

Understanding the Industrial USB Coupler



Purpose

The purpose of this document is to describe the Panduit® IndustrialNet™ USB Coupler and the best practices associated with its implementation.

Overview

Universal Serial Bus (USB) is a serial bus standard that provides a high data transfer rate, and is used extensively in consumer and commercial applications such as connecting devices (e.g., mice, keyboards, printers) and flash drives to a host computer. USB replaces the multitude of different connector types at the back of PCs and simplifies software configuration of communication devices. The design of the USB allows it to connect many devices using a single standardized interface socket and improve plug and play capabilities by allowing these devices to be connected and disconnected without rebooting the computer or turning it off. In addition to supporting data transfer, the USB 2.0 standard contains the power supply section specifying requirements at nominally five volts with a current of up to 100 milliamps.

The USB design is administered by the Standards Development Committee of the USB Forum, the industry standards body consisting of leading companies from the computer and electronics industries. The Committee has released standards that have progressed in data rates from up to 12 Mbps for USB version 1.0, through a rate of up to 480 Mbps for USB 2.0 and most recently to USB 3.0, which has a data rate of up to 4.8 Gbps. The approximate global count for USB 2.0-enabled devices currently exceeds four billion and equipment is becoming more available to support USB 3.0.

In addition to supporting high speed data rates, USB forms an extremely useful communications interface to professional equipment such as Rockwell Automation Powerflex® drives, types 400 and 700. In this example, a USB converter type 1203 would be used in between the USB inputs on the drives and a device such as a laptop that can be taken to the field and used in the industrial automation application as required. In a normal deployment, the drive would be located on the shop floor near the motor under control. To protect the drive from the industrial environment, the drive would, along with other equipment, be used in a control panel which would typically contain both data and power.

USB and High Voltages

A specific concern in a normal deployment scenario for the control panel in an industrial automation application is the risk of arc flash and electrical shock. If a technician opens the door of the control panel to access the USB port of the equipment needing to be programmed, there is a significant probability that the panel will contain high voltages associated with the power system for the motor being controlled. The technician touching or shorting energized contacts is at a risk that can lead to injury or death as well as severe damage to the equipment. The dilemma of needing to access equipment within the control panel containing high voltages has received much attention in recent years and the National Fire Protection Association (NFPA) has recently released a 2012 update to standard 70E entitled 'Standard for Electrical Safety in the Workplace' in order to address this in a comprehensive manner. According to the NFPA 70E update, if voltages of greater than 50 volts are used within the control panel or enclosure, arc flash and the corresponding shock hazard must be considered.

Each hazard category in the control panel has associated physical boundaries defining how physically close personnel can come to the energized control panel with further requirements for Personnel Protective Equipment (PPE) and training (for both authorized and unauthorized employees). The hazards associated with electrical shock and arc flash can also be mitigated through enabling IT personnel to access network interfaces without opening the enclosure. Please refer to the white paper, "WP-18: Arc Flash and Electrical Safety" to learn more about Panduit solutions available to help reduce arc flash incidents and optimize worker safety.

The IndustrialNet™ USB Coupler

Panduit introduces the IndustrialNet™ USB Coupler, which acts as an interface for transmission of data and enables USB access to required equipment in the control panel from outside the control panel without requiring personnel to open the control panel and being exposed to hazardous voltages. This application note describes the industrial USB coupler and gives use cases, or examples, of how the coupler could be used in real life scenarios.

The IndustrialNet™ USB Coupler is comprised of a USB type A female to USB type A female coupler module mounted into an IP67 rated industrial bulkhead adapter. The USB type A female interface is commonly used as the USB interface on a typical laptop computer. It contains four contacts, two for data and two for power. An example of a USB coupler module is shown in Figure 1.



Figure 1: Typical USB Coupler Module

The coupler permits the connection of equipment with a USB type A male plug. For example, a user could connect two USB patch cords together to make a longer cord. However, the USB Forum does not specifically give this as an example of a physical configuration because by joining a number of cords in succession, a user could exceed the maximum length of five meters (16.2 ft.). The electrical characteristics of the longer assembly quickly degrade and will not permit reliable communication much over the limit of five meters.



