TURN YOUR PC INTO A UNIVERSAL FREQUENCY COUNTER

Build a frequency-counter board that operates in a Windows environment in your personal computer.

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LAST MONTH WE STARTED TALKING about the PC10's circuitry. So let's pick up where we left off. The pin description and equations for the PAL (IC4), mentioned last month, is shown in Listing 1.

Shown in Fig. 3 are two 74HCT374 eight-bit registers (IC9 and IC10) that control operation of the PC10. The registers are of the write-only type; they may not be read back. Register 1 (REG1) controls the source selection for inputs A and B of the OE10 and the prescale used for frequency measurements. Register 2 (REG2) selects the input source for the pulse-width measurement, the pulse-width polarity, and hysteresis and gain levels for the input amplifiers. See the PC10 register map (Table 2) for more details.

Input signals to the A and B inputs on the OE10 are selected using 74AC11151 eight-to-one multiplexers (IC16–IC18). The input-A multiplexer, IC16, controlled by ASEL2–ASEL0 in register 1, determines which input signal drives input A. The output of the multiplexer drives one input of relay RY3, which selects either the multiplexer output or the output of the 50-ohm amplifier. That circuit is required because the 50-ohm amplifier generates signals that are higher in frequency than the multiplexer can pass. Relay RY3 is also controlled by ANSEL2–ANSEL0, decoded by IC23-a, the 74ALS12 NAND gate, which in turn drives Q3. Similarly, BSEL2–BSEL0 control which input signal drives input B with multiplexer IC17, but no relay is required.

An AD7528 (IC11) dual 8-bit multiplying digital-to-analog converter (DAC) is used to provide a threshold voltage for each high impedance amplifier. That type of DAC provides only a current output, so each of the two outputs is converted to a voltage with one section of IC12 (IC12-a and IC12-b), a TL074 quad operational amplifier. Two additional op-amps (IC12-c and IC12-d), configured as adders, convert the unipolar outputs of the first two op-amps to bipolar signals. The 2.5-volt reference voltage for each DAC is provided by IC13, and AD580 voltage reference.

The addition of an edge-detection circuit (Fig. 4) allows a pulse width to be measured. Two 74HCT74 D-type flip flops (IC19-a and -b) and two 74HC00 NAND gates (IC20-a and -b) form rising and falling edge detection circuits; IC20-a provides an active-low pulse, one timebase clock long, each time a rising edge is detected, and IC20-b provides a pulse for each falling edge. A 74HC157 quad two-input multiplexer (IC21) selects which edge detector goes to input C or D of the OE10. If a rising-edge pulse is sent to input C and a falling-edge pulse is sent to input D, positive-going pulse widths will be measured. The opposite selection measures negative-going pulse widths.

The PC10 provides a single 50-ohm input amplifier (see Fig. 5), typically used for input from RF circuits. The incoming signal is first amplified by IC25 and IC26, monolithic microwave integrated circuit (MMIC) 50-ohm amplifiers, each with a gain of 11 to 20

dB. Each amplifier is powered from +5 volts through a 75-ohm resistor, a 100-μH inductor, and several decoupling capacitors. Those components supply power to each amplifier and prevent high-frequency signals from entering the power-supply rails.

In order to provide frequency-measurement capabilities far higher than the input capabilities of the OE10, prescaling has been provided. The MMIC amplifiers drive two cascaded prescalers: a UPB582C divide-by-four prescaler (IC27), and a general-purpose CA3199E divide-by-four prescaler (IC28). When the two are cascaded, divide-by-16 prescaling is performed, allowing frequencies above 3 GHz to be measured.

Selection of the prescalers is controlled by the PRE1 and PRE0 signals from register 1. Those signals drive an LM339 quad voltage comparator (IC24), with a 2.5-volt threshold set by R15 and R16. If direct frequency measurements are required, PRE1 and PRE0 are both set to logic 0. The comparators' inputs are then driven below the threshold voltage, causing Q1 and Q2 to turn off. That causes relays RY1 and RY2 to be deactivated, turning off both prescalers. Diode D1 then routes the amplified signal to a third MMIC amplifier, IC11, before going to RY3, where the signal is sent on to the OE10. An input-bias adjustment potentiometer R31 is used to center the output of the MMIC amplifier at approximately 1.5 volts for best performance.

If measurements prescaled by 4 are required, PRE1 is set to logic 0 and PRE0 set to logic 1. That causes comparator IC24-c to activate, turning on Q1 and RY1. That forces IC27 to begin prescaling the signal, deactivates D1, activates D2, and routes the output of prescaler IC27 to the MMIC amplifier. Conversely, if measurements prescaled by 16 are required, PRE1 must be set to logic 1 and PRE0 to logic 0. That turns on both relays, causing both prescalers to start. Diodes D1 and D2 are then deactivated, sending the output of the second prescaler IC28 to the MMIC amplifier. The PC10's bypass capacitors and unused logic gates are shown in Fig. 6.

LISTING 1

```
DEVICE      20V8;
TITLE       PC COUNTER BOARD SELECTION LOGIC;
NAME        Bill Schulz;
SIGNATURE   COUNTER;
PIN   1     =   A0;
PIN   2     =   A1;
PIN   3     =   A2;
PIN   4     =   A3;
PIN   5     =   A4;
PIN   6     =   A5;
PIN   7     =   IOW;
PIN   8     =   IOR;
PIN   9     =   AEN;
PIN   10    =   S6;
PIN   11    =   S7;
PIN   13    =   S8;
PIN   14    =   S9;

PIN   17    =   COMP;
PIN   18    =   DAC;
PIN   19    =   REG2;
PIN   20    =   REG1;
PIN   21    =   OE10;
PIN   22    =   G;
PIN   16    =   RT;
PIN   23    =   RESET;

!DAC = !A1 & !A2 & A3 & A4 & !A5 & S6 & S7 & S8 & S9 & !AEN;

!REG1 = !A0 & A1 & !A2 & A3 & A4 & !A5 & S6 & S7 & S8 & S9 & !AEN & !IOW & IOR;

!REG2 = A0 & A1 & !A2 & A3 & A4 & !A5 & S6 & S7 & S8 & S9 & !AEN & !IOW & IOR;

!COMP = !A0 & !A1 & A2 & A3 & A4 & !A5 & S6 & S7 & S8 & S9 & !AEN & IOW & !IOR;

!OE10 = !A3 & !A5 & S6 & S7 & S8 & S9 & !AEN
      # !A4 & !A5 & S6 & S7 & S8 & S9 & !AEN
      # !A0 & !A1 & A2 & !A5 & S6 & S7 & S8 & S9 & !AEN;

!G = !A3 & !A5 & S6 & S7 & S8 & S9 & !AEN
   # !A4 & !A5 & S6 & S7 & S8 & S9 & !AEN
   # !A1 & !A2 & !A5 & S6 & S7 & S8 & S9 & !AEN
   # !A2 & !A5 & S6 & S7 & S8 & S9 & !AEN & !IOW & IOR
   # !A0 & !A1 & !A5 & S6 & S7 & S8 & S9 & !AEN & IOW & !IOR;

!RT = RESET
      # !A0 & A1 & A2 & A3 & A4 & !A5 & S6 & S7 & S8 & S9 & !AEN & !IOW & IOR;
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AP10H amplifier board

Because the insides of personal computers are electrically noisy, no high-impedance amplifiers are provided on the PC10. Instead, two high-impedance amplifiers are provided on an optional external amplifier board, the AP10H. That board, shown in Fig. 7, contains two identical 100-MHz high-impedance amplifiers, each with input attenuation, a low-pass filter for measuring low-frequency signals, and a variable threshold-level adjust. We will therefore discuss only one of the amplifier circuits.

