TIME MULTIPLEX PLL STEREO DECODER

GENERAL DESCRIPTION

The TDA1578A is a PLL stereo decoder based on the time-division multiplex principle.

Features

- adjustable input and output voltage levels
- automatic mono/stereo switching with hysteresis, controlled by both pilot signal and field strength level
- analogue control of mono/stereo change over
- pilot indicator driver
- analogue muting control
- muting indicator driver
- oscillator with decoupled frequency measurement output
- electronic smoothing of the supply voltage

QUICK REFERENCE DATA

Measured with a frequency deviation $\Delta f = \pm 75$ kHz without pilot; $f_m = 1$ kHz

Supply voltage (pin 8)	$V_P = V_{8\text{-}7}$	typ.	8,5	15	V
Supply current (pin 8)	$I_P = I_8$	typ.	21	30	mA
Multiplex input signal (adjustable)	$V_{MUX(p\text{-}p)}$	typ.	0,5	1	V
Input resistance (adjustable)	R_i	typ.		47	kΩ
A.F. output voltage (R = 15 kΩ)	V_o	typ.	0,75	1,5	V
Output resistance	R_o		low-ohmic		
Spread in gain	ΔG_v	⩽		1	dB
Channel separation	α	typ.		50	dB
Total harmonic distortion	THD	⩽	0,3	0,1	%
Signal-to-noise ratio	S/N	typ.		90	dB
Carrier and harmonic suppression					
pilot signal; f = 19 kHz	α_{19}	typ.		32	dB
subcarrier; f = 38 kHz	α_{38}	typ.		50	dB
f = 57 kHz	α_{57}	typ.		46	dB
f = 76 kHz	α_{76}	typ.		60	dB
traffic radio (V.W.F.); f = 57 kHz	$\alpha_{57(VWF)}$	typ.		70	dB
SCA (Subsidiary Communications Authorization); f = 67 kHz	α_{67}	typ.		70	dB
ACI (Adjacent Channel Interference); f = 114 kHz	α_{114}	typ.		80	dB
intermodulation; f = 10/13 kHz	α_2, α_3	typ.		70	dB
Supply voltage range (pin 8)	$V_P = V_{8\text{-}7}$			7,5 to 18	V
Operating ambient temperature range	T_{amb}			−30 to + 80	°C

PACKAGE OUTLINE

18-lead DIL; plastic (SOT102).

