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STEREO TONE/VOLUME CONTROL CIRCUIT

GENERAL DESCRIPTION

The TDA1525 is an active stereo tone/volume control for car radios, television receivers and mains-fed audio equipment. It includes functions for bass and treble control, volume control with built-in contour (can be switched off) and balance. All these functions can be controlled by DC voltages or by single linear potentiometers.

Features

- Few external components necessary
- Low noise due to internal gain
- Bass emphasis can be increased by a double-pole low-pass filter
- Wide power supply voltage range

QUICK REFERENCE DATA

parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage (pin 3)		$V_P = V_{3\text{-}18}$	7.5	12	16.5	V
Supply current		I_3	–	35	–	mA
Maximum input signal with DC feedback (RMS value)		$V_{i(rms)}$	–	2.5	–	V
Maximum output signal with DC feedback (RMS value)		$V_{o(rms)}$	–	3.0	–	V
Volume control range		ΔG_v	−80	–	+ 21.5	dB
Bass control range	at 40 Hz	ΔG_v	–	– 19 to + 17	–	dB
Treble control range	at 16 kHz	ΔG_v	–	± 15	–	dB
Total harmonic distortion		THD	–	0.3	–	%
Output noise voltage (RMS value)	unweighted; f = 20 Hz to 20 kHz; V_P = 12 V					
for maximum voltage gain		$V_{no(rms)}$	–	310	–	μV
for voltage gain = −40 dB		$V_{no(rms)}$	–	100	–	μV
Channel separation	G_v = −20 to + 21.5 dB	α_{cs}	–	60	–	dB
Tracking between channels	G_v = −20 to + 26 dB	ΔG_v	–	–	2.5	dB
Ripple rejection	f = 100 Hz	RR	–	50	–	dB
Operating ambient temperature range		T_{amb}	−40	–	+ 85	°C

PACKAGE OUTLINE

18-lead DIL; plastic (SOT102).

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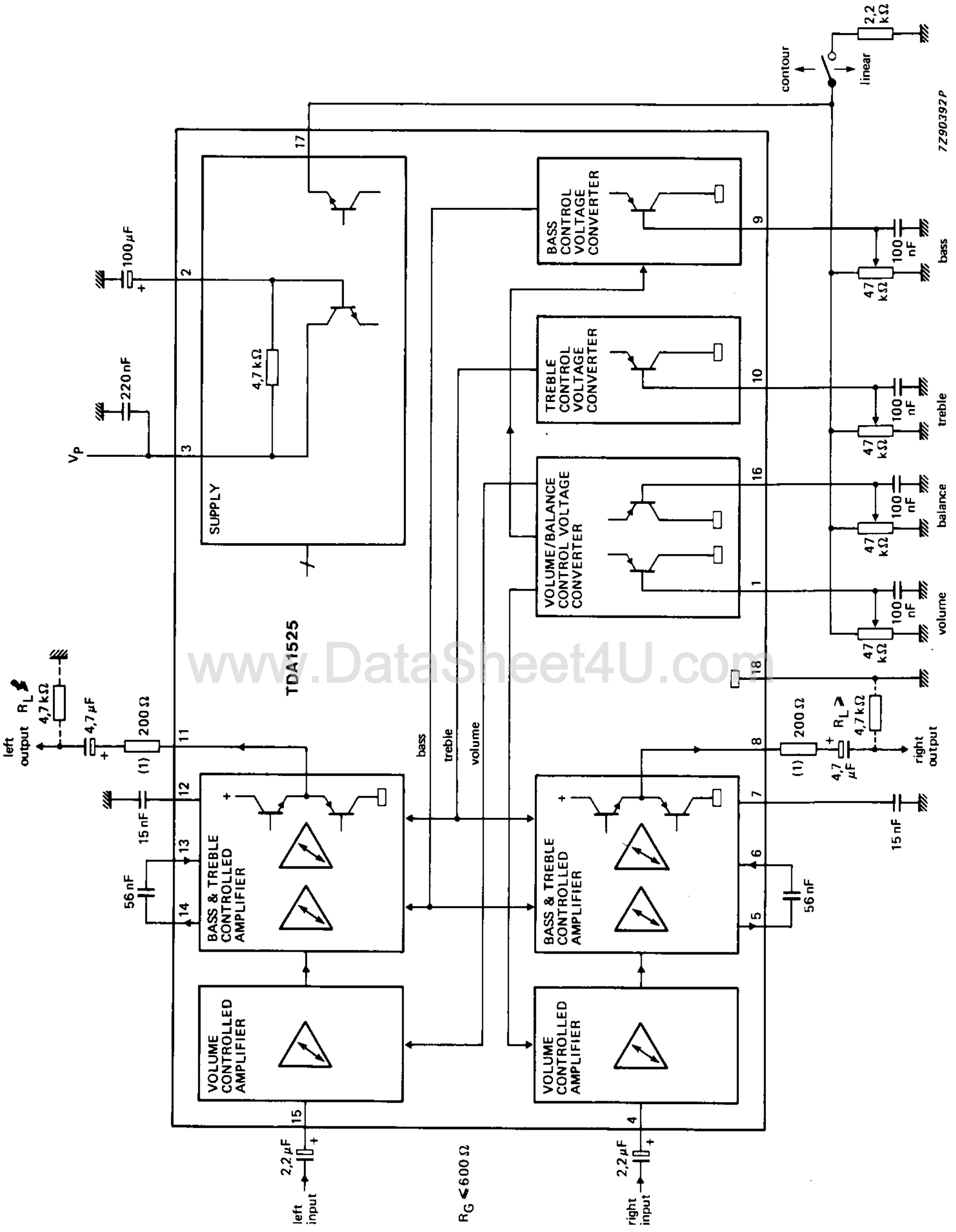

