# SIEMENS

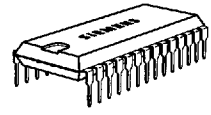
## TV-Stereo Processor

## TDA 6610-5

**Bipolar IC**

### Features

- All functions are I²C Bus controlled
- Suitable for multistandard including NICAM SCART-interface
- Independent headphones output high signal noise ratio
- Extremely low total harmonic distortion
- High security of detection of the stereo decoder part because of the digital interference suppression and the very narrow bandwidth



**P-DIP-28-3**

| Type | Ordering Code | Package |
|---|---|---|
| TDA 6610-5 | Q67000-A5126 | P-DIP-28-3 |

### General

The TDA 6610-5 represents a complete TV-stereo sound system controlled via the I²C Bus. The IC is divided into three functional blocks:

1. **Stereo Sound Processing with High Quality (exceeds DIN 45500; suitable for NICAM and CD)**
   a) Matrix for G-standard
   b) Additional single-channel AF-input (for e.g. AF-signal according to L-standard)
   c) Stereo SCART-interface is in accordance with FTZ-official specification
   d) Stereo loudspeaker signal section with Ch1/Ch2 switch, treble/bass control, quasi-stereo/ stereo base width control and separate left/right loudspeaker volume control
   e) Signal section with Ch1/Ch2 switch and volume control for stereo headphones

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

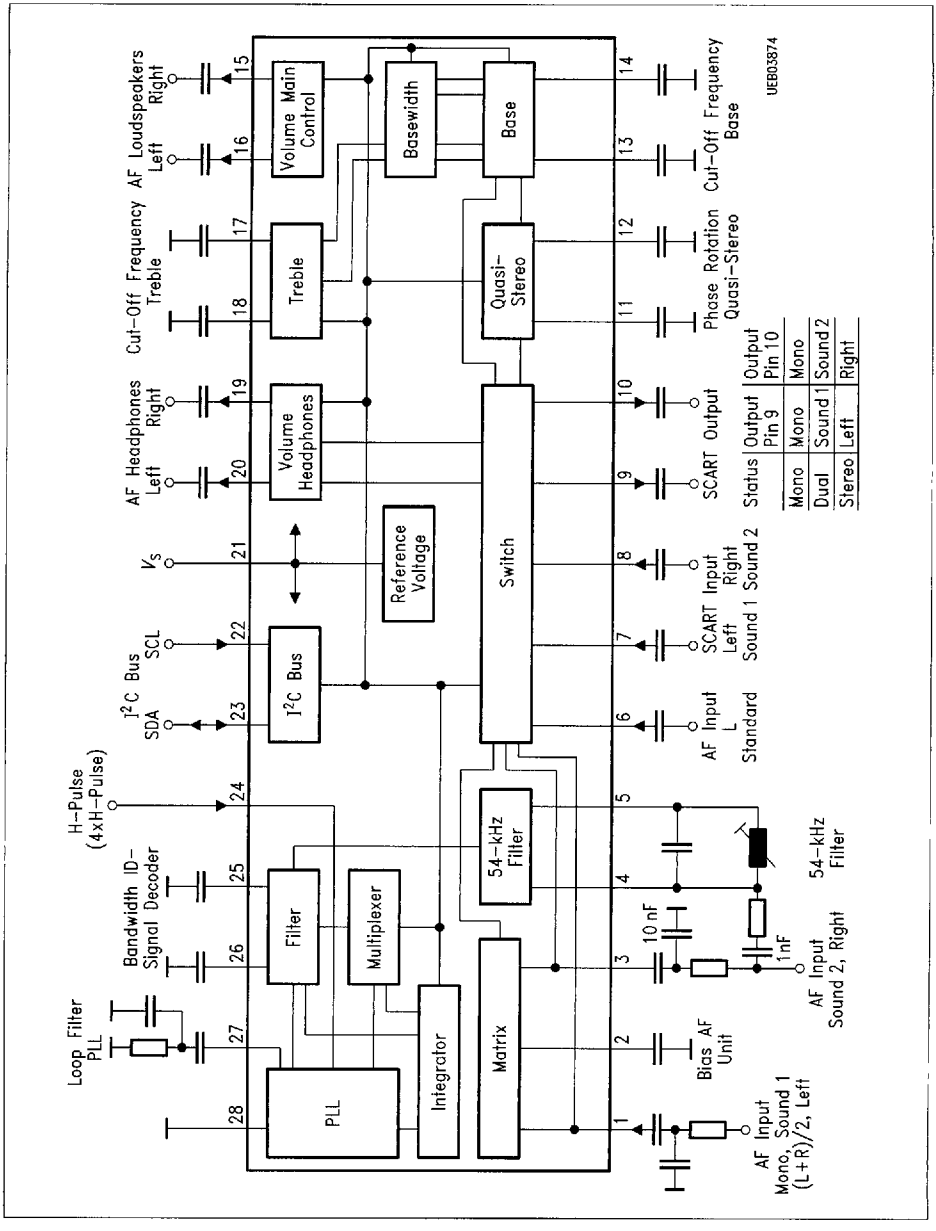
a) Active pilot signal filter
b) Phase-independent rectifier with very narrow bandwidth for evaluation of the identification signal
c) Digital integrator to reduce interference
d) Multiplexer for cyclical switch over between "stereo" or "dual" recognition
e) PLL for the generation of the reference signal. External synchronization with either the fly-back pulse or external reference clock signals of 62.5 kHz

**3. Control Section for:**

a) $I^2C$ Bus interface with listen/talk function
b) Control of the complete AF-sound processing
c) Control of the identification signal decoder
d) Reading of the identification signal decoder status
e) Test modes

**Pin Functions**

| Pin No. | Function |
|---|---|
| 1 | AF-input mono, left, sound 1 |
| 2 | Bias for AF-unit |
| 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 | Cut-off frequency base (base-width) left |
| 14 | Cut-off frequency base (base-width) right |
| 15 | AF-output, loudspeaker left |
| 16 | AF-output, loudspeaker right |
| 17 | Cut-off frequency treble left |
| 18 | Cut-off frequency treble right |
| 19 | AF-output, headphones left |
| 20 | AF-output, headphones right |
| 21 | + $V_S$ (supply voltage) |
| 22 | I²C Bus SCL |
| 23 | I²C Bus SDA |
| 24 | Input H-pulse (4 x H-pulse) |
| 25 | Filter ID-signal decoder |
| 26 | Filter ID-signal decoder |
| 27 | PLL-filter ID-signal decoder |
| 28 | Ground |




**Block Diagram**

## Circuit Description

### Signal Section

The audio signal processing in the matrix and the switch-over for multichannel TV-sound signals according to the two-carrier system used in Germany takes place in the matrix and switching sections. 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-inputs can be by-passed internally in such a way that decoded stereo sound signals of other audio systems (NICAM) can be processed. The switching section is terminated with the SCART-output and an independently switchable Ch1/Ch2 switch for the loudspeaker and headphone outputs.

In the loudspeaker signal path a switchable quasi-stereo section follows the Ch1/Ch2 switch. This section gives a special audio effect with mono signals due to a 180° phase shift at medium frequencies (about 1 kHz) in one channel. The following bass control exhibits a step of 3 dB with an adjustment range of + 15/– 12 dB. The cutoff frequency is set for each channel with an external capacitor.

A circuit for stereo base-width expansion, switchable if stereo signals are recognized, provides a more spatial audio effect due to 50 % of frequency dependent crosstalk in opposing phases. The circuit operates with the same cut-off frequency as the bass control, but the function is largely independent. Likewise the treble control, whose cut-off frequency is also controlled by a capacitor in each channel, has a step of 3 dB with an adjustment range of ± 12 dB. The volume control can be adjusted independently for the right and left loudspeaker signal path. Using 57 steps of 1.25 dB each, a 70 dB adjustment range is available, where the 57th step activates the "MUTE" function. Functions such as "balance" or "loudness" are realized by software adjustment of the appropriate tone and volume controls.

In the signal path for the headphones after the Ch1/Ch2 switch a volume control circuit is used for the simultaneous left/right adjustment. Thirty-two steps of 2 dB each allow an adjustment range of 62 dB (31 x 2 dB = 62 dB, while the 32nd step activates the "MUTE" function).

