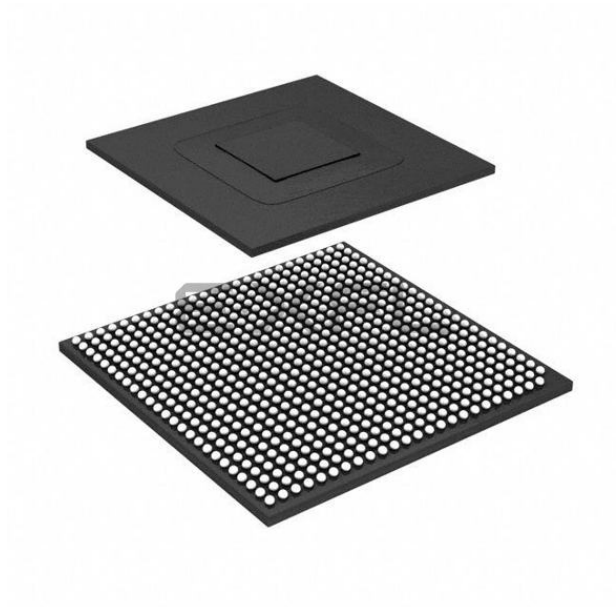

Welcome to E-XFL.COM

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 ~ 125°C (TJ)
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/mcimx6u6avm08acr

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 4 MHz. This is a higher max baud rate relative to the 1.875 MHz, which is stated by the TIA/EIA-232-F standard and the i.MX31 UART modules. • 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.

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 CLK2_P/CLK2_N	Two general purpose differential high speed clock Input/outputs are provided. Any or both of them could be used: • 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. • 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) See the i.MX 6Solo/6DualLite reference manual for details on the respective clock trees. The clock inputs/outputs are LVDS differential pairs compatible with TIA/EIA-644 standard, the maximal frequency range supported is 0...600 MHz. 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. See LVDS pad electrical specification for further details. After initialization, the CLKx inputs/outputs could be disabled (if not used). If unused any or both of the CLKx_N/P pairs may be left floating.
RTC_XTALI/RTC_XTALO	If the user wishes to configure RTC_XTALI and RTC_XTALO as an RTC oscillator, a 32.768 kHz crystal, (≤100 kΩ ESR, 10 pF load) should be connected between RTC_XTALI and RTC_XTALO. Keep in mind 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 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 RTC_XTALI and RTC_XTALO should bias to approximately 0.5 V. If it is desired to feed an external low frequency clock into RTC_XTALI the RTC_XTALO pin should be left floating or driven with a complimentary signal. The logic level of this forcing clock should not exceed VDD_SNVS_CAP level and the frequency should be <100 kHz under typical conditions. In case when high accuracy real time clock are not required system may use internal low frequency ring oscillator. It is recommended to connect RTC_XTALI to GND and keep RTC_XTALO floating.
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. The crystal must be rated for a maximum drive level of 250 μW. An ESR (equivalent series resistance) of typical 80 Ω is recommended. Freescale BSP (board support package) software requires 24 MHz on XTALI/XTALO. 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 is floated. 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.

4.1.3 Operating Ranges

Table 9 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 9. Operating Ranges

Parameter Description	Symbol	Min	Typ	Max[1]	Unit	Comment
Run mode: LDO enabled	VDDARM_IN	1.275[2]	—	1.5	V	LDO Output Set Point (VDDARM_CAP) = 1.150 V minimum for operation up to 792 MHz.
		1.175[2]	—	1.5	V	LDO Output Set Point (VDDARM_CAP) = 1.05 V minimum for operation up to 396 MHz.
	VDDSOC_IN[3]	1.275[2,4]	—	1.5	V	VPU </= 328 MHz, VDDSOC and VDDPU LDO outputs (VDDSOC_CAP and VDDPU_CAP) = 1.225 V maximum and 1.15 V minimum.
Run mode: LDO bypassed	VDDARM_IN	1.150	—	1.3	V	LDO bypassed for operation up to 792 MHz
		1.05	—	1.3	V	LDO bypassed for operation up to 396 MHz
	VDDSOC_IN[3]	1.15[4]	—	1.225	V	LDO bypassed for operation VPU </= 328 MHz
Standby/DSM mode	VDDARM_IN	0.9	—	1.3	V	Refer to Table 13, "Stop Mode Current and Power Consumption," on page 29.
	VDDSOC_IN	0.9	—	1.225	V	
VDDHIGH internal regulator	VDDHIGH_IN	2.8	—	3.3	V	Must match the range of voltges that the rechargeable backup battery supports.
Backup battery supply range	VDD_SNVS_IN[5]	2.9	—	3.3	V	Should be supplied from the same supply as VDDHIGH_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, DDR3-U
		1.425	1.5	1.575	V	DDR3
		1.283	1.35	1.45	V	DDR3_L
Supply for RGMII I/O power group[6]	NVCC_RGMII	1.15	—	2.625	V	1.15 V – 1.30 V in HSIC 1.2 V mode 1.43 V – 1.58 V in RMGII 1.5 V mode 1.70 V – 1.90 V in RMGII 1.8 V mode 2.25 V – 2.625 V in RMGII 2.5 V mode

