1.0 OBJECTIVE

The objective of this specification is to provide information on product features and recommended customer application of the GIG-ARRAY® High Speed Mezzanine BGA connector system. This specification is intended to provide general guidance for process development. It is recognized that no single process will work under all customer applications and that customers will develop processes to meet their needs. However, if these processes differ greatly from the following recommendations, FCI cannot guarantee results.

2.0 SCOPE

This specification provides information and requirements regarding customer application of GIG-ARRAY® BGA connectors with eutectic SnPb BGA and SnAgCu, Lead Free, RoHS compliant BGA 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 PRODUCT DRAWINGS AND APPLICABLE DOCUMENTS

Customer drawings and FCI Product Specification GS-12-192 are available on the FCI High Speed Web Site or by calling Technical Service at 800-237-2374 (717-938-7212 from outside the USA). In the event of a conflict between this note and the drawing or product specification, the drawing and product specification will take precedence. Customers are advised to refer to the latest revision of FCI customer drawings for appropriate details.

Item	200 Pos PN	296 Pos PN
10 mm Plug	55737	55720
12 mm Plug	10030626	10008026
13mm Plug	10060910	10060911
13mm Plug	10055142	10055143
15 mm Plug	55738	55700
20 mm Plug	55739	55727
25mm Plug	10054783	10054784
5 mm Recept	55740	55701
11mm Recept	10081496	10081497
15mm Recept	55741	55733

Lead Free RoHS compliant connectors are defined by a “LF” designation at the end of the part number. (Example; 55737-001LF)

Product Specification GS-12-192

5.0 APPLICATION REQUIREMENTS

5.1 GENERAL PRODUCT FEATURES

The GIG-ARRAY® High Speed Mezzanine Connector is designed to provide High Speed Differential and Single Ended electrical connection between two parallel boards. The connector utilizes Ball Grid Array (BGA) for solder attachment to the PCB (figure 1). For initial alignment, the plug housing has a chamfered lead-in that captures and guides the receptacle cover. To assure proper mating orientation, both parts are keyed at the A1 end. The A1 position is identified with a “Δ” at the end of the connector with the visual indicators as shown in figure 1.

For PCB assembly a processing cap is used for vacuum pick-up and automated SMT placement. Shown in figure 1.

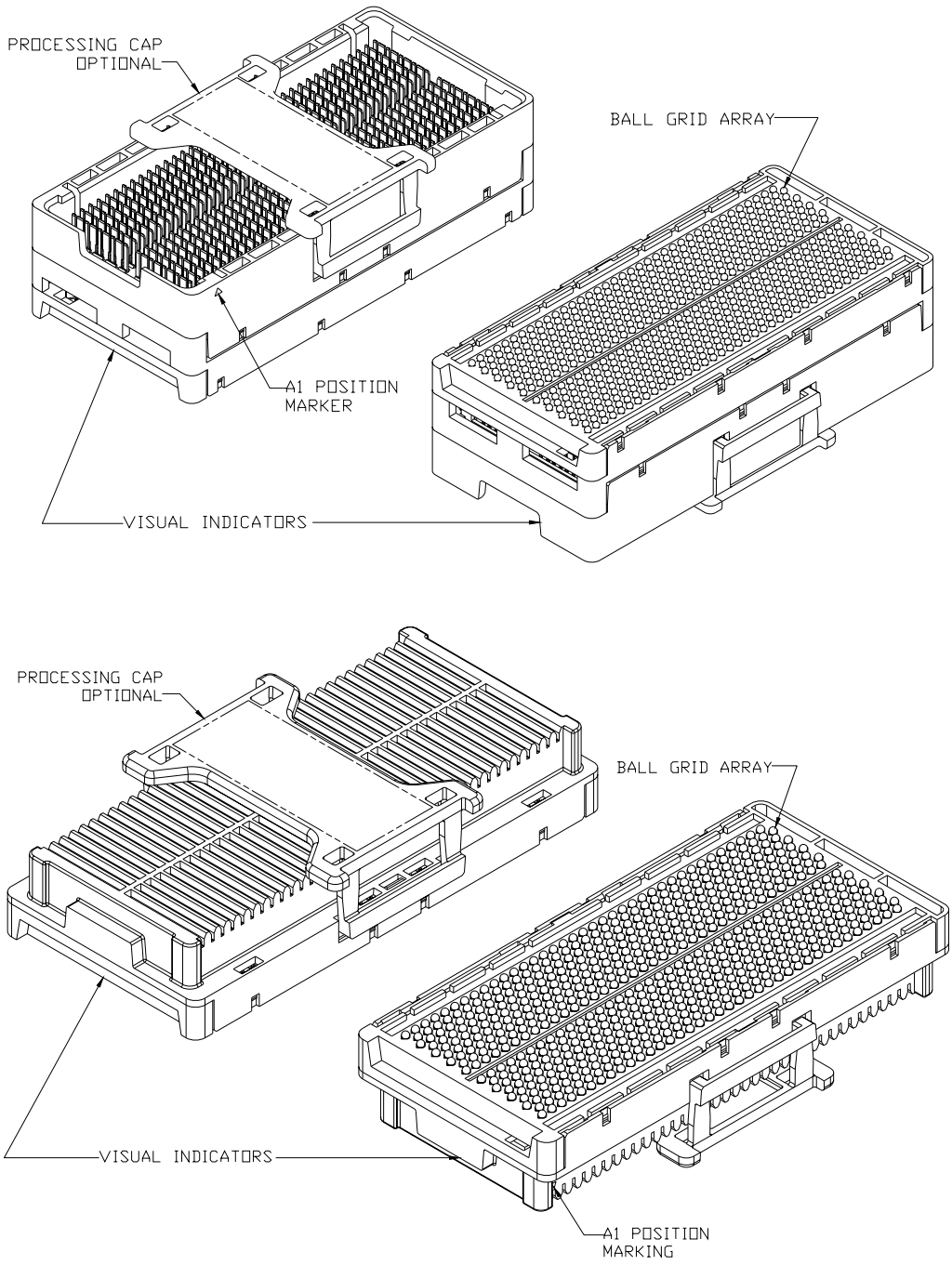


Figure 1: Connector Features

5.2 PRODUCT SIZES

		Plug Height S & TH (mm)					
		10	**12**	**13**	**15**	**20**	**25**
Receptacle Height S & TH (mm)	**5**	15	17	18	20	25	30
	11	21	23	24	26	31	36
	15	25	27	28	30	35	40

Table 1: Connector Mated Board-to-Board Height **

**Mated board-to-board height is affected by PCB pad size, plating, solder paste and solder profile.
S – Connector Size, TH – Total Connector Height as shown in figure 16.

CONNECTOR SIZE AND INFORMATION		
DESCRIPTION	**200 Pos**	**296 Pos**
HOUSING LENGTH (mm)	38.15	53.75
PAD TO PAD PCB LENGTH	31.85	47.45
NUMBER OF SIGNAL CONTACTS	200	296
NUMBER OF GROUND CONTACTS	250	370
NUMBER OF DIFF PAIRS, shielded	64	96
NUMBER OF DIFF PAIRS, cascaded	96	144

Table 2: Connector Size and Contact Quantities

5.3 PCB DESIGN

Proper PCB design affects connector reliability and performance. The connector uses dedicated ground contacts to provide impedance matching and low x-talk. This frees up the signal contacts so that they can be configured, as the application requires, while limiting any impact on performance. The following recommendations are intended to ensure reliable electrical connections, while maximizing manufacturing yields and aiding in possible rework applications. Figure 2A illustrates that Rows J and K in each connector column are tied together and appropriate actions should be considered when designing the board. Figure 2B is an example of how to configure the connector for both 100 ohm differential and 50 ohm single ended applications. Figures 3 through 7 further provide examples of the possible associated pad and trace routings required to distribute the signals. Since this hypothetical layout uses only ½ of the 104 contact positions, it should be used for reference purposes only.

