

USB compliance

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Agenda

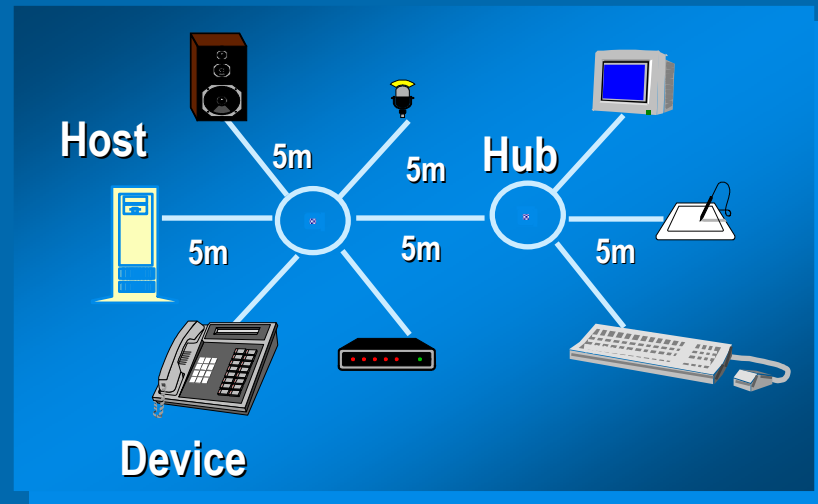
- Why should I test my devices for compliance ?
- Compliance laboratories.
- Test procedure.
- Common mistakes and how to avoid them.
- Demonstration

USB-IF Strategy

- Adopter Agreement provides license for compliant products only
 - “The USB 2.0 Adopters Agreement allows a signing company to participate in a reciprocal, royalty-free licensing arrangement for compliant products. “
- Enforceable logo and logo license
 - Logo will be issued to products passing compliance program
 - Create incentive for vendors to use logo with a Marketing program to build equity in new logo

Importance of Compatibility

- Your product will operate with others in real life
- Compliance would make compatibility easy
- Individual product testing is necessary not adequate
- Testing with other products is key
- Better find problems early



Goals of the Compliance Program

- High Quality USB 2.0 Products
- Stable, Repeatable, Documented Tests
 - Documented Test Procedures
 - Documented Test Assertions and Descriptions
- Instantly Available Testing (Qualified Test Houses)
- Minimize Test Equipment Costs

Test Procedure Doc

➤ Document

- Describes test procedure for both plugfests & labs
 - Lists procedure for all types of products: devices, hubs, and systems
- Consistent testing procedures, *no matter where you test*

➤ Always check the USB-IF website for latest information

➤ URL: www.USB.org/developers/compliant.html

Compliance Testing categories

- Peripheral (Device) (Today only this one)
- Host Add-In Cards
- Hubs
- Systems
- Silicon Building Blocks
- Cable Assemblies
- Connectors
- USB On-The-Go

Compliance Testing

- USB-IF sponsored compliance workshops (“Plugfests”)
- Certified independent test labs
 - Flexible in time
 - One top - Debug / Consultation / Compliance
 - No need to expose products to the public

<http://www.usb.org/developers/compliance/labs/>

Integrators List

- Confidential list of products that pass USB-IF compliance program on the USB-IF website.
 - Two lists: low/full speed and high speed
 - Pass compliance testing, demonstrated interoperability & submitted a checklist
- New additions made for vendors by USB-IF, based upon test results
- List is viewable by licensees only – password controlled

Cables

- Devices must test and ship with cable assemblies listed on Integrator's List
- Check the web for list of certified cable and connector test labs

USB logo

- In order for a company to use the Trademarked USB logo in conjunction with a product, the following requirements must be met:
 - The company should obtain a Vendor ID from the USB-IF
 - The products must pass USB-IF Compliance Testing for product quality and be listed on the Integrators List under their company name.
 - The company must execute the USB-IF Trademark License Agreement.
- The logo presents the fact that the device passed compliance test



