OCX256 Layout Guidelines

1.0 Introduction

The OCX256 is packaged in a 792-ball plastic TBGA package, and is an SRAM-based bit-oriented switching device offering flow-through NRZ datarates of 667Mb/s and registered data modes of 333MHz. The 128 Inputs and 128 Outputs are each configured as dedicated differential ports. The ports are connected to each other through the switch matrix, which supports One-to-One, One-to-Many, and One-to-All connections.

The proprietary RapidConfigure parallel interface allows fast configuration of the switch matrix. It also allows readback of the device for test and verification purposes. The OCX256 also supports the industry standard JTAG (IEEE 1149.1) interface for boundary scan testing. The JTAG interface can also be used to download configuration data to the device.

Applications include telecom and datacom switching, video switches and servers, and test equipment.

1.1 BGA Package Dimensions

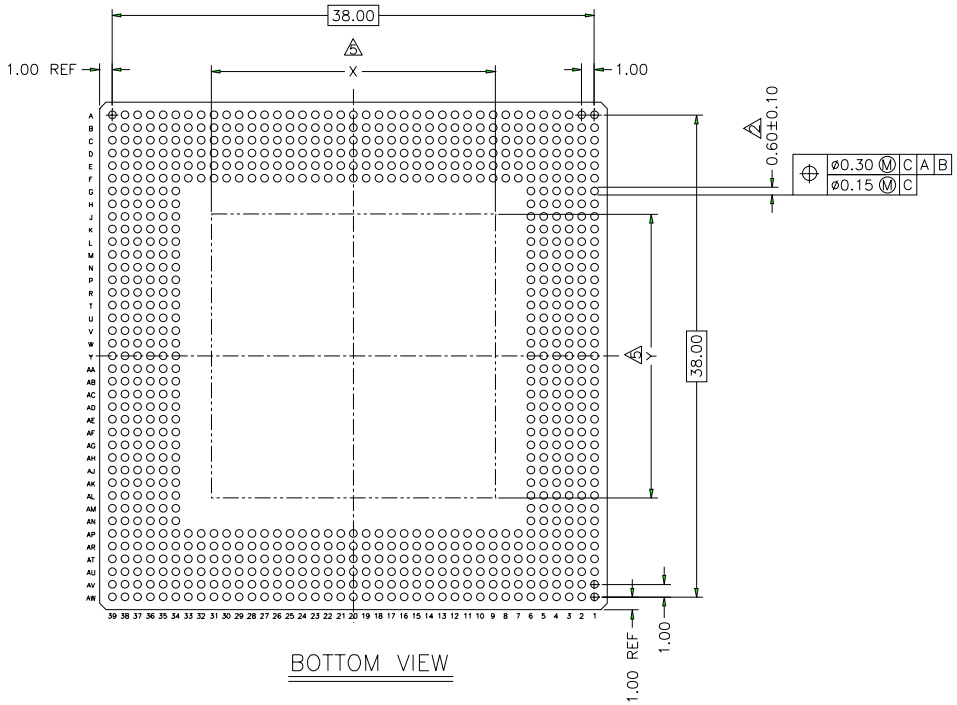

Figure 1. OCX256 BGA Package Dimensions (Bottom View)

