Powering Remote Data Links over Fiber

Introduction

Many applications utilize remote sensors, transducers, and other communication devices that subject electronics to high RF, EMI, or magnetic fields or very high voltage levels. Duplex communications with these devices are often accomplished using standard optical fiber. Optical energy, used to power the sensor and its signal conversion circuitry, can also be efficiently delivered through noise-immune and non-conductive optical fiber. The fiber optic cable is immune to electrical noise, RF fields, and the conduction of unexpected electrical currents. A dielectric fiber is also impervious to lightning discharge, thereby isolating the electronics.

Figure 1 depicts a means of delivering high optical power over a JDSU Photonic Power Module (PPM), efficiently converting optical power to electrical energy at a remote site by use of a photovoltaic power converter (PPC).

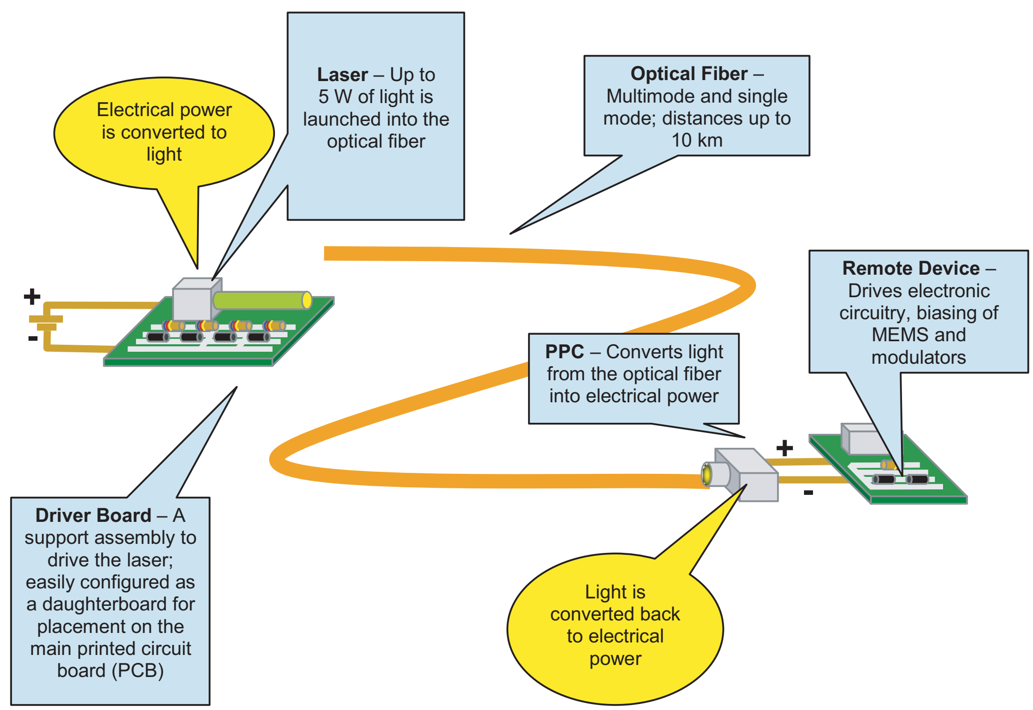

Figure 1. Powering remote electronics using a JDSU Photonic Power Module (PPM).

JDSU manufactures highly efficient PPMs that transform optical energy delivered via optical fiber into electrical energy, powering remote or isolated electronics. These unique modules consist of a laser diode, a driver, and a PPC that are all connected using standard optical fiber. These modules enable isolated power solutions for a wide range of applications, including communications, power transmission, and medical imaging. PPC conversion efficiencies approach 45% for voltages up to 12 VDC. Higher voltages can be achieved using a voltage up converter. A single power channel can deliver between 0.5 W and 1 W of electrical power. Output power levels up to 5 W can be achieved by

Introduction / continued

paralleling power channels. In addition, the PPM serves as the core technology for the JDSU 16-bit Optically Powered Data Link system, offering an all-fiber solution for powering remote electronic devices and transmitting data from them.

