SECTION 23

VERTICAL COLOUR BAR GENERATOR GE4/523

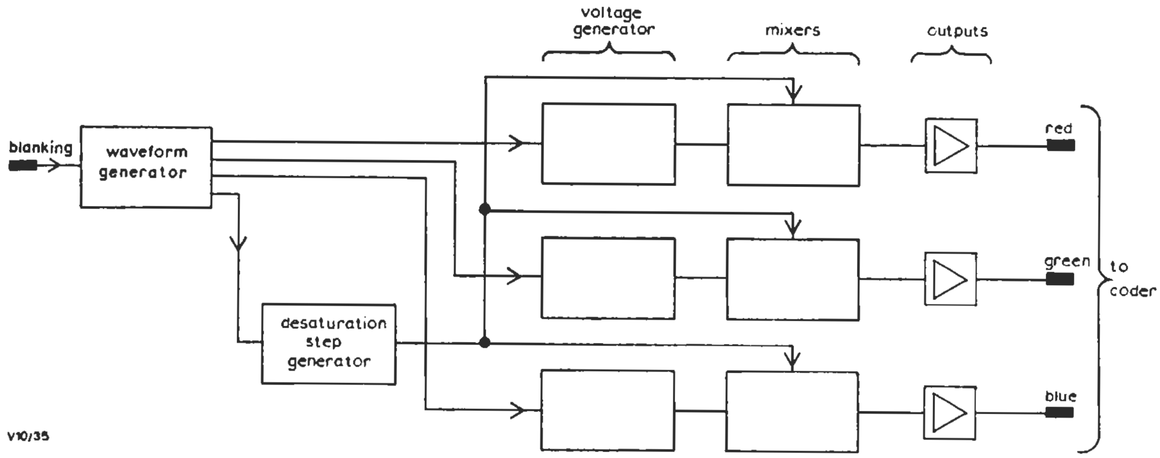

Fig. 23.1 Block Diagram of the GE4/523

Introduction

The GE4/523, which supersedes the GE4/512, produces the R.G.B. signals required to align colour coders. The coders, when aligned, produce the composite colour bar signal.

The generator is driven by mixed blanking on either the 525-line or the 625-line standard.

By means of a switch on the front panel, the colour bars can be made 100%, 95% or the E.B.U. standard.

The generator is a precision instrument and great care has been taken in the design to ensure accuracy of waveform and long term stability of output level. The output impedance of each of the three channels is an accurate 75 ohms and the 75-ohm terminations into which each is fed must be matched to each other to within 0·2 per cent. The leading edges of the red, green and blue output waveforms are timed to be within 2 ns of each other.

The generator has its own stabilised power supply and has most of its components mounted on printed wiring boards contained in a CH1/26B chassis for rack mounting.

A block diagram of the generator is given in Fig. 23.1 and the main circuit diagram in Fig. 23.2. The various waveforms produced, and their relation to each other and to line blanking, are shown in Fig. 23.3 and Fig. 23.4 diagrams A to V; these letter references are used in the following discussion. Fig. 23.5 shows the blue output (for the three degrees of saturation) and the composite colour bar signal produced by the coder.

General Specification

Line Standard	525/625
Mixed Blanking Input	2 volts p-p
Input Impedance	2 kilohms approx.
Output Signals (non-composite across 75 ohms)	
Green Channel	0·7 volts p-p ±0·05dB
Red Channel	Within 2mV of the green and blue channels
Blue Channel	Within 2mV of green and red channels
Output Impedance	
50 Hz	75 ohms ±0·5%
15 kHz	75 ohms ±0·2%
5 MHz	75 ohms ±2%
Operating Temperature	5 to 45 degrees C
Hum and Noise (each output)	Not more than 2mV
Power Supply	200-250 volts, 50Hz

Weight	3 lbs
Size	CH1/26B Chassis
Connections	15-way Painton Plug
Index Pegs	3 and 38

