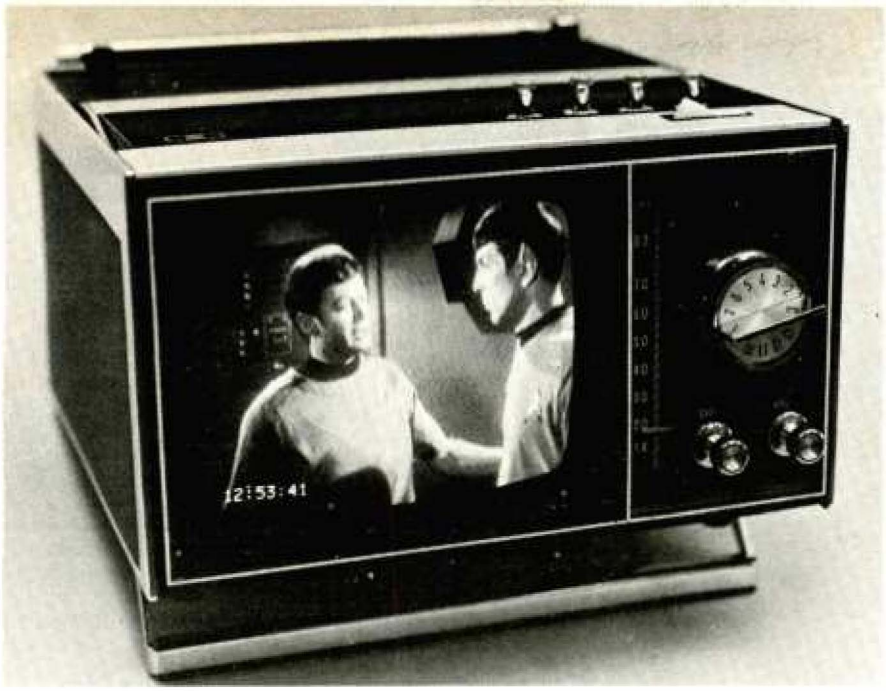


Get the exact time on your TV screen without interfering with the picture

Put the TIME on your TV screen

MANY RADIO-ELECTRONICS READERS HAVE asked for a way to connect their Superclock II (R-E, July and August '72) or other digital clocks to their TV set, so they can display time directly on top of an existing TV program. This eliminates the high cost of the self-decoding LED readouts from your Superclock design and is the ultimate in convenience for the discriminating TV viewer. When and if it is approved, the NBS (National Bureau of Standards) TV timing system is a natural source of self-resetting, always accurate signals for your Superclock, and the Revideo unit is the ideal output display.

You can also use the unit to transmit plant-wide or school-wide time, or to add time to a video recorder, cable TV system, or industrial recorder. While the unit was intended to give you an 08:18:36 style time display of any reasonable size positioned anywhere you want on the TV, it can be made to display *any* combination of eight letters, numbers, punctuation, or blanks. For instance, you could display the calendar date, the TV channel number, the temperature, the weather "CLOUDY"; "WARMER"; "RAIN"; etc. Or you can use it as a security monitor, a calculator readout, or anywhere else you want to display a changing, limited amount of alphanumeric information on a TV set or oscilloscope. The unit gives you complete control of presence, size, position, and contrast.

The Revideo unit consists of 14 IC's on a 4½×6¾-inch PC board and needs 5 volts dc at 200 mA and −12 volts dc at 25 mA. This is picked up from the clock, a lab supply, or from a small custom supply. The cost of the IC's come-to around $23, buying from the back ads in **Radio-Electronics**, and a complete kit of all *other* parts is available, as are individual PC boards—see parts list.

The TV Revideo unit will interface with the "1-2-4-8" *counter* outputs of any digital clock provided it uses the BCD code.

If you are using a one-chip or multiplexing clock circuit, you havce to make sure a BCD output is available and then add suitable simple latches so that all the outputs (1, 2, 4, 8, 10, 20, 40 minutes, and 1, 2, 4, 8, 10, (20?) hours are available all at once in parallel form.

The final outputs must be TTL compatible. Regardless of what type of clock you use, you have to end up with these parallel BCD outputs. Since these rarely already exist as output terminals or pins, you usually add a *short* piece of multi-conductor flat cable to the respective pins on the *counters* in the clock.

Before you begin—note two important things: The TV set *must* be modified to bring out horizontal and vertical trigger pulses and a video input. If done properly, this is easy and cheap, and only adds to the value of the TV. In no way will it hurt normal operation. Secondly, if the receiver is a hot-chassis type, you'll have to either use an isolation transformer or else run the entire clock "hot-chassis" and properly safely-isolated as well. A schematic of the TV you're going to use is a must; a good scope will also be essential to modify the TV.

Understanding TV scanning

A TV set has a raster scan. Once every 1/60th of a second, a spot starts at the upper left hand corner and rapidly scans to the right and slowly downward, generating a series of 262 1/2 lines. Video is produced by controlling the brightness of, or *modulating*, the spot. During the next 1/60th of a second, the TV generates another 262 1/2 lines, putting these *between* the ones it did on the previous go-around. The two *interlaced* 1/60th second *fields* make up a 1/30th second *frame*, the time needed to display one complete, stationary picture of 525 lines. By presenting 30 stationary frames per second, the pictures appear to move, since the eye cannot respond to each individual frame, but can only average them out for a final result. The fancy interlace scheme is used to reduce the apparent flicker.

The horizontal scan time, or the time to generate one line, is around 62 microseconds, of which 50 microseconds is spent in the actual scan and the rest in returning the *blanked* or turned off beam to the left side of the picture. A horizontal *synchronizing* pulse of some 5 microseconds is centered in the return blanking interval. It is used to lock the TV's horizontal scan to the scan at the TV camera. Obviously, the camera has to be looking at the same place the TV set is at the same time if we don't want a rolling or scrambled picture.

