

HITACHI

MODEL V-211/V-212
V-222/V-422
OSCILLOSCOPE

SERVICE MANUAL

 Hitachi Denshi, Ltd.

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“WARNING – THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.”

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— NOTICE —

This Service Manual describes the most typical product of this model. If there are any specific differences between this Manual and the servicing unit, please contact Hitachi Denshi sales office in your area.

MODEL V-211/V-212/V-222/V-422
OSCILLOSCOPE
Service Manual

1. SPECIFICATIONS

[] : Specifications for V-422

CRT

Type

Large 6" screen with internal graticule

Approximate 2kV [12kV] acceleration potential

Screen type

P31 phosphor standard

Useful screen area

8 × 10 div

Graticule

Internal graticule with centimeter divisions and 2 mm subdivisions along the central axis, 10 % and 90 % lines are indicated.

Illumination continuously variable. (For : V-222, V-422)

Focussing

Possible (with automatic focus correction circuit : V-222 and V-422)

Trace rotation Provided

Scale illumination Variable (For : V-222, V-422)

Intensity control Provided

Z-AXIS INPUT (INTENSITY MODULATION)

DC-coupled, positive-going signal decreases intensity: 5 Vp-p signal causes noticeable modulation at normal intensity: DC to 2 MHz.

Input impedance 47 k Ω (typ.) [33 k Ω (typ.)]

Maximum input voltage 30 V (DC + peak AC)

Coupling DC

VERTICAL DEFLECTION SYSTEMS (2 Identical Channels)

Bandwidth and rise time

DC to at least 20 MHz [40 MHz] and rise time 17.5 ns [8.8 ns] or less.

DC to at least 7 MHz and rise time 50 ns or less at magnifier extends.

The AC coupled lower -3 dB point is 10 Hz or less.

Deflection factor

5 mV/div to 5 V/div in 10 calibrated steps, in a 1-2-5 sequence.

The uncalibrated continuous control extends deflection factor to at least 12.5 V per division in the 5 volts/div position. The $\times 5$ magnifier increases sensitivity of each deflection factor setting to 1 mV/div.

Accuracy

$\pm 3\%$ (+10 to +35 °C)

Additional error for magnifier $\pm 2\%$

Display modes

CH1, CH2 (normal or invert), Alternate, Chopped (Approx. 250 kHz),
Added

Input impedance

1 M Ω $\pm 3\%$ in parallel with 23 ± 3 pF

Maximum input voltage

300 V (DC + peak AC)

Input coupling

AC, GND, DC

HORIZONTAL DEFLECTION SYSTEM

Time base

0.2 μ s/div to 0.2 s/div in 19 calibrated steps, in a 1-2-5 sequence.

The uncalibrated continuous control extends deflection factor to at least 0.5 seconds per division in the 0.2 sec/div position. The $\times 10$ magnifier extends maximum sweep rate to 100 ns/div [20 ns/div].

Accuracy

$\pm 3\%$ (+10 to +35 °C)

Additional error for magnifier $\pm 2\%$

TRIGGERING SYSTEM

Trigger modes

Automatic, Normal, TV (TV-H or TV-V)

Trigger source

Internal (CH1, CH2, V.MODE), Line, External : V-212, V-222, V-422
Internal, Line, External, EXT-H : V-211

Trigger slope

+ or -

TV sync polarity

TV (-)

Triggering level

Internal ; ± 6 div or more

variable range

External ; approx. ± 2 V

Triggering sensitivity

and frequency

Frequency	Internal (V.MODE)	External
20 Hz - 2 MHz [20 Hz - 5 MHz]	0.5 div (2.0 div)	200 mV
2 - 20 MHz [5 - 40 MHz]	1.5 div (3.0 div)	800 mV

(Except ; (V.MODE) : V-211)

TV-V, TV-H sensitivity: SYNC level more than 1 div or 1 V

AUTO: Approx. 25 Hz (when time base is 0.1 μ s/div to 2 ms/div)

Trigger coupling

AC : 25 Hz to full bandwidth

External trigger input impedance

1 M Ω +20 % in parallel with 25 pF ± 5 pF

(EXT ; about 100 k Ω : V-211)

Maximum input voltage

300 V (DC + AC to 1 kHz or less)

X-Y OPERATION

V·INPUT ; Vert, EXT TRIG IN ; Horiz : V-211

CH1 ; Horiz, CH2 ; Vert : V-212, V-222, V-422

Deflection factor

Same as vertical deflection

(X-axis; about 200 mV/div : V-211)

Accuracy

Y: $\pm 3\%$ (+10 to +35 °C)

X: $\pm 5\%$ (+10 to +35 °C)

Additional error for magnifier $\pm 2\%$

X-bandwidth

DC to at least 500 kHz

Phase error

3° or less from DC to 50 kHz : V-212, V-222, V-422

3° or less from DC to 10 kHz : V-211

CALIBRATOR

An approx. 1 kHz frequency 0.5 V ($\pm 3\%$) square wave.

POWER SUPPLY

VOLTAGE (50/60 Hz)	FUSE
100 V (90 - 110 V)	2A
120 V (108 - 132 V)	2A
220 V (198 - 242 V)	1A
240 V (216 - 264 V)	1A

Nominal voltage $\pm 5\%$ at 400 Hz

Power supply frequency : 50, 60, 400 Hz

Power consumption : Approximately 30 W

ENVIRONMENT

Limit of operation temperature 0 - 40 °C

Limit of operation humidity 35 - 85 %

Rated range of use temperature 10 - 35 °C

Rated range of use humidity 45 - 85 %

Storage and transportation temperature -20 - 70 °C

DIMENSIONS AND WEIGHT

Approx. 310(W) × 130(H) × 370(D) mm

(12.4(W) × 5.2(H) × 14.8(D) inch)

Approx. 6 kg (13.5 lbs): for V-211, V-212

Approx. 6.5 kg (14.6 lbs): for V-222, V-422

2. ACCESSORIES

This instrument is shipped along with following accessories.

— V-211 —

- 1 Probe (AT-10AJ 1.5)
- 1 AC power cord
- 1 Operation Manual

— V-212 —

- 2 Probes (AT-10AJ 1.5)
- 1 AC power cord
- 1 Operation Manual

— V-222/V-422 —

- 2 Probes (AT-10AK 1.5)
- 1 AC power cord
- 1 Operation Manual

3. PREVENTIVE MAINTENANCE

Preventive maintenance, when performed on a regular basis, can prevent instrument breakdown and may improve the reliability of the oscilloscope. The severity of environment to which this instrument is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is just prior to the recalibration of the instrument.

Disassembly

Remove all of the screws on the top cover of the instrument, then gently remove the top cover.

Take the same procedure for the bottom cover.

Most of the internal parts of the instrument are now accessible.

(See section 10. Exploded view)

Cleaning

The instrument should be cleaned as often as the operating conditions require, since the accumulation of dirt in the instrument may cause the component breakdown.

The covers can provide protection against dust in the interior of the instrument. Loose dust accumulated on these covers can be removed with a soft cloth or small brush.

Dirt that remains can be removed with a soft cloth applying in a mild detergent and water solution. Abrasive cleaners should not be used.

Cleaning the interior should be only occasionally necessary. The best way to clean the interior is to blow off the dust with a dry, low-velocity stream of air. A soft-bristle brush or a cotton-tipped applicator is useful for cleaning narrow spaces or for cleaning more delicate components.

Visual inspection

The instrument should be inspected occasionally for such defects as broken connections, improperly seated transistors, damaged circuit boards, and heat-damaged parts. The corrective procedure for most visible defects is apparent; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates

other trouble in the instrument; therefore, correcting the cause of the overheating is important to prevent the recurrence of the damage.

4. CALIBRATION

Hitachi Denshi, Ltd. provides complete instrument repair and recalibration at our office, and authorized dealer. Contact your local Hitachi Denshi sales office or representative.

4. 1 Calibration interval

To maintain instrument accuracy, perform the calibration of the V-211, V-212, V-222, V-422 at least every 1000 hours of operations or every six month if used infrequently.

4. 2 Test equipment required

The following test equipment and accessories, or its equivalent, are required for the complete calibration of the V-211, V-212, V-222, V-422. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, the specifications of any test equipment used must meet or exceed the listed specifications.

All the test equipment is assumed to be correctly calibrated and operated within the listed specification. Operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

4. 3 Preliminary procedure

This instrument should be calibrated at an ambient temperature of $+20^{\circ}\text{C}$ ($\pm 5^{\circ}\text{C}$) for best overall accuracy.

1. Connect the instrument to AC line voltage, 50/60/400 Hz line source.
2. Set the instrument controls as given in the preliminary control settings. Allow at least fifteen minutes of warmup before proceeding.
3. See the adjustment locations in the pullout pages.

Table 4-2

TEST EQUIPMENT REQUIRED

Description	Minimum specification	Usage	Example of applicable test equipment
1. Constant amplitude signal generator	50kHz reference frequency; maximum frequency 70MHz; variable amplitude	Check horizontal, vertical and trigger bandwidth.	
2. Standard amplitude calibrator	Amplitude accuracy: 0.25%, variable amplitude; 5mV to 40V; frequency: 1 kHz square wave	Check horizontal and vertical gain.	
3. Square-wave generator	Variable frequency: 10Hz to 1MHz; output amplitude; 10mV to 100V	Check probe and vertical compensation.	
4. Digital voltmeter	0.1% accuracy	Check power supply.	
5. Time mark generator	0.1% accuracy	Check horizontal timing.	
6. Cable	Impedance, 50 ohms; type, RG-58/U; length, 42 inches, connectors, BNC	External trigger operation check. Horizontal gain check and adjustment.	Hitachi part No.4202
7. Termination	Impedance, 50 ohms; connectors, BNC	Vertical amplifier compensation checks and adjustment.	
8. Attenuator	Ratio, 1/10; connectors, BNC; impedance, 50 ohms	Vertical amplifier bandwidth check.	
9. T-connector	Connectors, BNC	External trigger operation checks.	Hitachi part No.1301

4. 4 Preliminary control settings

Set the instrument controls as follows, when starting the calibration procedures.

