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Instruction Manual

Tektronix

1480 – Series
Waveform Monitors
SN B010100 – B059999

070-1813-01

Please check for change information at the rear of this manual.

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INSTALLATION

This section explains how to prepare the 1480-Series rackmount and cabinet model instruments for use. It describes and illustrates how to:

1. Check or change the power transformer primary taps to match available mains sources;

2. Check the factory-set electrical programming per the television standard or standards ordered;

3. Mount the instruments in rack or cradle assemblies.

ELECTRICAL

Power Requirements

Safety. The 1480-Series Waveform Monitors are designed to operate from a single-phase power source with one of the current-carrying conductors (the neutral) at ground (earth) potential. Only the Line conductor has over-current (fuse) protection within the instrument. In accordance with international standards, the instruments are provided with a detachable 3-wire power cord with a 3-terminal polarized plug for connection to the power source. The ground (earth) terminal of the plug is directly connected to the instrument frame. For electrical shock protection, insert this plug only into a mains supply outlet with a safety-earth contact.

Mains Supplies. The 1480-Series Waveform Monitors will operate over a mains frequency range of 48 to 62 Hz and at nominal mains voltage of 110 Vac or 220 Vac. Power consumption at center values of the mains voltage ranges is nominally 60 W, with a maximum of 75 W at low line conditions. Power transformer primary taps are provided to select any one of three ranges for the two nominal mains voltage sources. See Fig. 1-2.

Mains Ranges and Fuses

Checking. Make sure the instrument is disconnected from any power source. Remove the bottom dust cover (of either the rack or cabinet model). Referring to the illustrations in Fig. 1-2, verify that the power transformer wiring matches the range labeled on the rear panel of the instrument. Check the fuse installed at the rear of the instrument. 110 Vac nominal mains voltages should have a 0.8 A fuse, and 220 Vac nominals, a 0.4 A fuse.

Conversion. Occasionally the factory-wired range may not be compatible with the available mains supply. In this case, choose one of the three possible ranges whose center value is closest to the mains voltage to be used during regular operation. Change the jumper wiring according to Fig. 1-2.

Replace the voltage label on the rear panel with the appropriate stick-back label from the set of six, supplied with the standard accessory package.

Re-check the fuse rating.

Replace the bottom dust cover.

Internal Programming

Before mounting the Waveform Monitor in a rack or cradle assembly, the internal, factory-set programming plugs should be checked to verify that the instrument will be compatible with the operating system for which it is intended.

Remove the top cover of the rackmount model, or the two side covers of the cabinet model, to gain access to the circuit boards and plug jumpers.

Referring to Fig. 1-3, check or change the plug-jumpers to satisfy system requirements. A detailed discussion of the alternative modes is given in the Operating Changes part of Section 2.

MECHANICAL

The dust covers of the 1480-Series Waveform Monitors provide for proper electrical environment for the instruments, minimize handling damage, reduce dust collection within the instruments, and provide personnel protection from shock hazards. The covers (or optional field case for the cabinet models) should always remain in place except for servicing by qualified persons.

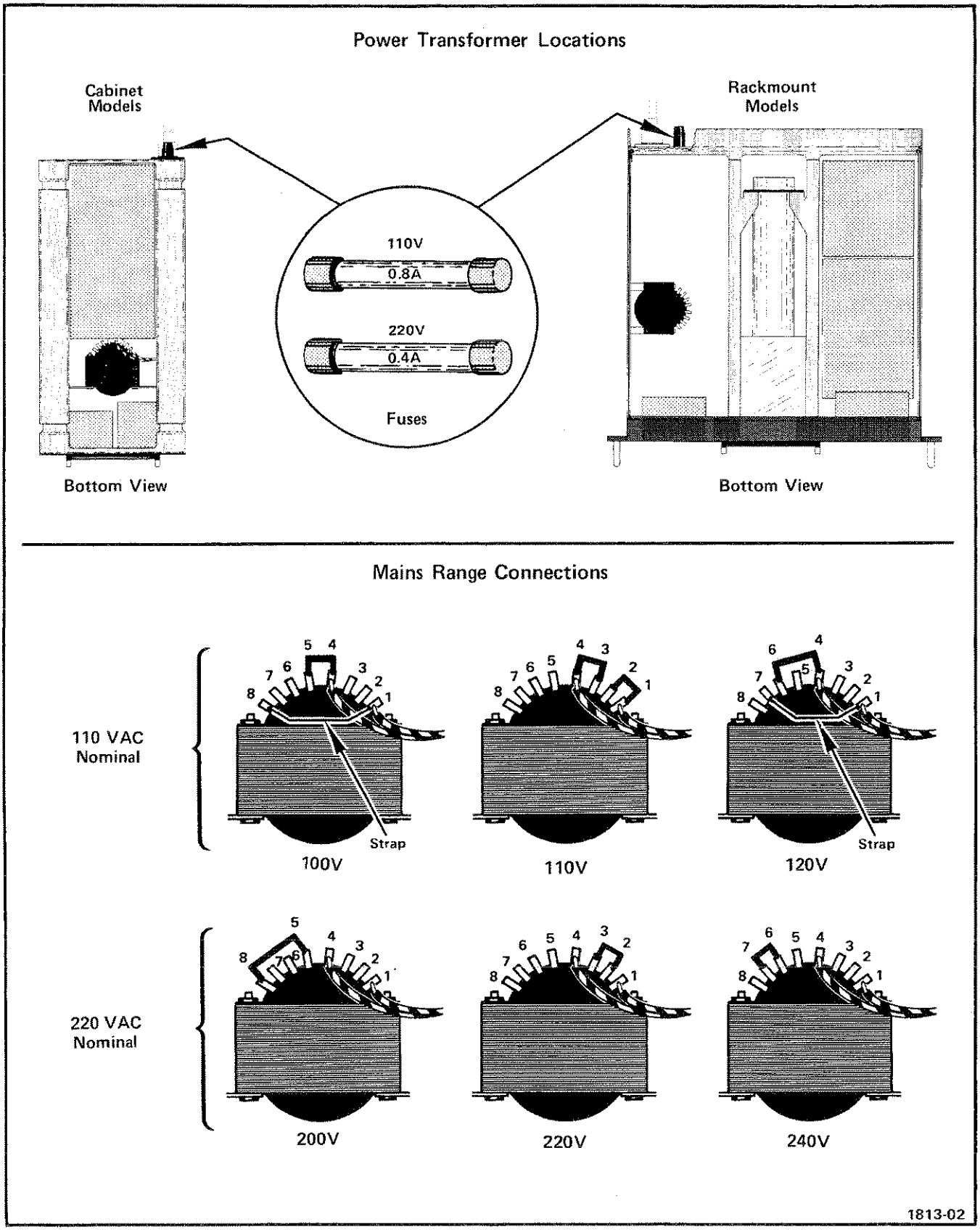
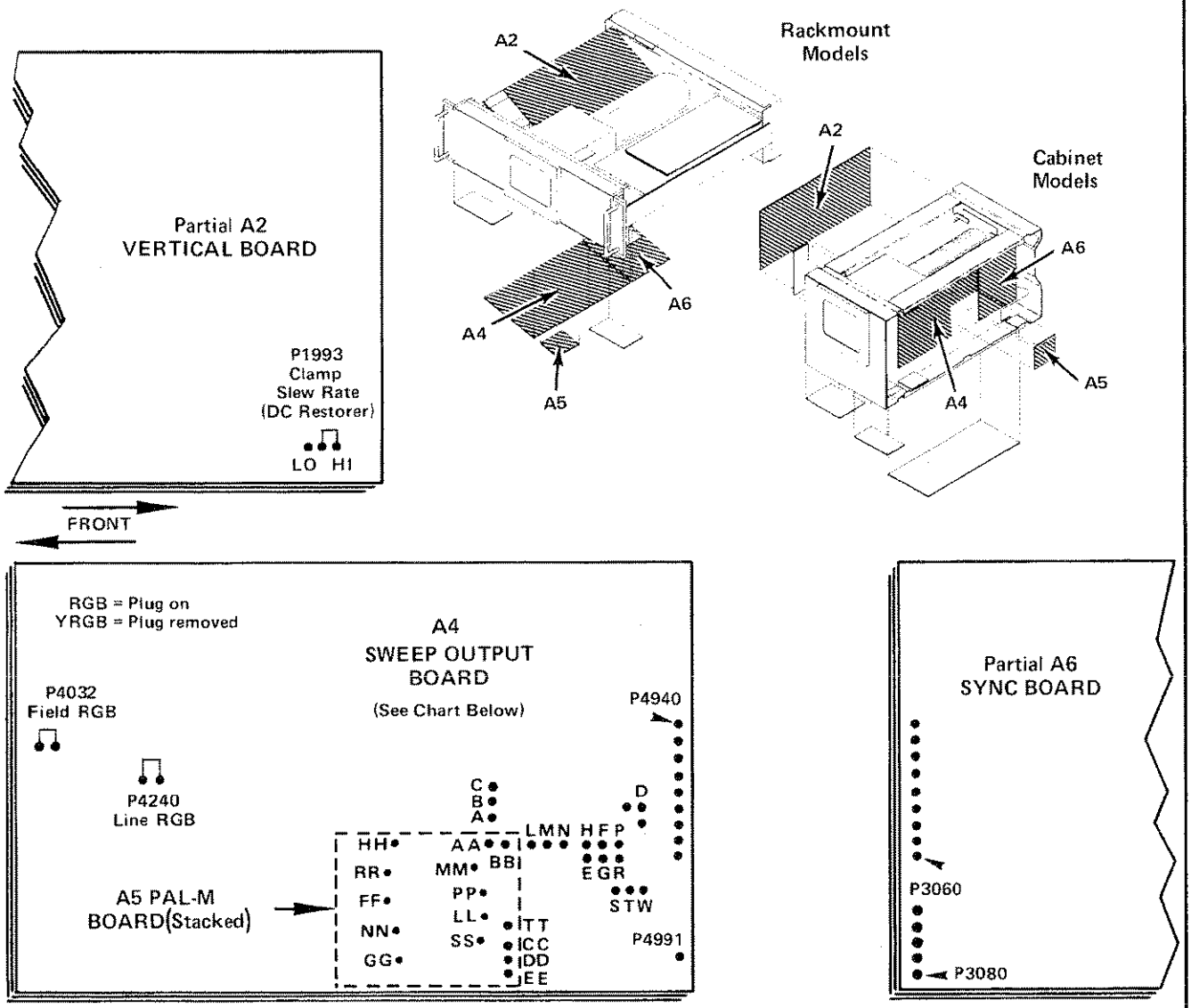


Fig. 1-2. Power transformer locations and primary winding mains range taps.

ELECTRICAL PROGRAMMING



2-FIELD GATE GENERATOR INTERCONNECTION CHART

1813-03A

Standards Single or dual	P4950-5 from	P4991-1 to	P4950-7 from	Pin TT to	The remaining interconnections for the 2 Field Gate generator should be listed below:							
NTSC (525/60)	NA	NA	NA	NA	B-C	E-F	G-H	L-M	P-R	T-S		
PAL (625/50)	NA	P3080-1	P3060-1	NA	A-B	E-F	G-H	L-M	P-R	T-S		
PAL-M (525/60)	NA	NA	P3060-1	P3080-1	A-B	C-E	F-H	L-M	P-R	S-EE	T-DD	AA-BB
NTSC + PAL	P3060-3	P3080-1	P3060-1	NA		E-F	G-H	L-M	P-R	T-S		

Fig. 1-3. Electrical programming plug-jumper locations and connections.

Rackmount Models

The rackmount models of the Waveform Monitors are designed to fit standard 19-inch racks. Chassis-sections for slide-out, non-tilt tracks are attached to each side of the instruments. Matching pairs of intermediate and stationary sections, plus all necessary mounting hardware are supplied as standard accessories. Fig. 1-4 illustrates a typical rack installation. See the foldouts at the rear of this manual for detailed dimensional drawings and assembly instructions.

With the rear of the front panel ears flush against the face of the rack, allow sufficient space for a reasonable bend radius for coaxial cables to be connected to the Waveform Monitor's rear panel.

Cabinet Models

The cabinet models are designed to be mounted in standard 19-inch racks or consoles, using cradle and bezel assemblies. See Fig. 1-5. Cradles and bezels are available from Tektronix for mounting two 1480 Series Waveform Monitors side-by-side, or one Waveform Monitor to the left or right side of 8-inch or 9-inch picture monitors. An optional field case is also available for operation outside a rack or console environment. Consult the Tektronix Television Products Catalog for the appropriate part numbers.

Threaded holes are provided in the bottom chassis rails so the cabinet model can be securely fastened to the cradle shelf or to its optional field case. Fig. 1-6 illustrates mounting hole locations. See the foldouts at the rear of this manual for detailed dimensional drawings.

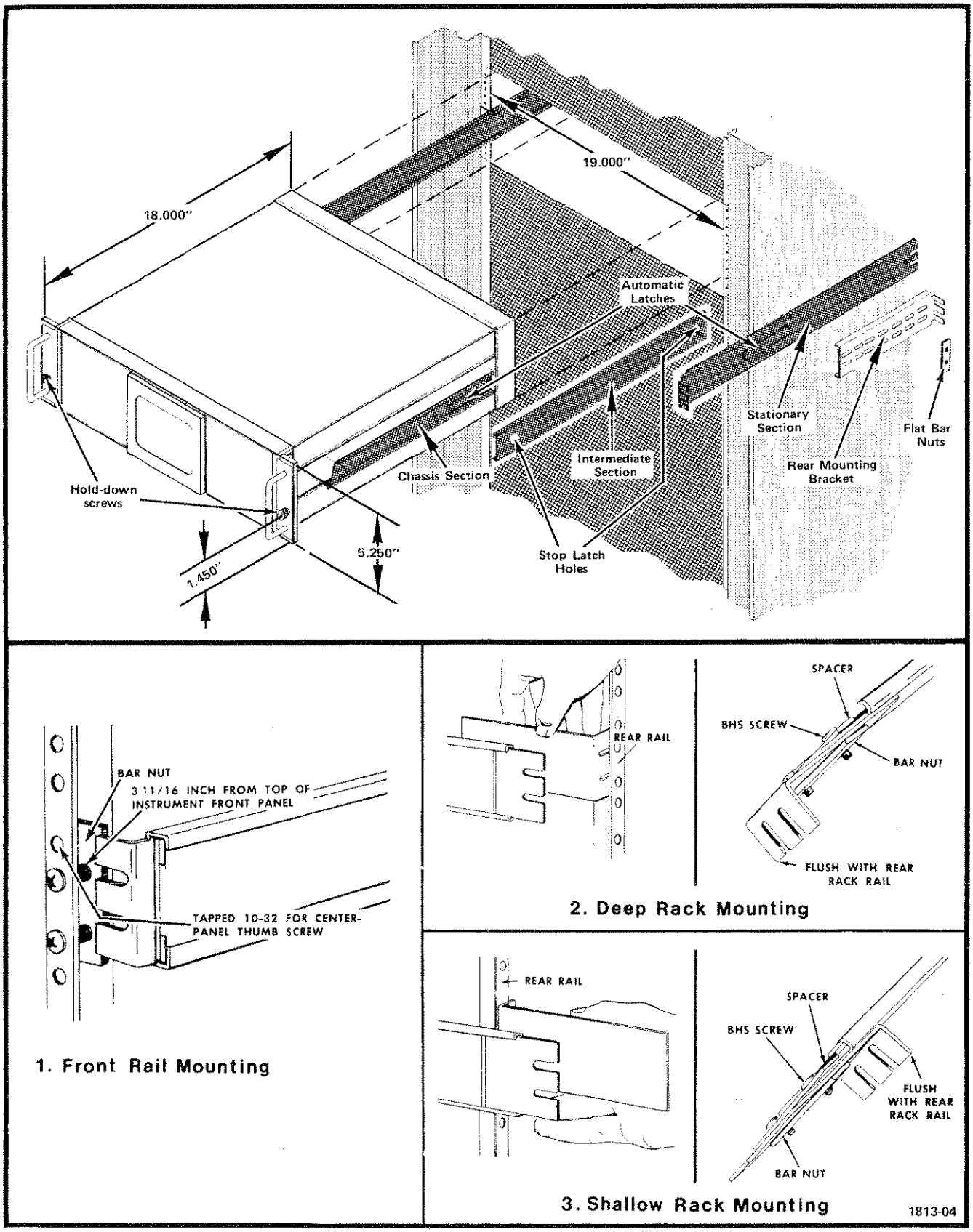


Fig. 1-4. Typical rack installation for a 1480-Series Rackmount model.

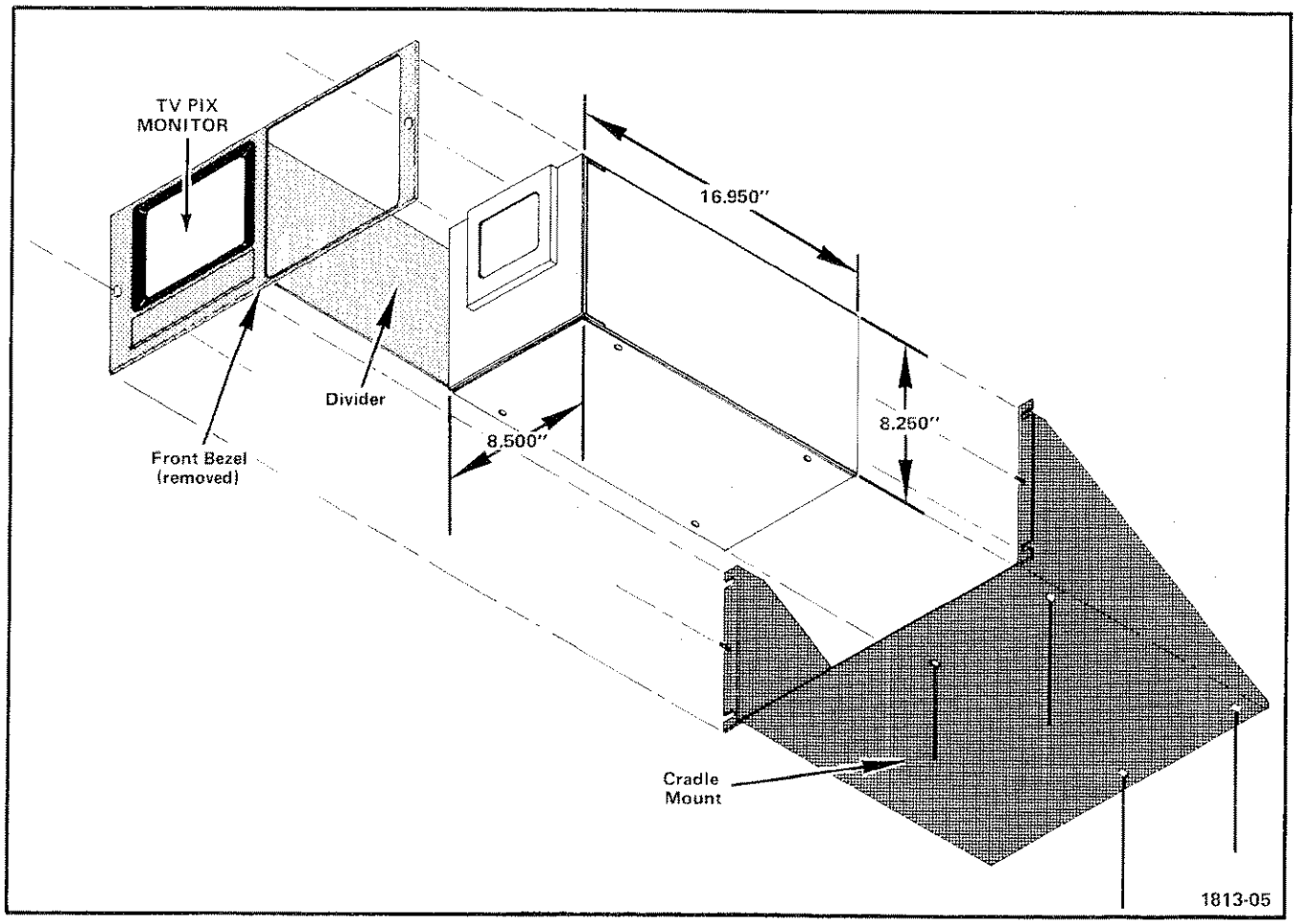


Fig. 1-5. Typical cradle mount for a 1480-Series Cabinet model.

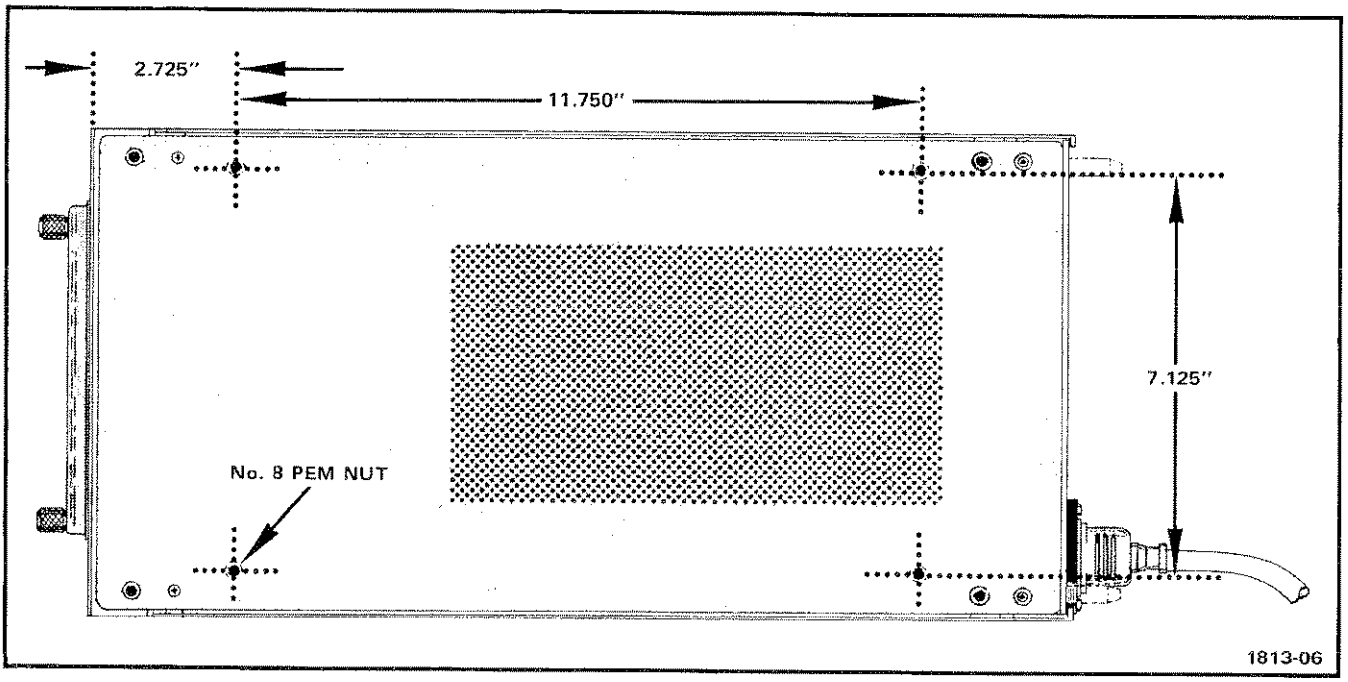


Fig. 1-6. 1480-Series Cabinet model mounting hole locations (approximate) for cradle or field case installation.

OPERATING INSTRUCTIONS

DESCRIPTION

The 1480-Series of Waveform Monitors is a line of versatile, high-performance, television broadcast waveform monitors designed for use in studio or mobile-control rooms, video tape recorder installations, and at transmitter facilities.

Single-standard models and dual-standard combinations are available for most of the world's television systems. The 1480-Series Waveform Monitors are configured in both rackmount and cabinet versions.

Vertical Features

A distortion-free, vertical overscan capability offers increased high-resolution measurements. Coupled with a wide vertical positioning range, any portion of a nominal 1-volt composite video signal can be viewed at any position of the VOLTS FULL SCALE settings.

The vertical response can be specialized by selecting one of several filters from the front panel, ranging from LOW PASS, through IRE and FLAT, to BAND PASS around certain color subcarrier frequencies. In addition, the same switch can select a differentiated-steps display or an auxiliary video input at the rear panel.

A versatile DC Restorer offers clamping on the back porch or at the sync tip of the composite video waveform. Fast and slow clamping speeds can be selected to suit specific needs.

An internal calibration squarewave is available at the push of a button. This calibration signal can also be used to offset the displayed video signal for quick amplitude accuracy checks.

A front-panel, X10 probe-input option is described in Section 5 of this manual.

Horizontal Features

Calibrated magnification to X50 and a high writing-rate crt allow viewing of fast-rise, low repetition-rate signals such as the 100 ns rise time of a test signal on a single line out of the four fields in the PAL system. In high-magnification positions, the crt is automatically brightened.

A Waveform Comparison feature provides for locating and overlaying any portion of a line-rate display with any other portion. For instance, when used with the vertical "windowing" ability (overscan), this mode enhances Pulse-to-Bar ratio measurements.

The LINE SELECTOR switch and individual field buttons provide for digitally-determined, positive line selections. A variable mode utilizes a bright-up strobe to select for display any line or group of 15 lines from 2-Field displays. An ALL FIELDS pushbutton overlays all fields at once, allowing for analysis of any line or group of 15 lines from each field simultaneously. (SN B02096 and up—Pressing FIELD 3 and 2 buttons provides the same mode of display.)

Direct-acting sync follows any horizontal jitter so it is not visible on the display. A selectable AFC mode ignores sync jitter and thus displays the sync jitter on the monitor.

Rear Panel Features

The main video and external sync signal inputs are of loop-through design (no internal termination) and can be isolated from the chassis, allowing for differential rejection of hum by the input stages. Input connectors are available for RGB displays and external horizontal inputs along with an auxiliary video input to the vertical amplifier. Output connectors supply auxiliary video out, a picture monitor video signal, and a line strobe pulse coincident with the setting of the LINE SELECTOR VARiable control, and the digital LINE SELECTOR.

Also available is a connector mounting location for customized, remote-operating installations.

Graticules

Graticules most usable in the television system for which a particular model is intended are supplied internal to the crt as standard. Also included as standard accessories are several external graticules, usually intended for specific measurements, or to convert dual-standard models from one line standard to the other. A blank crt is available as an option.

External graticules are available in both NTSC and CCIR configurations in two pattern sizes. One, intended for normal viewing use, is the same pattern size as the internal graticule. Part numbers for this pattern size are 331-0393-04 for NTSC and 331-0393-05 for CCIR.

The second pattern size is slightly smaller than the internal graticule pattern and is designed to remove parallax effects when using an oscilloscope camera. Part numbers for this pattern size are 331-0393-06 for NTSC and 331-0393-07 for CCIR.

CONTROLS

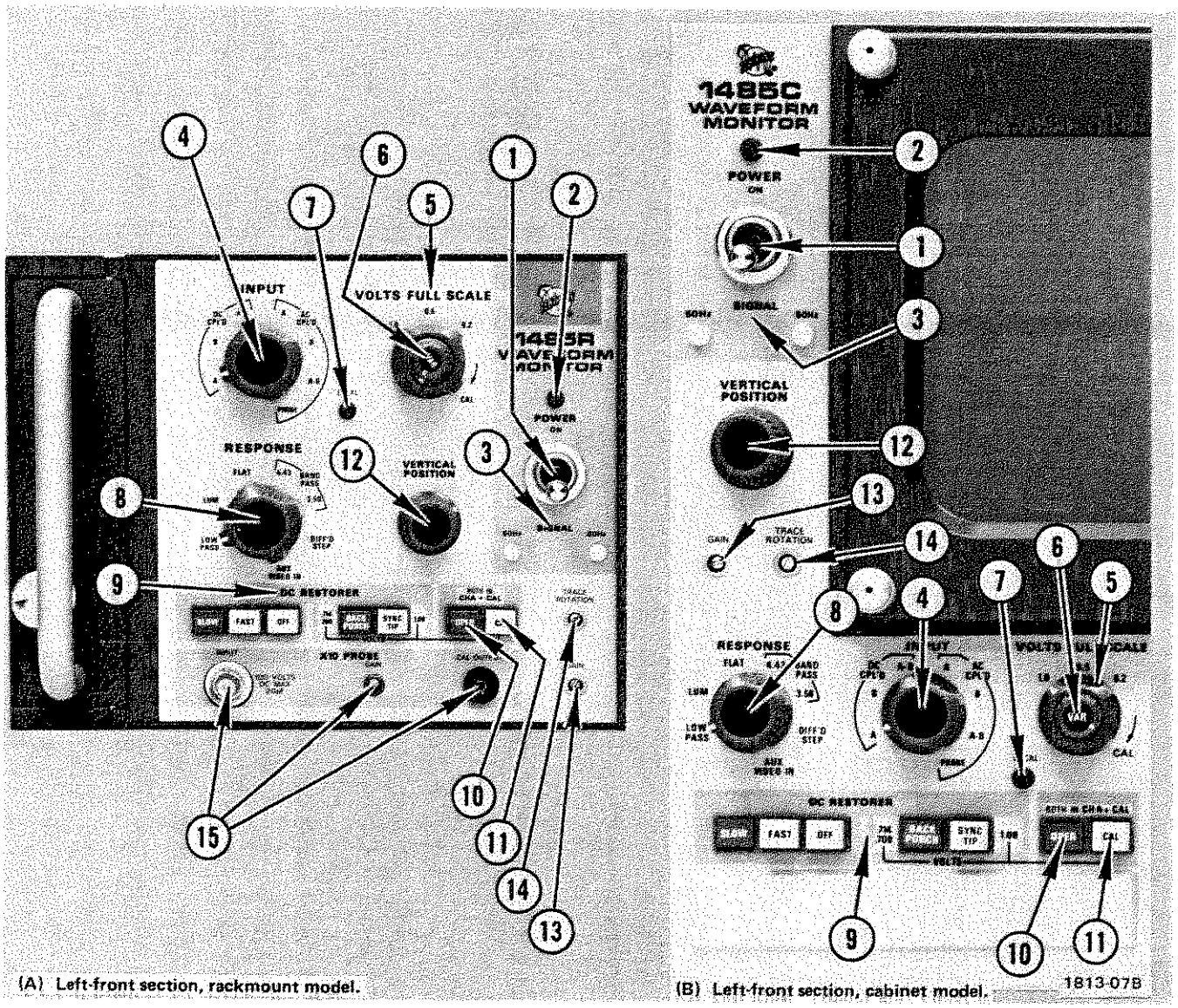
Certain pushbuttons on the front panel are color-coded dark gray. With all these buttons pushed in, the Waveform Monitor display will be normal according to the Vertical response mode selected. All pushbuttons have functional labels. Within their own groups, the buttons are self-cancelling when pushed individually. In certain operating modes, the OPER and CAL button-pair will be pushed in at the same time, as will pairs of the FIELD buttons.

Almost all of the functions, controls, connectors, and indicators needed and used by any of the models in the series are present on the NTSC/PAL dual-standard instrument. Therefore, the NTSC/PAL dual-standard instrument is used as the example to illustrate and describe the features of the 1480-Series of Waveform Monitors.

Refer to Fig. 2-1 as the following items are explained:

1. POWER—Applies or removes mains voltage to the power transformer primary.

2. POWER ON—Lights to indicate presence of mains voltage at power transformer primary.



(A) Left-front section, rackmount model.

(B) Left-front section, cabinet model.

1813-07B

Fig. 2-1. Vertical mode controls of the (A) 1485R rackmount, and (B) 1485C cabinet models.

3. SIGNAL—Lights indicate 50 Hz or 60 Hz field-rate input signal.

4. INPUT—Selects A or B VIDEO INPUTS, or A-B differentially, ac or dc coupling, and the X10 PROBE INPUT if the Waveform Monitor is equipped with that option (see Section 5, Options.).

5. VOLTS FULL SCALE—Alters vertical gain allowing 1.0, 0.5, or 0.2-volt signals to produce full screen deflection. Also acts as a vertical magnifier giving X1, X2, or X5 expansion of the input signal.

6. VAR VOLTS FULL SCALE—Varies vertical gain from X0.5 to X1.4 nominal (−6 dB to +3 dB) when not in the CAL detent position.

7. UNCAL—Lights up to indicate the VAR VOLTS FULL SCALE control is not in CAL.

8. RESPONSE—Selects wide-band, filtered, or differentiated vertical response modes. Also selects auxiliary video input from rear panel.

LOW PASS: Attenuates frequencies 500 kHz and up by at least 14 dB (−40 dB at 1 MHz typical).

IRE: Conforms to IRE standard 23S-1, 1958 (−22 dB at 4.43 MHz typical). 1480C and 1480R only.

LUM: Low-pass filter with a roll-off curve from ≤ -3 dB at 1 MHz to ≥ -40 dB attenuation at 4.43 MHz.

FLAT: Unfiltered, wide-band position. Flat to 5 MHz or more, −3% at 10 MHz.

4.43 BAND PASS: Provides bell-shaped response curve with 4.43 MHz as center frequency. Within 1% of FLAT reference at 4.43 MHz. (This filter not present in 525/60-line standard models, single- or dual-standard versions.)

3.58 BAND PASS: Provides bell-shaped response curve with 3.58 MHz as center frequency. Within 1% of FLAT reference at 3.58 MHz. (This filter not present in 625/50-line standard models, single- or dual-standard versions.)

DIFF'D STEP: Differentiates risers of linearity test signals, providing amplitude comparisons of staircase step risers. Automatically increases vertical gain to maximum (between 5 and 7 times). Attenuator increases from about −2 dB at 0.5 MHz to about −40 dB at color subcarrier center frequencies. Dc restoration not effective in this mode.

AUX VIDEO IN: Provides unfiltered, wide-band input to the vertical amplifier. The response characteristics are the same as FLAT.

9. DC RESTORER—Eliminates vertical drift and provides stable displays despite changes in signal amplitude and average luminance levels. Buttons select the clamping speeds and clamping-time locations on the composite video signal. In the DIFF'D STEP response mode, the dc restoration is automatically turned off. In the LOW PASS response mode, SYNC TIP is automatically locked out. In the BAND PASS response modes, the dc restorer circuits still operate, but, because the filters do not pass dc or a low-frequency component, dc restoration neither adds to, nor detracts from, measurements made from these filters.

OFF: Disables the dc restoration circuits. The trace level will follow the dc content of the incoming signal.

SLOW: Selects a time constant sufficiently long so that mains hum and field-rate tilt in the video signal will be displayed.

FAST: Selects instantaneous clamping to eliminate hum and tilt in the display. Attenuates mains hum at least −26 dB.

BACK PORCH: Sets the clamping sample pulse to occur at back-porch time in the composite video waveform.

SYNC TIP: Sets the clamping sample pulse to occur at sync-tip time in the composite video waveform.

10. OPER—Selects the INPUT signal for normal display operation.

11. CAL—Selects an internally-generated squarewave useful for checking vertical gain and the complete or component parts of a composite video signal.

When CAL is pushed in at the same time as the OPER button, the incoming signal at the A INPUT only is overlaid on the two levels of the CAL squarewave for quick and accurate evaluation of the video signal amplitude.

The CAL signal amplitude is dependent on the DC RESTORER settings: SYNC TIP, 1 V; BACK PORCH, 700 mV or 714 mV, depending further on which line-standard external graticule is being used for a measurement.

12. VERTICAL POSITION—Provides fine positioning of the vertical trace with a ten-turn potentiometer.

13. GAIN—Adjusts amplitude of the displayed signal with the VAR VOLTS FULL SCALE control in the CAL (detent) position. This is usually adjusted by comparing the internal CAL signal with the calibrated internal graticule.

14. TRACE ROTATION—Aligns the trace with the horizontal graticule lines.

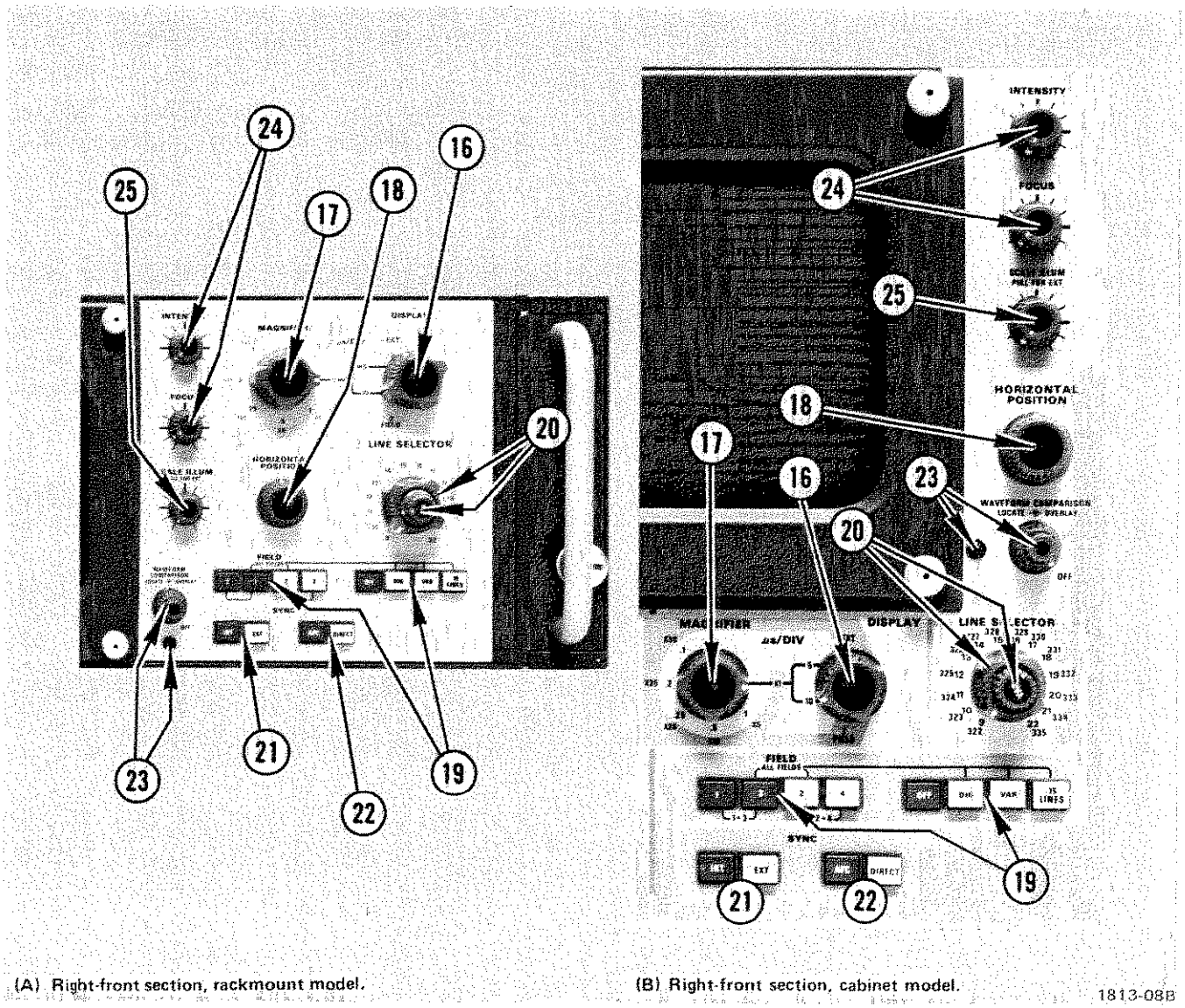
15. X10 PROBE INPUT, GAIN, CAL OUTPUT—See description of Option 1 in Section 5, Options.

Refer to Fig. 2-2 as the following items are explained:

16. DISPLAY—Selects three calibrated sweep speeds and an external horizontal input mode.

2 FIELD: Displays two fields at 25 Hz or 30 Hz frame rates. Sweep starts at line 16 of the vertical interval of the field or field-pair selected by FIELD switch.

10 μs/DIV: Selects sweep rate to effectively display two line periods of either 525-line or 625-line systems. (The graticule horizontal scale is marked for 12.7 div or 127 μs. In 525-line systems a two-line period equals 127 μs, in 625-line systems a two-line period equals 128 μs.)



(A) Right-front section, rackmount model.

(B) Right-front section, cabinet model.

1813-08B

Fig. 2-2. Horizontal-mode controls of the (A) 1480R rackmount, and (B) 1481C cabinet models.

5 μs/DIV: Selects sweep rate to effectively display one line-period of either system.

EXT: Selects the external horizontal input for display.

17. MAG μs/DIV—Overrides DISPLAY switch to select other sweep deflection factors. Display brightness is automatically increased to maintain balance displays.

OFF: Selects normal sweep modes controlled by DISPLAY switch.

X5, X10, X20, X25, X50: Magnifies 2 FIELD and EXT displays accordingly.

1, .5, .25, .2, .1: Overrides 10 μs/DIV or 5 μs/DIV modes to provide indicated calibrated sweep speeds.

18. HORIZONTAL POSITION—Moves display horizontally with a ten-turn potentiometer. This has sufficient range to display both ends of the sweep at 50 times magnification.

19. FIELD—Positively selects the beginning of the 2-FIELD sweep. Buttons select individual fields 1, 2, 3, or 4 for PAL systems, or EVEN (fields 1 and 3) or ODD (fields 2 and 4) field-pairs for NTSC systems.

(1480R, SN B021070 and up; 1481C, SN B030680 and up; 1481R, SN B031210 and up)

Simultaneously pressing FIELD 3 and 2 buttons selects all fields to be time overlaid.

20. LINE SELECTOR—Provides three modes of line selection to view any line in any field. The line or lines selected are intensified in the 2 FIELDS DISPLAY position. The dark gray OFF button turns the LINE SELECTOR off.

DIG: Provides positive, digitally-controlled line selections from the vertical interval of selected fields to start the line-rate sweeps. Selects the ninth through the twenty-second line of each field.

VAR: Selects single lines from the displayed fields with a multi-turn potentiometer. While in the 2 FIELD mode, the selected line is intensified by a bright-up strobe. When the DISPLAY switch is set to 10 μs/DIV or 5 μs/DIV, the display starts with the selected line.

15 LINES: Performs the same as the VAR mode except the strobe is fifteen lines wide. In the line-rate displays, the selected fifteen lines are overlaid on each other. This is used to display one head rotation of a quad-head video tape recorder.

(1480R, SN B021069 and below; 1481C SN B030679 and below; 1481R, SN B031209 and below)

21. ALL FIELDS—Selects all fields to be time overlaid by pushing the ON button. The dark gray OFF button turns off the ALL FIELDS mode, returning control to the FIELD switch.

(All Serial Numbers)

During the ALL FIELDS mode, the horizontal sweep is only one field-period long. The LINE SELECTOR VAR control cannot be used to select lines or groups of lines that belong in the second field of a normal 2 FIELD DISPLAY.

22. INT-EXT SYNC—Selects source for horizontal synchronization.

INT: Derives sync information from incoming video signal at the input selected by the INPUT switch.

EXT: Derives sync information from composite signals applied to the rear panel (A) and (B) inputs.

23. AFC-DIRECT SYNC—Selects sync processed instrument, but directly related to incoming sync, or phase-locked loop synchronization for stable displays in the presence of noise or with missing sync pulses.

AFC: Phase-locks the internal oscillator to incoming line sync. This mode offers more noise immunity (about 8 dB jitter reduction) than DIRECT. However, jitter present in the signal can be seen more readily in AFC mode.

This mode displays every line of incoming video, including those with missing sync pulses (at least ten consecutive lines before loss of lock). As long as the incoming line frequency is within 200 Hz of 15,750 Hz, the phase-locked loop will provide a stable display. Otherwise, the sweep will free run.

DIRECT: Provides a triggered display for every sync pulse received. This mode will operate on low rep-rate signals and up to 20 kHz line frequencies.

This mode will not display lines with missing sync pulses. After a long period of time without a trigger reference, sweep control will revert to the internal oscillator and free-run until a new sync pulse arrives.

24. WAVEFORM COMPARISON—Selects a time-overlay mode in the 10 μs/DIV and 5 μs/DIV DISPLAY positions. This mode is useful for comparing amplitudes of parts of complex waveforms within the same display.

LOCATE: Positions the comparison break-point on the 10 μs/DIV and 5 μs/DIV displays, provided that the OVERLAY control is out of the OFF (detent) position. The comparison break-point, a small gap in the trace, will be positioned at the right side of the sweep when the LOCATE control is near its clockwise end.

OVERLAY: Time-overlays that portion of the sweep occurring after the break-point with the preceding part of the sweep. As the control is rotated counterclockwise, the display will overlay from right to left. A red indicator turns on when the OVERLAY control is active.

25. INTENSITY & FOCUS—Control brightness of the beam and definition of the display.

26. SCALE ILLUM—Adjusts illumination of the internal or external graticule markings.

PULL FOR EXT: Selects lighting system for external graticules and turns off internal graticule system.

This switch also selects the calibrator waveform amplitude for the BACK PORCH mode of the DC Restorer. The external graticule restrains a slide switch at its base, behind the bezel, in one of two positions, thus selecting the appropriate calibration voltage. (See discussion on graticules later in this section.)

CONNECTORS

Each of the four loop-through connectors (A & B VIDEO and A & B EXTERNAL SYNC) have provisions for either grounding or floating the shield side. This is accomplished by using a non-insulated mounting bolt. (See Fig. 2-3.)

If the non-insulated bolt is installed, the input shield connector is grounded, providing good RF shielding. If the non-insulated bolt is removed, the input shield is floating, providing differential hum rejection.

Refer to Fig. 2-3, where the following items are explained:

27. VIDEO INPUTS A & B—High-impedance, loop-through inputs for composite video. Compensated for 75 Ω, not internally terminated.

28. EXTERNAL SYNC (A) & (B)—High impedance, loop-through inputs for composite sync. Compensated for 75 Ω, not internally terminated.

29. External Sync Selector Switch—Selects source for external sync information.

EXT SYNC SWITCHED WITH INPUT SWITCH (A) OR (B): Causes external input to the sync stripper to follow setting of the front-panel INPUT switch.

EXT SYNC ALWAYS (A): Causes external input to the sync stripper from the (A) input, regardless of the INPUT switch setting.

30. EXTERNAL HORIZ IN—Requires a 5-volt, positive-going input signal, starting at 0 volt, for full-screen deflection. Dc-coupling, input impedance, about 10 kΩ (no crt blanking).

31. LINE STROBE OUT—A TTL-derived line selector strobe pulse. The pulse present only during LINE SELECTOR modes.

32. PIX MONITOR OUT—A composite video output of incoming video signal, picked off after the vertical preamp, but before the RESPONSE filters. The Line Strobe is added to the output signal in LINE SELECTOR modes. Internally terminated in 75 Ω.

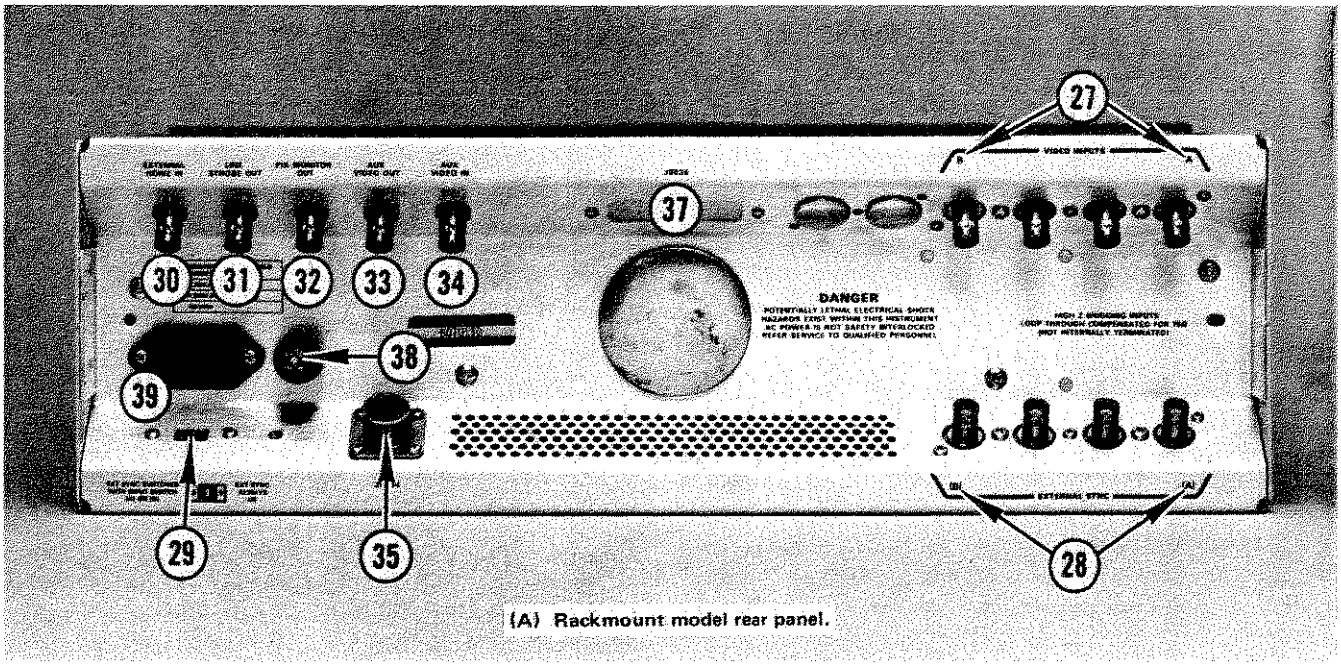
33. AUX VIDEO OUT—Same as PIX MONITOR OUT except that the Line Strobe pulse is not available. Internally terminated in 75 Ω.

34. AUX VIDEO IN—Video input, internally terminated in 75 Ω. 1.5 dB gain allows for loss of passive networks that may be used. Enters the vertical system after the RESPONSE filters.

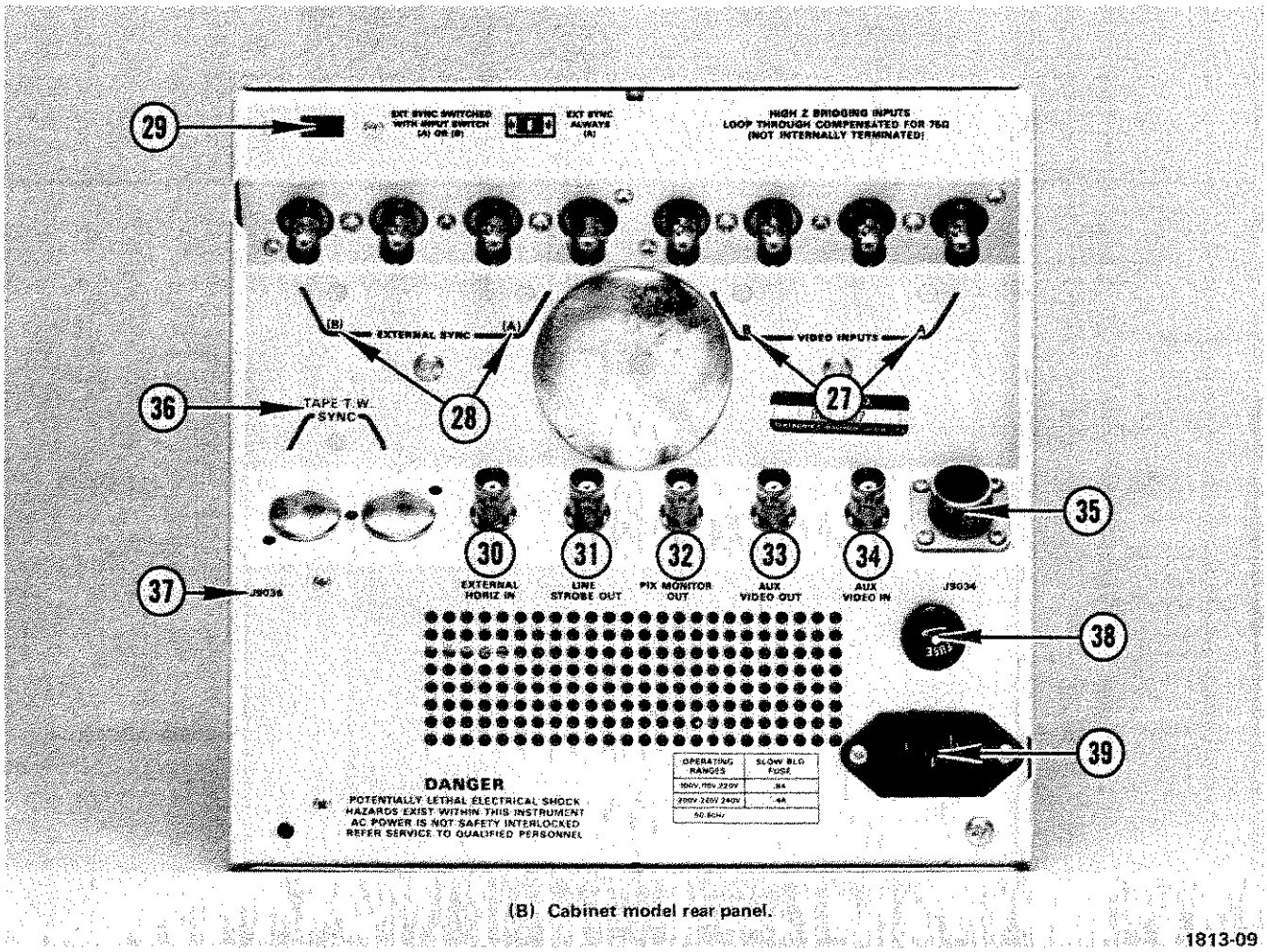
35. J9034—RGB input connector providing external switching control and signal access for RGB/YRGB displays. (See discussion of RGB/YRGB mode later in this section.)

36. TAPE T.W. SYNC—(Cabinet models only) Tone Wheel Sync input, Option 4.

37. J9036—Blank mounting location for possible remote control connector.



(A) Rackmount model rear panel.



(B) Cabinet model rear panel.

1813-09

Fig. 2-3. Rear-panel connectors of the 1480-Series rackmount and cabinet models.

38. Mains Fuse and Holder—0.4 A slow-blowing fuse for 220 V nominal mains and 0.8 A slow-blowing fuse for 110 V nominal mains.

39. Motor Base Connector Receptacle—3-bladed connector to receive power cord.

GRATICULES

Patterns

Two basic patterns are available as standard in both internal and external graticules. Figs. 2-4 and 2-5 illustrate the CCIR and NTSC composite patterns.

An NTSC non-composite pattern is available as an optional, extra-cost, external graticule. Refer to the TV Products Catalog or call your local Tektronix representative.

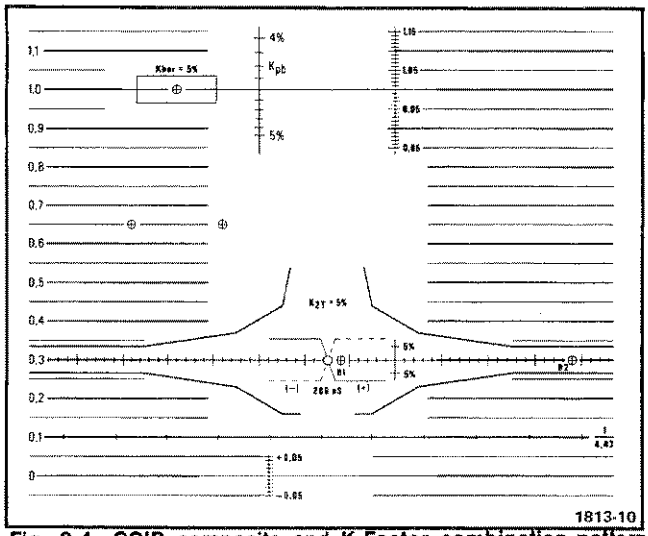


Fig. 2-4. CCIR composite and K-Factor combination-pattern graticule.

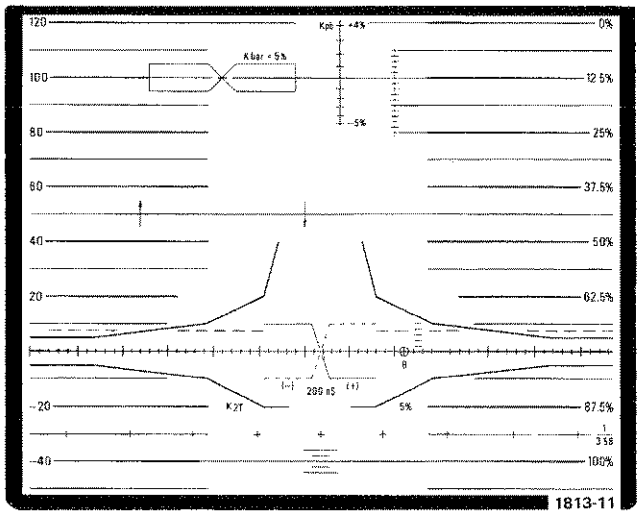


Fig. 2-5. NTSC composite, K-factor, and transmitter scale combination-pattern graticule.

The graticule horizontal scales are calibrated in 12.7 div (10 cm) along the horizontal line at the typical blanking level. The vertical graduations are scaled according to measuring units and ranges peculiar to each system—mV for the CCIR graticule, and IRE units and percent modulation for NTSC. The graticules are also marked for K-factor tolerances and linear distortion measurements.

Internal

With the SCALE ILLUM control pushed in, the internal graticule is edge-lighted. The range of illumination is sufficient for comfortable viewing in a studio environment or for taking waveform pictures with Tektronix Oscilloscope Camera Systems. The internal graticule offers parallax-free viewing that greatly enhances measuring distortions, amplitudes, and level-setting adjustments.

External

External graticules can be installed quickly and easily. Simply unscrew the crt bezel cap nuts, remove the crt bezel and fit the graticule over the faceplate with the printed side in. Depending on the TV system for which the graticule is designed, the BACK PORCH CAL AMPL switch (see Fig. 2-6) will be forced to the left (NTSC) or right (PAL) positions by a locating hole in the foot of the external graticule. Thus, when the PULL FOR EXT SCALE



Fig. 2-6. Location of BACK PORCH CAL AMPL S9955. (Same location in cabinet models.)

ILLUM control is activated to turn on the external-graticule lights, the CAL signal amplitude will be automatically selected when the DC RESTORER is in BACK PORCH. The switching just described will have no effect in the SYNC TIP mode, which always produces a 1-volt signal.

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OPERATING PRECAUTIONS

When operating the 1480-Series Waveform Monitors, front-panel controls can be set in such a manner as to exhibit anomalous displays. The following discussion identifies those operating modes that should be avoided.

1. In the ALL FIELDS mode (FIELD 3 and 2 buttons pressed), with DISPLAY in 5 μs/DIV or 10 μs/DIV, and LINE SELECTOR VAR pressed, no display will be obtained if the LINE SELECTOR VAR potentiometer is set to display lines during the time a second field would have been displayed.

The ALL FIELDS mode time-overlays each successive field on the first half of the 2 FIELD display, thus the maximum ramp amplitude at the 2 Field Sweep Generator (Diagram 8) is 5 volts. The LINE SELECTOR VAR control has a range of 0 to 10 volts at the input to the 2 Field Sweep Generator. Since the LINE SELECTOR VAR control voltage is applied to one side of a comparator in the 2 Field Sweep Generator device, there is no delayed gate output if the LINE SELECTOR VAR is set above the maximum ramp voltage (5 volts in this mode).

2. The four front-panel FIELD buttons would seem to imply that the 1480-Series monitors identify four fields of any television system. In PAL systems, the Bruch sequence certainly identifies four fields, but NTSC and PAL without Bruch sequence systems have four less-clearly identified fields. These fields are determined by subcarrier phase with respect to the leading edge of line sync. The 1480-Series monitors do positively identify four PAL fields in the presence of the Bruch sequence, but cannot identify fields that are different from each other only in the phase of the subcarrier with respect to line sync.

3. If composite PAL video is applied to the AUX VIDEO IN connector and composite sync to the EXT SYNC IN connectors, with no signal to the VIDEO INPUTS or with the INPUT switch in the PROBE position and SYNC in EXT, the 1480-Series monitors will not positively identify the four PAL fields even in the presence of the Bruch sequence. All the sync functions appear normal, but the Burst Gate Generator (Diagram 5) does not receive burst information from the + Amplifier (Diagram 1).

4. Do not attempt to use the AUX VIDEO IN as an end-of-line termination for a signal looped through other instruments if the 1480-Series POWER switch is off. With POWER on, the AUX VIDEO IN circuit is internally terminated in 75 Ω, but with POWER off, the impedance is around 80 Ω.

5. The additive calibrator mode (where the front-panel CAL and OPER buttons are pressed simultaneously) operates only with the video signal connected to the A VIDEO INPUT. If the INPUT switch is in B or PROBE, the display in the additive calibrator mode will still be whatever is connected to the A VIDEO INPUT superimposed on the calibrator signal.

6. With the INPUT switch in the PROBE position and the front-panel CAL button pressed, the DC Restorer is disabled and no clamping is done. The DC Restorer operates properly with the OPER button pressed.

7. The calibrator timing flipflop (U4640B, Diagram 7) is disabled if the LINE SELECTOR 15 LINE button is pressed and the DISPLAY switch is in 5 μs/DIV, 2 FIELD, or EXT.

8. In PAL models, the lack of Bruch sequence in the incoming video signal causes loss of sweep if FIELD 1 or FIELD 4 buttons are pressed individually (12 1/2 Hz sweep rate).

