GENERAL PURPOSE WAVEFORM MONITOR MN6/502

Introduction

The MN6/502 is specifically designed for the examination and measurement of television wave forms. The monitor can be used by itself, but the facilities provided are normally supplemented by two additional plug-in units. One unit[1,2] extends the Y facilities of the monitor and the other unit[3] extends the triggering facilities.

The basic MN6/502 (without plug-in units) comprises:

(a) A vertical-deflection amplifier with a four-position input attenuator and a fixed-gain horizontal-deflection amplifier.

(b) A blanking-level clamp which can be switched out of circuit when not required.

(c) A horizontal-scan generator with nine calibrated ranges (including *Line* and *Field* positions) and x1, x2 and x5 multipliers.

(d) A sync separator which derives Line and Field trigger pulses from the input signal.

Vertical signal delay is not provided as this facility is unnecessary when suitable triggers are available. All input impedances are 75 ohms.

A typical plug-in Y-facilities unit provides a high-input impedance variable-gain difference amplifier and a calibration-waveform generator. A typical trigger-facilities unit provides, Line Strobe, Insertion Test Signal and Pulse-and-Bar trigger pulses. Note that all plug-in Y-facility units must have index-peg positions 25 and 44 and all plug-in trigger-facility units must have index-peg positions 24 and 30.

The monitor is contained in a chassis which is similar to a PN3/23 and can be either bay-mounted or housed in a portable case. The monitor itself is positioned on the left-hand side of the chassis and the plug-in units are located on the right-hand side. When plug-in units are not required, the right-hand side of the chassis is blanked off.

A block diagram which shows the signal paths through the monitor and the associated plug-in units is given in Fig. 1.

General Specification

Vertical Amplifier

Deflection Factor	switchable between 0·1, 0·2, 0·5, 1 V/cm
Bandwidth	d.c. to more than 18 MHz
Risetime	less than 20 ns
Time Constant when Capacitively-coupled	about 0·2 s
Input Impedance	75 ohms
Maximum d.c. on Input	±6 V
Return Loss (with respect to 75 ohms)	more than 30 dB
Input Access	at rear when feeding directly into MN6/502 at front when feeding via plug-in unit
Continuously Variable Gain	not provided on MN6/502 but provided on plug-in unit

Horizontal Amplifier

Deflection Factor	0·25 V/cm
Bandwidth	d.c. to 10 MHz
Input Impedance	75 ohms ±6%
Input Access	at rear, input can be switched to accept output of scan generator

Scan Generator

Basic Scan Velocities	10 ns/cm to 0·1 s/cm in decade steps, plus a 3 ms/cm position. The 3 ms/cm position is marked *Field* and the 10 µs/cm position *Line*
Scan Multipliers	x1, x2 and x5
Scan Rate Accuracy (except for 100ms/cm)	±2% over the central 5 cm of display for the x1 multiplier ±3% over the central 5 cm for the x2 and x5 multipliers
100 ms/cm Scan Rate Accuracy	−10% +40% for all multipliers

