# TU106-410 GPU

NPN-09500-001_v01 | May 2019

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## New Product Notice

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# New Product Notice

NPN-09500-001_v01

## New Product Introduction

This NPN specifies the following new NVIDIA® TU106-410 GPU. This GPU is offered in the GB4B-256 (2228-ball BGA, 37.5 mm × 37.5 mm) package only.

| **Notification** | May 2019 | **Planned Implementation** | Now |
|---|---|---|---|

## Product Information

These new products represent the high-end of the Performance consumer desktop GPU segment. They are based on the new NVIDIA Turing graphics architecture and will be manufactured using qualified suppliers per our approved suppliers' list and are RoHS and Halogen-free compliant.

**Key Specifications:**

| | **TU106-410** |
|---|---|
| **Chip** | TU106-410-A1 |
| **Device ID** | 0x1F06 |
| **Memory interface** | 256-bit GDDR6 |
| **Package** | GB4B-256 |

## Impact of Change and Recommended Action

NVIDIA is committed to providing our customers with quality products that push the edge of technology and at the same time enable product segmentation. To help guarantee a rapid time-to-market launch and smooth and uninterrupted product supply, NVIDIA strongly recommends that customers qualify these GPUs as soon as possible.

## Forecasted Key Milestones

TU106-410-A1: QS.....May 20, 2019
TU106-410-A1: Production .....June 20, 2019

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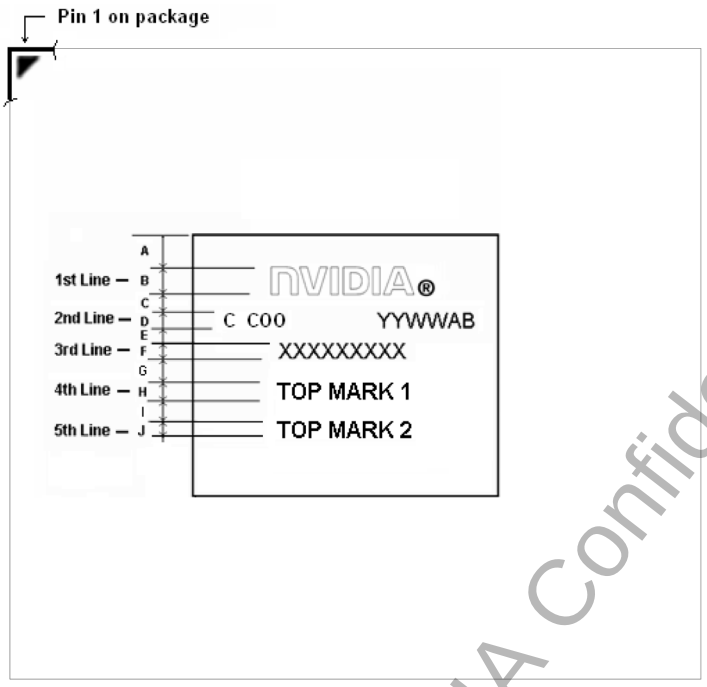
## Product Marking and Traceability

**TU106-410 Markings**




Pin 1: Location of Pin 1 in upper left when reading the marking.

Line 1: Company Name

Line 2: Assembly information: plant identifier (C) and country of origin (COO):
- C = Plant identifier: A (ASE), B (Amkor K5), K (Amkor K4), R (ATT - Amkor Tech), S (SPIL), T (TSMC).
- COO = Country of origin: Taiwan for ASE, ATT, SPIL and TSMC, and Korea for Amkor K4 and Amkor K5.
- YYWW = Assembly date code
- AB = Mask revision

Line 3: Assembly lot number (XXXXXXXXX).
The first character identifies the wafer Fab location:
- P = TSMC Fab 14

Line 4: Product Part Number, for example:
XXXXX-XX-XX

Line 5: <BLANK>

## Products Affected/Ordering Codes

| Product | NVIDIA Part Number [1] | Marketing Part Number for P.O. | Comments |
|---|---|---|---|
| TU106-410 | TU106-410-A1 | TU106-410-A1 | 37.5 mm × 37.5 mm 2228-ball BGA (GB4B-256) |

**Note:**

[1] The NVIDIA part number is provided in this document as a reference for product shipping and handling at factory. This part number is NVIDIA confidential.

## Revision History

| Version | Date | Authors | Description of Change |
|---|---|---|---|
| 01 | May 14, 2019 | QL, DR | Initial release |
| | | | |

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# TU106 Graphics Processing Unit

DS-09129-001_v01 | August 2018
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**Data Sheet**

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# DOCUMENT CHANGE HISTORY

DS-09129-001_v01

| Version | Date | Authors | Description of Change |
|---|---|---|---|
| 01 | August 7, 2018 | RT, DR | Initial Release |

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# 1 INTRODUCTION

## Overview

The Graphics Processing Unit (GPU) covered in this data sheet is designed using a new architecture to bring a new level of performance to visual graphics and computing software applications. This GPU fully integrates hardware acceleration for both graphics and computing code, enabling hardware acceleration of a wider class of software applications than ever before.

The NVIDIA® TU106 GPU is fabricated using TSMC 12FFB process technology to provide maximum performance. The TU106 GPU supports GDDR6 memories.

## Features and Technologies

The TU106 GPU supports the following features and technologies:

- Direct3D 12 and Shader Model 7.0
- OpenGL 4.5
- Vulkan 1.0
- NVIDIA® PhysX™ (Ageia PhysX) technology
- NVIDIA® CUDA® technology

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# Memory Support

The TU106 GPU supports a 256-bit frame buffer memory interface using GDDR6 memories.

# Display

Key display features include:

- Four display pipelines for quad independent display
- Pipeline pixel depth 12 bits per each color
- HDMI version: 2.0b
  - Full backwards compatibility with HDMI 1.x
- DisplayPort (DP) version: 1.4a
  - Max resolution 7680 x 4320 at 60Hz (DSC)
- DVI D: Dual-link resolution of 2560 × 1600 × 24 bpp at 60 Hz refresh rate
- USB-C VirtualLink

# Digital Audio

Digital audio features include:

- Support for HD Audio over PCI Express
- Data rates of 44.1 KHz, 48 KHz, 88.2 KHz, 96 KHz, 176 KHz, and 192 KHz with HDMI. Only 48 KHz supported over DP.
- Word sizes of 16-bit, 20-bit, and 24-bit

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# Video

The TU106 GPU introduces a new video engine, which is backward compatible with the video engine in earlier GPUs. The following video formats are supported:

- Decode
  - H264 (MPEG4 AVC)
  - H265 (HEVC)
  - VP8/VP9
  - MVC
  - MV-HEVC
  - MPEG2
  - MPEG4 ASP
  - VC1
- Encode
  - H264 (MPEG4 AVC)
  - H265 (HEVC)
  - MVC
  - MV-HEVC

A full range of resolutions are supported including 2160p, 1080p, 1080i, 720p, 480p, and 480i. The TU106 GPU provides hardware acceleration for the computationally intensive parts of video processing. The TU106 video processor provides improved video playback speeds via faster decode and transcode.

# PCI Express 3.0

The TU106 GPU supports PCI Express 3.0 with 16 lanes of PCIe traffic for a peak bandwidth (counting both directions) of up to 16 gigabytes (GBps) per second.

# GPIOs

The GPIO interface allows for basic control of devices on the graphics card.

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# Power Management Technologies

The TU106 GPU employs enhanced power management to achieve very low GPU power consumption. The following features are supported:

- ASLM and ASPM power management
- PLLs on lower voltage rails
- Dynamic memory termination
- Adaptive clocking
- Adaptive Power States

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# 2 SIGNAL DESCRIPTIONS

The signal description section contains definitions grouped under the following functions:

- Conventions
- PCI Express Interface
- Frame Buffer Memory Interface
- ROM Access Signals
- Digital Display Interface
- USB-C Display Interface
- I2C Interface
- Clock Reference Signals
- Power Rail Signals
- Test Signals
- Miscellaneous

**Note:** For detailed functionality and usage please refer to the D18 Hardware Design Guide (DG-08781-001).

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# Conventions

The following conventions are used to describe the signals for the TU106 GPU:

- Signal names listed in the ballout are written in bold *sans serif* font to distinguish them from other text. Single-ended active low signals are identified by an underscore and the letter "n" (**_N**) after the signal. For example, **PEX_TX1_N** indicates an active low signal. Signal names that do not appear in the ballout, but that are used for alternate interfaces are written in *sans serif* font without bold.
- Vendor signals appear as are standard for the vendor data sheets. For instance, $\overline{\text{CAS}}$ represents the active low Column Address Strobe signal in the frame buffer memory interface.
- I/O Type
  The signal I/O state is represented as a code to indicate the operational characteristics of the signal. Table 2.1 lists the I/O codes used in the signal description tables.

Table 2.1 I/O Codes for Signal Descriptions

| I/O Code | Meaning |
|---|---|
| I | Input signal |
| I/O | Input/output signal |
| O | Output signal |
| P, GND | Power/ground |
| B | Bidirectional signal |
| Z | Tri-state output |
| AB | Analog bidirectional signal |
| AI | Analog Input signal |
| AO | Analog Output signal |

# PCI Express Interface

The PCI Express Interface signals are given in Table 2.2.

Table 2.2 PCI Express Interface

| Signal | I/O | Description |
|---|---|---|
| PEX_RX[15:0]<br>PEX_RX[15:0]_N | I | PCI Express Receive Data Bus<br>This is the high-speed unidirectional differential input data bus. The raw data rate is<br>2.5 Gbps per differential pair for PCI Express 1.1, 5.0 Gbps for PCI Express 2.0, 8.0 Gbps for PCI Express 3.0, including the symbol overhead for an embedded clock. |

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## Table 2.2 PCI Express Interface

| Signal | I/O | Description |
|---|---|---|
| PEX_TX[15:0]<br>PEX_TX[15:0]_N | O | PCI Express Transmit Data Bus<br>This is the high-speed unidirectional differential output data bus. The raw data rate is 2.5 Gbps per differential pair for PCI Express 1.1, 5.0 Gbps for PCI Express 2.0, 8.0 Gbps for PCI Express 3.0, including the symbol overhead for an embedded clock. |
| PEX_REFCLK<br>PEX_REFCLK_N | I | PCI Express Reference Clock<br>The reference clock is a differential low-jitter input the GPU uses for its internal timing purposes. This input clock may be spread spectrum. Refer to the latest PCI Express specification for details on the reference clock spread spectrum. |
| PEX_RST_N | I | PCI Express Reset<br>The PEX_RST_N signal indicates when the power supply is within its specified voltage tolerance and is stable. It goes inactive after a delay time from the power rails, achieving specified tolerance and power up. Refer to the latest PCI Express specification for details on the PCI Express reset. |
| PEX_TERMP | AB | PCI Express Input/Output Termination Calibration<br>The PEX_TERMP signal provides the reference for the internal calibation of the PCI Express input/output termination. Use a pull-down to GND that is the same value as the desired termination. |
| PEX_CLKREQ_N | O | PCI Express Clock Request<br>This active low signal is driven to request that the PCI Express reference clock be available (active clock state) in order to allow the PCI Express interface to send/receive data. |
| PEX_WAKE_N | I/O | PCI Express Wake Request<br>This active low signal is driven to request that the PCI Express interfaces wakes up from a lower power state. |

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# Frame Buffer Memory Interface

The TU106 frame buffer memory interface supports GDDR6 memories. Each memory partition has its own set of command signals. To see how the frame buffer control signals map to the memory command signals, refer to the D18 Hardware Design Guide (DG-08781-001).

Table 2.3 and Table 2.4 describes the data and clock signals for each memory partition.

## Table 2.3 Frame Buffer Command Interface for GDDR6

| Signal | I/O | Description |
|---|---|---|
| FBx_CMD[35:0]<br>(x = A,B,C,D) | O | Command Address Bus Inversion (CABI_n)<br>Used to reduce power consumption on the command Address bus. |
| | O | Reset (RESET_n)<br>Asynchronous DRAM reset signal |
| | O | Memory Clock Enable (CKE_n)<br>Enables the clock receivers for the target RAM. |
| | O | Command Address Inputs ( CA[9:0] )<br>The CA inputs receive DDR Command and Address inputs |

## Table 2.4 Frame Buffer Interface

| Signal | I/O | Description |
|---|---|---|
| FBx_CLK[1:0]<br>FBx_CLK[1:0]_N<br>(x=A,B,C,D) | O | Memory Clock Signals<br>These are separate sets of clock signals for each memory partition. For a further reduction in loading, there are two sets of clocks per partition. Each partition has two clock pairs that control either the most significant 32 bits or the least significant 32 bits per partition. The active low CA signals switch on the falling clock edge. The active high CA signals switch on the rising clock edge.<br>The memory clock signals are as follows:<br>**FBx_CLK0** and **FBx_CLK0_N** → **FBx_D[31:0]**<br>**FBx_CLK1** and **FBx_CLK1_N** → **FBx_D[63:32]**<br>**x= A,B,C,D** |
| FBx_D[63:0]<br>(x=A,B,C,D) | I/O | Memory Data Bus<br>These signals connect to data signals of the memory device for each 64-bit partition. |

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## Table 2.4 Frame Buffer Interface

| Signal | I/O | Description |
|---|---|---|
| FBx_DQM[7:0]<br>(x=A,B,C,D) | I/O | Data Bus Inversion ( DBI )<br>**FBx_DQM[7:0]** signals are connected to DBI[7:0] signals of the memory. Used to reduce power consumption and VDD noise of the DRAM. |
| FBx_DQS_WP[7:0]<br>(x=A,B,C,D) | I | Error Detection Code ( EDC )<br>**FBx_DQS_WP[7:0]** signals are connected to the EDC[7:0] signals of the memory. The CRC data is communicated on these signals |
| FBx_WCK01<br>FBx_WCK01_N<br>FBx_WCK23<br>FBx_WCK23_N<br>FBx_WCK45<br>FBx_WCK45_N<br>FBx_WCK67<br>FBx_WCK67_N<br>(x=A,B,C,D) | O | Reference for read and write data. |
| FBx_WCKB01<br>FBx_WCKB01_N<br>FBx_WCKB23<br>FBx_WCKB23_N<br>FBx_WCKB45<br>FBx_WCKB45_N<br>FBx_WCKB67<br>FBx_WCKB67_N<br>(x=A,B,C,D) | O | Reference for read and write data. |
| FB_CAL_PD_VDDQ<br>FB_CAL_PU_GND | AO | Calibration Pull-Down/Pull-Up<br>When the frame buffer bus operates in high-speed source-synchronous mode, several signals require dynamic calibration. Other slower signals are calibrated once on power-up. **FB_CAL_PD_VDDQ** and **FB_CAL_PU_ GND** are used to compute the drive strength of the frame buffer pads. **FB_CAL_PD_VDDQ** connects to **FBVDDQ** and is pulled up through a precision resistor. **FB_CAL_PU_GND** is pulled down to **GND** through a precision resistor. |

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Table 2.4 Frame Buffer Interface

| Signal | I/O | Description |
|---|---|---|
| FB_CAL_TERM_GND | AO | Termination Calibration Signal<br>When the frame buffer bus operates in high-speed source-synchronous mode, it may use internal termination provided by the GPU. This signal provides the calibration for the internal termination. It should be tied to **GND** through a precision resistor that is the same value as the desired termination. |
| FB_VREF | I | Frame Buffer Voltage Reference<br>Sets switching threshold for inputs on the frame buffer when the frame buffer input pads are set to input mode. |
| FBVDDQ_SENSE | AO | Frame Buffer Power Rail Sense Signal |

# ROM Access Signals

Table 2.5 Serial ROM Access Signals

| Signal | I/O | Description |
|---|---|---|
| ROM_SCLK | O | Serial ROM Clock<br>**ROM_SCLK** supplies the clock signal for accessing serial ROM data. |
| ROM_CS_N | O | Chip Select. |
| ROM_SI | O | Serial Output<br>**ROM_SI** supplies the data signal to the **SROM_SI** serial ROM signal. |
| ROM_SO | I | Serial Input<br>**ROM_SO** accepts the data signal input from **SROM_SO** of the serial ROM as input. |

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# Digital Display Interface

The TU106 GPU enables Links A, B, C, D, E, and F to support DisplayPort. Links can also be configured to support DVI and HDMI.

## Table 2.6 Digital Display Interface Signals, Links A & B

| Signal | I/O | Description |
|---|---|---|
| IFPA_AUX_SCL/ IFPA_AUX_SDA_N | I/O | DisplayPort Auxiliary Lane (Link A) |
| IFPA_L0/IFPA_L0_N | O | DisplayPort Main Link Lane 0 (Link A) |
| IFPA_L1/IFPA_L1_N | O | DisplayPort Main Link Lane 1 (Link A) |
| IFPA_L2/IFPA_L2_N | O | DisplayPort Main Link Lane 2 (Link A) |
| IFPA_L3/IFPA_L3_N | O | DisplayPort Main Link Lane 3 (Link A) |
| IFPB_AUX_SCL IFPB_AUX_SDA_N | I/O | DisplayPort Auxiliary Lane (Link B) |
| IFPB_L0/IFPB_L0_N | O | DisplayPort Main Link Lane 0 (Link B) |
| IFPB_L1/IFPB_L1_N | O | DisplayPort Main Link Lane 1 (Link B) |
| IFPB_L2/IFPB_L2_N | O | DisplayPort Main Link Lane 2 (Link B) |
| IFPB_L3/IFPB_L3_N | O | DisplayPort Main Link Lane 3 (Link B) |
| IFPAB_RSET | I/O | Set Reference Current<br>Generate a reference current through connecting an external resistor to this signal. |

## Table 2.7 Digital Display Interface Signals, Links C, D, E, and F

| Signal | I/O | Description |
|---|---|---|
| IFPC_AUX_SCL / IFPC_AUX_SDA_N | I/O | DisplayPort Auxiliary Lane (Link C) |
| IFPC_L0/IFPC_L0_N | O | DisplayPort Main Link Lane 0 (Link C) |
| IFPC_L1/IFPC_L1_N | O | DisplayPort Main Link Lane 1 (Link C) |
| IFPC_L2/IFPC_L2_N | O | DisplayPort Main Link Lane 2 (Link C) |
| IFPC_L3/IFPC_L3_N | O | DisplayPort Main Link Lane 3 (Link C) |
| IFPCD_RSET | I/O | Set Reference Current<br>Generates a reference current through connecting an external resistor to this signal |
| IFPD_AUX_SCL/ IFPD_AUX_SDA_N | I/O | DisplayPort Auxiliary Channel (Link D) |
| IFPD_L0/IFPD_L0_N | O | DisplayPort Main Link Lane 0 (Link D) |
| IFPD_L1/IFPD_L1_N | O | DisplayPort Main Link Lane 1 (Link D) |

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Table 2.7 Digital Display Interface Signals, Links C, D, E, and F

| Signal | I/O | Description |
|---|---|---|
| IFPD_L2/IFPD_L2_N | O | DisplayPort Main Link Lane 2 (Link D) |
| IFPD_L3/IFPD_L3_N | O | DisplayPort Main Link Lane 3 (Link D) |
| IFPE_AUX_SCL/ IFPE_AUX_SDA_N | I/O | DisplayPort Auxiliary Lane (Link E) |
| IFPE_L0/IFPE_L0_N | O | DisplayPort Main Link Lane 0 (Link E) |
| IFPE_L1/IFPE_L1_N | O | DisplayPort Main Link Lane 1 (Link E) |
| IFPE_L2/IFPE_L2_N | O | DisplayPort Main Link Lane 2 (Link E) |
| IFPE_L3/IFPE_L3_N | O | DisplayPort Main Link Lane 3 (Link E) |
| IFPE_RSET | I/O | Set Reference Current<br>Generates a reference current through connecting an external resistor to this signal |
| IFPF_AUX_SCL/ IFPF_AUX_SDA_N | I/O | DisplayPort Auxiliary Lane (Link F) |
| IFPF_L0/IFPF_L0_N | O | DisplayPort Main Link Lane 0 (Link F); |
| IFPF_L1/IFPF_L1_N | O | DisplayPort Main Link Lane 1 (Link F) |
| IFPF_L2/IFPF_L2_N | O | DisplayPort Main Link Lane 2 (Link F) |
| IFPF_L3/IFPF_L3_N | O | DisplayPort Main Link Lane 3 (Link F) |

# USB-C Display Interface

Link F and IFPB_AUX support USB-C, as described in Table 2.8.

