

Instruction  
Hardware Engineering

No. LMS 8-2

Subject: Riveting

APPROVED BY Manager, Hardware Engineering

STATUS Maintenance Revision

PURPOSE Defines the general workmanship and quality requirements related to riveting. Requirements of this instruction are applicable to all L-3 Communications Corporation, Link Simulation and Training Division (hereafter referred to as Link) personnel involved in the installation of rivets into Link products.

AFFECTED FUNCTIONS Hardware Engineering  
Manufacturing

REFERENCES None

DEFINITIONS Cocked head. The seating of either the manufactured head or the upset head at an angle other than perpendicular to the shank of the rivet parallel to the surface.

Countersinking (machine countersinking). Chamfering a conical depression around the top of a hole for receiving the head of a fastener.

Dimpling. Stretching a relatively small shallow indentation into the sheet metal. Stretching metal into a conical flange for use of a countersunk rivet or screw. Dimpling is substantially stronger than countersinking and should be performed on relatively thin sheet metal panels.

Manufactured head. The head formed at the time the rivet is manufactured.

Upset head (shop formed). The head formed during the riveting operation.

## INSTRUCTION

### 1. Requirements

- 1.1 Hole sizes. Unless otherwise specified, pilot holes shall be drilled before dimpling. The final hole size shall be drilled or reamed after dimpling or countersinking. Hole tolerance shall be in accordance with Tables I and II.

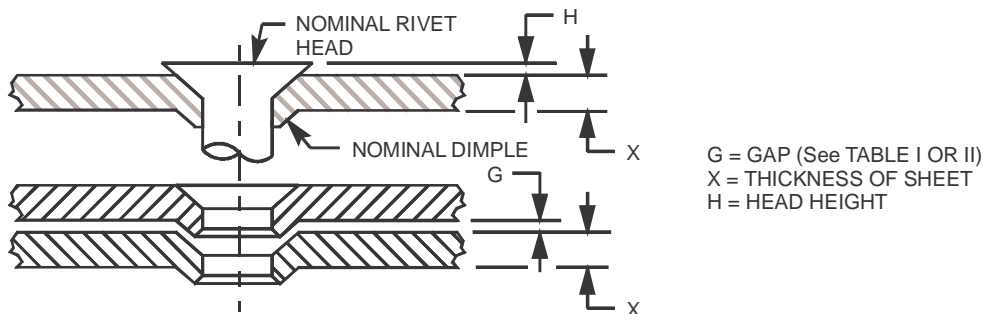
Countersinking. Countersinking shall be used when the outer sheet is within the limits specified in Tables I and II.

1.2 Rivets.

- a. Conventional rivets. The application of conventional rivets shall be in accordance with Table I, unless otherwise specified on the engineering drawing.
- b. Pull-through and self-plugging blind rivets. Pull-through and self-plugging blind rivets shall be installed in accordance with Table II and the manufacturer's recommended practices, except as modified by the engineering drawing.
- c. Acceptable and unacceptable limits of upset heads. Acceptable and unacceptable limits of upset heads shall be as shown in Figure 1.
- d. Rivet hole tolerance. Unless otherwise specified, holes shall be prepared for rivets in accordance with the tolerances specified in Tables I and II. Oversized holes shall be corrected by the use of one size larger rivet with the following restrictions:
  - (1) Not more than 10 percent of the rivets in the pattern shall be affected.
  - (2) The least required edge distance and sufficient head clearance for the replacement rivet shall be obtainable. The edge distance is the distance from the centerline of the rivet to the edge of the sheet or joint. This dimension shall not be less than two times the rivet diameter in sheet stock, three times the rivet diameter in nonferrous castings.
  - (3) The hole shall not have a dimension greater than the allowable diameter for the next larger size rivet.
  - (4) When countersinks are oversize, the skin thickness shall permit the use of the next larger size rivet.

