D.C. VOLUME AND BALANCE STEREO CONTROL CIRCUIT

The TCA730A is a monolithic integrated circuit for controlling volume and balance in stereo amplifiers by means of a d.c. voltage.

Features:
- physiological volume control
- balance control
- internal amplifier
- high-ohmic signals inputs
- internal supply voltage stabilization
- converter for the control voltage

QUICK REFERENCE DATA

Supply voltage (pin 8)	V_P	typ.	15	V
Supply current (pin 8)	I_P	typ.	35	mA
Input voltage range (r.m.s. value)	$V_{i(rms)}$		0,1 to 1,7	V
Nominal input voltage; m = 1 (r.m.s. value)	$V_{i(rms)}$	typ.	0,5	V
Input resistance	R_i	typ.	250	kΩ
Output voltage at nominal output power (r.m.s. value)	$V_{o(rms)}$	typ.	1	V
Volume control range	G_v		+20 to −80	dB
Channel balance	ΔG_v	typ.	1	dB
Balance control range	G_v		+5 to −7	dB
Total distortion at $V_{o(rms)}$ = 1 V	d_{tot}	typ.	0,1	%
Channel separation	α	typ.	55	dB
Signal-to-noise ratio	S/N	typ.	67	dB
Frequency response (−1 dB)			20 Hz to 20	kHz
Volume control voltage range	V_{13-15}		2 to 9,5	V
Balance control voltage range	V_{12-15}		2,5 to 9,0	V
Supply voltage range (pin 8)	V_P		13,5 to 16,5	V
Ambient temperature range	T_{amb}		−30 to +80	°C

PACKAGE OUTLINE
16-lead DIL; plastic (SOT-38).

(1) $6,6 \, V_{BE}$; $V_1 = 4,6$ V
(2) $0,35 \, V_P + 0,65 \, V_{BE}$; $V_2 = 5,7$ V.
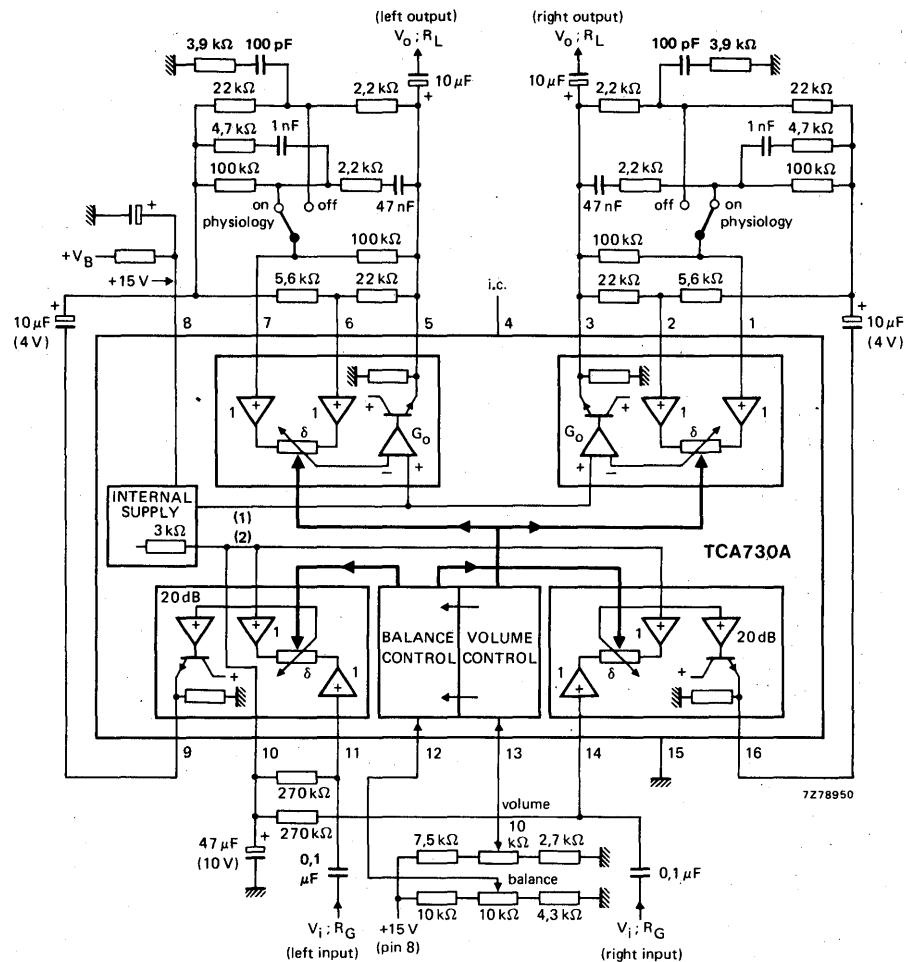
Fig. 1 Block diagram with external circuitry.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage (pin 8)	V_P	max.	18 V
Input voltages	$V_{11\text{-}15}; V_{14\text{-}15}$	min. max.	0 V V_P V
Control voltages	$V_{12\text{-}15}; V_{13\text{-}15}$	min. max.	−5 V 12 V
Total power dissipation	P_{tot}	max.	900 mW
Storage temperature range	T_{stg}		−55 to +150 °C
Operating ambient temperature range	T_{amb}		−30 to +80 °C

CHARACTERISTICS

V_P = 15 V; T_{amb} = 25 °C; measured in Fig. 1; balance control in mid-position ($V_{12\text{-}10}$ = 0); physiology switch off; f = 1 kHz; R_G = 22 kΩ; R_L = 5,6 kΩ; unless otherwise specified.