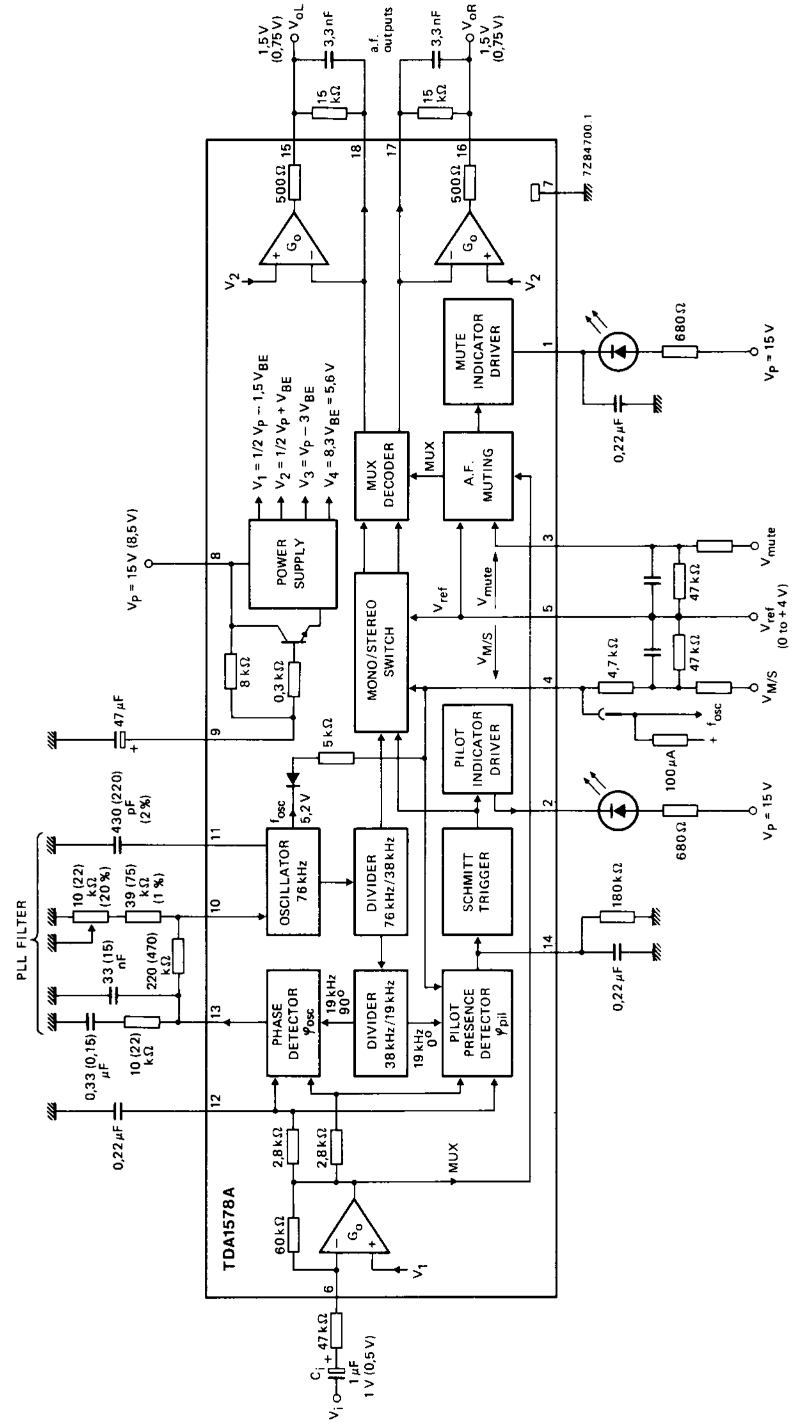


Fig. 1 Block diagram with external components; used as test circuit. Values given in parentheses are for $V_P = 8,5$ V.

RATINGS

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

Supply voltage (pin 8)	$V_P = V_{8\text{-}7}$	max.	20	V
Input voltages (pins 3, 4 and 5)	$V_{3;4;5\text{-}7}$		0 to 12	V
Indicator driver output voltage	$V_{1;2\text{-}7}$	max.	24	V
Indicator driver output current	$I_1; I_2$	max.	30	mA
Total power dissipation at T_{amb} = 25 °C	P_{tot}	max.	1,2	W
Storage temperature range	T_{stg}		−55 to + 150	°C
Operating ambient temperature range	T_{amb}		−30 to + 80	°C

THERMAL RESISTANCE

From crystal to ambient	$R_{th\ c\text{-}a}$	=	80	K/W

CHARACTERISTICS (measured in Fig. 1)

Input signal: m = 100% ($\Delta f = \pm$ 75 kHz); pilot signal: m = 9% ($\Delta f = \pm$ 6,75 kHz);
modulation frequency: 1 kHz; $V_{3\text{-}5} = V_{4\text{-}5} = 0$ V;
de-emphasizing time: T = 50 μs; oscillator adjusted to f_{osc} at a pilot voltage $V_i = 0$ V;
$T_{amb} = 25\ ^oC$; unless otherwise specified

