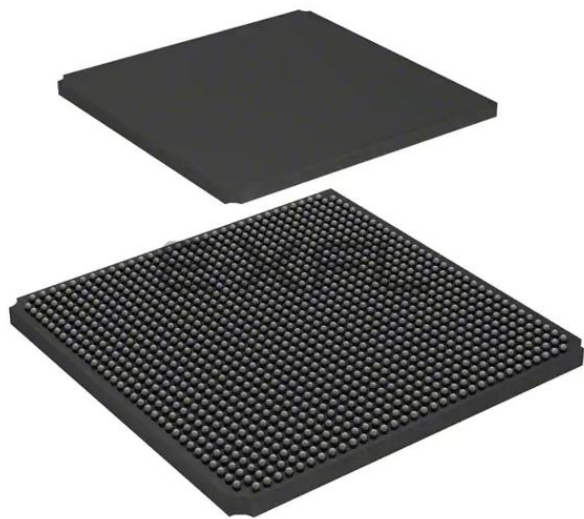




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Understanding Embedded - FPGAs (Field Programmable Gate Array)

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.

Applications of Embedded - FPGAs

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	300000
Total RAM Bits	21094400
Number of I/O	512
Number of Gates	-
Voltage - Supply	0.97V ~ 1.08V
Mounting Type	Surface Mount
Operating Temperature	-40°C ~ 100°C (TJ)
Package / Case	1152-BBGA, FCBGA
Supplier Device Package	1152-FCBGA (35x35)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/mpf300ts-fcg1152i

3 References

The following documents are recommended references. For more information about PolarFire static and dynamic power data, see the [PolarFire Power Estimator Spreadsheet](#).

- [PO0137](#): PolarFire FPGA Product Overview
- [ER0217](#): PolarFire FPGA Pre-Production Device Errata
- [UG0722](#): PolarFire FPGA Packaging and Pin Descriptions Users Guide
- [UG0726](#): PolarFire FPGA Board Design User Guide
- [UG0686](#): PolarFire FPGA User I/O User Guide
- [UG0680](#): PolarFire FPGA Fabric User Guide
- [UG0714](#): PolarFire FPGA Programming User Guide
- [UG0684](#): PolarFire FPGA Clocking Resources User Guide
- [UG0687](#): PolarFire FPGA 1G Ethernet Solutions User Guide
- [UG0727](#): PolarFire FPGA 10G Ethernet Solutions User Guide
- [UG0748](#): PolarFire FPGA Low Power User Guide
- [UG0676](#): PolarFire FPGA DDR Memory Controller User Guide
- [UG0743](#): PolarFire FPGA Debugging User Guide
- [UG0725](#): PolarFire FPGA Device Power-Up and Resets User Guide
- [UG0677](#): PolarFire FPGA Transceiver User Guide
- [UG0685](#): PolarFire FPGA PCI Express User Guide
- [UG0753](#): PolarFire FPGA Security User Guide
- [UG0752](#): PolarFire FPGA Power Estimator User Guide

4 Device Offering

The following table lists the PolarFire FPGA device options using the MPF300T as an example. The MPF100T, MPF200T, and MPF500T device densities have identical offerings.

Table 1 • PolarFire FPGA Device Options

Device Options	Extended Commercial 0 °C–100 °C	Industrial –40 °C–100 °C	STD	–1	Transceivers T	Lower Static Power L	Data Security S
MPF300T	Yes	Yes	Yes	Yes	Yes		
MPF300TL	Yes	Yes	Yes		Yes	Yes	
MPF300TS		Yes	Yes	Yes	Yes		Yes
MPF300TLS		Yes	Yes		Yes	Yes	Yes

