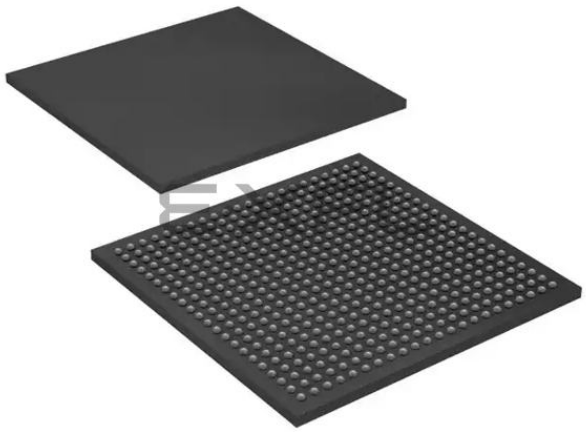


Welcome to E-XFL.COM

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	1079
Number of Logic Elements/Cells	21580
Total RAM Bits	1229184
Number of I/O	230
Number of Gates	-
Voltage - Supply	1.15V ~ 1.25V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 85°C (TJ)
Package / Case	484-BBGA
Supplier Device Package	484-FBGA (23x23)
Purchase URL	https://www.e-xfl.com/product-detail/intel/ep1agx20cf484c6

AGX51002-2.0

Transceivers

Arria® GX devices incorporate up to 12 high-speed serial transceiver channels that build on the success of the Stratix® II GX device family. Arria GX transceivers are structured into full-duplex (transmitter and receiver) four-channel groups called transceiver blocks located on the right side of the device. You can configure the transceiver blocks to support the following serial connectivity protocols (functional modes):

- PCI Express (PIPE)
- Gigabit Ethernet (GIGE)
- XAUI
- Basic (600 Mbps to 3.125 Gbps)
- SDI (HD, 3G)
- Serial RapidIO (1.25 Gbps, 2.5 Gbps, 3.125 Gbps)

Transceivers within each block are independent and have their own set of dividers. Therefore, each transceiver can operate at different frequencies. Each block can select from two reference clocks to provide two clock domains that each transceiver can select from.

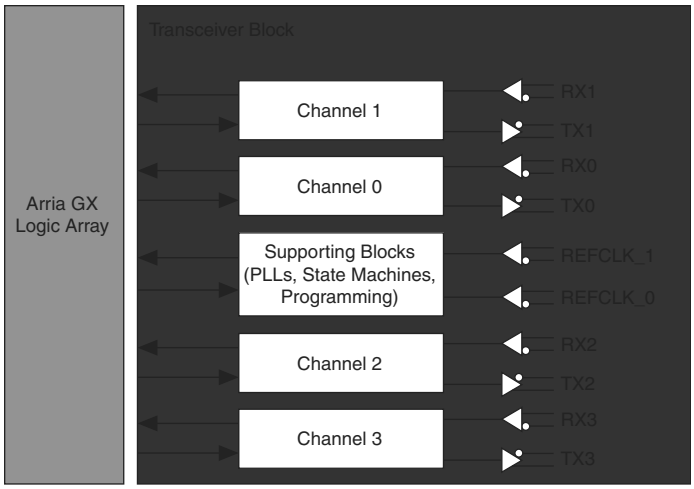
Table 2–1 lists the number of transceiver channels for each member of the Arria GX family.

Table 2–1. Arria GX Transceiver Channels

Device	Number of Transceiver Channels
EP1AGX20C	4
EP1AGX35C	4
EP1AGX35D	8
EP1AGX50C	4
EP1AGX50D	8
EP1AGX60C	4
EP1AGX60D	8
EP1AGX60E	12
EP1AGX90E	12

Figure 2–1 shows a high-level diagram of the transceiver block architecture divided into four channels.

Figure 2–1. Transceiver Block

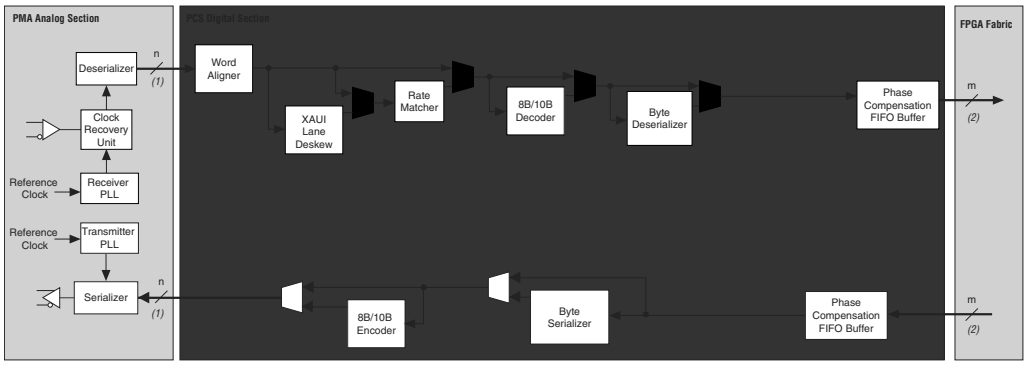


Each transceiver block has:

- Four transceiver channels with dedicated physical coding sublayer (PCS) and physical media attachment (PMA) circuitry
- One transmitter PLL that takes in a reference clock and generates high-speed serial clock depending on the functional mode
- Four receiver PLLs and clock recovery unit (CRU) to recover clock and data from the received serial data stream
- State machines and other logic to implement special features required to support each protocol

Figure 2–2 shows functional blocks that make up a transceiver channel.

Figure 2–2. Arria GX Transceiver Channel Block Diagram



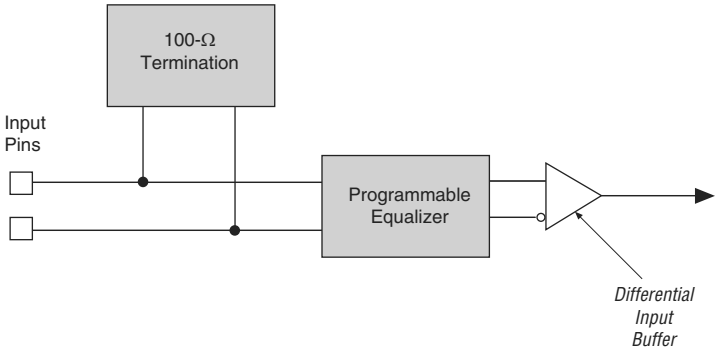
Notes to Figure 2–2:

(1) "n" represents the number of bits in each word that must be serialized by the transmitter portion of the PMA. n = 8 or 10.

