

NUMBER GS-20-0361	CATEGORY APPLICATION SPECIFICATION	Amphenol FCI	
TITLE ExaMAX® Connector System, press-fit products		PAGE 1 of 41	REVISION C
		GUARDIAN (VERIFIED BY) Justin Chen	DATE 2016-11-16
		APPROVED BY Heaven Cen	
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1.0 OBJECTIVE

This specification provides information and requirements regarding customer application of the ExaMAX® connector system with press-fit termination. This specification is intended to provide general guidance for application process development. It is recognized that no single application process will work under all customer scenarios and that customers will develop their own application processes to meet their needs. However, if these application processes differ greatly from the one recommended, FCI cannot guarantee acceptable results.

2.0 SCOPE

This specification provides information and requirements regarding customer application of the ExaMAX connector system with press-fit termination.

3.0 GENERAL

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

3.1 Product Description and Features

ExaMAX is a high speed electrical connector system for backplane, coplanar, and orthogonal applications. The system utilizes a Right Angle Receptacle (RAR) and a Vertical Header (VH) for backplane applications, and a Right Angle Header (RAH) and Right Angle Receptacle (RAR) for coplanar and orthogonal applications. ExaMAX connectors use compliant press-fit tails to provide a reliable electrical connection between the connector and the plated through holes (PTH) of the PCB. For signal terminals, the ExaMAX product has a small press-fit section that uses Ø0.36mm finished through holes while the ground terminals use the standard press-fit section with Ø0.50mm finished through holes. In addition to the signal pairs and grounds, there is a single low speed signal on the end of each column that may be utilized for miscellaneous low speed signals and/or low power requirements. These locations also have the small press-fit section and use Ø0.36mm finished through holes.

3.2 Product Configurations

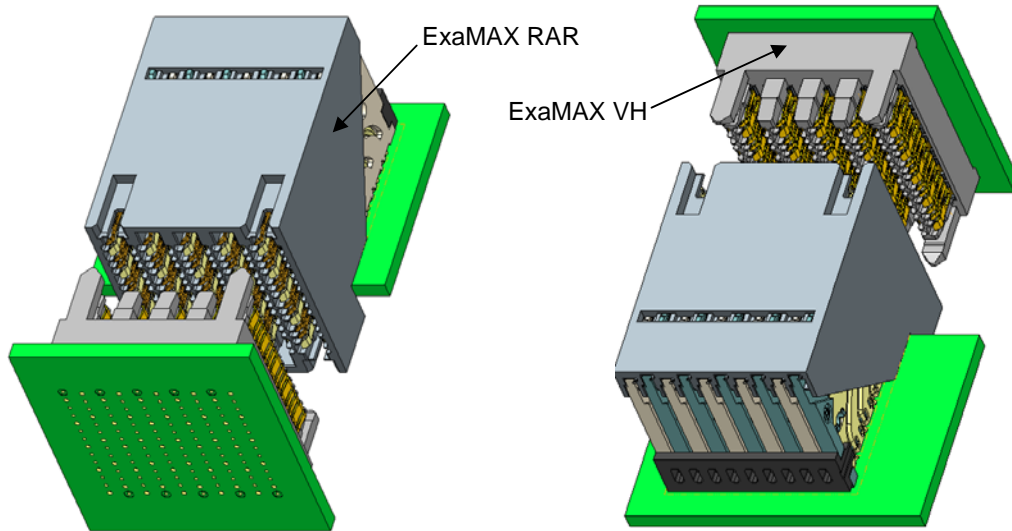
3.2.1 Backplane

For backplane applications, ExaMAX Right Angle Receptacle (RAR) and Vertical Header (VH) connectors will be offered in the size configurations shown in Table 1. When spacing allows, we recommend that connectors which have thick wall housings should be used in order to maximize robustness. Not all sizes are currently tooled, check with FCI sales or the FCI website for availability.

Signal Pairs per Column	Number of Columns	Column Spacing	Number of Positions (Including Grounds)
2 Pair	6, 8 and 10	2.0mm and 3.0mm	48, 64, and 80
3 Pair	6, 8 and 10	2.0mm and 3.0mm	66, 88 and 110
4 Pair	6, 8 and 10	2.0mm and 3.0mm	84, 112 and 140
6 Pair	6, 8, 10, and 12	2.0mm and 3.0mm	120, 160, 200, and 240
8 Pair (Prototype)	10	2.0mm and 3.0mm	260

Table 1: ExaMAX Backplane Connector Configuration Offerings

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**Figure 1: ExaMAX RAR and VH Backplane Application
(4 Pair, 2mm Pitch, 10-Column Configuration Shown)**

3.2.2 Coplanar

For coplanar applications, ExaMAX Right Angle Header (RAH) connectors will be offered in the size configuration shown in Table 2. Not all sizes are currently tooled, check with FCI sales or the FCI website for availability.

Signal Pairs per Column	Number of Columns	Column Spacing	Number of Positions (Including Grounds)
2 Pair	6, 8 and 10	2.0mm and 3.0mm	48, 64, and 80
3 Pair	6, 8 and 10	2.0mm and 3.0mm	66, 88 and 110
4 Pair	6, 8 and 10	2.0mm and 3.0mm	84, 112 and 140
6 Pair	6, 8, 10, and 12	2.0mm and 3.0mm	120, 160, 200, and 240

Table 2: ExaMAX RAH Connector Configuration Offerings

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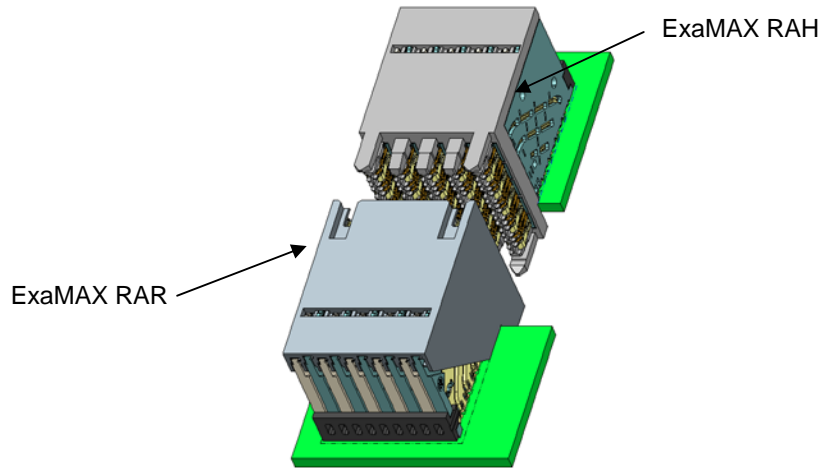


Figure 2: ExaMAX RAR and RAH Coplanar Application (4 Pair, 2mm Pitch, 10-Column Configuration Shown)

3.2.3 Orthogonal

For orthogonal applications, ExaMAX connectors will be offered in the size configuration shown in Table 3. Not all sizes are currently tooled, check with FCI sales or the FCI website for availability.

Signal Pairs per Column	Number of Columns	Column Spacing	Number of Positions (Including Grounds)
6 Pair	6, 8, 10, 12, 14, and 16	2.0 mm (Select Loading Possible)	120, 160, 200, 240, 280, and 320

Table 3: ExaMAX Orthogonal Connector Configuration Offerings

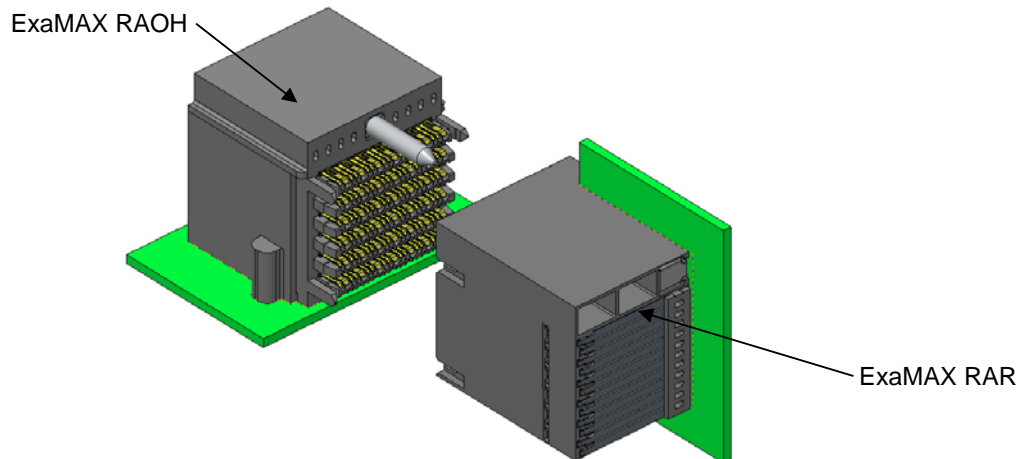


Figure 3: ExaMAX RAOH and RAR Application (6 Pair, 12-Column Configuration with guides Shown)

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3.3 Compatibility with Hard Metric Products

The ExaMAX product is compatible with hard metric standards in that the distance between the backplane and front edge of the daughter card is 12.5mm for back panel applications. This distance includes a 0.05 mm nominal gap between the top face of the VH and the front face of the RAR. See Figure 4 and Table 4 for dimensions relative to the daughter card for back panel applications.

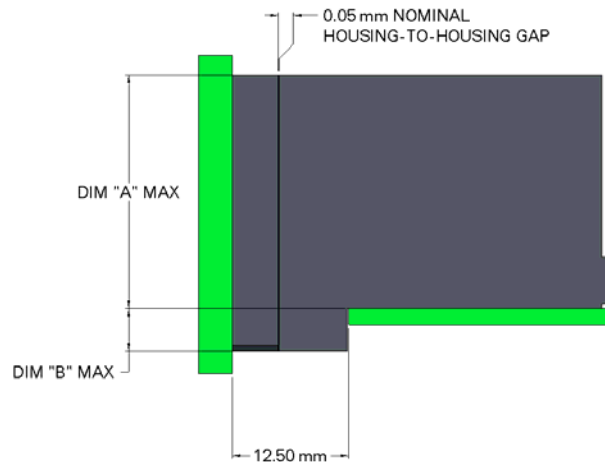


Figure 4: View of Back Panel Applications

Connector type	DIM A (mm)	DIM B (mm)
2 pair	9.60	3.50
3 pair	14.30	4.60
4 pair	17.90	4.60
6 pair	25.10	4.60
8 pair	39.90	4.60

Table 4: Connector Dimensions for Back Panel Applications (Relative to Daughter Card)

3.4 Thick Wall Assemblies, 2mm Column-to-Column Pitch

For applications where connectors do not need to be stacked side-by-side and on pitch, we recommend that thick walled assemblies be used. The thick wall assemblies are 1.00 mm wider in the column-to-column direction when compared to a thin wall assembly. An additional 0.50 mm of material is added to each side of a non-guided housing. For assemblies that have guide modules, the additional 0.50 mm of material is only added to the non-guide module side of the housing. Thick wall assemblies are available for 4-pair and 6-pair Right Angle Receptacles, Vertical Receptacles (VR), and some Vertical Headers.

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3.5 Connector Guidance

3.5.1 Housing Guide Features

Table 5 below shows the amount of misalignment in each direction that can be tolerated by the guiding features on the connector housings as they are mated. **It is important to note that this misalignment is not rigid misalignment. The chassis design must permit the card modules to move freely so these housing guide features can perform final alignment within clearances of separate guide modules and integrated guide pins.**

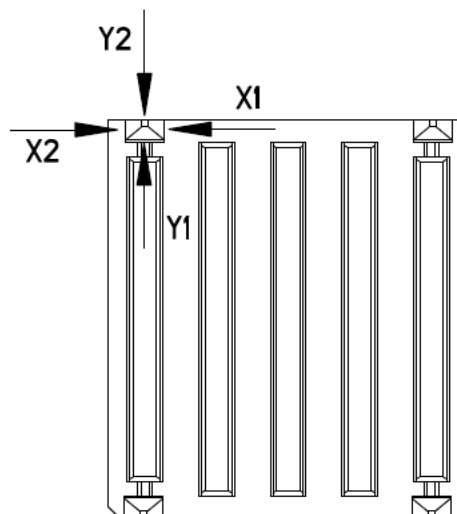
Connector type	Nominal misalignment correction in direction parallel to connector columns	Nominal misalignment correction in direction perpendicular to connector columns
ExaMAX 2 pair	± 0.5 mm	± 0.5 mm
ExaMAX 3, 4, 6, & 8 pair	± 1.1 mm	± 1.2 mm

Table 5: Connector Guidance Features

For backplane and orthogonal applications the maximum acceptable angular misalignment of the daughter card relative to the backplane is $\pm 2^\circ$.

3.5.2 Housing Guide Post Strength

Individually, each Vertical Header housing guide post can withstand 17 N in the X1, X2 and Y1 directions and 25 N in the Y2 direction.



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3.5.3 Optional Integrated Guide Features

If additional guidance is needed, an optional integrated guide system can be added to any product configuration. The system consists of a round metal guide pin placed on the male connector and a corresponding round hole with a generous lead in on the receptacle connector. This system provides a nominal diametrical misalignment of $\varnothing 6.0$ mm, or ± 3.0 mm in any direction and a wipe length of 15.35 mm after the guide pin is fully engaged into the guide hole.

