Selecting Sockets

for Altera Devices

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Introduction

Altera offers a number of surface-mount packages. Surface-mount assembly places unique demands on the development and manufacturing process by requiring different CAD symbols for printed circuit board (PCB) layout, different soldering processes for production (reflow vs. wave solder), and different test and reliability issues.

Socketing the surface-mount devices is a popular compromise. Conventional mounting techniques can be used on the socketed devices, either by through-hole soldering them to a PCB or by mounting them onto a socketed carrier board for wire-wrap applications.

This application note discusses the following topics:

- Mechanical considerations for J-lead sockets
- Socket evaluation for J-lead packages
- Socket evaluation for quad flat pack (QFP) packages
- Socket evaluation for ball-grid array (BGA) packages
- Socket evaluation for pin-grid array (PGA) packages
- Packaging operations for wire-wrap applications
- Socket manufacturers

Mechanical Considerations for J-Lead Sockets

J-lead devices make contact with electrical sockets from either the bottom or the side of the leads. Depending on how the devices are held in place, the sockets can bend the leads and make the electrical contact unreliable. Accordingly, the designer must consider the type of package, the number of device insertions and removals, and the amount of lead deformation before choosing a socket.

Burn-in sockets are zero-insertion-force sockets that do not deform a device's leads. Currently, burn-in sockets have dimensions similar to those of production sockets, making them the best option for prolonging the life of a reprogrammable device during prototyping, while still allowing the use of production sockets later in the design process.

Once a design enters the production phase, cost becomes a major concern. As a result, low-cost production sockets, designed to hold a device permanently and securely, are widely available. However, these sockets must exert a reasonable force on the device leads to prevent the device from popping out of the socket. After several insertions, this force can deform the leads, causing them to short out or fail to make contact, rendering the device unusable.

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Therefore, Altera strongly recommends using a burn-in socket during the design and development phases of a project, and a low-cost production socket during the production phase.

Production sockets must be chosen carefully. If a device must be removed more than 10 times, it is preferable to use non-deforming, low-insertion-force (burn-in) sockets. In high-stress environments (e.g., strong G-forces, thermal shock, high humidity), sockets with high-insertion forces and optional retention clips are needed. To reduce the possibility of damaging device pins, most manufacturers of high-quality sockets include a standoff mechanism inside the socket that prevents a device from being forced too far into a socket.

Sockets for J-Lead Packages

Altera tested available production sockets for use with 44-, 68-, and 84-pin windowed ceramic J-lead chip carrier (JLCC) packages. Although testing was performed using JLCC packages, the following information also applies to plastic J-lead chip carrier (PLCC) packages. Each socket was subjected to three tests:

- The change in the gap between the corner pins of each device was measured before and after each of 10 insertions.
- Each pin of the socket was wired in series and tested for open or short circuits lasting longer than 10 µs. This open-and-short circuit test was performed while the socket was attached to a vibration block. The amplitude of vibration was 3.0 mm peak-to-peak at a frequency that oscillated between 10 Hz and 55 Hz in 1-minute cycles for 2 hours. The vibration test was performed on all three axes at a temperature of 70° C.
- The actual point of contact between the socket pin and the device lead was photographed to determine the direction of the forces and the amount of surface contact between them.

Altera tested sockets from eight manufacturers. Tables 1, 2, and 3 show the results of the 44-, 68-, and 84-pin production sockets that passed the open-and-short circuit test. Sockets are ranked by their ability to maintain the device's pin integrity after multiple device insertions.

Table 1. Summary of 44-Pin Production Socket Analysis

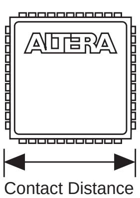
Vendor & Part Number	Comments
Thomas & Betts Corporation PCS-044A-1	Least pin deformation. Contact force has a downward component. No retainer clip option.
AMP, Inc. 821575-1	Moderate pin deformation. Contact force has a downward component. No retainer clip option.

Table 2. Summary of 68-Pin Production Socket Analysis

Vendor & Part Number	Comments
Thomas & Betts Corporation PCS-068A-1	Least pin deformation. Contact force has a downward component. No retainer clip option.
ITT/Cannon Corporation LCS-68-12	Low pin deformation. Contact force has a downward component. Has a retainer clip option.
AMP, Inc. 821574-1	Moderate pin deformation. Contact force has a downward component. No retainer clip option.

Table 3. Summary of 84-Pin Production Socket Analysis

Vendor & Part Number	Comments
Thomas & Betts Corporation PCS-084A-1	Least pin deformation. Contact force has a downward component. No retainer clip option.
ITT/Cannon Corporation LCS-84-12	Moderate pin deformation. Contact force has a downward component. Has a retainer clip option.
AMP, Inc. 822281-1 (for surface mount)	Moderate pin deformation. Contact force has a downward component. No retainer clip option. Designed for plastic packages.
AMP, Inc. 821573-1	Large pin deformation. Very tight fit. No retainer clip option. Due to pin deformation, Altera recommends a maximum of three insertions. Designed for ceramic packages.
FCI QILE-84P-410T	Large pin deformation. Very tight fit. No retainer clip option. Due to pin deformation, Altera recommends a maximum of three insertions.



Vendors may provide additional information about their products, such as material selection, prevention of solder ingress during wave soldering, or lead shape. Altera recommends qualifying sockets before committing to a particular vendor.

Table 4 shows the contact distances for Altera packages. These measurements should be used to select a socket, preferably with internal stand-offs, for use with Altera devices.

