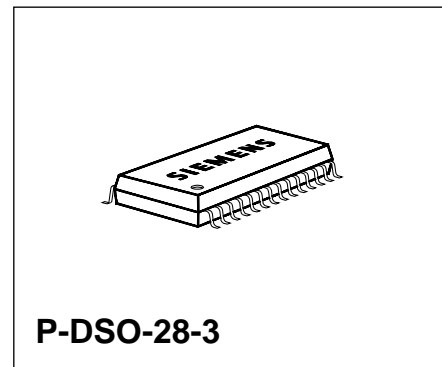


### 1 Overview

The TDA 4390-2X is a single-chip audio sound system. The circuit can be partitioned into two functional blocks.

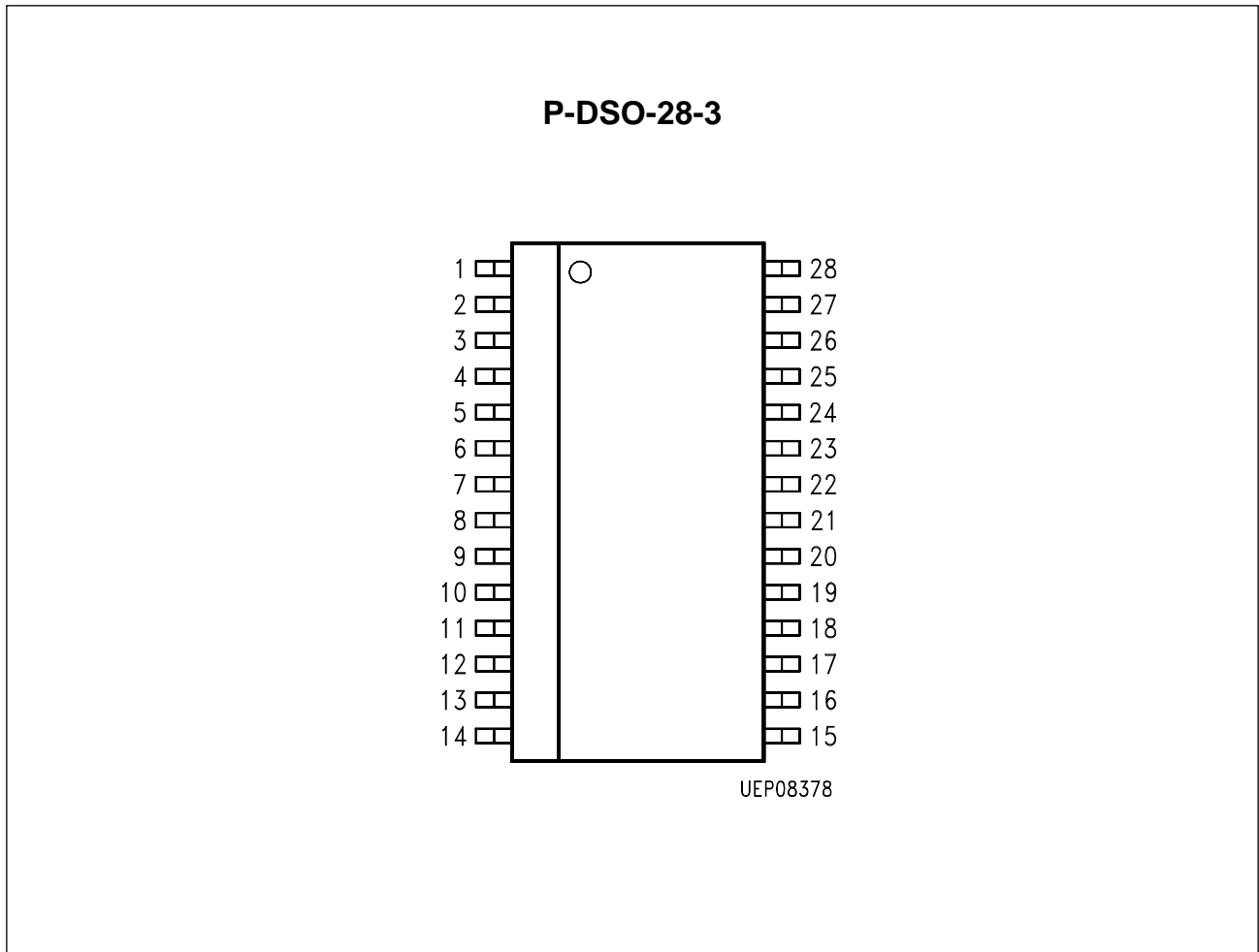


#### 1.1 Features

1. Stereo sound processing
  - Four stereo AF inputs
  - Input/Output interface for external equalizer
  - Max. gain switchable between 0 dB and 6 dB
  - Bass and treble control
  - Four independent attenuators for volume balance and fader control
2. Control part
  - I<sup>2</sup>C Bus interface compatible for standard and fast mode
  - Control of sound processing

Type	Ordering Code	Package
TDA 4390-2X	Q67000-A5183	P-DSO-28-3

## 1.2 Pin Configuration (top view)



**Figure 1**

### 1.3 Pin Definitions and Functions

Pin No.	Symbol	Function
1		AF input 1 left
2		AF input 2 left
3		AF input 3 left
4		AF input 3 left
5		AF output switch left
6		AF input tone control volume left
7		Reset (all functions in power ON status)
8		I <sup>2</sup> C Bus SCL
9		I <sup>2</sup> C Bus SDA
10		Supply voltage
11		Corner frequency treble left
12		Corner frequency treble right
13		AF output right front
14		AF output right rear
15		AF output left rear
16		AF output left front
17		Corner frequency bass right output
18		Corner frequency bass right input
19		Corner frequency bass left output
20		Corner frequency bass left input
21		Ground
22		Blocking AF operating point
23		AF input tone control volume right
24		AF output switch right
25		AF input 4 right
26		AF input 3 right
27		AF input 2 right
28		AF input 1 right

