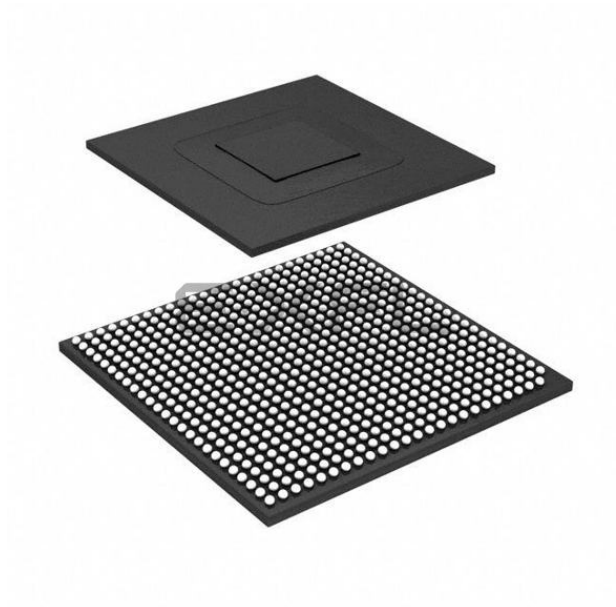

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Understanding Embedded - Microprocessors

Embedded microprocessors are specialized computing chips designed to perform specific tasks within an embedded system. Unlike general-purpose microprocessors found in personal computers, embedded microprocessors are tailored for dedicated functions within larger systems, offering optimized performance, efficiency, and reliability. These microprocessors are integral to the operation of countless electronic devices, providing the computational power necessary for controlling processes, handling data, and managing communications.

Applications of Embedded - Microprocessors

Embedded microprocessors are utilized across a broad spectrum of applications, making them indispensable in

Details	
Product Status	Active
Core Processor	ARM® Cortex®-A9
Number of Cores/Bus Width	2 Core, 32-Bit
Speed	800MHz
Co-Processors/DSP	Multimedia; NEON™ SIMD
RAM Controllers	LPDDR2, LVDDR3, DDR3
Graphics Acceleration	Yes
Display & Interface Controllers	Keypad, LCD
Ethernet	10/100/1000Mbps (1)
SATA	-
USB	USB 2.0 + PHY (4)
Voltage - I/O	1.8V, 2.5V, 2.8V, 3.3V
Operating Temperature	-40°C ~ 105°C (TA)
Security Features	ARM TZ, Boot Security, Cryptography, RTIC, Secure Fusebox, Secure JTAG, Secure Memory, Secure RTC, Tamper Detection
Package / Case	624-LFBGA
Supplier Device Package	624-MAPBGA (21x21)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mcimx6u7cvm08ac

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
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.
APBH-DMA	NAND Flash and BCH ECC DMA controller	System Control Peripherals	DMA controller used for GPMI2 operation
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. CAAM also implements a Secure Memory mechanism. In i.MX 6Solo/6DualLite processors, the security memory provided is 16 KB.
CCM GPC 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.

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

Block Mnemonic	Block Name	Subsystem	Brief Description
uSDHC-1 uSDHC-2 uSDHC-3 uSDHC-4	SD/MMC and SDXC Enhanced Multi-Media Card / Secure Digital Host Controller	Connectivity Peripherals	i.MX 6Solo/6DualLite specific SoC characteristics: All four MMC/SD/SDIO controller IPs are identical and are based on the uSDHC IP. They are: • Conforms to the SD Host Controller Standard Specification version 3.0. • 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. • 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. • Fully compliant with SDIO command/response sets and interrupt/read-wait mode as defined in the SDIO Card Specification, Part E1, v3.0 All four ports support: • 1-bit or 4-bit transfer mode specifications for SD and SDIO cards up to UHS-I SDR104 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) However, the SoC level integration and I/O muxing logic restrict the functionality to the following: • 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. • 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. • 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.
FlexCAN-1 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.