Table 2.8 USB Interface Signals

| Signal | I/O | Description |
|---|---|---|
| IFPF_AUX_SCL/ IFPF_AUX_SDA_N | I/O | DisplayPort Auxiliary Lane/USB-C Sideband signals SBU1/SBU2 |
| IFPB_AUX_SCL/ IFPB_AUX_SDA_N | I/O | Master I2C to USB-C PPC |
| IFPF_L0/IFPF_L0_N | O | USB3 RX+ / USB3 RX-<br>**Note:** This signal pad is used as USB3 RX+/ USB3 RX- for USB-C interface |
| IFPF_L1/IFPF_L1_N | O | USB3 TX+ / USB3 TX-<br>**Note:** This signal pad is used as USB3 TX+/ USB3 TX- for USB-C interface |
| IFPF_L2/IFPF_L2_N | O | USB3 TX+ / USB3 TX-<br>**Note:** This signal pad is used as USB3 TX+/ USB3 TX- for USB-C interface |
| IFPF_L3/IFPF_L3_N | O | USB3 RX+ / USB3 RX-<br>**Note:** This signal pad is used as USB3 RX+/ USB3 RX- for USB-C interface |

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Table 2.8 USB Interface Signals

| Signal | I/O | Description |
|---|---|---|
| USB_L0/USB_LO_N | O | USB3 TX+ or USB2+/USB3 TX- or USB2-<br>**Note:** This signal pad is used as USB3 TX+/USB3 TX- for USB-C interface |
| USB_L1/USB_L1_N | O | USB3 RX+ or USB2+/USB3 RX- or USB2<br>**Note:** This signal pad is used as USB3 RX+/ USB3 RX- for USB-C interface |
| USB_RBIAS | AI | USB Reference Resistor |
| USB_SCL | I/O | Slave I2C Clock interface for controlling integrated DP/USB cross-connect |
| USB_SDA | I/O | Slave I2C Data interface for controlling integrated DP/USB cross-connect |
| USB_TERMP0 | AI | USB PLL Reference Resistor 0 |
| USB_TERMP1 | AI | USB PLL Reference Resistor 1 |

# I2C Interface

Table 2.9 I2C Interface Signals

| Signal | I/O | Description |
|---|---|---|
| I2CB_SCL<br>I2CB_SDA | I/O | If not used for any external Bus, this bus may be used for embedded devices. |
| I2CC_SCL<br>I2CC_SDA | I/O | Restricted to embedded devices such as voltage regulators and power monitors. |
| I2CS_SCL<br>I2CS_SDA | I/O | Slave I2C-Compatible Bus Signal. |

# Clock Reference Signals

Table 2.10 Clock Reference Signals

| Signal | I/O | Description |
|---|---|---|
| XTAL_IN<br><br>XTAL_OUT | I<br><br>O | A series resonant crystal is connected between these two points to provide the reference clock for the internal clock synthesizers. Alternately, an external LVTTL clock oscillator output may be driven in XTAL_IN, leaving XTAL_OUT unconnected. |
| XTAL_OUTBUFF | O | **XTAL_OUTBUFF** is a buffered version of the **XTAL_IN**/ **XTAL_OUT**. |

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# Power Rail Signals

## IFP Power Rail Signals

Table 2.11 IFP Power Rail Signals

| Signal | I/O | Description |
|---|---|---|
| IFP_IOVDD | P | 1.0V supply for integrated Digital Display I/O Power Rails for all IFP links. |
| IFPAB_PLLVDD | P | 1.8V supply for integrated Digital Display PLL Power Rails for the IFP-A and IFP-B links. |
| IFPCD_PLLVDD | P | 1.8V supply for Integrated Digital Display PLL Power Rails for the IFP-C and IFP-D links. |
| IFPE_PLLVDD | P | 1.8V supply for Integrated Digital Display PLL Power Rails for the IFP-E link. |

## PEX Power Rail Signals

Table 2.12 PEX Power Rail Signals

| Signal | I/O | Description |
|---|---|---|
| PEX_CVDD / PEX_DVDD | P | 1.0V supply for PCIe interface/PLL digital power rail |
| PEX_HVDD | P | 1.8V supply for PCIe interface/PLL analog power rail |
| PEX_PLL_HVDD | P | 1.8V supply for the PEX PLL |

## Frame Buffer Power Rail Signals

Table 2.13 FrameBuffer Power Rail Signals

| Signal | I/O | Description |
|---|---|---|
| FB_REFPLL_AVDDx (x=0,1) | P | 1.8V supply for Frame Buffer Digital Power Rails |
| FBVDDQ | P | Frame Buffer Power Rail |
| FBVDDQ_SENSE | O | Frame Buffer Power Rail Sense Signal |
| FBx_PLL_AVDD (x=A,B,C,D) | P | 1.8V supply for Frame Buffer PLL Analog Power Rails |

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## General Power Rail Signals

Table 2.14 General Power Rail Signals

| Signal | I/O | Description |
|---|---|---|
| GPCPLL_AVDDx (x=0,1) | P | 1.8V supply for Analog Power Rails for GPCs |
| SP_PLLVDD | P | 1.8V supply for Core Clock PLL Analog Power Rail |
| VDD | P | Core Power Rail. Connect to NVVDD power supply. |
| 1V8_AON | P | 1.8V Always On Power Rail |
| VID_PLLVDD | P | 1.8V supply for Video Pixel Clock PLL Analog power rail |
| XS_PLLVDD | P | 1.8V supply for Core PLL Analog rail |

## USB Power Rail Signals

Table 2.15 USB Power Rail Signals

| Signal | I/O | Description |
|---|---|---|
| USB_DVDD | P | USB 1.0V Core Power Rail |
| USB_HVDD | P | USB 1.8V Voltage Power Rail |
| USB_PLL_HVDD | P | USB 1.8V PLL Power Rail |
| USB_VDDP | P | USB 3.3V Analog Supply |

**Note:** For detailed functionality and usage please refer to the D18 Hardware Design Guide (DG-08781-001).

# Test Signals

Table 2.16 Test Signals

| Signals | I/O | Description |
|---|---|---|
| JTAG_TCK<br>JTAG_TDI<br>JTAG_TDO<br>JTAG_TMS | I<br>I<br>Z<br>I | JTAG Test Signals |
| NVJTAG_SEL | I | JTAG Select |

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# Miscellaneous

Table 2.17 Miscellaneous Signals

| Signal | I/O | Description |
|---|---|---|
| STRAP[5:0] | I | Strap Signals |
| THERMDP<br>THERMDN | I<br>O | Thermal Monitor Signals<br>Leave floating and unconnected. |
| ADC_IN / ADC_IN_N | I | External current sense for power monitoring |
| GPIO [30:0] | I | General Purpose I/O |
| BUFRST_N | O | Behaves as a buffered copy of the system PEX_RST* signal in all operating modes **when 1V8 is present**.<br>Tri-state when **1V8 is not present**. |
| FP_FUSE_SRC | I | TBD |

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# 3 ELECTRICAL SPECIFICATIONS

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This section provides absolute maximum ratings and operating conditions for the TU106 GPU.

For more information about the core graphics voltage (NVVDD), frame buffer clock frequency (MCLK), and core clock frequency (GPCCLK) values and electrical and thermal design guidelines for this product, refer to the Product Specification.

The frame buffer memory clock, MCLK, is defined as an actual clock output (not as a data rate). The NVIDIA® GPU Boost™ technology manages the clocks dynamically.

Table 3.1 lists the absolute maximum ratings of the power rails.

Table 3.1 Absolute Maximum Ratings

| Symbol | Parameter | Min. | Max.[1] | Units | Notes |
|---|---|---|---|---|---|
| FBVDDQ | Frame buffer power rail | -0.3 | 1.98 | V | |
| FBx_PLL_AVDD (x=A,B,C,D) | Frame buffer PLL analog power rail | -0.3 | 1.854 | V | |
| GPCPLL_AVDD0 GPCPLL_AVDD1 | Core PLL Analog Rails | -0.3 | 1.854 | V | |
| IFP_IOVDD | Integrated Digital Display I/O power rails | -0.3 | 1.1 | V | |
| IFPAB_PLLVDD | Integrated Digital Display PLL power rails | -0.3 | 1.854 | V | |
| IFPCD_PLLVDD | Integrated Digital Display PLL power rails | -0.3 | 1.854 | V | |

## Table 3.1 Absolute Maximum Ratings

| Symbol | Parameter | Min. | Max.[1] | Units | Notes |
|---|---|---|---|---|---|
| IFPE_PLLVDD | Integrated Digital Display PLL power rails | -0.3 | 1.854 | V | |
| PEX_DVDD/ PEX_CVDD | PCIe interface/PLL digital power rail | -0.3 | 1.1 | V | |
| PEX_HVDD | PCIe interface/PLL analog power rail | -0.3 | 1.854 | V | |
| PEX_PLL_HVDD | PCIe interface PLL supply power rail | -0.3 | 1.854 | V | |
| SP_PLLVDD | Core clock PLL analog power rail | -0.3 | 1.854 | V | |
| USB_VDDP | USB analog supply | -0.3 | 3.63 | V | |
| USB_DVDD | USB analog supply | -0.3 | 1.1 | V | |
| USB_HVDD | USB analog supply | -0.3 | 1.854 | V | |
| USB_PLL_HVDD | USB analog PLL supply | -0.3 | 1.854 | V | |
| VDD | Core (NVVDD) power rail | -0.3 | TBD | V | |
| 1V8_AON | 1.8 V power rail | -0.3 | 1.854 | V | |
| VID_PLLVDD | Thermal controller and Video pixel clock PLL analog power rail | -0.3 | 1.854 | V | |
| XS_PLLVDD | Core PLL Analog Rails | -0.3 | 1.854 | V | |
| $T_j$ | Die junction temperature | Refer to the Product Specification | | °C | |

**Notes:**

1. Stress greater than those listed under "Absolute maximum ratings" may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these, or any other conditions above those indicated in the operational sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

**Note: Voltage settings may vary with the reference design; please refer to the specific reference design to get the required values.**

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Table 3.2 lists the operating conditions of the clock and power rail signals.

## Table 3.2 Operating Conditions

| Symbol | Parameter | Min. | Typ. | Max.[1] | Units | Notes |
|---|---|---|---|---|---|---|
| FBVDDQ | Frame buffer power rail | | 1.35 | | V | Note 2 |
| FBx_PLL_AVDD (x=A,B,C,D) | Frame buffer PLL analog power rail | 1.746 | 1.800 | 1.854 | V | |
| GPCPLL_AVDD0 GPCPLL_AVDD1 | Core PLL Analog Rails | 1.746 | 1.800 | 1.854 | V | |
| IFP_IOVDD | Integrated Digital Display I/O power rails | 0.97 | 1.00 | 1.03 | V | |
| IFPAB_PLLVDD | Integrated Digita Display PLL power rails | 1.746 | 1.800 | 1.854 | V | |
| IFPCD_PLLVDD | Integrated Digital Display PLL power rails | 1.746 | 1.800 | 1.854 | V | |
| IFPE_PLLVDD | Integrated Digital Display PLL power rails | 1.746 | 1.800 | 1.854 | V | |
| PEX_DVDD/ PEX_CVDD | PCIe interface/PLL digital power rail | 0.97 | 1.00 | 1.03 | V | |
| PEX_HVDD | PCIe interface/PLL analog power rail | 1.746 | 1.800 | 1.854 | V | |
| PEX_PLL_HVDD | PCIe interface PLL supply power rail | 1.746 | 1.800 | 1.854 | V | |
| SP_PLLVDD | Core clock PLL analog power rail | 1.746 | 1.800 | 1.854 | V | |
| USB_VDDP | USB analog supply | 3.135 | 3.3 | 3.456 | V | |
| USB_DVDD | USB analog supply | 0.97 | 1.0 | 1.03 | V | |
| USB_HVDD | USB analog supply | 1.746 | 1.800 | 1.854 | V | |
| USB_PLL_HVDD | USB analog PLL supply | 1.746 | 1.800 | 1.854 | V | |
| VDD | Core (NVVDD) power rail | NVVDD-2.5% | NVVDD | NVVDD+2.5% | V | |
| 1V8_AON | 1.8 V power rail | 1.746 | 1.800 | 1.854 | V | |
| VID_PLLVDD | Thermal controller and Video pixel clock PLL analog power rail | 1.746 | 1.800 | 1.854 | V | |
| XS_PLLVDD | Core PLL Analog Rails | 1.746 | 1.800 | 1.854 | V | |
| $T_j$ | Die junction temperature | 0 | Refer to the Product Specification | | °C | See Note 3. |

**Notes**:

1 This specification defines the goals for the DC supply at **VDD**. Short pulses due to switching noise on **VDD** may exceed this limit.
2 Min/Typ/Max/ should meet memory vendor spec which can vary.
3 $T_j$ is the maximum die temperature at which the GPU can operate at its maximum clock frequencies, as defined in the NVIDIA Product Specification.

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Table 3.3 GPIO Electrical Specifications

| Voh,Vih/min | Voh,Vih/max | Vol,Vil/min | Vol,Vil/max | Vi_mid max | Vi_mid min |
|---|---|---|---|---|---|
| 1.50V | 1.854V | 0V | 0.3V | 1.3V | 0.5V |

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# 4 MASTER SIGNAL LIST

This chapter contains the master signal list for the TU106 GPU.

Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| IOB Key:<br>B = Bidirectional signal<br>I = Input signal<br>O = Output signal<br>P = Power-related signal<br>Z= Tri-state output<br>AB = Analog bidirectional signal<br>AI = Analog input signal<br>AO = Analog output signal | | Reset & Initial Value Key:<br>Z= Tri-state<br>X = Indeterminate<br>0 = Drive 0<br>1 = Drive 1<br>C = Drive with toggle (clock)<br>Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution. | | | |
| Signal Name | IOB | Reset Value | Initial Value | Drive | Notes |
| I2C | | | | | |
| I2CB_SCL | O | | | +1.8V_AON | |
| I2CB_SDA | B | | | +1.8V_AON | |
| I2CC_SCL | O | | | +1.8V_AON | |
| I2CC_SDA | B | | | +1.8V_AON | |
| I2CS_SCL | O | | | +1.8V_AON | |
| I2CS_SDA | B | | | +1.8V_AON | |
| IFP | | | | | |
| IFPA_L0_N | O | | | | |
| IFPA_L0 | O | | | | |
| IFPA_L1_N | O | | | | |
| IFPA_L1 | O | | | | |
| IFPA_L2_N | O | | | | |
| IFPA_L2 | O | | | | |
| IFPA_L3_N | O | | | | |
| IFPA_L3 | O | | | | |
| IFPB_L0_N | O | | | | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| **IOB Key:**<br>**B = Bidirectional signal**<br>**I = Input signal**<br>**O = Output signal**<br>**P = Power-related signal**<br>**Z= Tri-state output**<br>**AB = Analog bidirectional signal**<br>**AI = Analog input signal**<br>**AO = Analog output signal** | | **Reset & Initial Value Key:**<br>**Z= Tri-state**<br>**X = Indeterminate**<br>**0 = Drive 0**<br>**1 = Drive 1**<br>**C = Drive with toggle (clock)**<br>**Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution.** | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| IFPB_L0 | O | | | | |
| IFPB_L1_N | O | | | | |
| IFPB_L1 | O | | | | |
| IFPB_L2_N | O | | | | |
| IFPB_L2 | O | | | | |
| IFPB_L3_N | O | | | | |
| IFPB_L3 | O | | | | |
| IFPC_L0_N | O | | | | |
| IFPC_L0 | O | | | | |
| IFPC_L1_N | O | | | | |
| IFPC_L1 | O | | | | |
| IFPC_L2_N | O | | | | |
| IFPC_L2 | O | | | | |
| IFPC_L3_N | O | | | | |
| IFPC_L3 | O | | | | |
| IFPD_L0_N | O | | | | |
| IFPD_L0 | O | | | | |
| IFPD_L1_N | O | | | | |
| IFPD_L1 | O | | | | |
| IFPD_L2_N | O | | | | |
| IFPD_L2 | O | | | | |
| IFPD_L3_N | O | | | | |
| IFPD_L3 | O | | | | |
| IFPE_L0_N | O | | | | |
| IFPE_L0 | O | | | | |
| IFPE_L1_N | O | | | | |
| IFPE_L1 | O | | | | |
| IFPE_L2_N | O | | | | |
| IFPE_L2 | O | | | | |
| IFPE_L3_N | O | | | | |
| IFPE_L3 | O | | | | |
| IFPF_L0_N | O | | | | |
| IFPF_L0 | O | | | | |
| IFPF_L1_N | O | | | | |
| IFPF_L1 | O | | | | |
| IFPF_L2_N | O | | | | |
| IFPF_L2 | O | | | | |
| IFPF_L3_N | O | | | | |
| IFPF_L3 | O | | | | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| IOB Key:<br>B = Bidirectional signal<br>I = Input signal<br>O = Output signal<br>P = Power-related signal<br>Z= Tri-state output<br>AB = Analog bidirectional signal<br>AI = Analog input signal<br>AO = Analog output signal | | Reset & Initial Value Key:<br>Z= Tri-state<br>X = Indeterminate<br>0 = Drive 0<br>1 = Drive 1<br>C = Drive with toggle (clock)<br>Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution. | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| IFPAB_RSET | AI | | | | |
| IFPCD_RSET | AI | | | | |
| IFPE_RSET | AI | | | | |
| IFPA_AUX_SCL | O | | | | |
| IFPA_AUX_SDA_N | B | | | | |
| IFPB_AUX_SCL | O | | | | |
| IFPB_AUX_SDA_N | B | | | | |
| IFPC_AUX_SCL | O | | | | |
| IFPC_AUX_SDA_N | B | | | | |
| IFPD_AUX_SCL | O | | | | |
| IFPD_AUX_SDA_N | B | | | | |
| IFPE_AUX_SCL | O | | | | |
| IFPE_AUX_SDA_N | B | | | | |
| IFPF_AUX_SCL | O | | | | |
| IFPF_AUX_SDA_N | B | | | | |
| IFPAB_PLLVDD | P | | | | |
| IFP_IOVDD | P | | | | |
| IFPCD_PLLVDD | P | | | | |
| IFPE_PLLVDD | P | | | | |
| IFPE_PLLVDD | P | | | | |
| Frame Buffer A | | | | | |
| FBA_D[63:0] | B | | | FBVDDQ | |
| FBA_DQM[7:0] | B | | | FBVDDQ | |
| FBA_DQS_WP[7:0] | I | | | FBVDDQ | |
| FBA_WCK01 | O | | | FBVDDQ | |
| FBA_WCK01_N | O | | | FBVDDQ | |
| FBA_WCKB01 | O | | | FBVDDQ | |
| FBA_WCKB01_N | O | | | FBVDDQ | |
| FBA_WCK23 | O | | | FBVDDQ | |
| FBA_WCK23_N | O | | | FBVDDQ | |
| FBA_WCKB23 | O | | | FBVDDQ | |
| FBA_WCKB23_N | O | | | FBVDDQ | |
| FBA_WCK45 | O | | | FBVDDQ | |
| FBA_WCK45_N | O | | | FBVDDQ | |
| FBA_WCKB45 | O | | | FBVDDQ | |
| FBA_WCKB45_N | O | | | FBVDDQ | |
| FBA_WCK67 | O | | | FBVDDQ | |
| FBA_WCK67_N | O | | | FBVDDQ | |
| FBA_WCKB67 | O | | | FBVDDQ | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| **IOB Key:**<br>**B = Bidirectional signal**<br>**I = Input signal**<br>**O = Output signal**<br>**P = Power-related signal**<br>**Z= Tri-state output**<br>**AB = Analog bidirectional signal**<br>**AI = Analog input signal**<br>**AO = Analog output signal** | | **Reset & Initial Value Key:**<br>**Z= Tri-state**<br>**X = Indeterminate**<br>**0 = Drive 0**<br>**1 = Drive 1**<br>**C = Drive with toggle (clock)**<br>**Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution.** | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| **FBA_WCKB67_N** | **O** | | | **FBVDDQ** | |
| **FBA_CMD[35:0]** | **O** | | | **FBVDDQ** | |
| **FBA_CLK0** | **O** | | | **FBVDDQ** | |
| **FBA_CLK0_N** | **O** | | | **FBVDDQ** | |
| **FBA_CLK1** | **O** | | | **FBVDDQ** | |
| **FBA_CLK1_N** | **O** | | | **FBVDDQ** | |
| **Frame Buffer B** | | | | | |
| **FBB_D[63:0]** | **B** | | | **FBVDDQ** | |
| **FBB_DQM[7:0]** | **B** | | | **FBVDDQ** | |
| **FBB_DQS_WP[7:0]** | **I** | | | **FBVDDQ** | |
| **FBB_WCK01** | **O** | | | **FBVDDQ** | |
| **FBB_WCK01_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB01** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB01_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCK23** | **O** | | | **FBVDDQ** | |
| **FBB_WCK23_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB23** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB23_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCK45** | **O** | | | **FBVDDQ** | |
| **FBB_WCK45_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB45** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB45_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCK67** | **O** | | | **FBVDDQ** | |
| **FBB_WCK67_N** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB67** | **O** | | | **FBVDDQ** | |
| **FBB_WCKB67_N** | **O** | | | **FBVDDQ** | |
| **FBB_CMD[35:0]** | **O** | | | **FBVDDQ** | |
| **FBB_CLK0** | **O** | | | **FBVDDQ** | |
| **FBB_CLK0_N** | **O** | | | **FBVDDQ** | |
| **FBB_CLK1** | **O** | | | **FBVDDQ** | |
| **FBB_CLK1_N** | **O** | | | **FBVDDQ** | |
| **Frame Buffer C** | | | | | |
| **FBC_D[63:0]** | **B** | | | **FBVDDQ** | |
| **FBC_DQM[7:0]** | **B** | | | **FBVDDQ** | |
| **FBC_DQS_WP[7:0]** | **I** | | | **FBVDDQ** | |
| **FBC_WCK01** | **O** | | | **FBVDDQ** | |
| **FBC_WCK01_N** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB01** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB01_N** | **O** | | | **FBVDDQ** | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| **IOB Key:**<br>**B = Bidirectional signal**<br>**I = Input signal**<br>**O = Output signal**<br>**P = Power-related signal**<br>**Z= Tri-state output**<br>**AB = Analog bidirectional signal**<br>**AI = Analog input signal**<br>**AO = Analog output signal** | | **Reset & Initial Value Key:**<br>**Z= Tri-state**<br>**X = Indeterminate**<br>**0 = Drive 0**<br>**1 = Drive 1**<br>**C = Drive with toggle (clock)**<br>**Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution.** | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| **FBC_WCK23** | **O** | | | **FBVDDQ** | |
| **FBC_WCK23_N** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB23** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB23_N** | **O** | | | **FBVDDQ** | |
| **FBC_WCK45** | **O** | | | **FBVDDQ** | |
| **FBC_WCK45_N** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB45** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB45_N** | **O** | | | **FBVDDQ** | |
| **FBC_WCK67** | **O** | | | **FBVDDQ** | |
| **FBC_WCK67_N** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB67** | **O** | | | **FBVDDQ** | |
| **FBC_WCKB67_N** | **O** | | | **FBVDDQ** | |
| **FBC_CMD[35:0]** | **O** | | | **FBVDDQ** | |
| **FBC_CLK0** | **O** | | | **FBVDDQ** | |
| **FBC_CLK0_N** | **O** | | | **FBVDDQ** | |
| **FBC_CLK1** | **O** | | | **FBVDDQ** | |
| **FBC_CLK1_N** | **O** | | | **FBVDDQ** | |
| **Frame Buffer D** | | | | | |
| **FBD_D[63:0]** | **B** | | | **FBVDDQ** | |
| **FBD_DQM[7:0]** | **B** | | | **FBVDDQ** | |
| **FBD_DQS_WP[7:0]** | **I** | | | **FBVDDQ** | |
| **FBD_WCK01** | **O** | | | **FBVDDQ** | |
| **FBD_WCK01_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB01** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB01_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCK23** | **O** | | | **FBVDDQ** | |
| **FBD_WCK23_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB23** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB23_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCK45** | **O** | | | **FBVDDQ** | |
| **FBD_WCK45_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB45** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB45_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCK67** | **O** | | | **FBVDDQ** | |
| **FBD_WCK67_N** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB67** | **O** | | | **FBVDDQ** | |
| **FBD_WCKB67_N** | **O** | | | **FBVDDQ** | |
| **FBD_CMD[35:0]** | **O** | | | **FBVDDQ** | |
| **FBD_CLK0** | **O** | | | **FBVDDQ** | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| IOB Key:<br>B = Bidirectional signal<br>I = Input signal<br>O = Output signal<br>P = Power-related signal<br>Z= Tri-state output<br>AB = Analog bidirectional signal<br>AI = Analog input signal<br>AO = Analog output signal | | Reset & Initial Value Key:<br>Z= Tri-state<br>X = Indeterminate<br>0 = Drive 0<br>1 = Drive 1<br>C = Drive with toggle (clock)<br>Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution. | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| FBD_CLK0_N | O | | | FBVDDQ | |
| FBD_CLK1 | O | | | FBVDDQ | |
| FBD_CLK1_N | O | | | FBVDDQ | |
| Mem Miscellaneous Signals | | | | | |
| FB_CAL_VDDQ | AI | | | FBVDDQ | |
| FB_CAL_GND | AI | | | FBVDDQ | |
| FB_CAL_TERM | AI | | | FBVDDQ | |
| FBVDDQ | P | | | | |
| FB_VREF | AI | | | FBVDDQ | |
| FBVDDQ_SENSE | AO | | | | |
| PCI Express | | | | | |
| PEX_RX[15:0] | I | | | | |
| PEX_RX[15:0]_N | I | | | | |
| PEX_TX[15:0] | O | | | | |
| PEX_TX[15:0]_N | O | | | | |
| PEX_REFCLK | I | | | | |
| PEX_REFCLK_N | I | | | | |
| PEX_CLKREQ_N | O | | | +1.8V_AON | |
| PEX_RST_N | I | | | +1.8V_AON | |
| PEX_HVDD | P | | | | |
| PEX_DVDD | P | | | | |
| PEX_PLL_HVDD | P | | | | |
| PEX_DVDD | P | | | | |
| PEX_WAKE_N | O | | | | |
| JTAG Interface | | | | | |
| JTAG_TMS | I | | | +1.8V_AON | |
| JTAG_TCK | I | | | +1.8V_AON | |
| JTAG_TRST_N | I | | | +1.8V_AON | |
| JTAG_TDI | I | | | +1.8V_AON | |
| JTAG_TDO | O | | | +1.8V_AON | |
| NVJTAG_SEL | I | | | +1.8V_AON | |
| Other Clocks | | | | | |
| ROM_CS_N | O | | | +1.8V_AON | |
| ROM_SCLK | B | | | +1.8V_AON | |
| ROM_SI | B | | | +1.8V_AON | |
| ROM_SO | B | | | +1.8V_AON | |
| XTAL_OUTBUFF | O | | | +1.8V_AON | |
| EXT_REFCLCK_FL | I | | | +1.8V_AON | |
| XTAL_IN | AI | | | +1.8V_AON | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| IOB Key:<br>B = Bidirectional signal<br>I = Input signal<br>O = Output signal<br>P = Power-related signal<br>Z= Tri-state output<br>AB = Analog bidirectional signal<br>AI = Analog input signal<br>AO = Analog output signal | | Reset & Initial Value Key:<br>Z= Tri-state<br>X = Indeterminate<br>0 = Drive 0<br>1 = Drive 1<br>C = Drive with toggle (clock)<br>Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution. | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| XTAL_OUT | AO | | | +1.8V_AON | |
| GPIO | | | | | |
| GPIO0 | B | | | +1.8V_AON | |
| GPIO1 | B | | | +1.8V_AON | |
| GPIO2 | B | | | +1.8V_AON | |
| GPIO3 | B | | | +1.8V_AON | |
| GPIO4 | B | | | +1.8V_AON | |
| GPIO5 | B | | | +1.8V_AON | |
| GPIO6 | B | | | +1.8V_AON | |
| GPIO7 | B | | | +1.8V_AON | |
| GPIO8 | B | | | +1.8V_AON | |
| GPIO9 | B | | | +1.8V_AON | |
| GPIO10 | B | | | +1.8V_AON | |
| GPIO11 | B | | | +1.8V_AON | |
| GPIO12 | B | | | +1.8V_AON | |
| GPIO13 | B | | | +1.8V_AON | |
| GPIO14 | B | | | +1.8V_AON | |
| GPIO15 | B | | | +1.8V_AON | |
| GPIO16 | B | | | +1.8V_AON | |
| GPIO17 | B | | | +1.8V_AON | |
| GPIO18 | B | | | +1.8V_AON | |
| GPIO19 | B | | | +1.8V_AON | |
| GPIO20 | B | | | +1.8V_AON | |
| GPIO21 | B | | | +1.8V_AON | |
| GPIO22 | B | | | +1.8V_AON | |
| GPIO23 | B | | | +1.8V_AON | |
| GPIO24 | B | | | +1.8V_AON | |
| GPIO25 | B | | | +1.8V_AON | |
| GPIO26 | B | | | +1.8V_AON | |
| GPIO27 | B | | | +1.8V_AON | |
| GPIO28 | B | | | +1.8V_AON | |
| GPIO29 | B | | | +1.8V_AON | |
| GPIO30 | B | | | +1.8V_AON | |
| System Interfaces | | | | | |
| BUFRST_N | O | | | +1.8V_AON | |
| STRAP0 | I | | | +1.8V_AON | |
| STRAP1 | I | | | +1.8V_AON | |
| STRAP2 | I | | | +1.8V_AON | |
| STRAP3 | I | | | +1.8V_AON | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| IOB Key:<br>B = Bidirectional signal<br>I = Input signal<br>O = Output signal<br>P = Power-related signal<br>Z= Tri-state output<br>AB = Analog bidirectional signal<br>AI = Analog input signal<br>AO = Analog output signal | | Reset & Initial Value Key:<br>Z= Tri-state<br>X = Indeterminate<br>0 = Drive 0<br>1 = Drive 1<br>C = Drive with toggle (clock)<br>Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution. | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| STRAP4 | I | | | +1.8V_AON | |
| STRAP5 | I | | | +1.8V_AON | |
| OVERT | B | | | +1.8V_AON | |
| THERMDP | AO | | | | |
| THERMDN | AO | | | | |
| TS_VREF | AI | | | | |
| GND_SENSE | AO | | | | |
| VDD_SENSE | AO | | | | |
| ADC_IN | AI | | | | |
| ADC_IN_N | AI | | | | |
| Power Direct Drills - IO voltage Rails & Core Voltages | | | | | |
| VDD | P | | | | |
| GND | P | | | | |
| 1V8_AON | P | | | +1.8V_AON | |
| PLLs | | | | | |
| XS_PLLVDD | P | | | | |
| FB_REFPLL_AVDD0 | P | | | | |
| FB_REFPLL_AVDD1 | P | | | | |
| VID_PLLVDD | P | | | | |
| SP_PLLVDD | P | | | | |
| XS_PLLVDD | P | | | | |
| GPCPLL_AVDD0 | P | | | | |
| GPCPLL_AVDD1 | P | | | | |
| FBA_PLL_AVDD | P | | | | |
| FBB_PLL_AVDD | P | | | | |
| FBC_PLL_AVDD | P | | | | |
| FBD_PLL_AVDD | P | | | | |
| USB | | | | | |
| USB_DVDD | P | | | | |
| USB_HVDD | P | | | | |
| USB_L0 | O | | | | |
| USB_L0_N | O | | | | |
| USB_L1 | O | | | | |
| USB_L1_N | O | | | | |
| USB_PLL_HVDD | P | | | | |
| USB_RBIAS | AI | | | | |
| USB_SCL | O | | | | |
| USB_SDA | B | | | | |
| USB_TERMP0 | AI | | | | |

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## Table 4.1 Master Signal List

| Master Signal List for TU106 GPU | | | | | |
|---|---|---|---|---|---|
| **IOB Key:**<br>**B = Bidirectional signal**<br>**I = Input signal**<br>**O = Output signal**<br>**P = Power-related signal**<br>**Z= Tri-state output**<br>**AB = Analog bidirectional signal**<br>**AI = Analog input signal**<br>**AO = Analog output signal** | | **Reset & Initial Value Key:**<br>**Z= Tri-state**<br>**X = Indeterminate**<br>**0 = Drive 0**<br>**1 = Drive 1**<br>**C = Drive with toggle (clock)**<br>**Note: Reset Value refers to the value while reset is being asserted to the GPU. Initial Value refers to the value after reset is released, but prior to any hardware or VBIOS execution.** | | | |
| **Signal Name** | **IOB** | **Reset Value** | **Initial Value** | **Drive** | **Notes** |
| **USB_TERMP1** | **AI** | | | | |
| **USB_VDDP** | **P** | | | | |

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# 5 PACKAGE DESCRIPTIONS

## Mechanical Specifications

This section provides the following mechanical specifications and characteristics for the TU106 GPU.

Figure 5.1 shows the package specifications for the TU106 GPU in a 37.5 mm x 37.5 mm FCBGA package with 2228 balls. Table 5.1 provides the package measurements.

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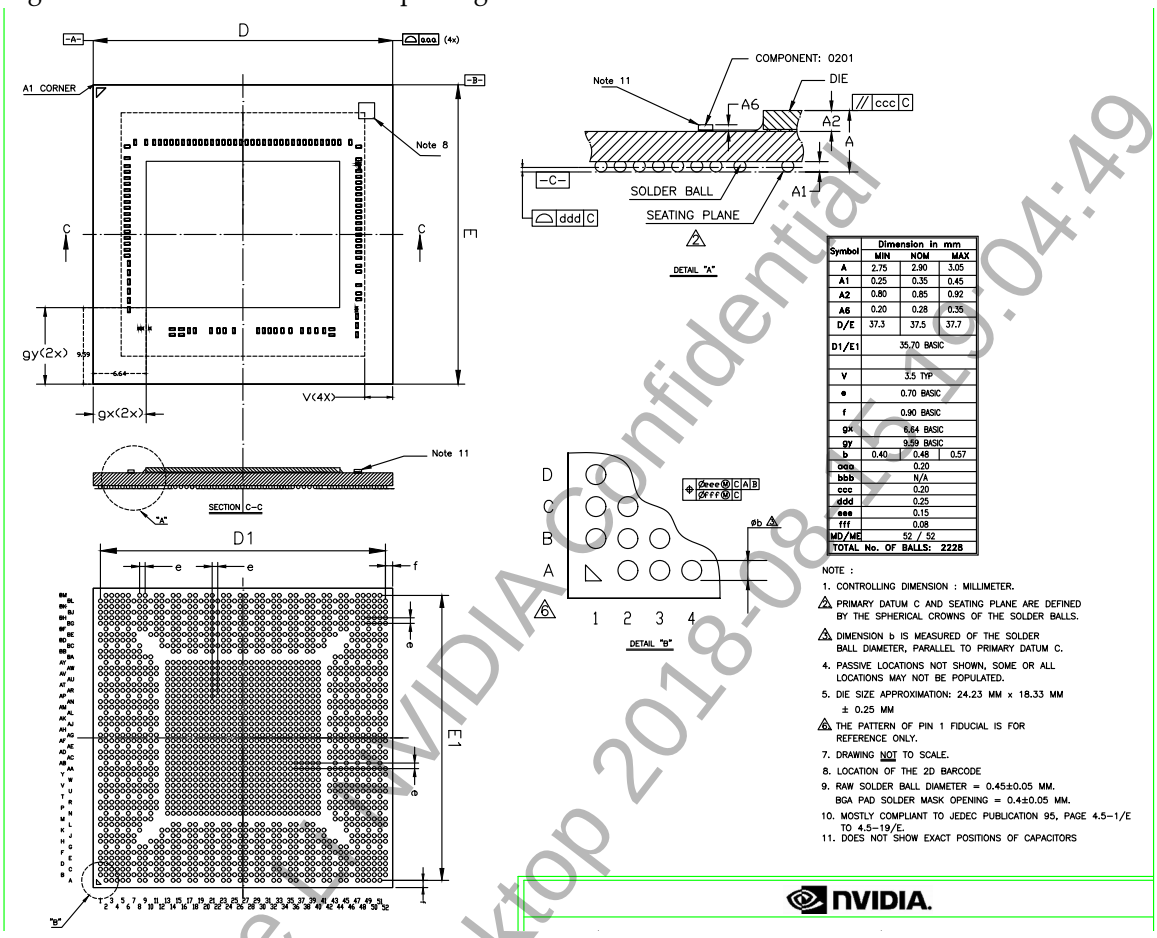
# GB4B-256 37.5 mm x 37.5 mm Package Specification

**Note: Drawings are not to scale.**

Figure 5.1 shows the GB4B-256 package.




| Symbol | Dimension in mm MIN | NOM | MAX |
|---|---|---|---|
| A | 2.75 | 2.90 | 3.05 |
| A1 | 0.25 | 0.35 | 0.45 |
| A2 | 0.80 | 0.85 | 0.92 |
| A6 | 0.20 | 0.28 | 0.35 |
| D/E | 37.3 | 37.5 | 37.7 |
| D1/E1 | | 35.70 BASIC | |
| V | | 3.5 TYP | |
| e | | 0.70 BASIC | |
| f | | 0.90 BASIC | |
| gx | | 6.84 BASIC | |
| gy | | 9.59 BASIC | |
| b | 0.40 | 0.48 | 0.57 |
| aaa | | 0.20 | |
| bbb | | N/A | |
| ccc | | 0.20 | |
| ddd | | 0.25 | |
| eee | | 0.15 | |
| fff | | 0.08 | |
| MD/ME | | 52 / 52 | |
| TOTAL No. OF BALLS: 2228 | | | |

Figure 5.1 GB4B-256 37.5 mm x 37.5 mm Package Specification

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# Mechanical and Environmental Specifications

Table 5.1 describes the mechanical characteristics for the packages.

