

AC274
Application Note
CQFP to FBGA Adapter Sockets



Power Matters.™

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1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 6.0

In revision 6.0 of this document, a recommendation to use a torque limit screwdriver was added. For more information, see [CQFP to FBGA Adapter Socket Assembly Procedure](#), page 6.

1.2 Revision 4.0

The following is a summary of the changes in revision 4.0 of this document.

- A note was added to the "Introduction" section, clarifying that the CQFP to FBGA adapter sockets are intended for functional prototyping, not at-speed prototyping (SAR 33471).
- In Table 1, last row, the part number of the KITTOP was changed from SH-AX2-CQ256-KITTOP to SK-AX2-CQ256-KITTOP (SAR 29920).
- In Table 1, third row and third column, the description for CQ256 to FG896 prototyping adapter has been changed from "For prototyping RTAX2000S/L-CQ352 or AX2000-CQ256 using the AX2000-FG896 package" to "For prototyping RTAX2000S/L-CQ256 or AX2000-CQ256 using the AX2000-FG896 package" (SAR 30009).
- Figure 22 · CQ256 to FG896 Adapter Socket Outline Drawing (unit: mm) was improved in resolution to make the dimensions legible (SAR 25336).
- The "Interposer Insertion Limitations" section is new (SAR 32813).
- The "High Frequency Signals" section is new (SAR 30885).
- The part numbers in Table 2 · CQFP to FBGA Adapter Pin Mapping List and Table 3 · Prototyping Design Matrix were inadvertently reverted to obsolete part numbers in revision 4 of this document. This has been corrected and the correct, current part numbers have been restored (SAR 29920).

1.3 Revision 3.0

In revision 3.0 of the document, information about the CQ256 to FG896 adapter, including instructions, drawings, photographs, and table entries, was added.

1.4 Revision 2.0

The following is a summary of the changes in revision 1.0 of this document.

- All tables were updated to include current part numbers for ordering.
- A note was added to "Step 1" to caution against soldering.
- "Step 3" was expanded.
- The Related Documents section was revised to add mechanical drawings and update the URL for the pin mapping lists.

2 CQFP to FBGA Adapter

RTAX™-S/SL devices are radiation-tolerant FPGAs that offer industry-leading advantages for designers of spaceflight systems. The RTAX-S/SL family is a derivative of the Axcelerator® family with up to two million system gates. The RTAX-S/SL FPGA provides designers with nearly 250K ASIC gates, with EDAC (error detection and correction)-protected static RAM.

Microsemi offers the RTAX-S/SL device in two package types: ceramic column grid array (CCGA) and ceramic quad flat pack (CQFP). Microsemi has developed four low-cost prototyping methods for designers to prototype RTAX-S/SL devices in both CQFP and CCGA packages. These adapter sockets use the Axcelerator family fine pitch ball grid array (FBGA) package or ceramic land grid array (CLGA) package as a prototyping vehicle.

- CQFP to FBGA adapter socket
- CQFP to CLGA adapter socket
- CCGA to FBGA adapter socket
- CCGA to CLGA adapter socket

This document describes the adapter sockets designed for the CQFP package and the procedure for assembling them.

Note: These adapters are intended for developing functional prototypes and are not designed for at-speed testing, especially for sensitive I/Os such as LVDS. The intention of the prototyping adapters is to provide functional validation; they may limit the performance of the FPGA.

2.1 CQFP to FBGA Adapter Sockets

The CQFP to FBGA adapter sockets have an FBGA configuration on the top and a CQFP configuration on the bottom. The adapter sockets enable customers to use a commercial Axcelerator FG package during prototyping, and then switch to an equivalent CQ256 or CQ352 package for production. The following table lists the top and bottom ordering part numbers for the four available CQFP to FBGA adapter sockets.

Table 1 • Adapter Socket Part Numbers

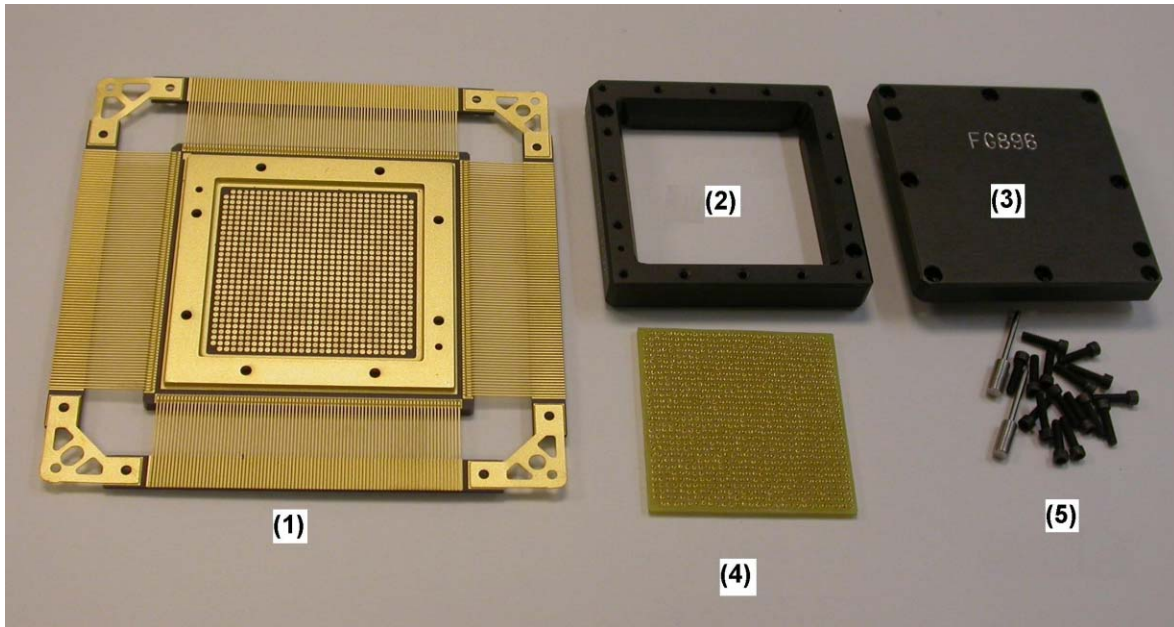
Adapter Socket	Ordering Part Numbers	Prototyped and Prototype Device
CQ352 to FG484 23x23	SK-AX250-CQ352RTFG484S	For prototyping RTAX250S/L-CQ352 or AX250-CQ352 using the AX250-FG484 package
CQ352 to FG896	SK-AX1-AX2-KITTOP and SK-AX1-CQ352-KITBTM	For prototyping RTAX1000S/L-CQ352 or AX1000-CQ352 using the AX1000-FG896 package
CQ352 to FG896	SK-AX1-AX2-KITTOP and SK-AX2-CQ352-KITBTM	For prototyping RTAX2000S/L-CQ352 or AX2000-CQ352 using the AX2000-FG896 package
CQ256 to FG896	SK-AX2-CQ256-KITTOP and SK-AX2-CQ256-KITBTM	For prototyping RTAX2000S/L-CQ256 or AX2000-CQ256 using the AX2000-FG896 package

The following figure shows the CQ352 to FG896 adapter socket parts.

- The kit top (SK-AX1-AX2-KITTOP) contains a socket lid (3), an interposer (4), and eight screws (5).
- The kit bottom for the AX1000 package (SK-AX1-CQ352-KITBTM) contains a ceramic adapter specific to AX1000 (1), socket housing (2), and eight screws (5).
- The kit bottom for the AX2000 package (SK-AX2-CQ352-KITBTM) contains a ceramic adapter specific to AX2000 (1), socket housing (2), and eight screws plus two alignment pins (5).

Note: The alignment pins are optional pins provided to assist in the assembly of the adapter socket.

