MODIFY YOUR TV FOR VIDEO INPUT

How to turn your isolated TV into an MPU terminal

THIS ARTICLE GIVES SOME HINTS on how to modify a normal television receiver so that a signal can be fed directly into the video circuit. This enables you to use your TV for video games or other video displays without needing to use an RF modulator.

Besides the obvious reduction of cost and complexity, the use of a direct video connection has the advantage of higher resolution. A good RF modulator is quite a complex device and because of the UHF signals it must handle, it calls for special construction techniques.

Once modified for external video input, the receiver can be used for a variety of experiments. It can be used with the VDU section of the microcomputer terminal that has recently appeared in ETI, or as a simple video monitor for black and white TV cameras. (For colour TV use much more elaborate circuitry would be required to ensure the required bandwidth and phase characteristics).

Normal Receiver Operation

Figure 1 is a block diagram of the signal processing section of a normal TV set.

The signal from the antenna is a low level UHF signal of a few microvolts amplitude. The tuner outputs a signal at the receiver's intermediate frequency, which is amplified by the IF stages to give an RF signal of about 1-2 volts peak to peak amplitude. The detector rectifies the output of the IF amplifier, usually by means of a diode, in much the same way as a crystal set. The result is a composite video waveform — that is

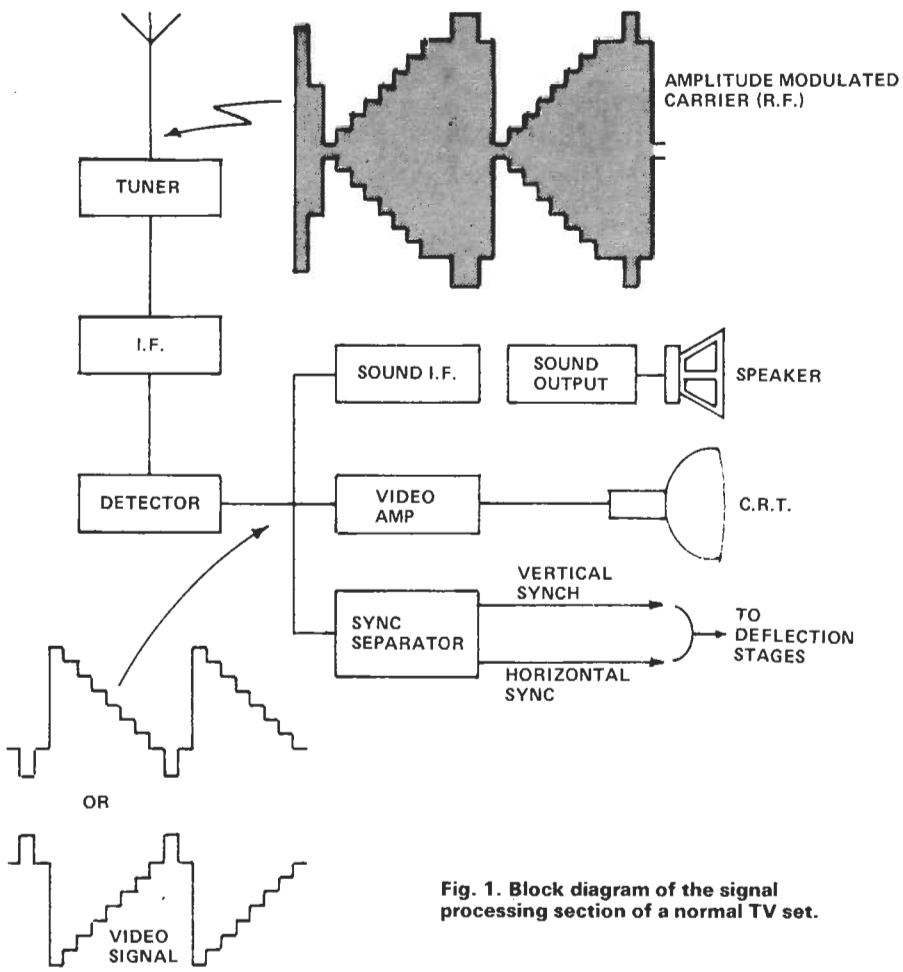

Fig. 1. Block diagram of the signal processing section of a normal TV set.

a waveform containing both picture and synchronising information. In addition, the 5.5 MHz sound carrier is usually extracted at the video detector.

This waveform would result from reception of a "staircase" test signal, which consists of a number of vertical bars ranging in greyscale from white to black. The output from the detector looks something like the waveform shown in Fig. 2(b). In this example it is assumed that the detector diode is configured so as to produce a more positive output with an increase in carrier amplitude.

The video amplifier provides a signal of sufficient amplitude for modulating the brightness of the dot displayed by the CRT.

The sync separator detects when the video signal reaches its maximum excursion, which corresponds to sync level. The horizontal and vertical sync pulses are then extracted from this composite sync signal and fed to the deflection circuitry.

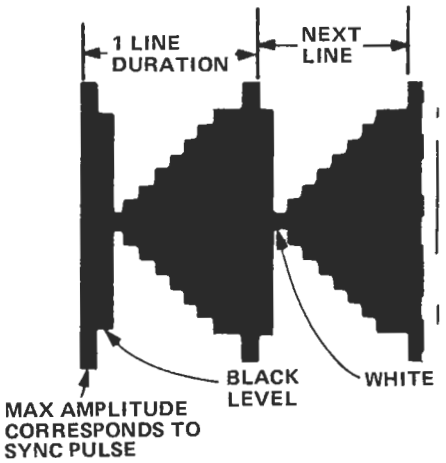

Fig. 2a. R.F. envelope before detection.

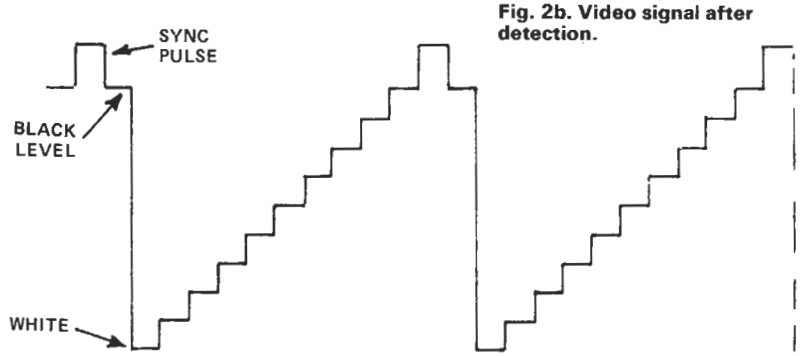

Fig. 2b. Video signal after detection.

Format

In England the vision information is put onto the radio wave at the TV transmitter using negative amplitude modulation. This means that the brighter the picture element is, the less the carrier amplitude. Maximum carrier amplitude corresponds to the sync pulses, minimum corresponds to white, and black level lies somewhere in between. The signal at the output of the IF amplifier therefore looks something like Fig. 2(a).

Requirements

The universally adopted standard for "line level" video is 1 volt peak-to-peak into 75 ohms positive-going (more positive means greater brightness). Most video games and the Video Display Unit in the ETI microcomputer terminal project provide such a video output suitable for feeding directly into a monitor or modified receiver. Alternatively an RF modulator can be used to generate a signal suitable for feeding into the TV set via the antenna terminals for viewing on a vacant TV channel. This latter alternative means that the video signal is modulated and then demodulated which can degrade the picture quality unless the modulator is carefully designed.

In many cases it is simpler to modify the TV set than build a modulator. The receiver can be fitted with a changeover switch which can be used to return it to normal reception when required, or an old black and white set can be butchered specifically for the job. In view of the low cost of second hand black and white sets it may be preferable to persue the latter course rather than strain family relationships by dissecting the new telly.

The modification involves feeding in the video signal where the detector normally goes. The input should be via a 75 ohm coaxial connector and it must present a 75 ohm terminating impedance to the source. In most cases a certain amount of additional circuitry will be required to match the 75 ohm, 1 V positive input to the impedance, amplitude and polarity required by the video stages of the receiver.

Before You Start

There are several important factors to consider before attempting the modification. Before you start check these points:

1 The TV must not be of the "hot chassis" type. These receivers do not use a transformer to isolate the works from the mains. In many cases one side of the mains connects directly to the chassis of the set. Check that the chassis is securely grounded via the power cord and that the power supply section does not use an isolating transformer. "Hot chassis" sets are not suitable for modifications. Moreover they are potentially lethal and should be left alone.

2 Unless you are sure about what's in your TV set you will need a circuit diagram of the chassis. These can be obtained from the manufacturers or their service departments.

3 Don't attempt the modification unless you are quite confident you know what you are doing. This is not meant to discourage the adventurous hobbyist spirit, but if you rush in without sufficient knowledge you could wind up with a smouldering wreckage where once your TV stood (or where you yourself stood).

Finding The Right Spot

The first task is to locate the video detector stage. This will often be ▷

labelled on the circuit diagram, but if it is not it can be found by following the circuit starting from the tuner. There will be a couple of stages of IF amplification followed by a detector in the form of a diode or, in more recent sets, part of an integrated circuit. Figure 3 shows a simplified diode detector stage. With the diode this way around, the recovered video waveform will be positive going, as shown. If the diode were reversed, an inverted video waveform would be present.

In some receivers the video detection and pre-amplification are accomplished by an integrated circuit. If the sync separator is internal to the IC you should look for a different receiver to modify as it may not be possible to find a suitable point to feed in the video signal. If the sync separator occurs after the IC you can treat the IC as a glorified diode detector and feed the video into the first transistor video stage.

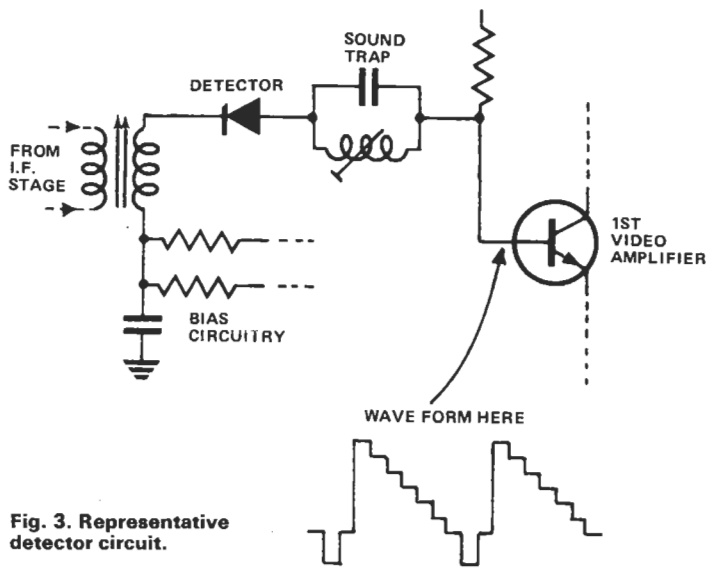

Fig. 3. Representative detector circuit.

The Simplest Case

If you are lucky the first video amplifier in your TV receiver will be designed to operate with a negative-going video signal of about 1 volt peak to peak. In this case very little extra circuitry will be required to modify the set. The simple arrangement shown in Fig. 4 will probably suffice.

The change-over switch SW1 selects an internal or external source of video for the 1st video amplifier transistor. When switched to *external* base bias for Q1 is provided by RV1 and R1. RV1 provides a large range of adjustment so that the DC level at the base of Q1 can be matched to the level present when the receiver is operating normally. Capacitor C1 provides DC isolation and R2 presents the required 75 ohm impedance to the coaxial video input.

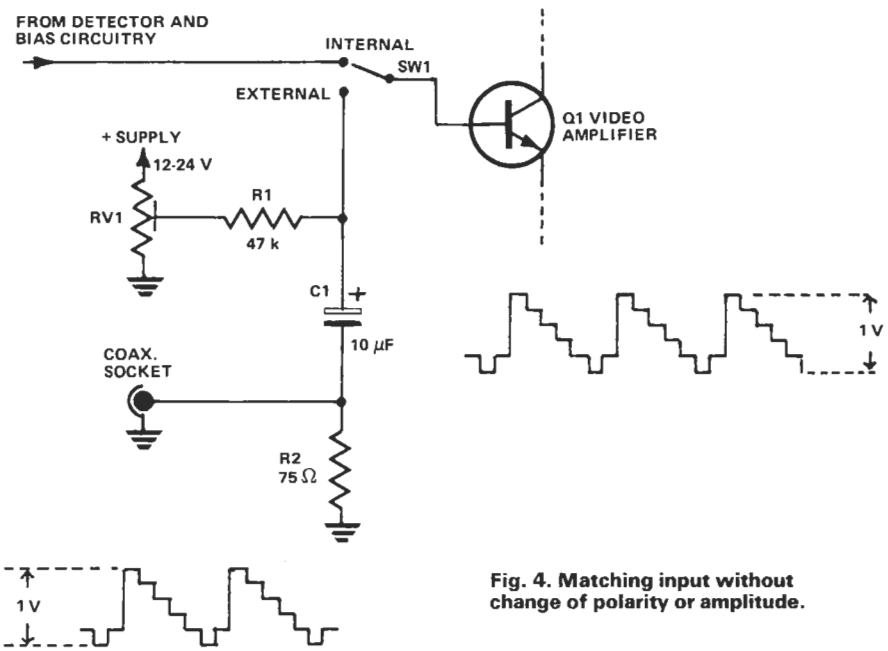

Fig. 4. Matching input without change of polarity or amplitude.