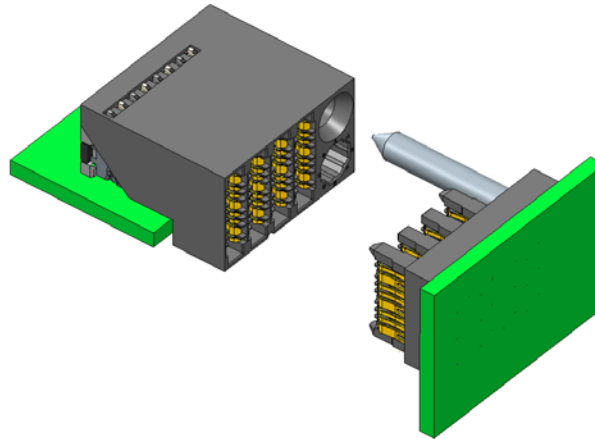


Figure 5: View of Backplane Connectors with Guides (2 Pair, 2mm Pitch, 8-Column Configuration Shown)

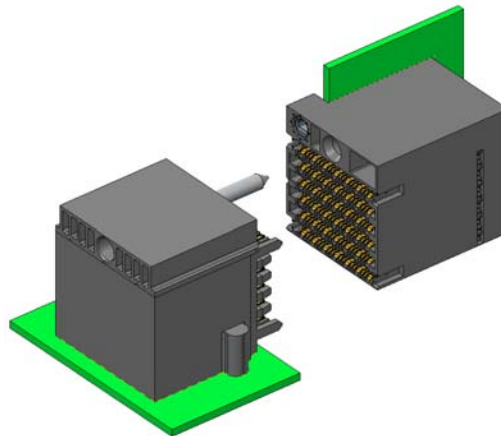


Figure 6: View of Orthogonal Connectors with Guides (6 Pair, 8-Column Configuration Shown)

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3.5.4 Integrated Guide Orientation: FCI Terminology

Left/Right integrated guide orientation is determined by the location of the guide features when looking at the mating face of the right angle receptacle. The L/R designation of the mating header is defined by the right angle receptacle that it mates with (i.e. A Right Guide VH mates with a Right Guide RAR). See Figure 7.

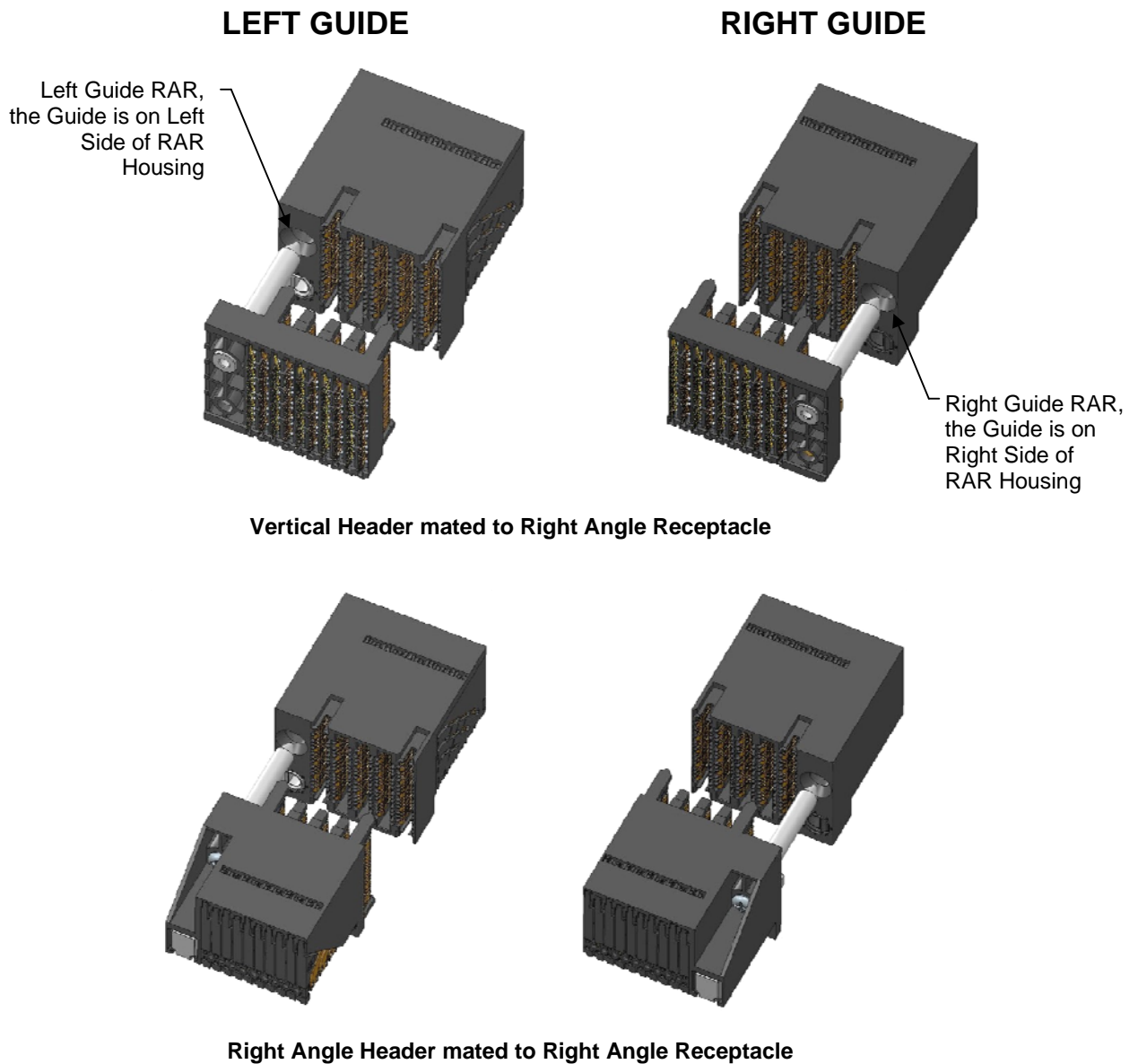


Figure 7: Designation of ExaMAX Left/Right Guide Orientation

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3.5.5 Integrated Guide Strength (Backplane)

The Vertical Header and Right Angle Header integrated guide pins will be deflected 0.2 mm or less with 13 N of force applied just past the guide-pin lead-in chamfer.

3.5.6 Separate Guide Modules

Separate metal guide modules should be used to maximize a system's mechanical robustness. Separate guide modules will allow for additional misalignment in each direction as shown in table 6 below. Please refer to GS-20-045 for additional information including strength ratings for Hard Metric Guide Connectors.

Guide Width	Nominal misalignment correction in direction parallel to connector columns	Nominal misalignment correction in direction perpendicular to connector columns	Wipe length after guide pin is fully engaged in guide receptacle
7.2 mm	2.9 mm	2.9 mm	17.9 mm
10.8 mm	3.5 mm	3.5 mm	22.4 mm

Table 6: Separate Guide Module Guidance Features

3.5.7 Quantity and Location of Guides Relative to Signal Modules

Whether using integrated or separate guide modules, one guide module should be placed at each end of a group of signal modules for coplanar or backplane applications. If the amount of bow in a daughter card exceeds the amount of signal connector guidance, then an additional guide module, separate or integrated, should be placed near the center of a group of signal modules. The guide pin strength rating versus the card weight must be taken into consideration.

3.5.8 Requirements for Direct-Mate Orthogonal (DMO) chassis layout

There must be some type of center structure located between horizontally-oriented card modules and vertically-oriented card modules in any Direct-Mate Orthogonal chassis design. This center structure should be mounted to a chassis datum feature in the connector mating direction. The center structure could be a "picture-frame" printed circuit board, two L-shaped printed circuit boards, a die cast piece of metal with holes, or some similar structure that permits airflow from front to back while providing features to properly locate metal guide pins to provide rough alignment and to support card weight on both sides. Each card module in the DMO chassis should have a minimum of 2 metal guide modules. As with coplanar and backplane applications the guide pin strength rating versus card module weight must be taken into consideration. All card modules must have the ability to move freely so there is no deformation of any chassis component due to misalignment between metal guide pins and guide receptacles.

3.5.9 Guide Keying Options

The purpose of keying is to prevent connectors with improperly matched keys from mating beyond the point of initial contact. Keying can be provided by using either integrated guide modules or by using separate 10.8mm keyed guide modules. Both approaches offer eight different keying options (plus an option without keying). See figure 8, below.

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MODULE DESCRIPTION	DESIGNATION REPRESENTED IN DASH NUMBER										BASE MODEL
WITHOUT END GUIDES MODULE (SEE SHEET 1)	01										
RIGHT GUIDANCE MODULE (SEE SHEET 6)	1A	1B	1C	1D	1E	1F	1G	1H	1J (END RELEASE)		
LEFT GUIDANCE MODULE (SEE SHEET 8)	2A	2B	2C	2D	2E	2F	2G	2H	2J (END RELEASE)		

Figure 8: Example of Guide Keying Options

For the integrated guide modules, refer to the product customer drawing for proper keying dash number designation and for PCB layout information.

For separate guide modules, refer to application specification GS-20-045.

3.6 Orthogonal Board-to-Board Spacing

Because the right angle orthogonal header (RAOH) sits flush on top of the PCB, the connector location relative to the board's edge can be adjusted to provide different board-to-board spacing. For example, when mated to a RAR for a direct mate orthogonal (DMO) application, the board-to-board spacing would be 10.0 mm when the RAOH A1 via is 1.50 mm from the front edge of the board. Likewise, when mated to a VR for a mid-plane orthogonal application the board-to-board spacing would be 12.50 mm when the RAOH A1 via is 1.55 mm from the front edge of the board. In both of these examples, by increasing the distance between the front edge of the RAOH board and the A1 via you can reduce the gap up until the boards are flush.

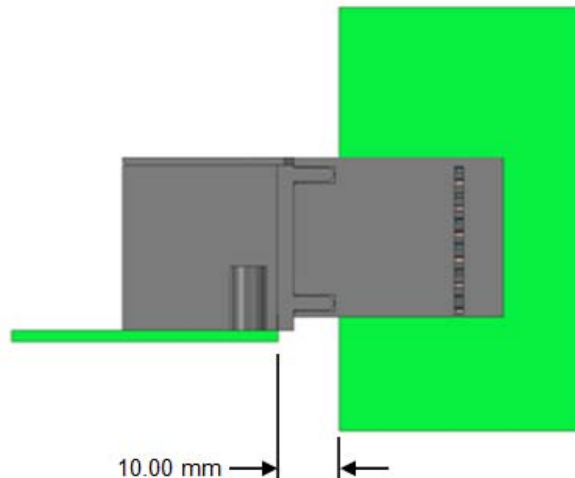


Figure 9: Example Board-to-Board Distance for Direct Mate Orthogonal Application

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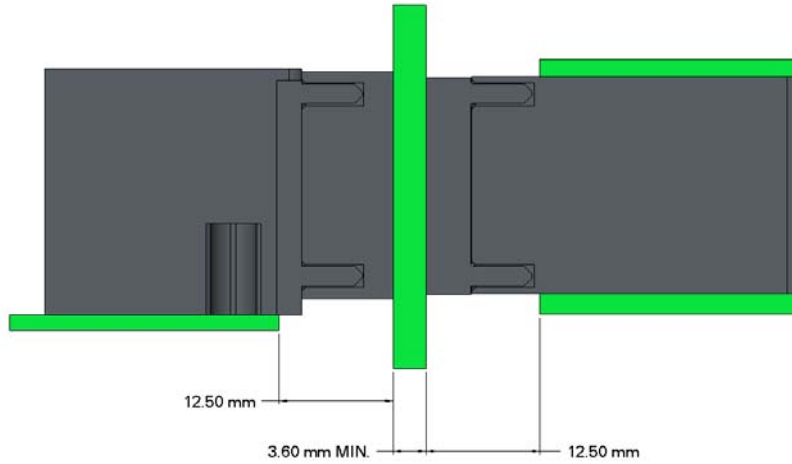


Figure 10: Example Board-to-Board Distance for Orthogonal Mid-plane Application

3.7 Direct-Mate Orthogonal Mating Orientation

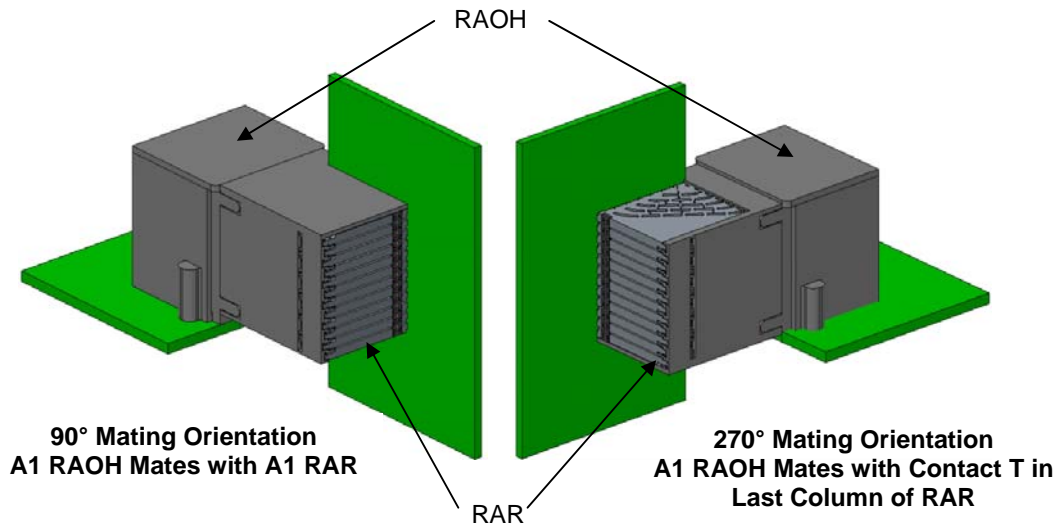


Figure 11: ExaMAX DMO Mating Orientation Designation

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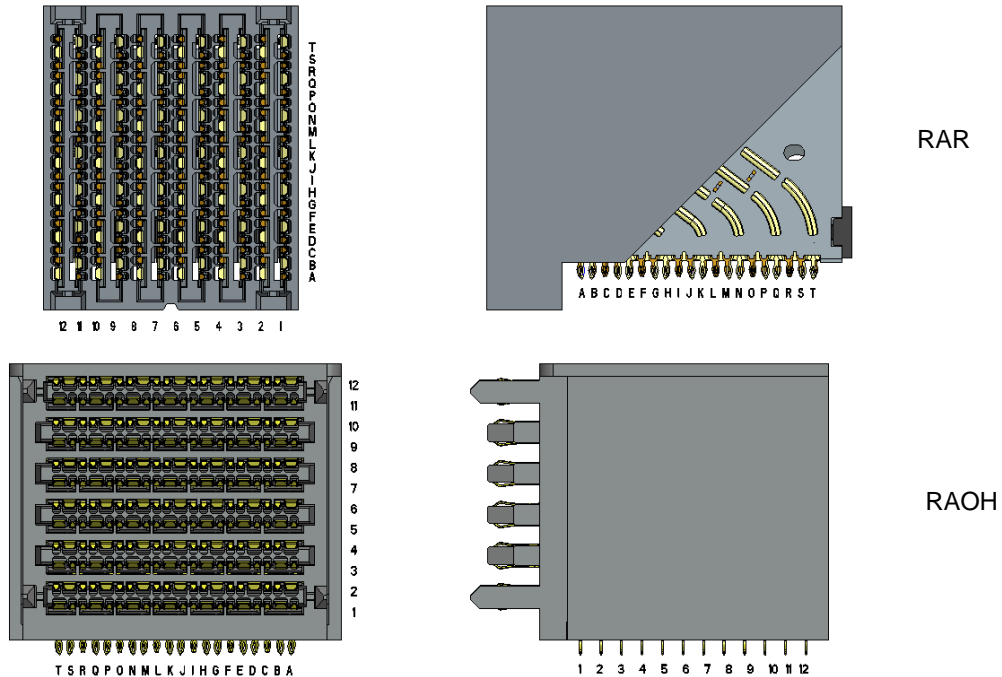


Figure 12: ExaMAX RAR and RAOH Connector Position Identification

3.8 Direct Mate Orthogonal Pin Mapping

Along with the flexibility of being able to mate the ExaMAX RAR with the ExaMAX RAOH in either the 90° mating orientation or the 270° mating orientation, comes the possible confusion of how the PCB Vias are related from one board to the other. To assist in PCB layout, FCI Form E-4511 provides visual maps and tables relating the Via IDs of the RAOH PCB to the Via IDs of the RAR PCB. Tables are provided for both orientations shown in Figure 11.

