CR1335, and CR1336 provide protection against accidental application of damaging voltage levels to the +A GATE and +B GATE output connectors.

B Sweep Latch

Q822 and Q828 compose the B Sweep Latch. Quiescently, (before either the A or B Sweeps have reached their maximum amplitudes) both transistors are off. Then, the sweep reset pulse from whichever sweep terminates first will be applied to the base of Q828 (A Sweep reset through CR826; B Sweep reset through CR825). The positive-going reset pulse turns on Q828 and the negative-going movement at its collector turns on Q822. The collector of Q822 in turn pulls up on the base of Q828, holding Q828 on, which causes the circuit to stay in its on or latched state. The HI at the collector of Q822 is applied to the base of the B Sweep Holdoff Amplifier (through CR809) to disable the B Trigger Tunnel Diodes. In the B ENDS A position of the A TRIG HOLDOFF control the HI is also applied to the holdoff start input terminal of the Sweep Control IC through C286. Thus, when B Sweep ends A Sweep ends also.

The B Latch Multivibrator is reset to its quiescent state by the LO Holdoff level Present at pin 10 of the Sweep Control IC during A Sweep holdoff.

HORIZONTAL AMPLIFIER

General

The Horizontal Amplifier circuit provides the output signals to the CRT horizontal deflection plates. The signal applied to the input of the Horizontal Amplifier is determined by the TIME/DIV switch. The signal can be a sawtooth waveform generated within the instrument, or some external signal applied to the CH 1 OR X input connector (X-Y mode of operation). The Horizontal Amplifier also contains the X10 magnifier, horizontal positioning, and some beam finder circuitry. Fig. 3-7 shows a detailed block diagram of the Horizontal Amplifier circuit. A schematic of this circuit is shown on diagram 9 at the rear of this manual.

X-Axis Amplifier

In all positions of the TIME/DIV switches except X-Y, the input signal to the base of Q1224 will be the sawtooth waveforms from the sweep generators. In the X-Y mode however, the sweeps are disabled and the signal applied to Q1224 comes from the Channel 1 Preamp via the X-Axis Amplifier stage. This stage includes Q1214, Q1218, and their associated circuitry.

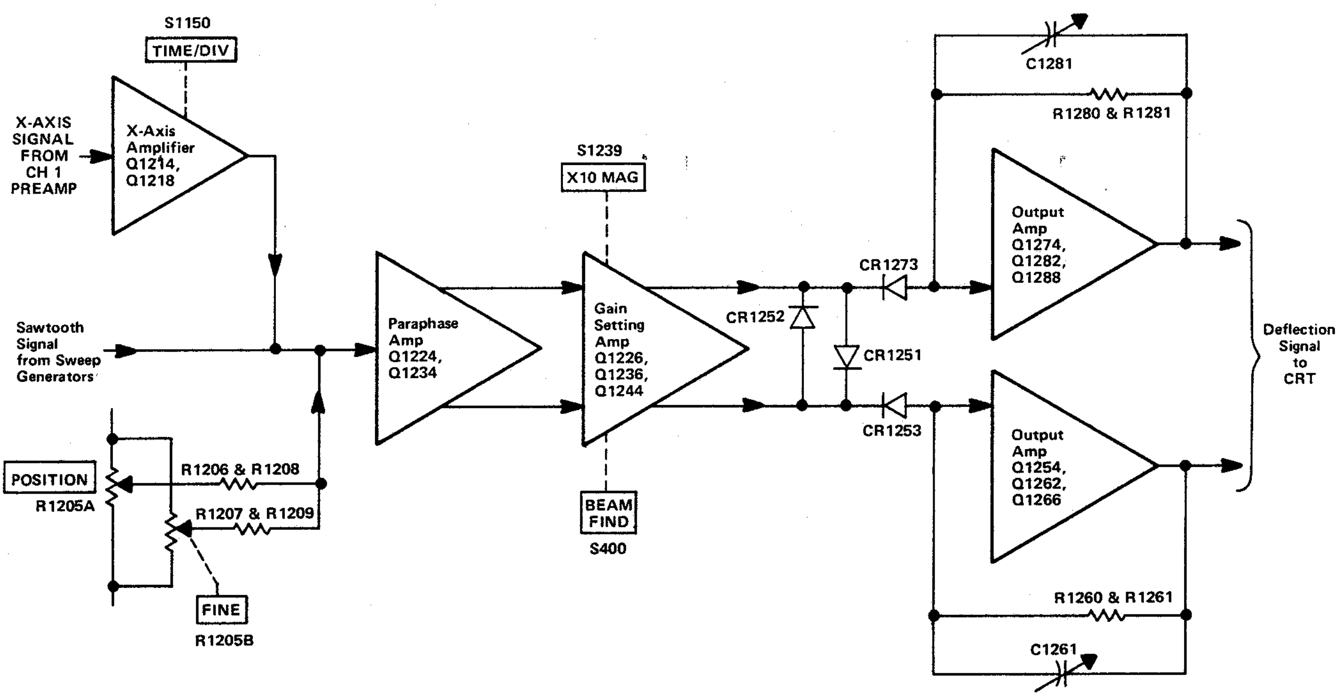

Fig. 3-7. Detailed block diagram of the Horizontal Amplifier.