(1) Series resistor is recommended in the event of the capacitive loads exceeding 200 pF.

Fig. 1 Block diagram and application circuit with single-pole filter.

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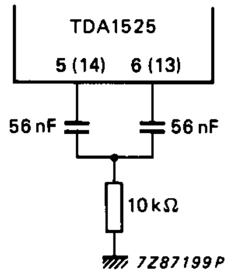

Fig.2 Double-pole low-pass filter for improved bass-boost.

RATINGS

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

parameter	conditions	symbol	min.	max.	unit
Supply voltage (pin 3)		$V_P = V_{3\text{-}18}$	–	18	V
Total power dissipation		P_{tot}	–	1200	mW
Storage temperature range		T_{stg}	–55	+ 150	°C
Operating ambient temperature range		T_{amb}	–40	+ 85	°C

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DC CHARACTERISTICS

$V_P = V_{3\text{-}18} = 12$ V; $T_{amb} = 25$ °C; all voltages are with reference to pin 18; measured in Fig. 1;
$R_G \leqslant 600\ \Omega$; $R_L > 4.7$ kΩ; $C_L \leqslant 200$ pF; unless otherwise specified

parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage		$V_P = V_3$	7.5	12	16.5	V
Supply current	$V_P = 8.5$ V	I_3	19	27	35	mA
	$V_P = 9.7$ V	I_3	–	–	40	mA
	$V_P = 12.0$ V	I_3	25	35	45	mA
	$V_P = 15.0$ V	I_3	30	43	56	mA
DC input levels (pins 4 and 15)	$V_P = 8.5$ V	$V_{4,\ 15}$	3.8	4.25	4.7	V
	$V_P = 12.0$ V	$V_{4,\ 15}$	5.3	5.9	6.6	V
	$V_P = 15.0$ V	$V_{4,\ 15}$	6.5	7.3	8.2	V
DC output levels (pins 8 and 11)	all control voltage conditions					
	$V_P = 8.5$ V	$V_{8,\ 11}$	3.3	4.25	5.2	V
	$V_P = 12.0$ V	$V_{8,\ 11}$	4.6	6.0	7.4	V
	$V_P = 15.0$ V	$V_{8,\ 11}$	5.7	7.5	9.3	V
Potentiometer supply voltage output (pin 17)	$V_P = 8.5$ V	V_{17}	3.25	3.6	3.85	V
Contour on/off switch (control by I_{17})						
contour	switch open	$-I_{17}$	–	–	0.5	mA
linear	switch closed	$-I_{17}$	1.5	–	10.0	mA
Application without potentiometer supply from pin 17 (contour cannot be switched off); voltage range forced to pin 17	$V_P \geqslant 10.8$ V	V_{17}	4.5	–	$\frac{V_P}{2} - V_{BE}$	V
DC voltage range for volume, bass, treble and balance controls (pins 1, 9, 10 and 16 respectively)	$V_{17} = 5.0$ V	$V_{1, 9, 10, 16}$	1.0	–	4.25	V
	using supply from pin 17	$V_{1, 9, 10, 16}$	0.25	–	3.8	V
Input current to pins 1, 9, 10 and 16		$-I_{1, 9, 10, 16}$	–	–	5.0	μA