Starting from the input BNC connector (J1), the input signal is terminated by R1 and R2 and C2 and C3. An attenuation of 20 dB is provided if RY1 is enabled. The signal is then sent through the input-protection circuits (D1–D4, R4, and R5) into the gate of an RF FET transistor Q1, which acts as an impedance converter, providing a low-impedance source to the remainder of the amplifier. The signal is then amplified by 20 dB by MMIC amplifier IC1. Relay RY2, when activated by Q3, low-pass filters the signal to provide noise-free measurements of low-frequency audio signals. Potentiometer R9 is

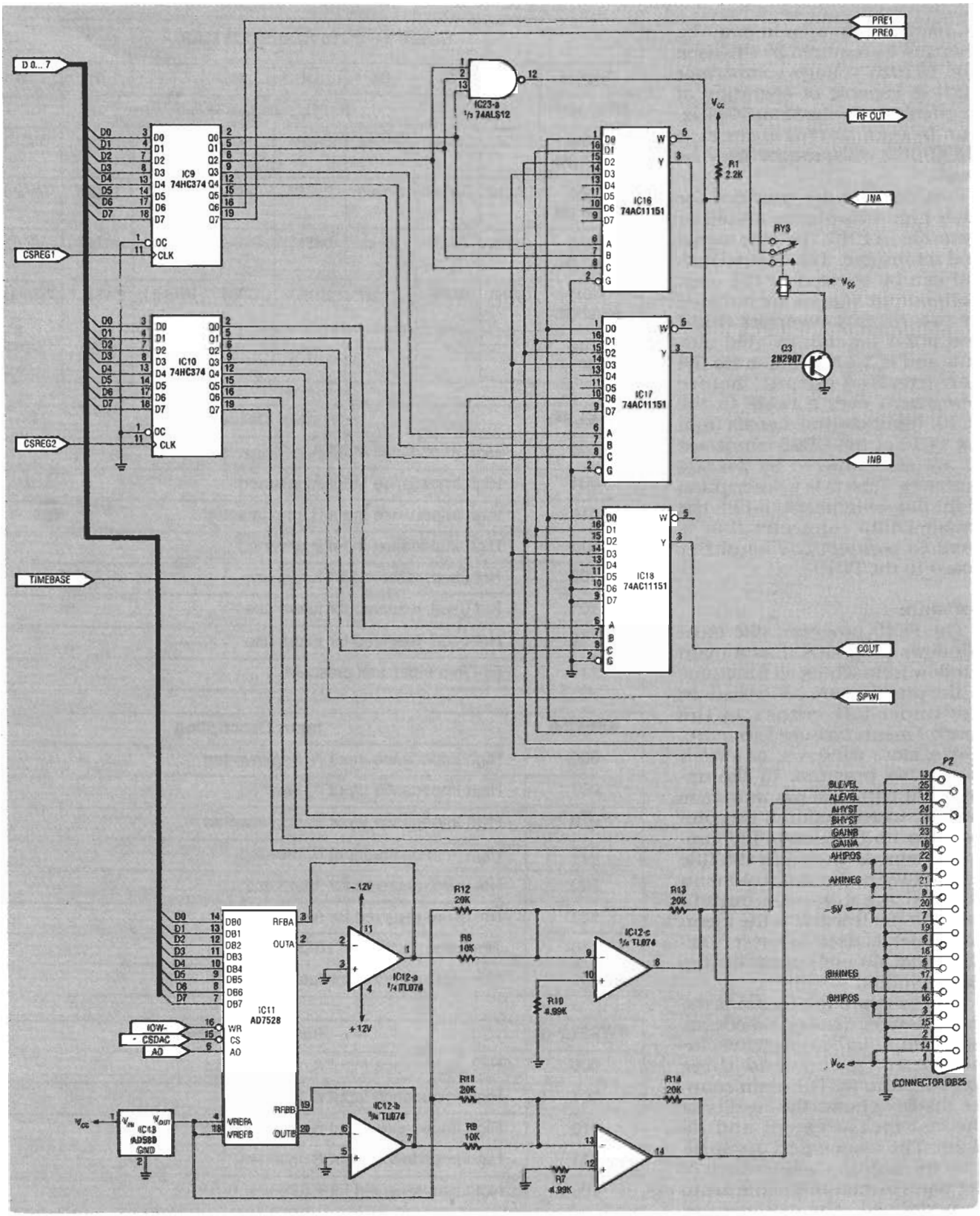


FIG. 3—TWO 74HCT374 EIGHT-BIT REGISTERS (IC9 and IC10) control operation of the PC10.

adjusted so that the input to the variable threshold circuit formed around voltage-comparator IC2 will be 0 volts.

The variable threshold circuit allows the user to position the threshold to the best value to ensure accurate, noise-free measurements. The circuit provides 50 mV of hysteresis to give immunity to noise. The hysteresis window is centered around the threshold voltage provided by the dual-threshold DAC's on the

PC10. The threshold may be changed as required by the user. The LT1016 voltage comparator (IC2) is capable of operating at frequencies greater than 50 MHz. For better performance, a MAX9689 comparator may be used.

Two outputs are provided for each high-impedance amplifier from the LT1016; the true signal and its inverse. The desired output can be selected by the user. Both output signals are buffered by two 74LS04 inverters (IC3-f and IC3-a for the inverted output, and IC3-e and IC3-b for the non-inverted output) before being sent over a cable to the PC10. Input control signals from the PC10 at the DB25 connector P1 are also buffered by 74LS04 inverters. Table 3 is a description of the pin assignments for P1, the female DB25 connector that is used to connect the amplifier board to the PC10.

Software

The PC10 program, like most Windows programs, has a main window from which all functions of the program are controlled. In the upper-left corner is the *control-menu box* used to move, resize, close windows, or switch to another program. In the upper-right corner is the *minimize button*, which reduces the program to its OEI icon. The program name is shown in the title bar between the control-menu box and the minimize button. Beneath the title bar is the menu bar, which is used to select functions that do not appear on the main window.

The main window contains the main counter display, a mode-select group, gate/average/resolution select group, and three control buttons. The main counter display shows the results of the last measurement and its units. The mode-select group allows the user to choose which of five types of measurements are to be performed. The gate/average/resolution box allows the user to determine the gate time (frequency measurements), number of measurements to average (period, time interval, and pulse width), or the resolution (ratio measurements). For frequency or period measurements, reciprocal measurements may be selected by activating the reciprocal check box.

For frequency measurements, the gate group will be shown. The user can select four gate times,

TABLE 2—PC10 REGISTER MAP

Address	D7	D6	D5	D4	D3	D2	D1	D0
00000-10111	OE10 Registers (see Table 1)							
11000 DACA (W)	DACA7	DACA6	DACA5	DACA4	DACA3	DACA2	DACA1	DACA0
11001 DACB (W)	DACB7	DACB6	DACB5	DACB4	DACB3	DACB2	DACB1	DACB0
11010 REG1 (W)	PRE0	PRE1	BSEL2	BSEL1	BSEL0	ASEL2	ASEL1	ASEL0
11011 REG2 (W)	GAINA	GAINB	BHYST	AHYST	SPWI	PWSEL2	PWSEL1	PWSEL0
11100 MCOMP (R)	—	—	—	—	—	—	BCNF	MCOMP

ASEL2-0	Input Description
000	High Impedance Input A, non-inverted
001	High Impedance Input A, inverted
010	High Impedance Input B, non-inverted
011	High Impedance Input B, inverted
100	Not used, reserved for future use
101	Not used, reserved for future use
110	Not used, reserved for future use
111	50-Ohm Input with prescale

BSEL2-0	Input Description
000	High Impedance Input A, non-inverted
001	High Impedance Input A, inverted
010	High Impedance Input B, non-inverted
011	High Impedance Input B, inverted
100	Not used, reserved for future use
101	Not used, reserved for future use
110	Timebase Oscillator (10.000 MHz)
111	Not used, reserved for future use

PWSEL2-0	Input Description
000	High Impedance Input A, non-inverted
001	High Impedance Input A, inverted
010	High Impedance Input B, non-inverted
011	High Impedance Input B, inverted
100	Not used, reserved for future use
101	Not used, reserved for future use
110	Not used, reserved for future use
111	Not used, reserved for future use

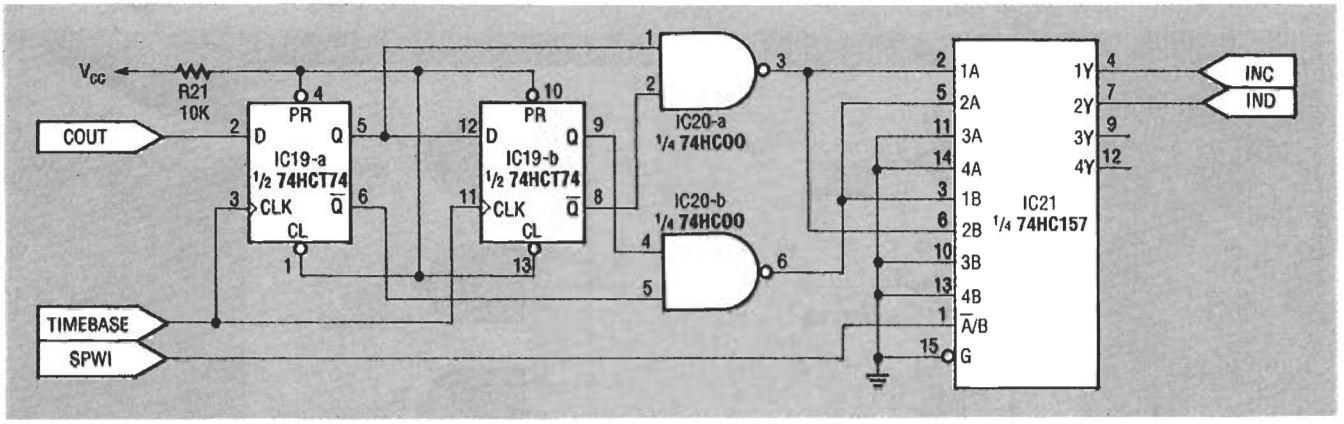


FIG. 4—AN EDGE-DETECTION CIRCUIT allows a pulse width to be measured.

