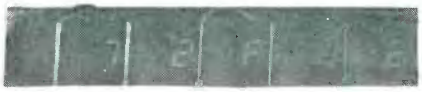
Project

WISARD

A Smart Weather Monitor



(Part 1)

An expandable stand-alone multifunction MCU-based real-world instrument that automatically records temperatures and can predict them as well

By Thomas R. Fox

At first glance, WISARD (an acronym for Weather Instrumentation System for Analysis and Recording of Data) might appear to be a fancy digital device that displays inside and outside temperatures and time of day. Closer inspection, however, reveals that it is much more. For example, it provides minimum and maximum temperature readings for the day. Furthermore, with the help of a computer printer, it produces hard copy of a number of different weather parameters. These include current temperature as well as minimum and maximum temperatures for the day, the time each occurred, and predictions on what the minimum and maximum temperatures will be for the next 24 hours. It also prints out when dawn and dusk occurred and when rain began to fall and when conditions cleared up.

WISARD is a stand-alone system that does not require a separate computer to operate. It has its own on-board computer-on-a-chip to do all the work normally assigned to a separate computer. (*Last month's "Smart" Thermometer had only a fraction of the "intelligence" of this one and required its own separate microcomputer with built-in BASIC interpreter—Editor.*) The project is built around commonly available and inexpensive components. Thus, it costs less to build than most weather-monitoring boards designed to be plugged into a separate computer and that have only a fraction of the flexibility of WISARD.

Features

Among WISARD's distinctive features is its automated record-keeping abilities. With a printer connected to the project, WISARD provides a hard copy of the previous day's weather conditions. It automatically prints out such information as hourly temperature and general hourly weather conditions (rain or no rain), mean and extreme temperatures and the time each occurred.

Every morning at dawn, WISARD prints out a dawn message that includes the exact time at which dawn occurred. Similarly, at dusk, WISARD prints out a dusk message that includes the hours and minutes of daylight and sunshine for that day.

When it rains, WISARD prints out a rain message. Conversely, when dry weather returns, that information is printed out as well.

As mentioned, WISARD is a stand-alone unit. Though it can be plugged into a computer printer to provide hard-copy printouts of messages, you can opt for no printout simply by turning off your printer or unplugging it from the project.

Battery back-up is included in this

Fig. 1. Schematic diagram of CPU module is shown here in six parts, labeled (A) through (F).