Q1214 is connected as a feedback amplifier with R1214 as the feedback element. The input resistance is made up of R1211 and the gain-setting adjustment R1215. When not operating in the X-Y mode, the base of Q1214 rises toward the +15 volt supply but is clamped at approximately +5.7 volts by CR1216. This reverse biases the base-emitter junction of Q1214. The base of Q1218 also rises to approximately +5.7 volts. With the junction of R1202-R1219 sitting at approximately 0 volts, Q1218 is also biased off.

When the TIME/DIV switches are set to the X-Y position (fully counterclockwise), −8 volts is applied to the junction of R1212 and R1217. Also, +5 volts is applied to the emitter circuit of Q1218 through CR1202. This biases the Z-Axis Amplifier circuit into conduction. At the same time, +5 volts is applied to the Channel 1 Scale-Factor Switching Amplifier circuit (through CR1201) and to pin 18 of the Sweep Control Integrated Circuit U870. This enables both scale-factor indicating circuits at the same time and disables sweep generation.

Input Paraphase Amplifier

Q1224 and Q1234 compose the Input Paraphase Amplifier. This is an emitter-coupled amplifier stage that converts the single-ended input signal to a push-pull output signal. The signal at the collector of Q1224 is opposite in phase to the input signal. The signal at the collector of Q1234 is in phase with the input signal. Thermistor resistor RT1230 reduces in value with increases in ambient temperature to increase the gain of the stage. This compensates for changes in amplifier gain that occur as operating temperatures vary. R1205A and R1205B are the Horizontal POSITION and FINE controls, respectively. The FINE control has approximately one tenth the range of the POSITION control and provides fine adjustment of a magnified display.

Gain Setting Amplifier

Q1226 and Q1236 are an emitter coupled push-pull amplifier stage. Q1244 is a constant current supply for the stage. The gain of the Horizontal Amplifier is controlled by adjusting the resistance connected between the emitters of this stage. The X1 Gain adjustment R1237 adjusts unmagnified horizontal gain and the X10 Gain adjustment R1238 adjusts magnified horizontal gain. Magnifier Registration adjustment R1225 balances quiescent DC current in Q1226 and Q1236 so that a center screen display does not change position when the X10 Magnifier is turned on.

When the BEAM FIND pushbutton is pressed, R1249 is connected to ground. This reduces the current supplied through Q1244, which has the effect of shifting the operating level at the collector of Q1244 in the positive direction. This causes the Horizontal Amplifier to operate closer to the point where signal limiting occurs, thereby ensuring that an overscanned display will remain within the viewing area of the CRT.

Output Amplifier

The push-pull signal from the Gain Setting Amplifier is connected to the Output Amplifier through CR1253 and CR1273. Each half of the Output Amplifier can be considered as a single-ended feedback amplifier, which amplifies the signal current at the input to produce a voltage output to drive the horizontal deflection plates of the CRT. The amplifiers have a low input impedance and require very little voltage change at the input to produce the desired output change. The Output Amplifiers are limited from overdrive by CR1251, CR1252, CR1253, and CR1273. The input diodes CR1253 and CR1273 become back-biased when the signal level at either input becomes too positive, and the diodes connected back to back between the two signal paths ensure that the signal amplitude side to side will be limited to a maximum of about 0.7 volt.

Transistors Q1254 and Q1274 are inverting amplifier stages whose collector signals drive the emitters of complementary amplifiers Q1262-Q1266 and Q1282-Q1288 respectively. C1256, C1262, and C1282 provide a signal path for fast AC signal currents from one side of the amplifier to the other. R1260-R1261 and R1280-R1281 are the feedback elements in the amplifier with C1261 and C1281 providing high-frequency compensation. The output signal from Q1262-Q1266 drives the right CRT deflection plate, while the signal from Q1282-Q1288 drives the left.

CRT CIRCUIT

General

The CRT Circuit provides the voltage levels and control circuits necessary for operation of the cathode-ray tube (CRT). Fig. 3-8 shows a detailed block diagram of the CRT Circuit. A schematic of this circuit is shown on diagram 10 at the rear of this manual.

