SECTION 1

MISCELLANEOUS AMPLIFIERS: AM1 SERIES

EQUALISER AMPLIFIER AM1/515

General Description

The AM1/515 is an equaliser amplifier for correcting high-frequency losses (so-called aperture losses) introduced into the television system by the finite size of the scanning spot used in television cameras and flying-spot scanners. The amount of correction is controlled by a knob on the front panel and can be varied to give a peak of up to 15 dB at 5 Mc/s for a 405-line system, and at 7·7 Mc/s for a 625-line system, relative to the low frequency gain which remains constant at —15 dB. The change-over from one line standard to the other is effected by a relay which is de-energised for the 625-line system and energised for the 405-line system.

The amplifier utilises transistors and printed wiring and is constructed on a CH1/12A plug-in chassis with a multiway connector for power and signal connections. Separate power supplies of 12 volts for the transistors and 50 volts for the relay are required.

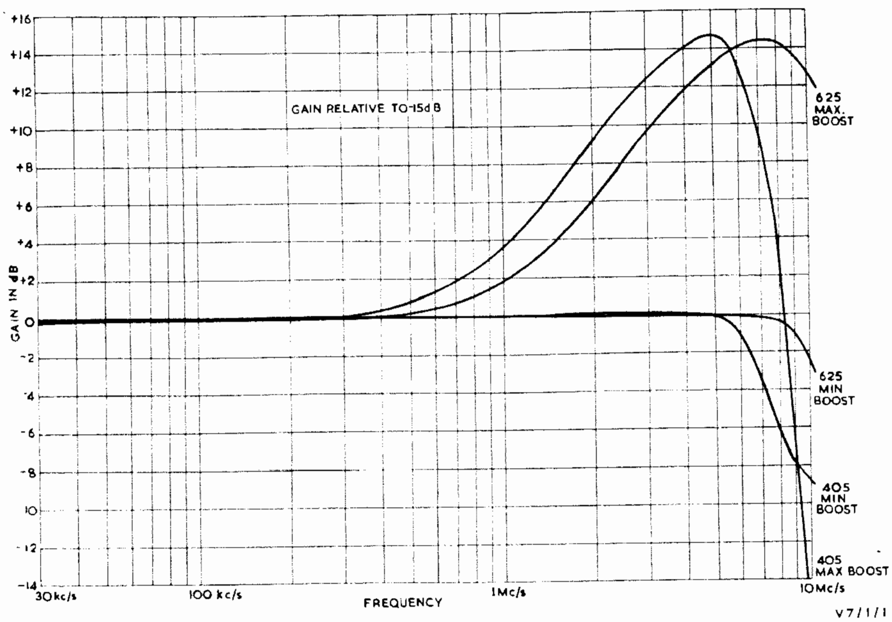

Fig. 1.1. Equaliser Amplifier AM1/515: Frequency Response

Drawing No. DA 11752

Circuit Description (Fig. 9)

General

The first two transistors TR1 and TR2 are connected as emitter-followers to give a very low output impedance and thereby enable the 75-ohm resistor R10 to provide a 75-ohm source impedance for the correction network.

The two transistors TR3 and TR4 form a difference amplifier with variable loads provided by the non-inductive variable resistors RV1 and RV2 which are ganged together by gears and control the gain at the peak frequency determined by the correction network. When relay RLA is energised it switches from the network for a 625-line system to the one for a 405-line system.

The emitter-follower TR5 ensures that the loading of the difference amplifier by external circuits in minimal, and TR6 provides the small amount of gain (variable over a limited range by the preset control RV3) required to give an overall gain of —15 dB at low frequencies at the terminals of the output stage TR7.

The overall response curves for maximum and minimum boost for both 405-line and 625-line systems are shown in Fig. 1.1.

Correction Network

The correction network employed in the difference amplifier is based upon certain properties of transmission lines with open circuit terminations and negligible loss. If the source impedance is equal to the characteristic impedance of the line the voltages at the sending and receiving ends have the same phase angle but different amplitudes.

At the receiving end the amplitude is equal to the source voltage V, but at the sending end it is equal to $V \cos 2\pi Df$, where D is the delay in microseconds along the line and f is the frequency in Mc/s. At low frequencies, $\cos 2\pi Df$ becomes very nearly equal to unity; the voltages at both ends then become equal to V and their difference will be zero.

At high frequencies $\cos 2\pi Df$ becomes equal to -1 when Df equals $\frac{1}{2}$; the voltage at the sending end will then be equal to $-V$ and the difference between the voltages at the two ends will be a maximum and equal to $2V$. Hence, by suitable choice of D for a network designed to have a constant time delay over the range for which correction is required, maximum difference between the sending and receiving end voltages can be obtained at any chosen value of f.

In the AM1/515 this principle is made use of by applying the two voltages to the two halves of a difference amplifier consisting of transistors TR3 and TR4 to give an overall output which is independent of frequency at the lower frequencies but has a controllable peak at the frequency selected.

