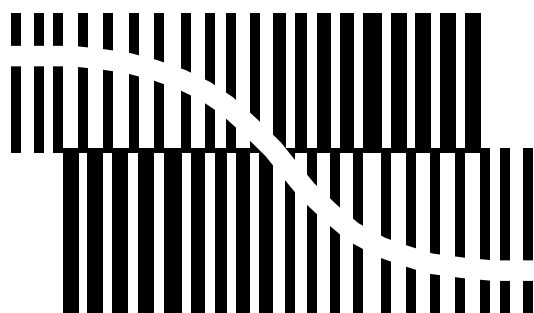


# DATA SHEET



BITSTREAM CONVERSION

## **TDA1307**

High-performance bitstream digital filter

Preliminary specification  
Supersedes data of July 1993  
File under Integrated Circuits, IC01

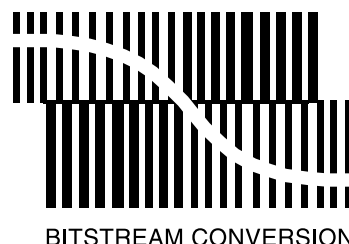
1996 Jan 08

## High-performance bitstream digital filter

TDA1307

## FEATURES

- Multiple format inputs: I<sup>2</sup>S, Sony 16, 18 and 20-bit
- 8-sample interpolation error concealment
- Digital mute, attenuation –12 dB
- Digital audio output function (biphase-mark encoded) according to IEC 958
- Digital silence detection (output)
- Digital de-emphasis (selectable, FS-programmable)
- 8 × oversampling finite impulse response (FIR) filter
- DC-cancelling filter (selectable)
- Peak detection (continuous) and read-out to microprocessor
- Fade function: sophisticated volume control
- Selectable 3rd/4th order noise shaping
- Selectable dither generation and automatic scaling
- Dedicated TDA1547 1-bit output
- Differential mode bitstream: complementary data outputs available
- Simple 3-line serial microprocessor command interface
- Flexible system clock oscillator circuitry
- Power-on reset
- Standby function
- SDIP42 package.



## QUICK REFERENCE DATA

Voltages are referenced to  $V_{SS}$  (ground = 0 V); all  $V_{SS}$  and all  $V_{DD}$  connections should be connected externally to the same supply.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{DDC1,2,3}$	supply voltage (pins 21, 41 and 8)		4.5	5.0	5.5	V
$V_{DDOSC}$	supply voltage (pin 24)		4.5	5.0	5.5	V
$V_{DDAR}$	supply voltage (pin 32)		4.5	5.0	5.5	V
$V_{DDAL}$	supply voltage (pin 29)		4.5	5.0	5.5	V
$I_{DDC1,2,3}$	supply current (pins 21, 41 and 8)	$V_{DD} = 5\text{ V}$	–	75	–	mA
$I_{DDOSC}$	supply current (pin 24)	$V_{DD} = 5\text{ V}$	–	2	–	mA
$I_{DDAR}$	supply current (pin 32)	$V_{DD} = 5\text{ V}$	–	2	–	mA
$I_{DDAL}$	supply current (pin 29)	$V_{DD} = 5\text{ V}$	–	1	–	mA
$f_{XTAL}$	oscillator clock frequency		–	33.8688	–	MHz
$T_{amb}$	operating ambient temperature		–20	–	+70	°C
$P_{tot}$	total power consumption		–	400	–	mW

## ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA1307	SDIP42	plastic shrink dual in-line package; 42 leads (600 mil)	SOT270-1

# High-performance bitstream digital filter

# TDA1307

## GENERAL DESCRIPTION

The TDA1307 is an advanced oversampling digital filter employing bitstream conversion technology, which has been designed for use in premium performance digital audio applications. Audio data is input to the TDA1307 through its multiple-format interface. Any of the four formats (I<sup>2</sup>S, Sony 16, 18 or 20-bit) are acceptable. By using a highly accurate audio data processing structure, including 8 times oversampling digital filtering and up to 4th order noise shaping, a high quality bitstream is produced which, when used in the recommended combination with the TDA1547 bitstream DAC, provides the optimum in dynamic range and signal-to-noise performance. With the TDA1307, a high degree of versatility is achieved by a multitude of functional features and their easy accessibility; error concealment functions,

audio peak data information and an advanced patented digital fade function are accessible through a simple microprocessor command interface, which also provides access to various integrated system settings and functions.