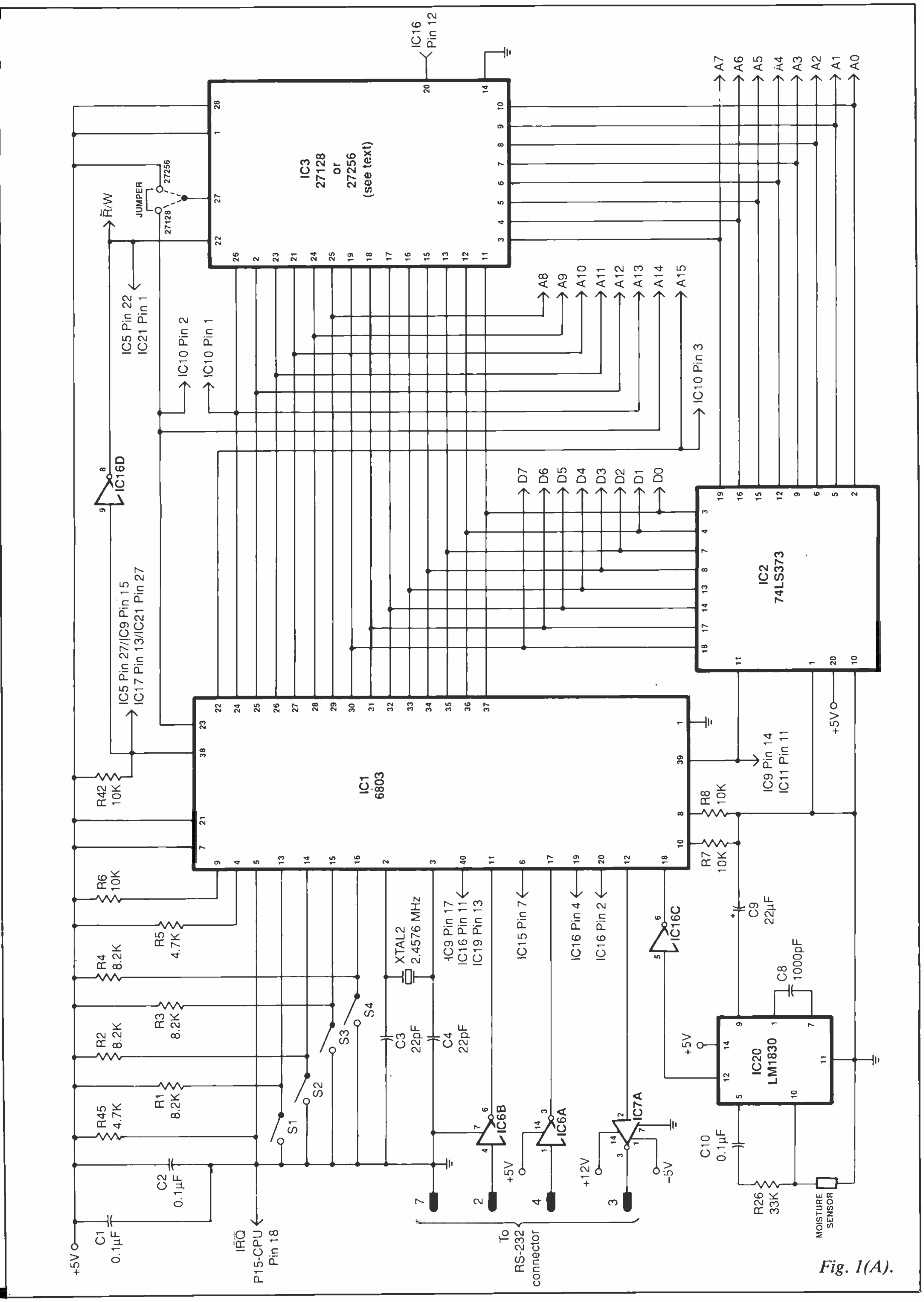

IC1
6803
IC2
74LS373
IC3
27128
or
27256
(see text)
IC20
LM1830
IC16
Pin 12
JUMPER
27128
27256
R/W
A7 A6 A5 A4 A3 A2 A1 A0
A8 A9 A10 A11 A12 A13 A14 A15
D7 D6 D5 D4 D3 D2 D1 D0
IC5 Pin 22
IC21 Pin 1
IC10 Pin 2
IC10 Pin 1
IC10 Pin 3
IC16D
IC5 Pin 27/IC9 Pin 15
IC17 Pin 13/IC21 Pin 27
IC9 Pin 14
IC11 Pin 11
R42
10K
R8
10K
R7
10K
R6
10K
R5
4.7K
R4
8.2K
R3
8.2K
R2
8.2K
R1
8.2K
R45
4.7K
C1
0.1µF
C2
0.1µF
+5V
IRQ
P15-CPU
Pin 18
XTAL2
2.4576 MHz
C3
22pF
C4
22pF
S1
S2
S3
S4
IC9 Pin 17
IC16 Pin 11
IC19 Pin 13
IC15 Pin 7
IC16 Pin 4
IC16 Pin 2
IC16C
IC6B
IC6A
IC7A
+12V
-5V
To
RS-232
connector
C9
22µF
C8
1000pF
C10
0.1µF
R26
33K
MOISTURE
SENSOR

Fig. 1(A).

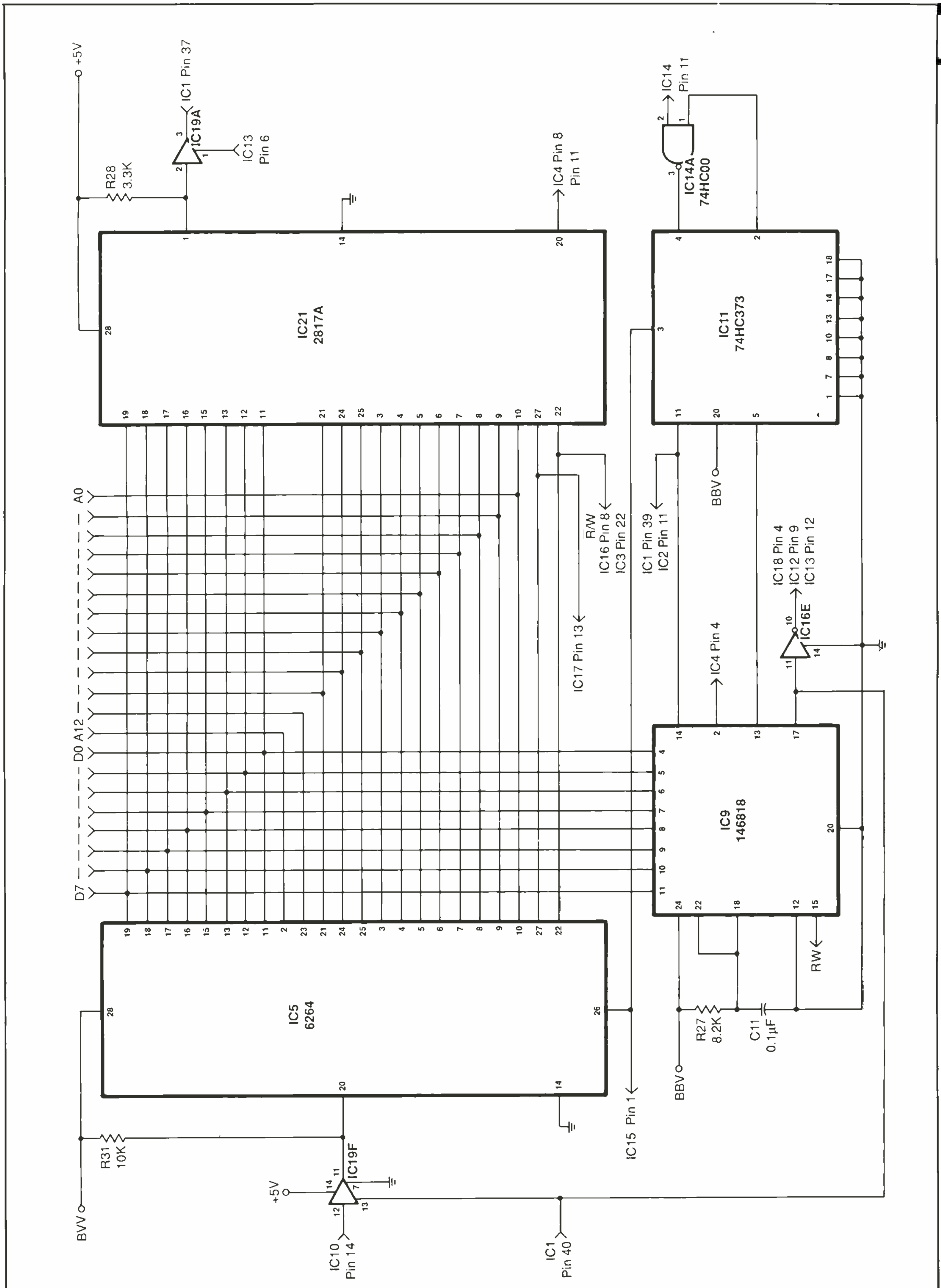
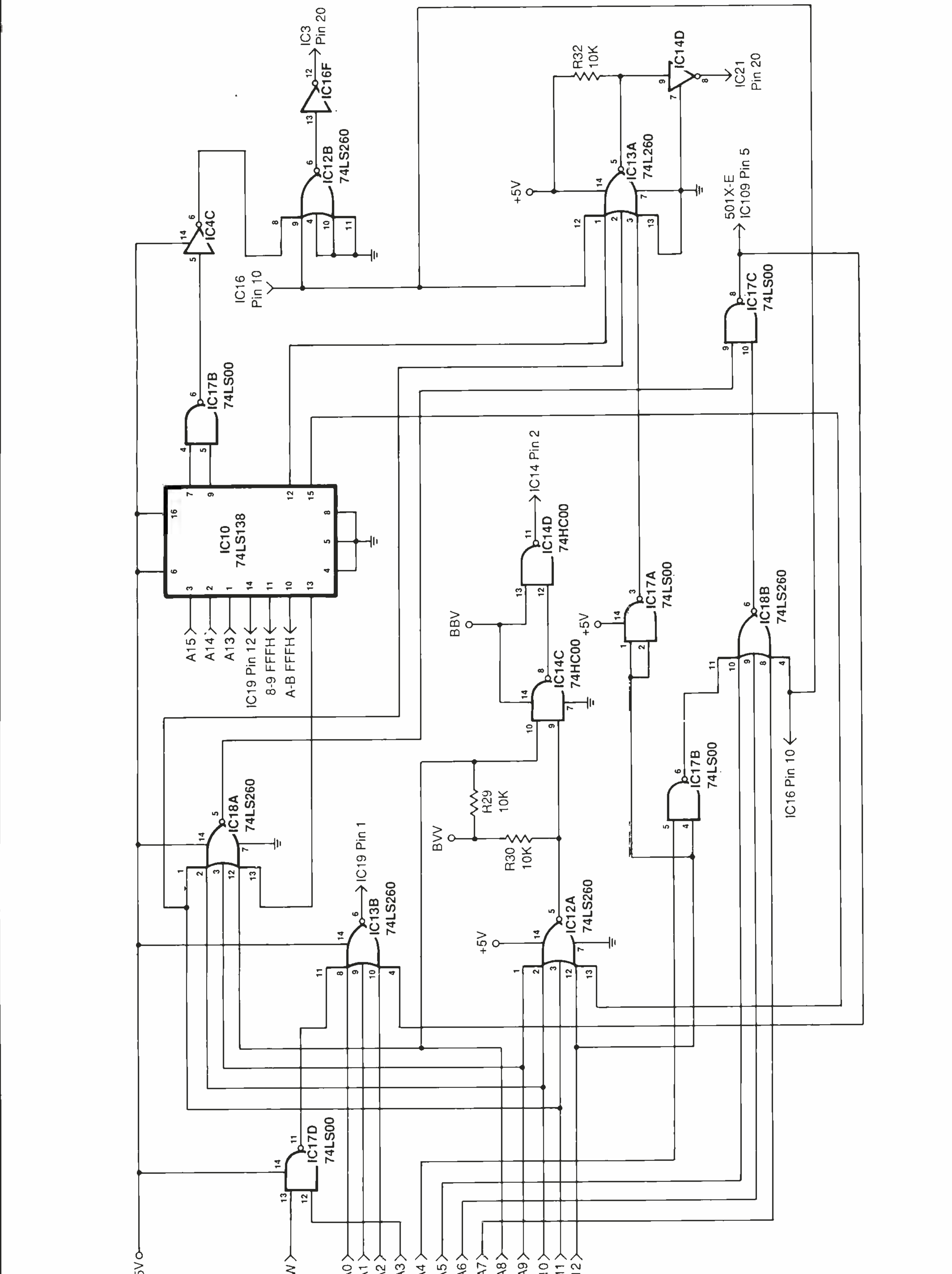

