1.0 OBJECTIVE

The objective of this specification is to provide information to assist with the application and use of the M-Series™ 56 High Speed Mezzanine BGA (Ball Grid Array) connectors system. This specification is intended to provide general guidance for application process development. It is recognized that no single application process will work for all board assemblies and that customers will develop processes to meet their needs. However, if these processes differ greatly from the following recommendations, AFCI cannot guarantee results.

2.0 SCOPE

This specification provides application guidelines and requirements regarding customer application of M-Series™ 56 BGA connectors with lead free SnAgCu, RoHS compliant BGA parts to printed circuit boards.

3.0 GENERAL

This document is meant to be an application guide. If there is conflict between the product drawings and specifications, the drawing takes precedence.

This specification consists of the following sections:

4.0 DRAWINGS AND APPLICABLE DOCUMENTS

- AFCI PRODUCT SPECIFICATION GS-12-1466
- AFCI PRODUCT DRAWINGS
- APPLICATION MANUALS/INSTRUCTION SHEETS (IF NOT INCLUDED IN THIS DOCUMENT)

Product drawings and **AFCI's GS-12-1466** Product Specification are available at www.**amphenol-icc**.com In the event of a conflict between this application specification and the drawing, the drawing will take precedence. Customers are advised to refer to the latest revision level of AFCI product drawings for appropriate details. For details on regulative compliance such as EU Directive and RoHS reference AFCI specification GS-22-008.

Table 1: Connector Sizes and Stack Heights

Board-to-Board Height***		
Size	Type	4.0mm
325 position 13 x 25 100 differential pairs	**Plug**	**10145700 1mm**
	Receptacle	**10145704 4mm**

5.0 APPLICATION REQUIREMENTS

5.1 GENERAL PRODUCT FEATURES

M-Series™ 56 connectors are an effective solution for high density, high-speed mezzanine applications. The connector utilizes Ball Grid Array (BGA) for solder attachment to the PCB (See Figures 1A and 1B). Connectors are available with Lead Free 96.5Sn / 3Ag / 0.5Cu BGA. For initial alignment during connector engagement, the plug housing has a chamfered lead-in that captures and guides the receptacle housing. To assure proper mating orientation, plug connectors are keyed with a “large slot” at one end and a “small slot” at the other end, and the receptacle parts are keyed with a “large key” at one end and a “small key” at the other end. The A1 position is identified with a “Δ” at the end of the connector.
Connectors are supplied in tape and reel (See Figure 5) and a pick-up cap is standard for vacuum pick- and-place during automated assembly.

