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Embedded - FPGAs, or Field Programmable Gate Arrays, are advanced integrated circuits that offer unparalleled flexibility and performance for digital systems. Unlike traditional fixed-function logic devices, FPGAs can be programmed and reprogrammed to execute a wide array of logical operations, enabling customized functionality tailored to specific applications. This reprogrammability allows developers to iterate designs quickly and implement complex functions without the need for custom hardware.

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The versatility of Embedded - FPGAs makes them indispensable in numerous fields. In telecommunications.

Details	
Product Status	Active
Number of LABs/CLBs	-
Number of Logic Elements/Cells	192000
Total RAM Bits	13619200
Number of I/O	170
Number of Gates	-
Voltage - Supply	0.97V ~ 1.08V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 100°C (TJ)
Package / Case	325-LFBGA, FC
Supplier Device Package	325-FCBGA (11x14.5)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/mpf200tl-fcsg325e

1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 1.3

Revision 1.3 was published in June 2018. The following is a summary of changes.

- The System Services section was updated. For more information, see System Services (see page 59).
- The Non-Volatile Characteristics section was updated. For more information, see Non-Volatile Characteristics (see page 51).
- The Fabric Macros section was updated. For more information, see Fabric Macros (see page 60).
- The Transceiver Switching Characteristics section was updated. For more information, see Transceiver Switching Characteristics (see page 42).

1.2 Revision 1.2

Revision 1.2 was published in June 2018. The following is a summary of changes.

- The datasheet has moved to preliminary status. Every table has been updated.

1.3 Revision 1.1

Revision 1.1 was published in August 2017. The following is a summary of changes.

- LVDS specifications changed to 1.25G. For more information, see HSIO Maximum Input Buffer Speed and HSIO Maximum Output Buffer Speed.
- LVDS18, LVDS25/LVDS33, and LVDS25 specifications changed to 800 Mbps. For more information, see I/O Standards Specifications.
- A note was added indicting a zeroization cycle counts as a programming cycle. For more information, see Non-Volatile Characteristics.
- A note was added defining power down conditions for programming recovery conditions. For more information, see Power-Supply Ramp Times.

1.4 Revision 1.0

Revision 1.0 was the first publication of this document.

2 Overview

This datasheet describes PolarFire® FPGA device characteristics with industrial temperature range (–40 °C to 100 °C T_J) and extended commercial temperature range (0 °C to 100 °C T_J). The devices are provided with a standard speed grade (STD) and a –1 speed grade with higher performance. The FPGA core supply V_{DD} can operate at 1.0 V for lower-power or 1.05 V for higher performance. Similarly, the transceiver core supply V_{DDA} can also operate at 1.0 V or 1.05 V. Users select the core operating voltage while creating the Libero project.

Parameter	Symbol	Min	Typ	Max	Unit
Transceiver TX and RX lanes supply at 1.05 V mode (when any lane rate is greater than 10.3125 Gbps)[1]	V_{DDA}	1.02	1.05	1.08	V
Programming and HSIO receiver supply	V_{DD18}	1.71	1.80	1.89	V
FPGA core and FPGA PLL high-voltage supply	V_{DD25}	2.425	2.50	2.575	V
Transceiver PLL high-voltage supply	V_{DDA25}	2.425	2.50	2.575	V
Transceiver reference clock supply –3.3 V nominal	$V_{DD\_XCVR\_CLK}$	3.135	3.3	3.465	V
Transceiver reference clock supply –2.5 V nominal	$V_{DD\_XCVR\_CLK}$	2.375	2.5	2.625	V
Global V_{REF} for transceiver reference clocks[3]	$XCVR_{VREF}$	Ground		$V_{DD\_XCVR\_CLK}$	V
HSIO DC I/O supply. Allowed nominal options: 1.2 V, 1.35 V, 1.5 V, and 1.8 V[4]	V_{DDIx}	1.14	Various	1.89	V
GPIO DC I/O supply. Allowed nominal options: 1.2 V, 1.5 V, 1.8 V, 2.5 V, and 3.3 V[2,4]	V_{DDIx}	1.14	Various	3.465	V
Dedicated I/O DC supply for JTAG and SPI (GPIO Bank 3). Allowed nominal options: 1.8 V, 2.5 V, and 3.3 V	V_{DDI3}	1.71	Various	3.465	V
GPIO auxiliary supply for I/O bank x with V_{DDIx} = 3.3 V nominal[2,4]	V_{DDAUXx}	3.135	3.3	3.465	V
GPIO auxiliary supply for I/O bank x with V_{DDIx} = 2.5 V nominal or lower[2,4]	V_{DDAUXx}	2.375	2.5	2.625	V
Extended commercial temperature range	T_J	0		100	°C
Industrial temperature range	T_J	–40		100	°C
Extended commercial programming temperature range	T_{PRG}	0		100	°C
Industrial programming temperature range	T_{PRG}	–40		100	°C

1. V_{DD} and V_{DDA} can independently operate at 1.0 V or 1.05 V nominal. These supplies are not dynamically adjustable.
2. For GPIO buffers where I/O bank is designated as bank number, if V_{DDIx} is 2.5 V nominal or 3.3 V nominal, V_{DDAUXx} must be connected to the V_{DDIx} supply for that bank. If V_{DDIx} for a given GPIO bank is <2.5 V nominal, V_{DDAUXx} per I/O bank must be powered at 2.5 V nominal.
3. $XCVR_{VREF}$ globally sets the reference voltage of the transceiver's single-ended reference clock input buffers. It is typically near $V_{DD\_XCVR\_CLK}$/2 V but is allowed in the specified range.
4. The power supplies for a given I/O bank x are shown as VDDIx and VDDAUXx.

