Sound fader control circuit

TEA6300
TEA6300T

GENERAL DESCRIPTION

The Sound Fader Control circuit (SOFAC) is an I²C-bus controlled preamplifier for car radios.

Features

- Source selector for three stereo inputs
- Inputs and outputs for noise reduction circuits
- Volume and balance control; control range of 86 dB in steps of 2 dB
- Bass and treble control from + 15 dB (treble 12 dB) to −12 dB in steps of 3 dB
- Fader control from 0 dB to −30 dB in steps of 2 dB
- Fast muting
- Low noise suitable for DOLBY* B and C NR (noise reduction)
- Signal handling suitable for compact disc
- I²C-bus control for all functions
- ESD protected

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	Supply voltage	7,0	8,5	13,2	V
$V_{i(rms)}$	Input sensitivity for full power at the output stage	–	50	–	mV
$V_{i(rms)}$	Input signal handling	–	1,65	–	V
f_r	Frequency response	35	–	20 000	Hz
α_{CS}	Channel separation; f = 250 Hz to 10 kHz	70	92	–	dB
THD	Total harmonic distortion	–	0,05	–	%
(S+N)/N	Signal plus noise-to-noise ratio	–	80	–	dB
T_{amb}	Operating ambient temperature range	−40	–	+ 85	°C

* Dolby is a registered trademark of Dolby Laboratories Licensing Corporation, San Francisco, California (U.S.A.).

PACKAGE OUTLINES

28-lead dual in-line; plastic (SOT117); SOT117-1; 1996 August 15.

28-lead mini-pack; plastic (SO28; SOT136A); SOT136-1; 1996 August 15.

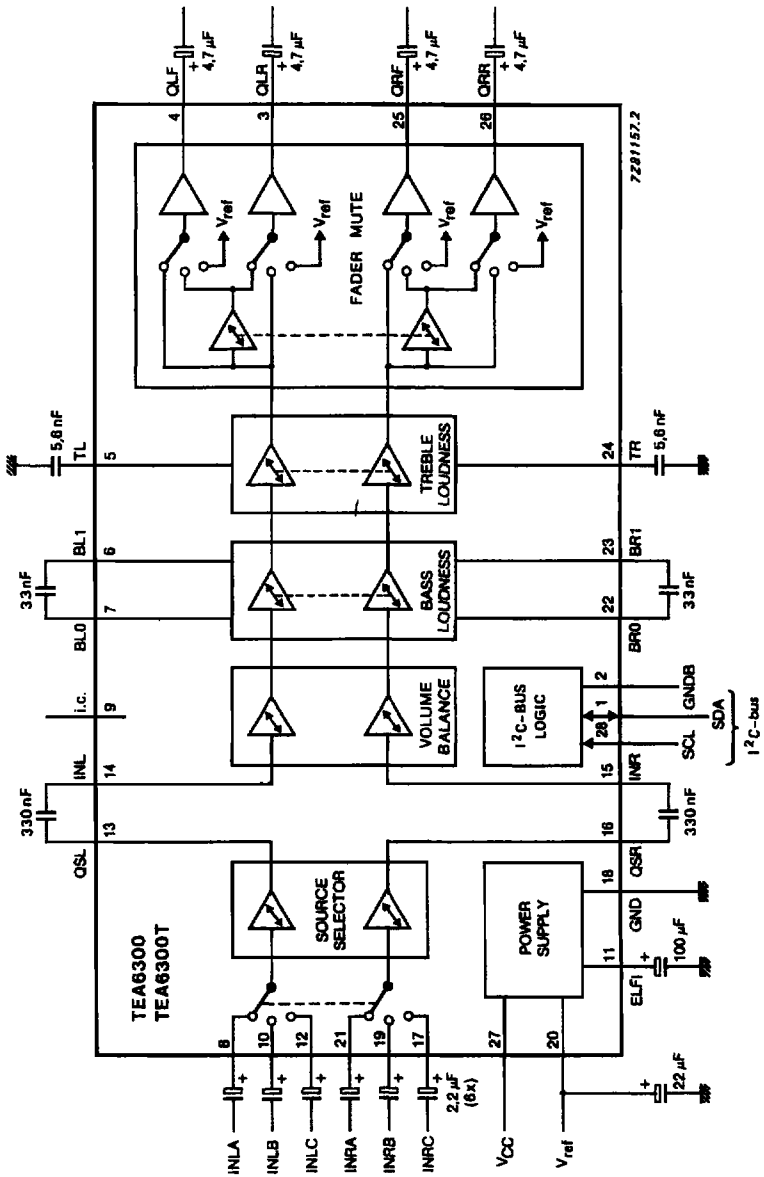


Fig.1 Block diagram.

