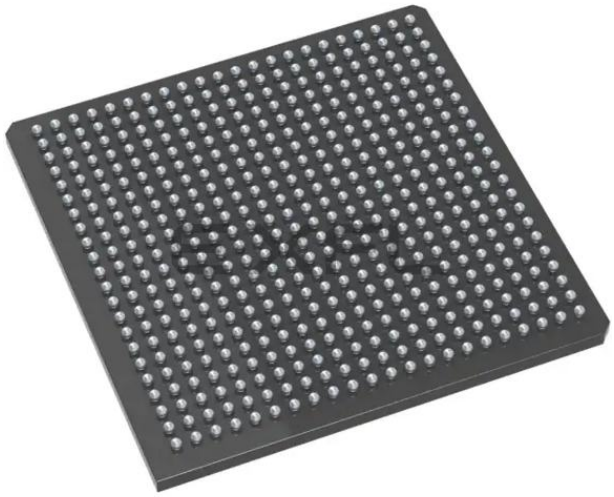

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Understanding Embedded - FPGAs (Field Programmable Gate Array)

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	Obsolete
Number of LABs/CLBs	-
Number of Logic Elements/Cells	13824
Total RAM Bits	110592
Number of I/O	270
Number of Gates	600000
Voltage - Supply	1.425V ~ 1.575V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 70°C (TA)
Package / Case	484-BGA
Supplier Device Package	484-FPBGA (23x23)
Purchase URL	https://www.e-xfl.com/product-detail/microsemi/agle600v5-fg484

IGLOOe Ordering Information

AGLE3000 V2 – FG G 896 Y I

- I: Application (Temperature Range)
  - Blank = Commercial (0°C to +70°C Ambient Temperature)
  - I = Industrial (–40°C to +85°C Ambient Temperature)
  - PP = Pre-Production
  - ES = Engineering Sample (Room Temperature Only)
- Y: Security Feature
  - Y = Device Includes License to Implement IP Based on the Cryptography Research, Inc. (CRI) Patent Portfolio
  - Blank = Device Does Not Include License to Implement IP Based on the Cryptography Research, Inc. (CRI) Patent Portfolio
- 896: Package Lead Count
- G: Lead-Free Packaging
  - Blank = Standard Packaging
  - G = RoHS-Compliant Packaging
- FG: Package Type
  - FG = Fine Pitch Ball Grid Array (1.0 mm pitch)
- V2: Supply Voltage
  - 2 = 1.2 V to 1.5 V
  - 5 = 1.5 V only
- AGLE3000: Part Number

IGLOOe Devices

AGLE600 = 600,000 System Gates
AGLE3000 = 3,000,000 System Gates

IGLOOe Devices with Cortex-M1

M1AGLE3000 = 3,000,000 System Gates

Note: Marking Information: IGLOO V2 devices do not have V2 marking, but IGLOO V5 devices are marked accordingly.

1 – IGLOOe Device Family Overview

General Description

The IGLOOe family of flash FPGAs, based on a 130-nm flash process, offers the lowest power FPGA, a single-chip solution, small footprint packages, reprogrammability, and an abundance of advanced features.

The Flash*Freeze technology used in IGLOOe devices enables entering and exiting an ultra-low power mode while retaining SRAM and register data. Flash*Freeze technology simplifies power management through I/O and clock management with rapid recovery to operation mode.

The Low Power Active capability (static idle) allows for ultra-low power consumption while the IGLOOe device is completely functional in the system. This allows the IGLOOe device to control system power management based on external inputs (e.g., scanning for keyboard stimulus) while consuming minimal power.

Nonvolatile flash technology gives IGLOOe devices the advantage of being a secure, low power, single-chip solution that is Instant On. IGLOOe is reprogrammable and offers time-to-market benefits at an ASIC-level unit cost.

These features enable designers to create high-density systems using existing ASIC or FPGA design flows and tools.

IGLOOe devices offer 1 kbit of on-chip, programmable, nonvolatile FlashROM storage as well as clock conditioning circuitry based on 6 integrated phase-locked loops (PLLs). IGLOOe devices have up to 3 million system gates, supported with up to 504 kbits of true dual-port SRAM and up to 620 user I/Os.

M1 IGLOOe devices support the high-performance, 32-bit Cortex-M1 processor developed by ARM for implementation in FPGAs. Cortex-M1 is a soft processor that is fully implemented in the FPGA fabric. It has a three-stage pipeline that offers a good balance between low power consumption and speed when implemented in an M1 IGLOOe device. The processor runs the ARMv6-M instruction set, has a configurable nested interrupt controller, and can be implemented with or without the debug block. Cortex-M1 is available for free from Microsemi for use in M1 IGLOOe FPGAs.

The ARM-enabled devices have Microsemi ordering numbers that begin with M1AGLE and do not support AES decryption.

Flash*Freeze Technology

The IGLOOe device offers unique Flash*Freeze technology, allowing the device to enter and exit ultra-low power Flash*Freeze mode. IGLOOe devices do not need additional components to turn off I/Os or clocks while retaining the design information, SRAM content, and registers. Flash*Freeze technology is combined with in-system programmability, which enables users to quickly and easily upgrade and update their designs in the final stages of manufacturing or in the field. The ability of IGLOOe V2 devices to support a wide range of core voltage (1.2 V to 1.5 V) allows further reduction in power consumption, thus achieving the lowest total system power.

When the IGLOOe device enters Flash*Freeze mode, the device automatically shuts off the clocks and inputs to the FPGA core; when the device exits Flash*Freeze mode, all activity resumes and data is retained.

The availability of low power modes, combined with reprogrammability, a single-chip and single-voltage solution, and availability of small-footprint, high pin-count packages, make IGLOOe devices the best fit for portable electronics.

Reduced Cost of Ownership

Advantages to the designer extend beyond low unit cost, performance, and ease of use. Unlike SRAM-based FPGAs, Flash-based IGLOOe devices allow all functionality to be Instant On; no external boot PROM is required. On-board security mechanisms prevent access to all the programming information and enable secure remote updates of the FPGA logic. Designers can perform secure remote in-system reprogramming to support future design iterations and field upgrades with confidence that valuable intellectual property cannot be compromised or copied. Secure ISP can be performed using the industry-standard AES algorithm. The IGLOOe family device architecture mitigates the need for ASIC migration at higher user volumes. This makes the IGLOOe family a cost-effective ASIC replacement solution, especially for applications in the consumer, networking/communications, computing, and avionics markets.

Firm-Error Immunity

Firm errors occur most commonly when high-energy neutrons, generated in the upper atmosphere, strike a configuration cell of an SRAM FPGA. The energy of the collision can change the state of the configuration cell and thus change the logic, routing, or I/O behavior in an unpredictable way. These errors are impossible to prevent in SRAM FPGAs. The consequence of this type of error can be a complete system failure. Firm errors do not exist in the configuration memory of IGLOOe flash-based FPGAs. Once it is programmed, the flash cell configuration element of IGLOOe FPGAs cannot be altered by high-energy neutrons and is therefore immune to them. Recoverable (or soft) errors occur in the user data SRAM of all FPGA devices. These can easily be mitigated by using error detection and correction (EDAC) circuitry built into the FPGA fabric.