**Table I Holes For Conventional Rivets  
Inches (mm)**

Rivet size		.0625	.0938	.125	.156	.188	.250	.313	.375	
Hole size before dimpling	Min.	.064 (1.626)	.096 (2.438)	.128 (3.251)	.159 (4.039)	.191 (4.851)	.250 (6.350)	.312 (7.925)	.375 (9.525)	
	Final hole size	Min.	.067 (1.702)	.098 (2.489)	.129 (3.277)	.161 (4.089)	.191 (4.851)	.257 (6.528)	.320 (8.128)	.386 (9.804)
	Max.	.071 (1.803)	.106 (2.692)	.139 (3.531)	.172 (4.369)	.204 (5.182)	.266 (6.756)	.330 (8.382)	.404 (10.262)	
Sheet thickness for dimpling	Min.	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	
	Max.	.040 (1.016)	.051 (1.295)	.064 (1.626)	.072 (1.829)	.091 (2.311)	.125 (3.175)	.156 (3.962)	.188 (4.775)	
Sheet thickness for countersinking	Min.	.032 (0.813)	.040 (1.016)	.051 (1.295)	.064 (1.626)	.072 (1.829)	.102 (2.591)	.125 (3.175)	.156 (3.962)	
	Max.	.095 (2.413)	.160 (4.064)	.206 (5.232)	.267 (6.782)	.334 (8.484)	.457 (11.608)	.545 (13.843)	.675 (17.145)	
Countersink diameter <sup>1</sup>	Min.	.095 (2.413)	.160 (4.064)	.206 (5.232)	.267 (6.782)	.334 (8.484)	.457 (11.608)	.545 (13.843)	.675 (17.145)	
	Max.	.105 (2.667)	.170 (4.318)	.216 (5.486)	.277 (7.036)	.344 (8.738)	.467 (11.862)	.555 (14.097)	.685 (17.399)	
Countersink diameter <sup>2</sup>	Min.	.117 (2.972)	.167 (4.242)	.215 (5.461)	.283 (7.188)	.349 (8.865)	.471 (11.963)			
	Max.	.127 (3.226)	.177 (4.496)	.225 (5.715)	.293 (7.442)	.359 (9.119)	.481 (12.217)			
“G” gap (see figure below)	Max.	.005 (0.127)	.010 (0.254)							

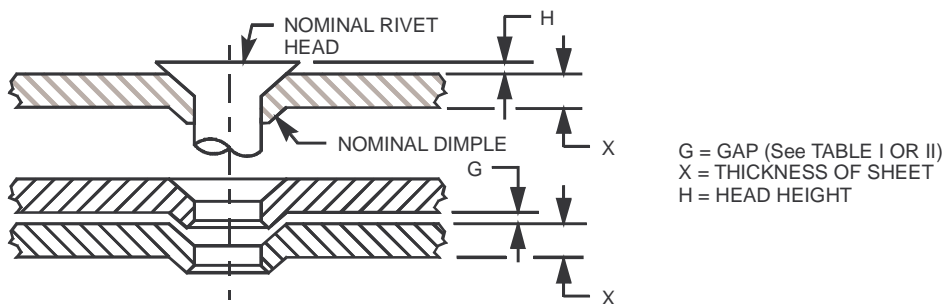


1. Countersink dimensions to be used when countersink is the only method of hole preparation used.
2. Countersink dimensions to be used when combination pre-dimple and countersink method of hole preparation is used.

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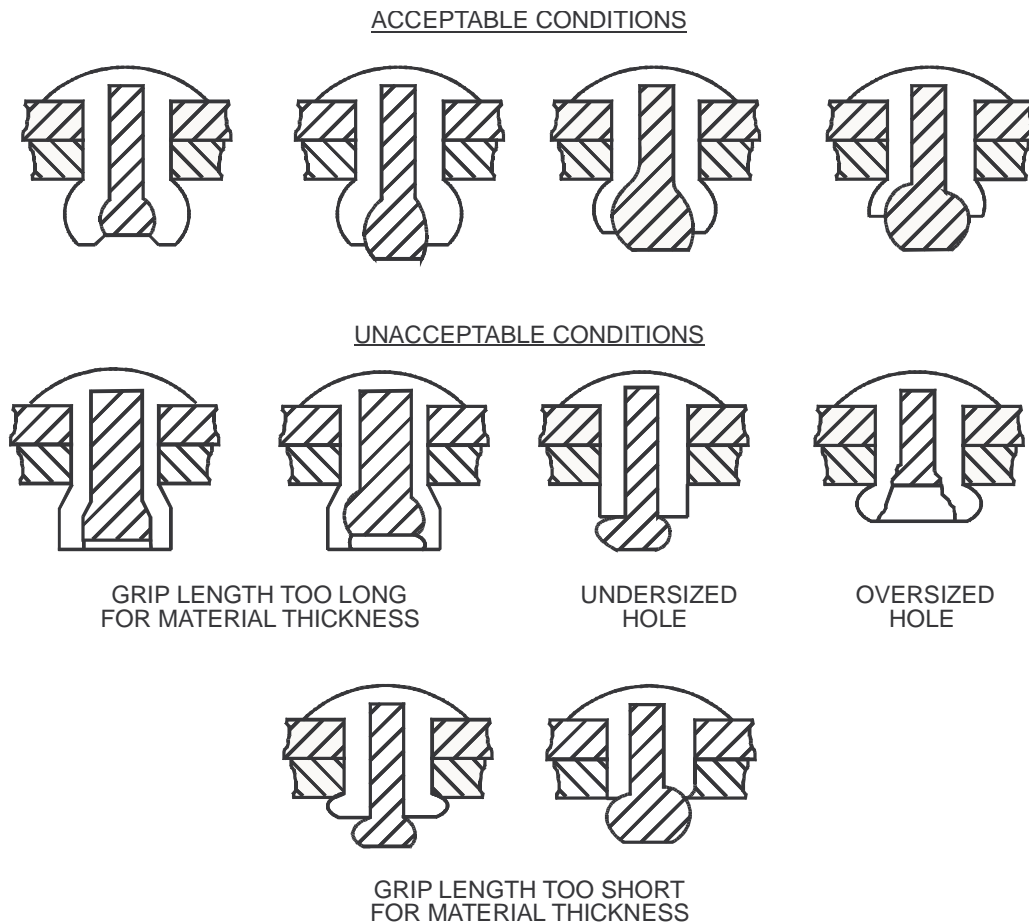
**Table II Holes For Pull-Through And Self-Plugging Rivets  
Inches (mm)**

