Low-cost fiber-optic link handles 20-megabit/s data rates

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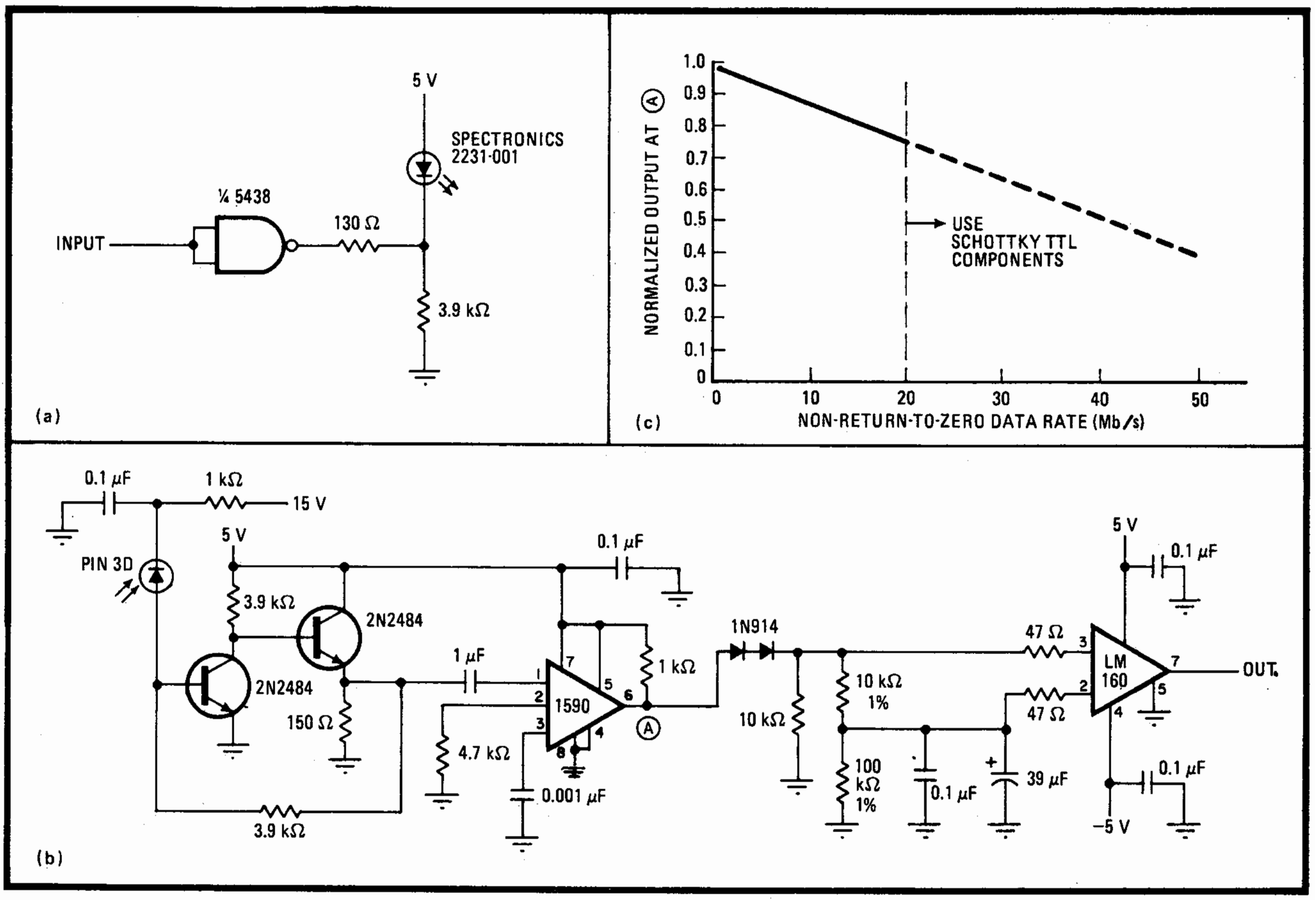
Providing an inexpensive link for the transmission and detection of digital signals over short distances, this fiber-optic system handles data rates in excess of 20 megabits per second. The system, which can be built for about $90, including cable, processes all types of data—a continuous-wave clock waveform, a burst of N clock cycles, handshaking signals, or a non-return-to-zero (NRZ) stream.

A TTL driver and a light-emitting diode serve well as the transmitter, shown in (a). The 5438 TTL driver is a two-input, open-collector NAND gate selected for its low power dissipation and 48-milliampere current-sinking capability. The LED is a gallium-arsenide device operating at 910 nanometers and provides 2 milliwatts of optical power at a forward current of 100 milliamperes. The 130-ohm resistor sets the current through the LED at about 30 mA, and so the output power is about 0.6 mW in this circuit.

The receiver (b) is also simple and sensitive. The output from the p-i-n photodiode (labeled the PIN 3D device) is several microamperes. This current is converted into a voltage by a two-transistor transimpedance amplifier. The 2N2484 transistors selected give low input capacitance, an adequate gain-bandwidth product, and the ability to detect small currents. Amplifier output is about 25 millivolts.

The MC1590 video amplifier that follows greatly boosts signal levels over a wide band (c). Two 1N914 diodes drop the output offset voltage of the single-ended amplifier, nominally at 4 volts, to within the input range of the LM160 comparater. The comparator's threshold is set by a simple voltage divider. The capacitors, across pin 2 and ground, combined with the 100-kilohm resistor, form a low-pass filter providing a threshold that varies with the comparator's supply voltage.

As for the electro-optical interface, the LED, which is contained in a TO-46 package, is easily mounted in an inexpensive window bushing made by AMP, model 530563-1. The PIN 3D photodiode can be mounted in



Light bits. Simple data transmitter (a) and a receiver (b) form the nucleus of a fiber-optic transmission system that is capable of handling all types of digital waveforms. Link operates over a wide band of frequencies (c). Cost of the 10-meter-long unit, including cable, is under $90.

the same type of connector if desired. The need for delicate mounting adjustments is avoided here by using a fiber bundle of sufficient diameter, in this case 45 mils. Galite 2000 cable is satisfactory, and Valtec, Rank Industries, and others produce similar bundles.

The Galite cable has 210 fiber elements having an attenuation of 450 decibels per kilometer at 910 nm and a bandwidth-distance product of 15 megahertz/km. For a 10-meter-long link, therefore, the cable loss will be 4.5 dB and the bandwidth will be 1 gigahertz. With the measured loss of 1.5 dB in the LED-to-cable interface and a cable/detector interface loss of 3.9 dB, the total loss amounts to 10 dB. Thus, the 0.6-mW output of the LED is reduced to 0.06 mW at the receiver.

Transmitter layout is not critical in a one-way link. Duplex operation will require electrical isolation between transmitter and receiver components. There are several precautions to take in constructing the receiver. Notably, the lead from the anode of the detector diode to the transimpedance amp must be kept as short as possible. The output of the receiver should be isolated from all previous stages to prevent unwanted pickup. A ground plane is not a necessity, but is recommended for processing data rates greater than 10 megabits/s.

The link's signal-to-noise ratio is slightly less than 40 dB, implying a bit-error rate above 10^{-8}. The system is operational over a temperature range of −40°C to 100°C, and a supply variation of 4.5 V to 5.5 V. □