Supply voltage range (pin 8)	V_P		13,5 to 16,5 V
Supply current	I_P	typ.	35 mA 25 to 43 mA

Control range

Voltage gain range	G_V		0 to 20 dB
Voltage gain at $V_{13\text{-}15}$ = 9,5 V (0,63 V_P)	G_V	typ.	20 dB 18 to 22 dB
Voltage attenuation range	G_V		0 to −80 dB
Voltage attenuation at $V_{13\text{-}15}$ = 3 V (0,2 V_P)	G_V	$>$ typ.	−75 dB −80 dB
Balance control range at G_V = −10 dB			+5 to −7 dB

Control inputs

Recommended control voltage range			
volume	$V_{13\text{-}15}$		2 to 9,5 V
balance	$V_{12\text{-}15}$		2,5 to 9,0 V
Control voltage for G_V = −10 dB; $V_{12\text{-}10}$ = 0	$V_{13\text{-}15}$		6,7 to 7,1 V*
Control voltage for balance 0 dB; $V_{13\text{-}15}$ = 6,9 V	$V_{12\text{-}10}$	typ. 0 ± 0,2 V	
Internal supply voltage (0,35 V_P + 0,65 V_{BE})	$V_{10\text{-}15}$	typ.	5,9 V 5,7 to 6,1 V
Output resistance (pin 10)	$R_{o}10$	typ.	3 kΩ
Control current			
volume ($V_{13\text{-}15}$ = 6,9 V)	I_{13}	typ. $<$	15 µA 50 µA
balance ($V_{12\text{-}15}$ = 5,9 V)	I_{12}	typ. $<$	8 µA 25 µA
Input resistance			
pin 13 (volume)	$R_{i}13$	typ.	500 kΩ
pin 12 (balance)	$R_{i}12$	typ.	600 kΩ

* Typical value 6,9 V.

CHARACTERISTICS (continued)

Signal processing

Frequency response (−1 dB)	f		20 Hz to 20 kHz
Input resistance; $R_{11\text{-}10} = R_{14\text{-}10} = 270$ kΩ (pins 11; 14)	$R_{i11;14}$	typ.	250 kΩ
Output resistance (pins 3; 5)	$R_{o3;5}$	typ.	10 Ω
Maximum input voltage; $V_{o(rms)} < 1$ V; $d_{tot} = 0{,}7$ % (r.m.s. value)	$V_{i(rms)}$	>	1,3 V
		typ.	1,7 V
Maximum output voltage; $V_{i(rms)} < 1$ V; $d_{tot} = 0{,}7\%$ (r.m.s. value)	$V_{o(rms)}$	>	1,8 V
		typ.	2,0 V
Nominal input voltage; m = 1 (r.m.s. value)	$V_{i(rms)}$	typ.	0,5 V
Nominal output voltage at nominal output power (r.m.s. value)	$V_{o(rms)}$	typ.	1 V
Total distortion			
$V_{o(rms)} = 1$ V; G_v = maximum	d_{tot}	typ.	0,07 %
		<	0,2 %
$V_{o(rms)} = 1$ V; $V_{i\ (rms)} = 1$ V	d_{tot}	typ.	0,2 %
$V_{o(rms)} = 50$ mV; $V_{i(rms)} = 150$ mV	d_{tot}	typ.	0,03 %
		<	0,1 %
$V_{o(rms)} = 50$ mV; $V_{i(rms)} = 1$ V	d_{tot}	typ.	0,2 %
Output noise voltage; f = 20 Hz to 20 kHz			
signal plus noise voltage (r.m.s. value)			
$G_v = -60$ dB	$V_{no(rms)}$	typ.	6 μV
$G_v = -10$ dB	$V_{no(rms)}$	typ.	15 μV
G_v = maximum (+20 dB)	$V_{no(rms)}$	typ.	100 μV
noise voltage; weighted conform DIN45405 (peak value)			
$G_v = -60$ dB	$V_{no(m)}$	typ.	15 μV
$G_v = -10$ dB	$V_{no(m)}$	typ.	35 μV
		<	80 μV
G_v = maximum (+20 dB)	$V_{no(m)}$	typ.	230 μV
		<	350 μV
Channel separation; $G_v = \pm20$ dB; $V_i = V_o < 1$ V			
f = 250 Hz to 12,5 kHz	α	>	52 dB
		typ.	53 dB
f = 40 Hz to 16 kHz	α	>	46 dB
		typ.	50 dB
Channel balance			
$G_v = +15$ to -50 dB	ΔG_v	typ.	1 dB
		<	2 dB
$G_v < 50$ dB	ΔG_v	typ.	2 dB

