUE OR A SWAB FIRST.

CAUTION: USE ONLY CLEAN, DRY, COMPRESSED AIR ON THE GLASS.

CAUTION: BEFORE YOU USE ISOPROPANOL AS A SOLVENT, MAKE SURE IT DOES NOT DAMAGE THE PAINTED SURFACES. APPLY A MINIMUM QUANTITY OF THE SOLVENT. DO NOT APPLY A SOLVENT DIRECTLY TO THE SURFACE. APPLY TO A TISSUE OR A SWAB FIRST.

(a) Preparation

Carefully remove any particles of grit, dirt, or sand with dry, compressed air or a clean, soft, natural-bristle brush.

(b) Cleaning

1 Clean with alcohol (1113678).

- a Dampen a clean piece of cleaning tissue with alcohol (1113678).
- b Carefully wipe the glass with the moist tissue until the glass is clean.
- c Alcohol (1113678) occasionally causes a layer of residue to show on the glass. Remove this layer with thin film cleaner.

2 Clean with thin film cleaner (11X0152).

- a Dampen a clean piece of cleaning tissue with the thin film cleaner (11X0152).
- b Carefully wipe the glass with the moist tissue until the glass is clean.
- c Wipe off any remaining moisture with a clean, dry cleaning tissue.

3 Clean with Alglas Visial VDU Cleaner (11X2586).

- a Dampen a clean piece of cleaning tissue with Alglas Visial VDU cleaner (11X2586).
- b Carefully wipe the glass with the moist tissue until the glass is clean.
- c Wipe off any remaining moisture with a clean, dry cleaning tissue.

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- 4 Clean with Alglas Visial Wet/Dry Anti-Static Sachet.
 - a Carefully wipe the glass with the wet sachet until the glass is clean.
 - b Wipe off remaining moisture with the dry sachet.
- 5 Clean with K-Lens-M-Lens Cleaner (11C1878).
 - a Spray K-Lens-M-Lens cleaner (11C1878) on the glass face.
 - b Carefully wipe the glass with a cleaning tissue until the glass is clean.
 - c Wipe off any remaining moisture with a clean, dry, cleaning tissue.
- 6 If any streaking occurs on the glass, wipe off with a clean tissue dampened with distilled water.

F. Clean with EVAPO-RUST rust remover.**(1) General Data**

The EVAPO-RUST rust remover is used to remove rust from ferrous metal and stainless steel. EVAPO-RUST removes deep rust on all types of mild steel and iron. It is safe on all surfaces and will not harm copper, brass, aluminum, plastic, rubber or vinyl. It is non-toxic, non-corrosive, biodegradable and contains no acids or alkalis. It is non-flammable and contains no petroleum solvents.

(2) Procedure**(a) Preparation**

Pre-clean item(s) to remove oil and dirt, using compressed air or a clean, soft cloth.

(b) Cleaning1 Light rust removing

- a Rinse item(s) in EVAPO-RUST
- b Immerse item(s) fully for 20 minutes or as needed
- c Check progress periodically
- d Once rust is removed, rinse item with water.

2 Deep rust removing (5mm or deeper)

- a Dip item(s) into EVAPO-RUST
- b Soak item(s) overnight (8 hours) or as needed.

3 Rust prevention

- a Dip item(s) back into EVAPO-RUST
- b Allow to dry.

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SECTION 13 – SURFACE MOUNT TECHNOLOGY

1. Surface Mount Technology (SMT) Overview

A. Background Information

- (1) Circuit technologies for various avionic applications require large scale integration (LSI), very large scale integration (VLSI), and very high-speed integrated circuits (VHSIC). The constant trend in the electronics industry is to shrink electronic module sizes, thus requiring unique approaches to packaging.
- (2) Surface mounting is the prime technique for reducing size, weight, and cost by improving the packaging density. It was initiated for military requirements for size and weight reduction but is expected to become the primary packaging method for commercial as well as military purposes because of cost advantages.
- (3) Surface mounting is a burgeoning technology, with problems to be resolved. The original problem, which is that there are few components in surface mounting packages, has been resolved by:
 - The introduction of all active circuit types in surface mounting packages
 - The availability of a wide variety of passive components that are specifically designed for surface mounting
 - The fact that many components designed for plunge-through mounting can be surface mounted.
- (4) The passive leadless components are the smallest individual components available; the active components in leadless packages are the smallest packaged active components and can be hermetically sealed for high reliability applications, or can be protected by organic molding for low-cost applications. The wide variety of components and the now proven low-cost methods for high-speed automated assembly have made surface mount technology (SMT) the prime contender in packaging technology.
- (5) Both the high density hybrid-based on ceramics and the lower density organic printed circuit board technologies are switching to surface-mounted components (SMCs) and techniques. The advantages of both technologies are being combined as a result.
- (6) The miniaturization of components has proceeded to the point that a term fine pitch has been coined. Fine pitch refers to any component with less than 50 mil pitch (center to center lead spacing). These components also have smaller leads and pads than standard SMCs. The only fine pitch lead shape presently being used by Honeywell is the gullwing style. The gullwing style lead is similar to the small outline integrated circuit (SOIC) package lead but much thinner.

B. Printed Wiring Boards

- (1) Several different types of printed wiring boards (PWBs) are used in surface mount projects. The two most common types are glass epoxy and copper-invar-copper PWBs.
- (2) Glass epoxy PWBs are fabricated from FR-4 glass epoxy standard multilayer material. They are lighter and cheaper to manufacture than the copper-invar-copper PWBs; however, they have a high coefficient of thermal expansion (CTE) and are not stable over temperature range. The high CTE prohibits the use of chip carrier devices on this type of PWB. Another disadvantage is warpage. Both high CTE and warpage can decrease solder joint reliability.

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- (3) Copper-invar-copper PWBs provide excellent heat sinking and dramatically reduce thermal hot spots. The coefficient of thermal expansion is much less in copper-invar-copper PWBs as compared to glass epoxy PWBs. This makes them much more conducive to leadless hermetic chip carriers (LCC) and leadless chip components because of the minimal solder joint stresses caused by differences in the coefficient of thermal expansion of the LCC and the PWB. The disadvantages of the copper-invar-copper PWB compared to the glass epoxy PWB are greater weight, higher manufacturing cost, and more difficult to repair.
- (4) Duroid is another type of printed wiring board that is currently being used. It is made of a teflon-based material and mixed with either glass epoxy or ceramic material. The mixture allows for a better dielectric constant throughout the whole printed wiring board. This board is used in stripline design, high frequency and microwave products.

C. Components

- (1) General Data About Components
 - (a) The paragraphs that follow survey a variety of SMT components, their evolution for both passive and active device packaging, and comparisons between surface mounted alternatives for multichip interconnections.
- (2) Passive Components
 - (a) Passive components have been used for some time in multichip thick film circuits, primarily chip capacitors and resistor elements. Packaged components are becoming available for surface mounting. Leaded packages for capacitors and networks which have their leads formed under the body so that they can be surface mounted and leadless packages in chip carrier form are being supplied to the industry. A unique characteristic of surface mounting is in applications where chip and packaged components are being attached to both the component and solder side of the board. Chip components are widely used in thick-film hybrid circuits for decoupling, filtering, termination in digital circuits, and in linear circuits for circuit elements.
- (3) Active Devices
 - (a) The small outline (SO) package was one of the first active devices in packaged form for surface mounting. This package style has become widely used in hybrid applications in the past few years for active devices with 100 or more terminals. The overall outline of the SO package is basically a dual inline package (DIP) with leads on 0.050-inch (1.3-mm) centers that are extended and formed similar to a flat pack for surface mounting. A major advantage of this package style for hybrid application is that it can be pretested prior to substrate assembly while still offering relatively high density. Its small area, low height, and minimal weight (up to 1/10 that of a DIP) are its major advantages over DIPs. The package has orientation features on the edge of the package to aid in handling and identification.
 - (b) Flat packs come in a variety of metal and multilayer ceramic flat packages and are widely used in high reliability applications. They are available with 14 to 84 or more terminals. The typical flat package has leads on both sides; the leads exit the body of the package on 0.050-inch (1.3-mm) centers. They are formed in a gull wing fashion and surface-attached to a printed wiring board. Widely used in military packaging since the 1960's, flat packs are quickly being replaced by chip carriers.



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- (c) Another surface mount component for active device packaging is the chip carrier. Chip carriers are available in leaded and leadless forms, in both ceramic and nonceramic (printed circuit and plastic) versions. Chip carriers are available with terminal counts from 16 terminals in a 0.180-inch (4.6-mm) square package with terminals on 0.040-inch (1.0-mm) centers up to 164 terminals in 1.15-inch (29.2-mm) square packages with terminals on 0.020-inch (0.5-mm) centers. They can be purchased in array form for economy of manufacturing.
- (d) The major advantage derived by chip carriers is the improvement in packaging density from 3:1 to 5:1 versus the use of dual inline packages. The improved packaging density can equal that of single-cavity-sealed hybrid.
- (e) Complex integrated circuits in chip carriers and the matched footprint substrates can be automatically tested 100 percent before assembly. Solder assembly is a process that consistently and predictably provides high yields. These facts have created a major shift by the hybrid industry toward chip carriers and other chip components that are soldered to multilayer thick film or green tape ceramic substrates, which have been the major substrate techniques for hybrids. In addition, the individually sealed leadless ceramic chip carriers eliminate large-area hermetic seals, which have disadvantages such as being difficult to open, replace components, reseal, and retest.
- (f) With the advent of printed wiring board materials, which are matched to the temperature coefficient of expansion of ceramic chip carriers, high-density printed wiring board assemblies have been achieved. The high-density boards can provide either fewer modules of a given size or more components on a given size module.
- (g) In addition to achieving smaller volume and weight by use of leadless chip carriers, there are other important advantages, such as:
 - No leads exist that might be damaged during test and assembly
 - Loading of automated pick and place assembly is easier
 - The planar connection pads with matched pads on the substrate provide self-alignment during solder reflow
 - The leadless package provides the lowest profile chip carriers
 - Better heat transfer to substrate occurs with the leadless package
 - Higher frequency circuit operation is available by more direct electrical paths
 - Removal, retest, recovery, and replacement of components or substrates can be achieved without damage to either components or substrates
 - Soldered leads can be added to leadless chip carriers where compliant mounting is required and the leads can be replaced if damaged.
- (h) There are also disadvantages caused by the direct solder connection of the leadless chip carrier to the substrate. The direct connection causes stress in the solder joint if there is a thermal mismatch between chip carriers and the substrate or if there is a significant difference in temperature between the chip carrier and the substrate. The larger the component, the more heat is produced by the component, and the wider the range of temperature to which the components are subjected, reducing the potential reliability of the solder joint.

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D. Printed Wiring Board Component Population Types

- (1) The PWB component population types are as follows:
- SMC on primary side (side B) only of PWB
 - SMC and through-hole component (THC) both on primary side of PWB
 - THC on primary side and passive discrete SMC on secondary (side A) only of PWB
 - SMC on primary side and passive discrete SMC on secondary of PWB
 - SMC on primary and secondary sides with THC intermixed on the primary side of PWB.

E. Parts Identification and Packaging

- (1) SMT and Fine Pitch Packaging Identification
- (a) Refer to Table 13-1 for SMT and fine pitch packaging identification.

Table 13-1. SMT and Fine Pitch Packaging Identification

Term	Used in SMT	Used in Fine Pitch
Ceramic quad flat pack		X
Dual inline package	X	
Leadless chip carrier	X	
Metalized electrode face	X	
Plastic chip carrier	X	
Plastic leaded chip carrier		X
Plastic quad flat pack		X
Single inline package	X	
Surface-mounted component	X	X
Surface-mounted device	X	X
Small outline	X	
Small outline integrated circuit	X	X
Small outline large	X	
Small outline transistor	X	
Through-hole (PWB) component	X	X
Thin small outline package		X
Very small outline package		X



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(2) Integrated Circuit Packaging

- (a) The small outline (SO), small outline large (SOL), and small outline integrated circuit (SOIC) are equivalent to the DIP. Look at the beveled edge of the device in Figure 13-1. At one end of the part, there is a depression or dot which is next to pin 1. Pin 1 can also be identified by a combination of the beveled edge and a line across the end of the part. Pin 1 is at the end of the part with the band, on the side with the beveled edge. When pin 1 is found, count the pins counterclockwise around the device.

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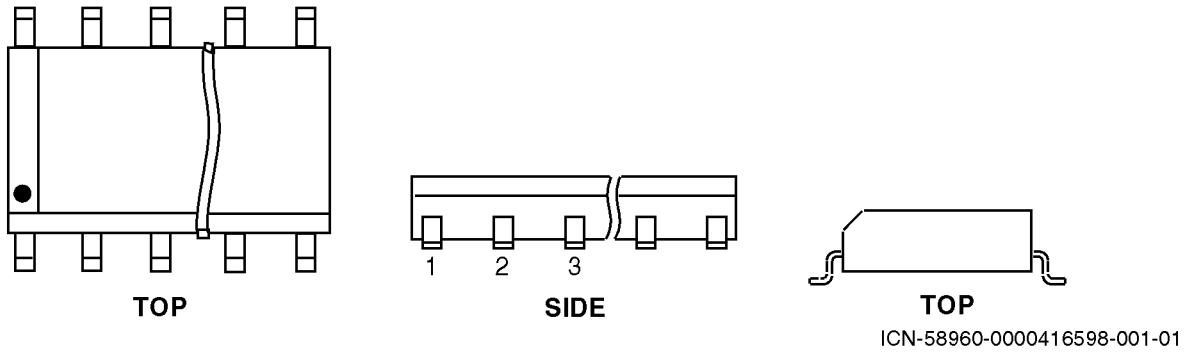


Figure 13-1. SMT SO and SOIC Packages

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The SOL packages are the same as the SO and SOIC, but the only difference is that the leads on the SOL are J-shaped (Figure 13-2).

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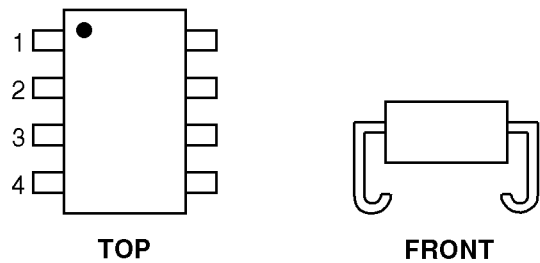
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Figure 13-2. SMT SOL Package



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- (b) Plastic leaded chip carrier (PLCC) and plastic chip carrier (PCC) devices are also numbered counterclockwise. It is necessary to look at the beveled edge and the angled corner to find pin 1 (Figure 13-3). Pin 1 will be about in the center along the beveled edge. If the PCC has an even number of pins along the edge, pin 1 will be the first pin left of the center line to the angled corner. Count the pins counterclockwise.

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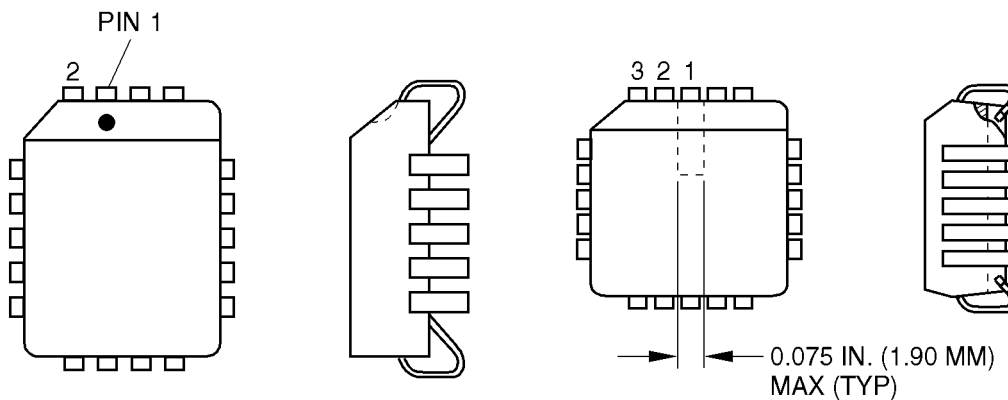
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Figure 13-3. SMT PLCC and PCC Packages

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(3) Transistor and Diode Identification

- (a) The small outline transistor (SOT) is a three-pin device, usually a transistor or diode. The top view of the SOT-23 in Figure 13-4 shows the part just as you would see it installed on a PWB. Install the part as shown, and count the pins counterclockwise. This numbering system is standard. Other systems exist and it will possibly be necessary to disregard the numbering system and identify pins in terms of their functions.

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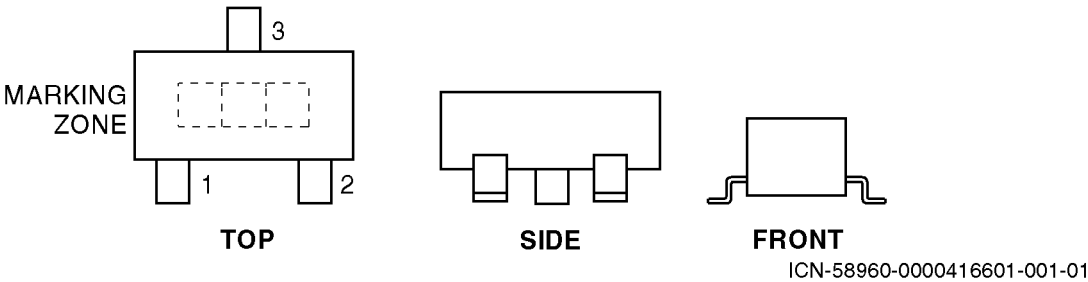


Figure 13-4. SMT SOT-23 Package



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- (b) The SOT-89 package (Figure 13-5) is almost the same package as the SOT-23, but slightly larger. The leads are found on one side of the device with a protrusion on the opposite side in the center. This package is used for higher power devices. Orient the part as shown and count the pins from left to right.

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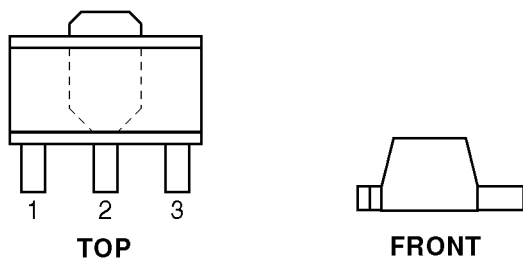
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Figure 13-5. SMT SOT-89 Package

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- (c) The metalized electrode face (MELF) package (Figure 13-6) is usually used for diodes. The purchased part drawing is the last authority on the marking. Usually the anode is the slotted end. Color bands usually give the value and tolerance of the part.

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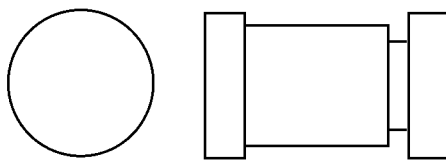
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Figure 13-6. SMT MELF Package



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(4) Capacitor Identification

- (a) Tantalum chip capacitors are usually identified by the weldment or wire nib at the anode or positive end (Figure 13-7). This is usually present on the various package styles. Tantalum chip capacitors without a weldment or nib usually have a colored band or bar at the anode or positive end.

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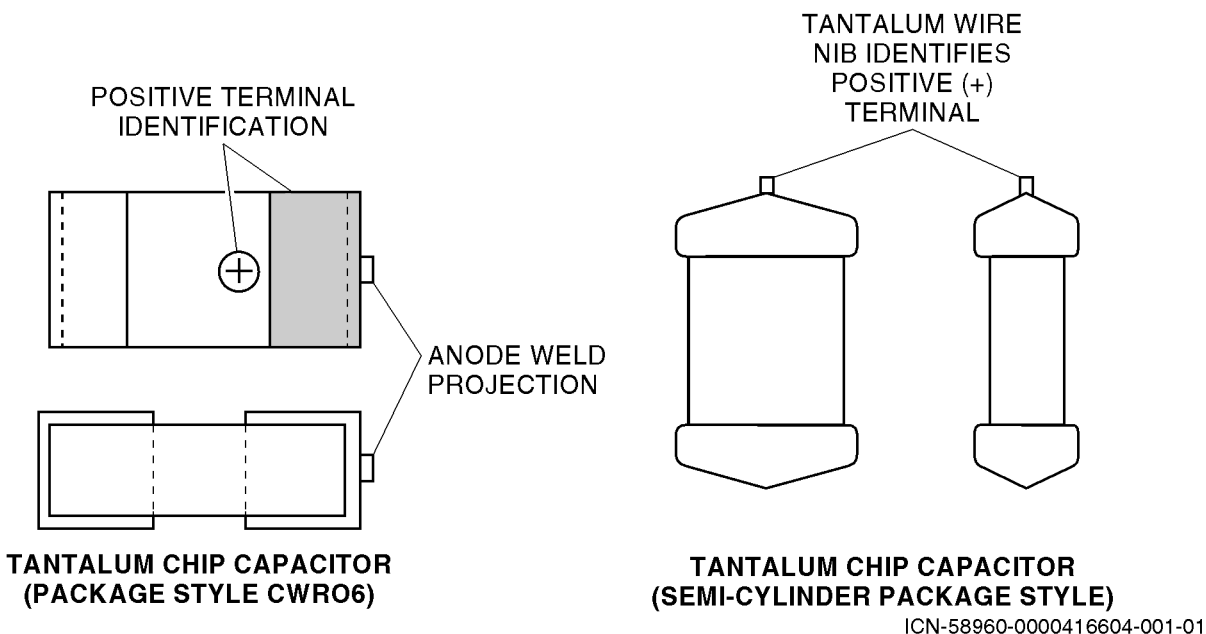


Figure 13-7. SMT Tantalum Chip Capacitors

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- (b) Ceramic chip capacitors (Figure 13-8) are not polarized but can be identified by their markings. Table 13-2 and Table 13-3 give the information necessary to decode the markings. Each table shows a different coding system.

