# USB Link Visualizer

The USB Link Visualizer allows operators to identify the state of USB link and its speed. The dongle is connected between a USB host (Type A receptacle) and a USB peripheral device. It helps the operator visualize and troubleshoot basic USB operations when there is uncertainty about the link performance. Since the USB protocol is designed to fall back to lower speed rates if the bus responses are inconsistent, whether on host or device side, due to signal integrity issues, bad cables, or bad (worn out) connectors, the USB Link Visualizer allows quick assessment of link issues before the need to deploy much more expensive USB protocol analyzer equipment . The Visualizer is designed to be non-invasive to USB signals as much as possible.

FEATURES:

- Monitors status of USB link for both USB3.0 (Super-Speed) and USB2.0 sub-links
- Indicates if connection is made at Super-Speed data rate, and/or HS rate, FS rate, or LS mode using color LED indicators
- Two separate LEDs provide link monitoring if used with hubs
- Detects if USB3.0 link falls into Compliance Mode
- Detects if the USB3.0 link is in Ux (inactive) state

- Monitors the presence of valid VBUS voltage level
- VBUS is tolerant up to 30V
- Uses USB3.0 signal ReDriver™ to provide equalization, De-Emphasis, and output level control optimized for Link use model
- Detects if the USB2.0 link is in SUSPEND mode
- Allows to detect RESUME events on USB2.0 bus.
- Typical power consumption 90mA@5V (SS active), 16mA in HS Mode
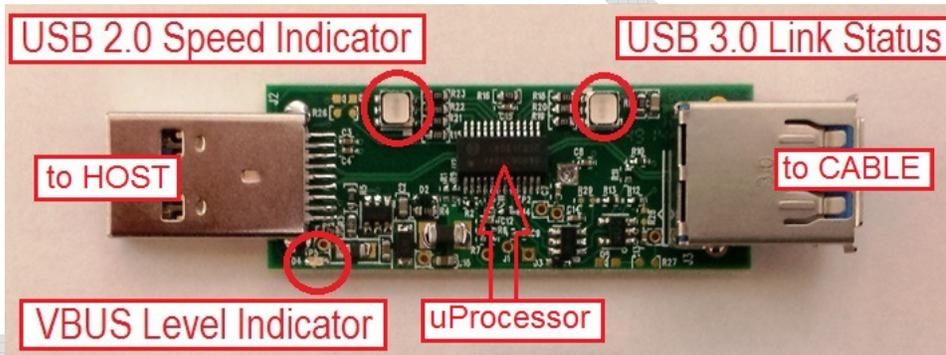
Top side

USB2 LED Indicator Functionality

BLUE	RED	Glowing YELLOW	Solid YELLOW	Breathing RED	Breathing BLUE
LS Device	FS Device	HS Device Idle	Dense HS traffic	SUSPEND HS/FS	SUSPEND LS

USB3.0 LED Indicator Functionality

LIGHT BLUE (AQUA)	Blinking BLUE	Blinking GREEN	Breathing RED
Normal Super-speed Link	Host (B) in Compliance Mode	Device (A) in Compliance Mode	Link in Low Power state

VBUS Level Indicator (Green LED) Functionality

| No light	Solid GREEN	Slow Blinking GREEN	Fast Blinking GREEN	Very fast Blinking
VBUS<4.3V	4.4V < VBUS < 5.5V	5.6V < VBUS < 12.6V	12.7>VBUS > 19V	VBUS>19V

Bottom Side
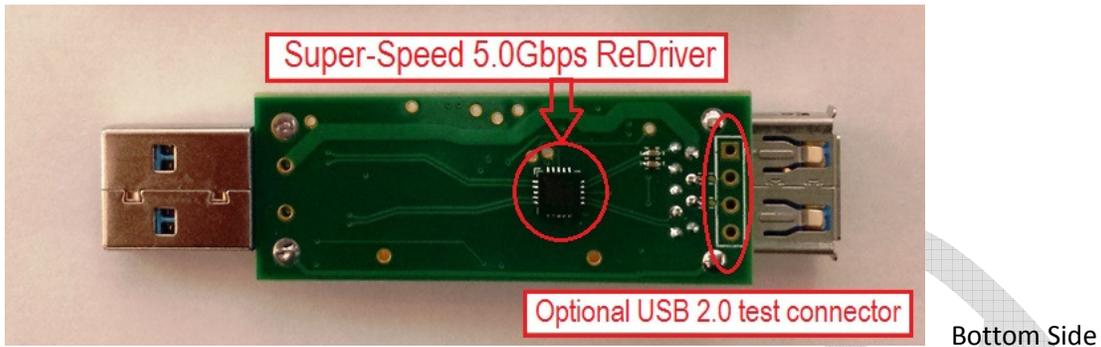
Theory of Operation

For USB2.0 connection, the data lines are simply passing through Type-A plug to Type-A receptacle. The dongle uses high-impedance low-capacitance (two single-ended and one differential) buffers to tap into D+ and D- data lines. The signals get conditioned and are fed into a microprocessor to determine the link state, and display it in color on a RGB LED chip.

For the USB3.0 (Super-Speed) channel monitoring, a ReDriver™ chip is used to detect the state of Super-Speed signals. The embedded microprocessor reads status of both links and displays it on a RGB LED. The ReDriver™ is also configured to compensate signal loss in additional connectors and PCB by applying signal conditioning in accord with typical use case of host-cable configuration.

