- Color eReaders
- IPTV
- Human Machine Interfaces (HMI)
- Portable medical
- IP phones
- Home energy management systems

The i.MX 6Solo/6DualLite applications processors feature:

- Applications processors—The processors enhance the capabilities of high-tier portable applications by fulfilling the ever increasing MIPS requirements of operating systems and games. The Dynamic Voltage and Frequency Scaling (DVFS) provides significant power reduction, allowing the device to run at lower voltage and frequency with sufficient MIPS for tasks, such as audio decode.
- Multilevel memory system—The multilevel memory system of each processor is based on the L1 instruction and data caches, L2 cache, and internal and external memory. The processors support many types of external memory devices, including DDR3, DDR3L, LPDDR2, NOR Flash, PSRAM, cellular RAM, NAND Flash (MLC and SLC), OneNAND™, and managed NAND, including eMMC up to rev 4.4/4.41.
- Smart speed technology—The processors have power management throughout the IC that enables the rich suite of multimedia features and peripherals to consume minimum power in both active and various low power modes. Smart speed technology enables the designer to deliver a feature-rich product, requiring levels of power far lower than industry expectations.
- Dynamic voltage and frequency scaling—The processors improve the power efficiency of devices by scaling the voltage and frequency to optimize performance.
- Multimedia powerhouse—The multimedia performance of each processor is enhanced by a multilevel cache system, NEON™ MPE (Media Processor Engine) co-processor, a multi-standard hardware video codec, an image processing unit (IPU), a programmable smart DMA (SDMA) controller, and an asynchronous sample rate converter.
- Powerful graphics acceleration—Each processor provides two independent, integrated graphics processing units: an OpenGL® ES 2.0 3D graphics accelerator with a shader and a 2D graphics accelerator.
- Interface flexibility—Each processor supports connections to a variety of interfaces: LCD controller for up to two displays (including parallel display, HDMI1.4, MIPI display, and LVDS display), dual CMOS sensor interface (parallel or through MIPI), high-speed USB on-the-go with PHY, high-speed USB host with PHY, multiple expansion card ports (high-speed MMC/SDIO host and other), 10/100/1000 Mbps Gigabit Ethernet controller two CAN ports, ESAI audio interface, and a variety of other popular interfaces (such as UART, $I^2C$, and $I^2S$ serial audio, and PCIe-II).
- Eink Panel Display Controller—The processors integrate EPD controller that supports E-INK color and monochrome with up to 1650x2332 resolution and 5-bit grayscale (32-levels per color channel).
- Advanced security—The processors deliver hardware-enabled security features that enable secure e-commerce, digital rights management (DRM), information encryption, secure boot, and secure



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software downloads. The security features are discussed in detail in the *i.MX 6Solo/6DualLite Security Reference Manual* (IMX6DQ6SDLSRM).

- Integrated power management—The processors integrate linear regulators and internally generate voltage levels for different domains. This significantly simplifies system power management structure.

## 1.1 Ordering Information

Table 1 provides examples of orderable part numbers covered by this data sheet. Table 1 does not include all possible orderable part numbers. The latest part numbers are available on the web page nxp.com/imx6series. If the desired part number is not listed in Table 1, go to nxp.com/imx6series or contact a NXP representative for details.

**Table 1. Example Orderable Part Numbers**

| Part Number | i.MX6 CPU Solo/ DualLite | Options | Speed Grade[1] | Temperature Grade | Package |
|---|---|---|---|---|---|
| MCIMX6U8DVM10AB | DualLite | With VPU, GPU, EPDC, MLB<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6U8DVM10AC | DualLite | With VPU, GPU, EPDC, MLB<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6U8DVM10AD | DualLite | With VPU, GPU, EPDC, MLB<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |
| MCIMX6U5DVM10AB | DualLite | With VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6U5DVM10AC | DualLite | With VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6U5DVM10AD | DualLite | With VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |
| SCIMX6U5DVM10CB | DualLite | HDCP enabled with VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| SCIMX6U5DVM10CC | DualLite | HDCP enabled with VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| SCIMX6U5DVM10CD | DualLite | HDCP enabled with VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |
| MCIMX6U5EVM10AB | DualLite | With VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Extended Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6U5EVM10AC | DualLite | With VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Extended Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6U5EVM10AD | DualLite | With VPU, GPU, MLB, no EPDC<br>2x Arm Cortex-A9 64-bit DDR | 1 GHz | Extended Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |



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**Table 1. Example Orderable Part Numbers (continued)**

| Part Number | i.MX6 CPU Solo/ DualLite | Options | Speed Grade[1] | Temperature Grade | Package |
|---|---|---|---|---|---|
| MCIMX6S8DVM10AB | Solo | With VPU, GPU, MLB, EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6S8DVM10AC | Solo | With VPU, GPU, MLB, EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6S8DVM10AD | Solo | With VPU, GPU, MLB, EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |
| MCIMX6S5DVM10AB | Solo | With VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6S5DVM10AC | Solo | With VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6S5DVM10AD | Solo | With VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |
| SCIMX6S5DVM10CB | Solo | HDCP enabled with VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| SCIMX6S5DVM10CC | Solo | HDCP enabled with VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| SCIMX6S5DVM10CD | Solo | HDCP enabled with VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |
| MCIMX6S5EVM10AB | Solo | With VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Extended Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6S5EVM10AC | Solo | With VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Extended Commercial | 21 mm x 21 mm,<br>0.8 mm pitch, MAPBGA |
| MCIMX6S5EVM10AD | Solo | With VPU, GPU, MLB, no EPDC<br>1x Arm Cortex-A9 32-bit DDR | 1 GHz | Extended Commercial | 21 mm x 21 mm, 0.8 mm pitch, MAPBGA |

[1] If a 24 MHz input clock is used (required for USB), then the maximum SoC speed is limited to 996 MHz.

Figure 1 describes the part number nomenclature to identify the characteristics of a specific part number (for example, cores, frequency, temperature grade, fuse options, and silicon revision).

The primary characteristic that differentiates which data sheet applies to a specific part is the temperature grade (junction) field. The following list describes the correct data sheet to use for a specific part:

- The *i.MX 6Solo/6DualLite Automotive and Infotainment Applications Processors* data sheet (IMX6SDLAEC) covers parts listed with an “A (Automotive temp)”
- The *i.MX 6Solo/6DualLite Applications Processors for Consumer Products* data sheet (IMX6SDLCEC) covers parts listed with a “D (Commercial temp)” or “E (Extended Commercial temp)”



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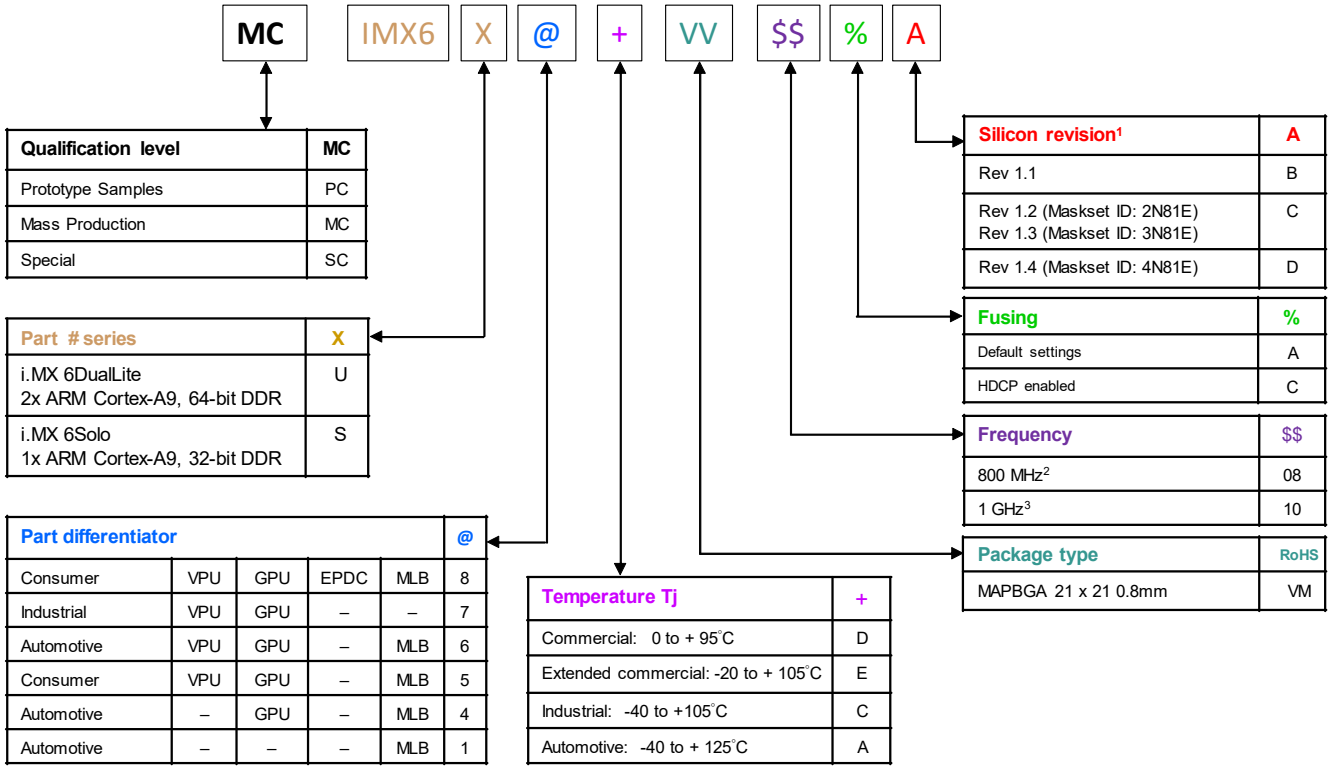
- The *i.MX 6Solo/6DualLite Applications Processors for Industrial Products* data sheet (IMX6SDLIEC) covers parts listed with "C (Industrial temp)"

For more information go to nxp.com/imx6series or contact a NXP representative for details.




1. See the nxp.com\imx6series Web page for latest information on the available silicon revision.
2. If a 24 MHz input clock is used (required for USB), the maximum SoC speed is limited to 792 MHz.
3. If a 24 MHz input clock is used (required for USB), the maximum SoC speed is limited to 996 MHz.

**Figure 1. Part Number Nomenclature—i.MX 6Solo and 6DualLite**

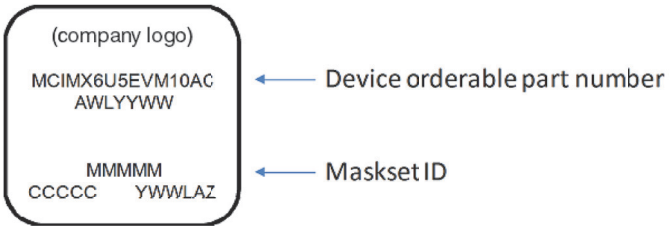



**Figure 2. Example Part Marking**

## 1.2 Features

The i.MX 6Solo/6DualLite processors are based on Arm Cortex-A9 MPCore Platform, which has the following features:

- The i.MX 6Solo supports single Arm Cortex-A9 MPCore (with TrustZone)
- The i.MX 6DualLite supports dual Arm Cortex-A9 MPCore (with TrustZone)
- The core configuration is symmetric, where each core includes:



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  - 32 KByte L1 Instruction Cache
  - 32 KByte L1 Data Cache
  - Private Timer and Watchdog
  - Cortex-A9 NEON MPE (Media Processing Engine) Co-processor

The Arm Cortex-A9 MPCore complex includes:

- General Interrupt Controller (GIC) with 128 interrupt support
- Global Timer
- Snoop Control Unit (SCU)
- 512 KB unified I/D L2 cache:
  - Used by one core in i.MX 6Solo
  - Shared by two cores in i.MX 6DualLite
- Two Master AXI bus interfaces output of L2 cache
- Frequency of the core (including NEON and L1 cache), as per Table 8.
- NEON MPE coprocessor
  - SIMD Media Processing Architecture
  - NEON register file with 32x64-bit general-purpose registers
  - NEON Integer execute pipeline (ALU, Shift, MAC)
  - NEON dual, single-precision floating point execute pipeline (FADD, FMUL)
  - NEON load/store and permute pipeline

The SoC-level memory system consists of the following additional components:

  - Boot ROM, including HAB (96 KB)
  - Internal multimedia / shared, fast access RAM (OCRAM, 128 KB)
  - Secure/non-secure RAM (16 KB)
- External memory interfaces: The i.MX 6Solo/6DualLite processors support latest, high volume, cost effective handheld DRAM, NOR, and NAND Flash memory standards.
  - 16/32-bit LP-DDR2-800, 16/32-bit DDR3-800 and DDR3L-800 in i.MX 6Solo; 16/32/64-bit LP-DDR2-800, 16/32/64-bit DDR3-800 and DDR3L-800, supporting DDR interleaving mode for 2x32 LPDDR2-800 in i.MX 6DualLite
  - 8-bit NAND-Flash, including support for Raw MLC/SLC, 2 KB, 4 KB, and 8 KB page size, BA-NAND, PBA-NAND, LBA-NAND, OneNAND™ and others. BCH ECC up to 40 bit.
  - 16/32-bit NOR Flash. All WEIMv2 pins are muxed on other interfaces.
  - 16/32-bit PSRAM, Cellular RAM

Each i.MX 6Solo/6DualLite processor enables the following interfaces to external devices (some of them are muxed and not available simultaneously):

- Displays—Total of five interfaces available. Total raw pixel rate of all interfaces is up to 450 Mpixels/sec, 24 bpp. Up to two interfaces may be active in parallel (excluding EPDC).
  - One Parallel 24-bit display port, up to 225 Mpixels/sec (for example, WUXGA at 60 Hz or dual HD1080 and WXGA at 60 Hz)



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  - LVDS serial ports—One port up to 165 Mpixels/sec or two ports up to 85 MP/sec (for example, WUXGA at 60 Hz) each
  - HDMI 1.4 port
  - MIPI/DSI, two lanes at 1 Gbps
  - EPDC, Color, and monochrome E-INK, up to 1650x2332 resolution and 5-bit grayscale
- Camera sensors:
  - Two parallel Camera ports (up to 20 bit and up to 240 MHz peak)
  - MIPI CSI-2 Serial port, supporting from 80 Mbps to 1 Gbps speed per data lane. The CSI-2 Receiver core can manage one clock lane and up to two data lanes. Each i.MX 6Solo/6DualLite processor has two lanes.
- Expansion cards:
  - Four MMC/SD/SDIO card ports all supporting:
    - 1-bit or 4-bit transfer mode specifications for SD and SDIO cards up to UHS-I SDR-104 mode (104 MB/s max)
    - 1-bit, 4-bit, or 8-bit transfer mode specifications for MMC cards up to 52 MHz in both SDR and DDR modes (104 MB/s max)
- USB:
  - One high speed (HS) USB 2.0 OTG (Up to 480 Mbps), with integrated HS USB Phy
  - Three USB 2.0 (480 Mbps) hosts:
    - One HS host with integrated High Speed Phy
    - Two HS hosts with integrated HS-IC USB (High Speed Inter-Chip USB) Phy
- Expansion PCI Express port (PCIe) v2.0 one lane
  - PCI Express (Gen 2.0) dual mode complex, supporting Root complex operations and Endpoint operations. Uses x1 PHY configuration.
- Miscellaneous IPs and interfaces:
  - SSI block is capable of supporting audio sample frequencies up to 192 kHz stereo inputs and outputs with $I^2S$ mode
  - ESAI is capable of supporting audio sample frequencies up to 260 kHz in $I^2S$ mode with 7.1 multi channel outputs
  - Five UARTs, up to 5.0 Mbps each:
    - Providing RS232 interface
    - Supporting 9-bit RS485 multidrop mode
    - One of the five UARTs (UART1) supports 8-wire while others four supports 4-wire. This is due to the SoC IOMUX limitation, since all UART IPs are identical.
  - Four eCSPI (Enhanced CSPI)
  - Four $I^2C$, supporting 400 kbps
  - Gigabit Ethernet Controller (IEEE1588 compliant), 10/100/1000[1] Mbps

1. The theoretical maximum performance of 1 Gbps ENET is limited to 470 Mbps (total for Tx and Rx) due to internal bus throughput limitations. The actual measured performance in optimized environment is up to 400 Mbps. For details, see the ERR004512 erratum in the i.MX 6Solo/6DualLite errata document (IMX6SDLCE).



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— Four Pulse Width Modulators (PWM)
— System JTAG Controller (SJC)
— GPIO with interrupt capabilities
— 8x8 Key Pad Port (KPP)
— Sony Philips Digital Interconnect Format (SPDIF), Rx and Tx
— Two Controller Area Network (FlexCAN), 1 Mbps each
— Two Watchdog timers (WDOG)
— Audio MUX (AUDMUX)
— MLB (MediaLB) provides interface to MOST Networks (MOST25, MOST50, MOST150) with the option of DTCP cipher accelerator

The i.MX 6Solo/6DualLite processors integrate advanced power management unit and controllers:

- Provide PMU, including LDO supplies, for on-chip resources
- Use Temperature Sensor for monitoring the die temperature
- Support DVFS techniques for low power modes
- Use SW State Retention and Power Gating for Arm and MPE
- Support various levels of system power modes
- Use flexible clock gating control scheme

The i.MX 6Solo/6DualLite processors use dedicated hardware accelerators to meet the targeted multimedia performance. The use of hardware accelerators is a key factor in obtaining high performance at low power consumption numbers, while having the CPU core relatively free for performing other tasks.

The i.MX 6Solo/6DualLite processors incorporate the following hardware accelerators:

- VPU—Video Processing Unit
- IPUv3H—Image Processing Unit version 3H
- GPU3Dv5—3D Graphics Processing Unit (OpenGL ES 2.0) version 5
- GPU2Dv2—2D Graphics Processing Unit (BitBlt)
- PXP—PiXel Processing Pipeline. Off loading key pixel processing operations are required to support the EPD display applications.
- ASRC—Asynchronous Sample Rate Converter

Security functions are enabled and accelerated by the following hardware:

- Arm TrustZone including the TZ architecture (separation of interrupts, memory mapping, etc.)
- SJC—System JTAG Controller. Protecting JTAG from debug port attacks by regulating or blocking the access to the system debug features.
- CAAM—Cryptographic Acceleration and Assurance Module, containing cryptographic and hash engines, 16 KB secure RAM, and True and Pseudo Random Number Generator (NIST certified).
- SNVS—Secure Non-Volatile Storage, including Secure Real Time Clock
- CSU—Central Security Unit. Enhancement for the IC Identification Module (IIM). Will be configured during boot and by eFUSEs and will determine the security level operation mode as well as the TZ policy.



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- A-HAB—Advanced High Assurance Boot—HABv4 with the new embedded enhancements: SHA-256, 2048-bit RSA key, version control mechanism, warm boot, CSU, and TZ initialization.

**NOTE**

The actual feature set depends on the part numbers as described in Table 1, "Example Orderable Part Numbers," on page 3. Functions, such as video hardware acceleration, and 2D and 3D hardware graphics acceleration may not be enabled for specific part numbers.

## 1.3 Updated Signal Naming Convention

The signal names of the i.MX6 series of products have been standardized to better align the signal names within the family and across the documentation. Some of the benefits of these changes are as follows:

- The names are unique within the scope of an SoC and within the series of products
- Searches will return all occurrences of the named signal
- The names are consistent between i.MX 6 series products implementing the same modules
- The module instance is incorporated into the signal name

This change applies only to signal names. The original ball names have been preserved to prevent the need to change schematics, BSDL models, IBIS models, etc.

Throughout this document, the updated signal names are used except where referenced as a ball name (such as the Functional Contact Assignments table, Ball Map table, and so on). A master list of the signal name changes is in the document, *IMX 6 Series Signal Name Mapping* (EB792). This list can be used to map the signal names used in older documentation to the new standardized naming conventions.



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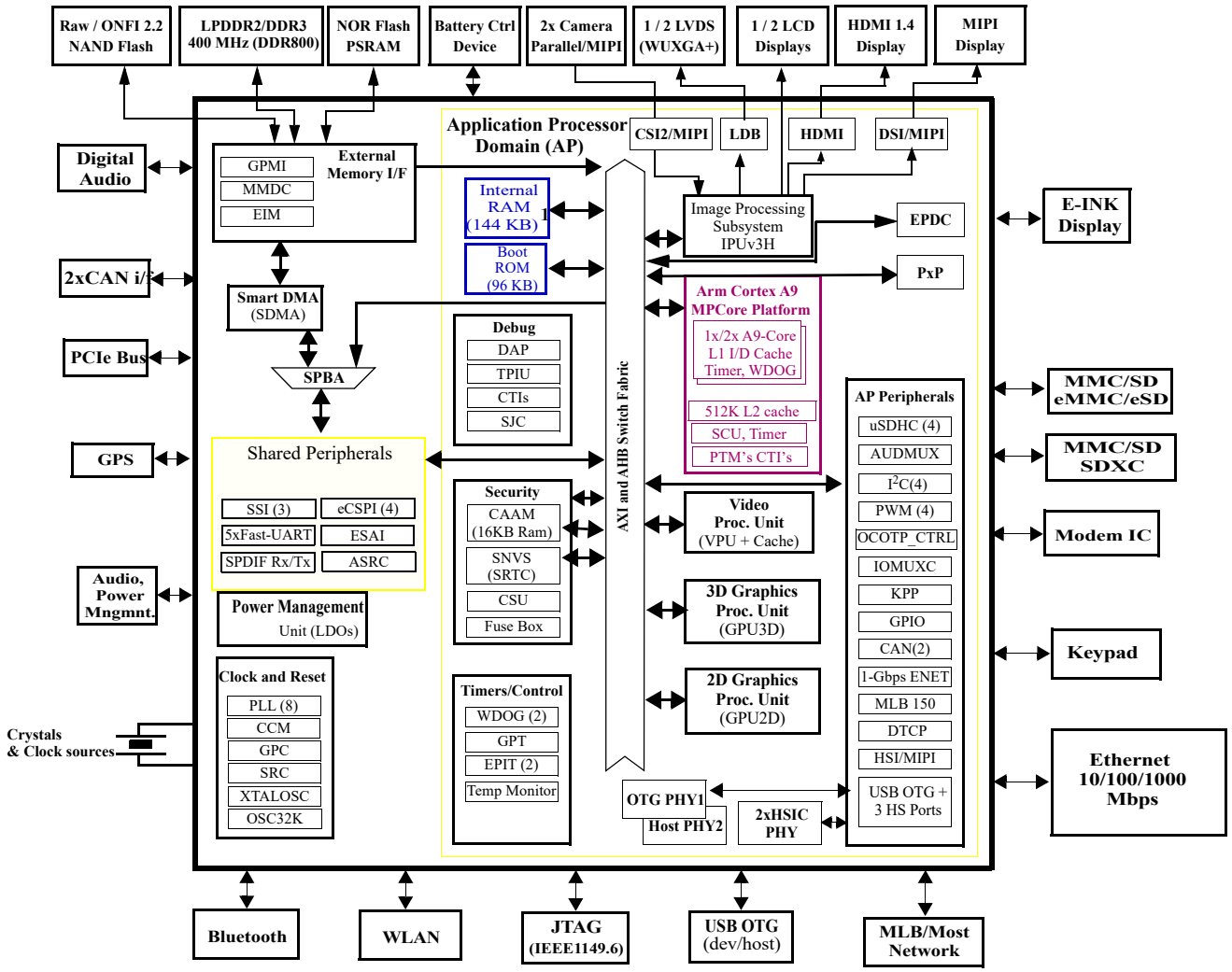
# 2 Architectural Overview

The following subsections provide an architectural overview of the i.MX 6Solo/6DualLite processor system.

## 2.1 Block Diagram

Figure 3 shows the functional modules in the i.MX 6Solo/6DualLite processor system.




1 144 KB RAM including 16 KB RAM inside the CAAM.

2 For i.MX 6Solo, there is only one A9-core platform in the chip; for i.MX 6DualLite, there are two A9-core platforms.

**Figure 3. i.MX 6Solo/6DualLite System Block Diagram**

### NOTE

The numbers in brackets indicate number of module instances. For example, PWM (4) indicates four separate PWM peripherals.



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# 3 Modules List

The i.MX 6Solo/6DualLite processors contain a variety of digital and analog modules. Table 2 describes these modules in alphabetical order.

**Table 2. i.MX 6Solo/6DualLite Modules List**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| APBH-DMA | NAND Flash and BCH ECC DMA controller | System Control Peripherals | DMA controller used for GPMI2 operation |
| Arm | Arm Platform | Arm | The Arm Core Platform includes 1x (Solo) Cortex-A9 core for i.MX 6Solo and 2x (Dual) Cortex-A9 cores for i.MX 6DualLite. It also includes associated sub-blocks, such as the Level 2 Cache Controller, SCU (Snoop Control Unit), GIC (General Interrupt Controller), private timers, watchdog, and CoreSight debug modules. |
| ASRC | Asynchronous Sample Rate Converter | Multimedia Peripherals | The Asynchronous Sample Rate Converter (ASRC) converts the sampling rate of a signal associated to an input clock into a signal associated to a different output clock. The ASRC supports concurrent sample rate conversion of up to 10 channels of about -120dB THD+N. The sample rate conversion of each channel is associated to a pair of incoming and outgoing sampling rates. The ASRC supports up to three sampling rate pairs. |
| AUDMUX | Digital Audio Mux | Multimedia Peripherals | The AUDMUX is a programmable interconnect for voice, audio, and synchronous data routing between host serial interfaces (for example, SSI1, SSI2, and SSI3) and peripheral serial interfaces (audio and voice codecs). The AUDMUX has seven ports with identical functionality and programming models. A desired connectivity is achieved by configuring two or more AUDMUX ports. |
| BCH40 | Binary-BCH ECC Processor | System Control Peripherals | The BCH40 module provides up to 40-bit ECC for NAND Flash controller (GPMI) |
| CAAM | Cryptographic accelerator and assurance module | Security | CAAM is a cryptographic accelerator and assurance module. CAAM implements several encryption and hashing functions, a run-time integrity checker, and a Pseudo Random Number Generator (PRNG). The pseudo random number generator is certified by Cryptographic Algorithm Validation Program (CAVP) of National Institute of Standards and Technology (NIST). Its DRBG validation number is 94 and its SHS validation number is 1455.<br>CAAM also implements a Secure Memory mechanism. In i.MX 6Solo/6DualLite processors, the security memory provided is 16 KB. |
| CCM<br>GPC<br>SRC | Clock Control Module, General Power Controller, System Reset Controller | Clocks, Resets, and Power Control | These modules are responsible for clock and reset distribution in the system, and also for the system power management. |
| CSI | MIPI CSI-2 i/f | Multimedia Peripherals | The CSI IP provides MIPI CSI-2 standard camera interface port. The CSI-2 interface supports from 80 Mbps to 1 Gbps speed per data lane. |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| CSU | Central Security Unit | Security | The Central Security Unit (CSU) is responsible for setting comprehensive security policy within the i.MX 6Solo/6DualLite platform. |
| CTI-0<br>CTI-1<br>CTI-2<br>CTI-3<br>CTI-4 | Cross Trigger Interfaces | Debug / Trace | Cross Trigger Interfaces allows cross-triggering based on inputs from masters attached to CTIs. The CTI module is internal to the Cortex-A9 Core Platform. |
| CTM | Cross Trigger Matrix | Debug / Trace | Cross Trigger Matrix IP is used to route triggering events between CTIs. The CTM module is internal to the Cortex-A9 Core Platform. |
| DAP | Debug Access Port | System Control Peripherals | The DAP provides real-time access for the debugger without halting the core to:<br>• System memory and peripheral registers<br>• All debug configuration registers<br>The DAP also provides debugger access to JTAG scan chains. The DAP module is internal to the Cortex-A9 Core Platform. |
| DCIC-0<br>DCIC-1 | Display Content Integrity Checker | Automotive IP | The DCIC provides integrity check on portion(s) of the display. Each i.MX 6Solo/6DualLite processor has two such modules. |
| DSI | MIPI DSI i/f | Multimedia Peripherals | The MIPI DSI IP provides DSI standard display port interface. The DSI interface support 80 Mbps to 1 Gbps speed per data lane. |
| DTCP | DTCP | Multimedia Peripherals | Provides encryption function according to Digital Transmission Content Protection standard for traffic over MLB150. |
| eCSPI1-4 | Configurable SPI | Connectivity Peripherals | Full-duplex enhanced Synchronous Serial Interface. It is configurable to support Master/Slave modes, four chip selects to support multiple peripherals. |
| ENET | Ethernet Controller | Connectivity Peripherals | The Ethernet Media Access Controller (MAC) is designed to support 10/100/1000 Mbps Ethernet/IEEE 802.3 networks. An external transceiver interface and transceiver function are required to complete the interface to the media. The module has dedicated hardware to support the IEEE 1588 standard. See the ENET chapter of the reference manual for details.<br><br>**Note:** The theoretical maximum performance of 1 Gbps ENET is limited to 470 Mbps (total for Tx and Rx) due to internal bus throughput limitations. The actual measured performance in optimized environment is up to 400 Mbps. For details, see the ERR004512 erratum in the i.MX 6Solo/6DualLite errata document (IMX6SDLCE). |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| EPDC | Electrophoretic Display Controller | Peripherals | The EPDC is a feature-rich, low power, and high-performance direct-drive, active matrix EPD controller. It is specifically designed to drive E-INK™ EPD panels, supporting a wide variety of TFT backplanes. It is available in both i.MX 6DualLite and i.MX 6Solo. |
| EPIT-1<br>EPIT-2 | Enhanced Periodic Interrupt Timer | Timer Peripherals | Each EPIT is a 32-bit “set and forget” timer that starts counting after the EPIT is enabled by software. It is capable of providing precise interrupts at regular intervals with minimal processor intervention. It has a 12-bit prescaler for division of input clock frequency to get the required time setting for the interrupts to occur, and counter value can be programmed on the fly. |
| ESAI | Enhanced Serial Audio Interface | Connectivity Peripherals | The Enhanced Serial Audio Interface (ESAI) provides a full-duplex serial port for serial communication with a variety of serial devices, including industry-standard codecs, SPDIF transceivers, and other processors. The ESAI consists of independent transmitter and receiver sections, each section with its own clock generator. All serial transfers are synchronized to a clock. Additional synchronization signals are used to delineate the word frames. The normal mode of operation is used to transfer data at a periodic rate, one word per period. The network mode is also intended for periodic transfers; however, it supports up to 32 words (time slots) per period. This mode can be used to build time division multiplexed (TDM) networks. In contrast, the on-demand mode is intended for non-periodic transfers of data and to transfer data serially at high speed when the data becomes available.<br>The ESAI has 12 pins for data and clocking connection to external devices. |
| FlexCAN-1<br>FlexCAN-2 | Flexible Controller Area Network | Connectivity Peripherals | The CAN protocol was primarily, but not only, designed to be used as a vehicle serial data bus, meeting the specific requirements of this field: real-time processing, reliable operation in the Electromagnetic interference (EMI) environment of a vehicle, cost-effectiveness and required bandwidth. The FlexCAN module is a full implementation of the CAN protocol specification, Version 2.0 B, which supports both standard and extended message frames. |
| 512x8 Fuse Box | Electrical Fuse Array | Security | Electrical Fuse Array. Enables to setup Boot Modes, Security Levels, Security Keys, and many other system parameters.<br>The i.MX 6Solo/6DualLite processors consist of 512x8-bit fuse fox accessible through OCOTP_CTRL interface. |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| GPIO-1<br>GPIO-2<br>GPIO-3<br>GPIO-4<br>GPIO-5<br>GPIO-6<br>GPIO-7 | General Purpose I/O Modules | System Control Peripherals | Used for general purpose input/output to external ICs. Each GPIO module supports 32 bits of I/O. |
| GPMI | General Purpose Media Interface | Connectivity Peripherals | The GPMI module supports up to 8x NAND devices. 40-bit ECC encryption/decryption for NAND Flash controller (GPMI2). The GPMI supports separate DMA channels per NAND device. |
| GPT | General Purpose Timer | Timer Peripherals | Each GPT is a 32-bit “free-running” or “set and forget” mode timer with programmable prescaler and compare and capture register. A timer counter value can be captured using an external event and can be configured to trigger a capture event on either the leading or trailing edges of an input pulse. When the timer is configured to operate in “set and forget” mode, it is capable of providing precise interrupts at regular intervals with minimal processor intervention. The counter has output compare logic to provide the status and interrupt at comparison. This timer can be configured to run either on an external clock or on an internal clock. |
| GPU3Dv5 | Graphics Processing Unit, ver.5 | Multimedia Peripherals | The GPU3Dv5 provides hardware acceleration for 3D graphics algorithms with sufficient processor power to run desktop quality interactive graphics applications on displays up to HD1080 resolution. The GPU3D provides OpenGL ES 2.0, including extensions, OpenGL ES 1.1, and OpenVG 1.1 |
| GPU2Dv2 | Graphics Processing Unit-2D, ver 2 | Multimedia Peripherals | The GPU2Dv2 provides hardware acceleration for 2D graphics algorithms, such as Bit BLT, stretch BLT, and many other 2D functions. |
| HDMI Tx | HDMI Tx i/f | Multimedia Peripherals | The HDMI module provides HDMI standard i/f port to an HDMI 1.4 compliant display. |
| HSI | MIPI HSI i/f | Connectivity Peripherals | The MIPI HSI provides a standard MIPI interface to the applications processor. |
| $I^2C$-1<br>$I^2C$-2<br>$I^2C$-3<br>$I^2C$-4 | $I^2C$ Interface | Connectivity Peripherals | $I^2C$ provide serial interface for external devices. Data rates of up to 400 kbps are supported. |
| IOMUXC | IOMUX Control | System Control Peripherals | This module enables flexible IO multiplexing. Each IO pad has default and several alternate functions. The alternate functions are software configurable. |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| IPUv3H | Image Processing Unit, ver.3H | Multimedia Peripherals | IPUv3H enables connectivity to displays and video sources, relevant processing and synchronization and control capabilities, allowing autonomous operation.<br>The IPUv3H supports concurrent output to two display ports and concurrent input from two camera ports, through the following interfaces:<br>• Parallel Interfaces for both display and camera<br>• Single/dual channel LVDS display interface<br>• HDMI transmitter<br>• MIPI/DSI transmitter<br>• MIPI/CSI-2 receiver<br>The processing includes:<br>• Image conversions: resizing, rotation, inversion, and color space conversion<br>• A high-quality de-interlacing filter<br>• Video/graphics combining<br>• Image enhancement: color adjustment and gamut mapping, gamma correction, and contrast enhancement<br>• Support for display backlight reduction |
| KPP | Key Pad Port | Connectivity Peripherals | KPP Supports 8x8 external key pad matrix. KPP features are:<br>• Open drain design<br>• Glitch suppression circuit design<br>• Multiple keys detection<br>• Standby key press detection |
| LDB | LVDS Display Bridge | Connectivity Peripherals | LVDS Display Bridge is used to connect the IPU (Image Processing Unit) to External LVDS Display Interface. LDB supports two channels; each channel has following signals:<br>• One clock pair<br>• Four data pairs<br>Each signal pair contains LVDS special differential pad (PadP, PadM). |
| MLB150 | MediaLB | Connectivity / Multimedia Peripherals | The MLB interface module provides a link to a MOST® data network, using the standardized MediaLB protocol (up to 6144 fs).<br>The module is backward compatible to MLB-50. |
| MMDC | Multi-Mode DDR Controller | Connectivity Peripherals | DDR Controller has the following features:<br>• Supports 16/32-bit DDR3-800 (LV) or LPDDR2-800 in i.MX 6Solo<br>• Supports 16/32/64-bit DDR3-800 (LV) or LPDDR2-800 in i.MX 6DualLite<br>• Supports 2x32 LPDDR2-800 in i.MX 6DualLite<br>• Supports up to 4 GByte DDR memory space |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| OCOTP_CTRL | OTP Controller | Security | The On-Chip OTP controller (OCOTP_CTRL) provides an interface for reading, programming, and/or overriding identification and control information stored in on-chip fuse elements. The module supports electrically-programmable poly fuses (eFUSEs). The OCOTP_CTRL also provides a set of volatile software-accessible signals that can be used for software control of hardware elements, not requiring non-volatility. The OCOTP_CTRL provides the primary user-visible mechanism for interfacing with on-chip fuse elements. Among the uses for the fuses are unique chip identifiers, mask revision numbers, cryptographic keys, JTAG secure mode, boot characteristics, and various control signals, requiring permanent non-volatility. |
| OCRAM | On-Chip Memory controller | Data Path | The On-Chip Memory controller (OCRAM) module is designed as an interface between system's AXI bus and internal (on-chip) SRAM memory module.<br>In i.MX 6Solo/6DualLite processors, the OCRAM is used for controlling the 128 KB multimedia RAM through a 64-bit AXI bus. |
| OSC32KHz | OSC32KHz | Clocking | Generates 32.768 KHz clock from external crystal. |
| PCIe | PCI Express 2.0 | Connectivity Peripherals | The PCIe IP provides PCI Express Gen 2.0 functionality. |
| PMU | Power-Management functions | Data Path | Integrated power management unit. Used to provide power to various SoC domains. |
| PWM-1<br>PWM-2<br>PWM-3<br>PWM-4 | Pulse Width Modulation | Connectivity Peripherals | The pulse-width modulator (PWM) has a 16-bit counter and is optimized to generate sound from stored sample audio images and it can also generate tones. It uses 16-bit resolution and a 4x16 data FIFO to generate sound. |
| PXP | PiXel Processing Pipeline | Display Peripherals | A high-performance pixel processor capable of 1 pixel/clock performance for combined operations, such as color-space conversion, alpha blending, gamma-mapping, and rotation. The PXP is enhanced with features specifically for gray scale applications. In addition, the PXP supports traditional pixel/frame processing paths for still-image and video processing applications, allowing it to interface with the integrated EPD. |
| RAM<br>128 KB | Internal RAM | Internal Memory | Internal RAM, which is accessed through OCRAM memory controller. |
| RAM<br>16 KB | Secure/non-secure RAM | Secured Internal Memory | Secure/non-secure Internal RAM, interfaced through the CAAM. |
| ROM<br>96KB | Boot ROM | Internal Memory | Supports secure and regular Boot Modes. Includes read protection on 4K region for content protection. |
| ROMCP | ROM Controller with Patch | Data Path | ROM Controller with ROM Patch support |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| SDMA | Smart Direct Memory Access | System Control Peripherals | The SDMA is multi-channel flexible DMA engine. It helps in maximizing system performance by off-loading the various cores in dynamic data routing. It has the following features:<br>• Powered by a 16-bit Instruction-Set micro-RISC engine<br>• Multi-channel DMA supporting up to 32 time-division multiplexed DMA channels<br>• 48 events with total flexibility to trigger any combination of channels<br>• Memory accesses including linear, FIFO, and 2D addressing<br>• Shared peripherals between Arm and SDMA<br>• Very fast Context-Switching with 2-level priority based preemptive multi-tasking<br>• DMA units with auto-flush and prefetch capability<br>• Flexible address management for DMA transfers (increment, decrement, and no address changes on source and destination address)<br>• DMA ports can handle unit-directional and bi-directional flows (copy mode)<br>• Up to 8-word buffer for configurable burst transfers<br>• Support of byte-swapping and CRC calculations<br>• Library of Scripts and API is available |
| SJC | System JTAG Controller | System Control Peripherals | The SJC provides JTAG interface, which complies with JTAG TAP standards, to internal logic. The i.MX 6Solo/6DualLite processors use JTAG port for production, testing, and system debugging. In addition, the SJC provides BSR (Boundary Scan Register) standard support, which complies with IEEE1149.1 and IEEE1149.6 standards.<br>The JTAG port must be accessible during platform initial laboratory bring-up, for manufacturing tests and troubleshooting, as well as for software debugging by authorized entities. The i.MX 6Solo/6DualLite SJC incorporates three security modes for protecting against unauthorized accesses. Modes are selected through eFUSE configuration. |
| SNVS | Secure Non-Volatile Storage | Security | Secure Non-Volatile Storage, including Secure Real Time Clock, Security State Machine, Master Key Control, and Violation/Tamper Detection and reporting. |
| SPDIF | Sony Philips Digital Interconnect Format | Multimedia Peripherals | A standard audio file transfer format, developed jointly by the Sony and Phillips corporations. Has Transmitter and Receiver functionality. |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| SSI-1<br>SSI-2<br>SSI-3 | I2S/SSI/AC97 Interface | Connectivity Peripherals | The SSI is a full-duplex synchronous interface, which is used on the AP to provide connectivity with off-chip audio peripherals. The SSI supports a wide variety of protocols (SSI normal, SSI network, I2S, and AC-97), bit depths (up to 24 bits per word), and clock / frame sync options.<br>The SSI has two pairs of 8x24 FIFOs and hardware support for an external DMA controller in order to minimize its impact on system performance. The second pair of FIFOs provides hardware interleaving of a second audio stream that reduces CPU overhead in use cases where two time slots are being used simultaneously. |
| TEMPMON | Temperature Monitor | System Control Peripherals | The Temperature sensor IP is used for detecting die temperature. The temperature read out does not reflect case or ambient temperature. It reflects the temperature in proximity of the sensor location on the die. Temperature distribution may not be uniformly distributed, therefore the read out value may not be the reflection of the temperature value of the entire die. |
| TZASC | Trust-Zone Address Space Controller | Security | The TZASC (TZC-380 by Arm) provides security address region control functions required for intended application. It is used on the path to the DRAM controller. |
| UART-1<br>UART-2<br>UART-3<br>UART-4<br>UART-5 | UART Interface | Connectivity Peripherals | Each of the UARTv2 modules support the following serial data transmit/receive protocols and configurations:<br>• 7- or 8-bit data words, 1 or 2 stop bits, programmable parity (even, odd or none)<br>• Programmable baud rates up to 5 Mbps.<br>• 32-byte FIFO on Tx and 32 half-word FIFO on Rx supporting auto-baud<br>• IrDA 1.0 support (up to SIR speed of 115200 bps)<br>• Option to operate as 8-pins full UART, DCE, or DTE |
| USBOH3 | USB 2.0 High Speed OTG and 3x HS Hosts | Connectivity Peripherals | USBOH3 contains:<br>• One high-speed OTG module with integrated HS USB PHY<br>• One high-speed Host module with integrated HS USB PHY<br>• Two identical high-speed Host modules connected to HSIC USB ports. |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| uSDHC-1<br>uSDHC-2<br>uSDHC-3<br>uSDHC-4 | SD/MMC and SDXC Enhanced Multi-Media Card / Secure Digital Host Controller | Connectivity Peripherals | i.MX 6Solo/6DualLite specific SoC characteristics:<br>All four MMC/SD/SDIO controller IPs are identical and are based on the uSDHC IP. They are:<br>• Conforms to the SD Host Controller Standard Specification version 3.0.<br>• Fully compliant with MMC command/response sets and Physical Layer as defined in the Multimedia Card System Specification, v4.2/4.3/4.4/4.41 including high-capacity (size > 2 GB) cards HC MMC.<br>• Fully compliant with SD command/response sets and Physical Layer as defined in the SD Memory Card Specifications, v3.0 including high-capacity SDHC cards up to 32 GB and SDXC cards up to 2 TB.<br>• Fully compliant with SDIO command/response sets and interrupt/read-wait mode as defined in the SDIO Card Specification, Part E1, v3.0<br>All four ports support:<br>• 1-bit or 4-bit transfer mode specifications for SD and SDIO cards up to UHS-I SDR104 mode (104 MB/s max)<br>• 1-bit, 4-bit, or 8-bit transfer mode specifications for MMC cards up to 52 MHz in both SDR and DDR modes (104 MB/s max)<br>However, the SoC level integration and I/O muxing logic restrict the functionality to the following:<br>• Instances #1 and #2 are primarily intended to serve as external slots or interfaces to on-board SDIO devices. These ports are equipped with “Card detection” and “Write Protection” pads and do not support hardware reset.<br>• Instances #3 and #4 are primarily intended to serve interfaces to embedded MMC memory or interfaces to on-board SDIO devices. These ports do not have “Card detection” and “Write Protection” pads and do support hardware reset.<br>• All ports can work with 1.8 V and 3.3 V cards. There are two completely independent I/O power domains for Ports #1 and #2 in four bit configuration (SD interface). Port #3 is placed in his own independent power domain and port #4 shares power domain with some other interfaces. |
| VDOA | VDOA | Multimedia Peripherals | Video Data Order Adapter (VDOA): used to re-order video data from the “tiled” order used by the VPU to the conventional raster-scan order needed by the IPU. |
| VPU | Video Processing Unit | Multimedia Peripherals | A high-performing video processing unit (VPU), which covers many SD-level and HD-level video decoders and SD-level encoders as a multi-standard video codec engine as well as several important video processing, such as rotation and mirroring.<br>See the i.*MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)* for complete list of VPU’s decoding/encoding capabilities. |



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**Table 2. i.MX 6Solo/6DualLite Modules List (continued)**

| Block Mnemonic | Block Name | Subsystem | Brief Description |
|---|---|---|---|
| WDOG-1 | Watch Dog | Timer Peripherals | The Watch Dog Timer supports two comparison points during each counting period. Each of the comparison points is configurable to evoke an interrupt to the Arm core, and a second point evokes an external event on the WDOG line. |
| WDOG-2 (TZ) | Watch Dog (TrustZone) | Timer Peripherals | The TrustZone Watchdog (TZ WDOG) timer module protects against TrustZone starvation by providing a method of escaping normal mode and forcing a switch to the TZ mode. TZ starvation is a situation where the normal OS prevents switching to the TZ mode. Such situation is undesirable as it can compromise the system's security. Once the TZ WDOG module is activated, it must be serviced by TZ software on a periodic basis. If servicing does not take place, the timer times out. Upon a time-out, the TZ WDOG asserts a TZ mapped interrupt that forces switching to the TZ mode. If it is still not served, the TZ WDOG asserts a security violation signal to the CSU. The TZ WDOG module cannot be programmed or deactivated by a normal mode SW. |
| WEIM | NOR-Flash /PSRAM interface | Connectivity Peripherals | The WEIM NOR-FLASH / PSRAM provides:<br>• Support 16-bit (in muxed IO mode only) PSRAM memories (sync and async operating modes), at slow frequency<br>• Support 16-bit (in muxed IO mode only) NOR-Flash memories, at slow frequency<br>• Multiple chip selects |
| XTALOSC | Crystal Oscillator I/F | Clocks, Resets, and Power Control | The XTALOSC module enables connectivity to external crystal oscillator device. In a typical application use-case, it is used for 24 MHz oscillator to provide USB required frequency. |



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## 3.1 Special Signal Considerations

Table 3 lists special signal considerations for the i.MX 6Solo/6DualLite processors. The signal names are listed in alphabetical order.

The package contact assignments can be found in Section 6, "Package Information and Contact Assignments." Signal descriptions are provided in the *i.MX 6Solo/6DualLite Reference Manual* (IMX6SDLRM).

**Table 3. Special Signal Considerations**

| Signal Name | Remarks |
|---|---|
| CLK1_P/CLK1_N<br>CLK2_P/CLK2_N | Two general purpose differential high speed clock Input/outputs are provided.<br>Any or both of them could be used:<br>• To feed external reference clock to the PLLs and further to the modules inside SoC, for example as alternate reference clock for PCIe, Video/Audio interfaces, etc.<br>• To output internal SoC clock to be used outside the SoC as either reference clock or as a functional clock for peripherals, for example it could be used as an output of the PCIe master clock (root complex use)<br>See the i.MX 6Solo/6DualLite reference manual for details on the respective clock trees.<br>The clock inputs/outputs are LVDS differential pairs compatible with TIA/EIA-644 standard, the maximum frequency range supported is 0...600 MHz.<br>Alternatively one may use single ended signal to drive CLKx_P input. In this case corresponding CLKx_N input should be tied to the constant voltage level equal 1/2 of the input signal swing. Termination should be provided in case of high frequency signals.<br>See LVDS pad electrical specification for further details.<br>After initialization, the CLKx inputs/outputs could be disabled (if not used). If unused any or both of the CLKx_N/P pairs may remain unconnected. |
| XTALOSC_RTC_XTALI/<br>RTC_XTALO | If the user wishes to configure XTALOSC_RTC_XTALI and RTC_XTALO as an RTC oscillator, a 32.768 kHz crystal, (≤100 kΩ ESR, 10 pF load) should be connected between XTALOSC_RTC_XTALI and RTC_XTALO. Remember that the capacitors implemented on either side of the crystal are about twice the crystal load capacitor. To hit the exact oscillation frequency, the board capacitors need to be reduced to account for board and chip parasitics. The integrated oscillation amplifier is self biasing, but relatively weak. Care must be taken to limit parasitic leakage from XTALOSC_RTC_XTALI and RTC_XTALO to either power or ground (>100 MΩ). This will debias the amplifier and cause a reduction of startup margin. Typically XTALOSC_RTC_XTALI and RTC_XTALO should bias to approximately 0.5 V.<br>If it is desired to feed an external low frequency clock into XTALOSC_RTC_XTALI the RTC_XTALO pin must remain unconnected or driven with a complimentary signal. The logic level of this forcing clock must not exceed VDD_SNVS_CAP level and the frequency must be <100 kHz under typical conditions. |
| XTALI/XTALO | • A 24.0 MHz crystal should be connected between XTALI and XTALO level and the frequency should be <32 MHz under typical conditions. See the Hardware Development Guide (IMX6DQ6SDLHDG), Design Checklist chapter, for details on crystal selection.<br>• NXP BSP (board support package) software requires 24 MHz on XTALI/XTALO.<br>• The crystal can be eliminated if an external 24 MHz oscillator is available in the system. In this case, XTALI must be directly driven by the external oscillator and XTALO remains unconnected.<br>• The XTALI signal level must swing from ~0.8 x NVCC_PLL_OUT to ~0.2 V. If this clock is used as a reference for USB and PCIe, then there are strict frequency tolerance and jitter requirements. See OSC24M chapter and relevant interface specifications chapters for details. |



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**Table 3. Special Signal Considerations (continued)**

| Signal Name | Remarks |
|---|---|
| DRAM_VREF | When using DDR_VREF with DDR I/O, the nominal reference voltage must be half of the NVCC_DRAM supply. The user must tie DDR_VREF to a precision external resistor divider. Use a 1 kΩ 0.5% resistor to GND and a 1 kΩ 0.5% resistor to NVCC_DRAM. Shunt each resistor with a closely-mounted 0.1 µF capacitor.<br><br>To reduce supply current, a pair of 1.5 kΩ 0.1% resistors can be used. Using resistors with recommended tolerances ensures the ± 2% DDR_VREF tolerance (per the DDR3 specification) is maintained when four DDR3 ICs plus the i.MX 6Solo/6DualLite are drawing current on the resistor divider.<br><br>It is recommended to use regulated power supply for “big” memory configurations (more that eight devices). |
| ZQPAD | DRAM calibration resistor 240 Ω 1% used as reference during DRAM output buffer driver calibration should be connected between this pad and GND. |
| NVCC_LVDS_2P5 | The DDR pre-drivers share the NVCC_LVDS_2P5 ball with the LVDS interface. This ball can be shorted to VDD_HIGH_CAP on the circuit board. |
| VDD_FA<br>FA_ANA | These signals are reserved for NXP manufacturing use only. User must tie both connections to GND. |
| GPANAIO | Analog output for NXP use only. This output must remain unconnected. |
| JTAG_*nnnn* | The JTAG interface is summarized in Table 4. Use of external resistors is unnecessary. However, if external resistors are used, the user must ensure that the on-chip pull-up/down configuration is followed. For example, do not use an external pull down on an input that has on-chip pull-up. |
| | JTAG_TDO is configured with a keeper circuit such that the non-connected condition is eliminated if an external pull resistor is not present. An external pull resistor on JTAG_TDO is detrimental and must be avoided. |
| | JTAG_MOD is referenced as SJC_MOD in the i.MX 6Solo/6DualLite reference manual. Both names refer to the same signal. JTAG_MOD must be externally connected to GND for normal operation. Termination to GND through an external pull-down resistor (such as 1 kΩ) is allowed. JTAG_MOD set to hi configures the JTAG interface to mode compliant with IEEE1149.1 standard. JTAG_MOD set to low configures the JTAG interface for common SW debug adding all the system TAPs to the chain. |
| NC | These signals are not functional and must remain unconnected by the user. |
| SRC_POR_B | This cold reset negative logic input resets all modules and logic in the IC. |
| ONOFF | In normal mode may be connected to ON/OFF button (De-bouncing provided at this input). Internally this pad is pulled up. Short connection to GND in OFF mode causes internal power management state machine to change state to ON. In ON mode short connection to GND generates interrupt (intended to SW controllable power down). Long above ~5s connection to GND causes “forced” OFF. |
| TEST_MODE | TEST_MODE is for NXP factory use. This signal is internally connected to an on-chip pull-down device. This signal must either be tied to Vss or remain unconnected. |
| PCIE_REXT | The impedance calibration process requires connection of reference resistor 200 Ω 1% precision resistor on PCIE_REXT pad to ground. |
| CSI_REXT | MIPI CSI PHY reference resistor. Use 6.04 KΩ 1% resistor connected between this pad and GND |
| DSI_REXT | MIPI DSI PHY reference resistor. Use 6.04 KΩ 1% resistor connected between this pad and GND |



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**Table 4. JTAG Controller Interface Summary**

| JTAG | I/O Type | On-Chip Termination |
|---|---|---|
| JTAG_TCK | Input | 47 kΩ pull-up |
| JTAG_TMS | Input | 47 kΩ pull-up |
| JTAG_TDI | Input | 47 kΩ pull-up |
| JTAG_TDO | 3-state output | Keeper |
| JTAG_TRSTB | Input | 47 kΩ pull-up |
| JTAG_MOD | Input | 100 kΩ pull-up |

## 3.2 Recommended Connections for Unused Analog Interfaces

The recommended connections for unused analog interfaces can be found in the section, "Unused analog interfaces," of the Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors (IMX6DQ6SDLHDG).

# 4 Electrical Characteristics

This section provides the device and module-level electrical characteristics for the i.MX 6Solo/6DualLite processors.

## 4.1 Chip-Level Conditions

This section provides the device-level electrical characteristics for the IC. See Table 5 for a quick reference to the individual tables and sections.

**Table 5. i.MX 6Solo/6DualLite Chip-Level Conditions**

| For these characteristics, … | Topic appears … |
|---|---|
| Absolute Maximum Ratings | on page 24 |
| BGA Case 2240 Package Thermal Resistance | on page 25 |
| Operating Ranges | on page 26 |
| External Clock Sources | on page 28 |
| Maximum Supply Currents | on page 29 |
| Low Power Mode Supply Currents | on page 30 |
| USB PHY Current Consumption | on page 32 |
| PCIe 2.0 Power Consumption | on page 32 |



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### 4.1.1 Absolute Maximum Ratings

**CAUTION**

Stresses beyond those listed under Table 6 may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Table 6 shows the absolute maximum operating ratings.

**Table 6. Absolute Maximum Ratings**

| Parameter Description | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Core supply input voltage (LDO enabled) | VDD_ARM_IN<br>VDD_SOC_IN | -0.3 | 1.6 | V |
| Core supply input voltage (LDO bypass) | VDD_ARM_IN<br>VDD_SOC_IN | -0.3 | 1.4 | V |
| Core supply output voltage (LDO enabled) | VDD_ARM_CAP<br>VDD_SOC_CAP<br>VDD_PU_CAP | -0.3 | 1.4 | V |
| VDD_HIGH_IN supply voltage (LDO enabled) | VDD_HIGH_IN | -0.3 | 3.7 | V |
| VDD_HIGH_CAP supply output voltage | VDD_HIGH_CAP | -0.3 | 2.85 | V |
| DDR I/O supply voltage | NVCC_DRAM | -0.4 | 1.975 (See note 1) | V |
| GPIO I/O supply voltage | NVCC_CSI<br>NVCC_EIM<br>NVCC_ENET<br>NVCC_GPIO<br>NVCC_LCD<br>NVCC_NAND<br>NVCC_SD<br>NVCC_JTAG | -0.5 | 3.7 | V |
| HDMI and PCIe high PHY VPH supply voltage | HDMI_VPH<br>PCIE_VPH | -0.3 | 2.85 | V |
| HDMI and PCIe low PHY VP supply voltage | HDMI_VP<br>PCIE_VP | -0.3 | 1.4 | V |
| LVDS and MIPI I/O supply voltage (2.5V supply) | NVCC_LVDS_2P5<br>NVCC_MIPI | -0.3 | 2.85 | V |
| PCIe PHY supply voltage | PCIE_VPTX | -0.3 | 1.4 | V |
| RGMII I/O supply voltage | NVCC_RGMII | -0.5 | 2.725 | V |
| SNVS IN supply voltage<br>(Secure Non-Volatile Storage and Real Time Clock) | VDD_SNVS_IN | -0.3 | 3.4 | V |
| USB I/O supply voltage | USB_H1_DN<br>USB_H1_DP<br>USB_OTG_DN<br>USB_OTG_DP<br>USB_OTG_CHD_B | -0.3 | 3.73 | V |
| USB VBUS supply voltage | USB_H1_VBUS<br>USB_OTG_VBUS | — | 5.35 | V |
| $V_{in}/V_{out}$ input/output voltage range (non-DDR pins) | $V_{in}/V_{out}$ | -0.5 | OVDD+0.3 (See note 2) | V |



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**Table 6. Absolute Maximum Ratings (continued)**

| Parameter Description | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| $V_{in}/V_{out}$ input/output voltage range (DDR pins) | $V_{in}/V_{out}$ | -0.5 | OVDD+0.4 (See notes 1 & 2) | V |
| ESD immunity (HBM) | $V_{esd_HBM}$ | — | 2000 | V |
| ESD immunity (CDM) | $V_{esd_CDM}$ | — | 500 | V |
| Storage temperature range | $T_{storage}$ | -40 | 150 | °C |

1 The absolute maximum voltage includes an allowance for 400 mV of overshoot on the IO pins. Per JEDEC standards, the allowed signal overshoot must be derated if NVCC_DRAM exceeds 1.575V.

2 OVDD is the I/O supply voltage.

## 4.1.2 Thermal Resistance

**NOTE**

Per JEDEC JESD51-2, the intent of thermal resistance measurements is solely for a thermal performance comparison of one package to another in a standardized environment. This methodology is not meant to and will not predict the performance of a package in an application-specific environment.

### 4.1.2.1 BGA Case 2240 Package Thermal Resistance

Table 7 displays the thermal resistance data.

**Table 7. Thermal Resistance Data**

| Rating | Test Conditions | Symbol | Value | Unit |
|---|---|---|---|---|
| Junction to Ambient[1] | Single-layer board (1s); natural convection[2]<br>Four-layer board (2s2p); natural convection[2] | $R_{\theta JA}$<br>$R_{\theta JA}$ | 38<br>23 | °C/W<br>°C/W |
| Junction to Ambient[1] | Single-layer board (1s); airflow 200 ft/min[2,3]<br>Four-layer board (2s2p); airflow 200 ft/min[2,3] | $R_{\theta JA}$<br>$R_{\theta JA}$ | 30<br>20 | °C/W<br>°C/W |
| Junction to Board[1,4] | — | $R_{\theta JB}$ | 14 | °C/W |
| Junction to Case[1,5] | — | $R_{\theta JC}$ | 6 | °C/W |
| Junction to Package Top[1,6] | Natural convection | $\Psi_{JT}$ | 2 | °C/W |

1 Junction temperature is a function of die size, on-chip power dissipation, package thermal resistance, mounting site (board) temperature, ambient temperature, air flow, power dissipation of other components on the board, and board thermal resistance.

2 Per JEDEC JESD51-2 with the single layer board horizontal. Thermal test board meets JEDEC specification for the specified package.

3 Per JEDEC JESD51-6 with the board horizontal.

4 Thermal resistance between the die and the printed circuit board per JEDEC JESD51-8. Board temperature is measured on the top surface of the board near the package.

5 Thermal resistance between the die and the case top surface as measured by the cold plate method (MIL SPEC-883 Method 1012.1).

6 Thermal characterization parameter indicating the temperature difference between package top and the junction temperature per JEDEC JESD51-2. When Greek letters are not available, the thermal characterization parameter is written as Psi-JT.



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## 4.1.3 Operating Ranges

Table 8 provides the operating ranges of the i.MX 6Solo/6DualLite processors. For details on the chip's power structure, see the "Power Management Unit (PMU)" chapter of the *i.MX 6Solo/6DualLite Reference Manual (*IMX6SDLRM*)*.

**Table 8. Operating Ranges**

| Parameter Description | Symbol | Min | Typ | Max[1] | Unit | Comment[2] |
|---|---|---|---|---|---|---|
| Run mode: LDO enabled | VDD_ARM_IN | 1.350[3] | — | 1.5 | V | LDO Output Set Point (VDD_ARM_CAP) = 1.225 V minimum for operation up to 996 MHz. |
| | | 1.275[3] | — | 1.5 | V | LDO Output Set Point (VDD_ARM_CAP) = 1.150 V minimum for operation up to 792 MHz. |
| | | 1.25[3] | — | 1.5 | V | LDO Output Set Point (VDD_ARM_CAP) = 1.125 V minimum for operation up to 396 MHz. |
| | VDD_SOC_IN | 1.275[3,4] | — | 1.5 | V | VPU ≤ 328 MHz, VDD_SOC and VDD_PU LDO outputs (VDD_SOC_CAP and VDD_PU_CAP) = 1.225 V[6] maximum and 1.15 V minimum. |
| Run mode: LDO bypassed | VDD_ARM_IN | 1.250 | — | 1.3 | V | LDO bypassed for operation up to 996 MHz |
| | | 1.150 | — | 1.3 | V | LDO bypassed for operation up to 792 MHz |
| | | 1.125 | — | 1.3 | V | LDO bypassed for operation up to 396 MHz |
| | VDD_SOC_IN | 1.150[5] | — | 1.21[6] | V | LDO bypassed for operation VPU ≤ 328 MHz |
| Standby/DSM mode | VDD_ARM_IN | 0.9 | — | 1.3 | V | Refer to Table 11, "Stop Mode Current and Power Consumption," on page 30. |
| | VDD_SOC_IN | 0.9 | — | 1.225[6] | V | — |
| VDD_HIGH internal regulator | VDD_HIGH_IN | 2.8 | — | 3.3 | V | Must match the range of voltages that the rechargeable backup battery supports. |
| Backup battery supply range | VDD_SNVS_IN[7] | 2.9 | — | 3.3 | V | Should be supplied from the same supply as VDD_HIGH_IN if the system does not require keeping real time and other data on OFF state. |
| USB supply voltages | USB_OTG_VBUS | 4.4 | — | 5.25 | V | — |
| | USB_H1_VBUS | 4.4 | — | 5.25 | V | — |
| DDR I/O supply voltage | NVCC_DRAM | 1.14 | 1.2 | 1.3 | V | LPDDR2 |
| | | 1.425 | 1.5 | 1.575 | V | DDR3 |
| | | 1.283 | 1.35 | 1.45 | V | DDR3L |
| Supply for RGMII I/O power group[8] | NVCC_RGMII | 1.15 | — | 2.625 | V | 1.15 V–1.30 V in HSIC 1.2 V mode<br>1.43 V–1.58 V in RGMII 1.5 V mode<br>1.70 V–1.90 V in RGMII 1.8 V mode<br>2.25 V–2.625 V in RGMII 2.5 V mode |



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**Table 8. Operating Ranges (continued)**

| Parameter Description | Symbol | Min | Typ | Max[1] | Unit | Comment[2] |
|---|---|---|---|---|---|---|
| GPIO supply voltages[8] | NVCC_CSI, NVCC_EIM, NVCC_ENET, NVCC_GPIO, NVCC_LCD, NVCC_NANDF, NVCC_SD1, NVCC_SD2, NVCC_SD3, NVCC_JTAG | 1.65 | 1.8, 2.8, 3.3 | 3.6 | V | — |
| | NVCC_LVDS_2P5[9] NVCC_MIPI | 2.25 | 2.5 | 2.75 | V | — |
| HDMI supply voltages | HDMI_VP | 0.99 | 1.1 | 1.3 | V | — |
| | HDMI_VPH | 2.25 | 2.5 | 2.75 | V | — |
| PCIe supply voltages | PCIE_VP | 1.023 | 1.1 | 1.21 | V | — |
| | PCIE_VPH | 2.325 | 2.5 | 2.75 | V | — |
| | PCIE_VPTX | 1.023 | 1.1 | 1.21 | V | — |
| Junction temperature Extended commercial | $T_J$ | -20 | — | 105 | °C | See *i.MX 6Solo/6DualLite Product Lifetime Usage Estimates Application Note*, AN4725, for information on product lifetime for this processor. |
| Junction temperature Standard commercial | $T_J$ | 0 | — | 95 | °C | See *i.MX 6Solo/6DualLite Product Lifetime Usage Estimates Application Note*, AN4725, for information on product lifetime for this processor. |

1 Applying the maximum voltage results in maximum power consumption and heat generation. NXP recommends a voltage set point = (Vmin + the supply tolerance). This results in an optimized power/speed ratio.

