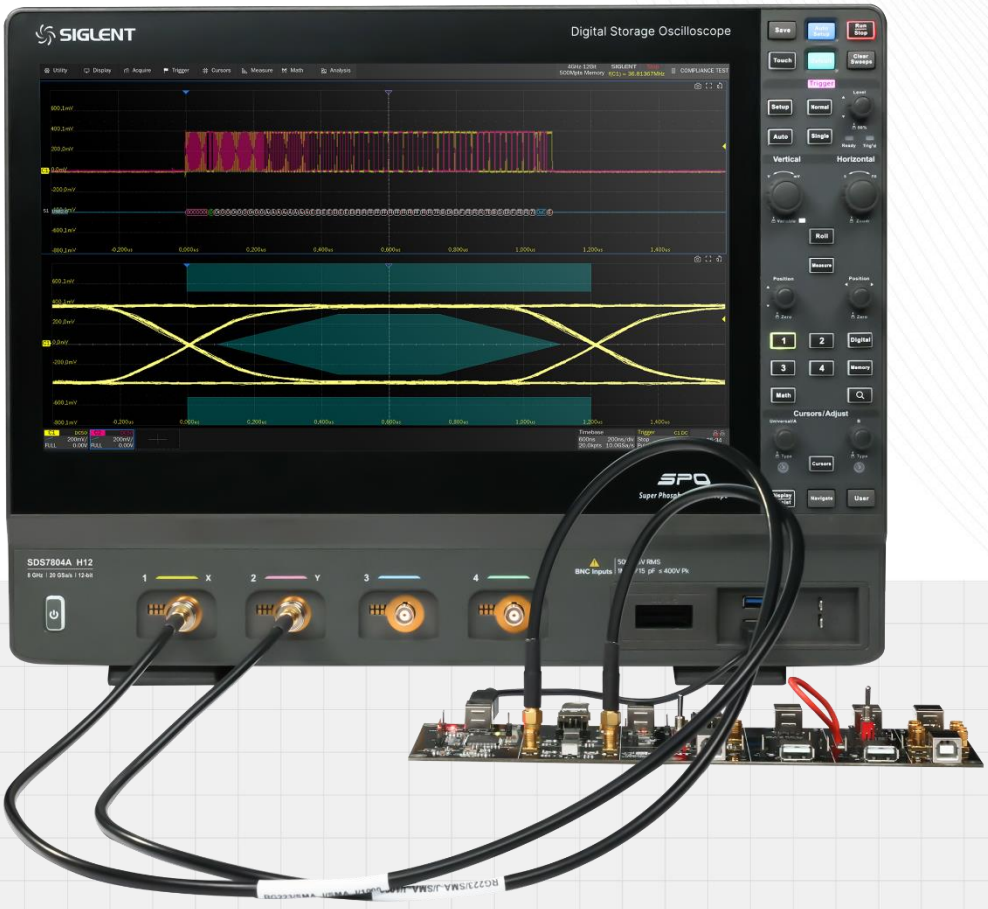
USB2.0Electrical Compliance Solution

PSO2403-0003EN01



深圳市鼎阳科技股份有限公司
SIGLENT TECHNOLOGIES CO.,LTD

Copyright

Trademark Information

SIGLENT is a registered trademark of SIGLENT Technologies Co., Ltd.

Notices

Product Compliance

SIGLENT certifies that this product complies with Chinese national and industry standards, and further certifies compliance with relevant standards of other international standard organizations.

Contact Us

SIGLENT Technologies Co., Ltd.
Address: Building 1, 4 & 5, Antongda Industrial Park, Zone 68, Bao'an District, Shenzhen, Guangdong, China
Service Hotline: 400-878-0807
E-mail: support@siglent.com
Website: https://www.siglent.com

1 Introduction

USB stands for Universal Serial Bus, a serial bus standard for connecting computer systems to peripheral devices, and a technical specification for input/output interfaces. Since its introduction in 1995, USB has gradually replaced traditional serial and parallel ports due to its high speed, convenience, and expandability, becoming widely used in various peripherals and favored by consumers. However, while the extensive interconnection of USB devices brings great convenience to users, it inevitably leads to issues such as connection compatibility, transmission interruptions, and file transfer errors. Therefore, USB devices must pass USB compliance testing to ensure interoperability between devices. This is not only a requirement of the USB Implementers Forum (USB-IF) but also a necessary step for manufacturers of devices containing USB interfaces to guarantee product quality and reliability.