Full and Low Speed Testing

- Current Consumption
- USBCheck
 - Chapter 9
 - Chapter 11
 - HidView
- Interoperability
 - HS Device and Hub Additions
 - Power Management
- USB FS/LS Test Fixtures
 - Droop/Drop
 - Inrush
 - FS/LS Signal Quality
 - Backdrive voltage

High speed Testing

➤ HS Electricals

- High Speed Signal Quality
- Time Domain Reflectometry (TDR)
- Receiver Sensitivity and Squelch
- J and K Voltage Levels
- Chirp
- Packet Parameters
- Suspend/Resume

➤ Transaction Translator

- Full Functional Test
- Protocol Response Cases
- Implementation Rules

➤ HS Hub Repeater

- Sync Bits
- Latency
- EOP Dribble

Test Fixtures

➤ Current



➤ Inrush

➤ Drop

◆ Droop



◆ Full/Low Speed Signal Quality



Current Consumption

- Unconfigured
 - 100 mA max
- Configured
 - 100 mA Max (Low Power)
 - 500 mA Max (High Power)
 - < bMaxPower value
- Active/Operating (Same as Configured)
- Suspend
 - 500 μ A max
 - 2.5 mA max for high power devices with remote wakeup enabled



Compliance Tool USBCheck

- Small extensions to Chapter 9 & Chapter 11
 - Chapter 9: new descriptors
 - *Get Descriptor* tests
 - Endpoint constraints
 - Chapter 11: new status bits & test mode
 - Port tests: Set/Clear Port Feature, PORT_TEST/PORT_INDICATOR
- Core functionality is already there
 - Chap 9: Enumeration
 - Chap 11: Events
 - Connects, disconnects, reset, suspend, etc.
- Test at both high and full speeds

Compliance Tool USBCheck

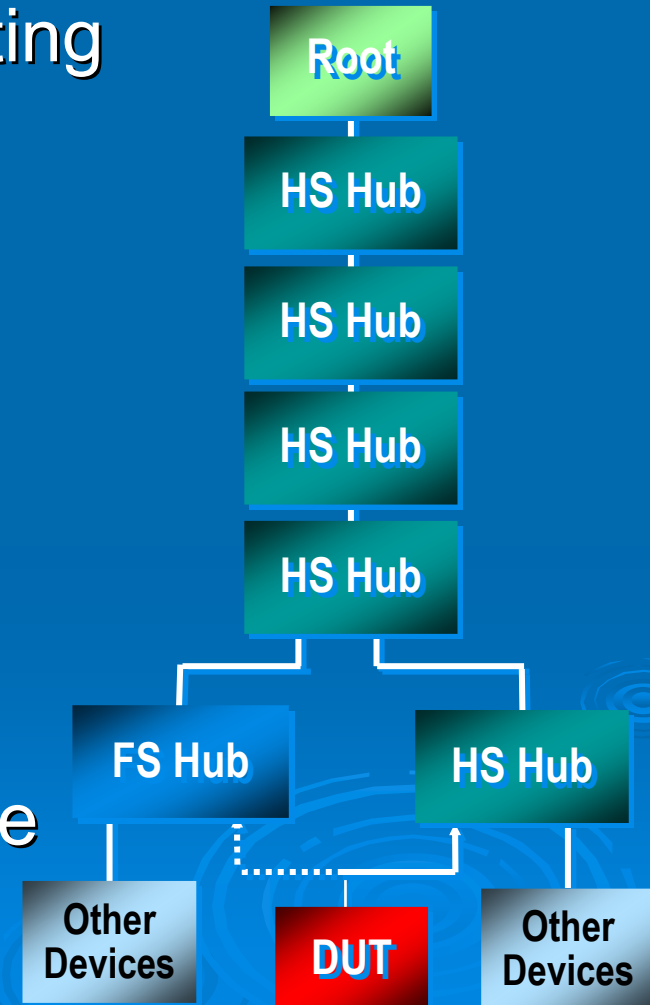
Get Device Qualifier Screenshot

Get Descriptor Call Report (Device Qualifier Descriptor)

bLength	0x0A	bMaxPacketSize0	0x40
bDescriptorType	0x06	bNumConfigurations	0x01 (1)
bcdUSB	0x0200 (USB spec. 02.00)	bReserved	0x00
bDeviceClass	0x00 (ifc's specify own)		
bDeviceSubClass	0x00		
bDeviceProtocol	0x00		