Input Buffering

In some cases the 1 volt video input will not be of sufficient amplitude to drive the video stages fully. Figure 5 shows the circuit of a simple non-inverting amplifier which will bring the input amplitude up to a suitable level.

Q1 is wired in common-base configuration which provides the low impedance input required and does not invert the signal. RV1 allows adjustment of the amplitude from 1 volt to 3 volts P-P. Once again, RV2 is provided for bias adjustment. The polarity of C2 will be determined by the relative settings of RV1 and RV2.

Inverting Buffer

If the receiver requires a positive-going video input, means must be provided for inverting the external video input. Depending on the exact requirements of the particular TV receiver in question, it may also be necessary to provide some gain as well.

Figure 6 shows a simple circuit which fulfills these requirements.

The gain is adjustable from 1 to 3 by means of VR2. VR1 adjusts the bias on the following stage of video amplification.

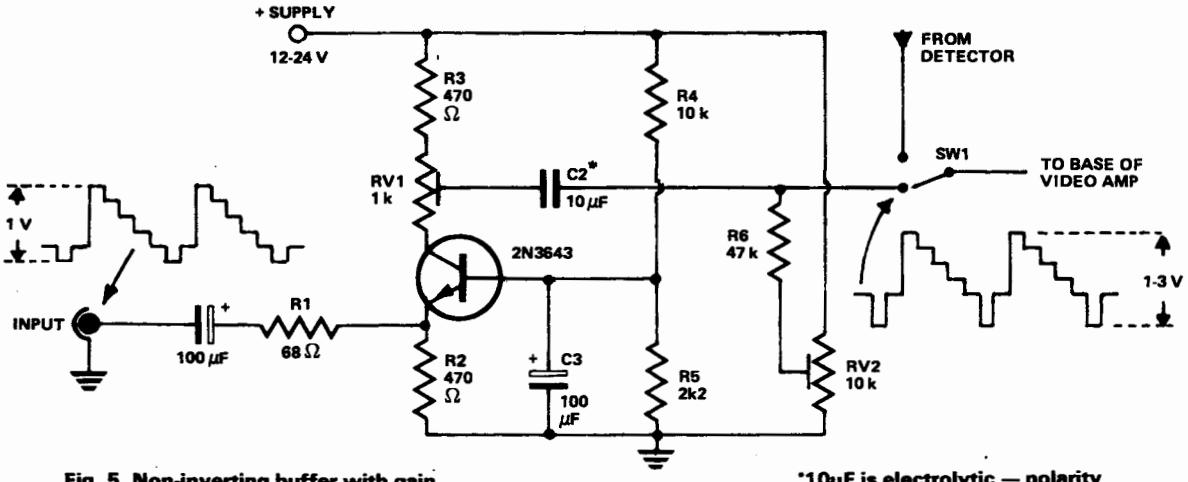

Fig. 5. Non-inverting buffer with gain.

***10uF is electrolytic — polarity is determined by setting of RVI**

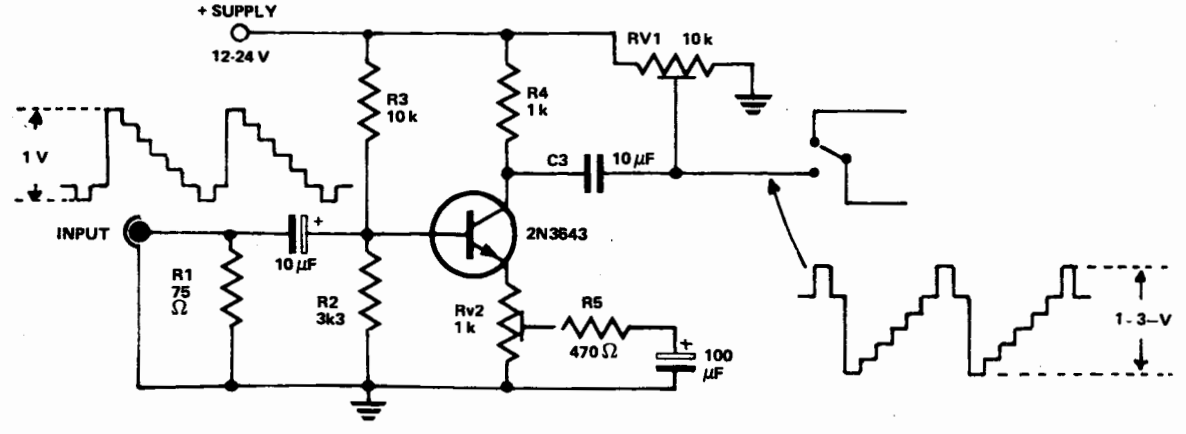

Fig. 6. Inverting buffer with gain.

Finishing Off

With a little experimentation a suitable circuit can be developed using the above hints as guidelines. Keep the wiring to the switch as short as possible. Mount a coaxial connector on the rear panel of the TV set for the external input.

The modern standard for video connectors is the "BNC" type, although there is still a lot of equipment using the more cumbersome "VHF" type (also known as a PL-259). A much cheaper alternative is the "Belling and Lee" coaxial connector commonly used at the antenna input connection of colour TV sets. □

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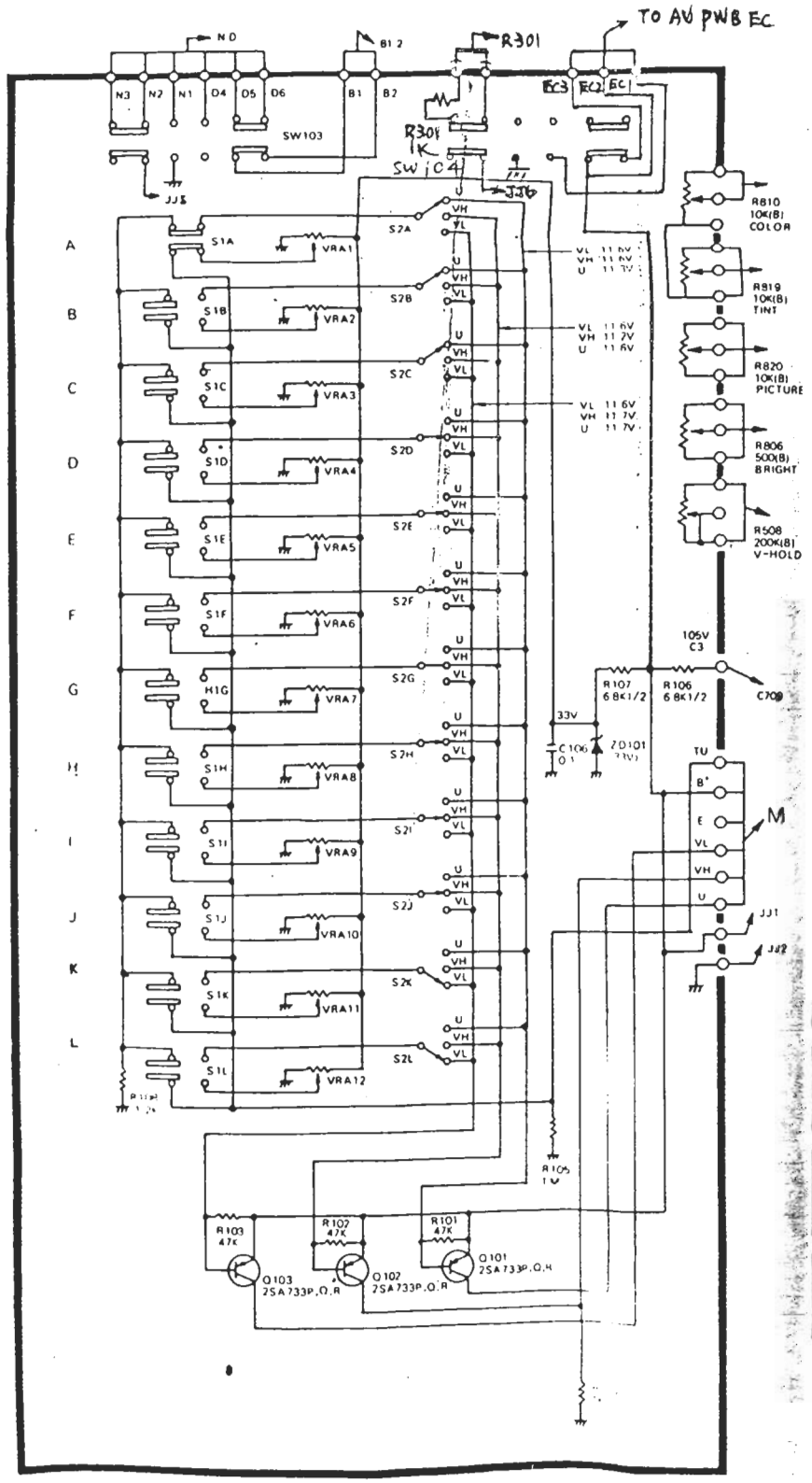
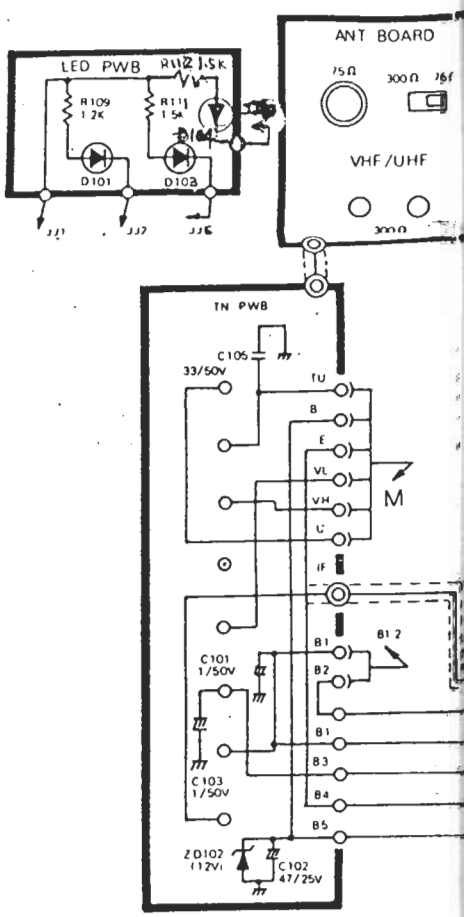
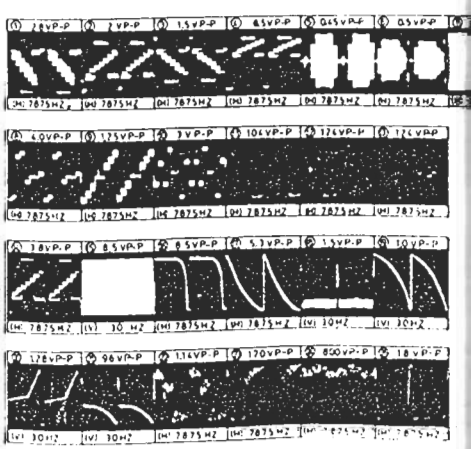