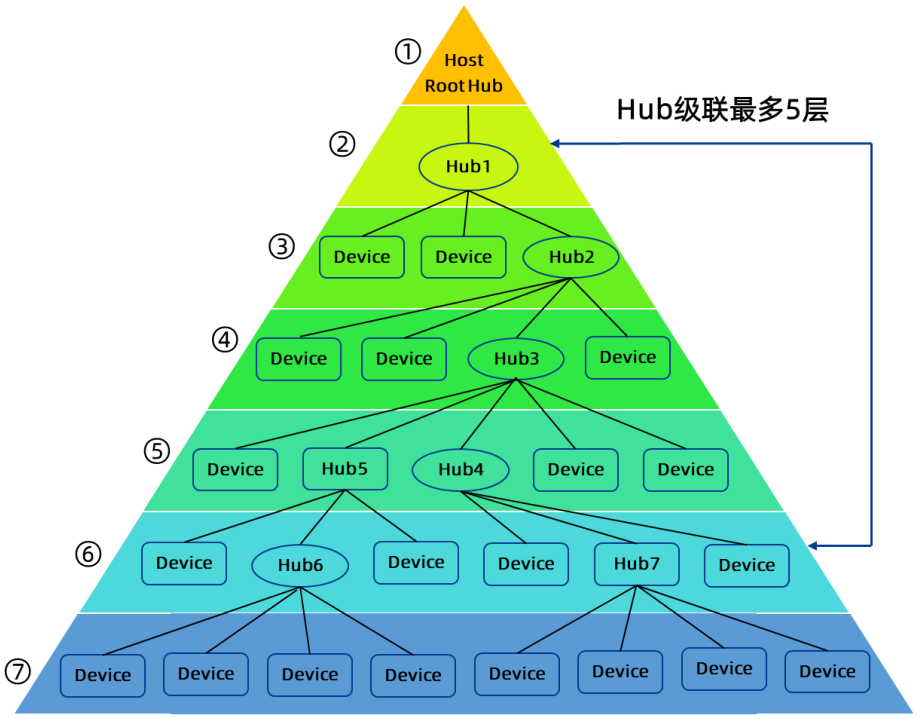
2 USB2.0 Fundamentals

USB2.0 is a 4-wire serial system comprising VBus, D-, D+, and ground lines. D- and D+ are differential signal lines and the primary carriers of information, while a 5V voltage is transmitted between VBus and ground. To meet the data transfer speed requirements of different application types, USB2.0 defines three speed grades: Low Speed (LS), Full Speed (FS), and High Speed (HS). Typical LS devices include computer mice, keyboards, and game controllers; common FS devices include phones, audio equipment, and microphones. Most USB2.0 devices on the market are HS devices, including digital cameras and portable hard drives. It is important to note: HS is backward compatible with LS and FS. Conversely, LS and FS devices are upward compatible with HS devices but cannot achieve HS transfer rates, automatically operating at the speed of the LS/FS side.

目前官网版本	官方市场代号	原名	标志	传输速度 (bit)	理论速度 (Byte)
USB2.0	Low-Speed	USB1.0		1.5Mbps	0.1875MB/s
	Full-Speed	USB1.1		12Mbps	1.5MB/s
	High-Speed	USB2.0		480Mbps	60MB/s

USB2.0 offers numerous advantages, such as simple power delivery, plug-and-play capability, support for hot-plugging, easy port expansion, diversified transfer modes, and good compatibility. The USB system adopts a tiered-star topology, consisting of three basic parts: the Host, the Hub, and the Device. The Host, responsible for system and application management, is a complex of hardware, software, and firmware that provides USB interfaces and interface management capabilities. It can be a PC or an OTG (On-The-Go) device. The Hub

provides expanded USB peripheral interfaces, supporting up to 5 tiers of cascading and a maximum of 127 connected USB devices. The Device responds to operations initiated by the Host, sending or receiving data. Furthermore, devices can be categorized as bus-powered (drawing current from the host) or self-powered. The port connecting to the host is called the Upstream Port, while the port connecting to a device is called the Downstream Port. A hub can detect the connection and removal of each downstream port, distribute power to downstream devices, and is responsible for bus fault detection and recovery. Each downstream port can be individually enabled and operate at different speed grades. Communication from a device to the host is termed upstream communication, and from the host to a device is termed downstream communication.