Table 9. Operating Ranges (continued)

Parameter Description	Symbol	Min	Typ	Max[1]	Unit	Comment
GPIO supply voltages[6]	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_LVDS2P5[7] 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	1.225	V	
	PCIE_VPH	2.325	2.5	2.75	V	
	PCIE_VPTX	1.023	1.1	1.225	V	
Junction temperature	T_J	-40	—	125	°C	Refer to Automotive qualification report for details.

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

2 VDDARM_IN and VDDSOC_IN must be 125 mV higher than the LDO Output Set Point for correct regulator supply voltage.

3 VDDSOC_CAP and VDDPU_CAP must be equal.

4 VDDSOC and VDDPU output voltage must be set to this rule: VDDARM - VDDSOC/PU < 100 mV.

5 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).

6 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 Pullup or Pulldown resistor applied to limit any floating gate current.

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

Table 10 shows on-chip LDO regulators that can supply on-chip loads.

Table 10. On-Chip LDOs[1] and their On-Chip Loads

Voltage Source	Load	Comment
VDDHIGH_CAP	NVCC_LVDS2P5	Board-level connection to VDDHIGH_CAP
	NVCC_MIPI	
	HDMI_VPH	
	PCIE_VPH	

Table 10. On-Chip LDOs[1] and their On-Chip Loads (continued)

Voltage Source	Load	Comment
VDDSOC_CAP	HDMI_VP	Board-level connection to VDDSOC_CAP[2 3]
	PCIE_VP	
	PCIE_VPTX	

1 On-chip LDOs are designed to supply i.MX6 loads and must not be used to supply external loads.

2 VDDARM_CAP should not exceed VDDSOC_CAP by more than 50 mV.

3 There is no requirement for VDDSOC_CAP to track within 50 mV as long as it is greater than VDDARM_CAP.

4.1.4 External Clock Sources

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

The CKIL 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 substitute the CKIL, in case accuracy is not important.

The system clock input XTAL 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 11 shows the interface frequency requirements.

Table 11. External Input Clock Frequency

Parameter Description	Symbol	Min	Typ	Max	Unit
CKIL Oscillator[1,2]	f_{ckil}	—	32.768[3]/32.0	—	kHz
XTAL 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.

4.5 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 VDDHIGH_IN such as the oscillator consumes power from VDDHIGH_IN when that supply is available and transitions to the back up battery when VDDHIGH_IN is lost.

In addition, if the clock monitor determines that the OSC32K is not present, then the source of the 32 K will automatically switch to a crude internal ring oscillator. The frequency range of this block is approximately 10–45 kHz. It highly depends on the process, voltage, and temperature.

The OSC32k runs from VDD_SNVS_CAP supply, which comes from the VDDHIGH_IN/VDD_SNVS_IN. The target battery is a ~3 V coin cell. Proper choice of coin cell type is necessary for chosen VDDHIGH_IN range. Appropriate series resistor (Rs) must be used when connecting the coin cell. Rs depends on the charge current limit that depends on the chosen coin cell. For example, for Panasonic ML621:

- Average Discharge Voltage is 2.5 V
- Maximum Charge Current is 0.6 mA

For a charge voltage of 3.2 V, Rs = (3.2-2.5)/0.6 m = 1.17 k

Table 23. OSC32K Main Characteristics

	Min	Typ	Max	Comments
Fosc		32.768 KHz		This frequency is nominal and determined mainly by the crystal selected. 32.0 K would 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.

Table 41. EIM Signal Cross Reference (continued)

Reference Manual EIM Chapter Nomenclature	Data Sheet Nomenclature, Reference Manual External Signals and Pin Multiplexing Chapter, and IOMUXC Controller Chapter Nomenclature
ADV_B	EIM_LBA
ADDR	EIM_A[25:16], EIM_DA[15:0]
ADDR/M_DATA	EIM_DAx (Addr/Data muxed mode)
DATA	EIM_NFC_D (Data bus shared with NAND Flash) EIM_Dx (dedicated data bus)
WAIT_B	EIM_WAIT

4.9.3.2 EIM Interface Pads Allocation

EIM supports 32-bit, 16-bit and 8-bit devices operating in address/data separate or multiplexed modes. Table 42 provides EIM interface pads allocation in different modes.