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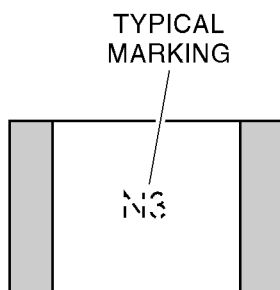
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Figure 13-8. SMT Ceramic Chip Capacitors

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Table 13-2. Code for SMT Ceramic Chip Capacitor Alphanumeric

Letter	Value	Letter	Value	Letter	Value
A	1.0	N	3.3	a	2.5
B	1.1	P	3.6	b	3.5
C	1.2	Q	3.9	d	4.0
D	1.3	R	4.3	f	5.0
E	1.4	S	4.7	m	6.0
F	1.6	T	5.1	n	7.0
G	1.8	U	5.6	t	8.0
H	2.0	V	6.2	y	9.0
J	2.2	W	6.8		
K	2.4	X	7.5		
L	2.7	Y	8.2		
M	3.0	Z	9.1		

NOTE: Use this table to cross-reference the letter on the capacitor (Figure 13-8) to the numeric value. The number that follows the letter tells how many positions to move the decimal point to the right for numbers zero (0) thru eight (8). A nine (9) moves the decimal point one position to the left. The resulting number is the capacitance in picofarads.

Example: Value Code N3

N Indicates a value of 3.3 from table above

3 Indicates move the decimal point 3 places to the right

N3 = 3,300 pF or 0.0033 μ F

Table 13-3. Code for SMT Ceramic Chip Capacitor Color

Character	Red (μ F)	Violet (μ F)	Blue (pF)	Green (pF)	Black (pF)	Orange (pF)
A	.10	.010	1000	100	10	1.0
B	.11	.011	1100	110	11	1.1
C	.12	.012	1200	120	12	1.2
D	.13	.013	1300	130	13	1.3
E	.15	.015	1500	150	15	1.5
H	.16	.016	1600	160	16	1.6
I	.18	.018	1800	180	18	1.8
J	.20	.020	2000	200	20	2.0
K	.22	.022	2200	220	22	2.2
L	.24	.024	2400	240	24	2.4
N	.27	.027	2700	270	27	2.7
O	.30	.030	3000	300	30	3.0

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Table 13-3. Code for SMT Ceramic Chip Capacitor Color (Cont)

Character	Red (μ F)	Violet (μ F)	Blue (pF)	Green (pF)	Black (pF)	Orange (pF)
R	.33	.033	3300	330	33	3.3
S	.36	.036	3600	360	36	3.6
T	.39	.039	3900	390	39	3.9
V	.43	.043	4300	430	43	4.3
W	.47	.047	4700	470	47	4.7
X	.51	.051	5100	510	51	5.1
Y	.56	.056	5600	560	56	5.6
Z	.62	.062	6200	620	62	6.2
3	.68	.068	6800	680	68	6.8
4	.75	.075	7500	750	75	7.5
7	.82	.082	8200	820	82	8.2
9	.91	.091	9100	910	91	9.1
NOTE: The chip can be identified with a colored character. Find the character in this table and move to the column under the color of the character to find the value.						

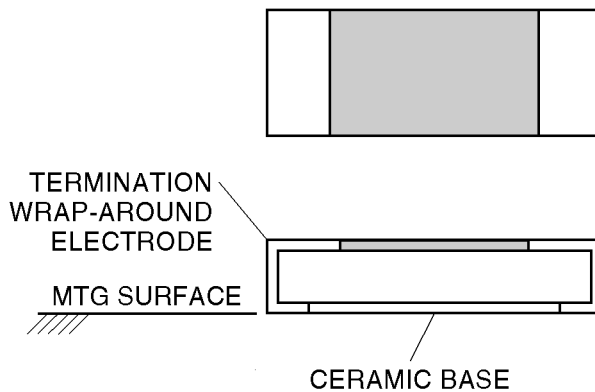
(5) Resistor Identification

- (a) Cermet chip resistors (Figure 13-9) usually have a three- or four-digit code stamped on the device which is used to find its value.



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Figure 13-9. SMT Cermet Chip Resistors

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- (b) The system of codes used to find the value of surface mount chip resistors is dependent upon the resistor tolerance. For 2% and 5% chip resistors, the value of the resistor can be found as follows.
- For values greater than 10 Ω , the first two digits are actual numbers. The third number is the number of positions to move the decimal point to the right.
Example: A resistor marked 103 has a value of 10,000 Ω .
 - For values less than 10 Ω , marking will contain two numbers with an R between them. The R shows where the decimal point is positioned.
Example: A resistor marked 6R8 has a value of 6.8 Ω .
 - For 0.1%, 0.5%, and 1% tolerance chip resistors, two types of codes are used. The first type is shown below, and the second type is shown in Table 13-4.
 - For values greater than 1000 Ω , the first three digits are actual numbers. The fourth number is the number of positions to move the decimal point to the right.
Example: A resistor marked 3742 has a value of 37,400 Ω .
 - For values less than 100 Ω , markings will contain three numbers with an R. The R shows where the decimal point is positioned.
Example: A resistor marked 5R62 has a value of 5.62 Ω .
- (c) Table 13-4 gives the value codes for 0.1, 0.5, and 1 percent chip resistors. The first two digits are code numbers that show the numeric value. The letter is a code which shows the number of positions to move the decimal point.

Table 13-4. Code for 0.1, 0.5, and 1 Percent SMT Chip Resistor

Code	Value	Code	Value	Code	Value	Code	Value
01	100	25	178	49	316	73	562
02	102	26	182	50	324	74	576
03	105	27	187	51	332	75	590
04	107	28	191	52	340	76	604
05	110	29	196	53	348	77	619
06	113	30	200	54	357	78	634
07	115	31	205	55	365	79	649
08	118	32	210	56	374	80	665
09	121	33	215	57	383	81	681
10	124	34	221	58	392	82	698
11	127	35	226	59	402	83	715
12	130	36	232	60	412	84	732
13	133	37	237	61	422	85	750
14	137	38	243	62	432	86	768

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Table 13-4. Code for 0.1, 0.5, and 1 Percent SMT Chip Resistor (Cont)

Code	Value	Code	Value	Code	Value	Code	Value
15	140	39	249	63	442	87	787
16	143	40	255	64	453	88	806
17	147	41	261	65	464	89	825
18	150	42	267	66	475	90	845
19	154	43	274	67	487	91	866
20	158	44	280	68	499	92	887
21	162	45	287	69	511	93	909
22	165	46	294	70	523	94	931
23	169	47	301	71	536	95	953
24	174	48	309	72	549	96	976

NOTE: The letter codes are:

A = 0 place R = 1 place left

B = 1 place right S = 2 places left

C = 2 places right

D = 3 places right

E = 4 places right

Examples:

<u>Code</u>	<u>Value</u>	<u>Code</u>	<u>Value</u>
22A	165 Ω	01S	1.0 Ω
22E	1,650,000 Ω	01R	10.0 Ω

(6) Inductor Identification

- (a) Two surface-mounted device (SMD) inductor types are commonly used by Honeywell: visible winding inductors and encapsulated inductors.

1 Visible Winding Inductor

- a The visible winding inductor shown in Figure 13-10 is marked with three color dots. To find the value, position the part as shown and read the dots in a counterclockwise direction. The dot in the upper left corner is the first significant figure. The dot just below it is the second significant figure and the dot on the right is the multiplier. The value of the dot is the standard color code value. It is important to remember that the values are read in nanohenries.

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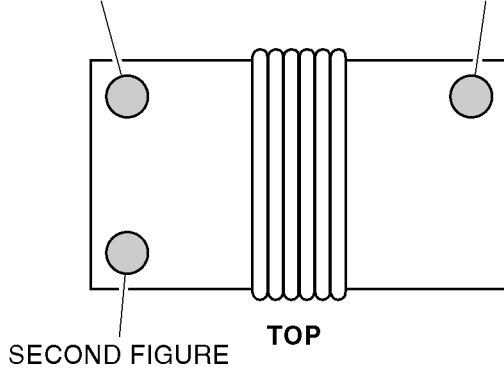
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COMMON TO ALL PARTS			
DOT COLOR	FIRST FIGURE	SECOND FIGURE	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10^1
RED	2	2	10^2
ORANGE	3	3	10^3
YELLOW	4	4	10^4
GREEN	5	5	10^5
BLUE	6	6	10^6
VIOLET	7	7	10^7
GREY	8	8	10^8
WHITE	9	9	10^9

NOTE:

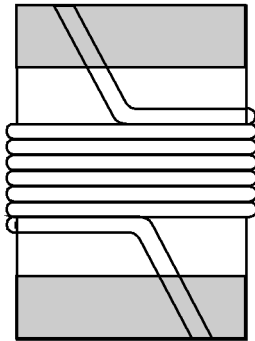
1 Values are read in nanohenries.

FIRST FIGURE MULTIPLIER

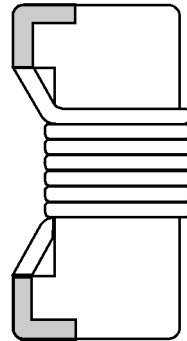


EXAMPLE:

FIRST FIGURE = BROWN = 1
 SECOND FIGURE = GREEN = 5
 MULTIPLIER = RED = $10^2 = 100$
 INDUCTANCE = 1500 NANOHENRIES



BOTTOM



SIDE

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Figure 13-10. SMT Visible Winding Inductor

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2 Encapsulated Inductor

- a The encapsulated inductor (windings are not visible) shown in Figure 13-11 is marked in two ways: the value can be laser printed directly on the part, or it can be marked with color bands. Color values are given in Figure 13-10. It is important to remember that the values are read in microhenries.

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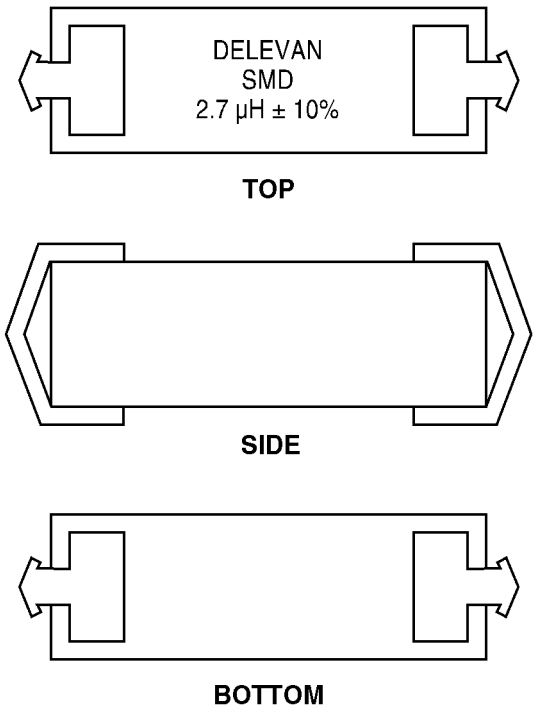
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Figure 13-11. SMT Encapsulated Inductor

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2. **SMT Equipment and Materials**

A. **Equipment and Materials For SMT Repair**

- (1) Refer to Table 13-5 for equipment.

WARNING: BEFORE YOU USE A MATERIAL, REFER TO THE MANUFACTURERS' MATERIAL SAFETY DATA SHEETS FOR SAFETY INFORMATION. SOME MATERIALS CAN BE DANGEROUS.

CAUTION: DO NOT USE MATERIALS THAT ARE NOT EQUIVALENT TO MATERIALS SPECIFIED BY HONEYWELL. MATERIALS THAT ARE NOT EQUIVALENT CAN CAUSE DAMAGE TO THE EQUIPMENT AND CAN VOID THE WARRANTY.

- (2) Refer to Table 13-6 for materials. Refer to Section 6, SOLDERING AND WIRE-WRAP, for approved soldering materials.

- (3) Equivalent alternatives are permitted for equipment and materials.

Table 13-5. Equipment for SMT Repair

Item	Description	Source
Desolder equipment	STA- TEMP Desolder System with appropriate replaceable tip cartridges	CAGE: 47882
Solder equipment	STA- TEMP Model STSS- 002 Solder System with appropriate replaceable tip cartridges	
Fine pitch vertical viewing/high resolution optics with integral hot gas or bar soldering machine [FP]	Model SIERM	CAGE: 1LG78
Hand craft knife [FP]	X- acto, with No. 16 blade	Commercially available
Hot gas rework station (SM)	Austin American Model SS620	Commercially available
Magnifier	5 to 30 power	Commercially available
Microscope [FP]	Zoom Stereo Trinocular & Accessories — Microscope system for fine pitch surface- mounted PWB work, Unitron Model ZSB	Commercially available
Parts cleaner, drum- mounted (CFC cleaning replacement)	Aqueous- based (semiaqueous) solutions (thermoplastic tub) — Model DH- 336	Commercially available
Parts cleaner, self-supporting (CFC cleaning replacement)	Aqueous-based (semiaqueous) solutions (thermoplastic tub) — Model PH-522 Handi-Kleen (supported by a four-legged stand containing a work shelf). The tank contains an internal parts shelf.	CAGE: 26023
Pneumatic handheld handling tool system [FP]	Air Vac Model EVG-100	Commercially available

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Table 13-5. Equipment for SMT Repair (Cont)

Item	Description	Source
Printed circuit board cleaning system (CFC cleaning replacement)	Controlled agitation (18 cfm air flow) uses alcohols, semi- aqueous solutions or water, Jetclean Model 1500	Commercially available
Repair station	CRAFT Model 100+	CAGE: 17794
Surface mount technology rework kit [SM]	Electa Model EZK-12 (formerly Model V8801KA12)	CAGE: 27246
Bench top repair system	Pace Model PRC-151	Commercially available
NOTE: In the Item column, [SM] indicates the equipment is only necessary to repair surface-mounted assemblies, and [FP] indicates the equipment is only necessary to repair fine pitch assemblies. All other equipment is necessary to repair either type of assembly.		

Table 13-6. Materials for SMT Repair

Item	Description	Source
1130778	Solvent — Isopropyl alcohol (99%), semigrade	Commercially available
111C678	Defluxer/cleaner, biodegradable, semi- aqueous, terpene, BIOACT EC-7R	Commercially available
111C778	Defluxer/cleaner, semi- aqueous, terpene, BIOACT EC- ULTRA,	Commercially available
111C878	Solvent, biodegradable, semiaqueous, hydrocarbon, AXAREL 32	Commercially available
11A7378	Cleaner and degreaser, SIMPLE GREEN	Commercially available
9702878	Adhesive, epoxy (Federal Specification MMM- A- 134, Type I) — A- 1177B (two parts)	Commercially available
97S0378	Adhesive, epoxy (Federal Specification MMM-A-134, Type I) — A1177B (two parts)	Commercially available

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3. SMT Cleaning

A. General Data About SMT Cleaning

- (1) In general, cleaning is done to prepare the PWB for resoldering of a replacement component and to remove any residual flux with a defluxer/cleaner or cleaner and degreaser after the soldering process has been completed. High-reliability soldering processes require the use of flux in order for the solder to wet the substrate and component metals, and to establish a smooth fillet without poor solder joint quality; however, activators in most flux materials change chemically with temperature variation. These chemical changes cause various corrosive processes to occur, stressing the need to remove the flux residue and its products after completion of the soldering operation.
- (2) Other electrical degradation failures caused by incomplete removal of flux residue are current leakage and electromigration. Current leakage is particularly detrimental to low power CMOS devices and takes place by either of two methods. The first is ionic transport where a charge is carried by free ions remaining on the part. The second is the normal electronic charge transport, generally associated with the bulk resistivity of most conductive materials. Physically, either of these methods produces an undesirable low resistance between active terminals, and can lead to electromigration. Electromigration is a physical process whereby metallic species move along with a current flow and are deposited in a tree-like pattern similar to leakage current paths. Over a period of time, this electric field-assisted process results in a short circuit of decreasing resistance.
- (3) Another problem created by SMDs is the potential trapping of particulate matter and solder balls underneath the devices. This is particularly troublesome in cleaning because of restricted access beneath these devices.

WARNING: DO NOT USE THE DEGREASER EQUIPMENT THAT WAS USED WITH FREON AND THE EARLIER METHODS OF CLEANING FLUX RESIDUE. THIS EQUIPMENT WILL PRESENT A SAFETY AND HEALTH HAZARD WHEN USED WITH CURRENT DEFLUXER/CLEANERS OR CLEANERS AND DEGREASERS.

B. Cleaning Methods

- (1) Freon-based products and other stripper agents which contain ozone depleting chemicals are no longer usable. Honeywell specifies semi-aqueous terpene (biodegradable when possible) defluxer/cleaners or cleaner and degreaser.
 - For PWBs and CCAs, use a printed circuit board, controlled-agitation (18 cfm air flow) cleaning system.
 - For units or assemblies larger than PWBs and CCAs or for any odd shaped item, use an aqueous-based (thermoplastic tub) parts cleaner.
 - For spot cleaning of a repaired area, use a stiff-bristled brush and either a specified defluxer/cleaner or isopropyl alcohol as solvent.
 - During repair you must remove all particulate matter and any residual flux without degrading either the PWB/CCA or any component on the board or assembly.
 - During single component replacement or small area repair, clean around the repair with a swab and a specified defluxer/cleaner, cleaner and degreaser, or isopropyl alcohol.

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4. **SMT Inspection**

A. **General Data About SMT Inspection**

- (1) These paragraphs give quality control techniques and inspection methods for assuring high-quality SMT hardware. It should be noted that the inspection of solder joints, particularly those on hermetic chip carriers, is still in the interpretive stage and that the characteristics described in this section should only be used as a guideline.

B. **Solder Paste Application Criteria**

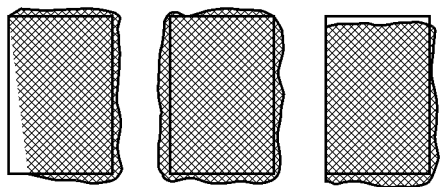
- (1) The screen printing or stenciling of solder paste forms the basis for the resultant reflowed solder joints. Screen printing or stenciling is usually done during the initial build-up of the CCA and is usually not required for repair operations; however, the application of solder paste can be required during some repair operations and as such, the alignment and thickness must be controlled. Proper alignment must be maintained to avoid bridging, solder balling, whiskers, or slivers of solder from forming. Figure 13-12 illustrates typical criteria for this function.

C. **Component Alignment**

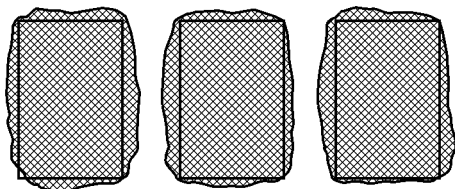
- (1) Proper component alignment during assembly is critical for the formation of acceptable solder joints after reflow. Figure 13-13 thru Figure 13-19 and Table 13-7 thru Table 13-13 show and give typical criteria for alignment.

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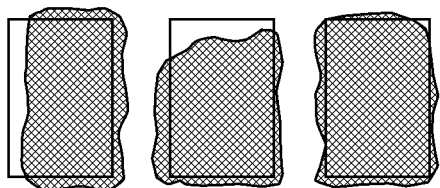
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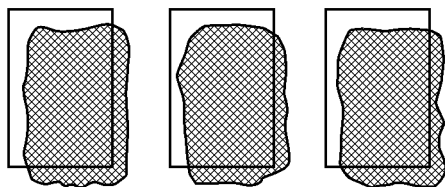
1. SOLDER PASTE IS ALIGNED WITH SOLDER PAD.
2. SOLDER PASTE CONFORMS TO SIZE AND SHAPE OF SOLDER PAD.
3. SURFACE OF SOLDER IS SMOOTH AND FREE FROM DISTURBED AREAS OR VOIDS.