(2) "m" represents the number of bits in the word that passes between the FPGA logic and the PCS portion of the transceiver. m = 8, 10, 16, or 20.

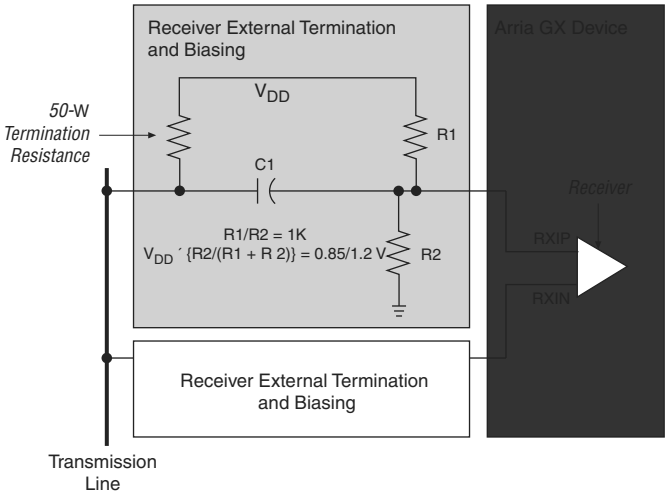
The receiver has 100-Ω on-chip differential termination (R_D OCT) for different protocols, as shown in Figure 2–11. You can disable the receiver's internal termination if external terminations and biasing are provided. The receiver and transmitter differential termination method can be set independently of each other.

Figure 2–11. Receiver Input Buffer



If a design uses external termination, the receiver must be externally terminated and biased to 0.85 V or 1.2 V. Figure 2–12 shows an example of an external termination and biasing circuit.

Figure 2–12. External Termination and Biasing Circuit



Programmable Equalizer

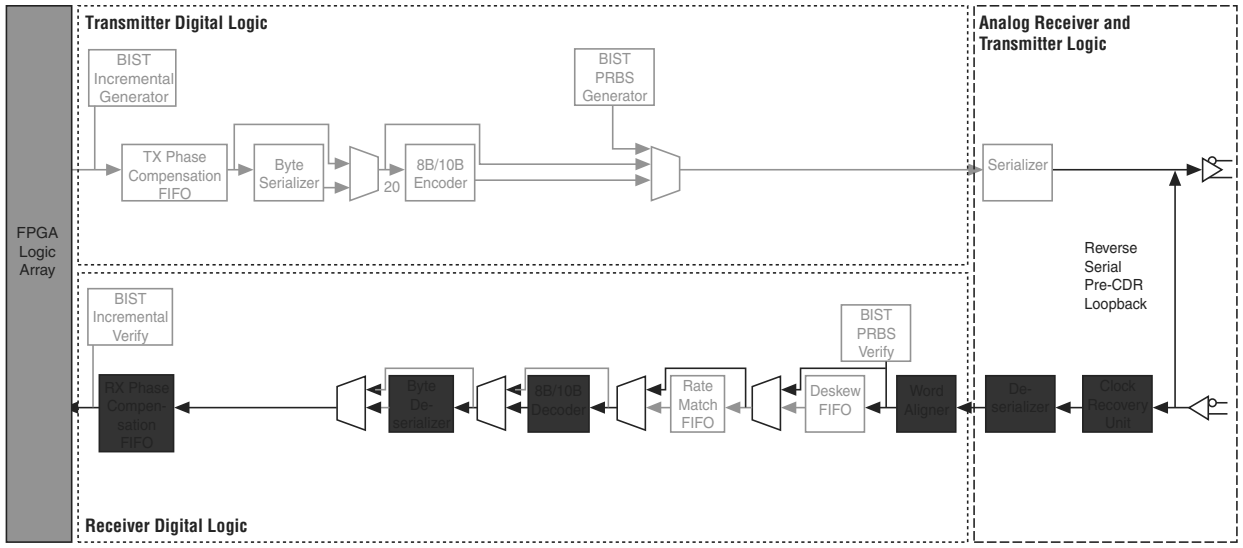
The Arria GX receivers provide a programmable receiver equalization feature to compensate for the effects of channel attenuation for high-speed signaling. PCB traces carrying these high-speed signals have low-pass filter characteristics. Impedance mismatch boundaries can also cause signal degradation. Equalization in the receiver diminishes the lossy attenuation effects of the PCB at high frequencies.

Reverse Serial Pre-CDR Loopback

Reverse serial pre-CDR loopback mode uses the analog portion of the transceiver. An external source (pattern generator or transceiver) generates the source data. The high-speed serial source data arrives at the high-speed differential receiver input buffer, loops back before the CRU unit, and is transmitted though the high-speed differential transmitter output buffer. It is for test or verification use only to verify the signal being received after the gain and equalization improvements of the input buffer. The signal at the output is not exactly what is received because the signal goes through the output buffer and the V_{OD} is changed to the V_{OD} setting level. Pre-emphasis settings have no effect.

Figure 2–20 shows the Arria GX block in reverse serial pre-CDR loopback mode.

Figure 2–20. Arria GX Block in Reverse Serial Pre-CDR Loopback Mode



PCI Express (PIPE) Reverse Parallel Loopback

Figure 2–21 shows the data path for PCI Express (PIPE) reverse parallel loopback. The reverse parallel loopback configuration is compliant with the PCI Express (PIPE) specification and is available only on PCI Express (PIPE) mode.