+5V
R28
3.3K
IC19A
IC1 Pin 37
IC13
Pin 6
IC4 Pin 8
Pin 11
IC14
Pin 11
IC14A
74HC00
IC21
2817A
IC11
74HC373
BBV
R/W
IC16 Pin 8
IC3 Pin 22
IC1 Pin 39
IC2 Pin 11
IC17 Pin 13
IC4 Pin 4
IC18 Pin 4
IC12 Pin 9
IC13 Pin 12
IC16E
A0
D0 A12
D7
IC9
146818
IC5
6264
RW
R27
8.2K
C11
0.1μF
BBV
IC15 Pin 1
R31
10K
IC19F
+5V
BVV
IC10
Pin 14
IC1
Pin 40

Fig. 1(B)



IC3 Pin 20
IC16F
IC12B 74LS260
IC4C
IC16 Pin 10
IC17B 74LS00
IC10 74LS138
A15
A14
A13
IC19 Pin 12
8-9 FFFH
A-B FFFH
R32 10K
IC14D
IC21 Pin 20
+5V
IC13A 74L260
501X-E IC109 Pin 5
IC17C 74LS00
IC14 Pin 2
IC14D 74HC00
BBV
IC14C 74HC00
IC17A 74LS00
IC18B 74LS260
IC16 Pin 10
R29 10K
BVV
R30 10K
IC18A 74LS260
IC19 Pin 1
IC13B 74LS260
IC12A 74LS260
IC17B 74LS00
IC17D 74LS00
+5V
R/W
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12

Fig. 1(C).

project to ensure against a 67F reading from becoming a 167F reading as the result of a power flicker.

Other features included in the WISARD project include display of current date, notification of when ac power has been interrupted and the time it was restored, and notification of battery failure.

On the keyboard is a PRINT switch that is used to force a printout of the current day's weather condition information. Temperature is given in either all Fahrenheit or both Fahrenheit and Celsius degrees, controlled by an OPTION switch.

Firmware version ME1 for WISARD (described here) has an abundance of features. Perhaps the most exciting thing about WISARD is its simplified expansion capability and versatility. For instance, while its RS-232 interface was designed with a printer in mind, you can hook up a modem to it to send the information to any modem-equipped telephone anywhere on Earth. You can also connect a terminal or computer (with the aid of a suitable terminal emulator program) to the project to display information on a video display's CRT. WISARD is electronically capable of two-way communication, but its firmware must be modified to accommodate this.

In its most basic form, WISARD has five separate sense inputs: two for indoor and outdoor temperatures and one each for rain, daylight and sunshine. The built-in display consists of six decades of seven-segment LED numeric readouts that can display 17 alphabetic characters and 0 through 9.

Although WISARD is able to "read" 20 keys, firmware version ME1 makes use of only 13 keys. This leaves seven keys for expansion.