**ACCEPTABLE**

1. EXCESS SOLDER PASTE EXTENDS BEYOND SOLDER PAD.
2. SOLDER PASTE DOES NOT BRIDGE TO ADJACENT PAD.

**ACCEPTABLE**

1. LESS THAN OPTIMUM AMOUNT OF SOLDER PASTE.
2. SOLDER PASTE COVERS MORE THAN 75° OF SOLDER PASTE.

**ACCEPTABLE**

1. SOLDER PASTE NOT ALIGNED WITH SOLDER PAD.
2. MORE THAN 75° OF SOLDER PAD IS COVERED WITH SOLDER PASTE.

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Figure 13-12. SMT Solder Paste Application Criteria

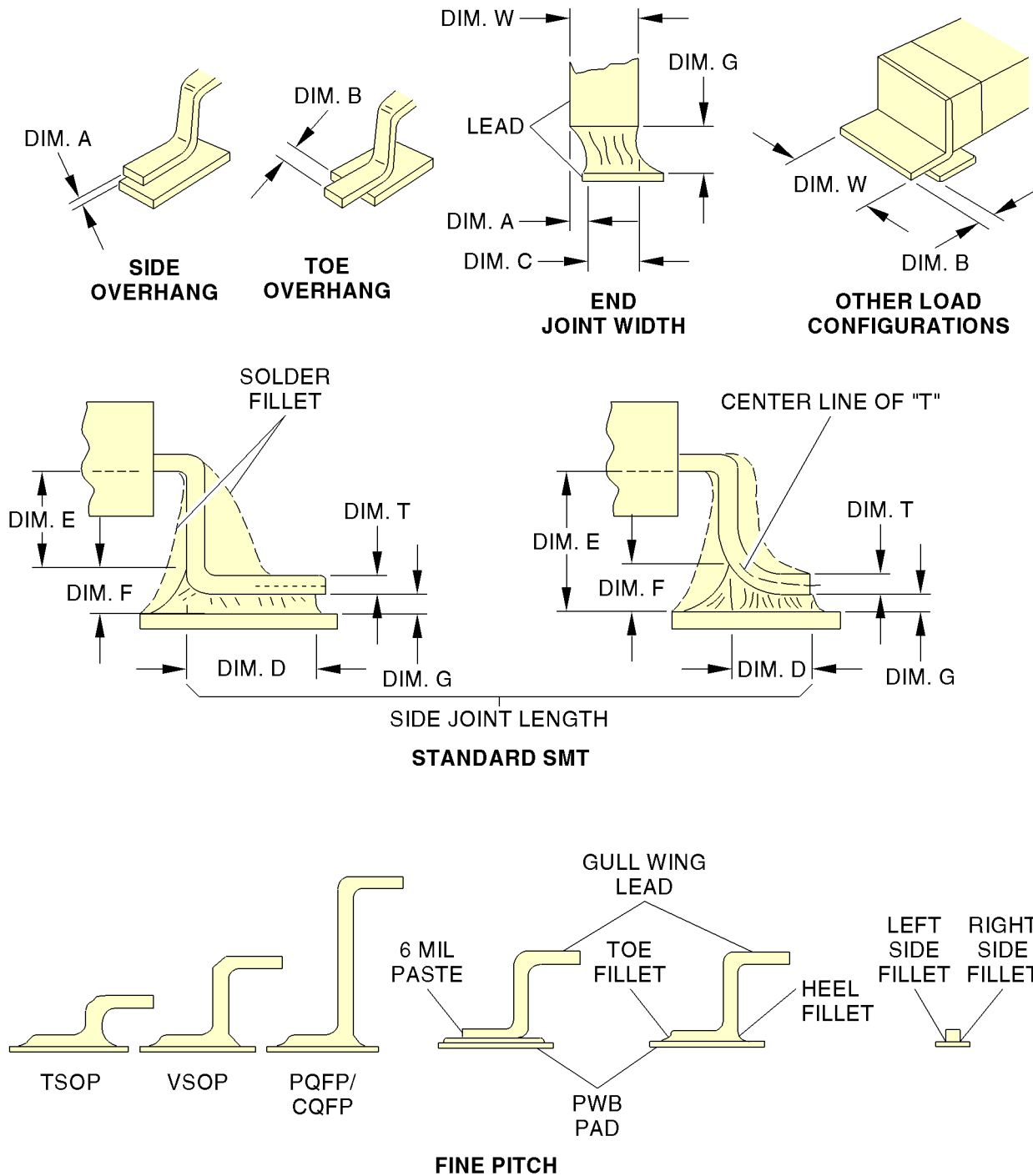
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Figure 13-13. SMT Standard, Fine Pitch, Flat L, and Gull Wing Lead Alignment

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Table 13-7. Specifications for SMT Standard, Fine Pitch, Flat L, and Gull Wing Lead Alignment

Feature	Dimension	Requirement
Max. lead/land side overhang	A	25% of flat lead width (W)
Max. toe/land overhang	B	Do not violate minimum design conductor spacing.
Min. end joint width	C	$W - A$
Min. side joint length	D	W
Max. heel fillet height	E	The solder fillet must extend to the top of the bend but not touch the package body or seal except for low profile SMDs (e.g., SOICs and SPOTs).
Min. heel fillet height	F	$G \text{ (height of land)} + T \text{ (thickness of lead)}$
Min. thickness of solder	G	The solder joint must show evidence of proper wetting fillet.
Max. thickness of solder	G	The maximum thickness is the thickness (T) X1. The fillet must be good.

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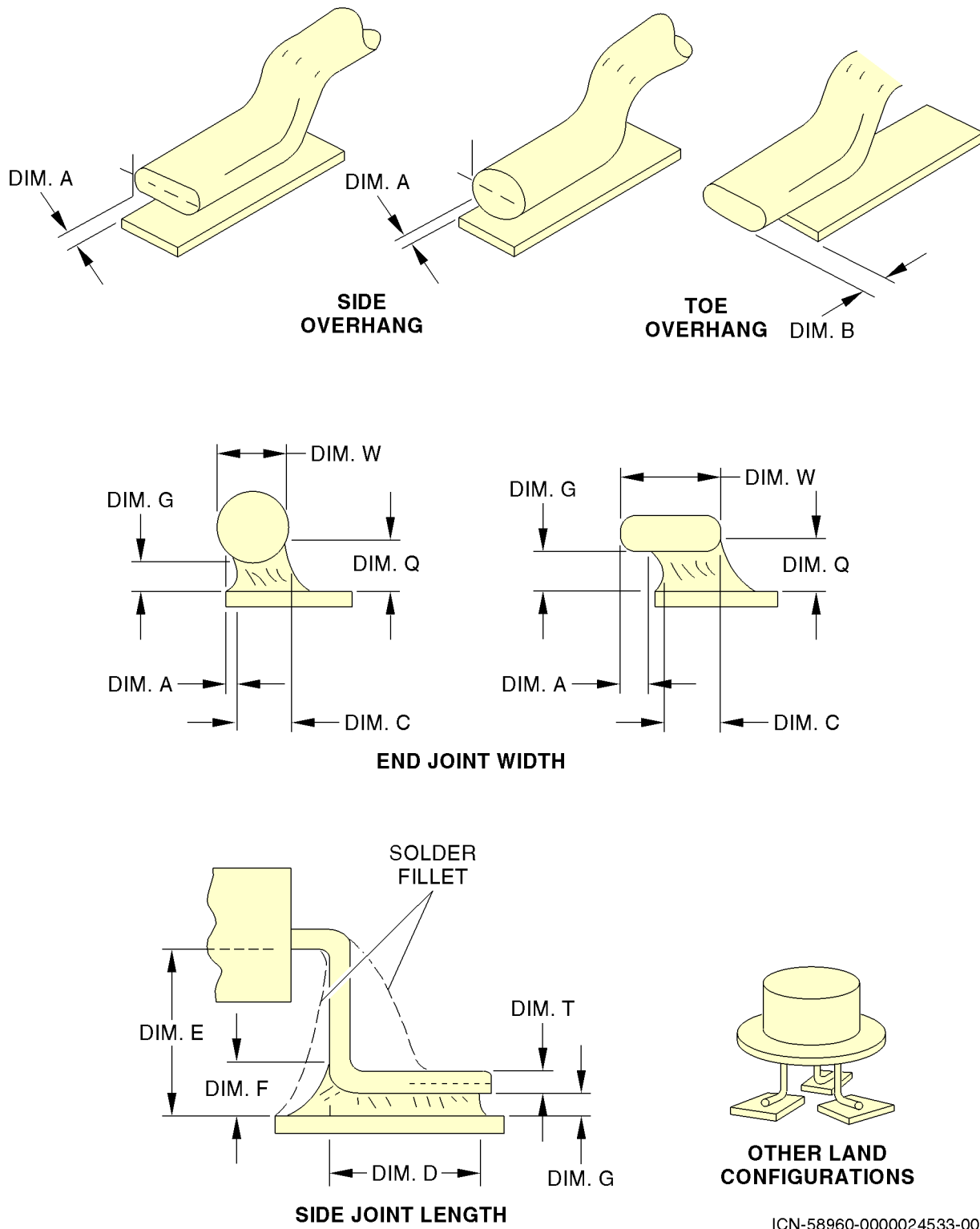


Figure 13-14. SMT Round and Flattened Lead Alignment

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Table 13-8. Specifications for SMT Round and Flattened Lead Alignment

Feature	Dimension	Requirement
Max. lead/land side overhang	A	25% of lead width (W)
Max. toe/land overhang	B	Do not violate minimum design conductor spacing.
Min. end joint width	C	$W - A$
Min. side joint length	D	$1 \frac{1}{2} \times W$
Max. heel fillet height	E	The solder fillet must extend to the top of the bend but not touch the package body or seal except for low profile SMDs (e.g., SOICs and SPOTs).
Min. heel fillet height	F	G (height of land) + T (thickness of lead)
Min. thickness of solder	G	The solder joint must show evidence of proper wetting fillet.
Max. thickness of solder	G	The maximum thickness is the thickness (T) $\times 1$. The fillet must be good.
Min. side joint height	Q	$G + \frac{1}{2} T$

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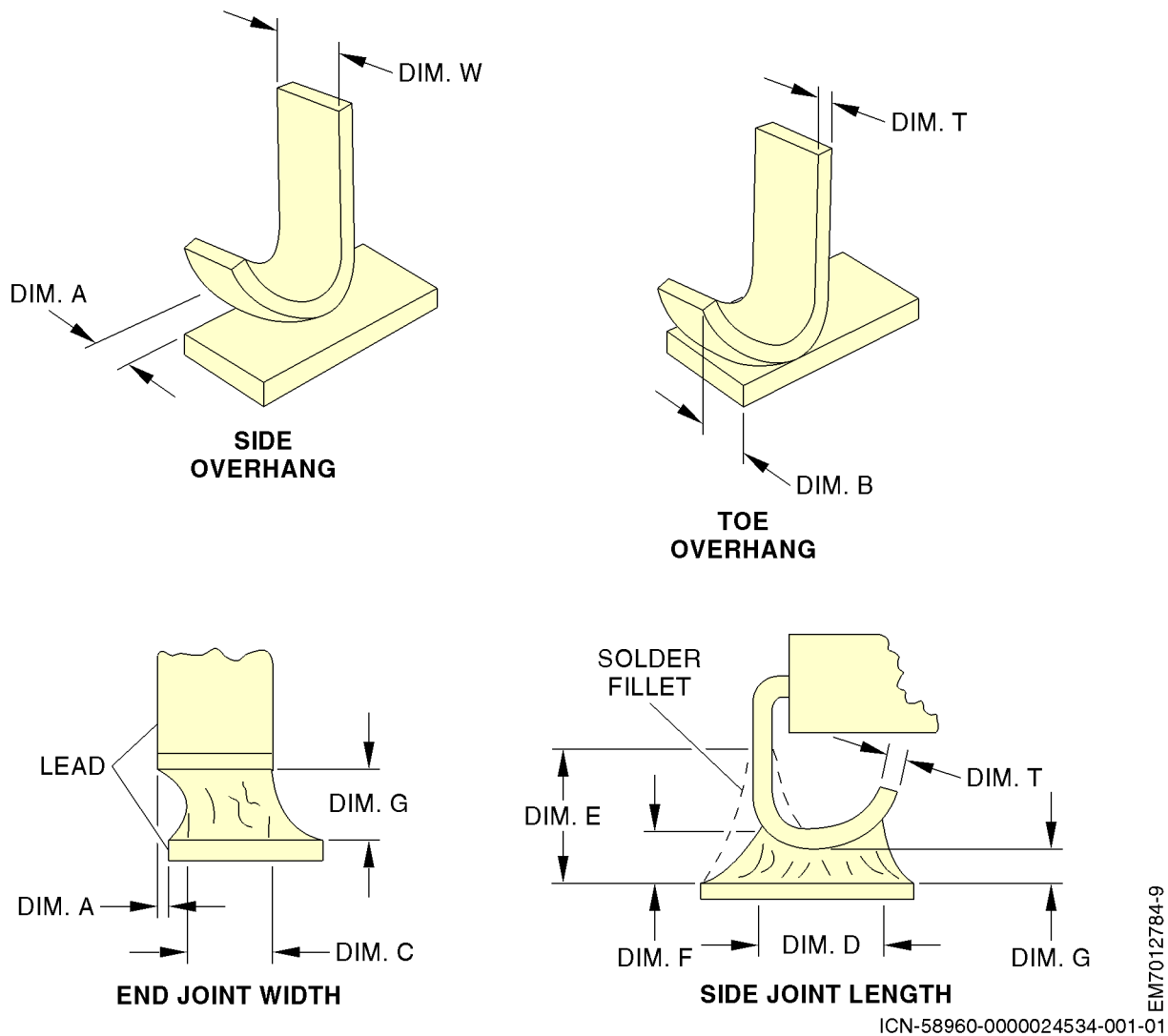


Figure 13-15. SMT J-Shaped Lead Alignment

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Table 13-9. Specifications for SMT J-Shaped Lead Alignment

Feature	Dimension	Requirement
Max. lead/land side overhang	A	25% of lead width (W)
Max. toe/land overhang	B	Unspecified parameter
Min. end joint width	C	$W - A$
Min. side joint length	D	$1 \frac{1}{2} \times W$
Max. heel fillet height	E	Maximum fillet of solder must not touch the package body.
Min. heel fillet height	F	G (height of land) + T (thickness of lead)
Min. thickness of solder	G	The solder joint must show evidence of proper wetting fillet.
Max. thickness of solder	G	The fillet must be good.

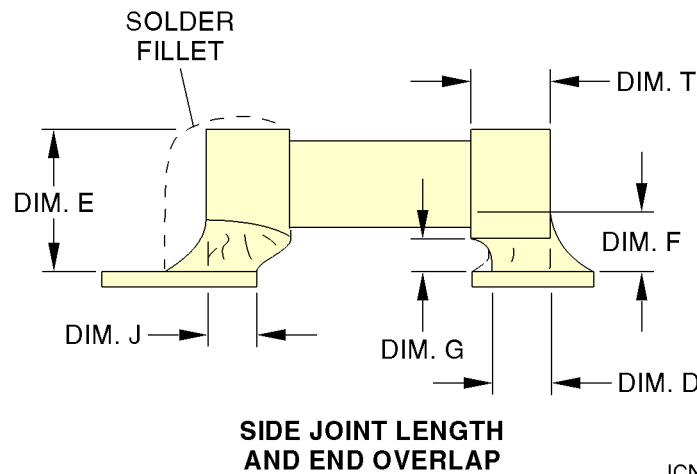
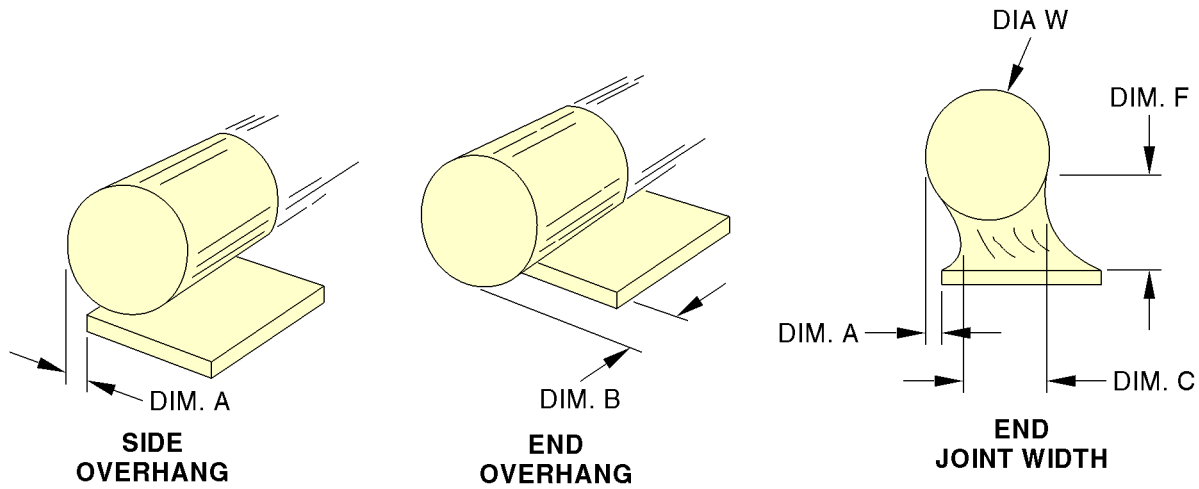
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Figure 13-16. SMT Cylindrical End Cap Termination Alignment

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Table 13-10. Specifications for SMT Cylindrical End Cap Termination Alignment

Feature	Dimension	Requirement
Max. side overhang	A	25% of lead diameter (W)
Max. end overhang	B	Not permitted
Min. end joint width	C	1/2 W (termination diameter)
Min. side joint length	D	3/4 T (termination/plating length) Does not apply to components with end only terminations.
Max. fillet height	E	Maximum fillet can overhang the land or extend onto the top of the end cap metalization. However, the solder must not extend further onto the component body.
Min. fillet height	F	G + 1/4 W
Min. thickness of solder (from component to land)	G	The solder joint must show evidence of proper wetting fillet.
Min. end overlap	J	Required

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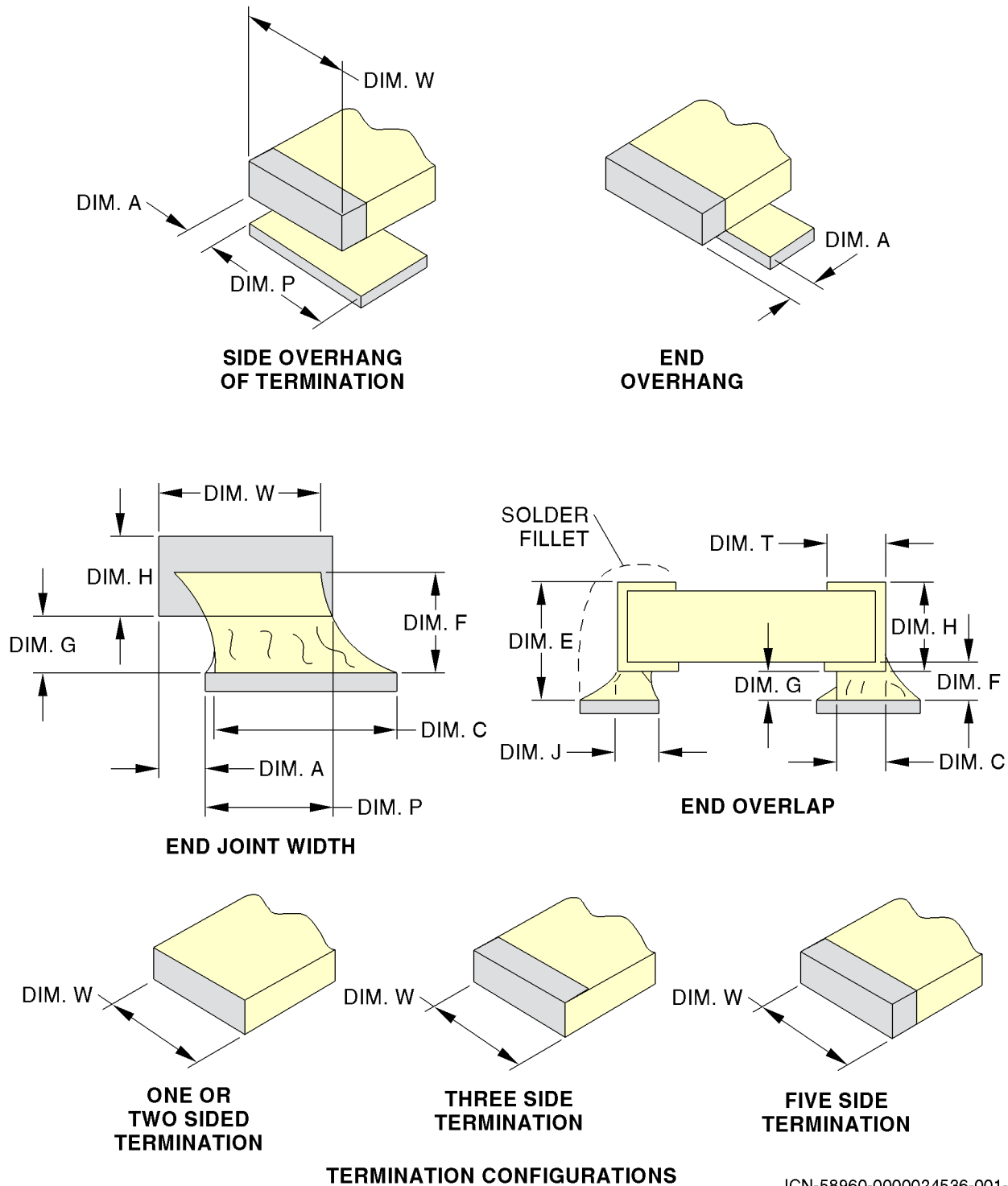
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Figure 13-17. SMT Rectangular and Square End Component Termination Alignment

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Table 13-11. Specifications for SMT Rectangular and Square End Component Termination Alignment

Feature	Dimension	Requirement
Max. side overhang	A	25% of lead width (W)
Max. end overhang A of P (land)	B	Not permitted
Min. end joint width	C	3/4 W
Min. side joint length	D	Not required
Max. fillet height	E	Maximum fillet can overhang the land or extend onto the top of the end cap metalization. However, the solder must not extend further onto the component body.
Min. fillet height	F	$G = 1/4 H$ [height of T (length of termination)]
Min. thickness of solder (from component to land)	G	0.2 inch (5 mm), unless satisfactory cleaning can be demonstrated with reduced clearance.
Min. end cap overlap	J	Required