Figure 2–21. PCI Express (PIPE) Reverse Parallel Loopback

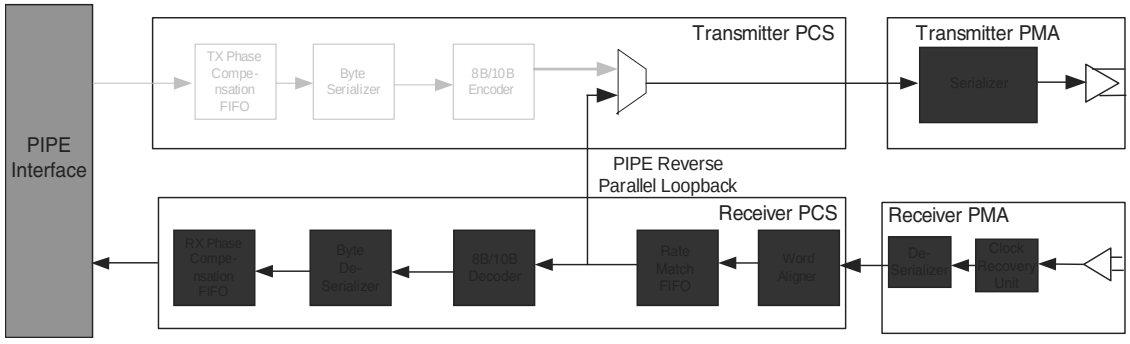
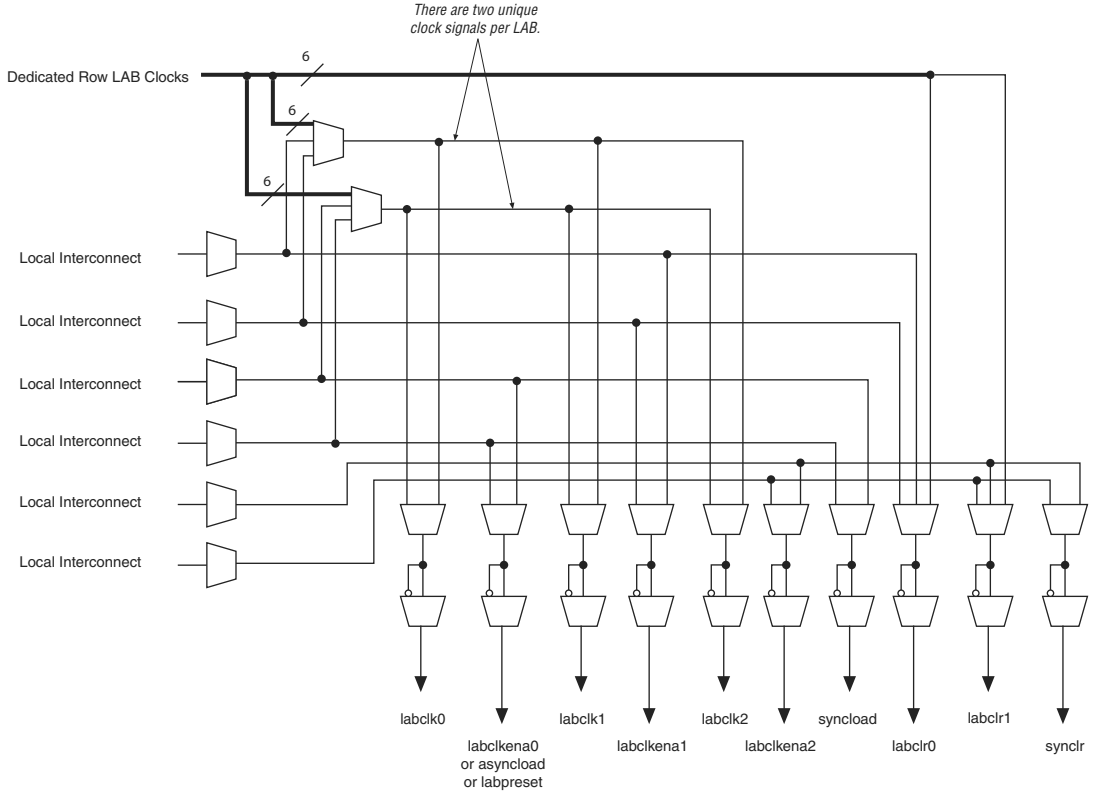


Figure 2–27 shows the LAB control signal generation circuit.

Figure 2–27. LAB-Wide Control Signals



Adaptive Logic Modules

The basic building block of logic in the Arria GX architecture is the ALM. The ALM provides advanced features with efficient logic utilization. Each ALM contains a variety of look-up table (LUT)-based resources that can be divided between two adaptive LUTs (ALUTs). With up to eight inputs to the two ALUTs, one ALM can implement various combinations of two functions. This adaptability allows the ALM to be completely backward-compatible with four-input LUT architectures. One ALM can also implement any function of up to six inputs and certain seven-input functions.

In addition to the adaptive LUT-based resources, each ALM contains two programmable registers, two dedicated full adders, a carry chain, a shared arithmetic chain, and a register chain. Through these dedicated resources, the ALM can efficiently implement various arithmetic functions and shift registers. Each ALM drives all types of interconnects: local, row, column, carry chain, shared arithmetic chain, register chain, and direct link interconnects. Figure 2–28 shows a high-level block diagram of the Arria GX ALM while Figure 2–29 shows a detailed view of all the connections in the ALM.

PLLs and Clock Networks

Arria GX devices provide a hierarchical clock structure and multiple PLLs with advanced features. The large number of clocking resources in combination with the clock synthesis precision provided by enhanced and fast PLLs provides a complete clock management solution.

Global and Hierarchical Clocking

Arria GX devices provide 16 dedicated global clock networks and 32 regional clock networks (eight per device quadrant). These clocks are organized into a hierarchical clock structure that allows for up to 24 clocks per device region with low skew and delay. This hierarchical clocking scheme provides up to 48 unique clock domains in Arria GX devices.

There are 12 dedicated clock pins (`CLK[15..12]` and `CLK[7..0]`) to drive either the global or regional clock networks. Four clock pins drive each side of the device except the right side, as shown in Figure 2–54 and Figure 2–55. Internal logic and enhanced and fast PLL outputs can also drive the global and regional clock networks. Each global and regional clock has a clock control block, which controls the selection of the clock source and dynamically enables or disables the clock to reduce power consumption. Table 2–16 lists the global and regional clock features.