WAVEFORM MEASUREMENT CONDITIONS

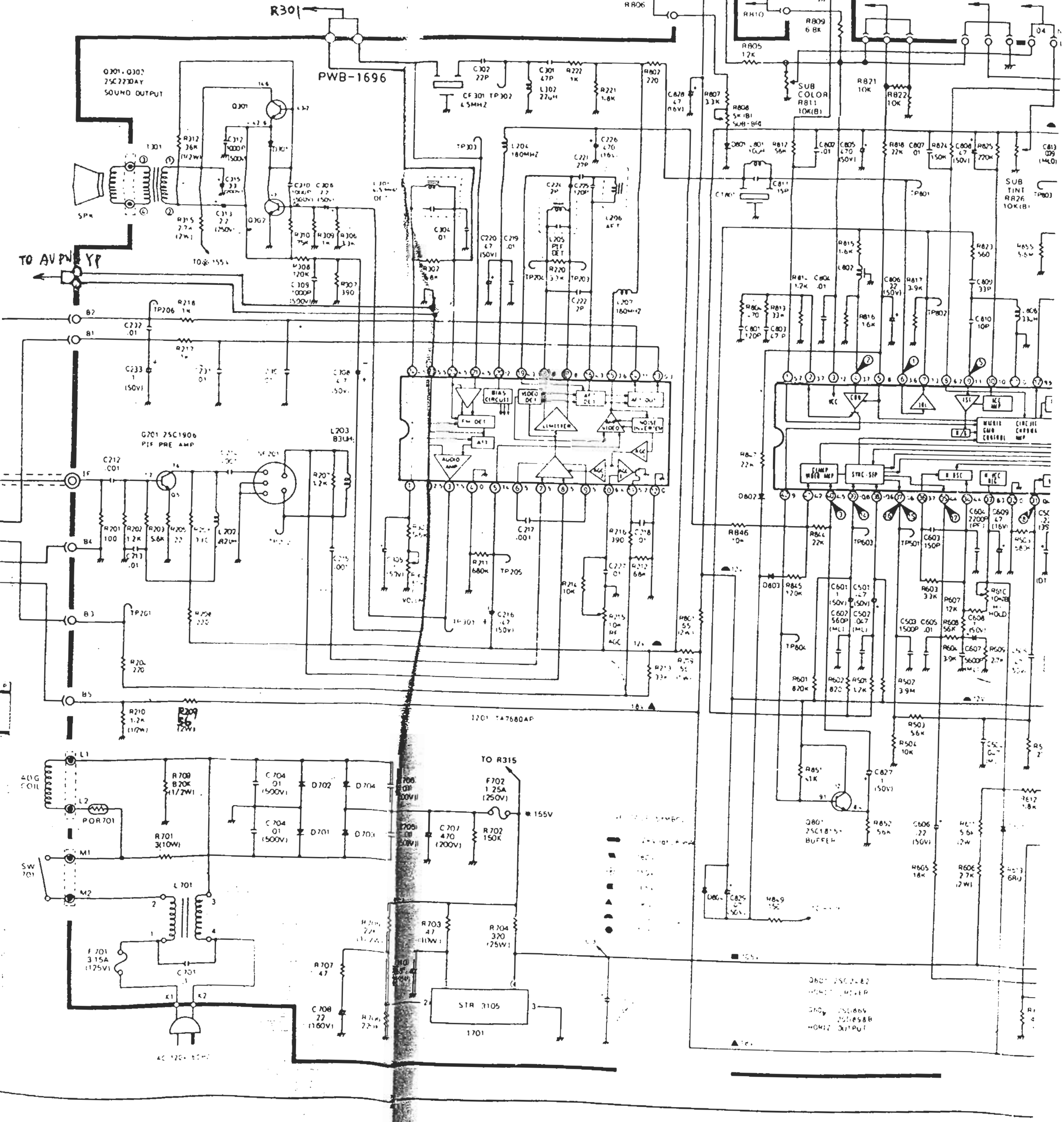
1 Color bar generator signal of 1V peak to peak applied at TP 801

2 Approximately 6.0V AGC bias

...REMENT CONDITIONS

... measured with VTVM placed between points ... ground line voltage set at 120V AC and all ... normal picture unless otherwise indicated, ... W switch to READ position and TV sets to ch12 ... parenthesis measured with 1000Ω/V B&W or

CRITICAL COMPONENT WARNING
THESE CRITICAL COMPONENTS THAT ARE SHADED ON THE SCHEMATIC DIAGRAM AND ASTERISKED ON THE PARTS LIST ARE USED TO PREVENT SHOCK FIRE HAZARD AND EXCESSIVE X-RADIATION. ALL THESE SPECIAL COMPONENTS MUST BE REPLACED ONLY WITH THE SAME TYPE IDENTICAL TO THOSE IN THE SCHEMATIC DIAGRAM AND PARTS LIST



IGE MEASUREMENT CONDITIONS

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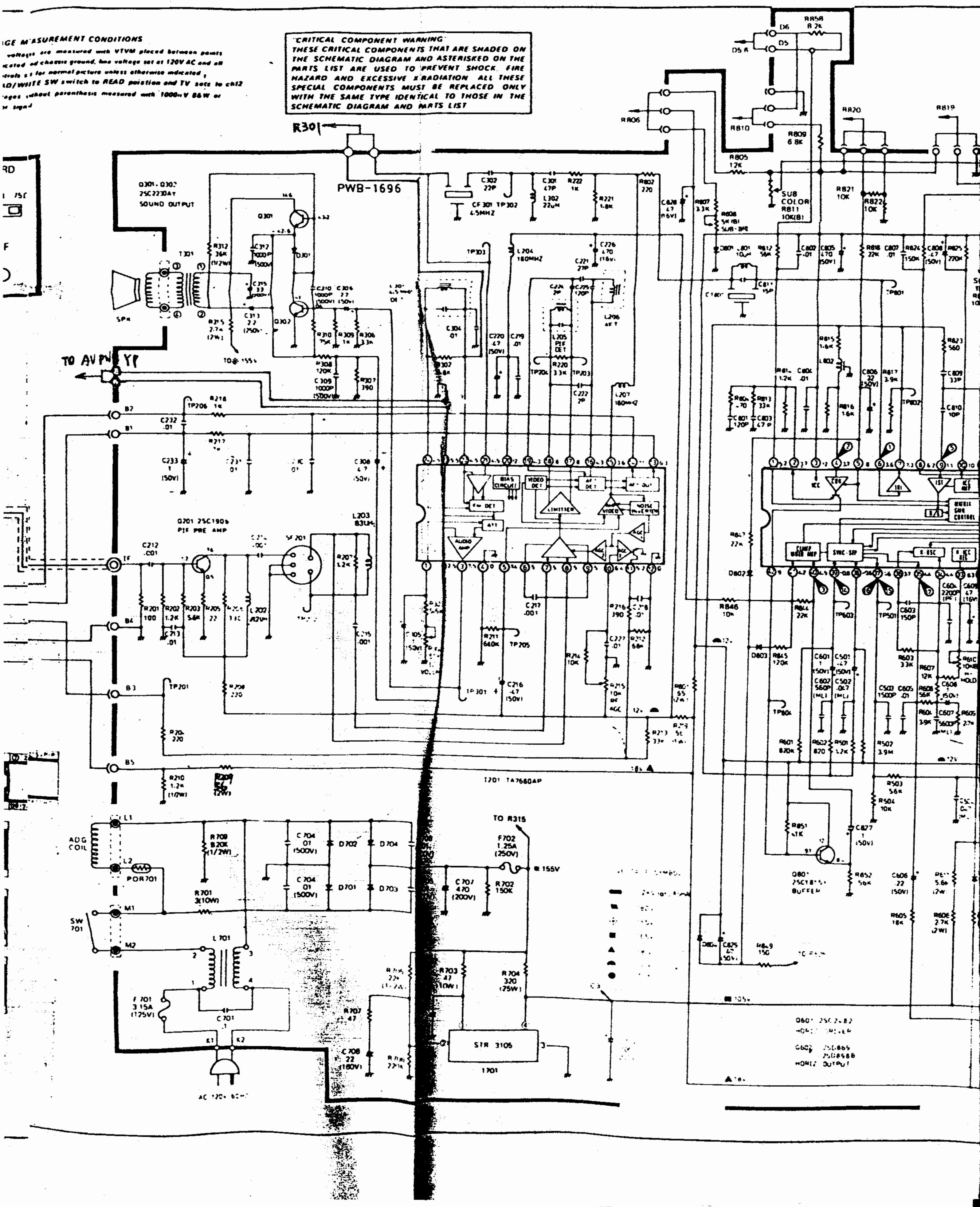
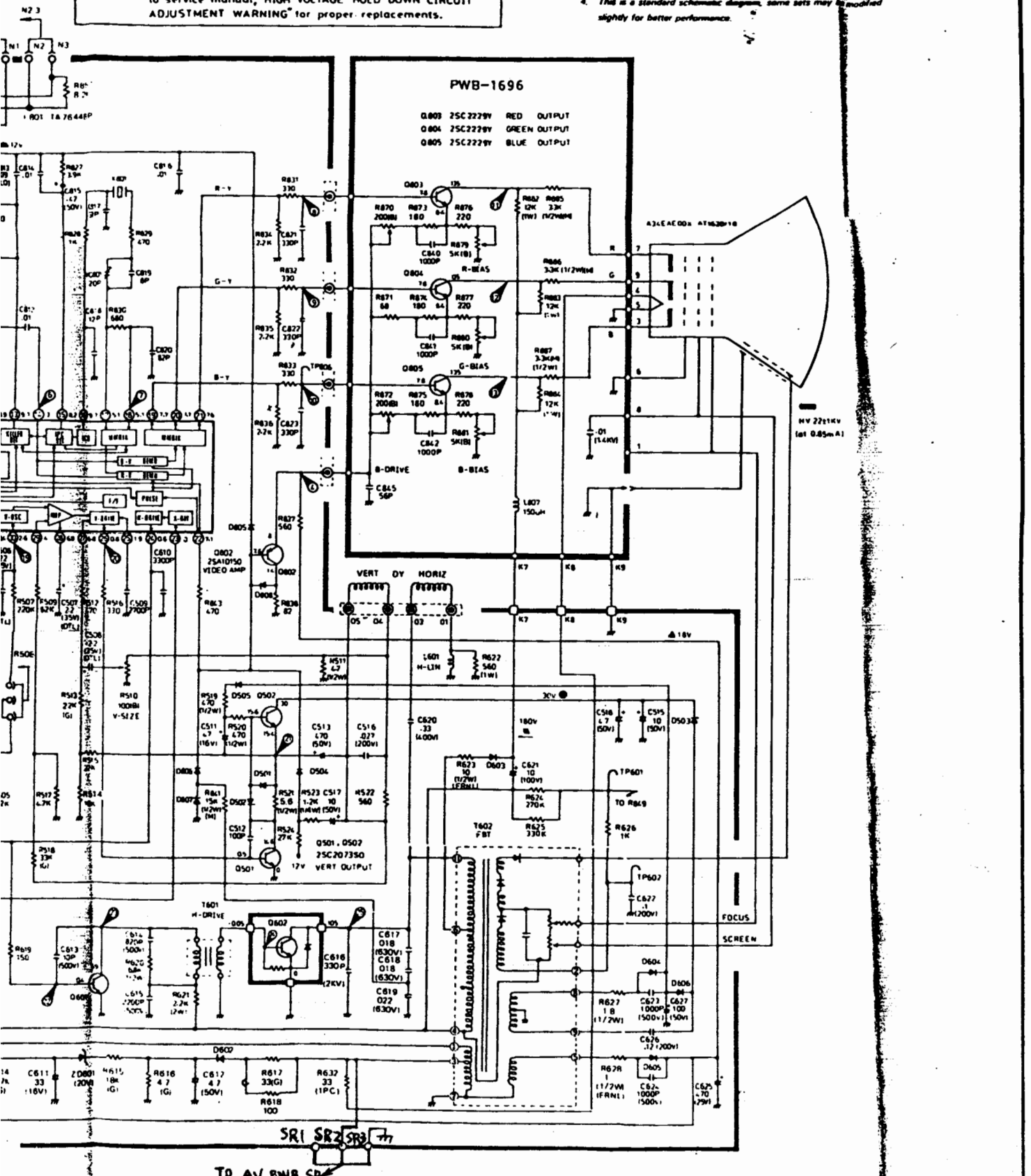
THESE CRITICAL COMPONENTS THAT ARE SHADED ON THE SCHEMATIC DIAGRAM AND ASTERISKED ON THE PARTS LIST ARE USED TO PREVENT SHOCK, FIRE HAZARD AND EXCESSIVE X-RADIATION. ALL THESE SPECIAL COMPONENTS MUST BE REPLACED ONLY WITH THE SAME TYPE IDENTICAL TO THOSE IN THE SCHEMATIC DIAGRAM AND PARTS LIST



NOTE

1. *The unit of resistance "ohm" is omitted (K-1000 ohms M-1 Megohm).*
2. *All resistors are 1/4 watt, unless otherwise noted.*
3. *All capacitors MFD, unless otherwise noted P-MMFD.*
4. *This is a standard schematic diagram, some sets may be modified slightly for better performance.*

CAUTION: Resistors R617, R618 are factory selected components. Refer to service manual, "HIGH VOLTAGE HOLD DOWN CIRCUIT ADJUSTMENT WARNING" for proper replacements.