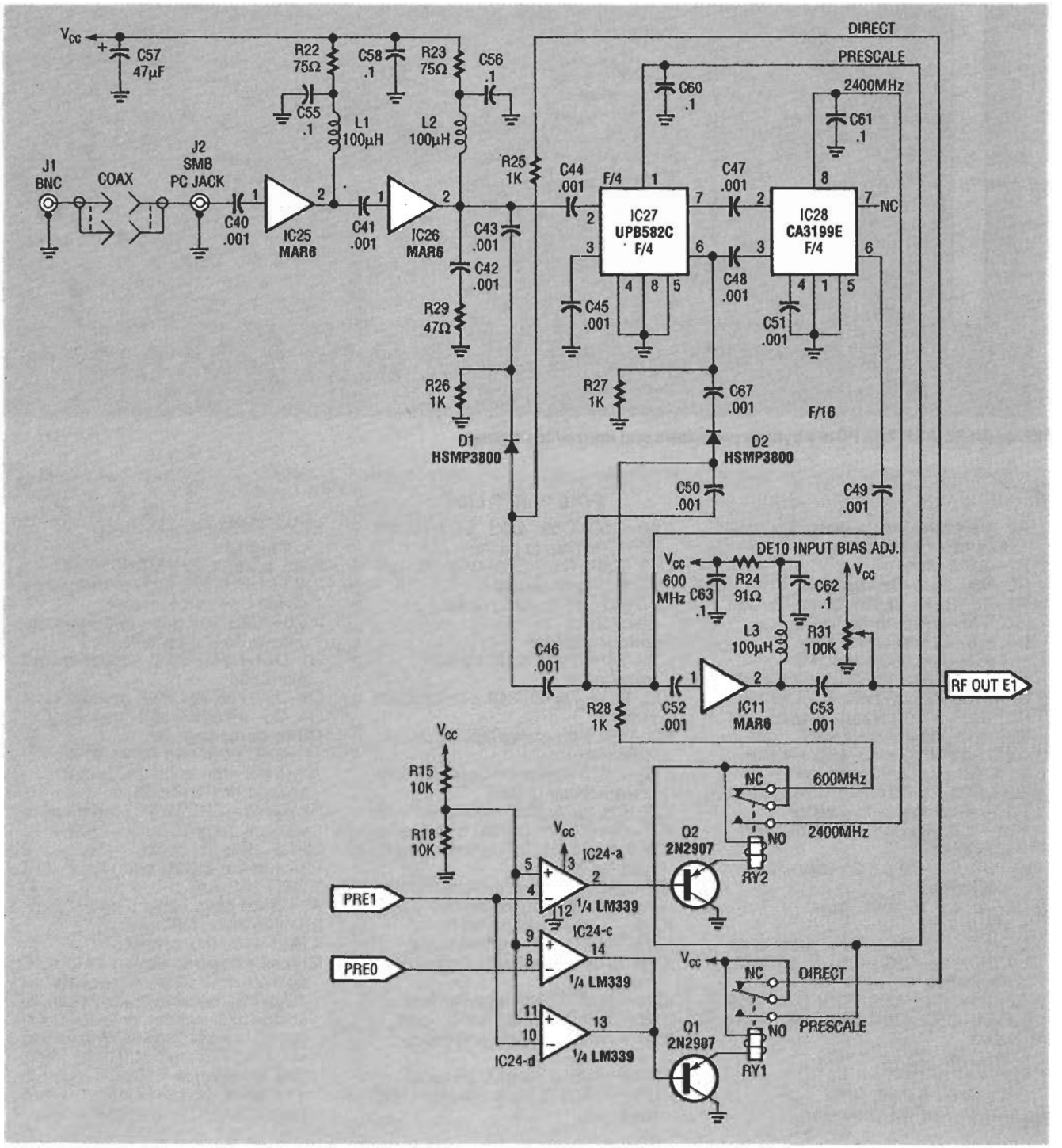


FIG. 5—THE PC10 PROVIDES a single 50-ohm input amplifier typically used for input from RF circuits.

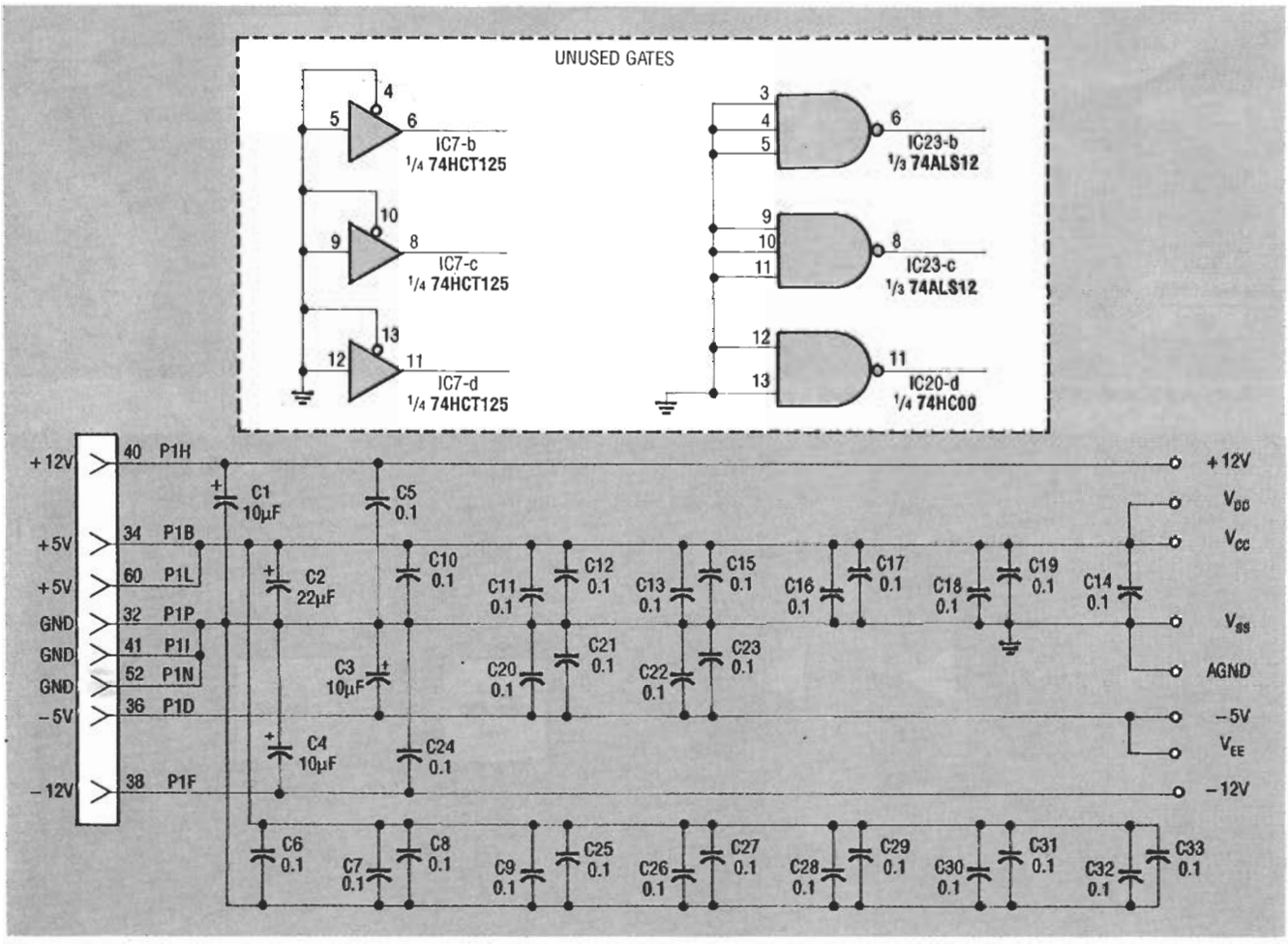


FIG. 6—HERE ARE THE PC10's bypass capacitors and unused logic gates.