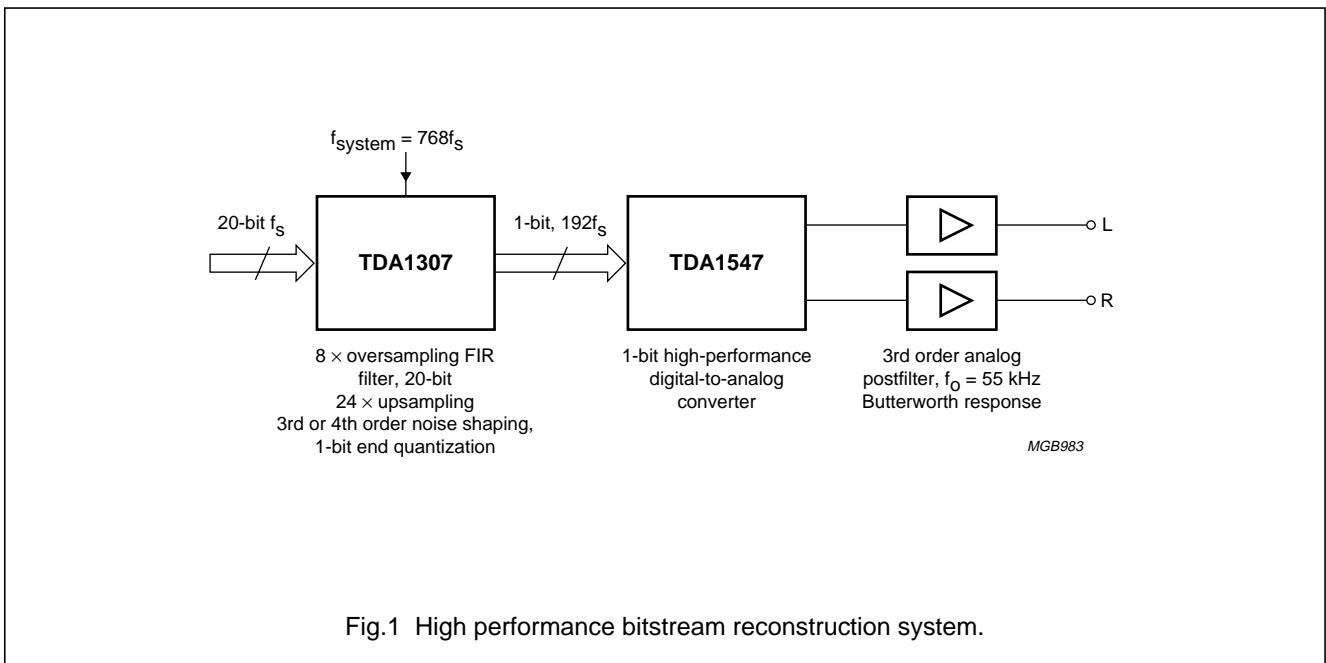
TDA1307 plus TDA1547 high-performance bitstream digital filter plus DAC combination:

For many features:

- Highly accessible structure
- Intelligent audio data processing.

For optimum performance:

- 4th order noise shaping
- Improvement dynamic range (113 dB)
- Improvement signal-to-noise (115 dB).



