

Q703 is one-half of a differential amplifier composed of Q703 and Q706. The base of Q706 is referenced to ground through R706. Transistor Q708 amplifies the output signal from the collector of Q706 and applies it to the drain of FET Q714. A feedback network composed of R709, R708, and C708 is connected between the collector of Q708 and the base of Q703. The feedback network sets the overall gain of the X Y Amplifier, with X-Gain potentiometer R709 adjustable to obtain the exact gain required.

The X-Axis signal passes through FET Q714 and is applied to the base of Q731 in the Horizontal Preamplifier. Horizontal positioning current on the base of Q730 is added to the X-Axis signal by the action of the differential amplifier. Then the sum of these two currents is amplified by Q736 and applied to the input of the Horizontal Output Amplifier.

Horizontal Output Amplifier

The Horizontal Output Amplifier converts the single-ended output of the Preamplifier into the differential output required to drive the crt horizontal deflection plates. The output stage consists of an input paraphase amplifier and an output complementary amplifier.

Horizontal signal voltage from Q736 is applied to the base of Q763. The base of the other transistor (Q753) in the paraphase amplifier, is biased through a voltage divider composed of R758, R757, and R756. Horizontal centering between the X1 and X10 Magnified sweeps is accomplished by adjusting Mag Registration potentiometer R758.

Gain of the paraphase amplifier is determined by components connected between the emitter leads of Q763 and Q753. The exact gain is adjusted by Horiz Gain potentiometer R752.

Transistor Q747 supplies the emitter current to both Q763 and Q753. The horizontal portion of the Beam Find circuitry affects the available current to Q747. Normally, -8.6 V is applied to the emitter of Q747 from the BEAM FIND switch via CR745 and R746. When the BEAM FIND push button is pressed in, the direct -8.6 V is removed. In this condition, -8.6 V is supplied via R745 which reduces the current available, thereby reducing the output voltage swing capability of Q763 and Q753. Diodes CR772, CR782, CR783, and CR773 prevent the paraphase amplifier from overdriving the output amplifier stage when the X10 Magnification feature is in use.

Final amplification of the horizontal deflection signal is provided by the complementary-pair output stage. Both sides of the differential output amplifier are identical in function, so only one side is discussed in detail.

Transistors Q780 and Q785 form a cascode feedback amplifier. Gain of the stage is set by feedback resistor R785, and high-speed compensation is provided by C783 and adjustable capacitor C784. For dc and low-frequency components of the horizontal deflection signal, Q789 acts as a current source for Q785. High-frequency components of the signal are coupled through C789 to the emitter of Q789 to speed up the output response time.

Emitter voltage for both Q780 and Q770 is supplied by a circuit composed of Q765 and associated components. The emitter voltage is maintained at a level that provides proper biasing for Q763 and Q753. Diodes CR770 and CR780 set up an emitter-bias difference between Q780 and Q770, causing the base voltage of both transistors to be equal.

POWER SUPPLY

The Power Supply circuitry converts the ac-source voltage into the various voltages needed for instrument operation. It consists of the Power Input, Preregulator, and Inverter circuits (which drive the primary of the power transformer) and other Secondary circuits (which produce the necessary supply voltages for the instrument).

This instrument has either the Current Limit board (A19) or the Preregulator board (A18) installed as part of the power supply. Refer to the appropriate circuit description for your particular instrument configuration.

NOTE

Instruments with a SN B020100 or above contain the Preregulator board. Some instruments below this serial number were built containing the Preregulator board. To determine if yours is one of these, look to see if there is an Option 48 sticker attached to the rear of the instrument. If there is not an Option 48 sticker attached and the serial number is below B020100, your instrument contains the Current Limit board.

Current Limit Board Configuration

The Power switch (S901) connects the line voltage to the instrument through line fuse F901 and transient suppressor VR901. Suppressor VR901 protects the instrument from large voltage transients. High-frequency line noise is attenuated by C901.

The Preregulator circuit converts the ac-power-source input voltage to a regulated dc voltage. A triac is used as a switch to conduct current during a controlled period of the input-line-voltage cycle so that energy to be used by the Inverter circuit is stored in capacitor C937.

Current from one side of the ac-power-source input will go through L925 (a current-limiting impedance) and triac Q925. Diodes CR931 and CR933 (on the Main board) and CR932 and CR934 (on the Current Limit board) form a full-wave bridge rectifier circuit. The rectifier converts the ac-input voltage into dc pulses that charge C937. Surge arrester VR938, connected in parallel with C937, conducts to protect the following circuitry should the Preregulator output voltage become too high.