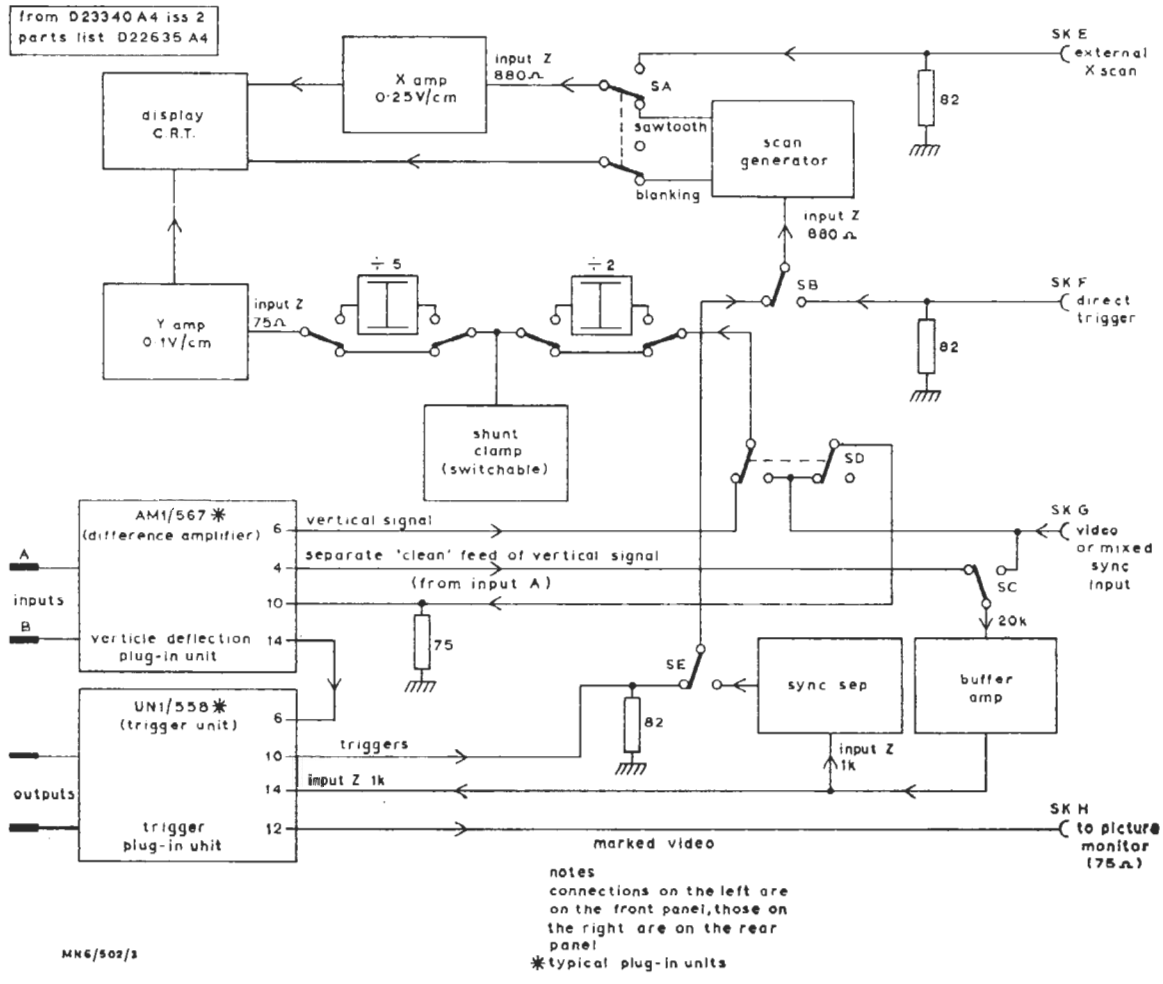

Fig. 1 Block Diagram of the Waveform Monitor MN6/502

Variable Scan Rate Facility	available but not calibrated
Trigger Input	
Input Impedance	75 ohms ±5%
Input Level	1 to 3 volts, negative-going w.r.t. earth
Maximum Frequency	5 MHz
Inhibit Period for Flyback	not more than 25% of the forward scan period
Cathode Ray Tube	
Type	D13—51GH
Display Area	6 cm high, 8 cm wide
E.H.T.	8·4 kV overall
Graticule	Video Graticule TE1A/505 with variable red illumination. (Other graticule types available are TE1A/504 and TE1A/506).
Bezel	suitable for mounting a Tektronix type C30 camera. The bezel also accepts a viewing hood (not supplied as part of the MN6/502)
Power	
Mains Input	240 V ±6%
Power Consumption	45 W for MN6/502 alone. 55 W with typical plug-in units
Fuses	500 mA
Mains Switch	combined with the graticule-illumination control
Ambient Temperature Range	
Storage	0—70 °C
Working	0—45 °C (a temperature cut-out operates at 55 °C)

Circuit Description

The circuit diagram of the MN6/502 is given in Figs. 2 and 5. The signal circuits are shown in Fig. 2 and the power supply and c.r.t. circuits in Fig. 5.

Positive logic is used in the integrated-circuit modules; i.e. an output voltage of —0·7 volts with respect to pin 3 of the module is referred to as a *1* output, and an output of —1·5 volts with respect to pin 3 is referred to as a *0* output. Voltages more negative than *0* have the same effect as a *0*.