Note: The following dedicated pins do not support hot socketing: TMS, TDI, TRSTB, DEVRST_N, and FF_EXIT_N. Weak pull-up (as specified in GPIO) is always enabled.

6.3 Input and Output

The following section describes:

- DC I/O levels
- Differential and complementary differential DC I/O levels
- HSIO and GPIO on-die termination specifications
- LVDS specifications

6.3.1 DC Input and Output Levels

The following tables list the DC I/O levels.

Table 12 • DC Input Levels

I/O Standard	V_{DDI} Min (V)	V_{DDI} Typ (V)	V_{DDI} Max (V)	V_{IL} Min (V)	V_{IL} Max (V)	V_{IH} Min (V)	V_{IH}[1] Max (V)
PCI	3.15	3.3	3.45	–0.3	0.3 × V_{DDI}	0.5 × V_{DDI}	3.45
LVTTL	3.15	3.3	3.45	–0.3	0.8	2	3.45
LVCMOS33	3.15	3.3	3.45	–0.3	0.8	2	3.45
LVCMOS25	2.375	2.5	2.625	–0.3	0.7	1.7	2.625
LVCMOS18	1.71	1.8	1.89	–0.3	0.35 × V_{DDI}	0.65 × V_{DDI}	1.89
LVCMOS15	1.425	1.5	1.575	–0.3	0.35 × V_{DDI}	0.65 × V_{DDI}	1.575
LVCMOS12	1.14	1.2	1.26	–0.3	0.35 × V_{DDI}	0.65 × V_{DDI}	1.26
SSTL25I[2]	2.375	2.5	2.625	–0.3	V_{REF} – 0.15	V_{REF} + 0.15	2.625
SSTL25II[2]	2.375	2.5	2.625	–0.3	V_{REF} – 0.15	V_{REF} + 0.15	2.625
SSTL18I[2]	1.71	1.8	1.89	–0.3	V_{REF} – 0.125	V_{REF} + 0.125	1.89
SSTL18II[2]	1.71	1.8	1.89	–0.3	V_{REF} – 0.125	V_{REF} + 0.125	1.89
SSTL15I	1.425	1.5	1.575	–0.3	V_{REF} – 0.1	V_{REF} + 0.1	1.575
SSTL15II	1.425	1.5	1.575	–0.3	V_{REF} – 0.1	V_{REF} + 0.1	1.575

Parameter	Description	Min (%)	Typ	Max (%)	Unit	Condition
Single-ended termination to V_{SS}[4, 5]	Internal parallel termination to V_{SS}	–20	120	20	Ω	V_{DDI} = 2.5 V/1.8 V/1.5 V/1.2 V
		–20	240	20	Ω	V_{DDI} = 2.5 V/1.8 V/1.5 V/1.2 V

1. Measured across P to N with 400 mV bias.
2. Thevenin impedance is calculated based on independent P and N as measured at 50% of V_{DDI}.
3. For 50 Ω/75 Ω/150 Ω cases, nearest supported values of 40 Ω/60 Ω/120 Ω are used.
4. Measured at 50% of V_{DDI}.
5. Supported terminations vary with the IO type regardless of V_{DDI} nominal voltage. Refer to Libero for available combinations.

Standard	STD	–1	Unit
LVCMOS18 (12 mA)	500	500	Mbps
LVCMOS15 (10 mA)	500	500	Mbps
LVCMOS12 (8 mA)	300	300	Mbps
MIPI25/MIPI33	800	800	Mbps

1. All SSTLD/HSTLD/HSULD/LVSTLD/POD type receivers use the LVDS differential receiver.
2. Performance is achieved with V_{ID} ≥200 mV.

7.1.4 Output Buffer Speed

Table 26 • HSIO Maximum Output Buffer Speed

Standard	STD	–1	Unit
SSTL18I	800	1066	Mbps
SSTL18II	800	1066	Mbps
SSTL18I (differential)	800	1066	Mbps
SSTL18II (differential)	800	1066	Mbps
SSTL15I	1066	1333	Mbps
SSTL15II	1066	1333	Mbps
SSTL15I (differential)	1066	1333	Mbps
SSTL15II (differential)	1066	1333	Mbps
SSTL135I	1066	1333	Mbps
SSTL135II	1066	1333	Mbps
SSTL135I (differential)	1066	1333	Mbps
SSTL135II (differential)	1066	1333	Mbps
HSTL15I	900	1100	Mbps
HSTL15II	900	1100	Mbps
HSTL15I (differential)	900	1100	Mbps
HSTL15II (differential)	900	1100	Mbps
HSTL135I	1066	1066	Mbps
HSTL135II	1066	1066	Mbps
HSTL135I (differential)	1066	1066	Mbps
HSTL135II (differential)	1066	1066	Mbps
HSUL18I	400	400	Mbps
HSUL18II	400	400	Mbps
HSUL18II (differential)	400	400	Mbps
HSUL12	1066	1333	Mbps
HSUL12I (differential)	1066	1333	Mbps
HSTL12	1066	1266	Mbps
HSTL12I (differential)	1066	1266	Mbps
POD12I	1333	1600	Mbps
POD12II	1333	1600	Mbps
LVCMOS18 (12 mA)	500	500	Mbps
LVCMOS15 (10 mA)	500	500	Mbps