2 See the Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors (IMX6DQ6SDLHDG) for bypass capacitors requirements for each of the *_CAP supply outputs.

3 VDD_ARM_IN and VDD_SOC_IN must be 125 mV higher than the LDO Output Set Point for correct regulator supply voltage.

4 In LDO enabled mode, the internal LDO output set points must be configured such that the:

- VDD_ARM LDO output set point does not exceed the VDD_SOC LDO output set point by more than 100 mV.
- VDD_SOC LDO output set point is equal to the VDD_PU LDO output set point.

The VDD_ARM LDO output set point can be lower than the VDD_SOC LDO output set point, however, the minimum output set points shown in this table must be maintained.

5 In LDO bypassed mode, the external power supply must ensure that VDD_ARM_IN does not exceed VDD_SOC_IN by more than 100 mV. The VDD_ARM_IN supply voltage can be lower than the VDD_SOC_IN supply voltage. The minimum voltages shown in this table must be maintained.

6 When using VDD_SOC_CAP to supply the PCIE_VP and PCIE_VPTX, the maximum setting is 1.175V. If VDD_SOC_CAP requires setting to 1.2V or higher, the PCIE_VP and PCIE_VPTX must use an external supply to guarantee not to exceed the 1.21V maximum operating voltage.

7 While setting VDD_SNVS_IN voltage with respect to Charging Currents and RTC, refer to Hardware Development Guide for i.MX 6Dual, 6Quad, 6Solo, 6DualLite Families of Applications Processors (IMX6DQ6SDLHDG).

8 All digital I/O supplies (NVCC_xxxx) must be powered under normal conditions whether the associated I/O pins are in use or not and associated IO pins need to have a pull-up or pull-down resistor applied to limit any non-connected gate current.

9 This supply also powers the pre-drivers of the DDR IO pins, hence, it must be always provided, even when LVDS is not used.



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### 4.1.4 External Clock Sources

Each i.MX 6Solo/6DualLite processor has two external input system clocks: a low frequency (RTC_XTALI) and a high frequency (XTALI).

The RTC_XTALI is used for low-frequency functions. It supplies the clock for wake-up circuit, power-down real time clock operation, and slow system and watch-dog counters. The clock input can be connected to either external oscillator or a crystal using internal oscillator amplifier. Additionally, there is an internal ring oscillator, which can be used instead of the RTC_XTALI if accuracy is not important.

**NOTE**

The internal RTC oscillator does not provide an accurate frequency and is affected by process, voltage, and temperature variations. NXP strongly recommends using an external crystal as the RTC_XTALI reference. If the internal oscillator is used instead, careful consideration must be given to the timing implications on all of the SoC modules dependent on this clock.

The system clock input XTALI is used to generate the main system clock. It supplies the PLLs and other peripherals. The system clock input can be connected to either external oscillator or a crystal using internal oscillator amplifier.

Table 9 shows the interface frequency requirements.

**Table 9. External Input Clock Frequency**

| Parameter Description | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| RTC_XTALI Oscillator[1,2] | $f_{ckil}$ | — | 32.768[3]/32.0 | — | kHz |
| XTALI Oscillator[2,4] | $f_{xtal}$ | — | 24 | — | MHz |

1 External oscillator or a crystal with internal oscillator amplifier.

2 The required frequency stability of this clock source is application dependent. For recommendations, see the Hardware Development Guide for i.MX 6Dual, 6Quad, 6Solo, 6DualLite Families of Applications Processors (IMX6DQ6SDLHDG).

3 Recommended nominal frequency 32.768 kHz.

4 External oscillator or a fundamental frequency crystal with internal oscillator amplifier.

The typical values shown in Table 9 are required for use with NXP BSPs to ensure precise time keeping and USB operation. For XTALOSC_RTC_XTALI operation, two clock sources are available.

- On-chip 40 kHz ring oscillator—this clock source has the following characteristics:
  - Approximately 25 µA more Idd than crystal oscillator
  - Approximately ±50% tolerance
  - No external component required
  - Starts up quicker than 32 kHz crystal oscillator
- External crystal oscillator with on-chip support circuit:
  - At power up, ring oscillator is utilized. After crystal oscillator is stable, the clock circuit switches over to the crystal oscillator automatically.
  - Higher accuracy than ring oscillator
  - If no external crystal is present, then the ring oscillator is used



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The choice of a clock source must be based on real-time clock use and precision timeout.

### 4.1.5 Maximum Supply Currents

The Power Virus numbers shown in Table 10 represent a use case designed specifically to show the maximum current consumption possible. All cores are running at the defined maximum frequency and are limited to L1 cache accesses only to ensure no pipeline stalls. Although a valid condition, it would have a very limited practical use case, if at all, and be limited to an extremely low duty cycle unless the intention was to specifically show the worst case power consumption.

The NXP power management IC, MMPF0100xxxx, which is targeted for the i.MX 6 series processor family, supports the power consumption shown in Table 10, however a robust thermal design is required for the increased system power dissipation.

See the i.MX 6Solo/6DualLite Power Consumption Measurement Application Note (AN4576) for more details on typical power consumption under various use case definitions.

**Table 10. Maximum Supply Currents**

| Power Line | Conditions | Max Current | Unit |
|---|---|---|---|
| VDD_ARM_IN | i.MX 6DualLite: 996 MHz Arm clock based on Power Virus operation | 2200 | mA |
| | i.MX 6Solo: 996 MHz Arm clock based on Power Virus operation | 1320 | mA |
| VDD_SOC_IN | 996 MHz Arm clock | 1260 | mA |
| VDD_HIGH_IN | — | 125[1] | mA |
| VDD_SNVS_IN | — | 275[2] | µA |
| USB_OTG_VBUS/ USB_H1_VBUS (LDO 3P0) | — | 25[3] | mA |
| **Primary Interface (IO) Supplies** | | | |
| NVCC_DRAM | — | —[4] | — |
| NVCC_ENET | N=10 | Use maximum IO equation[5] | — |
| NVCC_LCD | N=29 | Use maximum IO equation[5] | — |
| NVCC_GPIO | N=24 | Use maximum IO equation[5] | — |
| NVCC_CSI | N=20 | Use maximum IO equation[5] | — |
| NVCC_EIM | N=53 | Use maximum IO equation[5] | — |
| NVCC_JTAG | N=6 | Use maximum IO equation[5] | — |
| NVCC_RGMII | N=6 | Use maximum IO equation[5] | — |
| NVCC_SD1 | N=6 | Use maximum IO equation[5] | — |
| NVCC_SD2 | N=6 | Use maximum IO equation[5] | — |
| NVCC_SD3 | N=11 | Use maximum IO equation[5] | — |
| NVCC_NANDF | N=26 | Use maximum IO equation[5] | — |



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**Table 10. Maximum Supply Currents (continued)**

| Power Line | Conditions | Max Current | Unit |
|---|---|---|---|
| NVCC_LVDS2P5[6] | — | NVCC_LVDS2P5 is connected to VDD_HIGH_CAP at the board level. VDD_HIGH_CAP is capable of handing the current required by NVCC_LVDS2P5. | — |
| **MISC** | | | |
| DDR_VREF | — | 1 | mA |

1 The actual maximum current drawn from VDD_HIGH_IN will be as shown plus any additional current drawn from the VDD_HIGH_CAP outputs, depending upon actual application configuration (for example, NVCC_LVDS_2P5, NVCC_MIPI, or HDMI and PCIe VPH supplies).

2 Under normal operating conditions, the maximum current on VDD_SNVS_IN is shown in Table 10. The maximum VDD_SNVS_IN current may be higher depending on specific operating configurations, such as BOOT_MODE[1:0] not equal to 00, or use of the Tamper feature. During initial power on, VDD_SNVS_IN can draw up to 1 mA if the supply is capable of sourcing that current. If less than 1 mA is available, the VDD_SNVS_CAP charge time will increase.

3 This is the maximum current per active USB physical interface.

4 The DRAM power consumption is dependent on several factors, such as external signal termination. DRAM power calculators are typically available from the memory vendors. They take in account factors, such as signal termination. See the i.MX 6Solo/DualLite Power Consumption Measurement Application Note (AN4576) for examples of DRAM power consumption during specific use case scenarios.

5 General equation for estimated, maximum power consumption of an IO power supply:

Imax = N x C x V x (0.5 x F)

Where:

N—Number of IO pins supplied by the power line

C—Equivalent external capacitive load

V—IO voltage

(0.5 xF)—Data change rate. Up to 0.5 of the clock rate (F)

In this equation, Imax is in Amps, C in Farads, V in Volts, and F in Hertz.

6 NVCC_LVDS2P5 is supplied by VDD_HIGH_CAP (by external connection) so the maximum supply current is included in the current shown for VDD_HIGH_IN. The maximum supply current for NVCC_LVDS2P5 has not been characterized separately.

## 4.1.6 Low Power Mode Supply Currents

Table 11 shows the current core consumption (not including I/O) of i.MX 6Solo/6DualLite processors in selected low power modes.

**Table 11. Stop Mode Current and Power Consumption**

| Mode | Test Conditions | Supply | Typical[1] | Units |
|---|---|---|---|---|
| WAIT | • Arm, SoC, and PU LDOs are set to 1.225<br>• HIGH LDO set to 2.5 V<br>• Clocks are gated.<br>• DDR is in self refresh.<br>• PLLs are active in bypass (24MHz)<br>• Supply Voltages remain ON | VDD_ARM_IN (1.4V) | 4.5 | mA |
| | | VDD_SOC_IN (1.4V) | 23 | |
| | | VDD_HIGH_IN (3.0V) | 13.5 | |
| | | Total | 79 | mW |



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**Table 11. Stop Mode Current and Power Consumption (continued)**

| Mode | Test Conditions | Supply | Typical[1] | Units |
|---|---|---|---|---|
| STOP_ON | • Arm LDO set to 0.9V<br>• SoC and PU LDOs set to 1.225 V<br>• HIGH LDO set to 2.5 V<br>• PLLs disabled<br>• DDR is in self refresh. | VDD_ARM_IN (1.4V) | 4 | mA |
| | | VDD_SOC_IN (1.4V) | 22 | |
| | | VDD_HIGH_IN (3.0V) | 8.5 | |
| | | Total | 61.9 | mW |
| STOP_OFF | • Arm LDO set to 0.9V<br>• SoC LDO set to: 1.225 V<br>• PU LDO is power gated<br>• HIGH LDO set to 2.5 V<br>• PLLs disabled<br>• DDR is in self refresh | VDD_ARM_IN (1.4V) | 4 | mA |
| | | VDD_SOC_IN (1.4V) | 13.5 | |
| | | VDD_HIGH_IN (3.0V) | 7.5 | |
| | | Total | 47 | mW |
| STANDBY | • Arm and PU LDOs are power gated<br>• SoC LDO is in bypass<br>• HIGH LDO is set to 2.5V<br>• PLLs are disabled<br>• Low Voltage<br>• Well Bias ON<br>• Crystal oscillator is enabled | VDD_ARM_IN (0.9V) | 0.1 | mA |
| | | VDD_SOC_IN (0.9V) | 5 | |
| | | VDD_HIGH_IN (3.0V) | 5 | |
| | | Total | 19.6 | mW |
| Deep Sleep Mode (DSM) | • Arm and PU LDOs are power gated<br>• SoC LDO is in bypass<br>• HIGH LDO is set to 2.5V<br>• PLLs are disabled<br>• Low Voltage<br>• Well Bias ON<br>• Crystal oscillator and bandgap are disabled | VDD_ARM_IN (0.9V) | 0.1 | mA |
| | | VDD_SOC_IN (0.9V) | 2 | |
| | | VDD_HIGH_IN (3.0V) | 0.5 | |
| | | Total | 3.4 | mW |
| SNVS only | • VDD_SNVS_IN powered<br>• All other supplies off<br>• SRTC running | VDD_SNVS_IN (2.8V) | 41 | µA |
| | | Total | 115 | mW |

[1] The typical values shown here are for information only and are not guaranteed. These values are average values measured on a typical wafer at 25°C.



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## 4.1.7 USB PHY Current Consumption

### 4.1.7.1 Power Down Mode

In power down mode, everything is powered down, including the USB_VBUS valid detectors in typical condition. Table 12 shows the USB interface current consumption in power down mode.

**Table 12. USB PHY Current Consumption in Power Down Mode**

| | VDD_USB_CAP (3.0 V) | VDD_HIGH_CAP (2.5 V) | NVCC_PLL_OUT (1.1 V) |
|---|---|---|---|
| Current | 5.1 µA | 1.7 µA | <0.5 µA |

**NOTE**

The currents on the VDD_HIGH_CAP and VDD_USB_CAP were identified to be the voltage divider circuits in the USB-specific level shifters.

## 4.1.8 PCIe 2.0 Power Consumption

Table 13 provides PCIe PHY currents under certain Tx operating modes.

**Table 13. PCIe PHY Current Drain**

| Mode | Test Conditions | Supply | Max Current | Unit |
|---|---|---|---|---|
| P0: Normal Operation | 5G Operations | PCIE_VP (1.1 V) | 40 | mA |
| | | PCIE_VPTX (1.1 V) | 20 | |
| | | PCIE_VPH (2.5 V) | 21 | |
| | 2.5G Operations | PCIE_VP (1.1 V) | 27 | |
| | | PCIE_VPTX (1.1 V) | 20 | |
| | | PCIE_VPH (2.5 V) | 20 | |
| P0s: Low Recovery Time Latency, Power Saving State | 5G Operations | PCIE_VP (1.1 V) | 30 | mA |
| | | PCIE_VPTX (1.1 V) | 2.4 | |
| | | PCIE_VPH (2.5 V) | 18 | |
| | 2.5G Operations | PCIE_VP (1.1 V) | 20 | |
| | | PCIE_VPTX (1.1 V) | 2.4 | |
| | | PCIE_VPH (2.5 V) | 18 | |
| P1: Longer Recovery Time Latency, Lower Power State | — | PCIE_VP (1.1 V) | 12 | mA |
| | | PCIE_VPTX (1.1 V) | 2.4 | |
| | | PCIE_VPH (2.5 V) | 12 | |
| Power Down | — | PCIE_VP (1.1 V) | 1.3 | mA |
| | | PCIE_VPTX (1.1 V) | 0.18 | |
| | | PCIE_VPH (2.5 V) | 0.36 | |



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### 4.1.9 HDMI Power Consumption

Table 14 provides HDMI PHY currents for both Active 3D Tx with LFSR15 data and power-down modes.

**Table 14. HDMI PHY Current Drain**

| Mode | Test Conditions | Supply | Max Current | Unit |
|---|---|---|---|---|
| Active | Bit rate 251.75 Mbps | HDMI_VPH | 14 | mA |
| | | HDMI_VP | 4.1 | mA |
| | Bit rate 279.27 Mbps | HDMI_VPH | 14 | mA |
| | | HDMI_VP | 4.2 | mA |
| | Bit rate 742.5 Mbps | HDMI_VPH | 17 | mA |
| | | HDMI_VP | 7.5 | mA |
| | Bit rate 1.485 Gbps | HDMI_VPH | 17 | mA |
| | | HDMI_VP | 12 | mA |
| | Bit rate 2.275 Gbps | HDMI_VPH | 16 | mA |
| | | HDMI_VP | 17 | mA |
| | Bit rate 2.97 Gbps | HDMI_VPH | 19 | mA |
| | | HDMI_VP | 22 | mA |
| Power-down | — | HDMI_VPH | 49 | µA |
| | | HDMI_VP | 1100 | µA |

## 4.2 Power Supplies Requirements and Restrictions

The system design must comply with power-up sequence, power-down sequence, and steady state guidelines as described in this section to guarantee the reliable operation of the device. Any deviation from these sequences may result in the following situations:

- Excessive current during power-up phase
- Prevention of the device from booting
- Irreversible damage to the processor (worst-case scenario)

### 4.2.1 Power-Up Sequence

The restrictions that follow must be observed:

- VDD_SNVS_IN supply must be turned on before any other power supply or be connected (shorted) with VDD_HIGH_IN supply.
- If a coin cell is used to power VDD_SNVS_IN, then ensure that it is connected before any other supply is switched on.
- The SRC_POR_B signal controls the processor POR and must be immediately asserted at power-up and remain asserted until the VDD_ARM_CAP, VDD_SOC_CAP, and VDD_PU_CAP supplies are stable. VDD_ARM_IN and VDD_SOC_IN may be applied in either order with no restrictions.



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**NOTE**

Ensure that there is no back voltage (leakage) from any supply on the board towards the 3.3 V supply (for example, from the external components that use both the 1.8 V and 3.3 V supplies).

**NOTE**

USB_OTG_VBUS and USB_H1_VBUS are not part of the power supply sequence and may be powered at any time.

### 4.2.2 Power-Down Sequence

No special restrictions for i.MX 6Solo/6DualLite IC.

### 4.2.3 Power Supplies Usage

All I/O pins should not be externally driven while the I/O power supply for the pin (NVCC_xxx) is OFF. This can cause internal latch-up and malfunctions due to reverse current flows. For information about I/O power supply of each pin, see "Power Rail" columns in pin list tables of Section 6, "Package Information and Contact Assignments."

**NOTE**

When the PCIE interface is not used, the PCIE_VP, PCIE_VPH, and PCIE_VPTX supplies must be powered or grounded. The input and output supplies for the remaining ports (PCIE_REXT, PCIE_RX_N, PCIE_RX_P, PCIE_TX_N, and PCIE_TX_P) can remain unconnected. It is recommended not to turn the PCIE_VPH supply OFF while the PCIE_VP supply is ON, as it may lead to excessive power consumption. If boundary scan test is used, PCIE_VP, PCIE_VPH, and PCIE_VPTX must remain powered.

## 4.3 Integrated LDO Voltage Regulator Parameters

Various internal supplies can be powered ON from internal LDO voltage regulators. All the supply pins named *_CAP must be connected to external capacitors. The onboard LDOs are intended for internal use only and should not be used to power any external circuitry. See the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)* for details on the power tree scheme.

**NOTE**

The *_CAP signals must not be powered externally. These signals are intended for internal LDO or LDO bypass operation only.

### 4.3.1 Digital Regulators (LDO_ARM, LDO_PU, LDO_SOC)

There are three digital LDO regulators ("Digital", because of the logic loads that they drive, not because of their construction). The advantages of the regulators are to reduce the input supply variation because of



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their input supply ripple rejection and their on-die trimming. This translates into more stable voltage for the on-chip logics.

These regulators have three basic modes:

- Bypass. The regulation FET is switched fully on passing the external voltage, to the load unaltered. The analog part of the regulator is powered down in this state, removing any loss other than the IR drop through the power grid and FET.
- Power Gate. The regulation FET is switched fully off limiting the current draw from the supply. The analog part of the regulator is powered down here limiting the power consumption.
- Analog regulation mode. The regulation FET is controlled such that the output voltage of the regulator equals the programmed target voltage. The target voltage is fully programmable in 25 mV steps.

For additional information, see the i.MX 6Solo/6DualLite reference manual.

## 4.3.2 Regulators for Analog Modules

### 4.3.2.1 LDO_1P1

The LDO_1P1 regulator implements a programmable linear-regulator function from VDD_HIGH_IN (see Table 8 for minimum and maximum input requirements). Typical Programming Operating Range is 1.0 V to 1.2 V with the nominal default setting as 1.1 V. The LDO_1P1 supplies the USB Phy, LVDS Phy, HDMI Phy, MIPI Phy, and PLLs. A programmable brown-out detector is included in the regulator that can be used by the system to determine when the load capability of the regulator is being exceeded to take the necessary steps. Current-limiting can be enabled to allow for in-rush current requirements during start-up, if needed. Active-pull-down can also be enabled for systems requiring this feature.

For information on external capacitor requirements for this regulator, see the Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors (IMX6DQ6SDLHDG).

For additional information, see the i.MX 6Solo/6DualLite reference manual (IMX6SDLRM).

### 4.3.2.2 LDO_2P5

The LDO_2P5 module implements a programmable linear-regulator function from VDD_HIGH_IN (see Table 8 for minimum and maximum input requirements). Typical Programming Operating Range is 2.25 V to 2.75 V with the nominal default setting as 2.5 V. LDO_2P5 supplies the USB Phy, LVDS Phy, HDMI Phy, MIPI Phy, E-fuse module, and PLLs. A programmable brown-out detector is included in the regulator that can be used by the system to determine when the load capability of the regulator is being exceeded, to take the necessary steps. Current-limiting can be enabled to allow for in-rush current requirements during start-up, if needed. Active-pull-down can also be enabled for systems requiring this feature. An alternate self-biased low-precision weak-regulator is included that can be enabled for applications needing to keep the output voltage alive during low-power modes where the main regulator driver and its associated global bandgap reference module are disabled. The output of the weak-regulator



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is not programmable and is a function of the input supply as well as the load current. Typically, with a 3 V input supply the weak-regulator output is 2.525 V and its output impedance is approximately 40 Ω.

For information on external capacitor requirements for this regulator, see the Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors (IMX6DQ6SDLHDG).

For additional information, see the i.MX 6Solo/6DualLite reference manual.

#### 4.3.2.3 LDO_USB

The LDO_USB module implements a programmable linear-regulator function from the USB_OTG_VBUS and USB_H1_VBUS voltages (4.4 V–5.25 V) to produce a nominal 3.0 V output voltage. A programmable brown-out detector is included in the regulator that can be used by the system to determine when the load capability of the regulator is being exceeded, to take the necessary steps. This regulator has a built in power-mux that allows the user to select to run the regulator from either USB_VBUS supply, when both are present. If only one of the USB_VBUS voltages is present, then, the regulator automatically selects this supply. Current limit is also included to help the system meet in-rush current targets.

For information on external capacitor requirements for this regulator, see the Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors (IMX6DQ6SDLHDG).

For additional information, see the i.MX 6Solo/6DualLite reference manual.

## 4.4 PLL's Electrical Characteristics

### 4.4.1 Audio/Video PLL's Electrical Parameters

**Table 15. Audio/Video PLL's Electrical Parameters**

| Parameter | Value |
|---|---|
| Clock output range | 650 MHz ~1.3 GHz |
| Reference clock | 24 MHz |
| Lock time | <11250 reference cycles |

### 4.4.2 528 MHz PLL

**Table 16. 528 MHz PLL's Electrical Parameters**

| Parameter | Value |
|---|---|
| Clock output range | 528 MHz PLL output |



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**Table 16. 528 MHz PLL's Electrical Parameters (continued)**

| Parameter | Value |
|---|---|
| Reference clock | 24 MHz |
| Lock time | <11250 reference cycles |

### 4.4.3 Ethernet PLL

**Table 17. Ethernet PLL's Electrical Parameters**

| Parameter | Value |
|---|---|
| Clock output range | 500 MHz |
| Reference clock | 24 MHz |
| Lock time | <11250 reference cycles |

### 4.4.4 480 MHz PLL

**Table 18. 480 MHz PLL's Electrical Parameters**

| Parameter | Value |
|---|---|
| Clock output range | 480 MHz PLL output |
| Reference clock | 24 MHz |
| Lock time | <383 reference cycles |

### 4.4.5 MLB PLL

The MediaLB PLL is necessary in the MediaLB 6-Pin implementation to phase align the internal and external clock edges, effectively tuning out the delay of the differential clock receiver and is also responsible for generating the higher speed internal clock, when the internal-to-external clock ratio is not 1:1.

**Table 19. MLB PLL's Electrical Parameters**

| Parameter | Value |
|---|---|
| Lock time | <1 ms |



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### 4.4.6 Arm PLL

**Table 20. Arm PLL's Electrical Parameters**

| Parameter | Value |
|---|---|
| Clock output range | 650 MHz ~ 1.3 GHz |
| Reference clock | 24 MHz |
| Lock time | <2250 reference cycles |

## 4.5 On-Chip Oscillators

### 4.5.1 OSC24M

This block implements an amplifier that when combined with a suitable quartz crystal and external load capacitors implements an oscillator. The oscillator is powered from NVCC_PLL_OUT.

The system crystal oscillator consists of a Pierce-type structure running off the digital supply. A straight forward biased-inverter implementation is used.

### 4.5.2 OSC32K

This block implements an amplifier that when combined with a suitable quartz crystal and external load capacitors implements a low power oscillator. It also implements a power mux such that it can be powered from either a ~3 V backup battery (VDD_SNVS_IN) or VDD_HIGH_IN such as the oscillator consumes power from VDD_HIGH_IN when that supply is available and transitions to the back up battery when VDD_HIGH_IN is lost.

In addition, if the clock monitor determines that the OSC32K is not present, then the source of the 32 kHz clock will automatically switch to the internal ring oscillator.

**CAUTION**

The internal RTC oscillator does not provide an accurate frequency and is affected by process, voltage, and temperature variations. NXP strongly recommends using an external crystal as the RTC_XTALI reference. If the internal oscillator is used instead, careful consideration must be given to the timing implications on all of the SoC modules dependent on this clock.

The OSC32k runs from VDD_SNVS_CAP supply, which comes from VDD_HIGH_IN/VDD_SNVS_IN.



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**Table 21. OSC32K Main Characteristics**

| Characteristic | Min | Typ | Max | Comments |
|---|---|---|---|---|
| Fosc | — | 32.768 KHz | — | This frequency is nominal and determined mainly by the crystal selected. 32.0 K will work as well. |
| Current consumption | — | 4 μA | — | The 4 μA is the consumption of the oscillator alone (OSC32k). Total supply consumption will depend on what the digital portion of the RTC consumes. The ring oscillator consumes 1 μA when ring oscillator is inactive, 20 μA when the ring oscillator is running. Another 1.5 μA is drawn from vdd_rtc in the power_detect block. So, the total current is 6.5 μA on vdd_rtc when the ring oscillator is not running. |
| Bias resistor | — | 14 MΩ | — | This the integrated bias resistor that sets the amplifier into a high gain state. Any leakage through the ESD network, external board leakage, or even a scope probe that is significant relative to this value will debias the amp. The debiasing will result in low gain, and will impact the circuit's ability to start up and maintain oscillations. |
| **Crystal Properties** | | | | |
| Cload | — | 10 pF | — | Usually crystals can be purchased tuned for different Cloads. This Cload value is typically 1/2 of the capacitances realized on the PCB on either side of the quartz. A higher Cload will decrease oscillation margin, but increases current oscillating through the crystal. |
| ESR | — | 50 kΩ | 100 kΩ | Equivalent series resistance of the crystal. Choosing a crystal with a higher value will decrease the oscillating margin. |

## 4.6 I/O DC Parameters

This section includes the DC parameters of the following I/O types:

- General Purpose I/O (GPIO)
- Double Data Rate I/O (DDR) for LPDDR2 and DDR3 modes
- LVDS I/O
- MLB I/O

**NOTE**

The term ‘OVDD’ in this section refers to the associated supply rail of an input or output.

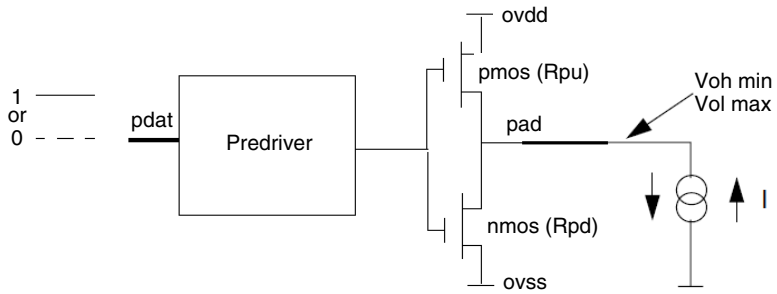


**Figure 4. Circuit for Parameters Voh and Vol for I/O Cells**



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### 4.6.1 XTALI and RTC_XTALI (Clock Inputs) DC Parameters

Table 22 shows the DC parameters for the clock inputs.

**Table 22. XTALI and RTC_XTALI DC Parameters**

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| XTALI high-level DC input voltage | Vih | — | 0.8 x NVCC_PLL | — | NVCC_PLL | V |
| XTALI low-level DC input voltage | Vil | — | 0 | — | 0.2V | V |
| RTC_XTALI high-level DC input voltage | Vih | — | 0.8 | — | 1.1[1] | V |
| RTC_XTALI low-level DC input voltage | Vil | — | 0 | — | 0.2 | V |
| Input capacitance | $C_{IN}$ | Simulated data | — | 5 | — | pF |
| XTALI input leakage current at startup | $I_{XTALI_STARTUP}$ | Power-on startup for 0.15msec with a driven 24 MHz clock at 1.1 V.[2] | — | — | 600 | µA |
| DC input current | $I_{XTALI_DC}$ | — | — | — | 2.5 | µA |

1 This voltage specification must not be exceeded and, as such, is an absolute maximum specification.

2 This current draw is present even if an external clock source directly drives XTALI. The 24 MHz oscillator cell is powered from NVCC_PLL_OUT.

**NOTE**

The Vil and Vih specifications only apply when an external clock source is used. If a crystal is used, Vil and Vih do not apply.

### 4.6.2 General Purpose I/O (GPIO) DC Parameters

Table 23 shows DC parameters for GPIO pads. The parameters in Table 23 are guaranteed per the operating ranges in Table 8, unless otherwise noted.

**Table 23. GPIO DC Parameters**

| Parameter | Symbol | Test Conditions | Min | Max | Units |
|---|---|---|---|---|---|
| High-level output voltage[1] | $V_{OH}$ | Ioh= -0.1mA (DSE=001,010)<br>Ioh= -1mA<br>(DSE=011,100,101,110,111) | OVDD - 0.15 | — | V |
| Low-level output voltage[1] | VOL | Iol= 0.1mA (DSE=001,010)<br>Iol= 1mA<br>(DSE=011,100,101,110,111) | — | 0.15 | V |
| High-Level input voltage[1,2] | VIH | — | 0.7 × OVDD | OVDD | V |
| Low-Level input voltage[1,2] | VIL | — | 0 | 0.3 × OVDD | V |
| Input Hysteresis (OVDD= 1.8V) | VHYS_LowVDD | OVDD=1.8V | 250 | — | mV |
| Input Hysteresis (OVDD=3.3V | VHYS_HighVDD | OVDD=3.3V | 250 | — | mV |
| Schmitt trigger VT+[2,3] | VTH+ | — | 0.5 × OVDD | — | mV |
| Schmitt trigger VT-[2,3] | VTH- | — | — | 0.5 × OVDD | mV |
| Pull-up resistor (22_kΩ PU) | RPU_22K | Vin=0V | — | 212 | uA |
| Pull-up resistor (22_kΩ PU) | RPU_22K | Vin=OVDD | — | 1 | uA |
| Pull-up resistor (47_kΩ PU) | RPU_47K | Vin=0V | — | 100 | uA |



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**Table 23. GPIO DC Parameters (continued)**

| Parameter | Symbol | Test Conditions | Min | Max | Units |
|---|---|---|---|---|---|
| Pull-up resistor (47_kΩ PU) | RPU_47K | Vin=OVDD | — | 1 | uA |
| Pull-up resistor (100_kΩ PU) | RPU_100K | Vin=0V | — | 48 | uA |
| Pull-up resistor (100_kΩ PU) | RPU_100K | Vin=OVDD | — | 1 | uA |
| Pull-down resistor (100_kΩ PD) | RPD_100K | Vin=OVDD | — | 48 | uA |
| Pull-down resistor (100_kΩ PD) | RPD_100K | Vin=0V | — | 1 | uA |
| Input current (no PU/PD) | IIN | VI = 0, VI = OVDD | -1 | 1 | uA |
| Keeper Circuit Resistance | R_Keeper | VI = 0.3 × OVDD, VI = 0.7 × OVDD | 105 | 175 | kΩ |

1 Overshoot and undershoot conditions (transitions above OVDD and below GND) on switching pads must be held below 0.6 V, and the duration of the overshoot/undershoot must not exceed 10% of the system clock cycle. Overshoot/ undershoot must be controlled through printed circuit board layout, transmission line impedance matching, signal line termination, or other methods. Non-compliance to this specification may affect device reliability or cause permanent damage to the device.

2 To maintain a valid level, the transition edge of the input must sustain a constant slew rate (monotonic) from the current DC level through to the target DC level, Vil or Vih. Monotonic input transition time is from 0.1 ns to 1 s.

3 Hysteresis of 250 mV is guaranteed over all operating conditions when hysteresis is enabled.

## 4.6.3 DDR I/O DC Parameters

The DDR I/O pads support LPDDR2 and DDR3/DDR3L operational modes.

### 4.6.3.1 LPDDR2 Mode I/O DC Parameters

For details on supported DDR memory configurations, see Section 4.9.4, “Multi-Mode DDR Controller (MMDC).

**Table 24. LPDDR2 I/O DC Electrical Parameters[1]**

| Parameters | Symbol | Test Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| High-level output voltage | VOH | Ioh= -0.1mA | 0.9 × OVDD | — | V |
| Low-level output voltage | VOL | Iol= 0.1mA | — | 0.1 × OVDD | V |
| Input Reference Voltage | Vref | — | 0.49 × OVDD | 0.51 × OVDD | V |
| DC High-Level input voltage | Vih_DC | — | Vref+0.13 | OVDD | V |
| DC Low-Level input voltage | Vil_DC | — | OVSS | Vref-0.13 | V |
| Differential Input Logic High | Vih_diff | — | 0.26 | Note[2] | |
| Differential Input Logic Low | Vil_diff | — | Note[3] | -0.26 | |
| Pull-up/Pull-down Impedance Mismatch | Mmpupd | — | -15 | 15 | % |
| 240 Ω unit calibration resolution | Rres | — | — | 10 | Ω |
| Keeper Circuit Resistance | Rkeep | — | 110 | 175 | kΩ |
| Input current (no pull-up/down) | Iin | VI = 0, VI = OVDD | -2.5 | 2.5 | µA |

1 Note that the JEDEC LPDDR2 specification (JESD209_2B) supersedes any specification in this document.

2 The single-ended signals need to be within the respective limits (Vih(dc) max, Vil(dc) min) for single-ended signals as well as the limitations for overshoot and undershoot.



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3 The single-ended signals need to be within the respective limits (Vih(dc) max, Vil(dc) min) for single-ended signals as well as the limitations for overshoot and undershoot.

### 4.6.3.2 DDR3/DDR3L Mode I/O DC Parameters

The parameters in Table 25 are guaranteed per the operating ranges in Table 8, unless otherwise noted. For details on supported DDR memory configurations, see Section 4.9.4, "Multi-Mode DDR Controller (MMDC).

**Table 25. DDR3/DDR3L I/O DC Electrical Characteristics[1]**

| Parameters | Symbol | Test Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| High-level output voltage | VOH | Ioh= -0.1mA<br>Voh (for DSE=001) | 0.8 × OVDD[2] | — | V |
| Low-level output voltage | VOL | Iol= 0.1mA<br>Vol (for DSE=001) | — | 0.2 × OVDD | V |
| High-level output voltage | VOH | Ioh= -1mA<br>Voh (for all except DSE=001) | 0.8 × OVDD | — | V |
| Low-level output voltage | VOL | Iol= 1mA<br>Vol (for all except DSE=001) | — | 0.2 × OVDD | V |
| Input Reference Voltage | Vref | — | 0.49 × OVDD | 0.51 × OVDD | V |
| DC High-Level input voltage | Vih_DC | — | Vref[3]+0.1 | OVDD | V |
| DC Low-Level input voltage | Vil_DC | — | OVSS | Vref-0.1 | V |
| Differential Input Logic High | Vih_diff | — | 0.2 | See Note[4] | V |
| Differential Input Logic Low | Vil_diff | — | See Note[3] | -0.2 | V |
| Termination Voltage | Vtt | Vtt tracking OVDD/2 | 0.49 × OVDD | 0.51 × OVDD | V |
| Pull-up/Pull-down Impedance Mismatch | Mmpupd | — | -10 | 10 | % |
| 240 Ω unit calibration resolution | Rres | — | — | 10 | Ω |
| Keeper Circuit Resistance | Rkeep | — | 105 | 165 | kΩ |
| Input current (no pull-up/down) | Iin | VI = 0,VI = OVDD | -2.9 | 2.9 | μA |

1 Note that the JEDEC DDR3 specification (JESD79_3D) supersedes any specification in this document.

2 OVDD – I/O power supply (1.425 V–1.575 V for DDR3 and 1.283 V–1.45 V for DDR3L)

3 Vref – DDR3/DDR3L external reference voltage.

4 The single-ended signals need to be within the respective limits (Vih(dc) max, Vil(dc) min) for single-ended signals as well as the limitations for overshoot and undershoot.

## 4.6.4 RGMII I/O 2.5V I/O DC Electrical Parameters

The RGMII interface complies with the RGMII standard version 1.3. The parameters in Table 26 are guaranteed per the operating ranges in Table 8, unless otherwise noted.



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**Table 26. RGMII I/O 1.8V and 2.5V mode DC Electrical Characteristics[1]**

| Parameters | Symbol | Test Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| High-level Output Voltage[1] | $V_{OH}$ | Ioh= -0.1mA (DSE=001,010)<br>Ioh= -1mA (DSE=011,100,101,110,111) | OVDD-0.15 | — | V |
| Low-level Output Voltage[1] | $V_{OL}$ | Iol= 0.1mA (DSE=001,010)<br>Iol= 1mA (DSE=011,100,101,110,111) | — | 0.15 | V |
| Input Reference Voltage | $V_{ref}$ | — | 0.49 × OVDD | 0.51 × OVDD | V |
| High-Level Input Voltage[2 3] | $V_{IH}$ | — | 0.7 × OVDD | OVDD | V |
| Low-Level Input Voltage[2 3] | $V_{IL}$ | — | 0 | 0.3 × OVDD | V |
| Input Hysteresis (OVDD=1.8V) | $V_{HYS_HighVDD}$ | OVDD=1.8V | 250 | — | mV |
| Input Hysteresis (OVDD=2.5V) | $V_{HYS_HighVDD}$ | OVDD=2.5V | 250 | — | mV |
| Schmitt Trigger VT+[3 4] | $V_{TH}^{+}$ | — | 0.5 × OVDD | — | mV |
| Schmitt Trigger VT-[3 4] | $V_{TH}^{-}$ | — | — | 0.5 × OVDD | mV |
| Pull-up Resistor (22 kΩ PU) | $R_{PU_22K}$ | Vin=0V | — | 212 | µA |
| Pull-up Resistor (22 kΩ PU) | $R_{PU_22K}$ | Vin=OVDD | -— | 1 | µA |
| Pull-up Resistor (47 kΩ PU) | $R_{PU_47K}$ | Vin=0V | — | 100 | µA |
| Pull-up Resistor (47 kΩ PU) | $R_{PU_47K}$ | Vin=OVDD | — | 1 | µA |
| Pull-up Resistor (100 kΩ PU) | $R_{PU_100K}$ | Vin=0V | — | 48 | µA |
| Pull-up Resistor (100 kΩ PU) | $R_{PU_100K}$ | Vin=OVDD | — | 1 | µA |
| Pull-down Resistor (100 kΩ PD) | $R_{PD_100K}$ | Vin=OVDD | — | 48 | µA |
| Pull-down Resistor (100 kΩ PD) | $R_{PD_100K}$ | Vin=0V | — | 1 | µA |
| Keeper Circuit Resistance | $R_{keep}$ | | 105 | 165 | kΩ |
| Input Current (no pull-up/down) | $I_{in}$ | VI = 0, VI = OVDD | -2.9 | 2.9 | µA |

1 Input Mode Selection "SW_PAD_CTL_GRP_DDR_TYPE_RGMII"='10' (1.8V Mode) "SW_PAD_CTL_GRP_DDR_TYPE_RGMII"='11' (2.5V Mode).

2 Overshoot and undershoot conditions (transitions above OVDD and below GND) on switching pads must be held below 0.6 V, and the duration of the overshoot/undershoot must not exceed 10% of the system clock cycle. Overshoot/ undershoot must be controlled through printed circuit board layout, transmission line impedance matching, signal line termination, or other methods. Non-compliance to this specification may affect device reliability or cause permanent damage to the device.

3 To maintain a valid level, the transition edge of the input must sustain a constant slew rate (monotonic) from the current DC level through to the target DC level, $V_{IL}$ or $V_{IH}$. Monotonic input transition time is from 0.1 ns to 1 s.

4 Hysteresis of 250 mV is guaranteed over all operating conditions when hysteresis is enabled (register IOMUXC_SW_PAD_CTL_PAD_RGMII_TXC[HYS]= 0).



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### 4.6.5 LVDS I/O DC Parameters

The LVDS interface complies with TIA/EIA 644-A standard. See TIA/EIA STANDARD 644-A, "*Electrical Characteristics of Low Voltage Differential Signaling (LVDS) Interface Circuits*" for details.

Table 27 shows the Low Voltage Differential Signaling (LVDS) I/O DC parameters.

**Table 27. LVDS I/O DC Characteristics**

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Differential Voltage | VOD | Rload-100 Ω Diff | 250 | 350 | 450 | mV |
| Output High Voltage | VOH | IOH = 0 mA | 1.25 | 1.375 | 1.6 | V |
| Output Low Voltage | VOL | IOL = 0 mA | 0.9 | 1.025 | 1.25 | V |
| Offset Voltage | VOS | — | 1.125 | 1.2 | 1.375 | V |

### 4.6.6 MLB I/O DC Parameters

The MLB interface complies with Analog Interface of 6-pin differential Media Local Bus specification version 4.1. See 6-pin differential MLB specification v4.1, "MediaLB 6-pin interface Electrical Characteristics" for details.

**NOTE**

The MLB 6-pin interface does not support speed mode 8192 fs.

Table 28 shows the Media Local Bus (MLB) I/O DC parameters.

**Table 28. MLB I/O DC Characteristics**

| Parameter | Symbol | Test Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| Output Differential Voltage | VOD | Rload-50Ω Diff | 300 | 500 | mV |
| Output High Voltage | VOH | Rload-50Ω Diff | 1.25 | 1.75 | V |
| Output Low Voltage | VOL | Rload-50Ω Diff | 0.75 | 1.25 | V |
| Common-mode output voltage ((Vpadp*+Vpadn*)/2) | Vocm | Rload-50Ω Diff | 1 | 1.5 | V |
| Differential output impedance | Zo | — | 1.6 | — | kΩ |

## 4.7 I/O AC Parameters

This section includes the AC parameters of the following I/O types:

- General Purpose I/O (GPIO)
- Double Data Rate I/O (DDR) for LPDDR2 and DDR3/DDR3L modes
- LVDS I/O
- MLB I/O

The GPIO and DDR I/O load circuit and output transition time waveforms are shown in Figure 5 and Figure 6.



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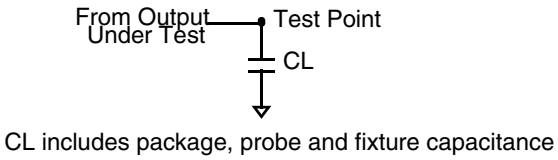


**Figure 5. Load Circuit for Output**

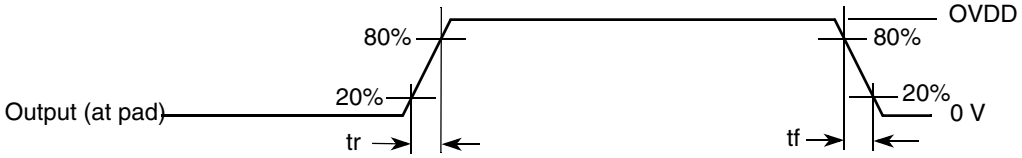


**Figure 6. Output Transition Time Waveform**

### 4.7.1 General Purpose I/O AC Parameters

The I/O AC parameters for GPIO in slow and fast modes are presented in the Table 29 and Table 30, respectively. Note that the fast or slow I/O behavior is determined by the appropriate control bits in the IOMUXC control registers.

**Table 29. General Purpose I/O AC Parameters 1.8 V Mode**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Pad Transition Times, rise/fall (Max Drive, DSE=111) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 2.72/2.79<br>1.51/1.54 | ns |
| Output Pad Transition Times, rise/fall (High Drive, DSE=101) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 3.20/3.36<br>1.96/2.07 | |
| Output Pad Transition Times, rise/fall (Medium Drive, DSE=100) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 3.64/3.88<br>2.27/2.53 | |
| Output Pad Transition Times, rise/fall (Low Drive. DSE=011) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 4.32/4.50<br>3.16/3.17 | |
| Input Transition Times[1] | trm | — | — | — | 25 | ns |

[1] Hysteresis mode is recommended for inputs with transition times greater than 25 ns.



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**Table 30. General Purpose I/O AC Parameters 3.3 V Mode**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Pad Transition Times, rise/fall (Max Drive, DSE=101) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 1.70/1.79<br>1.06/1.15 | ns |
| Output Pad Transition Times, rise/fall (High Drive, DSE=011) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 2.35/2.43<br>1.74/1.77 | |
| Output Pad Transition Times, rise/fall (Medium Drive, DSE=010) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 3.13/3.29<br>2.46/2.60 | |
| Output Pad Transition Times, rise/fall (Low Drive. DSE=001) | tr, tf | 15 pF Cload, slow slew rate<br>15 pF Cload, fast slew rate | — | — | 5.14/5.57<br>4.77/5.15 | |
| Input Transition Times[1] | trm | — | — | — | 25 | ns |

1 Hysteresis mode is recommended for inputs with transition times greater than 25 ns.

## 4.7.2 DDR I/O AC Parameters

Table 31 shows the AC parameters for DDR I/O operating in LPDDR2 mode. For details on supported DDR memory configurations, see Section 4.9.4, “Multi-Mode DDR Controller (MMDC).

**Table 31. DDR I/O LPDDR2 Mode AC Parameters[1]**

| Parameter | Symbol | Test Condition | Min | Max | Unit |
|---|---|---|---|---|---|
| AC input logic high | Vih(ac) | — | Vref + 0.22 | OVDD | V |
| AC input logic low | Vil(ac) | — | 0 | Vref - 0.22 | V |
| AC differential input high voltage[2] | Vidh(ac) | — | 0.44 | — | V |
| AC differential input low voltage | Vidl(ac) | — | — | 0.44 | V |
| Input AC differential cross point voltage[3] | Vix(ac) | Relative to Vref | -0.12 | 0.12 | V |
| Over/undershoot peak | Vpeak | — | — | 0.35 | V |
| Over/undershoot area (above OVDD or below OVSS) | Varea | 400 MHz | — | 0.3 | V-ns |
| Single output slew rate, measured between Vol(ac) and Voh(ac) | tsr | 50 Ω to Vref.<br>5 pF load.<br>Drive impedance = 40 Ω ± 30% | 1.5 | 3.5 | V/ns |
| | | 50 Ω to Vref.<br>5pF load.Drive impedance = 60 Ω ± 30% | 1 | 2.5 | |
| Skew between pad rise/fall asymmetry + skew caused by SSN | $t_{SKD}$ | clk = 400 MHz | — | 0.1 | ns |

1 Note that the JEDEC LPDDR2 specification (JESD209_2B) supersedes any specification in this document.

2 Vid(ac) specifies the input differential voltage | Vtr - Vcp | required for switching, where Vtr is the “true” input signal and Vcp is the “complementary” input signal. The Minimum value is equal to Vih(ac) - Vil(ac).



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3 The typical value of Vix(ac) is expected to be about 0.5 x OVDD. and Vix(ac) is expected to track variation of OVDD. Vix(ac) indicates the voltage at which differential input signal must cross.

Table 32 shows the AC parameters for DDR I/O operating in DDR3/DDR3L mode.

**Table 32. DDR I/O DDR3/DDR3L Mode AC Parameters[1]**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| AC input logic high | Vih(ac) | — | Vref + 0.175 | — | OVDD | V |
| AC input logic low | Vil(ac) | — | 0 | — | Vref - 0.175 | V |
| AC differential input voltage[2] | Vid(ac) | — | 0.35 | — | — | V |
| Input AC differential cross point voltage[3, 4] | Vix(ac) | Relative to Vref | Vref - 0.15 | — | Vref + 0.15 | V |
| Over/undershoot peak | Vpeak | — | — | — | 0.4 | V |
| Over/undershoot area (above OVDD or below OVSS) | Varea | 400 MHz | — | — | 0.5 | V-ns |
| Single output slew rate, measured between Vol(ac) and Voh(ac) | tsr | Driver impedance = 34 Ω | 2.5 | — | 5 | V/ns |
| Skew between pad rise/fall asymmetry + skew caused by SSN | $t_{SKD}$ | clk = 400 MHz | — | — | 0.1 | ns |

1 Note that the JEDEC JESD79_3C specification supersedes any specification in this document.

2 Vid(ac) specifies the input differential voltage | Vtr-Vcp | required for switching, where Vtr is the “true” input signal and Vcp is the “complementary” input signal. The Minimum value is equal to Vih(ac) - Vil(ac).

3 The typical value of Vix(ac) is expected to be about 0.5 x OVDD. and Vix(ac) is expected to track variation of OVDD. Vix(ac) indicates the voltage at which differential input signal must cross.

4 Extended range for Vix is only allowed for the clock and when the single-ended clock input signals CK and CK# are:
- monotonic with a single-ended swing VSEL/VSEH of at least VDD/2 ±250 mV, and
- the differential slew rate of CK - CK# is larger than 3 V/ns

## 4.7.3 LVDS I/O AC Parameters

The differential output transition time waveform is shown in Figure 7.

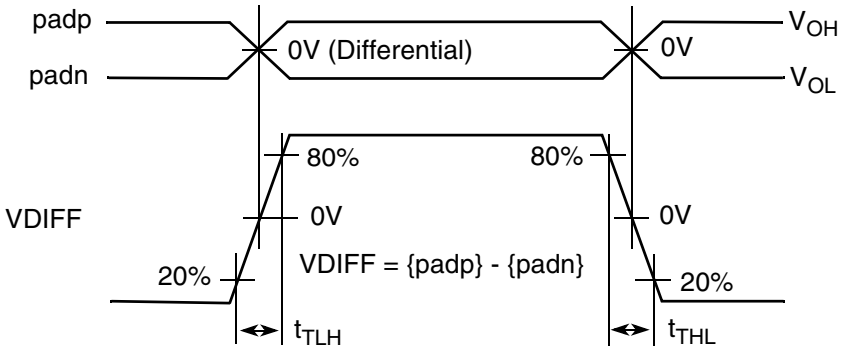


**Figure 7. Differential LVDS Driver Transition Time Waveform**

Table 33 shows the AC parameters for LVDS I/O.



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**Table 33. I/O AC Parameters of LVDS Pad**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Differential pulse skew[1] | $t_{SKD}$ | RIoad = 100 Ω, Cload = 2 pF | — | — | 0.25 | ns |
| Transition Low to High Time[2] | $t_{TLH}$ | | — | — | 0.5 | |
| Transition High to Low Time[2] | $t_{THL}$ | | — | — | 0.5 | |
| Operating Frequency | f | — | — | 600 | 800 | MHz |
| Offset voltage imbalance | Vos | — | — | — | 150 | mV |

1 $t_{SKD}$ = | $t_{PHLD}$ - $t_{PLHD}$ |, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.

2 Measurement levels are 20-80% from output voltage.

## 4.7.4 MLB I/O AC Parameters

The differential output transition time waveform is shown in Figure 8.

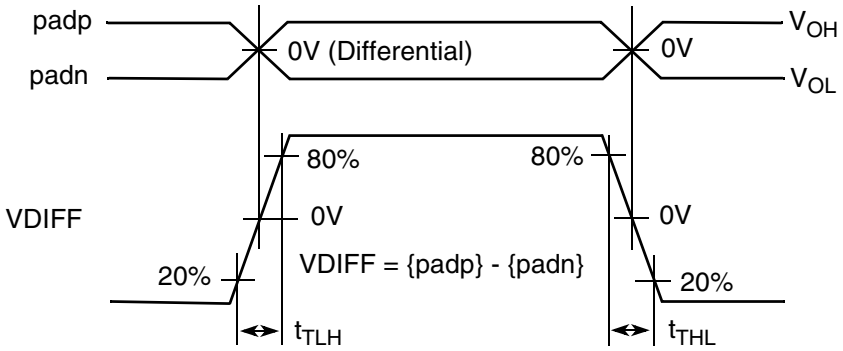


**Figure 8. Differential MLB Driver Transition Time Waveform**

A 4-stage pipeline is utilized in the MLB 6-pin implementation in order to facilitate design, maximize throughput, and allow for reasonable PCB trace lengths. Each cycle is one ipp_clk_in* (internal clock from MLB PLL) clock period. Cycles 2, 3, and 4 are MLB PHY related. Cycle 2 includes clock-to-output delay of Signal/Data sampling flip-flop and Transmitter, Cycle 3 includes clock-to-output delay of Signal/Data clocked receiver, Cycle 4 includes clock-to-output delay of Signal/Data sampling flip-flop.

MLB 6-pin pipeline diagram is shown in Figure 9.



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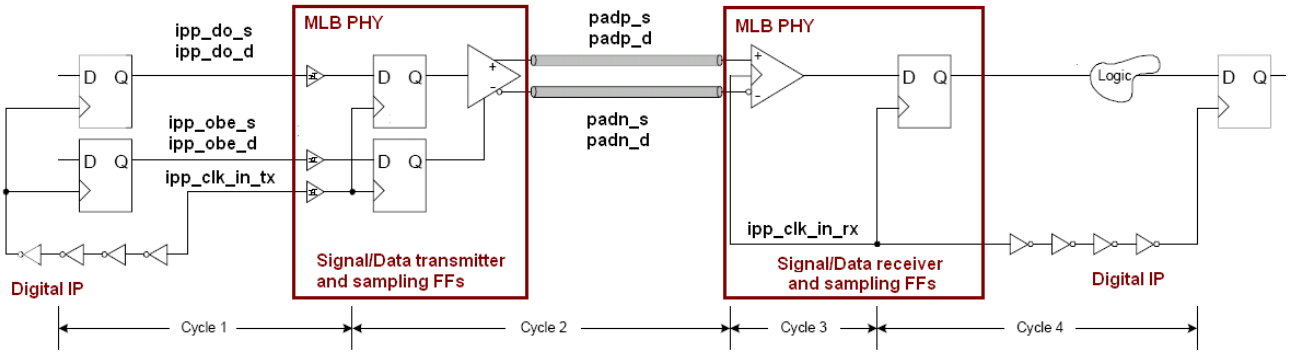


**Figure 9. MLB 6-Pin Pipeline Diagram**

Table 34 shows the AC parameters for MLB I/O.

## 4.8 Output Buffer Impedance Parameters

**Table 34. I/O AC Parameters of MLB PHY**

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Differential pulse skew[1] | $t_{SKD}$ | Rload = 50 Ω between padp and padn | — | — | 0.1 | ns |
| Transition Low to High Time[2] | $t_{TLH}$ | | — | — | 1 | |
| Transition High to Low Time | $t_{THL}$ | | — | — | 1 | |
| MLB external clock Operating Frequency | fclk_ext | — | — | — | 102.4 | MHz |
| MLB PLL clock Operating Frequency | fclk_pll | — | — | — | 307.2 | MHz |

1 $t_{SKD}$ = | $t_{PHLD}$ - $t_{PLHD}$ |, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.

2 Measurement levels are 20-80% from output voltage.

This section defines the I/O impedance parameters of the i.MX 6Solo/6DualLite processors for the following I/O types:

- General Purpose I/O (GPIO)
- Double Data Rate I/O (DDR) for LPDDR2, and DDR3/DDR3L modes
- LVDS I/O
- MLB I/O

**NOTE**

GPIO and DDR I/O output driver impedance is measured with “long” transmission line of impedance Ztl attached to I/O pad and incident wave launched into transmission line. Rpu/Rpd and Ztl form a voltage divider that defines specific voltage of incident wave relative to OVDD. Output driver impedance is calculated from this voltage divider (see Figure 10).



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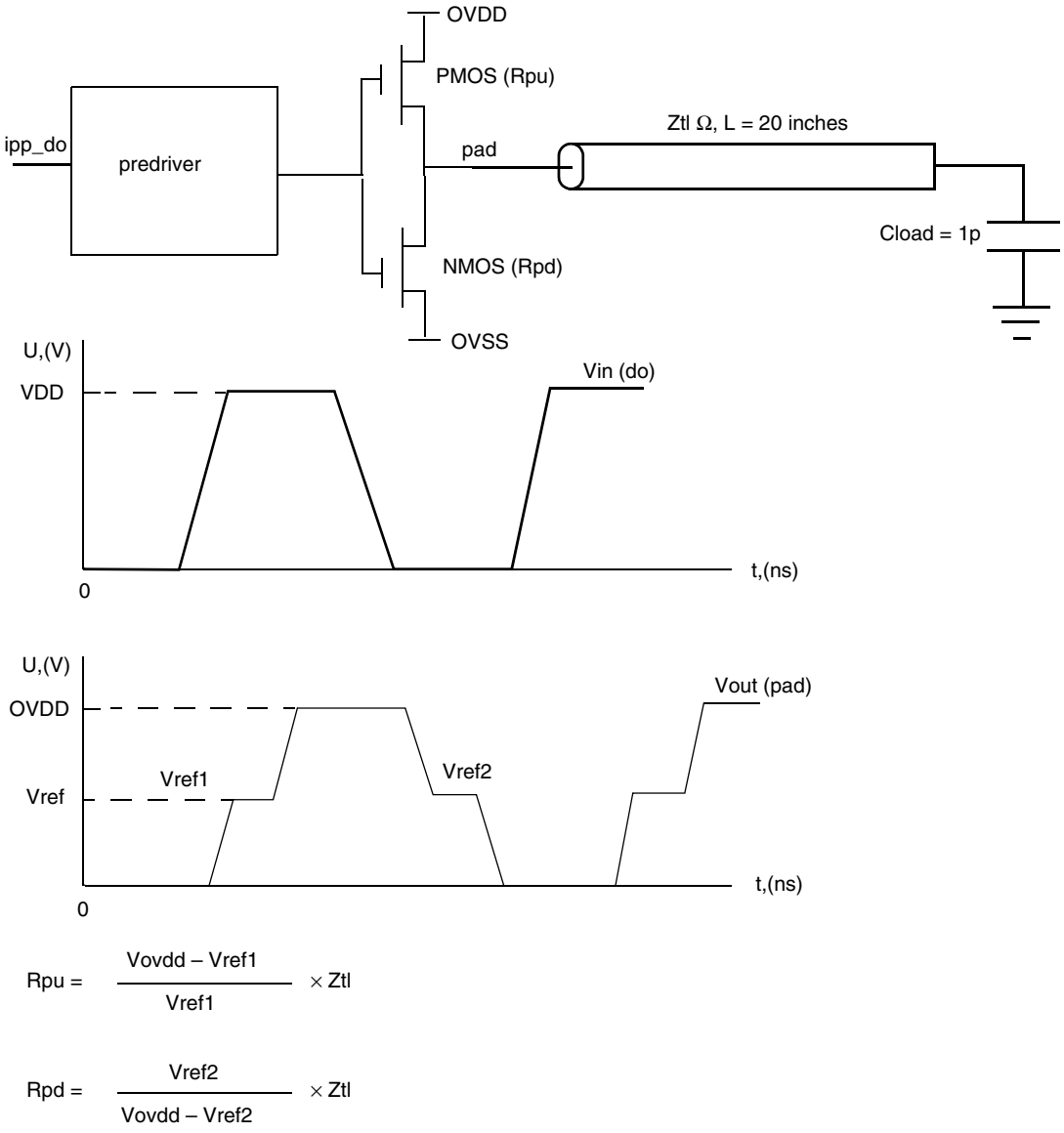


**Figure 10. Impedance Matching Load for Measurement**

## 4.8.1 GPIO Output Buffer Impedance

Table 35 shows the GPIO output buffer impedance (OVDD 1.8 V).

**Table 35. GPIO Output Buffer Average Impedance (OVDD 1.8 V)**

| Parameter | Symbol | Drive Strength (DSE) | Typ Value | Unit |
|---|---|---|---|---|
| Output Driver Impedance | Rdrv | 001<br>010<br>011<br>100<br>101<br>110<br>111 | 260<br>130<br>90<br>60<br>50<br>40<br>33 | Ω |



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Table 36 shows the GPIO output buffer impedance (OVDD 3.3 V).

**Table 36. GPIO Output Buffer Average Impedance (OVDD 3.3 V)**

| Parameter | Symbol | Drive Strength (DSE) | Typ Value | Unit |
|---|---|---|---|---|
| Output Driver Impedance | Rdrv | 001<br>010<br>011<br>100<br>101<br>110<br>111 | 150<br>75<br>50<br>37<br>30<br>25<br>20 | Ω |

## 4.8.2 DDR I/O Output Buffer Impedance

For details on supported DDR memory configurations, see Section 4.9.4, "Multi-Mode DDR Controller (MMDC).

Table 37 shows DDR I/O output buffer impedance of i.MX 6Solo/6DualLite processors.

**Table 37. DDR I/O Output Buffer Impedance**

| Parameter | Symbol | Test Conditions DSE (Drive Strength) | Typical | | Unit |
|---|---|---|---|---|---|
| | | | NVCC_DRAM=1.5 V (DDR3) DDR_SEL=11 | NVCC_DRAM=1.2 V (LPDDR2) DDR_SEL=10 | |
| Output Driver Impedance | Rdrv | 000<br>001<br>010<br>011<br>100<br>101<br>110<br>111 | Hi-Z<br>240<br>120<br>80<br>60<br>48<br>40<br>34 | Hi-Z<br>240<br>120<br>80<br>60<br>48<br>40<br>34 | Ω |

**Note:**

1. Output driver impedance is controlled across PVTs using ZQ calibration procedure.
2. Calibration is done against 240 Ω external reference resistor.
3. Output driver impedance deviation (calibration accuracy) is ±5% (max/min impedance) across PVTs.

## 4.8.3 LVDS I/O Output Buffer Impedance

The LVDS interface complies with TIA/EIA 644-A standard. See, TIA/EIA STANDARD 644-A, "*Electrical Characteristics of Low Voltage Differential Signaling (LVDS) Interface Circuits*" for details.



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### 4.8.4 MLB I/O Differential Output Impedance

Table 38 shows MLB I/O differential output impedance of the i.MX 6Solo/6DualLite processors.

**Table 38. MLB I/O Differential Output Impedance**

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Differential Output Impedance | Zo | — | 1.6 | — | — | kΩ |

## 4.9 System Modules Timing

This section contains the timing and electrical parameters for the modules in each i.MX 6Solo/6DualLite processor.

### 4.9.1 Reset Timings Parameters

Figure 11 shows the reset timing and Table 39 lists the timing parameters.

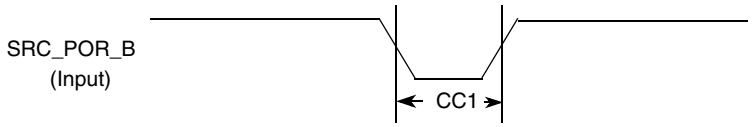


**Figure 11. Reset Timing Diagram**

**Table 39. Reset Timing Parameters**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| CC1 | Duration of SRC_POR_B to be qualified as valid. | 1 | — | XTALOSC_RTC_XTALI cycle |

### 4.9.2 WDOG Reset Timing Parameters

Figure 12 shows the WDOG reset timing and Table 40 lists the timing parameters.

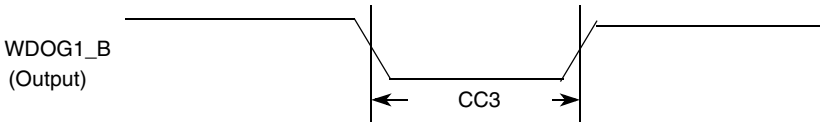


**Figure 12. WDOG1_B Timing Diagram**

**Table 40. WDOG1_B Timing Parameters**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| CC3 | Duration of WDOG1_B Assertion | 1 | — | XTALOSC_RTC_XTALI cycle |

**NOTE**

XTALOSC_RTC_XTALI is approximately 32 kHz.
XTALOSC_RTC_XTALI cycle is one period or approximately 30 µs.



