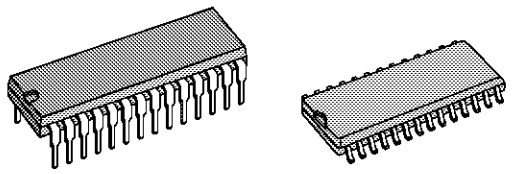
SGS-THOMSON MICROELECTRONICS

TDA7300

DIGITAL CONTROLLED STEREO AUDIO PROCESSOR

- SINGLE SUPPLY OPERATION
- FOUR STEREO INPUT SOURCE SELECTION
- MONO INPUT
- TREBLE, BASS, VOLUME, AND BALANCE CONTROL
- FOUR INDEPENDENT SPEAKER CONTROL (FRONT/REAR)
- SINGLE SUPPLY OPERATION
- ALL FUNCTIONS PROGRAMMABLE VIA SERIAL BUS
- VERY LOW NOISE AND VERY LOW DISTORTION
- POP FREE SWITCHING



DIP28 **SO28**

ORDERING NUMBERS:

TDA7300 TDA7300D

DESCRIPTION

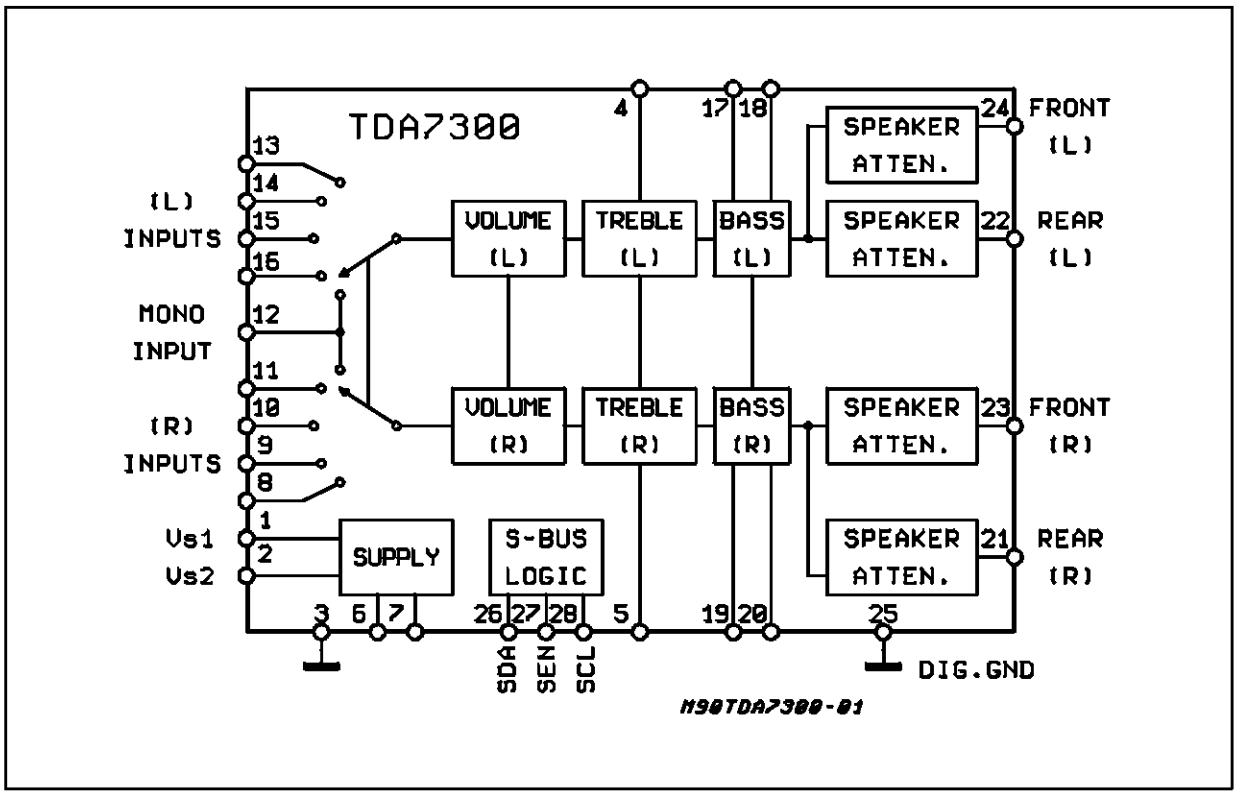
The TDA7300 is a volume, tone (bass and treble), balance (left/right) and fader (front/rear) processor for high quality audio applications in car radio and Hi-Fi systems.

Control is accomplished by serial bus microprocessor interface.

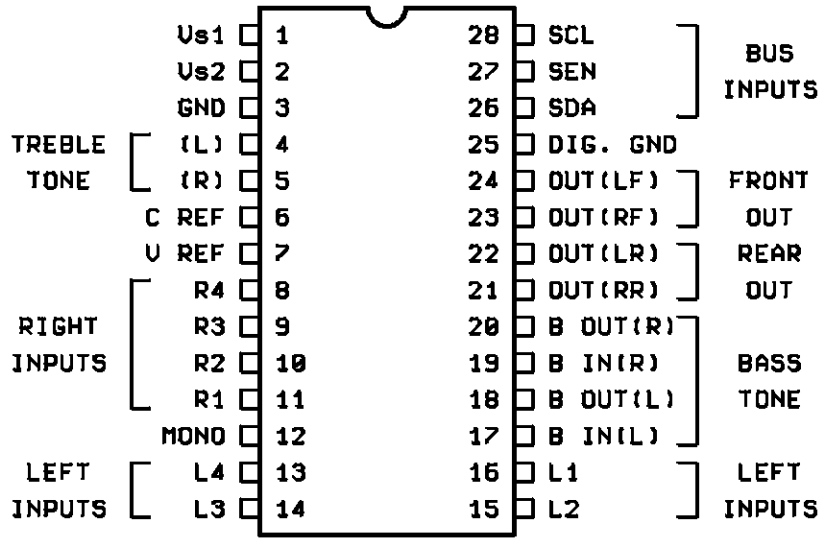
The AC signal setting is obtained by resistor networks and analog switches combined with operational amplifiers.

The results are: low noise, low distortion and high dynamic range.