9. In Option 4 and Option 5 (VTR T.W. Sync Input) models, the DISPLAY switch in 10 μs/DIV and 2 Field sweep enabled through J9034, using the MAG switch causes the display to shift about one field to the left.

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OPERATIONAL—CHECK OUT

The following procedure is a method for becoming familiar with the basic operation of the 1480-Series Waveform Monitors.

Because the 1485 dual-standard NTSC 525/60—PAL 625/50 model incorporates all the functions and all the ranges present in any one of the several models (except the PAL-M digital line selector range), it will be used as a demonstration vehicle for this procedure. Single-standard models can also be used by doing the connections, and control settings relative only to that line standard.

To check out fully the automatic field-rate detection, the positive field selection, the digital LINE SELECTOR

dual ranges, and the BAND PASS filters, NTSC and PAL signal sources should both be available at the same time. If only one line-standard signal source is available, only the functions named above cannot be completely demonstrated for dual-standards.

Single-standard models can also be checked with this procedure by ignoring steps relative to the opposite line-standard. Substitute PAL-M signal sources accordingly when a PAL-M 525/60 line-standard model is involved.

Each signal source should provide 1-volt (into 75 Ω) composite video color bars and modulated staircase signals, with test signals in the vertical intervals. They should also provide negative-going composite sync signals, at least 4 V peak-to-peak, into 75 Ω.

Tektronix 140 and 145 Test Signal Generators, for NTSC and PAL line-standards respectively, were used to write this procedure. A Tektronix Calibration Fixture, 067-0601-00, capable of simulating 3-step and 4-step RGB or YRGB signals was used to demonstrate and check that capability. A wide-band oscilloscope, such as a Tektronix 7603, was used to observe the output signals from the Waveform Monitor's rear panel. All of the above named equipment is usable in the Performance Check and Calibration Procedures given in Section 3.

Waveform Monitor controls and connectors are always named using all upper case letters. Names of specific test equipments and their controls and connectors are initial-capitalized. Generalized terms used are in lower case.

Powering Up

Check the mains voltage setting marked on the rear panel. Check that the fuse is proper, connect the 1485 to a suitable power source, and turn on the POWER switch.

No-Signal-In Checks and Alignments

Set up. Set RESPONSE to FLAT, DISPLAY to 2 FIELD, VOLTS FULL SCALE to 1.0, and depress all the dark gray buttons. Adjust the INTENSITY and FOCUS controls for a bright, well-defined trace.

Trace Rotation. Using the VERTICAL POSITION control, move the trace to upper-, lower-, and mid-screen graticule lines and check for horizontal alignment. Set the trace to one of the lines for reference and rotate the TRACE ROTATION control with a small screwdriver. Note that the trace rotates from end-to-end of the potentiometer. Re-align the trace with the reference graticule line.

Scale Illumination. Rotate the SCALE ILLUM control throughout its range and observe full illumination of the internal graticule lines. PULL FOR EXT position turns on the upper (or internal) graticule lights and turns on the lower (or external) graticule lights. Check for full illumination control, then return to the internal lights position (pushed in).

Vertical Gain. Push in the CAL and SYNC TIP buttons. Set the DISPLAY switch to 10 μs/DIV and observe a calibrator squarewave (4-line period). Position it vertically to fit the 0 and 1,0 lines of the graticule. Adjust the front-panel GAIN control until the CAL signal exactly overlays those two reference lines. The vertical amplifier is now calibrated for a 1-volt equivalent display between those two lines.

BACK PORCH Clamping. Depress BACK PORCH (cancelling SYNC TIP) and observe the CAL amplitude changes to 700 mV (blanking-to-peak white in PAL systems). Measure between the 0,3 and 1,0 lines. Remove the crt bezel and place the BACK PORCH CAL AMPL slide switch in the left (NTSC) position (see Fig. 2-6). Pull out the SCALE ILLUM PULL FOR EXT switch and observe the CAL signal amplitude to change slightly to 714 mV (blanking-to-peak white for NTSC).

NOTE

Since the primary signal to be used for most of the demonstration procedure is the 625/50 PAL signal, return the BACK PORCH CAL AMPL switch to the 700 mV (or PAL) position at the right side.

Replace the crt bezel.

Signal-In Checks

Input Coupling. Set the INPUT to A DC CPL'D and connect color bars from the PAL 625/50 signal source Comp Video output to the A VIDEO INPUT, terminated in 75 Ω. (Observe that the 50 Hz SIGNAL light turns on.) Depress OPER and observe a two-field display. Check out the ac- and dc-coupling functions of the INPUT switch for A INPUT.

Switch the signal connection to B VIDEO INPUT and repeat.

Connect the signal to both VIDEO INPUTS at the same time. Terminate in 75 Ω. Set the INPUT to A-B, both AC CPL'D and DC CPL'D in turn, and observe cancellation of all but a residual amount of high frequency components in the composite video waveform.

Connect the signal to just the A VIDEO INPUT and select INPUT A, DC CPL'D.

Scale Factors. Position the composite video signal between the 0 and 1,0 lines. Reduce the signal amplitude to half (use a X2 attenuator or double-terminate). Set VOLTS FULL SCALE to 0.5 and observe that the display amplitude is from the 0 to 1,0 lines. Each major vertical division now is equivalent to 50 mV. Reduce the signal amplitude X5 (use a X5 attenuator or =14 dB pad). Set VOLTS FULL SCALE to 0.2 and observe that the display amplitude is from the 0 to the 1,0 line. Each major division is now equivalent to 20 mV.

Remove the attenuators and return to 1.0 VOLTS FULL SCALE. Rotate the VAR control out of its detent and note that the red UNCAL light comes on. Observe that the display is larger than 1 volt at the clockwise-end of the VAR control, and less than 0.5 volt at the counter-clockwise end. Return VAR to the CAL detent position.

DC Restoration. Set DISPLAY to 10 μs/DIV. Position the composite video blanking level to the 0,3 line and press the DC RESTORER OFF button. Observe that the display moves upwards to the average luminance level. Press the FAST button and observe that the blanking level returns immediately to the 0,3 line. Press the OFF button and then the SLOW button. Observe that the display shift overshoots, then returns to the 0,3 line.

Select SYNC TIP and note that the display shifts upwards so the sync tips lie on the 0,3 reference line.

OPER-CAL Additive Mode. Depress the OPER and CAL buttons at the same time. Observe a chopped-type display in which the composite video waveform is added to each level of the CAL squarewave. The sync tips will be clamped to the 0-V and 1-V levels (see Fig. 2-7). The sync tips of the upper waveform should fall on the same horizontal reference line as the 100% white bar of the lower display, indicating a 1-volt composite video amplitude. Increased resolution without distortion is available by changing the VOLTS FULL SCALE to 0.5 and 0.2.

The video component of the composite waveform can be measured by pressing the BACK PORCH button. The CAL squarewave is now reduced in amplitude to 700 mV and the composite video waveform is clamped at the blanking levels. The blanking level of the upper waveform should align with the 100% white bar of the lower waveform.

Press OPER, canceling the CAL button.

RESPONSE Displays. For operator convenience in checking out the 1485's dual-standard modes, interconnect the Waveform Monitor and the two composite video signal sources as shown in Fig. 2-8. Set the rear panel external sync source slide switch to EXT SYNC SWITCHED WITH INPUT SWITCH (A) OR (B). Set both signal sources for the normal, full-field color bar test signal for each line-standard system.

1. FLAT. Switch between INPUT A and INPUT B. Assuming the input signals are standardized, observe no linear distortions of the waveforms. (Note also how the SIGNAL lights switch between 50 Hz and 60 Hz, according to the input signal field-rate. This function is not limited to the FLAT RESPONSE mode. The lights should indicate a field-rate whenever a signal is present at the video inputs.)

2. 4.43 BAND PASS. Set RESPONSE to 4.43 and INPUT to A. Note the absence of the luminance component in the chrominance envelopes (see Fig. 2-9A). Switch to INPUT B and note the attenuation of the NTSC color bar chrominance (see Fig. 2-9B).

3. 3.58 BAND PASS. Set RESPONSE to 3.58 and INPUT to B. Observe the reverse situation of the preceding step (see Fig. 2-10A and 2-10B).

4. LUM. Set INPUT to B and RESPONSE to FLAT. Set the NTSC composite video source for a modulated staircase. Observe the FLAT response and then switch to IRE. Note the attenuation of the chrominance component and clean riser steps (see Fig. 2-11).

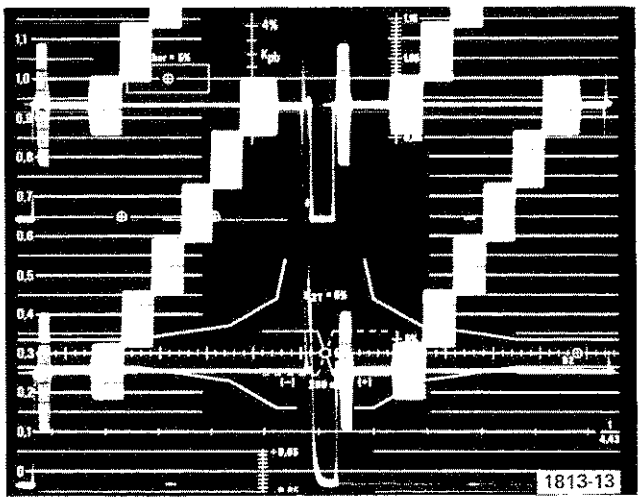


Fig. 2-7. Signal level comparisons using the OPER-CAL additive mode.

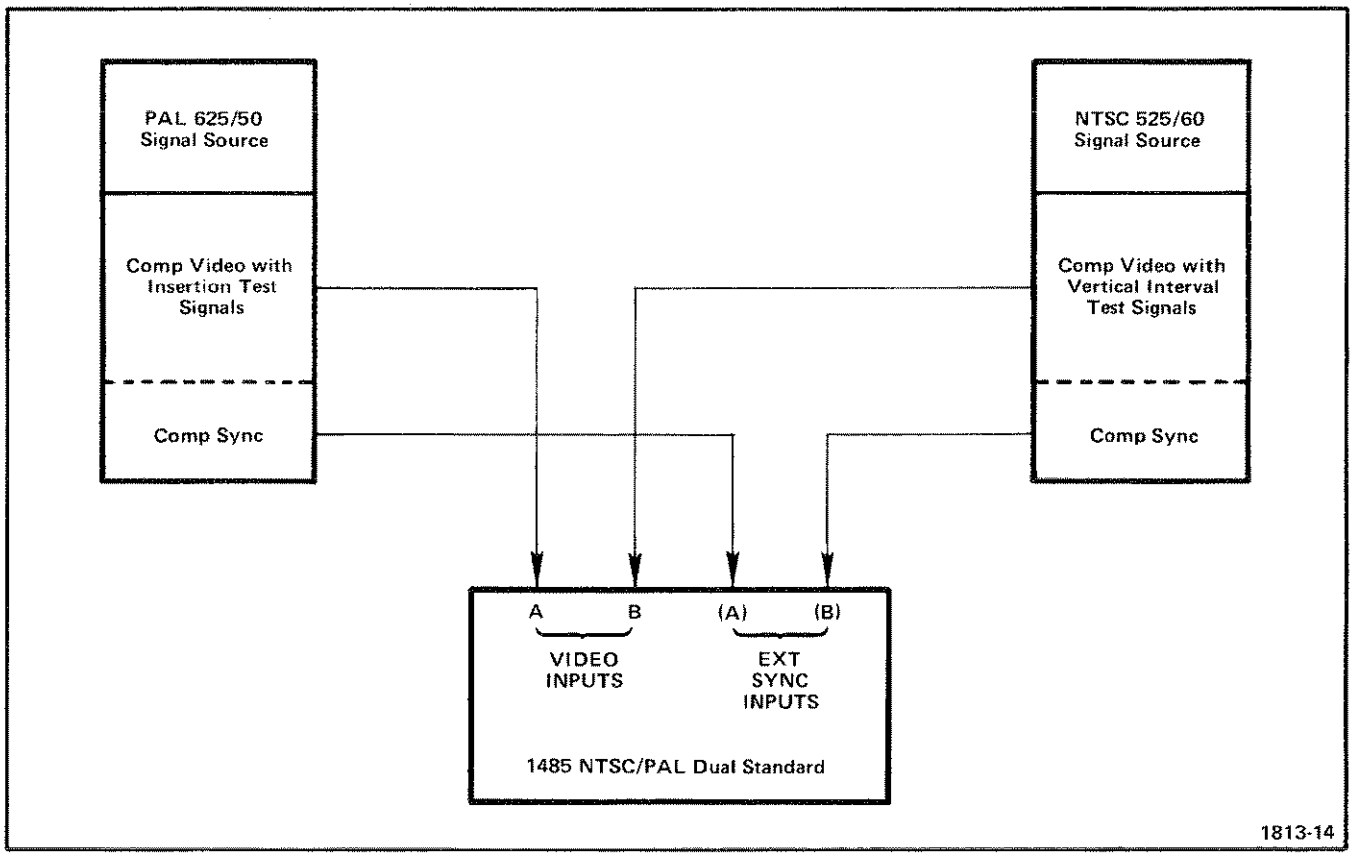


Fig. 2-8. Convenient signal hookup for demonstrating dual standard operation.

5. LOW PASS. Set INPUT to A and RESPONSE to FLAT. Set the PAL composite video source for a modulated staircase. Observe the FLAT response, then switch to LOW PASS. Note the roll-off effect on the line sync pulse edges and staircase step edges (see Fig. 2-12).

6. DIFF'D STEPS. Set RESPONSE to DIFF'D STEPS and observe a differentiated spike for each riser in the staircase waveform (see Fig. 2-13). In this mode, the vertical amplifier gain is automatically increased for maximum resolution.

Auxiliary Video Modes. Loop-through connect AUX VIDEO IN to VIDEO INPUT A at the rear panel of the 1485. Set RESPONSE to AUX VIDEO IN and observe the same triggered display as INPUT A in FLAT. Switch to INPUT B and note the sweep free runs.

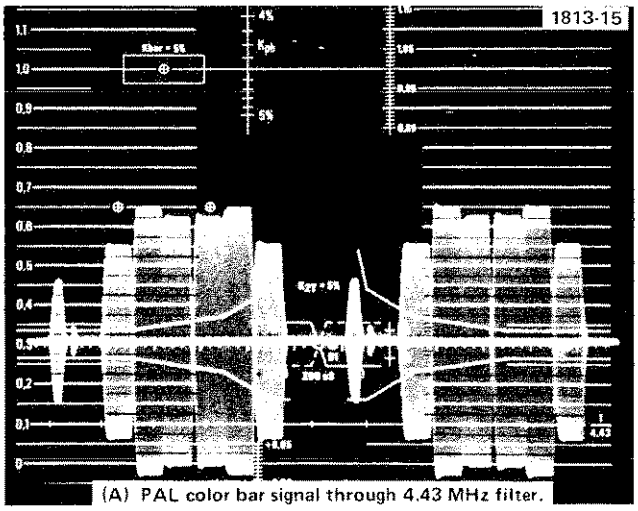
The AUX VIDEO OUT signal can be observed with a wide-band oscilloscope at any setting of the RESPONSE switch. The output signal will follow the input selected and cannot be altered by the RESPONSE switch.

Horizontal Sweep Modes. Set INPUT to A, RESPONSE to FLAT, and push in all the dark gray buttons. This should establish a basic operating display from which the horizontal modes can be demonstrated.

Set DISPLAY to 2 FIELD. Observe a triggered two-field sweep. Switch the INPUT between A and B and observe that the sweep re-triggers to each field-rate change.

Set DISPLAY to 10 μs/DIV. Observe a triggered sweep of approximately two lines duration. Set DISPLAY to 5 μs/DIV and observe about one complete line. Observe also that the trace brightens in this mode.

Set DISPLAY to EXT. Apply a 5-volt ramp to the EXTERNAL HORIZ IN connector. The ramp can be generated from a discrete ramp generator, or in this case, the Sawtooth Out from the oscilloscope applied through a variable attenuator. The oscilloscope is externally triggered from the same signal source that provides the VIDEO INPUT signal.



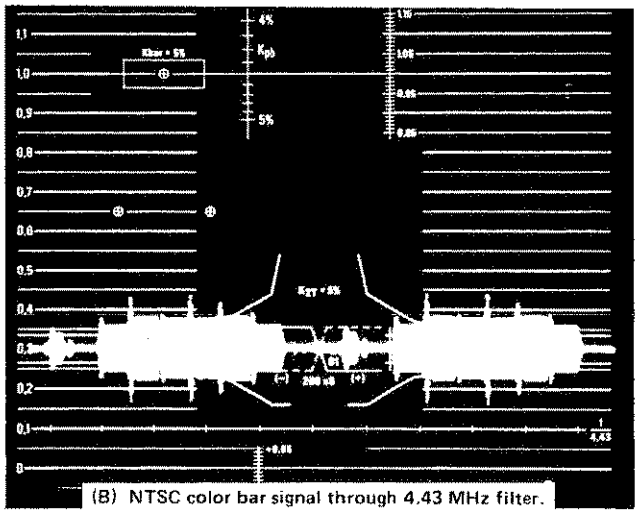
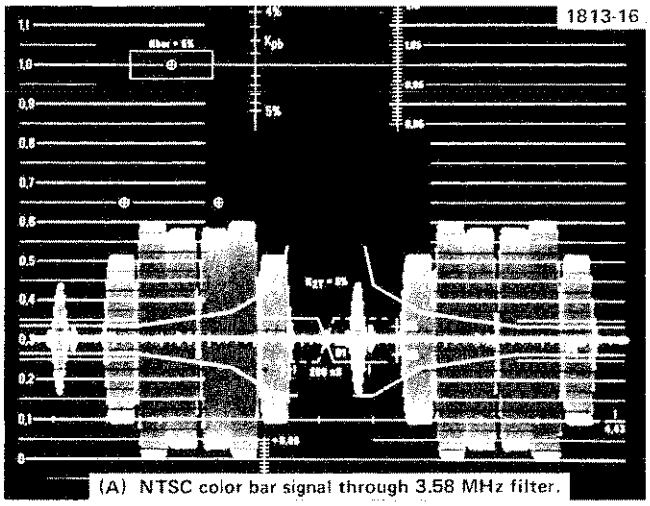


Fig. 2-9. Effect of 4.43 BAND PASS filter on a (A) PAL color bar signal, and (B) NTSC color bar signal.



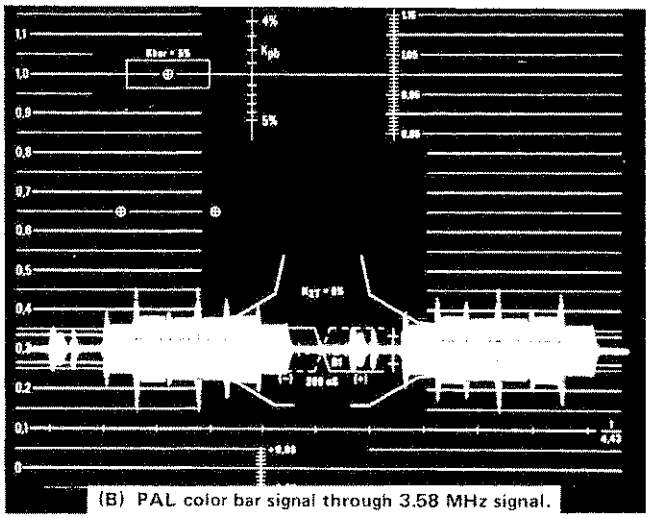


Fig. 2-10. Effect of 3.58 BAND PASS filter on PAL NTSC color bar signal, and (B) PAL color bar signal.

Observe a display similar to that on the oscilloscope. Also observe that the waveform monitor display timing is determined by the oscilloscope Time/Div control.

Set DISPLAY to 10 μs/DIV, and MAG to 1 μs/DIV. Observe that the MAG timing overrides DISPLAY timing. Rotate the MAG switch throughout its range and observe the sweep speed increase. Observe also the increased intensity.

Set the DISPLAY switch to 2 FIELD. Now, note the MAG positions increase from X5 to X50.

Set MAG OFF. Press the LINE SELECTOR DIG and EVEN field buttons, and set the LINE SELECTOR switch to 16. Select line 16 and fields 1 and 3 for insertion test signal on the video source. Connect the PIX MONITOR OUT

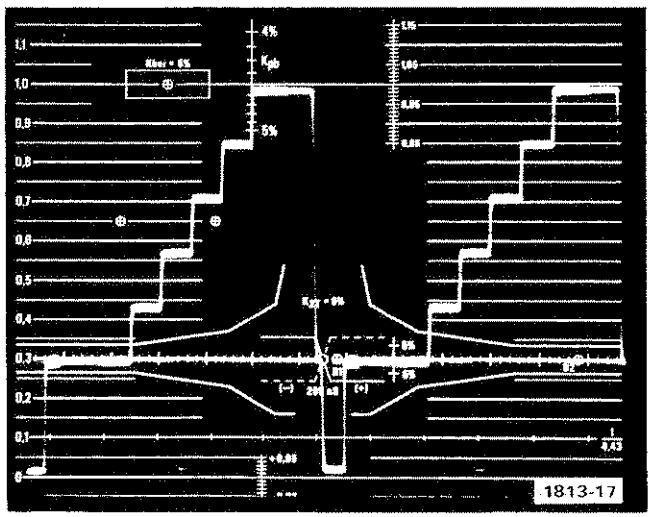


Fig. 2-11. Effect of the IRE filter on an NTSC modulated staircase signal.

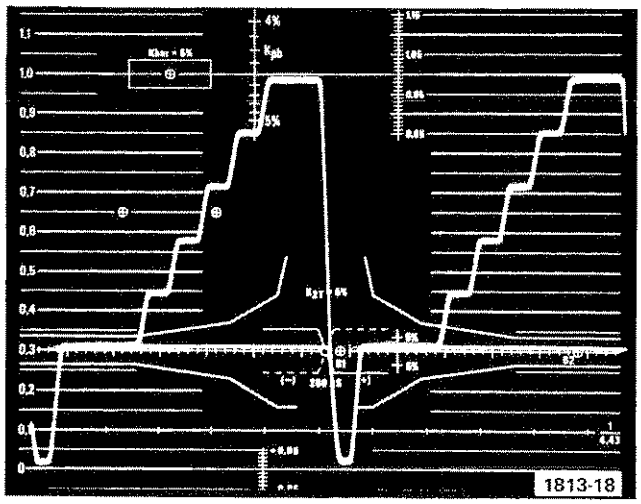


Fig. 2-12. Effect of the LOW PASS filter on a PAL modulated staircase signal.

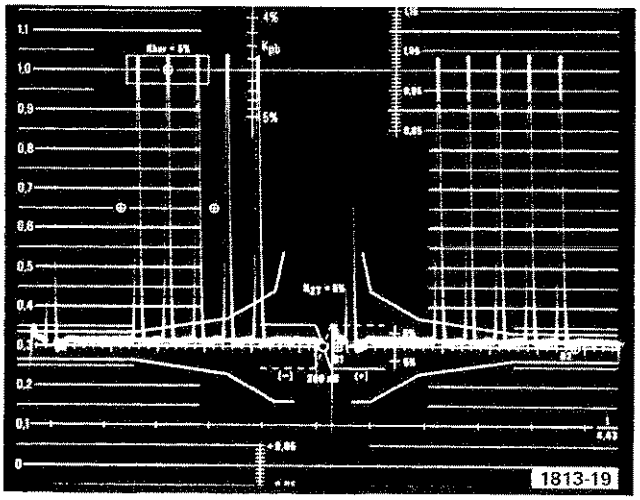


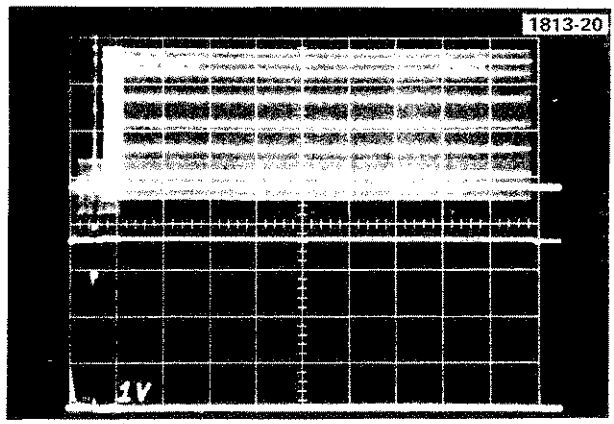
Fig. 2-13. Effect of the DIFF'D STEPS filter on a PAL modulated staircase signal.

through 75 Ω termination to one channel of the test oscilloscope dual-trace amplifier. Connect LINE STROBE OUT to the other channel of the dual-trace amplifier. Externally trigger the oscilloscope from the video source. Use the oscilloscope delayed sweep function to observe the selected line. Observe that line 16 is intensified in the first displayed field of the waveform monitor display. Note that the oscilloscope display identifies the selected line by a pedestal inserted on that line in PIX MONITOR OUT and that LINE STROBE OUT is a time-coincident, positive-going pulse (see Fig. 2-14).

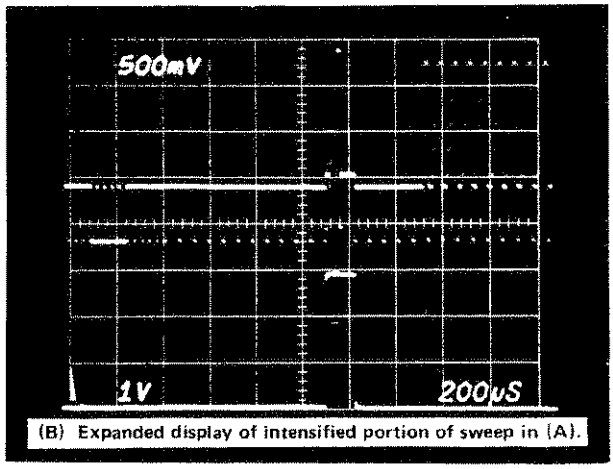
Set DISPLAY to 10 μs/DIV. Note that the inserted test signal appears on the first of the two lines displayed. Rotate the waveform monitor LINE SELECTOR switch and the video source line switch coincidentally and note that the selected line is always the first of the two displayed lines.

Press the VAR button and set DISPLAY to 2 FIELD. Rotate the LINE SELECTOR VAR control and observe the approximate two-field range of the control (see Fig. 2-15). Press the 15 LINES button and observe the 15-line intensified segment (see Fig. 2-16). Set DISPLAY to 2 FIELD and press the ALL FIELDS ON button. (For SN B020960 and up, press FIELD 3 and 2 buttons simultaneously.) Observe that the fields are now time-overlaid. (See Fig. 2-17).

Press all the dark gray buttons and set DISPLAY to 10 μs/DIV. Rotate the WAVEFORM COMPARISON OVERLAY control just out of detent. Note that the red lamp is lit, indicating the WAVEFORM COMPARISON circuits are operative. Rotate the LOCATE control to position the break-point to the center of the line sync pulse midway along the display. Rotate the OVERLAY control to superimpose the second line of the display on the first. See Fig. 2-18 for an example of WAVEFORM COMPARISON use. The pulse-to-bar ratio check was arbitrarily chosen for this illustration. Set the OVERLAY control to OFF.

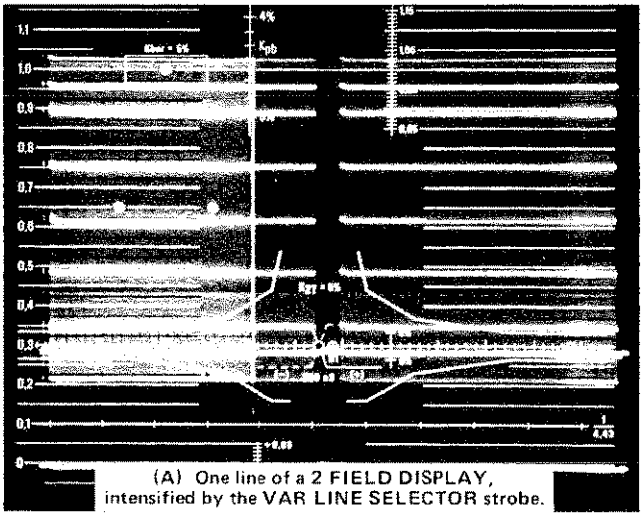


(A) Dual-trace oscilloscope display of PIX MONITOR OUT and LINE STROBE OUT. Scope externally-triggered with composite sync from same signal source.



(B) Expanded display of intensified portion of sweep in (A).

Fig. 2-14. Time coincidence of PIX MONITOR OUT and LINE STROBE OUT.



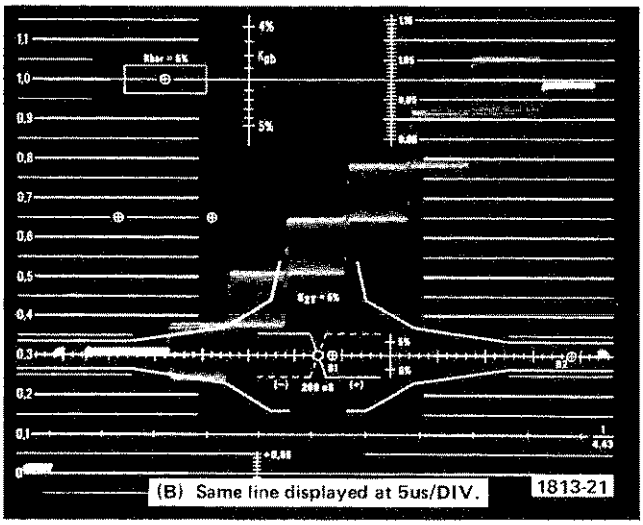
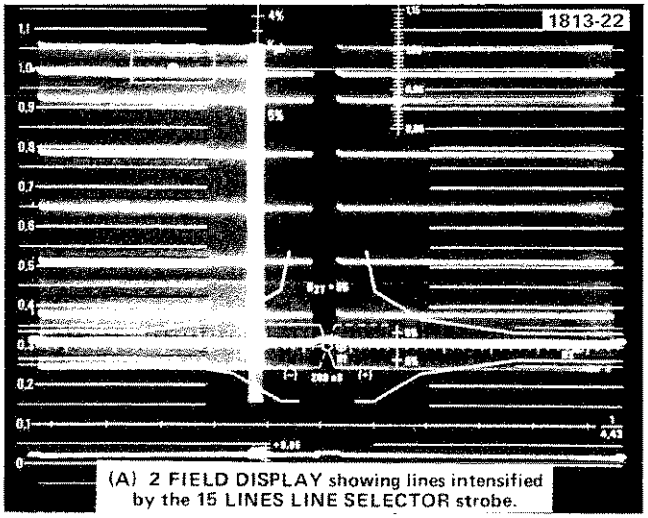


Fig. 2-15. VAR LINE SELECTOR mode display.



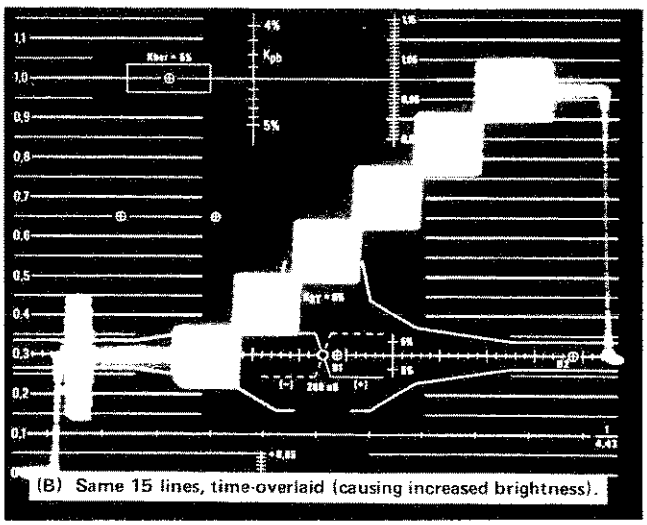


Fig. 2-16. 15 LINES LINE SELECTOR mode displays.

Connect signal sources as in Fig. 2-8. Set the rear-panel sync input selector to EXTERNAL SYNC ALWAYS (A). Press the EXT SYNC button and set the INPUT switch to A. Note the stable display. Set the INPUT switch to B and note the unlocked display. Press the INT SYNC button and note the stable display. Set the rear-panel sync input selector to EXTERNAL SYNC SWITCHED WITH INPUT SWITCH (A) OR (B). Check for stable displays in A or B INPUT positions and INT or EXT SYNC.

RGB/YRGB is best checked using in-studio RGB encoding equipment. For purposes of this procedure, a Tektronix 067-0601-00 Television Test Signal Generator was used to simulate RGB/YRGB checks. Connect inputs to J9034 as shown in Fig. 2-19. Close the switch to ground for RGB/YRGB display. Check for a three-step display as in Fig. 2-20A. Set the RGB encoder for a four-step staircase and remove P4032 and P4240 (three-step/four-step plug-jumpers located on the Sweep Output board). Check for a four-step display similar to Fig. 2-20B.

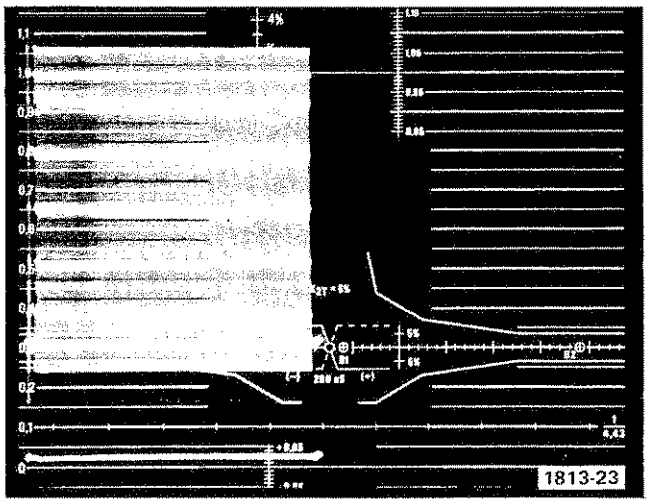


Fig. 2-17. Display of ALL FIELDS mode.

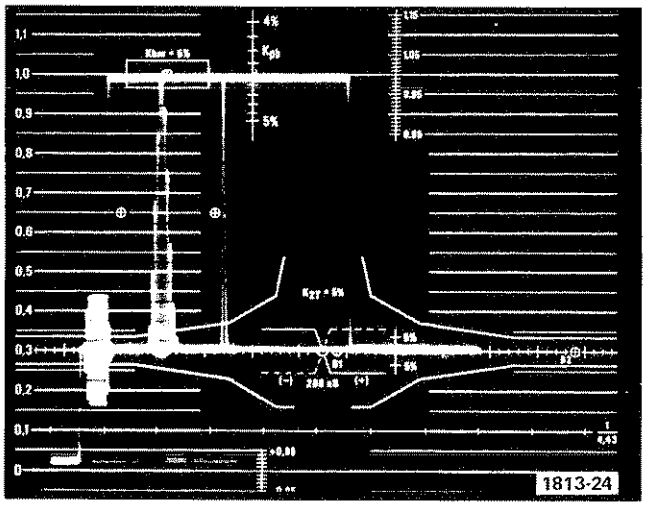


Fig. 2-18. Pulse-and-Bar Test Signal time-overlaid for amplitude ratio checks using the WAVEFORM COMPARISON feature.

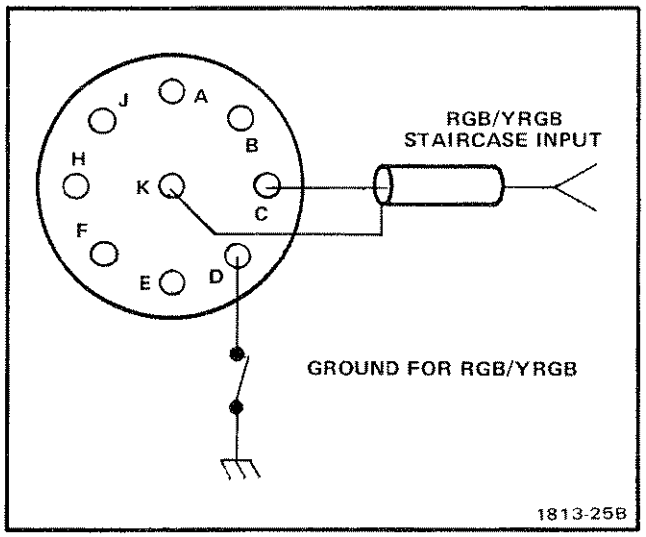


Fig. 2-19. J9034 connected for RGB/YRGB checks.

Remove all connections.

Operating Changes

Some functions of the 1480-Series Waveform Monitors can be altered by the position of certain plug-jumpers. Those functions are listed here.

2 FIELD RGB/YRGB (P4032)

When this plug-jumper is connected, it shorts across R4032. In RGB/YRGB operation, R4032 is connected as part of the input resistor for the Horizontal Input Amplifier on Diagram 10. With R4032 shorted the gain of the amplifier is one-third normal, allowing for a three-step display. With P4032 removed, amplifier gain is one-fourth normal, allowing for a four-step display.

Line Sweep RGB/YRGB (P4240)

P4240 performs the identical function for 5 μs/DIV and 10 μs/DIV sweep speeds as P4032 does for 2 FIELD.

Fast Clamp Slew-Rate (P1993)

When R1893 on Diagram 3 is connected directly to +15 volts, the sample-and-hold device, U1890, is turned on very hard during clamp time. This allows rapid restoration of the signal, but the circuit is somewhat more susceptible to noise. If R1992 is connected in series with R1893, the restoration is somewhat less rapid, but the circuit is less susceptible to noise.

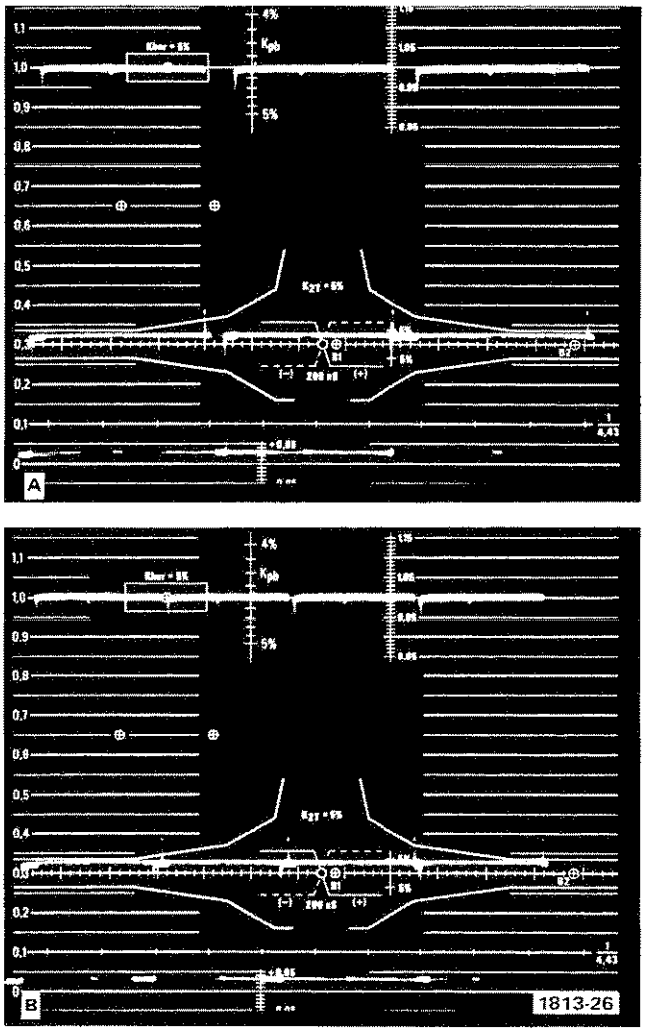


Fig. 2-20. (A) RGB display. (B) YRGB display.

MEASUREMENT TECHNIQUES

Using WAVEFORM COMPARISON

The most obvious use of the WAVEFORM COMPARISON function is that of amplitude ratio checks, such as pulse-to-bar measurement. This measurement mode can be used on any line or pair of lines that can be displayed, including lines selected in LINE SELECTOR modes.

WAVEFORM COMPARISON is also useful in comparing amplitudes of the modulated packets on the linearity staircase signal. Differential gain can be checked with the modulated staircase applied, and the waveform monitor in the BAND PASS RESPONSE position and 0.2 VOLTS FULL SCALE. By overlaying the last modulation packet on the first, any differences can be easily viewed and measured.

Adjacent lines can be overlaid and amplitudes compared, using the 10 μs/DIV DISPLAY position. Locate the break-point at the line sync pulse in the center of the display and adjust OVERLAY as necessary.

Using the CALIBRATOR

The calibrator signal can be set to one of three values, as determined by front-panel switches. With the CAL and SYNC TIP buttons pressed, the squarewave amplitude is one volt. No other value is possible, or needed, since all television standards employ a one-volt into 75 Ω composite video signal. Adjustment of the front-panel GAIN control in this mode is simply a matter of adjusting until the calibrator display coincides with the appropriate internal graticule markings. Measuring the distance from blanking to peak white is not so straight forward, since different television standards employ different amplitudes. Dual-standard models of the 1480-Series use a precise resistor divider with taps for different values. Which tap is used is determined by the setting of the Back Porch Calibrator Amplitude (Cal Ampl) switch and the position of the SCALE ILLUM switch. The Back Porch Cal Ampl switch is located inside the crt bezel below the crt.

When external graticule lighting is desired, pull the SCALE ILLUM control out. This also enables the Back Porch Cal Ampl switch to control signal amplitude. The setting of the Back Porch Cal Ampl switch is determined by a hole in the external graticule into which the switch thumb slide fits. NTSC graticules set the slide switch to the 714 mV tap on the resistor divider. PAL graticules set the slide switch to the 700 mV position.

The calibrator signal is particularly useful in the additive calibrator mode. In this mode, both OPER and CAL are pressed, superimposing the A VIDEO INPUT signal on the calibrator waveform. Signal amplitude errors are easily distinguished by noting differences between the bottom of the upper display and top of the lower display.

Using the DC RESTORER

The DC RESTORER clamps either the back porch or the sync tip of the composite-video waveform to 0 volts. The two rates or restoration (FAST and SLOW) allow the user to compare the signal in the presence of hum to the signal with hum attenuated. The FAST mode attenuates mains hum by at least 26 dB, while the SLOW mode attenuates by 0.9 dB or less.

Clamping at the back porch is automatically selected internally when RESPONSE is in LOW PASS. Rise and fall of sync pulses in LOW PASS are so low that there is no sync tip left to clamp.

The DC RESTORER is inhibited in DIFF'D STEPS because the recovery of the differentiated sync pulse is not complete by either sync tip or back porch time.

The BAND PASS filters do not pass any dc or low-frequency signal components, so while the DC RESTORER still operates, it does not affect the display.

Using the AUX VIDEO IN and AUX VIDEO OUT

The AUX VIDEO OUT jack on the rear panel provides an unfiltered output, internally-terminated in 75 Ω. The AUX VIDEO IN is a 75 Ω internally-terminated input that provides input access to the vertical system following the filters.

These two access points can form an external loop around the filters, and measurements or corrections can be made in this loop, (using a vectorscope, for example, or chrominance to luminance delay corrector) without disturbing the input signal. An advantage of this function is the ability to compare a pre-corrected signal with the corrected signal by switching between the AUX VIDEO IN and FLAT position of the RESPONSE switch.

The AUX VIDEO OUT is also one end of an impedance-converting network. The other end is the X10 PROBE input, available as an option. The signal acquired with the probe is processed in the same circuits as a video input. The AUX VIDEO OUT is internally terminated in 75 Ω, making it compatible with the rest of the video system. The signal acquired with the probe can then be routed through AUX VIDEO OUT to a display or measurement device such as a vectorscope.

Using an X1 probe for signal acquisition permits ten-times signal gain and is useful for low-level signals such as hum or residual subcarrier.

Using the RGB/YRGB Input (J9034)

J9034 provides control and signal access for stepping the Waveform Monitor Sweep with the RGB or YRGB staircase. The encoded line-rate or field-rate camera pick-up tube "parade" signal can then be applied to one of the VIDEO INPUTS, and the various pick-up tube matching adjustments can be easily made.

J9034 pin E is the access for sweep length alteration. Grounding this point shortens the sweep, allowing the RGB/YRGB staircase to step the "parade" across the crt so that the outputs of the camera pick-up tubes are seen on the same display.

The RGB/YRGB staircase is applied to J9034 pin C. The staircase repositions the shortened sweep. (The sweep is not shortened in time, only in distance traveled across the crt.)

Using PIX MONITOR OUT

The amplifier that drives AUX VIDEO OUT also drives PIX MONITOR OUT. The only difference between the two outputs is that PIX MONITOR OUT contains the line strobe when the waveform monitor is in one of the LINE SELECTOR modes.

This output, when connected to a picture monitor, enables the user to view the waveform monitor display as a television picture and at the same time to see the exact location of the line selected by the LINE SELECTOR controls.

Some picture monitors do not react favorably when the inserted line strobe crosses the field sync area. External synchronization of the picture monitor should eliminate the unfavorable reaction.

Using LINE STROBE OUT

The LINE STROBE OUT is an ac-coupled, positive-going, TTL-compatible output, time-coincident with the line or lines selected by the LINE SELECTOR controls. This signal can be used to brighten up a picture monitor display or can be superimposed on an oscilloscope display for identification of selected lines. The LINE STROBE OUT can also be used as a form of delayed gate to trigger some other unit at the selected line.

Using DIRECT and AFC SYNC

DIRECT SYNC is a wide-band trigger circuit that accepts and processes low-frequency signals as well as line-rate sync. AFC SYNC is a narrow-band trigger circuit that is limited to 15.75 kHz ±200 Hz, but at the same time is relatively immune to noise.

Noise-caused jitter can be reduced by using the AFC mode to enable the user to view the shape of a rising or falling portion of the waveform.

Using EXT SYNC

The EXT SYNC function is useful when viewing a non-composite video signal, such as might be acquired through the optional X10 PROBE input. The sync signal used must lock both the waveform monitor and the unit under test.

A stable display can be obtained in the presence of small-amplitude signals, assuming the availability of at least 200 mV of composite sync to lock both the waveform monitor and the signal source.

Using EXTERNAL HORIZ IN

The EXTERNAL HORIZ IN is provided for signal input access in case some special sweep rate is required. A five-volt ramp will generate a 12.7 division trace. Input impedance of this circuit is about 10 kΩ.

SPECIFICATIONS

The performance requirements listed here apply over an ambient temperature range of 0° C to +50° C. The rated accuracies are valid when the instrument is calibrated at +20° C to +30° C with ten minutes warm-up time. A twenty minute warm-up is required for rated accuracies at 0° C ambient temperature.

VERTICAL SYSTEM

Characteristics		Performance Requirements			Supplemental Information
Scale Factors			DISPLAY		
			NTSC	PAL	
INPUT A and B	1.0 VFS	1 V ±3 mV for	140 IRE	100%	Adjustable to 1.000 V.
	0.5 VFS	0.5 V ±15 mV for	140 IRE	100%	
	0.2 VFS	0.2 V ±6 mV for	140 IRE	100%	
Input Ratios					
INPUT A to INPUT B		1 ±0.002, to 1, or (0.998 to 1.002) to 1			
AUX VIDEO IN to INPUT A		1.5 dB ±0.3 dB			
Amplifier Gain					
INPUT A to AUX VIDEO OUT		1, ±0.005, (0.995 to 1.005)			Adjustable to Unity
INPUT A to PIX MONITOR OUT		1, ±0.02, (0.98 to 1.02)			
Maximum Input Signal					Maximum dc component, 5 V
AC CPL'D					
INPUT A and B		2.0 V, peak-to-peak at any average picture level (APL) 1.0 V, peak-to-peak at any APL, of both AUX VIDEO OUT and PIX MONITOR OUT are terminated, for distortion-free signal at those outputs			
DC CPL'D					
INPUT A and B		±1.5 V, dc + Peak ac			
AUX VIDEO IN		±1.5 V, dc + Peak ac			
Maximum output dc voltage, AUX VIDEO OUT and PIX MONITOR OUT into 75 Ω		±0.5 V dc			Input signal absent, line strobe inserted on PIX MONITOR OUT on selected line or lines in LINE SELECTOR mode.
Common Mode Rejection Ratio with 1 V peak-to-peak common mode signal					
60 Hz		⩾46 dB			
15 kHz		⩾46 dB			
4.43 MHz		⩾34 dB			

VERTICAL SYSTEM (cont)

Characteristics	Performance Requirements	Supplemental Information
Frequency Response		
FLAT, including:	From 50 kHz Reference:	
INPUT A, INPUT B or AUX VIDEO IN through AUX VIDEO OUT or PIX MONITOR OUT	50 kHz to 5 MHz ±0.5% 5 MHz to 10 MHz +0.5%, −5%	INPUT A, INPUT B, AUX VIDEO IN, 1 V, 0.5 V, or 0.2 V FULL SCALE. (In additive calibrator mode, response specs are valid to 5 MHz only.)
IRE	Conforms to IRE 1958 Standard 23S-1. Attenuation at 4.43 MHz, ≥22 dB. See Fig. 2-21.	
LOW PASS	Attenuation ≥14 dB, 500 kHz and above.	
3.58 BAND PASS	±1% of FLAT at 3.58 MHz. −3 dB at 3.1 MHz to 3.4 MHz and 3.8 MHz to 4.0 MHz.	
4.43 BAND PASS	±1% of FLAT at 4.43 MHz. −3 dB at 3.9 MHz to 4.1 MHz and 4.7 MHz to 4.9 MHz.	
DIFF'D STEPS	Permits amplitude comparisons of risers on staircase signal with automatic gain increase of ≈5 times. Attenuation: ≤2 dB from 0.4 MHz to 0.5 MHz ≥20 dB at 14 kHz and 2.0 MHz ≥40 dB at 3.58 MHz and 4.43 MHz.	
LUM Attenuation	≤3 dB at 1 MHz, ≥40 dB at 4.43 MHz.	
Linear Waveform Distortion		
Pulse preshoot, overshoot, and ringing	≤0.5% of applied pulse amplitude.	1 V Full Scale, any INPUT, 100 ns half amplitude duration (HAD) Pulse and Bar.
25 μs Bar Tilt	≤1% of applied pulse amplitude.	
Pulse-to-Bar Ratio	0.99:1 to 1.01:1	
Field Squarewave Tilt	≤1% of applied squarewave amplitude.	
Non-Linear Waveform Distortions		
Differential Gain		3.58 or 4.43 BAND PASS, 0.2 VOLTS FULL SCALE.
Displayed Diff Gain	≤0.5% at any APL	
AUX VIDEO OUT	≤0.25% at any APL	
PIX MONITOR OUT	≤0.25% at any APL	
Differential Phase		
AUX VIDEO OUT	≤0.25° at any APL	
PIX MONITOR OUT	≤0.25° at any APL	

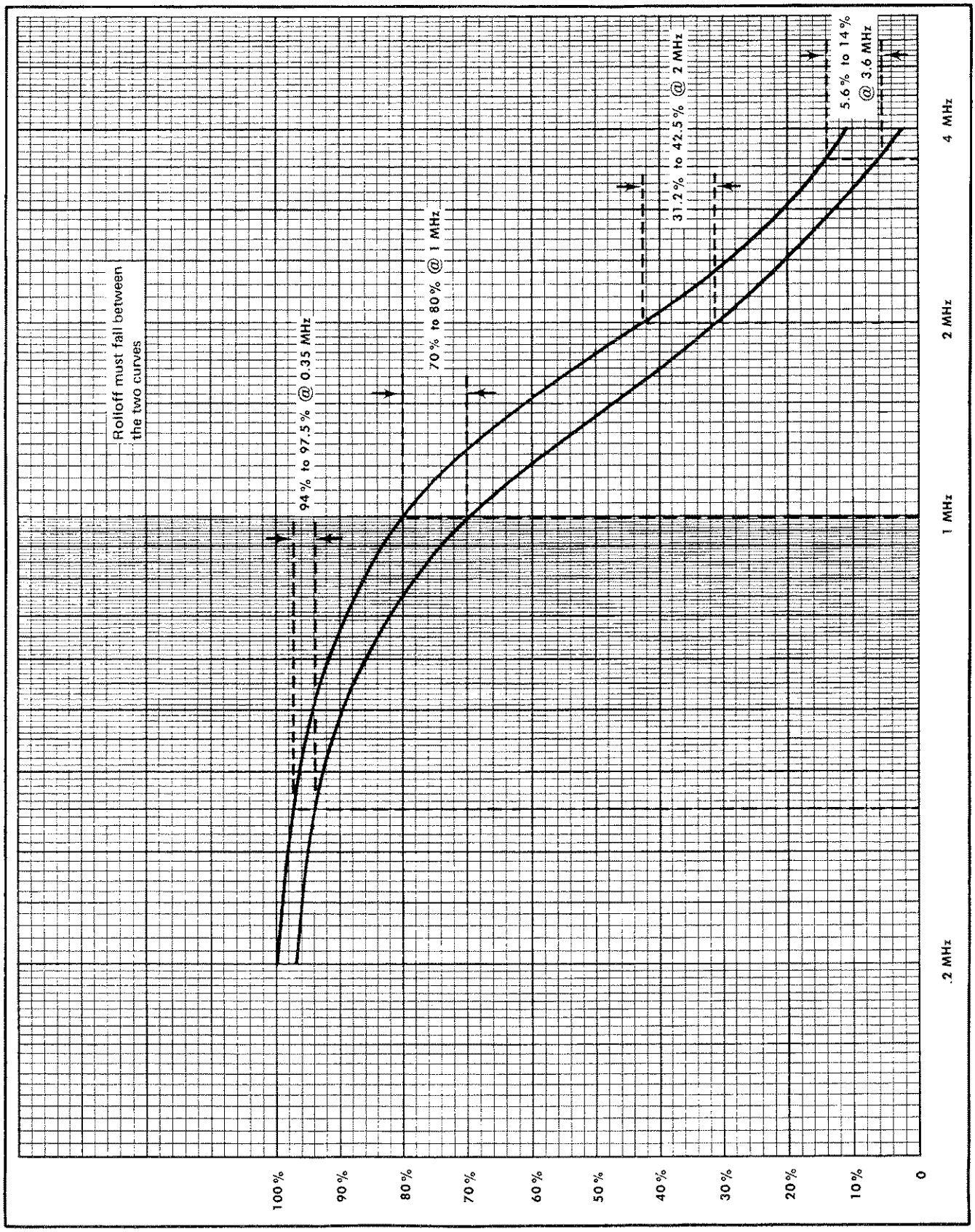


Fig. 2-21. IRE 1958 Standard 23S-1.

VERTICAL SYSTEM (cont)

Characteristics	Performance Requirements	Supplemental Information
DC RESTORER		
Mains Hum Attenuation		Change of back porch or sync tip level caused by hum.
SLOW	≤0.9 dB	
FAST	≥26 dB	
Shift caused by Presence or Absence of Burst	≤1 IRE (NTSC) or 7 mV (PAL)	
Return Loss (With 75 Ω termination)		
INPUT A or B	≥40 dB, dc to 5 MHz	Any front panel control setting, instrument on or off.
AUX VIDEO IN, AUX VIDEO OUT or PIX MONITOR OUT	≥34 dB, dc to 5 MHz	Instrument on.
Vertical Overscan for 1 V Peak-to-Peak Composite Video Signal	All specifications are valid at 1.0, 0.5, and 0.2 VOLTS FULL SCALE and any VERTICAL POSITION setting to 5 MHz. From 5 MHz to 10 MHz, five screen-heights peak-to-peak scan can degrade the signal up to ±8% from the condition seen at one screen-height. Two screen-heights peak-to-peak scan can degrade the signal up to ±3% from the condition seen at one screen-height.	Specifications will be degraded, typically by less than a factor of two if maximum variable gain is used.
CALIBRATOR Accuracy		
1 V	±0.2%	
0.714 V	±0.5%	
0.700 V	±0.5%	

HORIZONTAL SYSTEM

Characteristics	Performance Requirements		Supplemental Information
Sweep Timing Accuracy and Linearity			
(12.7 divisions = 10 cm)	Accuracy over Center 10 divisions	Linearity Overall	
5 μs/DIV	±1%	±1%	
10 μs/DIV	±1%	±1%	
Magnified Timing and Linearity	(For center 10 divisions of unmagnified sweep)		
1 μs/DIV (X5)	±2%	±2%	
.5 μs/DIV (X10)	±2%	±2%	
.25 μs/DIV (X20)	±2%	±2%	
.2 μs/DIV (X25)	±2%	±2%	
.1 μs/DIV (X50)	±2%	±2%	

HORIZONTAL SYSTEM (cont)

Characteristics	Performance Requirements	Supplemental Information
2 FIELD Sweep Linearity	±0.5 division	
FIELD Selector	Positive selection of ODD (2 & 4) or EVEN (1 & 3), in NTSC Systems. Positive selection of ODD (2 & 4) or EVEN (1 & 3), or Field 1, Field 2, Field 3, or Field 4 in PAL systems.	Display starts on selected field. Display starts on selected field.
LINE SELECTOR VAR Range	From approximately line 20 of the selected field to approximately line 8 of the next complementary field. (Example, line 20 of Field 1 to line 8 of Field 3.) The line intensified by the strobe in 2 FIELD display is the line displayed in 5 μs/DIV or the first line displayed in 10 μs/DIV DISPLAY.	H-locked. Strobe is blanked betwen lines 8 and 15.
DIG	Selects line 9 to 22 NTSC, line 9/322 to line 22/335 PAL, line 9/272 to line 22/285 PAL-M.	
15 LINES	Identical to VAR, except that 15 successive lines are displayed.	
ALL FIELDS (Below SN B020960)		Time overlay of all fields at any setting of the DISPLAY switch. VAR and 15 LINES mode functional in ALL FIELDS only with the LINE SELECTOR VAR set in the first displayed field.
ALL FIELDS (SN B020960 and up)		Press FIELD 3 and 2 buttons simultaneously.
Sync Input Requirements	Stable display with the following inputs.	
INT	200 mV, peak-to-peak, to 2 V, peak-to-peak, composite video	
EXT		
Comp Video In	400 mV, peak-to-peak, to 2 V, peak-to-peak composite video	Rear-panel switch selects sync from A INPUT only, or from the input selected with the front-panel INPUT switch.
Comp Sync In	200 mV, peak-to-peak, to 8 V, peak-to-peak, composite sync.	
Return Loss	≥46 dB down, to 5 MHz.	

HORIZONTAL SYSTEM (cont)

Characteristics	Performance Requirements	Supplemental Information
Maximum Jitter (with 1 V peak-to-peak Composite Video plus −26 dB White Noise)		
DIRECT	250 ns	
AFC	90 ns	
Maximum Jitter with Missing Line Sync Pulses	≤15 ns/missing sync pulse (maximum of 10 consecutive line sync pulses missing).	
50 Hz/60 Hz Recognition	Automatically recognizes 50 Hz or 60 Hz scan in dual-standard instruments.	
Horizontal Trigger	Stable display with the following conditions.	
AFC		
Horizontal Frequency Range	15.75 kHz ±200 Hz.	
Lock-In Time	≤1 second.	
Maximum Jitter with Respect to Input Sync	10 ns—Input Composite Video or Composite Sync from a 140-Series Generator. 12 ns—Variable APL (10%-90%). 12 ns—Variable APL plus 4 V rms hum. 30 ns—Variable APL plus 4 V rms hum. Plus −36 dB white noise.	With or without 4 V rms hum.
Jitter Reduction with Respect to White Noise		Jitter will double itself with every 6 dB white noise increase.
DIRECT		
Horizontal Frequency Range	≤20 kHz	
Maximum Jitter with Respect to Input Sync	12 ns—Input Composite Video or Composite Sync from a 140-Series Generator. 20 ns—Variable APL (10%-90%). 20 ns—Variable APL plus 4 V rms hum. 90 ns—Variable APL plus 4 V rms hum. Plus −36 dB white noise.	With or without 4 V rms hum.
RGB/YRGB (J9034)		
Staircase Input	≈12 volts for 12.7 division deflection. DC signal levels, plus peak ac, not to exceed limits of −12 to +12 volts. Maximum ac signal level is 12 volts peak-to-peak. Staircase is positive-going.	Factory-connected for RGB input (three-step). Sweep length altered by external switch closure to ground through J9034, pin E. Staircase applied through J9034 pin C.

HORIZONTAL SYSTEM (cont)

Characteristics	Performance Requirements	Supplemental Information
Sweep Repetition Rate		
2 FIELD	Field rate of applied video.	
5 μs/DIV or 10 μs/DIV	Line rate of applied video.	
Sweep Length (2 FIELD, 5 μs/DIV or 10 μs/DIV)		
RGB	27% to 33% of normal sweep.	
YRGB	20% to 25% of normal sweep.	
EXTERNAL HORIZ IN		
Sensitivity	5 V/10 divisions	Dc-coupled, positive-going from 0 volt. Input impedance ≈10 kΩ. Crt is unblanked with no provision for external blanking.
Linearity	±1%	
WAVEFORM COMPARISON		
LOCATE	Range sufficient to place LOCATE indication on 5 μs/DIV or unmagnified 10 μs/DIV sweeps.	With MAG on, range is unchanged in 5 μs/DIV, but reduced by one-half in 10 μs/DIV.
OVERLAY	Range sufficient to overlay any selected portion of 5 μs/DIV or unmagnified 10 μs/DIV sweeps on any other portion.	
LINE STROBE OUT	Strobe output of line or lines selected by VAR, 15 LINES, or DIG LINE SELECTOR modes and the DISPLAY switch.	TTL-amplitude.