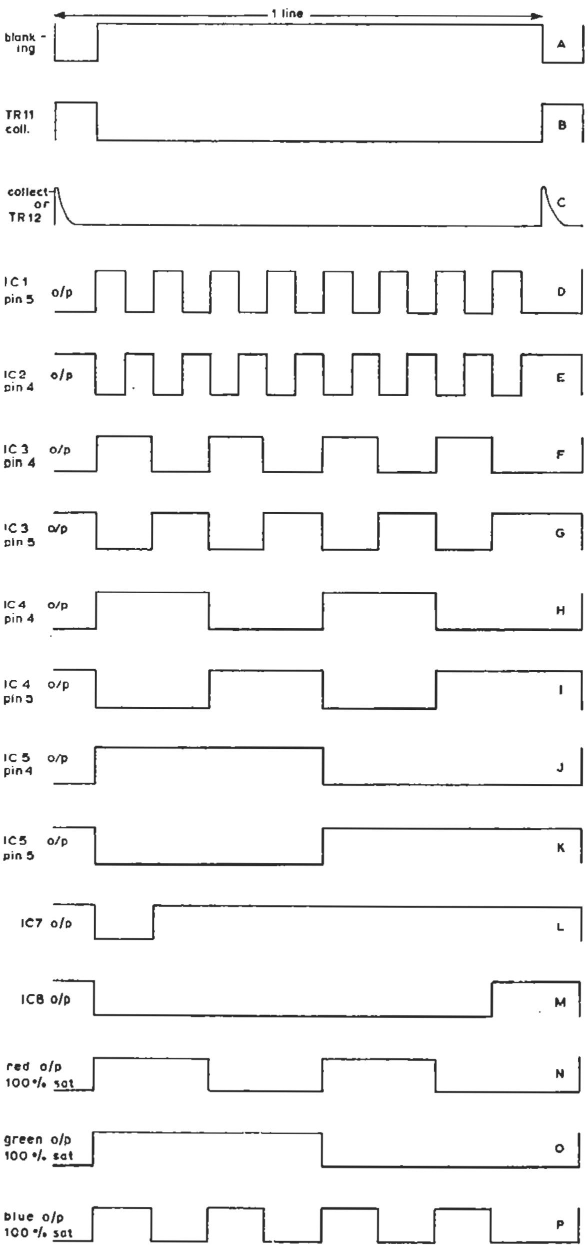

Fig. 23.3 Waveforms in the GE4/523

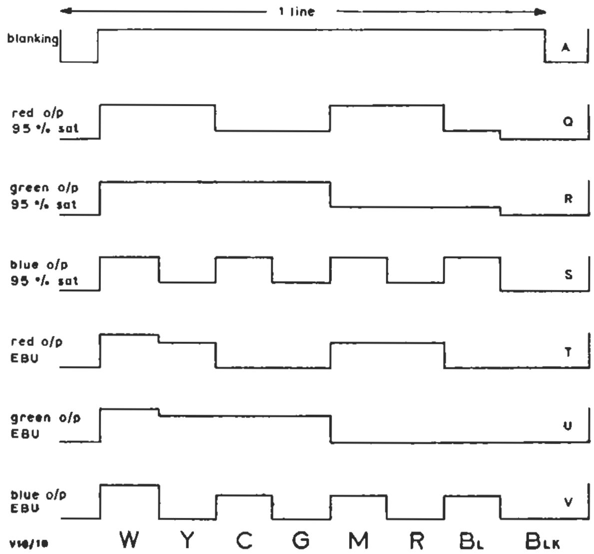

Fig. 23.4 Output Waveforms with Desaturation Steps

Circuit Description

Waveform Generator

This provides the controlling pulses for the voltage generators. The main part of the generator consists of 8 " MECL1 " integrated circuit elements and two single-transistor amplifiers. One of these amplifiers (TR11) d.c. restores, inverts and clips the mixed blanking input signal (diagram A). The positive-going pulses on the collector (diagram B) are used to control an astable multivibrator (IC1) and also as one input to a NOR gate (IC2). The natural frequency of the multivibrator is about 10 times the line frequency of both the 625-line and the 525-line standards.

The multivibrator action is stopped during the blanking period by the blanking pulse but, as the change of state is extremely rapid, the leading edge of the first pulse produced in every line always corresponds with the end of line blanking. The pulses from the multivibrator, diagram D, are applied to a second input of the NOR gate, IC2. IC2 ensures that a clean waveform is passed on to the next stage of the generator and provides a test point (pin 6) which, if earthed through a 4·7-kilohm resistor, stops the action of the waveform generator. Thus red, green and blue signals are not produced and this enables the d.c. conditions of the complete colour-bar generator to be checked.