PC10 PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted
R1—2200 ohms
R2, R30, R32—not used
R3–R6, R21—10,000 ohms, ⅛ watt
R7, R10—4990 ohms, 1%
R8, R9—10,000 ohms, 1%
R11–R14—20,000 ohms, 1%
R15, R16, R21—10,000 ohms, ⅛ watt
R17, R30—75,000 ohms, ⅛ watt
R18, R20—1000 ohms, ⅛ watt
R19—33,000 ohms, ⅛ watt
R22, R23—75 ohms, chip resistor
R24—91 ohms, chip resistor
R25–R28—1000 ohms, chip resistor
R29—47 ohms, chip resistor
R31—100,000-ohm potentiometer

Capacitors
C1, C3, C4—10 µF, 25 volts, radial electrolytic
C2—22 µF, 25 volts, radial electrolytic
C5–C7, C9–C12, C14, C16–C19, C24, C26–C33—0.1 µF, 50 volts, monolithic
C8, C13, C15, C20–C23, C25, C51, C54, C59, C64–C66, C68—not used
C34, C36—330 pF, NPO
C35—47 pF, NPO
C37, C38—8.2 pF, NPO
C39—2–7 pF NPO trimmer
C40–C50, C52, C53, C67—0.001 µF, 1206 chip capacitor
C55, C56, C58, C60–C63—0.1 µF, 1206 chip capacitor
C57—47 µF, 16 volts, radial electrolytic

Semiconductors
IC1—74HCT245 octal tristate transceiver
IC2, IC3—74HCT244 octal tristate buffer
IC4—20L8 programmable array logic (PAL)
IC5—OE10 application-specific integrated circuit (ASIC)
IC6, IC8, IC14, IC15—not used
IC7—74HCT125 tristate quad buffer
IC9, IC10—74HC374 tristate octal D-type flip-flop
IC11—AD7528 dual 8-bit multiplying digital-to-analog converter (DAC)
IC12—TL074 quad op-amp
IC13—AD580 voltage reference
IC16–IC18—74AC11151 eight-to-one multiplexer
IC19—74HCT74 D-type flip-flop
IC20—74HC00 quad NAND gate
IC21—74HC157 quad two-input multiplexer
IC22—74LS86 quad XOR gate
IC23—74ALS12 triple 3-input NAND gate
IC24—LM339 quad voltage comparator
IC25, IC26, IC29—MAR6 MMIC
IC27—UPB582C high-performance divide-by-four prescaler
IC28—CA3199E general-purpose divide-by-four prescaler
D1, D2—HSMP3800 surface-mount pin diode
Q1–Q3—2N2907 PNP transistor
Q4, Q5—PN2369 NPN transistor

Other components
J1—BNC bulkhead (R141-306)
J2—SMB right-angle PC board connector (R114-665)
RY1–RY3—SPDT DIP reed relay, 5-volt coil (form 1C)
L1–L3—100 µH choke
P2—female DB25 connector (ITT DBU-25S-AA)
P3—SMB plug, cable (R114-082)
S1—4-position DIP switch
XTAL1—10-MHz crystal
Miscellaneous: seven 14-pin IC sockets, four 16-pin IC sockets, six 20-pin IC sockets, one 24-pin IC socket (0.3-inches), one PLCC 44-pin IC socket, one G57 modified stamped PC bracket (Globe Mfg.), one lug (Zierick #334), 6-inch 50-ohm coaxial cable RG187 (0.1-inch diameter), PC board, solder, etc.

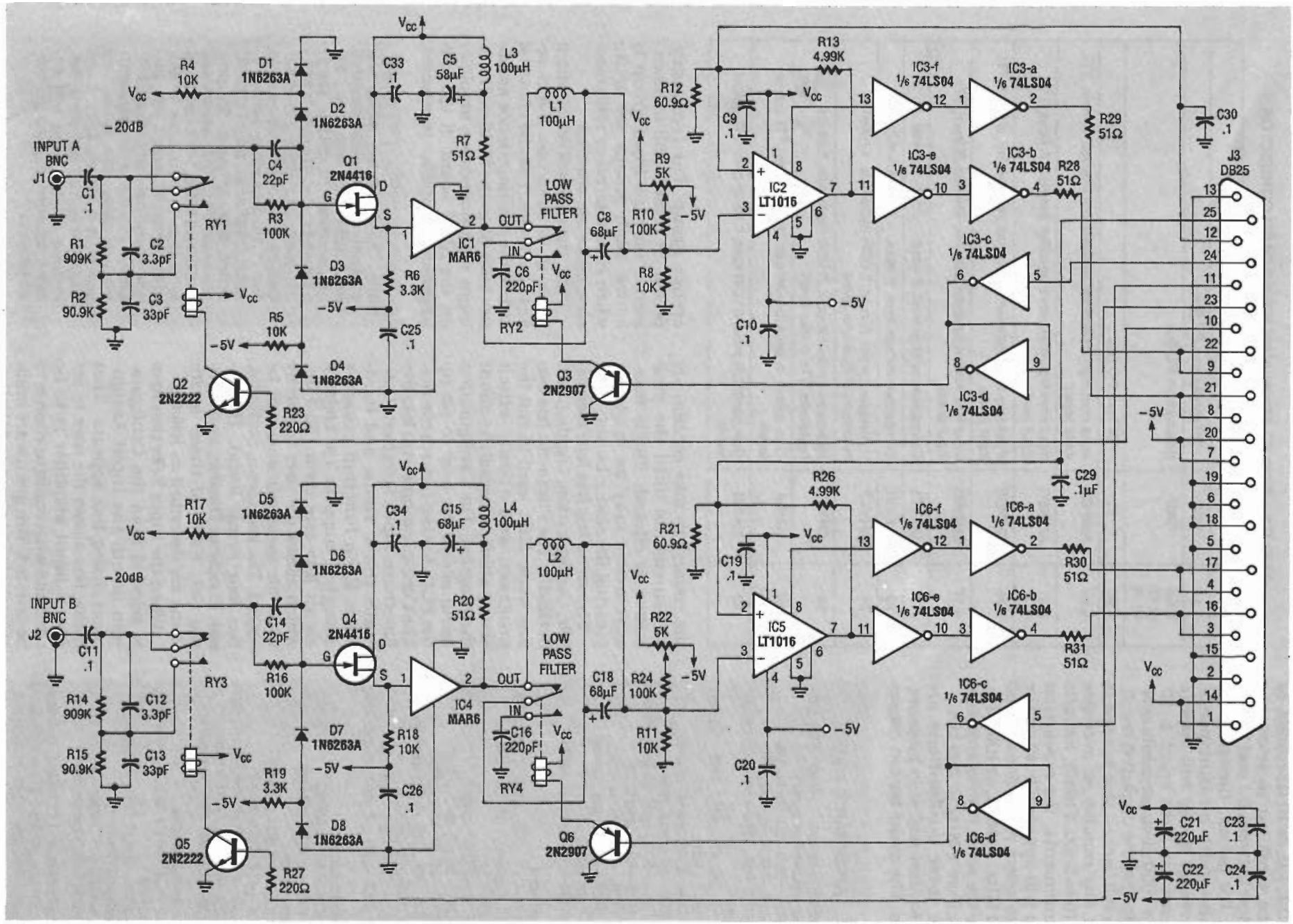


FIG. 7—THE INSIDES OF PERSONAL COMPUTERS are electrically noisy, so there are no high-impedance amplifiers provided on the PC10 board. Instead, two high-impedance amplifiers are provided on this AP10H optional external amplifier board. It contains two identical 100-MHz high-impedance amplifiers, each with input attenuation, a low-pass filter for measuring low-frequency signals, and a variable threshold-level adjust.