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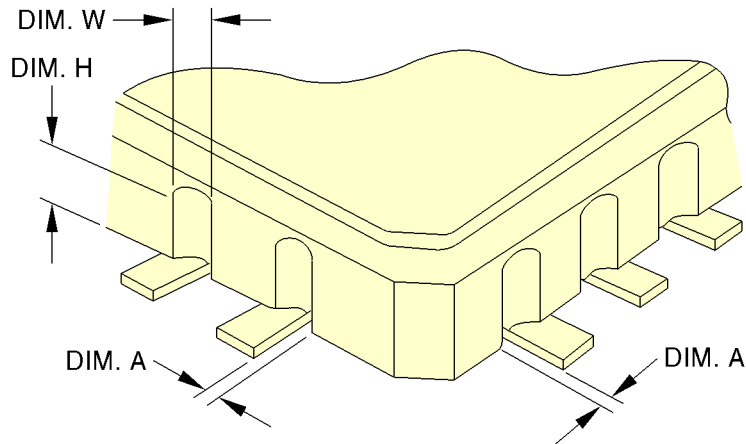
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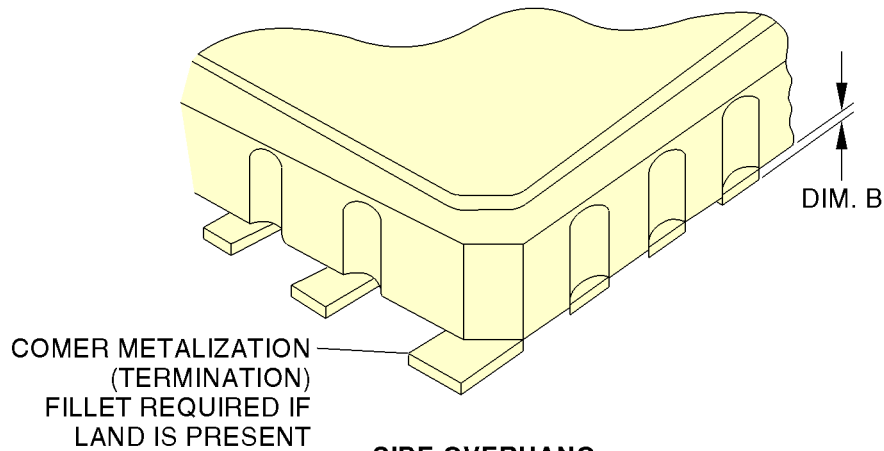
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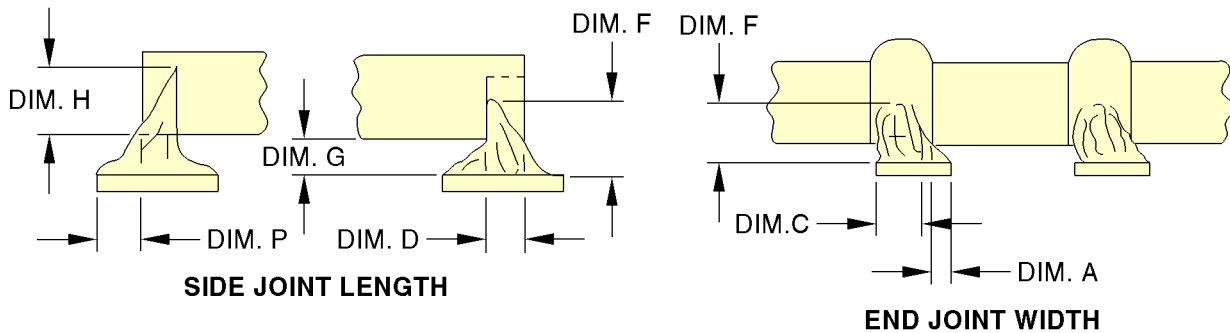
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SIDE OVERHANG



SIDE OVERHANG



SIDE JOINT LENGTH

END JOINT WIDTH

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Figure 13-18. SMT Leadless Chip Carrier and Castellated Termination Alignment

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Table 13-12. Specifications for SMT Leadless Chip Carrier and Castellated Termination Alignment

Feature	Dimension	Requirement
Max. side overhang	A	25% of lead width (W)
Max. end overhang A of P(land external to package)	B	Not permitted
Min. end joint width	C	3/4 W
Min. side joint length	D	1/2 F (min. fillet height) or P (land external to package)
Max. fillet height	E	Not applicable
Min. fillet height	F	G + 1/4 H (height of castellated depression in chip carrier body). Length D is dependent on fillet height F and is referenced to end of chip carrier body. Castellated area must be full.
Min. thickness of solder (from component to land)	G	0.02 inch (0.5 mm), unless satisfactory cleaning can be demonstrated with reduced clearance.

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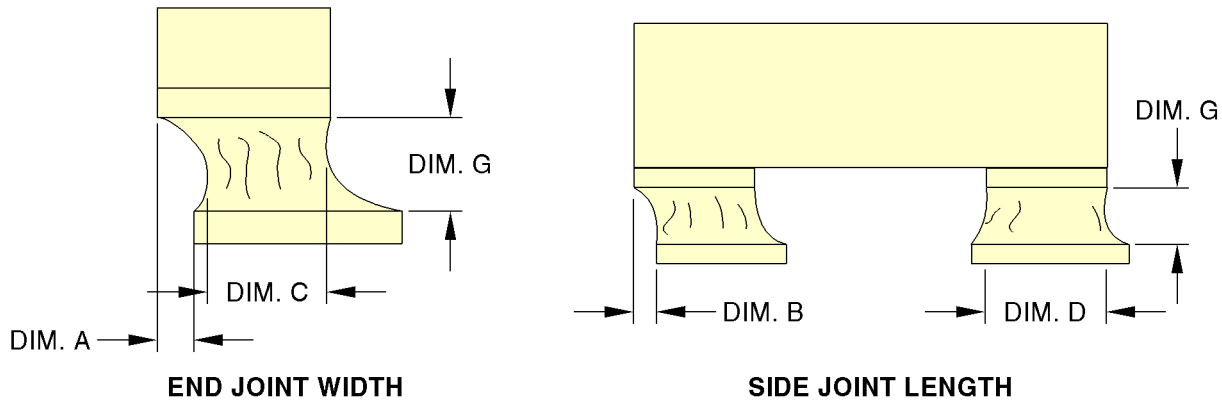
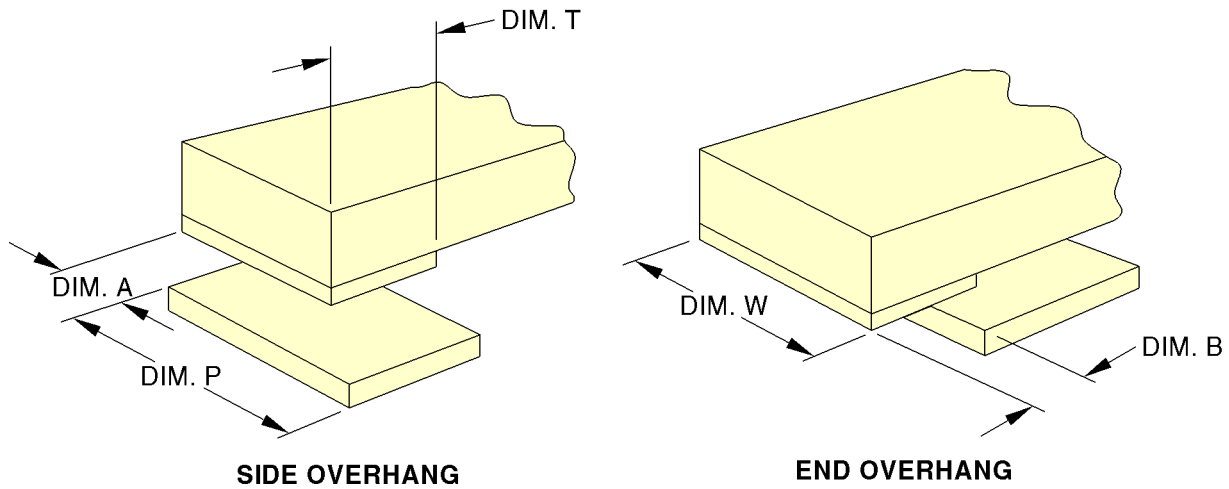
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Figure 13-19. SMT Bottom-Only Termination Alignment

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Table 13-13. Specifications for SMT Bottom-Only Termination Alignment

Feature	Dimension	Requirement
Max. side overhang	A	25% of lead width (W)
Max. end overhang	B	Not permitted
Min. end joint width	C	3/4 W
Min. side joint length	D	Unspecified parameter
Max. fillet height	E	
Min. fillet height	F	
Min. thickness of solder (from component to land)	G	0.2 inch (5 mm), unless satisfactory cleaning can be demonstrated with reduced clearance.

D. Reflow

- (1) During repair, all replacement components should be pretinned prior to assembly to ensure proper wetting during reflow. Either 62Sn/36Pb/2Ag or 63Sn/37Pb solder composition with type R flux should be used on most assemblies.
- (2) Actual reflow instructions should be in accordance with the operating procedures of the applicable hot air repair station being used. After reflow, all assemblies should be cleaned to remove flux residue from the PWB.
- (3) The solder joints formed by the reflow process differ from conventional (through the board or wraparound) solder joints in several important ways. First, there are no mechanical connections other than the solder joint itself, and second, the joints are typically smaller than those on conventional circuit boards. If leadless chip carriers are used, only about half of a solder pad is exposed with the remainder under the package. A cross-sectional view of a typical solder joint on a hermetic carrier is shown in Figure 13-20.

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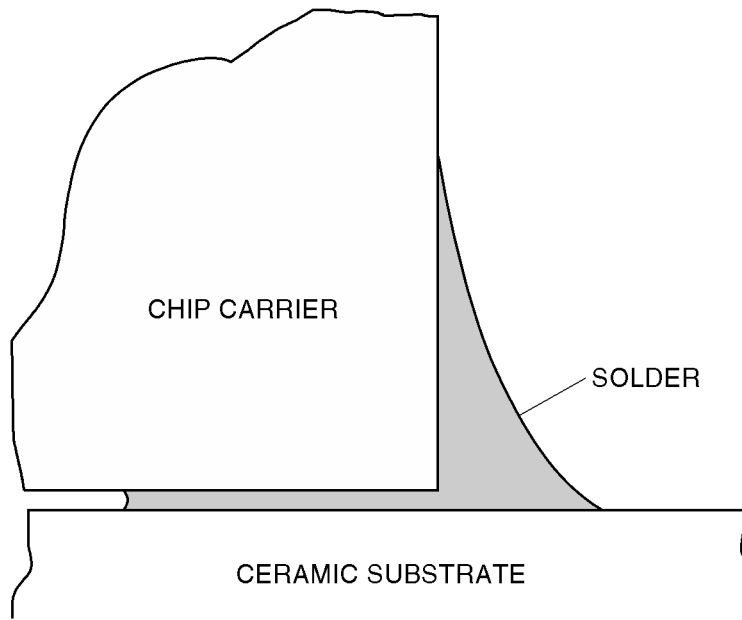
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Figure 13-20. Cross Section of SMT Chip Carrier Solder Joint

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E. Solder Joint Inspection

(1) General Data About Solder Joint Inspection

- (a) Solder joints on surface-mounted devices, especially hermetic chip carriers, present some unique problems. The size of the joint dictates that some magnification be used. The sheer quantity and density of solder joints (50 to 60 solder joints per square inch) severely limits throughput. The most critical portion of the solder joint and the spacing between solder joints is obscured by the chip carrier (Figure 13-21). Normal problems encountered in solder joint inspection are aggravated by the fact that almost all of the chip carriers used are sensitive to electrostatic discharge. All inspection aids must be rendered free of electrostatic charges. An extensive static prevention program should be instituted to ensure that sensitive devices are protected from electrostatic discharge at all times.

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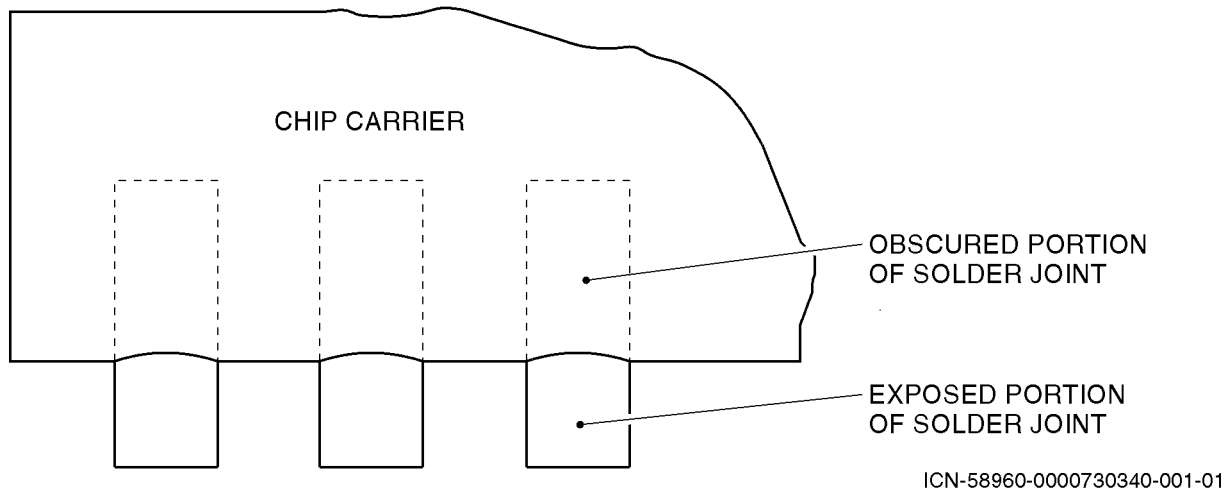


Figure 13-21. SMT Chip Carrier Solder Joint Inspection

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(2) Visual Solder Joint Inspection

- (a) All repaired assemblies should be visually inspected at 5 to 30 times or greater magnification. The solder joints must be free from sharp edges, looseness, or blistering. There must be no evidence of dirt, chips, or other foreign matter. Solder joints must indicate evidence of wetting and adherence where the solder blends to the soldered surface forming a small contact angle. Unevenness on the surface of the solder joint is acceptable. A line of demarcation or transition zone where applied solder blends with the solder coating, solder plate, or other surfaces must be acceptable provided wetting is evident. Solder joints that connect chip carriers or other surface-mounted devices must not show the properties that follow:
- Bridging - Solder shorting, or the spanning by solder, of sections that should be open between two or more conductors and/or component terminations.
 - Webbing - A continuous film or curtain of solder parallel to but not necessarily adhering to a surface or between separate sections of circuitry that should be free of solder.
 - Balls - Small spheres of solder adhering to laminate, mask, and/or conductor surfaces.
 - Slivers - Portions of tin-lead (solder) plating overhang on conductor edges partially or completely detached.
 - Whiskers - Slender acicular (needle-shaped) metallic growth between conductors and/or lands.
 - Flux - Visible flux residue after cleaning.

(3) Leadless Chip Carrier Solder Joint Inspection Criteria

- (a) As an aid to visual inspection of leadless chip carrier - PWB solder joints, detailed isometric and cross-section illustrations of acceptable and unacceptable solder joints are provided for reference as follows.
- (b) Figure 13-22 shows five basic types of solder joints for chip carriers with castellations. Figure 13-23 thru Figure 13-27 provides a detailed example of each type.
- (c) Figure 13-23 details the preferred LCC solder joint. The castellation is completely filled with solder with no visible gold or evidence of gold/tin intermetallic formation. Furthermore, the joint has a concave filleting appearance that usually guarantees the flow of solder under the chip carrier due to capillary action.
- (d) Figure 13-24 details the maximum allowable LCC solder joint. The castellation is completely filled with solder. The solder joint exhibits a convex curvature; however, wetting of the solder to the land and the castellation can be seen at the very edge of the solder joint. Evidence of solder flow under the chip carrier can be seen.
- (e) Figure 13-25 details the minimum allowable LCC solder joint. All gold surfaces are solder coated. Filleting of the solder is fairly thin, but extends to the land edges and completely up the metalized castellation. Evidence of solder flow under the chip carrier is seen.



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- (f) Figure 13-26 details an LCC solder joint that has insufficient solder. A short solder fillet is seen, but it extends only a short distance beyond the chip carrier and does not extend to the land edges.
 - (g) Figure 13-27 details an LCC solder joint that has excessive solder. The solder joint is bulging on the land and exhibits a poor flow or nonwetting region at the top of the joint.
- (4) Solder Fillet Acceptance Criteria
- (a) The addition of wires to components and lands must meet the requirements of Honeywell Specification 4091484 and IPC-A-610. Refer to Figure INTRO-3 (M4091484), IPC-A-610, Figure 13-28, Figure 13-29, and Figure 13-30 for acceptable soldering techniques for adding wires. Refer to Figure 13-13 thru Figure 13-19 for acceptable solder fillet requirements for various component and lead types.

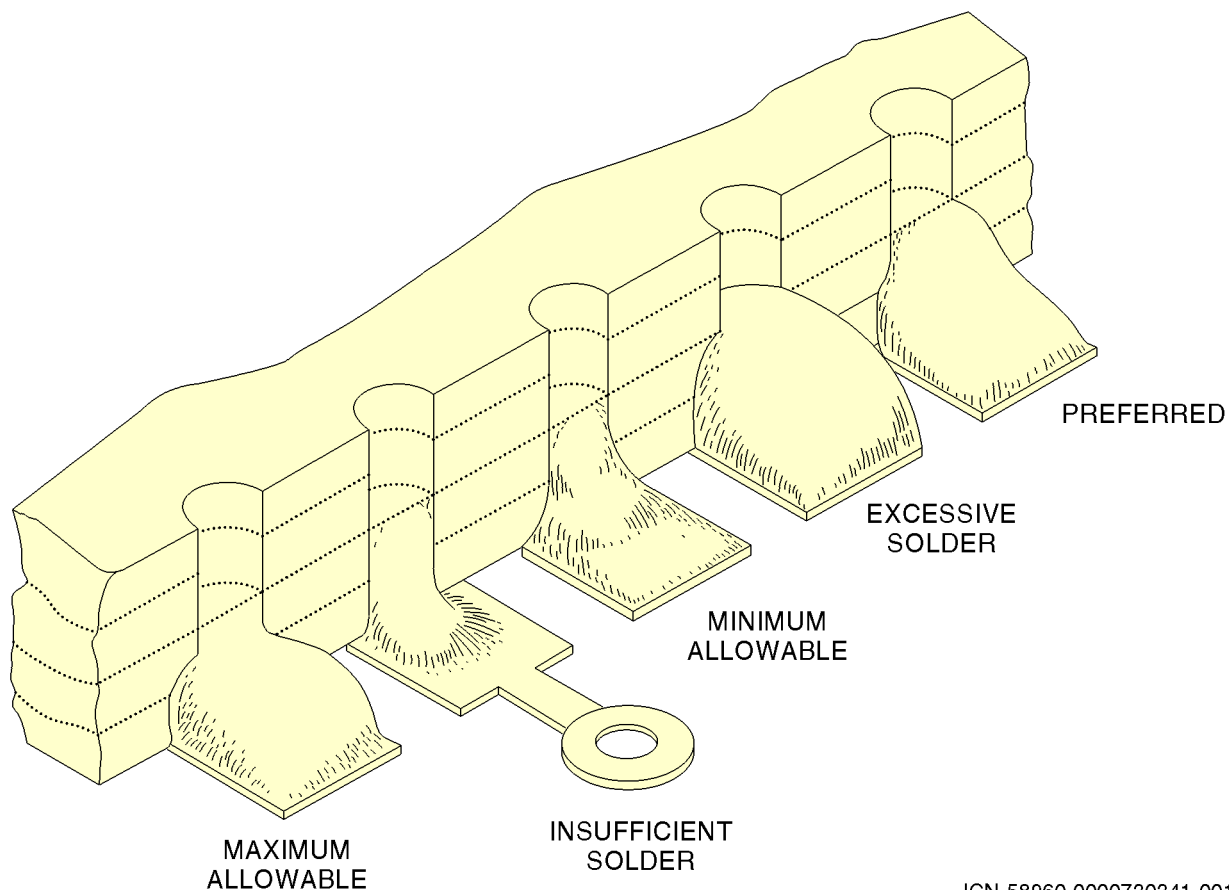
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Figure 13-22. SMT Chip Carrier Solder Joints

