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-encoding I.ED 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 Super-clock, 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 x 6-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, providing it uses the BCD code.

If you are using a one-chip or multiplexing clock circuit, you have 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 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 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, getting 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

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Get the exact time on your TV screen without interfering with the picture
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 vertical output stage and is attenuated to logic levels with external resistors and a coupling capacitor. While we could use the horizontal output signal, this is usually a bit too strong and could tune 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 get 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 “dots” between each character. We also let the timing run for an eighth line at the bottom, generating all blank dots. 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 interface 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 occur 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 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, and the 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...
When it is told which line of which 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 line 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 number, exactly the same code used in the Superlock 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. We get by with only four poles worth of input selector. A colon is 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 choose to change or don’t need. For instance, we can put the columns in permanently in positions three and six. We don’t need the 80 hours and 40 hours inputs, so we can make these permanently zero or ground. We don’t need the 20 hours input if we are using only a 2-hour display, but we do want it for a biser series. 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 or four long 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 latch is cleared, the counters are clamped to 0000 and the video oscillator is stopped at the next horizontal line.

The video counter goes around eight times and controls the output loading and spacing. It changes the input selector address and divides the divide-by-eight character counter and provides a shift register IC9 (Fig. 5) load count on the falling edge of its third count. This automatically 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 input data to the character generator in the right time slots. Character generator IC8 receives this data, along with a what-line-it’s 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 located as shown in Fig. 7.

Start assembly with the jumpers and the smaller components, followed up by the ICs and finally the control pot. Use a small iron and fine solder and be sure to observe which IC goes where and the code notches and dot on each one. Also, watch out for diode and electrolytic capacitor polarities. Chances are you'll want to start with the larger components and work your way toward the two upper “3K” holes in the size box. Do not unstack 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 of your TV and locate suitable tie-in
points. An oscilloscope is almost essential for this, even if you have extensive electronics experience. Fig. 8 suggests 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, more likely through a 3.3-kilo-ohm series resistor 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 bigger. 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 trigger signal is the plate or collector of R16, 10-kilohm, carbon.

IC5, IC6, IC7—7493 TTL divide by sixteen
IC8—2513 ASCII character generator (Signetics)
IC9—7406 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 1/2-watt carbon
R3, R6, R9, R13, R17, R22, R26, R29, R33, R36—2.2K, carbon
R7—1K upright mounting PC potentiometer
R8—1K, carbon
R14, R34—10K, carbon
R15, R24—2.2K 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 resistors 1/4-watt unless noted

Miscellaneous
PC Board, 4 x 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 0.05-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 could detune 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 agc 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 resistors) will be
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 ICR uninstalled and the clock unconnected for the initial checkout. Apply suitable supply power and complete the television set to Revideo unit connections.

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

SAFETY WARNING: IF TV IS HOT CHASSIS, USE ISOLATION TRANSFORMER OR COMPLETELY INSULATE ENTIRE CIRCUIT!

FIG. 7—THE COMPONENTS LAYOUT.

FIG. 8—TV MODIFICATIONS NEEDED.

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.

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TIME ON TV SCREEN

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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 rain 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 until 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 12...?! if you have a 12-hour system and 3...?! if you have a 24-hour one. The unconnected inputs are "read" as digital "11'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 on and off 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 break up 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.

MEASURE HI-FI PERFORMANCE

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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 external 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 multimeter attenuation potentiometers 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 new placed audio generator in Fig. 1, has provisions for external modulation. By modulating it with the available audio tones from the McAdam analyzer and connecting a 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

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