Table 42. 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
A[15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]	WEIM_DA_A [15:0]
A[25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_A [25:16]	WEIM_D [9:0]
D[7:0], EIM_EB0	WEIM_D [7:0]	—		—	WEIM_D [7:0]	—	WEIM_D [7:0]	WEIM_DA_A [7:0]	WEIM_DA_A [7:0]
D[15:8], EIM_EB1	—	WEIM_D [15:8]		—	WEIM_D [15:8]	—	WEIM_D [15:8]	WEIM_DA_A [15:8]	WEIM_DA_A [15:8]
D[23:16], EIM_EB2	—	—	WEIM_D [24:16]	—	—	WEIM_D [23:16]	EIM_D [23:16]	—	WEIM_D [7:0]
D[31:24], EIM_EB3	—	—		WEIM_D [31:24]	—	WEIM_D [31:24]	EIM_D [31:24]	—	WEIM_D [15:8]

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

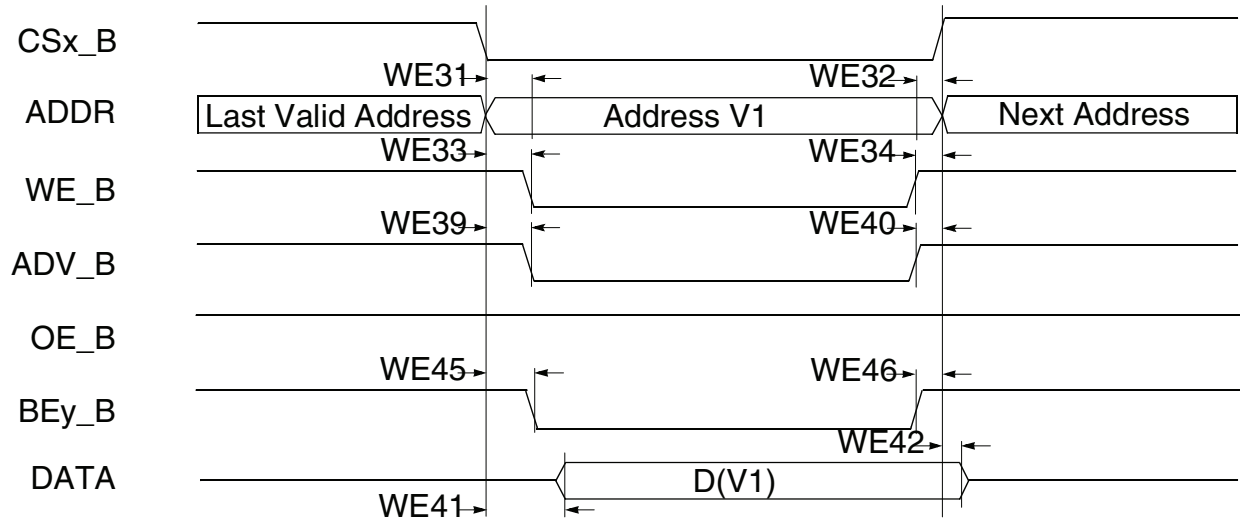

Figure 20. Asynchronous Memory Write Access

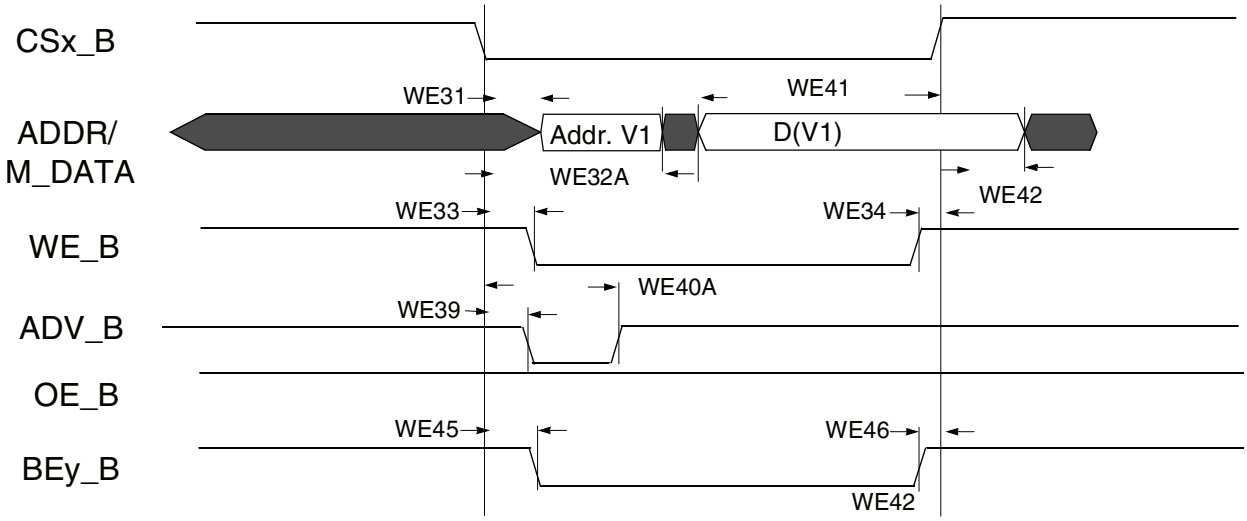

Figure 21. Asynchronous A/D Muxed Write Access

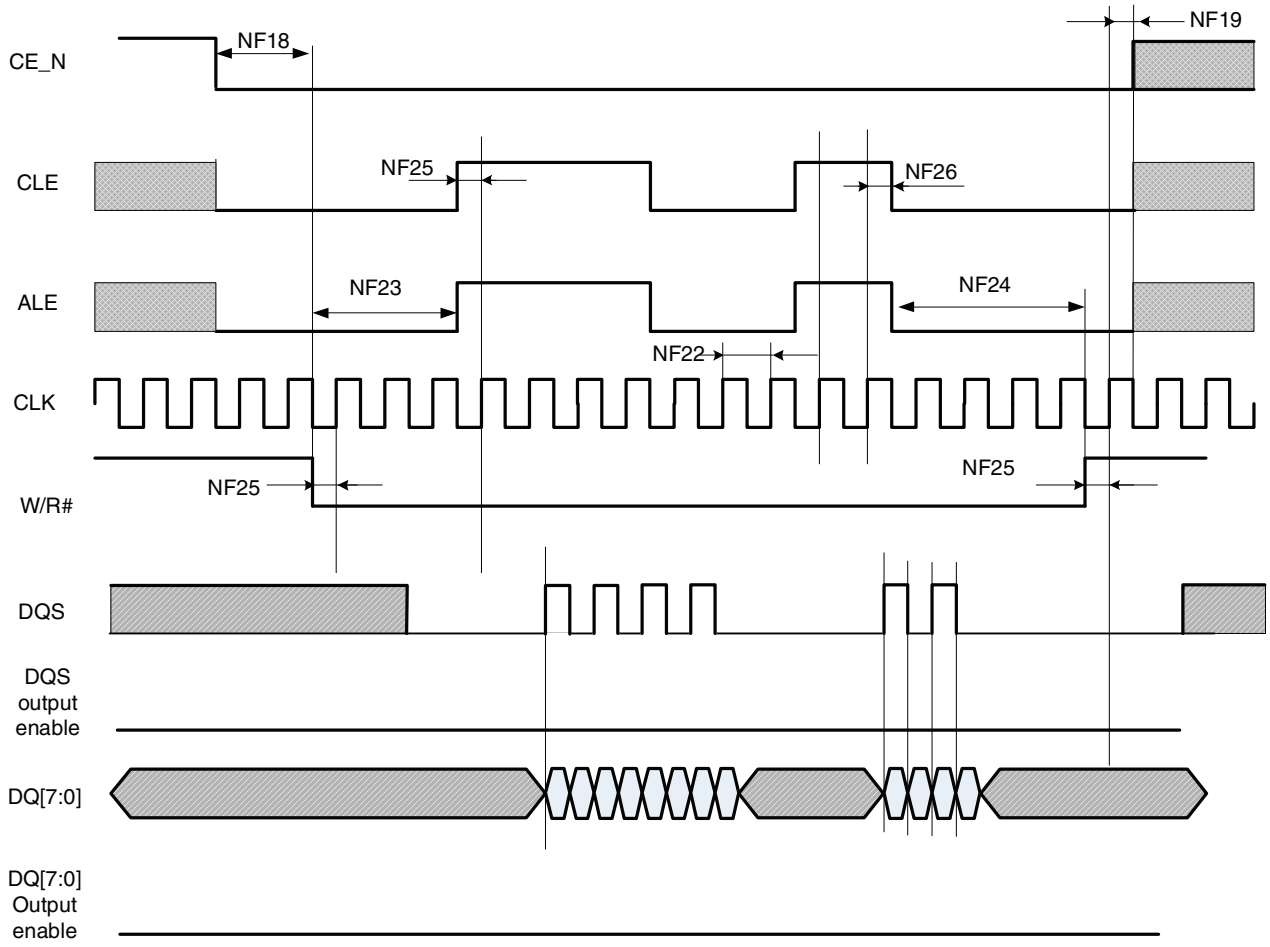