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**NOTE**

WDOG1_B output signals (for each one of the Watchdog modules) do not have dedicated pins, but are muxed out through the IOMUX. See the IOMUXC chapter of the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)*.

## 4.9.3 External Interface Module (EIM)

The following subsections provide information on the EIM. Maximum operating frequency for EIM data transfer is 104 MHz. Two system clocks are used with the EIM:

- ACLK_EIM_SLOW_CLK_ROOT is used to clock the EIM module.
  The maximum frequency for CLK_EIM_SLOW_CLK_ROOT is 132 MHz.
- ACLK_EXSC is also used when the EIM is in synchronous mode.
  The maximum frequency for ACLK_EXSC is 104 MHz.

Timing parameters in this section that are given as a function of register settings.

### 4.9.3.1 EIM Interface Pads Allocation

EIM supports 32-bit, 16-bit and 8-bit devices operating in address/data separate or multiplexed modes. Table 41 provides EIM interface pads allocation in different modes.

**Table 41. EIM Internal Module Multiplexing[1]**

| Setup | Non Multiplexed Address/Data Mode | | | | | | | Multiplexed Address/Data mode | |
|---|---|---|---|---|---|---|---|---|---|
| | 8 Bit | | | | 16 Bit | | 32 Bit | 16 Bit | 32 Bit |
| | MUM = 0, DSZ = 100 | MUM = 0, DSZ = 101 | MUM = 0, DSZ = 110 | MUM = 0, DSZ = 111 | MUM = 0, DSZ = 001 | MUM = 0, DSZ = 010 | MUM = 0, DSZ = 011 | MUM = 1, DSZ = 001 | MUM = 1, DSZ = 011 |
| EIM_ADDR [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] | EIM_AD [15:00] |
| EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_ADDR [25:16] | EIM_DATA [09:00] |
| EIM_DATA [07:00], EIM_EB0_B | EIM_DATA [07:00] | — | — | — | EIM_DATA [07:00] | — | EIM_DATA [07:00] | EIM_AD [07:00] | EIM_AD [07:00] |
| EIM_DATA [15:08], EIM_EB1_B | — | EIM_DATA [15:08] | — | — | EIM_DATA [15:08] | — | EIM_DATA [15:08] | EIM_AD [15:08] | EIM_AD [15:08] |
| EIM_DATA [23:16], EIM_EB2_B | — | — | EIM_DATA [23:16] | — | — | EIM_DATA [23:16] | EIM_DATA [23:16] | — | EIM_DATA [07:00] |
| EIM_DATA [31:24], EIM_EB3_B | — | — | — | EIM_DATA [31:24] | — | EIM_DATA [31:24] | EIM_DATA [31:24] | — | EIM_DATA [15:08] |

[1] For more information on configuration ports mentioned in this table, see the i.MX 6Solo/6DualLite reference manual.



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### 4.9.3.2 General EIM Timing-Synchronous Mode

Figure 13, Figure 14, and Table 42 specify the timings related to the EIM module. All EIM output control signals may be asserted and deasserted by an internal clock synchronized to the EIM_BCLK rising edge according to corresponding assertion/negation control fields.

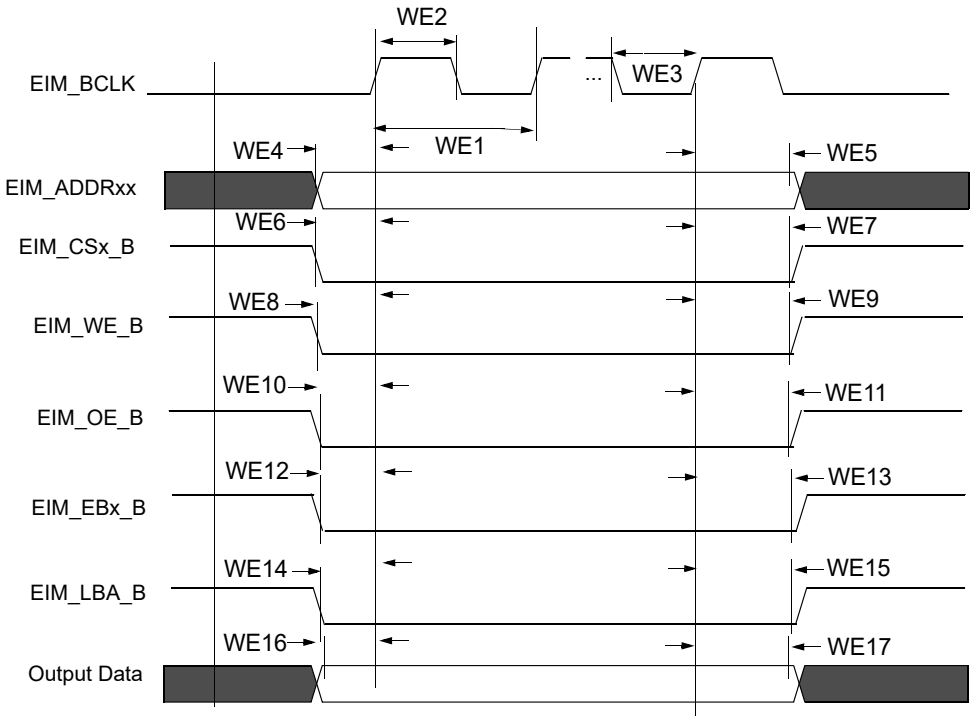


**Figure 13. EIM Outputs Timing Diagram**

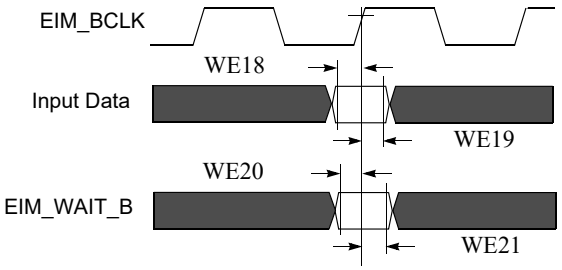


**Figure 14. EIM Inputs Timing Diagram**



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### 4.9.3.3 Examples of EIM Synchronous Accesses

**Table 42. EIM Bus Timing Parameters [1]**

| ID | Parameter | BCD = 0 | | BCD = 1 | | BCD = 2 | | BCD = 3 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | Min | Max | Min | Max |
| WE1 | EIM_BCLK Cycle time[2] | t | — | 2 x t | — | 3 x t | — | 4 x t | — |
| WE2 | EIM_BCLK Low Level Width | 0.4 x t | — | 0.8 x t | — | 1.2 x t | — | 1.6 x t | — |
| WE3 | EIM_BCLK High Level Width | 0.4 x t | — | 0.8 x t | — | 1.2 x t | — | 1.6 x t | — |
| WE4 | Clock rise to address valid[3] | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | -t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE5 | Clock rise to address invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE6 | Clock rise to EIM_CSx_B valid | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | - t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE7 | Clock rise to EIM_CSx_B invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE8 | Clock rise to EIM_WE_B Valid | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | - t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE9 | Clock rise to EIM_WE_B Invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE10 | Clock rise to EIM_OE_B Valid | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | - t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE11 | Clock rise to EIM_OE_B Invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE12 | Clock rise to EIM_EBx_B Valid | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | - t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE13 | Clock rise to EIM_EBx_B Invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE14 | Clock rise to EIM_LBA_B Valid | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | - t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE15 | Clock rise to EIM_LBA_B Invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE16 | Clock rise to Output Data Valid | -0.5 x t - 1.25 | -0.5 x t + 1.75 | -t - 1.25 | - t + 1.75 | -1.5 x t - 1.25 | -1.5 x t +1.75 | -2 x t - 1.25 | -2 x t + 1.75 |
| WE17 | Clock rise to Output Data Invalid | 0.5 x t - 1.25 | 0.5 x t + 1.75 | t - 1.25 | t + 1.75 | 1.5 x t - 1.25 | 1.5 x t +1.75 | 2 x t - 1.25 | 2 x t + 1.75 |
| WE18 | Input Data setup time to Clock rise | 2 | — | 4 | — | — | — | — | — |
| WE19 | Input Data hold time from Clock rise | 2 | — | 2 | — | — | — | — | — |
| WE20 | EIM_WAIT_B setup time to Clock rise | 2 | — | 4 | — | — | — | — | — |
| WE21 | EIM_WAIT_B hold time from Clock rise | 2 | — | 2 | — | — | — | — | — |



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[1] t is the maximum EIM logic (ACLK_EXSC) cycle time. The maximum allowed axi_clk frequency depends on the fixed/non-fixed latency configuration, whereas the maximum allowed EIM_BCLK frequency is:

—Fixed latency for both read and write is 104 MHz.

—Variable latency for read only is 104 MHz.

—Variable latency for write only is 52 MHz.

In variable latency configuration for write, if BCD = 0 & WBCDD = 1 or BCD = 1, axi_clk must be 104 MHz.Write BCD = 1 and 104 MHz ACLK_EXSC, will result in a EIM_BCLK of 52 MHz. When the clock branch to EIM is decreased to 104 MHz, other buses are impacted which are clocked from this source. See the CCM chapter of the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)* for a detailed clock tree description.

[2] EIM_BCLK parameters are being measured from the 50% point, that is, high is defined as 50% of signal value and low is defined as 50% as signal value.

[3] For signal measurements, “High” is defined as 80% of signal value and “Low” is defined as 20% of signal value.

Figure 15 to Figure 18 provide few examples of basic EIM accesses to external memory devices with the timing parameters mentioned previously for specific control parameters settings.

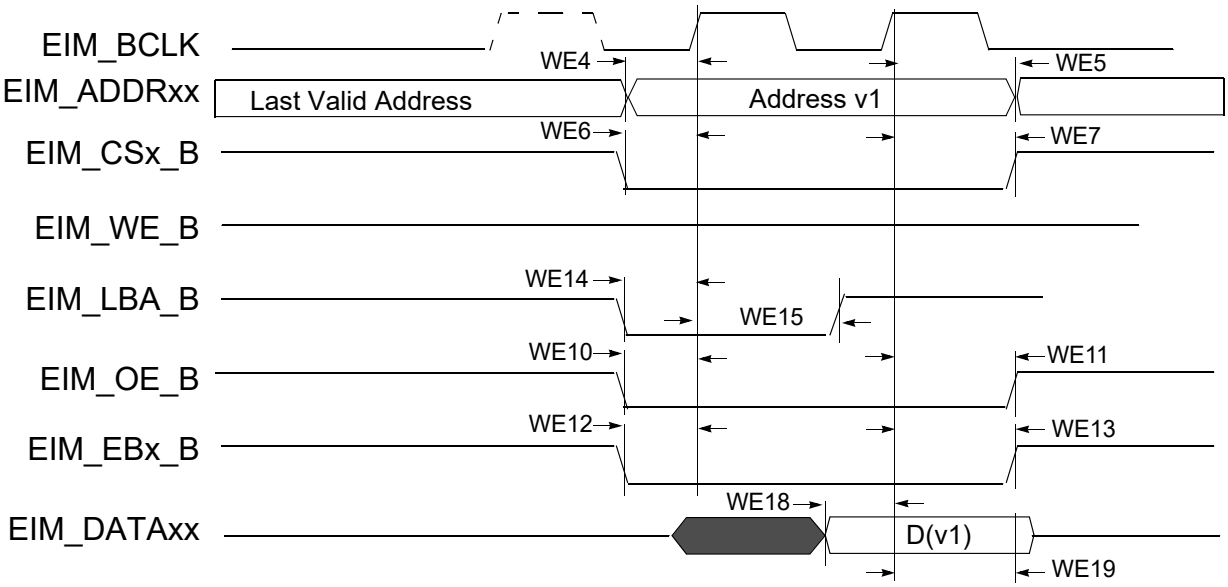


**Figure 15. Synchronous Memory Read Access, WSC=1**



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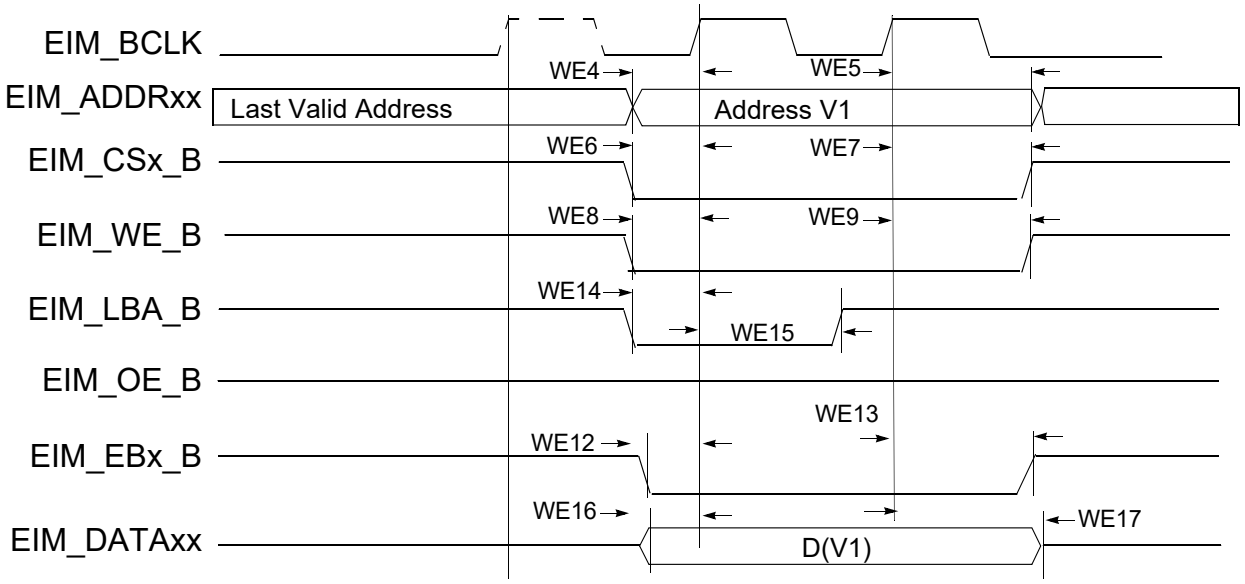


**Figure 16. Synchronous Memory, Write Access, WSC=1, WBEA=0 and WADVN=0**

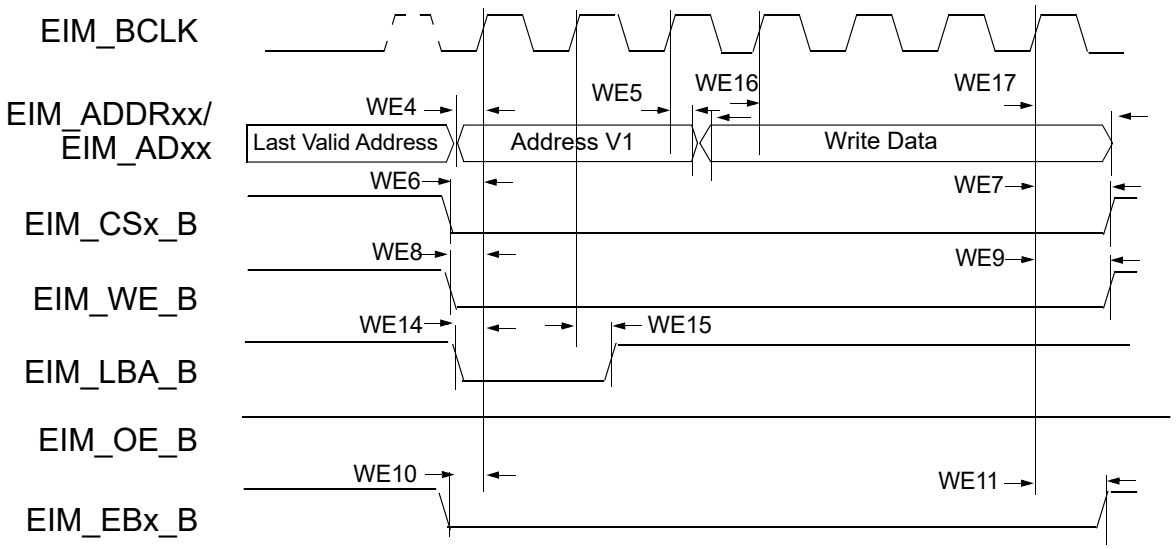


**Figure 17. Muxed Address/Data (A/D) Mode, Synchronous Write Access, WSC=6,ADVA=0, ADVN=1, and ADH=1**

## NOTE

In 32-bit muxed address/data (A/D) mode the 16 MSBs are driven on the data bus.



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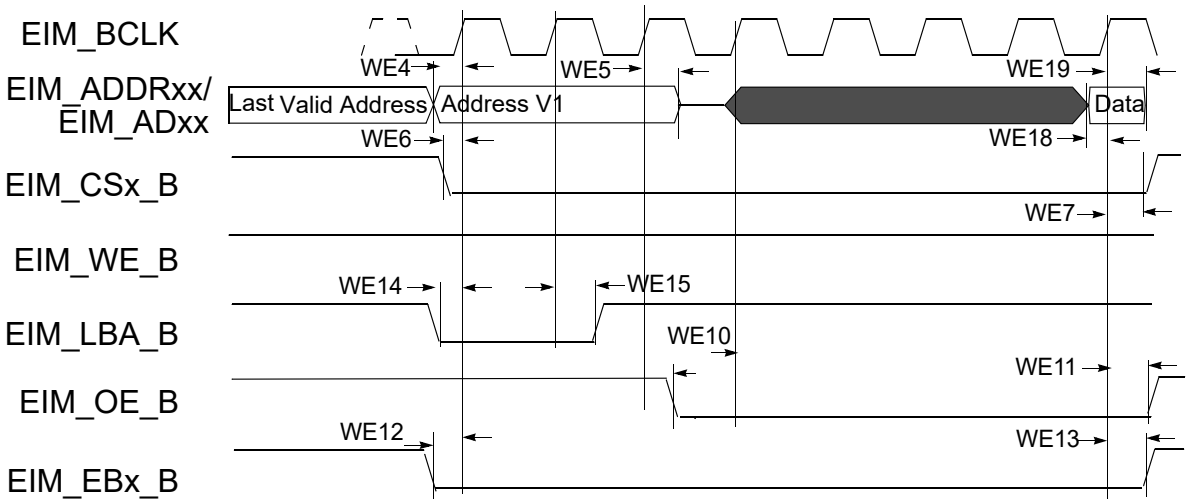


**Figure 18. 16-Bit Muxed A/D Mode, Synchronous Read Access, WSC=7, RADVN=1, ADH=1, OEA=0**

### 4.9.3.4 General EIM Timing-Asynchronous Mode

Figure 19 through Figure 23, and Table 43 help you determine timing parameters relative to the chip select (CS) state for asynchronous and DTACK EIM accesses with corresponding EIM bit fields and the timing parameters mentioned above.

Asynchronous read & write access length in cycles may vary from what is shown in Figure 19 through Figure 22 as RWSC, OEN and CSN is configured differently. See the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)* for the EIM programming model.

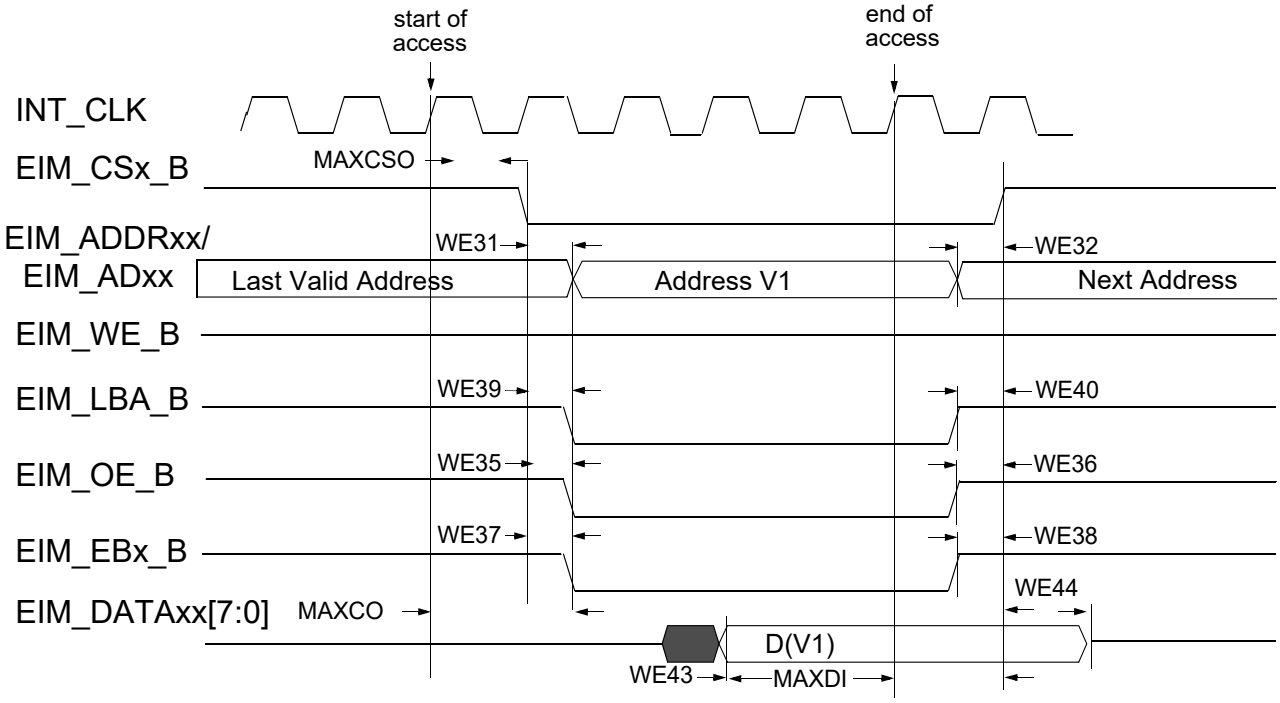


**Figure 19. Asynchronous Memory Read Access (RWSC = 5)**



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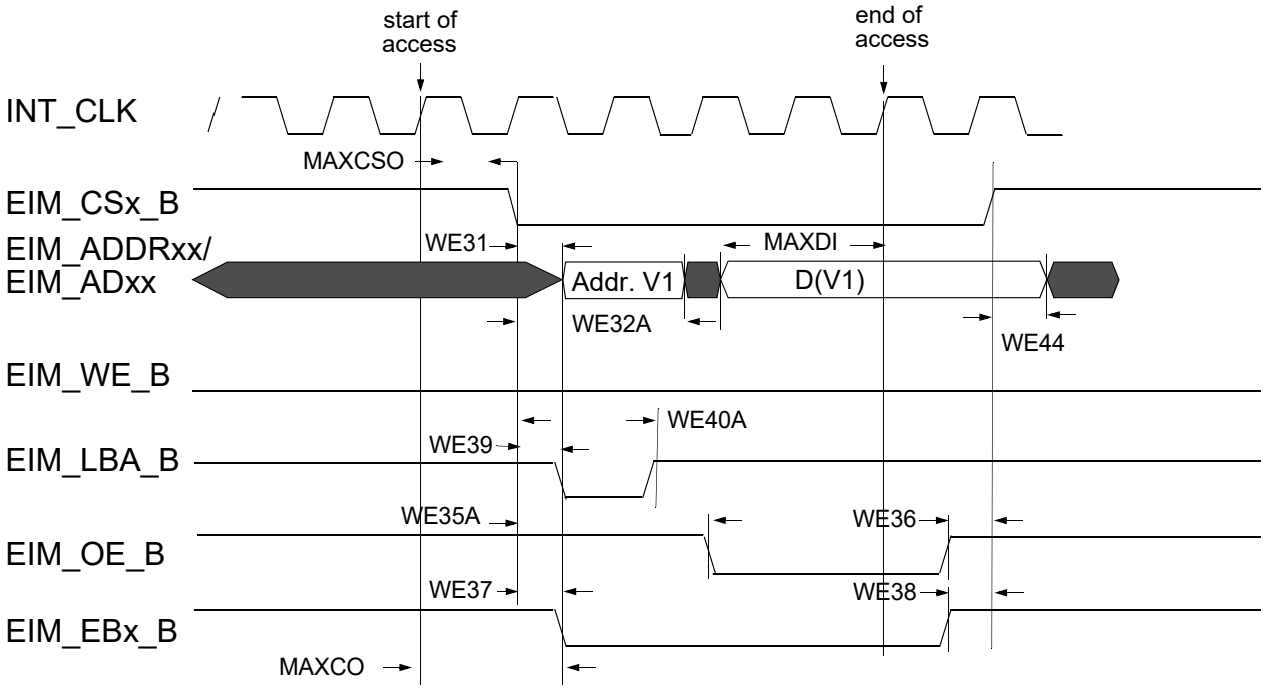


**Figure 20. Asynchronous A/D Muxed Read Access (RWSC = 5)**

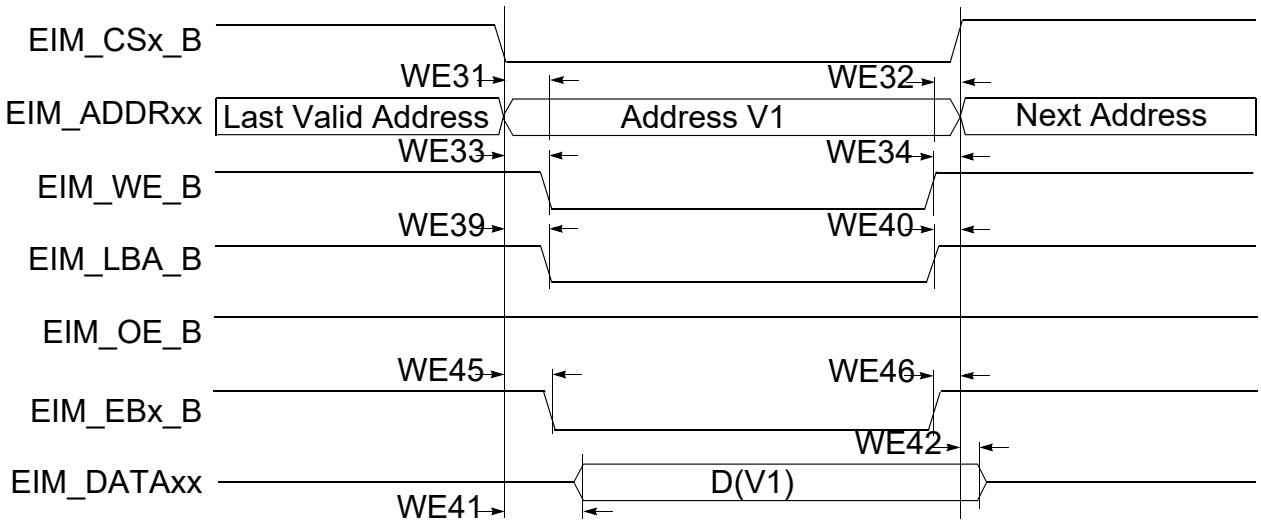


**Figure 21. Asynchronous Memory Write Access**



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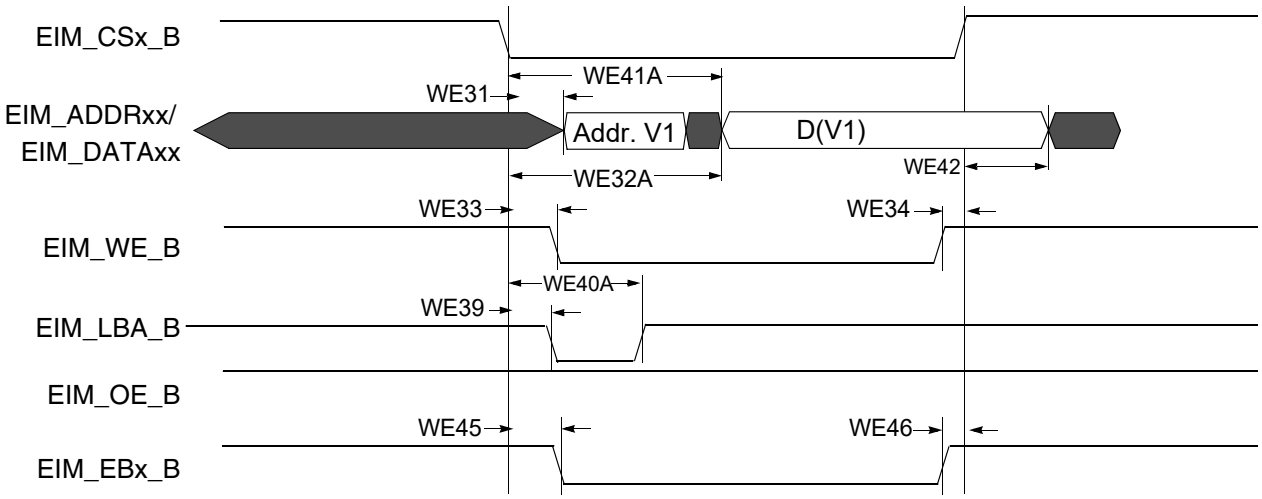


**Figure 22. Asynchronous A/D Muxed Write Access**

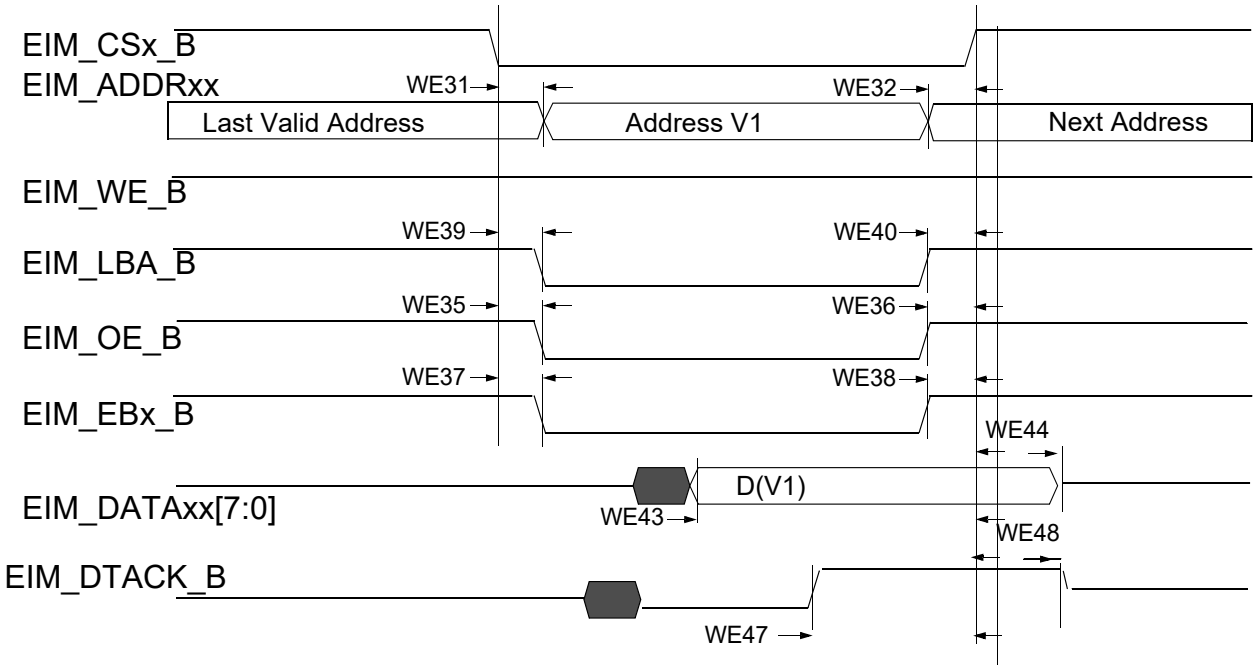


**Figure 23. DTACK Mode Read Access (DAP=0)**



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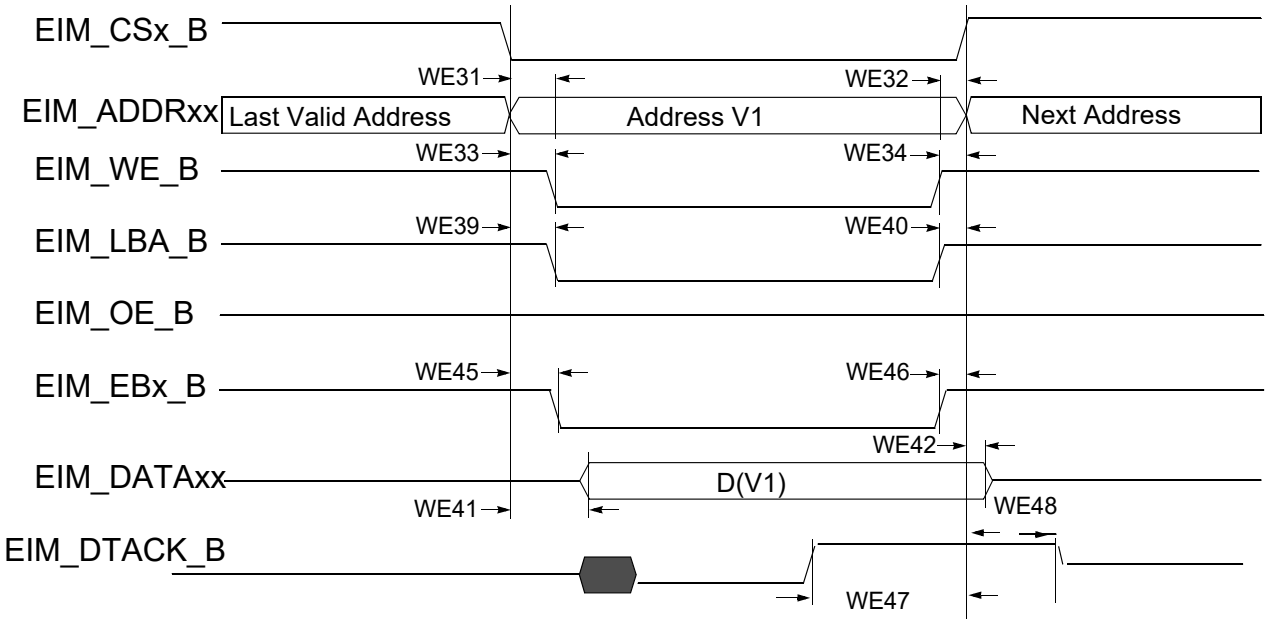


**Figure 24. DTACK Mode Write Access (DAP=0)**

**Table 43. EIM Asynchronous Timing Parameters Table Relative Chip to Select**

| Ref No. | Parameter | Determination by Synchronous measured parameters[1] | Min | Max | Unit |
|---|---|---|---|---|---|
| WE31 | EIM_CSx_B valid to Address Valid | WE4 - WE6 - CSA[2] | — | 3 - CSA | ns |
| WE32 | Address Invalid to EIM_CSx_B invalid | WE7 - WE5 - CSN[3] | — | 3 - CSN | ns |
| WE32A (muxed A/D | EIM_CSx_B valid to Address Invalid | t[4] + WE4 - WE7 + (ADVN[5] + ADVA[6] + 1 - CSA) | -3 + (ADVN + ADVA + 1 - CSA) | — | ns |
| WE33 | EIM_CSx_B Valid to EIM_WE_B Valid | WE8 - WE6 + (WEA - WCSA) | — | 3 + (WEA - WCSA) | ns |
| WE34 | EIM_WE_B Invalid to EIM_CSx_B Invalid | WE7 - WE9 + (WEN - WCSN) | — | 3 - (WEN_WCSN) | ns |
| WE35 | EIM_CSx_B Valid to EIM_OE_B Valid | WE10 - WE6 + (OEA - RCSA) | — | 3 + (OEA - RCSA) | ns |
| WE35A (muxed A/D) | EIM_CSx_B Valid to EIM_OE_B Valid | WE10 - WE6 + (OEA + RADVN + RADVA + ADH + 1 - RCSA) | -3 + (OEA + RADVN+RADVA+ ADH+1-RCSA) | 3 + (OEA + RADVN+RADVA+ADH +1-RCSA) | ns |
| WE36 | EIM_OE_B Invalid to EIM_CSx_B Invalid | WE7 - WE11 + (OEN - RCSN) | — | 3 - (OEN - RCSN) | ns |
| WE37 | EIM_CSx_B Valid to EIM_EBx_B Valid (Read access) | WE12 - WE6 + (RBEA - RCSA) | — | 3 + (RBEA - RCSA) | ns |



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**Table 43. EIM Asynchronous Timing Parameters Table Relative Chip to Select (continued)**

| Ref No. | Parameter | Determination by Synchronous measured parameters[1] | Min | Max | Unit |
|---|---|---|---|---|---|
| WE38 | EIM_EBx_B Invalid to EIM_CSx_B Invalid (Read access) | WE7 - WE13 + (RBEN - RCSN) | — | 3 - (RBEN- RCSN) | ns |
| WE39 | EIM_CSx_B Valid to EIM_LBA_B Valid | WE14 - WE6 + (ADVA - CSA) | — | 3 + (ADVA - CSA) | ns |
| WE40 | EIM_LBA_B Invalid to EIM_CSx_B Invalid (ADVL is asserted) | WE7 - WE15 - CSN | — | 3 - CSN | ns |
| WE40A (muxed A/D) | EIM_CSx_B Valid to EIM_LBA_B Invalid | WE14 - WE6 + (ADVN + ADVA + 1 - CSA) | -3 + (ADVN + ADVA + 1 - CSA) | 3 + (ADVN + ADVA + 1 - CSA) | ns |
| WE41 | EIM_CSx_B Valid to Output Data Valid | WE16 - WE6 - WCSA | — | 3 - WCSA | ns |
| WE41A (muxed A/D) | EIM_CSx_B Valid to Output Data Valid | WE16 - WE6 + (WADVN + WADVA + ADH + 1 - WCSA) | — | 3 + (WADVN + WADVA + ADH + 1 - WCSA) | ns |
| WE42 | Output Data Invalid to EIM_CSx_B Invalid | WE17 - WE7 - CSN | — | 3 - CSN | ns |
| MAXCO | Output maximum delay from internal driving EIM_ADDRxx/control FFs to chip outputs | 10 | — | — | ns |
| MAXCSO | Output maximum delay from CSx internal driving FFs to CSx out | 10 | — | — | ns |
| MAXDI | EIM_DATAxx maximum delay from chip input data to its internal FF | 5 | — | — | ns |
| WE43 | Input Data Valid to EIM_CSx_B Invalid | MAXCO - MAXCSO + MAXDI | MAXCO - MAXCSO + MAXDI | — | ns |
| WE44 | EIM_CSx_B Invalid to Input Data invalid | 0 | 0 | — | ns |
| WE45 | EIM_CSx_B Valid to EIM_EBx_B Valid (Write access) | WE12 - WE6 + (WBEA - WCSA) | — | 3 + (WBEA - WCSA) | ns |
| WE46 | EIM_EBx_B Invalid to EIM_CSx_B Invalid (Write access) | WE7 - WE13 + (WBEN - WCSN) | — | -3 + (WBEN - WCSN) | ns |
| MAXDTI | MAXIMUM delay from EIM_DTACK_B to its internal FF + 2 cycles for synchronization | 10 | — | — | — |



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**Table 43. EIM Asynchronous Timing Parameters Table Relative Chip to Select (continued)**

| Ref No. | Parameter | Determination by Synchronous measured parameters[1] | Min | Max | Unit |
|---|---|---|---|---|---|
| WE47 | EIM_DTACK_B Active to EIM_CSx_B Invalid | MAXCO - MAXCSO + MAXDTI | MAXCO - MAXCSO + MAXDTI | — | ns |
| WE48 | EIM_CSx_B Invalid to EIM_DTACK_B Invalid | 0 | 0 | — | ns |

1 For more information on configuration parameters mentioned in this table, see the i.MX 6Solo/6DualLite reference manual.
2 In this table, CSA means WCSA when write operation or RCSA when read operation.
3 In this table, CSN means WCSN when write operation or RCSN when read operation.
4 t is ACLK_EIM_SLOW_CLK_ROOT cycle time.
5 In this table, ADVN means WADVN when write operation or RADVN when read operation.
6 In this table, ADVA means WADVA when write operation or RADVA when read operation.

## 4.9.4 Multi-Mode DDR Controller (MMDC)

The Multi-Mode DDR Controller is a dedicated interface to DDR3/DDR3L/LPDDR2 SDRAM.

### 4.9.4.1 MMDC Compatibility with JEDEC-compliant SDRAMs

The i.MX 6Solo/6DualLite MMDC supports the following memory types:

- LPDDR2 SDRAM compliant to JESD209-2B LPDDR2 JEDEC standard release June, 2009
- DDR3/DDR3L SDRAM compliant to JESD79-3D DDR3 JEDEC standard release April, 2008

MMDC operation with the standards stated above is contingent upon the board DDR design adherence to the DDR design and layout requirements stated in the *Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors* (IMX6DQ6SDLHDG).

### 4.9.4.2 MMDC Supported DDR3/DDR3L/LPDDR2 Configurations

Table 44 and Table 45 show the supported DDR3/DDR3L/LPDDR2 configurations.

**Table 44. i.MX 6Solo Supported DDR3/DDR3L/LPDDR2 Configurations**

| Parameter | LPDDR2 | DDR3 | DDR3L |
|---|---|---|---|
| Clock frequency | 400 MHz | 400 MHz | 400 MHz |
| Bus width | 16/32-bit | 16/32-bit | 16/32-bit |
| Channel | Single | Single | Single |
| Chip selects | 2 | 2 | 2 |



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**Table 45. i.MX 6DualLite Supported DDR3/DDR3L/LPDDR2 Configurations**

| Parameter | LPDDR2 (Dual channel) | LPDDR2 (Single channel) | DDR3 | DDR3L |
|---|---|---|---|---|
| Clock frequency | 400 MHz | 400 MHz | 400 MHz | 400 MHz |
| Bus width | 32-bit per channel | 16/32-bit | 16/32/64-bit | 16/32/64-bit |
| Channel | Dual | Single | Single | Single |
| Chip selects | 2 per channel | 2 | 2 | 2 |

## 4.10 General-Purpose Media Interface (GPMI) Timing

The i.MX 6Solo/6DualLite GPMI controller is a flexible interface NAND Flash controller with 8-bit data width, up to 200 MB/s I/O speed and individual chip select.

It supports Asynchronous timing mode, Source Synchronous timing mode and Samsung Toggle timing mode separately described in the following subsections.

### 4.10.1 Asynchronous Mode AC Timing (ONFI 1.0 Compatible)

Asynchronous mode AC timings are provided as multiplications of the clock cycle and fixed delay. The maximum I/O speed of GPMI in asynchronous mode is about 50 MB/s. Figure 25 through Figure 28 depicts the relative timing between GPMI signals at the module level for different operations under asynchronous mode. Table 46 describes the timing parameters (NF1–NF17) that are shown in the figures.

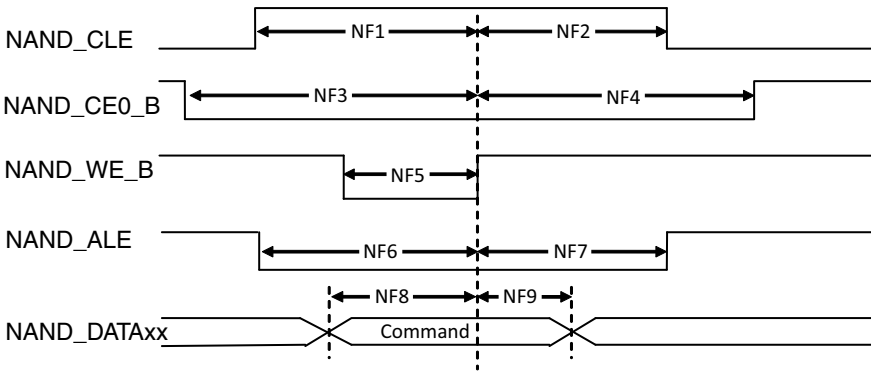


**Figure 25. Command Latch Cycle Timing Diagram**



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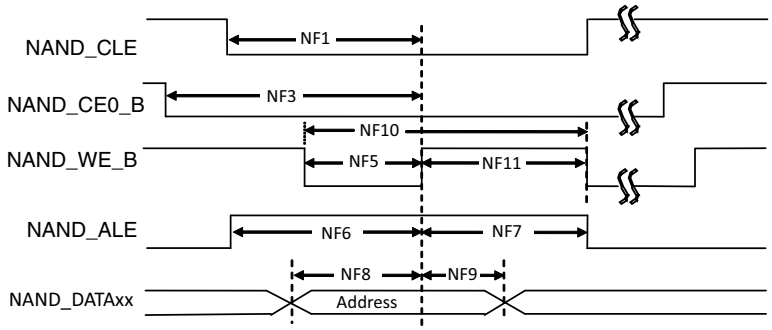


**Figure 26. Address Latch Cycle Timing Diagram**

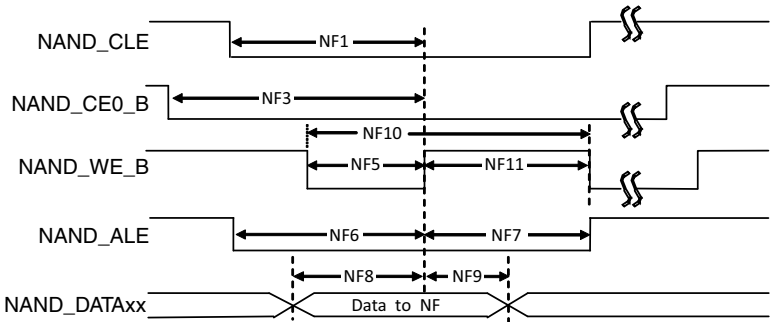


**Figure 27. Write Data Latch Cycle Timing Diagram**

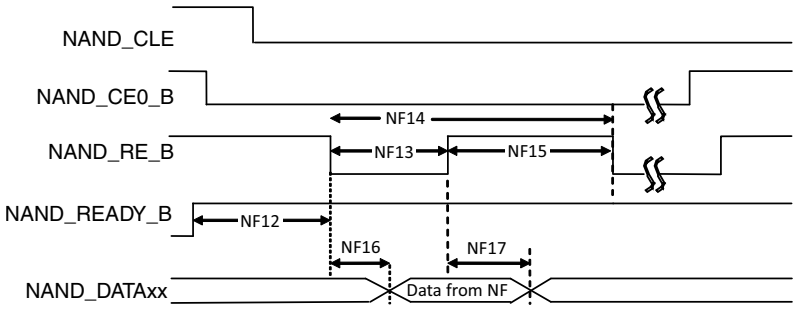


**Figure 28. Read Data Latch Cycle Timing Diagram (Non-EDO Mode)**

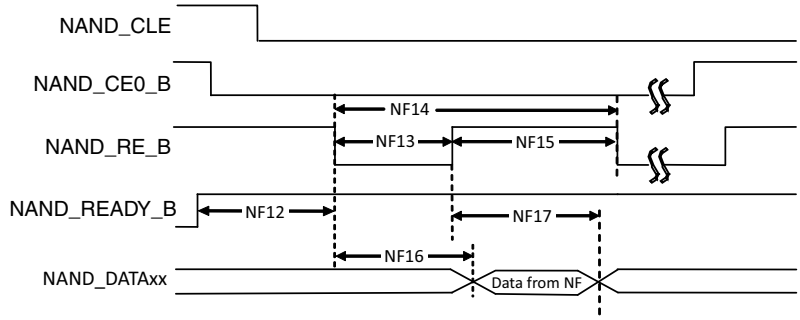


**Figure 29. Read Data Latch Cycle Timing Diagram (EDO Mode)**



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**Table 46. Asynchronous Mode Timing Parameters[1]**

| ID | Parameter | Symbol | Timing T = GPMI Clock Cycle | | Unit |
|---|---|---|---|---|---|
| | | | Min | Max | |
| NF1 | NAND_CLE setup time | tCLS | (AS + DS) × T - 0.12 [see 2,3] | | ns |
| NF2 | NAND_CLE hold time | tCLH | DH × T - 0.72 [see 2] | | ns |
| NF3 | NAND_CE0_B setup time | tCS | (AS + DS + 1) × T [see 3,2] | | ns |
| NF4 | NAND_CE0_B hold time | tCH | (DH+1) × T - 1 [see 2] | | ns |
| NF5 | NAND_WE_B pulse width | tWP | DS × T [see 2] | | ns |
| NF6 | NAND_ALE setup time | tALS | (AS + DS) × T - 0.49 [see 3,2] | | ns |
| NF7 | NAND_ALE hold time | tALH | (DH × T - 0.42 [see 2] | | ns |
| NF8 | Data setup time | tDS | DS × T - 0.26 [see 2] | | ns |
| NF9 | Data hold time | tDH | DH × T - 1.37 [see 2] | | ns |
| NF10 | Write cycle time | tWC | (DS + DH) × T [see 2] | | ns |
| NF11 | NAND_WE_B hold time | tWH | DH × T [see 2] | | ns |
| NF12 | Ready to NAND_RE_B low | tRR[4] | (AS + 2) × T [see 3,2] | — | ns |
| NF13 | NAND_RE_B pulse width | tRP | DS × T [see 2] | | ns |
| NF14 | READ cycle time | tRC | (DS + DH) × T [see 2] | | ns |
| NF15 | NAND_RE_B high hold time | tREH | DH × T [see 2] | | ns |
| NF16 | Data setup on read | tDSR | — | (DS × T -0.67)/18.38 [see 5,6] | ns |
| NF17 | Data hold on read | tDHR | 0.82/11.83 [see 5,6] | — | ns |

1 GPMI's Async Mode output timing can be controlled by the module's internal registers HW_GPMI_TIMING0_ADDRESS_SETUP, HW_GPMI_TIMING0_DATA_SETUP, and HW_GPMI_TIMING0_DATA_HOLD. This AC timing depends on these registers settings. In the table, AS/DS/DH represents each of these settings.

2 AS minimum value can be 0, while DS/DH minimum value is 1.

3 T = GPMI clock period -0.075ns (half of maximum p-p jitter).

4 NF12 is guaranteed by the design.

5 Non-EDO mode.

6 EDO mode, GPMI clock ≈ 100 MHz (AS=DS=DH=1, GPMI_CTL1 [RDN_DELAY] = 8, GPMI_CTL1 [HALF_PERIOD] = 0).

In EDO mode (Figure 28), NF16/NF17 are different from the definition in non-EDO mode (Figure 27). They are called tREA/tRHOH (RE# access time/RE# HIGH to output hold). The typical value for them are 16 ns (max for tREA)/15 ns (min for tRHOH) at 50 MB/s EDO mode. In EDO mode, GPMI will sample NAND_DATAxx at rising edge of delayed NAND_RE_B provided by an internal DPLL. The delay value can be controlled by GPMI_CTRL1.RDN_DELAY (see the GPMI chapter of the i.MX 6Solo/6DualLite reference manual). The typical value of this control register is 0x8 at 50 MT/s EDO mode. But if the board delay is big enough and cannot be ignored, the delay value should be made larger to compensate the board delay.



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## 4.10.2 Source Synchronous Mode AC Timing (ONFI 2.x Compatible)

Figure 30 to Figure 32 show the write and read timing of Source Synchronous Mode.

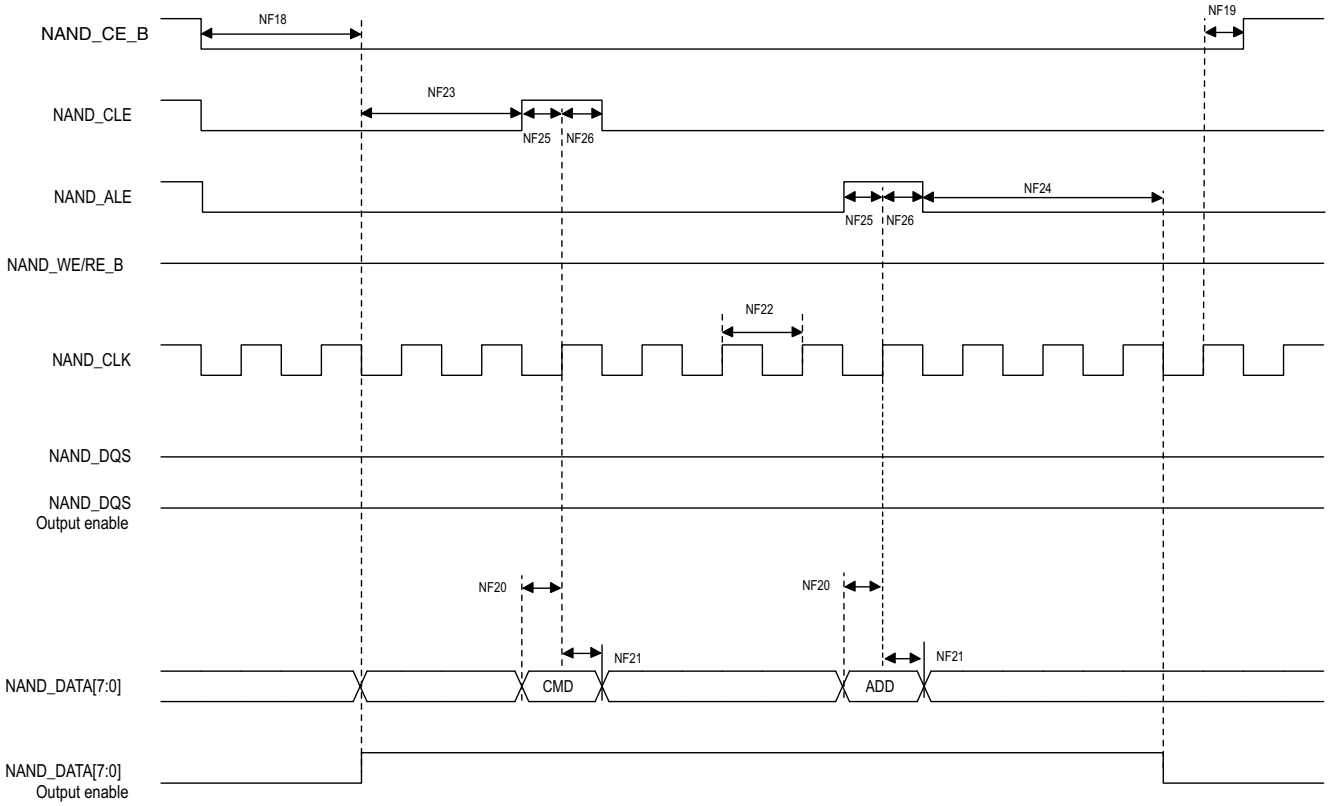


**Figure 30. Source Synchronous Mode Command and Address Timing Diagram**



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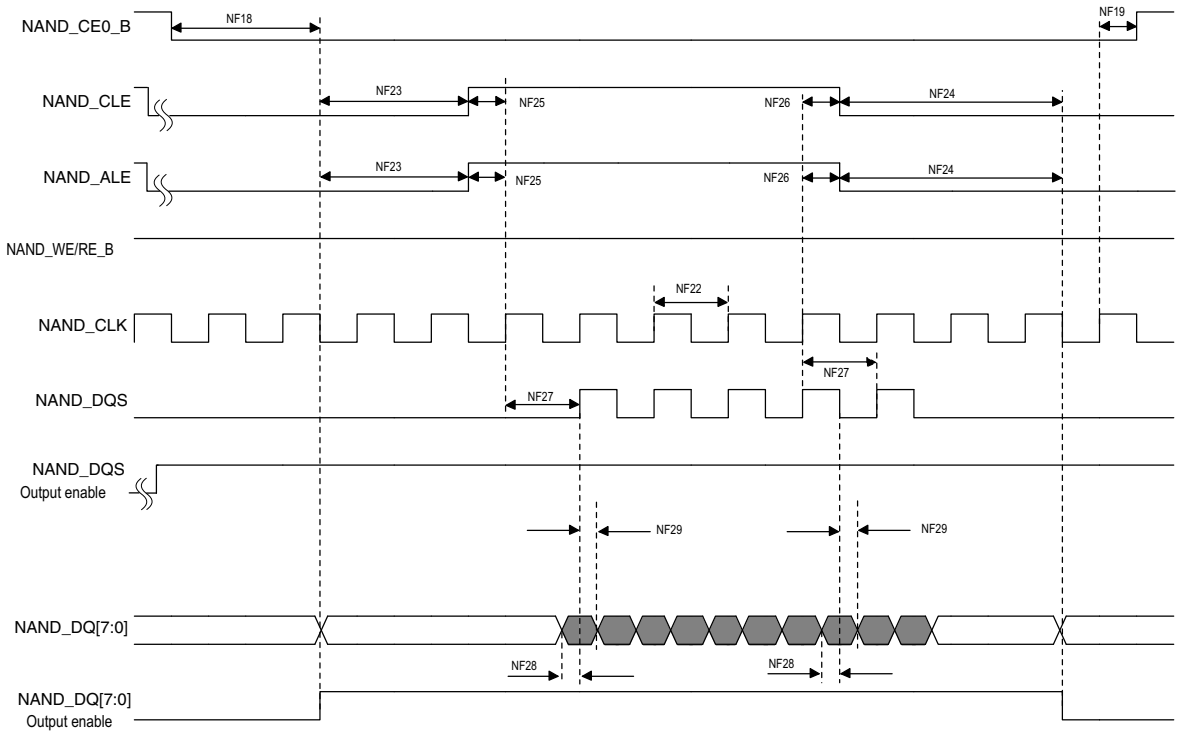


**Figure 31. Source Synchronous Mode Data Write Timing Diagram**

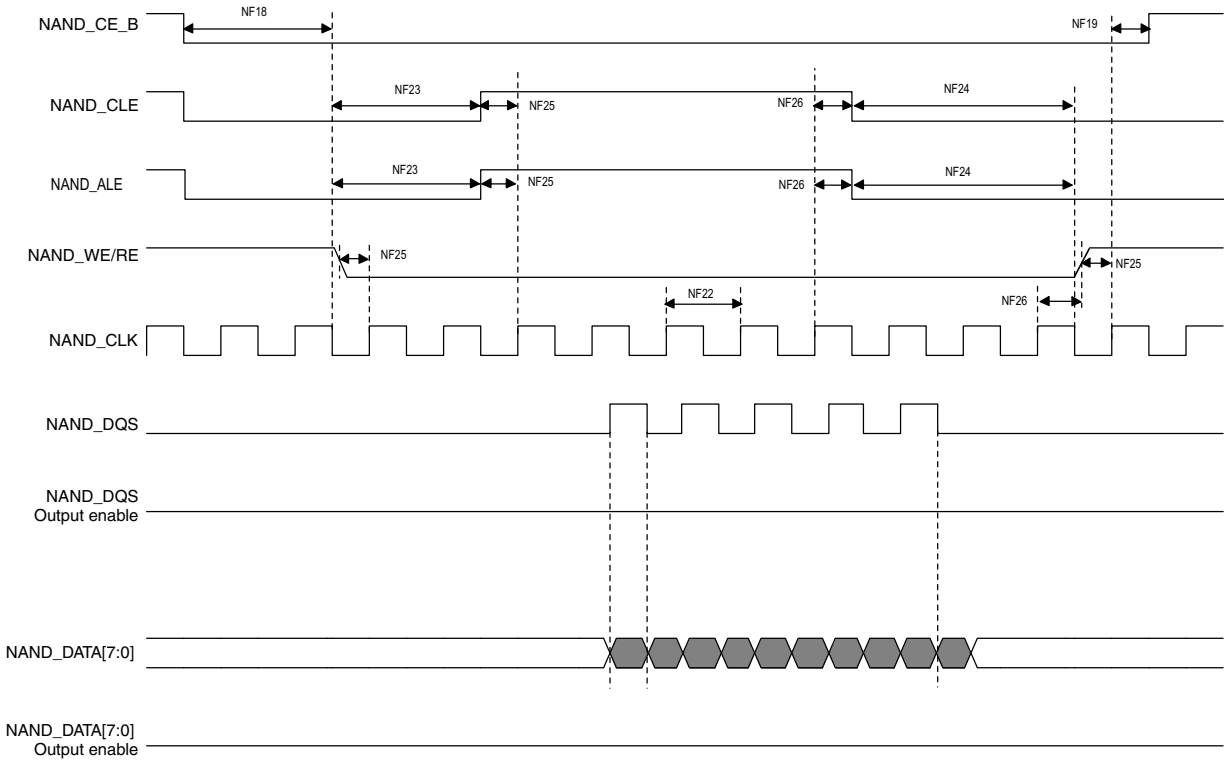


**Figure 32. Source Synchronous Mode Data Read Timing Diagram**



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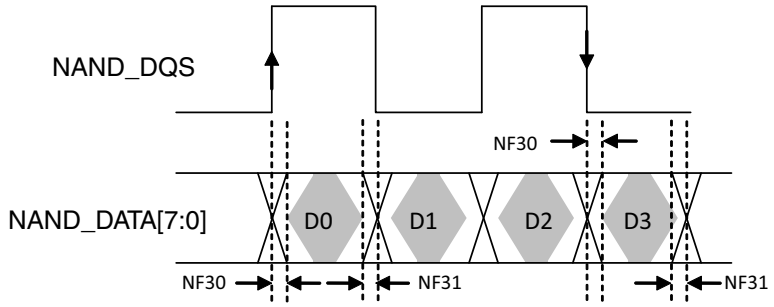


**Figure 33. NAND_DQS/NAND_DQ Read Valid Window**

**Table 47. Source Synchronous Mode Timing Parameters[1]**

| ID | Parameter | Symbol | Timing T = GPMI Clock Cycle | | Unit |
|---|---|---|---|---|---|
| | | | Min | Max | |
| NF18 | NAND_CE0_B access time | tCE | CE_DELAY × T - 0.79 [see 2] | | ns |
| NF19 | NAND_CE0_B hold time | tCH | 0.5 × tCK - 0.63 [see 2] | | ns |
| NF20 | Command/address NAND_DATAxx setup time | tCAS | 0.5 × tCK - 0.05 | | ns |
| NF21 | Command/address NAND_DATAxx hold time | tCAH | 0.5 × tCK - 1.23 | | ns |
| NF22 | clock period | tCK | — | | ns |
| NF23 | preamble delay | tPRE | PRE_DELAY × T - 0.29 [see 2] | | ns |
| NF24 | postamble delay | tPOST | POST_DELAY × T - 0.78 [see 2] | | ns |
| NF25 | NAND_CLE and NAND_ALE setup time | tCALS | 0.5 × tCK - 0.86 | | ns |
| NF26 | NAND_CLE and NAND_ALE hold time | tCALH | 0.5 × tCK - 0.37 | | ns |
| NF27 | NAND_CLK to first NAND_DQS latching transition | tDQSS | T - 0.41 [see 2] | | ns |
| NF28 | Data write setup | — | 0.25 × tCK - 0.35 | | |
| NF29 | Data write hold | — | 0.25 × tCK - 0.85 | | |
| NF30 | NAND_DQS/NAND_DQ read setup skew | — | — | 2.06 | |
| NF31 | NAND_DQS/NAND_DQ read hold skew | — | — | 1.95 | |

1 GPMI's source synchronous mode output timing can be controlled by the module's internal registers GPMI_TIMING2_CE_DELAY, GPMI_TIMING_PREAMBLE_DELAY, GPMI_TIMING2_POST_DELAY. This AC timing depends on these registers settings. In the table, CE_DELAY/PRE_DELAY/POST_DELAY represents each of these settings.

2 T = tCK(GPMI clock period) -0.075ns (half of maximum p-p jitter).

For DDR Source sync mode, Figure 33 shows the timing diagram of NAND_DQS/NAND_DATAxx read valid window. The typical value of tDQSQ is 0.85ns (max) and 1ns (max) for tQHS at 200MB/s. GPMI will sample NAND_DATA[7:0] at both rising and falling edge of an delayed NAND_DQS signal, which can be provided by an internal DPLL. The delay value can be controlled by GPMI register GPMI_READ_DDR_DLL_CTRL.SLV_DLY_TARGET (see the GPMI chapter of the i.MX 6Solo/6DualLite reference manual). Generally, the typical delay value of this register is equal to 0x7 which means 1/4 clock cycle delay expected. But if the board delay is big enough and cannot be ignored, the delay value should be made larger to compensate the board delay.



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## 4.10.3 Samsung Toggle Mode AC Timing

### 4.10.3.1 Command and Address Timing

**NOTE**

Samsung Toggle Mode command and address timing is the same as ONFI 1.0 compatible Async mode AC timing. See Section 4.10.1, "Asynchronous Mode AC Timing (ONFI 1.0 Compatible)," for details.

