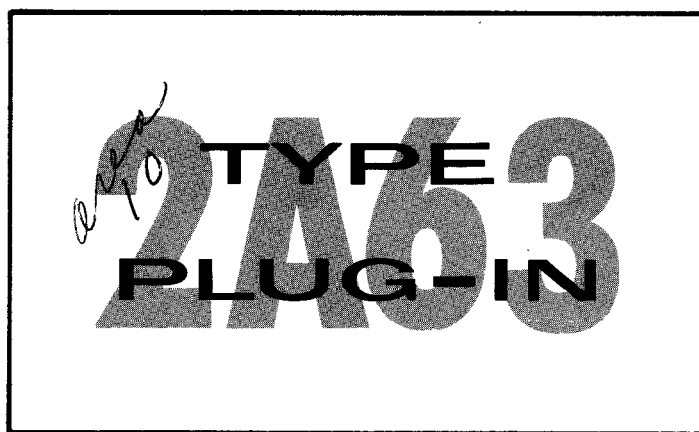


# INSTRUCTION MANUAL

Serial Number 2464

PRIOR TO SERIAL NUMBER 1320 THE TYPE 2A63 WAS REFERRED TO AS TYPE 63. The 2A63 Plug-in is interchangeable with the 63 and this manual also applies to the type 63 as far as operation and calibration are concerned.



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Fig. 1. Type 2A63 Differential Amplifier module.

# TYPE 2A63 DIFFERENTIAL AMPLIFIER

## INTRODUCTION

The Type 2A63 Differential Amplifier module, Fig. 1, is designed for use with Tektronix Type 560-Series Oscilloscopes. It has a bandpass of dc to 300 kc or greater and a differential rejection ratio of approximately 50 to 1 or better, depending upon frequency and sensitivity\*. Sensitivity is variable in 14 calibrated steps from 1 millivolt to 20 volts per division of deflection, and is continuously variable (uncalibrated) between steps and up to 50 volts per division. Accuracy is within 3% at each of the calibrated

steps. In addition to differential operation, the module can also be used for single-ended operation. The input impedance at both inputs is one megohm paralleled by 47 picofarads. Maximum allowable signal voltage at the INPUT connectors is 600 volts (dc plus peak ac).

A Type 2A63 module can be used with a Type 2A60 or Type 3A75 module, or another Type 2A63, in the same Type 560 series Oscilloscope to measure the phase relationship between two sine waves. Phase measurements accurate to within 1° at 50 kc can be made with two properly calibrated Type 2A63 modules.

## Operating Instructions

Throughout the instructions that follow, it is assumed, unless otherwise noted, that the Type 2A63 module is inserted in the Y-axis opening of a Type 560-Series Oscilloscope, thereby providing vertical deflection of the oscilloscope trace. If the module is inserted in the X-axis opening of the oscilloscope, it will provide horizontal deflection and the instructions must be interpreted accordingly. It is further assumed throughout the discussion that there is a time-base module in the X-axis opening of the oscilloscope.

### Signal Connections

When a single signal input is used with the Type 2A63 module, it may be applied to either the +INPUT connector or the -INPUT connector. If the signal is connected to the +INPUT connector, the -INPUT AC-DC-GND switch should be placed in the GND position and the +INPUT AC-DC-GND switch should be placed in the AC or DC position, depending upon the type of coupling desired. If the signal is connected to the -INPUT connector, the +INPUT AC-DC-GND switch should be placed in the GND position and the -INPUT AC-DC-GND switch should be placed in the AC or DC position. If the signal is applied to the -INPUT connector, the display on the oscilloscope screen will be opposite in polarity to a normal presentation. Conventionally, a normal display places the more positive

portions of a waveform in the vertical channel toward the top of the screen, and the more positive portions of a waveform in the horizontal channel toward the right side of the screen (see Fig. 2).

When it is desired to display the difference between two signals, one signal is connected to each INPUT connector and both AC-DC-GND switches are placed in either the AC or DC position. In this mode of operation, the two signals are subtracted from each other algebraically, and the difference is displayed as a single trace on the oscilloscope screen. This is called the differential mode of operation. It permits you to eliminate signals which are common to both inputs and to observe a waveform which is peculiar to one (see Fig. 3).

Use of the differential mode of operation is limited to signals of about  $\pm 5$  volts maximum at the input to the first amplifier stage of the module. For this reason, the common mode signal at the INPUT connectors should be limited to about  $\pm 5$  volts when the VOLTS/DIV. switch is set at any

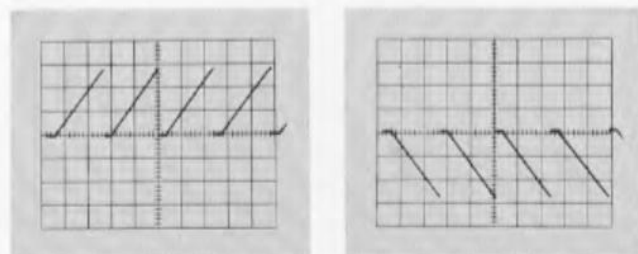


Fig. 2. Left—Displayed waveform when positive-going sawtooth signal is applied to the +INPUT connector. Right—Displayed waveform when positive-going sawtooth is applied to the -INPUT connector.

\* Rejection ratios as high as 2000 to 1 can be obtained through the use of two Tektronix Type P6023 attenuator probes.

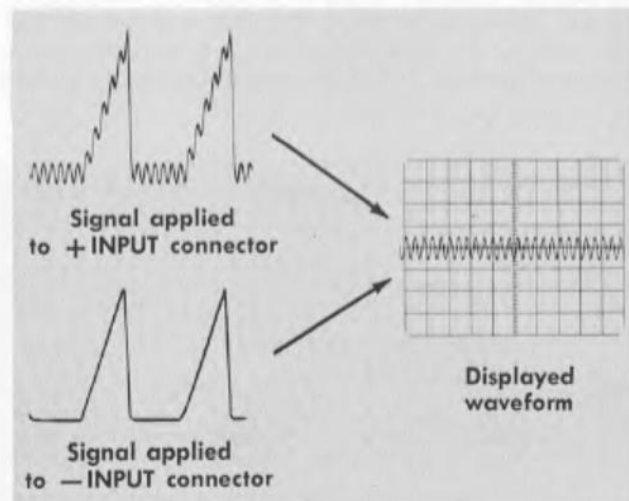


Fig. 3. Rejection of common-mode signal by differential operation. The signal applied to the -INPUT connector is algebraically subtracted from the signal applied to the +INPUT connector and the difference waveform is displayed on the screen.

## Type 2A63

position from 1 mVOLTS through .2 VOLTS and to about  $\pm 50$  volts when the VOLTS/DIV. switch is set at .5, 1, or 2 VOLTS. In the 5, 10, and 20 VOLTS positions of the VOLTS/DIV. switch, the common-mode signal at the INPUT connectors may be as high as  $\pm 500$  volts.

For best results, the signal or signals to be displayed should always be applied through a shielded cable, with the shield connected to the chassis of both the oscilloscope and the signal source. All leads and cables should be kept as short as practicable.

High impedance attenuator probes are available for use with the Type 2A63 module. These probes reduce the resistive and capacitive loading effects of the module and, at the same time, attenuate the signal to allow the display of larger signals than would otherwise be possible. These probes and other accessories are described in the Accessories section of the oscilloscope manual.

### Displaying a Signal

To display a signal with the Type 2A63 module, proceed as follows:

1. Connect the signal to one or both INPUT connectors as described in the foregoing paragraphs.
2. Establish a common ground between the oscilloscope and the signal source. This can be done by connecting the ground clip on a Tektronix attenuator probe to signal ground.
3. Adjust the time-base controls to obtain a stable display.
4. Set the VOLTS/DIV. switch and the POSITION control so that the signal is placed as desired on the graticule. In general, if you are interested only in the ac component of the signal, you should set the appropriate AC-DC-GND switch to AC; if you are interested in the dc level of the signal, you should set the appropriate AC-DC-GND switch to DC. An exception to this is in observing low-frequency signals. When the AC-DC-GND switch is in the AC position, and the AC STABILIZED switch is in the OFF position, the lower bandpass limit (3-db point) of the module is about

1.5 cps. Therefore, when displaying signals with frequency components of less than about 2 cps (0.2 cps when using a 10X attenuator probe), the best response will be obtained with the AC-DC-GND switch in the DC position.

When looking at ac signals of very small amplitude (less than about 10 millivolts), you may wish to use the AC STABILIZED switch to eliminate dc drift in the oscilloscope trace. Placing this switch in the ON position introduces ac coupling into the amplifier whenever the VOLTS/DIV. switch is in one of its five most sensitive positions (1 mVOLTS through 20 mVOLTS). This prevents small dc drift conditions in the Input Amplifier of the module from causing trace shift on the screen. When the VOLTS/DIV. switch is at 1 mVOLTS and the AC STABILIZED switch is ON, the lower bandpass limit (3-db point) of the module is about 10 cps.

Note that the small neon lamp to the left of the AC STABILIZED switch lights when either AC-DC-GND switch is in the DC position while the AC STABILIZED switch is ON. This is to warn the operator that the amplifier is ac coupled when the VOLTS/DIV. switch is in one of its five most sensitive positions, even though the AC-DC-GND switch is in the DC position. (The light can be ignored if the VOLTS/DIV. switch is not in one of these positions.) If you wish to measure dc levels in one of the five most sensitive positions of the VOLTS/DIV. switch, you must set the AC STABILIZED switch to OFF.