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AC CHARACTERISTICS

$V_P = V_{3\text{-}18} = 8.5$ V; $T_{amb} = 25$ °C; all voltages are with reference to pin 18; measured in Fig. 1; contour switch closed (linear position); volume, balance, bass, and treble controls in mid-position; $R_G \leqslant 600\ \Omega$; $R_L \geqslant 4.7$ kΩ; $C_L \leqslant 200$ pF; f = 1 kHz; unless otherwise specified

parameter	conditions	symbol	min.	typ.	max.	unit
Control range						
Max. gain (volume)	see Fig. 4	$G_{v\,max}$	20.5	21.5	23.0	dB
Volume control range	$G_{v\,max}/G_{v\,min}$	ΔG_v	90	100	–	dB
Balance control range	$G_v = 0$ dB; see Fig. 5	ΔG_v	–	–40	–	dB
Bass control range	f = 40 Hz; see Fig. 6	ΔG_v	± 12	–19 to + 17	–	dB
Treble control range	f = 16 kHz; see Fig. 7	ΔG_v	± 12	± 15	–	dB
Contour characteristics			see Figs 8 and 9			
Input signals (pins 4 and 15)						
Input resistance with volume control gain	note 1					
at 20 dB	$G_v = 20$ dB	$R_{i4,\,15}$	10	–	–	kΩ
at –40 dB	$G_v = -40$ dB	$R_{i4,\,15}$	–	160	–	kΩ
Output signals (pins 8 and 11)						
Output resistance		$R_{o8,\,11}$	–	–	300	Ω
Signal processing						
Power supply ripple rejection	$V_{P(rms)} \leqslant 200$ mV; f = 100 Hz; $G_v = 0$ dB	RR	35	50	–	dB
Channel separation	250 Hz to 10 kHz; $G_v = -20$ to + 21.5 dB	α_{cs}	46	60	–	dB
Spread of volume control with constant control voltage	$V_1 = V_{17}/2$	ΔG_v	–	–	± 3	dB
Gain tolerance between left and right channels	$V_1 = V_{16} = V_{17}/2$	$\Delta G_{vL\text{-}R}$	–	–	1.5	dB
Tracking between channels	$G_v = 21.5$ to –26 dB; f = 250 Hz to 6.3 kHz; balance adjusted for $G_v = 10$ dB	ΔG_v	–	–	2.5	dB

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AC CHARACTERISTICS (continued)

parameter	conditions	symbol	min.	typ.	max.	unit
Signal handling						
Input signal handling (RMS value)	V_P = 8.5 V; THD = 0.5%; f = 1 kHz	$V_{i(rms)}$	1.4	–	–	V
	V_P = 8.5 V; THD = 0.7%; f = 1 kHz	$V_{i(rms)}$	1.8	2.4	–	V
	V_P = 12 V; THD = 0.5%; f = 40 Hz to 16 kHz	$V_{i(rms)}$	1.4	–	–	V
	V_P = 12 V; THD = 0.7%; f = 40 Hz to 16 kHz	$V_{i(rms)}$	2.0	3.2	–	V
	V_P = 15 V; THD = 0.5%; f = 40 Hz to 16 kHz	$V_{i(rms)}$	1.4	–	–	V
	V_P = 15 V; THD = 0.7%; f = 40 Hz to 16 kHz	$V_{i(rms)}$	2.0	3.2	–	V
Output signal handling (RMS value)	notes 2 and 3; V_P = 8.5 V; THD = 0.5%; f = 1 kHz	$V_{o(rms)}$	1.8	2.0	–	V
	V_P = 8.5 V; THD = 10%; f = 1 kHz	$V_{o(rms)}$	–	2.2	–	V
	V_P = 12 V; THD = 0.5%; f = 40 Hz to 16 kHz	$V_{o(rms)}$	2.5	3.0	–	V
	V_P = 15 V; THD = 0.5%; f = 40 Hz to 16 kHz	$V_{o(rms)}$	–	3.5	–	V

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parameter	conditions	symbol	min.	typ.	max.	unit
Noise performance (V_P = 8.5 V)						
Output noise voltage; unweighted (RMS value)	see Fig. 14; f = 20 Hz to 20 kHz					
for max. voltage gain	note 4	$V_{no(rms)}$	–	260	–	μV
for G_v = –3 dB	note 4	$V_{no(rms)}$	–	70	140	μV
Output noise voltage; weighted as DIN45405 of 1981, CCIR recommendation 468-2 (peak value)						
for max. voltage gain	note 4	$V_{no(m)}$	–	890	–	μV
for max. emphasis of bass and treble	contour off; G_v = –40 dB	$V_{no(m)}$	–	360	–	μV
Noise performance (V_P = 12 V)						
Output noise voltage; unweighted (RMS value)	see Fig. 14; f = 20 Hz to 20 kHz; note 5					
for max. voltage gain	note 4	$V_{no(rms)}$	–	310	–	μV
for G_v = –16 dB	note 4	$V_{no(rms)}$	–	100	200	μV
Output noise voltage; weighted as DIN45405 of 1981, CCIR recommendation 468-2 (peak value)						
for max. voltage gain	note 4	$V_{no(m)}$	–	940	–	μV
for max. emphasis of bass and treble	contour off; G_v = –40 dB	$V_{no(m)}$	–	400	–	μV

