

# CCGA Application Notes For Standard Products

**Table 1: Cross Reference of Applicable Products**

Product Name	Manufacturer Part Number	SMD #	Pin Count	Internal PIC* Number
Arm Cortex MO+	UT32M0R500	5962-17212	143 pin	QS30
1 Gb Parallel NOR Flash Memory	UT81NFR1G1	5962-21209	142 pin	VA01
1 Gb SPI NOR Flash Memory	UT81NFR1G1	5962-21210	142 pin	VA02
Clock Network Manager	UT7R2XLR816	5962-08243	168 pin	WD39
Crosspoint Switch	UT65CML8X8FD	5962-17213	143 pin	WQ04
HSLVDS Repeater	UT54LVDS454	5962-21211	71 pin	WQ06
Matrix A Bus Switch	UT64BS1X433	5962-15242	400 pin	YB17
Matrix D Bus Switch	UT32BS1X833	5962-15243	400 pin	YB18
32-bit Bus Switch	UT54BS32245	5962-15241	99 pin	YB19

\* PIC = Frontgrade internal Product Identification Code

**Important Notice:** This information in this document is intended only to help customers begin PCB design, and Frontgrade Technologies recommends that customers work with a PCB manufacturing subject matter expert to ensure that they are following PCB design rules with respect to their part's operating environment. The use of this document without consulting with a PCB manufacturer is not recommended.

## 1.0 Overview

The growth of the "New Space" and "Small Satellite" markets is introducing more companies to the radiation-hardened space market, some of which are either not familiar with designing Printed Circuit Boards (PCB) for spaceflight, or are accustomed to the manufacturer providing a recommended footprint for their many parts. This document provides guidance necessary for creating a PCB footprint for the Ceramic Column Grid Array (CCGA) package, in addition to recommendations for attachment of the CCGA package. This document is applicable for Frontgrade Standard Product Offerings (SPO).

## 2.0 Technical Background

The Ceramic Column Grid Array (CCGA) package starts as a Ceramic Land Grid Array (LGA) package (i.e., a package with nothing attached to the landing pads). Solder columns are attached to the pads to create a CCGA package. Compared to Ball Grid Array (BGA) packages, which have solder balls attached to the LGA pads, CCGAs typically have increased durability due to the length of the columns and the column material composition, which enable the solder column to absorb coefficient of thermal expansion (CTE) mismatch between the package and PCB. Correctly sizing the pad of a PCB footprint to match with the size of the column is important, as a mismatch could cause a weak or even faulty connection between the package and the part.

Additionally, based upon the size of the columns, a specific solder paste volume (solids content) should be met to ensure the ideal ratio of solder to flux in the solder paste used to attach the CCGA part to the PCB during reflow (the process of using solder paste and controlled reflow temperature to solder one or more parts to a PCB).

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## 3.0 Ceramic Column Grid Array Description

Frontgrade Technologies currently contracts with Six Sigma Services for solder column attach to ceramic packages for commercial and QML products. Six Sigma solder columns are constructed using an 80Pb/20Sn core with a copper ribbon wrapping and a 63Sn/37Pb sheath. Solder columns are available in three diameters from Frontgrade Technologies as described in Table 2. Note that 0.41mm diameter columns are not qualified for QML products at this time. Table 2 also describes LGA package landing pad diameters for corresponding pitches and solder column diameters.

Diameter (mm)	Length (mm)	Description
0.55	2.20	0.86 optimum LGA-pad diameter; 0.81 minimum LGA-pad diameter; 1.27 minimum LGA-pad pitch
0.51	2.20	0.81 optimum LGA-pad diameter; 0.76 minimum LGA-pad diameter; 1.00 minimum LGA-pad pitch

Table 2. Solder column diameters, lengths, and LGA-pad dimensions (cross referenced from internal document 40-8800-YY)

The dimensions of the CCGA package directly affect both the recommended footprint and assembly recommendations. Figure 1 and Figure 2 below shows the Package Outline Drawing of the 143 CCGA package. CCGA packages also come in 71-, 99-, 142-, 168-, and 400-pin configurations. Please see the specific Manufacture Part Number Datasheet to verify CCGA Package Outline Drawing dimensions and pin count for each SPO part of interest.