Standard	STD	–1	Unit
LVCMOS12 (8 mA)	250	300	Mbps

Table 27 • GPIO Maximum Output Buffer Speed

Standard	STD	–1	Unit
LVDS25/LCMDS25	1250	1250	Mbps
LVDS33/LCMDS33	1250	1600	Mbps
RSDS25	800	800	Mbps
MINILVDS25	800	800	Mbps
SUBLVDS25	800	800	Mbps
PPDS25	800	800	Mbps
SLVSE15	500	500	Mbps
BUSLVDSE25	500	500	Mbps
MLVDSE25	500	500	Mbps
LVPECLE33	500	500	Mbps
SSTL25I	800	800	Mbps
SSTL25II	800	800	Mbps
SSTL25I (differential)	800	800	Mbps
SSTL25II (differential)	800	800	Mbps
SSTL18I	800	800	Mbps
SSTL18II	800	800	Mbps
SSTL18I (differential)	800	800	Mbps
SSTL18II (differential)	800	800	Mbps
SSTL15I	800	1066	Mbps
SSTL15II	800	1066	Mbps
SSTL15I (differential)	800	1066	Mbps
SSTL15II (differential)	800	1066	Mbps
HSTL15I	900	900	Mbps
HSTL15II	900	900	Mbps
HSTL15I (differential)	900	900	Mbps
HSTL15II (differential)	900	900	Mbps
HSUL18I	400	400	Mbps
HSUL18II	400	400	Mbps
HSUL18I (differential)	400	400	Mbps
HSUL18II (differential)	400	400	Mbps
PCI	500	500	Mbps
LVTTL33 (20 mA)	500	500	Mbps
LVCMOS33 (20 mA)	500	500	Mbps
LVCMOS25 (16 mA)	500	500	Mbps
LVCMOS18 (12 mA)	500	500	Mbps
LVCMOS15 (10 mA)	500	500	Mbps
LVCMOS12 (8 mA)	250	300	Mbps
MIPIE25	500	500	Mbps

7.1.6 User I/O Switching Characteristics

The following section describes characteristics for user I/O switching.

For more information about user I/O timing, see the *PolarFire I/O Timing Spreadsheet* (to be released).

7.1.6.1 I/O Digital

The following tables provide information about I/O digital.

Table 30 • I/O Digital Receive Single-Data Rate Switching Characteristics

Parameter	Interface Name	Topology	STD Min	STD Typ	STD Max	–1 Min	–1 Typ	–1 Max	Unit	Clock-to-Data Condition
FMAX	RX_SDR_G_A	Rx SDR							MHz	From a global clock source, aligned
FMAX	RX_SDR_L_A	Rx SDR							MHz	From a lane clock source, aligned
FMAX	RX_SDR_G_C	Rx SDR							MHz	From a global clock source, centered
FMAX	RX_SDR_L_C	Rx SDR							MHz	From a lane clock source, centered

Table 31 • I/O Digital Receive Double-Data Rate Switching Characteristics

Parameter	Interface Name	Topology	STD Min	STD Typ	STD Max	–1 Min	–1 Typ	–1 Max	Unit	Clock-to-Data Condition
FMAX	RX_DDR_G_A	Rx DDR		335			335	MHz	MHz	From a global clock source, aligned
FMAX	RX_DDR_L_A	Rx DDR		250			250		MHz	From a lane clock source, aligned
FMAX	RX_DDR_G_C	Rx DDR		335			335		MHz	From a global clock source, centered
FMAX	RX_DDR_L_C	Rx DDR		250			250		MHz	From a lane clock source, centered
FMAX 2:1	RX_DDRX_B_A	Rx DDR digital mode							MHz	From a HS_IO_CLK clock source, aligned

Parameter[1]	Symbol	Min	Typ	Max	Unit
Secondary output clock frequency[2]	F_{OUTSF}	33.3		800	MHz
Input clock cycle-to-cycle jitter	F_{INJ}			200	ps
Output clock period cycle-to-cycle jitter (w/clean input)	$T_{OUTJITTERP}$			300	ps
Output clock-to-clock skew between two outputs with the same phase settings	T_{SKEW}			±200	ps
DLL lock time	T_{LOCK}	16		16K	Reference clock cycles
Minimum reset pulse width	T_{MRPW}	3			ns
Minimum input pulse width[3]	T_{MIPW}	20			ns
Minimum input clock pulse width high	T_{MPWH}	400			ps
Minimum input clock pulse width low	T_{MPWL}	400			ps
Delay step size	T_{DEL}	12.7	30	35	ps
Maximum delay block delay[4]	T_{DELMAX}	1.8		4.8	ns
Output clock duty cycle (with 50% duty cycle input)[5]	T_{DUTY}	40		60	%
Output clock duty cycle (in phase reference mode)[5]	T_{DUTY50}	45		55	%

1. For all DLL modes.
2. Secondary output clock divided by four option.
3. On load, direction, move, hold, and update input signals.
4. 128 delay taps in one delay block.
5. Without duty cycle correction enabled.

7.2.4 RC Oscillators

The following tables provide internal RC clock resources for user designs and additional information about designing systems with RF front end information about emitters generated on-chip to support programming operations.

