Important Considerations for USB Devices in Industrial Applications

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Overview

USB (Universal Serial Bus) is the most popular interface in the IT industry today, thanks to its ease of use and versatility. In recent years, USB has also gained popularity in industrial applications as more and more devices support the interface. But industrial operations are more demanding than your typical office application and require additional considerations. For example, a factory floor may be subject to extreme temperatures that are too hot for a consumer-grade USB hub to handle. Industrial applications also require a higher level of reliability because system downtime is not only costly but potentially dangerous. To ensure that your USB devices meet these demands, system engineers should consider the following factors when selecting a USB device for industrial environments.

USB-IF Certification

USB-IF (USB Implementers Forum) is a non-profit organization founded by the group of companies that developed the Universal Serial Bus specification. Any vendor can design a USB product by following the USB specification but this doesn't mean their products have been tested for flaws. That's where USB-IF certification comes in. Products that pass certification testing are authorized to bear the USB logo and listed on the

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official USB-IF Integrators List on the USB-IF website. Users can choose products with the USB logo to ensure reliability and interoperability. Both USB device vendors and users can benefit from USB-IF certification.

Why Do We Need USB-IF Certification?

USB's popularity is due to its easy to use, Plug and Play interface. But when it comes to using USB in industrial applications, engineers have reported several problems. For example:

- **P1:** The USB device doesn't work with some operating systems.
- **P2:** The host hangs or is unable to recognize/detect the device.
- **P3:** The USB 2.0 device is detected as a USB 1.1 device and only runs at 12 Mbps.
- **P4:** The USB device malfunctions after plugging in and unplugging the device several times.

These problems are attributed to design flaws that can be easily detected and prevented through detailed testing. USB-IF certification testing identifies these design related problems so vendors can provide high quality USB products. By choosing a vendor whose products have passed USB certification, you can rest assured that your USB device will not malfunction or damage your host USB port—eliminating the above-mentioned problems.

What Tests Are Involved?

USB-IF certification involves rigorous USB protocol testing and a series of electrical tests.

USB Protocol

USB Specification, Chapters 8 and 9 define in detail the basic requirements and communication flows that all USB devices must follow. However, vendors still need to implement the protocol stack in devices and write the firmware for host requests themselves. In most applications, the host requests

are made by the operating system, such as Windows and Linux, and have subtle differences. Some developers only test a few operating systems and claim that development is complete. This explains why some USB devices are compatible with one operating system but not another. USB-IF certification ensures that your design covers all types of USB commands, solving problem P1. If the product uses a turnkey solution without any firmware or software, using properly designed chips will solve most compatibility issues.

Electrical Tests

In most cases, vendors use a turnkey solution and don't notice potential problems such as back voltage, inrush current, signal quality, and drop/droop voltage. Sure, the circuit design of a certified and uncertified USB Hi-Speed hub may be the same, but a poor layout can interfere with the actual transmission speed, which is supposed to be 480 Mbps. Even if vendors are aware of these issues, some may not be able to test their products because the equipment is too expensive, such as a real-time oscilloscope. Even if a USB device with design flaws—such as a bad eye diagram or high back voltage—is functional, it still destabilizes communication for other USB devices connected to the same bus. Using USB devices with the official USB logo is the best way to guarantee that you are using a product that has been tested for all of these factors.

The signal quality, or eye diagram, test pictured below can solve problems P2 and P3. Other electrical tests for back voltage, inrush current, and drop/droop voltage can solve problem P4.
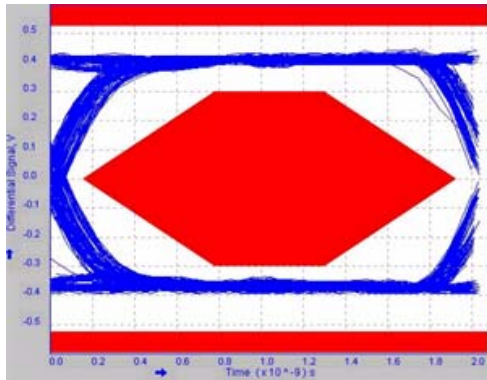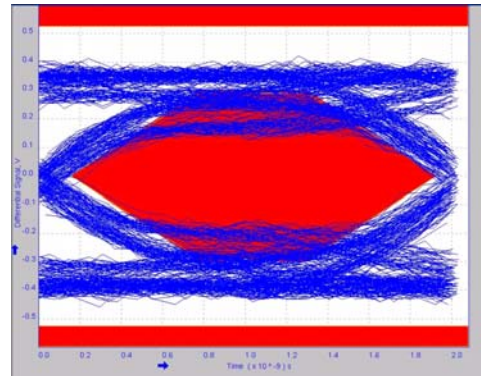
Good eye diagram   Bad eye diagram

Why Is USB-IF Certification More Important in Industrial Applications?

Reliability and efficiency are extremely important in industrial applications. Just imagine the frustration of having to shut down your entire operation just to replace a USB device that was disrupting communication for all networked equipment. That's why USB-IF certification is more important in industrial applications than consumer applications. USB-IF certification ensures that you have a sound USB connection so you don't need to worry about paying on-site engineers to find out why your USB connection is acting up again, saving valuable time and money.

ESD Protection

Since USB devices are designed to be frequently plugged into and unplugged from host devices, inrush current and electrostatic discharge (ESD) must also be considered in the design phase. Fortunately, USB-IF certification already takes inrush current into consideration. As for ESD protection, the IEC 61000-4-2 standard offers the best measure of a device's level of ESD protection. Frequently plugging and unplugging the USB device leaves it susceptible to ESD damage so high level ESD protection is necessary. That's why most major IT vendors try to provide the highest level (level 4) protection for their USB products. Level 4 protection means the device offers ±15 KV protection from air discharge and ±8 KV protection

from contact discharge. For some factory automation applications, operators need to plug each device into the USB port of a host or hub to download the firmware or run tests on the USB device, so up to 8 KV ESD protection from human contact is important.

Table 1. Stress levels from IEC 61000-4-2

Contact Discharge		Air Discharge	
Level	Voltage	Level	Voltage
1	2000 V	1	2000 V
2	4000 V	2	4000 V
3	6000 V	3	8000 V
4	8000 V	4	15000 V
X	Special	X	Special

Wide Temperature Support

In industrial applications, you also need to think about the operating temperature. Most consumer USB devices are designed for everyday office use and are ill-suited for outdoor applications. Rugged housing is just a basic requirement. You also need to make sure the USB device has wide operating temperature support (-40 to 85°C), which involves higher quality components and a more challenging power design. Bad design will lead to overheating and excessive power consumption. Overheating will reduce the product's MTBF value especially in high temperature environments such as a factory floor.

To solve this issue, Moxa's UPort™ 400 series industrial USB hubs are built with rugged metal housing that support both DIN-Rail and wall mounting. In addition to passing both bus power and self-power USB-IF certifications, the UPort™ 404 and 407 hubs support wide operating temperature from -40 to 85°C (404-T and 407-T models), making them especially suitable for industrial-grade applications such as vehicle, military, and factory automation.

Summary

The Plug and Play connectivity of USB hubs has made life easier in many ways, allowing us to connect multiple peripheral devices via a common interface. But when it comes to choosing USB devices for industrial applications, which are often subject to harsh environments and demanding requirements, commercial-grade products seldom meet the mark. That's why choosing products with USB-IF certification, ESD level 4 protection, and wide temperature support can ensure reliable, interoperable, and efficient communication for your industrial-grade USB applications.