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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	852MHz
Co-Processors/DSP	Multimedia; NEON™ SIMD
RAM Controllers	LPDDR2, DDR3L, DDR3
Graphics Acceleration	Yes
Display & Interface Controllers	HDMI, Keypad, LCD, LVDS, MIPI/DSI, Parallel
Ethernet	10/100/1000Mbps (1)
SATA	SATA 3Gbps (1)
USB	USB 2.0 + PHY (3), USB 2.0 OTG + PHY (1)
Voltage - I/O	1.8V, 2.5V, 2.8V, 3.3V
Operating Temperature	-40°C ~ 125°C (TJ)
Security Features	ARM TZ, A-HAB, CAAM, CSU, SJC, SNVS
Package / Case	624-FBGA, FCBGA
Supplier Device Package	624-FCBGA (21x21)
Purchase URL	https://www.e-xfl.com/product-detail/nxp-semiconductors/mcimx6dp6avt8aa

- 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, 512 KB)
- Secure/non-secure RAM (16 KB)
- External memory interfaces:
 - 16-bit, 32-bit, and 64-bit DDR3-1066, DDR3L-1066, and 1/2 LPDDR2 channels, supporting DDR interleaving mode, for dual x32 LPDDR2
 - 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 EIMv2 pins are muxed on other interfaces.
 - 16/32-bit PSRAM, Cellular RAM

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

- Hard Disk Drives—SATA II, 3.0 Gbps
- Displays—Total five interfaces available. Total raw pixel rate of all interfaces is up to 450 Mpixels/sec, 24 bpp. Up to four interfaces may be active in parallel.
 - 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)
 - 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
- Camera sensors:
 - Parallel Camera port (up to 20 bit and up to 240 MHz peak)
 - MIPI CSI-2 serial camera port, supporting up to 1000 Mbps/lane in 1/2/3-lane mode and up to 800 Mbps/lane in 4-lane mode. The CSI-2 Receiver core can manage one clock lane and up to four data lanes. Each i.MX 6DualPlus/6QuadPlus processor has four 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)

Introduction

- 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 capable of supporting audio sample frequencies up to 192 kHz stereo inputs and outputs with I²S mode
 - ESAI is capable of supporting audio sample frequencies up to 260kHz in I2S 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.
 - Five eCSPI (Enhanced CSPI)
 - Three I2C, supporting 400 kbps
 - Gigabit Ethernet Controller (IEEE1588 compliant), 10/100/1000¹ Mbps
 - 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 (150 Mbps) with the option of DTCP cipher accelerator

The i.MX 6DualPlus/6QuadPlus 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 Software State Retention and Power Gating for ARM and MPE

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 6Dual/6Quad errata document (IMX6DQCE).

Table 2. i.MX 6DualPlus/6QuadPlus Modules List (continued)

Block Mnemonic	Block Name	Subsystem	Brief Description
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: <ul style="list-style-type: none"> • One clock pair • Four data pairs 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 150 Mbps). The module is backward compatible to MLB-50.
MMDC	Multi-Mode DDR Controller	Connectivity Peripherals	DDR Controller has the following features: <ul style="list-style-type: none"> • Supports 16/32/64-bit DDR3 / DDR3L or LPDDR2 • Supports both dual x32 for LPDDR2 and x64 DDR3 / LPDDR2 configurations (including 2x32 interleaved mode) • Supports LPDDR2 up to 400 MHz and DDR3 up to 532 MHz • Supports up to 4 GByte DDR memory space
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. In i.MX 6DualPlus/6QuadPlus processors, the OCRAM is used for controlling the 512 KB multimedia RAM through a 64-bit AXI bus.
OSC 32 kHz	OSC 32 kHz	Clocking	Generates 32.768 kHz clock from an external crystal.
PCIe	PCI Express 2.0	Connectivity Peripherals	The PCIe IP provides PCI Express Gen 2.0 functionality.

Table 8. Maximum Supply Currents (continued)

Power Supply	Conditions	Maximum Current		Unit
		Power Virus	CoreMark	
NVCC_LVDS2P5	—	NVCC_LVDS2P5 is connected to VDD_HIGH_CAP at the board level. VDD_HIGH_CAP is capable of handling the current required by NVCC_LVDS2P5.		
MISC				
DRAM_VREF	—	1		mA

¹ i.MX 6DualPlus numbers assume VDD_ARM23_IN and VDD_ARM23_CAP are connected to ground.

² 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, PCIe, and SATA VPH supplies).

³ Under normal operating conditions, the maximum current on VDD_SNVS_IN is shown [Table 8](#). 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.

⁴ This is the maximum current per active USB physical interface.

⁵ The DRAM power consumption is dependent on several factors such as external signal termination. DRAM power calculators are typically available from memory vendors which take into account factors such as signal termination.

See the *i.MX 6Dual/6Quad Power Consumption Measurement Application Note (AN4509)* for examples of DRAM power consumption during specific use case scenarios.

⁶ General equation for estimated, maximum power consumption of an IO power supply:

$$I_{max} = N \times C \times V \times (0.5 \times F)$$

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, I_{max} is in Amps, C in Farads, V in Volts, and F in Hertz.

4.1.6 Low Power Mode Supply Currents

[Table 9](#) shows the current core consumption (not including I/O) of the i.MX 6DualPlus/6QuadPlus processors in selected low power modes.

Table 9. Stop Mode Current and Power Consumption

Mode	Test Conditions	Supply	Typical ¹	Unit
WAIT	<ul style="list-style-type: none"> ARM, SoC, and PU LDOs are set to 1.225 V HIGH LDO set to 2.5 V Clocks are gated DDR is in self refresh PLLs are active in bypass (24 MHz) Supply voltages remain ON 	VDD_ARM_IN (1.4 V)	6	mA
		VDD_SOC_IN (1.4 V)	23	mA
		VDD_HIGH_IN (3.0 V)	3.7	mA
		Total	52	mW

4.6.4 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 25 shows the Low Voltage Differential Signalling (LVDS) I/O DC parameters.