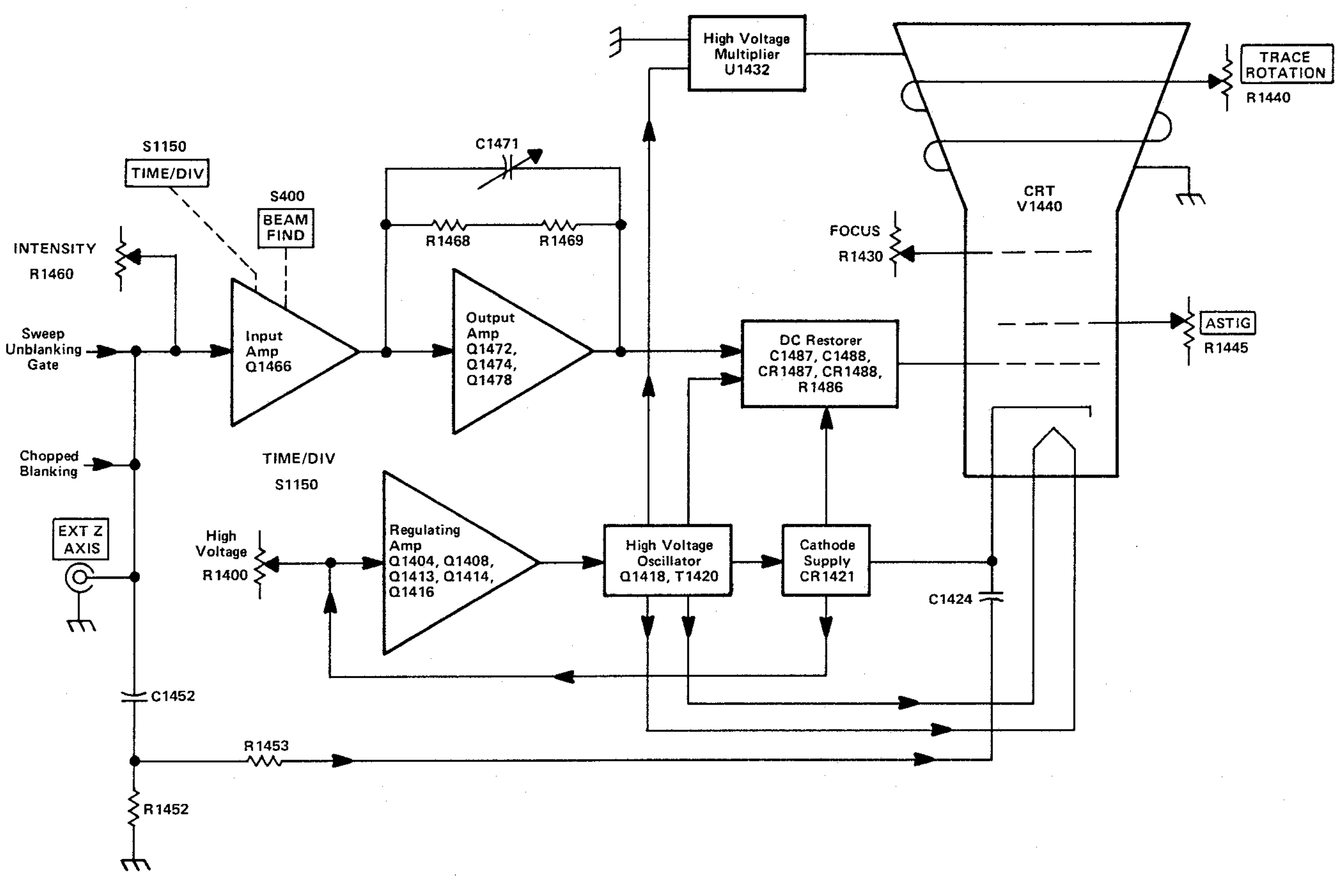

Fig. 3-8. Detailed block diagram of the CRT & Z-AXIS Circuits.

High-Voltage Oscillator

Q1418 and associated circuitry compose the high-voltage oscillator that produces the drive for high-voltage transformer T1420. When the instrument is turned on, current through Q1416 provides forward bias for Q1418. Q1418 conducts and the collector current increases, which develops a voltage across the collector winding of T1420. This produces a corresponding voltage increase in the feedback winding of T1420, which is connected to the base of Q1418, and Q1418 conducts even harder. Eventually the rate of collector current increase in Q1418 becomes less than that required to maintain the voltage across the collector winding, and the output voltage drops. This turns off Q1418 by way of the feedback voltage to the base. The voltage waveform at the collector of Q1418 is a sine wave at the resonant frequency of T1420. Q1418 remains off during the negative half cycle while the field collapses in the primary of T1420. When the field is collapsed sufficiently, the base of Q1418 becomes forward biased into conduction again and the cycle begins anew. The amplitude of sustained oscillation depends upon the average current delivered to the base of Q1418. The frequency of oscillation is approximately 50 kilohertz. Fuse F1419 protects the +15 volt supply in the event the High-Voltage Oscillator stage becomes shorted. C1419 and L1419 decouple the +15 volt supply line and prevent the current changes present in the circuit from affecting the +15 volt regulator.

