EQUALISER EQ5/501

Introduction

The EQ5/501 is a portable test-equaliser which is used in the selection of component values for fixed equalisers; it provides variable attenuation correction from line frequency to the upper limit of the video band. The correction network is a non constant-resistance version of that in the fixed equaliser EQ5/503 which is described earlier in this Section. A non constant-resistance form is used because it contains half the number of variable components that would otherwise be required. The disadvantages of this form of circuit are not important in this equaliser because it is only used to obtain component values for fixed equalisers.

The effective basic (low-frequency) loss of the correction network can be varied from 1 dB to 20 dB in ten steps but the loss between the signal input and signal output plugs is maintained at approximately 26 dB for all settings of basic loss. The unit provides correction for a loss which is approximately proportional to the square root of the frequency.

All the resistors in the equaliser are Erie Type 109 with a tolerance of ± 1 per cent. The inductors are all wound on Neosid formers and the capacitors are the continuously-variable air spaced Rogers type C73-01/1E.

The input and output connections to the unit are made through Musa coaxial plugs.

The dimensions of the unit with the lid in place are $16\frac{3}{4}$ in. by $5\frac{1}{4}$ in. by $5\frac{3}{8}$ in.

Circuit Description (Fig. 6)

The circuit diagram of the equaliser EQ5/501 is shown in Fig. 6. The equaliser can provide five sections of attenuation correction. Four sections are of the non-resonant type and the fifth section, which contains L11, can be made either resonant or non-resonant. The stepped resistors in the non-resonant sections are graded so that R12 has the lowest values and R13, R14 and R15 have progressively higher values. Each value of R15 is roughly twenty times greater than the corresponding value of R12.

The low-frequency correction is controlled by R15 and C15, while the high frequency correction is controlled by C11 and L11. The remaining sections of the network determine the correction at the intermediate frequencies.

The stepped variable-attenuator formed by R16, R17 and R18, determines the basic loss of the correction network. It is ganged to a second variable attenuator formed by R19, R20 and R21; this second attenuator adjusts the total loss between the signal input and signal output plugs to be 26 dB for all settings of basic loss. The control which operates the attenuators is labelled *Nominal Pad Loss* and the settings are marked in values of basic loss in the correction network.

The input impedance of the equaliser decreases from 75 ohms to 25 ohms at some settings of the *Nominal Pad Loss* control. A 14-dB masking pad is therefore included in the unit to provide a good termination for the cable or network which is to be equalised. When the pad is used, the input impedance of the unit will vary only between 75 ohms and 72 ohms.

The output impedance may become much less than 75 ohms but normally this does not matter.

The Use of the EQ5/501

General

The variable equaliser is used in the selection of component values for fixed equalisers EQ5/503 and EQ5/510. The selection procedure is outlined here and a full description is included in Designs Department Technical Memorandum No. 6.19(58) entitled *A Method of Equalising Cables for Video Transmission.* It is assumed here that a fixed equaliser is being used to equalise a cable such as a studio tie-line.

Additional Test Equipment Required

Pulse-and-bar generator, 405 or 625 line standards as appropriate.
Oscilloscope suitable for use with sine squared pulses.
40-dB video amplifier such as the TV/A/1.

Procedure

1. Connect the output of the pulse-and-bar generator directly to the oscilloscope. Examine the 1T pulse-and-bar waveform on the oscilloscope and note any imperfections.
2. If an amplifier is used to compensate for the loss of the equalised cable, check its frequency response. Connect the amplifier between the pulse-and-bar generator and the oscilloscope.

If the frequency response is satisfactory the effect of the amplifier on the shape of the pulse-and-bar waveform is negligible.

3. Disconnect the compensating amplifier and connect the variable equaliser EQ5/501 through its input pad to the pulse-and-bar generator. Connect the output of the EQ5/501 through the 40-dB test amplifier to the oscilloscope. Set the variable equaliser to provide no correction by selecting the value of both L11 and R12 to be infinity. The 40-dB amplifier and the variable equaliser should have negligible effect on the pulse-and-bar waveform. Note carefully the exact shape of the waveform now displayed because this shape must be reproduced when selecting settings for the variable equaliser.
4. Remove the pulse-and-bar generator and connect it to the sending end of the cable. Connect the variable equaliser through its input pad to the receiving end of the cable. Leave the output of the equaliser connected to the oscilloscope through the 40-dB amplifier. With the variable equaliser set to provide no correction, measure the pulse/bar ratio. This shows the amount of high-frequency loss in the cable and therefore the amount of basic (low-frequency) loss required in the equaliser. Table 2 indicates the *Nominal Pad Loss* settings which are required with pulse/bar ratios from 37 per cent to 100 per cent. Use the table to obtain the required settings of *Nominal Pad Loss* and set the control to this value.
5. Select a value of zero for L11 and turn the controls for R12, R13, R14, C11, C12, C13 and C14 to their mid-scale positions. Select a value of infinity for R15 unless the cable length is greater than 1500 feet. The low-frequency section of C15 and R15 is not needed for cable lengths of less than 1500 feet.
6. Adjust the controls R12, R13, R14, C11, C12, C13 and C14 and if necessary R15 and C15 to make the pulse-and-bar waveform the same shape as the waveform noted in operation 3 of the procedure. Do not turn the control L11 from the zero position unless the correct pulse-and-bar ratio cannot otherwise be obtained without producing overshoots on the bar.
7. When the correct waveform has been obtained, note the settings of all the controls in the variable equaliser. These are converted into component values for the fixed equaliser by means of a conversion factor known as the K scale factor.

