QUADRAPHONY - MATRIX H DATA

CONTENTS

DOMESTIC QUADRAPHONIC MATRIX H EQUIPMENT — GENERAL DATA

ENCODER

Frequency response — 30 Hz — 15 kHz $\pm$ 0.3 dB amplitude, $\pm$ 3° phase.

Matrix H transfer characteristic

$$\begin{bmatrix} L_T \\ \\ R_T \end{bmatrix} = \begin{bmatrix} 0.940\ e^{j10^{\circ}}, & 0.342\ e^{j65^{\circ}}, & 0.940\ e^{-j25^{\circ}}, & 0.342\ e^{-j115^{\circ}} \\ \\ 0.342\ e^{-j65^{\circ}}, & 0.940\ e^{-j10^{\circ}}, & 0.342\ e^{j115^{\circ}}, & 0.940\ e^{j25^{\circ}} \end{bmatrix} \begin{bmatrix} L_F \\ R_F \\ L_B \\ R_B \end{bmatrix}$$

DECODER — "SIMPLIFIED MATRIX H LOGIC DECODER" (see ref. 1*)

2 inputs, L_T and R_T

4 outputs, L_F, R_F, L_B, R_B corresponding to the respective encoder inputs and designed to feed four loudspeakers placed at the corners of a square centred on the listening position.

Input levels — Operating level 300 mV, overload margin +20 dB (3 V).

Frequency response — Overall power response is approximately constant over the audio band 30 Hz — 15 kHz, but individual outputs are not constant with frequency. The attached test-chart gives typical output figures measured at 1 kHz for checking decoder operation. Figure 9 of ref. 1 gives typical curves of separation versus frequency for a L_f source.

Gain — Nominally unity

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* Ref. 1 : Gaskell, P.S. and Ratliff, P.A. Quadraphony : developments in Matrix H decoding. BBC Research Department Report No. 1977/2.

BBC MATRIX H TEST CHART

INPUT 0dB Test Tone Applied (300mV)*	ENCODER OUTPUT — Level, dB — L_T	R_T	M $\frac{1}{2}(L_T + R_T)$	S $\frac{1}{2}(L_T - R_T)$	Phase-difference $L_T - R_T$	Typical DECODER OUTPUT at 1kHz — Level, dB — L_F	R_F	L_B	R_B
C_F	1.4	1.4	6.6	-0.5	47°	0	0	-15	-15
C_B	0	0	3.0	3.0	-90°	-15	-15	-1	-1
L_F	-0.5	-9.3	0.7	-0.8	75°	0	-20	-16	-30
R_F	-9.3	-0.5	0.7	-0.8	75°	-20	0	-30	-16
L_B	-0.5	-9.3	-3.0	1.7	-140°	-13	-22	0	-17
R_B	-9.3	-0.5	-3.0	1.7	-140°	-22	-15	-15	0
C_L	5.1	-∞	5.1	5.1	n/a	+2	-15	+1	-20
C_R	-∞	5.1	5.1	5.1	n/a	-15	+2	-20	+1

tolerances: phase-difference ± 3°, level ± 0.3 dB

in frequency range 30 Hz — 15 kHz.

*0 dB tone applied to C_F implies 0 dB tone applied equally to both L_F and R_F inputs.

Quick check on encoder :—   for C_F input $L_T = R_T$, M — S ≃ 7 dB

C_B input $L_T = R_T$, M = S

corner input $|L_T - R_T|$ ≃ 9 dB, $|M - S|$ ≃ 1.5 dB (front)

≃ 4.7 dB (back)

LINE-UP PROCEDURE - DECODER

1. Set pots "f", "b", "l", "r" on decoder board to their approximate centre positions.

2. For a C_F encoded, 1 kHz source at 300 mV, adjust pot "b" to give maximum separation (about 15 dB) from L_F and R_F to L_B and R_B.

3. For a C_B encoded source, adjust pot "f" to give maximum separation (about 15 dB) from L_B and R_B to L_F and R_F.

4. For a L_F encoded source, adjust pot "l" to give about 16 dB of separation from L_F to L_B.

5. For a R_F encoded source, adjust pot "r" to give about 16 dB of separation from R_F to R_B.

To arrive at a final optimisation of the separations for all the cardinal source positions, it may be necessary to make minor adjustments to the pot settings. The levels of the principal decoded signals should be within 0.5 dB of the quoted values for C_F and C_B sources and within 1 dB for other sources; if necessary, level correction can be applied in the output channels. Crosstalk signal levels should be close to or less than the quoted values.