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)
SSTL135I	1.283	1.35	1.418	−0.3	V _{REF} − 0.09	V _{REF} + 0.09	1.418
SSTL135II	1.283	1.35	1.418	−0.3	V _{REF} − 0.09	V _{REF} + 0.09	1.418
HSTL15I	1.425	1.5	1.575	−0.3	V _{REF} − 0.1	V _{REF} + 0.1	1.575
HSTL15II	1.425	1.5	1.575	−0.3	V _{REF} − 0.1	V _{REF} + 0.1	1.575
HSTL135I	1.283	1.35	1.418	−0.3	V _{REF} − 0.09	V _{REF} + 0.09	1.418
HSTL135II	1.283	1.35	1.418	−0.3	V _{REF} − 0.09	V _{REF} + 0.09	1.418
HSTL12I	1.14	1.2	1.26	−0.3	V _{REF} − 0.1	V _{REF} + 0.1	1.26
HSTL12II	1.14	1.2	1.26	−0.3	V _{REF} − 0.1	V _{REF} + 0.1	1.26
HSUL18I	1.71	1.8	1.89	−0.3	0.3 × V _{DDI}	0.7 × V _{DDI}	1.89
HSUL18II	1.71	1.8	1.89	−0.3	0.3 × V _{DDI}	0.7 × V _{DDI}	1.89
HSUL12I	1.14	1.2	1.26	−0.3	V _{REF} − 0.1	V _{REF} + 0.1	1.26
POD12I	1.14	1.2	1.26	−0.3	V _{REF} − 0.08	V _{REF} + 0.08	1.26
POD12II	1.14	1.2	1.26	−0.3	V _{REF} − 0.08	V _{REF} + 0.08	1.26

1. GPIO V_{IH} max is 3.45 V with PCI clamp diode turned off regardless of mode, that is, over-voltage tolerant.

2. For external stub-series resistance. This resistance is on-die for GPIO.

Note: 3.3 V and 2.5 V are only supported in GPIO banks.

I/O Standard	V _{DDI} Min (V)	V _{DDI} Typ (V)	V _{DDI} Max (V)	V _{OL} Min (V)	V _{OL} Max (V)	V _{OH} Min (V)	V _{OH} Max (V)	I _{OL} ^{2,6} mA	I _{OH} ^{2,6} mA
HSTL135I ⁴	1.283	1.35	1.418		0.2 x V _{DDI}	0.8 x V _{DDI}		V _{OL} /50	(V _{DDI} – V _{OH}) /50
HSTL135II ⁴	1.283	1.35	1.418		0.2 x V _{DDI}	0.8 x V _{DDI}		V _{OL} /25	(V _{DDI} – V _{OH}) /25
HSTL12I ⁴	1.14	1.2	1.26		0.1 x V _{DDI}	0.9 x V _{DDI}		V _{OL} /50	(V _{DDI} – V _{OH}) /50
HSTL12II ⁴	1.14	1.2	1.26		0.1 x V _{DDI}	0.9 x V _{DDI}		V _{OL} /25	(V _{DDI} – V _{OH}) /25
HSUL18I ⁴	1.71	1.8	1.89		0.1 x V _{DDI}	0.9 x V _{DDI}		V _{OL} /55	(V _{DDI} – V _{OH}) /55
HSUL18II ⁴	1.71	1.8	1.89		0.1 x V _{DDI}	0.9 x V _{DDI}		V _{OL} /25	(V _{DDI} – V _{OH}) /25
HSUL12I ⁴	1.14	1.2	1.26		0.1 x V _{DDI}	0.9 x V _{DDI}		V _{OL} /40	(V _{DDI} – V _{OH}) /40
POD12I ^{4,5}	1.14	1.2	1.26		0.5 x V _{DDI}			V _{OL} /48	(V _{DDI} – V _{OH}) /48
POD12II ^{4,5}	1.14	1.2	1.26		0.5 x V _{DDI}			V _{OL} /34	(V _{DDI} – V _{OH}) /34

1. Drive strengths per PCI specification V/I curves.
2. Refer to [UG0686: PolarFire FPGA User I/O User Guide](#) for details on supported drive strengths.
3. For external stub-series resistance. This resistance is on-die for GPIO.
4. I_{OL}/I_{OH} units for impedance standards in amps (not mA).
5. V_{OH_MAX} based on external pull-up termination (pseudo-open drain).
6. The total DC sink/source current of all IOs within a lane is limited as follows:
 - a. HSIO lane: 120 mA per 12 IO buffers.
 - b. GPIO lane: 160 mA per 12 IO buffers.