Figure 36. Source Synchronous Mode Data Read Timing Diagram

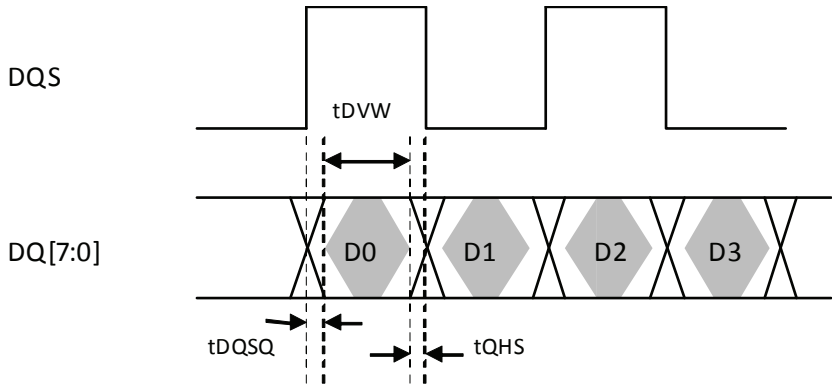

Figure 37. DQS/DQ Read Valid Window

Table 52. Source Synchronous Mode Timing Parameters[1]

ID	Parameter	Symbol	Timing T = GPMI Clock Cycle		Unit
			Min.	Max.	
NF18	CE# access time	tCE	CE_DELAY x tCK	—	ns
NF19	CE# hold time	tCH	0.5 x tCK	—	ns
NF20	Command/address DQ setup time	tCAS	0.5 x tCK	—	ns
NF21	Command/address DQ hold time	tCAH	0.5 x tCK	—	ns
NF22	clock period	tCK	5	--	ns
NF23	preamble delay	tPRE	PRE_DELAY x tCK	—	ns
NF24	postamble delay	tPOST	POST_DELAY x tCK	—	ns
NF25	CLE and ALE setup time	tCALS	0.5 x tCK	—	ns
NF26	CLE and ALE hold time	tCALH	0.5 x tCK	—	ns
NF27	Data input to first DQS latching transition	tDQSS	tCK	—	ns

1 GPMI's Sync Mode output timing could be controlled by module's internal registers, say HW_GPMI_TIMING2_CE_DELAY, HW_GPMI_TIMING_PREAMBLE_DELAY, and HW_GPMI_TIMING2_POST_DELAY. This