3.9 Contact Mating and Connector Mating Sequence

The ExaMAX connector system is capable of providing three different mating wipe lengths. When specifying the advance mate configuration, both the header and the receptacle need to have advance mate contacts. When specifying the short detect configuration, only the header or the receptacle can have a short detect contact. See tables 7 and 8 as well as customer drawings for additional details.

Item	Standard Mate Only	Advanced Mate	Short Detect	Advance Mate & Short Detect
Connector Suffix	-1YYLF	-2YYLF	-3YYLF	-4YYLF
Reliable Wipe Length (mm) Nominal	2.5 mm	3.7 mm	2.2 mm	Varies by Type
Contact Location	All	A-Contact 1 st Column and 2 nd to Last Column	Last Contact 2 nd Column	Location by Type

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Table 7: Contact Mating Details

Un-Mate Nominal Distance (mm)	Description of Event
22.40	Separate 10.8mm die cast guide pin is fully engaged past lead-in features
17.90	Separate 7.2mm die cast guide pin is fully engaged past lead-in features
15.35	ExaMAX integrated guide pin is fully engaged past lead-in features
6.70	ExaMAX housing guide post and guide slot start to align connectors
5.15	ExaMAX housing guide post and guide slot are fully engaged
4.40	ExaMAX advance mate contacts first touch
3.70	ExaMAX advance mate contacts reliable wipe begins
3.60	ExaMAX standard mate contacts first touch
2.60	ExaMAX short detect contact first touches
2.50	ExaMAX standard mate contact reliable wipe begins
2.20	ExaMAX short detect contact reliable wipe begins
2.00	ExaMAX standard mate contacts begin 2 points of contact
0.05	ExaMAX remaining gap when BP to card spacing is 12.5mm

Table 8: Connector Mating Sequence

3.10 Mated Connector-to-Connector Via and Housing Locations

The relative location of the header to the receptacle vias and the outside walls is dependent upon the inter-mating connector types. While the housing and PCB real estate varies by connector size (number of differential pairs), the locations between mated connectors remain constant for each of the six configurations shown in figures 13 thru 19.

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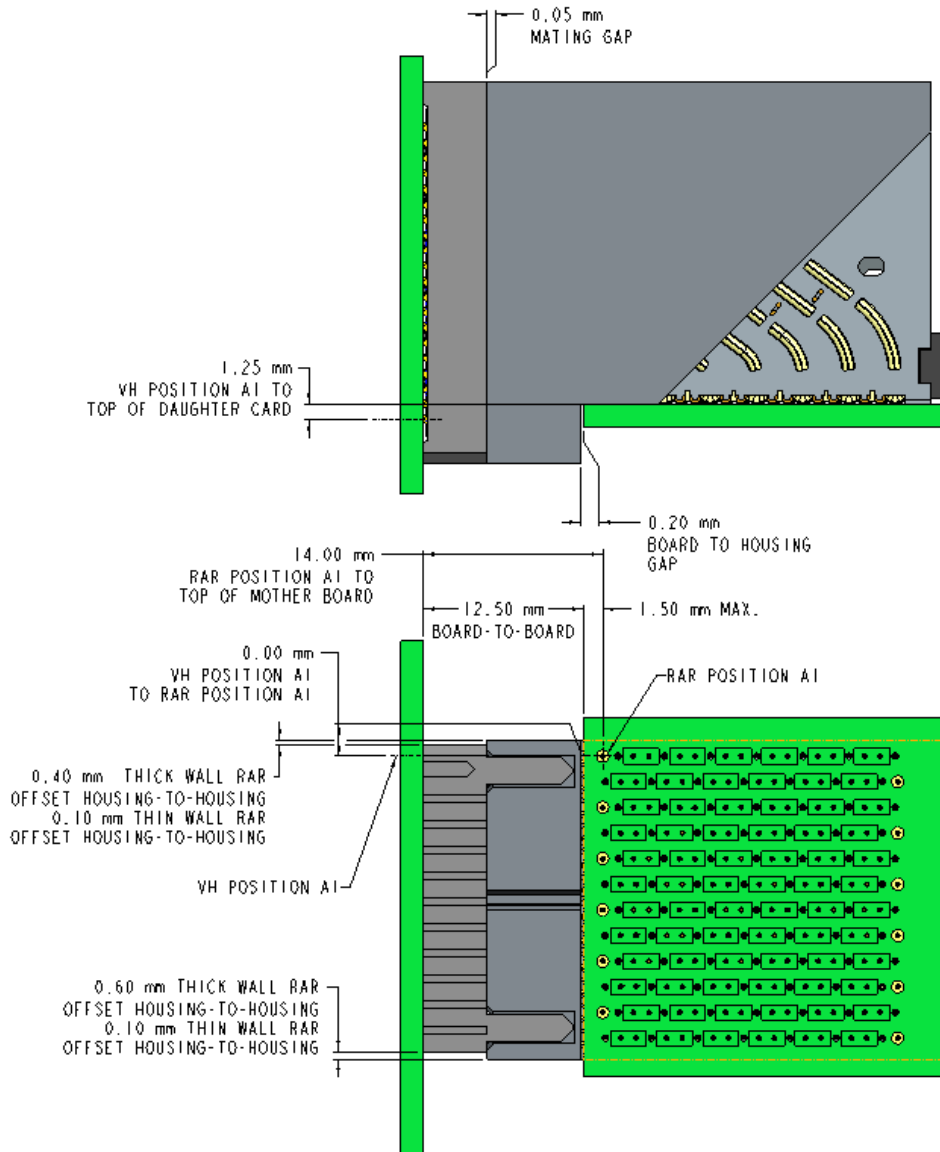


Figure 13: ExaMAX Backplane (Standard RAR to VH) Nominal Mated Connector-to-Connector Locations

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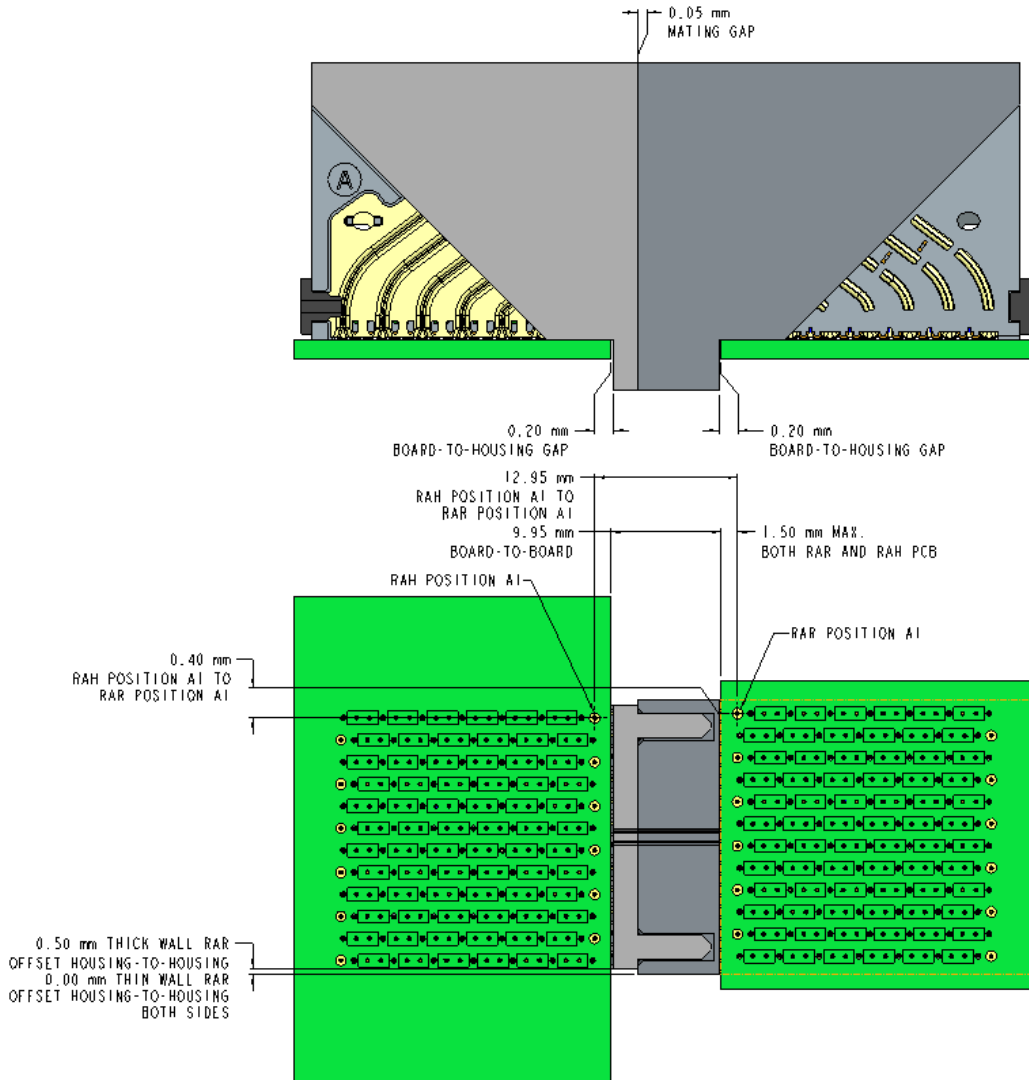


Figure 14: ExaMAX Co-Planar (RAR to RAH) Nominal Mated Connector-to-Connector Locations

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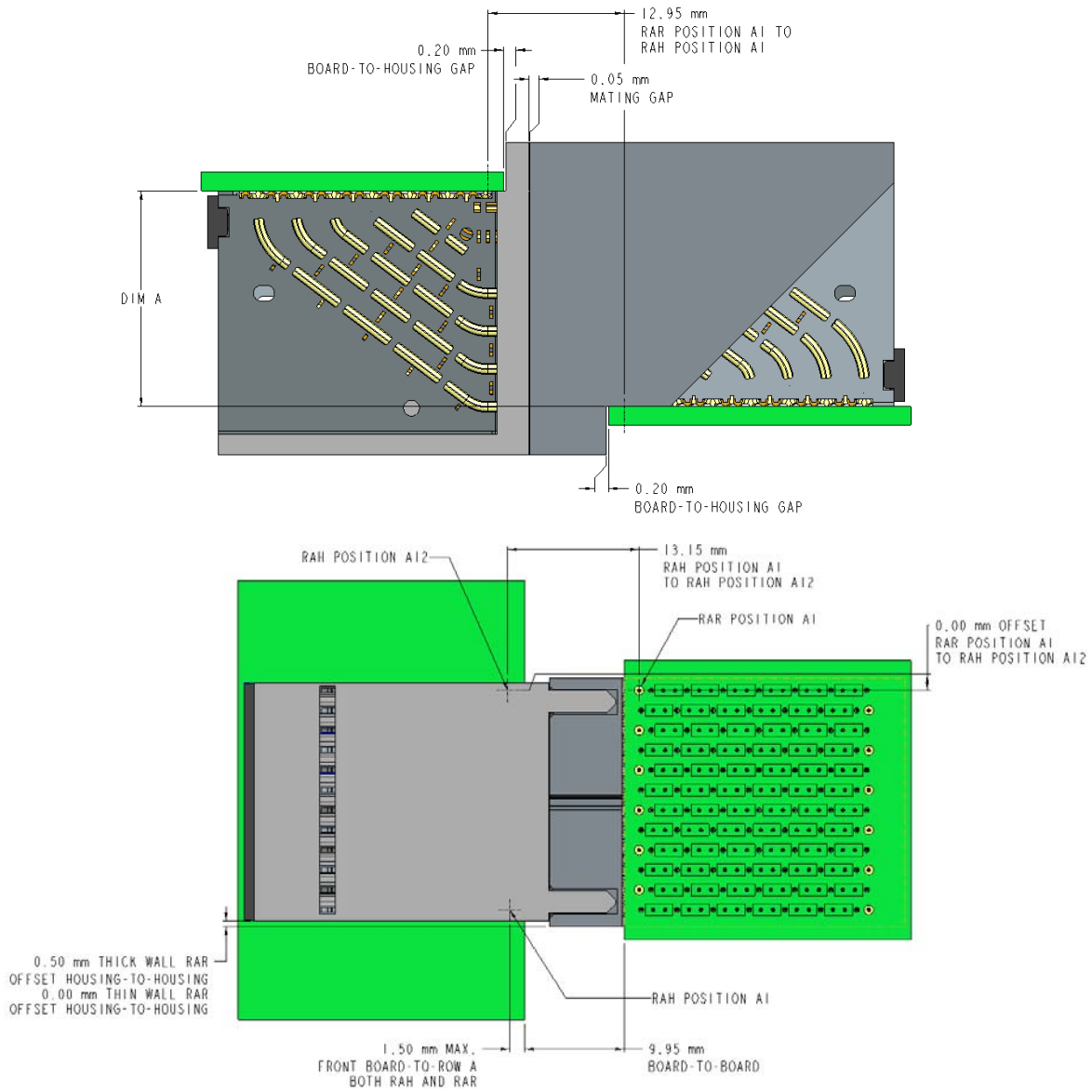


