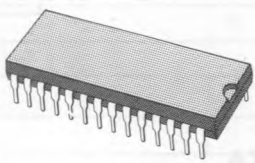
DIGITAL CONTROLLED STEREO AUDIO PROCESSOR

PRELIMINARY DATA

- INPUT AND OUTPUT PINS FOR EXTERNAL EQUALIZER
- THREE STEREO INPUT SOURCE SELECTION PLUS 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

The TDA7302 is a volume, tone (bass and treble) 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.



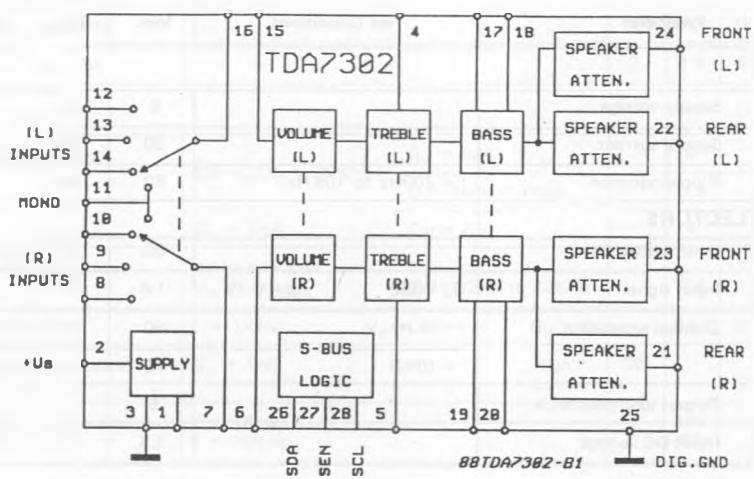
DIP-28 Plastic

ORDERING NUMBER: TDA7302

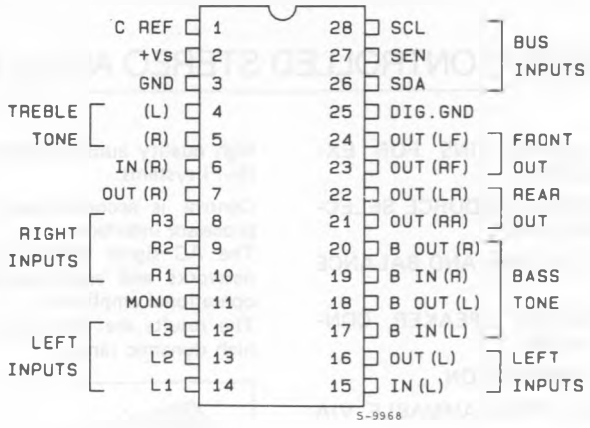
ABSOLUTE MAXIMUM RATINGS

V_s	Supply voltage	14	V
P_{tot}	Total power dissipation (T_{amb} = 25°C)	2	W
T_{amb}	Operating ambient temperature	-40 to 85	°C
T_{stg}	Storage temperature	-55 to 150	°C

BLOCK DIAGRAM



CONNECTION DIAGRAM



THERMAL DATA

$R_{th\ j\text{-}pins}$	Thermal resistance junction-pins	max.	65	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C; V_s = 8.5V; R_L = 10KΩ; and R_g = 600Ω; f = 1KHz unless otherwise specified)

Parameter		Test Conditions	Min.	Typ.	Max.	Unit
SUPPLY						
V_s	Supply voltage		6	8.5	14	V
I_s	Supply current		20	30	40	mA
SVR	Ripple rejection	f = 300Hz to 10KHz	50	60		dB
INPUT SELECTORS						
R_I	Input resistance		30	45		KΩ
$V_{IN\ MAX}$	Input signal	G_v = 0dB d = 0.3%	1.8	2.2		V_{RMS}
C_s	Channel separation	f = 1KHz	90	96		dB
		f = 10KH	70			
R_L	Output load resistance		5			KΩ
V_I (DC)	Input DC voltage		3.5	4.3	5	V

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test Conditions	Min.	Typ.	Max.	Unit
VOLUME CONTROLS						
R_{In}	Input resistance		7	10		KΩ
	Control range			78		dB
G_{max}	Max gain			10		dB
	Max attenuation		64	68		dB
	Step resolution			2	3	dB
	Attenuator set error	G_v = -50 to 10dB			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 (1)						
	Control range			± 15		dB
	Step resolution			2.5	3.5	dB
AUDIO OUTPUT						
V_o	Output voltage	d = 0.3%	1.8	2.2		V_{RMS}
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	1.8	4.5	V
GENERAL						
e_{No}	Output noise	BW = 22Hz to 22KHz; G_v = 0dB		6		μV
		BW = 22Hz to 22KHz; Out atten. ≥ 20dB		3.5		μV
		G_v = 0dB; Curve A		4		μV
S/N	Signal to noise ratio	All gain = 0dB; V_o = $1V_{RMS}$; 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 = 0dB; High	20			KHz
		G_v = 0dB; Low			20	Hz
S_c	Channel separation left/right	f = 1KHz		100		dB
		f = 10KHz		82		dB