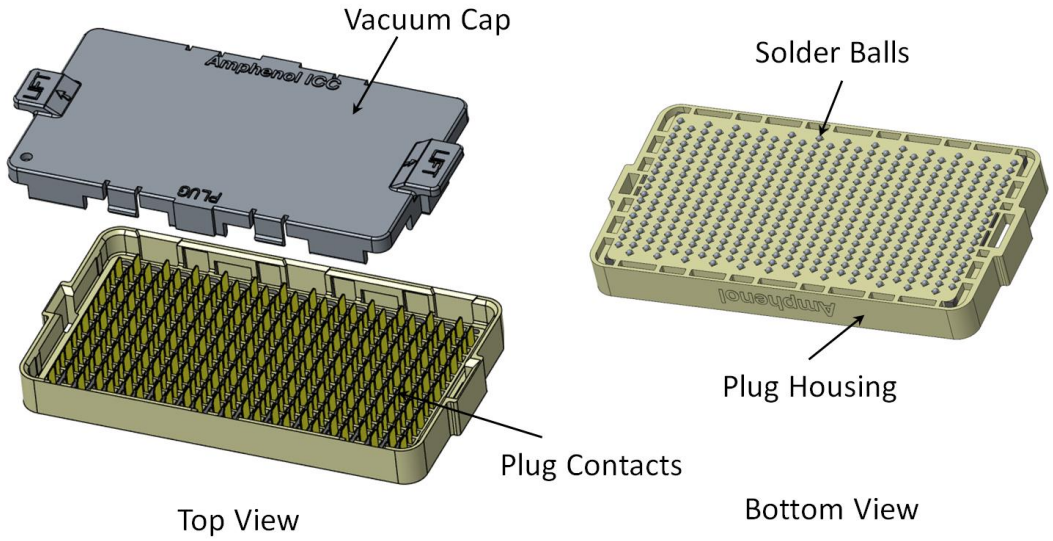


Figure 1A: Plug Connector Features

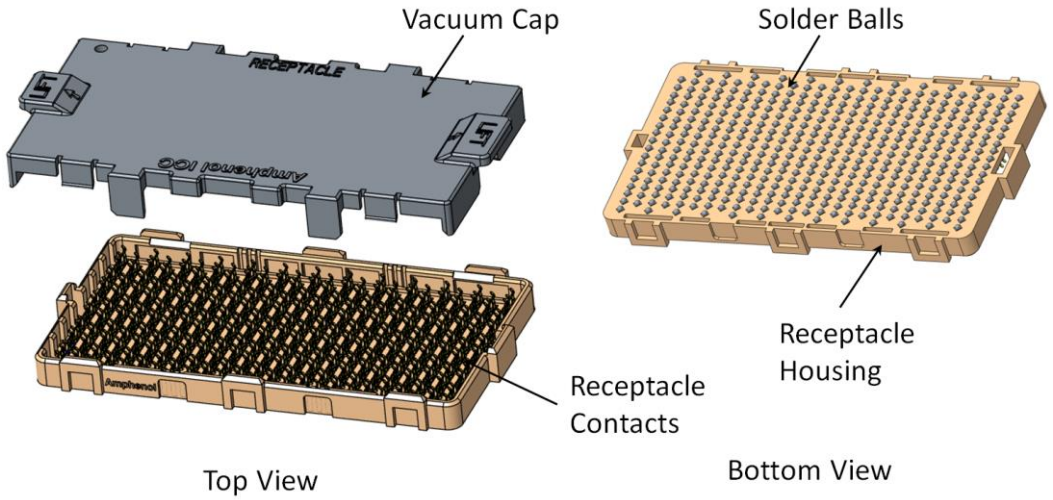
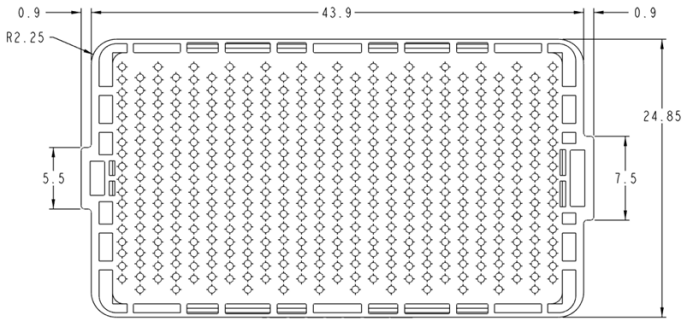


Figure 1B: Receptacle Connector Features

5.2 PRODUCT SIZES

Figure 2 outlines the PCB area required for the M-Series™ 56 connector - 13x 25, 325 positions.

Figure – 2 Plug Layout



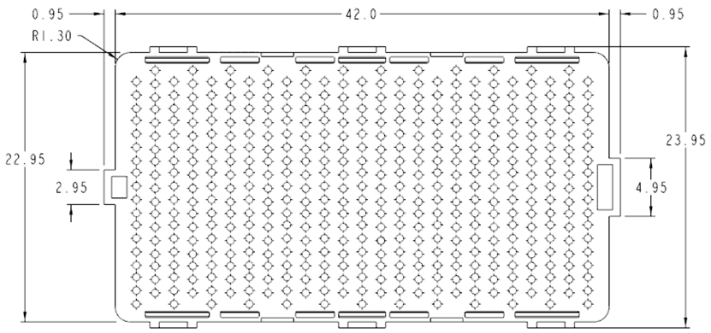


Figure – 3 Receptacle Layout

Table 2: Connector Heights and Weights

Connector Height and Weight							
		With Pick-up cap			Without Pick-up cap		
Description	Base Part Number	Height (mm)	Weight (grams)	Weight/Ball (grams)	Height (mm)	Weight (grams)	Weight/Ball (grams)
Plug (325 Position, 1mm)	10145700	6.79	TBD	TBD	4.77	TBD	TBD
Receptacle (325 Position, 4mm)	10145704	6.04	TBD	TBD	3.89	TBD	TBD

5.3 PCB DESIGN

Proper PCB design affects connector reliability and performance. The following recommendations are intended to ensure reliable electrical connections, while maximizing manufacturing yields and aiding in possible rework applications. Refer to customer drawings for overall pad layout. See Figure 2 for the detail of a single pad and via design.

- PCB pad diameter: 0.425 – 0.475 mm (.0167 – .0187 in.).
- Copper defined solder pads
- Pad materials: Copper with OSP
- Solder mask opening diameter must be greater than the PCB pad diameter and be registered properly so that 0.15 mm (.006 in.) minimum clearance is met all around the pad.
- PCB vias should be included in the ball grid array solder pads (See Figure 2).
- Keep out area around the part perimeter, 5.10 mm (.201in.), is generally recommended for clearance of rework equipment. Consult with equipment manufacturers for recommended clearance specifics.

5.3.1 Multiple Connector Applications

When designing for multiple mating applications, the ball grid array patterns shall be within +/-0.05 true position relative to each other (Connector to connector final location tolerance +/-0.1mm.). It is recommended that multiple connectors be parallel to each other or in the same orientation as shown in Figure 4. Orientation as shown in Figure 5 is not recommended. Proper connector orientation will aid compliance with the recommended connector mating and un-mating procedures that are described in section 11.2.