## Table 5.1 Mechanical Characteristics

| Symbol | Parameter | Min. | Nominal | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| $P_{cont}$ | Maximum allowable pressure during PCA, system assembly and operation. | - | ≤60 | ≤80 (die edge) | psi | 1 |
| $T_{pkg}$ | Maximum allowable package temperature during device operation | - | - | ≤ TBD | °C | 2 |
| $T_{reflow}$ | Maximum package temperature during surface mount to printed circuit board | Refer to NVIDIA specifications 630-0011-001 | | | | |
| $e_{max}$ | Maximum allowable strain during PCA, system assembly or operation | | | ≤500 | µstrains | 3 |

**Notes:**

1) This specification is based on the following conditions:
   a. This specification is based on solder ball deformation and die chips and cracks. Additional requirements may be needed to meet the thermal performance and/or long term reliability as to specific application,
   b. When a compliant thermal interface is used between die and heat sink, the bond line thickness must have less than 20% in variation.
   c. The pressure should be measured on the top of the die surface by an instrument equipped pressure sensors. See details in "GPU Load Distribution Measurement Application Note".
   d. Nominal pressure is the total force divided by the die surface area. Since the pressure may have variations across the whole surfaces. The following additional requirement is applied:
      i. The pressure has to be measured from the top of the die surface with a grid resolution of 1x1mm2 for the pressure sensor.
   e. Both nominal and maximum pressure requirement must be met.
2) Maximum package temperature allowed. It includes device case and/or junction temperature.
3) Strain measurement shall follow IPC-9704, particularly on following items:
   a. The strain shall be measured on the top side of PCB close to the four corners of the package. A rigid PCB is assumed.
   b. For generic application, the max. allowable strain must be no more than 500 µstrains for a board thickness from 1.0 to 3.2mm. A separate requirement may be specified and the qualification test should be performed if
      i. A sensitive PCB laminate and build up structure is used where the pad cratering occurs at a PCB strain of 500 µstrains or below.
      ii. A weak surface finish of PCB is used where cracked solder joint has been observed at a PCB strain of 500 µstrains or below.
      iii. The strain rate is too high (.5000 µstrains/second) during the PCA operations.
   c. For PCB thickness less than 1,0mm, the max. allowable strain shall follow IPC 9704.

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Table 5.2 contains information regarding environmental specifications and conditions.

Table 5.2 Environmental Specifications

| Specifications | Conditions |
|---|---|
| Storage temperature | -40 °C to 125 °C |
| Operating humidity | 5% to 90% RH |
| Storage humidity | 5% to 95% RH |

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# 6 BALL INFORMATION

The TU106 GPU uses the GB4B-256 package. The GB4B-256 ball list and ball map are included in this chapter.

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# GB4B-256 Ball List (Sorted by Ball Name)

Table 6.1 GB4B-256 Ball List

| Ball Name | Ball # |
|---|---|
| 1V8_AON | BA10 |
| 1V8_AON | BB14 |
| 1V8_AON | BC14 |
| ADC_IN | BJ9 |
| ADC_IN* | BJ11 |
| BUFRST* | BF9 |
| EXT_REFCLK_FL | BJ6 |
| EXT_REFCLK_SLI | AM2 |
| FB_CAL_PD_VDDQ | R44 |
| FB_CAL_PU_GND | P44 |
| FB_CAL_TERM_GND | R45 |
| FB_REFPLL_AVDD0 | AF42 |
| FB_REFPLL_AVDD1 | L29 |
| FB_VREF | P45 |
| FBA_CLK0 | AG45 |
| FBA_CLK0* | AG46 |
| FBA_CLK1 | AK46 |
| FBA_CLK1* | AK45 |
| FBA_CMD0 | Y51 |
| FBA_CMD1 | Y52 |
| FBA_CMD10 | AD52 |
| FBA_CMD11 | AD51 |
| FBA_CMD12 | AD50 |
| FBA_CMD13 | AF50 |
| FBA_CMD14 | AF51 |
| FBA_CMD15 | AF52 |
| FBA_CMD16 | AN50 |
| FBA_CMD17 | AN51 |
| FBA_CMD18 | AN52 |
| FBA_CMD19 | AM49 |
| FBA_CMD2 | Y49 |
| FBA_CMD20 | AM52 |
| FBA_CMD21 | AM51 |
| FBA_CMD22 | AM50 |
| FBA_CMD23 | AK50 |
| FBA_CMD24 | AK51 |
| FBA_CMD25 | AK52 |
| FBA_CMD26 | AJ49 |
| FBA_CMD27 | AJ52 |
| FBA_CMD28 | AJ51 |
| FBA_CMD29 | AJ50 |
| FBA_CMD3 | AA52 |
| FBA_CMD30 | AG50 |
| FBA_CMD31 | AG51 |
| FBA_CMD32 | AF49 |
| FBA_CMD33 | AG52 |
| FBA_CMD34 | Y50 |
| FBA_CMD35 | AR50 |
| FBA_CMD4 | AA51 |
| FBA_CMD5 | AA50 |
| FBA_CMD6 | AC50 |
| FBA_CMD7 | AC51 |
| FBA_CMD8 | AC52 |
| FBA_CMD9 | AC49 |
| FBA_D0 | U51 |
| FBA_D1 | U48 |
| FBA_D10 | Y47 |
| FBA_D11 | Y46 |
| FBA_D12 | V50 |
| FBA_D13 | V47 |
| FBA_D14 | U52 |
| FBA_D15 | V51 |
| FBA_D16 | AJ44 |
| FBA_D17 | AG48 |
| FBA_D18 | AJ45 |
| FBA_D19 | AG49 |
| FBA_D2 | U50 |
| FBA_D20 | AF46 |
| FBA_D21 | AF47 |
| FBA_D22 | AF48 |
| FBA_D23 | AD47 |
| FBA_D24 | AD49 |
| FBA_D25 | AD48 |
| FBA_D26 | AC46 |
| FBA_D27 | AC47 |
| FBA_D28 | AA47 |
| FBA_D29 | AA46 |
| FBA_D3 | U49 |
| FBA_D30 | AA45 |
| FBA_D31 | Y44 |
| FBA_D32 | AW51 |
| FBA_D33 | BA52 |
| FBA_D34 | AW50 |
| FBA_D35 | BA51 |
| FBA_D36 | BA50 |
| FBA_D37 | BB50 |
| FBA_D38 | BA49 |
| FBA_D39 | AW49 |
| FBA_D4 | R51 |
| FBA_D40 | AV48 |
| FBA_D41 | AT49 |
| FBA_D42 | AT47 |
| FBA_D43 | AT48 |
| FBA_D44 | AT46 |
| FBA_D45 | AV51 |
| FBA_D46 | AV52 |
| FBA_D47 | AV49 |
| FBA_D48 | AJ48 |
| FBA_D49 | AJ46 |
| FBA_D5 | R50 |
| FBA_D50 | AJ47 |
| FBA_D51 | AK49 |
| FBA_D52 | AM47 |
| FBA_D53 | AM46 |
| FBA_D54 | AN48 |
| FBA_D55 | AN49 |
| FBA_D56 | AM44 |
| FBA_D57 | AM45 |
| FBA_D58 | AN45 |
| FBA_D59 | AN46 |
| FBA_D6 | R47 |
| FBA_D60 | AR48 |
| FBA_D61 | AN47 |

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| Ball Name | Ball # |
|---|---|
| FBA_D62 | AR47 |
| FBA_D63 | AR46 |
| FBA_D7 | U46 |
| FBA_D8 | V46 |
| FBA_D9 | Y45 |
| FBA_DBG_RFU1 | AA44 |
| FBA_DBG_RFU2 | AN44 |
| FBA_DQM0 | U47 |
| FBA_DQM1 | Y48 |
| FBA_DQM2 | AG47 |
| FBA_DQM3 | AC48 |
| FBA_DQM4 | BB51 |
| FBA_DQM5 | AV50 |
| FBA_DQM6 | AM48 |
| FBA_DQM7 | AR49 |
| FBA_DQS_WP0 | R48 |
| FBA_DQS_WP1 | V48 |
| FBA_DQS_WP2 | AF44 |
| FBA_DQS_WP3 | AA48 |
| FBA_DQS_WP4 | BB52 |
| FBA_DQS_WP5 | AT50 |
| FBA_DQS_WP6 | AK48 |
| FBA_DQS_WP7 | AR51 |
| FBA_PLL_AVDD | AN42 |
| FBA_WCK01 | U45 |
| FBA_WCK01* | U44 |
| FBA_WCK23 | AC45 |
| FBA_WCK23* | AC44 |
| FBA_WCK45 | AV47 |
| FBA_WCK45* | AV46 |
| FBA_WCK67 | AR45 |
| FBA_WCK67* | AR44 |
| FBA_WCKB01 | V45 |
| FBA_WCKB01* | V44 |
| FBA_WCKB23 | AD46 |
| FBA_WCKB23* | AD45 |
| FBA_WCKB45 | AW48 |
| FBA_WCKB45* | AW47 |
| FBA_WCKB67 | AT45 |
| FBA_WCKB67* | AT44 |
| FBB_CLK0 | H42 |

| Ball Name | Ball # |
|---|---|
| FBB_CLK0* | G42 |
| FBB_CLK1 | F47 |
| FBB_CLK1* | E47 |
| FBB_CMD0 | B35 |
| FBB_CMD1 | A35 |
| FBB_CMD10 | A39 |
| FBB_CMD11 | B39 |
| FBB_CMD12 | C39 |
| FBB_CMD13 | C41 |
| FBB_CMD14 | B41 |
| FBB_CMD15 | A41 |
| FBB_CMD16 | B49 |
| FBB_CMD17 | A49 |
| FBB_CMD18 | A48 |
| FBB_CMD19 | D47 |
| FBB_CMD2 | D35 |
| FBB_CMD20 | A47 |
| FBB_CMD21 | B47 |
| FBB_CMD22 | C47 |
| FBB_CMD23 | C45 |
| FBB_CMD24 | B45 |
| FBB_CMD25 | A45 |
| FBB_CMD26 | D44 |
| FBB_CMD27 | A44 |
| FBB_CMD28 | B44 |
| FBB_CMD29 | C44 |
| FBB_CMD3 | A36 |
| FBB_CMD30 | C42 |
| FBB_CMD31 | B42 |
| FBB_CMD32 | D41 |
| FBB_CMD33 | A42 |
| FBB_CMD34 | C35 |
| FBB_CMD35 | B50 |
| FBB_CMD4 | B36 |
| FBB_CMD5 | C36 |
| FBB_CMD6 | C38 |
| FBB_CMD7 | B38 |
| FBB_CMD8 | A38 |
| FBB_CMD9 | D38 |
| FBB_D0 | H32 |
| FBB_D1 | D32 |

| Ball Name | Ball # |
|---|---|
| FBB_D10 | J36 |
| FBB_D11 | F36 |
| FBB_D12 | F33 |
| FBB_D13 | D33 |
| FBB_D14 | J32 |
| FBB_D15 | G33 |
| FBB_D16 | E45 |
| FBB_D17 | D45 |
| FBB_D18 | F45 |
| FBB_D19 | G45 |
| FBB_D2 | A33 |
| FBB_D20 | D42 |
| FBB_D21 | E42 |
| FBB_D22 | F42 |
| FBB_D23 | H41 |
| FBB_D24 | E41 |
| FBB_D25 | F39 |
| FBB_D26 | E39 |
| FBB_D27 | D39 |
| FBB_D28 | F38 |
| FBB_D29 | E38 |
| FBB_D3 | B32 |
| FBB_D30 | D36 |
| FBB_D31 | E36 |
| FBB_D32 | M50 |
| FBB_D33 | P48 |
| FBB_D34 | M51 |
| FBB_D35 | M49 |
| FBB_D36 | P47 |
| FBB_D37 | P52 |
| FBB_D38 | R46 |
| FBB_D39 | P46 |
| FBB_D4 | E32 |
| FBB_D40 | L50 |
| FBB_D41 | L51 |
| FBB_D42 | L52 |
| FBB_D43 | L49 |
| FBB_D44 | M46 |
| FBB_D45 | L47 |
| FBB_D46 | M48 |
| FBB_D47 | M47 |

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| Ball Name | Ball # |
|---|---|
| FBB_D48 | D48 |
| FBB_D49 | C50 |
| FBB_D5 | G32 |
| FBB_D50 | C48 |
| FBB_D51 | C49 |
| FBB_D52 | E49 |
| FBB_D53 | E50 |
| FBB_D54 | F49 |
| FBB_D55 | F48 |
| FBB_D56 | F50 |
| FBB_D57 | D52 |
| FBB_D58 | J50 |
| FBB_D59 | H48 |
| FBB_D6 | J30 |
| FBB_D60 | H51 |
| FBB_D61 | J51 |
| FBB_D62 | H49 |
| FBB_D63 | H52 |
| FBB_D7 | F32 |
| FBB_D8 | H36 |
| FBB_D9 | G36 |
| FBB_DBG_RFU1 | J35 |
| FBB_DBG_RFU2 | J41 |
| FBB_DQM0 | C32 |
| FBB_DQM1 | E33 |
| FBB_DQM2 | E44 |
| FBB_DQM3 | G39 |
| FBB_DQM4 | P49 |
| FBB_DQM5 | L48 |
| FBB_DQM6 | D50 |
| FBB_DQM7 | H50 |
| FBB_DQS_WP0 | B33 |
| FBB_DQS_WP1 | E35 |
| FBB_DQS_WP2 | G44 |
| FBB_DQS_WP3 | H38 |
| FBB_DQS_WP4 | P50 |
| FBB_DQS_WP5 | J48 |
| FBB_DQS_WP6 | D51 |
| FBB_DQS_WP7 | F51 |
| FBB_PLL_AVDD | L38 |
| FBB_WCK01 | J33 |

| Ball Name | Ball # |
|---|---|
| FBB_WCK01* | H33 |
| FBB_WCK23 | J39 |
| FBB_WCK23* | H39 |
| FBB_WCK45 | L46 |
| FBB_WCK45* | L45 |
| FBB_WCK67 | H47 |
| FBB_WCK67* | H46 |
| FBB_WCKB01 | G35 |
| FBB_WCKB01* | H35 |
| FBB_WCKB23 | F41 |
| FBB_WCKB23* | G41 |
| FBB_WCKB45 | M44 |
| FBB_WCKB45* | M45 |
| FBB_WCKB67 | J47 |
| FBB_WCKB67* | J46 |
| FBC_CLK0 | G15 |
| FBC_CLK0* | F15 |
| FBC_CLK1 | H21 |
| FBC_CLK1* | J21 |
| FBC_CMD0 | C11 |
| FBC_CMD1 | B11 |
| FBC_CMD10 | D14 |
| FBC_CMD11 | A15 |
| FBC_CMD12 | B15 |
| FBC_CMD13 | C15 |
| FBC_CMD14 | C17 |
| FBC_CMD15 | B17 |
| FBC_CMD16 | B24 |
| FBC_CMD17 | A24 |
| FBC_CMD18 | D23 |
| FBC_CMD19 | A23 |
| FBC_CMD2 | A11 |
| FBC_CMD20 | B23 |
| FBC_CMD21 | C23 |
| FBC_CMD22 | C21 |
| FBC_CMD23 | B21 |
| FBC_CMD24 | A21 |
| FBC_CMD25 | D20 |
| FBC_CMD26 | A20 |
| FBC_CMD27 | B20 |
| FBC_CMD28 | C20 |

| Ball Name | Ball # |
|---|---|
| FBC_CMD29 | C18 |
| FBC_CMD3 | D11 |
| FBC_CMD30 | B18 |
| FBC_CMD31 | A18 |
| FBC_CMD32 | A17 |
| FBC_CMD33 | D17 |
| FBC_CMD34 | A9 |
| FBC_CMD35 | C24 |
| FBC_CMD4 | A12 |
| FBC_CMD5 | B12 |
| FBC_CMD6 | C12 |
| FBC_CMD7 | C14 |
| FBC_CMD8 | B14 |
| FBC_CMD9 | A14 |
| FBC_D0 | C6 |
| FBC_D1 | D6 |
| FBC_D10 | E9 |
| FBC_D11 | B9 |
| FBC_D12 | B8 |
| FBC_D13 | A8 |
| FBC_D14 | F6 |
| FBC_D15 | E6 |
| FBC_D16 | F18 |
| FBC_D17 | G18 |
| FBC_D18 | E18 |
| FBC_D19 | H18 |
| FBC_D2 | A6 |
| FBC_D20 | D15 |
| FBC_D21 | E15 |
| FBC_D22 | G17 |
| FBC_D23 | H17 |
| FBC_D24 | J15 |
| FBC_D25 | H15 |
| FBC_D26 | E14 |
| FBC_D27 | F14 |
| FBC_D28 | H11 |
| FBC_D29 | G11 |
| FBC_D3 | B6 |
| FBC_D30 | F11 |
| FBC_D31 | E11 |
| FBC_D32 | J29 |

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| Ball Name | Ball # |
|---|---|
| FBC_D33 | F30 |
| FBC_D34 | H29 |
| FBC_D35 | G30 |
| FBC_D36 | B30 |
| FBC_D37 | A30 |
| FBC_D38 | H30 |
| FBC_D39 | C30 |
| FBC_D4 | B4 |
| FBC_D40 | D27 |
| FBC_D41 | J26 |
| FBC_D42 | F27 |
| FBC_D43 | G27 |
| FBC_D44 | C27 |
| FBC_D45 | B27 |
| FBC_D46 | A27 |
| FBC_D47 | G29 |
| FBC_D48 | H20 |
| FBC_D49 | D18 |
| FBC_D5 | A4 |
| FBC_D50 | G20 |
| FBC_D51 | E20 |
| FBC_D52 | F23 |
| FBC_D53 | E21 |
| FBC_D54 | D21 |
| FBC_D55 | E23 |
| FBC_D56 | G24 |
| FBC_D57 | H26 |
| FBC_D58 | F24 |
| FBC_D59 | G26 |
| FBC_D6 | B3 |
| FBC_D60 | F26 |
| FBC_D61 | D26 |
| FBC_D62 | B26 |
| FBC_D63 | C26 |
| FBC_D7 | C4 |
| FBC_D8 | D9 |
| FBC_D9 | C9 |
| FBC_DBG_RFU1 | J14 |
| FBC_DBG_RFU2 | J23 |
| FBC_DQM0 | A5 |
| FBC_DQM1 | C8 |

| Ball Name | Ball # |
|---|---|
| FBC_DQM2 | J18 |
| FBC_DQM3 | F12 |
| FBC_DQM4 | D29 |
| FBC_DQM5 | E27 |
| FBC_DQM6 | F20 |
| FBC_DQM7 | E26 |
| FBC_DQS_WP0 | D5 |
| FBC_DQS_WP1 | D8 |
| FBC_DQS_WP2 | E17 |
| FBC_DQS_WP3 | E12 |
| FBC_DQS_WP4 | E30 |
| FBC_DQS_WP5 | B29 |
| FBC_DQS_WP6 | G21 |
| FBC_DQS_WP7 | E24 |
| FBC_PLL_AVDD | L17 |
| FBC_WCK01 | F8 |
| FBC_WCK01* | G8 |
| FBC_WCK23 | H12 |
| FBC_WCK23* | G12 |
| FBC_WCK45 | J27 |
| FBC_WCK45* | H27 |
| FBC_WCK67 | G23 |
| FBC_WCK67* | H23 |
| FBC_WCKB01 | G9 |
| FBC_WCKB01* | F9 |
| FBC_WCKB23 | G14 |
| FBC_WCKB23* | H14 |
| FBC_WCKB45 | E29 |
| FBC_WCKB45* | F29 |
| FBC_WCKB67 | H24 |
| FBC_WCKB67* | J24 |
| FBD_CLK0 | Y8 |
| FBD_CLK0* | Y7 |
| FBD_CLK1 | R8 |
| FBD_CLK1* | R7 |
| FBD_CMD0 | AD2 |
| FBD_CMD1 | AD1 |
| FBD_CMD10 | Y1 |
| FBD_CMD11 | Y2 |
| FBD_CMD12 | Y3 |
| FBD_CMD13 | V3 |

| Ball Name | Ball # |
|---|---|
| FBD_CMD14 | V2 |
| FBD_CMD15 | V1 |
| FBD_CMD16 | L3 |
| FBD_CMD17 | L2 |
| FBD_CMD18 | L1 |
| FBD_CMD19 | M4 |
| FBD_CMD2 | AD4 |
| FBD_CMD20 | M1 |
| FBD_CMD21 | M2 |
| FBD_CMD22 | M3 |
| FBD_CMD23 | P3 |
| FBD_CMD24 | P2 |
| FBD_CMD25 | P1 |
| FBD_CMD26 | R4 |
| FBD_CMD27 | R1 |
| FBD_CMD28 | R2 |
| FBD_CMD29 | R3 |
| FBD_CMD3 | AC1 |
| FBD_CMD30 | U3 |
| FBD_CMD31 | U2 |
| FBD_CMD32 | V4 |
| FBD_CMD33 | U1 |
| FBD_CMD34 | AD3 |
| FBD_CMD35 | J3 |
| FBD_CMD4 | AC2 |
| FBD_CMD5 | AC3 |
| FBD_CMD6 | AA3 |
| FBD_CMD7 | AA2 |
| FBD_CMD8 | AA1 |
| FBD_CMD9 | AA4 |
| FBD_D0 | AK8 |
| FBD_D1 | AK4 |
| FBD_D10 | AG6 |
| FBD_D11 | AG7 |
| FBD_D12 | AJ4 |
| FBD_D13 | AJ5 |
| FBD_D14 | AJ6 |
| FBD_D15 | AG5 |
| FBD_D16 | Y6 |
| FBD_D17 | Y5 |
| FBD_D18 | V5 |

