

MSC316Q

High-Integrated H.265/HEVC IP

Camera SoC Processor

Preliminary Product Brief Version 0.1

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REVISION HISTORY

| Revision No. | Description | Date |
|--------------|-------------------|------------|
| 0.1 | • Initial release | 05/19/2016 |

FEATURES

■ High Performance Processor Core

- ARM Cortex-A7 Single Core 800MHz
- Neon and FPU
- Memory Management Unit for Linux support
- DMA Engine

■ Image/Video Processor

- Supports 10/12-bit parallel interface for raw data input
- Supports MIPI interface with 2 data lanes and 1 clock lane
- Supports 8/10-bit CCIR656 interface
- Supports 2M (1920x1080) pixels video recording and image snapshot
- Bad pixel compensation
- Noise Reduction (NR)
- Optical black correction
- Lens shading compensation
- Auto White Balance (AWB) / Auto Exposure (AE) / Auto Focus (AF)
- CFA color interpolation
- Color correction
- Gamma correction
- Video stabilization
- Wide Dynamic Range (WDR)
- Rotation with 90 or 270 degree
- Lens distortion correction
- Fully programmable multi-function scaling engines

■ MStar Advanced Color Engine (MStarACE)

- Luma gain/offset adjustment
- Supports 2D peaking
- Horizontal noise masking
- Direct Luma Correction (DLC)
- Black/White Level Extension (BLE/WLE)
- IHC/ICC/IBC for chroma adjustment
- Histogram statistics

■ H.265/HEVC Encoder

- Supports H.265/HEVC baseline and main profile encoding
- Supports MVs: 32x32, 16x16, 8x8
- Supports up to quarter-pixel
- Supports one reference frame
- Supports Max. 1920x1080p30fps encoding

■ H.264 Encoder

- Supports H.264 baseline and main profile encoding
- Supports MVs: 16x16, 16x8, 8x16, 8x8, 8x4, 4x8, 4x4
- Supports up to quarter-pixel
- Supports two reference frames
- Supports rate control and ROI
- Supports Max. 1920x1080p30fps encoding

■ JPEG Encoder

- Supports JPEG baseline encoding
- Supports YUV422 or YUV420 formats
- Supports Max. 1920x1080p15fps encoding

■ Video Encoding Performance

- Supports 1920x1080p30 + VGAp30 + QCIFp30 H.265/HEVC or H.264 encoding
- Supports MJPEG 2M (1920x1080) 15fps encoding

■ Audio Processor

- One stereo ADC for microphone inputs
- One stereo DAC for lineouts
- Supports 8K/16K/32KHz sampling rate audio recording
- Digital and analog gain adjustment

■ NOR Flash Interface

- Compliant with standard, dual and quad SPI Flash memory components

■ NAND Flash and SD Card Interface

- Supports SLC NAND Flash (8-bit interface, and 8-bit ECC)
- Compatible with SD spec. 2.0, data bus 1/4 bit mode

■ SDIO 2.0 Interface

- Compatible with SDIO spec. 2.0, data bus 1/4 bit mode
- Compatible with SD spec. 2.0, data bus 1/4 bit mode

■ USB 2.0 Interface

- One USB 2.0 configurable host or device
- Host mode supports EHCI specification
- Device mode supports 6 endpoints

■ DRAM Memory

- Embedded DDR3 DRAM memory
- Memory size up to 2Gb

■ Connectivity

- Built-in 10/100M Ethernet MAC and Ethernet PHY
- One USB 2.0 Host Controller could be used for USB Wi-Fi Dongle or Module
- One SDIO 2.0 Host Controller could be used for SDIO Wi-Fi module
- Supports Wakeup on LAN (WOL)

■ Security Engines

- Supports AES/DES/TDES
- Supports secure booting

■ Real Time Clock (RTC)

- Built-in RTC working with 32.768 KHz crystal
- Alarm interrupt for wakeup
- Tick time interrupt (millisecond)
- Built-in regulator

■ Peripherals

- Dedicated GPIOs for system control
- Four PWM outputs shared with GPIOs
- Two generic UARTs and one fast UART with flow control
- Three generic timers and one watchdog timer
- Two SPI masters
- Two I2C Masters
- Built-in SAR ADC with 3 channels analog inputs for different kinds of applications
- One IR input

■ Operating Voltage Range

- Core: 1.1V
- I/O: 2.5 ~ 3.3V
- DRAM: 1.5V
- Power Consumption: TBD

■ Package

- BGA, 13mm x 11mm

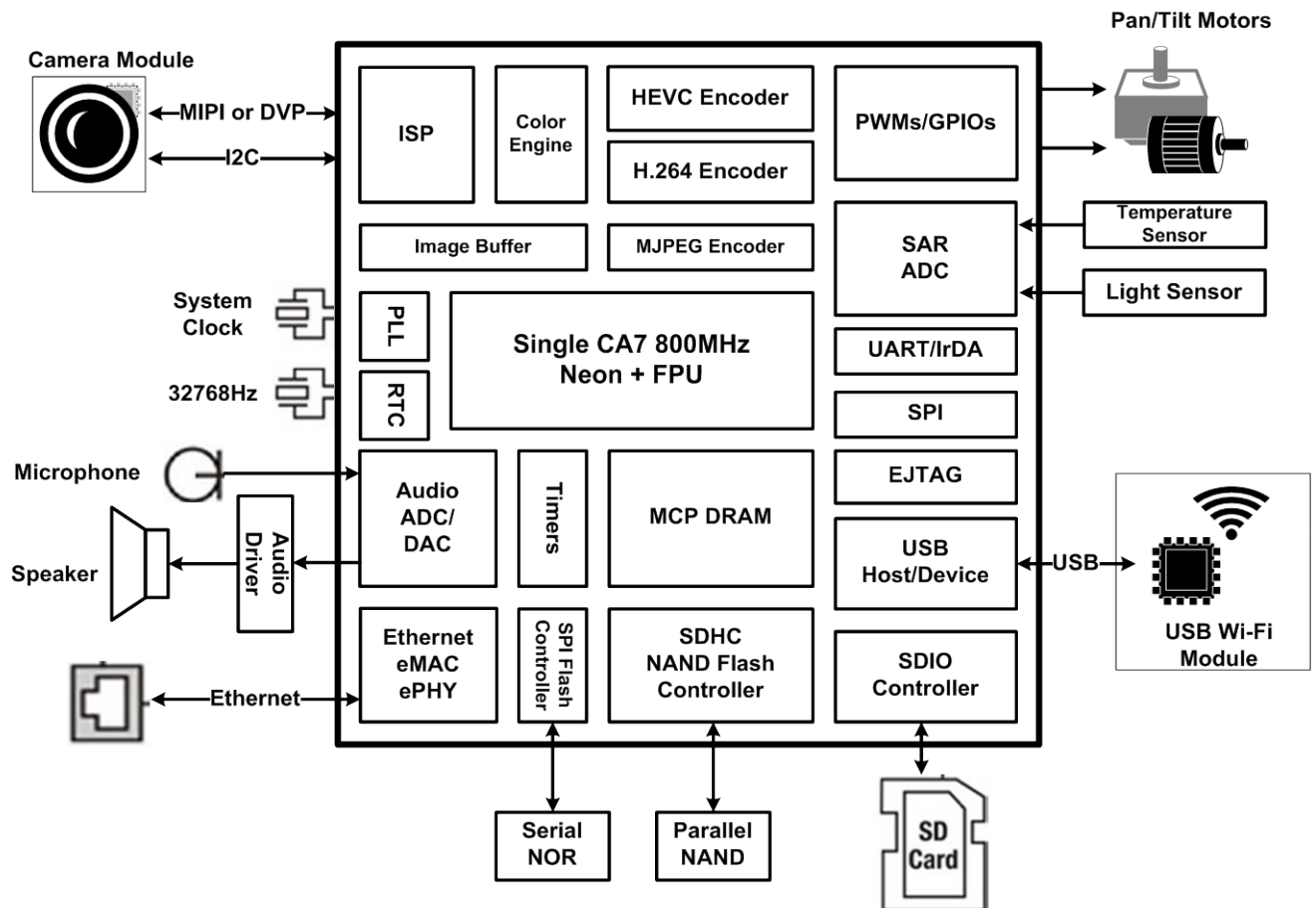
GENERAL DESCRIPTIONS

The MSC316Q is a highly integrated SOC. Based on ARM Cortex-A7, the MSC316Q integrates Image Signal Processor (ISP), Color Engine, Video (H.264/H.265/MJPEG) Encoders and other useful peripherals for IP camera applications.