Controls	Settings	Controls	Settings
FOCUS	Midrange		
TRACE ROTATION	As desired		
- VERT -			
V. POSITION	Midrange, pushed in	SWP VAR	Fully clockwise
V. VARIABLE	CAL, fully clockwise	CH1 ALT MAG	Normal (Button Out)
INPUT COUPLING	GND (AC-GND-DC)	- TRIG -	
VOLTS/DIV	5 mV/DIV		
V.MODE	CH1	LEVEL	Midrange, Normal
CH2 INV	Normal, Pushed in	SLOPE	+ Normal
- HORZ -			
H. POSITION	Midrange	MODE	AUTO
PULL ×10 MAG	Normal, Pushed in	SOURCE	INT
TIME/DIV	1 ms	INT TRIG	CH1

4. 5 Initial starting procedure

1. Rotate the INTENSity control to the midrange and set the POWER switch to ON.
2. Wait a few seconds for the cathode ray tube (CRT) to warm up. A trace should appear on the CRT.
3. If trace disappears, increase (clockwise) the INTENSity control setting until the trace is easily observed, or roughly check/adjust the DC balance to get a trace as same as ⑬.
4. Adjust the FOCUS control for the best focused display.
5. Readjust the POSITION controls if necessary, to center the trace.

POWER SUPPLY SYSTEM

NOTE

Before you start operation, see the adjustment locations in the pullout pages.

Control settings

Preset the controls as given in the preliminary control setting

- ① Check low-voltage supply, if necessary.
 - a. Connect the digital voltmeter (DVM) between the +8 V line (P1105-2) and ground
: +7.3 to +8.3 V
 - b. Connect the DVM between the -8 V line (P1105-4) and ground
: -8.3 to -7.7 V
 - c. Connect the DVM between the +5 V line (P1105-3) and ground
: +4.8 to +5.2 V
 - d. Connect the DVM from the +120 V/+75 V line (P1105-1) and ground
: +110 to +130 V (For V-211, V-212, V-222)
: +67.5 to +82.5 V (For V-422)
- ② Check high voltage supply.
 - a. Connect the DVM to the H.V. test point (P1001-1) with a high voltage probe.
 - b. Check for a reading of -1.995 to 1.805 kV --- V-211, V-212, V-222
-1.732 to 1.568 kV --- V-422

DISPLAY

Control setting

Preset the controls as given in the preliminary control setting.

- ③ Check/adjust CRT bias.

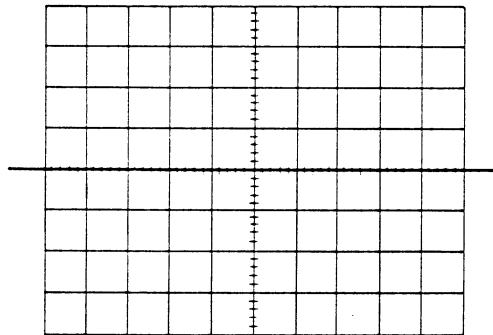
Set the Trig MODE switch to the AUTO, and set the TIME/DIV switch to the 1 ms.

 - a. Connect the digital voltmeter (DVM) to the R904 (or D1022-Ⓐ) and ground.
 - b. Adjust the INTENSITY control so that the DVM indicates 15.0 V.
 - c. Observe the trace of CRT.

d. Adjust the grid bias adjustment RV1021 for the trace makes a just appear.

④ Check/adjust trace rotation.

- a. Position the trace to the center graticule line.
- b. Check that the trace is in parallel with the center horizontal line.
- c. Adjust TRACE ROTATION (screwdriver adjustment on front panel) for a trace that is in parallel with the horizontal graticule lines.

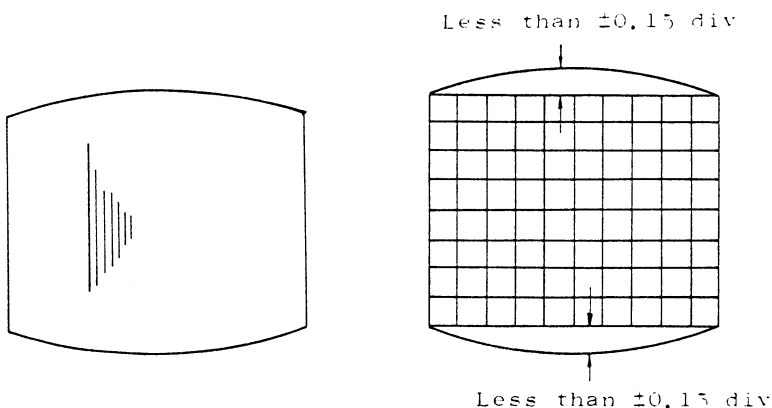


⑤ Check/adjust GEOMETRY

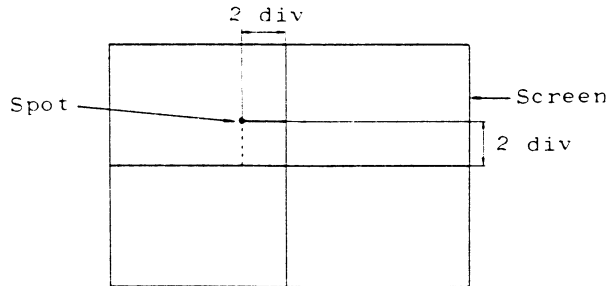
- a. Set the TIME/DIV to the 0.1 ms, and the input coupling switch to DC.
- b. Connect the constant amplitude signal generator to the input.
- c. Set the VOLTS/DIV switch setting for a full-screen (8 division) deflection.
- d. Check that horizontal bowing is less than ± 0.15 division.

For V-422

- e. Adjust the GEOM adjustment RV1033 for a display so that horizontal bowing is less than ± 0.15 division.



- ⑥ Check/adjust ASTIGmatism and FOCUS.
- Set the TIME/DIV switch to the X-Y position, and the input coupling switch to GND.
 - Set the INTENSity control for a small spot, as the following figure, using the position controls.



- Check that the spot is round.
- Adjust the FOCUS adjustment and ASTIG adjustment RV1035 for a round spot.

HORIZONTAL SYSTEM

Control settings

Preset the controls as given in the preliminary control settings.

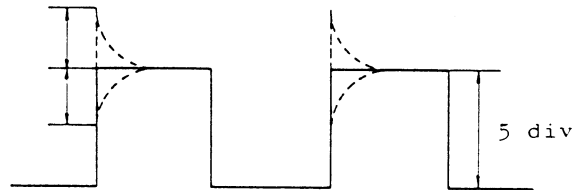
- ⑦ Check/adjust horizontal gain.
- Set the input AC-GND-DC to DC.
 - Connect the cable to the output of the time mark generator.
 - Set the time mark generator for 1 ms time marks.
 - Check that the time marks align with the graticule lines over the center eight divisions, within 3 %.
 - Adjust the H GAIN adjustment RV824 so that the time marks coincide with the middle eight graticule lines.
- ⑧ Check/adjust Horizontal $\times 10$ MAG Gain.
- Set the TIME/DIV switch to 1 ms.
 - Set $\times 10$ MAG (pull out the knob of the POSITION control).
 - Check that the one-cycle time marks align with the ten-divisions graticule lines, within 5 %.

- d. Adjust the MAG GAIN adjustment RV831 so that one-cycle time marks coincide with the ten-division graticule lines.
 - e. Push in the POSITION control after adjustment and check.
- ⑨ Check/adjust MAG CENT.
- a. Set the TIME/DIV switch to 1 ms.
 - b. So that the knob of H.POSITION is pulled out ($\times 10$ MAG), the left end of the trace is brought to the center point and then the knob of H.POSITION is depressed.
 - c. Observe the movement of the left end of the trace.
 - d. Adjust the MAG CENT adjustment RV821 for the movement of the left end of the trace within ± 0.2 div.
- ⑩ Check/adjust low speed sweep accuracy.
- a. Set the time mark generator for 10 ms time marks.
 - b. Set the TIME/DIV switch to 10 ms.
 - c. Check that the time marks align with the graticule lines over the middle eight divisions, within 3 %.
 - d. Adjust the 10 ms/DIV adjustment RV542 so that the time marks coincide with the middle eight graticule lines.
- ⑪ Check/adjust high speed sweep accuracy.
- a. Set the input coupling switch to DC.
 - b. Set the time mark generator for 2 μ s time marks.
 - c. Set the TIME/DIV switch to 2 μ s.
 - d. Check that the time marks align with the graticule lines over the middle eight divisions.
 - e. Adjust CV520 so that the time marks coincide with middle eight graticule lines.
- ⑫ Check/adjust high speed $\times 10$ MAG GAIN
- a. Set the TIME/DIV switch to the 2 μ s.
 - b. Set $\times 10$ MAG (pull out the knob of the POSITION control).
 - c. Check that the one-cycle time marks align with the ten-divisions graticule lines, within 5 %.
 - d. Adjust the high speed Mag gain adjustment CV840 so that one-cycle time marks align with the ten-division graticule lines.
 - e. Push in the POSITION control after adjustment and check.

VERTICAL SYSTEM

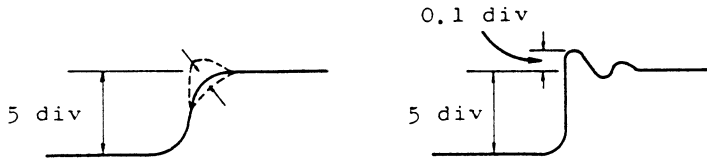
- ⑬ Check/adjust DC balance (Step attenuator balance).
- Set the VOLTS/DIV switch to the 5 mV position.
 - Position the trace to the horizontal center line.
 - Change the VOLTS/DIV switch to the 10 mV position.
 - Check that the trace is within ± 0.05 division of the center horizontal line.
 - Adjust the CH1 (CH2) DC BAL adjustment, RV22 (CH1) or RV122 (CH2), for a trace at the horizontal center line.
 - Repeat the part (a) through (e) until less than ± 0.05 division shift is noted when changing the VOLTS/DIV setting.
- ⑭ Check/adjust vertical position center.
- For V-211, V-212
- Confirm the vertical POSITION control at the midrange.
 - Check the trace is within 1 division.
 - Adjust the position center adjustment RV63 (CH1), RV163 (CH2) for a trace at the horizontal center line.
- For V-222, V-422 (CH1 only)
- Pull out the vertical POSITION control (set the DC OFFSET mode).
 - Connect a DVM to the DC OFFSET VOLT OUTPUT terminal.
 - Adjust the vertical POSITION control so that the DVM indicates 0 V.
 - Adjust the position center adjustment RV63 (CH1 only), for a trace at the horizontal center line.
- For V-222, V-422 (CH2)
- Confirm the vertical POSITION control at the midrange.
 - Check the trace is within 1 division.
 - Adjust the position center adjustment RV163 (CH2) for a trace at the horizontal center line.
- ⑮ Check/adjust $\times 1$ AC GAIN.
- Set the TIME/DIV switch to the 1 ms position.
 - Set the VOLTS/DIV switch to the 10 mV position.
 - Set the input coupling switch to DC.