The vertical scan time lasts the entire 1/60th of a second. About 800 microseconds of this time is reserved for retrace. A vertical sync pulse 180 microseconds wide is centered in the blanking interval to lock the TV's vertical scan to that of the camera and the transmitter.

We can't change what the TV scan is doing or where it is at any particular time. This means we can't use stroke or segment style numerals on our time display. We have to use a bunch of dots, gettings the dots to crop up at the right place and the right time to present a final numeral or character in a stationary and recognizable place.

We can easily sum an output signal from the Revideo unit right into the TV's video amplifier and present a composite time-on-picture display. The problem is to get the right dots in the right place at the right time. Fortunately, there is a stock MOS computer-on-a-chip that does most of the work for us.

To generate the dots, we have to derive a

horizontal trigger pulse and a vertical trigger pulse from the working TV and use these to synchronize and control the number generator. The vertical pulse is easily obtained from the vertial output stage and is attenuated to logic levels with external resistors and a coupling capacitor. While we could alsouse the horizontal output signal, this is usually a bit too strong and could detune the TV's flyback transformer. So, we have to find an equivalent positive-going horizontal pulse, such as off the plate or collector of the age keyer. This signal is also attenuated with external resistors and capacitors to present a logic-level-sized, positive-going output pulse.

Fig. 1 is a block diagram of the TV Revideo unit, while Fig. 2 takes you through the timing sequence of a single field. The Revideo unit has two parts—the *timing* portion and the *signal processing* portion. The signal processing portion picks the right input number and converts it to the proper dot sequence at the proper place in the picture. The timing tells the signal processor when to do what, and locks things into the TV's vertical and horizontal scanning.

Choosing a character

We could get by with a numeral 3 dots wide by 5 dots high, but it wouldn't be very pretty, and there's no standard IC that will do the job. Instead, we use a computer standard 5-dot-high number or letter that we can ge out of a standard ASCII alphanumeric character generator IC. To keep the timing simple and to still allow enough circuit setup time, we use three blank "udots" between each character. We also let the timing run for an eighth line at the bottom, generating all blank undots. This gets us by with a standard divide-by-eight counter.

While a seven-line-high character would do the job, it would be very small. It would also mean that you would have all sorts of interlace problems. So, we go to 14 lines of character height, putting identical information on both fields and solving both problems at once. Now, if you want the same thing to seven *pairs* of lines on *each* field, and end up with a 28-line-high character. Thus you have a choice of two possible character heights.

Now, we somehow have to get the right part of each numeral in the right place at the right time. This is what the Revideo unit is all about.

At the beginning of a field, a vertical trigger pulse trips a monostable delay that sets the vertical position of the numeral display. (Step 1, Fig. 2). Since the monostable could end up anywhere on the screen, it tells a *synchronizing* circuit to pick up the *next* eight *whole* horizontal lines and to allow a video output only during those lines. We use the first seven lines for numeric output; the final line is a blank. If, instead, we are using the double height characters, the *next* sixteen *whole* horizontal lines are picked, presenting 14 lines of numeral and 2 lines of blanks.

As we adjust the vertical position, the entire display moves up or down the screen to where we want it. Since the line counter is always working on *whole* horizontal lines, the vertical position control does not affect the side-to-side numeral positions, and the start of each numeral takes place on each field exactly the same distance from the side

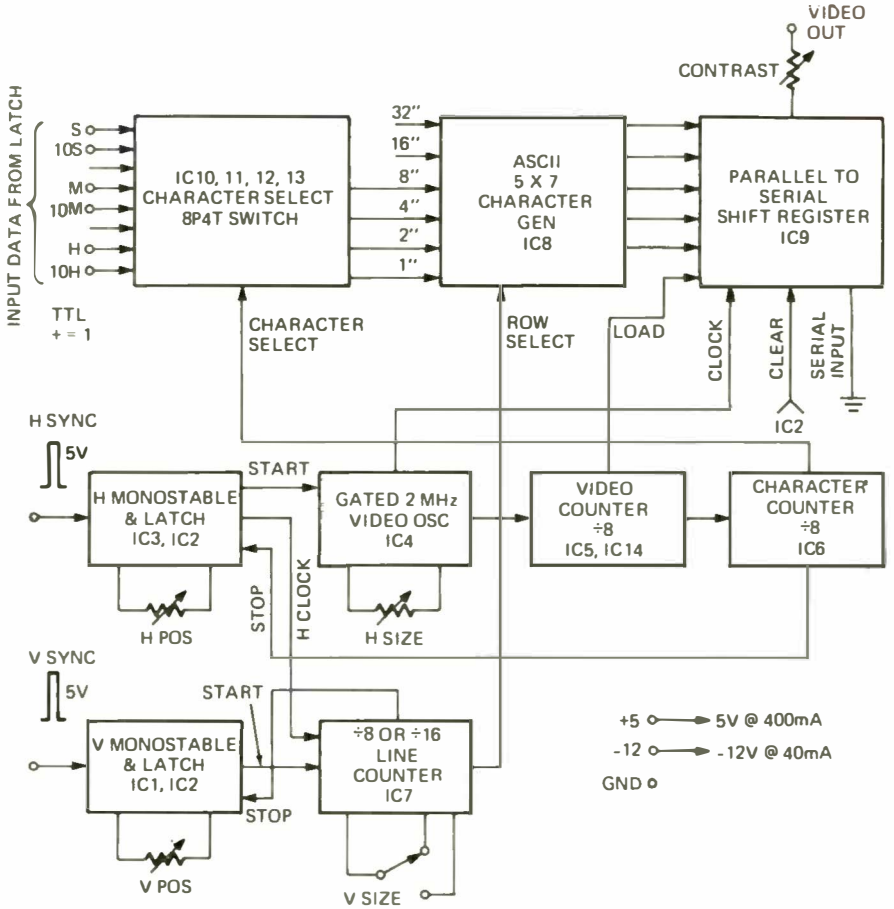


FIG. 1—REVIDEO UNIT for digital clocks, showing input and output connections.