Interoperability Testing

- Same Tree For HS/FS/LS Testing
- Similar To FS/LS Interopability
 - All Transfer Types
 - 5 hubs deep with 5 meter cables (i.e. Tier 6)
 - Mix of speeds
 - Power Management (S3)
- Test devices at both Full and High Speeds
- Current Test Procedures Online



High speed

- 480 MHz = 40x Frequency
 - Smaller margin for error!
- Have the process and tools defined early
 - Oscilloscope characteristics
 - Tools to acquire data from scope to create eye patterns
 - Test modes
 - Used to measure, capture eye pattern
 - Device independent way to test devices

Signal Quality

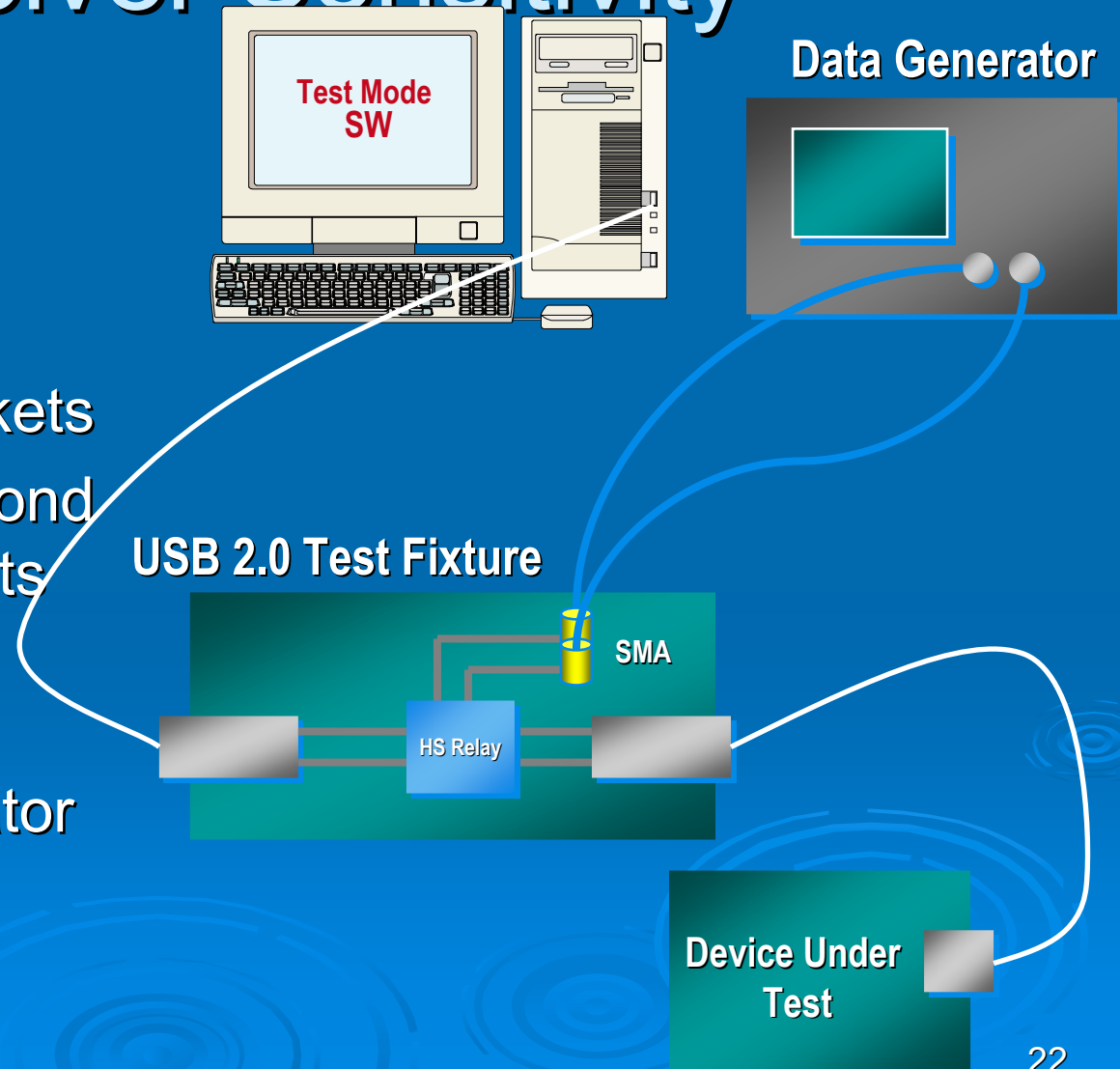
- USB 2.0 spec defines required eye pattern at internal/external connectors
 - 6 Patterns - Templates
 - 4 correspond to external connectors (TP2 & TP3)
 - 2 correspond to internal connectors (TP1 & TP4)
 - Rise / Fall Times
 - Allowance for jitter
 - Overshoot / undershoot
- Testing will be at external connectors
 - Test fixture for high speed signal quality