# High-performance bitstream digital filter

# TDA1307

## BLOCK DIAGRAM

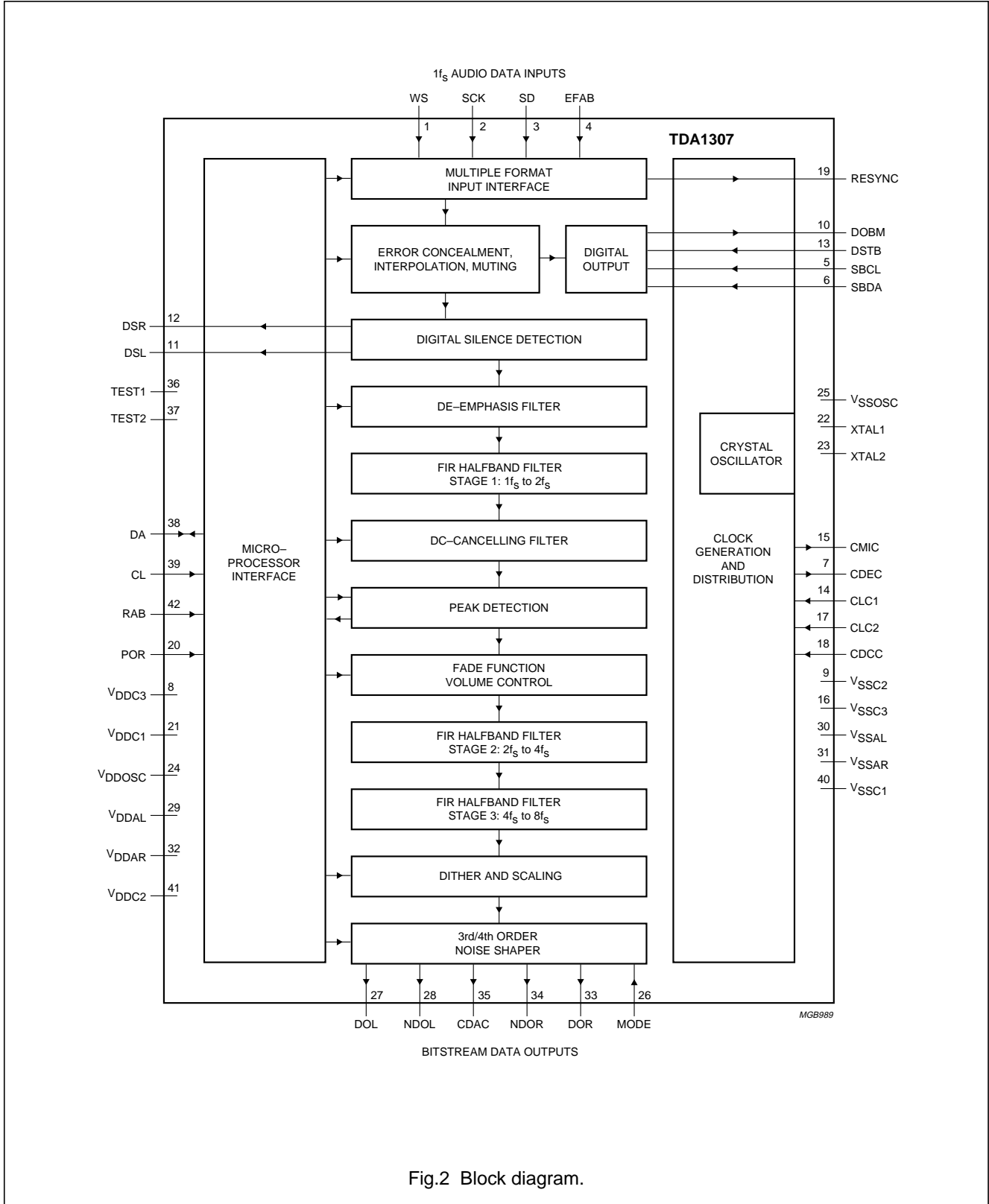


Fig.2 Block diagram.

## High-performance bitstream digital filter

TDA1307

## PINNING

SYMBOL	PIN	TYPE, I/O	DESCRIPTION
WS	1	I	word select input to data interface
SCK	2	I	clock input to data interface
SD	3	I	data input to interface
EFAB	4	I <sup>(1)</sup>	error flag (active HIGH): input from decoder chip indicating unreliable data
SBCL	5	I	subcode clock: a 10-bit burst clock (typ. 2.8224 MHz) input which synchronizes the subcode data
SBDA	6	I	subcode data: a 10-bit burst of data, including flags and sync bits, serially input once per frame, clocked by burst clock input SBCL
CDEC	7	O	decoder clock output: frequency division programmable by means of pins 14 (CLC1) and 17 (CLC2) to output 192, 256, 384 or 768 times $f_s$
V <sub>DDC3</sub>	8		positive supply 3
V <sub>SSC2</sub>	9		ground 2
DOBM	10	O	digital audio output: this output contains digital audio samples which have received interpolation, attenuation and muting plus subcode data; transmission is in biphase-mark code
DSL	11	O	digital silence detected (active LOW) on left channel
DSR	12	O	digital silence detected (active LOW) on right channel
DSTB	13	I <sup>(2)</sup>	DOBM standby mode enforce pin (active HIGH)
CLC1	14	I	application mode programming pin for CDEC (pin 7) frequency division
CMIC	15	O	clock output, provided to be used as running clock by microprocessor (in master mode only), output $96f_s$
V <sub>SSC3</sub>	16		ground 3
CLC2	17	I	application mode programming pin for CDEC (pin 7) frequency division
CDCC	18	I	master / slave mode selection pin
RESYNC	19	O	resynchronization: out-of-lock indication from data input section (active HIGH)
POR	20	I <sup>(2)</sup>	power-on reset (active LOW)
V <sub>DDC1</sub>	21		supply voltage 1
XTAL1	22	I	crystal oscillator terminal: local crystal oscillator sense forced input in slave mode
XTAL2	23	O	crystal oscillator output: drive output to crystal
V <sub>DDOSC</sub>	24		positive supply connection to crystal oscillator circuitry
V <sub>SSOSC</sub>	25		ground connection to crystal oscillator circuitry
MODE	26	I <sup>(2)</sup>	evaluation mode programming pin (active LOW); in normal operation, this pin should be left open-circuit or connected to the positive supply
DOL	27	O	data output left channel to bitstream DAC TDA1547
NDOL	28	O	complementary data output left channel to TDA1547 in double differential mode
V <sub>DDAL</sub>	29		positive supply connection to output data driving circuitry, left channel
V <sub>SSAL</sub>	30		ground connection to output data driving circuitry, left channel
V <sub>SSAR</sub>	31		ground connection to output data driving circuitry, right channel
V <sub>DDAR</sub>	32		positive supply connection to output data driving circuitry, right channel
DOR	33	O	data output right channel to TDA1547

High-performance bitstream digital filter

TDA1307

SYMBOL	PIN	TYPE, I/O	DESCRIPTION
NDOR	34	O	complementary data output right channel to TDA1547 in double differential mode
CDAC	35	O	clock output to bitstream DAC TDA1547
TEST1	36	I <sup>(1)</sup>	test mode input; in normal operation this pin should be connected to ground
TEST2	37	I <sup>(1)</sup>	test mode input; in normal operation this pin should be connected to ground
DA	38	I/O <sup>(2)</sup>	bidirectional data line intended for control data from the microprocessor and peak data from the TDA1307
CL	39	I <sup>(2)</sup>	clock input, to be generated by the microprocessor
V <sub>SSC1</sub>	40		ground 1
V <sub>DDC2</sub>	41		supply voltage 2
RAB	42	I <sup>(2)</sup>	command / peak data request line