3 Solution

3.1 Test Items

Host Tests	Device Tests	Hub Tests
HS Downstream Signal Quality	HS Upstream Signal Quality	HS Signal Quality (Up/Downstream Ports)
HS Downstream Packet Parameters	Remote Device with Cable	HS Packet Parameters (Up/Downstream Ports)
HS Downstream Chirp Timing Test	Local Device without Cable	HS Chirp Timing Test (Up/Downstream Ports)
HS Downstream Suspend and Resume	HS Upstream Packet Parameters	HS Suspend and Resume (Up/Downstream Ports)
HS Downstream High-Z Level	HS Upstream Chirp Timing Test	Upstream Port Reset from HS
FS Downstream Signal Quality	HS Upstream Suspend and Resume	Upstream Port Reset from Suspend
LS Downstream Signal Quality	Reset from HS	HS High-Z Level (Up/Downstream Ports)
VBus Drop	Reset from Suspend	HS Repeater Up/Downstream
VBus Transient Drop	HS Upstream High-Z Level	HS Upstream Receiver Sensitivity
	HS Upstream Receiver Sensitivity	FS Signal Quality (Up/Downstream Ports)
	FS Upstream Signal Quality	LS Signal Quality (Up/Downstream Ports)
	LS Upstream Signal Quality	VBus Drop
	Back-Voltage	VBus Transient Drop
	Inrush Current	Inrush Current
		Back-Voltage

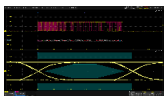
3.2 测试设备

Test Item	Oscilloscope & Test Fixture & Software	SMA Cables	Single-ended Probe or Differential Probe or Passive Probe	Other
Signal Quality	√	2 pcs (High Speed)	2 Single-ended Probes (Downstream FS/LS) 2 Single-ended Probes & 1 Passive Probe (Upstream FS/LS)	
Packet Parameters	√		2 Single-ended Probes or 1 Differential Probe	
Chirp Timing Test	√		2 Passive Probes	
Suspend and Resume	√		2 Passive Probes	
High-Z Level	√	2 pcs		
Receiver Sensitivity	√	2 pcs	2 Single-ended Probes	Signal Source
Reset from High Speed/Suspend	√		2 Passive Probes	
HS Repeater Up/Downstream	√		4 Single-ended Probes or 2 Differential Probes	
Inrush Current	√			1 Current Probe

Additional Equipment Required:

▶ Certified Self-powered High-Speed Hubs (×4): For FS/LS tests.
▶ Certified Self-powered Full-Speed Hub: For FS/LS tests.
▶ 5-meter Type-A to Type-B USB Cables (×6): For FS/LS tests.
▶ 1-meter Type-A to Type-B USB Cables (quantity depends on test items): For HS/FS/LS tests.
▶ Certified Low-Speed Device (e.g., mouse): For LS tests.
▶ Certified Full-Speed Device: For FS tests.
▶ Certified High-Speed Device (e.g., USB flash drive): For HS tests.
▶ Computer (with USBHSET installed): For HS host tests.

SIGLENT Provides:

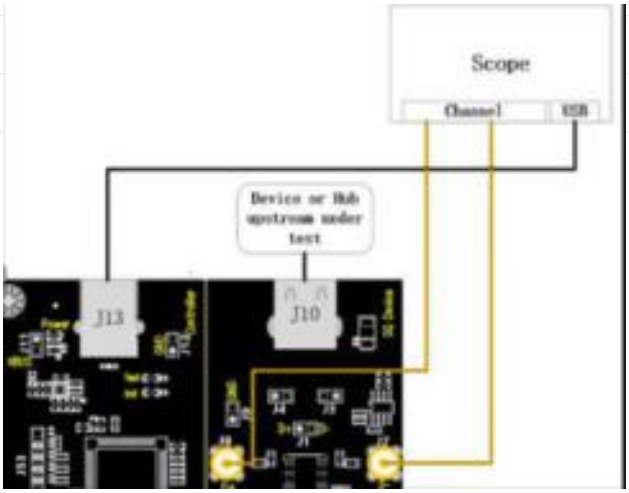
Product	Image	Model	Description
Oscilloscope		SDS7000A Series	2~4 GHz bandwidth, supports USB2.0/Ethernet/Auto Ethernet compliance analysis.
Compliance Test Software		SDS7000A-CT-USB2	Supports HS/FS/LS tests for Host/Hub/Device.
Test Fixture		FX-USB2	Supports HS/FS/LS tests for Host/Hub/Device.
Single-ended Probe		SAP2500	2.5 GHz bandwidth.
Differential Probe		SAP2500D	2.5 GHz bandwidth.
Passive Probe		SP3150A	500 MHz bandwidth, compatible with SDS7000A.
Current Probe		CP6000 Series	Adapter-powered.
		SCP5000 Series	Oscilloscope-powered.
Signal Source		SDG7102A	1 GHz bandwidth.

3.3 Test Challenges

3.3.1 Test Setup

USB2.0 compliance testing generally requires a test fixture. The fixture primarily converts USB cable signals into signals that can be input to the oscilloscope via probes. The Device Under Test (DUT) can be a Host,

Hub, or Device, and the speed can be HS, FS, or LS. Each measurement item requires the correct connection method between the test fixture, DUT, and oscilloscope. Relying solely on memory not only reduces efficiency but also compromises accuracy. The compliance test software effectively addresses this challenge by graphically displaying the connection methods between the fixture, oscilloscope, and DUT for each measurement item during the test process. Users can correctly set up the test environment without memorization, significantly reducing test time and the probability of measurement errors.