Figure 15: ExaMAX Inverse Co-Planar (RAR to RAH) Nominal Mated Connector-to-Connector Locations

Connector Type	Dim A (mm)
2-Pair	6.1
3-Pair	9.7
4-Pair	13.3
6-Pair	20.5

Table 9: Inverse Co-Planar Separation Distance between Component-Side Surfaces

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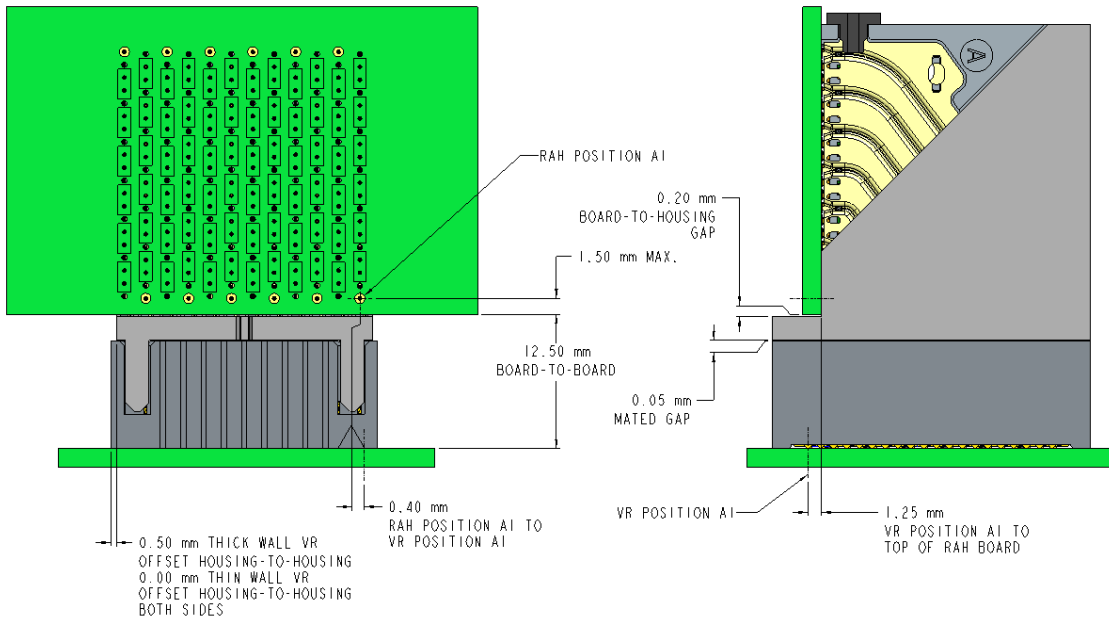


Figure 16: ExaMAX VR to RAH Nominal Mated Connector-to-Connector Locations

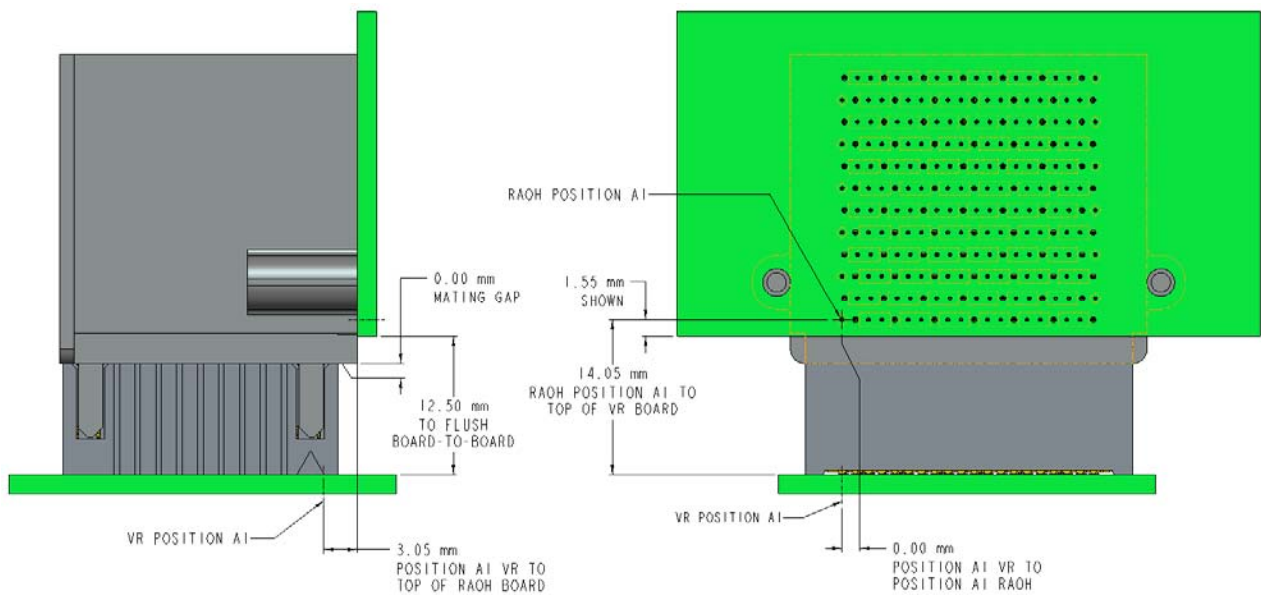


Figure 17: ExaMAX VR to RAOH Nominal Mated Connector-to-Connector Locations

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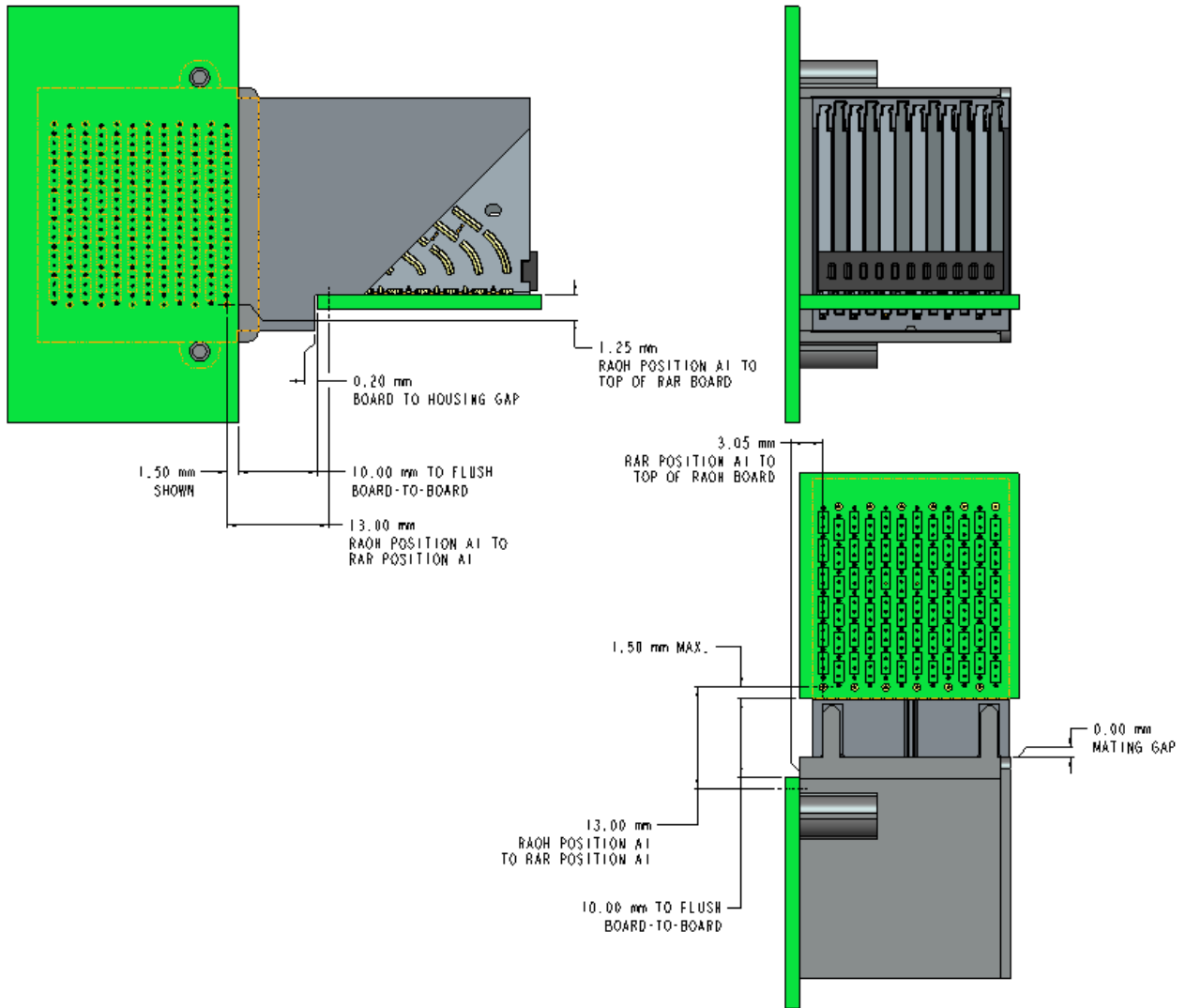


Figure 18: ExaMAX Orthogonal (RAOH to RAR) Nominal Mated Connector-to-Connector Locations

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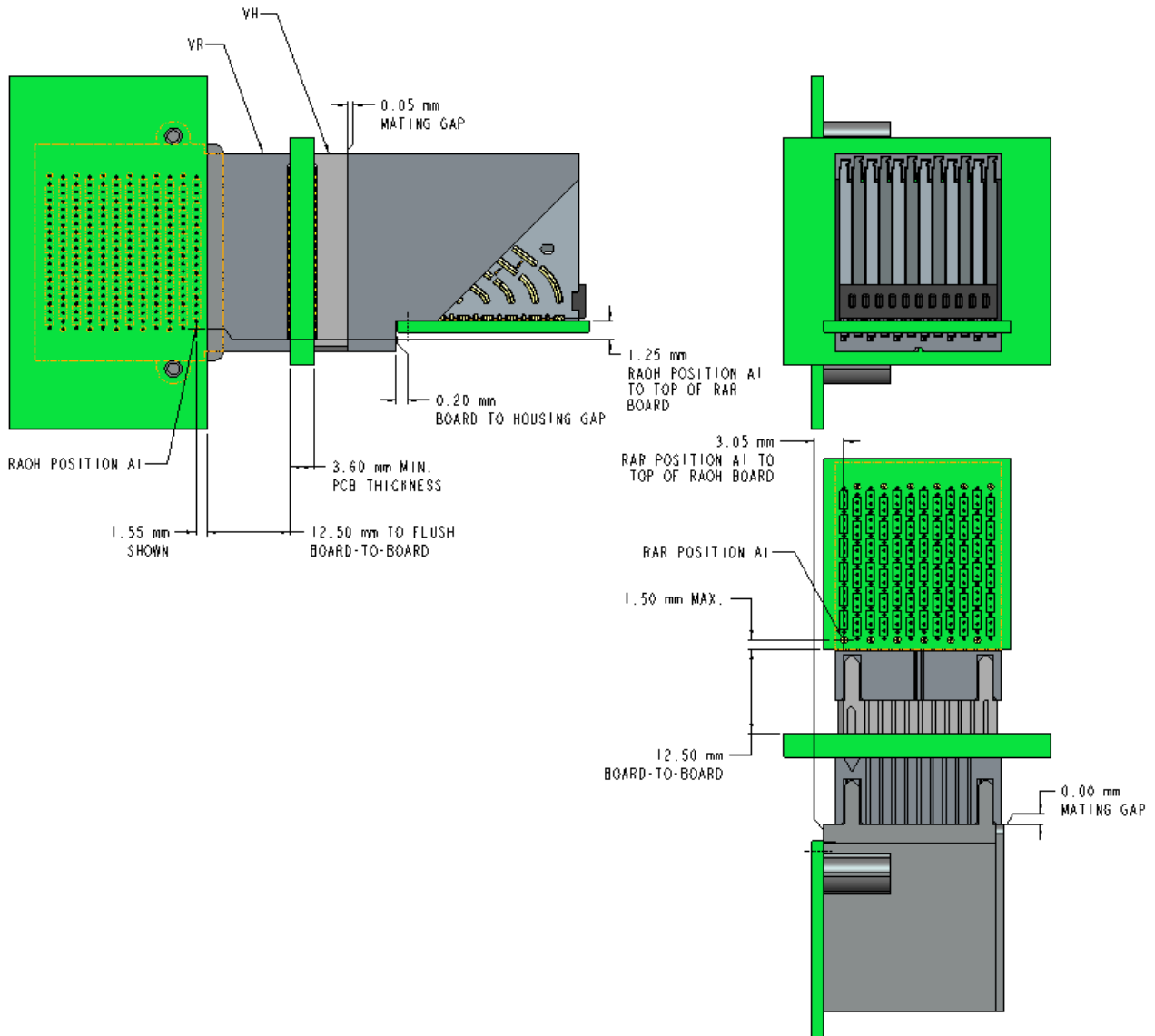


Figure 19: ExaMAX Orthogonal Mid-Plane (RAOH to VR to VH to RAR) Nominal Mated Connector-to-Connector Locations

3.11 Power Options

The ExaMAX connector system can be configured to provide both high speed signal and power within the same connector. While any contacts within the ExaMAX connector can be used for power, we do not recommend using short detect contacts. If ground contacts are used for power, all the ground contacts within a column must be used for power because they are commoned together. Refer to ExaMAX ExaMEZZ Power Design Guide, GS-20-0456, for additional details.

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4.0 PRINTED CIRCUIT BOARD LAYOUT INFORMATION

4.1 Board Thickness

The minimum PCB thickness that does not require PCB back-up tooling for EON tip clearance is 1.75mm. If back-up tooling with EON tip clearance will be used, the minimum PCB thickness can be reduced to 1.30mm. For mid-plane applications where connectors share the same via holes from opposite sides of the board the minimum PCB thickness should be 3.60mm. There are no maximum thickness requirements.

