Fiber Optic Components for Wind Turbine Applications

Application Brief 118

Introduction

Wind turbines convert the kinetic energy of the wind to mechanical power. This mechanical power can be used by a generator to produce electricity. Utility-scale turbines range in size from 50 kilowatts to as large as several megawatts. Larger turbines are grouped together into wind parks, which provide bulk power to the electrical grid.

This application brief will give the reader an overview of the common applications in wind turbines for Agilent's fiber optic products.

Wind Turbine Market

Wind energy is gaining ground in developed and developing countries alike. In developed countries, wind energy is mostly in demand because of its pollution-free qualities. In developing countries its popularity is linked to the fact that turbines can be installed quickly and require no subsequent fuel supplies. The wind turbine industry is now a US $6 billion industry worldwide with an extremely bright future, particularly if environmentally friendly energy policies gain ground.

Currently there are some 45 wind turbine manufacturers in Europe, with about 40 percent of the turbines in the world coming from Danish manufacturers. Some of the larger manufacturers in Europe are addressing a growing export market in Asia and in the US.

The Wind Turbine Control Panel

The wind turbine controller consists of a number of computers, which continuously monitor the condition of the wind turbine and collect statistics on its operation. The controller also controls a large number of switches, hydraulic pumps, valves, and motors within the wind turbine.

The controller continuously compares the readings from measurements throughout the wind turbine to ensure that both the sensors and the computers themselves are in working order. A controller is located both at the bottom of the tower and in the nacelle.

Agilent Fiber Optic Components

Agilent Technologies is the world's leading provider of fiber optic transmitters, receivers and transceivers.

Agilent offers high volume, low-cost manufacturing and provides parts with unmatched quality. Agilent fiber optic discrete components and transceivers are available in 650, 820, 1310 and 1550 nm wavelengths and operate over a wide range of link distances up to 80 km.

Agilent's Fiber Optic components come in various packages, including SMA, ST, SC, and Versatile Link; transceivers come in 1x9 SC and ST duplex, LC and MT-RJ packages.

For wind turbine applications, fiber optics provides EMI immunity, data integrity, and assured electrical isolation.

Communications between such components require a substantial amount of data to be transmitted over either copper wiring or fiber optics. On newer wind turbine models, the communication is usually performed over optical fibers.

As wind turbine sizes increase to the megawatt level, it becomes increasingly important that they have a high availability rate—that they function reliably all of the time. As a result, highly redundant fiber optic communication links can be found in today's wind turbines.

Main Components of a Wind Turbine

A typical wind turbine has the following working components that require connectivity to the control panel:

- Generator (power generation)
- Controller
- Brake
- Emergency Brake Circuit
- Top Control Panel
- Bottom Control Panel
- Voltage, Current and Frequency
- Temperature inside nacelle
- Gear bearing temperatures
- Anemometer (wind speed)
- Wind Vane (wind direction)
- Hydraulic Pressure Level
- Valve Function
- Yaw Angle
- Low-speed shaft rotational speed
- High-speed shaft rotational speed
- Temperature sensors in small electric motors controlling yaw, hydraulic pumps, etc.

The control panel is able to monitor and operate these working components through closed-loop control to achieve optimum performance of the wind turbine, and detect potential failures.

Networking with Fiber Optics for Power Distribution Networks and Wind Turbine Parks

Electrical power generated by wind turbines is connected to the electrical distribution grid via transformers and substations. Fiber optics is used to transmit data between the power distribution equipment.

- Step-up transformer (medium voltage power)
- Step-up Substation (high voltage power)

Transmitting data alongside electrically-noisy power lines is effectively accomplished using fiber optics.

The wind turbine controller communicates with the operator via a fiber-optic communications link to send alarms or requests for service. The operator can contact the wind turbine to collect statistics and check its status.

In wind parks one of the turbines will usually be equipped with a microcomputer from which it is possible to control and collect data from the rest of the wind turbines in the park. This "master" computer can be called over fiber optics.

Some wind turbine parks are built at sea, where there is both an abundance of wind power and a great deal of available space. Remote surveillance of the offshore parks is even more important than on land.

Radio links for this purpose have been in operation for years. At the newest offshore wind parks, the control center is connected to each wind turbine via fiber-optic cables.