PINNING

1	SDA	serial data input/output (I^2C-bus)
2	GNDB	ground for I^2C-bus terminals
3	QLR	output left rear
4	QLF	output left front
5	TL	treble control capacitor; left channel
6	BL1	bass control capacitor; left channel
7	BL0	bass control capacitor; left channel
8	INLA	input left source A
9	i.c.	internally connected
10	INLB	input left source B
11	ELFI	electronic filtering for supply
12	INLC	input left source C
13	QSL	output source selector left
14	INL	input left control part
15	INR	input right control part
16	QSR	output source selector right
17	INRC	input right source C
18	GND	ground
19	INRB	input right source B
20	V_{ref}	reference voltage (1/2 V_{CC})
21	INRA	input right source A
22	BR0	bass control capacitor; right channel
23	BR1	bass control capacitor; right channel
24	TR	treble control capacitor; right channel
25	QRF	output right front
26	QRR	output right rear
27	V_{CC}	supply voltage
28	SCL	serial clock input (I^2 C-bus)

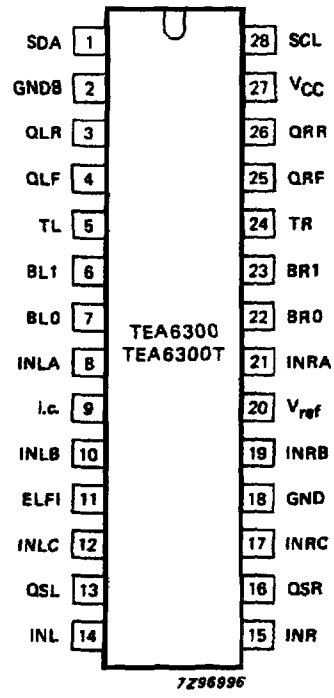


Fig.2 Pinning diagram.

FUNCTIONAL DESCRIPTION

The source selector selects three stereo channels –RF part (AM/FM), recorder and compact disc. As the outputs of the source selector and the inputs of the main control part are available, additional circuits such as compander and equalizer systems may be inserted into the signal path. The AC signal setting is performed by resistor chains in combination with multi-input operational amplifiers. The advantage of this principle is the combination of low noise, low distortion and a high dynamic range for the circuit.

The separate volume controls of the left and the right channel facilitate correct balance control. The range and balance control is software programmable.

Because the TEA6300 has four outputs a low-level fader is included. The fader control is independent of the volume control and an extra mute position is built in for the front, the rear or for all channels. The last function may be used for muting during preset selection. An extra pop suppression circuit is built in for pop-free switching on and off. As all switching and control functions are controllable via the two-wire I^2C-bus, no external interface between the microcomputer and the TEA6300 is required.

The on-chip power-on-reset sets the TEA6300 to the general mute mode.

RATINGS

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC}	Supply voltage (pin 27-18)	–	16	V
P_{tot}	Maximum power dissipation	–	1	W
T_{stg}	Storage temperature range	–55	+150	°C
T_{amb}	Operating ambient temperature range	–40	+ 85	°C

CHARACTERISTICS

V_{CC} = 8,5 V; R_S = 600 Ω; R_L = 10 kΩ; f = 1 kHz; T_{amb} = 25 °C; test circuit Fig.10; unless otherwise specified

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	Supply voltage	7,0	8,5	13,2	V
I_{CC}	Supply current	–	26	–	mA
I_{CC}	Supply current at 8,5 V	–	–	33	mA
I_{CC}	Supply current at 13,2 V	–	–	44	mA
	DC voltage				
V_{DC}	inputs, outputs and reference	0,45	0,5	0,55	V_{CC}
	Internal reference voltage (pin 20)				
V_{REF}	V_{ref} = 0,5 V_{CC}	–	4,25	–	V
	Maximum voltage gain				
G_v	bass and treble linear, fader off	19	20	21	dB
	Output voltage level				
$V_{o(rms)}$	for P_{max} at the output stage	–	500	–	mV
$V_{o(rms)}$	for start of clipping	–	1000	–	mV
	Input sensitivity				
$V_{i(rms)}$	at V_o = 500 mV	–	50	–	mV
	Frequency response				
	bass and treble linear; roll-off				
f_r	frequency –1 dB	35	–	20 000	Hz
	Channel separation				
	G_v = 0 dB; bass and treble linear;				
α_{CS}	frequency range 250 Hz to 10 kHz	70	92	–	dB
	Total harmonic distortion				
	frequency range 20 Hz to 12,5 kHz				
THD	V_i = 50 mV; G_v = 20 dB	–	0,1	0,3	%
THD	V_i = 500 mV; G_v = 0 dB	–	0,05	0,2	%
THD	V_i = 1,6 V; G_v = –10 dB	–	0,2	0,5	%
	Ripple rejection				
	$V_{r(rms)}$ < 200 mV; G_v = 0 dB;				
	bass and treble linear;				
RR_{100}	at f = 100 Hz	–	70	–	dB
RR_{range}	at f = 40 Hz to 12,5 kHz	–	60	–	dB

