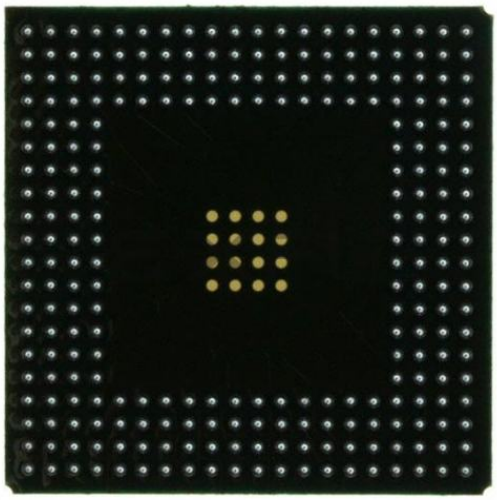


Welcome to E-XFL.COM

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	384
Number of Logic Elements/Cells	1728
Total RAM Bits	32768
Number of I/O	180
Number of Gates	57906
Voltage - Supply	2.375V ~ 2.625V
Mounting Type	Surface Mount
Operating Temperature	0°C ~ 85°C (TJ)
Package / Case	256-BBGA
Supplier Device Package	256-PBGA (27x27)
Purchase URL	https://www.e-xfl.com/product-detail/xilinx/xcv50-4bg256c

Virtex Device/Package Combinations and Maximum I/O

Table 3: **Virtex Family Maximum User I/O by Device/Package (Excluding Dedicated Clock Pins)**

Package	XCV50	XCV100	XCV150	XCV200	XCV300	XCV400	XCV600	XCV800	XCV1000
CS144	94	94							
TQ144	98	98							
PQ240	166	166	166	166	166				
HQ240						166	166	166	
BG256	180	180	180	180					
BG352			260	260	260				
BG432					316	316	316	316	
BG560						404	404	404	404
FG256	176	176	176	176					
FG456			260	284	312				
FG676						404	444	444	
FG680							512	512	512

Virtex Ordering Information

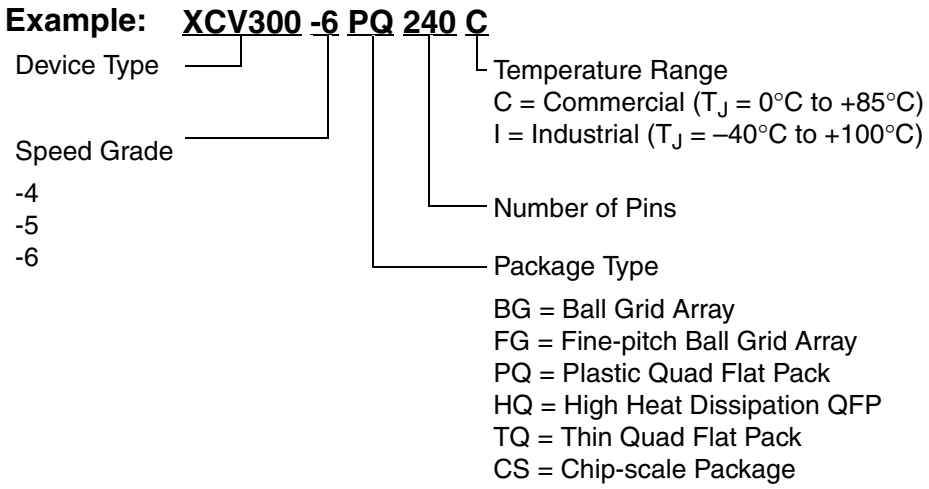


Figure 1: **Virtex Ordering Information**

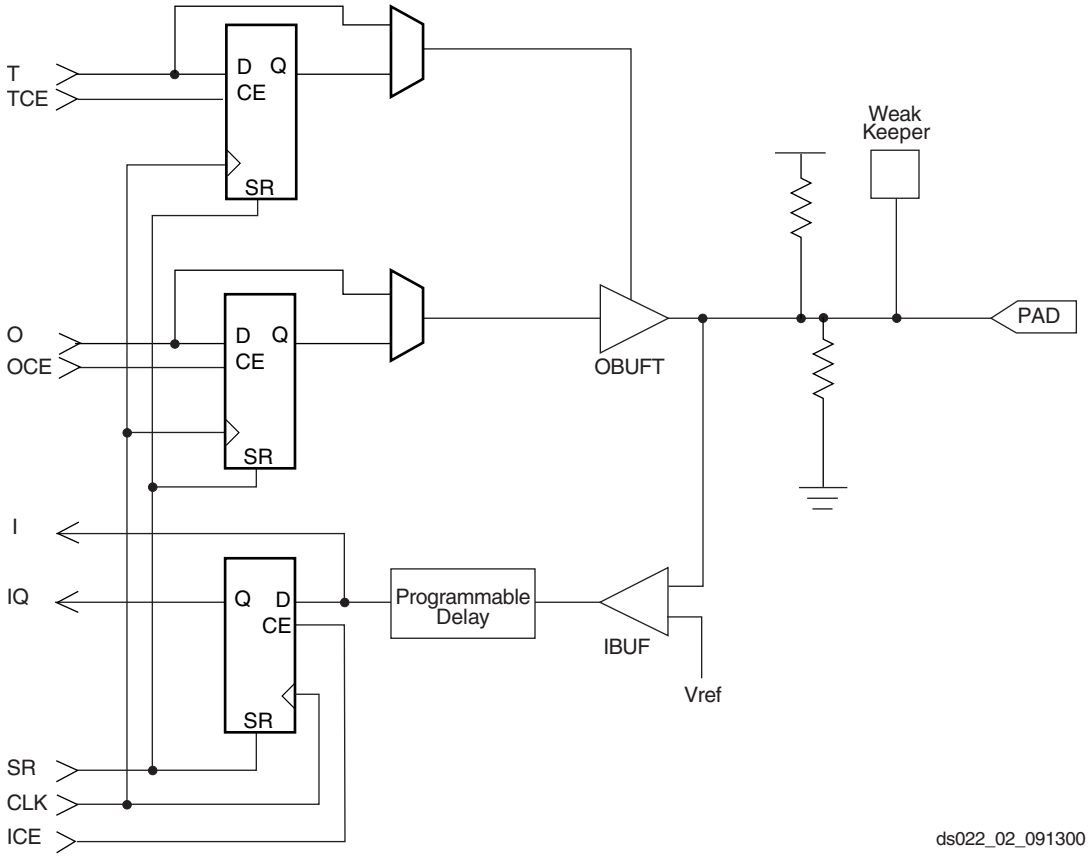


Figure 2: **Virtex Input/Output Block (IOB)**

Table 1: **Supported Select I/O Standards**

I/O Standard	Input Reference Voltage (V_{REF})	Output Source Voltage (V_{CCO})	Board Termination Voltage (V_{TT})	5 V Tolerant
LVTTL 2 – 24 mA	N/A	3.3	N/A	Yes
LVCMOS2	N/A	2.5	N/A	Yes
PCI, 5 V	N/A	3.3	N/A	Yes
PCI, 3.3 V	N/A	3.3	N/A	No
GTL	0.8	N/A	1.2	No
GTL+	1.0	N/A	1.5	No
HSTL Class I	0.75	1.5	0.75	No
HSTL Class III	0.9	1.5	1.5	No
HSTL Class IV	0.9	1.5	1.5	No
SSTL3 Class I &II	1.5	3.3	1.5	No
SSTL2 Class I & II	1.25	2.5	1.25	No
CTT	1.5	3.3	1.5	No
AGP	1.32	3.3	N/A	No

more I/O pins convert to V_{REF} pins. Since these are always a superset of the V_{REF} pins used for smaller devices, it is possible to design a PCB that permits migration to a larger device if necessary. All the V_{REF} pins for the largest device anticipated must be connected to the V_{REF} voltage, and not used for I/O.

In smaller devices, some V_{CCO} pins used in larger devices do not connect within the package. These unconnected pins can be left unconnected externally, or can be connected to the V_{CCO} voltage to permit migration to a larger device if necessary.