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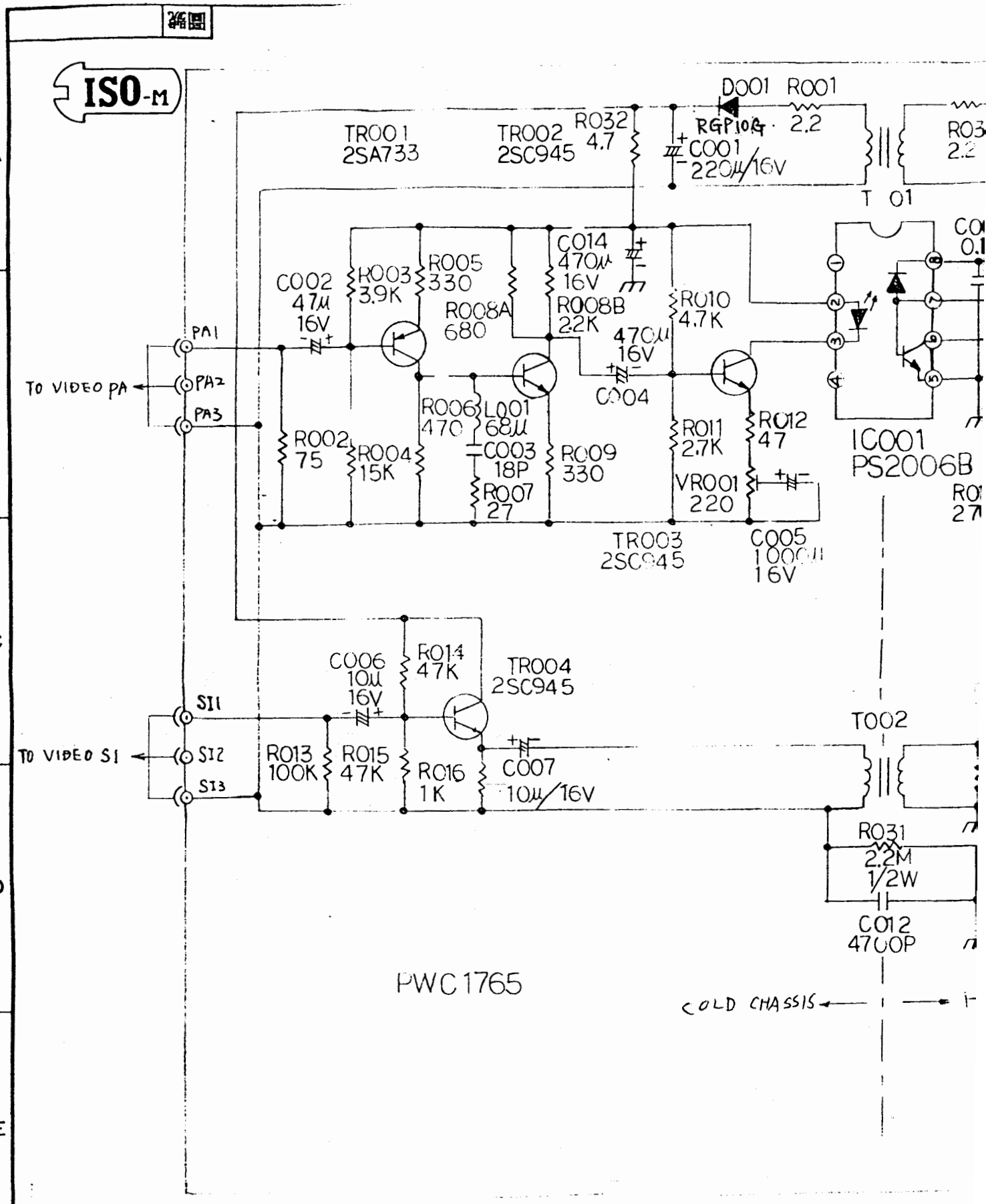
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TR001
2SA733
TR002
2SC945
R032
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R010
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TR003
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C005
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IC001
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R015
47K
R016
1K
C007
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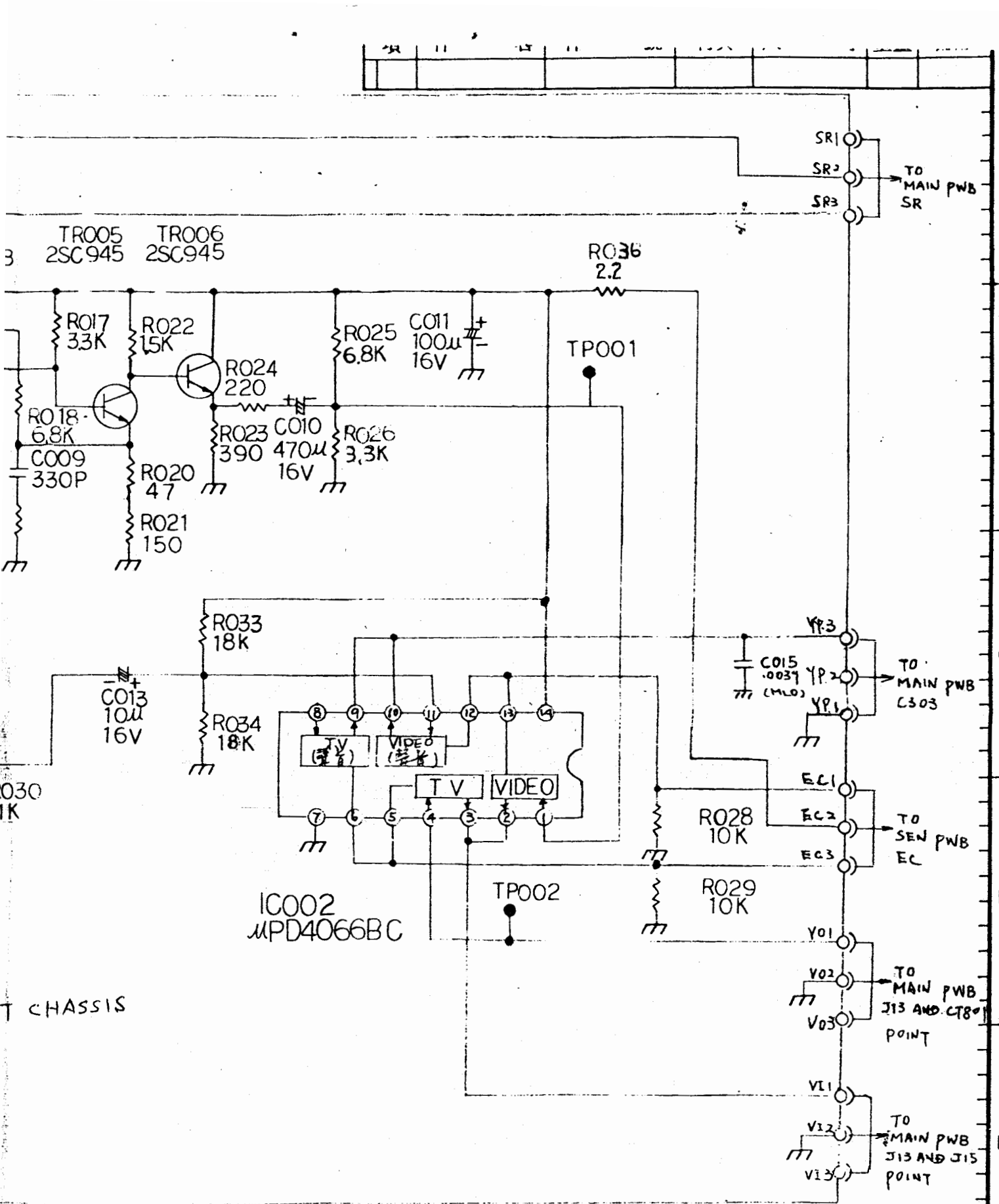

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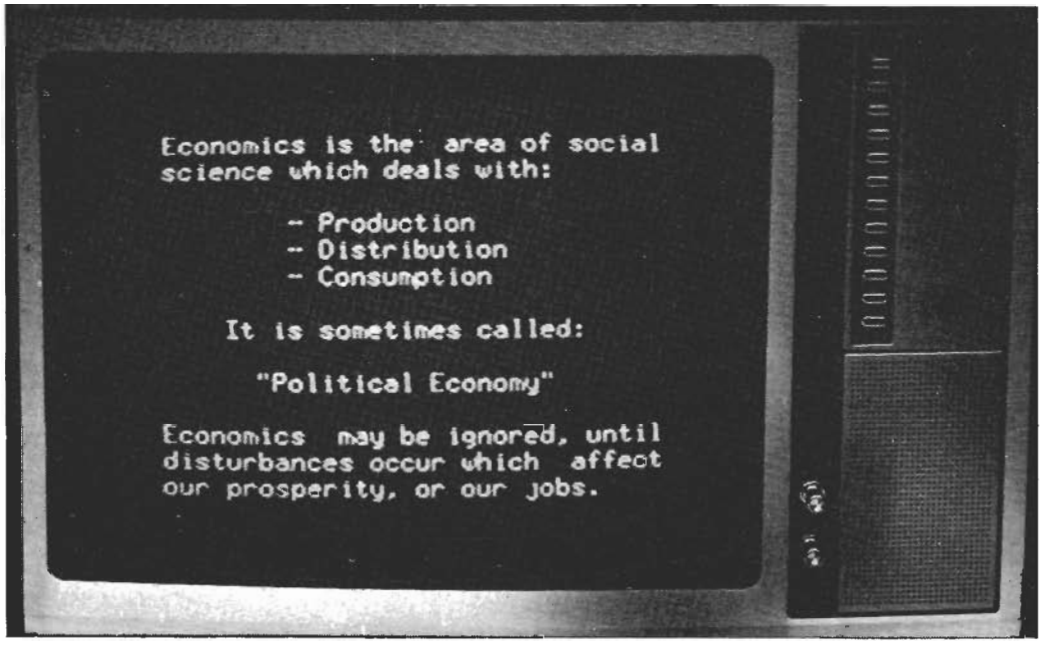
COMPUTER/TV INTERFACE



Any black-and-white TV set can safely serve as a monitor for your computer when you build this inexpensive optically-isolated interface.

DAVID E. CARTIER

A SHORT TIME AGO I BUILT A SMALL MIcrocomputer. As it neared completion, I realized that, since it had a composite video output, I would need a video monitor to use it. Because of my low budget, I decided to convert a 12-inch black-and-white TV set for this purpose. As is well known, you cannot connect an AC/DC TV set to a transformer-based computer without running the risk of electrical shock or of blowing up one or the other...or all of those. Therefore, I decided to build a circuit that would couple the computer to the TV set using optoisolators to separate the two electrically.

The circuit I designed is simple in concept, inexpensive, and not very critical with respect to parts-replacement or wiring. It can be built using wire-wrap or point-to-point wiring techniques on perforated construction board.

The one sensitive area, however, is the speed of the components used. Because the video rate of a 64-character line, using 5 × 7 dot-matrix characters with one space between characters (the output of the video board I am using) is about 8 MHz, high-speed components must be used.

Ordinary analog optoisolators won't even begin to do the job—they're much too slow. Instead, I used a *digital* device, the HP-5082-4360, that can run at speeds up to 20 MHz. Similarly, the NE529 comparators used in the circuit are high-speed devices.

Theory of operation

To understand how the analog TV signal is turned into a digital one for the optoisolators, refer to Fig. 1. It shows an idealized video waveform of the kind generated by the computer's video-board circuitry. You can see that only three voltage-levels are really involved. The sync level is at or near ground potential—close to zero volts. Black (the background) is at about 0.5 volt and white (the color of the characters) is around one volt. By using comparators to check the level of the video signal against reference voltages for black, white, and sync, it is possible to separate those three pieces of intelligence and then pass them through the optoisolator circuitry as logic-"highs" and logic-"lows".

The complete circuit is shown in Fig. 2. The composite video signal from the computer is input at J1 and supplied to the inputs (pin 3) of two NE529 high-speed comparators.

To recover the sync signal, IC1 is referenced by resistor R4 close to—but slightly above—ground potential (about 0.1 volt). That is done because a TTL or CMOS logic "0" actually may be slightly higher than zero volt. Since the sync pulse is the low-level part of the composite video signal, IC1 produces an output pulse for each sync pulse and ignores the video—the video level never gets that low.

On the other hand, IC2 has its reference voltage set higher by R3, to accommodate the video portion of the signal. That resistor is variable so as to make it easy to define the threshold level at which black turns to white.