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. The IPUv3H supports concurrent output to two display ports and concurrent input from two camera ports, through the following interfaces: • Parallel Interfaces for both display and camera • Single/dual channel LVDS display interface • HDMI transmitter • MIPI/DSI transmitter • MIPI/CSI-2 receiver The processing includes: • Image conversions: resizing, rotation, inversion, and color space conversion • A high-quality de-interlacing filter • Video/graphics combining • Image enhancement: color adjustment and gamut mapping, gamma correction, and contrast enhancement • Support for display backlight reduction
KPP	Key Pad Port	Connectivity Peripherals	KPP Supports 8x8 external key pad matrix. KPP features are: • Open drain design • Glitch suppression circuit design • Multiple keys detection • 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: • One clock pair • Four data pairs Each signal pair contains LVDS special differential pad (PadP, PadM).
MMDC	Multi-Mode DDR Controller	Connectivity Peripherals	DDR Controller has the following features: • Supports 16/32-bit DDR3-800 (LV) or LPDDR2-800 in i.MX 6Solo • Supports 16/32/64-bit DDR3-800 (LV) or LPDDR2-800 in i.MX 6DualLite • Supports 2x32 LPDDR2-800 in i.MX 6DualLite • Supports up to 4 GByte DDR memory space

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

Block Mnemonic	Block Name	Subsystem	Brief Description
SSI-1 SSI-2 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. 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 UART-2 UART-3 UART-4 UART-5	UART Interface	Connectivity Peripherals	Each of the UARTv2 modules support the following serial data transmit/receive protocols and configurations: • 7- or 8-bit data words, 1 or 2 stop bits, programmable parity (even, odd or none) • Programmable baud rates up to 5 Mbps. • 32-byte FIFO on Tx and 32 half-word FIFO on Rx supporting auto-baud • IrDA 1.0 support (up to SIR speed of 115200 bps) • 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: • One high-speed OTG module with integrated HS USB PHY • One high-speed Host module with integrated HS USB PHY • Two identical high-speed Host modules connected to HSIC USB ports.
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.

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
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

Table 20. 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

NOTE

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

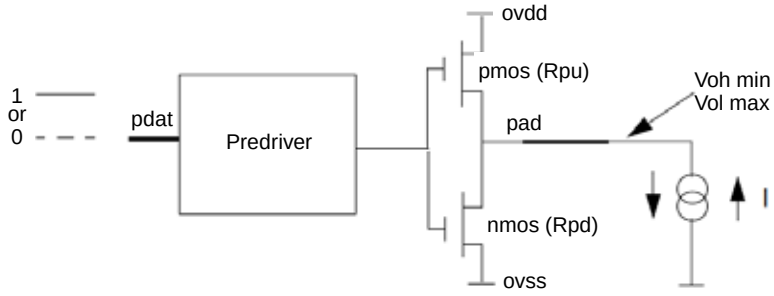


Figure 4. Circuit for Parameters Voh and Vol for I/O Cells

Table 26. 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, ipp_dse=111)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	2.72/2.79 1.51/1.54	ns
Output Pad Transition Times, rise/fall (High Drive, ipp_dse=101)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	3.20/3.36 1.96/2.07	
Output Pad Transition Times, rise/fall (Medium Drive, ipp_dse=100)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	3.64/3.88 2.27/2.53	
Output Pad Transition Times, rise/fall (Low Drive. ipp_dse=011)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	4.32/4.50 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.

Table 27. 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, ipp_dse=101)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	1.70/1.79 1.06/1.15	ns
Output Pad Transition Times, rise/fall (High Drive, ipp_dse=011)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	2.35/2.43 1.74/1.77	
Output Pad Transition Times, rise/fall (Medium Drive, ipp_dse=010)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	3.13/3.29 2.46/2.60	
Output Pad Transition Times, rise/fall (Low Drive. ipp_dse=001)	tr, tf	15 pF Cload, slow slew rate 15 pF Cload, fast slew rate	—	—	5.14/5.57 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 28 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 28. 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

Table 28. DDR I/O LPDDR2 Mode AC Parameters[1] (continued)

Parameter	Symbol	Test Condition	Min	Max	Unit
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. 5 pF load. Drive impedance = 40 Ω ± 30%	1.5	3.5	V/ns
		50 Ω to Vref. 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).