4.2 Connector to Connector Spacing

The connector-to-connector centerline spacing for ExaMAX products will depend on the number of columns, the column-to-column pitch, whether internal guides are used and the position of the connectors relative to each other. When using a recommended thick wall RAR, the column-to-column spacing of the vias between connectors is 1.0 mm larger than the spacing within the connector. In table 10 are listed the contact EON overall spacing (E), the distance from mating centerline to the A1 EON (C), adjacent EON Via to Via spacing (G) and mating centerline to mating centerline spacing (S) for three different configurations with 2mm and 3mm column-to-column pitch.

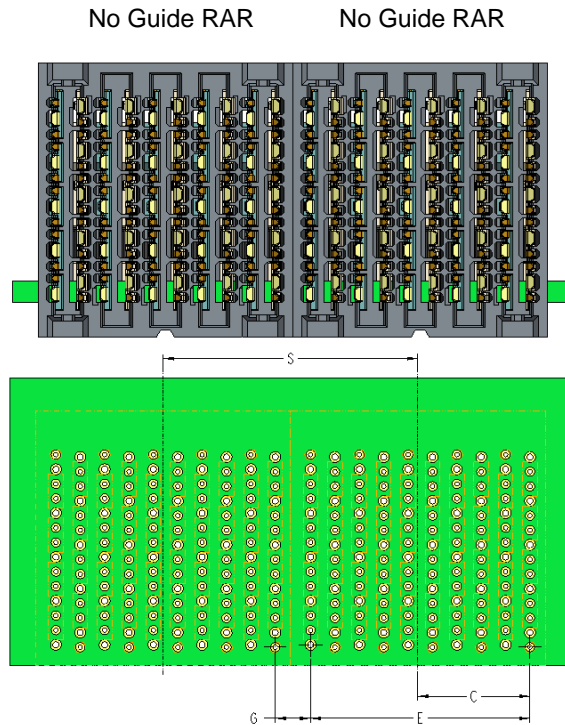
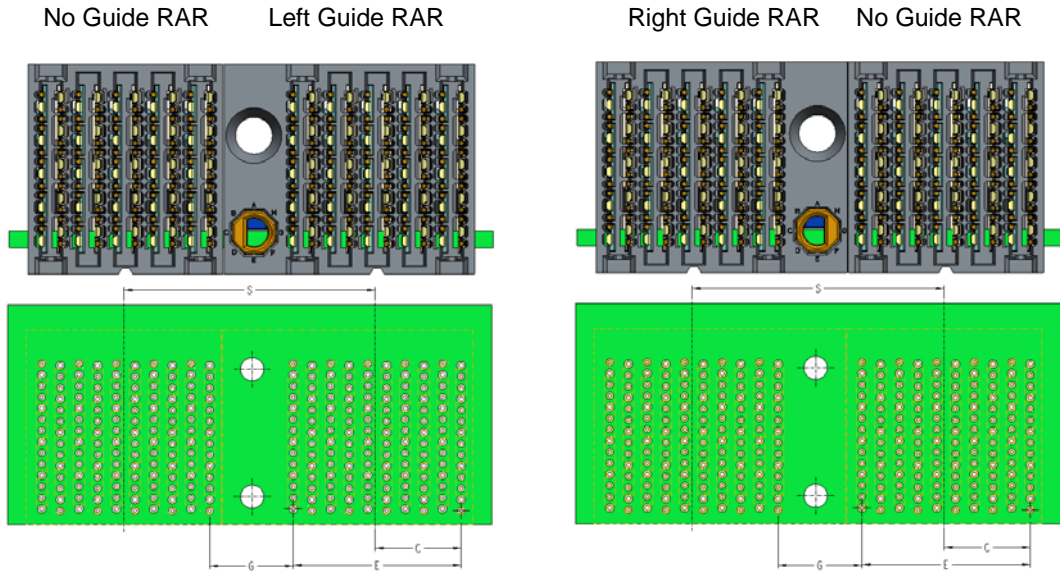


Figure 20: Connector to Connector Spacing With No Guides Option I

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**Figure 21: Connector to Connector Spacing with Left and Right Guides
Options II and III**

	No. Columns	2mm EON Pitch						3mm EON Pitch			
		Thick and Thin Wall		Thick Wall		Thin Wall		C	E	G	S
		C	E	G	S	G	S				
Option I: Both No Guides	6	5.2	10.0	3.0	13.0	2.0	12.0	7.7	15.0	3.0	18.0
	8	7.2	14.0	3.0	17.0	2.0	16.0	10.7	21.0	3.0	24.0
	10	9.2	18.0	3.0	21.0	2.0	20.0	13.7	27.0	3.0	30.0
	12	11.2	22.0	3.0	25.0	2.0	24.0	16.7	33.0	3.0	36.0
Option II: With Left Guide	6	5.2	10.0	8.95	18.95	8.45	18.45	7.7	15.0	8.45	23.45
	8	7.2	14.0	8.95	22.95	8.45	22.45	10.7	21.0	8.45	29.45
	10	9.2	18.0	8.95	26.95	8.45	26.45	13.7	27.0	8.45	35.45
	12	11.2	22.0	8.95	30.95	8.45	30.45	16.7	33.0	8.45	41.45
Option III: With Right Guide,	6	5.2	10.0	8.95	18.95	8.45	18.45	7.7	15.0	8.45	23.45
	8	7.2	14.0	8.95	22.95	8.45	22.45	10.7	21.0	8.45	29.45
	10	9.2	18.0	8.95	26.95	8.45	26.45	13.7	27.0	8.45	35.45
	12	11.2	22.0	8.95	30.95	8.45	30.45	16.7	33.0	8.45	41.45

Table 10: PCB Connector to Connector Spacing

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4.3 Printed Circuit Board Screen Printing Recommendations

It is recommended to print the outline of the connector housing onto the PCB to insure proper placement of the connector. Detailed information of the recommended outline is provided on the customer drawing.

4.4 Keep-Out Zones for Application and Removal Tooling

There are no keep-out zones necessary for application tooling because these tools fit within the outside envelope of the connector assemblies.

In order to minimize any strain on the board and other components near the connector, it is recommended that for PCB / connector rework, allowances on the connector side of the board should be made for 2mm keep-out zones adjacent to the connector on a minimum of two opposing sides. These zones will be needed for support tooling during the removal process. Refer to section 5.10 for additional details.

4.5 Position A1 Identification

Because Right Angle connectors can only be applied to the PCB in one orientation, no specific visual features have been added to the right angle connector housings. See the associated customer drawing for proper PCB layout and identification of the A1 contact position.

Vertical connectors can be placed onto the PCB in two different orientations. In order to clearly identify the A1 contact position, vertical header connector housings have serrations along the A-side of the housing and a corner chamfer and flag at the A1 position. The vertical receptacle housings have serrations along the A-side of the housing and a triangular flag at the A1 position (See figure 22).

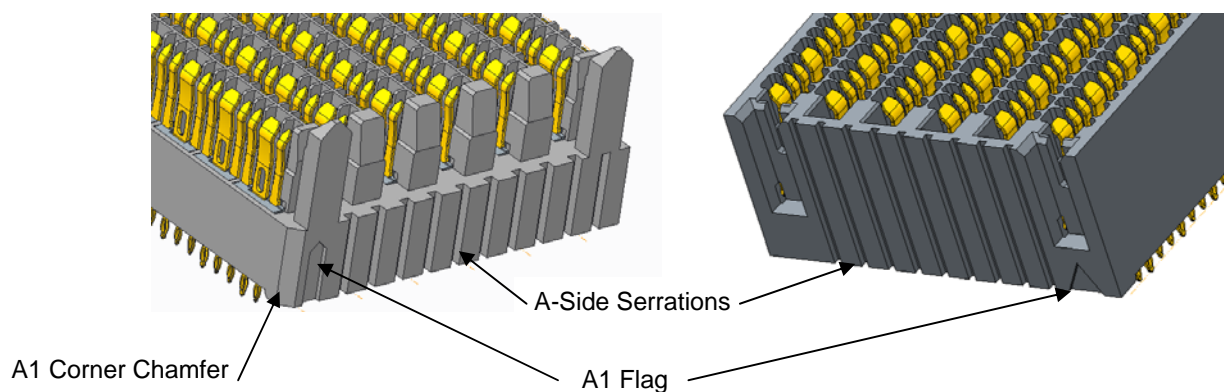


Figure 22: Vertical Connector A1 Identification

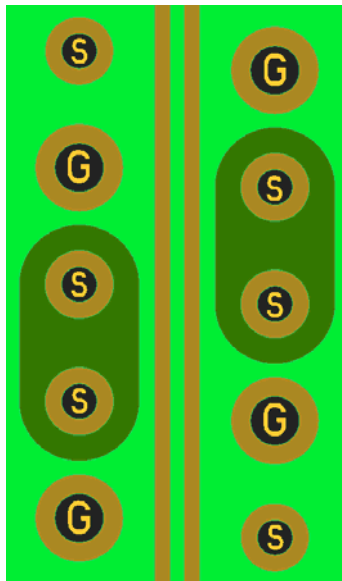
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4.6 Printed Circuit Board Trace Routing

To minimize trace loss in high-speed systems, board designers typically prefer to use trace widths no smaller than 0.10mm. The desired impedance between adjacent traces and the PCB layer thickness will define the spacing between those traces. The board designer will ultimately determine these parameters for a given system.

4.6.1 2.0mm Column Pitch

The routing channel is defined by the size of the antipads and the column spacing. One differential pair can be routed per layer using a 2mm column pitch. Refer to Figure 23 for 2mm pitch routing example. **Please note that the separation between traces and antipads is a key parameter for minimizing crosstalk between layers.**



	mils	mm
trace width	6.3	0.1600
trace-to-trace separation	5.7	0.1452
trace-to-antipad separation	6.0	0.1524
signal via(S) drill \emptyset	17.7	0.45
signal via(S) finish \emptyset	14	0.36
Signal via (S) pad \emptyset	27.7	0.70
ground via(G) drill \emptyset	23.6	0.60
ground via(G) finish \emptyset	20	0.50
antipad width	48.4	1.23
antipad length	110.2	2.80
row pitch		1.20
column pitch		2.00

Figure 23: PCB Single Differential Routing Example, 2mm Column Pitch

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4.6.2 3.0mm Column Pitch

The routing channel is defined by the size of the antipads and the column spacing. One or two differential pairs can be routed per layer using a 3mm column pitch. To maximize the crosstalk shielding for single differential pair layouts, small ground vias (“g” in figures 25 and 26) should be added, along with ground flooding of the top layer of the PCB. Refer to Figure 24 thru 26 for 3mm pitch routing examples. **Please note that the separation between traces and antipads is a key parameter for minimizing crosstalk between layers.**

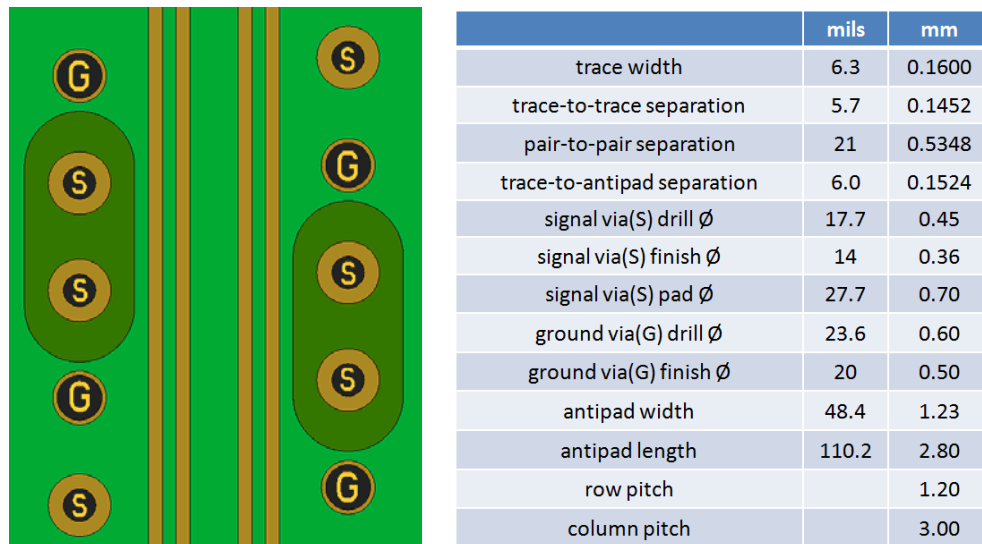


Figure 24: PCB Dual Differential Routing Example, 3mm Column Pitch

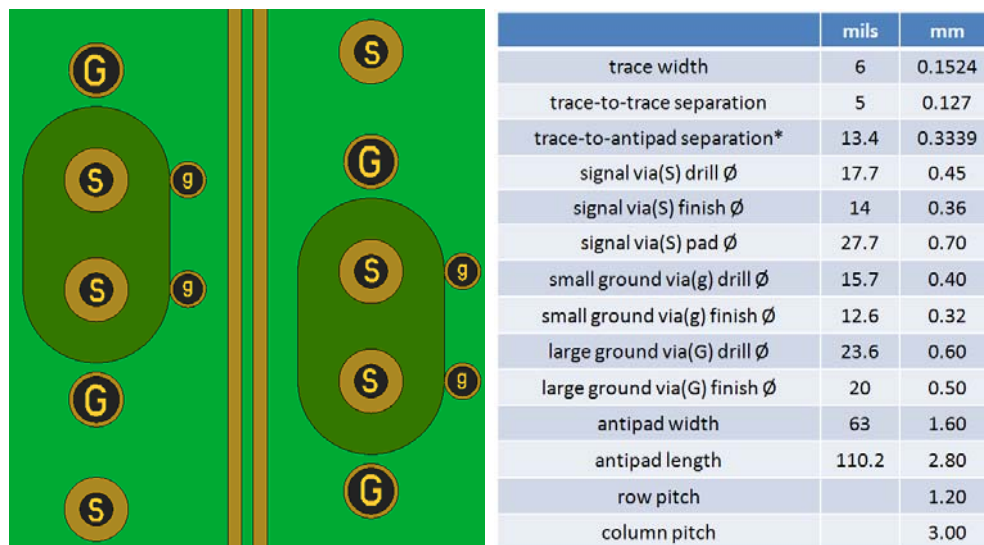


Figure 25 PCB Single Differential Routing Example, Stitching Vias on One Side, 3mm Column Pitch

* - Traces are not centered in the routing channel. Spacing is taken from right side of trace, where there are no stitching vias, to the left side of anti-pad, where there are no stitching vias.