Notes

1. These pins are configured as internal pull-down.
2. These pins are configured as internal pull-up.

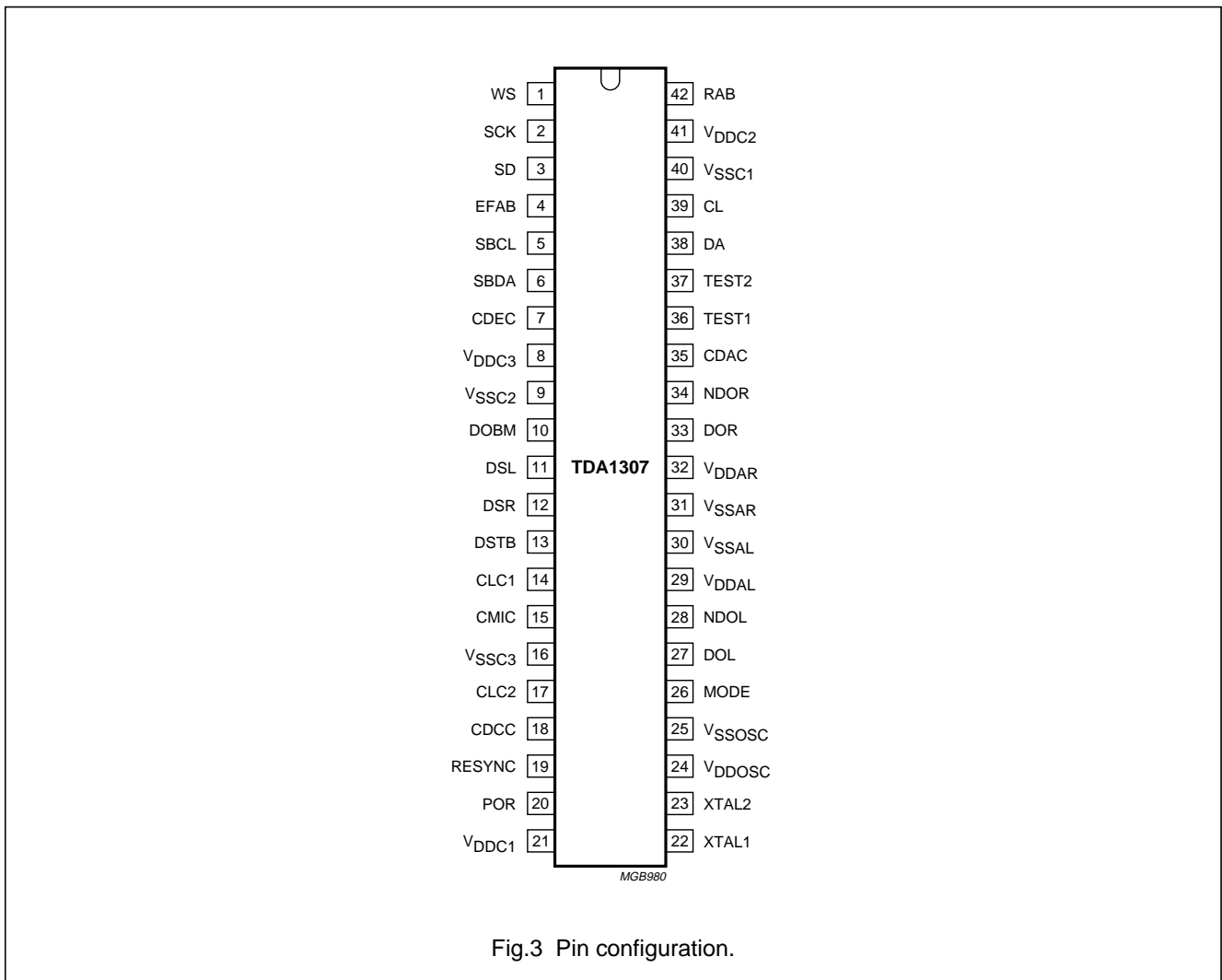


Fig.3 Pin configuration.

## High-performance bitstream digital filter

## TDA1307

**FUNCTIONAL DESCRIPTION**

In the block diagram, Fig.1, a general subdivision into three main functional sections is illustrated. The actual signal processing takes place in the central sequence of blocks, a representation of the audio data path from top to bottom. The two blocks named "Microprocessor Interface" and "Clock Generation and Distribution" fulfil a general auxiliary function to the audio data processing path. The Microprocessor Interface provides access to all the blocks in the audio path that require or allow for configuration or selection, and manipulates data read-out from the Peak Detection block, all via a simple three-line interface. The Clock Generation and Distribution section, driven either by its integrated oscillator circuit with external crystal or by an externally provided master clock, provides the data processing blocks with timebases, manages the system mode dependent frequency settings, and conveniently generates clocks for external use by the system decoder IC and microprocessor. Following are detailed explanations of the functions of each block in the audio data processing path and their setting options manipulated by the microprocessor interface, the use of the microprocessor interface, and the functions of the clock section with its various system settings.

