

T-77-07-07

## TV-Stereo-Sound

**TDA 6612**

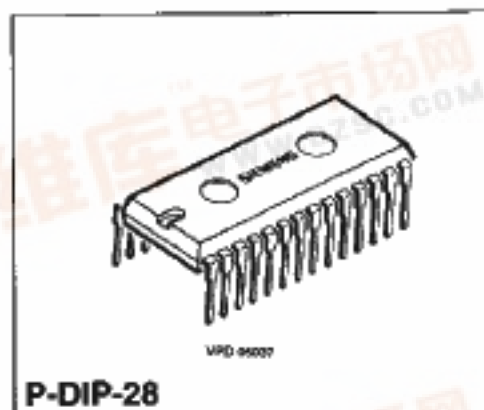
### Preliminary Data

**Bipolar IC**

### Features

The TDA 6612 represents a complete TV stereo system controlled by the I<sup>2</sup>C bus according to German TV Stereo standard.

- All functions inclusive matrix adjustment are I<sup>2</sup>C bus controlled
- Inputs for AM sound or NICAM
- SCART interface
- Independent headphones
- Universal clock generation circuit build-in
- Clipping detector build-in
- Volume control
- High signal-to-noise ratio
- Extremely low total harmonic distortions
- High security for the detection of the identification signals because of the digital interference suppression and the very narrow bandwidth



**P-DIP-28**

Type	Ordering Code	Package
TDA 6612	Q67000-A5034	P-DIP-28

The IC is divided into three functional blocks

**1. Stereo Sound Processing with High Performance (exceeds DIN 45500; suitable for NICAM and CD)**

- a) Matrix for G-standard with crosstalk compensation controlled via the I<sup>2</sup>C bus
- b) Additional single channel AF input (for e.g. AF signal according to L-standard)
- c) Stereo SCART interface according to FTZ official specification
- d) Stereo loudspeaker signal section with Ch1/Ch2 switch, bass/treble control, quasi stereo/stereo base width expansion and separate loudspeaker volume control for left and right (balance)
- e) Separate stereo head phone signal section with Ch1/Ch2 switch and volume control

**2. TV Sound Identification Signal Decoder Consisting of:**

- a) Active pilot signal filter
- b) Phase independent rectifier with very narrow bandwidth for evaluation of the identification signal
- c) Digital integrator to reduce interferences by noise
- d) Multiplexer for cyclical switch over between "stereo" or "dual" evaluation
- e) Reference signal generation with externally synchronized PLL
  - synchronization with external H-sync pulse or 62.5-kHz clock
  - build-in crystal oscillator and external 4-MHz crystal
  - external 4-MHz (or 1-MHz) clock signal

**Control Section for:**

- a) I<sup>2</sup>C bus interface with listen/talk function
- b) Control of the complete AF sound signal detector
- c) Read access to the clipping detector
- d) Control of the identification signal decoder
- e) Reading of the status of the identification signal decoder
- f) Test modes

**Circuit Description****Signal Section**

The audio signal processing in the matrix and the switch-over for multi channel TV sound signals according to the two carrier system used in Germany takes place in the matrix and switching sections. Crosstalk compensation is carried out in the sound 1 input stage. The crosstalk compensation range has an adjustment range of  $\pm 3$  dB with a step width of 0.2 dB. In addition to the two inputs for the demodulated sound carrier a two channel SCART input and an additional mono input (e.g. for demodulated L-standard sound) are provided. The two AF (pin 1 and pin 2) inputs can be bypassed internally in such a way that decoded stereo sound of other audio systems (NICAM) can be processed. The switching section includes also the SCART output with the possibility to select the sound 1 or 2 during the "Dual" mode. The Ch1/Ch2 switches for the loudspeaker and headphone outputs are independently switchable.

In the signal path for the volume control unit output there is the Ch1/Ch2 switch followed by two different volume control units. The first has a control range from 0 to  $-15$  dB with a step width of 1.25 dB. In conjunction with the main volume control after bass and treble control a high immunity against overdriving the output stage is reached. The first volume control is used as a "pre-stage" of the main volume control in conjunction with the clipping detector. This section is followed by a switchable quasi stereo stage which provides a stereophonic audio effect with mono signals due to a  $180^\circ$  phase shift at medium frequencies (about 1 kHz) in one channel. The following bass control has a control range of  $+15/-12$  dB with a step width of 3 dB. The cutoff frequency for each channel is set with an external capacitor. The implemented switchable circuit for stereo base width expansion provides a three dimensional aural reception. This is realized with a 50% frequency dependent crosstalk with opposite phase of the signal between both channels. The circuit operates with the same cutoff frequency as the bass control, but the function is widely independent. The treble control has a step width of 3 dB with an control range of  $+/-12$  dB. The cutoff frequency of the treble control is derived from one capacitor for each channel. The loudspeaker signal path is terminated with the loudspeaker control, independently adjustable for left and right. With 57 steps of 1.25 dB the adjustment range is 70 dB, where step 57 activates the "MUTE" function. Functions such as "balance" or "loudness" are realized by software and adjustment of the appropriate tone and volume controls. In the volume control unit there is a clipping detector. The status of the clipping detector can be evaluated via the I<sup>2</sup>C bus. Therefore it is possible to implement an automatic volume control using the clipping detector and software implemented into the controller.

After every evaluation the clipping bit is reset. Therefore after a read access to the clipping bit a new evaluation of the clipping detector status is possible.

The signal path for the headphones contains a volume control after the Ch1/Ch2 switch with a common adjustment for left and right. Thirty two steps of 2 dB give an adjustment range of 62 dB ( $31 \times 2$  dB = 62 dB, the 32nd step is MUTE).

**Identification Signal Decoder**

The input of the identification signal decoder consists of an op-amp for the pilot signal with its side bands. An external LC circuit is used. The signal is then passed to a phase independent active band-pass filter with a very narrow bandwidth (adjustable externally). This

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filter detects whether the lower side band of the pilot carrier, which is modulated with the identification signal, is present. The center frequency of the filter is switched between "dual" and "stereo" by a multiplexer. The multiplexing frequency is adjustable by software. If a side band is detected, the multiplexer stops. The interferences on the first "detected" criterion are suppressed by a digital integrator with a following comparator and can be read out via I<sup>2</sup>C bus (talk mode) as the "stereo" or "dual" mode. The control of the corresponding signal can be either directly internally or through the  $\mu$ C. All the necessary clock signal are derived from a fast setting PLL which is synchronized by a reference frequency. This reference frequency must be sufficiently close to the horizontal frequency, but a **rigid phase coupling is not required**. Therefore, alternatively the use of a crystal controlled 62.5-kHz frequency commonly found in PLL tuning systems is possible. A further alternative for the clock signal generation is a build-in crystal oscillator with an external 4-MHz crystal or the use an external 1- or 4-MHz clock frequency.

### Control Section

All functions are controlled via an I<sup>2</sup>C bus interface with "listen" / "talk" functions. The data bytes currently used are stored in a block of latches.

The telegram structure is formed in the following manner:

start condition - chip address - any number of bytes - stop condition

The following conditions apply to the data bytes:

Before the actual data byte (with the adjustment information), always an I<sup>2</sup>C bus sub-address byte has to be transmitted. The I<sup>2</sup>C bus interface however is interpreting this sub-address byte as a data byte.

Example: The headphone volume is to be increased in a number of steps.

Right	Wrong
Start condition	Start condition
Chip address 84 (Hex)	Chip address 84 (Hex)
Sub-addr. vol. HP 03 (Hex)	Sub-addr. vol. HP 03 (Hex)
Vol. step 8 08 (Hex)	Vol. step 8 08 (Hex)
Sub-addr. vol HP 03 (Hex)	Vol. step 9 09 (Hex)
Vol. step 9 09 (Hex)	Vol. step 10 0A (Hex)
Sub-addr. vol. HP 03 (Hex)	Stop condition
Vol. step 10 0A (Hex)	
Stop condition	

Within a telegram (i.e. without a new start condition) any different sub-addresses can be accessed. The changeover between "listen" and "talk" access to the IC however must always occur using the following sequence: stop condition - start condition - chip address. Before each read access always a start condition and chip address (talk) must be transmitted. The data to be read out are then loaded into the I<sup>2</sup>C bus interface and can be transferred to the  $\mu$ C.

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## Chip Address

MSB	•	•	•	•	•	•	LSB
1	0	0	0	0	1	0	R/W

R/W = 0 → Read (Listen)

R/W = 1 → Write (Talk)

## Subaddress Bytes

	MSB	•	•	•	•	•	•	LSB
Volume input control	X	X	X	X	X	1	0	0
Volume of left speaker	X	X	X	X	X	0	0	1
Volume of right speaker	X	X	X	X	X	0	1	0
Volume of headphones	X	X	X	X	X	0	1	1
Treble / bass	X	X	X	X	X	1	0	1
Switch byte I	X	X	X	X	X	1	1	1
Switch byte II	X	X	X	X	X	0	0	0
Crosstalk adjustment	X	X	X	X	X	1	1	0

## Control Bytes

### a) Volume Input Control

	MSB	•	•	•	•	•	•	LSB
Maximum volume	Qu-H	Ch1/Ch2 <sub>EN</sub>	Ch1/Ch2 <sub>sc</sub>	0	0	0	0	MUTE III
Max - 1	Qu-H	Ch1/Ch2 <sub>EN</sub>	Ch1/Ch2 <sub>sc</sub>	0	0	0	1	MUTE III
Min + 1	Qu-H	Ch1/Ch2 <sub>EN</sub>	Ch1/Ch2 <sub>sc</sub>	1	0	1	1	MUTE III
Minimum volume	Qu-H	Ch1/Ch2 <sub>EN</sub>	Ch1/Ch2 <sub>sc</sub>	1	1	0	0	MUTE III
Power ON	0	0	0	0	0	0	0	1

Qu-H = 0 PLL synchronization with H-pulse; power ON

Qu-H = 1 PLL synchronization with crystal oscillator,  
 additionally the bit "H-pulse" has to be set to "H" in switch byte II

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Ch1/Ch2 <sub>EN</sub>	Ch1/Ch2 <sub>SC</sub>	SCART output pin 9	SCART output pin 10
0	0	sound 1	sound 2
0	1	sound 2	sound 1
1	0	sound 1	sound 1
1	1	sound 2	sound 2

CH1/Ch2<sub>EN</sub>, Ch1/Ch2<sub>SC</sub> are only activated if the matrix is in the dual mode

(switch byte II: matrix 0 = 1 and matrix 1 = 0 or matrix 0 = 1, matrix 1 = 1 and the identification decoder is in the mode "dual")

MUTE III = 0 SCART output are muted.

MUTE III = 1 SCART output ON; power ON

(will be overwritten by MUTE 1 = 0 equal to all audio outputs muted)

MUTE III is "or" wired with MUTE I.