Amplifier characteristics

Input resistance (pins 11 and 14)	$R_{i11;14}$	>	3 MΩ
D.C. output voltages			
(0,35 V_P − 1,35 V_{BE})	V_{3-15}; V_{16-15}	typ.	4,2 V
(6,6 V_{BE})	V_{3-15}; V_{16-15}	typ.	4,6 V
Quiescent input currents (pins 1,2,6,7,11,14)	I_1; I_2; I_6; I_7; I_{11}; I_{14}	typ. <	0,5 μA 2 μA
Input resistance (pins 1,2,6 and 7) of physiology; without external circuitry	$R_{i1;2;6;7}$	>	1 MΩ
Internal load resistance at outputs (pins 3,5,9,16)	R_{3-15}; R_{5-15}; R_{9-15}; R_{10-15}	typ.	2 kΩ
Maximum gain; no load	G_{3-1}; G_{3-2}; G_{5-6}; G_{5-7}	> typ.	40 dB 43 dB
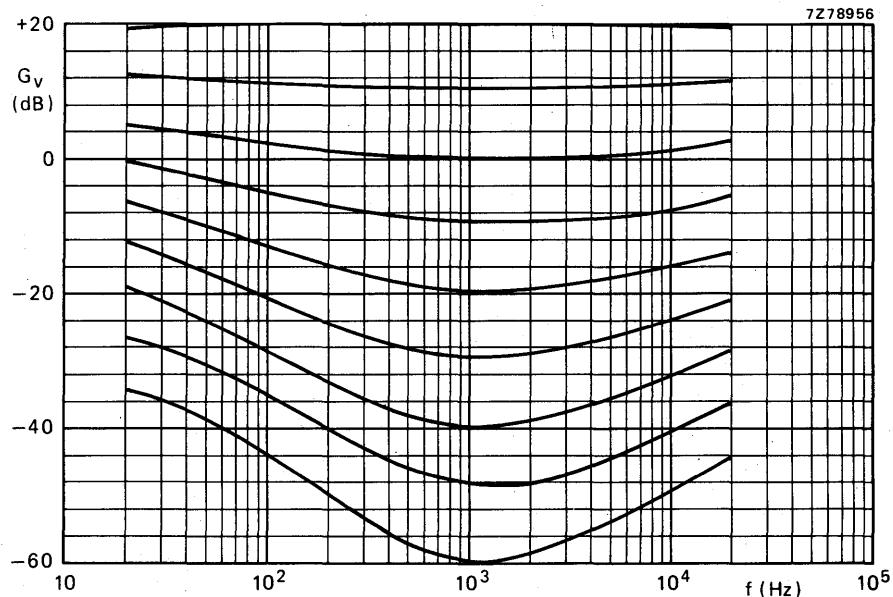
Fig. 2 Frequency response volume control with physiology.

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G_v (dB)

+40

0

−40

−80

0   5 V_{13-15} (V)   10
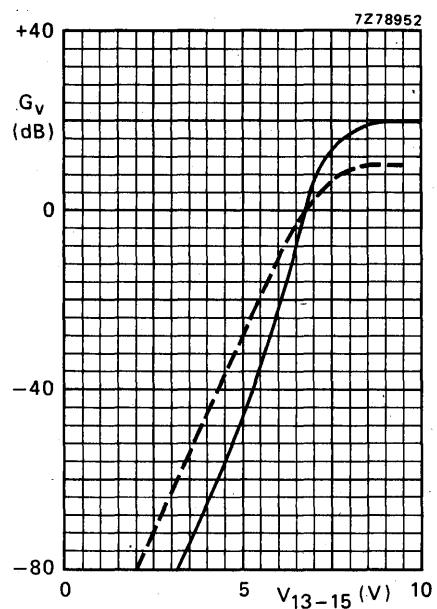
Fig. 3 Volume control curves; without physiology; balance = 0; V_{12-10} = 0.

——— G_v tot; G_v 5-11; G_v 3-14

——— G_v 9-11; G_v 16-14

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$G_{v tot}$ (dB)

+40

0

−40

−80

0   0,5 α/α_{max} 1

+15 V

7,5 kΩ   16 kΩ

100 kΩ (lin.) on   1 α → to pin 13
                    0

2,7 kΩ   13 kΩ

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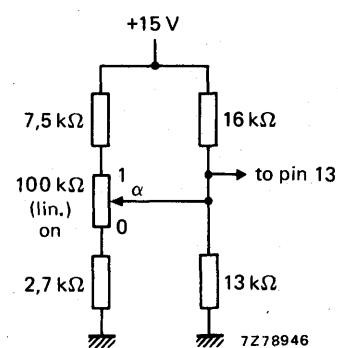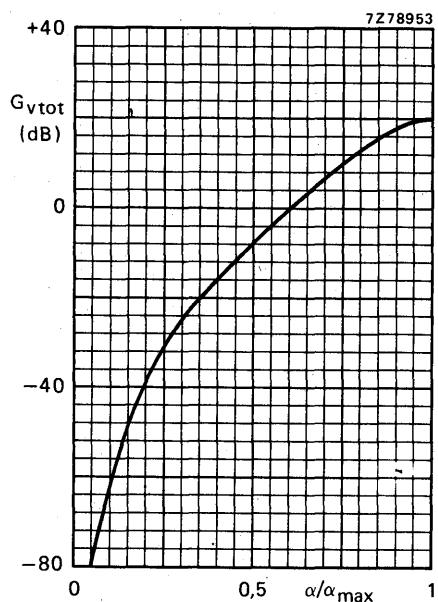
Fig. 4 Volume adjustment curve; balance = 0; V_{12-10} = 0.