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
	Signal plus noise-to-noise ratio				
	bass and treble linear; notes 1 and 2				
	CCIR 468-2 weighted; quasi peak				
$(S+N)/N$	$V_i = 50$ mV; $V_o = 46$ mV; $P_o = 50$ mW	–	65	–	dB
$(S+N)/N$	$V_i = 500$ mV; $V_o = 45$ mV; $P_o = 50$ mW	–	67	–	dB
$(S+N)/N$	$V_i = 50$ mV; $V_o = 200$ mV; $P_o = 1$ W	65	70	–	dB
$(S+N)/N$	$V_i = 500$ mV; $V_o = 200$ mV; $P_o = 1$ W	65	78	–	dB
$(S+N)/N$	$V_i = 50$ mV; $V_o = 500$ mV; $P_o = 6$ W	–	70	–	dB
$(S+N)/N$	$V_i = 500$ mV; $V_o = 500$ mV; $P_o = 6$ W	–	85	–	dB
	Noise output power				
	mute position, only contribution of				
P_{no}	TEA6300; power amplifier for 25 W	–	–	10	nW
	Crosstalk (20 log $V_{bus(p-p)}/V_{o(rms)}$)				
	between bus inputs and signal outputs				
α_B	$G_V = 0$ dB; bass and treble linear	–	110	–	dB
Source selector					
Z_i	Input impedance	20	30	40	kΩ
Z_o	Output impedance	–	–	100	Ω
R_L	Output load resistance	10	–	–	kΩ
C_L	Output load capacity	0	–	200	pF
	Input isolation				
	not selected source; frequency range				
α_S	40 Hz to 12,5 kHz	–	80	–	dB
	Voltage gain				
G_v	$R_L \geq 10$ kΩ	–	0	–	dB
$V_{b\ int}/V_{ref}$	Internal bias voltage ratio	–	1	–	
	Maximum input voltage level (RMS value)				
$V_{i(rms)}$	THD < 0,5%	–	1,65	–	V
$V_{i(rms)}$	THD < 0,5%; $V_{CC} = 7,5$ V	–	1,5	–	V
	Total harmonic distortion				
THD	$V_i = 500$ mV; $R_L = 10$ kΩ	–	–	0,1	%
	Noise output voltage				
V_{no}	weighted CCIR 468-2, quasi peak	–	9	20	μV
	DC offset voltage				
V_o	between any inputs	–	–	10	mV

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Control part					
	Source selector disconnected, source resistance 600 Ω				
Z_i	Input impedance	35	50	65	kΩ
Z_o	Output impedance	–	100	150	Ω
R_L	Output load resistance	5	–	–	kΩ
C_L	Output load capacity	0	–	2500	pF
$V_{i(rms)}$	Maximum input voltage THD < 0,5%; G_v = –10 dB; bass and treble linear	–	2,0	–	V
	Noise output voltage weighted acc CCIR 468-2, quasi-peak, bass and treble linear, fader off				
V_{no}	G_v = 20 dB	–	110	220	μV
V_{no}	G_v = 0 dB	–	25	50	μV
V_{no}	G_v = –66 dB	–	19	38	μV
V_{no}	mute position	–	11	22	μV
Volume control					
G_c	Continuous control range	–	86	–	dB
	Step resolution	–	2	–	dB
ΔG_a	Attenuator set error (G_v = + 20 to –50 dB)	–	–	2	dB
ΔG_a	Attenuator set error (G_v = + 20 to –66 dB)	–	–	3	dB
ΔG_t	Gain tracking error balance in mid position, bass and treble linear	–	–	2	dB
α_m	Mute attenuation	72	90	–	dB
DC step offset					
	Between any adjoining step and any step to mute				
	G_v = 0 to –66 dB	–	0,2	10	mV
	G_v = 20 to 0 dB	–	2	15	mV
	In any treble and fader position				
	G_v = 0 to –66 dB	–	–	10	mV
	In any bass position				
	G_v = 0 to –66 dB	–	–	20	mV