Advanced Flash Technology

The IGLOOe family offers many benefits, including nonvolatility and reprogrammability, through an advanced flash-based, 130-nm LVCMOS process with seven layers of metal. Standard CMOS design techniques are used to implement logic and control functions. The combination of fine granularity, enhanced flexible routing resources, and abundant flash switches allows for very high logic utilization without compromising device routability or performance. Logic functions within the device are interconnected through a four-level routing hierarchy.

IGLOOe family FPGAs utilize design and process techniques to minimize power consumption in all modes of operation.

Advanced Architecture

The proprietary IGLOOe architecture provides granularity comparable to standard-cell ASICs. The IGLOOe device consists of five distinct and programmable architectural features (Figure 1-1 on page 4):

- Flash*Freeze technology
- FPGA VersaTiles
- Dedicated FlashROM
- Dedicated SRAM/FIFO memory
- Extensive CCCs and PLLs
- Pro I/O structure

The FPGA core consists of a sea of VersaTiles. Each VersaTile can be configured as a three-input logic function, a D-flip-flop (with or without enable), or a latch by programming the appropriate flash switch interconnections. The versatility of the IGLOOe core tile as either a three-input lookup table (LUT) equivalent or a D-flip-flop/latch with enable allows for efficient use of the FPGA fabric. The VersaTile capability is unique to the Microsemi ProASIC® family of third-generation-architecture flash FPGAs. VersaTiles are connected with any of the four levels of routing hierarchy. Flash switches are distributed throughout the device to provide nonvolatile, reconfigurable interconnect programming. Maximum core utilization is possible for virtually any design.

Table 2-14 • Summary of I/O Output Buffer Power (per pin) – Default I/O Software Settings[1]

	C_{LOAD} (pF)	VCCI (V)	Static Power PDC7 (mW)[2]	Dynamic Power PAC10 (µW/MHz)[3]
Single-Ended				
3.3 V LVTTL/LVCMOS	5	3.3	–	148.00
3.3 V LVCMOS Wide Range [4]	5	3.3	–	148.00
2.5 V LVCMOS	5	2.5	–	83.23
1.8 V LVCMOS	5	1.8	–	54.58
1.5 V LVCMOS (JESD8-11)	5	1.5	–	37.05
1.2 V LVCMOS (JESD8-11)	5	1.2	–	17.94
1.2 V LVCMOS (JESD8-11) – Wide Range				17.94
3.3 V PCI	10	3.3	–	204.61
3.3 V PCI-X	10	3.3	–	204.61
Voltage-Referenced				
3.3 V GTL	10	3.3	–	24.08
2.5 V GTL	10	2.5	–	13.52
3.3 V GTL+	10	3.3	–	24.10
2.5 V GTL+	10	2.5	–	13.54
HSTL (I)	20	1.5	7.08	26.22
HSTL (II)	20	1.5	13.88	27.18
SSTL2 (I)	30	2.5	16.69	105.56
SSTL2 (II)	30	2.5	25.91	116.60
SSTL3 (I)	30	3.3	26.02	114.67
SSTL3 (II)	30	3.3	42.21	131.69
Differential				
LVDS	–	2.5	7.70	89.62
LVPECL	–	3.3	19.42	167.86

Notes:

1. *Dynamic power consumption is given for standard load and software default drive strength and output slew.*
2. *PDC7 is the static power (where applicable) measured on VCCI.*
3. *PAC10 is the total dynamic power measured on VCCI.*
4. *All LVCMOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JESD8b specification.*

Overview of I/O Performance

Summary of I/O DC Input and Output Levels – Default I/O Software Settings

Table 2-21 • Summary of Maximum and Minimum DC Input and Output Levels Applicable to Commercial and Industrial Conditions

I/O Standard	Drive Strength	Equivalent Software Default Drive Strength[2]	Slew Rate	VIL		VIH		VOL	VOH	IOL[1]	IOH[1]
				Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	mA	mA
3.3 V LVTTL / 3.3 V LVCMOS	12 mA	12 mA	High	–0.3	0.8	2	3.6	0.4	2.4	12	12
3.3 V LVCMOS Wide Range[3]	100 µA	12 mA	High	–0.3	0.8	2	3.6	0.2	VCCI – 0.2	0.1	0.1
2.5 V LVCMOS	12 mA	12 mA	High	–0.3	0.7	1.7	3.6	0.7	1.7	12	12
1.8 V LVCMOS	12 mA	12 mA	High	–0.3	0.35 * VCCI	0.65 * VCCI	3.6	0.45	VCCI – 0.45	12	12
1.5 V LVCMOS	12 mA	12 mA	High	–0.3	0.35 * VCCI	0.65 * VCCI	3.6	0.25 * VCCI	0.75 * VCCI	12	12
1.2 V LVCMOS	2 mA	2 mA	High	–0.3	0.35 * VCCI	0.65 * VCCI	3.6	0.25 * VCCI	0.75 * VCCI	2	2
1.2 V LVCMOS Wide Range[4]	100 µA	2 mA	High	–0.3	0.3 * VCCI	0.7 * VCCI	3.6	0.1	VCCI – 0.1	0.1	0.1
3.3 V PCI	Per PCI Specification										
3.3 V PCI-X	Per PCI-X Specification										
3.3 V GTL	20 mA[5]	20 mA[5]	High	–0.3	VREF – 0.05	VREF + 0.05	3.6	0.4	–	20	20
2.5 V GTL	20 mA[5]	20 mA[5]	High	–0.3	VREF – 0.05	VREF + 0.05	3.6	0.4	–	20	20
3.3 V GTL+	35 mA	35 mA	High	–0.3	VREF – 0.1	VREF + 0.1	3.6	0.6	–	35	35
2.5 V GTL+	33 mA	33 mA	High	–0.3	VREF – 0.1	VREF + 0.1	3.6	0.6	–	33	33
HSTL (I)	8 mA	8 mA	High	–0.3	VREF – 0.1	VREF + 0.1	3.6	0.4	VCCI – 0.4	8	8

Notes:

1. *Currents are measured at 85°C junction temperature.*
2. *The minimum drive strength for any LVCMOS 1.2 V or LVCMOS 3.3 V software configuration when run in wide range is ±100 µA. Drive strength displayed in the software is supported for normal range only. For a detailed I/V curve, refer to the IBIS models.*
3. *All LVCMOS 3.3 V software macros support LVCMOS 3.3 V wide range as specified in the JESD8-12 specification.*
4. *All LVCMOS 1.2 V software macros support LVCMOS 1.2 V wide range as specified in the JESD8-12 specification.*
5. *Output drive strength is below JEDEC specification.*
6. *Output Slew Rates can be extracted from IBIS Models, http://www.microsemi.com/soc/download/ibis/default.aspx.*