- PCB pad diameter: 0.55 – 0.60 mm (.022 – .024 in.).
- Copper defined solder pads
- Pad materials: Copper with OSP or HASL
- Solder mask opening diameter must be greater than the PCB pad diameter and be registered properly so that 0.075 mm (.003 in.) minimum clearance is met all around the pad.
- Keep out area around part perimeter (3.0 mm = .120 in.) is generally recommended for clearance of rework equipment. Consult with equipment manufacturers for recommended clearance specifics.
- PCB vias should not be directly under the ball grid array solder pads and on component side shall be fully covered with solder mask. To assist, mask may be truncated along interconnect trace.
- When designing for multiple mating applications, the ball grid array patterns shall be within 0.20mm true position relative to each other.
- When designing top and bottom side connector applications, if the connectors are back to back a difficulty is created for reworking one of the connectors.
- **Rows J and K are joined together in each column. For example positions J1 and K1 are commoned. Please see figure 2A. Users must avoid assigning different circuits to rows J and K within each column to prevent electrical shorts. Positions J and K in adjacent columns (J2 and K2 in this example) are electrically isolated and may be assigned to a different circuit.**

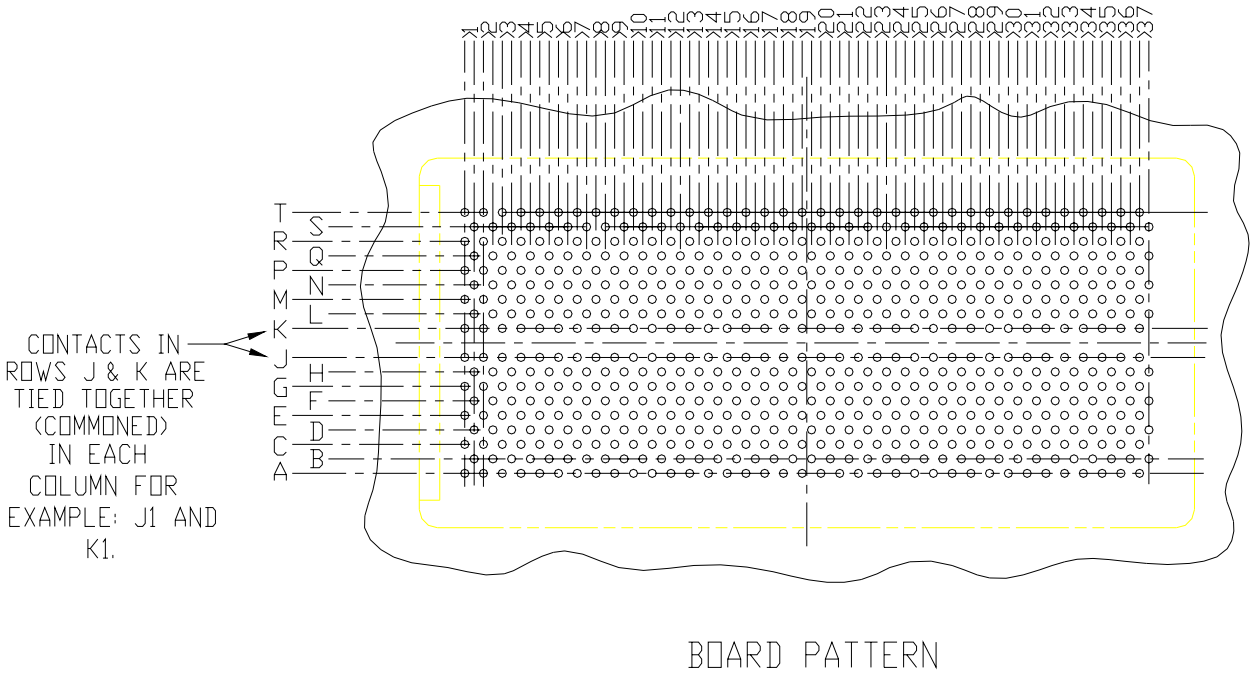


Figure 2A: Rows J & K Example of Each Column Tied Together

When designing for multiple mating applications, the ball grid array patterns shall be within 0.10mm true position relative to each other.