In TQ144 and PQ/HQ240 packages, all V_{CCO} pins are bonded together internally, and consequently the same V_{CCO} voltage must be connected to all of them. In the CS144 package, bank pairs that share a side are interconnected internally, permitting four choices for V_{CCO}. In both cases, the V_{REF} pins remain internally connected as eight banks, and can be used as described previously.

Configurable Logic Block

The basic building block of the Virtex CLB is the logic cell (LC). An LC includes a 4-input function generator, carry logic, and a storage element. The output from the function generator in each LC drives both the CLB output and the D input of the flip-flop. Each Virtex CLB contains four LCs, organized in two similar slices, as shown in Figure 4.

Figure 5 shows a more detailed view of a single slice.

In addition to the four basic LCs, the Virtex CLB contains logic that combines function generators to provide functions of five or six inputs. Consequently, when estimating the number of system gates provided by a given device, each CLB counts as 4.5 LCs.

Look-Up Tables

Virtex function generators are implemented as 4-input look-up tables (LUTs). In addition to operating as a function generator, each LUT can provide a 16 x 1-bit synchronous RAM. Furthermore, the two LUTs within a slice can be combined to create a 16 x 2-bit or 32 x 1-bit synchronous RAM, or a 16x1-bit dual-port synchronous RAM.

The Virtex LUT can also provide a 16-bit shift register that is ideal for capturing high-speed or burst-mode data. This mode can also be used to store data in applications such as Digital Signal Processing.

Storage Elements

The storage elements in the Virtex slice can be configured either as edge-triggered D-type flip-flops or as level-sensitive latches. The D inputs can be driven either by the function generators within the slice or directly from slice inputs, bypassing the function generators.

In addition to Clock and Clock Enable signals, each Slice has synchronous set and reset signals (SR and BY). SR forces a storage element into the initialization state specified for it in the configuration. BY forces it into the opposite state. Alternatively, these signals can be configured to operate asynchronously. All of the control signals are independently invertible, and are shared by the two flip-flops within the slice.

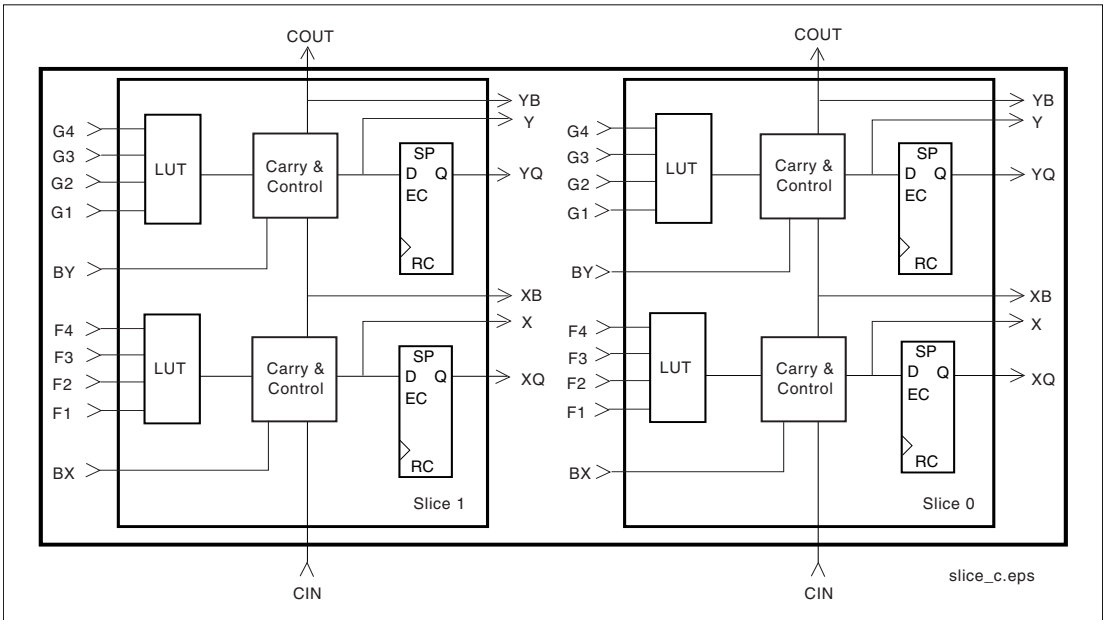


Figure 4: **2-Slice Virtex CLB**

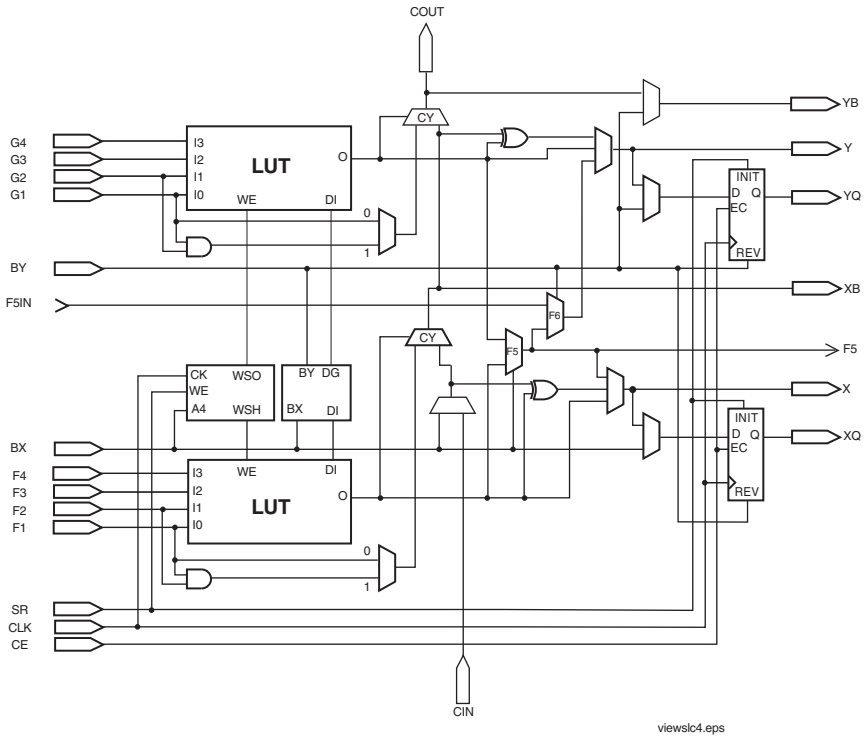


Figure 5: **Detailed View of Virtex Slice**

Additional Logic

The F5 multiplexer in each slice combines the function generator outputs. This combination provides either a function generator that can implement any 5-input function, a 4:1 multiplexer, or selected functions of up to nine inputs.

Similarly, the F6 multiplexer combines the outputs of all four function generators in the CLB by selecting one of the F5-multiplexer outputs. This permits the implementation of any 6-input function, an 8:1 multiplexer, or selected functions of up to 19 inputs.

Each CLB has four direct feedthrough paths, one per LC. These paths provide extra data input lines or additional local routing that does not consume logic resources.

Arithmetic Logic

Dedicated carry logic provides fast arithmetic carry capability for high-speed arithmetic functions. The Virtex CLB supports two separate carry chains, one per Slice. The height of the carry chains is two bits per CLB.

The arithmetic logic includes an XOR gate that allows a 1-bit full adder to be implemented within an LC. In addition, a dedicated AND gate improves the efficiency of multiplier implementation.

The dedicated carry path can also be used to cascade function generators for implementing wide logic functions.

BUFTs

Each Virtex CLB contains two 3-state drivers (BUFTs) that can drive on-chip busses. See **Dedicated Routing**, page 7. Each Virtex BUFT has an independent 3-state control pin and an independent input pin.

Block SelectRAM

Virtex FPGAs incorporate several large block SelectRAM memories. These complement the distributed LUT SelectRAMs that provide shallow RAM structures implemented in CLBs.

Block SelectRAM memory blocks are organized in columns. All Virtex devices contain two such columns, one along each vertical edge. These columns extend the full height of the chip. Each memory block is four CLBs high, and consequently, a Virtex device 64 CLBs high contains 16 memory blocks per column, and a total of 32 blocks.