**Clock generation and distribution**

The clock generation section of the TDA1307 is designed to accommodate two main modes. The master mode, in which the TDA1307 is the master in the digital audio system, and for which the clock is generated by connecting

a crystal of  $768f_s$  (33.8688 MHz) to the crystal oscillator pins XTAL1 (pin 22) and XTAL2 (pin 23); and the slave mode, in which the TDA1307 is supplied a clock by the IC in the system that acts as the master (e.g. the digital audio interface receiver). In this event a clock signal frequency of  $256f_s$  is input to pin XTAL1. Master or slave mode is programmed by means of pin CDCC (pin 18) logic 1 for master and logic 0 for slave mode. The circuit diagram of Fig.4 shows the typical connection of the external oscillator circuitry and crystal resonator for master mode operation. Note that the positive supply  $V_{DDOSC}$  is the reference to the oscillator circuitry. The LC network is used for suppression of the fundamental frequency component of the overtone crystal. Figure 5 shows how to connect for slave mode operation. A clock frequency of typical  $256f_s$  and levels of 0 V/+5 V is input to XTAL1 via AC coupling. The 100 k $\Omega$  resistor and the 10 nF capacitor are required to provide the necessary biasing for XTAL2 by filtering and feeding back the output signal of XTAL1.

Besides generating all necessary internal clocks for the audio data processing blocks and the clock to the DAC, the clock generation block further provides two clocks for external use when operating in master mode. Pin CDEC (pin 7) is used as the running clock for the system decoder IC, and pin CMIC (pin 15) is used as the running clock for the system microprocessor. CMIC outputs, by a fixed divider ratio to XTAL2, a clock signal at  $96f_s$ . For CDEC the divider ratio is programmable by means of pins CLC1 (pin 14) and CLC2 (pin 17). Table 1 gives the clock divider programming relationships.

**Table 1** Clock divider programming

CLC1	CLC2	CDEC OUTPUT FREQUENCY
0	0	$256f_s$
0	1	$384f_s$
1	0	$768f_s$
1	1	$192f_s$

High-performance bitstream digital filter

TDA1307

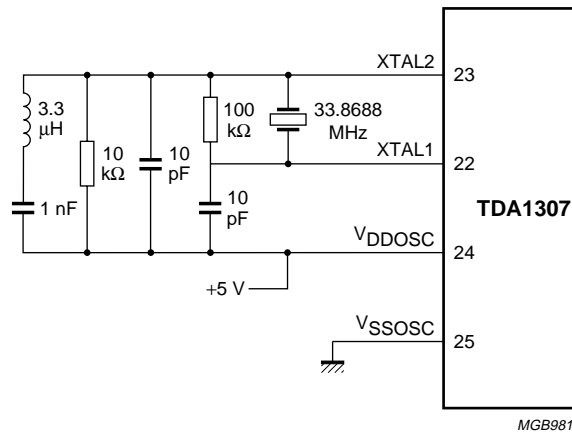


Fig.4 External crystal oscillator circuit.

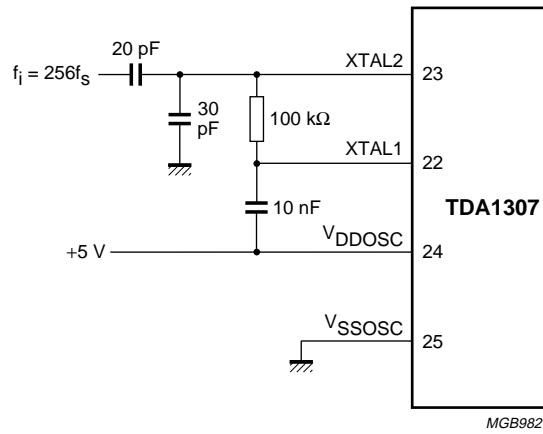


Fig.5 External clock input connections.