Table 39 • 2 MHz RC Oscillator Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Operating frequency	RC_{2FREQ}		2		MHz
Accuracy	RC_{2FACC}	–4		4	%
Duty cycle	RC_{2DC}	46		54	%
Peak-to-peak output period jitter	RC_{2PJIT}		5	10	ns
Peak-to-peak output cycle-to-cycle jitter	RC_{2CJIT}		5	10	ns
Operating current (V_{DD25})	RC_{2IVPPA}			60	µA
Operating current (V_{DD})	RC_{2IVDD}			2.6	µA

Table 40 • 160 MHz RC Oscillator Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Operating frequency	RC_{SCFREQ}		160		MHz
Accuracy	RC_{SCFACC}	–4		4	%
Duty cycle	RC_{SCDC}	47		52	%
Peak-to-peak output period jitter	RC_{SCPJIT}			600	ps
Peak-to-peak output cycle-to-cycle jitter	RC_{SCCJIT}			172	ps
Operating current (V_{DD25})	RC_{SCVPPA}			599	µA

Table 48 • Transceiver Differential Reference Clock I/O Standards

I/O Standard	Comment
LVDS25	For DC input levels, se e table Differential DC Input and Output Levels.
HCSL25 (for PCIe)	

Note: The transceiver reference clock differential receiver supports V_{CM} common mode.

7.4.4 Transceiver Interface Performance

The following table describes the single-ended I/O standards supported as transceiver reference clocks.

Table 49 • Transceiver Single-Ended Reference Clock I/O Standards

I/O Standard	Comment
LVCMOS25	For DC input levels, see table DC Input and Output Levels.

7.4.5 Transmitter Performance

The following tables describe performance of the transmitter.

Table 50 • Transceiver Reference Clock Input Termination

Parameter	Symbol	Min	Typ	Max	Unit
Single-ended termination	RefTerm		50		Ω
Single-ended termination	RefTerm		75		Ω
Single-ended termination	RefTerm		150		Ω
Differential termination	RefDiffTerm		115[1]		Ω
Power-up termination			>50K		Ω

1. Measured at VCM= 1.2 V and VID= 350 mV.

Note: All pull-ups are disabled at power-up to allow hot plug capability.

Table 51 • PolarFire Transceiver User Interface Clocks

Parameter	Modes [1]	STD Min	STD Max	–1 Min	–1 Max	Unit
Transceiver TX_CLK range (non-deterministic PCS mode with global or regional fabric clocks)	8-bit, max data rate = 1.6 Gbps		200		200	MHz
	10-bit, max data rate = 1.6 Gbps		160		160	MHz
	16-bit, max data rate = 4.8 Gbps		300		300	MHz
	20-bit, max data rate = 6.0 Gbps		300		300	MHz
	32-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		325		325	MHz
	40-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		260		320	MHz
	64-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		165		160	MHz
	80-bit, max data rate = 10.3125 Gbps(–STD) / 12.7 Gbps (–1)[1]		130		130	MHz
	Fabric pipe mode 32-bit, max data rate = 6.0 Gbps		150		150	MHz
	8-bit, max data rate = 1.6 Gbps		200		200	MHz

Parameter	Modes [1]	STD Min	STD Max	–1 Min	–1 Max	Unit
Transceiver RX_CLK range (non-deterministic PCS mode with global or regional fabric clocks)	10-bit, max data rate = 1.6 Gbps		160		160	MHz
	16-bit, max data rate = 4.8 Gbps		300		300	MHz
	20-bit, max data rate = 6.0 Gbps		300		300	MHz
	32-bit, max data rate = 10.3125 Gbps		325		325	MHz
	40-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		260		320	MHz
	64-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		165		200	MHz
	80-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		130		160	MHz
	Fabric pipe mode 32-bit, max data rate = 6.0 Gbps		150		150	MHz
Transceiver TX_CLK range (deterministic PCS mode with regional fabric clocks)	8-bit, max data rate = 1.6 Gbps		200		200	MHz
	10-bit, max data rate = 1.6 Gbps		160		160	MHz
	16-bit, max data rate = 3.6 Gbps (–STD) / 4.25 Gbps (–1)		225		266	MHz
	20-bit, max data rate = 4.5 Gbps (–STD) / 5.32 Gbps (–1)		225		266	MHz
	32-bit, max data rate = 7.2 Gbps (–STD) / 8.5 Gbps (–1)		225		266	MHz
	40-bit, max data rate = 9.0 Gbps (–STD) / 10.6 Gbps (–1)[1]		225		266	Mhz
	64-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		165		200	MHz
	80-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		130		160	MHz
Transceiver RX_CLK range (deterministic PCS mode with regional fabric clocks)	8-bit, max data rate = 1.6 Gbps		200		200	MHz
	10-bit, max data rate = 1.6 Gbps		160		160	MHz
	16-bit, max data rate = 3.6 Gbps (–STD) / 4.25 Gbps (–1)		225		266	MHz
	20-bit, max data rate = 4.5 Gbps (–STD) / 5.32 Gbps (–1)		225		266	MHz
	32-bit, max data rate = 7.2 Gbps (–STD) / 8.5 Gbps (–1)		225		266	MHz
	40-bit, max data rate = 9.0 Gbps (–STD) / 10.6 Gbps (–1)[1]		225		266	MHz
	64-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		165		200	MHz
	80-bit, max data rate = 10.3125 Gbps (–STD) / 12.7 Gbps (–1)[1]		130		160	MHz

1. For data rates greater than 10.3125 Gbps, VDDA must be set to 1.05 V mode. See supply tolerance in the section Recommended Operating Conditions (see page 6).