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| Ball Name | Ball # |
|---|---|
| FBD_D19 | Y4 |
| FBD_D2 | AK2 |
| FBD_D20 | AA6 |
| FBD_D21 | AA5 |
| FBD_D22 | AC5 |
| FBD_D23 | AC4 |
| FBD_D24 | AD7 |
| FBD_D25 | AC6 |
| FBD_D26 | AF6 |
| FBD_D27 | AD6 |
| FBD_D28 | AF7 |
| FBD_D29 | AF8 |
| FBD_D3 | AK3 |
| FBD_D30 | AF2 |
| FBD_D31 | AF3 |
| FBD_D32 | F4 |
| FBD_D33 | E1 |
| FBD_D34 | F3 |
| FBD_D35 | F5 |
| FBD_D36 | D2 |
| FBD_D37 | D1 |
| FBD_D38 | C3 |
| FBD_D39 | C2 |
| FBD_D4 | AK5 |
| FBD_D40 | J5 |
| FBD_D41 | J4 |
| FBD_D42 | L8 |
| FBD_D43 | J2 |
| FBD_D44 | F1 |
| FBD_D45 | F2 |
| FBD_D46 | H4 |
| FBD_D47 | H5 |
| FBD_D48 | V7 |
| FBD_D49 | V8 |
| FBD_D5 | AK6 |
| FBD_D50 | V6 |
| FBD_D51 | V9 |
| FBD_D52 | U4 |
| FBD_D53 | R5 |
| FBD_D54 | R6 |
| FBD_D55 | U8 |

| Ball Name | Ball # |
|---|---|
| FBD_D56 | P6 |
| FBD_D57 | R9 |
| FBD_D58 | P4 |
| FBD_D59 | P5 |
| FBD_D6 | AK9 |
| FBD_D60 | L7 |
| FBD_D61 | L6 |
| FBD_D62 | L4 |
| FBD_D63 | L5 |
| FBD_D7 | AK7 |
| FBD_D8 | AG4 |
| FBD_D9 | AF9 |
| FBD_DBG_RFU1 | AC9 |
| FBD_DBG_RFU2 | P9 |
| FBD_DQM0 | AJ1 |
| FBD_DQM1 | AG1 |
| FBD_DQM2 | AA7 |
| FBD_DQM3 | AD5 |
| FBD_DQM4 | D3 |
| FBD_DQM5 | H3 |
| FBD_DQM6 | U5 |
| FBD_DQM7 | M9 |
| FBD_DQS_WP0 | AJ3 |
| FBD_DQS_WP1 | AG2 |
| FBD_DQS_WP2 | AA9 |
| FBD_DQS_WP3 | AF4 |
| FBD_DQS_WP4 | E3 |
| FBD_DQS_WP5 | H2 |
| FBD_DQS_WP6 | U6 |
| FBD_DQS_WP7 | M5 |
| FBD_PLL_AVDD | V11 |
| FBD_WCK01 | AJ8 |
| FBD_WCK01* | AJ7 |
| FBD_WCK23 | AD8 |
| FBD_WCK23* | AD9 |
| FBD_WCK45 | J6 |
| FBD_WCK45* | J7 |
| FBD_WCK67 | P8 |
| FBD_WCK67* | P7 |
| FBD_WCKB01 | AG8 |
| FBD_WCKB01* | AG9 |

| Ball Name | Ball # |
|---|---|
| FBD_WCKB23 | AC7 |
| FBD_WCKB23* | AC8 |
| FBD_WCKB45 | H7 |
| FBD_WCKB45* | H6 |
| FBD_WCKB67 | M7 |
| FBD_WCKB67* | M8 |
| FBVDDQ | AA10 |
| FBVDDQ | AA11 |
| FBVDDQ | AA42 |
| FBVDDQ | AA43 |
| FBVDDQ | AC10 |
| FBVDDQ | AC11 |
| FBVDDQ | AC42 |
| FBVDDQ | AC43 |
| FBVDDQ | AD10 |
| FBVDDQ | AD11 |
| FBVDDQ | AD42 |
| FBVDDQ | AD43 |
| FBVDDQ | AF10 |
| FBVDDQ | AF43 |
| FBVDDQ | AG10 |
| FBVDDQ | AG11 |
| FBVDDQ | AG42 |
| FBVDDQ | AG43 |
| FBVDDQ | AJ10 |
| FBVDDQ | AJ11 |
| FBVDDQ | AJ42 |
| FBVDDQ | AJ43 |
| FBVDDQ | AK10 |
| FBVDDQ | AK11 |
| FBVDDQ | AK42 |
| FBVDDQ | AK43 |
| FBVDDQ | AM42 |
| FBVDDQ | AM43 |
| FBVDDQ | AN43 |
| FBVDDQ | AR42 |
| FBVDDQ | AR43 |
| FBVDDQ | AT43 |
| FBVDDQ | K12 |
| FBVDDQ | K14 |
| FBVDDQ | K15 |

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| Ball Name | Ball # |
|---|---|
| FBVDDQ | K17 |
| FBVDDQ | K18 |
| FBVDDQ | K20 |
| FBVDDQ | K21 |
| FBVDDQ | K23 |
| FBVDDQ | K24 |
| FBVDDQ | K26 |
| FBVDDQ | K27 |
| FBVDDQ | K29 |
| FBVDDQ | K30 |
| FBVDDQ | K32 |
| FBVDDQ | K33 |
| FBVDDQ | K35 |
| FBVDDQ | K36 |
| FBVDDQ | K38 |
| FBVDDQ | K39 |
| FBVDDQ | K41 |
| FBVDDQ | L14 |
| FBVDDQ | L15 |
| FBVDDQ | L18 |
| FBVDDQ | L20 |
| FBVDDQ | L21 |
| FBVDDQ | L23 |
| FBVDDQ | L24 |
| FBVDDQ | L26 |
| FBVDDQ | L27 |
| FBVDDQ | L30 |
| FBVDDQ | L32 |
| FBVDDQ | L33 |
| FBVDDQ | L35 |
| FBVDDQ | L36 |
| FBVDDQ | L39 |
| FBVDDQ | M10 |
| FBVDDQ | M43 |
| FBVDDQ | P10 |
| FBVDDQ | P11 |
| FBVDDQ | P42 |
| FBVDDQ | P43 |
| FBVDDQ | R10 |
| FBVDDQ | R11 |
| FBVDDQ | R42 |

| Ball Name | Ball # |
|---|---|
| FBVDDQ | R43 |
| FBVDDQ | U10 |
| FBVDDQ | U11 |
| FBVDDQ | U43 |
| FBVDDQ | V10 |
| FBVDDQ | V42 |
| FBVDDQ | V43 |
| FBVDDQ | Y10 |
| FBVDDQ | Y11 |
| FBVDDQ | Y42 |
| FBVDDQ | Y43 |
| FBVDDQ_SENSE | E52 |
| FP_FUSE_SRC | BD14 |
| GND | A2 |
| GND | A26 |
| GND | A29 |
| GND | A3 |
| GND | A32 |
| GND | A50 |
| GND | A51 |
| GND | AA49 |
| GND | AA8 |
| GND | AB10 |
| GND | AB14 |
| GND | AB15 |
| GND | AB16 |
| GND | AB17 |
| GND | AB18 |
| GND | AB19 |
| GND | AB2 |
| GND | AB20 |
| GND | AB21 |
| GND | AB22 |
| GND | AB23 |
| GND | AB24 |
| GND | AB25 |
| GND | AB26 |
| GND | AB27 |
| GND | AB28 |
| GND | AB29 |
| GND | AB30 |

| Ball Name | Ball # |
|---|---|
| GND | AB31 |
| GND | AB32 |
| GND | AB33 |
| GND | AB34 |
| GND | AB35 |
| GND | AB36 |
| GND | AB37 |
| GND | AB38 |
| GND | AB39 |
| GND | AB4 |
| GND | AB43 |
| GND | AB45 |
| GND | AB47 |
| GND | AB49 |
| GND | AB51 |
| GND | AB6 |
| GND | AB8 |
| GND | AD14 |
| GND | AD15 |
| GND | AD16 |
| GND | AD17 |
| GND | AD18 |
| GND | AD19 |
| GND | AD20 |
| GND | AD21 |
| GND | AD22 |
| GND | AD23 |
| GND | AD24 |
| GND | AD25 |
| GND | AD26 |
| GND | AD27 |
| GND | AD28 |
| GND | AD29 |
| GND | AD30 |
| GND | AD31 |
| GND | AD32 |
| GND | AD33 |
| GND | AD34 |
| GND | AD35 |
| GND | AD36 |
| GND | AD37 |

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| Ball Name | Ball # |
|---|---|
| GND | AD38 |
| GND | AD39 |
| GND | AD44 |
| GND | AE10 |
| GND | AE2 |
| GND | AE4 |
| GND | AE43 |
| GND | AE45 |
| GND | AE47 |
| GND | AE49 |
| GND | AE51 |
| GND | AE6 |
| GND | AE8 |
| GND | AF1 |
| GND | AF19 |
| GND | AF20 |
| GND | AF21 |
| GND | AF22 |
| GND | AF23 |
| GND | AF27 |
| GND | AF28 |
| GND | AF29 |
| GND | AF35 |
| GND | AF36 |
| GND | AF37 |
| GND | AF38 |
| GND | AF39 |
| GND | AF45 |
| GND | AF5 |
| GND | AG14 |
| GND | AG15 |
| GND | AG16 |
| GND | AG17 |
| GND | AG18 |
| GND | AG24 |
| GND | AG25 |
| GND | AG26 |
| GND | AG3 |
| GND | AG30 |
| GND | AG31 |
| GND | AG32 |

| Ball Name | Ball # |
|---|---|
| GND | AG33 |
| GND | AG34 |
| GND | AG44 |
| GND | AH10 |
| GND | AH2 |
| GND | AH4 |
| GND | AH43 |
| GND | AH45 |
| GND | AH47 |
| GND | AH49 |
| GND | AH51 |
| GND | AH6 |
| GND | AH8 |
| GND | AJ14 |
| GND | AJ15 |
| GND | AJ16 |
| GND | AJ17 |
| GND | AJ18 |
| GND | AJ19 |
| GND | AJ2 |
| GND | AJ20 |
| GND | AJ21 |
| GND | AJ22 |
| GND | AJ23 |
| GND | AJ24 |
| GND | AJ25 |
| GND | AJ26 |
| GND | AJ27 |
| GND | AJ28 |
| GND | AJ29 |
| GND | AJ30 |
| GND | AJ31 |
| GND | AJ32 |
| GND | AJ33 |
| GND | AJ34 |
| GND | AJ35 |
| GND | AJ36 |
| GND | AJ37 |
| GND | AJ38 |
| GND | AJ39 |
| GND | AJ9 |

| Ball Name | Ball # |
|---|---|
| GND | AK1 |
| GND | AK44 |
| GND | AK47 |
| GND | AL10 |
| GND | AL14 |
| GND | AL15 |
| GND | AL16 |
| GND | AL17 |
| GND | AL18 |
| GND | AL19 |
| GND | AL2 |
| GND | AL20 |
| GND | AL21 |
| GND | AL22 |
| GND | AL23 |
| GND | AL24 |
| GND | AL25 |
| GND | AL26 |
| GND | AL27 |
| GND | AL28 |
| GND | AL29 |
| GND | AL30 |
| GND | AL31 |
| GND | AL32 |
| GND | AL33 |
| GND | AL34 |
| GND | AL35 |
| GND | AL36 |
| GND | AL37 |
| GND | AL38 |
| GND | AL39 |
| GND | AL4 |
| GND | AL43 |
| GND | AL45 |
| GND | AL47 |
| GND | AL49 |
| GND | AL51 |
| GND | AL6 |
| GND | AL8 |
| GND | AM4 |
| GND | AM9 |

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| Ball Name | Ball # |
|---|---|
| GND | AN14 |
| GND | AN15 |
| GND | AN16 |
| GND | AN17 |
| GND | AN18 |
| GND | AN19 |
| GND | AN20 |
| GND | AN21 |
| GND | AN22 |
| GND | AN23 |
| GND | AN24 |
| GND | AN25 |
| GND | AN26 |
| GND | AN27 |
| GND | AN28 |
| GND | AN29 |
| GND | AN30 |
| GND | AN31 |
| GND | AN32 |
| GND | AN33 |
| GND | AN34 |
| GND | AN35 |
| GND | AN36 |
| GND | AN37 |
| GND | AN38 |
| GND | AN39 |
| GND | AN4 |
| GND | AN5 |
| GND | AN8 |
| GND | AP10 |
| GND | AP2 |
| GND | AP4 |
| GND | AP43 |
| GND | AP45 |
| GND | AP47 |
| GND | AP49 |
| GND | AP51 |
| GND | AP6 |
| GND | AP8 |
| GND | AR14 |
| GND | AR15 |

| Ball Name | Ball # |
|---|---|
| GND | AR16 |
| GND | AR17 |
| GND | AR18 |
| GND | AR19 |
| GND | AR20 |
| GND | AR21 |
| GND | AR22 |
| GND | AR23 |
| GND | AR24 |
| GND | AR25 |
| GND | AR26 |
| GND | AR27 |
| GND | AR28 |
| GND | AR29 |
| GND | AR30 |
| GND | AR31 |
| GND | AR32 |
| GND | AR33 |
| GND | AR34 |
| GND | AR35 |
| GND | AR36 |
| GND | AR37 |
| GND | AR38 |
| GND | AR39 |
| GND | AR4 |
| GND | AR52 |
| GND | AR9 |
| GND | AT4 |
| GND | AT5 |
| GND | AT51 |
| GND | AT52 |
| GND | AT8 |
| GND | AU10 |
| GND | AU14 |
| GND | AU15 |
| GND | AU16 |
| GND | AU17 |
| GND | AU18 |
| GND | AU19 |
| GND | AU2 |
| GND | AU20 |

| Ball Name | Ball # |
|---|---|
| GND | AU21 |
| GND | AU22 |
| GND | AU23 |
| GND | AU24 |
| GND | AU25 |
| GND | AU26 |
| GND | AU27 |
| GND | AU28 |
| GND | AU29 |
| GND | AU30 |
| GND | AU31 |
| GND | AU32 |
| GND | AU33 |
| GND | AU34 |
| GND | AU35 |
| GND | AU36 |
| GND | AU37 |
| GND | AU38 |
| GND | AU39 |
| GND | AU4 |
| GND | AU45 |
| GND | AU47 |
| GND | AU49 |
| GND | AU51 |
| GND | AU6 |
| GND | AU8 |
| GND | AV4 |
| GND | AV45 |
| GND | AV9 |
| GND | AW14 |
| GND | AW15 |
| GND | AW16 |
| GND | AW17 |
| GND | AW18 |
| GND | AW19 |
| GND | AW20 |
| GND | AW21 |
| GND | AW22 |
| GND | AW23 |
| GND | AW24 |
| GND | AW25 |

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| Ball Name | Ball # |
|---|---|
| GND | AW26 |
| GND | AW27 |
| GND | AW28 |
| GND | AW29 |
| GND | AW30 |
| GND | AW31 |
| GND | AW32 |
| GND | AW33 |
| GND | AW34 |
| GND | AW35 |
| GND | AW36 |
| GND | AW37 |
| GND | AW38 |
| GND | AW39 |
| GND | AW4 |
| GND | AW46 |
| GND | AW5 |
| GND | AW52 |
| GND | AW8 |
| GND | AY10 |
| GND | AY2 |
| GND | AY4 |
| GND | AY47 |
| GND | AY49 |
| GND | AY51 |
| GND | AY6 |
| GND | AY8 |
| GND | B1 |
| GND | B10 |
| GND | B13 |
| GND | B16 |
| GND | B19 |
| GND | B2 |
| GND | B22 |
| GND | B25 |
| GND | B28 |
| GND | B31 |
| GND | B34 |
| GND | B37 |
| GND | B40 |
| GND | B43 |

| Ball Name | Ball # |
|---|---|
| GND | B46 |
| GND | B48 |
| GND | B5 |
| GND | B51 |
| GND | B52 |
| GND | B7 |
| GND | BA48 |
| GND | BA9 |
| GND | BB49 |
| GND | BC13 |
| GND | BC16 |
| GND | BC19 |
| GND | BC2 |
| GND | BC22 |
| GND | BC25 |
| GND | BC28 |
| GND | BC31 |
| GND | BC34 |
| GND | BC37 |
| GND | BC4 |
| GND | BC51 |
| GND | BC6 |
| GND | BC8 |
| GND | BD26 |
| GND | BD29 |
| GND | BD32 |
| GND | BD35 |
| GND | BD38 |
| GND | BD52 |
| GND | BE10 |
| GND | BE13 |
| GND | BE15 |
| GND | BE16 |
| GND | BE18 |
| GND | BE19 |
| GND | BE21 |
| GND | BE22 |
| GND | BE24 |
| GND | BE25 |
| GND | BE27 |
| GND | BE28 |

| Ball Name | Ball # |
|---|---|
| GND | BE30 |
| GND | BE31 |
| GND | BE33 |
| GND | BE34 |
| GND | BE36 |
| GND | BE37 |
| GND | BE39 |
| GND | BE40 |
| GND | BF2 |
| GND | BF4 |
| GND | BF41 |
| GND | BF6 |
| GND | BG10 |
| GND | BG13 |
| GND | BG16 |
| GND | BG19 |
| GND | BG22 |
| GND | BG25 |
| GND | BG28 |
| GND | BG31 |
| GND | BG34 |
| GND | BG37 |
| GND | BG40 |
| GND | BG42 |
| GND | BG7 |
| GND | BH15 |
| GND | BH18 |
| GND | BH2 |
| GND | BH21 |
| GND | BH24 |
| GND | BH27 |
| GND | BH30 |
| GND | BH33 |
| GND | BH36 |
| GND | BH39 |
| GND | BH42 |
| GND | BH5 |
| GND | BJ10 |
| GND | BJ12 |
| GND | BJ13 |
| GND | BJ14 |