A typical utilization of the MSC316Q application processor is demonstrated in the following block diagram. The complete system includes a camera module (CMOS sensor), a connectivity module (WiFi or Ethernet), and a non-volatile storage (NOR flash, NAND flash or SD card). External crystal of 32KHz frequency is used to drive the Real Time Clock (RTC), which can keep time scale when the main system clock is off. The ISP and Color Engine handle images captured from the camera sensor, and the video stream is composed of lots images. There are pre- and post- video processing stages. The pre-video processing rotates images, reduces noises, enhances signals and translates color domains. The post-video processing corrects lens distortion, adjusts color quality, and generates multiple video streams with different resolutions. Multimedia Encoders can compress those video streams with different compressing standards at the same time. The well compressed video/audio streams could be streamed or stored in the cloud server through Wi-Fi or Ethernet or stored in a local SD Card. The NOR or NAND flash is usually reserved for operating system and application software. Moreover, other peripherals like SAR ADC, Audio ADC/DAC, UARTs, PWMs, GPIOs and SPI are supported to realize applications with maximal flexibility.

Besides, the MSC316Q supports secure booting and personalization authentication mechanism for securing system. The AES/DES/3DES cipher engines could also help encrypt the compressed video/audio streams to protect privacy.

BLOCK DIAGRAM



BALL ASSIGNMENT (MSC316Q)

Top View

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |
|---|-----------------|-------------|--------------|--------------|-----------|-------------|-------------|------------|----------|-------------|----------|--------------|----------|-----------|----------|----------|---|
| A | | AUD_VRM_DAC | AUD_VAG | | | USB_VBUS | SD_D3 | | | SPI1_CK | UART1_RX | | | NAND_DA2 | NAND_DA0 | | A |
| B | AUD_MICC_M0 | AUD_MICIN_0 | AUD_VRM_ADC | VSS | USB_DM | USB_CID | SD_CMD | SD_D0 | SPI1_DI | SPI1_CZ | UART0_TX | NAND_DA7 | NAND_DA5 | NAND_DA3 | NAND_RBZ | NAND_REZ | B |
| C | AUD_MICC_M1 | AUD_MICIN_1 | VSS | VSS | USB_DP | SD_D2 | SD_CLK | SD_D1 | SPI1_DO | UART1_TX | UART0_RX | NAND_DA6 | NAND_DA4 | NAND_DA1 | NAND_ALE | NAND_CLE | C |
| D | | | VSS | AVDD_AUD | VSS | VSS | AVDD_USB | | PWM0 | PWM1 | SPI0_CK | SPI0_CZ | NAND_CEZ | NAND_WEZ | NAND_WPZ | | D |
| E | AUD_LINE0_UT_L0 | VSS | VSS | VSS | AVDD_AUD | | | VSS | | | SPI0_DI | AVDD1P2_MIP1 | SR_IO17 | SR_IO16 | SR_IO14 | | E |
| F | AUD_LINE0_UT_R0 | | AVDDIO_D_RAM | AVDDIO_D_RAM | VSS | VSS | VSS | VDDIO_CM_D | VSS | VSS | SPI0_DO | VDDP_3 | SR_IO15 | SR_IO13 | SR_IO12 | SR_IO11 | F |
| G | VSS | VREF | VSS | VSS | VSS | | VSS | VDDIO_CM_D | VSS | VDD | VDD | VDD | SR_IO10 | SR_IO07 | SR_IO08 | SR_IO09 | G |
| H | PM_IRIN | PM_SD_CD_Z | PM_RESET | VSS | VSS | VSS | VDDIO_DATA | VDDIO_CM_D | VSS | VDD | VDD | VDD | VDDP_2 | SR_IO05 | SR_IO06 | | H |
| J | | PM_GPIO1 | PM_GPIO0 | VSS | VSS | | VDDIO_DATA | VDDIO_MCLK | VSS | VDD | VDD | VDD | VDDP_1 | SR_IO03 | SR_IO04 | | J |
| K | | PM_GPIO3 | PM_GPIO2 | | VSS | AVDD_PLL | | VDDIO_DATA | | VDD | VDD | VDD | GPIO13 | SR_IO00 | SR_IO02 | SR_IO01 | K |
| L | PM_GPIO6 | PM_GPIO5 | PM_GPIO4 | SAR_GPIO2 | GND_EFUSE | PM_SPL_DO | PM_SPL_CK | VDDIO_DATA | | DVDD_DDR_RX | DVDD_DDR | VDD | GPIO9 | I2C1_SDA | I2C1_SCL | I2C0_SDA | L |
| M | AVDD_NODIE | DVDD_NODIE | SAR_GPIO1 | | | PM_SPL_DI | PM_SPL_HL_D | | VSS | VSS | PM_LED1 | | GPIO8 | FUART_RTS | I2C0_SCL | | M |
| N | | PM_UART_RX | | SAR_GPIO0 | VSS | PM_SPL_CZ | PM_SPL_WPZ | | AVDD_ETH | PM_LED0 | | GPIO4 | GPIO5 | FUART_CTS | FUART_TX | | N |
| P | RTC_OUT | VSS | PM_UART_TX | | SAR_GPIO3 | VSS | | VSS | | VSS | VSS | GPIO1 | GPIO3 | FUART_RX | GPIO15 | GPIO14 | P |
| R | RTC_IN | VSS | PM_GPIO8 | PM_GPIO7 | | SE_XTAL_OUT | AVDD_XTAL | | ETH_RN | ETH_TP | | GPIO0 | GPIO2 | GPIO7 | GPIO11 | GPIO12 | R |
| T | | PM_GPIO10 | PM_GPIO9 | | | XTAL_IN | XTAL_OUT | | ETH_RP | ETH_TN | | | | GPIO6 | GPIO10 | | T |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | |

BALL CHARACTERISTICS

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|------------|-------------------------|------------|--------------------|--|-----------------|-------------|
| P1 | RTC_OUT | RTC_OUT | AVDD_NODIE | | | | |
| R1 | RTC_IN | RTC_IN | AVDD_NODIE | | | | |
| P5 | SAR_GPIO3 | SAR_GPIO[3] | AVDD_NODIE | >4mA | Hi-Z | Hi-Z | Yes |
| L4 | SAR_GPIO2 | SAR_AS12 SAR_GPIO[2] | AVDD_NODIE | >4mA | Hi-Z | Hi-Z | Yes |
| M3 | SAR_GPIO1 | SAR_AS11 SAR_GPIO[1] | AVDD_NODIE | >4mA | Hi-Z | Hi-Z | Yes |
| N4 | SAR_GPIO0 | SAR_AS10 SAR_GPIO[0] | AVDD_NODIE | >4mA | Hi-Z | Hi-Z | Yes |
| H2 | PM_SD_CDZ | SD_CDZ SD_CDZ_GPIO | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| H1 | PM_IRIN | IRIN IRIN_GPIO | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| H3 | PM_RESET | HW_RESET | AVDD_NODIE | | PD=64kohm ($\pm 15\%$)/52uA($\pm 15\%$) | PD | Yes |
| N2 | PM_UART_RX | UART_RX | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| P3 | PM_UART_TX | UART_TX | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| J3 | PM_GPIO0 | PWM0 GPIO_PM[0] | AVDD_NODIE | >4mA | PD=64kohm ($\pm 15\%$)/52uA($\pm 15\%$) | PD | Yes |
| J2 | PM_GPIO1 | PWM1 GPIO_PM[1] | AVDD_NODIE | >4mA | PD=64kohm ($\pm 15\%$)/52uA($\pm 15\%$) | PD | Yes |
| K3 | PM_GPIO2 | PWM2 GPIO_PM[2] | AVDD_NODIE | >4mA | PD=64kohm ($\pm 15\%$)/52uA($\pm 15\%$) | PD | Yes |
| K2 | PM_GPIO3 | PWM3 GPIO_PM[3] | AVDD_NODIE | >4mA | PD=64kohm ($\pm 15\%$)/52uA($\pm 15\%$) | PD | Yes |
| L3 | PM_GPIO4 | GPIO_PM[4] | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| L2 | PM_GPIO5 | PWM1 GPIO_PM[5] | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| L1 | PM_GPIO6 | PWM0 GPIO_PM[6] | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| R4 | PM_GPIO7 | GPIO_PM[7] | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| R3 | PM_GPIO8 | SPI_CZ2 GPIO_PM[8] | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |
| T3 | PM_GPIO9 | PWM2 GPIO_PM[9] | AVDD_NODIE | >4mA | PU=86kohm ($\pm 15\%$)/39uA($\pm 15\%$) | PU | Yes |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|-------------|-------------------------|------------|--------------------|--------------------------------|-----------------|-------------|
| T2 | PM_GPIO10 | PWM3 GPIO_PM[10] | AVDD_NODIE | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N6 | PM_SPI_CZ | SPI_CZ1 SPI_GPIO[0] | AVDD_NODIE | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| M6 | PM_SPI_DI | SPI_DI SPI_GPIO[2] | AVDD_NODIE | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N7 | PM_SPI_WPZ | SPI_WPZ SPI_GPIO[4] | AVDD_NODIE | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| L6 | PM_SPI_DO | SPI_DO SPI_GPIO[3] | AVDD_NODIE | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| L7 | PM_SPI_CK | SPI_CK SPI_GPIO[1] | AVDD_NODIE | >4mA/8mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| M7 | PM_SPI_HLD | SPI_HLDZ SPI_GPIO[5] | AVDD_NODIE | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N10 | PM_LED0 | ETH_LED0 LED_GPIO[0] | AVDD_NODIE | >4mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| M11 | PM_LED1 | ETH_LED1 LED_GPIO[1] | AVDD_NODIE | >4mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| T6 | XTAL_IN | XTAL_IN | AVDD_XTAL | | | | |
| R6 | SE_XTAL_OUT | SE_XTAL_OUT | AVDD_XTAL | | | | |
| T7 | XTAL_OUT | XTAL_OUT | AVDD_XTAL | | | | |
| R9 | ETH_RN | ETH_RN ETH_GPIO[0] | AVDD_ETH | | | | |
| T9 | ETH_RP | ETH_RP ETH_GPIO[1] | AVDD_ETH | | | | |
| T10 | ETH_TN | ETH_TN ETH_GPIO[2] | AVDD_ETH | | | | |
| R10 | ETH_TP | ETH_TP ETH_GPIO[3] | AVDD_ETH | | | | |
| R12 | GPIO0 | FUART_RX GPIO[0] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| P12 | GPIO1 | FUART_TX GPIO[1] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| R13 | GPIO2 | FUART_CTS GPIO[2] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| P13 | GPIO3 | FUART_RTS GPIO[3] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N12 | GPIO4 | UART0_RX GPIO[4] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N13 | GPIO5 | UART0_TX GPIO[5] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|-----------|--|----------|--------------------|--------------------------------|-----------------|-------------|
| T14 | GPIO6 | UART1_RX GPIO[6] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| R14 | GPIO7 | UART1_TX GPIO[7] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| M13 | GPIO8 | SPI0_CZ GPIO[8] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| L13 | GPIO9 | SPI0_CK GPIO[9] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| T15 | GPIO10 | SPI0_DI GPIO[10] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| R15 | GPIO11 | SPI0_DO GPIO[11] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| R16 | GPIO12 | SPI1_CZ PWM0 GPIO[12] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| K13 | GPIO13 | SPI1_CK PWM1 GPIO[13] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| P16 | GPIO14 | SPI1_DI PWM2 GPIO[14] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| P15 | GPIO15 | SPI1_DO PWM3 GPIO[15] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| P14 | FUART_RX | FUART_RX UART0_RX FUART_GPIO[0] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N15 | FUART_TX | FUART_TX UART0_TX FUART_GPIO[1] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| N14 | FUART_CTS | FUART_CTS UART1_RX FUART_GPIO[2] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| M14 | FUART_RTS | FUART_RTS UART1_TX FUART_GPIO[3] | VDDP_1 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| M15 | I2C0_SCL | I2C0_SCL SR_SCL I2C0_GPIO[0] | VDDP_2 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| L16 | I2C0_SDA | I2C0_SDA SR_SDA I2C0_GPIO[1] | VDDP_2 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| L15 | I2C1_SCL | I2C1_SCL SR_SCL I2C1_GPIO[0] | VDDP_2 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| L14 | I2C1_SDA | I2C1_SDA SR_SDA I2C1_GPIO[1] | VDDP_2 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|-----------|--|----------|--------------------|--|-----------------|-------------|
| K14 | SR_IO00 | I2C0_SCL I2C1_SCL SR_D[8] SR_PDN SR_GPIO[0] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| K16 | SR_IO01 | I2C0_SDA I2C1_SDA SR_D[6] SR_VS SR_GPIO[1] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| K15 | SR_IO02 | SR_D[9] SR_D[8] SR_D[4] SR_HS CCIR_IN_D[0] SR_GPIO[2] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| J14 | SR_IO03 | SR_D[7] SR_D[6] SR_D[2] SR_D[0] CCIR_IN_D[1] SR_GPIO[3] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |
| J15 | SR_IO04 | SR_PCK SR_D[4] SR_D[1] CCIR_IN_D[2] SR_GPIO[4] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |
| H14 | SR_IO05 | SR_D[1] SR_D[2] SR_D[0] CCIR_IN_D[3] SR_GPIO[5] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |
| H15 | SR_IO06 | SR_D[0] SR_PCK SR_D[2] SR_D[3] CCIR_IN_D[4] SR_GPIO[6] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |
| G14 | SR_IO07 | SR_D[3] SR_D[1] SR_PCK SR_D[9] SR_D[4] CCIR_IN_D[5] SR_GPIO[7] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |
| G15 | SR_IO08 | SR_D[5] SR_D[0] SR_D[1] SR_D[3] CCIR_IN_D[6] SR_GPIO[8] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |
| G16 | SR_IO09 | SR_D[4] SR_D[9] SR_D[7] SR_D[6] CCIR_IN_D[7] SR_GPIO[9] | VDDP_2* | >4mA/8mA | Option PU = 90kohm (+/-15%) Option PD = 64kohm (+/-15%) | PD | No |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|-----------|--|----------|--------------------|--|-----------------|-------------|
| G13 | SR_IO10 | SR_D[6] SR_D[3] SR_D[5] SR_RST SR_MCK CCIR_IN_D[8] SR_GPIO[10] | VDDP_2** | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| F16 | SR_IO11 | SR_MCK SR_D[7] SR_D[3] SR_D[5] CCIR_IN_D[9] SR_GPIO[11] | VDDP_2** | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| F15 | SR_IO12 | SR_HS SR_RST SR_D[9] SR_VS SR_D[8] CCIR_IN_CLK SR_GPIO[12] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| F14 | SR_IO13 | SR_VS SR_D[5] SR_HS SR_D[9] SR_GPIO[13] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| E15 | SR_IO14 | SR_D[8] SR_VS SR_PDN SR_D[10] SR_GPIO[14] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| F13 | SR_IO15 | SR_D[2] SR_HS SR_MCK SR_MCK SR_D[11] SR_GPIO[15] | VDDP_2** | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| E14 | SR_IO16 | SR_PDN SR_PCK SR_GPIO[16] | VDDP_2* | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| E13 | SR_IO17 | SR_RST SR_MCK SR_GPIO[17] | VDDP_2** | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C15 | NAND_ALE | NAND_ALE NAND_GPIO[1] | VDDP_3 | >4mA/8mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| C16 | NAND_CLE | NAND_CLE SD_CLK NAND_GPIO[2] | VDDP_3 | >4mA/8mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| D13 | NAND_CEZ | NAND_CEZ SD_CMD NAND_GPIO[0] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| D14 | NAND_WEZ | NAND_WEZ SD_D[0] NAND_GPIO[3] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|-----------|-------------------------------------|----------|--------------------|--|-----------------|-------------|
| D15 | NAND_WPZ | NAND_WPZ SD_D[1] NAND_GPIO[4] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| B16 | NAND_REZ | NAND_REZ SD_D[2] NAND_GPIO[5] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| B15 | NAND_RBZ | NAND_RBZ SD_D[3] NAND_GPIO[6] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| A15 | NAND_DA0 | NAND_DA[0] NAND_GPIO[7] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C14 | NAND_DA1 | NAND_DA[1] NAND_GPIO[8] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| A14 | NAND_DA2 | NAND_DA[2] NAND_GPIO[9] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| B14 | NAND_DA3 | NAND_DA[3] NAND_GPIO[10] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C13 | NAND_DA4 | NAND_DA[4] NAND_GPIO[11] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| B13 | NAND_DA5 | NAND_DA[5] NAND_GPIO[12] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C12 | NAND_DA6 | NAND_DA[6] NAND_GPIO[13] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| B12 | NAND_DA7 | NAND_DA[7] NAND_GPIO[14] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C11 | UART0_RX | UART0_RX UART0_GPIO[0] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| B11 | UART0_TX | UART0_TX UART0_GPIO[1] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| A11 | UART1_RX | UART1_RX UART1_GPIO[0] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C10 | UART1_TX | UART1_TX UART1_GPIO[1] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| D12 | SPI0_CZ | SPI0_CZ SPI0_GPIO[0] | VDDP_3 | >4mA/8mA/12mA/16mA | PU=86kohm (±15%)/39uA(±15%) | PU | No |
| D11 | SPI0_CK | SPI0_CK SPI0_GPIO[1] | VDDP_3 | >4mA/8mA/12mA/16mA | PD=64kohm (±15%)/52uA(±15%) | PD | No |
| E11 | SPI0_DI | SPI0_DI SPI0_GPIO[2] | VDDP_3 | >4mA/8mA/12mA/16mA | PD=64kohm (±15%)/52uA(±15%) | PD | No |
| F11 | SPI0_DO | SPI0_DO SPI0_GPIO[3] | VDDP_3 | >4mA/8mA/12mA/16mA | PD=64kohm (±15%)/52uA(±15%) | PD | No |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|-------------|---|----------|--------------------|--|-----------------|-------------|
| B10 | SPI1_CZ | SPI1_CZ SPI1_GPIO[0] | VDDP_3 | >4mA/8mA/12mA/16mA | PU=86kohm (±15%)/39uA(±15%) | PU | No |
| A10 | SPI1_CK | SPI1_CK SPI1_GPIO[1] | VDDP_3 | >4mA/8mA/12mA/16mA | PD=64kohm (±15%)/52uA(±15%) | PD | No |
| B9 | SPI1_DI | SPI1_DI SPI1_GPIO[2] | VDDP_3 | >4mA/8mA/12mA/16mA | PD=64kohm (±15%)/52uA(±15%) | PD | No |
| C9 | SPI1_DO | SPI1_DO SPI1_GPIO[3] | VDDP_3 | >4mA/8mA/12mA/16mA | PD=64kohm (±15%)/52uA(±15%) | PD | No |
| D9 | PWM0 | I2C0_SCL I2C1_SCL PWM0 PWM_GPIO[0] | VDDP_3 | >4mA/8mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| D10 | PWM1 | I2C0_SDA I2C1_SDA PWM1 PWM_GPIO[1] | VDDP_3 | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| C7 | SD_CLK | SDIO_CLK SD_GPIO[0] | VDDP_3 | >4mA/8mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| B7 | SD_CMD | SDIO_CMD SD_GPIO[1] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| B8 | SD_D0 | SPI1_CZ SDIO_D[0] SD_GPIO[2] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| C8 | SD_D1 | SPI1_CK SDIO_D[1] SD_GPIO[3] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| C6 | SD_D2 | SPI1_DI SDIO_D[2] SD_GPIO[4] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| A7 | SD_D3 | SPI1_DO SDIO_D[3] SD_GPIO[5] | VDDP_3 | >4mA/8mA | Option PU=86kohm (±15%)/39uA(±15%) | Hi-Z | Yes |
| B6 | USB_CID | USB_CID | AVDD_USB | >4mA | PU=86kohm (±15%)/39uA(±15%) | PU | Yes |
| A6 | USB_VBUS | USB_VBUS | AVDD_USB | >4mA | PD=64kohm (±15%)/52uA(±15%) | PD | Yes |
| B5 | USB_DM | USB_DM USB_GPIO[0] | AVDD_USB | | | | |
| C5 | USB_DP | USB_DP USB_GPIO[1] | AVDD_USB | | | | |
| A3 | AUD_VAG | AUD_VAG | AVDD_AUD | | | | |
| B3 | AUD_VRM_ADC | AUD_VRM_ADC | AVDD_AUD | | | | |
| A2 | AUD_VRM_DAC | AUD_VRM_DAC | AVDD_AUD | | | | |
| B2 | AUD_MICIN0 | AUD_MICIN0 | AVDD_AUD | | | | |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|--|----------------|----------------|----------|--------------------|---------------|-----------------|-------------|
| C2 | AUD_MICIN1 | AUD_MICIN1 | AVDD_AUD | | | | |
| B1 | AUD_MICCM0 | AUD_MICCM0 | AVDD_AUD | | | | |
| C1 | AUD_MICCM1 | AUD_MICCM1 | AVDD_AUD | | | | |
| F1 | AUD_LINEOUT_R0 | AUD_LINEOUT_R0 | AVDD_AUD | | | | |
| E1 | AUD_LINEOUT_L0 | AUD_LINEOUT_L0 | AVDD_AUD | | | | |
| G10, G11, G12, H10, H11, H12, J10, J11, J12, K10, K11, K12, L12 | VDD | | | | | | |
| L11 | DVDD_DDR | | | | | | |
| L10 | DVDD_DDR_RX | | | | | | |
| M2 | DVDD_NODIE | | | | | | |
| E12 | AVDD1P2_MIPI | | | | | | |
| D4,E5 | AVDD_AUD | | | | | | |
| N9 | AVDD_ETH | | | | | | |
| H13 | AVDD_MIPI | | | | | | |
| M1 | AVDD_NODIE | | | | | | |
| K6 | AVDD_PLL | | | | | | |
| D7 | AVDD_USB | | | | | | |
| R7 | AVDD_XTAL | | | | | | |
| F8, G8, H8 | VDDIO_CMD | | | | | | |
| F8, G8, H8 | VDDIO_CMD2 | | | | | | |
| H7, J7, K8, L8 | VDDIO_DATA | | | | | | |
| J8 | VDDIO_MCLK | | | | | | |
| J13 | VDDP_1 | | | | | | |
| H13 | VDDP_2 | | | | | | |
| F12 | VDDP_3 | | | | | | |
| B4, C3, C4, D3, D5, D6, E2, E3, E4, E8, F5, F6, F7, F9, F10, G1, G3, G4, G5, G7, G9, H4, H5, H6, H9, J4, J5, J9, K5, M9, M10, N5, P2, P6, P8, P10, P11, R2 | VSS | | | | | | |
| | DVSS_DDR | | | | | | |
| | AVSS_AUD | | | | | | |
| | AVSS_ETH | | | | | | |
| | AVSS_NODIE | | | | | | |
| | AVSS_PLL | | | | | | |
| | AVSS_RTC | | | | | | |
| | AVSS_USB | | | | | | |
| | AVSS_XTAL | | | | | | |
| | VSSIO_CMD | | | | | | |
| | VSSIO_CMD2 | | | | | | |