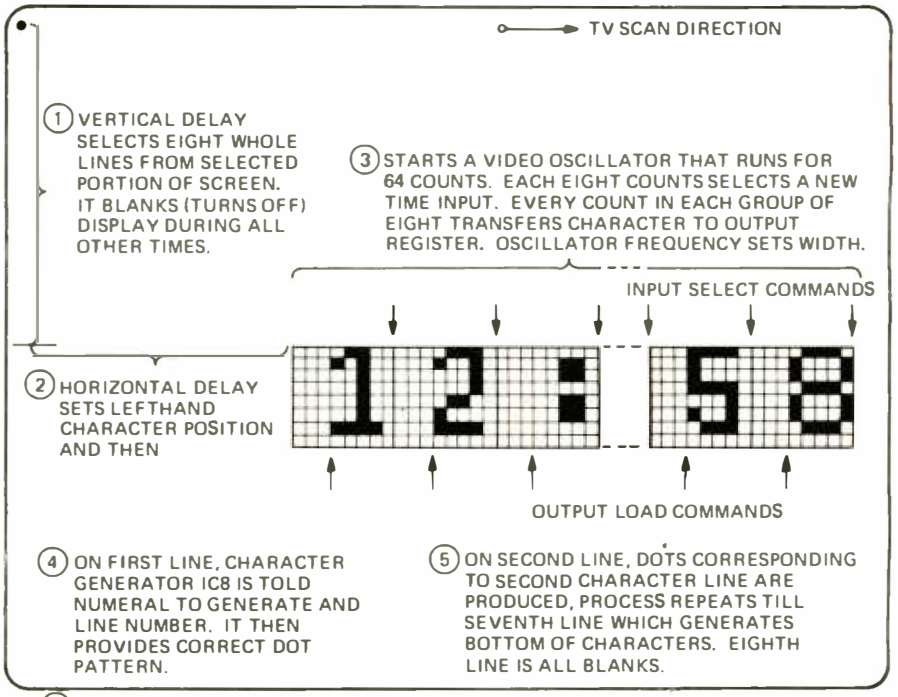


FIG. 2—TIMING OF A SINGLE FIELD

of the screen.

So much for the vertical action. Now (Step 2, Fig. 2) once each horizontal line, we start a delay monostable that tells us how far over to the right the display is going to be —this is our horizontal position control. After the delay is complete, a *video oscillator* is started and counts out exactly 64 counts and then shuts down. The *frequency* of the video oscillator determines the spacing between counts, and thus determines the horizontal size of each numeral. The 64 counts are grouped into eight groups of eight counts each. The first group

is for the ten hours, the second for the hours, the third for a colon, and so on, out to the final eight, which are for the seconds information. The first three counts of each group is for the three blank-between-numeral undots and for settling time. The numeral undots and for settling time. The final five counts of each group are for the five possible numeral dots in each line.

The read-only memory computer character generator is the heart of the circuit. It has three input lines that tell it what line of the numeral it is working on, and six input lines that tell in which of 64 possible letters, numbers punctuation, or blanks to work on. When it is told which line of what character to generate, it outputs a group of five dots or undots that are needed for that part of that character. These five bits of information are then loaded into a shift register and marched out as video, nicely putting the right thing in the right place at the right time.

An eight-position selector switch precedes the character generator and picks the right input for each of the eight slots across the screen. The character generator combines this with an input from the line counter to decide what pattern of dots to produce. A three-count delay is allowed between the time we change the input to the character generator and load its output—this lets things settle down and gives the character generator a chance to operate. Thus, the output of the character generator is loaded into the shift register on the falling edge of the *third* count in each group of eight video oscillator pulses; the input selector is changed on the beginning of the *first* count in each group.

The character generator starts with the tops of all eight numerals on the first horizontal line. On the next line, its line counting input changes, and it puts the second row of dots down for each numeral. It continues this way down to the seventh line when it puts down the bottoms of all the numerals. The next lineis a bunch of blanks, and after that, the circuit shuts down till the next field.

The ASCII character code

The input code for the character generator is shown in Fig. 3. The 64 possible inputs are represented by six lines. For numerals, the bottom four lines are simply the BCD or binary coded decimal representation of the numbers, exactly the same code used in the Superclock and the majority of digital clocks. If we wanted to have all the letters and numbers, we'd need a six-pole input selector. But for just numbers, we can hard-wire 1's (+5 volts) to the two most significant inputs, and we get by with only four poles worth of input selector. A colon is neeely a BCD "ten," or 1010.