POWER SOURCE AND SUPPLY

Characteristics	Performance Requirements	Supplemental Information
Mains Voltage Ranges	100 Vac 110 Vac 120 Vac 200 Vac 220 Vac 240 Vac ±10%	Ranges changeable by multi-tap transformer.
Frequency	48 Hz to 62 Hz	Crest Factor at least 1.3.
Max Power Consumption	75 W	60 W nominal at 110 Vac.
Fuses	0.8 A for 110 Vac nominals 0.4 A for 220 Vac nominals	

POWER SOURCE AND SUPPLY (cont)

Characteristics	Performance Requirements	Supplemental Information		
Supplies		**Accuracy**	**Ripple**	**Regulation**
+5 V		+4.7 V to +5.3 V	≤5 mV	400 mA load
−15 V		−14.925 V to −15.075 V Adjustable	≤2 mV	±1% (300 mA load)
+15 V		+14.925 V to +15.075 V Adjustable	≤2 mV	±1% (600 mA load)
+75 V		+73.5 V to +76.5 V	≤2 mV	±1% (250 mA load)
+140 V		+134.4 V to +145.6 V	≤10 mV	±1% (40 mA load)
−3940 V		−3861 V to −4018 V Surge-Protected at −5 kV.		
Current Limit				
−15 V		≤800 mA		
+15 V		≤800 mA		
+75 V		≤450 mA		
+140 V		≤65 mA		
Short-Circuit Current				
+5 V		≥1 A		
−15 V		≤300 mA		
+15 V		≤300 mA		
+75 V		≤50 mA		
+140 V		≤50 mA		

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
Temperature		
Operating	0°C to 50°C	
Storage	−40°C to +65°C	
Altitude		
Operating	To 15,000 Feet	
Storage	To 50,000 Feet	
Cabinet Model		
Length	16.95 inches	43 cm
Width	8.50 inches	21.6 cm
Height	8.25 inches	21 cm
Net Weight	21 lb. 8 oz.	9.81 kg
Domestic Shipping Weight	28 lb. 8 oz.	12.9 kg
Export Shipping Weight	41 lb. 8 oz.	18.8 kg
Rack Model		
Length	18 inches	45.7 cm
Width	19 inches	48.3 cm
Height	5.25 inches	13.3 cm
Net Weight	24 lb. 9 oz	11.2 kg
Domestic Shipping Weight	53 lb. 2 oz.	24.1 kg
Export Shipping Weight	75 lb. 2 oz.	34.1 kg

Warning

The following servicing instructions are for use only by qualified personnel. To avoid personnel injury, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so. Refer to General Safety Summary and Service Safety Summary prior to performing any service.

PERFORMANCE CHECK/CALIBRATION PROCEDURE

INTRODUCTION

This procedure combines performance checks and calibration steps. It can be used to either verify that the instrument is performing to specifications, or to recalibrate it after repairs or long periods of operation. A short form procedure precedes the combined Performance Check/Calibration Procedure and can be used as a calibration record and as an index to the complete procedure.

In the complete procedure, steps or parts of steps that relate to performance checks only are identified by the word "Check" in the step heading. Those steps that pertain both to performance checks and calibration steps are headed "Check/Adjust".

Not all checks or adjustments are required for every model of the 1480-Series. Those steps or checks that are peculiar to one model will be so identified in the step heading.

Front- and rear-panel control and connector names on the 1480-Series instrument under test are capitalized, for example: VOLTS FULL SCALE. Control and connector names on test equipment and internal controls in the 1480-Series instrument under test have only the first letter capitalized, for example: Test Oscilloscope Time/Div, or Max Intens control.

TEST EQUIPMENT

The test equipment listed here was used in preparing this procedure. The measurement capabilities described are the minimum required to recalibrate the instrument. Each piece of test equipment is assumed to be operating within its stated specifications. If alternative equipment is used, it must meet or exceed these requirements.

1. Video Signal Source

525/60 NTSC. Capable of generating color bars, composite sync and modulated staircase test signals. For example, a Tektronix 140.

625/50 PAL. Capable of generating color bars, composite sync and modulated staircase test signals. For example, a Tektronix 145.

525/60 PAL-M. Capable of generating color bars, composite sync and modulated staircase test signals. For example, a Tektronix 145.

2. Test Package (TM 500-Series)

Digital Voltmeter. Accurate within 0.1% for dc volts from −4500 to +200 V. For example, Tektronix DM 501 with a high voltage probe (Tektronix Part Number 010-0277-00).

Leveled Sine Wave Generator. Capable of amplitudes from 0.2 volt peak-to-peak to 5 volts peak-to-peak, frequency range from 50 kHz (reference) to 10 MHz. For example, a Tektronix SG 503.

Time Mark Generator. Capable of generating time marks from 100 ns to 10 μs, with accuracy adjustable to within 1 part in 10^{-7}. For example, a Tektronix TG 501.

Ramp Generator. Capable of generating a 5 volt ramp. For example, a Tektronix FG 501A.

The above instruments form a convenient test package. Install in a Tektronix TM 503 Power Unit.

3. Test Oscilloscope

Dual Time Base. Range from 50 ns/Div to 5 s/Div with provisions for a delaying sweep and television triggering.

Differential Comparator. Bandwidth, dc to 30 MHz; minimum deflection factor, 1 mV/Div; two channels capable of differential operation.

Dual Trace Amplifier. Vertical amplifier independent of the Differential Comparator. Bandwidth, dc to 30 MHz; minimum deflection factor 5 mV/Div.

For example, a Tektronix 7603 with 7B53A Option 5 Dual Time Base, 7A13 Differential Comparator, and 7A18 Dual Trace Amplifier.

4. Voltage Control Unit. Capable of varying mains voltage from 90 Vac to 132 Vac. For example, a General Radio W10MT3W Metered Variac Autotransformer.

5. Return Loss Bridge. Tektronix Part Number 015-0149-00.

6. Television Test Signal Generator. Capable of generating 3-step and 4-step RGB/YRGB signals. For example, a Tektronix 067-0601-00 Television Test Signal Generator.

7. 75 Ω Cable. 42 inches long. Four each. Tektronix Part Number 012-0074-00.

8. 75 Ω End-Line Termination. Four each, Tektronix Part Number 011-0102-00.

9. 75 Ω Feed-Through Termination. Two each, matched within 0.2%. Supplied as accessories with the Return Loss Bridge (item 5). Tektronix Part Numbers 011-0103-00 (red) and 011-0103-01 (green).

10. 75 Ω Feed-Through Termination. Tektronix Part Number 011-0103-02. Two each.

11. 50 Ω to 75 Ω Minimum Loss Attenuator. Tektronix Part Number 011-0057-00.

12. Attenuators

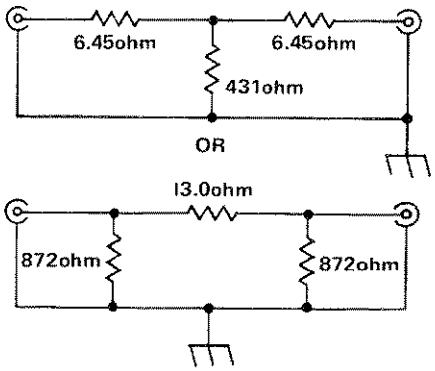
2X—Tektronix Part Number 011-0069-02
5X—Tektronix Part Number 011-0060-02
10X—Tektronix Part Number 011-0059-02.

13. BNC Cable T Connector. Tektronix Part Number 067-0525-00.

14. P6011 1X Probe. Tektronix Part Number 010-0193-00.

15. P6053B 10X Probe. Tektronix Part Number 010-6053-11.

16. 1.5 dB Attenuator. Manufactured locally as shown.



EQUIPMENT SETUP

1. 1480-Series

INPUT	A DC CPL'D
VOLTS FULL SCALE	1.0
VOLTS FULL SCALE VAR	In Detent
VERTICAL POSITION	Midrange (10-Turn Potentiometer)
RESPONSE	FLAT
DC RESTORER	SLOW, BACK PORCH
CAL/OPER	OPER
WAVEFORM COMPARISION	OFF
INTENSITY	Best display
FOCUS	Best display
SCALE ILLUM	Best display
HORIZONTAL POSITION	Midrange (10-Turn Potentiometer)
MAG μs/DIV	OFF
DISPLAY	5 μs/DIV
LINE SELECTOR	OFF
FIELD	EVEN
SYNC	INT, AFC
ALL FIELDS	OFF
Rear Panel Sync Selector	SYNC ALWAYS A

2. Test Oscilloscope

(A 7603 with 7A18 Vertical Amplifier in left compartment, 7A13 Differential Comparator in center compartment, and 7B53A in right compartment.)

7603

Power	ON
Readout	Best Display
Intensity	Best Display
Grat Illum	Best display
Focus	Best Display
Vert Mode	Press Left
Trig Source	Press Left

7A18

Display Mode	Ch 1
Trigger Source	Ch 1
Ch 1 Volts/Div	5 mV
Ch 1 Input Mode	AC
Variable Volts/Div	Cal
Position	Centered display

7B53A

Slope	—
Level	Best display
Main Triggering:	
Mode	Auto
Coupling	AC
Source	Ext
Position	Centered display
Mag	X1
Time/Div	5 ms

3. Video Signal Source

Set all front-panel switches for a standard Color Bar Test Signal. Connect the front-panel Comp Video output to the 1480-Series A VIDEO INPUT. Terminate the loop-through in 75 Ω. Connect the rear-panel Comp Video output to the 1480-Series A EXTERNAL SYNC input. Do not terminate the loop-through. Connect the rear-panel Comp Sync output to the 7B53A Main Trig In connector.

4. Test Package

DM 501

Range/Function	200 DC Volts
Input	Ext

SG 503

Frequency range (MHz)	2.5 — 5
Frequency Variable	Midrange
Output Amplitude	1
Amplitude Multiplier	1

TG 501

Markers (Sec)	10 μ

NOTE

Test Points and controls used in this procedure are illustrated on fold-out pages in Section 8, Servicing Illustrations. Tabs on Section 8 pages are tinted gray, and follow the order of the Performance Check/Calibration Procedure. The first illustration page covers Low Voltage, High Voltage and crt circuits, which is the first section of the procedure, and so forth.

SHORT FORM PROCEDURE

POWER SUPPLY PROCEDURE

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POWER SUPPLY PROCEDURE

1. Setup

a. Connect the power cord between the instrument under test and the Metered Variac Autotransformer.

b. Set the Metered Variac Autotransformer to the center of the mains supply range for which the instrument under test is connected.

2. Check/Adjust −15 V Supply

a. Connect the DC Voltmeter between ground and the −15 V test point (P6196).

b. Check—The −15 V supply should be −14.85 V to −15.15 V.

c. Adjust—R6096 (−15 V Adj.) for −15 V.

3. Check/Adjust +15 V Supply

a. Connect the DC Voltmeter between ground and the +15 V test point (P6198).

b. Check—The +15 V supply should be +14.85 V to +15.15 V.

c. Adjust—R6198 (+15 V Adj.) for +15 V.

4. Check +75 V Supply

a. Connect the DC Voltmeter between ground and the +75 V test point (P6296).

b. Check—The +75 V supply should be +73.5 V to +76.5 V.

5. Check +140 V Supply

a. Connect the DC Voltmeter between ground and the +140 V test point (P6298).

b. Check—The +140 V supply should be +134.4 V to +145.6 V.

6. Check H.V. Supply

a. Connect the H.V. Probe to the DC Voltmeter.

b. Connect the DC Voltmeter between ground and the −3940 V test point (TP6886).

c. Check—The −3940 V supply should be −3861 V to −4019 V.

7. Check +5 V Supply

a. Remove the H.V. Probe from the DC Voltmeter.

b. Connect the DC Voltmeter between ground and the +5 V test point (P6292).

c. Check—The +5 V supply should be +4.7 V to +5.3 V.

8. Check Power Supply Ripple and Regulation

a. Connect the DC Voltmeter to each of the Power Supply test points in Table 3-1.

TABLE 3-1

Supply	Ripple	Regulation
−15 V	≤2 mV	±0.15 V
+15 V	≤2 mV	±0.15 V
+5 V	≤5 mV TTL noise	±0.3 V
+5 V	≤50 mV Line Sel. Strobe Pulse Noise	±0.3 V
+75 V	≤5 mV	±1.5 V
+140 V	≤10 mV	±5.6 V

b. Check—Power Supply regulation as in Table 3-1, while varying the mains supply ±10% from range center with the Metered Variac Autotransformer.

c. Connect the 1X Probe from the Test Oscilloscope Dual-Trace Amplifier to each of the Power Supply test points in Table 3-1.

d. Check—Power Supply ripple as in Table 3-1 while varying the mains supply ±10% from range center with the Metered Variac Autotransformer.

e. Remove the instrument under test from the Metered Variac Autotransfromer, and connect directly to an appropriate mains supply.

9. Check/Adjust CRT Bias

a. Set INTENSITY counterclockwise and DISPLAY to EXT.

b. Check—There should be no visible crt display.

c. Adjust—R6680 (CRT Bias) until the display is just extinguished.

d. Set DISPLAY to 5 μs/DIV and INTENSITY clockwise.

e. Check—Time base retrace should not be visible.

10. Check/Adjust Astigmatism

a. Set INTENSITY to about "2 o'clock".

b. Check—The display should be sharp and well-defined.

c. Adjust—R6503 (Astigmatism) and the front-panel FOCUS control for a sharp, well-defined display.

11. Check/Adjust Maximum Intensity

a. Press the LINE SELECTOR DIG button. Do not adjust the INTENSITY control.

b. Check—The display should be well-defined.

c. Adjust—R6466 (Max Intens) for a sharp, well-defined display.

12. Check Magnified Intensification and Focus Tracking

a. Alternately press the LINE SELECTOR OFF and DIG buttons, without readjusting FOCUS or INTENSITY.

b. Check—The display should maintain its definition and brightness. Press the LINE SELECTOR OFF button.

c. Rotate the MAG switch throughout its range.

d. Check—The display should maintain its brightness over the MAG range.

13. Check/Adjust Geometry and Trace Rotation

a. Set INPUT to B DC CPL'D.

b. Check—The trace should be level with the center graticule line.

c. Adjust—TRACE ROTATION so the trace is level with the center graticule line.

d. Check—The trace should be level with the top and bottom graticule lines ±1 mm.

e. Adjust—R6508 (Geometry) for best trace alignment with the top and bottom graticule lines.

14. Check/Adjust Y Axis Alignment

a. Set INPUT to A DC CPL'D, DISPLAY to EXT and MAG to 1 μs/DIV. Move the wire in slot 1 of the multipin connector P4940 to slot 2 (Sweep board). This enables the EXT HORIZ unblanking.

b. Position the vertical line to graticule center.

c. Check—The line at graticule center should deviate from exact vertical by 1 mm or less.

d. Adjust—R6414 (Y Axis Align) for 1 mm or less deviation from exact vertical.

e. CHECK—The vertical line should have 1 mm or less deviation from exact vertical at the left and right graticule edge.

f. Set DISPLAY to 10 μs/DIV and MAG to OFF.

15. Check/Adjust H.V. Surge Protection

a. Connect the DC Voltmeter between ground and TP6642.

b. Check—The DC Voltmeter should read −250 mV.

c. Adjust—R6540 (Surge Protection) for −250 mV.

d. Set the 1480-Series POWER off.

e. Connect a 5 kΩ potentiometer from pin 4 to pin 7 of U6060. Set the potentiometer around midrange.

f. Set the 1480-Series POWER switch on.

g. Rotate the 5 kΩ potentiometer until the audible sound of the High-Voltage limiting is heard.

h. Connect the H.V. Probe to the DC Voltmeter.

i. Connect the DC Voltmeter between ground and TP6886.

j. Check—The H.V. should limit at ⩽ −4400 V.

k. Set the 1480-Series POWER switch off.

l. Remove the DC Voltmeter connections and the 5 kΩ potentiometer.

m. Set the 1480-Series POWER switch on.

VERTICAL SYSTEM PROCEDURE

1. Setup

a. Connect the Video Signal Source front-panel Comp Video output to the 1480-Series A VIDEO INPUT.

b. Connect the A VIDEO INPUT loop-through connector to the + Input of the Test Oscilloscope Differential Comparator through one of the matched 75 Ω terminations.

c. Connect the rear-panel AUX VIDEO OUT through the other matched 75 Ω termination to the − Input of the Test Oscilloscope Differential Comparator.

d. Set the Test Oscilloscope Differential Comparator for ac coupling on both inputs, and 20 mV/Div.

e. Set the Video Signal Source chrominance off.

2. Check/Adjust Gain, A VIDEO INPUT to AUX VIDEO OUT

a. Check—The Test Oscilloscope display should be a straight line.

b. Adjust—R1348 (Gain Out) for a nulled Test Oscilloscope display.

c. Set the Video Signal Source chrominance on.

3. Check/Adjust GAIN

a. Press the DC RESTORER SYNC TIP and the CAL button.

b. Check—For 1-volt equivalent display height.

c. ADJUST—Front-panel GAIN control for 1-volt equivalent display height.

4. Check/Adjust Maximum Variable Gain

a. Press the OPER button.

b. Note the displayed sync pulse amplitude.

c. Rotate the VOLTS FULL SCALE VAR just out of detent (maximum gain).

d. Check—The displayed sync pulse amplitude is 1.5X the amplitude noted in part b.

e. SN B010100 through SN B010214 only. Adjust—R1823 (Max Var Gain) for 1.5X the amplitude noted in part b.

f. Rotate the VOLTS FULL SCALE VAR fully counterclockwise.

g. Check—The displayed sync pulse amplitude should be 0.5X the amplitude noted in part b.

h. Set the VOLTS FULL SCALE VAR control to CAL.

5. Check/Adjust DC Balance and Centering

a. Set the VERTICAL POSITION control at the approximate center of its range (5 turns from either end).

b. Press the DC RESTORER OFF button.

c. Check—The back porch of the display should be at the PAL 0.3 line or NTSC 0 IRE line.

d. Adjust—R1666 (Cent) R1565 below SN B020960) until the back porch of the displayed signal is at PAL 0.3 line or NTSC 0 IRE line.

e. Press DC RESTORER FAST and BACK PORCH buttons.

f. Check—There should be no shift of the display. If no shift is noted, proceed to part k of this step. If shift is noted, proceed to part g of this step.

g. Rotate the VERTICAL POSITION control until the back porch of the display is at PAL 0.3 line or NTSC 0 IRE line.

h. Press the DC RESTORER OFF button.

i. Adjust—R1125 (DC Bal) until the back porch of the display is at PAL 0.3 line or NTSC 0 IRE line.

j. Repeat parts e, g, h, and i until no shift is observed when switching DC Restorer FAST and OFF buttons alternately.

k. Set VOLTS FULL SCALE to 0.2.

l. Rotate VERTICAL POSITION until the back porch of the display is at PAL 0.3 line or NTSC 0 IRE line.

m. Set VOLTS FULL SCALE to 1.0.

n. Check—There should be $\leq$10 IRE units shift of the display.

o. Adjust—R1565 (Cent) for no display shift as the VOLTS FULL SCALE is switched between 0.2 and 1.0.

p. Repeat parts k through o to eliminate the effects of interaction.

6. Check/Adjust AUX VIDEO IN Response Change

a. Connect a Color Bar Test Signal from the Video Signal Source to the rear panel A VIDEO INPUT. Connect the a VIDEO INPUT loop-through to the AUX VIDEO IN connector. Do not terminate.

b. With the RESPONSE switch in FLAT, and DISPLAY in 5 μs/DIV, note the amplitude difference between the tops of the yellow and cyan bars.

c. Set the RESPONSE switch to AUX VIDEO IN.

d. Check—The amplitude difference between the tops of the yellow and cyan bars should be the same as that noted in part b.

e. Adjust as follows:

Below SN B010215, adjust L1576 (Aux In Resp).

SN B010215 to SN B029999, skip this part.

SN B030000 and up, adjust C1666 (Vert HF Resp) for the same amplitude difference between the tops of the yellow and cyan bars as that noted in part b.

f. Set the VOLTS FULL SCALE to 0.2. Position the tops of the yellow and cyan bars to the top of the graticule, then to the bottom of the graticule.

g. (SN B029999 and below). Check—There should be 20 mV or less change in the amplitude difference between the yellow and cyan bars as they are positioned from the top of the graticule to the bottom.

(SN B030000 and up). The change should be 7.5 mV or less.

h. (SN B029999 and below). Adjust—L1605 and L1707 (Vert Resp.) for 20 mV or less change in the amplitude difference between the yellow and cyan bars as they are positioned from the top of the graticule to the bottom.

(SN B030000 and up). Adjust—L1605 and L1707 for 7.4 mV or less change as above.

i. Set the VOLTS FULL SCALE to 1.0.

j. Check—The amplitude difference between the tops of the yellow and cyan bars should be the same as that noted in part b.

k. Adjust as follows:

Below SN B010215, adjust L1576 and C1576 (Aux in Resp) until the amplitude difference between the tops of the yellow and cyan bars is the same as that noted in part b. Do not readjust L1605 and L1707.

SN B101215 to SN B029999, adjust C1567 (Aux In Resp) as described above.

SN B030000 and up, adjust C1567 (Aux In Resp) and C1666 (Vert HF Resp) as described above.

l. Connect the Leveled Sine Wave Generator Output, through the 50 Ω to 75 Ω Minimum Loss Attenuator, to the AUX VIDEO IN Connector. Set the Leveled Sine Wave Generator Frequency Range to Ref. ≈0.05 and Output Amplitude for 100 IRE units for NTSC models or 1 volt equivalent display height for PAL models.

m. Set the Leveled Sine Wave Generator frequency to 4.5 MHz.

n. Check—There should be ≤0.5% display amplitude change.

o. Adjust as follows:

Below SN B010215, adjust L1576 (Aux in Resp) for ≤0.5% display amplitude change between Ref. Freq. ≈0.005 and 4.5 MHz.

SN B010215 to SN B029999, skip this part.

SN B030000 and up, adjust C1666 (Vert HF Resp) for ≤0.5% display amplitude change between Ref. Freq. ≈0.05 and 4.5 MHz.

p. Set the Leveled Sine Wave Generator frequency to 10 MHz.

q. Check—The display height should be between +0.5% and −5% of that set in part l.

r. Adjust—C1567 (Aux in Resp.) for the same display height as that set in part l.

s. Set the Leveled Sine Wave Generator frequency to 8 MHz.

t. Check—The display height should be within 0.5% of that set in part l.

u. Repeat parts n through u until the calibration limits given in those parts are met at 4.5, 8 and 10 MHz.

v. Check/Adjust—AUX VIDEO IN response for 0.5 VOLTS FULL SCALE and 0.2 VOLTS FULL SCALE as in Table 3-2.

TABLE 3-2

V.F.S.	Frequency	Adjustment	Amplitude	Limit
0.5	50 kHz	Leveled Sine Wave Gen. Amplitude	100 IRE NTSC 1 V equivalent display PAL	Reference
	4.5 MHz	C1862	"	±0.5%
	8 MHz	Check	"	±0.5%
	10 MHz	Check	"	+0.5%, −5%
0.2	50 kHz	Leveled Sine Wave Gen. Amplitude	100 IRE NTSC 1 V equivalent display PAL	Reference
	4.5 MHz	C1854	"	±0.5%
	8 MHz	Check	"	±0.5%
	10 MHz	Check	"	+0.5%, −5%

w. Remove the Leveled Sine Wave Generator connection.

7. Check/Adjust DC RESTORER Burst Trap

a. Set the DISPLAY switch to 2 FIELD, RESPONSE to FLAT, and VOLTS FULL SCALE to 0.2. Press the FAST and BACK PORCH DC RESTORER buttons.

b. Set the MAG switch to X5 and rotate the POSITION controls to center the field interval on the crt.

c. Set P1993, on the Vertical Board, to the Fast Slew Rate position.

d. Check—Blanking level shift caused by absence of burst (keyboarding) for 7 mV or less.

e. Adjust—L1697 for 7 mV or less keyboarding.

NOTE

In 525/60 NTSC—625/50 PAL and 525/60 PAL-M—625/60 PAL dual-standard models, the adjustment of L1697 must be compromised for minimum keyboarding in both standards.

8. Check/Adjust Common Mode Rejection

a. Connect the Video Signal Source Comp Video output through a 75 Ω feed-through termination and the BNC Cable T connector to the A and B VIDEO INPUTS. Do not terminate the loop-through connectors.

b. Set the Video Signal Source for a 90% APL (average picture level) Modulated Pedestal signal.

c. Set the DISPLAY to 5 μs/DIV, INPUT to A-B DC CPL'D, and VOLTS FULL SCALE to 0.2.

d. Check—Display amplitude should be 70 mV or less.

e. Adjust—R1233 (L.F. CMR). C1240 (M.F. CMR) and C1244 (H.F. CMR) for nulls of low-frequency, mid-freqeuncy and high-frequency signal components respectively.

f. Set VOLTS FULL SCALE to 1.0 and INPUT to A AC CPL'D.

9. Check/Adjust A and B Frequency Response

a. Connect the Leveled Sine Wave Generator Output through the 50 Ω to 75 Ω Minimum Loss Attenuator, a 75 Ω feed-through termination and the BNC Cable T connector to the A and B VIDEO INPUTS. Do not terminate the loop-through connectors.

b. Set the Leveled Sine Wave Generator Freqeuncy to REF. ≈0.05, and Amplitude for NTSC 100 IRE units, or PAL 1 volt equivalent display height.

c. Set the Leveled Sine Wave Generator Frequency to 6 MHz.

d. Check—The display height should be the same as that set in part b within 0.5%.

e. Adjust—C1056 (A Input Comp) for the same display height as that set in part b.

f. Set INPUT to B AC CPL'D.

g. Check—The display height should be the same as that set in part b.

h. Adjust—C1023 (B Input Comp.) for the same display height as that set in part b.

i. Recheck Common Mode Rejection (Step 8). Readjust if necessary. Recheck A and B Frequency Response.

j. Check—Frequency response for A and B VIDEO INPUTS as in Table 3-3.

TABLE 3-3

Frequency	Limit
0.05 MHz	Reference-100 IRE NTSC, 1 V equivalent display height PAL
0.44 MHz	±0.5%
0.92 MHz	±0.5%
2.0 MHz	±0.5%
4.5 MHz	±0.5%
10.0 MHz	+0.5%, −5%

10. Check/Adjust AUX VIDEO OUT Response

a. Connect the Video Signal Source Comp Video output through a 75 Ω feed-through termination and the BNC Cable T connector to the A and B VIDEO INPUTS.

b. Connect the AUX VIDEO OUT through the 1.5 dB attenuator to the AUX VIDEO IN connector.

c. Set the Video Signal Source for a Color Bar Test Signal output.

d. With the RESPONSE switch in the FLAT position, note the amplitude of the chrominance portion of the display generally, and the amplitude difference between the yellow and cyan bars specifically. Note also the peak-to-peak amplitude of the composite signal.

e. Set the RESPONSE switch to AUX VIDEO IN.

f. Check—The peak-to-peak display amplitude of the composite signal should be within 5% of that noted in part d.

g. Check—The chrominance amplitude and the amplitude difference between the yellow and cyan bars should be within 0.5% of that noted in part d.

h. Adjust—C1437 (Vid. Out Resp.) for chrominance amplitude and amplitude difference between the yellow and cyan bars equal to that noted in part d.

i. Remove connection of the 1.5 dB attenuator between AUX VIDEO OUT and AUX VIDEO IN connectors.

11. Check/Adjust IRE Filter

a. Set the RESPONSE switch to IRE, and the INPUT switch to A AC CPL'D.

b. Set the Video Signal Source for a five-step staircase, modulated with 140 mV of subcarrier.

c. Check—Luminance portions of the signals should have no preshoot, overshoot, or ringing. Chrominance on the staircase should be 14 mV or less in amplitude.

d. Adjust—L1287 (IRE Filter) for no preshoot, overshoot, or ringing on luminance portions of the signal, and less than 14 mV of chrominance on the staircase.

12. Check/Adjust LOW PASS Filter

a. Press the CAL and DC RESTORE SYNC TIP buttons.

b. Set the RESPONSE switch to LOW PASS.

c. Check—The corner of the leading edge of the calibrator square-wave should have 0.5% or less overshoot or ringing.

d. Adjust—L1374, L1385, L1395 (Low Pass Filter) for 0.5% or less overshoot or ringing on the corner of the leading edge of the calibrator square-wave.

13. Check/Adjust DIFF'D STEPS Filter

a. Set the RESPONSE switch to DIFF'D STEPS and press the OPER button.

b. Set the Video Signal Source for a five-step staircase, modulated with 140 mV of subcarrier.

c. Check—The amplitude of the differential step risers should be ≈5X normal. The differentiated pulses should have 1% or less preshoot, overshoot and ringing.

d. Adjust—L1082 and L1094 (Diff'd Steps Filter) for maximum amplitude with minimum aberration.

e. Connect the Subcarrier from the Video Signal Source in place of Comp Video.

f. Check—The displayed subcarrier should be 20 mV or less.

g. Adjust—L1077 (Diff'd Steps Filter) for 20 mV or less displayed subcarrier.

h. Connect Comp Video from the Video Signal Source in place of the subcarrier. Set RESPONSE to FLAT.

14. Check/Adjust 3.58 BANDPASS Filter (525/60 NTSC single-standard, 525/60 PAL-single-standard, 525/60 NTSC-625/50 PAL dual-standard, and 525/60 PAL-M-625/50 PAL dual-standard models)

a. Set the Video Signal Source for a standard Color Bar Test Signal.

b. Set the VOLTS FULL SCALE and VOLTS FULL SCALE VAR so the red bar is 1 volt equivalent display height.

c. Set RESPONSE to 3.58 BANDPASS.

d. Check The red bar should be within 1% of the amplitude set in part b. The tops of the bars should be flat and rise- and fall-time of the color burst should be nearly identical.

e. Adjust—L1074, L1083, and C1080 (3.58 Filter) so the red bar amplitude is the same as that set in part b, the tops of the bars are flat, and the rise- and fall-time of the color burst is nearly identical.

f. Replace the Comp Video input with the Leveled Sine Wave Generator input.

g. Set the Leveled Sine Wave Generator Frequency to 3.58 MHz and Amplitude for a convenient reference.

h. Check—The display amplitude should be −3 dB from the reference set in part g at 3.1 to 3.4 MHz and 3.8 to 4.0 MHz.

i. If the limit in part h is not met, repeat step 14.

15. Check/Adjust 4.43 BANDPASS Filter (525/50 PAL single-standard, 525/60 NTSC-625/60 PAL dual-standard, 625/50 PAL-525/60 dual-standard models)

a. Connect the Video Signal Source to the A VIDEO INPUT. Terminate the loop-through connector in 75Ω.

b. Set the Video Signal Source for a Standard Color Bar Test Signal.

c. Set the VOLTS FULL SCALE and VOLTS FULL SCALE VAR so the red bar is 1-volt equivalent display height.

d. Set RESPONSE to 4.43 BANDPASS.

e. Check—The red bar should be within 1% of the amplitude set in part c. The tops of the bars should be flat and the rise- and fall-time of the color burst should be nearly identical.

f. Adjust—L1172, L1191, and C1182 (4.43 Filter) so the red bar amplitude is the same as that set in part c, the tops of the bars are flat, and the rise- and fall-time of the color burst are nearly identical.

g. Replace the Comp Video input with the Leveled Sine Wave Generator input.

h. Set the Leveled Sine Wave Generator Frequency for 4.43 MHz and Amplitude for a convenient reference.

i. Check—The display amplitude should be −3 dB at 3.9 to 4.1 MHz and 4.7 to 4.9 MHz.

j. If the limit in part i is not met, repeat step 15.

16. Check/Adjust Calibrator Accuracy

a. Press the CAL and DC RESTORER SYNC TIP buttons.

b. Connect AUX VIDEO OUT through 75 Ω termination to the Test Oscilloscope Differential Comparator + Input.

c. Set the Test Oscilloscope Time/Div to 50 μs, Volts/Div to 50 mV, and for Comparison Voltage operation.

d. Connect the Test Oscilloscope Differential Comparator V_C Out to the Digital Voltmeter Hi Input.

e. Connect the Digital Voltmeter Lo Input to the Test Oscilloscope ground.

f. Set the Test Oscilloscope Differential Comparator V_C to 0000. Vertically position the bottom of the squarewave at graticule center. Note the Digital Voltmeter reading.

g. Rotate the Differential Comparator Fine Comparison Voltage control to set the top of the squarewave at graticule center.

h. Check—The amplitude of the squarewave should be 1 V ±2 mV from that noted in part f.

i. Adjust—R1827 (Cal Ampl) for 1 V squarewave amplitude as read on the Digital Voltmeter.

j. Press the DC RESTORER BACK PORCH button.

k. Check—The squarewave amplitude should be 700 mV ±0.5% for 625/50 PAL and 525/60 PAL-M models and 714 mV ±0.5% in 525/60 NTSC models.

NOTE

In the dual-standard 525/60 NTSC-625/50 PAL and 525/60 NTSC-525/60 PAL-M models, check that when the SCALE ILLUM control is pushed in, the Calibrator squarewave amplitude should be 714 mV ±0.5%. When the SCALE ILLUM is pulled out, the Calibrator squarewave amplitude should be 714 mV ±0.5%. In single-standard models, the SCALE ILLUM switch should not change the squarewave amplitude.

17. Check/Adjust GAIN

a. Press the DC Restorer SYNC TIP button.

b. Check—The 1480-Series display should be 1-volt equivalent display height within 0.2%.

c. Adjust—GAIN control for 1-volt equivalent display height.

18. Check VOLTS FULL SCALE Accuracy

a. Connect the Television Test Signal Generator Composite Video through a 75 Ω termination to A VIDEO INPUT.

b. Adjust the Television Test Signal Generator Amplitude and APL for exactly 1-volt equivalent display height.

c. Set VOLTS FULL SCALE to 0.5.

d. Add the 2X Attenuator in series with 75 Ω termination.

e. Check—The display should be 0.5-volt equivalent display height, within 3%.

f. Set the VOLTS FULL SCALE switch to 0.2.

g. Replace the 2X Attenuator with the 5X Attenuator.

h. Check—The display should be 0.2-volt equivalent display height, within 3%.

HORIZONTAL SYSTEM PROCEDURE

1. Setup

a. Set INPUT to A AC CPL'D, VOLTS FULL SCALE to 1.0, VOLTS FULL SCALE VAR to CAL, RESPONSE to FLAT, MAG to OFF, and DISPLAY to 10 μs/DIV.

b. Press DC RESTORER SLOW, BACK PORCH, OPER, and SYNC INT and AFC buttons.

c. Connect the Video Signal Source Comp Video output to the A VIDEO INPUT. Terminate the loop-through in 75 Ω.

d. Set the Video Signal Source for a standard Color Bar Test Signal.

2. Check/Adjust Horizontal Limiters

a. Set MAG to .1 μs/DIV. Rotate HORIZONTAL POSITION throughout its range.

b. Check—The trace should not be visibly limited or fold back on screen at any point in the range of the HORIZONTAL POSITION control.

c. Adjust—R4330 and R4431 (Limit) for no visible limiting or on screen fold-back of the trace within the range of the HORIZONTAL POSITION control.

3. Check/Adjust MAG Registration

a. Set DISPLAY to 2 FIELD and center the display using the HORIZONTAL POSITION control.

b. Set MAG to X50.

c. Rotate the HORIZONTAL POSITION control to set the last field sync pulse at graticule center.

d. Set MAG to OFF.

e. Check—The last field sync pulse should be within 0.5 division of graticule center.

f. Adjust—R4240 (X5 Mag Regis) for registration of the last field sync pulse between MAG X5 and MAG OFF, and R4234 for registration of the last field sync pulse between MAG X50 and MAG X5.

4. Check/Adjust Horizontal Gain and Timing

a. Replace the Comp Video input with time markers from the Time Mark Generator. Set the Time Mark Generator for 10 μs markers.

b. Replace the input to A EXTERNAL SYNC with triggers from the Time Mark Generator.

c. Press SYNC EXT and DIRECT buttons.

d. Set DISPLAY to 10 μs/DIV.

e. Check—The display should be 1 time mark/div ±1%.

f. Adjust R4532 (Horiz Gain) for 1 time mark/div.

g. Set MAG to 0.1 μs/DIV.

h. Set the Time Mark Generator for 0.1 μs marks.

i. Check—The display should be 1 mark/div ±2%. Check for 1 mark/div ±2% over the center 10 divisions of the unmagnified display when it is magnified to 0.1 μs/DIV.

j. Adjust—C4620 (Mag Timing) for 1 mark/div and linearity of ±2% over the area that compromises the center 10 div. of unmagnified sweep.

k. Check—Magnified timing and linearity as in Table 3-4.

TABLE 3-4

TIME MARKERS	MAG	DISPLAY	LIMIT
1 μs	0.2 μs	1 mark/5 div	±2%
1 μs	0.25 μs	1 mark/4 div	±2%
1 μs	0.5 μs	1 mark/2 div	±2%
1 μs	1.0 μs	1 mark/div	±2%

l. If any of the limits are not met, repeat step 4.

5. Check WAVEFORM COMPARISON Range

a. Set the display switch to 5 μs/DIV.

b. Rotate the WAVEFORM COMPARISON OVERLAY just out of detent. Notice the small blanked portion of the trace.

c. Rotate the WAVEFORM COMPARISON LOCATE control to place the blanked portion at the start of the trace.

d. Rotate the WAVEFORM COMPARISON OVERLAY control throughout its range.

e. Check—The OVERLAY control should have sufficient range to position the display completely off screen.

f. Repeat this step with DISPLAY in 10 μs/DIV.

6. Check/Adjust RGB/YRGB Operation

a. Connect the Video Signal Source Comp Video to the A VIDEO INPUT connector. Terminate the loop-through connector in 75 Ω.

b. Set INPUT to A AC CPL'D, DISPLAY to 10 μs/DIV, and MAG to OFF.

c. Press SYNC INT and DIRECT buttons.

d. Connect J9034 on the rear panel for RGB/YRGB operation (ground pin D, connect RGB/YRGB steps to pin C).

e. Connect a 3 step staircase from the Television Test Signal Generator to J9034 pin C.

f. Set the Television Test Signal Generator Amplitude control for three video lines in 12.7 div.

g. Check—The display should be stable and centered without compression on either side.

h. Adjust—R4040 (RGB DC Bal) for a centered display without compression on either side.

i. Adjust—C4060 (RGB Comp) for stability and optimum display detail.

j. Set DISPLAY to 2 FIELD.

k. Check—The display should be three fields in 12.7 divisions.

l. Remove plug-jumpers P4032 and P4240. Set the Television Test Signal Generator for a 4-step display.

m. Check—The 2 FIELD and 10 μs/DIV DISPLAY switch positions should have a 4-step display.

7. Check EXTERNAL HORIZ Input

a. Set the DISPLAY switch to EXT.

b. Connect a precise, 5 volt, positive-going ramp from the Ramp Generator to the EXT HORIZ input.

c. Check—The trace should be 10.0 div ±3%.

SYNC AND RETURN LOSS

1. Setup

a. Connect the Return Loss Bridge to the Test Oscilloscope Differential Comparator.

b. Connect the Leveled Sine Wave Generator Output through the 50 Ω to 75 Ω Minimum Loss Attenuator to the Return Loss Bridge input.

c. Set the Test Oscilloscope Differential Comparator for differential operation and Volts/Div to .1.

d. Set the Leveled Sine Wave Generator to Ref. ≈0.05, remove the 75 Ω termination from the Unknown Arm of the Return Loss Bridge, and adjust the Leveled Sine Wave Generator Amplitude for 500 mV Test Oscilloscope display.

2. Check Return Loss

a. Connect the Return Loss Bridge Unknown Arm to the A VIDEO INPUT. Terminate the A VIDEO INPUT loop-through with the termination that was removed in step 1d.

b. Check—Return loss should be ≤2.5 mV.

c. Repeat part b for the B VIDEO INPUT and for A and B EXTERNAL SYNC inputs.

d. Connect the Return Loss Bridge Unknown Arm (do not terminate) to AUX VIDEO IN, AUX VIDEO OUT, and PIX MONITOR OUT.

e. Check—Return loss should be ≤11 mV.

3(a). Check Field Selection (525/60 NTSC)

a. Connect the Video Signal Source Comp Video to the A VIDEO INPUT. Terminate the loop-through in 75 Ω.

b. Set INPUT to A AC CPL'D, VOLTS FULL SCALE to 1.0, DISPLAY to 2 FIELD, RESPONSE to FLAT, and MAG to X20.

c. Press the EVEN FIELD and SYNC INT and DIRECT buttons.

d. Rotate the HORIZONTAL POSITION control to view the field interval that occurs at the center of the display.

e. Set the Video Signal Source VITS Signal switch to Mod Staircase, Field switch to 2, and Line to 20.

f. Check—The VIT Signal should appear on line 20 of the field interval displayed on the crt.

g. Rotate the HORIZONTAL POSITION control to view the start of the trace.

h. Check—No VIT Signal should appear on line 20 of the field interval at the start of the trace.

i. Press the ODD FIELD buttons.

j. Check—The VIT Signal should appear on line 20 of the field interval at the start of the trace.

k. Rotate the HORIZONTAL POSITION control to view the field interval that occurs at the center of the display.

l. Check—No VIT Signal should appear on this field.

3(b). Check Field Selection (625/50 PAL)

a. Connect the Video Signal Source Comp Video to the A VIDEO INPUT. Terminate the loop-through in 75 Ω.

b. Set the INPUT to A AC CPL'D, VOLTS FULL SCALE to 1.0, DISPLAY to 2 FIELD, RESPONSE to FLAT, and MAG to X20.

c. Press the FIELD 1, and the SYNC INT and DIRECT buttons.

d. Rotate the HORIZONTAL POSITION control to view the field interval that occurs at the center of the display.

e. Set the Video Signal Source Insertion Test Signal switch to Mod Staircase, Field switch to 2 and 4, and Line switch to 20.

f. Check—The Insertion Test Signal should appear on line 20 of the displayed field. The displayed field should be field 2.

g. Press the FIELD 2 button.

h. Set the Video Signal Source Insertion Field switch to 1 and 3.

i. Check—The Insertion Test Signal should appear on line 20 of the displayed field. The displayed field should be 3.

j. Press the FIELD 3 button.

k. Set the Video Signal Source Insertion Field switch to 2 and 4.

l. Check—The Insertion Test Signal should appear on line 20 of the displayed field. The displayed field should be 4.

m. Press the FIELD 4 button.

n. Set the Video Signal Source Insertion Field switch to 1 and 3.

o. Check—The Insertion Test Signal should appear on line 20 of the displayed field. The displayed field should be 1.

p. Check—With the EVEN FIELD button pressed, the odd fields should appear in the center of the display, and with the ODD FIELD buttons pressed, the even fields should appear in the center of the display.

3(c). Check Field Selection (525/60 PAL-M)

a. Connect the Video Signal Source Comp Video to the A VIDEO INPUT. Terminate the loop-through in 75 Ω.

b. Set INPUT to A AC CPL'D, VOLTS FULL SCALE to 1.0, DISPLAY to 2 FIELD, RESPONSE to FLAT, and MAG to X20.

c. Press the FIELD 1, and the SYNC DIRECT and INT buttons.

d. Rotate the HORIZONTAL POSITION control to view the field interval that occurs at the center of the display.

e. Set the Video Signal Source VITS Field switch to 2 and 4, Test Signal switch to Mod Staircase, and Line switch to 18.

f. Check—The VITS Signal should appear on line 18 of the displayed field. The displayed field should be field 2.

g. Press the FIELD 2 button.

h. Set the Video Signal Source VITS Field switch to 1 and 3.

i. Check—The VIT Signal should appear on line 18 of the displayed field. The displayed field should be 3.

j. Press the FIELD 3 button.

k. Set the Video Signal Source VITS Field switch to 2 and 4.

l. Check—The VIT Signal should appear on line 18 of the displayed field. The displayed field should be 4.

m. Press the FIELD 4 button.

n. Set the Video Signal Source VITS Field switch to 1 and 3.

o. Check—The VIT Signal should appear on line 18 of the displayed field. The displayed field should be 1.

p. Check—With the EVEN FIELD buttons pressed, the odd fields should appear in the center of the display, and with the ODD FIELD buttons pressed, the even fields should appear in the center of the display.

4. Check Line Selection

a. Connect the Video Signal Source Comp Video output to the A VIDEO INPUT. Terminate the loop-through in 75 Ω.

b. Set INPUT to A AC CPL'D, VOLTS FULL SCALE to 1.0, RESPONSE to FLAT, DISPLAY to 10 μs/Div, and MAG to OFF.

c. Press the LINE SELECTOR DIG and EVEN FIELD buttons.

d. Set the Video Signal Source Field switch to 1.

e. Check—The first line displayed should be the line selected for Test Signal Insertion when the Video Signal Source Line switch and the 1480-Series LINE SELECTOR LINE switch coincide.

f. Press the LINE SELECTOR VAR button and set DISPLAY to 2 FIELD.

g. Check—The selected line should be intensified, and can be moved the width of the display with the VAR control.

h. Press the LINE SELECTOR 15 LINES button.

i. Check—Fifteen consecutive lines should be intensified and can be moved the width of the display with the VAR control.

5. Check PIX MONITOR OUT and LINE STROBE OUT

a. Connect the Video Signal Source Comp Video output to the A VIDEO INPUT.

b. Set INPUT to A AC CPL'D, RESPONSE to FLAT, DISPLAY to 2 FIELD, VOLTS FULL SCALE to 1.0, and MAG to OFF.

c. Press LINE SELECTOR VAR button.

d. Connect the PIX MONITOR OUT connector through 75 Ω termination to the Test Oscilloscope Dual Trace Amplifier.

e. Check—The line selected by the LINE SELECTOR controls should be identified on the Test Oscilloscope display by a 60 mV pedestal. The pedestal should be one-line duration in 5 μs/DIV DISPLAY, two-lines duration in 10 μs/DIV DISPLAY and fifteen-lines duration with the 15 LINES button pressed.

f. Connect the LINE STROBE OUT to the Test Oscilloscope in place of PIX MONITOR OUT. Remove the 75 Ω termination.

g. Check—Control of the signal is identical to that for PIX MONITOR OUT except that there is no composite video and strobe amplitude is at least 2.4 V.

6. Check Sync Range

a. Connect the Video Signal Source Comp Video output through the 5X Attenuator and 75 Ω termination to the A VIDEO INPUT.

b. Set INPUT to AC CPL'D, VOLTS FULL SCALE to 0.2, RESPONSE to FLAT, and MAG to OFF.

c. Check—The display should be stable.

d. Remove the 5X Attenuator and the 75 Ω termination. Connect the Comp Video directly to the A VIDEO INPUT.

e. Check—The display should be stable.

f. Connect the Video Signal Source Comp Video output through four 75 Ω terminations to the A VIDEO INPUT.

g. Connect the A VIDEO INPUT loop-through to the EXTERNAL SYNC A input.

h. Press the SYNC EXT button.

i. Check—The display should be stable.

j. Remove the four 75 Ω terminations. Connect the Comp Video signal directly to the A VIDEO INPUT.

k. Check—The display should be stable.

l. Replace the Comp Video input with Comp Sync, connected through the 2X and 10X attenuators and the 75 Ω termination.

m. Check—The display should be stable.

n. Remove the two attenuators and the 75 Ω termination. Connect the Comp Sync directly to the A VIDEO INPUT.

o. Check—The display should be stable.

7. Check Sync Input Selector

a. Connect the Video Signal Source Comp Video output to the A VIDEO INPUT. Terminate the loop-through in 75 Ω.

b. Connect the Video Signal Source Comp Sync out to A EXTERNAL SYNC.

c. Set INPUT to A, VOLTS FULL SCALE to 1.0, MAG to OFF, RESPONSE to FLAT, and DISPLAY to 2 FIELD.

d. Press the SYNC DIRECT and EXT buttons.

e. Set the Sync Input Selector on the rear panel to EXT SYNC ALWAYS (A).

f. Check—The display should be stable.

g. Move the Comp Video input to B VIDEO INPUT, set INPUT to B.

h. Check—The display should be stable.

i. Set the Sync Input Selector to EXT SYNC SWITCHED WITH INPUT SWITCH (A) or (B).

j. Check—The display is not locked.

k. Move the Comp Sync input to B EXTERNAL SYNC.

l. Check—The display should be stable.

THEORY OF OPERATION

This section is divided into two parts. First is a basic overview of instrument operation that describes circuit relationships and signal flow as illustrated by the Block Diagram. Second is a more detailed discussion of each of the circuit diagrams.

The circuit diagrams are blocked off according to circuit function. These circuit block titles are used as indices to the circuit diagram discussion.

The Block Diagram and circuit diagrams are located on fold-out pages at the rear of the manual. Refer to the appropriate diagram when reading this discussion.

BLOCK DIAGRAM DESCRIPTION

There are three main areas of interest in the 1480 Series Waveform Monitors: the vertical channel, the sync circuits and the horizontal channel.

Vertical Channel

Signals applied to the A and B VIDEO INPUTS are routed through the Video Input Switch as commanded by front-panel controls. Either the A or the B input signal can be routed to the + Amplifier. The + Amplifier is so named because the signal is ultimately displayed in the same polarity as applied to the input connector. A signal applied to the B input can be routed through the − Amplifier when the INPUT switch is in the A-B position. The signal displayed on the crt is inverted from that applied. This function is useful in null applications.

If the instrument is equipped with Option 1 (X10 Probe Input), the signal from the probe circuit is routed through the + Amplifier.

The Calibrator Input is timed by a signal counted down from the line rate by two divide-by-two D flip-flops. The amplitude of the calibrator signal is determined by tapping a precise, series-resistor divider. The front-panel switching for calibrator amplitude is done by the SYNC TIP and BACK PORCH DC RESTORER switches in conjunction with the Back Porch Cal Ampl. switch. The Back Porch Cal Ampl. switch is a slide switch, located just below the crt, inside the metal graticule cover.

In the SYNC TIP mode, the calibrator amplitude produces a 1 volt equivalent display height. In the BACK PORCH mode, the equivalent display height is either 700 mV or 714 mV, depending upon the Back Porch Cal Ampl. switch position.

With both the OPER and CAL buttons pressed, the A video signal is superimposed on the calibrator signal for easy amplitude checks.

The + and − Amplifiers are followed by a Differential Amplifier, which drives the Filters, the Video Output Amplifier, and a pickoff circuit that routes a sample of the video signal to the sync circuits to derive internal sync.

The Video Out Amplifier provides two 75 Ω outputs for whatever input is selected. The Pix Monitor Out also has an input from the Line Selector Logic circuit to apply a pedestal for the line selected in LINE SELECTOR modes.

The AUX VIDEO OUT is especially useful as part of an impedance converter. That is, a signal acquired using the optional X10 probe can be routed into a 75 Ω system for testing.

Following the Differential Amplifier is a seven transistor array that switches the vertical channel signal to the desired filter on command from the RESPONSE switch. The selected filter then processes the signal in its own manner, and routes it to the Clamped Amplifier.

The Clamped Amplifier is a driver for the Gain Cell, and also the point of dc restoration. The signal into the Clamped Amplifier can come from the AUX VIDEO IN. The AUX VIDEO IN is a 75 Ω internally-terminated input that can be used in conjunction with the AUX VIDEO OUT to route a signal around the internal filters. As the signal is routed in this manner it can be processed by other peripheral equipment, such as a group delay corrector, or differential gain or phase testers.

Following the Clamped Amplifiers is the Gain Cell where vertical magnification takes place on command from the VOLTS FULL SCALE switch. From the Gain Cell, the signal is routed to the Limiting Amplifier. The Limiting Amplifier limits the amplitude excursion of the signal, preventing overdrive recovery problems.

The limited signal is then applied to the Vertical Deflection Amplifier and from there to the crt plates.

Horizontal Channel

The Odd/Even Recognition circuit reacts to the coincidence of the V pulse and the +H pulse that are generated in the Sync Circuit. When the field selected on the front panel is recognized, the Line Counter is enabled and counts to about the 23 line of that field. Since the counter is only enabled at the beginning of the selected field, the 2 FIELD sweep is enabled at that field. The sweep, then, always starts on the field selected by the front-panel FIELD pushbuttons.

The 2 Field Gate Generator enables the 2 Field Sweep Generator. The gate can be enabled from the Line Counter directly, or can be held off until the burst gate from the Sync Circuit arrives. The burst gate occurs only in 525/60 PAL-M or 625/50 PAL instruments and is used to gate the 2 FIELD sweep on individual fields.

The 2 Field Sweep Generator integrated circuit also generates a delayed gate. This gate can be timed to any point after about line 20 along the 2 Field ramp waveform. The delayed gate is applied to the Line Selector Logic. The control that times the delayed gate with respect to the 2 Field ramp is the front-panel VARIABLE LINE SELECTOR.

The 2 Field ramp waveform is routed to the Horizontal Switching circuit, which is controlled by the front-panel DISPLAY switch.

The 5 μs/DIV and 10 μs/DIV Sweep Generator is enabled by the H pulses from the Sync Circuit. Gating is done every other line except in RGB or 15 LINES LINE SELECTOR modes. The delayed gate function is also used in 5 μs/DIV and 10 μs/DIV sweeps. In this case, the delayed gate is positioned somewhere on the display by the WAVEFORM COMPARISON LOCATE control. The delayed gate is then applied to the Horizontal Positioning circuit (where a current source is enabled), allowing the portion of the display following the arrival of the delayed gate to be repositioned by the WAVEFORM COMPARISON OVERLAY control. In this manner, any selected portion of the display can overlay any other portion.

Both the 2 Field and the 5 μs/DIV and 10 μs/DIV ramps are applied to the Horizontal Switching Logic circuit, where either can be selected by the front-panel DISPLAY switch. An external signal can be connected to the rear-panel EXT HORIZ IN connector and be selected by the Horizontal Switching Logic circuit.

The signal from the switching circuit is applied to the Horizontal Input Amp, where positioning offset current from the Horizontal Positioning circuit is added. The Horizontal Input Amp applies the signal to the Magnifier, where horizontal gain is altered by the front-panel MAGNIFIER switch.

The signal is then applied to the Horizontal Limiter. This circuit ensures that the signal, no matter how highly magnified, does not overdrive the Horizontal Deflection Amplifier, or cause any non-linearity or other distortion. The Horizontal Deflection Amplifier converts the ramp to voltage drive for the crt deflection plates.

The unblanking Logic generates signals used to enable the Z-axis Logic circuit to unblank the crt and brighten magnified displays.

Sync Circuits

The Sync Input Switch selects either an internal signal, picked off in the Vertical Channel, or an external signal is applied to the rear-panel SYNC inputs. External sync is either electrically "ganged" to the front-panel INPUT switch, or selected from the A SYNC input only (the mode is selected by a slide switch on the rear panel).

After the sync signal is selected, the Sync Stripper removes video and regenerates the composite sync. The regenerated sync enables the Field Sync Generator, which generates a pulse at the last broad field sync pulse, and gates the Burst Gate Generator in the 525/60 PAL-M and 625/50 PAL instruments.

The 31 kHz lockout removes the equalizing pulses and field serrations and applies the line-rate signal to a phase-locked loop (SYNC AFC mode). The phase-locked loop maintains the line-rate output even in the absence of line sync for about ten consecutive lines. The phase-locked loop output drives the AFC/Direct Sync Switch.

The AFC/Direct Sync Switch selects the output of the phase-locked loop or the output of the 31 kHz lockout to drive the +H and −H Pulse Generator. The +H and −H pulses are used in the Horizontal Channel for gating.

In the dual-standard 525/60 - 625/50 instruments, a circuit recognizes the field rate and switches the gating for the 2 Field Sweep.

CIRCUIT DESCRIPTION

DIAGRAM 1
VERTICAL INPUT

Circuits on this diagram accept signals from the A and B VIDEO INPUTS on the rear panel, from the Internal Calibrator, or the optional front panel X10 PROBE INPUT. The signals are routed according to front panel switching to the Differential Amplifier on Diagram 2.

A Input

Signals connected to the rear panel A VIDEO INPUT are applied to the C1057 and the collector of Q1054 through the parallel RC network R1061-C1056. C1056 is the A Input compensation adjustment.

Q1054 is controlled by the position of the input switch via Q1051 and Q1052. With the front panel INPUT switch in an AC CPL'D position, the +10 V is applied to the base of Q1052. Q1054 cannot conduct in this case, so the input signal is coupled through C1057 to the emitter of Q1062. With the front panel INPUT switch in a DC CPL'D position, +10 V is applied to the base of Q1051, turning Q1051 on, saturating Q1054 and routing the input signal around C1057 to the emitter of Q1062.

The rear panel input connectors can be isolated from the chassis so that cable shields connect to Q1062's base network rather than ground. R1072-C1073 shunt high frequency noise to ground, while hum arrives at the base of Q1062 through CR1071. The hum on the base of Q1062 is in phase with hum in the composite video signal at the emitter of Q1062 and is rejected differentially.

B Input

The input circuit for signals connected to the B VIDEO INPUT is identical to the A VIDEO INPUT circuit. Q1036 and Q1025 form the AC-DC Coupling Switch, controlling the conduction of Q1026. Q1007 is the differential input for the floating ground.

Switching

The switching circuit drives a pair of transresistance amplifiers according to front panel commands. One of these amplifiers might be termed "+ Amplifier," the other "− Amplifier" because one drives the positive input and the other the negative input of the Differential Amplifier on Diagram 2.

The − Amplifier is used when differential or null measurements are desired, as in the A-B positions of the INPUT switch. The internal calibrator signal is also routed through the − Amplifier. At all other times, the + Amplifier is used.

A group of diode-transistor switches route the A or the B signal to the + Amplifier, the A signal to the + Amplifier and the B signal to the − Amplifier, the internal calibrator to the − Amplifier, the A signal to the + Amplifier, and the internal calibrator to the − Amplifier, or the optional X10 Probe signal to the + Amplifier.

Signal Switching with INPUT in A. With the front panel INPUT switch in A, P1206-3 is grounded, forward-biasing CR1145, saturating Q1063 and reverse-biasing CR1058. Signal flow in this condition is from the collector of Q1062 through Q1063 to the summing junction of the + Amplifier, the base of Q1141. CR1116 is also forward-biased in the A position. This saturates Q1221, providing holding current for the − Amplifier so that the − input of the Differential Amplifier on Diagram 2 is balanced with the + input.

Q1253-CR1147-CR1107, the switch for B signal to the + Amplifier, is off for lack of ground at the anodes of CR1147 and CR1107.

Signal Switching with INPUT in B. With the front panel INPUT switch in B, P1206-2 is grounded, forward-biasing CR1107 and CR1147, saturating Q1253, and reverse-biasing CR1108. Signal flow now is from the collector of Q1007 through Q1253 to the summing junction of the + Amplifier, the base of Q1141. CR1114 is also forward-biased at this time to saturate Q1221, providing − Amplifier holding current.

CR1145-Q1063, the A signal to the + Amplifier switch, is off for lack of ground at the anode of CR1145.

Signal Switching with INPUT in A-B. With the front panel INPUT switch in A-B, CR1144 in the A input and CR1112 in the B input are forward-biased, saturating Q1063 at the input to the + Amplifier and Q1008 at the input to the − Amplifier. This forms two signal paths: one, for A signals, from the collecor of Q1062 through Q1063 to the + Amplifier; the other, for B signals, from the collector of Q1007 through Q1008 to the − Amplifier.

The other switching diodes are off, blocking any other signal path to either amplifier.

Calibrator Input Switching. Q1303, U1223, and Q1322 form the Calibrator Input circuit, driving the − Amplifier with an internal calibrator square wave upon command from the front panel. The internal calibrator signal may be

used in two different modes: first, by itself as a gain calibration aid; second, with the A VIDEO INPUT signal superimposed on it, as a check of incoming signal amplitude.

In the first mode, switching is accomplished by grounding the anodes of CR1321 and CR1204. Grounding the anode of CR1321 saturates Q1227, which routes the internal calibrator signal to the − Amplifier. Grounding the anode of CR1204 saturates Q1127, providing holding current for the + Amplifier, balancing the Differential Amplifier on Diagram 2.

In the second mode, the anodes of CR1321 and CR1243 are grounded, routing the internal Calibrator signal through Q1227 to the − Amplifier and the A VIDEO INPUT signal through Q1063 to the − Amplifier. The second mode of calibrator switching is accomplished by pressing both front panel CAL and OPER buttons. When this is done, Q1063 is saturated by grounding CR1243 through the OPER switch and Q1253 is turned off by the CAL switch, removing the INPUT switch ground. So, in this mode, the A VIDEO INPUT signal will always be superimposed on the internal calibrator signal, never the B VIDEO INPUT signal.

Calibrator Input

With the front panel CAL switch pressed, the A and B inputs are switched off for lack of ground at the anodes of their switching diodes. CR1321 is forward-biased by the ground at its anode through the CAL switch. Q1227 is saturated, providing a signal path for the internal calibrator signal.

The amplitude of the internal calibrator signal is determined by the current through R1307, which is in turn determined by the voltage at pin 6 of voltage follower U1223. The voltage at U1223 pin 6 is controlled by three switches: the first is the front panel BACK PORCH/SYNC TIP switch: the second is S9955 (located just below the crt), the third is the INT-EXT SCALE ILLUM control.