ELECTRICAL CHARACTERISTICS (continued)

Parameter		Test Conditions	Min.	Typ.	Max.	Unit
BUS INPUTS						
V_{IL}	Input LOW voltage				0.8	V
V_{IH}	Input HIGH voltage		2			V
V_o	Output voltage SDA acknowledge	I = 1.6mA			0.4	V
	Digital input current		-5		+5	μA

Notes : (1) 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.

Fig. 1 - Test circuit

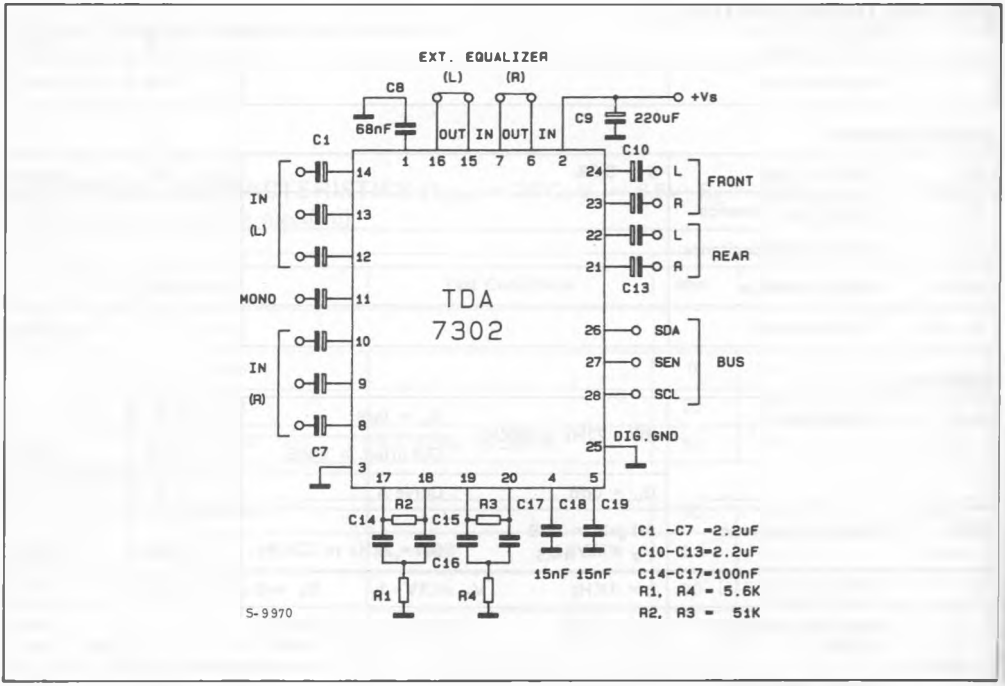


Fig. 2 - Total output noise vs. volume setting

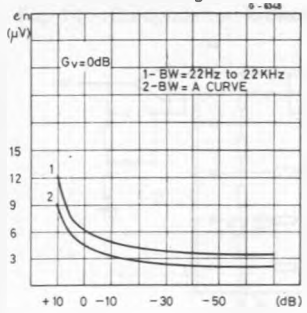


Fig. 3 - Signal to noise ratio vs. volume setting

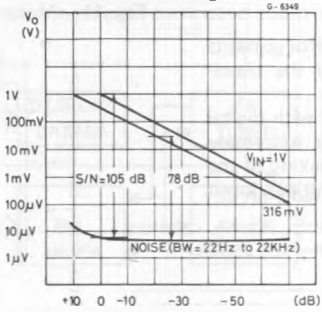


Fig. 4 - Distortion + noise vs. frequency

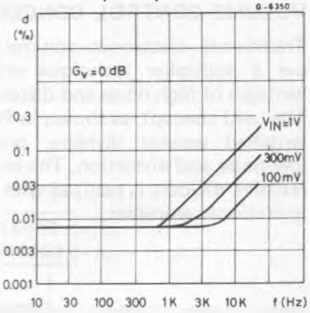


Fig. 5 - Distortion vs. output voltage

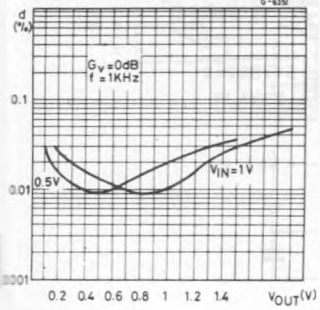


Fig. 6 - Distortion vs. load resistance

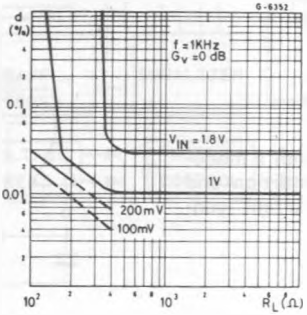