Note: 3.3 V and 2.5 V are only supported in GPIO banks.

6.3.2 Differential DC Input and Output Levels

The follow tables list the differential DC I/O levels.

Table 14 • Differential DC Input Levels

I/O Standard	Bank Type	VICM_RANGE Libero Setting	V _{ICM} ^{1,3} Min (V)	V _{ICM} ^{1,3} Typ (V)	V _{ICM} ^{1,3} Max (V)	V _{ID} ² Min (V)	V _{ID} Typ (V)	V _{ID} Max (V)
LVDS33	GPIO	Mid (default)	0.6	1.25	2.35	0.1	0.35	0.6
		Low	0.05	0.4	0.8	0.1	0.35	0.6
LVDS25	GPIO	Mid (default)	0.6	1.25	2.35	0.1	0.35	0.6
		Low	0.05	0.4	0.8	0.1	0.35	0.6
LVDS18 ⁴	GPIO	Mid (default)	0.6	1.25	1.65	0.1	0.35	0.6

I/O Standard	Bank Type	V _{OCM} ¹ Min (V)	V _{OCM} Typ (V)	V _{OCM} Max (V)	V _{OD} ² Min (V)	V _{OD} ² Typ (V)	V _{OD} ² Max (V)
MLVDSSE25 ³	GPIO		1.25		0.396	0.442	0.453
LVPECL33 ³	GPIO		1.65		0.664	0.722	0.755
MIPIE25 ³	GPIO		0.25		0.1	0.22	0.3

1. V_{OCM} is the output common mode voltage.
2. V_{OD} is the output differential voltage.
3. Emulated output only.

6.3.3 Complementary Differential DC Input and Output Levels

The following tables list the complementary differential DC I/O levels.

Table 16 • Complementary Differential DC Input Levels

I/O Standard	V _{DDI} Min (V)	V _{DDI} Typ (V)	V _{DDI} Max (V)	V _{ICM} ^{1,3} Min (V)	V _{ICM} ^{1,3} Typ (V)	V _{ICM} ^{1,3} Max (V)	V _{ID} ² Min (V)	V _{ID} Max (V)
SSTL25I	2.375	2.5	2.625	1.164	1.250	1.339	0.1	
SSTL25II	2.375	2.5	2.625	1.164	1.250	1.339	0.1	
SSTL18I	1.71	1.8	1.89	0.838	0.900	0.964	0.1	
SSTL18II	1.71	1.8	1.89	0.838	0.900	0.964	0.1	
SSTL15I	1.425	1.5	1.575	0.698	0.750	0.803	0.1	
SSTL15II	1.425	1.5	1.575	0.698	0.750	0.803	0.1	
SSTL135I	1.283	1.35	1.418	0.629	0.675	0.723	0.1	
SSTL135II	1.283	1.35	1.418	0.629	0.675	0.723	0.1	
HSTL15I	1.425	1.5	1.575	0.698	0.750	0.803	0.1	
HSTL15II	1.425	1.5	1.575	0.698	0.750	0.803	0.1	
HSTL135I	1.283	1.35	1.418	0.629	0.675	0.723	0.1	
HSTL135II	1.283	1.35	1.418	0.629	0.675	0.723	0.1	
HSTL12I	1.14	1.2	1.26	0.559	0.600	0.643	0.1	
HSUL18I	1.71	1.8	1.89	0.838	0.900	0.964	0.1	
HSUL18II	1.71	1.8	1.89	0.838	0.900	0.964	0.1	
HSUL12I	1.14	1.2	1.26	0.559	0.600	0.643	0.1	
POD12I	1.14	1.2	1.26	0.787	0.840	0.895	0.1	
POD12II	1.14	1.2	1.26	0.787	0.840	0.895	0.1	

1. V_{ICM} is the input common mode voltage.
2. V_{ID} is the input differential voltage.
3. V_{ICM} rules are as follows:
 - a. V_{ICM} must be less than V_{DDI} - 0.4V;
 - b. V_{ICM} + V_{ID}/2 must be < V_{DDI} + 0.4 V;
 - c. V_{ICM} - V_{ID}/2 must be > VSS - 0.3 V.