- d. Connect the square-wave generator (using 1 kHz output range).
- e. Adjust the output amplitude of that generator for 5 division deflection of screen.
- f. Check the high-voltage level of pulse is flat.



- g. Adjust the $\times 1$ AC GAIN RV33 (CH1), RV133 (CH2) adjustment for a flat level.
- ①6 Check/adjust vertical gain.
- a. Set the VOLTS/DIV switch to the 10 mV position and the input coupling switch to DC.
 - b. Connect the standard amplitude calibrator to the input connector.
 - c. Set the standard amplitude calibrator for a 50 mVp-p (5 divisions for display) signal.
 - d. Check for a display of five divisions.
 - e. Adjust the GAIN adjustment RV62 (CH1), RV162 (CH2) for a display of 5 divisions within 2 %.
 - f. Check all the VOLTS/DIV switch settings.
- ①7 Check/adjust input capacity (ATT: $\div 1$).
- a. Set the VOLTS/DIV switch to the 10 mV position.
 - b. Set the input coupling switches to DC.
 - c. Connect the L-C meter to the input terminals.
 - d. Check the input capacity for approx. 23 pF.
- ①8 Check/adjust vertical step response.
- a. Set the VOLTS/DIV switch to the 5 mV position.
 - b. Set the TIME/DIV switch to the 0.5 μ s position.
 - c. Connect the fast-rise, positive output (50 mV, 1 MHz) of the square-wave generator to the input. Use a 50 Ω termination and cable.
 - d. Adjust the square-wave generator output for a 5-divisions display.

- e. CH1 - Adjust CV336 (and CV355 : V-422 only) so that a square wave is flat. Then, adjust CV337 for overshoot of +0.2 div.
 CH2 - Adjust CV161 for overshoot of +0.2 div.



- ①9 Check/adjust attenuation compensation.
 (ATT : $\div 10$, $\div 100$)

- a. Set the input coupling switch to DC.
 b. Connect the square-wave generator to the CH1 (CH2) input terminal check for a square wave that is flat (flat top) under the following settings.

ATT	VOLTS/DIV	Square-wave generator output
$\div 10$	0.1 V	0.5 V
$\div 100$	1 V	5 V

- c. Adjust the trimmer capacitors (refer to the circuit board illustration with adjustment location - page 27) for a square wave that is flat (flat top) under the following settings.

ATT	VOLTS/DIV	Square-wave generator output	Adjust CH1 (CH2)
$\div 10$	0.1 V	0.5 V	CV4 (CV104)
$\div 100$	1 V	5 V	CV7 (CV107)

- ②0 Check/adjust input capacity (ATT: $\div 10$, $\div 100$).

- a. Connect the L-C meter to the input connector.
 b. Check the input capacity for approximately 23 pF.

- c. Adjust the trimmer capacitors for a 2 pF input capacity under the following settings.

ATT	VOLTS/DIV	Adjust CH1 (CH2)
÷ 1	5 mV	—
÷ 10	0.1 V	CV3 (CV103)
÷ 100	1 V	CV6 (CV106)

②1 X-Y operation

For V-212, V-222, V-422

21-1 Check/adjust X gain.

- Set the TIME/DIV switch to X-Y, the input coupling switch of CH1 to AC, the input coupling switch of CH2 to GND.
- Set the VOLTS/DIV switch to the 10 mV position.
- Connect the standard amplitude calibrator to the CH1 input connector.
- Set the standard amplitude calibrator for 50 mV.
- Check for a display of five divisions.
- Adjust the X GAIN adjustment RV550 for a display of five divisions within 6 %.

For V-211

21-2 Check/adjust X gain.

- Set the TIME/DIV switch to X-Y, the trig SOURCE switch to EXT , the input coupling switch of vertical INPUT to GND.
- Connect the standard amplitude calibrator to the EXT TRIG OR Input connector.
- Set the standard amplitude calibrator for 1 V.
- Check for a display of five divisions.
- Adjust the X GAIN adjustment RV550 for a display of five divisions within 6 %.

21-3 Check/adjust X position center.

- Set the TIME/DIV switch to the X-Y position, and the horizontal

POSITION control to the midposition, the input coupling switch of CH1 to GND.

- b. Check to see that the round spot is near the center graticule and is within ± 0.2 division against horizontal line.
- c. Adjust the X CENT adjustment RV85 to the position spot at the center.

TRIGGER SYSTEM

- ②② Check/adjust TRIG CENT.
 - a. Set the TRIG SOURCE switch to INT, the INT TRIG switch to CH1, the TRIG SLOPE knob push in, the VOLTS/DIV switch to 50 mV, the TIME/DIV switch to 10 μ s.
 - b. Connect the sine-wave generator to the input connector for a 0.5 div (50 kHz).
 - c. Set the TRIG LEVEL knob to the midposition.
 - d. Adjust RV420 so that synchronization is effected on the waveform, 0.5 div on the screen.
 - e. Next, set the TRIG SLOPE to - (pulled out state) and insure that the waveform is triggered. After confirmation, leave the TRIG SLOPE in depressed state. Readjust when stepped out.

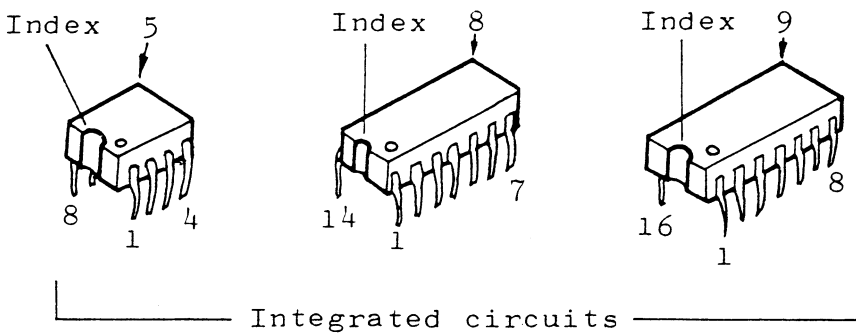
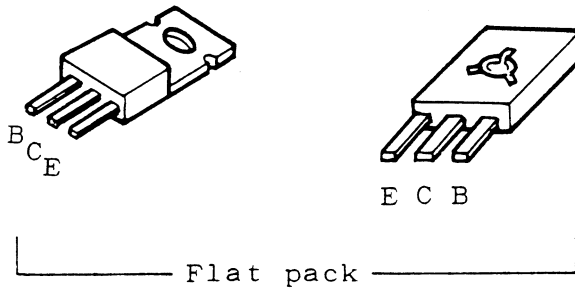
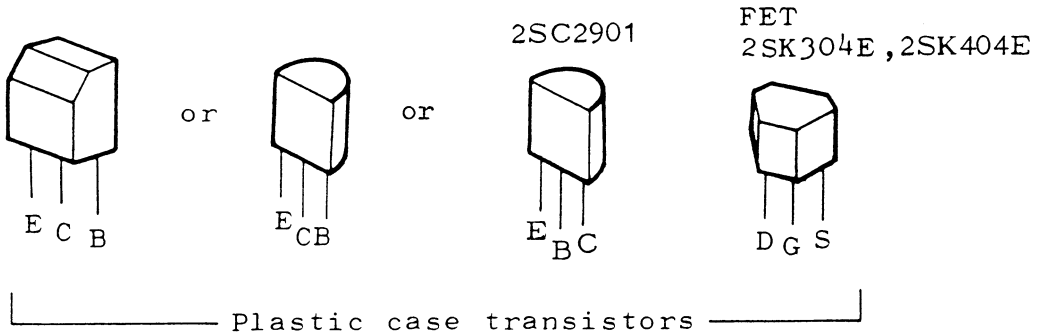
- ②③ Check/adjust CH2 TRIG BAL.
 - a. Set the VOLTS/DIV switch to 50 mV (CH1 and CH2), the TIME/DIV switch to 10 μ s, the TRIG SOURCE switch to INT, the INT TRIG switch to $\begin{matrix} \text{VERT} \\ \text{MODE} \end{matrix}$, the V.MODE switch to ALT, and the CH1 POSITION knob to the midposition.
 - b. Connect the sine-wave generator to the input connectors (CH1 and CH2) for a 5 div (50 kHz).
 - c. Adjust CH2 POSITION control so that CH2 waveform comes to CH1.
 - d. Next, adjust RV185 so that both waveforms (CH1 and CH2) coincides.

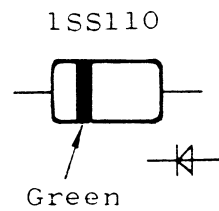
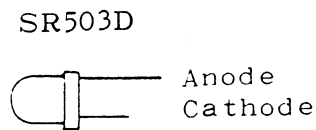
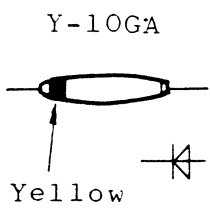
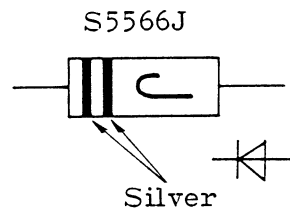
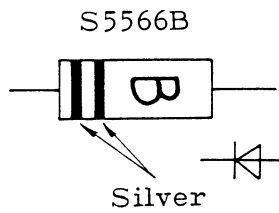
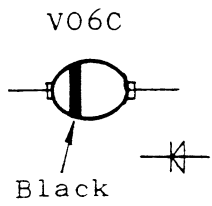
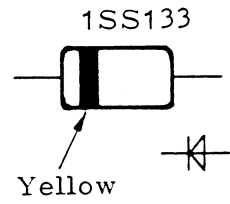
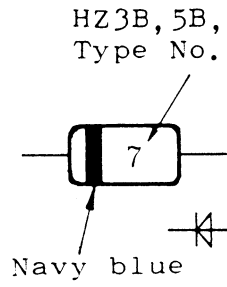
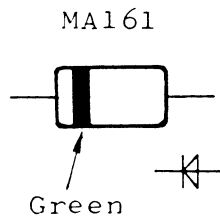
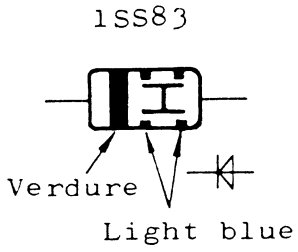
CALIBRATOR

- ②④ Check/adjust CAL terminal (0.5 Vp-p, 1 kHz).
- a. Connect the CAL terminal to the digital multimeter, short the terminal 1 to 3 of the connector (P1206).
 - b. Check for the CAL output of 0.5 V, within 1 %.
 - c. Adjust the 0.5 V adjustment RV1201 for the CAL output of 0.495 to 0.505 V.

