Good to Know about USB cables
Document version: v1.1
04/07/2023

Good to know about USB cables

USB cables are not just 4 wires. Proper USB cables have a strictly specified core (copper) thickness (thicker doesn't mean better for data wires), isolation thickness, shielding, and twisted pair. The combination of these properties results in an impedance for the cable. This impedance must be consistent throughout the entire transmission line (from chip to chip) for high-speed communication, such as USB 2.0 (high-speed mode). The USB 2.0 specification defines a differential characteristic impedance of 90 ohms. If there are mismatches between the impedances of the PCBs, cables, terminations, etc., reflections can occur. Excessive reflections can lead to distorted signals and corrupted packages, resulting in unstable or non-functional communication.

So, if you test a cable with a continuity tester and it passes, it doesn't necessarily mean that USB communication will also work fine. However, it is still recommended to test the cable for continuity, as a failure in that test indicates more fundamental issues. Testing the cable's impedance or signal integrity requires expensive equipment that people typically not have at home.

The problem with many coiled cables

Coiled USB cables are often custom-manufactured for sim steering wheels. Our experience shows that some companies do not specify the cables to meet USB 2.0 standards and the capability to transmit at 480Mbps. Over the years, we have tested various coiled cables from different manufacturers, including signal quality tests based on USB standards. It is surprising to see how many cables fail to pass the official USB tests. An example is shown below, where the signal should not touch the blue mask (further from the mask is better): the left side picture depicts a passed test, while the right side shows a failed test for a wrongly specified cable (coiled USB cable from a sim steering wheel manufacturer).
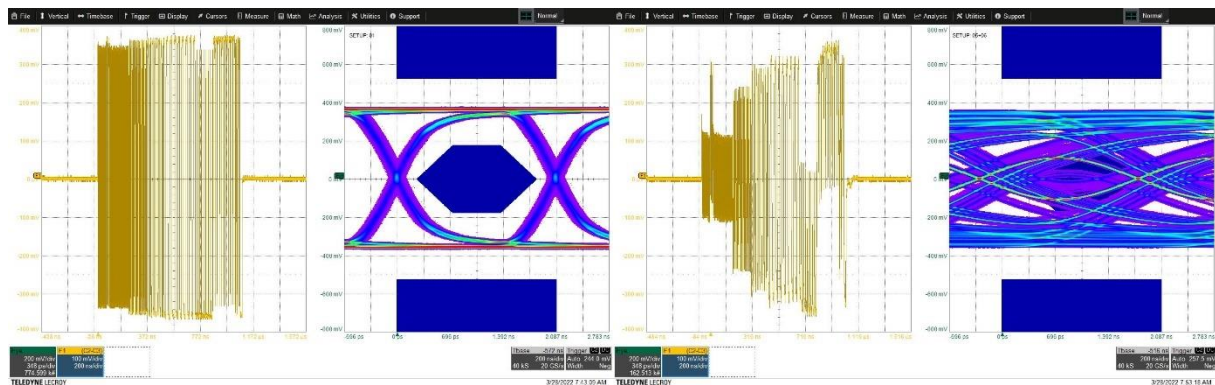
You may wonder why these cables still work, at least with the wheels from the same manufacturer. While something not meeting the standard can still function, it is not guaranteed. Some USB chips (HUBs, microcontrollers) are more tolerant than others, so if you use a specific combination, it may work. However, combining them with other parts can lead to issues. Therefore, it is best to always use components that meet the standards and combine them based on the standard. It's important to note that the entire system must also meet the standards, as you can create a system that does not meet the standards using components that do. (A simple example is connecting two 3m USB extension cables, which exceeds the 5m limit.)

Another significant reason is that not all wheels use high-speed USB 2.0 (480 Mbps). Many wheels only utilize full-speed USB 2.0 (12 Mbps), which is much more tolerant of cable due to the lower speed. This is

Good to Know about USB cables
Document version: v1.1
04/07/2023

why they often don't experience problems. For instance, all cables passed the test from a company that incorporates a display in their steering wheels (a display requires high-speed USB 2.0, except Nextion).

There is another common issue with many coiled USB cables: their length. These cables typically have a coiled length of no more than 0.6-1m, while the uncoiled length can reach even 3-5m. This may not necessarily impact communication if the cables meet the standards mentioned earlier. However, it can cause voltage drop on the power wires, which increases linearly with the cable length and wheel's current consumption. Therefore, we recommend avoiding the use of additional cable extensions or unnecessarily long cables.

If you would like to learn more about USB compliance testing, we recommend checking out this document: https://cdn.teledynelecroy.com/files/manuals/qualiphyusbmanual.pdf

We hope you find this extra bit of information interesting!

The most common USB issues

If you encounter the errors "Unknown USB Device," "USB Device not Recognized," or "Device Descriptor Request Failed," the issue is most often caused by one of the following:

- Wrong data line pinout (D+/D- swapped)
  - ➢ Double-check the USB pinout in all the USB connectors (GX12/GX16, in the wheel).
  - ➢ Using the wrong pinout may damage the PCB/electronics.
- Bad USB cable (USB cable is not capable of transmitting at 480Mbps)
  - ➢ Use USB cables recommended in the manual.
- Too long or poor USB connection inside the wheel (PCB - GX12/GX16 cable):
  - ➢ Make the internal cables as short as possible and twist the data lines (D+/D-).
- Poor USB cable quality resulting in a high voltage drop in the cable
  - ➢ In this case, the PC should recognize the wheel when the LEDs and display are off.
  - ➢ Use USB cables recommended in the manual.
- Using a too long USB cable
  - ➢ Avoid using passive extension cables.
- Insufficient power provided by the USB socket:
  - ➢ Try different USB ports.
  - ➢ Use a powered USB HUB near the wheel, such as TP-Link UH720.