High-Voltage Regulator

Feedback from the CRT cathode −2450 volt supply is applied to the base of Q1404 through R1431D. Any change in the level at the base of Q1404 produces an error signal at the collector of Q1404, which is amplified by Q1408 and Q1416 and applied to the base of Q1418 through the feedback winding of T1420. Regulation occurs as follows.

If the output voltage at the −2450 volt test point starts to go positive (less negative), this positive-going change is applied to the base of Q1404. Q1404 conducts harder, which in turn causes Q1408 and Q1416 to conduct harder. This results in greater bias current to the base of Q1418 through the feedback winding of T1420. Now, Q1418 is biased closer to its conduction level so that it comes into conduction sooner to produce a larger induced voltage in the secondary of T1420. This increased voltage appears as a more negative voltage at the −2450 volt test point to correct the original positive-going change. By sampling the

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output from the CRT cathode supply in this manner, the total output of the High-Voltage Supply is held relatively constant.

The output voltage levels of the High-Voltage Supply are controlled by the High Voltage Adjustment R1400 in the base circuit of Q1404. This adjustment sets the conduction of Q1404 to a level that establishes a –2450 volt operating potential at the CRT cathode.

Q1413 and Q1414 compose an overvoltage protection circuit. In the event the regulating action of the circuit should cause the CRT cathode supply to approach approximately –3000 volts, the voltage level at the emitter of Q1416 will be very close to –6 volts. Normally Q1413 and Q1414 are biased off and do not conduct. When the voltage level at the emitter of Q1416 reaches approximately –6 volts, Q1413 is biased into conduction which in turn biases Q1414 on. Q1414 now starts to reduce the base drive applied to Q1418 and prevents the amplitude of oscillations from increasing. This prevents the CRT cathode supply from going more negative than approximately –3000 volts.

High-Voltage Rectifiers and Output

The high-voltage transformer T1420 has two output windings. One winding provides filament voltage for the cathode-ray tube. The filament voltage can be supplied from the High-Voltage Supply, since the cathode-ray tube has a very low filament current drain. The cathode and filament of the CRT are connected together to elevate the filament and prevent cathode-to-filament breakdown. One high-voltage winding provides both the negative cathode potential and the positive anode accelerating voltage. The CRT grid bias voltage is derived by a DC restorer circuit that uses a sample of the signal in the high-voltage winding in conjunction with DC levels supplied by the Z-Axis Amplifier and the negative cathode potential.

The positive accelerating potential is supplied by High Voltage Multiplier U1432. Regulated output voltage is approximately +15,500 volts. The negative cathode potential is supplied by half-wave rectifier CR1241. Voltage output is –2450 volts. Voltage variations in this supply are monitored by the High-Voltage Regulator circuit to provide a regulated high-voltage output.

CRT Control Circuits

Focus of the CRT display is controlled by FOCUS control R1430. ASTIG adjustment R1445, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid. Geometry adjustment R1442 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display.

Two adjustments control the trace alignment by varying the magnetic field around the CRT. Y Axis adjustment R1446 controls the current through L1446, which affects the CRT beam after vertical deflection, but before horizontal deflection. Therefore, it affects only the vertical (Y) components of the display. TRACE ROTATION adjustment R1440 controls the current through L1440 and affects both vertical and horizontal rotation of the beam.

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. The input transistor Q1466 is a current-driven, low input impedance amplifier. It provides termination for the input signals as well as isolation between the input signals and the following stages. The current signals from the various control sources are connected to the emitter of Q1466 and the algebraic sum of the signals determines the collector conduction level.

Q1472, Q1474, and Q1478 compose a feedback amplifier stage; R1468 and R1469 are the feedback elements. C1469 and C1471 provide high frequency compensation. Q1472 is an emitter follower providing drive to complementary amplifier Q1474-Q1478. CR1468, CR1472, and CR1476 provide protection in the event of high-voltage arcing.

In the .1 s, .2 s, .5 s, and X-Y positions of the TIME/DIV switch, +5 volts is connected to the anode of CR1463. This limits the effective range of the INTENSITY control to reduce the unblanking capabilities of the amplifier, thereby reducing the possibility of inadvertently burning the CRT phosphor. When the BEAM FIND pushbutton is pressed, two things occur: First, +15 volts is applied to the anode of CR1465 which lifts the emitter of Q1466 sufficiently positive to ensure there will be no conduction through Q1466. Secondly, R1470 becomes connected to –8 volts through R1477 which establishes a fixed predetermined unblanking level at the output of the amplifier. Thus, the INTENSITY control and all of the input unblanking signals have no control over the intensity level of the CRT display when the BEAM FIND pushbutton is pressed.

DC Restorer Circuit

C1488, C1487, CR1487, CR1488, and R1486 form a DC restorer circuit. All DC levels in this circuit are referenced to the negative potential of the CRT cathode. The voltage difference across R1486 approximately equals the voltage swing present at the junction of CR1482 and CR1483. The control grid end of R1486 is more negative than the end connected to CR1488. The amplitude of the voltage swings present at the junction of CR1482 and CR1483 is determined by the voltage levels established by the Z-Axis Amplifier and the CRT Bias adjust circuit. CR1483 sets the limit of the positive excursion and CR1482 sets the limit of the negative excursion.

