

Document No.	
ECN No.	
Date of Issue	May 1990
Status	Preliminary Specification
RF Communications	

# TEA6300T

## Sound fader control circuit

### GENERAL DESCRIPTION

The Sound Fader Control circuit (SOFAC) is an I<sup>2</sup>C-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
- I<sup>2</sup>C-bus control for all functions
- ESD protected

#### QUICK REFERENCE DATA

parameter	symbol	min.	typ.	max.	unit
Supply voltage	V <sub>CC</sub>	7,0	8,5	13,2	V
Input sensitivity for full power at the output stage	V <sub>i(rms)</sub>	–	50	–	mV
Input signal handling	V <sub>i(rms)</sub>	–	1,65	–	V
Frequency response	f <sub>r</sub>	35	–	20 000	Hz
Channel separation f = 250 Hz to 10 kHz	α <sub>CS</sub>	70	92	–	dB
Total harmonic distortion	THD	–	0,05	–	%
Signal plus noise-to-noise ratio	(S+N)/N	–	80	–	dB
Operating ambient temperature range	T <sub>amb</sub>	–40	–	+ 85	°C

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

Sound fader control circuit

TEA6300T

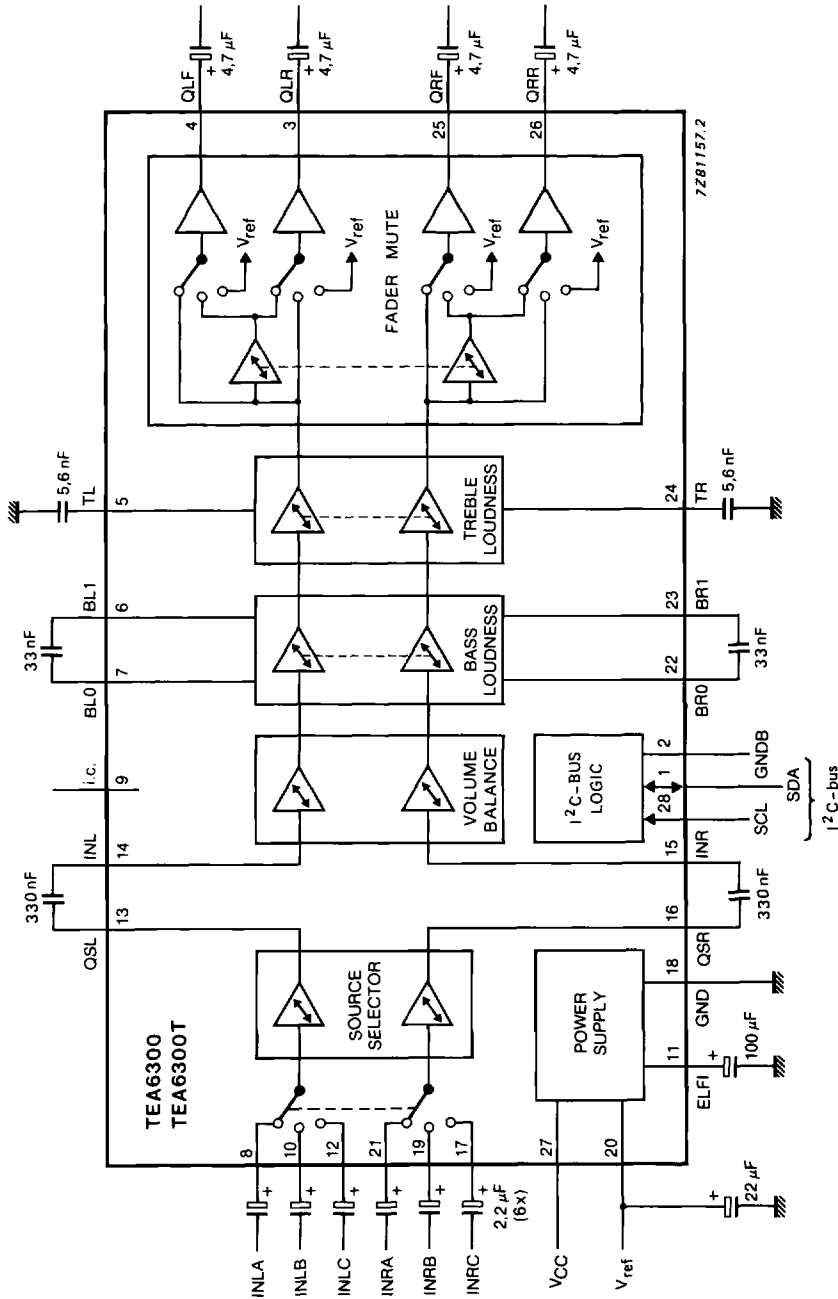


Fig. 1 Block diagram.

# Sound fader control circuit

# TEA6300T

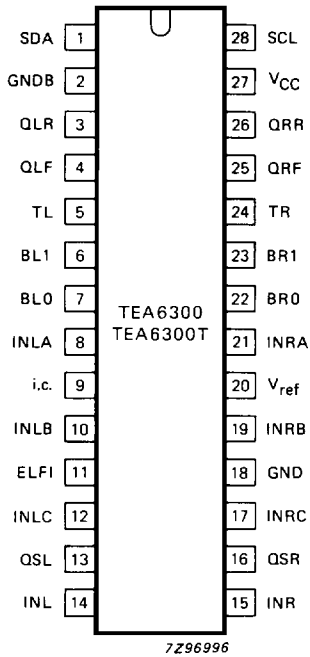


Fig. 2 Pinning diagram.

## PINNING

1	SDA	serial data input/output (I <sup>2</sup> C-bus)
2	GNDB	ground for I <sup>2</sup> C-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	BLO	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 <sub>ref</sub>	reference voltage (1/2 V <sub>CC</sub> )
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 <sub>CC</sub>	supply voltage
28	SCL	serial clock input (I <sup>2</sup> C-bus)

**Sound fader control circuit****TEA6300T****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<sup>2</sup>C-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)

parameter	symbol	min.	max.	unit
Supply voltage (pin 27-18)	V <sub>CC</sub>	–	16	V
Maximum power dissipation	P <sub>tot</sub>	–	1	W
Storage temperature range	T <sub>stg</sub>	–55	+ 150	°C
Operating ambient temperature range	T <sub>amb</sub>	–40	+ 85	°C

## Sound fader control circuit

TEA6300T

## CHARACTERISTICS

$V_{CC} = 8,5 \text{ V}$ ;  $R_S = 600 \Omega$ ;  $R_L = 10 \text{ k}\Omega$ ;  $f = 1 \text{ kHz}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ ; test circuit Fig. 10; unless otherwise specified

