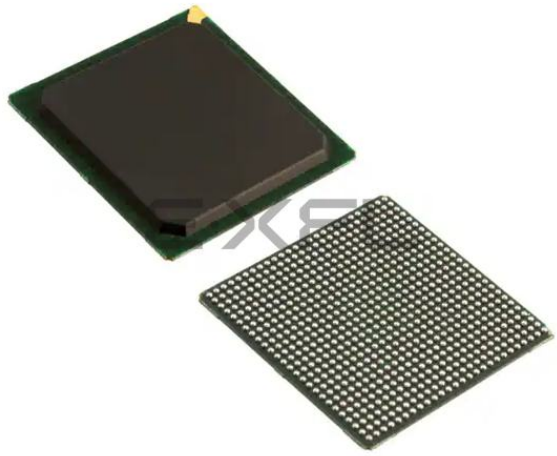

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Embedded - System On Chip (SoC): The Heart of Modern Embedded Systems

Embedded - System On Chip (SoC) refers to an integrated circuit that consolidates all the essential components of a computer system into a single chip. This includes a microprocessor, memory, and other peripherals, all packed into one compact and efficient package. SoCs are designed to provide a complete computing solution, optimizing both space and power consumption, making them ideal for a wide range of embedded applications.

What are Embedded - System On Chip (SoC)?

System On Chip (SoC) integrates multiple functions of a computer or electronic system onto a single chip. Unlike traditional multi-chip solutions, SoCs combine a central

Details	
Product Status	Active
Architecture	MCU, FPGA
Core Processor	ARM® Cortex®-M3
Flash Size	256KB
RAM Size	64KB
Peripherals	DDR, PCIe, SERDES
Connectivity	CANbus, Ethernet, I²C, SPI, UART/USART, USB
Speed	166MHz
Primary Attributes	FPGA - 60K Logic Modules
Operating Temperature	-40°C ~ 125°C (TJ)
Package / Case	676-BGA
Supplier Device Package	676-FBGA (27x27)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/m2s060ts-1fgg676t2

List of Figures

If the power consumption is higher than the device's maximum allowable power dissipation, a heat sink can be attached on top of the case, or the airflow inside the system must be increased.

4.3.3 Theta-JB

Junction-to-board thermal resistance (θ_{JB}) measures the ability of the package to dissipate heat from the surface of the chip to the PCB. As defined by the JEDEC (JESD-51) standard, the thermal resistance from junction to board uses an isothermal ring cold plate zone concept. The ring cold plate is simply a means to generate an isothermal boundary condition at the perimeter. The cold plate is mounted on a JEDEC standard board with a minimum distance of 5.0 mm away from the package edge.

4.3.4 Theta-JC

Junction-to-case thermal resistance (θ_{JC}) measures the ability of a device to dissipate heat from the surface of the chip to the top or bottom surface of the package. It is applicable for packages used with external heat sinks. Constant temperature is applied to the surface in consideration and acts as a boundary condition.

This only applies to situations where all or nearly all of the heat is dissipated through the surface in consideration.

5. Power Consumption

5.1 Quiescent Supply Current

Table 8 • **Quiescent Supply Current Characteristics**

Power Supplies/Blocks	Modes and Configurations		Notes
	Non-Flash*Freeze Mode	Flash*Freeze Mode	
FPGA Core	On	Off	–
VDD / SERDES_[01]_VDD	On	On	1
VPP / VPPNVM	On	On	–
MDDR_PLL_VDDA CCC_XX[01]_PLL_VDDA PLL0_PLL1_MDDR_VDDA FDDR_PLL_VDDA	0 V	0 V	–
SERDES_[01]_PLL_VDDA	0 V	0 V	3
SERDES_[01]_L[0123]_VDDAPLL / VDD_2V5	On	On	3
SERDES_[01]_L[0123]_VDDAIIO	On	On	3
VDDIx	On	On	2, 4
VREFx	On	On	–
MSSDDR CLK	32 kHz	32 kHz	–
RAM	On	Sleep state	–
HPMS Controller	50 MHz	50 MHz	–
50 MHz Oscillator (enable/disable)	Enabled	Disabled	–
1 MHz Oscillator (enable/disable)	Disabled	Disabled	–

Table 15 • **Timing Model Parameters (continued)**

Index	Parameter	Description	Speed Grade –1	Units	Notes
O	t_{DP}	Propagation Delay of SSTL2, Class I Transmitter on the MSIO Bank	2.283	ns	Refer to page 38 for more information
P	t_{DP}	Propagation Delay of LVCMOS 1.5 V Transmitter, Drive strength of 12mA, fast slew on the DDRIO Bank	3.703	ns	Refer to page 28 for more information

8. User I/O Characteristics

There are three types of I/Os supported in the IGLOO2 FPGA and SmartFusion2 SoC FPGA families: MSIO, MSIOD, and DDRIO I/O banks. The I/O standards supported by the different I/O banks is described in the “I/Os” section of the *UG0445: IGLOO2 FPGA and SmartFusion2 SoC FPGA Fabric User Guide*.