parameter	V_P (V)	symbol	min.	typ.	max.	unit
Supply voltage range (pin 8)	–	V_P	7,5	–	18	V
Supply current (except	8,5	I_P	–	21	–	mA
output and indicator) pin 8	15	I_P	–	30	40	mA
Nominal multiplex input						
voltage (peak-to-peak value)	8,5	$V_{MUX(p\text{-}p)}$	–	0,5	–	V
$R_i = 47\ k\Omega$	15	$V_{MUX(p\text{-}p)}$	–	1,0	–	V
Overdrive reserve of input						
at THD = 1 %	8,5		3	6	–	dB
at THD = 0,3 %	15		3	6	–	dB
A.F. output voltage (r.m.s. value; mono without pilot)						
$R_{15\text{-}18} = R_{16\text{-}17} = 15\ k\Omega$	8,5	$V_{o(rms)}$	–	0,75	–	V
	15	$V_{o(rms)}$	–	1,5	–	V
$R_{15\text{-}18} = R_{16\text{-}17} = 24\ k\Omega$	8,5	$V_{o(rms)}$	–	1,2	–	V
	15	$V_{o(rms)}$	–	2,4	–	V
Overdrive reserve of output						
$R_{15\text{-}18} = R_{16\text{-}17} = 24\ k\Omega$	*		3	–	–	dB
Spread in output voltage levels	*	$\pm \Delta V_o/V_o$	–	–	1	dB
Difference of output voltage levels	*	$\pm \Delta V_{15\text{-}16}/V_o$	–	–	1	dB
Output resistance	*	R_o	low-ohmic			
Available output current pins 15 and 16	*	$\pm I_o$	–	–	–	mA
Modulation range at output (unloaded)	*	$V_{15;16\text{-}7}$	–	1 to $V_{9\text{-}7}-1$	–	V
Internal current limiting	*	I_o	–	15	–	mA
D.C. output voltage	8,5	$V_{15;16\text{-}7}$	3,6	4,1	4,6	V
$R_{15\text{-}18} = R_{16\text{-}17} = 24\ k\Omega$	15	$V_{15;16\text{-}7}$	7,0	7,7	8,4	V
D.C. current	8,5	$-I_{17;18}$	–	33	–	μA
(pins 17 and 18)	15	$-I_{17;18}$	–	23	–	μA

* V_P = 8,5 or 15 V.

parameter	V_P (V)	symbol	min.	typ.	max.	unit
Channel separation	8,5	α	32	50	–	dB
at $V_{4\text{-}5} = 0$ V	15	α	39	50	–	dB
Total harmonic distortion	8,5	THD	–	0,1	0,3	%
	15	THD	–	0,04	0,1	%
Signal-to-noise ratio	8,5	S/N	–	87	–	dB
f = 20 Hz to 16 kHz	15	S/N	–	90	–	dB
Carrier and harmonic suppression at the output						
pilot signal; f = 19 kHz	*	α_{19}	–	32	–	dB
subcarrier; f = 38 kHz	*	α_{38}	40	50	–	dB
f = 57 kHz	*	α_{57}	–	46	–	dB
f = 76 kHz	*	α_{76}	–	60	–	dB
intermodulation (note 1) f_m = 10 kHz; spurious signal f_s = 1 kHz						
PLL-filter Fig. 1	*	α_2	–	50	–	dB
PLL-filter Fig. 2	*	α_2	–	70	–	dB
f_m = 13 kHz; spurious signal f_s = 1 kHz	*	α_3	–	75	–	dB
traffic radio (V.W.F.); f = 57 kHz (note 2)	*	$\alpha_{57(VWF)}$	–	70	–	dB
SCA (Subsidiary Communications Authorization); f = 67 kHz (note 4)	*	α_{67}	–	70	–	dB
ACI (Adjacent Channel Interference) (note 3); f = 114 kHz	*	α_{114}	–	80	–	dB
f = 190 kHz	*	α_{190}	–	52	–	dB
Ripple rejection at the output; f = 100 Hz; $V_{P(rms)}$ = 100 mV (pin 8)	*	RR_{100}	40	43	–	dB
Voltage on filter capacitor without external load	*	$V_{9\text{-}7}$	–	V_P–0,25	–	V
Source resistance	*	$R_{9\text{-}8}$	6	8	10	kΩ

* V_P = 8,5 or 15 V.

CHARACTERISTICS (continued)