Min (%)	Typ	Max (%)	Unit	Condition
-20	60	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	120	20	Ω	$V_{DDI} = 1.2\text{ V}$

Note: Thevenin impedance is calculated based on independent P and N as measured at 50% of V_{DDI} . For 50 Ω /75 Ω /150 Ω cases, nearest supported values of 40 Ω /60 Ω /120 Ω are used.

Table 19 • Single-Ended Termination to VDDI (Internal Parallel Termination to VDDI)

Min (%)	Typ	Max (%)	Unit	Condition
-20	34	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	40	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	48	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	60	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	80	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	120	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	240	20	Ω	$V_{DDI} = 1.2\text{ V}$

Note: Measured at 80% of V_{DDI} .

Table 20 • Single-Ended Termination to VSS (Internal Parallel Termination to VSS)

Min (%)	Typ	Max (%)	Unit	Condition
-20	120	20	Ω	$V_{DDI} = 1.8\text{ V}/1.5\text{ V}$
-20	240	20	Ω	$V_{DDI} = 1.8\text{ V}/1.5\text{ V}$
-20	120	20	Ω	$V_{DDI} = 1.2\text{ V}$
-20	240	20	Ω	$V_{DDI} = 1.2\text{ V}$

Note: Measured at 50% of V_{DDI} .

6.3.5 GPIO On-Die Termination

The following table lists the on-die termination calibration accuracy specifications for GPIO bank.

Table 21 • On-Die Termination Calibration Accuracy Specifications for GPIO Bank

Parameter	Description	Min (%)	Typ	Max (%)	Unit	Condition
Differential termination ¹	Internal differential termination	-20	100	20	Ω	$V_{ICM} < 0.8\text{ V}$
		-20	100	40	Ω	$0.6\text{ V} < V_{ICM} < 1.65\text{ V}$
		-20	100	80	Ω	$1.4\text{ V} < V_{ICM}$
Single-ended thevenin termination ^{2, 3}	Internal parallel thevenin termination	-40	50	20	Ω	$V_{DDI} = 1.8\text{ V}/1.5\text{ V}$
		-40	75	20	Ω	$V_{DDI} = 1.8\text{ V}$
		-40	150	20	Ω	$V_{DDI} = 1.8\text{ V}$
		-20	20	20	Ω	$V_{DDI} = 1.5\text{ V}$
		-20	30	20	Ω	$V_{DDI} = 1.5\text{ V}$
		-20	40	20	Ω	$V_{DDI} = 1.5\text{ V}$
		-20	60	20	Ω	$V_{DDI} = 1.5\text{ V}$
		-20	120	20	Ω	$V_{DDI} = 1.5\text{ V}$

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

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	Description	V_L^1	V_H^1	V_{ID}^2	V_{ICM}^2	$V_{MEAS}^{3,4}$	$V_{REF}^{1,5}$	Unit
HSUL18I	HSUL 1.8 V Class I	$V_{REF} -$ 0.54	$V_{REF} +$ 0.54			V_{REF}	0.90	V
HSUL18II	HSUL 1.8 V Class II	$V_{REF} -$ 0.54	$V_{REF} +$ 0.54			V_{REF}	0.90	V
HSUL12	HSUL 1.2 V	$V_{REF} -$.22	$V_{REF} +$.22			V_{REF}	0.60	V
POD12I	Pseudo open drain (POD) logic 1.2 V Class I	$V_{REF} -$.15	$V_{REF} +$.15			V_{REF}	0.84	V
POD12II	POD 1.2 V Class II	$V_{REF} -$.15	$V_{REF} +$.15			V_{REF}	0.84	V
LVDS33	Low-voltage differential signaling (LVDS) 3.3 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
LVDS25	LVDS 2.5 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
LVDS18	LVDS 1.8 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.900	0		V
RSDS33	RSDS 3.3 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
RSDS25	RSDS 2.5 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
RSDS18	RSDS 1.8 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
MINILVDS33	Mini-LVDS 3.3 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
MINILVDS25	Mini-LVDS 2.5 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
MINILVDS18	Mini-LVDS 1.8 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	1.250	0		V
SUBLVDS33	Sub-LVDS 3.3 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.900	0		V
SUBLVDS25	Sub-LVDS 2.5 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.900	0		V
SUBLVDS18	Sub-LVDS 1.8 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.900	0		V
PPDS33	Point-to-point differential signaling 3.3 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.800	0		V
PPDS25	PPDS 2.5 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.800	0		V
PPDS18	PPDS 1.8 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.800	0		V
SLVS33	Scalable low- voltage signaling 3.3 V	$V_{ICM} -$.125	$V_{ICM} +$.125	0.250	0.200	0		V