### 4.10.3.2 Read and Write Timing

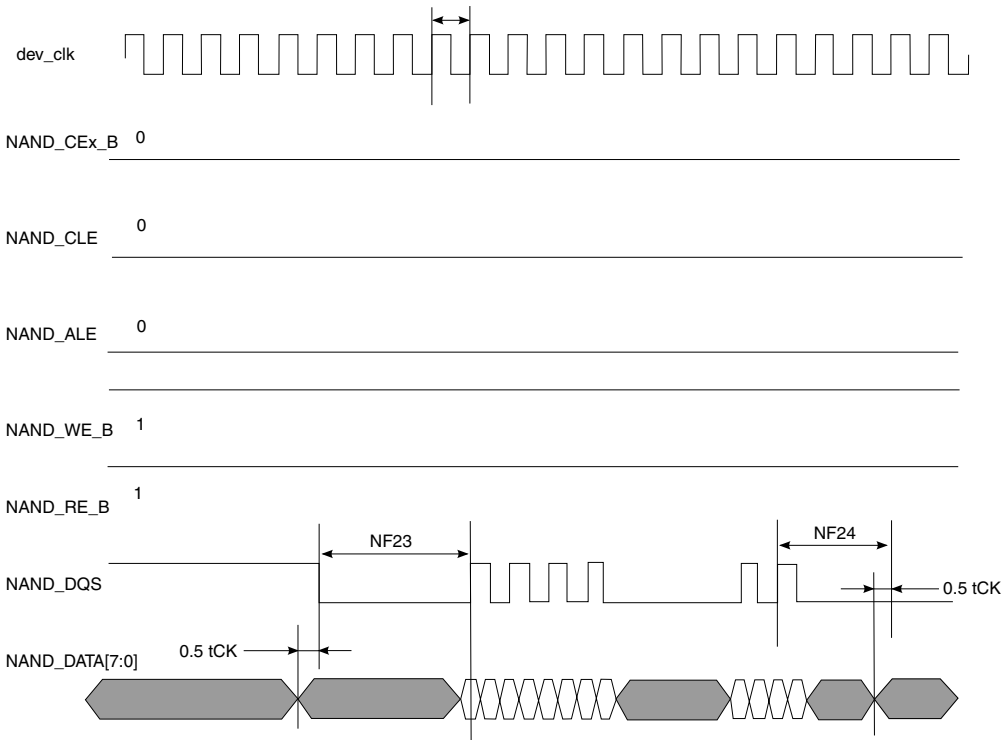


**Figure 34. Samsung Toggle Mode Data Write Timing**



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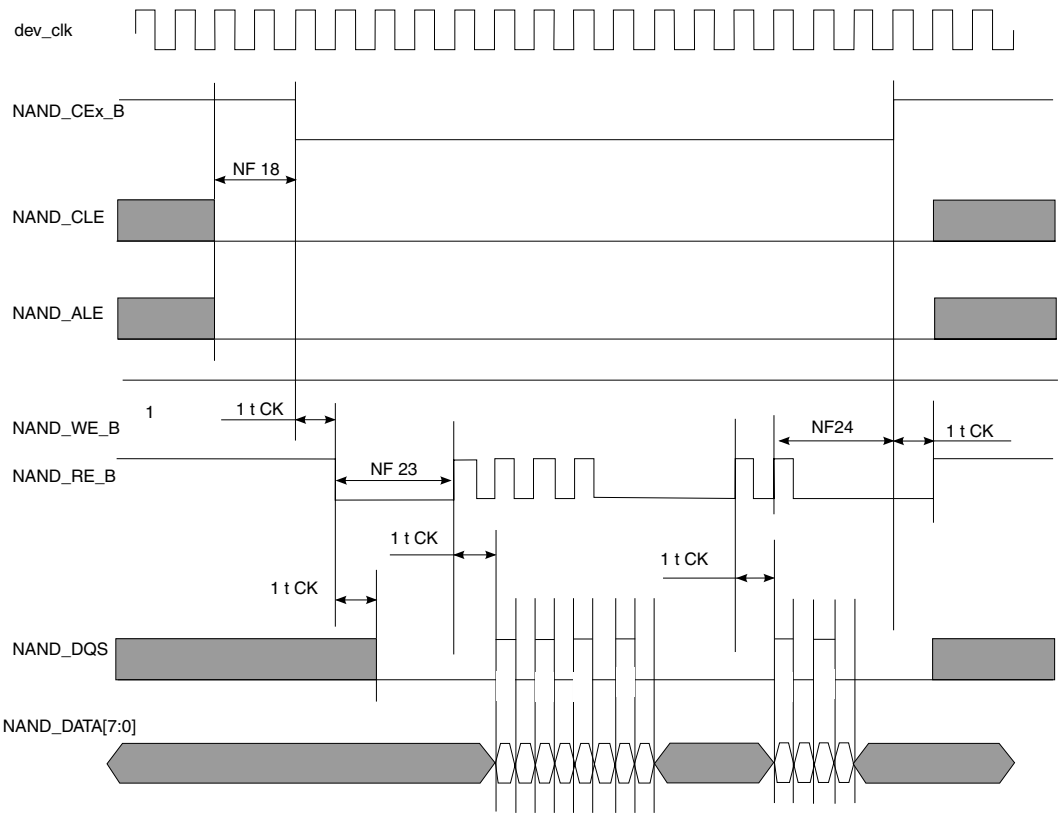


**Figure 35. Samsung Toggle Mode Data Read Timing**

**Table 48. Samsung Toggle Mode Timing Parameters[1]**

| ID | Parameter | Symbol | Timing T = GPMI Clock Cycle | | Unit |
|---|---|---|---|---|---|
| | | | Min | Max | |
| NF1 | NAND_CLE setup time | tCLS | (AS + DS) × T - 0.12 [see 2,3] | | |
| NF2 | NAND_CLE hold time | tCLH | DH × T - 0.72 [see 2] | | |
| NF3 | NAND_CE0_B setup time | tCS | (AS + DS) × T - 0.58 [see 3,2] | | |
| NF4 | NAND_CE0_B hold time | tCH | DH × T - 1 [see 2] | | |
| NF5 | NAND_WE_B pulse width | tWP | DS × T [see 2] | | |
| NF6 | NAND_ALE setup time | tALS | (AS + DS) × T - 0.49 [see 3,2] | | |
| NF7 | NAND_ALE hold time | tALH | DH × T - 0.42 [see 2] | | |
| NF8 | Command/address NAND_DATAxx setup time | tCAS | DS × T - 0.26 [see 2] | | |
| NF9 | Command/address NAND_DATAxx hold time | tCAH | DH × T - 1.37 [see 2] | | |
| NF18 | NAND_CEx_B access time | tCE | CE_DELAY × T [see 4,2] | — | ns |
| NF22 | clock period | tCK | — | — | ns |
| NF23 | preamble delay | tPRE | PRE_DELAY × T [see 5,2] | — | ns |
| NF24 | postamble delay | tPOST | POST_DELAY × T +0.43 [see 2] | — | ns |



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**Table 48. Samsung Toggle Mode Timing Parameters[1] (continued)**

| ID | Parameter | Symbol | Timing T = GPMI Clock Cycle | | Unit |
|---|---|---|---|---|---|
| | | | Min | Max | |
| NF28 | Data write setup | tDS[6] | 0.25 × tCK - 0.32 | — | ns |
| NF29 | Data write hold | tDH[6] | 0.25 × tCK - 0.79 | — | ns |
| NF30 | NAND_DQS/NAND_DQ read setup skew | tDQSQ[7] | — | 3.18 | |
| NF31 | NAND_DQS/NAND_DQ read hold skew | tQHS[7] | — | 3.27 | |

1 The GPMI toggle mode output timing can be controlled by the module's internal registers HW_GPMI_TIMING0_ADDRESS_SETUP, HW_GPMI_TIMING0_DATA_SETUP, and HW_GPMI_TIMING0_DATA_HOLD. This AC timing depends on these registers settings. In the table, AS/DS/DH represents each of these settings.

2 AS minimum value can be 0, while DS/DH minimum value is 1.

3 T = tCK (GPMI clock period) -0.075ns (half of maximum p-p jitter).

4 CE_DELAY represents HW_GPMI_TIMING2[CE_DELAY]. NF18 is guaranteed by the design. Read/Write operation is started with enough time of ALE/CLE assertion to low level.

5 PRE_DELAY+1) ≥ (AS+DS).

6 Shown in Figure 34, Samsung Toggle Mode Data Write Timing diagram.

7 Shown in Figure 33, NAND_DQS/NAND_DQ Read Valid Window.

For DDR Toggle mode, Figure 33 shows the timing diagram of NAND_DQS/NAND_DATAxx read valid window. The typical value of tDQSQ is 1.4 ns (max) and 1.4 ns (max) for tQHS at 133 MB/s. GPMI will sample NAND_DATA[7:0] at both rising and falling edge of an delayed NAND_DQS signal, which is provided by an internal DPLL. The delay value of this register can be controlled by GPMI register GPMI_READ_DDR_DLL_CTRL.SLV_DLY_TARGET (see the GPMI chapter of the i.MX 6Solo/6DualLite reference manual). Generally, the typical delay value is equal to 0x7 which means 1/4 clock cycle delay expected. But if the board delay is big enough and cannot be ignored, the delay value should be made larger to compensate the board delay.

## 4.11 External Peripheral Interface Parameters

The following subsections provide information on external peripheral interfaces.

### 4.11.1 AUDMUX Timing Parameters

The AUDMUX provides a programmable interconnect logic for voice, audio, and data routing between internal serial interfaces (SSIs) and external serial interfaces (audio and voice codecs). The AC timing of AUDMUX external pins is governed by the SSI module. For more information, see the respective SSI electrical specifications found within this document.

### 4.11.2 ECSPI Timing Parameters

This section describes the timing parameters of the ECSPI blocks. The ECSPI have separate timing parameters for master and slave modes.



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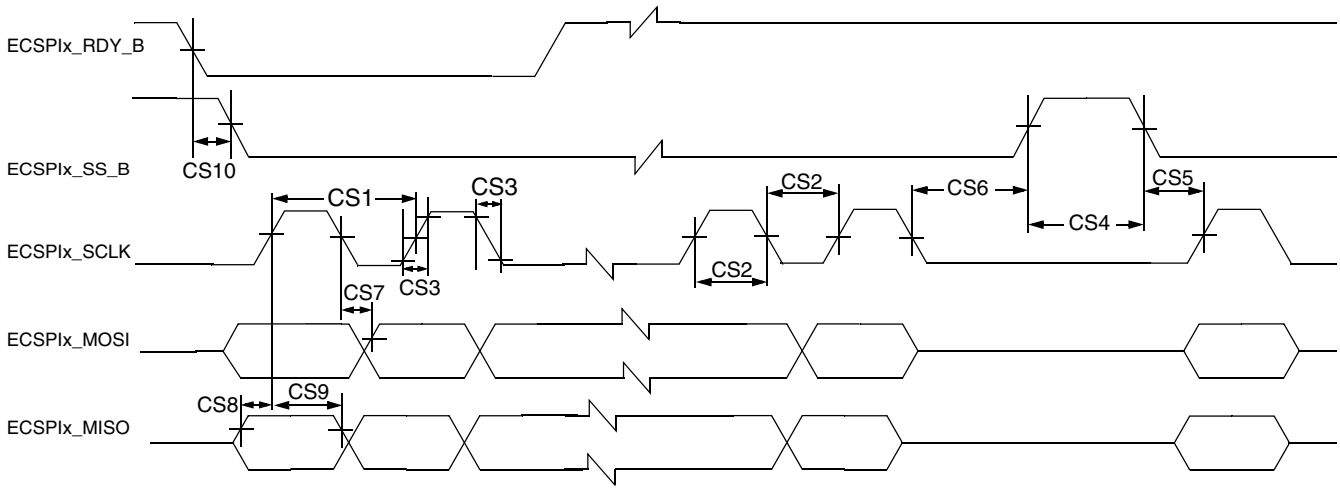
### 4.11.2.1 ECSPI Master Mode Timing

Figure 36 depicts the timing of ECSPI in master mode. Table 49 lists the ECSPI master mode timing characteristics.




Note: ECSPIx_MOSI is always driven (not tri-stated) between actual data transmissions. This limits the ECSPI to be connected between a single master and a single slave.

**Figure 36. ECSPI Master Mode Timing Diagram**

**Table 49. ECSPI Master Mode Timing Parameters**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| CS1 | ECSPIx_SCLK Cycle Time–Read<br>ECSPIx_SCLK Cycle Time–Write | $t_{clk}$ | 43<br>15 | — | ns |
| CS2 | ECSPIx_SCLK High or Low Time–Read<br>ECSPIx_SCLK High or Low Time–Write | $t_{SW}$ | 21.5<br>7 | — | ns |
| CS3 | ECSPIx_SCLK Rise or Fall[1] | $t_{RISE/FALL}$ | — | — | ns |
| CS4 | ECSPIx_SS_B pulse width | $t_{CSLH}$ | Half ECSPIx_SCLK period | — | ns |
| CS5 | ECSPIx_SS_B Lead Time (CS setup time) | $t_{SCS}$ | Half ECSPIx_SCLK period - 4 | — | ns |
| CS6 | ECSPIx_SS_B Lag Time (CS hold time) | $t_{HCS}$ | Half ECSPIx_SCLK period - 2 | — | ns |
| CS7 | ECSPIx_MOSI Propagation Delay ($C_{LOAD}$ = 20 pF) | $t_{PDmosi}$ | -1 | 1 | ns |
| CS8 | ECSPIx_MISO Setup Time<br>• | $t_{Smiso}$ | 18 | — | ns |
| CS9 | ECSPIx_MISO Hold Time | $t_{Hmiso}$ | 0 | — | ns |
| CS10 | RDY to ECSPIx_SS_B Time[2] | $t_{SDRY}$ | 5 | — | ns |

1 See specific I/O AC parameters Section 4.7, “I/O AC Parameters.”

2 SPI_RDY is sampled internally by ipg_clk and is asynchronous to all other CSPI signals.



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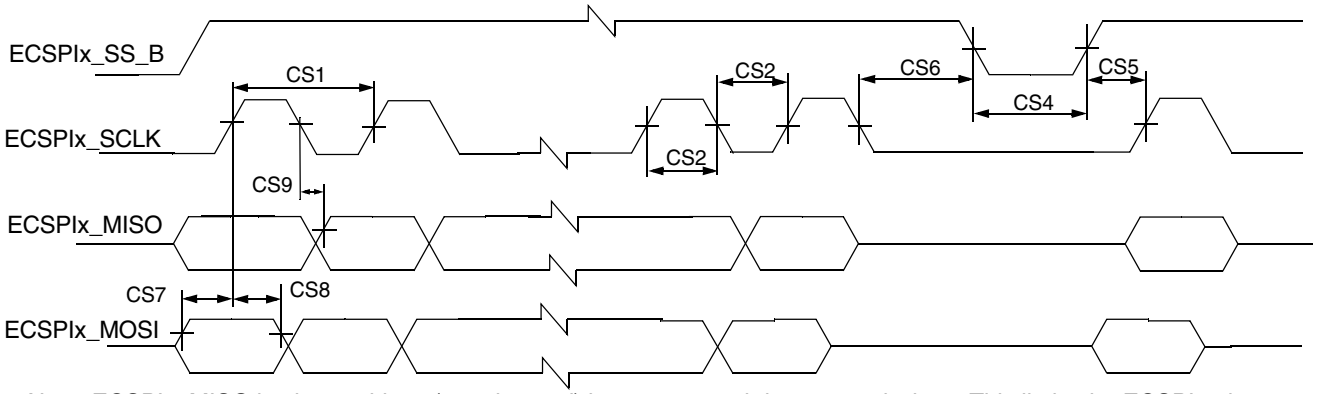
### 4.11.2.2 ECSPI Slave Mode Timing

Figure 37 depicts the timing of ECSPI in slave mode. Table 50 lists the ECSPI slave mode timing characteristics.




Note: ECSPIx_MISO is always driven (not tri-stated) between actual data transmissions. This limits the ECSPI to be connected between a single master and a single slave.

**Figure 37. ECSPI Slave Mode Timing Diagram**

**Table 50. ECSPI Slave Mode Timing Parameters**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| CS1 | ECSPIx_SCLK Cycle Time–Read<br>ECSPIx_SCLK Cycle Time–Write | $t_{clk}$ | 43<br>15 | — | ns |
| CS2 | ECSPIx_SCLK High or Low Time–Read<br>ECSPIx_SCLK High or Low Time–Write | $t_{SW}$ | 21.5<br>7 | — | ns |
| CS4 | ECSPIx_SS_B pulse width | $t_{CSLH}$ | Half ECSPIx_SCLK period | — | ns |
| CS5 | ECSPIx_SS_B Lead Time (CS setup time) | $t_{SCS}$ | 5 | — | ns |
| CS6 | ECSPIx_SS_B Lag Time (CS hold time) | $t_{HCS}$ | 5 | — | ns |
| CS7 | ECSPIx_MOSI Setup Time | $t_{Smosi}$ | 4 | — | ns |
| CS8 | ECSPIx_MOSI Hold Time | $t_{Hmosi}$ | 4 | — | ns |
| CS9 | ECSPIx_MISO Propagation Delay ($C_{LOAD}$ = 20 pF)<br>• | $t_{PDmiso}$ | 4 | 19 | ns |



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### 4.11.3 Enhanced Serial Audio Interface (ESAI) Timing Parameters

The ESAI consists of independent transmitter and receiver sections, each section with its own clock generator. Table 51 shows the interface timing values. The number field in the table refers to timing signals found in Figure 38 and Figure 39.

**Table 51. Enhanced Serial Audio Interface (ESAI) Timing Parameters**

| No. | Characteristics[1,2] | Symbol | Expression[2] | Min | Max | Condition[3] | Unit |
|---|---|---|---|---|---|---|---|
| 62 | Clock cycle[4] | $t_{SSICC}$ | $4 \times T_C$<br>$4 \times T_C$ | 30.0<br>30.0 | —<br>— | i ck<br>i ck | ns |
| 63 | Clock high period:<br>• For internal clock<br>• For external clock | <br>—<br>— | <br>$2 \times T_C - 9.0$<br>$2 \times T_C$ | <br>6<br>15 | <br>—<br>— | <br>—<br>— | ns |
| 64 | Clock low period:<br>• For internal clock<br>• For external clock | <br>—<br>— | <br>$2 \times T_C - 9.0$<br>$2 \times T_C$ | <br>6<br>15 | <br>—<br>— | <br>—<br>— | ns |
| 65 | ESAI_RX_CLK rising edge to ESAI_RX_FS out (bl) high | —<br>— | —<br>— | —<br>— | 17.0<br>7.0 | x ck<br>i ck a | ns |
| 66 | ESAI_RX_CLK rising edge to ESAI_RX_FS out (bl) low | —<br>— | —<br>— | —<br>— | 17.0<br>7.0 | x ck<br>i ck a | ns |
| 67 | ESAI_RX_CLK rising edge to ESAI_RX_FS out (wr) high[5] | —<br>— | —<br>— | —<br>— | 19.0<br>9.0 | x ck<br>i ck a | ns |
| 68 | ESAI_RX_CLK rising edge to ESAI_RX_FS out (wr) low[5] | —<br>— | —<br>— | —<br>— | 19.0<br>9.0 | x ck<br>i ck a | ns |
| 69 | ESAI_RX_CLK rising edge to ESAI_RX_FS out (wl) high | —<br>— | —<br>— | —<br>— | 16.0<br>6.0 | x ck<br>i ck a | ns |
| 70 | ESAI_RX_CLK rising edge to ESAI_RX_FS out (wl) low | —<br>— | —<br>— | —<br>— | 17.0<br>7.0 | x ck<br>i ck a | ns |
| 71 | Data in setup time before ESAI_RX_CLK (SCK in synchronous mode) falling edge | —<br>— | —<br>— | 12.0<br>19.0 | —<br>— | x ck<br>i ck | ns |
| 72 | Data in hold time after ESAI_RX_CLK falling edge | —<br>— | —<br>— | 3.5<br>9.0 | —<br>— | x ck<br>i ck | ns |
| 73 | ESAI_RX_FS input (bl, wr) high before ESAI_RX_CLK falling edge[5] | —<br>— | —<br>— | 2.0<br>12.0 | —<br>— | x ck<br>i ck a | ns |
| 74 | ESAI_RX_FS input (wl) high before ESAI_RX_CLK falling edge | —<br>— | —<br>— | 2.0<br>12.0 | —<br>— | x ck<br>i ck a | ns |
| 75 | ESAI_RX_FS input hold time after ESAI_RX_CLK falling edge | —<br>— | —<br>— | 2.5<br>8.5 | —<br>— | x ck<br>i ck a | ns |
| 78 | ESAI_TX_CLK rising edge to ESAI_TX_FS out (bl) high | —<br>— | —<br>— | —<br>— | 18.0<br>8.0 | x ck<br>i ck | ns |
| 79 | ESAI_TX_CLK rising edge to ESAI_TX_FS out (bl) low | —<br>— | —<br>— | —<br>— | 20.0<br>10.0 | x ck<br>i ck | ns |
| 80 | ESAI_TX_CLK rising edge to ESAI_TX_FS out (wr) high[5] | —<br>— | —<br>— | —<br>— | 20.0<br>10.0 | x ck<br>i ck | ns |



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**Table 51. Enhanced Serial Audio Interface (ESAI) Timing Parameters (continued)**

| No. | Characteristics[1,2] | Symbol | Expression[2] | Min | Max | Condition[3] | Unit |
|---|---|---|---|---|---|---|---|
| 81 | ESAI_TX_CLK rising edge to ESAI_TX_FS out (wr) low[5] | —<br>— | —<br>— | —<br>— | 22.0<br>12.0 | x ck<br>i ck | ns |
| 82 | ESAI_TX_CLK rising edge to ESAI_TX_FS out (wl) high | —<br>— | —<br>— | —<br>— | 19.0<br>9.0 | x ck<br>i ck | ns |
| 83 | ESAI_TX_CLK rising edge to ESAI_TX_FS out (wl) low | —<br>— | —<br>— | —<br>— | 20.0<br>10.0 | x ck<br>i ck | ns |
| 84 | ESAI_TX_CLK rising edge to data out enable from high impedance | —<br>— | —<br>— | —<br>— | 22.0<br>17.0 | x ck<br>i ck | ns |
| 86 | ESAI_TX_CLK rising edge to data out valid | —<br>— | —<br>— | —<br>— | 18.0<br>13.0 | x ck<br>i ck | ns |
| 87 | ESAI_TX_CLK rising edge to data out high impedance [6,7] | —<br>— | —<br>— | —<br>— | 21.0<br>16.0 | x ck<br>i ck | ns |
| 89 | ESAI_TX_FS input (bl, wr) setup time before ESAI_TX_CLK falling edge[5] | —<br>— | —<br>— | 2.0<br>18.0 | —<br>— | x ck<br>i ck | ns |
| 90 | ESAI_TX_FS input (wl) setup time before ESAI_TX_CLK falling edge | —<br>— | —<br>— | 2.0<br>18.0 | —<br>— | x ck<br>i ck | ns |
| 91 | ESAI_TX_FS input hold time after ESAI_TX_CLK falling edge | —<br>— | —<br>— | 4.0<br>5.0 | —<br>— | x ck<br>i ck | ns |
| 95 | ESAI_RX_HF_CLK/ESAI_TX_HF_CLK clock cycle | — | $2 \times T_C$ | 15 | — | — | ns |
| 96 | ESAI_TX_HF_CLK input rising edge to ESAI_TX_CLK output | — | — | — | 18.0 | — | ns |
| 97 | ESAI_RX_HF_CLK input rising edge to ESAI_RX_CLK output | — | — | — | 18.0 | — | ns |

1 i ck = internal clock
x ck = external clock
i ck a = internal clock, asynchronous mode
(asynchronous implies that ESAI_TX_CLK and ESAI_RX_CLK are two different clocks)
i ck s = internal clock, synchronous mode
(synchronous implies that ESAI_TX_CLK and ESAI_RX_CLK are the same clock)

2 bl = bit length
wl = word length
wr = word length relative

3 ESAI_TX_CLK(SCKT pin) = transmit clock
ESAI_RX_CLK(SCKR pin) = receive clock
ESAI_TX_FS(FST pin) = transmit frame sync
ESAI_RX_FS(FSR pin) = receive frame sync
ESAI_TX_HF_CLK(HCKT pin) = transmit high frequency clock
ESAI_RX_HF_CLK(HCKR pin) = receive high frequency clock

4 For the internal clock, the external clock cycle is defined by Icyc and the ESAI control register.

5 The word-relative frame sync signal waveform relative to the clock operates in the same manner as the bit-length frame sync signal waveform, but it spreads from one serial clock before the first bit clock (like the bit length frame sync signal), until the second-to-last bit clock of the first word in the frame.

6 Periodically sampled and not 100% tested.



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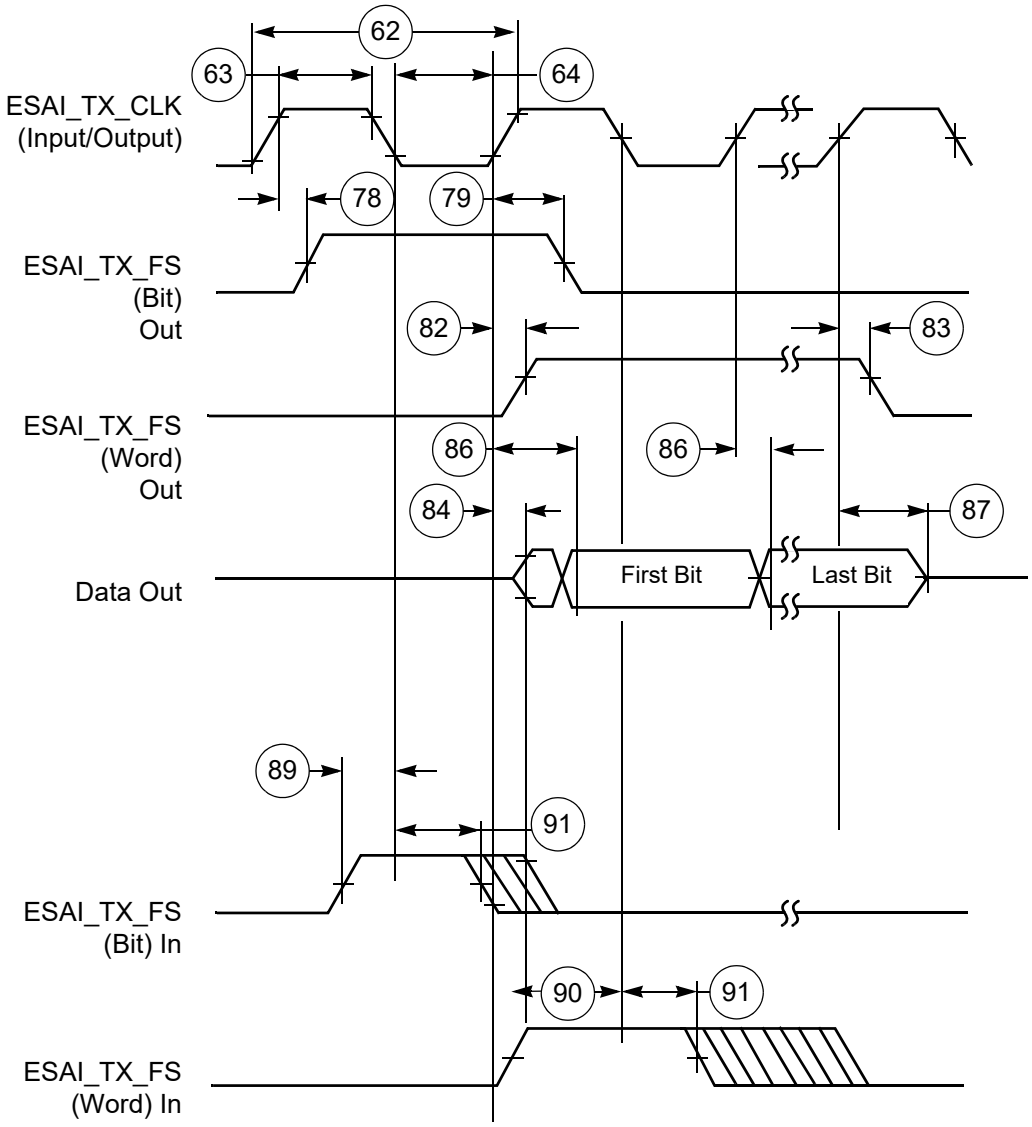


**Figure 38. ESAI Transmitter Timing**



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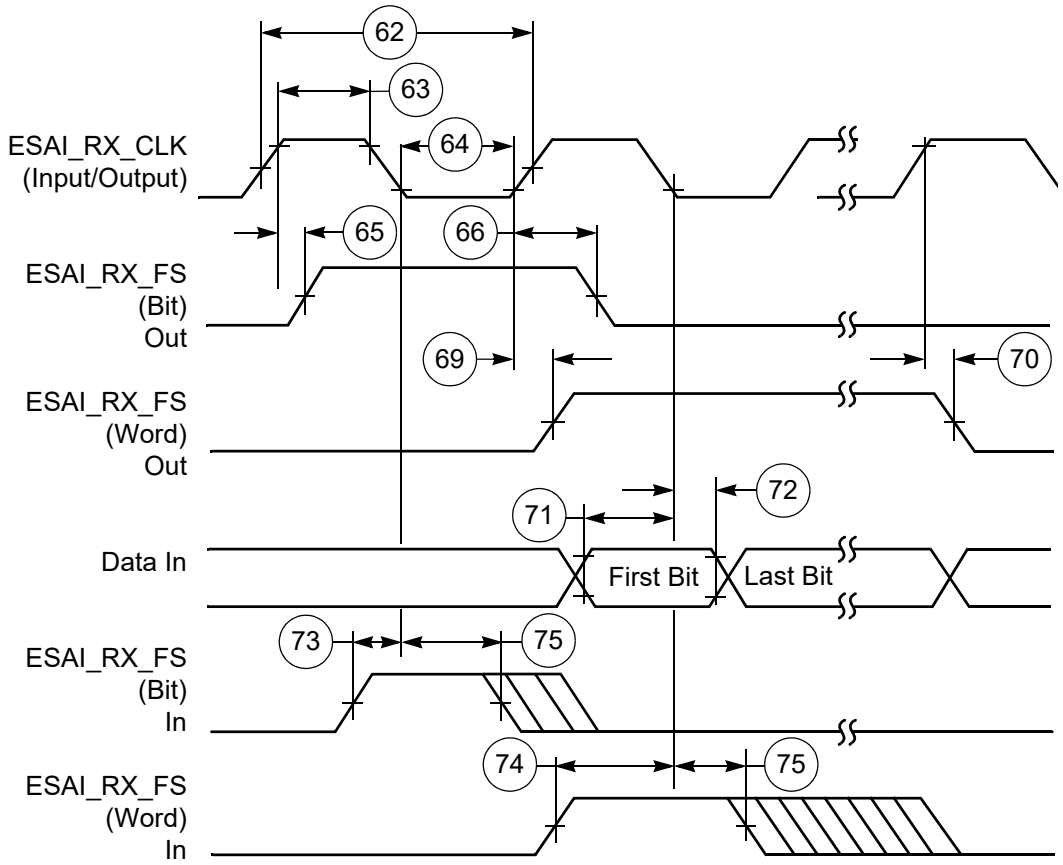


**Figure 39. ESAI Receiver Timing**



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## 4.11.4 Ultra High Speed SD/SDIO/MMC Host Interface (uSDHC) AC Timing

This section describes the electrical information of the uSDHC, which includes SD/eMMC4.3 (Single Data Rate) timing, eMMC4.4/4.41 (Dual Date Rate) timing and SDR104/50(SD3.0) timing.

### 4.11.4.1 SD/eMMC4.3 (Single Data Rate) AC Timing

Figure 40 depicts the timing of SD/eMMC4.3, and Table 52 lists the SD/eMMC4.3 timing characteristics.

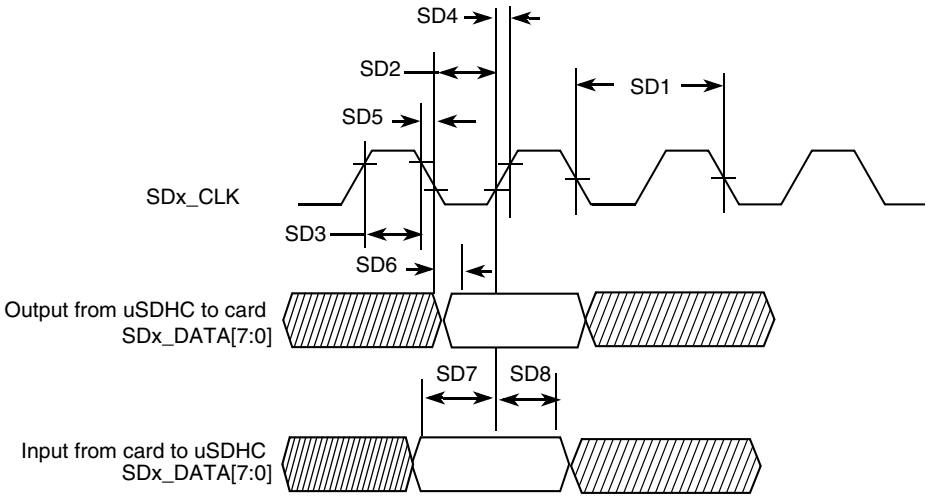


**Figure 40. SD/eMMC4.3 Timing**

**Table 52. SD/eMMC4.3 Interface Timing Specification**

| ID | Parameter | Symbols | Min | Max | Unit |
|---|---|---|---|---|---|
| **Card Input Clock** | | | | | |
| SD1 | Clock Frequency (Low Speed) | $f_{PP}$[1] | 0 | 400 | kHz |
| | Clock Frequency (SD/SDIO Full Speed/High Speed) | $f_{PP}$[2] | 0 | 25/50 | MHz |
| | Clock Frequency (MMC Full Speed/High Speed) | $f_{PP}$[3] | 0 | 20/52 | MHz |
| | Clock Frequency (Identification Mode) | $f_{OD}$ | 100 | 400 | kHz |
| SD2 | Clock Low Time | $t_{WL}$ | 7 | — | ns |
| SD3 | Clock High Time | $t_{WH}$ | 7 | — | ns |
| SD4 | Clock Rise Time | $t_{TLH}$ | — | 3 | ns |
| SD5 | Clock Fall Time | $t_{THL}$ | — | 3 | ns |
| **uSDHC Output/Card Inputs SDx_CMD, SDx_DATAx (Reference to CLK)** | | | | | |
| SD6 | uSDHC Output Delay | $t_{OD}$ | -6.6 | 3.6 | ns |



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**Table 52. SD/eMMC4.3 Interface Timing Specification (continued)**

| ID | Parameter | Symbols | Min | Max | Unit |
|---|---|---|---|---|---|
| **uSDHC Input/Card Outputs SDx_CMD, SDx_DATAx (Reference to CLK)** | | | | | |
| SD7 | uSDHC Input Setup Time | $t_{ISU}$ | 2.5 | — | ns |
| SD8 | uSDHC Input Hold Time[4] | $t_{IH}$ | 1.5 | — | ns |

1 In low speed mode, card clock must be lower than 400 kHz, voltage ranges from 2.7 to 3.6 V.

2 In normal (full) speed mode for SD/SDIO card, clock frequency can be any value between 0—25 MHz. In high-speed mode, clock frequency can be any value between 0—50 MHz.

3 In normal (full) speed mode for MMC card, clock frequency can be any value between 0—20 MHz. In high-speed mode, clock frequency can be any value between 0—52 MHz.

4 To satisfy hold timing, the delay difference between clock input and cmd/data input must not exceed 2 ns.

### 4.11.4.2 eMMC4.4/4.41 (Dual Data Rate) AC Timing

Figure 41 depicts the timing of eMMC4.4/4.41. Table 53 lists the eMMC4.4/4.41 timing characteristics. Be aware that only DATA is sampled on both edges of the clock (not applicable to CMD).

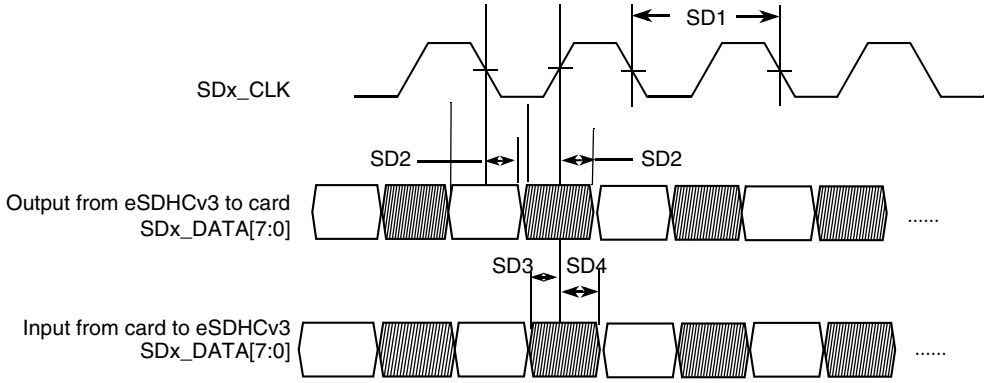


**Figure 41. eMMC4.4/4.41 Timing**

**Table 53. eMMC4.4/4.41 Interface Timing Specification**

| ID | Parameter | Symbols | Min | Max | Unit |
|---|---|---|---|---|---|
| **Card Input Clock[1]** | | | | | |
| SD1 | Clock Frequency (eMMC4.4/4.41 DDR) | $f_{PP}$ | 0 | 52 | MHz |
| SD1 | Clock Frequency (SD3.0 DDR) | $f_{PP}$ | 0 | 50 | MHz |
| **uSDHC Output / Card Inputs SDx_CMD, SDx_DATAx (Reference to CLK)** | | | | | |
| SD2 | uSDHC Output Delay | $t_{OD}$ | 2.8 | 6.8 | ns |
| **uSDHC Input / Card Outputs SDx_CMD, SDx_DATAx (Reference to CLK)** | | | | | |
| SD3 | uSDHC Input Setup Time | $t_{ISU}$ | 1.7 | — | ns |
| SD4 | uSDHC Input Hold Time | $t_{IH}$ | 1.5 | — | ns |

1 1 Clock duty cycle will be in the range of 47% to 53%.



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### 4.11.4.3 SDR50/SDR104 AC Timing

Figure 42 depicts the timing of SDR50/SDR104, and Table 54 lists the SDR50/SDR104 timing characteristics.

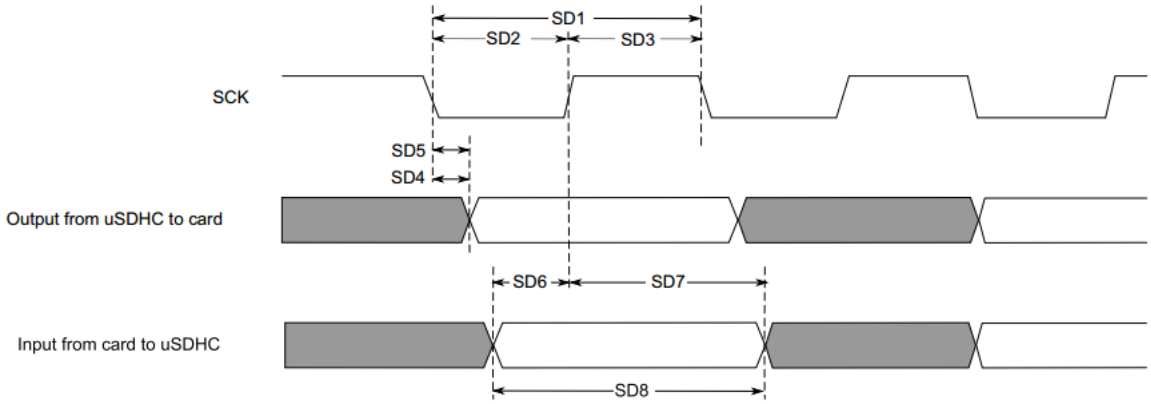


**Figure 42. SDR50/SDR104 Timing**

**Table 54. SDR50/SDR104 Interface Timing Specification**

| ID | Parameter | Symbols | Min | Max | Unit |
|---|---|---|---|---|---|
| **Card Input Clock** | | | | | |
| SD1 | Clock Frequency Period | $t_{CLK}$ | 4.8 | — | ns |
| SD2 | Clock Low Time | $t_{CL}$ | $0.46 \times t_{CLK}$ | $0.54 \times t_{CLK}$ | ns |
| SD3 | Clock High Time | $t_{CH}$ | $0.46 \times t_{CLK}$ | $0.54 \times t_{CLK}$ | ns |
| **uSDHC Output/Card Inputs SDx_CMD, SDx_DATAx in SDR50 (Reference to CLK)** | | | | | |
| SD4 | uSDHC Output Delay | $t_{OD}$ | –3 | 1 | ns |
| **uSDHC Output/Card Inputs SDx_CMD, SDx_DATAx in SDR104 (Reference to CLK)** | | | | | |
| SD5 | uSDHC Output Delay | $t_{OD}$ | –1.6 | 0.74 | ns |
| **uSDHC Input/Card Outputs SDx_CMD, SDx_DATAx in SDR50 (Reference to CLK)** | | | | | |
| SD6 | uSDHC Input Setup Time | $t_{ISU}$ | 2.5 | — | ns |
| SD7 | uSDHC Input Hold Time | $t_{IH}$ | 1.5 | — | ns |
| **uSDHC Input/Card Outputs SDx_CMD, SDx_DATAx in SDR104 (Reference to CLK)[1]** | | | | | |
| SD8 | Card Output Data Window | $t_{ODW}$ | $0.5 \times t_{CLK}$ | — | ns |

[1]Data window in SDR100 mode is variable.

### 4.11.4.4 Bus Operation Condition for 3.3 V and 1.8 V Signaling

Signaling level of SD/eMMC4.3 and eMMC4.4/4.41 modes is 3.3 V. Signaling level of SDR104/SDR50 mode is 1.8 V. The DC parameters for the NVCC_SD1, NVCC_SD2 and NVCC_SD3 supplies are identical to those shown in Table 23, "GPIO DC Parameters," on page 40.



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## 4.11.5 Ethernet Controller (ENET) AC Electrical Specifications

The following timing specs are defined at the chip I/O pin and must be translated appropriately to arrive at timing specs/constraints for the physical interface.

### 4.11.5.1 ENET MII Mode Timing

This subsection describes MII receive, transmit, asynchronous inputs, and serial management signal timings.

#### 4.11.5.1.1 MII Receive Signal Timing (ENET_RX_DATA3,2,1,0, ENET_RX_EN, ENET_RX_ER, and ENET_RX_CLK)

The receiver functions correctly up to an ENET_RX_CLK maximum frequency of 25 MHz + 1%. There is no minimum frequency requirement. Additionally, the processor clock frequency must exceed twice the ENET_RX_CLK frequency.

Figure 43 shows MII receive signal timings. Table 55 describes the timing parameters (M1–M4) shown in the figure.

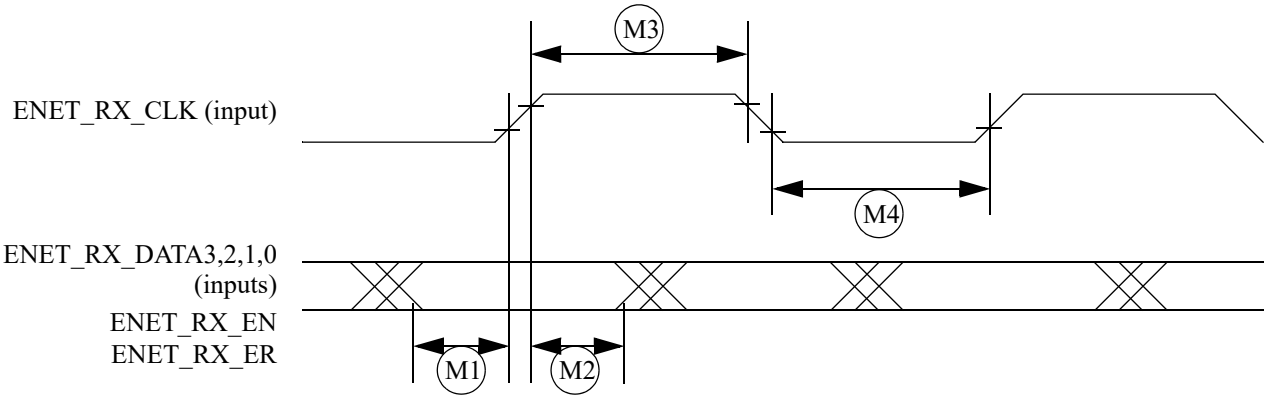


**Figure 43. MII Receive Signal Timing Diagram**

**Table 55. MII Receive Signal Timing**

| ID | Characteristic[1] | Min | Max | Unit |
|---|---|---|---|---|
| M1 | ENET_RX_DATA3,2,1,0, ENET_RX_EN, ENET_RX_ER to ENET_RX_CLK setup | 5 | — | ns |
| M2 | ENET_RX_CLK to ENET_RX_DATA3,2,1,0, ENET_RX_EN, ENET_RX_ER hold | 5 | — | ns |
| M3 | ENET_RX_CLK pulse width high | 35% | 65% | ENET_RX_CLK period |
| M4 | ENET_RX_CLK pulse width low | 35% | 65% | ENET_RX_CLK period |

[1] ENET_RX_EN, ENET_RX_CLK, and ENET0_RXD0 have the same timing in 10 Mbps 7-wire interface mode.



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#### 4.11.5.1.2 MII Transmit Signal Timing (ENET_TX_DATA3,2,1,0, ENET_TX_EN, ENET_TX_ER, and ENET_TX_CLK)

The transmitter functions correctly up to an ENET_TX_CLK maximum frequency of 25 MHz + 1%. There is no minimum frequency requirement. Additionally, the processor clock frequency must exceed twice the ENET_TX_CLK frequency.

Figure 44 shows MII transmit signal timings. Table 56 describes the timing parameters (M5–M8) shown in the figure.

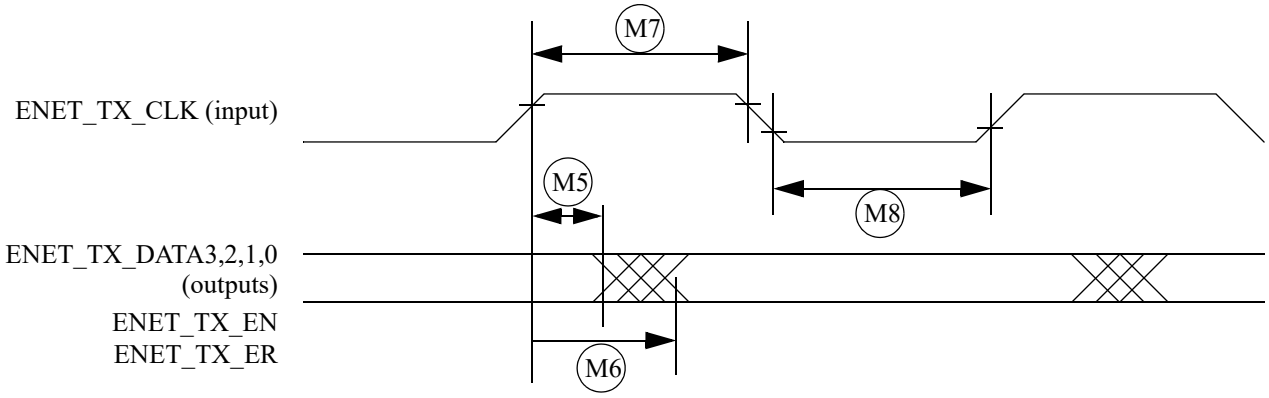


**Figure 44. MII Transmit Signal Timing Diagram**

**Table 56. MII Transmit Signal Timing**

| ID | Characteristic[1] | Min | Max | Unit |
|---|---|---|---|---|
| M5 | ENET_TX_CLK to ENET_TX_DATA3,2,1,0, ENET_TX_EN, ENET_TX_ER invalid | 5 | — | ns |
| M6 | ENET_TX_CLK to ENET_TX_DATA3,2,1,0, ENET_TX_EN, ENET_TX_ER valid | — | 20 | ns |
| M7 | ENET_TX_CLK pulse width high | 35% | 65% | ENET_TX_CLK period |
| M8 | ENET_TX_CLK pulse width low | 35% | 65% | ENET_TX_CLK period |

[1] ENET_TX_EN, ENET_TX_CLK, and ENET0_TXD0 have the same timing in 10-Mbps 7-wire interface mode.

#### 4.11.5.1.3 MII Asynchronous Inputs Signal Timing (ENET_CRS and ENET_COL)

Figure 45 shows MII asynchronous input timings. Table 57 describes the timing parameter (M9) shown in the figure.

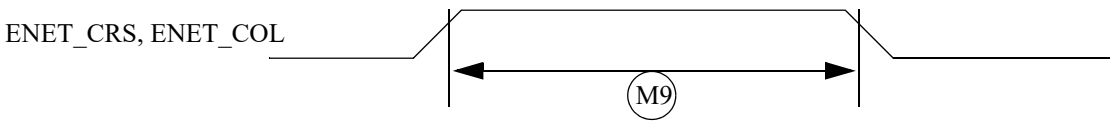


**Figure 45. MII Async Inputs Timing Diagram**



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**Table 57. MII Asynchronous Inputs Signal Timing**

| ID | Characteristic | Min | Max | Unit |
|---|---|---|---|---|
| M9[1] | ENET_CRS to ENET_COL minimum pulse width | 1.5 | — | ENET_TX_CLK period |

[1] ENET_COL has the same timing in 10-Mbit 7-wire interface mode.

#### 4.11.5.1.4 MII Serial Management Channel Timing (ENET_MDIO and ENET_MDC)

The MDC frequency is designed to be equal to or less than 2.5 MHz to be compatible with the IEEE 802.3 MII specification. However the ENET can function correctly with a maximum MDC frequency of 15 MHz.

Figure 46 shows MII asynchronous input timings. Table 58 describes the timing parameters (M10–M15) shown in the figure.

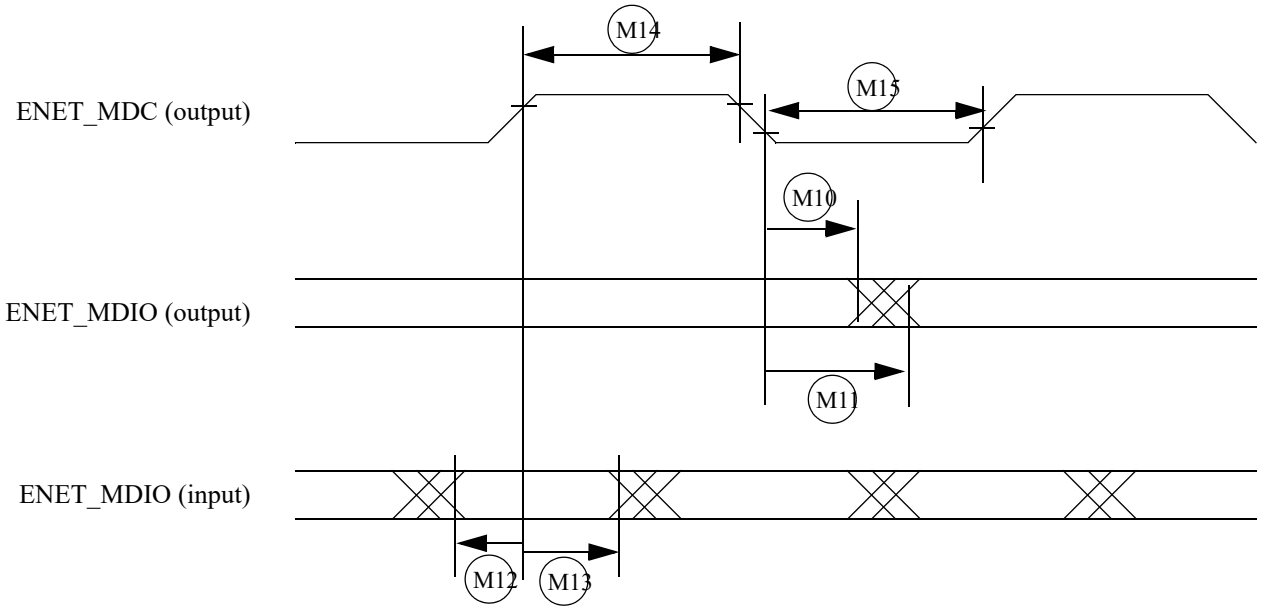


**Figure 46. MII Serial Management Channel Timing Diagram**

**Table 58. MII Serial Management Channel Timing**

| ID | Characteristic | Min | Max | Unit |
|---|---|---|---|---|
| M10 | ENET_MDC falling edge to ENET_MDIO output invalid (min. propagation delay) | 0 | — | ns |
| M11 | ENET_MDC falling edge to ENET_MDIO output valid (max. propagation delay) | — | 5 | ns |
| M12 | ENET_MDIO (input) to ENET_MDC rising edge setup | 18 | — | ns |
| M13 | ENET_MDIO (input) to ENET_MDC rising edge hold | 0 | — | ns |
| M14 | ENET_MDC pulse width high | 40% | 60% | ENET_MDC period |
| M15 | ENET_MDC pulse width low | 40% | 60% | ENET_MDC period |



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### 4.11.5.2 RMII Mode Timing

In RMII mode, ENET_CLK is used as the REF_CLK, which is a 50 MHz ± 50 ppm continuous reference clock. ENET_RX_EN is used as the ENET_RX_EN in RMII. Other signals under RMII mode include ENET_TX_EN, ENET_TX_DATA[1:0], ENET_RX_DATA[1:0] and ENET_RX_ER.

Figure 47 shows RMII mode timings. Table 59 describes the timing parameters (M16–M21) shown in the figure.

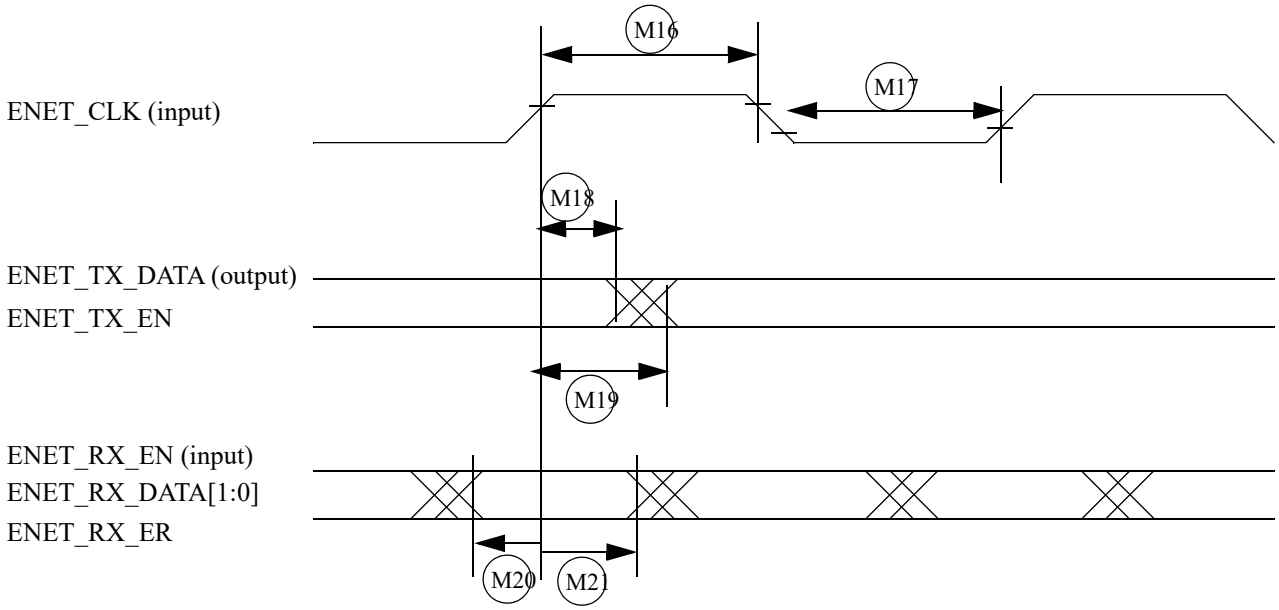


**Figure 47. RMII Mode Signal Timing Diagram**

**Table 59. RMII Signal Timing**

| ID | Characteristic | Min | Max | Unit |
|---|---|---|---|---|
| M16 | ENET_CLK pulse width high | 35% | 65% | ENET_CLK period |
| M17 | ENET_CLK pulse width low | 35% | 65% | ENET_CLK period |
| M18 | ENET_CLK to ENET0_TXD[1:0], ENET_TX_DATA invalid | 4 | — | ns |
| M19 | ENET_CLK to ENET0_TXD[1:0], ENET_TX_DATA valid | — | 15 | ns |
| M20 | ENET_RX_DATAD[1:0], ENET_RX_EN(ENET_RX_EN), ENET_RX_ER to ENET_CLK setup | 4 | — | ns |
| M21 | ENET_CLK to ENET_RX_DATAD[1:0], ENET_RX_EN, ENET_RX_ER hold | 2 | — | ns |

### 4.11.5.3 Signal Switching Specifications

The following timing specifications meet the requirements for RGMII interfaces for a range of transceiver devices.



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**Table 60. RGMII Signal Switching Specifications[1]**

| Symbol | Description | Min | Max | Unit |
|---|---|---|---|---|
| $T_{cyc}$[2] | Clock cycle duration | 7.2 | 8.8 | ns |
| $T_{skewT}$[3] | Data to clock output skew at transmitter | -500 | 500 | ps |
| $T_{skewR}$[3] | Data to clock input skew at receiver | 1 | 2.6 | ns |
| Duty_G[4] | Duty cycle for Gigabit | 45 | 55 | % |
| Duty_T[4] | Duty cycle for 10/100T | 40 | 60 | % |
| Tr/Tf | Rise/fall time (20–80%) | — | 0.75 | ns |

1 The timings assume the following configuration:
DDR_SEL = (11)b
DSE (drive-strength) = (111)b

2 For 10 Mbps and 100 Mbps, $T_{cyc}$ will scale to 400 ns ±40 ns and 40 ns ±4 ns respectively.

3 For all versions of RGMII prior to 2.0; This implies that PC board design will require clocks to be routed such that an additional trace delay of greater than 1.5 ns and less than 2.0 ns will be added to the associated clock signal. For 10/100, the Max value is unspecified.

4 Duty cycle may be stretched/shrunk during speed changes or while transitioning to a received packet's clock domain as long as minimum duty cycle is not violated and stretching occurs for no more than three Tcyc of the lowest speed transitioned between.

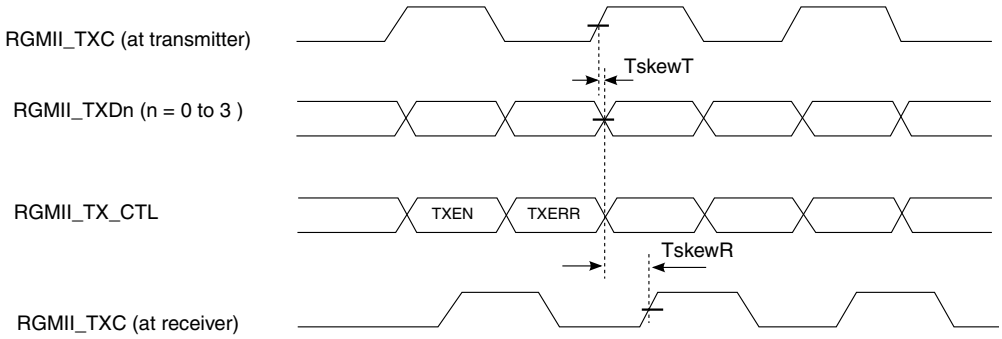


**Figure 48. RGMII Transmit Signal Timing Diagram Original**

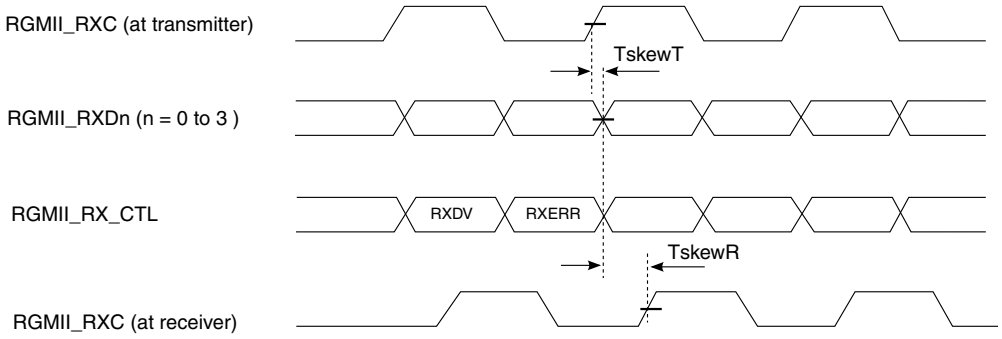


**Figure 49. RGMII Receive Signal Timing Diagram Original**



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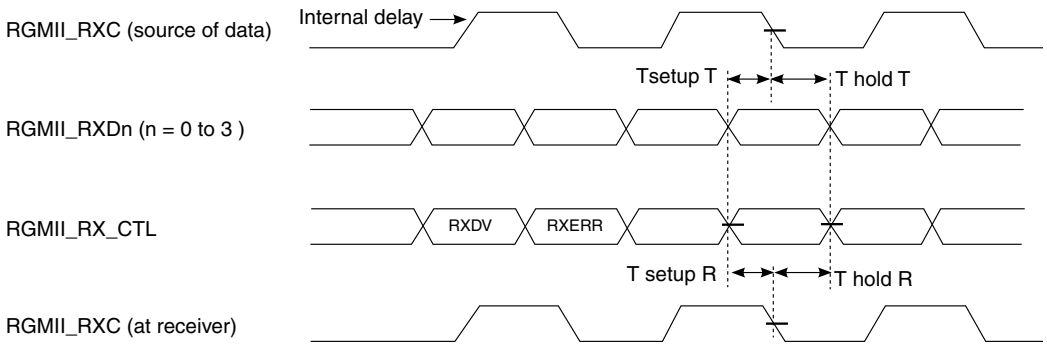


**Figure 50. RGMII Receive Signal Timing Diagram with Internal Delay**

## 4.11.6 Flexible Controller Area Network (FLEXCAN) AC Electrical Specifications

The Flexible Controller Area Network (FlexCAN) module is a communication controller implementing the CAN protocol according to the CAN 2.0B protocol specification. The processor has two CAN modules available for systems design. Tx and Rx ports for both modules are multiplexed with other I/O pins. See the IOMUXC chapter of the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)* to see which pins expose Tx and Rx pins; these ports are named FLEXCAN_TX and FLEXCAN_RX, respectively.

## 4.11.7 HDMI Module Timing Parameters

### 4.11.7.1 Latencies and Timing Information

Power-up time (time between TX_PWRON assertion and TX_READY assertion) for the HDMI 3D Tx PHY while operating with the slowest input reference clock supported (13.5 MHz) is 3.35 ms.

Power-up time for the HDMI 3D Tx PHY while operating with the fastest input reference clock supported (340 MHz) is 133 µs.

### 4.11.7.2 Electrical Characteristics

The table below provides electrical characteristics for the HDMI 3D Tx PHY. The following three figures illustrate various definitions and measurement conditions specified in the table below.