The project also uses a 6803 MCU (see box for details on this device's heritage), and its memory consists of up to 38K of EPROM, 10K of non-volatile RAM and 2K of EEPROM. It also has a real-time clock and an

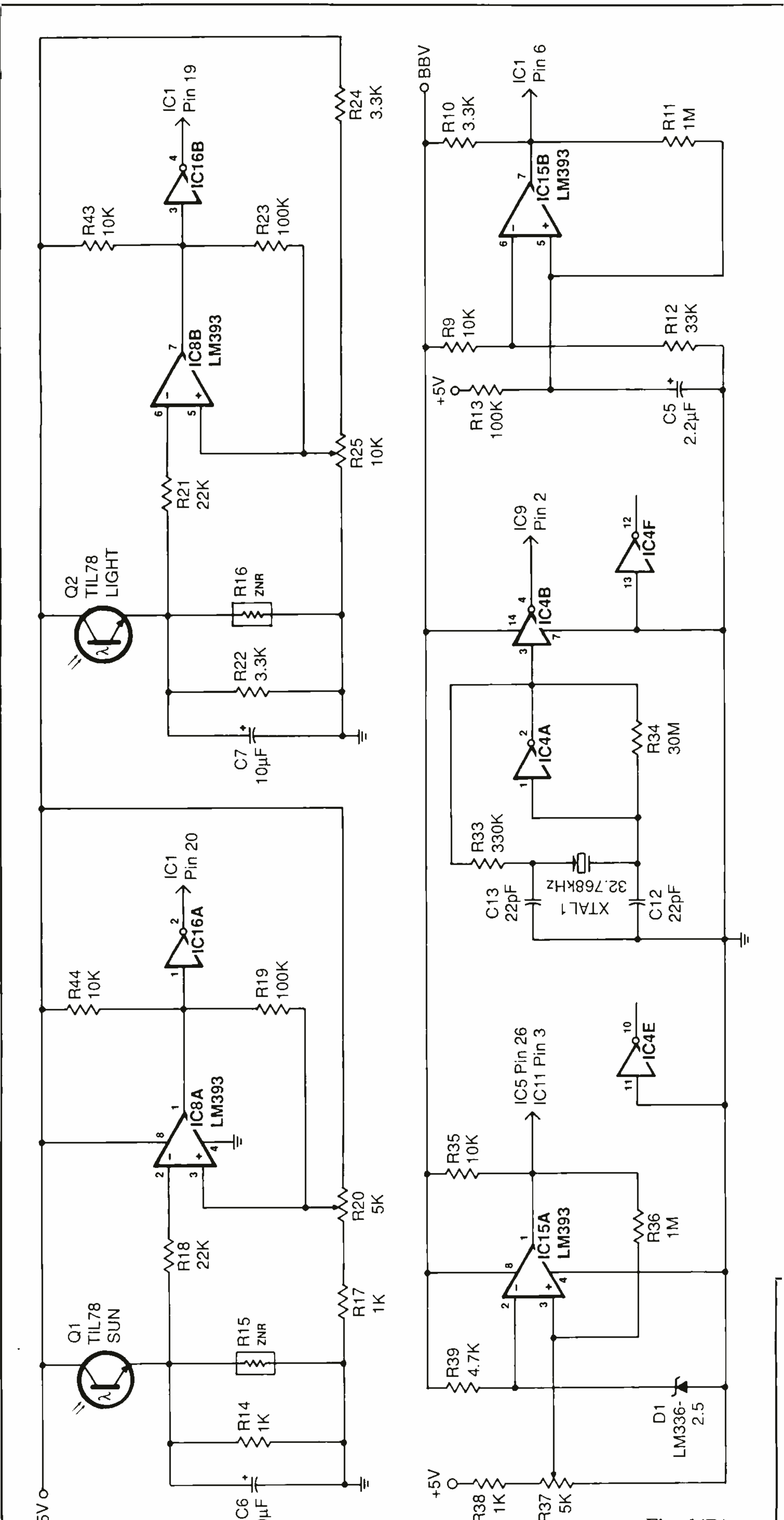


Fig. 1(D).

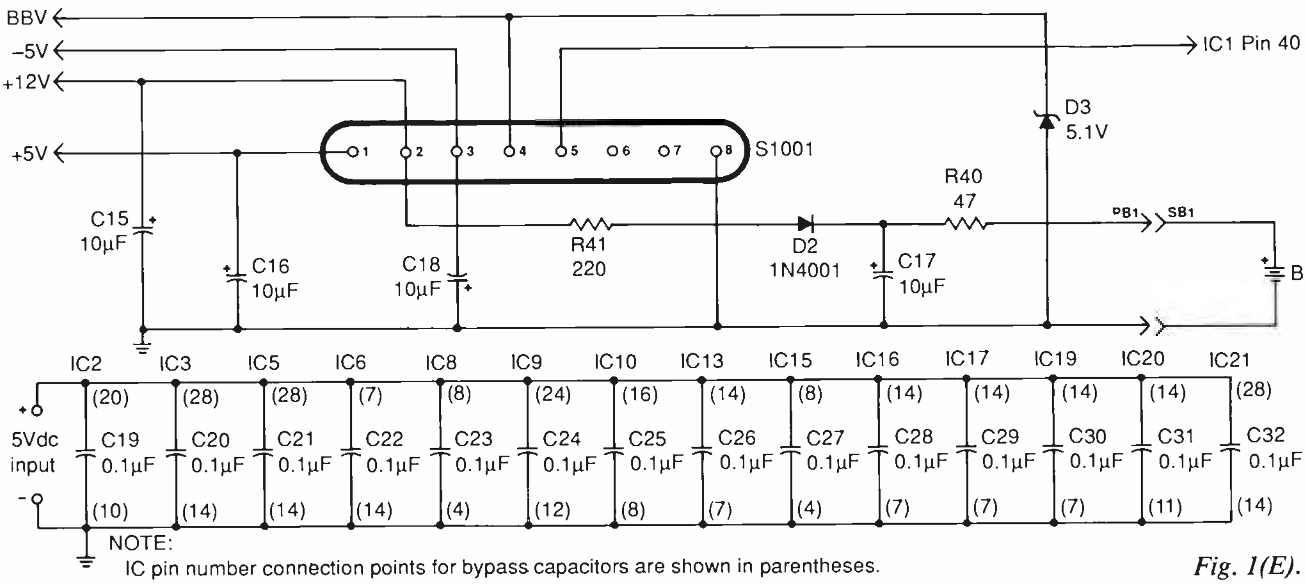


Fig. 1(E).