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

## Sound fader control circuit

## TEA6300T

## CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
<b>Signal plus noise-to-noise ratio</b>					
bass and treble linear; notes 1 and 2					
CCIR 468-2 weighted; quasi peak					
$V_i = 50 \text{ mV}; V_o = 46 \text{ mV}; P_o = 50 \text{ mW}$	(S + N)/N	—	65	—	dB
$V_i = 500 \text{ mV}; V_o = 45 \text{ mV}; P_o = 50 \text{ mW}$	(S + N)/N	—	67	—	dB
$V_i = 50 \text{ mV}; V_o = 200 \text{ mV}; P_o = 1 \text{ W}$	(S + N)/N	65	70	—	dB
$V_i = 500 \text{ mV}; V_o = 200 \text{ mV}; P_o = 1 \text{ W}$	(S + N)/N	65	78	—	dB
$V_i = 50 \text{ mV}; V_o = 500 \text{ mV}; P_o = 6 \text{ W}$	(S + N)/N	—	70	—	dB
$V_i = 500 \text{ mV}; V_o = 500 \text{ mV}; P_o = 6 \text{ W}$	(S + N)/N	—	85	—	dB
<b>Noise output power</b>					
mute position, only contribution of TEA6300; power amplifier for 25 W					
	$P_{no}$	—	—	10	nW
<b>Crosstalk (<math>20 \log V_{bus(p-p)}/V_o(rms)</math>)</b>					
between bus inputs and signal outputs					
$G_V = 0 \text{ dB}$ ; bass and treble linear					
	$\alpha_B$	—	110	—	dB
<b>Source selector</b>					
<b>Input impedance</b>					
	$Z_i$	20	30	40	k $\Omega$
<b>Output impedance</b>					
	$Z_o$	—	—	100	$\Omega$
<b>Output load resistance</b>					
	$R_L$	10	—	—	k $\Omega$
<b>Output load capacity</b>					
	$C_L$	0	—	200	pF
<b>Input isolation</b>					
not selected source; frequency range 40 Hz to 12,5 kHz					
	$\alpha_S$	—	80	—	dB
<b>Voltage gain</b>					
$R_L \geq 10 \text{ k}\Omega$					
	$G_V$	—	0	—	dB
<b>Internal bias voltage ratio</b>					
	$V_{b \text{ int}}/V_{ref}$	—	1	—	
<b>Maximum input voltage level (RMS value)</b>					
THD < 0,5%					
	$V_{i(rms)}$	—	1,65	—	V
THD < 0,5%; $V_{CC} = 7,5 \text{ V}$					
	$V_{i(rms)}$	—	1,5	—	V
<b>Total harmonic distortion</b>					
$V_i = 500 \text{ mV}; R_L = 10 \text{ k}\Omega$					
	THD	—	—	0,1	%
<b>Noise output voltage</b>					
weighted CCIR 468-2, quasi peak					
	$V_{no}$	—	9	20	$\mu\text{V}$
<b>DC offset voltage</b>					
between any inputs					
	$V_o$	—	—	10	mV
<b>Control part</b>					
Source selector disconnected, source resistance 600 $\Omega$					
<b>Input impedance</b>					
	$Z_i$	35	50	65	k $\Omega$
<b>Output impedance</b>					
	$Z_o$	—	100	150	$\Omega$
<b>Output load resistance</b>					
	$R_L$	5	—	—	k $\Omega$
<b>Output load capacity</b>					
	$C_L$	0	—	2500	pF

## Sound fader control circuit

TEA6300T

parameter	symbol	min.	typ.	max.	unit
Maximum input voltage THD < 0,5%; $G_V = -10$ dB; bass and treble linear	$V_{i(rms)}$	—	2,0	—	V
Noise output voltage weighted acc CCIR 468-2, quasi peak, bass and treble linear, fader off $G_V = 20$ dB	$V_{no}$	—	110	220	$\mu V$
$G_V = 0$ dB	$V_{no}$	—	25	50	$\mu V$
$G_V = -66$ dB	$V_{no}$	—	19	38	$\mu V$
mute position	$V_{no}$	—	11	22	$\mu V$
<b>Volume control</b>					
Continuous control range	$G_C$	—	86	—	dB
Step resolution		—	2	—	dB
Attenuator set error ( $G_V = +20$ to $-50$ dB)	$\Delta G_a$	—	—	2	dB
Attenuator set error ( $G_V = +20$ to $-66$ dB)	$\Delta G_a$	—	—	3	dB
Gain tracking error balance in mid position, bass and treble linear	$\Delta G_t$	—	—	2	dB
Mute attenuation	$\alpha_m$	72	90	—	dB
<b>DC step offset</b>					
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
<b>Bass control</b>					
Bass control range $f = 40$ Hz; maximum boost	$G_B$	14	15	16	dB
$f = 40$ Hz; maximum attenuation	$G_B$	11	12	13	dB
Step resolution		—	3	—	dB
Step error		—	—	0,5	dB
<b>Treble control</b>					
Treble control range $f = 15$ kHz; maximum boost	$G_t$	11	12	13	dB
$f = 15$ kHz; maximum attenuation	$G_t$	11	12	13	dB
$f > 15$ kHz; maximum boost	$G_t$	—	—	15	dB
Step resolution		—	3	—	dB
Step error		—	—	0,5	dB