BLOCK DIAGRAM



PIN CONNECTION (Top view)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_S	Supply Voltage (V_{S1})	18	V
T_{amb}	Operating Ambient Temperature Range	-40 to +85	°C
T_{stg}	Storage Temperature	-40 to 150	°C

THERMAL DATA

Symbol	Description		SO28	DIP28	Unit
$R_{th\ j\text{-}pins}$	Thermal Resistance Junction-pins	Max	85	65	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C, V_{S1} = 12V or V_{S2} = 8.5V , R_L = 10kΩ and R_g = 600Ω , f = 1KHz unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
SUPPLY (1)						
V_{S1}	Supply Voltage VS1		10	12	16	V
V_{S2}	Supply Voltage VS2		6	8.5	10	V
I_{S2}	Supply Current		15	30	40	mA
V_{ref}	Reference Voltage (pin 7)		3.5	4.3	5	V
SVR	Ripple Rejection at V_{S1}	f = 300Hz to 10KHz	80	97		dB
SVR	Ripple Rejection at V_{S2}	f = 300Hz to 10KHz	50	58		dB
INPUT SELECTORS						
R_i	Input Resistance		30	45		KΩ
$V_{IN\ max}$	Max. Input Signal	GV = 0dB d = 0.3%	1.5	2.2		Vrms
IN_S	Input Separation	f = 1KHz (2)	90	100		dB
		f = 10KHz (2)	70	80		dB
$V_{i\ (DC)}$	Input DC Voltage		3.5	4.3	5	V

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
VOLUME CONTROLS						
	Control Range			78		dB
G_{max}	Max Gain		8	10	12	dB
	Max Attenuation		64	68		dB
	Step Resolution	G_V = -50 to 10dB		2	3	dB
	Attenuator Set Error				2	dB
	Tracking Error				2	dB
SPEAKER ATTENUATORS						
	Control Range		35	38	41	dB
	Step Resolution			2	3	dB
	Attenuator Set Error				2	dB
	Tracking Error				2	dB
BASS AND TREBLE CONTROL (3)						
	Control Range			±15		dB
	Step Resolution			2.5	3.5	dB
AUDIO OUTPUT						
V_O	Max. Output Voltage	d = 0.3%	1.5	2.2		Vrms
R_L	Output Load Resistance		2			KΩ
C_L	Output Load Capacitance				1	nF
R_O	Output Resistance			70	150	Ω
V_O(DC)	DC Voltage Level		3	3.8	4.5	V
GENERAL						
e_{NO}	Output Noise	BW = 22Hz to 22KHz, G_v = 0dB		6	15	μV
		Curve A G_v = 0dB		4		
S/N	Signal to Noise Ratio	All gain = 0dB V_O = 1Vrms BW = 22Hz to 22KHz		105		dB
d	Distortion	f = 1KHz; V_O = 1V; G_V = 0		0.01	0.1	%
	Frequency Response (-1dB)	G_v = 0 High Low	20		 20	KHz Hz
S_C	Channnel Separation left/right	f = 1KHz f = 10KHz	90 70	100 80		dB dB
BUS INPUTS						
V_{IL}	Input LOW Voltage				0.8	V
V_{IH}	Input HIGH Voltage		2.4			V
V_O	Output Voltage SDA Acknowledge	I = 1.6mA			0.4	V
	Digital Input Current		-5		+5	μA

Notes:
(1) The circuit can be supplied either at V_{S1} or without the use of the internal voltage regulator at V_{S2} . The circuit also operates at a supply voltage V_{S1} lower than 10V. In this case the ripple rejection of V_{S2} is valid, because the voltage regulator saturates to a saturation voltage of about 0.8V.
(2) The selected input is grounded thru the 2.2μF capacitor.
(3) Bass and Treble response see attached diagram. The center frequency and quality of the resonance behaviour can be choosen by the external circuitry. A standard first order bass response can be realized by a standard feedback network.

Figure 1: Application Circuit

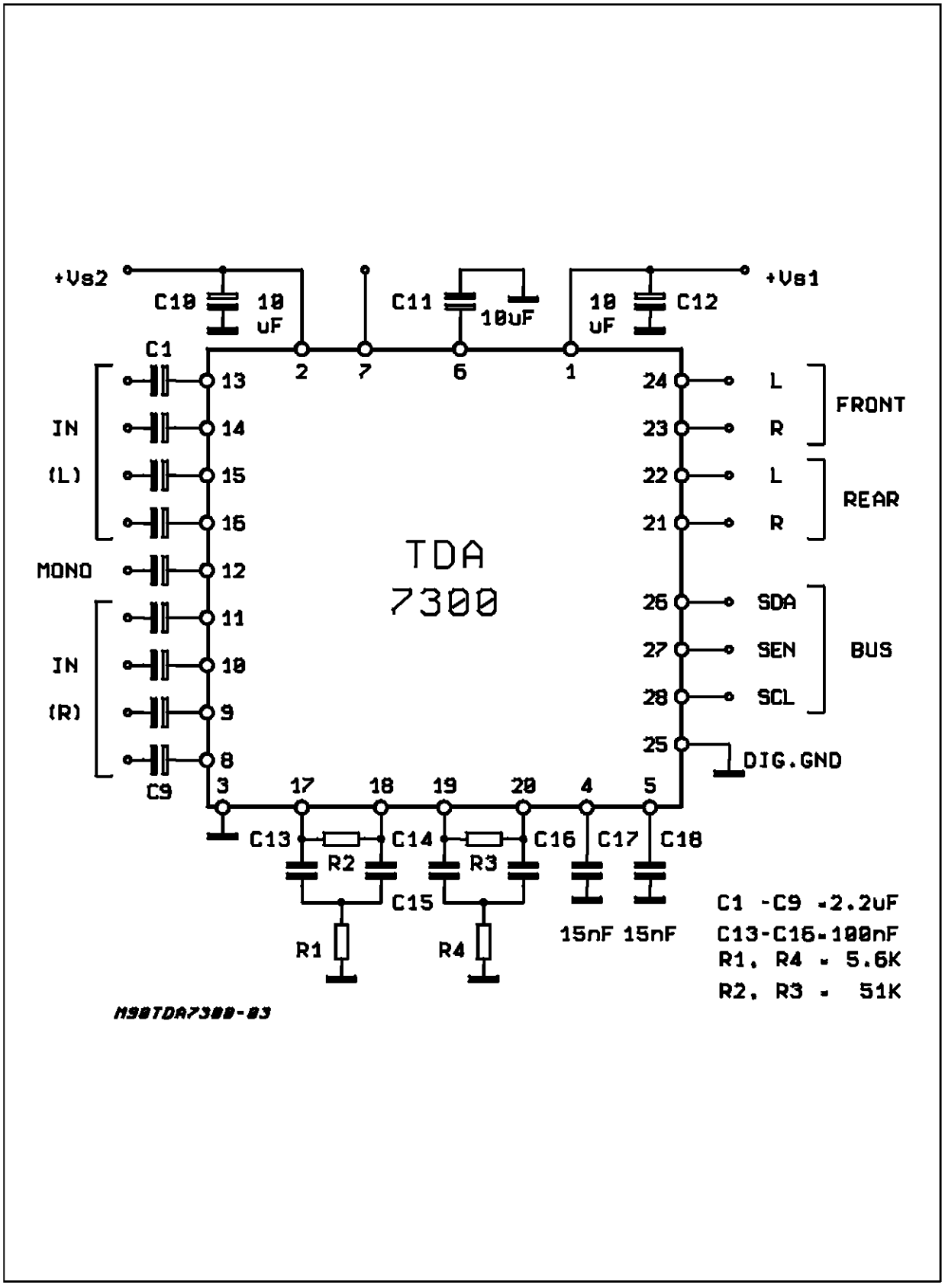


Figure 2: P.C. Board and Components Layout of the Fig.1 (1:1 scale)