8.1 Input Buffer and AC Loading

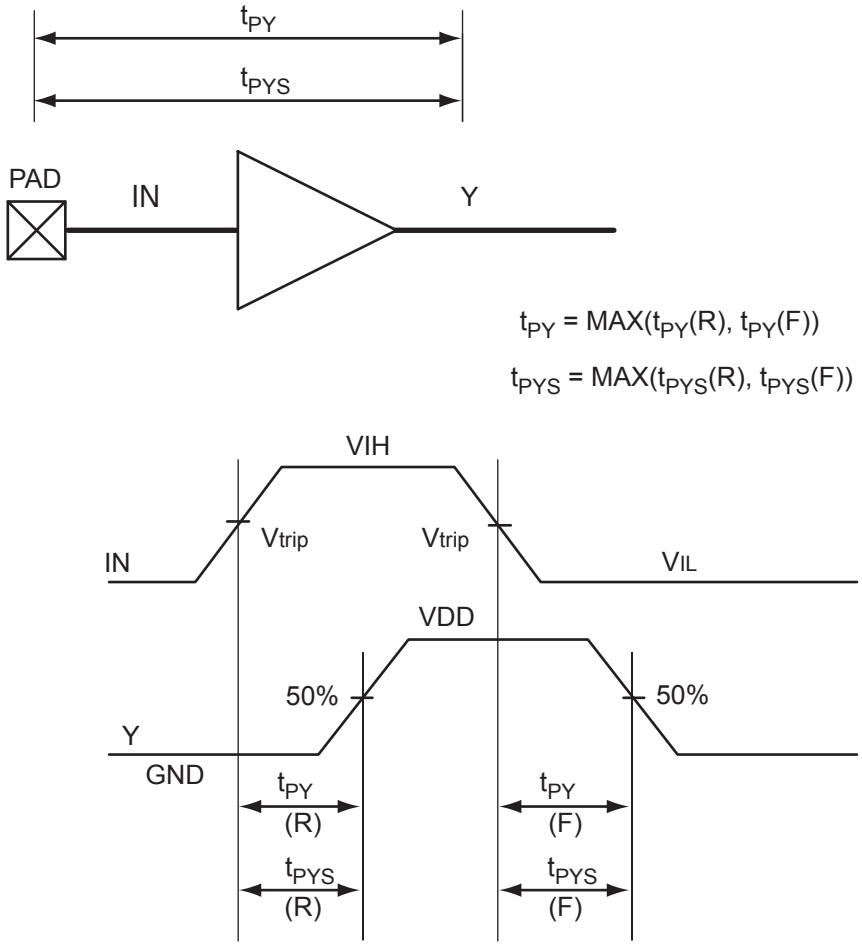

Figure 2 • **Input Buffer AC Loading**

8.5 Detailed I/O Characteristics

Table 18 • **Input Capacitance**

Symbol	Definition	Min	Max	Units
CIN	Input Capacitance	–	10	pF

Table 19 • **I/O Weak Pull-Up/Pull-Down Resistance Values for DDRIO, MSIO, and MSIOD Banks**
Minimum and Maximum Weak Pull-Up/Pull-Down Resistance Values at VOH/VOL Level

VDDI Domain	DDRIO I/O Bank				MSIO I/O Bank				MSIOD I/O Bank				
	$R_{(WEAK\ PULL\text{-}UP)}$ at VOH (Ω)		$R_{(WEAK\ PULL\text{-}DOWN)}$ at VOL (Ω)		$R_{(WEAK\ PULL\text{-}UP)}$ at VOH (Ω)		$R_{(WEAK\ PULL\text{-}DOWN)}$ at VOL (Ω)		$R_{(WEAK\ PULL\text{-}UP)}$ at VOH (Ω)		$R_{(WEAK\ PULL\text{-}DOWN)}$ at VOL (Ω)		Notes
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
3.3 V	N/A	N/A	N/A	N/A	9.9K	14.5K	9.98K	14.9K	N/A	N/A	N/A	N/A	
2.5 V	10K	15.1K	9.98K	15.3K	10K	15K	10.1K	15.6K	9.6K	14.1K	9.5K	13.9K	1,2
1.8 V	10.3K	16.2K	10.3K	16.6K	10.4K	16.2K	10.4K	17.3K	9.7K	14.7K	9.7K	14.5K	1,2
1.5 V	10.6K	17.2K	10.6K	17.9K	10.7K	17.3K	10.8K	18.9K	9.9K	15.3K	9.8K	15K	1,2
1.2 V	11.1K	19.3K	11.2K	20.9K	11.3K	19.7K	11.5K	22.7K	10.3K	16.7K	10K	16.2K	1,2

Notes:

1. *R(WEAK PULL-DOWN) = (VOLspec)/I(WEAK PULL-DOWN MAX)*
2. *R(WEAK PULL-UP) = (VDDImax - VOHspec)/I(WEAK PULL-UP MIN)*

Table 20 • **Schmitt Trigger Input Hysteresis**
Hysteresis Voltage Value for Schmitt Trigger Mode Input Buffers

Input Buffer Configuration	Hysteresis Value (Typical, unless otherwise noted)
3.3 V LVTTL / LVCMOS / PCI / PCI-X	0.05 × VDDI (Worst-case)
2.5 V LVCMOS	0.05 × VDDI (Worst-case)
1.8 V LVCMOS	0.1 × VDDI (Worst-case)
1.5 V LVCMOS	60 mV
1.2 V LVCMOS	20 mV

8.6 Single-Ended I/O Standards

8.6.1 Low Voltage Complementary Metal Oxide Semiconductor (LVCMOS)

LVCMOS is a widely used switching standard implemented in CMOS transistors. This standard is defined by JEDEC (JESD 8-5). The LVCMOS standards supported in IGLOO2 FPGAs and SmartFusion2 SoC FPGAs are: LVCMOS12, LVCMOS15, LVCMOS18, LVCMOS25, and LVCMOS33.

8.6.2 3.3 V LVCMOS/LVTTL

LVCMOS 3.3 V or Low-Voltage Transistor-Transistor Logic (LVTTL) is a general standard for 3.3 V applications.

8.6.2.1 Minimum and Maximum AC/DC Input and Output Levels Specification

Table 21 • LVTTL/LVCMOS 3.3 V DC Voltage Specification (Applicable to MSIO I/O Bank Only)

Symbol	Parameters	Conditions	Min	Typ	Max	Units	Notes
LVTTL/LVCMOS 3.3 V Recommended DC Operating Conditions							
VDDI	Supply voltage		3.15	3.3	3.45	V	–
LVTTL/LVCMOS 3.3 V DC Input Voltage Specification							
VIH (DC)	DC input logic High		2.0	–	3.45	V	–
VIL (DC)	DC input logic Low		–0.3	–	0.8	V	–
IIH (DC)	Input current High		–	–	10	µA	–
IIL (DC)	Input current Low		–	–	10	µA	–
LVCMOS 3.3 V DC Output Voltage Specification							
VOH	DC output logic High		2.4	–	–	V	*
VOL	DC output logic Low		–	–	0.4	V	*
LVTTL 3.3 V DC Output Voltage Specification							
VOH	DC output logic High		2.4	–	–	V	–
VOL	DC output logic Low		–	–	0.4	V	–

*Note: * The VOH/VOL test points selected ensure compliance with LVCMOS 3.3 V JESD8-B requirements.*

Table 22 • LVTTL/LVCMOS 3.3 V Maximum Switching Speeds (Applicable to MSIO I/O Bank Only)