The output from IC2, diagram E, drives a three stage divider, consisting of the integrated circuits

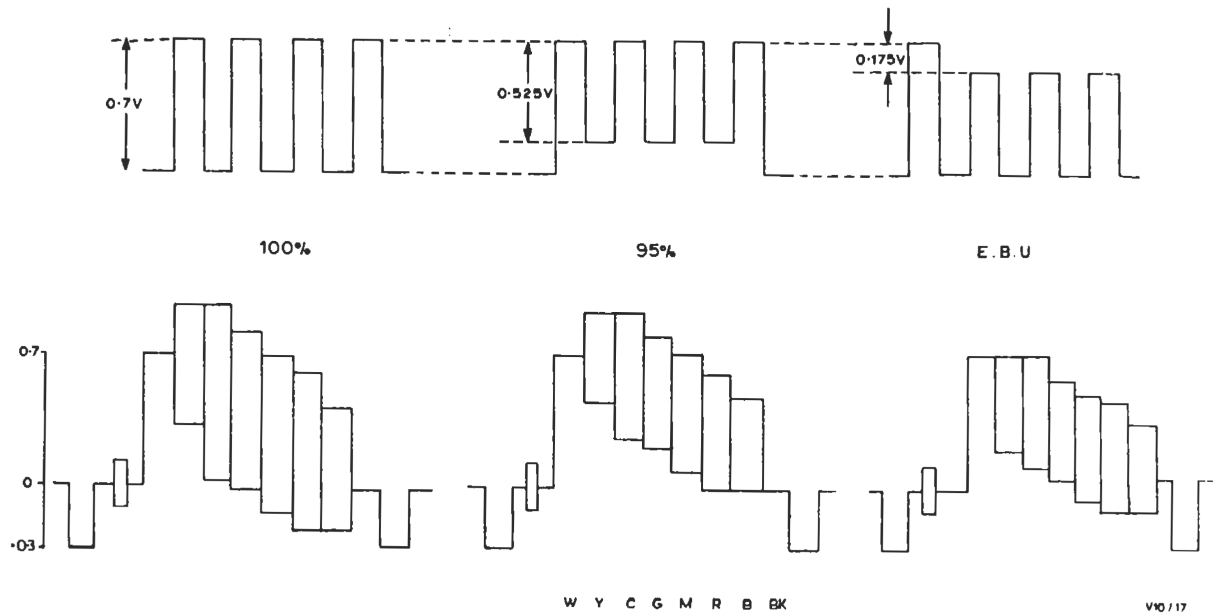

Fig. 5 Blue Output and Composite Colour-bar Signal for the Three Types of Colour Bar

IC3, IC4 and IC5. The output from IC5 consists of one pulse per line, diagram K, and is fed to the green channel. Correspondingly, the outputs from IC3 and IC4 (diagrams G and I) consists of 4 and 2 pulses per line and are fed to the blue and red channels respectively.

The second of the single stage amplifiers, TR12, differentiates the input line-blanking signal and suppresses the positive-going input peak. The negative-going input peak (from the leading edge of line blanking) is inverted and clipped by TR12, diagram C, and fed to IC3, IC4 and IC5 to ensure that the divider stages are set correctly at the start of each line.

The remainder of the waveform generator produces desaturation pulses which are used to modify the output waveform in the E.B.U. and the 95% saturation positions of the switch SA. These pulses are produced by the OR gate IC7 and the NOR gate IC8.

Each of the three inputs to IC7 and IC8 comes from one stage of the divider. The waveforms are shown in diagrams G, I and K (IC7) and F, H and J (IC8). When the three inputs to IC7 are negative, a negative pulse appears at the output (diagram L) and this occurs only during the first pulse from IC3 in each line. Similarly, IC8 gives a negative going output (diagram M) when one at least of the inputs is positive and this occurs throughout the active line period except for the duration of the black bar at the end of the line. The outputs from IC7 and IC8 are taken to the E.B.U. and 95% positions of SA1; the third position of the switch, 100% bars, is earthed to render the following voltage generator inoperative in this position.