CALIBRATOR

General

The Calibrator circuit produces a square-wave output signal with accurate voltage and current amplitudes. This output is available as a voltage or current at the CALIBRATOR current loop on the instrument front panel. Fig. 3-9 shows a detailed block diagram of the Calibrator circuit. A schematic of this circuit is shown on diagram 11 at the back of this manual.

Multivibrator

Q1590 and Q1594 along with their associated circuitry compose an astable multivibrator. The basic frequency of the multivibrator is approximately one kilohertz and is essentially determined by the RC combination of C1592, R1591, and R1593. Q1590 and Q1594 alternately conduct, producing a square-wave output signal, which is taken from the collector of Q1594. The amplitude of the square wave is limited in the negative direction by the base-emitter junction of Q1598 and in the positive direction by CR1596.

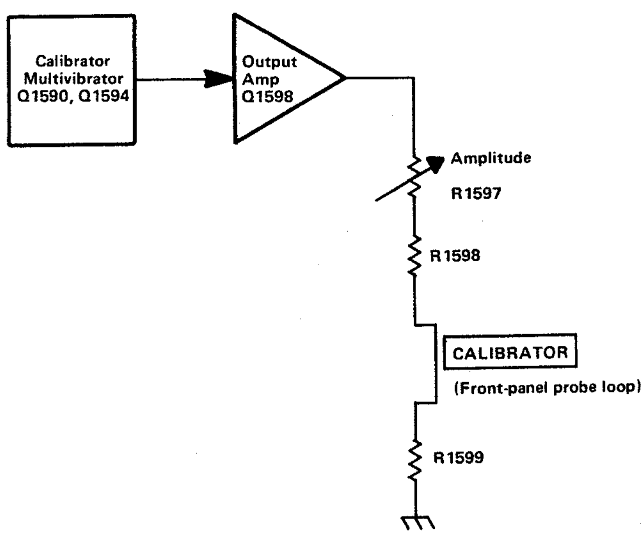

Fig. 3-9. Detailed block diagram of the Calibrator circuit.

Output Amplifier

The output signal from the Multivibrator overdrives Output Amplifier Q1598 to produce an accurate square wave at the output. When the base of Q1598 goes positive Q1598 is cut off and the collector level drops down to ground. When the base goes negative Q1598 is biased into saturation and the collector of Q1598 rises positive to about +5 volts. Amplitude adjustment R1597 adjusts the resistance between the collector of Q1598 and ground to determine the amount of current allowed to flow, which in turn determines the voltage developed across R1599.

A TRIGGER VIEW AMPLIFIER

General

The A Trigger View Amplifier circuit amplifies a sample of the signal present in the A Trigger Generator circuit and passes it on to the Vertical Output Amplifier for display on the CRT when the TRIG VIEW pushbutton is pressed. This provides a method of making a quick and convenient check of the signal being used to trigger the A Sweep Generator and is intended primarily to be used to check the signal applied to the A External Trigger Input connector. Fig. 3-10 shows a detailed block diagram of the A Trigger View Amplifier circuit. A schematic of this circuit is shown on diagram 11 at the back of this manual.

Amplifier

The amplifier consists of two emitter-coupled push-pull amplifier stages. The emitter source voltage for Q672 and Q682 is switched on and off by the TRIG VIEW pushbutton. With the TRIG VIEW pushbutton not pressed, the emitters of Q672 and Q682 are returned to −8 volts through R691. This reverse-biases the base-emitter junctions of the transistors, preventing any loading of the A Trigger Generator circuit. When the TRIG VIEW pushbutton is pressed, the emitters of Q672 and Q682 are returned to +15 volts through R690. This forward biases

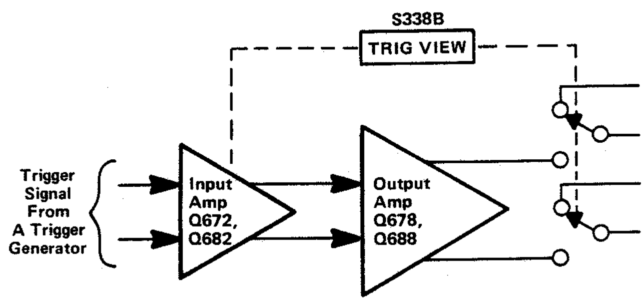

Fig. 3-10. Detailed block diagram of the Trigger View Amplifier.

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Q672 and Q682 to allow signal amplification. R675 adjusts for correct DC balance in the circuit.

Normally, the output of the Vertical Switching Amplifier is applied to the input of the Delay Line. When the TRIG VIEW pushbutton is pressed, the signal from the Vertical Switching Amplifier is removed and the output from the A Trigger View Amplifier is applied in its place.