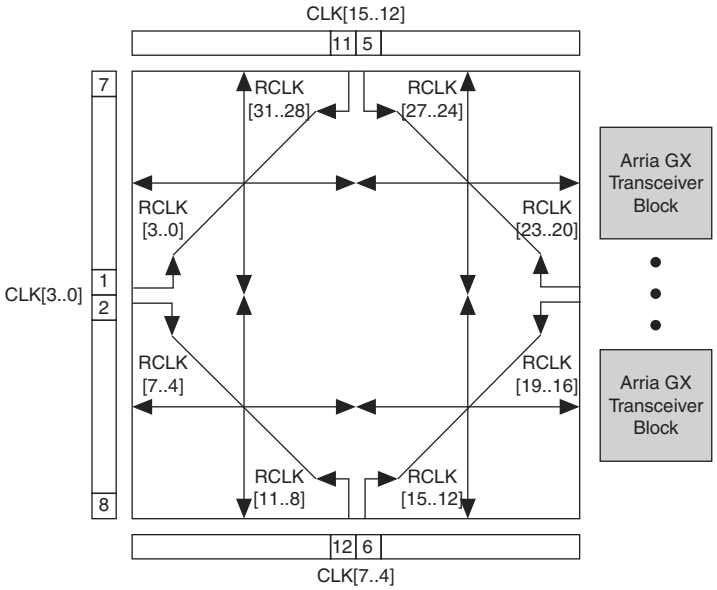
Table 2–16. Global and Regional Clock Features

Feature	Global Clocks	Regional Clocks
Number per device	16	32
Number available per quadrant	16	8
Sources	Clock pins, PLL outputs, core routings, inter-transceiver clocks	Clock pins, PLL outputs, core routings, inter-transceiver clocks
Dynamic clock source selection	✓	—
Dynamic enable/disable	✓	✓

Global Clock Network

These clocks drive throughout the entire device, feeding all device quadrants. GCLK networks can be used as clock sources for all resources in the device IOEs, ALMs, DSP blocks, and all memory blocks. These resources can also be used for control signals, such as clock enables and synchronous or asynchronous clears fed from the external pin. The global clock networks can also be driven by internal logic for internally generated global clocks and asynchronous clears, clock enables, or other control signals with large fanout. Figure 2–54 shows the 12 dedicated `CLK` pins driving global clock networks.

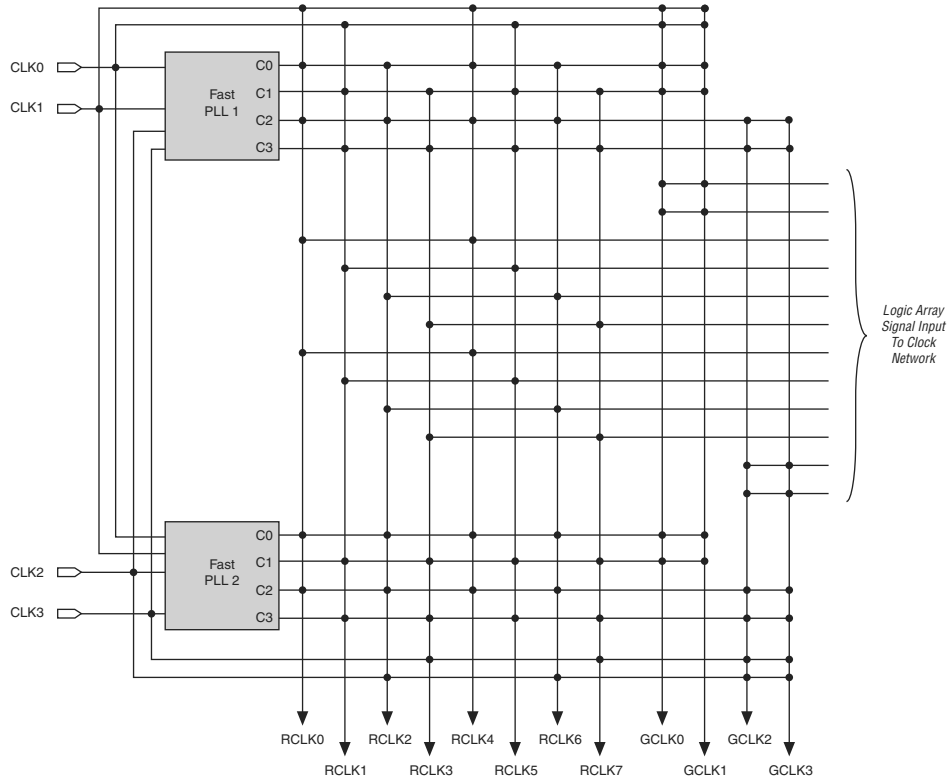
Figure 2–55. Regional Clocks



Dual-Regional Clock Network

A single source (CLK pin or PLL output) can generate a dual-RCLK by driving two RCLK network lines in adjacent quadrants (one from each quadrant), which allows logic that spans multiple quadrants to use the same low skew clock. The routing of this clock signal on an entire side has approximately the same speed but slightly higher clock skew when compared with a clock signal that drives a single quadrant. Internal logic-array routing can also drive a dual-regional clock. Clock pins and enhanced PLL outputs on the top and bottom can drive horizontal dual-regional clocks. Clock pins and fast PLL outputs on the left and right can drive vertical dual-regional clocks, as shown in Figure 2–56. Corner PLLs cannot drive dual-regional clocks.

Figure 2–62. Global and Regional Clock Connections from Center Clock Pins and Fast PLL Outputs *(Note 1)*



Note to Figure 2–62:

(1) The global or regional clocks in a fast PLL's quadrant can drive the fast PLL input. A dedicated clock input pin or other PLL must drive the global or regional source. The source cannot be driven by internally generated logic before driving the fast PLL.