1.3.1 Pin Description

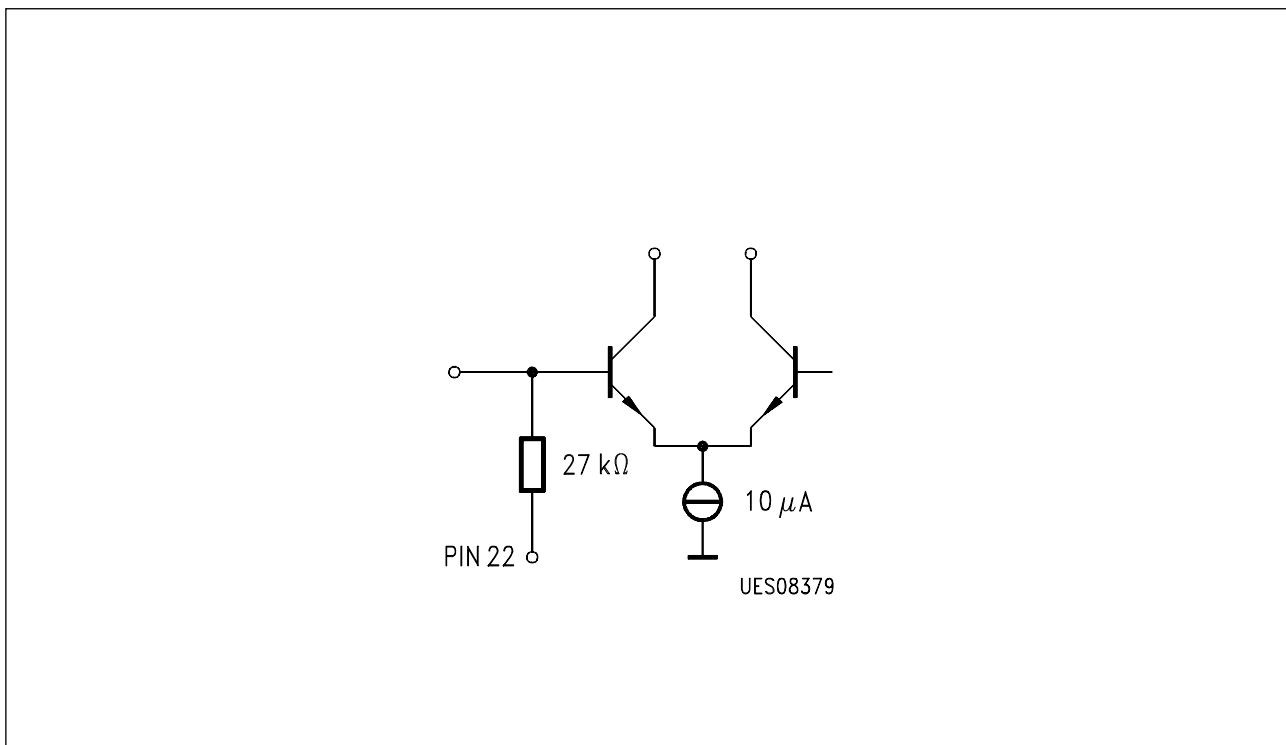


Figure 2  
AF Inputs PIN 1/2/3/4/6/23/25/26/27/28

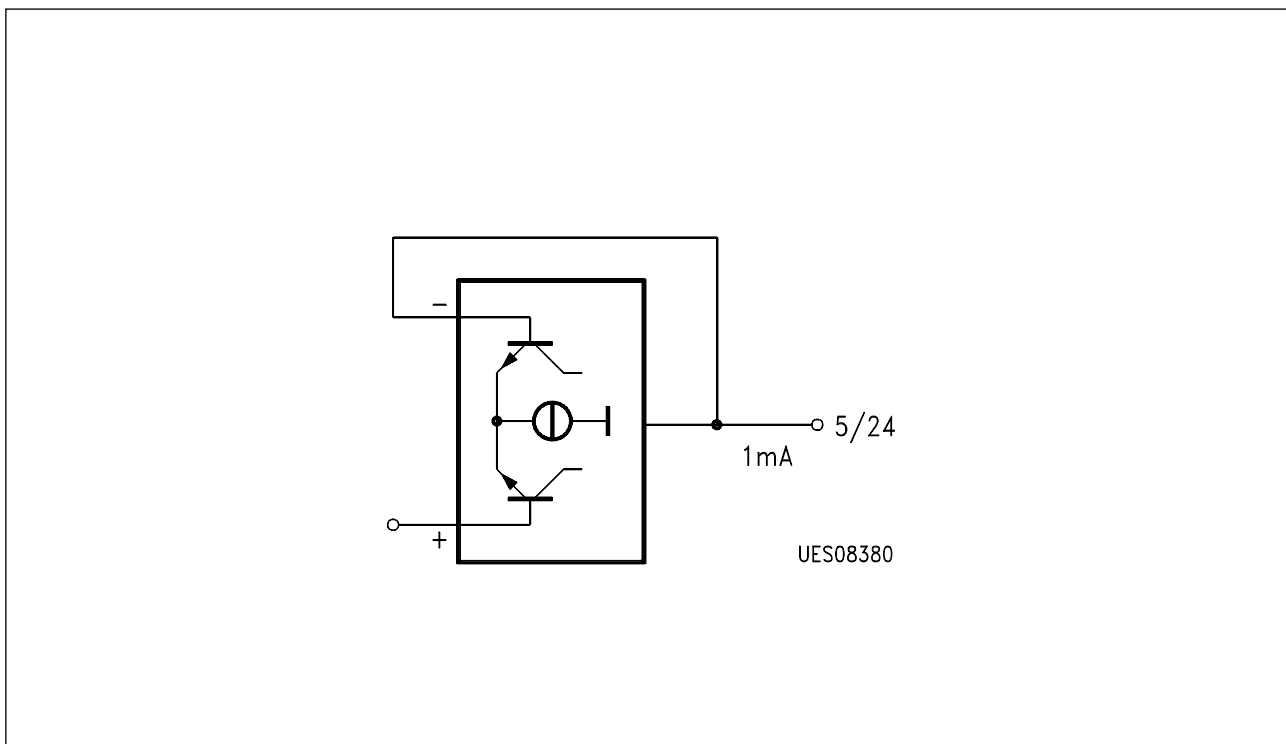
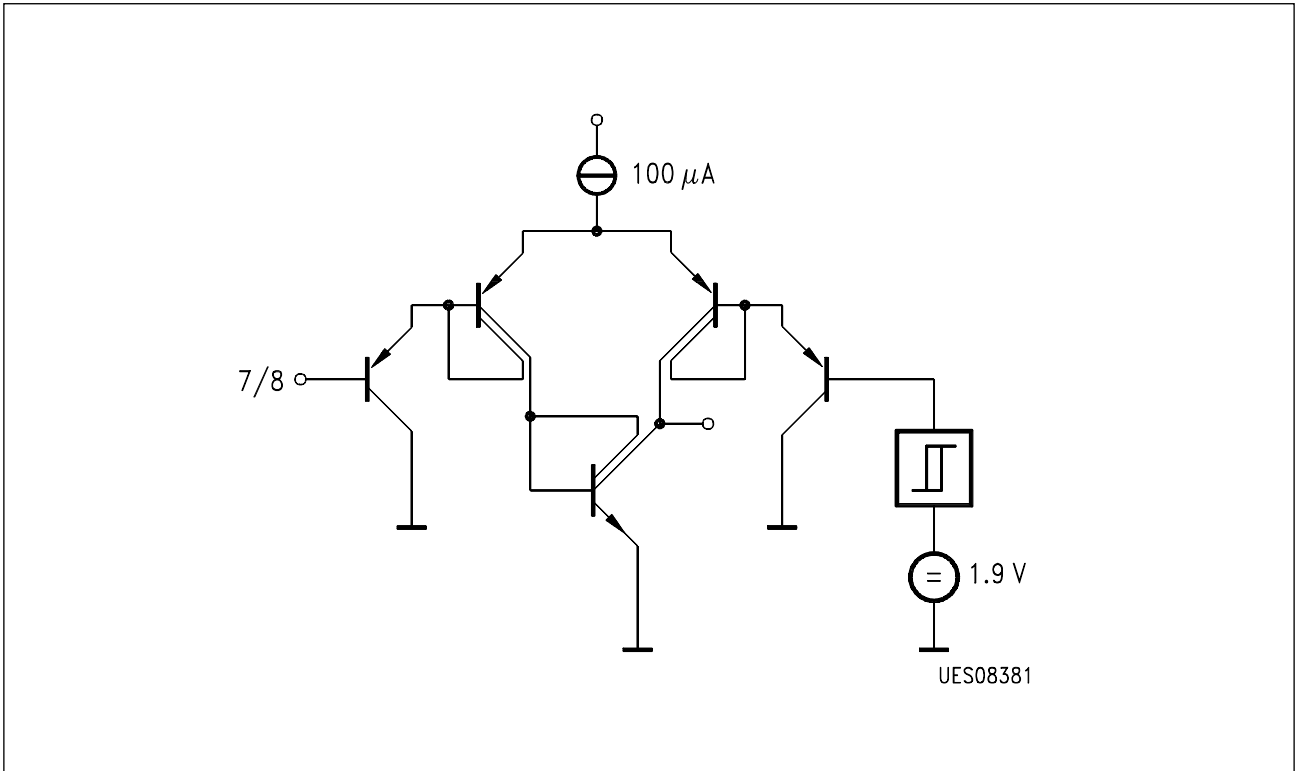
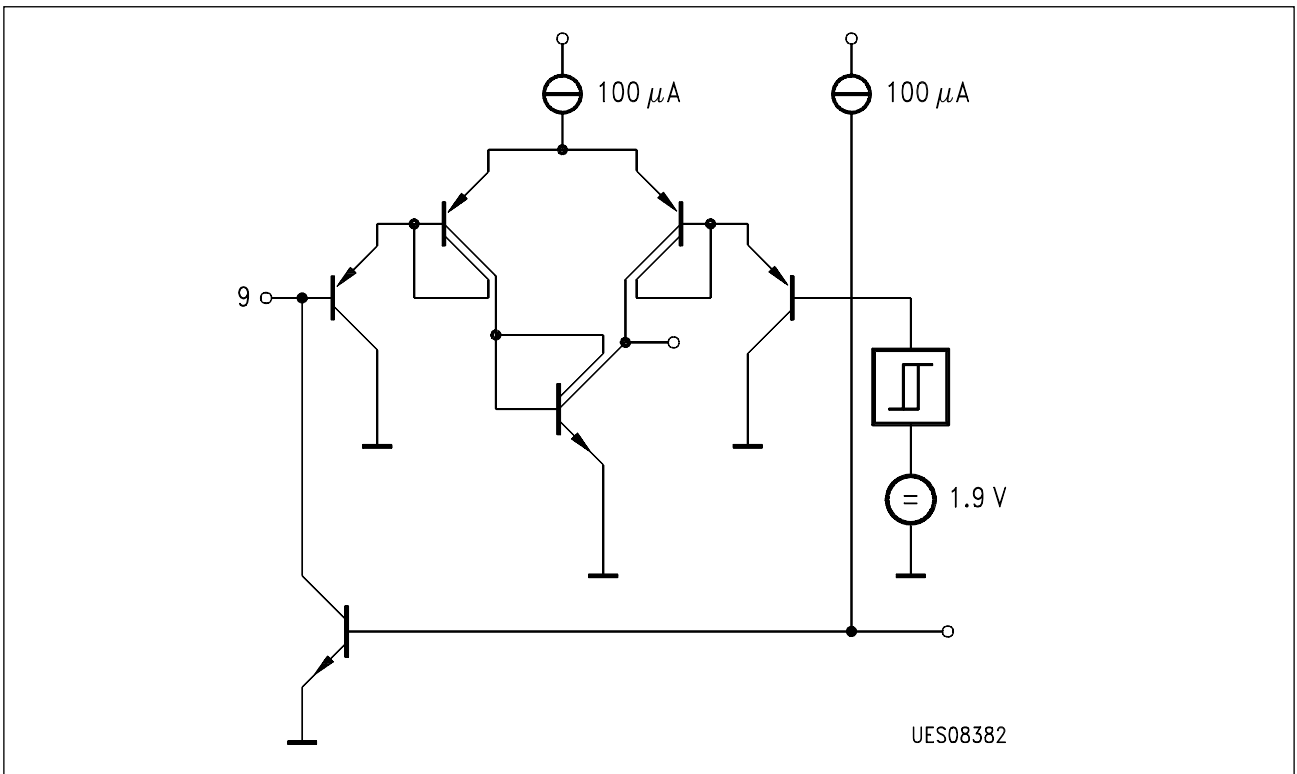