AC timing depends on these registers' settings. In the above table, we use CE_DELAY/PRE_DELAY/POST_DELAY to represent each of these settings.

For DDR Source sync mode, Figure 37 shows the timing diagram of DQS/DQ read valid window. The typical value of tDQSQ is 0.85ns (max) and 1ns (max) for tQHS at 200MB/s. GPMI will sample DQ[7:0] at both rising and falling edge of an delayed 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.

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.

Figure 48 shows MII transmit signal timings. Table 61 describes the timing parameters (M5–M8) shown in the figure.

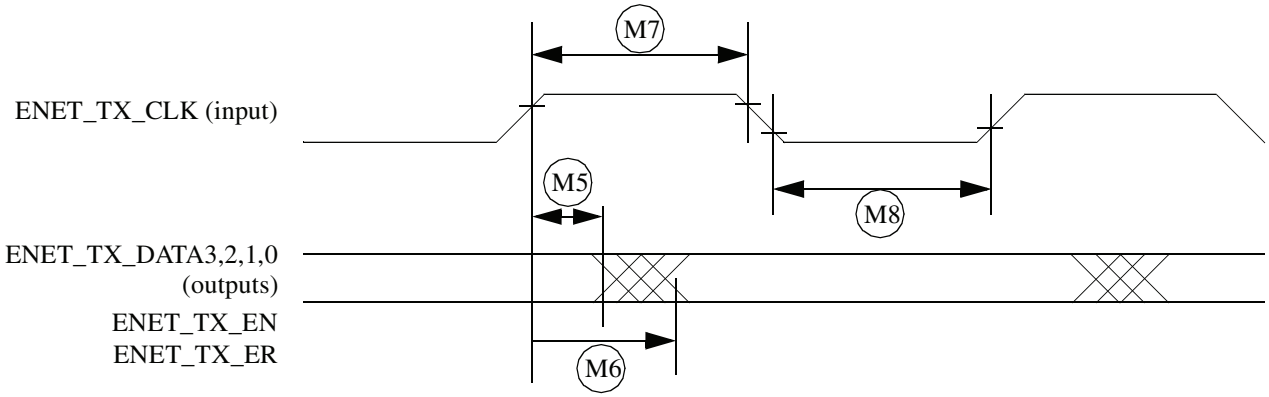

Figure 48. MII Transmit Signal Timing Diagram

Table 61. 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 49 shows MII asynchronous input timings. Table 62 describes the timing parameter (M9) shown in the figure.