Table 2–21. Global and Regional Clock Connections from Bottom Clock Pins and Enhanced PLL Outputs

Bottom Side Global and Regional Clock Network Connectivity	DLLCLK	CLK4	CLK5	CLK6	CLK7	RCLK8	RCLK9	RCLK10	RCLK11	RCLK12	RCLK13	RCLK14	RCLK15
Clock pins													
CLK4p	✓	✓	✓	—	—	✓	—	—	—	✓	—	—	—
CLK5p	✓	✓	✓	—	—	—	✓	—	—	—	✓	—	—
CLK6p	✓	—	—	✓	✓	—	—	✓	—	—	—	✓	—
CLK7p	✓	—	—	✓	✓	—	—	—	✓	—	—	—	✓
CLK4n	—	✓	—	—	—	✓	—	—	—	✓	—	—	—
CLK5n	—	—	✓	—	—	—	✓	—	—	—	✓	—	—
CLK6n	—	—	—	✓	—	—	—	✓	—	—	—	✓	—
CLK7n	—	—	—	—	✓	—	—	—	✓	—	—	—	✓
Drivers from internal logic													
GCLKDRV0	—	✓	—	—	—	—	—	—	—	—	—	—	—
GCLKDRV1	—	—	✓	—	—	—	—	—	—	—	—	—	—
GCLKDRV2	—	—	—	✓	—	—	—	—	—	—	—	—	—
GCLKDRV3	—	—	—	—	✓	—	—	—	—	—	—	—	—
RCLKDRV0	—	—	—	—	—	✓	—	—	—	✓	—	—	—
RCLKDRV1	—	—	—	—	—	—	✓	—	—	—	✓	—	—
RCLKDRV2	—	—	—	—	—	—	—	✓	—	—	—	✓	—
RCLKDRV3	—	—	—	—	—	—	—	—	✓	—	—	—	✓
RCLKDRV4	—	—	—	—	—	✓	—	—	—	✓	—	—	—
RCLKDRV5	—	—	—	—	—	—	✓	—	—	—	✓	—	—
RCLKDRV6	—	—	—	—	—	—	—	✓	—	—	—	✓	—
RCLKDRV7	—	—	—	—	—	—	—	—	✓	—	—	—	✓
Enhanced PLL 6 outputs													
c0	✓	✓	✓	—	—	✓	—	—	—	✓	—	—	—
c1	✓	✓	✓	—	—	—	✓	—	—	—	✓	—	—
c2	✓	—	—	✓	✓	—	—	✓	—	—		✓	
c3	✓	—	—	✓	✓	—	—	—	✓	—	—	—	✓
c4	✓	—	—	—	—	✓	—	✓	—	✓	—	✓	—
c5	✓	—	—	—	—	—	✓	—	✓	—	✓	—	✓
Enhanced PLL 12 outputs													
c0	—	✓	✓	—	—	✓	—	—	—	✓	—	—	—
c1	—	✓	✓	—	—	—	✓	—	—	—	✓	—	—
c2	—	—	—	✓	✓	—	—	✓	—	—	—	✓	—
c3	—	—	—	✓	✓	—	—	—	✓	—	—	—	✓
c4	—	—	—	—	—	✓	—	✓	—	✓	—	✓	—
c5	—	—	—	—	—	—	✓	—	✓	—	✓	—	✓

For the specific sustaining current driven through this resistor and overdrive current used to identify the next-driven input level, refer to the *DC & Switching Characteristics* chapter.

Programmable Pull-Up Resistor

Each Arria GX device I/O pin provides an optional programmable pull-up resistor during user mode. If you enable this feature for an I/O pin, the pull-up resistor (typically 25 kΩ) holds the output to the V_{CCIO} level of the output pin's bank.

Advanced I/O Standard Support

Arria GX device IOEs support the following I/O standards:

- 3.3-V LVTTL/LVCMOS
- 2.5-V LVTTL/LVCMOS
- 1.8-V LVTTL/LVCMOS
- 1.5-V LVCMOS
- 3.3-V PCI
- 3.3-V PCI-X mode 1
- LVDS
- LVPECL (on input and output clocks only)
- Differential 1.5-V HSTL class I and II
- Differential 1.8-V HSTL class I and II
- Differential SSTL-18 class I and II
- Differential SSTL-2 class I and II
- 1.2-V HSTL class I and II
- 1.5-V HSTL class I and II
- 1.8-V HSTL class I and II
- SSTL-2 class I and II
- SSTL-18 class I and II

device, PLL 1 can drive a maximum of 16 transmitter channels in I/O Bank 2 or a maximum of 29 transmitter channels in I/O Banks 1 and 2. The Quartus II software can also merge receiver and transmitter PLLs when a receiver is driving a transmitter. In this case, one fast PLL can drive both the maximum numbers of receiver and transmitter channels.

For more information, refer to the "Differential Pin Placement Guidelines" section in the *High-Speed Differential I/O Interfaces with DPA in Arria GX Devices* chapter.

Table 2–30. EP1AGX20 Device Differential Channels *(Note 1)*

Package	Transmitter/Receiver	Total Channels	Center Fast PLLs	
			PLL1	PLL2
484-pin FineLine BGA	Transmitter	29	16	13
			13	16
	Receiver	31	17	14
			14	17
780-pin FineLine GBA	Transmitter	29	16	13
			13	16
	Receiver	31	17	14
			14	17

Note to Table 2–30:

(1) The total number of receiver channels includes the four non-dedicated clock channels that can be optionally used as data channels.

Table 2–31. EP1AGX35 Device Differential Channels *(Note 1)*

Package	Transmitter/Receiver	Total Channels	Center Fast PLLs	
			PLL1	PLL2
484-pin FineLine BGA	Transmitter	29	16	13
			13	16
	Receiver	31	17	14
			14	17
780-pin FineLine BGA	Transmitter	29	16	13
			13	16
	Receiver	31	17	14
			14	17

Note to Table 2–31:

(1) The total number of receiver channels includes the four non-dedicated clock channels that can be optionally used as data channels.

In addition to the number of configuration methods supported, Arria GX devices also offer decompression and remote system upgrade features. The decompression feature allows Arria GX FPGAs to receive a compressed configuration bitstream and decompress this data in real-time, reducing storage requirements and configuration time. The remote system upgrade feature allows real-time system upgrades from remote locations of Arria GX designs. For more information, refer to "Configuration Schemes" on page 3–5.

Operating Modes

The Arria GX architecture uses SRAM configuration elements that require configuration data to be loaded each time the circuit powers up. The process of physically loading the SRAM data into the device is called configuration. During initialization, which occurs immediately after configuration, the device resets registers, enables I/O pins, and begins to operate as a logic device. The I/O pins are tri-stated during power up, and before and during configuration. Together, the configuration and initialization processes are called command mode. Normal device operation is called user mode.

SRAM configuration elements allow you to reconfigure Arria GX devices in-circuit by loading new configuration data into the device. With real-time reconfiguration, the device is forced into command mode with a device pin. The configuration process loads different configuration data, re-initializes the device, and resumes user-mode operation. You can perform in-field upgrades by distributing new configuration files either within the system or remotely.