Symbol	Parameters	Conditions	Min	Typ	Max	Units
LVTTL/LVCMOS 3.3 V Maximum Switching Speed						
Dmax	Maximum data rate (for MSIO I/O Bank)	AC loading: 17 pF load, maximum drive/slew	–	–	540	Mbps

Table 23 • LVTTL/LVCMOS 3.3 V AC Test Parameter Specifications (Applicable to MSIO Bank Only)

LVTTL/LVCMOS 3.3 V AC Test Parameter Specifications						
Symbol	**Parameters**	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Vtrip	Measuring/trip point for data path		–	1.4	–	V
Rent	Resistance for enable path (t_{ZH}, t_{ZL}, t_{HZ}, t_{LZ})		–	2k	–	Ω
Cent	Capacitive loading for enable path (t_{ZH}, t_{ZL}, t_{HZ}, t_{LZ})		–	5	–	pF
Cload	Capacitive loading for data path (t_{DP})		–	5	–	pF

Table 30 • LVCMOS 2.5 V Transmitter Drive Strength Specifications

Output Drive Selection			VOH (V) Min	VOL (V) Max	IOH (at VOH) mA	IOL (at VOL) mA
MSIO I/O Bank	MSIOD I/O Bank	DDRIO I/O Bank (With Software Default Fixed Code)				
2 mA	2 mA	2 mA	1.7	0.7	2	2
4 mA	4 mA	4 mA	1.7	0.7	4	4
6 mA	6 mA	6 mA	1.7	0.7	6	6
8 mA	8 mA	8 mA	1.7	0.7	8	8
12 mA	12 mA	12 mA	1.7	0.7	12	12
16 mA	N/A	16 mA	1.7	0.7	16	16

Note: For board design considerations, output slew rates extraction, detailed output buffer resistances and I/V Curve use the corresponding IBIS models located at: http://www.microsemi.com/products/fpga-soc/design-resources/ibis-models.

8.6.3.2 AC Switching Characteristics

AC Switching Characteristics for Receiver (Input Buffers)

Table 31 • LVCMOS 2.5 V AC Switching Characteristics for Receiver (Input Buffers)
Worst-case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 2.375 V

	On-Die Termination (ODT) in Ω	Speed Grade –1		Units
		t_{PY}	t_{PYS}	
LVCMOS 2.5 V (for DDRIO I/O Bank)	None	1.903	2.021	ns
LVCMOS 2.5 V (for MSIO I/O Bank)	None	2.689	2.698	ns
LVCMOS 2.5 V (for MSIOD I/O Bank)	None	2.447	2.46	ns

AC Switching Characteristics for Transmitter (Output and Tristate Buffers)

Table 32 • LVCMOS 2.5 V AC Switching Characteristics for Transmitter (Output and Tristate Buffers)
Worst-case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 2.375 V

Output Drive Selection	Slew Control	Speed Grade –1					Units
		t_{DP}	t_{ZL}	t_{ZH}	t_{HZ}	t_{LZ}	
LVCMOS 2.5 V (for DDRIO I/O Bank with Fixed Code)							
2 mA	slow	3.967	3.664	3.986	4.172	3.811	ns
	medium	3.625	3.38	3.647	3.882	3.458	ns
	medium_fast	3.485	3.259	3.507	3.747	3.327	ns
	fast	3.458	3.253	3.48	3.74	3.31	ns
4 mA	slow	3.371	2.942	3.362	5.148	4.71	ns
	medium	3.063	2.701	3.059	4.874	4.381	ns
	medium_fast	2.925	2.566	2.92	4.686	4.248	ns
	fast	2.91	2.559	2.905	4.683	4.238	ns

Table 32 • LVCMOS 2.5 V AC Switching Characteristics for Transmitter (Output and Tristate Buffers)
Worst-case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 2.375 V (continued)

Output Drive Selection	Slew Control	Speed Grade –1					Units
		t_{DP}	t_{ZL}	t_{ZH}	t_{HZ}	t_{LZ}	
6 mA	slow	3.189	2.716	3.169	5.56	5.092	ns
	medium	2.886	2.473	2.876	5.273	4.752	ns
	medium_fast	2.749	2.355	2.738	5.127	4.167	ns
	fast	2.731	2.345	2.72	5.115	4.6	ns
8 mA	slow	3.132	2.646	3.109	5.686	5.207	ns
	medium	2.832	2.407	2.82	5.402	4.864	ns
	medium_fast	2.698	2.292	2.685	5.262	4.732	ns
	fast	2.684	2.282	2.671	5.252	4.724	ns
12 mA	slow	3.013	2.504	2.984	5.918	5.416	ns
	medium	2.72	2.284	2.707	5.657	5.074	ns
	medium_fast	2.592	2.176	2.578	5.537	4.949	ns
	fast	2.58	2.166	2.566	5.529	4.946	ns
16 mA	slow	2.936	2.415	2.902	6.136	5.577	ns
	medium	2.66	2.206	2.645	5.901	5.261	ns
	medium_fast	2.536	2.102	2.519	5.815	5.142	ns
	fast	2.523	2.093	2.506	5.81	5.137	ns
LVCMOS 2.5 V (for MSIO I/O Bank)							
2 mA	slow	3.933	4.352	4.22	2.358	3.838	ns
4 mA	slow	2.905	3.423	3.508	4.681	5.262	ns
6 mA	slow	2.687	2.995	3.155	5.561	5.73	ns
8 mA	slow	2.594	2.877	3.07	6.602	6.248	ns
12 mA	slow	2.623	2.732	2.944	6.974	6.478	ns
16 mA	slow	2.717	2.617	2.84	7.455	6.824	ns
LVCMOS 2.5 V (for MSIOD I/O Bank)							
2 mA	slow	2.403	2.922	2.89	5.397	5.202	ns
4 mA	slow	1.998	2.446	2.468	5.936	5.665	ns
6 mA	slow	1.861	2.329	2.375	6.391	6.068	ns
8 mA	slow	1.781	2.145	2.208	6.884	6.44	ns
12 mA	slow	1.804	2.039	2.108	7.23	6.685	ns