Table 2-30 • I/O Short Currents IOSH/IOSL

	Drive Strength	IOSH (mA)*	IOSL (mA)*
3.3 V LVTTL / 3.3 V LVCMOS	4 mA	25	27
	8 mA	51	54
	12 mA	103	109
	16 mA	132	127
	24 mA	268	181
3.3 V LVCMOS Wide Range	100 µA	Same as regular 3.3 V LVCMOS	Same as regular 3.3 V LVCMOS
2.5 V LVCMOS	4 mA	16	18
	8 mA	32	37
	12 mA	65	74
	16 mA	83	87
	24 mA	169	124
1.8 V LVCMOS	2 mA	9	11
	4 mA	17	22
	6 mA	35	44
	8 mA	45	51
	12 mA	91	74
	16 mA	91	74
1.5 V LVCMOS	2 mA	13	16
	4 mA	25	33
	6 mA	32	39
	8 mA	66	55
	12 mA	66	55
1.2 V LVCMOS	2 mA	20	26
1.2 V LVCMOS Wide Range	100 µA	20	26
3.3 V PCI/PCIX	Per PCI/PCI-X Specification	Per PCI Curves	
3.3 V GTL	25 mA	268	181
2.5 V GTL	25 mA	169	124
3.3 V GTL+	35 mA	268	181
2.5 V GTL+	33 mA	169	124
HSTL (I)	8 mA	32	39
HSTL (II)	15 mA	66	55
SSTL2 (I)	15 mA	83	87
SSTL2 (II)	18 mA	169	124
SSTL3 (I)	14 mA	51	54
SSTL3 (II)	21 mA	103	109

Note: T_J = 100°C

Single-Ended I/O Characteristics

3.3 V LVTTL / 3.3 V LVCMOS

Low-Voltage Transistor–Transistor Logic is a general purpose standard (EIA/JESD) for 3.3 V applications. It uses an LVTTL input buffer and push-pull output buffer. The 3.3 V LVCMOS standard is supported as part of the 3.3 V LVTTL support.

Table 2-34 • Minimum and Maximum DC Input and Output Levels

3.3 V LVTTL / 3.3 V LVCMOS	VIL		VIH		VOL	VOH	IOL	IOH	IOSH	IOSL	IIL[1]	IIH[2]
Drive Strength	Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	mA	mA	Max. mA[3]	Max. mA[3]	µA[4]	µA[4]
4 mA	–0.3	0.8	2	3.6	0.4	2.4	4	4	25	27	10	10
8 mA	–0.3	0.8	2	3.6	0.4	2.4	8	8	51	54	10	10
12 mA	–0.3	0.8	2	3.6	0.4	2.4	12	12	103	109	10	10
16 mA	–0.3	0.8	2	3.6	0.4	2.4	16	16	132	127	10	10
24 mA	–0.3	0.8	2	3.6	0.4	2.4	24	24	268	181	10	10

Notes:

1. *IIL is the input leakage current per I/O pin over recommended operation conditions where –0.3 V < VIN < VIL.*
2. *IIH is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges.*
3. *Currents are measured at high temperature (100°C junction temperature) and maximum voltage.*
4. *Currents are measured at 85°C junction temperature.*
5. *Software default selection highlighted in gray.*

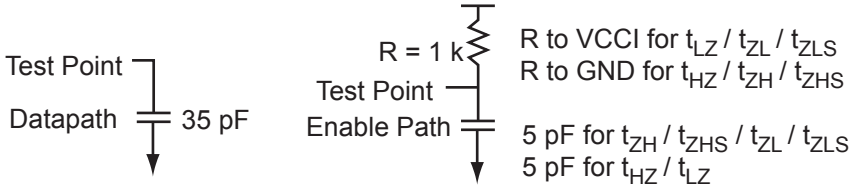

Figure 2-7 • AC Loading

Table 2-35 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ.) (V)	C_{LOAD} (pF)
0	3.3	1.4	–	5

*Note: *Measuring point = Vtrip. See Table 2-23 on page 2-23 for a complete table of trip points.*

1.2 V DC Core Voltage

Table 2-50 • 2.5 V LVCMOS Low Slew – Applies to 1.2 V DC Core Voltage
Commercial-Case Conditions: T_J = 70°C, Worst-Case VCC = 1.14 V, Worst-Case VCCI = 2.3 V

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	1.55	6.25	0.26	1.55	1.77	1.10	6.36	5.34	2.81	2.63	12.14	11.13	ns
8 mA	Std.	1.55	5.18	0.26	1.55	1.77	1.10	5.26	4.61	3.13	3.32	11.05	10.39	ns
12 mA	Std.	1.55	4.42	0.26	1.55	1.77	1.10	4.49	4.08	3.36	3.76	10.28	9.86	ns
16 mA	Std.	1.55	4.19	0.26	1.55	1.77	1.10	4.25	3.96	3.40	3.89	10.04	9.75	ns
24 mA	Std.	1.55	4.09	0.26	1.55	1.76	1.10	4.15	3.97	3.47	4.32	9.94	9.76	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

Table 2-51 • 2.5 V LVCMOS High Slew – Applies to 1.2 V DC Core Voltage
Commercial-Case Conditions: T_J = 70°C, Worst-Case VCC = 1.14 V, Worst-Case VCCI = 2.3 V

Drive Strength	Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{PYS}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
4 mA	Std.	1.55	3.38	0.26	1.55	1.77	1.10	3.42	3.11	2.81	2.72	9.21	8.89	ns
8 mA	Std.	1.55	2.83	0.26	1.55	1.77	1.10	2.87	2.51	3.13	3.42	8.66	8.30	ns
12 mA	Std.	1.55	2.51	0.26	1.55	1.77	1.10	2.54	2.22	3.36	3.85	8.33	8.00	ns
16 mA	Std.	1.55	2.45	0.26	1.55	1.77	1.10	2.48	2.16	3.40	3.97	8.27	7.95	ns
24 mA	Std.	1.55	2.46	0.26	1.55	1.77	1.10	2.49	2.09	3.47	4.44	8.28	7.88	ns

Notes:

1. *Software default selection highlighted in gray.*
2. *For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.*

2.5 V GTL

Gunning Transceiver Logic is a high-speed bus standard (JESD8-3). It provides a differential amplifier input buffer and an open-drain output buffer. The VCCI pin should be connected to 2.5 V.