Note: Until specified, all modes are non-deterministic. For more information, see UG0677: PolarFire FPGA Transceiver User Guide.

5. Improved jitter characteristics for a specific industry standard are possible in many cases due to improved reference clock or higher V_{CO} rate used.
6. Tx jitter is specified with all transmitters on the device enabled, a 10–12-bit error rate (BER) and Tx data pattern of PRBS7.
7. From the PMA mode, the TX_ELEC_IDLE port to the XVCR TXP/N pins.
   FTxRefClk = 75 MHz with typical settings.
   For data rates greater than 10.3125 Gbps, VDDA must be set to 1.05 V mode. See supply tolerance in the section Recommended Operating Conditions (see page 6). (see page 6)

7.4.6 Receiver Performance

The following table describes performance of the receiver.

Table 53 • PolarFire Transceiver Receiver Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Input voltage range	V_{IN}	0		V_{DDA} + 0.3	V	
Differential peak-to-peak amplitude	V_{IDPP}	140		1250	mV	
Differential termination	V_{ITERM}		85		Ω	
	V_{ITERM}		100		Ω	
	V_{ITERM}		150		Ω	
Common mode voltage	V_{ICMDC} [1]	0.7 × V_{DDA}		0.9 × V_{DDA}	V	DC coupled
Exit electrical idle detection time	T_{EIDET}		50	100	ns	
Run length of consecutive identical digits (CID)	C_{ID}			200	UI	
CDR PPM tolerance[2]	C_{DRPPM}			1.15	% UI	
CDR lock-to-data time	T_{LTD}				CDR_{REFCLK} UI	
CDR lock-to-ref time	T_{LTF}				CDR_{REFCLK} UI	
Loss-of-signal detect (Peak Detect Range setting = high)[9]	$V_{DETLHIGH}$				mV	Setting = 1
	$V_{DETLHIGH}$				mV	Setting = 2
	$V_{DETLHIGH}$				mV	Setting = 3
	$V_{DETLHIGH}$				mV	Setting = 4
	$V_{DETLHIGH}$				mV	Setting = 5
	$V_{DETLHIGH}$				mV	Setting = 6
	$V_{DETLHIGH}$				mV	Setting = 7
Loss-of-signal detect (Peak Detect Range setting = low)[9]	V_{DETLOW}	65		175	mV	Setting = PCIe[3,7]
	V_{DETLOW}	95		190	mV	Setting = SATA[4,8]
	V_{DETLOW}	75		170	mV	Setting = 1
	V_{DETLOW}	95		185	mV	Setting = 2
	V_{DETLOW}	100		190	mV	Setting = 3
	V_{DETLOW}	140		210	mV	Setting = 4
	V_{DETLOW}	155		240	mV	Setting = 5
	V_{DETLOW}	165		245	mV	Setting = 6
	V_{DETLOW}	170		250	mV	Setting = 7
Sinusoidal jitter tolerance	T_{SJTOL}				UI	>8.5 Gbps – 12.7 Gbps [5, 10]

7.5.7 CPRI

The following table describes CPRI.

Table 66 • CPRI

	Data Rate	Min	Max	Unit
Total transmit jitter	0.6144 Gbps			UI
	1.2288 Gbps			UI
	2.4576 Gbps			UI
	3.0720 Gbps			UI
	4.9152 Gbps			UI
	6.1440 Gbps			UI
	9.8304 Gbps			UI
	10.1376 Gbps			UI
	12.16512 Gbps [1]			UI
Receive jitter tolerance	0.6144 Gbps			UI
	1.2288 Gbps			UI
	2.4576 Gbps			UI
	3.0720 Gbps			UI
	4.9152 Gbps			UI
	6.1440 Gbps			UI
	9.8304 Gbps			UI
	10.1376 Gbps			UI
	12.16512 Gbps [1]			UI

1. For data rates greater than 10.3125 Gbps, VDDA must be set to 1.05 V mode. See supply tolerance in the section Recommended Operating Conditions (see page 6).

7.5.8 JESD204B

The following table describes JESD204B.

Table 67 • JESD204B

Parameter	Data Rate	Min	Max	Unit
Total transmit jitter	3.125 Gbps		0.35	UI
	6.25 Gbps		0.3	UI
	12.5 Gbps[1]			UI
Receive jitter tolerance	3.125 Gbps	0.56		UI
	6.25 Gbps	0.6		UI
	12.5 Gbps[1]			UI

1. For data rates greater than 10.3125 Gbps, VDDA must be set to 1.05V mode. See supply tolerance in the section Recommended Operating Conditions (see page 6).

7.6 Non-Volatile Characteristics

The following section describes non-volatile characteristics.

Table 75 • FPGA Programming Cycles Lifetime Factor

Programming T_J	Programming Cycles	LF
–40 °C to 100 °C	500	1
–40 °C to 85 °C	1000	0.8
–40 °C to 55 °C	2000	0.6

Notes:

- The maximum number of device digest cycles is 100K.
- Digests are operational only over the –40 °C to 100 °C temperature range.
- After a program cycle, an additional N digests cycles are allowed with the resultant retention characteristics for the total operating and storage temperature shown.
- Retention is specified for total device storage and operating temperature.
- All temperatures are junction temperatures (T_J).
- Example 1—500 digests cycles are performed between programming cycles. N = 500. The operating conditions are –40 °C to 85 °C T_J. 501 programming cycles have occurred. The retention under these operating conditions is 20 × LF = 20 × .8 = 16 years.
- Example 2—one programming cycle has occurred, N = 1500 digest cycles have occurred. Temperature range is –40 °C to 100 °C. The resultant retention is 10 × LF or 10 years over the industrial temperature range.