Table 4. Device Contact Distances

Package	Pins	Contact Distance (Minimum mils)	Contact Distance (Maximum mils)
PLCC	20	385	395
PLCC, JLCC	28	485	495
PLCC, JLCC	44	685	695
PLCC, JLCC	68	985	995
PLCC, JLCC	84	1,185	1,195

Sockets for QFP Packages

Because QFP packages are more susceptible to lead deformation, production sockets must be rigorously qualified. Altera recommends using a burn-in socket for QFP packages because of the socket's reliability. While sockets should always be qualified, Table 5 suggests sockets based on the number of pins and type of QFP package.

Table 5. Socket Vendor Information

Package Type	Number of Pins	Socket Vendor	Part Number
Thin quad flat pack (TQFP)	32	Yamaichi	IC51-0324-1498
Plastic quad flat pack (PQFP)	44	Yamaichi	IC51-467-KS11258
TQFP	44	Yamaichi	IC51-0444-1568
PQFP	100	Yamaichi	IC51-1004-814-2
Ceramic quad flat pack (CQFP)	100	Yamaichi	IC51-1004-814-2
TQFP	100	Yamaichi	IC51-1004-809
PQFP	132	Yamaichi	IC51-1324-828
TQFP	144	*Note (1)*	*Note (1)*
PQFP	160	Yamaichi	IC51-1604-845-4
PQFP	208	Yamaichi	1C51-2084-1052-11
Power quad flat pack (RQFP) (square heat sink)	208	Yamaichi	IC51-2084-1052-11
RQFP (round heat sink)	208	Yamaichi	IC51-1052KS-13087
CQFP	208	Yamaichi	IC51-1509-KS14057
RQFP (square heat sink)	240	Yamaichi	IC51-1655KS-13666
RQFP (round heat sink)	240	Yamaichi	IC51-2404-1655-2
RQFP	304	Yamaichi	IC51-3044-1471-2

Note:
(1) For more information, contact Altera Applications at (800) 800-EPLD.

Sockets for BGA Packages

Lead deformation is not a concern for BGA packages because the leads are solder balls. Therefore, a burn-in socket can be used if you intend to replace the device. See Table 6.

Table 6. Socket Vendor Information

Package Type	Number of Pins	Socket Vendor	Part Number
BGA	225	Enplas	BGA-225-1.5-01A
	256	*Note (1)*	*Note (1)*
	352	*Note (1)*	*Note (1)*
	356	3M/Textool	2-0356-08547-850-019-002
	600	*Note (1)*	*Note (1)*

Note:
(1) For more information, contact Altera Applications at (800) 800-EPLD.

Sockets for PGA Packages

Table 7 suggests sockets based on the number of pins and type of PGA package.

Table 7. Socket Vendor Information

Package Type	Number of Pins	Socket Vendor	Part Number
PGA	403	Yamaichi *(1)*	NP178-64401-KS14828
		AMP *(1)*	1-382320-7
	503	AMP *(1)*, *(2)*	382876-6
		Yamaichi *(1)*	NP236-102002-AC01601
		3M/Textool *(1)*	2-0503-01357-050-019-002
		Berg Electronics	*Note (3)*
		Mill-Max	*Note (3)*
	599	Yamaichi *(1)*	NP236-102002-AC05625

Notes:
(1) Zero-insertion force (ZIF) sockets are available for 403- and 503-pin PGA packages.
(2) Although the socket was created for 560-pin PGA packages, it is compatible with 503-pin packages.
(3) This low-profile PCB socket has no standard part number. Contact vendor for more information.

Table 8 suggests socket tools for inserting & extracting PGA packages into non-ZIF sockets.

Table 8. Socket Tools for PGA Package Insertion & Extraction in Non-ZIF Sockets

Action	Tool Vendor	Part Number
Insertion	Com-Kyl	181-MIC
Extraction	Com-Kyl	281-MIC

Packaging Operations for Wire-Wrap Applications

Wire-wrap applications require a through-hole mount compatible with the J-lead package. The sockets specified do not typically conform mechanically to most wire-wrap panels. Wire-wrap cards have machined receptacles in rows with 100-mil spacing between receptacles and 300-mil spacing between rows. Carrier boards provide an effective way to bridge the gap. Mounting a socket to a carrier board provides the convenience of wire wrap, and the socket occupies a relatively small area on a device. Some carrier boards have signal routing with shorter paths or 45° bends to minimize signal reflection.

Socket & Insertion/ Extraction Tool Manufacturers

Telephone numbers for various socket manufacturers are listed in Table 9. Contact the appropriate manufacturer for additional information.

Table 9. Socket & Insertion/Extraction Tool Manufacturers

Product	Company	Telephone Number
Production sockets	3M/Textool Corporation AMP, Inc. Thomas & Betts Corporation Framatome Connectors International (FCI) ITT/Cannon Corporation Berg Electronics Mill-Max IronWood Electronics	(800) 328-0411 (800) 522-6752 (508) 699-9800 (408) 946-9666 (714) 557-4700 (510) 651-2700 (516) 922-6000 (612) 452-8100
Test and burn-in sockets	3M/Textool Corporation AMP, Inc. Advanced Interconnections Corporation Dai-Ichi Seiko Company, Ltd. (Japan) Emulation Technology, Inc. Yamaichi Enplas IronWood Electronics	(800) 328-0411 (800) 522-6752 (401) 823-5200 (81) 0482-53-3131 (408) 982-0660 (408) 456-0797 (408) 749-8124 (612) 452-8100
Carrier boards and wire-wrap adapters	Advanced Interconnections Corporation Emulation Technology, Inc.	(401) 823-5200 (408) 982-0660
PGA socket insertion/extraction tools	Com-Kyl	(408) 734-9660

Information in this application note is based on tests performed by Altera and on information provided to Altera by various vendors. Altera assumes no liability for the use of third-party products mentioned in this document.