With the front panel SYNC TIP button pushed, the internal calibration amplitude provides 1 volt peak-to-peak equivalent display height. With the front panel BACK PORCH button pushed, the internal calibrator amplitude is determined by S9955. S9955 has two positions: the first is for 625/50 PAL and 525/60 PAL-M systems and provides 700 mV peak-to-peak equivalent display height; the second position is for 525/60 NTSC systems and provides 714 mV peak-to-peak equivalent display height. The switch positions are set by the external graticule. A push-pull switch on the SCALE ILLUM control permits overriding the graticule switch when an internal graticule for 625/50 PAL or 525/60 PAL-M is used with an external graticule for 525/60 NTSC (or vice-versa) or a dual standard instrument. The BACK PORCH and SYNC TIP switches and S9955 pick levels off a precision resistive divider (R1827-R1921-R1914-R1915-R1913 shown on Diagram 15) to drive the + input of U1223.

The internal calibrator is gated by a square wave of four lines duration from U4640B on Diagram 7 through CR1301 to the emitter of Q1303. When the calibrator-gating signal goes positive, CR1323 is reverse-biased, allowing the internal calibrator signal to drive the − Amplifier through CR1325 and Q1227. When the calibrator-gating signal goes negative, CR1325 is reverse-biased while CR1323 is forward-biased and shunts the internal calibrator signal away.

+ Amplifier

Q1141, Q1142, and Q1241 form an inverting, trans-resistance operational amplifier. The output of the stage is instantaneous input current times feed-back resistor R1251. The + Amplifier output drives the positive input of the Differential Amplifier on Diagram 2.

A second output from the + Amplifier is through Q1542 to the Sync Stripper circuit on Diagram 5.

− Amplifier

Q1137, Q1136, and Q1242 form the inverting, trans-resistance operational amplifier that drives the − input of the Differential Amplifier on Diagram 2. Rf is R1235 in series with R1233, a variable resistor used to match the gain of the − Amplifier with that of the + Amplifier. R1125 provides balanced input current to both amplifiers. C1240 and C1244 match the mid- and high-frequency gain of the + and − Amplifiers to achieve good common mode rejection in the Differential Amplifier on Diagram 2.

+10 V Supply

Q1037 supplies the +10 volts required by the ac-dc coupling switches.

DIAGRAM 2
FILTERS & AUX VIDEO OUTPUT

Circuits on this diagram amplify the input signal, filter it according to front panel commands, and route it to the Gain Cell on Diagram 3. Circuits here also provide unfiltered rear panel outputs (PIX MONITOR OUT and AUX VIDEO OUT).

Differential Amplifier

Q1340 and Q1236 form the Differential Amplifier, with Q1431 providing constant current for the amplifier as controlled by voltage set by Q1435. The base of Q1340 is the + input, receiving the signal from the + Amplifier on Diagram 1. The base of Q1236 is the − input, receiving the signal from the − Amplifier on Diagram 1.

Amplifier gain control is accomplished between the emitters, with R1348 used to set unity gain to AUX VIDEO OUT. Thermistor TR1335 compensates for gain changes caused by heat, while network R1342-C1443 compensates the amplifier gain at mid-frequencies.

In the A or B positions of the INPUT switch, only the + input (the base of Q1340) is driven. The − input (the base of Q1236) is held at a constant level by the output of the − Amplifier on Diagram 1. The signal at the base of Q1340 is inverted from the signal at the input of the + Amplifier on Diagram 1.

The output of Q1340 drives seven-transistor array U1347 in the Filter Switching circuit, while Q1236 drives the input to a transresistance amplifier in the Video Out circuit.

If the front panel INPUT switch is in A-B, the output of the Differential Amplifier is the instantaneous difference between the two input signals. If the input signals are identical, the crt display will be a straight line.

Filter Switching

U1347, a seven-transistor array, is the active device in the Filter Switch. All the transistor emitters in the device receive the signal from the positive side of the Differential Amplifier simultaneously.

Each of the transistor bases in U1347 is connected to −10 V (at the emitter of Q1435 in the Differential Amplifier bias network) through one end of a resistor divider. The other side of the resistor divider may be grounded by one or the other front panel RESPONSE switch positions. When the divider circuit is completed by the RESPONSE switch ground, that transistor is turned on, passing the signal at the emitter to the filter.

U1347C is used as a filter-off switch, and is turned on when P1696-2 is grounded. This ensures that none of the filters pass any signal when the front panel RESPONSE switch is in the AUX VIDEO IN position.

It should be noted at this point, that in the LOW PASS position of the RESPONSE switch, the operation of DC Restorer Timing circuit on Diagram 7 is altered. The DC Restorer Timing pulse is delayed in time to compensate for the longer propagation delay of the LOW PASS filter, and SYNC TIP restoration is inhibited.

In the DIFF'D STEPS position of the RESPONSE switch, Q1465 on Diagram 3 saturates and inhibits dc restoration.

Either CR1351, CR1355, or CR1364 is forward-biased when one of the ac-coupled filters is in use. This controls the DC Coupled Filter Current Balance circuit on Diagram 3.

Filters

Seven filters are available in the 1480-Series Monitors, but not all models contain all filters. Single-standard models for 625/50 PAL and 525/60 PAL-M contain the LUM (Luminance) filter, but not the IRE filter. The single-standard 525/60 NTSC model contains the IRE filter, but not the LUM filter. The dual-standard 525/60 NTSC—625/50 PAL model contains the LUM, but not the IRE filter. Single-standard 525/60 NTSC and 525/60 PAL-M models or the dual-standard model for 525/60 systems do not contain the 4.43 MHz BANDPASS filter, while the single-standard 625/50 PAL model does not contain the 3.58 MHz BANDPASS filter.

A nine-slot programming plug-jumper has been added to the 8-Row Front-Panel Interconnect board A8. The purpose of the programming plug-jumper is to provide common wiring of the 8-Row board in all models of the 1480-Series, even though RESPONSE switch positions are different for different models.

The single-standard models (1480, 1481, 1482) have only one BANDPASS filter. In these instruments, an extra FLAT position on the RESPONSE switch has been provided.

The dual-standard model (1485) has both a 3.58 MHz and a 4.43 MHz BANDPASS filter and does not have an extra FLAT position.

The changes are accomplished by substitution of one nine-pin jumper for another (see schematics) at the factory. Each of the three nine-pin jumpers is correct for a particular model and should not be altered.

DIFF'D STEPS. U1347F drives the DIFF'D STEPS filter. The staircase risers charge C1181 through L1082-R1075 during lead edge time. Then, during the flat portion of the step, C1181 discharges through L1094. C1181 charges to the amplitude of each riser, then discharges back to the starting level. The top of each riser becomes the peak of a differential pulse.

If all the risers are identical in amplitude, the differentiated pulses are identical in amplitude and differences are easily measured.

C1171, L1077, and R1076 pass chrominance to ground.

4.43 BANDPASS. The bandpass of this filter is about 800 kHz, centered at 4.43 MHz. L1191 is adjusted for amplitude, while L1172 and C1182 are adjusted for envelope shape and zero insertion loss, respectively.

3.58 BANDPASS. The bandpass of this filter is about 700 kHz, centered around 3.58 MHz. L1083 is adjusted for amplitude while L1074 and C1080 are adjusted for envelope shape and zero insertion loss, respectively.

FLAT. This position of the RESPONSE switch passes the signal, unfiltered, through U1347B to the Clamped Amplifier on Diagram 3.

IRE. This Pi filter has a rolloff curve conforming to IRE 1958 Standard 23S-1. At 3.6 MHz, the chrominance portion of a signal is attenuated about 20 dB. At 4.43 MHz, chrominance is attenuated 22 dB or more.

LOW PASS. This filter is designed to pass only the luminance portion of the signal; everything above 500 kHz is attenuated 14 dB or greater.

LUM. This filter is designed to pass lower frequencies and attenuate higher ones. Attenuation is less than 3 dB at 1 MHz and greater than 40 dB at 4.43 MHz.

Video Out

This circuit provides drive to the rear panel AUX VIDEO OUT and PIX MONITOR OUT connectors.

The collector of Q1236 (output of the negative side of the Differential Amplifier) drives the emitter of Q1421, the input of an inverting, transresistance, operational amplifier. The gain of the stage is the instantaneous input current times R1422, and R1517, (compensated at high frequencies by peaking network R1523-C1519). CR1413 corrects for some non-linear distortions.

The signal at the emitter of Q1529 is 2 volts peak-to-peak for a 1 volt peak-to-peak input.

At the PIX MONITOR OUT output, Q1402 inserts the Line Strobe (from the Line Selector circuit on Diagram 8), on the selected line or lines when in Line Selector modes.

The Video Out amplifier is compensated at high frequencies by R1432 and the Video Out H.F. Response control C1437, and at mid-frequencies by C1519, R1523, and the Video Out M.F. Response control R1525. (Below SN B020960, R1525 is omitted.)

DIAGRAM 3
DC RESTORATION AND GAIN CONTROL

This diagram can be divided into two major parts: the signal input, including the Clamped Amplifier, the DC Restorer, the Aux Video In Switch, and the DC Coupled Filter Current Balance; and the Gain Control with its associated "vertical magnifier" sources.

The signal input portion of the circuit conditions the signal by dc restoration, current balancing between ac- and dc-coupled filter outputs, and amplifying. The signal is then applied to the Gain Control where VOLTS FULL SCALE switching and DIFF'D STEPS expansion takes place.

Clamped Amplifier

Below SN B010214. Q1472A & B, Q1475, and Q1489 form an inverting, transresistance operational amplifier. The signal output of the amplifier is R1491 + R1587 times the instantaneous input current. C1593 and C1495 compensate the gain at high frequencies. C1567 and L1576 in the Clamped Amplifier output filter are adjusted for flat frequency response at mid- and high-frequencies.

SN B010215 to SN B029999. This circuit is the same in operation, except that the network including L1576 is not used.

SN B030000 and up. This circuit is the same in operation, except that Q1470 replaces Q1472B. The network including L1576 is not used.

DC Restorer

U1890 is an operational transconductance amplifier used in the "sample and hold" mode. The Clamped Amplifier output (with chrominance information rejected by L1697 and C1688) is applied to U1890 pin 3. U1890 pin 2 is referenced to ground. During sync tip or back porch time, depending on front panel commands, the amplifier bias input on pin 5 is enabled by a pulse from the collector of Q1891. The level at pin 3 is transferred through pin 6 to memory capacitor, C1888.

In the FAST DC RESTORER mode, the level on the memory capacitor is applied through source follower Q1785 to the Clamping Amplifier input.

In the SLOW DC RESTORER mode, Q1793 is turned on by +15 V at P1898-3, inserting C1892 in parallel with memory capacitor C1888 and slowing down the restoration of the amplifier output level following an offset.

When the DC RESTORER OFF button is pushed, ground is removed from P1696-9, saturating Q1483 and referencing the amplifier input to ground through R1477.

When the front panel RESPONSE switch is in the DIFF'D STEPS position, R1557 is grounded through P1696-5, disabling the DC Restorer by saturating Q1465. When the front panel RESPONSE switch is in other positions, R1557 is returned to −15 volts, ensuring that Q1465 is cut off.

Aux Video In Switching

With the front panel RESPONSE switch in the AUX VIDEO IN position, the base of Q1691 is grounded through R1695 at P1696-2. Q1691 is turned on, Q1496 turned off, and Q1396 turned on, passing the signal at the AUX VIDEO IN connector through Q1396 to the input of the Clamped Amplifier.

With the front panel RESPONSE switch in any position other than AUX VIDEO IN, the ground is removed from P1696-2, turning Q1691 and Q1396 off; Q1496 is turned on, grounding the AUX VIDEO IN signal.

The values of R1493 and R1591 are such that AUX VIDEO IN sensitivity is 1.5 dB greater than the A and B VIDEO INPUTS.

DC Coupled Filter Current Balance

When the front panel RESPONSE switch is in one of the dc-coupled filter positions (LOW PASS, IRE or FLAT) Q1452 is turned on by the lack of a positive level from CR1355, CR1351 or CR1364 in the Filter Switching circuit on Diagram 2. Q1452's conduction turns on Q1455, which becomes a current sink for about 5 mA of current that would otherwise offset the vertical deflection system and deflect the display off screen.

Gain Cell (SN B010100 to SN B010214)

The Clamped Amplifier output drives the Gain Cell input, U1671 pin 14. U1671 is like a paraphase amplifier with provisions for external variable gain control. U1671 pin 9 is the in-phase signal output, pin 8 is the inverted-signal output.

The signal passes through three blocks of circuitry inside the device: first, a paraphase amplifier; second, a gain control in which signal current can be limited by external controls, such as Max Gain control R1823, and the front panel GAIN and VOLTS FULL SCALE VAR controls; third, a centering block in which an external control (Vertical Center R1565) balances the output levels.

The selectable current sources provide for VOLTS FULL SCALE switching and DIFF'D STEPS RESPONSE expansion. The current source for 1.0 VOLTS FULL SCALE is Q1875. Q1875 is removed and Q1861 added in 0.5 VOLTS FULL SCALE; in 0.2 VOLTS FULL SCALE, Q1847 is substituted for Q1861.

With the front panel RESPONSE switch in DIFF'D STEPS, Q1775 is turned on. The base of that transistor is at higher voltage than those of Q1875, Q1861, or Q1847 so that the common-emitter connection shuts them off.

The DIFF'D STEPS position provides about five times vertical expansion of the input signal.

The Gain Cell output drives the input to the Vertical Deflection Amplifier on Diagram 4.

Gain Cell (SN B010215 to SN B029999)

For this range of serial numbers, the integrated circuit Gain Cell (U1671) and U1831 are replaced by discrete component circuitry mounted on a separate small circuit board, which is then mounted on the Vertical Amplifier board. Operation of the discrete circuitry is the same as the integrated circuit Gain Cell, except that the Max Var Gain control, R1823 is eliminated.

Gain Control (SN B030000 and up)

The Clamped Amplifier output is applied through R1585 and the front-panel GAIN and VOLTS FULL SCALE VAR controls (see Diagram 15) to the base of Q1670B. Q1670A and B form a paraphase amplifier with selectable gain-determining components in the emitter circuit. The base voltage of Q1670A is set by the front-panel VERTICAL POSITION control.

The selectable current sources in the emitter circuit provide for VOLTS FULL SCALE switching and DIFF'D STEPS expansion. The current source for 1.0 VOLTS FULL SCALE is Q1875. For 0.5 VOLTS FULL SCALE, Q1875 is removed and Q1861 added. R1864 and C1862, 0.5 V.F.S. Response control, compensate the amplifier at high frequencies. For 0.2 VOLTS FULL SCALE, Q1847 is substituted for Q1861. R1851 and C1854, the 0.2 V.F.S. Response control, compensate the amplifier at high frequencies.

When the front-panel RESPONSE switch is in the DIFF'D STEPS position, Q1775 is turned on. The common emitter connection between Q1775 and the VOLTS FULL SCALE current sources holds Q1875, Q1861, and Q1847 off since Q1775's emitter is at the same voltage as the base of whichever of the other three transistors was selected by the VOLTS FULL SCALE switch. DIFF'D STEPS RESPONSE provides about five times vertical expansion of the input signal.

The output of the amplifier drives through a series-parallel peaking network, compensated by C1666 Vert H.F. Reponse, to the input of the Vertical Deflection Amplifier on Diagram 4. R1666, Vert Centering, balances the output levels.

DIAGRAM 4
VERTICAL DEFLECTION

The Vertical Deflection circuit can be divided into three separate parts: the Deflection Input Amplifier (Q1654-Q1754); the Limiter (Q1637, Q1737, and Q1747); and the Deflection Amplifier (Q1617, Q1621, Q1732, and Q1723). Above SN B020960, Q1737A and B are replaced by Q1737 and Q1637.

The Deflection Input Amplifier receives the current signal from the Gain Cell, changes it to a voltage signal, and drives the Limiter. The Limiter amplifies the signal, limits its voltage excursion in both directions to eliminate offscreen recovery problems, and drives the Deflection Amplifier. The Deflection Amplifier amplifies the signal and drives the crt deflection plates.

Deflection Input Amplifier

Q1754 receives the signal from U1671 pin 9 (+ output), while Q1654 receives its input from U1671 pin 8 (− output). The Deflection Input Amplifier is a push-pull type amplifier with collector-to-base feedback for stability.

The collectors of Q1754 and Q1654 drive the bases of Q1737 A and B.

Limiter

The Limiter amplifier is a push-pull amplifier with a constant current source (1747) in the emitter circuit. The collector loads are formed of diode-resistor networks. Voltage excursion on the collectors is limited to about two volts peak-to-peak.

The upper voltage limit to either side of the amplifier occurs when the drive on the opposite side of the amplifier demands all the available emitter current. At that time, the diode bias resistor (for example, R1739 on the + side) satisfies the diodes' demand for current and the collector sits at about +12.5 volts.

The lower voltage limit occurs when the drive signal changes and the transistor formerly demanding no emitter current now demands all of it. At that time, the collector level is about 12.5 volts minus the drop across the collector load (for example, R1735 on the + side).

The collectors of the Limiter drive the input of the push-pull cascade Deflection Amplifier.

Deflection Amplifier

The bases of Q1621 and Q1732 are driven simultaneously with opposite polarity signals. The gain of each side of R_L, divided by one-half R_E, or 24.

The outputs are applied to the crt deflection plates through parallel LR networks LR1703 and LR1603 that compensate for deflection plate capacitance.

L1707 and L1605 compensate the gain of the stage at high frequencies.

DIAGRAM 5
INT/EXT SYNC SWITCHING

Circuits on this diagram select external sync signals from the EXTERNAL SYNC inputs, or internal sync picked off in the vertical system.

The EXTERNAL SYNC reference can be selected by a rear-panel switch to follow the front-panel INPUT switch. With the INPUT switch in A, the signal applied to EXTERNAL SYNC A is used; with the INPUT switch in B, the signal applied to EXTERNAL SYNC B is used. The rear-panel sync mode switch can also be set to the EXT SYNC ALWAYS (A) position, in which case the signal applied to EXTERNAL SYNC A is always used.

Another circuit on this diagram strips composite sync from incoming video, and in the case of models operating on a PAL system, a circuit generates a burst gate.

A Sync Input

The signal from the EXTERNAL SYNC A loop-through connector is applied through series-RC network R3411-C3411 to the emitter of Q3311. The high-impedance, bridging inputs can be isolated from the chassis, so that the cable shield connects to Q3311's base. Any hum present on the base of Q3311 is in phase with hum in the signal at the emitter of Q3311 and is rejected differentially. The EXTERNAL SYNC A signal passes through Q3311 to the Sync Switching circuit. The emitter of Q3311 is connected to the collector of Q3310, which supplies 1 mA of constant current.

B Sync Input

The B Sync Input circuit is identical to the A Sync input. Q3320 supplies the constant current, and Q3321 is the signal path to the Sync Switching circuit.

Internal Sync Input

The emitter of Q3441 receives the signal picked off at the − Amplifier on Diagram 1. The coaxial cable shield is connected to Q3441's base for differential rejection of hum. The collector of Q3441 applies the incoming signal to the Sync Switching circuit.

On all models except the 525/60 NTSC single-standard model, the signal picked off at the + Amplifier on Diagram 1 is also applied to Q3440, the input to the Burst Gate Generator.

Sync Switching

The signal ultimately applied to the Sync Stripper circuit can be derived in several different modes. First, internally—the input video from A or B VIDEO INPUT, whichever is selected by the front-panel INPUT switch, is picked off at the output of the − Amplifier on Diagram 1 and routed through Q3441 and CR3333 to the emitter of Q3330. CR3333 is forward-biased by switching current that has passed through CR3430. CR3430 is reverse-biased by CR3330, which is forward-biased by the ground at P3200-4 when the front-panel INT SYNC button is pressed.

Second, externally — EXT SYNC ALWAYS (A) is used. When the front-panel EXT SYNC button is pressed, P3200-3 is grounded. CR3200 at the A Sync Input and CR3319 at the B Sync Input are forward-biased, in turn reverse-biasing CR3300 for A and CR3320 for B.

P3200-1 is grounded when the rear-panel External Sync Mode Switch is in the EXT SYNC ALWAYS (A) position, forward-biasing CR3310. CR3311 is, in turn, reverse-biased. Now, collector current in Q3311, which has been shunted away by the diode switch, is routed through CR3331 to the emitter of Q3330, the input of the Chroma Filter.

The B Sync Input cannot supply any signal to Q3330 because, even though half of its current switch (CR3320) is operating. CR3312 is still reverse-biased for lack of ground at its cathode. Collector current in Q3321 is shunted away through CR3321.

The Int Sync Input does not supply signals to Q3330 because of the similar diode switch at the collector of Q3441. CR3330 is reverse-biased for lack of ground at its cathode so Q3441's collector current is shunted away through CR3430.

Third, externally — with the Sync Input circuit switched to follow the front-panel INPUT switch. With the front-panel EXT SYNC switch still closed, the rear-panel External Sync Mode switch in the EXT SYNC SWITCHED WITH INPUT SWITCH (A) OR (B) position, and the front-panel INPUT switch in A, P3200-1, P3200-3, and P3200-5 are grounded. CR3200, CR3310, CR3302, and CR3331 are forward-biased, reverse-biasing CR3300 and CR3400, and routing the A Ext Sync signal to Q3330. CR3321 in the B Ext Sync diode switch and CR3430 in the Int Sync diode switch are forward-biased, shunting B Ext Sync and Int Sync signals away.

With the front-panel INPUT switch in B, P3200-2 is grounded through the rear-panel External Sync Mode switch and the front-panel INPUT switch. P3200-1 and P3200-5 lose ground in this mode. P3200-3 is still grounded by the front-panel EXT SYNC switch. CR3320 and CR3321 are reverse-biased and CR3332 is forward-biased, allowing the Ext Sync B signal to drive Q3330.

With the front-panel INPUT switch in A-B, CR3301 is forward-biased allowing the Ext Sync A signal to drive Q3330. The Ext Sync B signal and Int Sync signal are shunted away.

Chroma Filter

Q3241 is the active component of an active filter with a frequency cut-off around 1 MHz. Frequencies above 1 MHz are attentuated, with 3.58 MHz being down about 20 dB. The emitter of Q3241 drives the input of the Sync Stripper through a series network consisting of R3344-C3252.

Sync Stripper

The signal from the Chroma Filter drives the emitter of Q3251, the input of the Sync Stripper. The Sync Stripper regenerates composite sync from a composite video waveform, even though the signal may be bandwidth degraded or contain white noise.

Q3251 drives the base of Q3250, which inverts and amplifies the signal, and drives summing amplifier Q3260. Q3260 drives emitter follower Q3259 with inverted video (sync positive), Q3259 drives three comparators: Sync Tip, CR3170-Q3162; Sync 50% Level, CR3270-Q3180; and Blanking Level, CR3271-Q3370. During active video time, the diodes in all three comparators are conducting.

Sync Tip. When the positive going pulse at the emitter of Q3259 rises past the level at the base of Q3162, the Sync Tip comparator is activated, clamping the sync tip at that point. Collector current in Q3162 charges Sync Tip Level Memory capacitor C3253. The level on C3253 is applied to emitter-follower Q3160. Q3160 drives summing amplifier Q3260, completing the sync tip clamp feedback loop. Q3260 demands more or less current from R3251, setting the sync tip level at the emitter of Q3261. C3253 rate-limits the Sync Tip Comparator, allowing the loop to open at the trailing edge of sync, making the loop unresponsive to impulse noise, and averaging the white noise on the sync tip to determine true sync tip level.

High frequency and low frequency error components in the input signal are split into two feedback paths. High frequency error components pass through a high-pass filter (R3242 and C3243) to summing amplifier Q3260 and back to the Sync Tip Comparator, allowing the slew-rate of the clamp circuit to eliminate sync tilt without regard to the incoming signal. Low frequency error components, such as mains frequency hum, feed back through low-pass filter, C3240, Q3240, and Q3250 to the summing amplifier. In this manner, mains frequency hum is eliminated outside of the amplifying portion of the circuit. The circuit can lock to a 400 mV composite video signal, simultaneously rejecting a large amount of mains frequency hum.

CR3171 provides some current to the Sync Tip Comparator, during sync time, allowing C3253 to slew negative if the sync tip is not far enough positive to turn CR3170 off.

Sync 50%. The Sync 50% level Comparator switches at the half-amplitude point of the sync pulse at the emitter of Q3259. Collector current in Q3180 saturates Q3171, producing a 5-volt pulse at the collector of Q3171 of the same width and polarity as incoming sync. This regenerated sync pulse drives the Phase-Locked Loop on Diagram 6 and the Clamp Pulse Generator on Diagram 7. The pulse also gates CR3171 on, to provide current to the Sync Tip Comparator during sync time. CR3172 catches the sync output level at +5 volts during non-sync time (when Q3171 is off).

Blanking Level. The Blanking Level Comparator is biased to switch about halfway between the setup level and the blanking level. This comparator provides gain drive for the entire circuit, determined by the length of time it charges C3260.

The charge on C3260 sets the bias at the base of Q3261, the AGC control. Q3261 carries part of the collector current for Q3251—the other part of this current is base current for Q3250.

If the input signal amplitude to the Sync Stripper is low, the Blanking Level Comparator switches at a point closer to black than to blanking. As a result, Q3370 conducts for a longer period of time than it would if the input were correct. The longer period of conduction charges C3260 more positive, decreasing current through Q3261. This forces more base current in Q3250, increasing circuit gain. If the input signal amplitude is high, the opposite condition prevails.

Q3360 and Q3262 hold the AGC loop active at maximum gain during the absence of an input signal.

Burst Gate Generator (525/60 PAL-M and 625/50 PAL only)

The output of the + Amplifier on Diagram 1 is applied to the emitter of Q3440 through series high pass filter, R3441-C3342. The subcarrier-rate signal is routed from the collector of Q3440 to a non-inverting, transresistance amplifier (Q3350-Q3351).

The output of Q3351 is applied through CR3460 to the base of Q3460. The collector of Q3460 drives a diode gate (CR3360 and CR3461) with the subcarrier-rate signal. The diode gate requires two separate actions to enable it: first, Q3361 must be turned off by the trailing edge of regenerated sync from the Sync Stripper; second, the inhibit voltage from the Line Counter on Diagram 8 must be gone. The inhibit voltage is gone only on PAL lines 6 and 319 in 625/50 PAL models, or field 3 line 8 and field 4 line 270 in 525/60 PAL-M models.

At line 6 or 319, at the trailing edge of sync, the diode gate is enabled and the signal from Q3460 turns off a Miller run-up circuit (Q3470). The collector of Q3470 ramps rapidly positive, stays there until the diode gate is again inhibited (approximately 2 μs), and falls to about 0 volt. The pulse generated is used to gate the 2 Field Gate Generator on Diagram 8.

DIAGRAM 6
AFC/DIRECT SWITCHING & PULSE GENERATOR

Circuits on this diagram use composite sync from the Sync Stripper on Diagram 5 to generate positive and negative-going line-rate pulses (designated +H and −H), and negative-going field-rate pulses (designated −V). These signals can be derived either directly from the regenerated compostive sync (DIRECT), or locked to a Phase-Locked Loop (AFC). The Phase-Locked Loop is referenced to the line (H) rate.

The 525/60 NTSC - 625/50 PAL dual-standard model also contains 50 Hz-60 Hz recognition circuits that indicate which standard is being displayed and change timing circuits on Diagram 8 for proper sweep timing and line counting.

+H and −H Pulse Generator

The +H and −H Pulse Generator operate differently in DIRECT than AFC. First, consider circuit operation in AFC, that is, with the Phase-Locked Loop in operation.

AFC. Assume the following conditions: regenerated composite sync is applied to U3070A pin 5. (U3070A is a monostable multivibrator that locks out any half-line rate signals, such as equalizing pulses and vertical serrations). Regenerated composite sync is applied to positive peak detector CR3050, R3050, and C3050. When sync is present, the emitter of Q3150, the Sync Present Detector, is at about +5 volts. This reverse-biases CR3040, the anode of which is grounded by the front-panel AFC switch. The ground at the AFC switch is also applied to U3040D pins 12 and 13, setting pin 11 high. This gates U3040C on for input from the Phase-Locked Loop oscillator. The ground is also applied to U3040A pin 1, which gates off the direct input from U3070 pin 7. The base of Q3230, the AFC Disable, is likewise grounded by the front-panel AFC switch.

Now, turn to the operation of the loop, assuming the preceding conditions have been met.

U3070A pin 7 switches low at the leading edge of the line sync, and stays low for about 48 μs, then pin 7 switches high and waits for the next line sync pulse. The output of U3070A drives Q3139 through C3136.

Q3139 is turned off by the negative-going edge, and stays off for about 2 μs. The time is determined by the charge time of C3136 through R3140. The 2 μs positive-going pulse at the collector of Q3139 is applied to the base of Q3141 as the Phase-Lock Sampling Pulse.

Q3141 is either on or off, depending on the state of comparator Q3151-Q3152. When the loop is locked, Q3152 is off for the first microsecond of the Phase-Lock Sampling Pulse, and on for the second microsecond. During the first half of the Phase-Lock Sampling Pulse, Q3151 provides Q3141 with a current source, discharging C3121 by the same amount as it was previously charged. During the second half of the Phase-Lock Sampling Pulse, the charge path for memory capacitor C3121 is through the collector-to-base junction of Q3141. This junction has been forward-biased by the Phase-Lock Sampling Pulse, the emitter having no current path at this time.

The level on C3121 is applied through voltage follower U3120B to Error Amplifier U3120A. U3120A compares the level applied to pin 2 with the reference at pin 3 and drives the oscillator. U3120A is rate-limited for noise immunity.

Q3020 and Q3120 form a Bowes oscillator that free-runs at about 16.5 kHz. The output frequency from the Bowes oscillator is altered by the error signal from U3120A pin 1 at the rate of about 70 Hz/volt. This oscillator is balanced in that the duty factor is nearly 50%. The time of the positive-going portion of the waveform is determined by R3020 and C3021, the negative-going timing is determined by R3021 and C3021.

The oscillator frequency is changed by altering the apparent Vcc of the transistors. The higher the apparent Vcc, the higher the frequency.

The oscillator output is applied through emitter-follower Q3031, to a differentiator composed of C3131 and the parallel resistance of R3032 and R3136. From the differentiator, the negative-going pulse (the negative-going edge of the oscillator output waveform) is applied to U3040C pin 9.

U3040C gates the differentiated oscillator output through to U3040B, if the SYNC AFC switch is closed. U3040B pin 4 is high already, because of the ground at U3040A pin 2, so the positive-going pulse at U3040B pin 5 is gated through and inverted to enable U3070B.

U3070B is a one-shot multivibrator with an output time of about 2 μs. The pulse at U3070B pin 10 is positive-going, and is designated "+H", while that at pin 9 is negative-going and is designated "−H". Both these pulses are used in the Sweep Generator (described later).

The +H pulse also drives the base of Q3140, which is normally on. The trailing edge of the +H pulse turns Q3140 off, and keeps it off until the base voltage ramps far enough positive to allow it to turn back on (the time constant is set by C3053, R3053 and R3040). The output of Q3140 switches current switch Q3152-Q3151 at the trailing edge of the +H pulse.

When the current switch changes states, Q3151 becomes a current source for Q3141 and charges C3121 during the first half of the Phase-Lock Sampling Pulse.

If the Bowes oscillator is operating at too low a frequency, Q3151 supplies discharging current during more than one-half of the Phase-Lock Sampling Pulse, and C3121 winds up with a net negative charge. A less-

positive voltage at U3120B pin 5 means a more-positive voltage at U3120A pin 1. A more-positive voltage at U3120A pin 1 causes an increase in the frequency of the Bowes oscillator.

If the Bowes oscillator is operating at too high a frequency, the whole situation is reversed and the apparent Vcc at the collectors of Q3020 and Q3120 is decreased, lowering the oscillator frequency.

DIRECT. In the DIRECT SYNC mode, P3040-2 is no longer grounded. The lack of ground allows R3033 to pull up on the base of Q3230, which disables the AFC Loop (U3040A pin 2). This gates the output of U3070A to the H Generator through U3040B and through U3040D pins 12 and 13 to gate out the Bowes oscillator signal in U3040C.

Field Sync Generator

U3190 is the Field Sync Generator. A negative-going, field-rate sync pulse (designated −V) about 30 μs in period, is generated by U3190 upon receipt of two commands: first, the −H pulse from U3070B pin 9; second, a negative-going reset pulse derived in the Vertical Integrator and Peak Detector circuit.

Q3290, the Vertical Integrator, is normally on. The relatively fast line-sync pulses cannot do much to bring Q3290 out of saturation. The broad field-sync pulses, however, can turn Q3290 off. Each field serration pulse removes some of the charge caused by the field-sync pulses on C3184, but the collector of Q3290 ramps up, step-by-step toward ground.

The ramp at the collector of Q3290 is peak-detected by CR3281, C3281, and R3281, following the last field serration pulse. At this time, Q3280 is turned on to saturation. But, the ramp at the collector of Q3290 immediately falls back toward −15 V and Q3280 turns off. The output of Q3280 is a 5 V, negative-going, 30 μs pulse. At the collector of Q3390 is a positive-going 30 μs pulse. This pulse is inverted again in Q3291 and applied to the reset input of the Field Sync Generator, U3190.

The Field Sync Generator free-runs in the absence of field sync pulses at approximately (but not exact) field time. U3190 is triggered by −H pulses produced by free-running Bowes oscillator driving U3070B. The Bowes oscillator pulses are gated through U3040C because the emitter of the Sync Present Detector, Q3150, is low, setting U3040D pin 11 high. When there is no incoming sync, the Field Sync Generator is locked to the +H pulse. The +H and −H Pulse Generator always free-runs, in no sync conditions, regardless of the AFC/Direct Switch state.

50 Hz/60 Hz Recognition (525/60 NTSC and 625/50 PAL Dual-Standard Models Only)

The output of Q3390 resets integrator U3380 to 0 volts. After the reset pulse is past, U3380B produces a positive-going ramp at pin 7. The ramp amplitude is determined by the time between reset pulses. For 60 Hz systems, the ramp amplitude is about +10 volts. For 50 Hz systems, it is about +12 volts.

The ramp is peak-detected by CR3480, C3470 and R3482. The detected level is compared to a reference voltage in U3380A. The reference level is +11 volts, set by R3374 and R3380. The output of U3380A is applied to three places: first to the Field Sweep Generator on Diagram 9, to change the sweep length as necessary; second, to the Line Counter on Diagram 8, to change the line count; third to the 50 Hz/60 Hz indicator drivers, Q3081 and Q3082.

If the input signal field rate is 50 Hz, U3380A pin 1 is positive, turning on Q3081. If the input signal field rate is 60 Hz, U3380A pin 1 is negative, turning on Q3082. If there is no incoming signal, the emitter of Sync Present Detector, Q3150 is low, forward-biasing CR3082 and disabling the 50 Hz/60 Hz indicators.

DIAGRAM 7
DC RESTORER TIMING

The two circuits on this diagram develop timing signals for the vertical system to time the DC Restorer clamp pulse, and to trigger the internal calibrator circuit.

DC Restorer Timing Logic

The DC Restorer Timing Logic circuit generates a 0.8 μs, 500 mV pulse that gates the DC Restorer Sampler on Diagram 3. The gate-pulse can be timed for either of three positions on the video line by front-panel command.

Negative-going composite sync, from the Sync Stripper on Diagram 5, is inverted in U4280D and applied to U4280C pin 10. U4280C pin 9 receives the +H pulse, which was generated in circuits shown on Diagram 6. When the two inputs to U4280C coincide, the output on pin 8 steps low, triggering monostable multivibrator U4080A.

The output pulse width from U4080A is selectable from the front panel. In any RESPONSE switch position except LOSS PASS, Q4070 is saturated, setting +5 Vcc at the junction of R4172 and R4171. With the DC RESTORER in BACK PORCH mode, the pulse width is a function of

R4171, R4173, and C4170. The actual pulse width is about 6 μs, with the leading edge nearly coincident with the leading edge of line sync.

If the front panel RESPONSE switch is set to LOW PASS, Q4070 is turned off by divider R4190 and R4191 (between ground and +15 V). At the same time, CR4170 is forward-biased turning off Q4090, if it was on. U4080A's output pulse width is now about 8 μs, being a function of R4172, R4171, R4173, and C4170. Its leading edge is still nearly coincident with the leading edge of line sync. The output of U4080A is made wider in the LOW PASS position of the RESPONSE switch because the trailing edge of this pulse triggers the gate-pulse generator. The gate pulse needs to be later in time because of the low rise and fall of the LOW PASS filter creating the need to move the clamp pulse.

SYNC TIP restoration is disabled in LOW PASS because dc restoration takes place even during equalizing pulses. The LOW PASS filter is so slow that the equalizing pulses have no tip left.

The trailing edge of whichever pulse has been selected triggers the second monostable multivibrator, U4080B. The output at U4080B pin 10 is the gate-pulse for the DC Restorer Sampler on Diagram 3 and is about 0.8 μs in width (a function of R4270 and C4190).

The position of the gate-pulse is dependent on the width of the pulse from U4080A, as stated before, so in the SYNC TIP mode, the gate-pulse begins about 1 μs after the leading edge of line sync. In the BACK PORCH mode, the gate pulse begins about 1.5 μs after the trailing edge of line sync. In LOW PASS, the gate pulse begins about 3.5 μs after the trailing edge of line sync, and SYNC TIP restoration is disabled.

Composite sync is routed through CR4390 to lock out the gate pulse during the broad vertical pulses, when using BACK PORCH restoration. When SYNC TIP restoration is in use, CR4190 is forward-biased by the conduction of Q4090 and the gate pulse is never locked out.

The gate pulse is routed through P4390-6 to the DC Restorer Sampler, Q1891, on Diagram 3.

Calibrator Timing Logic

The Calibrator Timing Logic circuit generates a square wave of one-fourth line rate that is counted down from line rate by two D-type flip-flops (U4640A on Diagram 9 and U4640B). The incoming clock pulse is twice the line period from U4640A on Diagram 9.

An output can occur only when the front-panel CAL button is pressed. At all other times, U4640B pin 10 is grounded, inhibiting U4640B.

DIAGRAM 8
LINE COUNTER & 2 FIELD SWEEP GENERATOR

Circuits on this diagram include an Odd/Even Field Recognition circuit that recognizes the proper field according to front-panel command, a 2 Field Gate Generator that initiates a sweep at the start of the selected field and the 2 Field Sweep Generator.

Odd/Even Field Recognition (525/60 NTSC)

U4850D is a coincidence gate that sets the clear input of U4860A low on line 7 of even fields. U4850D is driven by the +H pulse generated in the +H and −H Pulse Generator on Diagram 6 and a pulse designated +V. The +V pulse is generated in U4850C, which inverts the −V pulse generated in the Field Sync Generator on Diagram 6.

U4860A is clocked by the +V pulse, so on even fields, with the clear input low, the output (pin 6) goes high and remains high for the rest of the field. On odd fields, U4850D does not sense coincidence of +V and +H, so the output of U4860A is low for odd fields.

The output of U4860A is applied to pin 1 of U4770A, an exlusive-or gate. U4770A pin 2 is a sensor input, the state of which determines output polarity. U4770A pin 2 is low so that U4770A does not invert its input signal.

The high-during-even fields signal from U4770A is applied to the next exlusive-or gate, U4780D pin 13. U4780D pin 12 is high when the front-panel EVEN FIELD buttons are pressed. The output of U4780D is low during even fields, since the output of an exclusive-or gate can only be high when the inputs are complementary.

The low output from U4780D is applied to pin 9 of U4880B, a three-input NAND gate. The low at U4880B pin 8 causes a high to be applied to the clear inputs of the Line Counter. The high clear level is maintained until such time as the −V pulse resets the counter.

Two other conditions can occur that require the clear inputs of the Line Counter to be high. First, when the front-panel ALL FIELDS ON button is pressed, U4880B pin 11 is grounded, keeping the Line Counter clear inputs high at all times. This allows the Line Counter to run during the field interval of every field without regard to the state of the

Even/Odd Recognition circuit. In this case, however, Q4860 is saturated by the leading edge of the +V pulse, providing a negative-going pulse to the Line Counter clear inputs to keep the count correct. Second, with an RGB input. U4880B pin 10 is grounded, allowing the Line Counter to operate in every field interval.

Line Counter (525/60 NTSC)

The clear inputs to the five line Counter flip-flops go high at line 6 of the selected field. The next +H pulse that arrives at U4670A pin 3 starts the count. Fig. 4-1 shows a simplified diagram of Line Counter Operation.

NOTE

In 525/60 NTSC models, or in dual-standard models operating in the 525/60 NTSC mode, U4770B inverts the output of U4670A. U4770C does not invert the output of U4580A. These two exclusive-or gates are reprogrammed when the Line Counter is counting in different television standards, such as 625/50 PAL.

The output from each selection of the Line Counter and the preset gate are applied to the Line Selector circuit on Diagram 9.

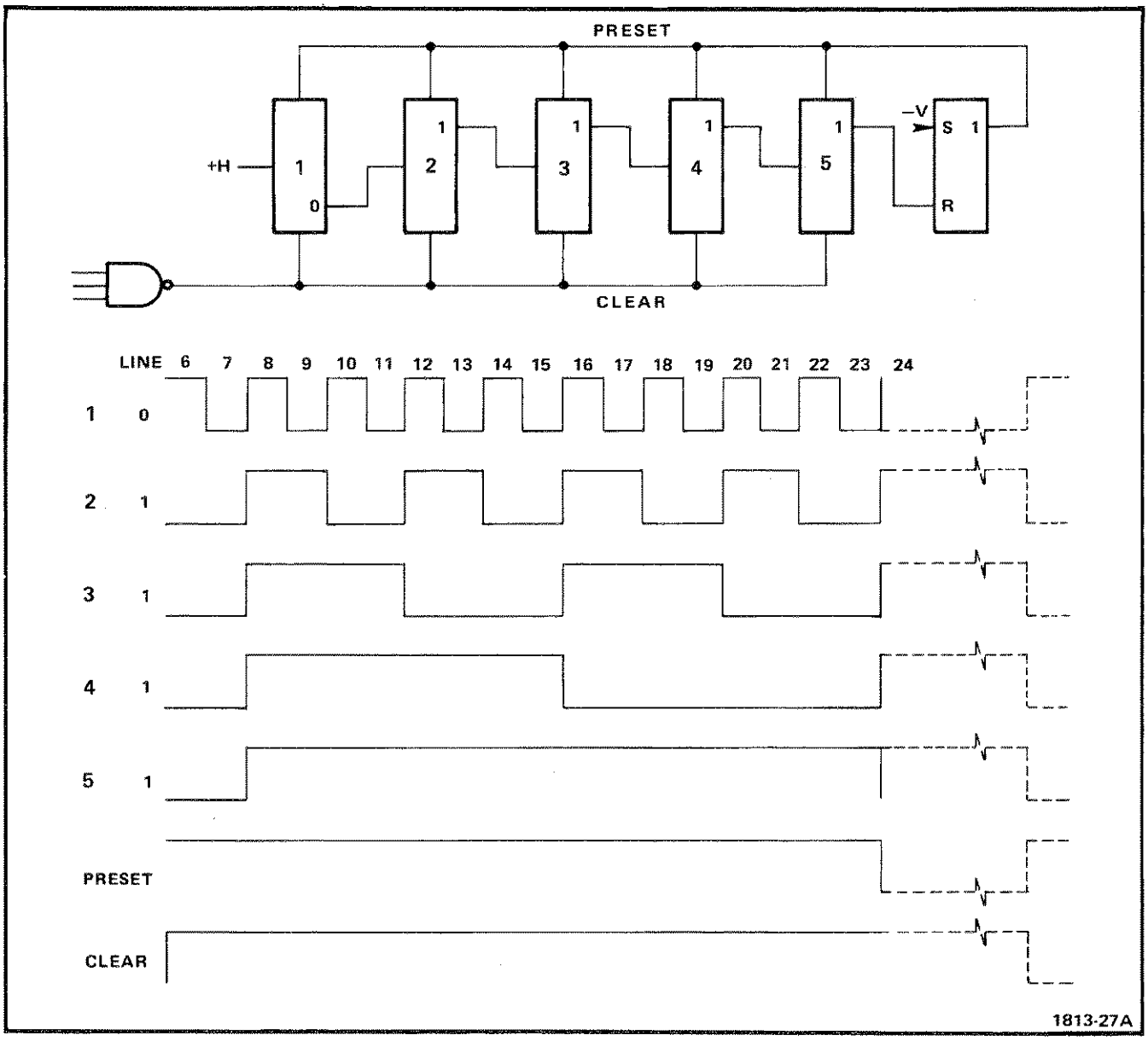


Fig. 4-1. 525/60 NTSC line counter operation.

Outputs from U4570B, U4570A, and the preset gate are "and-ed" in U4880A and applied as the line-8-to-line-16 lockout pulse to the 2 Field Sweep Gate, U4850B.

2 Field Gate Generator (525/60 NTSC)

Back in the description of the Odd/Even Recognition circuit, an exclusive-or gate, U4780D, switched polarity on command from the front-panel FIELD switches and determined the field on which the counter would operate. Three outputs from the counter were listed: the logic 1 outputs from U4570B and U4570A and the preset gate from U4460C are applied to the three inputs of NAND gate, U4880A.

The output from U4880A is low from line 8 to line 16 of the field selected at the front panel, and is applied to U4850B pin 4. In 525/60 NTSC models, or in dual-standard models operating in the 525/60 NTSC mode, U4850B pin 5 is always high, so output pin 6 is high from line 8 to line 16 of alternate fields, as selected at the front-panel.

U4850B drives U4930C pin 8. Except for models equipped with Option 4 (VTR Sync), U4930C pin 9 is always high. The output of U4930C, then is identical in width and polarity to the output of U4880A and drives the 2 Field Sweep Generator, U4810.

2 Field Sweep Generator (525/60 NTSC)

U4810 is a Tektronix-manufactured, integrated-circuit sweep generator. The sweep is reset to 0 volt when pin 1 is low, and is allowed to run when pin 1 is high. C4801 is the timing capacitor. In 525/60 NTSC models and in dual-standard models operating in the 525/60 NTSC mode, C4801 gets timing current through R4820 in parallel with the series combination of R4713 and R4722.

Q4710 is turned on by the leading edge of the delayed gate from U4810 pin 4. The delayed gate is enabled by a high at pin 5, which occurs at all times except when the LINE SELECTOR DIG button is pressed.

U4810 pin 6 is the offset input. Voltage changes at this point move the delayed gate in time with respect to the ramp. The output of Q4710 is applied as a set input to Line Selector RS flip-flop U4560 on Diagram 9.

The 2 Field Sweep Generator output is applied to a switching network on Diagram 10.

Odd/Even Field Recognition (625/50 PAL)

U4850D is a coincidence gate recognizing coincidence in time between the +H pulse generated in the +H and −H Pulse Generator on Diagram 6, and a pulse designated +V. The +V pulse is generated by U4850C, which inverts the −V pulse generated in the Field Sync Generator on Diagram 6. The output of U4850D sets the clear input of U4860A low on fields where coincidence of +V and +H occurs.

In 625/50 PAL, coincidence of +H and +V takes place in the odd fields (2 & 4) rather than in the even fields. The clear input of U4860A is set low at line 3 of odd fields.

U4860A is clocked by the +V pulse, so on odd fields, with the clear input low, the output (pin 6) goes high and remains high for the rest of the field. On even fields, U4850D does not sense coincidence of +H and +V, so U4860A pin 6 is low in even fields.

The output of U4860A is applied to pin 1 of U4770A, an exclusive-or gate. U4770A pin 2 is a sensor input, the state of which determines output polarity. In 625/50 PAL models, or in dual-standard models operating in the 625/50 PAL mode, U4770A pin 2 is high so that U4770A inverts its input signal.

The low at U4770A pin 3 is applied to pin 13 of U4780D, another exclusive OR gate. Its sensor input, pin 12, is low when the front-panel EVEN FIELD buttons are pressed. The output, U4780D pin 11, is low during even fields when front-panel EVEN FIELD buttons are pressed.

The low at U4780D pin 11 is applied to U4880B, pin 9, one input of a three input NAND gate. The low at pin 9 causes a high at the output, pin 8 which is applied to the clear inputs of the Line Counter. The high clear on the Line Counter is maintained until such time as the −V pulse resets the counter. A high at the clear inputs of the Line Counter allows the counter to operate.

Two other conditions can occur requiring the clear inputs of the Line Counter to be high. First, when the front-panel ALL FIELDS ON button is pressed (SN B020960 and up, FIELD 3 and 2 buttons are pressed,) U4880B pin 11 is grounded, keeping the Line Counter clear inputs high at all times. This allows the Line Counter to run during every field interval without regard to the state of the Odd/Even Recognition circuit. In this case, however, Q4860 is saturated by the leading edge of the +V pulse, providing a negative-going pulse to the Line Counter clear inputs to keep the count correct. Second, with an RGB input, U4880B pin 10 is grounded, allowing the Line Counter to operate in every field interval.

Line Counter (625/50 PAL)

The clear inputs of the five Line Counter flip-flops go high at the time of the last broad field pulse of the selected field. The next +H pulse that arrives at U4670A pin 3 starts the count (line 3/316 in odd fields, line 4 in even fields). Fig. 4-2 shows a simplified diagram of Line Counter operation for odd fields. Fig. 4-3 shows a simplified diagram of Line Counter operation for even fields.

Count changing is accomplished by reversing the polarity of the level on the sensor inputs of U4770B (pin 5), and U4770C (pin 10). U4770C pin 10 is set high in all 625/50 PAL models and in dual-standard models operating in the 625/50 PAL mode. U4770B pin 4 is low on even fields and high on odd fields, as set by U4760D.

2 Field Gate Generator (625/50 PAL)

This circuit gates the 2 Field Sweep Generator on either pair of fields, odd or even, or on individual fields, by front-panel command.

Odd/Even Field Gating. The Odd/Even Field Recognition circuit clears the Line Counter to run on odd or even

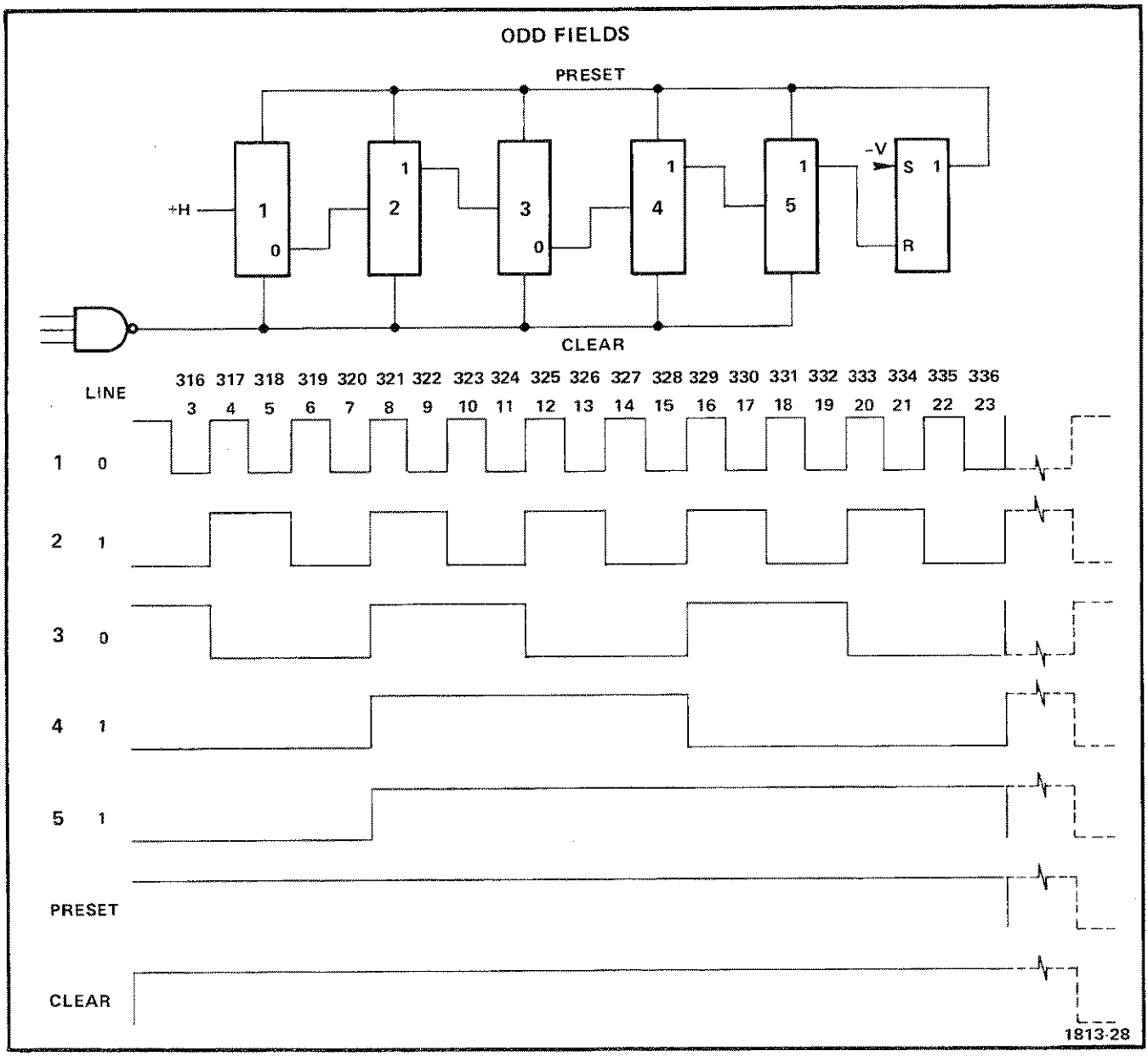


Fig. 4-2. 625/50 PAL line counter operation in odd fields.

fields by front-panel command. U4880A receives high inputs from U4570B pin 9, U4570A pin 5, and the preset gate, beginning at line 8 of the selected odd or even field. The input from U4570B goes low at line 16, ending the gate pulse.

U4880A pin 6 is low from line 8 to line 16, and drives U4850B pin 4. U4850B pin 5 is high any time both EVEN FIELD or both ODD FIELD buttons are pressed, so the sweep gate from U4880A is inverted and applied to U4930C pin 8. Except in models equipped with Option 4, VTR Sync, U4930C pin 9 is always high, so the signal at U4930C pin 10 is the same width and polarity as the signal at U4880A pin 6. This signal gates on the 2 Field Sweep Generator, which runs until the next gate occurs.

Individual Field Gating. Line 6 of field 3 and line 319 of field 2 are identified by the five-diode "and" gate formed by CR4690, CR4691, CR4592, CR4590, and CR4591. When all five are reverse-biased, a negative-going enable pulse is sent to the Burst Gate Generator circuit on Diagram 5. If burst is present, a positive-going pulse comes back from the Burst Gate Generator circuit on Diagram 5.

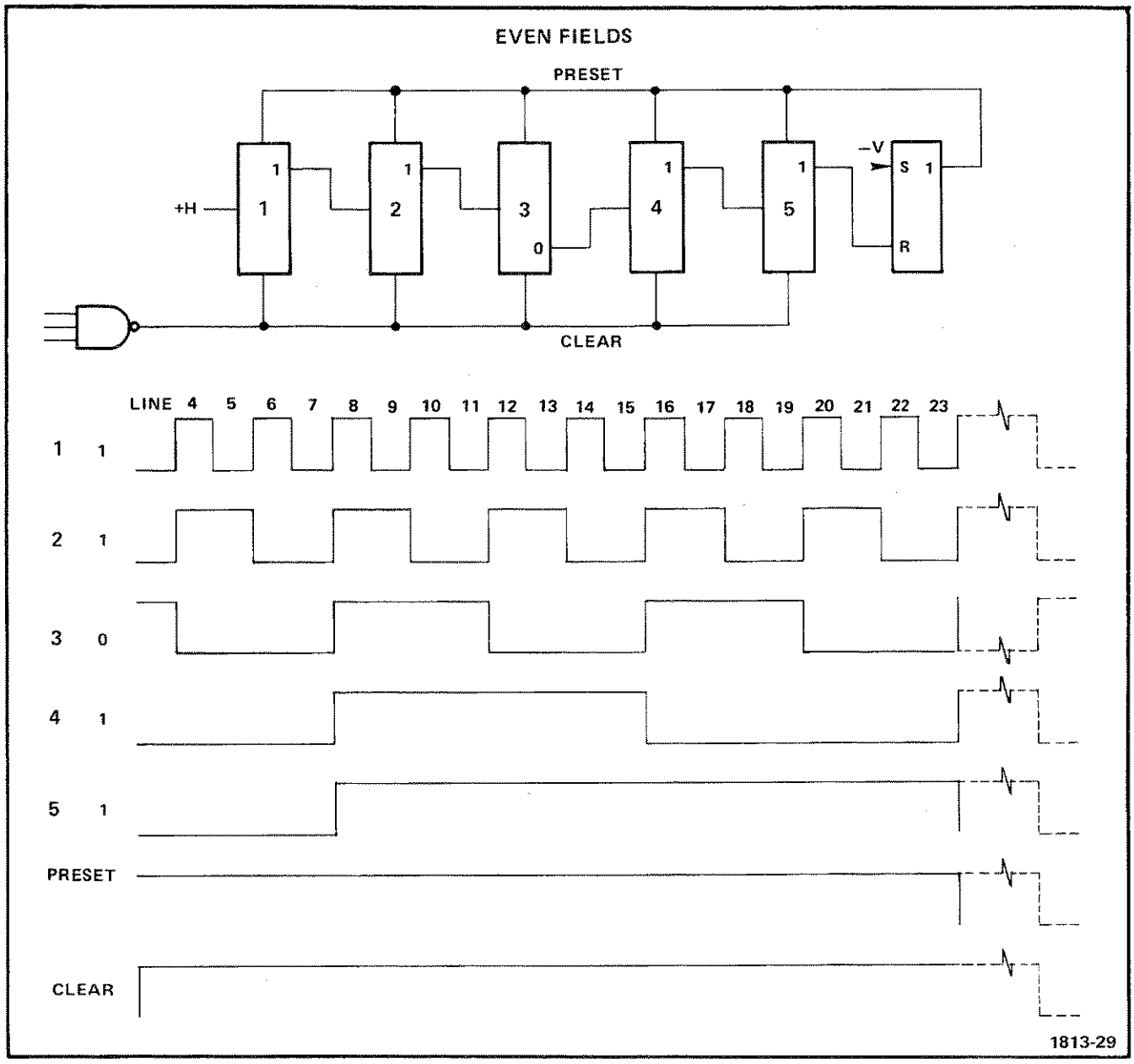


Fig. 4-3. 625/50 PAL line counter operation in even fields.

U4850A inverts the burst gate and sets the clear input of U4860B low at line 6 of field 3 and line 319 of field 2.

U4760A pin 2 receives the negative-going line-8-to-line-16 pulse from U4880A. U4760A pin 3 is high except in the 10 μs/DIV and 5 μs/DIV positions of the DISPLAY switch, so the signal at pin 2 is inverted and applied to U4860B pin 11 as the clock pulse.

U4880C pin 1 is low when both EVEN or both ODD FIELD buttons are pressed. When gating on individual fields, however, U4880C pin 1 is always high so that the gate is only inhibited by the state of pin 2. U4880C pin 2 is driven by U4770D, an exclusive-or gate.

U4770D pin 12 is the sensor input. In field 1 or in field 4, pin 12 is low, while in field 2 or field 3, pin 12 is high. Remember that the output of an exclusive-or gate can be high only with one input high when the other is low.

In field 1, the clear inplut of U4860B has been set high when the clock pulse arrives. The output to U4770D pin 13 goes low at the leading edge of the clock pulse. U4770D pin 12 is low in fields 1 and 4, so U4770D pin 11 is also low. This all results in a high at U4850B pin 5, allowing the 2 Field Sweep Generator to be gated on.

In field 2, the clear input of U4860B has been set low when the clock pulse arrives, so pin 9 goes high at the clock. U4770D pin 12 is high in field 2, so U4770D pin 11 is low, ultimately allowing the sweep to be gated on.

2 Field Sweep Generator (625/50 PAL)

U4810 is a Tektronix-manufactured integrated circuit sweep generator. Pin 1 is the gate input, pin 8 is the ramp output. When the gate goes low, the ramp is reset to 0 volt. When the gate is high, the ramp is allowed to run to +10 volts at a rate determined by external timing components. The timing capacitor is C4801, the timing resistor is R4820. The resistor networks in parallel with R4820 are now allowed to supply timing current in 625/50 PAL models or in dual-standard models operating in the 625/50 PAL mode.

U4810 pin 4 is the delayed gate output. The time relationship of the delayed gate to the ramp is determined by the voltage level at pin 6. The voltage level at pin 6 is set by the front-panel LINE SELECTOR VAR control, which can move the delayed gate to any point on the 2 Field ramp.

Odd/Even Recognition (525/60 PAL-M)

U4850D is a coincidence gate that reacts to the time relationship between the +H pulse that was generated in the +H and −H Pulse Generator circuit on Diagram 6, and a pulse, designated +V, that is generated by inverting the −V pulse, also from Diagram 6, in U4850C. The output of U4850D drives the clear input of U4860A (pin 1). The clear pulse (negative-going in even fields) ensures that the output on U4860A pin 6 is high during even fields and low during odd fields.

U4860A pin 6 drives the input of exclusive-or gate U4770A pin 1. U4770A's sensor input, pin 2, is always low in 525/60 PAL-M models or in dual-standard models operating in the 525/60 PAL-M mode, so the high-during-even-fields input at pin 1 is high at the output on U4770A pin 3.