Table 49 • LVCMOS 1.2 V Transmitter Drive Strength Specifications

Output Drive Selection			VOH (V)	VOL (V)	IOH (at VOH) mA	IOL (at VOL) mA
MSIO I/O Bank	MSIOD I/O Bank	DDRIO I/O Bank (with Fixed Code)	Min	Max		
2 mA	2 mA	2 mA	VDDI × 0.75	VDDI × 0.25	2	2
4 mA	4 mA	4 mA	VDDI × 0.75	VDDI × 0.25	4	4
N/A	N/A	6 mA	VDDI × 0.75	VDDI × 0.25	6	6

8.6.6.2 AC Switching Characteristics

AC Switching Characteristics for Receiver (Input Buffers)

Table 50 • LVCMOS 1.2 V AC Switching Characteristics for Receiver (Input Buffers)
Worst-Case Automotive Grade 2 Conditions: T_J=125°C, VDD=1.14 V, VDDI= 1.14 V

	ODT (On Die Termination) in Ω	Speed Grade –1		Units
		t_{PY}	t_{PYS}	
LVCMOS 1.2 V (for DDRIO I/O Bank with Fixed Codes)	None	2.539	2.556	ns
LVCMOS 1.2 V (for MSIO I/O Bank)	None	4.888	4.845	ns
	50	6.683	6.605	ns
	75	5.923	5.847	ns
	150	5.29	5.235	ns
LVCMOS 1.2 V (for MSIOD I/O Bank)	None	4.281	4.235	ns
	50	6.806	6.721	ns
	75	5.643	5.564	ns
	150	4.813	4.753	ns

AC Switching Characteristics for Transmitter (Output and Tristate Buffers)

Table 51 • LVCMOS 1.2 V AC Switching Characteristics for Transmitter (Output and Tristate Buffers)
Worst-Case Automotive Grade 2 Conditions: T_J=125°C, VDD=1.14 V, VDDI= 1.14 V

Output Drive Selection	Slew Control	Speed Grade –1					Units
		t_{DP}	t_{ZL}	t_{ZH}	t_{HZ}	t_{LZ}	
LVCMOS 1.2 V (for DDRIO I/O Bank with Fixed Code)							
2 mA	slow	6.938	5.599	6.948	7.568	6.612	ns
	medium	6.11	4.814	6.114	7.201	6.234	ns
	medium_fast	5.675	4.409	5.676	6.971	6.048	ns
	fast	5.633	4.379	5.634	6.958	6.037	ns
4 mA	slow	6.328	4.892	6.316	8.339	7.306	ns
	medium	5.538	4.192	5.521	7.961	6.923	ns
	medium_fast	5.119	3.832	5.097	7.76	6.741	ns
	fast	5.072	3.085	5.051	7.752	6.725	ns

8.8.2 B-LVDS

Bus LVDS (B-LVDS) specifications extend the existing LVDS standard to high-performance multipoint bus applications. Multidrop and multipoint bus configurations may contain any combination of drivers, receivers, and transceivers.

8.8.2.1 Minimum and Maximum AC/DC Input and Output Levels Specification

Table 89 • B-LVDS DC Voltage Specification

Symbols	Parameters	Conditions	Min	Typ	Max	Units
Bus-LVDS Recommended DC Operating Conditions						
VDDI	Supply voltage		2.375	2.5	2.625	V
Bus-LVDS DC Input Voltage Specification						
VI	DC input voltage		0	–	2.925	V
IIH (DC)	Input current High		–	–	10	µA
IIL (DC)	Input current Low		–	–	10	µA
Bus-LVDS DC Output Voltage Specification (for MSIO I/O Bank only)						
VOH	DC output logic High		1.25	1.425	1.6	V
VOL	DC output logic Low		0.9	1.075	1.25	V
Bus-LVDS Differential Voltage Specification						
VOD	Differential output voltage swing (for MSIO I/O Bank only)		65	–	460	mV
VOCM	Output common mode voltage (for MSIO I/O Bank only)		1.1	–	1.5	V
VICM	Input common mode voltage		0.05	–	2.4	V
VID	Input differential voltage		0.1	–	VDDI	V

Table 90 • B-LVDS AC Specifications

Symbols	Parameters	Conditions	Min	Typ	Max	Units
Bus-LVDS Maximum AC Switching Speed						
Dmax	Maximum data rate (for MSIO I/O Bank)	AC loading: 2 pF / 100 Ω differential load	–	–	450	Mbps
Bus-LVDS Impedance Specifications						
Rt	Termination resistance		–	27	–	Ω
Bus-LVDS AC Test Parameters Specifications						
Vtrip	Measuring/trip point for data path		–	Cross point	–	V
Rent	Resistance for enable path (t_{ZH}, t_{ZL}, t_{HZ}, t_{LZ})		–	2k	–	Ω
Cent	Capacitive loading for enable path (t_{ZH}, t_{ZL}, t_{HZ}, t_{LZ})		–	5	–	pF

8.8.2.2. AC Switching Characteristics

AC Switching Characteristics for Receiver (Input Buffers)

Table 91 • **B-LVDS AC Switching Characteristics for Receiver (Input Buffers)**
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 2.375 V

	On-Die Termination (ODT) in Ω	Speed Grade –1	Units
		t_{PY}	
Bus-LVDS (for MSIO I/O Bank)	None	3.011	ns
	100	3.006	ns
Bus-LVDS (for MSIOD I/O Bank)	None	2.722	ns
	100	2.725	ns

AC Switching Characteristics for Transmitter (Output and Tristate Buffers)

Table 92 • **B-LVDS AC *Switching Characteristics for Transmitter (Output and Tristate Buffers)***
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 2.375 V

	Speed Grade –1					Units
	t_{DP}	t_{ZL}	t_{ZH}	t_{HZ}	t_{LZ}	
Bus-LVDS (for MSIO I/O Bank)	2.78	2.632	2.617	2.448	2.436	ns

8.8.3 M-LVDS

M-LVDS specifications extend the existing LVDS standard to high-performance multipoint bus applications. Multidrop and multipoint bus configurations may contain any combination of drivers, receivers, and transceivers.

