STEREO-TONE/VOLUME CONTROL CIRCUIT

GENERAL DESCRIPTION

The device is designed as an active stereo-tone/volume control for car radios, TV receivers and mains-fed 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

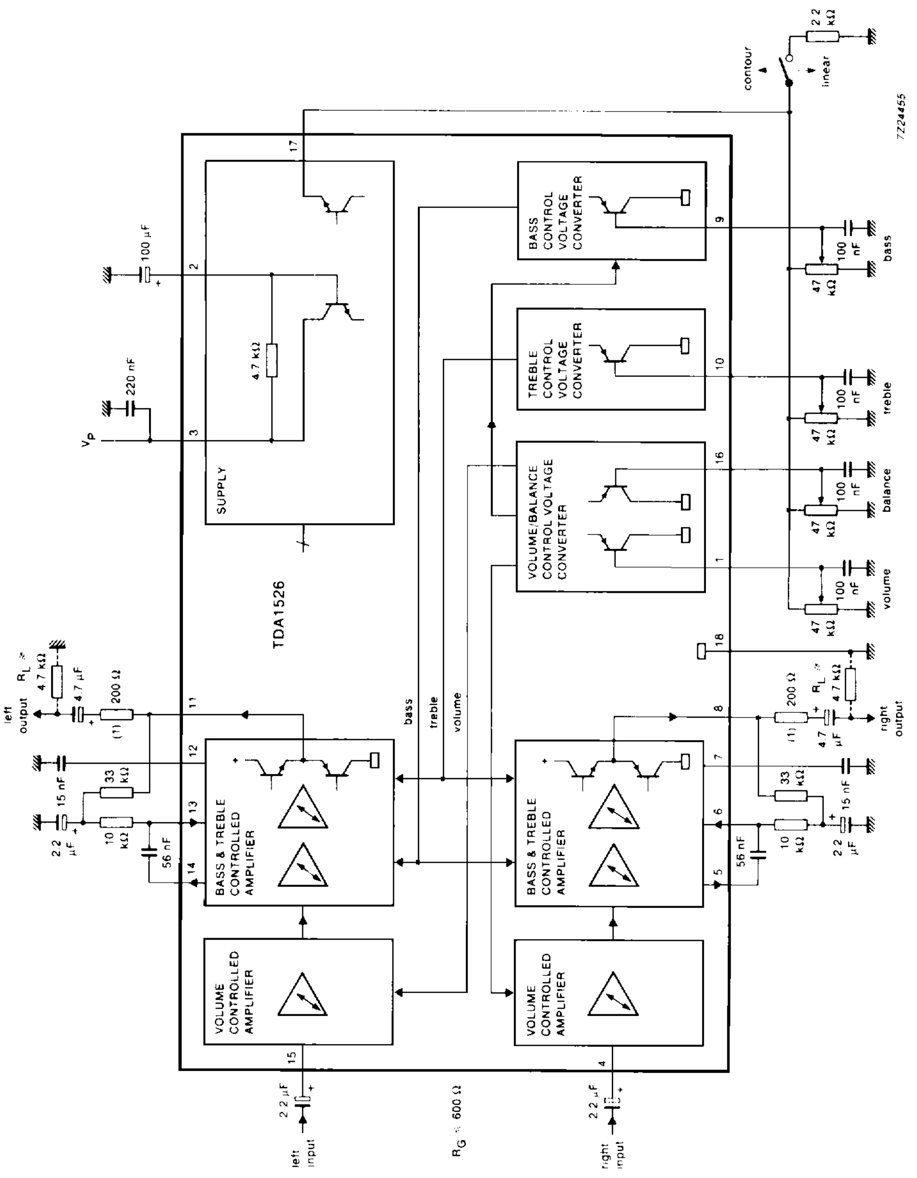
QUICK REFERENCE DATA

parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage (pin 3)		V_P	7.5	12	16.5	V
Supply current (pin 3)	V_P = 12 V	I_P	25	35	45	mA
Signal handling with DC feedback	V_P = 8.5 to 15 V; THD = 0.7%; f = 1 kHz					
Input signal handling (RMS value)		$V_{i(rms)}$	1.8	2.0	–	V
Output signal handling (RMS value)	notes 2 and 3	$V_{o(rms)}$	1.8	2.0	–	V
Control range						
Maximum gain of volume	see Fig. 4	$G_{v\,max}$	20.5	21.5	23	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	at 40 Hz; see Fig. 6	ΔG_v	–	−19 to +17 ±3	–	dB
Treble control range	at 16 kHz; see Fig. 7	ΔG_v	–	±15 ±3	–	dB
Total harmonic distortion		THD	–	–	0.5	%
Noise performance	V_P = 12 V					
Output noise voltage (unweighted) at f = 20 Hz to 20 kHz for G_v = −16 dB	RMS value; note 4 note 5	$V_{no(rms)}$	–	100	200	μV
Signal processing						
Channel separation at G_v = −20 to 21.5 dB	f = 250 Hz to 10 kHz	α_{cs}	46	60	–	dB
Tracking between channels for G_v = 21.5 to −26 dB	f = 250 Hz to 6.3 kHz; balance at G_v = 10 dB	ΔG_v	–	–	2.5	dB
Ripple rejection	$V_{P(rms)}$ = ≤ 200 mV; f = 100 Hz; G_v = 0 dB	RR	35	50	–	dB
Operating ambient temperature range		T_{amb}	−30	–	+85	°C

For explanation of notes see **Notes to the characteristics.**

PACKAGE OUTLINE

18-lead DIL; plastic (SOT102).



(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.

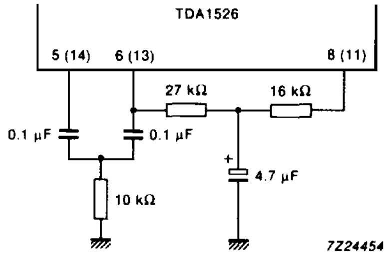


Fig.2 Double-pole low-pass filter for improved bass-boost.