# High-performance bitstream digital filter

# TDA1307

### Microprocessor interface

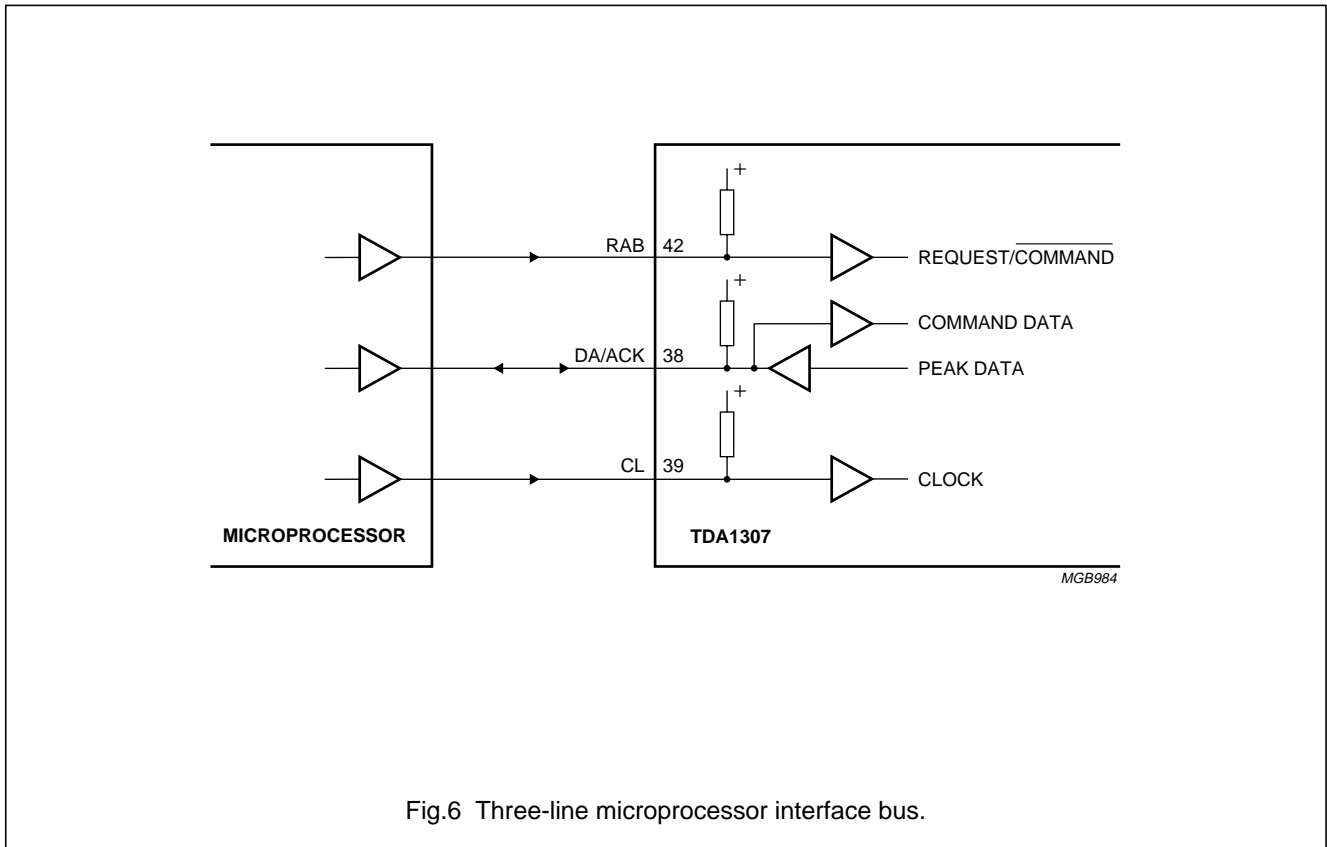
The microprocessor interface provides access to virtually all of the functional blocks in the audio data processing section. Its destination is two-fold: system constants (such as input format and sample frequency) as well as system variables (attenuation, muting, de-emphasis, volume control data etc.) can be 'written to' the respective blocks (command mode), and continuously collected stereo peak data 'read from' the peak detection block (peak request). The system settings are stored in the TDA1307 in an internal register file. Peak data is read from the stereo peak value register.

### THREE-LINE MICROPROCESSOR INTERFACE BUS

Communication is realized by a three-line bus, consisting of the following signals (see Fig.6):

- Clock input CL (pin 39), to be generated by the microprocessor
- Command/request input RAB (pin 42), by which either of the two mode commands (RAB = 0) and peak request (RAB = 1) are invoked
- Bidirectional data line DA (pin 38), which either receives command data from the microprocessor or outputs peak data from the peak detection block.

CL and RAB both default HIGH by internal pull-up, DATA is 3-state (high impedance, pull-up, pull-down).



# High-performance bitstream digital filter

# TDA1307

## INITIALIZATION OF THE BUS RECEIVER

The microprocessor interface section is initialized automatically by the power-on reset function, POR (pin 20). A LOW input on POR will initiate the reset procedure, which encompasses a functional reset plus setting of the initial states of the control words in the command register file. A wait time of at least one audio sample time after a LOW-to-HIGH transition of POR must be observed before communication can successfully be established between the TDA1307 and the microprocessor. In addition to the POR function, a software reset function issued from the microprocessor is provided (see section "Organization and programming of the internal register file"), which has the sole function of reinstating the initial values of the microprocessor control register. More information on initializing the TDA1307 can be found under "Application Information".