0.01, 0.1, 1.0, or 10.0 seconds, or use the scroll bar to select any gate time between 0.1 and 28 seconds. For period, time-interval, or pulse-width measurements, the average group will appear. The user can then select 1, 10, 100, or 1000 measurements averaged to give the displayed result. The scroll bar can also be used to select any number of averages from 10 to 2800. Finally, for ratio measurements, the resolution group will appear, allowing the user to select resolutions of 100 kHz, 1 MHz, 10 MHz, or 100 MHz, or use the scroll bar for any resolution from 1 MHz to 280 MHz.

The three pushbuttons are used to start and stop measurements. The START button causes the counter to take continuous measurements until the STOP button is clicked. Single measurements may be made by pressing the SINGLE button.

The menu bar has four menus: File, Configuration, Logging, and SetRadio. The File menu has two functions: Exit, used to end the program, and About, which shows some information about the program. The Configuration menu allows the user to set up the PC10 to take measurements. The Configuration menu has five functions: Input Selection, Calibrate, Units, Fonts, and Hardware. Each function causes a dialog box to appear. The Logging menu has one item, To File, which allows the user to specify what file measurements will be logged. The last menu, SetRadio, has four items: Radio, Threshold, Enable or Disable, and Manual Set. Each of those menu items are described as follows.

When the Input Selection item is selected from the Configuration menu, the Input Assignment dialog box appears. That dialog box allows the user to set which input amplifier is to be used and what configuration is to be selected. Two groups are available: the Input group and the Reference group. For frequency, period, or pulse-width measurements, only the Input group is active. Both groups are active when time-interval or ratio measurements are selected.

First, the user will select which input (A or B) to use. If A is selected, the user has the choice of either the low-impedance amplifier built-in to the PC10 or the A-input high-impedance amplifier on the AH10 board. If the low-impedance amplifier is selected,

TABLE 3—PC10 TO AP10H AMPLIFIER BOARD CONNECTOR

Pin	Pin Name	Description
1,14	VCC	+5V supply from PC Bus
2,5,6 13,15, 18,19	GND	Ground from PC Bus
7,20	−5V	−5V from PC Bus
9,22	AHIPOS	Input from high impedance amplifier, not inverted, A input, TTL input levels
8,21	AHINEG	Input from high impedance amplifier, inverted, A input, TTL input levels
3,16	BHIPOS	Input from high impedance amplifier, not inverted, B input, TTL input levels
4,17	BHINEG	Input from high impedance amplifier, inverted, B input, TTL input levels
12	ALEVEL	Comparison voltage level, A input, −2.5 to 2.5 volts
25	BLEVEL	Comparison voltage level, B input, −2.5 to 2.5 volts
24	AHYST	Hysteresis control, A input, 0 LOW hysteresis, 1 HIGH hysteresis, TTL output levels
11	BHYST	Hysteresis control, B input, 0 LOW hysteresis, 1 HIGH hysteresis, TTL output levels
10	GAINA	Gain control, A input, 0 LOW gain, 1 HIGH gain, TTL output levels
23	GAINB	Gain control, B input, 0 LOW gain, 1 HIGH gain, TTL output levels

AP10H PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted
R1, R14—909,000 ohms, 1%
R2, R15—90,900 ohms, 1%
R3, R10, R16, R24—100,000 ohms, ⅛ watt
R4, R5, R8, R11, R17, R18—10,000 ohms, ⅛ watt
R6, R19—3300 ohms, ⅛ watt
R7, R20—51 ohms, chip
R9, R22—5000-ohm potentiometer
R12, R21—60.9 ohms, 1%
R13, R26—4990 ohms, 1%
R23, R27—220 ohms, ⅛-watt
R25—not used
R28–R31—51 ohms, ⅛-watt

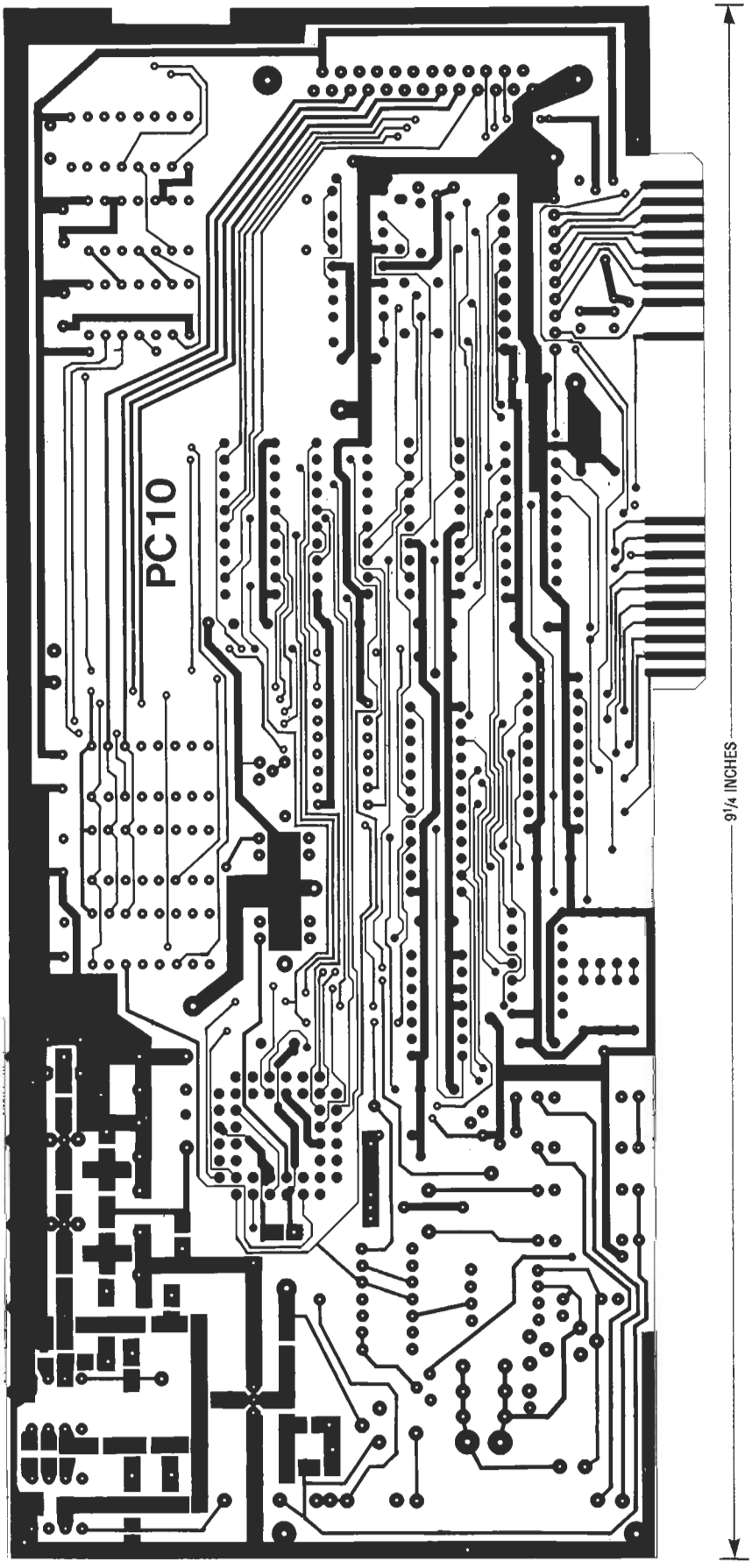
Capacitors
C1, C9–C11, C19, C20, C23–C26, C29, C30—0.1 µF, 50 volts, monolithic
C2, C12—3.3 pF, chip
C3, C13—33 pF, chip
C4, C14—22 pF, monolithic
C5, C8, C15, C18—µF, tantalum
C6, C16—220 pF, chip
C7, C17, C27, C28—not used
C21, C22—220 µF, axial electrolytic

Semiconductors
IC1, IC4—MAR6 MMIC
IC2, IC5—LT1016 voltage comparator
IC3, IC6—74LS04 inverter
D1–D8—1N6263A diode
Q1, Q4—2N4416 RF FET transistor
Q2, Q5—2N2222 NPN transistor
Q3, Q6—2N2907 PNP transistor

Other components
J1, J2—CP1094U BNC connector, modified
RY1–RY4—SPDT DIP reed relay, 5-volt coil (form 1C)
L1–L4—100 µH choke
J3—male DB25 connector

Miscellaneous: PC board, suitable enclosure, 6-foot 25-conductor straight-through cable, solder, etc.