Two outputs are available from the NE529's, inverted and non-inverted. I used the inverted output to complement the inverted output of the optoisolators. (The two inversions restore the signal to its original polarity.)

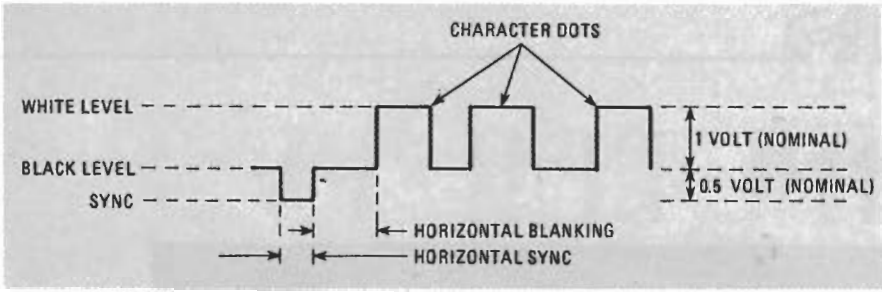
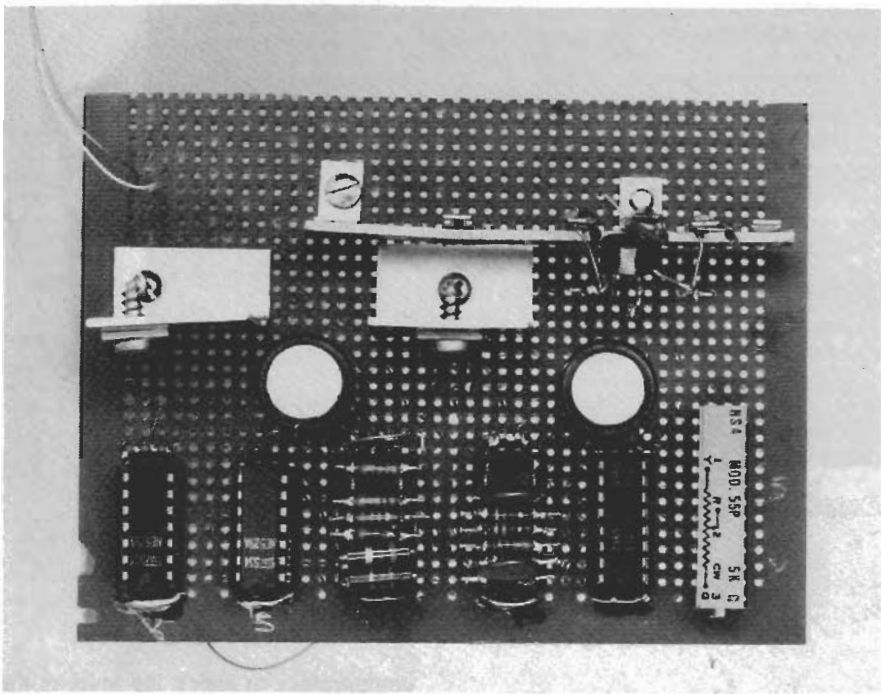


FIG. 1—COMPOSITE VIDEO SIGNAL from computer's video board has three main components: sync, black, and white.



COMPONENT LAYOUT is not critical. Tie-strip at upper-right holds bridge rectifier. Use of DIP headers simplifies mounting and connection of resistors and small capacitors.

PARTS LIST

Resistors ¼ watt, 5%
R1, R2—4700 ohms
R3—5000 ohms trimmer potentiometer
R4—100 ohms
R5, R6—560 ohms
R7—3600 ohms
R8, R10—2200 ohms
R9—10000 ohms
Capacitors
C1, C2—1000 μF, 15 volts, electrolytic
C3-C5—.1 μF ceramic disc
Semiconductors
BR1—full-wave bridge rectifier, 50 PIV, 1 amp
IC1, IC2—NE529 high-speed comparator (Signetics)
IC3, IC4—HP-5082-4360 or 6N137 opto-isolator (Hewlett-Packard)
IC5, IC6—7805 five-volt positive voltage regulator
T1—12.6-volt, 100 mA, center-tapped transformer
J1—female BNC connector
S1—SPDT switch
Miscellaneous: perforated construction board, IC sockets, 75-ohm coaxial cable, heat sinks, etc.
NOTE: If unavailable from your usual supplier, the optoisolators may be ordered from: Surplus Electronics, 9600 Baltimore Boulevard, College Park, MD 20740 for $4.95 each, postpaid. Visa and Mastercard accepted. MD residents add 5% tax.

With the sync and video components of the signal separated and translated to logic states, the individual signals are fed to the optoisolators, IC3 and IC4. Those IC's can sink 13 mA with just 5 mA of input current, and that is well within the drive capabilities of the NE529 comparators.

The video recombining network,

continued on page 80

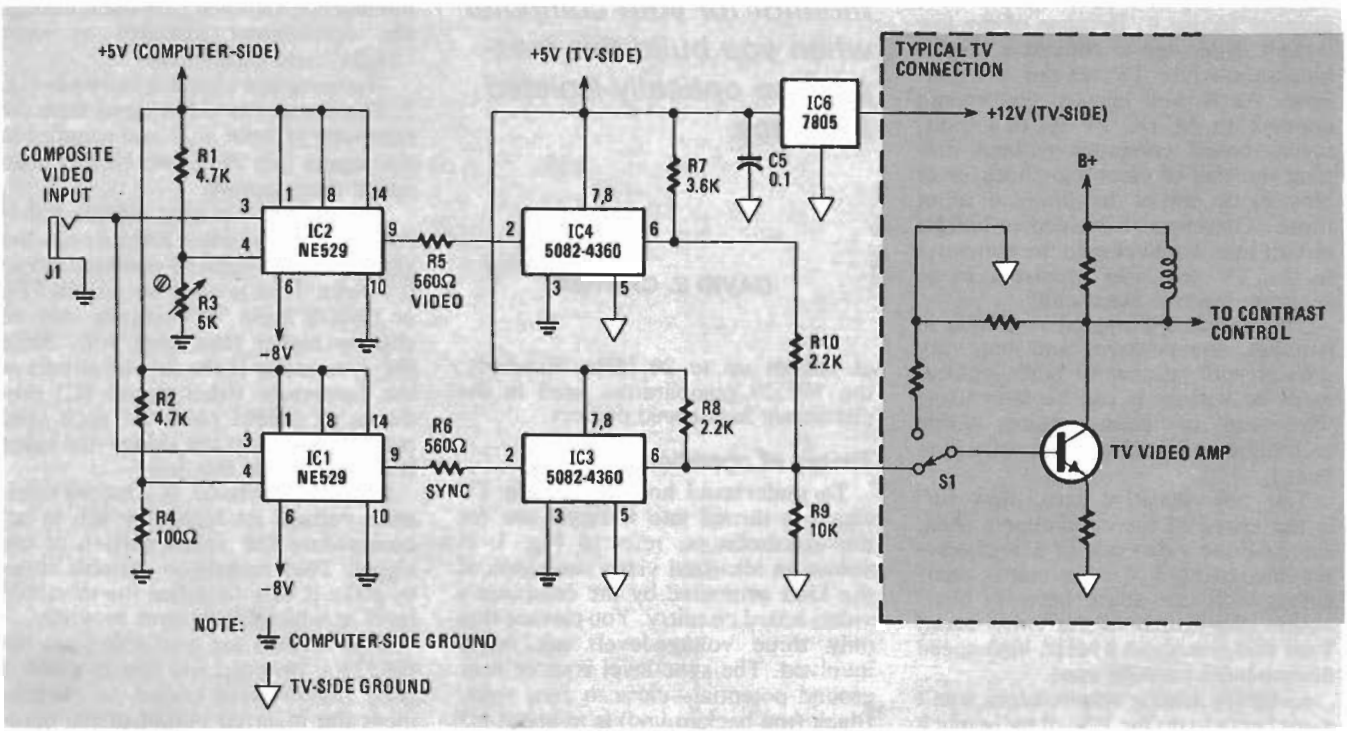


FIG. 2—TWO SEPARATE GROUND SYSTEMS are used by the interface. Make absolutely sure that each ground is made to the proper system!

COMPUTER TV

continued from page 50

resistors R8 and R9, is not critical. I found that I could use values ranging from 2K to 10K for R8, and from 5K to 10K for R9, with essentially the same results.

Power supplies

Two separate power supplies are required if the computer-side and the TV-side of the interface are to be completely isolated from each other. The TV-side requires only +5-volts DC. Most TV sets have 12 volts DC available internally somewhere, and that can be reduced to five volts by means of IC6, a 7805 regulator. The TV chassis is used as ground for this end of the circuit.

The computer-side of the interface requires both +5-volts and approximately −8-volts. A simple power supply to deliver those voltages is shown in Fig. 3. A transformer with an output of around 100 mA is adequate for the circuit. The transformer's center-tap should be used as the ground for the entire computer-side of the isolator. Use heat sinks on both of the five-volt regulators to keep them running cool.

Installation and use

The best place to locate the interface board is inside the TV set's cabinet, where accidental contact with the TV's chassis ground will be impossible. Switch S1 can be mounted inconspicuously on the TV set's cabinet. (Make certain that none of its metal parts are in contact with any of the TV's.) That switch allows you to use the TV set either as a monitor or for its intended purpose.

As suggested by the schematic, the best place to inject the composite video signal from the interface is at the TV's first video-amplifier stage. Refer to your set's schematic or to a Sams *Photofact* folder. An excellent source of TV-interfacing information is Don Lancaster's *TV Typewriter Cookbook*, published by Howard W. Sams and Co., Indianapolis, IN 46268.

The total cost of this project, including the power supply, should be under $25. It would be hard to find a monitor at that price! **R-E**

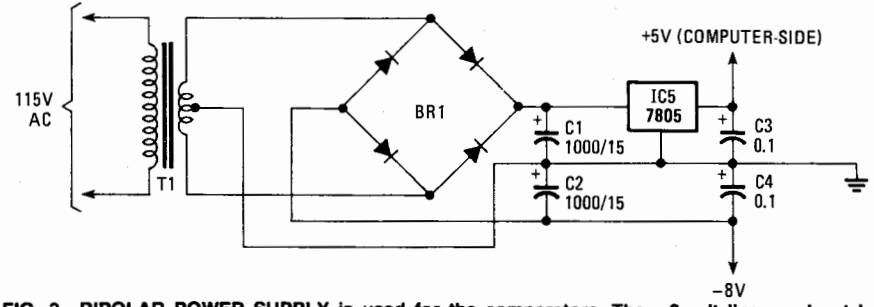


FIG. 3—BIPOLAR POWER SUPPLY is used for the comparators. The −8-volt line need not be regulated.

Modify your TV to include a direct video input for your computer or VCR—and still have it function as a receiver.

JOHN SOLUK

Add A Video Input To Your TV

ARE YOU ONE OF THE MANY THOUSANDS of owners of personal computers, VCR's, videodisc players, etc. whose eyes have been bothered because of color shift, signal beat, ghosts, and RF interference showing up on your TV screen? The source of your problem is probably the fact that you are RF-modulating the video signal from your device to get it into your TV set. Fortunately, there's a low-cost solution for you. With this easy-to-build direct-video modification for your TV set, you can rid yourself forever of the "RF syndrome."

Until recently, the most common and economical method of obtaining a display from a video source (computer, VCR, etc.) has been through an RF modulator, by means of which the video-source signal is fed through the antenna terminals of a standard TV set. By using a TV set in that manner—thereby eliminating the need to purchase an expensive display monitor—one could save hundreds or even thousands of dollars. However, as many users have come to realize, the RF-modulator method has several significant drawbacks. Most of the problems are related to RF radiation and the interference it causes, which degrade picture quality.

Theory of operation

In this direct-video modification, the tuner and IF sections of your set are bypassed. The video-source signal is injected directly into—or as close as possible to—the first-video-amplifier stage in your set. To provide electrical isolation between the input and output sections (both for safety and to protect your video source), two special-purpose optoisolators (optical couplers) are used; there is no electrical connection between the two sections. One optoisolator is a wide-bandwidth coupler for the video channel; the other is a narrow-bandwidth device for the audio channel.

Figure 1 shows a block diagram of the system. The output section is powered directly from the set's own DC power supply. The input section has an on-board rectifier and is powered by inductively-coupled AC that you get by placing a few turns of insulated wire around the exposed ferrite core of the flyback transformer (we'll talk more about how to do that later).