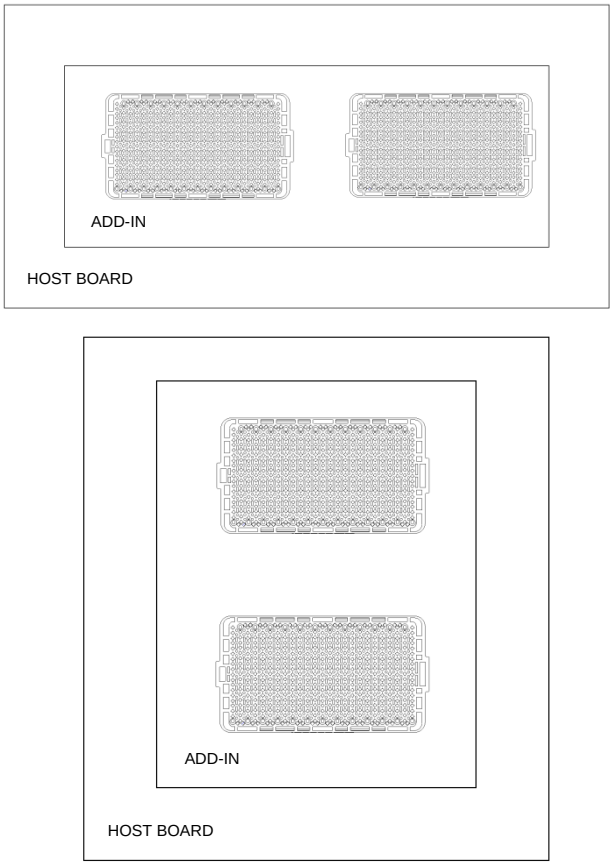


Figure 4: Recommended Orientation for Multiple Pairs

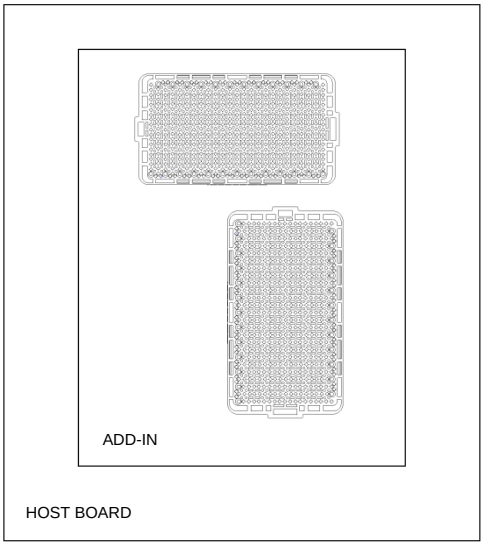


Figure 5: NOT Recommended unless eventual mating with another PCB is done vertically (without zippering)

6.0 APPLICATION TOOLING

Connector placement and assembly to PCB does not require any special tooling. However, depending upon a user's process, application specific tooling may be required.

7.0 APPLICATION PROCEDURE

IPC-A-610 defines specific criteria for Acceptable Electronic Assembly. Section 8.2.12 defines Surface Mount Area Array processing. Final Assembly must meet the acceptable industry criteria for SMT processing.

7.1 CONNECTOR PLACEMENT

- Connectors are packaged and shipped in anti-static plastic tape pockets, as shown in Figure 5. For additional information on connectors and tape, see Table 4. Reel diameter is 330mm.
- The pick-up cap, attached to the housing can be used for vacuum pick-up and placement with automated equipment. Placement by hand or with mechanical grippers that grip the outside of the connector housing will also work.
- Connector shall be placed so that solder balls are placed on top of or lightly pushed into the solder paste. Connector shall not be dragged into place, since this will track solder paste that may cause bridging and result in an electrical short.
- Connector placement utilizes typical BGA placement procedures.

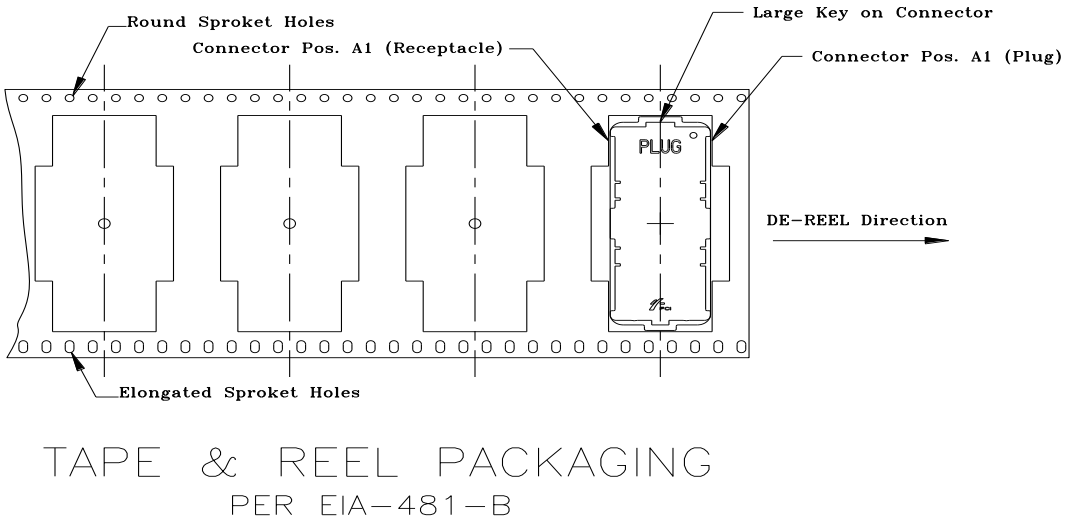


Figure 6: Tape-and-Reel Configuration (Plug Shown)