parameter	V_P (V)	symbol	min.	typ.	max.	unit
Mono/stereo control						
Pilot threshold voltages (peak-to-peak values)						
for stereo 'ON'	8,5	$V_{i(p-p)}$	–	21	30	mV
	15	$V_{i(p-p)}$	–	43	61	mV
for mono 'ON'	8,5	$V_{i(p-p)}$	6	15	–	mV
	15	$V_{i(p-p)}$	12	30	–	mV
Switch hysteresis $V_{i\,ON}/V_{i\,OFF}$	*	ΔV_i	–	3	–	dB
Switching time at $C_{14\text{-}7}$ = 0,22 μF						
for stereo 'ON'	*	$t_{st\,ON}$	–	15	–	ms
for mono 'ON'	*	$t_{m\,ON}$	–	27	–	ms
External mono/stereo control (see Fig. 12 and note 5)						
Switching voltage for external mono control	8,5	$V_{14\text{-}7}$	–	–	0,7	V
	15	$V_{14\text{-}7}$	–	–	1,4	V
	*	or: $-V_{4\text{-}5}$	315	–	–	mV
Control voltage for channel separation: α = 6 dB	8,5	$-V_{4\text{-}5}$	–	120	–	mV
	15	$-V_{4\text{-}5}$	–	130	–	mV
	*	$\Delta V_{4\text{-}5}$	–	–	± 20	mV
α = 26 dB	8,5	$-V_{4\text{-}5}$	–	70	–	mV
	15	$-V_{4\text{-}5}$	–	80	–	mV
Control voltage for mono 'ON'	8,5	$-V_{4\text{-}5}$	–	240	–	mV
	15	$-V_{4\text{-}5}$	–	270	–	mV
for stereo 'ON'	8,5	$-V_{4\text{-}5}$	–	220	–	mV
	15	$-V_{4\text{-}5}$	–	250	–	mV
Control voltage difference for α = 6 dB; stereo 'ON'	8,5	$\Delta V_{4\text{-}7}$	80	100	120	mV

* V_P = 8,5 or 15 V.

parameter	V_P (V)	symbol	min.	typ.	max.	unit
Muting circuit (see Fig. 13 and note 5)						
Control voltage for an attenuation: $\alpha = 3$ dB	8,5	$-V_{3\text{-}5}$	–	140	–	mV
	15	$-V_{3\text{-}5}$	–	145	–	mV
	*	$\Delta V_{3\text{-}5}$	–	± 20	–	mV
$\alpha = 26$ dB	8,5	$-V_{3\text{-}5}$	–	255	–	mV
	15	$-V_{3\text{-}5}$	–	270	–	mV
Attenuation with $V_{3\text{-}5} = 0$ V	*	α	–	–	0,2	dB
with $-V_{3\text{-}5} = 450$ mV	*	α	–	80	–	dB
LED driver output current at an attenuation: $\alpha = 3$ dB	*	I_1	1,2	1,7	2,2	mA
Control voltage for $I_1 = 200\ \mu A$	8,5	$-V_{3\text{-}5}$	–	150	–	mV
	15	$-V_{3\text{-}5}$	–	160	–	mV
Control inputs						
Recommended voltage range	*	$V_{3;4;5\text{-}7}$	0	–	4	V
Input bias current	*	$I_{3;4;5}$	–	10	100	nA
Indicator driver						
Output saturation voltages at $I_1 = 20$ mA; $V_{3\text{-}5} = 0$ V	*	$V_{1\text{-}7sat}$	–	1,2	1,8	V
at $I_2 = 20$ mA	*	$V_{2\text{-}7sat}$	–	0,5	1,0	V
Output leakage current at $V_{1;2\text{-}7} = 24$ V	*	$I_{1;2}$	–	20	–	μA

* $V_P = 8,5$ or 15 V.

CHARACTERISTICS (continued)

parameter	V_P (V)	symbol	min.	typ.	max.	unit
VCO						
Oscillator frequency adjustable with $R_{10\text{-}7}$	*	f_{osc}	–	76	–	kHz
Spread of free-running frequency at nominal external circuitry	*	f_{osc}	71	–	82	kHz
Free-running frequency dependency (note 6)						
with temperature	*	TC	–	1×10^{-4}	–	K^{-1}
with supply voltage	*	$\Delta f_{osc}/\Delta V_P$	–	–	400	Hz/V
Capture and holding range for a pilot input voltage $V_{pil} = 0{,}5 \times V_{pil\,nom}$	*	$\Delta f/f$	± 2	–	–	%
PLL control slope (total)	*	S_{tot}	–	4,5	–	kHz/μs
D.C. voltage at pin 10	*	$V_{10\text{-}7}$	–	2,1	–	V
		or:	–	3,2 V_{BE}	–	V
Frequency measuring point; internal switching threshold	*	$V_{4\text{-}7}$	–	6	–	V
		or:	–	9 V_{BE}	–	V
Output voltage (peak-to-peak value) at pin 4; R = 4,7 kΩ	*	$V_{4\text{-}7(p\text{-}p)}$	–	350	–	mV
Output resistance	*	$R_{4\text{-}7}$	–	5	–	kΩ

* V_P = 8,5 or 15 V.