### Identification Sound Decoder

The input of the identification sound decoder consists of an op-amp for the pilot signal with its sidebands. An external LC-circuit is used to select the pilot carrier and his sidebands. The signal is then passed to a phase-independent active band-pass filter wih a very narrow bandwidth (adjustable externally). This filter detects whether the lower side-band of the pilot carrier, 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 first "detected" criterion is processed by a digital integrator and a following comparator in order to suppress interferences due to noise. The decoder status caw can be read out via $I^2C$ Bus (talk mode) as the "stereo" or "dual" mode. The control of the corresponding signal path can take place either directly internally or through the µC . All required clock signals are derived from a fast lowding PLL synchronized by a external reference frequency. This reference frequency has to be sufficiently close to the horizontal frequency, but **a rigid phase coupling is not required**. Therefore, alternatively to the line frequency the use of a crystal-controlled 62.5 kHz frequency commonly available in PLL-tuning systems is possible.

### Control Section

All functions are controlled via I²C Bus interface with listen/talk functions. The actual valid data are stored in a latch block.

The telegram structure is:

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

The following conditions apply to the data bytes:

Before a data byte (with the adjustment information) is transmitted, a subaddress byte has **always** to be transmitted.

Example: The headphone volume (HP vol) has to be increased in several (i.e. 3) steps.

| **Right** | | **Wrong** | |
|---|---|---|---|
| Start condition | | Start condition | |
| Chip address | 84 (Hex) | Chip address | 84 (Hex) |
| Subaddr. vol | 03 (Hex) | Subaddr. vol | 03 (Hex) |
| Volume step 8 | 08 (Hex) | Volume step 8 | 08 (Hex) |
| Subaddr. vol | 03 (Hex) | Volume step 9 | 09 (Hex) |
| Volume step 9 | 09 (Hex) | Volume step 10 | 0A (Hex) |
| Subaddr. vol | 03 (Hex) | Stop condition | |
| Volume step 10 | 0A (Hex) | | |
| Stop condition | | | |

Within a telegram (i.e. without a new start condition) any different subaddresses can be accessed. The changeover between "listen" and "talk" however has always to be initialized via the sequence "stop condition - start condition - chip address". Before each readout always a start condition and chip address (talk) has to be transmitted. The data to be read out are loaded into the I²C Bus interface after this sequence and are available for the transfer to the µC.

### 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 |
|---|---|---|---|---|---|---|---|---|
| Loudspeaker volume left | X | X | X | X | X | 0 | 0 | 1 |
| Loudspeaker volume right | X | X | X | X | X | 0 | 1 | 0 |
| Headphone volume | 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 |

**Setting Bytes**
**a) Loudspeaker Volume Left / Right**

| | MSB | • | • | • | • | • | • | LSB |
|---|---|---|---|---|---|---|---|---|
| Maximum volume | X | X | 1 | 1 | 1 | 1 | 1 | 1 |
| Max – 1 step | X | X | 1 | 1 | 1 | 1 | 1 | 0 |
| Max – 15 steps | X | X | 1 | 1 | 0 | 0 | 0 | 0 |
| Max – 55 steps | 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 |

**b) Headphone Volume**

| | MSB | • | • | • | • | • | • | LSB |
|---|---|---|---|---|---|---|---|---|
| Max. volume | T2 | T1 | T0 | 1 | 1 | 1 | 1 | 1 |
| Max – 1 step | T2 | T1 | T0 | 1 | 1 | 1 | 1 | 0 |
| Max – 15 steps | T2 | T1 | T0 | 1 | 0 | 0 | 0 | 0 |
| Max – 31 steps | 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 have to be set to 0 for normal operation.

**c) 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 treble | | | LSB treble | MSB bass | | | LSB bass |

**d) Switch Byte I**

| MSB | • | • | • | • | • | • | LSB |
|---|---|---|---|---|---|---|---|
| MUTE I | MUTE II | $Ch1/Ch2_{vol}$ | $Ch1/Ch2_{HP}$ | Mono | SCART | SCART-D | AM |

MUTE I = 0 All AF-outputs are muted (loudspeakers, 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 | MUTE II | Loudspeaker outputs | Headphones, SCART-outputs |
|---|---|---|---|
| 0 | 0 | muted | muted |
| 0 | 1 | muted | muted |
| 1 | 0 | muted | ON |
| 1 | 1 | ON | ON |

$CH1/Ch2_{vol}$ = 0 Sound 1 on the loudspeaker outputs; power ON
$CH1/Ch2_{vol}$ = 1 Sound 2 on the loudspeaker outputs
$CH1/Ch2_{HP}$ = 0 Sound 1 on the headphone outputs; power ON
$CH1/Ch2_{HP}$ = 1 Sound 2 on the headphone outputs
$CH1/Ch2_{vol}$ and $CH1/Ch2_{HP}$ are only effective if the matrix is set to the position "dual sound".

Mono = 0 identification signal decoder is set to mono position and held; power ON
Mono = 1 normal operation of identification 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)
Standard L = 0 normal operation (G-standard)
Standard L = 1 AM AF-input is activated; power ON
AM = 1 has priority over bypass = 1

**e) Switch Byte II**

| MSB | • | • | • | • | • | • | LSB |
|---|---|---|---|---|---|---|---|
| MPX0 | MPX1 | Quasi-st | Be | H-pul | Matrix 0 | Matrix 1 | Bypass |

| MPX0 | MPX 1 | MPX period | | recommended $C_{25,\ 26}$ |
|---|---|---|---|---|
| 0 | 0 | 2 s | power ON | 1 µF |
| 0 | 1 | 4 s | | 2.2 µF |
| 1 | 0 | 8 s | | 4.7 µF |

MPX-period = 2 s signifies: Identification (ID) signal decoder searches 1 s for dual and 1 s for stereo transmission

| | | | |
|---|---|---|---|
| Quasi-st | = | 0 | Quasi-stereo OFF; Power ON |
| Quasi-St | = | 1 | Quasi-stereo ON |
| Be | = | 0 | Stereo basewidth expansion OFF; Power ON |
| Be | = | 1 | Stereo basewidth expansion ON |

| | | | |
|---|---|---|---|
| H pul | = | 0 | ID-signal decoder synchronization with $f_H$ = 15.625 kHz; power ON |
| H pul | = | 1 | ID-synchronization with 4 x $f_H$ |

| Matrix 0 | Matrix 1 | 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 bridged so that left/right signals can be fed in; power ON (AM = 1 has priority over bypass = 1) |

**Priority List of Setting Bits**

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

**h) Talk Mode**

| MS | • | • | • | • | • | • | LSB |
|---|---|---|---|---|---|---|---|
| St | D | T5 | T4 | T3 | X | X | X |
| 0 | 0 | decoder detects mono | | | | | |
| 1 | 0 | decoder detects stereo | | | | | |
| 0 | 1 | decoder detects dual | | | | | |
| 1 | 1 | internally inhibited | | | | | |

**T3 - T5 are test bits**

**Absolute Maximum Ratings**

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

| Parameter | Symbol | Limit Values | | Unit |
|---|---|---|---|---|
| | | 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 |
| 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 |

### Characteristics

$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

I²C Bus present: start - 84 - 01,3F - 0 2,3F - 0 3,1F - 0 5,88 - 0 6,10 - 07,C8 - 00,01 - stop

Chip address - *Vol LSl 63 - Vol LSr 63 - Vol HP 31 - tone lin - adj 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 code and with switch bits on the set bits and features are stated.

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Current consumption | $I_{21}$ | | 50 | | mA | |
| **Signal Section** | | | | | | |
| Max. gain | $V_{16\text{-}1}$ | −2 | 0 | 2 | dB | |
| Max. gain | $V_{15\text{-}3}$ | −2 | 0 | 2 | dB | |
| Max. gain | $V_{20\text{-}1}$ | −2 | 0 | 2 | dB | |
| Max. gain | $V_{19\text{-}3}$ | −2 | 0 | 2 | dB | |
| Max. gain | $V_{16\text{-}3}$ | −2 | 0 | 2 | dB | 00,02; $V_1$ = 01 *Matrix: Stereo* |
| Max. gain | $V_{15\text{-}3}$ | −2 | 0 | 2 | dB | 00,02; $V_1$ = 01 *Matrix: Stereo* |
| Max. gain | $V_{20\text{-}3}$ | −2 | 0 | 2 | dB | 00,02; $V_1$ = 0 *Matrix: Stereo* |
| Max. gain | $V_{19\text{-}3}$ | −2 | 0 | 2 | dB | 00,02; $V_1$ = 0 *Matrix: Stereo* |
| Max. gain | $V_{16\text{-}1}$ | 4 | 6 | 8 | dB | 00,02; $V_3$ = 0 *Matrix: Stereo* |
| Max. gain | $V_{20\text{-}1}$ | 4 | 6 | 8 | dB | 00,02; $V_3$ = 0 *Matrix: Stereo* |
| Max. gain | $V_{16\text{-}7}$ | −5 | −3 | −1 | dB | 07,CC, *SCART* |
| Max. gain | $V_{15\text{-}8}$ | −5 | −3 | −1 | dB | 07,CC, *SCART* |
| Max. gain | $V_{20\text{-}7}$ | −5 | −3 | −1 | dB | 07,CC, *SCART* |
| Max. gain | $V_{19\text{-}8}$ | −5 | −3 | −1 | dB | 07,CC, *SCART* |
| Max. gain | $V_{16\text{-}6}$ | −2 | 0 | 2 | dB | 07,C9, Standard L |
| Max. gain | $V_{15\text{-}6}$ | −2 | 0 | 2 | dB | 07,C9, Standard L |
| Max. gain | $V_{20\text{-}6}$ | −2 | 0 | 2 | dB | 07,C9, Standard L |
| Max. gain | $V_{19\text{-}6}$ | −2 | 0 | 2 | dB | 07,C9, Standard L |