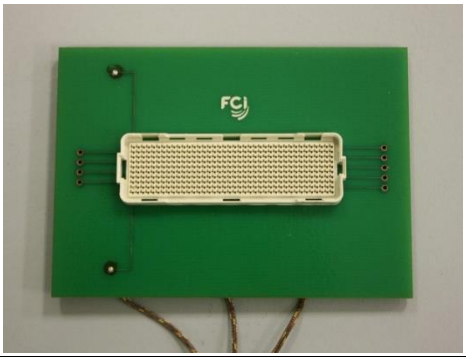
7.1 SOLDER PASTE & DEPOSITION

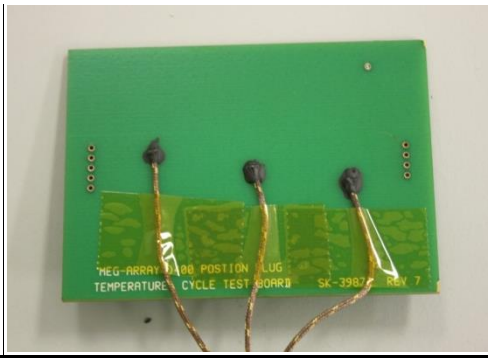
- For ease of use, a no-clean solder paste is recommended.
- 96.5Sn /3Ag /0.5Cu solder paste is recommended for Lead Free RoHS product.
- Recommended stencil thickness is 0.127 – 0.152 mm (.005 - .006 inch).
- Recommend a round aperture diameter of 0.405 mm (for 0.127 mm thick stencil) or 0.375 mm (for 0.152mm thick stencil).

7.3 SOLDER REFLOW

Thermal profiles are specified by the requirements of the solder paste being used. Solder paste companies use different flux chemistries and require different thermal profiles specific to their product. Water soluble flux is NOT recommended for M-Series™ 56 connectors. These requirements must be followed for best results. Figure 7 is a recommended general guideline. All products designed for reflow processing will withstand these ranges.

The most critical aspect of the profile is the location of the Thermocouples. As a minimum; thermocouples need to be placed in the middle and corner of the BGA field. Failure to do this can result in open and or incomplete solder joints. This is a common mistake that is made when processing the M-Series™ 56 connectors for the first time. Verifying the temperature in the center of the connector is the best way to ensure trouble free processing.





Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (Tsmax to Tp)	3° C/second max.	3° C/second max.
Preheat		
- Temperature Min (Ts_{min})	100 °C	150 °C
- Temperature Max (Ts_{max})	150 °C	200 °C
- Time (Ts_{min} to Ts_{max}) (ts)	60-120 seconds	60-180 seconds
Time maintained above:		
- Temperature (T_L)	183 °C	217 °C
- Time (t_L)	60-150 seconds	60-150 seconds
Peak Temperature (Tp)	See Table 4.1	See Table 4.2
Time within 5°C of actual Peak Temperature (tp)[2]	10-30 seconds	20-40 seconds
Ramp-down Rate	6 °C/second max.	6 °C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

Note 1: All temperatures refer to topside of the package, measured on the package body surface.
Note 2: Time within 5 °C of actual peak temperature (tp) specified for the reflow profiles is a "supplier" minimum and "user" maximum.

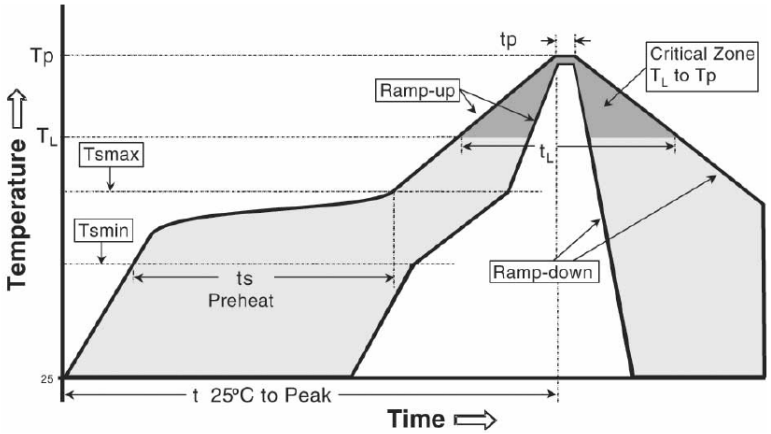


Figure 7:

7.4 DOUBLE-SIDED REFLOW

All M-Series™ 56 connector sizes are suitable for double-sided reflow (DSR). See Table 2 for individual connector weights. In all cases, users should verify connector applicability for inverted reflow through process verification testing.

7.5 CLEANING

If desired, following reflow, the connector and board assembly can be washed with an appropriate cleaner to remove any residue or contaminants. Vacuum pickup caps should be removed prior to cleaning to reduce the chance of trapping cleaning solutions

8.0 POST-APPLICATION INSPECTION PROCEDURES

- Visually inspect the connector for damage and cleanliness.
- Solder joints can be inspected with X-ray techniques that are typical to BGA components.
- Electrical testing can be performed with a customer-designed system. Caution must be taken to avoid damage to the connector terminals during electrical testing.