Table 25. LVDS I/O DC Parameters

Parameter	Symbol	Test Conditions	Min	Max	Unit
Output Differential Voltage	V_{OD}	$R_{load}=100\ \Omega$ between padP and padN	250	450	mV
Output High Voltage	V_{OH}	$I_{OH} = 0\ \text{mA}$	1.25	1.6	V
Output Low Voltage	V_{OL}	$I_{OL} = 0\ \text{mA}$	0.9	1.25	
Offset Voltage	V_{OS}	—	1.125	1.375	

4.6.5 MLB 6-Pin 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 8192fs.

Table 26 shows the Media Local Bus (MLB) I/O DC parameters.

Table 26. MLB I/O DC Parameters

Parameter	Symbol	Test Conditions	Min	Max	Unit
Output Differential Voltage	V_{OD}	$R_{load} = 50\ \Omega$ between padP and padN	300	500	mV
Output High Voltage	V_{OH}		1.15	1.75	V
Output Low Voltage	V_{OL}		0.75	1.35	V
Common-mode Output Voltage ($(V_{pad_P} + V_{pad_N}) / 2$)	V_{OCM}		1	1.5	V
Differential Output Impedance	Z_O	—	1.6	—	k Ω

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 4 and Figure 5.

² In this table:

- t means clock period from axi_clk frequency.
- CSA means register setting for WCSA when in write operations or RCSA when in read operations.
- CSN means register setting for WCSN when in write operations or RCSN when in read operations.
- ADVN means register setting for WADV when in write operations or RADVN when in read operations.
- ADVA means register setting for WADVA when in write operations or RADVA when in read operations.

4.9.4 DDR SDRAM Specific Parameters (DDR3/DDR3L and LPDDR2)

4.9.4.1 DDR3/DDR3L Parameters

Figure 24 shows the DDR3/DDR3L basic timing diagram. The timing parameters for this diagram appear in Table 42.

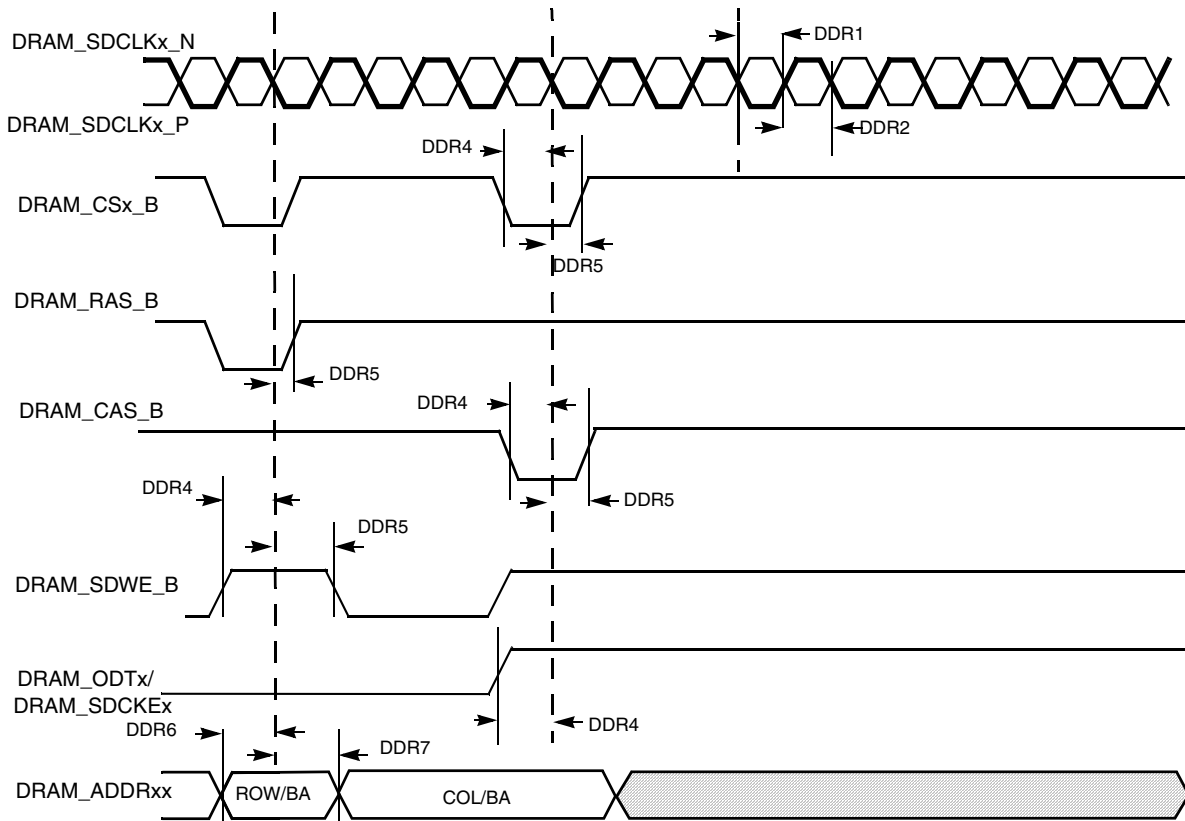


Figure 24. DDR3/DDR3L Command and Address Timing Diagram

Table 42. DDR3/DDR3L Command and Address Timing Parameter

ID	Parameter ^{1,2}	Symbol	CK = 532 MHz		Unit
			Min	Max	
DDR1	DRAM_SDCLKx_P clock high-level width	tCH	0.47	0.53	tCK
DDR2	DRAM_SDCLKx_P clock low-level width	tCL	0.47	0.53	tCK

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 30 through Figure 33 depict the relative timing between GPMI signals at the module level for different operations under Asynchronous mode. Table 48 describes the timing parameters (NF1–NF17) that are shown in the figures.