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| Ball Name | Ball # |
|---|---|
| GND | BJ15 |
| GND | BJ16 |
| GND | BJ17 |
| GND | BJ18 |
| GND | BJ19 |
| GND | BJ20 |
| GND | BJ21 |
| GND | BJ22 |
| GND | BJ23 |
| GND | BJ24 |
| GND | BJ25 |
| GND | BJ26 |
| GND | BJ27 |
| GND | BJ28 |
| GND | BJ29 |
| GND | BJ30 |
| GND | BJ31 |
| GND | BJ32 |
| GND | BJ33 |
| GND | BJ34 |
| GND | BJ35 |
| GND | BJ36 |
| GND | BJ37 |
| GND | BJ38 |
| GND | BJ39 |
| GND | BJ40 |
| GND | BJ41 |
| GND | BJ42 |
| GND | BJ43 |
| GND | BJ7 |
| GND | BK1 |
| GND | BL1 |
| GND | BL10 |
| GND | BL13 |
| GND | BL16 |
| GND | BL19 |
| GND | BL2 |
| GND | BL22 |
| GND | BL25 |
| GND | BL28 |
| GND | BL31 |

| Ball Name | Ball # |
|---|---|
| GND | BL34 |
| GND | BL37 |
| GND | BL40 |
| GND | BL43 |
| GND | BL5 |
| GND | BL7 |
| GND | BM2 |
| GND | BM3 |
| GND | C1 |
| GND | C29 |
| GND | C33 |
| GND | C5 |
| GND | C51 |
| GND | C52 |
| GND | D10 |
| GND | D12 |
| GND | D13 |
| GND | D16 |
| GND | D19 |
| GND | D22 |
| GND | D24 |
| GND | D25 |
| GND | D28 |
| GND | D30 |
| GND | D31 |
| GND | D34 |
| GND | D37 |
| GND | D4 |
| GND | D40 |
| GND | D43 |
| GND | D46 |
| GND | D49 |
| GND | D7 |
| GND | E2 |
| GND | E4 |
| GND | E48 |
| GND | E5 |
| GND | E51 |
| GND | E8 |
| GND | F10 |
| GND | F13 |

| Ball Name | Ball # |
|---|---|
| GND | F16 |
| GND | F17 |
| GND | F19 |
| GND | F21 |
| GND | F22 |
| GND | F25 |
| GND | F28 |
| GND | F31 |
| GND | F34 |
| GND | F35 |
| GND | F37 |
| GND | F40 |
| GND | F43 |
| GND | F44 |
| GND | F46 |
| GND | F52 |
| GND | F7 |
| GND | G2 |
| GND | G38 |
| GND | G4 |
| GND | G47 |
| GND | G49 |
| GND | G51 |
| GND | G6 |
| GND | H1 |
| GND | H10 |
| GND | H13 |
| GND | H16 |
| GND | H19 |
| GND | H22 |
| GND | H25 |
| GND | H28 |
| GND | H31 |
| GND | H34 |
| GND | H37 |
| GND | H40 |
| GND | H43 |
| GND | J1 |
| GND | J12 |
| GND | J17 |
| GND | J20 |

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| Ball Name | Ball # |
|---|---|
| GND | J38 |
| GND | J49 |
| GND | J52 |
| GND | K13 |
| GND | K16 |
| GND | K19 |
| GND | K2 |
| GND | K22 |
| GND | K25 |
| GND | K28 |
| GND | K31 |
| GND | K34 |
| GND | K37 |
| GND | K4 |
| GND | K40 |
| GND | K45 |
| GND | K47 |
| GND | K49 |
| GND | K51 |
| GND | K6 |
| GND | K8 |
| GND | M52 |
| GND | M6 |
| GND | N10 |
| GND | N2 |
| GND | N4 |
| GND | N43 |
| GND | N45 |
| GND | N47 |
| GND | N49 |
| GND | N51 |
| GND | N6 |
| GND | N8 |
| GND | P14 |
| GND | P15 |
| GND | P16 |
| GND | P17 |
| GND | P18 |
| GND | P19 |
| GND | P20 |
| GND | P21 |

| Ball Name | Ball # |
|---|---|
| GND | P22 |
| GND | P23 |
| GND | P24 |
| GND | P25 |
| GND | P26 |
| GND | P27 |
| GND | P28 |
| GND | P29 |
| GND | P30 |
| GND | P31 |
| GND | P32 |
| GND | P33 |
| GND | P34 |
| GND | P35 |
| GND | P36 |
| GND | P37 |
| GND | P38 |
| GND | P39 |
| GND | P51 |
| GND | R49 |
| GND | R52 |
| GND | T10 |
| GND | T14 |
| GND | T15 |
| GND | T16 |
| GND | T17 |
| GND | T18 |
| GND | T19 |
| GND | T2 |
| GND | T20 |
| GND | T21 |
| GND | T22 |
| GND | T23 |
| GND | T24 |
| GND | T25 |
| GND | T26 |
| GND | T27 |
| GND | T28 |
| GND | T29 |
| GND | T30 |
| GND | T31 |

| Ball Name | Ball # |
|---|---|
| GND | T32 |
| GND | T33 |
| GND | T34 |
| GND | T35 |
| GND | T36 |
| GND | T37 |
| GND | T38 |
| GND | T39 |
| GND | T4 |
| GND | T43 |
| GND | T45 |
| GND | T47 |
| GND | T49 |
| GND | T51 |
| GND | T6 |
| GND | T8 |
| GND | U7 |
| GND | U9 |
| GND | V14 |
| GND | V15 |
| GND | V16 |
| GND | V17 |
| GND | V18 |
| GND | V19 |
| GND | V20 |
| GND | V21 |
| GND | V22 |
| GND | V23 |
| GND | V24 |
| GND | V25 |
| GND | V26 |
| GND | V27 |
| GND | V28 |
| GND | V29 |
| GND | V30 |
| GND | V31 |
| GND | V32 |
| GND | V33 |
| GND | V34 |
| GND | V35 |
| GND | V36 |

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| Ball Name | Ball # |
|---|---|
| GND | V37 |
| GND | V38 |
| GND | V39 |
| GND | V49 |
| GND | V52 |
| GND | W10 |
| GND | W2 |
| GND | W4 |
| GND | W43 |
| GND | W45 |
| GND | W47 |
| GND | W49 |
| GND | W51 |
| GND | W6 |
| GND | W8 |
| GND | Y14 |
| GND | Y15 |
| GND | Y16 |
| GND | Y17 |
| GND | Y18 |
| GND | Y19 |
| GND | Y20 |
| GND | Y21 |
| GND | Y22 |
| GND | Y23 |
| GND | Y24 |
| GND | Y25 |
| GND | Y26 |
| GND | Y27 |
| GND | Y28 |
| GND | Y29 |
| GND | Y30 |
| GND | Y31 |
| GND | Y32 |
| GND | Y33 |
| GND | Y34 |
| GND | Y35 |
| GND | Y36 |
| GND | Y37 |
| GND | Y38 |
| GND | Y39 |

| Ball Name | Ball # |
|---|---|
| GND | Y9 |
| GND | BC24 |
| GND_SENSE | BL45 |
| GPCPLL_AVDD0 | U42 |
| GPCPLL_AVDD1 | AF11 |
| GPIO0 | BD6 |
| GPIO1 | BB5 |
| GPIO10 | BD3 |
| GPIO11 | BH3 |
| GPIO12 | BE6 |
| GPIO13 | BB1 |
| GPIO14 | BG4 |
| GPIO15 | BG1 |
| GPIO16 | BE2 |
| GPIO17 | BH1 |
| GPIO18 | BE3 |
| GPIO19 | BD4 |
| GPIO2 | BD1 |
| GPIO20 | BE5 |
| GPIO21 | BA5 |
| GPIO22 | BB6 |
| GPIO23 | BG3 |
| GPIO24 | BD5 |
| GPIO25 | BB2 |
| GPIO26 | BE7 |
| GPIO27 | BA4 |
| GPIO28 | BB4 |
| GPIO29 | BA3 |
| GPIO3 | BE4 |
| GPIO30 | BB3 |
| GPIO4 | BE1 |
| GPIO5 | BG2 |
| GPIO6 | BD2 |
| GPIO7 | BD7 |
| GPIO8 | BH4 |
| GPIO9 | BJ3 |
| I2CB_SCL | BG8 |
| I2CB_SDA | BF8 |
| I2CC_SCL | BG9 |
| I2CC_SDA | BH9 |
| I2CS_SCL | BJ8 |

| Ball Name | Ball # |
|---|---|
| I2CS_SDA | BH8 |
| IFP_IOVDD | BB17 |
| IFP_IOVDD | BC23 |
| IFP_IOVDD | BB18 |
| IFP_IOVDD | BB20 |
| IFP_IOVDD | BB21 |
| IFP_IOVDD | BB23 |
| IFP_IOVDD | BC17 |
| IFP_IOVDD | BC18 |
| IFP_IOVDD | BC20 |
| IFP_IOVDD | BC21 |
| IFPA_AUX_SCL | BG11 |
| IFPA_AUX_SDA* | BH11 |
| IFPA_L0 | BG24 |
| IFPA_L0* | BF24 |
| IFPA_L1 | BE23 |
| IFPA_L1* | BF23 |
| IFPA_L2 | BH23 |
| IFPA_L2* | BG23 |
| IFPA_L3 | BG21 |
| IFPA_L3* | BF21 |
| IFPAB_PLLVDD | BD21 |
| IFPAB_RSET | BD23 |
| IFPB_AUX_SCL | BH12 |
| IFPB_AUX_SDA* | BG12 |
| IFPB_L0 | BK21 |
| IFPB_L0* | BL21 |
| IFPB_L1 | BM21 |
| IFPB_L1* | BM20 |
| IFPB_L2 | BL20 |
| IFPB_L2* | BK20 |
| IFPB_L3 | BK18 |
| IFPB_L3* | BL18 |
| IFPC_AUX_SCL | BK9 |
| IFPC_AUX_SDA* | BL9 |
| IFPC_L0 | BE20 |
| IFPC_L0* | BF20 |
| IFPC_L1 | BH20 |
| IFPC_L1* | BG20 |
| IFPC_L2 | BG18 |
| IFPC_L2* | BF18 |

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| Ball Name | Ball # |
|---|---|
| IFPC_L3 | BE17 |
| IFPC_L3* | BF17 |
| IFPCD_PLLVDD | BD18 |
| IFPCD_RSET | BD20 |
| IFPD_AUX_SCL | BE11 |
| IFPD_AUX_SDA* | BF11 |
| IFPD_L0 | BM18 |
| IFPD_L0* | BM17 |
| IFPD_L1 | BL17 |
| IFPD_L1* | BK17 |
| IFPD_L2 | BK15 |
| IFPD_L2* | BL15 |
| IFPD_L3 | BM15 |
| IFPD_L3* | BM14 |
| IFPE_AUX_SCL | BK8 |
| IFPE_AUX_SDA* | BL8 |
| IFPE_L0 | BH17 |
| IFPE_L0* | BG17 |
| IFPE_L1 | BG15 |
| IFPE_L1* | BF15 |
| IFPE_L2 | BE14 |
| IFPE_L2* | BF14 |
| IFPE_L3 | BH14 |
| IFPE_L3* | BG14 |
| IFPE_PLLVDD | BD15 |
| IFPE_RSET | BD17 |
| IFPF_AUX_SCL | BM8 |
| IFPF_AUX_SDA* | BM9 |
| IFPF_L0 | BL14 |
| IFPF_L0* | BK14 |
| IFPF_L1 | BK12 |
| IFPF_L1* | BL12 |
| IFPF_L2 | BM12 |
| IFPF_L2* | BM11 |
| IFPF_L3 | BL11 |
| IFPF_L3* | BK11 |
| JTAG_TCK | BK24 |
| JTAG_TDI | BM23 |
| JTAG_TDO | BM24 |
| JTAG_TMS | BL23 |
| JTAG_TRST* | BL24 |

| Ball Name | Ball # |
|---|---|
| NC | BD24 |
| NC | BM44 |
| NC | AR10 |
| NC | AT11 |
| NC | AT10 |
| NC | AT9 |
| NC | AV10 |
| NC | AV11 |
| NC | AM10 |
| NC | AM11 |
| NC | AN10 |
| NC | AN11 |
| NC | AR11 |
| NC | AN9 |
| NC | AM6 |
| NC | AM5 |
| NC | AM3 |
| NC | AM1 |
| NC | AN1 |
| NC | AN2 |
| NC | AN3 |
| NC | AR3 |
| NC | AR2 |
| NC | AR1 |
| NC | AT1 |
| NC | AT2 |
| NC | AT3 |
| NC | AV3 |
| NC | AV2 |
| NC | AV1 |
| NC | AW1 |
| NC | AW2 |
| NC | AW3 |
| NC | AM7 |
| NC | AM8 |
| NC | AN7 |
| NC | AN6 |
| NC | AR6 |
| NC | AR5 |
| NC | AR7 |
| NC | AR8 |

| Ball Name | Ball # |
|---|---|
| NC | AT7 |
| NC | AT6 |
| NC | AV6 |
| NC | AV5 |
| NC | AV7 |
| NC | AV8 |
| NC | AW7 |
| NC | AW6 |
| NVJTAG_SEL | BK23 |
| OVERT | BG5 |
| PEX_CLKREQ* | BL26 |
| PEX_CVDD | BB33 |
| PEX_CVDD | BC33 |
| PEX_DVDD | BB35 |
| PEX_DVDD | BB36 |
| PEX_DVDD | BC35 |
| PEX_DVDD | BC36 |
| PEX_DVDD | BD33 |
| PEX_DVDD | BD36 |
| PEX_HVDD | BB26 |
| PEX_HVDD | BB27 |
| PEX_HVDD | BB29 |
| PEX_HVDD | BB32 |
| PEX_HVDD | BC26 |
| PEX_HVDD | BC27 |
| PEX_HVDD | BC29 |
| PEX_HVDD | BC30 |
| PEX_HVDD | BC32 |
| PEX_HVDD | BD27 |
| PEX_HVDD | BD30 |
| PEX_PLL_HVDD | BB30 |
| PEX_REFCLK | BM26 |
| PEX_REFCLK* | BM27 |
| PEX_RST* | BK26 |
| PEX_RX0 | BL27 |
| PEX_RX0* | BK27 |
| PEX_RX1 | BK29 |
| PEX_RX1* | BL29 |
| PEX_RX10 | BK38 |
| PEX_RX10* | BL38 |
| PEX_RX11 | BM38 |

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| Ball Name | Ball # |
|---|---|
| PEX_RX11* | BM39 |
| PEX_RX12 | BL39 |
| PEX_RX12* | BK39 |
| PEX_RX13 | BK41 |
| PEX_RX13* | BL41 |
| PEX_RX14 | BM41 |
| PEX_RX14* | BM42 |
| PEX_RX15 | BL42 |
| PEX_RX15* | BK42 |
| PEX_RX2 | BM29 |
| PEX_RX2* | BM30 |
| PEX_RX3 | BL30 |
| PEX_RX3* | BK30 |
| PEX_RX4 | BK32 |
| PEX_RX4* | BL32 |
| PEX_RX5 | BM32 |
| PEX_RX5* | BM33 |
| PEX_RX6 | BL33 |
| PEX_RX6* | BK33 |
| PEX_RX7 | BK35 |
| PEX_RX7* | BL35 |
| PEX_RX8 | BM35 |
| PEX_RX8* | BM36 |
| PEX_RX9 | BL36 |
| PEX_RX9* | BK36 |
| PEX_TERMP | BL44 |
| PEX_TX0 | BG26 |
| PEX_TX0* | BH26 |
| PEX_TX1 | BF26 |
| PEX_TX1* | BE26 |
| PEX_TX10 | BF35 |
| PEX_TX10* | BE35 |
| PEX_TX11 | BF36 |
| PEX_TX11* | BG36 |
| PEX_TX12 | BG38 |
| PEX_TX12* | BH38 |
| PEX_TX13 | BF38 |
| PEX_TX13* | BE38 |
| PEX_TX14 | BF39 |
| PEX_TX14* | BG39 |
| PEX_TX15 | BH41 |

| Ball Name | Ball # |
|---|---|
| PEX_TX15* | BG41 |
| PEX_TX2 | BF27 |
| PEX_TX2* | BG27 |
| PEX_TX3 | BG29 |
| PEX_TX3* | BH29 |
| PEX_TX4 | BF29 |
| PEX_TX4* | BE29 |
| PEX_TX5 | BF30 |
| PEX_TX5* | BG30 |
| PEX_TX6 | BG32 |
| PEX_TX6* | BH32 |
| PEX_TX7 | BF32 |
| PEX_TX7* | BE32 |
| PEX_TX8 | BF33 |
| PEX_TX8* | BG33 |
| PEX_TX9 | BG35 |
| PEX_TX9* | BH35 |
| PEX_WAKE* | BK44 |
| ROM_CS* | BJ4 |
| ROM_SCLK | BK3 |
| ROM_SI | BK2 |
| ROM_SO | BK4 |
| SP_PLLVDD | BD12 |
| STRAP0 | BL3 |
| STRAP1 | BL4 |
| STRAP2 | BM4 |
| STRAP3 | BM5 |
| STRAP4 | BK5 |
| STRAP5 | BJ5 |
| THERMDN | BJ1 |
| THERMDP | BJ2 |
| TS_VREF | BF12 |
| USB_DVDD | BB15 |
| USB_DVDD | BC15 |
| USB_HVDD | AW10 |
| USB_HVDD | AW11 |
| USB_L0 | BA2 |
| USB_L0* | BA1 |
| USB_L1 | BA8 |
| USB_L1* | BA7 |
| USB_PLL_HVDD | AW9 |

| Ball Name | Ball # |
|---|---|
| USB_RBIAS | BA6 |
| USB_SCL | BB8 |
| USB_SDA | BB7 |
| USB_TERMP0 | BG6 |
| USB_TERMP1 | BH6 |
| USB_VDDP | BE12 |
| VDD | AA13 |
| VDD | AA14 |
| VDD | AA15 |
| VDD | AA16 |
| VDD | AA17 |
| VDD | AA18 |
| VDD | AA19 |
| VDD | AA20 |
| VDD | AA21 |
| VDD | AA22 |
| VDD | AA23 |
| VDD | AA24 |
| VDD | AA25 |
| VDD | AA26 |
| VDD | AA27 |
| VDD | AA28 |
| VDD | AA29 |
| VDD | AA30 |
| VDD | AA31 |
| VDD | AA32 |
| VDD | AA33 |
| VDD | AA34 |
| VDD | AA35 |
| VDD | AA36 |
| VDD | AA37 |
| VDD | AA38 |
| VDD | AA39 |
| VDD | AA40 |
| VDD | AB13 |
| VDD | AB40 |
| VDD | AC13 |
| VDD | AC14 |
| VDD | AC15 |
| VDD | AC16 |
| VDD | AC17 |

