design ideas

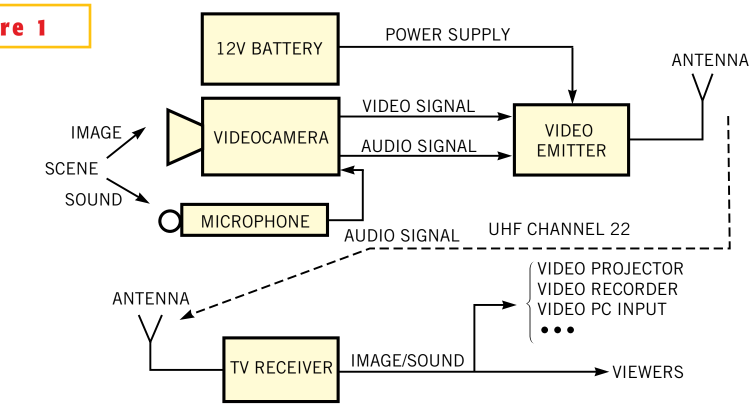
Edited by Bill Travis and Anne Watson Swager

Video emitter uses battery power

JM Terrade, Clermont-Ferrand, France

The block diagram in **Figure 1** shows how to make a cable-free, direct-video system. The system allows users to walk from booth to booth at an exhibition to interview people and to display the interviews in real time on three screens at key locations. You can use the small and simple system each time you need to capture image and sound on the run. **Figure 2** (pg 96) shows a detailed schematic diagram of the video system. The system provides no stereo audio but rather mixes together right and left sources. IC_{2A} acts as an inverter/adder. At Point C, the ac signal represents the sum of the left and right channels: $V_C = -R_1(V_A/R_2 + V_B/R_3)$. With the same value for the three resistors, $V_C = (V_A + V_B)$. C_8 and C_9 block any dc voltage at points A and B. IC_{2A} works from a single 12V supply but needs a continuous bias voltage to provide a positive and negative swing around 6V. R_4 and R_5 create a 6V bias source for both IC_{2A} and IC_{2B}. IC_{2B} acts as an inverting voltage amplifier with a gain of P_1/R_8. With the values shown, you can adjust the gain as high as 4.7. You can adjust P_1 for audio gain as high as 13 dB. C_{10} blocks the 6V dc at Point D, so only the ac audio voltage is present at the audio input of IC_4. The LM358N works well from a single supply, but when the output voltage is close to 0V, it needs some help to avoid signal distortion. Pulldown resistors R_6 and R_7 minimize the distortion.

Figure 1



A wireless, battery-powered video system uses UHF Channel 22 to transmit signals to video receivers.

IC_4 is a video-emitter IC from Aurel (www.aurel.it) that works in the UHF band at 479.5 MHz (UHF Channel 22). Its output power is 2 mW to a 75Ω antenna, A_2. Typical supply current is 90 mA. The signal from the videocamera connects directly to IC_4's input. If you need more power, you can add IC_3, also from Aurel. This IC works in the same frequency band as IC_4 and boosts power to 19 dBm in the 75Ω antenna. Both IC_3 and IC_4 are available in small, single-in-line packages. A Switching Level signal from Pin 8 of the SCART video connector is present when the videocamera is on. The current consumption of IC_3 and IC_4 is 90 (5V) and 100 mA (12V), respectively. To reduce power consumption, a dual-contact relay, K_1, connects IC_3 and IC_4 to the supplies only when the camera is on. When the videocamera is off or disconnected, the supply current decreases to only a few milliamperes.

IC_5 and C_4 through C_7 provide a 5V supply to IC_4. IC_1 and C_1 through C_3 provide a stable 12V supply to IC_3 and the LM358. You can connect a 12V battery directly to J_1. IC_3's data sheet specifies a supply level of 11.4 to 12.6V, but tests show that the IC works properly if the supply is higher than 11V. The total 200-mA current consumption yields approximately three-hour battery life with 12 AA cells. If you use a switching power supply, you would obtain longer battery life, but you need to take filtering measures to avoid interference with the video path. If an ac outlet is available, you could use an 18V, 300-mA wall adapter to replace the battery.