#### b) Volume of Left / Right Loudspeaker

	MSB	•	•	•	•	•	•	LSB
Maximum volume	X	X	1	1	1	1	1	1
Max - 1	X	X	1	1	1	1	1	0
Max - 15	X	X	1	1	0	0	0	0
Max - 55	X	X	0	0	1	0	0	0
MUTE	X	X	0	0	0	1	1	1
MUTE	X	X	0	0	0	0	0	0
MUTE	X	X	0	0	0	X	X	X
Power ON	0	0	0	0	0	0	0	1

#### c) Volume of Headphones

	MSB	•	•	•	•	•	•	LSB
Maximum volume	T2	T1	T0	1	1	1	1	1
Max - 1	T2	T1	T0	1	1	1	1	0
Max - 15	T2	T1	T0	1	0	0	0	0
Max - 31	T2	T1	T0	0	0	0	0	1
MUTE	T2	T1	T0	0	0	0	0	0
Power ON	0	0	0	0	0	0	0	1

T0 T2 are test bits; these must be set to 0 for normal operation

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**d) Crosstalk Compensation Matrix (sound 1)**

	MSB	•	•	•	•	•	•	LSB
Max. amplification	0	0	0	1	1	1	1	1
Max - 1	0	0	0	1	1	1	1	0
Gain 0 dB	0	0	0	1	0	0	0	0
Min. gain	0	0	0	0	0	0	0	1
Min. gain	0	0	0	0	0	0	0	X
Power ON	0	0	0	0	0	0	0	1

**e) Treble / Bass**

	MSB	•	•	•	•	•	•	LSB
Linear	1	0	0	0	1	0	0	0
Max. treble, lin. bass	1	1	0	0	1	0	0	0
Max. treble, lin. bass	1	1	X	X	1	0	0	0
Min. treble, lin. bass	0	1	0	0	1	0	0	0
Min. treble, lin. bass	0	0	X	X	1	0	0	0
Lin. treble, max. bass	1	0	0	0	1	1	0	1
Lin. treble, max. bass	1	0	0	0	1	1	X	1
Lin. treble, max. bass	1	0	0	0	1	1	1	X
Lin. treble, min. bass	1	0	0	0	0	1	0	0
Lin. treble, min. bass	1	0	0	0	0	0	X	X
Max. treble, max. bass	1	1	X	X	1	1	X	1
Min. treble, min. bass	0	0	X	X	0	0	X	X
Power ON	0	0	0	0	0	0	0	1
	MSB				LSB	MSB		LSB
	treble				treble	bass		bass

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**f) Switch Byte I**

MSB	.	.	.	.	.	.	LSB
MUTE I	MUTE II	CH1/CH2 <sub>LS</sub>	Ch1/Ch2 <sub>KH</sub>	Mono	SCART	SCART-D	AM

MUTE I = 0 All AF outputs are muted (speakers, headphones, SCART); power ON

MUTE I = 1 All AF outputs ON

MUTE II = 0 Loudspeaker outputs muted; power ON

MUTE II = 1 Loudspeaker outputs ON

MUTE I and MUTE II are OR gated with respect to the loudspeaker outputs

MUTE I and MUTE III are OR gated with respect to the SCART output

MUTE I	MUTE II	MUTE III	Loudspeaker output	headphone output	SCART output
0	0	0	muted	muted	muted
0	0	1	muted	muted	muted
0	1	0	muted	muted	muted
0	1	1	muted	muted	muted
1	0	0	muted	ON	muted
1	0	1	muted	ON	ON
1	1	0	ON	ON	muted
1	1	1	ON	ON	ON

CH1/Ch2<sub>LS</sub> = 0 Sound 1 on the loudspeaker outputs; power ON

CH1/Ch2<sub>LS</sub> = 1 Sound 2 on the loudspeaker outputs

Ch1/Ch2<sub>KH</sub> = 0 Sound 1 on the headphone outputs; power ON

Ch1/Ch2<sub>KH</sub> = 1 Sound 2 on the headphone outputs

Ch1/Ch2<sub>LS</sub> and Ch1/Ch2<sub>KH</sub> are only effective if the matrix is set to the position "dual sound".

Mono = 0 identification signal decoder is set to the position mono and held; power ON

Mono = 1 normal operation if ID signal decoder

SCART = 0 normal TV operation; power ON

SCART = 1 SCART playback; connection of SCART inputs - AF - outputs  
SCART = 1 has priority over AM = 1 (loudspeaker and headphones)

SCART-D = 0 SCART-playback stereo (mono); power ON

SCART-D = 1 Enable for the Ch1/Ch2 switch during SCART playback. (only effective when SCART = 1)



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AM = 0 Normal operation (G standard)  
 AM = 1 AM AF input is activated; power ON  
 AM = 1 has priority over bypass = 1

Qu-H, Ch1/Ch2<sub>EN</sub>, Ch1/Ch2<sub>SC</sub> MUTE III see chapter Control Bytes a.

**g) Switch Byte II**

MSB	•	•	•	•	•	•	LSB
MPX0	MPX1	quasi st	Bs	H-pulse	Matrix 0	Matrix 1	Bypass
MPX0	MPX1	MPX period					recommended C <sub>25,26</sub>
0	0	2 s		power ON			1 μF
0	1	4 s					2.2 μF
1	0	8 s					4.7 μF
1	1	1 s					470 nF

MPX period = 2 s signifies: ID signal decoder searches 1 s dual and 1 s stereo

Quasi stereo = 0 Quasi stereo OFF; power ON  
 Quasi stereo = 1 Quasi stereo ON  
 Bb = 0 Stereo base width expansion OFF; power ON  
 Bb = 1 Stereo base width expansion ON;

H-pulse = 0 ID signal decoder synchronization with  $f_H = 15.625$  kHz; power ON  
 H-pulse = 1 ID synchronization with  $4 \times f_H$   
 (has to be set to 1 during operation with crystal or 4-MHz reference frequency)

Matrix 0 Matrix1 Matrix status  
 0 0 mono power ON  
 0 1 stereo  
 1 0 dual  
 1 1 automatic according to ID signal decoder

Bypass = 0 Normal operations (G standard)  
 Bypass = 1 Matrix is bridge so that left/right signals can be fed; power ON  
 (AM = 1 has priority over bypass = 1)

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**Priority List of Setting Bits**

1. MUTE I
2. MUTE II (only with regard to the loudspeaker output)
3. SCART
4. AM
5. Bypass
6. Matrix 0, 1

**h) Talk Mode**

MS	•	•	•	•	•	•	LSB
St	D	T3	T4	T5	CL	X	X
0	0	decoder detects mono					
1	0	decoder detects stereo					
0	1	decoder detects dual					
1	1	internally inhibited					
CL = 1	The signal path for the loudspeaker reached the clipping level (The bit CL is automatical reset)						

T3 - T5 are test bits

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#### Pin Definitions and Functions

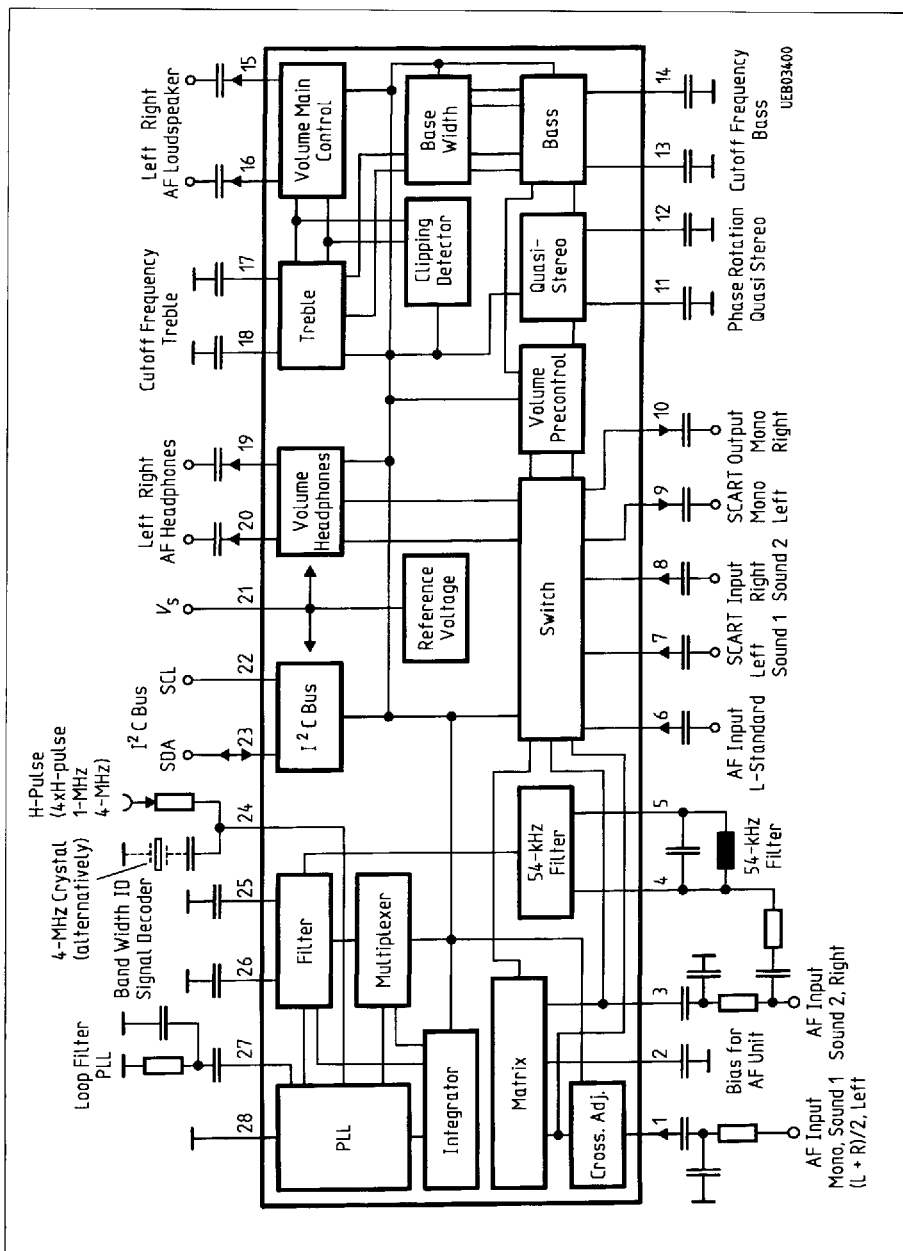
Pin No.	Function
1	AF input mono, left, sound 1 (may be balanced)
2	Bias for AF operating point
3	AF input right, sound 2
4	54-kHz input
5	54-kHz filter
6	AF input (L-standard)
7	AF input SCART left (sound 1)
8	AF input SCART right (sound 2)
9	AF output SCART (mono, sound 1, left)
10	AF output SCART (mono, sound 2, right)
11	Phase shifter quasi stereo
12	Phase shifter quasi stereo
13	Cutoff frequency bass (base width) left
14	Cutoff frequency bass (base width) right
15	AF output, loudspeaker right
16	AF output, loudspeaker left
17	Cutoff frequency treble left
18	Cutoff frequency treble right
19	AF output, headphones right
20	AF output, headphones left
21	+ V <sub>s</sub> (supply voltage)
22	I <sup>2</sup> C bus SCL
23	I <sup>2</sup> C bus SDA
24	Input H-pulse (4 x H-pulse), crystal oscillator
25	Filter ID signal decoder
26	Filter ID signal decoder
27	PLL filter ID signal decoder
28	Ground

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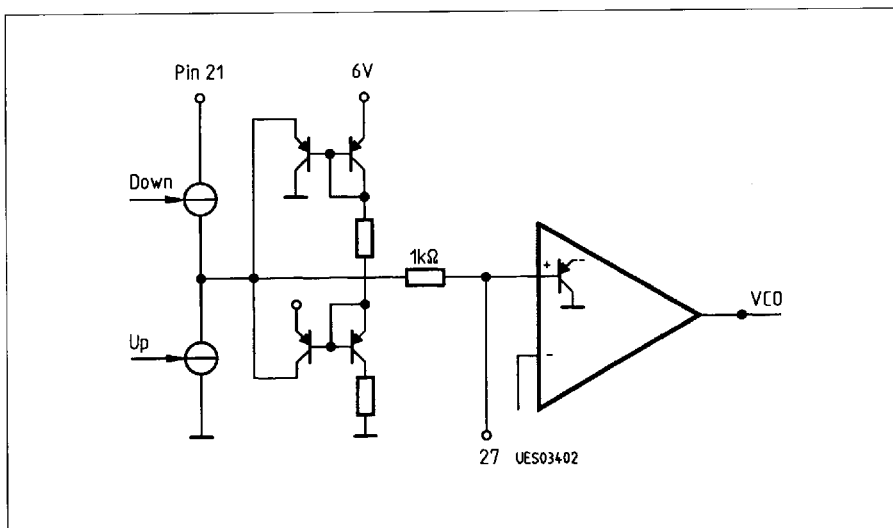
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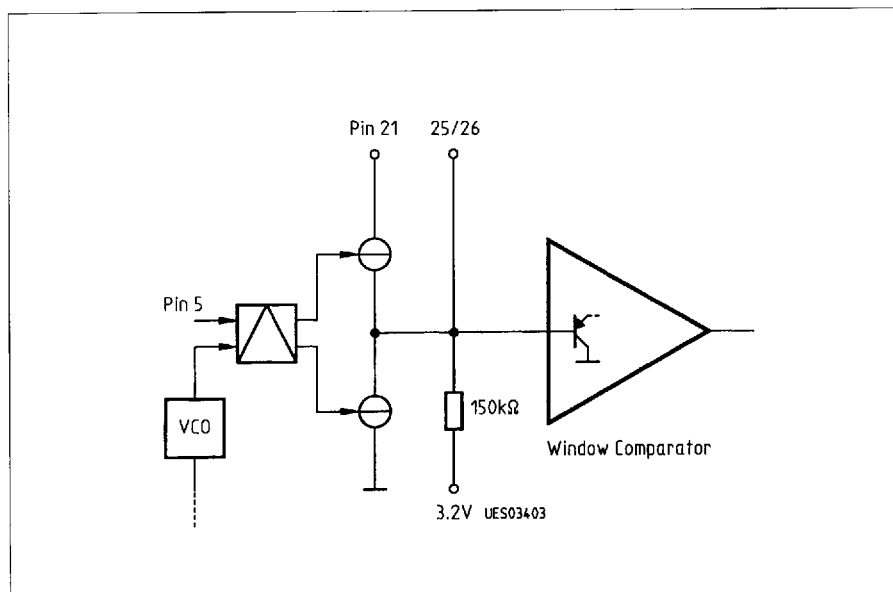