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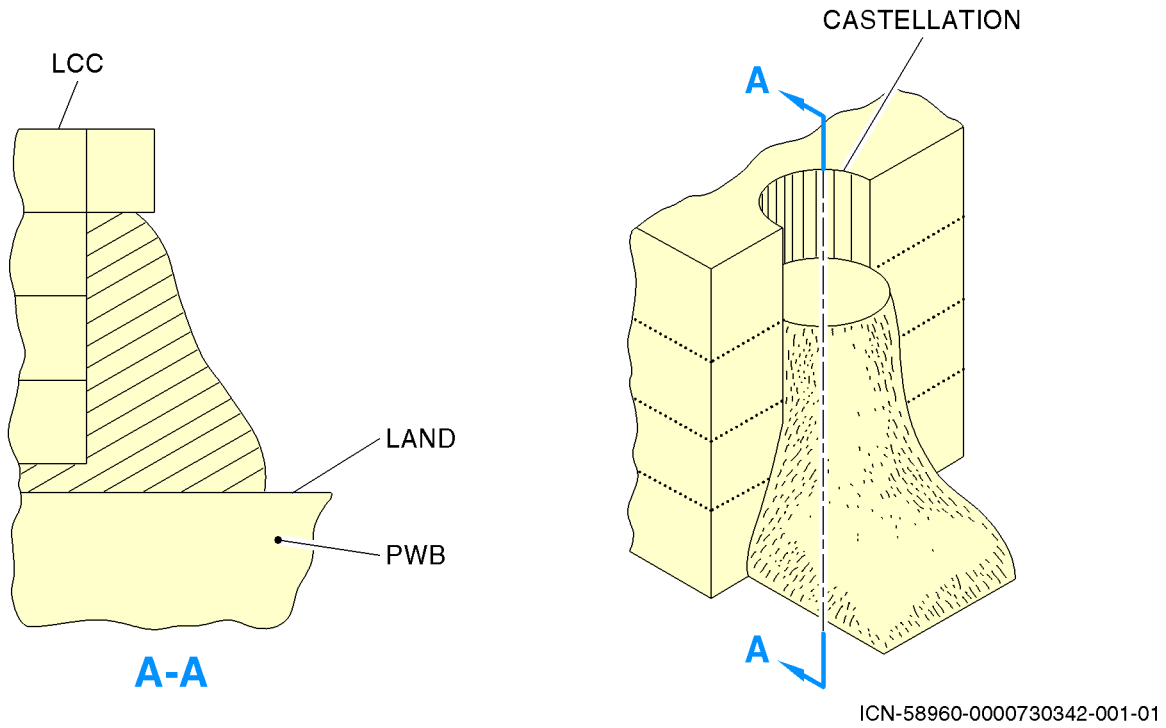


Figure 13-23. Preferred SMT LCC Solder Joint

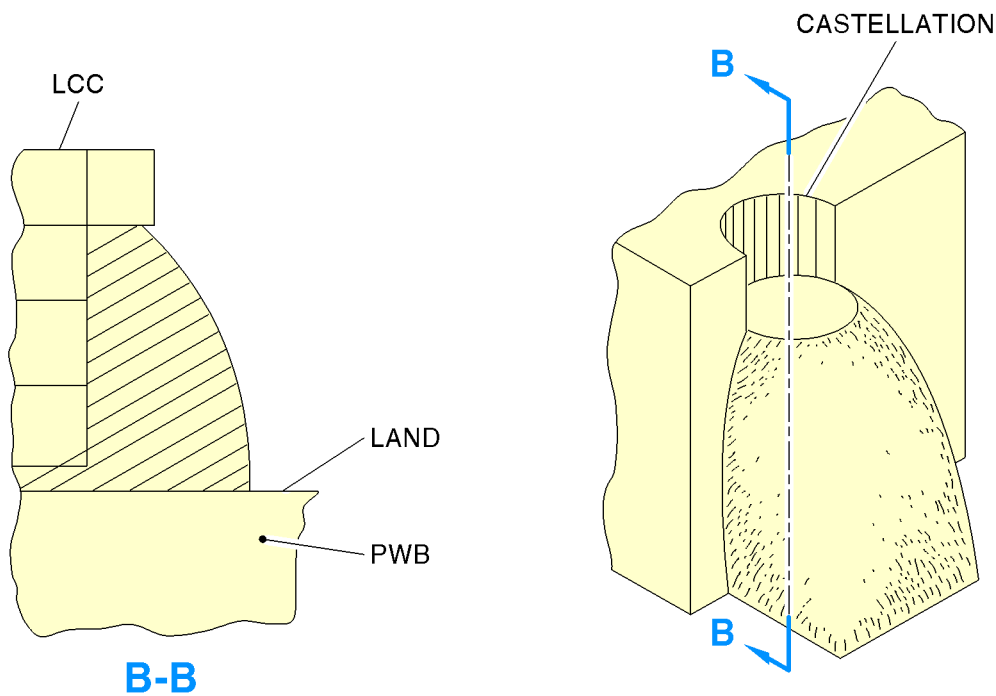
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Figure 13-24. Maximum Allowable SMT LCC Solder Joint

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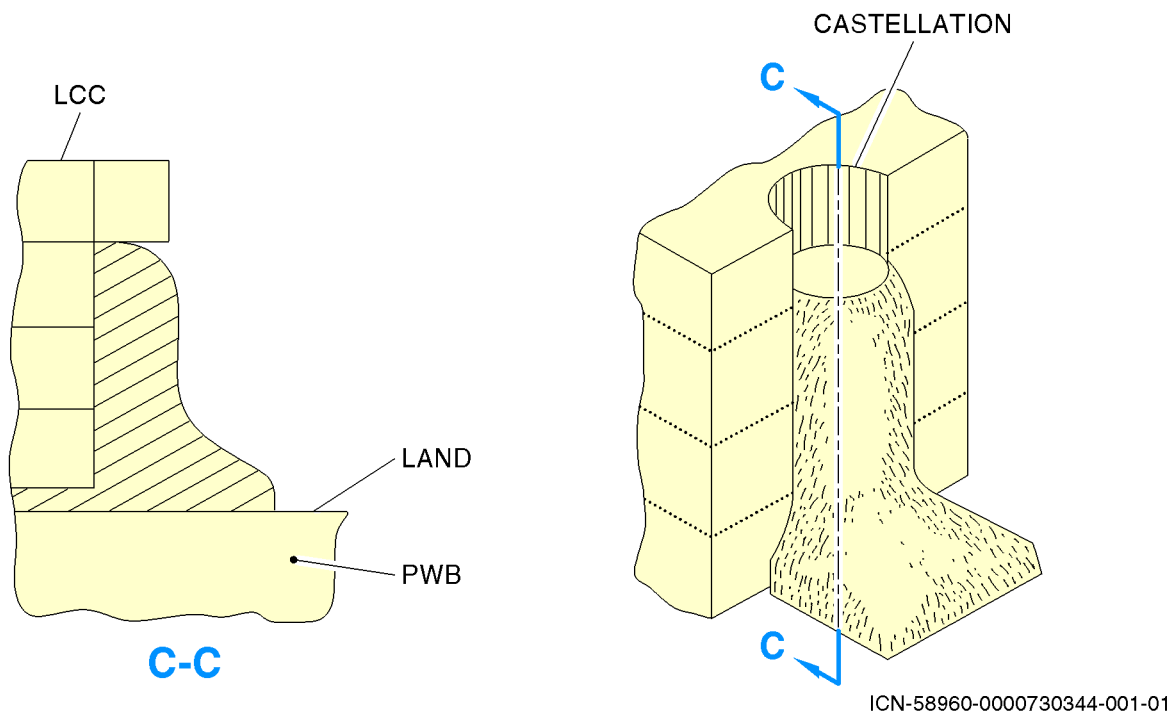


Figure 13-25. Minimum Allowable SMT LCC Solder Joint

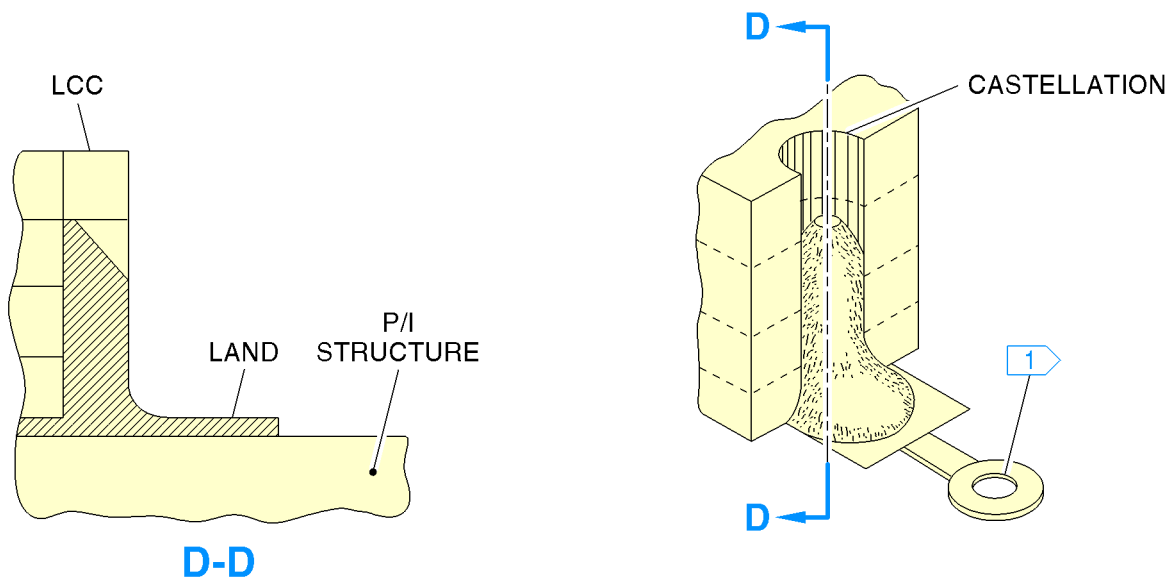
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NOTE:

1 If hole is filled, suspect solder flow from joint. Check back of P/I structure for shorts and bumps.

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Figure 13-26. Unacceptable (Insufficient Solder) SMT LCC Solder Joint

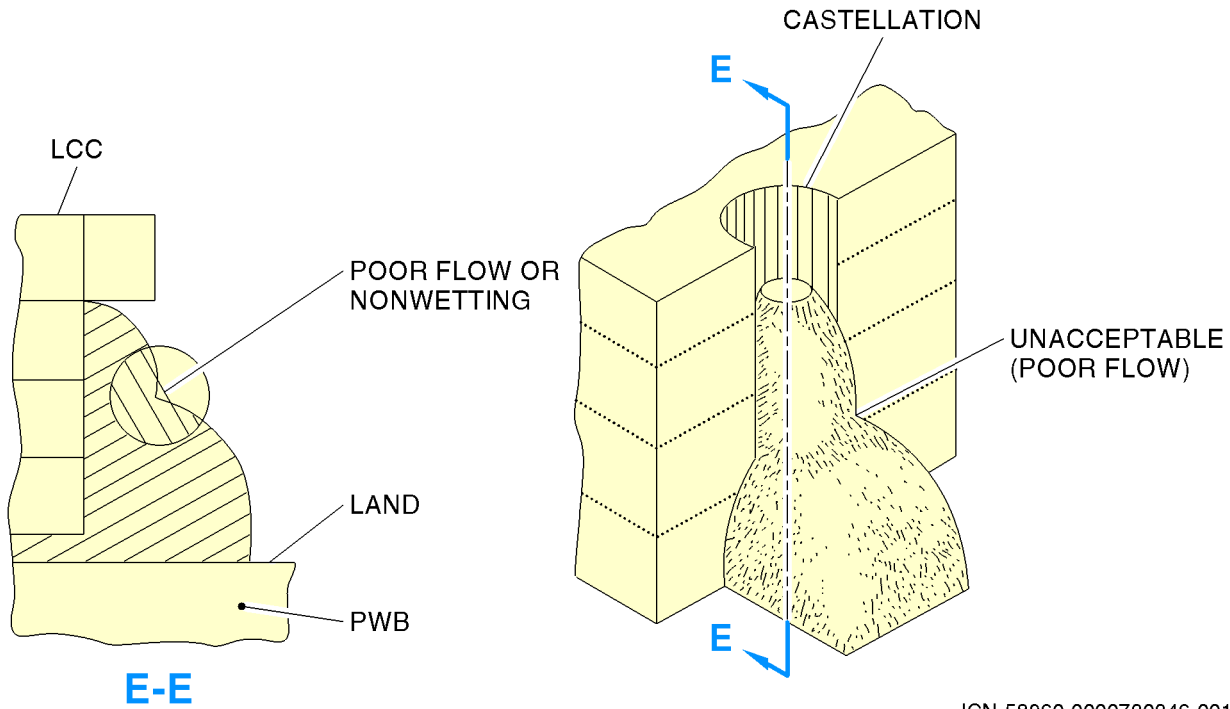
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Figure 13-27. Unacceptable (Excessive Solder) SMT LCC Solder Joint

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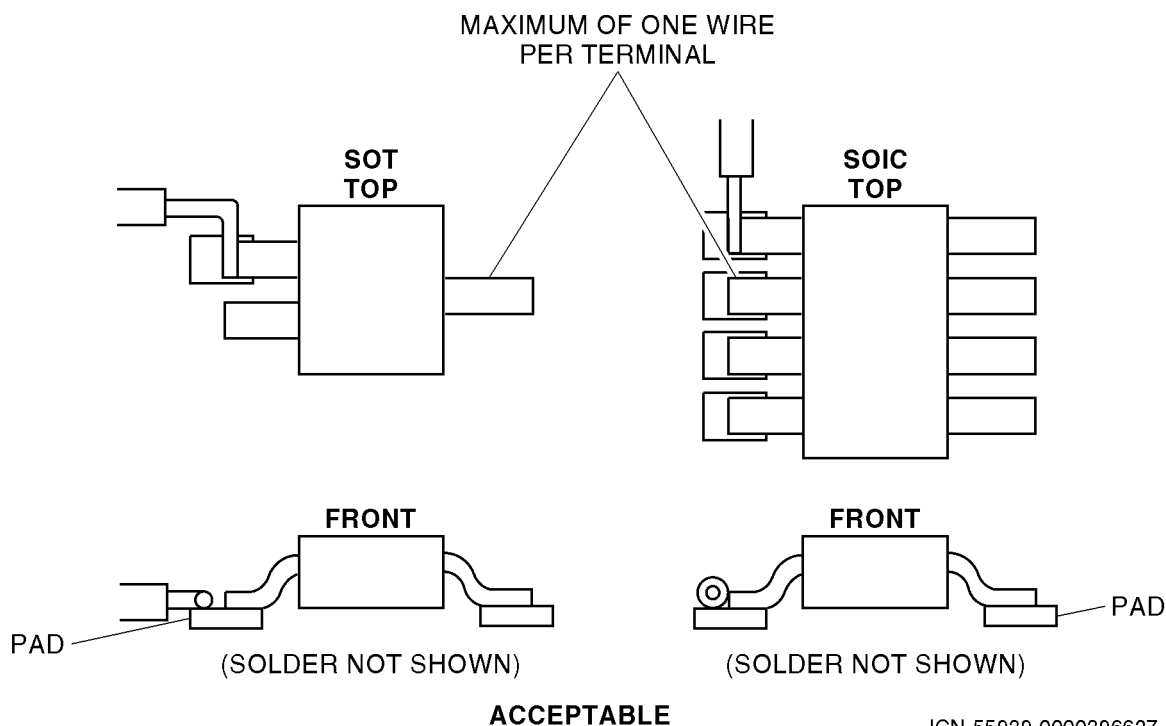
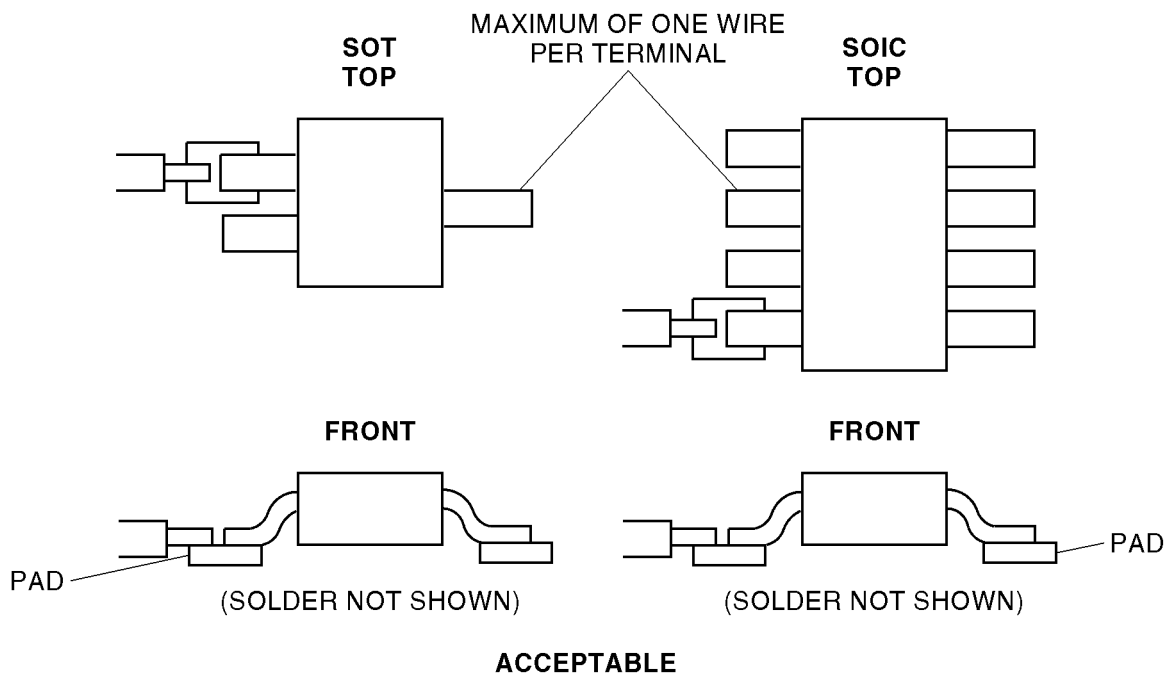
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Figure 13-28. (Sheet 1 of 2) Addition of Wires to SMT Flat L or Gull Wing Leads

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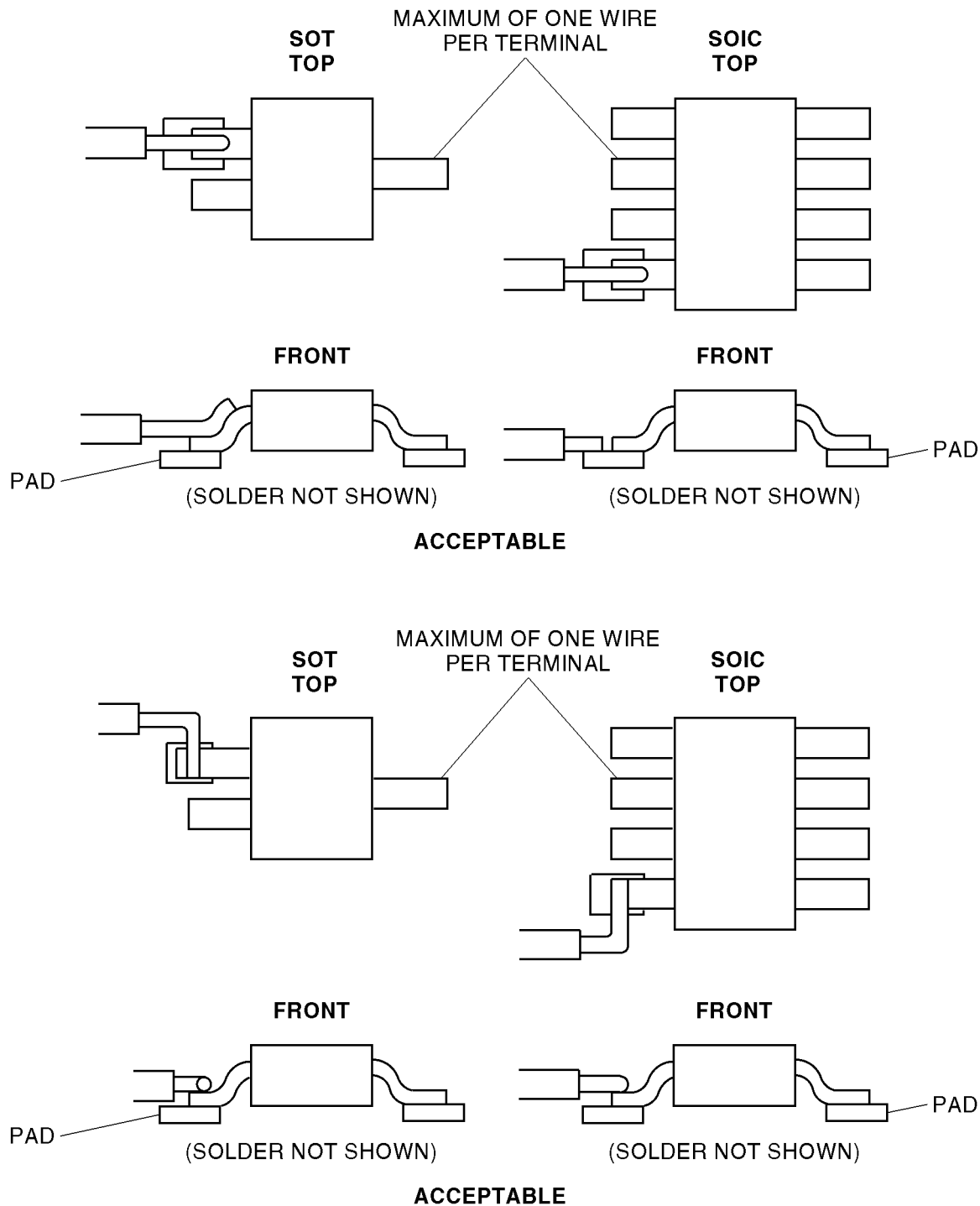
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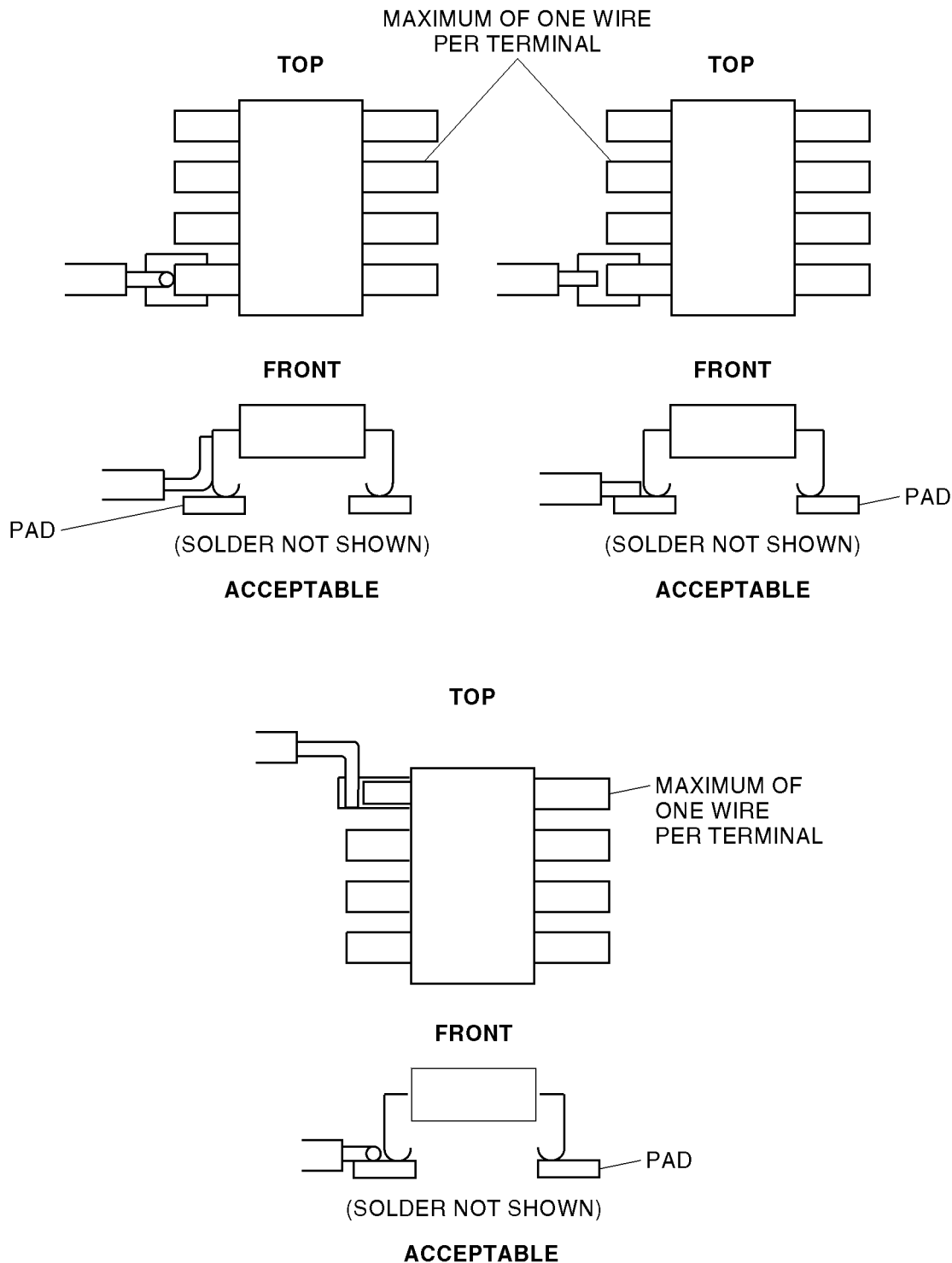