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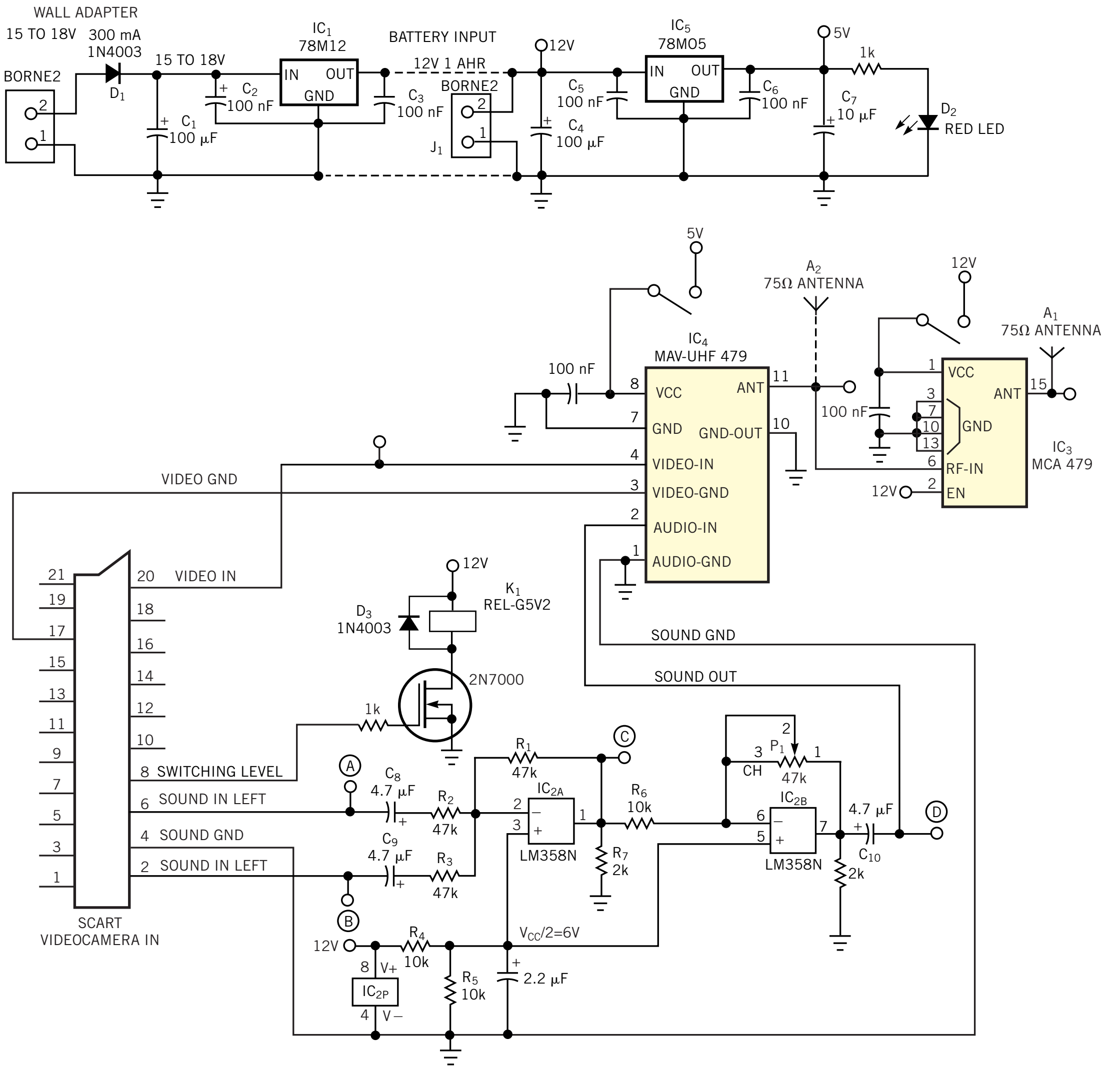
Figure 2

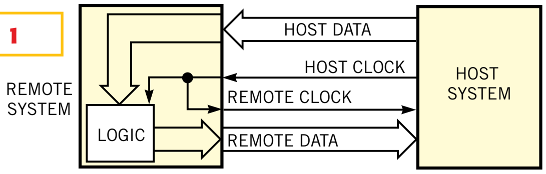


In this video transmitter, 12 AA cells provide approximately three hours of operation.

