

FIBER OPTIC APPLICATION IN A PROFIBUS NETWORK

Field busses are industrial control systems using Programmable Logic Controllers (PLC) to control and manage field devices found in industrial environments. The communication medium can be any combination of copper wire, fiber optics or wireless.

Over time, many field bus systems have been developed and several are standardized in IEC 61158. IEC 61158 describes PROFIBUS as Type 3 and PROFINet as Type 10. IEC 61784 further defines communication profiles and sets.

- Profile set 3/1 is used with PROFIBUS asynchronous transmission using RS485 in the physical layer.
- Profile set 3/2 is used with PROFIBUS synchronous transmission using Manchester encoding while distributing Bus Power (MBP).
- Profile set 3/3 is used with PROFINet using TCP/IP Ethernet.

Benefits of PROFIBUS include:

- Cost savings due to fewer bus components and easier installation.
- Easier management due to improved asset management tools.
- Improved productivity and reduced down time due to manufacturing flexibility

PROFIBUS (**PRO**cess **FI**eld **BUS**) has two versions: PROFIBUS DP (Decentralized Periphery) and PROFIBUS PA. PROFIBUS DP is used in production and automation and makes up about 90% of the PROFIBUS field devices. PROFIBUS PA is used in applications needing power distribution to the devices and where intrinsically safe operation may be required.

PROFIBUS DP is bit-serial asynchronous communication using non-return to zero (NRZ) encoding running at bite rates from 9.6kbps to 12Mbps.

The PROFIBUS DP copper wire medium is balanced twisted pair transmission line according to ANSI TIA/EIA-485-A forming a bus between the PLC and up to 31 field devices. Using shielded twisted pair is recommended and end terminations are required. In a linear topology, the number of field devices may be increased to 122 by adding a maximum of three repeaters. The interface is a 9-pin sub-D connector.

The PROFIBUS DP fiber optic medium can be either plastic or glass fiber using BFOC/2.5 connectors. An optical-electrical converter translates between the fiber optic medium and copper wire medium. The fiber optic medium insensitive to electrical noise, provides metallic isolation, and can span long distances. PROFIBUS PA does not support fiber optic medium.

A two port optic repeater with single electrical RS485 port forms a T-Connector. The T-Connector can be used as a simple optical-electrical converter, as an optic repeater, or as optic repeater with RS485 add/drop operation. In the optic repeater with RS485 add/drop operation, PROFIBUS devices in a tree topology can be distributed at great distances from the PLC.

This article deals with use of fiber optics in Profibus network.

As stated above Profibus is used in large factory automation projects e.g. Auto/Truck manufacturing, cement, steel, aluminum plants, food processing, chemical plants, water and sewage treatment plants. One such example is shown in **figure 1**. Large plants use heavy machinery, motors, generators which generate lot of EMI/RFI (noise), which can interfere with sensitive data communication between various computers and process control equipment. Plants also use high voltage, high currents which can cause problems with datacom and control equipment. If plant is old and proper grounding is not used, ground loops can result which are serious problem to new low voltage digital circuits and data communication.