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Figure 13-28. (Sheet 2 of 2) Addition of Wires to SMT Flat L or Gull Wing Leads

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Figure 13-29. Addition of Wires to SMT J-Shaped Leads

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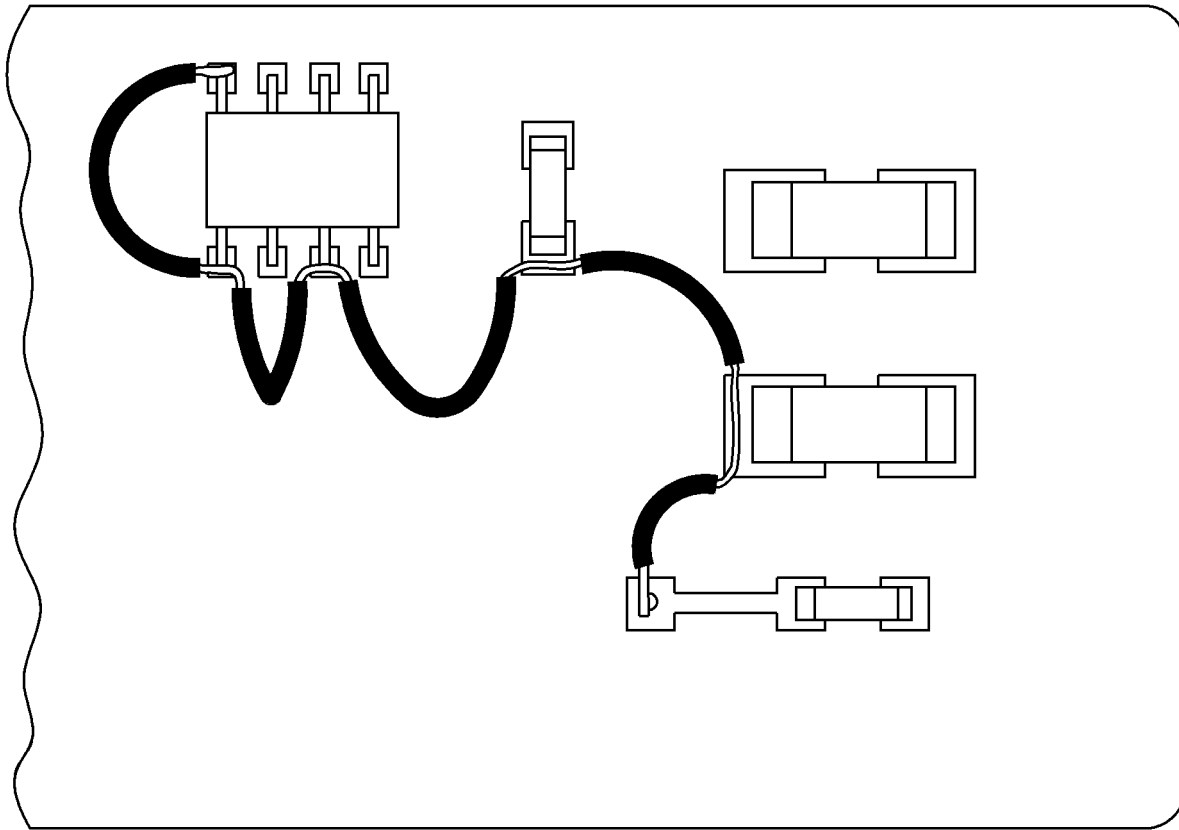
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(SOLDER NOT SHOWN)
ACCEPTABLE

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Figure 13-30. SMT Chain Lap Solder Connections

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F. Solder Joint Defects

- (1) Defects encountered during the inspection of solder joints are divided into two classes - major and minor. A major defect is one that will prevent, or will probably prevent, the assembly from functioning according to specification. A minor defect is one that will not, or probably will not, prevent the assembly from functioning according to specification. The placement of specific defects into one category or the other often requires familiarity with the strengths and weaknesses of the system along with a knowledge of the operating environment and reliability requirements. Some common defects with a brief description of each follow.
 - (a) Major Defects
 - No Solder - No continuous solder connection between the substrate and the component.
 - Bridge - Continuous solder between two separate circuits.
 - Crack - Fracture of the solder joint which can cause an open or intermittent open under environmental stress.
 - Dewetting - A lack of solder adhesion to either the substrate or the component which can result in an open.
 - Solder Ball - Solder that is not firmly attached to a conductor surface.
 - Solder Projections - Solder that stops in a sharp point.
 - (b) Minor Defects
 - Excess Solder - More than optimum amount of solder. Obscures the joint such that proper inspection is not possible.
 - Insufficient Solder - Not enough solder to form a well defined fillet.
 - Minor Dewetting or Lack of Coverage - A small portion of the solder pad on the component or the substrate not covered with solder.
 - Pin Holes - Small holes in the solder surface usually an external indication of voids.
 - Voids - Pockets of gas or flux residue within the solder.
 - Flux Residue or Contamination - Contamination which can interfere with a secondary operation such as conformal coating.

G. Causes of Solder Defects

- (1) In general, solder defects in surface-mounted device assemblies are caused by the same factors that cause defects in conventional assemblies. Specific causes are too numerous to list here, but some general categories are:
 - Contamination on components or substrates causing poor solderability
 - Insufficient or excess solder applied during the soldering operation
 - Process variations (e.g., improper heat application, use of outdated solder paste).

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5. SMT Repair

CAUTION: THE PARTS OR ASSEMBLIES CAN CONTAIN ESDS ITEMS. USE PROTECTIVE PROCEDURES.

A. General Caution and Data About SMT Repair

- (1) The caution that precedes this paragraph applies to all SMT repair procedures.
- (2) Repair consists of removal and replacement of damaged or defective components and modification of CCA circuitry.

CAUTION: IF THE EQUIPMENT HAS MOISTURE-SENSITIVE COMPONENTS, USE THE SPECIAL PROCEDURES THAT FOLLOW FOR PROTECTION OF THESE COMPONENTS.

B. Protection of Moisture-Sensitive Components

- (1) All plastic leaded chip carrier (PLCC) components with 28 leads or more are moisture sensitive. The components are moisture sensitive because they can absorb moisture during shipping and storage. When you install the components, the heat caused by the flow-solder procedure can make the moisture expand. When moisture expands, it can make the component defective. Do the applicable procedures that follow when you use moisture-sensitive components:
 - (a) Install all moisture-sensitive components within 2 days after you remove them from the sealed bag.
 - (b) If you remove components from the sealed bag but do not use them within 2 days, do the applicable step that follows:
 - 1 Put the components in a new bag and seal with new desiccant.
 - 2 Put the components in storage where the relative humidity is less than 25%.
 - (c) If the relative humidity increases to 30% or more and/or the date on the bag has expired before assembly to a board, do the applicable step that follows:
 - 1 Bake individual components for 24 hours at 257°F (125°C).
 - 2 Bake components that are taped on a reel at 113°F (45°C) for 168 hours.

CAUTION: THE OVEN MUST BE VENTED WITH AN OUTSIDE SOURCE OF DRY AIR. IF THE OVEN IS NOT VENTED, MOISTURE CAN BE ABSORBED AND TRAPPED WHEN THE MOISTURE BARRIER FILM IS APPLIED.

- (2) Before moisture barrier film (Refer to Section 3) is applied to any repaired or reworked SMT assembly:
 - (a) Let the assembly oven dry for 30 minutes at 155 ±10 °F (68 ±5 °C).
 - (b) Let the assembly cool at room temperature for a minimum of 2 hours.



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C. Component Rework

- (1) The minimum requirements for component removal, replacement, realignment, and touchup are given in Table 13-14.

NOTE: When you remove a component, remove the component as quickly as possible because solder iron heat can cause damage to components.

Table 13-14. SMT Component Rework Methods

Component	Remove	Replace	Realign	Touchup	Comments
Chip capacitor	NOTE 1., 2.	NOTE 1.	NOTE 1.	NOTE 1.	
Chip resistor	NOTE 1., 2.	NOTE 1.	NOTE 1.	NOTE 1.	
SOTs	NOTE 1., 2.	NOTE 1.	NOTE 1.	NOTE 1.	
SOIC - 8 TO - 16	NOTE 1., 2., 3.	NOTE 1., 2.	NOTE 1., 2.	NOTE 1.	
SOIC- 20, SOLIC	NOTE 2., 3.	NOTE 2., 3.	NOTE 2., 3.	NOTE 1.	
PLCCs	NOTE 3.	NOTE 3.	NOTE 3.	NOTE 1.	
QFPs	NOTE 3.	NOTE 3.	NOTE 3.	NOTE 1.	
BGAs	NOTE 3.	NOTE 3.	N/A	N/A	
BGAs-Mixed Metallurgy	NOTE 4.	NOTE 4.			
Micro BGAs	NOTE 3.	NOTE 3.	N/A	N/A	
NOTES: 1 Use temperature-controlled soldering iron. 2 Use temperature-controlled soldering iron with special tip designed for the package being removed and installed. 3 Use hot air reflow system which provides the capability to perform a controlled time/temperature profile. 4 Mixed Metallurgy BGAs are defined as Lead Free balled devices soldered with traditional tin-lead solder paste. Refer to Paragraph J. for requirements.					

D. Component Reuse Requirements

- (1) Surface-mounted components can be reused (reinstalled) after removal if the requirements in the applicable category are met.

- (a) Category 1 (Components with Two to Seven Leads or Terminations)

- 1 These components can be reused as long as a visual check shows no sign of physical damage and the parts meet the physical dimensions specified by the documents from the manufacturer or Honeywell.



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- (b) Category 2 (Components with Eight or More Leads or Terminations)
- 1 These components can be reused as long as a visual check shows no sign of physical damage and the parts meet the physical dimensions specified by the documents from the manufacturer or Honeywell.
 - 2 These components can also be reused if the component was removed and is installed with a controlled process which provides a controlled temperature profile that meets the requirements as follows, regardless of manufacturer specifications:
 - The maximum temperature must not exceed 473°F (225°C)
 - The ramp rate must not exceed 36°F/second (2°C/second)
 - The maximum time above 356°F (180°C) must not exceed 90 seconds.

E. Warp and Twist of CCAs and PWBs

- (1) The warp and twist of a fabricated assembly must meet the applicable requirements of the Honeywell specification that governs the CCA or PWB.

CAUTION: USE ISOPROPYL ALCOHOL CAREFULLY WHEN YOU CLEAN FLUX FROM THE SOLDER CONNECTIONS. DO NOT LET THE SOLVENT TOUCH THE CONNECTOR BODY.

CAUTION: BEFORE YOU USE ISOPROPYL ALCOHOL AS A SOLVENT, MAKE SURE IT DOES NOT CAUSE DAMAGE TO THE PAINTED SURFACES. APPLY A MINIMUM QUANTITY OF THE SOLVENT. TOO MUCH SOLVENT CAN CAUSE DAMAGE TO THE PARTS THAT ARE SENSITIVE TO MOISTURE.

F. Standard Repair of CCAs and PWBs

- (1) General Data About Repair of SMT plated-through holes (PTHs), CCAs and PWBs
- (a) The procedures that follow can be used on PTHs, CCAs and PWBs for minor repair.
- (2) Repair of Burned or Damaged Areas on a PTH, CCA or PWB
- (a) Use this procedure when an SMT component has exploded or burned and caused damage to the exterior surface of the PTH, CCA or PWB, but has not damaged any internal lands, pads, vias, etc.
 - 1 Use an approved cleaning solution to fully clean the damaged area and let dry.
 - 2 Make sure no internal lands, pads, vias, etc, are damaged.
 - 3 Protect any surrounding areas on the PTH, CCA or PWB.
 - 4 Use a stiff-bristled brush with isopropyl alcohol to remove any charring or fuzzy residue on the damaged area.
 - 5 Bake at 170°F (77°C) for 2 hours to remove any moisture.
 - 6 Apply adhesive (9702878) to the damaged area on the exterior of the CCA or PWB.

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- 7 Mark the upper corner of the CCA B side with an orange epoxy paint dot to indicate a repair to the PWB has been done.
 - 8 Bake the CCA at 170°F (77°C) for 1 hour.
- (3) Repair of Short Damaged Exterior Circuit Breaks 0.25 Inch (6.4 mm) or Less
 - (a) Use an approved cleaning solution to fully clean the damaged area and let dry.
 - (b) Remove solder from the area to be repaired.
 - (c) Prepare a 30 AWG Kapton bus wire 0.25 inch (6.4 mm) longer than the circuit break.
 - (d) Solder the bus wire to the original circuitry, bypassing the break.

NOTE: Adhesive is not necessary for bus wires on circuit breaks of 0.25 inch (6.4 mm) or less in length.
- (4) Repair of Long Damaged Exterior Circuit Breaks Greater than 0.25 Inch (6.4 mm)
 - (a) Use an approved cleaning solution to fully clean the damaged area and let dry.
 - (b) Remove solder from the area to be repaired.
 - (c) Prepare a 30 AWG Kapton bus wire (unless otherwise specified) long enough to dress around any components and terminate on a component lead or vias.
 - (d) Solder the bus wire to the original circuitry, bypassing the break.
 - (e) For insulated bus wires 2 inches (51 mm) in length or longer, attach the bus wire every 1 inch (25 mm) with adhesive (9702878).
- (5) Repair of Damaged Exterior Circuit Breaks by Alternate Method
 - (a) Use an approved cleaning solution to fully clean the damaged area and let dry.
 - (b) Install commercially available pretinned replacement conductor frames as instructed by the manufacturer or supplier.
 - (c) Attach the frames with adhesive recommended by the frame manufacturer or supplier.
- (6) Repair of Lifted Lands, Pads, or Annular Rings
 - (a) A lifted land, pad, or annular ring may be repaired as long as the damage does not exceed 25 percent of the total area. No more than six repairs are acceptable on one PWB.
 - 1 Use an approved cleaning solution to fully clean the damaged area and let dry.
 - 2 Secure lifted land, pad, or annular ring with epoxy adhesive (9702878).
- (7) Repair of Internal Shorts and Opens
 - (a) There are no standard repair procedures to repair internal (inner layers) shorts and opens. If this type of repair is necessary, contact the applicable product or methods engineer at Honeywell.

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(8) Missing Nonfunctional Pads

- (a) A nonfunctional pad (via) is one that has no attached circuitry. It is approved to have up to six missing nonfunctional pads per CCA or PWB as a function of rework if all of the plated-through holes are intact and the associated pads on the other side of the PWB are not lifted or missing.

G. Modification and Repair of Components on a CCA or PWB

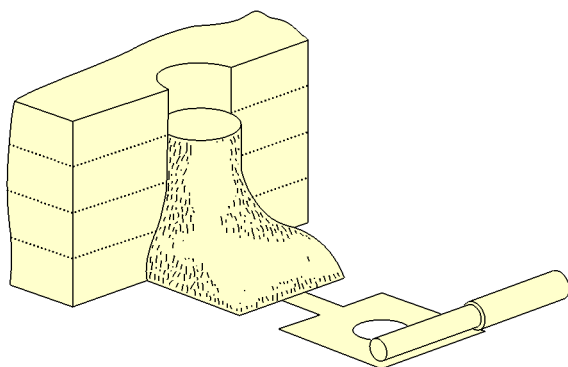
- (1) Discrete through-hole components must be mounted in accordance with the practices and procedures of Honeywell.
- (2) When you make repairs or modifications to discrete surface-mounted components, multileaded surface-mounted components, and multileaded through-hole components, make sure you obey the instructions from the applicable product or methods engineer at Honeywell.
- (3) Components that hang loose or are not mounted flat on the CCA or PWB must be bonded to the board or to another component with adhesive (9702878) or attached with a spot tie of lacing tape.

H. Installation of Additional Wires

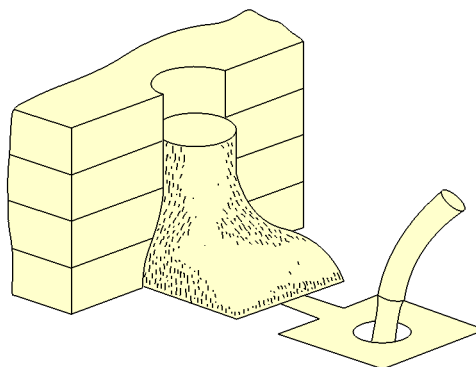
- (1) If it is necessary to add wires to SMT circuitry and parts, do as follows:
 - Make sure you use 30 AWG Kapton wire to do modifications and repairs, unless specified differently by the applicable product or methods engineer at Honeywell.
 - Make sure there is a maximum of two wires allowed per land, probe pad, via, or plated through-hole unless specified differently. The added wires must fit in or on the termination point and make a structurally sound solder connection.
 - Make sure added wires are routed in the shortest practical route. Wires that cross over each other must be kept to a minimum.
 - Make sure added wires do not cross over component mounting holes, vias, or probe pads.
 - When you do modifications and repairs, apply adhesive (9702878) to every bend of the wire, and every 1-inch (25 mm) interval along its length (unless the wire is less than 2 inches (51 mm) in length).
 - Figure 13-31 thru Figure 13-37 show the requirements for various surface-mounted wire terminations. The illustrations show no solder, for ease of illustration, but it is necessary.

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NOTE:

Wire may be lap soldered at any angle in the plane of the PWB surface.

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Figure 13-31. Additional Wire on SMT Probe Pads and Vias

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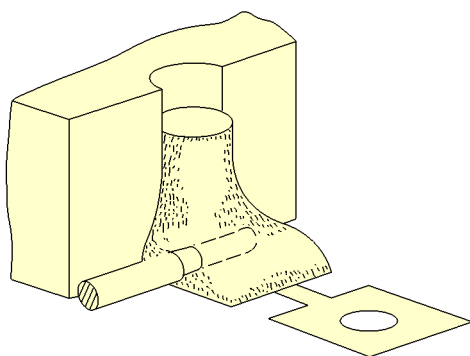
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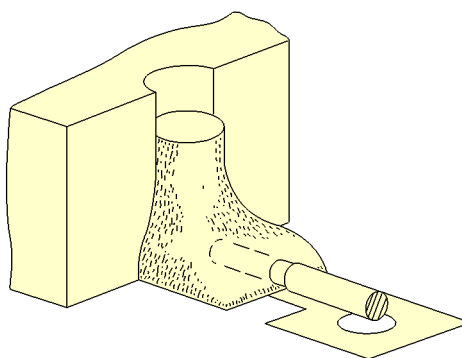
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NOTE:

Two wires maximum per termination on larger pads.