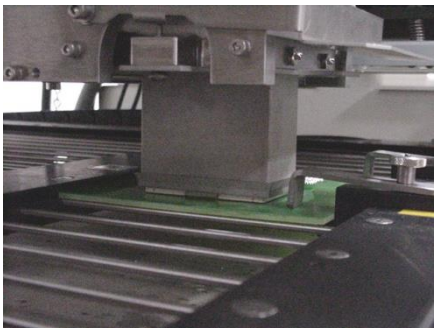
9.0 REWORK / REPAIR TOOLING

Naturally, prevention of defects is preferred to rework. Rework can be avoided through good process control, such as proper equipment setup and maintenance, in-process inspection, SPC use, and adequate operator training. The following rework procedure was developed using an SRT Summit 1100 rework station and a Pinnacle Scavenger to remove residual solder once the connector is removed. Other rework equipment would follow a similar procedure and would only need to be modified according to the equipment manufacturer's recommendations.

10.0 REWORK PROCEDURE: In the event that rework is required, the following guidelines are general for eutectic solder applications. Adjust the temperatures accordingly for lead free applications. Consult and follow all equipment manufactures recommendations.

Step 1: Develop the Thermal Process
To develop the thermal process, a thermocouple should be attached next to the outer row of solder balls and under the connector. Using the reflow nozzle as shown in the photograph.

Reflow Nozzle



REWORK PROCEDURE GUIDELINES (CONT.)

Step 2: Remove the Connector

First, slide a metal rework clip, similar to the one shown in Figure 7, in place. Then use the thermal profile developed in step 1 to reflow the solder. A few seconds after the solder has reflowed, a vacuum pickup, which has a rubber tip, automatically moves to the correct location and removes the connector. The connector that is removed cannot be reused and should therefore be discarded after the solder has solidified. Since the majority of the solder is left on the printed circuit board, the residual solder must be cleaned prior to the reinstallation of a new connector.

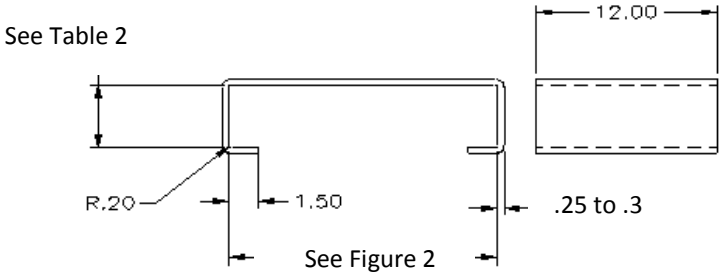


Figure 8: Rework Clip
Dimensions are in MM

Step 3: Board Cleaning and Preparation

Flux should be applied over the pads and residual solder. This will help in reactivating the solder and cleaning the pads. A solder scavenging system, which uses a hot gas non-contact nozzle to vacuum remove the solder, is recommended. The nozzle should be programmed to a scavenging height of approximately 0.2 mm (0.008") with a pre-programmed path that follows the M-Series™ 56 PCB pad layout and limits excess heating to other areas of the board. If a solder scavenging system is not available or is impractical, then a skilled operator can use other hand desoldering methods, though extra care must be taken to limit localized heating which could damage the PCB. After removal of the old residual solder, use cleaning chemistries that are compatible with flux chemistries to clean up any excess flux or debris.

Step 4: Connector Replacement

After cleaning, it is recommended to repaste the pads using an 0.127 – 0.152 mm (.005-.006 inch) thick stencil to apply approximately 0.041 mm^3 (2.50E-6 $inch^3$) of solder paste. To assist in aligning the

connector to the PCB pads, place a mark at the center of the long side of the housing. If the PCB does not have a silk-screened mark at the center pad location; hand mark the board, so that the center of the connector and the center of the pad layout align. Apply the metal clip used to remove the connector in step 2, to the new replacement connector. Then, with the metal clip in place, load and secure the connector into the vacuum pick-up system. The SRT Summit 1100 uses a split prism vision system to allow for the operator to simultaneously view the bottom of the connector and the top of the PCB. Align the PCB and connector center marks and place the connector. Once the connector is placed onto the board, reflow the solder using the established auto profile parameters. Remove the metal clip and reinspect and retest the connector as applicable.