U4770A pin 3 drives another exclusive-or gate, U4780D pin 13. U4780D sensor input, pin 12, is high during even fields and low during odd fields. If the odd fields have been selected on the front panel, U4780D pin 12 and pin 13 will both be high, resulting in a low at U4880B pin 9. If the even fields have been selected, U4780D pin 12 and pin 13 will be both low, again resulting in a low at U4880B pin 9.

The low input to U4880B causes a high output that sets the clear inputs of the Line Counter flip-flops high, and allows the Line Counter to count.

The odd/even switching that takes place by front-panel command at U4780D pin 12 also takes place at the base of Q8000 and ultimately sets the timing for burst recognition that takes place on Diagram 5.

Line Counter (525/60 PAL-M)

The Line Counter is a straight binary counter that begins on the first +H pulse following a high clear input. At the end of its count, the preset gate, U4460C and U4270A, presets the counter low. Fig. 4-4 shows a simplified diagram of Line Counter operation.

Outputs from the Line Counter drive three circuits: first, U4880A uses the outputs from U4570B, U4570A, and the preset gate to reset the 2 Field Sweep Generator; second, outputs from all five sections and the preset gate provide timing information to the Line Selector Logic on Diagram 9; third, outputs from all five sections drive the Line 8 and Line 270 Logic on the PAL-M Line Counter board, which is mounted on long pins on the Sweep Output board.

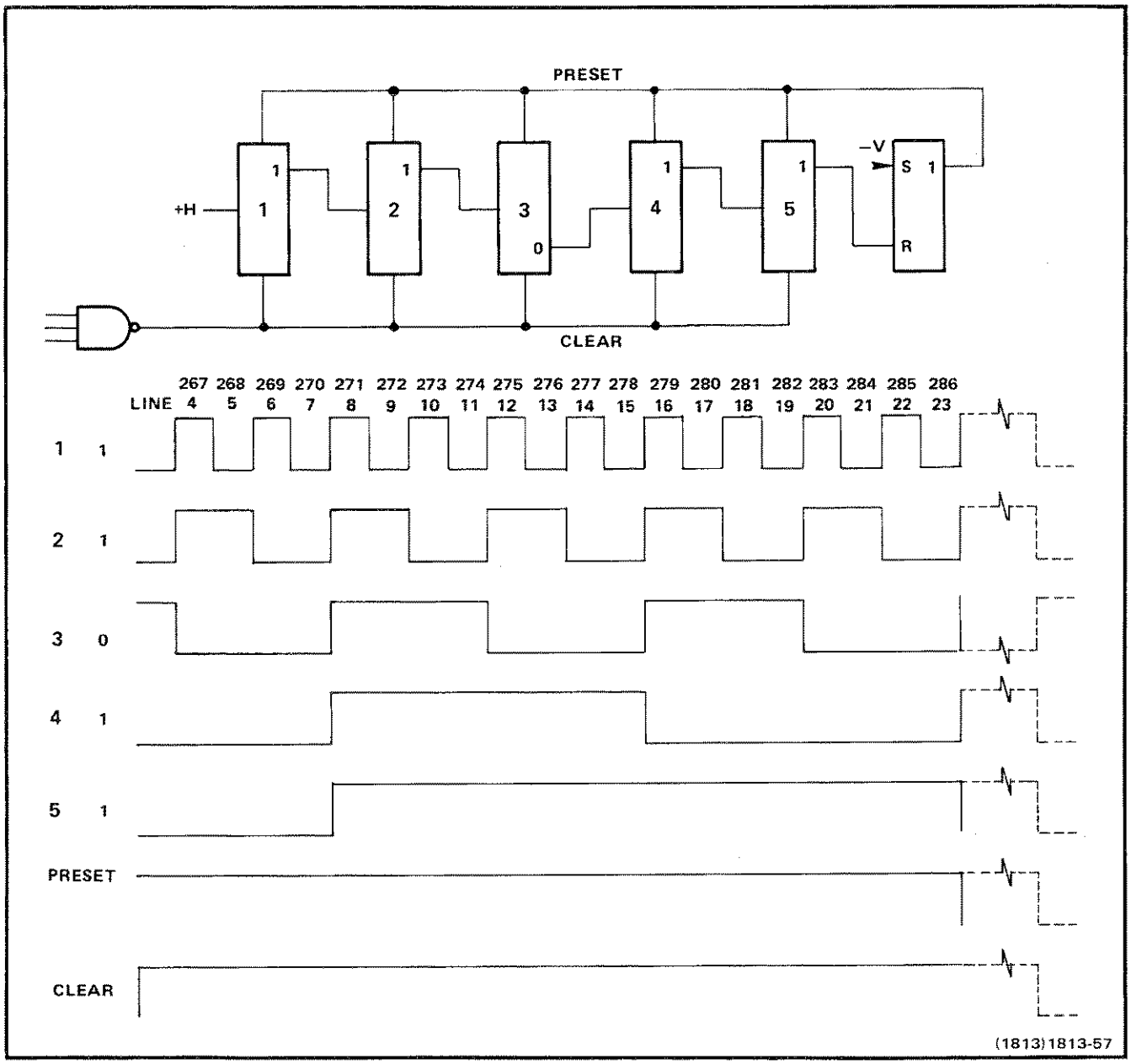


Fig. 4-4. 525/60 PAL-M line counter operation.

The Line Counter only operates during the fields selected on the front-panel in normal operation. During the fields not selected, the clear inputs to the counter are low. However, when the ALL FIELDS ON button (or FIELD 3 and 2 buttons, SN B020960 and up) is pressed, U4880B pin 11 is grounded, forcing the clear inputs to the counter high and allowing the counter to run in every field. In this mode of operation, the +V pulse saturates Q4860 to clear the counter at the start of each field and keep the count correct.

2 Field Gate Generator

The 2 Field Gate Generator can operate in two different modes: first, it will gate the 2 Field Sweep Generator on every odd or every even field, on command from the front panel; second, it will gate the 2 Field Sweep Generator on any one of the four fields as selected by front-panel switches.

Odd/Even Field Gating. From line 8 to line 16 of even fields or line 271 to line 279 of odd fields, the outputs of U4570B, U4570A, and the preset gate are all high. These highs drive the three inputs of "NAND" gate U4880A.

U4880A pin 6 is low from line 8 to line 16 if even fields have been selected, or from line 271 to line 279 if odd fields

have been selected. This 8-line negative-going signal is applied to U4850B pin 4.

U4850B pin 5 is held high when both even fields or both odd fields are selected, so the 8-line gate is inverted and applied to U4930C. Pin 9 is high at all times, except in models equipped with Option 4, VTR Sync, so the signal at U4930C pin 10 is identical in timing and polarity to the signal at U4880A pin 6.

Individual Field Gating. When only one of the front-panel FIELD switches is pressed, odd/even recognition and line counting occur exactly as before and the 8-line gate from U4880A still arrives at two-field intervals as before.

The difference between the two modes is in the state of U4880C. For individual field gating, U4880C pin 12 must be held low until the time to display the selected field arrives. To accomplish this, the PAL-M burst blanking sequence provides a convenient means of distinguishing one even field from the other, and one odd field from the other. Field 1, line 8 does not have burst; field 3, line 8 has. Field 2, line 270 does not have burst; field 4, line 270 does.

The Burst Gate Generator on Diagram 5 provides a Burst Gate pulse on lines that have burst, when the line 8 and line 270 logic on the PAL-M circuit board turns off five-diode gate CR8035, CR8037, CR8036, CR8029, and CR8038.

During even fields, Q8000 is on, applying a low to U8035B pin 5. U8035B pin 4 is high, causing a high at U8035B pin 6. The high from U8035B pin 6 is applied to the sensor inputs of U8035D, U8007D, U8035C, U8007A, and U8007C. When the signal input to each of these gates is high, all outputs are low, turning off the five-diode gate. The event occurs at line 8 of fields 1 and 3.

During odd fields, Q8000 is off and U8035B pin 6 is low. The signal input requirement is that all inputs are low. This event occurs at line 270 of fields 2 and 4.

When the five-diode gate is off, the inhibiting level to the Burst Gate Generator is gone. If burst is present on the line sampled at that time, a positive-going Burst Gate pulse is generated and routed to U4850A pins 1 and 2. The Burst Gate pulse is inverted in U4850A and applied to the clear input of U4860B (pin 13). The negative-going clear input ensures that U4860B pin 9 is low in field 3 when gating on even fields and high on field 4 when gating on odd fields.

U4860B is clocked by the line-8-to-16 sweep reset gate from U4880A, which has been inverted in U4760A. U4740C and U4660B inhibit the clocking of U4860B in 10 μs/DIV or 5 μs/DIV with the LINE SELECTOR OFF.

The output of U4860B is inverted by U8007B and applied to the signal input of exclusive-or gate U4770D pin 13. The sensor input of U4770D, pin 12 is high when the front-panel FIELD 2 or FIELD 4 are pushed. U4880C pin 2 then goes low at the start of the individual field selected on the front panel.

U4880C pins 1 and 13 are always high when gating on individual fields, so the output on U4880C pin 12 is high for a frame of video, starting with the selected field.

The output of U4930C drives the 2 Field Sweep Generator, allowing the generator to sweep, starting on the field selected on the front panel.

2 Field Sweep Generator (525/60 PAL-M)

U4810 is a Tektronix-manufactured, integrated circuit sweep generator. The sweep is reset to 0 volt when pin 1 is low, and is allowed to run when pin 1 is high. C4801 is the timing capacitor. In 525/60 PAL-M, and in dual-standard models operating in the 525/60 PAL-M mode, C4801 gets timing current through R4820 in parallel with the series combination of R4713 and R4722.

Q4710 is turned on by the delayed gate from U4810 pin 4. The delayed gate is enabled by a high at pin 5, which occurs at all times except when the LINE SELECTOR DIG button is pressed.

U4810 pin 6 is the offset input. Voltage changes at this point move the delayed gate in time with respect to the ramp. The output of Q4710 is applied as a set input to Line Selector RS flip-flop U4560 on Diagram 9.

The 2 Field Sweep Generator output from U4810 pin 8 is applied to a switching network on Diagram 10.

DIAGRAM 9
LINE SELECTOR LOGIC AND LINE SWEEP GENERATOR

Circuits on this diagram include timing, start and stop controls for the LINE SELECTOR functions, the gate generator and sweep generator for 5 μs/DIV and 10 μs/DIV sweeps, and unblanking drive for the Z-axis circuits on Diagram 13.

Line Selector Logic

The front-panel LINE SELECTOR switches select individual, digitally-determined lines from the field interval (DIG) individual lines selected from any point in approximately two fields (VAR) or fifteen-line segments from any place in approximately two fields (15 LINES).

DIG. U4680 generates a single, negative-going, line-length pulse, beginning at the leading edge of sync on the line selected by the front-panel LINE SELECTOR switch. Four of U4680's eight inputs (pin 2, pin 4, pin 5, and pin 12) are always high in the selected field with the front-panel DIG button pressed. The other four inputs to U4680 are controlled by the front-panel LINE SELECTOR switch and the first four sections of the Line Counter on Diagram 8.

The front-panel LINE SELECTOR switch has a range of fourteen lines; i.e., line 9 through line 22 (and their equivalents in odd PAL fields). Because of the state of the counter output, U4680 is not enabled before line 9 of any field. Fig. 4-5 shows the logic involved in generating the Line Selector gate pulse in U4680 for all fourteen lines.

When U4680 is enabled, the negative-going output is applied to the first set input of four-input RS flip-flop U4560A and C. The second set input of U4560A and C is high (Q4710 on Diagram 8 is off), so the output is low on the selected line.

The negative-going output from U4560A and C is applied to nand gate U4660 and to the reset inputs of four-bit binary counter U4550. U4460A enables Line Selector Start Pulse Generator U4580B. U4550 is the Line Selector Stop pulse generator.

U4460A pin 12 goes high when U4560A and C switches, enabling D flip-flop U4580B and reverse-biasing CR4638. The trailing edge of the −H pulse clocks U4580B, causing

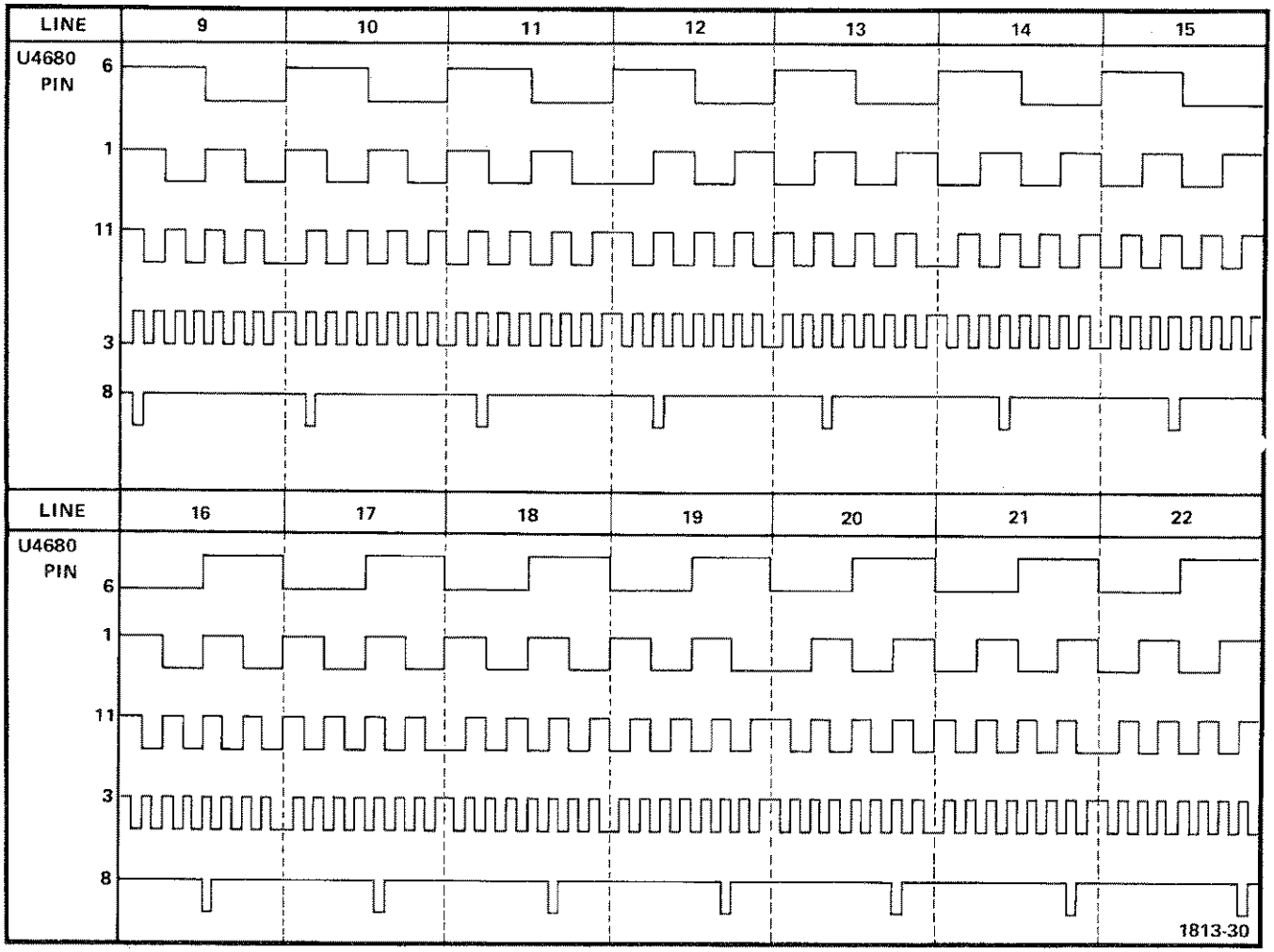


Fig. 4-5. Line Selector logic operation.

pin 9 to switch low and pin 8 to switch high. U4580B pin 8 enables the Unblanking Circuit. The signal at pin 9 drives one section of a three-diode gate, forward biasing CR4640, and is also routed to the Video Output Amplifier on Diagram 2, becoming the line strobe added to the signal at the PIX MONITOR connector and is added to the rear-panel LINE STROBE OUT connector. The fourth destination for the signal at U4580B pin 9 is the Z-axis Logic circuit at Diagram 13.

U4550, when enabled by U4560A and C, divides the line rate by 16 at the next +H pulse. Two of the counts are used in the DIG mode. The divide-by-two section resets U4560A and C through U4460A in the 5 μs/DIV sweep mode. The divide-by-four section is added to the divide-by-two section to reset U4560A and C after two lines in the 10 μs/DIV sweep mode.

VAR. The Line Selector Start and Stop operate in the same manner in VAR as in DIG. The sweep is still locked to −H by U4580B. The difference between the two modes is the manner in which U4560A and C is set.

When the front-panel VAR button is pressed, U4680 pin 4 is grounded, forcing the output high. Q4710 on Diagram 8 applies a negative-going pulse to U4560A and C pin 10, setting pins 11 and 12 low and applying a high to U4580B pin 10. The next −H pulse at U4580B pin 11 clocks the flip-flop as in DIG, and U4550 terminates the Line Selector Logic operation in the same manner as DIG.

15 LINE. This mode is identical to VAR, except that U4460B and U4560B are inhibited by a ground at U4560B pin 3 and U4460B pin 4. U4560A and C is reset by the divide-by-sixteen section of U4550.

Line Sweep Generator

U4440 is a Tektronix-manufactured sweep generator, identical to the 2 Field Sweep Generator. R4350 and C4341 are the timing components, which allow the ramp from U4440 to rise at a rate of 1 volt in 12.7 μs.

The ramp is enabled by a high at U440 pin 1. A low at pin 1 resets the ramp to 0 volt. Ramp gating for 10 μs/DIV and 5 μs/DIV sweep differs slightly.

10 μs/DIV. U4640A is clocked by the +H pulse. The preset input to U4640A is high except in the 15 LINES LINE SELECTOR mode with the DISPLAY switch in 10 μs/DIV so that the output at pin 6 is a square wave with a period of two lines. The square wave is applied to U4740B pin 5. U4740B pin 4 is high during normal operation, so the output at pin 6 is inverted from the signal at pin 5 and applied to U4740A pin 2.

U4740A pin 1 is driven by +H pulses from U4660D pin 11. U4660D is an exclusive-or gate with its sensor input grounded in 10 μs/DIV so that it does not invert the +H pulse at pin 12. When the high portion of the two-line gate of U4740A pin 2 and the +H pulse at U4640A pin 1 are coincident, there is a negative-going output pulse at U4740A pin 3. The pulse occurs at two-line intervals.

The pulse from U4740A pin 3 is applied to U4660A pin 1. In 10 μs/DIV, U4660A is a non-inverting gate, so the signal at pin 3 is identical to the input. The pulse from U4660A pin 3 is applied to diode gate CR4733 and CR4732.

In 5 μs/DIV and 10 μs/DIV, diode gate CR4733 and CR4732 is always enabled so the sweep gate pulse from U4660A pin 3 resets the output of U4440 to 0 volt and starts a new ramp every two lines.

5 μs/DIV. In 5 μs/DIV sweep speed, the sensor inputs of U4660D and U4660A are set high so that signals at their inputs are inverted. The two-line square wave from U4740B is inverted in U4740A and inverted again in U4660A. The gating waveform at U4440 pin 1 is a square wave with a two-line period, allowing the sweep to run for one line and inhibiting it the next.

Since the 5 μs/DIV sweep is allowed to run for only one line and the rate of rise as determined by the timing components does not change, the 5 μs/DIV sweep is half the amplitude of the 10 μs/DIV.

U4440 pin 4 is a delayed gate output. The delayed gate function is enabled by a high at pin 5, which occurs anytime the front-panel WAVEFORM COMPARISON OVERLAY control is out of its detent position. U4440 pin 6 is an offset input for the delayed gate. The voltage level at the offset input determines the delayed gate's position in time with respect to the ramp. The maximum voltage level at pin 6 is 10 μs/DIV is 10 volts, as determined by series divider R4341 and R4340. In 5 μs/DIV the maximum voltage level is halved by adding R4352 in parallel with R4340. The delayed gate is applied through R4333 to the base of Q4130 in the Horizontal Positioning circuit on Diagram 10. The ramp is applied to the Horizontal Switching circuit on Diagram 10.

Sweep gating in LINE SELECTOR modes is nearly the same as in normal operation because the sweep generator is not inhibited by the Line Selector Logic. The Line Selector Logic controls the Unblanking circuit to deter-

mine which line or lines will be displayed in LINE SELECTOR modes.

Sweep gating in 15 LINE, 5 μs/DIV is different than normal 5 μs/DIV. U4670B inhibits U4640A and allows the Line Sweep Generator to be gated on every line.

Unblanking

U4930B is the Unblanking Circuit input for 2 FIELD displays and U4740D is the input for 5 μs/DIV and 10 μs/DIV displays. In 2 FIELD displays U4930A is inhibited, while in 5 μs/DIV or 10 μs/DIV, U4930B is inhibited.

U4840C routes the unblanking signal to the Z-axis Logic on Diagram 13. U4840D's only purpose is to keep the crt continuously unblanked when in the EXT position of the DISPLAY switch.

DIAGRAM 10
HORIZONTAL SWITCHING LOGIC

Circuits on Diagram 10 provide switching for the various horizontal inputs, a buffer amplifier to drive the Horizontal Magnifier on Diagram 11, a Horizontal Positioning control circuit, and an input amplifier for RGB/YRGB operation.

Horizontal Switching

This circuit consists of six current switches that are switched, on front panel command, to provide the desired input to the horizontal amplifier. The switches are: 2 FIELD, U4260B-CR4030-CR4132; 10 μs/DIV, U4260D-CR4150-CR4151; 5 μs/DIV, U4270C-CR4153-CR4155; EXT, CR4024-CR4130; 2 FIELD RGB/YRGB, U4260C-CR4143-CR4040; 5 μs/DIV and 10 μs/DIV RGB/YRGB, U4260A-CR4250-CR4154.

The switching logic is straight-forward. When any one of the current switches is passing a signal, the other five are not.

R4025, the 2 FIELD input, R4146, the 10 μs/DIV input, and R4153, the 5 μs/DIV input becomes Ri for the Magnifier Driver operational amplifier. Rf for the amplifier, R4210 is identical in value to R4025 and R4146, but twice the value of R4153. This provides the 5 μs/DIV sweep with a gain of 2 in the amplifier, since the 5 μs/DIV ramp is one-half the size of 2 FIELD and 10 μs/DIV ramps.

In MAGNIFIER ranges, and 5 μs/DIV or 10 μs/DIV DISPLAY, the horizontal scale is measured in microseconds and not merely identified as an amount of magnification. Because of this factor, both the 10 μs/DIV and 5 μs/DIV ramps must have the same rate of rise when magnified.

To meet this end, the 10 μs/DIV current switch is disabled and the 5 μs/DIV current switch enabled any time the MAGNIFIER is operating.

The selected horizontal input is applied to the emitter of Q4110, the input of the Horizontal Input Amplifier.

Q4020 and Q4115 form a temperature compensated "current mirror". This circuit senses changes in current in the −15 volt power supply and forces the identical change in the +15 volt power supply. In this manner, the two power supplies are always at the same point, relative to each other, and circuits operating between the two supplies do not change operating points and gains.

Horizontal Input Amplifier

Q4110, Q4210 and Q4321 form an inverting operational amplifier with gain of one for 2 FIELD and 10 μs/DIV ramps, and two for the 5 μs/DIV ramp. The amplifier is high-frequency compensated by C4210.

Horizontal Positioning

Positioning current arrives at the base of Q4210A through R4201 and the HORIZONTAL POSITION control wiper arm. In 10 μs/DIV, with the MAGNIFIER on, however, more positioning current is needed because of the higher amplitude ramp. (The 10 μs/DIV ramp is twice the size of the 5 μs/DIV ramp because, in MAGNIFIER on positions, both ramps are routed through the 5 μs/DIV input circuit, which has a gain of 2 through the amplifier.)

In 10 μs/DIV with the MAGNIFIER ON, Q4211 is turned on and saturates Q4310 which applies −15 volts to one end of the HORIZONTAL POSITION control, doubling the position offset current.

Q4230 is the WAVEFORM COMPARISON OVERLAY input. The delayed gate from U4440 pin 4 (Diagram 9) is applied to the base of Q4230, turning it off for the duration of the gate. Remember that the point at which the gate starts with respect to the ramp is controlled by the WAVEFORM COMPARISON LOCATE control.

The current supplied by the WAVEFORM COMPARISON OVERLAY control acts as positioning offset current during the time of the delayed gate only. In this manner, any portion of the ramp arriving at the Horizontal Input Amplifier can be "repositioned", overlayed, with respect to the remainder of the ramp.

RGB/YRGB Steps Input

When J9034 on the rear-panel is selected for RGB/YRGB input, the operation of both sweep generators is altered. In 2 FIELD operation, the 2-field sweep generator is gated on every field and in 10 μs/DIV or 5 μs/DIV, the 10 μs/DIV, 5 μs/DIV sweep generator is gated on every line. This means that the ramps are allowed to run to only 5 volts amplitude, instead of the 10-volt ramp that is normal in 2 FIELD 10 μs/DIV.

For 2 FIELD RGB/YRGB operation, the input resistor for the Horizontal Input Amplifier is R4134 for RGB, and R4134 + R4022 for YRGB. For 10 μs/DIV and 5 μs/DIV, the input resistor is R4250 for RGB, and R4250 + R4251 for YRGB.

In RGB, the ramp amplitude at the output of the Magnifier Driver amplifier is one-third normal (one-half input ramp amplitude times an amplifier gain of 0.67).

For YRGB, the ramp amplitude at the output of the Magnifier Driver amplifier is one-fourth normal (one-half input ramp amplitude times an amplifier gain of 0.5).

The RGB/YRGB steps from J9034 are applied to the base of Q4051. Step amplitude requirement is for a 12-volt peak-to-peak series of symmetrical steps. Q4051 and Q4050 form a unity gain, inverting, operational amplifier, so the output is 12 volts peak-to-peak, applied to the Magnifier Driver amplifier through R4140 for 2 FIELD or R4242 for 10 μs/DIV and 5 μs/DIV.

DIAGRAM 11
HORIZONTAL AMPLIFIER

The three circuits on Diagram 11 accept the selected horizontal signal, pass it through the Horizontal Magnifier, where Horizontal Amplifier gain can be changed, limit the excursion on either side of the scan area (Horizontal Limiter), and convert it to driving potential for the crt (Horizontal Deflection Amplifier).

Horizontal Magnifier

Horizontal magnification is accomplished by changing the effective emitter resistance for Q4323 and the collector load for Q4411. In unmagnified operation, Q4323's emitter resistor is R4223. Q4411's collector load is R4420 in parallel with R4325. With MAGNIFIER on, R4420 is removed from the circuit and combinations (depending on MAGNIFIER position) of R4221, R4320 and R4322 are added.

The Horizontal Magnifier is an inverting amplifier with gains of 0.1 in OFF, 0.5 in 1 μs/DIV (x5), 1 in .5 μs/DIV (x10), 2 in .25 μs/DIV (x20), 2.5 in .2 μs/DIV (x25), and 5 in .1 μs/DIV (x50). The Horizontal Magnifier output is routed from the collector of Q4411 to the input of the Horizontal Limiter.

Horizontal Limiter

The signal from the collector of Q4411 is applied to the base of Q4522, the input of the Horizontal Limiter amplifier. Q4522 and Q4521 are an emitter-coupled complementary pair with a constant-current source (Q4540 and Q4531). R4532, in the emitter network is a gain control used to calibrate 10 μs/DIV timing.

Signal amplitude limiting takes place between the collectors of Q4522 and Q4521. Q4520 sets the lower limit (left side of the crt) at about +12.5 volts. Q4530 sets the upper limit (right side of the crt) at about +17.5 volts. The left limit control is R4240, the right limit control is R4330, CR4424 and CR4428 are temperature-compensating devices.

During unmagnified operation, the 5-volt range between limits is adequate to pass the entire ramp waveform. With the MAGNIFIER on, both limits are exceeded, with the result that the top and bottom of the ramp waveform (which is centered around +15 volts) are "chopped off". The rising portion between the limits is the portion of the sweep displayed on the crt.

Neither of the limiting transistors is allowed to saturate at any time during this circuit's operation, thus avoiding the delay and linearity problems inherent in bringing transistors out of saturation.

Horizontal Deflection Amplifier

The Horizontal Deflection Amplifier is an operational amplifier with complementary outputs. The summing junction is the base of Q4510. R4240 in the Horizontal Limiter circuit supplies offset current to the summing junction and is adjusted for display centering in MAGNIFIER x5.

Q4500-4400 and Q4600-4601 form complementary cascode amplifiers that provide the voltage swing necessary to drive the crt deflection plates. Each of these amplifiers is fed back to the summing junction for stability.

DIAGRAM 12
LOW VOLTAGE POWER SUPPLY

−15 Volt Supply

U6060 is an integrated circuit error amplifier. Pins 4 and 5 are complementary inputs with pin 4 the reference input, and pin 5 the feedback input. The error amplifier output, pin 11, drives the base of Q6020, which in turn drives series regulator, Q9600.

If the load current increases, the supply tries to move positive. U6060 pin 11 then moves negative, causing the collector of Q6020 to move positive. The more positive level at the base of the series regulator increases its current, if the load current decreases, the reverse takes place. The −15 volts supply is current limited by R6038 at about 600 mA.

R6034 and R6036 alter the voltage difference between U6060 pins 2 and 3 as the power supply current begins to limit, providing for current foldback.

+15 Volt Supply

U6160 is an error amplifier, with complementary inputs at pins 4 and 5, and the output at pin 11. When the feedback input (pin 4) tries to change, the output moves with it, causing an opposite change at the collector of Q6120 and changing the current in Q9500, the series regulator transistor.

+75 Volt Supply

Q6260A and B is a differential amplifier with the base of section A being the reference input. If the current load on the supply increases, the supply tries to move in a negative direction, increasing the current in Q6235. The more positive level at the base of Q6230 causes an increase in the conduction of Q9300, the series regulator.

The +75 volt supply current is limited when the drop across R6242 is large enough to start turning Q6230 off. At that time, current previously conducted by Q6235 is routed through CR6250.

+140 Volt Supply

The +140 volt supply is referenced to the +75 volt supply at the emitter of Q6326. Q6326 is both the comparator and the driver for the series regulator transistor Q9200.

Current limiting is accomplished by the voltage drop across R6318 being sensed by Q6322. When this voltage drop is sufficient, Q6322 is turned off, turning off Q6326. R6235 and C6322 are oscillation suppressors, slowing the rate of change at the base of Q6322.

DIAGRAM 13
Z-AXIS LOGIC

Circuits on Diagram 13 receive control signals from the Unblanking and Line Selector circuits on Diagram 9 and unblank and intensify the crt beam on those commands.

Z Axis Logic

U6474 is a five transistor array, with U6474E being a current source that drives two current switches (6474A and B, U6474C and D). The amount of current supplied by U6474E is dependent upon the setting of the front panel INTENSITY control.

The INTENSITY control range is set by the divider resistors R6578, R6580, R6582, R6586, and R6584. As the sweep magnification is increased, the resistors in the divider are removed one by one, bringing the positive end of the INTENSITY control closer to ground, increasing the current in U6474E, and increasing crt beam current.

When in LINE SELECTOR modes, Q6586 is saturated for maximum intensification. The maximum current available to the two current switches from U6474E is adjustable by R6466 in the emitter circuit of U6474E.

U6474A and B form the unblanking current switch. Section A is normally conducting. When the negative-going unblank command arrives from Diagram 9, section A switches off while section B switches on and supplies current to the summing junction of the Z-axis Amplifier.

U6474C and D form the line selector intensification current switch. U6474D conducts until the line selector strobe pulse turns it off. At that time, U6474C turns on and supplies additional current to the summing junction of the Z-axis Amplifier.

Z-Axis Amplifier

The base of Q6560 is the input to an inverting transresistance operational amplifier. The gain of the amplifier is input current times the feedback resistance, providing an output of about 18 volts for each milliamp of input current.

DIAGRAM 14
HIGH VOLTAGE POWER SUPPLY

Circuits on Diagram 14 provide control and the necessary accelerating potentials for the crt.

CRT Biasing

Bias is applied to the grid of the crt from P6946-3. The dc potential is derived by rectifying a clipped sine wave that appears at the junction of CR6890 and R6888. The clipped sine wave is a result of an input from T6810 through R6754 and C6752 being limited by CR6678 and CR6680.

CR6680 limits the positive excursion of the input at a point set by R6680, the CRT Grid Bias control. CR6678 limits the negative excursion of the input at a point set by the output of the Z-axis Amplifier. The bias on the crt grid then is the difference between the two limit points.

High Voltage Oscillator

Q9180 is the oscillator transistor, connected in a Hartley configuration. Oscillation is sustained by positive feedback from collector to base through the winding of T6810. C6425, through normally saturated Q6644, is the ac ground return for the base winding of T6810. L6510 and C6615 form a filter to prevent oscillations from appearing in the +75 volt supply.

High Voltage Regulator

U6535 is the regulator for the High Voltage Oscillator, adding to or subtracting from the bias current for Q9180. R6860A and R6860B form the feedback divider. The rc network between U6535 pin 6 and the negative input, pin 2, provides frequency compensation for the regulating circuit.

If the high voltage should go out of regulation, the signal at T6810 tap 22 increases in amplitude. The signal at tap 22 is half-wave rectified by CR6736, filtered by C6648, and applied to R6534 as reference voltage for Q6642. When the base of Q6642 is high enough to turn off normally saturated transistor Q6644, the oscillator base winding ac ground is removed, and the oscillator is shut down.

The post accelerator voltage is applied from T6810 tap 17 through a four-stage multiplier to the crt. This same transformer tap is also the source of cathode and grid potential. CR6942 rectifies the sine wave. The half-wave rectified voltage is then applied through a filter (C6848, R6946, C6860) to the crt cathode and the crt grid bias network. The voltage at the anode of CR6942 is also the elevating potential for the crt filaments.

The sine wave at T6810 tap 18 is rectified by CR6738 and CR6742 and filtered by C6738. The level is then clamped at −150 volts by VR6646 and applied to the crt as mesh voltage.

R6860C and R6550 provide automatic focus voltage change when in LINE SELECTOR operating modes.

+5 Volt Supply

CR6728 and CR6730 rectify the sine wave at T6810 taps 20 and 22. The resulting output is filtered by L6627, C6636, and L6546 and becomes Vcc for TTL circuits.

CRT Controls

TRACE ROTATION, R9935, varies the current through the Trace Rotating coil L9650, affecting both vertical and horizontal components of the display.

R6414, the Y-axis Align control, varies the current through L9350. Since this coil is physically located before the horizontal deflection plates, it affects only the vertical components of the display.

R6508, the Geometry control, varies the potential on the horizontal deflection plate shields, and controls the overall display geometry.

R6503, the Astigmatism control, is used along with the front-panel FOCUS control for display definition.

OPTIONS

This section provides for documenting catalog options offered for the 1480-Series. Custom modifications are negotiated and documented separately.

OPTION 1—X10 PROBE

Option 1 consists of three separate circuits. First is the X10 Probe Amplifier, which is located on the Vertical Switch board. This circuit accepts the signal through the front-panel BNC connector and amplifies it before routing it to the X10 Probe Switching circuit on Diagram 1. Second is the Probe Cal circuit, which provides a 1-volt squarewave of four-lines period that can be used to compensate the X10 Probe. Third is the X10 Probe Switching circuit, on Diagram 1, that routes the signal from the X10 Probe Amplifier to the Vertical Deflection system.

Operating Instructions

The signal from the X10 PROBE INPUT is inserted in the vertical system at the same point as signals applied to the A and B VIDEO INPUTS. All front-panel controls then have the same effect on the X10 Probe signal as they have on other signals.

Pressing the front-panel CAL button provides a squarewave output at the CAL OUTPUT jack, to be used for probe compensation.

Connect a 10X Probe from the X10 PROBE input to a source of 1-volt peak-to-peak composite video. Set the VOLTS FULL SCALE to 1.0, RESPONSE to FLAT, INPUT to PROBE, DISPLAY to 10 μs/DIV, and MAG to OFF. Press the DC RESTORER SLOW and BACK PORCH, OPER, EVEN FIELD, SYNC INT and AFC, LINE SELECTOR off and ALL FIELDS off buttons. Note the 1-volt equivalent display height.

Set the front-panel controls to each position in turn and note that the effect is the same for the X10 PROBE signal as for normal operation. See Section 2 for a complete check-out procedure.

Calibration Procedure

This procedure requires the following test equipment. (See Section 3, Performance Check/Calibration Procedure, for equipment specifications.)

1. Test Oscilloscope.
2. Video Signal Source.
3. 10X Probe.
(See Fig. 5-1 for adjustment locations.)

Compensate the 10X Probe using the Test Oscilloscope Vertical Amplifier and Calibrator.

Move the 10X Probe to the 1480-Series X10 PROBE INPUT and CAL OUTPUT. Press the CAL and DC RESTORER SYNC TIP buttons.

Adjust C2228 (under the shield housing) for a square corner on the leading edge of the waveform.

Adjust X10 PROBE GAIN for a 1-volt equivalent display height.

Press OPER button. Connect the Video Signal Source Comp Video to the A VIDEO INPUT. Terminate the loop-through connector in 75 Ω. Connect the X10 Probe to the output of the loop-through board.

Compare displays with the INPUT switch alternately in PROBE and A positions.

Adjust C2265 so the chrominance packets are identical in the A and PROBE positions of the RESPONSE switch.

Connect the 10X Probe between the Test Oscilloscope and the X10 PROBE CAL OUTPUT.

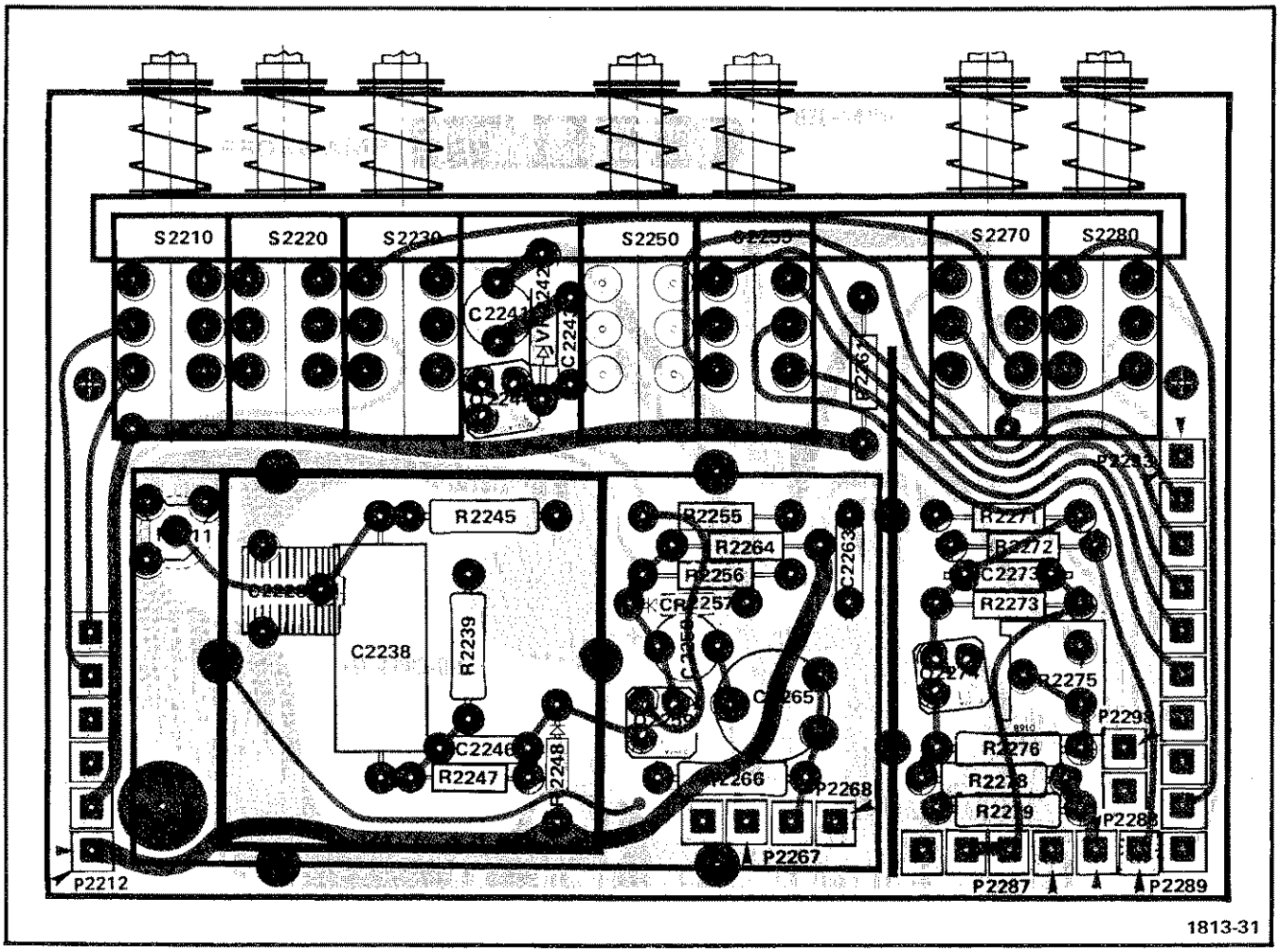


Fig. 5-1. Component locations for Option 1, X10 PROBE input.

Measure the CAL OUTPUT amplitude using the Differential Comparator Comparison Voltage feature.

Adjust R2275 for exactly 1-volt amplitude.

Circuit Description

(See Fig. 5-2.) The X10 PROBE Amplifier is a follower for the input signal. A 1-volt signal at the probe tip appears as a 0.1 volt signal at the amplifier input. R2245-C2228 are input compensation. C2238 is a dc block. R2247 protects input FET Q2259, from overload, while C2246 is a high-frequency bypass.

The signal arrives at the gate of Q2259 essentially unchanged from the input at R2245. The signal passes through Q2259 and Q2244 and is coupled to the X10 Probe Switching circuit on Diagram 1 through C2258. R2266 and the front-panel X10 PROBE GAIN control become the input resistors to the operational amplifier (+ Amplifier) on Diagram 1. The value of these resistors provides identical current for the operational amplifier, assuming a 0.1 volt input signal, as the A or B Input resistors do a 1-volt signal.

Q2274 is an on-off switch driven by the Calibrator Timing circuit on Diagram 7, and generates a positive-going, 1-volt squarewave output to the front-panel X10 PROBE CAL OUTPUT jack.

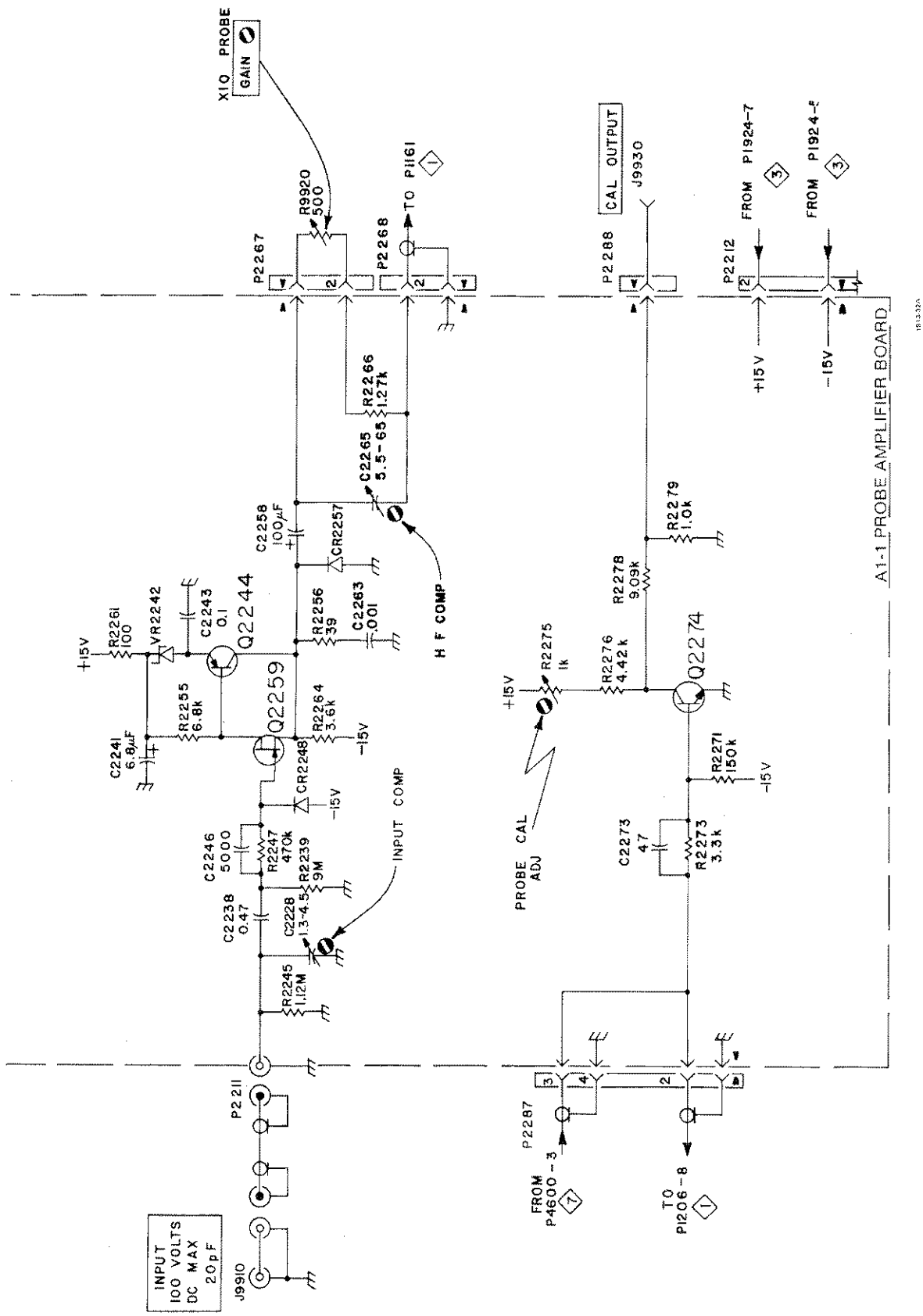


Fig. 5-2. Schematic diagram of X10 PROBE input circuit.

TABLE 5-1

Specification
X10 PROBE (Option 1)

Characteristic	Performance Requirements	Supplemental Information
Scale Factor	Adjustable to 1 V peak-to-peak equivalent display height.	
Gain Range	±10%	Sufficient to normalize gain to either the crt display or AUX VIDEO OUT.
Gain to AUX VIDEO OUT	Unity ±3%, with GAIN adjusted for 1 V peak-to-peak equivalent display height.	
Tilt	≤5% on 50 Hz squarewave	FAST DC RESTORER eliminates low-frequency tilt on a composite video signal.
High Frequency Response	±1%, 25 Hz to 5 MHz +3%, −5%, 5 MHz to 10 MHz Referenced to 50 kHz	
Differential Phase	≤0.25° at any APL	
Differential Gain	≤0.25% at any APL	
Input Resistance	1 MΩ, ±2%, not including probe	
Input RC Product	20 μs, ±0.5%, not including probe	
X10 PROBE Calibrator		
Output Voltage	1.000 V, ±0.005 V, or 0.995 V to 1.005 V	
Waveform	Squarewave	
Duty Factor	50%	
Period	4 lines	
Output Impedance	≈950 Ω	

OPTION 1

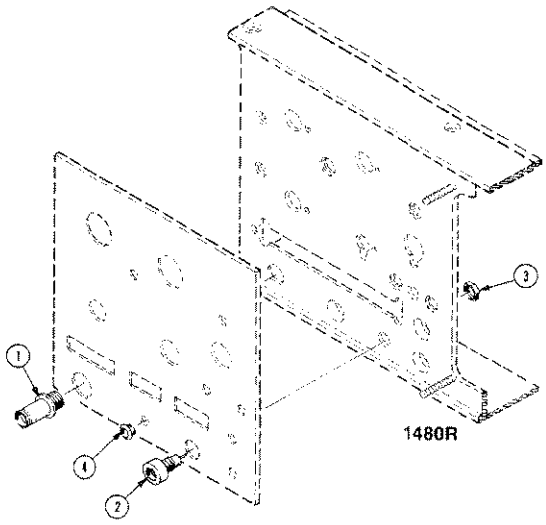
Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1-1	670-3491-00			CKT BOARD ASSY:PROBE	80009	670-3491-00
C2228	281-0209-00			CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0303-105
C2238	285-0898-00			CAP.,FXD,PLSTC:0.47UF,10%,100V	56289	LP66A1B474K
C2241	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C2243	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,30V	72982	8131N039Z5U-104Z
C2246	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	56289	19C242B
C2258	290-0519-00			CAP.,FXD,ELCTLT:100UF,20%,20V	56289	196D107X0020MA3
C2263	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C2265	281-0205-00			CAP.,VAR,PLSTC:4-65PF,100V	80031	222-808-32659
C2273	283-0115-00			CAP.,FXD,CER DI:47PF,5%,200V	72982	805-509C0G470J
CR2248	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR2257	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
P2211	131-1003-00			CONNECTOR BODY,:CKT CD MT,3 PRONG	80009	131-1003-00
Q2244	151-0221-00			TRANSISTOR:SILICON,PNP	80009	151-0221-00
Q2259	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1025-00
Q2274	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
R2239	325-0104-00			RES.,FXD,FILM:9M OHM,1%,0.25W	03888	PME60-G90003F
R2245	321-0486-00			RES.,FXD,FILM:1.13M OHM,1%,0.125W	91637	HMF188G11303F
R2247	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R2255	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R2256	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
R2261	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R2264	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R2266	321-0203-00			RES.,FXD,FILM:1.27K OHM,1%,0.125W	91637	MFF1816G12700F
R2271	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R2272	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R2273	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R2275	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
R2276	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	91637	MFF1816G44200F
R2278	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R2279	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R9920	311-0095-00			RES.,VAR,NONWIR:500 OHM,10%	11237	41022
S2210 S2220 S2230 S2250 S2255 S2270 S2280	260-1676-00 [1]			SWITCH,PUSH:	80009	260-1676-00
VR2242	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00

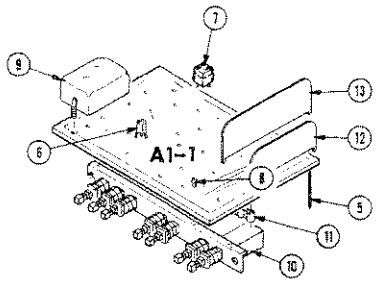
OPTION 3

V9600	154-0718-05			ELECTRON TUBE:BLANK	80009	154-0718-05
	331-0393-02			GRATICULE:CIR COMPOSITE	80009	331-0393-02

[1] Furnished as a unit.

Options—1480 Series





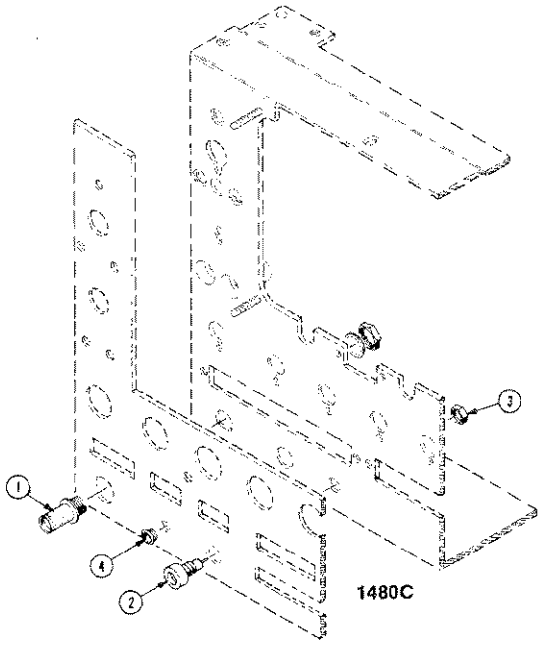


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
-1	131-1315-00			1		CONNECTOR,RCPT,:BNC,FEMALE	24931	28JR235-1
	136-0098-00			1		JACK,TIP:BLACK NYLON	74970	105-803
						(ATTACHING PARTS)		
	210-0583-00			1		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20224-402
						- - - * - - -		
	358-0301-01			1		BUSHING,SLEEVE:GRAY,MOLDED	80009	358-0301-01
	----- -----			1		CKT BOARD ASSY:PROBE AMPLIFIER BD(SEE A1-1 EPL)		
	131-0589-00			28		. CONTACT,ELEC:0.46 INCH LONG	22526	47350
	131-1003-00			1		. CONNECTOR BODY,:CKT CD MT,3 PRONG	80009	131-1003-00
	136-0220-00			2		. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
	136-0252-04			4		. SOCKET,PIN TERM:0.188 INCH LONG	22526	75060
	202-0196-01			1		. CAN,ALUMINUM:1.25 X 0.80 X0.02 INCH THK	0000G	OBD
	260-1676-00			1		. SWITCH,PUSH:VERTICAL	80009	260-1676-00
	361-0384-00			8		. SPACER,PB SW:0.133 INCH LONG	80009	361-0384-00
	337-0896-00			1		. PLATE,ELEC SHLD:CKT BOARD MOUNT,BRS	80009	337-0896-00
	337-2106-00			1		. SHIELD,ELEC:2.516 X 1.366 X 0.060 INCH	80009	337-2106-00

OPTION 2—CARRYING CASE FOR CABINET MODELS

For portable use, a painted aluminum case (Tektronix Part Number 437-0195-00) with handle and rubber feet is available. It can be ordered separately, or if this instrument is not intended for rack use, can be shipped on the instrument from the factory. Order Option 2.

OPTION 3—BLANK CRT

If special locally-produced graticules are going to be used and the internal graticule is not desired, blank crt's are available from Tektonix, as Option 3.

OPTION 4—VTR TONE WHEEL SYNC INPUT

(Applies to single-standard models for 525/60 NTSC, 525/60 PAL-M, and 625/50 PAL, and to the dual-standard model for 525/60 NTSC-625/50 PAL.)

OPTION 5—VTR TONE WHEEL SYNC INPUT

(Applies to the dual-standard model for 525/60 NTSC-625/50 PAL only.)

Option 5 is identical to Option 4 with the following exceptions:

1. CRT. The CCIR-ruled internal graticule crt, Tektronix Part Number 154-0718-01, is replaced with NTSC-ruled internal graticule crt Tektronix Part Number 154-0718-00.

2. Transformer Wiring. The mains supply input circuit is wired and fused for 120 Vac instead of 240 Vac.

Specification

NOTE

All standard specifications listed in Section 2 also apply.

Synchronizing Requirements. A stable display shall be obtained with the following input signals:

1. Internal Sync. Composite video with an amplitude of 0.2 volt P-P to 2.0 volts P-P from sync tip to peak white.

2. External Sync.

a. Composite Sync. Negative-going composite sync with an amplitude of 0.4 volt to 8.0 volts.

b. Composite Video. Composite video with an amplitude of 0.4 volt P-P to 2.0 volts P-P.

3. Tape Tone Wheel Sync.

a. 525/60 NTSC. Negative-going pulse with repetition rate of 240 Hz, period of 4.166 ms, pulse width of 300 μs, and amplitude of 4.0 volts to 15.0 volts.

b. 625/50 PAL. Negative-going pulse with repetition rate of 250 Hz, period of 4.0 ms, pulse width of 300 μs, and amplitude of 4.0 volts to 15.0 volts.

Standard Accessories (Options 4 and 5)

These are in addition to the accessories listed on the Accessories and Repackaging pull-out page.

Fuses. One 0.8 ampere slow-blow fuse (Tektronix Part Number 159-0018-00). One 0.4 ampere slow-blow fuse (Tektronix Part Number 159-0031-00).

Instruction Manual. Each Option 4 or Option 5 instrument package shall contain two Instruction Manuals including Options (Tektronix Part Number 070-1813-01).

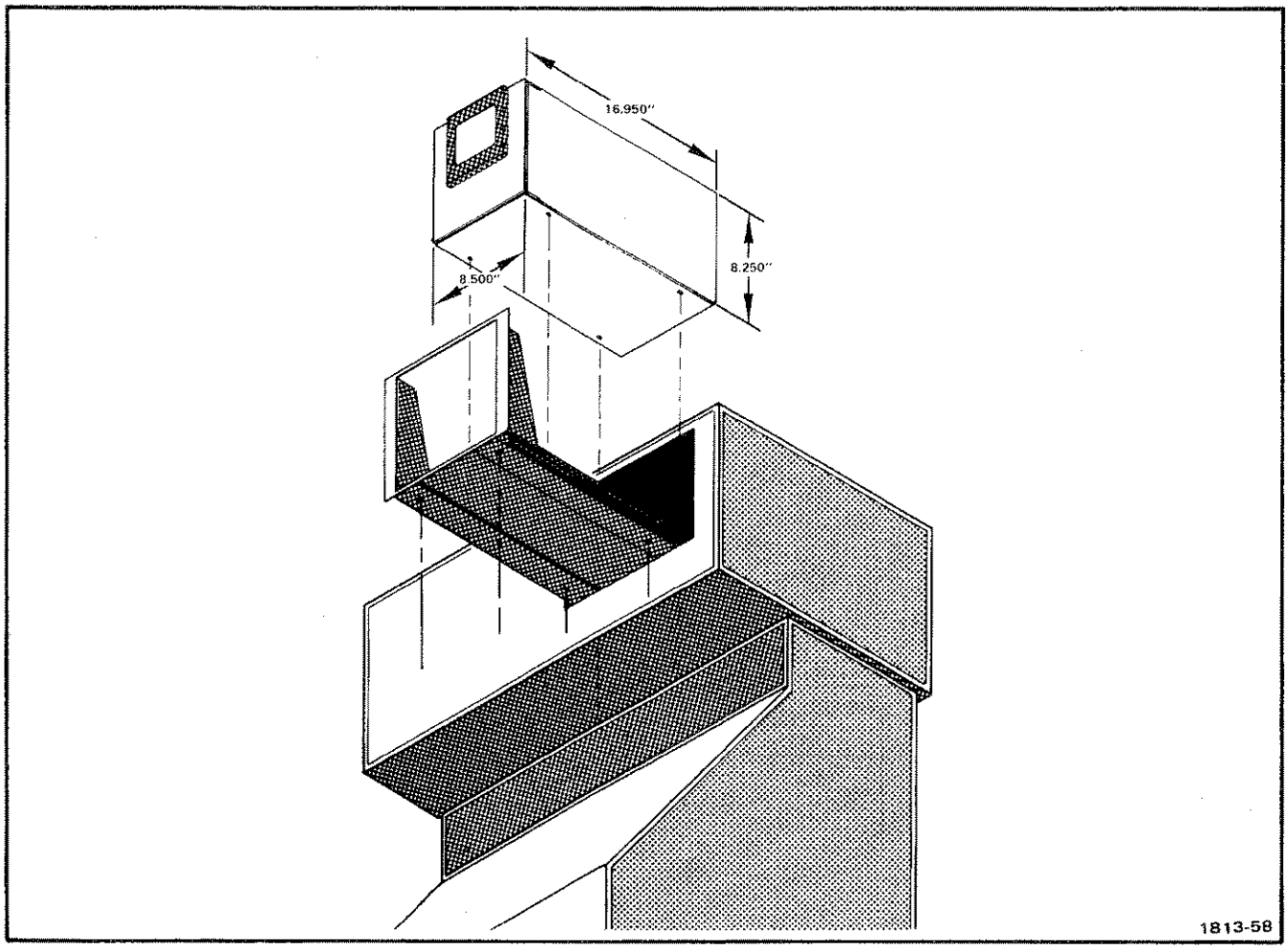
Termination. BNC 75 Ω End-Line (Tektronix Part Number 011-0102-00).

Installation

1480-Series Option 4 Waveform Monitor is a direct retrofit for the Tektronix 529 installed in RCA TR70C Television Tape Recorders. BNC male to UHF female adapters must be used on the six loop-through lines that connect to inputs on the rear panel of the Waveform Monitor. (A VIDEO INPUT, A EXT SYNC INPUT, and TAPE T. W. SYNC.) No provision is made for an external calibration signal on the 1480-Series Option 4. See Fig. 5-3 for installation illustrations.

Operating Instructions

With the 1480-Series Option 4 Waveform Monitor installed in an RCA TR70C, operation is virtually automatic. The TR70C provides external locking signals, switching commands, and input signals so that the Waveform Monitor displays the signal of interest.