Table 3 shows the amount of block SelectRAM memory that is available in each Virtex device.

Table 3: **Virtex Block SelectRAM Amounts**

Device	# of Blocks	Total Block SelectRAM Bits
XCV50	8	32,768
XCV100	10	40,960
XCV150	12	49,152
XCV200	14	57,344
XCV300	16	65,536
XCV400	20	81,920
XCV600	24	98,304
XCV800	28	114,688
XCV1000	32	131,072

General Purpose Routing

Most Virtex signals are routed on the general purpose routing, and consequently, the majority of interconnect resources are associated with this level of the routing hierarchy. The general routing resources are located in horizontal and vertical routing channels associated with the rows and columns CLBs. The general-purpose routing resources are listed below.

- Adjacent to each CLB is a General Routing Matrix (GRM). The GRM is the switch matrix through which horizontal and vertical routing resources connect, and is also the means by which the CLB gains access to the general purpose routing.
- 24 single-length lines route GRM signals to adjacent GRMs in each of the four directions.
- 12 buffered Hex lines route GRM signals to another GRMs six-blocks away in each one of the four directions. Organized in a staggered pattern, Hex lines can be driven only at their endpoints. Hex-line signals can be accessed either at the endpoints or at the midpoint (three blocks from the source). One third of the Hex lines are bidirectional, while the remaining ones are uni-directional.
- 12 Longlines are buffered, bidirectional wires that distribute signals across the device quickly and efficiently. Vertical Longlines span the full height of the device, and horizontal ones span the full width of the device.

I/O Routing

Virtex devices have additional routing resources around their periphery that form an interface between the CLB array and the IOBs. This additional routing, called the VersaRing, facilitates pin-swapping and pin-locking, such that logic redesigns can adapt to existing PCB layouts. Time-to-market is reduced, since PCBs and other system components can be manufactured while the logic design is still in progress.

Dedicated Routing

Some classes of signal require dedicated routing resources to maximize performance. In the Virtex architecture, dedicated routing resources are provided for two classes of signal.

- Horizontal routing resources are provided for on-chip 3-state busses. Four partitionable bus lines are provided per CLB row, permitting multiple busses within a row, as shown in Figure 8.
- Two dedicated nets per CLB propagate carry signals vertically to the adjacent CLB.

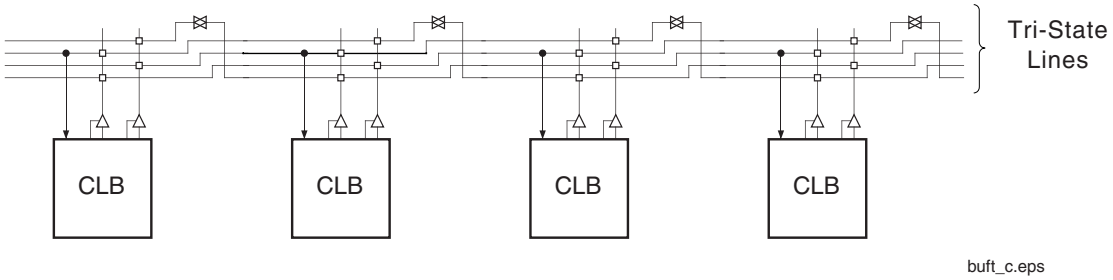


Figure 8: **BUFT Connections to Dedicated Horizontal Bus Lines**

Global Routing

Global Routing resources distribute clocks and other signals with very high fanout throughout the device. Virtex devices include two tiers of global routing resources referred to as primary global and secondary local clock routing resources.

- The primary global routing resources are four dedicated global nets with dedicated input pins that are designed to distribute high-fanout clock signals with minimal skew. Each global clock net can drive all CLB, IOB, and block RAM clock pins. The primary global nets can only be driven by global buffers. There are four global buffers, one for each global net.
- The secondary local clock routing resources consist of 24 backbone lines, 12 across the top of the chip and 12 across bottom. From these lines, up to 12 unique signals per column can be distributed via the 12 longlines in the column. These secondary resources are more flexible than the primary resources since they are not restricted to routing only to clock pins.

Clock Distribution

Virtex provides high-speed, low-skew clock distribution through the primary global routing resources described above. A typical clock distribution net is shown in Figure 9.

Four global buffers are provided, two at the top center of the device and two at the bottom center. These drive the four primary global nets that in turn drive any clock pin.

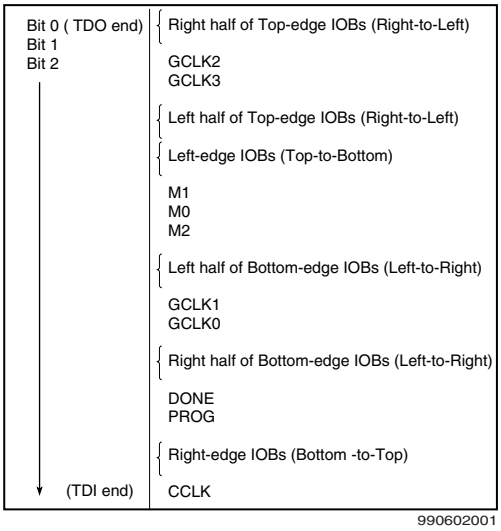


Figure 11: **Boundary Scan Bit Sequence**

Table 5: **Boundary Scan Instructions**

Boundary-Scan Command	Binary Code(4:0)	Description
EXTEST	00000	Enables boundary-scan EXTEST operation
SAMPLE/PRELOAD	00001	Enables boundary-scan SAMPLE/PRELOAD operation
USER 1	00010	Access user-defined register 1
USER 2	00011	Access user-defined register 2
CFG_OUT	00100	Access the configuration bus for read operations.
CFG_IN	00101	Access the configuration bus for write operations.
INTEST	00111	Enables boundary-scan INTEST operation
USERCODE	01000	Enables shifting out USER code
IDCODE	01001	Enables shifting out of ID Code
HIGHZ	01010	3-states output pins while enabling the Bypass Register
JSTART	01100	Clock the start-up sequence when StartupClk is TCK
BYPASS	11111	Enables BYPASS
RESERVED	All other codes	Xilinx reserved instructions

Identification Registers

The IDCODE register is supported. By using the IDCODE, the device connected to the JTAG port can be determined.

The IDCODE register has the following binary format:

vvvv:ffff:fffa:aaaa:aaaa:cccc:cccc:ccc1

where

v = the die version number

f = the family code (03h for Virtex family)

a = the number of CLB rows (ranges from 010h for XCV50 to 040h for XCV1000)

c = the company code (49h for Xilinx)

The USERCODE register is supported. By using the USERCODE, a user-programmable identification code can be loaded and shifted out for examination. The identification code is embedded in the bitstream during bitstream generation and is valid only after configuration.

Table 6: **IDCODEs Assigned to Virtex FPGAs**

FPGA	IDCODE
XCV50	v0610093h
XCV100	v0614093h
XCV150	v0618093h
XCV200	v061C093h
XCV300	v0620093h
XCV400	v0628093h
XCV600	v0630093h
XCV800	v0638093h
XCV1000	v0640093h

Including Boundary Scan in a Design

Since the boundary scan pins are dedicated, no special element needs to be added to the design unless an internal data register (USER1 or USER2) is desired.

If an internal data register is used, insert the boundary scan symbol and connect the necessary pins as appropriate.

Development System

Virtex FPGAs are supported by the Xilinx Foundation and Alliance CAE tools. The basic methodology for Virtex design consists of three interrelated steps: design entry, implementation, and verification. Industry-standard tools are used for design entry and simulation (for example, Synopsys FPGA Express), while Xilinx provides proprietary architecture-specific tools for implementation.