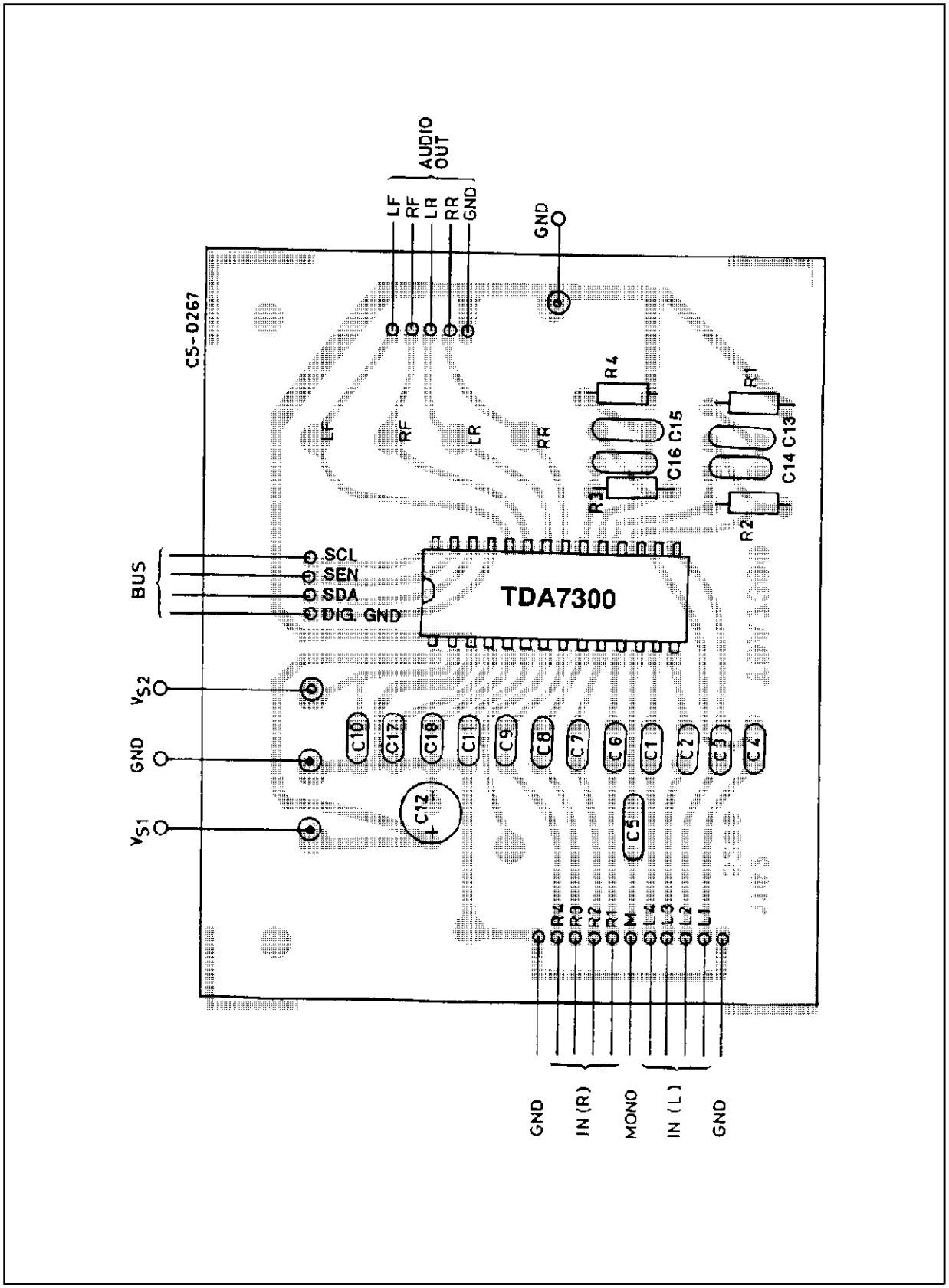


Figure 3: Total Output Noise vs. Volume Setting

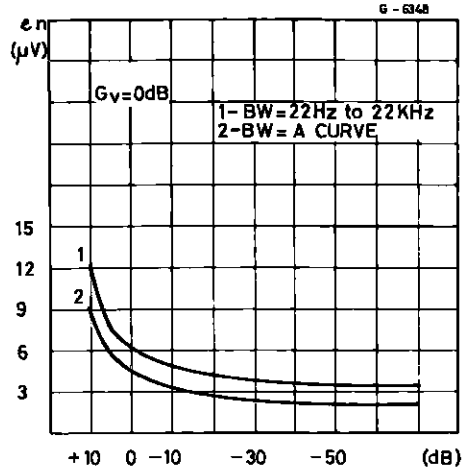


Figure 4: Signal to Noise Ratio vs. Volume Setting

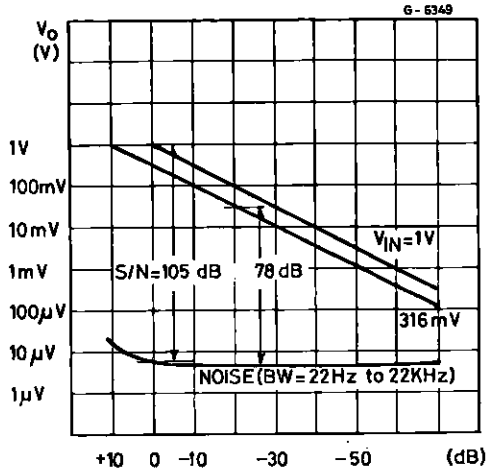


Figure 5: Distortion + Noise vs. Frequency

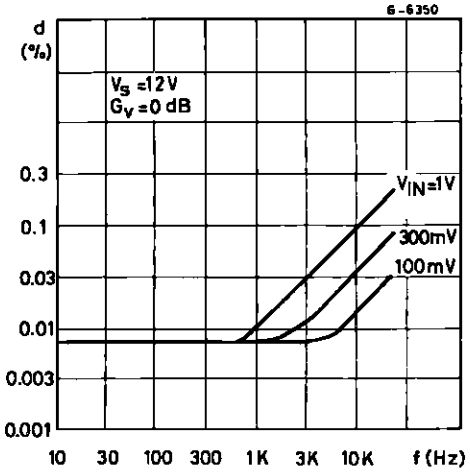


Figure 6: Distortion vs. Output Voltage

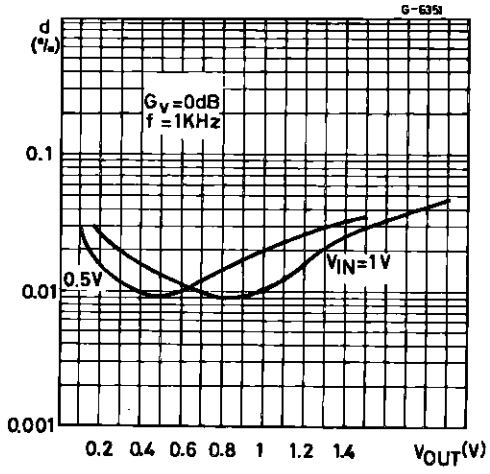


Figure 7: Distortion vs. Load Resistance

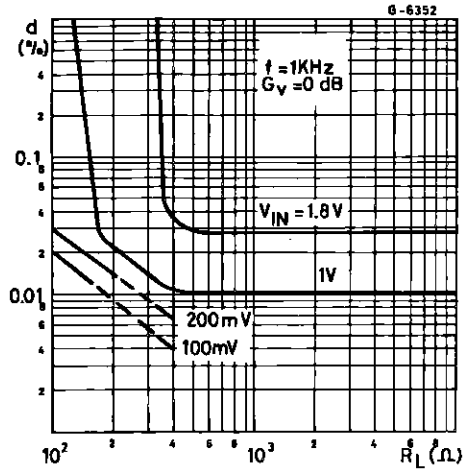


Figure 8: Channel Separation (L1 - R1) vs. Frequency

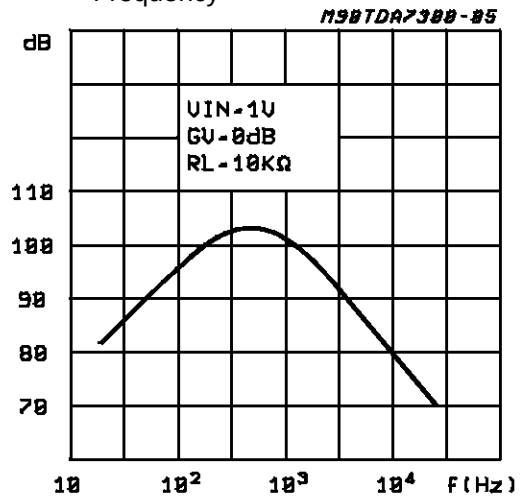


Figure 9: Input Separation (L1 - L2) vs. (V_{S1}) Frequency

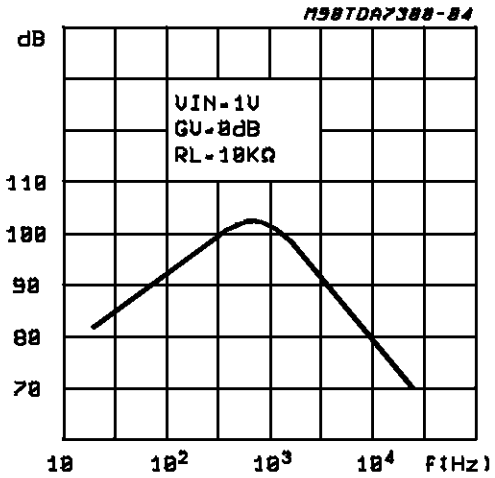


Figure 10: Supply Voltage Rejection (V_{S1}) vs. Frequency

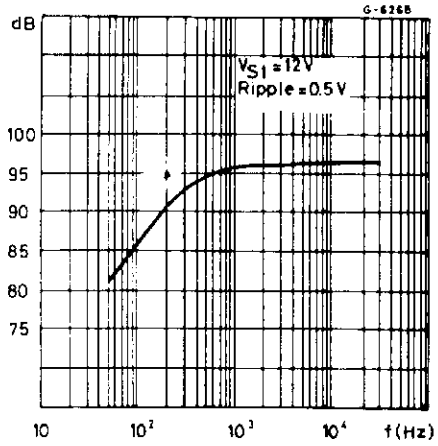