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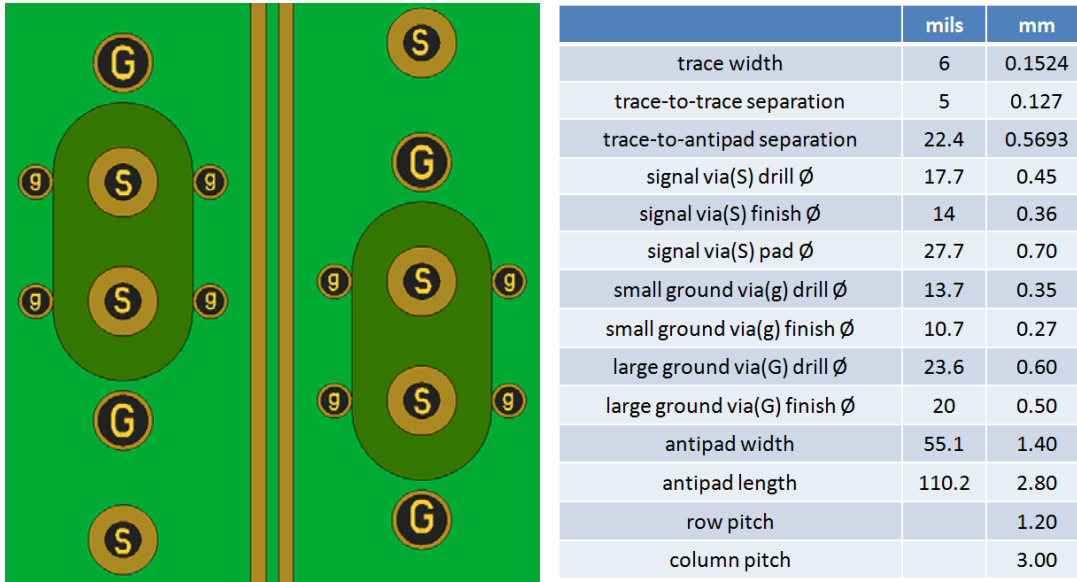


Figure 26: PCB Single Differential Routing Example, Stitching Vias on Two Sides, 3mm Column Pitch

4.7 Low Speed Positions

Each column of an ExaMAX connector has an extra pin for low speed signal or any other miscellaneous function. The finished hole size is the same as for all high speed signal positions (0.36mm). The drill diameter and pad size recommendations from the differential layout will be the same for these locations. A 0.95mm diameter antipad is shown, but any size that prevents shorting to the ground layer will work since impedance is typically not important. Trace width can vary, depending on the intended function of the pin.

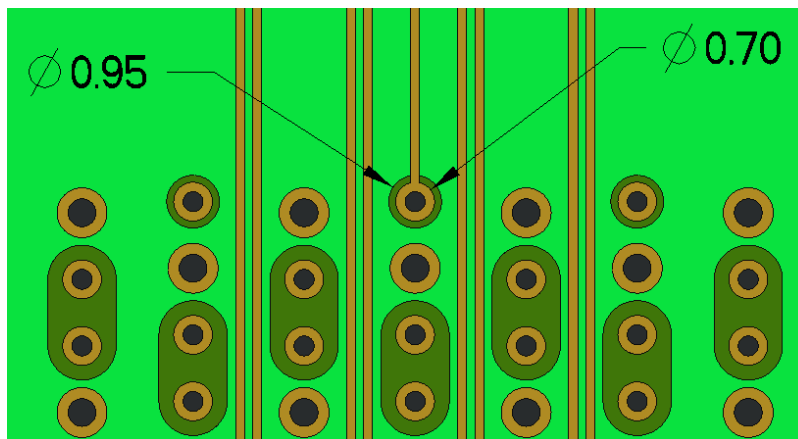


Figure 27: PCB Low Speed Example

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4.8 Skew Compensation at Connections to Signal Vias

When a pair of traces is connected to a pair of signal vias, the length of those traces will be different unless precautions are taken. Any difference in length will result in intra-pair skew. Please see figure 28 for a method to minimize the difference in length. The image on the left shows the signal routing layer, while the image on the right shows the ground plane layer. The trace connection to the right signal via in each pair is made longer than the connection to the left via to account for overall length differences. Also, on the ground layer, there are extensions to the ground plane that are found beneath the signal traces as they extend into the antipads. These ground layer extensions will help to maintain the desired impedance for that length of trace. Without the ground beneath the trace, the impedance will be higher.

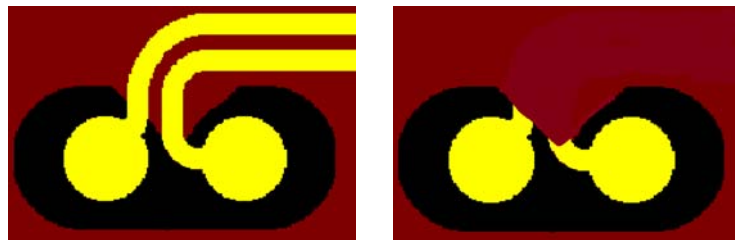


Figure 28: PCB Skew Compensation

4.9 Back-drilling

Back-drilling is a method used by system designers that reduces the length of a conductive via which will improve high speed signal integrity performance of a link. When back-drilling is performed it is important to avoid damaging the portion of the via that makes contact with any press-fit tails. The diameter of the back-drill should be at least 0.2mm (8 mils) larger than the drill sized used for the plated via. See figure 29 for recommendations on proper back-drilling.

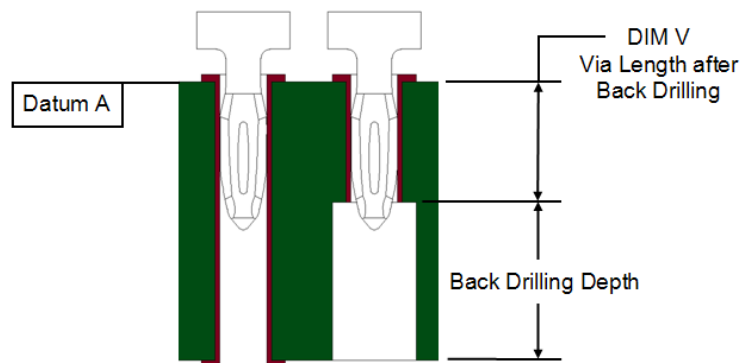


Figure 29: View of Back-drilling

After a back-drilling operation, the remaining via barrel length (Dim V) must be at least 1.0mm for the signal terminals to ensure a reliable connection between the press-fit tails and the PCB. Assuming that the PCB manufacturer can maintain a back-drilling depth tolerance of $\pm 0.3\text{mm}$ relative to datum A, the nominal via length after back-drilling would need to be 1.3mm.

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4.10 Anti-pads in back drilled regions

In regions where vias will be back-drilled, the anti-pad should be reduced to a diameter equal to the signal via drill hole + 0.4mm (16 mils). This assumes the back-drill size used is equal to the signal via drill + 0.2mm and the anti-pad is 0.2mm (8 mils) larger than the back-drill diameter to avoid contact between the drill and the ground layers being drilled through. These small anti-pads should only be used on non-reference ground layers in the back-drilled region. The ground plane immediately below the routed signal layer should still have the standard anti-pads for impedance matching. The smaller anti-pads will minimize layer-to-layer crosstalk leakage between any traces sharing the same routing channel on adjacent signal layers.

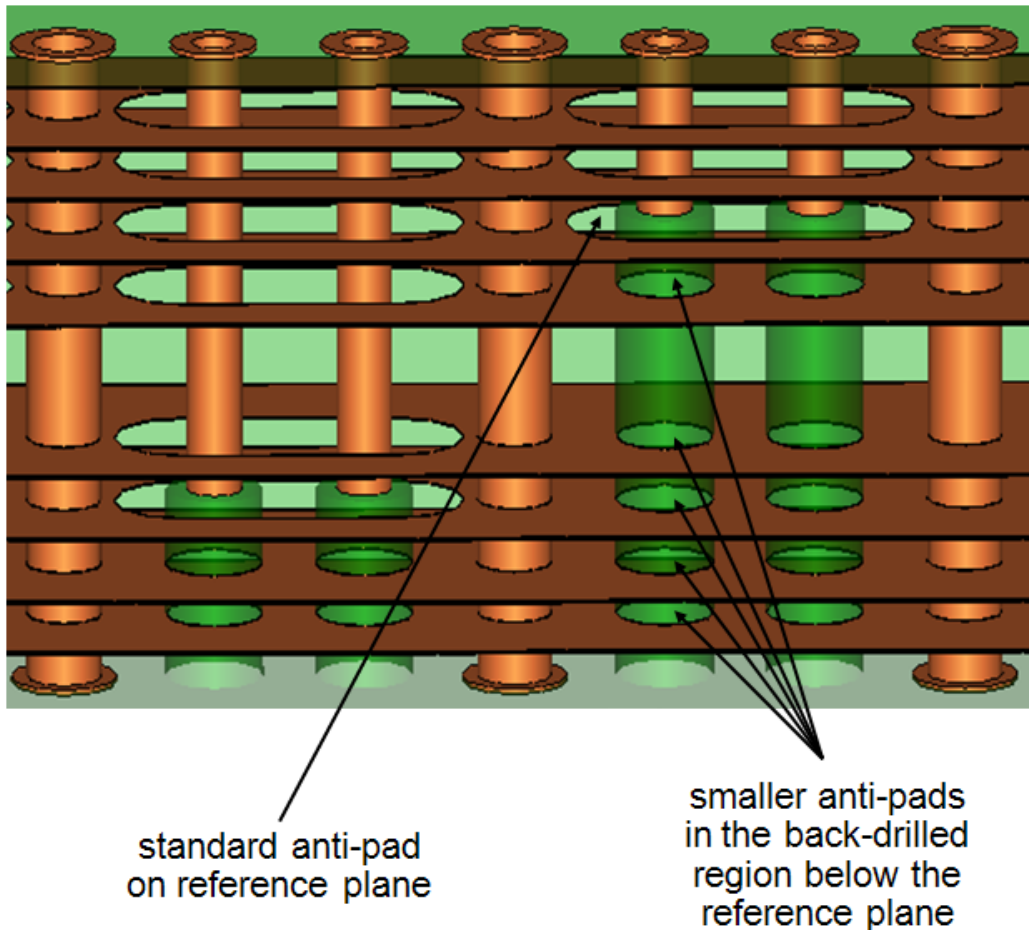


Figure 30: Reduced Anti-Pad Size in Back-Drilled Regions

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5.0 APPLICATION PROCEDURE

5.1 Connector Insertion Tooling

The ExaMAX Right Angle Receptacle (RAR) and Coplanar Right Angle Header (RAH) are designed for “flat rock” insertion and thus do not require any special insertion tooling.

The ExaMAX Vertical Header, Vertical Receptacle and Right Angle Orthogonal Header (RAOH) connectors are intended to be applied utilizing a “flat rock” along with one of the special insert tools listed in tables 11 and 12.

If a connector’s ground tails are longer than the thickness of the printed circuit board that the connector is being applied to (ground tail length specification is $1.60 \pm 0.15\text{mm}$) a special bottom support tool will be necessary. This tool could be a PCB with oversized holes or a custom tool designed by the user.

Pair	Column	Number Positions	2mm Insertion Tool PN		3mm Insertion Tool PN	
			VH	VR	VH	VR
2	6	48	10125489-006	10132534-006	10132462-006	10132536-006
	8	64	10125489-008	10132534-008	10132462-008	10132536-008
	10	80	10125489-010	10132534-010	10132462-010	10132536-010
3	6	66	10125490-006	10132535-006	10132463-006	10132537-006
	8	88	10125490-008	10132535-008	10132463-008	10132537-008
	10	110	10125490-010	10132535-010	10132463-010	10132537-010
4	6	84	10125491-006	10131053-006	10131122-006	10132538-006
	8	112	10125491-008	10131053-008	10131122-008	10132538-008
	10	140	10125491-010	10131053-010	10131122-010	10132538-010
6	6	120	10125493-006	10131054-006	10131537-006	10132539-006
	8	160	10125493-008	10131054-008	10131537-008	10132539-008
	10	200	10125493-010	10131054-010	10131537-010	10132539-010
	12	240	10125493-012	10131054-012	10131537-012	10132539-012
	16	320	10125493-016	10131054-016	10131537-016	10132539-016

Table 11: VH and VR 2mm and 3mm Insertion Tool Part Numbers

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Pair	Connector Housing Columns	Number Positions	Insertion Tool PN
6	6	120	10136747-006
	8	160	10136747-008
	10	200	10136747-010
	12	240	10136747-012
	14	280	10136747-014
	16	320	10136747-016
	8 Special, 4-Wall	160	10136748-008
	16 Special, 4-Wall	320	10136748-016

Table 12: DMOH Insertion Tool Part Numbers

5.2 Insertion Press

Several important items to consider when selecting an insertion press include:

- The press must have sufficient force capabilities
- The press must be capable of controlling the insertion rate.
- The press must be capable of pressing per a force gradient curve.
- The press ram must be large enough to cover the insertion tooling
- The press table must be large enough to properly accommodate the PCB size.

FCI recommends using a servo driven electronic press from the Tyco Electronics (ASG) MEP family of presses. See section 5.3 for programming details.

5.3 Recommended Insertion Press Settings

ExaMAX connectors, with the exception of the Right Angle Orthogonal Header, have a maximum insertion force of 12 Newton per press-fit terminal. The Right Angle Orthogonal Header requires a maximum insertion force of 18 Newton per press-fit terminal.

For all connector types except for the RAOH, FCI recommends using a 75 degree force gradient press profile to ensure that the connectors are fully seated, while at the same time are not damaged by over pressing the connectors onto the board. A typical 75 degree press profile would look like figure 31 below. The recommended insertion rate is 0.050"/sec for the entire time the ram is in contact with the connector press tool.

Note: FCI RECOMMENDS THAT ONLY ONE CONNECTOR ASSEMBLY BE INSERTED AT A TIME. If more than one connector is inserted at the same time then extra care must be taken to ensure that the push surface of the tool is parallel to the component surface of the board.