Standard	STD	–1	Unit
LVC MOS18 (12 mA)	500	500	Mbps
LVC MOS15 (10 mA)	500	500	Mbps
LVC MOS12 (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 $V_{ID} \geq 200$ 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
LVC MOS18 (12 mA)	500	500	Mbps
LVC MOS15 (10 mA)	500	500	Mbps

7.1.5 Maximum PHY Rate for Memory Interface IP

The following tables provide information about the maximum PHY rate for memory interface IP.

Table 28 • Maximum PHY Rate for Memory Interfaces IP for HSIO Banks

Memory Standard	Gearing Ratio	VDDAUX	VDDI	STD (Mbps)	–1 (Mbps)	Fabric STD (MHz)	Fabric –1 (MHz)
DDR4	8:1	1.8 V	1.2 V	1333	1600	167	200
DDR3	8:1	1.8 V	1.5 V	1067	1333	133	167
DDR3L	8:1	1.8 V	1.35 V	1067	1333	133	167
LPDDR3	8:1	1.8 V	1.2 V	1067	1333	133	167
QDRII+	8:1	1.8 V	1.5 V	900	1100	112.5	137.5
RLDRAM3 ¹	8:1	1.8 V	1.35 V	1067	1067	133	133
RLDRAM3 ¹	4:1	1.8 V	1.35 V	667	800	167	200
RLDRAM3 ¹	2:1	1.8 V	1.35 V	333	400	167	200
RLDRAM2 ¹	8:1	1.8 V	1.8 V	800	1067	100	133
RLDRAM2 ¹	4:1	1.8 V	1.8 V	667	800	167	200
RLDRAM2 ¹	2:1	1.8 V	1.8 V	333	400	167	200

1. RLDRAM2 and RLDRAM3 are not supported with a soft IP controller currently.

Table 29 • Maximum PHY Rate for Memory Interfaces IP for GPIO Banks

Memory Standard	Gearing Ratio	VDDAUX	VDDI	STD (Mbps)	–1 (Mbps)	Fabric STD (MHz)	Fabric –1 (MHz)
DDR3	8:1	2.5 V	1.5 V	800	1067	100	133
QDRII+	8:1	2.5 V	1.5 V	900	900	113	113
RLDRAM2 ¹	4:1	2.5 V	1.8 V	800	800	200	200
RLDRAM2 ¹	2:1	2.5 V	1.8 V	400	400	200	200

1. RLDRAM2 is currently not supported with a soft IP controller.

Parameter	Symbol	Min	Typ	Max	Unit
Operating current (V_{DD18})	RC_{SCVPP}			0.1	μA
Operating current (V_{DD})	RC_{SCVDD}			60.7	μA

7.3 Fabric Specifications

The following section describes specifications for the fabric.

7.3.1 Math Blocks

The following tables describe math block performance.