The final element of the waveform generator is IC6 which produces a suitable bias voltage for IC2, IC7 and IC8.

The circuit arrangement of the IC's is given on Designs Department drawings D19315A4, D19316A4, D19317A4 and D19318A4.

Voltage Generator and Output Circuits

Each of the voltage generator and output circuits are similar and produce output waveforms having very precise amplitudes (diagrams N to V.). The operation will be described with reference to the green channel.

Voltage Generating Circuit

The voltage generating circuit consists basically of a Schmitt trigger circuit controlled by pulses from the waveform generator. The input, from pin 5 of IC5, is inverted and amplified by TR24 and is then applied to the Schmitt trigger, TR25 and TR26. TR26 is normally conducting with TR25 cut off. The input pulses reverse this state, so generating the output pulses.

The voltages at the collector of TR26 corresponding to its on and off states (which determine the output pulse amplitude) are closely stabilised by the use of high stability metal film resistors and by the use of D19 and D20, which stabilise the current through TR26 against temperature changes. The resistors concerned are R91, R92, R94, R95, R96 and R97 and in the off state, when the positive peaks appear at the channel output, the voltage is determined only by R96 and R97. The precise value of the current through TR26 when conducting, and therefore of the output-pulse amplitude, is set by adjustment of R93 so that the signal obtained at the channel output is the specified 0·7V p-p ±0·05dB across 75 ohms. R93 is connected either across R92 or across R94 and its value adjusted during manufacturing tests. L3, C31 form a pulse shaping network and remove any tendency to overshoot on pulse edges.

The pulses from TR26, which are positive going with respect to earth, pass to the output amplifier via R98, R99 and R102 which, with R100 and R101, form a resistive adding network for the injection of desaturation pulses. If desaturation pulses are present at terminal X, they are added to the pulses from the Schmitt trigger circuit on the base of TR27.

Output Amplifier

The output amplifier, consisting of TR27, TR28, TR29 and TR30, is extremely stable in operation owing to the considerable negative feedback employed. The d.c. feedback from the collector of TR30, via R112, stabilises the output voltage against temperature variations.

The leading edges of the red, green and blue output waveforms are coincident with each other to within 2 ns at the start of each line and this coincidence is achieved during manufacturing tests by adjustment of C19 and C39, which alter the time at which the red and blue Schmitt circuits operate with respect to the green Schmitt circuit. Additionally, C31 has a higher value than C20 and C40, in the red and blue channels respectively, and C48 is put in parallel with C31 in the 95% and E.B.U. switch positions. These differences compensate for rise-time variations and timing delays arising from the fact that pulses from the red and blue Schmitt triggers pass through additional printed circuit cards to their respective positions on switch SA, while those from the green Schmitt trigger go direct.

The desaturation pulses are produced by the Schmitt trigger, TR14, TR15. This operates in a similar manner to that described for TR25, TR26. The pulses are fed to the adding networks via TR16, an emitter follower, the low output impedance of which minimises crosstalk between the three channels in the adding networks. Because these pulses are attenuated in the networks it is not necessary to use temperature compensation as in the channel voltage generators.

The output waveforms are positive going from earth potential and are shown in diagrams N to V for the three degrees of saturation. Fig. 23.5 shows the blue waveform in relation to the composite colour bar signal.

Power Supply

The power supply is very precisely stabilised to ensure the stability of the output waveforms. It produces 9·00 volts with a low impedance earth point of 5·20 volts from the negative rail. The main stabiliser circuit TR4, TR5 and TR6 has a low temperature coefficient zener diode D12 as a reference-voltage source. Diodes D13 and D14 stabilise the current through TR4 against temperature variations. TR1, TR2 and TR3 form an auxiliary stabiliser circuit which minimises variations due to changes of mains input voltage. This stabiliser controls the supply to the voltage amplifier TR4 in the main stabiliser. It has a low temperature coefficient zener diode D9 as a reference and diodes D10 and D11 to stabilise the current through TR1 against temperature variations. Transistors TR7, TR8, TR9 and TR10 form a third voltage stabiliser to give a low impedance output between the negative rail and earth.