Figure 2: Industrial rated USB coupler

Key Features of the USB Coupler

- Provides interface for transmitting data between devices such as scanners, digital cameras, printers, etc.
- Accepts USB 2.0 Patch Cords and is backwards compatible with USB 1.1 Patch Cords
- Supports cable lengths up to 15 feet between devices
- Bulkhead provides IP67/IP65 seal when mated with IP67/IP65 plug or patch cord
- Meets industrial Ethernet specifications from ODVA, TIA and IEC sealed RJ45 connectors
- Gasket and seal are made of inert, chemically resistant material
- Connector components are made of high temperature rated material
- Tethered caps maintain seal during unmated connection

Figure 2 shows the coupler fitted in the industrial rated bulkhead. Typically, in the use of the IndustrialNet™ USB Coupler, a suitable hole is made in the control panel to provide the coupler an insertion point from the outside of the panel. A lock nut is securely tightened from the inside of the panel, and an O-ring seal is firmly depressed to make a water tight seal between the IndustrialNet™ USB Coupler and the wall of the control panel. Figure 2 shows a cap attached to the IndustrialNet™ USB Coupler by means of a lanyard. The cap can be fitted to the external thread of the bulkhead fitting and forms an IP67 rated seal. This cap would normally be fitted to prevent the ingress of particulate matter and water or other liquid if the USB connection is not being used.

The USB cabling has not been designed to be especially resilient to the effects of electromagnetic interference, which might be encountered in control panel environments and can be generated by a number of devices such as high voltage contactors, relays, variable frequency drives, etc. Effective design practices include establishing good separation between low voltage cabling and cabling, equipment, etc., associated with high voltages, inclusion of noise mitigation techniques such as the use of Panduit shielded noise duct solutions, inclusion of metal shielding baffles and structures, appropriate grounding and bonding both inside and outside the control panel, etc. The use of noise duct solutions is described in more detail in the Panduit white paper entitled "WP-14: Unified Physical Infrastructure - Solutions for Industrial Automation."

IndustrialNet™ USB Coupler Use Cases

Computer Access to Equipment Within the Control Panel

The coupler can be applicable in a control panel that can allow a technician computer access to internal electronic equipment without having to open the control panel. An illustration of this scenario is shown in Figure 3.

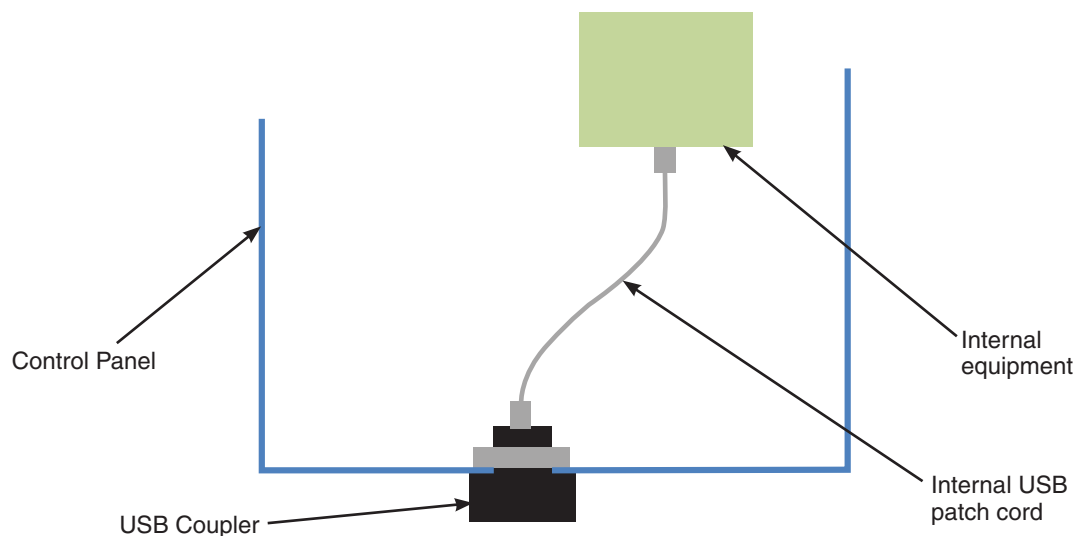


Figure 3: Use Case for Industrial USB Coupler Within the Control Panel

In normal operation of the panel with the coupler fitted, the externally directed USB A female of the coupler is closed off by the cap of the bulkhead connector. Inside the panel, there is a USB cable assembly with a USB A male plugged into the internal, female connector at the internal side of the coupler. The other end of the internal USB cable assembly might go to a Variable Frequency Drive (VFD), a system for controlling the rotational speed of an alternating current (AC) electric motor by controlling the frequency of the electrical power supplied to the motor. With the cap fitted on the externally facing USB A female of the coupler, the system is IP67 protected. The technician would unscrew the cap and let it hang on its lanyard and then use, for example, a USB A male to USB A male cable assembly to connect the laptop USB port to the coupler. The connection would not be IP67 rated, because the protective cap is not fitted while the technician connects to the internal electronic equipment through the USB cabling.