A schematic of the direct-video modification board is shown in Fig. 2. The video signal is applied across R1 and is coupled via C1 to the Q1–Q2 power-driver stage. That transistor pair steps up the input-signal level enough to modulate the input LED (in IC1) and also provides a low impedance for best frequency response. Resistor R5 determines the amount of modulation drive-signal, and R6 and C2 provide additional boost at frequencies above 2 MHz for improved video response. The signal is coupled through C3 to the LED in optoisolator IC1. Resistor R7 provides the DC-bias point about which the input signal will be modulated.

Inside IC1 are an LED and a phototransistor that are optically coupled by a light pipe. There is no internal electrical connection between the two devices. The modulated light strikes the detector surface and the resultant current flow appears at pin 5 of IC1 with a signal being developed across R20. That signal is typically 200 to 300 mV peak-to-peak and requires amplification to bring it up to a

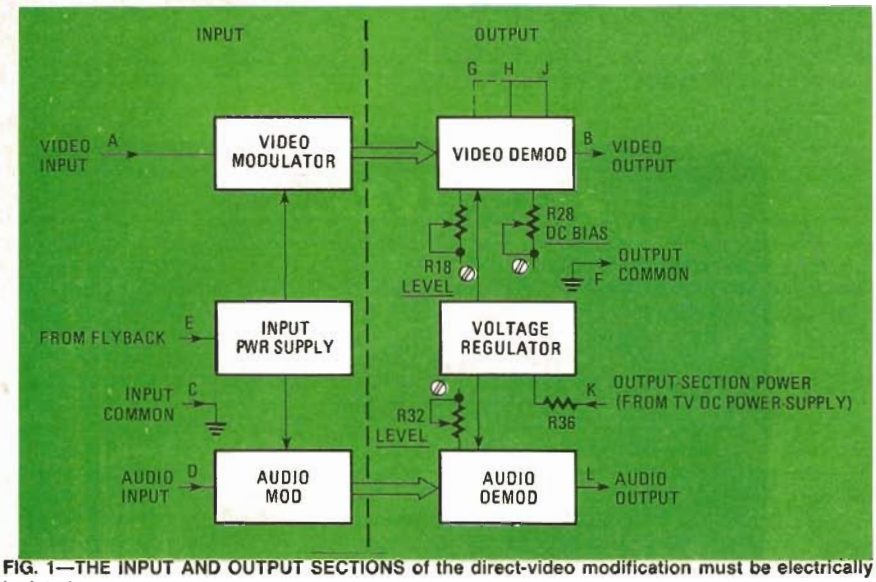


FIG. 1—THE INPUT AND OUTPUT SECTIONS of the direct-video modification must be electrically isolated.

usable level. Transistor Q5 performs that function. Resistor R18 sets the video-output level. The signal at that point is inverted with respect to the input and is coupled to Q6 through C9. The signals at the collector and emitter of Q6 are equal in amplitude but are inverted with respect to one another. Thus, an in-phase signal is available at pad "J" while the signal at "G" is out of phase. The signal with the desired phase is coupled through C12 and C13 to the output, where it is mixed with a DC component whose level is set by R28.

The audio portion of the circuit functions similarly. But, because of audio's narrower bandwidth-requirements, a simpler circuit is used. An audio signal is applied to C4. Transistor Q3 amplifies that signal and sets the DC-bias point for optoisolator IC2's LED simultaneously. Resistor R11 sets the drive-current range. The modulated light falling on the detector of IC2 produces an output current at pin 5. The output level is set by R32.

As mentioned earlier, to isolate the input and output sections, separate power supplies are used. The output section can usually take low-voltage DC directly from within the set, while the input section gets its power from inductive coupling to the TV's flyback transformer. A few turns of wire are wound around the flyback's ferrite core and the resulting signal is rectified and filtered by D3, R12, and C6. The voltage at that point will be approximately 12 volts, if two turns of wire are used.

Transistor Q4 and its bias network, along with LED1, form a low cost go/no-go indicator that is especially helpful for those who do not have an oscilloscope or VOM at their disposal. When the voltage is approximately 12 volts, LED1 will begin to glow dimly. If it glows too brightly, there are too many turns on the flyback and thus too high a voltage.

The output power is controlled by D4, a Zener diode that limits the voltage to the output stage to a maximum of 12 volts. Resistors R38 and R36 provide the voltage drop necessary to ensure safe operation of D4. The value of R36 depends

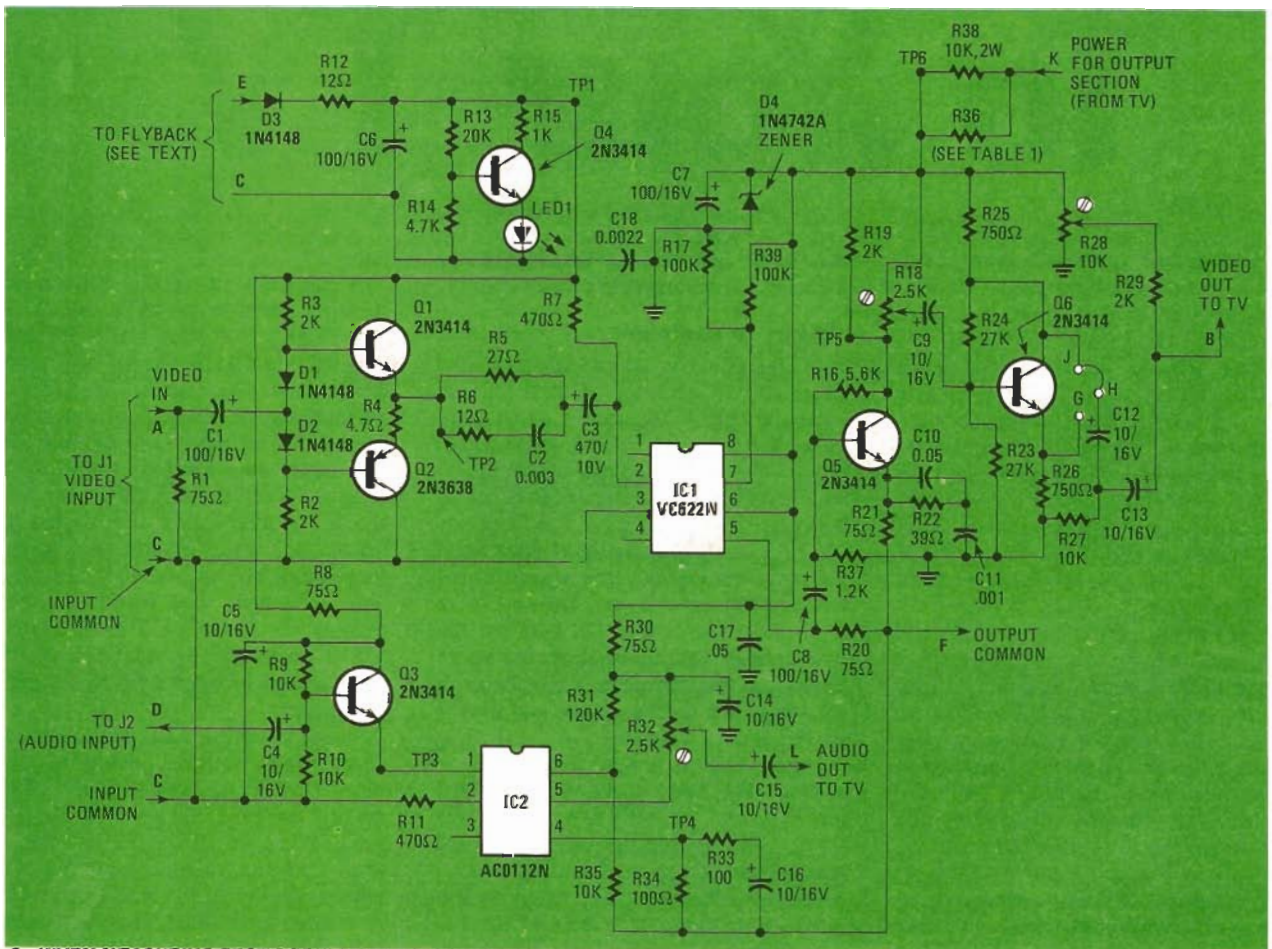


FIG. 2—WHEN MEASURING TEST POINT voltages, make sure that you use the correct reference—TP1-TP6 are measured with respect to "C" and all others are measured with respect to "F."

upon the value of the input voltage. See Table 1 for help in selecting a resistor of the correct value.

Construction

A foil pattern for a single-sided PC board is shown in Fig. 3, and a parts-placement diagram in Fig. 4. Install all components on the component (non-foil) side of the PC board. Start by inserting all of the resistors except R36 (that will be installed once we have determined the output-section power source). Next, install all of the capacitors as indicated, except for C16 (and R33), which can be installed later if your set requires a boost in audio output. Install the remaining components as shown in the parts-placement diagram. When mounting the transistors and diodes be sure to orient them correctly. Once you have completed the board assembly you can proceed to the next phase—converting the set.

TABLE 1

Receive-section input voltage	R36
10 to 11.9 VDC	Jumper
12 to 17 VDC	27 ohms, ½W
18 to 24 VDC	100 ohms, ½W
105 to 165 VDC	10K ohms, 2W

Set modification

As an example, we'll show the conversion process for a 13-inch Samsung color receiver. However, the process will work for any other set. Before you start tearing apart your TV, it would probably be a good idea (actually, it's just about essential) to get the appropriate Sams *Photofact* folder, which will provide you with a schematic for your model and show you where all the components are located.

With that in hand, several points will have to be located and marked off for future reference. Remove the back panel of your set so that you can find and verify those points. For your own safety, unplug the set and to discharge the high-voltage power supply prior to performing any work on it.

The first point to locate is the power source for the output section. Begin by finding the power supply on your circuit diagram. Most transistorized TV sets will either have a low- or high-voltage output (or both) present at the power supply, but a vacuum-tube set may have only a high voltage output. *Do not* use the 6.3-volts AC heater windings on tube sets for a power supply; the direct-video PC board requires DC, preferably 12 volts. By using Table 1 and choosing the appropriate resistance value for R36, you can use other DC source-voltages to power the converter board.

PARTS LIST

All resistors ¼-watt, 5% unless otherwise specified
R1, R8, R20, R21, R30—75 ohms
R2, R3, R19, R29—2000 ohms
R4—4.7 ohms
R5—27 ohms
R6, R12—12 ohms
R7, R11—470 ohms
R9, R10, R27, R35—10,000 ohms
R13—20,000 ohms
R14—4700 ohms
R15—1000 ohms
R16—5600 ohms
R17, R39—100,000 ohms
R18, R32—2500 ohms, trimmer potentiometer, PC-mount
R22—39 ohms
R23, R24—27,000 ohms
R25, R26—750 ohms
R28—10,000 ohms, potentiometer, PC-mount
R31—120,000 ohms
R33, R34—100 ohms
R36—see text and Table 1
R37—1200 ohms
R38—10,000 ohms, 2 watts
Capacitors
C1, C6, C7, C8—100 µF, 16 volts, electrolytic
C2—.003 µF, 50 volts, ceramic disc
C3—470 µF, 10 volts, electrolytic
C4, C5, C9, C12, C13, C14, C15, C16—10 µF, 16 volts, electrolytic
C10, C17,— 0.05 µF, 50 volts, ceramic disc
C11—0.001 µF, 50 volts, ceramic disc
C18—0.0022 µF, 400 volts, ceramic disc
Semiconductors
IC1—VC622N wideband opto-isolator
IC2—AC0112N opto-isolator
Q1, Q3–Q6—2N3414
Q2—2N3638A
D1–D3—1N4148
D4—1N4742A, 12-volt Zener
LED1—jumbo red LED
S1—DPDT miniature toggle switch (on-on), 125 volts, 3 amperes
J1, J2—phono, BNC, UHF, or phone jack
Miscellaneous: PC board, 75-ohm coax (RG-59/U), hookup wire, single- and two-conductor sheilded audio cable, hardware, etc.
The following are available from V.A.M.P. Incorporated, P.O.Box 411, Los Angeles, CA 90028: Complete kit with PC board and all components (DVM-1), $64.95; PC board and optoisolators (VC622N and AC0112N), $29.00; optoisolators only, $19.95. Please add $2.00 for shipping and handling within U.S.A. Foreign orders please add $4.00. California residents please add 6% sales tax.