RATINGS

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

parameter	symbol	min.	max.	unit
Supply voltage (pin 3)	V_P	–	20	V
Total power dissipation	P_{tot}	–	1200	mW
Storage temperature range	T_{stg}	–55	+ 150	°C
Operating ambient temperature range	T_{amb}	–30	+ 80	°C

DC CHARACTERISTICS

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

parameter	symbol	min.	typ.	max.	unit
Supply (pin 3)					
Supply voltage	$V_P = V_{3\text{-}18}$	7.5	–	16.5	V
Supply current					
at $V_P = 8.5$ V	$I_P = I_3$	19	27	35	mA
at $V_P = 12$ V	$I_P = I_3$	25	35	45	mA
at $V_P = 15$ V	$I_P = I_3$	30	43	56	mA
DC input levels (pins 4 and 15)					
at $V_P = 8.5$ V	$V_{4,15\text{-}18}$	3.8	4.25	4.7	V
at $V_P = 12$ V	$V_{4,15\text{-}18}$	5.3	5.9	6.6	V
at $V_P = 15$ V	$V_{4,15\text{-}18}$	6.5	7.3	8.2	V
DC output levels (pins 8 and 11) under all control voltage conditions with DC feedback					
at $V_P = 8.5$ V	$V_{8,11\text{-}18}$	3.3	4.25	5.2	V
at $V_P = 12$ V	$V_{8,11\text{-}18}$	4.6	6.0	7.4	V
at $V_P = 15$ V	$V_{8,11\text{-}18}$	5.7	7.5	9.3	V
Pin 17					
Internal potentiometer supply voltage at $V_P = 8.5$ V	$V_{17\text{-}18}$	3.5	3.75	4.0	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	mA
Application without internal potentiometer supply voltage at $V_P \geqslant 10.8$ V (contour cannot be switched off)					
Voltage range forced to pin 17	$V_{17\text{-}18}$	4.5	–	$V_P/2-V_{BE}$	V
DC control voltage range for volume, bass, treble and balance (pins 1, 9, 10 and 16 respectively)					
at $V_{17\text{-}18} = 5$ V	$V_{1,9,10,16}$	1.0	–	4.25	V
using internal supply	$V_{1,9,10,16}$	0.25	–	3.8	V
Input current of control inputs (pins 1, 9, 10 and 16)	$-I_{1,9,10,16}$	–	–	5	μA