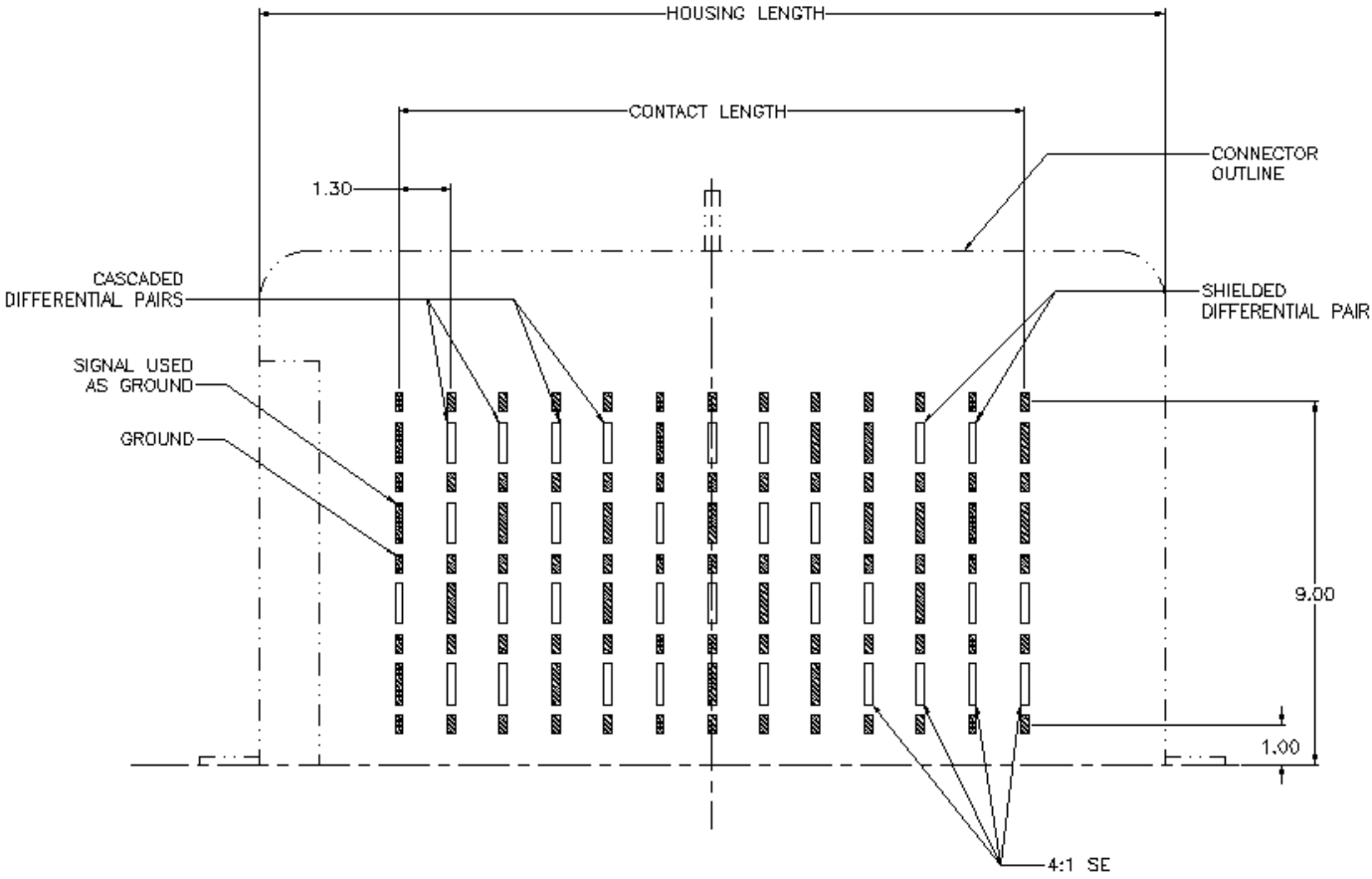


Figure 2B: Contact Interface Example

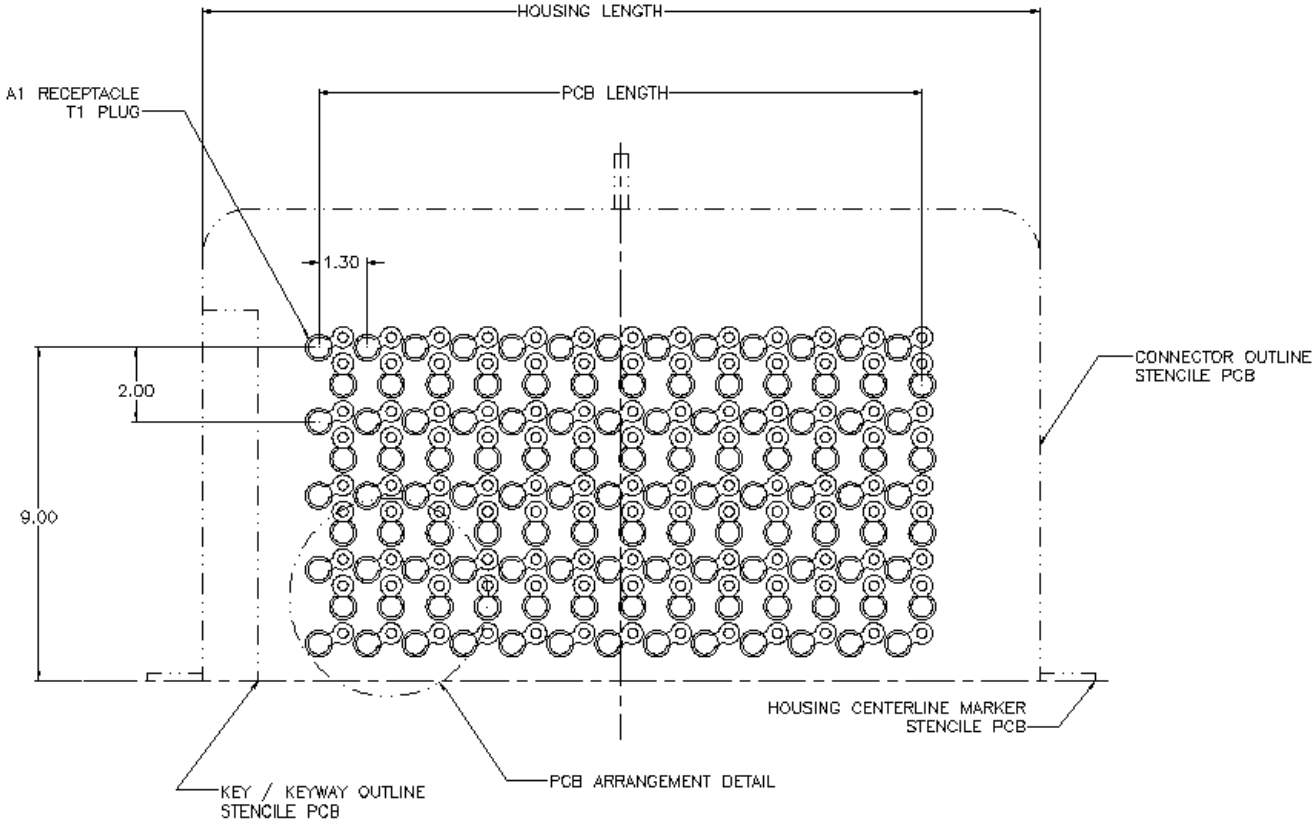


Figure 3: Pad Layout Example

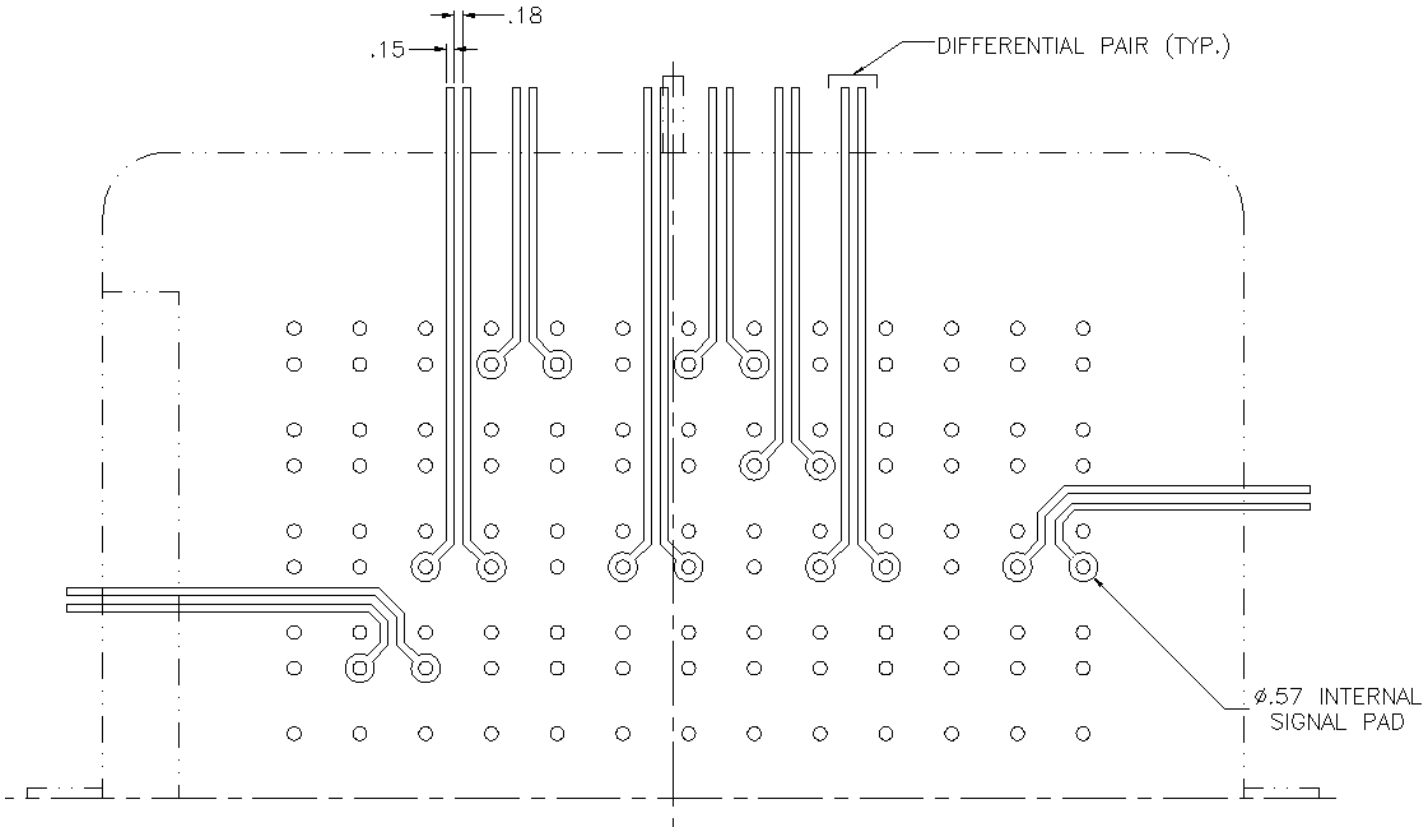


Figure 4: Signal Layer 1 Example

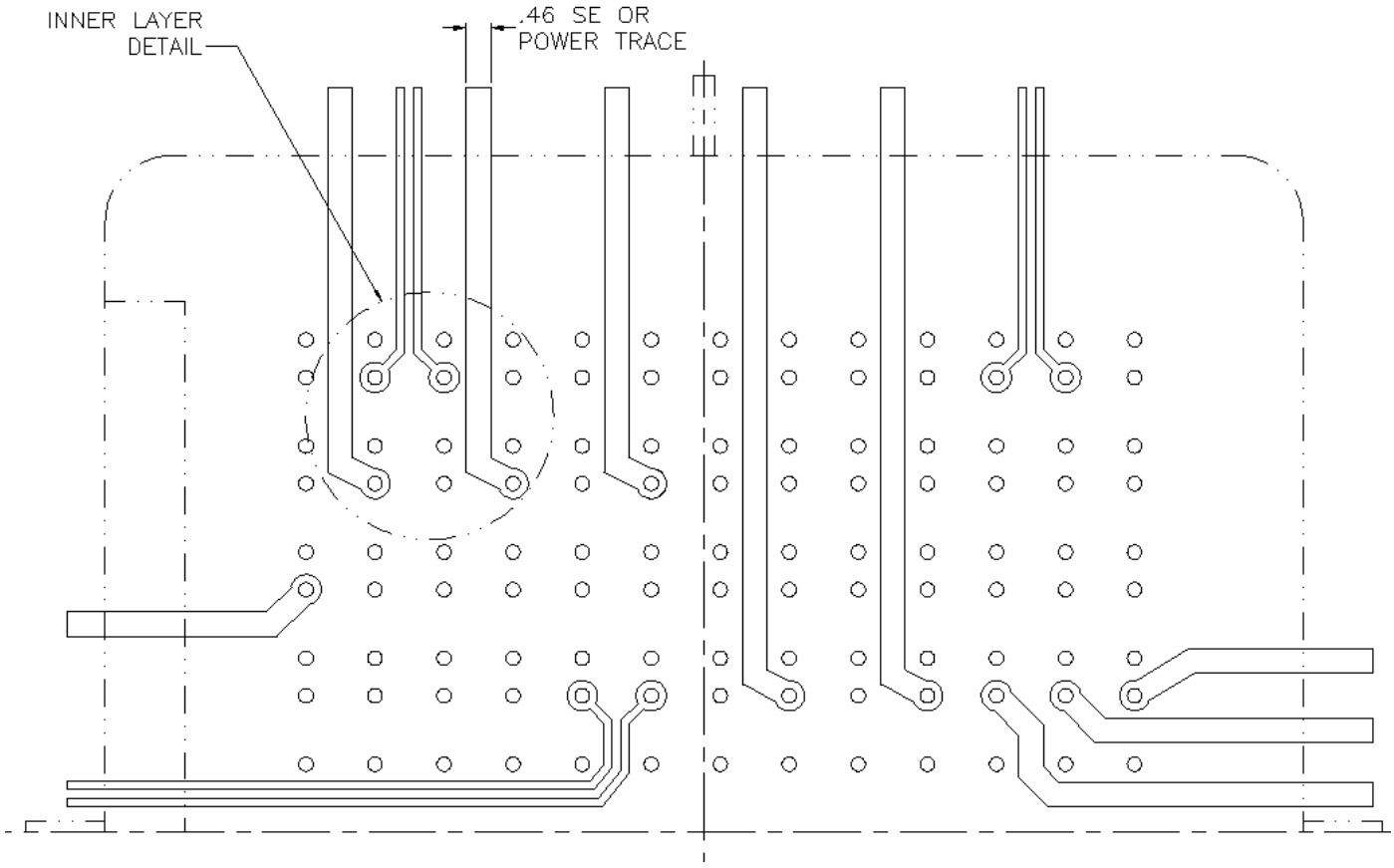


Figure 5: Signal Layer 2 Example

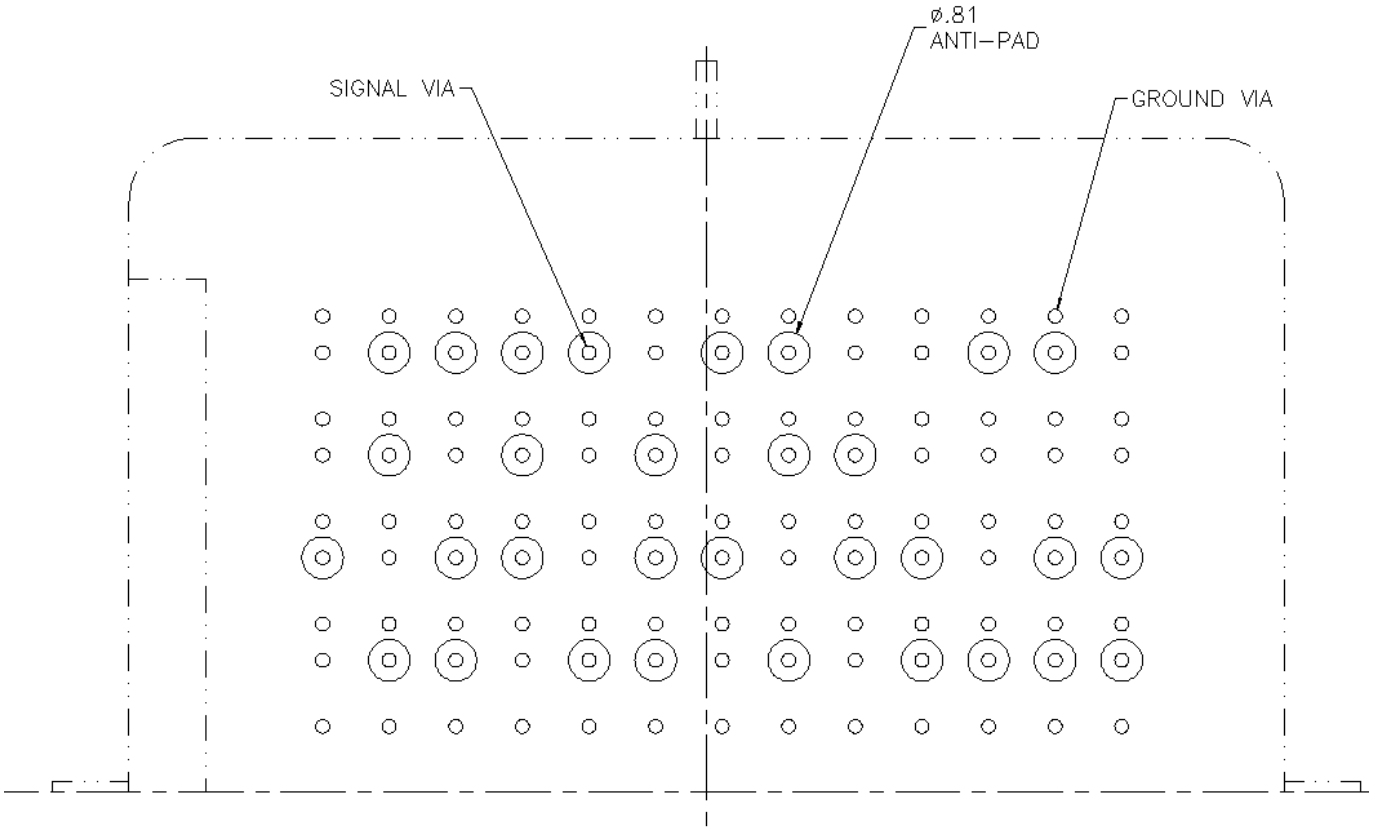


Figure 6: Ground Layer Example

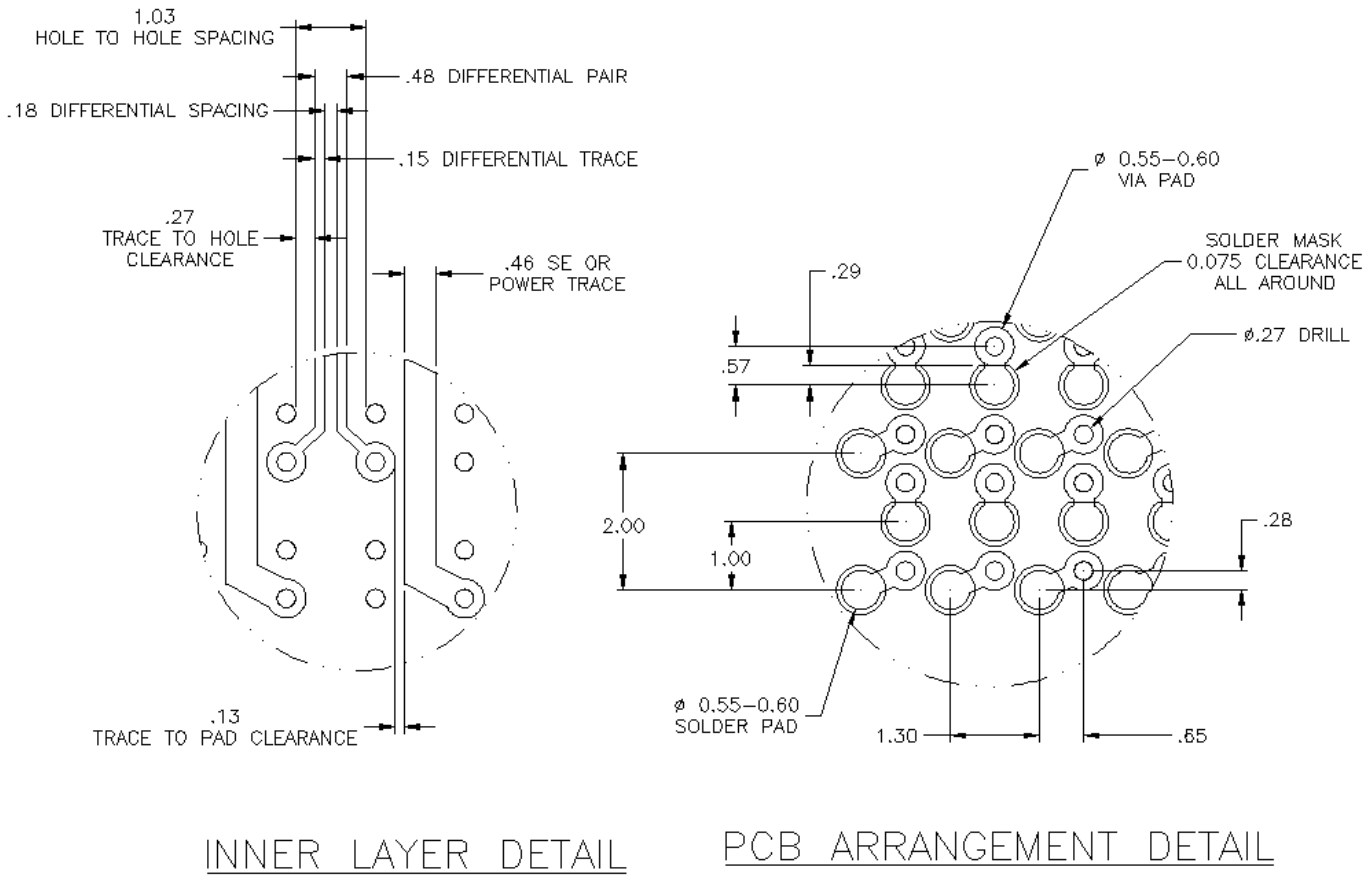


Figure 7: Details

6.0 APPLICATION TOOLING

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

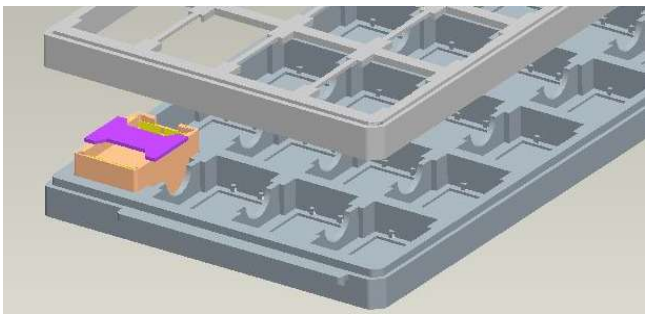
7.0 APPLICATION PROCEDURE

7.1 SOLDER PASTE DEPOSITION

- For ease of use, recommend a no-clean solder paste.
- Eutectic SnPb solder paste is required for standard product.