Many of the components on the MN6/502 are mounted on printed-wiring boards. To avoid confusion when servicing, the components are given a three-figure number which indicates the board on which they are mounted. For example; TR103 is mounted on board 1 and R307 is mounted on board 3. Those components not mounted on the boards are given numbers which start at 1 in the usual way; on the circuit diagram these components are further identified by asterisks.

Sync Separator

The *Trigger Source* switch SC selects either the video input signal to the MN6/502 or the *Clean Feed* output from the Y-facilities plug-in unit and applies the selected signal to the sync separator TR201 via the buffer emitter-follower TR301. In TR201 any picture information is removed from the signal and the inverted sync pulses which appear at the collector are fed to integrated circuit module IC 201. This module functions as a monostable multivibrator and produces a *1* at the P output while in the unstable state and a *1* at the Q output when it reverts to the stable state. The Q output pulse is fed to the R input of module IC202.

Module IC202 has two modes of operation; when the *Trigger* switch is set to *Field* the module functions as a monostable multivibrator; when the switch is set to *Line* or *Trig Unit* the P output of the module is always positive with respect to the Q output. The P and Q outputs of IC202 are applied to either side of a difference amplifier comprising transistors TR202 and TR203; transistor TR202 is fed also, via a differentiating circuit, with the P output of IC201. The standing potentials at the base of TR202 are such that the transistor is driven into conduction only when the P output of IC202 is *1* and the P output of IC201 changes to *1*. When the *Trigger* switch is set to *Line* this happens once per line coincident with the leading edge of syncs. However, when the *Trigger* switch is set to *Field* this happens only during field-blanking periods and, for 625-line working, first occurs during equalising pulses on lines 311 and 623. This results in a non-interlaced field trigger.