7.6.5 Digest Time

The following table describes digest time.

Table 76 • Digest Times

Parameter	Devices	Typ	Max	Unit
Setup time	All	2		µs
Fabric digest run time	MPF100T, TL, TS, TLS			ms
	MPF200T, TL, TS, TLS	1005	1072	ms
	MPF300T, TL, TS, TLS	1503.9	1582	ms
	MPF500T, TL, TS, TLS			ms
UFS CC digest run time	MPF100T, TL, TS, TLS			µs
	MPF200T, TL, TS, TLS	33.2	35	µs
	MPF300T, TL, TS, TLS	33.2	35	µs
	MPF500T, TL, TS, TLS			µs
sNVM digest run time[1]	MPF100T, TL, TS, TLS			ms
	MPF200T, TL, TS, TLS	4.4	4.8	ms
	MPF300T, TL, TS, TLS	4.4	4.8	ms
	MPF500T, TL, TS, TLS			ms
UFS UL digest run time	MPF100T, TL, TS, TLS			µs
	MPF200T, TL, TS, TLS	46.6	48.8	µs
	MPF300T, TL, TS, TLS	46.6	48.8	µs
	MPF500T, TL, TS, TLS			µs
User key digest run time[2]	MPF100T, TL, TS, TLS			µs
	MPF200T, TL, TS, TLS	525.4	543.3	µs
	MPF300T, TL, TS, TLS	525.4	543.3	µs
	MPF500T, TL, TS, TLS			µs

Parameter	Typ	Max	Unit	Conditions
Time to destroy data in non-volatile memory (recoverable)[1, 3]			ms	One iteration of scrubbing
Time to destroy data in non-volatile memory (non-recoverable)[1, 4]			ms	One iteration of scrubbing
Time to scrub the fabric data[1]			s	Full scrubbing
Time to scrub the pNVM data (like new)[1, 2]			s	Full scrubbing
Time to scrub the pNVM data (recoverable)[1, 3]			s	Full scrubbing
Time to scrub the fabric data PNVM data (non-recoverable)[1, 4]			s	Full scrubbing
Time to verify[5]			s	

1. Total completion time after interning zeroization.
2. Like new mode—zeroizes user design security setting and sNVM content.
3. Recoverable mode—zeroizes user design security setting, sNVM and factory keys.
4. Non-recoverable mode—zeroizes user design security setting, sNVM and factory keys, and factory data required for programming.
5. Time to verify after scrubbing completes.

Table 79 • Zeroization Times for MPF300T, TL, TS, and TLS Devices

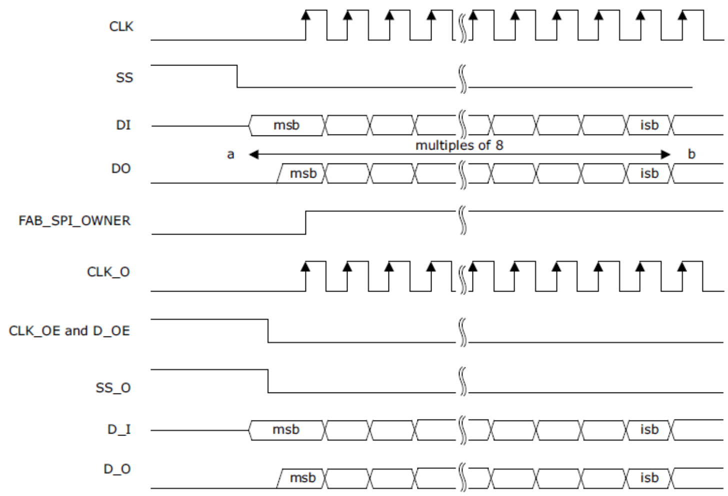
Parameter	Typ	Max	Unit	Conditions
Time to enter zeroization			ms	Zip flag set
Time to destroy the fabric data[1]			ms	Data erased
Time to destroy data in non-volatile memory (like new)[1, 2]			ms	One iteration of scrubbing
Time to destroy data in non-volatile memory (recoverable)[1, 3]			ms	One iteration of scrubbing
Time to destroy data in non-volatile memory (non- recoverable)[1, 4]			ms	One iteration of scrubbing
Time to scrub the fabric data[1]			s	Full scrubbing
Time to scrub the pNVM data (like new)[1, 2]			s	Full scrubbing
Time to scrub the pNVM data (recoverable)[1, 3]			s	Full scrubbing
Time to scrub the fabric data pNVM data (non-recoverable)[1, 4]			s	Full scrubbing
Time to verify[5]			s	

1. Total completion time after interning zeroization.
2. Like new mode—zeroizes user design security setting and sNVM content.
3. Recoverable mode—zeroizes user design security setting, sNVM and factory keys.
4. Non-recoverable mode—zeroizes user design security setting, sNVM and factory keys, and factory data required for programming.
5. Time to verify after scrubbing completes.