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

Table 29. 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

Table 32 shows the GPIO output buffer impedance (OVDD 3.3 V).

Table 32. GPIO Output Buffer Average Impedance (OVDD 3.3 V)

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

4.8.2 DDR I/O Output Buffer Impedance

The LPDDR2 interface fully complies with JESD209-2B LPDDR2 JEDEC standard release June, 2009. The DDR3 interface fully complies with JESD79-3D DDR3 JEDEC standard release April, 2008.

Table 33 shows DDR I/O output buffer impedance of i.MX 6Solo/6DualLite processors.

Table 33. 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	000 001 010 011 100 101 110 111	Hi-Z 240 120 80 60 48 40 34	Hi-Z 240 120 80 60 48 40 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.

4.9 System Modules Timing

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

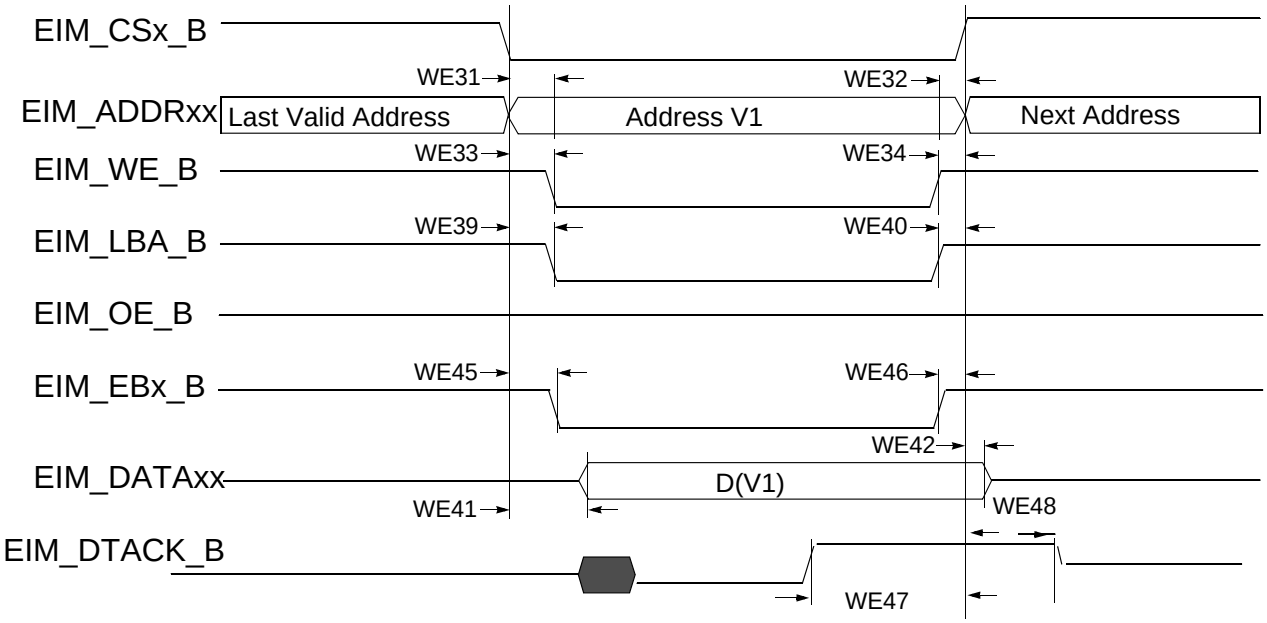


Figure 22. DTACK Mode Write Access (DAP=0)

Table 38. 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

Table 41. 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 26), NF16/NF17 are different from the definition in non-EDO mode (Figure 25). 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.

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 41 shows MII receive signal timings. Table 50 describes the timing parameters (M1–M4) shown in the figure.