5. SEMICONDUCTOR LEAD CONFIGURATIONS

Lead configurations and case styles are typical, but may vary due to vendor changes or instrument modifications.





6. CIRCUIT DESCRIPTION

— Introduction —

This section of the manual contains a description of the circuitry used in V-211/V-212/V-222/V-422 Oscilloscope.

The block diagram (p. 31) shows the overall relationship between all of the circuits. Complete schematics of each circuit are also given in section Schematic diagrams (p. 51 to 129). Refer to these diagrams throughout the following circuit description for electrical values and relationships.

CHANNELS 1 and 2 VERTICAL PREAMP

Input signals for vertical deflection on the CRT can be connected to the "CH1 OR X" and (or) "CH2 OR Y" input connectors. In the X-Y mode of operation, CH1 input signal provides the horizontal (X-axis) deflection and CH2 input signal provides the vertical (Y-axis) deflection.

The Channel 1 and 2 Vertical Preamp circuits provide control of input coupling, vertical deflection factor, DC balance, vertical position and vertical gain.

They also contain a stage to provide a sample of the input signal to the Trigger Preamp circuit for internal triggering from the Channel 1 and (or) Channel 2 signal only.

VERTICAL SWITCHING CIRCUIT

The vertical switching circuit determines whether the CH1 or CH2 or both Vertical Preamp output signals are connected to the Vertical Output Amplifier circuit (through the Delay Line Driver and Delay Line stages: V-422 only).

In the ALT and CHOP modes, both channels are alternately displayed on a shared time basis.

VERTICAL OUTPUT AMPLIFIER

The Vertical Output Amplifier circuit provides the final amplification for the signal before it is applied to the vertical deflection plates of the CRT.

TRIGGER PREAMP

The Trigger Preamp circuit amplifies the internal trigger signal to the

level necessary to drive the Trigger Generator circuit.

Input signal for the Trigger Preamplifier circuit is obtained by sampling the signal applied to Channel 1 or the composite vertical signal from the Vertical Switching circuit.

This circuit also provides a signal to the Horizontal Amplifier for X-Y mode operation.

TRIGGER GENERATOR

The Trigger Generator circuit produces trigger pulses to start the Sweep Generator circuit. These trigger pulses are derived either from the internal trigger signal from the vertical deflection system, an external signal connected to the EXT TRIG INput connector or a sample of the line voltage applied to the instrument.

Controls are provided in this circuit to select trigger level, slope and source.

The Trigger MODE switch determines the operating mode for the trigger circuit. In the NORM Trig position, a sweep is produced only when a trigger pulse is received from the Trigger Generator circuit. Operation in the AUTO Trig mode is the same mode as NORM Trig mode, except that a free-running trace is displayed when a trigger pulse is not present or when the amplitude of the trigger signal is not adequate.

SWEEP GENERATOR

The Sweep Generator circuit produces a sawtooth voltage which is amplified by the Horizontal Amplifier circuit to provide horizontal deflection on the CRT. This sawtooth voltage is generated on command (trigger pulse) from the Trigger Generator circuit.

The Sweep Generator circuit also produces an unblanking gate to unblank the CRT during sweep time.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier circuit provides the output signal to the CRT horizontal deflection plates. In all positions of the TIME/DIV select switch except X-Y, the horizontal deflection signal is a sawtooth from the Sweep Generator circuit. In the X-Y position, the horizontal deflection

signal is obtained from the Channel 1 Vertical Preamp (or X-SIGNAL PREAMP : V-211 only) through the Trigger Preamp circuit. In addition, the horizontal amplifier contains the horizontal magnifier and the horizontal positioning circuits.

POWER SUPPLY

The low-voltage Power Supply circuit provides the operating power for this instrument from four regulated supplies and one unregulated supply. The Power Input stage is provided with a Voltage Selector Assembly. This selector allows selection of the nominal operating voltage and regulating range for the instrument.

CALIBRATOR

The Calibrator circuit produces a square-wave output with accurate amplitude and frequency. This output is available as a square-wave voltage at the CAL 0.5 V (1 kHz) connector.

Z AXIS AMPLIFIER

The Z-Axis Amplifier circuit controls the CRT intensity level from several inputs. The effect of these input signals is to either increase or decrease the trace intensity, or to completely blank portions of the display.

CRT CIRCUIT

The CRT Circuit provides the high-voltage and control circuits necessary for operation of the cathode-ray tube (CRT).

◆ INPUT AMP
CH1 and CH2 INPUT

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
C 1	CQX0068	C, Plastic 400V 0.047μF ±10%	1	1	1	1
C 101	CQX0068	C, Plastic 400V 0.047μF ±10%		1	1	1
S 1	8393985	SW, Lever, SLE623	1	1	1	1
S 101	8393985	SW, Lever, SLE623		1	1	1
S 202	8398985	SW, Lever, SLE623		1	1	1
PEF-622	PCB PB-14		R	R	R	R

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 25	RCE0755	R, Carbon 1/4W 68Ω ±0.5%	1	1	1	1
R 26	RME1081	R, Metal 1/4W 5.62kΩ ±1%	1	1	1	1
R 26	RME1079	R, Metal 1/4W 3.92kΩ ±1%				1
R 30	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 30	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	1
R 32	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
R 34	RME1145	R, Metal 1/4W 60.0Ω ±0.5%	1	1	1	1
R 35	RCE0766	R, Carbon 1/4W 560Ω ±5%	1	1	1	1
R 36	RME1154	R, Metal 1/4W 600Ω ±0.5%	1	1	1	1
R 33	RCE0762	R, Carbon 1/4W 270Ω ±5%	1	1	1	1
R 40	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	1
R 41	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	1
R 42	RCE0764	R, Carbon 1/4W 390Ω ±5%	1	1	1	1
R 43	RCE0767	R, Carbon 1/4W 680Ω ±5%	1	1	1	1
R 44	RCE0767	R, Carbon 1/4W 680Ω ±5%	1	1		
R 44	RCE0765	R, Carbon 1/4W 470Ω ±5%				1
R 45	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	1
R 46	RME1157	R, Metal 1/4W 16.0kΩ ±0.5%	1	1	1	1
R 47	RME1162	R, Metal 1/4W 80.0kΩ ±0.5%	1	1	1	1
R 48	RME1155	R, Metal 1/4W 4.00kΩ ±0.5%				1
RM 43	3173846	R, Block For ATT	1	1	1	1

CH1 1st ATTENUATOR

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 2	RME0860	R, MET Chip 1/8W 470Ω ±5%	1	1	1	1
R 4	RMS0043	R, Metal 1/4W 900kΩ ±0.5%	1	1	1	1
R 5	RME1163	R, Metal 1/4W 111kΩ ±0.5%	1	1	1	1
R 7	RMS0044	R, Metal 1/4W 990kΩ ±0.5%	1	1	1	1
R 8	RME1156	R, Metal 1/4W 10.1kΩ ±0.5%	1	1	1	1
R 9	RME0852	R, MET, Chip 1/8W 10Ω ±5%	1	1	1	1
R 10	RME0864	R, MET, Chip 1/8W 100Ω ±5%	1	1	1	1
R 12	RCE0749	R, Carbon 1/4W 22Ω ±5%	1	1	1	1
C 2	CCG0132	C, Ceramic Chip 50V 22 pF ±5%				1
C 5	CCG0139	C, Ceramic Chip 50V 47 pF ±5%	1	1	1	1
C 9	CCG0144	C, Ceramic Chip 50V 220 pF ±5%	1	1	1	1
C 10	CCG0142	C, Ceramic Chip 50V 82 pF ±5%	1	1	1	1
CV 3	CVE0046	C, Variable ECR-HA010A11	1	1	1	1
CV 4	CVE0050	C, Variable ECR-HA007A11	1	1	1	1
CV 6	CVE0046	C, Variable ECR-HA010A11	1	1	1	1
CV 7	CVE0048	C, Variable ECR-HA003A11	1	1	1	1
ATT 1	8398872	SW, Rotary ADR-255S	1	1	1	1

C 16	CCD0286	C, Ceramic 500V 1000 pF ±100% -0%	1	1	1	1
C 18	CCC0996	C, Ceramic 50V 2 pF ±0.25%	1	1	1	1
C 20	CCC1014	C, Ceramic 50V 47 pF ±5%	1	1	1	1
C 23	CQA0091	C, Plastic 50V 0.001μF ±10%	1	1	1	1
C 25	CCC1014	C, Ceramic 50V 47 pF ±5%	1	1	1	1
C 26	CES0028	C, Alelyc 10V 47μF ±20%	1	1	1	1
C 30	CES0028	C, Alelyc 10V 47μF ±20%	1	1	1	1
C 32	CCC1002	C, Ceramic 50V 10 pF ±0.5%				1
C 40	CES0028	C, Alelyc 10V 47μF ±20%	1	1	1	1
C 42	CCC1007	C, Ceramic 50V 22 pF ±5%	1	1	1	1
C 44	CES0028	C, Alelyc 10V 47μF ±20%	1	1	1	1
C 53	CEX0563	C, Alelyc 16V 10μF BP				1
RV 22	RNE0057	VR, Metal EVN49C00YB54 (50K)	1	1	1	1
RV 33	RNE0048	VR, Metal EVN39C00YB22 (200)	1	1	1	1
TR 24	HTK0099	Transistor 2SK404E	1	1	1	1
TR 30	HTC0148	Transistor 2SC458C	1	1	1	1
TR 30	HTC0557	Transistor 2SC1674K				1
TR 40	HTA0224	Transistor 2SA1029D	1	1	1	1
L 34	TLE0107	Coil ELE-VR47MA	1	1	1	1
IC 16	8397023	IC LF411CN	1	1	1	1
D 16	HDS0437	Diode 1SS133	1	1	1	1
D 21	HDS0477	Diode 1SS110	1	1	1	1
D 51	HDS0407	Diode SR503D (RED)				1