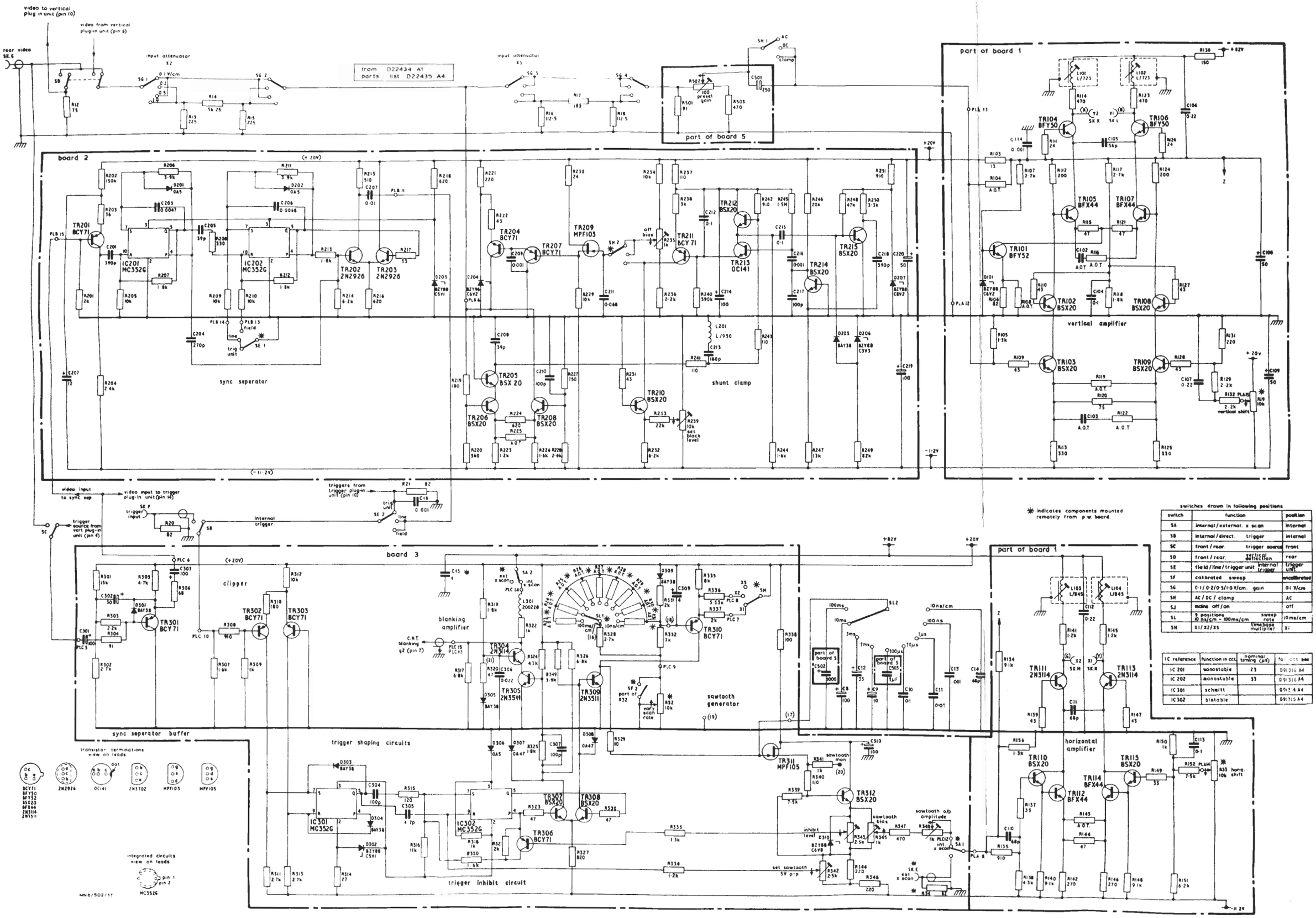

Fig. 2 Circuit of the Waveform Monitor MN6/502

Trigger Circuit

The negative-going line or field trigger pulses developed at the collector of TR202 are applied via switch SE2 (at which point trigger pulses derived from the plug-in trigger unit may be selected if desired) to the base of TR302. This transistor forms a long-tailed pair with TR303 and functions as a clipper stage. When the input signal to the stage is more negative than −1 volt, transistor TR302 conducts and applies a positive-going signal to the S input of IC301, whereupon the Q output of the module changes to 1. Module IC301 acts as a schmitt trigger because on the cessation of the positive-going pulse to the S input the state of the module is changed by the negative-going output of TR303. Diodes D303 and D304 prevent the pulses applied to the S and R inputs from becoming too negative.

Sawtooth Generator

The Sawtooth generator is shown in block diagram form in Fig. 3.

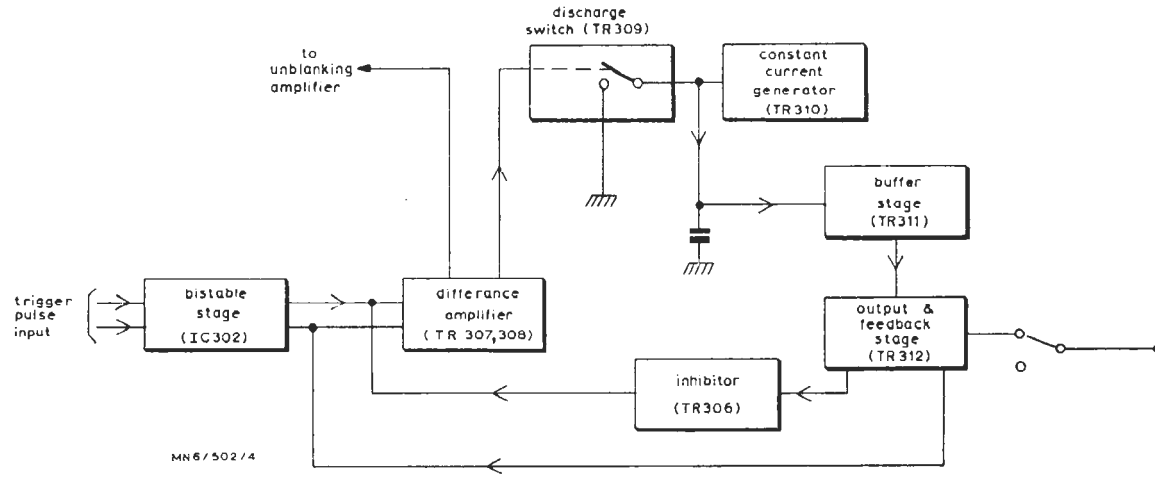

Fig. 3 Block Diagram of the Sawtooth Generator

When the Q output of IC301 changes to *1* module IC302 changes to the Q = *1* condition, provided that transistor TR306 is conducting. This transistor acts as an inhibitor when cut off and prevents input trigger pulses changing the state of IC302 during the discharge period.