Fig. 7 - Channel separation (L1 - R1) vs. frequency

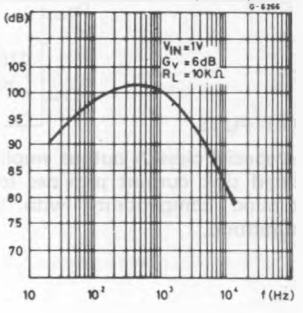


Fig. 8 - Channel separation (L1 - L2) vs. frequency

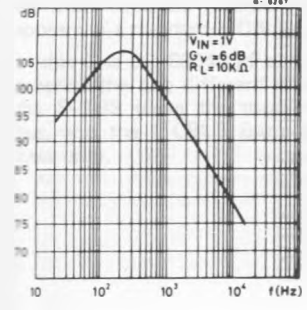


Fig. 9 - Supply voltage rejection vs. frequency

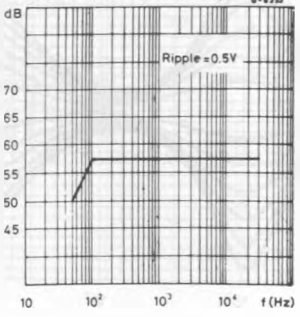
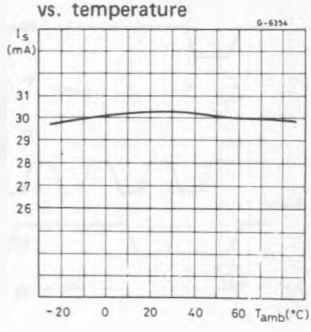


Fig. 10 - Quiescent current vs. temperature

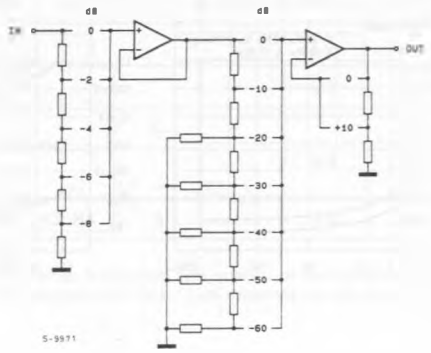


APPLICATION INFORMATION

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. 11 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.

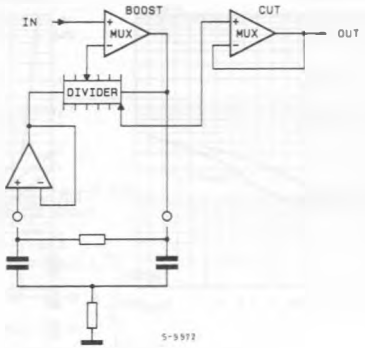
Fig. 11 - Volume control



BASS AND TREBLE CONTROL

The principle operation of the bass control is shown in Fig. 12. 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 filter curve is shown in Fig. 13.