Table 41 • Math Block Performance Extended Commercial Range (0 °C to 100 °C)

Parameter	Symbol	Modes	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 operating frequency	F _{MAX}	18 × 18 multiplication	370	470	440	500	MHz
		18 × 18 multiplication summed with 48-bit input	370	470	440	500	MHz
		18 × 19 multiplier pre-adder ROM mode	365	465	435	500	MHz
		Two 9 × 9 multiplication	370	470	440	500	MHz
		9 × 9 dot product (DOTP)	370	470	440	500	MHz
		Complex 18 × 19 multiplication	360	455	430	500	MHz

Table 42 • Math Block Performance Industrial Range (–40 °C to 100 °C)

Parameter	Symbol	Modes	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 operating frequency	F _{MAX}	18 × 18 multiplication	365	465	435	500	MHz
		18 × 18 multiplication summed with 48-bit input	365	465	435	500	MHz
		18 × 19 multiplier pre-adder ROM mode	355	460	430	500	MHz
		Two 9 × 9 multiplication	365	465	435	500	MHz
		9 × 9 DOTP	365	465	435	500	MHz
		Complex 18 × 19 multiplication	350	450	425	500	MHz

Table 44 • μ SRAM Performance

Parameter	Symbol	$V_{DD} = 1.0\text{ V} - \text{STD}$	$V_{DD} = 1.0\text{ V} - 1$	$V_{DD} = 1.05\text{ V} - \text{STD}$	$V_{DD} = 1.05\text{ V} - 1$	Unit	Condition
Operating frequency	F_{MAX}	400	415	450	480	MHz	Write-port
Read access time	T_{ac}		2		2	ns	Read-port

Table 45 • μ PROM Performance

Parameter	Symbol	$V_{DD} = 1.0\text{ V} - \text{STD}$	$V_{DD} = 1.0\text{ V} - 1$	$V_{DD} = 1.05\text{ V} - \text{STD}$	$V_{DD} = 1.05\text{ V} - 1$	Unit
Read access time	T_{ac}	10	10	10	10	ns

7.4 Transceiver Switching Characteristics

This section describes transceiver switching characteristics.

7.4.1 Transceiver Performance

The following table describes transceiver performance.

Table 46 • PolarFire Transceiver and TXPLL Performance

Parameter	Symbol	STD Min	STD Typ	STD Max	-1 Min	-1 Typ	-1 Max	Unit
Tx data rate ^{1,2}	F_{TXRate}	0.25		10.3125	0.25		12.7	Gbps
Tx OOB (serializer bypass) data rate	$F_{TXRateOOB}$	DC		1.5	DC		1.5	Gbps
Rx data rate when AC coupled ²	$F_{RxRateAC}$	0.25		10.3125	0.25		12.7	Gbps
Rx data rate when DC coupled	$F_{RxRateDC}$	0.25		3.2	0.25		3.2	Gbps
Rx OOB (deserializer bypass) data rate	$F_{TXRateOOB}$	DC		1.25	DC		1.25	Gbps
TXPLL output frequency ³	F_{TXPLL}	1.6		6.35	1.6		6.35	GHz
Rx CDR mode	F_{RXCDR}	0.25		10.3125	0.25		10.3125	Gbps
Rx DFE mode ²	F_{RXDFE}	3.0		10.3125	3.0		12.7	Gbps
Rx Eye Monitor mode ²	$F_{RXEyeMon}$	3.0		10.3125	3.0		12.7	Gbps

1. The reference clock is required to be a minimum of 75 MHz for data rates of 10 Gbps and above.
2. 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).
3. The Tx PLL rate is between 0.5x to 5.5x the Tx data rate. The Tx data rate depends on per XCVR lane Tx post-divider settings.

7.4.2 Transceiver Reference Clock Performance

The following table describes performance of the transceiver reference clock.

Table 47 • PolarFire Transceiver Reference Clock AC Requirements

Parameter	Symbol	STD Min	STD Typ	STD Max	-1 Min	-1 Typ	-1 Max	Unit
Reference clock input rate ^{1,2}	$F_{TXREFCLK}$	20		800	20		800	MHz