## COMMAND PROTOCOL

The protocol for writing data to the TDA1307 is illustrated in Fig.7. The command mode is invoked by forcing RAB LOW. A unit command is given in the form of an 8-bit burst on the DA line, clocked on the rising edge of CL. The command consists of 4 address bits followed by 4 control data bits (both MSB first). A next command may be immediately issued while keeping RAB forced LOW. Only commands for which the MSB of the address bits is

LOW are accepted; of the remaining set of addresses, only four have meaning (see section "Organization and programming of the internal register file"). The command input receiver is provided with a built-in protection against erroneous command transfer due to spikes, by a 2-bit debounce mechanism on lines DA and CL. The waveforms on these lines are sampled by the receiver at the internal system clock rate  $256f_s$ . A state transition on DA or CL is accepted only when the new state perseveres for two consecutive sampled waveform instants.

## ORGANIZATION AND PROGRAMMING OF THE INTERNAL REGISTER FILE

Command data received from the microprocessor is stored in an internal register file (see Table 2), which is organized as a page of 10 registers, each containing a 4-bit command data word (D3 to D0). Access to the words in the register file involves two controls: selection of the address of a set of registers (by means of A3, A2, A1 and A0) and setting the number of the bank in which the desired register is located (by means of the 'bank bits' B0 and B1). First the desired bank is selected by programming the command word at address 0000 (supplying the bank bits plus refreshing bits ATT and DIM). A subsequent addressing (one of three addresses, 1H, 4H and 6H) will yield access to the register corresponding to the last set bank.

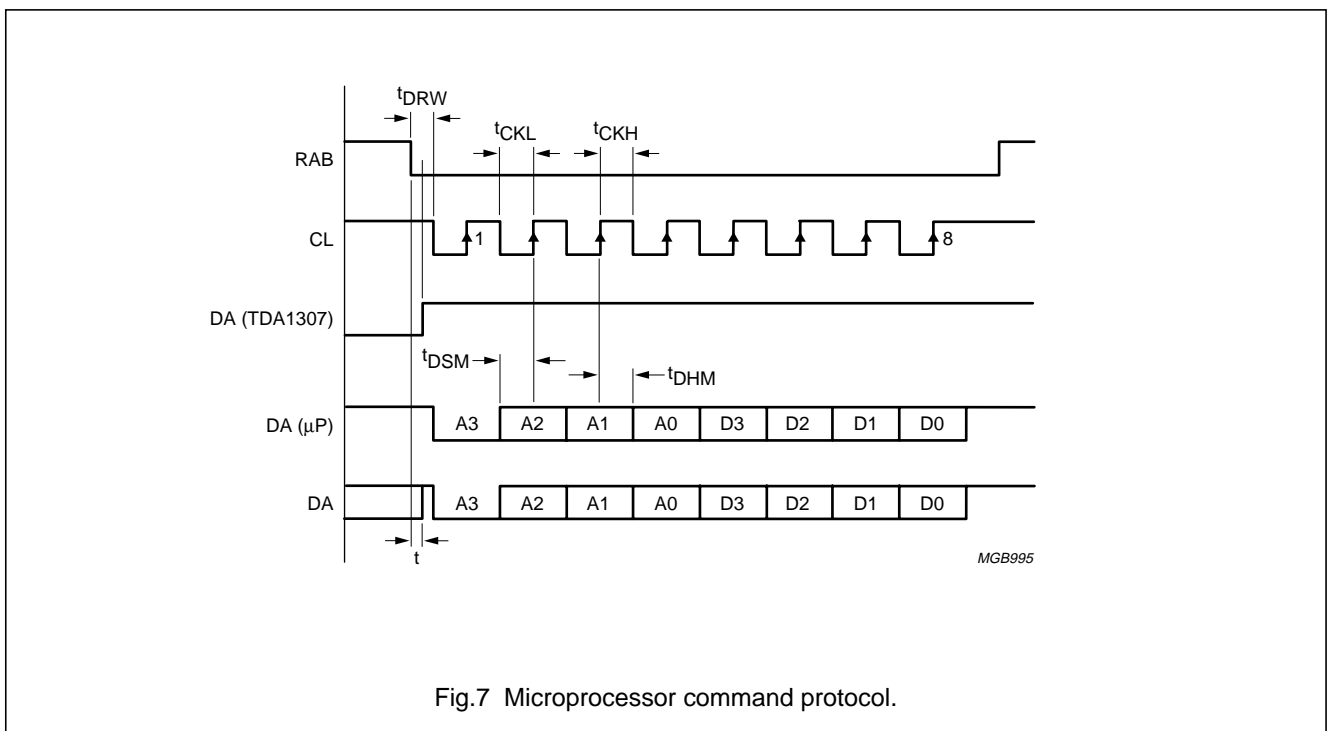


Fig.7 Microprocessor command protocol.