PORSEL is a dedicated input pin used to select power-on reset (POR) delay times of 12 ms or 100 ms during power up. When the PORSEL pin is connected to ground, the POR time is 100 ms. When the PORSEL pin is connected to V_{CC}, the POR time is 12 ms.

The nIO_PULLUP pin is a dedicated input that chooses whether the internal pull-up resistors on the user I/O pins and dual-purpose configuration I/O pins (nCSO, ASDO, DATA[7..0], nWS, nRS, RDYnBSY, nCS, CS, RUnLU, PGM[2..0], CLKUSR, INIT_DONE, DEV_OE, DEV_CLR) are on or off before and during configuration. A logic high (1.5, 1.8, 2.5, 3.3 V) turns off the weak internal pull-up resistors, while a logic low turns them on.

Arria GX devices also offer a new power supply, V_{CCPD}, which must be connected to 3.3 V in order to power the 3.3-V/2.5-V buffer available on the configuration input pins and JTAG pins. V_{CCPD} applies to all the JTAG input pins (TCK, TMS, TDI, and TRST) and the following configuration pins: nCONFIG, DCLK (when used as an input), nIO_PULLUP, DATA[7..0], RUnLU, nCE, nWS, nRS, CS, nCS, and CLKUSR. The V_{CCSEL} pin allows the V_{CCIO} setting (of the banks where the configuration inputs reside) to be independent of the voltage required by the configuration inputs. Therefore, when selecting the V_{CCIO} voltage, you do not have to take the VIL and VIH levels driven to the configuration inputs into consideration. The configuration input pins, nCONFIG, DCLK (when used as an input), nIO_PULLUP, RUnLU, nCE, nWS, nRS, CS, nCS, and CLKUSR, have a dual buffer design: a 3.3-V/2.5-V input buffer and a 1.8-V/1.5-V input buffer. The V_{CCSEL} input pin selects which input buffer is used. The 3.3-V/2.5-V input buffer is powered by V_{CCPD}, while the 1.8-V/1.5-V input buffer is powered by V_{CCIO}.

Table 4–6. Arria GX Transceiver Block AC Specification (Part 1 of 3)

Symbol / Description	Conditions	–6 Speed Grade Commercial and Industrial			Units
		Min	Typ	Max	
Reference clock					
Input reference clock frequency	—	50	—	622.08	MHz
Absolute V_{MAX} for a REFCLK Pin	—	—	—	3.3	V
Absolute V_{MIN} for a REFCLK Pin	—	–0.3	—	—	V
Rise/Fall time	—	—	0.2	—	UI
Duty cycle	—	45	—	55	%
Peak to peak differential input voltage V_{ID} (diff p-p)	—	200	—	2000	mV
Spread spectrum clocking *(1)*	0 to –0.5%	30	—	33	kHz
On-chip termination resistors	—		115 ± 20%		Ω
V_{ICM} (AC coupled)	—		1200 ± 5%		mV
V_{ICM} (DC coupled) *(2)*	PCI Express (PIPE) mode	0.25	—	0.55	V
RREFB	—		2000 +/-1%		Ω
Transceiver Clocks					
Calibration block clock frequency	—	10	—	125	MHz
Calibration block minimum power-down pulse width	—	30	—	—	ns
fixedclk clock frequency *(3)*	—		125 ±10%		MHz
reconfig clock frequency	SDI mode	2.5	—	50	MHz
Transceiver block minimum power-down pulse width	—	100	—	—	ns
Receiver					
Data rate	—	600	—	3125	Mbps
Absolute V_{MAX} for a receiver pin *(4)*	—	—	—	2.0	V
Absolute V_{MIN} for a receiver pin	—	–0.4	—	—	V
Maximum peak-to-peak differential input voltage V_{ID} (diff p-p)	Vicm = 0.85 V	—	—	3.3	V
Minimum peak-to-peak differential input voltage V_{ID} (diff p-p)	DC Gain = 3 dB	160	—	—	mV
On-chip termination resistors	—		100±15%		Ω
V_{ICM} *(15)*	Vicm = 0.85 V setting	850 ± 10%	850 ± 10%	850 ± 10%	mV
	Vicm = 1.2 V setting	1200 ± 10%	1200 ± 10%	1200 ± 10%	mV
Bandwidth at 3.125 Gbps	BW = Low	—	30	—	MHz
	BW = Med	—	40	—	
	BW = High	—	50	—	

Table 4–36. 1.8-V HSTL Class I Specifications

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
V_{CCIO}	Output supply voltage	—	1.71	1.80	1.89	V
V_{REF}	Input reference voltage	—	0.85	0.90	0.95	V
V_{TT}	Termination voltage	—	0.85	0.90	0.95	V
V_{IH} (DC)	DC high-level input voltage	—	V_{REF} + 0.1	—	—	V
V_{IL} (DC)	DC low-level input voltage	—	–0.3	—	V_{REF} – 0.1	V
V_{IH} (AC)	AC high-level input voltage	—	V_{REF} + 0.2	—	—	V
V_{IL} (AC)	AC low-level input voltage	—	—	—	V_{REF} – 0.2	V
V_{OH}	High-level output voltage	I_{OH} = 8 mA *(1)*	V_{CCIO} – 0.4	—	—	V
V_{OL}	Low-level output voltage	I_{OH} = –8 mA *(1)*	—	—	0.4	V

Note to Table 4–36:

(1) This specification is supported across all the programmable drive settings available for this I/O standard, as shown in the *Arria GX Architecture* chapter.

Table 4–37. 1.8-V HSTL Class II Specifications

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
V_{CCIO}	Output supply voltage	—	1.71	1.80	1.89	V
V_{REF}	Input reference voltage	—	0.85	0.90	0.95	V
V_{TT}	Termination voltage	—	0.85	0.90	0.95	V
V_{IH} (DC)	DC high-level input voltage	—	V_{REF} + 0.1	—	—	V
V_{IL} (DC)	DC low-level input voltage	—	–0.3	—	V_{REF} – 0.1	V
V_{IH} (AC)	AC high-level input voltage	—	V_{REF} + 0.2	—	—	V
V_{IL} (AC)	AC low-level input voltage	—	—	—	V_{REF} – 0.2	V
V_{OH}	High-level output voltage	I_{OH} = 16 mA *(1)*	V_{CCIO} – 0.4	—	—	V
V_{OL}	Low-level output voltage	I_{OH} = –16 mA *(1)*	—	—	0.4	V

Note to Table 4–37:

(1) This specification is supported across all the programmable drive settings available for this I/O standard, as shown in the *Arria GX Architecture* chapter in volume 1 of the *Arria GX Device Handbook*.