Notes to the characteristics

1. Intermodulation suppression (BFC: Beat-Frequency Components)

$$\alpha_2 = \frac{V_{o(signal)}\ \text{(at 1 kHz)}}{V_{o(spurious)}\ \text{(at 1 kHz)}};\ f_s = (2 \times 10\ \text{kHz}) - 19\ \text{kHz}$$

$$\alpha_3 = \frac{V_{o(signal)}\ \text{(at 1 kHz)}}{V_{o(spurious)}\ \text{(at 1 kHz)}};\ f_s = (3 \times 13\ \text{kHz}) - 38\ \text{kHz}$$

measured with: 91% mono signal; f_m = 10 or 13 kHz; 9% pilot signal.

2. Traffic radio (V.W.F.) suppression

$$\alpha_{57(VWF)} = \frac{V_{o(signal)}\ \text{(at 1 kHz)}}{V_{o(spurious)}\ \text{(at 1 kHz} \pm \text{23 kHz)}}$$

measured with: 91% stereo signal; f_m = 1 kHz; 9% pilot signal;
5% traffic subcarrier (f = 57 kHz, f_m = 23 Hz AM, m = 60%).

3. ACI (Adjacent Channel Interference)

$$\alpha_{114} = \frac{V_{o\ (signal)}\ \text{(at 1 kHz)}}{V_{o(spurious)}\ \text{(at 4 kHz)}};\ f_s = 110\ \text{kHz} - (3 \times 38\ \text{kHz})$$

$$\alpha_{190} = \frac{V_{o(signal)}\ \text{(at 1 kHz)}}{V_{o(spurious)}\ \text{(at 4 kHz)}};\ f_s = 186\ \text{kHz} - (5 \times 38\ \text{kHz})$$

measured with: 90% mono signal; f_m = 1 kHz; 9% pilot signal;
1% spurious signal (f_s = 110 or 186 kHz, unmodulated).

4. SCA (Subsidiary Communications Authorization)

$$\alpha_{67} = \frac{V_{o(signal)}\ \text{(at 1 kHz)}}{V_{o(spurious)}\ \text{(at 9 kHz)}};\ f_s = (2 \times 38\ \text{kHz}) - 67\ \text{kHz}$$

measured with: 81% mono signal; f_m = 1 kHz; 9% pilot signal;
10% SCA-subcarrier (f_s = 67 kHz, unmodulated).

5. Assuming $V_T = \frac{k \times T}{q}$ = 28,6 mV at T_j = 330 K.

6. The effects of external components are not taken into account.

APPLICATION NOTES

1. When mono/stereo control and muting control are not used, pins 3, 4 and 5 have to be grounded.
2. In a receiver, channel separation adjustment can be obtained by:
   a. A capacitor at pin 12 ($C_{12\text{-}7}$): phasing 19/38 kHz
   b. RC or LCR filter at the input: frequency response compensation ($V_G = f(\omega)$)
   c. Feeding the output signals of the output amplifier to the inputs of the other channel.
3. PLL-filter for reduced intermodulation (α_2); see Fig. 2.
4. External mono 'ON' switch; see Fig. 3.
5. Switching 'OFF' the oscillator; see Fig. 4.

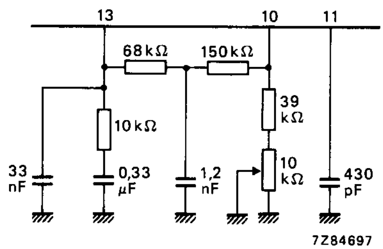


Fig. 2 PLL-filter for α_2 = 70 dB at V_P = 15 V (see also Fig. 1).