**Characteristics** (cont'd)

$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Gain | $V_{9\text{-}1}$ | – 2 | 0 | 2 | dB | |
| Gain | $V_{10\text{-}3}$ | – 2 | 0 | 2 | dB | |
| Gain | $V_{9\text{-}3}$ | – 2 | 0 | 2 | dB | 00,02; $V_1$ = 0<br>*Matrix: Stereo* |
| Gain | $V_{10\text{-}3}$ | – 2 | 0 | 2 | dB | 00,02; $V_1$ = 0<br>*Matrix: Stereo* |
| Gain | $V_{9\text{-}1}$ | 4 | 6 | 8 | dB | 00,02; $V_3$ = 0<br>*Matrix: Stereo* |
| Gain | $V_{10\text{-}6}$ | – 2 | 0 | 2 | dB | 07,C9 Standard L |
| Gain | $V_{9\text{-}6}$ | – 2 | 0 | 2 | dB | 07,C9 Standard L |
| Min. gain | $V_{16\text{-}1}$ | – 65 | – 70 | | dB | 01,08-02,08<br>*Vol* $_{LSl}$ *8-Vol* $_{LSr}$ *8* |
| Min. gain | $V_{15\text{-}3}$ | – 65 | – 70 | | dB | 01,08-02,08<br>*Vol* $_{LSl}$ *8-Vol* $_{LSr}$ *8*<br>01,08-02,08 |
| Min. gain | $V_{20\text{-}1}$ | – 57 | – 62 | | dB | 03,01 *Vol* $_{HP}$ *1* |
| Min. gain | $V_{19\text{-}3}$ | – 57 | – 62 | | dB | 03,01 *Vol* $_{HP}$ *1* |
| Min. gain | $V_{16\text{-}7}$ | – 68 | – 73 | | dB | 07,CC-01,08-02,08<br>*SCART-Vol* $_{LSl}$ *8-Vol* $_{LSr}$ *8* |
| Min. gain | $V_{15\text{-}8}$ | – 68 | – 73 | | dB | 07,CC-01,08-02,08<br>*SCART-Vol LSl 8-Vol* $_{LSr}$ *8* |
| Min. gain | $V_{20\text{-}7}$ | – 60 | – 65 | | dB | 07,CC-03,01<br>*SCART-Vol* $_{KH}$ *1* |
| Min. gain | $V_{19\text{-}8}$ | – 60 | – 65 | | dB | 07,CC-03,01<br>*SCART-Vol* $_{KH}$ *1* |
| Min. gain | $V_{16\text{-}6}$ | – 60 | – 70 | | dB | 07,C9-01,08-02,08<br>Standard L *Vol* $_{LSl}$ *8-Vol* $_{LSr}$ *8* |
| Min. gain | $V_{15\text{-}6}$ | – 60 | – 70 | | dB | 07,C9-01,08-02,08<br>Standard L *Vol* $_{LSl}$ *8-Vol* $_{LSr}$ *8* |
| Min. gain | $V_{20\text{-}6}$ | – 57 | – 62 | | dB | 07,C9-03,01<br>Standard L *Vol* $_{KH}$ *1* |
| Min. gain | $V_{19\text{-}6}$ | – 57 | – 62 | | dB | 07,C9-03,01<br>Standard L *Vol* $_{KH}$ *1* |
| Flutter and wow | $\Delta V_{15\text{-}16}$ | | | ± 2 | dB | 01,3F to 01,24<br>02,3F to 02,24<br>*Vol* $_{LSl}$ *63-36-Vol* $_{LSr}$ *63-36* |
| Flutter and wow | $\Delta V_{19\text{-}20}$ | | | ± 2 | dB | 03,1F to 03,13<br>*Vol* $_{KH}$ *31-19* |

**Characteristics** (cont'd)
$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Step width $Vol_{15}$ | $\Delta V_{15}$ | 0 | 1.25 | 2.5 | dB | 01,X-01, (X ± 1)<br>*$Vol_{LSl}$ X-$Vol_{LSl}$ (X 1)* |
| Step width $Vol_{16}$ | $\Delta V_{16}$ | 0 | 1.25 | 2.5 | dB | 02,X-02,(X±1)<br>*$Vol_{Lsr}$ X-$Vol_{LSr}$ (X 1)* |
| Step width $Vol_{19}$ | $\Delta V_{19}$ | 0 | 2 | 4 | dB | 03,X-03, (X ± 1)<br>*$Vol_{KH}$ X-$Vol_{KH}$ (X 1)* |
| Step width $Vol_{20}$ | $\Delta V_{20}$ | 0 | 2 | 4 | dB | 03,X-03, (X ± 1)<br>*$Vol_{KH}$ X-$Vol_{KH}$ (X 1)* |
| Bass boost | $V_{16\text{-}1}$ | 13 | 15 | | dB | 05,8F; $f_l$ = 40 Hz<br>*Bass max, treble lin.* |
| Bass boost | $V_{15\text{-}3}$ | 13 | 15 | | dB | 05,8F; $f_l$ = 40 Hz<br>*Bass max, treble lin.* |
| Bass boost | $V_{16\text{-}1}$ | – 10 | – 12 | | dB | 05,8F; $f_l$ = 40 Hz<br>*Bass max, treble lin.* |
| Bass boost | $V_{15\text{-}3}$ | – 10 | – 12 | | dB | 05,8F; $f_l$ = 40 Hz<br>*Bass max, treble lin.* |
| Step wide bass | $\Delta V_{15}$ | 1 | 3 | 5 | dB | 05,8X-05,8 (X ± 1)<br>*Bass X – bass (X ± 1)* |
| Step wide bass | $\Delta V_{16}$ | 1 | 3 | 5 | dB | 05,8X-05,8 (X ± 1)<br>*Bass X – bass (X ± 1)* |
| High frequency emphasis | $V_{16\text{-}1}$ | 10 | 12 | | dB | 05,8F; $f_l$ = 15 kHz<br>*Treble max, bass lin.* |
| High frequency emphasis | $V_{15\text{-}3}$ | 10 | 12 | | dB | 05,8F; $f_l$ = 15 kHz<br>*Treble max, bass lin.* |
| High frequency emphasis | $V_{16\text{-}1}$ | – 10 | – 12 | | dB | 05,8F; $f_l$ = 15 kHz<br>*Treble max, bass lin.* |
| High frequency emphasis | $V_{15\text{-}3}$ | – 10 | – 12 | | dB | 05,8F; $f_l$ = 15 kHz<br>*Treble max, bass lin.* |
| Step wide treble | $\Delta V_{15}$ | 1 | 3 | 5 | dB | 05,X8-0,5 (X ± 1) 8<br>*Treble X – treble (X ± 1)* |
| Step wide treble | $\Delta V_{16}$ | 1 | 3 | 5 | dB | 05,X8-0,5 (X ± 1) 8<br>*Treble X – treble (X ± 1)* |
| Linearity sound | $\Delta V_{15}$ | | | ± 2 | dB | 05,88; $f_l$ = 40 Hz – 15 kHz<br>*Treble, bass lin.* |
| Linearity sound | $\Delta V_{16}$ | | | ± 2 | dB | 05,88; $f_l$ = 40 Hz – 15 kHz<br>*Treble, bass lin.* |
| Channel separation | $\Delta V_{15\text{-}16}$ | 50 | | | dB | $V_3$ or $V_1$ = 600 mVrms |
| Channel separation | $\Delta V_{19\text{-}20}$ | 50 | | | dB | $V_3$ or $V_1$ = 600 mVrms |
| Channel separation | $\Delta V_{9\text{-}10}$ | 50 | | | dB | $V_3$ or $V_1$ = 600 mVrms |