Setup	Test Item Selection	Configuration	Connection	Start Test	Results
USB2.0 > Device > High Speed Upstream High-Z Level (EL8, EL9)					
Scope Channel	**USB**				
Device or Hub upstream under test					
A. Connect J8 and J7 to the configured D+ and D- channels using two SMA cables. Connect J13 to the oscilloscope via a cable for communication. The Power indicator should illuminate. **B.** Insert the Device Under Test (DUT) into J10. If enumeration is successful, the Init indicator will illuminate. If the Init indicator does not illuminate, please re-plug the DUT. **C.** Click the "Start Test" button in the "Start Test" section. The Init indicator will turn off, and the Test indicator will illuminate. The oscilloscope will automatically complete this test item.					

3.3.2 Obtaining Test Patterns

For Host:

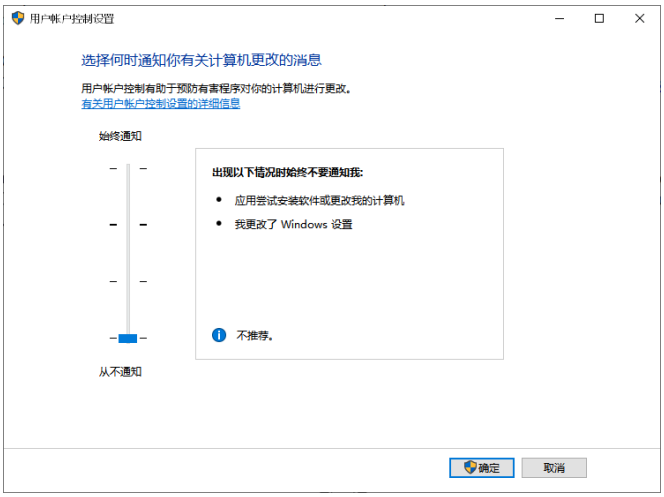
- For non-Windows OS hosts, contact the chip supplier to provide specific control software to command the DUT to generate test patterns.
- For Windows OS hosts, the HSETT software (USB High-speed Electrical Test Tool) can be used to command the DUT to generate test patterns.
- For Hub and Device:
- Use HSETT software to command the DUT to generate test patterns.
- The SIGLENT test fixture FX-USB2 can directly command the DUT to generate test patterns.

Steps for Obtaining Host Test Patterns:

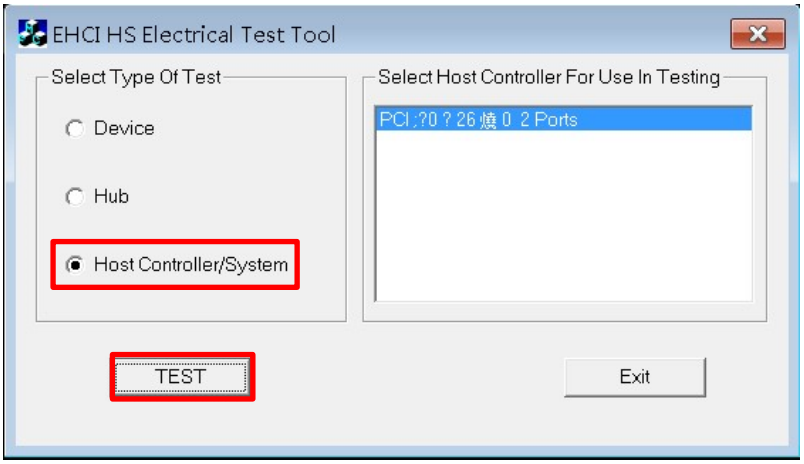
Software Installation: Before installation, disable "User Account Control" in Windows: Start > Control Panel > User Accounts and Family Safety > User Accounts > Change User Account Control Settings, set to

"Never notify," click "OK," then restart the computer.