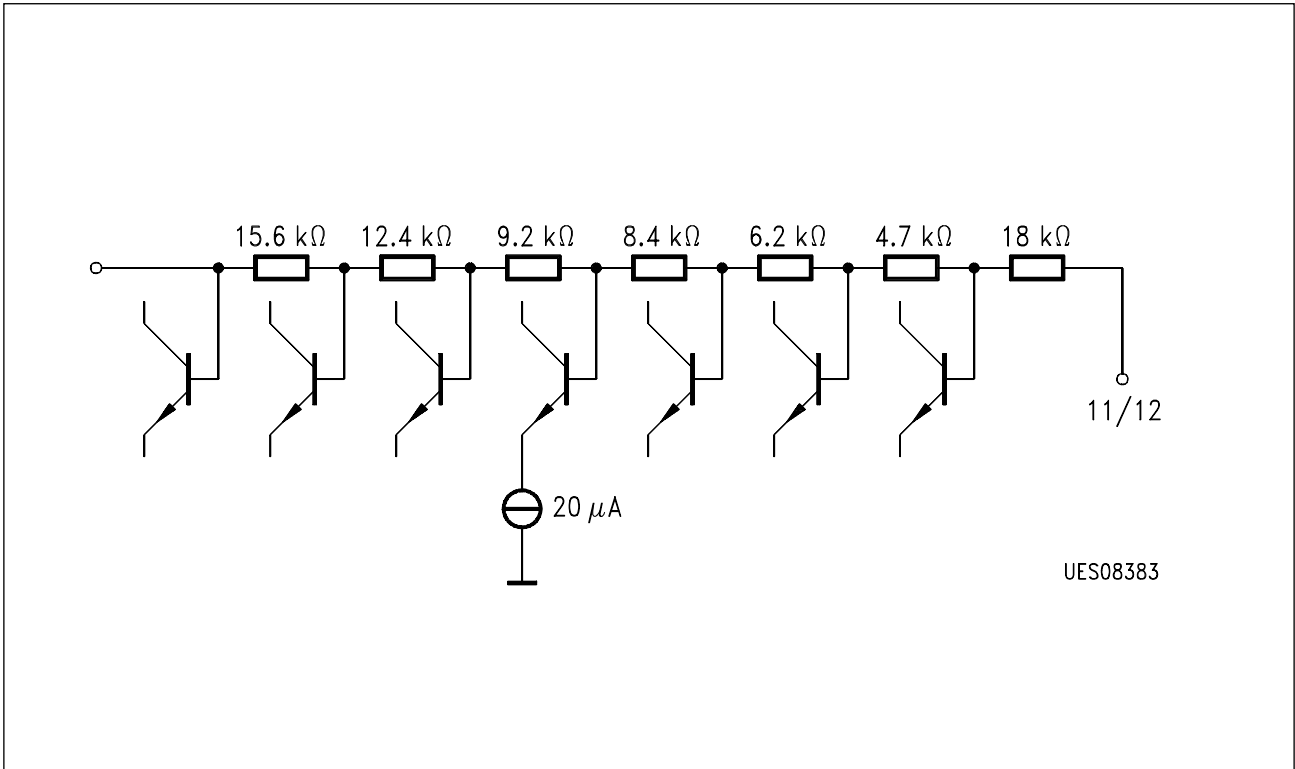
Figure 3  
AF Outputs PIN 5/24



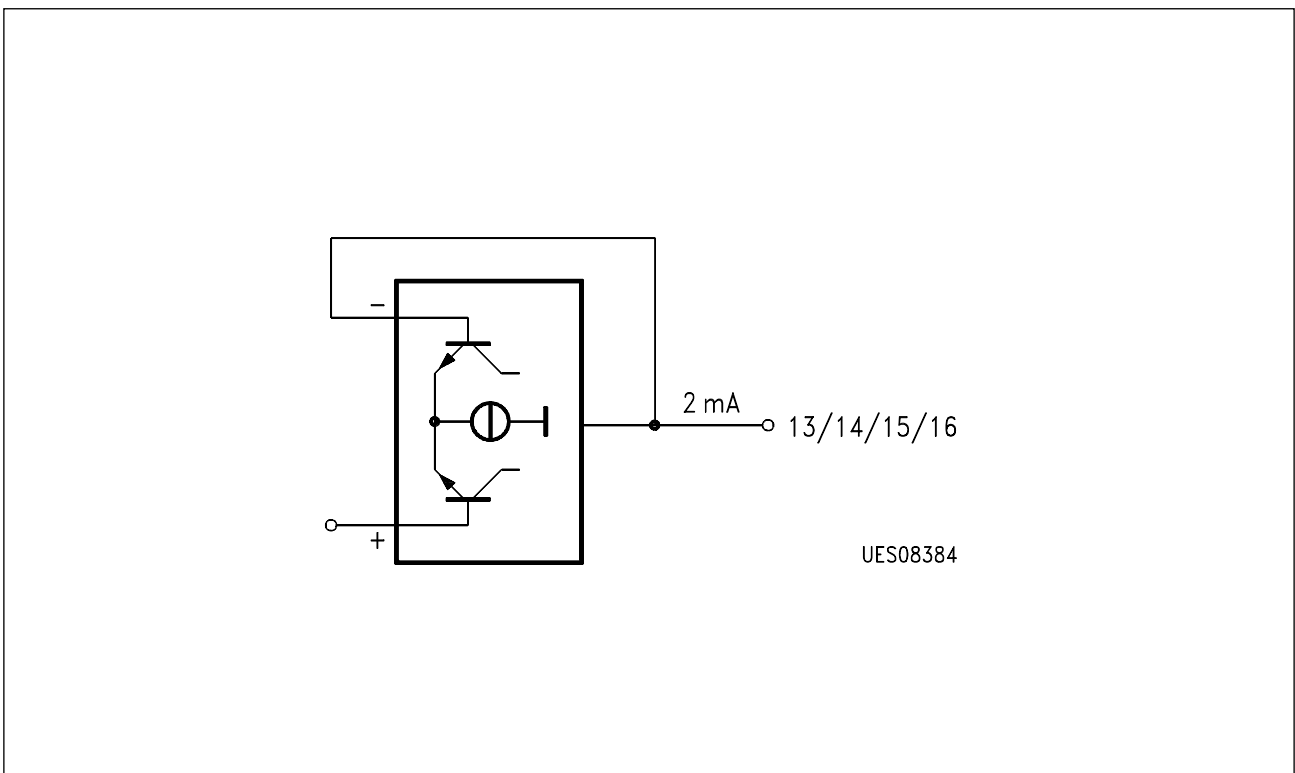
**Figure 4**  
**Reset PIN 7, I<sup>2</sup>C Bus SCL PIN 8**



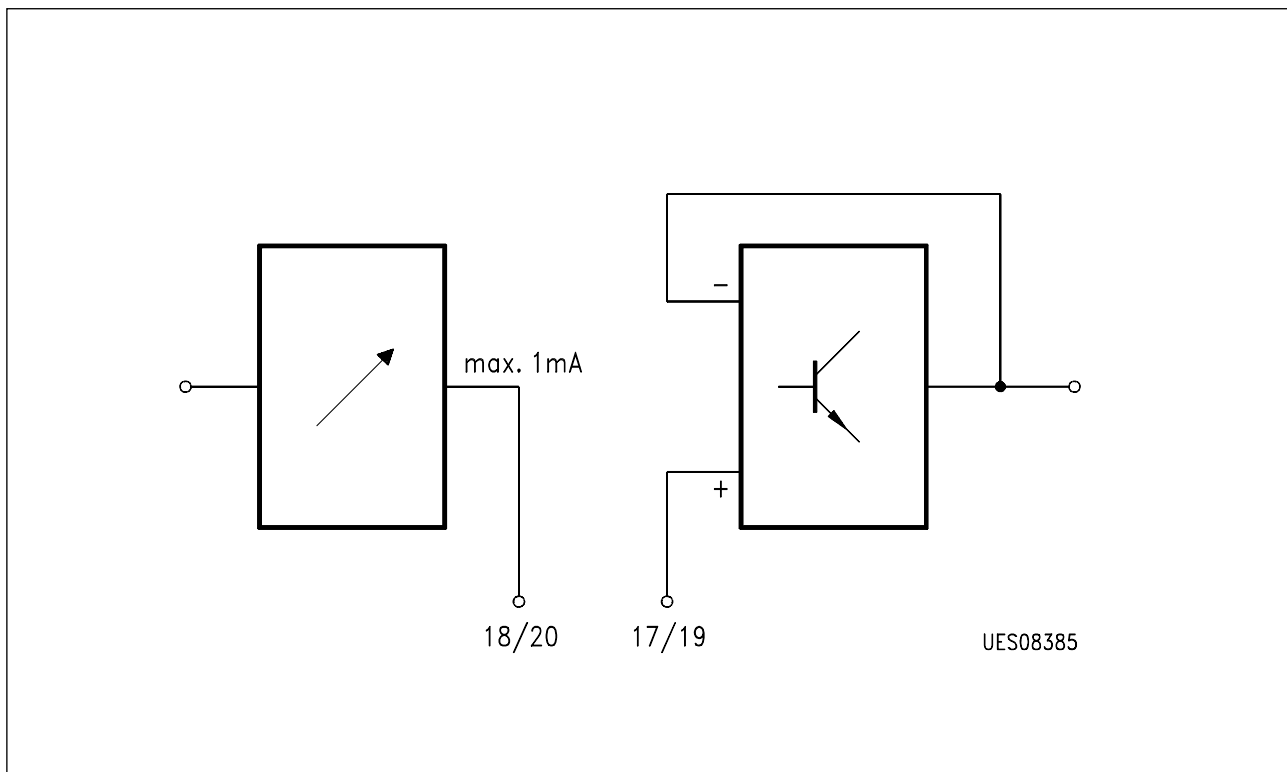
**Figure 5**  
**I<sup>2</sup>C Bus SDA PIN 9**



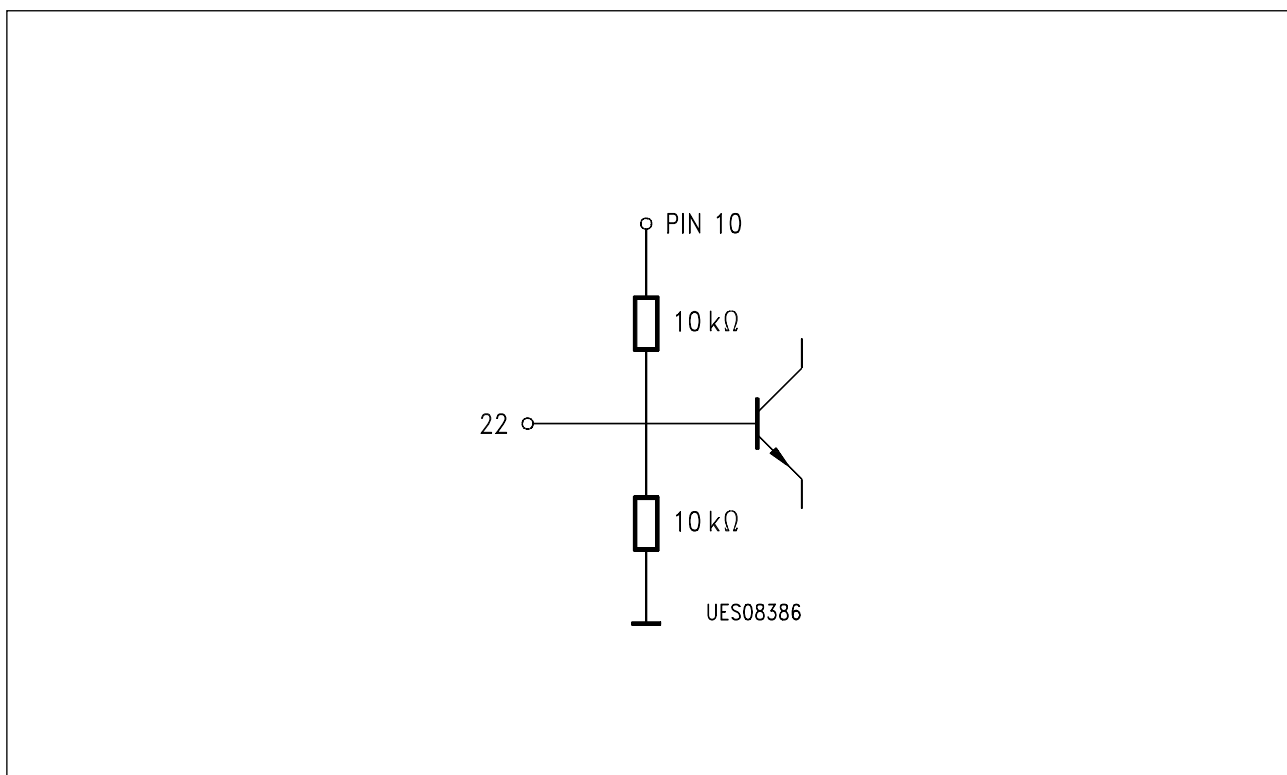
**Figure 6**  
**Corner Frequency Treble PIN 11/12**