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AC CHARACTERISTICS (continued)

parameter	conditions	symbol	min.	typ.	max.	unit
Noise performance (V_P = 15 V)						
Output noise voltage; unweighted (RMS value)	see Fig. 14; f = 20 Hz to 20 kHz; note 5					
for max. voltage gain	note 4	$V_{no(rms)}$	–	350	–	μV
for G_v = –16 dB	note 4	$V_{no(rms)}$	–	110	220	μV
Output noise voltage; weighted as DIN45405 of 1981, CCIR recommendation 468-2 (peak value)						
for max. voltage gain	note 4	$V_{no(m)}$	–	980	–	μV
for max. emphasis of bass and treble	contour off; G_v = –40 dB	$V_{no(m)}$	–	420	–	μV

Notes to the characteristics

1. Equation for input resistance (see also Fig. 3)

$$R_i = \frac{160\ k\Omega}{1 + G_v};\ G_{v\,max} = 12.$$

2. Frequencies below 200 Hz and above 5 kHz have reduced voltage swing, the reduction at 40 Hz and at 16 kHz is 30%.
3. In the event of bass boosting the output signal handling is reduced. The reduction is 1 dB for maximum bass boost.
4. Linear frequency response.
5. For peak values add 4.5 dB to RMS values.

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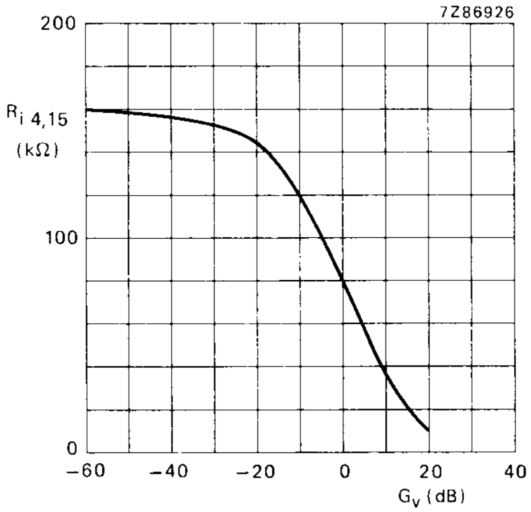

Fig. 3 Input resistance (R_i) as a function of gain of volume control (G_v). Measured in Fig. 1.

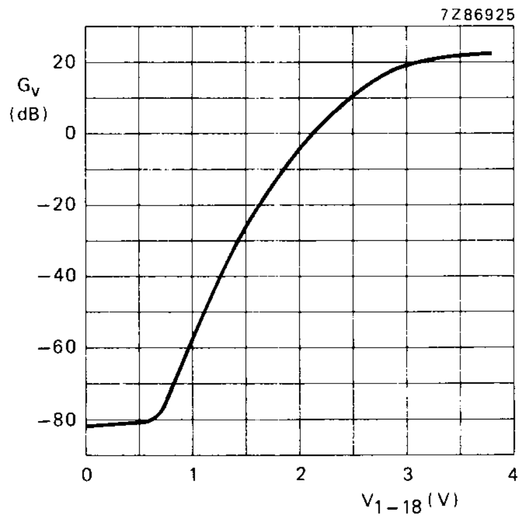

Fig. 4 Volume control curve; voltage gain (G_v) as a function of control voltage ($V_{1\text{-}18}$). Measured in Fig. 1 (internal potentiometer supply from pin 17 used); V_P = 8.5 V; f = 1 kHz.