## Sound fader control circuit

TEA6300T

## CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
<b>Fader control</b>					
Continuous attenuation fader control range	$G_f$	—	30	—	dB
Step resolution		—	2	—	dB
Attenuator set error		—	—	1,5	dB
Mute attenuation	$\alpha_m$	74	84	—	dB
<b>Digital part</b>					
<i>Bus terminals</i>					
Input voltage					
HIGH	$V_{IH}$	3	—	12	V
LOW	$V_{IL}$	—0,3	—	+ 1,5	V
Input current					
HIGH	$I_{IH}$	—10	—	+ 10	$\mu A$
LOW	$I_{IL}$	—10	—	+ 10	$\mu A$
Output voltage LOW $I_L = 3 \text{ mA}$	$V_{OL}$	—	—	0,4	V
<i>AC characteristics</i>					
in accordance with the I <sup>2</sup> C-bus specification					
<i>Power-on-Reset</i>					
When RESET is active the GMU (general mute) bit is set and the I <sup>2</sup> C-bus receiver is in RESET position					
Increasing supply voltage					
start of reset	$V_{CC}$	—	—	2,5	V
end of reset	$V_{CC}$	5,2	6,0	6,8	V
Decreasing supply voltage					
start of reset	$V_{CC}$	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.



# Sound fader control circuit

# TEA6300T

## I<sup>2</sup>C-BUS FORMAT

S	SLAVE ADDRESS	A	SUBADDRESS	A	DATA	A	P
---	---------------	---	------------	---	------	---	---

S = start condition  
 SLAVE ADDRESS = 1000 0000  
 A = acknowledge, generated by the slave

SUBADDRESS = see Table 1  
 DATA = see Table 1  
 P = STOP condition

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

**Table 1** I<sup>2</sup>C-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)

**Sound fader control circuit**

**TEA6300T**

**Table 2** Bass setting

G <sub>v</sub> dB	DATA			
	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 <sub>v</sub> dB	DATA			
	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

Sound fader control circuit

TEA6300T

Table 4 Volume setting LEFT

Table 5 Volume setting RIGHT

G <sub>V</sub> 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
-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

G <sub>V</sub> dB	DATA					
	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
-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

# Sound fader control circuit

TEA6300T

**Table 6** Fader function

setting		DATA					
front dB	rear 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 dB	rear 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

# Sound fader control circuit

# TEA6300T

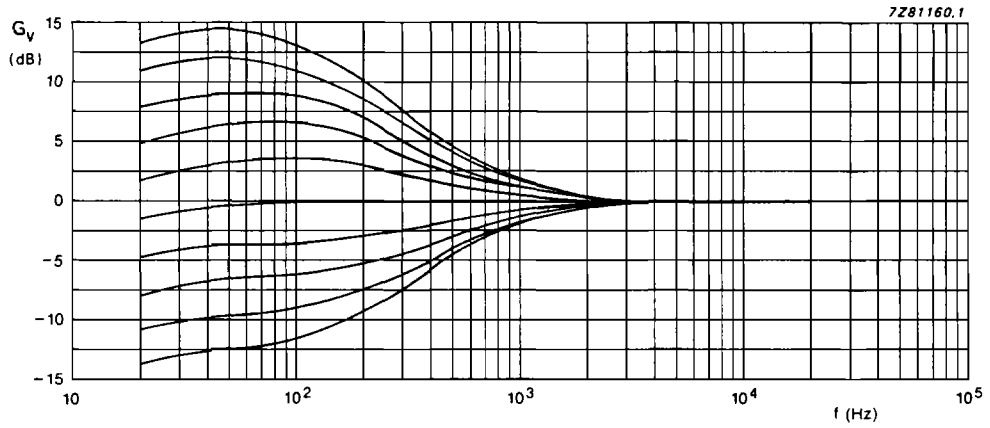


Fig. 3 Bass control without T-pass filter.