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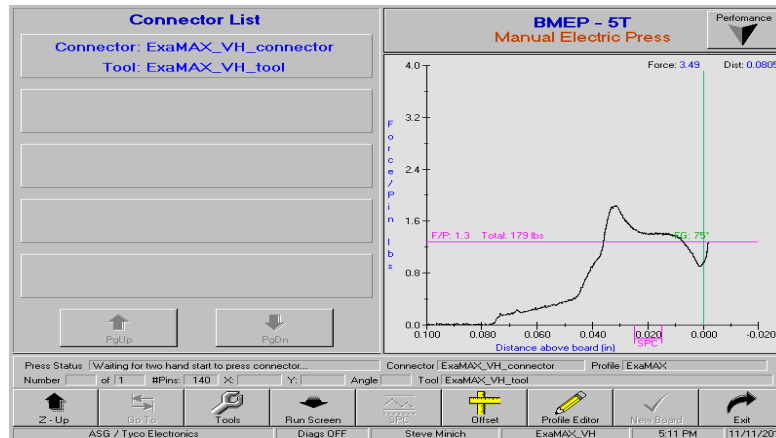


Figure 31: Example of 75 Degree Force Gradient Press Profile

	RAOH Configuration	All Other Configurations
Recommended Press-Fit Force	18 N Max. Per Pin	75 Degree Force Gradient (12 N Max. Per Pin)

Table 13: Summary of Insertion Force Recommendations

5.4 Board Insertion Procedure for Right Angle Receptacle or Coplanar Right Angle Header Connectors

- Begin by holding the connector at a slight angle so that the tips of the outside column press fit tails, left or right, can be inserted into either the first or last column of via holes on the PCB. See figure 32.

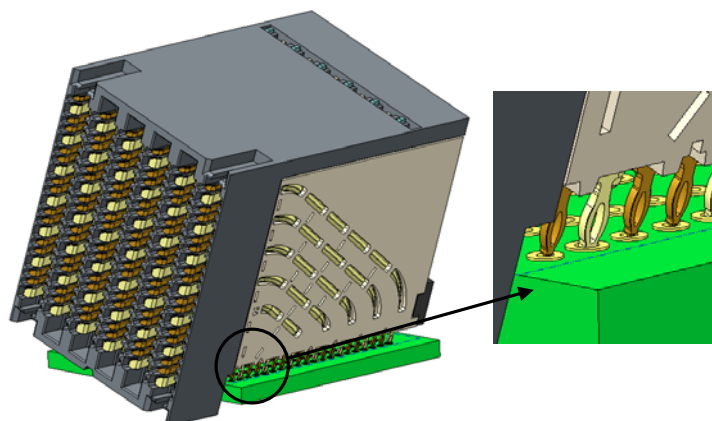


Figure 32: Right Column EONs Being Aligned With PCB Vias

- Once the end column EON tips have been inserted, rotate the connector towards the board to insert the rest of the EON tips into their corresponding vias. The top surface of the connector should be parallel with the top surface of PCB after all of the tips have been properly inserted. Refer to figure 33.

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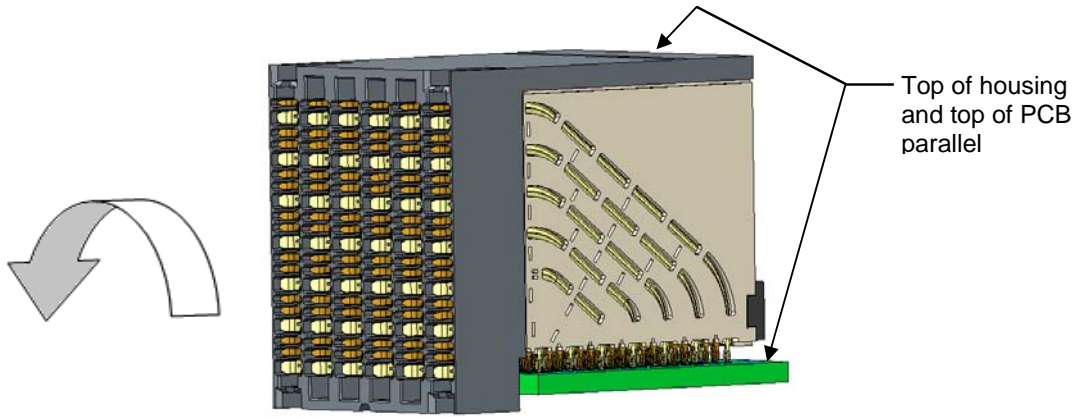


Figure 33: Connector Rotated Parallel to Top of PCB and EONs Aligned

- Using a flat rock surface and an insertion press, apply force to the flat area of the connector as shown in figure 34.

75 degree Force Gradient (12 N MAX per pin)

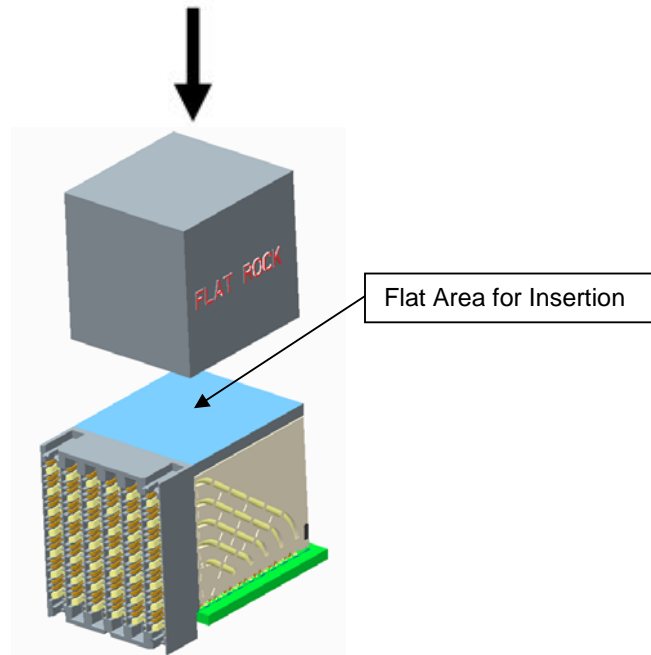


Figure 34: Flat Rock Tool Application to Seat Right Angle Connector

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- Inspect for proper application (refer to section 5.7).
- When a force is applied to the front underside surface of the housing, the typical peel strength per IMLA, without hold down screws, is shown in table 14. (i.e. 2-pair x 8 IMLA = 8 x 11.6 N = 92.8 N peel strength)
- For connectors with either a right or left guide module, two Phillips Pan Head M2 x 0.4 hold-down screws must be used to secure the connector more rigidly to the PCB. The length of the screws shall be as shown in table 14. Screws are not provided with the connectors.
- For a connector assembly with hold down screws you will typically obtain an additional 70 N peel strength. (i.e. 2-pair 8 IMLA w / screws = 92.8 N + 70 N = 162.8 N peel strength)

Connector Size	Screw Length (mm)	Peel Strength w/o Screws (N / IMLA)
2-Pair	1.5 – 2.7 + PCB Thickness	11.6
3-Pair	2.0 – 6.0 + PCB Thickness	16.0
4-Pair	2.0 – 6.0 + PCB Thickness	20.0
6-Pair	2.0 – 6.0 + PCB Thickness	29.0

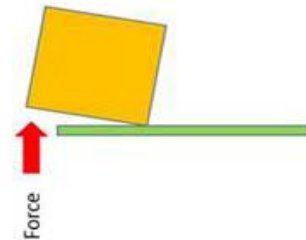


Table 14: Guide Module Hold-Down Screw Length

5.5 Board Insertion Procedure for Vertical Connectors

- Place insertion tool into the connector assembly and carefully locate onto the printed circuit board, taking care to assure that all press-fit tails are aligned with the proper PCB hole (i.e. A1 to A1) and each cavity slot of the connector has a blade from the insert tool located in it.

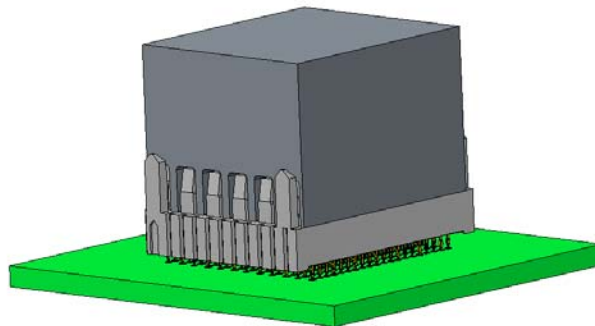


Figure 35: Vertical Connector and Insertion Tool Placed Onto PCB

- Using a flat rock surface and an insertion press, apply force to the top of the insert tool as shown in figure 36.

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75 degree Force Gradient (12 N MAX per pin)

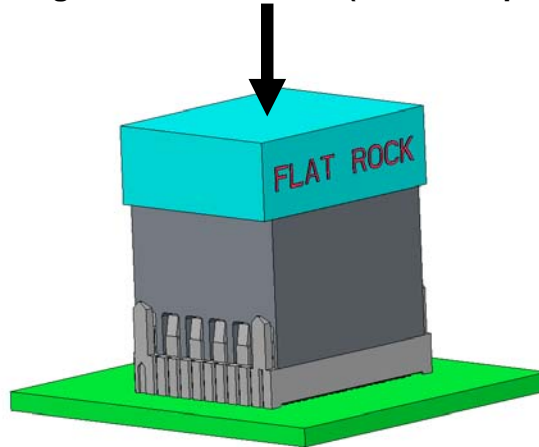


Figure 36: Flat Rock Tool Used to Seat Vertical Connector

- Inspect for proper application (refer to section 5.7).
- For connectors with either a right or left guide module, one Phillips Pan Head M2 x 0.4 hold-down screw must be used to secure the connector and guide pin to the PCB. The length of the screw shall be 2.0 - 6.0 mm plus the thickness of the PCB. Screws are not provided with the connectors.

5.6 Board Insertion Procedure for Right Angle Orthogonal Headers

- Begin by placing insertion tool specified in table 12 over the top of the RAOH connector as shown in figure 37. The same tool is used for both guided and non-guided assemblies.

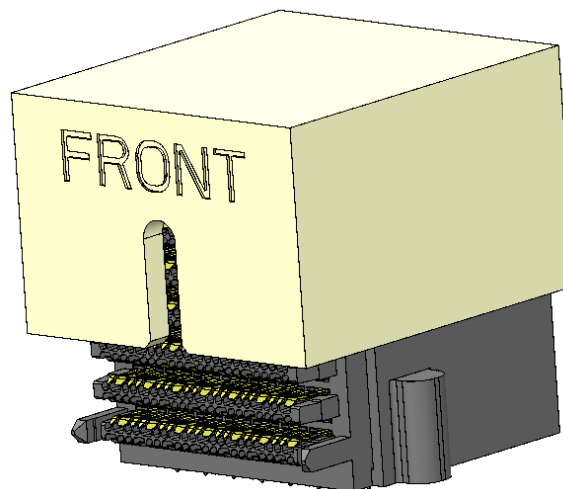


Figure 37: Placing Insertion Tool on Top of RAOH Connector

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- Hold the connector at a slight angle so that the tips of the last row of press fit tails can be aligned and inserted into the last row of via holes on the PCB. Refer to figure 38.

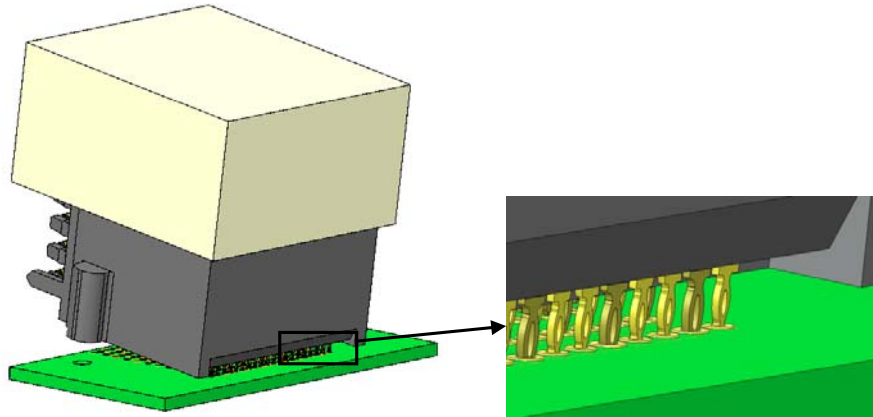


Figure 38: Last Row of EON tips Inserted into Last Row of PCB Vias

- Once the last row of EON tips have been inserted, rotate the connector towards the front edge of board. This will insert the rest of the EON tips into their corresponding vias. With the EON tips all started, the top surface of the insertion tool should be parallel with the top surface of PCB. Refer to figure 39.

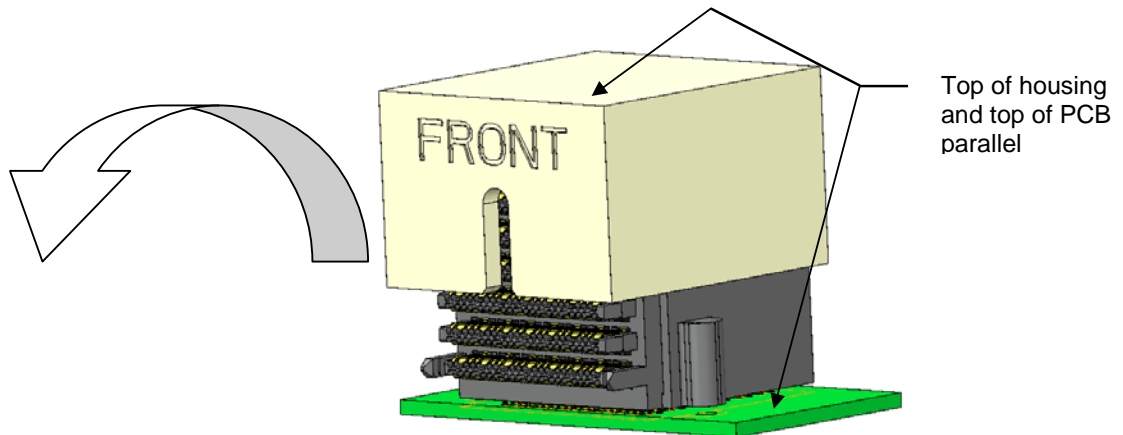


Figure 39: Connector Rotated Parallel to the Top of PCB and EONs Aligned

- Using a flat rock surface and an insertion press, apply force to the top flat surface of the insertion tool, as shown in figure 40.