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
Bass control					
	Bass control range				
G_b	f = 40 Hz; maximum boost	14	15	16	dB
G_b	f = 40 Hz; maximum attenuation	11	12	13	dB
	Step resolution	–	3	–	dB
	Step error	–	–	0,5	dB
Treble control					
	Treble control range				
G_t	f = 15 kHz; maximum boost	11	12	13	dB
G_t	f = 15 kHz; maximum attenuation	11	12	13	dB
G_t	f > 15 kHz; maximum boost	–	–	15	dB
	Step resolution	–	3	–	dB
	Step error	–	–	0,5	dB
Fader control					
	Continuous attenuation				
G_f	fader control range	–	30	–	dB
	Step resolution	–	2	–	dB
	Attenuator set error	–	–	1,5	dB
α_m	Mute attenuation	74	84	–	dB
Digital part					
Bus terminals					
	Input voltage				
V_{IH}	HIGH	3	–	12	V
V_{IL}	LOW	−0,3	–	+1,5	V
	Input current				
I_{IH}	HIGH	−10	–	+10	μA
I_{IL}	LOW	−10	–	+10	μA
V_{OL}	Output voltage LOW; I_L = 3 mA	–	–	0,4	V
AC characteristics	In accordance with the I2C-bus specification				
Power-on-Reset					
	When RESET is active the GMU (general mute) bit is set and the I^2C-bus receiver is in RESET position				
	Increasing supply voltage				
V_{CC}	start of reset	–	–	2,5	V
V_{CC}	end of reset	5,2	6,0	6,8	V
V_{CC}	Decreasing supply voltage; start of reset	4,2	5,0	5,8	V

Notes to the characteristics

1. The indicated values for output power assume a 6 W power amplifier with 20 dB gain, connected to the output of the

circuit. Signal-to-noise ratios exclude noise contribution of the power amplifier.

2. Signal-to-noise ratios on a CCIR 468-2 average meter reading are 4,5 dB better than on CCIR 468-2 quasi peak.

I²C-BUS FORMAT

S	SLAVE ADDRESS	A	SUBADDRESS	A	DATA	A	P

S	=	start condition	SUBADDRESS	=	see Table 1
SLAVE ADDRESS	=	1000 0000	DATA	=	see Table 1
A	=	acknowledge, generated by the slave	P	=	STOP condition

If more than 1 byte of DATA is transmitted, then auto-increment of the subaddress is performed.

Table 1 I²C-bus; subaddress/data

FUNCTION	SUBADDRESS	DATA							
		D7	D6	D5	D4	D3	D2	D1	D0
volume left	0 0 0 0 0 0 0 0	X	X	VL5	VL4	VL3	VL2	VL1	VL0
volume right	0 0 0 0 0 0 0 1	X	X	VR5	VR4	VR3	VR2	VR1	VR0
bass	0 0 0 0 0 0 1 0	X	X	X	X	BA3	BA2	BA1	BA0
treble	0 0 0 0 0 0 1 1	X	X	X	X	TR3	TR2	TR1	TR0
fader	0 0 0 0 0 1 0 0	X	X	MFN	FCH	FA3	FA2	FA1	FA0
switch	0 0 0 0 0 1 0 1	GMU	X	X	X	X	SCC	SCB	SCA

Function of the bits:

VL0 to VL5	volume control left
VR0 to VR5	volume control right
BA0 to BA3	bass control
TR0 to TR3	treble control
FA0 to FA3	fader control
FCH	select fader channel (front or rear)
MFN	mute control of the selected fader channel (front or rear)
SCA to SCC	source selector control
GMU	mute control (general mute) for the outputs QLF, QLR, QRF and QRR
X	don't care bits (logic 1 during testing)

Table 2 Bass setting

G_V	DATA			
DB	BA3	BA2	BA1	BA0
+15	1	1	1	1
+15	1	1	1	0
+15	1	1	0	1
+15	1	1	0	0
+12	1	0	1	1
+ 9	1	0	1	0
+ 6	1	0	0	1
+ 3	1	0	0	0
0	0	1	1	1
− 3	0	1	1	0
− 6	0	1	0	1
− 9	0	1	0	0
−12	0	0	1	1
−12	0	0	1	0
−12	0	0	0	1
−12	0	0	0	0

Table 3 Treble setting

G_V	DATA			
DB	TR3	TR2	TR1	TR0
+12	1	1	1	1
+12	1	1	1	0
+12	1	1	0	1
+12	1	1	0	0
+12	1	0	1	1
+ 9	1	0	1	0
+ 6	1	0	0	1
+ 3	1	0	0	0
0	0	1	1	1
− 3	0	1	1	0
− 6	0	1	0	1
− 9	0	1	0	0
−12	0	0	1	1
−12	0	0	1	0
−12	0	0	0	1
−12	0	0	0	0