**Figure 7**  
**AF Outputs PIN 13/14/15/16**

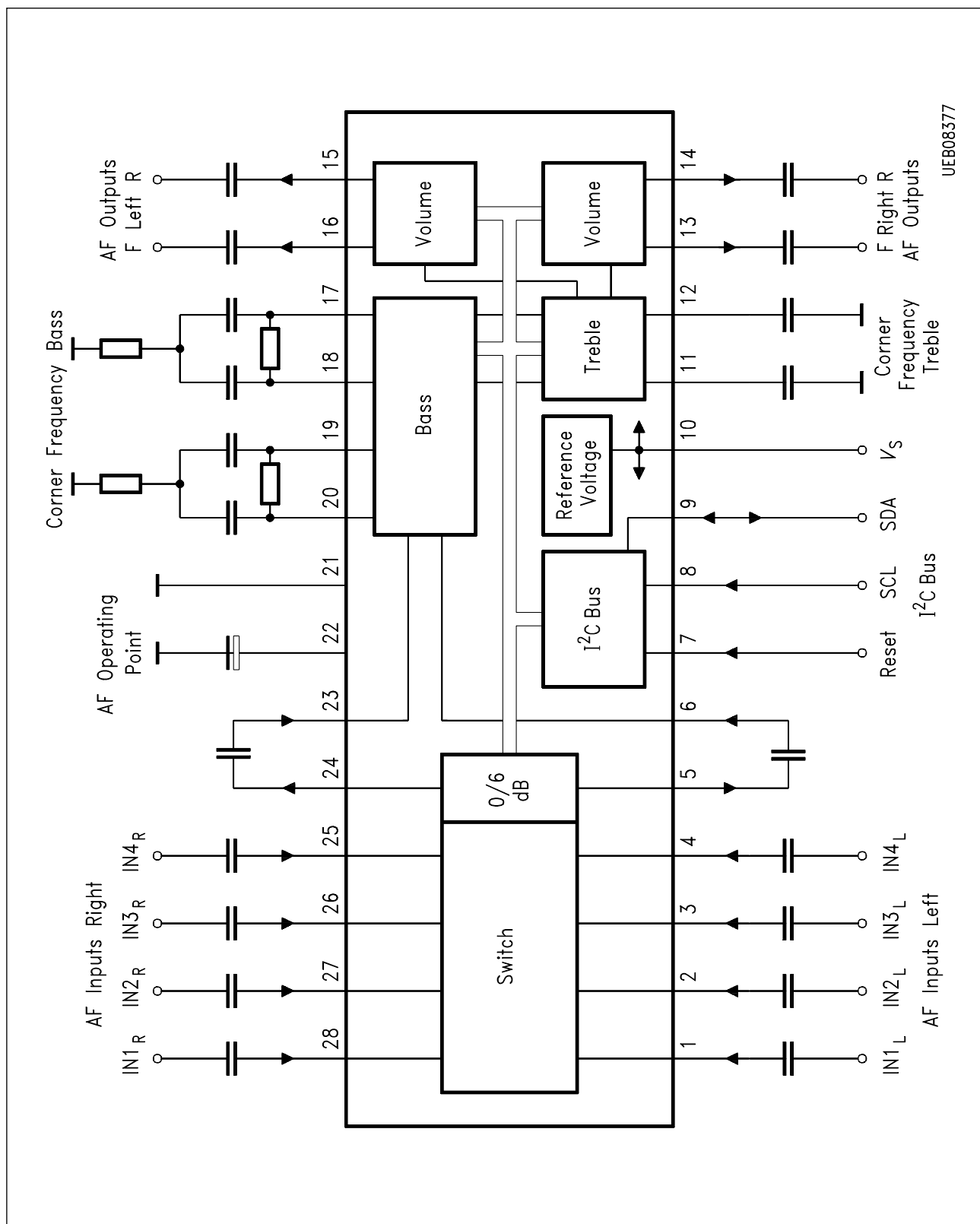


**Figure 8**  
**Corner Frequency Bass PIN 17/18/19/20**



**Figure 9**  
**AF Operating Point PIN 22**

1.4 Functional Block Diagram



UEB08377

Figure 10  
Block Diagram



## 2 Circuit Description

### 2.1 Signal Processing

1. The selection of the AF inputs happens in the input switch. There are four stereo inputs available. An input level switch circuitry behind the input switch realizes the adaption of different signal source levels. A gain of 0 dB or 6 dB is possible. After this section a stereo output/input is placed for connecting external circuits like an equalizer.
2. In the following signalpath there is tone control, consisting of bass and treble control. Bass control offers a control range of + 18 dB to – 12 dB with a stepwidth of 2 dB. Frequency characteristic, 1st order or 2nd order (resonance type) is fixed by external components. Treble control offers a control range of  $\pm 12$  dB with a stepwidth of 2 dB. The treble control corner frequency is fixed by an external capacitor. Last stage in signalpath is volume control which can be adjusted independent for left, right, rear and front. 57 steps with an increment of 1.25 dB give a setting range of 70 dB, the 57th step activates muting.

### 2.2 Controlpart

All functions are controlled via an I<sup>2</sup>C Bus interface. All data is stored into a latch circuit. The telegram structure is built as follows:

Startcondition – chipaddress – any number of databytes – stopcondition.

For the databytes the following conditions must be fulfilled:

Before transmitting a databyte a subaddress byte must *first* be placed in the data telegram.

## 2.2.1 Chipaddress

MSB					LSB		
1	0	0	0	0	0	1	0

## 2.2.2 Subaddress bytes

	MSB					LSB		
Volume front left	×	×	×	×	×	0	0	0
Volume front right	×	×	×	×	×	0	0	1
Volume rear left	×	×	×	×	×	0	1	0
Volume rear right	×	×	×	×	×	0	1	1
Bass/treble	×	×	×	×	×	1	0	1
Switchbyte	×	×	×	×	×	1	1	1

## 2.2.3 Controlbytes

a) Volume left, right, front, rear

	MSB					LSB		
Max. volume	×	×	1	1	1	1	1	1
Max-1	×	×	1	1	1	1	1	0
Max-16	×	×	1	1	0	0	0	0
Max-55	×	×	0	0	1	0	0	0
MUTE	×	×	0	0	0	1	1	1
MUTE	×	×	0	0	0	0	0	0
MUTE	×	×	0	0	0	×	×	×
Power ON	0	0	0	0	0	0	0	1

## b) Treble/Bass

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

### c) Switchbyte

MSB					LSB		
MUTE	IN1	IN2	IN3	IN4	Gain	×	×
MUTE = 0	MUTE OFF; power ON						
MUTE = 1	MUTE ON						
IN1 = 0	Input1 OFF; power ON						
IN1 = 1	Input1 ON						
IN2 = 0	Input1 OFF; power ON						
IN2 = 1	Input1 ON						
IN3 = 0	Input1 OFF; power ON						
IN3 = 1	Input1 ON						
IN4 = 0	Input1 OFF; power ON						
IN4 = 1	Input1 ON						
Gain = 0	Gain 0 dB; power ON						
Gain = 1	Gain 6 dB						

If no signal is activated, this is interpreted as muting.  
 There is no mutual lockout of the inputs for multiple selections.

## 3 Electrical Characteristics

### 3.1 Absolute Maximum Ratings

$T_A = -40\text{ °C to }85\text{ °C}$

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	$V_{10}$	0	14	V	
Max. DC voltage	$V_1$	0	$V_{10}$	V	
Max. DC voltage	$V_2$	0	$V_{10}$	V	
Max. DC voltage	$V_3$	0	$V_{10}$	V	
Max. DC voltage	$V_4$	0	$V_{10}$	V	
Max. DC voltage	$V_6$	0	$V_{10}$	V	
Max. DC voltage	$V_7$	0	$V_{10}$	V	
Max. DC voltage	$V_8$	0	6	V	
Max. DC voltage	$V_{11}$	0	$V_{10}$	V	
Max. DC voltage	$V_{12}$	0	$V_{10}$	V	
Max. DC voltage	$V_{18}$	0	$V_{10}$	V	
Max. DC voltage	$V_{20}$	0	$V_{10}$	V	
Max. DC voltage	$V_{22}$	0	$V_{10}$	V	
Max. DC voltage	$V_{23}$	0	$V_{10}$	V	
Max. DC voltage	$V_{25}$	0	$V_{10}$	V	
Max. DC voltage	$V_{26}$	0	$V_{10}$	V	
Max. DC voltage	$V_{27}$	0	$V_{10}$	V	
Max. DC voltage	$V_{28}$	0	$V_{10}$	V	
Max. DC current	$I_5$	0	2	mA	
Max. DC current	$I_9$	0	2	mA	
Max. DC current	$I_{13}$	0	2	mA	
Max. DC current	$I_{14}$	0	2	mA	

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

$T_A = -40\text{ °C to }85\text{ °C}$

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Max. DC current	$I_{15}$	0	2	mA	
Max. DC current	$I_{16}$	0	2	mA	
Max. DC current	$I_{17}$	0	2	mA	
Max. DC current	$I_{19}$	0	2	mA	
Max. DC current	$I_{24}$	0	2	mA	
Junction temperature	$T_j$		150	°C	
Storage temperature	$T_S$	- 40	125	°C	
Thermal resistance	$R_{thSA}$		76	K/W	

*Note: Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.*

**3.2 Operating Range**

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Supply voltage	$V_S$	7.5	13.2	V
Ambient temperature range	$T_A$	- 40	85	°C
Input frequency range	$f_i$	0.01	20	kHz

*Note: In the operating range the functions given in the circuit description are fulfilled.*

### 3.3 AC/DC Characteristics

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ °C}$  to  $85\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

AF reference level 0 dB = 150 mV,  $f_i = 1\text{ kHz}$ , if not stated otherwise.

I<sup>2</sup>C Bus preset: Start – 82 – 00, 3F – 01, 3F – 02, 3F – 03, 3F – 05, 89 – 07, 40 – Stop

Chipaddr. – Vol 63 – Vol 63 – Vol 63 – Vol 63 – tone lin – IN1

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 code and which switch bits on the setbytes are stated.

Current consumption	$I_{10}$		39	55	mA		1
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#### A. Signal Section

Gain <sup>1)</sup>	$V_{5-1}$	-1	0	1	dB		1
Gain <sup>1)</sup>	$V_{24-28}$	-1	0	1	dB		1
Gain <sup>1)</sup>	$V_{5-1}$	5	6	7	dB	07, 44; <i>gain = 6 dB</i>	1
Gain <sup>1)</sup>	$V_{24-28}$	5	6	7	dB	07, 44; <i>gain = 6 dB</i>	1
Max. gain	$V_{15-6}$	-2	0	2	dB		1
Max. gain	$V_{16-6}$	-2	0	2	dB		1
Max. gain	$V_{13-23}$	-2	0	2	dB		1
Max. gain	$V_{14-23}$	-2	0	2	dB		1
Min. gain	$V_{15-6}$		-70	-60	dB	00, 08-02, 08; <i>Vol 8</i>	1
Min. gain	$V_{16-6}$		-70	-60	dB	00, 08-02, 08; <i>Vol 8</i>	1
Min. gain	$V_{13-23}$		-70	-60	dB	01, 08-03, 08; <i>Vol 8</i>	1
Min. gain	$V_{14-23}$		-70	-60	dB	01, 08-03, 08; <i>Vol 8</i>	1
Tracking error	$\Delta V_{13-14}$			± 3	dB	01, 3F to 01, 24 03, 3F to 03, 24; <i>Vol 63-36</i>	1
Tracking error	$\Delta V_{15-16}$			± 3	dB	00, 3F to 00, 24 02, 3F to 02, 24; <i>Vol 63-36</i>	1
Tracking error	$\Delta V_{13-16}$			± 3	dB	00, 3F to 00, 24 01, 3F to 01, 24; <i>Vol 63-36</i>	1
Tracking error	$\Delta V_{14-15}$			± 3	dB	02, 3F to 02, 24 03, 3F to 03, 24; <i>Vol 63-36</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 2 ... 4, and 25 ... 27.