| BGA Ball Location | Ball Name | Multi Function | IO Power | Driving Capability | Pull Resistor | Core-Off Status | 5V-Tolerant |
|-------------------|------------|----------------|----------|--------------------|---------------|-----------------|-------------|
| | VSSIO_DATA | | | | | | |
| | VSSIO_MCLK | | | | | | |

*: VDDP_2 operating voltage range 1.7V~3.6V for digital parallel video input CMOS image sensors,

** : VDDP_2 operating voltage range 2.5V~3.6V when used as SR_MCLK, 1.7V~3.6V when not used as SR_MCLK for digital parallel video input CMOS image sensors

SIGNAL DESCRIPTION

Image Sensor

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|-------------------------------------|-------------------------|
| SR_D[0] | Input | Image Sensor Data Bus | H15, G15, H14, H15, J14 |
| SR_D[1] | Input | Image Sensor Data Bus | H14, G14, G15, H14, J15 |
| SR_D[2] | Input | Image Sensor Data Bus | F13, H14, H15, J14, H14 |
| SR_D[3] | Input | Image Sensor Data Bus | G14, G13, F16, G15, H15 |
| SR_D[4] | Input | Image Sensor Data Bus | G16, J15, J15, K15, G14 |
| SR_D[5] | Input | Image Sensor Data Bus | G15, F14, G13, F16, G15 |
| SR_D[6] | Input | Image Sensor Data Bus | G13, J14, J14, K16, G16 |
| SR_D[7] | Input | Image Sensor Data Bus | J14, F16, G16, G16, F16 |
| SR_D[8] | Input | Image Sensor Data Bus | E15, K15, K15, K14, F15 |
| SR_D[9] | Input | Image Sensor Data Bus | K15, G16, F15, G14, F14 |
| SR_D[10] | Input | Image Sensor Data Bus | E15 |
| SR_D[11] | Input | Image Sensor Data Bus | F13 |
| SR_HS | Input | Image Sensor Horizontal Sync Signal | F15, F13, F14, F14, K15 |
| SR_VS | Input | Image Sensor Vertical Sync Signal | F14, E15, E15, F15, K16 |
| SR_PCK | Input | Image Sensor Pixel Clock | J15, H15, G14, J15, E14 |
| SR_PDN | Output | Image Sensor Power Down Control | E14, E14, E14, E15, K14 |
| SR_RST | Output | Image Sensor Reset Control | E13, F15, E13, G13, E13 |
| SR_MCK | Output | Image Sensor Reference Clock | F16, E13, F13, F13, G13 |
| SR_SCL | Output | Image Sensor I2C Serial Clock | M15, L15 |
| SR_SDA | Input/Output | Image Sensor I2C Serial Data | L16, L14 |

CCIR Sensor

| Signal Name | Signal Type | Function | Ball Location |
|--------------|-------------|-------------------|---------------|
| CCIR_IN_D[0] | Input | CCIR Data Bus | K15 |
| CCIR_IN_D[1] | Input | CCIR Data Bus | J14 |
| CCIR_IN_D[2] | Input | CCIR Data Bus | J15 |
| CCIR_IN_D[3] | Input | CCIR Data Bus | H14 |
| CCIR_IN_D[4] | Input | CCIR Data Bus | H15 |
| CCIR_IN_D[5] | Input | CCIR Data Bus | G14 |
| CCIR_IN_D[6] | Input | CCIR Data Bus | G15 |
| CCIR_IN_D[7] | Input | CCIR Data Bus | G16 |
| CCIR_IN_D[8] | Input | CCIR Data Bus | G13 |
| CCIR_IN_D[9] | Input | CCIR Data Bus | F16 |
| CCIR_IN_CLK | Input | CCIR Sample Clock | F15 |