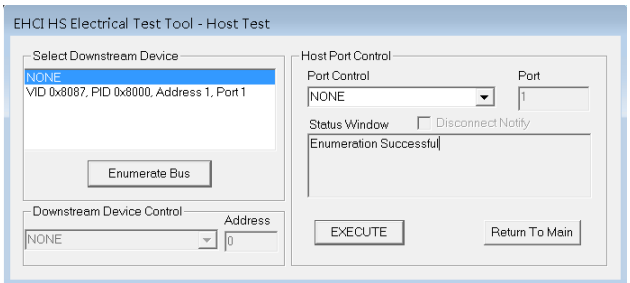
Software Download: https://www.usb.org/document-library/usbhset-ehci-64-bit

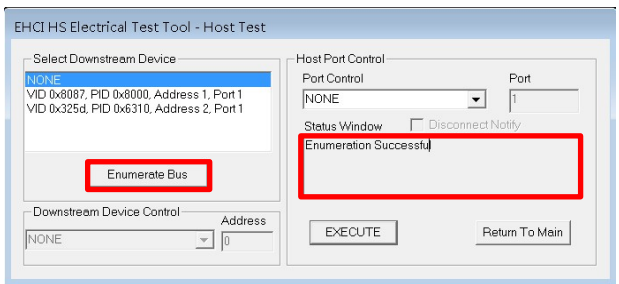


- Note: When using USBHSETT software, the corresponding USB hub will be occupied, and its externally connected devices (e.g., an external mouse) will not function normally, though a touchpad or remote control can be used.
- Set Test Type: Open the High-speed Electrical Test Tool software, enter the main menu; click 【Host Controller/System】, then click the 【Test】 button to enter the host test menu.

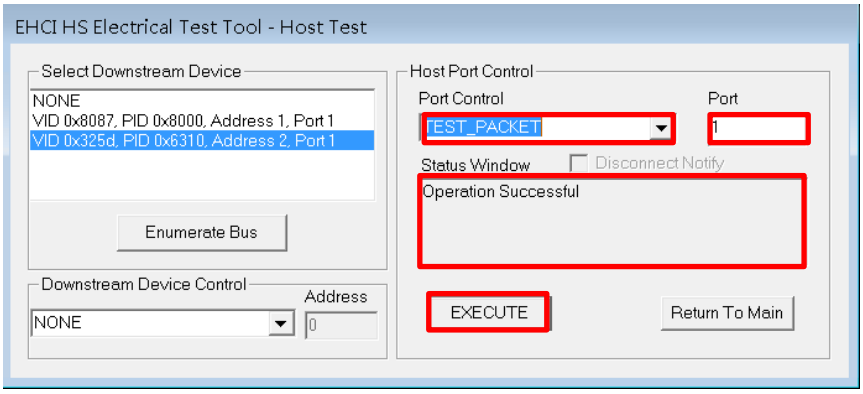


Bus Enumeration: Connect a USB device (with speed type matching the host under test) to the host's port under test. Click 【Enumerate Bus】, and the status window on the right should display "Enumeration Successful".

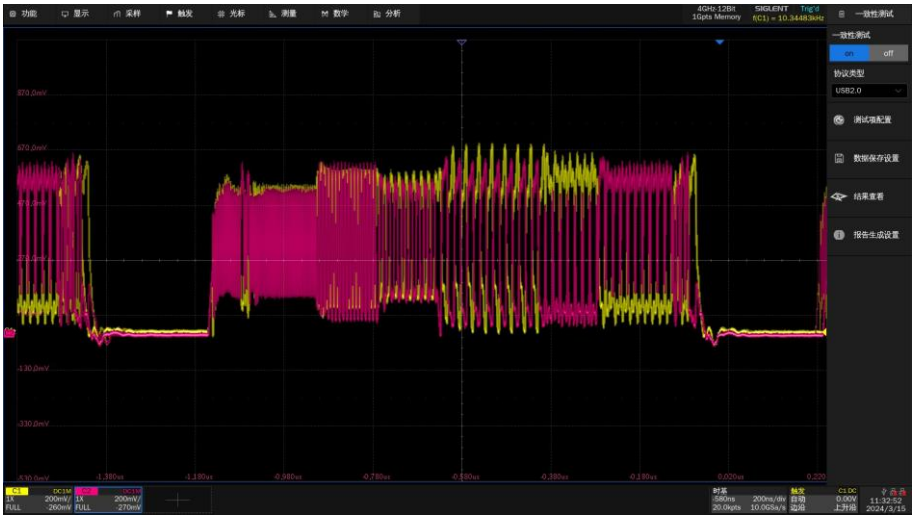




Port Control: In "Host Port Control," enter the host port number under test in "Port." The selection in the "Port Control" dropdown is related to the test item, e.g., select 【TEST_PACKET】 for signal quality tests, 【SUSPEND】 for suspend and resume tests, 【TEST_J】 for High-Z level tests. Click 【EXECUTE】, and the status window should display "Operation Successful".



Display Test Pattern: Remove the USB device from the host port under test. Use a USB cable to connect the port under test to the test fixture (which is already connected to the oscilloscope). The oscilloscope will now display the test pattern.