11.0 RECOMMENDED PICK-UP CAP REMOVAL:

11.1 PLUG AND RECEPTACLE PICK-UP CAP INSTRUCTIONS:

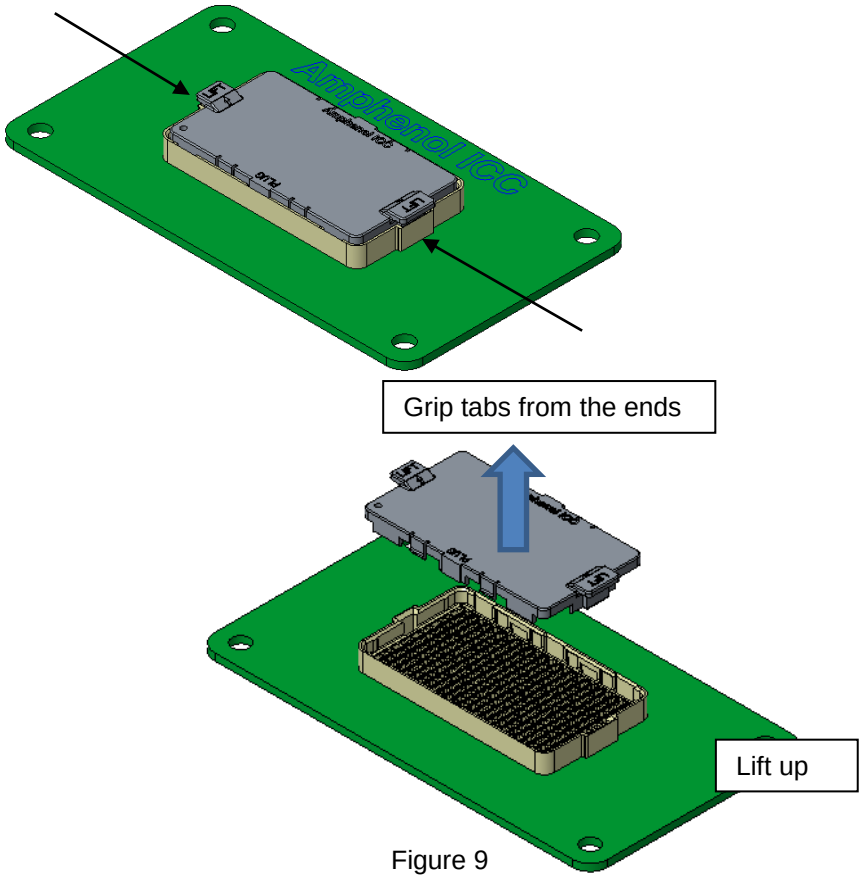


Figure 9

12.0 ADDITIONAL INFORMATION:

12.1 STANDOFFS:

Application of M-Series™ 56 Connectors does not require the use of mechanical standoffs, however, using them in blind-mate applications is recommended. Benefits from using standoffs are gross alignment prior to mating, robust mechanical attachment of stacked boards, and isolation of connectors from mechanical stresses.

The stack height information provided in Table 1 is based on a specific PCB construction, reflow process, stencil size, & paste type. Solder sphere collapse will vary with changes to these parameters. Therefore, it is always best practice for the user to verify minimum and maximum stack heights post reflow (via cross-sections) using the exact PCB, reflow parameters, stencil size, and paste that will be used for a specific board assembly. This study will determine the minimum standoff shoulder height for the application. It is recommended that the connectors are not over mated such that they are in a compressed condition. See Figure 11.