CH1 INPUT AMP and 2nd ATTENUATOR

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 16	RME1168	R, Metal 1/4W 500kΩ ±0.5%	1	1	1	1
R 17	RME1168	R, Metal 1/4W 500kΩ ±0.5%	1	1	1	1
R 18	RCE0757	R, Carbon 1/4W 100Ω ±5%	1	1	1	1
R 19	RCE0793	R, Carbon 1/4W 100kΩ ±5%	1	1	1	1
R 20	RCE0793	R, Carbon 1/4W 100kΩ ±5%	1	1	1	1
R 21	RSE0434	R, Solid 1/4W 10MΩ ±5%	1	1	1	1
R 22	RCE0791	R, Carbon 1/4W 68kΩ ±5%	1	1	1	1
R 23	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	1
R 25	RCE0757	R, Carbon 1/4W 100Ω ±5%	1	1	1	1

DC OFFSET NETWORK

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 48	RME1157	R, Metal 1/4W 16.0kΩ ±0.5%			1	1
R 49	RME1155	R, Metal 1/4W 4.00kΩ ±0.5%			1	1
R 50	RME1157	R, Metal 1/4W 16.0kΩ ±0.5%			1	1
R 51	RCE0769	R, Carbon 1/4W 1kΩ ±5%			1	1
R 52	RME1069	R, Metal 1/4W 562Ω ±5%			1	1
R 53	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%			1	1
R 54	RCE0769	R, Carbon 1/4W 1kΩ ±5%			1	1
R 55	RCE0771	R, Carbon 1/4W 1.5kΩ ±5%			1	1
R 56	RME1157	R, Metal 1/4W 16.0kΩ ±0.5%			1	1
R 57	RME1155	R, Metal 1/4W 4.00kΩ ±0.5%			1	1
RV 61	8348452	VR, Carbon EVH-CCAK20B14	1	1		
RV 61	RDE0003	VR, Carbon EVH-YK3325B14			1	1

CH2 1st ATTENUATOR

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 102	RME0860	R, MET, Chip 1/8W 47Ω ±5%			1	1
R 104	RMS0043	R, Metal 1/4W 900Ω ±0.5%			1	1
R 105	RME1163	R, Metal 1/4W 111kΩ ±0.5%			1	1
R 107	RMS0044	R, Metal 1/4W 990kΩ ±1%			1	1
R 108	RME1156	R, Metal 1/4W 10.1kΩ ±0.5%			1	1
R 109	RME0852	R, MET, Chip 1/8W 10Ω ±5%			1	1
R 110	RME0864	R, MET, Chip 1/8W 100Ω ±5%			1	1
R 112	RCE0749	R, Carbon 1/4W 22Ω ±5%			1	1
C 102	CCG0132	C, CER, Chip 50V 22 pF ±5%				1
C 105	CCG0139	C, CER, Chip 50V 47pF ±5%			1	1
C 109	CCG0144	C, CER, Chip 50V 220pF ±5%			1	1
C 110	CCG0142	C, CER, Chip 50V 82 pF ±5%			1	1
CV 103	CVE0046	C, Variable ECR-HA010A11			1	1
CV 104	CVE0050	C, Variable ECR-HA007A11			1	1
CV 106	CVE0046	C, Variable ECR-HA010A11			1	1
CV 107	CVE0048	C, Variable ECR-HA003A11			1	1
ATT 101	8398872	SW, Rotary ADR-255S	1	1		

CH2 INPUT AMP and 2nd ATTENUATOR

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 116	RME1168	R, Metal 1/4W 500kΩ ±0.5%			1	1
R 117	RME1168	R, Metal 1/4W 500kΩ ±0.5%			1	1
R 118	RCE0757	R, Carbon 1/4W 100Ω ±5%			1	1
R 119	RCE0793	R, Carbon 1/4W 100kΩ ±5%			1	1
R 120	RCE0793	R, Carbon 1/4W 100kΩ ±5%			1	1
R 121	RSE0434	R, Solid 1/4W 10mΩ ±5%			1	1
R 122	RCE0791	R, Carbon 1/4W 68kΩ ±5%			1	1
R 123	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%			1	1
R 125	RCE0757	R, Carbon 1/4W 100Ω ±5%			1	1
R 125	RCE0755	R, Carbon 1/4W 68Ω ±5%				1
R 126	RME1081	R, Metal 1/4W 5.62kΩ ±1%			1	1
R 126	RME1079	R, Metal 1/4W 3.92kΩ ±1%				1
R 130	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%			1	1
R 130	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 132	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
R 133	RCE0762	R, Carbon 1/4W 270Ω ±5%			1	1
R 134	RME1145	R, Metal 1/4W 60.0Ω ±0.5%			1	1
R 135	RCE0766	R, Carbon 1/4W 560Ω ±5%			1	1
R 136	RME1154	R, Metal 1/4W 600Ω ±0.5%			1	1
R 140	RCE0745	R, Carbon 1/4W 10Ω ±5%			1	1
R 141	RCE0745	R, Carbon 1/4W 10Ω ±5%			1	1
R 142	RCE0764	R, Carbon 1/4W 390Ω ±5%			1	1
R 143	RCE0767	R, Carbon 1/4W 680Ω ±5%			1	1
R 144	RCE0767	R, Carbon 1/4W 680Ω ±5%			1	1
R 144	RCE0766	R, Carbon 1/4W 560Ω ±5%				1
R 145	RCE0745	R, Carbon 1/4W 10Ω ±5%			1	1
R 146	RME1157	R, Metal 1/4W 16.0kΩ ±0.5%			1	1
R 147	RME1162	R, Metal 1/4W 80.0kΩ ±0.5%			1	1
R 148	RME1155	R, Metal 1/4W 4.00kΩ ±0.5%			1	1
R 151	RCE0769	R, Carbon 1/4W 1kΩ ±5%			1	1
RM 143	3173846	R, Block For ATT			1	1
C 116	CCD0286	C, Ceramic 50V 1000 pF ±100% 0%			1	1
C 118	CCC0996	C, Ceramic 50V 2 pF ±0.25%			1	1
C 120	CCC1014	C, Ceramic 50V 47 pF ±5%			1	1
C 123	CQA0091	C, Plastic 50V 1000 pF ±10%			1	1
C 125	CCC1014	C, Ceramic 50V 47 pF ±5%			1	1
C 126	CES0028	C, Alelyc 10V 47μF ±20%			1	1
C 130	CES0028	C, Alelyc 10V 47μF ±20%			1	1
C 132	CCC1002	C, Ceramic 50V 10 pF ±0.5%				1
C 140	CES0028	C, Alelyc 10V 47μF ±20%			1	1
C 142	CCC1007	C, Ceramic 50V 22 pF ±5%			1	1
C 144	CES0028	C, Alelyc 10V 47μF ±20%			1	1
RV 122	RNE0057	VR, Metal EVN49C00YB54 (50k)			1	1
RV 133	RNE0048	VR, Metal EVN39C00YB22 (200)			1	1
TR 124	HTK0099	Transistor 2SK404E			1	1
TR 130	HTC0148	Transistor 2SC458C			1	1
TR 130	HTC0557	Transistor 2SC1674K				1
TR 140	HTA0224	Transistor 2SA1029D			1	1
IC 116	8397023	IC LF411CN			1	1
L 134	TLE0107	Coil ELE-VR47MA			1	1
D 116	HDS0437	Diode 1SS133			1	1
D 121	HDS0477	Diode 1SS110			1	1
D 151	HDS0407	Diode SR503D (RED)				1

PANEL and OTHERS

Symbol	Part Code	Description	Qty			
			A	B	C	D
R 13	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
R 113	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
C 13	CCC1004	C, Ceramic 50V 15 pF ±5%				1
C 113	CCC1004	C, Ceramic 50V 15 pF ±5%				1
J 1	JHB0088	CON, Coax BNC071	1	1	1	1
J 5		Jack TJ-10A (RED)			1	1
J 101	JHD0088	CON, Coax BNC071	1	1	1	1

CH1 PREAMP

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 59	RCE0761	R, Carbon 1/4W 22Ω ±5%	1	1	1	
R 59	RCE0759	R, Carbon 1/4W 150Ω ±5%				1
R 60	RCE0797	R, Carbon 1/4W 220kΩ ±5%	1	1	1	
R 60	RCE0795	R, Carbon 1/4W 150kΩ ±5%				1
R 61	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	
R 61	RCE0752	R, Carbon 1/4W 39Ω ±5%				1
R 62	RCE0755	R, Carbon 1/4W 68Ω ±5%	1	1	1	
R 62	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
R 63	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	
R 63	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 64	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	
R 64	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 64	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 65	RCE0781	R, Carbon 1/4W 10kΩ ±5%	1	1	1	1
R 66	RCE0785	R, Carbon 1/4W 22kΩ ±5%	1	1	1	1
R 67	RCE0578	R, Carbon 1/4W 120Ω ±5%	1	1	1	1
R 68	RCE0749	R, Carbon 1/4W 22Ω ±5%	1	1	1	1
R 69	RCE0770	R, Carbon 1/4W 1.2kΩ ±5%	1	1	1	1
R 69	RCE0767	R, Carbon 1/4W 680Ω ±5%				1
R 70	RCE0770	R, Carbon 1/4W 1.2kΩ ±5%	1	1	1	1
R 70	RCE0767	R, Carbon 1/4W 680Ω ±5%				1
R 71	RCE0749	R, Carbon 1/4W 22Ω ±5%	1	1	1	1
R 72	RCE0753	R, Carbon 1/4W 47Ω ±5%	1	1	1	1
R 73	RME1070	R, Metal 1/4W 681Ω ±1%	1	1	1	1
R 73	RME1191	R, Metal 1/4W 432Ω ±1%				1
R 74	RME1070	R, Metal 1/4W 681Ω ±1%	1	1	1	1
R 74	RME1191	R, Metal 1/4W 432Ω ±1%				1
R 75	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	1
R 76	RCE0765	R, Carbon 1/4W 470Ω ±5%	1	1	1	1
R 77	RCE0753	R, Carbon 1/4W 47Ω ±5%	1	1	1	1
C 61	CCC1011	C, Ceramic 50V 33 pF ±5%				1
C 61	CCC1007	C, Ceramic 50V 10 pF ±0.5%	1	1	1	
C 67	CQA0099	C, Plastic 50V 0.022μF ±10%	1	1	1	
C 67	CQA0097	C, Plastic 50V 0.001μF ±10%				1
C 69	CCE1365	C, Ceramic 50V 680 pF ±10%	1	1	1	1
C 71	CCC1365	C, Ceramic 50V 680 pF ±10%	1	1	1	1
C 72	CCC1030	C, Ceramic 50V 10000 pF ±10%	1	1	1	1
C 77	CCC0997	C, Ceramic 50V 3 pF ±0.25pF	1	1	1	1
RV 62	RNE0049	VR, Metal EVN39C00YB12 (100)	1	1	1	1
RV 63	RNE0047	VR, Metal EVN39C00YB54 (50K)	1	1	1	1
TR 61	HTC0168	Transistor 2SC535C	1	1	1	1
TR 62	HTC0168	Transistor 2SC535C	1	1	1	1
TR 63	HTA0224	Transistor 2SA1029D	1	1	1	1
TR 64	HTA0224	Transistor 2SA1029D	1	1	1	1