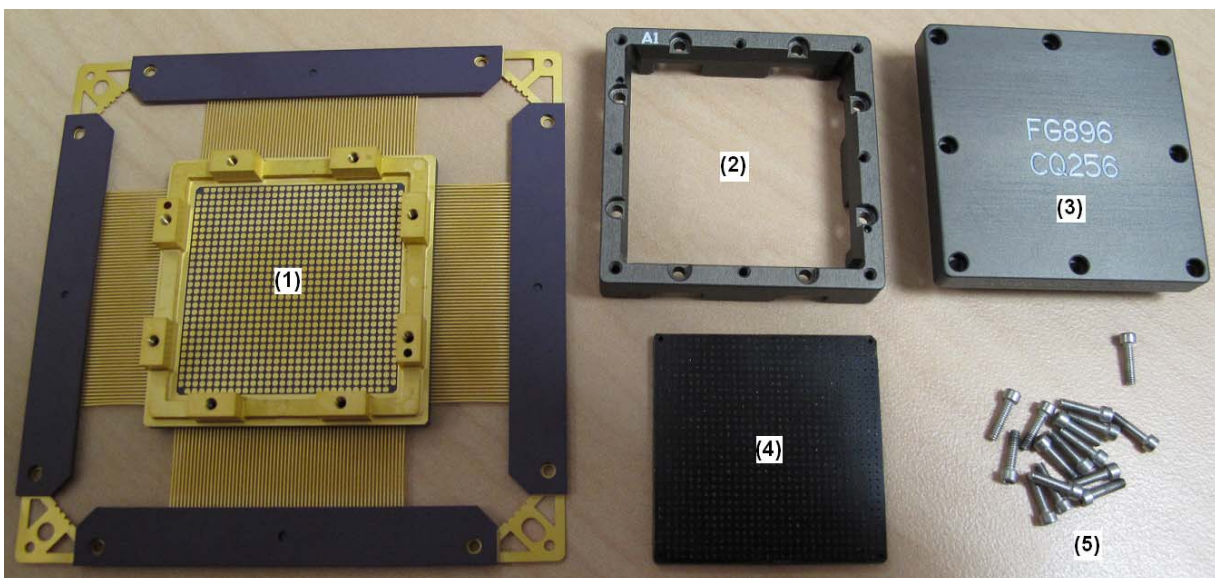
Figure 1 • CQ352 to FG896 Adapter Socket Parts



The following figure shows the CQ256 to FG896 adapter socket parts.

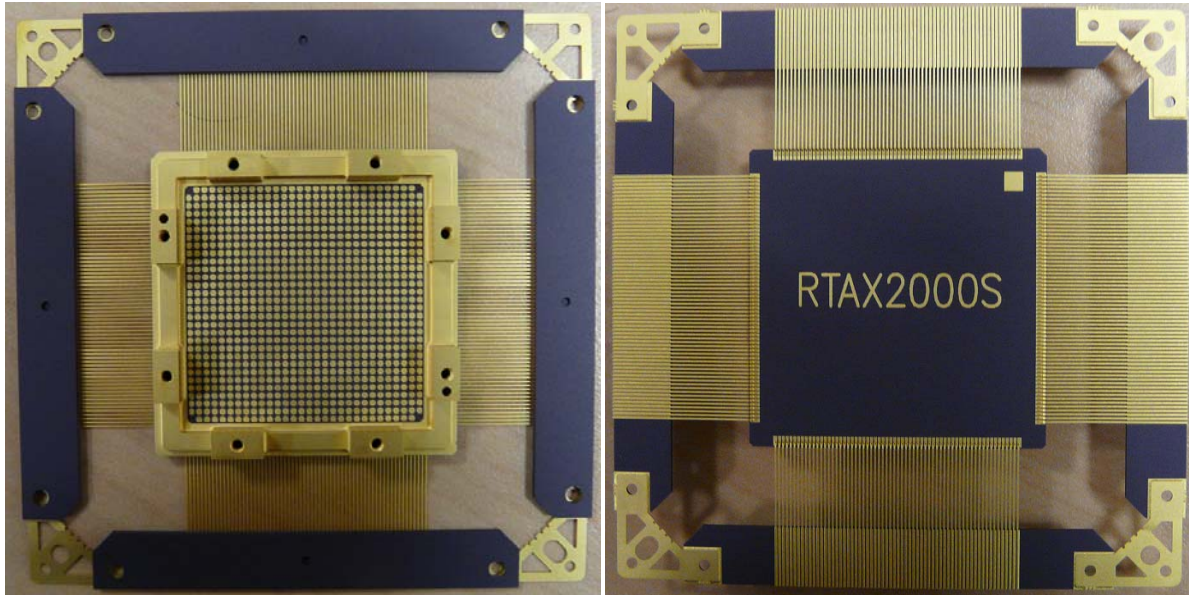
- The kit top (SK-AX2-CQ256-KITTOP) contains a socket lid (3), an interposer (4), and eight screws (5).
- The kit bottom (SK-AX2-CQ256-KITBTM) contains a ceramic adapter exclusive for RT/AX2000 (1), socket housing (2), and eight screws (5).

Figure 2 • CQ256 to FG896 Adapter Socket Parts



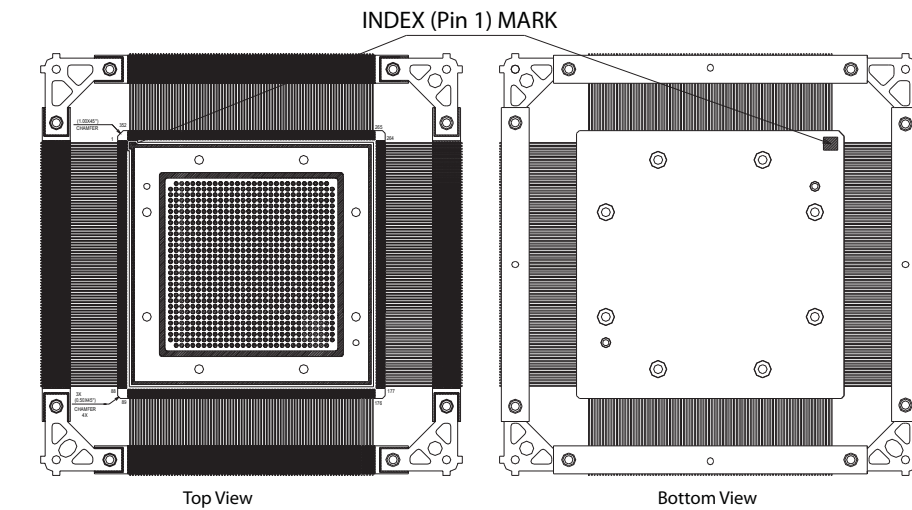
The following figure shows the top view, bottom view, and orientation of the RTAX2000S CQ256 to FG896 adapter.

Figure 3 • RTAX2000S CQ256 to FG896 Ceramic Adapter Top View, Bottom View, and Orientation



The following figure shows the top view, bottom view, and orientation of the RTAX2000S CQ352 to FG896 adapter.

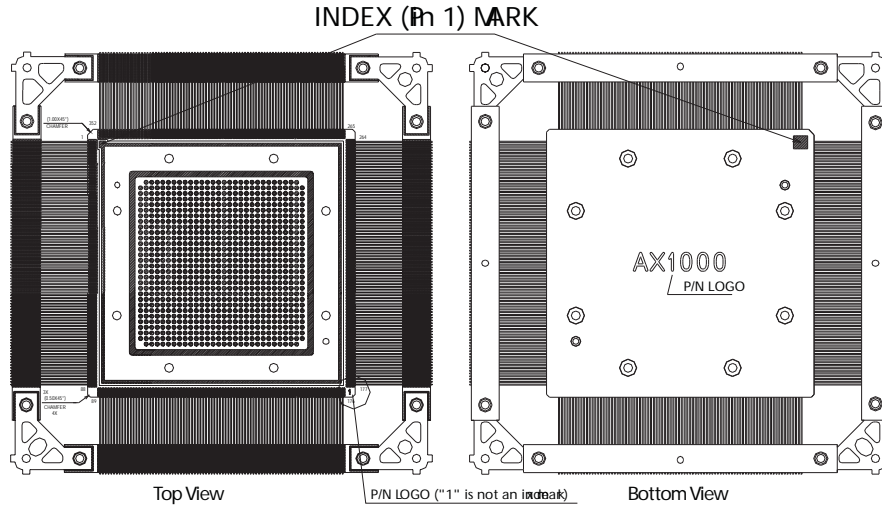
Figure 4 • RTAX2000S CQ352 to FG896 Adapter Top View, Bottom View, and Orientation



RTAX2000S (or AX2000) CQ352 to AX2000 FG896 Adapter Top View and Bottom View Drawing

The following figure shows the top view, bottom view, and orientation of the RTAX1000S CQ352 to FG896 adapter.