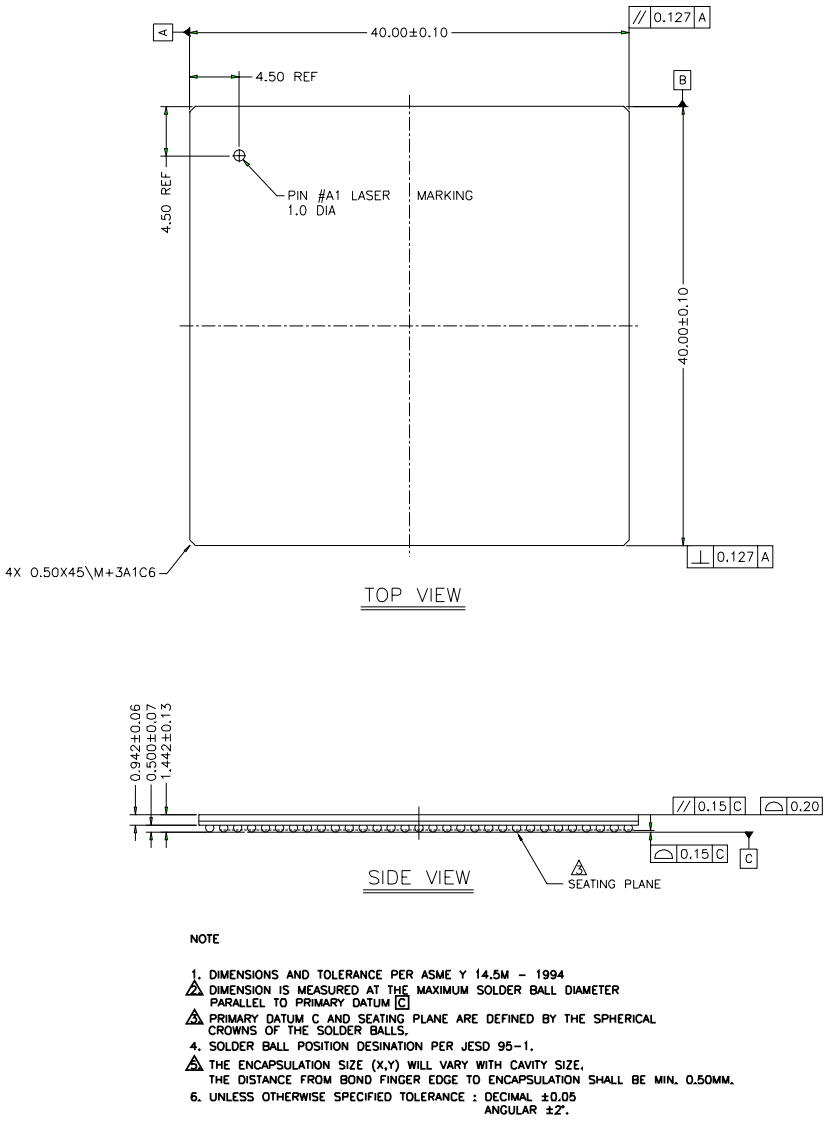

Figure 2. OCX256 BGA Package Dimensions (Top and Side Views)

2.0 Recommended BGA Pad Layout

The OCX256's 792-pin BGA package has a ball spacing of 1mm (0.0394"). (Ball spacing is the distance from the center of one ball to the center of the adjacent ball). BGA pads on the printed circuit board should be circular.

I-Cube recommends that the following dimensions be used for the printed circuit board pad:

- Pad Diameter: 0.4572mm (0.018")
- Solder Mask Diameter: 0.4318mm (0.017")