8.8.3.1 Minimum and Maximum Input and Output Levels

Table 93 • **M-LVDS DC Voltage Specification**

Symbols	Parameters	Conditions	Min	Typ	Max	Units	Notes
M-LVDS Recommended DC Operating Conditions							–
VDDI	Supply voltage		2.375	2.5	2.625	V	*
M-LVDS DC Input Voltage Specification							–
VI	DC input voltage		0	–	2.925	V	–
IIH (DC)	Input current High		–	–	10	µA	–
IIL (DC)	Input current Low		–	–	10	µA	–
M-LVDS DC Output Voltage Specification (for MSIO I/O Bank Only)							–
VOH	DC output logic High		1.25	1.425	1.6	V	–
VOL	DC output logic Low		0.9	1.075	1.25	V	–
M-LVDS Differential Voltage Specification							–
VOD	Differential output voltage Swing (for MSIO I/O Bank only)		300	–	650	mV	–
VOCM	Output common mode voltage (for MSIO I/O Bank only)		0.3	–	2.1	V	–
VICM	Input common mode voltage		0.3	–	1.2	V	–
VID	Input differential voltage		50	–	2400	mV	–
*Note: *Only M-LVDS TYPE I is supported*							

AC Switching Characteristics for Transmitter (Output and Tristate Buffers)

Table 104 • **RSDS AC Switching Characteristics for Transmitter (Output and Tristate Buffers)**
Worst-case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 2.375 V

	Speed Grade –1					Units
	t_{DP}	t_{ZL}	t_{ZH}	t_{HZ}	t_{LZ}	
RSDS (for MSIO I/O Bank)	2.256	2.484	2.472	2.111	2.096	ns
RSDS (for MSIOD I/O Bank)						
No pre-emphasis	1.661	1.648	1.645	1.675	1.665	ns
Min pre-emphasis	1.651	1.84	1.833	1.988	1.964	ns
Med pre-emphasis	1.577	1.868	1.859	2.019	1.993	ns
Max pre-emphasis	1.555	1.894	1.883	2.047	2.018	ns

8.8.6 LVPECL

Low-Voltage Positive Emitter-Coupled Logic (LVPECL) is another differential I/O standard. It requires that one data bit be carried through two signal lines. Similar to LVDS, two pins are needed. It also requires external resistor termination. IGLOO2 and SmartFusion2 SoC FPGAs support only LVPECL receivers and do not support LVPECL transmitters.

8.8.6.1 Minimum and Maximum Input and Output Levels

Table 105 • **LVPECL DC Voltage Specification (Applicable to MSIO I/O Banks Only)**

Symbols	Parameters	Conditions	Min	Typ	Max	Units
Recommended DC Operating Conditions						
VDDI	Supply voltage		3.15	3.3	3.45	V
LVPECL DC Input Voltage Specification						
VI	DC input voltage		0	–	3.45	V
LVPECL Differential Voltage Specification						
VICM	Input common mode voltage		0.3		2.8	V
VIDIFF	Input differential voltage		100	300	1,000	mV

Table 106 • **LVPECL Maximum AC Switching Speeds (Applicable to MSIO I/O Banks Only)**

Symbols	Parameters	Conditions	Min	Typ	Max	Units
LVPECL AC Specifications						
Fmax	Maximum data rate (for MSIO I/O Bank)		–	–	810	Mbps

8.8.6.2 AC Switching Characteristics

AC Switching Characteristics for Receiver (Input Buffers)

Table 107 • **LVPECL Receiver Characteristics**
Worst-case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V, VDDI = 3.15 V

	On-Die Termination (ODT) in Ω	t_{PY} Speed Grade –1	Units
LVPECL (for MSIO I/O Bank)	None	2.71	ns
	100	2.71	ns

Table 108 • Input Data Register Propagation Delays
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Parameter	Description	Measuring Nodes (from, to)*	Speed Grade –1	Units
t_{IBYP}	Bypass Delay of the Input Register	F,G	0.364	ns
t_{ICLKQ}	Clock-to-Q of the Input Register	E,G	0.165	ns
t_{ISUD}	Data Setup Time for the Input Register	A,E	0.369	ns
t_{IHD}	Data Hold Time for the Input Register	A,E	0	ns
t_{ISUE}	Enable Setup Time for the Input Register	B,E	0.475	ns
t_{IHE}	Enable Hold Time for the Input Register	B,E	0	ns
t_{ISUSL}	Synchronous Load Setup Time for the Input Register	D,E	0.475	ns
t_{IHSL}	Synchronous Load Hold Time for the Input Register	D,E	0	ns
t_{IALn2Q}	Asynchronous Clear-to-Q of the Input Register (ADn=1)	C,G	0.648	ns
	Asynchronous Preset-to-Q of the Input Register (ADn=0)	C,G	0.606	ns
$t_{IREMALn}$	Asynchronous Load Removal Time for the Input Register	C,E	0	ns
$t_{IRECALn}$	Asynchronous Load Recovery Time for the Input Register	C,E	0.076	ns
t_{IWALn}	Asynchronous Load Minimum Pulse Width for the Input Register	C,C	0.313	ns
$t_{ICKMPWH}$	Clock Minimum Pulse Width High for the Input Register	E,E	0.078	ns
$t_{ICKMPWL}$	Clock Minimum Pulse Width Low for the Input Register	E,E	0.164	ns