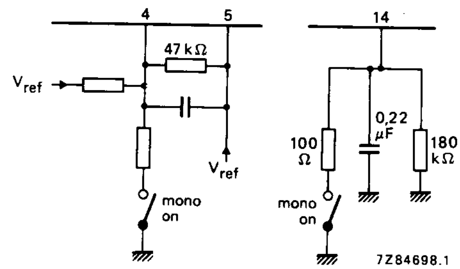


Fig. 3 (a) At pin 4; $-V_{4\text{-}5} > 300$ mV; (b) at pin 14.

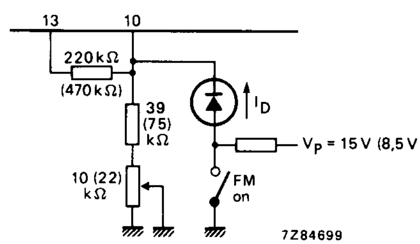


Fig. 4 The oscillator is switched-off when:
$I_D > 100\ \mu A$ ($> 50\ \mu A$ for $V_P = 8{,}5$ V) and $I_D < 1$ mA.

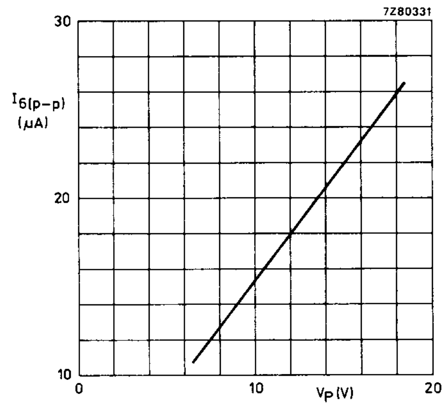


Fig. 5 Signal handling range at the input for I_{6nom} (± 75 kHz); $V_{9\text{-}7} = V_P$.

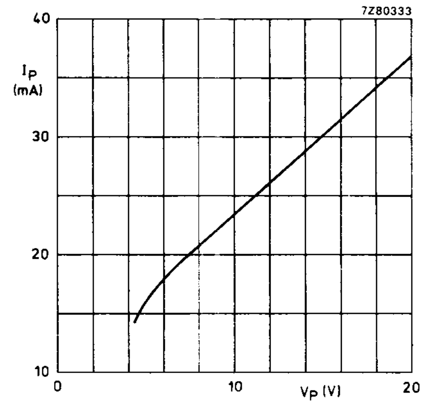


Fig. 6 Supply current comsumption at $V_{9\text{-}7} = V_P$.

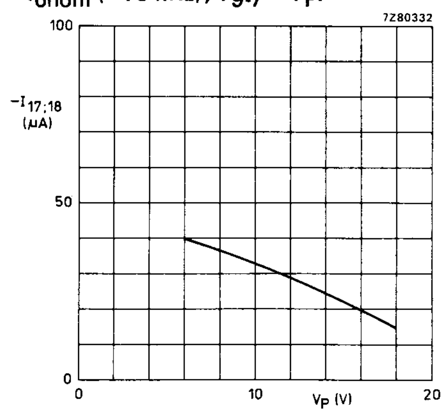


Fig. 7 D.C. current in the feedback loop of the output amplifier.

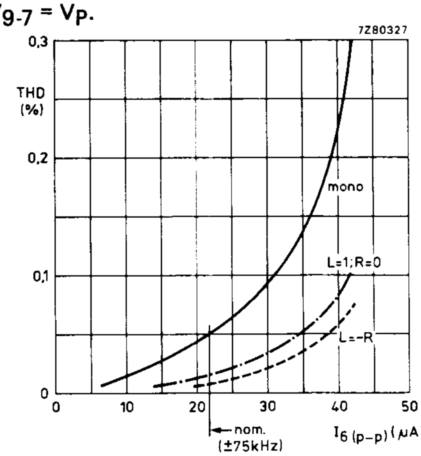


Fig. 8 Total harmonic distortion (THD) as a function of the peak-to-peak input current at pin 6; $V_P = 15$ V; $f_m = 1$ kHz; $V_{3\text{-}5} = V_{4\text{-}5} = 0$ V.