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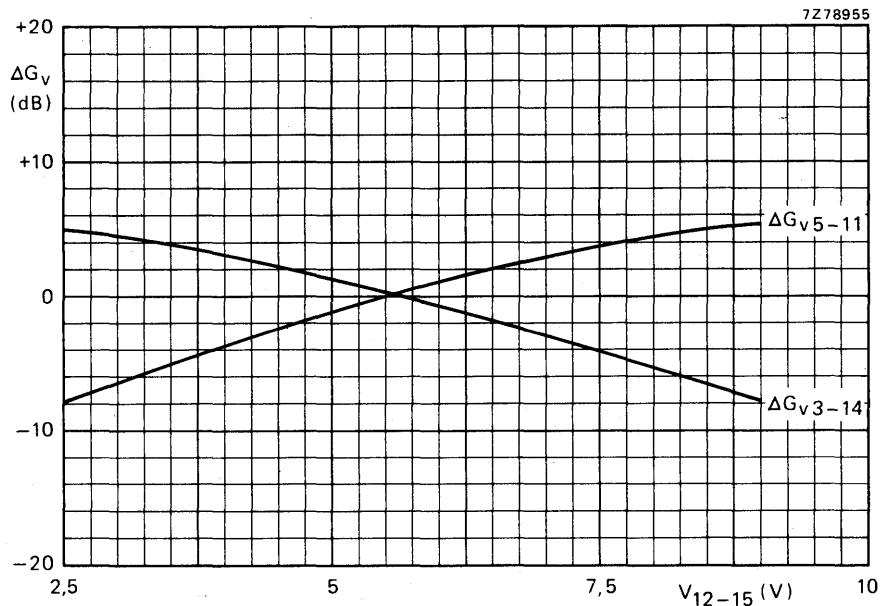
Fig. 5 Balance control curves; $G_{v\,tot}$ = −10 dB ($V_{13\text{-}15}$ = 6,9 V); for balance = 0.

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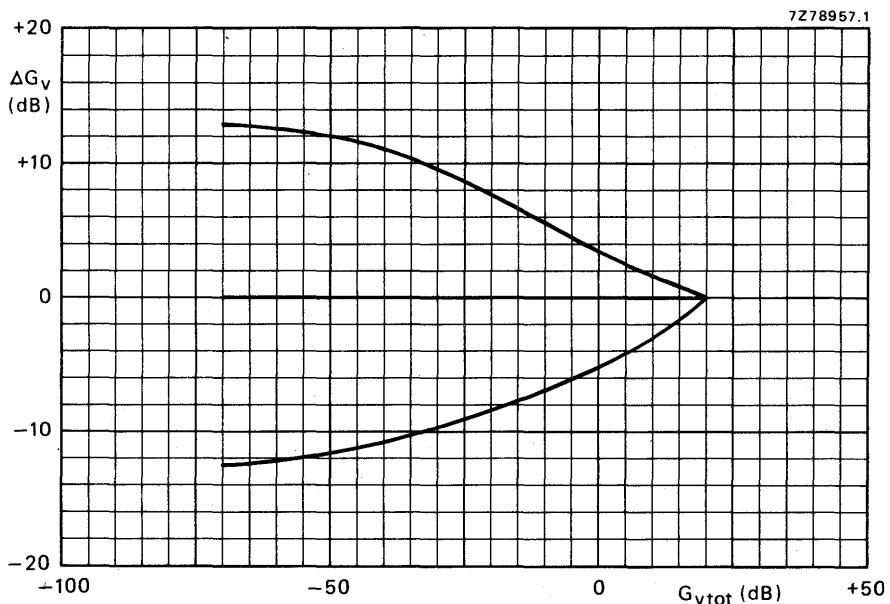
Fig. 6 Balance control range; $V_{12\text{-}15}$ = 2,5 to 9,0 V.