Matrix H — Domestic Decoder

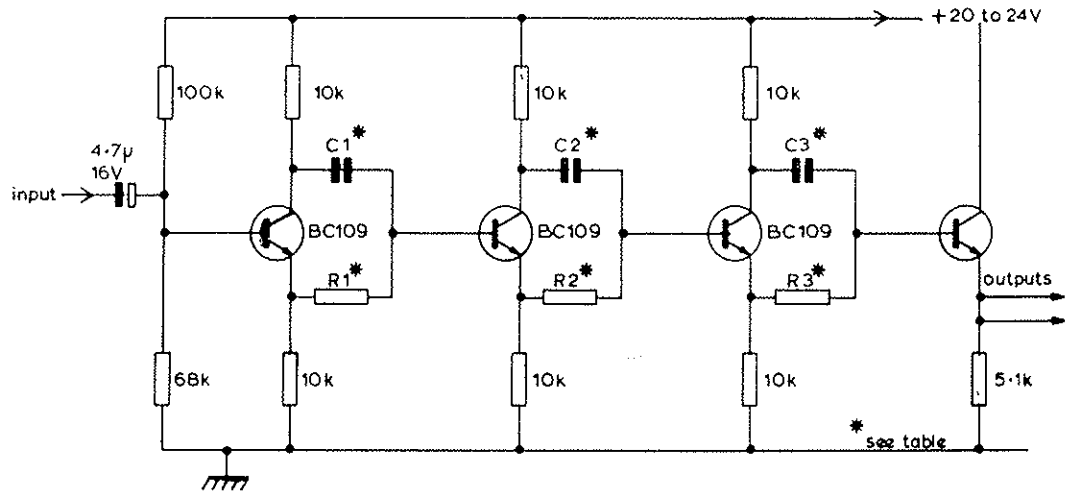### Block Diagram   (-equivalent to that in fig 10 of draft report)
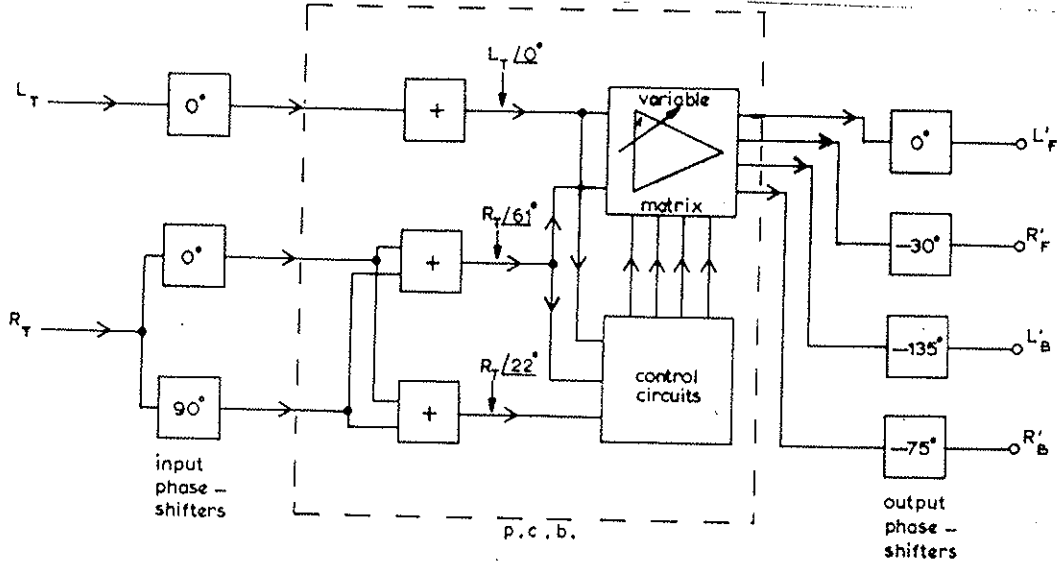
Ancillory ciruits to variable matrix section
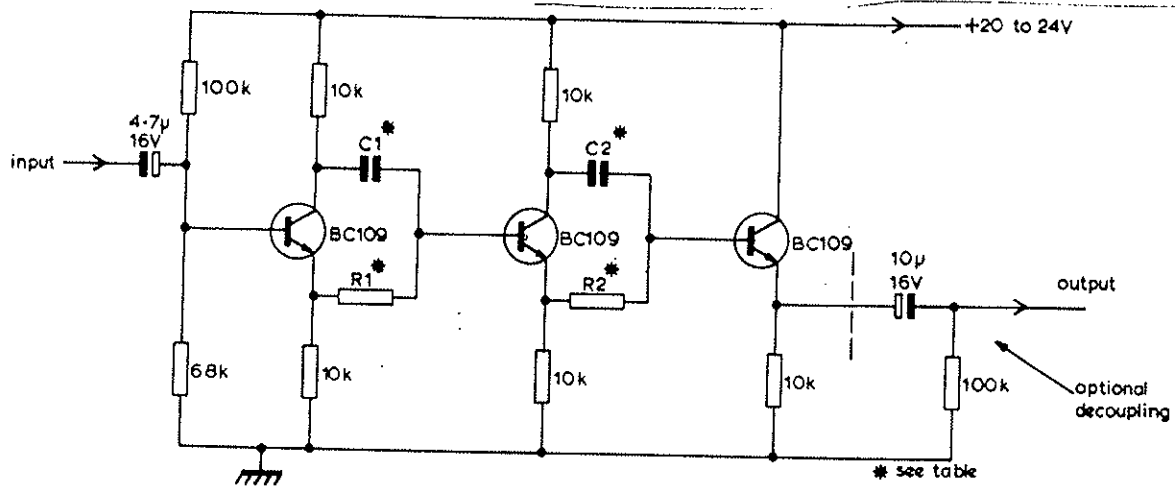
Channel	Phase shift	C_1	R_1	C_2	R_2
L_F	θ°	22 n	33.6 k	1.0 n	37.4 k
R_F	$(\theta - 30)^{\circ}$	22 n	60.3 k	1.0 n	63.7 k
L_B	$(\theta - 135)^{\circ}$	220 n	39.1 k	10 n	45.5 k
R_B	$(\theta - 75)^{\circ}$	47 n	60.5 k	3.3 n	42.7 k

All resistors 2% metal oxide or film, C2 - 2% polystyrene
C1 - 5% polycarbonate.