Audio Interface

| Signal Name | Signal Type | Function | Ball Location |
|----------------|-------------|---|---------------|
| AUD_LINEOUT_L0 | Output | Audio Left Channel Line Output | E1 |
| AUD_LINEOUT_R0 | Output | Audio Right Channel Line Output | F1 |
| AUD_VAG | Output | Audio Reference Voltage from 1/2 AVDD_AUD | A3 |
| AUD_VRM_ADC | Input | Audio Reference Voltage for ADC | B3 |
| AUD_VRM_DAC | Input | Audio Reference Voltage for DAC | A2 |
| AUD_MICIN0 | Input | Audio Left Channel Microphone Postive Input | B2 |
| AUD_MICIN1 | Input | Audio Right Channel Microphone Postive Input | C2 |
| AUD_MICCM0 | Input | Audio Left Channel Microphone Negative Input | B1 |
| AUD_MICCM1 | Input | Audio Right Channel Microphone Negative Input | C1 |

10/100 Ethernet Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--|---------------|
| ETH_RN | Input | 10/100 Ethernet Negative Receiving Input | R9 |
| ETH_RP | Input | 10/100 Ethernet Positive Receiving Input | T9 |
| ETH_TN | Output | 10/100 Ethernet Negative Transmitting Output | T10 |

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--|---------------|
| ETH_TP | Output | 10/100 Ethernet Positive Transmitting Output | R10 |
| ETH_LED0 | Output | 10/100 Ethernet LED 0 Control | N10 |
| ETH_LED1 | Output | 10/100 Ethernet LED 1 Control | M11 |

NAND Flash Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|--|---------------|
| NAND_ALE | Output | NAND Flash Address Latch Enable | C15 |
| NAND_CLE | Output | NAND Flash Command Latch Enable | C16 |
| NAND_CEZ | Output | NAND Flash Chip 0 Enable (active low) | D13 |
| NAND_WEZ | Output | NAND Flash Write Enable (active low) | D14 |
| NAND_WPZ | Output | NAND Flash Write Protect (active low) | D15 |
| NAND_REZ | Output | NAND Flash Read Enable (active low) | B16 |
| NAND_RBZ | Input | NAND Flash Status (high: ready, low: busy) | B15 |
| NAND_DA[0] | Input/Output | NAND Flash Data Bus | A15 |
| NAND_DA[1] | Input/Output | NAND Flash Data Bus | C14 |
| NAND_DA[2] | Input/Output | NAND Flash Data Bus | A14 |
| NAND_DA[3] | Input/Output | NAND Flash Data Bus | B14 |
| NAND_DA[4] | Input/Output | NAND Flash Data Bus | C13 |
| NAND_DA[5] | Input/Output | NAND Flash Data Bus | B13 |
| NAND_DA[6] | Input/Output | NAND Flash Data Bus | C12 |
| NAND_DA[7] | Input/Output | NAND Flash Data Bus | B12 |

SD Card Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|-----------------------------|---------------|
| SD_CDZ | Input | SD Card Detect (active low) | H2 |
| SD_CLK | Output | SD Card Clock | C16 |
| SD_CMD | Output | SD Card Command | D13 |
| SD_D[0] | Input/Output | SD Card Data Bus | D14 |
| SD_D[1] | Input/Output | SD Card Data Bus | D15 |
| SD_D[2] | Input/Output | SD Card Data Bus | B16 |
| SD_D[3] | Input/Output | SD Card Data Bus | B15 |

SDIO Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|------------------|---------------|
| SDIO_CLK | Output | SDIO 2.0 Clock | C7 |
| SDIO_CMD | Output | SDIO 2.0 Command | B7 |

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|-------------------|---------------|
| SDIO_D[0] | Input/Output | SDIO 2.0 Data Bus | B8 |
| SDIO_D[1] | Input/Output | SDIO 2.0 Data Bus | C8 |
| SDIO_D[2] | Input/Output | SDIO 2.0 Data Bus | C6 |
| SDIO_D[3] | Input/Output | SDIO 2.0 Data Bus | A7 |

SPI Flash Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--|---------------|
| SPI_CK | Output | SPI Flash Clock | L7 |
| SPI_CZ1 | Output | SPI Flash Chip Select 1 (active low) | N6 |
| SPI_CZ2 | Output | SPI Flash Chip Select 2 (active low) | R3 |
| SPI_DI | Output | SPI Flash Serial Data To Device | M6 |
| SPI_DO | Input | SPI Flash Serial Data From Device | L6 |
| SPI_WPZ | Output | SPI Flash Write Protect Control (active low) | N7 |
| SPI_HLDZ | Output | SPI Flash Hold Control (active low) | M7 |

USB 2.0 Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|---|---------------|
| USB_CID | Input | USB 2.0 OTG ID (high slave mode, low host mode) | B6 |
| USB_VBUS | Input | USB 2.0 VBUS Power | A6 |
| USB_DM | Input/Output | USB 2.0 Inverting Data | B5 |
| USB_DP | Input/Output | USB 2.0 Non-inverting Data | C5 |

Master SPI Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|---------------------------------------|---------------|
| SPI0_CZ | Output | Master SPI 0 Chip Select (active low) | D12, M13 |
| SPI0_CK | Output | Master SPI 0 Serial Clock | D11, L13 |
| SPI0_DI | Output | Master SPI 0 Serial Data In | E11, T15 |
| SPI0_DO | Input | Master SPI 0 Serial Data Out | F11, R15 |
| SPI1_CZ | Output | Master SPI 1 Chip Select (active low) | B10, R16, B8 |
| SPI1_CK | Output | Master SPI 1 Serial Clock | A10, K13, C8 |
| SPI1_DI | Output | Master SPI 1 Serial Data In | B9, P16, C6 |
| SPI1_DO | Input | Master SPI 1 Serial Data Out | C9, P15, A7 |

Master I2C Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|---------------------------|---------------|
| I2C0_SCL | Output | Master I2C 0 Serial Clock | M15, D9, K14 |
| I2C0_SDA | Input/Output | Master I2C 0 Serial Data | L16, D10, K16 |
| I2C1_SCL | Output | Master I2C 1 Serial Clock | L15, D9, K14 |
| I2C1_SDA | Input/Output | Master I2C 1 Serial Data | L14, D10, K16 |

UART Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--------------------|---------------|
| UART_RX0 | Input | UART 0 Receiver | C11, P14, N12 |
| UART_TX0 | Output | UART 0 Transmitter | B11, N15, N13 |
| UART_RX1 | Input | UART 1 Receiver | A11, N14, T14 |
| UART_TX1 | Output | UART 1 Transmitter | C10, M14, R14 |

Fast UART Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--------------------------|---------------|
| FUART_RX | Input | Fast UART Receiver | P14, R12 |
| FUART_TX | Output | Fast UART Transmitter | N15, P12 |
| FUART_CTS | Input | Fast UART Clear to Set | N14, R13 |
| FUART_RTS | Output | Fast UART Request to Set | M14, P13 |

PWM Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--------------|------------------|
| PWM0 | Output | PWM 0 Output | D9, R16, J3, L1 |
| PWM1 | Output | PWM 1 Output | D10, K13, J2, L2 |
| PWM2 | Output | PWM 2 Output | P16, K3, T3 |
| PWM3 | Output | PWM 3 Output | P15, K2, T2 |

IR Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|-------------|---------------|
| IRIN | Input | IR Receiver | H1 |

SAR Interface

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|-----------------------------|---------------|
| SAR_ASIO | Input | SAR Analog Signal Channel 0 | N4 |
| SAR_ASII | Input | SAR Analog Signal Channel 1 | M3 |

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|-----------------------------|---------------|
| SAR_ASI2 | Input | SAR Analog Signal Channel 2 | L4 |

System

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|--|---------------|
| XTAL_IN | Input | 24MHz Crystal Output | T6 |
| XTAL_OUT | Output | 24MHz Crystal Input | T7 |
| SE_XTAL_OUT | Output | 24MHz Clock Output | R6 |
| HW_RESET | Input | Chip Reset (active high) | H3 |
| RTC_OUT | Output | 32KHz Crystal Output | P1 |
| RTC_IN | Input | 32KHz Crystal Input | R1 |
| UART_RX | Input | Debug Port for UART Receiver or Slave I2C Serial Clock | N2 |
| UART_TX | Output | Debug Port for UART Transmitter or Slave I2C Serial Data | P3 |
| GND_EFUSE | Input | Power Source if eFuse Burning (connect to ground) | L5 |