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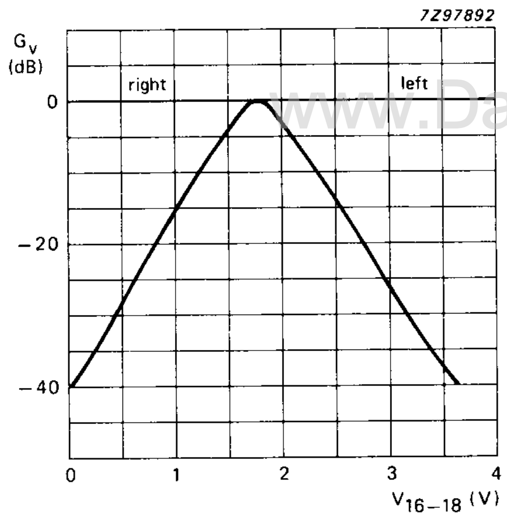

Fig. 5 Balance control curve; voltage gain (G_v) as a function of control voltage ($V_{16\text{-}18}$). Measured in Fig. 1 (internal potentiometer supply from pin 17 used); V_P = 8.5 V.

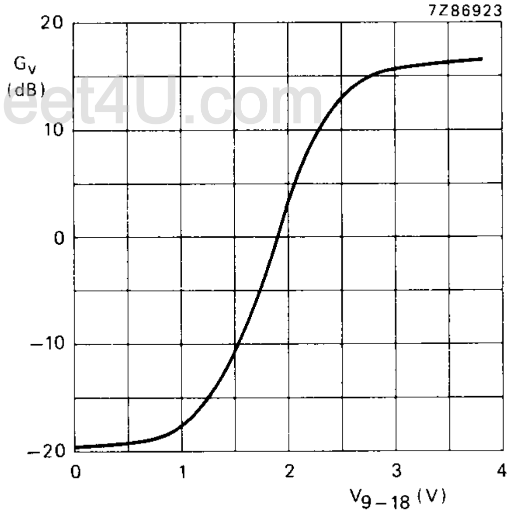

Fig. 6 Bass control curve; voltage gain (G_v) as a function of control voltage ($V_{9\text{-}18}$). Measured in Fig. 1 with single-pole filter (internal potentiometer supply from pin 17 used); V_P = 8.5 V; f = 40 Hz.

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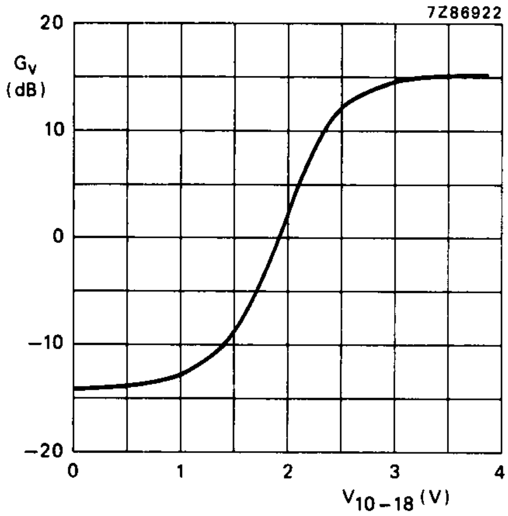

Fig. 7 Treble control curve; voltage gain (G_V) as a function of control voltage ($V_{10\text{-}18}$). Measured in Fig. 1 (internal potentiometer supply from pin 17 used); V_P = 8.5 V; f = 16 kHz.

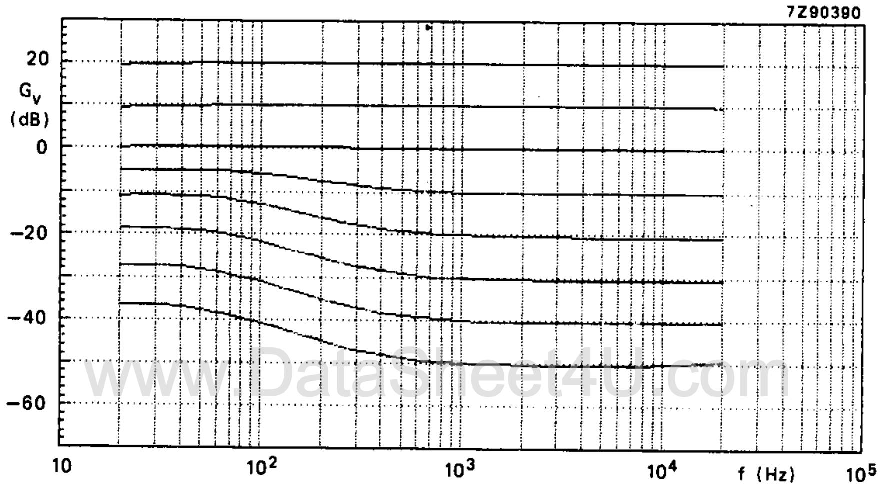

Fig. 8 Contour frequency response curves; voltage gain (G_V) as a function of audio input frequency. Measured in Fig. 1 with single-pole filter; V_P = 8.5 V.