Optically Powered Data Links (OPDL)

The JDSU OPDL is a modular, low-power, and noise-immune system that delivers both power and data over standard optical fiber (Figure 2). Optical power is precisely controlled and delivered by a laser diode and driver (LDD) and is then converted into electrical power using a PPC, which drives the sensor and associated electronics at the remote end. Next, the analog sensor data is converted into a 16-bit digital format and is transmitted onto a second fiber to a main control area where the data may be reconverted to analog format or digitally analyzed. Alternatively, if the data is converted into digital format at the remote end, it can be transmitted directly onto the fiber. Feedback and self-check features monitor all vital functions of the laser output level, data link integrity, recovery and, if necessary, synchronization. This all-fiber approach provides a unique, electrically isolated, lightning-proof power delivery and data transmission system.

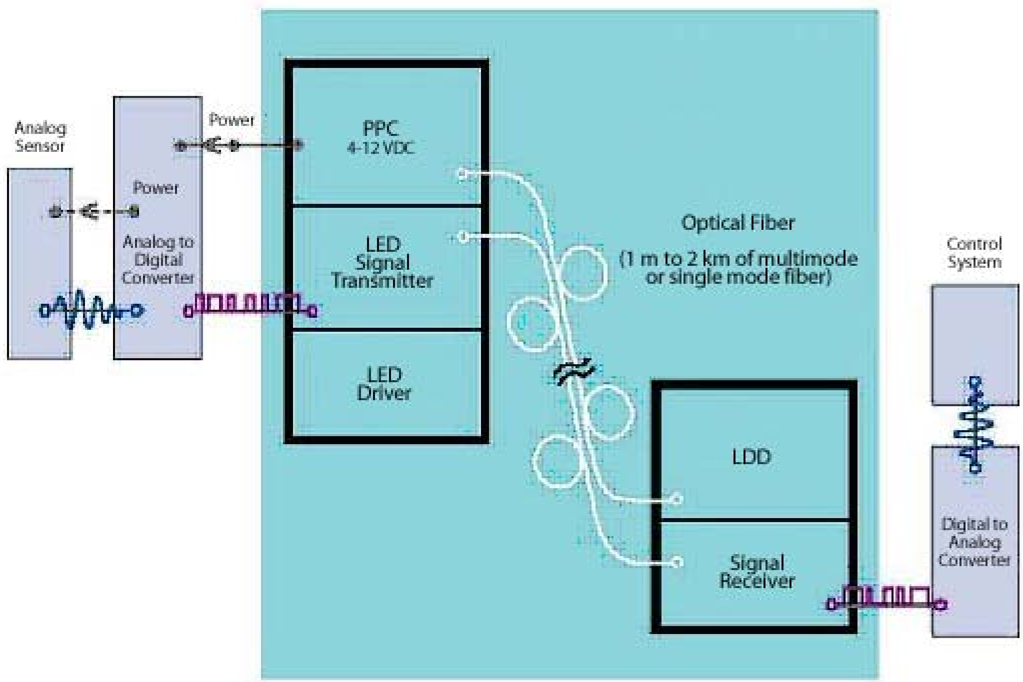

Figure 2. A schematic diagram of JDSU's OPDL system.

OPDL Applications

Electric Power

OPDLs can be used for current or voltage sensing in high voltage electric power substations where accurate metering and protection are essential to maintaining the integrity of the high voltage network. A typical installation of an OPDL for electric power applications is shown in Figure 3. Measurement is accomplished by converting the analog output from a current transducer to digital format in the OPDL. The use of fiber optic cables isolates the current transducer or sensor from ground potential. The fiber optic cables are routed through a lightweight "dry" signal column. This configuration is lighter, is environmentally safer, and offers significant cost and space savings as compared to conventional oil or SF-6 gas filled high voltage instrument transformers. Therefore, by using an OPDL, potentially explosive transformers are replaced by an electrically isolated, spark-free optical installation.