### Probe Compensation

If an attenuator probe is used, its input capacitance must be compensated to that of the module for best signal response. It is advisable to check the compensation of the probe each time it is used. To compensate a Tektronix attenuator probe, proceed as follows:

1. Connect the probe to the INPUT connector with which it will be used, and touch the probe tip to the CAL. OUT connector.
2. Set the oscilloscope controls to display several cycles of the Calibrator waveform, as shown in Fig. 4.
3. Adjust the variable capacitor in the body of the probe to obtain a square leading corner on the positive half-cycle

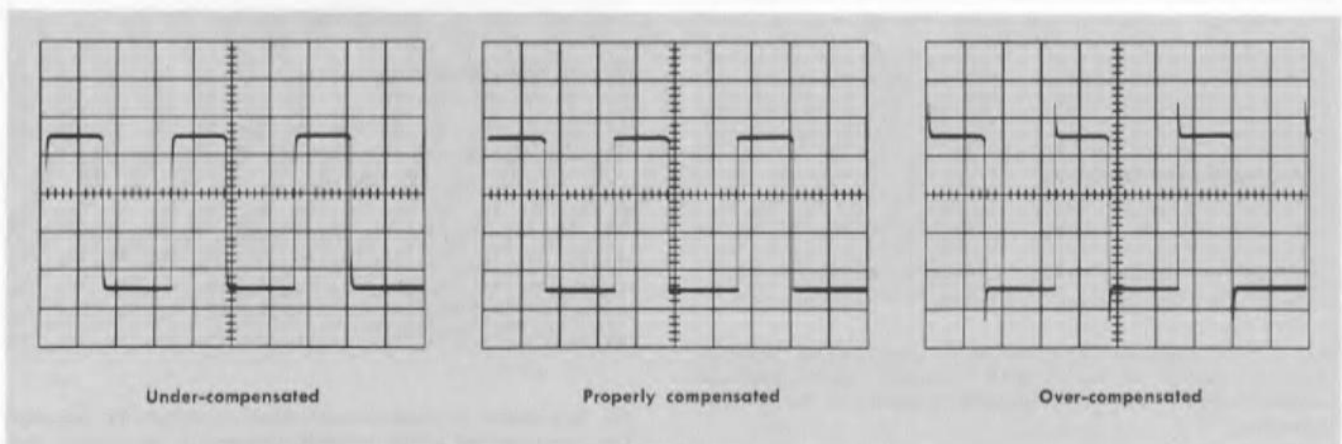


Fig. 4. Probe compensation waveforms.

if the probe is connected to the +INPUT connector, or on the negative half-cycle if the probe is connected to the -INPUT connector.

## Gain and DC Balance Adjustment

Any time you move the Type 2A63 module from one oscilloscope opening to another you must adjust the gain to compensate for difference in crt deflection sensitivities. This should also be done from time to time even if the module has not been moved. In addition, the dc balance of the module should be checked and adjusted, as necessary, from time to time, especially when you are making dc voltage measurements on small signals.

To properly set the gain of the Type 2A63 module, proceed as follows:

1. Set the +INPUT AC-DC-GND switch to DC and the -INPUT AC-DC-GND switch to GND.
2. Set the VOLTS/DIV. switch to .2 VOLTS and the VARIABLE control fully clockwise (to the CALIBRATED position).
3. Apply a 1-volt signal from the oscilloscope Calibrator to the +INPUT connector.
4. Adjust the front-panel GAIN ADJ. for a deflection of exactly five major divisions on the oscilloscope screen.

To properly adjust the dc balance of the Type 63 module, proceed as follows:

1. Set both AC-DC-GND switches to GND and the VOLTS/DIV. switch to 1 mVOLTS.
2. Set the AC STABILIZED switch to ON and position a free-running trace (or spot) to the horizontal centerline of the graticule.
3. Set the AC STABILIZED switch to OFF and adjust the front-panel DC BAL. control to bring the trace or spot back to the centerline of the graticule.
4. Repeat steps 2 and 3 until no further adjustment is necessary.

If it is not possible to set the dc balance with the DC BAL. control, the COARSE DC BAL. needs resetting (see Calibration instructions).

## Voltage Measurements

### NOTE

When making any measurements, make sure there is a common ground between the oscilloscope and the signal source.

To measure the potential difference between two points on a displayed signal (such as peak-to-peak ac volts), proceed as follows:

1. Measure the vertical distance, in graticule divisions, between the two points you wish to measure. Make sure

the VARIABLE control is set fully clockwise (to the CALIBRATED position). The AC-DC-GND switch may be in either the AC or DC position.

2. Multiply this distance by the setting of the VOLTS/DIV. switch and the attenuation factor, if any, of the probe. This is the potential difference between the two points measured.

To measure the dc level at a given point on a displayed signal, proceed as follows:

1. Set both AC-DC-GND switches to GND and check the dc balance of the module. Make sure the VARIABLE control is set fully clockwise (to the CALIBRATED position).
2. Position a free-running trace so that it lies along one of the horizontal graticule lines. This line will be used as a zero reference line. Do not adjust the POSITION control on the Type 2A63 module after the reference line has been established.
3. Set the appropriate AC-DC-GND switch to DC. If the differential mode of operation is being used, set both AC-DC-GND switches to DC. (If the position of the trace or spot shifts by more than 1 minor graticule division, see Troubleshooting, "DC Reference-Level Shift.")
4. Connect the probe, or probes, to the signal source and adjust the VOLTS/DIV. switch for suitable vertical deflection and the time-base controls to obtain a stable display.
5. Measure the vertical distance, in graticule divisions, from the zero reference line established in step 2 to the point on the waveform at which the dc level is desired. Make sure the VARIABLE control is set fully clockwise (to the CALIBRATED position).
6. Multiply this distance by the setting of the VOLTS/DIV. switch and the attenuation factor, if any, of the probe. This is the dc level of the point measured.

### NOTE

When measuring very small dc voltages, it is wise to repeat the above procedure to eliminate possible error due to drift.

## Phase-Shift Measurements

To measure the phase difference between two sine waves of the same frequency, using two Type 2A63 modules in the X-Y mode of operation, proceed as follows:

1. Insert the two Type 2A63 modules into the oscilloscope.\* For accurate measurements, they must be properly phase-shift compensated as described in the Calibration instructions. (You can check the phase-shift compensation by performing this procedure with in-phase sine waves applied to both modules.)
2. Set both +INPUT AC-DC-GND switches to AC and both -INPUT AC-DC-GND switches to GND.

\* Type 565 Oscilloscope cannot be used in this application.

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3. Apply the two sine waves to the two +INPUT connectors. The display will be an ellipse. (Actually, the display will appear as a diagonal straight line if the two sine waves are in phase or exactly  $180^\circ$  out of phase, or it will appear as a circle if the two sine waves are exactly  $90^\circ$  out of phase. Application of these instructions, however, will still apply.)

4. Center the ellipse horizontally on the screen.

5. Measure the distances A and B on the display as shown in Fig. 5. A/B is equal to the sine of the phase difference between the two signals. (see Table 1, page 11).

X-Y phase measurements can also be made using a Type 2A63 module with a Type 2A60 or Type 3A75 in the same oscilloscope. In this case, it will be necessary to insert an adjustable phase-shifting network ahead of the Type 2A60 or Type 3A75, apply the same sine wave to both modules, and adjust the phase-shifting network for zero phase difference as displayed on the screen. The signal through either module will then serve as a reference against which to measure the phase of any signal of the same frequency applied to the other module. (If you change frequency you will have to change the setting of the phase-shifting network.) The proper method for setting the internal adjustments of the Type 2A63 module for this type of operation is described in the Calibration instructions.

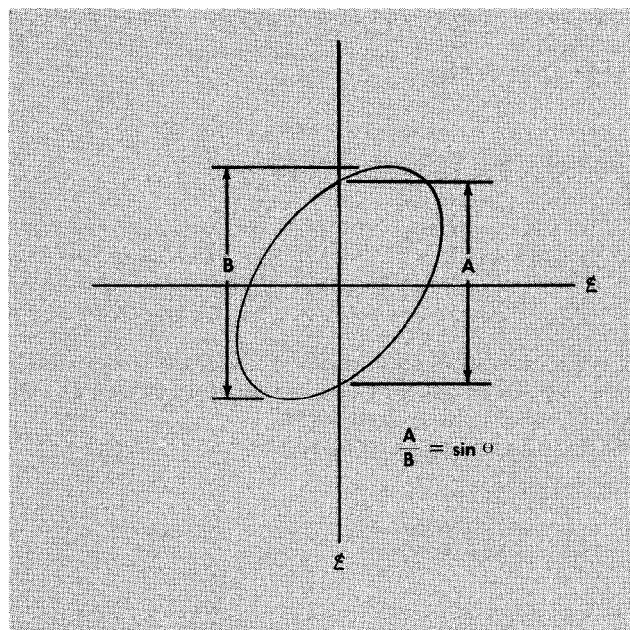


Fig. 5. X-Y method of calculating phase difference ( $\theta$ ) between two sine waves.

## Circuit Description

The Type 2A63 Differential Amplifier consists basically of two opposing input circuits, a two-stage Input Amplifier, and a one-stage push-pull Output Amplifier. The Input Amplifier is inherently an extremely high-gain amplifier, limited to a maximum gain of about 1000 by negative feedback. The Output Amplifier has a gain of about 20. Step changes in sensitivity are accomplished by input attenuation and changes in the amount of negative feedback in the Input Amplifier. Vernier changes in sensitivity are accomplished by varying the amount of degeneration in the cathode circuit of the Output Amplifier.

### Input Circuits

The signals to be displayed are applied either "straight through" or through a 10X or 100X attenuator to the grid circuit, or circuits, of the Input Amplifier. The attenuators are both resistive and capacitive dividers which provide constant attenuation throughout the frequency range of the amplifier. At low frequencies they act primarily as resistive dividers; at the higher frequencies, they act primarily as capacitive dividers.

In addition to providing the proper degree of attenuation, the resistance and capacitance values of the attenuators are chosen (or adjusted) to provide a constant input resistance of one megohm and a constant input capacitance of 47 picofarads, regardless of which attenuator is in the circuit.

### Input Amplifier

The first stage of the Input Amplifier amplifies the potential difference between the two grids of V424. When one grid goes positive and the other goes negative, the output of the stage is proportional to the sum of the amplitudes of the two signals. When both grids go positive or both go negative, the output is proportional to the difference between the amplitudes of the two signals. In single-ended operation, a signal is applied to one grid while the other grid circuit is grounded; therefore, the output is proportional to the amplitude of the signal applied. The output of V424, then, is a push-pull signal to the bases of the transistors, Q454 and Q464, regardless of whether the module is being operated single-endedly or differentially.