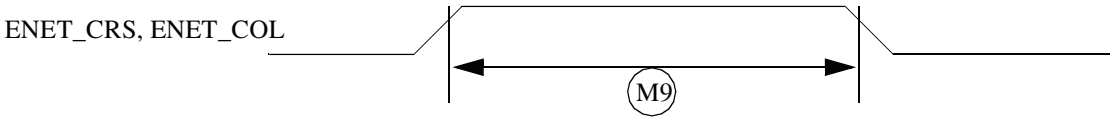

Figure 49. MII Async Inputs Timing Diagram

Table 62. 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 50 shows MII asynchronous input timings. Table 63 describes the timing parameters (M10–M15) shown in the figure.

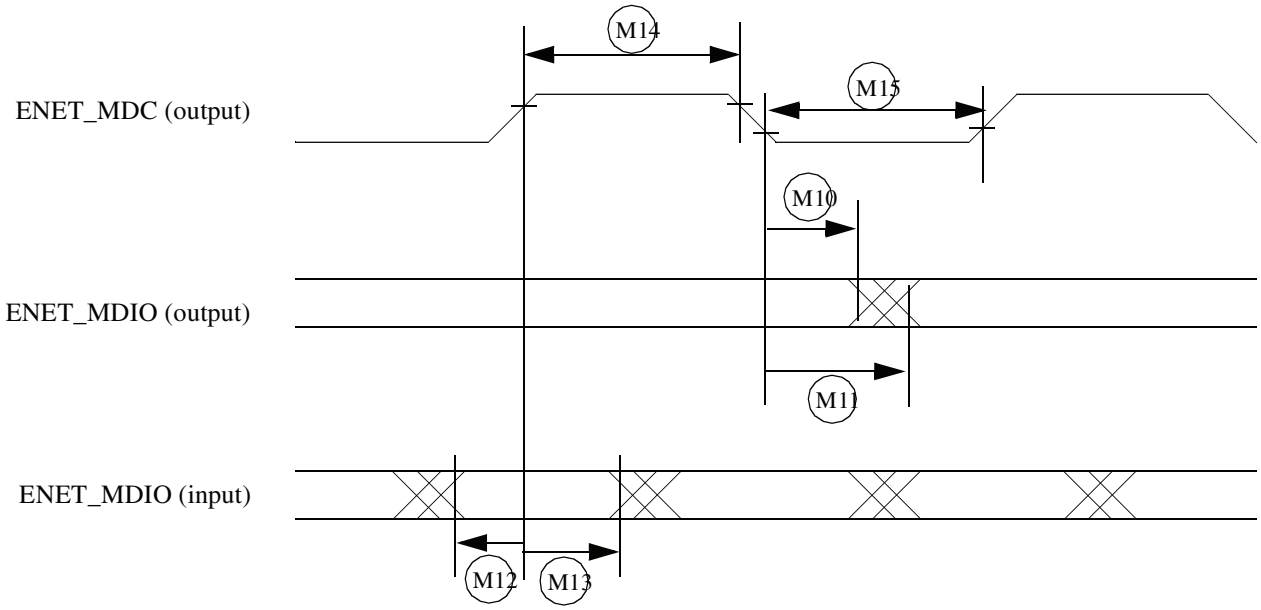

Figure 50. MII Serial Management Channel Timing Diagram

Table 63. 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

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 CRS_DV in RMII. Other signals under RMII mode include ENET_TX_EN, ENET0_TXD[1:0], ENET0_RXD[1:0] and ENET_RX_ER.

Table 68. I²C Module Timing Parameters (continued)

ID	Parameter	Standard Mode		Fast Mode		Unit
		Min	Max	Min	Max	
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 I2DAT and I2CLK signals	—	1000	$20 + 0.1C_b$[4]	300	ns
IC11	Fall time of both I2DAT and I2CLK 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 I2DAT signal in order to bridge the undefined region of the falling edge of I2CLK.

2 The maximum hold time has only to be met if the device does not stretch the LOW period (ID no IC5) of the I2CLK 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 I2CLK signal. If such a device does stretch the LOW period of the I2CLK signal, it must output the next data bit to the I2DAT line max_rise_time (IC9) + data_setup_time (IC7) = 1000 + 250 = 1250 ns (according to the Standard-mode I²C-bus specification) before the I2CLK line is released.

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

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.