Circuit avoids metastability

Jonathan Eckrich, Adaptivation, Sioux Falls, SD

Figure 1



At or near 360 or 180° phase difference between the two clocks, this remote-I/O system is subject to metastability.

CONSIDER A COMPUTER system that has a host processor connected to a remote-I/O subsystem (**Figure 1**). The host clock treats the I/O system, which is located far from the main hardware, as a slave. Because of the transmitters, receivers, remote-system logic, and cable length, the data the host receives has a dramatic latency. This latency can be larger than the clock period. If the length of the cable is indeterminate, then the latency is also indeterminate. The problem with such latency is that receiving registers in the host system might clock in the data from the remote system while some bits are changing. The result is that some data may be corrupt, or, worse, the input registers may go into a metastable state. The circuit in **Figure 2** prevents clocking bad or changing data. It does so using only general-purpose, "jellybean" logic. The key is to remote-clock back to host. This action allows XOR gate IC_{1A} to compare the phase difference between the host clock and the delayed clock.

When the two clocks are nearly in phase, the duty cycle of IC$_{1A}$'s output is close to 0%. When the two clocks are close to 180° out of phase, the duty cycle approaches 100%. Whatever the duty cycle is, it is constant during normal operation. The only way it can change is for the cable length between the two systems to change. R$_1$ and C$_1$ form a lowpass filter. Set R$_3$ equal to R$_4$ so that the reference voltage is at midpoint. IC$_2$ and IC$_{1B}$ then select whether to clock register IC$_3$ on the rising or falling edge of the host clock. IC$_4$ ensures that the data changes consistently with the rest of the host system. **Figure 3** shows a (delayed) remote clock that is nearly 360° out of phase with the host clock. If the host were to clock in the data on the rising edge of its clock, metastability would become a concern. You can simply clock in the data on the falling edge of the host clock, but this solution yields the same problem if you choose a new cable with a different length.

Without any analytical effort on the designer's part, the circuit in **Figure 2** automatically selects which clock edge to use. Note that comparator IC$_2$ can be a low-speed part, because it operates at dc only. Note also that if the two clocks are 360±90° out of phase, the circuit uses the falling edge of the clock. If they are 180±90° out of phase, the circuit uses the rising edge. If the R$_1$C$_1$ time constant is too low, the resulting ripple can cause the output of the comparator to be unstable. You could use a comparator with hysteresis to reject the ripple. Some instability of the comparator's output is acceptable, because you can safely use either the rising or the falling edge for most latencies. You need stability only when the clock is near 360 and 180° out of phase, so you have little to lose by using a large R$_1$C$_1$ time constant to present a dc voltage to the comparator's input.