The two-transistor circuit composed of Q933, Q938, and associated components provides over-current protection in the event of triac misfiring or ac-power-source transients. Transistor Q938 is an insulated-gate FET used as a switch in the charging path of C937. Transistor Q933 controls the FET bias to limit the current under abnormal firing conditions of Q925. In normal power-supply operation, the voltage developed across R937 is not sufficient to bias Q933 into conduction. The gate-to-source voltage of Q938 is set to 10 V by VR934 and R938, so the FET presents a low resistance to the charging current to C937. If triac Q925 should misfire to cause excessive current, Q933 becomes forward biased and Q938 is switched off to reduce the current. When Q938 switches off, the current that was flowing through Q938 flows through R939. The voltage drop developed across R939 causes current to flow through VR933 and R933, which holds Q933 on for most of the remainder of the ac-power-source input cycle. Resistor R939 limits the rate of collapse of the field around L925 to prevent damage to Q938. Thermistor RT935 adjusts the bias of Q933 over varying ambient temperatures.

PREREGULATOR CONTROL. The ac-source voltage is full-wave rectified by CR903 through CR906 and applied to a voltage divider composed of R911, R912, and R915. Output from this divider serves as a reference voltage for a ramp-and-pedestal comparator utilizing a programmable unijunction transistor (PUT), Q921. Capacitor C912 filters the line noise to prevent false triggering of the PUT. Voltage-dropping resistor R914 provides current for zener diodes VR914 and VR915 to produce constant voltages during each half of the ac-power-source cycle.

When the instrument is first turned on, C917 is not charged. Capacitor C915 charges through CR917 to the voltage of VR915 minus the diode drop of CR917. When the anode voltage of Q921 is greater than the gate voltage, Q921 will fire and C915 will discharge through the primary of T925. This event will happen after the peak of the voltage waveform. Pulse transformer T925 is connected to the gate of Q925, and the discharge of C915 through the T925 primary winding is coupled to the secondary to cause triac Q925 to conduct. After firing, the triac will turn off again when the sinusoidal source voltage crosses through zero. As C917 charges through R917, Q918 current increases proportionally to charge C915 more rapidly. When C915 charges at a faster rate, the anode voltage of Q921 rises above the gate voltage earlier in the ac-source cycle and thereby causes Q925 to conduct for a longer period of time.

The portion of the cycle preceding the zero-crossing point over which the triac is conducting is called the conduction angle. The conduction angle will increase from nearly zero (at turn on) to an angle sufficient to supply the energy needed by the inverter. Feedback from the inverter through optical isolator U931 holds the correct conduction angle by shunting current from R917. This shunting action controls the voltage on C917, thereby controlling the increase in base voltage on Q918. This action controls the charging rate of C915 and therefore the conduction angle of Q925.

The Preregulator circuit can handle a wide range of input voltages by changing the conduction angle of the triac as the input voltage changes. As the input voltage increases, the conduction angle will decrease to maintain the Preregulator output voltage at a constant level. The voltage divider composed of R911, R912, and R915 produces an output voltage proportional to the input line voltage that is applied to the gate of Q921. Since VR914 and VR915 hold bias levels on Q918 constant regardless of input voltage, the point on the cycle at which Q921 fires will vary with changes in the ac-source voltage. This feed-forward, together with the feedback from the Inverter through optical isolator U931, ensures a constant Preregulator output to the Inverter.

Preregulator Board Configuration

The Power Input circuit converts the input ac-source voltage to filtered dc for use by the Preregulator.

The POWER switch (S901) connects the ac-supply source through fuse F901 to bridge rectifier CR904. The bridge full-wave rectifies the source voltage, and its output is filtered by C909. Input surge current at the time of instrument power-up is limited by thermistors RT901 and RT902. Initially their resistances are high, but as they warm up, their resistances decrease and they dissipate less power. The instrument is protected from large voltage transients by suppressor VR901. Conducted EMI is attenuated by line filter FL9001, common-mode transformer T901, differential-mode transformer T907, and capacitors C901, C903, C904, and C905. Capacitors C907, C908, and C910 form a high-frequency bypass network to prevent the diodes in CR904 from generating EMI.

The Preregulator provides a regulated dc-output voltage for use by the Inverter circuitry.

When the instrument is turned on, voltage developed across C909 will charge C913 through R911. When the voltage has risen to a level high enough that U920 can reliably drive Q933, U920 will receive its Vcc voltage through Q915. This level is set by zener diode VR917 in the emitter circuit of Q917 and by the voltage divider consisting of R912 and R913. The zener diode will keep Q917 off until the voltage at its base reaches approximately 6.9V. Then