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Figure 13-32. Additional Wire on SMT Leadless Chip Carrier

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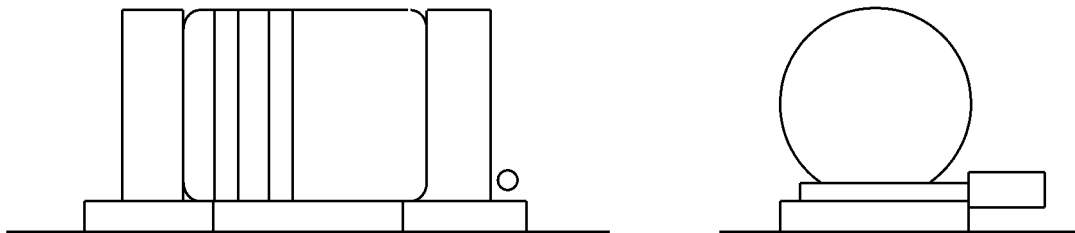
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NOTE:

One wire maximum per termination.

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Figure 13-33. Additional Wire on SMT Cylindrical End Cap

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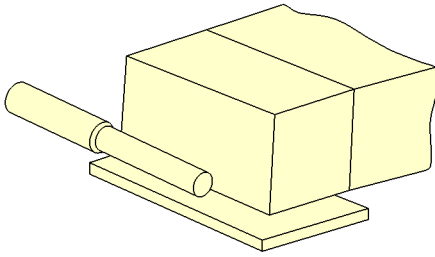
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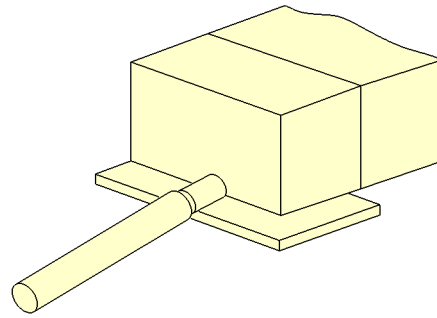
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UNACCEPTABLE

NOTE:

One wire maximum per termination.

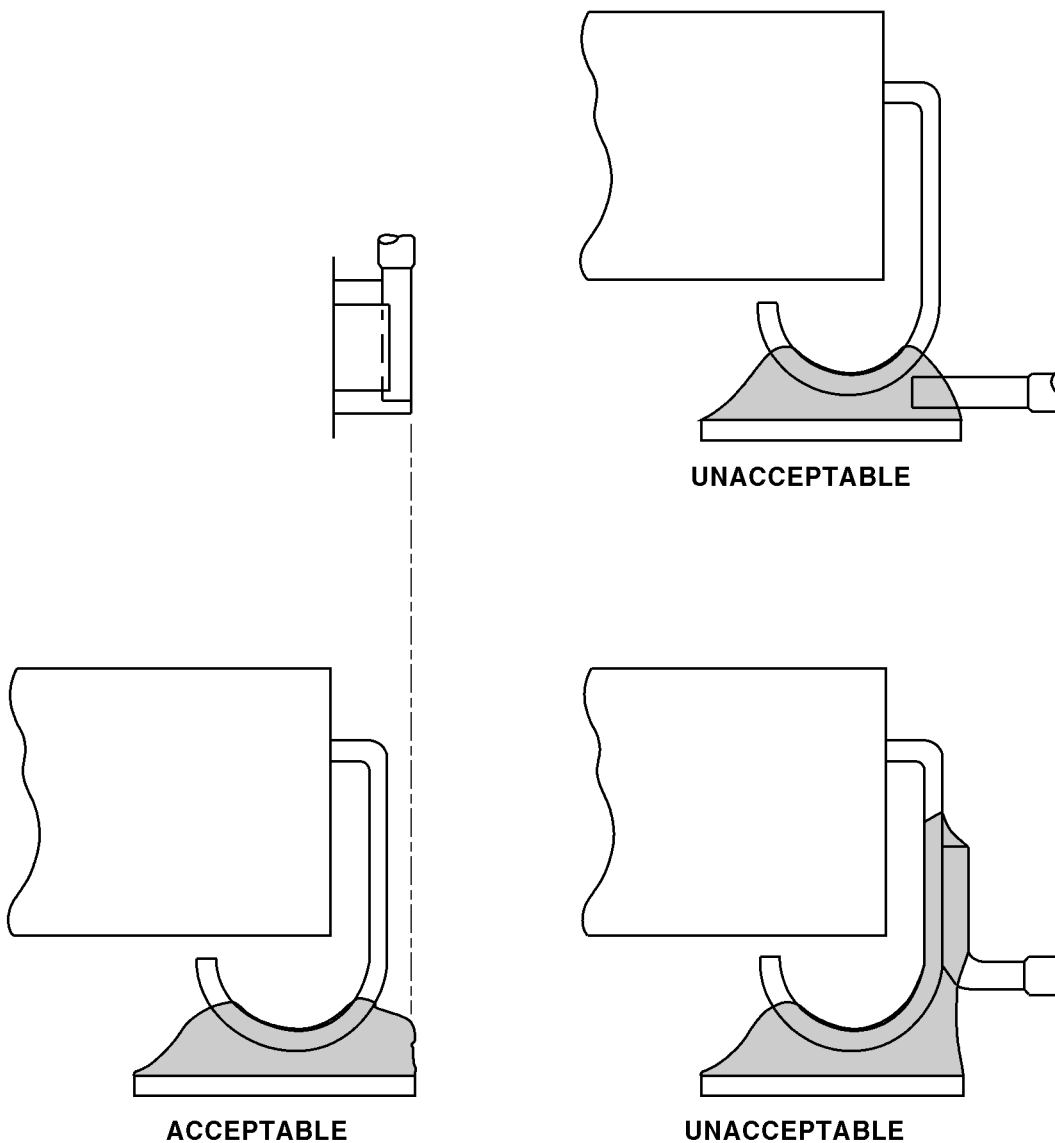
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Figure 13-34. Additional Wire on SMT All Chip Devices

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NOTE:

One wire maximum per termination.

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Figure 13-35. Additional Wire on SMT J-Shaped Leads

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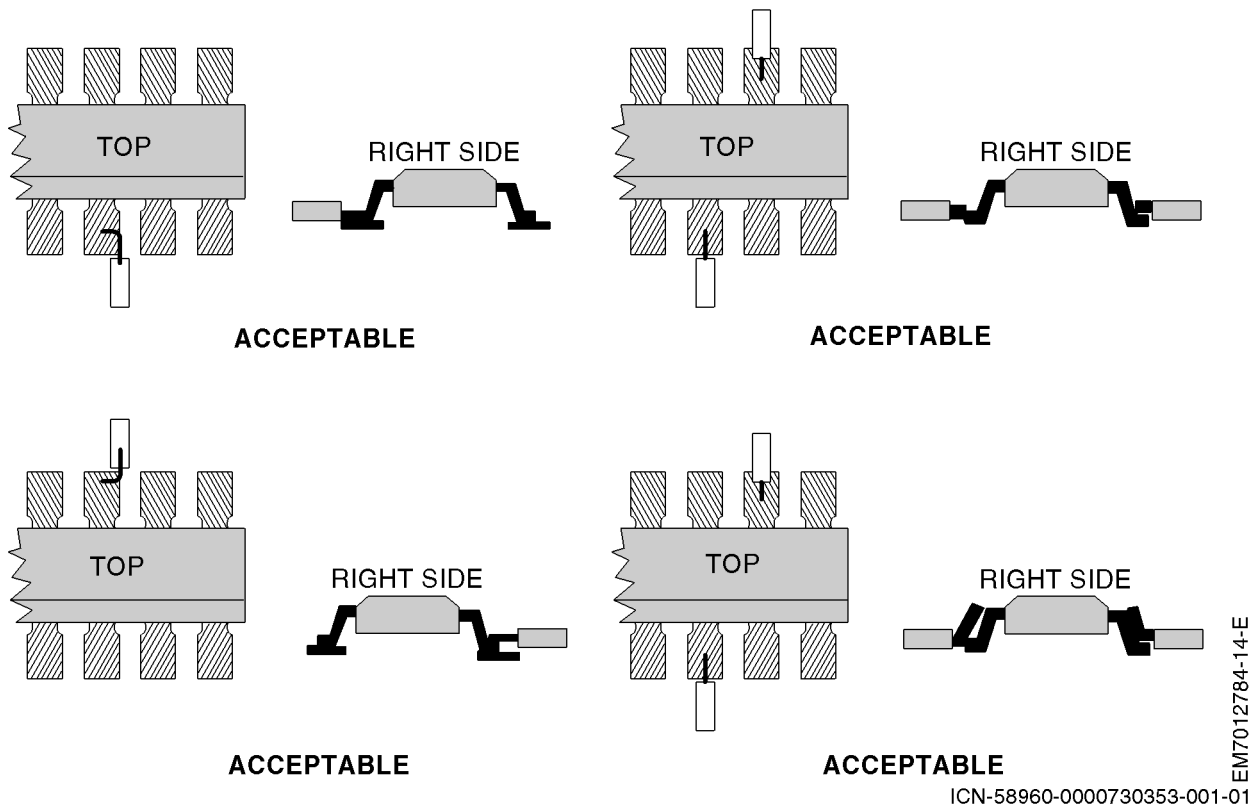
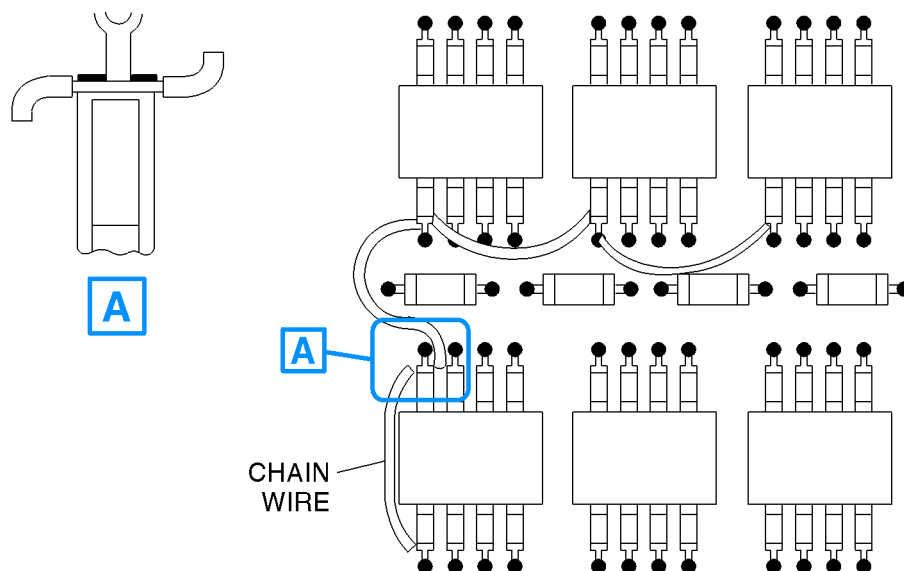


Figure 13-36. Additional Wires on SMT Gull Wing Leads

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**NOTE:**

The chain lap method must be used when a connection is made from one land to two or more lands. The chain is made from one wire with the insulation stripped at each solder point. One wire per termination is allowed.

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Figure 13-37. SMT Daisy Chain

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I. Removal and Installation of Surface-Mounted Connectors

(1) Removal of Surface-Mounted Connectors

(a) Remove a surface-mounted connector as follows (see Figure 13-38):

- 1 If applicable, remove conformal coating around the connector.
- 2 Clean the area to be reworked.
- 3 Apply a type R flux to connector leads and pad.
- 4 Use a soldering iron and wick to reflow solder and release leads.
- 5 Slide a thin wedge (razor blade) between connector leads and pads to prevent rebounding of leads when heat is removed from lead. Be careful with the wedge to prevent damage to the pad and runs.
- 6 Remove the mounting hardware and then remove the connector.

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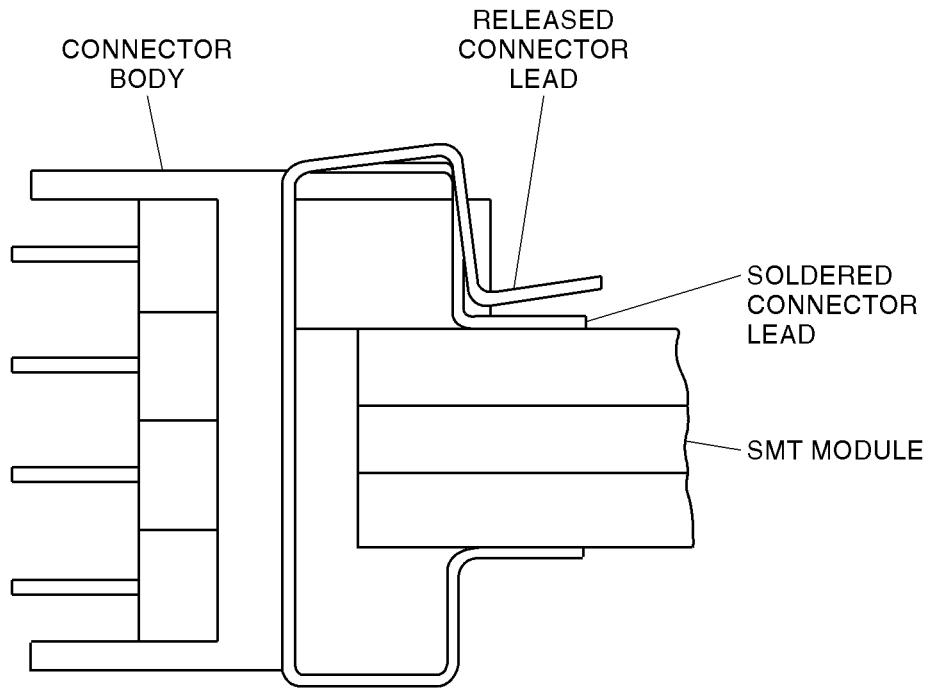
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Figure 13-38. SMT Connector Removal

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(2) Installation of Surface-Mounted Connectors

(a) Install a surface-mounted connector as follows (see Figure 13-39):

- 1 Clean the area where the old connector was installed.
- 2 Add solder to the pads if the initial solder was wicked away.
- 3 Apply type R flux to connector pads.
- 4 Carefully install the new connector on the board and align the connector leads with applicable pads.
- 5 Install the connector mounting hardware. Make sure that the connector leads and pads remain aligned.
- 6 Apply type R flux to the connector leads.
- 7 Use a soldering iron or heat bar to reflow solder and attach connector leads.
- 8 Do a check of the solder joints for proper connector lead alignment.
- 9 Clean the CCA or PWB. Make sure you remove all flux residue and contamination.
- 10 If necessary, reapply the conformal coating in areas where it was removed.

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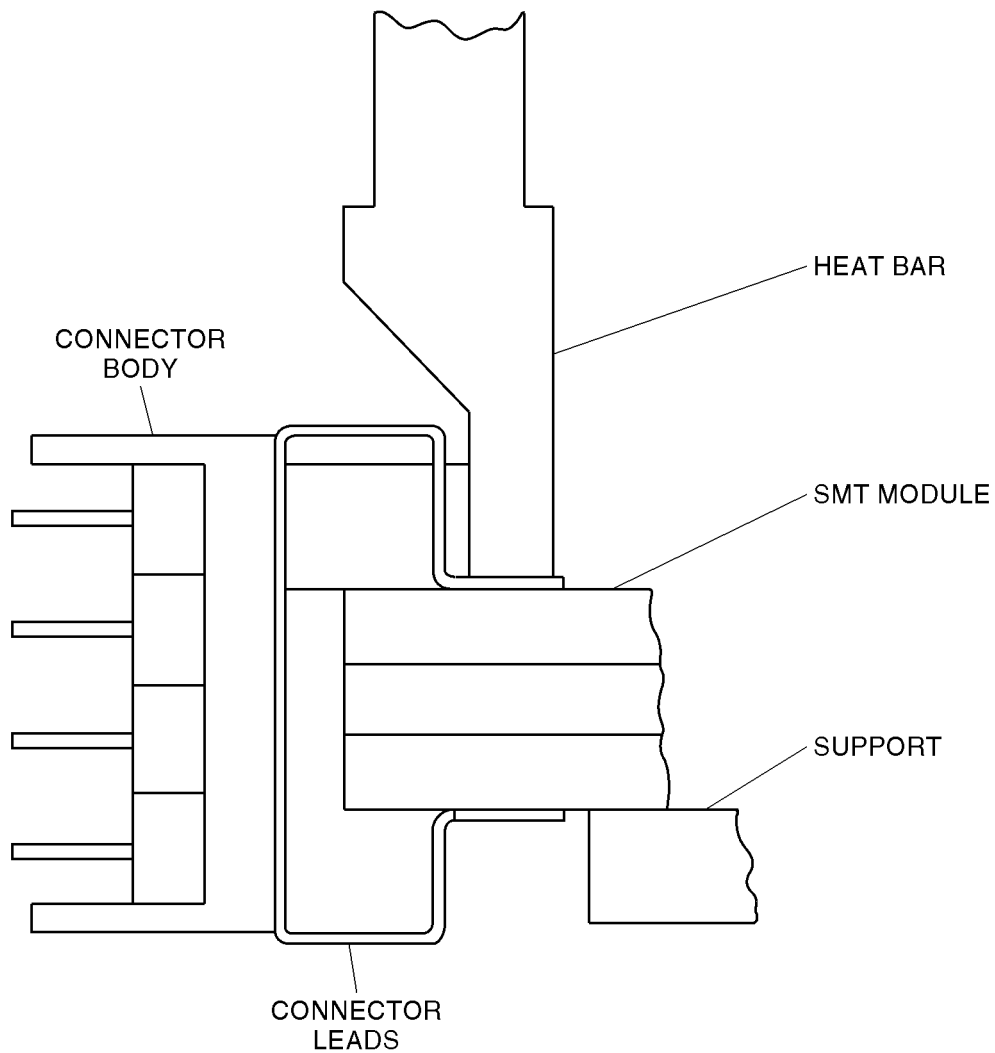
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Figure 13-39. SMT Connector Installation

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J. Mixed Metallurgy BGA Rework

(1) Scope

(a) Purpose

- 1 This specification details the requirements and procedures applicable to validate and perform mixed metallurgy BGA rework processes for Honeywell designed printed board assemblies (PBAs) when using lead-based solder to attach lead-free BGAs. Reballing of BGAs is not a part of this specification.

(b) Application

- 1 The requirements and procedures contained within this specification apply when using lead-based solder to replace BGAs with lead-free BGAs during the rework process. This process uses an elevated thermal profile that extends beyond the 220°C tin-lead reflow profile process.
- 2 Only BGA components with balls of tin-silver-copper (SAC) alloys containing 2 to 5 percent by weight of silver, specifically SAC 305 or SAC 405 alloys, are defined as "mixed metallurgy" within the processes outlined in this document. Use of any other alloy shall be as agreed between Honeywell and supplier (AABUS). See Paragraph J.(6)(a)1.

(c) Safety-Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

(2) Applicable Documents

The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated by a revision letter, number or issue date, the issue in effect on the date of the purchase order shall apply.

(a) U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <https://assist.dla.mil/quicksearch/>.

(b) Department Of Defense Standards

MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
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(c) ANSI Publications



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Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI/ESD S20.20 For the Development of an Electrostatic Discharge Control Program for – Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

(d) British Standards Institution Publications

Available from BSI 389 Chiswick High Road, London W4 4AL, United Kingdom
[http://www.bsigroup.com/Contact- Us/](http://www.bsigroup.com/Contact-Us/).

BS EN 61340-5-1 Electrostatics – Part 5-1: Protection of Electronic Devices From Electrostatic Phenomena– General Requirements

(e) IPC Publications

Available from IPC, 3000 Lakeside Drive, Bannockburn, IL 60015, Tel: 847-597-2862, <http://www.ipc.org>.

IPC-A-610E	Acceptability of Electronic Assemblies
IPC-7711/7721	Rework, Modification and Repair of Electronic Assemblies
IPC J-STD-001E	Requirements for Soldered Electrical and Electronic Assemblies
PC J-STD-004	Requirement for Soldering Fluxes
PC J-STD-006	Requirement for Electronic Grade Solder Alloys and Fluxed and Non Fluxes Solid Solder for Electronic Soldering Applications
J-STD-033	Handling, Packaging, Shipping and Use of Moisture/ Reflow Sensitive Surface Mount Devices

(f) Honeywell Publications

Available from the Honeywell Supply Management.

HPS1007	Application of Conformal Coating
HPS1008	Cable and Wire Harness Assemblies

(g) Order of Precedence

- 1 In the event of a conflict with the text of this specification, the following order of precedence applies:
 - CMM
 - This specification
 - IPC J-STD-001, Class 3

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- IPC-A-610, Class 3
- Documents referenced in this specification.

2 However, nothing in this specification supersedes applicable laws and regulations unless a specific exemption has been obtained.