4.11.10.3 Electrical Characteristics

Figure 66 depicts the sensor interface timing. SENSB_MCLK signal described here is not generated by the IPU. Table 70 lists the sensor interface timing characteristics.

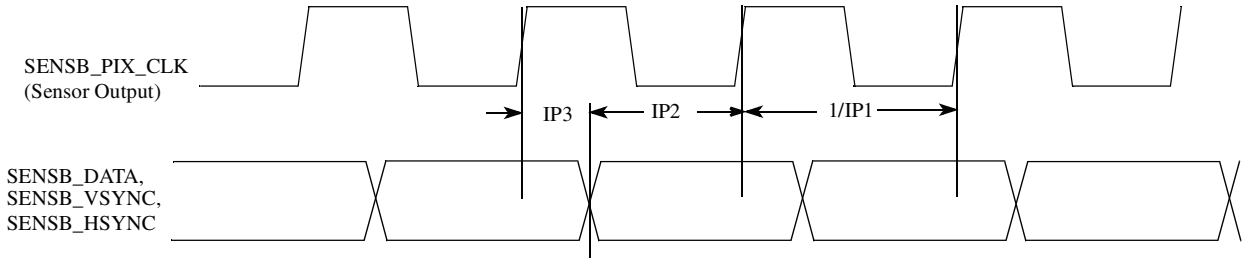

Figure 66. Sensor Interface Timing Diagram

Table 70. 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 71 defines the mapping of the Display Interface Pins used during various supported video interface formats.

NOTE

Table 71 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 table for details.

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.

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 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/VSYCN) 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 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 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.

Table 72. Synchronous Display Interface Timing Characteristics (Pixel Level) (continued)

ID	Parameter	Symbol	Value	Description	Unit
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). Defined by DISP_CLK counter	ns
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.

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

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 maximal accuracy of UP/DOWN edge of controls is:

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

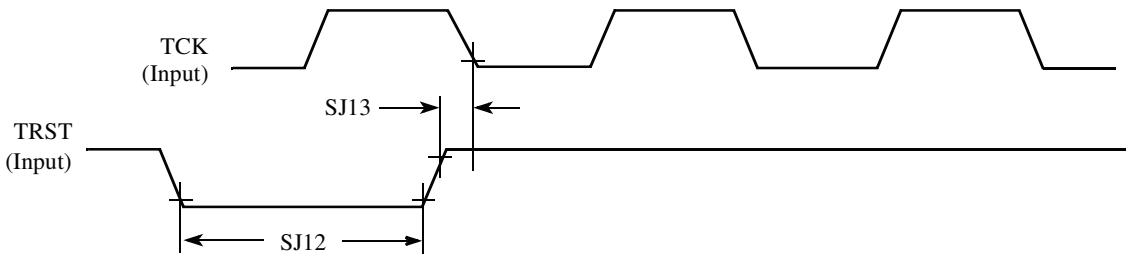

Figure 92. $\overline{\text{TRST}}$ Timing Diagram

Table 84. JTAG Timing

ID	Parameter[1,2]	All Frequencies		Unit
		Min	Max	
SJ0	TCK frequency of operation $1/(3 \bullet T_{DC})$[1]	0.001	22	MHz
SJ1	TCK cycle time in crystal mode	45	—	ns
SJ2	TCK clock pulse width measured at V_M[2]	22.5	—	ns
SJ3	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	TCK low to output data valid	—	40	ns
SJ7	TCK low to output high impedance	—	40	ns
SJ8	TMS, TDI data set-up time	5	—	ns
SJ9	TMS, TDI data hold time	25	—	ns
SJ10	TCK low to TDO data valid	—	44	ns
SJ11	TCK low to TDO high impedance	—	44	ns
SJ12	$\overline{\text{TRST}}$ assert time	100	—	ns
SJ13	$\overline{\text{TRST}}$ set-up time to 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 85 and Figure 93 and Figure 94 show SPDIF timing parameters for the Sony/Philips Digital Interconnect Format (SPDIF), including the timing of the modulating Rx clock (SRCK) for SPDIF in Rx mode and the timing of the modulating Tx clock (STCLK) for SPDIF in Tx mode.

4.11.19.2 SSI Receiver Timing with Internal Clock

Figure 96 depicts the SSI receiver internal clock timing and Table 88 lists the timing parameters for the receiver timing with the internal clock.