The high gain of the Input Amplifier is provided by positive feedback from the collector of each transistor to the base of the other. This feedback is developed across R459 and R460 in parallel with the base resistance of each of the transistors. R460 provides the means of adjusting the amount of positive feedback to set the gain of this stage.

At the same time, the transistors also develop signals across R408 which are applied to the cathodes of V424 as negative feedback to limit the overall gain of the Input Amplifier. The amount of negative feedback is least when R408 is the smallest, hence the effect of R460 on the overall gain of the amplifier is greatest when the VOLTS/DIV. switch is set at 1 mVOLTS.

C426, C436, C456, C457, C458, C466, and C467 are included to maintain constant feedback ratios throughout



the frequency range of the amplifier. This is necessary because of the increased effects of the tube and transistor capacitances at higher frequencies. C457 and C467 provide the means of adjusting the feedback ratios at high frequencies to be equal to those at low frequencies.

C408 is effectively in the circuit when the AC STABILIZED switch is ON and the VOLTS/DIV. switch is in one of its five most sensitive positions (1 mVOLTS through 20 mVOLTS). The purpose of C408 is to ac couple the two sides of the first stage of the Input Amplifier. This prevents small dc drift conditions within V424 from causing excessive trace shift at the higher sensitivity positions. The AC STABILIZED switch also activates indicator lamp B407 when either AC-DC-GND switch is in the DC position. This is to warn the operator that dc coupling does not exist in the five most sensitive positions of the VOLTS/DIV. switch unless the AC STABILIZED switch is returned to the OFF position.

Dc balance of the Input Amplifier is accomplished by means of the COARSE DC BAL. adjustment (an internal adjustment) and the DC BAL. adjustment (a front-panel adjustment). Proper adjustment of these two controls sets the two ends of R408 at the same potential (under no-signal conditions) so that there is no current flowing through it. This prevents the dc level of a no-signal trace from shifting as the VOLTS/DIV. switch is moved from position to position.

In addition to changing the value of R408 and selecting the input attenuators, the VOLTS/DIV. switch also changes the value of C480 to compensate for changes in the effective tube and transistor capacitance as the value of R408 is changed. This maintains equal phase shift through the amplifier at all settings of the VOLTS/DIV. switch.

## Output Amplifier

The gain of the Output Amplifier is adjusted by means of the GAIN ADJ. adjustment, R497, and the VARIABLE control, R498, which vary the amount of degeneration in the cathode circuit. The GAIN ADJ. is a front-panel screw-driver adjustment which sets the overall gain of the amplifier to match the sensitivity of the crt deflection plates to which its output is connected. The VARIABLE control provides the means of reducing the sensitivity of the module by a factor of about 2½ at any position of the VOLTS/DIV. switch. When the VARIABLE control is set fully clockwise (to the CALIBRATED position), R498 is set at zero resistance.

Adjustment of the POSITION control varies the return voltage of each of the cathodes of the Output Amplifier inversely to the other and, at the same time, produces a small dc voltage change of opposite polarity at the corresponding grid. The result is that the cathodes remain essentially constant in voltage while the current through the resistors, and therefore through the tubes, changes. The change in current through each of the Output Amplifier tubes changes the average dc plate voltage of each tube inversely to the other, and the position of the crt beam is shifted correspondingly.

## Trigger Pickoff Circuit

The Trigger Pickoff Cathode Follower, V503, applies a sample of the signal at the plate of V484 through the inter-connecting plug to the sweep triggering circuit, if used. The time-base generator, then, may use this as an internal triggering signal. The output of V503 has a peak-to-peak amplitude of about 4 volts for each division of deflection on the screen.

# Troubleshooting

General maintenance and troubleshooting information is contained in the Type 560-Series Oscilloscope manuals. In the following discussion it is assumed that you have already read that information and have definitely isolated a trouble to the Type 2A63 module by the procedures described there.

### CAUTION

Do not operate the module with V424 removed; it may ruin Q454 and/or Q464.

### No Spot or Trace

If there is no spot or trace on the crt, the trouble is probably a dc imbalance between the two sides of the amplifier. To isolate the imbalance, connect a shorting strap between the collectors of Q454 and Q464. If the spot or trace appears and can be positioned with the POSITION control, the trouble is in the Input Amplifier. If the spot or trace does not appear, the trouble is in the Output Amplifier.

If the trouble is found to be in the Input Amplifier, change V424 and then the two transistors. If the trouble still persists, set the VOLTS/DIV. switch to .2 VOLTS and measure the voltage at the cathodes (pins 3 and 8) of V424. Both cathodes should be at approximately the same voltage and should be between 1 and 2 volts positive with respect to ground. If they are not, the trouble is probably in some component in that side of the amplifier. Check especially the plate load resistor and the divider in the collector circuit of the transistor.

If the trouble is found to be in the Output Amplifier, replace V484 and V494. If the trouble still persists, check the rest of the circuit by voltage and resistance measurements.

### Insufficient Deflection

If the proper deflection cannot be obtained through adjustment of the GAIN ADJ. control (see Operating Instruc-

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tions), check the supply voltages in the Indicator Unit. If they are all correct, check the deflection at all positions of the VOLTS/DIV. switch and with the signal applied to first one INPUT connector and then to the other. If the deflection is incorrect at only one or a few positions of the VOLTS/DIV. switch, or only when the signal is applied to one of the INPUT connectors but not to the other, comparing the conditions under which the trouble occurs with the schematic diagram will give an indication as to where the trouble lies. Then it can be isolated by voltage and resistance checks.

If the deflection is incorrect at all positions of the VOLTS/DIV. switch and with the signal applied to either INPUT connector, replace V424, V484, V494, Q454, and Q464, in that order. If this does not eliminate the trouble, check those components which can affect the gain of the amplifier but not the dc balance, such as R450, R451, R452, R453, R459, R460, C453, and the common cathode resistors.

## DC Reference Level Shift

If, when the AC STABILIZED switch is OFF and the VOLTS/DIV. switch is at 1 mVOLTS, the position of a no-signal trace shifts by more than 1 major graticule division as either AC-DC-GND switch is moved from GND to DC, V424 is probably gassy and should be replaced. (The trace will shift less at the other positions of the VOLTS/DIV. switch; at positions above 50 mVOLTS, the shift should be less than one-half minor division.)

If this condition occurs and cannot be immediately corrected, or if the amount of shift cannot be tolerated due to accuracy requirements, satisfactory measurement of dc levels can be accomplished by establishing the zero reference line with the appropriate AC-DC-GND switch set at DC and the signal probe connected to signal ground (see Operating Instructions, "Voltage Measurements"). In this case, you should establish the zero reference line each time you move the VOLTS/DIV. switch.

# Calibration

Calibration of the Type 2A63 is performed with the module inserted in the left-hand opening of a Type 560-series oscilloscope. For calibration of the coarse dc balance, one-millivolt gain, and internal dc triggering level, you may have either an amplifier module or a time-base module in the other opening. For calibration of the input capacitance and the attenuator frequency compensation, you should have a time-base module in the X-axis opening.\* Two methods for phase-shift compensation are given; one with another Type 2A63 module in the X-axis opening, one with a Type 2A60 or Type 3A75 module in the X-axis opening.

In order to maintain the high degree of accuracy of the instrument, we recommend that it be fully calibrated after each 500 hours of operation. The one-millivolt gain should be checked from time to time between calibration periods. The phase-shift compensation is necessary only where two amplifier modules are being used together to make X-Y phase comparisons between two sine waves. Each of the calibration adjustments should be checked as necessary whenever a component has been changed.

Because of interaction among some of the adjustments, it is recommended that you perform the calibration procedures in the order presented. To obtain access to the adjustments referred to in the procedures, the left-hand side panel of the oscilloscope must be removed. The locations of the internal adjustments are shown in Fig. 6.

## Equipment Required

The following special equipment is used in a complete calibration of the Type 2A63 module:

1. Dc voltmeter.
2. Square-wave generator, capable of producing a 50-volt (peak-to-peak), 1-kc square wave with a risetime of

\* In the Type 565 Oscilloscope there is no X-axis opening; the time-base circuitry is part of the Indicator Unit itself.

1 microsecond or less. (You may use the oscilloscope Calibrator output if a square-wave generator is not available; it has a risetime of about 2 microseconds, which will allow accurate enough calibration for most normal use of the module.)

3. 47-picofarad capacitance standardizer (Tektronix Type CS 47 recommended), and an attenuator probe with adjustable capacitance.

4. Signal generator, capable of producing a 10-millivolt (peak-to-peak) sine wave at 350 kc. (This generator and the one following are required only for phase-shift compensation of two Type 2A63 modules.)

5. Signal generator, capable of producing a 100-kc sine wave of at least one volt amplitude (peak-to-peak) into a 93-ohm load. (You may wish to select a different frequency for this generator; see the introductory remarks under "Phase-Shift Compensation.")

6. 100X zero-phase-shift attenuator (see the note regarding this attenuation following step 11 of the first method of phase-shift compensation).

7. Adjustable phase-shifting network. (This will be required only if you are going to phase-shift compensate a Type 2A63 module against a Type 2A60 or Type 3A75 module.)