Block Diagram

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PLL Filter ID Signal Decoder



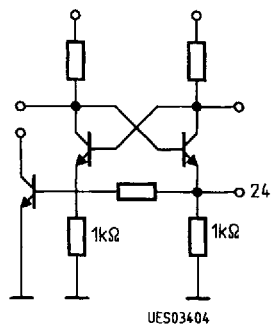
Filter ID Signal Decoder (Pin 25/26)

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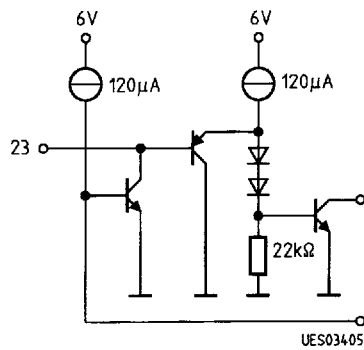
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H-Pulse/Crystal Oscillator (Pin 24)



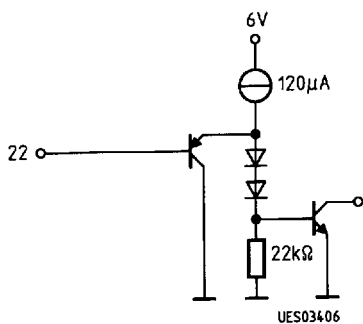
I<sup>2</sup>C Bus SDA (Pin 23)

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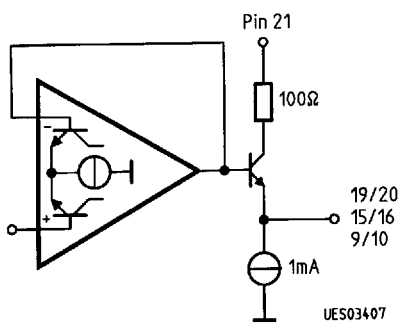
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I<sup>2</sup>C Bus SCL (Pin 22)



AF Outputs Headphones (Pin 19/20)

Loudspeaker (Pin 15/16)

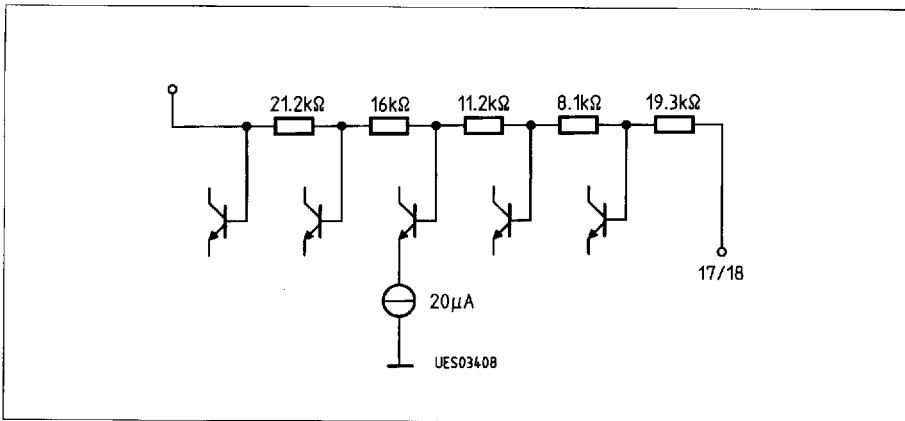
SCART (Pin 9/10)

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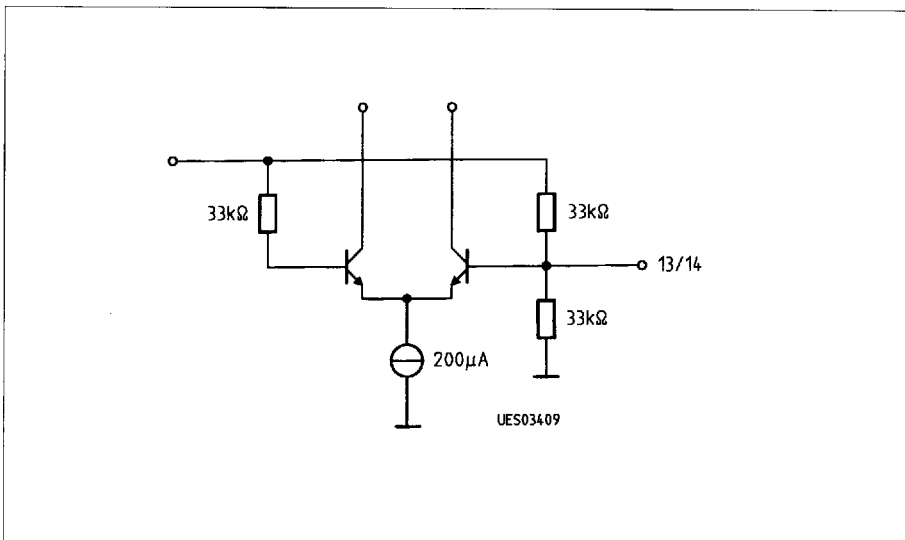
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Cutoff Frequency Treble (Pin 17/18)



Cutoff Frequency Bass (Pin 13/14)

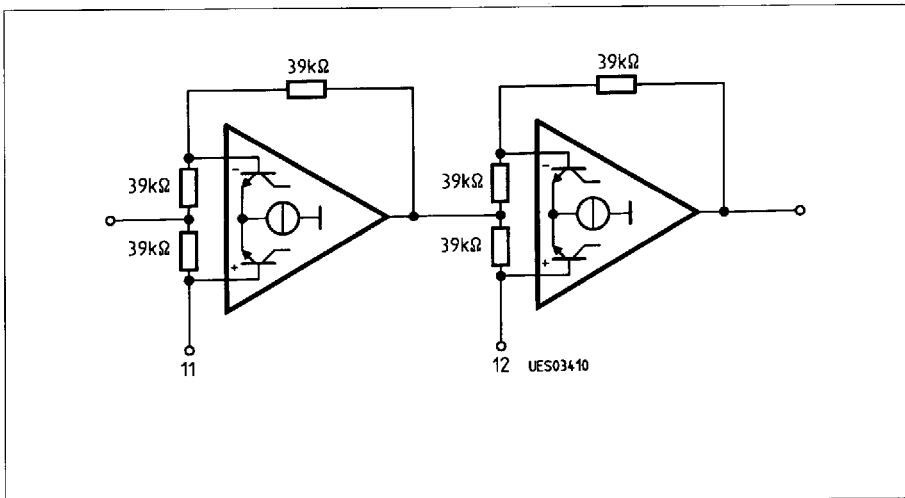


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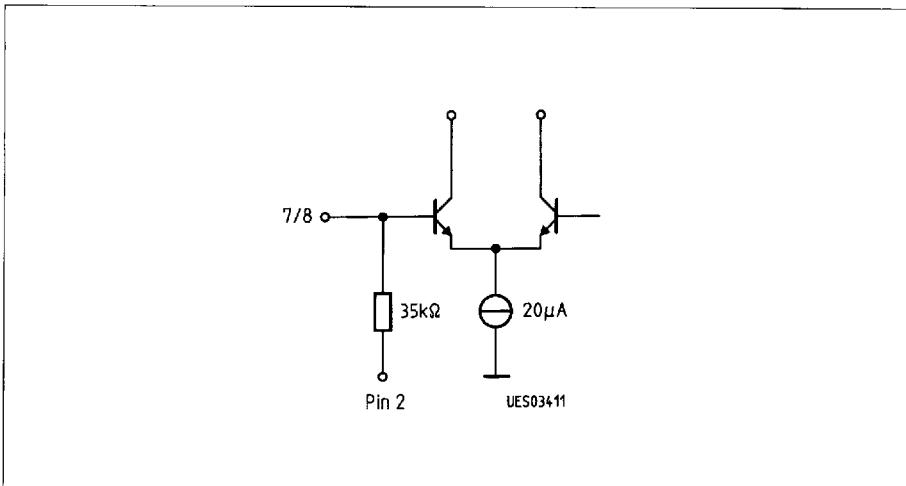
Phase Advancer Quasi Stereo (Pin 11/12)

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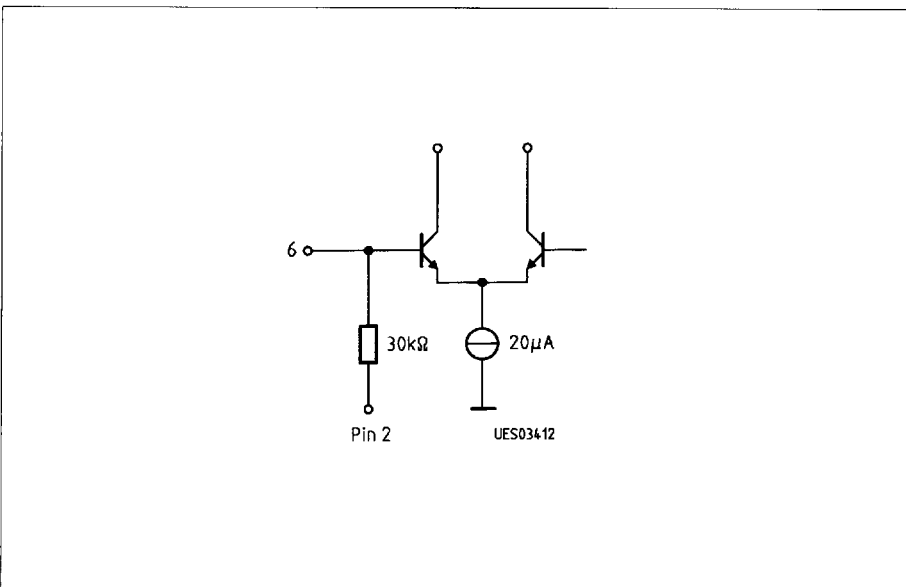
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AF Inputs SCART (Pin 7/8)



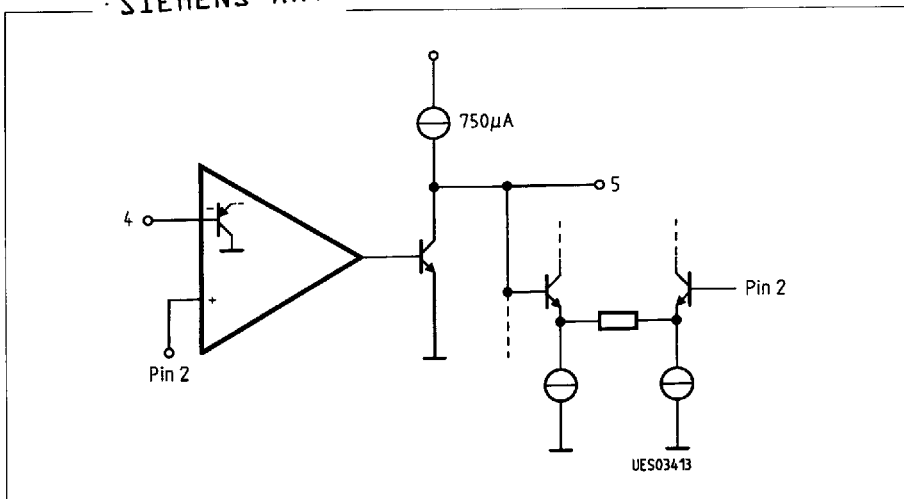
AF Input AM (Pin 6)