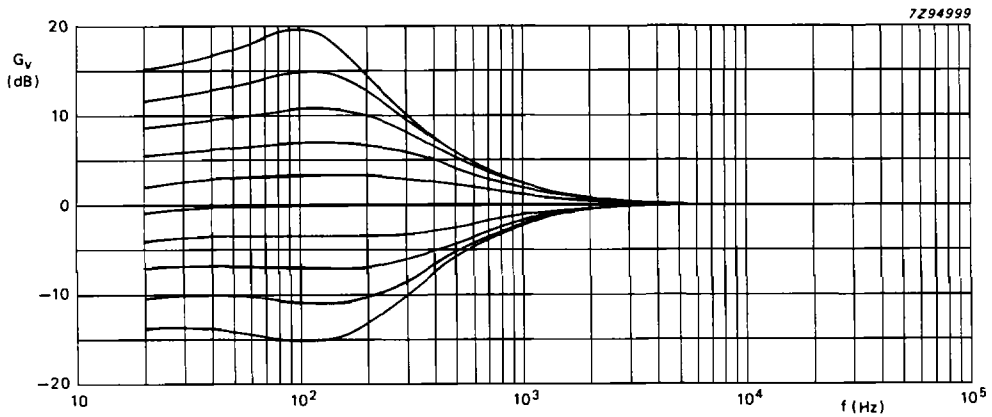
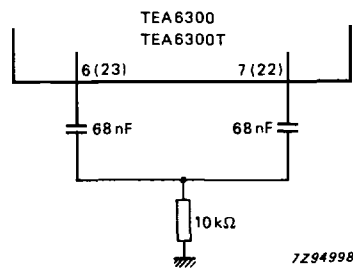


Fig. 4 Bass control with T-pass filter.



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

Fig. 5 T-pass filter.

Sound fader control circuit

TEA6300T

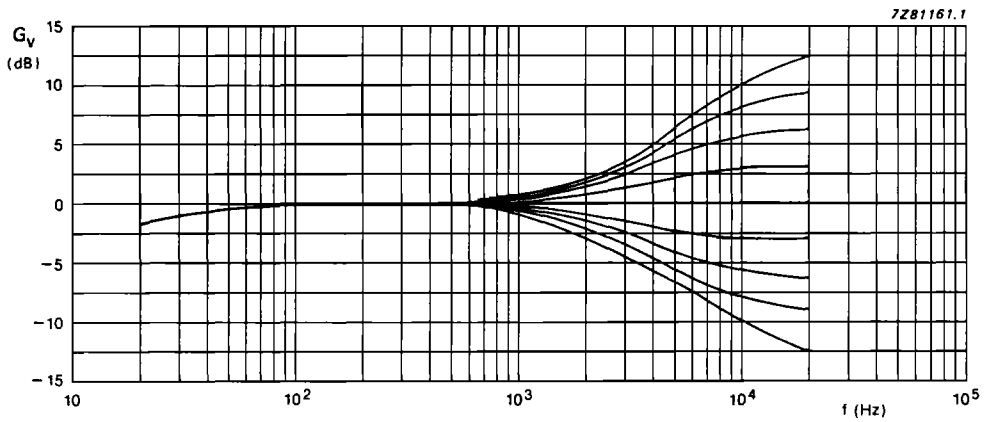


Fig. 6 Treble control.