For more USBHSETT usage tips or troubleshooting, visit:

https://www.usb.org/sites/default/files/HSETT_Instruction_0_4_1.pdf

3.4 Test Procedure

Clicking on the test item configuration will pop up the specific test window, as shown below. The process is divided into six steps: Setup, Test Item Selection, Configuration, Connection, Start Test, and Results.

Setup

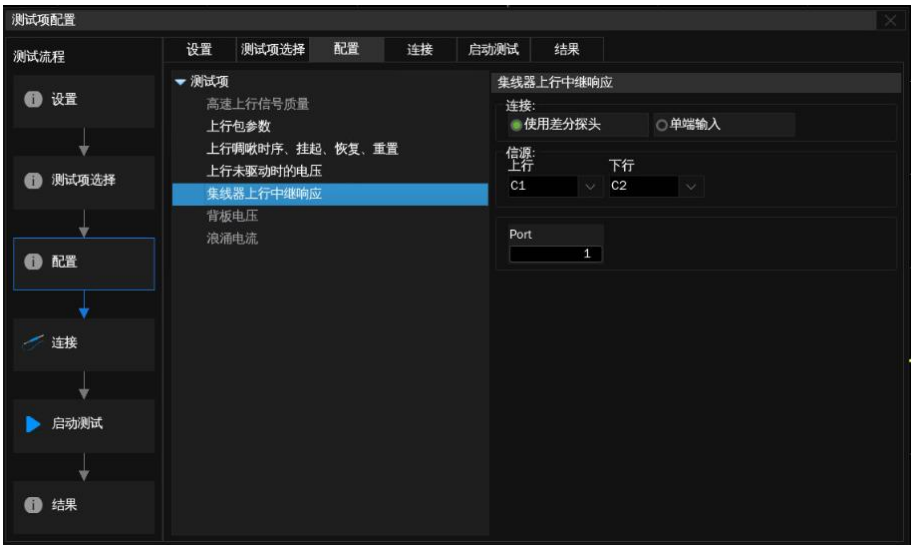
- Configuration have "Recall," "Last Used," and "Save" functions.
- Select the DUT type in "DUT Type," where Hubs also require distinguishing "Downstream" or "Upstream."
- Select the DUT speed in "Speed Selection."

Test Item Selection

Select the required test items in this section. Single or multiple items can be selected.

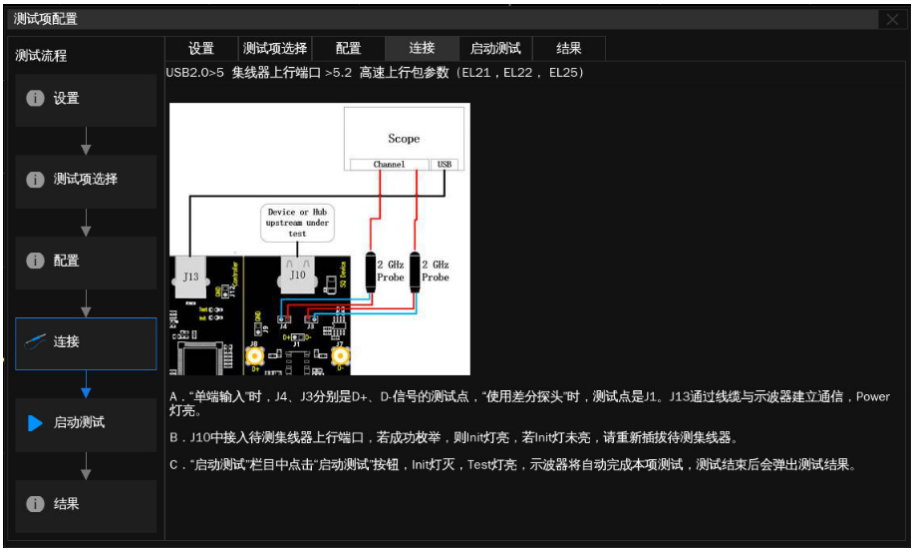
Configuration

The test items selected earlier are highlighted in this section. Click to configure the corresponding test item and set up the oscilloscope measurement channels.



Connection

This section displays the test connection diagram and steps. If multiple test items are selected at once, only the information for the first pending test item is shown. Connection diagrams for other test items will pop up in separate windows after the previous test item is completed.