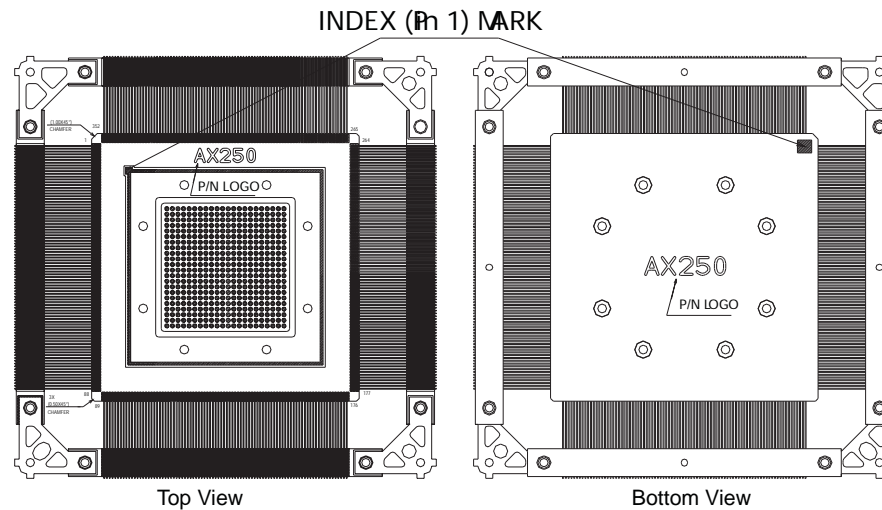
Figure 5 • RTAX1000S CQ352 to FG896 Adapter Top View, Bottom View, and Orientation



RTAX1000S (or AX1000) CQ352 to AX2000 FG896 Adapter Top View and Bottom View Drawing

The following figure shows the top view, bottom view, and orientation of the RTAX250S CQ352 to FG484 23x23 adapter.

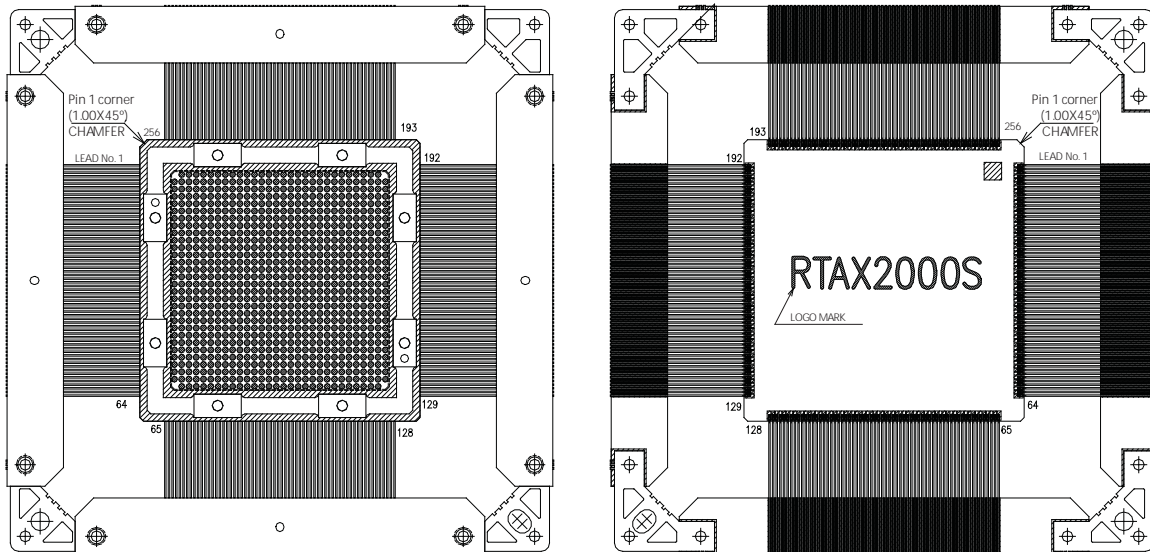
Figure 6 • RTAX250S CQ352 to FG484 Adapter Top View, Bottom View, and Orientation Drawing



RTAX250S (or AX250) CQ352 to AX250 FG896 Adapter Top View and Bottom View Drawing

The following figure shows the top view and bottom view of the RTAX2000S CQ256 to FG896 ceramic adapter.

Figure 7 • RTAX2000S CQ256 to FG896 Ceramic Adapter Top View and Bottom View



Top View
Bottom View
RTAX2000S (or AX2000) CQ256 to AX2000 FG896 Adapter Top View and Bottom View Drawing

2.2 CQFP to FBGA Adapter Socket Assembly Procedure

The following steps describe how to assemble the CQFP to FBGA adapter socket.

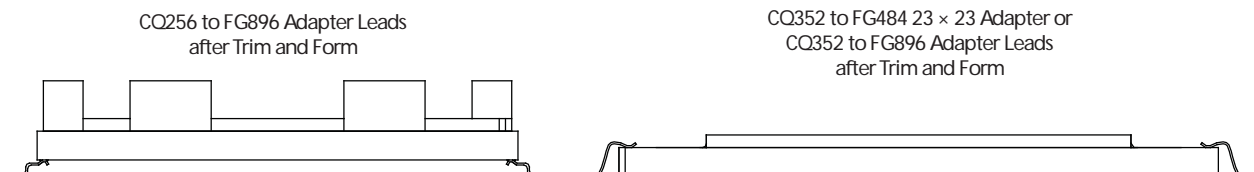
2.2.1 Step 1

Trim and form the CQFP ceramic adapter.

Notes:

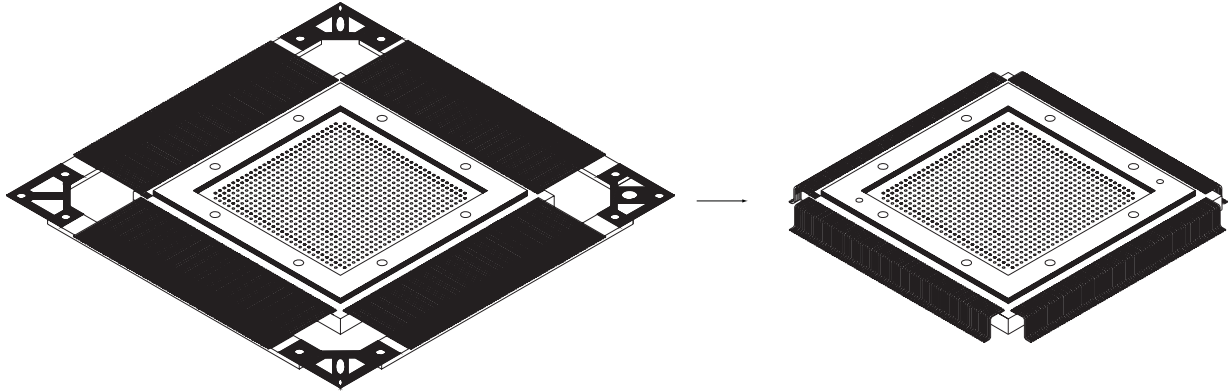
- Do not solder the adapter to the circuit board until socket housing has been attached (as detailed in [Step 2](#), page 8).
- The shape of the CQ256 to FG896 adapter leads after trim and form is different from that of the CQ352 to FG896 adapter and the CQ352 to FG484 23x23 adapter, as shown in the following figure.

Figure 8 • CQ256 to FG896 Adapter Leads vs. CQ352 to FG896 Adapter or CQ352 to FG484 23x23 Adapter



The following figure shows CQ352 to FG896 adapter trim and form.

Figure 9 • CQ352 to FG896 Adapter Leads After Trim and Form



The following figures show the CQ256 to FG896 adapter trim and form.