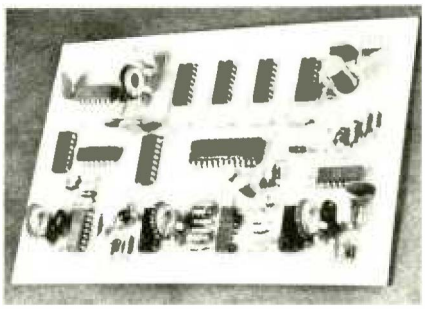
If we brought all the leads out, there would be 32 of them on the input. It turns out we can save on input wires by hardwiring what we aren't going to change or don't need. For instance, we can put the colons in permanently in positions three and six. We don't need the 80 hours and 40 hours inputs, so we can made these permanently zero or ground. We don't need the 20 hours input if we are using only a 12-hour display, but we do need it for the 24-hour version. Similarly, we don't need the 80 minutes and 80 seconds inputs; these can also be zeros. This reduces the input leads to 19 or 20. These can be a small flat cable (or two) a foot long

ASCII CHARACTER CODE

fedcba		fedcba	
000000	@	100000	BLANK
000001	A	100001	!
000010	B	100010	"
000011	C	100011	#
000100	D	100100	$
000101	E	100101	%
000110	F	100110	&
000111	G	100111	'
001000	H	101000	(
001001	I	101001	)
001010	J	101010	*
001011	K	101011	+
001100	L	101100	COMMA
001101	M	101101	DASH
001110	N	101110	PERIOD
001111	O	101111	/
010000	P	110000	0
010001	Q	110001	1
010010	R	110010	2
010011	S	110011	3
010100	T	110100	4
010101	U	110101	5
010110	V	110110	6
010111	W	110111	7
011000	X	111000	8
011001	Y	111001	9
011010	Z	111010	:
011011	[	111011	;
011100	\	111100	<
011101	]	111101	=
011110	^	111110	>
011111	UNDERLINE	111111	?

a = a_0 = WEIGHT "1" = PIN 17 OF IC8 (FIG. 1)
b = a_1 = WEIGHT "2" = PIN 18 OF IC8
c = a_2 = WEIGHT "4" = PIN 19 OF IC8
d = a_3 = WEIGHT "8" = PIN 20 OF IC8
e = a_4 = WEIGHT "16" = PIN 21 OF IC8
f = a_5 = WEIGHT "32" = PIN 22 OF IC8
"1" = +3 TO +5 VOLTS
"0" = GROUND

FIG. 3—ASCII CODE (The American Standard Code for information Interchange).



THE REVIDEO UNIT, carefully constructed, works as well as it looks.

that plugs directly into the readout sockets on the Superclock.

The circuit

With these operating principles in mind, let's turn to the actual circuit and parts lists of Figs. 4 and 5. The H and V inputs are conditioned with Q1-D4 and Q2-D5 respectively and then fed to monostables IC3 and IC1 for the horizontal and vertical position delays. At the end of their delay times, the pair of latches in IC2 are respectively set. The vertical latch (pins 8-12) releases the clear on a divide-by-eight or a divide-by-sixteen counter IC7 that counts out the horizontal lines used for the active portion of the display. The V SIZE control jumper lets you pick a normal or double height character.

Once each horizontal line, the horizontal latch (pins 1 to 16 on IC2) releases a clearing clamp on the video oscillator IC4, the divide-by-eight video counter (IC5) and the cascaded divide-by-eight character counter (IC6). The video oscillator is a free running astable multivibrator when it is not being clamped by IC2. Its frequency is coarsely controlled by C11 and finely adjusted by R24, the horizontal size control. After exactly 64 counts, the H latch is cleared, the counters are clamped to 0000 and the video oscillator is stopped to await the next horizontal line.

The video counter goes around eight times and controls the output loading and spacing. It changes the input selector address just before its *first* count, and provides a shift register IC9 (Fig. 5) load count on the falling edge of its *third* count. This automaticially transfers the contents of the character generator IC8 to the output register after a three-count settling delay. Three undots, or the space between numerals is generated during the three-count settling time. The final five counts of each numeral sequence are for the actual numeral video.

The character counter goes around only once per line, stepping a four-pole, eight-position input data selector IC10-13 once around as needed, routing the report inputs to the character generator in the right time slots. Character generator IC8 receives this data, along with a what-line-is-it? command from the line counter IC7. The character generator then outputs the proper dot combination to the output register IC9 which in turn marches the dots out as video.

Building it

PC boards are commercially available for this project, as are parts kits—see the parts list. If you are building and etching your own board instead, a full size replica appears in Fig. 6. Components are loacted as shown in Fig. 7.

Start assembly with the jumpers and the smaller components, followed up by the IC's and finally the control pots. Use a small iron and fine solder and be sure to observe which IC goes where and the code notch and dot on each one. Also, watch out for diode and electrolytic capacitor polarities. Chances are you'll want to start with the larger character size, so jumpers the two upper "28" holes in the V SIZE box. Do not unwrap IC8 or remove it from its protective foam until you have modified the TV suitable and have *completely* tested the rest of your circuit.

Modifying your television

You'll need three modifications on your TV. One is to provide a new video input to sum the time on top of the existing program. One is to derive a narrow, positive-going, vertical sync pulse of 3 to 5 volts amplitude across a 10,000-ohm resistor. Finally, you have to derive a suitable narrow positive horizontal sync pulse of 3-5 volts across a 10,000-ohm resistor. *Any* method you use that doesn't obviously affect the TV operation and still gets the job done is acceptable, and the best way varies from brand to brand and model to model.

Before you modify your television, sit down carefully with a complete schematic or *PhotoFact* set and locate suitable tie-in