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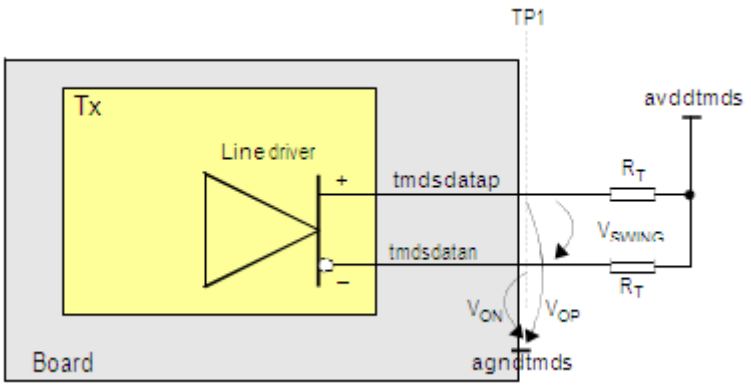


**Figure 51. Driver Measuring Conditions**

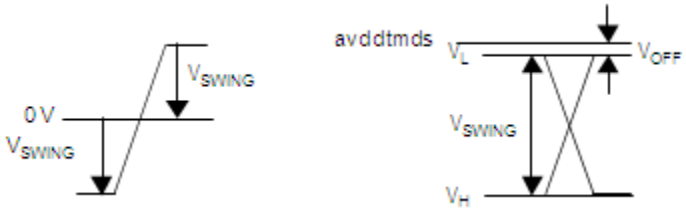


**Figure 52. Driver Definitions**

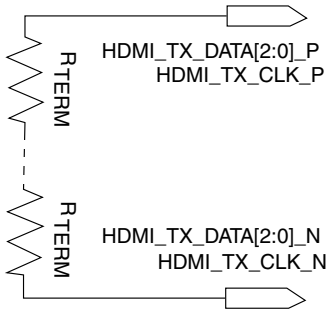


**Figure 53. Source Termination**

**Table 61. Electrical Characteristics**

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Operating conditions for HDMI** | | | | | | |
| avddtmds | Termination supply voltage | — | 3.15 | 3.3 | 3.45 | V |
| $R_T$ | Termination resistance | — | 45 | 50 | 55 | Ω |



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**Table 61. Electrical Characteristics (continued)**

| Symbol | Parameter | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TMDS drivers DC specifications** | | | | | | |
| $V_{OFF}$ | Single-ended standby voltage | RT = 50 Ω<br>For measurement conditions and definitions, see the first two figures above.<br>Compliance point TP1 as defined in the HDMI specification, version 1.3a, section 4.2.4. | avddtmds ± 10 mV | | | mV |
| $V_{SWING}$ | Single-ended output swing voltage | | 400 | — | 600 | mV |
| $V_H$ | Single-ended output high voltage<br>For definition, see the second figure above | If attached sink supports TMDSCLK < or = 165 MHz | avddtmds ± 10 mV | | | mV |
| | | If attached sink supports TMDSCLK > 165 MHz | avddtmds - 200 mV | — | avddtmds + 10 mV | mV |
| $V_L$ | Single-ended output low voltage<br>For definition, see the second figure above | If attached sink supports TMDSCLK < or = 165 MHz | avddtmds - 600 mV | — | avddtmds - 400mV | mV |
| | | If attached sink supports TMDSCLK > 165 MHz | avddtmds - 700 mV | — | avddtmds - 400 mV | mV |
| $R_{TERM}$ | Differential source termination load (inside HDMI 3D Tx PHY)<br>Although the HDMI 3D Tx PHY includes differential source termination, the user-defined value is set for each single line (for illustration, see Figure 53).<br>**Note:** $R_{TERM}$ can also be configured to be open and not present on TMDS channels. | — | 50 | — | 200 | Ω |
| **Hot plug detect specifications** | | | | | | |
| $HPD^{VH}$ | Hot plug detect high range | — | 2.0 | — | 5.3 | V |
| $^{VHPD}_{VL}$ | Hot plug detect low range | — | 0 | — | 0.8 | V |
| $HPD_Z$ | Hot plug detect input impedance | — | 10 | — | — | kΩ |
| $HPD_t$ | Hot plug detect time delay | — | — | — | 100 | µs |

## 4.11.8 Switching Characteristics

Table 62 describes switching characteristics for the HDMI 3D Tx PHY. Figure 54 to Figure 58 illustrate various parameters specified in table.

**NOTE**

All dynamic parameters related to the TMDS line drivers' performance imply the use of assembly guidelines.



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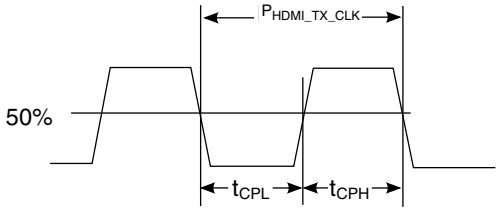


**Figure 54. TMDS Clock Signal Definitions**

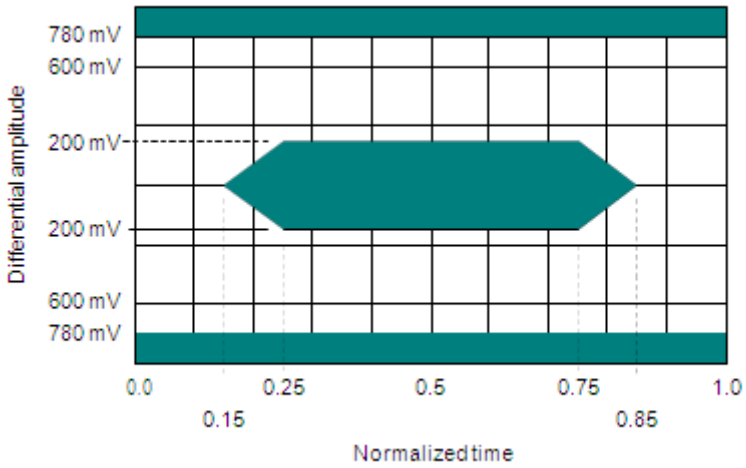


**Figure 55. Eye Diagram Mask Definition for HDMI Driver Signal Specification at TP1**

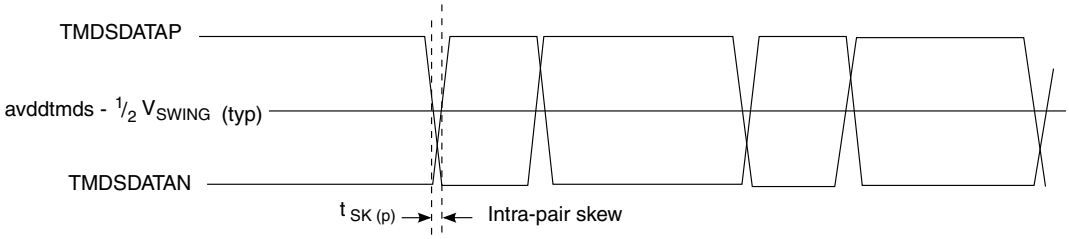


**Figure 56. Intra-Pair Skew Definition**

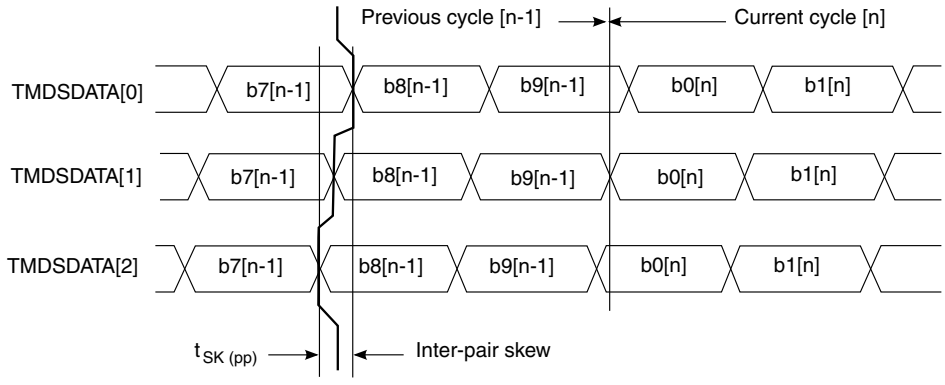


**Figure 57. Inter-Pair Skew Definition**



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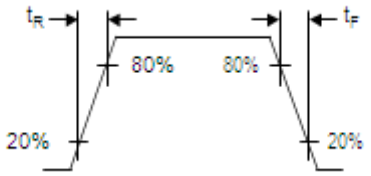


**Figure 58. TMDS Output Signals Rise and Fall Time Definition**

**Table 62. Switching Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TMDS Drivers Specifications** | | | | | | |
| — | Maximum serial data rate | — | — | — | 3.4 | Gbps |
| $F_{TMDSCLK}$ | TMDSCLK frequency | On TMDSCLKP/N outputs | 25 | — | 340 | MHz |
| $P_{TMDSCLK}$ | TMDSCLK period | RL = 50 Ω<br>See Figure 54. | 2.94 | — | 40 | ns |
| $t_{CDC}$ | TMDSCLK duty cycle | $t_{CDC} = t_{CPH} / P_{TMDSCLK}$<br>RL = 50 Ω<br>See Figure 54. | 40 | 50 | 60 | % |
| $t_{CPH}$ | TMDSCLK high time | RL = 50 Ω<br>See Figure 54. | 4 | 5 | 6 | UI[1] |
| $t_{CPL}$ | TMDSCLK low time | RL = 50 Ω<br>See Figure 54. | 4 | 5 | 6 | UI[1] |
| — | TMDSCLK jitter[2] | RL = 50 Ω | — | — | 0.25 | UI[1] |
| $t_{SK(p)}$ | Intra-pair (pulse) skew | RL = 50 Ω<br>See Figure 56. | — | — | 0.15 | UI[1] |
| $t_{SK(pp)}$ | Inter-pair skew | RL = 50 Ω<br>See Figure 57. | — | — | 1 | UI[1] |
| $t_R$ | Differential output signal rise time | 20–80%<br>RL = 50 Ω<br>See Figure 58. | 75 | — | 0.4 UI | ps |
| $t_F$ | Differential output signal fall time | 20–80%<br>RL = 50 Ω<br>See Figure 58. | 75 | — | 0.4 UI | ps |
| — | Differential signal overshoot | Referred to 2x $V_{SWING}$ | — | — | 15 | % |
| — | Differential signal undershoot | Referred to 2x $V_{SWING}$ | — | — | 25 | % |

1 UI means TMDS clock unit.

2 Relative to ideal recovery clock, as specified in the HDMI specification, version 1.4a, section 4.2.3.



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## 4.11.9 I²C Module Timing Parameters

This section describes the timing parameters of the I²C module. Figure 59 depicts the timing of I²C module, and Table 63 lists the I²C module timing characteristics.

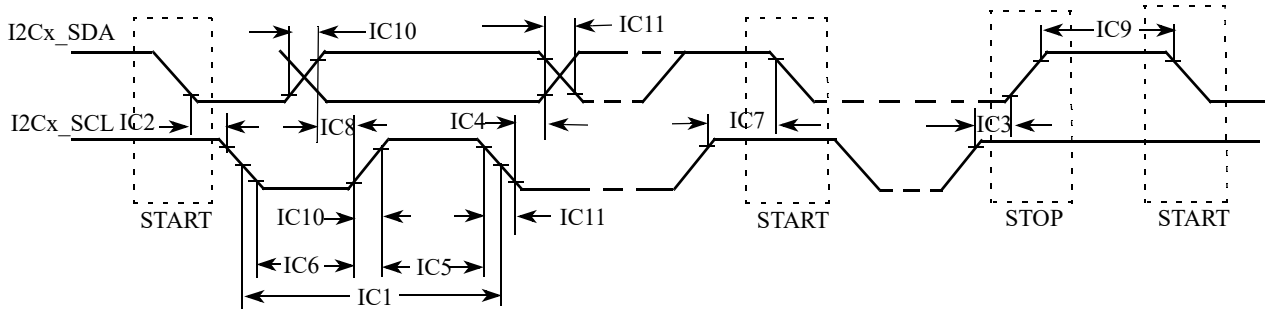


**Figure 59. I²C Bus Timing**

**Table 63. I²C Module Timing Parameters**

| ID | Parameter | Standard Mode | | Fast Mode | | Unit |
|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | |
| IC1 | I2Cx_SCL cycle time | 10 | — | 2.5 | — | µs |
| IC2 | Hold time (repeated) START condition | 4.0 | — | 0.6 | — | µs |
| IC3 | Set-up time for STOP condition | 4.0 | — | 0.6 | — | µs |
| IC4 | Data hold time | 0[1] | 3.45[2] | 0[1] | 0.9[2] | µs |
| IC5 | HIGH Period of I2Cx_SCL Clock | 4.0 | — | 0.6 | — | µs |
| IC6 | LOW Period of the I2Cx_SCL Clock | 4.7 | — | 1.3 | — | µs |
| IC7 | Set-up time for a repeated START condition | 4.7 | — | 0.6 | — | µs |
| IC8 | Data set-up time | 250 | — | 100[3] | — | ns |
| IC9 | Bus free time between a STOP and START condition | 4.7 | — | 1.3 | — | µs |
| IC10 | Rise time of both I2Cx_SDA and I2Cx_SCL signals | — | 1000 | $20 + 0.1C_b$[4] | 300 | ns |
| IC11 | Fall time of both I2Cx_SDA and I2Cx_SCL signals | — | 300 | $20 + 0.1C_b$[4] | 300 | ns |
| IC12 | Capacitive load for each bus line ($C_b$) | — | 400 | — | 400 | pF |

1 A device must internally provide a hold time of at least 300 ns for I2Cx_SDA signal to bridge the undefined region of the falling edge of I2Cx_SCL.

2 The maximum hold time has only to be met if the device does not stretch the LOW period (ID no IC5) of the I2Cx_SCL signal.

3 A Fast-mode I²C-bus device can be used in a Standard-mode I²C-bus system, but the requirement of Set-up time (ID No IC7) of 250 ns must be met. This automatically is the case if the device does not stretch the LOW period of the I2Cx_SCL signal. If such a device does stretch the LOW period of the I2Cx_SCL signal, it must output the next data bit to the I2Cx_SDA line max_rise_time (IC9) + data_setup_time (IC7) = 1000 + 250 = 1250 ns (according to the Standard-mode I²C-bus specification) before the I2Cx_SCL line is released.

4 $C_b$ = total capacitance of one bus line in pF.



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## 4.11.10 Image Processing Unit (IPU) Module Parameters

The purpose of the IPU is to provide comprehensive support for the flow of data from an image sensor and/or to a display device. This support covers all aspects of these activities:

- Connectivity to relevant devices—cameras, displays, graphics accelerators, and TV encoders.
- Related image processing and manipulation: sensor image signal processing, display processing, image conversions, and other related functions.
- Synchronization and control capabilities, such as avoidance of tearing artifacts.

### 4.11.10.1 IPU Sensor Interface Signal Mapping

The IPU supports a number of sensor input formats. Table 64 defines the mapping of the Sensor Interface Pins used for various supported interface formats.

**Table 64. Camera Input Signal Cross Reference, Format, and Bits Per Cycle**

| Signal Name[1] | RGB565 8 bits 2 cycles | RGB565[2] 8 bits 3 cycles | RGB666[3] 8 bits 3 cycles | RGB888 8 bits 3 cycles | YCbCr[4] 8 bits 2 cycles | RGB565[5] 16 bits 1 cycle | YCbCr[6] 16 bits 1 cycle | YCbCr[7] 16 bits 1 cycle | YCbCr[8] 20 bits 1 cycle |
|---|---|---|---|---|---|---|---|---|---|
| IPUx_CSIx_ DATA00 | — | — | — | — | — | — | — | 0 | C[0] |
| IPUx_CSIx_ DATA01 | — | — | — | — | — | — | — | 0 | C[1] |
| IPUx_CSIx_ DATA02 | — | — | — | — | — | — | — | C[0] | C[2] |
| IPUx_CSIx_ DATA03 | — | — | — | — | — | — | — | C[1] | C[3] |
| IPUx_CSIx_ DATA04 | — | — | — | — | — | B[0] | C[0] | C[2] | C[4] |
| IPUx_CSIx_ DATA05 | — | — | — | — | — | B[1] | C[1] | C[3] | C[5] |
| IPUx_CSIx_ DATA06 | — | — | — | — | — | B[2] | C[2] | C[4] | C[6] |
| IPUx_CSIx_ DATA07 | — | — | — | — | — | B[3] | C[3] | C[5] | C[7] |
| IPUx_CSIx_ DATA08 | — | — | — | — | — | B[4] | C[4] | C[6] | C[8] |
| IPUx_CSIx_ DATA09 | — | — | — | — | — | G[0] | C[5] | C[7] | C[9] |
| IPUx_CSIx_ DATA10 | — | — | — | — | — | G[1] | C[6] | 0 | Y[0] |
| IPUx_CSIx_ DATA11 | — | — | — | — | — | G[2] | C[7] | 0 | Y[1] |
| IPUx_CSIx_ DATA12 | B[0], G[3] | R[2],G[4],B[2] | R/G/B[4] | R/G/B[0] | Y/C[0] | G[3] | Y[0] | Y[0] | Y[2] |



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**Table 64. Camera Input Signal Cross Reference, Format, and Bits Per Cycle (continued)**

| Signal Name[1] | RGB565 8 bits 2 cycles | RGB565[2] 8 bits 3 cycles | RGB666[3] 8 bits 3 cycles | RGB888 8 bits 3 cycles | YCbCr[4] 8 bits 2 cycles | RGB565[5] 16 bits 1 cycle | YCbCr[6] 16 bits 1 cycle | YCbCr[7] 16 bits 1 cycle | YCbCr[8] 20 bits 1 cycle |
|---|---|---|---|---|---|---|---|---|---|
| IPUx_CSIx_ DATA13 | B[1], G[4] | R[3],G[5],B[3] | R/G/B[5] | R/G/B[1] | Y/C[1] | G[4] | Y[1] | Y[1] | Y[3] |
| IPUx_CSIx_ DATA14 | B[2], G[5] | R[4],G[0],B[4] | R/G/B[0] | R/G/B[2] | Y/C[2] | G[5] | Y[2] | Y[2] | Y[4] |
| IPUx_CSIx_ DATA15 | B[3], R[0] | R[0],G[1],B[0] | R/G/B[1] | R/G/B[3] | Y/C[3] | R[0] | Y[3] | Y[3] | Y[5] |
| IPUx_CSIx_ DATA16 | B[4], R[1] | R[1],G[2],B[1] | R/G/B[2] | R/G/B[4] | Y/C[4] | R[1] | Y[4] | Y[4] | Y[6] |
| IPUx_CSIx_ DATA17 | G[0], R[2] | R[2],G[3],B[2] | R/G/B[3] | R/G/B[5] | Y/C[5] | R[2] | Y[5] | Y[5] | Y[7] |
| IPUx_CSIx_ DATA18 | G[1], R[3] | R[3],G[4],B[3] | R/G/B[4] | R/G/B[6] | Y/C[6] | R[3] | Y[6] | Y[6] | Y[8] |
| IPUx_CSIx_ DATA19 | G[2], R[4] | R[4],G[5],B[4] | R/G/B[5] | R/G/B[7] | Y/C[7] | R[4] | Y[7] | Y[7] | Y[9] |

1 IPUx_CSIx stands for IPUx_CSI0 or IPUx_CSI1.

2 The MSB bits are duplicated on LSB bits implementing color extension.

3 The two MSB bits are duplicated on LSB bits implementing color extension.

4 YCbCr, 8 bits—Supported within the BT.656 protocol (sync embedded within the data stream).

5 RGB 16 bits—Supported in two ways: (1) As a “generic data” input, with no on-the-fly processing; (2) With on-the-fly processing, but only under some restrictions on the control protocol.

6 YCbCr 16 bits—Supported as a “generic-data” input, with no on-the-fly processing.

7 YCbCr 16 bits—Supported as a sub-case of the YCbCr, 20 bits, under the same conditions (BT.1120 protocol).

8 YCbCr, 20 bits—Supported only within the BT.1120 protocol (syncs embedded within the data stream).

## 4.11.10.2 Sensor Interface Timings

There are three camera timing modes supported by the IPU.

### 4.11.10.2.1 BT.656 and BT.1120 Video Mode

Smart camera sensors, which include imaging processing, usually support video mode transfer. They use an embedded timing syntax to replace the IPUx_CSIx_VSYNC and IPUx_CSIx_HSYNC signals. The timing syntax is defined by the BT.656/BT.1120 standards.

This operation mode follows the recommendations of ITU BT.656/ ITU BT.1120 specifications. The only control signal used is IPUx_CSIx_PIX_CLK. Start-of-frame and active-line signals are embedded in the data stream. An active line starts with a SAV code and ends with a EAV code. In some cases, digital blanking is inserted in between EAV and SAV code. The CSI decodes and filters out the timing-coding from the data stream, thus recovering IPUx_CSIx_VSYNC and IPUx_CSIx_HSYNC signals for internal use. On BT.656 one component per cycle is received over the IPUx_CSIx_DATA_EN bus. On BT.1120 two components per cycle are received over the IPUx_CSIx_DATA_EN bus.



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#### 4.11.10.2.2 Gated Clock Mode

The IPUx_CSIx_VSYNC, IPUx_CSIx_HSYNC, and IPUx_CSIx_PIX_CLK signals are used in this mode. See Figure 60.

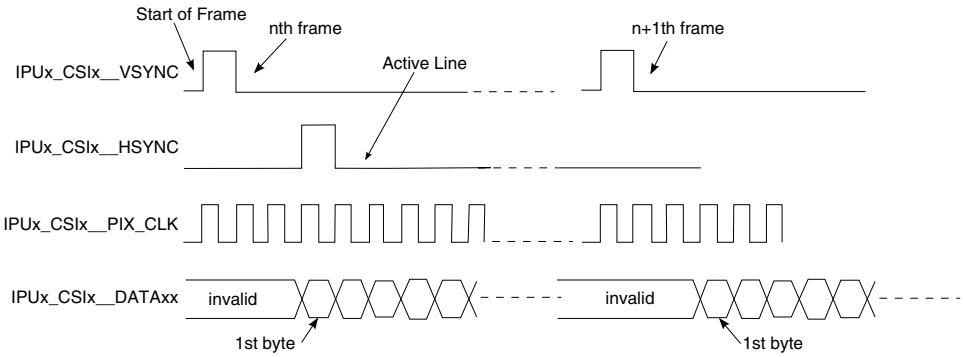


**Figure 60. Gated Clock Mode Timing Diagram**

A frame starts with a rising edge on IPUx_CSIx_VSYNC (all the timings correspond to straight polarity of the corresponding signals). Then IPUx_CSIx_HSYNC goes to high and hold for the entire line. Pixel clock is valid as long as IPUx_CSIx_HSYNC is high. Data is latched at the rising edge of the valid pixel clocks. IPUx_CSIx_HSYNC goes to low at the end of line. Pixel clocks then become invalid and the CSI stops receiving data from the stream. For the next line, the IPUx_CSIx_HSYNC timing repeats. For the next frame, the IPUx_CSIx_VSYNC timing repeats.

#### 4.11.10.2.3 Non-Gated Clock Mode

The timing is the same as the gated-clock mode (described in Section 4.11.10.2.2, "Gated Clock Mode,") except for the IPUx_CSIx_HSYNC signal, which is not used (see Figure 61). All incoming pixel clocks are valid and cause data to be latched into the input FIFO. The IPUx_CSIx_PIX_CLK signal is inactive (states low) until valid data is going to be transmitted over the bus.

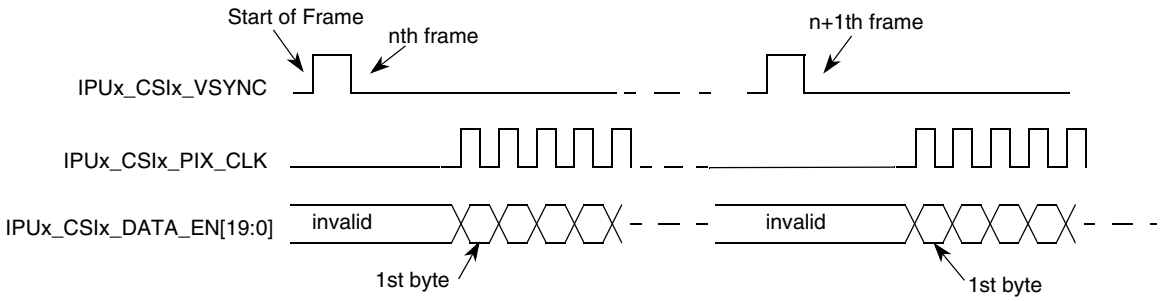


**Figure 61. Non-Gated Clock Mode Timing Diagram**

The timing described in Figure 61 is that of a typical sensor. Some other sensors may have a slightly different timing. The CSI can be programmed to support rising/falling-edge triggered IPUx_CSIx_VSYNC; active-high/low IPUx_CSIx_HSYNC; and rising/falling-edge triggered IPUx_CSIx_PIX_CLK.



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### 4.11.10.3 Electrical Characteristics

Figure 62 depicts the sensor interface timing. IPUx_CSIx_PIX_CLK signal described here is not generated by the IPU. Table 65 lists the sensor interface timing characteristics.

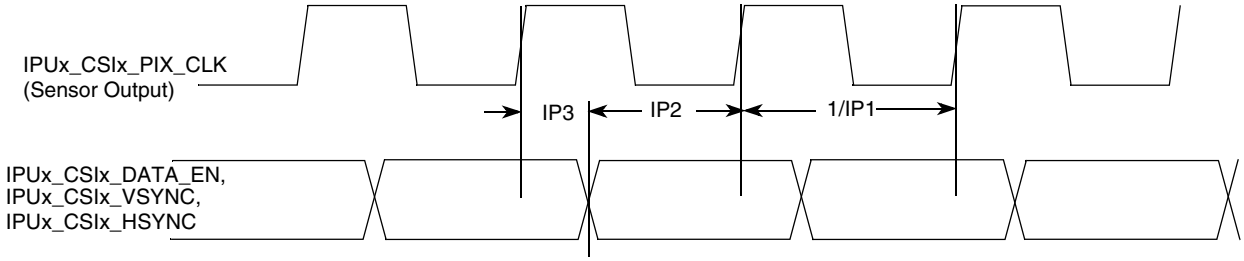


**Figure 62. Sensor Interface Timing Diagram**

**Table 65. Sensor Interface Timing Characteristics**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| IP1 | Sensor output (pixel) clock frequency | Fpck | 0.01 | 180 | MHz |
| IP2 | Data and control setup time | Tsu | 2 | — | ns |
| IP3 | Data and control holdup time | Thd | 1 | — | ns |

### 4.11.10.4 IPU Display Interface Signal Mapping

The IPU supports a number of display output video formats. Table 66 defines the mapping of the Display Interface Pins used during various supported video interface formats.

**Table 66. Video Signal Cross-Reference**

| i.MX 6Solo/6DualLite | LCD | | | | | | | Comment[1,2] |
|---|---|---|---|---|---|---|---|---|
| Port Name (x=0, 1) | RGB, Signal Name (General) | RGB/TV Signal Allocation (Example) | | | | | | |
| | | 16-bit RGB | 18-bit RGB | 24 Bit RGB | 8-bit YCrCb[3] | 16-bit YCrCb | 20-bit YCrCb | |
| IPUx_DISPx_DAT00 | DAT[0] | B[0] | B[0] | B[0] | Y/C[0] | C[0] | C[0] | — |
| IPUx_DISPx_DAT01 | DAT[1] | B[1] | B[1] | B[1] | Y/C[1] | C[1] | C[1] | — |
| IPUx_DISPx_DAT02 | DAT[2] | B[2] | B[2] | B[2] | Y/C[2] | C[2] | C[2] | — |
| IPUx_DISPx_DAT03 | DAT[3] | B[3] | B[3] | B[3] | Y/C[3] | C[3] | C[3] | — |
| IPUx_DISPx_DAT04 | DAT[4] | B[4] | B[4] | B[4] | Y/C[4] | C[4] | C[4] | — |
| IPUx_DISPx_DAT05 | DAT[5] | G[0] | B[5] | B[5] | Y/C[5] | C[5] | C[5] | — |
| IPUx_DISPx_DAT06 | DAT[6] | G[1] | G[0] | B[6] | Y/C[6] | C[6] | C[6] | — |



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**Table 66. Video Signal Cross-Reference (continued)**

| i.MX 6Solo/6DualLite | LCD | | | | | | | Comment[1,2] |
|---|---|---|---|---|---|---|---|---|
| Port Name (x=0, 1) | RGB, Signal Name (General) | RGB/TV Signal Allocation (Example) | | | | | | |
| | | 16-bit RGB | 18-bit RGB | 24 Bit RGB | 8-bit YCrCb[3] | 16-bit YCrCb | 20-bit YCrCb | |
| IPUx_DISPx_DAT07 | DAT[7] | G[2] | G[1] | B[7] | Y/C[7] | C[7] | C[7] | — |
| IPUx_DISPx_DAT08 | DAT[8] | G[3] | G[2] | G[0] | — | Y[0] | C[8] | — |
| IPUx_DISPx_DAT09 | DAT[9] | G[4] | G[3] | G[1] | — | Y[1] | C[9] | — |
| IPUx_DISPx_DAT10 | DAT[10] | G[5] | G[4] | G[2] | — | Y[2] | Y[0] | — |
| IPUx_DISPx_DAT11 | DAT[11] | R[0] | G[5] | G[3] | — | Y[3] | Y[1] | — |
| IPUx_DISPx_DAT12 | DAT[12] | R[1] | R[0] | G[4] | — | Y[4] | Y[2] | — |
| IPUx_DISPx_DAT13 | DAT[13] | R[2] | R[1] | G[5] | — | Y[5] | Y[3] | — |
| IPUx_DISPx_DAT14 | DAT[14] | R[3] | R[2] | G[6] | — | Y[6] | Y[4] | — |
| IPUx_DISPx_DAT15 | DAT[15] | R[4] | R[3] | G[7] | — | Y[7] | Y[5] | — |
| IPUx_DISPx_DAT16 | DAT[16] | — | R[4] | R[0] | — | — | Y[6] | — |
| IPUx_DISPx_DAT17 | DAT[17] | — | R[5] | R[1] | — | — | Y[7] | — |
| IPUx_DISPx_DAT18 | DAT[18] | — | — | R[2] | — | — | Y[8] | — |
| IPUx_DISPx_DAT19 | DAT[19] | — | — | R[3] | — | — | Y[9] | — |
| IPUx_DISPx_DAT20 | DAT[20] | — | — | R[4] | — | — | — | — |
| IPUx_DISPx_DAT21 | DAT[21] | — | — | R[5] | — | — | — | — |
| IPUx_DISPx_DAT22 | DAT[22] | — | — | R[6] | — | — | — | — |
| IPUx_DISPx_DAT23 | DAT[23] | — | — | R[7] | — | — | — | — |
| DIx_DISP_CLK | PixCLK | | | | | | | — |
| DIx_PIN1 | — | | | | | | | May be required for anti-tearing |
| DIx_PIN2 | HSYNC | | | | | | | — |
| DIx_PIN3 | VSYNC | | | | | | | VSYNC out |



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**Table 66. Video Signal Cross-Reference (continued)**

| i.MX 6Solo/6DualLite | LCD | | | | | | Comment[1,2] |
|---|---|---|---|---|---|---|---|
| Port Name (x=0, 1) | RGB, Signal Name (General) | RGB/TV Signal Allocation (Example) | | | | | |
| | | 16-bit RGB | 18-bit RGB | 24 Bit RGB | 8-bit YCrCb[3] | 16-bit YCrCb | 20-bit YCrCb | |
| DIx_PIN4 | — | | | | | | Additional frame/row synchronous signals with programmable timing |
| DIx_PIN5 | — | | | | | | |
| DIx_PIN6 | — | | | | | | |
| DIx_PIN7 | — | | | | | | |
| DIx_PIN8 | — | | | | | | |
| DIx_D0_CS | — | | | | | | — |
| DIx_D1_CS | — | | | | | | Alternate mode of PWM output for contrast or brightness control |
| DIx_PIN11 | — | | | | | | — |
| DIx_PIN12 | — | | | | | | — |
| DIx_PIN13 | — | | | | | | Register select signal |
| DIx_PIN14 | — | | | | | | Optional RS2 |
| DIx_PIN15 | DRDY/DV | | | | | | Data validation/blank, data enable |
| DIx_PIN16 | — | | | | | | Additional data synchronous signals with programmable features/timing |
| DIx_PIN17 | Q | | | | | | |

1 Signal mapping (both data and control/synchronization) is flexible. The table provides examples.

2 Restrictions for ports IPUx_DISPx_DAT00 through IPUx_DISPx_DAT23 are as follows:
- A maximum of three continuous groups of bits can be independently mapped to the external bus. Groups must not overlap.
- The bit order is expressed in each of the bit groups, for example, B[0] = least significant blue pixel bit.

3 This mode works in compliance with recommendation ITU-R BT.656. The timing reference signals (frame start, frame end, line start, and line end) are embedded in the 8-bit data bus. Only video data is supported, transmission of non-video related data during blanking intervals is not supported.

**NOTE**

Table 66 provides information for both the DISP0 and DISP1 ports. However, DISP1 port has reduced pinout depending on IOMUXC configuration and therefore may not support all the above configurations. See the IOMUXC chapter of the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)*.

### 4.11.10.5 IPU Display Interface Timing

The IPU Display Interface supports two kinds of display accesses: synchronous and asynchronous. There are two groups of external interface pins to provide synchronous and asynchronous controls accordantly.



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#### 4.11.10.5.1 Synchronous Controls

The synchronous control changes its value as a function of a system or of an external clock. This control has a permanent period and a permanent wave form.

There are special physical outputs to provide synchronous controls:

- The IPP_DISP_CLK is a dedicated base synchronous signal that is used to generate a base display (component, pixel) clock for a display.
- The IPUx_DIx_PIN01—IPUx_DIx_PIN07 are general purpose synchronous pins, that can be used to provide HSYNC, VSYNC, DRDY or any other independent signal to a display.

The IPU has a system of internal binding counters for internal events (such as, HSYNC/VSYNC) calculation. The internal event (local start point) is synchronized with internal DI_CLK. A suitable control starts from the local start point with predefined UP and DOWN values to calculate control's changing points with half DI_CLK resolution. A full description of the counters system can be found in the IPU chapter of the *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)*.

#### 4.11.10.5.2 Asynchronous Controls

The asynchronous control is a data-oriented signal that changes its value with an output data according to additional internal flags coming with the data.

There are special physical outputs to provide asynchronous controls, as follows:

- The IPUx_DIx_D0_CS and IPUx_DIx_D1_CS pins are dedicated to provide chip select signals to two displays.
- The IPUx_DIx_PIN11—IPUx_DIx_PIN17 are general purpose asynchronous pins, that can be used to provide WR. RD, RS or any other data oriented signal to display.

**NOTE**

The IPU has independent signal generators for asynchronous signals toggling. When a DI decides to put a new asynchronous data in the bus, a new internal start (local start point) is generated. The signals generators calculate predefined UP and DOWN values to change pins states with half DI_CLK resolution.

### 4.11.10.6 Synchronous Interfaces to Standard Active Matrix TFT LCD Panels

#### 4.11.10.6.1 IPU Display Operating Signals

The IPU uses four control signals and data to operate a standard synchronous interface:

- IPP_DISP_CLK—Clock to display
- HSYNC—Horizontal synchronization
- VSYNC—Vertical synchronization
- DRDY—Active data

All synchronous display controls are generated on the base of an internally generated "local start point". The synchronous display controls can be placed on time axis with DI's offset, up and down parameters.



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The display access can be whole number of DI clock (Tdiclk) only. The IPP_DATA can not be moved relative to the local start point. The data bus of the synchronous interface is output direction only.

### 4.11.10.6.2 LCD Interface Functional Description

Figure 63 depicts the LCD interface timing for a generic active matrix color TFT panel. In this figure, signals are shown with negative polarity. The sequence of events for active matrix interface timing is:

- DI_CLK internal DI clock is used for calculation of other controls.
- IPP_DISP_CLK latches data into the panel on its negative edge (when positive polarity is selected). In active mode, IPP_DISP_CLK runs continuously.
- HSYNC causes the panel to start a new line. (Usually IPUx_DIx_PIN02 is used as HSYNC.)
- VSYNC causes the panel to start a new frame. It always encompasses at least one HSYNC pulse. (Usually IPUx_DIx_PIN03 is used as VSYNC.)
- DRDY acts like an output enable signal to the CRT display. This output enables the data to be shifted onto the display. When disabled, the data is invalid and the trace is off.
  (DRDY can be used either synchronous or asynchronous generic purpose pin as well.)

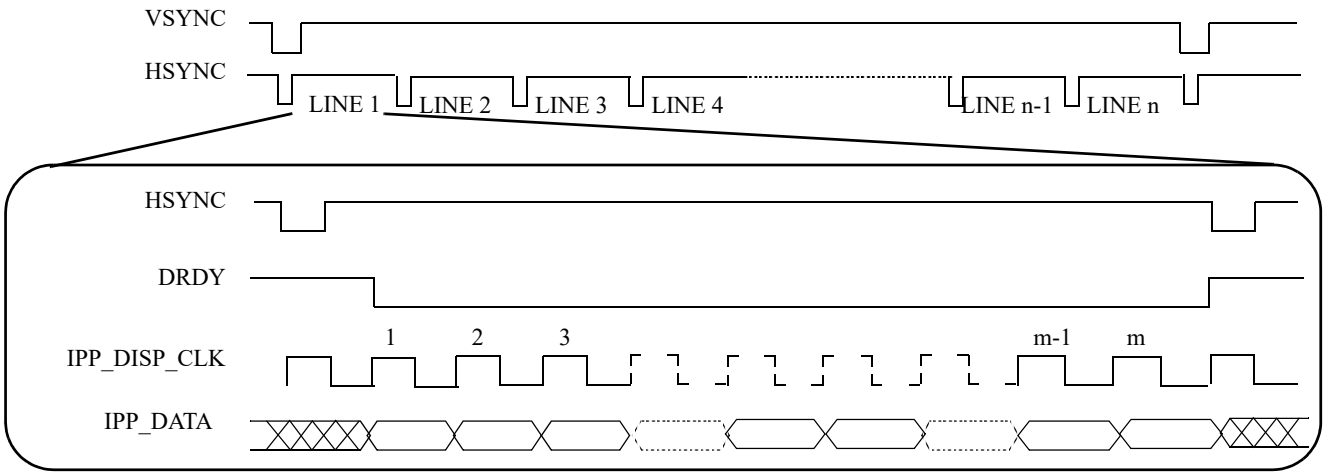


**Figure 63. Interface Timing Diagram for TFT (Active Matrix) Panels**

### 4.11.10.6.3 TFT Panel Sync Pulse Timing Diagrams

Figure 64 depicts the horizontal timing (timing of one line), including both the horizontal sync pulse and the data. All the parameters shown in the figure are programmable. All controls are started by



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corresponding internal events—local start points. The timing diagrams correspond to inverse polarity of the IPP_DISP_CLK signal and active-low polarity of the HSYNC, VSYNC, and DRDY signals.

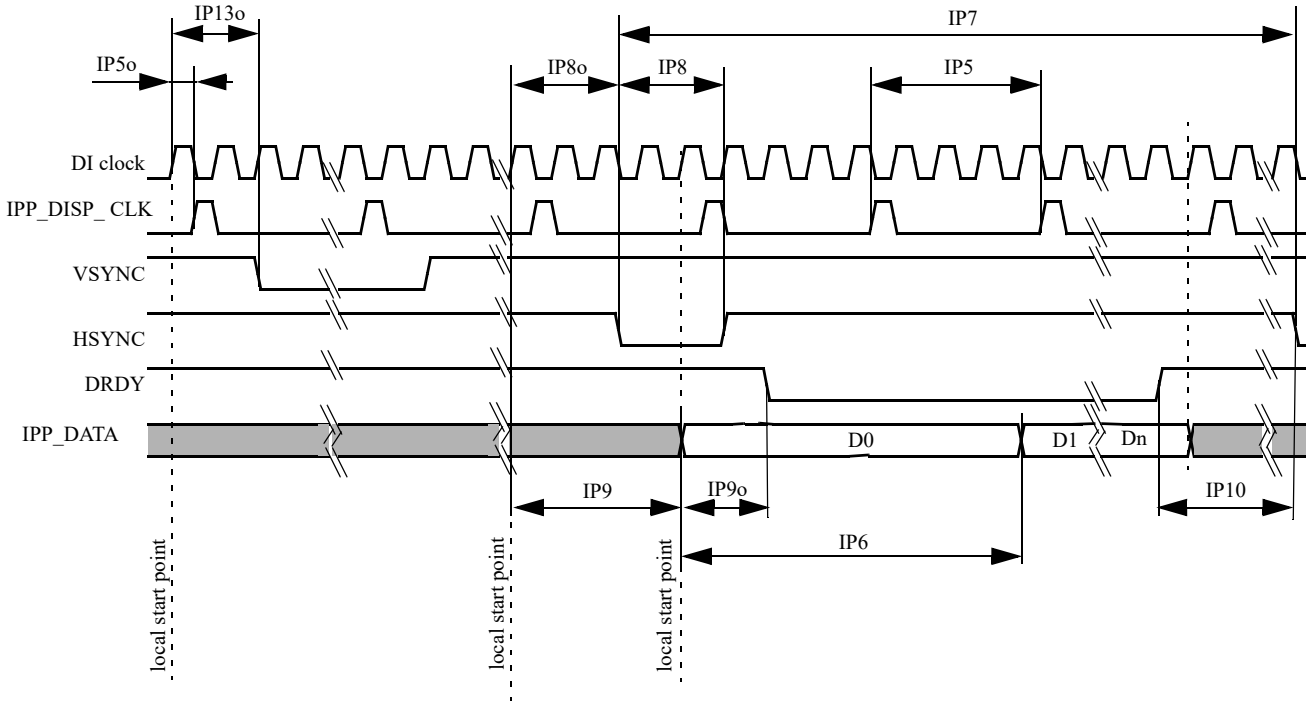


**Figure 64. TFT Panels Timing Diagram—Horizontal Sync Pulse**

Figure 65 depicts the vertical timing (timing of one frame). All parameters shown in the figure are programmable.

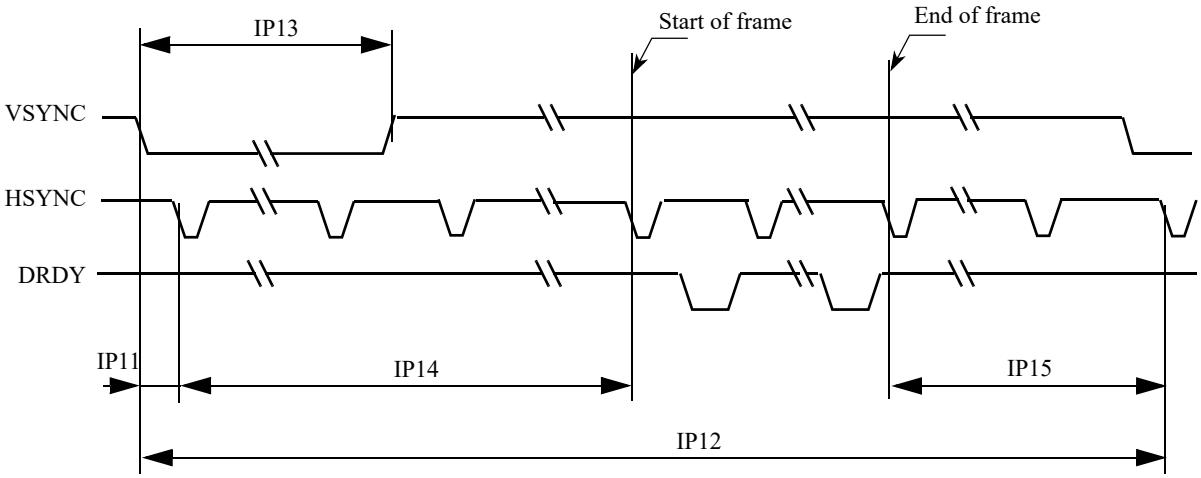


**Figure 65. TFT Panels Timing Diagram—Vertical Sync Pulse**



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Table 67 shows timing characteristics of signals presented in Figure 64 and Figure 65.

**Table 67. Synchronous Display Interface Timing Characteristics (Pixel Level)**

| ID | Parameter | Symbol | Value | Description | Unit |
|---|---|---|---|---|---|
| IP5 | Display interface clock period | Tdicp | ([1]) | Display interface clock. IPP_DISP_CLK | ns |
| IP6 | Display pixel clock period | Tdpcp | DISP_CLK_PER_PIXEL × Tdicp | Time of translation of one pixel to display, DISP_CLK_PER_PIXEL—number of pixel components in one pixel (1.n). The DISP_CLK_PER_PIXEL is virtual parameter to define Display pixel clock period.<br>The DISP_CLK_PER_PIXEL is received by DC/DI one access division to **n** components. | ns |
| IP7 | Screen width time | Tsw | (SCREEN_WIDTH) × Tdicp | SCREEN_WIDTH—screen width in, interface clocks. horizontal blanking included.<br>The SCREEN_WIDTH should be built by suitable DI's counter[2]. | ns |
| IP8 | HSYNC width time | Thsw | (HSYNC_WIDTH) | HSYNC_WIDTH—Hsync width in DI_CLK with 0.5 DI_CLK resolution. Defined by DI's counter. | ns |
| IP9 | Horizontal blank interval 1 | Thbi1 | BGXP × Tdicp | BGXP—width of a horizontal blanking before a first active data in a line (in interface clocks). The BGXP should be built by suitable DI's counter. | ns |
| IP10 | Horizontal blank interval 2 | Thbi2 | (SCREEN_WIDTH - BGXP - FW) × Tdicp | Width a horizontal blanking after a last active data in a line (in interface clocks)<br>FW—with of active line in interface clocks. The FW should be built by suitable DI's counter. | ns |
| IP12 | Screen height | Tsh | (SCREEN_HEIGHT) × Tsw | SCREEN_HEIGHT— screen height in lines with blanking.<br>The SCREEN_HEIGHT is a distance between 2 VSYNCs.<br>The SCREEN_HEIGHT should be built by suitable DI's counter. | ns |
| IP13 | VSYNC width | Tvsw | VSYNC_WIDTH | VSYNC_WIDTH—Vsync width in DI_CLK with 0.5 DI_CLK resolution. Defined by DI's counter | ns |
| IP14 | Vertical blank interval 1 | Tvbi1 | BGYP × Tsw | BGYP—width of first Vertical blanking interval in line. The BGYP should be built by suitable DI's counter. | ns |
| IP15 | Vertical blank interval 2 | Tvbi2 | (SCREEN_HEIGHT - BGYP - FH) × Tsw | Width of second Vertical blanking interval in line. The FH should be built by suitable DI's counter. | ns |
| IP5o | Offset of IPP_DISP_CLK | Todicp | DISP_CLK_OFFSET × Tdiclk | DISP_CLK_OFFSET—offset of IPP_DISP_CLK edges from local start point, in DI_CLK×2 (0.5 DI_CLK Resolution).<br>Defined by DISP_CLK counter | ns |



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**Table 67. Synchronous Display Interface Timing Characteristics (Pixel Level) (continued)**

| ID | Parameter | Symbol | Value | Description | Unit |
|---|---|---|---|---|---|
| IP13o | Offset of VSYNC | Tovs | VSYNC_OFFSET × Tdiclk | VSYNC_OFFSET—offset of Vsync edges from a local start point, when a Vsync should be active, in DI_CLK×2 (0.5 DI_CLK Resolution). The VSYNC_OFFSET should be built by suitable DI's counter. | ns |
| IP8o | Offset of HSYNC | Tohs | HSYNC_OFFSET × Tdiclk | HSYNC_OFFSET—offset of Hsync edges from a local start point, when a Hsync should be active, in DI_CLK×2 (0.5 DI_CLK Resolution). The HSYNC_OFFSET should be built by suitable DI's counter. | ns |
| IP9o | Offset of DRDY | Todrdy | DRDY_OFFSET × Tdiclk | DRDY_OFFSET—offset of DRDY edges from a suitable local start point, when a corresponding data has been set on the bus, in DI_CLK×2 (0.5 DI_CLK Resolution). The DRDY_OFFSET should be built by suitable DI's counter. | ns |

[1]Display interface clock period immediate value.

$$Tdicp = \begin{cases} T_{diclk} \times \dfrac{DISP_CLK_PERIOD}{DI_CLK_PERIOD}, & \text{for integer } \dfrac{DISP_CLK_PERIOD}{DI_CLK_PERIOD} \\ T_{diclk}\left(\text{floor}\left[\dfrac{DISP_CLK_PERIOD}{DI_CLK_PERIOD}\right] + 0.5 \pm 0.5\right), & \text{for fractional } \dfrac{DISP_CLK_PERIOD}{DI_CLK_PERIOD} \end{cases}$$

DISP_CLK_PERIOD—number of DI_CLK per one Tdicp. Resolution 1/16 of DI_CLK.
DI_CLK_PERIOD—relation of between programing clock frequency and current system clock frequency
Display interface clock period average value.

$$\overline{T}dicp = T_{diclk} \times \frac{DISP_CLK_PERIOD}{DI_CLK_PERIOD}$$

[2] DI's counter can define offset, period and UP/DOWN characteristic of output signal according to programed parameters of the counter. Same of parameters in the table are not defined by DI's registers directly (by name), but can be generated by corresponding DI's counter. The SCREEN_WIDTH is an input value for DI's HSYNC generation counter. The distance between HSYNCs is a SCREEN_WIDTH.

The maximum accuracy of UP/DOWN edge of controls is:

$$Accuracy = (0.5 \times T_{diclk}) \pm 0.62ns$$

The maximum accuracy of UP/DOWN edge of IPP_DATA is:

$$Accuracy = T_{diclk} \pm 0.62ns$$

The DISP_CLK_PERIOD, DI_CLK_PERIOD parameters are programmed through the registers.



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Figure 66 depicts the synchronous display interface timing for access level. The DISP_CLK_DOWN and DISP_CLK_UP parameters are set through the Register. Table 68 lists the synchronous display interface timing characteristics.

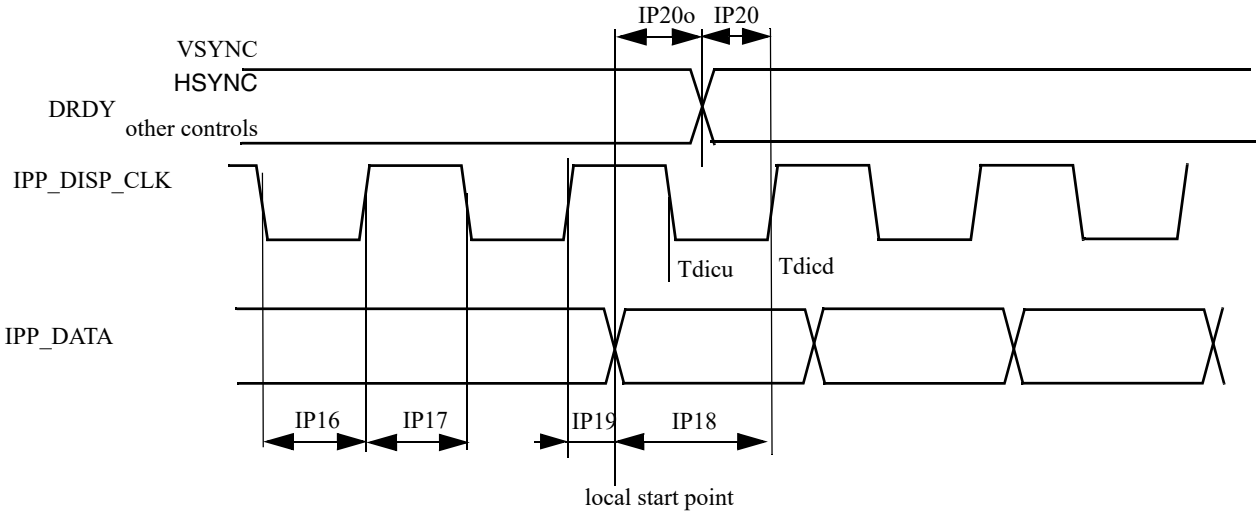


**Figure 66. Synchronous Display Interface Timing Diagram—Access Level**

**Table 68. Synchronous Display Interface Timing Characteristics (Access Level)**

| ID | Parameter | Symbol | Min | Typ[1] | Max | Unit |
|---|---|---|---|---|---|---|
| IP16 | Display interface clock low time | Tckl | Tdicd-Tdicu-1.24 | Tdicd[2]-Tdicu[3] | Tdicd-Tdicu+1.24 | ns |
| IP17 | Display interface clock high time | Tckh | Tdicp-Tdicd+Tdicu-1.24 | Tdicp-Tdicd+Tdicu | Tdicp-Tdicd+Tdicu+1.2 | ns |
| IP18 | Data setup time | Tdsu | Tdicd-1.24 | Tdicu | — | ns |
| IP19 | Data holdup time | Tdhd | Tdicp-Tdicd-1.24 | Tdicp-Tdicu | — | ns |
| IP20o | Control signals offset times (defines for each pin) | Tocsu | Tocsu-1.24 | Tocsu | Tocsu+1.24 | ns |
| IP20 | Control signals setup time to display interface clock (defines for each pin) | Tcsu | Tdicd-1.24-Tocsu%Tdicp | Tdicu | — | ns |

[1]The exact conditions have not been finalized, but will likely match the current customer requirement for their specific display. These conditions may be chip specific.

[2] Display interface clock down time

$$Tdicd = \frac{1}{2}\left(T_{diclk} \times ceil\left[\frac{2 \times DISP_CLK_DOWN}{DI_CLK_PERIOD}\right]\right)$$

[3] Display interface clock up time where CEIL(X) rounds the elements of X to the nearest integers towards infinity.

$$Tdicu = \frac{1}{2}\left(T_{diclk} \times ceil\left[\frac{2 \times DISP_CLK_UP}{DI_CLK_PERIOD}\right]\right)$$



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## 4.11.11 LVDS Display Bridge (LDB) Module Parameters

The LVDS interface complies with TIA/EIA 644-A standard. For more details, see TIA/EIA STANDARD 644-A, "*Electrical Characteristics of Low Voltage Differential Signaling (LVDS) Interface Circuits*".

**Table 69. LVDS Display Bridge (LDB) Electrical Specification**

| Parameter | Symbol | Test Condition | Min | Max | Units |
|---|---|---|---|---|---|
| Differential Voltage Output Voltage | $V_{OD}$ | 100 Ω Differential load | 250 | 450 | mV |
| Output Voltage High | Voh | 100 Ω differential load (0 V Diff—Output High Voltage static) | 1.25 | 1.6 | V |
| Output Voltage Low | Vol | 100 Ω differential load (0 V Diff—Output Low Voltage static) | 0.9 | 1.25 | V |
| Offset Static Voltage | $V_{OS}$ | Two 49.9 Ω resistors in series between N-P terminal, with output in either Zero or One state, the voltage measured between the 2 resistors. | 1.15 | 1.375 | V |
| VOS Differential | $V_{OSDIFF}$ | Difference in $V_{OS}$ between a One and a Zero state | -50 | 50 | mV |
| Output short circuited to GND | ISA ISB | With the output common shorted to GND | -24 | 24 | mA |
| VT Full Load Test | VTLoad | 100 Ω Differential load with a 3.74 kΩ load between GND and IO Supply Voltage | 247 | 454 | mV |

## 4.11.12 MIPI D-PHY Timing Parameters

This section describes MIPI D-PHY electrical specifications, compliant with MIPI CSI-2 version 1.0, D-PHY specification Rev. 1.0 (for MIPI sensor port x2 lanes) and MIPI DSI Version 1.01, and D-PHY specification Rev. 1.0 (and also DPI version 2.0, DBI version 2.0, DSC version 1.0a at protocol layer) (for MIPI display port x2 lanes).

### 4.11.12.1 Electrical and Timing Information

**Table 70. Electrical and Timing Information**

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Input DC Specifications - Apply to DSI_CLK_P/DSI_CLK_N and DSI_DATA_P/DSI_DATA_N inputs** | | | | | | |
| $V_I$ | Input signal voltage range | Transient voltage range is limited from -300 mV to 1600 mV | -50 | — | 1350 | mV |
| $V_{LEAK}$ | Input leakage current | VGNDSH(min) = VI = VGNDSH(max) + VOH(absmax)<br>Lane module in LP Receive Mode | -10 | — | 10 | mA |
| $V_{GNDSH}$ | Ground Shift | — | -50 | — | 50 | mV |
| $V_{OH(absmax)}$ | Maximum transient output voltage level | — | — | — | 1.45 | V |



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**Table 70. Electrical and Timing Information (continued)**

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{voh(absmax)}$ | Maximum transient time above VOH(absmax) | — | — | — | 20 | ns |
| **HS Line Drivers DC Specifications** | | | | | | |
| $\|V_{OD}\|$ | HS Transmit Differential output voltage magnitude | 80 Ω<= RL< = 125 Ω | 140 | 200 | 270 | mV |
| $\Delta\|V_{OD}\|$ | Change in Differential output voltage magnitude between logic states | 80 Ω<= RL< = 125 Ω | — | — | 10 | mV |
| $V_{CMTX}$ | Steady-state common-mode output voltage. | 80 Ω<= RL< = 125 Ω | 150 | 200 | 250 | mV |
| $\Delta V_{CMTX}(1,0)$ | Changes in steady-state common-mode output voltage between logic states | 80 Ω<= RL< = 125 Ω | — | — | 5 | mV |
| $V_{OHHS}$ | HS output high voltage | 80 Ω<= RL< = 125 Ω | — | — | 360 | mV |
| $Z_{OS}$ | Single-ended output impedance. | — | 40 | 50 | 62.5 | Ω |
| $\Delta Z_{OS}$ | Single-ended output impedance mismatch. | — | — | — | 10 | % |
| **LP Line Drivers DC Specifications** | | | | | | |
| $V_{OL}$ | Output low-level SE voltage | — | -50 | | 50 | mV |
| $V_{OH}$ | Output high-level SE voltage | — | 1.1 | 1.2 | 1.3 | V |
| $Z_{OLP}$ | Single-ended output impedance. | — | 110 | — | — | Ω |
| $\Delta Z_{OLP(01-10)}$ | Single-ended output impedance mismatch driving opposite level | — | — | — | 20 | % |
| $\Delta Z_{OLP(0-11)}$ | Single-ended output impedance mismatch driving same level | — | — | — | 5 | % |
| **HS Line Receiver DC Specifications** | | | | | | |
| $V_{IDTH}$ | Differential input high voltage threshold | — | — | — | 70 | mV |
| $V_{IDTL}$ | Differential input low voltage threshold | — | -70 | — | — | mV |
| $V_{IHHS}$ | Single ended input high voltage | — | — | — | 460 | mV |
| $V_{ILHS}$ | Single ended input low voltage | — | -40 | — | — | mV |
| $V_{CMRXDC}$ | Input common mode voltage | — | 70 | — | 330 | mV |



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**Table 70. Electrical and Timing Information (continued)**

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $Z_{ID}$ | Differential input impedance | — | 80 | — | 125 | Ω |
| **LP Line Receiver DC Specifications** | | | | | | |
| $V_{IL}$ | Input low voltage | — | — | — | 550 | mV |
| $V_{IH}$ | Input high voltage | — | 920 | — | — | mV |
| $V_{HYST}$ | Input hysteresis | — | 25 | — | — | mV |
| **Contention Line Receiver DC Specifications** | | | | | | |
| $V_{ILF}$ | Input low fault threshold | — | 200 | — | 450 | mV |

## 4.11.12.2 MIPI D-PHY Signaling Levels

The signal levels are different for differential HS mode and single-ended LP mode. Figure 67 shows both the HS and LP signal levels on the left and right sides, respectively. The HS signaling levels are below the LP low-level input threshold such that LP receiver always detects low on HS signals.

