USB OTG and Embedded Host
Topics

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- USB Embedded Host
- USB On-The-Go
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- OTG Architecture
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- Microchip USB OTG Features
- Microchip USB OTG Product Portfolio
- Meeting the needs of Product Makers
- Summary
Nomenclature

- Embedded Host – also Mini Host, a Type A host class product with fixed capabilities to save cost and complexity

- Peripheral – Device, a Type B class product that requires a host or embedded host or OTG

- OTG – A Type AB product, a combination of Embedded host and Peripheral
USB Universe

Traditional Host / Peripheral

OTG
On-The-Go Versus Embedded Host

OTG

- Limited host capabilities
- Possess dual role - host or peripheral capability to switch between the two
- Devices have Mini-AB receptacle
- OTG devices must have Host Negotiation Protocol (HNP) and Session Request Protocol (SRP)

Embedded Host

- Limited host capabilities
- Posses single role – host
- Devices have only Mini-A receptacle
- Does not require Host Negotiation Protocol (HNP) and optionally support Session Request Protocol (SRP)
- Do not operate either as hub or full host as normal host does
Embedded Host

- Limited resources
- Target Peripheral List
- Must be capable of supplying at least 8mA on VBUS
- High-, Full-, Low-speed may be supported
- Of the 4 USB transfer modes – Mandatory to support Control and could support Bulk, Interrupt and Isochronous based on target peripheral list
- Example – Set Top box
USB On-The-Go

- Meeting the requirements of connectivity in a standardized method for small form factor devices
- Supplement to USB 2.0 specification
- Gives dual role (Host and Peripheral) capability to the devices and to switch between the two
- Low power requirements to facilitate USB on small footprint devices
OTG – Must have features

- A limited Host capability
- Full-speed operation as a peripheral (high-speed optional)
- Full-speed support as a host (low-speed and high-speed optional)
- Targeted Peripheral List (Device classes)
- Session Request Protocol
- Host Negotiation Protocol
- One, and only one connection: a Micro-AB receptacle
- Bus current of minimum 8mA
- Means for communicating messages to the user
USB Device Classes

- Joystick
- Mouse
- Thumb Drive
- External Hard Drive
- Floppy Drive
- Ethernet Adapter
- Modem
- Mass Storage Device Class (MSD)
- Communication Device Class (CDC)
- ICD2
- Custom Class (Vendor Class)
- Many more USB classes....

Human Interface Device Class (HID)

PIwik™ 2 Starter Kit
Data Glove
Keyboard
Thumb Drive
External Hard Drive
Floppy Drive
Session Request Protocol (SRP)

Peripheral requests host to start a session

Host activates power bus for peripheral, session commences

When session ends, bus is turned off, conserving power
Host Negotiation Protocol (HNP)

Host Starts as Host, Interrogates peripheral

If peripheral is device, then it remains host

If peripheral is host, then it becomes device

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Mini-AB Connectors

- An OTG device contains a single Mini-AB receptacle that functions as either a host or a peripheral e.g. PDA
  - An OTG device acts as host when Mini-A plug is inserted
  - An OTG device acts as device when Mini-B plug is inserted

- Only Mini-B receptacle is used for devices that operate as peripheral only e.g. cameras

- Only Mini-A receptacle is used for devices that operate as embedded host only e.g. set top box
OTG Architecture

Host
- HID
- MSC
- CDC
- Generic

USB Protocol Driver

Host Controller Device (HCD)

Peripheral

USB Protocol Layer

Peripheral Controller Device (PCD)

Transceiver Driver

Host Controller

Regs.

Peripheral Controller

Regs.

OTG Dual Role Device

On-The-Go Transceiver

Regs.
## Application Examples

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<th>Host</th>
<th>Peripheral</th>
<th>Application</th>
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<td>Mobile Phone Still Image Camera</td>
<td>Exchange contact information</td>
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<td>MP3 Player Mass Storage Scanner</td>
<td>Email pictures, upload pictures to web</td>
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<td>MP3 Player</td>
<td>MP3 Player Mass Storage</td>
<td>Exchange songs</td>
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<tr>
<td></td>
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<td>Upload/download songs</td>
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PIC24FJ256GB1 General Purpose Family USB On-the-Go, 256KB Flash

Features
- Performance 16 MIPS @ 32 MHz
- Program Memory
  - Self programming Flash supports EEPROM emulation
    - 256KB, 192 KB, 128 KB, 64 KB
    - 10,000 erase write cycles
- 16 KB RAM
- 100, 80, 64-pin TQFP Packages
- Internal Oscillator
- Low Power Modes
- JTAG Boundary Scan & Flash Memory Programming
- 3.3 V operation
- Low power 2.6uA at 2V
- Sleep power <100nA

USB OTG (device, mini-host, host)
- Internal Boost Regulator requires minimal external components
- Separate 3.3V regulator
- Transparent RAM buffer interface

Peripherals
- 4 x UART w/LIN and IrDA® interfaces
- 3 x \text{I}^2\text{C}™
- 3 x SPI™
- 16 ch. x 10-bit A/D (500 ksp/s)
- 5 x 16-bit general purpose timers
- 9 x IC, 9 x OC/PWM
  - Each IC and OC/PWM includes a dedicated 16-bit scaling timer
  - Total of individual 21 timers
- Peripheral Pin Select
  - Select peripherals, map to pins
- 3 x comparators
- CTMU – Charge/Time Measurement Unit
- Hardware RTCC and Hardware CRC
- Parallel Master Port

Availability
- Samples - NOW
- Production – NOW
Microchip meeting the needs of product makers

- Selection of USB products from 8 to 32bit MCU portfolio
  - Peripheral
  - Embedded Host
  - OTG

- Feature rich products
  - USB v2.0 On-The-Go (OTG) compliant
  - Capacitive touch sensing for touch screens and capacitive switches
  - Lowest power, highest memory

- Cost effective, BOM saving, board space saving
  - Meeting user demand of friendliness, upgradeability and expandability
  - Meeting multiple applications requirements with low BOM cost

- Support
  - Seamless 8-/16-/32-bit toolchain
  - Free software to get up and running
Summary

- First to have USB OTG implementation on 16bit MCU
- The only 16bit MCU integrated with OTG and CTMU
- Microchip solution caters the markets of OTG and embedded host segments
- Complete software support, via free USB class drivers (Host / Peripheral) for USB applications
- Large memory and rich peripheral set
- PIC’s maintains pin, peripheral and software compatibility with Microchip’s PIC32 USB microcontroller family