Super-Speed Link Default Configuration
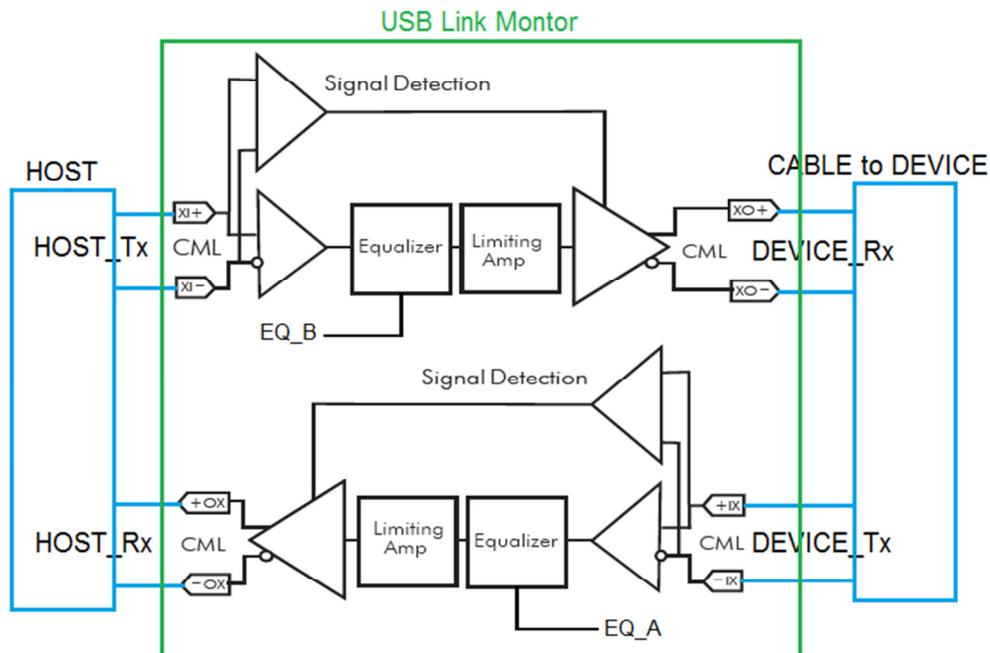
The re-driver settings are chosen on assumption that the Host end of USB3.0 link faces only a relatively short channel on a system board (and therefore requires less signal conditioning), while the cable end of the Visualizer can face a full-length cable with substantial signal loss (and therefore requires full Tx de-emphasis and high linear equalization on Rx).

Use Case Examples

Typical Problem: A USB device is plugged in, but the host does not recognize it.

Step 1: Plug the USB Link Visualizer into the USB port. Does the Super GREEN LED light on? If not, the host port failed to supply VBUS, so the connected device will not know if it is plugged in, and will not power-up, and won't try to connect.

Step 2: If the VBUS indicator is Solid GREEN, plug the questionable device/cable into USB Link Visualizer. Following are some scenarios of indicator behavior.

Link Visualizer Behavior	System reaction	Interpretation
USB3.0 indicator turns bright BLUE, then turns off, then HS Indicator goes from RED to light YELLOW	Device bandwidth below expectations	USB3.0 link fails to train, and the port falls back into high-speed USB2.0 mode
USB3.0 indicator turns bright BLUE, then goes Blinking BLUE	No reaction	Device side of USB3.0 link fails to respond, host port enters Compliance (test) mode. Suspect contaminated or damaged USB connector contacts.
USB3.0 indicator turns bright BLUE, then turns into breathing RED, then bright BLUE comes out sporadically	Normal device enumeration	The host and device both support Link Power Management, and it gets activated. It is normal (but rare) behavior, designed for power saving
USB2.0 LED Indicator goes RED, following "breathing RED"	No reaction	Host fails to recognize "Connect Event", likely due to a problem with host USB driver. Driver re-load (or system reboot) might be required
USB2.0 LED Indicator goes RED; RED momentarily turns OFF two-three times, following "breathing RED"	Connect-disconnect sound, device "yellow banged"	Host recognizes connect event, and tries to reset (RED goes off) AND enumerate the device, but without success. Link goes into SUSPEND mode
USB2.0 LED Indicator goes BLUE	Connect sound.	Device is a Low-Speed USB device
GREEN indicator blinking	Normal enumeration	The system under test and the USB device both support the USB Power Delivery protocol, and the host has negotiated (and applied) VBUS voltage above 11V

1. The USB Link Visualizer has provisions to attach a test connector (or oscilloscope leads) to USB 2.0 data signals (DP and DM) to monitor HS chirp negotiation signaling or other general state of USB 2.0 bus. Use of high-impedance (>1M) low-capacitance (<1pF) probes is highly advised.
2. USB-IF-compliant color encoding is available upon request.

Electrical Parameters

- USB2.0 load impedance – >200kΩ to ground
- Power drawn from VBUS – 90mA typical at 5V when Super-Speed link is active; 16mA with HS traffic.

Default Repeater Tuning

Super-Speed Channels	Rx equalization	Tx De-emphasis	Driver p-p Amplitude
Device-to-Host (Channel A)	8.1dB	0dB	900mV
Host-to-Device (Channel B)	3.3dB	-3.5dB	1200mV

Dimensions 70mm(L) x 20mm(W) x 12mm(H); Weight – 10g

All trademarks are property of their respective owners
The USB Link Monitor is exempted from RoHS compliance as Category 9 "Control and monitoring equipment", http://www.rohsguide.com/rohs-categories.htm