Figure 11: Supply Voltage Rejection (V_{S2}) vs. Frequency

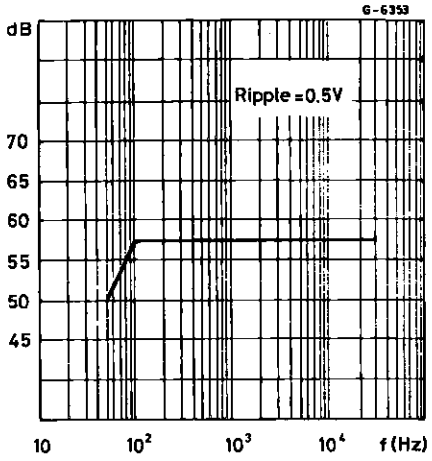


Figure 12: Supply Voltage Rejection vs. V_{S1}

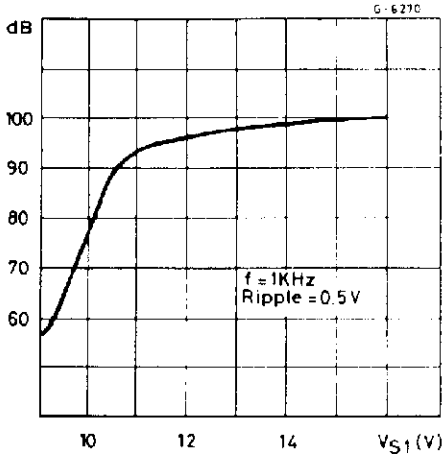


Figure 13: Supply Voltage Rejection vs. V_{S2}

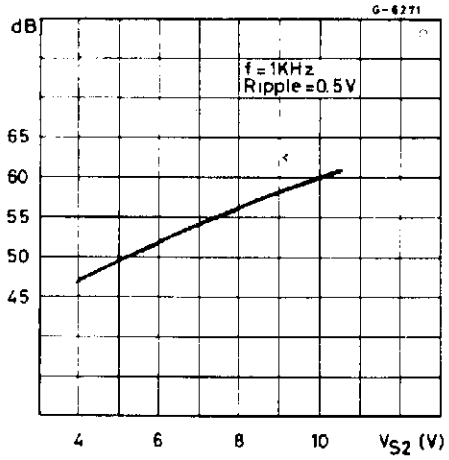
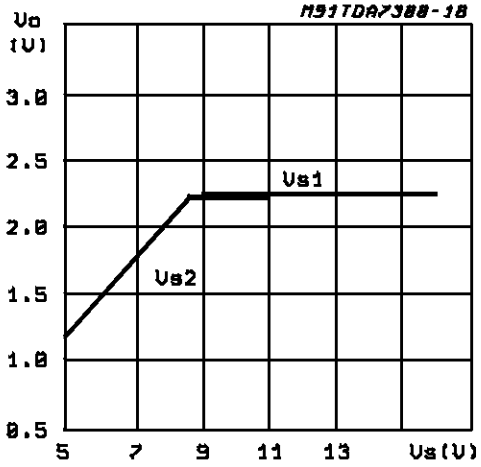


Figure 14: Clipping Level (Vrms) vs. Supply Voltage



APPLICATION INFORMATION

Volume Control Concept

Traditional electronic volume control circuits use a multiplier technique with all the disadvantages of high noise and distortion.
The used concept, as shown in Fig. 15 with digital switched resistor dividers, provides extremely low noise and distortion. The multiplexing of the resistive dividers is realized with a multiple-input operational amplifier.