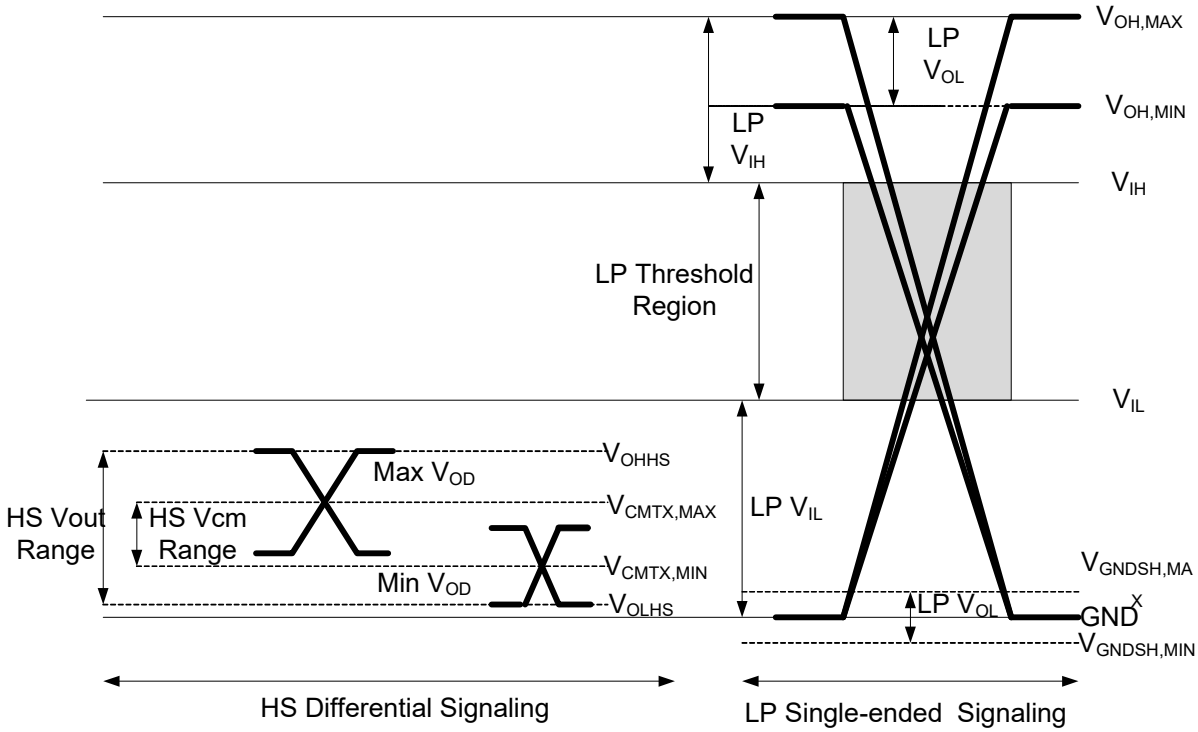


**Figure 67. D-PHY Signaling Levels**



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### 4.11.12.3 MIPI HS Line Driver Characteristics

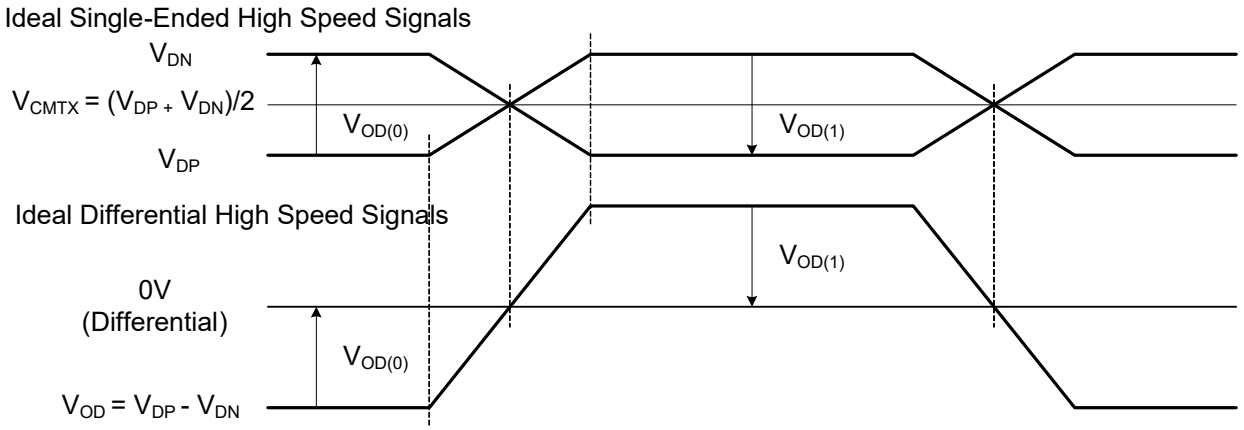


**Figure 68. Ideal Single-ended and Resulting Differential HS Signals**

### 4.11.12.4 Possible ΔVCMTX and ΔVOD Distortions of the Single-ended HS Signals

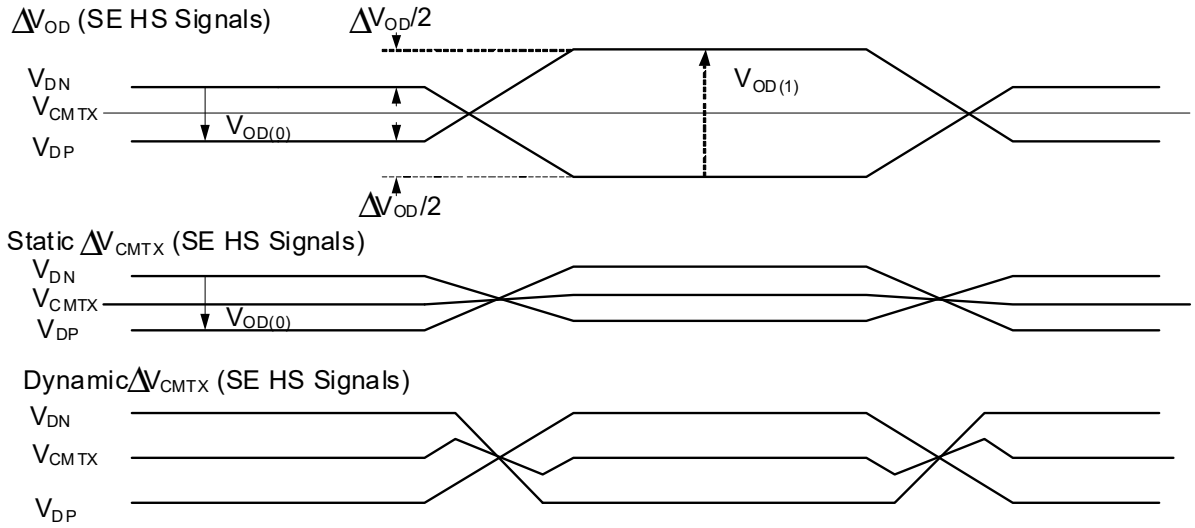


**Figure 69. Possible ΔVCMTX and ΔVOD Distortions of the Single-ended HS Signals**

### 4.11.12.5 MIPI D-PHY Switching Characteristics

**Table 71. Electrical and Timing Information**

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **HS Line Drivers AC Specifications** | | | | | | |
| — | Maximum serial data rate (forward direction) | On DATAP/N outputs. 80 Ω <= RL <= 125 Ω | 80 | — | 1000 | Mbps |



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**Table 71. Electrical and Timing Information (continued)**

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $F_{DDRCLK}$ | DDR CLK frequency | On DATAP/N outputs. | 40 | — | 500 | MHz |
| $P_{DDRCLK}$ | DDR CLK period | 80 Ω<= RL< = 125 Ω | 2 | — | 25 | ns |
| $t_{CDC}$ | DDR CLK duty cycle | $t_{CDC} = t_{CPH} / P_{DDRCLK}$ | — | 50 | — | % |
| $t_{CPH}$ | DDR CLK high time | — | — | 1 | — | UI |
| $t_{CPL}$ | DDR CLK low time | — | — | 1 | — | UI |
| — | DDR CLK / DATA Jitter | — | — | 75 | — | ps pk–pk |
| $t_{SKEW[PN]}$ | Intra-Pair (Pulse) skew | — | — | 0.075 | — | UI |
| $t_{SKEW[TX]}$ | Data to Clock Skew | — | 0.350 | — | 0.650 | UI |
| $t_r$ | Differential output signal rise time | 20% to 80%, RL = 50 Ω | 150 | — | 0.3UI | ps |
| $t_f$ | Differential output signal fall time | 20% to 80%, RL = 50 Ω | 150 | — | 0.3UI | ps |
| $\Delta V_{CMTX(HF)}$ | Common level variation above 450 MHz | 80 Ω<= RL< = 125 Ω | — | — | 15 | $mV_{rms}$ |
| $\Delta V_{CMTX(LF)}$ | Common level variation between 50 MHz and 450 MHz. | 80 Ω<= RL< = 125 Ω | — | — | 25 | $mV_p$ |
| **LP Line Drivers AC Specifications** | | | | | | |
| $t_{rlp}, t_{flp}$ | Single ended output rise/fall time | 15% to 85%, $C_L$<70 pF | — | — | 25 | ns |
| $t_{reo}$ | | 30% to 85%, $C_L$<70 pF | — | — | 35 | ns |
| $\delta V/\delta t_{SR}$ | Signal slew rate | 15% to 85%, $C_L$<70 pF | — | — | 120 | mV/ns |
| $C_L$ | Load capacitance | — | 0 | — | 70 | pF |
| **HS Line Receiver AC Specifications** | | | | | | |
| $t_{SETUP[RX]}$ | Data to Clock Receiver Setup time | — | 0.15 | — | — | UI |
| $t_{HOLD[RX]}$ | Clock to Data Receiver Hold time | — | 0.15 | — | — | UI |
| $\Delta V_{CMRX(HF)}$ | Common mode interference beyond 450 MHz | — | — | — | 200 | mVpp |
| $\Delta V_{CMRX(LF)}$ | Common mode interference between 50 MHz and 450 MHz. | — | -50 | — | 50 | mVpp |
| $C_{CM}$ | Common mode termination | — | — | — | 60 | pF |
| **LP Line Receiver AC Specifications** | | | | | | |
| $e_{SPIKE}$ | Input pulse rejection | — | | — | 300 | Vps |
| $T_{MIN}$ | Minimum pulse response | — | 50 | — | | ns |
| $V_{INT}$ | Pk-to-Pk interference voltage | — | — | — | 400 | mV |
| $f_{INT}$ | Interference frequency | — | 450 | — | — | MHz |



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**Table 71. Electrical and Timing Information (continued)**

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Model Parameters used for Driver Load switching performance evaluation** | | | | | | |
| $C_{PAD}$ | Equivalent Single ended I/O PAD capacitance. | — | — | — | 1 | pF |
| $C_{PIN}$ | Equivalent Single ended Package + PCB capacitance. | — | — | — | 2 | pF |
| $L_S$ | Equivalent wire bond series inductance | — | — | — | 1.5 | nH |
| $R_S$ | Equivalent wire bond series resistance | — | — | — | 0.15 | Ω |
| $R_L$ | Load resistance | — | 80 | 100 | 125 | Ω |

## 4.11.12.6 High-Speed Clock Timing

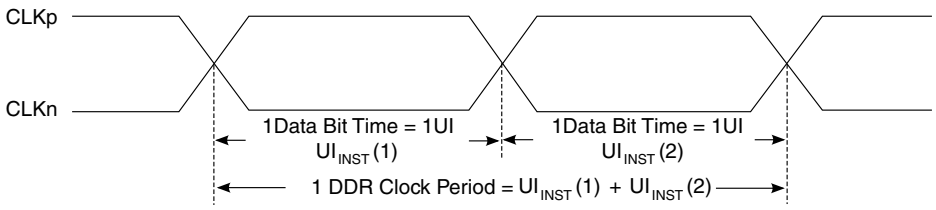


**Figure 70. DDR Clock Definition**

## 4.11.12.7 Forward High-Speed Data Transmission Timing

The timing relationship of the DDR Clock differential signal to the Data differential signal is shown in Figure 71:

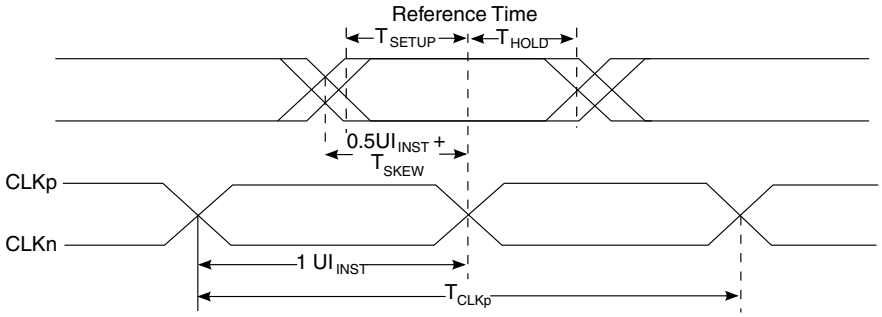


**Figure 71. Data to Clock Timing Definitions**



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### 4.11.12.8 Reverse High-Speed Data Transmission Timing

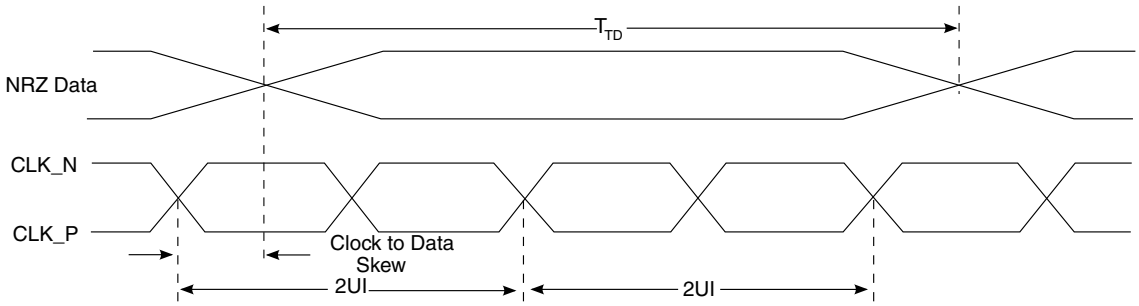


**Figure 72. Reverse High-Speed Data Transmission Timing at Slave Side**

### 4.11.12.9 Low-Power Receiver Timing

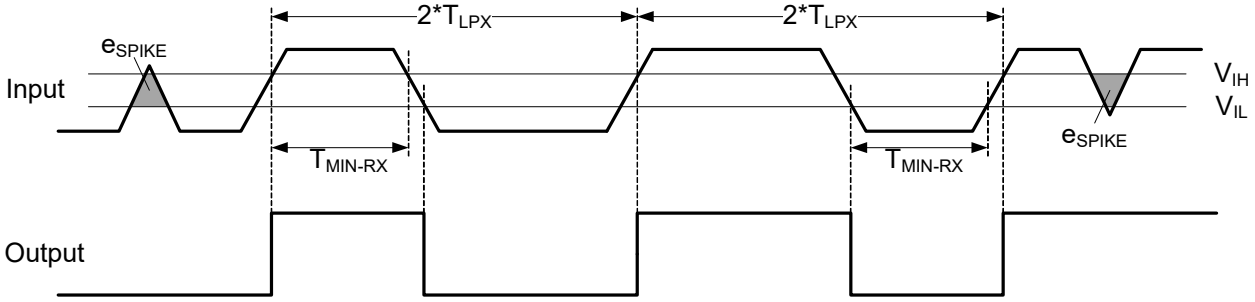


**Figure 73. Input Glitch Rejection of Low-Power Receivers**

## 4.11.13 HSI Host Controller Timing Parameters

This section describes the timing parameters of the HSI Host Controller which are compliant with High-speed Synchronous Serial Interface (HSI) Physical Layer specification version1.01.

### 4.11.13.1 Synchronous Data Flow

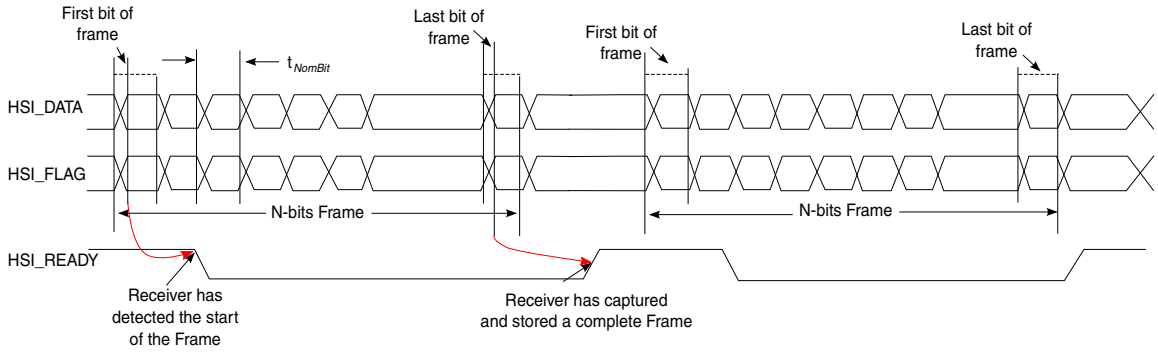


**Figure 74. Synchronized Data Flow READY Signal Timing (Frame and Stream Transmission)**



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### 4.11.13.2 Pipelined Data Flow

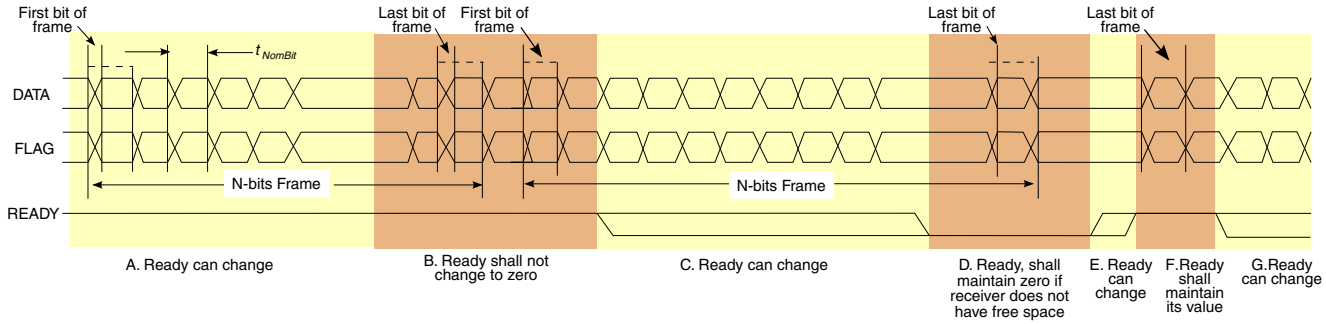


**Figure 75. Pipelined Data Flow Ready Signal Timing (Frame Transmission Mode)**

### 4.11.13.3 Receiver Real-Time Data Flow

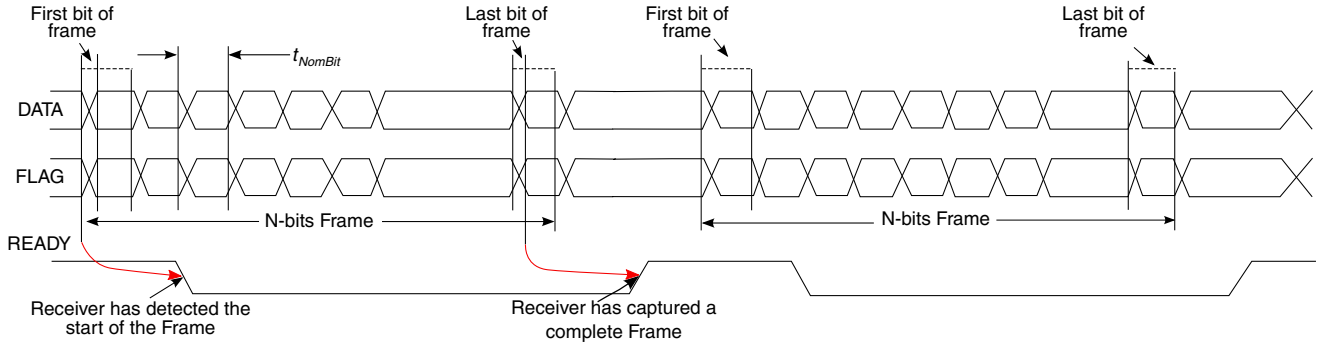


**Figure 76. Receiver Real-Time Data Flow READY Signal Timing**

### 4.11.13.4 Synchronized Data Flow Transmission with Wake

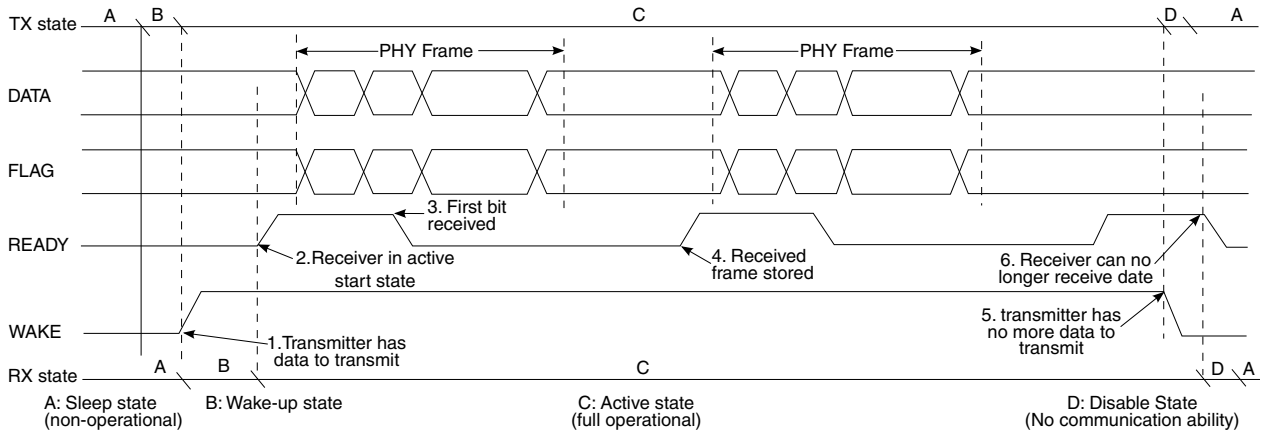


**Figure 77. Synchronized Data Flow Transmission with WAKE**



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### 4.11.13.5 Stream Transmission Mode Frame Transfer

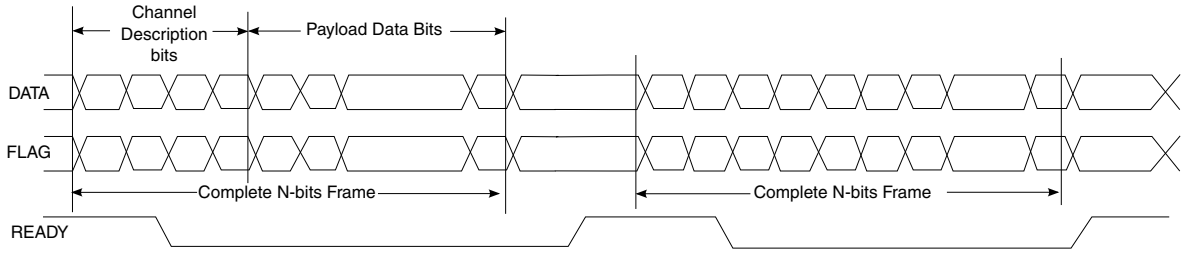


**Figure 78. Stream Transmission Mode Frame Transfer (Synchronized Data Flow)**

### 4.11.13.6 Frame Transmission Mode (Synchronized Data Flow)

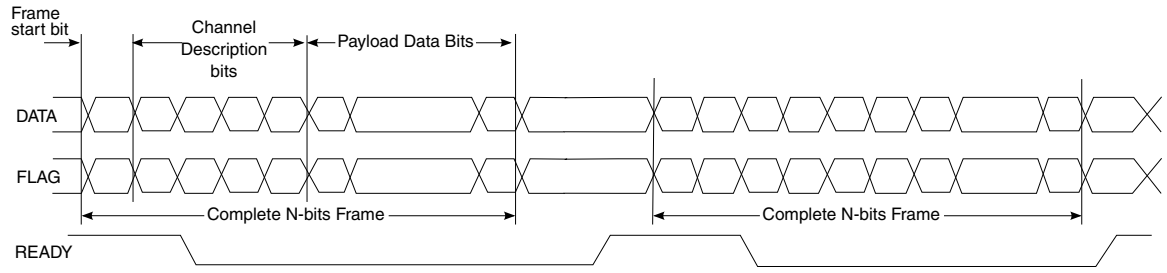


**Figure 79. Frame Transmission Mode Transfer of Two Frames (Synchronized Data Flow)**

### 4.11.13.7 Frame Transmission Mode (Pipelined Data Flow)

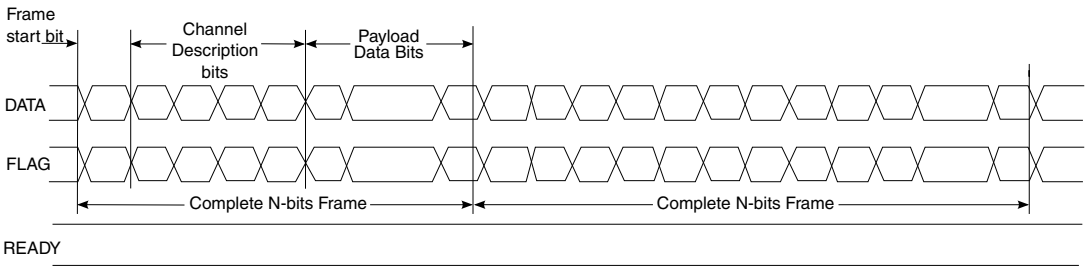


**Figure 80. Frame Transmission Mode Transfer of Two Frames (Pipelined Data Flow)**

### 4.11.13.8 DATA and FLAG Signal Timing Requirement for a 15 pF Load

**Table 72. DATA and FLAG Timing**

| Parameter | Description | 1 Mbit/s | 100 Mbit/s | 200 Mbit/s |
|---|---|---|---|---|
| $t_{Bit, nom}$ | Nominal bit time | 1000 ns | 10.0 ns | 5.00 ns |
| $t_{Rise, min}$ and $t_{Fall, min}$ | Minimum allowed rise and fall time | 2.00 ns | 2.00 ns | 1.00 ns |
| $t_{TxToRxSkew, maxfq}$ | Maximum skew between transmitter and receiver package pins | 50.0 ns | 0.5.0 ns | 0.25 ns |



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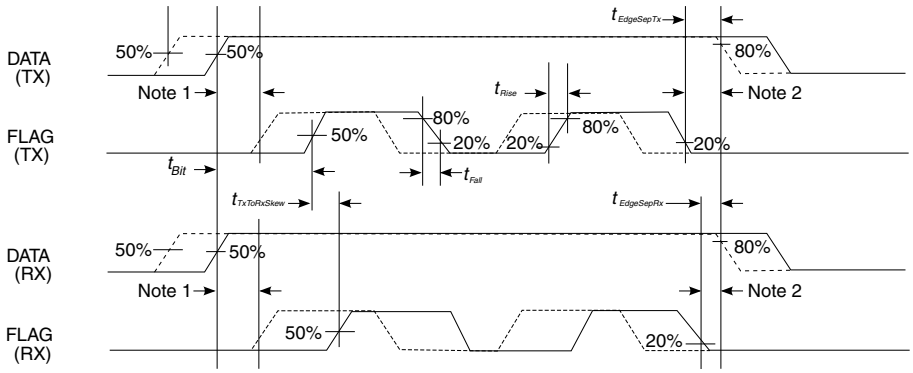
**Table 72. DATA and FLAG Timing (continued)**

| Parameter | Description | 1 Mbit/s | 100 Mbit/s | 200 Mbit/s |
|---|---|---|---|---|
| $t_{EageSepTx, min}$ | Minimum allowed separation of signal transitions at transmitter package pins, including all timing defects, for example, jitter and skew, inside the transmitter. | 400 ns | 4.00 ns | 2.00 ns |
| $t_{EageSepRx, min}$ | Minimum separation of signal transitions, measured at the receiver package pins, including all timing defects, for example, jitter and skew, inside the receiver. | 350 ns | 3.5 ns | 1.75 ns |




1 This case shows that the DATA signal has slowed down more compared to the FLAG signal
2 This case shows that the FLAG signal has slowed down more compared to the DATA signal.

**Figure 81. DATA and FLAG Signal Timing**

## 4.11.14 MediaLB (MLB) Characteristics

### 4.11.14.1 MediaLB (MLB) DC Characteristics

Table 73 lists the MediaLB 3-pin interface electrical characteristics.

**Table 73. MediaLB 3-Pin Interface Electrical DC Specifications**

| Parameter | Symbol | Test Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| Maximum input voltage | — | — | — | 3.6 | V |
| Low level input threshold | $V_{IL}$ | — | — | 0.7 | V |
| High level input threshold | $V_{IH}$ | See Note[1] | 1.8 | — | V |
| Low level output threshold | $V_{OL}$ | $I_{OL}$ = 6 mA | — | 0.4 | V |
| High level output threshold | $V_{OH}$ | $I_{OH}$ = -6 mA | 2.0 | — | V |
| Input leakage current | $I_L$ | 0 < $V_{in}$ < VDD | — | ±10 | µA |

1 Higher $V_{IH}$ thresholds can be used; however, the risks associated with less noise margin in the system must be evaluated and assumed by the customer.



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Table 74 lists the MediaLB 6-pin interface electrical characteristics.

**Table 74. MediaLB 6-Pin Interface Electrical DC Specifications**

| Parameter | Symbol | Test Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| **Driver Characteristics** | | | | | |
| Differential output voltage (steady-state): $\lvert V_{O+} - V_{O-} \rvert$ | $V_{OD}$ | See Note[1] | 300 | 500 | mV |
| Difference in differential output voltage between (high/low) steady-states: $\lvert V_{OD, high} - V_{OD, low} \rvert$ | $\Delta V_{OD}$ | — | -50 | 50 | mV |
| Common-mode output voltage: $(V_{O+} - V_{O-}) / 2$ | $V_{OCM}$ | — | 1.0 | 1.5 | V |
| Difference in common-mode output between (high/low) steady-states: $\lvert V_{OCM, high} - V_{OCM, low} \rvert$ | $\Delta V_{OCM}$ | — | -50 | 50 | mV |
| Variations on common-mode output during a logic state transitions | $V_{CMV}$ | See Note[2] | — | 150 | mVpp |
| Short circuit current | $\lvert I_{OS} \rvert$ | See Note[3] | — | 43 | mA |
| Differential output impedance | $Z_O$ | — | 1.6 | — | kΩ |
| **Receiver Characteristics** | | | | | |
| Differential clock input:<br>• logic low steady-state<br>• logic high steady-state<br>• hysteresis | <br>$V_{ILC}$<br>$V_{IHC}$<br>$V_{HSC}$ | See Note[4] | <br>—<br>50<br>-25 | <br>-50<br>—<br>25 | <br>mV<br>mV<br>mV |
| Differential signal/data input:<br>• logic low steady-state<br>• logic high steady-state | <br>$V_{ILS}$<br>$V_{IHS}$ | — | <br>—<br>50 | <br>-50<br>— | <br>mV<br>mV |
| Signal-ended input voltage (steady-state):<br>• MLB_SIG_P, MLB_DATA_P<br>• MLB_SIG_N, MLB_DATA_N | <br>$V_{IN+}$<br>$V_{IN-}$ | — | <br>0.5<br>0.5 | <br>2.0<br>2.0 | <br>V<br>V |

[1] The signal-ended output voltage of a driver is defined as $V_{O+}$ on MLB_CLK_P, MLB_SIG_P, and MLB_DATA_P. The signal-ended output voltage of a driver is defined as $V_{O-}$ on MLB_CLK_N, MLB_SIG_N, and MLB_DATA_N.

[2] Variations in the common-mode voltage can occur between logic states (for example, during state transitions) as a result of differences in the transition rate of $V_{O+}$ and $V_{O-}$.

[3] Short circuit current is applicable when $V_{O+}$ and $V_{O-}$ are shorted together and/or shorted to ground.

[4] The logic state of the receiver is undefined when -50 mV < $V_{ID}$ < 50 mV.



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### 4.11.14.2 MediaLB (MLB) Controller AC Timing Electrical Specifications

This section describes the timing electrical information of the MediaLB module. Figure 82 show the timing of MediaLB 3-pin interface, and Table 75 and Table 76 lists the MediaLB 3-pin interface timing characteristics.

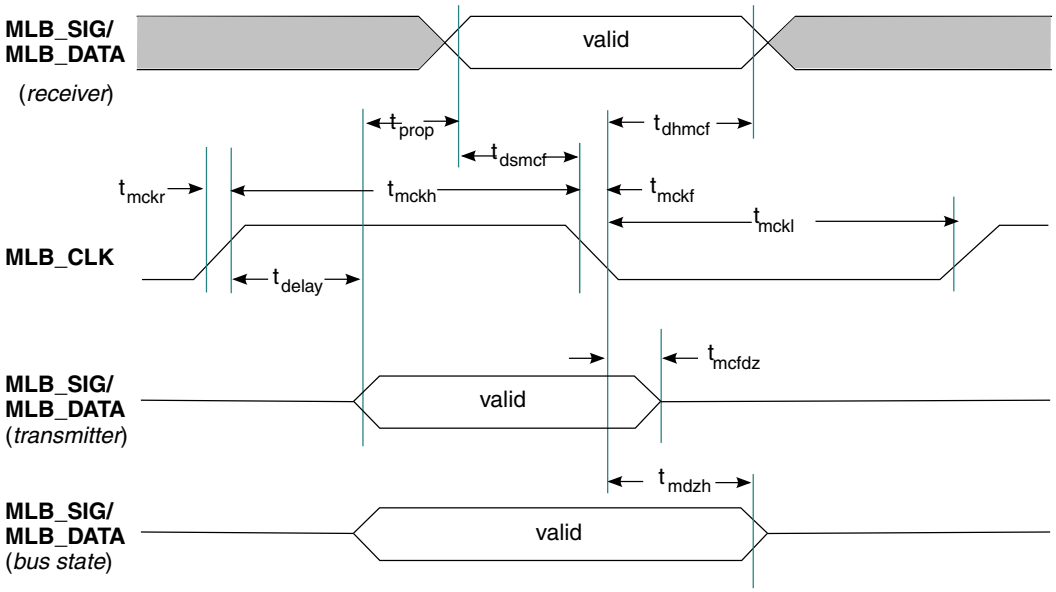


**Figure 82. MediaLB 3-Pin Timing**

Ground = 0.0 V; Load Capacitance = 60 pF; MediaLB speed = 256/512 Fs; Fs = 48 kHz; all timing parameters specified from the valid voltage threshold as listed below; unless otherwise noted.

**Table 75. MLB 256/512 Fs Timing Parameters**

| Parameter | Symbol | Min | Max | Unit | Comment |
|---|---|---|---|---|---|
| MLB_CLK operating frequency[1] | $f_{mck}$ | 11.264 | 25.6 | MHz | 256xFs at 44.0 kHz<br>512xFs at 50.0 kHz |
| MLB_CLK rise time | $t_{mckr}$ | — | 3 | ns | $V_{IL}$ TO $V_{IH}$ |
| MLB_CLK fall time | $t_{mckf}$ | — | 3 | ns | $V_{IH}$ TO $V_{IL}$ |
| MLB_CLK low time[2] | $t_{mckl}$ | 30<br>14 | — | ns | 256xFs<br>512xFs |
| MLB_CLK high time | $t_{mckh}$ | 30<br>14 | — | ns | 256xFs<br>512xFs |
| MLB_SIG/MLB_DATA receiver input valid to MLB_CLK falling | $t_{dsmcf}$ | 1 | — | ns | — |
| MLB_SIG/MLB_DATA receiver input hold from MLB_CLK low | $t_{dhmcf}$ | $t_{mdzh}$ | — | ns | — |
| MLB_SIG/MLB_DATA output high impedance from MLB_CLK low | $t_{mcfdz}$ | 0 | $t_{mckl}$ | ns | [3] |
| Bus Hold from MLB_CLK low | $t_{mdzh}$ | 4 | — | ns | — |



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**Table 75. MLB 256/512 Fs Timing Parameters (continued)**

| Parameter | Symbol | Min | Max | Unit | Comment |
|---|---|---|---|---|---|
| MLB_SIG/MLB_DATA output valid from transition of MLB_CLK (low to high) | $t_{delay}$ | — | 10 | ns | — |
| Transmitter MLBSIG (MLBDAT) output valid from transition of MLBCLK (low-to-high) | $t_{delay}$ | — | 10.75 | ns | — |

1 The controller can shut off MLB_CLK to place MediaLB in a low-power state. Depending on the time the clock is shut off, a runt pulse can occur on MLB_CLK.

2 MLB_CLK low/high time includes the pulse width variation.

3 The MediaLB driver can release the MLB_DATA/MLB_SIG line as soon as MLB_CLK is low; however, the logic state of the final driven bit on the line must remain on the bus for $t_{mdzh}$. Therefore, coupling must be minimized while meeting the maximum load capacitance listed.

Ground = 0.0 V; load capacitance = 40 pF; MediaLB speed = 1024 Fs; Fs = 48 kHz; all timing parameters specified from the valid voltage threshold as listed in Table 76; unless otherwise noted.

**Table 76. MLB 1024 Fs Timing Parameters**

| Parameter | Symbol | Min | Max | Unit | Comment |
|---|---|---|---|---|---|
| MLB_CLK Operating Frequency[1] | $f_{mck}$ | 45.056 | 51.2 | MHz | 1024xfs at 44.0 kHz<br>1024xfs at 50.0 kHz |
| MLB_CLK rise time | $t_{mckr}$ | — | 1 | ns | $V_{IL}$ TO $V_{IH}$ |
| MLB_CLK fall time | $t_{mckf}$ | — | 1 | ns | $V_{IH}$ TO $V_{IL}$ |
| MLB_CLK low time | $t_{mckl}$ | 6.1 | — | ns | [2] |
| MLB_CLK high time | $t_{mckh}$ | 9.3 | — | ns | — |
| MLB_SIG/MLB_DATA receiver input valid to MLB_CLK falling | $t_{dsmcf}$ | 1 | — | ns | — |
| MLB_SIG/MLB_DATA receiver input hold from MLB_CLK low | $t_{dhmcf}$ | $t_{mdzh}$ | — | ns | — |
| MLB_SIG/MLB_DATA output high impedance from MLB_CLK low | $t_{mcfdz}$ | 0 | $t_{mckl}$ | ns | [3] |
| Bus Hold from MLB_CLK low | $t_{mdzh}$ | 2 | — | ns | — |
| MLB_SIG/MLB_DATA output valid from transition of MLB_CLK (low to high) | $t_{delay}$ | — | 7 | ns | — |
| Transmitter MLBSIG (MLBDAT) output valid from transition of MLBCLK (low-to-high) | $t_{delay}$ | — | 6 | ns | — |

1 The controller can shut off MLB_CLK to place MediaLB in a low-power state. Depending on the time the clock is shut off, a runt pulse can occur on MLB_CLK.

2 MLB_CLK low/high time includes the pulse width variation.

3 The MediaLB driver can release the MLB_DATA/MLB_SIG line as soon as MLB_CLK is low; however, the logic state of the final driven bit on the line must remain on the bus for $t_{mdzh}$. Therefore, coupling must be minimized while meeting the maximum load capacitance listed.

Table 77 lists the MediaLB 6-pin interface timing characteristics, and Figure 83 shows the MLB 6-pin delay, setup, and hold times.



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**Table 77. MLB 6-Pin Interface Timing Parameters**

| Parameter | Symbol | Min | Max | Unit | Comment |
|---|---|---|---|---|---|
| Cycle-to-cycle system jitter | $t_{jitter}$ | — | 600 | ps | — |
| Transmitter MLB_SIG_P/_N (MLB_DATA_P/_N) output valid from transition of MLB_CLK_P/_N (low-to-high)[1] | $t_{delay}$ | 0.6 | 1.3 | ns | — |
| Disable turnaround time from transition of MLB_CLK_P/_N (low-to-high) | $t_{phz}$ | 0.6 | 3.5 | ns | — |
| Enable turnaround time from transition of MLB_CLK_P/_N (low-to-high) | $t_{plz}$ | 0.6 | 5.6 | ns | — |
| MLB_SIG_P/_N (MLB_DATA_P/_N) valid to transition of MLB_CLK_P/_N (low-to-high) | $t_{su}$ | 0.05 | — | ns | — |
| MLB_SIG_P/_N (MLB_DATA_P/_N) hold from transition of MLB_CLK_P/_N (low-to-high)[2] | $t_{hd}$ | 0.6 | | | — |

1 $t_{delay}$, $t_{phz}$, $t_{plz}$, $t_{su}$, and $t_{hd}$ may also be referenced from a low-to-high transition of the recovered clock for 2:1 and 4:1 recovered-to-external clock ratios.

2 The transmitting device must ensure valid data on MLB_SIG_P/_N (MLB_DATA_P/_N) for at least $t_{hd(min)}$ following the rising edge of MLB_CLK_P/N; receivers must latch MLB_SIG_P/_N (MLB_DATA_P/_N) data within $t_{hd(min)}$ of the rising edge of MLB_CLK_P/_N.

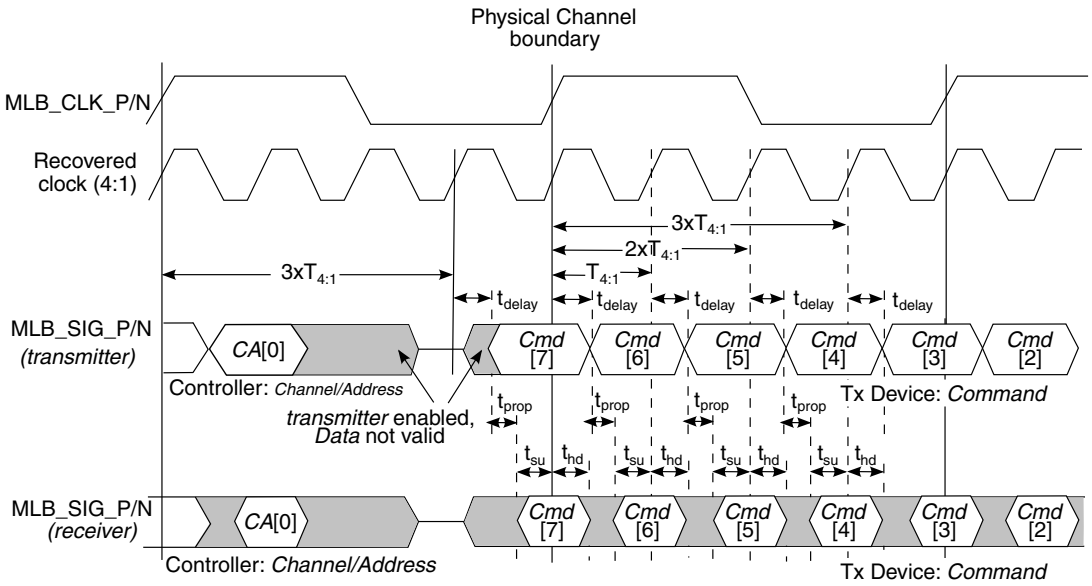


**Figure 83. MLB 6-Pin Delay, Setup, and Hold Times**

## 4.11.15 PCIe PHY Parameters

The PCIe interface complies with PCIe specification Gen2 x1 lane and supports the PCI Express 1.1/2.0 standard.



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### 4.11.15.1 PCIE_REXT Reference Resistor Connection

The impedance calibration process requires connection of reference resistor 200 Ω. 1% precision resistor on PCIE_REXT pads to ground. It is used for termination impedance calibration.

## 4.11.16 Pulse Width Modulator (PWM) Timing Parameters

This section describes the electrical information of the PWM. The PWM can be programmed to select one of three clock signals as its source frequency. The selected clock signal is passed through a prescaler before being input to the counter. The output is available at the pulse-width modulator output (PWMO) external pin.

Figure 84 depicts the timing of the PWM, and Table 78 lists the PWM timing parameters.

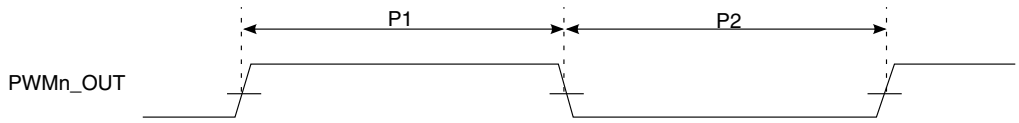


**Figure 84. PWM Timing**

**Table 78. PWM Output Timing Parameters**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| | PWM Module Clock Frequency | 0 | ipg_clk | MHz |
| P1 | PWM output pulse width high | 15 | — | ns |
| P2 | PWM output pulse width low | 15 | — | ns |

## 4.11.17 SCAN JTAG Controller (SJC) Timing Parameters

Figure 85 depicts the SJC test clock input timing. Figure 86 depicts the SJC boundary scan timing. Figure 87 depicts the SJC test access port. Signal parameters are listed in Table 79.

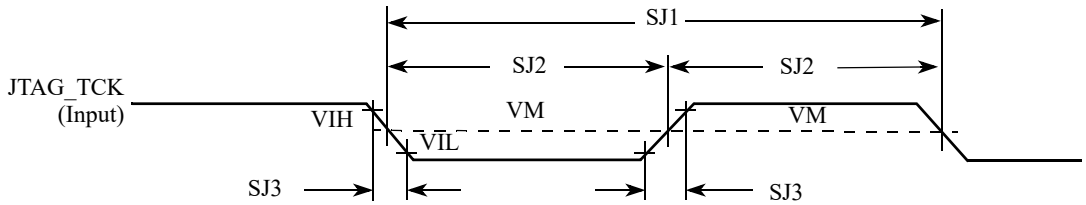


**Figure 85. Test Clock Input Timing Diagram**



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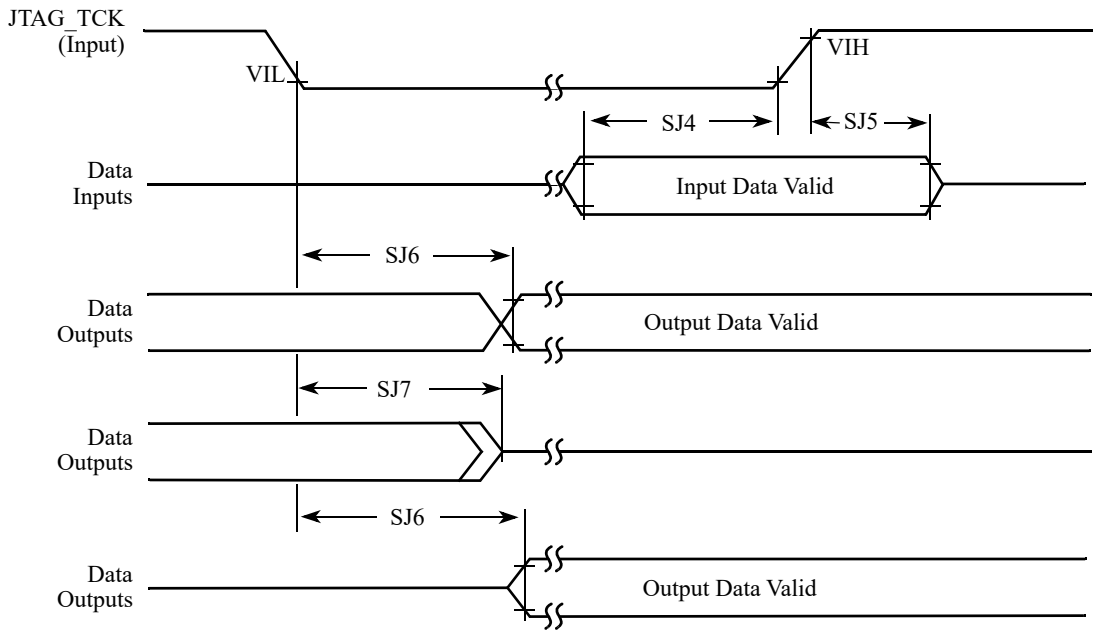


**Figure 86. Boundary Scan (JTAG) Timing Diagram**

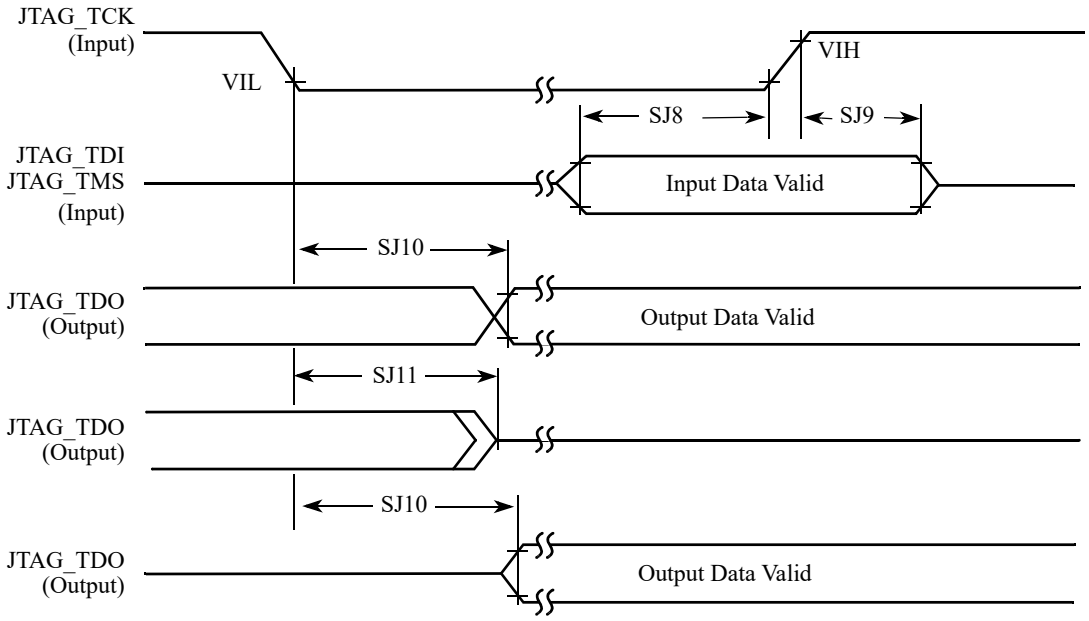


**Figure 87. Test Access Port Timing Diagram**



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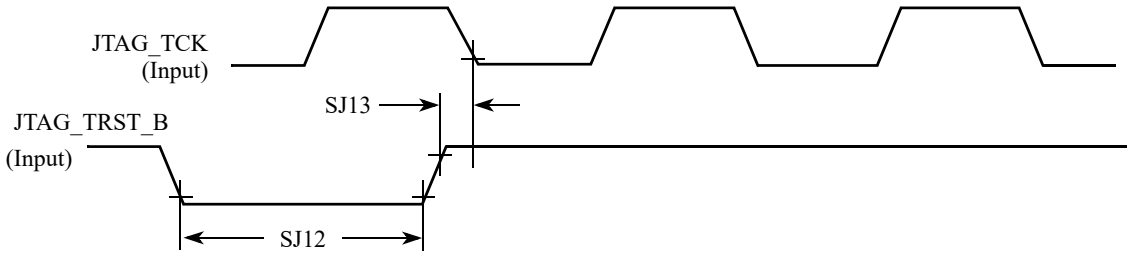


**Figure 88. JTAG_TRST_B Timing Diagram**

**Table 79. JTAG Timing**

| ID | Parameter[1,2] | All Frequencies | | Unit |
|---|---|---|---|---|
| | | Min | Max | |
| SJ0 | JTAG_TCK frequency of operation $1/(3 \bullet T_{DC})$[1] | 0.001 | 22 | MHz |
| SJ1 | JTAG_TCK cycle time in crystal mode | 45 | — | ns |
| SJ2 | JTAG_TCK clock pulse width measured at $V_M$[2] | 22.5 | — | ns |
| SJ3 | JTAG_TCK rise and fall times | — | 3 | ns |
| SJ4 | Boundary scan input data set-up time | 5 | — | ns |
| SJ5 | Boundary scan input data hold time | 24 | — | ns |
| SJ6 | JTAG_TCK low to output data valid | — | 40 | ns |
| SJ7 | JTAG_TCK low to output high impedance | — | 40 | ns |
| SJ8 | JTAG_TMS, JTAG_TDI data set-up time | 5 | — | ns |
| SJ9 | JTAG_TMS, JTAG_TDI data hold time | 25 | — | ns |
| SJ10 | JTAG_TCK low to JTAG_TDO data valid | — | 44 | ns |
| SJ11 | JTAG_TCK low to JTAG_TDO high impedance | — | 44 | ns |
| SJ12 | JTAG_TRST_B assert time | 100 | — | ns |
| SJ13 | JTAG_TRST_B set-up time to JTAG_TCK low | 40 | — | ns |

1 $T_{DC}$ = target frequency of SJC

2 $V_M$ = mid-point voltage

## 4.11.18 SPDIF Timing Parameters

The Sony/Philips Digital Interconnect Format (SPDIF) data is sent using the bi-phase marking code. When encoding, the SPDIF data signal is modulated by a clock that is twice the bit rate of the data signal.

Table 80 and Figure 89 and Figure 90 show SPDIF timing parameters for the Sony/Philips Digital Interconnect Format (SPDIF), including the timing of the modulating Rx clock (SPDIF_SR_CLK) for SPDIF in Rx mode and the timing of the modulating Tx clock (SPDIF_ST_CLK) for SPDIF in Tx mode.



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**Table 80. SPDIF Timing Parameters**

| Characteristics | Symbol | Timing Parameter Range | | Unit |
|---|---|---|---|---|
| | | Min | Max | |
| SPDIF_IN Skew: asynchronous inputs, no specs apply | — | — | 0.7 | ns |
| SPDIF_OUT output (Load = 50pf)<br>• Skew<br>• Transition rising<br>• Transition falling | <br>—<br>—<br>— | <br>—<br>—<br>— | <br>1.5<br>24.2<br>31.3 | ns |
| SPDIF_OUT output (Load = 30pf)<br>• Skew<br>• Transition rising<br>• Transition falling | <br>—<br>—<br>— | <br>—<br>—<br>— | <br>1.5<br>13.6<br>18.0 | ns |
| Modulating Rx clock (SPDIF_SR_CLK) period | srckp | 40.0 | — | ns |
| SPDIF_SR_CLK high period | srckph | 16.0 | — | ns |
| SPDIF_SR_CLK low period | srckpl | 16.0 | — | ns |
| Modulating Tx clock (SPDIF_ST_CLK) period | stclkp | 40.0 | — | ns |
| SPDIF_ST_CLK high period | stclkph | 16.0 | — | ns |
| SPDIF_ST_CLK low period | stclkpl | 16.0 | — | ns |

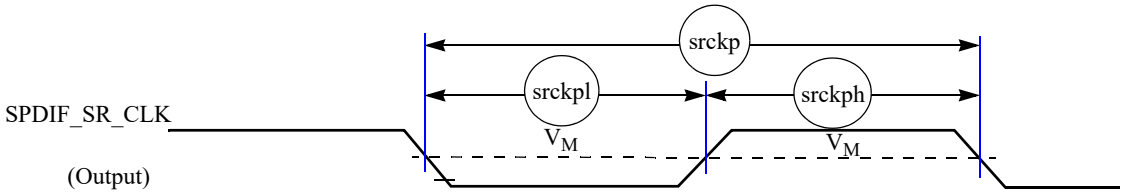


**Figure 89. SPDIF_SR_CLK Timing Diagram**

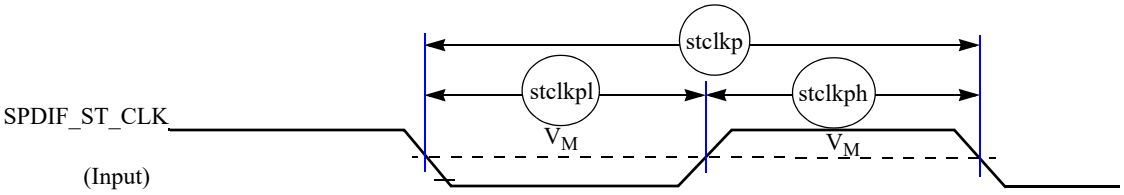


**Figure 90. SPDIF_ST_CLK Timing Diagram**



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## 4.11.19 SSI Timing Parameters

This section describes the timing parameters of the SSI module. The connectivity of the serial synchronous interfaces are summarized in Table 81.

**Table 81. AUDMUX Port Allocation**

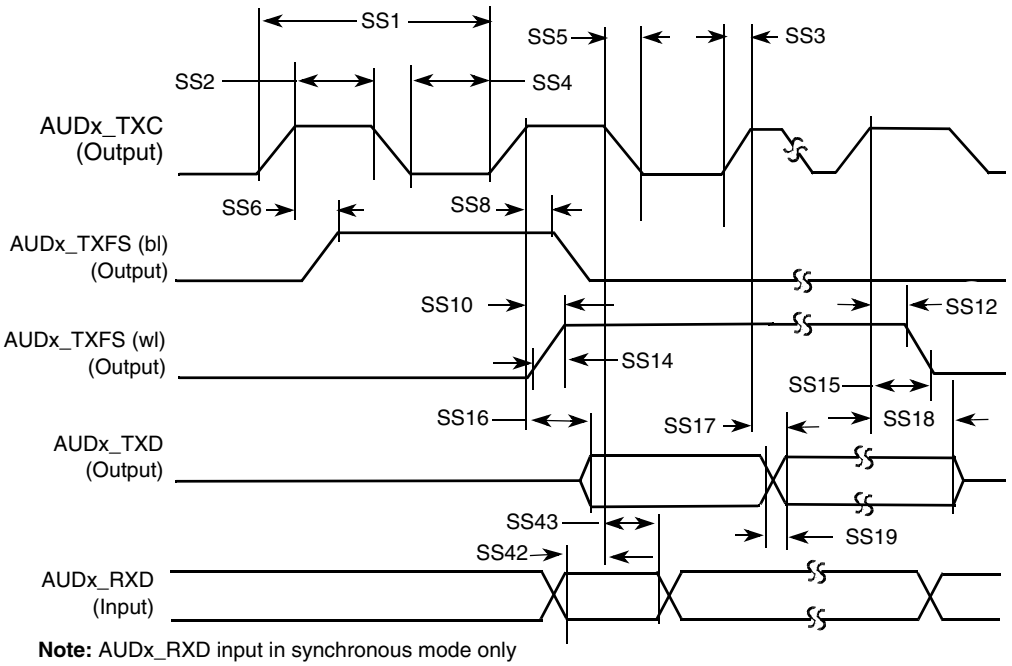
| Port | Signal Nomenclature | Type and Access |
|---|---|---|
| AUDMUX port 1 | SSI 1 | Internal |
| AUDMUX port 2 | SSI 2 | Internal |
| AUDMUX port 3 | AUD3 | External—AUD3 I/O |
| AUDMUX port 4 | AUD4 | External—EIM or CSPI1 I/O through IOMUXC |
| AUDMUX port 5 | AUD5 | External—EIM or SD1 I/O through IOMUXC |
| AUDMUX port 6 | AUD6 | External—EIM or DISP2 through IOMUXC |
| AUDMUX port 7 | SSI 3 | Internal |

**NOTE**

The terms WL and BL used in the timing diagrams and tables refer to Word Length (WL) and Bit Length (BL).

### 4.11.19.1 SSI Transmitter Timing with Internal Clock

Figure 91 depicts the SSI transmitter internal clock timing and Table 82 lists the timing parameters for the SSI transmitter internal clock.




**Note:** AUDx_RXD input in synchronous mode only

**Figure 91. SSI Transmitter Internal Clock Timing Diagram**



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**Table 82. SSI Transmitter Timing with Internal Clock**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| **Internal Clock Operation** | | | | |
| SS1 | AUDx_TXC/AUDxRXC clock period | 81.4 | — | ns |
| SS2 | AUDx_TXC/AUDxRXC clock high period | 36.0 | — | ns |
| SS4 | AUDx_TXC/AUDxRXC clock low period | 36.0 | — | ns |
| SS6 | AUDx_TXC high to AUDx_TXFS (bl) high | — | 15.0 | ns |
| SS8 | AUDx_TXC high to AUDx_TXFS (bl) low | — | 15.0 | ns |
| SS10 | AUDx_TXC high to AUDx_TXFS (wl) high | — | 15.0 | ns |
| SS12 | AUDx_TXC high to AUDx_TXFS (wl) low | — | 15.0 | ns |
| SS14 | AUDx_TXC/AUDxRXC Internal AUDx_TXFS rise time | — | 6.0 | ns |
| SS15 | AUDx_TXC/AUDxRXC Internal AUDx_TXFS fall time | — | 6.0 | ns |
| SS16 | AUDx_TXC high to AUDx_TXD valid from high impedance | — | 15.0 | ns |
| SS17 | AUDx_TXC high to AUDx_TXD high/low | — | 15.0 | ns |
| SS18 | AUDx_TXC high to AUDx_TXD high impedance | — | 15.0 | ns |
| **Synchronous Internal Clock Operation** | | | | |
| SS42 | AUDx_RXD setup before AUDx_TXC falling | 10.0 | — | ns |
| SS43 | AUDx_RXD hold after AUDx_TXC falling | 0.0 | — | ns |

## NOTE

- All the timings for the SSI are given for a non-inverted serial clock polarity (TSCKP/RSCKP = 0) and a non-inverted frame sync (TFSI/RFSI = 0). If the polarity of the clock and/or the frame sync have been inverted, all the timing remains valid by inverting the clock signal AUDx_TXC/AUDx_RXC and/or the frame sync AUDx_TXFS/AUDx_RXFS shown in the tables and in the figures.
- All timings are on Audiomux Pads when SSI is being used for data transfer.
- The terms, WL and BL, refer to Word Length (WL) and Bit Length (BL).
- For internal Frame Sync operation using external clock, the frame sync timing is same as that of transmit data (for example, during AC97 mode of operation).



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### 4.11.19.2 SSI Receiver Timing with Internal Clock

Figure 92 depicts the SSI receiver internal clock timing and Table 83 lists the timing parameters for the receiver timing with the internal clock.

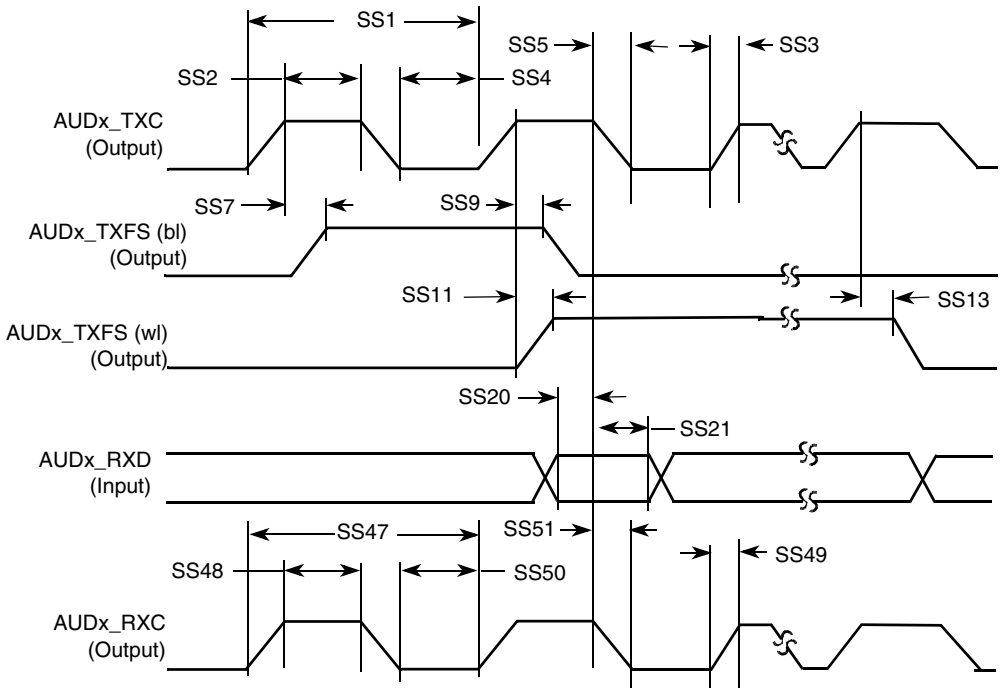


**Figure 92. SSI Receiver Internal Clock Timing Diagram**

**Table 83. SSI Receiver Timing with Internal Clock**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| **Internal Clock Operation** | | | | |
| SS1 | AUDx_TXC/AUDx_RXC clock period | 81.4 | — | ns |
| SS2 | AUDx_TXC/AUDx_RXC clock high period | 36.0 | — | ns |
| SS3 | AUDx_TXC/AUDx_RXC clock rise time | — | 6.0 | ns |
| SS4 | AUDx_TXC/AUDx_RXC clock low period | 36.0 | — | ns |
| SS5 | AUDx_TXC/AUDx_RXC clock fall time | — | 6.0 | ns |
| SS7 | AUDx_RXC high to AUDx_TXFS (bl) high | — | 15.0 | ns |
| SS9 | AUDx_RXC high to AUDx_TXFS (bl) low | — | 15.0 | ns |
| SS11 | AUDx_RXC high to AUDx_TXFS (wl) high | — | 15.0 | ns |
| SS13 | AUDx_RXC high to AUDx_TXFS (wl) low | — | 15.0 | ns |
| SS20 | AUDx_RXD setup time before AUDx_RXC low | 10.0 | — | ns |
| SS21 | AUDx_RXD hold time after AUDx_RXC low | 0.0 | — | ns |



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**Table 83. SSI Receiver Timing with Internal Clock (continued)**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| **Oversampling Clock Operation** | | | | |
| SS47 | Oversampling clock period | 15.04 | — | ns |
| SS48 | Oversampling clock high period | 6.0 | — | ns |
| SS49 | Oversampling clock rise time | — | 3.0 | ns |
| SS50 | Oversampling clock low period | 6.0 | — | ns |
| SS51 | Oversampling clock fall time | — | 3.0 | ns |

**NOTE**

- All the timings for the SSI are given for a non-inverted serial clock polarity (TSCKP/RSCKP = 0) and a non-inverted frame sync (TFSI/RFSI = 0). If the polarity of the clock and/or the frame sync have been inverted, all the timing remains valid by inverting the clock signal AUDx_TXC/AUDx_RXC and/or the frame sync AUDx_TXFS/AUDx_RXFS shown in the tables and in the figures.
- All timings are on Audiomux Pads when SSI is being used for data transfer.
- The terms, WL and BL, refer to Word Length (WL) and Bit Length (BL).
- For internal Frame Sync operation using external clock, the frame sync timing is same as that of transmit data (for example, during AC97 mode of operation).



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### 4.11.19.3 SSI Transmitter Timing with External Clock

Figure 93 depicts the SSI transmitter external clock timing and Table 84 lists the timing parameters for the transmitter timing with the external clock.

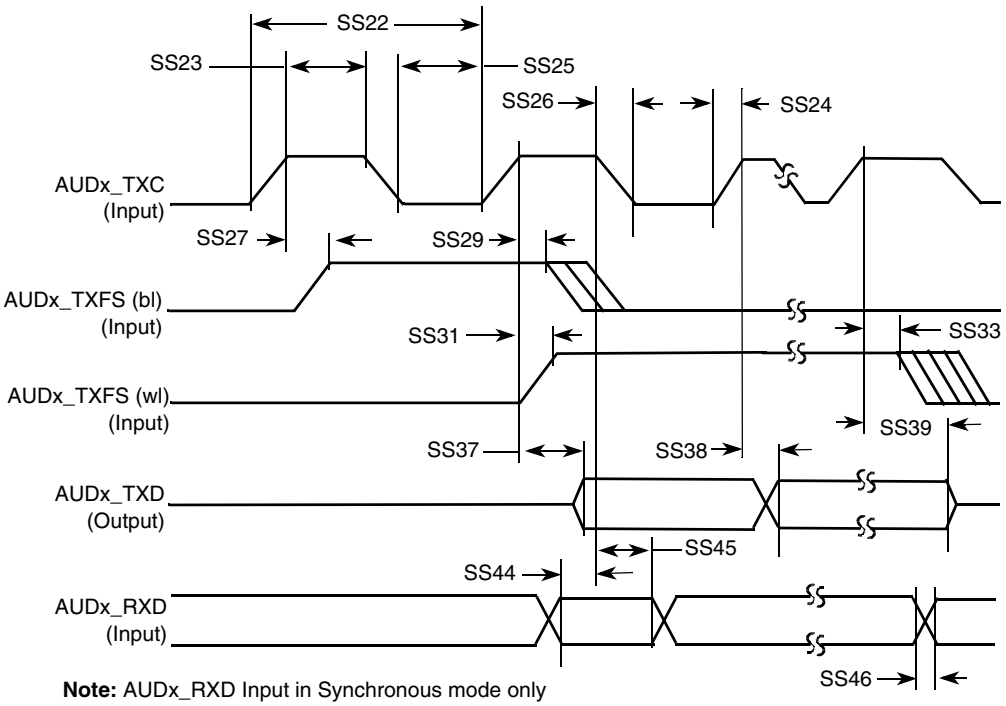


**Figure 93. SSI Transmitter External Clock Timing Diagram**

**Table 84. SSI Transmitter Timing with External Clock**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| **External Clock Operation** | | | | |
| SS22 | AUDx_TXC/AUDx_RXC clock period | 81.4 | — | ns |
| SS23 | AUDx_TXC/AUDx_RXC clock high period | 36.0 | — | ns |
| SS24 | AUDx_TXC/AUDx_RXC clock rise time | — | 6.0 | ns |
| SS25 | AUDx_TXC/AUDx_RXC clock low period | 36.0 | — | ns |
| SS26 | AUDx_TXC/AUDx_RXC clock fall time | — | 6.0 | ns |
| SS27 | AUDx_TXC high to AUDx_TXFS (bl) high | -10.0 | 15.0 | ns |
| SS29 | AUDx_TXC high to AUDx_TXFS (bl) low | 10.0 | — | ns |
| SS31 | AUDx_TXC high to AUDx_TXFS (wl) high | -10.0 | 15.0 | ns |
| SS33 | AUDx_TXC high to AUDx_TXFS (wl) low | 10.0 | — | ns |
| SS37 | AUDx_TXC high to AUDx_TXD valid from high impedance | — | 15.0 | ns |
| SS38 | AUDx_TXC high to AUDx_TXD high/low | — | 15.0 | ns |
| SS39 | AUDx_TXC high to AUDx_TXD high impedance | — | 15.0 | ns |



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**Table 84. SSI Transmitter Timing with External Clock (continued)**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| **Synchronous External Clock Operation** | | | | |
| SS44 | AUDx_RXD setup before AUDx_TXC falling | 10.0 | — | ns |
| SS45 | AUDx_RXD hold after AUDx_TXC falling | 2.0 | — | ns |
| SS46 | AUDx_RXD rise/fall time | — | 6.0 | ns |

**NOTE**

- All the timings for the SSI are given for a non-inverted serial clock polarity (TSCKP/RSCKP = 0) and a non-inverted frame sync (TFSI/RFSI = 0). If the polarity of the clock and/or the frame sync have been inverted, all the timing remains valid by inverting the clock signal AUDx_TXC/AUDx_RXC and/or the frame sync AUDx_TXFS/AUDx_RXFS shown in the tables and in the figures.
- All timings are on Audiomux Pads when SSI is being used for data transfer.
- The terms WL and BL refer to Word Length (WL) and Bit Length (BL).
- For internal Frame Sync operation using external clock, the frame sync timing is same as that of transmit data (for example, during AC97 mode of operation).