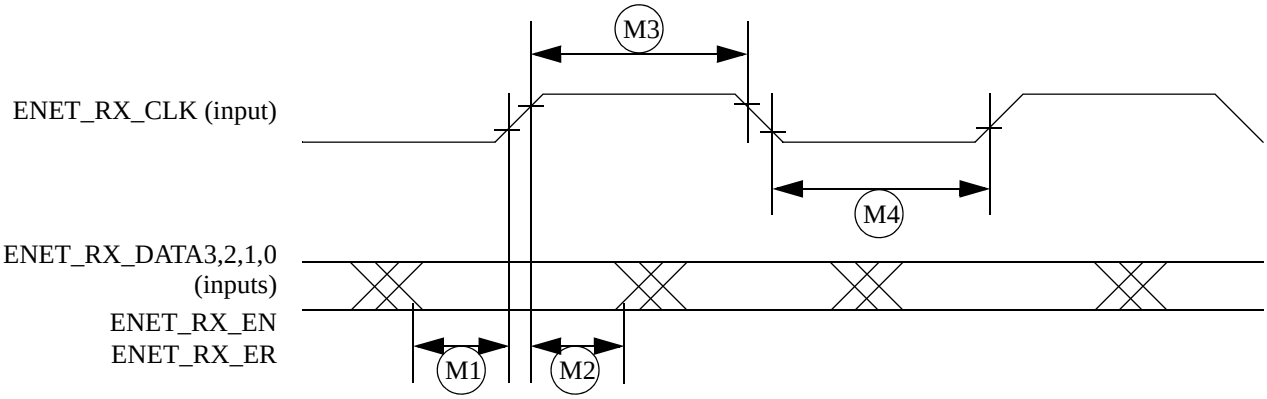


Figure 41. MII Receive Signal Timing Diagram

Table 50. 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.

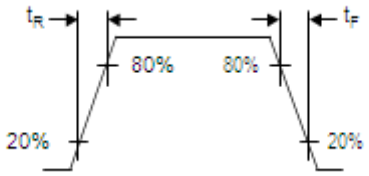


Figure 56. TMDS Output Signals Rise and Fall Time Definition

Table 57. 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 See Figure 52.	2.94	—	40	ns
t_{CDC}	TMDSCLK duty cycle	$t_{CDC} = t_{CPH} / P_{TMDSCLK}$ RL = 50 Ω See Figure 52.	40	50	60	%
t_{CPH}	TMDSCLK high time	RL = 50 Ω See Figure 52.	4	5	6	UI[1]
t_{CPL}	TMDSCLK low time	RL = 50 Ω See Figure 52.	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 See Figure 54.	—	—	0.15	UI[1]
$t_{SK(pp)}$	Inter-pair skew	RL = 50 Ω See Figure 55.	—	—	1	UI[1]
t_R	Differential output signal rise time	20–80% RL = 50 Ω See Figure 56.	75	—	0.4 UI	ps
t_F	Differential output signal fall time	20–80% RL = 50 Ω See Figure 56.	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.

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

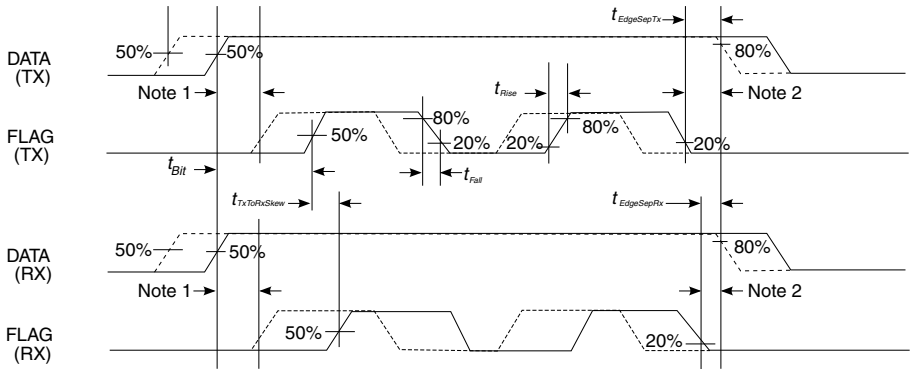
The IPU uses four control signals and data to operate a standard synchronous interface:

- 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.

Table 67. 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 79. DATA and FLAG Signal Timing

4.11.14 PCIe PHY Parameters

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

4.11.14.1 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.

4.11.15 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 80 depicts the timing of the PWM, and Table 68 lists the PWM timing parameters.