Transistors TR307 and TR308 form a long-tailed pair; when the Q output of IC302 changes to *1*, transistor TR308 conducts and TR307 is cut off. Diode D308 prevents TR308 bottoming; if the transistor bottomed the associated output stage of module IC302 would pass a relatively heavy current and the module might be damaged. When TR308 conducts the sawtooth-discharge transistor TR309 is cut off and the selected scan-rate capacitor charges with the constant current provided by TR310 towards the 20-volt line. Because the only load on this circuit is the high input impedance of field-effect transistor TR311, the sawtooth obtained is linear and linearity-correction circuits are not required. Switch SL1 is used to select an adjust-on-test resistor which modifies the charging current to compensate for any variation from nominal in the value of the charging capacitor. The required sweep-speed multiplying factor is obtained by means of switch SM. Continuous variation of the sweep speed is obtained by bringing variable resistor R32 into circuit. When the wiper of this resistor is moved away from the upper end of the track, switch SF2 opens and inserts R32 in the base-bias circuit of TR310. At the same time, switch SF1 (shown in the mains-input circuit on Fig. 5) lights the *Uncal* indication lamp on the front panel of the monitor.

The sawtooth waveform is fed via source-follower TR311 to emitter-follower TR312. Monitor point R341 is provided between these two stages for line-up purposes. From the emitter of TR312 the sawtooth waveform is fed, via a resistor network and the *Int./Ext.* X-scan switch, to the horizontal

amplifier.

Two additional feeds are taken from the resistor network in the emitter circuit of TR312 and these are fed back to module IC302. The signal present at the wiper of the *Set Sawtooth 5V p-p* control (R432) is fed back to the R input of IC302 and at end of the forward scan period (i.e. when the sawtooth amplitude at monitor point R341 is 5 volts p-p) this signal is sufficiently positive to trigger the module into the Q = 0, P = 1 state. Consequently, TR308 cuts off and TR307 conducts, and the scan-rate capacitor discharges through R329 and TR309. The signal present at the wiper of the *Inhibit Level* control (R343) is fed back to the base of TR306. The control is adjusted so that TR306 starts to conduct at the end of the discharge stroke. When TR306 conducts, the inhibit potential is removed from the S input of IC302 and the module is then ready to be triggered by the next trigger pulse.

Blanking Amplifier

Transistors TR305 and TR304 form a cascode-connected blanking amplifier. During the forward-scan period of the sawtooth generator TR307 is cut off and TR305 is driven into conduction. The voltage at the collector of TR304 is reduced from about 50 volts to near earth potential and this fall in potential is applied to the unblanking electrode of the c.r.t. to make the trace visible. When the sawtooth generator is not in the forward-scan condition, TR307 conducts, TR305 is cut off and the c.r.t. is blanked off.

When an external X-scan signal is used the c.r.t. is unblanked continuously by means of switch SA2.

Horizontal Deflection Amplifier

Transistors TR110, 112, 114 and 115 form a compound long-tailed pair which, in the *Int.X-scan* condition, is driven by a balanced 2-volt peak-to-peak sawtooth waveform. To obtain high current gain the transistors are connected as darlington pairs. Variable resistor R33 functions as a *Horizontal Shift* control. Capacitor C110 compensates for the input capacitance of the stage.

The signals from the long-tailed pair input stage are applied to the common-base stages formed by transistors TR111 and TR113. The resulting push-pull cascode amplifier provides adequate bandwidth and power. Capacitor C111, connected between the emitters of TR111 and TR113, prevents oscillation at u.h.f.

Note that the signals applied to the X-deflection plates may have up to one volt of hum superimposed on them. This occurs because the 82-volt supply is not stabilised; it is not a fault condition and it has no effect on the display because the same signal is applied to both deflection plates.

Vertical Deflection Amplifier

This amplifier is fed either with the signal applied to SKG at the rear of the MN6/502 or with the output of the Y-facilities plug-in unit[1]. The selected signal is then applied via the input attenuators, the *Preset Gain* control and the *AC/DC/Clamp* switch to transistor TR103.