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G_v (dB)

+20

(1)

0

(2)

(3)

(6)

(7)

-20

(5)

(4)

-40

10   10^2 10^3 10^4 f (Hz) 10^5
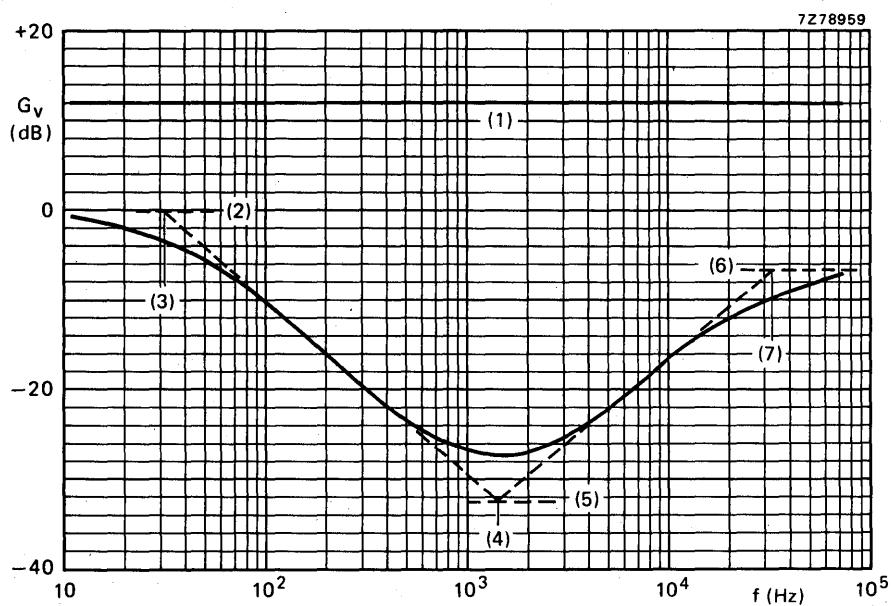
(1) $G_v = R2/R1$
(2) $G_v = R42/R31$
(3) $G_v = 1/2\pi \cdot R42 \cdot C42$
(4) $G_v = 1/2\pi \cdot R41 \cdot C31 = 1/2\pi \cdot R31 \cdot C31$
(5) $G_v \approx R41/R32$
(6) $G_v \approx R41/R32$
(7) $G_v = 1/2\pi \cdot R32 \cdot C31$

V2

G_o

δ

1(7)   2(6)   3(5)

5,6 kΩ R1   R2 22 kΩ

V_i → C_c

100 kΩ R31   R42 100 kΩ   → V_o

4,7 kΩ 1 nF   47 nF 2,2 kΩ

R32 C31   C41 R41   7Z78947
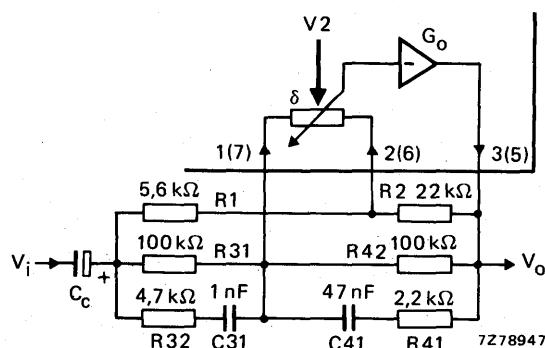
Fig. 7 Frequency response of the physiology part.
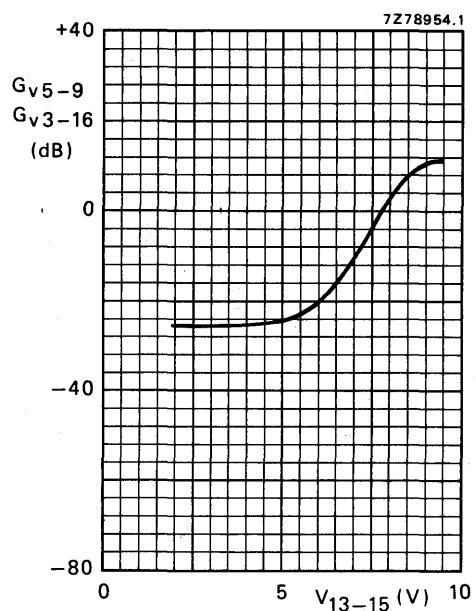
Fig. 8 Physiology control curve; f = 1 kHz; balance = 0; $V_{12\text{-}15}$ = 0.

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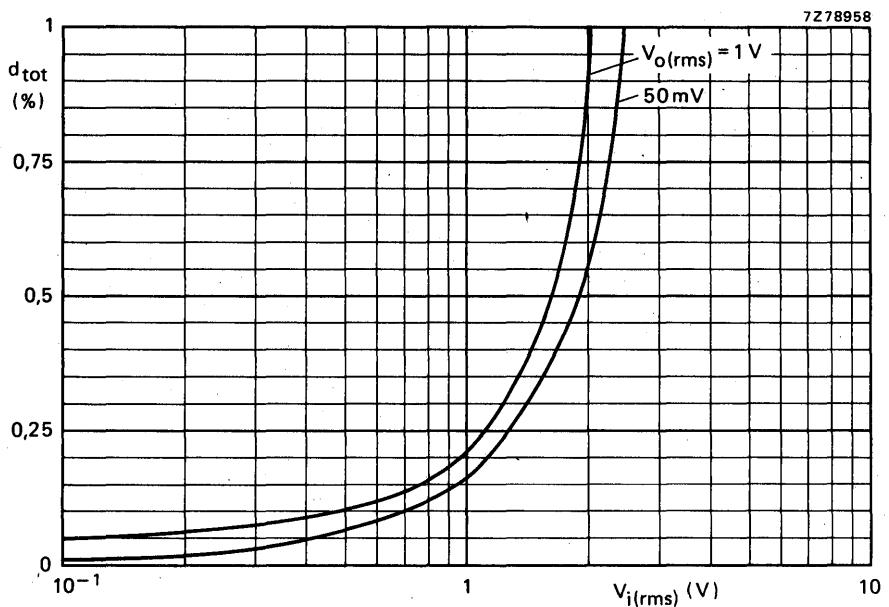
Fig. 9 Total distortion as a function of r.m.s. input voltage; f = 1 kHz; R_L = 5,6 kΩ.