**Characteristics** (cont'd)
$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Cross talk attenuation switch | $\alpha_{\text{input interf / Output rms}}$ | 60 | | | dB | $V_{I\,rms}$ = 0<br>$V_{I\,Int1,3,6}$ = 600 mVrms<br>$V_{I\,Int7,8}$ = 2 Vrms |
| Attenuation MUTE | $\alpha_{1\text{-}16}$ | 80 | | | dB | 01,00-02,00<br>*Vol* $_{LSl}$ *0-Vol* $_{LSr}$ *0*<br>$V_1$ = 600 mVrms |
| Attenuation MUTE | $\alpha_{1\text{-}16}$ | 80 | | | dB | 07,48; $V_1$ = 600 mVrms<br>*MUTE I: 0* |
| Attenuation MUTE | $\alpha_{1\text{-}16}$ | 80 | | | dB | 07,88; $V_1$ = 600 mVrms<br>*MUTE II: 0* |
| Attenuation MUTE | $\alpha_{3\text{-}15}$ | 80 | | | dB | 01,00-02,00<br>*Vol* $_{LSl}$ *0-Vol* $_{LSr}$ *0*<br>$V_3$ = 600 mVrms |
| Attenuation MUTE | $\alpha_{3\text{-}15}$ | 80 | | | dB | 07,48; $V_3$ = 600 mVrms<br>*MUTE I: 0* |
| Attenuation MUTE | $\alpha_{3\text{-}15}$ | 80 | | | dB | 07,88; $V_3$ = 600 mVrms<br>*MUTE II: 0* |
| Attenuation MUTE | $\alpha_{1\text{-}20}$ | 80 | | | dB | 03,00; $V_1$ = 600 mVrms<br>*Vol* $_{KH}$ *0* |
| Attenuation MUTE | $\alpha_{1\text{-}20}$ | 80 | | | dB | 07,48; $V_1$ = 600 mVrms<br>*MUTE I: 0* |
| Attenuation MUTE | $\alpha_{3\text{-}19}$ | 80 | | | dB | 03,00; $V_3$ = 600 mVrms<br>*Vol* $_{KH}$ *0* |
| Attenuation MUTE | $\alpha_{3\text{-}19}$ | 80 | | | dB | 07,48; $V_3$ = 600 mVrms<br>*MUTE I: 0* |
| Analog values are valid for feed-in at the pin 6, 7, 8; $V_{7,8}$ = 2 Vrms; $V_6$ = 600 mVrms | | | | | | |
| Attenuation MUTE | $\alpha_{3\text{-}10}$ | 80 | | | dB | 07,48; $V_3$ = 600 mVrms<br>*MUTE I: 0* |
| Attenuation MUTE | $\alpha_{1\text{-}9}$ | 80 | | | dB | 07,48; $V_3$ = 600 mVrms<br>*MUTE I: 0* |
| Attenuation MUTE | $\alpha_{6\text{-}10}$ | 80 | | | dB | 07,49; $V_6$ = 600 mVrms<br>*MUTE I: 0*, Standard L |
| Attenuation MUTE | $\alpha_{6\text{-}9}$ | 80 | | | dB | 07,49; $V_6$ = 600 mVrms<br>*MUTE I: 0*, Standard L |

**Characteristics** (cont'd)

$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| 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 *Matrix: Stereo* |
| Max. input voltage | $V_7$ | 2 | | | Vrms | $THD_{16}$ = 1 % |
| | | | | | Vrms | 07, CC, SCART |
| Max. input voltage | $V_8$ | 2 | | | % | $THD_{15}$ = 3 % |
| | | | | | | 07, CC, SCART |
| Distortion | $THD_{19}$ | 0 | 0.01 | 0.1 | % | $V_3$ = 250 mVrms |
| Distortion | $THD_{20}$ | | 0.01 | 0.1 | % | $V_1$ = 250 mVrms |
| Distortion | $THD_{19}$ | | 0.01 | 0.1 | % | $V_3$ = 250 mVrms; 03,15 *$Vol_{KH}$ 21* |
| Distortion | $THD_{20}$ | | 0.01 | 0.1 | % | $V_1$ = 250 mVrms; 03,15 *$Vol_{KH}$ 21* |
| Analog values are valid for feed-in at the pin 6, 7, 8; $V_{7,8}$ = 2 Vrms; $V_6$ = 250 mVrms | | | | | | |
| Distortion | $THD_{16}$ | | 0.01 | 0.1 | % | $V_1$ = 250 mVrms |
| Distortion | $THD_{15}$ | | 0.01 | 0.1 | % | $V_3$ = 250 mVrms |
| Distortion | $THD_{16}$ | | 0.01 | 0.2 | % | $V_1$ = 250 mVrms; 01 2F-02,2F *$Vol_{LSl}$ 47-$Vol_{LSr}$ 47* |
| Distortion | $THD_{15}$ | | 0.01 | 0.2 | % | $V_3$ = 250 mVrms; 01 2F-02,2F *$Vol_{LSl}$ 47-$Vol_{LSr}$ 47* |
| Distortion | $THD_{16}$ | | 0.01 | 0.4 | % | $V_1$ = 250 mVrms; 05,XX *any sound* |
| Distortion | $THD_{15}$ | | 0.01 | 0.4 | % | $V_3$ = 250 mVrms; 05,XX *any sound* |
| Analog values are valid for feed-in at the pin 6, 7, 8; $V_{7,8}$ = 2 Vrms; $V_6$ = 250 mVrms | | | | | | |
| Distortion | $THD_{10}$ | | 0.01 | 0.1 | % | $V_3$ = 250 mVrms |
| Distortion | $THD_9$ | | 0.01 | 0.1 | % | $V_1$ = 250 mVrms |
| Distortion | $THD_{10}$ | | 0.01 | 0.1 | % | $V_6$ = 250 mVrms 07,C9, Standard L |
| Distortion | $THD_9$ | | 0.01 | 0.1 | % | $V_1$ = 250 mVrms 07,C9, Standard L |
| Antiphase Cross talk atten. | $\Delta V_{16\text{-}15}$ | 0.5 | 0.55 | | | $V_3$ = 600 mVrms |
| Base width | | | | | | $f_l$ = 2 kHz; 00,11, *Basis width* |

**Characteristics** (cont'd)
$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Antiphase Cross talk atten. | $\Delta V_{16\text{-}15}$ | 0.5 | 0.55 | | | $V_3$ = 600 mVrms |
| Base width | | | | | | $f_l$ = 2 kHz; 00,11, *Basis width* |
| Base width phase | $\Phi_{16\text{-}15}$ | 150 | 180 | 210 | deg | $V_1$ = 600 mVrms; 00,11 *Basis width*, $f$ = 2 kHz |
| Base width phase | $\Phi_{15\text{-}16}$ | 150 | 180 | 210 | deg | $V_1$ = 600 mVrms; 00,11 *Basis width*, $f$ = 2 kHz |
| Phase rotation quasi stereo | $\Phi_{16\text{-}15}$ | 0 | 10 | 40 | deg | $V_{3,1}$ = 600 mVrms; 00,21 *Quasi stereo*, $f$ = 40 Hz |
| Phase rotation quasi stereo | $\Phi_{16\text{-}15}$ | 130 | 180 | 230 | deg | $V_{3,1}$ = 600 mVrms; 00,21 *Quasi stereo*, $f$ = 1 kHz |
| Phase rotation quasi stereo | $\Phi_{16\text{-}15}$ | – 30 | 10 | 0 | deg | $V_{3,1}$ = 600 mVrms; 00,21 *Quasi stereo*, $f$ = 15 kHz |
| Unweighted signal-to-noise ratio | $\alpha_{S/N16}$ | 1 | 90 | 97 | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_1$ = 0.6 Vrms |
| Unweighted signal-to-noise ratio | $\alpha_{S/N15}$ | 1 | 90 | 97 | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_3$ = 0.6 Vrms |
| Unweighted signal-to-noise ratio | $\alpha_{S/N16}$ | 70 | 80 | | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_1$ = 0.6 Vrms 01,27-02,27 *Vol LSl 39-Vol LSr 39* |
| Unweighted signal-to-noise ratio | $\alpha_{S/N15}$ | 70 | 80 | | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_3$ = 0.6 Vrms 01,27-02,27 *Vol LSl 39-Vol LSr 39* |
| External voltage | $V_{N15}$ | | 2 | 10 | µVrms | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$ 01,00-02,00 *Vol LSl 0-Vol LSr 0* |
| External voltage | $V_{N16}$ | | 2 | 10 | µVrms | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$ 01,00-02,00 *Vol LSl 0-Vol LSr 0* |