Note: The following items are available from Optoelectronics Inc., 5821 N.E. 14th Ave., Ft. Lauderdale, FL 33334 (800) 327-5912, in Florida (305) 771-2050, FAX (305) 771-2052: Complete Kit of all parts to build the PC10, including software, $299; OE10 ASIC, $49; PC10 PC board, $59; software, $5; programmed PAL, $19; assembled and tested PC10, $339; complete kit of all parts to build the AP10H, $179; AP10H PC board, $39; machined and painted cabinet, $49; 6-foot 25-conductor straight-through cable, $20; assembled and tested AP10H, $229. Send SASE for priced out parts list. Include 5% shipping and 6% sales tax when shipped to Florida address.



FOIL PATTERN for the component side of the PC10 board.

the user can choose no prescale, prescale by 4 or prescale by 16. The remaining items are grayed, indicating that they may not be chosen. If the high-impedance amplifier is chosen, the user can choose to include low-pass filtering. Signal polarity may be set to positive or negative. Last, the voltage threshold may by changed to any value between −0.5 and +2.5 volts.

The Calibrate dialog box appears when the Configuration menu item "Calibrate" is chosen. That dialog box allows the user to calibrate in software the timebase of the PC10 from an external frequency source. *Before* selecting this item, the user must first set up the Input Assignments dialog for the proper input. The user then enters the reference frequency and hits the OK pushbutton. The dialog box will disappear and a dialog box giving the measured reference frequency will appear after about 25 seconds. The user can confirm that measurement by hitting the OK button. The reference frequency will then be stored in the WIN.INI file in the Counter section.

The Units dialog box, which appears when the Units item is selected from the Configuration menu, allows the unit of measurement to be selected. For frequency measurement, Hz, kHz, MHz, GHz, and RPM/CPM (revolutions or cycles per minute) may be chosen. For period, interval and pulse-width measurements, seconds, milliseconds, microseconds, or nanoseconds may be selected.

The Fonts dialog box appears whenever the Fonts item is selected from the Configuration menu. That dialog box allows the user to select the font and its size to match the user's video configuration. The selected font is then stored in the WIN.INI file in the Counter section.

The Hardware dialog box appears the first time the program is run, or whenever the Hardware item on the Configuration menu is selected. That allows the user to inform the Windows program what DIP switches are set on the PC10 board. The user checks boxes on the menu to match the setting on the PC10 board.

The Logging dialog box, which appears when the To File item is

selected on the Logging menu, informs the Windows program of the file chosen to log measurements. The filename of the logging file is entered into an edit box. The user can also select if time, date, and units information is to be stored with each measurement.

The Radio Select dialog box appears when the Radio item is selected from the SetRadio menu. That allows the user to select which radio the frequency measurement will be sent. One radio from a list of more than 10 radios may be chosen, and the choice will be saved in the WIN.INI file in the Counter section.

Whenever the Threshold item is selected from the SetRadio menu, the SetRadio Threshold dialog box appears. That allows the user to filter frequency measurements so that only valid measurements from strong signals are sent to the radio. The user selects how close successive measurements must be to each other, and how many consecutive measurements must appear before sending the measurement to the radio.

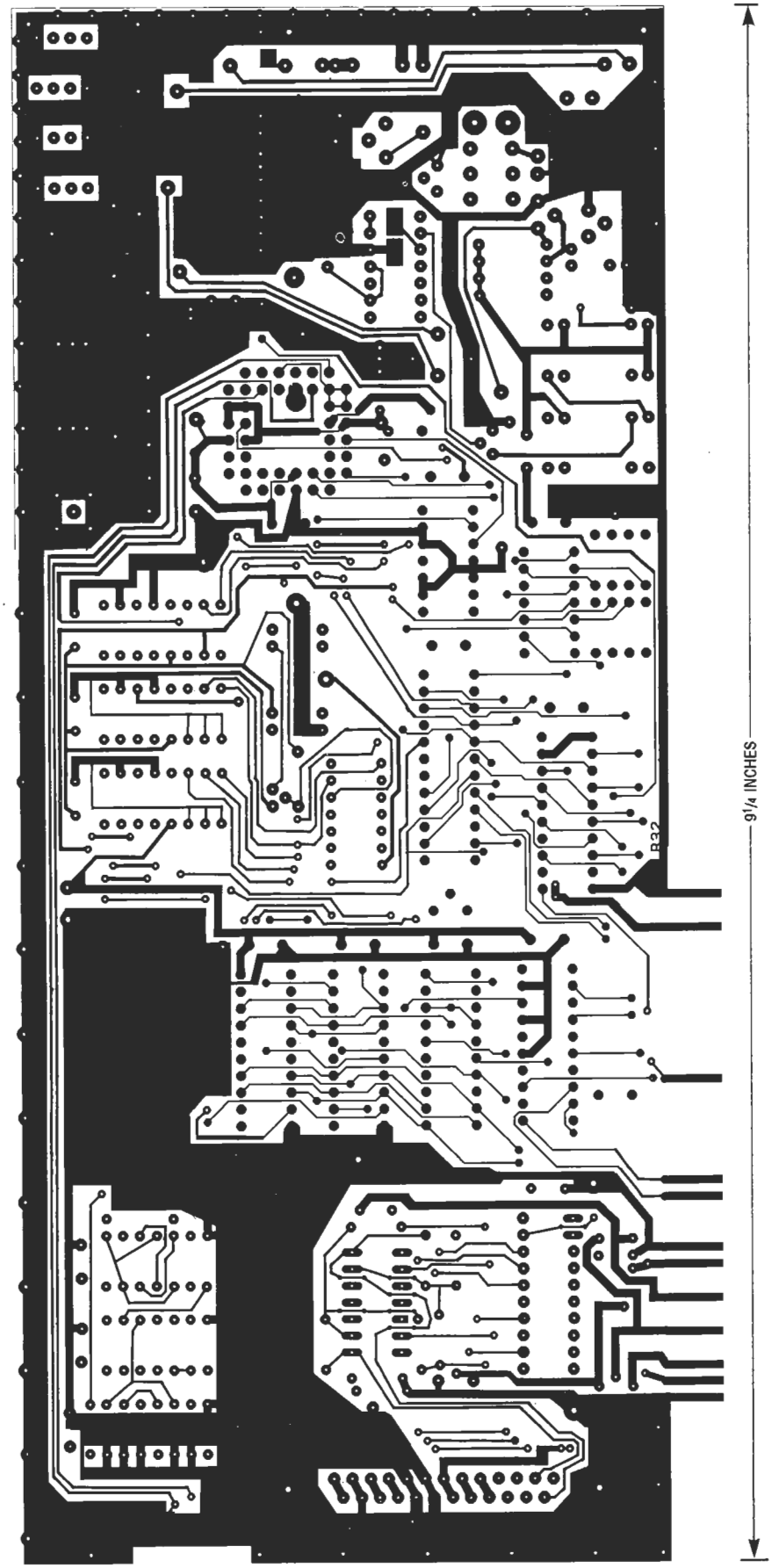
The Enable menu item on the SetRadio menu enables the PC10 to send frequency measurements meeting the requirements set in the SetRadio Threshold dialog box to the selected radio. If sending measurements is enabled, the menu item will change to Disable, allowing the user to stop sending measurements.