## Coarse DC Balance

The COARSE DC BAL. of the Type 2A63 module should be adjusted any time you are not able to obtain dc balance with the front-panel DC BAL. The proper method of setting the front-panel DC BAL. control is described in the Operating Instructions. To properly set the COARSE DC BAL. adjustment, proceed as follows:

1. Set both AC-DC-GND switches to GND, the VOLTS/DIV. switch to 1 mVOLTS, and the AC STABILIZED switch to ON.

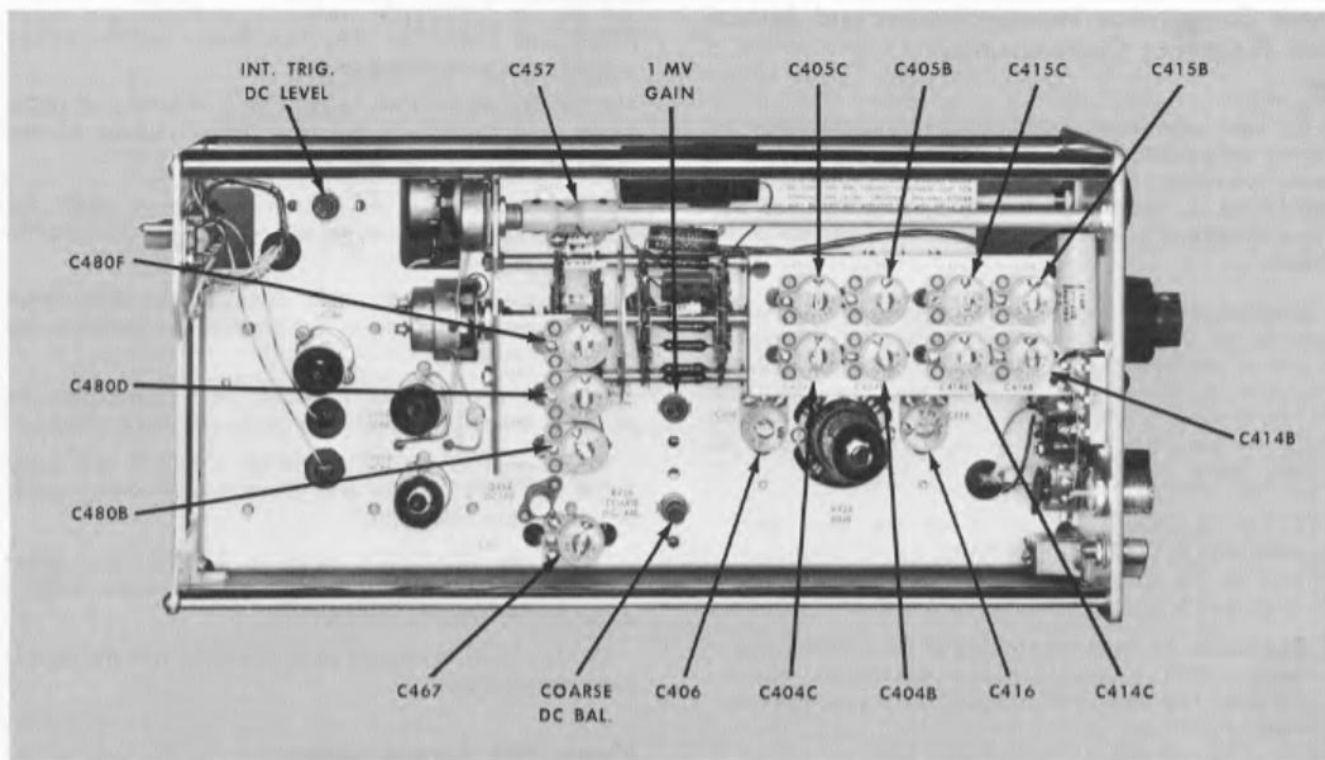


Fig. 6. Type 2A63 module internal calibration adjustments.

2. Set the front-panel DC BAL. control to midrange (approximately five turns from either extreme.)

3. Position a free-running trace (or spot) to the horizontal centerline of the graticule with the POSITION control.

4. Set the AC STABILIZED switch to OFF. The trace or spot will probably move, possibly clear off the screen.

5. Adjust the COARSE DC BAL. adjustment to bring the trace or spot back to the horizontal centerline of the graticule.

Subsequent adjustments of dc balance can now be accomplished with the front-panel DC BAL. control.

### Internal Trigger DC Level Adjustment

The INT. TRIG. DC LEVEL adjustment sets the output dc level of the Trigger Pickoff circuit. To properly set this adjustment, proceed as follows:

1. Set both AC-DC-GND switches to GND.
2. With the POSITION control, position the spot or trace to the horizontal centerline of the graticule.
3. With the dc voltmeter, measure the voltage at pin 11 of the plug-in connector to which the module is connected and adjust the INT. TRIG. DC LEVEL adjustment for a reading of zero volts.

### 1 mV GAIN Adjustment

The 1 mV GAIN adjustment sets the gain of the amplifier at the higher sensitivity settings of the VOLTS/DIV. switch. To properly set the 1 mV GAIN adjustment, proceed as follows:

1. Set the +INPUT AC-DC-GND switch to DC, the -INPUT AC-DC-GND switch to GND, and the AC STABILIZED switch to OFF. Make sure the VARIABLE control is set fully clockwise (to the CALIBRATED position).
2. Set the VOLTS/DIV. switch to .2 VOLTS and apply a 1-volt Calibrator signal to the +INPUT connector.
3. Set the front-panel GAIN ADJ. for a deflection of exactly five major graticule divisions.
4. Set the VOLTS/DIV. switch to 2 mVOLTS and apply a 10-millivolt Calibrator signal to the +INPUT connector. (If you are using a Type 561 Oscilloscope, you may set the VOLTS/DIV. switch to 1 mVOLTS and apply a 5-millivolt Calibrator signal.)
5. Set the 1 mV GAIN adjustment for a deflection of exactly five major graticule divisions.
6. It may be necessary to repeat steps 2 through 5 due to interaction between the GAIN ADJ. and the 1 mV GAIN adjustments.

The dc balance will probably need readjustment following adjustment of the 1 mV GAIN adjustment (see Operating Instructions).

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### Input Capacitance Standardization and Attenuator Frequency Compensation

The input capacitance standardization and attenuator frequency compensation interact so both are performed in the same procedure. The need for either or both of these calibrations is normally indicated by distortion of fast-rising waveforms on one or more sensitivity ranges of the module.

Standardization of the input capacitance of the module requires the use of 47-picofarad capacitance standardizer. If you do not have such a standardizer, you can make an attenuator probe into one by performing these five steps (if you do have a 47-picofarad standardizer, you may skip these five steps and go immediately to the procedure following them):

1. Set the VOLTS/DIV. switch on the Type 2A63 module to .2 VOLTS, the VARIABLE control fully clockwise (to the CALIBRATED position), and the AC-DC-GND switch to DC. Turn the instrument on.
2. Measure the input capacitance at the +INPUT connector. With a low-capacitance screwdriver, adjust C416 for a reading of 47 picofarads on the capacitance meter.
3. Disconnect the capacitance meter and connect the attenuator probe to the +INPUT connector.
4. Touch the probe tip to the output of the square-wave generator or the oscilloscope Calibrator, and adjust the oscilloscope controls to display several cycles of the square-wave signal.
5. Adjust the variable capacitor in the body of the probe to obtain the best square-wave response.

Your probe is now standardized to perform as a 47-picofarad capacitance standardizer. You may use it as such in the following procedure to set the input capacitances of any Type 2A63 module to 47 picofarads. (Do not adjust the probe further during the procedure.)

To set the input capacitances of a Type 2A63 module to 47 picofarads and to frequency compensate the input attenuators, proceed as follows:

1. Set the +INPUT AC-DC-GND switch to DC, the VOLTS/DIV. switch to .2 VOLTS, and the VARIABLE control fully clockwise (to the CALIBRATED position).
2. Apply the output of the square-wave generator (or the oscilloscope Calibrator) through the 47-picofarad capacitance standardizer (or the standardized probe) to the +INPUT connector.
3. Set the time-base controls so that several cycles of the square wave are displayed on the screen. (In this step and throughout the rest of the procedure adjust the amplitude of the square wave and the VARIABLE control on the Type 2A63 module as necessary to maintain about 6 divisions of deflection on the screen, if possible.)
4. Adjust C416 for the most nearly square leading corner on the positive half-cycle of the displayed waveform.

5. Set the VOLTS/DIV. switch to .5 VOLTS and adjust C415B and C415C for the most nearly square leading corner on the positive half-cycle.

6. Set the VOLTS/DIV. switch to 5 VOLTS and adjust C414B and C414C for the most nearly square leading corner on the positive half-cycle.

7. Set the +INPUT AC-DC-GND switch to GND, the -INPUT AC-DC-GND switch to DC, and the VOLTS/DIV. switch to .2 VOLTS.

8. Apply the square wave through the 47-picofarad capacitance standardizer (or the standardized probe) to the -INPUT connector.

9. Adjust the C406 for the most nearly square leading corner on the negative half-cycle of the displayed waveform.

10. Set the VOLTS/DIV. switch to .5 VOLTS and adjust C405B and C405C for the most nearly square leading corner on the negative half-cycle.

11. Set the VOLTS/DIV. switch to 5 VOLTS and adjust C404B and C404C for the most nearly square leading corner on the negative half-cycle.

12. Disconnect the square-wave generator and the capacitance standardizer.

### Phase-Shift Compensation

#### NOTE

If you do not intend to use your Type 2A63 module for X-Y phase comparisons, you should set all of the phase-shift compensation adjustments (C457, C467, C480B, C480D, and C480F) to the center of their ranges and disregard this procedure.

The purpose of phase-shift compensation is to allow you to make accurate phase comparisons by the X-Y mode of operation—that is, with amplifier modules in both openings of a Type 560-Series oscilloscope.\* The adjustments compensate for differences in the amount of phase shift a sine wave will undergo at the various sensitivity ranges as it passes through a Type 2A63 module.

X-Y phase comparisons can be made using either two Type 2A63 modules or one Type 2A63 module and one Type 2A60 or Type 3A75 module. The method of compensation differs with the modules used. Therefore, two methods are presented here. You should use the first method if you are planning to use two Type 2A63 modules; you should use the second if you are planning to use a Type 2A63 and a Type 2A60 or Type 3A75.

The frequency of the signal used in steps 8 through 20 of the first method (100 kc) has been selected to provide 1° or less of phase difference between the two modules at all frequencies up to 50 kc and at all sensitivity ranges. However, any frequency between about 30 kc and 500 kc may be used, if desired, to give more exact compensation at a specific frequency, with some sacrifice in compensation at other frequencies. (See item 5 under "Equipment Required".) The second method provides compensation at only a specific selected frequency.