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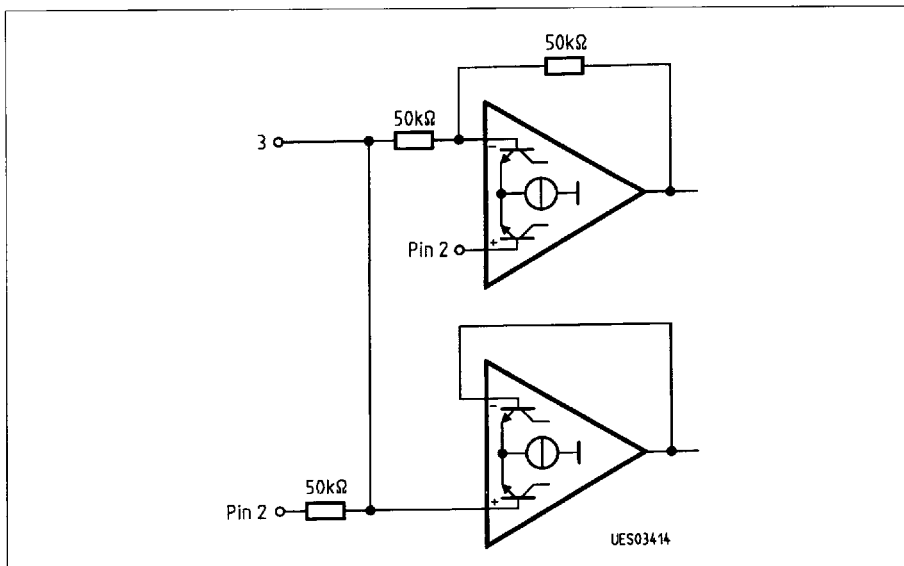
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54-kHz Filter (Pin 4/5)



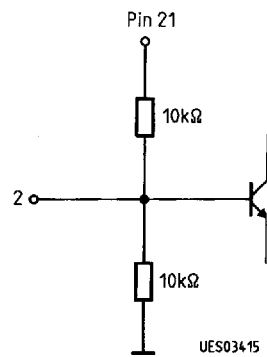
AF Input (Pin 3)

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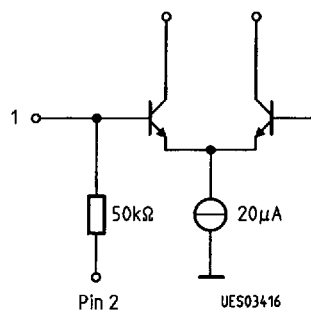
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Input for AF Unit Bias Blocking Capacitor (Pin 2)



AF Input (Pin 1)

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**Absolute Maximim Ratings**

$T_A = 0$  to  $70$  °C; all voltages relatives to  $V_{SS}$

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	$V_{21}$	0	14	V	
Max. DC voltage	$V_1$	0	$V_{21}$	V	
Max. DC voltage	$V_2$	0	$V_{21}$	V	
Max. DC voltage	$V_3$	0	$V_{21}$	V	
Max. DC voltage	$V_4$	0	$V_{21}$	V	
Max. DC voltage	$V_6$	0	$V_{21}$	V	
Max. DC voltage	$V_7$	0	$V_{21}$	V	
Max. DC voltage	$V_8$	0	$V_{21}$	V	
Max. DC voltage	$V_{11}$	0	$V_{21}$	V	
Max. DC voltage	$V_{12}$	0	$V_{21}$	V	
Max. DC voltage	$V_{13}$	0	$V_{21}$	V	
Max. DC voltage	$V_{14}$	0	$V_{21}$	V	
Max. DC voltage	$V_{17}$	0	$V_{21}$	V	
Max. DC voltage	$V_{18}$	0	$V_{21}$	V	
Max. DC voltage	$V_{22}$	0	$V_{21}$	V	
Max. DC voltage	$V_{23}$	0	$V_{21}$	V	
Max. DC voltage	$V_{24}$	0	$V_{21}$	V	
Max. DC voltage	$V_{25}$	0	$V_{21}$	V	
Max. DC voltage	$V_{26}$	0	$V_{21}$	V	
Max. DC current	$I_5$	0	2	mA	
Max. DC current	$I_9$	0	2	mA	
Max. DC current	$I_{10}$	0	2	mA	
Max. DC current	$I_{15}$	0	2	mA	
Max. DC current	$I_{16}$	0	2	mA	
Max. DC current	$I_{19}$	0	2	mA	
Max. DC current	$I_{20}$	0	2	mA	
Max. DC current	$I_{27}$	0	1	mA	

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**Absolute Maximum Ratings (cont'd)**

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
ESD voltage	$V_{ESD}$	- 2	2	kV	HBM ( $R = 1.5 \text{ k}\Omega$ , $C = 100 \text{ pF}$ )
ESD voltage	$V_{ESD7,8,9,10}$	- 6	6	kV	HBM ( $R = 1.5 \text{ k}\Omega$ , $C = 100 \text{ pF}$ )
Junction temperature	$T_j$		150	°C	
Storage temperature	$T_{stg}$	- 40	125	°C	
Thermal resistance system ambient	$R_{th SA}$		53	K/W	

**Operating Range**

Supply voltage	$V_6$	10	13.2	V	
Ambient temperature	$T_A$	0	70	°C	
Input frequency range	$f_i$	0.01	20	kHz	

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**Characteristics**

$V_S = 12\text{ V}$ ;  $T_A = 25\text{ °C}$ ; audio reference level 0 dB–250 mVrms, if not differently defined; in accordance with test circuit 1

I<sup>2</sup>C bus preset: start - 84 - 01,3F - 02,3F - 04,00 - 03,1F - 05,88 - 06,10 - 07,C8 - 00,01 - stop

Chip addr. - Vol Lsr 63 - Vol Lsr 63 Vol VLs - Vol HP 31 - Sound lin Adjust 0dB - MUTE I, MUTE II, Mono - Bypass

The basic setting for each point in the specification is always preset; only settings which deviate from this are given in the test conditions. Details in italics only provide explanation of the hexadecimal codes. If switch byte are mentioned only the bit status and activated features are indicated.

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Current consumption	$I_{21}$		55	80	mA	

**Signal Section**

Max. gain	$V_{16-1}$	-2	0	2	dB	
Max. gain	$V_{15-3}$	-2	0	2	dB	
Max. gain	$V_{20-1}$	-2	0	2	dB	
Max. gain	$V_{19-3}$	-2	0	2	dB	
Max. gain	$V_{16-3}$	-2	0	2	dB	00,02; $V_1 = 0$ <i>Matrix: Stereo</i>
Max. gain	$V_{15-3}$	-2	0	2	dB	00,02; $V_1 = 0$ <i>Matrix: Stereo</i>
Max. gain	$V_{20-3}$	-2	0	2	dB	00,02; $V_1 = 0$ <i>Matrix: Stereo</i>
Max. gain	$V_{19-3}$	-2	0	2	dB	00,02; $V_1 = 0$ <i>Matrix: Stereo</i>
Max. gain	$V_{16-1}$	4	6	8	dB	00,02; $V_3 = 0$ <i>Matrix: Stereo</i>
Max. gain	$V_{20-1}$	4	6	8	dB	00,02; $V_3 = 0$ <i>Matrix: Stereo</i>
Max. gain	$V_{16-7}$	-2	0	2	dB	07,CC, SCART
Max. gain	$V_{15-8}$	-2	0	2	dB	07,CC, SCART
Max. gain	$V_{20-7}$	-2	0	2	dB	07,CC, SCART
Max. gain	$V_{19-8}$	-2	0	2	dB	07,CC, SCART
Max. gain	$V_{16-6}$	-2	0	2	dB	07,C9, AM
Max. gain	$V_{15-6}$	-2	0	2	dB	07,C9, AM
Max. gain	$V_{20-6}$	-2	0	2	dB	07,C9, AM
Max. gain	$V_{19-6}$	-2	0	2	dB	07,C9, AM

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Gain	$V_{9-1}$	-2	0	2	dB	
Gain	$V_{10-3}$	-2	0	2	dB	
Gain	$V_{9-3}$	-2	0	2	dB	
Gain	$V_{10-3}$	-2	0	2	dB	00,02; $V_1 = 0$ <i>Matrix: Stereo</i>
Gain	$V_{9-1}$	4	6	8	dB	00,02; $V_1 = 0$ <i>Matrix: Stereo</i>
Gain	$V_{10-6}$	-2	0	2	dB	00,02; $V_3 = 0$ <i>Matrix: Stereo</i>
Gain	$V_{9-6}$	-2	0	2	dB	07,C9, AM
Min. gain Main control	$V_{16-1}$		-70	-65	dB	01,08-02,08 $Vol_{LSr} 8 - Vol_{LSr} 8$
Min. gain Main control	$V_{15-3}$		-70	-65	dB	01,08-02,08 $Vol_{LSr} 8 - Vol_{LSr} 8$
Min. gain 1st. control	$V_{16-1}$	-17	-15	-13	dB	04,18 $Vol_{VLS} 24$
Min. gain 1st. control	$V_{15-3}$	-17	-15	-13	dB	04,18 $Vol_{VLS} 24$
Min. gain	$V_{20-1}$		-62	-57	dB	03,01, $Vol_{HP1}$
Min. gain	$V_{19-3}$		-62	-57	dB	03,01, $Vol_{HP1}$



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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Analogous values are valid for feed in at the pins 6, 7 and 8						
Channel tracking error	$\Delta V_{15-16}$			$\pm 2$	dB	01,3F up to 01,24 02,3F up to 02,24 Vol <sub>LSI</sub> 63-36 – Vol <sub>LSr</sub> 63-36
Channel tracking error	$\Delta V_{19-20}$			$\pm 2$	dB	03,1F up to 03,13 Vol <sub>HP</sub> 31-19
Step width Vol <sub>15</sub>	$\Delta V_{15}$	0	1.25	2.5	dB	01,X-01,(X $\pm$ 1) Vol <sub>LSI</sub> X – Vol <sub>LSI</sub> (X 1)
Step width Vol <sub>16</sub>	$\Delta V_{16}$	0	1.25	2.5	dB	02,X-02,(X $\pm$ 1) Vol <sub>LSr</sub> X – Vol <sub>LSr</sub> (X 1)
Step width Vol <sub>15</sub>	$\Delta V_{15}$	0	1.25	2.5	dB	04,X-04,(X $\pm$ 1) Vol <sub>VLS</sub> X – Vol <sub>VLS</sub> (X 1)
Step width Vol <sub>16</sub>	$\Delta V_{16}$	0	1.25	2.5	dB	04,X-04,(X $\pm$ 1) Vol <sub>VLS</sub> X – Vol <sub>VLS</sub> (X 1)
Step width Vol <sub>19</sub>	$\Delta V_{19}$	0	2	4	dB	03,X-03,(X $\pm$ 1) Vol <sub>HPX</sub> – Vol <sub>HP</sub> (X 1)
Step width Vol <sub>20</sub>	$\Delta V_{20}$	0	2	4	dB	03,X-03,(X $\pm$ 1) Vol <sub>HP</sub> X – Vol <sub>HP</sub> (X 1)
Matrix adjustment	$V_{16-1}$	2.5	3	3.5	dB	06,1F, Adjust. max
Matrix adjustment	$V_{20-1}$	2.5	3	3.5	dB	06,1F, Adjust. max
Matrix adjustment	$V_{9-1}$	2.5	3	3.5	dB	06,1F, Adjust. max
Matrix adjustment	$V_{16-1}$	-3.5	-3	-2.5	dB	06,01, Adjust. min
Matrix adjustment	$V_{20-1}$	-3.5	-3	-2.5	dB	06,01, Adjust. min
Matrix adjustment	$V_{9-1}$	-3.5	-3	-2.5	dB	06,1F, Adjust. max
Adjust. step width	$\Delta V_{16}$	0.1	0.2	0.3	dB	06,X-06 (X $\pm$ 1) Adjust. X – Adjust. (X 1)