TABLE 2

IT Pulse/Bar Ratio Per Cent	*Nominal Pad Loss Setting dB*
59 to 100	1
91 to 95	2
87 to 91	3
83 to 87	4
79 to 83	5
69 to 79	8
60 to 69	11
52 to 60	14
44 to 52	17
37 to 44	20

Obtain the value of K corresponding to the *Nominal Pad Loss* setting from the table in Fig. 6. Also note the value of R1 for the fixed equaliser from this table.

8. Calculate first the component values for the series sections in the fixed equaliser. Multiply the resistance and inductance settings of the variable equaliser by K to determine the value of the corresponding component in the fixed equaliser. Obtain capacitance values by dividing the capacitor setting by K. When the series elements have been calculated, derive component values for the shunt elements from the relationship between the series and shunt elements. This relationship is

$$(Z \text{ series}) \times (Z \text{ shunt}) = R_o^2$$

where R_o is the characteristic resistance, which in the EQ5/503 and EQ5/510 is 75 ohms.

Hence, for example, $RA = (75)^2/R1$

$LA = (75)^2.C1$

$CA = L1/(75)^2$

$LB = (75)^2.C2$

Select resistors in the Erie 109 range which have the nearest values to the calculated values. If a resistor is required to have a value which

TABLE 3

Inductance (μH)	*No. of Turns*
0·21 to 0·33	3
0·30 to 0·50	4
0·47 to 0·90	6
0·70 to 1·5	8
1·2 to 2·6	12
2·0 to 4·5	17
2·5 to 6·0	20
3·0 to 7·5	25
6·0 to 11·0	35
8·0 to 20·0	36
15·0 to 35·0	60

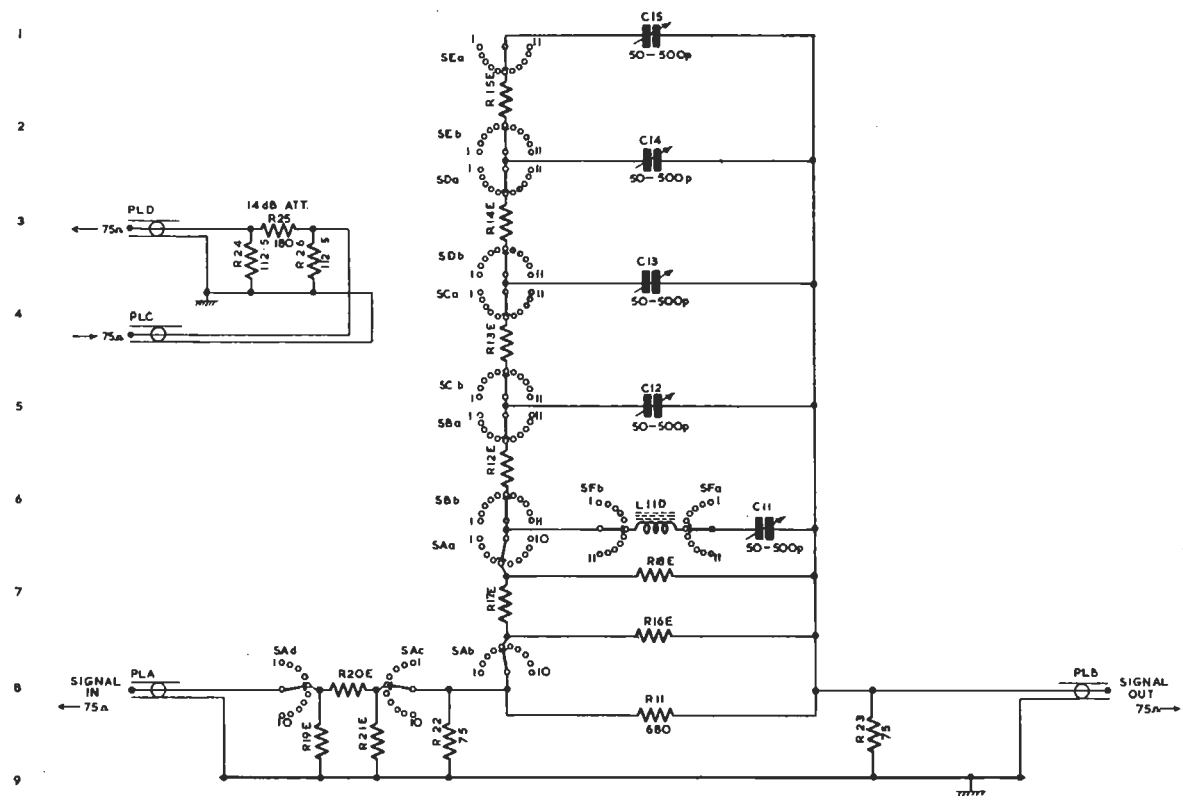
is outside the Erie 109 range then use a wire-wound resistor. Select the capacitors from the T.C.C. SM3N range or the T.C.C. CSM20 range. Form inductors by winding 30 s.w.g. enamelled copper wire on 6-mm by 1-mm Neosid formers. Use Table 3 to obtain the correct number of turns for the required inductance.