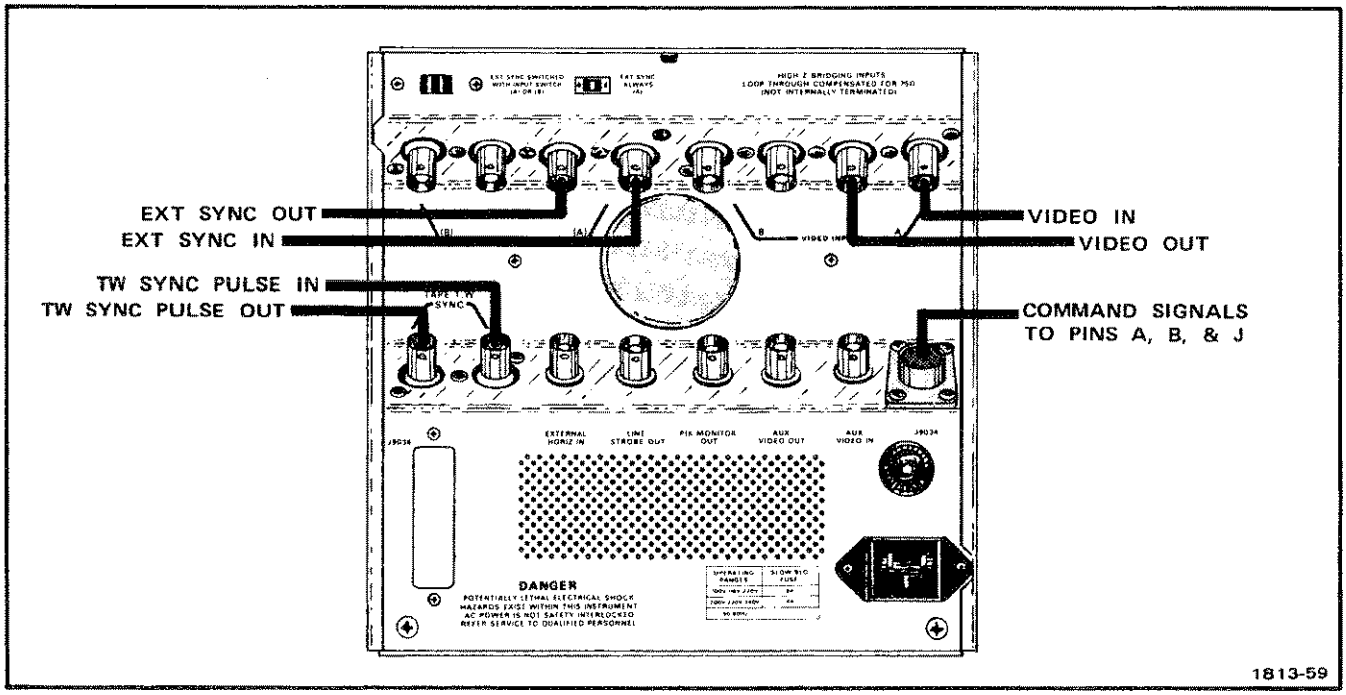
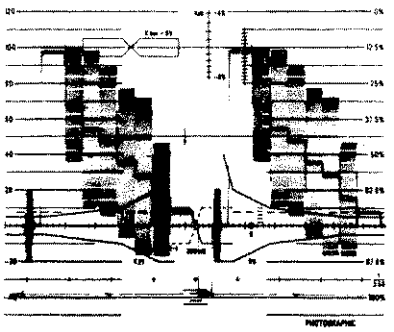
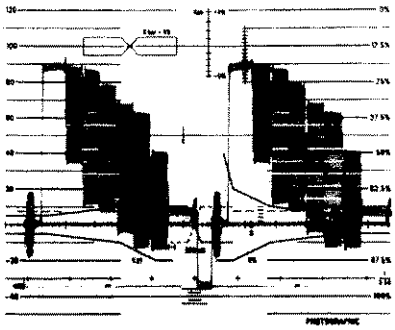
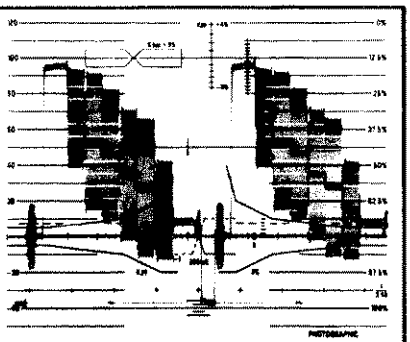


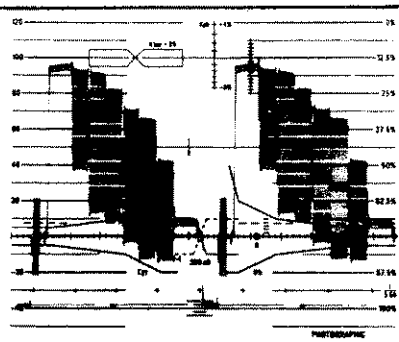
Fig. 5-3. Installation.

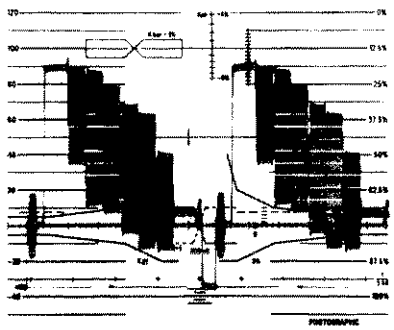
TABLE 5-2

TR-70C PUSHBUTTON	1480-Series DISPLAY
IN	 Displays VIDEO INPUT A signal as a reference to allow for correct level adjustments.
1813-61	

TR-70C PUSHBUTTON	1480-Series DISPLAY
CATC	 Displays the video from the Color Automatic Time Corrector.
1813-64	

DEMOD	 Displays the video output from the demodulator.
1813-62	

OUT	 Displays the TR 70C output video to allow for level checking.
1813-65	

ATC	 Displays the video from the Automatic Time Corrector.
1813-63	

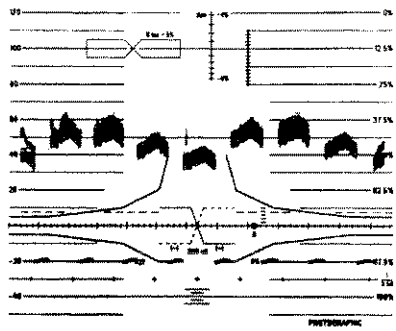
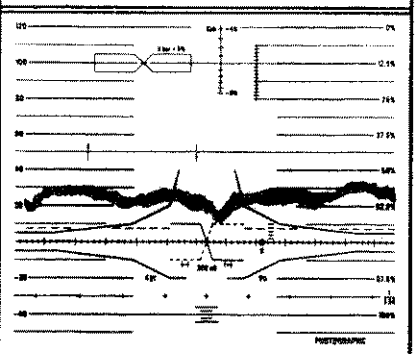
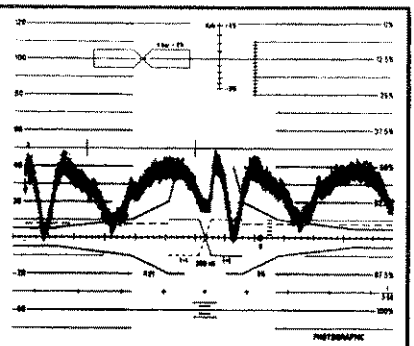
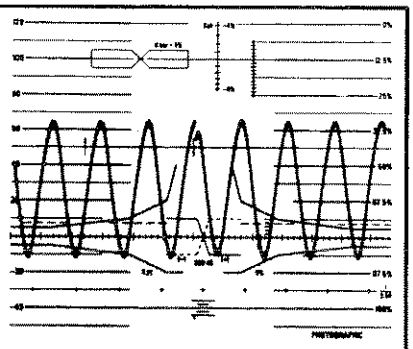
FM LEVEL	 Head-by-head display of detected FM from the playback head amplifier.
1813-66	

TABLE 5-2 (cont)

TR-70C PUSHBUTTON	1480-Series DISPLAY
ATC 1813-67	 Displays error signal from the Automatic Time Corrector module.
CATC 1813-68	 Displays error signal from the Color Automatic Time Corrector module.
CT REC 1813-69	 Displays the record current signal in the control track head in the record mode.

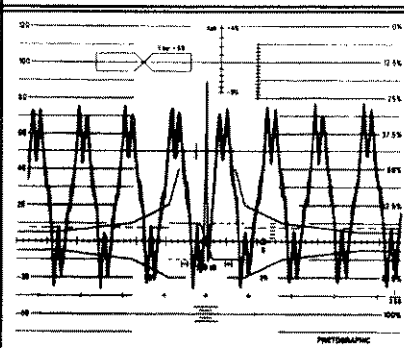
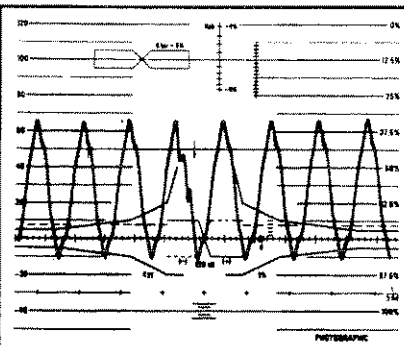
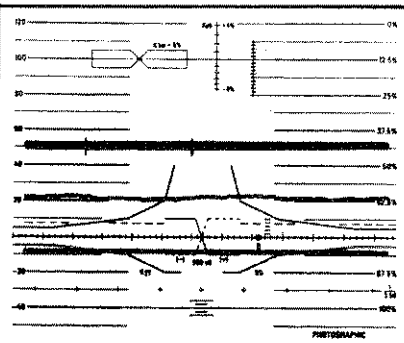
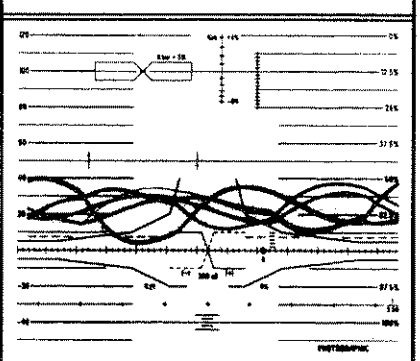
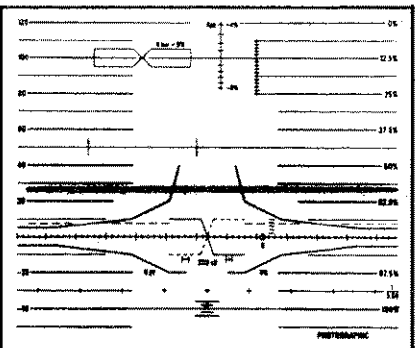
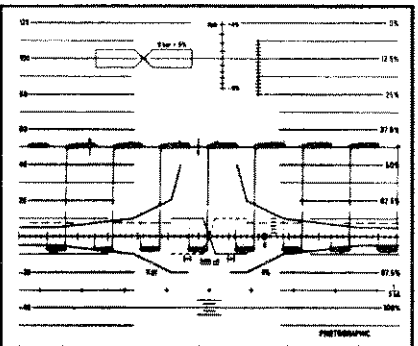
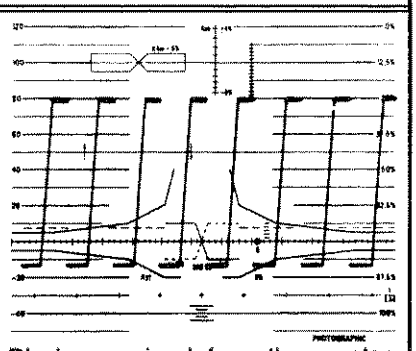
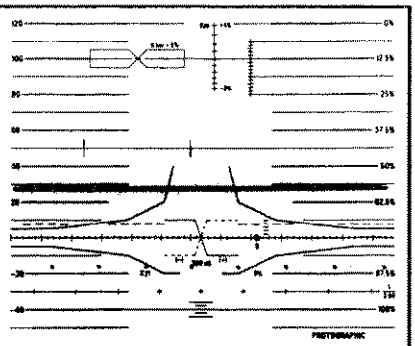
TR-70C PUSHBUTTON	1480-Series DISPLAY
CT PB 1813-70	 Displays capstan servo control track signal in the playback mode.
CT PB (Record Mode) 1813-71	 Displays control track during record for check of proper control track signal.
CAC 1813-72	 Displays line-by-line chrominance error signal.

TABLE 5-2 (cont)

TR-70C PUSHBUTTON	1480-Series DISPLAY
GUIDE 1813-73	 Displays a signal from the guide servo system as a performance check for that system.
REF 1813-74	 Displays the reference pulse as an operational check of the reference generator.
HW 1813-75	 Displays a signal from the head wheel servo system that indicates lockup of the system either in record or playback mode.

TR-70C PUSHBUTTON	1480-Series DISPLAY
CAP 1813-76	 Displays a signal from the capstan servo system that indicates lockup of the system either in record or playback mode.
TW 1813-77	 Displays the tonewheel pulse as an operational check of the tonewheel processor.

The signal of interest is selected by pressing one of the Waveform Monitor Selector pushbuttons, located on the TR70C panel below the Waveform Monitor. For detailed instructions about using the Waveform Monitor in the TR70C, see RCA Operation and Installation Manual, 1B-32168. Some typical displays are shown in Table 5-2.

Calibration Procedure

To check out or calibrate the 1480-Series Option 4 outside a Video Tape Recorder, use the following procedure.

Equipment Required. See Section 3, Performance Check/Calibration Procedure, for equipment specifications.

1. Test Oscilloscope.

2. 067-0621-00 Calibration Fixture. Remote Control for VTR Waveform Monitor.

3. Pulse Generator. Tektronix PG 501, a plug-in unit for the TM 500 test package.

4. Television Signal Source.

5. 75 Ω BNC Coaxial Cables (3) 012-0074-00.

6. 75 Ω End-Line Terminations (2) 011-0102-00.

7. 50 Ω BNC Coaxial Cable (2).

8. 50 Ω End-Line Termination (1) 011-0049-01.

Setup. Connect the PG 501 minus (−) output to the 1480-Series TAPE T. W. SYNC loop-through input using 50 Ω cable. Connect the second TAPE T. W. SYNC connector through 50 Ω cable and a 50 Ω termination to the Test Oscilloscope vertical input.

Connect composite video from the Television Signal Source to the 1480-Series A VIDEO INPUT using 75 Ω cable. Terminate the A VIDEO INPUT loop-through connector in 75 Ω.

Connect composite sync from the Television Signal Source to the 1480-Series A EXTERNAL SYNC input using 75 Ω cable. Terminate the loop-through connector in 75 Ω.

Connect the 067-0621-00 Calibration Fixture to J9034 on the 1480-Series rear panel.

Set the 1480-Series INPUT switch to A-AC, DC RESTORER to FAST and BACK PORCH, and SYNC to EXT. Set all switches on the 067-0621-00 up (Normal).

Set the Test Oscilloscope Time/Div to .5 ms and Volts/Div to 5. Set the PG 501 Output Amplitude for 3 volts, Pulse Duration for 300 μs and Period for 4.167 ms (4 ms for 625/50 PAL).

Rotate the 1480-Series vertical POSITION control to set the back porch of the displayed signal at the NTSC 0 IRE line, or the PAL 0.3 line.

Remove the 75 Ω termination from the A VIDEO INPUT loop-through. Note that the back porch of the displayed signal is clamped at the NTSC 0 IRE line or PAL 0.3 IRE line. Replace the 75 Ω termination.

Set the 067-0621-00 Horiz Display switch to 2 Field or Tone Wheel. Note that the back porch of the displayed signal remains at the NTSC 0 IRE line or PAL 0.3 line. If necessary, adjust R1823, on the Vertical board to replace the back porch of the displayed signal on the NTSC 0 IRE line or PAL 0.3 line.

Remove the 75 Ω termination from the A VIDEO INPUT loop-through connector. Note that the back porch of the displayed signal is not clamped. Replace the 75 Ω termination.

Rotate the DISPLAY switch to each position except EXT. Note that the display does not change.

Set the 067-0621-00 Ext Sync Source switch to Ext. Note that the display is stable.

Remove the 75 Ω cable from the A EXT SYNC loop-through connector. Note an unstable display. Replace the 75 Ω cable. Return the 067-0621-00 Ext Sync Source switch to Int.

Set the RESPONSE switch to AUX IN. Set the 067-0621-00 Ext Sync mode switch to Tone Wheel. Note that the display does not flicker, remains stable, and is 12.5 div ±0.5 div in length.

Remove the 50 Ω termination from the Test Oscilloscope Vertical Input. Adjust the PG 501 Output Amplitude control for maximum output. Note that the display is unchanged.

Remove all connections.

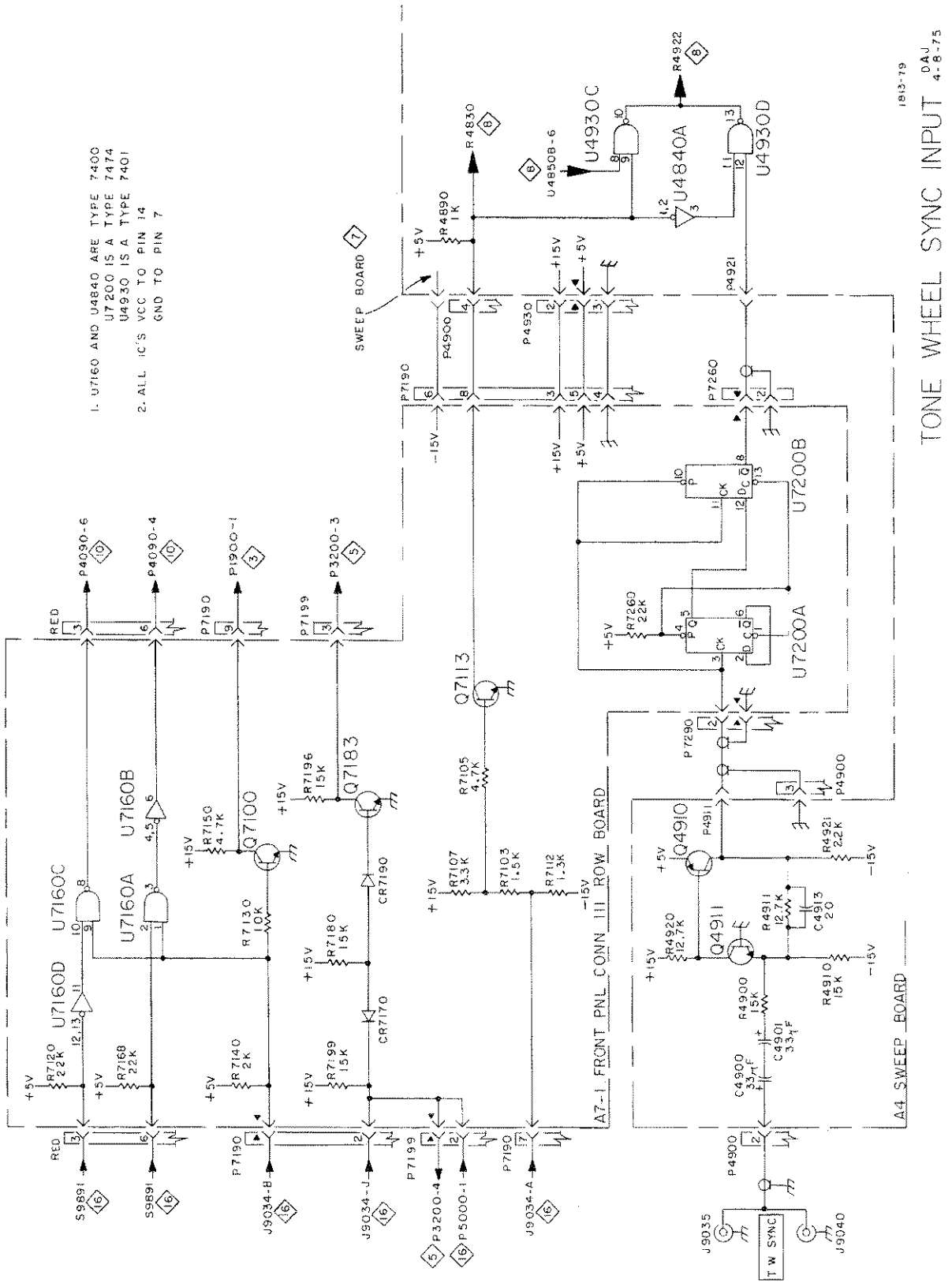

TONE WHEEL SYNC INPUT
A4 SWEEP BOARD
A7-1 FRONT PNL CONN III ROW BOARD
SWEEP BOARD
1. U7160 AND U4840 ARE TYPE 7400
U7200 IS A TYPE 7474
U4930 IS A TYPE 7401
2. ALL IC'S VCC TO PIN 14
GND TO PIN 7
U7160C
U7160D
U7160A
U7160B
U7200A
U7200B
U4930C
U4930D
U4840A
Q7100
Q7113
Q7183
Q4910
Q4911
T W SYNC

Fig. 5-4.

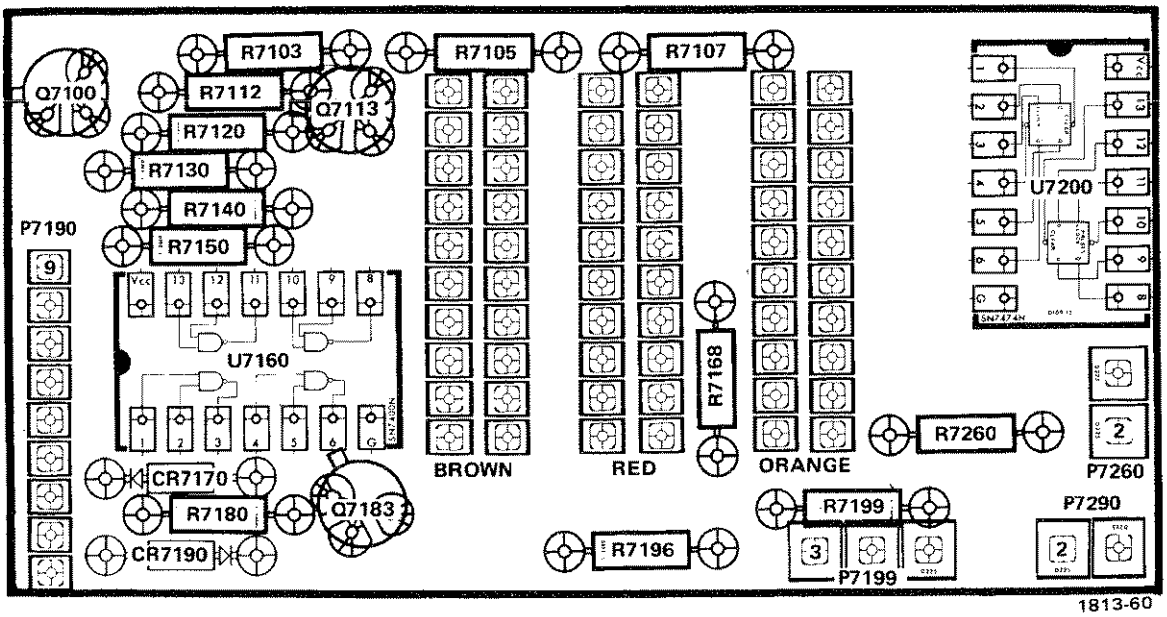


Fig. 5-5. A7-1 Front Panel Three-Row Interconnect Board.

Circuit Description

The Tone Wheel Sync Input circuit is composed of five sub-circuits (see Fig. 5-4):

1. 2 Field Sweep Enable. U7160A, B, C, and D switch the DISPLAY mode to 2 FIELD if the front-panel DISPLAY switch is in 5 μs/DIV or 10 μs/DIV. This can be accomplished by grounding J9034 pin B.

2. DC Restorer Control. Q7100 disables the DC Restorer circuit on Diagram 3 anytime J9034 pin B is grounded.

3. Internal Sync Switch. Q7183 enables the internal sync circuits in the Int/Ext Sync Switching circuit on Diagram 5 when J9034 pin J is grounded.

4. T. W. Sync Gate. Q7113 gates the 2 Field Sweep Generator on Diagram 8 to accept the Tone Wheel Sync pulses and turns off Q4820 on Diagram 8 to change sweep speed if 2 FIELD DISPLAY has been selected (either by the front-panel DISPLAY switch or by grounding J9034 pin B), and J9034 pin A is grounded.

5. T. W. Sync ÷ 2. U7200 divides the tone wheel sync rate by two, ensuring a full horizontal trace.

2 Field Sweep Enable. The ground at J9034 pin B is applied through P7190-1 to U7160A pin 1 and U7160C pin 9. U7160A pin 3 is normally high if the front-panel DISPLAY switch is in 2 FIELD or EXT and low if 5 μs/DIV or 10 μs/DIV have been selected. If the front-panel DISPLAY switch is in 2 FIELD or EXT, the ground at U7160A pin 1 has no effect. If the DISPLAY switch is in 5 μs/DIV or 10 μs/DIV, the ground at U7160A pin 1 switches U7160A pin 3 from low to high, causing a low output at U7160B pin 6. That low output is applied to the Horizontal Switching circuit on Diagram 10 (P4090-4) to inhibit the 5 μs/DIV or 10 μs/DIV sweep. At the same time U7160C pin 9 receives the same ground as U7160A pin 1. If the front-panel DISPLAY switch is in 2 FIELD or EXT, the ground has no effect. If the DISPLAY switch is in 5 μs/DIV or 10 μs/DIV, the output of U7160C is switched from low to high. That high is applied to the Horizontal Switching circuit on Diagram 10 (P4090-6), enabling the 2 FIELD sweep.

DC Restorer Control. Certain VTR measurements are made using signals that are not composite video. When these measurements (for instance FM Level, Velocity Error Correction, and Chrominance Amplitude Correction) are made, the DC Restorer on Diagram 3 must be turned off because there is no signal reference for the DC Restorer.

When J9034 pin B is grounded, Q7100 is turned off, applying a positive voltage to the base of Q1483 on Diagram 3. Q1483 saturates, inhibiting the DC Restorer.

At the same time Q1483 on Diagram 3 saturates, an added circuit on Diagram 3 is enabled. This added circuit consists of U1820 and associated components, and is used to apply additional positioning current to the Gain Control circuit when Q7100 turns off. R1814 on Diagram 3 is adjusted for minimum trace shift when J9034 pin B is grounded.

Internal Sync Switch. Q7183 is normally off with the front-panel SYNC INT button pushed, and saturated with the front-panel SYNC EXT button pushed. If the SYNC EXT button is pushed and J9034 pin J is grounded, CR7170 is forward biased, turning off Q7183, and switching the Int/Ext Sync Switching circuit on Diagram 5 to internal sync.

T. W. Sync Gate. With J9034 pin A open, Q7113 is off, allowing the 2 Field Sweep Gate on Diagram 8 to operate as usual. When J9034 pin A is grounded, Q7113 is saturated, applying a low to U4930C pin 9 and U4840A pins 1 and 2. This switches the sweep gating function from U4930C to U4930D. U4930D is gated by Tone Wheel Sync from U7200.

T. W. Sync ÷2. Q4911 and Q4910 on the Sweep board receive the Tone Wheel Sync signal from the rear-panel TAPE T. W. SYNC input. These two transistors form an inverting operational amplifier with an output pulse amplitude of about 5 volts. The collector of Q4910 drives the clock inputs of divide-by-two circuit U7200A and U7200B.

At the leading edge of the Tone Wheel Sync pulse, U7200B pin 10 goes low. At the trailing edge of the Tone Wheel Sync pulse, U7200A pin 5 changes states. If U7200A pin 5 is low when the Tone Wheel Sync pulse arrives, U7200B pin 8 will go low, but will be reset high at the trailing edge of Tone Wheel Sync by U7200A pin 5. The result is a pulse out at U7200B pin 8 for every two pulses in at the TAPE T. W. SYNC connectors.

The output of U7200B gates U4930D on the Sweep board to reset and start the 2 Field Sweep Generator, and grounds the emitter of Q4820 on Diagram 8. When Q4820 turns off, the base current source for Q4821 is removed, removing the ground at the junction of R4720 and R4712. This places R4720 and R4712 in parallel with the 2 Field Sweep timing resistor, changing the sweep speed.

OPTION 4

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
REMOVE:						
	670-3515-00			CKT BOARD ASSY:3 ROW INTERCONNECT	80009	670-3515-00
ADD:						
	670-3915-00			CKT BOARD ASSY:3 ROW INTERCONNECT W/VTR	80009	670-3915-00
CR7170	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
CR7190	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
Q7100	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q7113	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q7183	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
R7103	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R7105	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R7107	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R7112	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R7120	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R7130	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R7140	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R7150	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R7180	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R7185	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R7196	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R7199	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R7260	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
U7160	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U7200	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N

OPTION 4 AND 5

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
	670-3485-05[1,2]	B030000	B041267	VERTICAL AMPLIFIER SAME AS STANDARD CIRCUIT BOARD		
	670-3485-10[1,2]	B041268		EXCEPT AS FOLLOWS:		
	670-3485-05[1,3]	B030000	B040295	VERTICAL AMPLIFIER SAME AS STANDARD CIRCUIT BOARD		
	670-3485-10[1,3]	B040296		EXCEPT AS FOLLOWS:		
REMOVE:						
R1781	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1820	131-0566-00			LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
R1830	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
ADD:						
C1815	283-0068-00	XB043170		CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
Q1805	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1025-00
R1814	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
U1820	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
	670-3488-01[4]			SWEEP OUTPUT SAME AS STANDARD CIRCUIT BOARD EXCEPT AS FOLLOWS:		
REMOVE:						
CR4821	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	1N4152
Q4820	151-0216-00			TRANSISTOR:SILICON,PNP	04713	MPS6523
R4712	321-0363-00			RES.,FXD,FILM:59K OHM,1%,0.125W	91637	MFF1816G59001F
R4921	315-0492-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
C4913	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
Q4820	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4821	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q4910	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4911	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
R4712	321-0399-00			RES.,FXD,FILM:140K OHM,1%,0.125W	91637	MFF1816G14002F
R4713	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R4921	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
V960C[5]	154-0718-00			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-00
V960[6]	154-0718-01			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-01
	670-3485-02[7,2]	B030000	B041267	VERTICAL AMPLIFIER SAME AS STANDARD CIRCUIT BOARD		
	670-3485-07[7,2]	B041268		EXCEPT AS FOLLOWS:		
	670-3485-02[7,3]	B030000	B040295	VERTICAL AMPLIFIER SAME AS STANDARD CIRCUIT BOARD		
	670-3485-07[7,3]	B040296		EXCEPT AS FOLLOWS:		
REMOVE:						
R1781	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1820	131-0566-00			LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
R1830	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
ADD:						
C1815	283-0068-00	XB043170		CAP.,FXD,CER DI:0.01UF,+100-0%,500V	56289	19C241
Q1805	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1025-00
R1814	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
U1820	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00

[1] 1481 Option 4 and 1485 Option 4.
[2] Cabinet only.
[3] Rackmount only.
[4] 1480 Option 4, 1481 Option 4, 1485 Option 4 and 1485 Option 5.
[5] 1480 Option 4 and 1485 Option 5.
[6] 1481, 1482 and 1485 Option 4.
[7] 1485 Option 5, 1480 and 1482 Option 4.

OPTION 4 AND 5

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
	131-0566-00[1]			4		LINK,TERM.CONNE:0.086 DIA X 2.375 INCH L	55210	L-2007-1
	136-0514-00[1]			1		SOCKET,PLUG IN:MICROCIRCUIT,8 CONTACT	73803	C9308-02
	136-0220-00[2]			3		SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
-1	131-0955-00			2		CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	05091	31-279
-2	346-0118-00			1		STRAP,GROUNDING:BNC	80009	346-0118-00
-3	386-3088-00			1		PLATE,MTG:2 BNC	80009	386-3088-00
						(ATTACHING PARTS)		
-4	213-0054-00			1		SCR,TPG,THD FOR:6-32 X 0.312 INCH,PNH STL	83385	OBD
-5	211-0097-00			2		SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
						- - - * - - -		
-6	200-1888-00			1		COVER,CONN HOLE:PROBE VTR	80009	200-1888-00
						(ATTACHING PARTS)		
-7	220-0743-00			2		NUT,STAMPED:0.187 THD X 0.217 H,CD PL STL	80009	220-0743-00
						- - - * - - -		
-8	179-2315-00			1		WIRING HARNESS:VTR	80009	179-2315-00
	----- -----			1		CKT BOARD ASSY:3 ROW INTERCONNECT(SEE EPL)		
	131-0589-00			7		. CONTACT,ELEC:0.46 INCH LONG	22526	47350
	131-0608-00			69		. CONTACT,ELEC:0.365 L X 0.25 PH BRZ GOLD PL	22526	47357
	136-0220-00			3		. SOCKET,PLUG-IN:3 PIN,SQUARE	71785	133-23-11-034
	136-0269-02			2		. SOCKET,PLUG-IN:14 CONTACT,LOW CLEARANCE	01295	C931402
	331-0393-00			1		SCALE,CRT:EXT,NTSC GRATICULE B 100%	80009	331-0393-00
	331-0393-05			1		SCALE,CRT:CCIR K FACTOR(VISUAL)(1481)	80009	331-0393-05
						STANDARD ACCESSORIES		
	103-0031-00			2		ADAPTER,CONN:BNC RIGHT ANGLE	05617	KUG-306A/U
	011-0102-00			1		TERMN.COAX:75 OHM,BNC	80009	011-0102-00
	159-0018-00[3]			1		FUSE,CARTRIDGE:3AG,0.8A,250V,SLOW-BLOW	71400	MDL 8/10
	159-0031-00[4]			1		FUSE,CARTRIDGE:3AG,0.4A,250V,SLOW-BLOW	71400	MDL 4/10
	161-0104-00			1		CABLE ASSY,PWR,:3 WIRE,98.0" LONG	80009	161-0104-00
	331-0393-00			1		SCALE,CRT:EXT,NTSC GRATICULE B 100%	80009	331-0393-00
	331-0393-01			1		SCALE,CRT:NTSC,W/HOLE	80009	331-0393-01
	331-0393-02			1		SCALE,CRT:CCIR,W/HOLE	80009	331-0393-02
	331-0393-05			1		SCALE,CRT:CCIR K FACTOR(VISUAL (1481)	80009	331-0393-05
	331-0393-07			1		SCALE,CRT:CCIR K FACTOR,PHOTOGRAPHIC	80009	331-0393-07
	331-0393-08			1		SCALE,CRT:EXT,NTSC GRATICULE A 100%	80009	331-0393-08
	331-0393-09			1		SCALE,CRT:EXT,NTSC,GRATICULE	80009	331-0393-09
	331-0343-10			1		SCALE,CRT:EXT,NTSC,GRAT B PHOGRAPHIC	80009	331-0343-10
	331-0393-11			1		SCALE,CRT:EXT,NTSC GRATB PHOTOGRAPHIC	80009	331-0393-11

[1]Vertical Amplifier
[2]Sweep Output
[3]For 115 V.
[4]For 230 V.

MAINTENANCE

The maintenance information contained in this section falls into three categories; Preventive Maintenance, Troubleshooting, and Corrective Maintenance.

Preventive Maintenance includes inspection, cleaning, lubrication, and recalibration. Troubleshooting contains information for isolating a trouble to a component. Corrective Maintenance includes procedures for removing and replacing components.

PREVENTIVE MAINTENANCE

A regular schedule of preventive maintenance can improve instrument reliability. How often the preventive maintenance schedule is performed should be determined by the severity of the operating environment.

Visual Inspection

Visually inspect the instrument during the preventive maintenance routine for such defects as broken connectors, loose or disconnected pin connectors, improperly seated transistors and integrated circuits, and damaged components.

The corrective procedure for most visible defects is obvious; however, care must be taken to determine and correct the cause of heat-damaged components. Heat damage is frequently an indication of troubles elsewhere in the instrument.

Multi-Pin Connectors

Most inter-circuit connections between the circuit boards or between boards and chassis-mounted components are made through multi-pin connectors. The connector holder has identification numbers that identify terminal connector No. 2 and up. A triangular key symbol is also located on the circuit board to identify pin No. 1 (see Fig. 6-1) so that the connector holder can be properly oriented.

Cleaning

Dust accumulating in the instrument acts as an insulating blanket, preventing efficient heat dissipation, and possibly causing overheating and component breakdown. Accumulated dust can also provide an electrical conduction path, especially under high humidity conditions.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Avoid chemicals that contain benzene, toluene, xylene, or similar solvents.

Exterior. Remove accumulated dust with a soft cloth or small paint brush. The brush is particularly useful around the front panel controls.

Remaining dust can be removed with a soft cloth, dampened in a mild detergent and water solution. Do not use abrasive cleaners.

Crt. Clean the crt face, graticule mask, external graticule, filter, and bezel with a soft, lint-free cloth dampened with mild detergent and water. Repeat with a cloth dampened with water only. Avoid hard rubbing when cleaning the painted side of the external graticule to prevent dislodging the markings.

Interior. The best way to remove accumulated dust inside the instrument is to blow it off with dry, low-velocity air. Remaining dust can be removed with a small paint brush followed by a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful in tight places.

Lubrication

The reliability of potentiometers, rotary switches, and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant on switch contacts (for example, Tektronix Part Number 006-0442-00), and a heavier grease on switch detents (for example, Tektronix Part Number 006-0219-00). Lubricate non-sealed potentiometers with a lubricant that does not affect the electrical characteristics (for example, Tektronix Part Number 006-0172-00). The potentiometer lubricant can also be used on shaft bushings. Do not overlubricate.

A kit, containing the necessary lubricants and instructions may be ordered from Tektronix, Inc. Order Tektronix Part Number 003-0342-01.

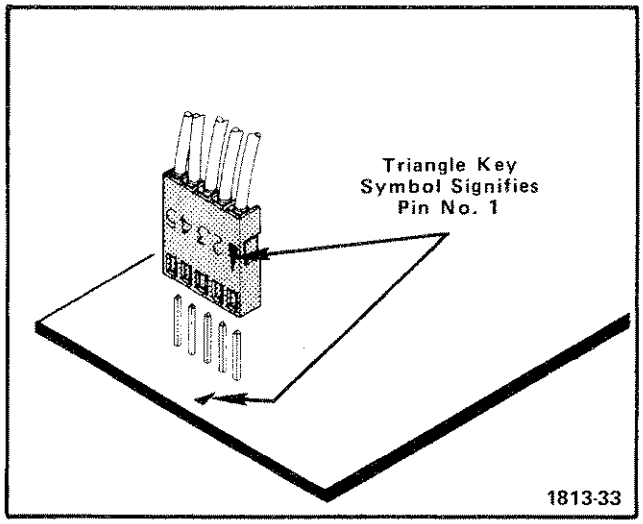


Fig. 6-1. Multi-pin circuit board connector.

Transistor and Integrated Circuit Checks

Periodic transistor and integrated circuit checks are not recommended. The best performance check for these devices is actual operation of the instrument. Performance of the circuit is thoroughly checked during the performance check or calibration procedure. Any substandard transistors or integrated circuits will usually be detected at that time.

Recalibration

The length of time between recalibration depends on the amount of use the instrument receives, the nature of the environment, and the change in performance when some components are replaced.

In general, a partial recalibration is necessary if the components replaced affect the calibration of a portion of the instrument. Complete recalibration is recommended if the instrument is not operating at its full capability, or if the crt or power transformer T9400 is replaced. To ensure correct and accurate instrument operation, the instrument performance should be checked at regular intervals; for example, after 1000 hours of operation if used continuously or every 6 months if used infrequently.

A Performance Check/Calibration Procedure is given in Section 3.

TROUBLESHOOTING

The following is provided to augment information contained in other sections of this manual when troubleshooting a 1480-Series instrument. The schematic diagrams, circuit description, and calibration sections should be used to full advantage.

Troubleshooting Aids

Theory of Operation. Section 4 describes circuit operating theory. Used in conjunction with the schematics, test point waveforms, and block diagrams, the information provided in the Theory of Operation section is helpful when analyzing circuit operation.

Diagrams. Circuit diagrams are given on the foldout pages in Section 9. The circuit number and electrical value of each component in this instrument are shown on the diagrams. Important waveforms are also shown.

Circuit Boards. The circuit boards used in the 1480-Series instrument are outlined in blue on the schematic diagrams. Circuit board illustrations are provided on the back of the foldout pages that precede the relevant diagrams. The assembly number assigned to the circuit boards is an abbreviated method for identifying the boards. Figs. 6-2 and 6-3 show the physical location of the boards along with the assembly numbers for the cabinet and rackmount models.

Circuit Board Illustration. Each circuit board is illustrated in the Diagrams & Parts Locations section. For an example, refer to the Vertical Amplifier board which is illustrated on the back of the Block Diagram fold-out page.

Circuit numbers are assigned on a grid system. The upper left hand corner of this board has been assigned numbers around 1000. Proceeding from left to right, the numbers increase toward 1900. From left to right across the bottom of the board, the numbers increase from around 1090 toward 1999. Using this method, the physical location of each component is readily available.

Wire Color Code. All insulated wires used for interconnection in the instrument are color-coded to facilitate tracing a wire from one point to another.

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

Resistor Color Code. Colored stripes on resistors signify electrical values, tolerances, etc., according to the EIA standard color code (see Fig. 6-4). Resistors not color-coded usually have the value imprinted on the body.

Capacitor Markings. The capacitance value of a common disc capacitor or small electrolytic is marked in microfarads on the side of the component body. The white ceramic capacitors used in the instrument are color-

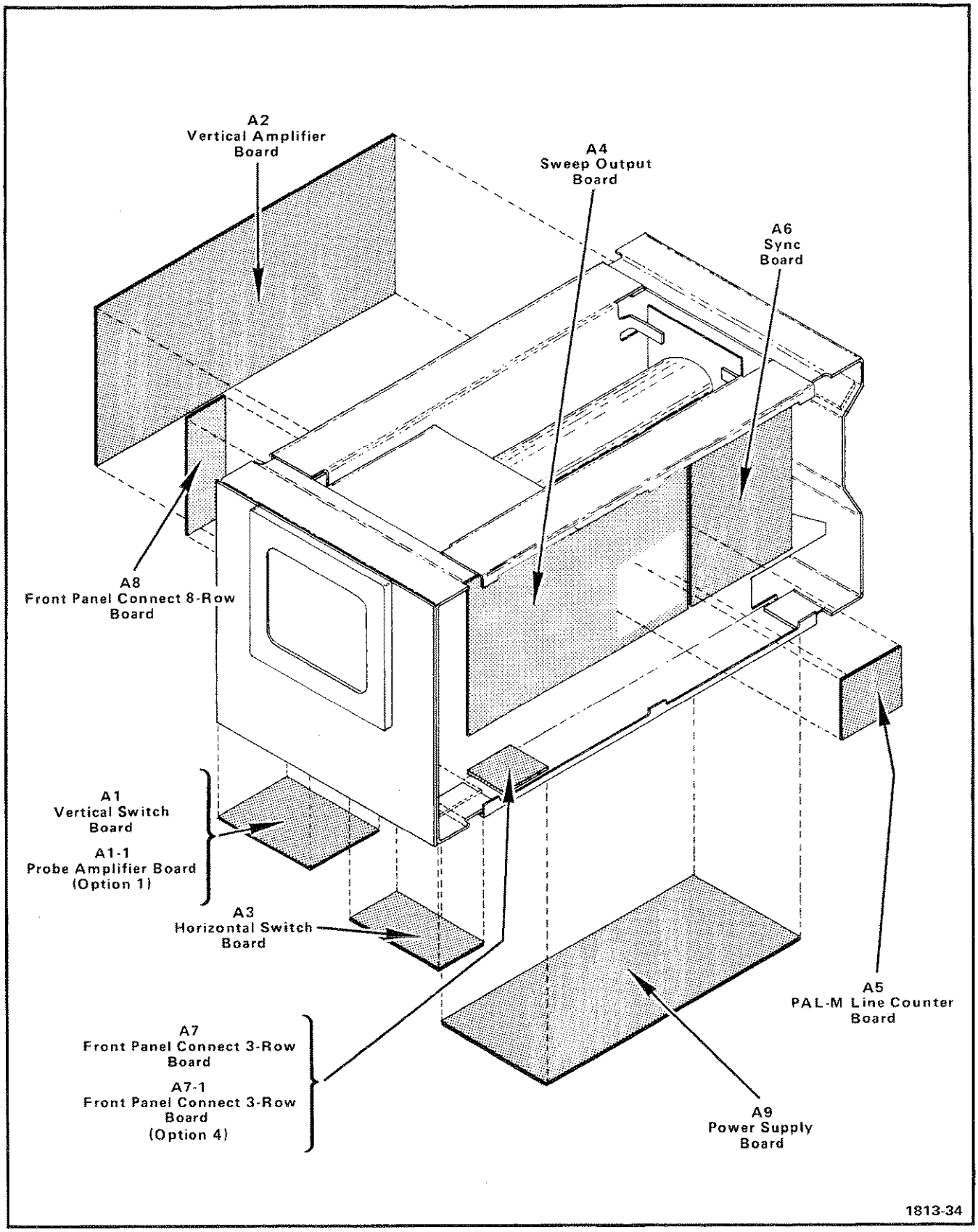


Fig. 6-2. Location of circuit boards in the 1480C-Series (cabinet model) instruments.

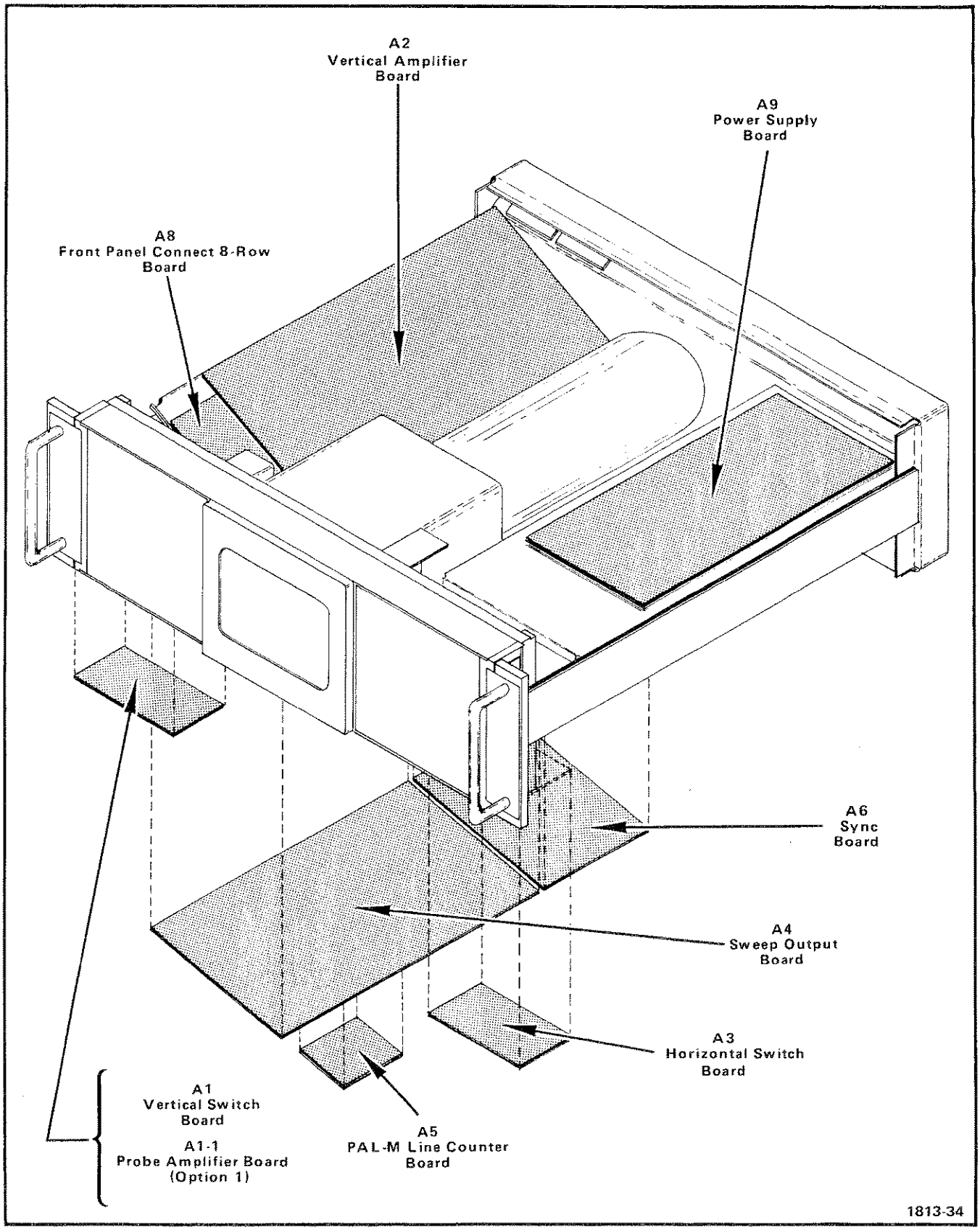
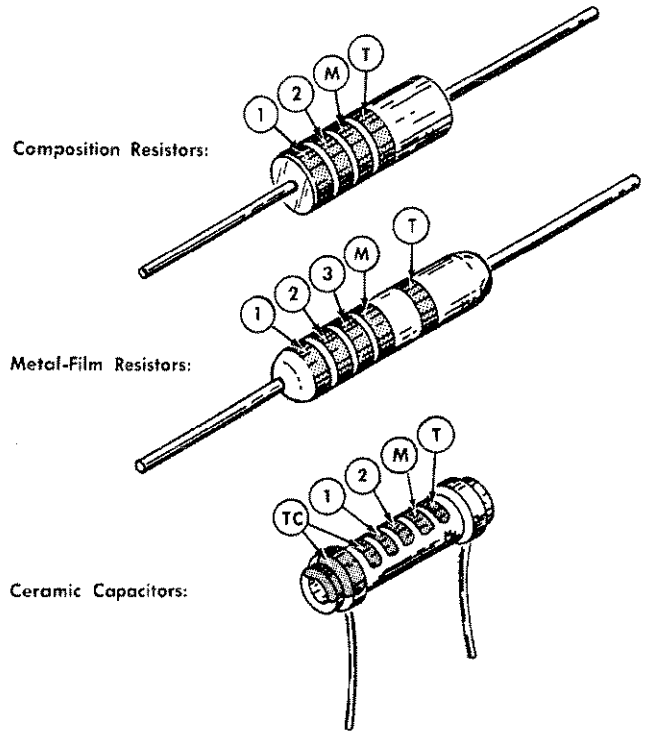


Fig. 6-3. Location of circuit boards in the 1480R-Series (rackmount model) instruments.



Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier: Resistors	Multiplier: Capacitors	Tolerance: Resistors	Tolerance: Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^{2}	10^{2}	±2%	±2%
Orange	3	10^{3}	10^{3}	±3%	±3%
Yellow	4	10^{4}	10^{4}	±4%	+100% —0%
Green	5	10^{5}	10^{5}	±0.5%	±5% or 0.5 pF*
Blue	6	10^{6}	10^{6}	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% —20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

*For capacitance of 10 pF or less.

NOTE: T and/or TC color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 6-4. Color Code for resistors and ceramic capacitors.

coded in picofarads using a modified EIA code (see Fig. 6-4). The "tear drop" capacitors are color-coded in microfarads using a modified EIA code, with the dot indicating both temperature and positive (+) side. See Fig. 6-5.

Transistor and Integrated Circuit Lead Configurations. Fig. 6-6 illustrates the lead configurations for the socket-mounted transistors, field effect transistors (FET's) and Integrated Circuits (IC's) used in the instrument.

IC Diagrams and Troubleshooting Chart. The IC diagrams illustrate the positive logic functions of the IC's. The troubleshooting chart is a block diagram procedure for isolating troubles. Both of these are located in Section 8 of this manual.

Troubleshooting Equipment

The following signals and equipment are useful for troubleshooting the 1480-Series instrument.

1. Signals. 1-V peak-to-peak composite video test signals—NTSC and 625/50 PAL.

2. Test Oscilloscope. For viewing waveforms at various test points in the circuit. Frequency response: dc to at least 10 MHz. It should be equipped with a 10X probe.

3. DVM and Ohmmeter. For measuring dc voltages and resistances accurately. The ohmmeter is also required for checking continuity.

4. Semiconductor Tester. Some means of testing the transistors, diodes, and FET's used in this instrument is helpful. A transistor-curve tracer such as the Tektronix Type 576 will give the most complete information.

Troubleshooting Procedure

This procedure is arranged in a sequence that checks the simple trouble possibilities first.

1. Check Control Settings. Incorrect control settings or wrong internal jumper positions can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control or jumper, refer to the Operating Instructions section.

Rated Voltage VDC 25°C	Color	CODE FOR CAPACITANCE IN PICOFARADS		
		1st Figure	2nd Figure	Multiplier—pF
4	Black	0	0	None
6	Brown	1	1	X 10
10	Red	2	2	X 10^2
15	Orange	3	3	X 10^3
20	Yellow	4	4	X 10^4
25	Green	5	5	X 10^5
35	Blue	6	6	X 10^6
50	Violet	7	7	X 10^7
	Gray	8	8	
3	White	9	9	

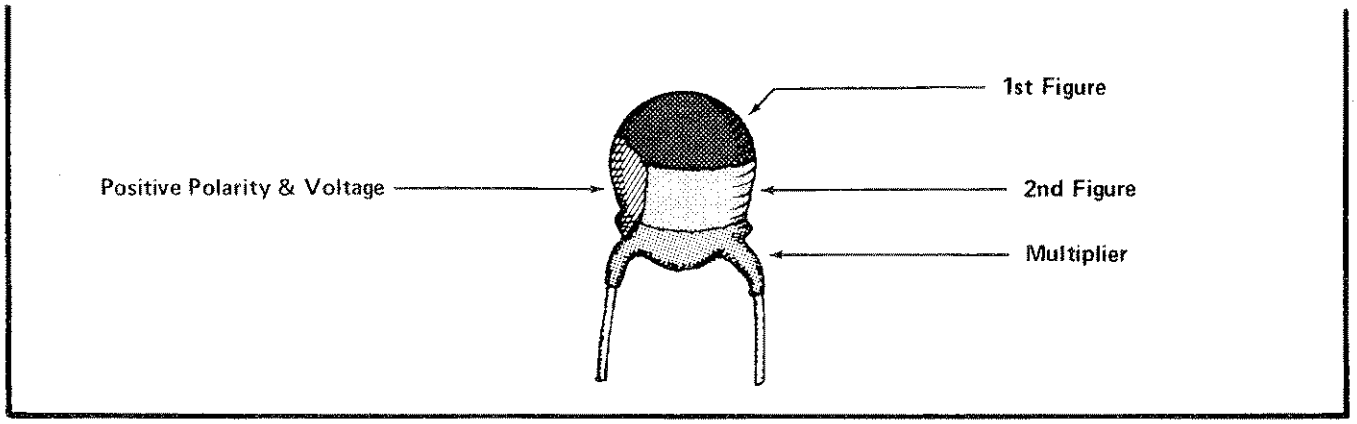


Fig. 6-5. Color coding for dipped tantalum "tear drop" capacitors.

2. Check Associated Equipment. Before trouble-shooting the instrument, check that the applied signal is correct and properly connected. Check that the probe, if used, is not defective.

3. Isolate Trouble to a Circuit. If the 1480-Series instrument is at fault, isolate the trouble to a circuit by noticing the trouble symptoms. This can be accomplished by using the front panel controls and observing the crt display to identify the nature of the trouble. Then, use steps 4 through 6 to isolate the trouble to the probable cause such as a defective component or connection. For example, the instrument operates normally in all positions of the INPUT switch except the PROBE position. The next step is to check the PROBE position of the switch and associated circuitry. Another useful aid is the trouble-shooting chart provided on the last pullout page in Section 8 of this manual.

4. Visual Check. Visually check the portion of the instrument in which the trouble is suspected. Some troubles can be located by checking for unsoldered connections, broken wires, loosely-seated transistors, loose-fitting connectors, damaged components, or damaged circuit boards.

5. Check Voltages and Waveforms. Often the defective component or stage can be located by checking for the correct voltage or waveform in the circuit. Typical waveforms are given near the diagrams. To obtain operating conditions similar to those used to take these waveforms, refer to the instructions at the start of the Diagrams section.

CAUTION

Because of component density on circuit boards, care should be taken with meter leads and probe tips. Accidental shorts can cause abnormal voltages or transients that may destroy components. "Ground lugs" are not always at ground potential. Check the diagrams before using such connections as ground for meter prods or oscilloscope probes. Some transistor cases may be elevated.

6. Check Individual Components. When you have isolated the trouble to one circuit or stage, the next step is to isolate the trouble to one component or part. Components that are soldered in place are best checked by disconnecting one end to isolate the measurement from the effects of surrounding circuitry. The following methods are provided for checking individual electrical components in the instrument.

a. Transistors. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can be checked by substituting a new component or one which has been checked previously. However, be sure that the circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester (such as the Tektronix Type 576) to check the transistor.

b. Integrated Circuits. Integrated circuits should not be replaced unless they are actually defective. The best method for checking these devices is by direct substitution with a new component or one which is known to be good. Be sure that circuit conditions are not such that a replacement component might be damaged.

c. Diodes. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. Use an ohmmeter, set to the 1k scale to keep from damaging the diode, for measuring the diode resistance. The resistance should be very high in one direction and very low when the ohmmeter leads are reversed.

d. Resistors. Resistors can be checked with an ohmmeter. Check the Electrical Parts List for the tolerance of the resistors used in the instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

e. Inductors & Switch Contacts. Check for an open circuit (that should normally be closed) by checking continuity with an ohmmeter.

f. Capacitors. A leaky or shorted capacitor can best be detected by checking the resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Soldering Techniques

WARNING

Disconnect the instrument from the power source before soldering.

Reliability and optimum performance of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. Soldering techniques that apply to maintenance of precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core, electronic grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards, use a 15- to 25-watt pencil-type soldering iron with a 1/8-inch wide, wedge-shaped tip. Keep the tip properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the etched wiring from the base material. Avoid excessive heat; apply only enough heat to remove the component or to make a good solder joint. Also, apply only enough solder to make a firm solder joint; do not apply too much solder. Use a desoldering tool or other device when it is necessary to remove excess solder.

The pencil-type soldering iron used on the circuit boards can be used for soldering to switch terminals, potentiometers, or metal terminals mounted in plastic holders. For ground lugs that are connected to the chassis, or other metal terminals that are connected to a large heat-radiating serface, use a higher-wattage-rating soldering iron with a larger tip.

After soldering is completed, clean the area around the solder connection with a flux-remover solvent. Be careful not to remove any information printed in the area.

Location Guide for Replacing Parts

The exploded-view drawings associated with the Mechanical Parts List (located at the rear of the manual) are helpful in the removal or disassembly of individual components or subassemblies. Circuit board illustrations are provided on the backs of foldout pages in the Diagrams section of this manual.

WARNING

Disconnect the instrument from the power source before replacing components.

Circuit Board Replacement

If a circuit board is damaged beyond repair, the entire assembly, including all soldered-on components, can be replaced. Tektronix part numbers are given in the Electrical Parts List.

Most of the circuit boards in this instrument are mounted on the chassis. Multi-pin connectors are used for interconnection with other circuits. Use the following procedure to remove circuit boards.

Chassis-Mounted Boards.

1. Disconnect the multi-pin connectors from the board. Note the order of these connectors so they can be correctly replaced. Disconnect any other connectors that are used for interconnection to other circuits.

2. Remove the securing screws.

3. Remove the board.

4. To replace the board, reverse the order of removal. Match the triangle key symbol on the multi-pin connectors to the same symbol on the board.

Loop-Thru Boards. These boards are mounted and soldered directly to the center pins of the BNC connectors.

1. Unsolder the coaxial cable signal lead from the board.

2. Desolder the BNC connector pins that protrude through the board.

3. Remove the board and install the new one.

Vertical and Horizontal Switch Boards.

1. Disconnect the multi-pin connectors from the board.

2. Remove the securing screws. To obtain access to these screws in the 1480C-Series (cabinet model) instruments, remove the eight flat-head screws that hold the front assembly to the chassis. Move the front frame assembly outward sufficiently to reach the board securing screws.

3. Remove the board with attached pushbutton assemblies.

4. Install the board by reversing the order of removal.

Pin Connector Replacements

Circuit board pins, end-lead pin connectors, and multi-pin connectors are used to interconnect the circuit boards and power transistors in the instrument.

Circuit Board Pins.

NOTE

A circuit-board pin replacement kit including necessary tools, instructions and replacement pins is available from Tektronix, Inc. Order Tektronix Part No. 040-0542-00.

To replace a pin that is mounted on a circuit board, first disconnect the multi-pin connector. Then, unsolder the damaged pin and pull it out of the circuit board with a pair of pliers. Be careful not to damage the etched wiring on the board with too much heat. Ream out the hole in the circuit board with a 0.031-inch drill. Press the new pin into the hole in the circuit board. Position the pin in the same manner as the old pin. Then, solder the pin on both sides of the circuit board.

End-Lead Pin Connectors. End-lead pin connectors are used at the ends of the wire leads that mate with circuit board pins and power transistor leads. When several end-lead pin connectors are mounted in a plastic holder, this arrangement is called a multi-pin connector. Table 6-1 lists three basic sizes of end-lead pin connectors for replacement use in the instrument.

TABLE 6-1

End-Lead Pin Connectors

Description	Tektronix Part No.
Used with 0.100-inch pin spacing connector holder:	
For 22 to 26 AWG wire and 50 Ω or 75 Ω subminiature coaxial cable braid and center conductor	131-0707-00
Used with 0.150-inch pin spacing connector holder:	
For 22 to 26 AWG wire and 50 Ω or 75 Ω subminiature coaxial cable braid and center conductor	131-0621-00
For 18 AWG wire and large coaxial cable braid	131-0792-00

To replace a damaged end-lead pin connector, remove the old pin connector by cutting the connector where the bare (stripped portion) wire is clamped. By doing this, you can avoid making the wire too short. Then, pull the wire out of the remaining attached portion of the connector. Cut the excess material from the replacement connector. Clamp the replacement connector securely to the lead and insert the connector in its holder.