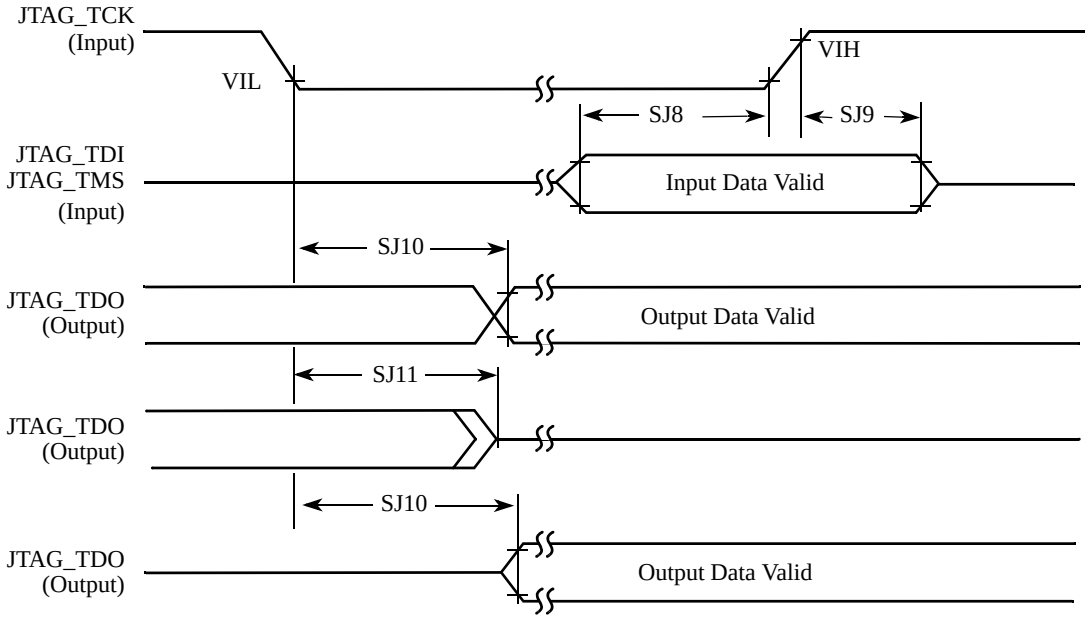


Figure 83. Test Access Port Timing Diagram

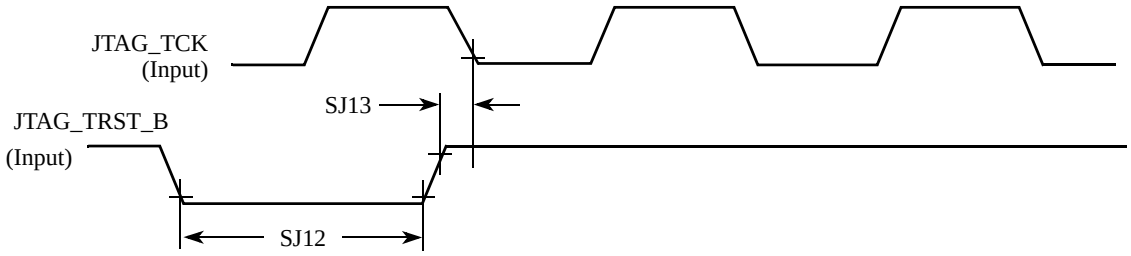


Figure 84. JTAG_TRST_B Timing Diagram

Table 69. 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

Table 74. 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).

4.11.18.4 SSI Receiver Timing with External Clock

Figure 90 depicts the SSI receiver external clock timing and Table 75 lists the timing parameters for the receiver timing with the external clock.

