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Fiber-Optic Modules Augment Wireless Systems

Fiber-optic transmitters and receivers are ideal for many RF applications, including in-building cellular distribution.

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OPTICAL signals are not often considered part of a wireless RF system, but fiber-optic transmitters and receivers can go a long way toward ensuring the success of modern communications systems. Fiber-optic modules from Anacom Systems Corp. (New Brunswick, NJ), for example, are ideal for applications such as distributed antenna networks for in-building cellular coverage as well as for remote antennas connected to cellular and personal-communications-services (PCS) base stations.

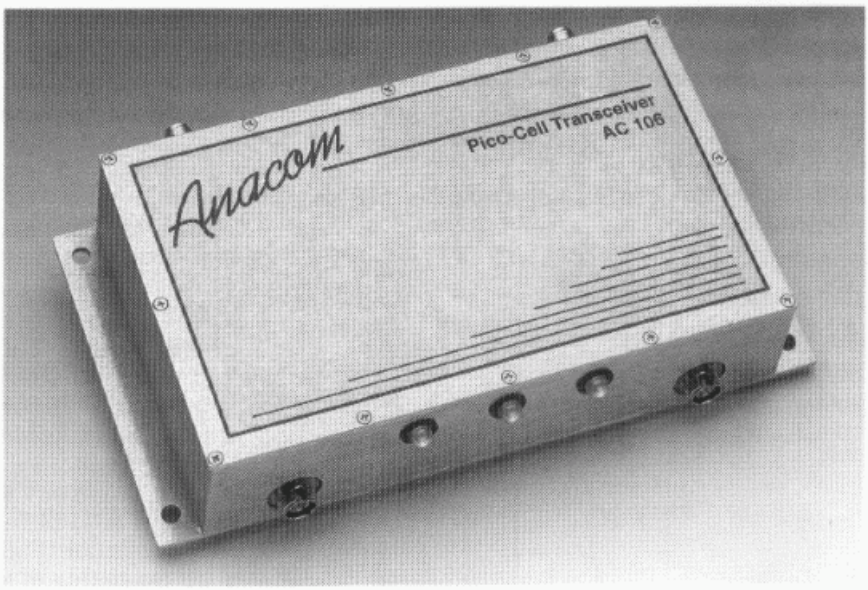
Fiber-optic technology has long been a part of in-building cellular systems since optical fibers can extend for several kilometers with negligible loss at cellular frequencies (800 to 900 MHz) compared to copper coaxial cables. Using advanced fiber-optic laser and photodiode technology, the engineers at Anacom have developed an extensive series of transmitter, receiver, and transceiver modules operating at a wavelength of 1300 nm. The modules work with standard 9/125-μm single-mode fiber-optic cables to provide high-performance optical links capable of RF bandwidths as wide as 2 GHz.

By direct modulation, the fiber-optic transmitter converts an RF input signal into an optical signal at a wavelength of approximately 1300 nm. The optical amplitude is proportional to the RF input voltage. On the other end of the link, the receiver uses a high-speed, high-linearity PIN-diode photodetector to convert the optical signal back to an RF signal. Integral low-noise linear amplifiers are then used to boost the RF signal back to the desired amplitude.

Design engineers who are familiar with RF circuitry need not view fiber-optic technology as foreign. In fact, an RF fiber-optic link can be modeled as a gain stage. With 50-Ω input and output ports, the fiber-optic link has gain (loss), input noise, and intercept point. These three factors are defined at a given optical loss or fiber distance, with the factors changing as the fiber distance between the transmitter and receiver changes.

REVIEWING PRODUCTS

One example of the company's many offerings is the model AC106 fiber-optic picocell transceiver (Fig. 1). Ideal for indoor cellular-telephone distributed antenna applications, the transceiver is based on a 1300-nm low-noise laser operating over 9/125-μm single-mode fiber. It achieves a bandwidth of 1 GHz while generating optical output power of 1 mW. The frequency response across the cellu-



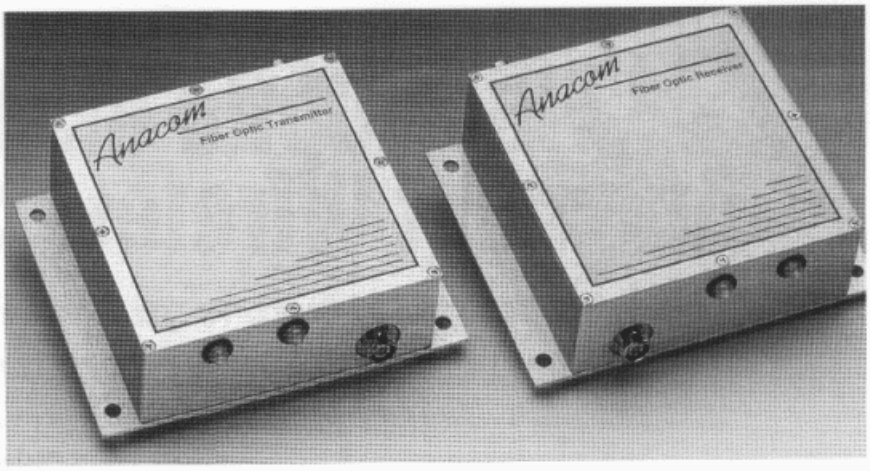
1. Model AC106 is a fiber-optic picocell transceiver that provides 1-GHz bandwidth for indoor cellular-telephone distributed-antenna applications.

lar range from 800 to 1000 MHz is ±1 dB.