Table 2-77 • Minimum and Maximum DC Input and Output Levels

2.5 GTL	VIL		VIH		VOL	VOH	IOL	IOH	IOSH	IOSL	IIL[1]	IIH[2]
Drive Strength	Min. V	Max. V	Min. V	Max. V	Max. V	Min. V	mA	mA	Max. mA[3]	Max. mA[3]	µA[4]	µA[4]
20 mA[5]	–0.3	VREF – 0.05	VREF + 0.05	3.6	0.4	–	20	20	169	124	10	10

Notes:

1. *IIL is the input leakage current per I/O pin over recommended operating conditions where –0.3 V < VIN < VIL.*
2. *IIH is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges.*
3. *Currents are measured at high temperature (100°C junction temperature) and maximum voltage.*
4. *Currents are measured at 85°C junction temperature.*
5. *Output drive strength is below JEDEC specification.*

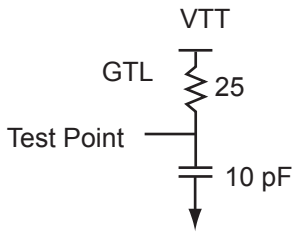

Figure 2-14 • AC Loading

Table 2-78 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ.) (V)	VTT (typ.) (V)	C_{LOAD} (pF)
VREF – 0.05	VREF + 0.05	0.8	0.8	1.2	10

*Note: *Measuring point = Vtrip. See Table 2-23 on page 2-23 for a complete table of trip points.*

Timing Characteristics

1.5 V DC Core Voltage

Table 2-79 • 2.5 V GTL – Applies to 1.5 V DC Core Voltage
Commercial-Case Conditions: T_J = 70°C, Worst-Case VCC = 1.425 V,
Worst-Case VCCI = 3.0 V VREF = 0.8 V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	0.98	1.90	0.19	2.04	0.67	1.94	1.87			5.57	5.50	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

1.2 V DC Core Voltage

Table 2-80 • 2.5 V GTL – Applies to 1.2 V DC Core Voltage
Commercial-Case Conditions: T_J = 70°C, Worst-Case VCC = 1.14 V,
Worst-Case VCCI = 3.0 V VREF = 0.8 V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	t_{EOUT}	t_{ZL}	t_{ZH}	t_{LZ}	t_{HZ}	t_{ZLS}	t_{ZHS}	Units
Std.	1.55	2.16	0.26	2.35	1.10	2.20	2.13			8.01	7.94	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

Table 2-113 • Minimum and Maximum DC Input and Output Levels

DC Parameter	Description	Min.	Typ.	Max.	Units
VCCI	Supply Voltage	2.375	2.5	2.625	V
VOL	Output Low Voltage	0.9	1.075	1.25	V
VOH	Output High Voltage	1.25	1.425	1.6	V
IOL[1]	Output Lower Current	0.65	0.91	1.16	mA
IOH[1]	Output High Current	0.65	0.91	1.16	mA
VI	Input Voltage	0		2.925	V
IIH[2,3]	Input High Leakage Current			10	µA
IIL[2,4]	Input Low Leakage Current			10	µA
VODIFF	Differential Output Voltage	250	350	450	mV
VOCM	Output Common Mode Voltage	1.125	1.25	1.375	V
VICM	Input Common Mode Voltage	0.05	1.25	2.35	V
VIDIFF	Input Differential Voltage	100	350		mV

Notes:

1. *IOL/IOH is defined by VODIFF/(resistor network).*
2. *Currents are measured at 85°C junction temperature.*
3. *IIH is the input leakage current per I/O pin over recommended operating conditions VIH < VIN < VCCI. Input current is larger when operating outside recommended ranges.*
4. *IIL is the input leakage current per I/O pin over recommended operating conditions where –0.3 V < VIN < VIL.*

Table 2-114 • AC Waveforms, Measuring Points, and Capacitive Loads

Input Low (V)	Input High (V)	Measuring Point* (V)	VREF (typ.) (V)
1.075	1.325	Cross point	–

*Note: *Measuring point = Vtrip. See Table 2-23 on page 2-23 for a complete table of trip points.*

Timing Characteristics

1.5 V DC Core Voltage

Table 2-115 • LVDS – Applies to 1.5 V DC Core Voltage
Commercial-Case Conditions: T_J = 70°C, Worst-Case VCC = 1.425 V, Worst-Case VCCI = 2.3 V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	Units
Std.	0.98	1.77	0.19	1.62	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

1.2 V DC Core Voltage

Table 2-116 • LVDS – Applies to 1.2 V DC Core Voltage
Commercial-Case Conditions: T_J = 70°C, Worst-Case VCC = 1.14 V, Worst-Case VCCI = 2.3 V

Speed Grade	t_{DOUT}	t_{DP}	t_{DIN}	t_{PY}	Units
Std.	1.55	2.19	0.26	1.88	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

Output DDR Module

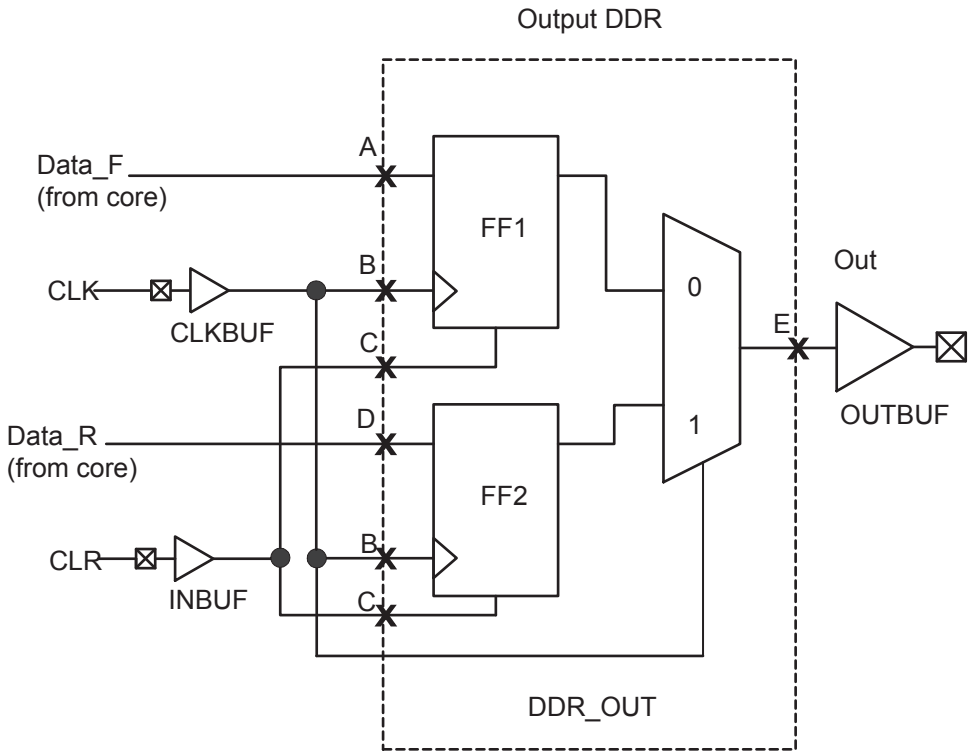

Figure 2-33 • **Output DDR Timing Model**

Table 2-132 • **Parameter Definitions**

Parameter Name	Parameter Definition	Measuring Nodes (from, to)
$t_{DDROCLKQ}$	Clock-to-Out	B, E
$t_{DDROCLR2Q}$	Asynchronous Clear-to-Out	C, E
$t_{DDROREMCLR}$	Clear Removal	C, B
$t_{DDRORECCLR}$	Clear Recovery	C, B
$t_{DDROSUD1}$	Data Setup Data_F	A, B
$t_{DDROSUD2}$	Data Setup Data_R	D, B
$t_{DDROHD1}$	Data Hold Data_F	A, B
$t_{DDROHD2}$	Data Hold Data_R	D, B