Bass and Treble Control

The principle operation of the bass control is shown in Fig. 16. The external filter together with the internal buffer allows a flexible filter design according to the different requirements in car radios. The function of the treble is similar to the bass.
A typical curve is shown in Fig.19.

Outputs

A special class-A output amplifier with a modulated sink current provides low distortion and ground compatibility with low current consumption.

Figure 15: Volume Control

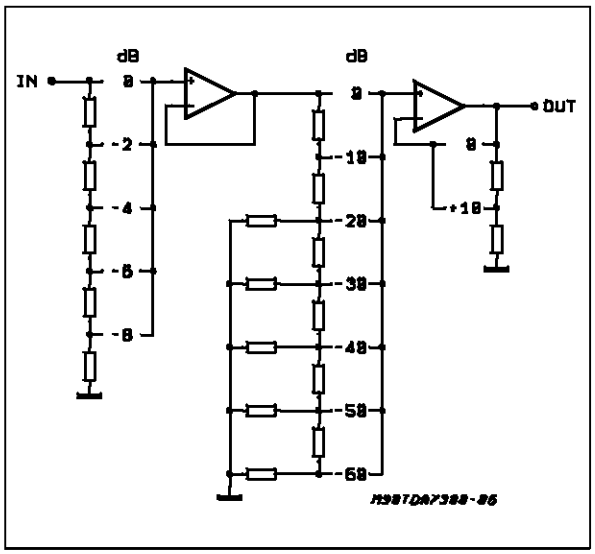


Figure 16: Bass Control

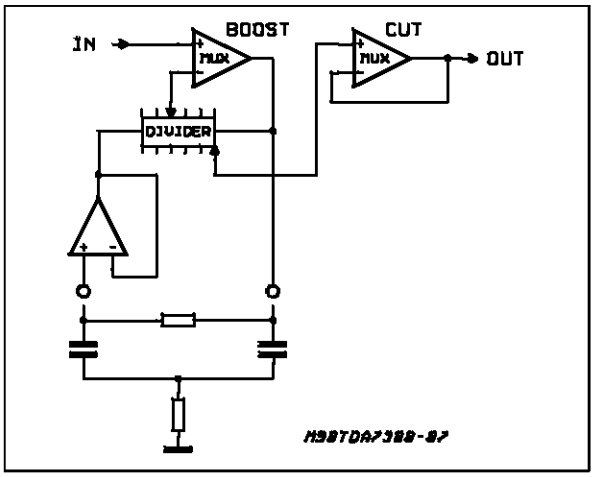


Figure 17: Quiescent Current vs. Supply Voltage

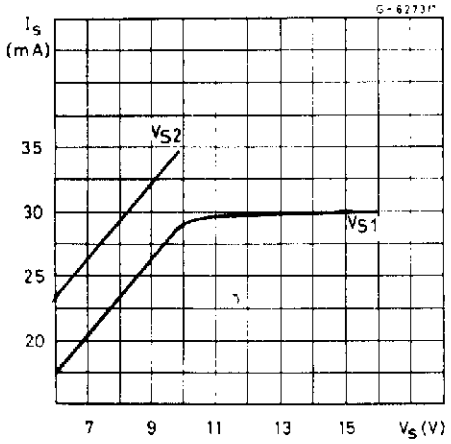
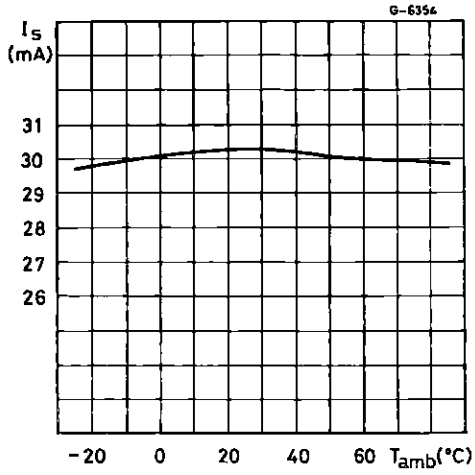


Figure 18: Quiescent Current vs. Temperature



APPLICATION INFORMATION (continued)