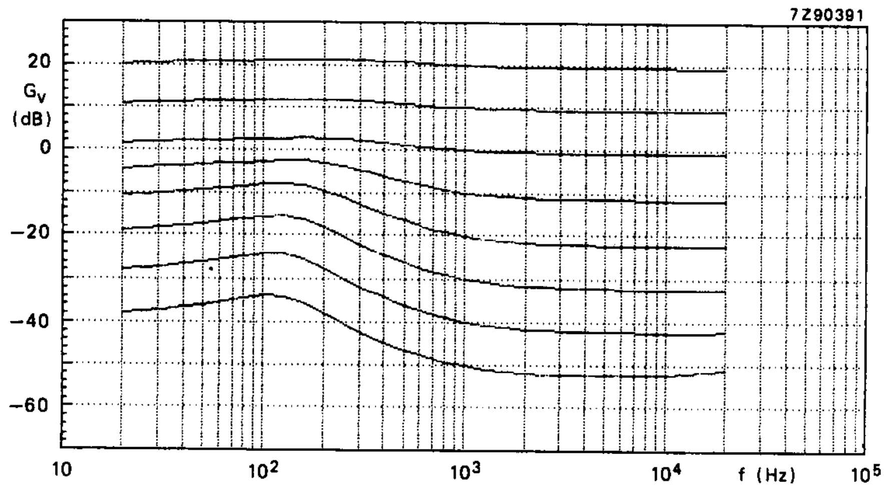

Fig. 9 Contour frequency response curves; voltage gain (G_V) as a function of audio input frequency. Measured in Fig. 1 with double-pole filter; V_P = 8.5 V.

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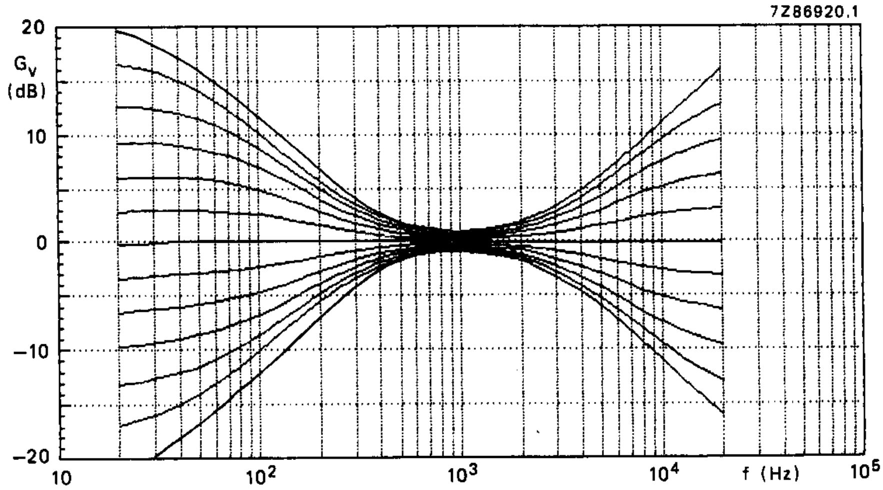

Fig. 10 Tone control frequency response curves; voltage gain (G_V) as a function of audio input frequency. Measured in Fig. 1 with single-pole filter; V_P = 8.5 V.

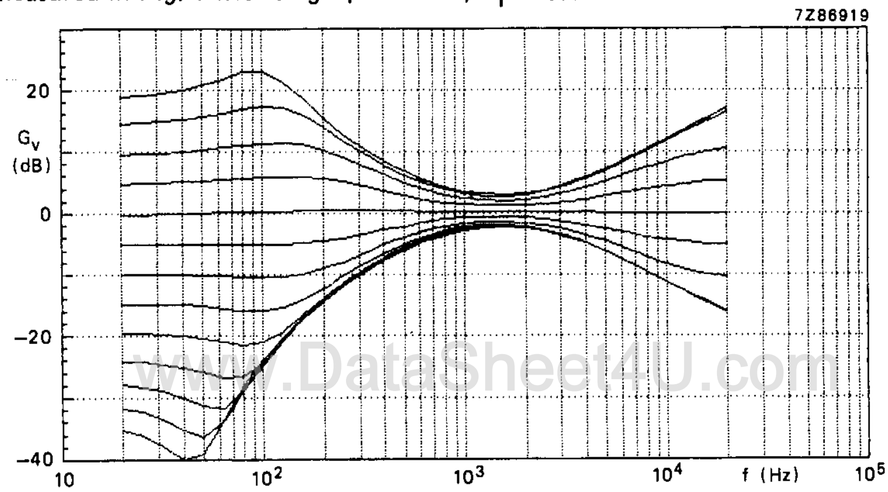

Fig. 11 Tone control frequency response curves; voltage gain (G_V) as a function of audio input frequency. Measured in Fig. 1 with double-pole filter; V_P = 8.5 V.