Table 80 • Zeroization Times for MPF500T, TL, TS, and TLS Devices

Parameter	Typ	Max	Unit	Conditions
Time to enter zeroization			ms	Zip flag set
Time to destroy the fabric data[1]			ms	Data erased
Time to destroy data in non-volatile memory (like new)[1, 2]			ms	One iteration of scrubbing
Time to destroy data in non-volatile memory (recoverable)[1, 3]			ms	One iteration of scrubbing

Figure 4 • USPI Switching Characteristics



7.8.4 Tamper Detectors

The following section describes tamper detectors.

Table 91 • ADC Conversion Rate

Parameter	Description	Min	Typ[1]	Max
T_{CONV1}	Time from enable changing from zero to non-zero value to first conversion completes. Minimum value applies when POWEROFF = 0.	420 µs		470 µs
T_{CONVN}	Time between subsequent channel conversions.		480 µs	
T_{SETUP}	Data channel and output to valid asserted. Data is held until next conversion completes, that is >480 µs.	0 ns		
T_{VALID}[2]	Width of the valid pulse.	1.625 µs		2 µs
T_{RATE}	Time from start of first set of conversions to the start of the next set. Can be considered as the conversion rate. Is set by the conversion rate parameter.	480 µs	Rate × 32 µs	8128 µs

1. Min, typ, and max refer to variation due to functional configuration and the raw TVS value. The actual internal correction time will vary based on the raw TVS value.
2. The pulse width varies depending on the time taken to complete the internal calibration multiplication, this can be up to 375 ns.

Note: Once the TVS block is active, the enable signal is sampled 25 ns before the falling edge of valid. The next enabled channel in the sequence 0-1-2-3 is started; that is, if channel 0 has just completed and only channels 0 and 3 are enabled, the next channel will be 3. When all the enabled channels in the sequence 0-1-2-3 are completed, the TVS waits for the conversion rate timer to expire. The enable signal may be changed at any time if it changes to 4’b0000 while valid is asserted (and 25 ns before valid is de-asserted), then no further conversions will be started.

Table 92 • Temperature and Voltage Sensor Electrical Characteristics

Parameter	Min	Typ	Max	Unit	Condition
Temperature sensing range	–40		125	°C	
Temperature sensing accuracy	–10		10	°C	

Parameter	Symbol	Typ	Max	Unit
Time from negation of RESPONSE to all I/Os re-enabled	$T_{CLR\_IO\_DISABLE}$	28	38	µs
Time from triggering the response to security locked	$T_{LOCKDOWN}$			ns
Time from negation of RESPONSE to earlier security unlock condition	$T_{CLR\_LOCKDOWN}$			ns
Time from triggering the response to device enters RESET	T_{tr_RESET}	11.7	14	µs
Time from triggering the response to start of zeroization	$T_{tr\_ZEROLISE}$	7.4	8.2	ms

7.8.5 System Controller Suspend Switching Characteristics

The following table describes the characteristics of system controller suspend switching.

Table 95 • System Controller Suspend Entry and Exit Characteristics

Parameter	Symbol	Definition	Typ	Max	Unit
Time from TRSTb falling edge to SUSPEND_EN signal assertion	$T_{suspend\_Tr}$[1, 2]	Suspend entry time from TRST_N assertion	42	44	ns
Time from TRSTb rising edge to ACTIVE signal assertion	$T_{suspend\_exit}$	Suspend exit time from TRST_N negation	361	372	ns

1. ACTIVE indicates that the system controller is inactive or active regardless of the state of SUSPEND_EN.
2. ACTIVE signal must never be asserted with SUSPEND_EN is asserted.

7.8.6 Dynamic Reconfiguration Interface

The following table provides interface timing information for the DRI, which is an embedded APB slave interface within the FPGA fabric that does not use FPGA resources.

Table 96 • Dynamic Reconfiguration Interface Timing Characteristics

Parameter	Symbol	Max	Unit
PCLK frequency	F_{PD_PCLK}	200	MHz

7.9 Power-Up to Functional Timing

Microsemi non-volatile FPGA technology offers the fastest boot-time of any mid-range FPGA in the market. The following tables describes both cold-boot (from power-on) and warm-boot (assertion of DEVRST_N pin or assertion of reset from the tamper macro) timing. The power-up diagrams assume all power supplies to the device are stable.

7.9.1 Power-On (Cold) Reset Initialization Sequence

The following cold reset timing diagram shows the initialization sequencing of the device.

Table 101 • Cold and Warm Boot

Parameter	Symbol	Min	Typ	Max	Unit	Condition
The time from T_{FAB_READY} to ready to program through JTAG/SPI-Slave		0	0	0	ms	
The time from T_{FAB_READY} to auto-update start			T_{PUF_OVHD}[1]	T_{PUF_OVHD}[1]	ms	
The time from T_{FAB_READY} to programming recovery start			T_{PUF_OVHD}[1]	T_{PUF_OVHD}[1]	ms	
The time from T_{FAB_READY} to the tamper flags being available	T_{TAMPER_READY}	0	0	0	ms	
The time from T_{FAB_READY} to the Athena Crypto co-processor being available (for S devices only)	T_{CRYPTO_READY}	0	0	0	ms	

1. Programming depends on the PUF to power up. Refer to T_{PUF_OVHD} at section Secure NVM Performance (see page 58).

7.9.8 I/O Calibration

The following tables specify the initial I/O calibration time for the fastest and slowest supported VDDI ramp times of 0.2 ms to 50 ms, respectively. This only applies to I/O banks specified by the user to be auto-calibrated.