Figure 19: Typical Tone Response

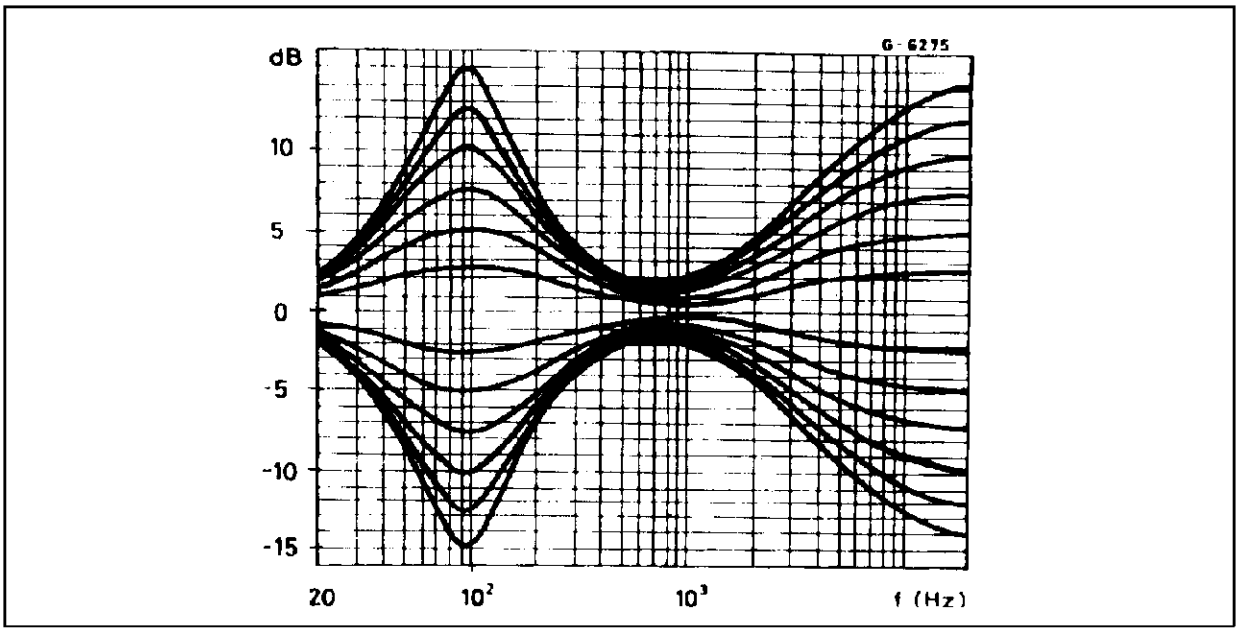
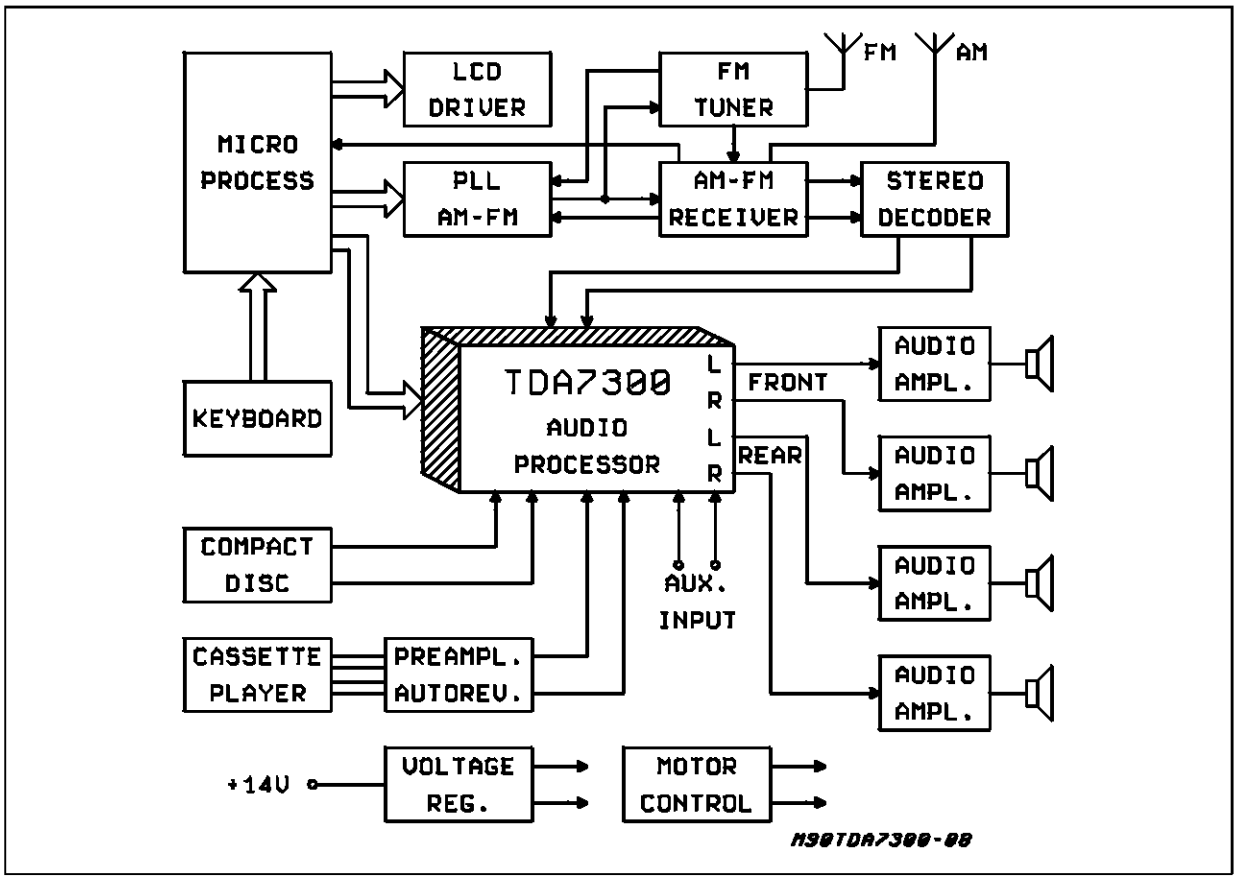


Figure 20: Complete Car-Radio System using Digital Controlled Audio Processor



APPLICATION INFORMATION (continued)

SERIAL BUS INTERFACE

S-BUS Interface and I²CBUS Compatibility

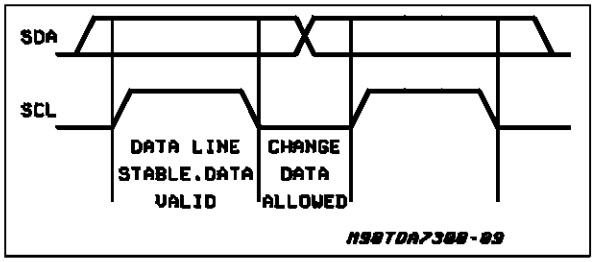
Data transmission from microprocessor to the TDA7300 and viceversa takes place thru the 3-wire S-BUS interface, consisting of the three lines SDA, SCL, SEN. If SDA and SEN inputs are short-circuited together, then the TDA7300 appears as a standard I²CBUS slave.

According to I²CBUS specification the S-BUS lines are connected to a positive supply voltage via pull-up resistors.

Data Validity

As shown in fig. 21, the data on the SDA line must be stable during the high period of the clock. The HIGH and LOW state of the data line can only change when the clock signal on the SCL line is LOW.

Figure 21: Data Validity on the I²CBUS



Start and Stop Conditions

I²CBUS:

as shown in fig.22 a start condition is a HIGH to LOW transition of the SDA line while SCL is HIGH. The stop condition is a LOW to HIGH transition of the SDA line while SCL is HIGH.

S-bus:

the start/stop conditions (points 1 and 6) are detected exclusively by a transition of the SEN line ($1 \rightarrow 0$ / $0 \rightarrow 1$) while the SCL line is at the HIGH level.

The SDA line is only allowed to change during the time the SCL line is low (points 2, 3, 4, 5). After the start information (point 1) the SEN line returns to the HIGH level and remains unchanged for all the time the transmission is performed.