GPIO Interface

| Signal Name | Signal Type | Function | Ball Location |
|---------------|--------------|------------------------------|---------------|
| GPIO[0] | Input/Output | General Purpose Input/Output | R12 |
| GPIO[1] | Input/Output | General Purpose Input/Output | P12 |
| GPIO[2] | Input/Output | General Purpose Input/Output | R13 |
| GPIO[3] | Input/Output | General Purpose Input/Output | P13 |
| GPIO[4] | Input/Output | General Purpose Input/Output | N12 |
| GPIO[5] | Input/Output | General Purpose Input/Output | N13 |
| GPIO[6] | Input/Output | General Purpose Input/Output | T14 |
| GPIO[7] | Input/Output | General Purpose Input/Output | R14 |
| GPIO[8] | Input/Output | General Purpose Input/Output | M13 |
| GPIO[9] | Input/Output | General Purpose Input/Output | L13 |
| GPIO[10] | Input/Output | General Purpose Input/Output | T15 |
| GPIO[11] | Input/Output | General Purpose Input/Output | R15 |
| GPIO[12] | Input/Output | General Purpose Input/Output | R16 |
| GPIO[13] | Input/Output | General Purpose Input/Output | K13 |
| GPIO[14] | Input/Output | General Purpose Input/Output | P16 |
| GPIO[15] | Input/Output | General Purpose Input/Output | P15 |
| FUART_GPIO[0] | Input/Output | General Purpose Input/Output | P14 |

| Signal Name | Signal Type | Function | Ball Location |
|---------------|--------------|------------------------------|---------------|
| FUART_GPIO[1] | Input/Output | General Purpose Input/Output | N15 |
| FUART_GPIO[2] | Input/Output | General Purpose Input/Output | N14 |
| FUART_GPIO[3] | Input/Output | General Purpose Input/Output | M14 |
| UART0_GPIO[0] | Input/Output | General Purpose Input/Output | C11 |
| UART0_GPIO[1] | Input/Output | General Purpose Input/Output | B11 |
| UART1_GPIO[0] | Input/Output | General Purpose Input/Output | A11 |
| UART1_GPIO[1] | Input/Output | General Purpose Input/Output | C10 |
| I2C0_GPIO[0] | Input/Output | General Purpose Input/Output | M15 |
| I2C0_GPIO[1] | Input/Output | General Purpose Input/Output | L16 |
| I2C1_GPIO[0] | Input/Output | General Purpose Input/Output | L15 |
| I2C1_GPIO[1] | Input/Output | General Purpose Input/Output | L14 |
| SPI0_GPIO[0] | Input/Output | General Purpose Input/Output | D12 |
| SPI0_GPIO[1] | Input/Output | General Purpose Input/Output | D11 |
| SPI0_GPIO[2] | Input/Output | General Purpose Input/Output | E11 |
| SPI0_GPIO[3] | Input/Output | General Purpose Input/Output | F11 |
| SPI1_GPIO[0] | Input/Output | General Purpose Input/Output | B10 |
| SPI1_GPIO[1] | Input/Output | General Purpose Input/Output | A10 |
| SPI1_GPIO[2] | Input/Output | General Purpose Input/Output | B9 |
| SPI1_GPIO[3] | Input/Output | General Purpose Input/Output | C9 |
| PWM_GPIO[0] | Input/Output | General Purpose Input/Output | D9 |
| PWM_GPIO[1] | Input/Output | General Purpose Input/Output | D10 |
| NAND_GPIO[0] | Input/Output | General Purpose Input/Output | D13 |
| NAND_GPIO[1] | Input/Output | General Purpose Input/Output | C15 |
| NAND_GPIO[10] | Input/Output | General Purpose Input/Output | B14 |
| NAND_GPIO[11] | Input/Output | General Purpose Input/Output | C13 |
| NAND_GPIO[12] | Input/Output | General Purpose Input/Output | B13 |
| NAND_GPIO[13] | Input/Output | General Purpose Input/Output | C12 |
| NAND_GPIO[14] | Input/Output | General Purpose Input/Output | B12 |
| NAND_GPIO[2] | Input/Output | General Purpose Input/Output | C16 |
| NAND_GPIO[3] | Input/Output | General Purpose Input/Output | D14 |
| NAND_GPIO[4] | Input/Output | General Purpose Input/Output | D15 |
| NAND_GPIO[5] | Input/Output | General Purpose Input/Output | B16 |
| NAND_GPIO[6] | Input/Output | General Purpose Input/Output | B15 |
| NAND_GPIO[7] | Input/Output | General Purpose Input/Output | A15 |
| NAND_GPIO[8] | Input/Output | General Purpose Input/Output | C14 |

| Signal Name | Signal Type | Function | Ball Location |
|--------------|--------------|------------------------------|---------------|
| NAND_GPIO[9] | Input/Output | General Purpose Input/Output | A14 |
| SD_GPIO[0] | Input/Output | General Purpose Input/Output | C7 |
| SD_GPIO[1] | Input/Output | General Purpose Input/Output | B7 |
| SD_GPIO[2] | Input/Output | General Purpose Input/Output | B8 |
| SD_GPIO[3] | Input/Output | General Purpose Input/Output | C8 |
| SD_GPIO[4] | Input/Output | General Purpose Input/Output | C6 |
| SD_GPIO[5] | Input/Output | General Purpose Input/Output | A7 |
| SR_GPIO[0] | Input/Output | General Purpose Input/Output | K14 |
| SR_GPIO[1] | Input/Output | General Purpose Input/Output | K16 |
| SR_GPIO[2] | Input/Output | General Purpose Input/Output | K15 |
| SR_GPIO[3] | Input/Output | General Purpose Input/Output | J14 |
| SR_GPIO[4] | Input/Output | General Purpose Input/Output | J15 |
| SR_GPIO[5] | Input/Output | General Purpose Input/Output | H14 |
| SR_GPIO[6] | Input/Output | General Purpose Input/Output | H15 |
| SR_GPIO[7] | Input/Output | General Purpose Input/Output | G14 |
| SR_GPIO[8] | Input/Output | General Purpose Input/Output | G15 |
| SR_GPIO[9] | Input/Output | General Purpose Input/Output | G16 |
| SR_GPIO[10] | Input/Output | General Purpose Input/Output | G13 |
| SR_GPIO[11] | Input/Output | General Purpose Input/Output | F16 |
| SR_GPIO[12] | Input/Output | General Purpose Input/Output | F15 |
| SR_GPIO[13] | Input/Output | General Purpose Input/Output | F14 |
| SR_GPIO[14] | Input/Output | General Purpose Input/Output | E15 |
| SR_GPIO[15] | Input/Output | General Purpose Input/Output | F13 |
| SR_GPIO[16] | Input/Output | General Purpose Input/Output | E14 |
| SR_GPIO[17] | Input/Output | General Purpose Input/Output | E13 |
| USB_GPIO[0] | Input/Output | General Purpose Input/Output | B5 |
| USB_GPIO[1] | Input/Output | General Purpose Input/Output | C5 |
| PM_GPIO[0] | Input/Output | General Purpose Input/Output | J3 |
| PM_GPIO[1] | Input/Output | General Purpose Input/Output | J2 |
| PM_GPIO[2] | Input/Output | General Purpose Input/Output | K3 |
| PM_GPIO[3] | Input/Output | General Purpose Input/Output | K2 |
| PM_GPIO[4] | Input/Output | General Purpose Input/Output | L3 |
| PM_GPIO[5] | Input/Output | General Purpose Input/Output | L2 |
| PM_GPIO[6] | Input/Output | General Purpose Input/Output | L1 |
| PM_GPIO[7] | Input/Output | General Purpose Input/Output | R4 |

| Signal Name | Signal Type | Function | Ball Location |
|-------------|--------------|------------------------------|---------------|
| PM_GPIO[8] | Input/Output | General Purpose Input/Output | R3 |
| PM_GPIO[9] | Input/Output | General Purpose Input/Output | T3 |
| PM_GPIO[10] | Input/Output | General Purpose Input/Output | T2 |
| SD_CDZ_GPIO | Input/Output | General Purpose Input/Output | H2 |
| IRIN_GPIO | Input/Output | General Purpose Input/Output | H1 |
| SPI_GPIO[0] | Input/Output | General Purpose Input/Output | N6 |
| SPI_GPIO[1] | Input/Output | General Purpose Input/Output | L7 |
| SPI_GPIO[2] | Input/Output | General Purpose Input/Output | M6 |
| SPI_GPIO[3] | Input/Output | General Purpose Input/Output | L6 |
| SPI_GPIO[4] | Input/Output | General Purpose Input/Output | N7 |
| SPI_GPIO[5] | Input/Output | General Purpose Input/Output | M7 |
| SAR_GPIO[0] | Input/Output | General Purpose Input/Output | N4 |
| SAR_GPIO[1] | Input/Output | General Purpose Input/Output | M3 |
| SAR_GPIO[2] | Input/Output | General Purpose Input/Output | L4 |
| SAR_GPIO[3] | Input/Output | General Purpose Input/Output | P5 |
| ETH_GPIO[0] | Input/Output | General Purpose Input/Output | R9 |
| ETH_GPIO[1] | Input/Output | General Purpose Input/Output | T9 |
| ETH_GPIO[2] | Input/Output | General Purpose Input/Output | T10 |
| ETH_GPIO[3] | Input/Output | General Purpose Input/Output | R10 |
| LED_GPIO[0] | Input/Output | General Purpose Input/Output | N10 |
| LED_GPIO[1] | Input/Output | General Purpose Input/Output | M11 |