LOW-VOLTAGE POWER SUPPLY

General

The Low-Voltage Power Supply circuit provides the operating power for this instrument from four regulated supplies and one unregulated supply. Electronic regulation is used to provide stable, low-ripple output voltages. Fig. 3-11 shows a detailed block diagram of the Power Supply circuit. A schematic of this circuit is shown at the back of this manual.

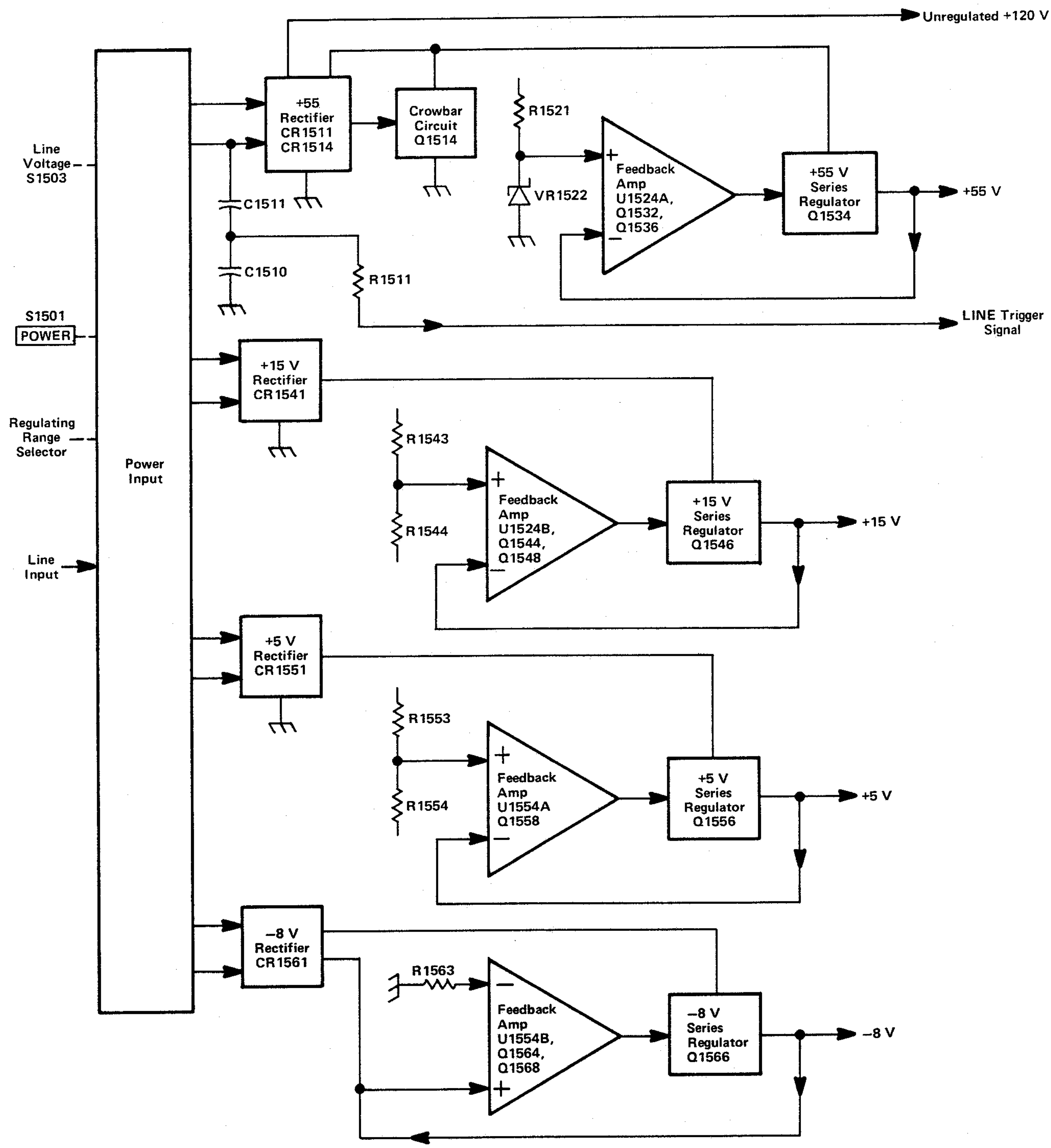

Fig. 3-11. Detailed block diagram of the Low Voltage Power Supply.

Power Input

Power is applied to the primary of transformer T1501 through Line Fuse F1501, POWER switch S1501, Thermal Cutout S1502, Line Voltage Selector switch S1503, and the Regulating Range Selector Assembly. Line Voltage Selector switch S1503 connects the split primaries of T1501 in parallel for 115-volt nominal operation, or in series for 230-volt nominal operation. Line Fuse F1501 should be changed to the correct value to provide the correct protection for each nominal line voltage (current rating of fuse for 230-volt operation is one-half the current rating of fuse for 115-volts).