AC CHARACTERISTICS

$V_P = V_{3\text{-}18} = 8.5$ V; $T_{amb} = 25$ °C; 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	symbol	min.	typ.	max.	unit
Control range					
Maximum gain of volume (Fig. 4)	$G_{v\,max}$	20.5	21.5	23	dB
Volume control range; $G_{v\,max}/G_{v\,min}$	ΔG_v	90	100	–	dB
Balance control range; $G_v = 0$ dB (Fig. 5)	ΔG_v	–	–40	–	dB
Bass control range at 40 Hz (Fig. 6)	ΔG_v	–	–19 to +17 ±3		dB
Treble control range at 16 kHz (Fig. 7)	ΔG_v	–	±15 ±3	–	dB
Contour characteristics			see Figs 9 and 10		
Signal inputs, outputs					
Input resistance; pins 4 and 15 (note 1) at gain of volume control: $G_v = 20$ dB	$R_{i4,15}$	10	–	–	kΩ
$G_v = -40$ dB	$R_{i4,15}$	–	160	–	kΩ
Output resistance (pins 8 and 11)	$R_{o8,11}$	–	–	300	Ω
Signal processing					
Power supply ripple rejection at $V_{P(rms)} \leqslant 200$ mV; f = 100 Hz; $G_v = 0$ dB	RR	35	50	–	dB
Channel separation (250 Hz to 10 kHz) at $G_v = -20$ to $+21.5$ dB	α_{cs}	46	60	–	dB
Spread of volume control with constant control voltage $V_{1\text{-}18} = 0.5\,V_{17\text{-}18}$	ΔG_v	–	–	±3	dB
Gain tolerance between left and right channel $V_{16\text{-}18} = V_{1\text{-}18} = 0.5\,V_{17\text{-}18}$	$\Delta G_{v,L\text{-}R}$	–	–	1.5	dB
Tracking between channels for $G_v = 21.5$ to -26 dB f = 250 Hz to 6.3 kHz; balance adjusted at $G_v = 10$ dB	ΔG_v	–	–	2.5	dB

AC CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
Signal handling with DC feedback					
Input signal handling at V_P = 8.5 V – 15 V; THD = 0.7%; f = 1 kHz (RMS value)	$V_{i(rms)}$	1.8	2.0	–	V
Output signal handling (note 2 and note 3) at V_P = 8.5 V; THD = 0.7%; f = 1 kHz (RMS value)	$V_{o(rms)}$	1.8	2.0	–	V
Noise performance (V_P = 12 V)					
Output noise voltage (unweighted; Fig. 14) at f = 20 Hz to 20 kHz (RMS value; note 4) for G_v = –16 dB (note 5)	$V_{no(rms)}$	–	100	200	μV

Notes to 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. For peak values add 4.5 dB to RMS values.
5. Linear frequency response.

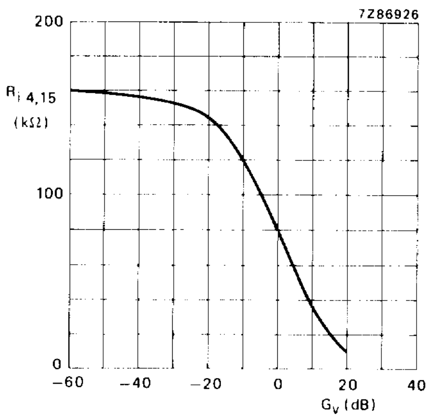


Fig.3 Input resistance (R_i) as a function of gain of volume control (G_v). Measured in Fig.1.