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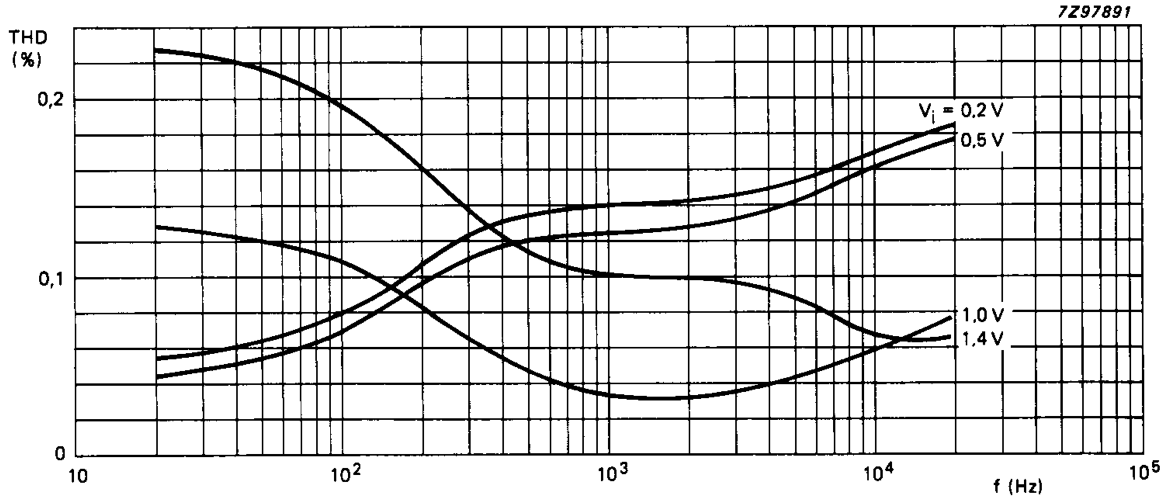

Fig. 12 Total harmonic distortion (THD) as a function of audio input frequency. Measured in Fig. 1; V_P = 8.5 V; volume control voltage gain at $G_V = 20 \log \frac{V_o}{V_i} = 0$ dB.

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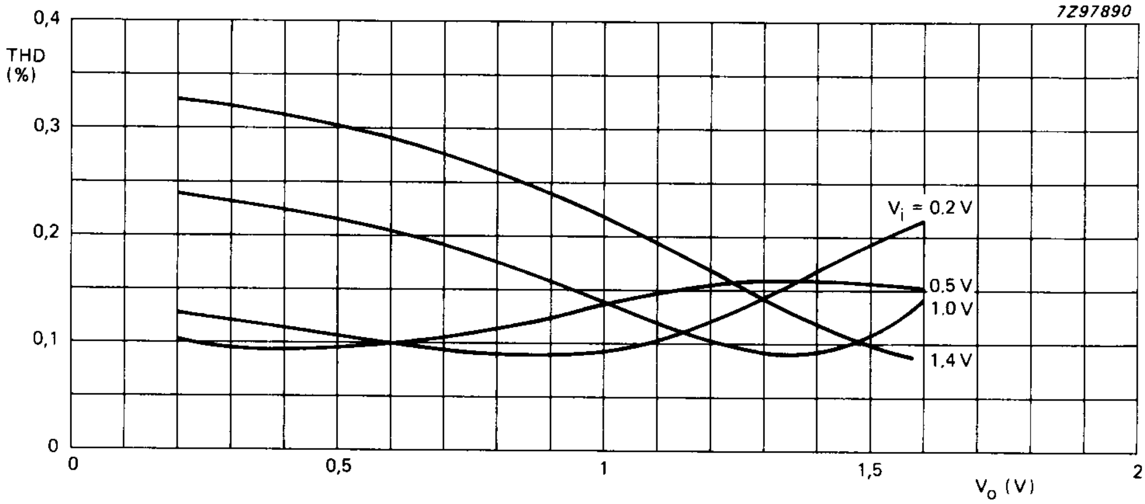
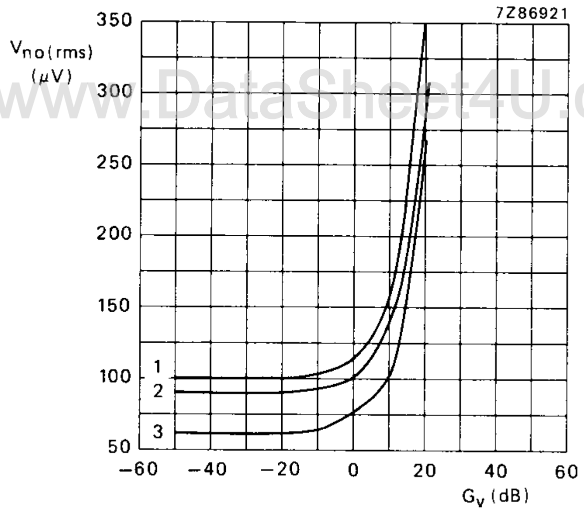