The network employed for the 405-line system is a delay line with a delay time of 0·1 µsec which gives a peak response at 5 Mc/s; that for 625 lines has a delay time of 0·065 µsec giving a peak response at 7·7 Mc/s. The principles employed in the design of these networks are described in Designs Department Technical Memorandum No. 9.19 (61): Delay Networks with Complex Conjugate *m* Values.

Difference Amplifier

In the difference amplifier used in the AM1/515 the signal at the input to the delay network is amplified by TR3 and that at the output of the network by TR4. The collector currents in the two transistors are determined by these signals and to a very close approximation are independent of the settings of the boost control.

Because of the resistance R13, which is common to both transistor circuits, a fraction K of the signal voltage applied to each transistor is transferred to the base-emitter circuit of the other transistor, K being the same in each case and determined by R12, R13 and R15.

The voltage transferred to each transistor is in opposition to its own signal voltage, and hence the collector current of the transistor is proportional to the difference between the two. The collector current of TR3 is therefore proportional to $(V \cos 2\pi Df - \mathrm{K}V)$ and that of TR4 is proportional to $(V - \mathrm{K}V \cos 2\pi Df)$.

At low frequencies, as f tends towards zero and $\cos 2\pi Df$ becomes equal to 1, the two collector currents become equal and proportional to $V(1 - \mathrm{K})$ and the output voltage across RV1, R14, RV2 is independent of the setting of the boost control because the product of the resistance in circuit and the current flowing through it remains constant.

At the frequency of maximum boost, $\cos 2\pi Df$ becomes equal to -1 and the two collector currents are equal and opposite and proportional to $V(1 + \mathrm{K})$. In the absence of R14 the output voltage would therefore be zero with the boost control in the minimum position, i.e., with only RV1 in circuit. When the boost control is at maximum setting the output voltage is the product of the collector current of one transistor (TR4) and the total collector load.

With R14 in circuit to give an output at minimum boost equal to that at low frequencies, the maximum boost available is therefore the ratio of the collector current of TR4 at the boost frequency and the current at low frequencies. This ratio is

$$\frac{V(1 + \mathrm{K})}{V(1 - \mathrm{K})} = \frac{1 + \mathrm{K}}{1 - \mathrm{K}}$$

and corresponds to a peak of 15 dB.

The value of the resistor R14 is selected on initial test to give a flat response over the whole frequency range with the boost control in the minimum position; too high a value of R14 causes a rise in high-frequency response.

Further information on the design of the difference amplifier is given in Designs Department Technical Memorandum No. 7.57 (63): Equaliser Amplifier AM1/515.

General Data

Voltage gain	−15 dB ±0·5 dB at low frequencies. −15 dB to 0 dB variable at 5 Mc/s (405-line standard) or 7·7 Mc/s (625-line standard).
Number of outputs	one at standard level.
Nominal input level	0·7 V peak-to-peak at low frequencies.
Input overload point	3 V peak-to-peak sine waveform at low frequencies. 2 V at 6 Mc/s for minimum boost. 1 V at maximum boost frequency.
Amplitude frequency response	See Fig. 1.1.
50-c/s square wave response	< 1% sag.
Input impedance	75 Ω
Output impedance return loss figure (75 Ω)	−37 dB at 30 kc/s. −30 dB at 5·5 Mc/s.
Permitted d.c. at input	±2 V d.c.
Hum on output	< 5 mV peak-to-peak.
Non-linearity	< 1%.
Operating temperature	10°—45° C.
Change of gain with temperature	< 0·1 dB at low frequencies. < 0·5 dB at half boost and 4 Mc/s.
Power requirements	+12 V 66 mA d.c. 50 V 25 mA d.c.
Weight	1½ lb.

Maintenance

The supply is at +12 volts. The approximate d.c. voltages on the transistors when no signal is present are:

Transistor	*Emitter*	*Base*	*Collector*
TR1	6·1	6·75	11·3
TR2	5·4	6·2	10·2
TR3	4·7	5·4	11 } minimum boost
TR4	4·7	5·4	10·8 } minimum boost
TR5	10·2	10·8	11·8
TR6	10·4	10·2	2·6
TR7	1·9	2·6	7·8

The two delay lines are lined up on initial test and should not be readjusted. It is important that the rotational relationships of the two variable resistors RV1 and RV2 of the boost control should be correct, i.e., they are both at the ends of their travel when the boost control is turned fully anti-clockwise.

The resistor R14 is selected on initial test for flat frequency response when the boost control is at minimum.

W.G. 8/64.