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	$0.7 \times V_{DDA}$		$0.9 \times V_{DDA}$	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	$V_{DETLLOW}$	65		175	mV	Setting = PCIe ^{3,7}
	$V_{DETLLOW}$	95		190	mV	Setting = SATA ^{4,8}
	$V_{DETLLOW}$	75		170	mV	Setting = 1
	$V_{DETLLOW}$	95		185	mV	Setting = 2
	$V_{DETLLOW}$	100		190	mV	Setting = 3
	$V_{DETLLOW}$	140		210	mV	Setting = 4
	$V_{DETLLOW}$	155		240	mV	Setting = 5
	$V_{DETLLOW}$	165		245	mV	Setting = 6
	$V_{DETLLOW}$	170		250	mV	Setting = 7
Sinusoidal jitter tolerance	T_{SJITOL}				UI	>8.5 Gbps – 12.7 Gbps ^{5, 10}

7.6.1 FPGA Programming Cycle and Retention

The following table describes FPGA programming cycle and retention.

Table 68 • FPGA Programming Cycles vs Retention Characteristics

Programming T _i	Programming Cycles, Max	Retention Years	Retention Years at T _i
0 °C to 85 °C	1000	20	85 °C
0 °C to 100 °C	500	20	100 °C
–20 °C to 100 °C	500	20	100 °C
–40 °C to 100 °C	500	20	100 °C
–40 °C to 85 °C	1000	16	100 °C
–40 °C to 55 °C	2000	12	100 °C

Note: Power supplied to the device must be valid during programming operations such as programming and verify . Programming recovery mode is available only for in-application programming mode and requires an external SPI flash.

7.6.2 FPGA Programming Time

The following tables describe FPGA programming time.

Table 69 • Master SPI Programming Time (IAP)

Parameter	Symbol	Devices	Typ	Max	Unit
Programming time	T _{PROG}	MPF100T, TL, TS, TLS			s
		MPF200T, TL, TS, TLS	17	25	s
		MPF300T, TL, TS, TLS	26	32	s
		MPF500T, TL, TS, TLS			s

Table 70 • Slave SPI Programming Time

Parameter	Symbol	Devices	Typ	Max	Unit
Programming time	T _{PROG}	MPF100T, TL, TS, TLS			s
		MPF200T, TL, TS, TLS	41 ¹		s
		MPF300T, TL, TS, TLS	50 ¹	60	s
		MPF500T, TL, TS, TLS			s

1. SmartFusion2 with MSS running at 100 MHz, MSS_SPI_0 port running at 6.67 MHz. Bitstream stored in DDR. DirectC version 4.1.

Table 71 • JTAG Programming Time

Parameter	Symbol	Devices	Typ	Max	Unit
Programming time	T _{PROG}	MPF100T, TL, TS, TLS			s
		MPF200T, TL, TS, TLS		56	s
		MPF300T, TL, TS, TLS ¹		95	s
		MPF500T, TL, TS, TLS			s