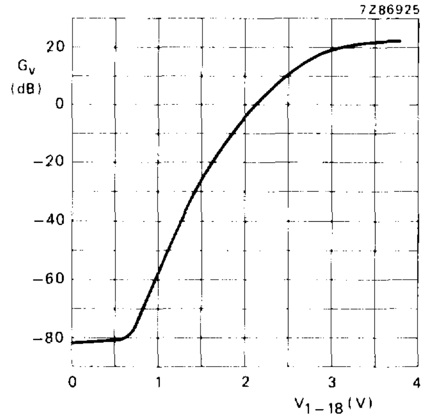


Fig.4 Volume control curve; voltage gain (G_v) as a function of control voltage ($V_{1\text{-}18}$). Measured in Fig.1 (internal potentiometer supply from pin 17 used); V_P = 8.5 V; f = 1 kHz.

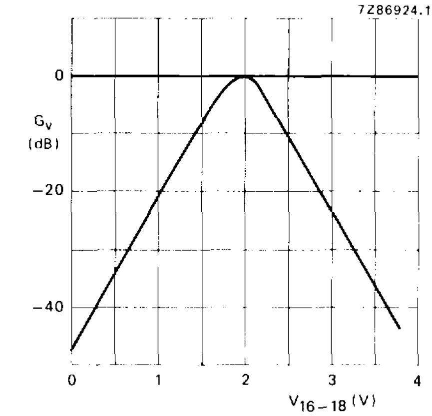


Fig.5 Balance control curve; voltage gain (G_v) as a function of control voltage ($V_{16\text{-}18}$). Measured in Fig.1 (internal potentiometer supply from pin 17 used); V_P = 8.5 V.

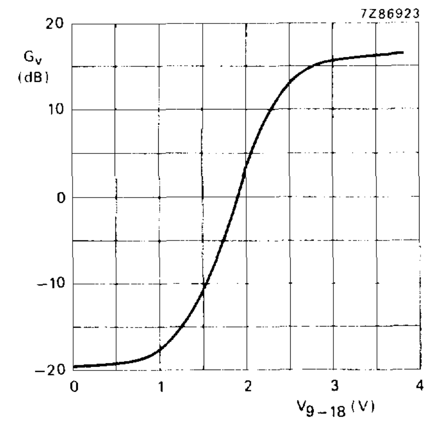


Fig.6 Bass control curve; voltage gain (G_v) as a function of control voltage ($V_{9\text{-}18}$). Measured in Fig.1 with single-pole filter (internal potentiometer supply from pin 17 used); V_P = 8.5 V; f = 40 Hz.

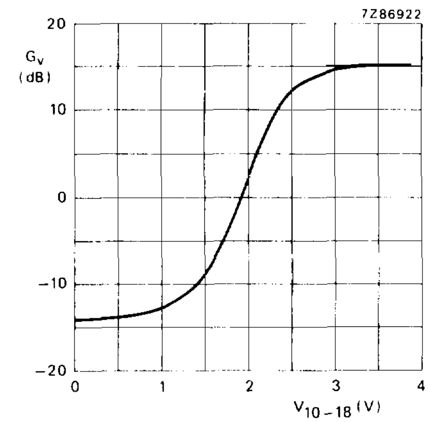


Fig.7 Treble control curve; voltage gain (G_v) as a function of control voltage ($V_{10\text{-}18}$). Measured in Fig.1 (internal potentiometer supply from pin 17 used); V_P = 8.5 V; f = 16 kHz.