The ManualSet menu item on the SetRadio menu sends the last frequency measurement value directly to the selected radio. It bypasses the filtering performed by the SetRadio Threshold dialog box.

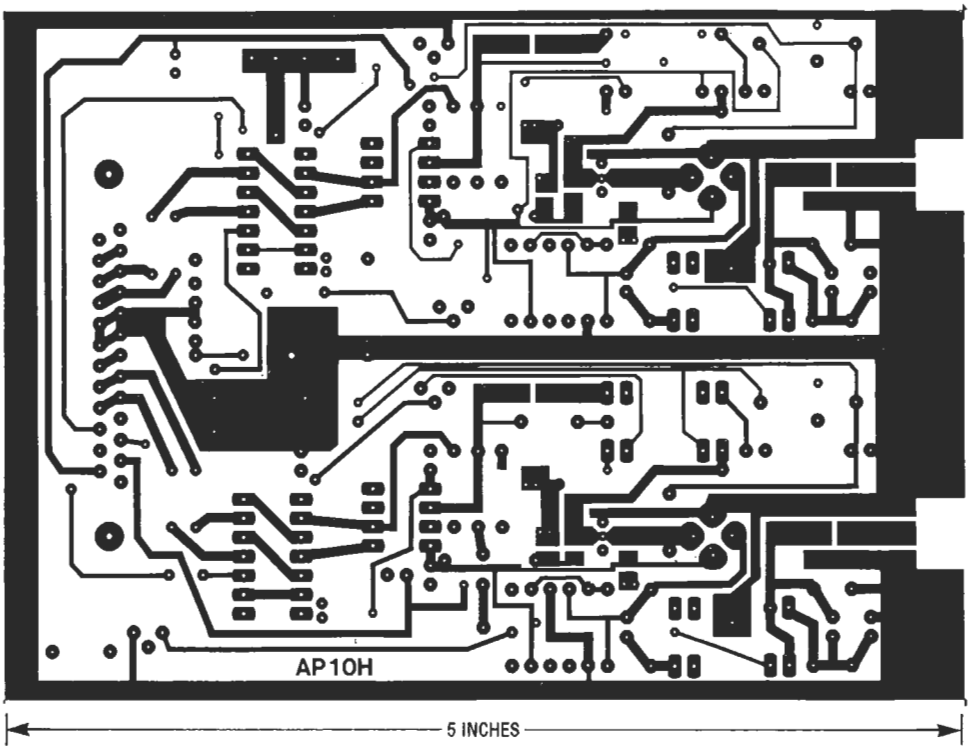
The program icon (also displayed on the ABOUT dialog box) is the Optoelectronics, Inc. logo. The software is available as mentioned in the sources box, and will also be posted on the RE-BBS (516 293-2283) as COUNTER.EXE.

Assembly

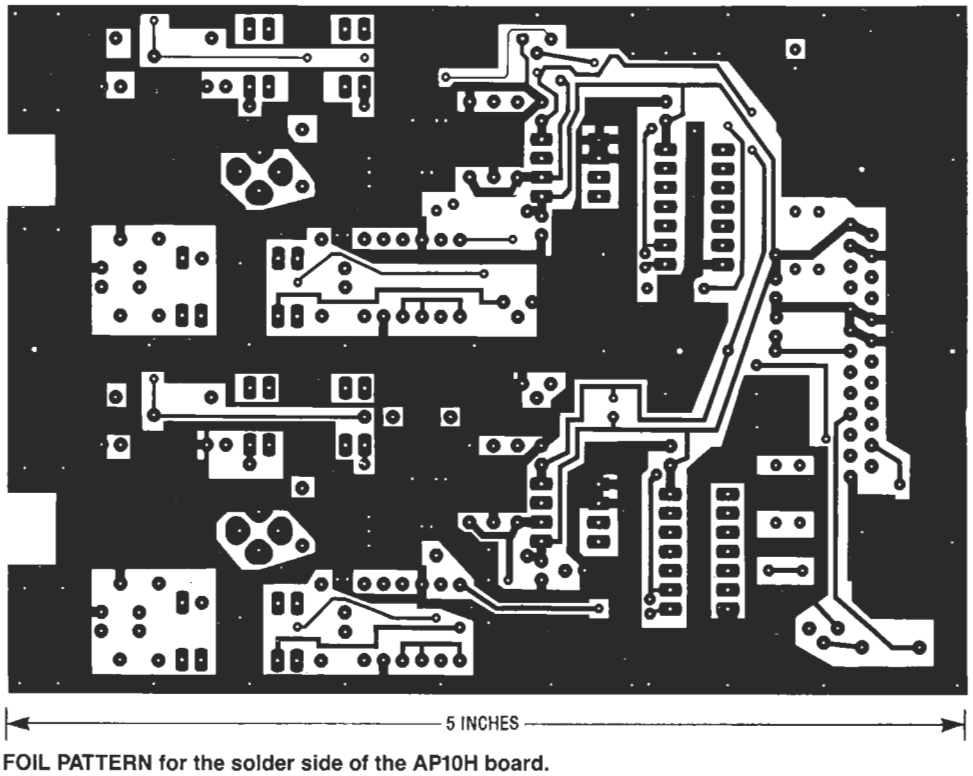
The PC10 mostly contains socketed IC's and leaded parts conventionally mounted. However, there are also some surface-mount components in the RF section. Figure 8 shows the parts-placement diagram for the PC10 board.



FOIL PATTERN for the solder side of the PC10 board.



FOIL PATTERN for the component side of the AP10H board.



FOIL PATTERN for the solder side of the AP10H board.

You will notice that, in Fig. 8, certain parts and groups of parts are labeled G1 and G2. This project can be built for several different applications and, depending on the application, certain parts can be left off the board for significant cost savings.

To build a 10-MHz-to-2.4-GHz RF frequency counter, all G1 parts must be installed, and G2 parts can be omitted. In that case, the AP10H amplifier is not needed. To build a 10-Hz-to-100-MHz universal counter, all G2 parts must be installed, and G1 parts can be omitted; the AP10H is required. Otherwise, for a 10-Hz-to-2.4-GHz universal counter, all G1 and G2 parts must be installed and the AP10H is also required.

Also note points E1, E2, and E3 as indicated in Fig. 8. Normally, for the GO version (all G1 and G2 parts installed), you must jumper point E1 to point E2 using a short piece of shielded coaxial cable. For the G1 version (G2 parts left out), jumper E1 to E3. For the G2 version (G1 parts left out), no jumper is required.

Install the surface-mount resistors and capacitors first while the PC board is open. If you haven't tried chasing a 1206 sized component all over the place with your soldering iron then here is your chance. While it does require some expertise, you will quickly learn the technique.

Melt a small amount of solder on one of the PC-board pads where the part is to go. Use a small pick to hold the part in place while heating the solder. Continue holding the part in place while the solder cools. After you are satisfied, solder the other end of the part to the PC board. Do not attempt to move or push against the part after one end has been soldered or you will stress the part and may damage it.