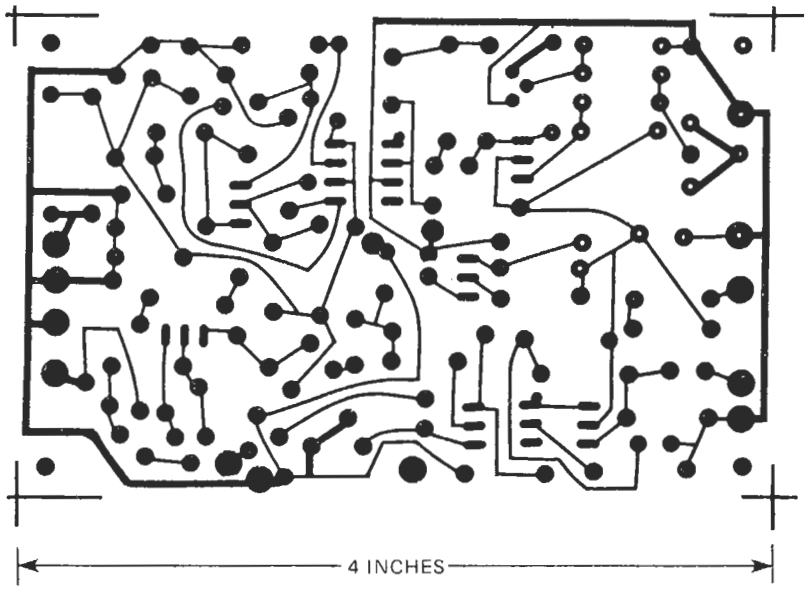


FIG. 3—SINGLE-SIDED PC BOARD is small enough to fit comfortably inside most TV sets.

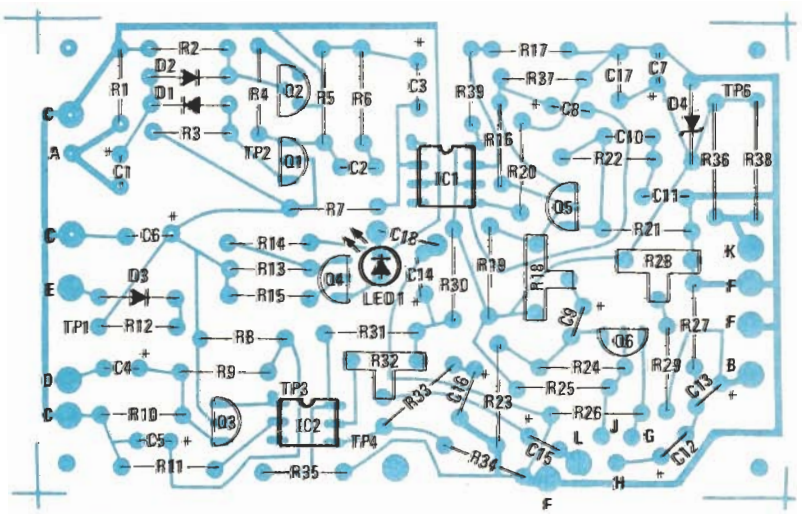


FIG. 4—ONLY THE BYPASS switch and input jacks are not contained on the circuit board.

For our Samsung set, we selected an input voltage of 12 volts. The appropriate value for R36—determined from Table 1—in our case was 27 ohms. Mark on your circuit drawing the point from which you will tap your power and then find that point in your set. Be sure that your value for R36 is correct, and install the resistor on the PC board. Then strip one end of a three-foot length of red wire and connect it to pad "K" on the PC board. Connect a similar length of black wire to pad "F." (Longer lengths may be required if you are working with a large console.) Do not connect the free ends of the red and black wires to your set at this time.

Next, you have to determine the point for external-video injection. Due to design differences, that point will vary from one set to another. The objective, in any case, is to get as close to the first video-amplifier as possible. At that point the signal-level within the set closely matches that of the signal that will be injected. The circuit impedence must be greater than 1000 ohms—otherwise the ability of the direct-video PC board to provide the appropriate video level and DC bias may be hampered. A high impedence is usually found at the base of a transistor or at the input of an integrated circuit. In general, when you choose the injection point, select it so that it will eliminate all (or most) of the set's bias networks when the BYPASS switch is thrown to its EXTERNAL position. Doing that will leave only the video signal and the DC bias from the direct-video board at the injection point. Mark your injection point on your own circuit diagram, and locate and mark it in your set.

Once the video-injection point has been determined, you'll have to determine whether positive or negative video is required. (Positive video means that the video-information signal is positive with respect to ground, and the sync signal negative; the opposite is true for negative video.) If you are unable to determine which type of signal your set needs at the injection point, assume for the moment that it's positive video. To select a positive-video output, connect pads "H" and "J" on the PC board with a jumper. For negative video, connect pads "G" and "H."

The final injection-point to be located is the one for external audio. The simplest place to inject the audio is usually at the high side of the volume control. However, some sets—as was the case with our Samsung—use an IC to control the volume level. In such sets the audio should be injected at a point after the detector de-emphasis network, and the level controlled through R32 on the PC board.

Some sets may require that you feed the driver stage directly. In that type of installation, the DC bias to the audio power-stage must be maintained. That can be done easily with a resistor network like

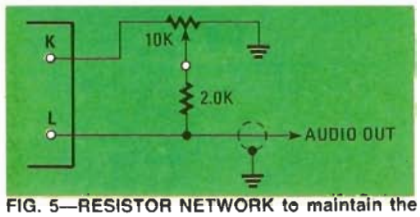


FIG. 5—RESISTOR NETWORK to maintain the DC bias to your set's audio power-stage.

the one shown in Fig. 5.

Having selected the injection point for your set, mark it on your circuit diagram and make sure you know where it is in the set.

Installation

Find a convenient place inside your set to mount the PC board, and drill the appropriate mounting holes. Figure 6 shows how the board was mounted in our Samsung. Place as much distance as is practical between the PC board and the flyback transformer to avoid any possibility of interference. Do not mount the PC board at this time, though.

Next, mount the audio and video input-jacks. Install them in a convenient location either on the back panel or side of the set. The jacks should be as close as possible to the PC board. Make sure that the video-input jack is mounted on an insulated surface (preferably plastic) if you are converting a hot-chassis type set. In our installation, we used a standard ¼-inch phono jack requiring a ⅜-inch hole, but BNC- or UHF-type connectors can also be used, as long as they are mounted on an insulated surface.

The miniature DPDT BYPASS switch, S1, should be mounted as close to the input jacks as possible. That switch will allow you to select either the RECEIVE or EXTERNAL mode. Once again, if you are converting a hot-chassis set, make sure that you mount the switch on an insulated surface.

You can now proceed with the wiring phase of the installation. Earlier, you determined the power source for the output section of the PC board and inserted an R36 of the appropriate value. Now, you must consider the power source for the input section of the PC board. If you are converting a set which is already transformer-isolated from the power line (as opposed to a hot-chassis set), the input portion of the direct-video board can use the same power source as the output section. In that case, take a piece of insulated

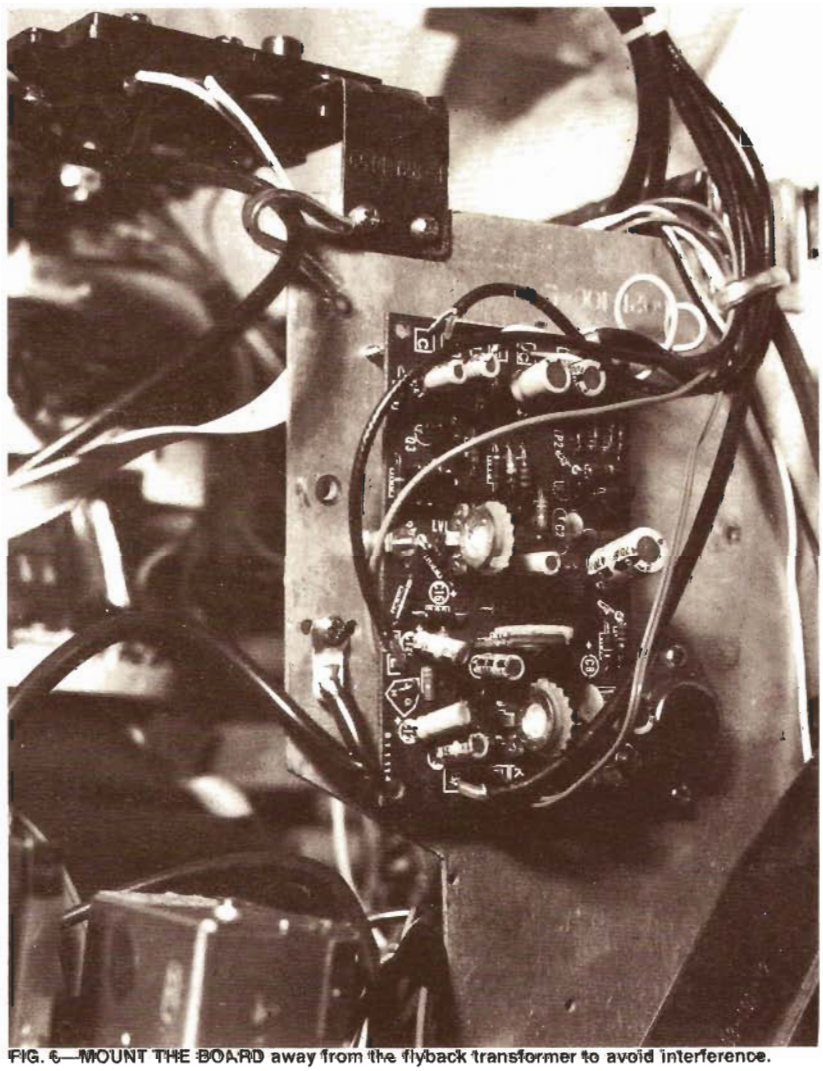


FIG. 6—MOUNT THE BOARD away from the flyback transformer to avoid interference.

wire and connect pads "C" and "F" which are the input common and outout common respectively. Use a second piece of insulated wire to connect pad "E" with the pad at TP6. Remember, those connections should be made only if the set you are converting is transformer isolated.

If the set you are converting is *not* transformer isolated, but is a hot-chassis type, then the power for the input section can be obtained from the flyback transformer. That will involve work in the high-voltage section of the set. Any time you are working in that area, be sure to unplug the set for safety. (*It would be a good idea to have the set unplugged* anytime *you're working inside it*—Editor.) As a further precaution, discharge the power supply. That is done by connecting one end of a wire to the chassis of the set and then carefully slipping the other end under the rubber high-voltage cap on the picture tube itself. Don't forget to remove the wire afterward.

Take a 6-foot length of (white) insulated single-conductor wire and fold it in half. Slip one end of the wire through the ferrite core of the flyback transformer so that there are two equal lengths on both sides of the core. Then take one of the ends of the wire and loop it twice around the ferrite core so that you end up with approximately 2½ turns around the core. (For console sets with screens larger than 19 inches you may require only 1½–2 turns.) Twist the wires together for their entire length and connect them to the direct-video board at pads "E" and "C." Figure 7 shows the windings around the core of the flyback in the Samsung set that we converted.

The next step is to determine whether there is a sufficient number of turns around the core of the flyback, and whether the wires to the board are phased properly. During the following test make sure that the PC board is clear of the set, to prevent any accidental shorts. Apply power to the set and turn it on. Indicator LED1 should light. If it does not, unplug the set and interchange the wires at pads "E" and "C." If the LED still doesn't light, unplug the set and add an additional ½–1 turn around the core of the flyback. If the LED still doesn't light, unplug the set again and interchange the wires on pads "E" and "C" so they're back in their original positions. (If you have an oscilloscope at your disposal, connect the leads from the windings so that the flyback pulse is positive with respect to ground.) If the LED *still* doesn't light, measure the voltage at TP-1. It should be positive with respect to ground. Increase or decrease the number of turns until the voltage at TP-1 reaches a value between 12 and 15 volts DC. The LED should light when the voltage exceeds 11-volts DC.

In the event that you can't get at the ferrite core of the flyback transformer, you will have to add a step-down transformer (120 volts:12 volts) or use a commercially available portable 12-volt DC power-adapter so that the input section can be powered directly from the AC line.