Figure 10 • CQ256 to FG896 Adapter View Before and After Trim and Form (Package Drawing)

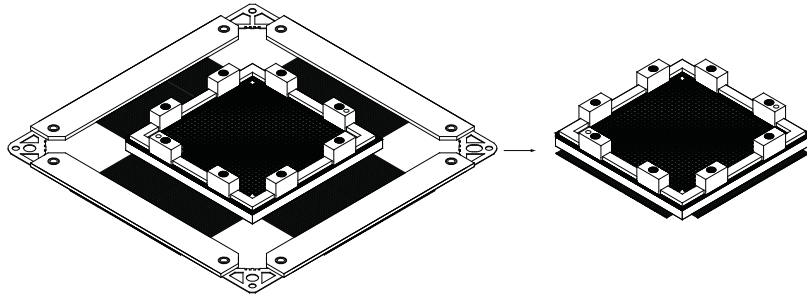
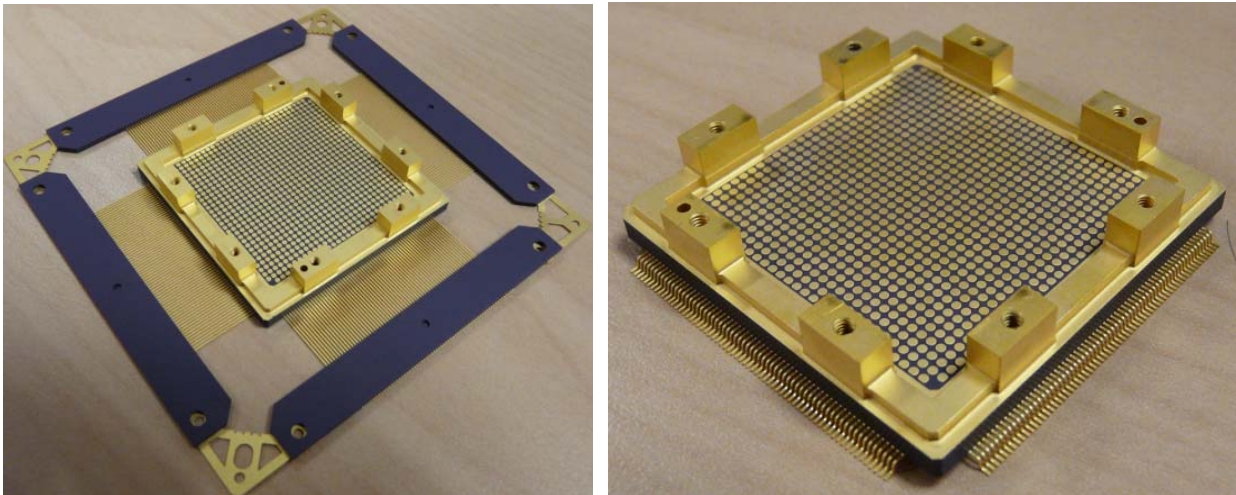


Figure 11 • CQ256 to FG896 Adapter View Before and After Trim and Form (Photo)

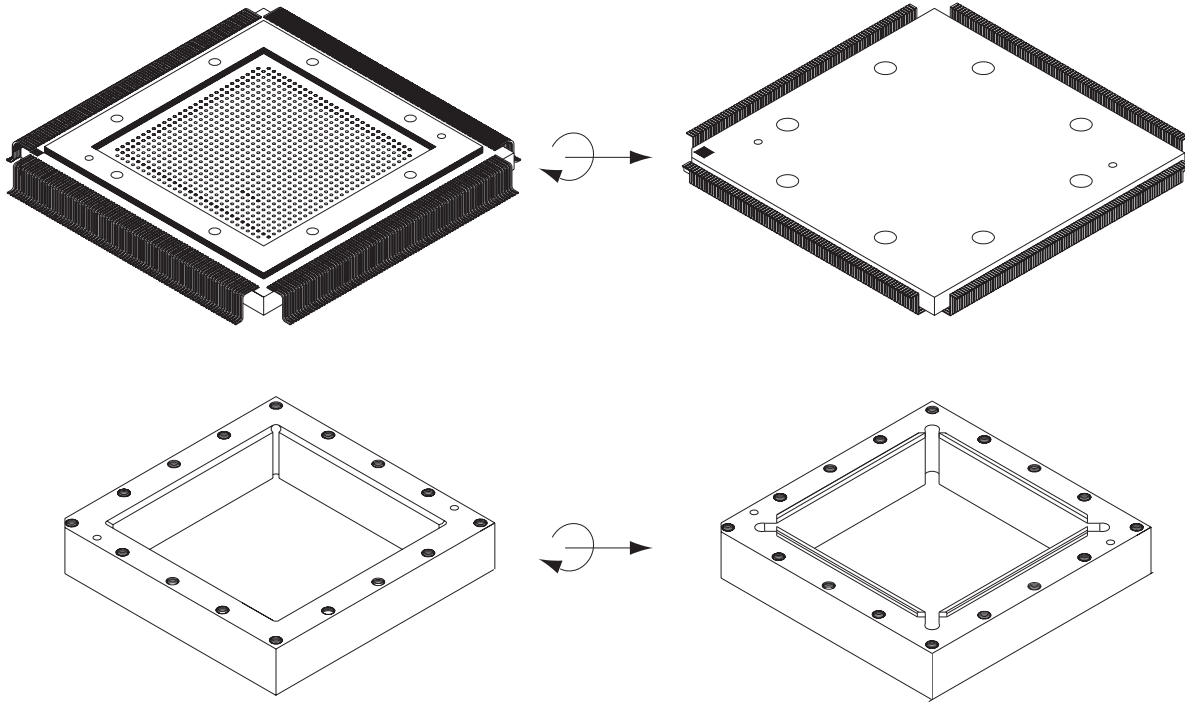


2.2.2 Step 2

Assemble the socket housing onto the adapter. It is recommended to use a torque limit screwdriver with the setting 1.3 to 2.0 lb-in.

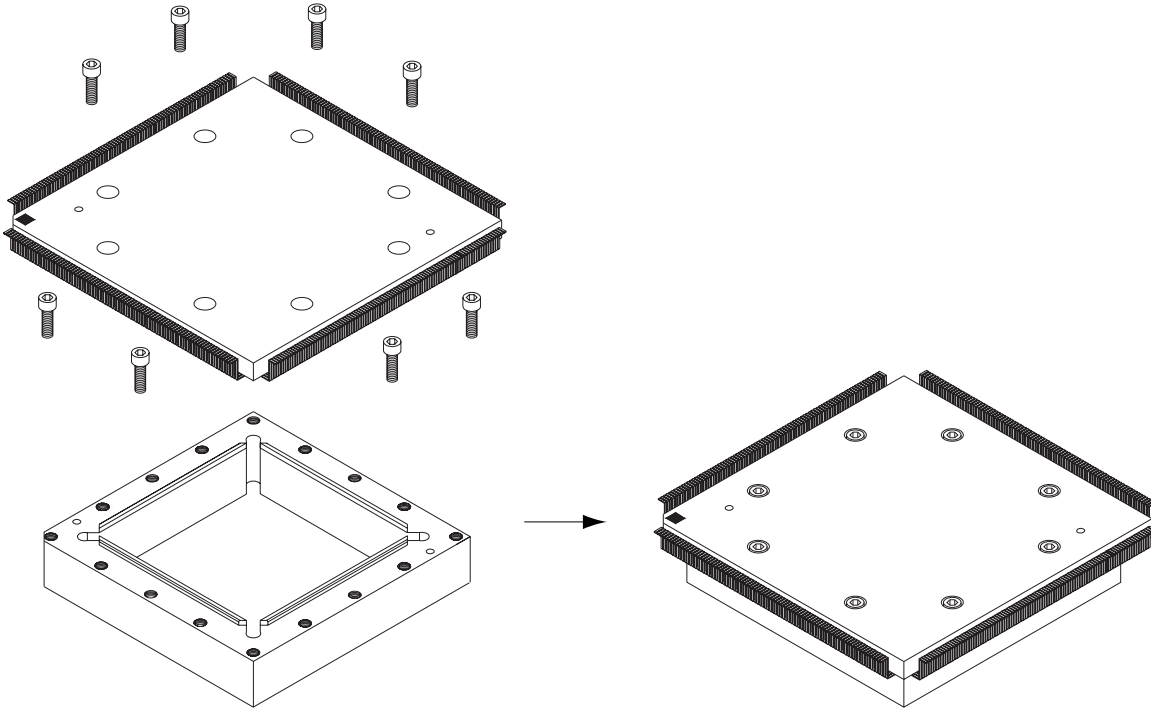
For the CQ352 to FG896 adapter, turn the ceramic adapter and the socket housing upside down, as shown in the following figure.