The Xilinx development system is integrated under the Xilinx Design Manager (XDM™) software, providing design-

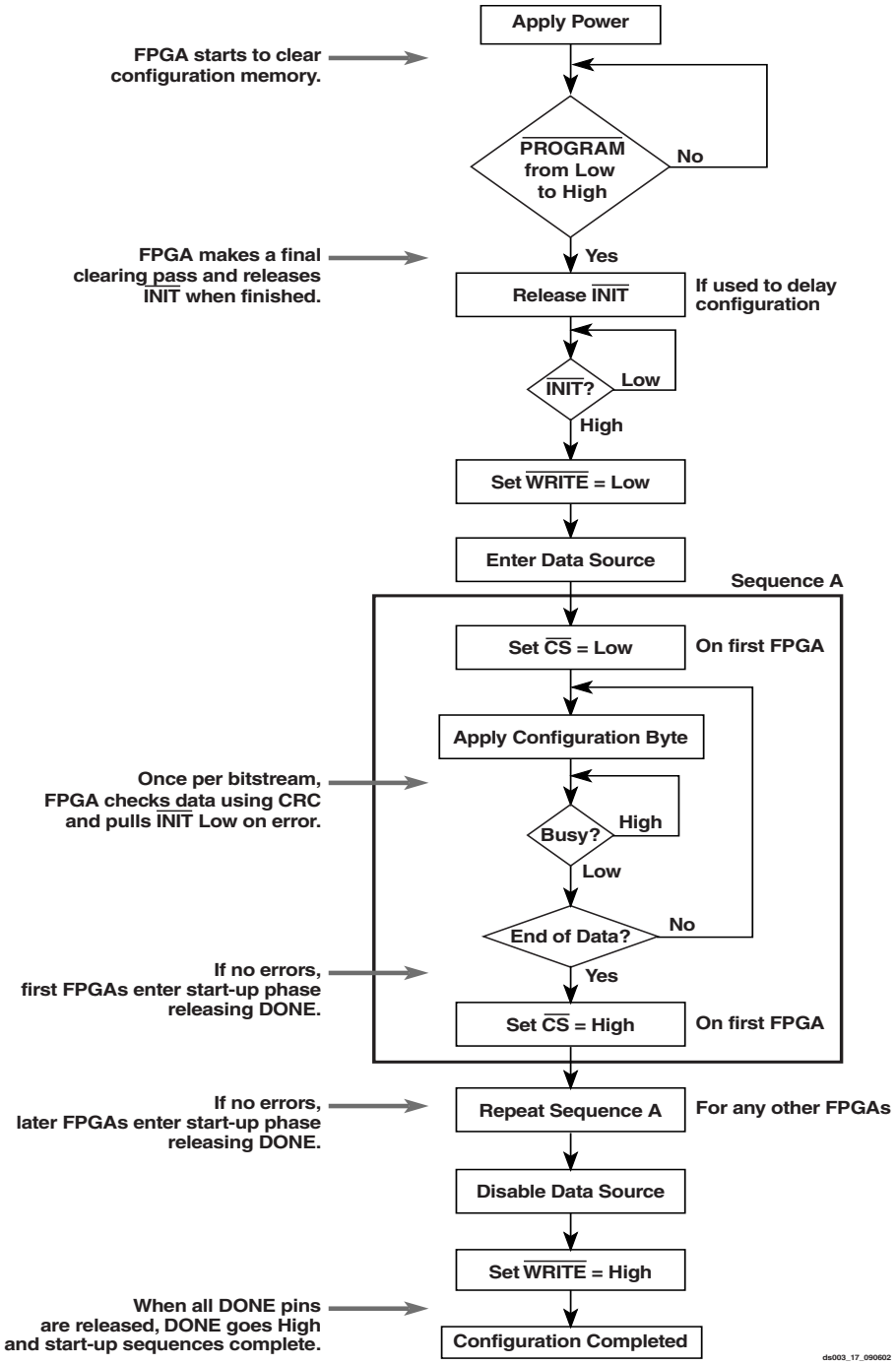


Figure 17: **SelectMAP Flowchart for Write Operation**

Abort

During a given assertion of $\overline{CS}$, the user cannot switch from a write to a read, or vice-versa. This action causes the current packet command to be aborted. The device will remain BUSY until the aborted operation has completed. Following an abort, data is assumed to be unaligned to word boundaries, and the FPGA requires a new synchronization word prior to accepting any new packets.

To initiate an abort during a write operation, de-assert $\overline{WRITE}$. At the rising edge of CCLK, an abort is initiated, as shown in Figure 18.

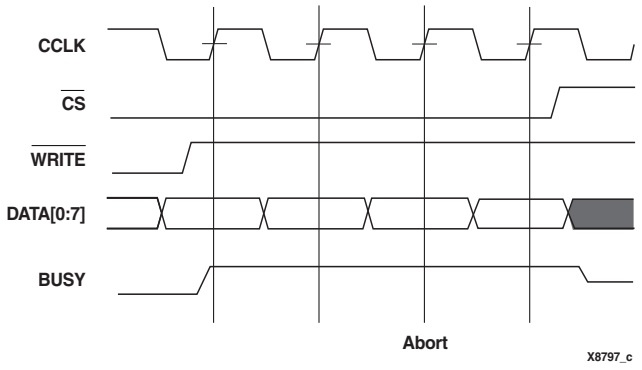


Figure 18: **SelectMAP Write Abort Waveforms**

Boundary-Scan Mode

In the boundary-scan mode, configuration is done through the IEEE 1149.1 Test Access Port. Note that the PROGRAM pin must be pulled High prior to reconfiguration. A Low on the PROGRAM pin resets the TAP controller and no JTAG operations can be performed.

Configuration through the TAP uses the CFG_IN instruction. This instruction allows data input on TDI to be converted into data packets for the internal configuration bus.

The following steps are required to configure the FPGA through the boundary-scan port (when using TCK as a start-up clock).

1. Load the CFG_IN instruction into the boundary-scan instruction register (IR)
2. Enter the Shift-DR (SDR) state
3. Shift a configuration bitstream into TDI
4. Return to Run-Test-Idle (RTI)
5. Load the JSTART instruction into IR
6. Enter the SDR state
7. Clock TCK through the startup sequence
8. Return to RTI

Configuration and readback via the TAP is always available. The boundary-scan mode is selected by a <101> or 001> on the mode pins (M2, M1, M0). For details on TAP characteristics, refer to XAPP139.

Configuration Sequence

The configuration of Virtex devices is a three-phase process. First, the configuration memory is cleared. Next, configuration data is loaded into the memory, and finally, the logic is activated by a start-up process.

Configuration is automatically initiated on power-up unless it is delayed by the user, as described below. The configuration process can also be initiated by asserting PROGRAM.

The end of the memory-clearing phase is signalled by INIT going High, and the completion of the entire process is signalled by DONE going High.

The power-up timing of configuration signals is shown in Figure 19. The corresponding timing characteristics are listed in Table 10.

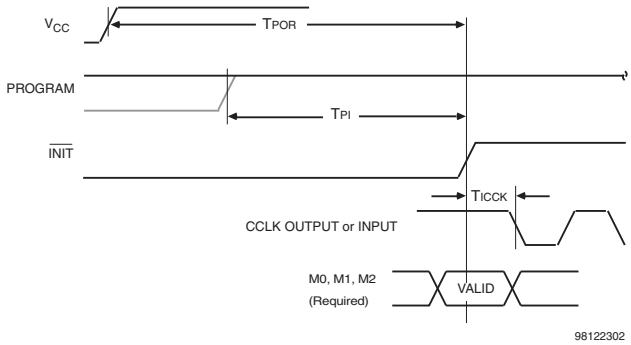


Figure 19: **Power-Up Timing Configuration Signals**

Table 10: **Power-up Timing Characteristics**

Description	Symbol	Value	Units
Power-on Reset	T_{POR}	2.0	ms, max
Program Latency	T_{PL}	100.0	µs, max
CCLK (output) Delay	T_{ICCK}	0.5	µs, min
		4.0	µs, max
Program Pulse Width	$T_{PROGRAM}$	300	ns, min

Delaying Configuration

INIT can be held Low using an open-drain driver. An open-drain is required since INIT is a bidirectional open-drain pin that is held Low by the FPGA while the configuration memory is being cleared. Extending the time that the pin is Low causes the configuration sequencer to wait. Thus, configuration is delayed by preventing entry into the phase where data is loaded.