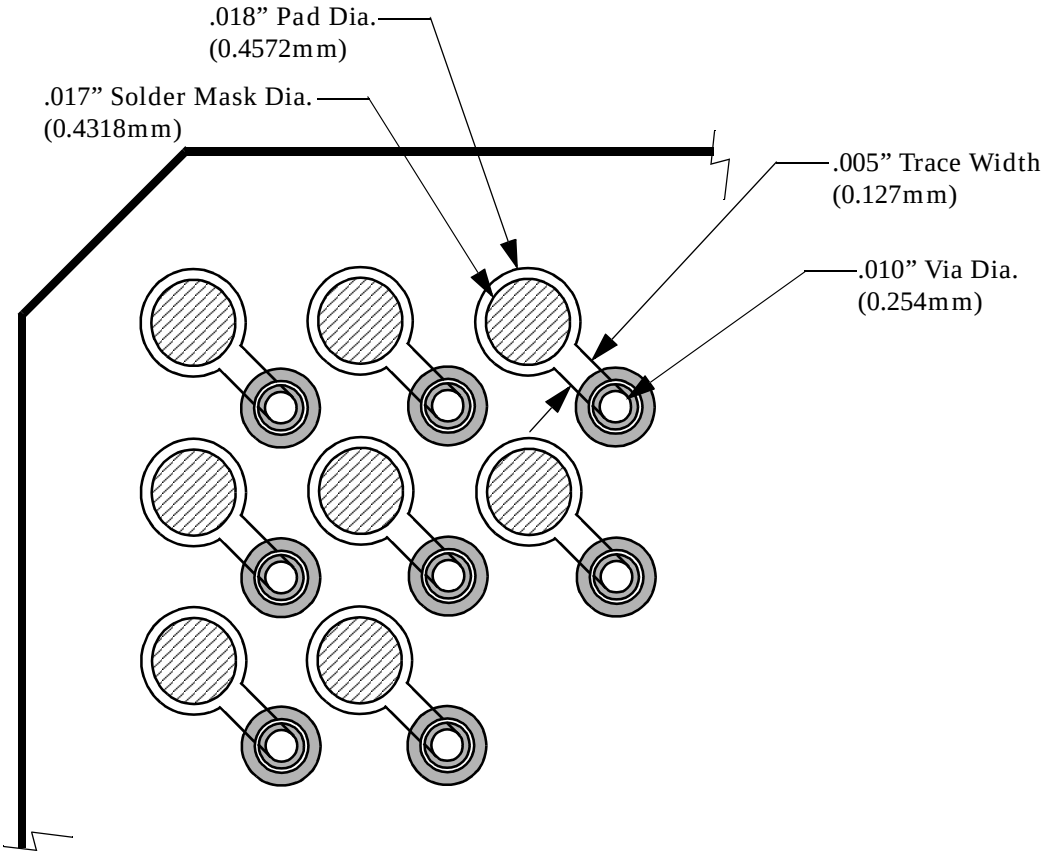

Figure 3. Pad and Solder Mask Diameters

Solder mask will cover the outer 0.0127mm (0.0005") of the PCB pad. This will help make the placement of the OCX256 onto the PCB easier during manufacturing. A common problem with BGAs is solder migration away from the pads. If solder mask does not cover the trace leading from the BGA pad to a nearby via, then the solder will migrate away from the BGA pad and fill the via hole when the BGA’s solder ball melts during placement. This can lead to broken and unreliable connections. It is highly recommended that solder mask be used to cover all vias in the vicinity of the BGA. This is sometimes referred to as “tenting” or “tented vias”, since the solder mask forms a protective tent over the via hole.

3.0 Layout Considerations

The I-Cube OCX256 Evaluation Board was manufactured with a trace width and spacing of 0.127mm (0.005"). All vias have a diameter of 0.254mm (0.010").

Bringing the signal traces out from the BGA requires careful planning of routing, number of layers, and layer stackup. The rule for determining the number of signal layers that will be required for routing signals to a BGA is to count the number of ball rows and subtract one. Usually one layer can be used to break out the signals from the outermost two rings, and one additional layer will be required to route each additional ring. The OCX256 has six rings of balls, so plan on using five signal

layers. Careful planning could reduce this number to four. The I-Cube OCX256 Evaluation Board is a twelve-layer board with six signal layers and six power planes. However, the signal breakout around the OCX256 required only four layers.

Most signals are routed from the BGA pad directly to an adjacent via. This must be done very carefully in order to prevent creating a wall of vias that will act as a plane cut for all of the layers on the board. Remember that internal power plane layers will fill in copper in open areas but leave a safety zone around all vias. This safety zone is usually wide enough that if two vias are side-by-side (as they will be for adjacent BGA pads) there will be no copper filled in between them. This can prevent the area underneath the BGA from actually being connected to the power and ground planes. In some cases the plane cut will be incomplete, but will leave the center region connected by a very thin strip of copper on an inner layer. In order to prevent this, leave space for channels on the ground planes to reach the area underneath the BGA.