\* Type 565 cannot be used in this application.

The Type 2A63 module, or modules, must be properly calibrated in accordance with the foregoing procedures before either method of phase-shift compensation is undertaken. Likewise, the Type 2A60 or Type 3A75 module must be properly calibrated according to the procedures in its instruction manual.

**First Method (for two Type 2A63 modules).** To mutually phase-shift compensate two type 2A63 modules, proceed as follows:

1. Insert one of the modules in the left-hand opening of the oscilloscope. Set its +INPUT AC-DC-GND switch to AC and its -INPUT AC-DC-GND switch to GND. (You do not need a module in the right-hand opening at this point.)

2. Set the GAIN ADJ. adjustments according to the procedure given in the Operating Instructions.

3. Set the VOLTS/DIV. switch to 1 mVOLTS and apply a 350-kc sine wave of about 10 millivolts amplitude (peak-to-peak) to the +INPUT connector. (It is important that you know the amplitude of this signal very accurately; the frequency is also rather critical. Use auxiliary measuring equipment if necessary.)

4. Set C467 so that the length of the displayed vertical line on the screen is 0.707 times the amplitude of the applied signal divided by 1 millivolt per division. (For a 10-millivolt signal the line should be 7.1 major graticule divisions long.)

5. Disconnect the 350-kc signal, move this module to the right-hand oscilloscope opening, and insert the other Type 2A63 module in the left-hand opening.

6. Set both GAIN ADJ. adjustments according to the procedure given in the Operating Instructions.

7. Set both VOLTS/DIV. switches to 1 mVOLTS, both +INPUT AC-DC-GND switches to AC, both -INPUT AC-DC-GND switches to GND, and both AC STABILIZED switches to ON.

8. Apply a 100-kc sine wave to the +INPUT connectors of both modules. (This signal is used throughout the remainder of this procedure; see the discussion regarding its frequency in the introduction to the procedure.)

9. Adjust the output amplitude of the signal generator to produce about 8 divisions of deflection vertically and horizontally.

10. Adjust C467 of the left-hand module to close the ellipse on the screen.

11. Attenuate the signal at the +INPUT connector of the right-hand module by a factor of 100.

#### NOTE

The attenuator, or attenuators, called for in this step must not introduce any phase shift or delay into the signal at the INPUT connector. We recommend that you use one 93-ohm 10-to-1 "T" attenuator (Tek part no. 011-015) and one 93-ohm 10-to-1 "L" attenuator (Tek part no. 011-013) connected as shown in Fig 7. It should be noted that these attenuators will terminate the output of the signal generator in 93 ohms, which will probably be beyond its specified output loading. Check to see if the generator will put out adequate signal (approximately 1 volt peak-to-peak) under these conditions.

12. Set the VOLTS/DIV. switch on the left-hand module to 50 mVOLTS, and adjust the signal amplitude to produce

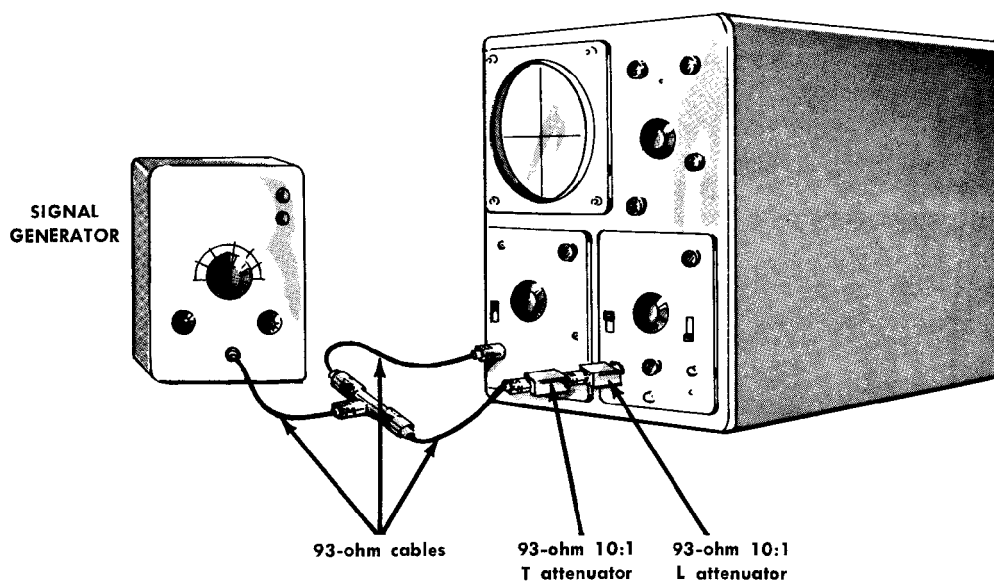


Fig. 7. Output of 100-kc signal generator connected to two Type 2A63 modules for phase-shift compensation (50 mVOLTS, .1 VOLTS, and .2 VOLTS ranges).

## Type 2A63

approximately 8 divisions of vertical deflection. Adjust C480F to close the ellipse on the screen.

13. Set the VOLTS/DIV. switch on the left-hand module to .1 VOLTS, and increase the signal amplitude to produce approximately 8 divisions of vertical deflection. Adjust C480D to close the ellipse on the screen.

14. Set the VOLTS/DIV. switch on the left-hand module to .2 VOLTS, and increase the signal amplitude to produce approximately 10 divisions of horizontal deflection. Adjust C480B to close the ellipse on the screen.

15. On the left-hand module, set the +INPUT AC-DC-GND switch to GND and the -INPUT AC-DC-GND switch to AC.

16. On the left-hand module, disconnect the signal from the +INPUT connector and apply it to the -INPUT connector. Adjust C457 to close the ellipse on the screen. Remove the signal leads and attenuators.

17. Interchange the positions of the two modules, and reset the GAIN ADJ. adjustments.

18. Set both +INPUT AC-DC-GND switches to AC and both -INPUT AC-DC-GND switches to GND. Set the VOLTS/DIV. switch on the right-hand module to 1 mVOLTS.

19. Apply the 100-kc signal directly to the +INPUT connector of the left-hand module, and through the 100X attenuation to the +INPUT connector of the right-hand module.

20. Repeat steps 12 through 16. (This time you will be adjusting the other module.)

**Second Method (for a Type 2A63 and a Type 2A60 or Type 3A75 module).** To phase-shift compensate a Type 2A60 module against a Type 2A60 or Type 3A75 module, proceed as follows:

1. Perform steps 1 through 4 of the First Method (preceding).

2. Disconnect the 350-kc signal and insert the Type 2A60 or Type 3A75 module in the right-hand oscilloscope opening. Connect the adjustable phase-shifting network to the INPUT connector of the module in the right-hand opening.

3. On the Type 2A60 module, set the AC STABILIZED switch to ON, the +AC-DC-GND switch to AC, and the -AC-DC-GND switch to GND. On the other module, set the AC-DC-GND switch to AC.

4. Apply a sine wave of the frequency to be measured to the +INPUT connector of the Type 2A63 module and through the phase-shifting network to the INPUT connector of the other module.

5. Set the VOLTS/DIV. switches of the two modules to the lowest settings (farthest clockwise) you expect to use during the measurements.

6. Adjust the phase-shifting network to close the ellipse on the screen.

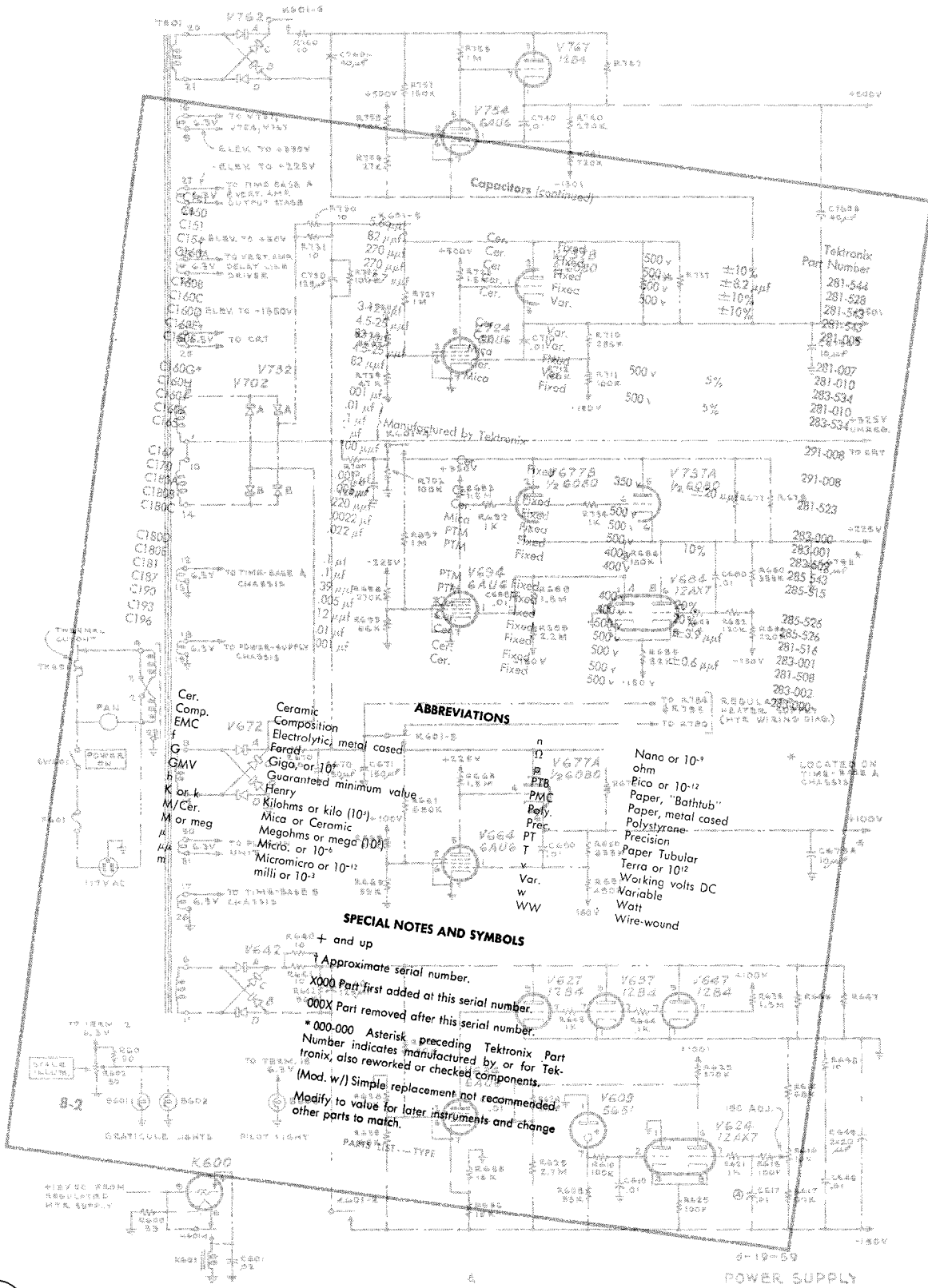
7. Set the Type 2A63 VOLTS/DIV. switch to the other settings you expect to use and adjust C480B, C480D, and C480F (in the Type 2A63 module) as appropriate to close the ellipse at each setting. (At the 50 mVOLTS, .5 VOLTS, or 5 VOLTS position, adjust C480F; at the .1, 1, or 10 VOLTS position, adjust C480D; at the .2, 2, or 20 VOLTS position, adjust C480B.)