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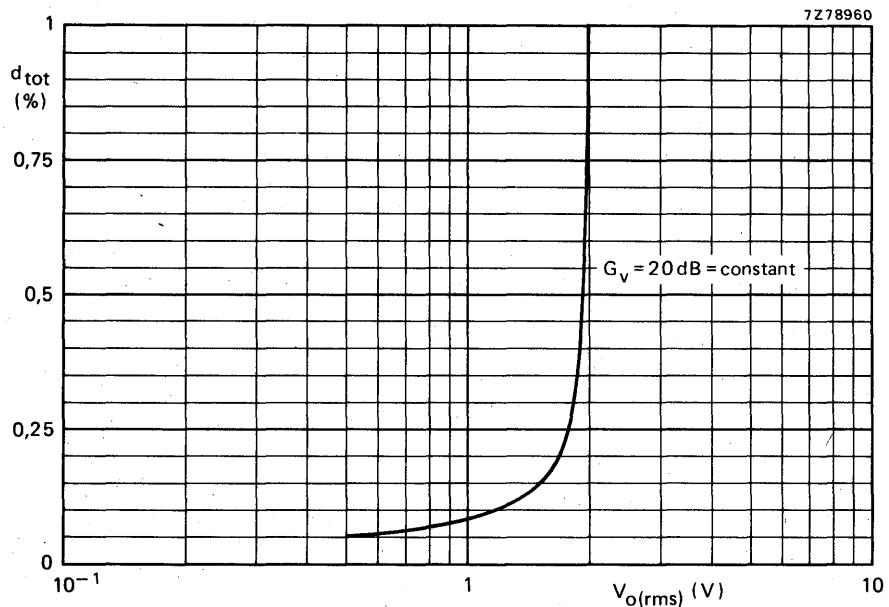

Fig. 10 Total distortion as a function of r.m.s. output voltage; f = 1 kHz; R_L = 5,6 kΩ.

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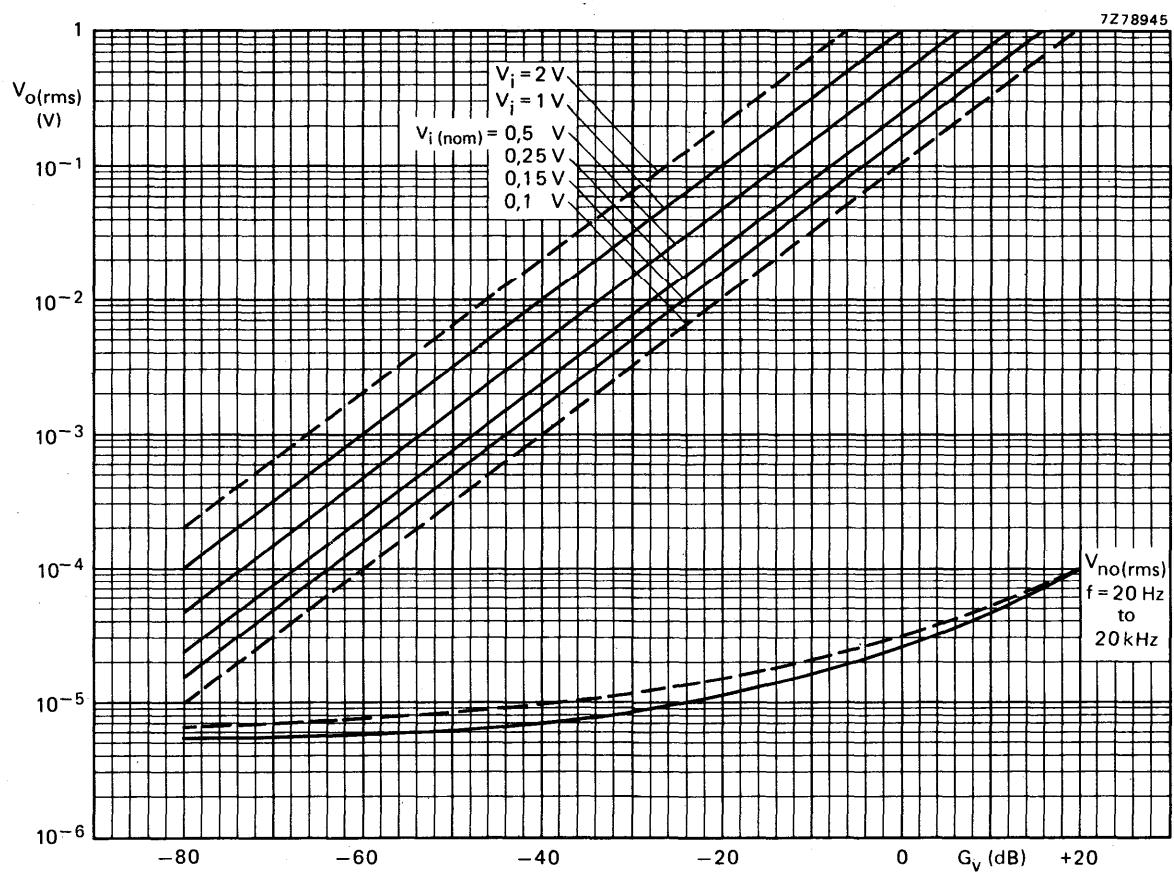
Fig. 11 The r.m.s. output voltage as a function of voltage gain; $P_{o(nom)}$ relative to $V_{o(rms)} = 1$ V:
——— without physiological volume control; ——— with physiological volume control.