Test Modes J and K

- Enable output level and source impedance testing
- When placed in J or K mode, a port continuously asserts a HS J or K, respectively
- DC level testing with a DVM and test load
- Driver impedance testing during assertion of HS J or K

Electrical Example – HS Receiver Sensitivity

- DUT Placed In Test_SEO_NAK Mode
- Data Generator Generates IN Packets
- Device Must Respond For In Spec Packets
- Device Must Not Respond to Out of Spec Data Generator Output

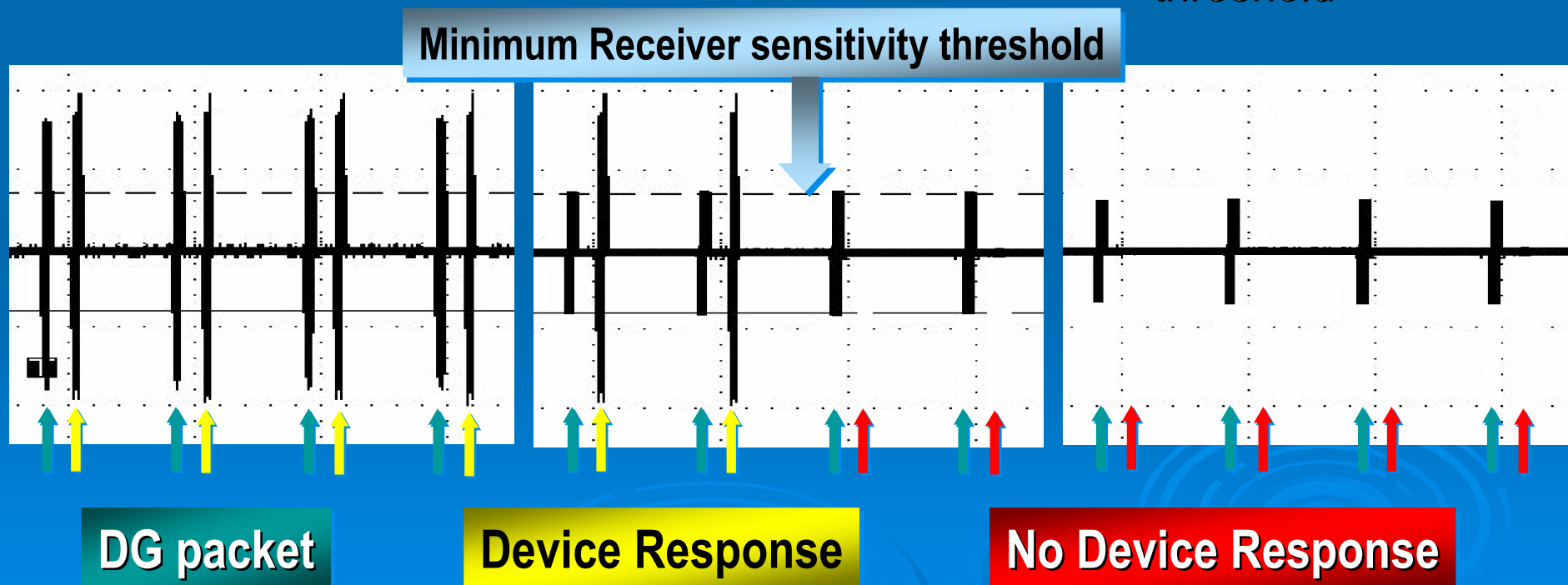


HS Device Receiver Sensitivity and Squelch

- Device response to nominal packets

- Device response to minimum packets

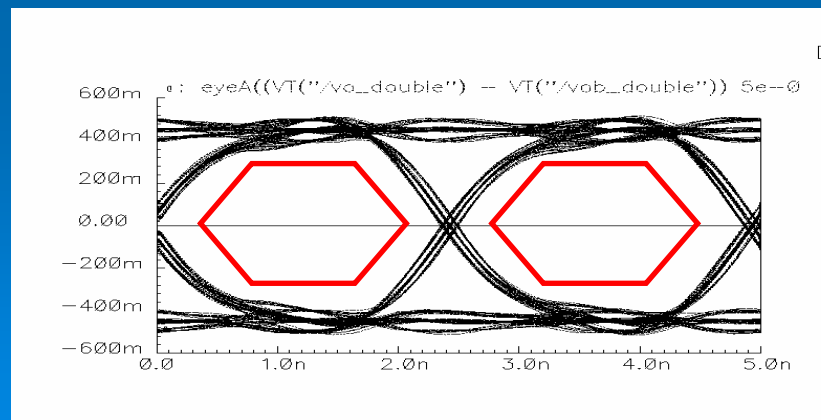
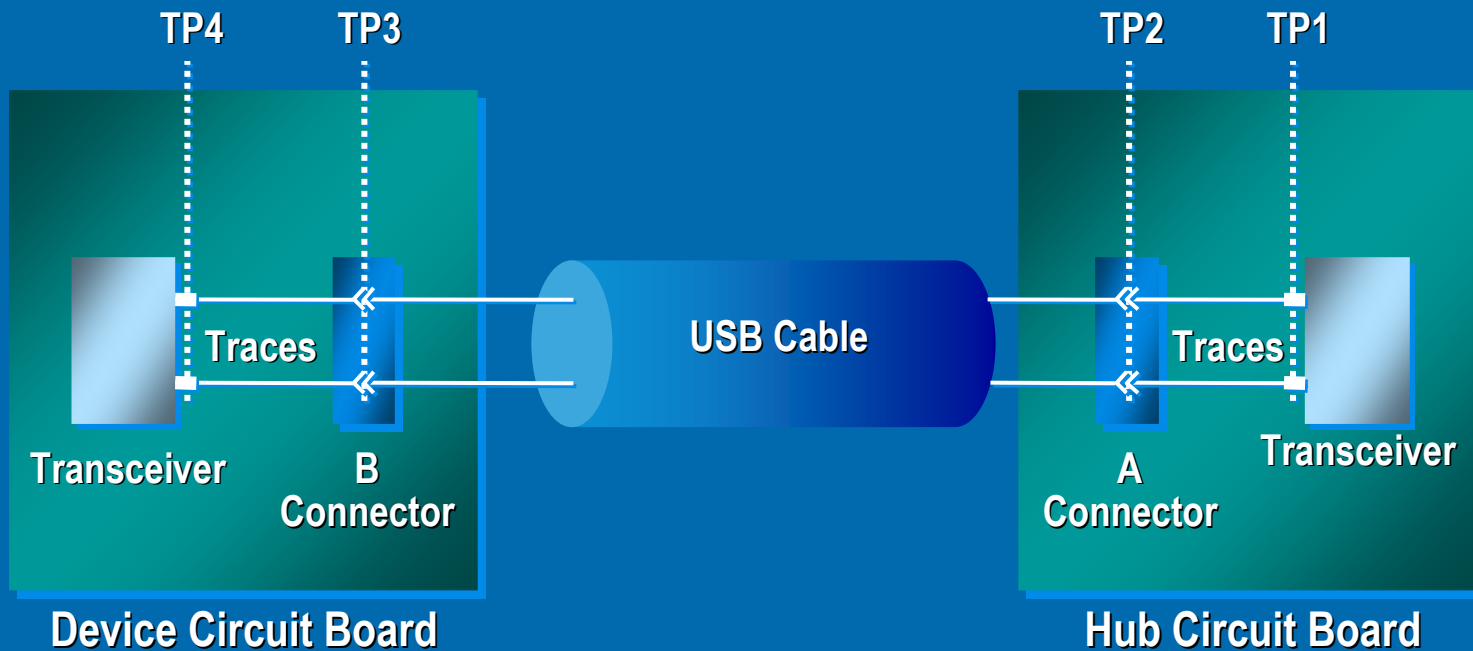
- Device must not respond to packets below squelch threshold