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Adjust. step width	$\Delta V_{20}$	0.1	0.2	0.3	dB	06,X-06(X ± 1) Adjust. X – adjust.(X ± 1)
Adjust. step width	$\Delta V_9$	0.1	0.2	0.3	dB	06,X-06(X ± 1) Adjust. X – adjust.(X ± 1)
Bass boost	$V_{16-1}$	13	15		dB	05,8F; $f_1 = 40$ Hz Bass max, treble lin.
Bass boost	$V_{15-3}$	13	15		dB	05,8F; $f_1 = 40$ Hz Bass max, treble lin.
Bass cut	$V_{16-1}$		- 12		dB	05,8F; $f_1 = 40$ Hz Bass max, treble lin.
Bass cut	$V_{15-3}$		- 12		dB	05,8F; $f_1 = 40$ Hz Bass max, treble lin.
Step width bass	$\Delta V_{15}$	1	3	5	dB	05,8X-05,8 (X ± 1) Bass X – bass (X ± 1)
Step width bass	$\Delta V_{16}$	1	3	5	dB	05,8X-05,8 (X ± 1) Bass X – bass (X ± 1)

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Treble boost	$V_{16-1}$	10	12		dB	05,F8 $f_1 = 15$ kHz <i>Treble max, bass lin.</i>
Treble boost	$V_{15-3}$	10	12		dB	05,F8 $f_1 = 15$ kHz <i>Treble max, bass lin.</i>
Treble cut	$V_{16-1}$		- 12		dB	05,F8 $f_1 = 15$ kHz <i>Treble min, bass lin.</i>
Treble cut	$V_{15-3}$		- 12		dB	05,F8 $f = 15$ kHz <i>Treble min, bass lin.</i>
Step width treble	$\Delta V_{15}$	1	3	5	dB	05,X8-05,(X $\pm$ 1)8 <i>Treble X -</i> <i>Treble (X 1)</i>
Step width treble	$\Delta V_{16}$	1	3	5	dB	05,X8-05,(X $\pm$ 1)8 <i>Treble X -</i> <i>Treble (X 1)</i>
Linearity sound	$\Delta V_{15}$			$\pm 2$	dB	05,88; $f_1 = 40$ Hz - 15 kHz <i>Treble, bass lin.</i>
Linearity sound	$\Delta V_{16}$			$\pm 2$	dB	05,88; $f_1 = 40$ Hz - 15 kHz <i>Treble, bass lin.</i>
Detection level of the clipping detector	$V_1$		580		mVrms	05,8F; $f_1 = 40$ Hz <i>Treble lin, bass max.</i> 01,2F - 02,2F $Vol_{Lsr} 47 - Vol_{Lsr} 47$

The same values are valid if the test signals are applied at pin 3, 6, 7 or 8

Channel separation	$\Delta V_{15-16}$	50			dB	$V_3$ or $V_8 =$ 600 mVrms
Channel separation of the clipping	$\Delta V_{19-20}$	50			dB	$V_3$ or $V_8 =$ 600 mVrms
Channel separation	$\Delta V_{9-10}$	50			dB	$V_3$ or $V_8 =$ 600 mVrms
Cross talk attenuation switch	$\alpha_{1 \text{ interf. } Q \text{ rms}}$	60			dB	$V_{1 \text{ rms}} = 0$ $V_{1 \text{ Interf. } 3,6} =$ 600 mV rms $V_{\text{Interf. } 7,8} = 2 \text{ V rms}$

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Attenuation MUTE	$\alpha_{1-16}$	80			dB	01,00 - 02,00 <i>Vol<sub>LSI</sub> 0 - Vol<sub>LSr</sub> 0</i> <i>V<sub>1</sub> = 600 mVrms</i>
Attenuation MUTE	$\alpha_{1-16}$	80			dB	07,48; <i>V<sub>1</sub> = 600 mVrms</i> <i>MUTE I: 0</i>
Attenuation MUTE	$\alpha_{1-16}$	80			dB	07,88; <i>V<sub>1</sub> = 600 mVrms</i> <i>MUTE II: 0</i>
Attenuation MUTE	$\alpha_{3-15}$	80			dB	01,00 - 02,00 <i>Vol<sub>LSI</sub> 0 - Vol<sub>LSr</sub> 0</i> <i>V<sub>3</sub> = 600 mVrms</i>
Attenuation MUTE	$\alpha_{3-15}$	80			dB	07,48; <i>V<sub>3</sub> = 600 mVrms</i> <i>MUTE I: 0</i>
Attenuation MUTE	$\alpha_{3-15}$	80			dB	07,88; <i>V<sub>3</sub> = 600 mVrms</i> <i>MUTE II: 0</i>
Attenuation MUTE	$\alpha_{1-20}$	80			dB	03,00; <i>V<sub>1</sub> = 600 mVrms</i> <i>Vol<sub>HP</sub> 0</i>
Attenuation MUTE	$\alpha_{1-20}$	80			dB	07,48; <i>V<sub>1</sub> = 600 mVrms</i> <i>MUTE I: 0</i>

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Attenuation MUTE	$\alpha_{3-19}$	80			dB	03,00; $V_3 = 600$ mVrms <i>Vol<sub>HP</sub> 0</i>
Attenuation MUTE	$\alpha_{3-19}$	80			dB	07,48; $V_3 = 600$ mVrms <i>MUTE I: 0</i>
Analogous values are valid for feed in at pins 6, 7, 8; $V_{7,8} = 2$ Vrms; $V_6 = 600$ mVrms						
Attenuation MUTE	$\alpha_{3-10}$	80			dB	07, 48; $V_3 = 600$ mVrms <i>MUTE I: 0</i>
Attenuation MUTE	$\alpha_{1-9}$	80			dB	07, 48; $V_1 = 600$ mVrms <i>MUTE I: 0</i>
Attenuation MUTE	$\alpha_{6-10}$	80			dB	07, 49; $V_6 = 600$ mVrms <i>MUTE I: 0, AM</i>
Attenuation MUTE	$\alpha_{6-9}$	80			dB	07, 49; $V_6 = 600$ mVrms <i>MUTE I: 0, AM</i>
Max. input voltage	$V_6$	600			mVrms	$THD_{15,16} = 1$ %
Max. input voltage	$V_3$	600			mVrms	$THD_{15} = 1$ %
Max. input voltage	$V_1$	600			mVrms	$THD_{16} = 1$ %
Max. input voltage	$V_1$	300			mVrms	$THD_{16} = 1$ %;00,02 <i>Matrix; Stereo</i>
Max. input voltage*)	$V_7$	2			Vrms	$THD_{16} = 3$ %;07, <i>CC, SCART</i>
Max. input voltage*)	$V_8$	2			Vrms	$THD_{15} = 1$ %;07, <i>CC, SCART</i>

\*) The tone control is possible over the full functional range if 04, 18, *Vol<sub>VLS</sub> 24*

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**Characteristics (cont'd)**

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Distortion	<i>THD</i> <sub>19</sub>		0.01	0.1	%	$V_3 = 250 \text{ mVrms}$
Distortion	<i>THD</i> <sub>20</sub>		0.01	0.1	%	$V_1 = 250 \text{ mVrms}$
Distortion	<i>THD</i> <sub>19</sub>		0.01	0.1	%	$V_3 = 250 \text{ mVrms};$ 03,15 <i>Vol HP 21</i>
Distortion	<i>THD</i> <sub>20</sub>		0.01	0.1	%	$V_1 = 250 \text{ mVrms};$ 03,15 <i>Vol HP 21</i>
Analogous values are valid for feed in at pins 6, 7, 8; $V_{7,8} = 600 \text{ mVrms}; V_6 = 250 \text{ mVrms}$						
Distortion	<i>THD</i> <sub>16</sub>		0.01	0.1	%	$V_1 = 250 \text{ mVrms}$
Distortion	<i>THD</i> <sub>15</sub>		0.01	0.1	%	$V_3 = 250 \text{ mVrms}$
Distortion	<i>THD</i> <sub>16</sub>		0.01	0.2	%	$V_1 = 250 \text{ mVrms};$ 01,2F-02,2F <i>Vol LSI 47 Vol LSR 47</i>
Distortion	<i>THD</i> <sub>15</sub>		0.01	0.2	%	$V_3 = 250 \text{ mVrms}$ 01,2F-02,2F <i>Vol LSI 47 Vol LSR 47</i>
Distortion	<i>THD</i> <sub>16</sub>		0.1	0.4	%	$V_1 = 250 \text{ mVrms};$ 05,XX <i>any sound</i>
Distortion	<i>THD</i> <sub>15</sub>		0.1	0.4	%	$V_3 = 250 \text{ mVrms};$ 05,XX <i>any sound</i>
Analogous values are valid for feed in at pins 6, 7, 8; $V_{7,8} = 600 \text{ mVrms}; V_6 = 250 \text{ mVrms}$						
Distortion	<i>THD</i> <sub>10</sub>		0.01	0.1	%	$V_3 = 250 \text{ mVrms}$
Distortion	<i>THD</i> <sub>9</sub>		0.01	0.1	%	$V_1 = 250 \text{ mVrms}$
Distortion	<i>THD</i> <sub>10</sub>		0.01	0.1	%	$V_6 = 250 \text{ mVrms};$ 07,C9,AM
Distortion	<i>THD</i> <sub>9</sub>		0.01	0.1	%	$V_6 = 250 \text{ mVrms};$ 07,C9,AM

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Anti-phase cross talk Base width	$\Delta V_{16-15}$	0.5	0.55			$V_3 = 600 \text{ mVrms}$ $f_1 = 2 \text{ kHz}; 00,11,$ <i>Base width</i>
Anti-phase cross talk Base width	$\Delta V_{15-16}$	0.5	0.55			$V_1 = 600 \text{ mVrms}$ $f_1 = 2 \text{ kHz}; 00,11,$ <i>Base width</i>
Base width phase	$\Phi_{16-15}$	150	180	210	deg	$V_1 = 600 \text{ mVrms}$ $f = 2 \text{ kHz}; 00,11,$ <i>Base width</i>
Base width phase	$\Phi_{15-16}$	150	180	210	deg	$V_3 = 600 \text{ mVrms}$ $f = 2 \text{ kHz}; 00,11,$ <i>Base width</i>
Phase rotation quasi stereo	$\Phi_{16-15}$	0	10	40	deg	$V_{3,1} = 600 \text{ mVrms}$ $f = 40 \text{ Hz}; 00,21,$ <i>Quasi stereo</i>
Phase rotation quasi stereo	$\Phi_{16-15}$	130	180	230	deg	$V_{3,1} = 600 \text{ mVrms}$ $f = 700 \text{ Hz}; 00,21,$ <i>Quasi stereo</i>
Phase rotation quasi stereo	$\Phi_{16-15}$	-30	10	0	deg	$V_{3,1} = 600 \text{ mVrms}$ $f = 15 \text{ kHz}; 00,21,$ <i>Quasi stereo</i>
Signal to noise ratio	$\alpha_{S/N16}$	90	97		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_1 = 0.6 \text{ Vrms}$
Signal to noise ratio	$\alpha_{S/N15}$	90	97		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_3 = 0.6 \text{ Vrms}$
Signal to noise ratio	$\alpha_{S/N16}$	70	80		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_1 = 0.6 \text{ Vrms}$ 01,27-02,27 <i>Vol LSi 39-Vol Lsr 39</i>
Signal to noise ratio	$\alpha_{S/N15}$	70	80		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_3 = 0,6 \text{ Vrms}$ 01,27-02,27 <i>Vol LSi 39-Vol Lsr 39</i>