Table 4–38. 1.8-V HSTL Class I & II Differential Specifications

Symbol	Parameter	Minimum	Typical	Maximum	Units
V_{CCIO}	I/O supply voltage	1.71	1.80	1.89	V
V_{DIF} (DC)	DC input differential voltage	0.2	—	—	V
V_{CM} (DC)	DC common mode input voltage	0.78	—	1.12	V
V_{DIF} (AC)	AC differential input voltage	0.4	—	—	V
V_{OX} (AC)	AC differential cross point voltage	0.68	—	0.9	V

For more information about PowerPlay tools, refer to the *PowerPlay Early Power Estimator and PowerPlay Power Analyzer* page and the *PowerPlay Power Analysis* chapter in volume 3 of the *Quartus II Handbook*.

For typical I_{CC} standby specifications, refer to Table 4–14 on page 4–14 .

I/O Timing Model

The DirectDrive technology and MultiTrack interconnect ensures predictable performance, accurate simulation, and accurate timing analysis across all Arria GX device densities and speed grades. This section describes and specifies the performance of I/Os.

All specifications are representative of worst-case supply voltage and junction temperature conditions.

The timing numbers listed in the tables of this section are extracted from the Quartus II software version 7.1.

Preliminary, Correlated, and Final Timing

Timing models can have either preliminary, correlated, or final status. The Quartus II software issues an informational message during design compilation if the timing models are preliminary. Table 4–43 lists the status of the Arria GX device timing models.

- **Preliminary** status means the timing model is subject to change. Initially, timing numbers are created using simulation results, process data, and other known parameters. These tests are used to make the preliminary numbers as close to the actual timing parameters as possible.
- **Correlated** numbers are based on actual device operation and testing. These numbers reflect the actual performance of the device under worst-case voltage and junction temperature conditions.
- **Final timing** numbers are based on complete correlation to actual devices and addressing any minor deviations from the correlated timing model. When the timing models are final, all or most of the Arria GX family devices have been completely characterized and no further changes to the timing model are expected.

Table 4–43. Arria GX Device Timing Model Status

Device	Preliminary	Correlated	Final
EP1AGX20	—	—	✓
EP1AGX35	—	—	✓
EP1AGX50	—	—	✓
EP1AGX60	—	—	✓
EP1AGX90	—	—	✓

Table 4–55. EP1AGX35 Column Pins Input Timing Parameters (Part 3 of 3)

I/O Standard	Clock	Parameter	Fast Corner		–6 Speed Grade	Units
			Industrial	Commercial		
1.5-V HSTL CLASS I	GCLK	t_{SU}	1.131	1.131	2.607	ns
		t_H	–1.026	–1.026	–2.330	ns
	GCLK PLL	t_{SU}	2.573	2.573	5.713	ns
		t_H	–2.468	–2.468	–5.436	ns
1.5-V HSTL CLASS II	GCLK	t_{SU}	1.132	1.132	2.607	ns
		t_H	–1.027	–1.027	–2.330	ns
	GCLK PLL	t_{SU}	2.574	2.574	5.715	ns
		t_H	–2.469	–2.469	–5.438	ns
3.3-V PCI	GCLK	t_{SU}	1.256	1.256	2.903	ns
		t_H	–1.151	–1.151	–2.626	ns
	GCLK PLL	t_{SU}	2.698	2.698	6.009	ns
		t_H	–2.593	–2.593	–5.732	ns
3.3-V PCI-X	GCLK	t_{SU}	1.256	1.256	2.903	ns
		t_H	–1.151	–1.151	–2.626	ns
	GCLK PLL	t_{SU}	2.698	2.698	6.009	ns
		t_H	–2.593	–2.593	–5.732	ns
LVDS	GCLK	t_{SU}	1.106	1.106	2.489	ns
		t_H	–1.001	–1.001	–2.212	ns
	GCLK PLL	t_{SU}	2.530	2.530	5.564	ns
		t_H	–2.425	–2.425	–5.287	ns

Table 4–56 lists I/O timing specifications.

Table 4–56. EP1AGX35 Row Pins Output Timing Parameters (Part 1 of 3)

I/O Standard	Drive Strength	Clock	Parameter	Fast Model		–6 Speed Grade	Units
				Industrial	Commercial		
3.3-V LVTTL	4 mA	GCLK	t_{CO}	2.904	2.904	6.699	ns
		GCLK PLL	t_{CO}	1.485	1.485	3.627	ns
3.3-V LVTTL	8 mA	GCLK	t_{CO}	2.776	2.776	6.059	ns
		GCLK PLL	t_{CO}	1.357	1.357	2.987	ns
3.3-V LVTTL	12 mA	GCLK	t_{CO}	2.720	2.720	6.022	ns
		GCLK PLL	t_{CO}	1.301	1.301	2.950	ns
3.3-V LVCMOS	4 mA	GCLK	t_{CO}	2.776	2.776	6.059	ns
		GCLK PLL	t_{CO}	1.357	1.357	2.987	ns
3.3-V LVCMOS	8 mA	GCLK	t_{CO}	2.670	2.670	5.753	ns
		GCLK PLL	t_{CO}	1.251	1.251	2.681	ns
2.5 V	4 mA	GCLK	t_{CO}	2.759	2.759	6.033	ns
		GCLK PLL	t_{CO}	1.340	1.340	2.961	ns

Table 4–57. EP1AGX35 Column Pins Output Timing Parameters (Part 2 of 4)