Transistors TR103 and TR109 form a long-tailed pair which is driven by the input signal and produces push-pull output signals. Variable resistor R19 functions as a *Vertical Shift* control. From the collectors of TR103 and TR109 the signals are applied via common-base stages TR102 and TR108 to a further long-tailed pair amplifier comprising transistors TR105 and TR107; transistor TR101 provides a constant-current source for this stage. The outputs from TR105 and TR107 feed the final common-base stage comprising transistors TR104 and TR106. Capacitor C105 is connected between the emitters of the output transistors to prevent u.h.f. oscillation. As with the horizontal amplifier, the signals applied to the deflection plates may have up to one volt of hum superimposed on them but this has no effect on the display because the same signal is applied to both deflection plates.

Shunt Clamp

The shunt clamp is shown in block diagram form in Fig. 4.

The video signal appearing at the junction of the two input-attenuator sections is sampled by transistor TR206. This transistor has two functions, it forms a long-tailed pair in conjunction with TR208 and a cascode amplifier in conjunction with TR205. The signal developed at the collector of TR208 is fed back to the sampling point as positive feedback to ensure that the clamp does not appreciably load the video line. The signal developed at the output of the cascode stage is applied via a low-pass filter to a tuned circuit which removes any sub-carrier component from the signal and the resulting signal is fed via emitter-follower TR212 to the symmetrical switching transistor TR213 and also to sync-separator stage TR215. From the sync-separator, pulses are fed to the clamp-pulse generator TR214 and the positive-going clamp pulses developed at the collector of this stage are applied to the switching

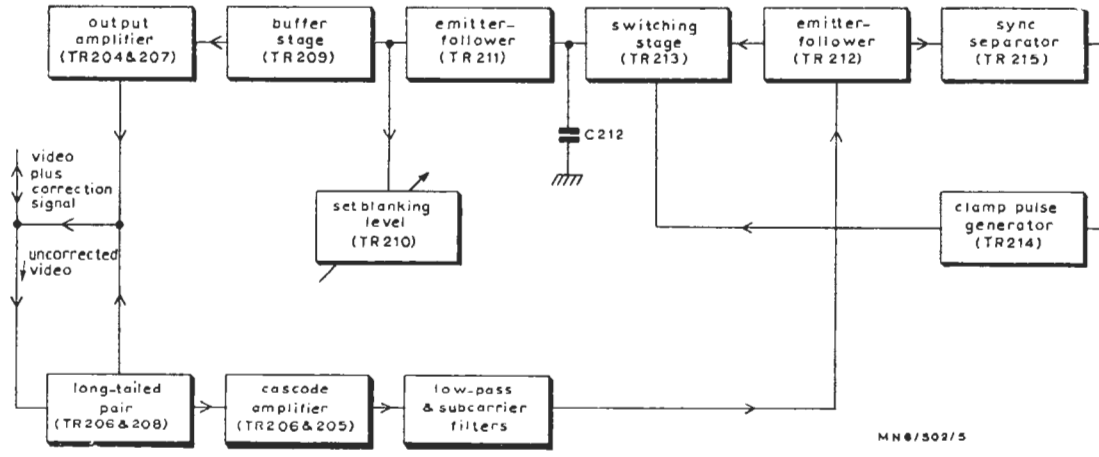

Fig. 4 Block Diagram of the Shunt Clamp

transistor TR213 which is thus driven into conduction for the duration of each pulse.

When TR213 conducts, it charges or discharges capacitor C212; this charge constitutes an error-correction signal and is applied via inverter stage TR211 to the field-effect transistor TR209, provided that switch SH2 is in the *Clamp* position. Transistor TR210 is shunted between the gate of TR209 and the −11·2 volt line, the emitter potential of this transistor can be varied by means of R239 which thus functions as a blanking-level control. Field-effect transistor TR209 operates as a source-follower, it has a very high input impedance and so provides an effective buffer between the clamp circuits and the output amplifier while acting as an impedance matching device between the two stages. The output stage consists of emitter-follower TR207 and amplifier-inverter TR204. The signal appearing at the collector of TR204 is applied as an error-correction signal to the original video signal.

Power Supplies

(*a*) *General*

The circuit diagram is given in Fig. 5. Stabilised supplies are provided at:

+7·5 kilovolts
+125 volts
+20 volts
−11·2 volts
−920 volts

Unstabilised supplies are provided at:

+82 volts
+6 volts
6·3 volts, 50 Hz

The 7·5-kilovolt, 112-volt and −920-volt supplies are derived from a PS1/14 e.h.t. power supplier which is contained in the MN6/502 and is fed from the stabilised 20-volt supply.