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| Ball Name | Ball # |
|---|---|
| VDD | AC18 |
| VDD | AC19 |
| VDD | AC20 |
| VDD | AC21 |
| VDD | AC22 |
| VDD | AC23 |
| VDD | AC24 |
| VDD | AC25 |
| VDD | AC26 |
| VDD | AC27 |
| VDD | AC28 |
| VDD | AC29 |
| VDD | AC30 |
| VDD | AC31 |
| VDD | AC32 |
| VDD | AC33 |
| VDD | AC34 |
| VDD | AC35 |
| VDD | AC36 |
| VDD | AC37 |
| VDD | AC38 |
| VDD | AC39 |
| VDD | AC40 |
| VDD | AD13 |
| VDD | AD40 |
| VDD | AE13 |
| VDD | AE14 |
| VDD | AE15 |
| VDD | AE16 |
| VDD | AE17 |
| VDD | AE18 |
| VDD | AE19 |
| VDD | AE20 |
| VDD | AE21 |
| VDD | AE22 |
| VDD | AE23 |
| VDD | AE24 |
| VDD | AE25 |
| VDD | AE26 |
| VDD | AE27 |
| VDD | AE28 |

| Ball Name | Ball # |
|---|---|
| VDD | AE29 |
| VDD | AE30 |
| VDD | AE31 |
| VDD | AE32 |
| VDD | AE33 |
| VDD | AE34 |
| VDD | AE35 |
| VDD | AE36 |
| VDD | AE37 |
| VDD | AE38 |
| VDD | AE39 |
| VDD | AE40 |
| VDD | AF13 |
| VDD | AF14 |
| VDD | AF15 |
| VDD | AF16 |
| VDD | AF17 |
| VDD | AF18 |
| VDD | AF24 |
| VDD | AF25 |
| VDD | AF26 |
| VDD | AF30 |
| VDD | AF31 |
| VDD | AF32 |
| VDD | AF33 |
| VDD | AF34 |
| VDD | AF40 |
| VDD | AG13 |
| VDD | AG19 |
| VDD | AG20 |
| VDD | AG21 |
| VDD | AG22 |
| VDD | AG23 |
| VDD | AG27 |
| VDD | AG28 |
| VDD | AG29 |
| VDD | AG35 |
| VDD | AG36 |
| VDD | AG37 |
| VDD | AG38 |
| VDD | AG39 |

| Ball Name | Ball # |
|---|---|
| VDD | AG40 |
| VDD | AH13 |
| VDD | AH14 |
| VDD | AH15 |
| VDD | AH16 |
| VDD | AH17 |
| VDD | AH18 |
| VDD | AH19 |
| VDD | AH20 |
| VDD | AH21 |
| VDD | AH22 |
| VDD | AH23 |
| VDD | AH24 |
| VDD | AH25 |
| VDD | AH26 |
| VDD | AH27 |
| VDD | AH28 |
| VDD | AH29 |
| VDD | AH30 |
| VDD | AH31 |
| VDD | AH32 |
| VDD | AH33 |
| VDD | AH34 |
| VDD | AH35 |
| VDD | AH36 |
| VDD | AH37 |
| VDD | AH38 |
| VDD | AH39 |
| VDD | AH40 |
| VDD | AJ13 |
| VDD | AJ40 |
| VDD | AK13 |
| VDD | AK14 |
| VDD | AK15 |
| VDD | AK16 |
| VDD | AK17 |
| VDD | AK18 |
| VDD | AK19 |
| VDD | AK20 |
| VDD | AK21 |
| VDD | AK22 |

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| Ball Name | Ball # |
|---|---|
| VDD | AK23 |
| VDD | AK24 |
| VDD | AK25 |
| VDD | AK26 |
| VDD | AK27 |
| VDD | AK28 |
| VDD | AK29 |
| VDD | AK30 |
| VDD | AK31 |
| VDD | AK32 |
| VDD | AK33 |
| VDD | AK34 |
| VDD | AK35 |
| VDD | AK36 |
| VDD | AK37 |
| VDD | AK38 |
| VDD | AK39 |
| VDD | AK40 |
| VDD | AL13 |
| VDD | AL40 |
| VDD | AM13 |
| VDD | AM14 |
| VDD | AM15 |
| VDD | AM16 |
| VDD | AM17 |
| VDD | AM18 |
| VDD | AM19 |
| VDD | AM20 |
| VDD | AM21 |
| VDD | AM22 |
| VDD | AM23 |
| VDD | AM24 |
| VDD | AM25 |
| VDD | AM26 |
| VDD | AM27 |
| VDD | AM28 |
| VDD | AM29 |
| VDD | AM30 |
| VDD | AM31 |
| VDD | AM32 |
| VDD | AM33 |

| Ball Name | Ball # |
|---|---|
| VDD | AM34 |
| VDD | AM35 |
| VDD | AM36 |
| VDD | AM37 |
| VDD | AM38 |
| VDD | AM39 |
| VDD | AM40 |
| VDD | AN13 |
| VDD | AN40 |
| VDD | AP13 |
| VDD | AP14 |
| VDD | AP15 |
| VDD | AP16 |
| VDD | AP17 |
| VDD | AP18 |
| VDD | AP19 |
| VDD | AP20 |
| VDD | AP21 |
| VDD | AP22 |
| VDD | AP23 |
| VDD | AP24 |
| VDD | AP25 |
| VDD | AP26 |
| VDD | AP27 |
| VDD | AP28 |
| VDD | AP29 |
| VDD | AP30 |
| VDD | AP31 |
| VDD | AP32 |
| VDD | AP33 |
| VDD | AP34 |
| VDD | AP35 |
| VDD | AP36 |
| VDD | AP37 |
| VDD | AP38 |
| VDD | AP39 |
| VDD | AP40 |
| VDD | AR13 |
| VDD | AR40 |
| VDD | AT13 |
| VDD | AT14 |

| Ball Name | Ball # |
|---|---|
| VDD | AT15 |
| VDD | AT16 |
| VDD | AT17 |
| VDD | AT18 |
| VDD | AT19 |
| VDD | AT20 |
| VDD | AT21 |
| VDD | AT22 |
| VDD | AT23 |
| VDD | AT24 |
| VDD | AT25 |
| VDD | AT26 |
| VDD | AT27 |
| VDD | AT28 |
| VDD | AT29 |
| VDD | AT30 |
| VDD | AT31 |
| VDD | AT32 |
| VDD | AT33 |
| VDD | AT34 |
| VDD | AT35 |
| VDD | AT36 |
| VDD | AT37 |
| VDD | AT38 |
| VDD | AT39 |
| VDD | AT40 |
| VDD | AT42 |
| VDD | AU13 |
| VDD | AU40 |
| VDD | AU43 |
| VDD | AV13 |
| VDD | AV14 |
| VDD | AV15 |
| VDD | AV16 |
| VDD | AV17 |
| VDD | AV18 |
| VDD | AV19 |
| VDD | AV20 |
| VDD | AV21 |
| VDD | AV22 |
| VDD | AV23 |

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| Ball Name | Ball # |
|---|---|
| VDD | AV24 |
| VDD | AV25 |
| VDD | AV26 |
| VDD | AV27 |
| VDD | AV28 |
| VDD | AV29 |
| VDD | AV30 |
| VDD | AV31 |
| VDD | AV32 |
| VDD | AV33 |
| VDD | AV34 |
| VDD | AV35 |
| VDD | AV36 |
| VDD | AV37 |
| VDD | AV38 |
| VDD | AV39 |
| VDD | AV40 |
| VDD | AV42 |
| VDD | AV43 |
| VDD | AV44 |
| VDD | AW13 |
| VDD | AW40 |
| VDD | AW42 |
| VDD | AW43 |
| VDD | AW44 |
| VDD | AW45 |
| VDD | AY13 |
| VDD | AY14 |
| VDD | AY15 |
| VDD | AY16 |
| VDD | AY17 |
| VDD | AY18 |
| VDD | AY19 |
| VDD | AY20 |
| VDD | AY21 |
| VDD | AY22 |
| VDD | AY23 |
| VDD | AY24 |
| VDD | AY25 |
| VDD | AY26 |
| VDD | AY27 |

| Ball Name | Ball # |
|---|---|
| VDD | AY28 |
| VDD | AY29 |
| VDD | AY30 |
| VDD | AY31 |
| VDD | AY32 |
| VDD | AY33 |
| VDD | AY34 |
| VDD | AY35 |
| VDD | AY36 |
| VDD | AY37 |
| VDD | AY38 |
| VDD | AY39 |
| VDD | AY40 |
| VDD | AY43 |
| VDD | AY45 |
| VDD | BA43 |
| VDD | BA44 |
| VDD | BA45 |
| VDD | BA46 |
| VDD | BA47 |
| VDD | BB38 |
| VDD | BB39 |
| VDD | BB45 |
| VDD | BB46 |
| VDD | BB47 |
| VDD | BB48 |
| VDD | BC38 |
| VDD | BC39 |
| VDD | BC40 |
| VDD | BC41 |
| VDD | BC45 |
| VDD | BC47 |
| VDD | BC49 |
| VDD | BD39 |
| VDD | BD41 |
| VDD | BD46 |
| VDD | BD47 |
| VDD | BD48 |
| VDD | BD49 |
| VDD | BD50 |
| VDD | BD51 |

| Ball Name | Ball # |
|---|---|
| VDD | BE41 |
| VDD | BE42 |
| VDD | BE43 |
| VDD | BE46 |
| VDD | BE47 |
| VDD | BE48 |
| VDD | BE49 |
| VDD | BE50 |
| VDD | BE51 |
| VDD | BE52 |
| VDD | BF42 |
| VDD | BF44 |
| VDD | BF45 |
| VDD | BF47 |
| VDD | BF49 |
| VDD | BF51 |
| VDD | BG43 |
| VDD | BG44 |
| VDD | BG45 |
| VDD | BG46 |
| VDD | BG47 |
| VDD | BG48 |
| VDD | BG49 |
| VDD | BG50 |
| VDD | BG51 |
| VDD | BG52 |
| VDD | BH44 |
| VDD | BH45 |
| VDD | BH47 |
| VDD | BH48 |
| VDD | BH49 |
| VDD | BH50 |
| VDD | BH51 |
| VDD | BH52 |
| VDD | BJ44 |
| VDD | BJ45 |
| VDD | BJ46 |
| VDD | BJ47 |
| VDD | BJ48 |
| VDD | BJ49 |
| VDD | BJ50 |

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| Ball Name | Ball # |
|---|---|
| VDD | BJ51 |
| VDD | BJ52 |
| VDD | BK47 |
| VDD | BK48 |
| VDD | BK49 |
| VDD | BK50 |
| VDD | BK51 |
| VDD | BK52 |
| VDD | BL46 |
| VDD | BL47 |
| VDD | BL48 |
| VDD | BL49 |
| VDD | BL50 |
| VDD | BL51 |
| VDD | BL52 |
| VDD | BM47 |
| VDD | BM48 |
| VDD | BM49 |
| VDD | BM50 |
| VDD | BM51 |
| VDD | N13 |
| VDD | N14 |
| VDD | N15 |
| VDD | N16 |
| VDD | N17 |
| VDD | N18 |
| VDD | N19 |
| VDD | N20 |
| VDD | N21 |
| VDD | N22 |
| VDD | N23 |
| VDD | N24 |
| VDD | N25 |
| VDD | N26 |
| VDD | N27 |
| VDD | N28 |
| VDD | N29 |
| VDD | N30 |
| VDD | N31 |
| VDD | N32 |
| VDD | N33 |

| Ball Name | Ball # |
|---|---|
| VDD | N34 |
| VDD | N35 |
| VDD | N36 |
| VDD | N37 |
| VDD | N38 |
| VDD | N39 |
| VDD | N40 |
| VDD | P13 |
| VDD | P40 |
| VDD | R13 |
| VDD | R14 |
| VDD | R15 |
| VDD | R16 |
| VDD | R17 |
| VDD | R18 |
| VDD | R19 |
| VDD | R20 |
| VDD | R21 |
| VDD | R22 |
| VDD | R23 |
| VDD | R24 |
| VDD | R25 |
| VDD | R26 |
| VDD | R27 |
| VDD | R28 |
| VDD | R29 |
| VDD | R30 |
| VDD | R31 |
| VDD | R32 |
| VDD | R33 |
| VDD | R34 |
| VDD | R35 |
| VDD | R36 |
| VDD | R37 |
| VDD | R38 |
| VDD | R39 |
| VDD | R40 |
| VDD | T13 |
| VDD | T40 |
| VDD | U13 |
| VDD | U14 |

| Ball Name | Ball # |
|---|---|
| VDD | U15 |
| VDD | U16 |
| VDD | U17 |
| VDD | U18 |
| VDD | U19 |
| VDD | U20 |
| VDD | U21 |
| VDD | U22 |
| VDD | U23 |
| VDD | U24 |
| VDD | U25 |
| VDD | U26 |
| VDD | U27 |
| VDD | U28 |
| VDD | U29 |
| VDD | U30 |
| VDD | U31 |
| VDD | U32 |
| VDD | U33 |
| VDD | U34 |
| VDD | U35 |
| VDD | U36 |
| VDD | U37 |
| VDD | U38 |
| VDD | U39 |
| VDD | U40 |
| VDD | V13 |
| VDD | V40 |
| VDD | W13 |
| VDD | W14 |
| VDD | W15 |
| VDD | W16 |
| VDD | W17 |
| VDD | W18 |
| VDD | W19 |
| VDD | W20 |
| VDD | W21 |
| VDD | W22 |
| VDD | W23 |
| VDD | W24 |
| VDD | W25 |

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| Ball Name | Ball # |
|---|---|
| VDD | W26 |
| VDD | W27 |
| VDD | W28 |
| VDD | W29 |
| VDD | W30 |
| VDD | W31 |
| VDD | W32 |
| VDD | W33 |
| VDD | W34 |
| VDD | W35 |
| VDD | W36 |

| Ball Name | Ball # |
|---|---|
| VDD | W37 |
| VDD | W38 |
| VDD | W39 |
| VDD | W40 |
| VDD | Y13 |
| VDD | Y40 |
| VDD_SENSE | BK45 |
| VID_PLLVDD | BC12 |
| XSN_PLLVDD | BB24 |
| XTAL_IN | BL6 |
| XTAL_OUT | BM6 |