The output impedances of the stabilisers tend to rise with frequency and, to counteract this and to decouple the power leads within the generator, the capacitors C7, C8 and C9 on the power unit and C25, C26, C27, C28, C36, C37, C45, C46 and C47 at the amplifier end, are fitted.

Installation

In use it is essential for the generator to be correctly terminated if the accuracy of the output waveforms is to be maintained and the three terminations must be matched to each other within 0·2%.

It is also essential that the relative timing (to within 2 ns) of the red, green and blue channels is maintained right up to the coder input terminals.

Connecting cable lengths and types must, therefore be identical for the three channels.

Similarly, if the generator is feeding circuits via distribution amplifiers, then these must have closely controlled propagation delays. A suitable amplifier is the AM4/518. If amplifiers which do not meet this requirement are used, then the R.G.B. signals from the generator must be retimed at the coder inputs. This may be done either by selection of amplifiers or by adjustment of cable lengths, but under these conditions the amplifiers cannot be interchanged.

Maintenance

General

The generator has been designed with stability as a specific requirement and any ageing that does occur should not cause the specified limits to be exceeded. If the performance does become suspect, then the tests detailed below may be made if the listed test gear is available; otherwise the generator should be returned to Equipment Department for service. Routine maintenance is not required.

The generator must be powered for 15 minutes before any tests are started and this delay must be repeated if the generator is switched off for any reason during the tests.

If, during maintenance work, any resistors are removed, they must be replaced with the specified types having the specified tolerances and temperature coefficients. Other types or other tolerances or temperature coefficients, must not be used. In a similar manner, the correct types of capacitor for C12 and C13 must be used if replacement becomes necessary.

Test Apparatus

Digital Voltmeter Solarton LM 1420.2
Waveform Auxiliary Unit PA1M/529
Return Loss Measuring Set UN1/524
625-line Pulse and Bar Generator GE4/504
Difference Amplifier AM1/535 or AM1/535P
Tektronix Oscilloscope type 533, 535 or 545, with plug-in unit type H
Source of 525-line and 625-line mixed blanking (2 volts)

Voltage Measurement

With the digital voltmeter check the following in turn:

1. The voltage across C7. This should be 9·00V ±50mV. If outside these limits, it should be reset to 9·00V ±20mV by adjusting the value of R15 which is in parallel with either R13 or R14.
2. The voltage across C8. This should be 5·20V ±25mV. If outside these limits, it should be reset to 5·2V ±10mV by adjusting the value of R16 which is in parallel with either R17 or R18.
3. The voltage across C4. This should be between 14·3 and 15·6 volts.

Return Loss Measurement

The return loss of each output can be checked, if necessary, using the UN1/524 and the GE4/504 with pin 6 of IC2 earthed via a 4·7-kilohm resistor. Each output should have a return loss of better than 56dB measured on the flat portion of the bar, 46dB measured on the 2T pulse and 50dB at 50 Hz. Any serious reduction of these figures, say 3dB, indicates a fault probably in the output amplifier. If the figures are acceptable except for the 50Hz figure, a possible cause is the deterioration of the 5000μF decoupling capacitors C24, C34 and C43.

Alignment

1. Apply 525-line mixed blanking to the input and display the blue output on the oscilloscope, the connecting cable being terminated with 75 ohms at the oscilloscope end. Trigger the oscilloscope externally from mixed blanking and set the timebase to 10μs/cm. Set switch SA on the generator to the *100%* position.
   The displayed waveform should be as diagram P, with the leading edge of the first pulse coincident with the trailing edge of the blanking pulse. If a spike is seen just preceding the start of mixed blanking, adjust the value of R37 until it just disappears; then increase the value of R37 until the time interval between the end of the fourth pulse and the start of blanking is reduced by 0·5μs. The actual resistor (type N6 or MOG55) to be used in the generator should have the value as found, or the nearest higher preferred value.
2. Replace the 525-line mixed blanking with 625-line mixed blanking and check that:
   (a) The output still consists of four pulses as previously and that any spike found has not reappeared.
   (b) The last three pulses are 6-7μs in duration and that the first pulse is about 1-μs longer.
   (c) The rise and fall times are between 0·07μs and 0·1μs

(d) The amplitude of any hum, noise, h.f. spikes or overshoots is less than 2·5mV p-p.