Semiconductor Replacement

Semiconductors should not be replaced unless they are actually defective.

CAUTION

The POWER switch must be turned off before removing or replacing semiconductors.

If the semiconductors are removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the calibration of this instrument. When semiconductors are replaced, check the operation of the parts of the instrument whose calibration may be affected.

Replacement semiconductors should be of the original type or a direct replacement. Fig. 6-6 shows the lead configuration of the semiconductors used in this instrument. Some plastic-cased transistors have lead configurations that do not agree with those shown here. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in this instrument are wired for the standard basing as used for metal-cased transistors. Power transistors that are mounted on the chassis use silicone grease to increase heat transfer. Replace the silicone grease when replacing these transistors.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

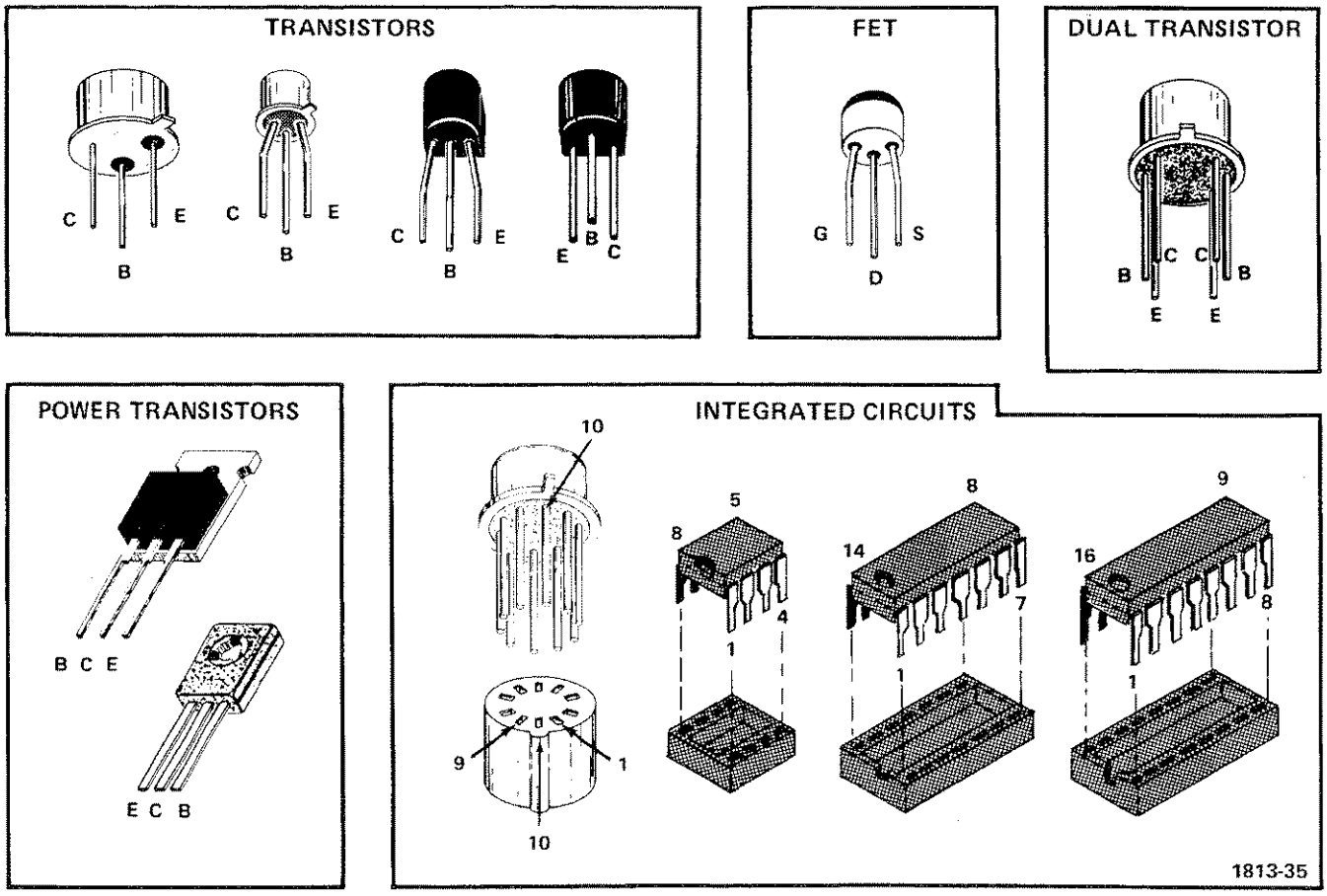


Fig. 6-6. Basing diagram for semiconductors.

An extracting tool should be used to remove the 8-, 14-, and 16-pin integrated circuits to prevent damage to the pins. This tool is available from Tektronix, Inc. Order Tektronix Part No. 003-0619-00. If an extracting tool is not available when removing one of these integrated circuits, pull slowly and evenly on both ends of the device. Try to avoid having one end of the integrated circuit disengage from the socket before the other, as this may damage the pins.

Cathode-Ray Tube Replacement

WARNING

Use care when handling the crt. Protective clothing and safety glasses should be used. Avoid striking it on any object that might cause it to crack or implode. When storing a crt, place it in protective carton or set it face down in a protected location on a smooth surface with a soft mat under the faceplate to protect it from scratches.

Removal.

1. Push off from the inside, or pry off from the outside, the rear panel crt hole cover.

2. Remove the crt base socket from the rear of the crt.

3. Loosen the neck clamp screw (see Fig. 6-7).

4. Disconnect the deflection-plate connectors. Be careful that you do not bend the deflection plate pins.

5. Disconnect the crt anode lead where it connects to the high voltage connector outside of the crt shield. Ground the crt anode lead to the chassis to dissipate any stored charge.

6. Remove the front panel bezel mounting nuts. Remove the bezel, rubber washers, filter, external graticule, and the gray plastic graticule mask.

7. Hold one hand on the crt faceplate and push on the crt base with the other. As the crt starts moving out of the shield, grasp the crt firmly. If the crt does not budge, loosen the crt neck positioning screws (see Fig. 6-7) slightly so the crt can be moved around. Then push on the crt base while moving the base gently from side to side. Guide the anode lead through the hole in the crt shield as the crt is removed.

Replacement.

1. Insert the crt in the shield. Guide the anode lead through the hole in the crt shield.

2. Clean the crt faceplate with denatured alcohol.

3. Clean the graticule mask, external graticule, filter, and bezel with a soft, lint-free cloth dampened with mild detergent and water. Then use a dry cloth to finish cleaning the surfaces. Install all the parts, including the rubber washers, and tighten the graticule nuts.

4. Push forward on the crt base to check that the crt is as far forward as possible. At the same time move the base of the crt so that the faceplate is flush (not tilted) with the external graticule. Hold the crt in this position while tightening the crt neck clamp and positioning screws.

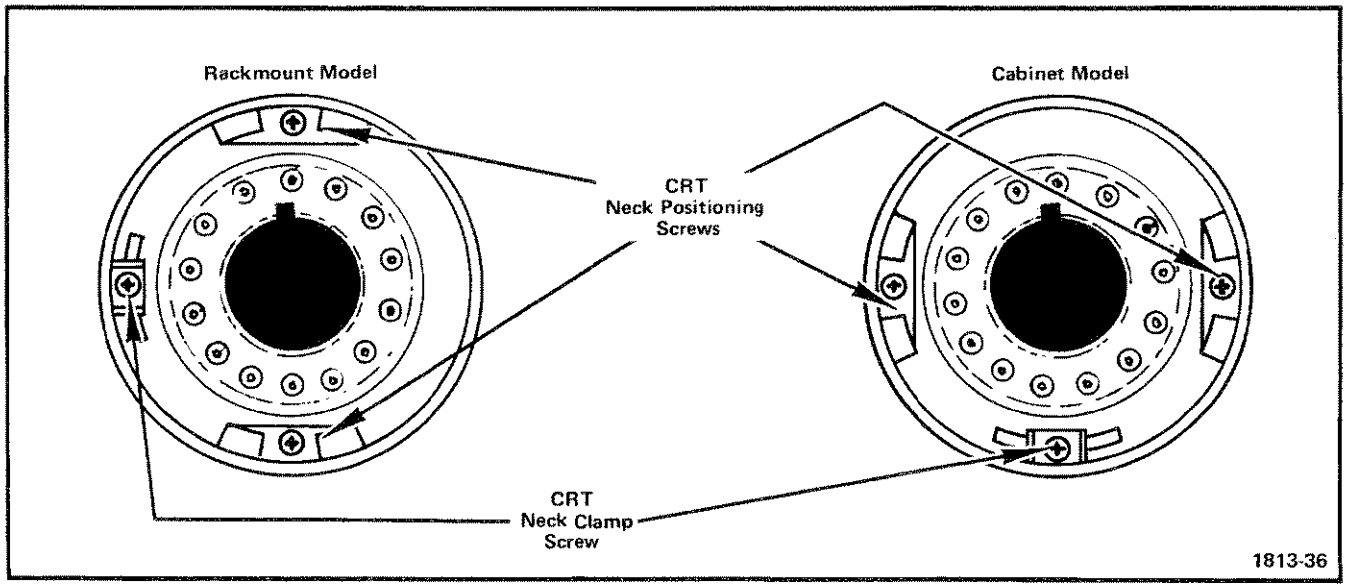


Fig. 6-7. Rear view of crt shield.

5. Install the crt base socket and cover plate.

6. Reconnect the crt anode lead to the high voltage connector.

7. Carefully reconnect the deflection-plate pin connectors. After installing each connector, pull on the connector lightly to check that the connector fits snugly and will not slip off by itself.

8. Check the calibration of the complete instrument. A Performance Check/Calibration procedure is given in Section 3.

Removal of Orthogonality Coil L9350

This coil is located just behind the crt deflection plate pins inside the shield. Two self-tapping screws hold the coil in its proper position.

Removal.

1. Remove the crt using the procedure given earlier.

2. Disconnect the orthogonality coil multi-pin connector from the power supply board.

3. Remove the two self-tapping screws that go through the crt shield to the coil form. For rackmount models, the screws are accessible from the bottom of the instrument. For cabinet models, you will need to use an offset Phillips screwdriver to reach the screws that are located on the left side (looking from the front) of the crt shield.

4. Remove the coil through the front of the crt shield.

Replacement. Install the replacement coil by reversing the order of removal. Use the crt replacement procedure to install the crt.

Removal of Trace Rotation Coil L9650

This coil snaps into the square mounting holes located in the front crt shield.

Removal.

1. Remove the crt using the procedure given earlier.

2. Disconnect the trace rotation coil multi-pin connector from the front panel 8-row interconnect board.

3. Remove the front plastic support for the crt. There are four self-tapping screws holding this support; one screw per side of the front crt shield. For a rackmount model, use an offset Phillips screwdriver to loosen the hard-to-reach screws. For a cabinet model, remove the vertical amplifier and sweep output boards to reach two of the screws. Direct access to the screw at the bottom of the shield is blocked by the power transformer but it is possible to use a long-shank slender screwdriver to reach the screw at an angle and remove it. After removing the four self-tapping screws, remove the crt support through the front of the crt shield.

4. Note the position of the trace rotation coil and the routing of its leads. Unsnap the trace rotation coil from the shield and remove the coil through the front of the shield.

Replacement. Install the replacement trace rotation coil by reversing the order of removal. Follow the crt replacement procedure when installing the crt.

Removal of Power Transformer T9400

Replace the power transformer only with a direct replacement transformer. Tag the soldered-on leads with corresponding terminal numbers to aid in connecting the new transformer. The removal and replacement procedure is as follows:

1. For cabinet model instruments: remove the power supply board. For rackmount models: remove the transformer multi-pin connectors from the power supply board and push them back through the hole in the chassis.

2. Unsolder the black-red on gray and brown-white on gray wires from the transformer primary terminals.

3. Unsolder the black (transformer shield) wire from the chassis ground lug.

4. Remove the four bolts that mount the transformer in the instrument. For rackmount models: loosen the two screws in the transformer bracket.

5. Install the replacement transformer and check the performance of the complete instrument using the Performance Check/Calibration Procedure in Section 3.

Lamp Replacement

To replace any of the lamps used in the 1480-Series instrument, it is first necessary to remove the front panel bezel mounting nuts, bezel, rubber washers, filter, external graticule, and graticule mask.

External Graticule Lamps. These lamps have a groove around their base that holds them in their spring-loaded sockets. One method for removing a lamp is to push a tight-fitting rubber sleeve or spaghetti over the bulb and pull the lamp straight out. Another method is to use an L-shaped wire made from a paper clip that can be inserted through the widest slot in the socket to remove the lamp. A third method is to use the IC extracting tool described

earlier. Push the replacement lamp straight into its socket until the lamp groove is seated within the socket.

Internal Graticule Lamps. These miniature lamps are located above the crt faceplate and are mounted in a plastic light-pipe assembly. To remove a lamp, unsolder the wires attached to the lamp and solder these wires to the replacement lamp.

Indicator Lamps. These lamps are equipped with long wire leads and are held in position by the front panel. To remove a lamp, disconnect the leads and remove the front panel using the appropriate procedure that applies to your instrument as follows:

For cabinet models—Remove all the knobs using 1/16-inch and 0.050-inch hex wrenches. Remove the two screws located near the lower left and right corners of the front panel. Remove the POWER switch mounting nut using a 12-sided 5/8-inch nutdriver; remove the washer. Remove the INTENSITY switch mounting nut using a 5/16-inch nutdriver; remove the washer. Remove the front panel and the lamp. Install the replacement lamp and all removed parts.

For rackmount models—There are two front panels: left and right.

To replace a left front panel indicator lamp, remove all the left front panel knobs using a 1/16-inch hex wrench. Remove the POWER switch mounting nut using a 12-sided 5/8-inch nutdriver; remove the washer. Remove the RESPONSE switch mounting nut using a 7/16-inch nutdriver; remove the washer. Remove the left front panel and defective lamp. Install the replacement lamp and all removed parts.

To replace a right front panel indicator lamp, remove all the right front panel knobs using a 1/16-inch and 0.050-inch hex wrench. Remove the LINE SELECTOR switch mounting nut using a 7/16-inch nutdriver; remove the washer. Remove the right front panel and defective lamp. Install the replacement lamp and all removed parts.

Removal of Front Panel Controls

Pushbutton Switches: Refer to the Vertical and Horizontal Switch board removal procedure for removing the boards. Then replace the switch by desoldering the switch terminals and removing the switch from the board. Install the replacement switch in the same position as the old one so that the pushbuttons are aligned with their respective holes in the front panel and do not bind.

Front Panel Controls and POWER Switch: Make a sketch of the terminals and show the color-code of the wires so these can be properly reconnected on the replacement part. For the hard-to-see controls on the cabinet model, you will have to make the sketch after the front frame assembly is separated from the chassis. This is accomplished by removing eight flat-head screws and the multi-pin connectors. A control can be removed by removing the knob(s), mounting nut, and washer; unsolder the wires. The POWER switch is removed by unsoldering the wires, removing the mounting nut and washer.

Front Panel Screwdriver Adjustments: Make a sketch of the terminals and color-coded wires. Unsolder the wires and use a 1/16-inch hex wrench to remove the control.

Removal of 4X Multiplier

Disconnect the high-voltage lead at the crt anode lead connector. Unsolder the wire attached to the 4X Multiplier terminal. For rackmount models, use an offset Phillips screwdriver to remove the three mounting screws. For cabinet models, remove the vertical amplifier board to reach the 4X Multiplier mounting screws. Remove 8 screws on back panel and 2 supporting screws to loosen back panel for removal of the 4X Multiplier. For all models, when installing the replacement 4X Multiplier, be sure to make a smooth-surface solder joint when soldering the wire to the terminal. Then coat the exposed solder connection with corona dope.

Instrument Repackaging

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Refer to the following table for carton test strength requirements.
2. Surround the instrument with polyethylene sheeting to protect the finish of the instrument.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.
4. Seal carton with shipping tape or industrial stapler.

SHIPPING CARTON TEST STRENGTH

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500
140-160	600

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:) Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P.O. BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC. SEMICONDUCTOR GROUP	P.O. BOX 5012	DALLAS, TX 75222
02660	BUNKER RAMO CORP., CONNECTOR DIVISION	2801 S 25TH AVENUE	BROADVIEW, IL 60153
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
02777	HOPKINS ENGINEERING COMPANY	12900 FOOTHILL BLVD.	SAN FERNANDO, CA 91342
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05397	UNION CARBIDE CORPORATION, MATERIALS SYSTEMS DIVISION	11901 MADISON AVENUE	CLEVELAND, OH 44101
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
09023	CORNELL-DUBILIER ELECTRONIC DIVISION FEDERAL PACIFIC ELECTRIC CO.	2652 DALRYMPLE ST.	SANFORD, NC 27330
11237	CTS KEENE, INC.	3230 RIVERSIDE AVE.	PASO ROBLES, CA 93446
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
12969	UNITRODE CORPORATION	580 PLEASANT STREET	WATERTOWN, MA 02172
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.		LOS GATOS, CA 95030
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
15238	ITT SEMICONDUCTORS, A DIVISION OF INTER NATIONAL TELEPHONE AND TELEGRAPH CORP.	P.O. BOX 168, 500 BROADWAY	LAWRENCE, MA 01841
17856	SILICONIX, INC.	2201 LAURELWOOD DRIVE	SANTA CLARA, CA 95054
19396	ILLINOIS TOOL WORKS, INC. PAKTRON DIV.	900 FOLLIN LANE, SE	VIENNA, VA 22180
19647	CADDOCK ELECTRONICS INC.	3127 CHICAGO AVENUE	RIVERSIDE, CA 92507
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
27193	CUTLER-HAMMER, INC. SPECIALTY PRODUCTS DIVISION	4201 N. 27TH ST.	MILWAUKEE, WI 53216
32293	INTERSIL, INC.	10900 N. TANTAU AVE.	CUPERTINO, CA 95014
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50157	MIDWEST COMPONENTS INC.	P. O. BOX 787 1981 PORT CITY BLVD.	MUSKEGON, MI 49443
51642	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801
51984	NEC AMERICA INC. RADIO AND TRANSMISSION DIV.	2990 TELESTAR CT. SUITE 212	FALLS CHURCH, VA 22042
52306	HIGH VOLTAGE DEVICES, INC.	7485 AVENUE 304	VISALIA, CA 93277
54473	MATSUSHITA ELECTRIC, CORP. OF AMERICA	1 PANASONIC WAY	SECAUCUS, NJ 07094
55292	LEDCO DIV., WILBRECHT ELECTRONICS, INC.	240 EAST PLATO BLVD.	ST. PAUL, MN 55107
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
57668	R-OHM CORP.	16931 MILLIKEN AVE.	IRVINE, CA 92713
59660	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
59821	CENTRALAB INC SUB NORTH AMERICAN PHILIPS CORP	7158 MERCHANT AVE	EL PASO, TX 79915
60705	CERA-MITE CORP.	1327 6TH AVE.	GRAFTON, WI 53024
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74276	SIGNALITE DIV., GENERAL INSTRUMENT CORP.	1933 HECK AVE.	NEPTUNE, NJ 07753
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
79727	C-W INDUSTRIES	550 DAVISVILLE RD.,P O BOX 96	WARMINISTER, PA 18974
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
82389	SWITCHCRAFT, INC.	5555 N. ELSTON AVE.	CHICAGO, IL 60630
83003	VARO, INC.	P O BOX 411, 2203 WALNUT STREET	GARLAND, TX 75040

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
90201	MALLORY CAPACITOR CO., DIV. OF	3029 E. WASHINGTON STREET	
	P. R. MALLORY AND CO., INC.	P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Replaceable Electrical Parts—1480 Series

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-3486-00			CKT BOARD ASSY:VERTICAL SWITCH	80009	670-3486-00
A2	670-3485-00	B010100	B029999	CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-00
A2	---- ----			(1480 CABINET)		
A2	670-3485-01	B030000	B041267	CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-01
A2	---- ----			(1480 CABINET)		
A2	670-3485-06	B041268		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-06
A2	---- ----			(1480 CABINET)		
A2	670-3485-00	B010100	B029999	CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-00
A2	---- ----			(1480 RACKMOUNT)		
A2	670-3485-01	B030000	B040295	CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-01
A2	---- ----			(1480 RACKMOUNT)		
A2	670-3485-06	B040296		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-06
A2	---- ----			(1480 RACKMOUNT)		
A2	670-3485-04	B030000	B041267	CKT CARD ASSY:	80009	670-3485-04
A2	---- ----			(1481, 1482, 1485 CABINET)		
A2	670-3485-09	B041268		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-09
A2	---- ----			(1481, 1482, 1485 CABINET)		
A2	670-3485-04	B030000	B040295	CKT CARD ASSY:	80009	670-3485-04
A2	---- ----			(1481, 1482, 1485 RACKMOUNT)		
A2	670-3485-09	B040296		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-09
A2	---- ----			(1481, 1482, 1485 RACKMOUNT)		
A3	670-3489-00			CKT BOARD ASSY:HORIZONTAL SWITCH	80009	670-3489-00
A4	670-3488-00			CKT BOARD ASSY:SWEEP OUTPUT	80009	670-3488-00
A4	---- ----			(CABNIT)		
A4	670-3488-00	B010100	B053176	CKT BOARD ASSY:SWEEP OUTPUT	80009	670-3488-00
A4	---- ----			(RACKMOUNT)		
A4	670-3488-05	B053178		CKT CARD ASSY:	80009	670-3488-05
A4	---- ----			(RACKMOUNT)		
A5	670-3754-00			CKT BOARD ASSY:PIGGY BACK	80009	670-3754-00
A5	---- ----			(1482 ONLY)		
A6	670-3487-05			CKT BOARD ASSY:SYNC AND TIMING	80009	670-3487-05
A7	670-3515-00			CKT BOARD ASSY:FRONT PANEL CONNECTOR	80009	670-3515-00
A8	670-3516-00			CKT BOARD ASSY:FRONT PANEL CONNECTOR	80009	670-3516-00
A9	670-3490-00	B010100	B030881	CKT BOARD ASSY:POWER SUPPLY	80009	670-3490-00
A9	---- ----			(CABINET)		
A9	670-3490-01	B030882		CKT BOARD ASSY:POWER SUPPLY	80009	670-3490-01
A9	---- ----			(CABINET)		
A9	670-3490-00	B010100	B031997	CKT BOARD ASSY:POWER SUPPLY	80009	670-3490-00
A9	---- ----			(RACKMOUNT)		
A9	670-3490-01	B031998		CKT BOARD ASSY:POWER SUPPLY	80009	670-3490-01
A9	---- ----			(RACKMOUNT)		
A10	670-4110-00	B010150	B029999	CKT BOARD ASSY:GAIN CELL	80009	670-4110-00
A11	670-4387-00	B041228		CKT BOARD ASSY:RGB	80009	670-4387-00
A11	---- ----			(CABINET)		
A11	670-4387-00	B042929		CKT BOARD ASSY:RGB	80009	670-4387-00
A11	---- ----			(RACKMOUNT)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C1002	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C1023	281-0077-00			CAP.,VAR,AIR DI:1.3-5.4PF,800V	74970	189-0502-075
C1024	290-0367-00			CAP.,FXD,ELCTLT:70UF,20%,6V NONPOLARIZED	56289	30D1802
C1034	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1038	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C1042	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C1043	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C1044	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1046	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1048	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1053	281-0500-00	B010150		CAP.,FXD,CER DI:2.2PF,+/-0.5PF,500V	04222	7001-COJ-2R2D
C1055	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D155F4771F0
C1056	281-0077-00			CAP.,VAR,AIR DI:1.3-5.4PF,800V	74970	189-0502-075
C1057	290-0367-00			CAP.,FXD,ELCTLT:70UF,20%,6V NONPOLARIZED	56289	30D1802
C1073	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C1080	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	2810C5R565QJ02F0
C1081	283-0660-00			CAP.,FXD,MICA D:510PF,2%,500V	00853	D155F511G0
C1082	283-0648-00			CAP.,FXD,MICA D:10PF,5%,100V	00853	D151C100D0
C1091	283-0638-00			CAP.,FXD,MICA D:130PF,1%,100V	00853	D151F131F0
C1105	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1107	283-0000-00	B030000		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1108	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C1109	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C1115	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C1124	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C1154	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C1156	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1162	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C1166	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C1171	283-0669-00			CAP.,FXD,MICA D:360PF,1%,500V	00853	D155F361F0
C1181	283-0605-00			CAP.,FXD,MICA D:678PF,1%,300V	00853	D153F6780F0
C1182	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	2810C5R565QJ02F0
C1183	281-0577-00			CAP.,FXD,CER DI:14PF,5%,500V	04222	7001-COG-140J
C1184	283-0604-00	B010100	B041267	CAP.,FXD,MICA D:304PF,2%,300V	00853	D155F3040G0
C1184	---- ----			(CABINET)		
C1184	283-0669-00	B041268		CAP.,FXD,MICA D:360PF,1%,500V	00853	D155F361F0
C1184	---- ----			(CABINET)		
C1184	283-0604-00	B010100	B040295	CAP.,FXD,MICA D:304PF,2%,300V	00853	D155F3040G0
C1184	---- ----			(RACKMOUNT)		
C1184	283-0669-00	B040296		CAP.,FXD,MICA D:360PF,1%,500V	00853	D155F361F0
C1184	---- ----			(RACKMOUNT)		
C1193	283-0638-00			CAP.,FXD,MICA D:130PF,1%,100V	00853	D151F131F0
C1200	283-0000-00	B030000		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1232	281-0123-00	B030000		CAP.,VAR,CER DI:5-25PF,100V	59660	518-000A5-25
C1235	281-0123-00	B010150		CAP.,VAR,CER DI:5-25PF,100V	59660	518-000A5-25
C1237	283-0600-00	B010100	B010149	CAP.,FXD,MICA D:43PF,5%,500V	00853	D105E430J0
C1237	283-0615-00	B010150		CAP.,FXD,MICA D:33PF,5%,500V	00853	D155E330J0
C1240	281-0153-00	B010100	B041267	CAP.,VAR,AIR DI:1.7-10PF,250V	74970	187-0106-005
C1240	---- ----			(CABINET)		
C1240	281-0093-00	B041268		CAP.,VAR,CER DI:5.5-18PF	59660	538-011A5.5-18
C1240	---- ----			(CABINET)		
C1240	281-0153-00	B010100	B040295	CAP.,VAR,AIR DI:1.7-10PF,250V	74970	187-0106-005
C1240	---- ----			(RACKMOUNT)		
C1240	281-0093-00	B040296		CAP.,VAR,CER DI:5.5-18PF	59660	538-011A5.5-18
C1240	---- ----			(RACKMOUNT)		

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C1244	281-0092-00			CAP.,VAR,CER DI:9-35PF,200V	59660	538-011 D9-35
C1245	283-0642-00			CAP.,FXD,MICA D:33PF,+/-0.5PF,300V	00853	D10-5E330G
C1246	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	59660	0301-080-COHO-80
C1252	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C1261	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C1272	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1274	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1282	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1283	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1284	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1288	283-0698-00	B030000		CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15FD391F03
C1292	283-0646-00	B010100	B029999	CAP.,FXD,MICA D:170PF,1%,100V	00853	D155F171F0
C1292	---- ----			(1481,1482,1485,CABINET)		
C1292	283-0674-00	B030000	B041267	CAP.,FXD,MICA D:85PF,1%,500V	00853	D155F850F0
C1292	---- ----			(1481,1482,1485,CABINET)		
C1292	283-0646-00	B041268		CAP.,FXD,MICA D:170PF,1%,100V	00853	D155F171F0
C1292	---- ----			(1481,1482,1485,CABINET)		
C1292	283-0646-00	B010100	B029999	CAP.,FXD,MICA D:170PF,1%,100V	00853	D155F171F0
C1292	---- ----			(1481,1482,1485,RACKMOUNT)		
C1292	283-0674-00	B030000	B040295	CAP.,FXD,MICA D:85PF,1%,500V	00853	D155F850F0
C1292	---- ----			(1481,1482,1485,RACKMOUNT)		
C1292	283-0646-00	B040296		CAP.,FXD,MICA D:170PF,1%,100V	00853	D155F171F0
C1292	---- ----			(1481,1482,1485,RACKMOUNT)		
C1294	283-0636-00	B041268		CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C1294	---- ----			(1481,1482,1485,CABINET)		
C1294	283-0636-00	B040296		CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C1294	283-0636-00			CAP.,FXD,MICA D:36PF,1.4%,100V	00853	D155E360G0
C1295	283-0634-00	B010100	B029999	CAP.,FXD,MICA D:65PF,1%,100V	00853	D155E650F0
C1295	283-0634-00	B041268		CAP.,FXD,MICA D:65PF,1%,100V	00853	D155E650F0
C1295	---- ----			(1481,1482,1485,CABINET)		
C1295	283-0634-00	B040296		CAP.,FXD,MICA D:65PF,1%,100V	00853	D155E650F0
C1295	---- ----			(1481,1482,1485,RACKMOUNT)		
C1338	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C1371	283-0687-00			CAP.,FXD,MICA D:560PF,2%,300V	00853	D153F561G0
C1375	283-0698-00			CAP.,FXD,MICA D:390PF,1%,500V	09023	CD15FD391F03
C1377	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C1381	283-0626-00			CAP.,FXD,MICA D:1800PF,5%,500V	00853	D195F182J0
C1383	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	09023	CD15FD(253)J03
C1387	283-0596-00			CAP.,FXD,MICA D:528PF,1%,300V	00853	D153F5280F0
C1391	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D155F1050F0
C1403	281-0509-00			CAP.,FXD,CER DI:15PF,+/-1.5PF,500V	59660	301-000C0G0150K
C1407	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C1413	281-0500-00	B030000		CAP.,FXD,CER DI:2.2PF,+/-0.5PF,500V	04222	7001-COJ-2R2D
C1437	281-0168-00	B010100	B041267	CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0103-035
C1437	---- ----			(CABINET)		
C1437	281-0091-00	B041268		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C1437	---- ----			(CABINET)		
C1437	281-0168-00	B010100	B040295	CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0103-035
C1437	---- ----			(RACKKMOUNT)		
C1437	281-0091-00	B040296		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C1437	---- ----			(RACKMOUNT)		
C1443	283-0003-00	B010100	B010149	CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C1445	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D155F4771FO

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C1447	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C1451	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1457	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1461	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D155F4771FO
C1485	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D155F1050F0
C1492	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1493	281-0509-00			CAP.,FXD,CER DI:15PF,+/-1.5PF,500V	59660	301-000C0G0150K
C1507	281-0630-00			CAP.,FXD,CER DI:390PF,5%,500V	72982	630000Y5D391J
C1511	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C1519	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	59660	0301-080-COHO-80
C1522	283-0669-00	B010100	B010399	CAP.,FXD,MICA D:360PF,1%,500V	00853	D155F361F0
C1522	---- ----			(CABINET)		
C1522	283-0644-00	B010400	B041267	CAP.,FXD,MICA D:150PF,1%,500V	00853	D155F151F0
C1522	---- ----			(CABINET)		
C1522	283-0669-00	B010100	B010399	CAP.,FXD,MICA D:360PF,1%,500V	00853	D155F361F0
C1522	---- ----			(RACKMOUNT)		
C1522	283-0644-00	B010400	B040295	CAP.,FXD,MICA D:150PF,1%,500V	00853	D155F151F0
C1522	---- ----			(RACKMOUNT)		
C1535	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C1541	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D155F1050F0
C1567	281-0153-00	B010100	B041267	CAP.,VAR,AIR DI:1.7-10PF,250V	74970	187-0106-005
C1567	---- ----			(CABINET)		
C1567	281-0091-00	B041268		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C1567	---- ----			(CABINET)		
C1567	281-0153-00	B010100	B040295	CAP.,VAR,AIR DI:1.7-10PF,250V	74970	187-0106-005
C1567	---- ----			(RACKMOUNT)		
C1567	281-0091-00	B040296		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C1567	---- ----			(RACKMOUNT)		
C1572	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1578	290-0745-00	B010100	B010149	CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C1578	285-0919-00	B010150	B010399	CAP.,FXD,PLSTC:0.22UF,10%,100V	56289	LP66A1B224K002
C1578	290-0745-00	B010400		CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C1589	281-0509-00	B010100	B010149	CAP.,FXD,CER DI:15PF,+/-1.5PF,500V	59660	301-000C0G0150K
C1593	281-0662-00			CAP.,FXD,CER DI:10PF,+/-0.5PF,500V	59660	301-000H3M0100D
C1611	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C1612	283-0003-00	B010100	B029999	CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C1626	283-0267-00	B010100	B029999	CAP.,FXD,CER DI:0.01UF,20%,500V	60705	562CBD501AL103MA
C1626	283-0620-00	B030000		CAP.,FXD,MICA D:470PF,1%,300V	00853	D155F4771FO
C1666	281-0204-00	B030000		CAP.,VAR,PLSTC:2-22PF,100V	80031	287C00222MJ02
C1667	290-0523-00	B010100	B010149	CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C1669	283-0059-00	B010100	B029999	CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C1670	281-0122-00	B010150	B010399	CAP.,VAR,CER DI:2.5-9PF,100V	59660	518-000A2.5-9
C1670	281-0093-00	B010400	B029999	CAP.,VAR,CER DI:5.5-18PF	59660	538-011A5.5-18
C1670	283-0642-00	B030000		CAP.,FXD,MICA D:33PF,+/-0.5PF,300V	00853	D10-5E330G
C1672	283-0637-00	B010400	B029999	CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
C1680	283-0059-00	B030000		CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C1687	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1688	283-0632-00			CAP.,FXD,MICA D:87PF,1%,100V	00853	D155E870F0
C1699	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C1712	283-0000-00	B030000		CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1730	283-0078-00	B010150	B029999	CAP.,FXD,CER DI:0.001UF,20%,500V	59660	0801 547X5F0102M
C1775	290-0517-00	B030000		CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1775	---- ----			(CABINET)		

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C1788	283-0649-00			CAP.,FXD,MICA D:105PF,1%,300V	00853	D155F1050F0
C1791	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1819	283-0003-00	B030000		CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C1835	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1842	283-0000-00	B010100	B029999	CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1845	283-0000-00	B010100	B029999	CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1852	283-0628-00	B010100	B010150	CAP.,FXD,MICA D:410PF,1%,500V	00853	D155F411F0
C1854	281-0093-00	B010100	B029999	CAP.,VAR,CER DI:5.5-18PF	59660	538-011A5.5-18
C1854	281-0205-00	B030000		CAP.,VAR,PLSTC:5.5-65PF,100V	80031	2810C5R565QJ02F0
C1856	281-0504-00	B010400	B029999	CAP.,FXD,CER DI:10PF,+/-1PF,500V	04222	7001-COG-100F
C1858	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1862	281-0077-00	B010100	B029999	CAP.,VAR,AIR DI:1.3-5.4PF,800V	74970	189-0502-075
C1862	281-0204-00	B030000		CAP.,VAR,PLSTC:2-22PF,100V	80031	287C00222MJ02
C1864	281-0557-00	B010400	B029999	CAP.,FXD,CER DI:1.8PF,10%,500V	04222	7001-COK-1R8B
C1866	283-0647-00	B010100	B010150	CAP.,FXD,MICA D:70PF,1%,100V	00853	D155E700F0
C1874	283-0639-00	B010100	B010150	CAP.,FXD,MICA D:56PF,1%,100V	00853	D151E560F0
C1877	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1879	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C1885	290-0517-00	B030000		CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1886	290-0517-00	B030000		CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C1888	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C1892	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	72982	8121N083Z5U0104Z
C1923	290-0746-00			CAP.,FXD,ELCTLT:47UF,+50-10%,16V	55680	ULA1C470TEA
C1931	290-0746-00			CAP.,FXD,ELCTLT:47UF,+50-10%,16V	55680	ULA1C470TEA
C1954	281-0511-00			CAP.,FXD,CER DI:22PF,+/-2.2PF,500V	59660	301-000C0G0220K
C1965	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C3010	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C3011	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C3021	283-0593-00			CAP.,FXD,MICA D:0.01UF,1%,100V	00853	D301F103F0
C3022	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C3040	290-0746-00			CAP.,FXD,ELCTLT:47UF,+50-10%,16V	55680	ULA1C470TEA
C3050	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3053	283-0660-00			CAP.,FXD,MICA D:510PF,2%,500V	00853	D155F511G0
C3061	283-0672-00			CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F2010F0
C3070	283-0655-00			CAP.,FXD,MICA D:0.0033UF,1%,500V	00853	D195F332F0
C3087	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C3100	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C3110	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C3112	290-0525-00			CAP.,FXD,ELCTLT:4.7UF,20%,50V	56289	196D475X0050KA1
C3114	290-0525-00			CAP.,FXD,ELCTLT:4.7UF,20%,50V	56289	196D475X0050KA1
C3120	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
C3121	283-0628-00			CAP.,FXD,MICA D:410PF,1%,500V	00853	D155F411F0
C3130	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
C3131	283-0641-00			CAP.,FXD,MICA D:180PF,1%,100V	00853	DD155F181F0
C3136	283-0630-00			CAP.,FXD,MICA D:110PF,1%,100V	00853	D155F111F0
C3160	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C3170	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C3180	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3181	283-0600-00			CAP.,FXD,MICA D:43PF,5%,500V	00853	D105E430J0
C3184	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C3190	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
C3200	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C3201	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3210	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1

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C3220	283-0026-00			CAP.,FXD,CER DI:0.2UF,+80-20%,25V	56289	274C3
C3230	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3240	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C3241	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3242	281-0577-00			CAP.,FXD,CER DI:14PF,5%,500V	04222	7001-COG-140J
C3243	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T362C476M020AS
C3250	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C3251	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C3252	290-0512-00			CAP.,FXD,ELCTLT:22UF,20%,15V	56289	196D226X0015KA1
C3253	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C3260	290-0529-00			CAP.,FXD,ELCTLT:47UF,20%,20V	05397	T362C476M020AS
C3280	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C3281	283-0593-00			CAP.,FXD,MICA D:0.01UF,1%,100V	00853	D301F103F0
C3282	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3290	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020FL
C3310	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3320	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3330	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C3340	281-0651-00			CAP.,FXD,CER DI:47PF,5%,200V	59660	0374018T2H0 470J
C3341	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C3342	283-0634-00			CAP.,FXD,MICA D:65PF,1%,100V	00853	D155E650F0
C3350	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C3364	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3365	283-0687-00	B010520		CAP.,FXD,MICA D:560PF,2%,300V	00853	D153F561G0
C3370	283-0672-00			CAP.,FXD,MICA D:200PF,1%,500V	00853	D155F2010F0
C3371	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3400	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3410	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C3411	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C3412	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C3420	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C3421	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C3430	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C3431	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C3451	283-0645-00			CAP.,FXD,MICA D:790PF,1%,100V	00853	D153F791F0
C3460	283-0600-00			CAP.,FXD,MICA D:43PF,5%,500V	00853	D105E430J0
C3462	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C3470	283-0167-00			CAP.,FXD,CER DI:0.1UF,10%,100V	72982	8131N145X5R0104K
C3480	283-0593-00			CAP.,FXD,MICA D:0.01UF,1%,100V	00853	D301F103F0
C4003	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C4005	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C4010	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C4022	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C4055	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	04222	7001-C0J-2R2C
C4060	281-0168-00	B010100	B041074	CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0103-035
C4060	—— ——			(CABINET)		
C4060	281-0091-00	B041075		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C4060	—— ——			(CABINET)		
C4060	281-0168-00	B010100	B042733	CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0103-035
C4060	—— ——			(RACKMOUNT)		
C4060	281-0091-00	B042734		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C4060	—— ——			(RACKMOUNT)		
C4100	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C4122	281-0544-00			CAP.,FXD,CER DI:5.6PF,10%,500V	04222	7001-C0H-5R6D

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C4150	281-0534-00			CAP.,FXD,CER DI:3.3PF,+/-0.25PF,500V	04222	7001-COJ-3R3C
C4151	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	59660	0301-080-COHO-80
C4152	281-0557-00			CAP.,FXD,CER DI:1.8PF,10%,500V	04222	7001-COK-1R8B
C4160	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C4170	283-0596-00			CAP.,FXD,MICA D:528PF,1%,300V	00853	D153F5280F0
C4190	283-0598-00			CAP.,FXD,MICA D:253PF,5%,300V	09023	CD15FD(253)J03
C4200	290-0745-00			CAP.,FXD,ELCTLT:22UF,+50-10%,25V	54473	ECE-A25V22L
C4201	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4202	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C4210	281-0544-00			CAP.,FXD,CER DI:5.6PF,10%,500V	04222	7001-COH-5R6D
C4236	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	2C20Z5U104Z200B
C4243	281-0529-00			CAP.,FXD,CER DI:1.5PF,+/-0.25PF,500V	04222	7001-COK1R5C
C4250	281-0503-00			CAP.,FXD,CER DI:8PF,+/-0.5PF,500V	59660	0301-080-COHO-80
C4270	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4340	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	59821	2DDH66J103Z
C4341	285-0597-00			CAP.,FXD,PLSTC:0.001UF,1%,100V	14752	41OB1B102F
C4342	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C4370	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4390	283-0641-00			CAP.,FXD,MICA D:180PF,1%,100V	00853	DD155F181F0
C4410	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C4431	283-0059-00			CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C4440	281-0510-00			CAP.,FXD,CER DI:22PF,+/-4.4PF,500V	59660	301-000C0G0220M
C4441	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	59660	301-000U2J0680K
C4442	290-0746-00			CAP.,FXD,ELCTLT:47UF,+50-10%,16V	55680	ULA1C470TEA
C4450	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4460	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4470	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4471	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4480	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4481	283-0114-00			CAP.,FXD,CER DI:0.0015UF,5%,200V	59660	805534Y5DO152J
C4490	283-0059-00	B010100	B010124	CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C4490	283-0059-00	B010100	B010154	CAP.,FXD,CER DI:1UF,+80-20%,50V	51642	400050Z5U105Z
C4500	283-0104-00			CAP.,FXD,CER DI:2000PF,5%,500V	59660	811-565B202J
C4550	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4580	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4601	283-0104-00			CAP.,FXD,CER DI:2000PF,5%,500V	59660	811-565B202J
C4611	281-0604-00			CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	04222	7001-C0J-2R2C
C4616	281-0610-00			CAP.,FXD,CER DI:2.2PF,+/-0.1PF,500V	59660	374-018COJ0229B
C4620	281-0153-00	B010100	B041074	CAP.,VAR,AIR DI:1.7-10PF,250V	74970	187-0106-005
C4620	---- ----			(CABINET)		
C4620	281-0091-00	B041075		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C4620	---- ----			(CABINET)		
C4620	281-0153-00	B010100	B042733	CAP.,VAR,AIR DI:1.7-10PF,250V	74970	187-0106-005
C4620	---- ----			(RACKMOUNT)		
C4620	281-0091-00	B042734		CAP.,VAR,CER DI:2-8PF	59660	538-011 A2-8
C4620	---- ----			(RACKMOUNT)		
C4621	283-0602-00			CAP.,FXD,MICA D:53PF,5%,300V	00853	D155E53OJ0
C4670	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D155F4771FO
C4680	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4710	283-0630-00			CAP.,FXD,MICA D:110PF,1%,100V	00853	D155F111F0
C4730	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4750	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4751	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4800	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z

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C4801	285-1050-00			CAP.,FXD,PLSTC:0.1UF,1%,200V	14752	230B1C104F
C4802	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4820	281-0510-00			CAP.,FXD,CER DI:22PF,+/-4.4PF,500V	59660	301-000C0G0220M
C4821	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C4822	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4830	283-0081-00			CAP.,FXD,CER DI:0.1UF,+80-20%,25V	59821	2DDU69E104Z
C4831	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4850	283-0620-00			CAP.,FXD,MICA D:470PF,1%,300V	00853	D155F4771FO
C4861	281-0558-00			CAP.,FXD,CER DI:18PF,10%,500V	59660	301-000C0G0180K
C4880	283-0028-00			CAP.,FXD,CER DI:0.0022UF,20%,50V	59660	0805585Y5SO222M
C4881	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4892	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4896	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4897	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C4900	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C4901	290-0535-00			CAP.,FXD,ELCTLT:33UF,20%,10V	56289	196D336X0010KA1
C4911	281-0549-00			CAP.,FXD,CER DI:68PF,10%,500V	59660	301-000U2J0680K
C4970	283-0680-00			CAP.,FXD,MICA D:330PF,1%,500V	00853	D155F331F0
C4980	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C6043	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	04222	7001-COG-100F
C6044	281-0638-00			CAP.,FXD,CER DI:240PF,5%,500V	72982	301000Z5D241J
C6070	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C6084	290-0747-00			CAP.,FXD,ELCTLT:100UF,+50-10%,25V	56289	500D148
C6143	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	04222	7001-COG-100F
C6144	281-0550-00			CAP.,FXD,CER DI:120PF,10%,500V	04222	7001-1373
C6180	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C6190	290-0747-00			CAP.,FXD,ELCTLT:100UF,+50-10%,25V	56289	500D148
C6244	283-0669-00			CAP.,FXD,MICA D:360PF,1%,500V	00853	D155F361F0
C6278	290-0582-00			CAP.,FXD,ELCTLT:5UF,+75-10%,150V	90201	TT5RON150C0P3P
C6280	290-0194-00			CAP.,FXD,ELCTLT:10UF,+50-10%,100V	56289	30D106F100C9
C6322	283-0119-00			CAP.,FXD,CER DI:2200PF,5%,200V	59660	855-536Y5E0222J
C6326	281-0523-00	B010100	B030881	CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C6326	—— ——			(CABINET)		
C6326	283-0128-00	B030882		CAP.,FXD,CER DI:100PF,5%,500V	59660	871-536T2H101J
C6326	—— ——			(CABINET)		
C6326	281-0523-00	B010100	B031997	CAP.,FXD,CER DI:100PF,+/-20PF,500V	72982	301-000U2M0101M
C6326	—— ——			(RACKMOUNT)		
C6326	283-0128-00	B031998		CAP.,FXD,CER DI:100PF,5%,500V	59660	871-536T2H101J
C6326	—— ——			(RACKMOUNT)		
C6360	290-0442-00			CAP.,FXD,ELCTLT:120UF,+75-10%,150V	56289	39D1197
C6425	285-0622-00			CAP.,FXD,PLSTC:0.1UF,20%,100V	56289	192P10402M474
C6430	283-0058-00			CAP.,FXD,CER DI:0.027UF,10%,100V	56289	1C20X7R273K100B
C6432	290-0523-00			CAP.,FXD,ELCTLT:2.2UF,20%,20V	56289	196D225X0020HA1
C6434	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	2C20Z5U104Z200B
C6440	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C6446	283-0057-00			CAP.,FXD,CER DI:0.1UF,+80-20%,200V	56289	2C20Z5U104Z200B
C6448	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6468	281-0064-00			CAP.,VAR,PLSTC:0.25-1.5PF,600V	74970	273-0001-101
C6472	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6474	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C6535	283-0111-00	B030882		CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C6535	—— ——			(CABINET)		
C6535	283-0111-00	B031998		CAP.,FXD,CER DI:0.1UF,20%,50V	56289	273C11
C6535	—— ——			(RACKMOUNT)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C6560	283-0328-00			CAP.,FXD,CER DI:0.03UF,+80-20%,200V	72982	8131N225Z5U0303Z
C6564	283-0328-00			CAP.,FXD,CER DI:0.03UF,+80-20%,200V	72982	8131N225Z5U0303Z
C6600	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6602	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6615	290-0194-00			CAP.,FXD,ELCTLT:10UF,+50-10%,100V	56289	30D106F100C9
C6636	290-0746-00			CAP.,FXD,ELCTLT:47UF,+50-10%,16V	55680	ULA1C470TEA
C6648	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	2C20Z5U105Z025B
C6649	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	56289	1C10Z5U223M050B
C6662	283-0328-00			CAP.,FXD,CER DI:0.03UF,+80-20%,200V	72982	8131N225Z5U0303Z
C6670	283-0328-00			CAP.,FXD,CER DI:0.03UF,+80-20%,200V	72982	8131N225Z5U0303Z
C6696	290-0164-00			CAP.,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA7
C6704	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6708	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6738	283-0002-00			CAP.,FXD,CER DI:0.01UF,+80-20%,500V	59821	SDDH69L103Z
C6752	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	59660	301-055P2G0270M
C6785	283-0162-00			CAP.,FXD,CER DI:0.01UF,+80-30%,5000V	59660	3905SF706Y5S103Z
C6788	283-0021-00			CAP.,FXD,CER DI:0.001UF,20%,5000V	59660	848-556-Y5S-102M
C6805	285-1104-00			CAP.,FXD,PLSTC:0.033UF,5%,200V	19396	333J02PP580
C6830	283-0001-00			CAP.,FXD,CER DI:0.005UF,+100-0%,500V	59821	2DDH61L502P
C6832	281-0504-00			CAP.,FXD,CER DI:10PF,+/-1PF,500V	04222	7001-COG-100F
C6848	283-0162-00			CAP.,FXD,CER DI:0.01UF,+80-30%,5000V	59660	3905SF706Y5S103Z
C6860	283-0162-00			CAP.,FXD,CER DI:0.01UF,+80-30%,5000V	59660	3905SF706Y5S103Z
C6870	283-0021-00			CAP.,FXD,CER DI:0.001UF,20%,5000V	59660	848-556-Y5S-102M
C6986	283-0021-00			CAP.,FXD,CER DI:0.001UF,20%,5000V	59660	848-556-Y5S-102M
C8021	283-0004-00			CAP.,FXD,CER DI:0.02UF,+80-20%,150V	59821	SDDH69J203Z
C8021	----- ----			(1482 ONLY)		
C9030	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C9032	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C9034	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C9035	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651 104Z
C9040	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	59660	831610Y5U0102P
C9510	290-0704-00			CAP.,FXD,ELCTLT:250UF,+50-10%,150V	90201	20-24550
C9520	290-0705-00			CAP.,FXD,ELCTLT:4500UF,+75-10%,30V	90201	20-24551
C9530	290-0705-00			CAP.,FXD,ELCTLT:4500UF,+75-10%,30V	90201	20-24551
CR1004	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1058	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1071	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1107	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1108	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1111	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1112	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1114	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1116	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1123	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1144	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1145	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1147	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1158	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1204	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1221	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1222	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1234	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1243	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1301	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR1321	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1322	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1323	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1325	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1351	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1353	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1355	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1364	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1413	152-0246-00	B010100	B010399	SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
CR1563	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1629	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1631	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1633	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1634	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1656	152-0141-02	B010100	B029999	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1672	152-0141-02	B010150	B029999	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1673	152-0141-02	B010150	B029999	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1721	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1741	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1743	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1744	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1748	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1760	152-0141-02	B010100	B029999	SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1763	152-0141-02	B030000		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1765	152-0141-02	B030000		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1767	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1771	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1773	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1774	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1776	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1777	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1794	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1853	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1865	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1947	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1956	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1981	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR1987	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3012	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3040	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3050	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3082	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3150	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3170	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3171	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3172	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3200	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3270	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3271	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3280	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3281	152-0246-00			SEMICOND DEVICE:SW,SI,40V,200MA	03508	DE140
CR3300	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3301	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3302	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3310	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR3311	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3312	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3319	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3320	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3321	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3330	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3331	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3332	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3333	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3360	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3430	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3460	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3461	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3480	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3490	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR3491	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4024	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4030	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4040	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4090	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4091	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4110	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4130	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4132	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4143	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4150	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4151	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4153	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4154	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4155	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4170	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4190	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4191	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4220	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4221	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4250	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4350	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4370	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4390	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4421	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4424	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4428	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4470	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4590	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4591	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4592	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4636	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4638	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4640	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4651	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4690	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4691	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4732	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4733	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4734	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR4760	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4782	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR4821	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6010	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	04713	SDA317
CR6050	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6074	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6086	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
CR6110	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	04713	SDA317
CR6150	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6186	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
CR6210	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	04713	SDA317
CR6236	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6250	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6274	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6310	152-0488-00			SEMICOND DEVICE:SILICON,200V,1500MA	04713	SDA317
CR6334	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
CR6370	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6429	152-0141-02	B030882		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6429	--- ---			(CABINET)		
CR6429	152-0141-02	B031998		SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6429	--- ---			(RACKMOUNT)		
CR6490	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR6678	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
CR6680	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
CR6690	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
CR6694	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
CR6728	152-0413-00	B010100	B019999	SEMICOND DEVICE:SILICON,400V,750MA	12969	UTR307
CR6728	152-0400-00	B020000		SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
CR6730	152-0413-00	B010100	B019999	SEMICOND DEVICE:SILICON,400V,750MA	12969	UTR307
CR6730	152-0400-00	B020000		SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
CR6736	152-0413-00	B010100	B019999	SEMICOND DEVICE:SILICON,400V,750MA	12969	UTR307
CR6736	152-0400-00	B020000		SEMICOND DEVICE:SILICON,400V,1A	80009	152-0400-00
CR6738	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
CR6742	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
CR6888	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
CR6890	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	07263	FDH2161
CR6942	152-0409-00			SEMICOND DEVICE:SILICON,12,000V,5MA	83003	VG12X-1
CR6956	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	12969	G727
CR8001	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR8001	--- ---			(1482 ONLY)		
CR8029	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR8029	--- ---			(1482 ONLY)		
CR8035	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR8035	--- ---			(1482 ONLY)		
CR8036	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR8036	--- ---			(1482 ONLY)		
CR8037	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR8037	--- ---			(1482 ONLY)		
CR8038	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR8038	--- ---			(1482 ONLY)		
DS9820	150-0123-02			LAMP,CARTRIDGE:14V,23MA,RED	55292	71523-01
DS9836	150-0123-03			LAMP,CARTRIDGE:14V,23MA	55292	71523-02
DS9850	150-0077-01	B010100	B010149	LAMP,INCAND:14V,0.08A	08806	2182D
DS9850	150-0004-00	B010150		LAMP,INCAND:GE #328	08806	328
DS9855	150-0004-00	B010150		LAMP,INCAND:GE #328	08806	328

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
DS9860	150-0077-01	B010100	B010149	LAMP,INCAND:14V,0.08A	08806	2182D
DS9860	150-0004-00	B010150		LAMP,INCAND:GE #328	08806	328
DS9930	150-0123-00			LAMP,CARTRIDGE:14V,23MA,WHITE	55292	72323-14
DS9940	150-0123-00			LAMP,CARTRIDGE:14V,23MA,WHITE	55292	72323-14
DS9950	150-0059-00			LAMP,INCAND:14V,0.08A	08806	386
DS9960	150-0059-00			LAMP,INCAND:14V,0.08A	08806	386
DS9980	150-0123-02			LAMP,CARTRIDGE:14V,23MA,RED	55292	71523-01
F9185	159-0018-00			FUSE,CARTRIDGE:3AG,0.8A,250V,SLOW-BLOW	71400	MDL 8/10
F9185	---- ----			(115V OPERATION)		
F9185	159-0031-00			FUSE,CARTRIDGE:3AG,0.4A,250V,SLOW-BLOW	71400	MDL 4/10
F9185	---- ----			(230V OPERATION)		
FL9190	119-0389-00			FILTER,RAD INTE:115/230V,3A	02777	F11935-3
J9010	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9015	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9020	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9025	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9034	136-0089-00			CONNECTOR,RCPT,:9 PIN CHASSIS MOUNT	02660	165-16
J9070	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9075	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9080	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9085	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9090	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9110	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9115	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9120	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
J9125	131-0955-00			CONN,RCPT,ELEC:BNC,FEMALE	13511	31-279
L1074	114-0303-00			COIL,RF:6.5-23UH,CORE 276-0506-00	80009	114-0303-00
L1077	114-0308-00			COIL,RF:2.9-6.5UH	80009	114-0308-00
L1082	114-0311-00			COIL,RF:65-190UH,CORE 276-0568-00	80009	114-0311-00
L1083	114-0311-00			COIL,RF:65-190UH,CORE 276-0568-00	80009	114-0311-00
L1094	114-0340-00			COIL,RF:VARIABLE,350-750UH	80009	114-0340-00
L1172	114-0303-00			COIL,RF:6.5-23UH,CORE 276-0506-00	80009	114-0303-00
L1191	114-0219-00			COIL,RF:VARIABLE,43-130UH	80009	114-0219-00
L1287	114-0343-00	B030000		COIL,RF:200-400UH,CORE 276-0568-00	80009	114-0343-00
L1294	114-0254-00			COIL,RF:30-60UH,CORE NOT REPLACEABL	80009	114-0254-00
L1294	---- ----			(1481,1482,1485 CABINET AND RACKMOUNT)		
L1374	114-0259-00			COIL,RF:150-240UH,CORE NOT REPLACEA	80009	114-0259-00
L1385	114-0259-00			COIL,RF:150-240UH,CORE NOT REPLACEA	80009	114-0259-00
L1395	114-0219-00			COIL,RF:VARIABLE,43-130UH	80009	114-0219-00
L1576	114-0308-00	B010100	B010149	COIL,RF:2.9-6.5UH	80009	114-0308-00
L1605	114-0308-00			COIL,RF:2.9-6.5UH	80009	114-0308-00
L1658	108-0088-00	B030000	B041267	COIL,RF:FIXED,3.35UH	80009	108-0088-00
L1658	---- ----			(CABINET)		
L1658	108-0561-00	B041268		COIL,RF:3.75UH	80009	108-0561-00
L1658	---- ----			(CABINET)		
L1658	108-0088-00	B030000	B040295	COIL,RF:FIXED,3.35UH	80009	108-0088-00
L1658	---- ----			(RACKMOUNT)		
L1658	108-0561-00	B040296		COIL,RF:3.75UH	80009	108-0561-00
L1658	---- ----			(RACKMOUNT)		
L1662	108-0088-00	B030000	B041267	COIL,RF:FIXED,3.35UH	80009	108-0088-00
L1662	---- ----			(CABINET)		
L1662	108-0561-00	B041268		COIL,RF:3.75UH	80009	108-0561-00
L1662	---- ----			(CABINET)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
L1662	108-0088-00	B030000	B040295	COIL,RF:FIXED,3.35UH	80009	108-0088-00
L1662	---- ----			(RACKMOUNT)		
L1662	108-0561-00	B040296		COIL,RF:3.75UH	80009	108-0561-00
L1662	---- ----			(RACKMOUNT)		
L1672	108-0341-00	B010150	B010399	COIL,RF:FIXED,1.4UH	80009	108-0341-00
L1672	108-0054-00	B010400	B029999	COIL,RF:6.4UH	80009	108-0054-00
L1673	108-0341-00	B010150	B010399	COIL,RF:FIXED,1.4UH	80009	108-0341-00
L1673	108-0054-00	B010400	B029999	COIL,RF:6.4UH	80009	108-0054-00
L1697	114-0324-00	B010100	B029999	COIL,RF:VARIABLE,200-300UH	80009	114-0324-00
L1697	114-0343-00	B030000		COIL,RF:200-400UH,CORE 276-0568-00	80009	114-0343-00
L1707	114-0308-00			COIL,RF:2.9-6.5UH	80009	114-0308-00
L6510	108-0205-00			COIL,RF:1MH	76493	8209
L6546	108-0473-00			COIL,RF:150UH	80009	108-0473-00
L6627	108-0809-00			COIL,RF:FIXED,3.12MH	80009	108-0809-00
L9350	108-0804-00			COIL,TUBE DEFL:X-Y ALIGNMENT	80009	108-0804-00
L9650	108-0805-00			COIL,TUBE DEFL:TRACE ROTATOR	80009	108-0805-00
LR1603	108-0807-00			COIL,RF:8.5UH	80009	108-0807-00
LR1703	108-0807-00			COIL,RF:8.5UH	80009	108-0807-00
LR3001	108-0111-00			COIL,RF:5.5UH	80009	108-0111-00
LR3050	108-0114-00			COIL,RF:47UH	80009	108-0114-00
LR3108	108-0111-00			COIL,RF:5.5UH	80009	108-0111-00
LR3200	108-0111-00			COIL,RF:5.5UH	80009	108-0111-00
LR4160	108-0226-00			COIL,RF:100UH	76493	DWG B4257
LR6912	108-0806-00			COIL,RF:5.5UH	80009	108-0806-00
P1670	136-0503-00	B010150		CONN,RCPT,ELEC:16 PIN,DIP	08261	SS-800-034
Q1007	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1008	151-0192-00	B010100	B010399	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1008	151-0230-00	B010400		TRANSISTOR:SILICON,NPN	01295	SAC6176
Q1025	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1026	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1036	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1037	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1051	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1052	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1054	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1062	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1063	151-0230-00			TRANSISTOR:SILICON,NPN	01295	SAC6176
Q1121	151-0192-00	B010100	B010399	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1121	151-0333-00	B010400		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q1127	151-0192-00	B010100	B010399	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1127	151-0333-00	B010400		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q1136	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1137	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1141	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1142	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1155	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1157	151-0192-00	B010100	B010399	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1157	151-0333-00	B010400		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q1227	151-0192-00	B010100	B010399	TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1227	151-0333-00	B010400		TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS1752
Q1236	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1241	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q1242	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q1253	151-0230-00			TRANSISTOR:SILICON,NPN	01295	SAC6176
Q1303	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q1322	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1340	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1396	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1402	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1421	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1423	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q1431	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1435	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1452	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1455	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q1465	151-0207-00			TRANSISTOR:SILICON,NPN	03508	X32D6191
Q1470	151-0192-00	B030000		TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1472	151-0353-00	B010100	B010399	TRANSISTOR:SILICON,NPN	32293	ITS1251
Q1472	151-0236-00	B010400	B029999	TRANSISTOR:SILICON,NPN	32293	ITS1074
Q1472	151-0192-00	B030000		TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q1475	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
Q1483	151-0207-00			TRANSISTOR:SILICON,NPN	03508	X32D6191
Q1489	151-0190-00	B010100	B010399	TRANSISTOR:SILICON,NPN	07263	S032677
Q1489	151-0236-00	B010400	B029999	TRANSISTOR:SILICON,NPN	32293	ITS1074
Q1489	151-0302-00	B030000		TRANSISTOR:SILICON,NPN	07263	S038487
Q1496	151-0207-00			TRANSISTOR:SILICON,NPN	03508	X32D6191
Q1529	151-0302-00	B010100	B029999	TRANSISTOR:SILICON,NPN	07263	S038487
Q1529	151-0103-00	B030000		TRANSISTOR:SILICON,NPN	80009	151-0103-00
Q1542	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1617	151-0446-00			TRANSISTOR:SILICON,NPN	80009	151-0446-00
Q1621	151-0195-00	B010100	B029999	TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q1621	151-0302-00	B030000		TRANSISTOR:SILICON,NPN	07263	S038487
Q1637	151-0367-00	B030000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	04713	EP7426
Q1654	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q1670	151-0139-00	B030000		TRANSISTOR:SILICON,NPN	80009	151-0139-00
Q1671	151-0139-00	B010150	B029999	TRANSISTOR:SILICON,NPN	80009	151-0139-00
Q1681	151-1025-00	B010100	B010149	TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
Q1691	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1723	151-0446-00			TRANSISTOR:SILICON,NPN	80009	151-0446-00
Q1732	151-0195-00	B010100	B029999	TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q1732	151-0302-00	B030000		TRANSISTOR:SILICON,NPN	07263	S038487
Q1737	151-0353-00	B010100	B010399	TRANSISTOR:SILICON,NPN	32293	ITS1251
Q1737	151-0236-00	B010400	B029999	TRANSISTOR:SILICON,NPN	32293	ITS1074
Q1737	151-0367-00	B030000		TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	04713	EP7426
Q1747	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1754	151-0325-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4258	80009	151-0325-00
Q1775	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1785	151-1025-00	B010100	B041267	TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
Q1785	----- -----			(CABINET)		
Q1785	151-1022-00	B041268		TRANSISTOR:FET,N-CHAN,SI,F1782,T0-18	17856	FN1234
Q1785	----- -----			(CABINET)		
Q1785	151-1025-00	B010100	B040295	TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
Q1785	----- -----			(RACKMOUNT)		
Q1785	151-1022-00	B040296		TRANSISTOR:FET,N-CHAN,SI,F1782,T0-18	17856	FN1234
Q1785	----- -----			(RACKMOUNT)		
Q1793	151-0207-00			TRANSISTOR:SILICON,NPN	03508	X32D6191
Q1805	151-1025-00	B053178		TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
Q1805	----- -----			(RACKMOUNT)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q1847	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1861	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1875	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q1891	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3020	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3031	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3081	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q3082	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3120	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3139	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3140	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3141	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3150	151-0223-00	B010100	B010149	TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3150	151-0302-00	B010150		TRANSISTOR:SILICON,NPN	07263	S038487
Q3151	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3152	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3160	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3161	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3162	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3171	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3180	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3230	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3240	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3241	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q3250	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3251	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3259	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q3260	151-0225-00			TRANSISTOR:SILICON,NPN	07263	S39291
Q3261	151-0225-00			TRANSISTOR:SILICON,NPN	07263	S39291
Q3262	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q3280	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q3290	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3291	151-0223-00			TRANSISTOR:SILICON,NPN	04713	SPS8026
Q3310	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q3311	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q3320	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q3321	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q3330	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3350	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3351	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q3360	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3361	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q3370	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3390	151-0220-00			TRANSISTOR:SILICON,PNP	07263	S036228
Q3440	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3441	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q3460	151-0198-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	04713	SPS8802-1
Q3470	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q4020	151-0261-00	B010100	B041074	TRANSISTOR:SILICON,PNP,DUAL	04713	SD441
Q4020	---- ----			(CABINET)		
Q4020	151-0261-01	B041075		TRANSISTOR:SILICON,PNP,DUAL,LOW NOISE	04713	SD441-1
Q4020	---- ----			(CABINET)		
Q4020	151-0261-00	B010100	B042733	TRANSISTOR:SILICON,PNP,DUAL	04713	SD441
Q4020	---- ----			(RACKMOUNT)		
Q4020	151-0261-01	B042734		TRANSISTOR:SILICON,PNP,DUAL,LOW NOISE	04713	SD441-1
Q4020	---- ----			(RACKMOUNT)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q4050	151-0190-01			TRANSISTOR:SILICON,NPN	80009	151-0190-01
Q4051	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4070	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4090	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4110	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
Q4115	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q4210	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	07263	SP12141
Q4211	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4230	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4310	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4311	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4312	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4313	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4321	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4322	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4323	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q4400	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q4410	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4411	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4500	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
Q4510	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4511	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4520	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4521	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q4522	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q4530	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4531	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4540	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q4541	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4600	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q4601	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
Q4710	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4720	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4820	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
Q4860	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q6020	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q6120	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q6230	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
Q6235	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q6260A,B	151-0232-00			TRANSISTOR:SILICON,NPN,DUAL	07263	SP12141
Q6322	151-0350-00			TRANSISTOR:SILICON,PNP	04713	SPS6700
Q6326	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q6560	151-0127-00			TRANSISTOR:SILICON,NPN	07263	S006075
Q6562	151-0133-00			TRANSISTOR:SILICON,PNP	80009	151-0133-00
Q6580	151-0407-00			TRANSISTOR:SILICON,NPN	04713	SS2456
Q6586	151-0188-00			TRANSISTOR:SILICON,PNP	04713	SPS6868K
Q6588	151-0406-00			TRANSISTOR:SILICON,PNP	04713	OBD
Q6642	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q6644	151-0134-00			TRANSISTOR:SILICON,PNP	80009	151-0134-00
Q8000	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
Q8000	---- ----			(1482 ONLY)		
Q9180	151-0423-00			TRANSISTOR:SILICON,NPN	51984	NTC2333L
Q9200	151-0311-01			TRANSISTOR:SILICON,NPN	04713	SJE908
Q9300	151-0311-01			TRANSISTOR:SILICON,NPN	04713	SJE908
Q9500	151-0334-00			TRANSISTOR:SILICON,NPN	04713	SJE914

