IP2 - USB 2.0

This course covers USB2.0

Objectives

- The course details the hardware implementation and describes the tests required to check the compliance of an equipment.
- All interconnect standards between Link and PHY are explained: UTMI, UTMI+, ULPI as well Inter-Chip USB.
- An architectural view of an USB system implementing low speed, full speed and high speed devices is described.
- The course details the various steps of the bus enumeration sequence.
- Packet format and USB transactions are taught with the assistance of the Lecroy USB analyser.
- The course details the requirements of the EHCI specification.
- HID class device specification and mass-storage classes are covered on request.

A Lecroy USB analyser is used to capture and display USB traffic.
• A lot of traces are included in the material.
A more detailed course description is available on request at training@ac6-training.com

Prerequisites

- Experience of a digital bus is mandatory.

Course Environment

- Theoretical course
  - PDF course material (in English) supplemented by a printed version for face-to-face courses.
  - Online courses are dispensed using the Teams video-conferencing system.
  - The trainer answers trainees' questions during the training and provide technical and pedagogical assistance.
- At the start of each session the trainer will interact with the trainees to ensure the course fits their expectations and correct if needed

Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

Course Outline

SYSTEM ARCHITECTURE

- Introduction to USB
- Management of periodic traffics
- Software organization
- Highlighting the differences between transfer, transaction and packet
- Device configuration, standard descriptors and commands

ELECTRICAL SPECIFICATION

- Cable and connectors
- Low Speed / Full Speed signalling
- Reset sequence
- High Speed signalling

- Reset sequence, chirp negotiation

TRANSFER PROTOCOL

- Low Speed / Full Speed protocol
- Periodic traffics in High Speed systems
- Non periodic traffics in High Speed systems
- Error detection
- Power management

BUS CONFIGURATION

- Device configuration Standard descriptors
- Device configuration Standard commands
- Initialization sequence
  - A trace is studied to understand the initialization sequence by using the ability of the trace viewer to decode standard requests
- Purpose of USB classes, list of classes

USB ON-THE-GO 2.0

- Typical applications
- New plug and receptacles
- Electrical requirements
- Attach Detection Protocol
- Session Request Protocol
- Host Negociation Protocol
- Testing the interface

BATTERY CHARGING SPECIFICATION

- Accessory Charger Adapter
- Charger detection hardware
- Primary detection
- Secondary detection
- Charger detection algorithms
- Electrical requirements

HUB OPERATION

- Hub architecture
- Split transactions
- The Hub class - Descriptors
- The Hub class - Commands
  - A trace is studied to understand the configuration of a hub by using the ability of the trace viewer to decode hub class requests

TRANSCEIVER STANDARD INTERFACES

- UTMI, elastic buffer, transmit and receive transmit diagrams
- Carkit, multiplexing USB traffic, UART and analog audio on the USB cable
- UTMI+ 1.0, description of new signals required to support OTG
- UTMI+ 1.0, level 2 and 3
- ULPI 1.1, low pin count interface, transfer protocol

HOST CONTROLLER OPERATION

- OHCI

- UHCI
- Introduction to EHCI
- Host Controller initialisation
- Port routing and control
- Periodic schedule
- Asynchronous schedule
- Managing Control / Bulk / Interrupt transfer via Queue Heads

DEBUGGING A USB APPLICATION

- Compliance checklists released by the USB Implementers Forum
- USB2.0 electrical test specification
- Detailing the list of tests to be run on the oscilloscope
- Lecroy solutions: protocol analysers / exercicers, test of the physical layer

HID CLASS DEVICES [On request]

- Operational model, item parser, report ID
- Descriptors, HID descriptor, report descriptor: main item, global item, local item
- Requests: GetReport/SetReport, GetIdle/SetIdle, GetProtocol/SetProtocol
- Boot interface descriptors: mouse and keyboard
  - A trace related to a mouse is used all along this chapter to provide practical examples of HID report descriptor and mouse report transfer format

MASS STORAGE CLASS DEVICES [On request]

- Relationship with ATAPI specification
- Reduced Block commands
- SCSI primary commands
- MMC command set
- Control, Bulk, Interrupt transport
- Standard descriptors
- Bulk only transport
  - USB memory stick traffic has been captured to explain the various protocols described in this chapter

USB FOR SMARTCARD [On request]

- Basics of ISO/IEC 7816-3
- Answer To Reset
- Protocol and Parameter Selection
- Interchip USB, voltage class negotiation
- Interchip USB, device attachment / detachment, highlighting when RPU and RPD have to be connected and disconnected
- ETSI TS 102 600 UICC-Terminal interface, Characteristics of the USB interface
- SimCard, ICCD class, transporting ISO messages over USB
- Managing a POS, CCID class

AUDIO CLASS [On Request]

- Audio device types
- Synchronization issues, difference between synchronous and isochronous
- Synchronous, asynchronous and adaptive synchronizations
- Feedback pipe
- Isochronous endpoint descriptor
- Interface descriptor
- Audio Control
- Unit descriptors
- Audio specific requests

- Retrieving the audio system architecture through the chained units and terminals