3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ °C}$  to  $85\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Step width Vol <sub>13</sub>	$\Delta V_{13}$	0	1.25	2.5	dB	01, X-01, (X ± 1) Vol X-Vol (X ± 1)	1
Step width Vol <sub>14</sub>	$\Delta V_{14}$	0	1.25	2.5	dB	03, X-03, (X ± 1) Vol X-Vol (X ± 1)	1
Step width Vol <sub>15</sub>	$\Delta V_{15}$	0	1.25	2.5	dB	02, X-02, (X ± 1) Vol X-Vol (X ± 1)	1
Step width Vol <sub>16</sub>	$\Delta V_{16}$	0	1.25	2.5	dB	02, X-02, (X ± 1) Vol X-Vol (X ± 1)	1
Bass boost	$V_{15-6}$	15	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{16-6}$	15	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{13-23}$	15	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{14-23}$	15	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{15-6}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Bass boost	$V_{16-6}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Bass boost	$V_{13-23}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Bass boost	$V_{14-23}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Step width bass	$\Delta V_{13}$	1	2	3	dB	05, 8X-05,8 (X ± 1) bass X-bass (X ± 1)	1
Step width bass	$\Delta V_{14}$	1	2	3	dB	05, 8X-05,8 (X ± 1) bass X-bass (X ± 1)	1
Step width bass	$\Delta V_{15}$	1	2	3	dB	05, 8X-05,8 (X ± 1) bass X-bass (X ± 1)	1
Step width bass	$\Delta V_{16}$	1	2	3	dB	05, 8X-05,8 (X ± 1) bass X-bass (X ± 1)	1



3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ °C}$  to  $85\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Treble boost	$V_{15-6}$	9	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{16-6}$	9	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{13-23}$	9	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{14-23}$	9	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{15-6}$	9	12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{15-6}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{16-6}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{13-23}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{14-23}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Step width treble	$\Delta V_{13}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1
Step width treble	$\Delta V_{14}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1
Step width treble	$\Delta V_{15}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1
Step width treble	$\Delta V_{16}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1

3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Tone linearity	$\Delta V_{13}$			$\pm 3$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Tone linearity	$\Delta V_{14}$			$\pm 3$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Tone linearity	$\Delta V_{15}$			$\pm 3$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Tone linearity	$\Delta V_{16}$			$\pm 3$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Channel separation	$\Delta V_{14-15}$	60			dB	$V_6$ or $V_{23} = 300\text{ mVrms}$	1
Channel separation	$\Delta V_{13-16}$	60			dB	$V_6$ or $V_{23} = 300\text{ mVrms}$	1
Crosstalk of the switch <sup>1)</sup>	$a_{\text{input unwanted/output wanted}}$	80			dB	$V_{i \text{ wanted}} = 0$ $V_{i \text{ unwanted}} = 300\text{ mVrms}$	1
Attenuation MUTE <sup>2)</sup>	$a_{1-5}$	80			dB	01, 00-03, 00; $V_1 = 300\text{ mVrms}$ ; <i>Vol 0</i>	1
Attenuation MUTE <sup>2)</sup>	$a_{1-5}$	80			dB	07, C0; $V_1 = 300\text{ mVrms}$ <i>MUTE active</i>	1
Attenuation MUTE <sup>2)</sup>	$a_{1-5}$	80			dB	07, 00; $V_1 = 300\text{ mVrms}$ <i>not select</i>	1
Attenuation MUTE <sup>3)</sup>	$a_{28-24}$	80			dB	00, 00 to 03, 00; $V_{28} = 300\text{ mVrms}$ ; <i>Vol 0</i>	1
Attenuation MUTE <sup>3)</sup>	$a_{28-24}$	80			dB	07, 00; $V_{28} = 300\text{ mVrms}$ <i>MUTE active</i>	1
Attenuation MUTE <sup>3)</sup>	$a_{28-24}$	80			dB	07, 00; $V_{28} = 300\text{ mVrms}$ <i>not select</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 1 ... 4 or 25 ... 28, and measurement on pins 5 or 24.

<sup>2)</sup> Analogous values apply for feeding in on pins 2, 3, 4.

<sup>3)</sup> Same values apply for feeding in on pins 25, 26, 27.

3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Max. input voltage <sup>1)</sup>	$V_1$	1.5			Vrms	$k_{15, 16} \leq 1\%$ ; $R_{L15, 16} = 2.2\text{ k}\Omega$	1
Max. input voltage <sup>1)</sup>	$V_1$	0.75			Vrms	$k_{15, 16} \leq 1\%$ ; 07, 44 $R_{L15, 16} = 2.2\text{ k}\Omega$	1
Max. input voltage <sup>2)</sup>	$V_{28}$	1.5			Vrms	$k_{13, 14} \leq 1\%$ ; $R_{L13, 14} = 2.2\text{ k}\Omega$	1
Max. input voltage <sup>2)</sup>	$V_{28}$	0.75			Vrms	$k_{13, 14} \leq 1\%$ ; 07, 44 $R_{L13, 14} = 2.2\text{ k}\Omega$	1
Max. input voltage	$V_6$	250			Vrms	$k_{15, 16} < 1\%$ ; 05, XX <i>any sound</i>	1
Max. input voltage	$V_{23}$	250			Vrms	$k_{13, 14} < 1\%$ ; 05, XX <i>any sound</i>	1
Max. output voltage	$V_{13}$	2.0			Vrms	$k_{13} < 1\%$	1
Max. output voltage	$V_{14}$	2.0			Vrms	$k_{14} < 1\%$	1
Max. output voltage	$V_{15}$	2.0			Vrms	$k_{15} < 1\%$	1
Max. output voltage	$V_{16}$	2.0			Vrms	$k_V < 1\%$	1
Distortion <sup>3)</sup>	$k_5$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{24}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{13}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{14}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{15}$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{16}$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{13}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$ 01, 2F; Vol 47	1
Distortion <sup>3)</sup>	$k_{14}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$ 03, 2F; Vol 47	1
Distortion <sup>3)</sup>	$k_{15}$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$ 02, 2F; Vol 47	1
Distortion <sup>3)</sup>	$k_{16}$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$ 00, 2F; Vol 47	1

<sup>1)</sup> Same values apply for feeding in on pins 2, 3, 4.

<sup>2)</sup> Same values apply for feeding in on pins 25, 26, 27.

<sup>3)</sup> Same values apply for feeding in on pins 2 ... 4 or 25 ... 27.

3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ °C}$  to  $85\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Distortion <sup>1)</sup>	$k_{13}$		0.05	0.5	%	$V_{28} = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Distortion <sup>1)</sup>	$k_{14}$		0.05	0.5	%	$V_{28} = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Distortion <sup>1)</sup>	$k_{15}$		0.05	0.5	%	$V_1 = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Distortion <sup>1)</sup>	$k_{16}$		0.05	0.5	%	$V_1 = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N13}$	80	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N14}$	80	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N15}$	80	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N16}$	80	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N13}$	60	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$ 01, 27; <i>Vol 39</i>	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N14}$	60	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$ 03, 27; <i>Vol 39</i>	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N15}$	60	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$ ; 02, 27	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N16}$	60	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$ 00, 27; <i>Vol 39</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 2 ... 4 or 25 ... 27.

3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ °C}$  to  $85\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Noise voltage	$V_{N13}$		2	10	$\mu\text{Vrms}$	$V_{Nrms}$ 20 Hz-20 kHz 01, 00-03, 00; <i>Vol 0</i>	1
Noise voltage	$V_{N14}$		2	10	$\mu\text{Vrms}$	$V_{Nrms}$ 20 Hz-20 kHz 00, 00-03, 00; <i>Vol 0</i>	1
Noise voltage	$V_{N15}$		2	10	$\mu\text{Vrms}$	$V_{Nrms}$ 20 Hz-20 kHz 00, 00-02, 00; <i>Vol 0</i>	1
Noise voltage	$V_{N16}$		2	10	$\mu\text{Vrms}$	$V_{Nrms}$ 20 Hz-20 kHz 01, 00-02, 00; <i>Vol 0</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{13}$			$\pm 10$	mV	01, X-01, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{14}$			$\pm 10$	mV	03, X-03, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{15}$			$\pm 10$	mV	02, X-02, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{16}$			$\pm 10$	mV	00, X-00, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{13}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{14}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{15}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{16}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
PSRR	$A_{PSRR13}$		70		dB	$V_{undesired} = 1\text{ Vrms}$ $f_{undesired} = 100\text{ Hz} \dots 20\text{ kHz}$	1
PSRR	$A_{PSRR14}$		70		dB	input termination with $220\ \Omega$	1
PSRR	$A_{PSRR15}$		70		dB	measurement rms according CCIR 651	1
PSRR	$A_{PSRR16}$		70		dB		1

3.3 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

Design Hints

Input resistance	$R_1$	22	27		k $\Omega$		
Input resistance	$R_2$	22	27		k $\Omega$		
Input resistance	$R_3$	22	27		k $\Omega$		
Input resistance	$R_4$	22	27		k $\Omega$		
Input resistance	$R_6$	24	30		k $\Omega$		
Input resistance	$R_{23}$	24	30		k $\Omega$		
Input resistance	$R_{25}$	22	27		k $\Omega$		
Input resistance	$R_{26}$	22	27		k $\Omega$		
Input resistance	$R_{27}$	22	27		k $\Omega$		
Input resistance	$R_{28}$	22	27		k $\Omega$		
Output resistance	$R_5$			200	$\Omega$		
Output resistance	$R_{13}$			200	$\Omega$		
Output resistance	$R_{14}$			200	$\Omega$		
Output resistance	$R_{15}$			200	$\Omega$		
Output resistance	$R_V$			200	$\Omega$		
Output resistance	$R_{24}$			200	$\Omega$		