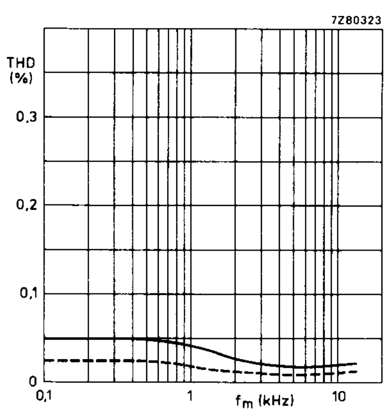


Fig. 9 Total harmonic distortion (THD) as a function of the modulation frequency (f_m); $V_P = 15$ V; $I_{6(p\text{-}p)} = 21{,}5$ μA.

———— mono

– – – – stereo; L = −R; 91% + 9% pilot signal.

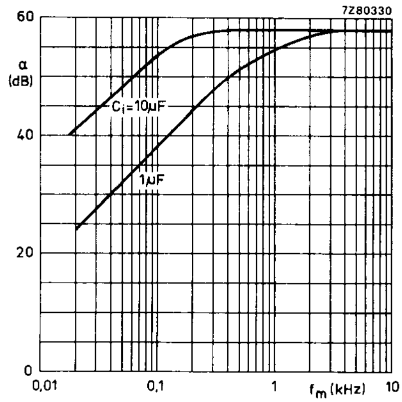


Fig. 10 Channel separation (α) as a function of the modulation frequency (f_m); V_P = 15 V; R_i = 47 kΩ; $V_{4\text{-}5}$ = 0 V.

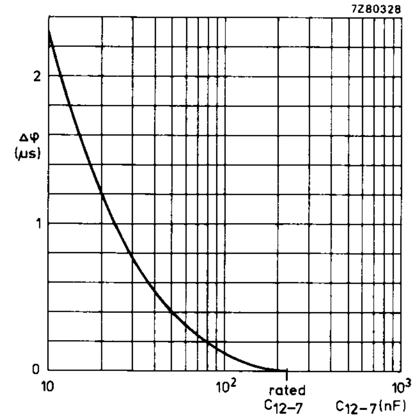


Fig. 11 Phase shift between pilot signal at the input and the internal carrier processing as a function of $C_{12\text{-}7}$.

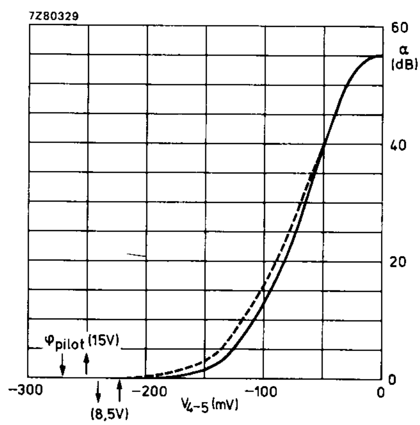
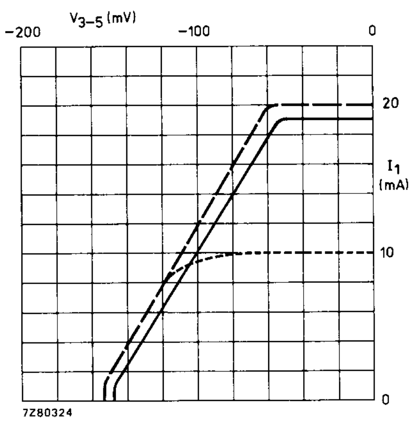


Fig. 12 Mono/stereo control at f_m = 1 kHz; α is the channel separation.
———— V_P = 8,5 V
– – – – V_P = 15 V



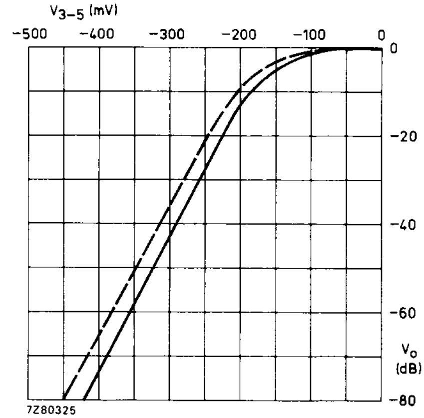


Fig. 13 Muting (V_o) and muting indicator current (I_1) as a function of $V_{3\text{-}5}$.