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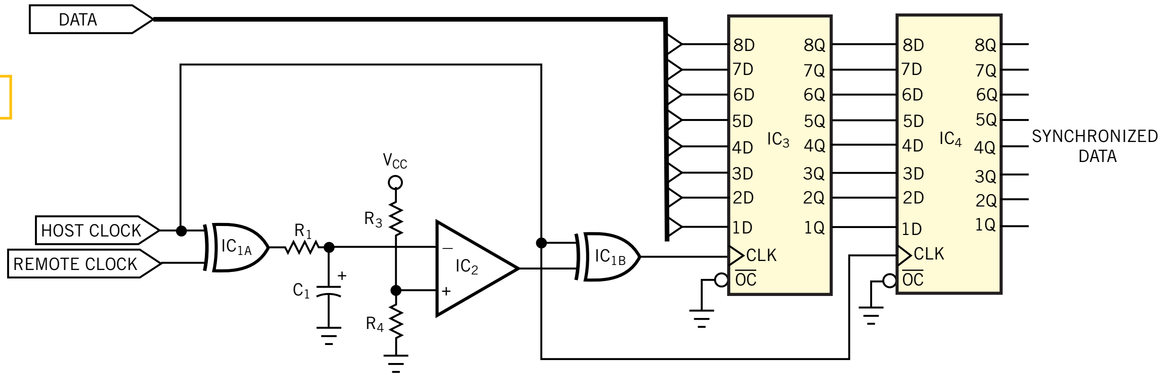
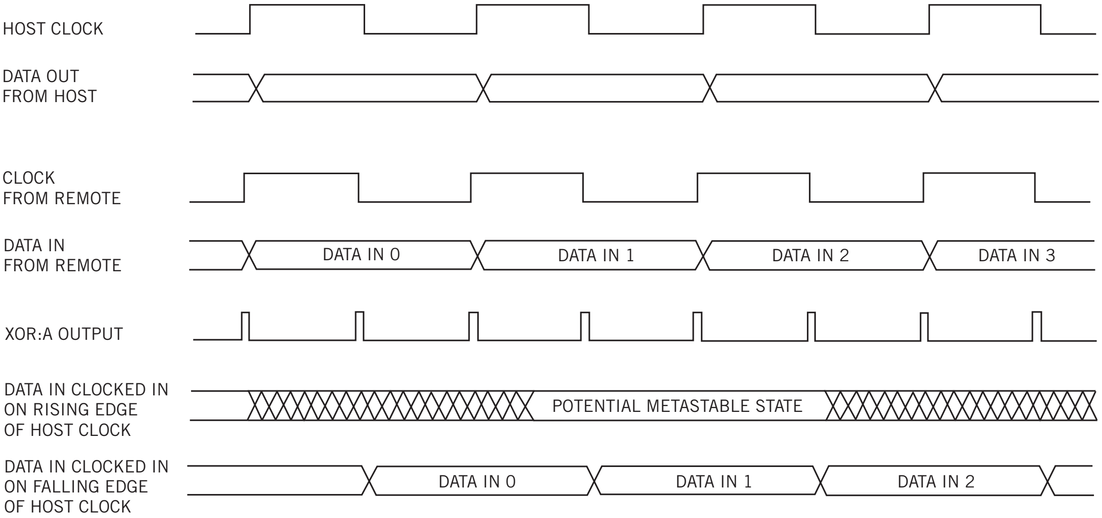
Figure 2



This circuit automatically chooses between the rising and the falling edge on the host clock for clocking in data.

Figure 3



Clocking data on the wrong edge can result in metastability; the circuit in Figure 2 selects the right edge.

Microphone uses “phantom power”

Bruce Trump, Texas Instruments, Tucson, AZ

The electret microphone capsule is similar to those commonly used in telephones, cassette recorders, and computers. The element functions as a capacitor with a fixed trapped charge. Sound pressure moves a diaphragm, producing variations in the capacitance. This action produces an ac-output voltage with an extremely high source impedance. A FET inside the capsule uses an external-resistor drain load (**Figure 1**). R_1 and R_2 provide an appropriate load impedance and voltage from the 10V supply. The basic performance of this simple capsule is excellent, but it requires further signal processing to conform to professional phantom-powered-microphone standards.

The output of a phantom-powered microphone is a low-impedance differential signal. IC_1 is a simple voltage buffer that provides low-impedance drive for one output. IC_2 is a unity-gain inverter that derives its drive from the output of IC_1. Bias for the noninverting input of IC_2 comes from a heavily filtered output of IC_1. We selected the dual op-amp IC_1/IC_2 for its low noise and low distortion properties. R_6 and R_7 provide immunity from long-line capacitance, RF interference, and transients that occur when you “hot-plug” the microphone into a live phantom-power source. The amplifier outputs use ac coupling, C_2 and C_3, to the microphone’s output terminals to block the dc phantom-power voltage on the audio lines. Differential-output voltage capability is limited to approximately 2V p-p because of the limited power supply available to drive the op-amp output currents. This level is adequate, because it corresponds to an extraordinary sound level beyond the linear range of the capsule.