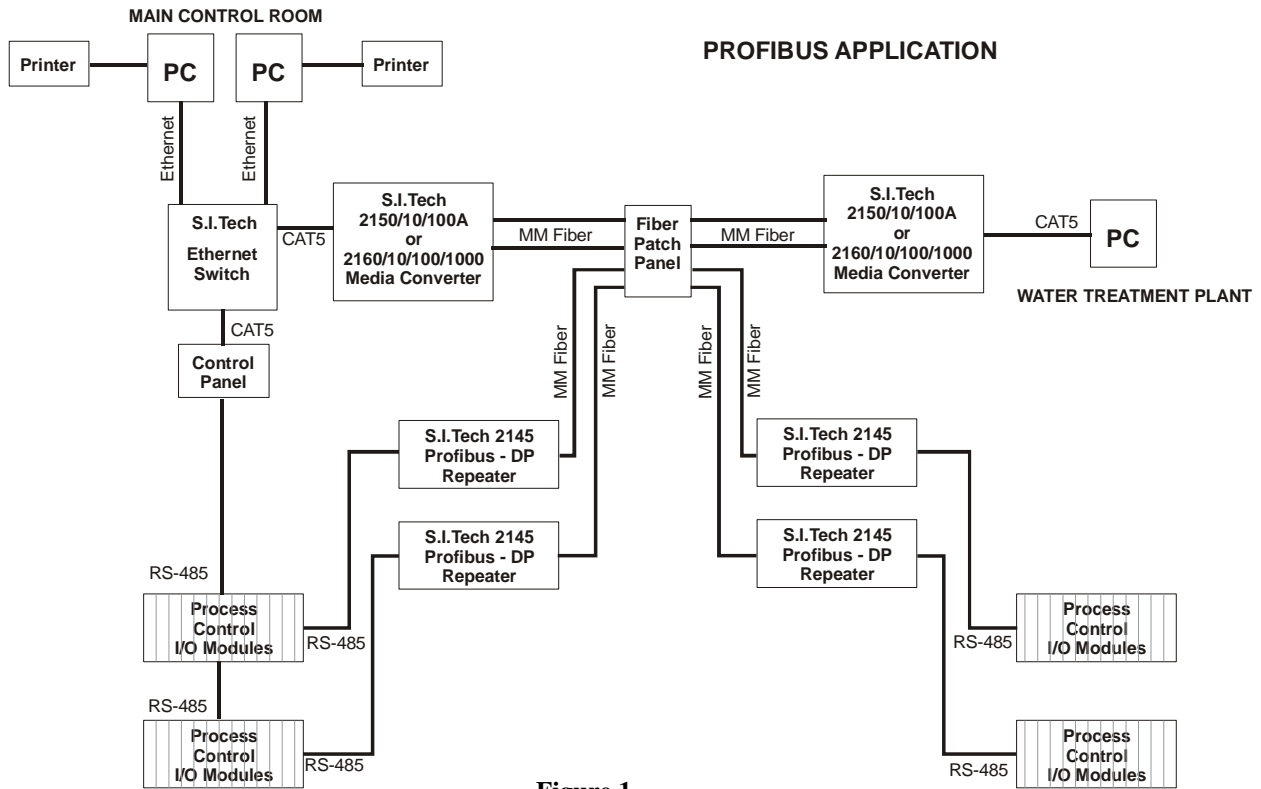


Figure 1

In large manufacturing plants, distances can be one kilometer to several kilometers which is beyond the data communication limits of most computers and process control equipment. All of these problems can be overcome with use of fiber optic cabling and optical equipment.

Key Advantages of Fiber

<p>All Dielectric</p> <ul style="list-style-type: none"> • Low Signal Radiation • Secure Transmission • RFI and EMI Immunity • High Voltage Installations <p>Small Size</p> <ul style="list-style-type: none"> • Less Duct Space • Fewer Additional ducts Installed <p>Low Attenuation</p> <ul style="list-style-type: none"> • Greater Distance/Fewer Repeaters • Less Installation and maintenance 	<p>Optical Signal</p> <ul style="list-style-type: none"> • No ground Loops • No Spark Hazard • Operation in Flammable Area <p>High Bandwidth</p> <ul style="list-style-type: none"> • Future Signal Capability Expansion
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Advantages Explained

1. Secure communication (low signal radiation):

Data traveling over fiber is very secure. No electronic eaves dropping can be used making it extremely difficult to “Tap” fiber optic cable. Also, if tapped it is very easy to determine that cable is tapped.

2. Immunity from EMI/RFI/High Voltage/Lightning:

Resulting in clean, error free data transmission over long distances bit error rates of better than 10^{-9} . Fiber is made of glass or plastic all dielectric material which is not affected by proximity to high voltage or lightning. Fiber optic cable can be routed in same ducts or cable trays as high voltage or power cables. Saving cost and providing ease of installation.

3. Small Size:

Fiber optic cables are physically very small and light weight, saving space, weight, and allowing ease of installation.