Value Proposition of Fiber Optics: Electromagnetic interference immunity, data integrity, and electrical isolation

Wind turbines are growing in size with the latest designs generating up to 1–2 MW. There are very powerful electromagnetic fields around power cables and generators in a large wind turbine. This is a big problem for signal and data lines within the turbine. Copper has traditionally been used, especially with the smaller turbines, and can be cheaper than fiber, but it cannot be used with good performance in wind turbines with extremely noisy power lines. Also, lightning can strike any portion of the wind turbine; it is extremely important to isolate sensitive electronic equipment to prevent costly damage. For the above reasons, fiber has now become the preferred solution. Many manufacturers of wind turbine systems prefer Agilent fiber optics parts because of the availability of extended temperature ranges, high performance and high quality.

Many control networks are based on the RS-232/422/485 physical media interface, which is a bus topology. Different ground potentials and noise sources may not allow a non-isolated bus structure. A mixed topology consisting of fiber cable and twisted-pair wire is common. Agilent's Versatile Link family is the most cost-effective line of products for short distance data communication and control. There are also many third-party off-the shelf line drivers and receivers for RS-232/422/485 interface between the twisted pair bus and the Versatile Link TTL receiver output and transmitter input. Versatile Link is most useful for replacing short copper links on RS-232/422/485 interfaces, which are susceptible to electromagnetic interference; or when designing new short data-links using fiber optics.

Figure 2 shows the schematic of a complete fiber-optic transceiver, which can be easily constructed on boards designed for industry-standard fiber optic transceiver modules with a 1x9 footprint and used as a cost-effective method for data communications and networking in wind turbine applications. Applications include networking within wind parks and between wind parks which require longer distances than twisted pair copper lines can provide. Data communications alongside noisy power distribution lines with fiber optics ensures data integrity, since fiber optics is inherently immune to electromagnetic interference.

Recommended Products

HFBR-1528/2528 (10 MBd Versatile Link Transmitter and Receiver with digital TTL output)

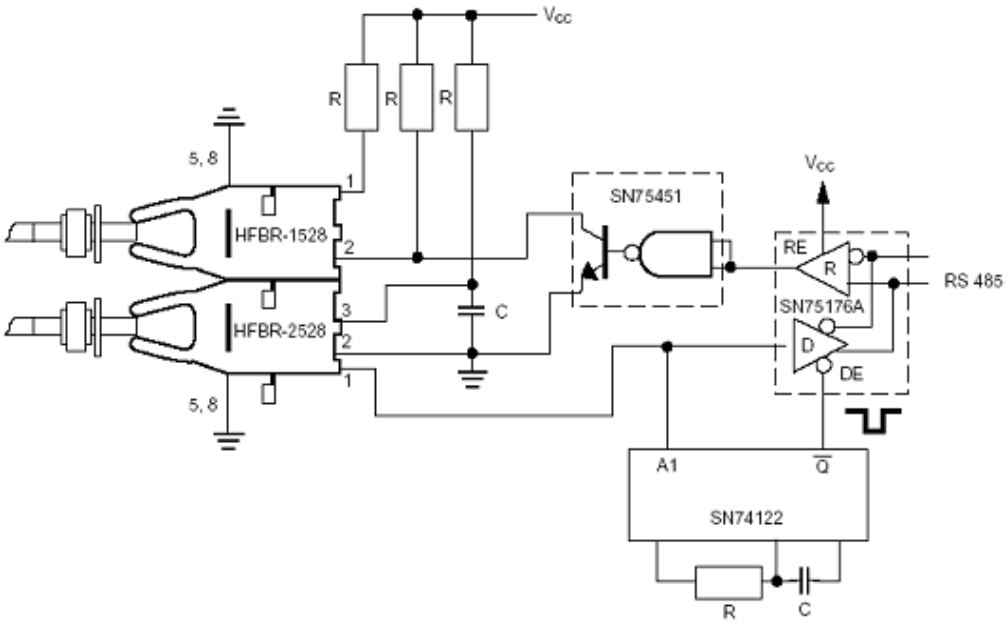

Figure 1. Basic RS-485 Fiber Optic Interface Adapter to Data Terminal.