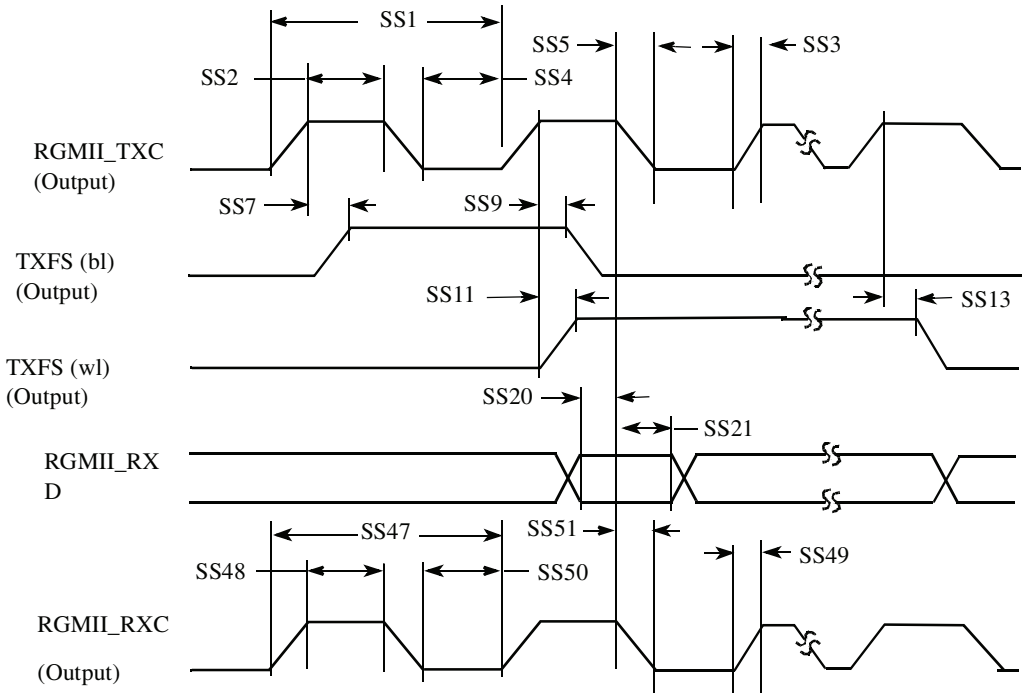

Figure 96. SSI Receiver Internal Clock Timing Diagram

Table 88. SSI Receiver Timing with Internal Clock

ID	Parameter	Min	Max	Unit
Internal Clock Operation				
SS1	(Tx/Rx) CK clock period	81.4	—	ns
SS2	(Tx/Rx) CK clock high period	36.0	—	ns
SS3	(Tx/Rx) CK clock rise time	—	6.0	ns
SS4	(Tx/Rx) CK clock low period	36.0	—	ns
SS5	(Tx/Rx) CK clock fall time	—	6.0	ns
SS7	(Rx) CK high to FS (bl) high	—	15.0	ns
SS9	(Rx) CK high to FS (bl) low	—	15.0	ns
SS11	(Rx) CK high to FS (wl) high	—	15.0	ns
SS13	(Rx) CK high to FS (wl) low	—	15.0	ns
SS20	SRXD setup time before (Rx) CK low	10.0	—	ns
SS21	SRXD hold time after (Rx) CK low	0.0	—	ns
Oversampling Clock Operation				

4.11.21.2 Receive Timing

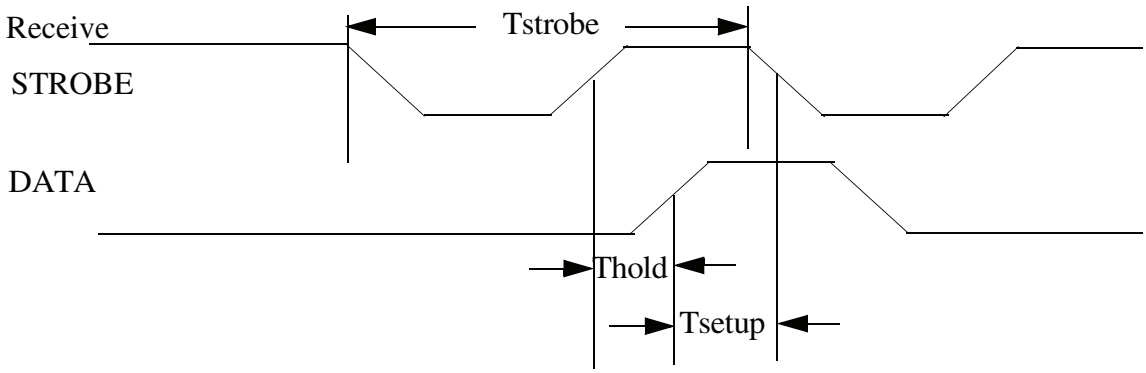

Figure 104. USB HSIC Receive Waveform

Table 97. 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

Table 100. 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	
VDD_FA	B5	
ZQPAD	AE17	
NC	C14	
NC	G12	