Phantom-powered microphones derive power for their active circuitry from the receiving-end circuit through the same leads that transmit the audio signal. The 48V phantom-power supply couples through two 6.8-kΩ resistors, R_{10} and R_{11}, to both signal lines. This coupling allows the microphone’s low output impedance to drive a differential ac signal on the relatively “soft” impedance of the phantom supply voltage. In the microphone, power comes from the signal lines through resistors R_8 and R_9. Zener diode D_1 regulates the voltage. These resistors also provide a soft impedance on the balanced line, allowing the outputs of IC_1 and IC_2 to inject their differential ac-output signal. You can locate the microphone hundreds of feet from the receiving-end phantom power and amplifier and still obtain excellent performance.

The receiving-end amplifier, IC_3, is a low-noise instrumentation amplifier with three internal op amps. Its configuration and laser-trimmed resistors provide excellent CMR (common-mode-rejection) properties. The high CMR rejects noise and power-line hum that appear equally in both signal lines. Low noise (1 nV/$\sqrt{\text{Hz}}$), though unnecessary for high-output microphones such as those described here, is necessary in professional-audio equipment to accommodate the use of low-output ribbon and dynamic microphones. These microphone types are strictly passive electromechanical generators and do not require a power source. Phantom power earns its name from the fact that these microphone types “float” at 48V without harm. The electret capsules are available in various sizes and physical configurations. They include both omnidirectional and directional (cardioid) types. Directional capsules have a vent in the rear; you must mount them with free access to both the front and the back to obtain proper characteristics.

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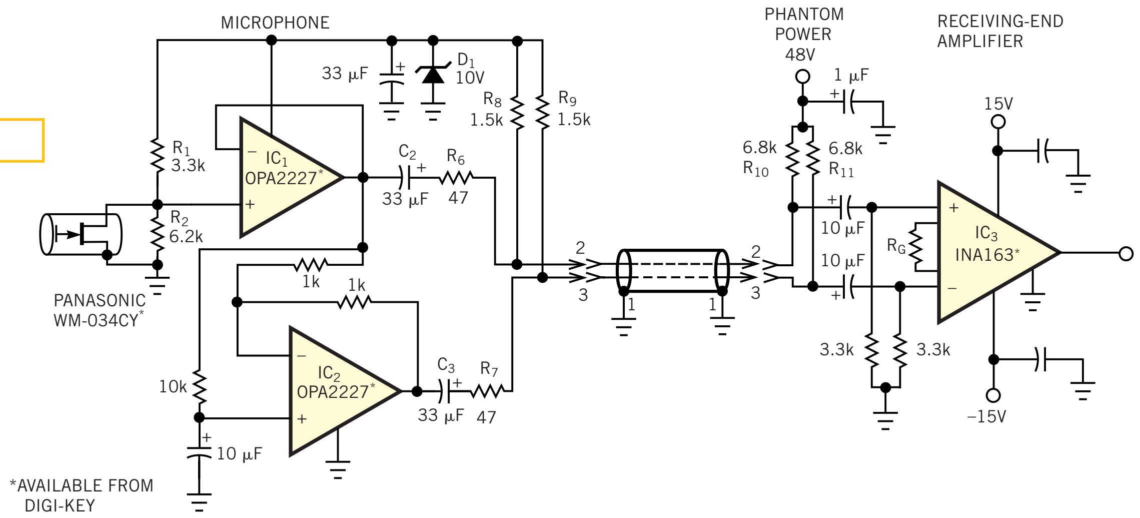
Figure 1