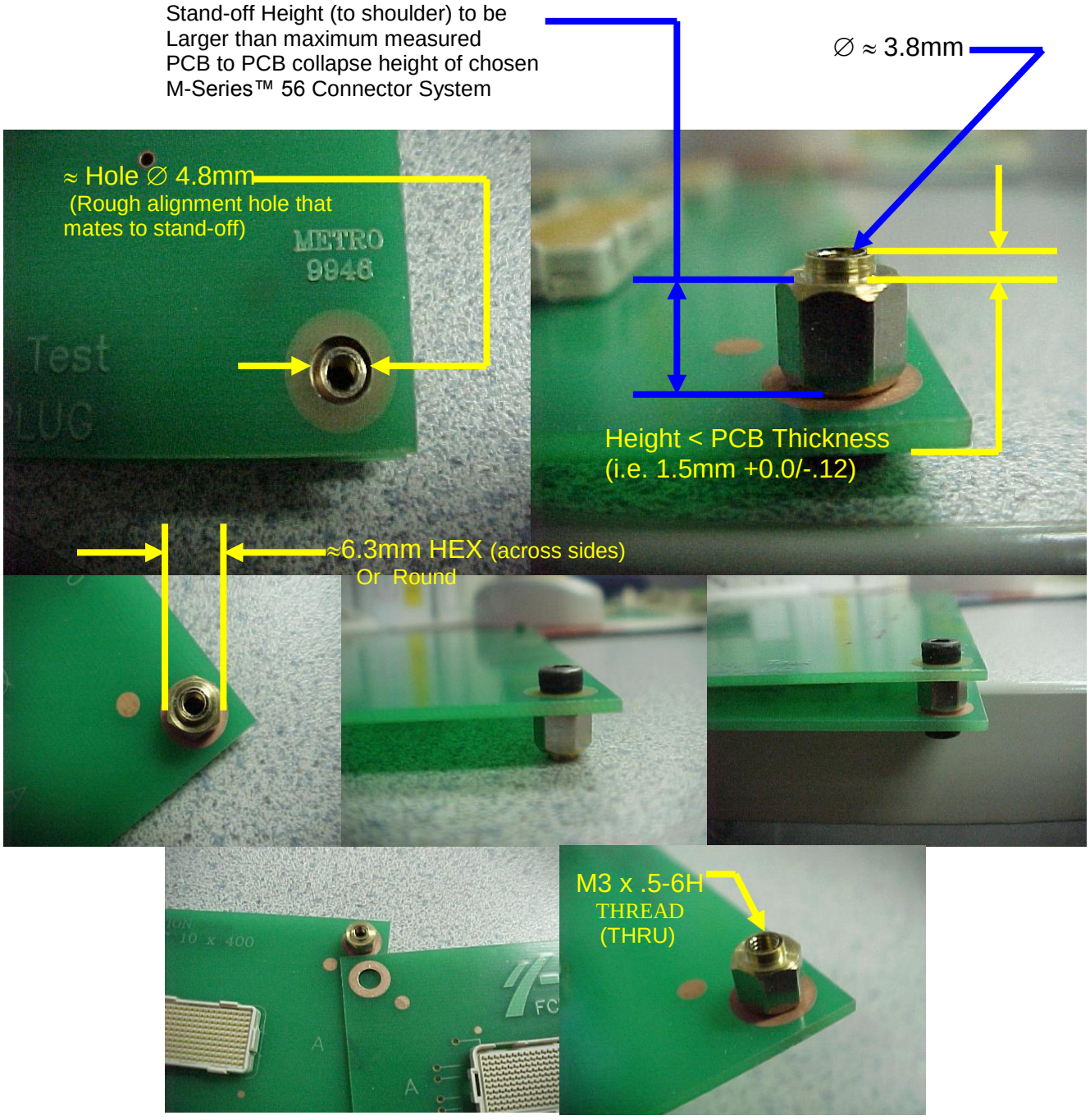


Figure 11 : Stand-off Detail

12.2 RECOMMENDED MATING / UNMATING METHODS:

The M-Series™ 56 connectors are preferred to be mated straight (Figure 12), however, when mating a large pin count connector, less effort is required if you roll-mate the two-connector halves together as shown in Figure 13.

A part can be started from either end. Locate and match the connector's A1 position marking ("Δ") for both the Plug and Receptacle. (Markings are located on the long side of the housing.) Rough alignment is required prior to connector mating as misalignment of >0.8mm could damage connector contacts. Rough alignment of the connector is achieved through matching the Small alignment slot of the plug housing with the Small alignment key of the receptacle housing and the Large alignment slot with the Large alignment key. Both connector housings have generous lead-in around the perimeter and will allow the user to blind mate assemble the connectors. Align the two connectors by feel and when the receptacle keys start into the plug slots, push down on one end and then move force forward until the receptacle cover flange bottoms on the front face of the plug.