Start-Up Sequence

The default Start-up sequence is that one CCLK cycle after DONE goes High, the global 3-state signal (GTS) is released. This permits device outputs to turn on as necessary.

One CCLK cycle later, the Global Set/Reset (GSR) and Global Write Enable (GWE) signals are released. This permits the internal storage elements to begin changing state in response to the logic and the user clock.

The relative timing of these events can be changed. In addition, the GTS, GSR, and GWE events can be made dependent on the DONE pins of multiple devices all going High, forcing the devices to start in synchronism. The sequence can also be paused at any stage until lock has been achieved on any or all DLLs.

Virtex DC Characteristics

Absolute Maximum Ratings

Symbol	Description(1)			Units
V_{CCINT}	Supply voltage relative to GND(2)		–0.5 to 3.0	V
V_{CCO}	Supply voltage relative to GND(2)		–0.5 to 4.0	V
V_{REF}	Input Reference Voltage		–0.5 to 3.6	V
V_{IN}	Input voltage relative to GND(3)	Using V_{REF}	–0.5 to 3.6	V
		Internal threshold	–0.5 to 5.5	V
V_{TS}	Voltage applied to 3-state output		–0.5 to 5.5	V
V_{CC}	Longest Supply Voltage Rise Time from 1V-2.375V		50	ms
T_{STG}	Storage temperature (ambient)		–65 to +150	°C
T_J	Junction temperature(4)	Plastic Packages	+125	°C

Notes:
1. Stresses beyond those listed under Absolute Maximum Ratings can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those listed under Operating Conditions is not implied. Exposure to Absolute Maximum Ratings conditions for extended periods of time can affect device reliability.
2. Power supplies can turn on in any order.
3. For protracted periods (e.g., longer than a day), V_{IN} should not exceed V_{CCO} by more than 3.6 V.
4. For soldering guidelines and thermal considerations, see the "Device Packaging" information on www.xilinx.com.

Recommended Operating Conditions

Symbol	Description		Min	Max	Units
V_{CCINT}(1)	Input Supply voltage relative to GND, T_J = 0 °C to +85°C	Commercial	2.5 – 5%	2.5 + 5%	V
	Input Supply voltage relative to GND, T_J = –40°C to +100°C	Industrial	2.5 – 5%	2.5 + 5%	V
V_{CCO}(4)	Supply voltage relative to GND, T_J = 0 °C to +85°C	Commercial	1.4	3.6	V
	Supply voltage relative to GND, T_J = –40°C to +100°C	Industrial	1.4	3.6	V
T_{IN}	Input signal transition time			250	ns

Notes:
1. Correct operation is guaranteed with a minimum V_{CCINT} of 2.375 V (Nominal V_{CCINT} –5%). Below the minimum value, all delay parameters increase by 3% for each 50-mV reduction in V_{CCINT} below the specified range.
2. At junction temperatures above those listed as Operating Conditions, delay parameters do increase. Please refer to the TRCE report.
3. Input and output measurement threshold is ~50% of V_{CC}.
4. Min and Max values for V_{CCO} are I/O Standard dependant.

DC Characteristics Over Recommended Operating Conditions

Symbol	Description	Device	Min	Max	Units
V_{DRINT}	Data Retention V_{CCINT} Voltage (below which configuration data can be lost)	All	2.0		V
V_{DRIO}	Data Retention V_{CCO} Voltage (below which configuration data can be lost)	All	1.2		V
I_{CCINTQ}	Quiescent V_{CCINT} supply current(1,3)	XCV50		50	mA
		XCV100		50	mA
		XCV150		50	mA
		XCV200		75	mA
		XCV300		75	mA
		XCV400		75	mA
		XCV600		100	mA
		XCV800		100	mA
		XCV1000		100	mA
I_{CCOQ}	Quiescent V_{CCO} supply current(1)	XCV50		2	mA
		XCV100		2	mA
		XCV150		2	mA
		XCV200		2	mA
		XCV300		2	mA
		XCV400		2	mA
		XCV600		2	mA
		XCV800		2	mA
		XCV1000		2	mA
I_{REF}	V_{REF} current per V_{REF} pin	All		20	µA
I_L	Input or output leakage current	All	–10	+10	µA
C_{IN}	Input capacitance (sample tested) BGA, PQ, HQ, packages	All		8	pF
I_{RPU}	Pad pull-up (when selected) @ V_{in} = 0 V, V_{CCO} = 3.3 V (sample tested)	All	Note (2)	0.25	mA
I_{RPD}	Pad pull-down (when selected) @ V_{in} = 3.6 V (sample tested)		Note (2)	0.15	mA

Notes:
1. With no output current loads, no active input pull-up resistors, all I/O pins 3-stated and floating.
2. Internal pull-up and pull-down resistors guarantee valid logic levels at unconnected input pins. These pull-up and pull-down resistors do not guarantee valid logic levels when input pins are connected to other circuits.
3. Multiply I_{CCINTQ} limit by two for industrial grade.

IOB Output Switching Characteristics Standard Adjustments

Output delays terminating at a pad are specified for LVTTL with 12 mA drive and fast slew rate. For other standards, adjust the delays by the values shown.

Description	Symbol	Standard(1)	Speed Grade				Units
			Min	-6	-5	-4	
Output Delay Adjustments							
Standard-specific adjustments for output delays terminating at pads (based on standard capacitive load, Csl)	T_{OLVTTL_S2}	LVTTL, Slow, 2 mA	4.2	14.7	15.8	17.0	ns
	T_{OLVTTL_S4}	4 mA	2.5	7.5	8.0	8.6	ns
	T_{OLVTTL_S6}	6 mA	1.8	4.8	5.1	5.6	ns
	T_{OLVTTL_S8}	8 mA	1.2	3.0	3.3	3.5	ns
	T_{OLVTTL_S12}	12 mA	1.0	1.9	2.1	2.2	ns
	T_{OLVTTL_S16}	16 mA	0.9	1.7	1.9	2.0	ns
	T_{OLVTTL_S24}	24 mA	0.8	1.3	1.4	1.6	ns
	T_{OLVTTL_F2}	LVTTL, Fast, 2mA	1.9	13.1	14.0	15.1	ns
	T_{OLVTTL_F4}	4 mA	0.7	5.3	5.7	6.1	ns
	T_{OLVTTL_F6}	6 mA	0.2	3.1	3.3	3.6	ns
	T_{OLVTTL_F8}	8 mA	0.1	1.0	1.1	1.2	ns
	T_{OLVTTL_F12}	12 mA	0	0	0	0	ns
	T_{OLVTTL_F16}	16 mA	–0.10	–0.05	–0.05	–0.05	ns
	T_{OLVTTL_F24}	24 mA	–0.10	–0.20	–0.21	–0.23	ns
	$T_{OLVCMOS2}$	LVCMOS2	0.10	0.10	0.11	0.12	ns
	T_{OPCI33_3}	PCI, 33 MHz, 3.3 V	0.50	2.3	2.5	2.7	ns
	T_{OPCI33_5}	PCI, 33 MHz, 5.0 V	0.40	2.8	3.0	3.3	ns
	T_{OPCI66_3}	PCI, 66 MHz, 3.3 V	0.10	–0.40	–0.42	–0.46	ns
	T_{OGTL}	GTL	0.6	0.50	0.54	0.6	ns
	T_{OGTLP}	GTL+	0.7	0.8	0.9	1.0	ns
	T_{OHSTL_I}	HSTL I	0.10	–0.50	–0.53	–0.5	ns
	T_{OHSTL_III}	HSTL III	–0.10	–0.9	–0.9	–1.0	ns
	T_{OHSTL_IV}	HSTL IV	–0.20	–1.0	–1.0	–1.1	ns
	T_{OSSTL2_I}	SSTL2 I	–0.10	–0.50	–0.53	–0.5	ns
	T_{OSSLT2_II}	SSTL2 II	–0.20	–0.9	–0.9	–1.0	ns
	T_{OSSTL3_I}	SSTL3 I	–0.20	–0.50	–0.53	–0.5	ns
	T_{OSSTL3_II}	SSTL3 II	–0.30	–1.0	–1.0	–1.1	ns
	T_{OCTT}	CTT	0	–0.6	–0.6	–0.6	ns
	T_{OAGP}	AGP	0	–0.9	–0.9	–1.0	ns

Notes:
1. Output timing is measured at 1.4 V with 35 pF external capacitive load for LVTTL. For other I/O standards and different loads, see Table 2 and Table 3.