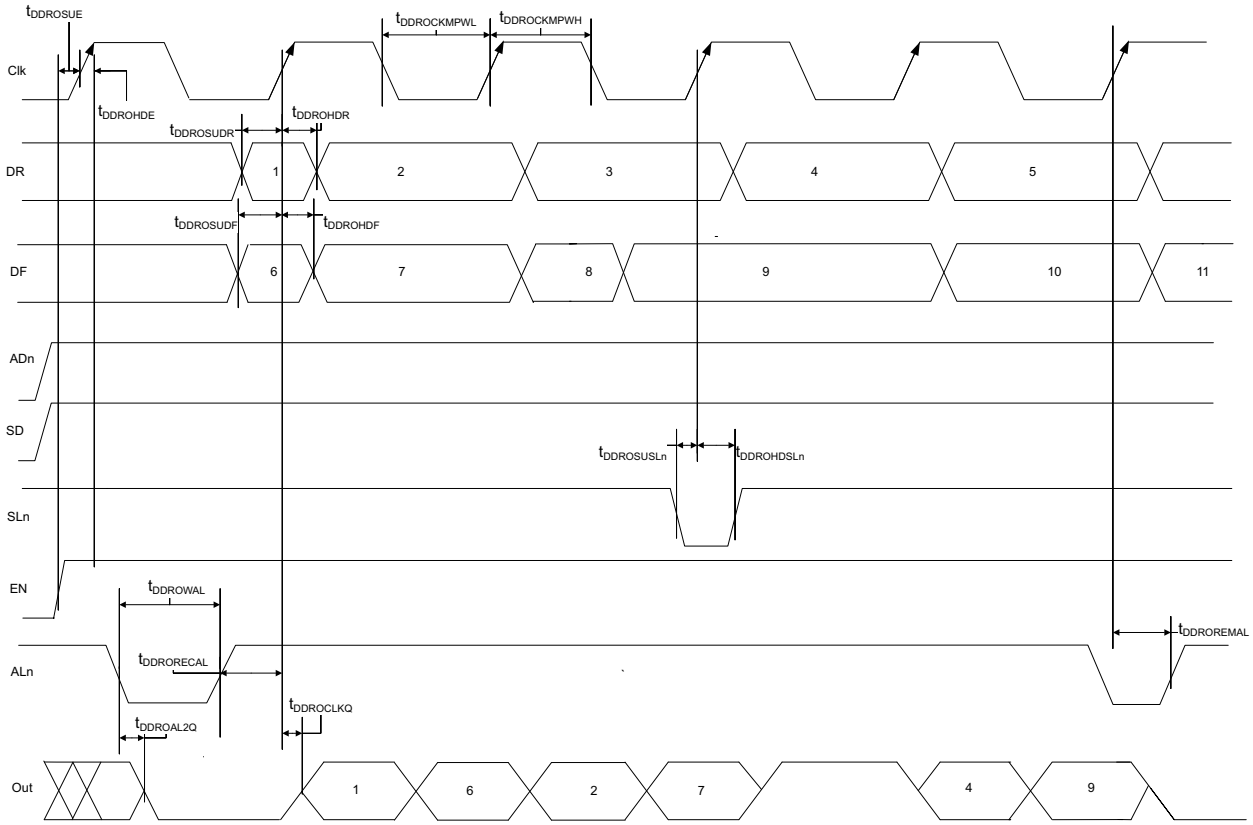

***Figure 12* • Output DDR Timing Diagram**

11. FPGA Fabric SRAM

Refer to the *UG0445: IGLOO2 FPGA and SmartFusion2 SoC FPGA Fabric User Guide* for more information.

11.1 FPGA Fabric Large SRAM (LSRAM)

Table 118 • **RAM1K18 – Dual-Port Mode for Depth × Width Configuration 1Kx18**
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Parameter	Description	Speed Grade –1		Units
		Min	Max	
t_{CY}	Clock Period	3.333	–	ns
$t_{CLKMPWH}$	Clock Minimum Pulse Width High	1.5	–	ns
$t_{CLKMPWL}$	Clock Minimum pulse Width Low	1.5	–	ns
t_{PLCY}	Pipelined Clock Period	3.333	–	ns
$t_{PLCLKMPWH}$	Pipelined Clock Minimum Pulse Width High	1.5	–	ns
$t_{PLCLKMPWL}$	Pipelined Clock Minimum pulse Width Low	1.5	–	ns
t_{CLK2Q}	Read Access Time with Pipeline Register	–	0.346	ns
	Read Access Time without Pipeline Register	–	2.346	ns
	Access Time with Feed-Through Write Timing	–	1.578	ns
t_{ADDRSU}	Address Setup Time	0.455	–	ns
t_{ADDRHD}	Address Hold Time	0.282	–	ns
t_{DSU}	Data Setup Time	0.352	–	ns
t_{DHD}	Data Hold Time	0.11	–	ns
t_{BLKSU}	Block Select Setup Time	0.214	–	ns
t_{BLKHD}	Block Select Hold Time	0.223	–	ns
t_{BLK2Q}	Block Select to Out Disable Time (when Pipe-Lined Registered is Disabled)	–	1.578	ns
t_{BLKMPW}	Block Select Minimum Pulse Width	0.218	–	ns
t_{RDESU}	Read Enable Setup Time	0.463	–	ns
t_{RDEHD}	Read Enable Hold Time	0.173	–	ns
$t_{RDPLESU}$	Pipelined Read Enable Setup Time (A_DOUT_EN, B_DOUT_EN)	0.256	–	ns
$t_{RDPLEHD}$	Pipelined Read Enable Hold Time (A_DOUT_EN, B_DOUT_EN)	0.106	–	ns
t_{R2Q}	Asynchronous Reset to Output Propagation Delay	–	1.561	ns
t_{RSTREM}	Asynchronous Reset Removal Time	0.522	–	ns
t_{RSTREC}	Asynchronous Reset Recovery Time	0.005	–	ns
t_{RSTMPW}	Asynchronous Reset Minimum Pulse Width	0.352	–	ns
$t_{PLRSTREM}$	Pipelined Register Asynchronous Reset Removal Time	-0.288	–	ns
$t_{PLRSTREC}$	Pipelined Register Asynchronous Reset Recovery Time	0.338	–	ns
$t_{PLRSTMPW}$	Pipelined Register Asynchronous Reset Minimum Pulse Width	0.33	–	ns
t_{SRSTSU}	Synchronous Reset Setup Time	0.233	–	ns

Table 119 • RAM1K18 – Dual-Port Mode for Depth × Width Configuration 2Kx9
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V (continued)

Parameter	Description	Speed Grade –1		Units
		Min	Max	
t_{RSTREC}	Asynchronous Reset Recovery Time	0.005	–	ns
t_{RSTMPW}	Asynchronous Reset Minimum Pulse Width	0.352	–	ns
$t_{PLRSTREM}$	Pipelined Register Asynchronous Reset Removal Time	-0.288	–	ns
$t_{PLRSTREC}$	Pipelined Register Asynchronous Reset Recovery Time	0.338	–	ns
$t_{PLRSTMPW}$	Pipelined Register Asynchronous Reset Minimum Pulse Width	0.33	–	ns
t_{SRSTSU}	Synchronous Reset Setup Time	0.233	–	ns
t_{SRSTHD}	Synchronous Reset Hold Time	0.037	–	ns
t_{WESU}	Write Enable Setup Time	0.428	–	ns
t_{WEHD}	Write Enable Hold Time	0.05	–	ns
Fmax	Maximum Frequency	–	300	MHz