The PIN diodes have "DO" on top and look like surface-mount transistors. Solder them in place with the side of a single leg pointing to the top of the PC board.

The MMIC's must be installed with the input lead pointing toward the right (gold fingers down). The input lead is marked on the body (you may need a magnifier to see it). Trim the leads to fit on the PC lands between the capacitors. The two remaining leads are bent down to pass

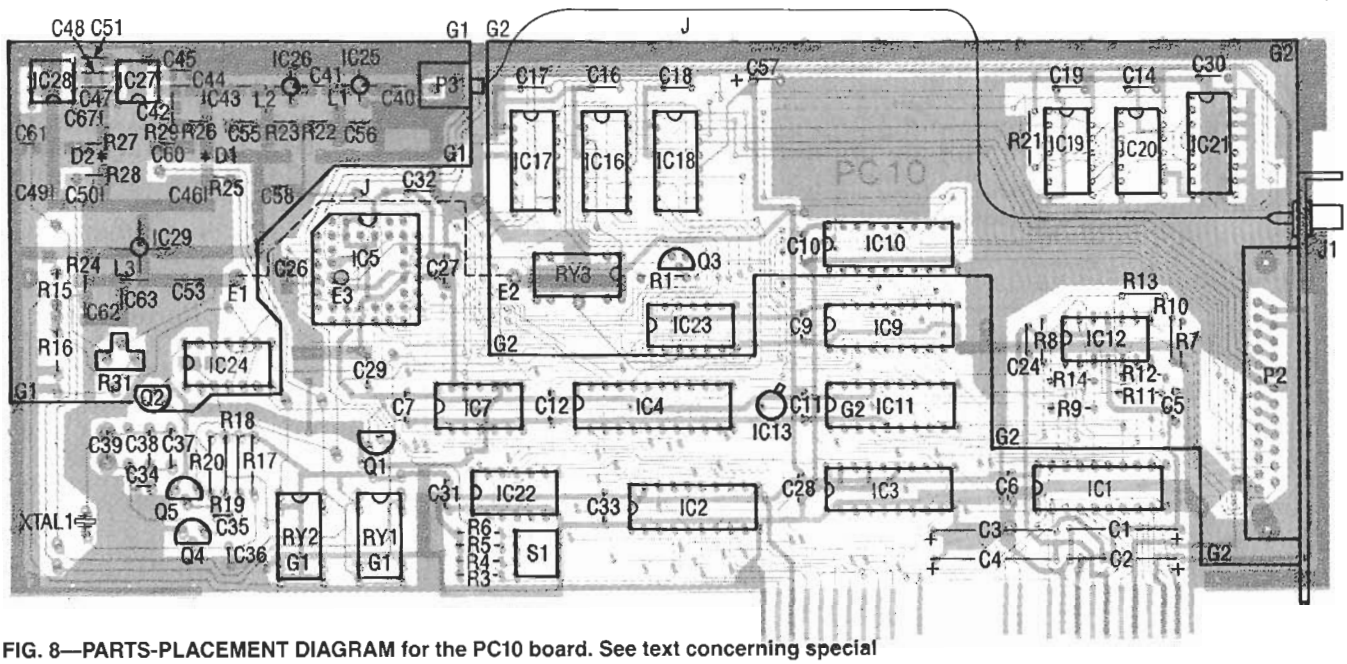


FIG. 8—PARTS-PLACEMENT DIAGRAM for the PC10 board. See text concerning special instructions for G1 and G2 parts.

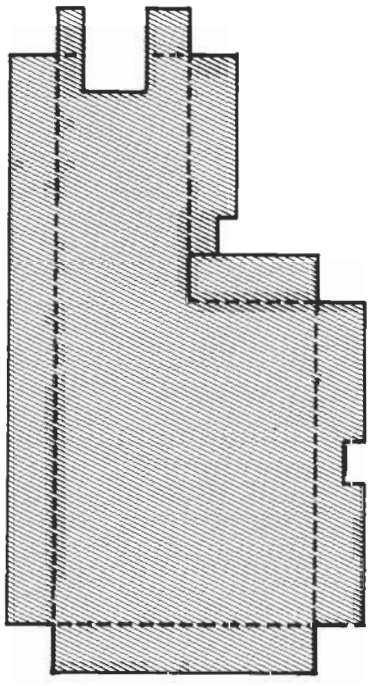


FIG. 9—HERE IS AN ACTUAL-SIZE template for a brass RF shield that goes over the surface-mount input section of the PC10 board.

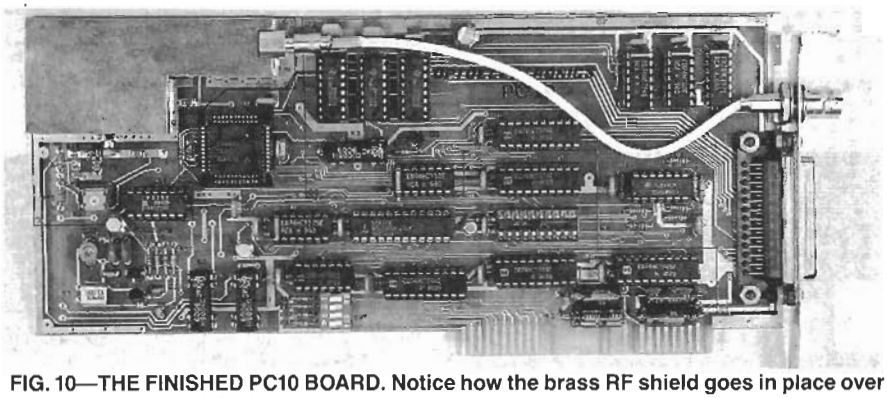


FIG. 10—THE FINISHED PC10 BOARD. Notice how the brass RF shield goes in place over the input section of the board.

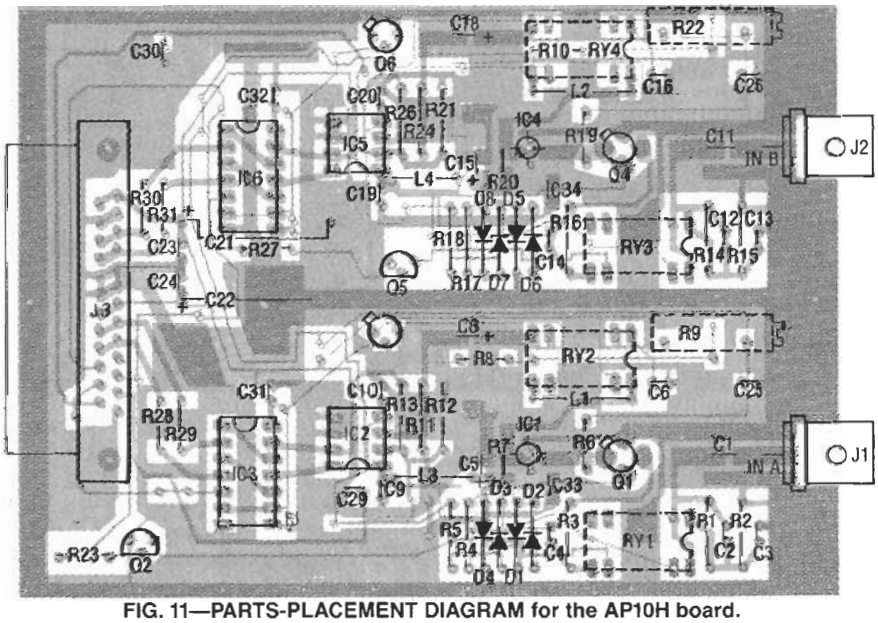


FIG. 11—PARTS-PLACEMENT DIAGRAM for the AP10H board.

through the PC board where they are soldered. Note that the body of the MMIC will fit in the hole drilled through the PC board. Solder the input and output leads first and then the two ground leads.

The three 100-µH chokes are soldered directly to the PC foil where indicated. Solder the two 8-pin prescaler chips into the PC board where indicated for the best possible high-frequency performance. Do not socket the 74HC157 because it will interfere with the BNC input connector.

Place and solder the 44-pin PLCC socket with the truncated

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