APPLICATION INFORMATION

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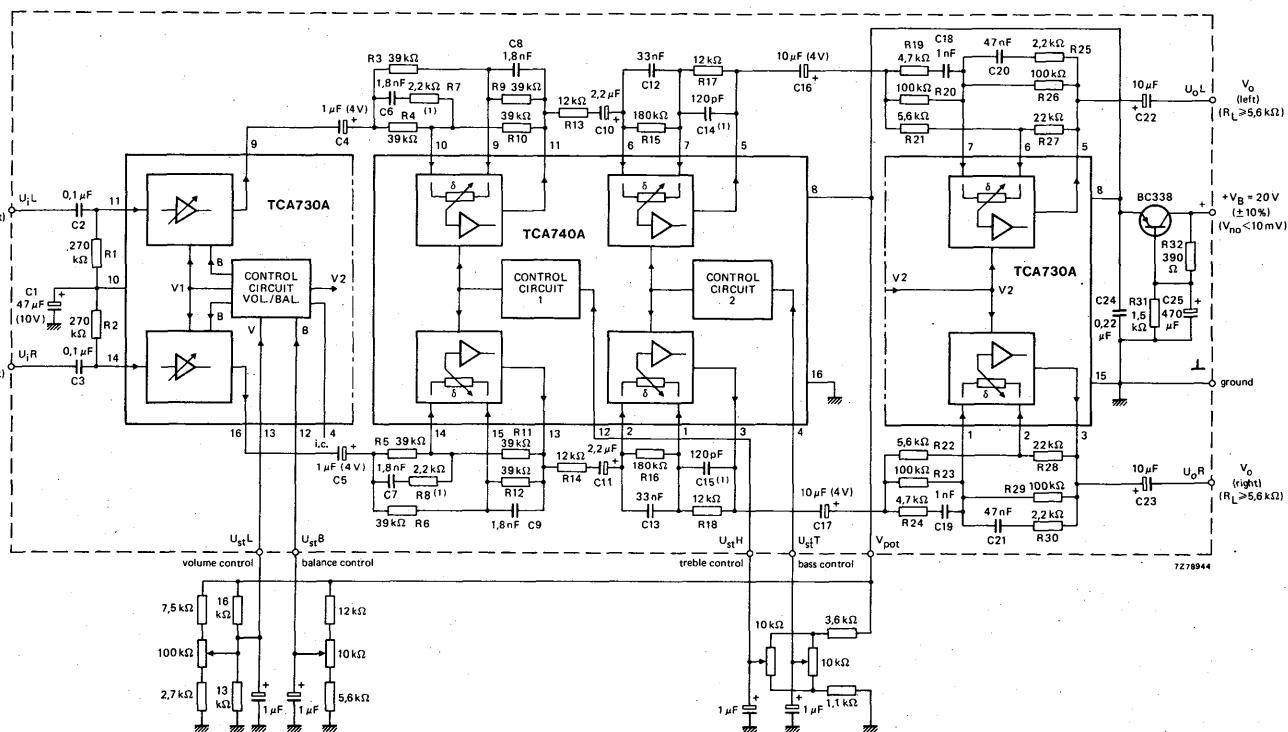
(1) RC network for limiting treble boost (linear: $f_{-3\,dB} = 100$ kHz).

Fig. 12 Application diagram for TCA730A and TCA740A. For printed-circuit board see Fig. 13.

right input   left input   balance volume   bass treble   +V$_B$ left output ground   right output

