Circle 520

A Network Of RS-485 Smart Temperature Sensors

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The system described here implements a smart temperature-sensor network. In this particular application, each of the intelligent network nodes is equipped with two temperature sensors.

The network consists of a two-wire twisted-pair cable and multiple RS-485 transceivers *(Fig. 1)*. With this infrastructure, it's possible to communicate reliably using line lengths up to 4000 feet (1.2 km) without repeaters over a network containing more than 100 nodes. This design has been successfully implemented for 18 nodes (36 temperature sensors).

By using this architecture, the system can monitor the temperature of up to 36 points of a building to efficiently regulate the heating system. The system also can acquire and store the temperature profile of different points, allowing the temperature variations to be analyzed.

A standard PC acts as the network master and the temperature-sensor boards act as slaves. To interface the PC's RS-232 serial port to the RS-485 network, a simple converter has been designed *(Fig. 2)*. The speed and word length chosen in this development are 9600,N,8,1. Selection of higher speeds would reduce the transmission distances.

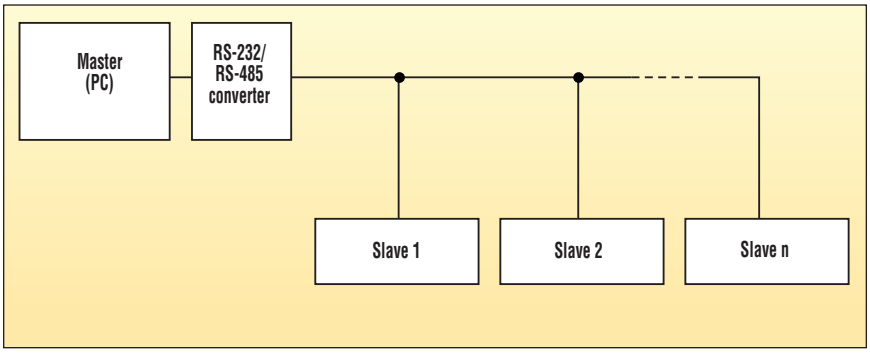
The block diagram of the temperature-sensor cards is shown in Figure 3. The complete schematic of the PIC12C508-based temperature-sensor card is shown in Figure 4.

After power-on or reset, the PIC12C508 checks the board ID number and starts checking the messages circulating along the network. If any messages have the matching board address (ID), the microcontroller executes the command and sends an answer. The format of the messages exchanged between master and the slaves is shown in Figure 5.

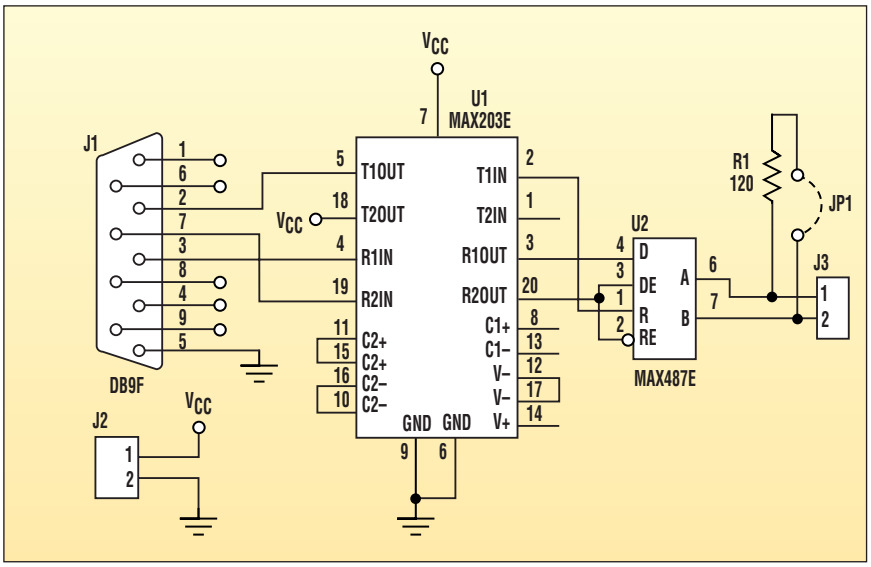
If the processor detects a system or hardware error (i.e., no MAX1617 connected, a checksum error, or an end-of-frame byte error), the error indicator LED (D1) is turned on until a correct message is received.