Table 4 Volume setting LEFT

G_V DB	DATA					
	VL5	VL4	VL3	VL2	VL1	VL0
20	1	1	1	1	1	1
18	1	1	1	1	1	0
16	1	1	1	1	0	1
14	1	1	1	1	0	0
12	1	1	1	0	1	1
10	1	1	1	0	1	0
8	1	1	1	0	0	1
6	1	1	1	0	0	0
4	1	1	0	1	1	1
2	1	1	0	1	1	0
0	1	1	0	1	0	1
− 2	1	1	0	1	0	0
− 4	1	1	0	0	1	1
− 6	1	1	0	0	1	0
− 8	1	1	0	0	0	1
−10	1	1	0	0	0	0
−12	1	0	1	1	1	1
−14	1	0	1	1	1	0
−16	1	0	1	1	0	1
−18	1	0	1	1	0	0
−20	1	0	1	0	1	1
−22	1	0	1	0	1	0
−24	1	0	1	0	0	1
−26	1	0	1	0	0	0
−28	1	0	0	1	1	1

G_V DB	DATA					
	VL5	VL4	VL3	VL2	VL1	VL0
−30	1	0	0	1	1	0
−32	1	0	0	1	0	1
−34	1	0	0	1	0	0
−36	1	0	0	0	1	1
−38	1	0	0	0	1	0
−40	1	0	0	0	0	1
−42	1	0	0	0	0	0
−44	0	1	1	1	1	1
−46	0	1	1	1	1	0
−48	0	1	1	1	0	1
−50	0	1	1	1	0	0
−52	0	1	1	0	1	1
−54	0	1	1	0	1	0
−56	0	1	1	0	0	1
−58	0	1	1	0	0	0
−60	0	1	0	1	1	1
−62	0	1	0	1	1	0
−64	0	1	0	1	0	1
−66	0	1	0	1	0	0
mute left	0	1	0	0	1	1
mute left	0	1	0	0	1	0
.				.		
.				.		
.				.		
mute left	0	0	0	0	0	0

Table 5 Volume setting RIGHT

G_V	DATA					
DB	VR5	VR4	VR3	VR2	VR1	VR0
20	1	1	1	1	1	1
18	1	1	1	1	1	0
16	1	1	1	1	0	1
14	1	1	1	1	0	0
12	1	1	1	0	1	1
10	1	1	1	0	1	0
8	1	1	1	0	0	1
6	1	1	1	0	0	0
4	1	1	0	1	1	1
2	1	1	0	1	1	0
0	1	1	0	1	0	1
− 2	1	1	0	1	0	0
− 4	1	1	0	0	1	1
− 6	1	1	0	0	1	0
− 8	1	1	0	0	0	1
−10	1	1	0	0	0	0
−12	1	0	1	1	1	1
−14	1	0	1	1	1	0
−16	1	0	1	1	0	1
−18	1	0	1	1	0	0
−20	1	0	1	0	1	1
−22	1	0	1	0	1	0
−24	1	0	1	0	0	1
−26	1	0	1	0	0	0
−28	1	0	0	1	1	1

G_V	DATA					
DB	VR5	VR4	VR3	VR2	VR1	VR0
−30	1	0	0	1	1	0
−32	1	0	0	1	0	1
−34	1	0	0	1	0	0
−36	1	0	0	0	1	1
−38	1	0	0	0	1	0
−40	1	0	0	0	0	1
−42	1	0	0	0	0	0
−44	0	1	1	1	1	1
−46	0	1	1	1	1	0
−48	0	1	1	1	0	1
−50	0	1	1	1	0	0
−52	0	1	1	0	1	1
−54	0	1	1	0	1	0
−56	0	1	1	0	0	1
−58	0	1	1	0	0	0
−60	0	1	0	1	1	1
−62	0	1	0	1	1	0
−64	0	1	0	1	0	1
−66	0	1	0	1	0	0
mute right	0	1	0	0	1	1
mute right	0	1	0	0	1	0
.				.		
.				.		
.				.		
mute right	0	0	0	0	0	0