**Characteristics** (cont'd)

$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| Unweighted signal-to-noise ratio | $\alpha_{S/N20}$ | 90 | 97 | | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_1$ = 0.6 Vrms |
| Unweighted signal-to-noise ratio | $\alpha_{S/N19}$ | 1 | 90 | 97 | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_3$ = 0.6 Vrms |
| Unweighted signal-to-noise ratio | $\alpha_{S/N20}$ | 70 | 80 | | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_1$ = 0.6 Vrms 03,10, *Vol* $_{KH}$ *16* |
| Unweighted signal-to-noise ratio | $\alpha_{S/N19}$ | 70 | 80 | | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_3$ = 0.6 Vrms 03,10, *Vol* $_{KH}$ *16* |
| External voltage | $V_{N20}$ | | 2 | 10 | µVrms | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; 03,00 *Vol* $_{KH}$ *0* |
| External voltage | $V_{N19}$ | | 2 | 10 | µVrms | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; 03,00 *Vol* $_{KH}$ *0* |
| Unweighted signal-to-noise ratio | $\alpha_{S/N9}$ | 1 | 90 | 97 | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_1$ = 0.6 Vrms |
| Unweighted signal-to-noise ratio | $\alpha_{S/N10}$ | 1 | 90 | 97 | dB | $V_{N\ rms\ 20\ Hz\text{-}20\ kHz}$; $V_1$ = 0.6 Vrms |
| Change of DC-switch Δ1 Bit | $\Delta V_{16}$ | | | ± 10 | mV | 01,X-01,X ± 1 *Vol* $_{LSl}$ *X-Vol* $_{LSl}$ *(X ± 1)* |
| Change of DC-switch Δ1 Bit | $\Delta V_{15}$ | | | ± 10 | mV | 02,X-02,X ± 1 *Vol* $_{LSr}$ *X-Vol* $_{LSr}$ *(X ± 1)* |
| Change of DC-switch Δ1 Bit | $\Delta V_{16}$ | | | ± 10 | mV | 05,X-05,X ± 1 *Sound X-Sound (X ± 1)* |
| Change of DC-switch Δ1 Bit | $\Delta V_{15}$ | | | ± 10 | mV | 05,X-05,X ± 1 *Sound X-Sound (X ± 1)* |
| Change of DC-switch Δ1 Bit | $\Delta V_{19}$ | | | ± 10 | mV | 03,X-03,X ± 1 *Vol* $_{KH}$*X-Vol* $_{KH}$ *(X ± 1)* |
| Change of DC-switch Δ1 Bit | $\Delta V_{20}$ | | | ± 10 | mV | 03,X-03,X ± 1 *Vol* $_{KH}$*X-Vol* $_{KH}$ *(X ± 1)* |

**Characteristics** (cont'd)

$V_S$ = 12 V; $T_A$ = 25 °C, in accordance with test circuit 1

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | |
| **Design-Related Data** | | | | | | |
| Input resistance | $R_7$ | 35 | | | kΩ | |
| Input resistance | $R_8$ | 35 | | | kΩ | |
| Input resistance | $R_6$ | 20 | | | kΩ | |
| Input resistance | $R_3$ | 20 | | | kΩ | |
| Input resistance | $R_1$ | 20 | | | kΩ | |
| Output resistance | $R_{19}$ | | | 200 | Ω | |
| Output resistance | $R_{20}$ | | | 200 | Ω | |
| Output resistance | $R_{15}$ | | | 200 | Ω | |
| Output resistance | $R_{16}$ | | | 200 | Ω | |
| Output resistance | $R_9$ | | | 200 | Ω | |
| Output resistance | $R_{10}$ | | | 200 | Ω | |

**Characteristics** (cont'd)
$V_S$ = 12 V; $T_A$ = 25 °C

| Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | | |
| **ID-Signal Decoder** | | | | | | | |
| Gain Filter OP-amp | $V_5$ | 13 | 14 | 15 | dB | $V_{IF}$ = 80 mVpp | 1 |
| Max. input voltage | $V_5$ | 600 | | | mVpp | Function | 2 |
| VCO voltage PLL | $V_{27}$ | 1.3 | | | V | $f_{24}$ = 14.6 kHz; $V_{24}$ = 2.5 V | 2 |
| VCO voltage PLL | $V_{27}$ | 2 | 3 | 4 | V | $f_{24}$ = 15.625 kHz; $V_{24}$ = 2.5 V | 2 |
| VCO voltage PLL | $V_{27}$ | | | 4.7 | V | $f_{24}$ = 16.6 kHz; $V_{24}$ = 2.5 V | 2 |
| VCO voltage PLL | $V_{27}$ | 1.3 | | | V | $f_{24}$ = 58.4 kHz; $V_{24}$ = 2.5 V 00,09, *H-Imp* | 2 |
| VCO voltage PLL | $V_{27}$ | | | 4.7 | V | $f_{24}$ = 66.4 kHz; $V_{24}$ = 2.5 V 00,09, *H-Imp* | 2 |

$$V_{KT\ FILTER} = \frac{\sqrt{(V_{25} - V_{25}^*)^2 + (V_{26} - V_{26}^*)^2}}{V_5}$$

$V_{25}$ or $V_{26}$ when $V_5$ = 0
$V_{25}^*$ or $V_{26}^*$ when $V_5$ = 400 mVpp

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ID-filter gain | $V_{KT\ Filter}$ | 3.4 | | 6.8 | | $f_5$ = Pilot signal: dual I²C-talk: dual | |
| ID-filter gain | $V_{KT\ Filter}$ | 3.4 | | 6.8 | | $f_5$ = Pilot signal: stereo I²C-talk: stereo | |

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Detection threshold | $\Delta V_{25}$ | 900 | | | mV | I²C-talk: stereo or dual | 3 |
| Detection threshold | $-\Delta V_{25}$ | 900 | | | mV | I²C-talk: stereo or dual | 3 |
| Detection threshold | $\Delta V_{26}$ | 900 | | | mV | I²C-talk: stereo or dual | 3 |
| Detection threshold | $-\Delta V_{26}$ | 900 | | | mV | I²C-talk: stereo or dual | 3 |

**Characteristics** (cont'd)
$V_S$ = 12 V; $T_A$ = 25 °C

| Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|---|---|---|---|---|---|---|
| | | min. | typ. | max. | | | |
| Mono threshold | $\Delta V_{25}$ | 0 | | 100 | mV | I²C-talk: mono | 3 |
| Mono threshold | $-\Delta V_{25}$ | 0 | | 100 | mV | I²C-talk: mono | 3 |
| Mono threshold | $\Delta V_{26}$ | 0 | | 100 | mV | I²C-talk: mono | 3 |
| Mono threshold | $-\Delta V_{26}$ | 0 | | 100 | mV | I²C-talk: mono | 3 |
| Detection response | $t_{det}$ | 1/4 | | 1/2 | $t_{MPX}$ | I²C-talk: stereo or dual $\pm \Delta V_{25}$ = 1 V | 3 |
| Detection response | $t_{det}$ | 1/4 | | 1/2 | $t_{MPX}$ | I²C-talk: stereo or dual $\pm \Delta V_{25}$ = 1 V | 3 |
| Switching threshold $f_{REF}$-input | $V_{24L}$ | 0 | | 1.5 | V | | 2 |
| Switching threshold $f_{REF}$-input | $V_{24L}$ | 3.5 | | $V_{21}$ | V | | 2 |
| Multiplexer clock | $t_{MPX}$ | | 1.08 | | s | 00,C0, *MPX = 1 s* | |
| Multiplexer clock | $t_{MPX}$ | | 2.17 | | s | 00,C0, *MPX = 2 s* | |
| Multiplexer clock | $t_{MPX}$ | | 4.34 | | s | 00,C0, *MPX = 4 s* | |
| Multiplexer clock | $t_{MPX}$ | | 8.68 | | s | 00,C0, *MPX = 8 s* | |