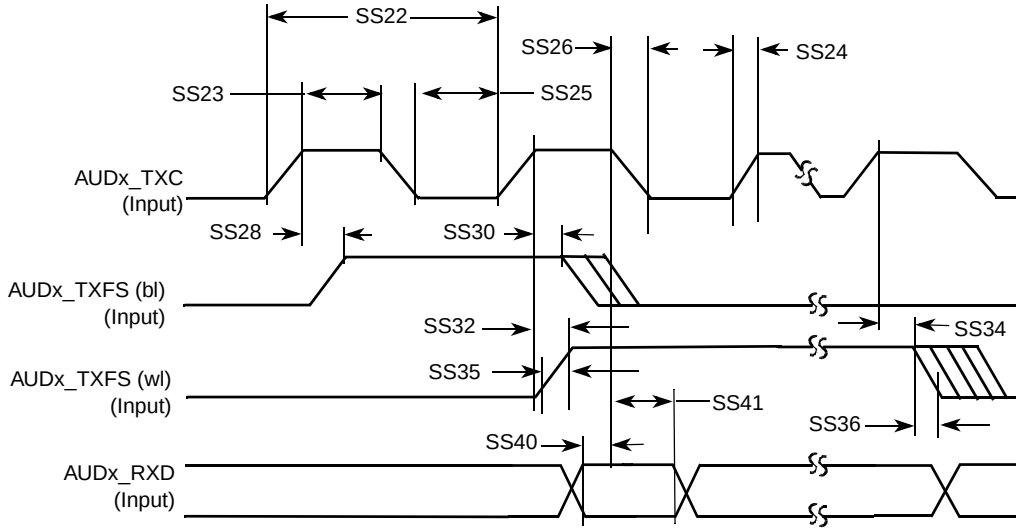


Figure 90. SSI Receiver External Clock Timing Diagram

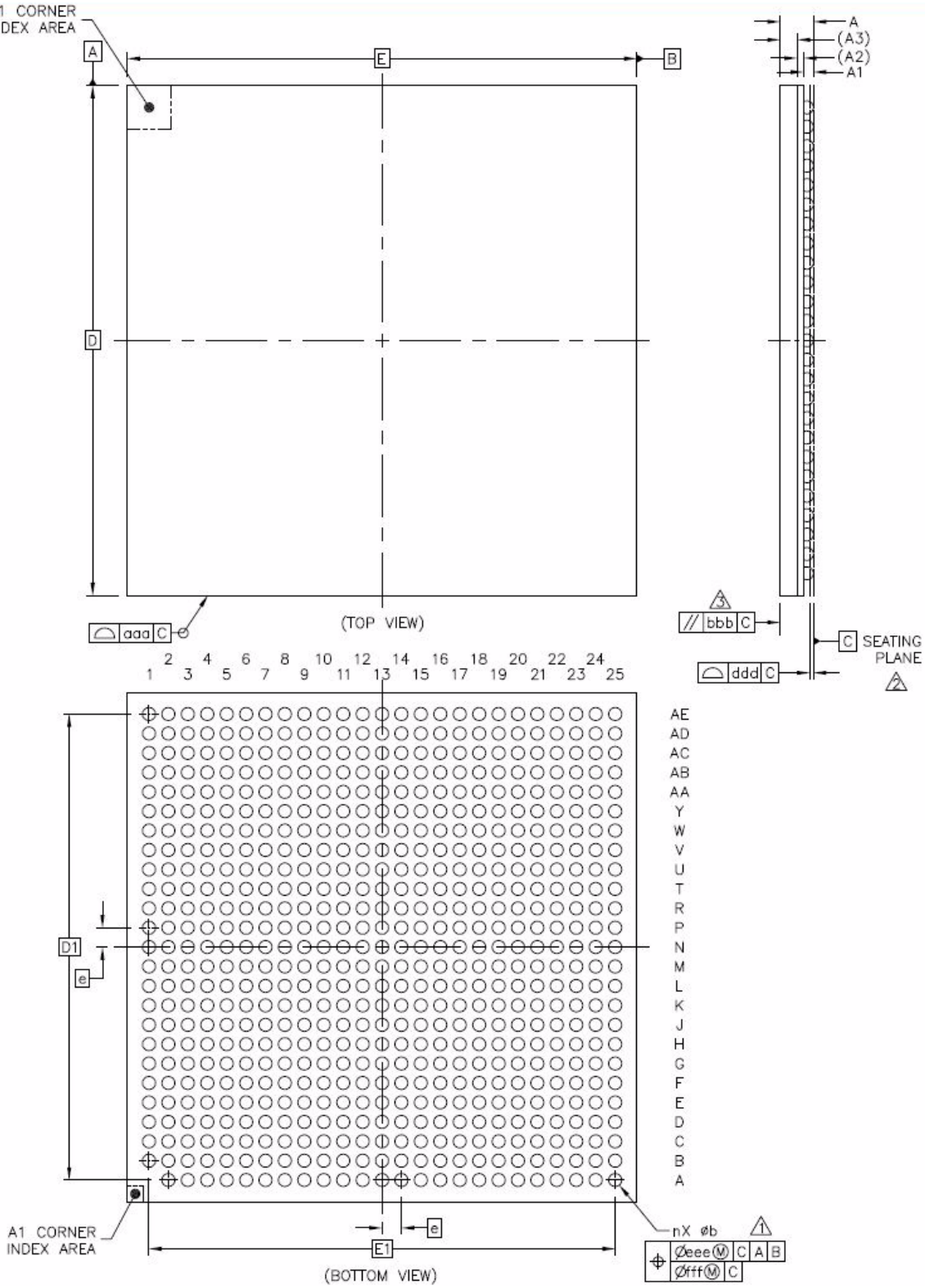


Figure 97. 21 x 21 mm BGA, Case 2240 Package Top, Bottom, and Side Views

Table 90. 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	

Table 92. i.MX 6Solo/6DualLite Data Sheet Document Past Revision Histories (continued)

Rev. Number	Date	Substantive Changes
Rev. 4	12/2014	• Figure 1, “Part Number Nomenclature—i.MX 6Solo and 6DualLite”: Added Silicon Rev 1.3. to diagram • Table 2, Modules List, UART 1–5 Description changed: baud rate up from 5MHz to 5Mbps. • Added Figure 2, "Example Part Marking for Revision 1.2/1.3 Devices," on page 4. • Section 1.2, “Features”: under, *Miscellaneous IPs and interfaces*: Changed *UARTs* bullet, from “up to 4.0 Mbps”, to “up to 5.0 Mbps”. • Table 8, “Operating Ranges,” on page 29: — 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*. — Changed *PCIe supply voltages; PCIE_VP/PCIE_VPTX* maximum value from 1.225V to 1.21V • Table 10, "Maximum Supply Currents," on page 28; — Changed *VDD_ARM_IN* from single condition to include DualLite and Solo conditions with Maximum current values of 2200 and 1320 mA, respectively. — Added footnote for NVCC_LVDS2P5 supply. • Table 38, “Reset Timing Parameters”: Removed footnote regarding SRC_POR_B rise and fall times. • 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). • Table 31, “DDR I/O DDR3/DDR3L Mode