Table 120 • RAM1K18 – Dual-Port Mode for Depth × Width Configuration 4Kx4
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Parameter	Description	Speed Grade –1		
		Min	Max	Units
t_{CY}	Clock Period	3.333	–	ns
$t_{CLKMPWH}$	Clock Minimum Pulse Width High	1.5	–	ns
$t_{CLKMPWL}$	Clock Minimum pulse Width Low	1.5	–	ns
t_{PLCY}	Pipelined Clock Period	3.333	–	ns
$t_{PLCLKMPWH}$	Pipelined Clock Minimum Pulse Width High	1.5	–	ns
$t_{PLCLKMPWL}$	Pipelined Clock Minimum pulse Width Low	1.5	–	ns
t_{CLK2Q}	Read Access Time with Pipeline Register		0.334	ns
	Read Access Time without Pipeline Register	–	2.346	ns
	Access Time with Feed-Through Write Timing	–	1.56	ns
t_{ADDRSU}	Address Setup Time	0.56	–	ns
t_{ADDRHD}	Address Hold Time	0.282	–	ns
t_{DSU}	Data Setup Time	0.345	–	ns
t_{DHD}	Data Hold Time	0.084	–	ns
t_{BLKSU}	Block Select Setup Time	0.214	–	ns
t_{BLKHD}	Block Select Hold Time	0.223	–	ns
t_{BLK2Q}	Block Select to Out Disable Time (when Pipe-Lined Registered is Disabled)	–	1.56	ns
t_{BLKMPW}	Block Select Minimum Pulse Width	0.218	–	ns
t_{RDESU}	Read Enable Setup Time	0.532	–	ns
t_{RDEHD}	Read Enable Hold Time	0.073	–	ns

Table 127 • uSRAM (RAM128x8) in 128x8 Mode
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Parameter	Description	Speed Grade –1		Units
		Min	Max	
t_{CY}	Read Clock Period	4	–	ns
$t_{CLKMPWH}$	Read Clock Minimum Pulse Width High	1.8	–	ns
$t_{CLKMPWL}$	Read Clock Minimum pulse Width Low	1.8	–	ns
t_{PLCY}	Read Pipe-line clock period	4	–	ns
$t_{PLCLKMPWH}$	Read Pipe-line clock Minimum Pulse Width High	1.8	–	ns
$t_{PLCLKMPWL}$	Read Pipe-line clock Minimum Pulse Width Low	1.8	–	ns
t_{CLK2Q}	Read Access Time with Pipeline Register	–	0.276	ns
	Read Access Time without Pipeline Register	–	1.776	ns
t_{ADDRSU}	Read Address Setup Time in Synchronous Mode	0.311	–	ns
	Read Address Setup Time in Asynchronous Mode	1.959	–	ns
t_{ADDRHD}	Read Address Hold Time in Synchronous Mode	0.125	–	ns
	Read Address Hold Time in Asynchronous Mode	-0.704	–	ns
t_{RDENSU}	Read Enable Setup Time	0.287	–	ns
t_{RDENHD}	Read Enable Hold Time	0.059	–	ns
t_{BLKSU}	Read Block Select Setup Time	1.898	–	ns
t_{BLKHD}	Read Block Select Hold Time	-0.671	–	ns
t_{BLK2Q}	Read Block Select to Out Disable Time (when Pipe-Lined Registered is Disabled)	–	2.14	ns
t_{RSTREM}	Read Asynchronous Reset Removal Time (Pipelined Clock)	-0.15	–	ns
	Read Asynchronous Reset Removal Time (Non-Pipelined Clock)	0.047	–	ns
t_{RSTREC}	Read Asynchronous Reset Recovery Time (Pipelined Clock)	0.524	–	ns
	Read Asynchronous Reset Recovery Time (Non-Pipelined Clock)	0.244	–	ns
t_{R2Q}	Read Asynchronous Reset to Output Propagation Delay (With Pipe-Line Register Enabled)	–	0.865	ns
t_{SRSTSU}	Read Synchronous Reset Setup Time	0.279	–	ns
t_{SRSTHD}	Read Synchronous Reset Hold Time	0.062	–	ns
t_{CCY}	Write Clock Period	4	–	ns
$t_{CCLKMPWH}$	Write Clock Minimum Pulse Width High	1.8	–	ns
$t_{CCLKMPWL}$	Write Clock Minimum Pulse Width Low	1.8	–	ns
t_{BLKCSU}	Write Block Setup Time	0.417	–	ns
t_{BLKCHD}	Write Block Hold Time	0.007	–	ns
t_{DINCSU}	Write Input Data setup Time	0.104	–	ns
t_{DINCHD}	Write Input Data hold Time	0.142	–	ns

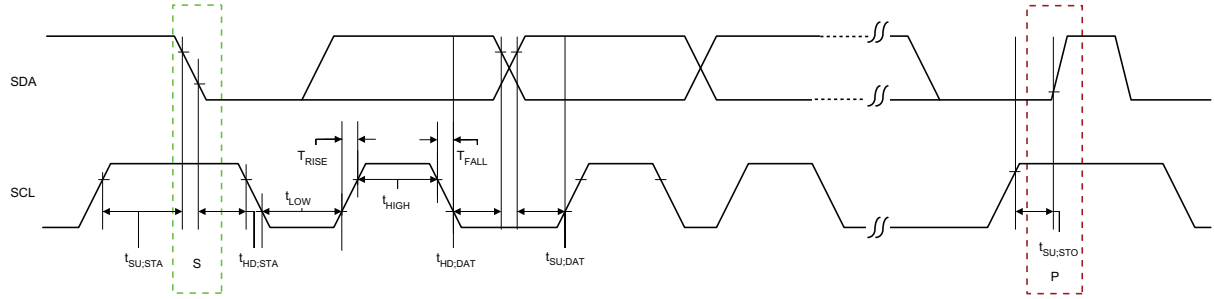

Figure 16 • **I^2C Timing Parameter Definition**

24.3 Serial Peripheral Interface (SPI) Characteristics

This section describes the DC and switching of the SPI interface. Unless otherwise noted, all output characteristics given are for a 35 pF load on the pins and all sequential timing characteristics are related to SPI_x_CLK. For timing parameter definitions, refer to Figure 17 on page 102.