Another piece of equipment that is becoming prevalent in the industrial environment is the Human Machine Interface (HMI). HMI is the device that presents process data to a human operator and is used by the human operator to monitor and control the process. For example, the Rockwell Automation PanelView™ Plus 6 series of machine-level HMIs offers scalable visualization solutions and are available in a range of configurations and sizes. These terminals are ideal for applications that require monitoring, displaying and controlling. Typically, the terminal is mounted on the front side of the control panel, with the rear of the unit projecting into the control panel. Figure 4 shows an image of the PanelView™ Plus 6 700 graphic terminal.



Figure 4: Image of the PanelView™ Plus 6 700 Graphic Terminal

The terminal includes rear mounted USB communications ports for data input and retrieval, as well as other port types for versatility. The USB coupler could be employed to enable an external laptop computer to be connected to the HMI terminal. As in the previous use case, an internal USB cable assembly is in place between the internal USB A type jack of the coupler and the USB A port of the HMI terminal. Attention needs to be given at the time of design and installation to ensure the cable assembly type matches the available connector interface types. The cable assembly in this use case would have a USB type A plug on both ends. The USB Forum developing the standards never meant for the USB physical layer to be used in this manner, therefore these assemblies are not widely available but can be found in specialized electronics stores.

With the increase in use of equipment for industrial applications that incorporates USB 2.0 interfaces, it is very likely that a control panel may contain more than one piece of equipment requiring USB access. Several options are available to accommodate this scenario.

- a) Where only a few parts, (e.g. one to three), of equipment are used, it may be appropriate to install additional USB couplers for each item of equipment. The USB interfaces should be clearly labeled.
- b) In situations where a small number of items of active equipment is used, an alternative in the panel maybe to include a USB hub mounted inside the control panel. The common connection would be routed to the USB coupler internal interface, and each individual connection from the hub would be routed to the required active equipment interfaces.
- c) In the case where there might be several items of equipment, the Panduit IndustrialNet™ Data Access Port might be an alternative to the USB coupler. The Data Access Port provides a safe and secure means to maintain and monitor performance of active devices without the need to gain physical access to the inside of the control panel. The Data Access Port supports up to six Mini-Com® Modules, including the USB coupler module shown in Figure 1.

Connection to USB Flash Drive Housed Inside the Control Panel

Another use case might be for the original designer of the control panel to attach a USB flash drive to the internal USB A female connector of the coupler that contains pertinent design, installation and operation information about the panel. The externally directed USB A female connector of the coupler is closed off by the cap of the bulkhead connector, as shown in Figure 5, when the control panel is in normal use (without the external laptop connected).

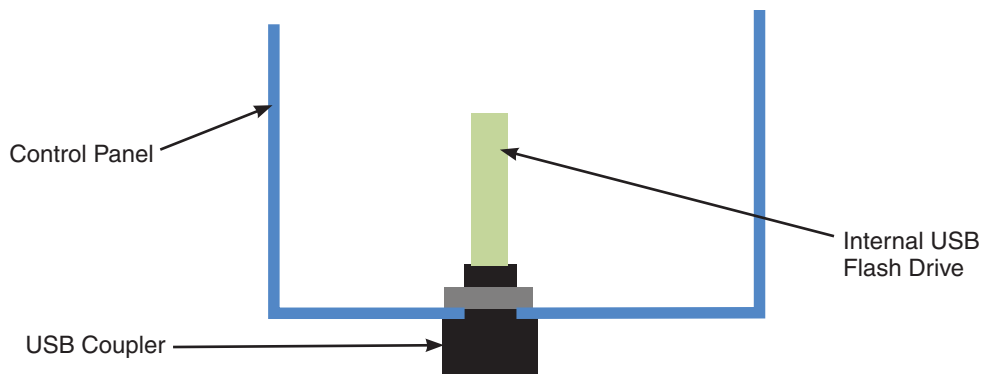


Figure 5: Use Case Showing Internal USB Drive

When access to the data contained on the flash drive is required, the protective cap is unscrewed to expose the externally directed USB A female connector interface. The technician can then use a laptop to access the relevant data, connected to the coupler by means of a USB Type A male to USB Type A male patch cord assembly. In many examples, this use case is particularly useful because reference circuit diagrams, installation manuals, etc. would be in hard copy form and might typically be left inside the enclosure for future reference. Having the data accessible on a USB based flash drive within the enclosure allows this data to be accessed safely from outside the enclosure, without having to open the control panel door.

Summary

The Panduit® IndustrialNet™ USB Coupler overcomes the challenge of IT accessing computer equipment data interfaces on the industrial shop floor without being exposed to voltages associated with power found in the machine control panel that could cause shock and arc flash risks.

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www.panduit.com • cs@panduit.com • 800-777-3300

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