When the temperature of the sensors is out of range, an LED (D2) is switched on. The temperature warning limits are programmable.

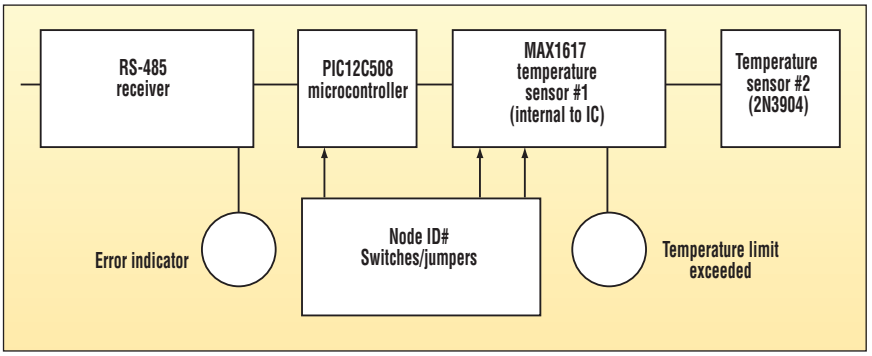
The address is selected with the



1. The RS-485 network structure consists of a two-wire cable and multiple RS-485 transceivers. This arrangement allows reliable communications at line length up to 4000 ft.



2. This simple converter was designed so that the PC's RS-232 serial port can interface with the RS-485 network. Data is transmitted across the network at 9600 baud.



3. Shown is the block diagram of the intelligent temperature-sensor board.

three on-board jumpers that change the state of three pins (ADD0 and ADD1 of MAX1617, and GP5 of PIC12C508 through a 10k resistor). The different states of these pins and the corresponding addresses are shown in Table 1. The different commands that have been implemented are defined in Table 2 *(see page 84)*.

The twisted-pair cable must connect J1 of the RS-232/RS-485 converter to J1 of the temperature-sensor boards—pin 1 with pin 1 and pin 2 with pin 2. The JP1 jumpers on both types of boards have to be closed for the two boards at the end of the network for proper termination.

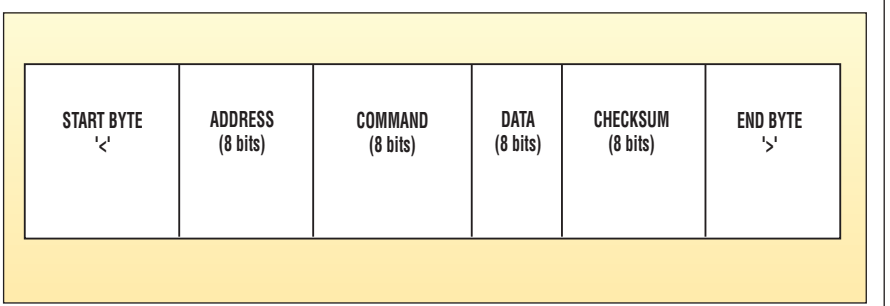
With a few changes, the system can be electrically isolated to provide more noise immunity in industrial applications. For these situations, it's also important to use a shielded cable connected to ground in the converter board, as well as to ground through a series capacitor in the rest of the boards.

With some other changes, it's possible to connect the sensor boards to a modem and have the master PC located many kilometers away.