Cortex-A7 JTAG

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|----------------------|---------------|
| EJ_TCK | Input | CA7 JTAG Clock | P14, D12 |
| EJ_TMS | Input | CA7 JTAG Mode Select | N15, D11 |
| EJ_TDO | Output | CA7 JTAG Data Out | N14, E11 |
| EJ_TDI | Input | CA7 JTAG Data In | M14, F11 |

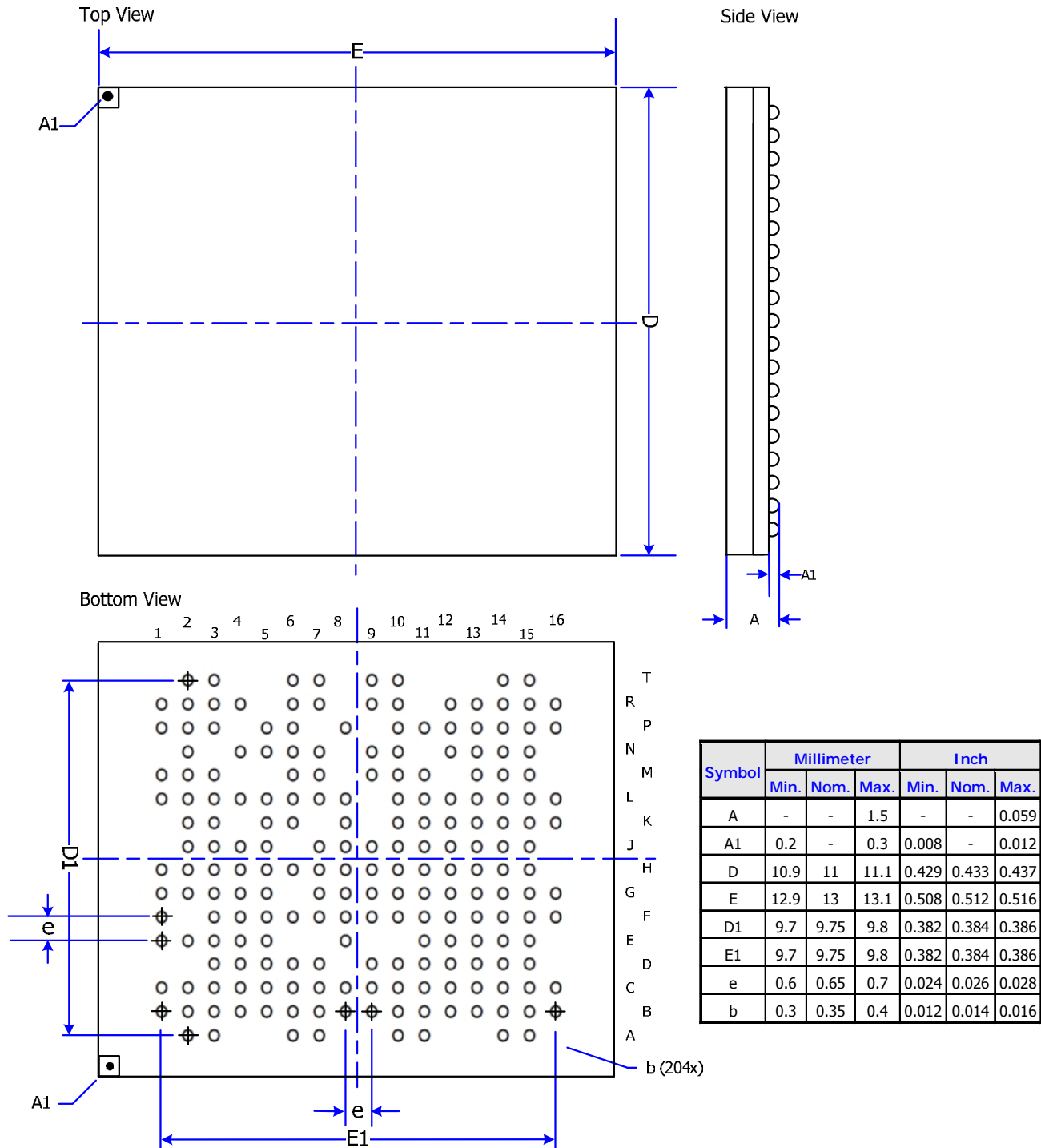
Power Pins

| Signal Name | Signal Type | Function | Ball Location |
|--------------|-------------|---------------------------|---|
| VDD | Input | Digital Power | G10, G11, G12, H10, H11, H12, J10, J11, J12, K10, K11, K12, L12 |
| DVDD_DDR | Input | Digital Power for DDR | L11 |
| DVDD_DDR_RX | Input | Digital Power for DDR | L10 |
| DVDD_NODIE | Output | PM LDO Output | M2 |
| AVDD1P2_MIPI | Output | MIPI LDO Output | E12 |
| AVDD_AUD | Input | Analog Power for Audio | D4, E5 |
| AVDD_ETH | Input | Analog Power for Ethernet | N9 |
| AVDD_MIPI | Input | Analog Power for MIPI | H13 |
| AVDD_NODIE | Input | Analog Power for PM | M1 |
| AVDD_PLL | Input | Analog Power for PLL | K6 |
| AVDD_USB | Input | Analog Power for USB | D7 |
| AVDD_XTAL | Input | Analog Power for XTAL | R7 |
| VDDIO_CMD | Input | Analog Power for DDR | F8, G8, H8 |
| VDDIO_CMD2 | Input | Analog Power for DDR | F8, G8, H8 |
| VDDIO_DATA | Input | Analog Power for DDR | H7, J7, K8, L8 |
| VDDIO_MCLK | Input | Analog Power for DDR | J8 |
| VDDP_1 | Input | Pad Power | J13 |
| VDDP_2 | Input | Pad Power | H13 |
| VDDP_3 | Input | Pad Power | F12 |

Ground

| Signal Name | Signal Type | Function | Ball Location |
|-------------|-------------|------------------------------|--|
| VSS | Input | Digital Ground | B4, C3, C4, D3, D5, D6, E2, E3, E4, E8, F5, F6, F7, F9, F10, G1, G3, G4, G5, G7, G9, H4, H5, H6, H9, J4, J5, J9, K5, M9, M10, N5, P2, P6, P8, P10, P11, R2 |
| DVSS_DDR | Input | Digital Ground for DDR | |
| AVSS_AUD | Input | Analog Ground for Audio | |
| AVSS_ETH | Input | Analog Ground for Ethernet | |
| AVSS_NODIE | Input | Analog Ground for PM | |
| AVSS_PLL | Input | Analog Ground for PLL | |
| AVSS_RTC | Input | Analog Ground for 32KHz XTAL | |
| AVSS_USB | Input | Analog Ground for USB | |
| AVSS_XTAL | Input | Analog Ground for 24MHz XTAL | |
| VSSIO_CMD | Input | Analog Ground for DDR | |
| VSSIO_CMD2 | Input | Analog Ground for DDR | |
| VSSIO_DATA | Input | Analog Ground for DDR | |
| VSSIO_MCLK | Input | Analog Ground for DDR | |

MECHANICAL DIMENSIONS



ELECTRICAL SPECIFICATIONS

Interface Characteristics

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|----------------------|----------|-------------------------------|------|---------------|------|
| DIGITAL INPUTS | | | | | |
| Input Voltage, High | V_{IH} | 2.5 | | | V |
| Input Voltage, Low | V_{IL} | | | 0.8 | V |
| Input Current, High | I_{IH} | | | -1.0 | uA |
| Input Current, Low | I_{IL} | | | 1.0 | uA |
| Input Capacitance | | | 5 | | pF |
| DIGITAL OUTPUTS | | | | | |
| Output Voltage, High | V_{OH} | $V_{DDP}-0.1$ ^{Note} | | | V |
| Output Voltage, Low | V_{OL} | | | 0.1 | V |
| SAR ADC Input | | 0 | | V_{VDD_33} | V |
| AUDIO OUTPUTS | | | | | |
| Line-Out | | | 2.4 | | Vp-p |

Note: V_{DDP} can be V_{VDD_33} , V_{VDD_15}

Recommended Operating Conditions

| Parameter | Symbol | Min | Typ. | Max. | Unit |
|-------------------------------|---------------|-----|------|------|------|
| 3.3V Supply Voltage | V_{VDD_33} | | 3.3 | | V |
| 1.5V Supply Voltage (DDR III) | V_{VDD_15} | | 1.5 | | V |
| 1.1V Supply Voltage (Core) | V_{VDD_11} | | 1.1 | | V |
| Ambient Operation Temperature | T_A | -40 | | 85 | °C |
| Junction Temperature | T_J | | | 125 | °C |

Absolute Maximum Ratings

| Parameter | Symbol | Min | Typ. | Max. | Unit |
|-------------------------------|---------------|-----|------|------|------|
| 3.3V Supply Voltage | V_{VDD_33} | | | 3.63 | V |
| 1.5V Supply Voltage (DDR III) | V_{VDD_15} | | | 1.65 | V |
| 1.1V Supply Voltage (Core) | V_{VDD_11} | | | 1.47 | V |
| Storage Temperature | T_{STG} | -40 | | 150 | °C |

Note: Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and does not imply functional operation of device. Exposure to absolute maximum ratings for extended periods may affect device reliability.