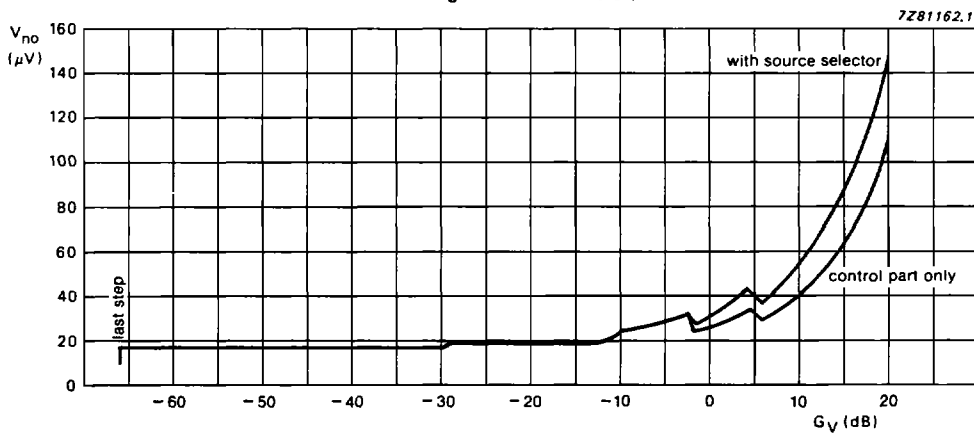


Fig. 7 Output noise voltage (CCIR 468-2 weighted; quasi peak).

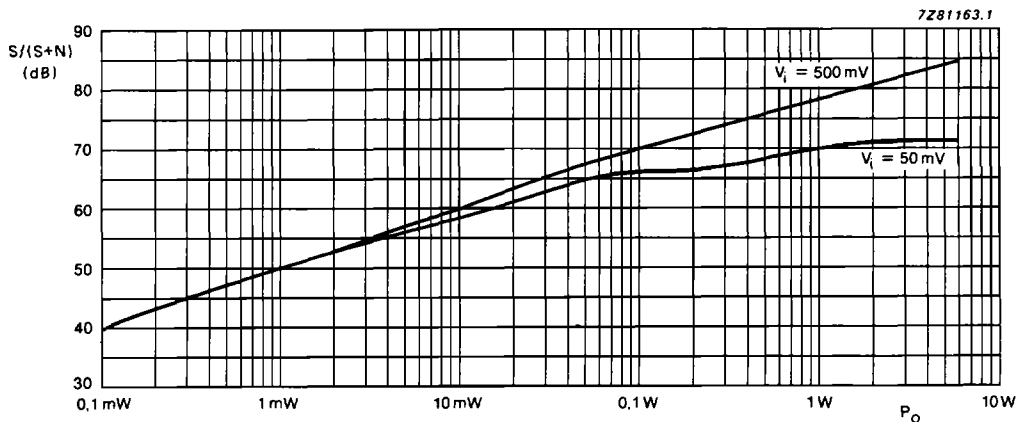


Fig. 8 Signal-to-noise ratio (CCIT 468-2 weighted; quasi peak) with a 6 W power amplifier (gain 20 dB) without noise contribution of the power amplifier (see Fig. 9).

# Sound fader control circuit

# TEA6300T

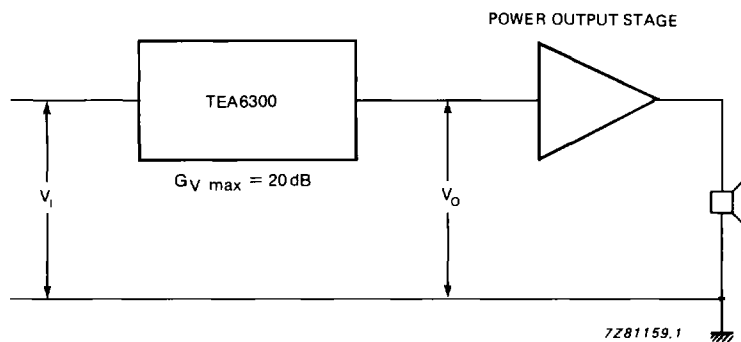


Fig. 9 Recommended level diagram;  $V_{i\ min} = 50\ mV$ ,  $V_o = 500\ mV$  for  $P_{max}$ .