Rivet size		.125	.156	.188	.250	.134	.172	.203
Hole size before	Min.	.120 (3.048)	.128 (3.251)	.161 (4.089)	.234 (5.944)	.120 (3.048)	.159 (4.039)	.193 (4.902)
	Final hole size	Min.	.128 (3.251)	.160 (4.064)	.192 (4.877)	.256 (6.502)	.137 (3.480)	.177 (4.496)
	Max.	.132 (3.353)	.164 (4.166)	.196 (4.978)	.261 (6.629)	.141 (3.581)	.181 (4.597)	.210 (5.334)
Sheet thickness for dimpling	Min.	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)	.016 (0.406)
	Max.	.051 (1.295)	.072 (1.829)	.091 (2.311)	.125 (3.175)	.051 (1.295)	.072 (1.829)	.091 (2.311)
Sheet thickness for countersinking	Min.	.051 (1.295)	.064 (1.626)	.072 (1.829)	.102 (2.591)	.051 (1.295)	.064 (1.626)	.072 (1.829)
	Max.	.216 (5.486)	.277 (7.036)	.344 (8.738)	.467 (11.862)	.216 (5.486)	.277 (7.036)	.344 (8.738)
Countersink diameter <sup>1</sup>	Min.	.206 (5.232)	.267 (6.782)	.334 (8.484)	.457 (11.608)	.206 (5.232)	.267 (6.782)	.334 (8.484)
	Max.	.215 (5.461)	.283 (7.188)	.349 (8.865)	.471 (11.963)	.215 (5.461)	.283 (7.188)	.349 (8.865)
Countersink diameter <sup>2</sup>	Min.	.225 (5.715)	.293 (7.442)	.359 (9.119)	.481 (12.217)	.225 (5.715)	.293 (7.442)	.359 (9.119)
	Max.	.010 (0.254)						
"G" gap (see figure below)	Max.	.010 (0.254)						



1. Countersink dimensions to be used when countersink is the only method of hole preparation used.
2. Countersink dimensions to be used when combination pre-dimple and countersink method of hole preparation is used.

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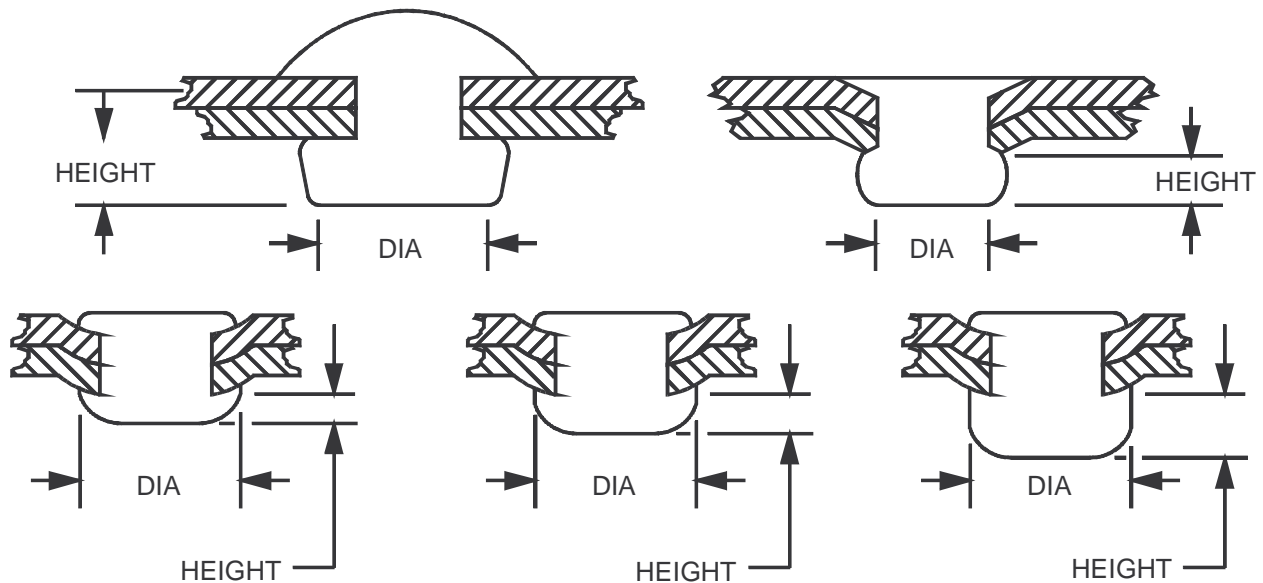
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**Figure 1 Acceptable and Unacceptable Conditions for Pull-Through and Self-Plugging Rivets**