Table 102 • I/O Initial Calibration Time (TCALIB)

Ramp Time	Min (ms)	Max (ms)	Condition
0.2 ms	0.98	2.63	Applies to HSIO and GPIO banks
50 ms	41.62	62.19	Applies to HSIO and GPIO banks

Notes:

- The user may specify any VDDI ramp time in the range specified above. The nominal initial calibration time is given by the specified VDDI ramp time plus 2 ms.
- In order for IO calibration to start, VDDI and VDDAUX of the I/O bank must be higher than the trip point levels specified in I/O-Related Supplies (see page 66).

Table 103 • I/O Fast Recalibration Time (TRECALIB)

I/O Type	Min (ms)	Typ (ms)	Max (ms)	Condition
GPIO bank	0.16	0.20	0.24	GPIO configured for 3.3 V operation
HSIO bank	0.20	0.25	0.30	HSIO configured for 1.8 V operation

Note: In order to obtain fast re-calibration, the user must assert the relevant clock request signal from the FPGA fabric to the I/O bank controller.

The following table describes the time to enter Flash*Freeze Mode and to exit Flash*Freeze mode.

Table 107 • SPI Master Mode (PolarFire Master) During Device Initialization

Parameter	Symbol	Min	Typ	Max	Unit	Condition
SCK frequency	F_{MSCK}			40	MHz	

Table 108 • SPI Slave Mode (PolarFire Slave)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
SCK frequency	F_{SSCK}			80	MHz	

7.10.3 SmartDebug Probe Switching Characteristics

The following table describes characteristics of SmartDebug probe switching.

Table 109 • SmartDebug Probe Performance Characteristics

Parameter	Symbol	V_{DD} = 1.0 V STD	V_{DD} = 1.0 V – 1	V_{DD} = 1.05 V STD	V_{DD} = 1.05 V – 1	Unit
Maximum frequency of probe signal	F_{MAX}	100	100	100	100	MHz
Minimum delay of probe signal	T_{Min_delay}	13	12	13	12	ns
Maximum delay of probe signal	T_{Max_delay}	13	12	13	12	ns

7.10.4 DEVRST_N Switching Characteristics

The following table describes characteristics of DEVRST_N switching.

Table 110 • DEVRST_N Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Condition
DEVRST_N ramp rate	DR_{RAMP}		10		µs	It must be a normal clean digital signal, with typical rise and fall times
DEVRST_N assert time	DR_{ASSERT}	1			µs	The minimum time for DEVRST_N assertion to be recognized
DEVRST_N de-assert time	$DR_{DEASSERT}$	2.75			ms	The minimum time DEVRST_N needs to be de-asserted before assertion

7.10.5 FF_EXIT Switching Characteristics

The following table describes characteristics of FF_EXIT switching.

Table 111 • FF_EXIT Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Condition
FF_EXIT_N ramp rate	FF_{RAMP}		10		µs	
Minimum FF_EXIT_N assert time	FF_{ASSERT}	1			µs	The minimum time for FF_EXIT_N to be recognized
Minimum FF_EXIT_N de-assert time	$FF_{DEASSERT}$	170			µs	The minimum time FF_EXIT_N needs to be de-asserted before assertion

ECDSA SigVer, P-384/SHA-384	1024	6421841	5759
	8K	6273510	5759
Key Agreement (KAS), P-384		5039125	6514
Point Multiply, P-256[1]		5176923	4482
Point Multiply, P-384[1]		12043199	5319
Point Multiply, P-521[1]		26887187	6698
Point Addition, P-384		3018067	5779
KeyGen (PKG), P-384		12055368	6908
Point Verification, P-384		5091	3049

1. With DPA counter measures.

Table 120 • IFC (RSA)

Modes	Message Size (bits)	Athena TeraFire Crypto Core Clock-Cycles	CAL Delay In CPU Clock-Cycles
Encrypt, RSA-2048, e=65537	2048	436972	8,972
Encrypt, RSA-3072, e=65537	3072	962162	12,583
Decrypt, RSA-2048[1], CRT	2048	26862392	15900
Decrypt, RSA-3072[1], CRT	3072	75153782	22015
Decrypt, RSA-4096, CRT	4096	89235615	23710
Decrypt, RSA-3072, CRT	3072	37880180	18638
SigGen, RSA-3072/SHA-384[1] ,CRT, PKCS #1 V 1 1.5	1024	75197644	20032
	8K	75213653	19303
SigGen, RSA-3072/SHA-384, PKCS #1, V 1.5	1024	148090970	14642
	8K	148102576	13936
SigVer, RSA-3072/SHA-384, e = 65537, PKCS #1 V 1.5	1024	970991	12000
	8K	982011	11769
SigVer, RSA-2048/SHA-256, e = 65537, PKCS #1 V 1.5	1024	443493	8436
	8K	453007	8436
SigGen, RSA-3072/SHA-384, ANSI X9.31	1024	147138254	13945
	8K	147155896	13523
SigVer, RSA-3072/SHA-384, e = 65537, ANSI X9.31	1024	973269	11313
	8K	983255	11146

1. With DPA counter measures.

Table 121 • FFC (DH)

Modes	Message Size (bits)	Athena TeraFire Crypto Core Clock-Cycles	CAL Delay In CPU Clock-Cycles
SigGen, DSA-3072/SHA-384[1]	1024	27932907	13969
	8K	27942415	13501
SigGen, DSA-3072/SHA-384	1024	12086356	13602
SigVer, DSA-3072/SHA-384	1024	24597916	15662
	8K	24229420	15133