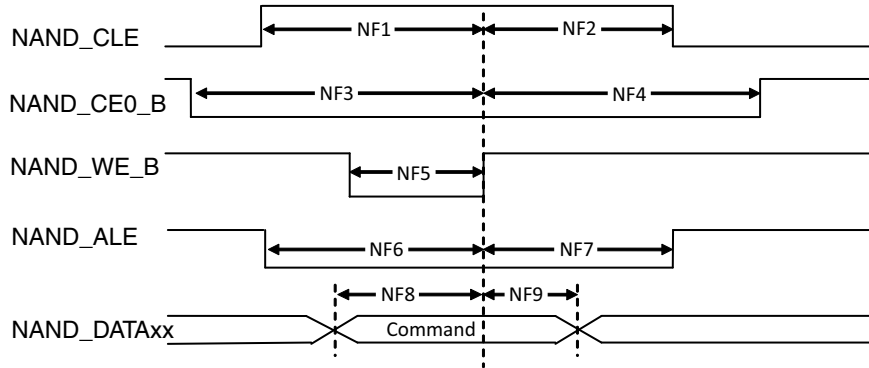


Figure 30. Command Latch Cycle Timing Diagram

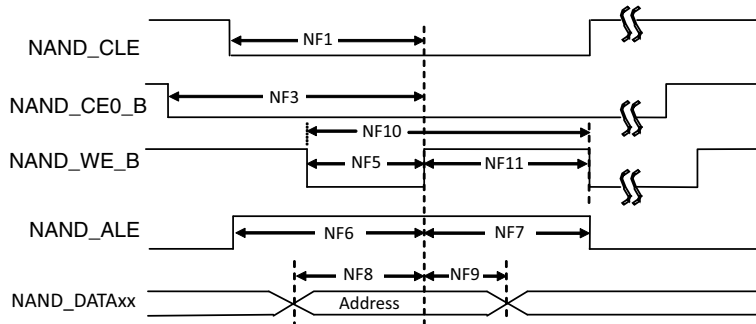


Figure 31. Address Latch Cycle Timing Diagram

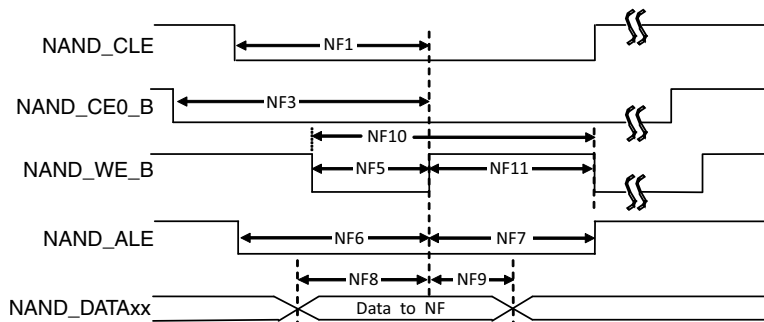


Figure 32. Write Data Latch Cycle Timing Diagram

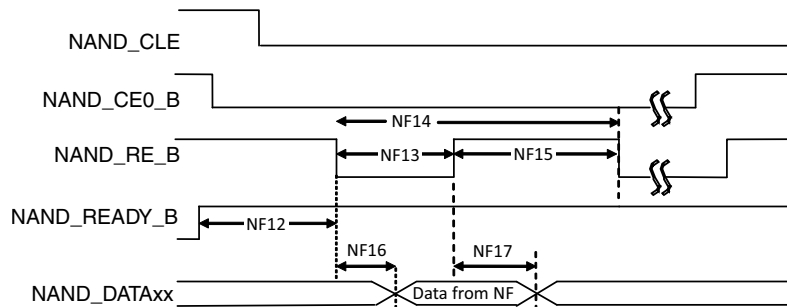


Figure 33. Read Data Latch Cycle Timing Diagram (Non-EDO Mode)

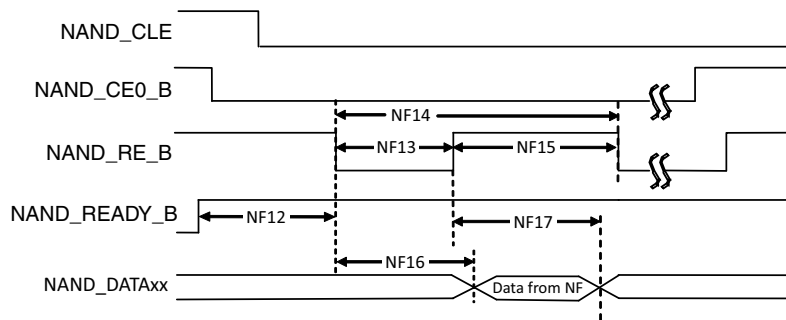


Figure 34. Read Data Latch Cycle Timing Diagram (EDO Mode)

Table 48. Asynchronous Mode Timing Parameters¹

ID	Parameter	Symbol	Timing T = GPMI Clock Cycle		Unit
			Min	Max	
NF1	NAND_CLE setup time	tCLS	$(AS + DS) \times T - 0.12$ [see ^{2,3}]		ns
NF2	NAND_CLE hold time	tCLH	$DH \times T - 0.72$ [see ²]		ns
NF3	NAND_CEx_B setup time	tCS	$(AS + DS + 1) \times T$ [see ^{3,2}]		ns
NF4	NAND_CEx_B hold time	tCH	$(DH+1) \times T - 1$ [see ²]		ns
NF5	NAND_WE_B pulse width	tWP	$DS \times T$ [see ²]		ns
NF6	NAND_ALE setup time	tALS	$(AS + DS) \times T - 0.49$ [see ^{3,2}]		ns
NF7	NAND_ALE hold time	tALH	$(DH \times T - 0.42)$ [see ²]		ns
NF8	Data setup time	tDS	$DS \times T - 0.26$ [see ²]		ns
NF9	Data hold time	tDH	$DH \times T - 1.37$ [see ²]		ns
NF10	Write cycle time	tWC	$(DS + DH) \times T$ [see ²]		ns
NF11	NAND_WE_B hold time	tWH	$DH \times T$ [see ²]		ns
NF12	Ready to NAND_RE_B low	tRR ⁴	$(AS + 2) \times T$ [see ^{3,2}]	—	ns
NF13	NAND_RE_B pulse width	tRP	$DS \times T$ [see ²]		ns
NF14	READ cycle time	tRC	$(DS + DH) \times T$ [see ²]		ns
NF15	NAND_RE_B high hold time	tREH	$DH \times T$ [see ²]		ns