Eye pattern Test Mode

- Enables eye pattern and waveform parameter testing of output drivers
- When placed in eye pattern test mode, a port continuously drives specified HS data pattern
- Testing accomplished with connection to scope via recommended fixture
 - Voltage margin
 - Time (jitter) margin
 - Waveform rise and fall times

Specifications - Eye Patterns



Common mistakes

- Power supply/consumption/Suspend
- HS devices should support test states
- Signal integrity
- Cables
- Default Isochronous endpoints
- Back-voltage test - Checks that D+ and D- are not being driven when VBUS is not being driven
- Self and Third party device drivers

Read the spec, design your products compliant

Common mistakes

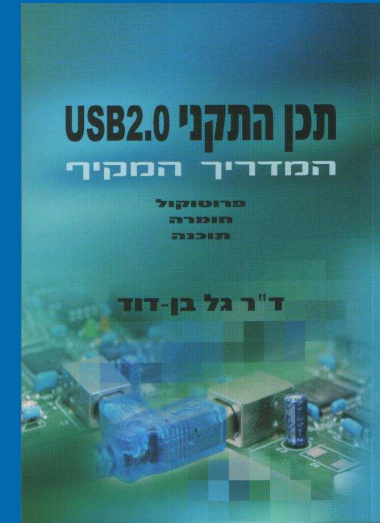
- HS devices should also work in FS environment
- HS Devices Tested At High and Full Speeds
- Other Speed Device Qualifier and Configuration Descriptors
 - HS/FS Devices Must Use In Either Environment
 - Standard Configuration Descriptors Only For Current Environment
- Endpoint Packet Size and Interval Rules
- bcdUSB = 0200H for ANY device designed to 2.0 Spec
- Bulk out endpoints should support PING

Read the spec, design your products compliant

Summarize

- Will I ship USB product out of my lab ? – Obtain Vendor ID
- Will my products be a part of a self contained, known configuration, limited number of other USB devices ? - Make the tests yourself
- Will I sell my products off-the-shelf ? – Make your own tests, send to compliance lab, place USB logo on product packaging

Books



- **Devices**

- Dr. Gal Ben-David, *USB2.0 Peripheral design (Hebrew)*
- Anderson, *USB System Architecture*
- Axelson, *USB Complete*
- Hyde, *USB Design by Example*
- Garney, *USB Hardware and Software*

- **Windows Drivers (including USB)**

- Oney, *Programming the Microsoft Windows Driver Model*
- Cant, *Writing Windows WDM Device Drivers*