TABLE 1

## NATURAL SINE FUNCTIONS

ANGLE (in degrees)	SIN	ANGLE (in degrees)	SIN	ANGLE (in degrees)	SIN
0	.0000	30	.5000	60	.8660
1	.0175	31	.5150	61	.8746
2	.0349	32	.5299	62	.8829
3	.0523	33	.5446	63	.8910
4	.0698	34	.5592	64	.8988
5	.0872	35	.5736	65	.9063
6	.1045	36	.5878	66	.9135
7	.1219	37	.6018	67	.9205
8	.1392	38	.6157	68	.9272
9	.1564	39	.6293	69	.9336
10	.1736	40	.6428	70	.9397
11	.1908	41	.6561	71	.9455
12	.2079	42	.6691	72	.9511
13	.2250	43	.6820	73	.9563
14	.2419	44	.6947	74	.9613
15	.2588	45	.7071	75	.9659
16	.2756	46	.7193	76	.9703
17	.2924	47	.7314	77	.9744
18	.3090	48	.7431	78	.9781
19	.3256	49	.7547	79	.9816
20	.3420	50	.7660	80	.9848
21	.3584	51	.7771	81	.9877
22	.3746	52	.7880	82	.9903
23	.3907	53	.7986	83	.9925
24	.4067	54	.8090	84	.9945
25	.4226	55	.8192	85	.9962
26	.4384	56	.8290	86	.9976
27	.4540	57	.8387	87	.9986
28	.4695	58	.8480	88	.9994
29	.4848	59	.8572	89	.9998
				90	1.0000

# PARTS LIST *and* DIAGRAMS



MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES



## **HOW TO ORDER PARTS**

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

# PARTS LIST

## Type 2A63

Values fixed unless marked Variable.

### Bulbs

			Tektronix Part Number
B407	NE-2		150-002

### Capacitors

Tolerance  $\pm 20\%$  unless otherwise indicated.

C400		0.1 $\mu f$	PTM		600 v		285-587
C404B		7-45 pf	Cer.	Var.			281-012
C404C		1.5-7 pf	Cer.	Var.			281-005
C404E		198 pf	Cer.		500 v		281-560
C405B		7-45 pf	Cer.	Var.			281-012
C405C		1.5-7 pf	Cer.	Var.			281-005
C406		4.5-25 pf	Cer.	Var.			281-010
C408		250 $\mu f$	EMT		6 v		290-111
C410		0.1 $\mu f$	PTM		600 v		285-587
C414B		7-45 pf	Cer.	Var.			281-012
C414C		1.5-7 pf	Cer.	Var.			281-005
C414E		198 pf	Cer.		500 v		281-560
C415B		7-45 pf	Cer.	Var.			281-012
C415C		1.5-7 pf	Cer.	Var.			281-005
C416		4.5-25 pf	Cer.	Var.			281-010
C420		.001 $\mu f$	Discap		500 v		283-000
C426		.1 $\mu f$	Discap		100 v		283-012
C430		.001 $\mu f$	Discap		500 v		283-000
C436		0.1 $\mu f$	Discap		100 v		283-012
C453		0.1 $\mu f$	Discap		100 v		283-012
C456		2.2 pf	Cer.		500 v	$\pm 0.25$ pf	Use 281-604
C457		7-45 pf	Cer.	Var.			281-012
C458		47 pf	Cer.		500 v	10%	use 281-519
C459		24 pf			500 v	5%	281-564
C466		2.2 pf	Cer.		500 v	$\pm 0.25$ pf	Use 281-604
C467		7-45 pf	Cer.	Var.			281-012
C468	X360-up	12 pf	Cer.		500 v	10%	281-505
C480A		270 pf	Discap		500 v	5%	283-047
C480B		7-45 pf	Cer.	Var.			281-012
C480C		120 pf	Cer.		500 v	10%	281-550
C480D		7-45 pf	Cer.	Var.			281-012
C480E		47 pf	Cer.		500 v	10%	281-519
C480F		7-45 pf	Cer.	Var.			281-012
C480G		39 pf	Cer.			1%	281-575
C480H	X1880-up	10 pf	Selected Nominal Value				281-504
C480J		22 pf	Cer.		500 v	10%	281-511
C480L		12 pf	Cer.		500 v	10%	281-506
C480N		3.3 pf	Cer.		500 v	$\pm 0.25$ pf	281-534
C480P		10 pf	Selected Nominal Value				281-504
C487		1.5 pf	Cer.		500 v	$\pm 0.25$ pf	281-529

### Inductors

				Tektronix Part Number
L400 } L401 } L410 } L411 }	X1300-up	Ferramic suppressor		276-507
L480		100 $\mu$ h		108-226
L483		2.5 mh		*108-213
L490		100 $\mu$ h		108-226
L493		2.5 mh		*108-213

### Resistors

Resistors are fixed, composition,  $\pm 10\%$  unless otherwise indicated.

R404C		990 k	$\frac{1}{2}$ w	Prec.	1%		309-145
R404E		10.1 k	$\frac{1}{2}$ w	Prec.	1%		309-135
R405C		900 k	$\frac{1}{2}$ w	Prec.	1%		309-142
R405E		111 k	$\frac{1}{2}$ w	Prec.	1%		309-138
R406		1 meg	$\frac{1}{2}$ w	Prec.	1%		309-148
R407		100 k	$\frac{1}{4}$ w			Use	316-104
R408A		10 k	$\frac{1}{2}$ w	Prec.	1%		309-100
R408C		3.33 k	$\frac{1}{2}$ w	Prec.	1%		309-283
R408E		1.11 k	$\frac{1}{2}$ w	Prec.	1%		309-284
R408G		526 $\Omega$	$\frac{1}{2}$ w	Prec.	1%		309-285
R408H		256 $\Omega$	$\frac{1}{2}$ w	Prec.	1%		309-286
R408L		101 $\Omega$	$\frac{1}{2}$ w	Prec.	1%		309-287
R408N		50.9 $\Omega$	$\frac{1}{2}$ w	Prec.	1%		309-216
R409		21.5 k	$\frac{1}{2}$ w	Prec.	1%		309-290
R410	X1300-up	100 k	$\frac{1}{4}$ w				316-104
R414C		990 k	$\frac{1}{2}$ w	Prec.	1%		309-145
R414E		10.1 k	$\frac{1}{2}$ w	Prec.	1%		309-135
R415C		900 k	$\frac{1}{2}$ w	Prec.	1%		309-142
R415E		111 k	$\frac{1}{2}$ w	Prec.	1%		309-138
R416		1 meg	$\frac{1}{2}$ w	Prec.	1%		309-148
R420		100 k	$\frac{1}{2}$ w				302-104
R421	101-1299	470 $\Omega$	$\frac{1}{2}$ w				302-471
R421	1300-up	47 $\Omega$	$\frac{1}{2}$ w				302-470
R424		75 k	$\frac{1}{2}$ w	Prec.	1%		309-323
R426		250 $\Omega$	$\frac{1}{2}$ w	Var.		Coarse DC Bal.	Use 311-367
R427		100 $\Omega$	$\frac{1}{2}$ w				302-101
R428		38.3 k	1 w	Prec.	1%		310-074
R430		100 k	$\frac{1}{2}$ w				302-104
R431	101-1299	470 $\Omega$	$\frac{1}{2}$ w				302-471
R431	1300-up	47 $\Omega$	$\frac{1}{2}$ w				302-470
R434		75 k	$\frac{1}{2}$ w	Prec.	1%		309-323
R436		200 $\Omega$		Var.		DC BAL.	311-240
R437		100 $\Omega$	$\frac{1}{2}$ w				302-101
R438		38.3 k	1 w	Prec.	1%		310-074
R450		2.2 k	$\frac{1}{2}$ w				302-222
R451		15 k	5 w	WW	5%		308-108
R452		10 k	1 w				303-103
R453	101-359	10 k	$\frac{1}{2}$ w				301-103
R453	360-up	6.8 k	$\frac{1}{2}$ w				301-682
R454	X360-up	3.3 k	$\frac{1}{2}$ w				301-332
R456		390 k	$\frac{1}{4}$ w				316-394
R457		12.5 k	$\frac{1}{2}$ w	Prec.	1%		309-228
R458		820 k	$\frac{1}{2}$ w				302-824
R460		20 k	$\frac{1}{2}$ w	Var.		1 mv Gain	Use 311-364
R466		390 k	$\frac{1}{4}$ w				316-394
R467		12.5 k	$\frac{1}{2}$ w	Prec.	1%		309-228