Electrical Characteristics

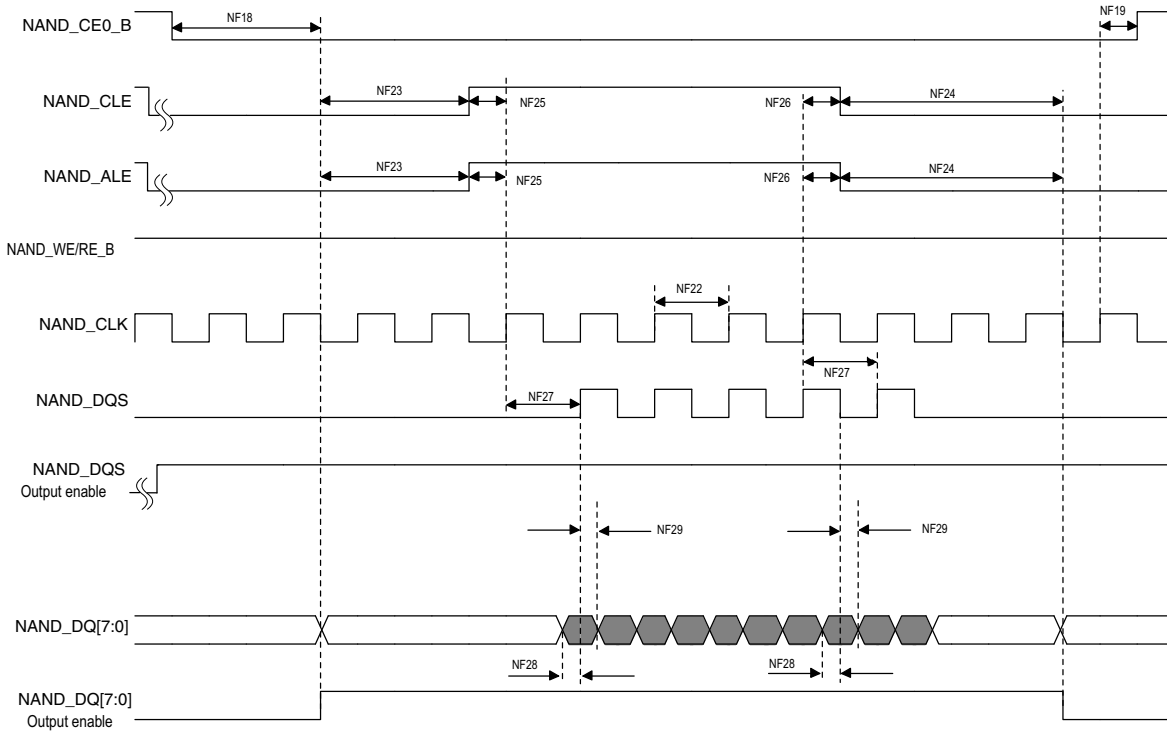


Figure 36. Source Synchronous Mode Data Write Timing Diagram

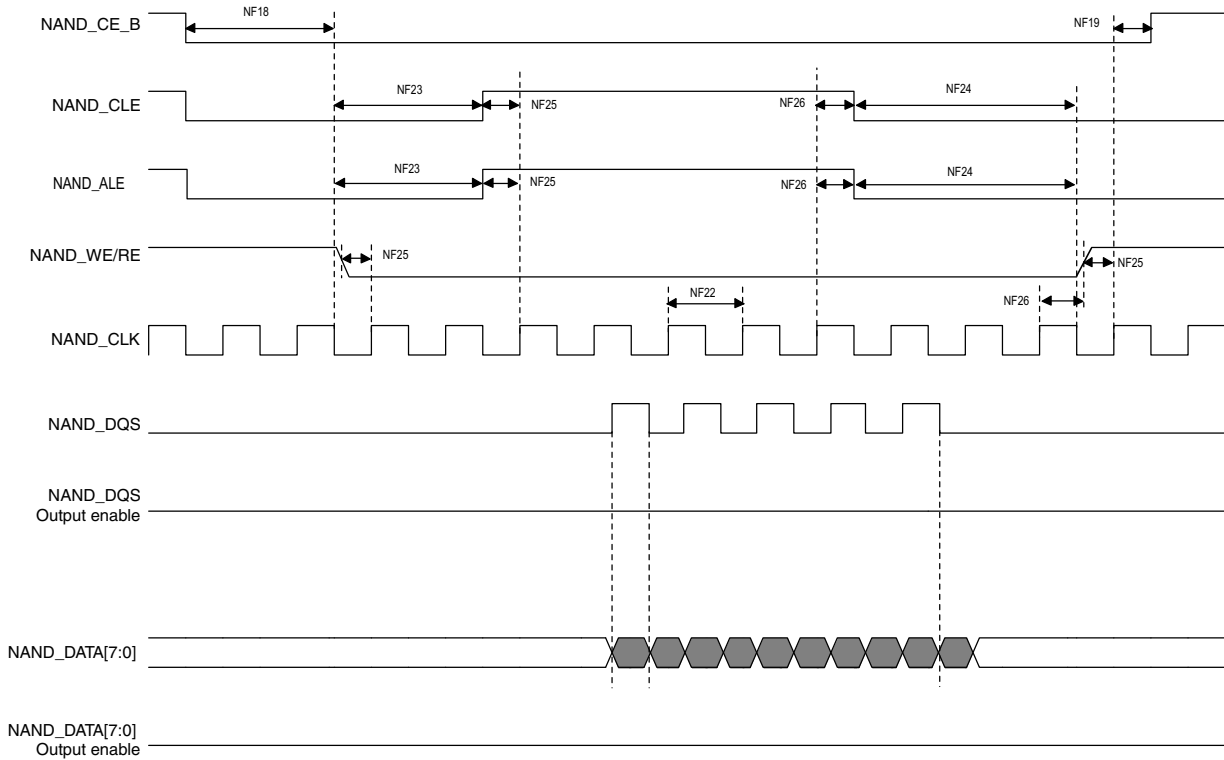


Figure 37. Source Synchronous Mode Data Read Timing Diagram

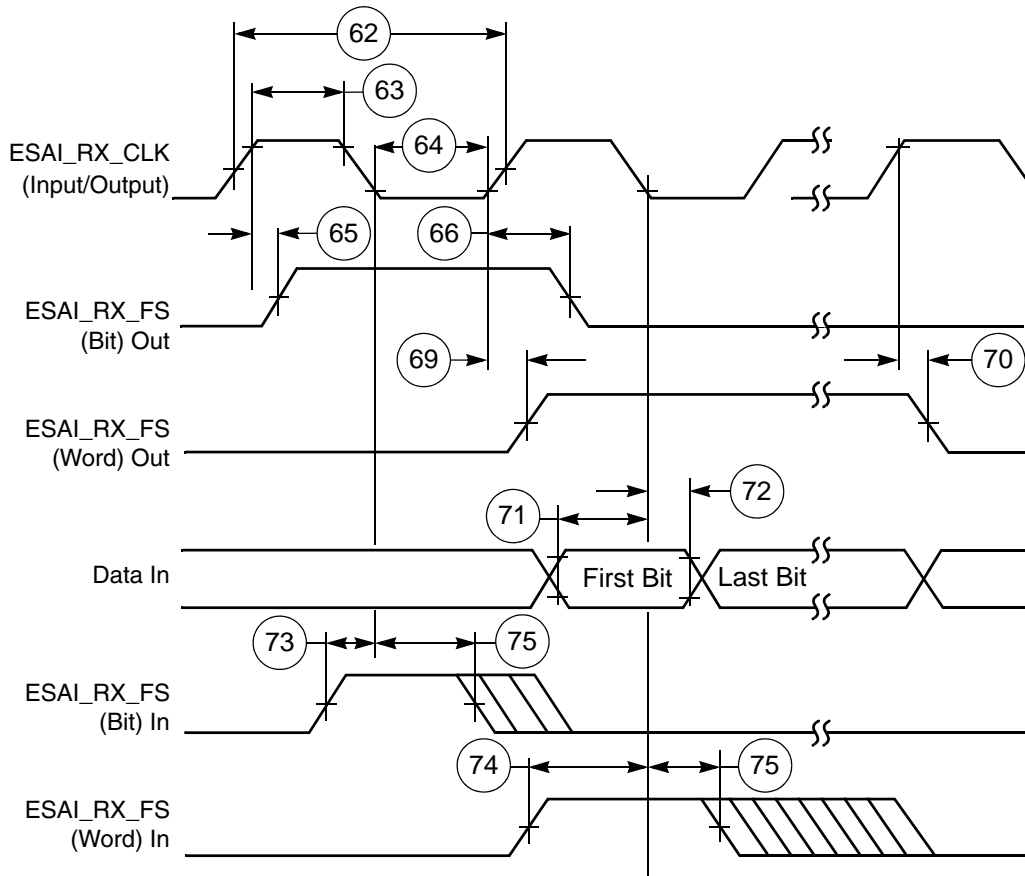


Figure 44. ESAI Receiver Timing

4.11.5.3 RGMII Signal Switching Specifications

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

Table 62. RGMII Signal Switching Specifications¹

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	-100	900	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 delay of greater than 1.2 ns and less than 1.7 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 T_{cyc} of the lowest speed transitioned between.

