

Industrial Fiber Optic Products for Wind Generation Applications



Your Imagination, Our Innovation
Sense • Illuminate • Connect

Avago Technologies' Industrial Fiber Products Solution to Power Generation Applications

Introduction

Global warming and climate changes from CO₂ emissions of traditional energy sources, such as those powered by fossil fuels, have created huge markets for alternative power generation. Wind turbine energy has become a popular alternative to meet the fast growing energy demand. Unlike fossil fuels, which are a limited and diminishing resource, wind energy is limitless and readily available.

Conversion of wind energy into utility-grade AC power requires power electronics, such as rectifiers and inverters. In a high power generation system, galvanic insulation becomes very important to ensure the quality and reliability of the power generation. Fiber optic components offer protection by providing insulation from high-voltage glitches and unwanted signals into power electronic devices.

Avago Technologies offers highly reliable industrial fiber optic components for data-acquisition/control and isolation in the power generation market. Featuring outstanding performance in high insulation voltage and high immunity to EMI, these products are able to be installed and operate in close proximity to power-carrying conduits which emit disruptive electrical interference. As the demand for renewable energy grows globally, wind turbine designs are becoming larger and larger. Avago's industrial fiber products offer a wide range of data-rate and link lengths for many applications in this power generation market.

Key applications for industrial fiber optic components in wind turbine systems include:

- Power electronic gate driver for rectifiers and inverters
- Control and communication boards
- Turbine control units
- Condition monitoring systems
- Wind farm networking

Wind Turbine Power Generation

Wind turbine is used to convert kinetic energy into electrical energy through use of a generator. As wind conditions vary, the electrical energy created from the generator needs to be converted for usability. A rectifier, inverter, transformer and filter are needed within the wind turbine, in order for utility-grade AC power to be transmitted over long distances (Figure 1).

A transformer is usually installed at the bottom of the tower to provide voltage conversion from the low voltage generated by the wind turbine, to medium/high voltage for transmission.

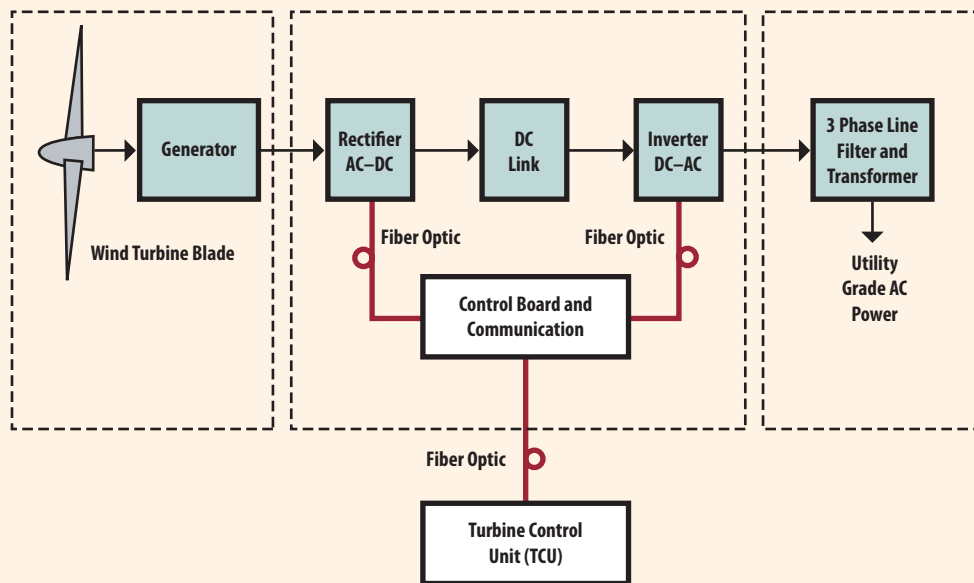


Figure 1: Wind Turbine Power Generation

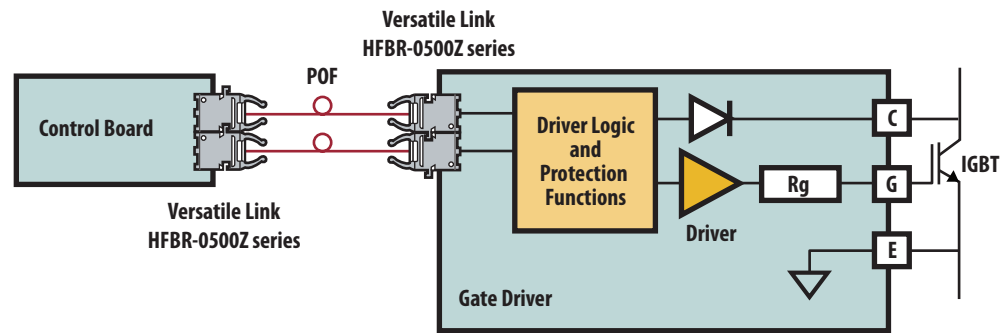


Figure 2: IGBT's Gate Driver Block Diagram

Rectifier and Inverter

The rectifier and inverter are key components in the wind turbine system. The rectifier converts noisy AC power to DC power, while the inverter converts DC power to clean and reliable AC power. The switching of these devices is usually controlled by a DSP embedded controller via a fiber optic link, to provide efficient and reliable switching control with high galvanic isolation capability.