1.3 Rivet heads.

- a. Manufactured rivet head height. Manufactured heads of countersunk rivets shall not be below the skin of exposed or critical surfaces either before or after driving. Unless otherwise specified on the engineering drawing, the projection height of countersunk heads shall not be greater than .004 inch (0.102 mm). A maximum of .006 inch (0.152 mm) may be shaved from a protruding head in order to meet this requirement.

- b. Cocked heads. Cocking of either head (manufactured or upset) shall not be allowed, except where one or more joined surfaces are angular. When only one side of the material to be joined is an angular position, the upset head shall be formed on the angular side of the material.
- c. Upset heads. The diameter and height of upset heads shall be determined in accordance with Figure 2 and Table III.
- d. Malformed upset heads. The mean height of malformed upset heads shall be not less than one-third of the rivet-shank diameter. The mean height shall be within the limits specified in Table III.
- e. Cracked upset heads. Very fine radial cracks located on or around the periphery are not acceptable if they are wedge shaped or permit chips to fall out. Radial shear cracks shall not be greater than .125 inch (3.175 mm) of nominal shank diameter in depth or .063 inch (1.600 mm) of nominal shank diameter in width.



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Figure 2 Upset Head Diameters (See Table III)

**Table III For All Rivets Except 2017-T Rivets Driven Hard  
(See Figure 2)**

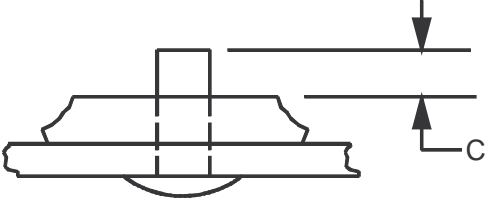
Rivet Size	Tolerance of upset rivet heads - Inches (mm)			
	Diameter max. 1.66D (42.16)	Height min. .33D (8.38)	Diameter min. 1.25D (31.75)	Height max. .66D (16.76)
.0938	.156 (3.962)	.031 (0.787)	.125 (3.175)	.062 (1.575)
.125	.203 (5.156)	.047 (1.194)	.156 (3.962)	.078 (1.981)
.156	.264 (6.706)	.047 (1.194)	.203 (5.156)	.109 (2.769)
.188	.312 (7.925)	.063 (1.600)	.234 (5.944)	.125 (3.175)
.250	.423 (10.744)	.078 (1.981)	.312 (7.925)	.172 (4.369)
.313	.515 (13.081)	.108 (2.743)	.391 (9.931)	.203 (5.156)
.375	.625 (15.875)	.125 (3.175)	.469 (11.913)	.250 (6.350)

- f. Marring of the manufactured head. A cut or ring caused by the riveting equipment used shall be acceptable on nonflush rivets, providing the depth of the cut is not greater than one-fourth of the head height. Cut or ringed flush rivets shall not be acceptable.
- g. Head gap. Gaps under the manufactured head of nonflush rivets installed on a flat surface shall not be acceptable. Heads of nonflush rivets installed on convex surfaces shall seat flat longitudinally only.

1.4 Rivet lengths. The rivet length shall be selected to allow sufficient material to form the correct size driven head. Table IV shows the nominal shank projection before driving for rivets up to .375 inch (9.525 mm) in length.

**Table IV Average Nominal Projection Before Driving**

Rivet Diameter	Dimension "C" Inches (mm)
.0625	.094 (2.388)
.0938	.141 (3.581)
.125	.188 (4.775)
.156	.234 (5.944)
.188	.281 (7.137)
.250	.375 (9.525)
.313	.469 (11.913)
.375	.562 (14.275)



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**UNSIGNED HARDCOPY  
NOT CONTROLLED**



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2. Quality Assurance Requirements
  - 2.1 The Quality Assurance Organization shall be responsible for insuring that the requirements of this instruction are met.
3. Preparation for Delivery (Not Applicable)