Table 159 • **SPI Characteristics**

Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Symbol	Description	All Devices/Speed Grades			Unit	Notes
		Min	Typ	Max		
sp1	**SPI_[0|1]_CLK minimum period**					
	SPI_[0|1]_CLK = PCLK/2	12	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/4	24.1	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/8	48.2	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/16	0.1	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/32	0.19	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/64	0.39	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/128	0.77	–	–	µs	–
sp2	**SPI_[0|1]_CLK minimum pulse width high**					
	SPI_[0|1]_CLK = PCLK/2	6	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/4	12.05	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/8	24.1	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/16	0.05	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/32	0.095	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/64	0.195	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/128	0.385	–	–	µs	–

Notes:

1. *For specific Rise/Fall Times board design considerations and detailed output buffer resistances, use the corresponding IBIS models located on the Microsemi SoC Products Group website: http://www.microsemi.com/products/fpga-soc/design-resources/ibis-models.*
2. *For allowable pclk configurations, refer to the Serial Peripheral Interface Controller section in the UG0331: SmartFusion2 Microcontroller Subsystem User Guide.*

27. IGLOO2 Specifications

27.1 HPMS Clock Frequency

Table 162 • **Maximum Frequency for HPMS Main Clock**
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Symbol	Description	Speed Grade –1	Units
HPMS_CLK	Maximum Frequency for the HPMS Main Clock (FCLK)	133	MHz

27.2 IGLOO2 Serial Peripheral Interface (SPI) Characteristics

This section describes the DC and switching of the SPI interface. Unless otherwise noted, all output characteristics given are for a 35 pF load on the pins and all sequential timing characteristics are related to SPI_0_CLK. For timing parameter definitions, refer to Figure 18 on page 105.

Table 163 • **SPI Characteristics**
Worst-Case Automotive Grade 2 Conditions: T_J = 125°C, VDD = 1.14 V

Symbol	Description	All Devices/Speed Grades			Unit	Notes
		Min	Typ	Max		
sp1	**SPI_[0|1]_CLK minimum period**					
	SPI_[0|1]_CLK = PCLK/2	12	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/4	24.1	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/8	48.2	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/16	0.1	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/32	0.19	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/64	0.39	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/128	0.77	–	–	µs	–
sp2	**SPI_[0|1]_CLK minimum pulse width high**					
	SPI_[0|1]_CLK = PCLK/2	6	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/4	12.05	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/8	24.1	–	–	ns	–
	SPI_[0|1]_CLK = PCLK/16	0.05	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/32	0.095	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/64	0.195	–	–	µs	–
	SPI_[0|1]_CLK = PCLK/128	0.385	–	–	µs	–

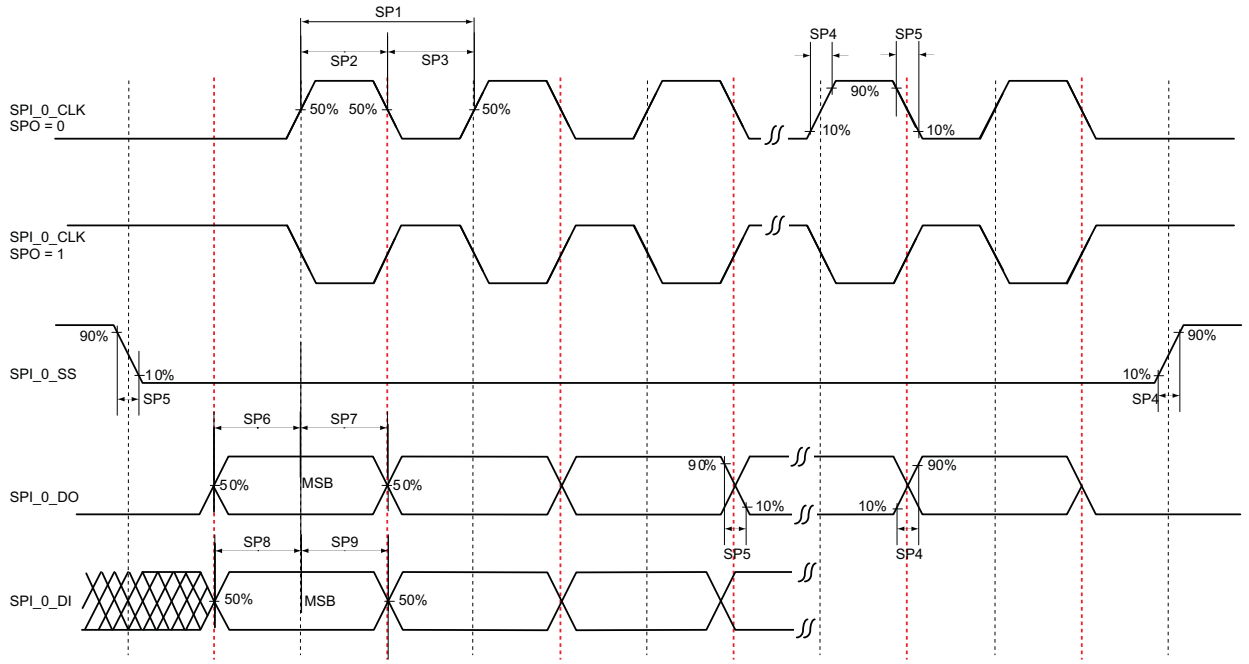

Figure 18 • **SPI Timing for a Single Frame Transfer in Motorola Mode (SPH = 1)**

Datasheet Categories

Categories

In order to provide the latest information to designers, some datasheet parameters are published before data has been fully characterized from silicon devices. The data provided for a given device, as highlighted in Table 1 on page 1 is designated as either "Product Brief," "Advance," "Preliminary," or "Production." The definitions of these categories are as follows:

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The product brief is a summarized version of a datasheet (advance or production) and contains general product information. This document gives an overview of specific device and family information.

Advance

This version contains initial estimated information based on simulation, other products, devices, or speed grades. This information can be used as estimates, but not for production.

This label only applies to the DC and Switching Characteristics chapter of the datasheet and will only be used when the data has not been fully characterized.

Preliminary

The datasheet contains information based on simulation and/or initial characterization. The information is believed to be correct, but changes are possible.

Production

This version contains information that is considered to be final.

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