1. Programmer: FlashPro5 with TCK 10 MHz. PC Configuration: Intel i7 at 3.6 GHz, 32 GB RAM, Windows 10.

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

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

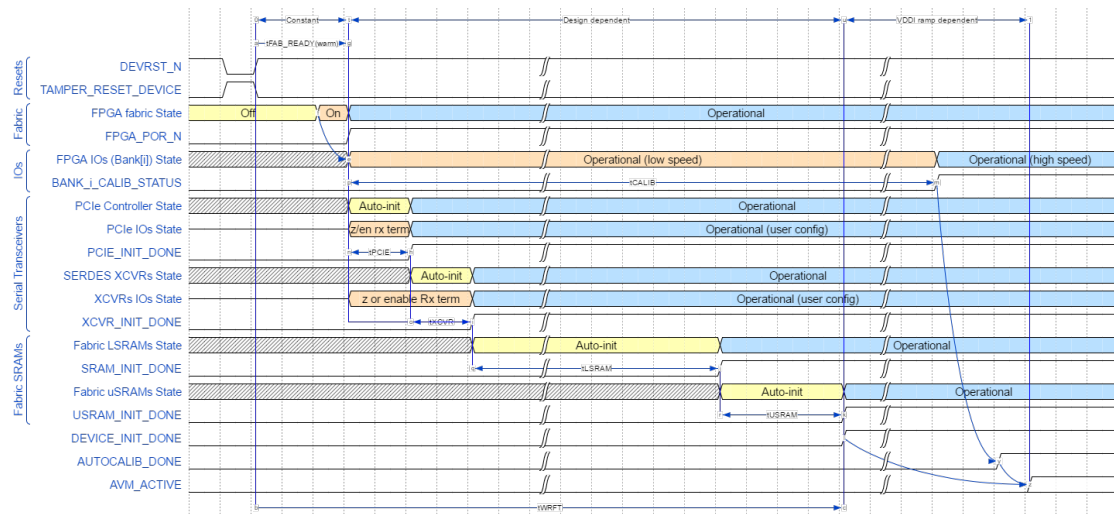
7.9 Power-Up to Functional Timing

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.

Figure 6 • Warm Reset Timing



7.9.3 Power-On Reset Voltages

7.9.3.1 Main Supplies

The start of power-up to functional time (T_{PUFT}) is defined as the point at which the latest of the main supplies (VDD, VDD18, VDD25) reach the reference voltage levels specified in the following table. This starts the process of releasing the reset of the device and powering on the FPGA fabric and IOs.

Table 97 • POR Ref Voltages

Supply	Power-On Reset Start Point (V)	Note
VDD	0.95	Applies to both 1.0 V and 1.05 V operation.
VDD18	1.71	
VDD25	2.25	

7.9.3.2 I/O-Related Supplies

For the I/Os to become functional (for low speed, sub 400 MHz operation), the (per-bank) I/O supplies (VDDI, VDDAUX) must reach the trip point voltage levels specified in the following table and the main supplies above must also be powered on.

Table 98 • I/O-Related Supplies

Supply	I/O Power-Up Start Point (V)
VDDI	0.85
VDDAUX	1.6

There are no sequencing requirements for the power supplies. However, VDDI3 and must be valid at same time as the main supplies. The other IO supplies (VDDI, VDDAUX) have no effect on power-up of FPGA fabric (that is, the fabric still powers up even if the IO supplies of some IO banks remain powered off).

Table 104 • Flash*Freeze

Parameter	Symbol	Min	Typ	Max	Unit	Condition
The time from Flash*Freeze entry command to the Flash*Freeze state	T _{FF_ENTRY}		59		μs	
The time from Flash*Freeze exit pin assertion to fabric operational state	T _{FF_FABRIC_UP}		133		μs	
The time from Flash*Freeze exit pin assertion to I/Os operational	T _{FF_IO_ACTIVE}		143		μs	

7.10 Dedicated Pins

The following section describes the dedicated pins.

7.10.1 JTAG Switching Characteristics

The following table describes characteristics of JTAG switching.

Table 105 • JTAG Electrical Characteristics

Symbol	Description	Min	Typ	Max	Unit	Condition
T _{DISU}	TDI input setup time	0.0			ns	
T _{DIHD}	TDI input hold time	2.0			ns	
T _{TMSSU}	TMS input setup time	1.5			ns	
T _{TMSHD}	TMS input hold time	1.5			ns	
F _{TCK}	TCK frequency			25	MHz	
T _{TCKDC}	TCK duty cycle	40		60	%	
T _{TDOCQ}	TDO clock to Q out			8.4	ns	C _{LOAD} = 40 pf
T _{TRSTBCQ}	TRSTB clock to Q out			23.5	ns	C _{LOAD} = 40 pf
T _{TRSTBPW}	TRSTB min pulse width	50			ns	
T _{TRSTBREM}	TRSTB removal time	0.0			ns	
T _{TRSTBREC}	TRSTB recovery time	12.0			ns	
C _{INTDI}	TDI input pin capacitance			5.3	pf	
C _{INTMS}	TMS input pin capacitance			5.3	pf	
C _{INTCK}	TCK input pin capacitance			5.3	pf	
C _{INTTRSTB}	TRSTB input pin capacitance			5.3	pf	

7.10.2 SPI Switching Characteristics

The following tables describe characteristics of SPI switching.

Table 106 • SPI Master Mode (PolarFire Master) During Programming

Parameter	Symbol	Min	Typ	Max	Unit	Condition
SCK frequency	F _{MSCK}			20	MHz	

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