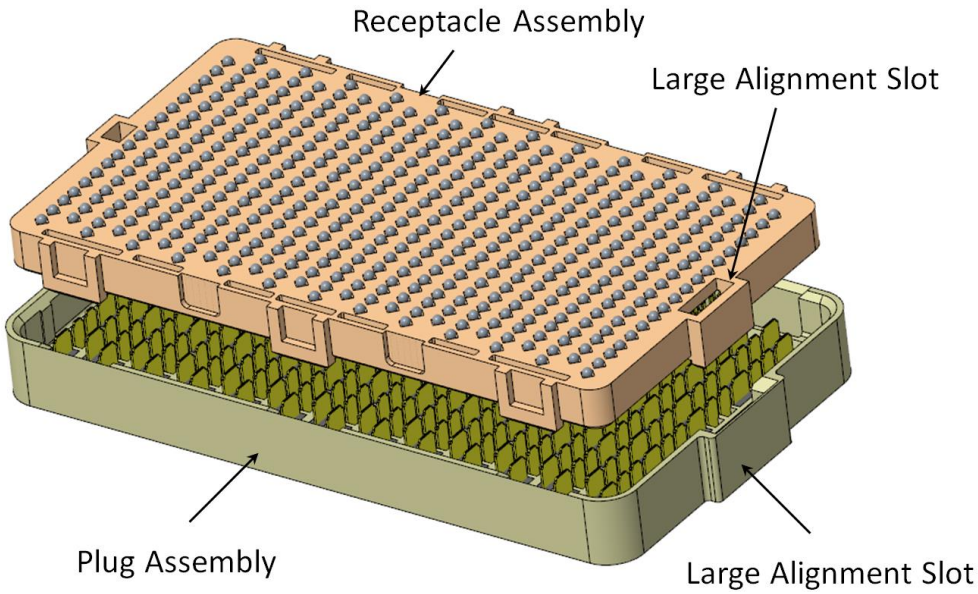


Figure 12: Recommended Mating

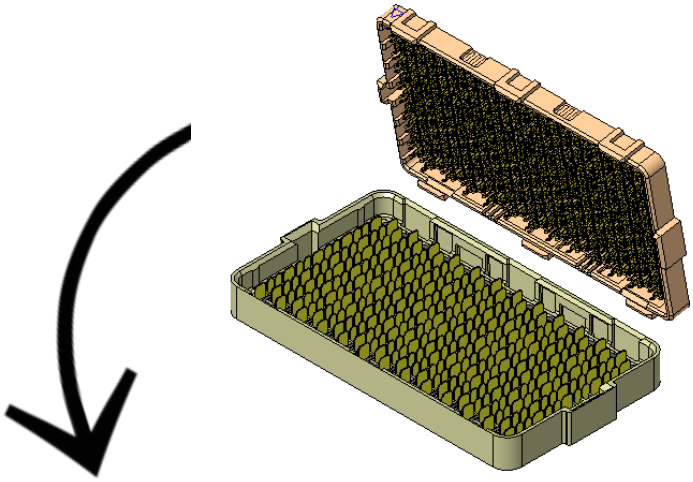


Figure 13: Recommended Mating

Like mating, a connector pair can be unmated by pulling them straight apart (See Figure 9). However, it requires less effort to un-mate if the force is originated from one of the slot/key ends of the assembly. (Reverse procedure from mating, see Figure 11.) Mating or un-mating of the connector by rolling in a direction perpendicular to alignment slots/keys may cause damage to the terminal contacts and is not recommended, see Figure 12.

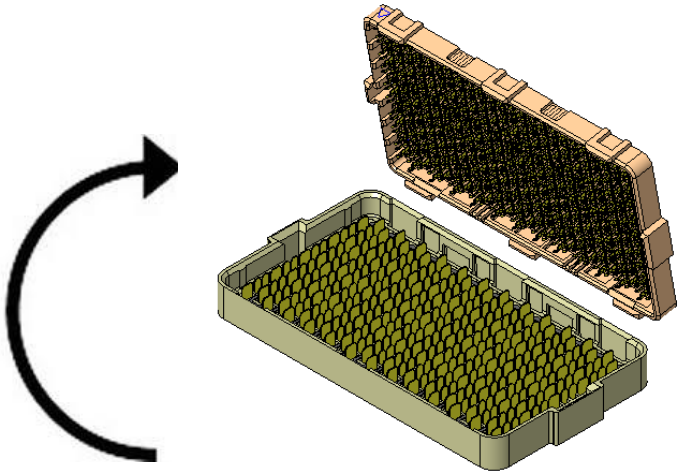


Figure 14: Recommended Un-Mating

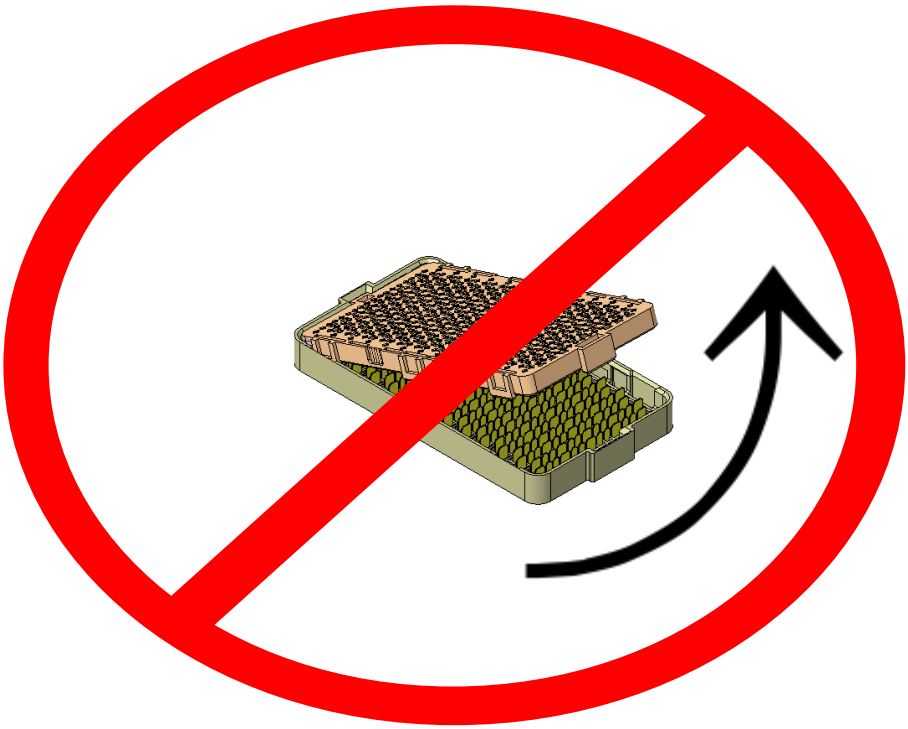


Figure 15: Not Recommended

12.3 GUIDELINES FOR FLEXIBLE CIRCUIT FABRICATION AND ASSEMBLY

M-Series™ 56 connectors can be assembled to Flexible Circuits to provide high density cable solutions. When using the M-Series™ 56 connector with Flex Circuits it is required that IPC-6012 and IPC-6013 are followed to ensure quality and reliable performance. Class 1 shall apply to standard product (-1XXLF).

13.0 REVISION RECORD

REV	PAGE	DESCRIPTION	EC #	DATE
1	All	Preliminary	N/A	6/25/2018
2	All	Revised: Figures 1A, 1B, 2, 3 & 12, Table 2 & company logo	N/A	11/08/2018