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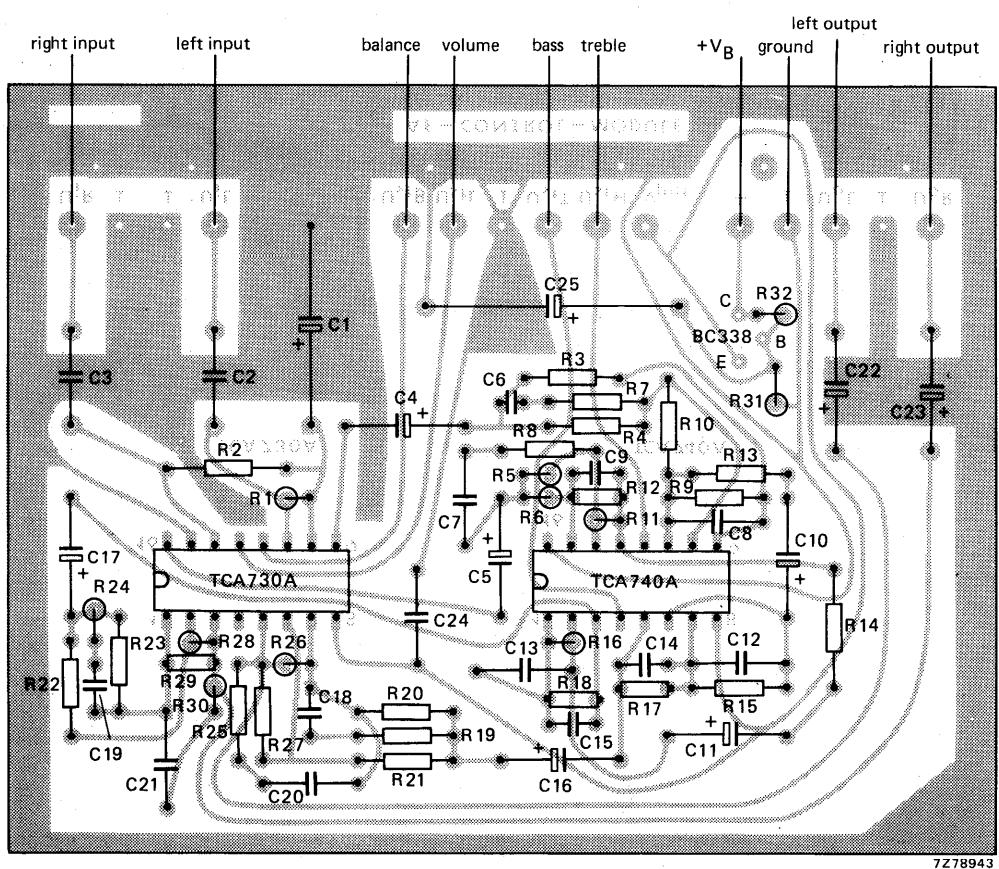
Fig. 13 Printed-circuit board component side, showing component layout; for circuit diagram see Fig. 12.

APPLICATION INFORMATION (continued)
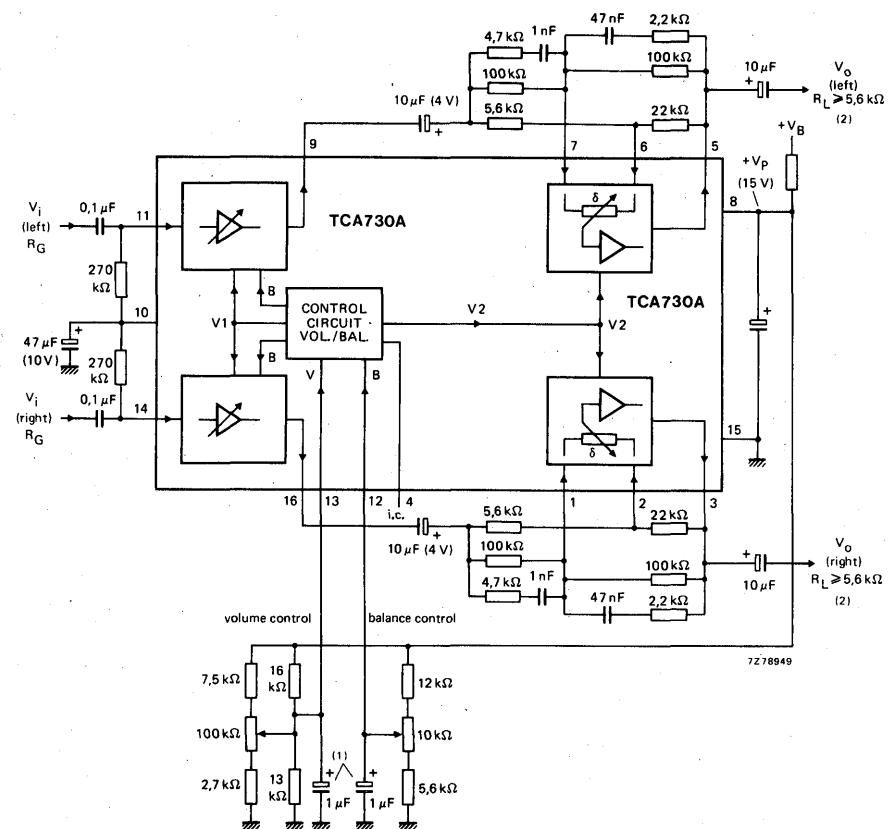
(1) $C_{13\text{-}15} = C_{12\text{-}15} = 1\,\mu F$ are intended for suppression of the noise when adjusting the mechanical potentiometers.

(2) For rejecting noise, caused by switching on or off, corresponding muting switches can be used before or in the output power stage.

Fig. 14 Application example of TCA730A used for volume and balance control.