- 95.5Sn /4Ag /0.5Cu solder paste is recommended for Lead Free RoHS product.
- Recommended stencil thickness 0.152 – 0.178 mm (.006 - .007 inch)
- Recommended round aperture diameter 0.56 mm (for 0.178 mm thick stencil) or 0.61 mm (for 0.152mm thick stencil). These combinations give paste volume of approximately 0.044 mm^3 (2.68E-6 $inch^3$). For 25mm plug due to a larger weight we recommend paste volume on the lower side of the recommendation presented above.

7.2 CONNECTOR PLACEMENT

- Connectors are packaged and shipped in molded JEDEC style plastic trays, as shown in figure 8 and table 3. Trays have visual indictors and keying features to assure that the connectors are always oriented as shown. For additional packaging information, see FCI packaging specification GS-14-777.
- Trays can be used individually or stacked. Prior to stacking, shipping covers (Not Shown) shall be removed.
- A pick-up cap, attached to the housing is 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 or straddle the gull wings of the pick-up cap 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.
- Tray sizes higher than 10mm plug and 5mm Receptacles are constructed in two pieces, a base tray and a top spacer to accommodate placement equipment with vertical lift less than 12.7mm. This tray design shown below makes it possible for less vertical pick up travel to be needed to remove the connector once the tray top spacer is removed. Trays should not be stacked with the top spacer tray removed.