Clock Conditioning Circuits

CCC Electrical Specifications

Timing Characteristics

Table 2-143 • IGLOOe CCC/PLL Specification
For IGLOOe V2 or V5 Devices, 1.5 V DC Core Supply Voltage

Parameter	Min.	Typ.	Max.	Units
Clock Conditioning Circuitry Input Frequency f_{IN_CCC}	1.5		250	MHz
Clock Conditioning Circuitry Output Frequency f_{OUT_CCC}	0.75		250	MHz
Serial Clock (SCLK) for Dynamic PLL[1]			100	MHz
Delay Increments in Programmable Delay Blocks [2, 3]		360[4]		ps
Number of Programmable Values in Each Programmable Delay Block			32	ns
Input Cycle-to-Cycle Jitter (peak magnitude)			1	
CCC Output Peak-to-Peak Period Jitter F_{CCC_OUT}	Max Peak-to-Peak Period Jitter			
	1 Global Network Used	External FB Used	3 Global Networks Used	
0.75 MHz to 24 MHz	0.50%	0.75%	0.70%	
24 MHz to 100 MHz	1.00%	1.50%	1.20%	
100 MHz to 250 MHz	2.50%	3.75%	2.75%	
Acquisition Time				
LockControl = 0			300	µs
LockControl = 1			6.0	ms
Tracking Jitter[5]				
LockControl = 0			2.5	ns
LockControl = 1			1.5	ns
Output Duty Cycle	48.5		51.5	%
Delay Range in Block: Programmable Delay 1 [2, 3, 6]	1.25		15.65	ns
Delay Range in Block: Programmable Delay 2 [2, 3, 6]	0.469		15.65	ns
Delay Range in Block: Fixed Delay [2, 3]		3.5		ns

Notes:

1. *Maximum value obtained for a Std. speed grade device in Worst Case Commercial Conditions. For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.*
2. *This delay is a function of voltage and temperature. See Table 2-6 on page 2-6 and Table 2-7 on page 2-6 for deratings.*
3. *T_J = 25°C, VCC = 1.5 V*
4. *When the CCC/PLL core is generated by Microsemi core generator software, not all delay values of the specified delay increments are available. Refer to the Libero SoC Online Help associated with the core for more information.*
5. *Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to the PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by the period jitter parameter.*
6. *For definitions of Type 1 and Type 2, refer to the PLL Block Diagram in the "Clock Conditioning Circuits in IGLOO and ProASIC3 Devices" chapter of the IGLOOe FPGA Fabric User's Guide.*

Table 2-144 • IGLOOe CCC/PLL Specification
For IGLOOe V2 Devices, 1.2 V DC Core Supply Voltage

Parameter	Min.	Typ.	Max.	Units
Clock Conditioning Circuitry Input Frequency f_{IN_CCC}	1.5		160	MHz
Clock Conditioning Circuitry Output Frequency f_{OUT_CCC}	0.75		160	MHz
Serial Clock (SCLK) for Dynamic PLL[1]			60	MHz
Delay Increments in Programmable Delay Blocks[2, 3]		580[4]		ps
Number of Programmable Values in Each Programmable Delay Block			32	
Input Cycle-to-Cycle Jitter (peak magnitude)			0.25	ns
CCC Output Peak-to-Peak Period Jitter F_{CCC_OUT}[5]	Max Peak-to-Peak Period Jitter			
	1 Global Network Used	External FB Used	3 Global Networks Used	
0.75 MHz to 24 MHz	0.50%	0.75%	0.70%	
24 MHz to 100 MHz	1.00%	1.50%	1.20%	
100 MHz to 160 MHz	2.50%	3.75%	2.75%	
Acquisition Time				
LockControl = 0			300	µs
LockControl = 1			6.0	ms
Tracking Jitter[6]				
LockControl = 0			4	ns
LockControl = 1			3	ns
Output Duty Cycle	48.5		51.5	%
Delay Range in Block: Programmable Delay 1[2, 3, 7]	2.3		20.86	ns
Delay Range in Block: Programmable Delay 2[2, 3, 7]	0.863		20.86	ns
Delay Range in Block: Fixed Delay[2, 3]		5.7		ns

Notes:

1. *Maximum value obtained for a Std. speed grade device in Worst Case Commercial Conditions. For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.*
2. *This delay is a function of voltage and temperature. See Table 2-6 on page 2-6 and Table 2-7 on page 2-6 for deratings.*
3. *T_J = 25°C, VCC = 1.5 V*
4. *When the CCC/PLL core is generated by Microsemi core generator software, not all delay values of the specified delay increments are available. Refer to the Libero SoC Online Help associated with the core for more information.*
5. *VCO output jitter is calculated as a percentage of the VCO frequency. The jitter (in ps) can be calculated by multiplying the VCO period by the per cent jitter. The VCO jitter (in ps) applies to CCC_OUT regardless of the output divider settings. For example, if the jitter on VCO is 300 ps, the jitter on CCC_OUT is also 300 ps, regardless of the output divider settings.*
6. *Tracking jitter is defined as the variation in clock edge position of PLL outputs with reference to PLL input clock edge. Tracking jitter does not measure the variation in PLL output period, which is covered by period jitter parameter.*
7. *For definitions of Type 1 and Type 2, refer to the PLL Block Diagram in the "Clock Conditioning Circuits in IGLOO and ProASIC3 Devices" chapter of the IGLOOe FPGA Fabric User's Guide.*