V_o in dB curves; ——— V_P = 8,5 V
– – – – V_P = 15 V

I_1 in mA curves for V_{PL}/R_{bias1} (pin 1); – – – – 22 V/1 kΩ
——— 14 V/680 Ω
- - - - - - - 10 V/680 Ω

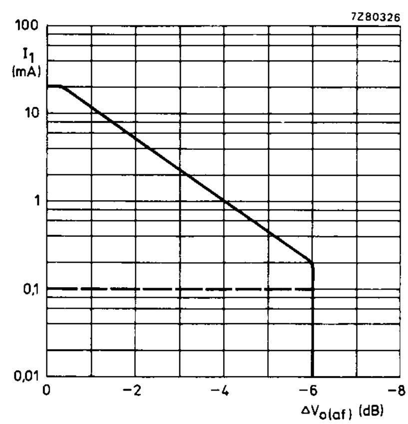


Fig. 14 Muting indicator current; V_P = 8,5 to 15 V; V_{PL} = 14 V.

——— R_{bias1} = 680 Ω
– – – – R_{bias1} = matched

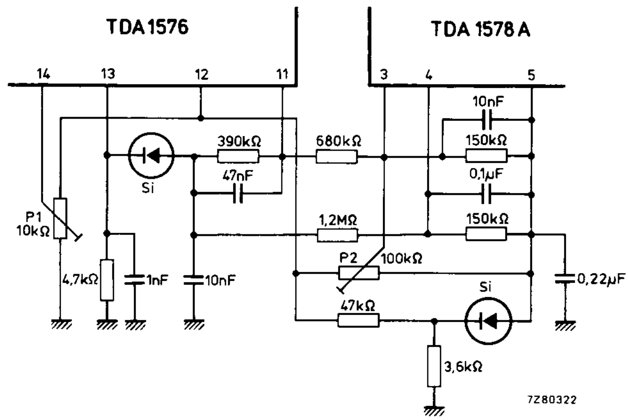


Fig. 15 Application information for external circuitry to provide external mono/stereo and muting control.

Adjustment recommendations:

at $V_{i(hf)}$ = 100 μV with P1 to α = 6 dB (channel separation),
at $V_{i(hf)}$ = 15 μV with P2 to $V_{o(af)}$ = −3 dB.

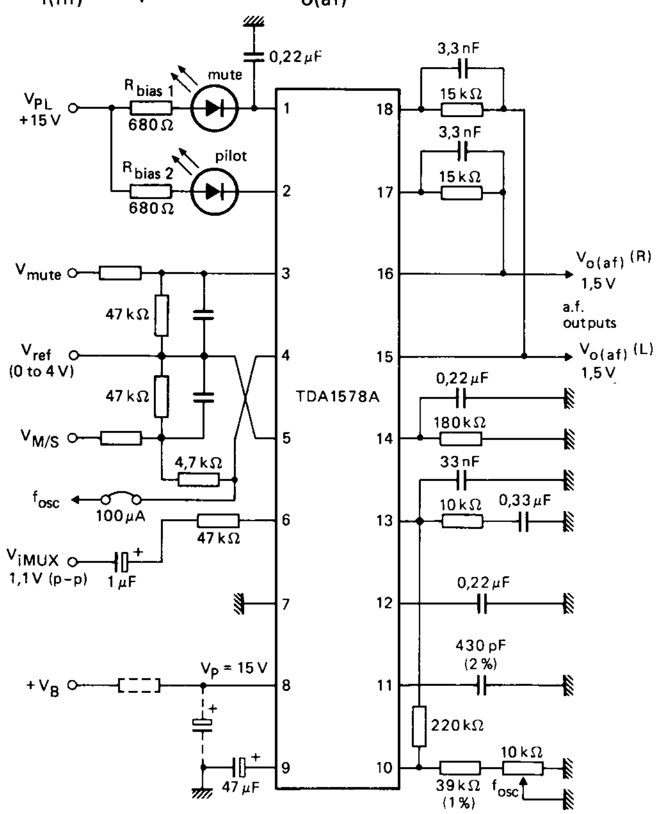


Fig. 16 Typical application circuit using TDA1578A for V_P = 15 V.