Recommended Products

1. **HFBR-1527/2526 (160 MBd Versatile Link Analog Transmitter and Receiver)**
2. **HFBR-14x4/24x6 (160 MBd SC/ST Analog Transmitter and Receiver)**

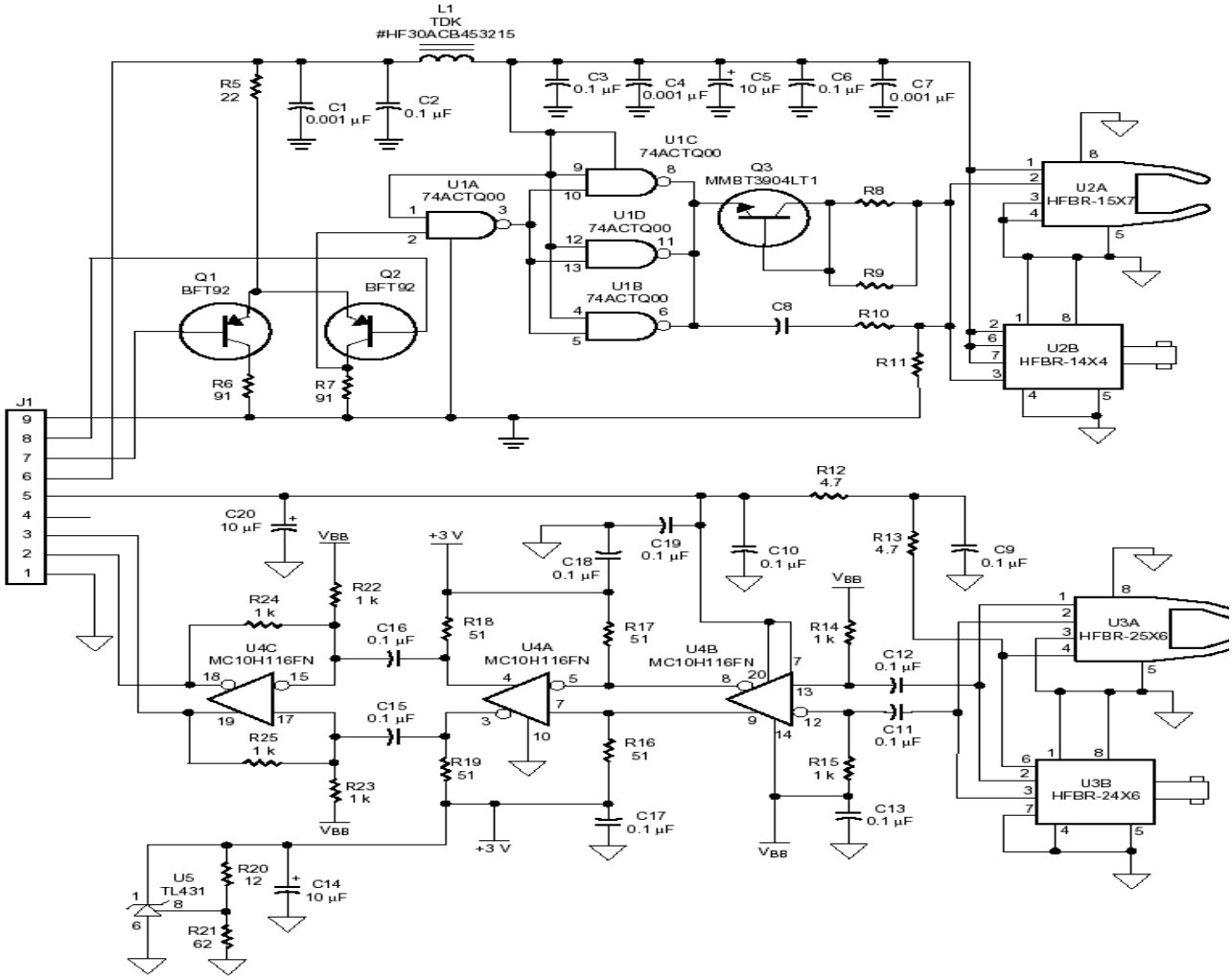

Figure 2. Cost-Effective 160 MBd Fiber Optic Transceiver.

www.agilent.com/semiconductors

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

For technical assistance call:

Americas/Canada: +1 (800) 235-0312 or (916) 788-6763

Europe: +49 (0) 6441 92460

China: 10800 650 0017

Hong Kong: (65) 6756 2394

India, Australia, New Zealand: (65) 6755 1939

Japan: (+81 3) 3335-8152(Domestic/International), or 0120-61-1280(Domestic Only)

Korea: (65) 6755 1989

Singapore, Malaysia, Vietnam, Thailand, Philippines, Indonesia: (65) 6755 2044

Taiwan: (65) 6755 1843

Data subject to change.

May 21, 2004
5989-1153EN

Agilent Technologies