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 formation@ac6-formation.com

Prerequisites

- Experience of a digital bus is mandatory.

Environnement du cours

- Cours théorique
  - Support de cours au format PDF (en anglais) et une version imprimée lors des sessions en présentiel
  - Cours dispensé via le système de visioconférence Teams (si à distance)
  - Le formateur répond aux questions des stagiaires en direct pendant la formation et fournit une assistance technique et pédagogique
- Au début de chaque demi-journée une période est réservée à une interaction avec les stagiaires pour s'assurer que le cours répond à leurs attentes et l'adapter si nécessaire

Audience visée

- Tout ingénieur ou technicien en systèmes embarqués possédant les prérequis ci-dessus.

Modalités d'évaluation

- Les prérequis indiqués ci-dessus sont évalués avant la formation par l'encadrement technique du stagiaire dans son entreprise, ou par le stagiaire lui-même dans le cas exceptionnel d'un stagiaire individuel.
- Les progrès des stagiaires sont évalués par des quizz proposés en fin des sections pour vérifier que les stagiaires ont assimilé les points présentés
- En fin de formation, une attestation et un certificat attestant que le stagiaire a suivi le cours avec succès.
  - En cas de problème dû à un manque de prérequis de la part du stagiaire, constaté lors de la formation, une formation différente ou complémentaire lui est proposée, en général pour conforter ses prérequis, en accord avec son responsable en entreprise le cas échéant.

Plan

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

Renseignements pratiques

Renseignements : 4 jours