Timing Waveforms

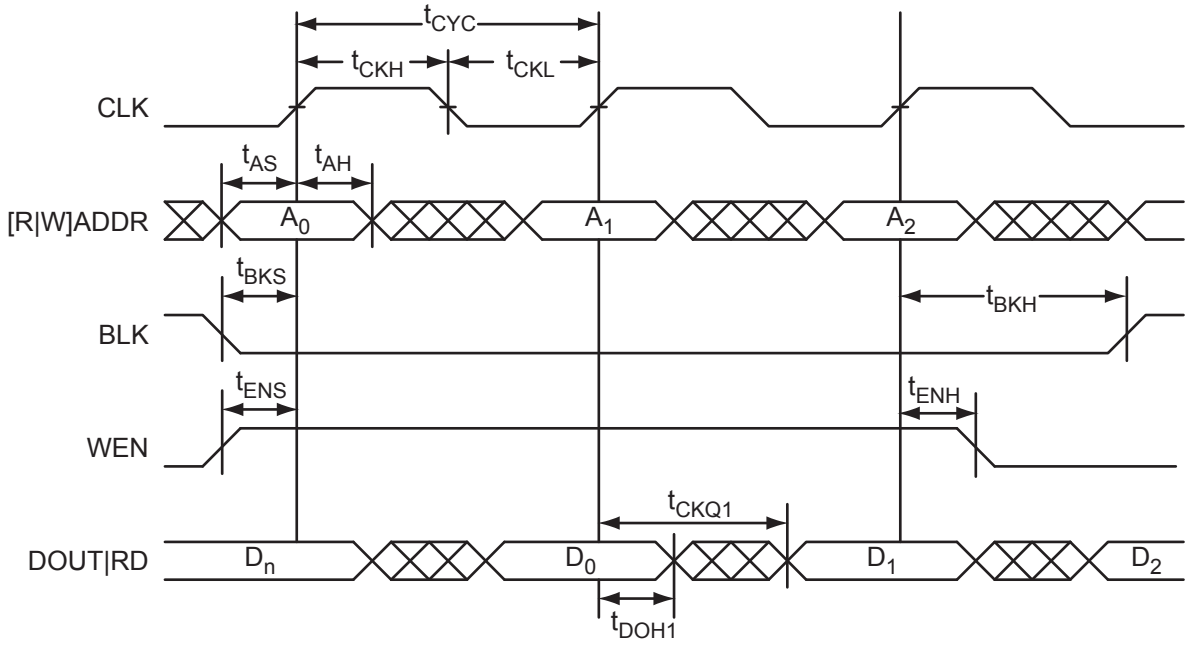

Figure 2-42 • **RAM Read for Pass-Through Output. Applicable to Both RAM4K9 and RAM512X18.**

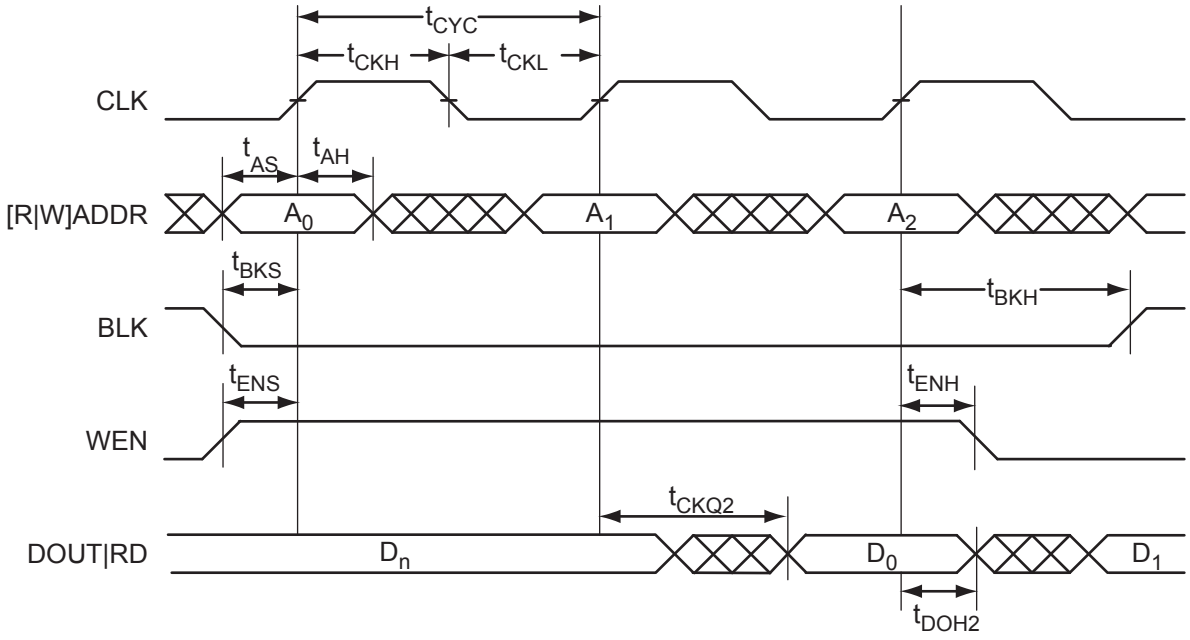

Figure 2-43 • **RAM Read for Pipelined Output. Applicable to Both RAM4K9 and RAM512X18.**

Embedded FlashROM Characteristics

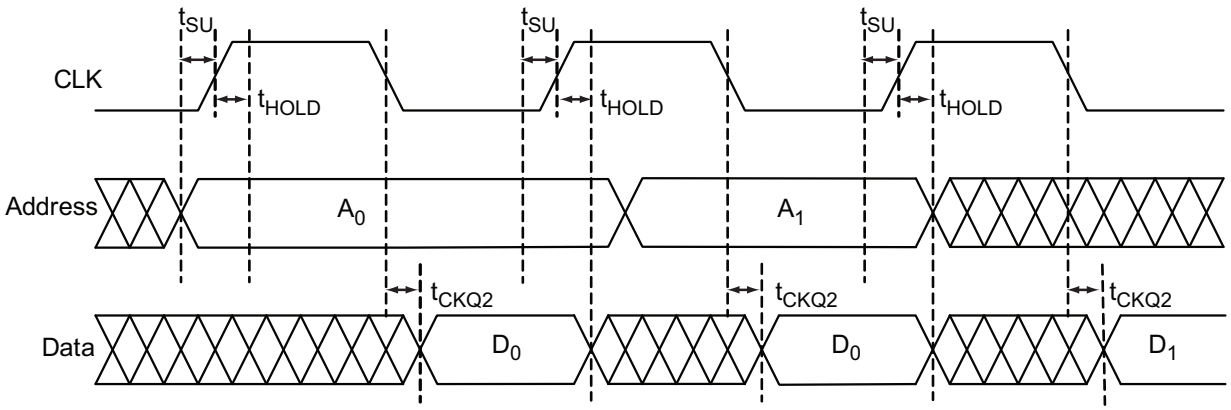

Figure 2-55 • **Timing Diagram**

Timing Characteristics

Applies to 1.5 V DC Core Voltage

Table 2-151 • **Embedded FlashROM Access Time**
Commercial-Case Conditions: T_J = 70°C, VCC = 1.425 V

Parameter	Description	Std.	Units
t_{SU}	Address Setup Time	0.58	ns
t_{HOLD}	Address Hold Time	0.00	ns
t_{CK2Q}	Clock-to-Out	34.14	ns
F_{MAX}	Maximum Clock Frequency	15	MHz

Applies to 1.2 V DC Core Voltage

Table 2-152 • **Embedded FlashROM Access Time**
Commercial-Case Conditions: T_J = 70°C, VCC = 1.14 V

Parameter	Description	Std.	Units
t_{SU}	Address Setup Time	0.59	ns
t_{HOLD}	Address Hold Time	0.00	ns
t_{CK2Q}	Clock-to-Out	52.90	ns
F_{MAX}	Maximum Clock Frequency	10	MHz

JTAG 1532 Characteristics

JTAG timing delays do not include JTAG I/Os. To obtain complete JTAG timing, add I/O buffer delays to the corresponding standard selected; refer to the I/O timing characteristics in the "User I/O Characteristics" section on page 2-16 for more details.