(*b*) *Mains Input Circuit*

A 240-volt mains supply is applied via a thermal cut-out which operates at 55° C to transformer T1, the secondary windings of which feed the various rectifier circuits and also provide heater power for the cathode-ray tube. Two neon indicators are connected across the primary winding of T1; one is the *Mains On* indicator, the other one is labelled *Uncal* and lights when switch SF1 is in the open position to show that the sawtooth generator is operating in the uncalibrated mode.

(*c*) *11·2-volt Circuit*

Transistors TR1 and TR401 to TR403 form a stabiliser circuit in which the output is taken from the collector of TR1. An attenuated version of the output voltage is compared in a difference amplifier comprising TR401 and TR402 with a reference voltage derived from zener diode D405 and any variations are applied as correction signals to the base of TR403. The collector of TR403 is returned, via R405, to the +6-volt line to extend the stabilisation range and provide current limitation under overload conditions.

(*d*) *20-volt Circuit*

This is similar to the 11·2-volt circuit except that the series stabiliser section contains two parallel-connected transistors, TR2 and TR3, to increase

the current-handling capacity of the circuit.

(*e*) *6-volt and Graticule Illumination Circuit*

The output of the bridge rectifier feeds the +6-volt line and also, via emitter-follower TR409, the graticule illumination lamps. Resistor R128 modifies the law of the dimmer resistor R7.

Tube Supplies

The connections to the c.r.t. are conventional though there are some points to be noted.

Because the tube is rectangular it cannot be rotated to give a level display. Therefore, display rotation is carried out electromagnetically by feeding a current from TR601 through a rotation coil.

The internal connection shown between the final anode and S11 is a high-resistance (100 megohm minimum) spiral coating on the inside of the tube. It provides a post-deflection accelerating field.

A 68-volt zener diode, D601, makes the potential divider chain which feeds the c.r.t. electrodes independent of the loading of the beam current.

Alignment

(*a*) *Power Supplies*

1. Connect an Avometer between any convenient point on the +20-volt line and chassis. Adjust R414 for a reading of 20 volts.
2. Connect an Avometer between any convenient point on the −11·2 volt line and chassis. Adjust R407 for a reading of −11·2 volts.

(*b*) *Sawtooth Generator*

The four preset controls associated with the sawtooth generator are on the right-hand side of board 3 (viewed from the front of the unit) and are easily accessible when the adjacent plug-in unit is removed. They must be adjusted in the order given below.

1. Set the *Sweep Rate* switch to any convenient position and monitor the waveform at the *Sawtooth Mon.* point with an oscilloscope. Turn R343 clockwise until a sawtooth waveform is displayed, then give the control a further half-turn in the clockwise direction; this additional adjustment compensates for drift caused by the warming-up process and provides a setting of the control which is suitable when the instrument has just been switched on and which remains suitable when it has been running for some time.
2. Adjust R342 to make the amplitude of the display 5 volts peak-to-peak.
3. Monitor at PLC12 or at the socket into which PLC12 plugs. Adjust R348 for a sawtooth amplitude of 2 volts peak-to-peak. Check that switch SA is set to *Internal* while making this measurement, otherwise the output of the sawtooth generator will not be correctly loaded.
4. Set up the oscilloscope for d.c. measurement. Still monitoring at PLC12, adjust R345 to make the sawtooth waveform symmetrical about earth.

(*c*) *Clamp*

1. Remove the Y-input signal and adjust the *Horizontal Shift* control to position the trace in the centre of the c.r.t.
   Switch the input attenuator to the most sensitive position (0·1V/cm).
2. Short-circuit the clamp input to chassis (this can be done either at PLB6 or between the two sections of the input attenuator) and move the *AC/DC/Clamp* switch between the *AC* and *DC* positions. If the position of the trace alters, then the value of resistor R104 must be changed.
3. Set the *AC/DC/Clamp* switch in the *DC* position. Remove and replace the short-circuit at the clamp input while observing the display. Adjust R235 for no movement of the trace in either condition.
4. Remove the short-circuit. Adjust R239 for no movement of the trace when switching between the *DC* and *Clamp* positions.