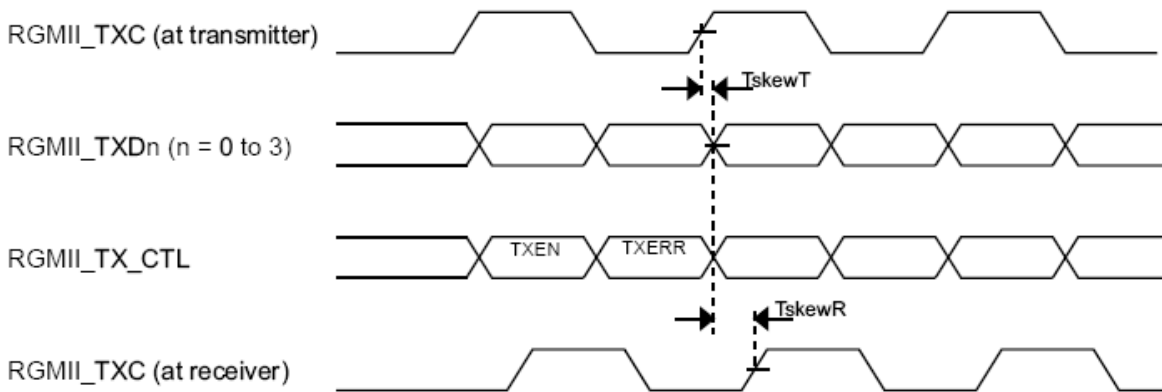


Figure 53. RGMII Transmit Signal Timing Diagram Original

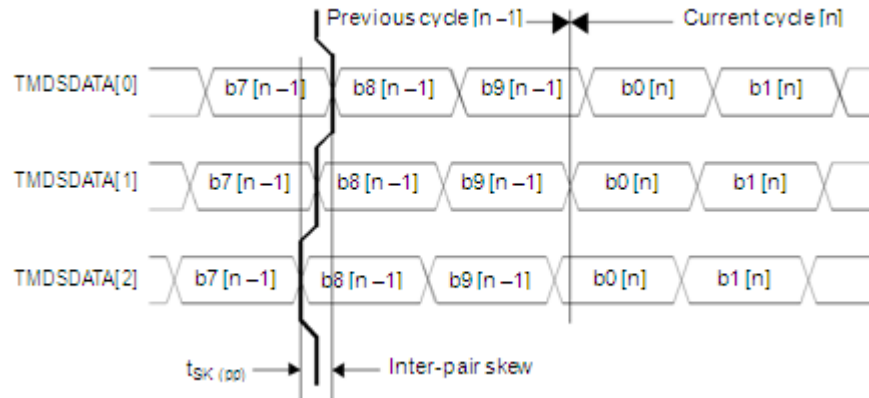


Figure 62. Inter-Pair Skew Definition

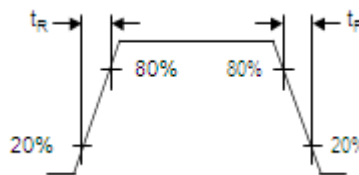


Figure 63. TMDs Output Signals Rise and Fall Time Definition

Table 64. Switching Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
TMDs Drivers Specifications						
—	Maximum serial data rate	—	—	—	3.4	Gbps
$F_{TMDsCLK}^F$	TMDsCLK frequency	On TMDsCLKP/N outputs	25	—	340	MHz
$P_{TMDsCLK}^P$	TMDsCLK period	RL = 50 Ω See Figure 59.	2.94	—	40	ns
t_{CDC}^t	TMDsCLK duty cycle	$t_{CDC} = t_{CPH} / P_{TMDsCLK}$ RL = 50 Ω See Figure 59.	40	50	60	%
t_{CPH}^t	TMDsCLK high time	RL = 50 Ω See Figure 59.	4	5	6	UI
t_{CPL}^t	TMDsCLK low time	RL = 50 Ω See Figure 59.	4	5	6	UI
—	TMDsCLK jitter ¹	RL = 50 Ω	—	—	0.25	UI
$t_{SK(p)}^t$	Intra-pair (pulse) skew	RL = 50 Ω See Figure 61.	—	—	0.15	UI
$t_{SK(pp)}^t$	Inter-pair skew	RL = 50 Ω See Figure 62.	—	—	1	UI
t_R^t	Differential output signal rise time	20–80% RL = 50 Ω See Figure 63.	75	—	0.4 UI	ps

4.11.10.1 IPU Sensor Interface Signal Mapping

The IPU supports a number of sensor input formats. Table 66 defines the mapping of the Sensor Interface Pins used for various supported interface formats.

Table 66. 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 2 cycles	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]
IPU2_CSIX_DATA_05	—	—	—	—	—	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]
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 IPU2_CSIX stands for IPU2_CSI1 or IPU2_CSI2.

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 `ipp_pin_1`–`ipp_pin_7` are general purpose synchronous pins, that can be used to provide HSYNC, VSYNC, DRDY or any else 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 counter system can be found in the IPU chapter of the i.MX 6DualPlus/6QuadPlus reference manual (IMX6DQPRM).