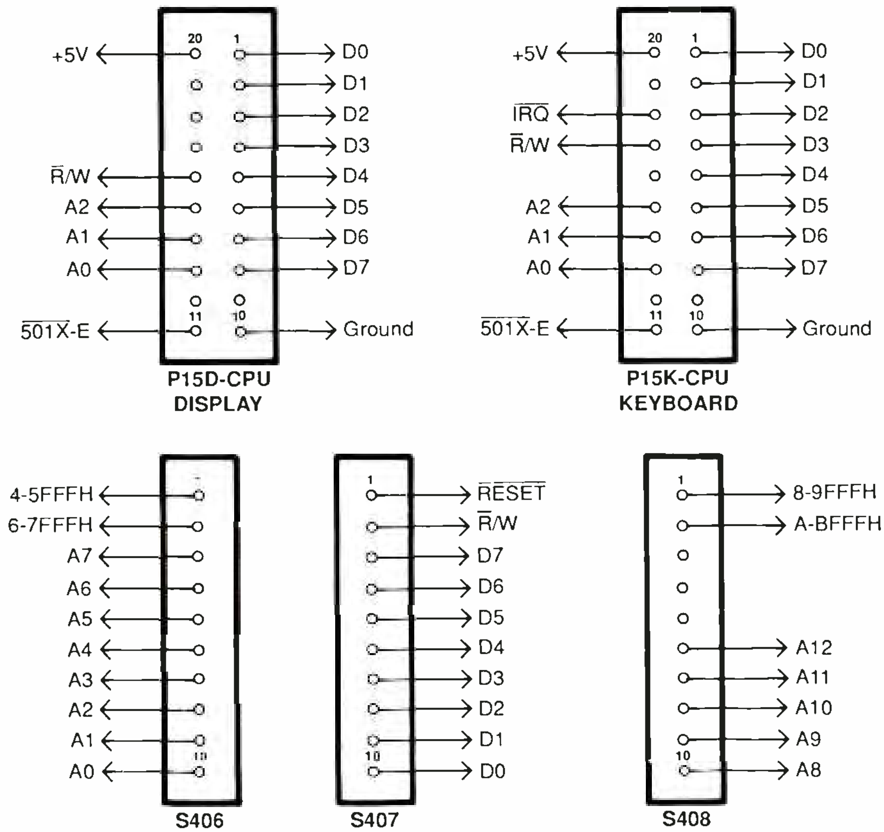


Fig. 1(F).

eight-channel A/D (analog-to-digital) converter. Only two channels of the A/D converter are used in the basic project, which leaves six channels for expansion purposes.

Up to eight high/low logic input lines are available to accommodate two-state input devices, such as micro switches. In addition to the LEDs and RS-232 interface, 16 output lines are available as well. With suitable buffering—using optical isolators and/or relays—these lines can be used to control heaters, cooling systems, lights, solenoid-operated valves, alarms, etc.

About the Circuit

WISARD consists of four circuit-function modules, the primary one of which is the CPU module that can function all by itself. The circuitry for this CPU module is complex, at least in terms of semiconductor-device count. The schematic diagram for this module is quite large and, thus, is presented here in six parts. For the following discussion, therefore, refer to the appropriate (A) through (F) part of Fig. 1.

In this circuit 6803 MCU *IC1* is operated at a clock frequency of 614.4 kHz, which is derived by dividing the 2.4576-MHz frequency of *XTAL2* by four inside *IC1*. Eight different operating modes are possible for *IC1*. However, since the 6803 has no on-board ROM, only two modes—2 and 3—are relevant here. The logic levels on pins 8, 9 and 10 of *IC1* at the rising edge of the reset signal determines which mode of the MCU chip is selected. WISARD uses mode 2, a multiplexed address/data bus and internal RAM.

Address strobe pin 39 of *IC1* is connected to ENABLE pin 11 of octal latch *IC2*, which demultiplexes ad-

PARTS LIST (CPU Board)

Semiconductors
D1—LM336Z-2.5 2.5-volt reference
D2—1N4001 silicon rectifier diode
D3—1N5231B or similar 5.1-volt, ½-watt zener diode
IC1—6803 MCU
IC2—74LS373 octal D flip-flop
IC3—EPROM (27128 or 27256—see text)
IC4—74HC14 hex inverter Schmitt trigger
IC5—6464LP-15 static RAM
IC6—LM1489 quad RS-232 line receiver
IC7—LM1488 quad RS-232 line driver
IC8,IC15—LM393 dual comparator
IC9—MC146818 real-time clock and RAM
IC10—74LS138 expandable 3-to-8 decoder
IC11—74HC373 octal D flip-flop
IC12,IC13,IC18—74LS260 dual 5-input NOR gate
IC14—74HC00 quad 2-input NAND gate
IC16—74LS14 hex inverter Schmitt trigger
IC17—74LS00 quad 2-input NAND gate
IC19—74LS126 tri-state quad buffer
IC20—LM1830 fluid-level detector
IC21—2817A (2K, 350-ns) EEPROM
Q1,Q2—TIL78 or equivalent phototransistor

Capacitors
C1,C2,C10,C11,C19 thru C32—0.1-µF, 50-volt monolithic or equivalent
C3,C4,C12,C13—22-pF, 100-volt disc
C5—2.2-µF, 25-volt tantalum
C6,C7,C15 thru C18—10-µF, 25-volt miniature electrolytic
C8—1,000-pF, 50-volt monolithic or equivalent
C9—22-µF, 25-volt miniature electrolytic
C14—Not used

Resistors (¼-watt, 5% tolerance)
R1 thru R4,R27—8,200 ohms
R5,R39,R45—4,700 ohms
R6 thru R9,R29 thru R32,R35,R42, R43,R44,—10,000 ohms
R10,R22,R24,R28—3,300 ohms
R11,R36—1 megohm
R12,R26—33,000 ohms
R13,R19,R23—100,000 ohms
R14,R17,R38—1,000 ohms
R15,R16—ZNR (Digi-Key Cat. No. P7022 or equivalent; optional—see text)
R18,R21—22,000 ohms
R33—330,000 ohms
R34—30 megohms (three 10-megohm resistors in series)
R40—47 ohms (½-watt)
R41—220 ohms (½-watt)
R20,R37—5,000-ohm subminiature 15-turn, pc-mount trimmer potentiometer
R25—10,000-ohm subminiature 15-turn, pc-mount trimmer potentiometer

Miscellaneous
B1—Nickel-cadmium C cells (three in series)
S1 thru S4—4-position DIP switch
S406,S407,S408—10-pin female sockets with holes on 0.1-inch centers (Digi-Key Cat. No. 929974-01-10)
XTAL1—32.768-kHz crystal
XTAL2—2.4576-MHz crystal
Printed-circuit board or perforated board with holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware; home-fabricated moisture sensor (see text); suitable enclosure; sockets for all DIP ICs; P1001-CPU 8-circuit header with holes on 0.156 inches (Digi-Key Cat. No. WM4406 or WM4606);P15D-CPU,P15K-CPU 20-pin dual-row male headers with holes on 0.1-inch centers (Digi-Key Cat. No. 929836-01-36 or 929665-01-36); connectors for moisture sensor, B1, Q1, Q2 and power supply; RS-232 connector or/and cable (optional —see text); hookup wire; solder; etc.