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Output noise voltage	$V_{N16}$		2	10	$\mu\text{Vrms}$	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ 01,00-02,00 $Vol_{LSI} 0-Vol_{LSr} 0$
Output noise voltage	$V_{N15}$		2	10	$\mu\text{Vrms}$	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ 01,00-02,00 $Vol_{LSI} 0-Vol_{LSr} 0$
Signal to noise ratio	$\alpha_{S/N20}$	90	97		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_1 = 0,6 \text{ Vrms}$
Signal to noise ratio	$\alpha_{S/N19}$	90	97		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_3 = 0,6 \text{ Vrms}$
Signal to noise ratio	$\alpha_{S/N20}$	70	80		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_1 = 0,6 \text{ Vrms}$ 03, 10, $Vol_{HP16}$
Signal to noise ratio	$\alpha_{S/N19}$	70	80		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_3 = 0,6 \text{ Vrms}$ 03, 10, $Vol_{HP16}$
Output noise voltage	$V_{N20}$		2	10	$\mu\text{Vrms}$	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ 03, 00, $Vol_{HP} 0$
Output noise voltage	$V_{N19}$		2	10	$\mu\text{Vrms}$	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ 03, 00, $Vol_{HP} 0$
Signal to noise ratio	$\alpha_{S/N9}$	90	97		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_1 = 0,6 \text{ Vrms}$
Signal to noise ratio	$\alpha_{S/N10}$	90	97		dB	$V_{N \text{ rms } 20 \text{ Hz-20 kHz}}$ $V_1 = 0,6 \text{ Vrms}$



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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
DC/pop Δ1 Bit	$\Delta V_{16}$			± 10	mV	01, X-01, X ± 1 Vol <sub>LSI</sub> X - Vol <sub>LSI</sub> (X 1)
DC/pop Δ1 Bit	$\Delta V_{15}$			± 10	mV	02, X-02, X ± 1 Vol <sub>LSr</sub> X - Vol <sub>LSr</sub> (X 1)
DC/pop Δ1 Bit	$\Delta V_{16}$			± 10	mV	04, X-04, X ± 1 Vol <sub>VLS</sub> X - Vol <sub>VLS</sub> (X 1)
DC/pop Δ1 Bit	$\Delta V_{15}$			± 10	mV	04, X-04, X ± 1 Vol <sub>VLS</sub> X - Vol <sub>VLS</sub> (X 1)
DC/pop Δ1 Bit	$\Delta V_{16}$			± 10	mV	05, X-05, X ± 1 ToneX - Tone (X 1)
DC/pop Δ1 Bit	$\Delta V_{15}$			± 10	mV	05, X-05, X ± 1 Tone X - Tone (X 1)
DC/pop Δ1 Bit	$\Delta V_{19}$			± 10	mV	03, X-03, X ± 1 Vol <sub>HPX</sub> - Vol <sub>HP</sub> (X 1)
DC/pop Δ1 Bit	$\Delta V_{20}$			± 10	mV	03, X-03, X ± 1 Vol <sub>HPX</sub> - Vol <sub>HP</sub> (X 1)

Design-Related data

Input resistance	$R_7$	35			kΩ	
Input resistance	$R_8$	35			kΩ	
Input resistance	$R_6$	20			kΩ	
Input resistance	$R_3$	40			kΩ	
Input resistance	$R_1$	40			kΩ	
Output resistance	$R_{19}$			200	Ω	
Output resistance	$R_{20}$			200	Ω	
Output resistance	$R_{15}$			60	Ω	
Output resistance	$R_{16}$			60	Ω	
Output resistance	$R_9$			60	Ω	
Output resistance	$R_{10}$			60	Ω	

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**Characteristics (cont'd)**

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
<b>ID Signal Decoder</b>							
Gain filter OP-amplif.	$V_5$	13	14	15	dB	$V_{IF} = 80 \text{ mVpp}$	1
Max. input voltage	$V_5$	600			mVpp	Function	2
VCO voltage PLL	$V_{27}$	1.3			V	$f_{24} = 14.6 \text{ kHz};$ $V_{24} = 2.5 \text{ V}_{OS}$	2
VCO voltage PLL	$V_{27}$	2	3	4	V	$f_{24} = 15.625 \text{ kHz};$ $V_{24} = 2.5 \text{ V}_{OS}$	2
VCO voltage PLL	$V_{27}$			4.7	V	$f_{24} = 16.6 \text{ kHz};$ $V_{24} = 2.5 \text{ V}_{OS}$	2
VCO voltage PLL	$V_{27}$	1.3			V	$f_{24} = 58.4 \text{ kHz};$ $V_{24} = 2.5 \text{ V}_{OS}$	2
VCO voltage PLL	$V_{27}$	2	3	4.7	V	$f_{24} = 66.4 \text{ kHz};$ $V_{24} = 2.5 \text{ V}_{OS}$	2
VCO voltage PLL	$V_{27}$				V	00,08, <i>H-pulse</i> 00,08 - 04.81 <i>H-pulse; quartz</i> <i>cont. function</i>	4

$$V_{\text{Filter gain}} = \frac{\sqrt{(V_{25} - V_{25}^*)^2 + (V_{26} - V_{26}^*)^2}}{V_5}$$

$V_{25}$  or  $V_{26}$  when  $V_5 = 0$   
 $V_{25}^*$  or  $V_{26}^*$  when  $V_5 = 100 \text{ mVpp}; m = 50 \%$

ID filter gain	$V_{K \text{ TFilter}}$	3.4		6.8	V	$f_5 = \text{Pilot signal dual};$ I <sup>2</sup> C-talk: dual	2
ID filter gain	$V_{K \text{ TFilter}}$	3.4		6.8	V	$f_5 = \text{Pilot signal stereo};$ I <sup>2</sup> C-talk: stereo	2

$$V_{25 \text{ test}} = V_{25} (V_5 = 0) \pm \Delta V_{25}; V_{26 \text{ test}} = V_{26} (V_5 = 0) \pm \Delta V_{26}$$

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**Characteristics** (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Detection threshold	$\Delta V_{25}$	900			mV	I <sup>2</sup> C talk: stereo or dual	3
Detection threshold	$-\Delta V_{25}$	900			mV	I <sup>2</sup> C talk: stereo or dual	3
Detection threshold	$\Delta V_{26}$	900			mV	I <sup>2</sup> C talk: stereo or dual	3
Detection threshold	$-\Delta V_{26}$	900			mV	I <sup>2</sup> C talk: stereo or dual	3
Mono threshold	$\Delta V_{25}$	0		100	mV	I <sup>2</sup> C talk: mono	3
Mono threshold	$-\Delta V_{25}$	0		100	mV	I <sup>2</sup> C talk: mono	3
Mono threshold	$\Delta V_{26}$	0		100	mV	I <sup>2</sup> C talk: mono	3
Mono threshold	$-\Delta V_{26}$	0		100	mV	I <sup>2</sup> C talk: mono	3
Response of detection	$t_{\text{detec}}$	1/4		1/2	t <sub>MPX</sub>	I <sup>2</sup> C talk: stereo o. dual; $\pm \Delta V_{25} = 1V$	3
Response of detection	$t_{\text{detec}}$	1/4		1/2	t <sub>MPX</sub>	I <sup>2</sup> C talk: stereo o. dual; $\pm \Delta V_{26} = 1V$	3

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Characteristics (cont'd)

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Switching threshold $f_{REF}$ -input	$V_{H\text{in}L}$	0		1.5	V		2
Switching threshold $f_{REF}$ -input	$V_{H\text{in}L}$	3.5		$V_{21}$	V		2
Amplitude crystal oscillator	$V_{24}$		2		$V_{pp}$	$f_0 = 4.00000$ MHz Serial resonance	2
Ext. 1- or 4 MHz-clock signal	$V_{24}$		0.3		$V_{pp}$		3
Multiplexer clock	$t_{MPX4}$		1.08		s	00,C0, $MPX = 1$	
Multiplexer clock	$t_{MPX4}$		2.17		s	00,00, $MPX = 2$	
Multiplexer clock	$t_{MPX4}$		4.34		s	00,40, $MPX = 4$	
Multiplexer clock	$t_{MPX4}$		8.68		s	00,80, $MPX = 8$	

Design-Related data

Filter output resistance	$R_{25,26}$	110			$k\Omega$		
$f_{REF}$ input resistance	$R_{24}$	800			$\Omega$		
Input impedance crystal oscillator	$Z_{24}$		- 120		$\Omega$		

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Characteristics (cont'd)

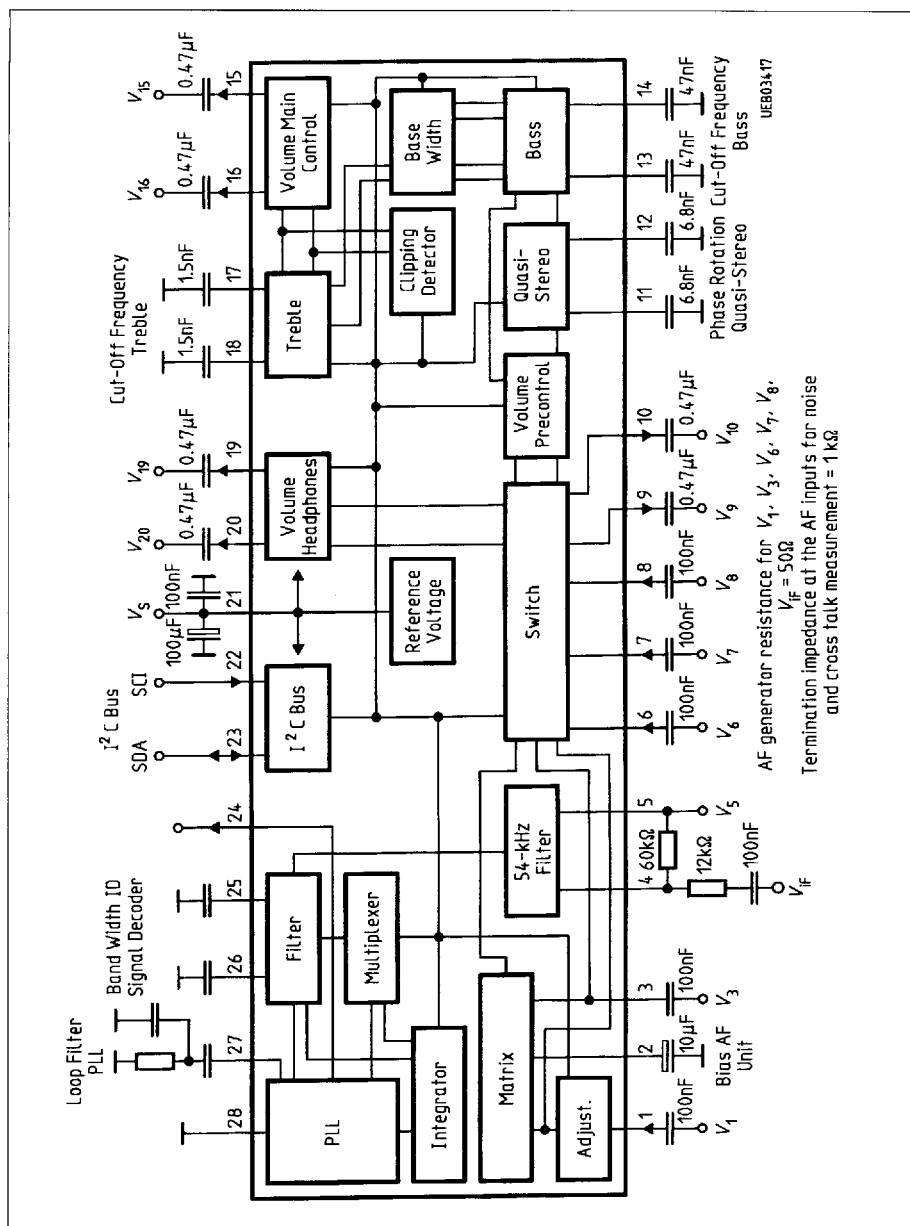
Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
<b>I<sup>2</sup>C Bus (SCL, SDA)</b>						
SCL, SDA edges						
Rise time	$t_R$			1	$\mu$ s	
Fall time	$t_F$			300	ns	
Shift register clock pulse SCL						
Frequency	$f_{SCL}$	0		100	kHz	
H-pulse width	$t_{HIGH}$	4			$\mu$ s	
L-pulse width	$t_{LOW}$	4			$\mu$ s	
Start						
Set-up time	$t_{SUSTA}$	4			$\mu$ s	
Hold time	$t_{HDSTA}$	4			$\mu$ s	
Stop						
Set-up time	$t_{SUSTO}$	4			$\mu$ s	
Bus free time	$t_{BUF}$	4			$\mu$ s	
Data transfer						
Set-up time	$t_{SUDAT}$	1			$\mu$ s	
Hold time	$t_{HDDAT}$	1			$\mu$ s	
Input SCL, SDA						
Input voltage	$V_{QH}$	2.4		5.5	V	
	$V_{QL}$			1	V	
Input current	$I_{QH}$			50	$\mu$ A	
	$I_{QL}$			100	$\mu$ A	
Output SDA (Open collector)						
Output voltage	$V_{QH}$	5.4			V	$R_L = 2.5 \text{ k}\Omega$ $I_{QL} = 3 \text{ mA}$
	$V_{QL}$			0.4	V	