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 160	RCE0797	R, Carbon 1/4W 220kΩ ±5%	1	1		
R 160	RCE0795	R, Carbon 1/4W 150kΩ ±5%				1
R 161	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	
R 162	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
R 162	RCE0755	R, Carbon 1/4W 68Ω ±5%	1	1		
R 163	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1		
R 163	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 164	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1		
R 164	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 165	RCE0781	R, Carbon 1/4W 10kΩ ±5%	1	1	1	
R 166	RCE0785	R, Carbon 1/4W 22kΩ ±5%	1	1	1	
R 167	RCE0758	R, Carbon 1/4W 120Ω ±5%	1	1	1	
R 168	RCE0749	R, Carbon 1/4W 22Ω ±5%	1	1	1	1
R 169	RCE0767	R, Carbon 1/4W 680Ω ±5%				1
R 169	RCE0770	R, Carbon 1/4W 2.2kΩ ±5%	1	1		
R 170	RCE0770	R, Carbon 1/4W 1.2kΩ ±5%	1	1		
R 170	RCE0767	R, Carbon 1/4W 680Ω ±5%				1
R 171	RCE0749	R, Carbon 1/4W 22Ω ±5%	1	1	1	1
R 172	RCE0753	R, Carbon 1/4W 47Ω ±5%	1	1	1	
R 173	RME1070	R, Metal 1/4W 681Ω ±1%	1	1		
R 173	RME1191	R, Metal 1/4W 432Ω ±1%				1
R 174	RME1070	R, Metal 1/4W 681Ω ±1%	1	1		
R 174	RME1191	R, Metal 1/4W 432Ω ±1%				1
R 175	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	1
R 176	RCE0765	R, Carbon 1/4W 470Ω ±5%	1	1	1	1
R 177	RCE0765	R, Carbon 1/4W 470Ω ±5%	1	1	1	1
R 178	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	1
R 179	RCE0753	R, Carbon 1/4W 47Ω ±5%	1	1	1	1
C 167	CQA0099	C, Plastic 50V 0.022μF ±10%	1	1		
C 167	CQA0097	C, Plastic 50V 0.01μF ±10%				1
C 169	CCC1365	C, Ceramic 50V 680 pF ±10%	1	1	1	
C 171	CCC1365	C, Ceramic 50V 680 pF ±10%	1	1	1	
C 172	CCC1030	C, Ceramic 50V 10000 pF ±10%	1	1	1	
C 179	CCC1030	C, Ceramic 50V 10000 pF ±10%	1	1	1	
RV 161	RDE0003	VR, Carbon EVH-YK3325B14	1	1	1	
RV 162	RNE0049	VR, Metal EVN39C00YB12 (100)	1	1	1	
RV 163	RNE0047	VR, Metal EVN39C00YB54 (50K)	1	1	1	
CV 161	CVE0047	C, Variable ECR-HA020D11	1	1		
CV 161	CVE0049	C, Variable ECR-HA040E11				1
TR 161	HTC0168	Transistor 2SC535C	1	1	1	
TR 162	HTC0168	Transistor 2SC535C	1	1	1	
TR 163	HTA0224	Transistor 2SA1029D	1	1	1	
TR 164	HTA0224	Transistor 2SA1029D	1	1	1	
TR 165	HTA0224	Transistor 2SA1029D	1	1	1	
TR 166	HTA0224	Transistor 2SA1029D	1	1	1	

CH2 PREAMP and INVERT SW CKT

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 159	RCE0761	R, Carbon 1/4W 220Ω ±5%		1	1	
R 159	RCE0759	R, Carbon 1/4W 150Ω ±5%				1

DIODE GATE and VERTICAL AMP

Symbol	Part Code	Symbol				Q'ty			
						A	B	C	D
R 201	RCE0773	R, Carbon	1/4W	2.2kΩ	±5%	1	1		
R 201	RCE0770	R, Carbon	1/4W	1.2kΩ	±5%				1
R 202	RCE0773	R, Carbon	1/4W	2.2kΩ	±5%	1	1		
R 202	RCE0770	R, Carbon	1/4W	1.2kΩ	±5%				1
R 203	RME1066	R, Metal	1/4W	332Ω	±5%	1	1	1	
R 203	RME1063	R, Metal	1/4W	182Ω	±5%				1
R 204	RME1066	R, Metal	1/4W	332Ω	±5%	1	1	1	
R 204	RME1063	R, Metal	1/4W	182Ω	±5%				1
R 205	RCE0769	R, Carbon	1/4W	1kΩ	±5%	1	1	1	
R 205	RCE0766	R, Carbon	1/4W	560Ω	±5%				1
R 206	RCE0769	R, Carbon	1/4W	1kΩ	±5%	1	1	1	1
R 207	RCE0785	R, Carbon	1/4W	22kΩ	±5%	1	1	1	
R 207	RCE0782	R, Carbon	1/4W	12kΩ	±5%				1
R 208	RME1066	R, Metal	1/4W	332Ω	±5%	1	1	1	
R 208	RME1064	R, Metal	1/4W	221Ω	±5%				1
R 209	RME1066	R, Metal	1/4W	332Ω	±5%	1	1	1	
R 209	RME1064	R, Metal	1/4W	221Ω	±5%				1
R 210	RCE0789	R, Carbon	1/4W	47kΩ	±5%				1
R 210	RCE0791	R, Carbon	1/4W	68kΩ	±5%	1	1	1	
R 211	RCE0766	R, Carbon	1/4W	560Ω	±5%	1	1	1	
R 211	RCE0768	R, Carbon	1/4W	820Ω	±5%				1
R 212	RCE0766	R, Carbon	1/4W	560Ω	±5%	1	1	1	
R 212	RCE0768	R, Carbon	1/4W	820Ω	±5%				1
R 213	RME1107	R, Metal	1/4W	86.6Ω	±1%				1
R 213	RCE0753	R, Carbon	1/4W	47Ω	±5%	1	1	1	
R 214	RME1107	R, Metal	1/4W	86.6Ω	±1%				1
R 214	RCE0753	R, Carbon	1/4W	47Ω	±5%	1	1	1	
R 215	RCE0773	R, Carbon	1/4W	2.2kΩ	±5%	1	1	1	
R 215	RCE0772	R, Carbon	1/4W	1.8kΩ	±5%				1
R 216	RCE0773	R, Carbon	1/4W	2.2kΩ	±5%	1	1	1	
R 216	RCE0772	R, Carbon	1/4W	1.8kΩ	±5%				1
R 217	RCE0761	R, Carbon	1/4W	220Ω	±5%				1
C 201	CCC1030	C, Ceramic	50V	10000pF	±10%	1	1	1	
C 207	CCC1014	C, Ceramic	50V	47pF	±5%	1	1	1	
C 207	CCC1025	C, Ceramic	50V	100pF	±5%				1
C 210	CEX0563	C, Alelyc	16V	10μF	BP	1	1	1	1
C 217	CCC1002	C, Ceramic	50V	10pF	±0.5pF				1
TR 201	HTC0338	Transistor	2SC1906			1	1	1	1
TR 202	HTC0338	Transistor	2SC1906			1	1	1	1
D 201	HDS0437	Diode	1SS133			1	1	1	
D 202	HDS0437	Diode	1SS133			1	1	1	
D 203	HDS0437	Diode	1SS133			1	1	1	
D 204	HDS0437	Diode	1SS133			1	1	1	
D 205	HDS0437	Diode	1SS133			1	1	1	
D 206	HDS0437	Diode	1SS133			1	1	1	
D 207	HDS0437	Diode	1SS133			1	1	1	
D 208	HDS0437	Diode	1SS133			1	1	1	