DLL Timing Parameters

All devices are 100 percent functionally tested. Because of the difficulty in directly measuring many internal timing parameters, those parameters are derived from benchmark timing patterns. The following guidelines reflect worst-case values across the recommended operating conditions.

Description	Symbol	Speed Grade						Units
		-6		-5		-4		
		Min	Max	Min	Max	Min	Max	
Input Clock Frequency (CLKDLLHF)	FCLKINHF	60	200	60	180	60	180	MHz
Input Clock Frequency (CLKDLL)	FCLKINLF	25	100	25	90	25	90	MHz
Input Clock Pulse Width (CLKDLLHF)	$T_{DLLPWHF}$	2.0	-	2.4	-	2.4	-	ns
Input Clock Pulse Width (CLKDLL)	$T_{DLLPWLF}$	2.5	-	3.0		3.0	-	ns

Notes:
1. All specifications correspond to Commercial Operating Temperatures (0°C to + 85°C).

DLL Clock Tolerance, Jitter, and Phase Information

All DLL output jitter and phase specifications determined through statistical measurement at the package pins using a clock mirror configuration and matched drivers.

Description	Symbol	F_{CLKIN}	CLKDLLHF		CLKDLL		Units
			Min	Max	Min	Max	
Input Clock Period Tolerance	T_{IPTOL}		-	1.0	-	1.0	ns
Input Clock Jitter Tolerance (Cycle to Cycle)	T_{IJITCC}		-	± 150	-	± 300	ps
Time Required for DLL to Acquire Lock	T_{LOCK}	> 60 MHz	-	20	-	20	µs
		50 - 60 MHz	-	-	-	25	µs
		40 - 50 MHz	-	-	-	50	µs
		30 - 40 MHz	-	-	-	90	µs
		25 - 30 MHz	-	-	-	120	µs
Output Jitter (cycle-to-cycle) for any DLL Clock Output(1)	T_{OJITCC}			± 60		± 60	ps
Phase Offset between CLKIN and CLKO(2)	T_{PHIO}			± 100		± 100	ps
Phase Offset between Clock Outputs on the DLL(3)	T_{PHOO}			± 140		± 140	ps
Maximum Phase Difference between CLKIN and CLKO(4)	T_{PHIOM}			± 160		± 160	ps
Maximum Phase Difference between Clock Outputs on the DLL(5)	T_{PHOOM}			± 200		± 200	ps

Notes:
1. **Output Jitter** is cycle-to-cycle jitter measured on the DLL output clock, *excluding* input clock jitter.
2. **Phase Offset between CLKIN and CLKO** is the worst-case fixed time difference between rising edges of CLKIN and CLKO, *excluding* Output Jitter and input clock jitter.
3. **Phase Offset between Clock Outputs on the DLL** is the worst-case fixed time difference between rising edges of any two DLL outputs, *excluding* Output Jitter and input clock jitter.
4. **Maximum Phase Difference between CLKIN an CLKO** is the sum of Output Jitter and Phase Offset between CLKIN and CLKO, or the greatest difference between CLKIN and CLKO rising edges due to DLL alone (*excluding* input clock jitter).
5. **Maximum Phase DIfference between Clock Outputs on the DLL** is the sum of Output JItter and Phase Offset between any DLL clock outputs, or the greatest difference between any two DLL output rising edges sue to DLL alone (*excluding* input clock jitter).
6. All specifications correspond to Commercial Operating Temperatures (0°C to +85°C).

Table 2: **Virtex Pinout Tables (Chip-Scale and QFP Packages)** ***(Continued)***

Pin Name	Device	CS144	TQ144	PQ/HQ240
V_{CCO}	All	Banks 0 and 1: A2, A13, D7 Banks 2 and 3: B12, G11, M13 Banks 4 and 5: N1, N7, N13 Banks 6 and 7: B2, G2, M2	No I/O Banks in this package: 1, 17, 37, 55, 73, 92, 109, 128	No I/O Banks in this package: 15, 30, 44, 61, 76, 90, 105, 121, 136, 150, 165, 180, 197, 212, 226, 240
V_{REF}, Bank 0 (V_{REF} pins are listed incrementally. Connect all pins listed for both the required device and all smaller devices listed in the same package.) Within each bank, if input reference voltage is not required, all V_{REF} pins are general I/O.	XCV50	C4, D6	5, 13	218, 232
	XCV100/150	... + B4	... + 7	... + 229
	XCV200/300	N/A	N/A	... + 236
	XCV400	N/A	N/A	... + 215
	XCV600	N/A	N/A	... + 230
	XCV800	N/A	N/A	... + 222
V_{REF}, Bank 1 (V_{REF} pins are listed incrementally. Connect all pins listed for both the required device and all smaller devices listed in the same package.) Within each bank, if input reference voltage is not required, all V_{REF} pins are general I/O.	XCV50	A10, B8	22, 30	191, 205
	XCV100/150	... + D9	... + 28	... + 194
	XCV200/300	N/A	N/A	... + 187
	XCV400	N/A	N/A	... + 208
	XCV600	N/A	N/A	... + 193
	XCV800	N/A	N/A	... + 201
V_{REF}, Bank 2 (V_{REF} pins are listed incrementally. Connect all pins listed for both the required device and all smaller devices listed in the same package.) Within each bank, if input reference voltage is not required, all V_{REF} pins are general I/O.	XCV50	D11, F10	42, 50	157, 171
	XCV100/150	... + D13	... + 44	... + 168
	XCV200/300	N/A	N/A	... + 175
	XCV400	N/A	N/A	... + 154
	XCV600	N/A	N/A	... + 169
	XCV800	N/A	N/A	... + 161

Table 3: **Virtex Pinout Tables (BGA) *(Continued)***

Pin Name	Device	BG256	BG352	BG432	BG560
V_{CCINT} **Notes:** • Superset includes all pins, including the ones in **bold** type. Subset excludes pins in **bold** type. • In BG352, for XCV300 all the V_{CCINT} pins in the superset must be connected. For XCV150/200, V_{CCINT} pins in the subset must be connected, and pins in **bold** type can be left unconnected (these unconnected pins cannot be used as user I/O.) • In BG432, for XCV400/600/800 all V_{CCINT} pins in the superset must be connected. For XCV300, V_{CCINT} pins in the subset must be connected, and pins in **bold** type can be left unconnected (these unconnected pins cannot be used as user I/O.) • In BG560, for XCV800/1000 all V_{CCINT} pins in the superset must be connected. For XCV400/600, V_{CCINT} pins in the subset must be connected, and pins in **bold** type can be left unconnected (these unconnected pins cannot be used as user I/O.)	XCV50/100	C10, D6, D15, F4, F17, L3, L18, R4, R17, U6, U15, V10	N/A	N/A	N/A
	XCV150/200/300	Same as above	A20, C14, D10, J24, K4, P2, P25, V24, W2, AC10, AE14, AE19, **B16, D12, L1, L25, R23, T1, AF11, AF16**	A10, A17, B23, C14, C19, K3, K29, N2, N29, T1, T29, W2, W31, AB2, AB30, AJ10, AJ16, AK13, AK19, AK22, **B26, C7, F1, F30, AE29, AF1, AH8, AH24**	N/A
	XCV400/600/800/1000	N/A	N/A	Same as above	A21, B14, B18, B28, C24, E9, E12, F2, H30, J1, K32, N1, N33, U5, U30, Y2, Y31, AD2, AD32, AG3, AG31, AK8, AK11, AK17, AK20, AL14, AL27, AN25, **B12, C22, M3, N29, AB2, AB32, AJ13, AL22**
V_{CCO}, Bank 0	All	D7, D8	A17, B25, D19	A21, C29, D21	A22, A26, A30, B19, B32
V_{CCO}, Bank 1	All	D13, D14	A10, D7, D13	A1, A11, D11	A10, A16, B13, C3, E5
V_{CCO}, Bank 2	All	G17, H17	B2, H4, K1	C3, L1, L4	B2, D1, H1, M1, R2
V_{CCO}, Bank 3	All	N17, P17	P4, U1, Y4	AA1, AA4, AJ3	V1, AA2, AD1, AK1, AL2
V_{CCO}, Bank 4	All	U13, U14	AC8, AE2, AF10	AH11, AL1, AL11	AM2, AM15, AN4, AN8, AN12
V_{CCO}, Bank 5	All	U7, U8	AC14, AC20, AF17	AH21, AJ29, AL21	AL31, AM21, AN18, AN24, AN30
V_{CCO}, Bank 6	All	N4, P4	U26, W23, AE25	AA28, AA31, AL31	W32, AB33, AF33, AK33, AM32