The vacant windings between pins 10, 11, and 12 of T1501 are intended for use with the optional Inverter Circuit Board (Option 7). This allows the instrument to be operated from an external DC power source or an 1106 Power Supply.

Secondary Circuit

The −8 volt, +5 volt, +15 volt, and +55 volt supplies are series-regulated supplies. U1524A and B and U1554A and B are high-gain amplifier cells with differential inputs. These amplifiers monitor voltage variations in the output voltages.

For SN B080000 and up, a regulated +110 V supply is provided in addition to the unregulated +120 V supply. Both are derived from the terminal 14, 15, and 16 winding of T1501 and the full wave bridge rectifier CR1511. The +110 V regulated supply is referenced to the +55 V regulated supply via 56 V zener diode VR1515 and CR1514 to the base of series regulator transistor Q1516. Q1516 collector is fed from the +120 V supply through CR1516. R1516 shunts Q1516 to provide additional +110 V supply current. Q1518 provides short circuit protection by limiting the current through Q1516 during overload conditions.

Below SN B080000, the +120 V unregulated supply functions in place of the +110 V and +120 V supplies of later production. This +120 V supply includes SCR Q1514 to provide over-voltage protection for the various +120 V loads in the event of higher than specified line voltage levels. This Q1514 "Crowbar" circuit places a short across the T1501 secondary winding which will cause fuse F1501 to blow within 40 milliseconds if the line voltage exceeds the range selected on the T1501 primary taps. Fuse F1501 should always be replaced with the specified value to protect Q1514. If Q1514 is destroyed due to too high F1501 value, the +120 V supply can rise to about 160 V and possibly damage components in the +120 V load circuitry.

C1510, C1511, and R1511 compose a wave-shaping circuit that provides a sample of the AC voltage present in the secondary of T1501 to the trigger circuitry for use in the LINE positions of the Trigger SOURCE switches. CR1512 provides a relatively fast discharge path for C1542 when instrument power is turned off.

FAN MOTOR CIRCUIT

General

The fan motor used in the 465 is a brushless DC fan motor using Hall Effect devices. The fan motor circuitry varies the rotational speed of the fan with variations in operating temperature. When the ambient temperature increases, the value of thermistor RT1696 reduces. This biases Q1698 on harder to conduct more current through the Hall devices. Higher currents through the Hall devices causes the potential difference across them (for instance, between pins 6 and 8 of the fan) to increase. This potential difference biases one of a pair of transistors on and the other off. For instance, if pin 8 is more positive than pin 6 of the fan, Q1690A will be on and Q1690D will be off. The higher the potential difference between pin 8 and pin 6 the harder the on transistor will be conducting. The harder the transistor is conducting, the faster the fan rotates.

MAINTENANCE

Cabinet Removal

WARNING

Dangerous potentials exist at several points throughout this instrument. When the instrument is operated with the cover removed, do not touch exposed connections or components. Some transistors may have elevated cases. Disconnect power before cleaning the instrument or replacing parts.

The instrument wrap-around cabinet can be removed in the following manner:

1. Unwrap the power cord from the instrument feet.

2. Remove the six screws indicated in Fig. 4-1 and remove the instrument feet and rear ring assembly from the instrument.

3. Slide the wrap-around cabinet to the rear and remove the oscilloscope.

To replace the instrument in its wrap-around cabinet, reverse the removal procedure. The portable wrap-around cabinet should be installed with the carrying handle pivot points positioned toward the bottom of the instrument.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, preventive maintenance can prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 465 is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument.

Cleaning

General. The 465 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path which can result in instrument failure.

The cabinet provides protection against dust in the interior of the instrument. Operation without the cabinet in place necessitates more frequent cleaning. The front cover provides a measure of dust protection for the front panel and the CRT face. The front cover should be installed when storing or transporting the instrument.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents. Recommended cleaning agents are isopropyl alcohol or Kelite (1 part Kelite, 20 parts water).

Switch Contacts. Most of the switching in the 465 is accomplished with circuit-board mounted, cam-actuated contacts. Care must be exercised to preserve the high-frequency characteristics of these switches. Seldom is switch maintenance necessary, but if it is required, observe the following precautions.

Cleaning the switch contacts should only be done using isopropyl alcohol or a solution of one part Kelite to 20 parts water. In the absence of these three cleaners it is safe to use petroleum ether, white kerosene, or a solution of 1% Joy detergent and 99% water. Do not use acetone, MEK, MIBK, benzol, toluol, carbon tetrachloride,

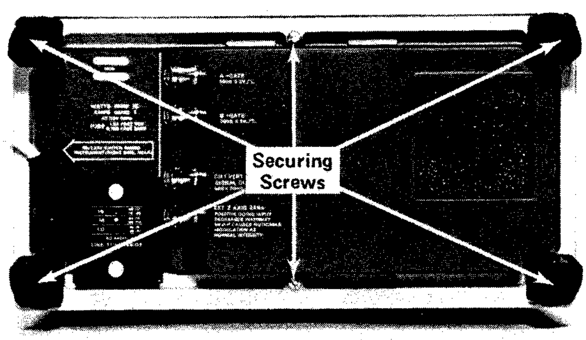

Fig. 4-1. Removing wrap-around cabinet.

trichlor, trichlene, methyl alcohol, methylene chloride, sulfuric acid, or Freon TC-TE-TF-22-TA-12.