### 4.11.19.4 SSI Receiver Timing with External Clock

Figure 94 depicts the SSI receiver external clock timing and Table 85 lists the timing parameters for the receiver timing with the external clock.

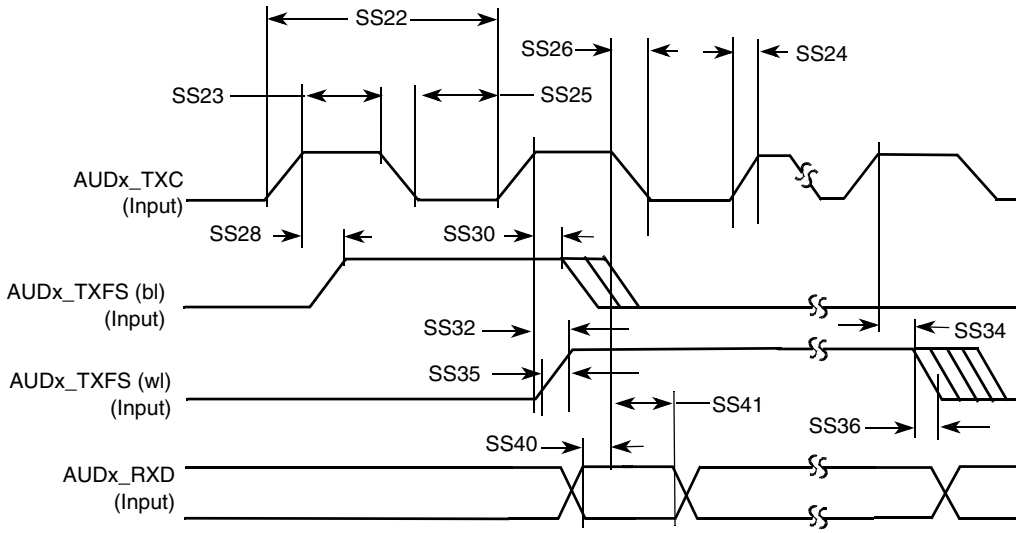


**Figure 94. SSI Receiver External Clock Timing Diagram**



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**Table 85. SSI Receiver Timing with External Clock**

| ID | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| **External Clock Operation** | | | | |
| SS22 | AUDx_TXC/AUDx_RXC clock period | 81.4 | — | ns |
| SS23 | AUDx_TXC/AUDx_RXC clock high period | 36 | — | ns |
| SS24 | AUDx_TXC/AUDx_RXC clock rise time | — | 6.0 | ns |
| SS25 | AUDx_TXC/AUDx_RXC clock low period | 36 | — | ns |
| SS26 | AUDx_TXC/AUDx_RXC clock fall time | — | 6.0 | ns |
| SS28 | AUDx_RXC high to AUDx_TXFS (bl) high | -10 | 15.0 | ns |
| SS30 | AUDx_RXC high to AUDx_TXFS (bl) low | 10 | — | ns |
| SS32 | AUDx_RXC high to AUDx_TXFS (wl) high | -10 | 15.0 | ns |
| SS34 | AUDx_RXC high to AUDx_TXFS (wl) low | 10 | — | ns |
| SS35 | AUDx_TXC/AUDx_RXC External AUDx_TXFS rise time | — | 6.0 | ns |
| SS36 | AUDx_TXC/AUDx_RXC External AUDx_TXFS fall time | — | 6.0 | ns |
| SS40 | AUDx_RXD setup time before AUDx_RXC low | 10 | — | ns |
| SS41 | AUDx_RXD hold time after AUDx_RXC low | 2 | — | ns |

**NOTE**

- All the timings for the SSI are given for a non-inverted serial clock polarity (TSCKP/RSCKP = 0) and a non-inverted frame sync (TFSI/RFSI = 0). If the polarity of the clock and/or the frame sync have been inverted, all the timing remains valid by inverting the clock signal AUDx_TXC/AUDx_RXC and/or the frame sync AUDx_TXFS/AUDx_RXFS shown in the tables and in the figures.
- All timings are on Audiomux Pads when SSI is being used for data transfer.
- The terms, WL and BL, refer to Word Length (WL) and Bit Length (BL).
- For internal Frame Sync operation using external clock, the frame sync timing is same as that of transmit data (for example, during AC97 mode of operation).



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## 4.11.20 UART I/O Configuration and Timing Parameters

### 4.11.20.1 UART RS-232 I/O Configuration in Different Modes

The i.MX 6Solo/6DualLite UART interfaces can serve both as DTE or DCE device. This can be configured by the DCEDTE control bit (default 0—DCE mode). Table 86 shows the UART I/O configuration based on the enabled mode.

**Table 86. UART I/O Configuration vs. Mode**

| Port | DTE Mode | | DCE Mode | |
|---|---|---|---|---|
| | Direction | Description | Direction | Description |
| UARTx_RTS_B | Output | RTS from DTE to DCE | Input | RTS from DTE to DCE |
| UARTx_CTS_B | Input | CTS from DCE to DTE | Output | CTS from DCE to DTE |
| UARTx_DTR_B | Output | DTR from DTE to DCE | Input | DTR from DTE to DCE |
| UARTx_DSR_B | Input | DSR from DCE to DTE | Output | DSR from DCE to DTE |
| UARTx_DCD_ B | Input | DCD from DCE to DTE | Output | DCD from DCE to DTE |
| UARTx_RI_B | Input | RING from DCE to DTE | Output | RING from DCE to DTE |
| UARTx_TX_DATA | Input | Serial data from DCE to DTE | Output | Serial data from DCE to DTE |
| UARTx_RX_DATA | Output | Serial data from DTE to DCE | Input | Serial data from DTE to DCE |

### 4.11.20.2 UART RS-232 Serial Mode Timing

The following sections describe the electrical information of the UART module in the RS-232 mode.

#### 4.11.20.2.1 UART Transmitter

Figure 95 depicts the transmit timing of UART in the RS-232 serial mode, with 8 data bit/1 stop bit format. Table 87 lists the UART RS-232 serial mode transmit timing characteristics.

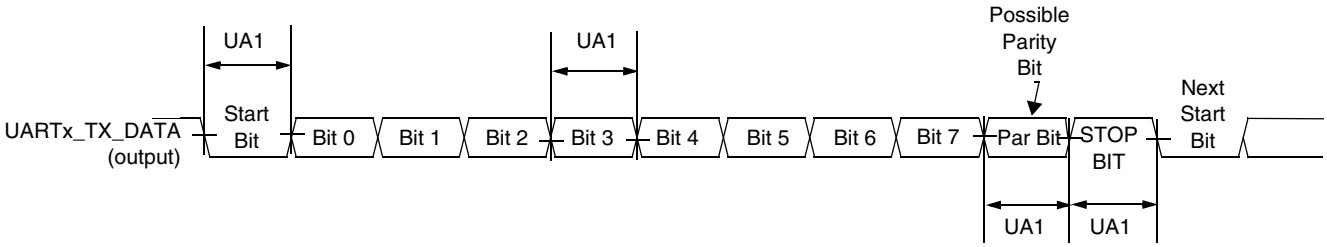


**Figure 95. UART RS-232 Serial Mode Transmit Timing Diagram**

**Table 87. RS-232 Serial Mode Transmit Timing Parameters**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| UA1 | Transmit Bit Time | $t_{Tbit}$ | $1/F_{baud_rate}$ [1] - $T_{ref_clk}$ [2] | $1/F_{baud_rate} + T_{ref_clk}$ | — |

[1] $F_{baud_rate}$: Baud rate frequency. The maximum baud rate the UART can support is (*ipg_perclk* frequency)/16.

[2] $T_{ref_clk}$: The period of UART reference clock *ref_clk* (*ipg_perclk* after RFDIV divider).



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### 4.11.20.2.2 UART Receiver

Figure 96 depicts the RS-232 serial mode receive timing with 8 data bit/1 stop bit format. Table 88 lists serial mode receive timing characteristics.

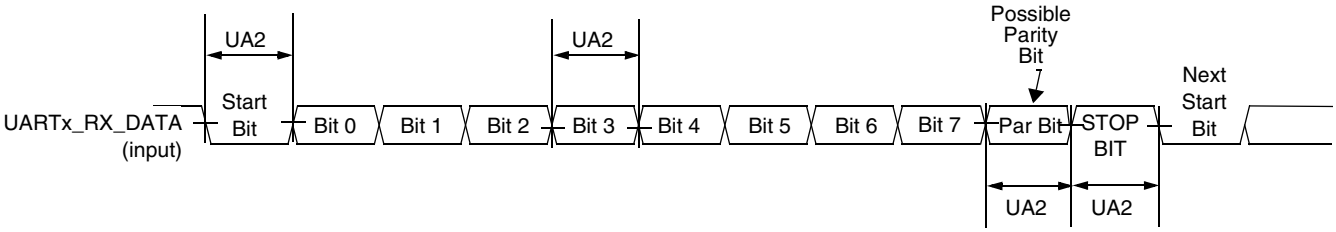


**Figure 96. UART RS-232 Serial Mode Receive Timing Diagram**

**Table 88. RS-232 Serial Mode Receive Timing Parameters**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| UA2 | Receive Bit Time[1] | $t_{Rbit}$ | $1/F_{baud_rate}$[2] - $1/(16 \times F_{baud_rate})$ | $1/F_{baud_rate} + 1/(16 \times F_{baud_rate})$ | — |

1 The UART receiver can tolerate $1/(16 \times F_{baud_rate})$ tolerance in each bit. But accumulation tolerance in one frame must not exceed $3/(16 \times F_{baud_rate})$.

2 $F_{baud_rate}$: Baud rate frequency. The maximum baud rate the UART can support is (*ipg_perclk* frequency)/16.

### 4.11.20.2.3 UART IrDA Mode Timing

The following subsections give the UART transmit and receive timings in IrDA mode.

#### UART IrDA Mode Transmitter

Figure 97 depicts the UART IrDA mode transmit timing, with 8 data bit/1 stop bit format. Table 89 lists the transmit timing characteristics.

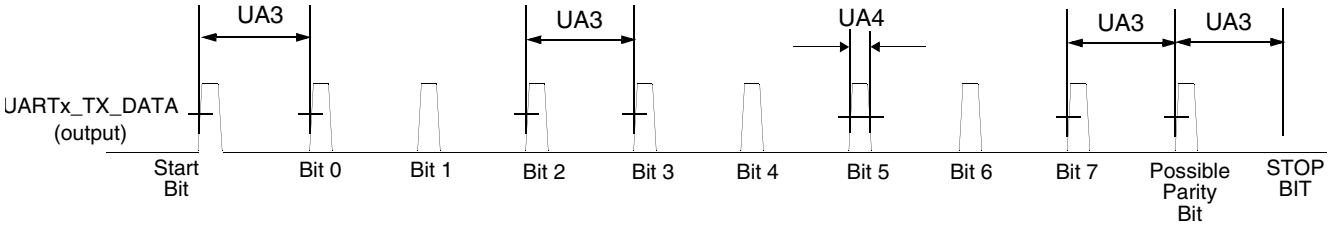


**Figure 97. UART IrDA Mode Transmit Timing Diagram**

**Table 89. IrDA Mode Transmit Timing Parameters**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| UA3 | Transmit Bit Time in IrDA mode | $t_{TIRbit}$ | $1/F_{baud_rate}$[1] - $T_{ref_clk}$[2] | $1/F_{baud_rate} + T_{ref_clk}$ | — |
| UA4 | Transmit IR Pulse Duration | $t_{TIRpulse}$ | $(3/16) \times (1/F_{baud_rate}) - T_{ref_clk}$ | $(3/16) \times (1/F_{baud_rate}) + T_{ref_clk}$ | — |

1 $F_{baud_rate}$: Baud rate frequency. The maximum baud rate the UART can support is (*ipg_perclk* frequency)/16.

2 $T_{ref_clk}$: The period of UART reference clock *ref_clk* (*ipg_perclk* after RFDIV divider).



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### UART IrDA Mode Receiver

Figure 98 depicts the UART IrDA mode receive timing, with 8 data bit/1 stop bit format. Table 90 lists the receive timing characteristics.

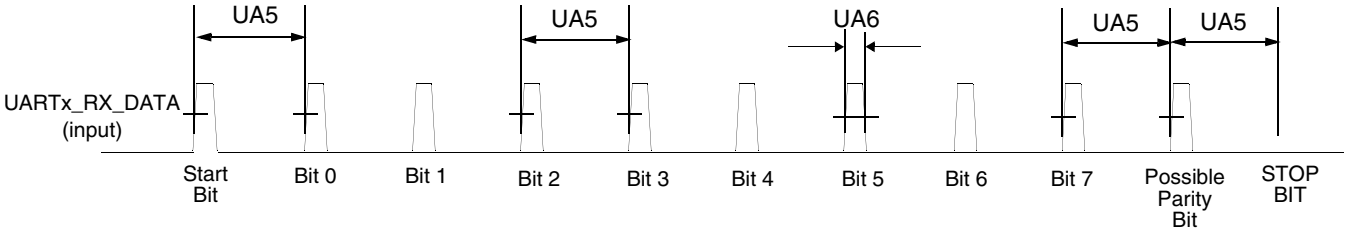


**Figure 98. UART IrDA Mode Receive Timing Diagram**

**Table 90. IrDA Mode Receive Timing Parameters**

| ID | Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|---|
| UA5 | Receive Bit Time[1] in IrDA mode | $t_{RIRbit}$ | $1/F_{baud_rate}$[2] - $1/(16 \times F_{baud_rate})$ | $1/F_{baud_rate} + 1/(16 \times F_{baud_rate})$ | — |
| UA6 | Receive IR Pulse Duration | $t_{RIRpulse}$ | 1.41 µs | $(5/16) \times (1/F_{baud_rate})$ | — |

[1] The UART receiver can tolerate $1/(16 \times F_{baud_rate})$ tolerance in each bit. But accumulation tolerance in one frame must not exceed $3/(16 \times F_{baud_rate})$.

[2] $F_{baud_rate}$: Baud rate frequency. The maximum baud rate the UART can support is (*ipg_perclk* frequency)/16.

## 4.11.21 USB HSIC Timings

This section describes the electrical information of the USB HSIC port.

**NOTE**

HSIC is DDR signal, following timing spec is for both rising and falling edge.

### 4.11.21.1 Transmit Timing

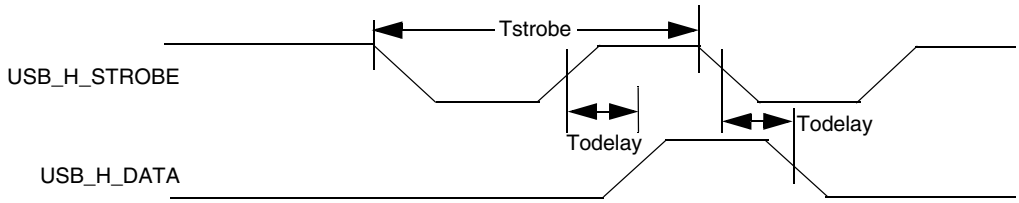


**Figure 99. USB HSIC Transmit Waveform**

**Table 91. USB HSIC Transmit Parameters**

| Name | Parameter | Min | Max | Unit | Comment |
|---|---|---|---|---|---|
| Tstrobe | strobe period | 4.166 | 4.167 | ns | — |
| Todelay | data output delay time | 550 | 1350 | ps | Measured at 50% point |
| Tslew | strobe/data rising/falling time | 0.7 | 2 | V/ns | Averaged from 30% – 70% points |



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### 4.11.21.2 Receive Timing

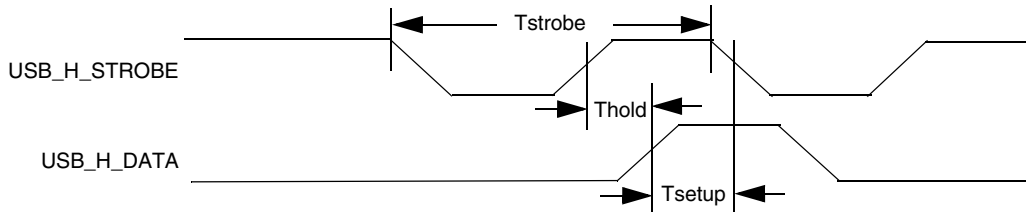


**Figure 100. USB HSIC Receive Waveform**

**Table 92. USB HSIC Receive Parameters[1]**

| Name | Parameter | Min | Max | Unit | Comment |
|---|---|---|---|---|---|
| Tstrobe | strobe period | 4.166 | 4.167 | ns | — |
| Thold | data hold time | 300 | — | ps | Measured at 50% point |
| Tsetup | data setup time | 365 | — | ps | Measured at 50% point |
| Tslew | strobe/data rising/falling time | 0.7 | 2 | V/ns | Averaged from 30% – 70% points |

[1] The timings in the table are guaranteed when:
—AC I/O voltage is between 0.9x to 1x of the I/O supply
—DDR_SEL configuration bits of the I/O are set to (10)b

## 4.11.22 USB PHY Parameters

This section describes the USB-OTG PHY and the USB Host port PHY parameters.

The USB PHY meets the electrical compliance requirements defined in the Universal Serial Bus Revision 2.0 OTG, USB Host with the amendments below (On-The-Go and Embedded Host Supplement to the USB Revision 2.0 Specification is not applicable to Host port).

- USB ENGINEERING CHANGE NOTICE
  - Title: 5V Short Circuit Withstand Requirement Change
  - Applies to: Universal Serial Bus Specification, Revision 2.0
- Errata for USB Revision 2.0 April 27, 2000 as of 12/7/2000
- USB ENGINEERING CHANGE NOTICE
  - Title: Pull-up/Pull-down resistors
  - Applies to: Universal Serial Bus Specification, Revision 2.0
- USB ENGINEERING CHANGE NOTICE
  - Title: Suspend Current Limit Changes
  - Applies to: Universal Serial Bus Specification, Revision 2.0
- USB ENGINEERING CHANGE NOTICE
  - Title: USB 2.0 Phase Locked SOFs
  - Applies to: Universal Serial Bus Specification, Revision 2.0
- On-The-Go and Embedded Host Supplement to the USB Revision 2.0 Specification



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— Revision 2.0 plus errata and ecn June 4, 2010

- Battery Charging Specification (available from USB-IF)
  — Revision 1.2, December 7, 2010
  — Portable device only

# 5 Boot Mode Configuration

This section provides information on boot mode configuration pins allocation and boot devices interfaces allocation.

## 5.1 Boot Mode Configuration Pins

Table 93 provides boot options, functionality, fuse values, and associated pins. Several input pins are also sampled at reset and can be used to override fuse values, depending on the value of BT_FUSE_SEL fuse. The boot option pins are in effect when BT_FUSE_SEL fuse is '0' (cleared, which is the case for an unblown fuse). For detailed boot mode options configured by the boot mode pins, see the i.MX 6Solo/6DualLite Fuse Map document and the System Boot chapter in *i.MX 6Solo/6DualLite Reference Manual (IMX6SDLRM)*.

**Table 93. Fuses and Associated Pins Used for Boot**

| Pin | Direction at Reset | eFuse Name |
|---|---|---|
| **Boot Mode Selection** | | |
| BOOT_MODE1 | Input | N/A |
| BOOT_MODE0 | Input | N/A |
| **Boot Options[1]** | | |
| EIM_DA0 | Input | BOOT_CFG1[0] |
| EIM_DA1 | Input | BOOT_CFG1[1] |
| EIM_DA2 | Input | BOOT_CFG1[2] |
| EIM_DA3 | Input | BOOT_CFG1[3] |
| EIM_DA4 | Input | BOOT_CFG1[4] |
| EIM_DA5 | Input | BOOT_CFG1[5] |
| EIM_DA6 | Input | BOOT_CFG1[6] |
| EIM_DA7 | Input | BOOT_CFG1[7] |
| EIM_DA8 | Input | BOOT_CFG2[0] |
| EIM_DA9 | Input | BOOT_CFG2[1] |
| EIM_DA10 | Input | BOOT_CFG2[2] |
| EIM_DA11 | Input | BOOT_CFG2[3] |
| EIM_DA12 | Input | BOOT_CFG2[4] |
| EIM_DA13 | Input | BOOT_CFG2[5] |



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**Table 93. Fuses and Associated Pins Used for Boot (continued)**

| Pin | Direction at Reset | eFuse Name |
|---|---|---|
| EIM_DA14 | Input | BOOT_CFG2[6] |
| EIM_DA15 | Input | BOOT_CFG2[7] |
| EIM_A16 | Input | BOOT_CFG3[0] |
| EIM_A17 | Input | BOOT_CFG3[1] |
| EIM_A18 | Input | BOOT_CFG3[2] |
| EIM_A19 | Input | BOOT_CFG3[3] |
| EIM_A20 | Input | BOOT_CFG3[4] |
| EIM_A21 | Input | BOOT_CFG3[5] |
| EIM_A22 | Input | BOOT_CFG3[6] |
| EIM_A23 | Input | BOOT_CFG3[7] |
| EIM_A24 | Input | BOOT_CFG4[0] |
| EIM_WAIT | Input | BOOT_CFG4[1] |
| EIM_LBA | Input | BOOT_CFG4[2] |
| EIM_EB0 | Input | BOOT_CFG4[3] |
| EIM_EB1 | Input | BOOT_CFG4[4] |
| EIM_RW | Input | BOOT_CFG4[5] |
| EIM_EB2 | Input | BOOT_CFG4[6] |
| EIM_EB3 | Input | BOOT_CFG4[7] |

[1] Pin value overrides fuse settings for BT_FUSE_SEL = '0'. Signal Configuration as Fuse Override Input at Power Up. These are special I/O lines that control the boot up configuration during product development. In production, the boot configuration can be controlled by fuses.

## 5.2 Boot Device Interface Allocation

Table 94 lists the interfaces that can be used by the boot process in accordance with the specific boot mode configuration. The table also describes the interface's specific modes and IOMUXC allocation, which are configured during boot when appropriate.

**Table 94. Interface Allocation During Boot**

| Interface | IP Instance | Allocated Pads During Boot | Comment |
|---|---|---|---|
| SPI | ECSPI-1 | EIM_D17, EIM_D18, EIM_D16, EIM_EB2, EIM_D19, EIM_D24, EIM_D25 | — |
| SPI | ECSPI-2 | CSI0_DAT10, CSI0_DAT9, CSI0_DAT8, CSI0_DAT11, EIM_LBA, EIM_D24, EIM_D25 | — |
| SPI | ECSPI-3 | DISP0_DAT2, DISP0_DAT1, DISP0_DAT0, DISP0_DAT3,DISP0_DAT4,DISP0_DAT5,DISP0_DAT6 | — |



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**Table 94. Interface Allocation During Boot (continued)**

| Interface | IP Instance | Allocated Pads During Boot | Comment |
|---|---|---|---|
| SPI | ECSPI-4 | EIM_D22, EIM_D28, EIM_D21, EIM_D20, EIM_A25, EIM_D24, EIM_D25 | — |
| EIM | EIM | EIM_DA[15:0], EIM_D[31:16], CSI0_DAT[19:4], CSI0_DATA_EN, CSI0_VSYNC | Used for NOR, OneNAND boot<br>Only CS0 is supported |
| NAND Flash | GPMI | NANDF_CLE, NANDF_ALE, NANDF_WP_B, SD4_CMD, SD4_CLK, NANDF_RB0, SD4_DAT0, NANDF_CS0, NANDF_CS1, NANDF_CS2, NANDF_CS3, NANDF_D[7:0] | 8 bit<br>Only CS0 is supported |
| SD/MMC | USDHC-1 | SD1_CLK, SD1_CMD, SD1_DAT0, SD1_DAT1, SD1_DAT2, SD1_DAT3, GPIO_1, NANDF_D0, NANDF_D1, NANDF_D2, NANDF_D3, KEY_COL1 | 1, 4, or 8 bit |
| SD/MMC | USDHC-2 | SD2_CLK, SD2_CMD, SD2_DAT0, SD2_DAT1, SD2_DAT2, SD2_DAT3, GPIO_4, NANDF_D4, NANDF_D5, NANDF_D6, NANDF_D7, KEY_ROW1 | 1, 4, or 8 bit |
| SD/MMC | USDHC-3 | SD3_CLK, SD3_CMD, SD3_DAT0, SD3_DAT1, SD3_DAT2, SD3_DAT3, SD3_DAT4, SD3_DAT5, SD3_DAT6, SD3_DAT7, SD3_RST, GPIO_18 | 1, 4, or 8 bit |
| SD/MMC | USDHC-4 | SD4_CLK, SD4_CMD, SD4_DAT0, SD4_DAT1, SD4_DAT2, SD4_DAT3, SD4_DAT4, SD4_DAT5, SD4_DAT6, SD4_DAT7, NANDF_ALE, NANDF_CS1 | 1, 4, or 8 bit |
| $I^2C$ | $I^2C$-1 | EIM_D28, EIM_D21 | — |
| $I^2C$ | $I^2C$-2 | EIM_D16, EIM_EB2 | — |
| $I^2C$ | $I^2C$-3 | EIM_D18, EIM_D17 | — |
| USB | USB-OTG PHY | USB_OTG_DP<br>USB_OTG_DN<br>USB_OTG_VBUS | — |

# 6 Package Information and Contact Assignments

This section includes the contact assignment information and mechanical package drawing.

## 6.1 Updated Signal Naming Convention

The signal names of the i.MX6 series of products have been standardized to better align the signal names within the family and across the documentation. Some of the benefits of these changes are as follows:

- The names are unique within the scope of an SoC and within the series of products
- Searches will return all occurrences of the named signal
- The names are consistent between i.MX 6 series products implementing the same modules
- The module instance is incorporated into the signal name

This change applies only to signal names. The original ball names have been preserved to prevent the need to change schematics, BSDL models, IBIS models, etc.



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Throughout this document, the updated signal names are used except where referenced as a ball name (such as the Functional Contact Assignments table, Ball Map table, and so on). A master list of the signal name changes is in the document, *IMX 6 Series Signal Name Mapping* (EB792). This list can be used to map the signal names used in older documentation to the new standardized naming conventions.

## 6.2 21x21 mm Package Information

### 6.2.1 Case 2240, 21 x 21 mm, 0.8 mm Pitch, 25 x 25 Ball Matrix

Figure 101 shows the top, bottom, and side views of the 21×21 mm BGA package.



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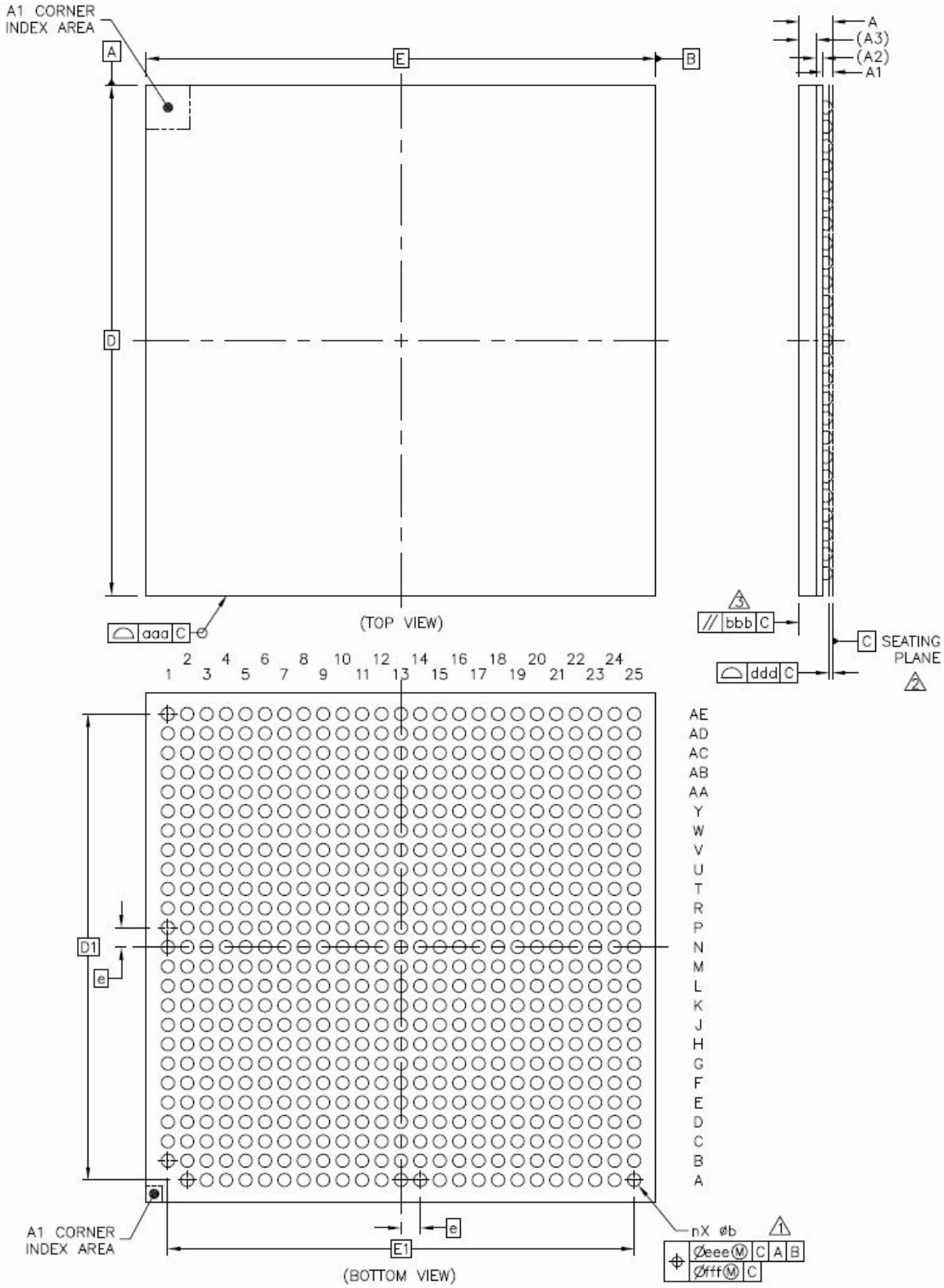


**Figure 101. 21 x 21 mm BGA, Case 2240 Package Top, Bottom, and Side Views**



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Table 95 shows the 21 × 21 mm BGA package details.

**Table 95. 21 x 21, 0.8 mm BGA Package Details**

| Parameter | Symbol | Common Dimensions | | |
|---|---|---|---|---|
| | | Minimum | Normal | Maximum |
| Total Thickness | A | — | — | 1.6 |
| Stand Off | A1 | 0.36 | — | 0.46 |
| Substrate Thickness | A2 | 0.26 REF | | |
| Mold Thickness | A3 | 0.7 REF | | |
| Body Size | D | 21 BSC | | |
| | E | 21 BSC | | |
| Ball Diameter | — | 0.5 | | |
| Ball Opening | — | 0.4 | | |
| Ball Width | b | 0.44 | — | 0.64 |
| Ball Pitch | e | 0.8 BSC | | |
| Ball Count | n | 624 | | |
| Edge Ball Center to Center | D1 | 19.2 BSC | | |
| | E1 | 19.2 BSC | | |
| Body Center to Contact Ball | SD | — | | |
| | SE | — | | |
| Package Edge Tolerance | aaa | 0.1 | | |
| Mold Flatness | bbb | 0.2 | | |
| Coplanarity | ddd | 0.15 | | |
| Ball Offset (Package) | eee | 0.15 | | |
| Ball Offset (Ball) | fff | 0.08 | | |



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### 6.2.2 21 x 21 mm Supplies Contact Assignments and Functional Contact Assignments

Table 96 shows supplies contact assignments for the 21 x 21 mm package.

**Table 96. 21 x 21 mm Supplies Contact Assignments**

| Supply Rail Name | Ball(s) Position(s) | Remark |
|---|---|---|
| CSI_REXT | D4 | — |
| DRAM_VREF | AC2 | — |
| DSI_REXT | G4 | — |
| GND | A4, A8, A13, A25, B4, C1, C4, C6, C10, D3, D6, D8, E5, E6, E7, F5, F6, F7, F8, G3, G10, G19, H8, H12, H15, H18, J2, J8, J12, J15, J18, K8, K10, K12, K15, K18, L2, L5, L8, L10, L12, L15, L18, M8, M10, M12, M15, M18, N8, N10, N15, N18, P8, P10, P12, P15, P18, R8, R12, R15, R17, T8, T11, T12, T15, T17, T19, U8, U11, U12, U15, U17, U19, V8, V19, W3, W7, W8, W9, W10, W11, W12, W13, W15, W16, W17, W18, W19, Y5, Y24, AA7, AA10, AA13, AA16, AA19, AA22, AB3, AB24, AD4, AD7, AD10, AD13, AD16, AD19, AD22, AE1, AE25 | — |
| HDMI_REF | J1 | — |
| HDMI_VP | L7 | — |
| HDMI_VPH | M7 | — |
| NVCC_CSI | N7 | Supply of the camera sensor interface |
| NVCC_DRAM | R18, T18, U18, V9, V10, V11, V12, V13, V14, V15, V16, V17, V18 | Supply of the DDR interface |
| NVCC_EIM | K19, L19, M19 | Supply of the EIM interface |
| NVCC_ENET | R19 | Supply of the ENET interface |
| NVCC_GPIO | P7 | Supply of the GPIO interface |
| NVCC_JTAG | J7 | Supply of the JTAG tap controller interface |
| NVCC_LCD | P19 | Supply of the LCD interface |
| NVCC_LVDS2P5 | V7 | Supply of the LVDS display interface and DDR pre-drivers |
| NVCC_MIPI | K7 | Supply of the MIPI interface |
| NVCC_NANDF | G15 | Supply of the raw NAND Flash memories interface |
| NVCC_PLL_OUT | E8 | — |
| NVCC_RGMII | G18 | Supply of the ENET interface |
| NVCC_SD1 | G16 | Supply of the SD card interface |
| NVCC_SD2 | G17 | Supply of the SD card interface |
| NVCC_SD3 | G14 | Supply of the SD card interface |



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**Table 96. 21 x 21 mm Supplies Contact Assignments (continued)**

| Supply Rail Name | Ball(s) Position(s) | Remark |
|---|---|---|
| PCIE_REXT | A2 | — |
| PCIE_VP | H7 | — |
| PCIE_VPH | G7 | PCI PHY supply |
| PCIE_VPTX | G8 | PCI PHY supply |
| VDD_SNVS_CAP | G9 | Secondary supply for the SNVS (internal regulator output—requires capacitor if internal regulator is used) |
| VDD_SNVS_IN | G11 | Primary supply for the SNVS regulator |
| VDDARM_CAP | H11, H13, J11, J13, K11, K13, L11, L13, M11, M13, N11, N13, P11, P13, R11, R13 | Secondary supply for core (internal regulator output—requires capacitor if internal regulator is used) |
| VDDARM_IN | H14, J14, K9, K14, L9, L14, M9, M14, N9, N14, P9, P14, R9, R14, T9, U9 | Primary supply for the Arm core's regulator |
| VDDHIGH_CAP | H10, J10 | Secondary supply for the 2.5 V domain (internal regulator output—requires capacitor if internal regulator is used) |
| VDDHIGH_IN | H9, J9 | Primary supply for the 2.5 V regulator |
| VDDPU_CAP | H17, J17, K17, L17, M17, N17, P17 | Secondary supply for VPU and GPUs (internal regulator output—requires capacitor if internal regulator is used) |
| VDDSOC_CAP | R10, T10, T13, T14, U10, U13, U14 | Secondary supply for SoC and PU regulators (internal regulator output—requires capacitor if internal regulator is used) |
| VDDSOC_IN | H16, J16, K16, L16, M16, N16, P16, R16, T16, U16 | Primary supply for SoC and PU regulators |
| VDDUSB_CAP | F9 | Secondary supply for the 3 V Domain (internal regulator output—requires capacitor if internal regulator is used) |
| USB_H1_VBUS | D10 | Primary supply for the 3 V regulator |
| USB_OTG_VBUS | E9 | Primary supply for the 3 V regulator |
| HDMI_DDCCEC | K2 | Analog Ground (Ground reference for the Hot Plug Detect signal) |
| FA_ANA | A5 | — |
| GPANAIO | C8 | Analog output for NXP use only. This output must remain unconnected. |
| VDD_FA | B5 | — |



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**Table 96. 21 x 21 mm Supplies Contact Assignments (continued)**

| Supply Rail Name | Ball(s) Position(s) | Remark |
|---|---|---|
| ZQPAD | AE17 | Connect ZQPAD to an external 240 Ω 1% resistor to GND. This is a reference used during DRAM output buffer driver calibration. |
| NC | **For i.MX 6DualLite:**<br>A12, A14, B12, B14, C14, E1, E2, F1, F2, G12, G13, N12<br><br>**For i.MX 6Solo:**<br>A12, A14, B12, B14, C14, E1, E2, F1, F2, G12, G13, N12, W25, Y17, Y18, Y19, Y20, Y21, Y22, Y23, Y25, AA17, AA18, AA20, AA21, AA23, AA24, AA25, AB18, AB19, AB20, AB21, AB22, AB23, AB25, AC18, AC19, AC20, AC21, AC22, AC23, AC24, AC25, AD18, AD20, AD21, AD23, AD24, AD25, AE18, AE19, AE20, AE21, AE22, AE23, AE24 | These signals are not functional and must remain unconnected by the user. |

Table 97 shows an alpha-sorted list of functional contact assignments for the 21 x 21 mm package.

**Table 97. 21 x 21 mm Functional Contact Assignments**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| BOOT_MODE0 | C12 | VDD_SNVS_IN | GPIO | ALT0 | SRC_BOOT_MODE0 | Input | 100 kΩ pull-down |
| BOOT_MODE1 | F12 | VDD_SNVS_IN | GPIO | ALT0 | SRC_BOOT_MODE1 | Input | 100 kΩ pull-down |
| CLK1_N | C7 | VDDHIGH_CAP | — | — | CLK1_N | — | — |
| CLK1_P | D7 | VDDHIGH_CAP | — | — | CLK1_P | — | — |
| CLK2_N | C5 | VDDHIGH_CAP | — | — | CLK2_N | — | — |
| CLK2_P | D5 | VDDHIGH_CAP | — | — | CLK2_P | — | — |
| CSI_CLK0M | F4 | NVCC_MIPI | ANALOG | — | CSI_CLK_N | — | — |
| CSI_CLK0P | F3 | NVCC_MIPI | ANALOG | — | CSI_CLK_P | — | — |
| CSI_D0M | E4 | NVCC_MIPI | ANALOG | — | CSI_DATA0_N | — | — |
| CSI_D0P | E3 | NVCC_MIPI | ANALOG | — | CSI_DATA0_P | — | — |
| CSI_D1M | D1 | NVCC_MIPI | ANALOG | — | CSI_DATA1_N | — | — |
| CSI_D1P | D2 | NVCC_MIPI | ANALOG | — | CSI_DATA1_P | — | — |
| CSI0_DAT10 | M1 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO28 | Input | 100 kΩ pull-up |
| CSI0_DAT11 | M3 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO29 | Input | 100 kΩ pull-up |
| CSI0_DAT12 | M2 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO30 | Input | 100 kΩ pull-up |
| CSI0_DAT13 | L1 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO31 | Input | 100 kΩ pull-up |
| CSI0_DAT14 | M4 | NVCC_CSI | GPIO | ALT5 | GPIO6_IO00 | Input | 100 kΩ pull-up |
| CSI0_DAT15 | M5 | NVCC_CSI | GPIO | ALT5 | GPIO6_IO01 | Input | 100 kΩ pull-up |
| CSI0_DAT16 | L4 | NVCC_CSI | GPIO | ALT5 | GPIO6_IO02 | Input | 100 kΩ pull-up |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| CSI0_DAT17 | L3 | NVCC_CSI | GPIO | ALT5 | GPIO6_IO03 | Input | 100 kΩ pull-up |
| CSI0_DAT18 | M6 | NVCC_CSI | GPIO | ALT5 | GPIO6_IO04 | Input | 100 kΩ pull-up |
| CSI0_DAT19 | L6 | NVCC_CSI | GPIO | ALT5 | GPIO6_IO05 | Input | 100 kΩ pull-up |
| CSI0_DAT4 | N1 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO22 | Input | 100 kΩ pull-up |
| CSI0_DAT5 | P2 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO23 | Input | 100 kΩ pull-up |
| CSI0_DAT6 | N4 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO24 | Input | 100 kΩ pull-up |
| CSI0_DAT7 | N3 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO25 | Input | 100 kΩ pull-up |
| CSI0_DAT8 | N6 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO26 | Input | 100 kΩ pull-up |
| CSI0_DAT9 | N5 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO27 | Input | 100 kΩ pull-up |
| CSI0_DATA_EN | P3 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO20 | Input | 100 kΩ pull-up |
| CSI0_MCLK | P4 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO19 | Input | 100 kΩ pull-up |
| CSI0_PIXCLK | P1 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO18 | Input | 100 kΩ pull-up |
| CSI0_VSYNC | N2 | NVCC_CSI | GPIO | ALT5 | GPIO5_IO21 | Input | 100 kΩ pull-up |
| DI0_DISP_CLK | N19 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO16 | Input | 100 kΩ pull-up |
| DI0_PIN15 | N21 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO17 | Input | 100 kΩ pull-up |
| DI0_PIN2 | N25 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO18 | Input | 100 kΩ pull-up |
| DI0_PIN3 | N20 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO19 | Input | 100 kΩ pull-up |
| DI0_PIN4 | P25 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO20 | Input | 100 kΩ pull-up |
| DISP0_DAT0 | P24 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO21 | Input | 100 kΩ pull-up |
| DISP0_DAT1 | P22 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO22 | Input | 100 kΩ pull-up |
| DISP0_DAT10 | R21 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO31 | Input | 100 kΩ pull-up |
| DISP0_DAT11 | T23 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO05 | Input | 100 kΩ pull-up |
| DISP0_DAT12 | T24 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO06 | Input | 100 kΩ pull-up |
| DISP0_DAT13 | R20 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO07 | Input | 100 kΩ pull-up |
| DISP0_DAT14 | U25 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO08 | Input | 100 kΩ pull-up |
| DISP0_DAT15 | T22 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO09 | Input | 100 kΩ pull-up |
| DISP0_DAT16 | T21 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO10 | Input | 100 kΩ pull-up |
| DISP0_DAT17 | U24 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO11 | Input | 100 kΩ pull-up |
| DISP0_DAT18 | V25 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO12 | Input | 100 kΩ pull-up |
| DISP0_DAT19 | U23 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO13 | Input | 100 kΩ pull-up |
| DISP0_DAT2 | P23 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO23 | Input | 100 kΩ pull-up |
| DISP0_DAT20 | U22 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO14 | Input | 100 kΩ pull-up |
| DISP0_DAT21 | T20 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO15 | Input | 100 kΩ pull-up |
| DISP0_DAT22 | V24 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO16 | Input | 100 kΩ pull-up |
| DISP0_DAT23 | W24 | NVCC_LCD | GPIO | ALT5 | GPIO5_IO17 | Input | 100 kΩ pull-up |
| DISP0_DAT3 | P21 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO24 | Input | 100 kΩ pull-up |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| DISP0_DAT4 | P20 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO25 | Input | 100 kΩ pull-up |
| DISP0_DAT5 | R25 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO26 | Input | 100 kΩ pull-up |
| DISP0_DAT6 | R23 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO27 | Input | 100 kΩ pull-up |
| DISP0_DAT7 | R24 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO28 | Input | 100 kΩ pull-up |
| DISP0_DAT8 | R22 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO29 | Input | 100 kΩ pull-up |
| DISP0_DAT9 | T25 | NVCC_LCD | GPIO | ALT5 | GPIO4_IO30 | Input | 100 kΩ pull-up |
| DRAM_A0 | AC14 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR00 | Output | Low |
| DRAM_A1 | AB14 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR01 | Output | Low |
| DRAM_A10 | AA15 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR10 | Output | Low |
| DRAM_A11 | AC12 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR11 | Output | Low |
| DRAM_A12 | AD12 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR12 | Output | Low |
| DRAM_A13 | AC17 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR13 | Output | Low |
| DRAM_A14 | AA12 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR14 | Output | Low |
| DRAM_A15 | Y12 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR15 | Output | Low |
| DRAM_A2 | AA14 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR02 | Output | Low |
| DRAM_A3 | Y14 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR03 | Output | Low |
| DRAM_A4 | W14 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR04 | Output | Low |
| DRAM_A5 | AE13 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR05 | Output | Low |
| DRAM_A6 | AC13 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR06 | Output | Low |
| DRAM_A7 | Y13 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR07 | Output | Low |
| DRAM_A8 | AB13 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR08 | Output | Low |
| DRAM_A9 | AE12 | NVCC_DRAM | DDR | ALT0 | DRAM_ADDR09 | Output | Low |
| DRAM_CAS | AE16 | NVCC_DRAM | DDR | ALT0 | DRAM_CAS | Output | Low |
| DRAM_CS0 | Y16 | NVCC_DRAM | DDR | ALT0 | DRAM_CS0 | Output | Low |
| DRAM_CS1 | AD17 | NVCC_DRAM | DDR | ALT0 | DRAM_CS1 | Output | Low |
| DRAM_D0 | AD2 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA00 | Input | 100 kΩ pull-up |
| DRAM_D1 | AE2 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA01 | Input | 100 kΩ pull-up |
| DRAM_D10 | AA6 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA10 | Input | 100 kΩ pull-up |
| DRAM_D11 | AE7 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA11 | Input | 100 kΩ pull-up |
| DRAM_D12 | AB5 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA12 | Input | 100 kΩ pull-up |
| DRAM_D13 | AC5 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA13 | Input | 100 kΩ pull-up |
| DRAM_D14 | AB6 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA14 | Input | 100 kΩ pull-up |
| DRAM_D15 | AC7 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA15 | Input | 100 kΩ pull-up |
| DRAM_D16 | AB7 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA16 | Input | 100 kΩ pull-up |
| DRAM_D17 | AA8 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA17 | Input | 100 kΩ pull-up |
| DRAM_D18 | AB9 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA18 | Input | 100 kΩ pull-up |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| DRAM_D19 | Y9 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA19 | Input | 100 kΩ pull-up |
| DRAM_D2 | AC4 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA02 | Input | 100 kΩ pull-up |
| DRAM_D20 | Y7 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA20 | Input | 100 kΩ pull-up |
| DRAM_D21 | Y8 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA21 | Input | 100 kΩ pull-up |
| DRAM_D22 | AC8 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA22 | Input | 100 kΩ pull-up |
| DRAM_D23 | AA9 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA23 | Input | 100 kΩ pull-up |
| DRAM_D24 | AE9 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA24 | Input | 100 kΩ pull-up |
| DRAM_D25 | Y10 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA25 | Input | 100 kΩ pull-up |
| DRAM_D26 | AE11 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA26 | Input | 100 kΩ pull-up |
| DRAM_D27 | AB11 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA27 | Input | 100 kΩ pull-up |
| DRAM_D28 | AC9 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA28 | Input | 100 kΩ pull-up |
| DRAM_D29 | AD9 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA29 | Input | 100 kΩ pull-up |
| DRAM_D3 | AA5 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA03 | Input | 100 kΩ pull-up |
| DRAM_D30 | AD11 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA30 | Input | 100 kΩ pull-up |
| DRAM_D31 | AC11 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA31 | Input | 100 kΩ pull-up |
| **Note: DRAM_D32 to DRAM_D63 are only available for i.MX 6DualLite chip; for i.MX 6Solo chip, these pins are NC.** | | | | | | | |
| DRAM_D32 | AA17 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA32 | Input | 100 kΩ pull-up |
| DRAM_D33 | AA18 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA33 | Input | 100 kΩ pull-up |
| DRAM_D34 | AC18 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA34 | Input | 100 kΩ pull-up |
| DRAM_D35 | AE19 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA35 | Input | 100 kΩ pull-up |
| DRAM_D36 | Y17 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA36 | Input | 100 kΩ pull-up |
| DRAM_D37 | Y18 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA37 | Input | 100 kΩ pull-up |
| DRAM_D38 | AB19 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA38 | Input | 100 kΩ pull-up |
| DRAM_D39 | AC19 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA39 | Input | 100 kΩ pull-up |
| DRAM_D40 | Y19 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA40 | Input | 100 kΩ pull-up |
| DRAM_D41 | AB20 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA41 | Input | 100 kΩ pull-up |
| DRAM_D42 | AB21 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA42 | Input | 100 kΩ pull-up |
| DRAM_D43 | AD21 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA43 | Input | 100 kΩ pull-up |
| DRAM_D44 | Y20 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA44 | Input | 100 kΩ pull-up |
| DRAM_D45 | AA20 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA45 | Input | 100 kΩ pull-up |
| DRAM_D46 | AE21 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA46 | Input | 100 kΩ pull-up |
| DRAM_D47 | AC21 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA47 | Input | 100 kΩ pull-up |
| DRAM_D48 | AC22 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA48 | Input | 100 kΩ pull-up |
| DRAM_D49 | AE22 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA49 | Input | 100 kΩ pull-up |
| DRAM_D50 | AE24 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA50 | Input | 100 kΩ pull-up |
| DRAM_D51 | AC24 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA51 | Input | 100 kΩ pull-up |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| DRAM_D52 | AB22 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA52 | Input | 100 kΩ pull-up |
| DRAM_D53 | AC23 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA53 | Input | 100 kΩ pull-up |
| DRAM_D54 | AD25 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA54 | Input | 100 kΩ pull-up |
| DRAM_D55 | AC25 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA55 | Input | 100 kΩ pull-up |
| DRAM_D56 | AB25 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA56 | Input | 100 kΩ pull-up |
| DRAM_D57 | AA21 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA57 | Input | 100 kΩ pull-up |
| DRAM_D58 | Y25 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA58 | Input | 100 kΩ pull-up |
| DRAM_D59 | Y22 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA59 | Input | 100 kΩ pull-up |
| DRAM_D60 | AB23 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA60 | Input | 100 kΩ pull-up |
| DRAM_D61 | AA23 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA61 | Input | 100 kΩ pull-up |
| DRAM_D62 | Y23 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA62 | Input | 100 kΩ pull-up |
| DRAM_D63 | W25 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA63 | Input | 100 kΩ pull-up |
| DRAM_D4 | AC1 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA04 | Input | 100 kΩ pull-up |
| DRAM_D5 | AD1 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA05 | Input | 100 kΩ pull-up |
| DRAM_D6 | AB4 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA06 | Input | 100 kΩ pull-up |
| DRAM_D7 | AE4 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA07 | Input | 100 kΩ pull-up |
| DRAM_D8 | AD5 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA08 | Input | 100 kΩ pull-up |
| DRAM_D9 | AE5 | NVCC_DRAM | DDR | ALT0 | DRAM_DATA09 | Input | 100 kΩ pull-up |
| DRAM_DQM0 | AC3 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM0 | Output | Low |
| DRAM_DQM1 | AC6 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM1 | Output | Low |
| DRAM_DQM2 | AB8 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM2 | Output | Low |
| DRAM_DQM3 | AE10 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM3 | Output | Low |
| DRAM_DQM4 | AB18 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM4 | Output | Low |
| DRAM_DQM5 | AC20 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM5 | Output | Low |
| DRAM_DQM6 | AD24 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM6 | Output | Low |
| DRAM_DQM7 | Y21 | NVCC_DRAM | DDR | ALT0 | DRAM_DQM7 | Output | Low |
| DRAM_RAS | AB15 | NVCC_DRAM | DDR | ALT0 | DRAM_RAS | Output | Low |
| DRAM_RESET | Y6 | NVCC_DRAM | DDR | ALT0 | DRAM_RESET | Output | Low |
| DRAM_SDBA0 | AC15 | NVCC_DRAM | DDR | ALT0 | DRAM_SDBA0 | Output | Low |
| DRAM_SDBA1 | Y15 | NVCC_DRAM | DDR | ALT0 | DRAM_SDBA1 | Output | Low |
| DRAM_SDBA2 | AB12 | NVCC_DRAM | DDR | ALT0 | DRAM_SDBA2 | Output | Low |
| DRAM_SDCKE0 | Y11 | NVCC_DRAM | DDR | ALT0 | DRAM_SDCKE0 | Output | Low |
| DRAM_SDCKE1 | AA11 | NVCC_DRAM | DDR | ALT0 | DRAM_SDCKE1 | Output | Low |
| DRAM_SDCLK_0 | AD15 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDCLK0_P | Output | Low |
| DRAM_SDCLK_0_B | AE15 | NVCC_DRAM | — | — | DRAM_SDCLK0_N | — | — |
| DRAM_SDCLK_1 | AD14 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDCLK1_P | Output | Low |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| DRAM_SDCLK_1_B | AE14 | NVCC_DRAM | — | — | DRAM_SDCLK1_N | — | — |
| DRAM_SDODT0 | AC16 | NVCC_DRAM | DDR | ALT0 | DRAM_ODT0 | Output | Low |
| DRAM_SDODT1 | AB17 | NVCC_DRAM | DDR | ALT0 | DRAM_ODT1 | Output | Low |
| DRAM_SDQS0 | AE3 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS0_P | Input | Hi-Z |
| DRAM_SDQS0_B | AD3 | NVCC_DRAM | — | — | DRAM_SDQS0_N | — | — |
| DRAM_SDQS1 | AD6 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS1_P | Input | Hi-Z |
| DRAM_SDQS1_B | AE6 | NVCC_DRAM | — | — | DRAM_SDQS1_N | — | — |
| DRAM_SDQS2 | AD8 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS2_P | Input | Hi-Z |
| DRAM_SDQS2_B | AE8 | NVCC_DRAM | — | — | DRAM_SDQS2_N | — | — |
| DRAM_SDQS3 | AC10 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS3_P | Input | Hi-Z |
| DRAM_SDQS3_B | AB10 | NVCC_DRAM | — | — | DRAM_SDQS3_N | — | — |
| DRAM_SDQS4 | AD18 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS4_P | Input | Hi-Z |
| DRAM_SDQS4_B | AE18 | NVCC_DRAM | — | — | DRAM_SDQS4_N | — | — |
| DRAM_SDQS5 | AD20 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS5_P | Input | Hi-Z |
| DRAM_SDQS5_B | AE20 | NVCC_DRAM | — | — | DRAM_SDQS5_N | — | — |
| DRAM_SDQS6 | AD23 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS6_P | Input | Hi-Z |
| DRAM_SDQS6_B | AE23 | NVCC_DRAM | — | — | DRAM_SDQS6_N | — | — |
| DRAM_SDQS7 | AA25 | NVCC_DRAM | DDRCLK | ALT0 | DRAM_SDQS7_P | Input | Hi-Z |
| DRAM_SDQS7_B | AA24 | NVCC_DRAM | — | — | DRAM_SDQS7_N | — | — |
| DRAM_SDWE | AB16 | NVCC_DRAM | DDR | ALT0 | DRAM_SDWE | Output | Low |
| DSI_CLK0M | H3 | NVCC_MIPI | ANALOG | — | DSI_CLK_N | — | — |
| DSI_CLK0P | H4 | NVCC_MIPI | ANALOG | — | DSI_CLK_P | — | — |
| DSI_D0M | G2 | NVCC_MIPI | ANALOG | — | DSI_DATA0_N | — | — |
| DSI_D0P | G1 | NVCC_MIPI | ANALOG | — | DSI_DATA0_P | — | — |
| DSI_D1M | H2 | NVCC_MIPI | ANALOG | — | DSI_DATA1_N | — | — |
| DSI_D1P | H1 | NVCC_MIPI | ANALOG | — | DSI_DATA1_P | — | — |
| EIM_A16 | H25 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR16 | Output | Low |
| EIM_A17 | G24 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR17 | Output | Low |
| EIM_A18 | J22 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR18 | Output | Low |
| EIM_A19 | G25 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR19 | Output | Low |
| EIM_A20 | H22 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR20 | Output | Low |
| EIM_A21 | H23 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR21 | Output | Low |
| EIM_A22 | F24 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR22 | Output | Low |
| EIM_A23 | J21 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR23 | Output | Low |
| EIM_A24 | F25 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR24 | Output | Low |
| EIM_A25 | H19 | NVCC_EIM | GPIO | ALT0 | EIM_ADDR25 | Output | Low |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| EIM_BCLK | N22 | NVCC_EIM | GPIO | ALT0 | EIM_BCLK | Output | Low |
| EIM_CS0 | H24 | NVCC_EIM | GPIO | ALT0 | EIM_CS0 | Output | High |
| EIM_CS1 | J23 | NVCC_EIM | GPIO | ALT0 | EIM_CS1 | Output | High |
| EIM_D16 | C25 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO16 | Input | 100 kΩ pull-up |
| EIM_D17 | F21 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO17 | Input | 100 kΩ pull-up |
| EIM_D18 | D24 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO18 | Input | 100 kΩ pull-up |
| EIM_D19 | G21 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO19 | Input | 100 kΩ pull-up |
| EIM_D20 | G20 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO20 | Input | 100 kΩ pull-up |
| EIM_D21 | H20 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO21 | Input | 100 kΩ pull-up |
| EIM_D22 | E23 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO22 | Input | 100 kΩ pull-down |
| EIM_D23 | D25 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO23 | Input | 100 kΩ pull-up |
| EIM_D24 | F22 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO24 | Input | 100 kΩ pull-up |
| EIM_D25 | G22 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO25 | Input | 100 kΩ pull-up |
| EIM_D26 | E24 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO26 | Input | 100 kΩ pull-up |
| EIM_D27 | E25 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO27 | Input | 100 kΩ pull-up |
| EIM_D28 | G23 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO28 | Input | 100 kΩ pull-up |
| EIM_D29 | J19 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO29 | Input | 100 kΩ pull-up |
| EIM_D30 | J20 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO30 | Input | 100 kΩ pull-up |
| EIM_D31 | H21 | NVCC_EIM | GPIO | ALT5 | GPIO3_IO31 | Input | 100 kΩ pull-down |
| EIM_DA0 | L20 | NVCC_EIM | GPIO | ALT0 | EIM_AD00 | Input | 100 kΩ pull-up |
| EIM_DA1 | J25 | NVCC_EIM | GPIO | ALT0 | EIM_AD01 | Input | 100 kΩ pull-up |
| EIM_DA10 | M22 | NVCC_EIM | GPIO | ALT0 | EIM_AD10 | Input | 100 kΩ pull-up |
| EIM_DA11 | M20 | NVCC_EIM | GPIO | ALT0 | EIM_AD11 | Input | 100 kΩ pull-up |
| EIM_DA12 | M24 | NVCC_EIM | GPIO | ALT0 | EIM_AD12 | Input | 100 kΩ pull-up |
| EIM_DA13 | M23 | NVCC_EIM | GPIO | ALT0 | EIM_AD13 | Input | 100 kΩ pull-up |
| EIM_DA14 | N23 | NVCC_EIM | GPIO | ALT0 | EIM_AD14 | Input | 100 kΩ pull-up |
| EIM_DA15 | N24 | NVCC_EIM | GPIO | ALT0 | EIM_AD15 | Input | 100 kΩ pull-up |
| EIM_DA2 | L21 | NVCC_EIM | GPIO | ALT0 | EIM_AD02 | Input | 100 kΩ pull-up |
| EIM_DA3 | K24 | NVCC_EIM | GPIO | ALT0 | EIM_AD03 | Input | 100 kΩ pull-up |
| EIM_DA4 | L22 | NVCC_EIM | GPIO | ALT0 | EIM_AD04 | Input | 100 kΩ pull-up |
| EIM_DA5 | L23 | NVCC_EIM | GPIO | ALT0 | EIM_AD05 | Input | 100 kΩ pull-up |
| EIM_DA6 | K25 | NVCC_EIM | GPIO | ALT0 | EIM_AD06 | Input | 100 kΩ pull-up |
| EIM_DA7 | L25 | NVCC_EIM | GPIO | ALT0 | EIM_AD07 | Input | 100 kΩ pull-up |
| EIM_DA8 | L24 | NVCC_EIM | GPIO | ALT0 | EIM_AD08 | Input | 100 kΩ pull-up |
| EIM_DA9 | M21 | NVCC_EIM | GPIO | ALT0 | EIM_AD09 | Input | 100 kΩ pull-up |
| EIM_EB0 | K21 | NVCC_EIM | GPIO | ALT0 | EIM_EB0 | Output | High |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| EIM_EB1 | K23 | NVCC_EIM | GPIO | ALT0 | EIM_EB1 | Output | High |
| EIM_EB2 | E22 | NVCC_EIM | GPIO | ALT5 | GPIO2_IO30 | Input | 100 kΩ pull-up |
| EIM_EB3 | F23 | NVCC_EIM | GPIO | ALT5 | GPIO2_IO31 | Input | 100 kΩ pull-up |
| EIM_LBA | K22 | NVCC_EIM | GPIO | ALT0 | EIM_LBA | Output | High |
| EIM_OE | J24 | NVCC_EIM | GPIO | ALT0 | EIM_OE | Output | High |
| EIM_RW | K20 | NVCC_EIM | GPIO | ALT0 | EIM_RW | Output | High |
| EIM_WAIT | M25 | NVCC_EIM | GPIO | ALT0 | EIM_WAIT | Input | 100 kΩ pull-up |
| ENET_CRS_DV | U21 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO25 | Input | 100 kΩ pull-up |
| ENET_MDC | V20 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO31 | Input | 100 kΩ pull-up |
| ENET_MDIO | V23 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO22 | Input | 100 kΩ pull-up |
| ENET_REF_CLK[3] | V22 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO23 | Input | 100 kΩ pull-up |
| ENET_RX_ER | W23 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO24 | Input | 100 kΩ pull-up |
| ENET_RXD0 | W21 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO27 | Input | 100 kΩ pull-up |
| ENET_RXD1 | W22 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO26 | Input | 100 kΩ pull-up |
| ENET_TX_EN | V21 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO28 | Input | 100 kΩ pull-up |
| ENET_TXD0 | U20 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO30 | Input | 100 kΩ pull-up |
| ENET_TXD1 | W20 | NVCC_ENET | GPIO | ALT5 | GPIO1_IO29 | Input | 100 kΩ pull-up |
| GPIO_0 | T5 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO00 | Input | 100 kΩ pull-down |
| GPIO_1 | T4 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO01 | Input | 100 kΩ pull-up |
| GPIO_16 | R2 | NVCC_GPIO | GPIO | ALT5 | GPIO7_IO11 | Input | 100 kΩ pull-up |
| GPIO_17 | R1 | NVCC_GPIO | GPIO | ALT5 | GPIO7_IO12 | Input | 100 kΩ pull-up |
| GPIO_18 | P6 | NVCC_GPIO | GPIO | ALT5 | GPIO7_IO13 | Input | 100 kΩ pull-up |
| GPIO_19 | P5 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO05 | Input | 100 kΩ pull-up |
| GPIO_2 | T1 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO02 | Input | 100 kΩ pull-up |
| GPIO_3 | R7 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO03 | Input | 100 kΩ pull-up |
| GPIO_4 | R6 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO04 | Input | 100 kΩ pull-up |
| GPIO_5 | R4 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO05 | Input | 100 kΩ pull-up |
| GPIO_6 | T3 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO06 | Input | 100 kΩ pull-up |
| GPIO_7 | R3 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO07 | Input | 100 kΩ pull-up |
| GPIO_8 | R5 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO08 | Input | 100 kΩ pull-up |
| GPIO_9 | T2 | NVCC_GPIO | GPIO | ALT5 | GPIO1_IO09 | Input | 100 kΩ pull-up |
| HDMI_CLKM | J5 | HDMI | — | — | HDMI_TX_CLK_N | — | — |
| HDMI_CLKP | J6 | HDMI | — | — | HDMI_TX_CLK_P | — | — |
| HDMI_D0M | K5 | HDMI | — | — | HDMI_TX_DATA0_N | — | — |
| HDMI_D0P | K6 | HDMI | — | — | HDMI_TX_DATA0_P | — | — |
| HDMI_D1M | J3 | HDMI | — | — | HDMI_TX_DATA1_N | — | — |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| HDMI_D1P | J4 | HDMI | — | — | HDMI_TX_DATA1_P | — | — |
| HDMI_D2M | K3 | HDMI | — | — | HDMI_TX_DATA2_N | — | — |
| HDMI_D2P | K4 | HDMI | — | — | HDMI_TX_DATA2_P | — | — |
| HDMI_HPD | K1 | HDMI | — | — | HDMI_TX_HPD | — | — |
| JTAG_MOD | H6 | NVCC_JTAG | GPIO | ALT0 | JTAG_MODE | Input | 100 kΩ pull-up |
| JTAG_TCK | H5 | NVCC_JTAG | GPIO | ALT0 | JTAG_TCK | Input | 47 kΩ pull-up |
| JTAG_TDI | G5 | NVCC_JTAG | GPIO | ALT0 | JTAG_TDI | Input | 47 kΩ pull-up |
| JTAG_TDO | G6 | NVCC_JTAG | GPIO | ALT0 | JTAG_TDO | Output | Low |
| JTAG_TMS | C3 | NVCC_JTAG | GPIO | ALT0 | JTAG_TMS | Input | 47 kΩ pull-up |
| JTAG_TRSTB | C2 | NVCC_JTAG | GPIO | ALT0 | JTAG_TRSTB | Input | 47 kΩ pull-up |
| KEY_COL0 | W5 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO06 | Input | 100 kΩ pull-up |
| KEY_COL1 | U7 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO08 | Input | 100 kΩ pull-up |
| KEY_COL2 | W6 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO10 | Input | 100 kΩ pull-up |
| KEY_COL3 | U5 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO12 | Input | 100 kΩ pull-up |
| KEY_COL4 | T6 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO14 | Input | 100 kΩ pull-up |
| KEY_ROW0 | V6 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO07 | Input | 100 kΩ pull-up |
| KEY_ROW1 | U6 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO09 | Input | 100 kΩ pull-up |
| KEY_ROW2 | W4 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO11 | Input | 100 kΩ pull-up |
| KEY_ROW3 | T7 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO13 | Input | 100 kΩ pull-up |
| KEY_ROW4 | V5 | NVCC_GPIO | GPIO | ALT5 | GPIO4_IO15 | Input | 100 kΩ pull-down |
| LVDS0_CLK_N | V4 | NVCC_LVDS2P5 | — | — | LVDS0_CLK_N | — | — |
| LVDS0_CLK_P | V3 | NVCC_LVDS2P5 | — | ALT0 | LVDS0_CLK_P | Input | Keeper |
| LVDS0_TX0_N | U2 | NVCC_LVDS2P5 | — | — | LVDS0_TX0_N | — | — |
| LVDS0_TX0_P | U1 | NVCC_LVDS2P5 | — | ALT0 | LVDS0_TX0_P | Input | Keeper |
| LVDS0_TX1_N | U4 | NVCC_LVDS2P5 | — | — | LVDS0_TX1_N | — | — |
| LVDS0_TX1_P | U3 | NVCC_LVDS2P5 | — | ALT0 | LVDS0_TX1_P | Input | Keeper |
| LVDS0_TX2_N | V2 | NVCC_LVDS2P5 | — | — | LVDS0_TX2_N | — | — |
| LVDS0_TX2_P | V1 | NVCC_LVDS2P5 | — | ALT0 | LVDS0_TX2_P | Input | Keeper |
| LVDS0_TX3_N | W2 | NVCC_LVDS2P5 | — | — | LVDS0_TX3_N | — | — |
| LVDS0_TX3_P | W1 | NVCC_LVDS2P5 | — | ALT0 | LVDS0_TX3_P | Input | Keeper |
| LVDS1_CLK_N | Y3 | NVCC_LVDS2P5 | — | — | LVDS1_CLK_N | — | — |
| LVDS1_CLK_P | Y4 | NVCC_LVDS2P5 | — | ALT0 | LVDS1_CLK_P | Input | Keeper |
| LVDS1_TX0_N | Y1 | NVCC_LVDS2P5 | — | — | LVDS1_TX0_N | — | — |
| LVDS1_TX0_P | Y2 | NVCC_LVDS2P5 | — | ALT0 | LVDS1_TX0_P | Input | Keeper |
| LVDS1_TX1_N | AA2 | NVCC_LVDS2P5 | — | — | LVDS1_TX1_N | — | — |
| LVDS1_TX1_P | AA1 | NVCC_LVDS2P5 | — | ALT0 | LVDS1_TX1_P | Input | Keeper |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| LVDS1_TX2_N | AB1 | NVCC_LVDS2P5 | — | — | LVDS1_TX2_N | — | — |
| LVDS1_TX2_P | AB2 | NVCC_LVDS2P5 | — | ALT0 | LVDS1_TX2_P | Input | Keeper |
| LVDS1_TX3_N | AA3 | NVCC_LVDS2P5 | — | — | LVDS1_TX3_N | — | — |
| LVDS1_TX3_P | AA4 | NVCC_LVDS2P5 | — | ALT0 | LVDS1_TX3_P | Input | Keeper |
| MLB_CN | A11 | VDDHIGH_CAP | — | — | MLB_CLK_N | — | — |
| MLB_CP | B11 | VDDHIGH_CAP | — | — | MLB_CLK_P | — | — |
| MLB_DN | B10 | VDDHIGH_CAP | — | — | MLB_DATA_N | — | — |
| MLB_DP | A10 | VDDHIGH_CAP | — | — | MLB_DATA_P | — | — |
| MLB_SN | A9 | VDDHIGH_CAP | — | — | MLB_SIG_N | — | — |
| MLB_SP | B9 | VDDHIGH_CAP | — | — | MLB_SIG_P | — | — |
| NANDF_ALE | A16 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO08 | Input | 100 kΩ pull-up |
| NANDF_CLE | C15 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO07 | Input | 100 kΩ pull-up |
| NANDF_CS0 | F15 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO11 | Input | 100 kΩ pull-up |
| NANDF_CS1 | C16 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO14 | Input | 100 kΩ pull-up |
| NANDF_CS2 | A17 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO15 | Input | 100 kΩ pull-up |
| NANDF_CS3 | D16 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO16 | Input | 100 kΩ pull-up |
| NANDF_D0 | A18 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO00 | Input | 100 kΩ pull-up |
| NANDF_D1 | C17 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO01 | Input | 100 kΩ pull-up |
| NANDF_D2 | F16 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO02 | Input | 100 kΩ pull-up |
| NANDF_D3 | D17 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO03 | Input | 100 kΩ pull-up |
| NANDF_D4 | A19 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO04 | Input | 100 kΩ pull-up |
| NANDF_D5 | B18 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO05 | Input | 100 kΩ pull-up |
| NANDF_D6 | E17 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO06 | Input | 100 kΩ pull-up |
| NANDF_D7 | C18 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO07 | Input | 100 kΩ pull-up |
| NANDF_RB0 | B16 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO10 | Input | 100 kΩ pull-up |
| NANDF_WP_B | E15 | NVCC_NANDF | GPIO | ALT5 | GPIO6_IO09 | Input | 100 kΩ pull-up |
| ONOFF | D12 | VDD_SNVS_IN | GPIO | ALT0 | SRC_ONOFF | Input | 100 kΩ pull-up |
| PCIE_RXM | B1 | PCIE_VPH | — | — | PCIE_RX_N | — | — |
| PCIE_RXP | B2 | PCIE_VPH | — | — | PCIE_RX_P | — | — |
| PCIE_TXM | A3 | PCIE_VPH | — | — | PCIE_TX_N | — | — |
| PCIE_TXP | B3 | PCIE_VPH | — | — | PCIE_TX_P | — | — |
| PMIC_ON_REQ | D11 | VDD_SNVS_IN | GPIO | ALT0 | SNVS_PMIC_ON_REQ | Output | Open drain with PU(100K) enable |
| PMIC_STBY_REQ | F11 | VDD_SNVS_IN | GPIO | ALT0 | CCM_PMIC_STBY_REQ | Output | Low |
| POR_B | C11 | VDD_SNVS_IN | GPIO | ALT0 | SRC_POR_B | Input | 100 kΩ pull-up |
| RGMII_RD0 | C24 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO25 | Input | 100 kΩ pull-up |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| RGMII_RD1 | B23 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO27 | Input | 100 kΩ pull-up |
| RGMII_RD2 | B24 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO28 | Input | 100 kΩ pull-up |
| RGMII_RD3 | D23 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO29 | Input | 100 kΩ pull-up |
| RGMII_RX_CTL | D22 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO24 | Input | 100 kΩ pull-down |
| RGMII_RXC | B25 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO30 | Input | 100 kΩ pull-down |
| RGMII_TD0 | C22 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO20 | Input | 100 kΩ pull-up |
| RGMII_TD1 | F20 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO21 | Input | 100 kΩ pull-up |
| RGMII_TD2 | E21 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO22 | Input | 100 kΩ pull-up |
| RGMII_TD3 | A24 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO23 | Input | 100 kΩ pull-up |
| RGMII_TX_CTL | C23 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO26 | Input | 100 kΩ pull-down |
| RGMII_TXC | D21 | NVCC_RGMII | DDR | ALT5 | GPIO6_IO19 | Input | 100 kΩ pull-down |
| RTC_XTALI | D9 | VDD_SNVS_CAP | — | — | RTC_XTALI | — | — |
| RTC_XTALO | C9 | VDD_SNVS_CAP | — | — | RTC_XTALO | — | — |
| SD1_CLK | D20 | NVCC_SD1 | GPIO | ALT5 | GPIO1_IO20 | Input | 100 kΩ pull-up |
| SD1_CMD | B21 | NVCC_SD1 | GPIO | ALT5 | GPIO1_IO18 | Input | 100 kΩ pull-up |
| SD1_DAT0 | A21 | NVCC_SD1 | GPIO | ALT5 | GPIO1_IO16 | Input | 100 kΩ pull-up |
| SD1_DAT1 | C20 | NVCC_SD1 | GPIO | ALT5 | GPIO1_IO17 | Input | 100 kΩ pull-up |
| SD1_DAT2 | E19 | NVCC_SD1 | GPIO | ALT5 | GPIO1_IO19 | Input | 100 kΩ pull-up |
| SD1_DAT3 | F18 | NVCC_SD1 | GPIO | ALT5 | GPIO1_IO21 | Input | 100 kΩ pull-up |
| SD2_CLK | C21 | NVCC_SD2 | GPIO | ALT5 | GPIO1_IO10 | Input | 100 kΩ pull-up |
| SD2_CMD | F19 | NVCC_SD2 | GPIO | ALT5 | GPIO1_IO11 | Input | 100 kΩ pull-up |
| SD2_DAT0 | A22 | NVCC_SD2 | GPIO | ALT5 | GPIO1_IO15 | Input | 100 kΩ pull-up |
| SD2_DAT1 | E20 | NVCC_SD2 | GPIO | ALT5 | GPIO1_IO14 | Input | 100 kΩ pull-up |
| SD2_DAT2 | A23 | NVCC_SD2 | GPIO | ALT5 | GPIO1_IO13 | Input | 100 kΩ pull-up |
| SD2_DAT3 | B22 | NVCC_SD2 | GPIO | ALT5 | GPIO1_IO12 | Input | 100 kΩ pull-up |
| SD3_CLK | D14 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO03 | Input | 100 kΩ pull-up |
| SD3_CMD | B13 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO02 | Input | 100 kΩ pull-up |
| SD3_DAT0 | E14 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO04 | Input | 100 kΩ pull-up |
| SD3_DAT1 | F14 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO05 | Input | 100 kΩ pull-up |
| SD3_DAT2 | A15 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO06 | Input | 100 kΩ pull-up |
| SD3_DAT3 | B15 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO07 | Input | 100 kΩ pull-up |
| SD3_DAT4 | D13 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO01 | Input | 100 kΩ pull-up |
| SD3_DAT5 | C13 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO00 | Input | 100 kΩ pull-up |
| SD3_DAT6 | E13 | NVCC_SD3 | GPIO | ALT5 | GPIO6_IO18 | Input | 100 kΩ pull-up |
| SD3_DAT7 | F13 | NVCC_SD3 | GPIO | ALT5 | GPIO6_IO17 | Input | 100 kΩ pull-up |
| SD3_RST | D15 | NVCC_SD3 | GPIO | ALT5 | GPIO7_IO08 | Input | 100 kΩ pull-up |