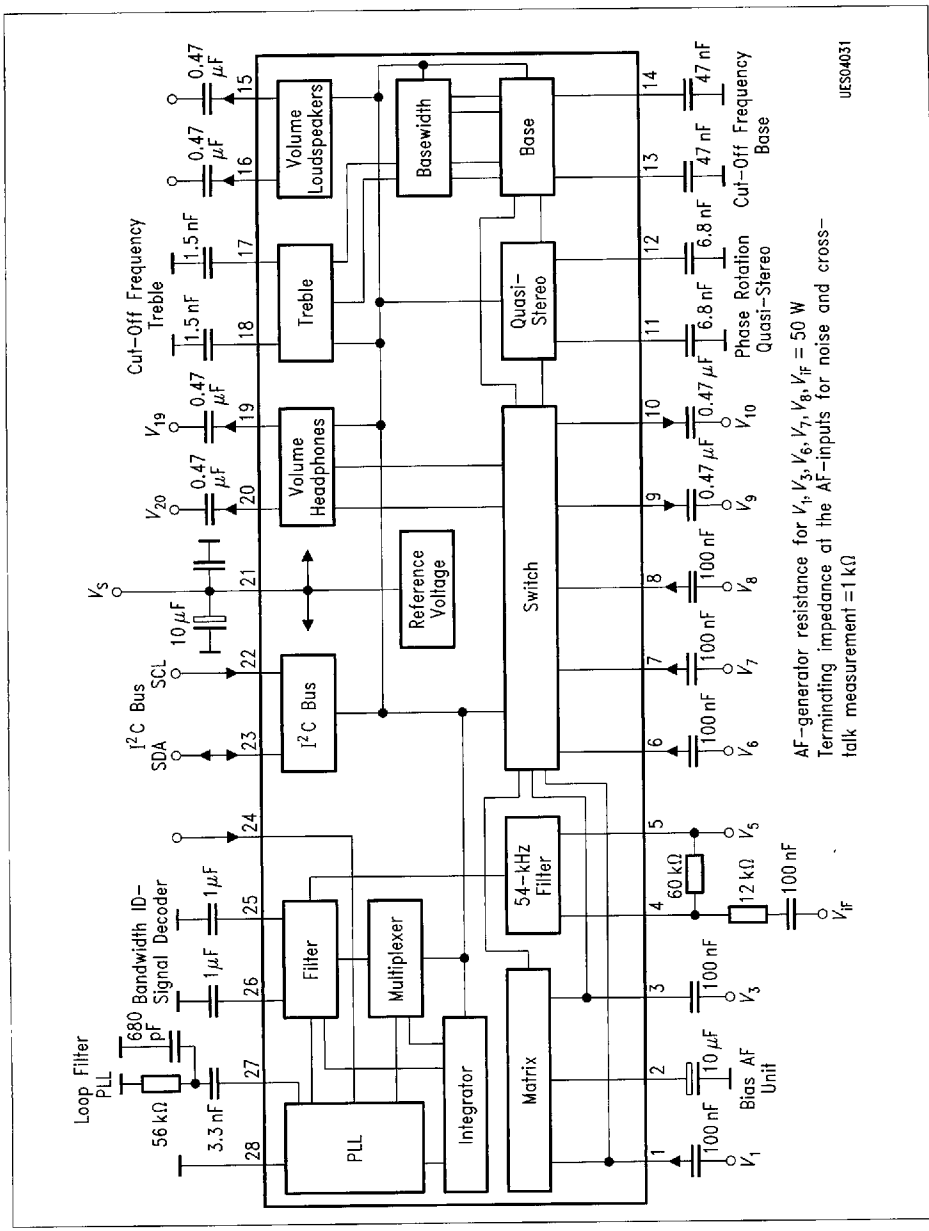
**Design-Related Data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Filter output resistance | $R_{25, 26}$ | 110 | | | kΩ | | |
| $f_{REF}$-input resistance | $R_{24}$ | 7 | | | kΩ | | |