Table 4: **Virtex Pinout Tables (Fine-Pitch BGA)**

Pin Name	Device	FG256	FG456	FG676	FG680
GCK0	All	N8	W12	AA14	AW19
GCK1	All	R8	Y11	AB13	AU22
GCK2	All	C9	A11	C13	D21
GCK3	All	B8	C11	E13	A20
M0	All	N3	AB2	AD4	AT37
M1	All	P2	U5	W7	AU38
M2	All	R3	Y4	AB6	AT35
CCLK	All	D15	B22	D24	E4
PROGRAM	All	P15	W20	AA22	AT5
DONE	All	R14	Y19	AB21	AU5
INIT	All	N15	V19	Y21	AU2
BUSY/DOUT	All	C15	C21	E23	E3
D0/DIN	All	D14	D20	F22	C2
D1	All	E16	H22	K24	P4
D2	All	F15	H20	K22	P3
D3	All	G16	K20	M22	R1
D4	All	J16	N22	R24	AD3
D5	All	M16	R21	U23	AG2
D6	All	N16	T22	V24	AH1
D7	All	N14	Y21	AB23	AR4
WRITE	All	C13	A20	C22	B4
CS	All	B13	C19	E21	D5
TDI	All	A15	B20	D22	B3
TDO	All	B14	A21	C23	C4
TMS	All	D3	D3	F5	E36
TCK	All	C4	C4	E6	C36
DXN	All	R4	Y5	AB7	AV37
DXP	All	P4	V6	Y8	AU35

Table 4: **Virtex Pinout Tables (Fine-Pitch BGA) *(Continued)***

Pin Name	Device	FG256	FG456	FG676	FG680
V_{REF}, Bank 7 (V_{REF} pins are listed incrementally. Connect all pins listed for both the required device and all smaller devices listed in the same package.) Within each bank, if input reference voltage is not required, all V_{REF} pins are general I/O.	XCV50	C1, H3	N/A	N/A	N/A
	XCV100/150	... + D1	E2, H4, K3	N/A	N/A
	XCV200/300	... + B1	... + D2	N/A	N/A
	XCV400	N/A	N/A	F4, G4, K6, M2, M5	N/A
	XCV600	N/A	N/A	... + H1	E38, G38, L36, N36, U36, U38
	XCV800	N/A	N/A	... + K1	... + N38
	XCV1000	N/A	N/A	N/A	... + F36
GND	All	A1, A16, B2, B15, F6, F7, F10, F11, G6, G7, G8, G9, G10, G11, H7, H8, H9, H10, J7, J8, J9, J10, K6, K7, K8, K9, K10, K11, L6, L7, L10, L11, R2, R15, T1, T16	A1, A22, B2, B21, C3, C20, J9, J10, J11, J12, J13, J14, K9, K10, K11, K12, K13, K14, L9, L10, L11, L12, L13, L14, M9, M10, M11, M12, M13, M14, N9, N10, N11, N12, N13, N14, P9, P10, P11, P12, P13, P14, Y3, Y20, AA2, AA21, AB1, AB22	A1, A26, B2, B9, B14, B18, B25, C3, C24, D4, D23, E5, E22, J2, J25, K10, K11, K12, K13, K14, K15, K16, K17, L10, L11, L12, L13, L14, L15, L16, L17, M10, M11, M12, M13, M14, M15, M16, M17, N2, N10, N11, N12, N13, N14, N15, N16, N17, P10, P11, P12, P13, P14, P15, P16, P17, P25, R10, R11, R12, R13, R14, R15, R16, R17, T10, T11, T12, T13, T14, T15, T16, T17, U10, U11, U12, U13, U14, U15, U16, U17, V2, V25, AB5, AB22, AC4, AC23, AD3, AD24, AE2, AE9, AE13, AE18, AE25, AF1, AF26	A1, A2, A3, A37, A38, A39, AA5, AA35, AH4, AH5, AH35, AH36, AR5, AR12, AR19, AR20, AR21, AR28, AR35, AT4, AT12, AT20, AT28, AT36, AU1, AU3, AU20, AU37, AU39, AV1, AV2, AV38, AV39, AW1, AW2, AW3, AW37, AW38, AW39, B1, B2, B38, B39, C1, C3, C20, C37, C39, D4, D12, D20, D28, D36, E5, E12, E19, E20, E21, E28, E35, M4, M5, M35, M36, W5, W35, Y3, Y4, Y5, Y35, Y36, Y37