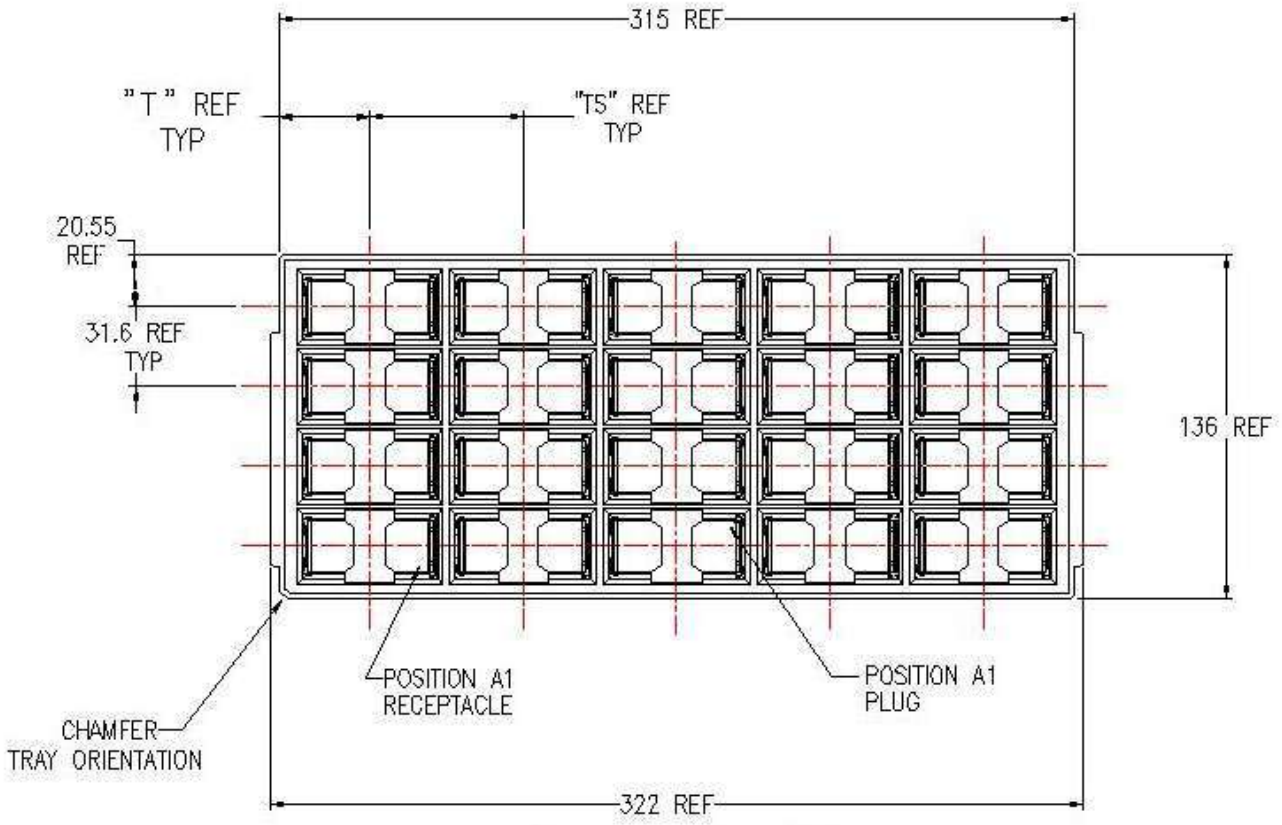


Figure 8: Packaging Tray Configuration (296 Pos Shown)

Gender	Connector	Part Weight (g)	Part Weight (g)	Part Weight (g)	Part Weight (g)	Tray Spacing, T & TS (mm)	
	Height	200 Std	200 LF	296 Std	296 LF	200	296
Plug	10	12.12	11.74	17.48	16.91	T = 26.7 TS = 43.4	T = 35.9 TS = 60.8
	12	TBD	TBD	TBD	TBD		
	13	14.82	14.44	21.19	20.62		
	15	16.62	16.24	24.14	23.57		
	20	21.5	21.13	27.9	27.33		
	25	26.52	26.29	32.9	32.35		
Recpt	5	10.56	10.27	15.34	14.77		
	11	17.25	16.9	24.4	23.85		
	15	20.33	19.95	29.21	28.64		
Numbers of parts per tray:						28	20

- Weight estimates do not include processing cap.

Table 3: Packaging and Connector Weight

7.3 SOLDER REFLOW

For Standard connectors using Eutectic SnPb solder paste; (see Figure 9 for Eutectic profile)

- All recommended temperatures are on top surface of the board within or near the connector ball grid array.
- To obtain temperature equalization at all the BGA locations, soak the assembly above 145°C prior to reflow for 105-125 seconds.
- Reflow time above 183°C should be at least 60 to 90 seconds and center ball locations shall be at least 30 seconds.
- Peak temperature should be between 225°C and 235°C.
- The maximum temperature on the board should not exceed 235 for more than 10 seconds.
- The maximum total cumulative time to ramp up, soak, and reflow the board shall be limited to 330 seconds.
- Nitrogen environment of 1,000 to 4,000 ppm O_2 may improve solderability, but is not required.
- Maximum ramp rate should be < 2.5°C per second.

For Lead Free RoHS product;

- All recommended temperatures are on top surface of the board within or near the connector ball grid array.
- To obtain temperature equalization at all the BGA locations, soak at 150°C to 210°C prior to reflow for 60-90 seconds typical.
- Reflow time above 219°C should be a maximum of 90 seconds.
- Peak temperature should be between 230°C and 260°C.
- The maximum temperature on the board should not exceed 260°C for more than 10 seconds.
- The maximum total cumulative time to ramp up, soak, and reflow the board shall be limited to 330 seconds.
- Nitrogen environment of equal to or less than 4,000 ppm O_2 can improve solderability, but is not required.
- Maximum ramp rate should be < 2.5°C per second.

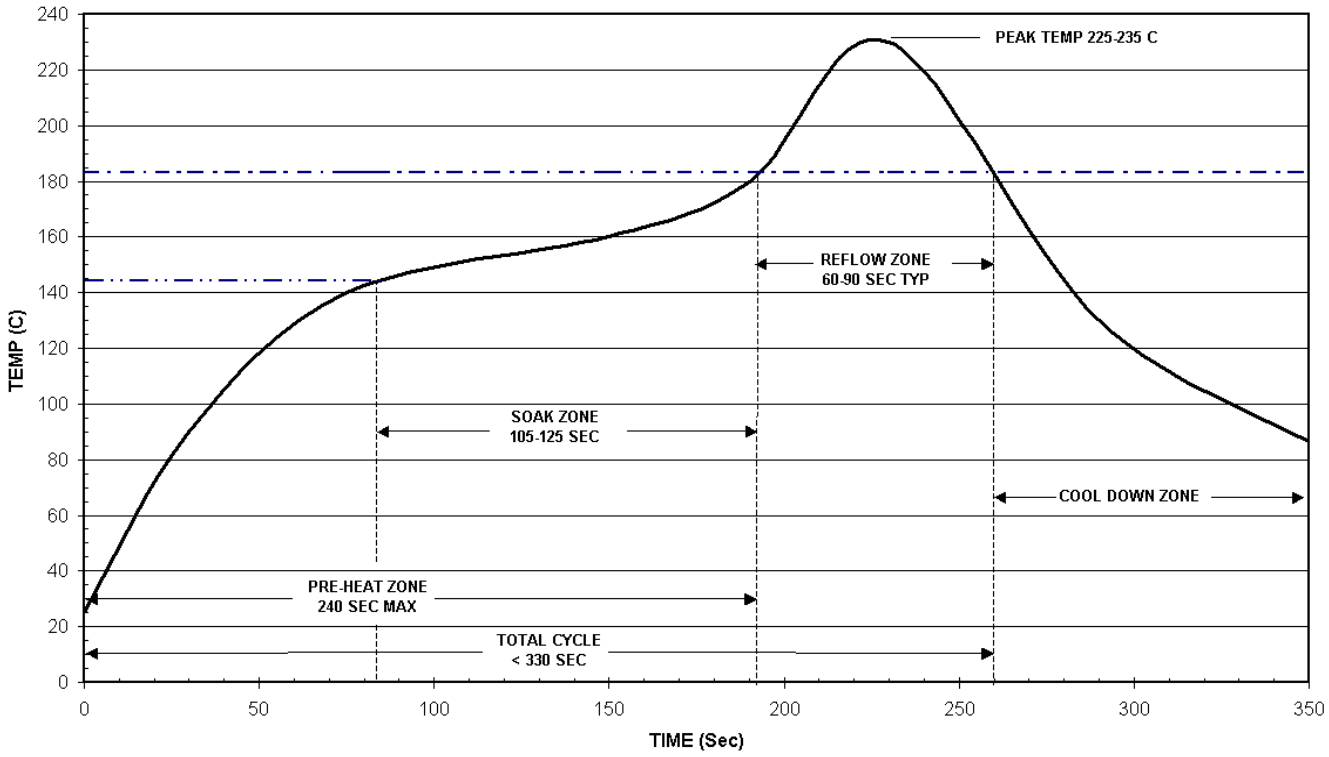


Figure 9: Solder Profile (std shown)

7.4 TWO PASS REFLOW

Connector weight, top reflow temperature, board thickness, board size and the number of layers will all affect connector retention to the PCB during inverted reflow. If possible, use the lighter GIG-ARRAY® mating half, as shown in table 3, for the inverted reflow side. In all cases, customer needs to verify connector applicability for inverted reflow through process verification testing since not all sizes can meet this requirement without special processing.

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.