$V_S = 8.5\text{ V}$

Max. input voltage	$V_6$	180			mVrms	$k_{15,16} < 5\%$ ; 05, XX any sound	1
Max. input voltage	$V_{23}$	180			mVrms	$k_{13,14} < 5\%$ ; 05, XX any sound	1
Bass boost	$V_{15-6}$	10	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1
Bass boost	$V_{16-6}$	10	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1
Bass boost	$V_{13-23}$	10	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1
Bass boost	$V_{14-23}$	10	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1

**3.3 AC/DC Characteristics (cont'd)**

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $85\text{ }^\circ\text{C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

$V_S = 12\text{ V}$

Max. input voltage	$V_6$	300			mVrms	$k_{15,16} < 1\%$ ; 05, XX <i>any sound</i>	1
Max. input voltage	$V_{23}$	300			mVrms	$k_{13,14} < 1\%$ ; 05, XX <i>any sound</i>	1

**B. I<sup>2</sup>C Bus (SCL, SDA edges)**

Rise time	$t_R$			300	ns		
Fall time	$t_F$			300	ns		

**Shift Register Clock Pulse SCL**

Frequency	$f_{SCL}$	0		400	kHz		
H-pulse width	$t_{HIGH}$	0.6			$\mu\text{s}$		
L-pulse width	$t_{LOW}$	1.3			$\mu\text{s}$		

**Start**

Set-up time	$t_{SUSTA}$	0.6			$\mu\text{s}$		
Hold time	$t_{HDSTA}$	0.6			$\mu\text{s}$		

**Stop**

Set-up time	$t_{SUSTO}$	0.6			$\mu\text{s}$		
Bus free time	$t_{BUF}$	1.3			$\mu\text{s}$		

**Data Transfer**

Set-up time	$t_{SUDAT}$	100			$\mu\text{s}$		
Hold time	$t_{HDDAT}$	0		0.9	$\mu\text{s}$		

**3.3 AC/DC Characteristics (cont'd)**

$V_S = 10\text{ V}$ ,  $T_A = -40\text{ °C}$  to  $85\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

**Inputs SCL, SDA**

Input voltage	$V_{QH}$	3		5.5	V		
	$V_{QL}$			1.5	V		
Hysteresis	$V_{HYS}$	0.2			V		
Spike suppression	$t_{SP}$	50			ns		
Input current	$I_{QH}$			50	$\mu\text{A}$		
	$V_{QL}$			100	$\mu\text{A}$		

**Output SDA (open collector)**

Output voltage	$V_{QH}$	5.4			V	$R_L = 2.5\text{ k}\Omega$	
	$V_{QL}$			0.4	V	$I_{QL} = 3\text{ mA}$	
Reset inactive	$V_L$			1.5	V		
Reset active	$V_H$	3		5.5	V		

*Note: The listed characteristics are ensured over the operating range of the integrated circuit. Typical characteristics specify mean values expected over the production spread. If not otherwise specified, typical characteristics apply at  $T_A = 25\text{ °C}$  and the given supply voltage.*



### 3.4 AC/DC Characteristics

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

AF reference level 0 dB = 150 mV,  $f_i = 1\text{ kHz}$ , if not stated otherwise.

I<sup>2</sup>C Bus preset: Start – 82 – 00, 3F – 01, 3F – 02, 3F – 03, 3F – 05, 89 – 07, 40 – Stop

Chipaddr. – Vol 63 – Vol 63 – Vol 63 – Vol 63 – tone lin – IN1

The basic setting for each point in the specification is always preset; only settings which are deviate from this, are given in the test conditions. Details in *italics* only provide explanation of the hexadecimal code and which switch bits on the setbytes are stated.

Current consumption	$I_{10}$		39	50	mA		1
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#### A. Signal Section

Gain <sup>1)</sup>	$V_{5-1}$	–1	0	1	dB		1
Gain <sup>1)</sup>	$V_{24-28}$	–1	0	1	dB		1
Gain <sup>1)</sup>	$V_{5-1}$	5	6	7	dB	07, 44; <i>gain = 6 dB</i>	1
Gain <sup>1)</sup>	$V_{24-28}$	5	6	7	dB	07, 44; <i>gain = 6 dB</i>	1
Max. gain	$V_{15-6}$	–2	0	2	dB		1
Max. gain	$V_{16-6}$	–2	0	2	dB		1
Max. gain	$V_{13-23}$	–2	0	2	dB		1
Max. gain	$V_{14-23}$	–2	0	2	dB		1
Min. gain	$V_{15-6}$		–70	–65	dB	00, 08-02, 0; 8 <i>Vol 8</i>	1
Min. gain	$V_{16-6}$		–70	–65	dB	00, 08-02, 0; 8 <i>Vol 8</i>	1
Min. gain	$V_{13-23}$		–70	–65	dB	01, 08-03, 0; 8 <i>Vol 8</i>	1
Min. gain	$V_{14-23}$		–70	–65	dB	01, 08-03, 08; <i>Vol 8</i>	1
Tracking error	$\Delta V_{13-14}$			± 2	dB	01, 3F to 01, 24 03, 3F to 03, 24; <i>Vol 63-36</i>	1
Tracking error	$\Delta V_{15-16}$			± 2	dB	00, 3F to 00, 24 02, 3F to 02, 24; <i>Vol 63-36</i>	1
Tracking error	$\Delta V_{13-16}$			± 2	dB	00, 3F to 00, 24 01, 3F to 01, 24; <i>Vol 63-36</i>	1
Tracking error	$\Delta V_{14-15}$			± 2	dB	02, 3F to 02, 24 03, 3F to 03, 24; <i>Vol 63-36</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 2 ... 4, and 25 ... 27.

3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Step width Vol <sub>13</sub>	$\Delta V_{13}$	0	1.25	2.5	dB	01, X-01, (X ± 1) Vol X-Vol (X ± 1)	1
Step width Vol <sub>14</sub>	$\Delta V_{14}$	0	1.25	2.5	dB	03, X-03, (X ± 1) Vol X-Vol (X ± 1)	1
Step width Vol <sub>15</sub>	$\Delta V_{15}$	0	1.25	2.5	dB	02, X-02, (X ± 1) Vol X-Vol (X ± 1)	1
Step width Vol <sub>16</sub>	$\Delta V_{16}$	0	1.25	2.5	dB	00, X-00, (X ± 1) Vol X-Vol (X ± 1)	1
Bass boost	$V_{15-6}$	16	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{16-6}$	16	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{13-23}$	16	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{14-23}$	16	18		dB	05, 80; $f_i = 40\text{ Hz}$ bass max, treble lin	1
Bass boost	$V_{15-6}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Bass boost	$V_{16-6}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Bass boost	$V_{13-23}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Bass boost	$V_{14-23}$		- 12		dB	05, 8F; $f_i = 40\text{ Hz}$ bass min, treble lin	1
Step width bass	$\Delta V_{13}$	1	2	3	dB	05, 8X-05, 8 (X ± 1) bass X-bass (X ± 1)	1
Step width bass	$\Delta V_{14}$	1	2	3	dB	05, 8X-05, 8 (X ± 1) bass X-bass (X ± 1)	1
Step width bass	$\Delta V_{15}$	1	2	3	dB	05, 8X-05, 8 (X ± 1) bass X-bass (X ± 1)	1
Step width bass	$\Delta V_{16}$	1	2	3	dB	05, 8X-05, 8 (X ± 1) bass X-bass (X ± 1)	1

3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Treble boost	$V_{15-6}$	10	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{16-6}$	10	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{13-23}$	10	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{14-23}$	10	12		dB	05, 09; $f_i = 15\text{ kHz}$ <i>treble max, bass lin</i>	1
Treble boost	$V_{15-6}$	10	12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{15-6}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{16-6}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{13-23}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Treble boost	$V_{14-23}$		- 12		dB	05, F9; $f_i = 15\text{ kHz}$ <i>treble min, bass lin</i>	1
Step width treble	$\Delta V_{13}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1
Step width treble	$\Delta V_{14}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1
Step width treble	$\Delta V_{15}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1
Step width treble	$\Delta V_{16}$	1	2	3	dB	05, X9-05, $(X \pm 1) 9$ <i>treble X-treble <math>(X \pm 1)</math></i>	1

### 3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Tone linearity	$\Delta V_{13}$			$\pm 2$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Tone linearity	$\Delta V_{14}$			$\pm 2$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Tone linearity	$\Delta V_{15}$			$\pm 2$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Tone linearity	$\Delta V_{16}$			$\pm 2$	dB	05, 89; $f_i = 40\text{ Hz} \dots 15\text{ kHz}$ <i>treble, bass lin</i>	1
Channel separation	$\Delta V_{14-15}$	60			dB	$V_6$ or $V_{23} = 300\text{ mVrms}$	1
Channel separation	$\Delta V_{13-16}$	60			dB	$V_6$ or $V_{23} = 300\text{ mVrms}$	1
Crosstalk of the switch <sup>1)</sup>	$a_{\text{input unwanted/ output wanted}}$	80			dB	$V_{i \text{ wanted}} = 0$ $V_{i \text{ unwanted}} = 300\text{ mVrms}$	1
Attenuation MUTE <sup>2)</sup>	$a_{1-5}$	80			dB	01, 00-03, 00; $V_1 = 300\text{ mVrms}$ ; <i>Vol 0</i>	1
Attenuation MUTE <sup>2)</sup>	$a_{1-5}$	80			dB	07, C0; $V_1 = 300\text{ mVrms}$ <i>MUTE active</i>	1
Attenuation MUTE <sup>2)</sup>	$a_{1-5}$	80			dB	07, 00; $V_1 = 300\text{ mVrms}$ <i>not select</i>	1
Attenuation MUTE <sup>3)</sup>	$a_{28-24}$	80			dB	00, 00 to 03, 00; $V_{28} = 300\text{ mVrms}$ ; <i>Vol 0</i>	1
Attenuation MUTE <sup>3)</sup>	$a_{28-24}$	80			dB	07, C0; $V_{28} = 300\text{ mVrms}$ <i>MUTE active</i>	1
Attenuation MUTE <sup>3)</sup>	$a_{28-24}$	80			dB	07, 00; $V_{28} = 300\text{ mVrms}$ <i>not select</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 1 ... 4 or 25 ... 28, and measurement on pins 5 or 24.

<sup>2)</sup> Analogous values apply for feeding in on pins 2, 3, 4.

<sup>3)</sup> Same values apply for feeding in on pins 25, 26, 27.