Sound fader control circuit

TEA6300T

APPLICATION INFORMATION

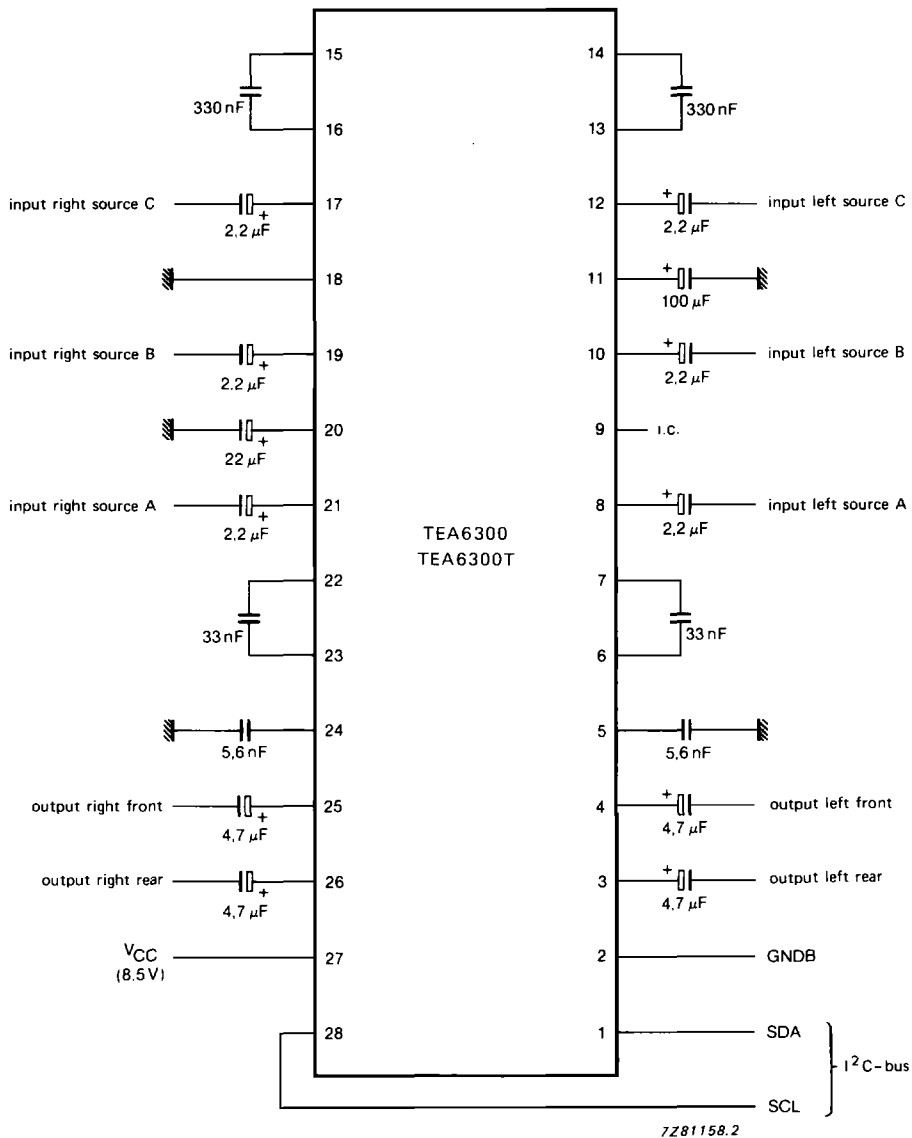


Fig. 10 Test and application circuit.