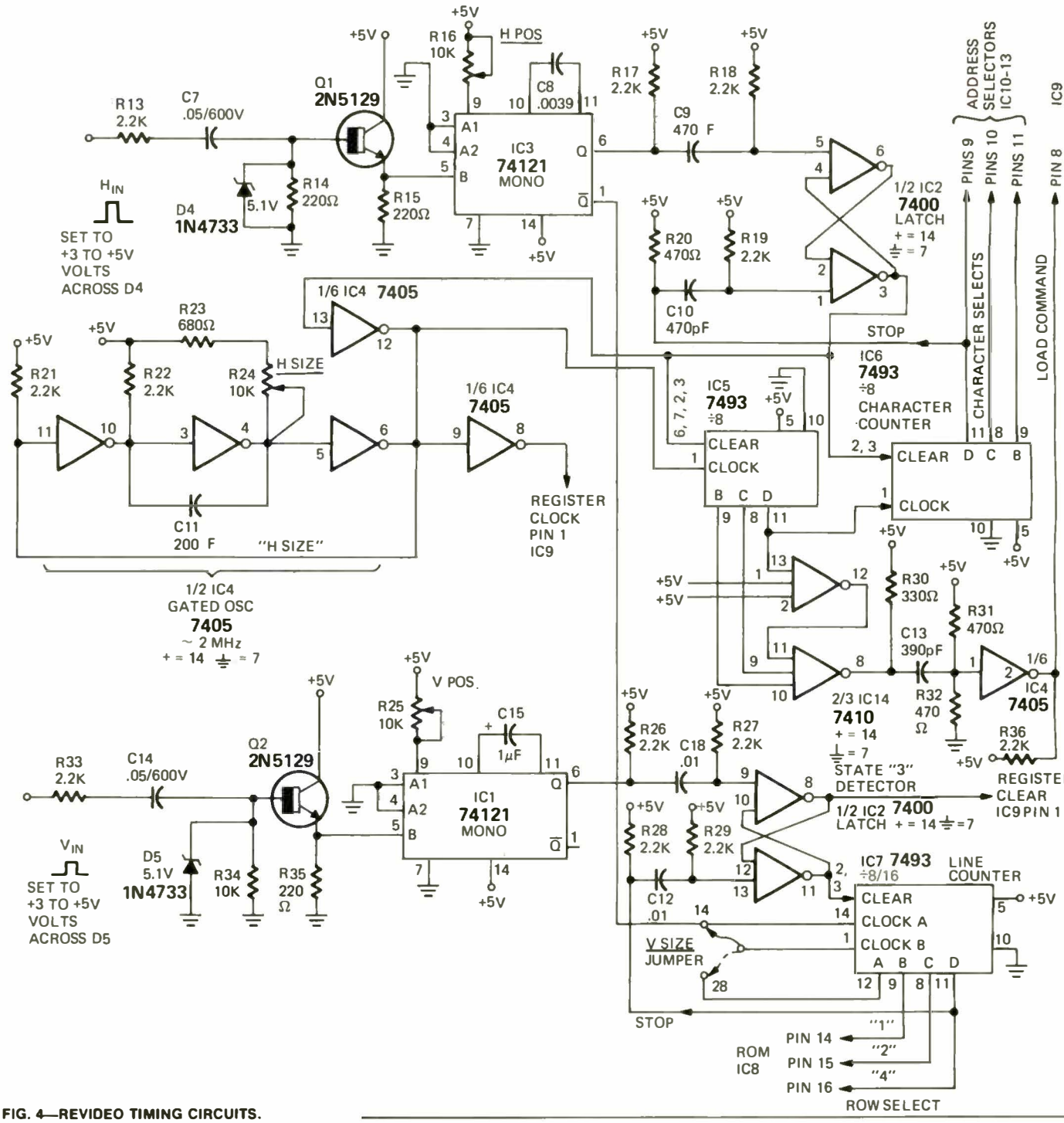


FIG. 4—REVIDEO TIMING CIRCUITS.

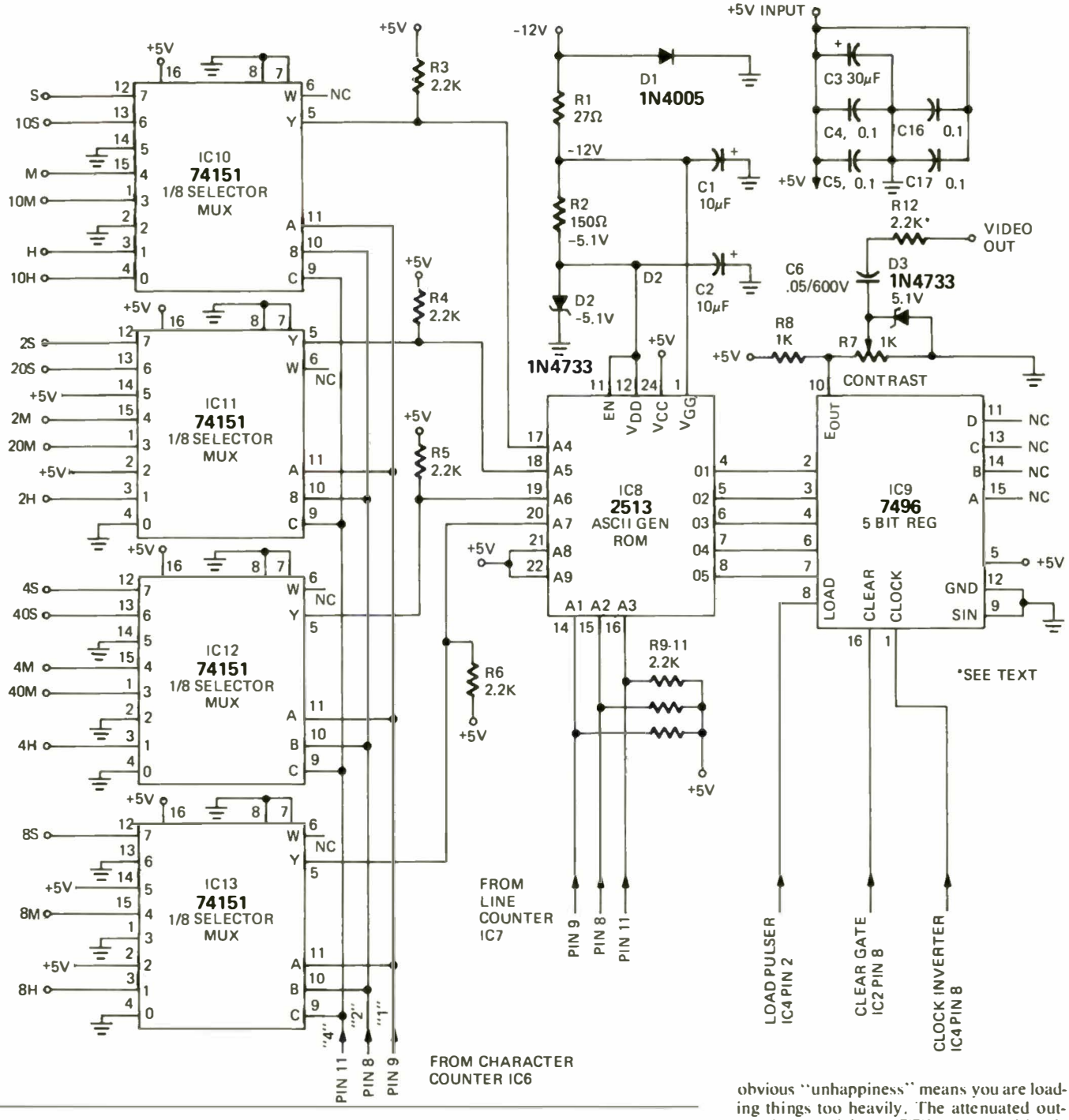
points. An oscilloscope is almost essential for this, even if you have extensive electronics experience. Fig. 8 suggets some possible interface points.