Most spray circuit coolants and contact cleaners contain Freon 12 as a propellant. Because many Freons adversely affect the contacts, check the contents before using a spray cleaner or coolant. An acceptable contact cleaner-restorer is No Noise (Electronic Chemical). The only recommended circuit coolants are dry ice or isopropyl alcohol. There are three recommended switch lubricants. They are Silicone Versilube (General Electric Co.), Rykon R (Standard Oil, and WD-40 (Rocket Chemical Co.).

Exterior. Loose dust accumulated on the outside of the 465 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

CRT. Clean the blue and clear plastic light filters and the CRT face with a soft, lint-free cloth dampened with denatured alcohol or a mild detergent and water solution. The optional CRT mesh filter can be cleaned in the following manner.

1. Hold the filter in a vertical position and brush lightly with a soft No. 7 watercolor brush to remove light coatings of dust and lint.

2. Greasy residues or dried-on dirt can be removed with a solution of warm water and a neutral pH liquid detergent. Use the brush to lightly scrub the filter.

3. Rinse the filter thoroughly in clean water and allow to air dry.

4. If any lint or dirt remains, use clean low-pressure air to remove. Do not use tweezers or other hard cleaning tools on the filter as the special finish may be damaged.

5. When not in use, store the mesh filter in a lint-free dust-proof container such as a plastic bag.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-pressure air. Remove any dirt that remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning circuit boards.

Lubrication

The fan motor and most of the potentiometers used in the 465 are permanently sealed and generally do not require periodic lubrication. The switches used in the 465, both cam- and lever-type, are installed with proper lubrication applied where necessary and will only rarely require any additional lubrication. It is recommended that a regular periodic lubrication program not be performed on any of the components used in the 465.

Transistor Checks

Periodic checks of the transistors and other semiconductors in the 465 are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in the Calibration section.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed or corrected by recalibration.

CORRECTIVE MAINTENANCE

General

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the 465 can be obtained through your local TEKTRONIX Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special components are used in the 465. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local TEKTRONIX Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., it is imperative that all of the following information be included in the order to ensure receiving the proper parts.

1. Instrument type.
2. Instrument serial number.
3. A description of the part (if electrical, include the circuit number).
4. TEKTRONIX Part number.

Soldering Techniques

WARNING

Always disconnect the instrument from the power source before attempting to solder in the instrument.

Ordinary 60/40 solder and a 35- to 40-watt pencil-type soldering iron can be used to accomplish the majority of the soldering to be done in the 465. If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material.

CAUTION

The Vertical Preamplifier Attenuator circuit boards are made of material easily damaged by excessive heat. When soldering to these boards, do not use a soldering iron with a rating of more than approximately 15 watts. Avoid prolonged applications of heat to circuit-board connections. Use only isopropyl alcohol when cleaning this circuit board.

When soldering to the ceramic strips in the instrument a slightly larger soldering iron can be used. It is recommended that a solder containing about 3% silver be used when soldering to these strips to avoid destroying the bond to the ceramic material. This bond can be broken by repeated use of ordinary tin-lead solder or by the application of too much heat; however, occasional use of ordinary solder will not break the bond if excessive heat is not applied.

If it becomes necessary to solder in the general area of any of the high-frequency contacts in the instrument, clean the contacts immediately upon completion of the soldering. Refer to the section entitled Switch Contacts under PREVENTIVE MAINTENANCE for recommended cleaners and procedures.

Component Replacement

WARNING

Always disconnect the instrument from the power source before attempting to replace components.

Circuit Board Replacement. Occasionally it may be necessary to gain access to the reverse side of a circuit board or to remove one circuit board to gain access to another. The following procedures outline the necessary steps to facilitate instrument disassembly. Most of the connections to the circuit boards in the instrument are made with pin connectors. However, some connections are soldered to the board. Observe the soldering precautions given under Soldering Techniques in this section.

Vertical Preamp Assembly Removal.

1. Remove the instrument wrap-around cabinet in the manner given under Cabinet Removal earlier in this section.

2. Remove the knobs from the VOLTS/DIV switches and from the Input Coupling Switches. The knobs on the VOLTS/DIV switches must have a setscrew in each one loosened (using a 1/16" Allen wrench) before they can be removed, while the knobs on the Input Coupling switches can be pulled off by hand.

3. Disconnect the vertical POSITION control shaft couplers from the vertical POSITION potentiometers (.050" Allen wrench required).