Figure 12 • Upside-Down View of CQ352 to FG896 Ceramic Adapter and Socket Housing



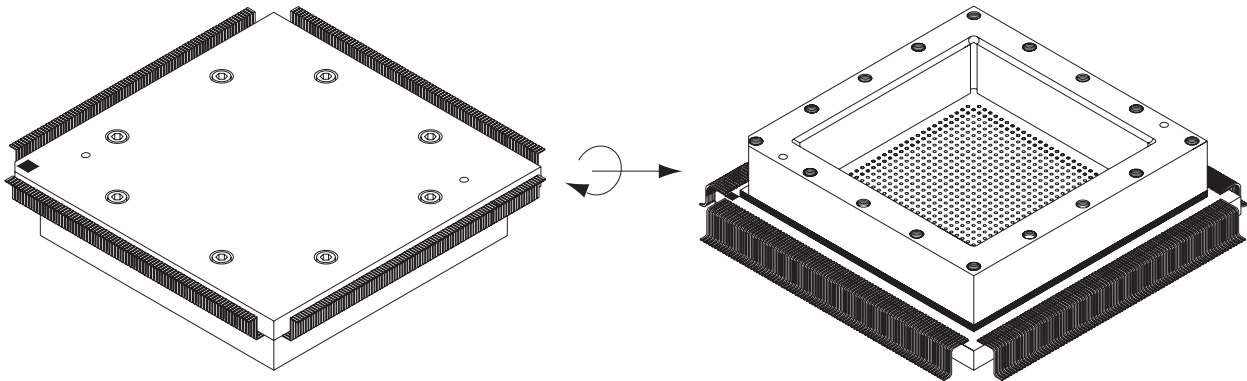
Align adapter A1 corner to the socket housing notch corner, and fasten the ceramic adapter to the socket housing using eight of the screws provided in the kit.

Figure 13 • Assembling Socket Housing to CQ352 to FG896 Adapter



Turn the assembly adapter over, as shown in the following figure.

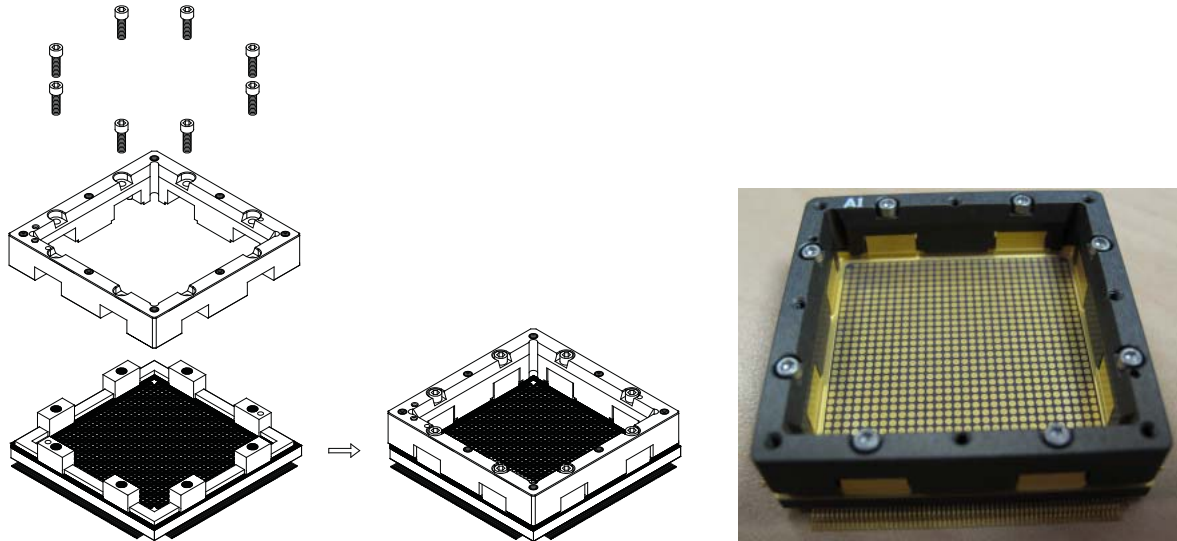
Figure 14 • Assembled CQ352 to FG896 Adapter Socket with Socket Housing



Note: The housing, eight screws, two alignment pins (optional), and the ceramic adapter form the KITBTM assembly.

For the CQ256 to FG896 adapter, step 2 is to assemble the socket housing on the ceramic adapter as shown in the following figure.

Figure 15 • Assembled CQ256 to FG896 Adapter with Socket Housing

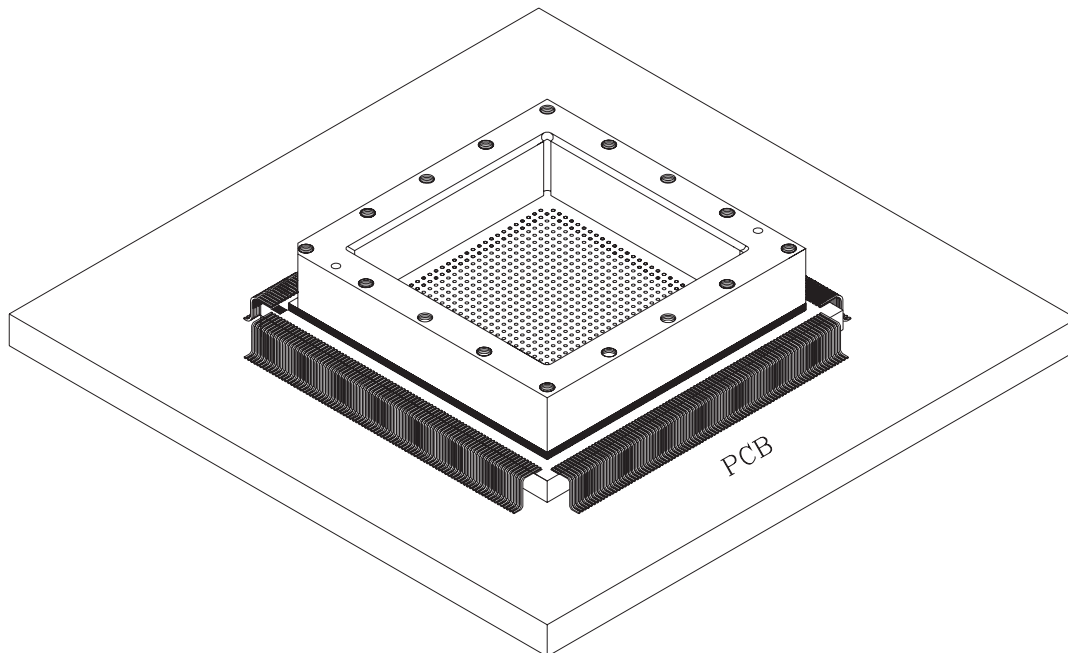


2.2.3 Step 3

Reflow the adapter to the printed circuit board (PCB).

Note: Reflow profiles depend upon the size of the board and its components, so it is recommended to perform reflow process optimization for better results.

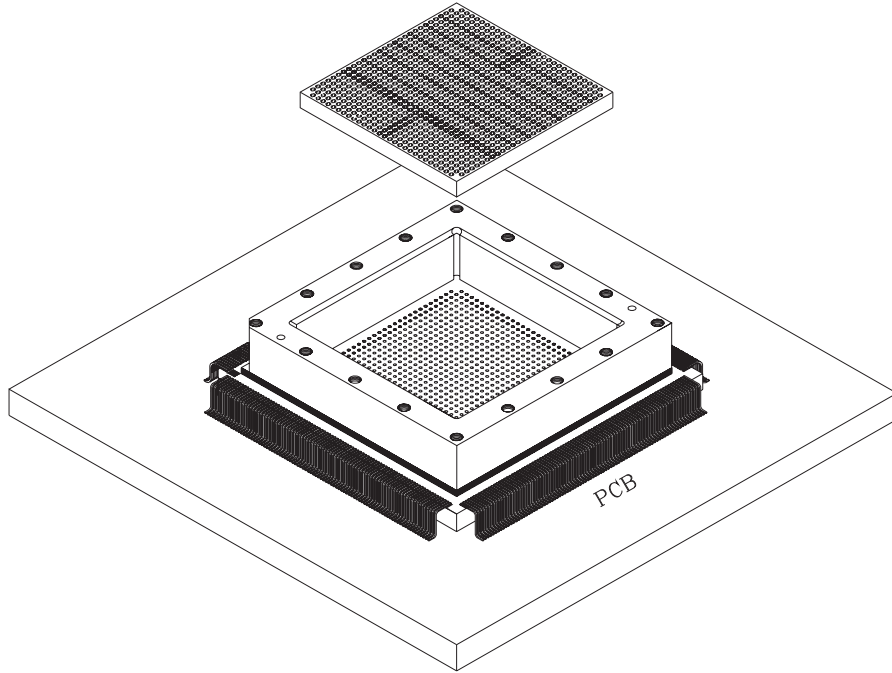
Figure 16 • Reflowing Adapter to PCB



2.2.4 Step 4

Place the socket interposer into the adapter.