8.0 POST APPLICATION INSPECTION

- Visually inspect the connector for damage and cleanliness.
- Visual solder joint inspection of ball grid array components is not feasible.
- Solder joints can be inspected with X-ray techniques. A solder pad shape different than the ball section may assist in viewing the solder plane.
- 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. Other rework equipment would follow a similar procedure and would only need to be modified according to the equipment manufacturer's recommendations. Avoid locating connectors back to back for double sided connector design.

10.0 REWORK PROCEDURE GUIDELINES: In the event that rework is required, the following guidelines are general.

Step 1: Develop the Thermal Process

To develop the thermal process, a thermocouple should be attached next to the outer row of solder balls or preferably under the connector. Using the reflow nozzle shown in figure 10, heat the connector by ramping the temperature from 25° C to 150° C with a maximum slope of 3° C per second. Soak at 130°C to 160° C for two minutes maximum. Depending upon thermocouple placement, re-flow for 1 to 2 minutes with a peak temperature of 210° C to 225° C, ensuring that the center solder locations reflow. Cool to 50° C with a maximum ramp of 3° per second. For Lead Free product adjust for higher temperatures for SAC alloy reflow.

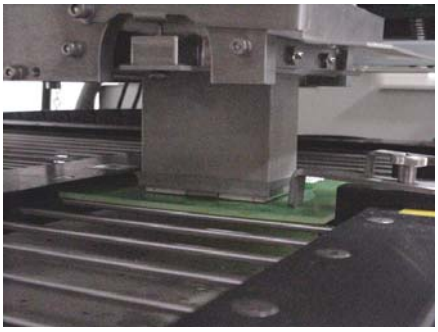


Figure 10: Reflow Nozzle

REWORK PROCEDURE GUIDELINES (CONT.)

Step 2: Remove the Connector

First, slide a metal rework clip, similar to the one shown in figure 12, 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 and is shown in figure 11, 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.

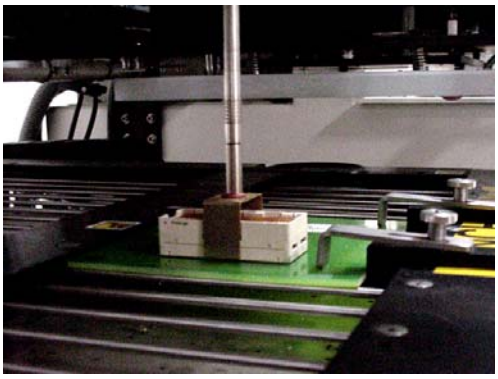


Figure 11: Vacuum Pick-Up

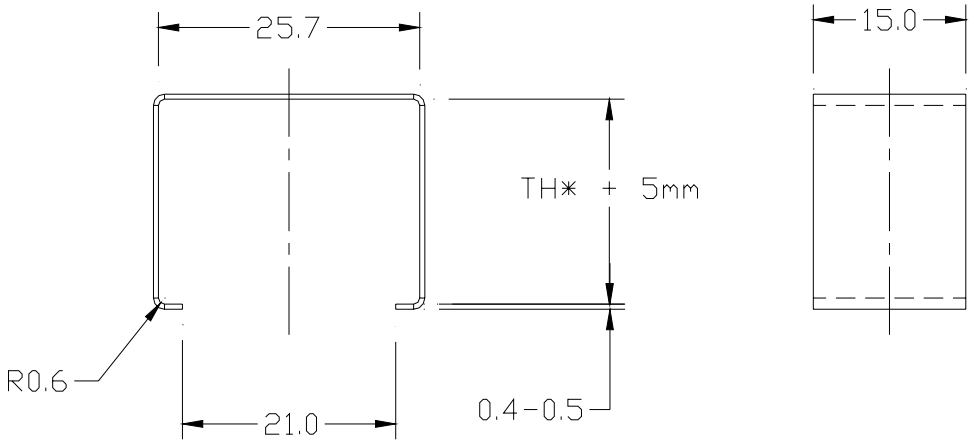


Figure 12: Rework Clip
*TH is shown in table 1 and figure 16

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 GIG-ARRAY® 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, isopropyl alcohol can be used to clean up any excess flux or debris.

REWORK PROCEDURE GUIDELINES (CONT.)

Step 4: Connector Replacement

After cleaning, it is recommended to repaste the pads using an 0.152 – 0.178 mm (.006-.007 inch) thick stencil to apply approximately 0.044 mm^3 (2.68E-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 for Eutectic or Lead Free SAC alloy. Remove the metal clip and reinspect and retest the connector as applicable.

11.0 ADDITIONAL INFORMATION:

11.1 STANDOFFS:

Proper system application of GIG-ARRAY® Connectors requires the use of mechanical standoffs. The purpose of these standoffs is to provide strain relief of connectors and connector intermate retention.

- Standoff height should be 0.25 mm larger than nominal mated connector board-to-board height.
- Holes on bottom PCB should be close fit to bottom screw major diameter. To assure proper mating of connectors the top PCB holes can be up to 1.0 mm larger than standoff through shoulder diameter.
- The through shoulder can be a cylinder with internal thread or an external thread, as shown below.
- Standoffs are not provided with connectors. A typical standoff is shown in figure 13 and can be purchased from hardware vendors.

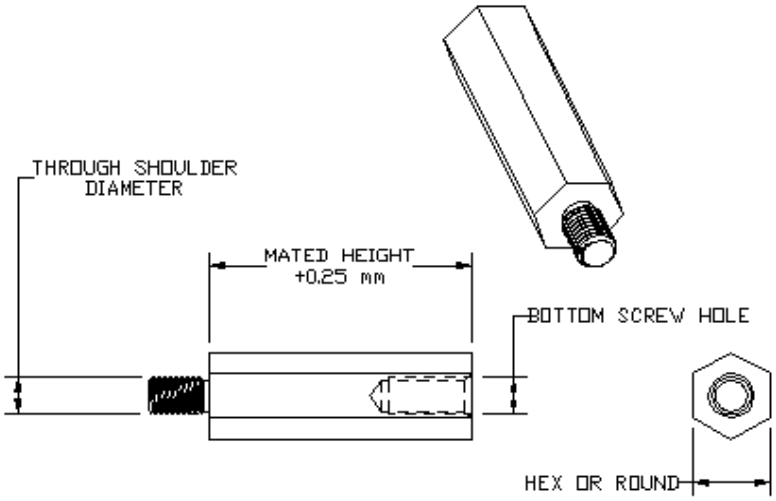


Figure 13: PCB Standoff

11.2 RECOMMENDED MATING / UNMATING METHODS:

The GIG-ARRAY® Connector can be mated straight, however, when mating a large pin count connector, like the 296 signal position GIG-ARRAY® Connector, it will require less effort if you roll-mate the two-connector halves together as shown in Figure 14A. Please refer to Figure 14B which describes how not to mate this connector.

A part can be started from either end. Since connectors have asymmetric keying, you cannot reverse mate the parts (i.e. can not start the key end of the receptacle into the non-keyway end of the plug). Both connector housings have generous lead-in around the perimeter and will allow the user to blind mate assemble the connectors. Align two connectors by feel and when the receptacle keys start into the plug keyways, push down on one end and then move force forward until the receptacle cover flange bottoms on the front face of the plug.