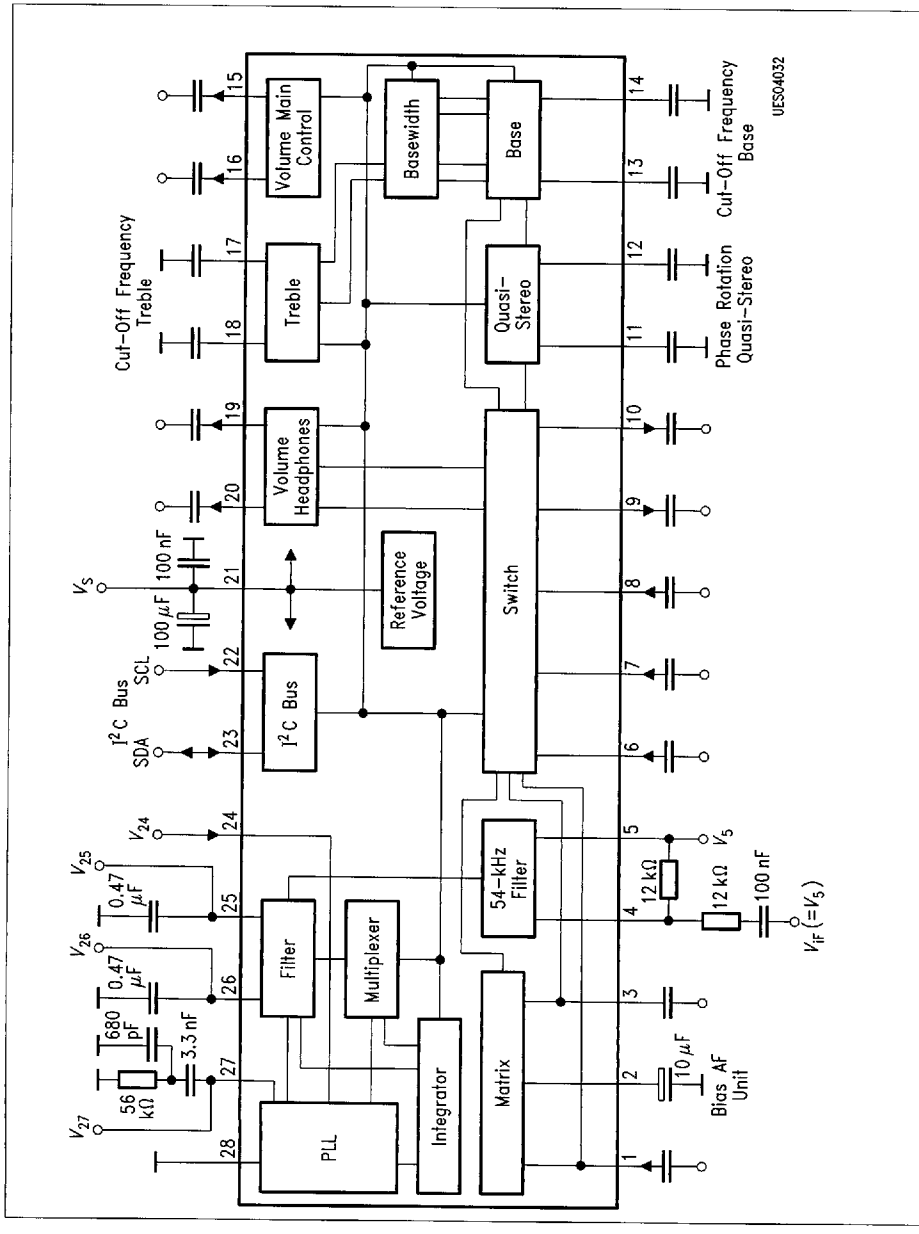
**Characteristics**

$V_S$ = 12 V; $T_A$ = 25 °C

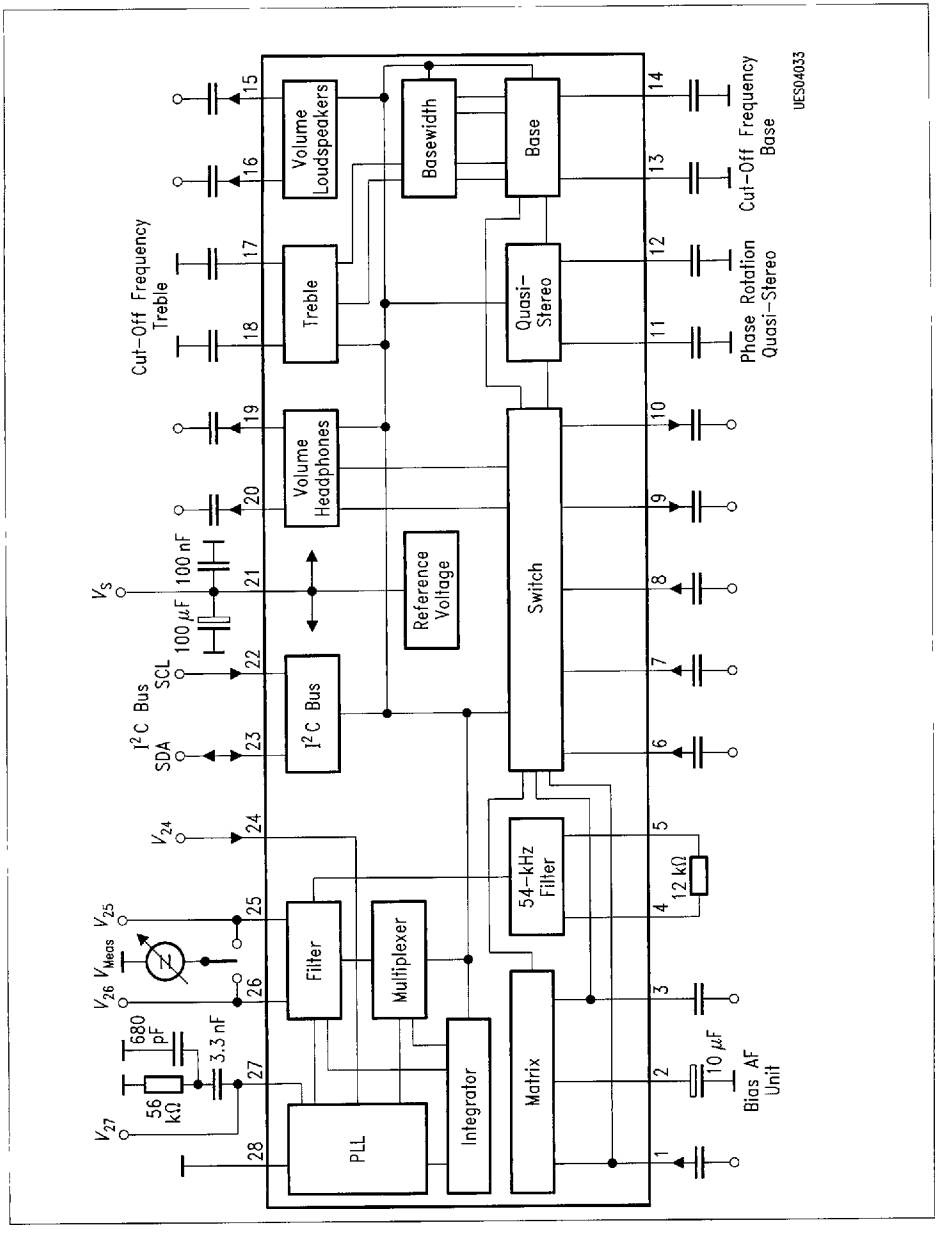
| Parameter | Symbol | Limit Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **I²C Bus (SCL, SDA)** | | | | | |
| SCL, SDA edges | | | | | |
| Rise time | $t_R$ | | | 1 | µs |
| Fall time | $t_F$ | | | 300 | ns |
| Shift register clock pulse SCL | | | | | |
| Frequency | $f_{SCL}$ | 0 | | 100 | kHz |
| H-pulse width | $t_{HIGH}$ | 4 | | | µs |
| L-pulse width | $t_{LOW}$ | 4 | | | µs |
| Start | | | | | |
| Setup time | $t_{SUSTA}$ | 4 | | | µs |
| Hold time | $t_{HDSTA}$ | 4 | | | µs |
| Stop | | | | | |
| Setup time | $t_{SUSTO}$ | 4 | | | µs |
| Bus free time | $t_{BUF}$ | 4 | | | µs |
| Data transfer | | | | | |
| Setup time | $t_{SUDAT}$ | 1 | | | µs |
| Hold time | $t_{HDDAT}$ | 1 | | | µs |
| Input SCL, SDA | | | | | |
| Input voltage | $V_{QH}$ | 2.4 | | 5.5 | V |
| | $V_{QL}$ | | | 1 | V |
| Input current | $I_{QH}$ | | | 20 | µA |
| | $I_{QL}$ | | | 20 | µA |
| Output SDA (open collector) | | | | | |
| Output voltage | $V_{QH}$ | 5.4 | | | V |
| $R_L$ = 2.5 kΩ | $V_{QL}$ | | | 0.4 | V |
| $I_{QL}$ = 3 mA | | | | | |