AC Parameters”; Added footnote about extended range for Vix. • 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. • Figure 25, “DDR3 Command and Address Timing Parameters,” on page 76; Added DDR0. • 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). • Table 46, “LPDDR2 Write Cycle,” on page 64; Changed LP21 min/max parameter values from -0.25/+0.25 to 0.75/1.25. • Table 37, "EIM Bus Timing Parameters," on page 51: Changed footnotes regarding the system clocks used with EIM: from *axi_clk* to *ACLK_EXSC* or *ACLK_EIM_SLOW_CLK_ROOT.* • 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. • Table 49, “DDR3/DDR3L Write Cycle,” on page 77: Added footnote 4. • Table 64, "LVDS Display Bridge (LDB) Electrical Specification," on page 101: Corrected Units for Output Voltage High and Output Voltage Low from mV to V. • Table 66, "Electrical and Timing Information," on page 104: Moved rows *tSETUP[RX]* and *tHOLD[RX]* to be directly under *HS Line Receiver AC Specifications* heading row. • Table 86, "21 x 21 mm Supplies Contact Assignments," on page 132: Removed A1 pin. • Table 87, "21 x 21 mm Functional Contact Assignments," on page 134: 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). • Table 89, "21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6Solo," on page 147: Removed “NC” from A1 pin location. • Table 90, "21 x 21 mm, 0.8 mm Pitch Ball Map i.MX 6DualLite," on page 150: Removed “NC” from A1 pin location.