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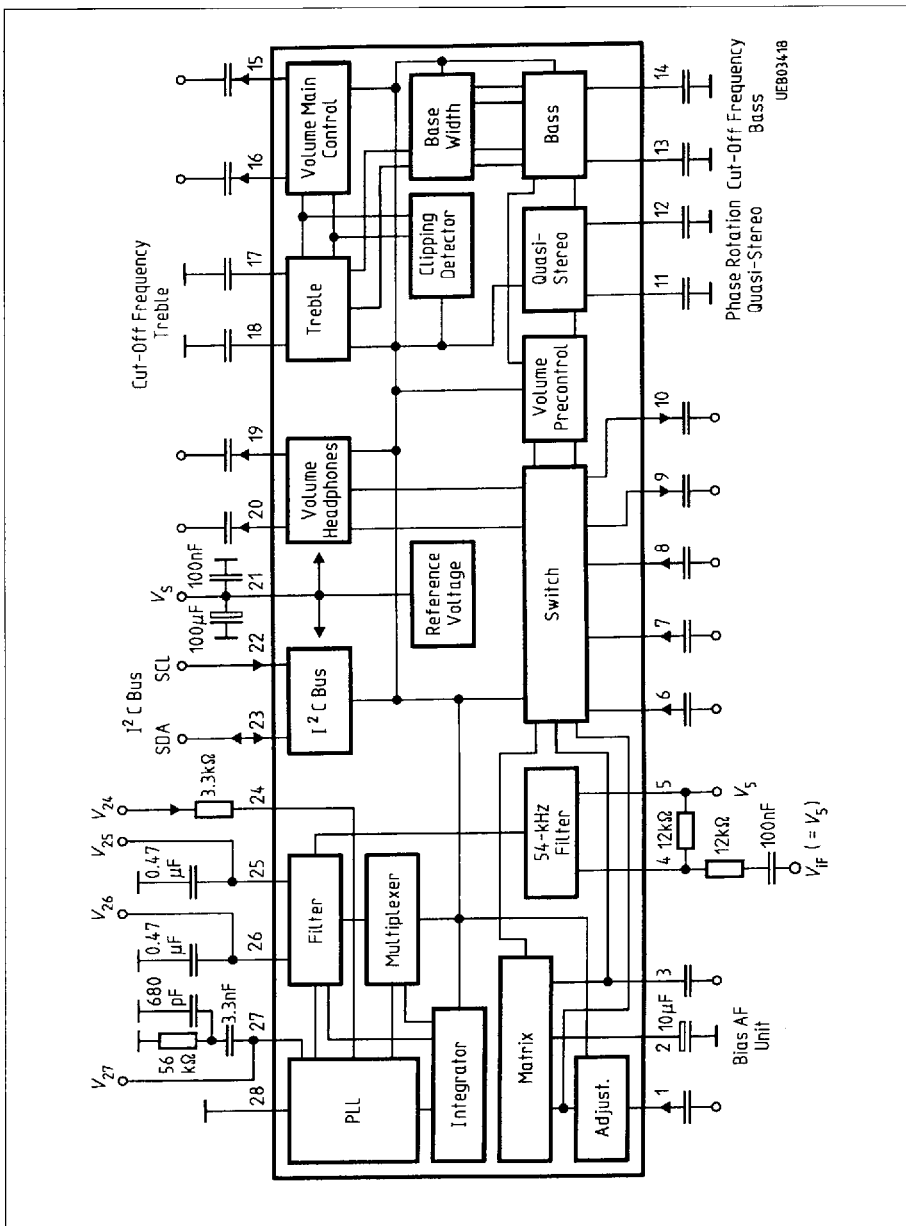
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Test Circuit 1