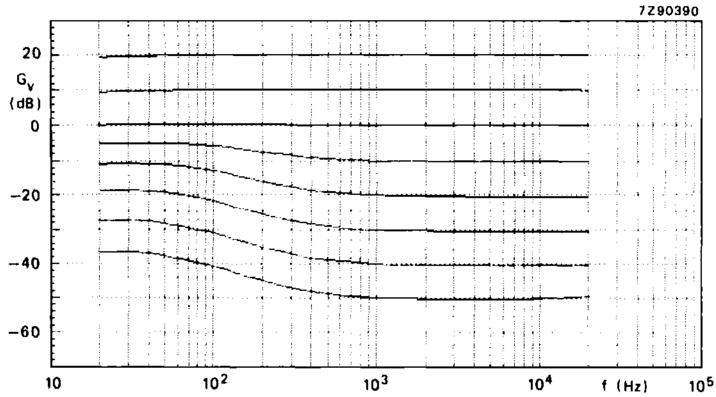


Fig.8 Contour frequency response curves; voltage gain (G_v) as a function of audio input frequency. Measured in Fig.1 with single-pole filter; V_P = 8.5 V.

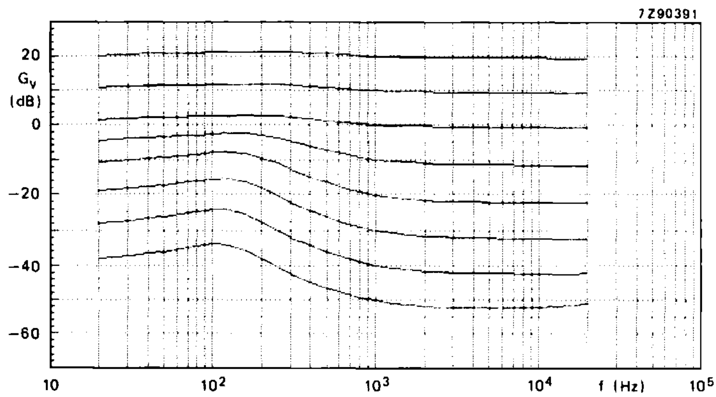


Fig.9 Contour frequency response curves; voltage gain (G_v) as a function of audio input frequency. Measured in Fig.1 with double-pole filter; V_P = 8.5 V.

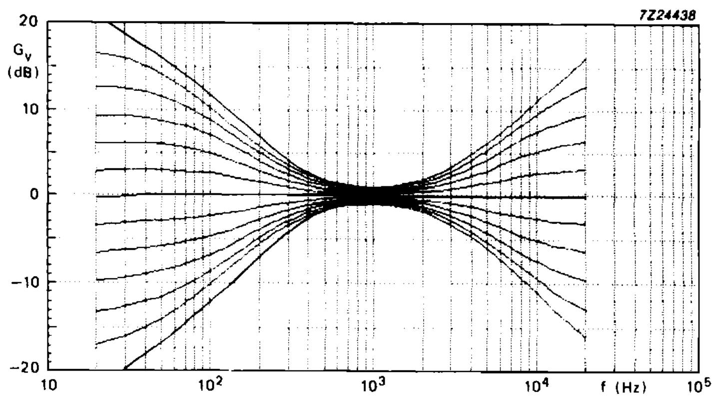


Fig.10 Tone control frequency response curves; voltage gain (G_v) as a function of audio input frequency. Measured in Fig.1 with single-pole filter; V_P = 8.5 V.