COMPONENT TABLE: FIG. 9

Comp.	Loc.	Type	Tolerance per cent	Comp.	Loc.	Type	Tolerance per cent
C1	B4	U.C.C. 599/7LS 12V		R13	G6	Erie 109	2
C2	C3	U.C.C. SM65S 12V		R14	G3	Erie N1	2
C3	D3	U.C.C. SM65S 12V		R15	J4	Erie N1	2
C4	L3	Erie K.7004/811 300V		R16	K6	Erie N1	2
C5	P4	U.C.C. SC584/6LS 12V		R17	L2	Erie N1	2
C6	P5	U.C.C. 641/6LS 6V		R18	L6	Erie 109	2
C7	H9	G.E.C. P.F. 125V	2	R19	L2	Erie N1	2
C8	G7	G.E.C. P.F. 125V	2	R20	N3	Erie N1	2
C9	H9	G.E.C. P.F. 125V	2	R21	N6	Erie N1	2
C10	H11	G.E.C. P.F. 125V	2	R22	P2	Erie N1	2
				R23	P6	Erie N1	2
R1	A2	Erie N1	2	R24	Q5	Erie N1	2
R2	A6	Erie N1	2	R25	R4	Erie N1	2
R3	B2	Erie N1	2	R26	R6	Erie N1	2
R4	B6	Erie N1	2				
R5	C2	Erie N1	2				
R6	C6	Erie 109	2	RLA	R8	Clare-Elliott RP7641G31	
R7	D7	Erie N1	2				
R8	E3	Erie N1	2				
R9	E6	Erie 109	2	RV1	G2	Reliance TW/1/8S/W N.1	10
R10	E5	Erie N1	2	RV2	G3	Reliance TW/1/8S/W N.1	10
R11	F4	Erie N1	2	RV3	N2	Plessey 404/1/00142/470	
R12	G4	Erie N1	2				

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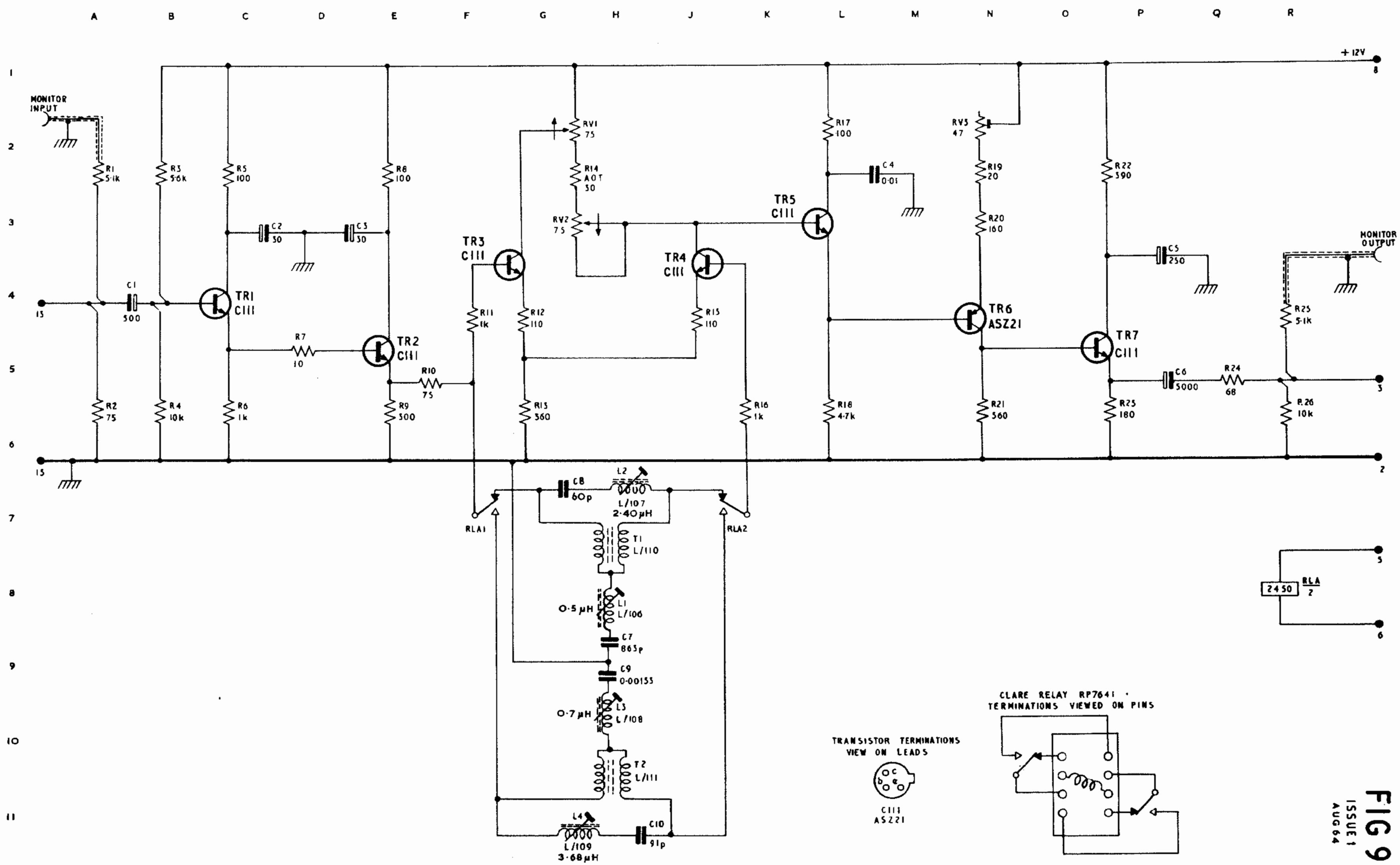

EQUALISER AMPLIFIER AM1/515: CIRCUIT

FIG 9
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V7
SECTION 1