Coat finished coils with Distrine cement.

9. When the fixed equaliser has been constructed, check its input impedance and transmission characteristics using an Equaliser Tester TE1/502. The way to do this is outlined in the description of the TE1/502 earlier in this Section.

J.W. 4/66

FIG 6



DIALS OF SB-SE (R12-R18) ARE ENGRAVED AT EACH POSITION WITH RESISTANCE VALUE												
SWITCH POSITION		1	2	3	4	5	6	7	8	9	10	11
SB	CIRCUIT REF.		R12A	R12B	R12C	R12D	R12E	R12F	R12G	R12H	R12J	R12K
	VALUE	∞	180	220	270	330	390	470	560	680	820	1k
SC	CIRCUIT REF		R13A	R13B	R13C	R13D	R13E	R13F	R13G	R13H	R13J	R13K
	VALUE	∞	470	560	680	820	1k	1·2k	1·5k	1·8k	2·2k	2·7k
SD	CIRCUIT REF		R14A	R14B	R14C	R14D	R14E	R14F	R14G	R14H	R14J	R14K
	VALUE	∞	1·2k	1·5k	1·8k	2·2k	2·7k	3·3k	3·9k	4·7k	5·6k	6·8k
SE	CIRCUIT REF.		R15A	R15B	R15C	R15D	R15E	R15F	R15G	R15H	R15J	R15K
	VALUE	∞	3·9k	4·7k	5·6k	6·8k	8·2k	10k	12k	15k	18k	22k
SF	CIRCUIT REF.			L11A	L11B	L11C	L11D	L11E	L11F	L11G	L11H	L11J
	VALUE(μH)	O/C	0	0·84	1·26	1·86	2·62	3·82	5·62	8·45	12·6	15·6
	DIAL ENGRAVED	∞	0	0·84	1·24	1·86	2·62	3·82	5·62	8·42	12·4	18·6

TABLE OF K SCALE FACTOR & RJ FOR USE WITH EQ5/501 (SEE DB 5285)										
NOMINAL PAD LOSS	1dB	2dB	3dB	4dB	5dB	6dB	8dB	14dB	17dB	30dB
K SCALE FACTOR	·0563	·0838	0·115	0·16	0·198	0·227	0·487	0·626	0·791	1
VALUE OF RJ IN EQUALISER EQ5/502	8·2	20	30	43	56	110	200	300	470	680

ATTENUATOR SA										
SWITCH POSITION	1	2	3	4	5	6	7	8	9	10
DIAL ENGRAVED	1dB	2dB	3dB	4dB	5dB	6dB	11dB	14dB	17dB	30dB
CIRCUIT REF.	R16A	R16B	R16C	R16D	R16E	R16F	R16G	R16H	R16J	
VALUE	330	432	503	598	673	1·022k	1·71k	2·77k	5·91k	∞
CIRCUIT REF	R17A	R17B	R17C	R17D	R17E	R17F	R17G	R17H	R17J	
VALUE	457	282	228	181	152·5	94·2	54·3	33·3	15·6	0
CIRCUIT REF.	R18A	R18B	R18C	R18D	R18E	R18F	R18G	R18H	R18J	
VALUE	338	433	508	598	673	1·022k	1·71k	2·77k	5·91k	∞
CIRCUIT REF	R19A	R19B	R19C	R19D	R19E	R19F	R19G	R19H	R19J	
VALUE	150	150	150	150	150	200	270	360	620	∞
CIRCUIT REF.	R20A	R20B	R20C	R200	R20E	R20F	R20G	R20H	R20J	
VALUE	100	100	100	90·1	75·6	66·5	45·15	32·67	16·61	0
CIRCUIT REF.	R21A	R21B	R21C	R21D	R21E	R21F	R21G	R21H	R21J	
VALUE	150	150	150	160	180	200	270	360	620	∞

NOTES.
1. LOW FREQUENCY LOSS AT ALL SETTINGS OF PAD ≙ 26dB
2. SWITCHES ARE SHOWN EQUIPPED IN ONE POSITION ONLY. FOR OTHER COMPONENTS REFER TO TABLES.

VARIABLE EQUALISER EQ5/501: CIRCUIT