3. Repeat the above but using the red output, checking that:
   (a) The displayed waveform is as shown in diagram N
   (b) The pulses are 12 to 14μs in duration with the first pulse slightly longer than the second
   (c) Pulse rise and fall times are as for the blue output
   (d) Any hum, noise, h.f. spikes or overshoots do not exceed 5mV in amplitude.
4. Repeat the above but using the green output, checking that:
   (a) The displayed waveform is as shown in diagram 0
   (b) The pulse duration is 24 to 27μs
   (c) The pulse rise and fall times are as for the blue output
   (d) Any hum, noise, h.f. spikes or overshoots do not exceed 5mV in amplitude.

Output Level

The output levels may be checked using the PA1M/529 which must have been tested and recalibrated within the previous four weeks to ensure its proper performance. The PA1M/529 should be set up as follows:

(a) Gain switch to *0dB*
(b) Clamp switch to the *Off* position
(c) Calibration signal level to 0 ±0·01dB
(d) Select-B switch to 0·7 volts
(e) Oscilloscope, terminated with 75 ohms, connected to the output
(f) Difference amplifier properly balanced

The following tests should then be done in sequence:

1. Connect the green output of the generator to the PA1M/529. Set switch SA in the *100%* position, the mode switch (on the PA1M/529) in the *A—B* position and check that the green output level is 0·7 volts ±0·05dB
2. Connect the red and blue outputs to the PA1M/529. With the Select-B switch in the *Red* and *Blue* positions in turn, check that the red and blue levels are exactly equal to the green. If they are not equal to within 1mV, then R68 or R126 should be adjusted. (Access to these two resistors is obtained by removing the front panel)
3. Set switch SA to *E.B.U.*, set the select-B switch on the PA1M/529 to *0·7V* and check that the amplitude of the green bar is 0·7V ±0·05dB. Set SA to *95%* and check that the amplitude is within the same limits.
4. Set switch SA to *E.B.U.* and the select-B switch to *Red* and check that the inputs balance to within 2mV, adjusting R71 if necessary. Set switch SA to *95%* and check that the balance is maintained within the same limits.
5. Set switch SA to *E.B.U.* and the select-B switch to *Blue* and check that the inputs balance to within 2mV, adjusting R129 if necessary. Set switch SA to *95%* and check that the balance is maintained within the same limits.

If the performance of the generator falls outside the above limits, it should be returned to Equipment Department for service. Alternatively, reference can be made to the production test schedule in D.D. Specification No. 8.232(66).

Timing Checks

The following checks can be made using the difference amplifier AM1/535 and the oscilloscope.

1. Set switch SA to *100%* and connect the green and blue outputs to the inputs of the AM1/535. Terminate the inputs with 75 ohms. It is essential that the coaxial cables used for the connections be short (18 inches or less) and of equal length to within ¼ inch and also that the AM1/535 is in accordance with the production test schedule of D.D. Specification No. 8.177(65).
2. Connect the output of the AM1/535 to the high impedance input of the oscilloscope and trigger the oscilloscope externally from mixed blanking. Display the difference signal produced by the first leading edge of the green and blue bars. The displayed waveform will consist of a pulse not exceeding 200 ns in duration and of indeterminate amplitude. The relative timing of the edges of the two bars can be measured by increasing the length of one of the 75-ohm cables feeding the AM1/535 to delay the earlier of the two signals. The length is increased until the waveform is roughly sinusoidal and sitting with equal positive and negative excursions. The amplitude should then not exceed 30mV p-p and the required additional length of cable should not be more than 15 inches. Under these conditions the waveforms are timed to within 2ns. Remove the additional length of cable and repeat the test with switch SA in the *95%* and *E.B.U.* positions; the same limits apply.

3. Repeat the above test, comparing the green and red and the red and blue outputs for all positions of the switch SA. In all cases the timing should be within 2ns (15 inches of added coaxial cable).

If the generator fails to meet these timing limits, it should be returned to Equipment Department for service. Alternatively, reference can be made to the production test schedule.