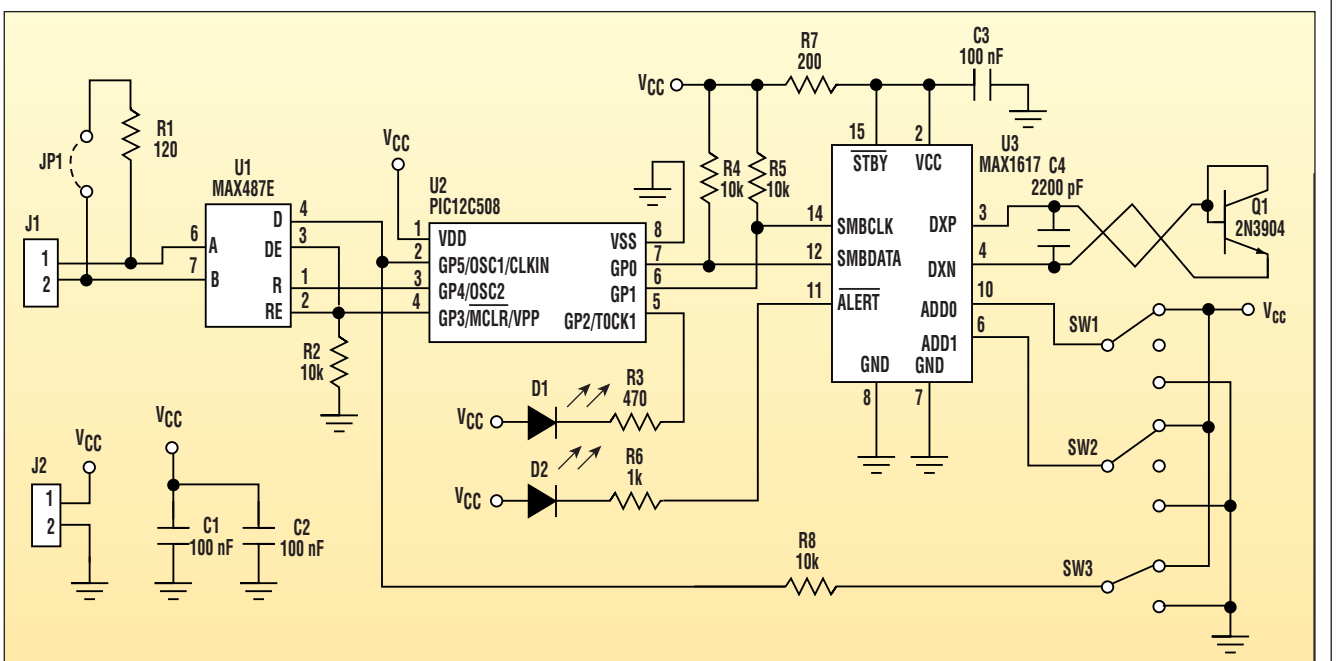
The program listings for the smart temperature-sensor element and the PC master control can be found on the Ideas For Design section of the ELECTRONIC DESIGN web site at: *http://www.elecdesign.com*.

TABLE 1: TEMPERATURE-SENSOR BOARD ADDRESSING

ADDRESS	ADD0	ADD1	GP5
30h	GND	GND	GND
31h	GND	GND	Vcc
32h	GND	High-Z	GND
33h	GND	High-Z	Vcc
34h	GND	Vcc	GND
35h	GND	Vcc	Vcc
52h	High-Z	GND	GND
53h	High-Z	GND	Vcc
54h	High-Z	High-Z	GND
55h	High-Z	High-Z	Vcc
56h	High-Z	Vcc	GND
57h	High-Z	Vcc	Vcc
98h	Vcc	GND	GND
99h	Vcc	GND	Vcc
9Ah	Vcc	High-Z	GND
9Bh	Vcc	High-Z	Vcc
9Ch	Vcc	Vcc	GND
9Dh	Vcc	Vcc	Vcc



5. This illustrates the format of the messages exchanged between the master and slave units.



4. In this intelligent temperature-sensor board, built around an 8-pin Microchip PIC12C508 microcontroller, when the temperature of the sensors is out of range, an LED (D2) switches on. Network communication errors and hardware errors are detected and indicated using LED D1 .

TABLE 2: SYSTEM COMMANDS