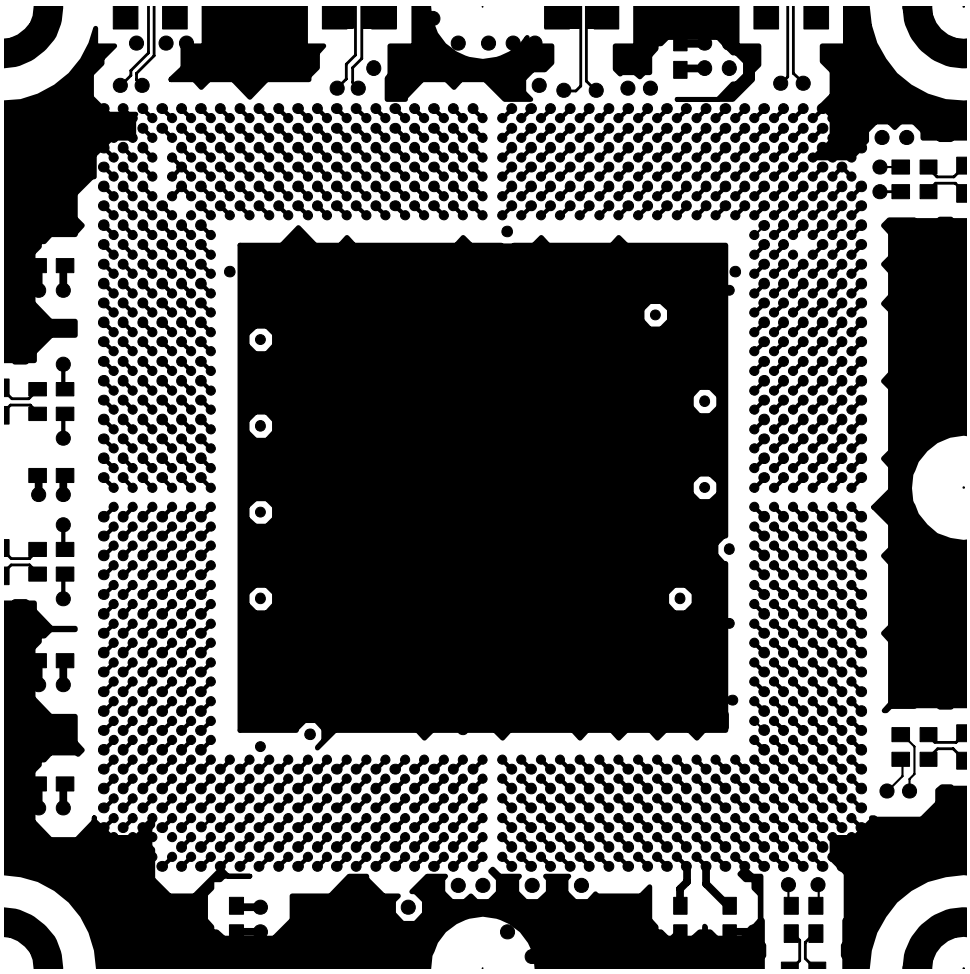

Figure 4. OCX256 BGA Signal Breakout (inner chip via's removed for clarity)

If the area underneath the BGA is not connected to the printed circuit board's power planes by several wide areas of copper, then the part may not be able to receive sufficient power and may be susceptible to power supply noise. The OCX256 requires a lot of decoupling capacitors in order to

reduce noise on the power planes from affecting operation. These capacitors should be placed on the side of the PCB opposite the BGA and many should be placed directly beneath the BGA's center. This makes connecting that region to both the power and ground planes even more important.

I-Cube recommends that at least three power planes be used to supply power to the OCX256—one plane for each $V_{DD.CORE}$, $V_{DD.IN}$, and $V_{DD.PAD}$. Using multiple power planes and designing the BGA signal breakout such that channels to the inner area of the BGA are available will make an OCX256 system more reliable. The I-Cube OCX256 Evaluation Board has three power planes and three ground planes.

As with any high-speed interface, the RapidConfigure Interface to the OCX256 must be carefully routed if it is to be operated at very high speeds. The trace lengths of the signals should be matched to within approximately 12.7mm (0.500"). The RC Clock signal should also be routed directly from its source to the OCX256, with no T-junctions that could cause reflections on the line.

An OCX256 based switch system can never include too many decoupling capacitors. The OCX256 has approximately one hundred power pins and one hundred ground pins. I-Cube recommends using one small decoupling capacitor (typically 0603 size, 0.01µF) for every two power pins, or approximately fifty small decoupling capacitors. The decoupling capacitors should be placed on the opposite side of the board from the OCX256, and should be arranged underneath the center of the chip. Decoupling capacitors should also be placed on the same side of the board as the OCX256, if routing permits.

4.0 References

- Books:

  Johnson, H. & Graham, M., High-Speed Digital Design, 1993, Prentice Hall, 0-13-395724-1.

  Montrose, M., EMC and the Printed Circuit Board, 1999, IEEE Press, 0-7803-4703-X.

- Links:

  AN 75 (High-Speed Board Designs), ver. 3.01, December 1999 (223 Kb)
  http://www.altera.com/document/an/an075.pdf

  MICROSTAR BGA PACKAGING REFERENCE GUIDE (PDF: 1136 KB)
  http://www-s.ti.com/sc/psheets/ssyz015a/ssyz015a.pdf

  PRINTED CIRCUIT BOARD LAYOUT FOR IMPROVED ELECTROMAGNETIC CAPATIBILITY (PDF: 148 KB)
  http://www-s.ti.com/sc/psheets/sdya011/sdya011.pdf

  THE BYPASS CAPACITOR IN HIGH-SPEED ENVIRONMENTS (PDF: 68 KB)
  http://www-s.ti.com/sc/psheets/scba007a/scba007a.pdf

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