Byte Format

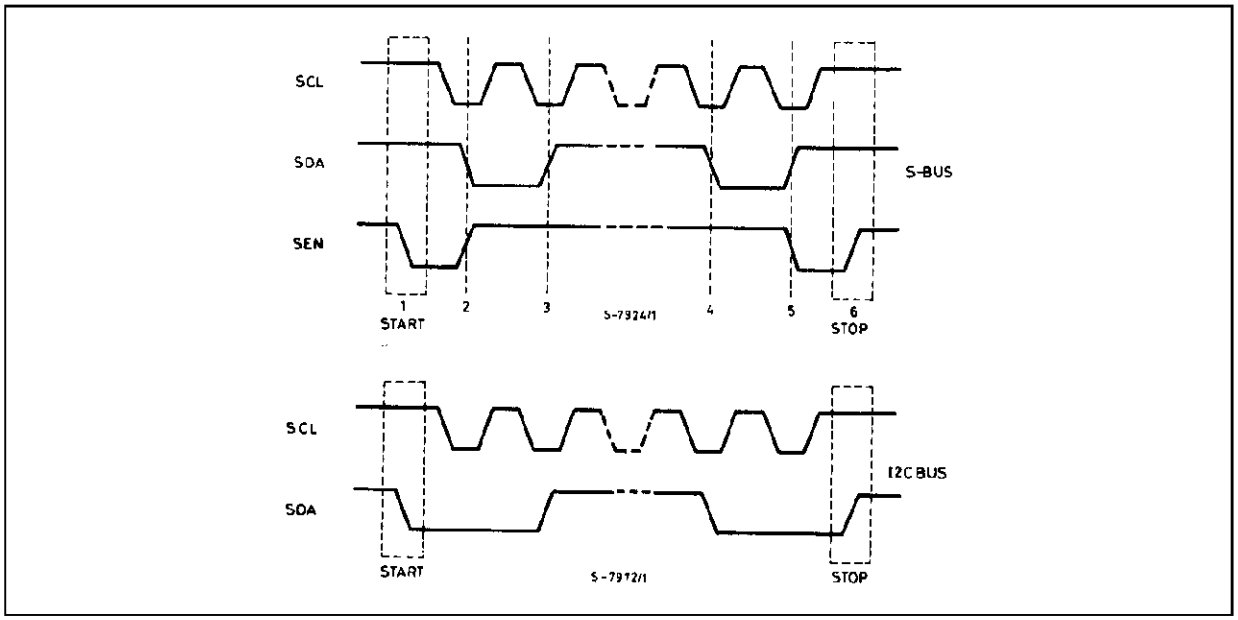
Every byte transferred on the SDA line must contain 8 bits. Each byte must be followed by an acknowledge bit. The MSB is transferred first.

Acknowledge

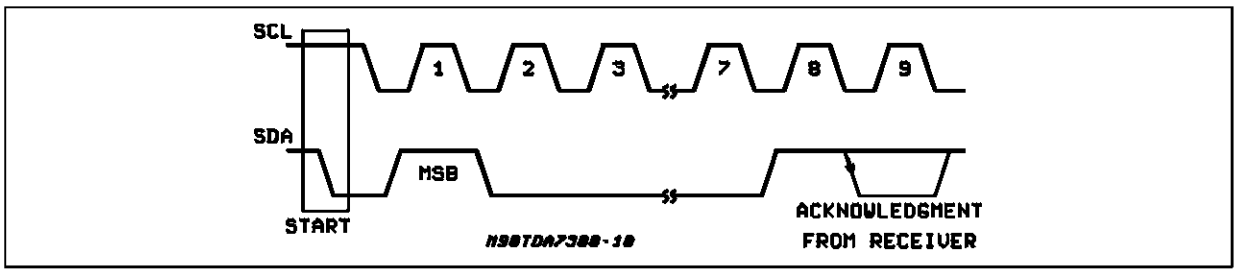
The master (µP) puts a resistive HIGH level on the SDA line during the acknowledge clock pulse (see fig. 23). The peripheral (audioprocessor) that acknowledges has to pull-down (LOW) the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during this clock pulse.

The audioprocessor which has been addressed has to generate an acknowledge after the reception of each byte, otherwise the SDA line remains at the HIGH level during the ninth clock pulse time. In this case the master transmitter can generate the STOP information in order to abort the transfer.

Figure 22: Timing Diagram of S-BUS and I²CBUS



APPLICATION INFORMATION (continued)
Figure 23: Acknowledge on the I²CBUS



Transmission without Acknowledge

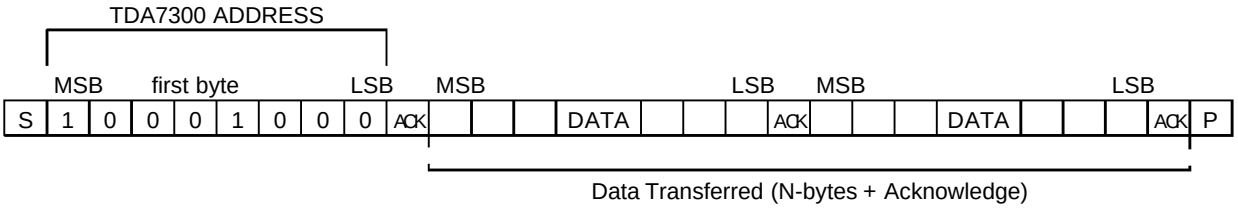
Avoiding to detect the acknowledge of the audio-processor, the µP can use a simplier transmission: simply it waits one clock without checking the slave acknowledging, and sends the new data.

This approach of course is less protected from misworking and decreases the noise immunity.

Interface Protocol

The interface protocol comprises:

- A start condition (S)
- A chip address byte, containing the TDA7300 address (the 8th bit of the byte must be 0). The TDA7300 must always acknowledge at the end of each transmitted byte.
- A sequence of data (N-bytes + acknowledge)
- A stop condition (P)



ACK = Acknowledge
S = Start
P = Stop

MAX CLOCK SPEED 100kbits/s

SOFTWARE SPECIFICATION

Chip address (TDA7300 address)

1	0	0	0	1	0	0	0
MSB							LSB

DATA BYTES

MSB							LSB	Function
0	0	B2	B1	B0	A2	A1	A0	Volume Control
1	1	0	B1	B0	A2	A1	A0	Speaker ATT LR
1	1	1	B1	B0	A2	A1	A0	Speaker ATT RR
1	0	0	B1	B0	A2	A1	A0	Speaker ATT LF
1	0	1	B1	B0	A2	A1	A0	Speaker ATT RF
0	1	0	X	X	S2	S1	S0	Audio switch
0	1	1	0	C3	C2	C1	C0	Bass control
0	1	1	1	C3	C2	C1	C0	Treble control

X = don't care
Ax = 2dB steps
Bx = 10dB steps
Cx = 2.5dB steps

Status after power-on reset

Volume	–68dB
Speaker	–38dB
Audio Switch	Mono
Bass	+2.5dB
Treble	+2.5dB

SOFTWARE SPECIFICATION (continued)
DATA BYTES (detailed description)