Table 6 Fader function

SETTING		DATA					
FRONT REAR							
DB	DB	MFN	FCH	FA3	FA2	FA1	FA0
		fader off					
0	0	1	1	1	1	1	1
0	0	0	1	1	1	1	1
		fader front					
− 2	0	1	1	1	1	1	0
− 4	0	1	1	1	1	0	1
− 6	0	1	1	1	1	0	0
− 8	0	1	1	1	0	1	1
−10	0	1	1	1	0	1	0
−12	0	1	1	1	0	0	1
−14	0	1	1	1	0	0	0
−16	0	1	1	0	1	1	1
−18	0	1	1	0	1	1	0
−20	0	1	1	0	1	0	1
−22	0	1	1	0	1	0	0
−24	0	1	1	0	0	1	1
−26	0	1	1	0	0	1	0
−28	0	1	1	0	0	0	1
−30	0	1	1	0	0	0	0
		mute front					
−80	0	0	1	1	1	1	0
.	.			.			
.	.			.			
.	.			.			
−80	0	0	1	0	0	0	0

SETTING		DATA					
FRONT REAR							
DB	DB	MFN	FCH	FA3	FA2	FA1	FA0
		fader off					
0	0	1	0	1	1	1	1
0	0	0	0	1	1	1	1
		fader rear					
0	− 2	1	0	1	1	1	0
0	− 4	1	0	1	1	0	1
0	− 6	1	0	1	1	0	0
0	− 8	1	0	1	0	1	1
0	−10	1	0	1	0	1	0
0	−12	1	0	1	0	0	1
0	−14	1	0	1	0	0	0
0	−16	1	0	0	1	1	1
0	−18	1	0	0	1	1	0
0	−20	1	0	0	1	0	1
0	−22	1	0	0	1	0	0
0	−24	1	0	0	0	1	1
0	−26	1	0	0	0	1	0
0	−28	1	0	0	0	0	1
0	−30	1	0	0	0	0	0
		mute rear					
0	−80	0	0	1	1	1	0
.	.			.			
.	.			.			
.	.			.			
0	−80	0	0	0	0	0	0

Table 7 Selected inputs

SELECTED INPUTS	DATA		
	SCC	SCB	SCA
data not allowed	1	1	1
data not allowed	1	1	0
data not allowed	1	0	1
INLC, INRC	1	0	0
data not allowed	0	1	1
INLB, INRB	0	1	0
INLA, INRA	0	0	1
data not allowed	0	0	0

Table 8 Mute control

MUTE CONTROL	DATA GMU	REMARKS
active	1	outputs QLF, QLR QRF and QRR are muted
passive	0	no general mute

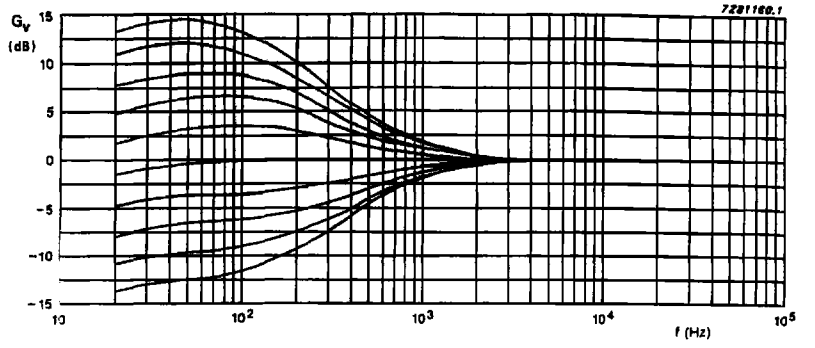


Fig.3 Bass control without T-pass filter.

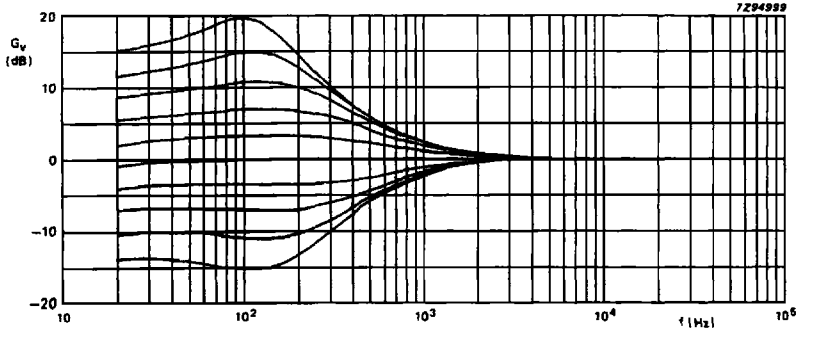
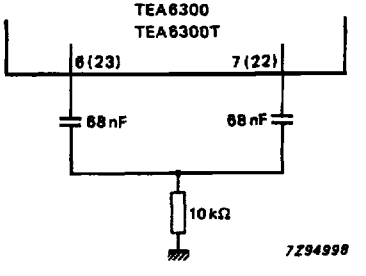


Fig.4 Bass control with T-pass filter.