3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Max. input voltage <sup>1)</sup>	$V_1$	2			Vrms	$k_{15, 16} \leq 1\%$ ; $R_{L15, 16} = 2.2\text{ k}\Omega$	1
Max. input voltage <sup>1)</sup>	$V_1$	1			Vrms	$k_{15, 16} \leq 1\%$ ; 07, 44 $R_{L15, 16} = 2.2\text{ k}\Omega$	1
Max. input voltage <sup>2)</sup>	$V_{28}$	2			Vrms	$k_{13, 14} \leq 1\%$ ; $R_{L13, 14} = 2.2\text{ k}\Omega$	1
Max. input voltage <sup>2)</sup>	$V_{28}$	1			Vrms	$k_{13, 14} \leq 1\%$ ; 07, 44 $R_{L13, 14} = 2.2\text{ k}\Omega$	1
Max. input voltage	$V_6$	280			Vrms	$k_{15, 16} < 1\%$ ; 05, XX <i>any sound</i>	1
Max. input voltage	$V_{23}$	280			Vrms	$k_{13, 14} < 1\%$ ; 05, XX <i>any sound</i>	1
Max. output voltage	$V_{13}$	2.2			Vrms	$k_{13} < 1\%$	1
Max. output voltage	$V_{14}$	2.2			Vrms	$k_{14} < 1\%$	1
Max. output voltage	$V_{15}$	2.2			Vrms	$k_{15} < 1\%$	1
Max. output voltage	$V_{16}$	2.2			Vrms	$k_{16} < 1\%$	1
Distortion <sup>3)</sup>	$k_5$		0.01	0.05	%	$V_1 = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{24}$		0.01	0.05	%	$V_{28} = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{13}$		0.01	0.05	%	$V_{28} = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{14}$		0.01	0.05	%	$V_{28} = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{15}$		0.01	0.05	%	$V_1 = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{16}$		0.01	0.05	%	$V_1 = 150\text{ mVrms}$	1
Distortion <sup>3)</sup>	$k_{13}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$ 01, 2F; <i>Vol 47</i>	1
Distortion <sup>3)</sup>	$k_{14}$		0.01	0.1	%	$V_{28} = 150\text{ mVrms}$ 03, 2F; <i>Vol 47</i>	1
Distortion <sup>3)</sup>	$k_{15}$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$ 02, 2F; <i>Vol 47</i>	1
Distortion <sup>3)</sup>	$k_{16}$		0.01	0.1	%	$V_1 = 150\text{ mVrms}$ 00, 2F; <i>Vol 47</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 2, 3, 4.

<sup>2)</sup> Same values apply for feeding in on pins 25, 26, 27.

<sup>3)</sup> Same values apply for feeding in on pins 2 ... 4 or 25 ... 27.

### 3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Distortion <sup>1)</sup>	$k_{13}$		0.05	0.2	%	$V_{28} = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Distortion <sup>1)</sup>	$k_{14}$		0.05	0.2	%	$V_{28} = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Distortion <sup>1)</sup>	$k_{15}$		0.05	0.2	%	$V_1 = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Distortion <sup>1)</sup>	$k_{16}$		0.05	0.2	%	$V_1 = 150\text{ mVrms}$ 05, XX; <i>any sound</i>	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N13}$	90	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N14}$	90	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N15}$	90	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N16}$	90	95		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N13}$	70	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$ 01, 27; <i>Vol 39</i>	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N14}$	70	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_{28} = 0.3\text{ Vrms}$ 03, 27; <i>Vol 39</i>	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N15}$	70	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$ ; 02, 27	1
Signal/noise ratio <sup>1)</sup>	$a_{S/N16}$	70	80		dB	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ $V_1 = 0.3\text{ Vrms}$ 00, 27; <i>Vol 39</i>	1

<sup>1)</sup> Same values apply for feeding in on pins 2 ... 4 or 25 ... 27.

3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			
Noise voltage	$V_{N13}$		2	5	$\mu\text{Vrms}$	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ 01, 00-03, 00; <i>Vol 0</i>	1
Noise voltage	$V_{N14}$		2	5	$\mu\text{Vrms}$	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ 01, 00-03, 00; <i>Vol 0</i>	1
Noise voltage	$V_{N15}$		2	5	$\mu\text{Vrms}$	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ 00, 00-02, 00; <i>Vol 0</i>	1
Noise voltage	$V_{N16}$		2	5	$\mu\text{Vrms}$	$V_{Nrms\ 20\text{ Hz-20 kHz}}$ 00, 00-02, 00; <i>Vol 0</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{13}$			$\pm 10$	mV	01, X-01, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{14}$			$\pm 10$	mV	03, X-03, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{15}$			$\pm 10$	mV	02, X-02, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{16}$			$\pm 10$	mV	00, X-00, (X $\pm$ 1) <i>Vol X-Vol (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{13}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{14}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{15}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
DC jump $\Delta$ 1 bit	$\Delta V_{16}$			$\pm 10$	mV	05, X-05, (X $\pm$ 1) <i>tone X-tone (X <math>\pm</math> 1)</i>	1
PSRR	$A_{PSRR13}$		70		dB	$V_{undesired} = 1\text{ Vrms}$ $f_{undesired} = 100\text{ Hz} \dots 20\text{ kHz}$	1
PSRR	$A_{PSRR14}$		70		dB	input termination with $220\ \Omega$	1
PSRR	$A_{PSRR15}$		70		dB	measurement rms according CCIR 651	1
PSRR	$A_{PSRR16}$		70		dB		1

3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

Design Hints

Input resistance	$R_1$	23	27		k $\Omega$		
Input resistance	$R_2$	23	27		k $\Omega$		
Input resistance	$R_3$	23	27		k $\Omega$		
Input resistance	$R_4$	23	27		k $\Omega$		
Input resistance	$R_6$	25.5	30		k $\Omega$		
Input resistance	$R_{23}$	25.5	30		k $\Omega$		
Input resistance	$R_{25}$	23	27		k $\Omega$		
Input resistance	$R_{26}$	23	27		k $\Omega$		
Input resistance	$R_{27}$	23	27		k $\Omega$		
Input resistance	$R_{28}$	23	27		k $\Omega$		
Output resistance	$R_5$			200	$\Omega$		
Output resistance	$R_{13}$			200	$\Omega$		
Output resistance	$R_{14}$			200	$\Omega$		
Output resistance	$R_{15}$			200	$\Omega$		
Output resistance	$R_{16}$			200	$\Omega$		
Output resistance	$R_{24}$			200	$\Omega$		

$V_S = 8.5\text{ V}$

Max. input voltage	$V_6$	220			mVrms	$k_{15,16} < 5\%$ ; 05, XX any sound	1
Max. input voltage	$V_{23}$	220			mVrms	$k_{13,14} < 5\%$ ; 05, XX any sound	1
Bass boost	$V_{15-6}$	11	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1
Bass boost	$V_{16-6}$	11	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1
Bass boost	$V_{13-23}$	11	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1
Bass boost	$V_{14-23}$	11	12		dB	05,83; $f_i = 40\text{ Hz}$ bass step 6, treble lin	1



### 3.4 AC/DC Characteristics (cont'd)

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

$V_S = 12\text{ V}$

Max. input voltage	$V_6$	370			mVrms	$k_{15, 16} < 1\%$ ; 05, XX <i>any sound</i>	1
Max. input voltage	$V_{23}$	370			mVrms	$k_{13, 14} < 1\%$ ; 05, XX <i>any sound</i>	1

### B. I<sup>2</sup>C Bus (SCL, SDA edges)

Rise time	$t_R$			300	ns		
Fall time	$t_F$			300	ns		

### Shift Register Clock Pulse SCL

Frequency	$f_{SCL}$	0		400	kHz		
H-pulse width	$t_{HIGH}$	0.6			$\mu\text{s}$		
L-pulse width	$t_{LOW}$	1.3			$\mu\text{s}$		

### Start

Set-up time	$t_{SUSTA}$	0.6			$\mu\text{s}$		
Hold time	$t_{HDSTA}$	0.6			$\mu\text{s}$		

### Stop

Set-up time	$t_{SUSTO}$	0.6			$\mu\text{s}$		
Bus free time	$t_{BUF}$	1.3			$\mu\text{s}$		

### Data Transfer

Set-up time	$t_{SUDAT}$	100			$\mu\text{s}$		
Hold time	$t_{HDDAT}$	0		0.9	$\mu\text{s}$		

**3.4 AC/DC Characteristics (cont'd)**

$V_S = 10\text{ V}$ ,  $T_A = 25\text{ °C}$

Parameter	Symbol	Limit Values			Unit	Test Condition	Test Circuit
		min.	typ.	max.			

**Inputs SCL, SDA**

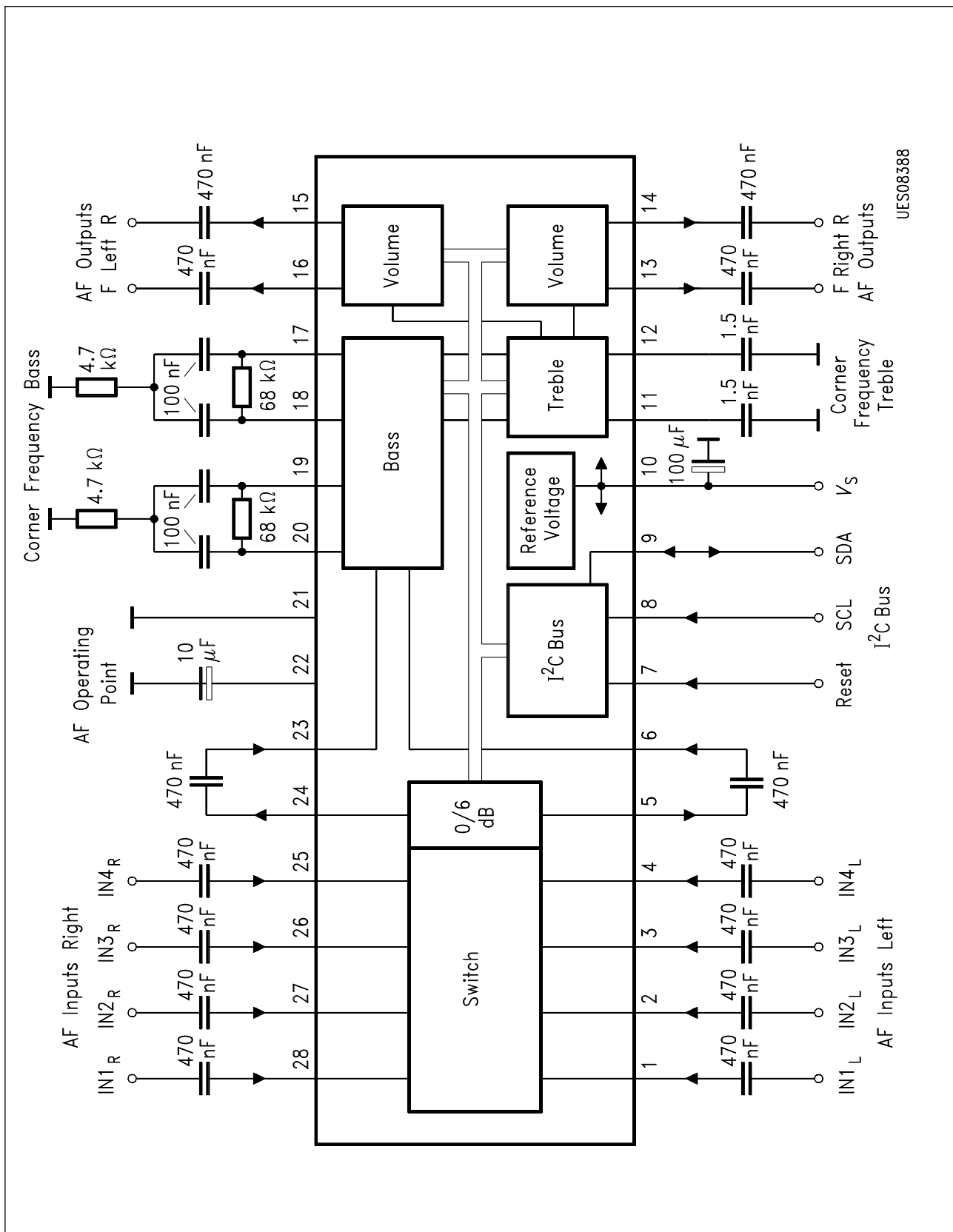
Input voltage	$V_{QH}$	3		5.5	V		
	$V_{QL}$			1.5	V		
Hysteresis	$V_{HYS}$	0.2			V		
Spike suppression	$t_{SP}$	50			ns		
Input current	$I_{QH}$			50	$\mu\text{A}$		
	$V_{QL}$			100	$\mu\text{A}$		