VOLUME

MSB							LSB	
0	0	B2	B1	B0	A2	A1	A0	Volume 2dB Steps
					0	0	0	0
					0	0	1	-2
					0	1	0	-4
					0	1	1	-6
					1	0	0	-8
					1	0	1	Not allowed
					1	1	0	Not allowed
					1	1	1	Not allowed
0	0	B2	B1	B0				Volume 10dB steps
		0	0	0				+10
		0	0	1				0
		0	1	0				-10
		0	1	1				-20
		1	0	0				-30
		1	0	1				-40
		1	1	0				-50
		1	1	1				-60

For example if you want setting the volume at -32dB the 8 bit string is: 0 0 1 0 0 0 0 1

SPEAKER ATTENUATORS

MSB							LSB	
1	0	0	B1	B0	A2	A1	A0	Speaker LF
1	0	1	B1	B0	A2	A1	A0	Speaker RF
1	1	0	B1	B0	A2	A1	A0	Speaker LR
1	1	1	B1	B0	A2	A1	A0	Speaker RR
					0	0	0	0
					0	0	1	-2
					0	1	0	-4
					0	1	1	-6
					1	0	0	-8
					1	0	1	Not allowed
					1	1	0	Not allowed
					1	1	1	Not allowed
			0	0				0
			0	1				-10
			1	0				-20
			1	1				-30

For example attenuation of 24dB on speaker RF is given by: 1 0 1 1 0 0 1 0

SOFTWARE SPECIFICATION (continued)

AUDIO SWITCH - Select the input Channel to Activate

MSB							LSB	
0	1	0	X	X	S2	S1	S0	Audio Switch
			X	X	0	0	0	Stereo 1
			X	X	0	0	1	Stereo 2
			X	X	0	1	0	Stereo 3
			X	X	0	1	1	Stereo 4
			X	X	1	0	0	Mono
			X	X	1	0	1	Not Allowed
			X	X	1	1	0	Not Allowed
			X	X	1	1	1	Not Allowed

X = don't care
For example to set the stereo 2 channel the 8 bit string may be: 0 1 0 0 0 0 0 1

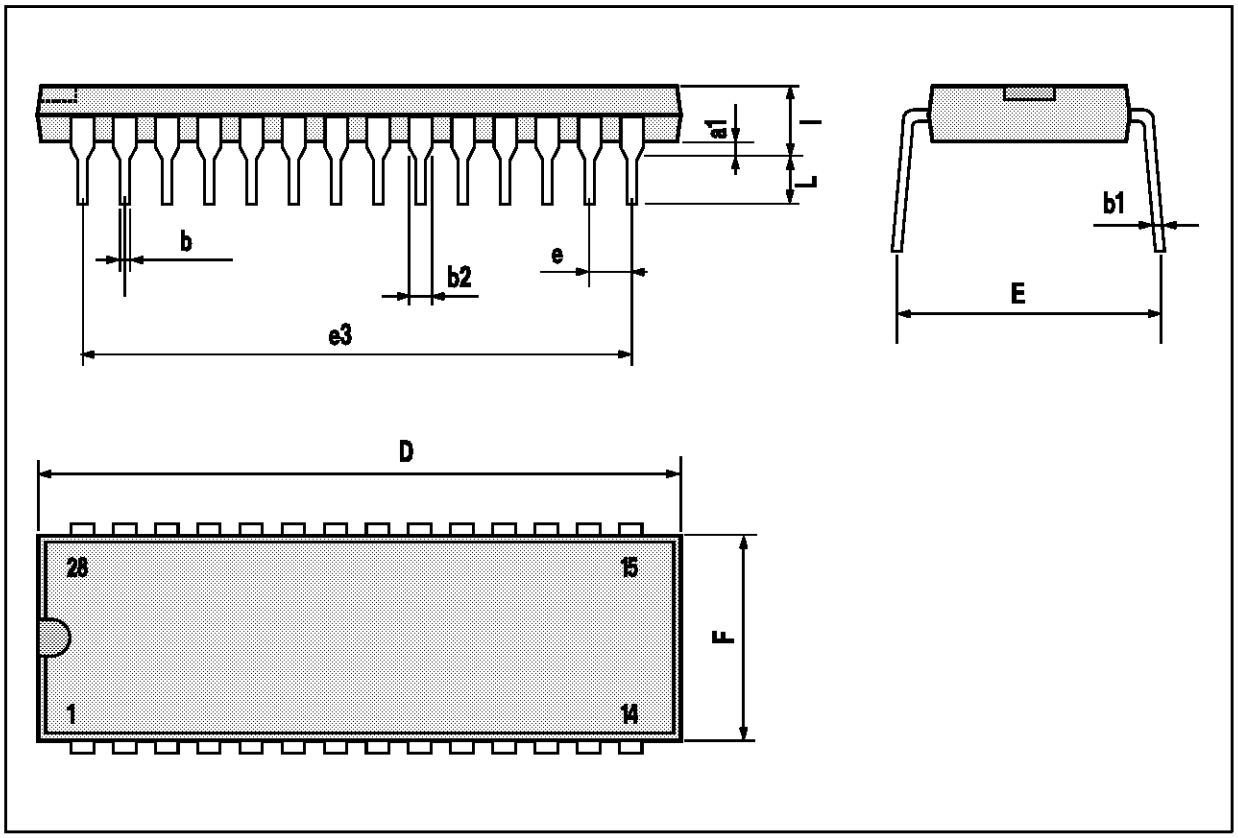
BASS AND TREBLE - Control Range of ± 15dB (boost and cut) Steps of 2.5dB

0	1	1	0	C3	C2	C1	C0	Bass
0	1	1	1	C3	C2	C1	C0	Treble
				0	0	0	0	- 15
				0	0	0	1	- 15
				0	0	1	0	- 12.5
				0	0	1	1	- 10
				0	1	0	0	- 7.5
				0	1	0	1	- 5
				0	1	1	0	- 2.5
				0	1	1	1	- 0
				1	1	1	1	0
				1	1	1	0	2.5
				1	1	0	1	5
				1	1	0	0	7.5
				1	0	1	1	10
				1	0	1	0	12.5
				1	0	0	1	15
				1	0	0	0	15

C3 = Sign
For example Bass at -12.5dB is obtained by the following 8 bit string: 0 1 1 0 0 0 1 0

DIP28 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1		0.63			0.025	
b		0.45			0.018	
b1	0.23		0.31	0.009		0.012
b2		1.27			0.050	
D			37.34			1.470
E	15.2		16.68	0.598		0.657
e		2.54			0.100	
e3		33.02			1.300	
F			14.1			0.555
I		4.445			0.175	
L		3.3			0.130	



SO28 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			2.65			0.104
a1	0.1		0.3	0.004		0.012
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.013
C		0.5			0.020	
c1	45° (typ.)					
D	17.7		18.1	0.697		0.713
E	10		10.65	0.394		0.419
e		1.27			0.050	
e3		16.51			0.65	
F	7.4		7.6	0.291		0.299
L	0.4		1.27	0.016		0.050
S	8° (max.)