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q9600	151-0334-00			TRANSISTOR:SILICON,NPN	04713	SJE914
Q9700	151-0405-00			TRANSISTOR:SILICON,NPN,SEL FROM MJE800	04713	SJE943
R1003	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R1005	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1006	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1009	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1022	312-0648-00			RES.,SET,MTCHD:15K OHM	80009	312-0648-00
R1024	315-0475-00	B030000		RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R1027	321-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R1030	315-0102-00	B010100	B029999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1031	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1032	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1033	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1035	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1039	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R1040	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R1041	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R1045	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1047	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1049	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1050	321-0256-00	B010100	B0299999	RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R1050	315-0102-00	B030000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1053	321-0326-00			RES.,FXD,FILM:24.3K OHM,1%,0.125W	91637	MFF1816G24301F
R1054	321-0256-00	B030000		RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R1055	315-0475-00	B030000		RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R1061	312-0648-00			RES.,SET,MTCHD:15K OHM	80009	312-0648-00
R1062	315-0152-00	B010150		RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R1064	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1065	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R1070	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1072	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R1075	315-0821-00	B010100	B029999	RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R1075	315-0751-00	B030000		RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R1076	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R1092	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R1095	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R1101	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R1102	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1103	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R1104	321-0275-00	B010100	B040295	RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
R1104	---- ----			(RACKMOUNT)		
R1104	321-0265-00	B040296		RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R1104	---- ----			(RACKMOUNT)		
R1104	321-0275-00	B010100	B041267	RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
R1104	---- ----			(CABINET)		
R1104	321-0265-00	B041268		RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R1104	---- ----			(CABINET)		
R1110	315-0471-00	B010100	B040295	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1110	---- ----			(RACKMOUNT)		
R1110	315-0470-00	B040296		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1110	---- ----			(RACKMOUNT)		
R1110	315-0471-00	B010100	B041267	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1110	---- ----			(CABINET)		
R1110	315-0470-00	B041268		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1110	---- ----			(CABINET)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1113	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R1122	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1124	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R1125	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
R1126	321-0238-00			RES.,FXD,FILM:2.94K OHM,1%,0.125W	91637	MFF1816G29400F
R1131	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1132	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1133	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1134	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1135	321-0322-00	B010100	B040295	RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R1135	---- ----			(RACKMOUNT)		
R1135	321-0324-00	B040296		RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R1135	---- ----			(RACKMOUNT)		
R1135	321-0322-00	B010100	B041267	RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R1135	---- ----			(CABINET)		
R1135	321-0324-00	B041268		RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R1135	---- ----			(CABINET)		
R1143	321-0275-00	B010100	B040295	RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
R1143	---- ----			(RACKMOUNT)		
R1143	321-0265-00	B040296		RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R1143	---- ----			(RACKMOUNT)		
R1143	321-0275-00	B010100	B041267	RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
R1143	---- ----			(CABINET)		
R1143	321-0265-00	B041268		RES.,FXD,FILM:5.62K OHM,1%,0.125W	91637	MFF1816G56200F
R1143	---- ----			(CABINET)		
R1146	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1151	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1152	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R1153	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1156	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R1160	315-0151-00	B010100	B029999	RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1164	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1165	315-0101-00	B010100	B029999	RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1167	315-0151-00	B030000		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1172	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1172	---- ----			(1480,1482)		
R1192	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R1201	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R1202	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R1203	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R1219	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1226	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1231	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R1233	311-1224-00			RES.,VAR,NONWIR:500 OHM,20%,0.50W	32997	3386F-T04-501
R1235	321-0258-00			RES.,FXD,FILM:4.75K OHM,1%,0.125W	91637	MFF1816G47500F
R1245	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R1251	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R1254	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1255	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R1256	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R1262	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R1263	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R1264	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R1265	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R1271	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115

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R1273	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1274	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1285	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1291	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1296	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R1304	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R1305	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1307	321-0364-03			RES.,FXD,FILM:60.4K OHM,0.25%,0.125W	91637	MFF1816D60401C
R1327	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1329	321-0324-00	B010100	B040295	RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R1329	----- -----			(RACKMOUNT)		
R1329	321-0326-00	B040296		RES.,FXD,FILM:24.3K OHM,1%,0.125W	91637	MFF1816G24301F
R1329	----- -----			(RACKMOUNT)		
R1329	321-0324-00	B010100	B041267	RES.,FXD,FILM:23.2K OHM,1%,0.125W	91637	MFF1816G23201F
R1329	----- -----			(CABINET)		
R1329	321-0326-00	B041268		RES.,FXD,FILM:24.3K OHM,1%,0.125W	91637	MFF1816G24301F
R1329	----- -----			(CABINET)		
R1330	321-0101-00			RES.,FXD,FILM:110 OHM,1%,0.125W	91637	MFF1816G110R0F
R1332	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R1333	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R1334	315-0102-00	B010100	B040295	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1334	----- -----			(RACKMOUNT)		
R1334	315-0511-00	B040296		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R1334	----- -----			(RACKMOUNT)		
R1334	315-0102-00	B010100	B041267	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1334	----- -----			(CABINET)		
R1334	315-0511-00	B041268		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R1334	----- -----			(CABINET)		
R1335	307-0124-00			RES.,THERMAL:5K OHM,10%	50157	1D1618
R1337	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R1339	321-0101-00			RES.,FXD,FILM:110 OHM,1%,0.125W	91637	MFF1816G110R0F
R1341	315-0102-00	B010100	B040295	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
1341	----- -----			(RACKMOUNT)		
R1341	315-0511-00	B040296		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R1341	----- -----			(RACKMOUNT)		
R1341	315-0102-00	B010100	B041267	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1341	----- -----			(CABINET)		
R1341	315-0511-00	B041268		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R1341	----- -----			(CABINET)		
R1342	315-0104-00	B010100	B029999	RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1344	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R1345	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1348	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R1349	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R1352	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1354	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R1361	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R1362	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1363	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R1365	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1366	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1367	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1398	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R1405	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R1408	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F

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R1411	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R1412	321-0085-00	B030000		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R1415	321-0085-00			RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R1417	321-0085-00	B010100	B029999	RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R1422	321-0176-00			RES.,FXD,FILM:665 OHM,1%,0.125W	91637	MFF1816G665R0F
R1425	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R1427	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1429	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R1432	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1438	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R1439	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R1441	321-0230-00			RES.,FXD,FILM:2.43K OHM,1%,0.125W	91637	MFF1816G24300F
R1442	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1443	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1453	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1476	315-0101-00	B010100	B029999	RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1477	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1478	315-0103-00	B030000		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1479	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R1481	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1482	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	91637	MFF1816G35700F
R1487	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1488	315-0680-00			RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R1491	321-0176-00			RES.,FXD,FILM:665 OHM,1%,0.125W	91637	MFF1816G665R0F
R1493	321-0168-00			RES.,FXD,FILM:549 OHM,1%,0.125W	91637	MFF1816G549R0F
R1494	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R1495	315-0273-00	B010100	B010149	RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R1495	315-0333-00	B010400	B029999	RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R1495	315-0223-00	B030000		RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R1502	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1504	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R1517	321-0176-00			RES.,FXD,FILM:665 OHM,1%,0.125W	91637	MFF1816G665R0F
R1521	303-0471-00			RES.,FXD,CMPSN:470 OHM,5%,1W	01121	GB4715
R1523	315-0102-00	B010100	B029999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1523	----- -----			(RACKMOUNT)		
R1523	315-0471-00	B030000	B040295	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1523	----- -----			(RACKMOUNT)		
R1523	131-0566-00	B040296		BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R1523	----- -----			(RACKMOUNT)		
R1523	315-0102-00	B010100	B029999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1523	----- -----			(CABINET)		
R1523	315-0471-00	B030000	B041267	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1523	----- -----			(CABINET)		
R1523	131-0566-00	B041268		BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R1523	----- -----			(CABINET)		
R1524	315-0181-00	B010100	B029999	RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R1524	315-0131-00	B030000		RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R1525	311-1267-00	B030000		RES.,VAR,NONWIR:5K OHM,10%,0.50W	32997	3329P-L58-502
R1526	315-0471-00	B010400	B029999	RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1527	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R1533	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1537	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1539	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1543	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225

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R1545	315-0302-00	B010100	B040295	RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R1545	----- -----			(RACKMOUNT)		
R1545	315-0362-00	B040296		RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R1545	----- -----			(RACKMOUNT)		
R1545	315-0302-00	B010100	B041267	RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R1545	----- -----			(CABINET)		
R1545	315-0362-00	B041268		RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R1545	----- -----			(CABINET)		
R1547	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R1549	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R1551	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R1552	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R1555	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1557	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1565	311-1232-00	B010100	B029999	RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R1568	315-0393-00	B030000		RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R1569	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R1571	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1574	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
R1575	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1577	315-0472-00	B010100	B040295	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1577	----- -----			(RACKMOUNT)		
R1577	315-0332-00	B040296		RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R1577	----- -----			(RACKMOUNT)		
R1577	315-0472-00	B010100	B041267	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1577	----- -----			(CABINET)		
R1577	315-0332-00	B041268		RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R1577	----- -----			(CABINET)		
R1581	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
R1582	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1584	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1585	321-0164-00	B010100	B010149	RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499R0F
R1585	321-0066-00	B010150		RES.,FXD,FILM:47.5 OHM,1%,0.125W	91637	MFF1816G47R50F
R1586	315-0102-00	B010100	B040295	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1586	----- -----			(RACKMOUNT)		
R1586	301-0751-00	B040296		RES.,FXD,CMPSN:750 OHM,5%,0.50W	01121	EB7515
R1586	----- -----			(RACKMOUNT)		
R1586	315-0102-00	B010100	B041267	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1586	----- -----			(CABINET)		
R1586	301-0751-00	B041268		RES.,FXD,CMPSN:750 OHM,5%,0.50W	01121	EB7515
R1586	----- -----			(CABINET)		
R1587	321-0176-00			RES.,FXD,FILM:665 OHM,1%,0.125W	91637	MFF1816G665R0F
R1591	321-0091-00			RES.,FXD,FILM:86.6 OHM,1%,0.125W	91637	MFF1816G86R60F
R1592	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1595	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1597	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
R1607	307-1033-00			RES.,FXD,FILM:1.2K OHM,1%,3W	19647	MS245N-D12000F
R1609	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1623	315-0822-00	B010150	B029999	RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R1625	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1627	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R1628	315-0391-00	B030000		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R1634	321-0059-00	B030000		RES.,FXD,FILM:40.2 OHM,1%,0.125W	91637	MFF1816G40R20F
R1635	323-0208-00			RES.,FXD,FILM:1.43K OHM,1%,0.50W	75042	CECT0-1431F
R1645	301-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.50W	01121	EB1225

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R1647	321-0169-00			RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F
R1655	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
R1656	321-0126-00	B030000		RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R1660	315-0100-00	B030000		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1663	315-0823-00	B010100	B010149	RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R1663	315-0473-00	B010150	B029999	RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1664	315-0100-00	B030000		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1665	315-0101-00	B010100	B029999	RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1666	311-1232-00	B030000		RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R1670	315-0391-00	B010150	B029999	RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R1671	315-0391-00	B010150	B029999	RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R1675	315-0151-00	B010100	B029999	RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1675	---- ----			(CABINET)		
R1675	131-0566-00	B030000	B040295	BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R1675	---- ----			(CABINET)		
R1675	315-0100-00	B040296		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1675	---- ----			(CABINET)		
R1675	315-0151-00	B010100	B029999	RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1675	---- ----			(RACKMOUNT)		
R1675	131-0566-00	B030000	B041267	BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R1675	---- ----			(RACKMOUNT)		
R1675	315-0100-00	B041268		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1675	---- ----			(RACKMOUNT)		
R1681	315-0101-00	B030000		RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1682	315-0122-00	B010100	B010149	RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R1683	315-0332-00	B010100	B010149	RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R1684	321-0114-00	B030000		RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R1685	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R1688	315-0472-00	B010100	B040295	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1688	---- ----			(CABINET)		
R1688	315-0362-00	B040296		RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R1688	---- ----			(CABINET)		
R1688	315-0472-00	B010100	B041267	RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1688	---- ----			(RACKMOUNT)		
R1688	315-0362-00	B041268		RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R1688	---- ----			(RACKMOUNT)		
R1693	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1695	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1713	315-0183-00	B010100	B029999	RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R1713	315-0472-00	B030000		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1715	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1717	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1724	323-0158-00			RES.,FXD,FILM:432 OHM,1%,0.50W	75042	CECT0-4320F
R1725	323-0158-00			RES.,FXD,FILM:432 OHM,1%,0.50W	75042	CECT0-4320F
R1727	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816G100R0F
R1734	315-0223-00	B010100	B029999	RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R1734	315-0153-00	B030000		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1735	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R1738	315-0391-00	B030000		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R1739	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1740	321-0059-00	B010100	B029999	RES.,FXD,FILM:40.2 OHM,1%,0.125W	91637	MFF1816G40R20F
R1745	321-0059-00			RES.,FXD,FILM:40.2 OHM,1%,0.125W	91637	MFF1816G40R20F
R1749	301-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.50W	01121	EB1225
R1751	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1752	321-0169-00			RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F

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R1755	321-0143-00			RES.,FXD,FILM:301 OHM,1%,0.125W	91637	MFF1816G301R0F
R1761	321-0138-00			RES.,FXD,FILM:267 OHM,1%,0.125W	91637	MFF1816G267R0F
R1762	321-0126-00	B030000		RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R1765	315-0101-00	B010100	B010149	RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1768	321-0090-00	B010100	B029999	RES.,FXD,FILM:84.5 OHM,1%,0.125W	91637	MFF1816G84R50F
R1768	315-0102-00	B030000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1769	315-0102-00	B030000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1779	321-0090-00	B010100	B029999	RES.,FXD,FILM:84.5 OHM,1%,0.125W	91637	MFF1816G84R50F
R1779	321-0117-00	B030000		RES.,FXD,FILM:162 OHM,1%,0.125W	91637	MFF1816G162R0F
R1781	315-0752-00	B010100	B029999	RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R1781	315-0151-00	B030000		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1786	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R1787	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R1789	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1797	315-0823-00			RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R1802	321-0391-00	B010100	B029999	RES.,FXD,FILM:115K OHM,1%,0.125K	91637	MFF1816G11502F
R1805	321-0391-00	B010100	B029999	RES.,FXD,FILM:115K OHM,1%,0.125K	91637	MFF1816G11502F
R1806	315-0752-00	B030000		RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R1807	307-1033-00			RES.,FXD,FILM:1.2K OHM,1%,3W	19647	MS245N-D12000F
R1808	315-0753-00	B030000		RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R1809	321-0210-00	B010100	B029999	RES.,FXD,FILM:1.5K OHM,1%,0.125W	91637	MFF1816G15000F
R1809	315-0624-00	B030000		RES.,FXD,CMPSN:620K OHM,5%,0.25W	01121	CB6245
R1810	315-0914-00	B030000		RES.,FXD,CMPSN:910K OHM,5%,0.25W	01121	CB9145
R1811	321-0331-00	B010100	B029999	RES.,FXD,FILM:27.4K OHM,1%,0.125W	91637	MFF1816G27401F
R1812	315-0103-00	B030000		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1813	321-0226-00	B010100	B029999	RES.,FXD,FILM:2.21K OHM,1%,0.125W	91637	MFF1816G22100F
R1814	311-1228-00	B030000		RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R1815	321-0182-00	B010100	B029999	RES.,FXD,FILM:768 OHM,1%,0.125W	91637	MFF1816G768R0F
R1815	315-0822-00	B030000		RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R1821	321-0327-00	B010100	B029999	RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R1823	311-1228-00	B010100	B029999	RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R1825	321-0269-00	B010100	B029999	RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
R1825	315-0753-00	B030000		RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R1827	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
R1830	315-0102-00	B030000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1833	315-0512-00	B010100	B029999	RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R1844	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1848	321-0147-00			RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
R1849	321-0125-00	B010100	B010149	RES.,FXD,FILM:196 OHM,1%,0.125W	91637	MFF1816G196R0F
R1849	321-0124-00	B010150	B029999	RES.,FXD,FILM:191 OHM,1%,0.125W	91637	MFF1816G191R0F
R1849	321-0123-00	B030000		RES.,FXD,FILM:187 OHM,1%,0.125W	91637	MFF1816G187R0F
R1851	315-0823-00	B010100	B010150	RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R1851	315-0102-00	B030000		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1855	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	91637	MFF1816G93100F
R1857	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1859	321-0125-00	B010100	B010149	RES.,FXD,FILM:196 OHM,1%,0.125W	91637	MFF1816G196R0F
R1859	321-0124-00	B010150	B029999	RES.,FXD,FILM:191 OHM,1%,0.125W	91637	MFF1816G191R0F
R1859	321-0123-00	B030000		RES.,FXD,FILM:187 OHM,1%,0.125W	91637	MFF1816G187R0F
R1863	321-0163-00			RES.,FXD,FILM:487 OHM,1%,0.125W	91637	MFF1816G487R0F
R1864	315-0184-00	B010100	B010150	RES.,FXD,CMPSN:180K OHM,5%,0.25W	01121	CB1845
R1864	315-0681-00	B030000		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R1867	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	91637	MFF1816G93100F
R1868	321-0163-00			RES.,FXD,FILM:487 OHM,1%,0.125W	91637	MFF1816G487R0F
R1869	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1870	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	91637	MFF1816G93100F

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R1871	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R1872	315-0334-00	B010100	B010150	RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R1876	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R1877	315-0102-00	B010100	B029999	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1881	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1885	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1887	315-0823-00			RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R1889	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	91637	MFF1816G93100F
R1891	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R1893	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1894	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R1895	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R1896	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R1897	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R1899	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R1913	321-0236-03			RES.,FXD,FILM:2.8K OHM,0.25%,0.125W	91637	MFF1816D28000C
R1914	321-0073-00			RES.,FXD,FILM:56.2 OHM,1%,0.125W	91637	MFF1816G56R20F
R1915	321-0199-03			RES.,FXD,FILM:1.15K OHM,0.25%,0.125W	91637	MFF1816D11500C
R1921	321-0292-03			RES.,FXD,FILM:10.7K OHM,0.25%,0.125W	91637	MFF1816D10701C
R1945	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R1953	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R1955	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R1975	321-0269-00	B010100	B029999	RES.,FXD,FILM:6.19K OHM,1%,0.125W	91637	MFF1816G61900F
R1975	321-0271-00	B030000		RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
R1977	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R1991	321-0218-00	B030000		RES.,FXD,FILM:1.82K OHM,1%,0.125W	91637	MFF1816G18200F
R1992	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R3010	321-0330-00			RES.,FXD,FILM:26.7K OHM,1%,0.125W	91637	MFF1816G26701F
R3011	321-0232-00			RES.,FXD,FILM:2.55K OHM,1%,0.125W	91637	MFF1816G25500F
R3015	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3020	321-0316-00			RES.,FXD,FILM:19.1K OHM,1%,0.125W	91637	MFF1816G19101F
R3021	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	91637	CMF55-116G18701F
R3030	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
R3031	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3032	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3033	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3040	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3050	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R3051	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3052	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3053	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R3060	321-0332-00			RES.,FXD,FILM:28K OHM,1%,0.125W	91637	MFF1816G28001F
R3061	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3062	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R3080	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	91637	MFF1816G49901F
R3081	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R3082	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R3090	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R3091	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3092	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R3110	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R3111	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R3112	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R3113	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R3114	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045

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R3120	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R3130	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R3131	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R3132	316-0336-00			RES.,FXD,CMPSN:33M OHM,10%,0.25W	01121	CB3361
R3133	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R3134	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3135	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3136	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3140	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R3141	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3142	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R3150	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R3151	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3152	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3160	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R3161	321-0332-00			RES.,FXD,FILM:28K OHM,1%,0.125W	91637	MFF1816G28001F
R3162	315-0623-00			RES.,FXD,CMPSN:62K OHM,5%,0.25W	01121	CB6235
R3169	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3170	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3171	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R3172	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R3174	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3180	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R3181	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R3182	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R3183	315-0334-00			RES.,FXD,CMPSN:330K OHM,5%,0.25W	01121	CB3345
R3184	321-0357-00			RES.,FXD,FILM:51.1K OHM,1%,0.125W	91637	MFF1816G51101F
R3190	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R3191	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R3192	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3200	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R3210	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R3211	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3212	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3213	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R3220	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R3221	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R3222	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
R3223	321-0302-00			RES.,FXD,FILM:13.7K OHM,1%,0.125W	91637	MFF1816G13701F
R3224	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3225	321-0254-00			RES.,FXD,FILM:4.32K OHM,1%,0.125W	91637	MFF1816G43200F
R3230	321-0331-00			RES.,FXD,FILM:27.4K OHM,1%,0.125W	91637	MFF1816G27401F
R3231	321-0247-00			RES.,FXD,FILM:3.65K OHM,1%,0.125W	91637	MFF1816G36500F
R3232	321-0267-00			RES.,FXD,FILM:5.9K OHM,1%,0.125W	91637	MFF1816G59000F
R3233	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R3240	321-0273-00			RES.,FXD,FILM:6.81K OHM,1%,0.125W	91637	MFF1816G68100F
R3241	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R3242	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3250	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R3251	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R3252	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
R3260	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3261	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3262	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R3273	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735

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R3270	315-0914-00			RES.,FXD,CMPSN:910K OHM,5%,0.25W	01121	CB9145
R3271	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R3272	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R3273	315-0113-00			RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
R3280	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R3281	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R3282	316-0126-00			RES.,FXD,CMPSN:12M OHM,10%,0.25W	01121	CB1261
R3290	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R3310	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3320	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R3321	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R3330	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3340	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R3341	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3342	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R3343	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3344	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R3346	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R3350	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R3351	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R3352	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3353	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3354	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R3355	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R3361	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R3370	315-0274-00			RES.,FXD,CMPSN:270K OHM,5%,0.25W	01121	CB2745
R3371	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R3372	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R3373	321-0357-00			RES.,FXD,FILM:51.1K OHM,1%,0.125W	91637	MFF1816G51101F
R3374	321-0373-00			RES.,FXD,FILM:75K OHM, 1%,0.125W	91637	MFF1816G75001F
R3380	321-0415-00			RES.,FXD,FILM:205K OHM,1%,0.125W	91637	MFF1816G20502F
R3381	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	91637	MFF1816G49902F
R3382	321-0510-00			RES.,FXD,FILM:2M OHM,1%,0.125W	91637	HFF188G20003F
R3390	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3391	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3392	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R3393	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R3400	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R3401	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3402	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3410	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R3411	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R3420	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R3421	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3422	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3430	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R3431	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R3440	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R3441	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R3442	315-0470-00	B010400		RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R3450	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R3451	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R3460	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R3470	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R3471	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015

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R3480	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755
R3481	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R3482	315-0106-00			RES.,FXD,CMPSN:10M OHM,5%,0.25W	01121	CB1065
R3490	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4000	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R4001	321-0151-00			RES.,FXD,FILM:365 OHM,1%,0.125W	91637	MFF1816G365R0F
R4011	315-0181-00			RES.,FXD,CMPSN:180 OHM,5%,0.25W	01121	CB1815
R4012	321-0245-00			RES.,FXD,FILM:3.48K OHM,1%,0.125W	91637	MFF1816G34800F
R4013	321-0312-00			RES.,FXD,FILM:17.4K OHM,1%,0.125W	91637	MFF1816G17401F
R4020	321-0391-00			RES.,FXD,FILM:115K OHM,1%,0.125K	91637	MFF1816G11502F
R4022	321-0287-00			RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
R4025	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R4032	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R4040	311-1254-00			RES.,VAR,NONWIR:1M OHM,20%,0.50W	73138	72-18-0
R4052	315-0754-00			RES.,FXD,CMPSN:750K OHM,5%,0.25W	01121	CB7545
R4060	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4070	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	24546	NA4D1004F
R4100	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	91637	MFF1816G93100F
R4120	321-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.125W	91637	MFF1816G22101F
R4122	315-0824-00			RES.,FXD,CMPSN:820K OHM,5%,0.25W	01121	CB8245
R4123	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F
R4124	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4125	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4131	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
R4132	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R4133	321-0603-07			RES.,FXD,FILM:15K OHM,0.1%,0.125W	91637	MFF1816C15001B
R4134	321-0323-00			RES.,FXD,FILM:22.6K OHM,1%,0.125W	91637	MFF1816G22601F
R4140	321-0331-00			RES.,FXD,FILM:27.4K OHM,1%,0.125W	91637	MFF1816G27401F
R4146	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R4148	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
R4151	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F
R4153	321-0277-03			RES.,FXD,FILM:7.5K OHM,0.25%,0.125W	24546	NC55C7501C
R4160	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R4161	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4170	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R4171	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	91637	MFF1816G31601F
R4172	321-0295-00			RES.,FXD,FILM:11.5K OHM,1%,0.125W	91637	MFF1816G11501F
R4173	321-0241-00			RES.,FXD,FILM:3.16K OHM,1%,0.125W	91637	MFF1816G31600F
R4190	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4191	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4200	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R4201	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R4210	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R4211	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R4212	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R4220	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R4221	321-0288-00			RES.,FXD,FILM:9.76K OHM,1%,0.125W	91637	MFF1816G97600F
R4222	321-0307-00			RES.,FXD,FILM:15.4K OHM,1%,0.125W	91637	MFF1816G15401F
R4223	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816G10001F
R4224	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4231	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R4232	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R4233	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R4234	311-1263-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	32997	3329P-L58-102
R4240	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	32997	3329P-L58-103

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R4241	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	91637	MFF1816G64900F
R4242	321-0331-00			RES.,FXD,FILM:27.4K OHM,1%,0.125W	91637	MFF1816G27401F
R4250	321-0323-00			RES.,FXD,FILM:22.6K OHM,1%,0.125W	91637	MFF1816G22601F
R4251	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R4270	321-0279-00			RES.,FXD,FILM:7.87K OHM,1%,0.125W	91637	MFF1816G78700F
R4300	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R4301	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R4302	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R4310	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R4311	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R4312	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R4313	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R4314	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R4320	321-0242-00			RES.,FXD,FILM:3.24K OHM,1%,0.125W	91637	MFF1816G32400F
R4322	321-0220-00			RES.,FXD,FILM:1.91K OHM,1%,0.125W	91637	MFF1816G19100F
R4323	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4325	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R4330	311-1265-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	32997	3329P-L58-202
R4331	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R4332	323-0295-00			RES.,FXD,FILM:11.5K OHM,1%,0.50W	75042	CECT0-1152F
R4333	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4340	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R4341	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4342	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R4350	321-0411-00			RES.,FXD,FILM:187K OHM,1%,0.125W	91637	MFF1816G18702F
R4351	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
R4352	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4370	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4371	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4372	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4381	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4382	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4383	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4384	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4390	315-0183-00			RES.,FXD,CMPSN:18K OHM,5%,0.25W	01121	CB1835
R4400	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4401	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	91637	MFF1816G51100F
R4402	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4410	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4411	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4412	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
R4413	321-0266-00			RES.,FXD,FILM:5.76K OHM,1%,0.125W	91637	MFF1816G57600F
R4414	321-0266-00			RES.,FXD,FILM:5.76K OHM,1%,0.125W	91637	MFF1816G57600F
R4420	321-0202-00			RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
R4422	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R4423	322-0324-00			RES.,FXD,FILM:23.2K OHM,1%,0.25W	91637	MFF1421G23201F
R4431	311-1265-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	32997	3329P-L58-202
R4432	322-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.25W	91637	MFF1421G30101F
R4433	321-0314-00			RES.,FXD,FILM:18.2K OHM,1%,0.125W	91637	MFF1816G18201F
R4434	321-0308-00			RES.,FXD,FILM:15.8K OHM,1%,0.125W	91637	MFF1816G15801F
R4435	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R4440	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4450	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4451	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4460	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235

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R4470	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4480	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4481	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4490	315-0103-00	B010100	B010124	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4490	---- ----			(CABINET)		
R4490	315-0103-00	B010100	B010154	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4490	----- -----			(RACKMOUNT)		
R4491	315-0102-00	B010100	B010124	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4491	---- ----			(CABINET)		
R4491	315-0102-00	B010100	B010154	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4491	----- -----			(RACKMOUNT)		
R4493	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R4500	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R4501	303-0333-00			RES.,FXD,CMPSN:33K OHM,5%,1W	01121	GB3335
R4502	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R4503	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R4504	303-0333-00			RES.,FXD,CMPSN:33K OHM,5%,1W	01121	GB3335
R4510	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
R4511	322-0353-00			RES.,FXD,FILM:46.4K OHM,1%,0.25W	91637	MFF1421G46401F
R4520	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R4521	321-0374-00			RES.,FXD,FILM:76.8K OHM,1%,0.125W	91637	MFF1816G76801F
R4522	321-0372-00			RES.,FXD,FILM:73.2K OHM,1%,0.125W	91637	MFF1816G73201F
R4527	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R4531	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	91637	MFF1816G16500F
R4532	311-0634-00			RES.,VAR,NONWIR:TRMR,500 OHM,0.5W	32997	3329H-G48-501
R4540	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R4550	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4560	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4600	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R4601	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R4602	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R4612	322-0349-00			RES.,FXD,FILM:42.2K OHM,1%,0.25W	75042	CEBT0-4222F
R4613	321-0147-00	B010100	B041074	RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
R4613	---- ----			(RACKMOUNT)		
R4613	321-0159-00	B041075		RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R4613	---- ----			(RACKMOUNT)		
R4613	321-0147-00	B010100	B042733	RES.,FXD,FILM:332 OHM,1%,0.125W	91637	MFF1816G332R0F
R4613	----- -----			(CABINET)		
R4613	321-0159-00	B042734		RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R4613	---- ----			(CABINET)		
R4621	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R4630	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R4630	---- ----			(CABNIT)		
R4630	321-0197-00	B010100	B053177	RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R4630	----- -----			(RACKMOUNT)		
R4630	321-0209-00	B053178		RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
R4630	----- -----			(RACKMOUNT)		
R4631	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R4631	----- -----			(CABNIT)		
R4631	321-0197-00	B010100	B051377	RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R4631	----- -----			(RACKMOUNT)		
R4631	321-0209-00	B051378		RES.,FXD,FILM:1.47K OHM,1%,0.125W	91637	MFF1816G14700F
R4631	---- ----			(RACKMOUNT)		
R4632	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4632	---- ----			(CABNIT)		

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R4632	315-0102-00	B010100	053177	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4632	---- ----			(RACKMOUNT)		
R4632	321-0183-00	B053178		RES.,FXD,FILM:787 OHM,1%,0.125W	91637	MFF1816G787R0F
R4632	---- ----			(RACKMOUNT)		
R4633	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R4633	---- ----	B053178		(RACKMOUNT)		
R4642	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4650	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4680	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R4690	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R4700	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4701	321-0393-00			RES.,FXD,FILM:121K OHM,1%,0.125W	91637	MFF1816G12102F
R4702	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4707	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R4708	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R4711	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4712	321-0363-00			RES.,FXD,FILM:59K OHM,1%,0.125W	91637	MFF1816G59001F
R4712	---- ----			(USED IF NECESSARY)		
R4713	315-0914-00			RES.,FXD,CMPSN:910K OHM,5%,0.25W	01121	CB9145
R4720	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	91637	MFF1816G15001F
R4721	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R4722	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R4723	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4724	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R4725	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4730	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4731	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4732	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R4750	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4751	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4770	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4780	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4781	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4800	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4801	315-0203-00	B010100	B041074	RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R4801	---- ----			(CABINET)		
R4801	321-0318-00	B041075		RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R4801	---- ----			(CABINET)		
R4801	315-0203-00	B010100	B042733	RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R4801	---- ----			(RACKMOUNT)		
R4801	321-0318-00	B042734		RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R4801	---- ----			(RACKMOUNT)		
R4802	315-0103-00	B010100	B041074	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4802	---- ----			(CABINET)		
R4802	321-0287-00	B041075		RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
R4802	---- ----			(CABINET)		
R4802	315-0103-00	B010100	B042733	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4802	---- ----			(RACKMOUNT)		
R4802	321-0287-00	B042734		RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
R4802	---- ----			(RACKMOUNT)		
R4803	315-0474-00	B041075		RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4803	---- ----			(CABINET)		
R4803	315-0474-00	B042734		RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4803	---- ----			(RACKMOUNT)		
R4804	315-0475-00			RES.,FXD,CMPSN:4.7M OHM,5%,0.25W	01121	CB4755

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R4810	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R4820	321-0459-00			RES.,FXD,FILM:590K OHM,1%,0.125W	91637	MFF1816G59002F
R4821	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	91637	MFF1816G750R0F
R4822	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R4830	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R4840	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4850	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4851	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4852	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4860	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4861	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R4880	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4890	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4896	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R4900	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4909	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4911	321-0299-00			RES.,FXD,FILM:12.7K OHM,1%,0.125W	91637	MFF1816G12701F
R4920	321-0299-00			RES.,FXD,FILM:12.7K OHM,1%,0.125W	91637	MFF1816G12701F
R4921	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4922	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4923	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4930	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4960	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4970	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4971	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4980	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4981	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4990	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4991	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R5052	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R5062	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R5072	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R5074	315-0104-00	B010150		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R6016	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R6018	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R6032	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R6034	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R6036	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R6038	308-0677-00			RES.,FXD,WW:1 OHM,5%,2W	75042	BWH-1R000J
R6042	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R6046	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R6070	321-0200-00			RES.,FXD,FILM:1.18K OHM,1%,0.125W	91637	MFF1816G11800F
R6072	321-0150-00			RES.,FXD,FILM:357 OHM,1%,0.125W	91637	MFF1816G357R0F
R6076	321-0188-00			RES.,FXD,FILM:887 OHM,1%,0.125W	91637	MFF1816G887R0F
R6078	321-0173-00			RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G619R0F
R6082	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R6096	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
R6116	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R6118	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R6132	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R6134	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R6136	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R6138	308-0677-00			RES.,FXD,WW:1 OHM,5%,2W	75042	BWH-1R000J
R6142	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R6146	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045

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R6164	311-1035-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	73138	82-40-0
R6172	321-0214-00			RES.,FXD,FILM:1.65K OHM,1%,0.125W	91637	MFF1816G16500F
R6174	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	91637	MFF1816G14701F
R6176	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R6180	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R6182	321-0243-00			RES.,FXD,FILM:3.32K OHM,1%,0.125W	91637	MFF1816G33200F
R6184	321-0236-00			RES.,FXD,FILM:2.8K OHM,1%,0.125W	91637	MFF1816G28000F
R6216	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R6220	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R6225	308-0273-00			RES.,FXD,WW:6.5K OHM,2%,5W	91637	RS2A-65000G
R6235	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R6242	308-0365-00			RES.,FXD,WW:1.5 OHM,5%,3W	91637	CW2B-1R500J
R6246	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R6252	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R6254	323-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.50W	75042	CECT0-4022F
R6264	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F
R6266	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R6272	321-0272-00			RES.,FXD,FILM:6.65K OHM,1%,0.125W	91637	MFF1816G66500F
R6276	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	91637	MFF1816G40201F
R6314	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R6316	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R6318	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R6320	308-0273-00			RES.,FXD,WW:6.5K OHM,2%,5W	91637	RS2A-65000G
R6322	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R6332	323-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.50W	91637	MFF1226G24901F
R6338	323-0322-00			RES.,FXD,FILM:22.1K OHM,1%,0.50W	75042	CECT0-2212F
R6360	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
R6414	311-1227-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	32997	3386F-T04-502
R6426	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R6429	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R6434	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R6436	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R6440	315-0224-00			RES.,FXD,CMPSN:220K OHM,5%,0.25W	01121	CB2245
R6442	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R6444	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R6450	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R6460	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R6462	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R6464	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R6465	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R6466	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
R6468	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R6482	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R6484	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R6486	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R6503	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	32997	3386F-T04-104
R6508	311-1235-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	32997	3386F-T04-104
R6524	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R6525	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R6532	321-0235-00	B010100	B010599	RES.,FXD,FILM:2.74K OHM,1%,0.125W	91637	MFF1816G27400F
R6532	321-0234-00	B010600		RES.,FXD,FILM:2.67K OHM,1%,0.125W	91637	MFF1816G26700F
R6534	321-0253-00	B010100	B010599	RES.,FXD,FILM:4.22K OHM,1%,0.125W	91637	MFF1816G42200F
R6534	321-0251-00	B010600		RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R6536	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725

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R6540	311-0978-00	B010100	B010599	RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	82-4-2
R6540	311-1261-00	B010600		RES.,VAR,NONWIR:500 OHM,10%,0.50W	32997	3329P-L58-501
R6546	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R6550	301-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.50W	01121	EB2755
R6566	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R6570	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R6572	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R6574	323-0312-00			RES.,FXD,FILM:17.4K OHM,1%,0.50W	91637	MFF1226G17401F
R6576	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R6578	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R6580	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R6582	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R6584	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R6586	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R6618	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R6619	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R6660	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R6664	303-0203-00			RES.,FXD,CMPSN:20K OHM,5%,1W	01121	GB2035
R6672	315-0562-00			RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R6674	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R6676	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R6680	311-1232-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	32997	3386F-T04-503
R6682	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R6684	315-0121-00			RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R6718	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R6728	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R6754	315-0205-00	B010100	B030881	RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R6754	---- ----			(CABINET)		
R6754	315-0105-00	B030882		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R6754	---- ----			(CABINET)		
R6754	315-0205-00	B010100	B031997	RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R6754	---- ----			(RACKMOUNT)		
R6754	315-0105-00	B031998		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R6754	---- ----			(RACKMOUNT)		
R6788	315-0272-03			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R6860	307-0414-00			RES.,FXD,FILM:HIGH VOLTAGE REGULATOR	80009	307-0414-00
R6885	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
R6888	315-0272-03			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R6892	315-0272-03			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R6942	315-0271-03			RES.,FXD CMPSN:270 OHM,5%,0.25W	01121	CB2715
R6944	315-0182-03			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R6946	315-0203-02			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R6947	315-0120-00			RES.,FXD,CMPSN:12 OHM,5%,0.25W	01121	CB1205
R6952	315-0182-03			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R6954	315-0511-02			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R6958	315-0915-02			RES.,FXD,CMPSN:9.1M OHM,5%,0.25W	01121	CB9155
R8003	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R8003	---- ----			(1482 ONLY)		
R8015	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R8015	---- ----			(1482 ONLY)		
R8030	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R8030	---- ----			(1482 ONLY)		
R8031	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R8031	---- ----			(1482 ONLY)		
R8039	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R8039	---- ----			(1482 ONLY)		

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R9030	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R9821	321-0085-00	B010150		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
R9822	321-0114-00	B010150		RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R9828	311-1703-00	B010100	B010149	RES.,VAR,NONWIR:5K OHM,10%,1W	01121	14M602
R9828	---- ----			(PART OF S9820)		
R9828	311-1804-00	B010150		RES.,VAR,NONWIR:500 OHM,10%,1W	01121	15M848
R9828	---- ----			(PART OF S9820)		
R9880	311-1524-00			RES.,VAR,NONWIR:20K OHM,10%,1W	01121	73A1G040L203U
R9882	311-0254-00			RES.,VAR,NONWIR:5M OHM,10%,1W	12697	CM29709
R9892	311-1929-00	B053178		RES.,VAR,NONWIR:PNL,1K OHM,1W,LINEAR	01121	OBD
R9892	---- ----			(PART OF S9892, RACKMOUNT)		
R9894	315-0361-00	B053178		RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R9894	---- ----			(RACKMOUNT)		
R9922	321-0114-00	B010100	B041227	RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R9922	---- ----			(CABINET)		
R9922	321-0114-00	B010100	B042928	RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R9922	---- ----			(RACKMOUNT)		
R9925	311-1057-00			RES.,VAR,NONWIR:5K OHM,3%,0.0 1%	32997	3540S-420-502
R9935	311-0310-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	W-7350A
R9940	311-0546-00	B010100	B010149	RES.,VAR,NONWIR:10K OHM,20%,0.75W	80009	311-0546-00
R9940	311-0169-00	B010150		RES.,VAR,NONWIR:100 OHM,20%,0.50W	01121	W-7564B
R9980	311-1310-00			RES.,VAR,NONWIR:20K OHM,20%,1W	01121	10M654
R9982	311-1704-00			RES.,VAR,NONWIR:10K X 10K OHM,20%,0.50W	01121	17M599
R9983	311-1704-00			RES.,VAR,NONWIR:10K X 10K OHM,20%,0.50W	01121	17M599
R9984	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R9990	311-1057-00			RES.,VAR,NONWIR:5K OHM,3%,0.0 1%	32997	3540S-420-502
R9992	311-1705-00			RES.,VAR,WW:PNL,10K OHM,2W	73138	7266-397-00
S5001	260-1674-00			SWITCH,PUSH:6 STA,2 POLE,INTERLOCK	80009	260-1674-00
S5001	---- ----			(PART OF S5001, S5041, S5071)		
S5006	260-1675-00			SWITCH,PUSH:8 STA,2 POLE,INTERLOCK	80009	260-1675-00
S5016	---- ----			(PART OF S5006,S5016,S5026,		
S5026	---- ----			S5036,S5056,S5076,S5096)		
S5036	---- ----					
S5041	260-1674-00			SWITCH,PUSH:6 STA,2 POLE,INTERLOCK	80009	260-1674-00
S5041	---- ----			(PART OF S5041,S5071)		
S5056	260-1675-00			SWITCH,PUSH:8 STA,2 POLE,INTERLOCK	80009	260-1675-00
S5056	---- ----			(PART OF S5016,S5026,S5036,		
S5056	---- ----			S5056,S5076,S5086,S5096)		
S5071	260-1674-00			SWITCH,PUSH:6 STA,2 POLE,INTERLOCK	80009	260-1674-00
S5071	---- ----			(PART OF S5041,S5071)		
S5076	260-1675-00			SWITCH,PUSH:8 STA,2 POLE,INTERLOCK	80009	260-1675-00
S5086	---- ----			(PART OF S5016,S5026,S5036,		
S5096	---- ----			S5056,S5076,S5086,S5096)		
S9190	260-0675-00			SWITCH,SLIDE:DPDT,W/O DETENTS	82389	11A1024
S9815	260-1679-00			SWITCH,ROTARY:	80009	260-1679-00
S9820	---- ----			(PART OF R9828)		
S9828	260-1677-00			SWITCH,ROTARY:	80009	260-1677-00
S9836	260-0276-00			SWITCH,TOGGLE:DPST,15A,125V	27193	7561 K 4
S9890	260-1681-00			SWITCH,ROTARY:	80009	260-1681-00
S9891	260-1680-00			SWITCH,ROTARY:	80009	260-1680-00
S9892	311-1929-00	B053178		RES.,VAR,NONWIR:PNL,1K OHM,1W,LINEAR	01121	OBD
S9892	---- ----			(PART OF R9892, RACKMOUNT)		
S9915	260-1682-00			SWITCH,ROTARY:	80009	260-1682-00
S9955	260-1648-00			SWITCH,SLIDE:0.5A,125VAC	79727	G-128-L
S9982	311-1704-00			RES.,VAR,NONWIR:10K X 10K OHM,20%,0.50W	01121	17M599
S9982	---- ----			(PART OF R9982)		

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S9983	311-1704-00			RES.,VAR,NONWIR:10K X 10K OHM,20%,0.50W	01121	17M599
S9983	---- ----			(PART OF) R9983)		
S9992	260-1678-00			SWITCH,ROTARY:	80009	260-1678-00
T6810	120-0948-00			XFMR,PWR,STU:HV	80009	120-0948-00
T9400	120-0949-00			XFMR,PWR,SDN&SU:	80009	120-0949-00
U1223	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U1347	156-0355-00			MICROCIRCUIT,LI:7-XSTR,COMMON EMITTER	02735	CA3081
U1671	155-0032-00	B010100	B010149	MICROCIRCUIT,LI:ML,PRE-AMPLIFIER	80009	155-0032-00
U1831	156-0067-00	B010100	B010149	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U1890	156-0356-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0356-00
U3040	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U3070	156-0487-02			MICROCIRCUIT,DI:DUAL RETRIGGERABLE MONO MV	07263	96L02
U3120	156-0158-05			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-05
U3190	156-0402-00			MICROCIRCUIT,LI:TIMER	27014	LM555CN
U3380	156-0158-05			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-05
U4080	156-0405-03			MICROCIRCUIT,DI:DUAL RETRIG MONOSTABLE MV	07263	9602
U4260	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U4270	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U4280	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U4440	155-0028-00			MICROCIRCUIT,LI:ML,MILLER INTEGRATOR	80009	155-0028-00
U4460	156-0047-02			MICROCIRCUIT,DI:TP1 3 INP,NAND GATE	27014	DM7410NA+ OR JA+
U4550	156-0032-03			MICROCIRCUIT,DI:4 BIT BINARY COUNTER,SCRN	07263	7493(PCQR)
U4560	156-0047-02			MICROCIRCUIT,DI:TP1 3 INP,NAND GATE	27014	DM7410NA+ OR JA+
U4570	156-0041-05			MICROCIRCUIT,DI:DUAL D-TYPE FF,BURN-IN	01295	SN7474
U4580	156-0041-05			MICROCIRCUIT,DI:DUAL D-TYPE FF,BURN-IN	01295	SN7474
U4640	156-0041-05			MICROCIRCUIT,DI:DUAL D-TYPE FF,BURN-IN	01295	SN7474
U4660	156-0062-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN7486
U4670	156-0041-05			MICROCIRCUIT,DI:DUAL D-TYPE FF,BURN-IN	01295	SN7474
U4680	156-0035-00			MICROCIRCUIT,DI:SGL 8-INPUT POS NAND GATE	80009	156-0035-00
U4740	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U4760	156-0057-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7401(NP3 OR JP
U4770	156-0062-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN7486
U4780	156-0062-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN7486
U4810	155-0028-00			MICROCIRCUIT,LI:ML,MILLER INTEGRATOR	80009	155-0028-00
U4840	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U4850	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U4860	156-0041-05			MICROCIRCUIT,DI:DUAL D-TYPE FF,BURN-IN	01295	SN7474
U4880	156-0047-02			MICROCIRCUIT,DI:TP1 3 INP,NAND GATE	27014	DM7410NA+ OR JA+
U4930	156-0057-02			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7401(NP3 OR JP
U6060	156-0071-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC1723CL
U6160	156-0071-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC1723CL
U6474	156-0048-00			MICROCIRCUIT,LI:FIVE NPN TRANSISTOR ARRAY	02735	CA3046
U6535	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
U8007	156-0062-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN7486
U8007	---- ----			(1482 ONLY)		
U8035	156-0062-02			MICROCIRCUIT,DI:QUAD 2-INP EXCL OR GATE	01295	SN7486
U8035	---- ----			(1482 ONLY)		
U9240	152-0587-00			SEMICOND DEVICE:V MULTR,8KV IN,16KV DC OUT	52306	CMX192
U9700	156-0277-00	B041228		MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	MICROA7805UC
U9700	---- ----			(1482 CABINET)		
U9700	156-0277-00	B042929		MICROCIRCUIT,LI:VOLTAGE REGULATOR	07263	MICROA7805UC
U9700	---- ----			(1482 RACKMOUNT)		
V9600	154-0718-00	B010100	B039999	ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-00
V9600	154-0718-10	B040000		ELECTRON TUBE:CRT,P31	80009	154-0718-10
V9600	154-0718-01			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-01

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V9600	154-0718-05			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-05
V9600	---- ----			(OPTION 3 ONLY)		
VR1412	152-0461-00	B010100	B029999	SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZG25002K2
VR1520	152-0461-00	B030000		SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZG25002K2
VR1579	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	15238	Z5409
VR3174	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL
VR3450	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	04713	SZG35010RL
VR6071	152-0317-00			SEMICOND DEVICE:ZENER,0.25W,6.2V,5%	04713	SZG20012
VR6528	152-0227-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	04713	SZ13903
VR6646	152-0247-00			SEMICOND DEVICE:ZENER,0.4W,150V,5%	04713	SZG275K1RL
VR6946	150-0050-00			LAMP,GLOW:135V MAX,1.9MA	74276	LT2-24-2(NE2H)
VR6960	150-0050-00			LAMP,GLOW:135V MAX,1.9MA	74276	LT2-24-2(NE2H)
VR6962	150-0050-00			LAMP,GLOW:135V MAX,1.9MA	74276	LT2-24-2(NE2H)
Z9015	388-4026-00			CIRCUIT BOARD:LOOP THRU COMP	80009	388-4026-00
Z9025	388-4026-00			CIRCUIT BOARD:LOOP THRU COMP	80009	388-4026-00
Z9115	388-4026-00			CIRCUIT BOARD:LOOP THRU COMP	80009	388-4026-00
Z9125	388-4026-00			CIRCUIT BOARD:LOOP THRU COMP	80009	388-4026-00

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				OPTION 1		
C2228	281-0209-00			CAP.,VAR,AIR DI:1.3-5.4PF,250V	74970	187-0303-105
C2238	285-0898-00			CAP.,FXD,PLSTC:0.47UF,10%,100V	56289	LP66A1B474K
C2241	290-0517-00			CAP.,FXD,ELCTLT:6.8UF,20%,35V	56289	196D685X0035KA1
C2243	283-0024-00			CAP.,FXD,CER DI:0.1UF,+80-20%,50V	72982	8121N083Z5U0104Z
C2246	283-0110-00			CAP.,FXD,CER DI:0.005UF,+80-20%,150V	59660	855-547-E-502Z
C2258	290-0519-00			CAP.,FXD,ELCTLT:100UF,20%,20V	90201	TDC107M020WLD
C2263	283-0594-00			CAP.,FXD,MICA D:0.001UF,1%,100V	00853	D151F102F0
C2265	281-0205-00			CAP.,VAR,PLSTC:5.5-65PF,100V	80031	2810C5R565QJ02F0
C2273	283-0115-00			CAP.,FXD,CER DI:47PF,5%,200V	59660	805-519-C0G0470J
CR2248	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR2257	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
P2211	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
Q2244	151-0221-00			TRANSISTOR:SILICON,PNP	04713	SPS246
Q2259	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
Q2274	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
R2239	325-0104-00			RES.,FXD,FILM:9M OHM,1%,0.25W	03888	A3AT66
R2245	321-0486-00			RES.,FXD,FILM:1.13M OHM,1%,0.125W	91637	HMF188G11303F
R2247	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R2255	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R2256	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
R2261	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0. 25W	01121	CB1015
R2264	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
R2266	321-0203-00			RES.,FXD,FILM:1.27K OHM,1%,0.125W	91637	MFF1816G12700F
R2271	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R2272	315-0361-00			RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R2273	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R2275	311-1225-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	32997	3386F-T04-102
R2276	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	91637	MFF1816G44200F
R2278	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	91637	MFF1816G90900F
R2279	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R1920	311-0095-00			RES.,VAR,NONWIR:500 OHM,10%	11237	41022
S2210	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	—— ——			(PART OF S2220,S2230,S2250,S2255,S2270,S228		
S2220	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	—— ——			(PART OF S2210,S2230,S2250,S2255,S2270,S228		
S2230	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	----- -----			(PART OF S2210,S2220,S2250,S2255,S2270,S228		
S2250	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	—— ——			(PART OF S2210,S2220,S2230,S2255,S2270,S228		
S2255	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	—— ——			(PART OF S2210,S2220,S2230,S2250,S2270,S228		
S2270	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	----- -----			(PART OF S2210,S2220,S2230,S2250,S2255,S228		
S2280	260-1676-00			SWITCH,PUSH:7 STA,2 POLE,INTERLOCK	80009	260-1676-00
	—— ——			(PART OF S2210,S2220,S2230,S2250,S2255,S228		
VR2242	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
				OPTION 3		
V9600	154-0718-05			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-05
	331-0393-02			SCALE,CRT:CCIR,CLEAR	80009	331-0393-02

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				OPTION 4		
	REMOVE:					
	670-3515-00			CKT BOARD ASSY:FRONT PANEL CONNECTOR	80009	670-3515-00
	670-3915-00			CKT BOARD ASSY:FRONT PANEL CONNECTOR	80009	670-3915-00
CR7170	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
CR7190	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
Q7100	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q7113	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q7183	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
R7103	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R7105	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R7107	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R7112	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R7120	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R7130	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R7140	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R7150	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R7180	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R7185	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R7196	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R7199	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R7260	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
U7160	156-0030-03			MICROCIRCUIT,DI:QUAD 2-INP NAND GATE,SCRN	01295	SN7400(NP3 OR JP
U7200	156-0041-05			MICROCIRCUIT,DI:DUAL D-TYPE FF,BURN-IN	01295	SN7474

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
				OPTION 4 and 5		
	670-3485-05	B030000	B041267	CKT CARD ASSY:	80009	670-3485-05
	---- ----			STANDARD CIRCUIT BOARD)		
	670-3485-10	B041268		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-10
	670-3485-05	B030000	B040295	CKT CARD ASSY:	80009	670-3485-05
	---- ----			STANDARD CIRCUIT BOARD)		
	670-3485-10	B040296		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-10
	REMOVE:					
R1781	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1820	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R1830	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
C1815	283-0068-00	B043170		CAP.,FXD,CER DI:0.01UF,+100-0%,500V	59660	871-533E103P
Q1805	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129
R1814	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
U1820	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP
	670-3488-01			SWEEP OUTPUT(SAME AS STANDARD CIRCUIT BOARD		
	---- ----			EXCEPT AS FOLLOWS:		
	REMOVE:					
CR4821	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	01295	1N4152R
Q4820	151-0216-00			TRANSISTOR:SILICON,PNP	04713	SPS8803
R4712	321-0363-00			RES.,FXD,FILM:59K OHM,1%,0.125W	91637	MFF1816G59001F
R4921	315-0492-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
C4913	283-0637-00			CAP.,FXD,MICA D:20PF,2.5%,100V	00853	D151E200D0
Q4820	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4821	151-0190-00			TRANSISTOR:SILICON,NPN	07263	S032677
Q4910	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q4911	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS652	04713	SPS8801
R4712	321-0399-00			RES.,FXD,FILM:140K OHM,1%,0.125W	91637	MFF1816G14002F
R4713	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R4921	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
V9600	154-0718-00			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-00
V9600	154-0718-01			ELECTRON TUBE:CRT,P31,INT SCALE	80009	154-0718-01
	670-3485-02	B030000	B041267	VERTICAL AMPLIFIER SAME AS STANDARD CKT BD		
	670-3485-07	B041268		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-07
	670-3485-02	B030000	B040295	VERTICAL AMPLIFIER SAME AS STANDARD CKT BD		
	670-3485-07	B040296		CKT BOARD ASSY:VERTICAL AMPLIFIER	80009	670-3485-07
	REMOVE:					
R7181	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R1820	131-0566-00			BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0
R1830	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
C1815	283-0068-00	B043170		CAP.,FXD,CER DI:0.01UF,+100-0%,500V	59660	871-533E103P
Q1805	151-1025-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	01295	SFB8129

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1814	311-1228-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	32997	3386F-T04-103
U1820	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	01295	MICROA741CP

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