### Resistors (continued)

							Tektronix Part Number
R468		820 k	1/2 w				302-824
R479		2 x 10 k	2 w	Var.		POSITION	311-228
R480		1 k	1/2 w				302-102
R481		100 Ω	1/2 w				302-101
R483		20 k	8 w		WW	5%	308-081
R485		10 k	5 w		WW	5%	308-054
R486		8 k	5 w		WW	5%	308-053
R487		470 k	1/2 w			5%	301-474
R488		200 k	1/2 w			5%	301-204
R489	101-1625 1626-up	100 k 100 k	1/2 w	Var. Var.		Int. Trig. DC Level Int. Trig. DC Level	311-207 311-369
R490		1 k	1/2 w				302-102
R491		100 Ω	1/2 w				302-101
R493		20 k	8 w		WW	5%	308-081
R495		10 k	5 w		WW	5%	308-054
R496		8 k	5 w		WW	5%	308-053
R497		2 k		Var.		GAIN ADJ.	311-221
R498		2 k		Var.		VARIABLE	311-189
R501		100 Ω	1/2 w				302-101
R505		47 k	1/2 w				302-473
R510		16 Ω	5 w		WW	5%	308-166

### Switches

				Wired	Unwired
SW400	101-1319	Slide	AC-DC-GND		260-251
SW400	1320-up	Slide	AC-DC-GND		260-450
SW404		Rotary	VOLTS/DIV.	*262-374	*260-351
SW408	101-1319	Slide	AC STABILIZED		260-212
SW408	1320-up	Slide	AC STABILIZED		260-447
SW410	101-1319	Slide	AC-DC-GND		260-251
	1320-up	Slide	AC-DC-GND		260-450

### Transistors

Q454	101-409			Use	050-057
Q454	410-up	2N1749			151-081
Q464	101-409			Use	050-057
Q464	410-up	2N1749			151-081

### Electron Tubes

V424		6DJ8 Checked		Use	*157-066
V484		6CB6			154-030
V494		6CB6			154-030
V503		6CB6			154-030

### Diodes

D454	X360-up	T12G			152-008
D464	X360-up	T12G			152-008

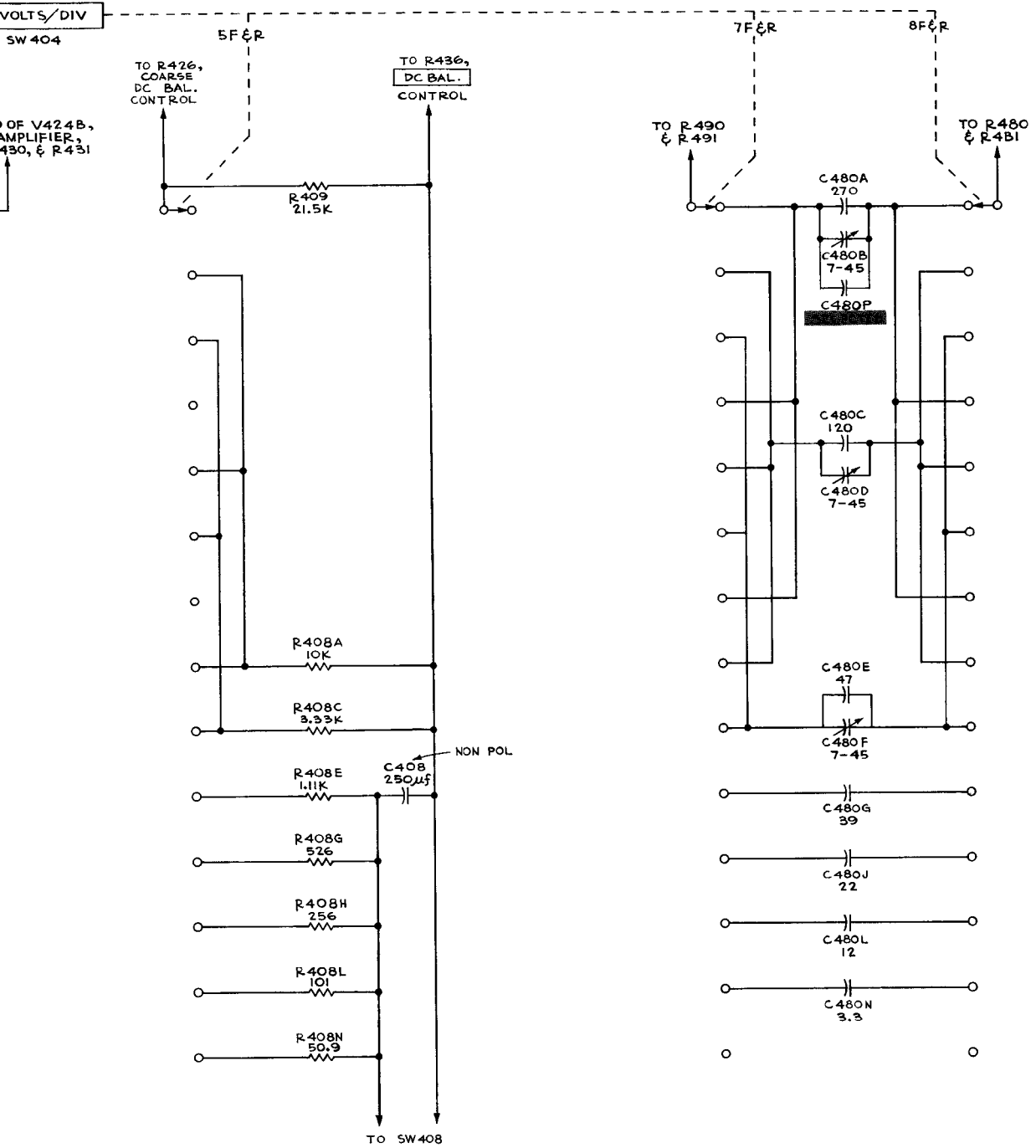
## Type 2A63 Mechanical Parts List

	Tektronix Part Number
BRACKET, ATTEN. MTG.	406-611
BUSHING, $\frac{3}{8}$ -32 x $\frac{7}{16}$ x .412	358-010
BUSHING, HEX $\frac{3}{8}$ -32 x $\frac{13}{32}$ x .252 (PLATED)	358-029
CABLE HARNESS, AMPLIFIER #1	179-459
CABLE HARNESS, AMPLIFIER #2	179-462
CAP, POT. 1" DIA. x .390 HI	200-247
CHASSIS	441-335
CLAMP, CABLE $\frac{3}{16}$ PLASTIC	343-002
CLAMP, CABLE $\frac{3}{4}$ PLASTIC	343-008
CONNECTOR, CHAS. MT. 1 CONT. FEMALE	131-081
CONNECTOR, CHAS. MT. 24 CONT. MALE	131-149
COUPLING, INSULATING MLD. NYLON ASS'Y	376-011
COUPLING, POT. WIRE STEEL	376-014
COVER, DUST POT.	200-263
FASTENER, PAWL RIGHT W/STOP	214-052
FASTENER, SNAP DOUBLE-PRONGED	214-153
GROMMET, RUBBER $\frac{3}{8}$	348-004
GROMMET, POLYPROPYLENE SNAP-IN	348-031
GUIDE, DELRIN $\frac{5}{8}$ x $\frac{13}{16}$ W/ $\frac{3}{16}$ TRACK	351-037
HOLDER, NEON BULB SINGLE	352-008
KNOB, SMALL RED $\frac{1}{8}$ HOLE PART WAY	366-038
KNOB, SMALL BLACK $\frac{1}{4}$ HOLE PART WAY (101-1319)	366-044
KNOB, SMALL CHARCOAL $\frac{1}{4}$ HOLE PART WAY (1320-up)	366-113
KNOB, LARGE BLACK $\frac{17}{64}$ HOLE THRU (101-1319)	366-058
KNOB, LARGE CHARCOAL $\frac{17}{64}$ HOLE THRU (1320-up)	366-144
KNOB, PLUG-IN SECURING $\frac{9}{16}$ x $\frac{5}{8}$	366-109
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. $\frac{1}{4}$	210-011
LOCKWASHER, POT INT. $\frac{3}{8}$ x $\frac{1}{2}$	210-012
LOCKWASHER, POT INT. $\frac{3}{8}$ x $\frac{11}{16}$	210-013
LUG, SOLDER, SE4	210-201
LUG, SOLDER, POT PLAIN $\frac{3}{8}$	210-207
LUG, GROUND .025 THICK MILD STEEL $\frac{15}{16}$ LG.	210-241
NUT, HEX 4-40 x $\frac{3}{16}$	210-406
NUT, HEX 6-32 x $\frac{1}{4}$	210-407

**Mechanical Parts List (continued)**

	Tektronix Parts Number
NUT, HEX $\frac{3}{8}$ -32 x $\frac{1}{2}$	210-413
NUT, HEX 5-40 x $\frac{1}{4}$	210-449
NUT, HEX $\frac{1}{4}$ -32 x $\frac{3}{8}$ x $\frac{3}{32}$	210-465
PANEL, FRONT	Use 333-726
PLATE, FRONT	387-579
PLATE, REAR	387-581
POST, BINDING ASS'Y OF 335-507 & 200-103	129-053
ROD, $\frac{1}{4}$ x $5\frac{3}{4}$	384-214
ROD, EXT. SHAFT POT. $\frac{1}{4}$ x $7\frac{1}{2}$	384-133
ROD, EXT. SHAFT $\frac{1}{8}$ x $8\frac{1}{16}$	384-228
ROD, FRAME $\frac{3}{8}$ x $12\frac{1}{4}$ TAPPED 8-32 BOTH ENDS	384-566
SCREW, 4-40 x $\frac{1}{4}$ BHS	211-008
SCREW, 4-40 x $\frac{3}{8}$ RHS	211-013
SCREW, 4-40 x 1 FHS	211-031
SCREW, 4-40 x $\frac{5}{16}$ PAN HS W/LOCKWASHER	211-033
SCREW, 6-32 x $\frac{1}{4}$ BHS	211-504
SCREW, 6-32 x $\frac{1}{2}$ BHS	211-511
SCREW, 6-32 x $\frac{5}{16}$ FHS 100°, CSK, PHILLIPS	211-538
SCREW, 8-32 x $\frac{1}{2}$ FHS 100°, PHILLIPS	212-043
SCREW, 8-32 x $\frac{1}{2}$ RHS	212-044
SCREW, 5-32 x $\frac{3}{16}$ PHS, PHILLIPS, THREAD CUTTING	213-044
SCREW, 2-32 x $\frac{5}{16}$ RHS PHILLIPS	213-113
SHIELD, F & I	337-386
SPACER, NYLON MLD., $\frac{1}{4}$ FOR CERAMIC STRIP	361-008
SOCKET, STM7	136-007
SOCKET, 9 PIN SHLD. BASE W/SHOCK MTG. SPRING AND PHOS. BRZ. PINS	136-087
SOCKET, TINI-JAX NO. 42A	136-095
STRIP, CERAMIC $\frac{7}{16}$ x 11 NOTCHES, CLIP MTG.	124-106
WASHER, STEEL 6L x $\frac{3}{8}$	210-803
WASHER, STEEL .390 x $\frac{9}{16}$	210-840