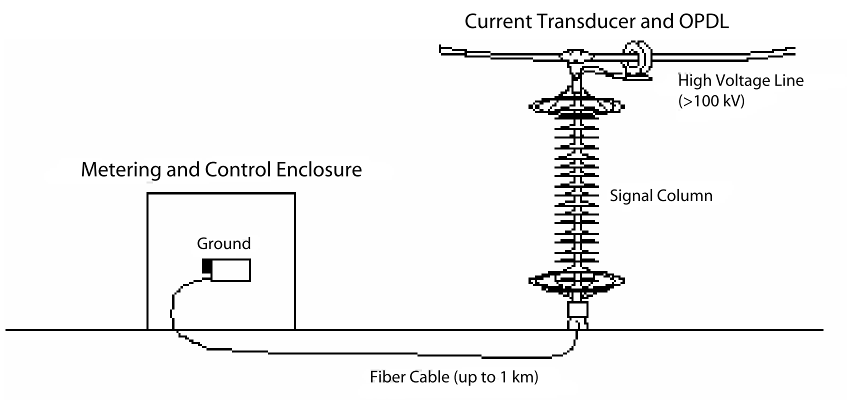

Figure 3. A schematic diagram of an optically powered current transducer system.

The sensor is a low voltage rated current transducer integrated with a burden resistor. The voltage output of the sensor head is fed into the OPDL and is converted to digital format. The fiber cable contains two links. The first link is the composite insulator with the incorporated fiber and is connected at the high voltage side of the remote OPDL. The second link is located at the ground side of the signal column and is connected to the fiber cable wired to the control building. The receiving unit in the metering and control enclosure provides the signal output for either the protection relays or the metering equipment. Figure 4 shows a 100 kV optically powered current transducer system.

Figure 4. A 100 kV optically powered current transducer system.

OPDL Applications / continued

This all-fiber solution provides the following benefits for electric power applications:
• High accuracy for metering applications
• An environmentally friendly, dry technology (no oil or SF-6 gas)
• Rapid, low cost installation
• No ground loops
• Lightweight and virtually maintenance free
• Seismically insensitive
• Low power consumption

Mobile Wireless Network Deployments

GPS receivers provide timing signals for the synchronization of voice and data streams. In some cases, they also provide stability inputs to a local frequency source at mobile base station locations. The GPS antenna/amplifier assembly is mounted so as to provide a clear view of the GPS satellite. Traditionally, the GPS receiver has been located inside the equipment room, and the analog RF signal is transmitted to the receiver for down conversion and digitizing of the data stream. Many recent configurations, though, install the GPS engine remotely with the antenna/amplifier assembly and transmit the digital signal to the equipment room for processing. When the GPS engine is located remotely, an OPDL system can be used to power the RF amplifier, GPS engine, and any associated control electronics as shown in Figure 5. The use of an OPDL system eliminates the need for coaxial connections, line amplifiers, and lightning suppression. The coaxial/power connection is replaced by an all-fiber solution. The digitized GPS signal is fed into the OPDL where it is optically modulated onto a downlink fiber using a light emitting diode and transmitted to the equipment room for analysis.