Output Phase-Shift Circuit

Table (Input Phase-shift Circuit):

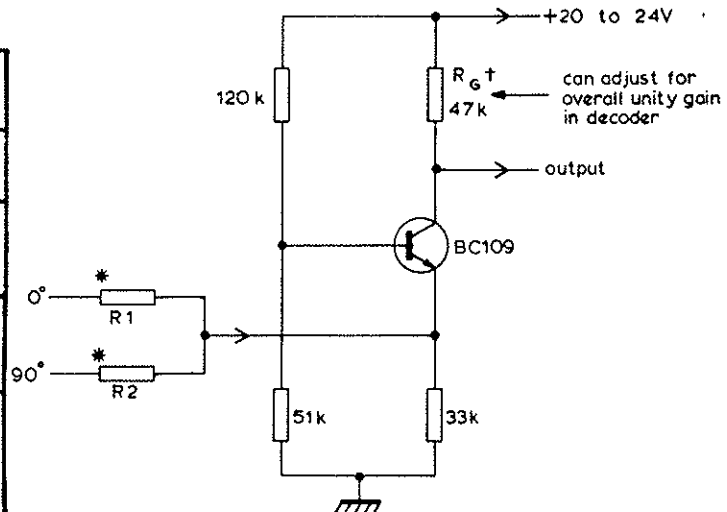| Phase shift	C_1	R_1	C_2	R_2	C_3	R_3
$\emptyset^\circ$	150 n (or 220 n)	52.3 k (or 35.6 k)	8.2 n	54.6 k	680 p	51.0 k
$(\emptyset + 90)^\circ$	33 n (or 47 n)	49.2 k (or 34.5 k)	8.2 n	57.2 k	150 p	47.9 k

All resistors 2% metal oxide or film, Cl – 3 2% polystyrene or 5% polycarbonate for large values.

Input Phase-shift Circuit

Summation Circuit

(alternative to input MC1439 adders on the p.c.b.)

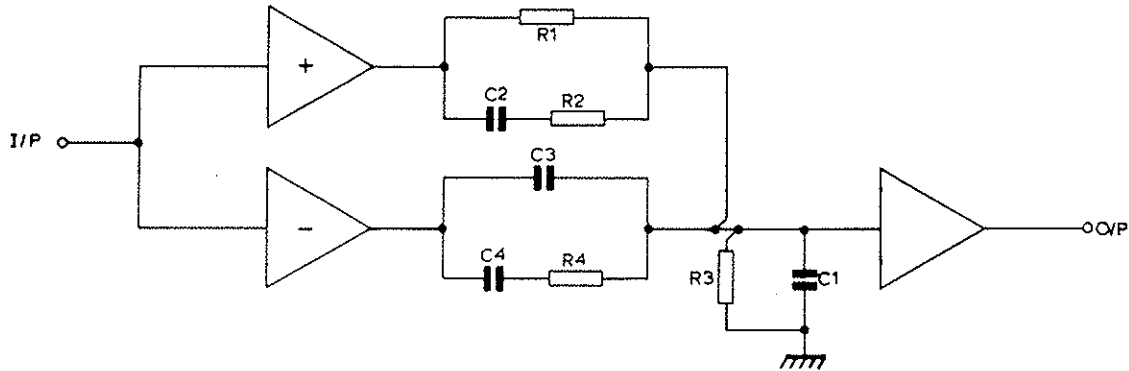| $\emptyset$	R1 †	R2 †
0°	47K	∞
22°	51K	120K
67°	120K	51K
45°	66.5K	66.5K
	(use say 68K resistors)	

† 2% metal oxide or film

* resistor value = 47K/matrix coefficient

Alternative configuration for input phase-shift circuit

Albersheim and Shirley network — reference IEEE transactions on circuit theory 16, 2nd May 1969.

	'B' network	'A' network
R1	30.30	144.6
R2	1.737	3.240
R3	13.51	64.49
R4	4.417	11.52
C1	5.026	12.86
C2	28.12	39.33
C3	2.242	5.733
C4	100	100

R's in KΩ, C's in nF.

'B' leads 'A' by 90°.

Insertion loss of both 'A' and 'B' networks = 10.2 dB.

Component values to be within 2% of quoted values.

Estimated phase accuracy = $\pm 7^\circ$.

The driving impedances should have suitably low values (less than 50Ω).