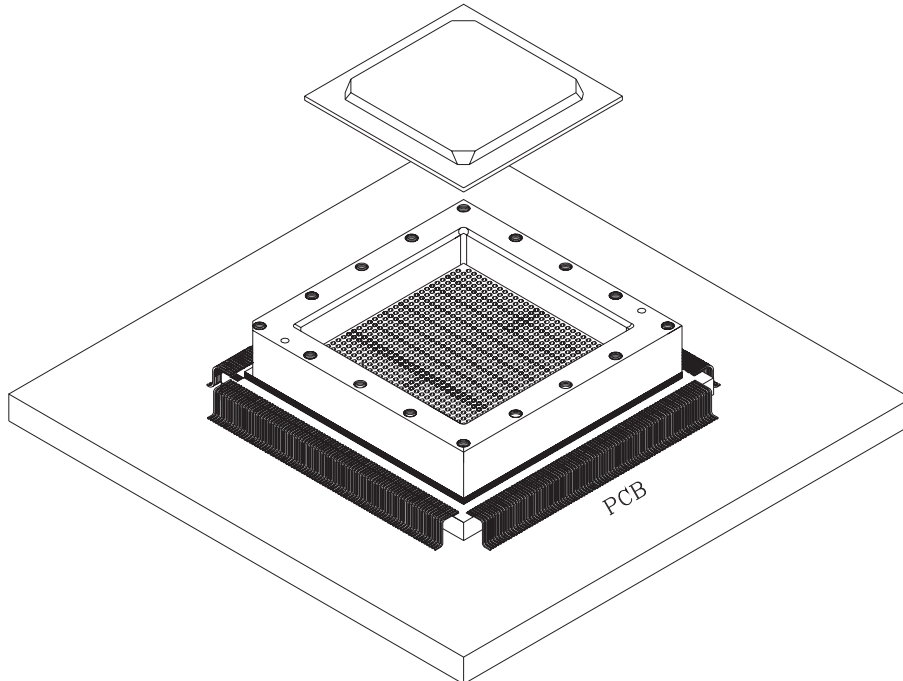
Figure 17 • Placing Socket Interposer into Adapter Assembly



2.2.5 Step 5

Place the FBGA Package into the adapter.

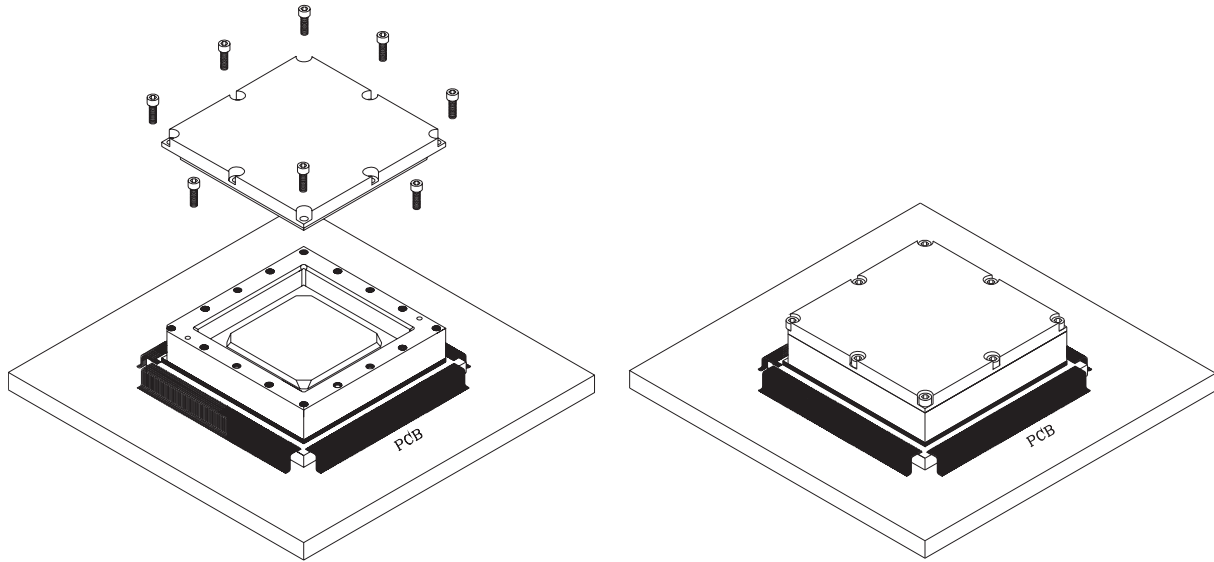
Figure 18 • Placing FBGA Package into Adapter Assembly



2.2.6 Step 6

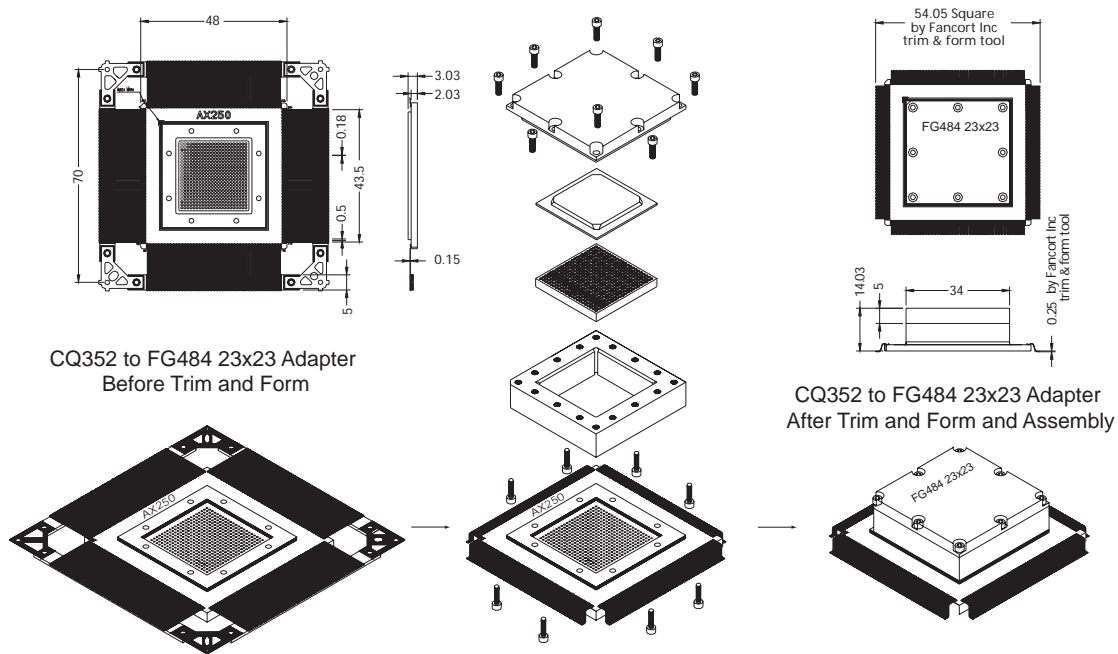
Place the socket lid on the socket housing, and tighten it using the remaining eight screws. It is recommended to use a torque limit screwdriver with the setting 1.3 to 2.0 lb-in.