4. Lightning damage:

Particularly outdoors between buildings etc. can be avoided with use of F.O cable. If lightning strikes one plant it does not travel to other parts of same plant as F.O cable provides electrical isolation.

5. No Ground Loops:

Expensive grounding and shielding not required – saving on installation cost. Also, protects equipment from high voltage damage.

6. Low Loss (low signal attenuation):

Data can be sent long distances error free. With proper F.O. equipment and cabling 100 Km is possible without repeaters.

7. High data rate and High bandwidth:

Large data files such as engineering drawings can be transmitted in seconds. This allows main computers or process controllers to be in a more controlled and safe area away from plant. Also, future proofs installation.

8. No Spark Hazard:

Extremely important in chemical plants, oil refineries and other hazardous locations, since fiber cable is made of glass or plastic, if cut no electrical sparks. This way cable cut cannot start a fire.

To take advantage of fiber optic cabling and associated benefits, we have to use appropriate fiber optic equipment. In case of large plants, many use “Profibus” and “Profinet”.

S. I. Tech offers two products specially designed for use in Profibus applications. S.I.Tech #2145 “Profibus-DP” fiber optic bit driver is used in linear networks and the S.I.Tech #2147 is used in redundant ring networks.

Both the #2145 and #2147 products come with many options such as multimode fiber, single mode fiber, plastic or glass fiber. This allows implementation in any size, small to large plants with any of type of fiber optic cabling. RS485 (DB9) side allows multi dropping to various pieces of equipment such as a Bar Code reader, motor controls, electronic scale, and so on allowing integration of all plant equipment into network.

S. I. Tech #2145 and #2147 common features

Various data rates are possible from 9600 Bps to 12 Mbps. This way high and low speed equipment can be integrated on to “Profibus”.

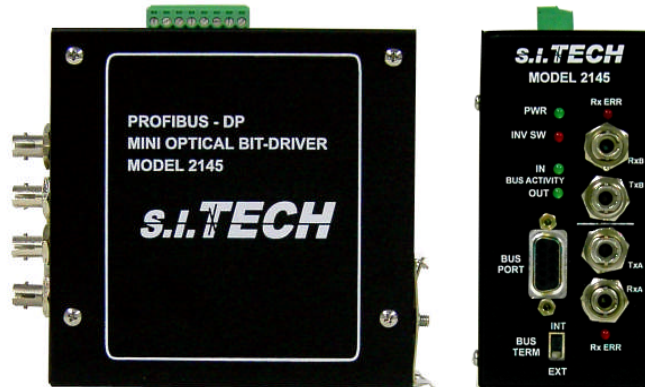
Both products are Din rail mountable so common rails can be used.

The S. I. Tech Profibus products come in ruggedized highly shielded metal enclosures. The circuitry is conformal coated for protection from dust/sand/moisture, so that the product can be used in any part of world. Units with multimode fiber is rated -25 to $+70^{\circ}\text{C}$ and single mode is rated -25 to $+60^{\circ}\text{C}$.

If application requires short distance and low data rate, low cost plastic fibers and 2145-00 units can be used.

S. I. Tech products are UL approved, is designed to meet FCC Class B, Part 15 and CE requirements.

The S. I. Tech #2145 and #2147 use 24VDC and 3 Watts input power.



S. I. Tech #2145 unique features

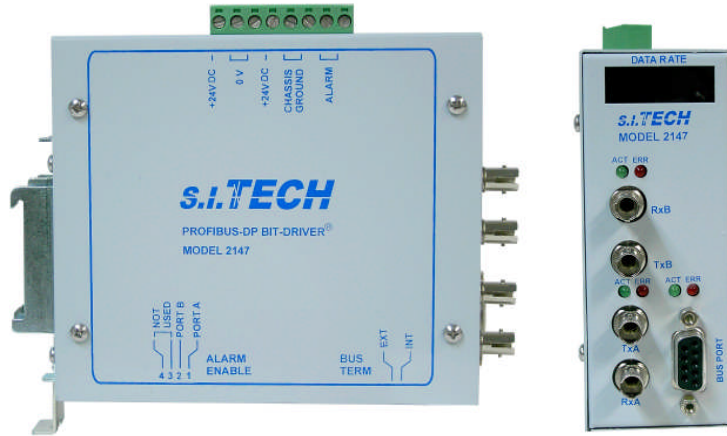
S.I.Tech #2145 is a two port fiber optic repeater so equipment can be daisy chained or connected in point to point or star configuration which allows total flexibility to plant engineers for network configuration.