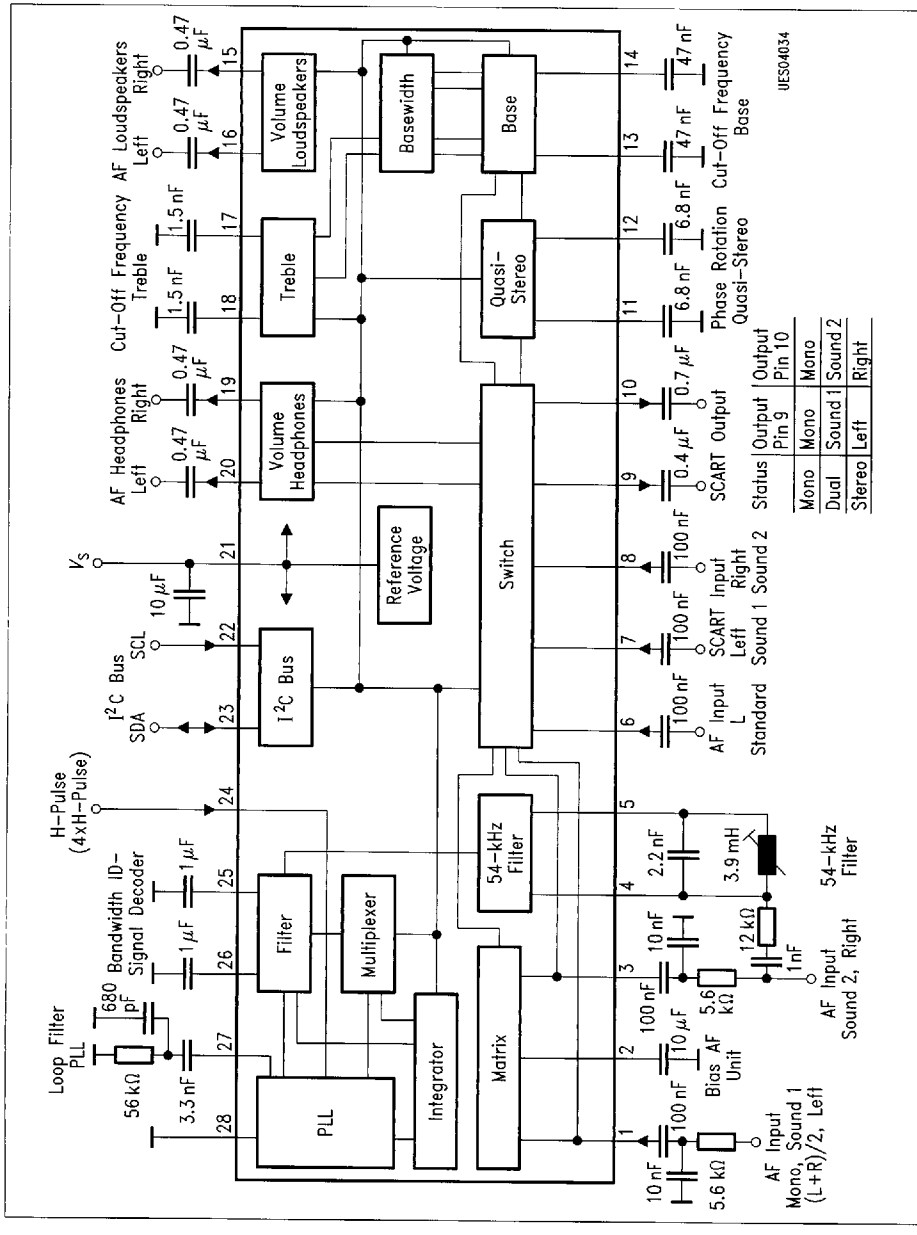

**Test Circuit 1**



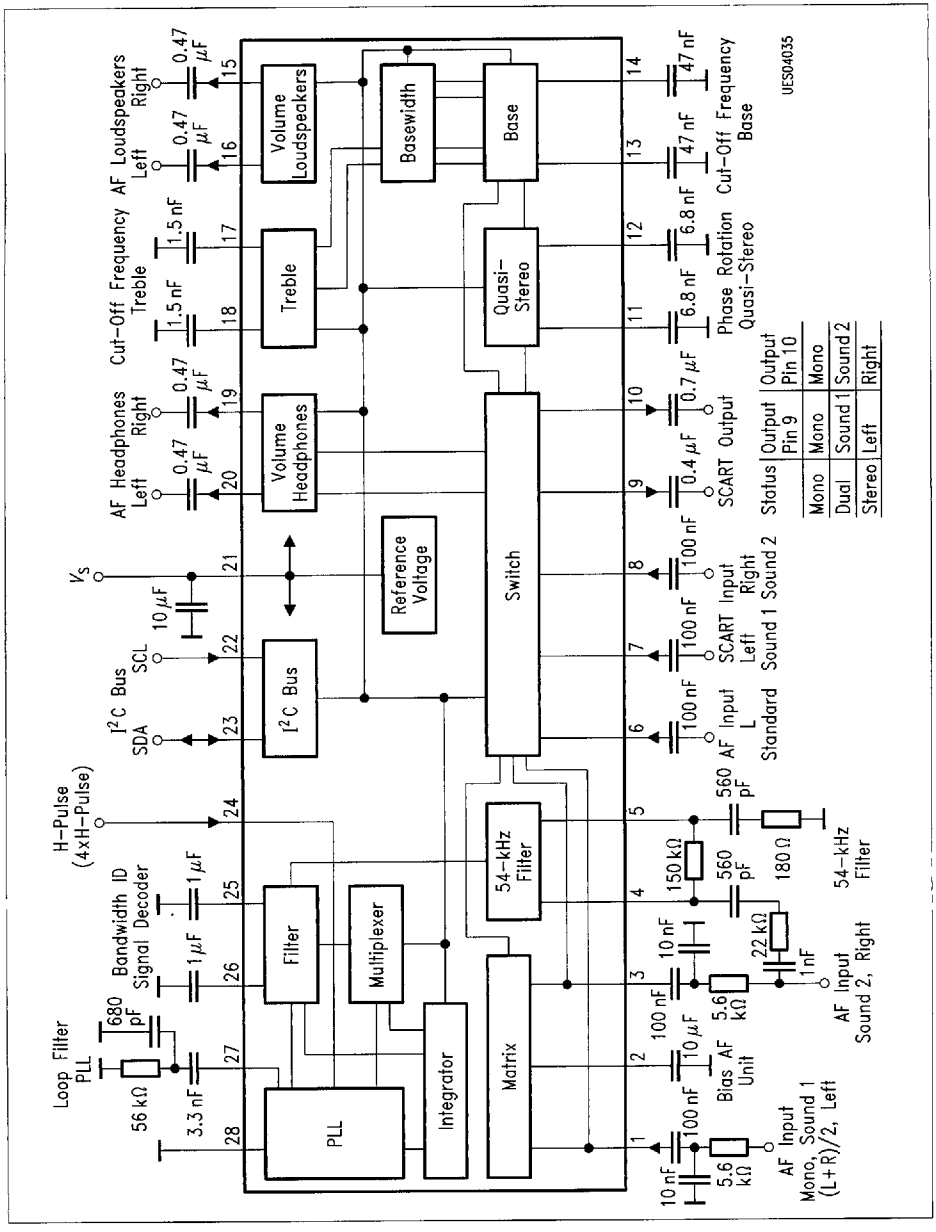

**Test Circuit 2**



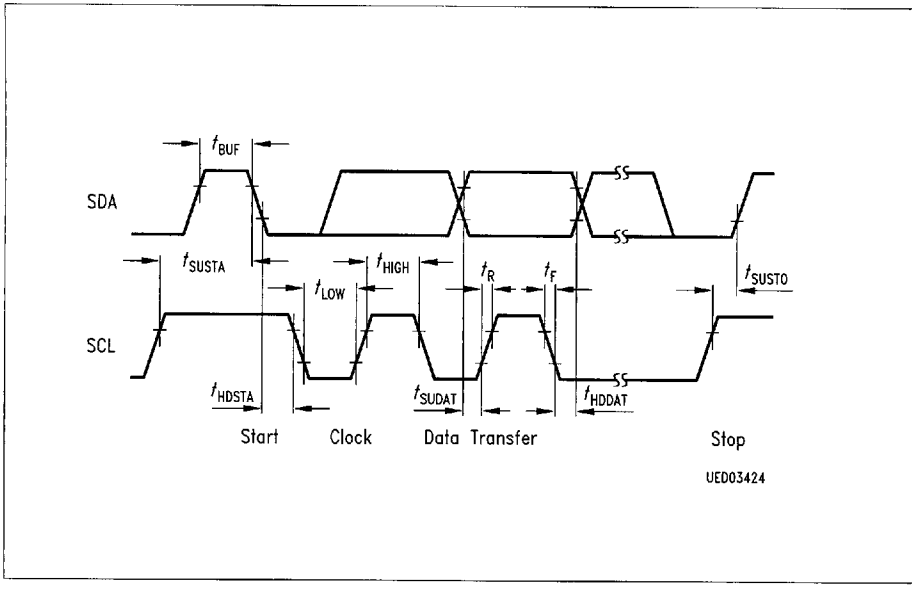

**Test Circuit 3**




**Application Circuit 1**




**Application Circuit 2**

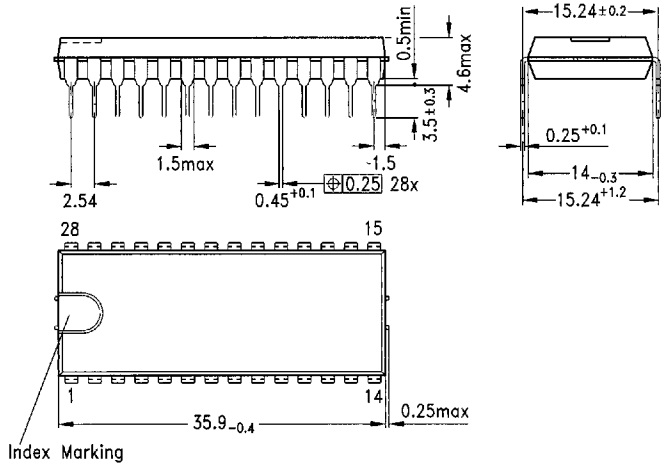



**I²C Bus Timing Diagram**

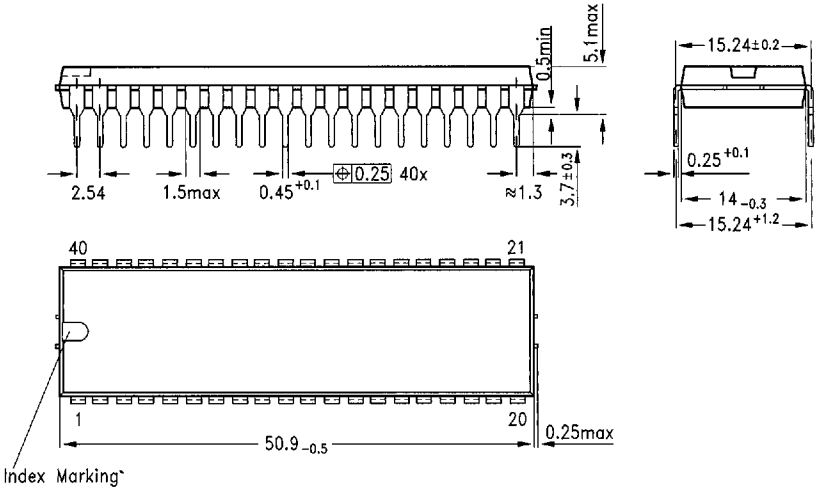
| | |
|---|---|
| $t_{SUSTA}$ | Setup time (start) |
| $t_{HDSTA}$ | Hold time (start) |
| $t_{HIGH}$ | H-pulse width (clock) |
| $t_{LOW}$ | L-pulse width (clock) |
| $t_{SUDAT}$ | Setup time (data transfer) |
| $t_{HDDAT}$ | Hold time (data transfer) |
| $t_{SUSTO}$ | Setup time (stop) |
| $t_{BUF}$ | Bus free time |
| $t_F$ | Fall time |
| $t_R$ | Rise time |

All times referred to $V_{IH}$ and $V_{IL}$ values.

**Plastic Package, P-DIP-28-3**
(Dual-in-Line)

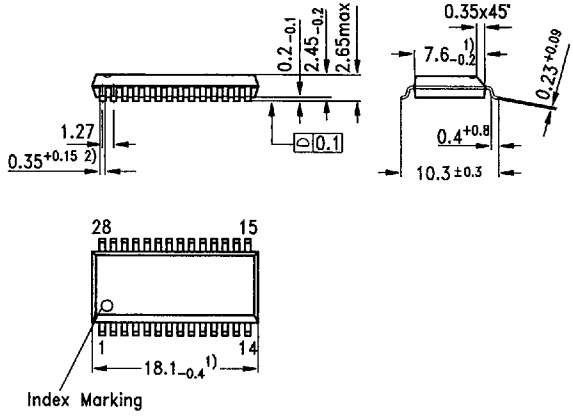



**Plastic Package, P-DIP-40-2**
(Dual-in-Line)




Dimensions in mm

## Plastic Package, P-DSO-28-1 (SMD)
(Plastic Dual Small Outline)




1) Does not include plastic or metal protrusions of 0.15 max per side
2) Does not include dambar protrusion of 0.05 max per side

**Sorts of Packing**
Package outlines for tubes, trays ect. are contained in our Data Book "Package Information"

SMD = Surface Mounted Devices

Dimensions in mm





B111-H6621-
G1-X-7600