Figure 19 • Placing and Tightening Socket Lid Using Eight Screws and Optional Alignment Pins



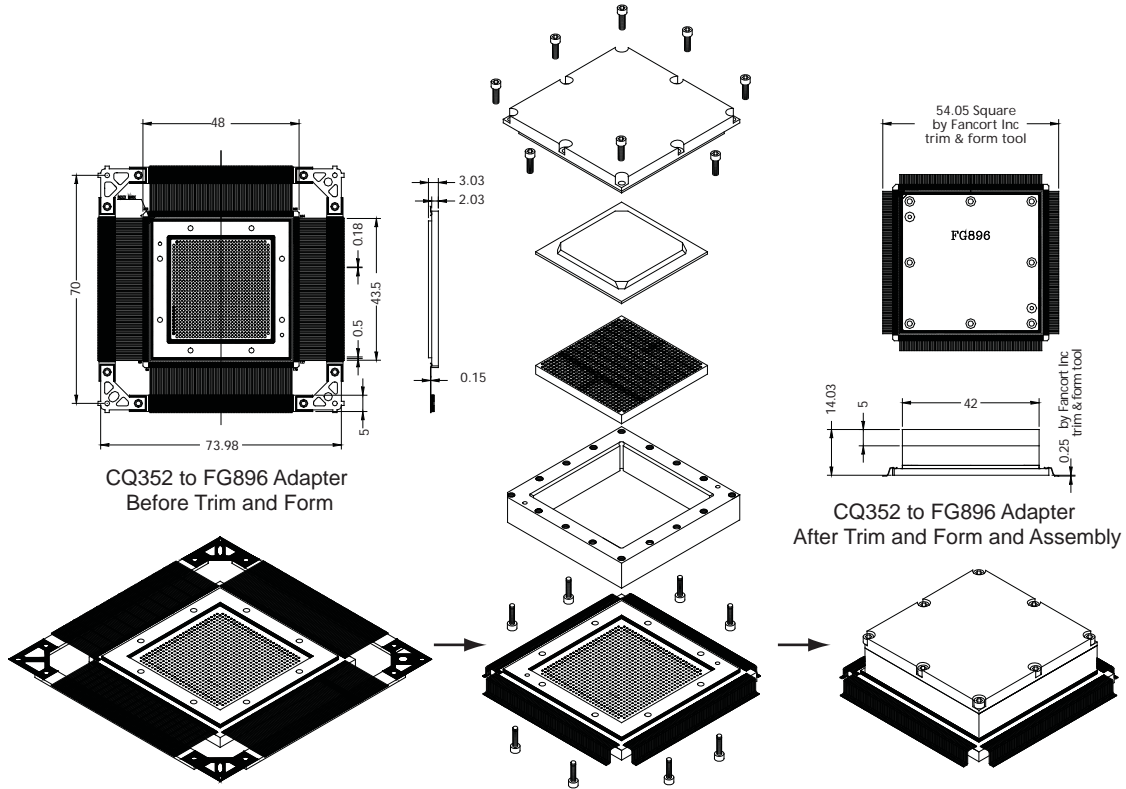
2.3 CQ352 to FG484 23x23 Adapter Socket Outline Drawing

Figure 20 • CQ352 to FG484 (23x23) Adapter Socket Outline Drawing (unit: mm)



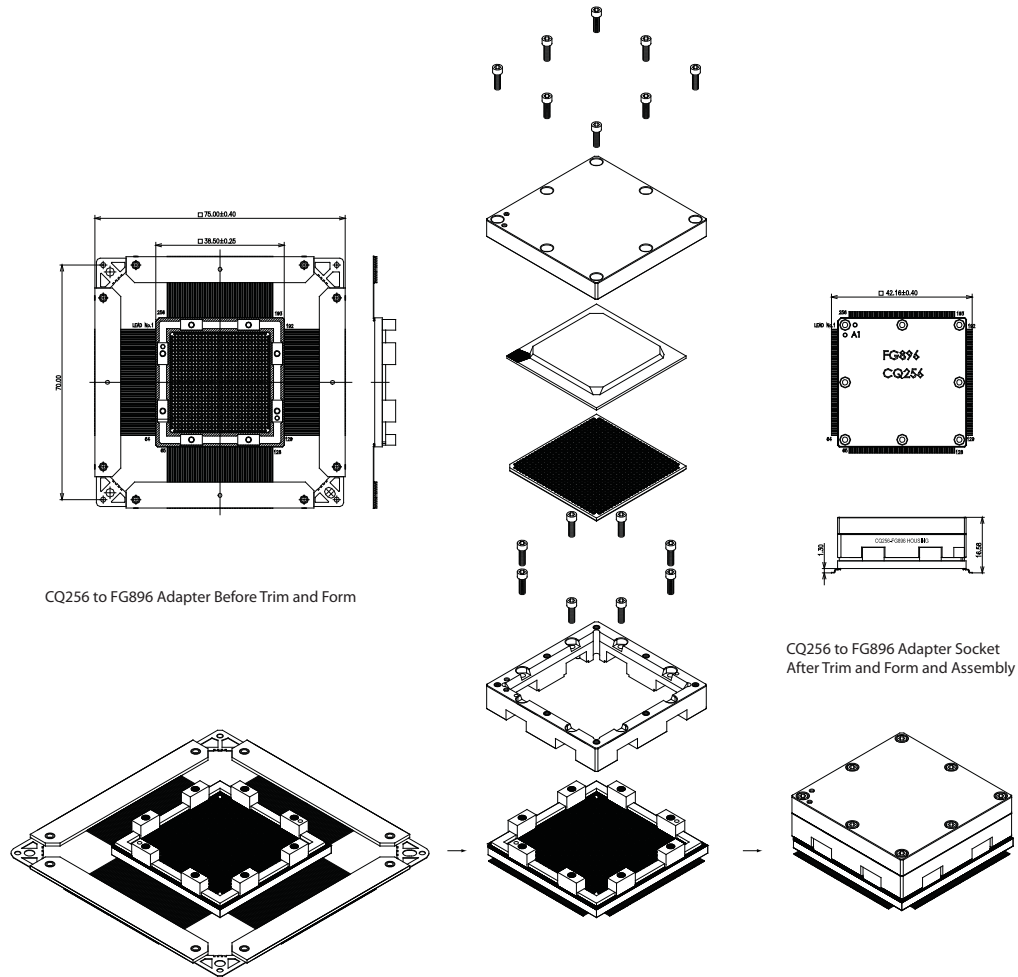
2.4 CQ352 to FG896 Adapter Socket Outline Drawing

Figure 21 • CQ352 to FG896 Adapter Socket Outline Drawing (unit: mm)



2.5 CQ256 to FG896 Adapter Socket Outline Drawing

Figure 22 • CQ256 to FG896 Adapter Socket Outline Drawing (unit: mm)



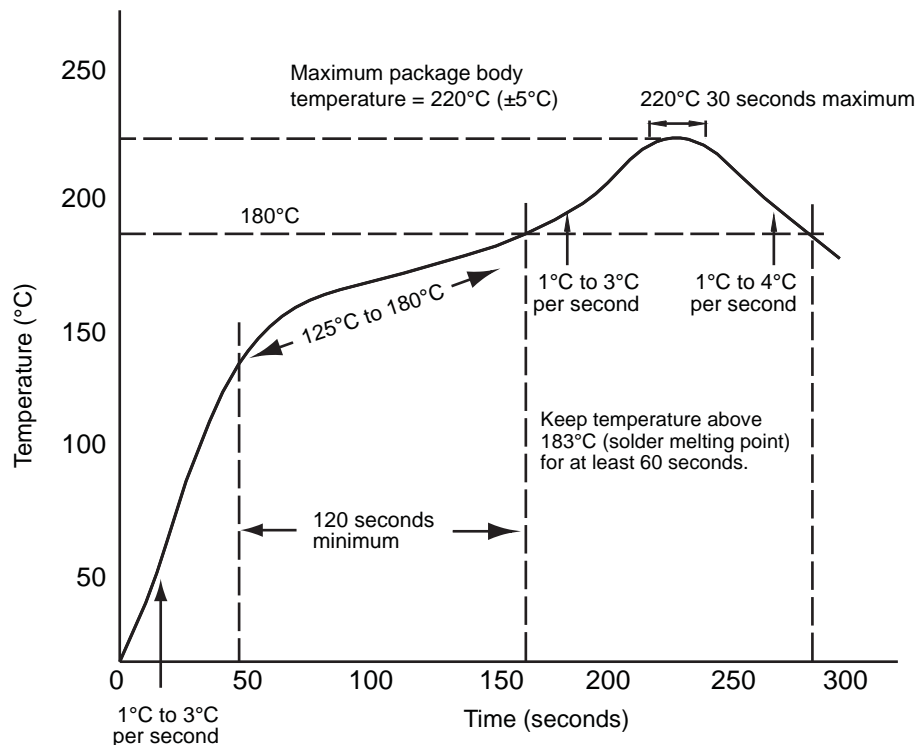
2.6 CQ352 to FG896 Adapter Socket Alignment Pins

There are two optional alignment pins with the CQ352 to FG896 adapter for aligning the socket housing to the adapter. The same pins can be used to align the assembled adapter socket to the PCB. Alignment holes on the PCB are optional. End users must decide whether or not to have alignment holes on a board.