Pin numbers in parentheses refer to the bass control, right channel.

Fig.5 T-pass filter.

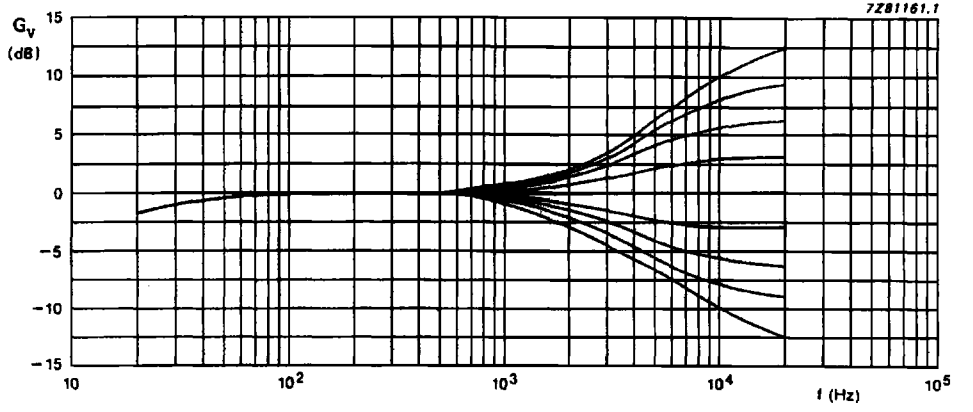


Fig.6 Treble control.

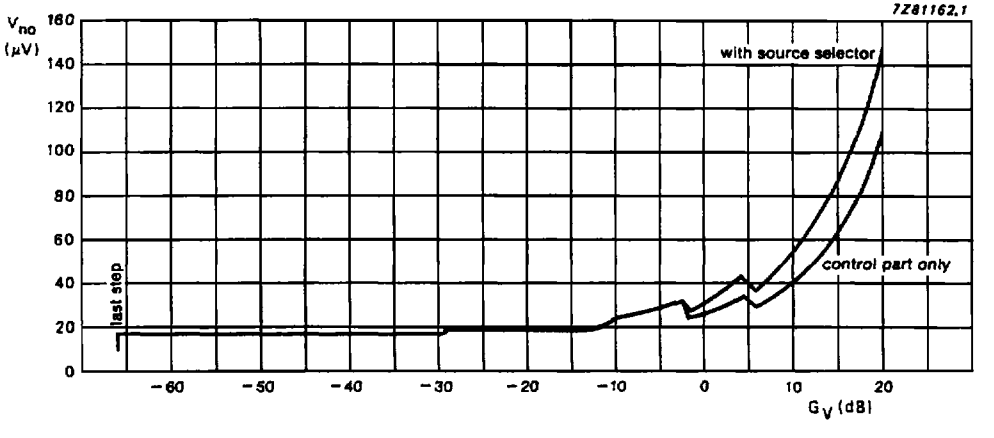


Fig.7 Output noise voltage (CCIR 468-2 weighted: quasi peak).

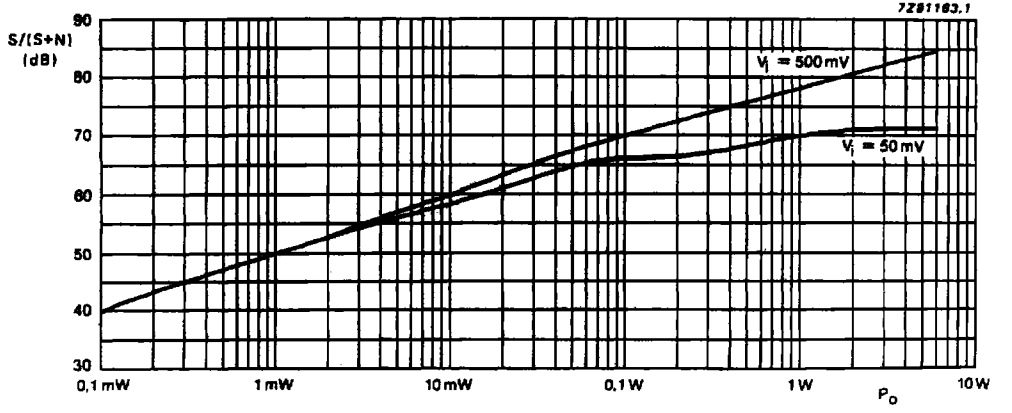


Fig.8 Signal-to-noise ratio (CCIT 468-2 weighted; quasi peak) with a 6 W power amplifier (gain 20 dB) without noise contribution of the power amplifier (see Fig.9).