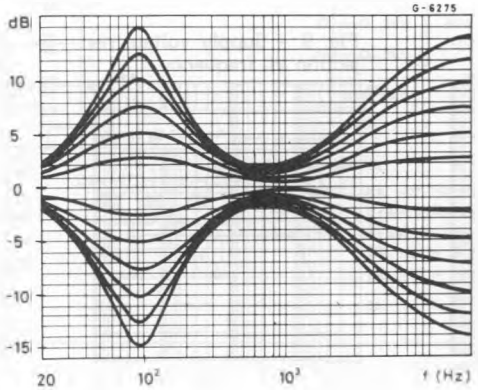
Fig. 12 - Bass control



OUTPUTS

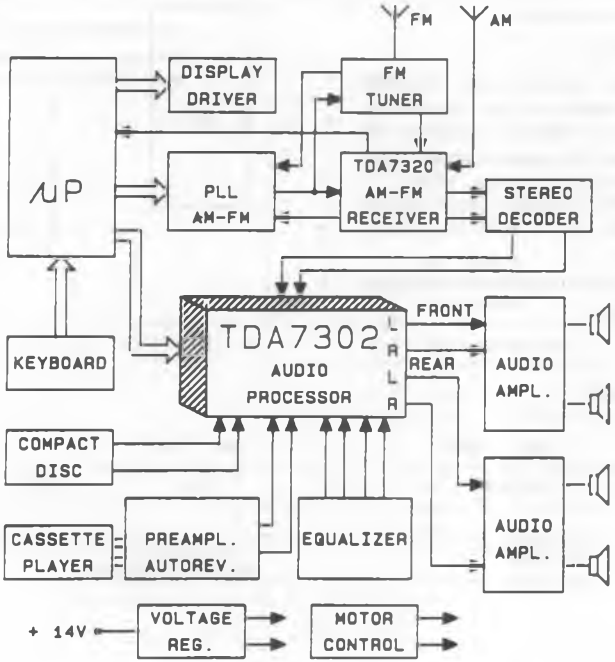
A special class-A output amplifier with a modulated sink current provides low distortion and ground compatibility with low current consumption.

Fig. 13 - Typical tone response



APPLICATION INFORMATION (continued)

Fig. 14 - Complete car-radio system using digital controlled audio processor



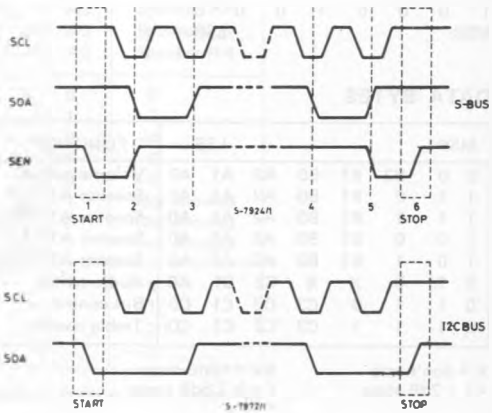
SERIAL BUS INTERFACE

S-BUS Interface and I²CBUS Compatibility

Data transmission from microprocessor to the TDA7302 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 TDA7302 appears as a standard I²CBUS slave.

In this case the S6040 µP can be programmed to generate the two different transmission systems: the S-BUS using the three lines of the serial bus, and the I²CBUS using the SCL and SDA lines only.

Fig. 15 - Timing Diagram of S-BUS and I²CBUS



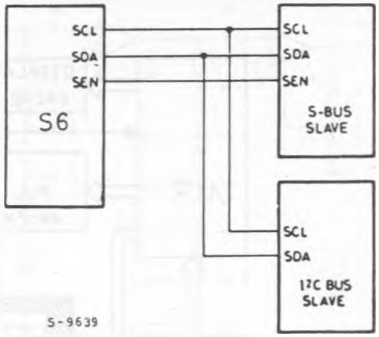
APPLICATION INFORMATION (continued)

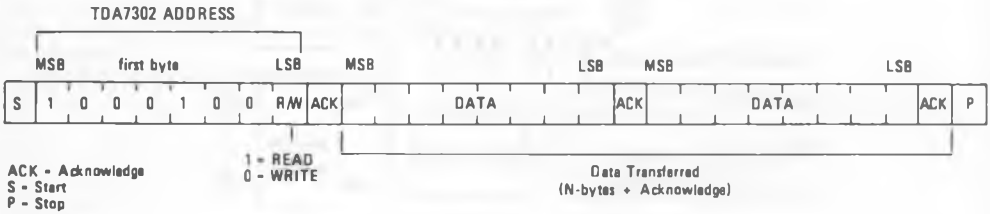
Interface Protocol

The interface protocol comprises:

- A start conditions (S)
- A chip address byte, containing the TDA7302 address and the direction of the transmission on the BUS (this information is given in the 8th bit of the byte: "0" means "write", that is from the maste r to the slave, while "1" means "read"). The TDA7302 must always acknowledge at the end of each transmitted byte.
- A sequence of data (N-bytes + acknowledge)
- A stop condition (P)

Fig. 16 - System with Mixed S-BUS Peripherals





SOFTWARE SPECIFICATION

Chip address (TDA7302 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	A0	Audio switch
0	1	1	0	C3	C2	C1	C0	Bus 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

NOTE - Using S6 is it necessary an external EPROM (M2716 F6X) previously programmed. Further information is available in S6 µP data sheet.

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	A2	A1	A0	Volume10dB 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 colume 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	Mute Input
	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 0 1 1 1	C3 C2 C1 C0 C3 C2 C1 C0	Bass Treable
	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	+25
	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 forlowing 8 bit string: 0 1 1 0 0 0 1 0