Fig. 13 Total harmonic distortion (THD) as a function of output voltage (V_O). Measured in Fig. 1; V_P = 8.5 V; f = 1 kHz.



(1) V_P = 15 V.
(2) V_P = 12 V.
(3) V_P = 8.5 V.

Fig. 14 Noise output voltage ($V_{no(rms)}$; unweighted) as a function of voltage gain (G_v). Measured in Fig. 1; f = 20 Hz to 20 kHz.

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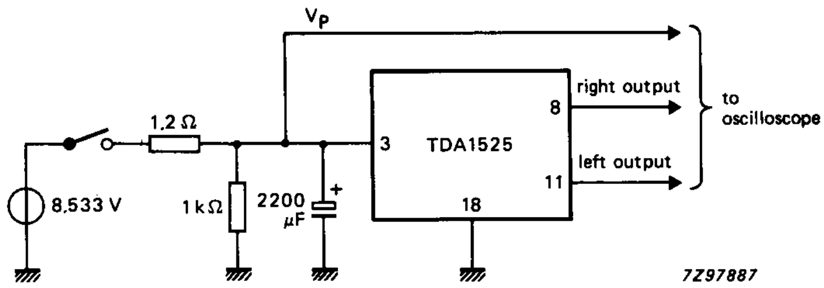
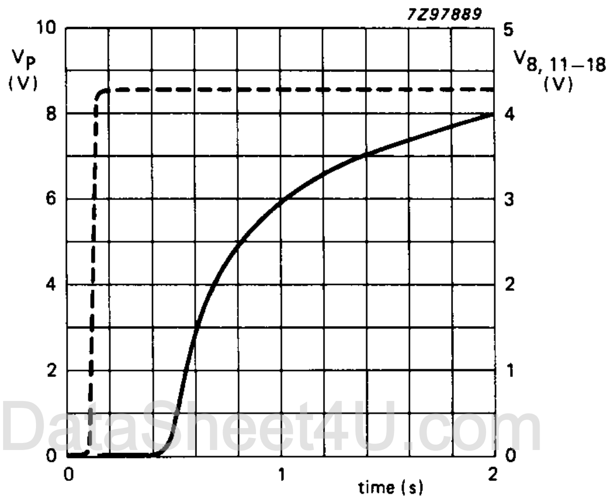


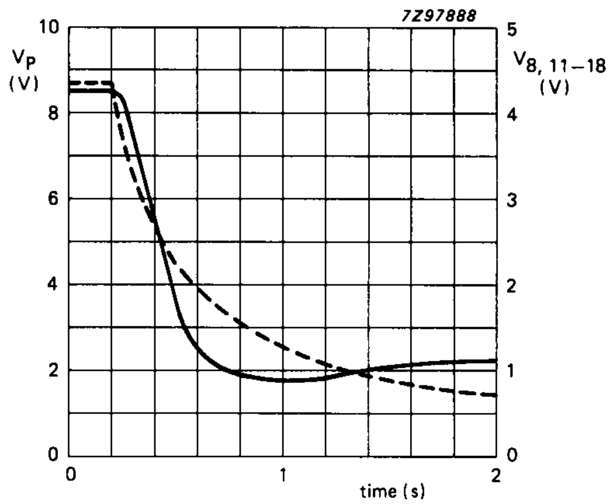
Fig. 15 Test circuit for power-on and power-off response measurements.



– – – – – represents V_P

———— represents $V_{8,\ 11\text{-}18}$

Fig. 16 Response at power-on. Measured in circuit of Fig. 15.



– – – – – represents V_P

———— represents $V_{8,\ 11\text{-}18}$

Fig. 17 Response at power-off. Measured in circuit of Fig. 15.

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