2.7 Reflow Profile

Since reflow profile depends upon the size of the board and other components, end users must perform additional fine tuning from the general profile shown in the following figure.

Figure 23 • Sample Temperature Profile for I/R or Convection Reflow



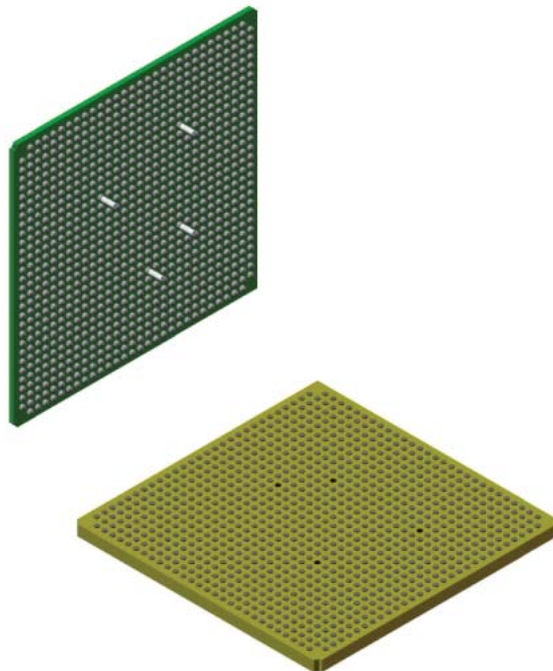
Note: This temperature profile guideline is for reference only

2.8 Interposer Insertion Limitations

The prototyping adapter sockets are designed for validation and functional testing of user FPGA designs on commercial devices before programming the design on the intended hermetic units. The interposer is typically used for a limited number of insertions (no more than 25 insertions) per user design/application. Additionally, the interposer is not intended for long term compression of the commercial prototype unit. The maximum duration for which the interposer should remain compressed is 10 days per insertion. The prototyping adapter sockets can only withstand a temperature range of -25°C to $+125^{\circ}\text{C}$. In the event that the socket is used in ways other than the intended use model (for example, in conditions such as temperatures exceeding 125°C , high current, long mating duration exceeding 10 days, or a combination of all), there is a possibility of interposer damage or dislodging of pins from the interposer.

The following figure shows a pin dislodged from the interposer.

Figure 24 • Pin Dislodged from Interposer



Possible solutions for fixing interposers with dislodged pins are as follows.

- For five or fewer dislodged pins, fix them by putting the dislodged pins back into the interposer using tweezers.
- If more than five pins are dislodged, the damaged interposer should be replaced with a new interposer.

When replacing a damaged interposer, the interposer specific to the prototyping adapter socket must be used. The interposer for the CQ352 to FG484 socket is different from the interposer used with the CQ352 to FG896 socket or the CQ256 to FG896 socket.

2.9 High-Frequency Signals

Adapter sockets are built for functional prototyping only. They are not intended to support at-speed testing, especially for high-frequency signals such as LVDS. No specific series or parallel termination is available on the adapter boards. To operate high-frequency signals with the adapter sockets, both series and parallel termination should be placed close to the I/O pins. The only possible location is on the main board, which is too distant from I/O pins, and also increases parasitic resistance significantly. If you need to implement low-voltage differential signaling (LVDS) or higher-frequency signals, you must build a standalone board.

2.10 CQFP to FBGA Adapter Pin Mapping List

The CQFP to FBGA adapter is routed from the FBGA package to match the existing die pad available for the CQFP device being prototyped. The following table provides information about where to download the pin mapping lists.

Table 2 • CQFP to FBGA Adapter Pin Mapping List

Adapter Socket	Ordering Part Number	Prototyped and Prototype Device	Document Number
CQ352 to FG484 23x23	SK-AX250-CQ352RTFG484S	For prototyping RTAX250S/L-CQ352 or AX250-CQ352 using the AX250-FG484 package	Refer to the <i>Prototyping Solutions</i> section of the Microsemi SoC Products Group website: www.microsemi.com/soc/techdocs/package/default.aspx .
CQ352 to FG896	SK-AX1-AX2-KITTOP and SK-AX1-CQ352-KITBTM	For prototyping RTAX1000S/L-CQ352 or AX1000-CQ352 using the AX1000-FG896 package	
CQ352 to FG896	SK-AX1-AX2-KITTOP and SK-AX2-CQ352-KITBTM	For prototyping RTAX2000S/L-CQ352 or AX2000-CQ352 using the AX2000-FG896 package	

2.11 Prototyped Product, Adapter, and PCB Design Matrix

Designing PCBs for specific products requires an understanding of which adapter socket works for specific products. Each adapter socket is routed differently. The design is based on the Axcelerator device (or its radiation-tolerant equivalent derivative) being prototyped, and the commercial Axcelerator FG package used for prototyping. The following table lists the device-PCB combinations that work.

Table 3 • Prototyping Design Matrix

Prototyped Product	Adapter Part Number	Prototype Vehicle	PCB Design
AX250-CQ352	SK-AX250-CQ352RTFG484S	AX250-FG484 23x23	AX250-CQ352
AX1000-CQ352	SK-AX1-AX2-KITTOP and SK-AX1-CQ352-KITBTM	AX1000-FG896	AX1000-CQ352
AX2000-CQ352	SK-AX1-AX2-KITTOP and SK-AX2-CQ352-KITBTM	AX2000-FG896	AX2000-CQ352
RTAX250S-CQ352, RTAX250SL-CQ352	SK-AX250-CQ352RTFG484S	AX250-FG484 23x23	AX250-CQ352 ¹
RTAX1000S-CQ352, RTAX1000SL-CQ352	SK-AX1-AX2-KITTOP and SK-AX1-CQ352-KITBTM	AX1000-FG896	AX1000-CQ352 ¹
RTAX2000S-CQ352, RTAX2000SL-CQ352	SK-AX1-AX2-KITTOP and SK-AX2-CQ352-KITBTM	AX2000-FG896	AX2000-CQ352 ¹
RTAX250S-CQ352, RTAX250SL-CQ352	SK-AX250-CQ352RTFG484S	AX250-FG484 23x23	RTAX250S-CQ352, RTAX250SL-CQ352 ^{1, 2}
RTAX1000S-CQ352, RTAX1000SL-CQ352	SK-AX1-AX2-KITTOP and SK-AX1-CQ352-KITBTM	AX1000-FG896	RTAX1000S-CQ352, RTAX1000SL-CQ352 ^{1, 2}
RTAX2000S-CQ352, RTAX2000SL-CQ352	SK-AX1-AX2-KITTOP and SK-AX2-CQ352-KITBTM	AX2000-FG896	RTAX2000S-CQ352, RTAX2000SL-CQ352 ^{1, 2}

- The PCB designer should consider the eight pin pairs of the phase-locked loop (PLL) analog power supply (VCCPLA/VCOMPLA, VCCPLB/VCOMPLB, VCCPLC/VCOMPLC, VCCPLD/VCOMPLD, VCCPLE/VCOMPLE, VCCPLF/VCOMPLF, VCCPLG/VCOMPLG, and VCCPLH/VCOMPLH). They should be treated as follows:
 - VCCPLA/B/C/D/E/F/G/H: There are eight in each device. VCCPLA supports the PLL associated with global resource HCLKA, and VCCPLB supports the PLL associated with global resource HCLKB. These PLL analog power supply pins should be connected to 1.5 V whether or not the PLL is used. Refer to the Axcelerator Family FPGAs and RTAX-S/SL and RTAX-DSP Radiation-Tolerant FPGAs datasheets for pin assignment information.
 - VCOMPLA/B/C/D/E/F/G/H: These are compensation reference signals for the internal PLL. There are eight in each device. VCOMPLA supports the PLL associated with global resource HCLKA, and VCOMPLE supports the PLL associated with global resource HCLKE. The VCOMPLX pins should be left floating if the PLL is not being used. Refer to the Axcelerator Family FPGAs and RTAX-S/SL and RTAX-DSP Radiation-Tolerant FPGAs datasheets for pin assignment information.
- Since the Axcelerator and RTAX-S/L devices are exactly pin-compatible, except for the PLL (which RTAX-S/L does not have), designing the PCB with VCCPL(X) pins connected to 1.5 V will not affect the function of the RTAX-S/L devices. Pins for VCOMPL(X) can be designed with land patterns only. These 16 PLL pins are not connected internally inside the RTAX-S packages.