There are numerous rectifier and inverter control switches available:

- Insulated Gate Bipolar Transistor (IGBT)
- Gate Turn Off Thyristor (GTO)
- Integrated Gate Commutated Thyristor (IGCT)
- Symmetrical Gate Commutated Thyristor (SGCT)
- Emitter Turn Off Thyristor (ETO)

Fiber optic components are commonly used to control a high voltage and current switching device, with reliable control and feedback signals (Figures 2 and 3).

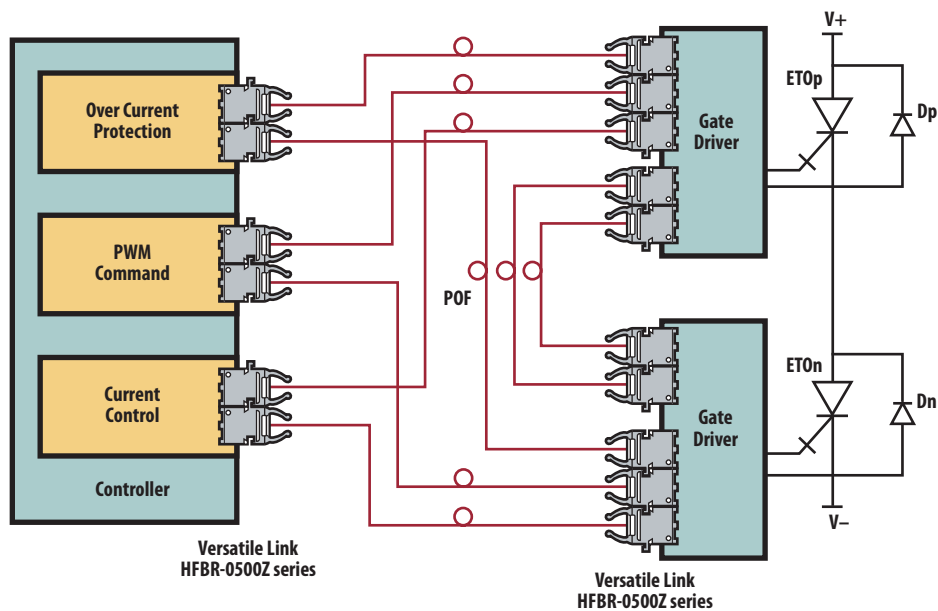


Figure 3: ETO's Two-Level Voltage Source Converter Phase Leg Block Diagram

Common Avago Fiber Optic Components Part Numbers

| Part Numbers | Description | Data Rate | Distance* | |
|--------------|---------------------|-------------|------------|---------------|
| | | | POF (1 mm) | HCS® (200 µm) |
| HFBR-1521Z | 650 nm, Transmitter | DC – 5 MBd | 20 m | – |
| HFBR-2521Z | 650 nm, Receiver | DC – 5 MBd | 20 m | – |
| HFBR-1522Z | 650 nm, Transmitter | DC – 1 MBd | 45 m | – |
| HFBR-2522Z | 650 nm, Receiver | DC – 1 MBd | 45 m | – |
| HFBR-1528Z | 650 nm, Transmitter | DC – 10 MBd | 40 m | 300 m |
| HFBR-2528Z | 650 nm, Receiver | DC – 10 MBd | 40 m | 300 m |

*Optical link distance varies with operating data rate. Lower data rate allows longer optical link distance.
HCS is a registered trademark of OFS

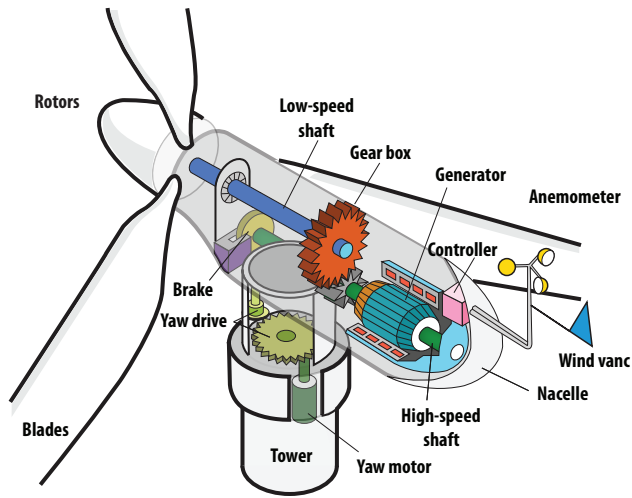


Figure 4: Elements within a Wind Turbine Nacelle Requiring Fiber Communication

Condition Monitoring System

Most modern wind turbines have intelligent features to monitor and control the system to accommodate varying wind conditions. For example, atmospheric sensors detect wind speed and direction. Other sensors monitor the condition and strength of the turbine's parts to avoid run-to-failure.