VERTICAL SWITCHING MULTI

Symbol	Part Code	Description				Q'ty			
						A	B	C	D
R 221	RCE0750	R, Carbon	1/4W	27Ω	±5%	1	1		
R 221	RCE0758	R, Carbon	1/4W	120Ω	±5%				1
R 222	RCE0761	R, Carbon	1/4W	220Ω	±5%	1	1		
R 222	RCE0758	R, Carbon	1/4W	120Ω	±5%				1
R 223	RCE0750	R, Carbon	1/4W	27Ω	±5%	1	1	1	
R 223	RCE0748	R, Carbon	1/4W	18Ω	±5%				1
R 224	RCE0761	R, Carbon	1/4W	220Ω	±5%	1	1		
R 224	RCE0758	R, Carbon	1/4W	120Ω	±5%				1
R 225	RCE0789	R, Carbon	1/4W	47kΩ	±5%	1	1	1	
R 226	RCE0749	R, Carbon	1/4W	10Ω	±5%	1	1	1	1
R 228	RCE0789	R, Carbon	1/4W	47kΩ	±5%	1	1	1	
T 229	RCE0776	R, Carbon	1/4W	3.9kΩ	±5%	1	1	1	
R 230	RCE0777	R, Carbon	1/4W	4.7kΩ	±5%	1	1	1	
R 231	RCE0777	R, Carbon	1/4W	4.7kΩ	±5%	1	1	1	
R 232	RCE0769	R, Carbon	1/4W	1kΩ	±5%	1	1	1	
R 232	RCE0768	R, Carbon	1/4W	820Ω	±5%				1
R 233	RCE0781	R, Carbon	1/4W	10kΩ	±5%	1	1	1	
R 234	RCE0781	R, Carbon	1/4W	10kΩ	±5%	1	1	1	
R 235	RCE0789	R, Carbon	1/4W	47kΩ	±5%	1	1	1	
R 236	RCE0789	R, Carbon	1/4W	47kΩ	±5%	1	1	1	
R 237	RCE0789	R, Carbon	1/4W	47kΩ	±5%	1	1	1	
R 390	RCE0781	R, Carbon	1/4W	10kΩ	±5%				1
R 391	RCE0765	R, Carbon	1/4W	740Ω	±5%				1
R 392	RCE0778	R, Carbon	1/4W	5.6kΩ	±5%				1
R 393	RCE0767	R, Carbon	1/4W	680Ω	±5%				1
R 394	RCE0775	R, Carbon	1/4W	3.3kΩ	±5%				1
R 395	RCE0775	R, Carbon	1/4W	3.3kΩ	±5%				1
R 396	RCE0785	R, Carbon	1/4W	22Ω	±5%				1
C 221	CCC1160	C, Ceramic	50V	330pF	±10%	1	1	1	
C 222	CES0028	C, Alelyc	10V	47μF	±20%	1	1	1	
C 223	CCC1160	C, Ceramic	50V	330pF	±10%	1	1	1	
C 224	CES0028	C, Alelyc	10V	47μF	±20%	1	1	1	
TR 232	HTA0224	Transistor	2SA1029D			1	1	1	
TR 390	HTC0148	Transistor	2SC458C						1
TR 396	HTC0148	Transistor	2SC458C						1
IC 222	IDH0467	IC	HD74LS00P			1	1	1	
IC 226	IDH0586	IC	HD74LS74AP			1	1	1	
D 221	HDS0437	Diode	1SS133			1	1	1	
D 223	HDS0437	Diode	1SS133			1	1	1	
D 224	HDS0437	Diode	1SS133			1	1	1	
D 225	HDS0437	Diode	1SS133			1	1	1	
D 226	HDS0437	Diode	1SS133			1	1	1	
D 230	HDS0437	Diode	1SS133			1	1	1	
D 231	HDS0437	Diode	1SS133			1	1	1	
D 394	HDS0437	Diode	1SS133						1
D 395	HDS0437	Diode	1SS133						1
S 201	3165210	SW, Rotary	SBU 1025			1	1	1	
D 243	HDS0437	Diode	1SS133			1	1	1	
D 244	HDS0437	Diode	1SS133			1	1	1	
D 245	HDH0029	Diode	HZ5B			1	1	1	

CH1 TRIG PICKOFF and CH1 OUT

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 81	RCE0693	R, Carbon 1/2W 100Ω ±5%				1
R 82	RME1107	R, Metal 1/4W 26.6Ω ±1%	1	1	1	1
R 83	RCE0757	R, Carbon 1/4W 100Ω ±5%	1	1	1	1
R 84	RCE0759	R, Carbon 1/4W 150Ω ±5%	1	1	1	1
R 85	RCE0783	R, Carbon 1/4W 15kΩ ±5%		1	1	1
R 86	RCE0771	R, Carbon 1/4W 1.5kΩ ±5%	1	1	1	
R 87	RCE0755	R, Carbon 1/4W 68Ω ±5%		1	1	
R 87	RCE0756	R, Carbon 1/4W 82Ω ±5%	1			
R 87	RCE0751	R, Carbon 1/4W 33Ω ±5%				1
R 88	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	
R 88	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 89	RCE0773	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	
R 89	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 90	RCE0763	R, Carbon 1/4W 330Ω ±5%	1	1	1	
R 90	RCE0745	R, Carbon 1/4W 10Ω ±5%				1
R 91	RCE0763	R, Carbon 1/4W 330Ω ±5%	1	1	1	
R 91	RCE0761	R, Carbon 1/4W 220Ω ±5%				1
R 92	RCE0787	R, Carbon 1/4W 33kΩ ±5%	1	1	1	
R 93	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 93	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	
R 94	RME1070	R, Metal 1/4W 681Ω ±5%				1
R 94	RCE0771	R, Carbon 1/4W 1.5kΩ ±5%	1	1	1	
R 95	RCE0753	R, Carbon 1/4W 47Ω ±5%	1	1	1	1
R 96	RCE0755	R, Carbon 1/4W 68Ω ±5%	1	1	1	
R 96	RCE0757	R, Carbon 1/4W 100Ω ±5%				1
R 96	RCE0753	R, Carbon 1/4W 47Ω ±5%				1
R 97	RCE0769	R, Carbon 1/4W 1kΩ ±5%	1			
R 97	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%		1	1	
R 97	RCE0781	R, Carbon 1/4W 10kΩ ±5%				1
R 98	RCE0767	R, Carbon 1/4W 680Ω ±5%		1	1	
R 99	RCE0768	R, Carbon 1/4W 820Ω ±5%		1	1	
R 99	RCE0767	R, Carbon 1/4W 680Ω ±5%				1
C 83	CES0028	C, Alelyc 10V 47μF/LB	1	1	1	1
C 86	CCC1034	C, Ceramic 50V 68 pF ±5%				1
C 86	CCC1365	C, Ceramic 50V 680 pF ±10%	1	1	1	
C 90	CCC1365	C, Ceramic 50V 680 pF ±10%	1	1	1	
C 91	CCC1365	C, Ceramic 50V 680 pF ±10%	1	1	1	
C 94	CES0028	C, Alelyc 10V 47μF/LB	1	1	1	1
C 96	CCC1030	C, Ceramic 50V 10000 pF ±10%	1	1	1	1
C 97	CCC1007	C, Ceramic 50V 22 pF ±5%				1
C 97	CCC1027	C, Ceramic 50V 220 pF ±10%	1	1		
RV 85	RNE0051	VR, Metal EVN39C00YB14 (10K)	1	1	1	
TR 85	HTC0168	Transistor 2SC535C	1	1	1	1
TR 86	HTC0168	Transistor 2SC535C	1	1	1	1
TR 87	HTC0148	Transistor 2SC458C	1	1	1	1
D 97	HDH0024	Diode HZ3B	1	1	1	
L 98	TLF0067	Coil FL-5H101K				1

CH2 TRIG PICKOFF

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 181	RCE0757	R, Carbon 1/4W 100Ω ±5%				1
R 184	RCE0759	R, Carbon 1/4W 150Ω ±5%			1	1
R 185	RCE0783	R, Carbon 1/4W 15kΩ ±5%			1	1
R 186	RCE0771	R, Carbon 1/4W 1.5kΩ ±5%		1	1	
R 186	RCE0753	R, Carbon 1/4W 100Ω ±5%				1
R 187	RCE0755	R, Carbon 1/4W 68Ω ±5%		1	1	
R 187	RCE0751	R, Carbon 1/4W 33Ω ±5%				1
R 188	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%		1	1	
R 188	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 189	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%		1	1	
R 189	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%				1
R 190	RCE0763	R, Carbon 1/4W 330Ω ±5%		1	1	
R 190	RCE0745	R, Carbon 1/4W 100Ω ±5%				1
R 191	RCE0776	R, Carbon 1/4W 3.9kΩ ±5%		1	1	
R 191	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%				1
R 192	RCE0773	R, Carbon 1/4W 2.2kΩ ±5%		1	1	
R 192	RCE0770	R, Carbon 1/4W 1.2kΩ ±5%				1
RV 185	RNE0051	VR, Metal EVN39C00YB14 (10K)	1	1	1	
C 186	CCC1365	C, Ceramic 50V 680 pF ±10%		1	1	
C 186	CCC1034	C, Ceramic 50V 68 pF ±5%				1
C 190	CCC1365	C, Ceramic 50V 680 pF ±10%		1	1	1
TR 185	HTC0168	Transistor 2SC535C		1	1	1
TR 186	HTC0168	Transistor 2SC535C		1	1	1

TRIG PREAMP

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
R 241	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%		1	1	1
R 242	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%		1	1	1
R 243	RCE0765	R, Carbon 1/4W 470kΩ ±5%		1	1	1
R 244	RCE0765	R, Carbon 1/4W 2.2kΩ ±5%		1	1	1
R 245	RCE0766	R, Carbon 1/4W 560Ω ±5%				1
R 245	RCE0770	R, Carbon 1/4W 1.2kΩ ±5%	1	1	1	
R 246	RCE0768	R, Carbon 1/4W 560Ω ±5%				1
R 246	RCE0770	R, Carbon 1/4W 1.2kΩ ±5%	1	1	1	
R 247	RCE0768	R, Carbon 1/4W 820Ω ±5%	1	1	1	
R 247	RCE0765	R, Carbon 1/4W 470Ω ±5%				1
R 248	RCE0753	R, Carbon 1/4W 47Ω ±5%	1	1	1	1
R 249	RCE0757	R, Carbon 1/4W 100Ω ±5%				1
C 241	CCC1030	C, Ceramic 50V 10000 pF ±10%		1	1	1
C 242	CES0028	C, Alelyc 10V 47μF ±20%		1	1	1
C 243	CCC1007	C, Ceramic 50V 22 pF ±5%				1
C 244	CCC1007	C, Ceramic 50V 22 pF ±5%				1
C 245	CES0028	C, Alelyc 10V 47μF ±20%	1	1	1	1
C 248	CCC1025	C, Ceramic 50V 100 pF ±5%				1
C 248	CCC1032	C, Ceramic 50V 82 pF ±5%		1	1	1
C 249	CCC0999	C, Ceramic 50V 5 pF ±0.25pF				1
C 270	CES0028	C, Alelyc 10V 47μF ±20%	1	1	1	1

DELAY LINE

Symbol	Part Code	Description	Q'ty							
			A	B	C	D				
C	271	CES0028	C, Alelyc	10V	47 μ F	$\pm 20\%$	1	1	1	1
TR	241	HTC0192	Transistor	2SC641K				1	1	1
TR	242	HTC0192	Transistor	2SC641K				1	1	1
TR	246	HTA0224	Transistor	2SA1029D			1	1	1	1
TR	246	HTA0099	Transistor	2SA781K						1

Symbol	Part Code	Description	Q'ty							
			A	B	C	D				
DL	201	8311741	Delay Line	CD-3A						1
PEF-624			PCB	PB-14						R