| Ball Name | Ball # |
|---|---|
| XTAL_OUTBUFF | BK6 |

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| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | | GND | GND | FBC_D5 | FBC_DQM0 | FBC_D2 | | FBC_D13 | FBC_CMD34 | | FBC_CMD2 | FBC_CMD4 | | FBC_CMD8 | FBC_CMD11 | | FBC_CMD12 | FBC_CMD31 | | FBC_CMD26 | FBC_CMD24 | | FBC_CMD18 | FBC_CMD17 | | GND | FBC_D46 | | GND | FBC_D37 | | GND | FBB_D2 | | FBB_CMD3 | FBB_CMD0 | | FBB_CMD8 | FBB_CMD10 | | FBB_CMD13 | FBB_CMD33 | | FBB_CMD27 | FBB_CMD25 | | FBB_CMD30 | FBB_CMD18 | FBB_CMD17 | GND | GND | | A | 1 |
| 2 | B | GND | GND | FBC_D6 | FBC_D4 | GND | FBC_D3 | GND | FBC_D12 | FBC_D11 | GND | FBC_CMD1 | FBC_CMD5 | GND | FBC_CMD9 | FBC_CMD13 | GND | FBC_CMD15 | FBC_CMD30 | GND | FBC_CMD27 | FBC_CMD23 | GND | FBC_CMD20 | FBC_CMD16 | GND | FBC_D62 | FBC_D45 | GND | FBC_DQS_WP0 | FBC_D36 | GND | FBB_D3 | FBB_DQS_WP0 | GND | FBB_CMD6 | FBB_CMD4 | GND | FBB_CMD7 | FBB_CMD31 | GND | FBB_CMD14 | FBB_CMD31 | GND | FBB_CMD28 | FBB_CMD24 | GND | FBB_CMD21 | GND | FBB_CMD16 | FBB_CMD35 | GND | GND | B | 2 |
| 3 | C | GND | FBB_D39 | FBB_D38 | FBC_D7 | GND | FBC_D0 | | FBC_DQM1 | FBC_D9 | | FBC_CMD0 | FBC_CMD6 | | FBC_CMD7 | FBC_CMD12 | | FBC_CMD14 | FBC_CMD29 | | FBC_CMD28 | FBC_CMD22 | | FBC_CMD21 | FBC_CMD35 | | FBC_D63 | FBC_D44 | | GND | FBC_D39 | | FBB_DQM0 | GND | | FBB_CMD34 | FBB_CMD5 | | FBB_CMD9 | FBB_CMD12 | | FBB_CMD13 | FBB_CMD39 | | FBB_CMD29 | FBB_CMD23 | | FBB_CMD22 | FBB_D50 | FBB_D51 | FBB_D49 | GND | GND | C | 3 |
| 4 | D | FBD_D37 | FBB_D36 | FBD_DQM4 | GND | FBC_DQS_WP0 | FBC_D1 | GND | FBC_DQS_WP1 | FBC_D8 | GND | FBC_CMD3 | GND | GND | FBC_CMD10 | FBC_D20 | GND | FBC_CMD33 | FBC_D49 | GND | FBC_CMD25 | FBC_D54 | GND | FBC_CMD18 | GND | GND | FBC_D61 | FBC_D40 | GND | FBC_DQM4 | GND | GND | FBB_D1 | FBB_D13 | GND | FBB_CMD2 | FBB_D30 | GND | FBB_CMD8 | FBB_D27 | GND | FBB_CMD32 | FBB_D20 | GND | FBB_CMD26 | FBB_D17 | GND | FBB_CMD19 | FBB_D48 | GND | FBB_DQS_WP0 | FBB_D57 | D | 4 |
| 5 | E | FBD_D33 | GND | FBD_DQS_WP4 | GND | GND | FBC_D15 | | GND | FBC_D10 | | FBC_D31 | FBC_DQS_WP3 | | FBC_D26 | FBC_D21 | | FBC_DQS_WP2 | FBC_D18 | | FBC_D51 | FBC_D53 | | FBC_D55 | FBC_DQS_WP7 | | FBC_DQM7 | FBC_DQM5 | | FBC_WCK45_N | FBC_DQS_WP4 | | FBB_D4 | FBB_DQM1 | | FBB_DQS_WP1 | FBB_D31 | | FBB_D29 | FBB_D26 | | FBB_D24 | FBB_D21 | | FBB_DQM2 | FBB_D16 | | FBB_CLK1_N | GND | FBB_D52 | FBB_D53 | GND | FBVHDQ_SENSE | E | 5 |
| 6 | F | FBD_D44 | FBD_D45 | FBD_D34 | FBD_D32 | FBD_D35 | FBC_D14 | GND | FBC_WCK01_N | | GND | FBC_DQM2 | | GND | FBC_D27 | FBC_CLK0_N | GND | FBC_D16 | GND | GND | FBC_DQM6 | GND | GND | FBC_D52 | FBC_D58 | GND | FBC_D60 | FBC_D42 | GND | FBC_WCK45_N | FBC_D33 | GND | FBB_D7 | FBB_D12 | GND | FBB_D11 | GND | GND | FBB_D28 | FBB_D25 | GND | FBB_D22 | GND | GND | FBB_D18 | GND | FBB_CLK1 | FBB_D55 | FBB_D54 | FBB_D56 | FBB_DQS_WP7 | GND | F | 6 |
| 7 | G | | GND | | GND | | GND | | FBC_WCK01_N | FBC_WCK00 | | | | | FBC_D29 | FBC_WCK23_N | | FBC_WCK23 | FBC_CLK3 | | FBC_D22 | FBC_D17 | | FBC_D50 | FBC_DQS_WP5 | | FBC_WCK67 | FBC_D56 | | FBC_D59 | FBC_D43 | | FBC_D47 | FBC_D35 | | FBB_D5 | FBB_D15 | | FBB_WCK01 | FBB_D9 | | GND | FBB_DQM3 | | FBB_WCK23_N | FBB_CLK3_N | | FBB_DQS_WP3 | FBB_D19 | | GND | GND | | G | 7 |
| 8 | H | GND | FBD_DQS_WP5 | FBD_DQM5 | FBD_D46 | FBD_D47 | FBD_WCK45_N | FBD_WCK45 | | | GND | FBC_D28 | FBC_WCK23 | GND | FBC_WCK23_N | FBC_D25 | GND | FBC_D23 | FBC_D19 | GND | FBC_D48 | FBC_CLK1 | GND | FBC_WCK67_N | FBC_WCK67 | GND | FBC_D57 | FBC_WCK45_N | GND | FBC_D34 | FBC_D38 | GND | FBB_D0 | FBB_WCK01_N | GND | FBB_WCK01_N | FBB_D8 | GND | FBB_DQS_WP3 | FBB_WCK23_N | GND | FBB_D23 | FBB_CLK0 | GND | | | FBB_WCK67_N | FBB_WCK67 | FBB_D59 | FBB_D62 | FBB_DQM7 | FBB_D60 | FBB_D63 | H | 8 |
| 9 | J | GND | FBD_D43 | FBD_CMD35 | FBD_D41 | FBD_D40 | FBD_WCK45 | FBD_WCK45_N | | | | | GND | | FBC_DBG_RFU2 | FBC_D24 | | GND | FBC_DQM3 | | GND | FBC_CLK1_N | | FBC_DBG_RFU2 | FBC_WCK67_N | | FBC_D41 | FBC_WCK45 | | FBC_D32 | FBB_D6 | | FBB_D14 | FBB_WCK11 | | FBB_DBG_RFU2 | FBB_D10 | | GND | FBB_WCK23 | | FBB_DBG_RFU2 | | | | | FBB_WCK67_N | FBB_WCK67 | FBB_DQS_WP5 | GND | FBB_D58 | FBB_D61 | GND | J | 9 |
| 10 | K | | GND | | GND | | GND | | GND | | | | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | FBVDDQ | GND | FBVDDQ | | | | | GND | | GND | | GND | | GND | K | 10 |
| 11 | L | FBD_CMD18 | FBD_CMD17 | FBD_CMD16 | FBD_D62 | FBD_D63 | FBD_D61 | FBD_D60 | FBD_D42 | | | | | | FBVDDQ | FBVDDQ | | FBC_PLL_AVDD | FBVDDQ | | FBVDDQ | FBVDDQ | | FBVDDQ | FBVDDQ | | FBVDDQ | FBVDDQ | | FB_REFPLL_AVDD | FBVDDQ | | FBVDDQ | FBVDDQ | | FBVDDQ | FBVDDQ | | FBB_PLL_AVDD | FBVDDQ | | | | | | | FBB_WCK45_N | FBB_WCK45 | FBB_D45 | FBB_DQM5 | FBB_D43 | FBB_D40 | FBB_D41 | FBB_D42 | L | 11 |
| 12 | M | FBD_CMD20 | FBD_CMD21 | FBD_CMD22 | FBD_CMD23 | FBD_DQS_WP7 | GND | FBD_WCK367 | FBD_WCK367_N | FBD_DQM7 | FBVDDQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | M | 12 |
| 13 | N | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | | | GND | | GND | | GND | | GND | N | 13 |
| 14 | P | FBD_CMD25 | FBD_CMD24 | FBD_CMD23 | FBD_D58 | FBD_D59 | FBD_D56 | FBD_WCK67_N | FBD_WCK67 | FBD_DBG_RFU2 | FBVDDQ | FBVDDQ | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | FB_CAL_PU_GND | FB_VREF | FBB_D39 | FBB_D36 | FBB_D33 | FBB_DQM4 | FBB_DQS_WP4 | FBB_D37 | P | 14 |
| 15 | R | FBD_CMD27 | FBD_CMD26 | FBD_CMD28 | FBD_D53 | FBD_D54 | FBD_CLK1_N | FBD_CLK1 | FBD_D57 | FBVDDQ | FBVDDQ | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FBVDDQ | FBVDDQ | FB_CAL_PD_VDD2 | FB_CAL_TERM_GND | FBB_D38 | FBB_D6 | FBA_DQS_WP0 | GND | FBA_D5 | FBA_D4 | GND | R | 15 |
| 16 | T | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | | GND | | GND | | GND | | GND | T | 16 |
| 17 | U | FBD_CMD33 | FBD_CMD31 | FBD_CMD30 | FBD_D52 | FBD_DQM6 | FBD_DQS_WP6 | GND | FBD_D55 | GND | FBVDDQ | FBVDDQ | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | GPCPLL_AVDD | FBVDDQ | FBA_WCK01_N | FBA_WCK01 | FBA_D7 | FBA_DQM0 | FBA_D1 | FBA_D3 | FBA_D2 | FBA_D0 | FBA_D14 | U | 17 |
| 18 | V | FBD_CMD15 | FBD_CMD14 | FBD_CMD13 | FBD_CMD32 | FBD_D18 | FBD_D50 | FBD_D48 | FBD_D49 | FBD_D51 | FBVDDQ | FBVDDQ | FBB_PLL_AVDD | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | FBA_WCK45_N | FBA_WCK45 | FBA_D8 | FBA_D13 | FBA_DQS_WP1 | GND | FBA_D12 | FBA_D15 | GND | V | 18 |
| 19 | W | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | | GND | | GND | | GND | | GND | W | 19 |
| 20 | Y | FBD_CMD10 | FBD_CMD11 | FBD_CMD12 | FBD_D19 | FBD_D17 | FBD_D16 | FBD_CLK0_N | FBD_CLK0 | GND | FBVDDQ | FBVDDQ | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | FBA_D31 | FBA_D9 | FBA_D11 | FBA_D10 | FBA_DQM1 | FBA_CMD2 | FBA_CMD34 | FBA_CMD0 | FBA_CMD1 | Y | 20 |
| 21 | AA | FBD_CMD8 | FBD_CMD7 | FBD_CMD6 | FBD_CMD9 | FBD_D21 | FBD_D20 | FBD_DQM2 | GND | FBD_DQS_WP2 | FBVDDQ | FBVDDQ | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FBVDDQ | FBVDDQ | FBA_DBG_RFU2 | FBA_D30 | FBA_D29 | FBA_D28 | FBA_DQS_WP3 | FBA_CMD5 | FBA_CMD4 | FBA_CMD3 | AA | 21 |
| 22 | AB | | GND | | GND | | GND | | GND | | GND | | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | | GND | | GND | | GND | | GND | AB | 22 |
| 23 | AC | FBD_CMD3 | FBD_CMD4 | FBD_CMD5 | FBD_D23 | FBD_D22 | FBD_D25 | FBD_WCK223 | FBD_WCK223_N | FBD_DBG_RFU2 | FBVDDQ | FBVDDQ | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FBVDDQ | FBVDDQ | FBA_WCK23_N | FBA_WCK23 | FBA_D26 | FBA_D27 | FBA_DQM3 | FBA_CMD9 | FBA_CMD8 | FBA_CMD7 | FBA_CMD6 | AC | 23 |
| 24 | AD | FBD_CMD1 | FBD_CMD0 | FBD_CMD36 | FBD_CMD2 | FBD_DQM1 | FBD_D27 | FBD_D24 | FBD_WCK23 | FBD_WCK23_N | FBVDDQ | FBVDDQ | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | GND | FBA_WCK923_N | FBA_WCK923 | FBA_D23 | FBA_D25 | FBA_D24 | FBA_CMD12 | FBA_CMD11 | FBA_CMD10 | AD | 24 |
| 25 | AE | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | | GND | | GND | | GND | | GND | AE | 25 |
| 26 | AF | GND | FBD_D30 | FBD_D31 | FBD_DQS_WP3 | GND | FBD_D26 | FBD_D28 | FBD_D29 | FBD_D9 | FBVDDQ | GPCPLL_AVDD1 | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | GND | GND | GND | VDD | VDD | VDD | VDD | VDD | GND | GND | GND | GND | GND | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FB_REFPLL_AVDD | FBVDDQ | FBA_DQS_WP2 | GND | FBA_D20 | FBA_D21 | FBA_D22 | FBA_CMD32 | FBA_CMD13 | FBA_CMD14 | FBA_CMD15 | AF | 26 |
| 27 | AG | FBD_DQM1 | FBD_DQS_WP1 | GND | FBD_D8 | FBD_D15 | FBD_D10 | FBD_D11 | FBD_WCK901 | FBD_WCK901_N | FBVDDQ | FBVDDQ | | VDD | GND | GND | GND | GND | GND | VDD | VDD | VDD | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | GND | FBA_CLK0 | FBA_CLK0_N | FBA_DQM2 | FBA_D17 | FBA_D19 | FBA_CMD30 | FBA_CMD31 | FBA_CMD33 | AG | 27 |
| 28 | AH | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | | GND | | GND | | GND | | GND | AH | 28 |
| 29 | AJ | FBD_DQM0 | GND | FBD_DQS_WP0 | FBD_D12 | FBD_D13 | FBD_D14 | FBD_WCK01_N | FBD_WCK01 | GND | FBVDDQ | FBVDDQ | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | FBA_D16 | FBA_D18 | FBA_D49 | FBA_D50 | FBA_D48 | FBA_CMD26 | FBA_CMD25 | FBA_CMD24 | FBA_CMD27 | AJ | 29 |
| 30 | AK | GND | FBD_D2 | FBD_D3 | FBD_D1 | FBD_D4 | FBD_D5 | FBD_D7 | FBD_D0 | FBD_D6 | FBVDDQ | FBVDDQ | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FBVDDQ | FBVDDQ | GND | FBA_CLK1_N | FBA_CLK1 | GND | FBA_DQS_WP6 | FBA_D51 | FBA_CMD23 | FBA_CMD24 | FBA_CMD25 | AK | 30 |
| 31 | AL | | GND | | GND | | GND | | GND | | GND | | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | | GND | | GND | | GND | | GND | AL | 31 |
| 32 | AM | NC | EXT_REFCLK_SEL | NC | GND | NC | NC | NC | NC | GND | NC | NC | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FBVDDQ | FBVDDQ | FBA_D56 | FBA_D57 | FBA_D53 | FBA_D52 | FBA_DQM8 | FBA_CMD18 | FBA_CMD22 | FBA_CMD21 | FBA_CMD20 | AM | 32 |
| 33 | AN | NC | NC | NC | GND | GND | NC | NC | GND | NC | NC | NC | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBA_PLL_AVDD | FBVDDQ | FBA_DBG_RFU2 | FBA_D58 | FBA_D59 | FBA_D61 | FBA_D54 | FBA_D55 | FBA_CMD16 | FBA_CMD17 | FBA_CMD19 | AN | 33 |
| 34 | AP | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | | GND | | GND | | GND | | GND | AP | 34 |
| 35 | AR | NC | NC | NC | GND | NC | NC | NC | NC | GND | NC | NC | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | FBVDDQ | FBVDDQ | FBA_WCK67_N | FBA_WCK67 | FBA_D63 | FBA_D62 | FBA_D60 | FBA_DQM7 | FBA_CMD29 | FBA_DQS_WP7 | GND | AR | 35 |
| 36 | AT | NC | NC | NC | GND | GND | NC | NC | GND | NC | NC | NC | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | FBVDDQ | FBA_WCK867_N | FBA_WCK867 | FBA_D44 | FBA_D42 | FBA_D43 | FBA_D41 | FBA_DQS_WP8 | GND | GND | AT | 36 |
| 37 | AU | | GND | | GND | | GND | | GND | | GND | | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | | VDD | | GND | | GND | | GND | AU | 37 |
| 38 | AV | NC | NC | NC | GND | NC | NC | NC | NC | GND | NC | NC | | VDD | VDD | VDD | GND | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | GND | FBA_WCK45_N | FBA_WCK45 | FBA_D40 | FBA_D47 | FBA_D46 | AV | 38 |
| 39 | AW | NC | NC | NC | GND | GND | NC | NC | GND | USB_PLL_AVDD1 | USB_HVDD | USB_HVDD | | VDD | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | VDD | VDD | VDD | VDD | GND | FBA_WCK845_N | FBA_WCK845 | FBA_D39 | FBA_D34 | FBA_D32 | GND | AW | 39 |
| 40 | AY | | GND | | GND | | GND | | GND | | GND | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | | VDD | | VDD | | GND | | GND | AY | 40 |
| 41 | BA | USB_LO_N | USB_LO | GPIO29 | GPIO27 | GPIO21 | USB_RBIAS | USB_L1_N | USB_L1 | GND | 1V8_AON | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | VDD | VDD | VDD | VDD | VDD | GND | FBA_D38 | FBA_D36 | FBA_D35 | FBA_D33 | BA | 41 |
| 42 | BB | GPIO13 | GPIO25 | GPIO30 | GPIO28 | GPIO1 | GPIO22 | USB_SDA | USB_SCL | | | | | | 1V8_AON | USB_DVDD | | IFP_IOVDD | IFP_IOVDD | | IFP_IOVDD | IFP_IOVDD | | IFP_IOVDD | XSN_PLLVDD | | PEX_HVDD | PEX_HVDD | | PEX_HVDD | PEX_PLL_AVDD | | PEX_HVDD | PEX_CVDD | | PEX_DVDD | PEX_DVDD | | VDD | VDD | | VDD | VDD | VDD | VDD | GND | FBA_D37 | FBA_DQM4 | FBA_DQS_WP4 | BB | 42 |
| 43 | BC | | GND | | GND | | GND | | GND | | | | VID_PLLVDD | GND | 1V8_AON | USB_DVDD | GND | IFP_IOVDD | IFP_IOVDD | GND | IFP_IOVDD | IFP_IOVDD | GND | IFP_IOVDD | GND | GND | PEX_HVDD | PEX_HVDD | GND | PEX_HVDD | PEX_HVDD | GND | PEX_HVDD | PEX_CVDD | GND | PEX_DVDD | PEX_DVDD | GND | VDD | VDD | VDD | VDD | VDD | | | VDD | | VDD | | GND | | VDD | BC | 43 |
| 44 | BD | GPIO2 | GPIO16 | GPIO10 | GPIO19 | GPIO24 | GPIO0 | GPIO7 | | | | | SP_PLLVDD | FB_FUSE_SRC | IFPE_PLLVDD | | IFPE_RSET | IFPCD_PLLVDD | | IFPCD_RSET | IFPAB_PLLVDD | | IFPAB_RSET | NC | | GND | PEX_HVDD | | GND | PEX_HVDD | | GND | PEX_DVDD | | GND | PEX_DVDD | | GND | VDD | VDD | | VDD | | | | VDD | VDD | VDD | VDD | VDD | VDD | VDD | GND | BD | 44 |
| 45 | BE | GPIO4 | GPIO16 | GPIO18 | GPIO3 | GPIO20 | GPIO12 | GPIO26 | | | | | IFPD_L2 | GND | IFPE_L2 | GND | GND | IFPC_L3 | GND | GND | IFPC_L0 | GND | GND | IFPA_L1 | GND | GND | PEX_TX1_N | GND | GND | PEX_TX4_N | GND | GND | PEX_TX13_N | GND | GND | PEX_TX10_N | GND | GND | PEX_TX11_N | GND | GND | PEX_TX14_N | GND | GND | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | BE | 45 |
| 46 | BF | | GND | | GND | | GND | I2CB_SDA | BUFRST_N | | | | IFPD_AUX_SDA_N | TS_VREF | IFPE_L2_N | IFPE_L1_N | | IFPC_L3_N | IFPC_L2_N | | IFPC_L0_N | IFPA_L3_N | | IFPA_L1_N | IFPA_L0_N | | PEX_TX1 | PEX_TX2 | | PEX_TX4 | PEX_TX5 | | PEX_TX7 | PEX_TX8 | | PEX_TX10 | PEX_TX11 | | PEX_TX13 | PEX_TX14 | | GND | VDD | | VDD | VDD | | VDD | VDD | | VDD | VDD | | VDD | BF | 46 |
| 47 | BG | GPIO15 | GPIO5 | GPIO23 | GPIO14 | OVERT | USB_TERMP0 | GND | I2CB_SCL | I2CC_SCL | GND | IFPA_AUX_SCL | IFPA_AUX_SCL_N | GND | IFPE_L3_N | IFPE_L1 | GND | IFPE_L0_N | IFPC_L2 | GND | IFPC_L1_N | IFPA_L3 | GND | IFPA_L2_N | IFPA_L0 | GND | PEX_TX0_N | PEX_TX2_N | GND | PEX_TX3_N | PEX_TX5_N | GND | PEX_TX6_N | PEX_TX8_N | GND | PEX_TX9_N | PEX_TX11_N | GND | PEX_TX12_N | PEX_TX14_N | GND | PEX_TX15_N | GND | | VDD | VDD | | VDD | VDD | | VDD | VDD | | VDD | BG | 47 |
| 48 | BH | GPIO17 | GND | GPIO11 | GPIO8 | GND | USB_TERMP1 | | I2CS_SCL | I2CC_SCL | | IFPA_AUX_SDA_N | IFPA_AUX_SCL | | IFPE_L3 | | | IFPE_L0 | | | IFPC_L1 | | | IFPA_L2 | | | PEX_TX0_N | GND | | PEX_TX3_N | GND | | PEX_TX6_N | GND | | PEX_TX9_N | GND | | PEX_TX12_N | GND | | PEX_TX15 | GND | | VDD | VDD | | VDD | VDD | | VDD | VDD | | VDD | BH | 48 |
| 49 | BJ | THERMDN | THERMDP | GPIO9 | ROM_CS_N | STRAP5 | EXT_REFCLK_N | GND | I2CS_SCL | ADC_IN | GND | ADC_IN_N | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | GND | VDD | VDD | VDD | VDD | VDD | VDD | VDD | VDD | BJ | 49 |
| 50 | BK | GND | ROM_SI | ROM_SCLK | ROM_SO | STRAP4 | XTAL_OUTBUFF | | IFPE_AUX_SCL | IFPC_AUX_SCL | | IFPF_L3_N | IFPF_L1 | | IFPF_L0_N | IFPD_L2 | | STRAP1 | IFPD_L1_N | | IFPB_L3_N | IFPB_L2_N | | IFPB_L0_N | NVJTAG_SEL | JTAG_TCK | | PEX_RST_N | PEX_RX0_N | | PEX_RX1_N | PEX_RX3_N | | PEX_RX4_N | PEX_RX6_N | | PEX_RX7_N | PEX_RX9_N | | PEX_RX10_N | PEX_RX12_N | | PEX_RX13_N | PEX_RX15_N | | PEX_WAKE_N | VDD_SENSE | | VDD | VDD | VDD | VDD | VDD | VDD | BK | 50 |
| 51 | BL | GND | GND | STRAP0 | STRAP1 | GND | XTAL_IN | GND | IFPE_AUX_SDA_N | IFPC_AUX_SDA_N | | IFPF_L3 | IFPF_L1_N | GND | IFPF_L0 | IFPD_L2_N | GND | IFPD_L1 | IFPB_L3_N | GND | IFPB_L2 | IFPB_L0_N | GND | JTAG_TMS | JTAG_TRST_N | GND | PEX_CLKREQ_N | PEX_RX0 | GND | PEX_RX1 | PEX_RX3 | GND | PEX_RX4_N | PEX_RX6 | GND | PEX_RX7_N | PEX_RX9 | GND | PEX_RX10_N | PEX_RX12 | GND | PEX_RX13_N | PEX_RX15 | GND | PEX_TERMP | GND_SENSE | | VDD | VDD | VDD | VDD | VDD | VDD | BL | 51 |
| 52 | BM | | GND | GND | STRAP2 | STRAP3 | XTAL_OUT | | IFPF_AUX_SCL | IFPF_AUX_SCL_N | | IFPF_L2_N | IFPF_L2 | | IFPD_L3_N | IFPD_L3 | | IFPD_L0_N | IFPD_L0 | | IFPB_L1_N | IFPB_L1 | | JTAG_TDI | JTAG_TDO | | PEX_REFCLK_P | PEX_REFCLK_N | | PEX_RX2 | PEX_RX2_N | | PEX_RX5 | PEX_RX5_N | | PEX_RX8 | PEX_RX8_N | | PEX_RX11 | PEX_RX11_N | | PEX_RX14 | PEX_RX14_N | | NC | NC | | VDD | VDD | VDD | VDD | VDD | VDD | BM | 52 |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | | |

Jane Li
Gigabyte Desktop

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