Timing Characteristics

Applies to 1.2 V DC Core Voltage

***Table 2-153* • JTAG 1532**
Commercial-Case Conditions: T_J = 70°C, VCC = 1.14 V

Parameter	Description	Std.	Units
t_{DISU}	Test Data Input Setup Time	1.50	ns
t_{DIHD}	Test Data Input Hold Time	3.00	ns
t_{TMSSU}	Test Mode Select Setup Time	1.50	ns
t_{TMDHD}	Test Mode Select Hold Time	3.00	ns
t_{TCK2Q}	Clock to Q (data out)	11.00	ns
t_{RSTB2Q}	Reset to Q (data out)	30.00	ns
F_{TCKMAX}	TCK Maximum Frequency	9.00	MHz
$t_{TRSTREM}$	ResetB Removal Time	1.18	ns
$t_{TRSTREC}$	ResetB Recovery Time	0.00	ns
$t_{TRSTMPW}$	ResetB Minimum Pulse	TBD	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-7 on page 2-6 for derating values.

Applies to 1.5 V DC Core Voltage

***Table 2-154* • JTAG 1532**
Commercial-Case Conditions: T_J = 70°C, VCC = 1.425 V

Parameter	Description	Std.	Units
t_{DISU}	Test Data Input Setup Time	1.00	ns
t_{DIHD}	Test Data Input Hold Time	2.00	ns
t_{TMSSU}	Test Mode Select Setup Time	1.00	ns
t_{TMDHD}	Test Mode Select Hold Time	2.00	ns
t_{TCK2Q}	Clock to Q (data out)	8.00	ns
t_{RSTB2Q}	Reset to Q (data out)	25.00	ns
F_{TCKMAX}	TCK Maximum Frequency	15.00	MHz
$t_{TRSTREM}$	ResetB Removal Time	0.58	ns
$t_{TRSTREC}$	ResetB Recovery Time	0.00	ns
$t_{TRSTMPW}$	ResetB Minimum Pulse	TBD	ns

Note: For specific junction temperature and voltage supply levels, refer to Table 2-6 on page 2-6 for derating values.

VCOMPLA/B/C/D/E/F PLL Ground

Ground to analog PLL power supplies. When the PLLs are not used, the place-and-route tool automatically disables the unused PLLs to lower power consumption. The user should tie unused VCCPLx and VCOMPLx pins to ground.

There are six VCOMPL pins (PLL ground) on IGLOOe devices.

VJTAG JTAG Supply Voltage

Low power flash devices have a separate bank for the dedicated JTAG pins. The JTAG pins can be run at any voltage from 1.5 V to 3.3 V (nominal). Isolating the JTAG power supply in a separate I/O bank gives greater flexibility in supply selection and simplifies power supply and PCB design. If the JTAG interface is neither used nor planned for use, the VJTAG pin together with the TRST pin could be tied to GND. It should be noted that VCC is required to be powered for JTAG operation; VJTAG alone is insufficient. If a device is in a JTAG chain of interconnected boards, the board containing the device can be powered down, provided both VJTAG and VCC to the part remain powered; otherwise, JTAG signals will not be able to transition the device, even in bypass mode.

Microsemi recommends that VPUMP and VJTAG power supplies be kept separate with independent filtering capacitors rather than supplying them from a common rail.

VPUMP Programming Supply Voltage

IGLOOe devices support single-voltage ISP of the configuration flash and FlashROM. For programming, VPUMP should be 3.3 V nominal. During normal device operation, VPUMP can be left floating or can be tied (pulled up) to any voltage between 0 V and the VPUMP maximum. Programming power supply voltage (VPUMP) range is listed in the datasheet.

When the VPUMP pin is tied to ground, it will shut off the charge pump circuitry, resulting in no sources of oscillation from the charge pump circuitry.

For proper programming, 0.01 µF and 0.33 µF capacitors (both rated at 16 V) are to be connected in parallel across VPUMP and GND, and positioned as close to the FPGA pins as possible.

Microsemi recommends that VPUMP and VJTAG power supplies be kept separate with independent filtering capacitors rather than supplying them from a common rail.

User-Defined Supply Pins

VREF I/O Voltage Reference

Reference voltage for I/O minibanks. VREF pins are configured by the user from regular I/Os, and any I/O in a bank, except JTAG I/Os, can be designated the voltage reference I/O. Only certain I/O standards require a voltage reference—HSTL (I) and (II), SSTL2 (I) and (II), SSTL3 (I) and (II), and GTL/GTL+. One VREF pin can support the number of I/Os available in its minibank.

FG484	
Pin Number	AGLE600 Function
H13	VCCIB1
H14	VCCIB1
H15	VMV1
H16	GBC2/IO38PDB2V0
H17	IO37NDB2V0
H18	IO41NDB2V0
H19	IO41PDB2V0
H20	VCC
H21	NC
H22	NC
J1	IO123NDB7V0
J2	IO123PDB7V0
J3	NC
J4	IO124PDB7V0
J5	IO125PDB7V0
J6	IO126PDB7V0
J7	IO130NDB7V1
J8	VCCIB7
J9	GND
J10	VCC
J11	VCC
J12	VCC
J13	VCC
J14	GND
J15	VCCIB2
J16	IO38NDB2V0
J17	IO40NDB2V0
J18	IO40PDB2V0
J19	IO45PPB2V1
J20	NC
J21	IO48PDB2V1
J22	IO46PDB2V1
K1	IO121NDB7V0
K2	IO121PDB7V0
K3	NC

FG484	
Pin Number	AGLE600 Function
K4	IO124NDB7V0
K5	IO125NDB7V0
K6	IO126NDB7V0
K7	GFC1/IO120PPB7V0
K8	VCCIB7
K9	VCC
K10	GND
K11	GND
K12	GND
K13	GND
K14	VCC
K15	VCCIB2
K16	GCC1/IO50PPB2V1
K17	IO44NDB2V1
K18	IO44PDB2V1
K19	IO49NPB2V1
K20	IO45NPB2V1
K21	IO48NDB2V1
K22	IO46NDB2V1
L1	NC
L2	IO122PDB7V0
L3	IO122NDB7V0
L4	GFB0/IO119NPB7V0
L5	GFA0/IO118NDB6V1
L6	GFB1/IO119PPB7V0
L7	VCOMPLF
L8	GFC0/IO120NPB7V0
L9	VCC
L10	GND
L11	GND
L12	GND
L13	GND
L14	VCC
L15	GCC0/IO50NPB2V1
L16	GCB1/IO51PPB2V1