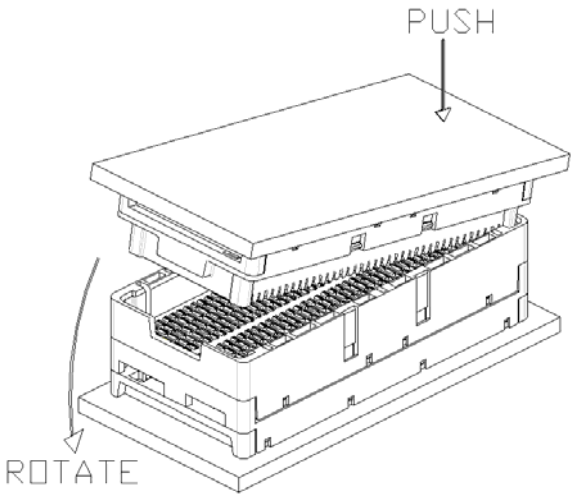


Figure 14A: Recommended Mating

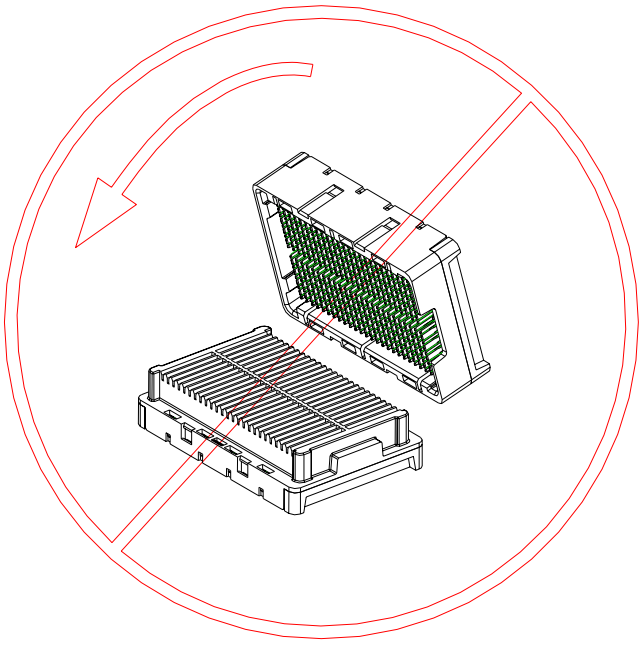


Figure 14B: Mating in This Direction not Permissible

Like mating, a connector pair can be unmated by pulling them straight apart. However, it requires less effort if you rock the connectors side-to-side a maximum of 1-2˚ while pulling the two boards apart, as shown in Figure 15.

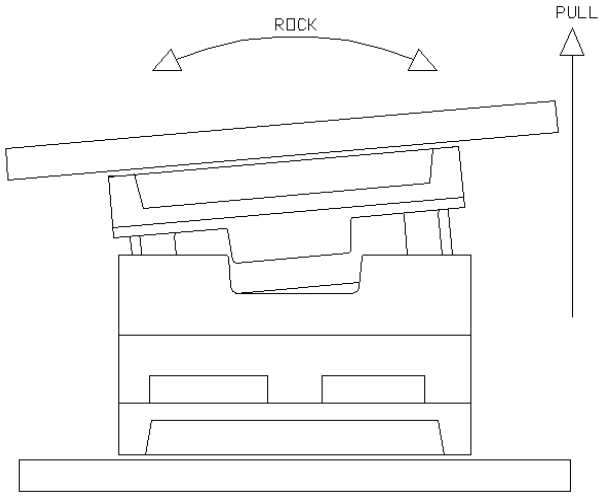


Figure 15: Recommended Un-Mating

11.3 MATING SEQUENCE:

Figure 16 and table 4 show the mating sequence as related to the distance between the inside board surfaces of a 20mm mated pair. For mated heights other than 20mm, determine the board-to-board spacing by adding the difference of new mated-height – 20 mm to the values specified. The mate distance and wipe length values will not change.

Description	Mate Distance	Board-to-Board Height	Wipe Length	Notes
Connectors start to mate	0	24.78	--	Pre-Align
Cover key and keyways start to engage	0.45	24.33	--	Key Align
Plug contacts start into cover	1.33	23.45	--	Full Align
Front of plug contact past cover slot	2.03	22.75	--	
Plug contact starts into receptacle contact lead-in	2.32	22.46	--	Cont Align
Plug and receptacle contacts make contact	2.84	21.94	--	Cont Engage
Plug cover bottoms on receptacle (Fully Mated)	4.83	19.95	2.0	Wipe length

Table 4: Nominal Mating Sequence

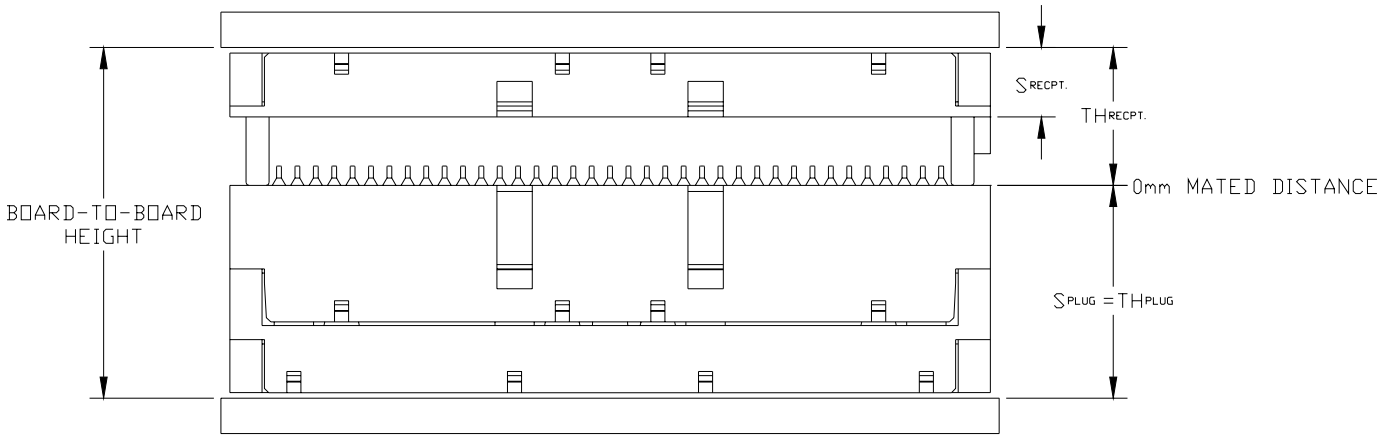


Figure 16: Nominal Mating Sequence

11.4 ELECTRICAL PERFORMANCE:

The GIG-ARRAY® HS Mezzanine Connector was designed to provide high bandwidth with low crosstalk for High Speed differential signals. This is achieved by providing close edge coupling to dedicated ground contacts on each side of the signal contacts and matching the impedance between contact pairs. Typical performance parameters are shown below in table 5. For additional connector performance requirements, see Product Specification GS-12-192 or contact FCI.

Test Description	1:1 Differential Pair	1:1 Single Ended
Impedance	85-110 Ohms	50-60 Ohms
Bandwidth (3 dB)	5+ GHz	5 GHz
Multi-Active NEXT @ 100 ps	< 3%	< 3%

Table 5: Typical Electrical Performance

12.0 REFERENCE DOCUMENTS (N/A)
13.0 NOTES (N/A)
14.0 RECORD RETENTION N/A

REVISION RECORD

REV	PAGE	DESCRIPTION	EC #	DATE
A	All	Initial Release of Application Specification	V21483	09/10/02
B	All	Added 200 position information and removed all references to the 104 position. Also added information pertaining to rows J and K showing they are commoned.	V03-1134	10/17/03
C	7&19	Added note on page 7 showing a TP of 0.10mm pertaining to multiple mating applications. Added an illustration showing the connector cannot be mated in the narrow direction.	V04-0371	4/22/04
D	All	Added new part numbers for 13mm Plugs, 25mm Plugs. Added Lead Free process guidelines. Added new packaging information plus general improvements. Update Form with current Rev	V06-0082	3/10/06
E	All	Change logo	V06-0539	6/5/06
F	All	Added new part numbers in section 4 & 5 & 7 Added updated paste details for 25mm Plug in section 7 Updated nitrogen range in section 7 Updated Double sided reflow paragraph	V08-0404	9/22/08