Final Test

Display each output in turn on the oscilloscope, which should be d.c. coupled. The waveforms obtained should correspond to those shown in diagrams N to V. Check that the sit of the black bar of any output is 0 $\pm$150mV and that any hum, spikes or overshoots on the waveforms do not exceed 8mV p-p.

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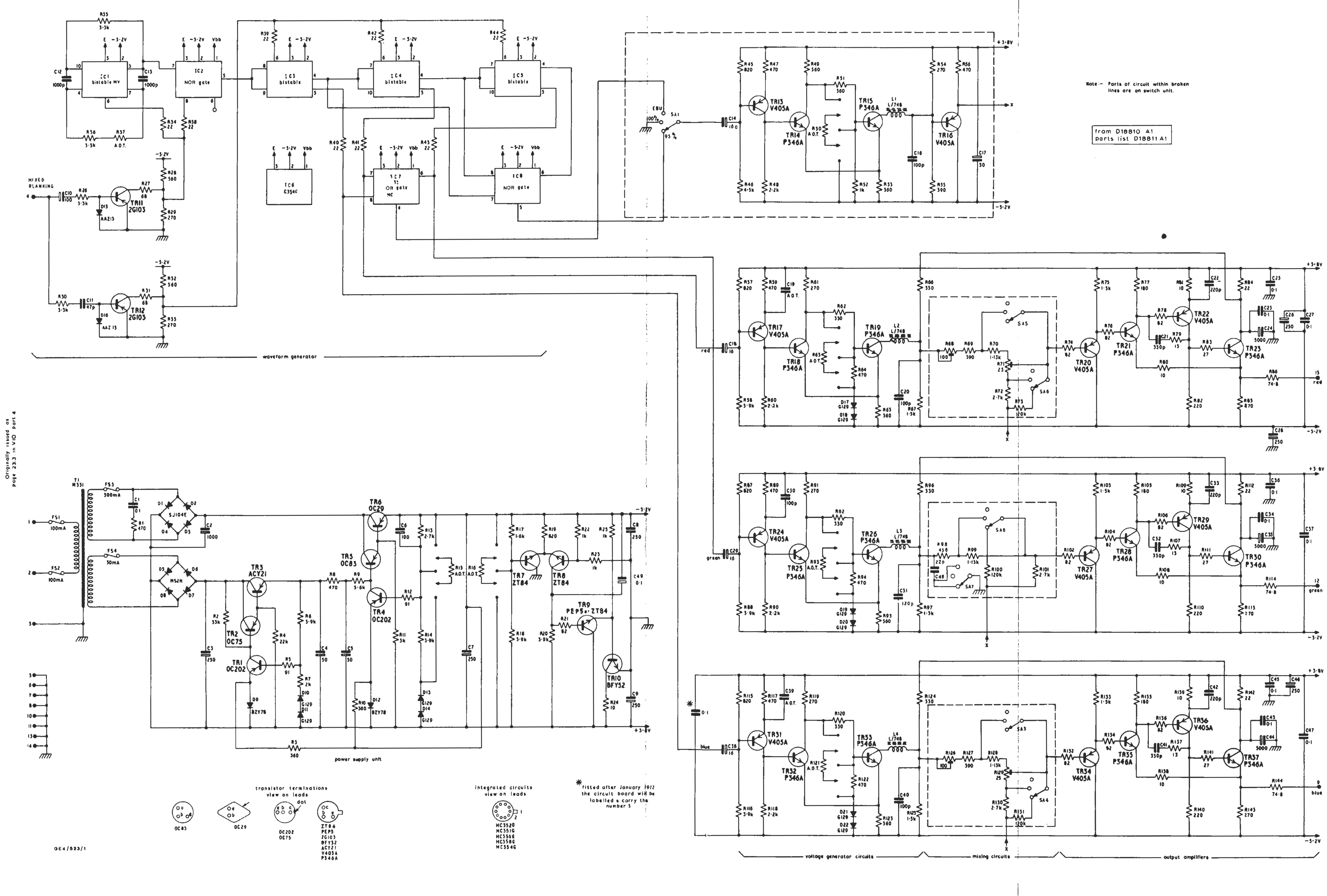

Fig.2 Circuit of the Vertical Colour Bar Generator GE4/523