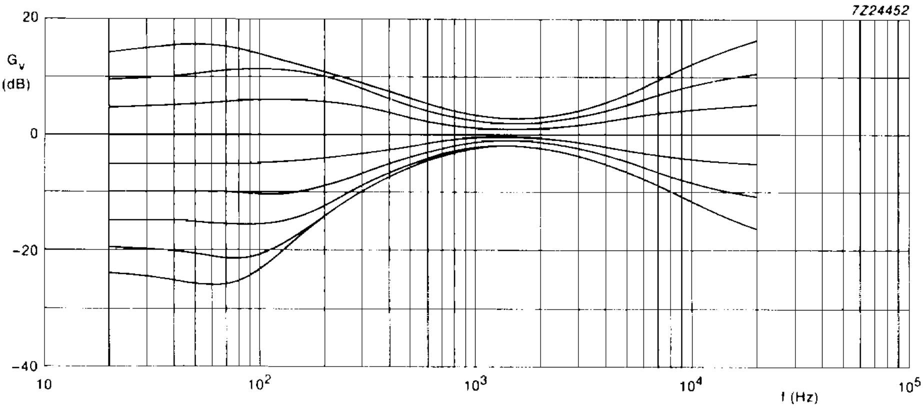


Fig.11 Tone control frequency response curves; voltage gain (G_V) as a function of audio input frequency. Measured in Fig.1 with double-pole filter; V_P = 8.5 V.

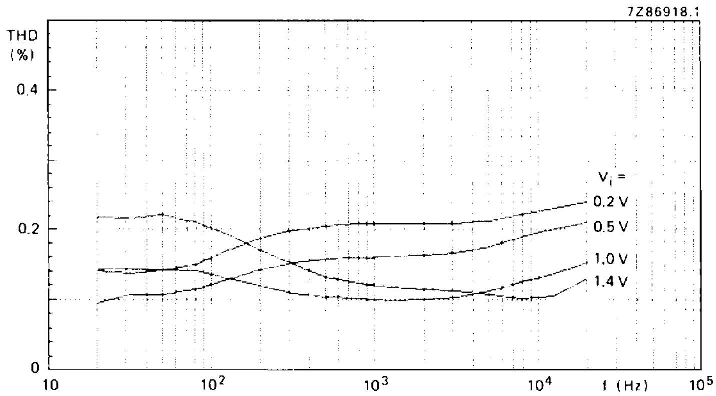


Fig.12 Total harmonic distortion (THD); as a function of audio input frequency. Measured in Fig.1; V_P = 8.5 V; volume control voltage gain at

$$G_V = 20 \log \frac{V_o}{V_i} = 0 \text{ dB}.$$

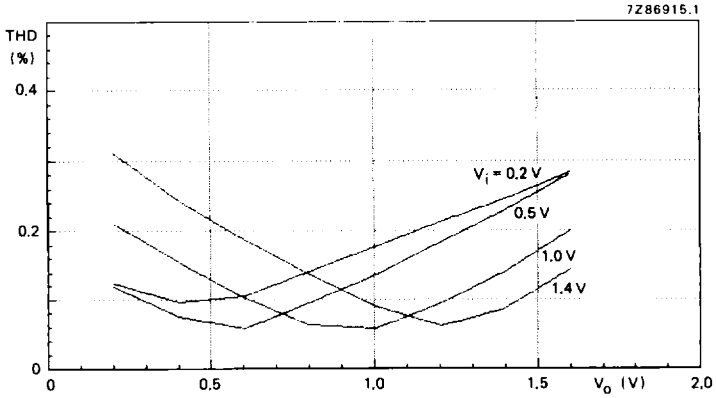


Fig.13 Total harmonic distortion (THD); as a function of output voltage (V_O). Measured in Fig.1; V_P = 8.5 V; f_i = 1 kHz.

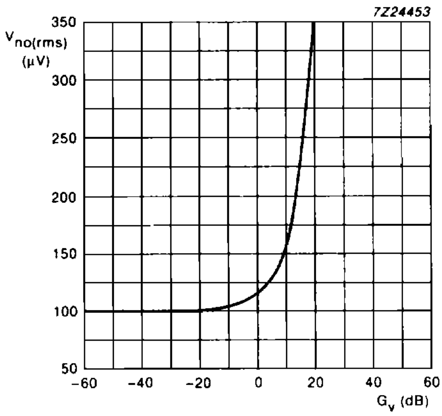


Fig.14 Noise output voltage ($V_{no(rms)}$; unweighted); as a function of voltage gain (G_v). Measured in Fig.1; V_P = 15 V; f = 20 Hz to 20 kHz.