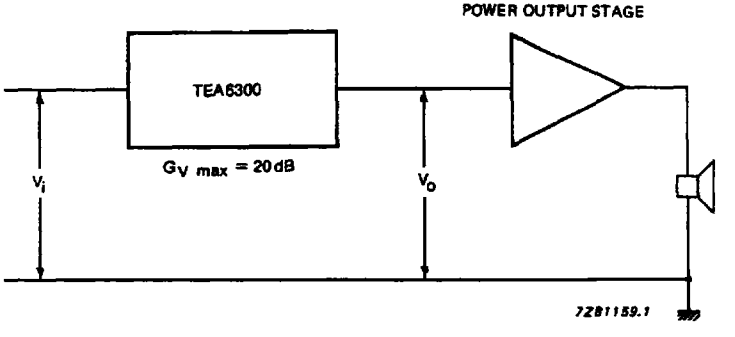


Fig.9 Recommended level diagram; $V_{i\ min}$ = 50 mV, V_o = 500 mV for P_{max}.

APPLICATION INFORMATION

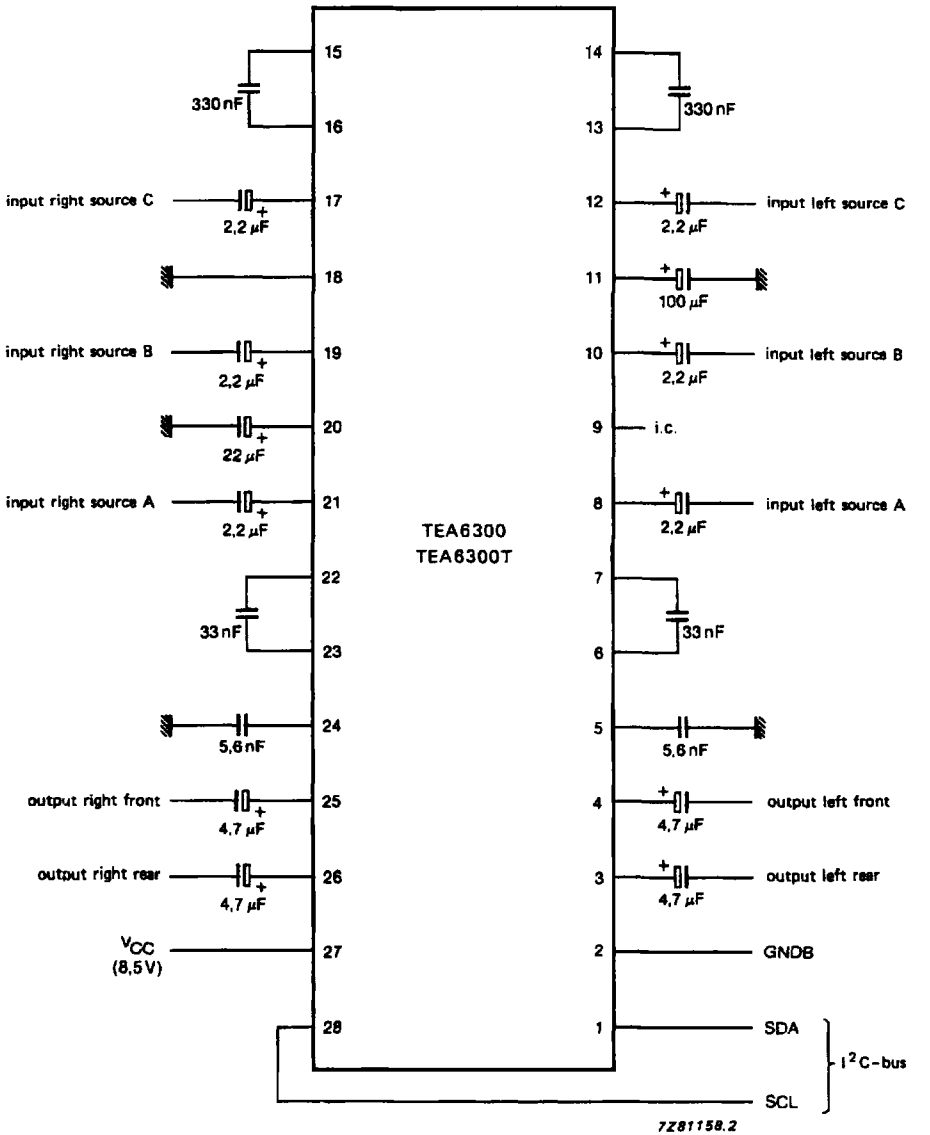


Fig.10 Test and application circuit.