Start Test

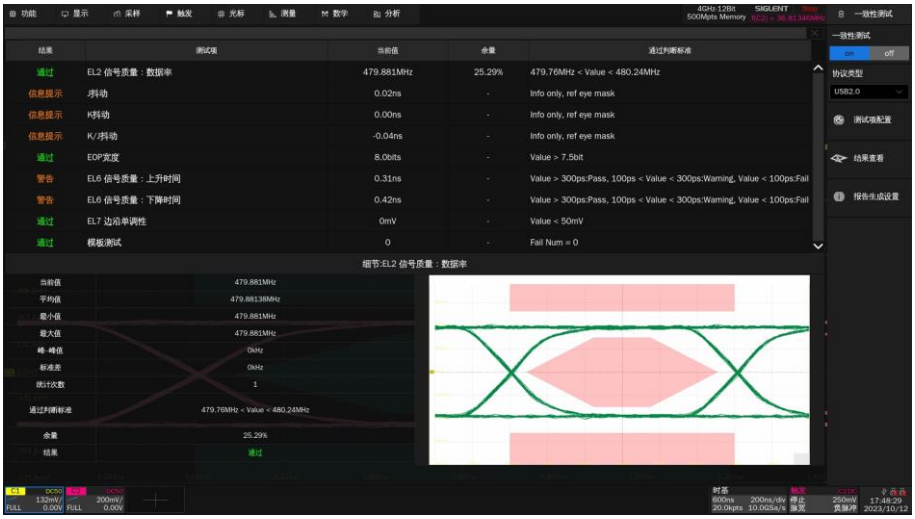
- When a test fails, options to "Continue" or "Abort" are supported.
- For the results of the current test round, options for saving the results are provided.
- Click "Start Test" in the lower right corner to begin the test round.

3.5 Follow the pop-up prompts to complete the test. Upon completion of all test items, the test results will pop up. If multiple test items are selected in one round, a pop-up will 提示 (提示: prompt) the connection method for the next item when proceeding. It supports returning to the "Configuration" section mid-process to modify the signal source for that test item. After modification, click "Start Test" in the pop-up to continue testing.

3.6 Test Results

Click "View Results" to view the corresponding test results.

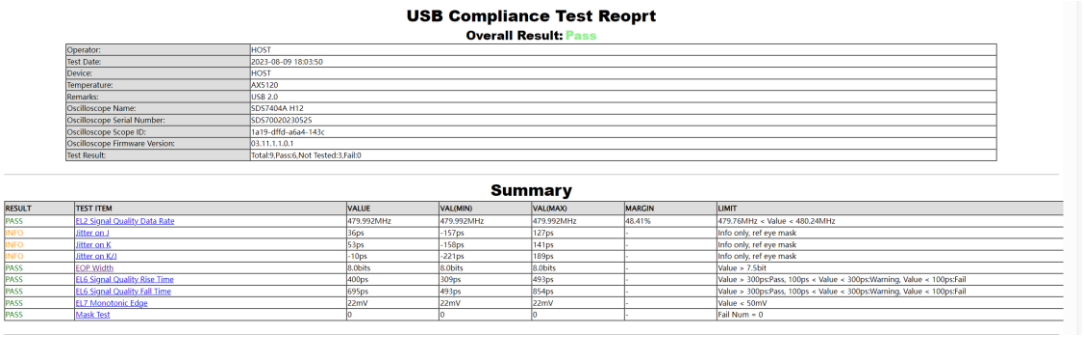
The upper part lists the test items, providing individual test results and the official required limit values for reference. The lower part shows the corresponding detailed graphs. Click on an item of interest in the upper part to display its details below. Clicking on the image allows viewing image details.。



3.7 Test Report

Click "Report Generation Settings," fill in relevant test information, and select the report type. "Preview Report" allows viewing the report effect in advance. In "File Management," select the save path and click "Save" to save the test results.

Note: When saving in HTML format, a folder and an HTML file are generated. To copy, both must be copied and kept in the same path.