I/O Standard	Drive Strength	Clock	Parameter	Fast Corner		–6 Speed Grade	Units
				Industrial	Commercial		
3.3-V LVCMOS	24 mA	GCLK	t_{CO}	2.627	2.627	5.724	ns
		GCLK PLL	t_{CO}	1.185	1.185	2.618	ns
2.5 V	4 mA	GCLK	t_{CO}	2.726	2.726	6.201	ns
		GCLK PLL	t_{CO}	1.284	1.284	3.095	ns
2.5 V	8 mA	GCLK	t_{CO}	2.674	2.674	5.939	ns
		GCLK PLL	t_{CO}	1.232	1.232	2.833	ns
2.5 V	12 mA	GCLK	t_{CO}	2.653	2.653	5.822	ns
		GCLK PLL	t_{CO}	1.211	1.211	2.716	ns
2.5 V	16 mA	GCLK	t_{CO}	2.635	2.635	5.748	ns
		GCLK PLL	t_{CO}	1.193	1.193	2.642	ns
1.8 V	2 mA	GCLK	t_{CO}	2.766	2.766	7.193	ns
		GCLK PLL	t_{CO}	1.324	1.324	4.087	ns
1.8 V	4 mA	GCLK	t_{CO}	2.771	2.771	6.419	ns
		GCLK PLL	t_{CO}	1.329	1.329	3.313	ns
1.8 V	6 mA	GCLK	t_{CO}	2.695	2.695	6.155	ns
		GCLK PLL	t_{CO}	1.253	1.253	3.049	ns
1.8 V	8 mA	GCLK	t_{CO}	2.697	2.697	6.064	ns
		GCLK PLL	t_{CO}	1.255	1.255	2.958	ns
1.8 V	10 mA	GCLK	t_{CO}	2.651	2.651	5.987	ns
		GCLK PLL	t_{CO}	1.209	1.209	2.881	ns
1.8 V	12 mA	GCLK	t_{CO}	2.652	2.652	5.930	ns
		GCLK PLL	t_{CO}	1.210	1.210	2.824	ns
1.5 V	2 mA	GCLK	t_{CO}	2.746	2.746	6.723	ns
		GCLK PLL	t_{CO}	1.304	1.304	3.617	ns
1.5 V	4 mA	GCLK	t_{CO}	2.682	2.682	6.154	ns
		GCLK PLL	t_{CO}	1.240	1.240	3.048	ns
1.5 V	6 mA	GCLK	t_{CO}	2.685	2.685	6.036	ns
		GCLK PLL	t_{CO}	1.243	1.243	2.930	ns
1.5 V	8 mA	GCLK	t_{CO}	2.644	2.644	5.983	ns
		GCLK PLL	t_{CO}	1.202	1.202	2.877	ns
SSTL-2 CLASS I	8 mA	GCLK	t_{CO}	2.629	2.629	5.762	ns
		GCLK PLL	t_{CO}	1.184	1.184	2.650	ns
SSTL-2 CLASS I	12 mA	GCLK	t_{CO}	2.612	2.612	5.712	ns
		GCLK PLL	t_{CO}	1.167	1.167	2.600	ns
SSTL-2 CLASS II	16 mA	GCLK	t_{CO}	2.590	2.590	5.639	ns
		GCLK PLL	t_{CO}	1.145	1.145	2.527	ns
SSTL-2 CLASS II	20 mA	GCLK	t_{CO}	2.591	2.591	5.626	ns
		GCLK PLL	t_{CO}	1.146	1.146	2.514	ns

Table 4–90 lists clock timing specifications.

Table 4–90. EP1AGX50 Row Pins Regional Clock Timing Parameters

Parameter	Fast Model		–6 Speed Grade	Units
	Industrial	Commercial		
t_{CIN}	1.653	1.653	3.841	ns
t_{COUT}	1.651	1.651	3.839	ns
t_{PLLCIN}	0.245	0.245	0.755	ns
$t_{PLLCOUT}$	0.245	0.245	0.755	ns

EP1AGX60 Clock Timing Parameters

Table 4–91 to Table 4–92 on page 4–82 list the GCLK clock timing parameters for EP1AGX60 devices.

Table 4–91 lists clock timing specifications.

Table 4–91. EP1AGX60 Row Pins Global Clock Timing Parameters

Parameter	Fast Model		–6 Speed Grade	Units
	Industrial	Commercial		
t_{CIN}	1.531	1.531	3.593	ns
t_{COUT}	1.536	1.536	3.587	ns
t_{PLLCIN}	–0.023	–0.023	0.188	ns
$t_{PLLCOUT}$	–0.018	–0.018	0.182	ns

Table 4–92 lists clock timing specifications.

Table 4–92. EP1AGX60 Row Pins Global Clock Timing Parameters

Parameter	Fast Model		–6 Speed Grade	Units
	Industrial	Commercial		
t_{CIN}	1.792	1.792	4.165	ns
t_{COUT}	1.792	1.792	4.165	ns
t_{PLLCIN}	0.238	0.238	0.758	ns
$t_{PLLCOUT}$	0.238	0.238	0.758	ns

Table 4–105. Arria GX Maximum Output Toggle Rate for Column I/O Pins (Part 3 of 3)

I/O Standards	Drive Strength	–6 Speed Grade	Units
1.8-V HSTL CLASS II	16 mA	420	MHz
	18 mA	467	MHz
	20 mA	514	MHz
1.5-V HSTL CLASS I	4 mA	280	MHz
	6 mA	420	MHz
	8 mA	561	MHz
	10 mA	607	MHz
	12 mA	654	MHz
1.5-V HSTL CLASS II	16 mA	514	MHz
	18 mA	561	MHz
	20 mA	561	MHz
3.3-V PCI	—	626	MHz
3.3-V PCI-X	—	626	MHz

Table 4–106 shows the maximum output clock toggle rates for Arria GX device row I/O pins.

Table 4–106. Arria GX Maximum Output Toggle Rate for Row I/O Pins

I/O Standards	Drive Strength	–6 Speed Grade	Units
3.3-V LVTTL	4 mA	196	MHz
	8 mA	303	MHz
	12 mA	393	MHz
3.3-V LVCMOS	4 mA	215	MHz
	8 mA	411	MHz
2.5 V	4 mA	168	MHz
	8 mA	355	MHz
	12 mA	514	MHz
1.8 V	2 mA	97	MHz
	4 mA	215	MHz
	6 mA	336	MHz
	8 mA	486	MHz
1.5 V	2 mA	168	MHz
	4 mA	303	MHz
SSTL-2 CLASS I	8 mA	280	MHz
	12 mA	327	MHz
SSTL-2 CLASS II	16 mA	280	MHz
SSTL-18 CLASS I	4 mA	140	MHz
	6 mA	186	MHz
	8 mA	280	MHz
	10 mA	373	MHz