Also the unit provides status indicators showing activity such as power ON/OFF, TXD and RXD fiber activity, and invalid switch setting for RS485.

S.I.Tech #2145 was tested and approved by “Profibus Lab” an outside independent laboratory testing for compatibility with “Profibus” network and various manufacturer’s equipment and Profibus specification.

S.I.Tech #2145 is field proven with ABB advent controller AC31/AC800F/800XA. It can also be used with Siemens, Allen Bradley GE and other process controllers.

Figure 1 shows integration of Profinet and Profibus in a water treatment plant where S.I. Tech #2145 fiber optic equipment is used.



S. I. Tech #2147 unique features

S.I.Tech #2145 is a two port fiber optic repeater so equipment can be configured in a redundant fiber ring. When the #2147 units detect loss of signal from connecting fiber, the network is autonomously reconfigured from ring to linear network thus preserving full network operation for a single fiber fault. When the #2147 units detect the recovery of the fiber the network is autonomously reconfigured back into the redundant ring network.

Also the unit provides status indicators showing activity such as activity on each of the ports, error detection for each port and display of the operational data rate.

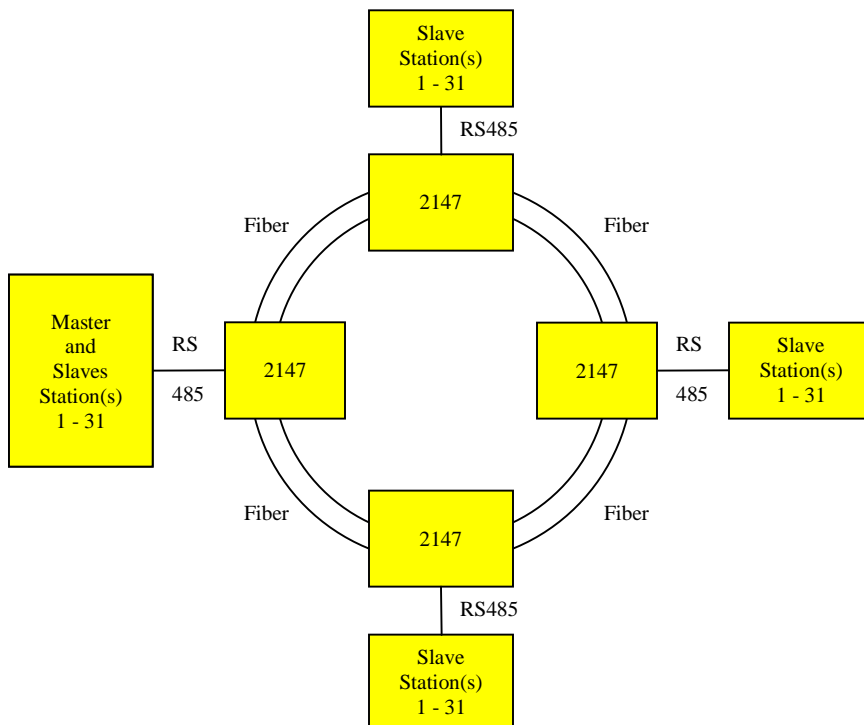


Figure 2

A typical redundant ring network using S. I. Tech #2147 units

S.I.Tech is a manufacturer of fiber optic Bit Drivers (Media converters), multiplexers, LAN/WAN equipment, repeaters, hubs, and cable assemblies for enterprise and industrial application. For further details contact tech@sitech-bitdriver.com. USA Tel 630-761-3640, Fax 630-761-3644.