SQUARE WAVE CAL 1kHz

Symbol	Part Code	Description	Q'ty							
			A	B	C	D				
R	1201	RME1174	R, Metal	1/4W	2.00k Ω	$\pm 1\%$	1	1	1	1
R	1202	RME1065	R, Metal	1/4W	267 Ω	$\pm 1\%$	1	1	1	1
R	1203	RCE0783	R, Carbon	1/4W	15k Ω	$\pm 5\%$	1	1	1	1
R	1204	RCE0781	R, Carbon	1/4W	10k Ω	$\pm 5\%$	1	1	1	1
R	1205	RCE0783	R, Carbon	1/4W	15k Ω	$\pm 5\%$	1	1	1	1
R	1206	RCE0789	R, Carbon	1/4W	47k Ω	$\pm 5\%$	1	1	1	1
R	1207	RCE0781	R, Carbon	1/4W	10k Ω	$\pm 5\%$	1	1	1	1
R	1208	RCE0787	R, Carbon	1/4W	33k Ω	$\pm 5\%$	1	1	1	1
R	1209	RCE0781	R, Carbon	1/4W	10k Ω	$\pm 5\%$	1	1	1	1
R	1210	RCE0745	R, Carbon	1/4W	10 Ω	$\pm 5\%$	1	1	1	1
C	1201	CCC1002	C, Ceramic	50V	10pF	$\pm 0.5pF$	1	1	1	1
C	1202	CQA0091	C, Plastic	50V	0.001 μ F	$\pm 10\%$	1	1	1	1
C	1208	CQA0099	C, Plastic	50V	0.022 μ F	$\pm 10\%$	1	1	1	1
C	1210	CES0028	C, Alelyc	10V	47 μ F	$\pm 20\%$	1	1	1	1
RV	1201	RNE0058	VR, Metal	EVN39C00YB13	(1K)		1	1	1	1
TR	1201	HTA0224	Transistor	2SA1029D			1	1	1	1
TR	1208	HTC0148	Transistor	2SC458C			1	1	1	1
TR	1209	HTC0148	Transistor	2SC458C			1	1	1	1

PANEL and OTHERS

Symbol	Part Code	Description	Q'ty							
			A	B	C	D				
J	80	JHB0088	CON, Coax	BNC071			1	1	1	1
J	1201	JHB0088	CON, Coax	BNC071			1	1	1	1

Symbol	Part Code	Description	Q'ty			
			A	B	C	D
CV 337	CVE0049	C, Variable ECR-HA040E11	1	1	1	1
CV 355	CVE0049	C, Variable ECR-HA040E11				1
CV 366	CVE0049	C, Variable ECR-HA040E11	1	1	1	
CV 366	CVE0047	C, Variable ECR-HA020D11				1
D 374	HDH0029	Diode HZ5B	1	1	1	1
D 375	HDH0029	Diode HZ5B	1	1	1	1
D 377	HDH0029	Diode HZ5B	1	1	1	1
PEF-620		PCB PB-14	R	R	R	R

TRIG GENERATOR

Symbol	Part Code	Description	Qty			
			A	B	C	D
R 401	RCE0800	R, Carbon 1/4W 470kΩ ±5%	1	1	1	1
R 402	RCE0755	R, Carbon 1/4W 68Ω ±5%	1	1	1	1
R 404	RCE0764	R, Carbon 1/4W 390Ω ±5%	1	1	1	1
R 406	RCE0800	R, Carbon 1/4W 470kΩ ±5%	1	1	1	1
R 407	RCE0761	R, Carbon 1/4W 220Ω ±5%	1	1	1	1
R 408	RCE0757	R, Carbon 1/4W 100Ω ±5%	1	1	1	1
R 409	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	1
R 409	RCE0779	R, Carbon 1/4W 6.8kΩ ±5%	1	1	1	1
R 410	RCE0772	R, Carbon 1/4W 1.8kΩ ±5%	1	1	1	1
R 417	RCE0769	R, Carbon 1/4W 1kΩ ±5%	1	1	1	1
R 418	RCE0779	R, Carbon 1/4W 6.8kΩ ±5%	1	1	1	1
R 420	RCE0781	R, Carbon 1/4W 10kΩ ±5%	1	1	1	1
R 425	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	1
R 430	RCE0757	R, Carbon 1/4W 100Ω ±5%	1	1	1	1
R 432	RCE0767	R, Carbon 1/4W 680Ω ±5%	1	1	1	1
R 433	RCE0768	R, Carbon 1/4W 820Ω ±5%	1	1	1	1
R 433	RCE0769	R, Carbon 1/4W 1kΩ ±5%	1	1	1	1
R 434	RCE0689	R, Carbon 1/2W 47Ω ±5%	1	1	1	1
R 435	RCE0774	R, Carbon 1/4W 2.7kΩ ±5%	1	1	1	1
R 436	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	1
R 437	RCE0775	R, Carbon 1/4W 3.3kΩ ±5%	1	1	1	1
R 438	RCE0789	R, Carbon 1/4W 47kΩ ±5%	1	1	1	1
R 439	RCE0789	R, Carbon 1/4W 47kΩ ±5%	1	1	1	1
R 441	RCE0769	R, Carbon 1/4W 1kΩ ±5%	1	1	1	1
R 443	RCE0769	R, Carbon 1/4W 47kΩ ±5%	1	1	1	1
R 444	RCE0771	R, Carbon 1/4W 1.5kΩ ±5%	1	1	1	1
R 445	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	1
R 450	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	1
R 452	RCE0785	R, Carbon 1/4W 22kΩ ±5%	1	1	1	1
R 460	RCE0745	R, Carbon 1/4W 10Ω ±5%	1	1	1	1
R 460	RCE0749	R, Carbon 1/4W 22Ω ±5%	1	1	1	1
R 470	RCE0800	R, Carbon 1/4W 470kΩ ±5%	1	1	1	1
R 471	RCE0777	R, Carbon 1/4W 4.7kΩ ±5%	1	1	1	1
R 472	RCE0777	R, Carbon 1/4W 1.5kΩ ±5%	1	1	1	1
R 473	RCE0781	R, Carbon 1/4W 10kΩ ±5%	1	1	1	1
C 402	CCD0279	C, Ceramic 500V 22pF ±5%	1	1	1	1
C 403	CQX0068	C, Plastic 400V 0.047μF ±10%	1	1	1	1
C 404	CCC1029	C, Ceramic 50V 1000pF ±80% -20%	1	1	1	1
C 405	CQA0101	C, Plastic 50V 47000pF ±10%	1	1	1	1
C 407	CCC0999	C, Ceramic 50V 5pF ±0.25%	1	1	1	1
C 408	CES0028	C, AL Elyc 10V 47μF ±20%	1	1	1	1
C 417	CEC0176	C, AL Elyc 25V 10μF ±20%	1	1	1	1
C 418	CCC1030	C, Ceramic 50V 1000pF ±80% -20%	1	1	1	1
C 425	CES0028	C, AL Elyc 10V 47μF ±20%	1	1	1	1
C 442	CEX0230	C, AL Elyc 50V 1BP ±80% -20%	1	1	1	1
C 444	CES0028	C, AL Elyc 10V 47μF ±20%	1	1	1	1
C 452	CQA0097	C, Plastic 50V 10000pF ±10%	1	1	1	1
C 460	CES0028	C, AL Elyc 10V 47μF ±20%	1	1	1	1
C 470	CCC1030	C, Ceramic 50V 10000pF ±80% -20%	1	1	1	1
RV 418	RDE0003	VR, Carbon EVH-YK3325B14	1	1	1	1
RV 420	RNE0051	VR, Metal EVN39C00YB14 (10K)	1	1	1	1
RV 473	RNE0047	VR, Metal EVN39C00&B54 (50K)	1	1	1	1
TR 401	HTK0099	Transistor 2SK404E	1	1	1	1
TR 402	HTC0148	Transistor 2SC458C	1	1	1	1
TR 431	HTC0168	Transistor 2SC535C	1	1	1	1

Symbol	Part Code	Description	Qty			
			A	B	C	D
TR4 432	HTC0168	Transistor 2SC535C	1	1	1	1
TR 441	HTA0224	Transistor 2SA1029D	1	1	1	1
TR 470	HTK0099	Transistor 2SK404E	1	1	1	1
L 432	TLE0111	Coil ELE-V 6R8KA	1	1	1	1
IC 401	IDH0402	Digital IC HD74S00	1	1	1	1
IC 401	IDH0467	Digital IC HD74LS00P	1	1	1	1
S 401		SW Lever SLR024	1	1	1	1
S 403		SW Lever SLR024	1	1	1	1
D 401	HDS0437	Diode 1SS133	1	1	1	1
D 444	HDS0437	Diode 1SS133	1	1	1	1

PANEL and OTHERS

Symbol	Part Code	Description	Qty			
			A	B	C	D
J 403	JHB0088	CON. Coax BNC071	1	1	1	1

CHOP PULSE GENERATOR

Symbol	Part Code	Description	Q'ty						
			A	B	C	D			
R	571	RCE0769	R, Carbon	1/4W	1k Ω	$\pm 5\%$	1	1	1
R	572	RCE0776	R, Carbon	1/4W	3.9k Ω	$\pm 5\%$	1	1	1
R	573	RCE0765	R, Carbon	1/4W	470 Ω	$\pm 5\%$	1	1	1
R	574	RCE0783	R, Carbon	1/4W	15k Ω	$\pm 5\%$	1	1	1
R	576	RCE0745	R, Carbon	1/4W	10 Ω	$\pm 5\%$	1	1	1
R	578	RCE0776	R, Carbon	1/4W	3.9k Ω	$\pm 5\%$	1	1	1
C	571	CCC1030	C, Ceramic	50V	10000 pF	+80% -20%	1	1	1
C	572	CCC1014	C, Ceramic	50V	47 pF	$\pm 5\%$	1	1	1
C	573	CCC1027	C, Ceramic	50V	220 pF	$\pm 10\%$	1	1	1
C	575	CCC1027	C, Ceramic	50V	220 pF	$\pm 10\%$	1	1	1
C	576	CCC1030	C, Ceramic	50V	10000 pF	+80% -20%	1	1	1
IC	571	IDH0646	Digital, IC	HD74LS02P			1	1	1
L	537	TLE0138	Coil	ELE-V	681KA			1	
L	537	TLE0092	Coil	ELE-V	331KA				1
L	571	TLE0128	Coil	ELE-V	330KA		1	1	1
D	571	HDS0437	Diode	1SS133			1	1	1
D	572	HDS0437	Diode	1SS133			1	1	1
D	573	HDS0437	Diode	1SS133			1	1	1
D	574	HDS0437	Diode	1SS133			1	1	1