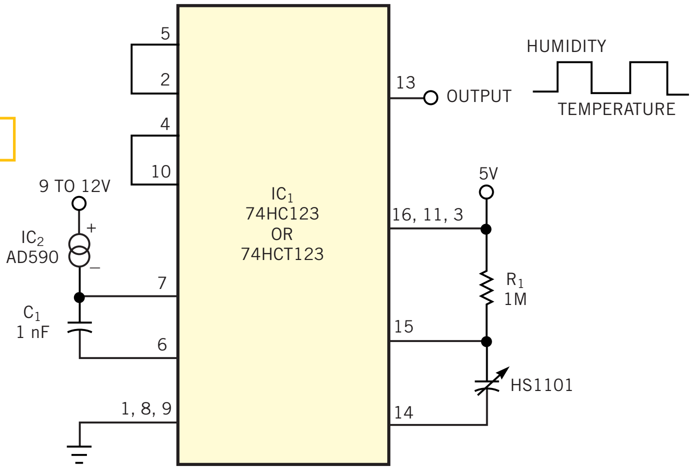
This microphone system derives its power from the receiving-end circuitry through the leads that carry the audio signal.

Measure humidity and temperature on one TTL line

Shyam Tiwari, Sensors Technology Pvt Ltd, Gwalior, India

By combining the responses of an Analog Devices (www.analog.com) AD590 temperature sensor and a Humirel (www.humirel.com) HS1101 humidity sensor, you can generate a single TTL-level signal containing information from both sensors (**Figure 1**). This design uses a 74HC123 monostable multivibrator, IC_1, to form a free-running oscillator. The AD590 current source (1 μA/K), IC_2, and a fixed 1-nF capacitor, C_1, control the timing of the first monostable multivibrator in the 74HC123. Another monostable multivibrator uses a fixed 1-MΩ resistor along with the capacitive output of the HS1101 (172 pF at 0% relative humidity and 222 pF at 100% relative humidity) for its timing. Combining the two monostable multivibrators creates a free-running oscillator that produces a single-line signal from both sensors. The high- and low-level pulse widths carry the information related to the sensor signals. The AD590 circuit displays pulse-width reduction with rising temperature, because of its increased output current with higher temperatures. The HS1101 circuit displays increased pulse width with rises in humidity levels. The circuit in **Figure 1** represents a simple method of transmitting signals from analog sensors by digital rather than analog means. The technique eliminates noise in signal transmission over long distances. You could add an optoisolator in the output path if you need, say, 1500V isolation.

Figure 1



A monostable-multivibrator IC provides temperature and humidity information in one TTL signal.

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Low-cost anemometer fights dust

Jim Christensen, Maxim Integrated Products, Sunnyvale, CA

As higher levels of power dissipation underscore the need for cooling, more and more fans are finding their way into small electronic enclosures. The dust that fans pull into these enclosures can, however, cause major problems for high-reliability systems. By coating heat sinks and electrically charged components, the dust acts as a blanket that raises the effective thermal impedance between the components and the air. A simple way to combat this problem is to place a disposable filter on the air intake. If you fail to replace the filter on a regular basis, however, it can become clogged and act as an air dam, a condition that is worse than the original problem. Trying to sense a clogged filter by sensing the fan's rotation with tachometer signals is useless, because fan rotation is not directly related to airflow. You can detect poor filter maintenance by determining the actual airflow with a "hot-wire" anemometer, but most electronic anemometers are costly and bulky. As an alternative, you can create an SMBus/I²C anemometer using an I/O expander, a few inexpensive switches, and a low-cost remote-temperature sensor (**Figure 1**).

TABLE 1—FAN VOLTAGE VERSUS COOLING TIME

Fan voltage (V)	Cooling time (sec)
12	30
8	47
6	60
0 (no fan)	84

Use the SMBus I/O expander, IC_4, to turn off MOSFETs Q_1 and Q_2 and to turn on the analog switches IC_2 and IC_3. Measure the ambient air temperature with no preheating of Q_3. Then, to apply current for heating Q_3, turn off IC_2 and IC_3 and turn on Q_1 and Q_2. Allow an approximate five-minute "soak" to reach temperature equilibrium. (The exact heating time necessary for equilibrium depends on the setup; you must determine it by experiment.) At equilibrium, remove power from Q_3 by turning off Q_1 and Q_2, and turn on analog switches IC_2 and IC_3 to make temperature measurements. Airflow directly relates to the rate at which the temperature drops; you can determine it by noting the time required for the transistor to return to within 1° of its original temperature. The temperature sensor injects a small current into the base junction, so careful layout is important to keep noise off the DXP and DXN lines.