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 `ipp_d0_cs` and `ipp_d1_cs` pins are dedicated to provide chip select signals to two displays.
- The `ipp_pin_11`–`ipp_pin_17` 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 on the bus, a new internal start (local start point) is generated. The signal 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. The display access can be whole number of DI clock (`Tdick`) 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.

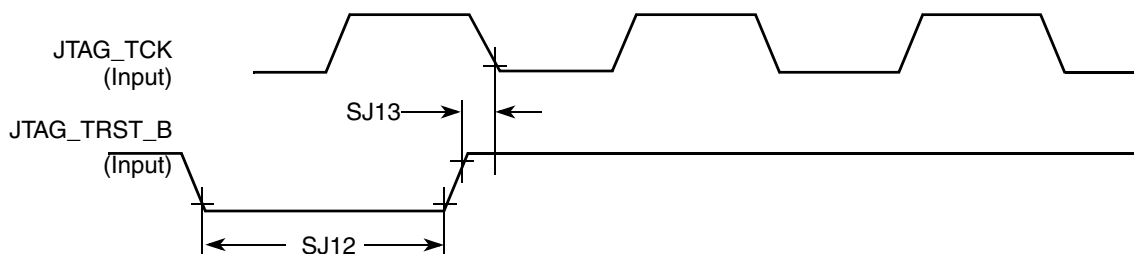


Figure 93. JTAG_TRST_B Timing Diagram

Table 83. JTAG Timing

ID	Parameter ^{1,2}	All Frequencies		Unit
		Min	Max	
SJ0	JTAG_TCK frequency of operation $1/(3 \times T_{DC})^1$	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

4.11.19 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 84 and Figure 94 and Figure 95 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.

4.11.20.2 SSI Receiver Timing with Internal Clock

Figure 97 depicts the SSI receiver internal clock timing and Table 87 lists the timing parameters for the receiver timing with the internal clock.

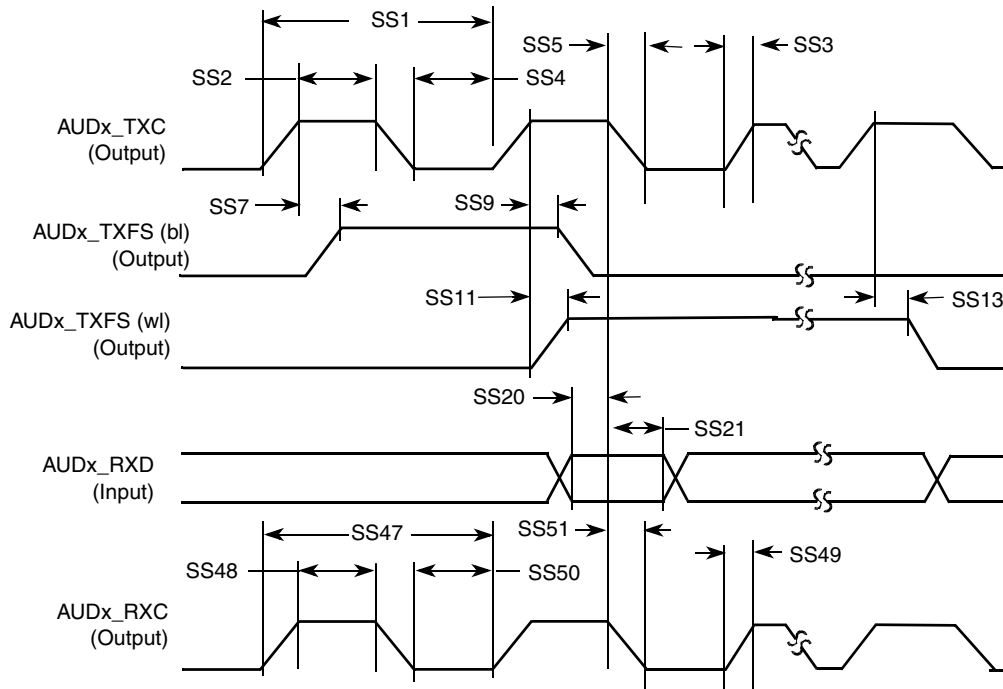


Figure 97. SSI Receiver Internal Clock Timing Diagram

Table 87. 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

4.11.21 UART I/O Configuration and Timing Parameters

4.11.21.1 UART RS-232 I/O Configuration in Different Modes

The i.MX 6DualPlus/6QuadPlus UART interfaces can serve both as DTE or DCE device. This can be configured by the DCEDTE control bit (default 0 – DCE mode). [Table 90](#) shows the UART I/O configuration based on the enabled mode.