The AC106 transceiver incorporates average optical power feedback which monitors and actively adjusts the laser for constant output power over temperature and operating lifetime. The RF interface is via a 50-Ω SMA connector and the optical connector is a low-reflection FC/APC or SC/APC connector. The input/output VSWR is typically 1.60:1 while the link gain is typically 0 dB. The transceiver achieves a minimum spurious-free dynamic range of 60 dB in a 30-kHz noise bandwidth and an output noise floor of typically –130 dBm/Hz. The input third-order intercept point is typically +20 dBm. The transceiver operates with a single +12-VDC supply.

For cellular backhaul applications, the AC122 fiber-optic remote link offers low-noise operation from 100 to 1000 MHz. The link consists of DC-powered (±5 and 15 VDC) transmitter and receiver modules, each measuring only 3 × 5 in. (7.62 × 12.7 cm). The transmitter employs an optically-isolated DFB laser operating at 1300 nm while the receiver uses a low-distortion InGaAs PIN-diode photodetector. The combination forms a link with ±1-dB frequency response from 800 to 1000 MHz and minimum spurious-free dynamic range of 72 dB. The output noise floor is –135 dBm/Hz while the input third-order intercept point is typically +32 dBm. Link gain is typically –6 dB over 10 km of fiber. A nine-pin connector on the receiver module provides access to optical monitor and alarm warning signals.

For higher-frequency applications in PCS systems, the model AC206 transceiver operates over the same wavelength but achieves an operating bandwidth of 2 GHz. The transceiver can also be used for multichannel, multipoint-distribution-system (MMDS) applications. The minimum spurious-free dynamic range is 90 dB/Hz and the input third-order intercept point is typically +20 dBm. The frequency response at PCS frequencies from 1800 to 2000 MHz is ±1 dB. The AC206 transceiver exhibits an RF-link gain of –2 dB and input noise floor of typically –128 dBm/Hz.



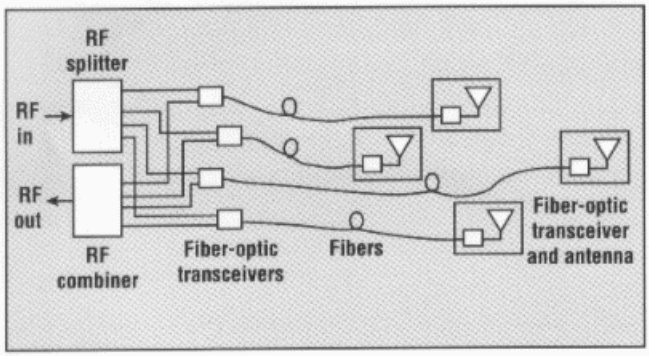
3. Model AC102 IF links include transmitter and receiver modules operating at a wavelength of 1300 nm. The modules provide 500-MHz bandwidth for high-frequency and VHF systems.

REMOTE ANTENNAS

Remote antenna connections, for systems requiring a long link between a base station and an antenna, are another "wireless" application well-suited for fiber-optic technology (Fig. 2). Fiber-optic cables, with low signal losses compared to coaxial cables, are an ideal solution for long links. In addition, fiber-optic links exhibit immunity from electromagnetic interference (EMI) and lightning strikes.

The company's model AC102 fiber-optic link (Fig. 3), consisting of a transmitter and receiver, is ideal for remote antenna connections at intermediate frequencies (IFs) such as 70- and 140-MHz radio IFs. Model AC102 operates over a bandwidth of 5 to 500 MHz with 1-mW optical power at 1300 nm. The frequency response over any 40-MHz bandwidth is ±1 dB while the spurious-free dynamic range is at least 95 dB/Hz. The IF link exhibits an input noise floor of typically –130 dBm/Hz and achieves a third-order intercept point of +25 dBm. The RF-link gain (with 0-dB optical loss) is 0 dB. The transmitter and receiver can be supplied as compact DC-powered (+12-VDC) modules or in 19-in. AC-powered rack-mount chassis.

Many of the company's fiber-optic systems are also available in 19-in. rack-mount enclosures operating from standard AC lines. The firm offers a variety of fiber-optic accessories, such as connector adapters, couplers, and power splitters, that can simplify installation of its transmitting and receiving systems. In addition, the company manufactures a handheld, battery-powered optical power meter that is ideal for on-site measurements. The instrument includes a digital readout that indicates optical power in dBm. The optical power meter can be supplied with either FC or SC connectors. **Anacom Systems Corp., 100 Jersey Ave., Bldg. D, New Brunswick, NJ 08901; (908) 846-2680, FAX: (908) 846-2626.**



2. A typical antenna remoting application often involves in-building distribution of cellular networks.