FG484	
Pin Number	AGLE600 Function
L17	GCA0/IO52NPB3V0
L18	VCOMPLC
L19	GCB0/IO51NPB2V1
L20	IO49PPB2V1
L21	IO47NDB2V1
L22	IO47PDB2V1
M1	NC
M2	IO114NPB6V1
M3	IO117NDB6V1
M4	GFA2/IO117PDB6V1
M5	GFA1/IO118PDB6V1
M6	VCCPLF
M7	IO116NDB6V1
M8	GFB2/IO116PDB6V1
M9	VCC
M10	GND
M11	GND
M12	GND
M13	GND
M14	VCC
M15	GCB2/IO54PPB3V0
M16	GCA1/IO52PPB3V0
M17	GCC2/IO55PPB3V0
M18	VCCPLC
M19	GCA2/IO53PDB3V0
M20	IO53NDB3V0
M21	IO56PDB3V0
M22	NC
N1	IO114PPB6V1
N2	IO111NDB6V1
N3	NC
N4	GFC2/IO115PPB6V1
N5	IO113PPB6V1
N6	IO112PDB6V1
N7	IO112NDB6V1

Revision	Changes	Page
Revision 10 (April 2012)	In Table 2-2 • Recommended Operating Conditions 1, VPUMP programming voltage for operation was changed from "0 to 3.45 V" to "0 to 3.6 V" (SAR 32256). Values for VCCPLL at 1.2–1.5 V DC core supply voltage were changed from "1.14 to 1.26 V" to "1.14 to 1.575 V" (SAR 34701).	2-2
	The tables in the "Quiescent Supply Current" section were updated with revised notes on IDD. Table 2-8 • Power Supply State per Mode is new (SARs 34745, 36949).	2-7
	t_{DOUT} was corrected to t_{DIN} in Figure 2-4 • Input Buffer Timing Model and Delays (example) (SAR 37105).	2-17
	"TBD" for 3.3 V LVCMOS Wide Range in Table 2-28 • I/O Output Buffer Maximum Resistances1 and Table 2-30 • I/O Short Currents IOSH/IOSL was replaced by "Same as regular 3.3 V LVCMOS" (SAR 33855). Values were also added for 1.2 V LVCMOS and 1.2 V LVCMOS Wide Range.	2-28, 2-30
	The formulas in the table notes for Table 2-29 • I/O Weak Pull-Up/Pull-Down Resistances were corrected (SAR 34753).	2-29
	IOSH and IOSL values were added to 3.3 V LVCMOS Wide Range Table 2-40 • Minimum and Maximum DC Input and Output Levels, 1.2 V LVCMOS Table 2-64 • Minimum and Maximum DC Input and Output Levels, and 1.2 V LVCMOS Wide Range Table 2-68 • Minimum and Maximum DC Input and Output Levels (SAR 33855).	2-35, 2-47, 2-48
	Figure 2-48 • FIFO Read and Figure 2-49 • FIFO Write have been added (SAR 34844).	2-103
	Values for $F_{DDRIMAX}$ and F_{DDOMAX} were added to the tables in the Input DDR "Timing Characteristics" section and Output DDR "Timing Characteristics" section (SAR 34802).	2-77,2-81
	Minimum pulse width High and Low values were added to the tables in the "Global Tree Timing Characteristics" section. The maximum frequency for global clock parameter was removed from these tables because a frequency on the global is only an indication of what the global network can do. There are other limiters such as the SRAM, I/Os, and PLL. SmartTime software should be used to determine the design frequency (SAR 36952).	2-89
Revision 9 (March 2012)	The "In-System Programming (ISP) and Security" section and "Security" section were revised to clarify that although no existing security measures can give an absolute guarantee, Microsemi FPGAs implement the best security available in the industry (SAR 34665).	I, 1-2
	The Y security option and Licensed DPA Logo were added to the "IGLOOe Ordering Information" section. The trademarked Licensed DPA Logo identifies that a product is covered by a DPA counter-measures license from Cryptography Research (SAR 34725).	III
	The following sentence was removed from the "Advanced Architecture" section: "In addition, extensive on-chip programming circuitry allows for rapid, single-voltage (3.3 V) programming of IGLOOe devices via an IEEE 1532 JTAG interface" (SAR 34685).	1-3
	The "Specifying I/O States During Programming" section is new (SAR 34696).	1-7
	Values for VCCPLL at 1.5 V DC core supply voltage were changed from "1.4 to 1.6 V" to "1.425 to 1.575 V" in Table 2-2 • Recommended Operating Conditions 1 (SAR 32292).	2-2
	The reference to guidelines for global spines and VersaTile rows, given in the "Global Clock Contribution—PCLOCK" section, was corrected to the "Spine Architecture" section of the Global Resources chapter in the *IGLOOe FPGA Fabric User's Guide* (SAR 34731).	2-13

Revision	Changes	Page
Revision 9 (continued)	The example in the paragraph above Table 2-31 • Duration of Short Circuit Event before Failure was revised to change the maximum temperature from 110°C to 100°C, with an example of six months instead of three months (SAR 32287).	2-31
	The notes regarding drive strength in the "Summary of I/O Timing Characteristics – Default I/O Software Settings" section, "3.3 V LVCMOS Wide Range" section and "1.2 V LVCMOS Wide Range" section tables were revised for clarification. They now state that the minimum drive strength for the default software configuration when run in wide range is ±100 µA. The drive strength displayed in software is supported in normal range only. For a detailed I/V curve, refer to the IBIS models (SAR 34766).	2-23, 2-35, 2-48
	The AC Loading figures in the "Single-Ended I/O Characteristics" section were updated to match tables in the "Summary of I/O Timing Characteristics – Default I/O Software Settings" section (SAR 34886).	2-32
	The following sentence was deleted from the "2.5 V LVCMOS" section (SAR 34793): "It uses a 5 V–tolerant input buffer and push-pull output buffer."	2-38
	Table 2-143 • IGLOOe CCC/PLL Specification and Table 2-144 • IGLOOe CCC/PLL Specification were updated. A note was added to both tables indicating that when the CCC/PLL core is generated by Microsemi core generator software, not all delay values of the specified delay increments are available (SAR 34818).	2-91, 2-92
	The following figures were deleted. Reference was made to a new application note, *Simultaneous Read-Write Operations in Dual-Port SRAM for Flash-Based cSoCs and FPGAs*, which covers these cases in detail (SAR 34869). Figure 2-46 • Write Access after Write onto Same Address Figure 2-47 • Read Access after Write onto Same Address Figure 2-48 • Write Access after Read onto Same Address The port names in the SRAM "Timing Waveforms", SRAM "Timing Characteristics" tables, Figure 2-50 • FIFO Reset, and the FIFO "Timing Characteristics" tables were revised to ensure consistency with the software names (SAR 35749).	2-95, 2-98, 2-104, 2-106
	The "Pin Descriptions and Packaging" chapter is new (SAR 34768).	3-1
	Package names used in the "Package Pin Assignments" section were revised to match standards given in *Package Mechanical Drawings* (SAR 34768)	4-1
July 2010	The versioning system for datasheets has been changed. Datasheets are assigned a revision number that increments each time the datasheet is revised. The "IGLOOe Device Status" table on page II indicates the status for each device in the device family.	N/A