If you mount the remote transistor in an air channel, the use of twisted-pair wire allows distances to 12 ft. **Table 1** shows fan voltage (airflow) versus cooling time for a sensor placed approximately 12 in. away from a fan running at full speed (12V), medium speed (8V), low speed (6V), and zero speed. Soak times as long as 30 minutes do not significantly alter the times. The circuit draws approximately 200 mA when Q_3 is heating. If this power dissipation poses a problem, you can lower the measurement frequency to hourly or even daily cycles, because changes in airflow occur slowly over time. You can also schedule the measurements during times of low system activity, when overall power use is low.

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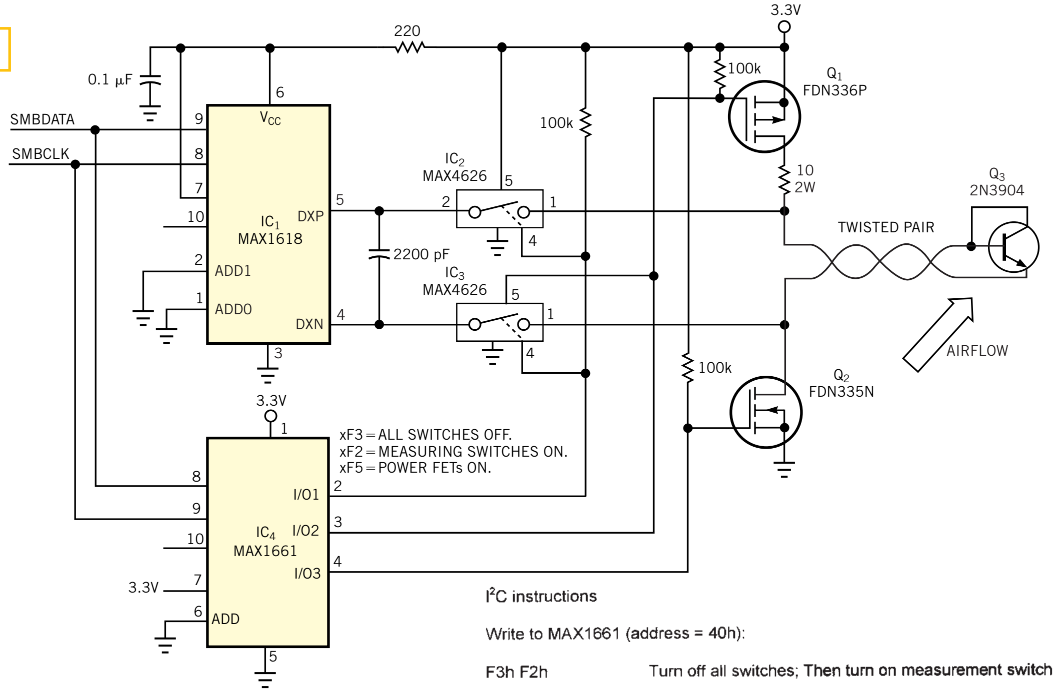
Figure 1



I²C instructions

Write to MAX1661 (address = 40h):

F3h F2h	Turn off all switches; Then turn on measurement switches

Write to MAX1618 (address = 30h):

09h 48h	Write Configure; One shot mode
0Fh	Write one shot command
W 01 R ??h	Read ambient temperature

Write to MAX1661

F3h F5h	Turn off all switches. Then turn on power FETs

Soak for 5 minutes

Write to MAX1661

F3h F2h	Turn off all switches; Then turn on measurement switches

Write to MAX1618

0Fh	Write one shot command
W 01 R ??h	Read temperature

Loop on last two statements and count the time it takes for the temperature to drop to the initial ambient temperature +1°

This anemometer measures airflow by heating Q_3 and then noting the time for Q_3 to return to its original temperature.