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Note: The RAOH connector should be pressed to 18N max and not 75 degree Force Gradient. A 75 degree Force Gradient (12 N max force per pin) profile is recommended for all other connector configurations.

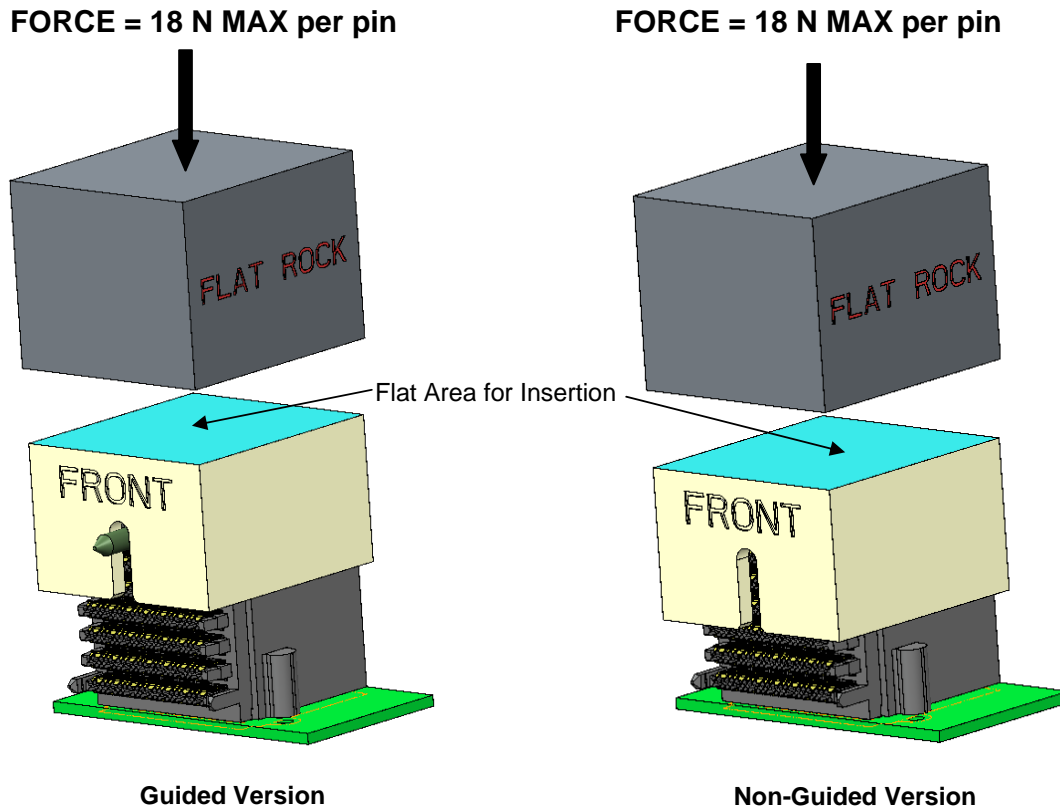


Figure 40: Flat Rock Tool Application to Seat RAOH Connector

- Inspect for proper application (refer to section 5.7).
- For connectors with the optional screw mounting features, apply two M2 X 0.91 thread forming tri-roundular shaped screws, designed specifically for plastic material, into the mounting holes in order to more rigidly secure the connector to the PCB. Screw length should range from 4 to 8 millimeters long plus the board thickness. Screws are not provided with the connectors.

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5.7 Post-Application Inspection Procedures

The post-application inspection should consist of several simple checks to assure that the connector is applied properly and is not damaged.

- Visually assure that all press-fit tails are seated in the proper PCB holes and that none have been crushed during application.
- Visually check that the standoffs on the bottom of each assembly are seated flush and parallel with the PCB surface (see Figure 41). Once fully seated, there may be some minor gaps (<0.1 mm) due to component tolerances.
- For right angle products, not being fully seated can cause misalignment when the daughter card is mated to the backplane.

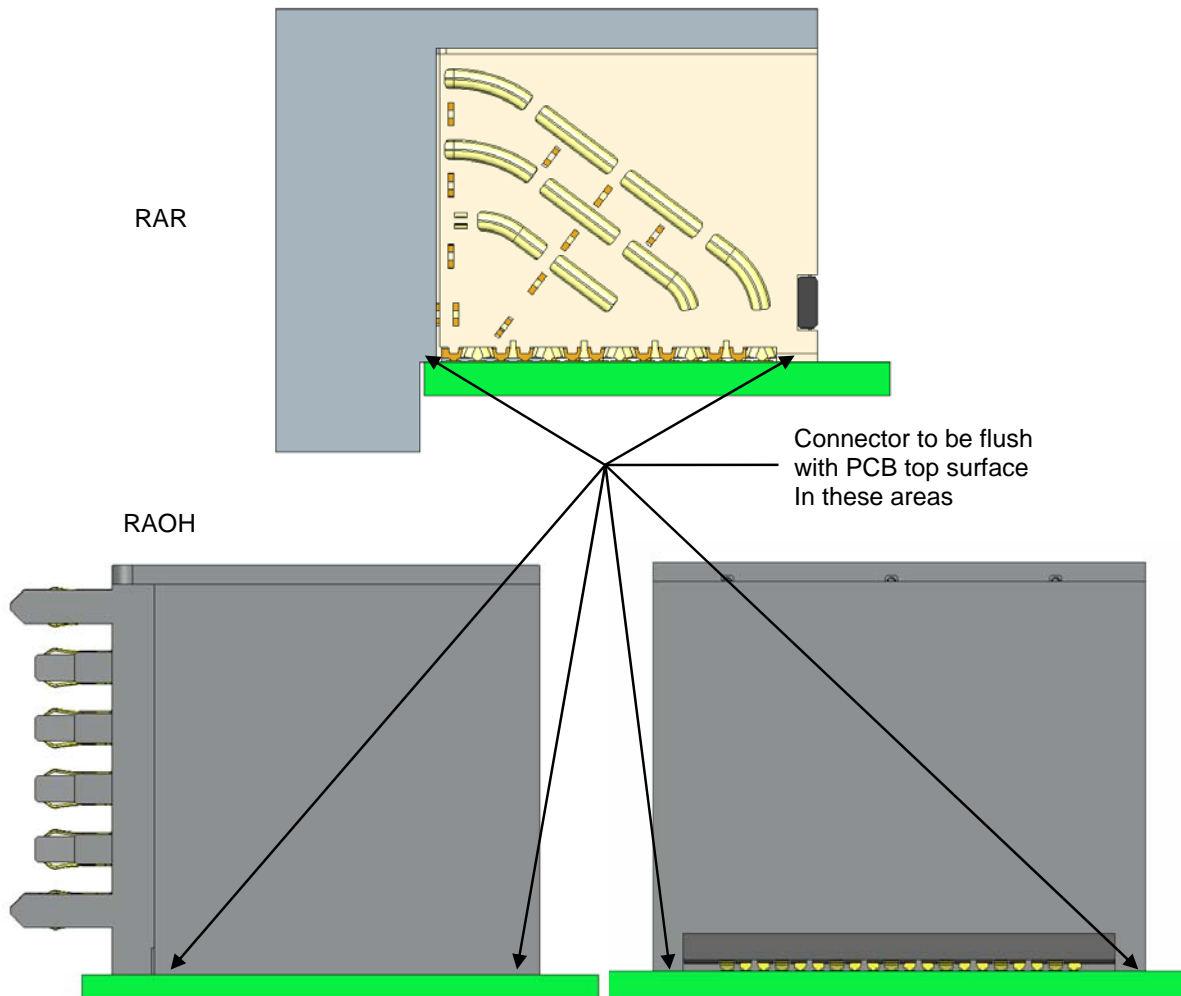


Figure 41: Proper Seating after Board Application

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5.8 Connector Removal Tooling

The following are FCI removal tool part numbers for ExaMAX connectors. Due to size restrictions, the removal tool only presses on the ground press-fit tails.

RAOH connectors use the same RAH tool that is listed below, but the tool must be rotated 90° so that the front face of the tool is perpendicular to the front edge of the PCB.

Differential Pairs	No. Columns	2mm Removal Tool PN *		3mm Removal Tool PN *	
		VH & RAH	RAR & VR	VH & RAH	RAR & VR
2	6	10126121-006	10126141-006	10132464-006	10132468-006
	8	10126121-008	10126141-008	10132464-008	10132468-008
	10	10126121-010	10126141-010	10132464-010	10132468-010
3	6	10126126-006	10126146-006	10132465-006	10132469-006
	8	10126126-008	10126146-008	10132465-008	10132469-008
	10	10126126-010	10126146-010	10132465-010	10132469-010
4	6	10126131-006	10126151-006	10132466-006	10132470-006
	8	10126131-008	10126151-008	10132466-008	10132470-008
	10	10126131-010	10126151-010	10132466-010	10132470-010
6	6	10126136-006	10126156-006	10132467-006	10132471-006
	8	10126136-008	10126156-008	10132467-008	10132471-008
	10	10126136-010	10126156-010	10132467-010	10132471-010
	12	10126136-012	10126156-012	10132467-012	10132471-012
	16	10126136-016	10126156-016	10132467-016	10132471-016
8	10	10132098-010	10120817-010	NA	NA

Table 15: ExaMAX Removal Tools

* To minimize cost, the largest removal tool for a given column pitch may be used to remove any connector with the same column pitch. To use a larger tool, disassemble the tool and remove any excess pins. Pins only go into the ground holes.

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5.9 Removal Tool Description

The connector removal tool is a hand tool used to remove ExaMAX connectors from the back side of the circuit board by pressing on the ground EONs. A hand operated arbor press and bottom support tool (not included with removal tool) are required to actuate the tool and provide support around the connector during the removal process.

It is important to note that the header removal tool is red in color and the receptacle tool is blue in color. If the wrong tool is used for rework, damage to the plated through holes and/or the tool may occur.

5.10 Connector Removal Procedure

- A manual arbor press is adequate to perform connector removal.
- With the connector to be removed facing downward, place the board assembly over a bottom support tool (not included) that is appropriate for the board layout (see figure 42).
- Make sure that the support tool extends along the entire length of at least two opposing sides of the connector. Also make sure that no small components (chip resistors, chip capacitors, etc.) are between the board and the support tool. The size and shape of the support tooling will vary due to the connector size, number of EONs, whether there are adjacent connectors, and any other surrounding components.
- From the back side of the board, roughly align the A1 side of the tool with the A1 via location on the PCB.
- Final align the tool so that all the pins protruding from the face of the tool are inserted into the ground vias (larger 0.50mm diameter vias) belonging to the connector that you wish to remove. If the pins and vias do not align, rotate the tool 180° and try again. The pins and vias will only align one way. **DO NOT TRY TO PUSH PINS INTO SIGNAL VIAS (smaller 0.36mm diameter vias) OR WHERE THERE ARE NO VIAS. THE PINS WILL BUCKLE AND BREAK.**

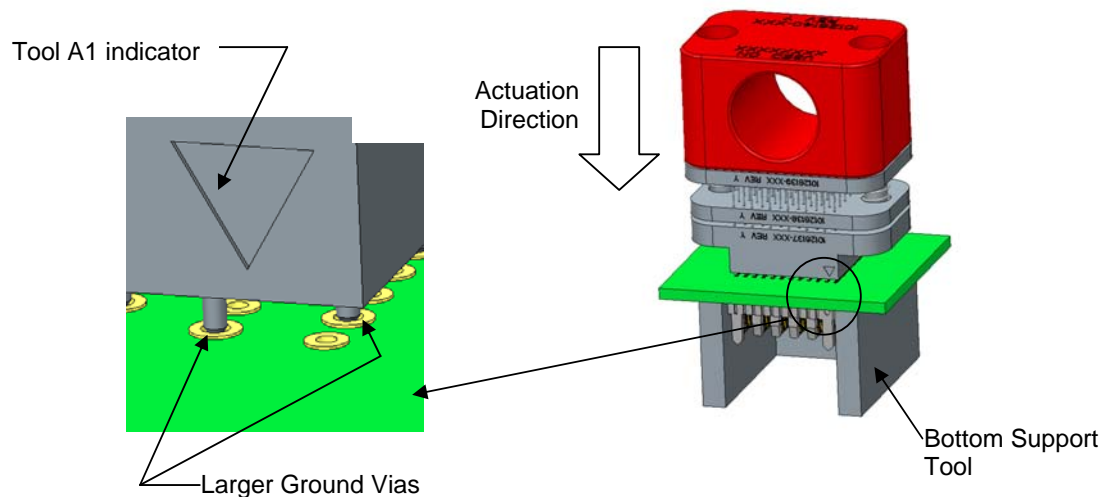


Figure 42: Removal Tool Procedure

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- Actuate the press so that the tool is compressed. Apply pressure evenly and slowly, not with a quick motion. Stop applying pressure when the force drops or the press handle becomes easy to move. This will indicate that the EONs have released from the printed circuit board. The connector should be lying on the bench or can be easily removed by hand.

6.0 REFERENCE DOCUMENTS

- FCI PRODUCT SPECIFICATION GS-12-1096
- FCI PRODUCT CUSTOMER DRAWINGS
- FCI PACKAGING SPECIFICATION GS-14-920 (Lead Free Labeling)
- FCI CUSTOMER DRAWING 10119933 (Recommended Via Drill Sizes and Plating)
- FCI APPLICATION SPECIFICATION GS-20-045 (Hard Metric Guide Connectors)
- ExaMAX ExaMEZZ Power Design Guide GS-20-0456
- FCI ExaMAX User Guide and Maps for Orthogonal Routing, Form E-4511

FCI product drawings and specifications can be obtained by accessing the FCI website www.fci.com or contacting FCI Technical Service. 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 FCI product drawings for appropriate details.

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7.0 NOTES

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8.0 RECORD RETENTION

REV	PAGES	DESCRIPTION	EC #	DATE
A	All	Initial release	-	10/16/2015
B	2, 12, 20, 28, 32-34	Up-dated tables 1, 7 and 10, added table 12, and up-dated section 5.6, RAOH insertion procedure	ECR-ELX-V-23905	4/22/2016
C	6 9 29 36	Update section 3.5.1 Update sections 3.5.6 & 3.5.7; Add section 3.5.8 Add part number into table 12 Update arrows on Fig 41	ECR-ELX-DG- 25339	11/16/2016