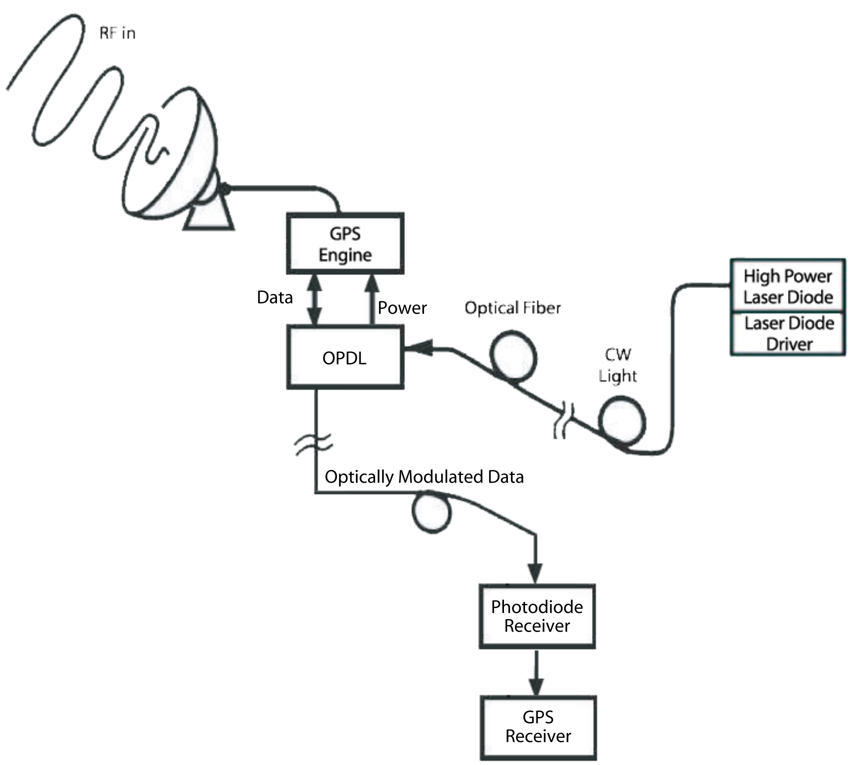

Figure 5. Using an OPDL to power a GPS timing antenna system.

OPDL Applications / continued

This all-fiber solution provides the following benefits for GPS applications:
• Isolated power immune to noise, EMI, and lightning effects
• Simplified installation, eliminating the need for lightning arrestors and booster amplifiers
• Reduced installation and logistics costs by eliminating the need to store, ship, and install bulky low-loss coaxial cable
• Reduced total cost of ownership, resulting from fewer maintenance truck rolls and the elimination of damage from lightning strikes
• Reduced signal attenuation over long cable runs
• Improved security due to the use of fiber that is less vulnerable to sniffing or tapping of the data line

Sensor Applications

Electronic sensors are used in many industrial monitoring and test and measurement applications to record operating parameters or environmental conditions such as temperature, pressure, acoustics, and instrumentation readouts. Many sensors are installed in environments that are hazardous, electrically noisy, inaccessible, or exposed to extreme weather. Other sensors use batteries as their power source even though the batteries require frequent replacement or recharging. The use of OPDL technology to power and transmit the sensor data ensures continuous, fully isolated power, which is free from the effects of RF, EMI, or magnetic fields. It also ensures spark-free operation in environments where safety is paramount, such as the powering and monitoring of fuel gauges on commercial and military aircraft.

OPDL technology is currently being used for electro-magnetic inspection (EMI) test measurement. Electrical circuits produce electric and magnetic fields that radiate radio frequency (RF) energy, increasing the possibility for electronics to exceed regulated EMI limits. Magnetic or electric field probes are utilized in EMI testing to quantify emission levels and help identify EMI sources. Traditional EMI chamber testing can be long and arduous. Oftentimes, batteries provide the power for the probes, and the testing must be halted in order to recharge or replace the batteries. This down time limits the number of tests that can be performed in a 24-hour period. JDSU's all-fiber OPDL solution continuously powers the probe while generating sampling data at high rates, facilitating performance measurement. The OPDL serves as an isolated power supply to drive the EMI probes, offering a very pure power source that contributes no extraneous interference and eliminates the need for batteries and battery exchange or recharge. Therefore, EMI testing can be completed more efficiently and more cost effectively.

Any low power digital measurement or transceiver application can be powered by an OPDL system, including a digital video camera used for surveillance or monitoring applications in the medical or security markets. Approximately 500 mW is required to power the camera, the control electronics, and the data channel. The major advantage of using an OPDL system in this application is the isolation from high magnetic fields in certain medical applications and the reduced vulnerability to sniffing or tapping of the fiber cable in security or defense applications.

This all-fiber solution provides the following benefits for sensor applications:
• Isolated, spark-free power that is immune to noise, EMI, and RF effects
• A pure power source that will not contribute interfering emissions to the EMI measurement
• Reduced costs and test times due to the elimination of battery power
• A lower weight alternative to copper or coaxial cable
• Reduced vulnerability to sniffing or tapping of the data line

Summary

The JDSU OPDL system is a modular, low-power, and noise-immune data acquisition and power delivery system for sensors, transducers, and other remote data communications devices. This technology offers particular advantages for powering electronics in high voltage, RF, EMI, and magnetic fields or where spark-free operation is required. It can be used for a wide range of applications including electric power current monitoring, test and measurement, sensing in industrial, medical, and aerospace applications, and video surveillance. The OPDL system allows for the elimination of large, costly instrument transformers, bulky coaxial cable, batteries, and lightning arrestors while offering fully isolated electric power at a competitive price.