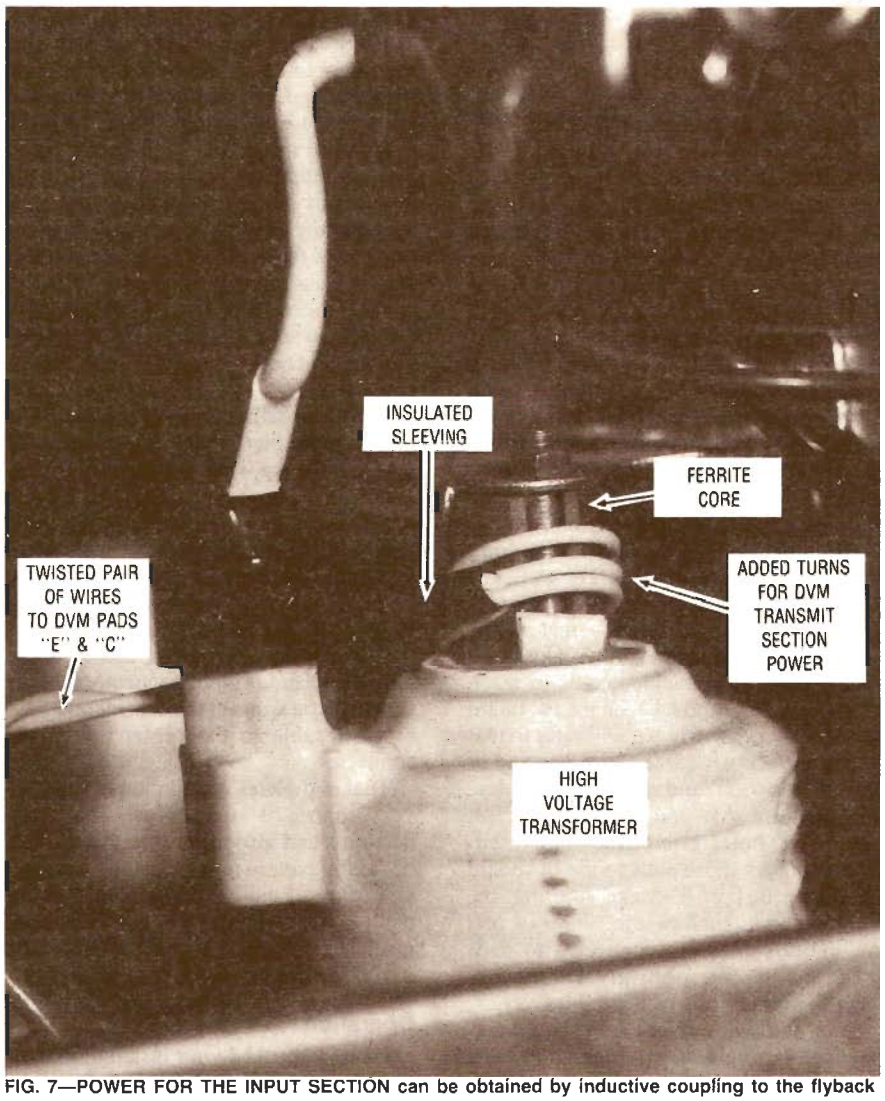


FIG. 7—POWER FOR THE INPUT SECTION can be obtained by inductive coupling to the flyback transformer.

Using Fig. 8 as a wiring guide, you can now start the final phase of the installation. First, cut two equal lengths of video cable (RG-59/U) long enough to reach from the video injection-point to S1. We'll refer to that as the DEMOD/RETURN cable pair. Label and set those cables aside momentarily. Next, cut a length of video cable that will reach from the S1 to the video output of the PC board at pads "B" and "F." We shall refer to it as the "B" cable. Label it accordingly. Cut an-

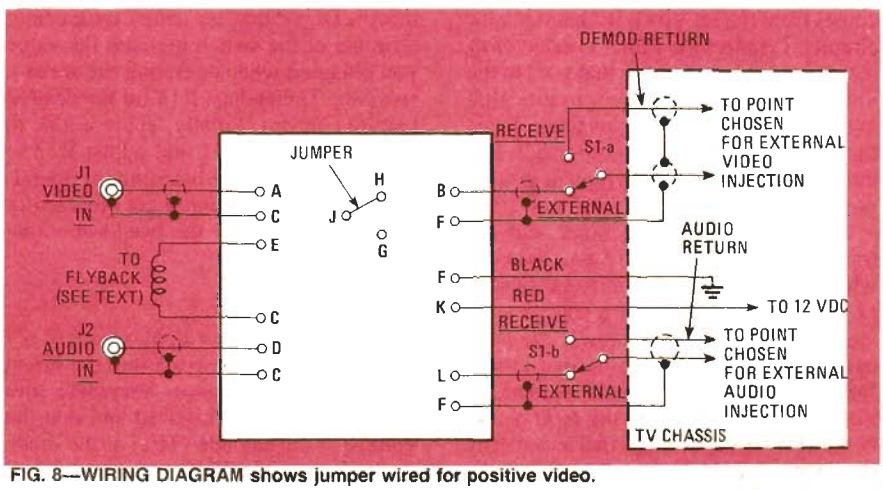


FIG. 8—WIRING DIAGRAM shows jumper wired for positive video.

other length of cable that will reach from the VIDEO-IN connector J1 to pad "A" on the PC board and label it as the "A" cable.

Strip one end of the "A" and "B" cables, making sure that you have a sufficient length of outer conductor (shield) unraveled. Then connect those ends to the PC board as shown in Fig. 8. Make sure that the center conductors of the cables are connected to the correct pads ("A" to "A" and "B" to "B"). Do not connect the other ends of the cables yet.

Prepare the audio cables next. Cut a length of *two-conductor* shielded cable long enough to reach from the BYPASS switch (S1) to the audio-injection point. We shall refer to this as the AUDIO-RETURN cable. Label it and set it aside momentarily. Now cut a length of *single-conductor* shielded audio cable long enough to reach from pads "D" and "C" on the PC board to the AUDIO-IN (J1) connector. We will refer to that as the AUDIO-IN cable. Cut another length of single-conductor shielded cable to reach from pads "L" and "F" on the PC board to the BYPASS switch; we will refer to that as the AUDIO-OUT cable. Strip one end of the AUDIO-OUT and AUDIO-IN cables, making sure that you have a sufficient length of outer conductor unraveled. Then connect those ends to the PC board as shown in Fig. 8. Make sure that the center conductors of the audio-in and audio-out cables are connected to pads "D" and "L," respectively. Do not connect the other ends of the cables yet.

You can now mount the PC board permanently using 4-40 machine screws and nuts. Use ¼-inch fiber spacers to insulate the board from the TV chassis, and make sure that the PC-board foil doesn't touch any metal surface. Once you have secured the PC board, strip one end of each of the DEMOD/RETURN cables you set aside earlier. At the external-video injection point remove a small portion of the copper trace that connects the two points between which you wish to insert the BYPASS switch. (Instead of breaking a trace you may have to cut a wire; it depends on your TV set.) Connect the center conductor of the demodulator cable to the side that comes from the set's own IF/demodulator circuits. Connect the center conductor of the return cable to the side that goes to the video amplifiers and the circuits that eventually drive the picture tube. Twist the shields of that cable pair together, and then solder them to a convenient ground point.

At the audio-injection point, cut the trace that connects the two points between which you'll insert the BYPASS switch. (Again, a wire instead of a copper trace may have to be cut.) Connect the *dark* center conductor to the side that comes from the set's own sound IF demodulation circuits and connect the *light* center conductor to the circuits that eventually terminate at the set's speaker. Route the AUDIO-RETURN cable and the DEMOD-RETURN cables through the set and connect them to S1 as shown in Fig. 8. Now strip the free end of the "B" cable and connect it to the switch. Next, strip the free end of cable "A" and connect it to the video-input connector. Then, strip the free end of the audio-out cable and connect it to the BYPASS switch; also strip the free end of the audio-in cable and connect it to the audio-input connector. Finally, connect the red wire from the PC board to the voltage-source point you selected earlier, and connect the black wire to chassis ground.

If your installlation used the inductive pickup from the flyback transformer, be sure to route the wires to the board so they avoid, as much as is practical, the RF and low-level video demodulator circuits; that will minimize interference. Also, make sure that the pair of wires is twisted its full length—all the way from the flyback to the PC board.

Connect the appropriate cables to the video- and audio-input connectors. Make sure that you connect the center conductor of each cable to the center pin of the connector.

That completes installation of the conversion board. Check all your connections, and also make sure that the PC-board foil pattern is not touching any metal surface. Finally, make sure that the input connectors and BYPASS switch are insulated from the TV chassis, especially if you are converting a hot-chassis set.

Operation

Having checked your installation thoroughly, apply power to the set. Place the BYPASS switch in position for normal TV operation. If the set does not work properly, you have wired something incorrectly (most likely the switch). Retrace your steps through the installation instructions.

Once the set operates normally as a receiver, use a voltmeter to measure the DC-bias voltage at the center terminal of the BYPASS switch with respect to chassis. Then apply a standard video signal to the VIDEO IN jack. Set the BYPASS switch to the EXTERNAL position. Adjust R28 so that the DC voltage measured at the center terminal of the switch matches the value you obtained when operating the set as a receiver. Then adjust R18 for the desired picture contrast. Finally, apply a tone to the AUDIO IN jack J1 and adjust R32 to obtain a comfortable listening (or operating) range. If you cannot get satisfactory video or audio, see the troubleshooting section that follows.

Troubleshooting

If the LED will not light, check to see that it is properly inserted into the board and is not reverse biased. Also make sure that D3 is properly inserted and that the voltage at the cathode (TP1) of the diode is positive with respect to ground.

If you have no video, or if the picture quality is poor, the problem may be due to an incorrect DC bias (that can result in complete picture loss or heavy picture tearing). To correct the problem, adjust R28 for the appropriate bias level.

If you have no video in either mode (RECEIVE or EXTERNAL), the problem is probably a mis-wired BYPASS switch. Check the wiring, referring to Fig. 8.

A streaky, clipped, or washed-out picture may be caused by too high a video level. Adjust R18. Sometimes a misadjusted bias level (R28) can cause similar problems.

Interference may be due to ripple from the low-voltage source used to power the receiver section of the direct-video board. Changing the board to operate from a DC source in the 105–165-volt range usually clears up the problem. Also check the shields of the cables for proper connections. Another source for possible interference is the route selected for the twisted pair of wires that runs from the PC board to the inductive loop on the core of the flyback. It is important that the pair be twisted over its entire length, and that the bundle be kept away from the demodulator, IF, and RF circuits.

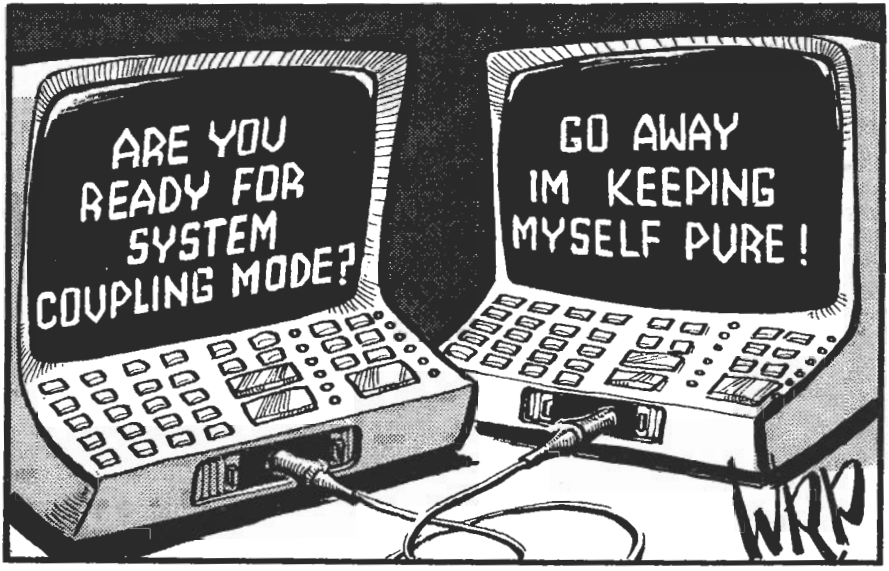
TABLE 2
Test Point Voltages

	VDC Min.	VDC Max	
TP1	11.0	15.0	Ref. "C"
TP2	5.0	8.0	
TP3	5.0	7.5	
TP4	0.2	0.35	Ref. "F"
TP5	5.0	7.0	
TP6	10.0	12.5	
B	Adjustable		
G	2.2	4.0	
J	7.0	9.0	

Low audio output can be caused by your set requiring a higher signal level at the audio-injection point than is currently being supplied. Install C16 to boost the board's audio output.

Should your set not display external video and you have wired everything correctly, check the direct-video board for failure. Refer to Table 2 and measure the voltages at the appropriate test points. Note that the voltages at test points TP1, TP2, and TP3 are measured with respect to pad "C." The voltages at all other test points are measured with respect to chassis common or pad "F." Check to make sure you have not installed the transistors or optoisolators incorrectly.

After you've made any adjustments necessary, replace the rear cover of the set. Your newly converted set is now ready for use. Rest easy and let your eyes relax. **R-E**


ARE YOU READY FOR SYSTEM COUPLING MODE?
GO AWAY IM KEEPING MYSELF PURE!
WRP