HARDWARE POWER SEQUENCE PROCEDURE

The timing requirements of the hardware reset signal are shown as below:

Hardware Reset

HWRESET: Chip Reset; High Reset (Level)

The HWRESET pin is suggested to connect with 3.3V standby as shown in Figure 1. The VIH is 2V (Typ) +/- 10% (2.2V~1.8V); the VIL is 1.2V (Typ) +/- 10% (1.08V~1.32V). The power sequence is as shown in Figure 2.

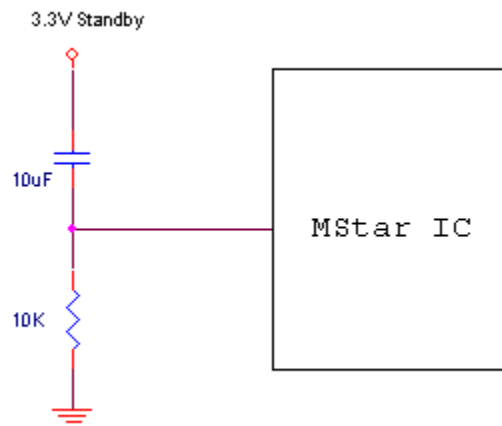
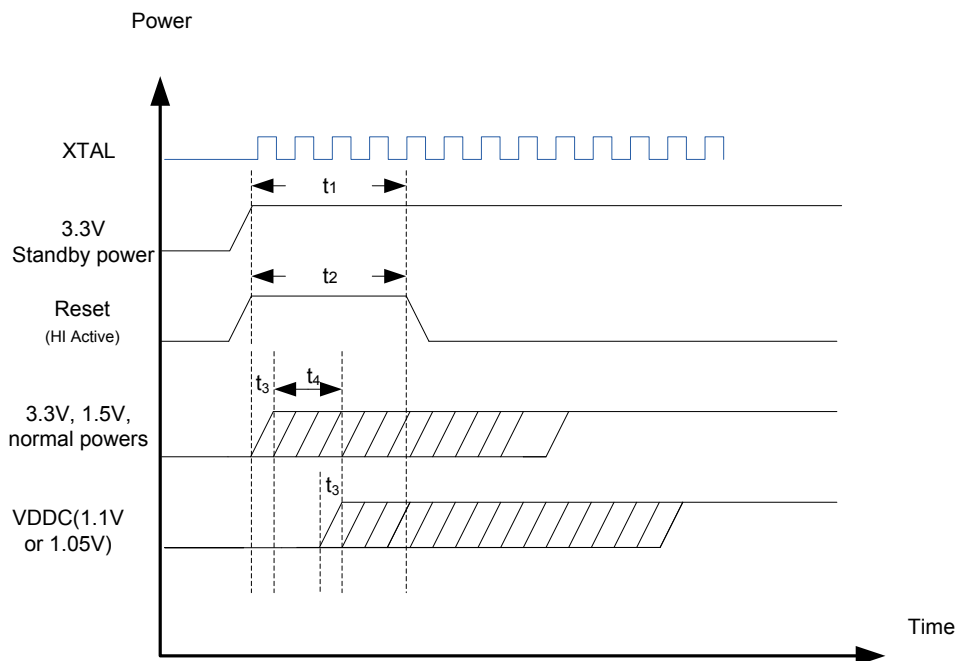


Figure 1: Reset Application Circuit

External Reset IC with External LDO

The timing is shown as Figure 2. The RST and power waveform must satisfy Figure 2 with parameters listed in Table 1.



Note:

- *3.3V standby power (AVDD_NODIE, AVDD_XTAL, AVDD_ETH)
- *1.1V/1.05V (VDD, DVDD_DDR, DVDD_DDR_RX)
- *1.5V (AVDDIO_DRAM, VDDIO_DATA, VDDIO_MCLK, VDDIO_CMD)
- *3.3V normal power (AVDD_AUD, AVDD_PLL, AVDD_USB, VDDP_1, VDDP_2, VDDP_3)

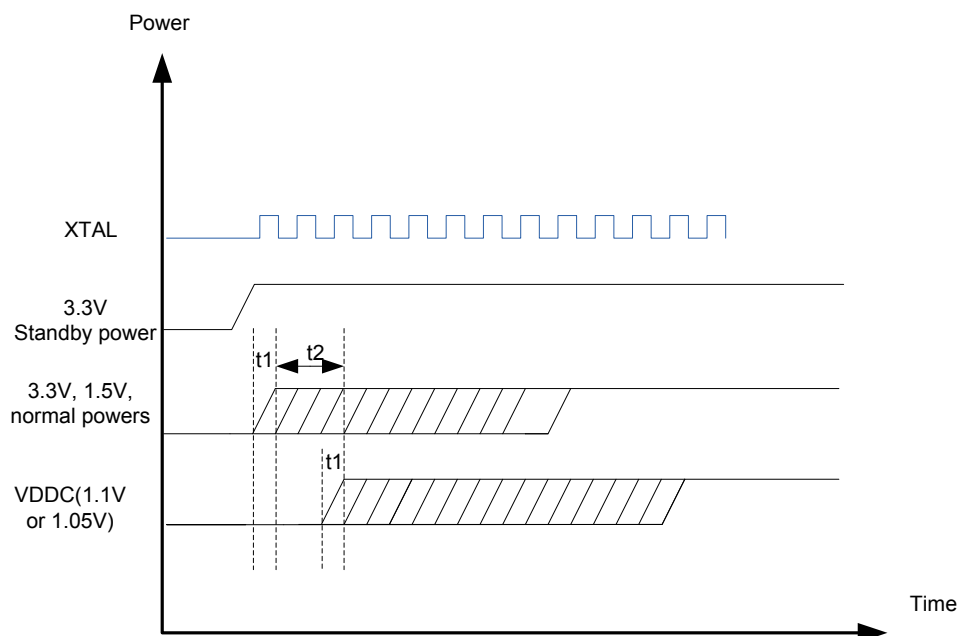
Figure 2: Power on Sequence

Table 1: Power Requirements

| Time | Description | Min | Typ. | Max | Unit |
|----------------|--|-----|------|-----|------|
| t ₁ | XTAL stable to Reset falling | 5 | — | — | ms |
| t ₂ | Reset pulse width | 5 | — | — | ms |
| t ₃ | Normal 3.3V, 1.5V, VDDC power rising time (0% to 100%) | — | — | 20 | ms |
| t ₄ | Normal 3.3V and 1.5V to VDDC lead time | 1 | — | — | ms |

Without external Reset IC with External LDO

The timing is shown as Figure 3. The power waveform must satisfy Figure 3 with parameters listed in Table 1.



Note:

*3.3V standby power (AVDD_NODIE, AVDD_XTAL, AVDD_ETH)

*1.1V/1.05V (VDD, DVDD_DDR, DVDD_DDR_RX)

*1.5V (AVDDIO_DRAM, VDDIO_DATA, VDDIO_MCLK, VDDIO_CMD)

*3.3V normal power (AVDD_AUD, AVDD_PLL, AVDD_USB, VDDP_1, VDDP_2, VDDP_3)

Figure 3: Power on Sequence

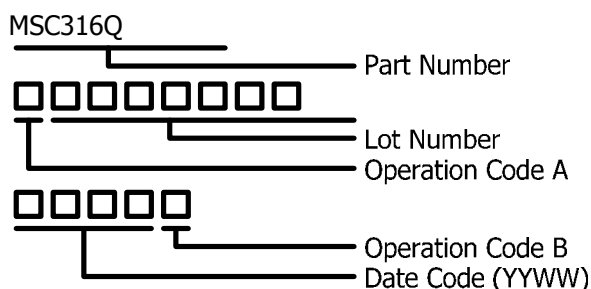
Table 2: Power Requirements

| Time | Description | Min | Typ. | Max | Unit |
|----------------|--|-----|------|-----|------|
| t ₁ | Normal 3.3V, 1.5V, VDDC power rising time (0% to 100%) | — | — | 20 | ms |
| t ₂ | Normal 3.3V and 1.5V to VDDC lead time | 1 | — | — | ms |

ORDERING GUIDE

| Part Number | Temperature Range | Package Description | Package Option |
|-------------|-------------------|---------------------|----------------|
| MSC316Q | -40°C to +85°C | BGA | 204-ball |

MARKING INFORMATION



DISCLAIMER

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Electrostatic charges accumulate on both test equipment and human body and can discharge without detection. MSC316Q comes with ESD protection circuitry, however, the device may be permanently damaged when subjected to high energy discharges. The device should be handled with proper ESD precautions to prevent malfunction and performance degradation.