Table 90. 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

4.11.21.2.3 UART IrDA Mode Timing

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

UART IrDA Mode Transmitter

Figure 102 depicts the UART IrDA mode transmit timing, with 8 data bit/1 stop bit format. Table 93 lists the transmit timing characteristics.

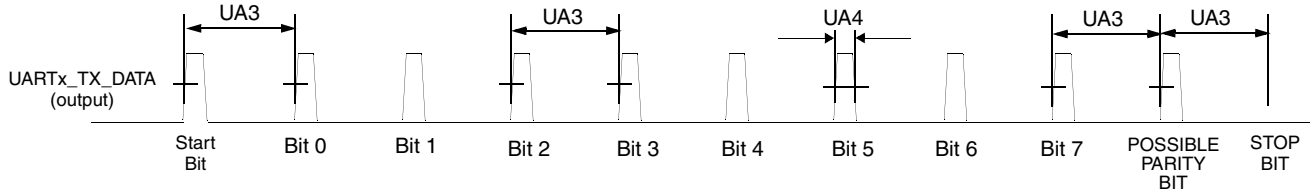


Figure 102. UART IrDA Mode Transmit Timing Diagram

Table 93. 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).

UART IrDA Mode Receiver

Figure 103 depicts the UART IrDA mode receive timing, with 8 data bit/1 stop bit format. Table 94 lists the receive timing characteristics.

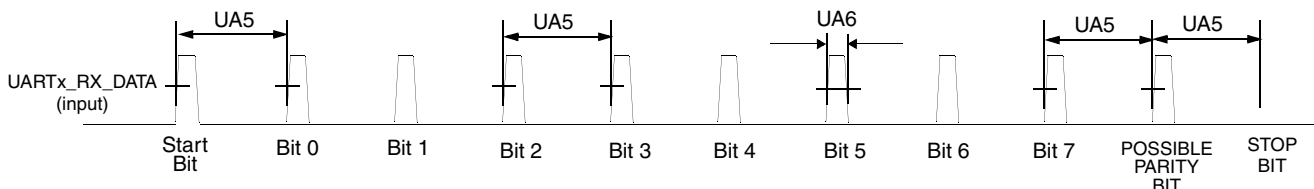


Figure 103. UART IrDA Mode Receive Timing Diagram

Table 94. 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 μ s	$(5/16) \times (1/F_{baud_rate})$	—

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.

Table 100. 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 (Signal Name)	Input/Output	Value ²
EIM_DA10	M22	NVCC_EIM2	GPIO	ALT0	EIM_AD10	Input	PU (100K)
EIM_DA11	M20	NVCC_EIM2	GPIO	ALT0	EIM_AD11	Input	PU (100K)
EIM_DA12	M24	NVCC_EIM2	GPIO	ALT0	EIM_AD12	Input	PU (100K)
EIM_DA13	M23	NVCC_EIM2	GPIO	ALT0	EIM_AD13	Input	PU (100K)
EIM_DA14	N23	NVCC_EIM2	GPIO	ALT0	EIM_AD14	Input	PU (100K)
EIM_DA15	N24	NVCC_EIM2	GPIO	ALT0	EIM_AD15	Input	PU (100K)
EIM_EB0	K21	NVCC_EIM2	GPIO	ALT0	EIM_EB0_B	Output	1
EIM_EB1	K23	NVCC_EIM2	GPIO	ALT0	EIM_EB1_B	Output	1
EIM_EB2	E22	NVCC_EIM0	GPIO	ALT5	GPIO2_IO30	Input	PU (100K)
EIM_EB3	F23	NVCC_EIM0	GPIO	ALT5	GPIO2_IO31	Input	PU (100K)
EIM_LBA	K22	NVCC_EIM1	GPIO	ALT0	EIM_LBA_B	Output	1
EIM_OE	J24	NVCC_EIM1	GPIO	ALT0	EIM_OE	Output	1
EIM_RW	K20	NVCC_EIM1	GPIO	ALT0	EIM_RW	Output	1
EIM_WAIT	M25	NVCC_EIM2	GPIO	ALT0	EIM_WAIT	Input	PU (100K)
ENET_CRSDV	U21	NVCC_ENET	GPIO	ALT5	GPIO1_IO25	Input	PU (100K)
ENET_MDC	V20	NVCC_ENET	GPIO	ALT5	GPIO1_IO31	Input	PU (100K)
ENET_MDIO	V23	NVCC_ENET	GPIO	ALT5	GPIO1_IO22	Input	PU (100K)
ENET_REF_CLK ³	V22	NVCC_ENET	GPIO	ALT5	GPIO1_IO23	Input	PU (100K)
ENET_RX_ER	W23	NVCC_ENET	GPIO	ALT5	GPIO1_IO24	Input	PU (100K)
ENET_RXD0	W21	NVCC_ENET	GPIO	ALT5	GPIO1_IO27	Input	PU (100K)
ENET_RXD1	W22	NVCC_ENET	GPIO	ALT5	GPIO1_IO26	Input	PU (100K)
ENET_TX_EN	V21	NVCC_ENET	GPIO	ALT5	GPIO1_IO28	Input	PU (100K)
ENET_TXD0	U20	NVCC_ENET	GPIO	ALT5	GPIO1_IO30	Input	PU (100K)
ENET_TXD1	W20	NVCC_ENET	GPIO	ALT5	GPIO1_IO29	Input	PU (100K)
GPIO_0	T5	NVCC_GPIO	GPIO	ALT5	GPIO1_IO00	Input	PD (100K)
GPIO_1	T4	NVCC_GPIO	GPIO	ALT5	GPIO1_IO01	Input	PU (100K)
GPIO_16	R2	NVCC_GPIO	GPIO	ALT5	GPIO7_IO11	Input	PU (100K)
GPIO_17	R1	NVCC_GPIO	GPIO	ALT5	GPIO7_IO12	Input	PU (100K)
GPIO_18	P6	NVCC_GPIO	GPIO	ALT5	GPIO7_IO13	Input	PU (100K)
GPIO_19	P5	NVCC_GPIO	GPIO	ALT5	GPIO4_IO05	Input	PU (100K)
GPIO_2	T1	NVCC_GPIO	GPIO	ALT5	GPIO1_IO02	Input	PU (100K)
GPIO_3	R7	NVCC_GPIO	GPIO	ALT5	GPIO1_IO03	Input	PU (100K)
GPIO_4	R6	NVCC_GPIO	GPIO	ALT5	GPIO1_IO04	Input	PU (100K)
GPIO_5	R4	NVCC_GPIO	GPIO	ALT5	GPIO1_IO05	Input	PU (100K)
GPIO_6	T3	NVCC_GPIO	GPIO	ALT5	GPIO1_IO06	Input	PU (100K)
GPIO_7	R3	NVCC_GPIO	GPIO	ALT5	GPIO1_IO07	Input	PU (100K)