References to Typical Associated Equipment

1. Video Difference Amplifier AM1/567.
2. Video Amplifier AM5/514.
3. Trigger Unit UN1/558.

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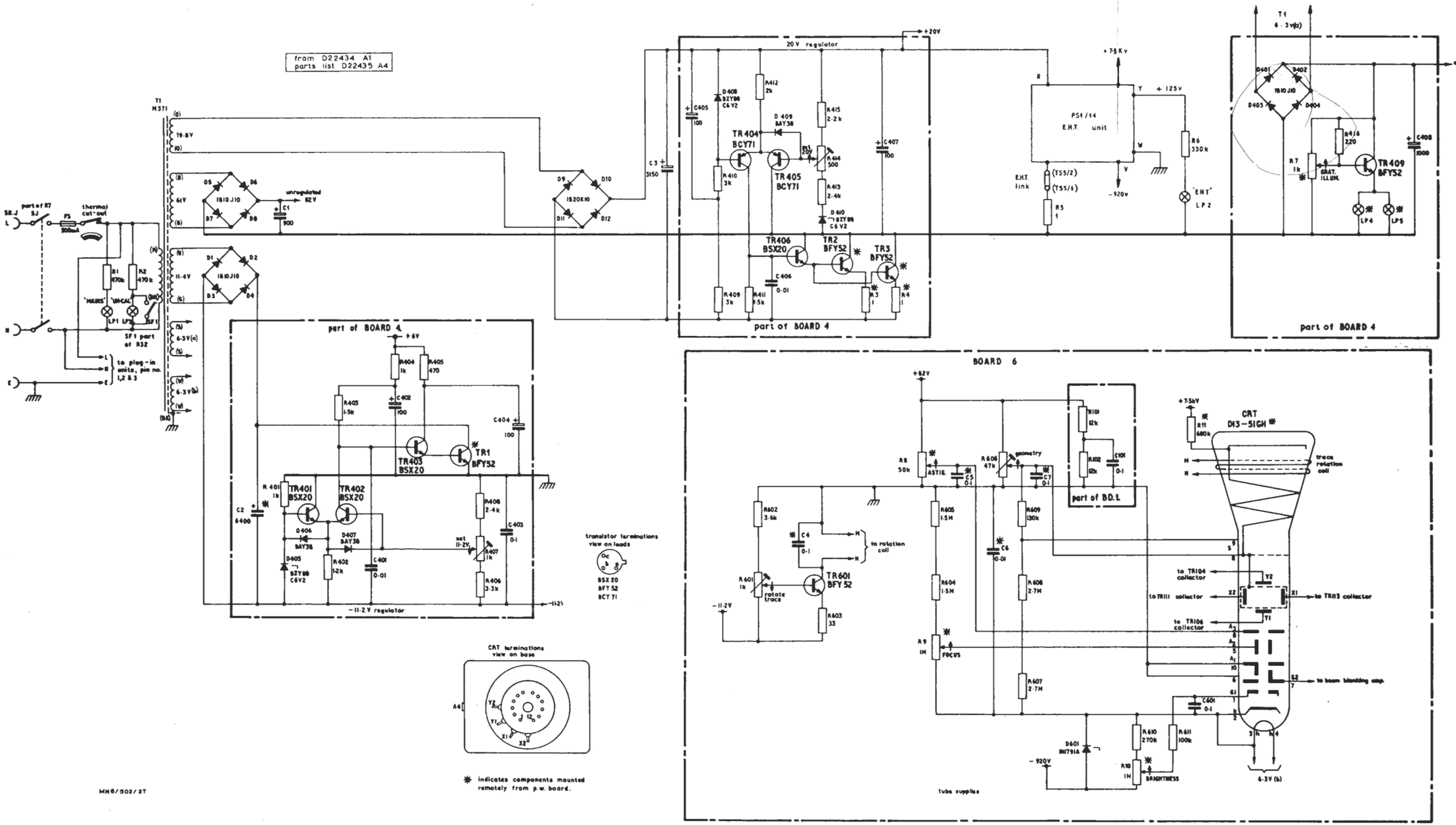

Fig. 5 Power-supply and C.R.T. Circuits in the Waveform Monitor MN6/502