Note: The following items are available from Magicland, 4380 S. Gordon, Fremont, MI 49412: Double-sided, plated-through pc board for A/D memory expansion, $22 (CPU, display and keyboard pc boards are not currently available commercially); 27128 EPROM containing Firmware ME1, Version 1.8, $18, and programmed 2732A EPROM (required for A/D board), $12, or both EPROMs, $25; 6803, $3.75; LM1830, $2.25; 74LS541, $1.45; 74LS126, 60¢; and for the required A/D board, ADC0809, $4; LM335, $2; 6116LP, $7. A PC-compatible disk that contains the firmware's assembly-language source code and Intel hex record that can be used by many EPROM programmers for $2.75 to cover duplication cost. Also available is a brand-new Coleco dc power supply that delivers: +5 volts at 3 amperes, −5 volts at 200 mA, two +12 volts at 2.9 amperes, and +18 volts at 1 ampere for $20 plus $5 shipping. Michigan residents, please add 4% state sales tax on all orders.

dresses A0 through A7 from the multiplexed A0/D0 through A7/D7 lines.

Contained within CPU EPROM *IC3* is the firmware that gives WISARD its "smarts." In firmware version ME1, *IC3* is a 16K-byte 27128 EPROM. However, a 32K-byte 27256 EPROM can be used instead of the 27128, which requires movement of a jumper as shown in the upper-right in Fig. 1(A).

Integrated circuits *IC18*, *IC14*, *IC4*, *IC12*, and *IC16*, in conjunction with primary address decoder *IC10*, provide address decoding for *IC3*, which is selected by addresses C000H through FFFFH (or 8000H through FFFFH if a 27256 is used in place of the 27128).

On reset (power first turned on), the interrupt vector points to address FFFEH. The data bytes stored at locations FFFEH and FFFFH is the starting address for the main program. (In firmware version ME1, this address is C000H.)

A suitable reset signal is required to start WISARD. From a power-down condition, RESET pin 6 of *IC1* must be held low (less than 0.8 volt) for a period of time sufficient to permit the clock to stabilize. A fairly sophisticated reset signal is developed by voltage comparator *IC15B* and support components *C5* and *R9* through *R13*. The output of this comparator, at pin 7, connects to RESET pin 6 of *IC1* and pin 1 of the header identified as *S407*.

Address decoding for the CPU circuit's primary RAM, *IC5*, is provided by *IC10*. Three-state buffer *IC19* ensures that the bus driver in the RAM is on only when the clock signal is high. Static RAM *IC5*, an 8K memory device, has battery back-up to make it nonvolatile (prevent the RAM's contents from being wiped out when an ac line power interruption occurs). This rechargeable Ni-Cd battery, consisting of three cells in series, keeps data in the RAM for a day with no ac power applied to the circuit. RAM *IC5* is selected by addresses 2000H through 3FFFH.

The 2K EEPROM identified as *IC21* is optional. The version ME1 firmware does not make use of this EEPROM. Nevertheless, the firmware does support it with a specialized write subroutine. A socket and complete decoding are provided for this EEPROM.

The 2817A EEPROM provides nearly permanent storage and can be written to and erased through software. It is reliable for up to 10,000 write/erase cycles per byte.

While the *IC21* EEPROM has many potential uses, one fascinating possibility is that it can be used in an advanced AI (artificial-intelligence) type of program that learns from past experience.

Address decoding that selects *IC21* is accomplished with *IC10*, *IC17*, *IC13* and *IC4*. This chip is selected for a read/write operation by addresses 7000H through 7FFFH. Notice that while *IC21* was designed specifically to be easy to use, it cannot be written to in the same manner as RAM because it requires up to 20 milliseconds to erase and write a bit from and into memory. Most ordinary RAM is more than 100,000 times faster than this.

Pin 1 of *IC21* is the RDY/BUSY line of the 2817A EEPROM. When this line is high, the chip is ready to be read or written to. This RDY/BUSY line is connected to three-state buffer *IC19A*, whose pin 1 output is connected to data line D0 at pin 37 of *IC1*. This buffer is selected by a read to address 5018H. Address decoding for this buffer is accomplished with *IC10*, *IC17*, *IC18* and *IC13*.

Real-time clock (RTC) *IC9* has battery back-up. This chip has 50 bytes of nonvolatile RAM on-board. The clock is selected by addresses 100H through 13FH. The first 14 bytes are used by the clock's registers. The remaining 36 bytes are user RAM. Decoding is accomplished with *IC10*, *IC12* and *IC14*. The purpose of *IC11* is to assure that CE pin 13 of *IC9* is synchronized with the address strobe.

The real-time clock uses a multiplexed data/address bus that reduces circuit complexity (as well as physical circuit layout on the circuit board). Though MC146818 *IC9* has an internal time-base oscillator, WISARD uses an external oscillator because the built-in oscillator caused reliability problems. The external oscillator is composed of Schmitt-trigger inverters *IC4A* and *IC4B*, 32.768-kHz crystal *XTAL1*, capacitors *C12* and *C13*, and resistors *R40* and *R41*.

The battery back-up circuit, shown in Fig. 1(E), consists of *R40*, *R41*, *D2*, *D3* and *B1*. The battery is made up of three Ni-Cd C cells in series. Zener diode *D3* ensures that the BBV (Battery Back-up Voltage) supply does not exceed 5.25 volts when ac power is supplied to the circuit. With ac removed from the circuit, BBV is slightly less than 4 volts.

Once it is fully charged, *B1* can retain the contents of 10K bytes of RAM and the real-time clock for more than 24 hours. For applications where memory *must* be retained permanently, you can make use of 2817 EEPROM *IC21*.

Because of its relatively high power drain in standby mode, no battery back-up source is is connected to *IC1*. Thus, all of this integrated circuit's internal RAM (addresses 80H through FFH) is volatile.

Included in the CPU module is a "shutdown" circuit, the output of which is connected to pin 26 of *IC5*. This shutdown circuit insures that the data stored in *IC5*, the primary RAM system, does not change while the +5-volt supply is dropping toward zero, which is normally caused by loss of ac power to the circuit. The output of the shutdown circuit is also connected to pin 3 of *IC11* to protect *IC9*'s data.

