

# USB Function Controller Megafunction

Solution Brief 24

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## Target Applications:

Buses & Interfaces

Family: FLEX 10K & FLEX 8000

Vendor:



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## Features

- Fully compliant with universal serial bus (USB) 1.0 Specification
- Automatic hardware-managed protocol
- Up to 16 end points of any type
- Simple application interface
- Applications
  - High-speed interface to audio, human interface, and storage devices
  - USB target hardware prototyping

## General Description

The USB function controller megafunction implements the complete USB 1.0 Specification and is suitable for audio, human interface, and storage applications. This megafunction automatically manages all USB protocol requirements in hardware. It also offers a fast, low-risk method of implementing a USB connection that can be easily integrated into any application.

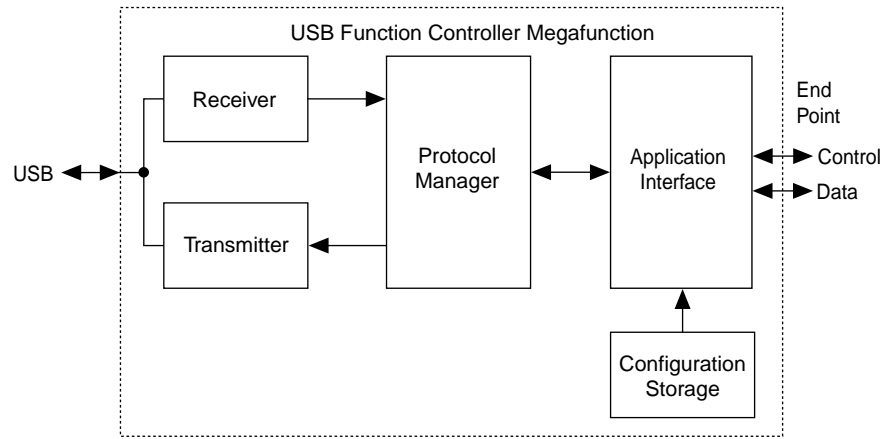
The USB function controller megafunction efficiently uses the Altera® FLEX® 10K and FLEX 8000 architecture and offers a low-risk prototype or production solution. This megafunction is available in EDIF netlist, Verilog HDL, or VHDL format.

## Functional Description

The megafunction is comprised of receiver, transmitter, protocol manager, configuration storage, and application interface logic blocks (see [Figure 1](#)). The receiver and transmitter blocks support low-level USB protocol operations, such as bit-stuff, NRZI, PID, and cyclic redundancy check (CRC). The receiver block decodes the destination of incoming packets and classifies them according to the transfer type. It also checks the CRC and detects bit errors for reporting to the protocol manager. The transmitter block formats packets from the data stream, adding the appropriate CRC header and other protocol requirements.

The protocol manager is responsible for managing higher level USB protocol functions such as `ack`, `nack`, and `stall` handshakes. The protocol manager responds to control transfers by accessing the configuration storage for configuration transfers. The configuration storage contains the device, configuration, interface, and end point descriptor information, which is used to dynamically define and configure the megafunction. The application interface communicates with the USB through the protocol manager and, in turn, is used by the application logic to transfer data, control, and status.

Figure 1. USB Function Controller Megafunction Block Diagram



The FLEX 10K embedded array blocks (EABs) are used to store the configuration ROM code for the device and end point descriptors. They are also used as storage buffers, and in some applications, as FIFOs.

The megafunction is verified to operate at either full- or low-speed transfer rates. A 4X over-sample phase-locked loop (PLL) in the receiver block synchronizes the data to the megafunction clock. The application side can be operated synchronously or asynchronously to the USB clock.

All versions have a control end point. Customized interrupt, bulk transfer, and single or dual isochronous versions are also available.

## Performance

Table 1 lists the typical device utilization for the USB function controller megafunction in EPF10K20 and EPF81500 devices.

Table 1. Typical Device Utilization						
Family	Smallest Device	Speed	Logic Cells	EABs	Performance	Availability
FLEX 10K	EPF10K20	-4	1,120	3 to 6	12 MHz, <i>Note (1)</i>	Now
FLEX 8000	EPF81500	A-4	1,172	–	12 MHz, <i>Note (1)</i>	Now

**Note:**

(1) 12 MHz is the standard USB operating frequency. However, the devices are capable of operating at higher speeds.

The USB function controller megafunction can be delivered as a netlist or in source code format. Sapient Design supplies a user guide and synthesis scripts and offers telephone, e-mail, and on-site technical support.



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