(3) Technical Requirements

(a) General Requirements

- 1 The rework of mixed metallurgy BGAs shall be qualified per the requirements contained within this specification. The requirements shall be applied as a part number specific qualification performed on production representative hardware.
- 2 IPC J-STD-001, Class 3 and IPC-A-610, Class 3 requirements, with additions and exceptions in Table 13-15, shall apply.

(b) Materials

- 1 The rework of mixed metallurgy BGAs shall use only materials which have been qualified per Appendix A.
- 2 Production representative PBAs for use in temperature profiling and process validation shall be utilized for the rework process development and validation.

(c) Assembly Marking

The supplier shall have a documented procedure for marking/labeling of all products containing mixed metallurgy content after rework that ensures traceability. Each assembly shall be marked or labeled to identify the assembly as containing mixed metallurgy content with either "MM" or "HPS1028" if not already marked.

(d) Procedure

- 1 The rework procedure shall be in accordance with IPC-7711/7721, Methods using Hot Air Rework System and using solder paste to prefill lands.
- 2 All moisture sensitive devices shall be handled in accordance with J-STD-033 and their moisture levels shall be verified and applicable bake outs completed prior to installation. This includes the component being replaced and applicable components in the immediate rework area that may be subjected to temperatures that could lead to degradation of the sensitive components.
- 3 The rework thermal profile peak temperature for removing lead-free BGAs from the PBA should be 235 to 245 °C (455 to 473°F).
- 4 Product or process engineers shall review the compatibility of mixed metallurgy BGAs with the replacement thermal profiles. At a minimum, the review shall include definition of ball metallurgy, validated reflow profile plots for each BGA, including ramp rates, and maximum reflow temperature/time above liquidus (TAL).



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- 5 The rework site shall provide the process steps for each rework BGA, including evidence of the component thermal compatibility assessment, see Paragraph (4)(c).
- a The validated thermal profile for the assembly shall include thermocouple placement at each rework BGA location.
 - b The rework machine and model shall be defined.
 - c The procedure shall include assessment and review of the components in the surrounding area where the BGA is removed and replaced (top and bottom).
 - d All rework activities shall be fully documented, including locations, component designators, and number of rework cycles.
 - e If the BGAs are removed and replaced after conformal coating, coating rework shall be performed as specified on the CMM. If coating rework is not defined, this Standard Repair Manual shall be the rework document.

(e) Inspection

- 1 Visual inspection for all surrounding parts and BGAs shall be in accordance with IPC J-STD-001, Class 3 and IPC-A-610, Class 3, with additions and exceptions defined in Table 13-15.
- 2 X-Ray inspection shall be performed after BGA rework in accordance with IPC J-STD-001, Class 3 and IPC-A-610, Class 3, with additions and exceptions defined in Table 13-15.

(f) Qualifications

The process to initially qualify or re-qualify changes to solder, flux, and/or cleaning chemistries as well as any related process and/or equipment changes used in the rework of Honeywell mixed metallurgy assemblies shall be in accordance with Appendix A. The qualification process shall be part number specific, manufacturing facility-specific and shall be done on hardware produced using the manufacturing facility's processes and equipment.

(4) Quality Assurance Provisions

(a) Responsibility for Inspection

The supplier is responsible for supplying all samples, if applicable, and performing all required inspections and tests.

(b) Qualification Tests

Qualification requirements are listed in Paragraph (3)(f) and Appendix A.

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(c) Approval

- 1 This is a controlled specification. Authorization to fulfill the requirements of this specification is limited to suppliers who have been approved by Honeywell for this process.
- 2 A Honeywell team shall evaluate the results of the qualification testing, see Paragraph (4)(b). This review team shall act as Honeywell's technical focal point. The review team shall include a representative from the Honeywell Materials & Process Engineering Group.

(d) Rejection

Parts not conforming to the requirements of this specification shall be subject to rejection.

(5) Preparation for Delivery

(a) Preservation and Packaging

Unless otherwise specified, PBAs shall be packaged in a manner that will afford protection against corrosion, deterioration, and physical damage. All applicable electrostatic discharge sensitive (ESDS) devices and moisture sensitive devices (MSD) handling and packaging requirements shall be incorporated.

(6) Notes

This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.

(a) Definitions

1 AABUS

This is an acronym for "as agreed between Honeywell and supplier". It indicates inclusion of additional or alternate requirements in the procurement documentation that have been agreed upon by the user and the supplier. Examples include contractual agreements, modifications to purchase documentation, and information on the drawing. Agreements can be used to define test methods, conditions, frequencies, categories or acceptance criteria within a test, if not already established.

2 Honeywell

As used in this specification, refers collectively to the Honeywell Aerospace sites listed on the title page.

3 Honeywell Site

As used in this specification, refers to the current Honeywell site responsible for the part as designated by the CAGE Code on the applicable CMM. Participating sites for this specification and their CAGE codes appear on the cover page.

4 Additional Definitions

Definitions not listed in this specification may be found in IPC-T-50.

(b) Custodian

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Materials & Process Engineering (M&PE)

Honeywell International Inc.

Honeywell Aerospace of PR

Hwy. 110 North, Km 5.1

Parque Industrial San Antonio

Aguadilla PR 00604

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Table 13-15. Requirements Exceptions/Additions

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
1	1.5.1	–	Process Indicators	The following shall be an addition to section 1.5.1: Process Indicator – Process indicator conditions are not desirable and indicate that the process is not operating within the target parameters. It is a condition which identifies a characteristic that neither fully meets the specified acceptance criteria nor is considered a defect because it does not affect the “form, fit, or function” of the end product. Honeywell requires the manufacturer to provide objective evidence that they have an effective system in place to monitor their processes to the extent that process indicators shall be identified, analyzed, and appropriate action implemented to correct the condition. Based on frequency of occurrence or related production circumstances associated with the process indicators, Honeywell reserves the right to change the level of acceptance from a “Process Indicator” to a “Defect”. Honeywell Supplier Quality shall notify suppliers of this change in classification. Failure of the manufacturer to provide proper and timely corrective action may result in a Honeywell corrective action request.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
2	1.10	–	Personnel Proficiency	The following shall replace section 1.10: Certification/Training: Before working on a Honeywell product, operators and inspectors shall be trained to the requirements of this specification. Operators shall maintain IPC certification per IPC J-STD-001 and inspectors shall maintain IPC certification per IPC-A-610. All training shall be traceable to a Master IPC Trainer (MIT). Operator training shall include demonstration of operator proficiency with test pieces being produced to the standards required. The test pieces shall be kept for the certification validity period as confirmation. Operators shall be trained to IPC-7711/7721 Methods 3.9.1 and 5.7.2. Note: Certification to IPC-7711/7721 is not necessary.
3	3.1	–	Materials	The following shall be an addition to section 3.1: There shall be a documented process to control materials, including consumable materials that are subject to age degradation. Limited shelf life items shall be stored and controlled per material manufacturer's recommendations, or per the supplier's documented procedures for controlling shelf life and shelf life extensions.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
4	3.2	–	Solder	The following shall be an addition to Section 3.2: Unless otherwise specified, Sn60Pb40, Sn62Pb36Ag2, or Sn63Pb37 shall be used, per IPC J-STD-006. Solder alloys and solder pastes previously tested or qualified in accordance with other specifications shall meet the requirements of Appendix A of this specification.
5 DELETED				
6	3.2.2	–	Solder Purity Maintenance	The following shall be an exception to Section 3.2.2: SnPb alloys used for preconditioning or assembly shall have a tin content maintained within 1.5% of the nominal alloy being used.
7	3.3	–	Flux	The following shall replace Section 3.3: Flux shall be in accordance with IPC J-STD-004, or equivalent. Flux shall conform to flux activity levels L0 and L1 of flux materials rosin (RO), resin (RE), or organic (OR). Other activity levels or flux materials shall be approved, in writing, by the Engineering Authority at the applicable Honeywell site. Flux or solder paste soldering process combinations previously tested or qualified in accordance with other specifications shall meet the requirements of Appendix A of this specification. Type H or M fluxes shall not be used for tinning of stranded wires.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
8	3.9	–	Soldering Tools and Equipment	The following shall be an addition to Section 3.9: Solder irons, benchtop and hand soldering systems shall meet the requirements of IPC J-STD-001, Appendix A. Periodic verification of compliance to these requirements shall be documented and available for review. The verification interval shall not exceed 12 months.
9	4.1	–	ESD Control Plan	The following shall be an addition to Section 4.1: The manufacturer shall have an electrostatic discharge (ESD) control plan per MIL-STD-1686, ANSI/ESD S20.20, or BS EN 61340-5-1.
10 DELETED				
11	4.5.a	–	Removal of Component Surface Finishes	The following shall be an exception to Section 4.5.a: All exceptions shall be approved, in writing, by the Engineering Authority at the applicable Honeywell site. - Objective evidence of approval shall be available for review. - This option does not apply to gold finishes on surface mount components. Gold shall always be removed from 95% of all surfaces to be soldered of surface mount components regardless of gold thickness.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
12	4.5.2	–	Other Metallic Surface Finishes Removal	The following shall be an addition to Section 4.5.2: The Engineering Authority at the applicable Honeywell site shall make the determination if there is any solder joint integrity issue.
13	4.6	–	Thermal Protection	The following shall be an addition to Section 4.6: If it is not possible to implement an effective heat sink, the component shall be preheated. Multilayer ceramic chip capacitors (MLCCs) and “stacked” capacitors containing these parts shall be handled as thermal stock sensitive. Heat up and cool down rates shall be controlled within the manufacturer’s recommendation. NOTE: Hand soldering with solder irons and tinning operations are particularly at risk. Consult your component manufacturer for heat sensitivity levels, and/or hand soldering and pre-tinning recommendations or guidelines.
14	5	–	Wires and Terminal Connections	The following shall be an addition to Section 5: The crimping and harnessing processes shall be per applicable paragraphs of HPS1008.
15	5.1.2	–	Strand Damage	The following shall be an exception to Section 5.1.2: No broken or severed strands allowed.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
16	7.5.14.3	–	Column Grid Array Components (CCGA)	The following shall be an addition to Section 7.15.4.3: Solder paste print requirements shall be: a. For 1.27 mm pitch CCGA: 1. A minimum paste volume of 0.047 mm³ (3000 cubic mils). 2. A minimum print height of 0.18 mm (0.007 in). 3. Maximum volume of 0.120 mm³ (7600 cubic mils). 4. Print registration of ± 0.10 mm (0.004 in). b. For 1.00 mm pitch CCGA: 1. A minimum paste volume of 0.031 mm³ (2000 cubic mils). 2. A minimum print height of 0.18 mm (0.007 in). 3. Maximum volume of 0.078 mm³ (5000 cubic mils). 4. Print registration of ± 10 mm (0.004 in). All deviations to these requirements shall be approved in writing by the Engineering Authority at the applicable Honeywell site.
17	7.5.15	–	Bottom Termination Components (BTC)	The following shall be an exception to Section 7.5.15: Process validation and control cannot be used in lieu of X-ray and visual inspection.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
18	7.5.15	–	Bottom Termination Components (BTC)	The following shall be an addition to Section 7.5.15: There shall be 25% or less voiding of any termination in the X-ray image area. There shall be 50% or less voiding of the thermal plane termination in the X-ray image area. The maximum size for a void in the thermal plane area shall be less than the via pitch within the plane.
19	8	–	Cleaning Process Requirements	The following shall be an addition to Section 8: Flux residues shall be removed as soon as possible after each soldering process. The maximum time between soldering and completion of cleaning shall be defined in supplier's procedures and shall not exceed the following: For rosin based flux: - Halide free, low solids (defined as equal to or less than 15%), 8 hours. - Halide containing or high solids (defined as greater than 15%), 1 hour. For organic acid based flux: - ORLO, 8 hours. For higher activity fluxes (if approved, in writing, by the Engineering Authority at the applicable Honeywell site, as an exception to use): - ORM0 or ORH0, 2 hours. - ORM1 or ORH1, 1 hour.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
20	8.2.b	–	Ultrasonic Cleaning	The following shall be an addition to Section 8.2.b: Ultrasonic cleaning on electronic assemblies with electrical components shall not be performed unless approved in writing by the Engineering Authority at the applicable Honeywell site.
21	8.3.2	–	Flux Residues and Other Ionic or Organic Contaminants	The following shall be an addition to Section 8.3.2: a. Cleanliness designator C-22 shall apply. b. All samples selected shall be PBAs with the greatest cleaning challenges based on density/complexity (ie. BGAs, QFNs, etc).
22	8.3.2	–	Flux Residues and Other Ionic or Organic Contaminants	The following shall be an addition to Section 8.3.2: Cleanliness designator C-25 is invoked per Appendix A of this specification.
23 DELETED				
24	10.1	–	Conformal Coating	The following shall be an addition to Section 10.1: Conformal coating process shall be per this Standard Repair Manual.
25 DELETED				
26 DELETED				
27	11.2.1	–	Process Verification Inspection	The following shall be an addition to Section 11.2.1: The supplier shall be required to establish the capability and process to perform AXI testing.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
				a. AXI solder inspection shall include solder ball formation in inspection site area, and registration, voids, solder profile, insufficient/excessive solder, solder balls/splashes, and solder bridges.
28	11.2.2.1	–	Magnification Aids	The following shall be an addition to Section 11.2.2.1: General inspection of surface mount technology (SMT) and mixed technology PBAs shall be performed at 10X magnification. Magnification up to 40X shall be used when suspect conditions required higher magnification levels for detection. For example, if it has been determined that a residue is only visible at 30X or a solder fracture can only be detected at 30X, then 30X shall be used to inspect the non-conforming condition. Inspection for any suspect condition requiring referee action for acceptability determination shall be performed at 40X.
29	12	–	Rework	The following shall be an addition to Section 12: Rework procedures shall be in accordance with IPC-7711, Class 3 (high conformance level).
DELETED				

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
31	Appendix A	–	Requirements for Soldering Tools and Equipment	The following shall replace Appendix A of IPC J-STD-001: Requirements for Soldering Tools and Equipment: The following requirements for tools and equipment selection and use have been found through industry practice to be effective in meeting the requirements of this standard and shall be implemented for Honeywell products. Replace “should” with “shall” for entire Appendix A of IPC J-STD-001.
32	–	3	Handling Electronic Assemblies	The following shall be an addition to Section 3: The supplier shall provide and maintain a documented procedure for dropped PBAs, ESD violations, and moisture sensitive devices (MSD) violations.
33	–	5.2.7.1	Soldering Anomalies – Excess Solder – Solder Balls/ Solder Fines	The following shall be an addition to Section 5.2.7.1: See exception/addition no. 28 for inspection requirement. There shall be no loose plating slivers on the surface of the board which includes solder balls. If solder balls meet all of the listed conditions below, the PBA shall not be rejected for this condition. a. Shall not violate minimum electrical spacing.

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Table 13-15. Requirements Exceptions/Additions (Cont)

Exception/Addition Number	Applicable Section in IPC J-STD-001	Applicable Section in IPC-A-610	Subject	Exceptions/Additions
				b. Shall be physically connected and fused to metallic surface. c. Shall not be visible at magnification of 10X or less, solder balls only visible at magnifications greater than 10X are acceptable provided conditions a and b above are met.

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APPENDIX A – QUALIFICATION OF MATERIALS, PROCESSES, AND EQUIPMENT USED IN THE REWORK OF MIXED METALLURGY BGAS

1. Qualification of Materials, Processes, and Equipment Used in the Rework of Mixed Metallurgy BGAS

A. Scope

(1) Purpose

This appendix provides Honeywell sites a standard process for qualification of materials, processes and equipment used in the rework of mixed metallurgy BGAs. The qualification outlined in this appendix provides the rework supplier with some degree of flexibility for material and process selection.

B. Applicable Documents

(1) IPC Publications

Available from IPC, 3000 Lakeside Drive, Bannockburn, IL 60015, Tel: 847-597-2862, <http://www.ipc.org>.

IPC-TM-650

Test Methods Manual

C. Technical Requirements

(1) Qualification Test Plan

(a) The test plan shall include the part number(s) being qualified, and all materials (Paragraph J.(3)(b)), processes (Paragraphs J.(3)(c), (d) and (e)), equipment (including AXI equipment, per Appendix B), and test methods (Paragraphs C.(2) thru C.(3)) to be used. Manufacturing location, qualification sample size, and other information shall also be listed in the test plan.

(b) Honeywell Material and Process Engineering shall evaluate the proposal (see Paragraph (4)(c)2) and provide feedback. This feedback shall include definition of any additional site-specific testing that may be required. This review team shall act as Honeywell's technical focal point throughout any future qualification activities.

(c) Following approval to proceed, the supplier shall proceed with the approved test plan.

(2) Process Cleanliness

(a) Ion chromatography shall be performed using localized (C3 type) extraction techniques in all replacement BGA areas. Results shall meet the acceptance levels for specific ionic species as per Table A-1.

(b) Ionic Cleanliness Level 2



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Ionic cleanliness shall be tested in accordance with IPC-TM-650, Method 2.3.28. Table A-1 defines maximum allowable limits for the ionic species listed. The values listed are to be used as a baseline for comparison. The extraction solution shall be 75/25 v/v IPA/DI.

NOTE: Analytical results from IPC-TM-650, Method 2.3.28, are expressed in $\mu\text{g}/\text{in}^2$ of residue ionic species. This should not be confused with the $\mu\text{g}/\text{cm}^2$ sodium chloride (NaCl) equivalent defined in IPC J-STD-001, Class 3, and IPC-TM-650, Method 2.3.25, Ionic Resistivity of Solvent Extract (ROSE) method. The ROSE method test equipment measures resistivity of the extract solution, it does not directly quantify the ionic species found in the test solution. The NaCl equivalence refers to the amount of sodium chloride needed to produce a solution of the same conductivity. The results are used as a process control tool for detection of bulk or gross ion contamination. Ion chromatography (IC) provides a method for process evaluation, characterization, and qualification.

Table A-1. Maximum Contamination Level for Specific Ionic Species

Contaminant	Allowable Limit $\mu\text{g}/\text{in}^2$
Bromide	< 10
Chloride	< 6
Fluoride	< 3
Sulfate	< 3
Phosphates	< 7
Nitrates	< 3
Nitrites	< 3
Weak organic acids ¹	< 25
NOTE: 1 At a minimum, the weak organic acid summation shall include succinic, maleic, malic, glutaric, tartaric, and adipic acid levels. If other unspecified weak acids are found to be present during the analysis, they shall also be included in the summation.	

(3) Process Microsection

- (a) Microsection evaluations shall be performed for each mixed metallurgy BGA from at least one mixed metallurgy configured PBA. Microsections shall be evaluated using magnification range between 100X and 1000X. Microsection data shall meet the requirements of Paragraphs (b) and (c).



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- (b) Microsections shall show evidence of complete mixing/alloying of the SAC BGA ball with the tin-lead paste. Validation of intermetallics compound (IMC) thicknesses, tin-copper or tin-nickel, at balls to printed board (PB) interface shall meet Honeywell Materials & Process Engineering proprietary standards.
 - (c) Microsection data shall show evidence of meeting the Class 3 acceptance criteria for voiding of surface mount area arrays as specified in IPC-A-610 and IPC J-STD-001.
- (4) Reports
 - (a) A qualification test report shall be submitted for review. This report shall include, as a minimum, the following information:
 - 1 Name and address of the facility performing the process.
 - 2 The part number of parts processed.
 - 3 The quantity of parts processed.
 - 4 Lot designation and/or processing date.
 - 5 Assembly information: materials, processes, equipment, manufacturing location.
 - 6 Applicable qualification test data and results, including photo-documentation.
 - 7 Any excluded data points and rationale.
 - 8 Any unusual events during processing or testing.
 - (b) The report shall be reviewed by Honeywell to ensure all requirements have been met and a written response to the supplier shall be provided. This response shall include a designation in accordance with the following:
 - 1 Acceptable to Honeywell
 - 2 Additional information or test required
 - 3 Unacceptable to Honeywell.
 - (c) The response shall include the rationale for the designation. Disagreements may be presented to Honeywell in writing for review. The intent is to provide the greatest amount of process and material flexibility without assuming higher levels of product reliability risks.
 - (d) Honeywell Materials and Process Engineering shall reserve the right to refuse acceptance of any proposed solder, flux, cleaning chemistry, and/or processes that it believes compromises the quality, reliability, performance, and/or customer satisfaction of its products.
- (5) Approval
 - (a) Honeywell Materials and Process Engineering shall evaluate the results of the qualification testing. Approval for the qualification shall be provided in writing by Honeywell Materials and Process Engineering. See Paragraph C.(4)(b).

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D. Quality Assurance Provisions

- (1) The supplier shall be responsible for reviewing and validating that the processes used are:
 - (a) In conformance with this specification
 - (b) Capable of producing consistent results
 - (c) Adequately controlled to ensure product quality.

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APPENDIX B – AUTOMATED X-RAY INSPECTION (AXI) MACHINES

1. Automated X-Ray Inspection (AXI) Machines

A. Scope

(1) Purpose

This appendix defines the defect detection criteria for BGAs on AXI machines.

B. Technical Requirements

(1) Detection Criteria

The AXI machine shall detect the defect criteria in Table B-1.

Table B-1. Defect Detection Using X-Ray Machine

Detection	BGAs
Voids	Yes
Shorts	Yes
Opens	Yes
Miss alignment	Yes
Inspect at different slices (planes)	Yes
Record, or print out the defect image for reviewing later	Yes
Polarity	Can be visually inspected
Insufficient ball sizes, shapes	Yes
Head-in-pillow	Yes

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