Let's start with the video. This can usually be injected into the grid or base of the first video amplifier stage, most likely through a 3,300-ohm series resitor and 0.1-μF coupling capacitor. The optimum network here is one that doesn't degrade the normal picture response, yet at the same time provides enough numeral contrast. Be sure to pick a point that gives you *white* numerals. This means a point in the circuit where more positive means *whiter*. Adjust the value of R12 for the desired numeral contrast.

On a tube TV, a whole bunch of attenuation will be required to bring the trigger signals down to size. One good place to et the vertical triger signal is the plate or col-

COMPLETE

C1, C2—10-μF, 15-volt electrolytic
C3—30-μF, 6-volt electrolytic
C4, C5, C16, C17, C18—0.1-μF, 10-volt disc ceramic
C6, C7, C14—0.05-μF, 600-volt mylar
C8—.0039-μF polystyrene
C9, C10—470-pF poly, mica, or disc
C11—200-pF polystyrene or mica
C12, C16—0.01-μF, 10-volt disc ceramic
C13—390-pF polystyrene or mica
C15—1-μF, 15-volt tantalum electrolytic
D1—1N4001 or equivalent silicon power diode
D2, D3, D4, D5—5.1-volt, 1-watt Zener diode, 1N4733 or equivalent
IC1, IC3—72121 TTL monostable
IC2—7400 TTL quad two-input gate
IC4—7405 TTL open collector hex inverter
IC5, IC6, IC7—7493 TTL divide by sixteen
IC8—2513 ASCII character generator (Signetics)
IC9—7496 TTL five-bit shift register
IC10 to IC 13—74151 TTL one-of-eight selector
IC14—7410 TTL triple three-input gate
Q1, Q2—2N5129 transistor
R1—27-ohm, carbon
R2—150-ohm ½-watt carbon
R3, R6, R9, R13, R17, R22, R,26, R29, R33, R36—2.2K, carbon
R7—1K upright mounting PC potentiometer
R8—1K, carbon
R14, R34—10K, carbon
R16, R24, R25—10K upright mounting PC potentiometer
R23—680-ohm carbon



PARTS LIST

R29—4.7K, carbon
R30—330-ohm, carbon
R20, R26, R31, R32—470-ohm, carbon
R15, R35—220-ohm, carbon

All resisters ¼-watt unless noted

Miscellaneous

PC Board, 4 × 6½ inches; PC terminals, optional (25); No. 24 wire jumpers and sleeving; mounting hardware; Flat 16-conductor input cable (2 lengths); solder; TV interface connector and lead kit (optional); gating switch (optional);

NOTE: The following is available from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas, 78216; Circuit Board, etched and drilled No. RV-1, $2.85
(IC's are considerably cheaper from surplus and volume suppliers listed in **Radio-Electronics** ads than could be offered as part of a kit—the kit is thus split to give the **Radio-Electronics** reader the lowest possible unit price.)

lector of the vertical output stage. This will be several hundred volts high and a suitable narrow, positive going spike. Cut it down to size with two series 470K, 1-watt resistors and a 005-μF, 600-volt coupling capacitor. Use two series capacitors if the voltage is higher. When the network is added to the TV, nothing drastic should happen. A slight change in picture height or hold setting might occur, but any tearing, breakup, or obvious "unhappiness" means you are loading things too heavily. The attenuated output has to drive a TTL monostable. It should stay below 0.8 volts most of the time: the narrow positive portion of the output should be 3 to 5 volts high with the Revideo unit connected. Unconnected, the signal should be *twice* as great (6-10 volts).

Don't try using the horizontal output stage as a trigger point—besides being lethal we coulddetune the flyback and cause all sorts of problems. So, look around for another, tamer narrow horizontal trigger pulse. On older tube TV's the plate of the age keyer should have a several-hundred-volt narrow positive pulse suitable for our needs. Attenuate it down to the same size as the vertical trigger is—mostly below 0.8 volts except for a narrow, 3 to 5-volt positive pulse with the Revideo unit connected. 6-10 volts on open circuit.