**Output SDA (open collector)**

Output voltage	$V_{QH}$	5.4			V	$R_L = 2.5\text{ k}\Omega$	
	$V_{QL}$			0.4	V	$I_{QL} = 3\text{ mA}$	
Reset inactive	$V_L$			1.5	V		
Reset active	$V_H$	3		5.5	V		

*Note: The listed characteristics are ensured over the operating range of the integrated circuit. Typical characteristics specify mean values expected over the production spread. If not otherwise specified, typical characteristics apply at  $T_A = 25\text{ °C}$  and the given supply voltage.*





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Figure 12  
Application Circuit

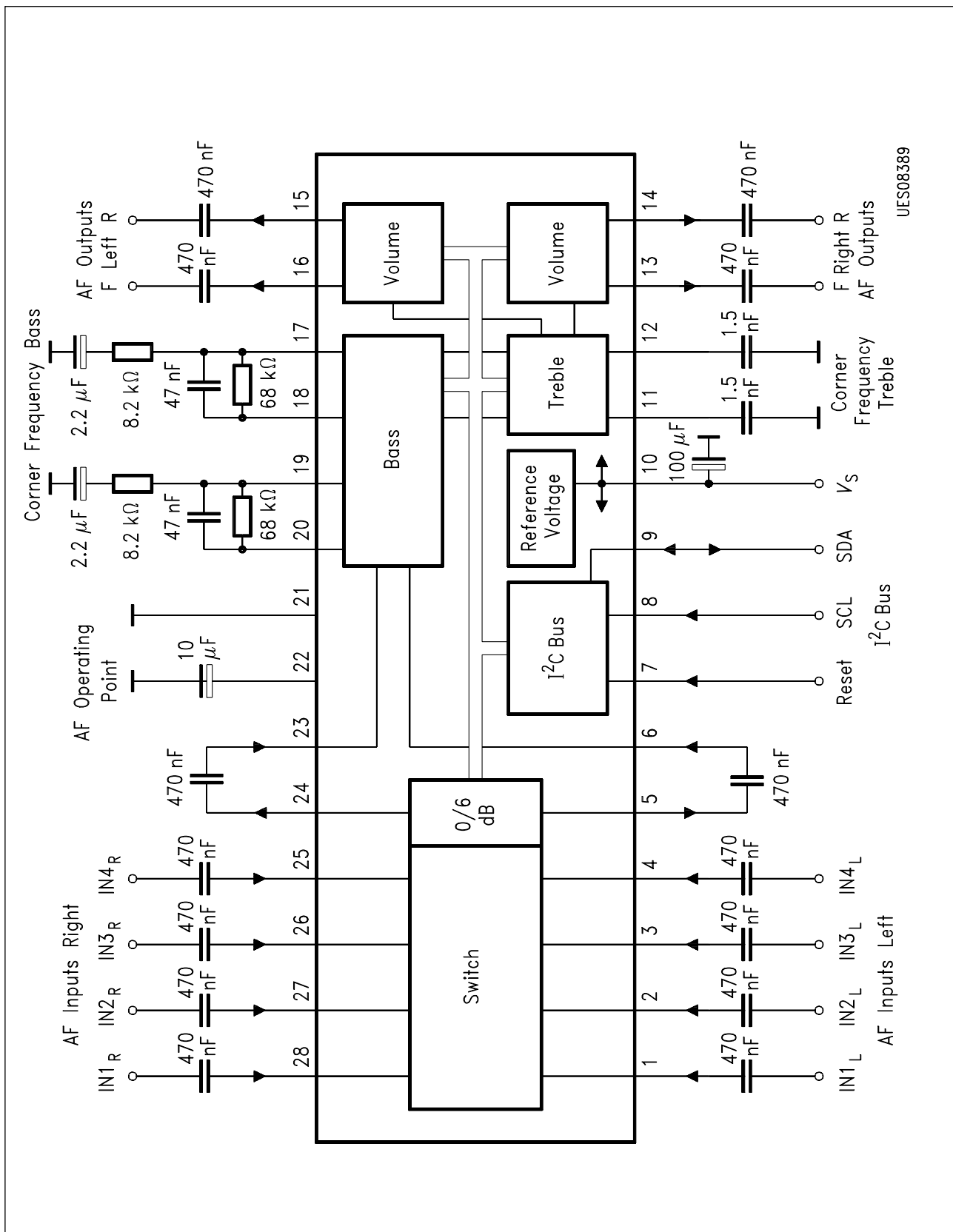
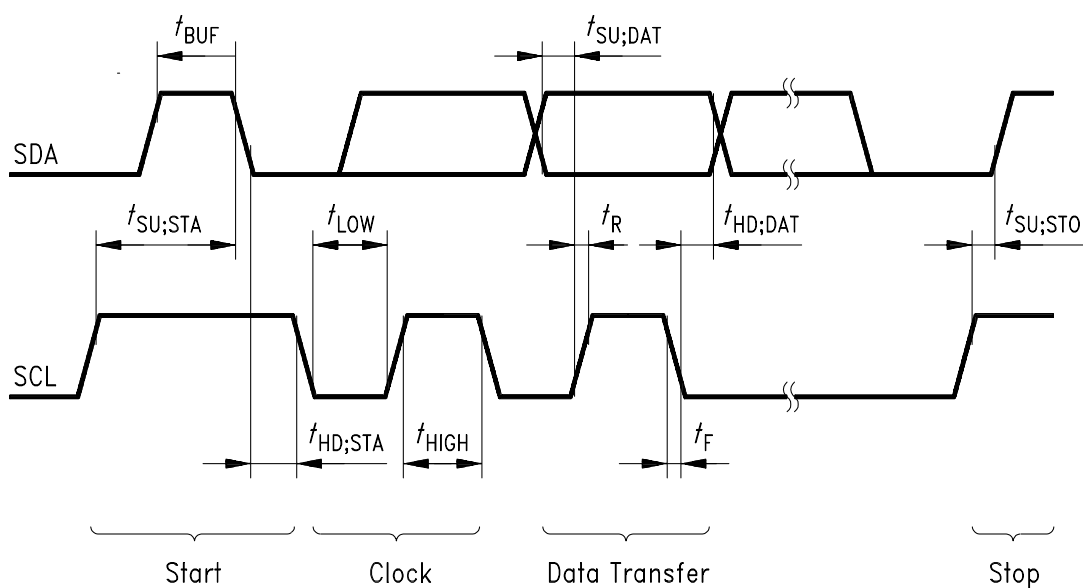


Figure 13  
Application Circuit



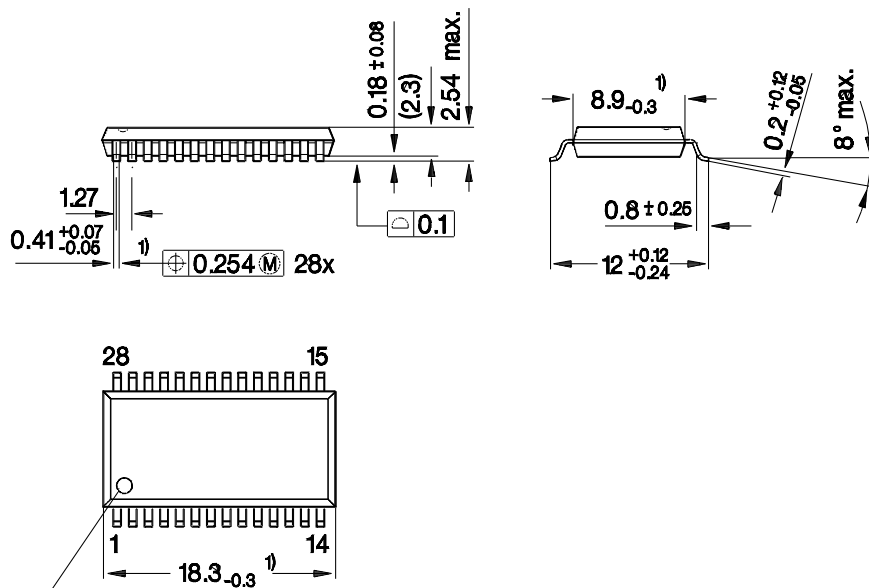
- $t_{SU;STA}$  Set-up Time (Start)
- $t_{HD;STA}$  Hold Time (Start)
- $t_{HIGH}$  HIGH Pulse Width (Clock)
- $t_{LOW}$  LOW Pulse Width (Clock)
- $t_{SU;DAT}$  Set-up Time (Data Transfer)
- $t_{HD;DAT}$  Hold Time (Data Transfer)
- $t_{SU;STO}$  Set-up Time (Stop)
- $t_{BUF}$  Bus Free Time
- $t_F$  Fall Time
- $t_R$  Rise Time

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**Figure 14**  
**I<sup>2</sup>C Bus Timing**

4 Package Outlines

**P-DSO-28-3**  
(Plastic Dual Small Outline Package)



Index Marking

- 1) Does not include plastic or metal protrusion of 0.25 max. per side
- 2) Does not include dambar protrusion

GPS05182

**Sorts of Packing**

Package outlines for tubes, trays etc. are contained in our Data Book "Package Information".

SMD = Surface Mounted Device

Dimensions in mm