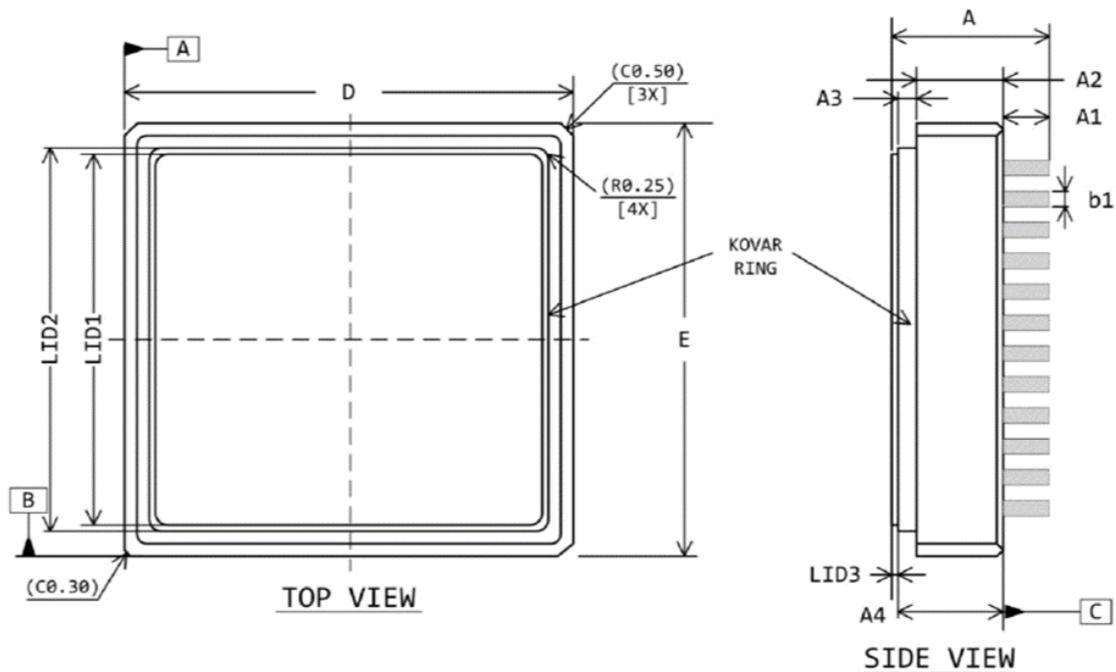
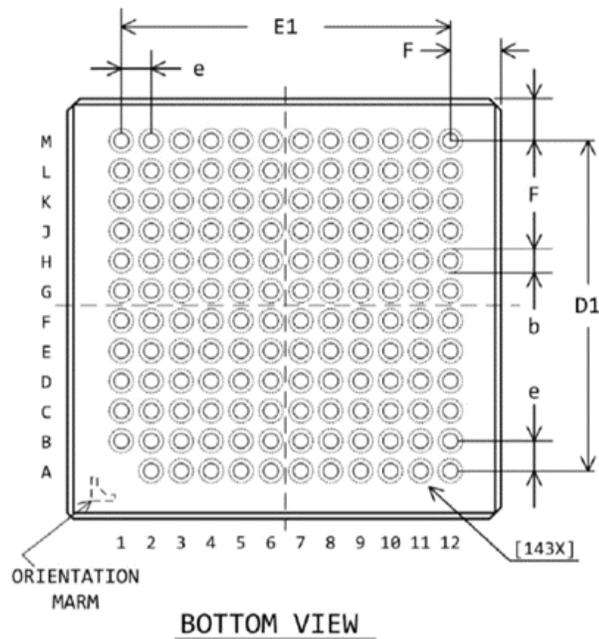


Figure 1. 143-Pin CCGA Package Outline Drawing

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SYMBOL	Millimeters		
	Min	Typ	Max
A			7.69
A1	2.01	2.21	2.41
A2	3.6	4.0	4.4
A3	0.60	0.65	0.70
A4	4.20	4.65	5.10
b	0.75	0.80	0.85
b1	0.51	0.51	0.61
D/E	14.35	14.5	14.65
D1/E1	10.87	11.0	11.13
e	0.95	1.0	1.05
F		1.75	
LID1	12.38	12.43	12.47
LID2	12.81	12.94	13.07
LID3	0.124	0.127	0.130

Figure 2. 143-Pin CCGA Package Outline Drawing

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### 4.0 Creating a PCB Footprint

Six Sigma Services has provided guidelines for designing a PCB footprint for the parts that use their columns. In regards to the CCGA package, the solder column diameter is typically 0.51 mm or 0.55 mm for Frontgrade QML standard products. To determine PCB pad diameter, Six Sigma says “the optimum [PCB] pad diameter is 0.30 mm larger than the column diameter. As a minimum, the pad diameter should be 0.25 mm larger than the column diameter.” – SM-4077: User’s Guide – Six Sigma Solder Columns (Information reprinted with permission from Six Sigma)

Based on this information, and because the column diameter is 0.51 mm for the 143-pin CCGA package shown in Figure 1, the PCB pad diameter should be 0.76 to 0.81 mm. All other relevant dimensions of the PCB footprint should be made to match that of the CCGA Package Outline Drawing.

Note that NASA Goddard Space Flight Center (GSFC) has published GSFC-STD-6001 Ceramic Column Grid Array Design and Manufacturing Rules for Flight Hardware; this document is publicly available from both GSFC and Six Sigma Services. This document recommends the landing pad diameter be a minimum of 120% larger than the diameter of the column used. Frontgrade defaults to using a landing pad that is 0.25 to 0.30 mm larger than the diameter of the solder column, as recommended by Six Sigma.

### 5.0 Assembly Recommendations

Six Sigma provides two recommendations on how to perform assembly upon CCGA parts using their columns. In regards to solder paste volume:

“For board assembly, Six Sigma recommends that the “solids content” of the solder paste be [...] ~0.10 mm<sup>3</sup> for the 0.51 mm and 0.55 mm diameter columns. This does not include the flux, which can be as much as 50% of the solder paste volume. If the pad size is outside of the recommended range, then the solder paste volume may need to be adjusted.”

– SM-4077: User’s Guide – Six Sigma Solder Columns (Information reprinted with permission from Six Sigma)

In regards to the reflow process:

“During reflow, it is important to ensure that the component body temperature be less than or equal to the board temperature. This will avoid issues such as “column kick-out” or “columns that do not attach to the board.” This issue can occur when the existing fillet (between the column and the component” reflows before the solder paste.”

– SM-4077: User’s Guide – Six Sigma Solder Columns (Information reprinted with permission from Six Sigma)

### 6.0 Conclusion

This document contains recommendations for creating a PCB footprint for a CCGA package, including the CCGA package outline drawing, proper PCB footprint pad size based upon the column size, the recommended solder paste volume, and reflow recommendations for attaching the CCGA part to a PCB. This information is provided as a general guideline for PCB assembly when using CCGA packaged parts. The information contained in this Application Note (AN) should be reviewed with the PCB manufacturing functional organization before being implemented into the final design.

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## *Revision History*

Date	Revision	Author	Change Description
08/27/2019	1.0.0	OW	Initial Release
06/13/2023	1.1.0	AM	Converted format to current Frontgrade Template.

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