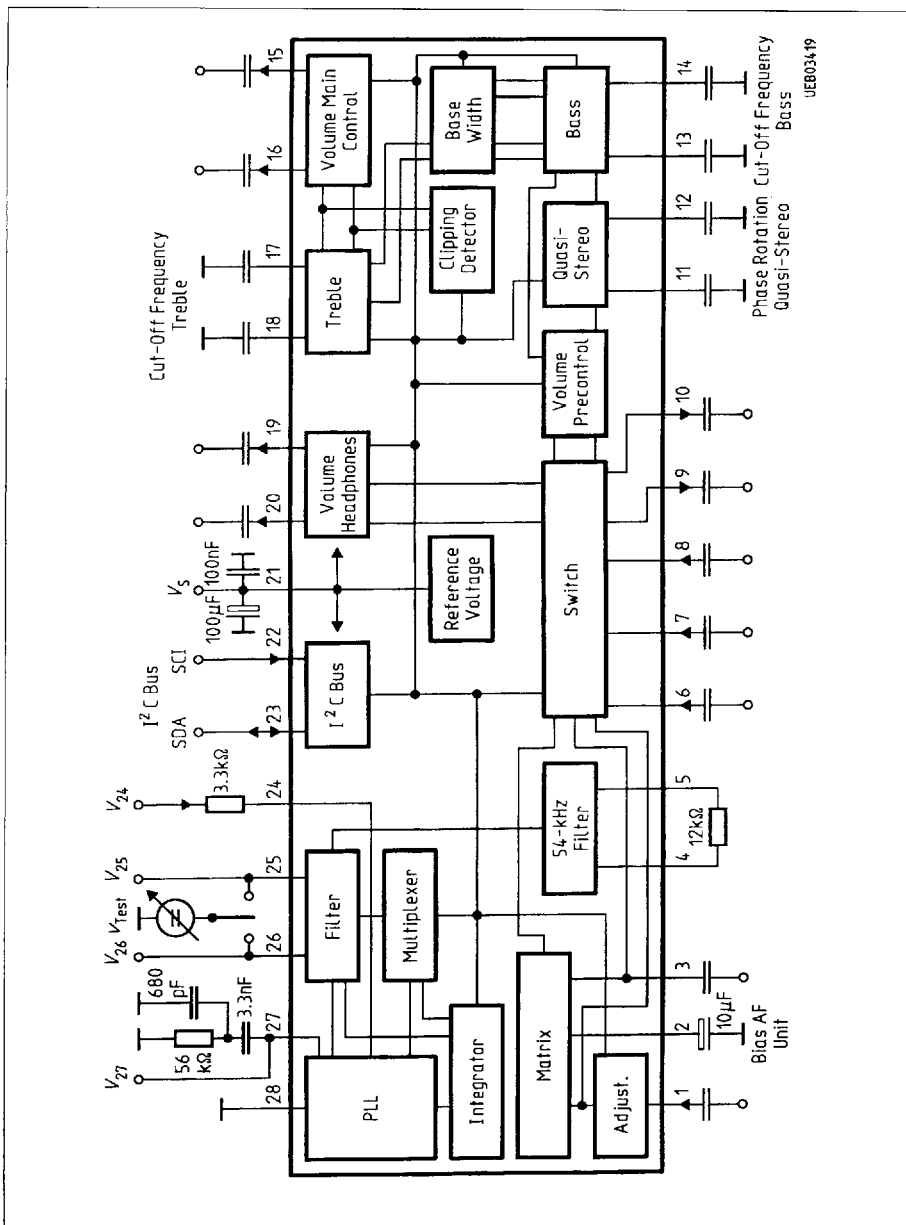
Test Circuit 2

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Test Circuit 3

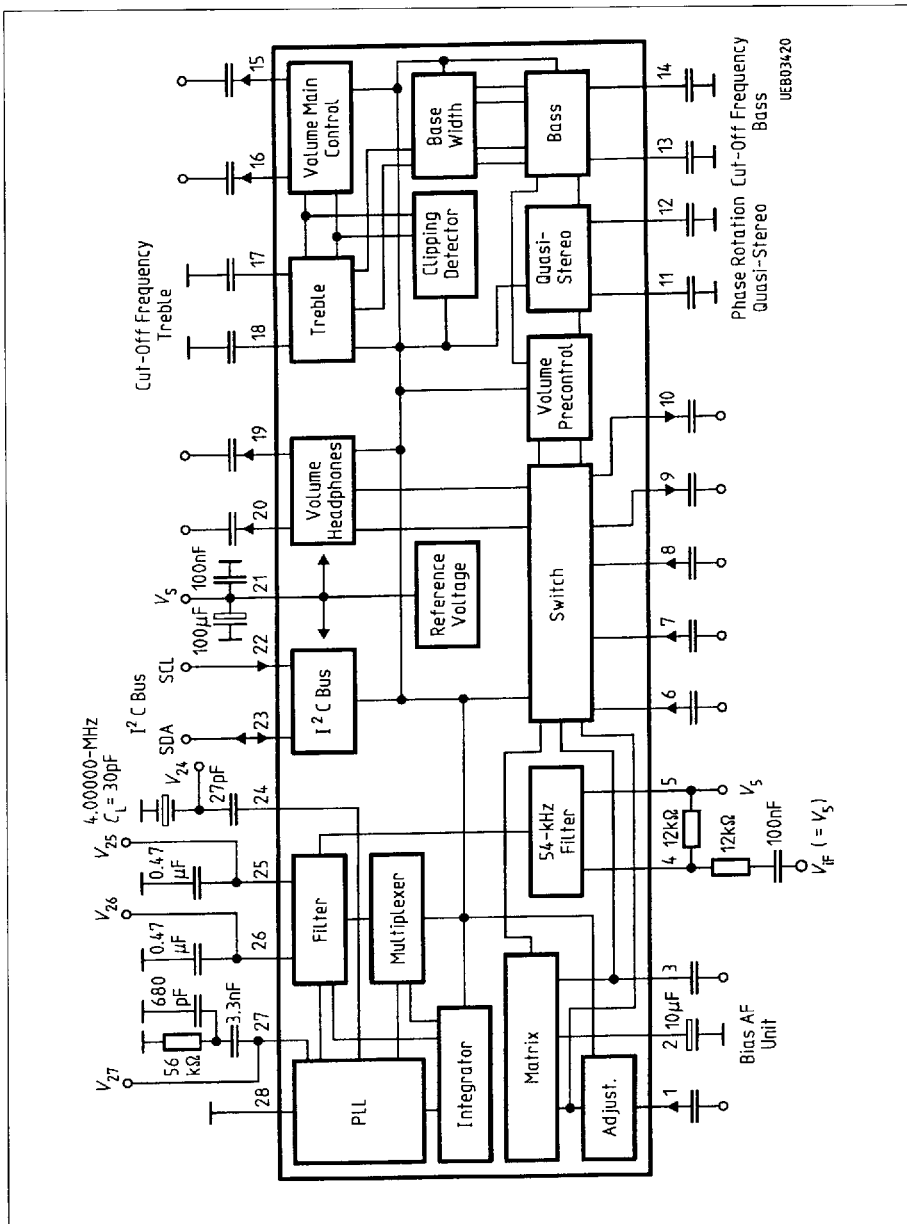


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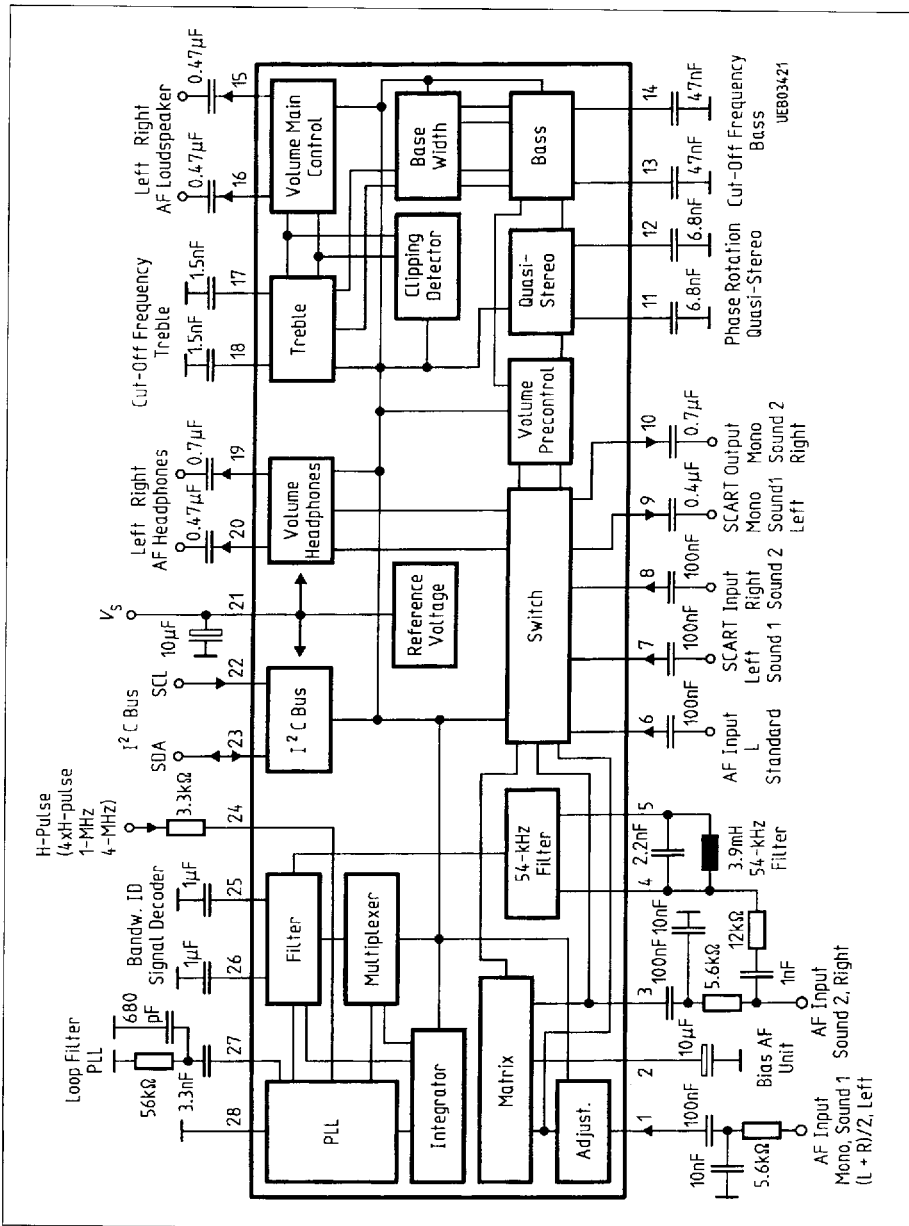
Test Circuit 4

60E D ■ 8235605 0049131 826 ■ SIEG

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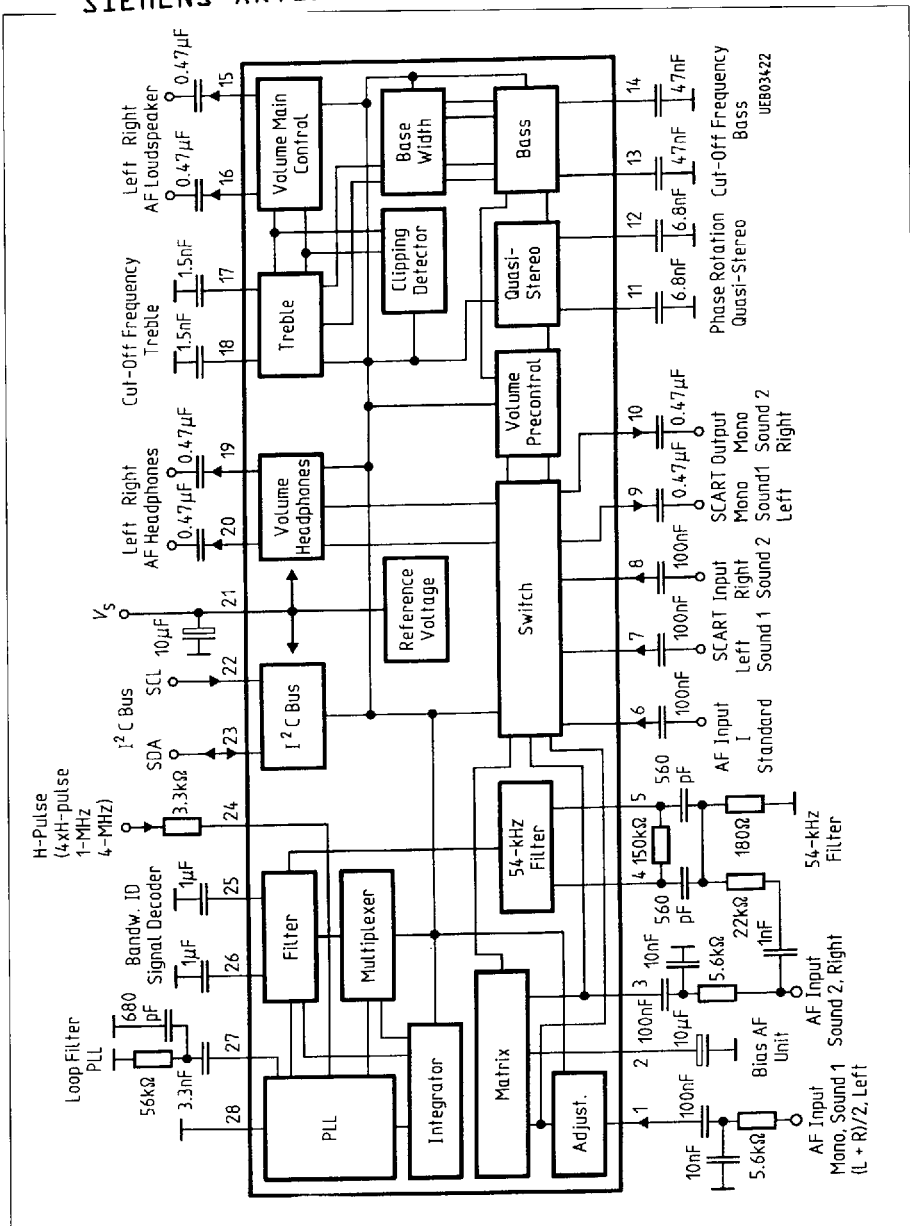
Application Circuit 1

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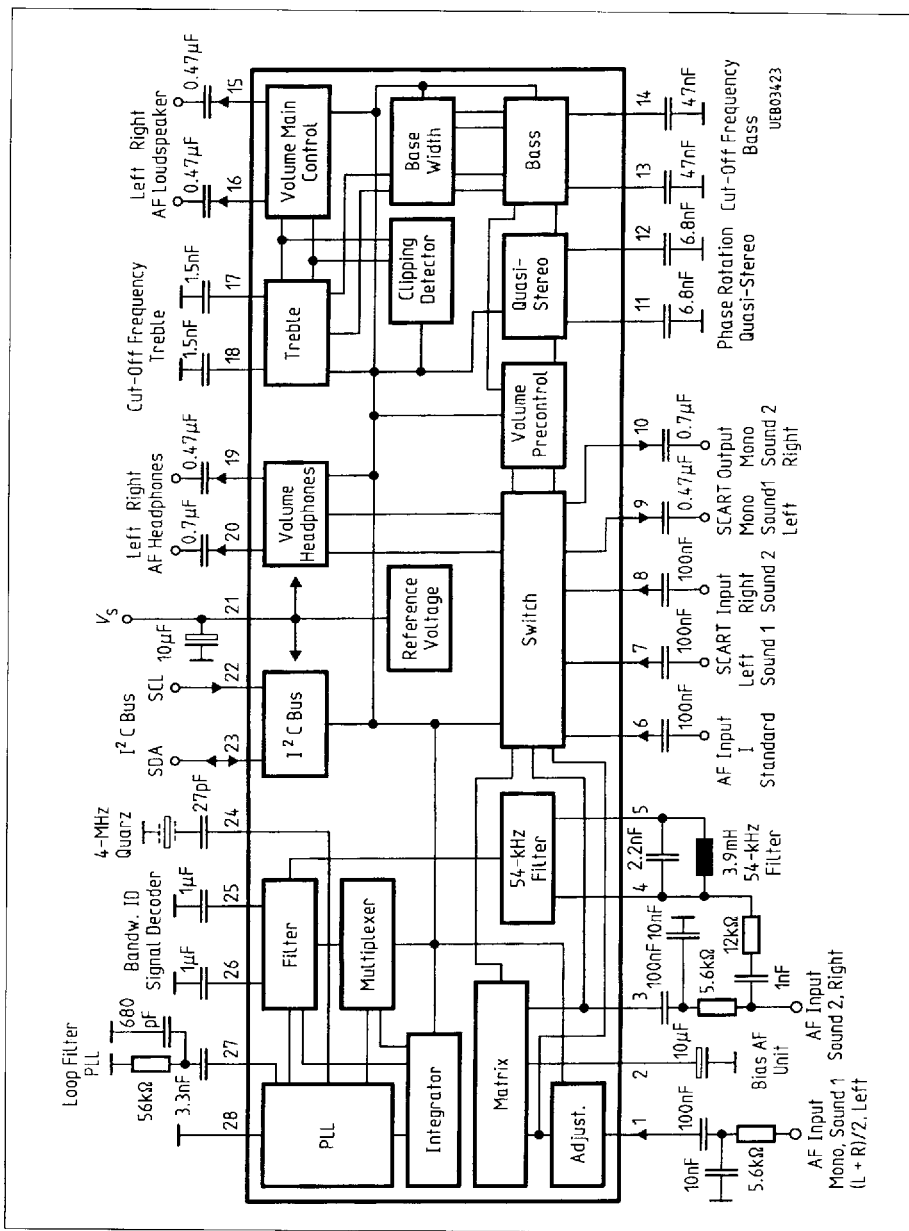
Application Circuit 2

60E D ■ 8235605 0049133 6T9 ■ SIEG

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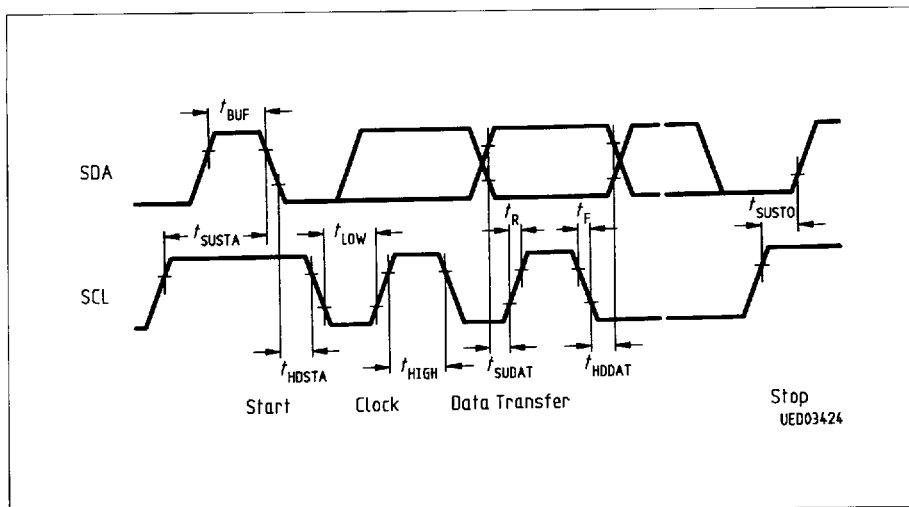
Application Circuit 3

60E D ■ 8235605 0049134 535 ■ SIEG

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I<sup>2</sup>C Bus Timing Diagram

$t_{SUSTA}$	Set-up time (start)
$t_{HDSTA}$	Hold time (start)
$t_{HIGH}$	High pulse width (clock)
$t_{LOW}$	Low pulse width (clock)
$t_{SUBAT}$	Set-up time (data transfer)
$t_{HDDAT}$	Hold time (data transfer)
$t_{SUSTO}$	Set-up time (stop)
$t_{BUF}$	Bus free time
$t_F$	Fall time
$t_R$	Rise time

All times are referenced to the  $V_{IH}$  and  $V_{IL}$  values.