TQ144 Pin Function Diagram

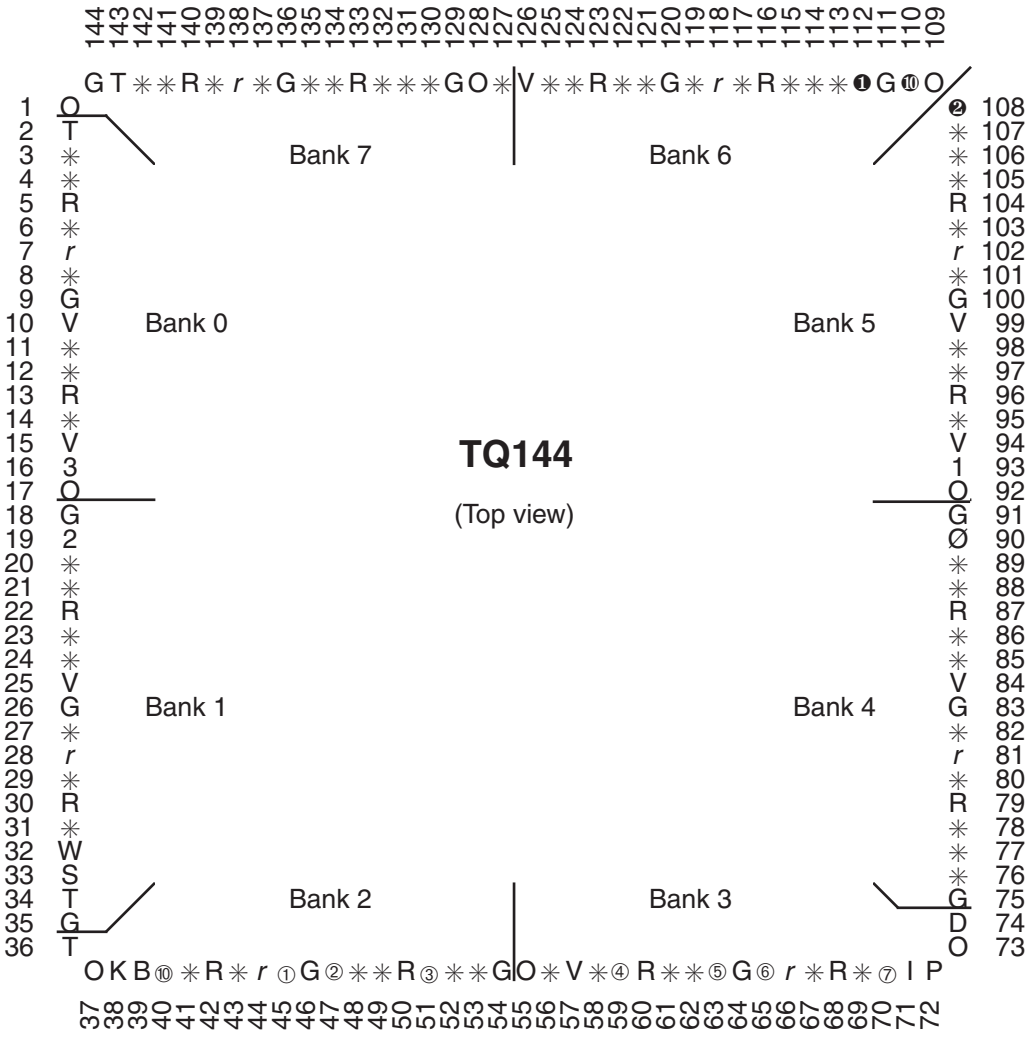
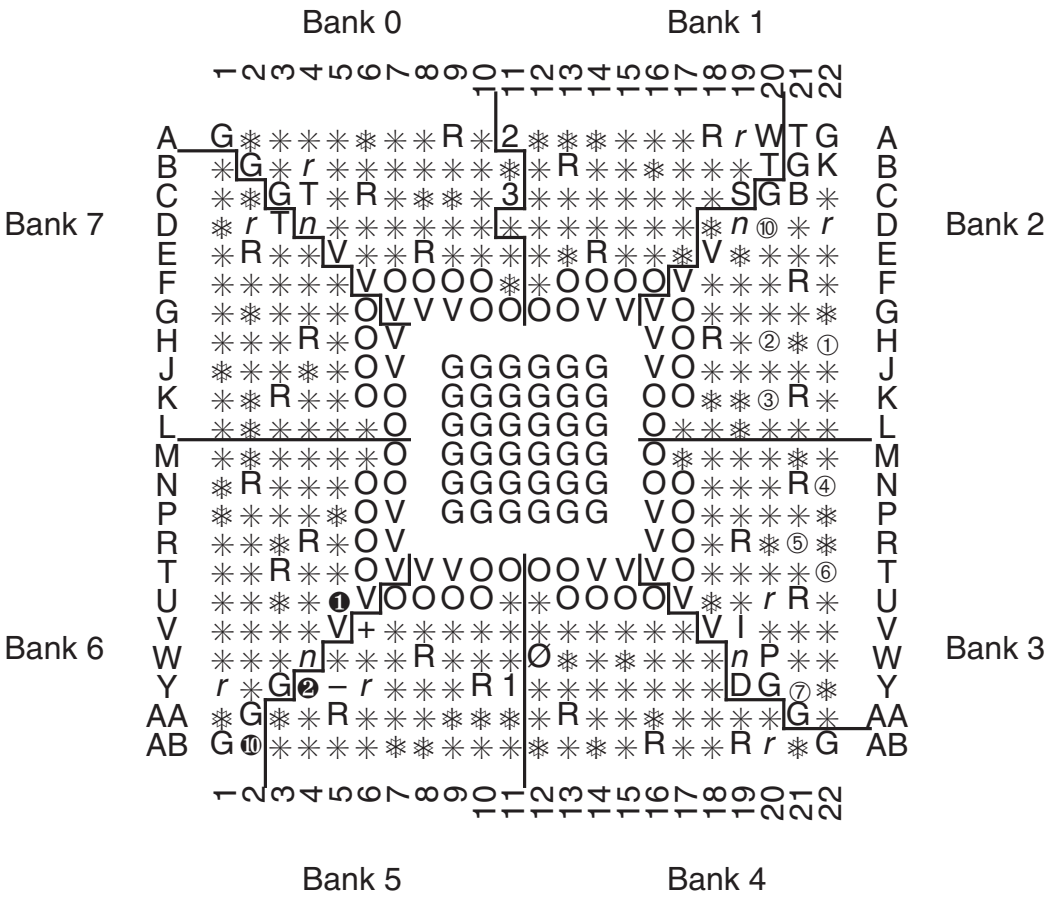


Figure 2: **TQ144 Pin Function Diagram**

FG456 Pin Function Diagram



FG456
(Top view)

Figure 9: **FG456 Pin Function Diagram**

Notes:

Packages FG456 and FG676 are layout compatible.

FG680 Pin Function Diagram

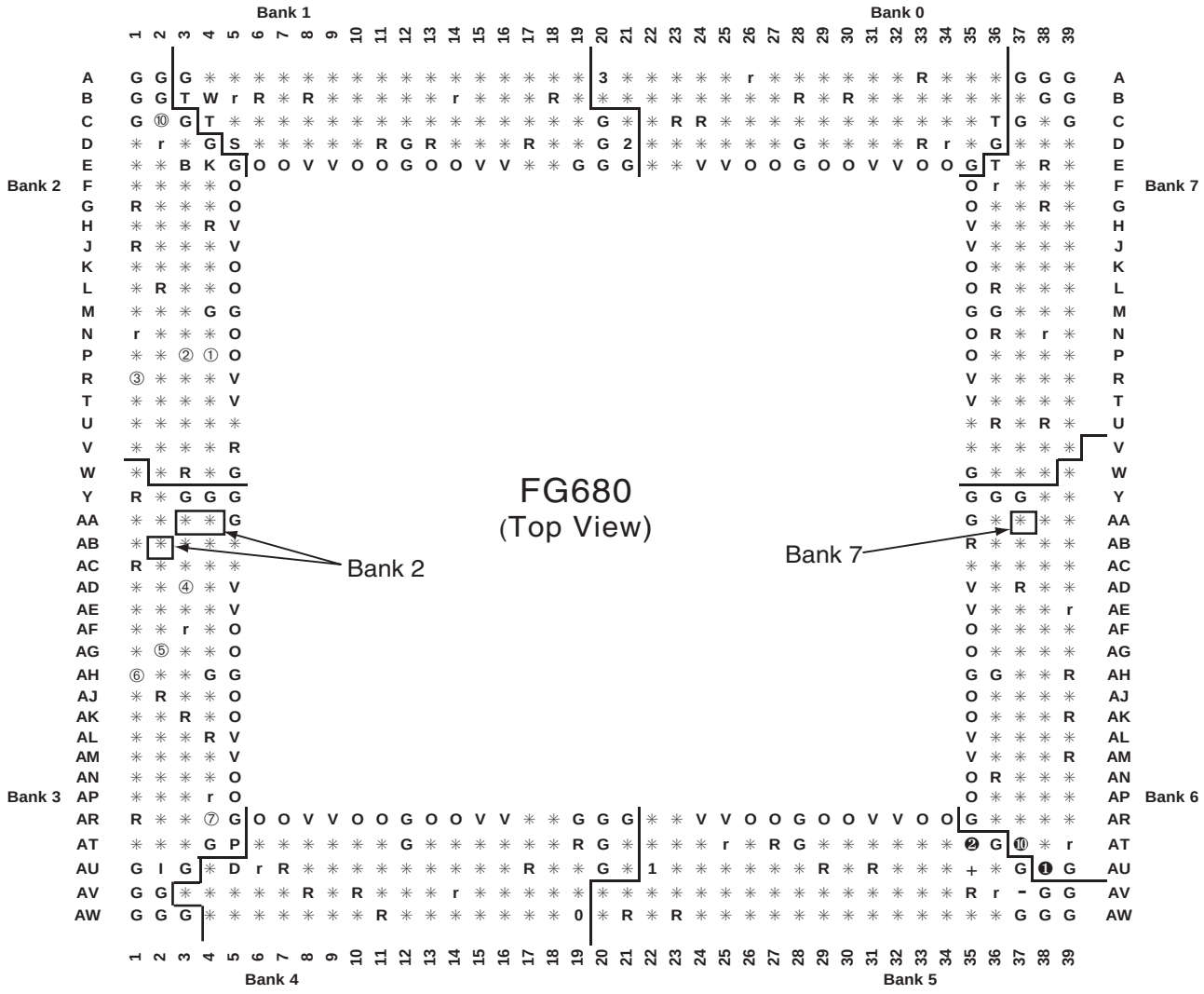


Figure 11: **FG680 Pin Function Diagram**