The shutdown circuit is made up of *IC15A*, *D1* and *R35* through *R39*. Trimmer potentiometer *R37* is adjusted during initial calibration for a potential of 2.7 volts at pin 3 of *IC15*. When ac voltage starts to drop, the potential on pin 1 of *IC15* drops to near ground potential. As you can see, *IC15* is powered by the battery back-up system.

The firmware in *IC3* initializes the Serial Communication Interface (SCI) of *IC1*. The actual procedure for accomplishing this is a bit complex. Suffice it to say that *IC3*'s pin 12 transmits, pin 11 receives and pin 10 is not used at all. The SCI is programmed to use the 6803's internal clock source.

Using a 2.4576-MHz crystal for *XTAL2* permits use communication rates of 150, 600, 4,800 and 38,400 baud, but only the 600- and 4,800-baud rates are used by WISARD. The firmware monitors the logic level at pin 14 of *IC1* to determine which baud rate to use.

Pin 14 of *IC1* is connected to *S4*. Pins 13 through 20 are connected to Port 1 of *IC1*, which is located at address 02H. During reset, Port 1 is configured as an input.

No built-in handshaking is included in the SCI. No handshaking is needed for fast printers and/or low baud rates. However, WISARD does use handshaking. One input of Port 1, at pin 17 of *IC1* acts as a BUSY input. The firmware will not permit the SCI to send data while pin 17 (port 1's D4 data line) is high.

An EIA receiver, *IC6A*, has its output connected to pin 17 of *IC1*.

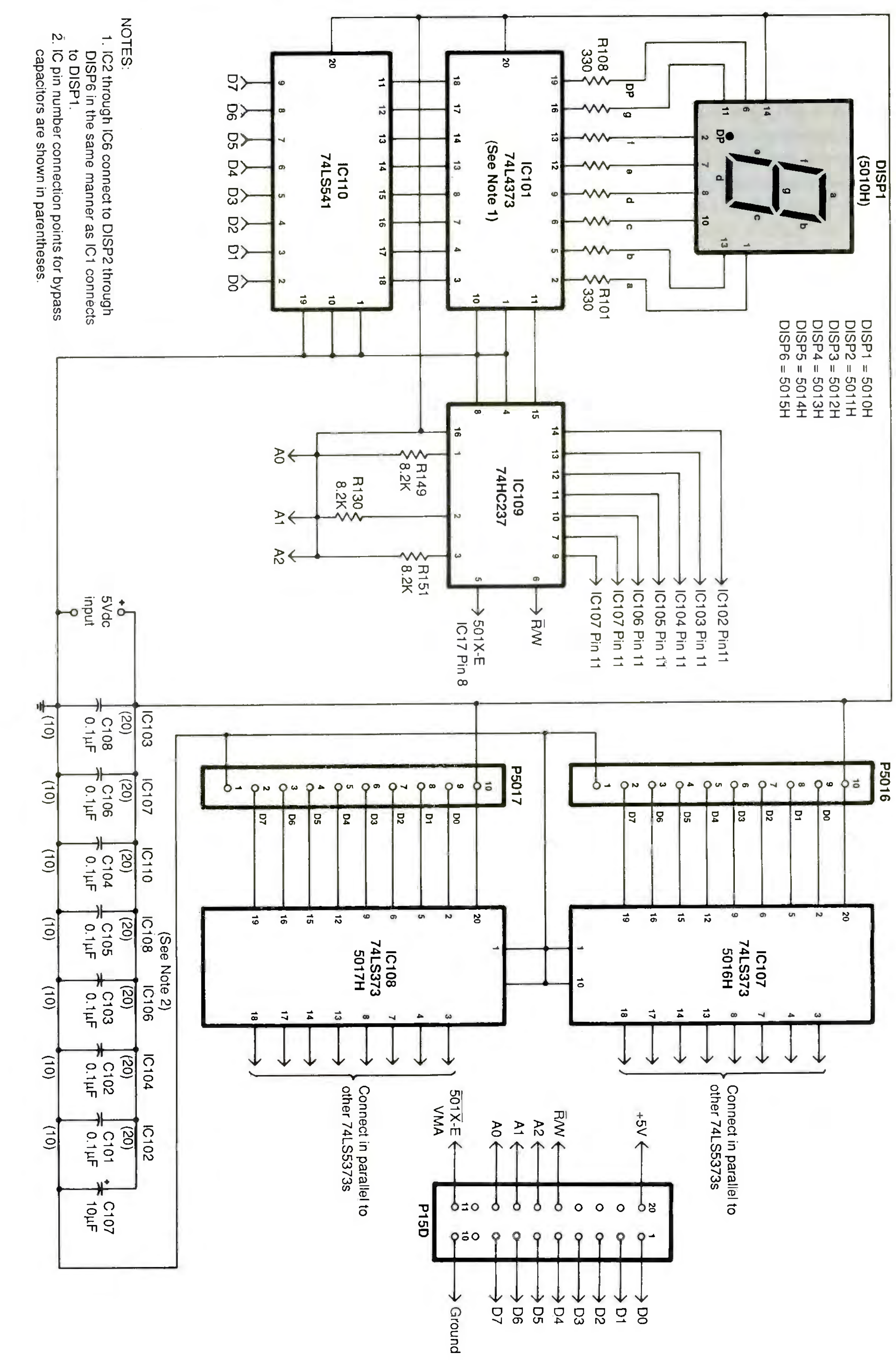


Fig. 2. Complete schematic diagram of display module.

PARTS LIST (Display/Output Board)

Semiconductors
IC101 thru IC108—74LS373 octal D flip-flop
IC9—74HC237 3-to-8 line decoder with latches
IC110—74LS541 octal buffer
DISP1 thru DISP6—MAN72A 7-segment LED numeric display

Capacitors
C101 thru C106,C108—0.1-μF, 50-volt monolithic ceramic
C107—10-μF, 25-volt tantalum

Resistors (¼-watt, 5% tolerance)
R101 thru R148—330 ohms
R149,R150,R151—8,200 ohms

Miscellaneous
P15D—20-pin dual-row male header with holes on 0.1-inch spacing (Digi-Key Cat. No. 929836-01-36 or 929665-01-36 or similar)
P5016,P5017—10-pin single-row male header with 0.1-inch spacing (Digi-Key Cat. No. 929834-01-36 or similar)
Printed-circuit board or perforated board with holes on 0.1-inch centers and suitable Wire Wrap or soldering hardware; sockets for all ICs; 18-inch long, 20-conductor cable terminated in sockets at both ends (Digi-Key Cat. No. R8322-18-ND or similar); hookup wire; solder; etc.