Table 100. 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 (Signal Name)	Input/Output	Value ²
GPIO_8	R5	NVCC_GPIO	GPIO	ALT5	GPIO1_IO08	Input	PU (100K)
GPIO_9	T2	NVCC_GPIO	GPIO	ALT5	GPIO1_IO09	Input	PU (100K)
HDMI_CLKM	J5	HDMI_VPH	—	—	HDMI_TX_CLK_N	—	—
HDMI_CLKP	J6	HDMI_VPH	—	—	HDMI_TX_CLK_P	—	—
HDMI_D0M	K5	HDMI_VPH	—	—	HDMI_TX_DATA0_N	—	—
HDMI_D0P	K6	HDMI_VPH	—	—	HDMI_TX_DATA0_P	—	—
HDMI_D1M	J3	HDMI_VPH	—	—	HDMI_TX_DATA1_N	—	—
HDMI_D1P	J4	HDMI_VPH	—	—	HDMI_TX_DATA1_P	—	—
HDMI_D2M	K3	HDMI_VPH	—	—	HDMI_TX_DATA2_N	—	—
HDMI_D2P	K4	HDMI_VPH	—	—	HDMI_TX_DATA2_P	—	—
HDMI_HPD	K1	HDMI_VPH	—	—	HDMI_TX_HPD	—	—
JTAG_MOD	H6	NVCC_JTAG	GPIO	ALT0	JTAG_MODE	Input	PU (100K)
JTAG_TCK	H5	NVCC_JTAG	GPIO	ALT0	JTAG_TCK	Input	PU (47K)
JTAG_TDI	G5	NVCC_JTAG	GPIO	ALT0	JTAG_TDI	Input	PU (47K)
JTAG_TDO	G6	NVCC_JTAG	GPIO	ALT0	JTAG_TDO	Output	Keeper
JTAG_TMS	C3	NVCC_JTAG	GPIO	ALT0	JTAG_TMS	Input	PU (47K)
JTAG_TRSTB	C2	NVCC_JTAG	GPIO	ALT0	JTAG_TRST_B	Input	PU (47K)
KEY_COL0	W5	NVCC_GPIO	GPIO	ALT5	GPIO4_IO06	Input	PU (100K)
KEY_COL1	U7	NVCC_GPIO	GPIO	ALT5	GPIO4_IO08	Input	PU (100K)
KEY_COL2	W6	NVCC_GPIO	GPIO	ALT5	GPIO4_IO10	Input	PU (100K)
KEY_COL3	U5	NVCC_GPIO	GPIO	ALT5	GPIO4_IO12	Input	PU (100K)
KEY_COL4	T6	NVCC_GPIO	GPIO	ALT5	GPIO4_IO14	Input	PU (100K)
KEY_ROW0	V6	NVCC_GPIO	GPIO	ALT5	GPIO4_IO07	Input	PU (100K)
KEY_ROW1	U6	NVCC_GPIO	GPIO	ALT5	GPIO4_IO09	Input	PU (100K)
KEY_ROW2	W4	NVCC_GPIO	GPIO	ALT5	GPIO4_IO11	Input	PU (100K)
KEY_ROW3	T7	NVCC_GPIO	GPIO	ALT5	GPIO4_IO13	Input	PU (100K)
KEY_ROW4	V5	NVCC_GPIO	GPIO	ALT5	GPIO4_IO15	Input	PD (100K)
LVDS0_CLK_N	V4	NVCC_LVDS_2P5	LVDS	—	LVDS0_CLK_N	—	—
LVDS0_CLK_P	V3	NVCC_LVDS_2P5	LVDS	ALT0	LVDS0_CLK_P	Input	Keeper
LVDS0_TX0_N	U2	NVCC_LVDS_2P5	LVDS	—	LVDS0_TX0_N	—	—
LVDS0_TX0_P	U1	NVCC_LVDS_2P5	LVDS	ALT0	LVDS0_TX0_P	Input	Keeper
LVDS0_TX1_N	U4	NVCC_LVDS_2P5	LVDS	—	LVDS0_TX1_N	—	—
LVDS0_TX1_P	U3	NVCC_LVDS_2P5	LVDS	ALT0	LVDS0_TX1_P	Input	Keeper
LVDS0_TX2_N	V2	NVCC_LVDS_2P5	LVDS	—	LVDS0_TX2_N	—	—
LVDS0_TX2_P	V1	NVCC_LVDS_2P5	LVDS	ALT0	LVDS0_TX2_P	Input	Keeper
LVDS0_TX3_N	W2	NVCC_LVDS_2P5	LVDS	—	LVDS0_TX3_N	—	—