Which transistor TV's, the voltages generally will be lower and somewhat less attenuation (lower value resitors) will be

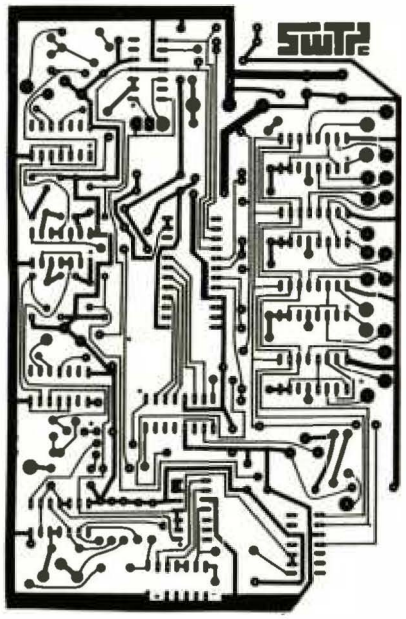


FIG. 6—LAYOUT OF THE PRINTED CIRCUIT BOARD, one-half actual size.

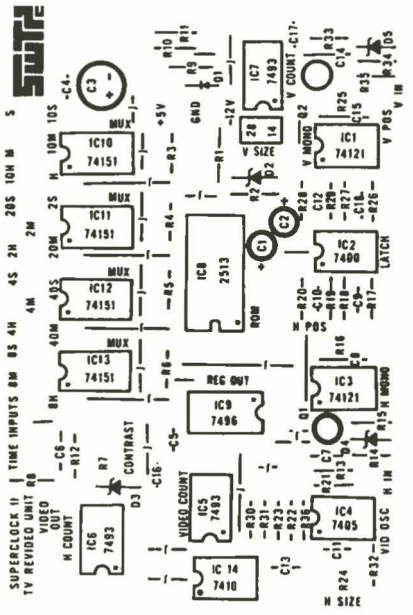


FIG. 7—THE COMPONENTS LAYOUT.

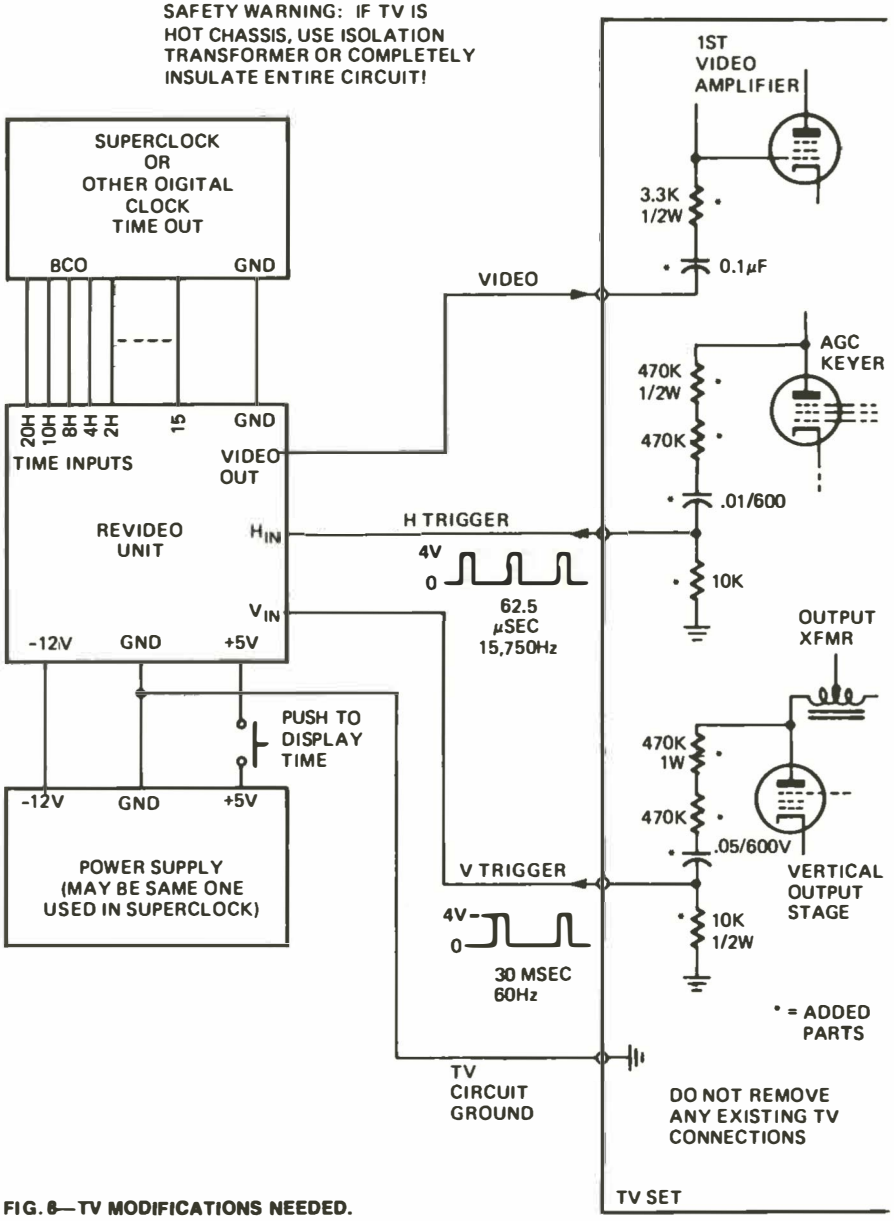


FIG. 8—TV MODIFICATIONS NEEDED.

needed. Since the total energy you need for triggering is negligible compared to the normal circuit needs of the TV, you should have no problem after a try or two. Above all, work with the schematic and the scope when you're modifying the TV and don't connect the Revideo unit up until you are *sure* you have safe and reasonable trigger signals. Remember that connecting the Revideo unit will cut the trigger amplitude in half—from 6-10 volts to between 3 and 5 volts.

Preliminary checkout

You'll also need a ground lead between the TV and the Revideo unit. A complete set of system interconnections is shown in Fig. 8. *Remember that if the TV has a hot chassis you'll have to use an isolation transformer or live with a completely "hands off" system!*

Leave IC8 uninstalled and the clock unconnected for the initial checkout. Apply suitable supply power and complete the television set to Revideo unit connections.