Wind turbines need to withstand extreme weather conditions, such as storms and lightning. In these types of conditions, it is important to ensure that the turbine's monitoring system is designed to provide high voltage and current isolation. Fiber optics becomes a preferred choice of medium as it offers much higher voltage and current isolation properties compared to optocouplers and other similar components.

In the nacelle of the wind turbine, short link distances using fiber optics can utilize POF (plastic optical fiber) and Avago's HFBR-0500Z products. Connectors with snap-in, latching and screw-in designs are various options designers can select from. Avago's versatile link sub-family allows field connector capabilities for POF and the associated connectors, allowing for field repairs, maintenance and installation.

Besides good isolation properties, these products provide excellent signal integrity as they are immune to electro-magnetic interference (EMI). It becomes an excellent solution for monitoring system communications over long distances with reliable data transmission in high voltage/current applications.

For greater ESD and EMI protection, Avago's HFBR-0506AMZ series offers a metalized packaging that provides excellent shielding. The SMA-styled connector also works well in areas with vibration and mechanical shocks.

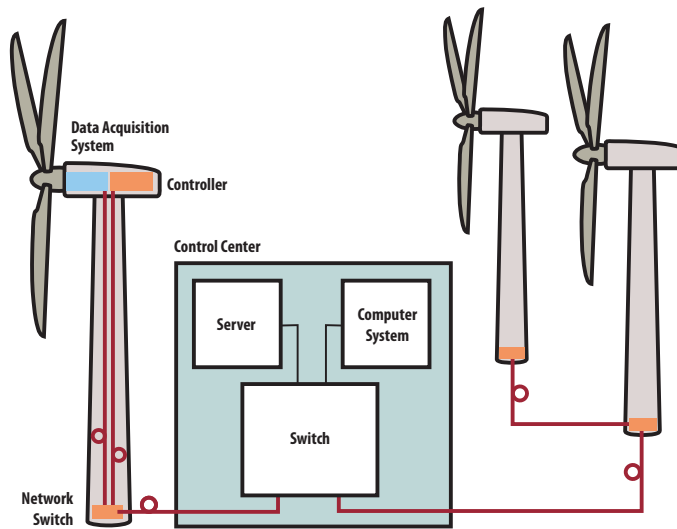


Figure 5: Wind Farming Configuration

Wind Turbine and Wind Farm Networking

Data collected from the condition monitoring systems, with the use of short-link POF fiber links in individual wind turbines, are typically multiplexed into HCS (hard-clad silica) or multi-mode fiber cables. The longer link distances of HCS and multi-mode fiber may be needed if wind turbine towers are greater than 100 meters in height. Fiber cables are both robust, offer greater resistance to harsh environmental elements and are lightweight. All of these are requirements for vertical cabling in wind turbine towers.

Industry standard connectors like the ST/ST-thread and SMA are all available from Avago. The HFBR-0400Z series operates over both HCS and multi-mode fiber, which offer greater bandwidth and link distance as compared to the POF solution. These parts are commonly used in wind turbine towers and over long distance wind farm networks.

Avago Technologies has developed a series of fiber optic transmitters, receivers and transceivers for wind turbine monitoring systems and networking applications. Avago offers parts from 650 nm, 820 nm or 1300 nm, which have data rates up to 160 MBd to meet customers' needs over various link distances.

Common Avago Fiber Optic Components Part Numbers

| Part Numbers | Description | Data Rate | Distance* | | |
|--------------|----------------------|-----------|-----------|--------------|--------------|
| | | | POF (1mm) | HCS® (200µm) | 62.5um/125um |
| HFBR-1527Z | 650 nm, Transmitter | 160 MBd | 50 m | 50 m | — |
| HFBR-2526Z | 650 nm, Receiver | 125 MBd | 30 m | 100 m | — |
| AFBR-5789Z | 650 nm, Transceiver | 125 MBd | 50 m | 100 m | — |
| HFBR-14X4Z | 820 nm, Transmitter | 160 MBd | — | — | 500 m |
| HFBR-24X6Z | 820 nm, Receiver | 160 MBd | — | — | 500 m |
| HFBR-1312TZ | 1300 nm, Transmitter | 160 MBd | — | — | 2 km |
| HFBR-2316TZ | 1300 nm, Receiver | 160 MBd | — | — | 2 km |

*Optical link distance varies with operating data rate. Lower data rate allows longer optical link distance.
HCS is a registered trademark of OFS

About Avago Technologies

Avago Technologies is a leading supplier of analog interface components for communications, industrial and consumer applications. By leveraging its core competencies in III-V compound and silicon semiconductor design and processing, the company provides an extensive range of analog, mixed signal and optoelectronics components and subsystems to more than 40,000 customers. Backed by strong customer service support, the company's products serve four diverse end markets: industrial and automotive, wired infrastructure, wireless communications, and computer peripherals. Avago has a global employee presence and heritage of technical innovation dating back 40 years to its Hewlett-Packard roots. Information about Avago is available on the Web at www.avagotech.com

For product information and a complete list of distributors,
please go to our web site:

www.avagotech.com

www.avagotech.com/fiberoptics

For technical support please email a Technical Response Center in
your region:

United States: support@avagotech.com

Europe: info@promotionteam.de

Asia Pacific: pacrim.components@avagotech.com