The printer's Request To Send (RTS) line, from RS-232 connector pin 4, connects to pin 1 of *IC6*. Since inverter *IC6A* is between pin 4 of the connector and pin 17 of *IC1*, WISARD stops transmitting serial data when connector pin 4 is low.

For the rain (moisture) sensor shown at the lower-left of Fig. 1(A), a small piece of printed-circuit-board material with narrowly spaced parallel copper traces is used. This simple sensor is a home-made device.

Integrated circuit *IC20* is a special-purpose fluid level detector that eliminates plating problems because of the ac voltage applied to the sensor. Connected as shown, the logic level at pin 18 of *IC1* will be low when the resistance of the moisture sensor drops to less than 35,000 ohms. This resistance drop is normally the result of water coating the copper-trace side of the sensor. Pin 18 of *IC1* is connected to data line D5 of Port 1.

Day LIGHT and SUN light sensors are also connected to the CPU module and are both TIL78 phototransistors. (The temperature sensors used with this project connect to the A/D module that will be described next month.) Sensors *Q1* and *Q2* connect to separate comparators *IC8A* and *IC8B*, respectively.

Trimmer control *R20* in the SUN sensor circuit is set so that output pin 1 of *IC8A* goes low when sunlight falls directly on the sensitive surface of *Q1*. Similarly, trimmer *R25* is set so that output pin 7 of *IC8B* goes low at dawn and high at dusk. The outputs of both converters are passed through inverters *IC16A* and *IC16B* and on to Port 1 at pins 19 and 20 of *IC1*. When the sun is shining, Port 1's most-significant bit (MSB), on data line D7 goes high. Also, when there is sufficient daylight, Port 1's D6 data line is high.

The purpose of ZNRs *R15* and *R16* on the input sides of both light-sensing circuits is to protect WISARD during electrical storms, though their effectiveness has not been conclusively proven. Consequently, if you wish, you can omit these devices from the circuit without affecting normal project performance.

Options switches *S1* through *S4* are all contained inside an eight-pin DIP package and are connected to Port 1. Switches *S1*, *S2*, *S3* and *S4* represent data D0 through D3 inputs to *IC1*. These switches allow you to custom configure WISARD. For example, in the ME1 version of the firmware, *S1* is "off" if the 2716 EPROM in the A/D module is installed, *S2* is "on" if a CPU test is wanted, *S3* is "on" if only Fahrenheit displays are desired, and *S4* is "on" for 4,800-baud and "off" for 600-baud communication rates.

Shown in Fig. 2 is the schematic diagram of the display module's circuitry. As you can see, this module contains six seven-segment MAN-72A numeric displays, identified as *DISP1* through *DISP6*. In this circuit configuration, each segment and the decimal point of each display connects to a separate 74LS373 octal D-type latch that can be "set" or "reset" by instructions from the CPU module. This enables each decade to display 0 through 9 and 17 alphabetic characters.

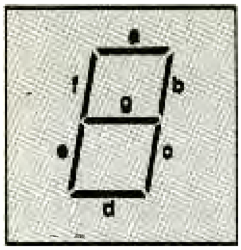
Each 74LS373 latch has a separate address, and the D input of each is connected to a data line. Also, each of these TTL latches can sink sufficient current to directly drive the LED segments in the displays.

Since the MAN72A numeric display features a common-anode arrangement, a LED segment is turned on when its 74LS373 latch output is low. Thus, to light all segments of the display, you "write" 00000000 (0H) at the address of the latch. In 6803 mnemonics, all segments in left-most display *DISP1*, which has an address of 5010H, would light after the following instructions were processed.

```
LDAA #0      ;load accumulator
              A with 0
STAA 5010H ;store 0 at 5010H
```

By storing different data at address 5010H, you can have the display form more than 27 different recognizable numeric and alphabetic characters. For example, the letter "H" can be formed by storing 10001001 (89H) at the appropriate address. If you wish to modify the firmware, refer to Fig. 3, which gives details on addressing displays and forming numerals and letters.

Returning to Fig. 2, note that there are two more 74LS373 latches than there are numeric displays. With this arrangement, there are 16 latches that can be used to control a combination of just about any electrically operated devices you would like.



DATA LINE	SEGMENT
D7	DP
D6	g
D5	f
D4	e
D3	d
D2	c
D1	b
D0	a

SYMBOL	DATA IN HEX
0	C0
1	F9
2	A4
3	B0
4	99
5	92
b	83
7	F8
8	80
9	98
A	88
b	83
c	87
d	A1
E	86
F	8E
6	82
H	89
i	F3
J	E1
L	C7
n	AB
P	8C
r	AF

Fig. 3. Details on addressing displays and forming letters and numbers.

With the addition of an appropriate optical isolator or relay, you can use these latches to control on/off action of heaters, air conditioners, alarms, solenoid-operated valves, and other electrical devices from independent power sources. Part 3 of this article will discuss in detail use of these 16 extra latches.

The purpose of *IC110* in the Fig. 2 circuit is to provide buffering of the data bus from the CPU module. The CPU module provides address decoding at pin 8 of *IC17C* (see Fig. 1). This line is low for all addresses that start with "501" in hexadecimal. For example, a write to or read from addresses 5010H, 50522H . . . 5015H will cause the line from pin 8 of *IC17C* to go low. Finally, *IC109* in Fig. 2 provides final address decoding for each individual latch.

Data connections from the CPU module to the display module are made via data lines D0 through D7 at pins 2 through 9 of *IC110* at the lower-left in Fig. 2. Similarly, pins 1, 2, 3 and 6 of *IC109* connect to address lines A0, A1, A2 and R/W in Fig. 1. Decoding lines from the CPU go to the display module via pins 7, 9, 10, 11, 12, 13 and 14 of *IC109*.

Coming Attractions

This completes the first installment in this series of articles on our Smart Weather Monitor. Next month, we will continue with complete construction details for the CPU and display modules and give fabrication information for the various sensors used with the project. In the subsequent issue, our coverage will include operational details and construction of the two remaining modules—an A/D (analog-to-digital converter) and memory-expansion board and the input keyboard. A final installment will deal with physical placement of the various sensors used with the project and how to use WISARD.