USB Compliance Test Reoprt

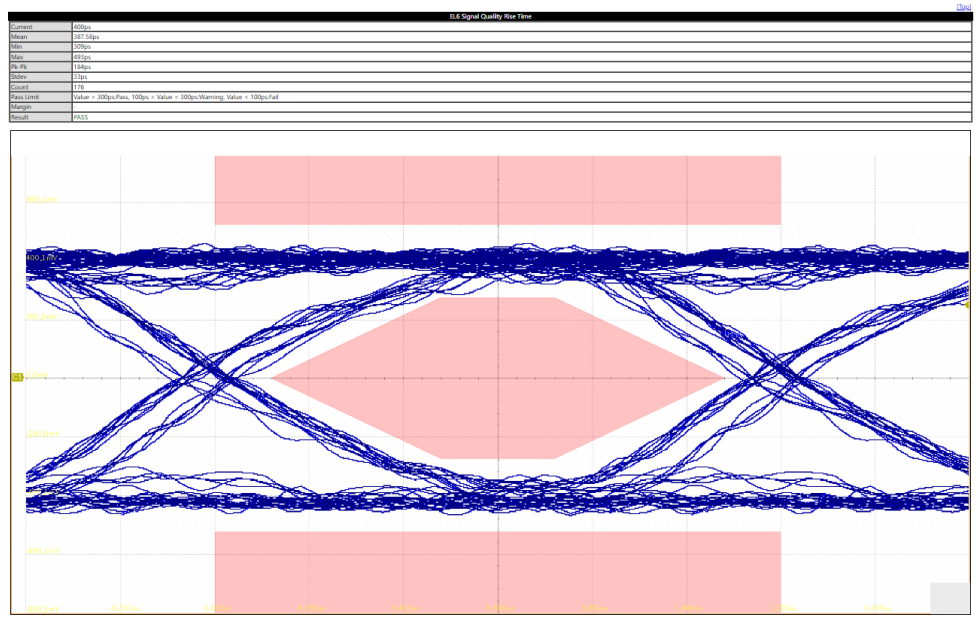
Overall Result: Pass

Operator:	HOST
Test Date:	2023-08-09 18:03:50
Device:	HOST
Temperature:	AXS120
Remarks:	USB 2.0
Oscilloscope Name:	SDS7404A H12
Oscilloscope Serial Number:	SDS7002023052S
Oscilloscope Scope ID:	1a19-dffd-a6a4-143c
Oscilloscope Firmware Version:	03.11.1.1.0.1
Test Result:	Total:9,Pass:6,Not Tested:1,Fail:0

Summary

RESULT	TEST ITEM	VALUE	VAL(MIN)	VAL(MAX)	MARGIN	LIMIT
PASS	EL2 Signal Quality Data Rate	479.992MHz	479.992MHz	479.992MHz	48.41%	479.76MHz < Value < 480.24MHz
INFO	Jitter on J	36ps	-157ps	127ps	-	Info only, ref eye mask
INFO	Jitter on K	53ps	-158ps	141ps	-	Info only, ref eye mask
INFO	Jitter on KJ	-10ps	-221ps	189ps	-	Info only, ref eye mask
PASS	EQP Width	8.0bits	8.0bits	8.0bits	-	Value > 7.5bit
PASS	EL6 Signal Quality Rise Time	400ps	309ps	493ps	-	Value > 300ps:Pass, 100ps < Value < 300ps:Warning, Value < 100ps:Fail
PASS	EL6 Signal Quality Fall Time	695ps	493ps	854ps	-	Value > 300ps:Pass, 100ps < Value < 300ps:Warning, Value < 100ps:Fail
PASS	EL7 Monotonic Edge	22mV	22mV	22mV	-	Value < 50mV
PASS	Mask Test	0	0	0	-	Fail Num = 0

Clicking on a test item provides a hyperlink directly to the specific test waveform:



EL6 Signal Quality Rise Time

Current	400ps
Mean	387.58ps
Min	309ps
Max	493ps
Pk-Pk	184ps
Stdev	33ps
Count	178
Pass Limit	Value > 300ps:Pass, 100ps < Value < 300ps:Warning, Value < 100ps:Fail
Margin	
Result	PASS

4 Summary

As a critical step before product shipment, USB2.0 compliance testing plays a vital role in today's product development and manufacturing, inevitably involving significant workload. SIGLENT's USB2.0 compliance test solution is continuously evolving towards greater simplicity, standardization, and automation. It eliminates the tedious and time-consuming processes of manual oscilloscope setup, cursor placement, and result comparison against the USB 2.0 specification. Through straightforward configuration methods and easy-to-understand graphical connection guides, it helps users reduce test complexity and improve production efficiency.。

关于鼎阳

鼎阳科技（SIGLENT）是通用电子测试测量仪器领域的行业领军企业，A股上市公司。

2002年，鼎阳科技创始人开始专注于示波器研发，2005年成功研制出鼎阳第一款数字示波器。历经多年发展，鼎阳产品已扩展到数字示波器、手持示波表、函数/任意波形发生器、频谱分析仪、矢量网络分析仪、射频/微波信号源、台式万用表、直流电源、电子负载等基础测试测量仪器产品，是全球极少数能够同时研发、生产、销售数字示波器、信号发生器、频谱分析仪和矢量网络分析仪四大通用电子测试测量仪器主力产品的厂家之一，国家重点“小巨人”企业。同时也是国内主要竞争对手中极少数同时拥有这四大主力产品并且四大主力产品全线进入高端领域的厂家。公司总部位于深圳，在美国克利夫兰、德国奥格斯堡、日本东京成立了子公司，在成都成立了分公司，产品远销全球80多个国家和地区，SIGLENT已经成为全球知名的测试测量仪器品牌。

联系我们

深圳市鼎阳科技股份有限公司

全国免费服务热线：400-878-0807

网址：www.siglent.com