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**Table 97. 21 x 21 mm Functional Contact Assignments (continued)**

| Ball Name | Ball | Power Group | Ball Type | Out of Reset Condition[1] | | | |
|---|---|---|---|---|---|---|---|
| | | | | Default Mode (Reset Mode) | Default Function | Input/ Output | Value[2] |
| SD4_CLK | E16 | NVCC_NANDF | GPIO | ALT5 | GPIO7_IO10 | Input | 100 kΩ pull-up |
| SD4_CMD | B17 | NVCC_NANDF | GPIO | ALT5 | GPIO7_IO09 | Input | 100 kΩ pull-up |
| SD4_DAT0 | D18 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO08 | Input | 100 kΩ pull-up |
| SD4_DAT1 | B19 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO09 | Input | 100 kΩ pull-up |
| SD4_DAT2 | F17 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO10 | Input | 100 kΩ pull-up |
| SD4_DAT3 | A20 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO11 | Input | 100 kΩ pull-up |
| SD4_DAT4 | E18 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO12 | Input | 100 kΩ pull-up |
| SD4_DAT5 | C19 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO13 | Input | 100 kΩ pull-up |
| SD4_DAT6 | B20 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO14 | Input | 100 kΩ pull-up |
| SD4_DAT7 | D19 | NVCC_NANDF | GPIO | ALT5 | GPIO2_IO15 | Input | 100 kΩ pull-up |
| TAMPER | E11 | VDD_SNVS_IN | GPIO | ALT0 | SNVS_TAMPER | Input | 100 kΩ pull-down |
| TEST_MODE | E12 | VDD_SNVS_IN | GPIO | ALT0 | TCU_TEST_MODE | Input | 100 kΩ pull-down |
| USB_H1_DN | F10 | VDDUSB_CAP | — | — | USB_H1_DN | — | — |
| USB_H1_DP | E10 | VDDUSB_CAP | — | — | USB_H1_DP | — | — |
| USB_OTG_CHD_B | B8 | VDDUSB_CAP | — | — | USB_OTG_CHD_B | — | — |
| USB_OTG_DN | B6 | VDDUSB_CAP | — | — | USB_OTG_DN | — | — |
| USB_OTG_DP | A6 | VDDUSB_CAP | — | — | USB_OTG_DP | — | — |
| XTALI | A7 | NVCC_PLL_OUT | — | — | XTALI | — | — |
| XTALO | B7 | NVCC_PLL_OUT | — | — | XTALO | — | — |

1 The state immediately after reset and before ROM firmware or software has executed.

2 Variance of the pull-up and pull-down strengths are shown in the tables as follows:

- Table 23, "GPIO DC Parameters," on page 40
- Table 24, "LPDDR2 I/O DC Electrical Parameters," on page 41
- Table 25, "DDR3/DDR3L I/O DC Electrical Characteristics," on page 42

3 ENET_REF_CLK is used as a clock source for MII and RGMII modes only. RGMII mode uses either GPIO_16 or RGMII_TX_CTL as a clock source. For more information on these clocks, see the device Reference Manual and the Hardware Development Guide for i.MX 6Quad, 6Dual, 6DualLite, 6Solo Families of Applications Processors (IMX6DQ6SDLHDG).

**Table 98. Signals with Differing Before Reset and After Reset States**

| Ball Name | Before Reset State | |
|---|---|---|
| | Input/Output | Value |
| EIM_A16 | Input | PD (100K) |
| EIM_A17 | Input | PD (100K) |
| EIM_A18 | Input | PD (100K) |
| EIM_A19 | Input | PD (100K) |



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**Table 98. Signals with Differing Before Reset and After Reset States (continued)**

| Ball Name | Before Reset State | |
|---|---|---|
| | Input/Output | Value |
| EIM_A20 | Input | PD (100K) |
| EIM_A21 | Input | PD (100K) |
| EIM_A22 | Input | PD (100K) |
| EIM_A23 | Input | PD (100K) |
| EIM_A24 | Input | PD (100K) |
| EIM_A25 | Input | PD (100K) |
| EIM_DA0 | Input | PD (100K) |
| EIM_DA1 | Input | PD (100K) |
| EIM_DA2 | Input | PD (100K) |
| EIM_DA3 | Input | PD (100K) |
| EIM_DA4 | Input | PD (100K) |
| EIM_DA5 | Input | PD (100K) |
| EIM_DA6 | Input | PD (100K) |
| EIM_DA7 | Input | PD (100K) |
| EIM_DA8 | Input | PD (100K) |
| EIM_DA9 | Input | PD (100K) |
| EIM_DA10 | Input | PD (100K) |
| EIM_DA11 | Input | PD (100K) |
| EIM_DA12 | Input | PD (100K) |
| EIM_DA13 | Input | PD (100K) |
| EIM_DA14 | Input | PD (100K) |
| EIM_DA15 | Input | PD (100K) |
| EIM_EB0 | Input | PD (100K) |
| EIM_EB1 | Input | PD (100K) |
| EIM_EB2 | Input | PD (100K) |
| EIM_EB3 | Input | PD (100K) |
| EIM_LBA | Input | PD (100K) |
| EIM_RW | Input | PD (100K) |
| EIM_WAIT | Input | PD (100K) |
| GPIO_17 | Output | Drive state unknown (x) |



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**Table 98. Signals with Differing Before Reset and After Reset States (continued)**

| Ball Name | Before Reset State | |
|---|---|---|
| | Input/Output | Value |
| GPIO_19 | Output | Drive state unknown (x) |
| KEY_COL0 | Output | Drive state unknown (x) |



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### 6.2.3 21 x 21 mm, 0.8 mm Pitch Ball Map

Table 99 shows the 21 x 21 mm, 0.8 mm pitch ball map for the i.MX 6Solo.

**Table 99. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6Solo**

| | 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | PCIE_REXT | PCIE_TXM | GND | FA_ANA | USB_OTG_DP | XTALI | GND | MLB_SN | MLB_DP | MLB_CN | NC | GND | NC | SD3_DAT2 | NANDF_ALE | NANDF_CS2 | NANDF_D0 | NANDF_D4 | SD4_DAT3 | SD1_DAT0 | SD2_DAT0 | SD2_DAT2 | RGMII_TD3 | GND | A |
| B | PCIE_RXM | PCIE_RXP | PCIE_TXP | GND | VDD_FA | USB_OTG_DN | XTALO | USB_OTG_CHD_B | MLB_SP | MLB_DN | MLB_CP | NC | SD3_CMD | NC | SD3_DAT3 | NANDF_RB0 | SD4_CMD | NANDF_D5 | SD4_DAT1 | SD4_DAT6 | SD1_CMD | SD2_DAT3 | RGMII_RD1 | RGMII_RD2 | RGMII_RXC | B |
| C | GND | JTAG_TRSTB | JTAG_TMS | GND | CLK2_N | GND | CLK1_N | GPANAIO | RTC_XTALO | GND | POR_B | BOOT_MODE0 | SD3_DAT5 | NC | NANDF_CLE | NANDF_CS1 | NANDF_D1 | NANDF_D7 | SD4_DAT5 | SD1_DAT1 | SD2_CLK | RGMII_TD0 | RGMII_TX_CTL | RGMII_RD0 | EIM_D16 | C |
| D | CSI_D1M | CSI_D1P | GND | CSI_REXT | CLK2_P | GND | CLK1_P | GND | RTC_XTALI | USB_H1_VBUS | PMIC_ON_REQ | ONOFF | SD3_DAT4 | SD3_CLK | SD3_RST | NANDF_CS3 | NANDF_D3 | SD4_DAT0 | SD4_DAT7 | SD1_CLK | RGMII_TXC | RGMII_RX_CTL | RGMII_RD3 | EIM_D18 | EIM_D23 | D |
| E | NC | NC | CSI_D0P | CSI_D0M | GND | GND | GND | NVCC_PLL_OUT | USB_OTG_VBUS | USB_H1_DP | TAMPER | TEST_MODE | SD3_DAT6 | SD3_DAT0 | NANDF_WP_B | SD4_CLK | NANDF_D6 | SD4_DAT4 | SD1_DAT2 | SD2_DAT1 | RGMII_TD2 | EIM_EB2 | EIM_D22 | EIM_D26 | EIM_D27 | E |
| F | NC | NC | CSI_CLK0P | CSI_CLK0M | GND | GND | GND | GND | VDDUSB_CAP | USB_H1_DN | PMIC_STBY_REQ | BOOT_MODE1 | SD3_DAT7 | SD3_DAT1 | NANDF_CS0 | NANDF_D2 | SD4_DAT2 | SD1_DAT3 | SD2_CMD | RGMII_TD1 | EIM_D17 | EIM_D24 | EIM_EB3 | EIM_A22 | EIM_A24 | F |
| G | DSI_D0P | DSI_D0M | GND | DSI_REXT | JTAG_TDI | JTAG_TDO | PCIE_VPH | PCIE_VPTX | VDD_SNVS_CAP | GND | VDD_SNVS_IN | NC | NC | NVCC_SD3 | NVCC_NANDF | NVCC_SD1 | NVCC_SD2 | NVCC_RGMII | GND | EIM_D20 | EIM_D19 | EIM_D25 | EIM_D28 | EIM_A17 | EIM_A19 | G |



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**Table 99. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6Solo (continued)**

| | 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | DSI_D1P | DSI_D1M | DSI_CLK0M | DSI_CLK0P | JTAG_TCK | JTAG_MOD | PCIE_VP | GND | VDDHIGH_IN | VDDHIGH_CAP | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | EIM_A25 | EIM_D21 | EIM_D31 | EIM_A20 | EIM_A21 | EIM_CS0 | EIM_A16 | H |
| J | HDMI_REF | GND | HDMI_D1M | HDMI_D1P | HDMI_CLKM | HDMI_CLKP | NVCC_JTAG | GND | VDDHIGH_IN | VDDHIGH_CAP | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | EIM_D29 | EIM_D30 | EIM_A23 | EIM_A18 | EIM_CS1 | EIM_OE | EIM_DA1 | J |
| K | HDMI_HPD | HDMI_DDCCEC | HDMI_D2M | HDMI_D2P | HDMI_D0M | HDMI_D0P | NVCC_MIPI | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_EIM | EIM_RW | EIM_EB0 | EIM_LBA | EIM_EB1 | EIM_DA3 | EIM_DA6 | K |
| L | CSI0_DAT13 | GND | CSI0_DAT17 | CSI0_DAT16 | GND | CSI0_DAT19 | HDMI_VP | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_EIM | EIM_DA0 | EIM_DA2 | EIM_DA4 | EIM_DA5 | EIM_DA8 | EIM_DA7 | L |
| M | CSI0_DAT10 | CSI0_DAT12 | CSI0_DAT11 | CSI0_DAT14 | CSI0_DAT15 | CSI0_DAT18 | HDMI_VPH | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_EIM | EIM_DA11 | EIM_DA9 | EIM_DA10 | EIM_DA13 | EIM_DA12 | EIM_WAIT | M |
| N | CSI0_DAT4 | CSI0_VSYNC | CSI0_DAT7 | CSI0_DAT6 | CSI0_DAT9 | CSI0_DAT8 | NVCC_CSI | GND | VDDARM_IN | GND | VDDARM_CAP | NC | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | DI0_DISP_CLK | DI0_PIN3 | DI0_PIN15 | EIM_BCLK | EIM_DA14 | EIM_DA15 | DI0_PIN2 | N |
| P | CSI0_PIXCLK | CSI0_DAT5 | CSI0_DATA_EN | CSI0_MCLK | GPIO_19 | GPIO_18 | NVCC_GPIO | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_LCD | DISP0_DAT4 | DISP0_DAT3 | DISP0_DAT1 | DISP0_DAT2 | DISP0_DAT0 | DI0_PIN4 | P |
| R | GPIO_17 | GPIO_16 | GPIO_7 | GPIO_5 | GPIO_8 | GPIO_4 | GPIO_3 | GND | VDDARM_IN | VDDSOC_CAP | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | GND | NVCC_DRAM | NVCC_ENET | DISP0_DAT13 | DISP0_DAT10 | DISP0_DAT8 | DISP0_DAT6 | DISP0_DAT7 | DISP0_DAT5 | R |



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**Table 99. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6Solo (continued)**

| | 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AC** | DRAM_D4 | DRAM_VREF | DRAM_DQM0 | DRAM_D2 | DRAM_D13 | DRAM_DQM1 | DRAM_D15 | DRAM_D22 | DRAM_D28 | DRAM_SDQS3 | DRAM_D31 | DRAM_A11 | DRAM_A6 | DRAM_A0 | DRAM_SDBA0 | DRAM_SDODT0 | DRAM_A13 | NC | NC | NC | NC | NC | NC | NC | NC | NC | **AC** |
| **AB** | LVDS1_TX2_N | LVDS1_TX2_P | GND | DRAM_D6 | DRAM_D12 | DRAM_D14 | DRAM_D16 | DRAM_DQM2 | DRAM_D18 | DRAM_SDQS3_B | DRAM_D27 | DRAM_SDBA2 | DRAM_A8 | DRAM_A1 | DRAM_RAS | DRAM_SDWE | DRAM_SDODT1 | NC | NC | NC | NC | NC | NC | NC | GND | NC | **AB** |
| **AA** | LVDS1_TX1_P | LVDS1_TX1_N | LVDS1_TX3_N | LVDS1_TX3_P | DRAM_D3 | DRAM_D10 | GND | DRAM_D17 | DRAM_D23 | GND | DRAM_SDCKE1 | DRAM_A14 | GND | DRAM_A2 | DRAM_A10 | GND | NC | NC | GND | NC | NC | NC | GND | NC | NC | NC | **AA** |
| **Y** | LVDS1_TX0_N | LVDS1_TX0_P | LVDS1_CLK_N | LVDS1_CLK_P | GND | DRAM_RESET | DRAM_D20 | DRAM_D21 | DRAM_D19 | DRAM_D25 | DRAM_SDCKE0 | DRAM_A15 | DRAM_A7 | DRAM_A3 | DRAM_SDBA1 | DRAM_CS0 | NC | NC | NC | NC | NC | NC | NC | GND | NC | NC | **Y** |
| **W** | LVDS0_TX3_P | LVDS0_TX3_N | GND | KEY_ROW2 | KEY_COL0 | KEY_COL2 | GND | GND | GND | GND | GND | GND | GND | DRAM_A4 | GND | GND | GND | GND | GND | ENET_TXD1 | ENET_RXD0 | ENET_RXD1 | ENET_RX_ER | DISP0_DAT23 | NC | **W** |
| **V** | LVDS0_TX2_P | LVDS0_TX2_N | LVDS0_CLK_P | LVDS0_CLK_N | KEY_ROW4 | KEY_ROW0 | NVCC_LVDS2P5 | GND | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | GND | ENET_MDC | ENET_TX_EN | ENET_REF_CLK | ENET_MDIO | DISP0_DAT22 | DISP0_DAT18 | **V** |
| **U** | LVDS0_TX0_P | LVDS0_TX0_N | LVDS0_TX1_P | LVDS0_TX1_N | KEY_COL3 | KEY_ROW1 | KEY_COL1 | GND | VDDARM_IN | VDDSOC_CAP | GND | GND | VDDSOC_CAP | VDDSOC_CAP | GND | VDDSOC_IN | GND | NVCC_DRAM | GND | ENET_TXD0 | ENET_CRS_DV | DISP0_DAT20 | DISP0_DAT19 | DISP0_DAT17 | DISP0_DAT14 | **U** |
| **T** | GPIO_2 | GPIO_9 | GPIO_6 | GPIO_1 | GPIO_0 | KEY_COL4 | KEY_ROW3 | GND | VDDARM_IN | VDDSOC_CAP | GND | GND | VDDSOC_CAP | VDDSOC_CAP | GND | VDDSOC_IN | GND | NVCC_DRAM | GND | DISP0_DAT21 | DISP0_DAT16 | DISP0_DAT15 | DISP0_DAT11 | DISP0_DAT12 | DISP0_DAT9 | **T** |



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**Table 99. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6Solo (continued)**

| | 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AD** | DRAM_D5 | DRAM_D0 | DRAM_SDQS0_B | GND | DRAM_D8 | DRAM_SDQS1 | GND | DRAM_SDQS2 | DRAM_D29 | GND | DRAM_D30 | DRAM_A12 | GND | DRAM_SDCLK_1 | DRAM_SDCLK_0 | GND | DRAM_CS1 | NC | GND | NC | NC | GND | NC | NC | NC | **AD** |
| **AE** | GND | DRAM_D1 | DRAM_SDQS0 | DRAM_D7 | DRAM_D9 | DRAM_SDQS1_B | DRAM_ | DRAM_SDQS2_B | DRAM_D24 | DRAM_DQM3 | DRAM_D26 | DRAM_A9 | DRAM_A5 | DRAM_SDCLK_1_B | DRAM_SDCLK_0_B | DRAM_CAS | ZQPAD | NC | NC | NC | NC | NC | NC | NC | GND | **AE** |
| | 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 | |

Table 100 shows the 21 x 21 mm, 0.8 mm pitch ball map for the i.MX 6DualLite.

**Table 100. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6DualLite**

| | 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | | PCIE_REXT | PCIE_TXM | GND | FA_ANA | USB_OTG_DP | XTALI | GND | MLB_SN | MLB_DP | MLB_CN | NC | GND | NC | SD3_DAT2 | NANDF_ALE | NANDF_CS2 | NANDF_D0 | NANDF_D4 | SD4_DAT3 | SD1_DAT0 | SD2_DAT0 | SD2_DAT2 | RGMII_TD3 | GND | **A** |
| **B** | PCIE_RXM | PCIE_RXP | PCIE_TXP | GND | VDD_FA | USB_OTG_DN | XTALO | USB_OTG_CHD_B | MLB_SP | MLB_DN | MLB_CP | NC | SD3_CMD | NC | SD3_DAT3 | NANDF_RB0 | SD4_CMD | NANDF_D5 | SD4_DAT1 | SD4_DAT6 | SD1_CMD | SD2_DAT3 | RGMII_RD1 | RGMII_RD2 | RGMII_RXC | **B** |
| **C** | GND | JTAG_TRSTB | JTAG_TMS | GND | CLK2_N | GND | CLK1_N | GPANAIO | RTC_XTALO | GND | POR_B | BOOT_MODE0 | SD3_DAT5 | NC | NANDF_CLE | NANDF_CS1 | NANDF_D1 | NANDF_D7 | SD4_DAT5 | SD1_DAT1 | SD2_CLK | RGMII_TD0 | RGMII_TX_CTL | RGMII_RD0 | EIM_D16 | **C** |
| **D** | CSI_D1M | CSI_D1P | GND | CSI_REXT | CLK2_P | GND | CLK1_P | GND | RTC_XTALI | USB_H1_VBUS | PMIC_ON_REQ | ONOFF | SD3_DAT4 | SD3_CLK | SD3_RST | NANDF_CS3 | NANDF_D3 | SD4_DAT0 | SD4_DAT7 | SD1_CLK | RGMII_TXC | RGMII_RX_CTL | RGMII_RD3 | EIM_D18 | EIM_D23 | **D** |



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**Table 100. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6DualLite (continued)**

| | 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **M** | CSI0_DAT10 | CSI0_DAT12 | CSI0_DAT11 | CSI0_DAT14 | CSI0_DAT15 | CSI0_DAT18 | HDMI_VPH | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_EIM | EIM_DA11 | EIM_DA9 | EIM_DA10 | EIM_DA13 | EIM_DA12 | EIM_WAIT | **M** |
| **L** | CSI0_DAT13 | GND | CSI0_DAT17 | CSI0_DAT16 | GND | CSI0_DAT19 | HDMI_VP | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_EIM | EIM_DA0 | EIM_DA2 | EIM_DA4 | EIM_DA5 | EIM_DA8 | EIM_DA7 | **L** |
| **K** | HDMI_HPD | HDMI_DDCCEC | HDMI_D2M | HDMI_D2P | HDMI_D0M | HDMI_D0P | NVCC_MIPI | GND | VDDARM_IN | GND | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | NVCC_EIM | EIM_RW | EIM_EB0 | EIM_LBA | EIM_EB1 | EIM_DA3 | EIM_DA6 | **K** |
| **J** | HDMI_REF | GND | HDMI_D1M | HDMI_D1P | HDMI_CLKM | HDMI_CLKP | NVCC_JTAG | GND | VDDHIGH_IN | VDDHIGH_CAP | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | EIM_D29 | EIM_D30 | EIM_A23 | EIM_A18 | EIM_CS1 | EIM_OE | EIM_DA1 | **J** |
| **H** | DSI_D1P | DSI_D1M | DSI_CLK0M | DSI_CLK0P | JTAG_TCK | JTAG_MOD | PCIE_VP | GND | VDDHIGH_IN | VDDHIGH_CAP | VDDARM_CAP | GND | VDDARM_CAP | VDDARM_IN | GND | VDDSOC_IN | VDDPU_CAP | GND | EIM_A25 | EIM_D21 | EIM_D31 | EIM_A20 | EIM_A21 | EIM_CS0 | EIM_A16 | **H** |
| **G** | DSI_D0P | DSI_D0M | GND | DSI_REXT | JTAG_TDI | JTAG_TDO | PCIE_VPH | PCIE_VPTX | VDD_SNVS_CAP | GND | VDD_SNVS_IN | NC | NC | NVCC_SD3 | NVCC_NANDF | NVCC_SD1 | NVCC_SD2 | NVCC_RGMII | GND | EIM_D20 | EIM_D19 | EIM_D25 | EIM_D28 | EIM_A17 | EIM_A19 | **G** |
| **F** | NC | NC | CSI_CLK0P | CSI_CLK0M | GND | GND | GND | GND | VDDUSB_CAP | USB_H1_DN | PMIC_STBY_REQ | BOOT_MODE1 | SD3_DAT7 | SD3_DAT1 | NANDF_CS0 | NANDF_D2 | SD4_DAT2 | SD1_DAT3 | SD2_CMD | RGMII_TD1 | EIM_D17 | EIM_D24 | EIM_EB3 | EIM_A22 | EIM_A24 | **F** |
| **E** | NC | NC | CSI_D0P | CSI_D0M | GND | GND | GND | NVCC_PLL_OUT | USB_OTG_VBUS | USB_H1_DP | TAMPER | TEST_MODE | SD3_DAT6 | SD3_DAT0 | NANDF_WP_B | SD4_CLK | NANDF_D6 | SD4_DAT4 | SD1_DAT2 | SD2_DAT1 | RGMII_TD2 | EIM_EB2 | EIM_D22 | EIM_D26 | EIM_D27 | **E** |



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**Table 100. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6DualLite (continued)**

| | Y | W | V | U | T | R | P | N | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | LVDS1_TX0_N | LVDS0_TX3_P | LVDS0_TX2_P | LVDS0_TX0_P | GPIO_2 | GPIO_17 | CSI0_PIXCLK | CSI0_DAT4 | 1 |
| 2 | LVDS1_TX0_P | LVDS0_TX3_N | LVDS0_TX2_N | LVDS0_TX0_N | GPIO_9 | GPIO_16 | CSI0_DAT5 | CSI0_VSYNC | 2 |
| 3 | LVDS1_CLK_N | GND | LVDS0_CLK_P | LVDS0_TX1_P | GPIO_6 | GPIO_7 | CSI0_DATA_EN | CSI0_DAT7 | 3 |
| 4 | LVDS1_CLK_P | KEY_ROW2 | LVDS0_CLK_N | LVDS0_TX1_N | GPIO_1 | GPIO_5 | CSI0_MCLK | CSI0_DAT6 | 4 |
| 5 | GND | KEY_COL0 | KEY_ROW4 | KEY_COL3 | GPIO_0 | GPIO_8 | GPIO_19 | CSI0_DAT9 | 5 |
| 6 | DRAM_RESET | KEY_COL2 | KEY_ROW0 | KEY_ROW1 | KEY_COL4 | GPIO_4 | GPIO_18 | CSI0_DAT8 | 6 |
| 7 | DRAM_D20 | GND | NVCC_LVDS2P5 | KEY_COL1 | KEY_ROW3 | GPIO_3 | NVCC_GPIO | NVCC_CSI | 7 |
| 8 | DRAM_D21 | GND | GND | GND | GND | GND | GND | GND | 8 |
| 9 | DRAM_D19 | GND | NVCC_DRAM | VDDARM_IN | VDDARM_IN | VDDARM_IN | VDDARM_IN | VDDARM_IN | 9 |
| 10 | DRAM_D25 | GND | NVCC_DRAM | VDDSOC_CAP | VDDSOC_CAP | VDDSOC_CAP | GND | GND | 10 |
| 11 | DRAM_SDCKE0 | GND | NVCC_DRAM | GND | GND | VDDARM_CAP | VDDARM_CAP | VDDARM_CAP | 11 |
| 12 | DRAM_A15 | GND | NVCC_DRAM | GND | GND | GND | GND | NC | 12 |
| 13 | DRAM_A7 | GND | NVCC_DRAM | VDDSOC_CAP | VDDSOC_CAP | VDDARM_CAP | VDDARM_CAP | VDDARM_CAP | 13 |
| 14 | DRAM_A3 | DRAM_A4 | NVCC_DRAM | VDDSOC_CAP | VDDSOC_CAP | VDDARM_IN | VDDARM_IN | VDDARM_IN | 14 |
| 15 | DRAM_SDBA1 | GND | NVCC_DRAM | GND | GND | GND | GND | GND | 15 |
| 16 | DRAM_CS0 | GND | NVCC_DRAM | VDDSOC_IN | VDDSOC_IN | VDDSOC_IN | VDDSOC_IN | VDDSOC_IN | 16 |
| 17 | DRAM_D36 | GND | NVCC_DRAM | GND | GND | GND | VDDPU_CAP | VDDPU_CAP | 17 |
| 18 | DRAM_D37 | GND | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | NVCC_DRAM | GND | GND | 18 |
| 19 | DRAM_D40 | GND | GND | GND | GND | NVCC_ENET | NVCC_LCD | DI0_DISP_CLK | 19 |
| 20 | DRAM_D44 | ENET_TXD1 | ENET_MDC | ENET_TXD0 | DISP0_DAT21 | DISP0_DAT13 | DISP0_DAT4 | DI0_PIN3 | 20 |
| 21 | DRAM_DQM7 | ENET_RXD0 | ENET_TX_EN | ENET_CRS_DV | DISP0_DAT16 | DISP0_DAT10 | DISP0_DAT3 | DI0_PIN15 | 21 |
| 22 | DRAM_D59 | ENET_RXD1 | ENET_REF_CLK | DISP0_DAT20 | DISP0_DAT15 | DISP0_DAT8 | DISP0_DAT1 | EIM_BCLK | 22 |
| 23 | DRAM_D62 | ENET_RX_ER | ENET_MDIO | DISP0_DAT19 | DISP0_DAT11 | DISP0_DAT6 | DISP0_DAT2 | EIM_DA14 | 23 |
| 24 | GND | DISP0_DAT23 | DISP0_DAT22 | DISP0_DAT17 | DISP0_DAT12 | DISP0_DAT7 | DISP0_DAT0 | EIM_DA15 | 24 |
| 25 | DRAM_D58 | DRAM_D63 | DISP0_DAT18 | DISP0_DAT14 | DISP0_DAT9 | DISP0_DAT5 | DI0_PIN4 | DI0_PIN2 | 25 |
| | Y | W | V | U | T | R | P | N | |



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**Table 100. 21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6DualLite (continued)**

| | AE | AD | AC | AB | AA | |
|---|---|---|---|---|---|---|
| 1 | GND | DRAM_D5 | DRAM_D4 | LVDS1_TX2_N | LVDS1_TX1_P | 1 |
| 2 | DRAM_D1 | DRAM_D0 | DRAM_VREF | LVDS1_TX2_P | LVDS1_TX1_N | 2 |
| 3 | DRAM_SDQS0 | DRAM_SDQS0_B | DRAM_DQM0 | GND | LVDS1_TX3_N | 3 |
| 4 | DRAM_D7 | GND | DRAM_D2 | DRAM_D6 | LVDS1_TX3_P | 4 |
| 5 | DRAM_D9 | DRAM_D8 | DRAM_D13 | DRAM_D12 | DRAM_D3 | 5 |
| 6 | DRAM_SDQS1_B | DRAM_SDQS1 | DRAM_DQM1 | DRAM_D14 | DRAM_D10 | 6 |
| 7 | DRAM_D11 | GND | DRAM_D15 | DRAM_D16 | GND | 7 |
| 8 | DRAM_SDQS2_B | DRAM_SDQS2 | DRAM_D22 | DRAM_DQM2 | DRAM_D17 | 8 |
| 9 | DRAM_D24 | DRAM_D29 | DRAM_D28 | DRAM_D18 | DRAM_D23 | 9 |
| 10 | DRAM_DQM3 | GND | DRAM_SDQS3 | DRAM_SDQS3_B | GND | 10 |
| 11 | DRAM_D26 | DRAM_D30 | DRAM_D31 | DRAM_D27 | DRAM_SDCKE1 | 11 |
| 12 | DRAM_A9 | DRAM_A12 | DRAM_A11 | DRAM_SDBA2 | DRAM_A14 | 12 |
| 13 | DRAM_A5 | GND | DRAM_A6 | DRAM_A8 | GND | 13 |
| 14 | DRAM_SDCLK_1_B | DRAM_SDCLK_1 | DRAM_A0 | DRAM_A1 | DRAM_A2 | 14 |
| 15 | DRAM_SDCLK_0_B | DRAM_SDCLK_0 | DRAM_SDBA0 | DRAM_RAS | DRAM_A10 | 15 |
| 16 | DRAM_CAS | GND | DRAM_SDODT0 | DRAM_SDWE | GND | 16 |
| 17 | ZQPAD | DRAM_CS1 | DRAM_A13 | DRAM_SDODT1 | DRAM_D32 | 17 |
| 18 | DRAM_SDQS4_B | DRAM_SDQS4 | DRAM_D34 | DRAM_DQM4 | DRAM_D33 | 18 |
| 19 | DRAM_D35 | GND | DRAM_D39 | DRAM_D38 | GND | 19 |
| 20 | DRAM_SDQS5_B | DRAM_SDQS5 | DRAM_DQM5 | DRAM_D41 | DRAM_D45 | 20 |
| 21 | DRAM_D46 | DRAM_D43 | DRAM_D47 | DRAM_D42 | DRAM_D57 | 21 |
| 22 | DRAM_D49 | GND | DRAM_D48 | DRAM_D52 | GND | 22 |
| 23 | DRAM_SDQS6_B | DRAM_SDQS6 | DRAM_D53 | DRAM_D60 | DRAM_D61 | 23 |
| 24 | DRAM_D50 | DRAM_DQM6 | DRAM_D51 | GND | DRAM_SDQS7_B | 24 |
| 25 | GND | DRAM_D54 | DRAM_D55 | DRAM_D56 | DRAM_SDQS7 | 25 |
| | AE | AD | AC | AB | AA | |



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# 7 Revision History

Table 101 provides the current revision history for this data sheet. Table 102 provides a revision history for previous revisions.

**Table 101. i.MX 6Solo/6DualLite Data Sheet Document Rev. 9 History**

| Rev. Number | Date | Substantive Changes |
|---|---|---|
| 9 | 10/2018 | Changes to Revision 9 include the following:<br>• Table 3, "Special Signal Considerations," on page 21: Corrected,<br>– Row: NC, from “These signals are No Connected …” to read, “These signals are not functional and must remain unconnected by the user.”<br>• Table 8, "Operating Ranges," on page 26: Corrected footnote 6:<br>– Changed *from*: “When VDD_SOC_IN does not supply… then maximum setting can be 1.3V.”<br>– Changed *to*: “When using VDD_SOC_CAP to supply the PCIE_VP and PCIE_VPTX, the maximum setting is 1.175V. …”<br>• Table 53, "eMMC4.4/4.41 Interface Timing Specification," on page 80,<br>– Row: SD2, uSDHC Output Delay: Changed $t_{OD}$ from 2.5ns minimum to 2.8ns and 7.1ns maximum to 6.8ns.<br>• Table 96, "21 x 21 mm Supplies Contact Assignments," on page 140: Corrected,<br>– Last row: NC, from “—” to read, These signals are not functional and must remain unconnected by the user. |
| 8 | 09/2017 | • Replaced ipp_dse with DSE throughout.<br>• Section 1, “Introduction: Replaced text “low voltage DDR3” with “DDR3L” in the features list of i.MX 6Solo/6DualLite applications processors.<br>• Table 1, "Example Orderable Part Numbers," on page 3: Added orderable part numbers.<br>• Figure 1: Updated to include Rev 1.4 in Silicon Revision section.<br>• Section 2.1, “Block Diagram: Updated WEIM with EIM in the block diagram.<br>• Table 2, "i.MX 6Solo/6DualLite Modules List," on page 11: Rearranged alphabetically.<br>• Table 6, "Absolute Maximum Ratings," on page 24:<br>– Removed VDD_HIGH_IN supply voltage (LDO bypass) parameter.<br>– Max. value of VDD_HIGH_CAP supply output voltage corrected to 2.85V.<br>• Table 22: Updated test condition of “XTALI input leakage current at startup” parameter; replaced 32KHz RTC with 24MHz.<br>• Added Section 4.6.4, “RGMII I/O 2.5V I/O DC Electrical Parameters.<br>• Section 4.8.2, “DDR I/O Output Buffer Impedance: Modified introductory text.<br>• Corrected Figure 22, "Asynchronous A/D Muxed Write Access," on page 60.<br>• Table 53, "eMMC4.4/4.41 Interface Timing Specification," on page 80:<br>– Added the following footnote to Card Input Clock section: 1 Clock duty cycle will be in the range of 47% to 53%.<br>– Min. value of uSDHC Input Setup Time reduced to 1.7ns. |



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**Table 102. i.MX 6Solo/6DualLite Data Sheet Document Past Revision Histories**

| Rev. Number | Date | Substantive Changes |
|---|---|---|
| 7 | 10/2016 | • Figure 1, "Part Number Nomenclature—i.MX 6Solo and 6DualLite," on page 5: Added to Silicon Revision block: Revision 1.2 and 1.3 and associated Mask ID.<br>• Table 6, "Absolute Maximum Ratings," on page 24:<br>– NVCC_DRAM maximum value changed to 1.975 V.<br>– Included footnote to NVCC_DRAM maximum value regarding maximum voltage allowance.<br>– Added row to Vin/Vout I/O supply voltage, separating DDR pins and non-DDR pins and included footnote regarding maximum voltage allowance.<br>• Table 8, "Operating Ranges," on page 26: Added footnotes within the Comments column for the Run Mode, LDO Enabled row; VDD_SOC_IN maximum values.<br>• Section 4.6.3, “DDR I/O DC Parameters: Added reference for more DDR details to see the MMDC section.<br>Moved JEDEC standard information to footnote.<br>• Section 4.7.2, “DDR I/O AC Parameters: Added reference for more DDR details to see the MMDC section.<br>Moved JEDEC standard information to footnote.<br>• Table 44, "i.MX 6Solo Supported DDR3/DDR3L/LPDDR2 Configurations," on page 63: Changed LPDDR2 Channel column from “Dual” to “Single.”<br>• Table 45, "i.MX 6DualLite Supported DDR3/DDR3L/LPDDR2 Configurations," on page 64: Added LPDDR2 Dual Channel column.<br>• Table 95, "21 x 21, 0.8 mm BGA Package Details," on page 139: Correction to package total thickness.<br>• Table 97, "21 x 21 mm Functional Contact Assignments," on page 142: DRAM_SDCKL*n* rows, reverted to “Low” rather than “0” in the Value column. |



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**Table 102. i.MX 6Solo/6DualLite Data Sheet Document Past Revision Histories (continued)**

| Rev. Number | Date | Substantive Changes |
|---|---|---|
| 6 | 8/2016 | • Changed throughout:<br>- LVDDR3 to DDR3L<br>- Changed terminology from “floating” to “not connected”.<br>• Table 2, "i.MX 6Solo/6DualLite Modules List," on page 11:<br>- uSDHC1–4, SD/MMC and SDXC Enhanced Multi-Media Card/Secure Digital Host Controller row: Added new bullet at top: “Conforms to the SD Host Controller…”.<br>- eCSPI1-4 row: removed from the Brief Description column, “with data rate up to 52Mbit/s.”<br>- BCH row, removed from Brief Description column, “encryption/decryption”.<br>• Table 3, "Special Signal Considerations," on page 21:<br>- GPANAIO row, modified remarks to be NXP use only.<br>- SRC_POR_B row: removed reference to internal POR which is not supported on device.<br>- TEST_MODE row: modified remarks to be NXP use only and added tie to Vss or remain unconnected.<br>• Table 6, "Absolute Maximum Ratings," on page 24” throughout table: clarified parameter descriptions including adding LDO state. Clarified symbol names.<br>- Added row, RGMII I/O supply voltage.<br>- Added VDD_HIGH_CAP supply voltage row for LDO output.<br>- Added to USB supply voltage row: USB_OTG_CHD_B.<br>- All maximum voltages increased (improved).<br>• Section 4.1.2, “Thermal Resistance: added NOTE.<br>• Table 8, "Operating Ranges," on page 26: Changed minimum parameter of Run mode: LDO enabled from 1.175 to 1.25 V.<br>• Section 4.2.1, “Power-Up Sequence”: Removed references to the internal POR function. Internal POR is not supported. Removed fourth and fifth bullets.<br>• Section 4.2.3, “Power Supplies Usage”: Added NOTE, “When the PCIE interface is not used…”.<br>• Section 4.5.2, “OSC32K”: Removed battery resistor (coin cell) calculation.<br>• Section 4.6.1, “XTALI and RTC_XTALI (Clock Inputs) DC Parameters”:<br>- Added 3 rows: Input capacitance; Startup current; and DC input current.<br>- Added footnote to RTC_XTALI high-level DC input voltage at the Max parameter.<br>- Added NOTE following table: “The Vil and Vih only apply when external clock source is used…”.<br>• Section 4.9.4, “Multi-Mode DDR Controller (MMDC)”: this new section added, replacing the original section 4.9.4 “DDR SRAM Specific Parameters (DDR3/DDR3L and LPDDR2)”.<br>• Figure 36, "ECSPI Master Mode Timing Diagram," on page 73: Added note, “ECSPI_MOSI always…”.<br>• Figure 37, "ECSPI Slave Mode Timing Diagram," on page 74: Added note, “ECSPI_MOSI always driven…”.<br>• Figure 42, "SDR50/SDR104 Timing," on page 81: Aligned SD4 and SD5.<br>• Table 54, "SDR50/SDR104 Interface Timing Specification," on page 81:<br>- Corrected Clock High Time ID to SD3.<br>- Changed SD2 and SD3 Min and max values to 0.46 and 0.54.<br>- Changed SD5 Max to 0.74.<br>• Table 64, "Camera Input Signal Cross Reference, Format, and Bits Per Cycle," on page 93: Changed RGB565 column heading from 2 to 1 cycle.<br>• Table 97, "21 x 21 mm Functional Contact Assignments," on page 142:<br>- Table row: DRAM_SDCLK0 and DRAM_SDCLK1 changed Out of Reset Condition from Low to 0.<br>- Added to ZQPAD row: requirement to add resistor to GND. |
| 5 | 6/2015 | • Table 8, “Operating Ranges,” Run mode: LDO enabled row; Changed comments for VDD_ARM_IN, from “1.05V minimum for operation up to 396MHz” to “1.125V minimum for operation up to 396MHz”.<br>• Table 3, “Special Signal Considerations,” XTALI/XTALO row: Changed from “The crystal must be rated...”, to “See Hardware Development Guide”. |



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**Table 102. i.MX 6Solo/6DualLite Data Sheet Document Past Revision Histories (continued)**

| Rev. Number | Date | Substantive Changes |
|---|---|---|
| Rev. 4 | 12/2014 | • Table 1, "Example Orderable Part Numbers," on page 3: Speed Grade footnote added as follows: If a 24 MHz input clock is used (required for USB), the maximum SoC speed is limited to 996 MHz.<br>• Table 1, "Example Orderable Part Numbers," on page 3: Added (4) devices; SCIMX6U5DVM10BC/CC and SCIMX6S5DVM10BC/CC.<br>• Figure 1, “Part Number Nomenclature—i.MX 6Solo and 6DualLite”: Added Silicon Rev 1.3. to diagram<br>• Table 2, Modules List, UART 1–5 Description changed: baud rate up from 5MHz to 5Mbps.<br>• Added Figure 2, "Example Part Marking," on page 5.<br>• Section 1.2, “Features”: under, *Miscellaneous IPs and interfaces*: Changed *UARTs* bullet, from “up to 4.0 Mbps”, to “up to 5.0 Mbps”.<br>• Table 8, “Operating Ranges,” on page 29:<br>— Changed *Run mode: VDD_ARM_IN* minimum value from 1.05 to 1.125V; for operation up to 396 MHz. and changed *LDO bypassed* maximum value from 1.225V to 1.21V; for *VDD_SOC_IN*.<br>— Changed *PCIe supply voltages; PCIE_VP/PCIE_VPTX* maximum value from 1.225V to 1.21V<br>• Table 10, "Maximum Supply Currents," on page 29;<br>— Changed *VDD_ARM_IN* from single condition to include DualLite and Solo conditions with Maximum current values of 2200 and 1320 mA, respectively.<br>— Added footnote for NVCC_LVDS2P5 supply.<br>• Table 38, “Reset Timing Parameters”: Removed footnote regarding SRC_POR_B rise and fall times.<br>• Section 4.9.3, “External Interface Module (EIM)”: Changed first paragraph to describe two systems clocks used with EIM: ACLK_EIM_SLOW_CLK_ROOT and ACLK_EXSC (for synchronous mode).<br>• Table 31, “DDR I/O DDR3/DDR3L Mode AC Parameters”; Added footnote about extended range for Vix.<br>• Table 48, “DDR3/DDR3L Timing Parameter Table,” on page 76; Added DDR0, tCK(avg) and parameter values. Changed symbol names DDR1 through DDR7 to include avg or base; changed minimum parameter values for DDR4–DDR7. Added footnote about tIS and tIH base values.<br>• Figure 25, “DDR3 Command and Address Timing Parameters,” on page 76; Added DDR0.<br>• Table 49, “DDR3/DDR3L Write Cycle,” on page 77; Changed symbol names of DDR17 and DDR18 to include base(AC150/DC100); Changed Units from tCK to tCK(avg).<br>• Table 46, “LPDDR2 Write Cycle,” on page 64; Changed LP21 min/max parameter values from -0.25/+0.25 to 0.75/1.25.<br>• Table 42, "EIM Bus Timing Parameters," on page 55: Changed footnotes regarding the system clocks used with EIM: from *axi_clk* to *ACLK_EXSC* or *ACLK_EIM_SLOW_CLK_ROOT.*<br>• Table 49, “DDR3/DDR3L Write Cycle,” on page 77: Changed *DDR17* minimum value from 420 ps to 125 ps and *DDR18* from 345 ps to 150 ps.<br>• Table 49, “DDR3/DDR3L Write Cycle,” on page 77: Added footnote 4.<br>• Table 69, "LVDS Display Bridge (LDB) Electrical Specification," on page 105: Corrected Units for Output Voltage High and Output Voltage Low from mV to V.<br>• Table 71, "Electrical and Timing Information," on page 108: Moved rows *tSETUP[RX]* and *tHOLD[RX]* to be directly under *HS Line Receiver AC Specifications* heading row.<br>• Table 96, "21 x 21 mm Supplies Contact Assignments," on page 140: Removed A1 pin.<br>• Table 97, "21 x 21 mm Functional Contact Assignments," on page 142: Moved rows *DRAM_4*, *DRAM_5,* and *DRAM_6* out of the i.MX 6DualLite section (shaded gray) to the i.MX 6Solo section above DRAM_7 and (unshaded).<br>• Table 99, "21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6Solo," on page 156: Removed “NC” from A1 pin location.<br>• Table 100, "21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6DualLite," on page 159: Removed “NC” from A1 pin location. |



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**Table 102. i.MX 6Solo/6DualLite Data Sheet Document Past Revision Histories (continued)**

| Rev. Number | Date | Substantive Changes |
|---|---|---|
| Rev. 3 | 02/2014 | • Updates throughout for Silicon revision C, including:<br>- Figure 1 Part number nomenclature diagram<br>- Table 1 Example Orderable Part Numbers<br>• Feature descriptions updated for:<br>- Camera sensors: updated from one to two ports at up to 240 MHz peak.<br>- Miscellaneous IPs and interfaces; SSI and ESAI.<br>• Table 2, Modules List, uSDHC 1–4 description change: including SDXC cards up to 2 TB.<br>• Table 2, Modules List, UART 1–5 description change: programmable baud rate up to 5 MHz.<br>• Table 3, Special Signal Considerations: XTALOSC_RTC_XTALI/RTC_XTALO: ending paragraph removed. Was: “In case when high accuracy real time clock are not required system may use internal low frequency ring oscillator. It is recommended to connect XTALOSC_RTC_XTALI to GND and keep RTC_XTALO floating.”<br>• Table 8, Operating Ranges for Run mode LDO bypassed: Added footnote regarding alternate maximum voltage on VDD_SOC_IN … this maximum can be 1.3V.<br>• Table 8, Operating Ranges Standby/DSM mode: Added footnote regarding alternate maximum voltage on VDD_SOC_IN … this maximum can be 1.3V.<br>• Table 8, Operating Ranges GPIO supply voltages: Corrected supply name to NVCC_NANDF<br>• Table 8, Operating ranges: updated table footnotes for clarity.<br>• Removed table “On-Chip LDOs and their On-Chip Loads.”<br>• Section 4.1.4, External Clock Sources; added Note, “The internal RTC oscillator does not...”.<br>• Section 4.1.5, Maximum Supply Currents: Reworded second paragraph about the power management IC to explain that a robust thermal design is required for the increased system power dissipation.<br>• Table 10, Maximum Supply Currents: NVCC_RGMII Condition value corrected to N=6.<br>• Table 10, Maximum Supply Currents: Corrected supply name NVCC_NANDF.<br>• Table 10, Maximum Supply currents: Added row NVCC_LVDS2P5<br>• Section 4.2.1, Power-Up Sequence: Clarified wording of third bulleted item regarding POR control.<br>• Section 4.2.1, Power-Up Sequence: Removed Note.<br>• Section 4.2.1, Power-Up Sequence: Corrected bullet regarding VDD_ARM_CAP / VDD_SOC_CAP difference from 50 mV to 100 mV.<br>• Section 4.5.2, OSC32K, second paragraph reworded to describe OSC32K automatic switching.<br>• Section 4.5.2, OSC32K, added Note following second paragraph to caution use of internal oscillator.<br>• Table 23, XTALI and RTC_XTALI DC parameters; changed RTC_XTALI Vih minimum value to 0.8.<br>• Table 23, XTALI and RTC_XTALI DC parameters; changed RTC_XTALI Vih maximum value to 1.1.<br>• Table 39, Reset Timing Parameters; removed rise/fall time requirement<br>• Section 4.9.3, External Interface Module; enhanced wording to first paragraph to describe operating frequency for data transfers, and to explain register settings are valid for entire range of frequencies. |
| Rev. 3 continued | 2/2014 | • Table 42, EIM Bus Timing Parameters; reworded footnotes for clarity.<br>• Table 42, EIM Asynchronous Timing Parameters; removed comment from the Max heading cell.<br>• Figure 60, Gated Clock Mode Timing Diagram: Corrected HSYNC trace behavior<br>• Table 66, Video Signal Cross-Reference: Corrected naming of HSYNC and VSYNC<br>• Section 4.11.22, USB PHY Parameters: Updated Battery Charging Specification bullet<br>• Table 95, BGA Package Details: Corrected to read “21 x 21, 0.8 mm”.<br>• Table 96, Supplies Contact Assignments: Corrected supply name NVCC_NANDF<br>• Table 96, Supplies Contact Assignments: Updated NC rows to show i.MX 6DualLite vs. i.MX 6Solo<br>• Table 97, Functional Contact Assignments: ALT5 Default function signal names corrected<br>• Table 97, Functional Contact Assignments: PMIC_ON_REQ Out of Reset value corrected to “Open Drain with PU (100K) enabled”<br>• Table 97, Functional Contact Assignments: TEST_MODE row included<br>• Table 97, Functional Contact Assignments: VDD_ARM_IN and ZQPAD row removed |



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**Table 102. i.MX 6Solo/6DualLite Data Sheet Document Past Revision Histories (continued)**

| Rev. Number | Date | Substantive Changes |
|---|---|---|
| Rev. 2.2 | 8/2013 | • 21x21 functional contact table: changed from NAND to NANDF<br>• System Timing Parameters Table 39, *Reset timing parameter*, CC1 description, change from:<br>"Duration of SRC_POR_B to be qualified as valid (<= 5 ns)" to:<br>"Duration of SRC_POR_B to be qualified as valid"<br>and added a footnote to the parameter with the following text:<br>"SRC_POR_B rise and fall times must be 5 ns or less." |
| Rev. 2.1 | 5/2013 | Substantive changes throughout this document are as follows:<br>• Incorporated standardized signal names. This change is extensive throughout.<br>• Added reference to EB792, i.MX Signal Name Mapping.<br>• Figures updated to align to standardized signal names.<br>• Updated references to eMMC standard to include 4.41.<br>• Added MediaLB (MLB) feature and DTCP module to the commercial temperature grade version.<br>• Figure 1 Part Number Nomenclature: Updates to Part differentiator section to align with Table 1.<br>• Table 1 "Orderable Part Numbers," added Arm core information to the Options column:<br>2x "Arm Cortex-A9" 64-bit to 6DualLite<br>1x "Arm Cortex -A9" 32-bit to 6Solo<br>• Table 2 Changed reference to Global Power Controller to read General Power Controller.<br>• Table 8 "Operating Ranges," added reference for information on product lifetime: i.MX 6Dual/6Quad Product Usage Lifetime Estimates Application Note, AN4725.<br>• Table 10 "Maximum Supply Currents," updated footnote 2.<br>• Table 11 Stop Mode Current and Power Consumption: Added SNVS Only mode.<br>• Table 60 RGMII parameter TskewT minimum and maximum values corrected.<br>• Table 60 RGMII parameter TskewR units corrected.<br>• Table 97 Clarification of ENET_REF_CLK naming.<br>• Added Table 98, "Signals with Differing Before Reset and After Reset States," on page 153.<br>• Removed section, EIM Signal Cross Reference. Signal names are now aligned with reference manual.<br>• Removed table from Section 3.2, "Recommended Connections for Unused Analog Interfaces and referenced the Hardware Development Guide.<br>• Section 1.2, "Features added bulleted item regarding the SOC-level memory system.<br>• Section 1.2, "Features Camera sensors: Changed Camera port to be up to 180 MHz peak.<br>• Added Section 1.3, "Updated Signal Naming Convention<br>• Section 4.2.1, "Power-Up Sequence" updated wording.<br>• Section 4.3.2, "Regulators for Analog Modules" section updates.<br>• Added Section 4.6.1, "XTALI and RTC_XTALI (Clock Inputs) DC Parameters."<br>• Section 4.10, "General-Purpose Media Interface (GPMI) Timing" figures replaced, tables revised. |



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