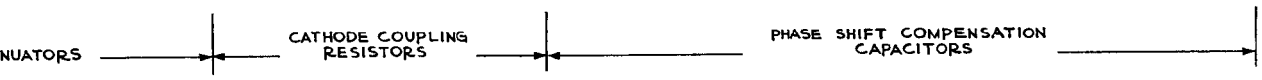




414C  
5-7  
414E  
9B

415C  
5-7

SEE PARTS LIST FOR EARLIER  
VALUES AND S/N CHANGES OF  
PARTS MARKED WITH RED  
TINT BLOCKS

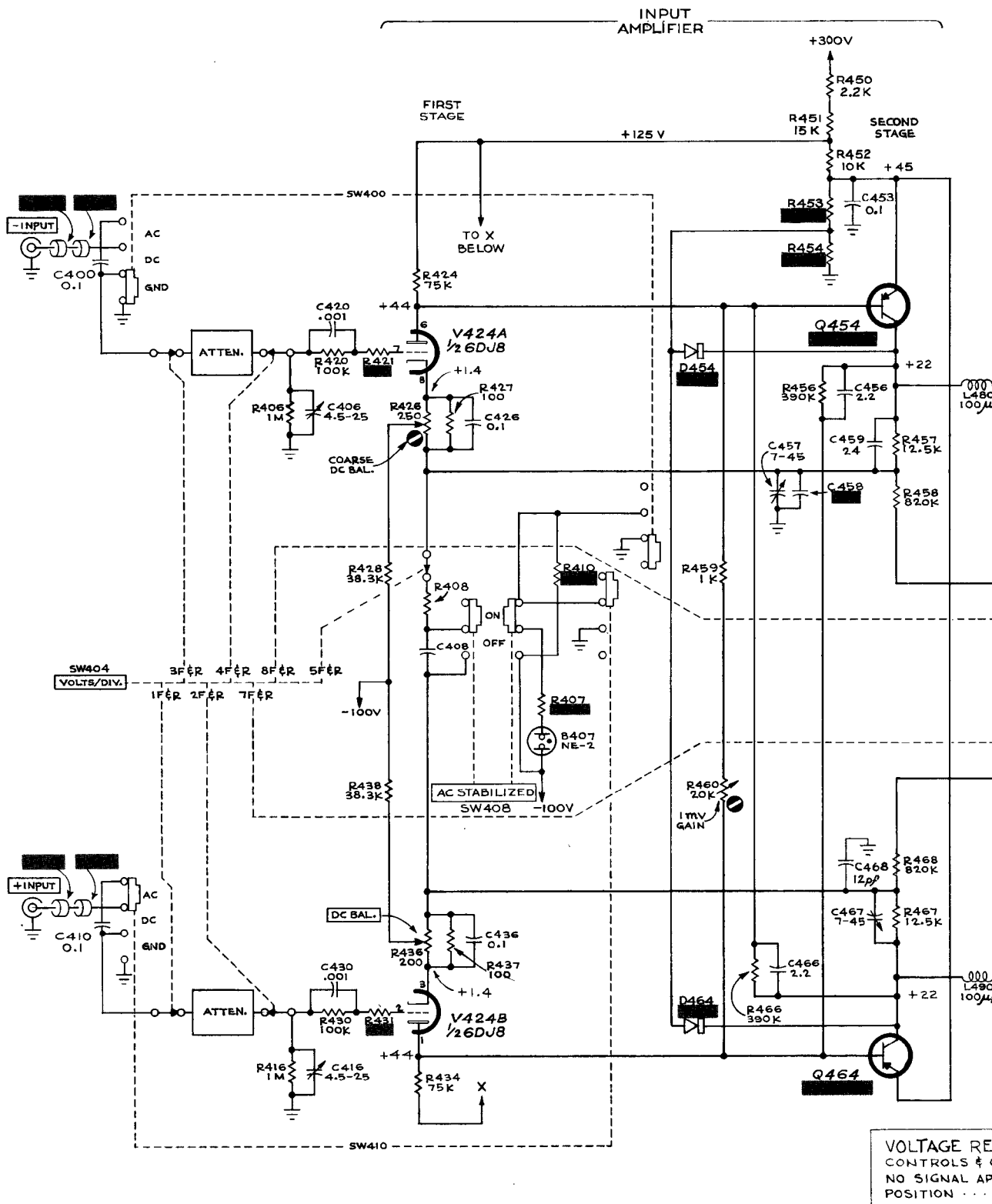


B<sub>1</sub>

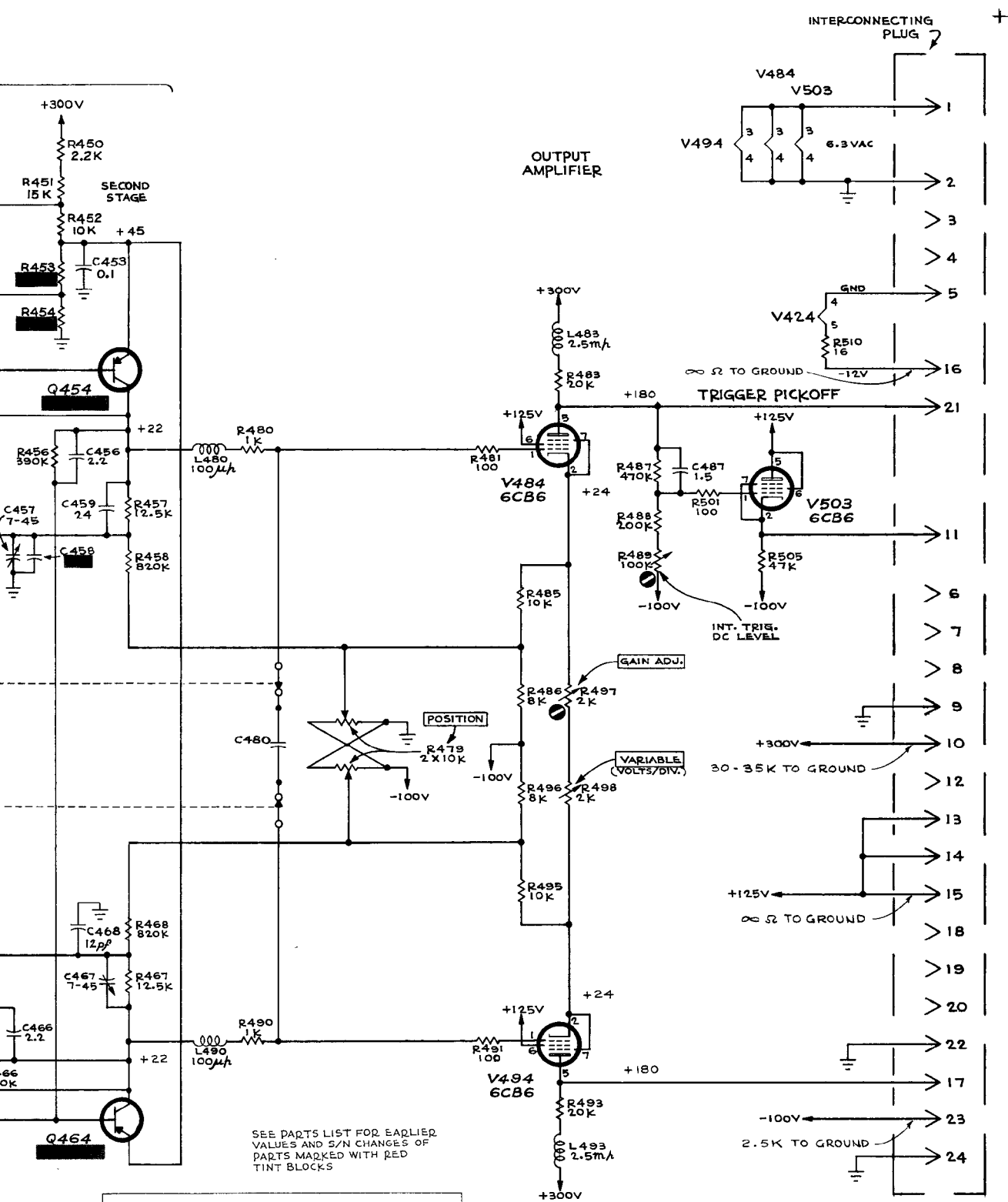
VOLTS/DIV. SWITCH

GAB  
11-3-62





TYPE 2AG3 PLUG-IN



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

VOLTAGE READINGS WERE TAKEN WITH CONTROLS & CONDITIONS AS FOLLOWS. NO SIGNAL APPLIED TO INPUT POSITION . . . . . MIDRANGE

RESISTANCE READINGS TAKEN WITH MODULE REMOVED FROM OSCILLOSCOPE

11-22-62

DIFFERENTIAL AMPLIFIER

F

## **MANUAL CHANGE INFORMATION**

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

MOD 6860

Type 2A60 - Tent S/N 1150

Type 2A63 - Tent S/N 1880

Connectors    Change to    Chassis Mtg.        "D" hole    BNC    131-126