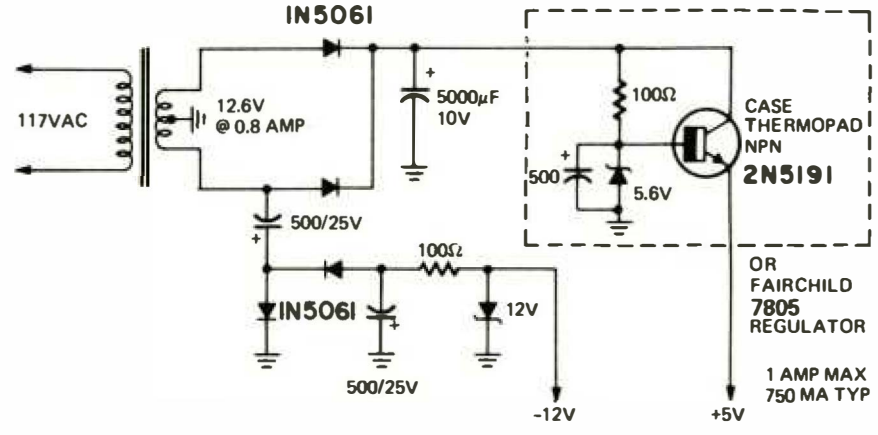


FIG. 9 — OPTIONAL POWER SUPPLY

(An optional power supply is shown in Fig 9; use it only if you can't get power from the clock, the TV or a handy bench supply.)

If everything is working right, you should have eight white boxes where the numerals are to go, and you can move them around and change their size as you want to.

If you don't have the boxes, use a scope to debug. Check first for proper trigger pulses on IC1 and IC3, followed by proper operation of the video oscillator and the three counters, finishing up with the output register and the stage-three decoder IC14. Usually trouble is caused by the input networks being wrong or crossed to the wrong inputs. *(continued on page 94)*

TIME ON TV SCREEN
(continued from page 42)

Once you have the eight white boxes, carefully measure the voltages where IC8 is to go—+5 on pin 24; −5 on 11 and 12; and finally −12 on pin 1. *Reverse supply voltage will instantly ruin IC13*, so even with the idiot-proofing network D1, R1 *be careful!*

IC8 is a MOS integrated circuit, and exceptionally careless handling could damage it. Leave it in the case and protective foam till you are ready to use it, then quickly solder it in place with a small soldering iron, watching to get the code dot and notch correct. After it is soldered in place, the circuit will protect the IC from most damage.

Reapply supply power, and the eight boxes should now read 1?:7?:7? if you have a 12-hour system and 3?:7?:7? if you have a 2400-hour one. The unconnected inputs are "read" as digital "1"s, as are +5 signals. Only a ground is read as "0". Do not connect anything to your clock until you have the exact display called for above. Once you are certain all is well, connect up the multiconductor cable to the proper place in your Superclock (either the inputs to the readouts or the 1-2-4-8 outputs of the various counters). Keep these short, preferably under 15 inches. The TV interconnects can be reasonably long, but avoid running across the room with them. When the clock is connected, you should have the correct time to your TV set and the project is complete.

Using it

Remember, you can turn the time display off and on by applying or removing the +5, by breaking the video line, or by breaking the vertical trigger line. If you experience some character breakup at the minimum horizontal width settings of the display, you can increase the −12V supply by a volt to −13, or, if you're real brave, you can short out R1. Should you want a bigger than the largest available time display, increase C11. For a very small display, decrease C11 and you can go down to the breakup point. With the circuit we've shown you, the *minimum* display size will be slightly *wider* than shown in the lead photo. You should be able to use the available controls to move the display most anywhere you want to place it on the screen and almost any size, within reasonable limits.

If you want to display something besides the time, you can rework the input data selectors and perhaps add two more to pick up the total alphanumeric capability of this circuit.

Should you want lots more than 8 numerals at a time and want internal storage as well, a much more elaborate TV ALPHABETIZER system is in the works here at RADIO-ELECTRONICS. We'll be telling you about it shortly. In the meantime, good luck on this project. **R-E**

MEASURE HI-FI PERFORMANCE
(continued from page 63)

Additional measurements

Another convenient pushbutton on the analyzer permits the user to directly measure and read the wattage consumed by any audio product from the power line source. There is also an eternal input to the digital readout module which lets you read the amplitude of any sinusoidal waveform up to 250 volts rms.

External inputs are provided through which signals may be fed into the instrument in the event that audio frequencies other than those built in are required for any reason. Such signals will, of course, have their amplitudes read directly by the digital module and are fully controllable by the switches and multiturn attenuation poteniometers of the analyzer.

The acquisition of the McAdam audio analyzer has, of course, simplified many of the audio measurements which I am called upon to make almost daily and I have found that it is relatively easy to interface this equipment with the rf equipment which is used for AM and FM measurements. For example, the Sound Technology FM generator model 1000A, shown standing atop my now displaced audio generator in Fig. 1, has provisions for external modulation. By modulating it with the available audio tones from the McAdam analyzer and connecting tuner or receiver under test to the output terminals of the analyzer, full use can be made of the distortion measurement facilities of the analyzer and THD as well as S/N readings can be made digitally as well. By continuing to use the internally supplied stereo composite signal generating facilities of the FM generator, separation measurements can also easily be made using the generator in combination with the McAdam analyzer.

The McAdam analyzer is not inexpensive, retailing for $3450.00, but even in the short time we have had an opportunity to use it in our daily lab work it has begun to pay off in terms of time saved and increased accuracy and reliability of measured results. **R-E**