## High-performance bitstream digital filter

TDA1307

**Table 2** Microprocessor control register file

ADDRESS						D3	D2	D1	D0	INITIAL STATE
A3	A2	A1	A0	BANK						
				B0	B1					
0	0	0	0	X	X	BANK B0	BANK B1	ATT	DIM	0 0 1 1
0	0	0	1	0	1	FCON	DIT	FSS9	FSS8	0 0 0 0
				1	0	FSS7	FSS6	FSS5	FSS4	0 0 1 0
				1	1	FSS3	FSS2	FSS1	FSS0	1 0 0 0
0	1	0	0	0	1	DCEN	DCSH	FN9	FN8	0 1 1 1
				1	0	FN7	FN6	FN5	FN4	0 0 0 0
				1	1	FN3	FN2	FN1	FN0	1 1 0 1
0	1	1	0	0	1	DEMC1	DEMC0	RES0	RES1	0 0 0 0
				1	0	INS1	INS0	FS1	FS0	0 0 0 0
				1	1	RES2	NS	RST	STBY	1 0 0 0

Following is a list of the programming values for the various control words in the register file. Information on the meaning of the different controls can be found under the sections covering the corresponding signal processing blocks (see sections "Multiple format input interface" to "Third and fourth order noise shaping").

**BANK B0, BANK B1**

Programming of the bank bits is given in Table 2. The bank bits can be changed by addressing register location 0000. Subsequent addressing will result in access of locations according to the last selected bank.

**ATT**

Attenuation control bit: logic 1 to activate –12 dB attenuation, logic 0 to deactivate. As the attenuate control bit shares a control word with the bank bits, ATT has to be refreshed each time a new bank is selected.

**DIM**

Digital mute control bit: logic 1 to activate mute, logic 0 to deactivate. An active digital mute will override the attenuation function. As with ATT, DIM needs to be refreshed with each change in bank selection.

**FCON**

Fade function control bit: logic 1 to activate the fade function, logic 0 to deactivate.

**DIT**

Dither control bit: logic 1 to activate dither addition, logic 0 deactivates.

**FSS9 to FSS0**

Fade function 10-bit control value to program fade speed, in number of samples per fade step.

**DCEN**

DC-filter enable bit: logic 1 enables subtraction of the DC-level from the input signal, logic 0 disables.

**DCSH**

DC-filter sample or hold control bit: when DCSH = 0 the DC-level of the input signal is continuously evaluated. When DCSH = 1 the once acquired DC value, to be subtracted from the input signal, is held constant.

**FN9 to FN0**

Fade function 10-bit control value to program volume level.

**DEMC1, DEMC0**

De-emphasis function enable and  $f_s$  selection bits.

## High-performance bitstream digital filter

## TDA1307

**Table 3** De-emphasis mode programming

DEMC1	DEMC0	DE-EMPHASIS FUNCTION
0	0	de-emphasis disabled
0	1	de-emphasis for $f_s = 32.0$ kHz
1	0	de-emphasis for $f_s = 44.1$ kHz
1	1	de-emphasis for $f_s = 48.0$ kHz

**Table 4** Input format programming

INS1	INS0	INPUT FORMAT
0	0	I <sup>2</sup> S up to 20 bits
0	1	Sony format 16 bits
1	0	Sony format 18 bits
1	1	Sony format 20 bits

**Table 5** Sample frequency indication programming

FS1	FS0	DOB M SAMPLE FREQUENCY INDICATION
0	0	$f_s = 44.1$ kHz
0	1	$f_s = 48.0$ kHz
1	0	no meaning
1	1	$f_s = 32.0$ kHz

**RES2 to RES0**

These are reserved locations and have no functional meaning in the TDA1307.

**INS1, INS0**

Input format selection control bits.

**FS1, FS0**

Sample frequency indication control bits for the digital output section.

**NS**

Control bit for Noise Shaper section. When NS = 0, 3rd order noise shaping is selected; when NS = 1, 4th order noise shaping is selected.

**RST**

Software reset function. When RST = 1 the contents of the microprocessor control registers will immediately be preset to their initial values as shown in Table 2. As part of this reset action, bit RST is automatically returned to its initial state 0, that being normal operation.

**STBY**

Standby mode control bit. When STBY = 1 the standby mode will be initiated (explained under the section treating the Digital Output block). STBY = 0 for normal activity.

**PEAK DATA OUTPUT PROTOCOL**

The peak data read-out protocol is illustrated in Fig.8. A peak request is performed by releasing RAB (which will be pulled HIGH by TDA1307) while CL = HIGH, and maintaining RAB = 1 throughout the peak data transmission. TDA1307 will acknowledge the peak request by returning a LOW state on the DA line. Upon this peak acknowledge, the microprocessor may commence collecting data from the internal peak data output register (16-bit Left, 16-bit Right channel peak data) by sending a clock onto the CL line. The contents of the peak data output register will not change during the peak request. The first peak bit, the MSB of the Left channel peak value, is output upon the first LOW-to-HIGH transition of CL. To access Right channel peak value, all 16 bits of channel Left have to be read out, after which up to 16 bits of Right channel peak data may be read out. The peak data read out procedure may be aborted at any instant by returning RAB LOW, marking the end of the peak request: the internal peak register will be reset and the peak detector will start collecting new peak data and transferring this to the peak data output register.

High-performance bitstream digital filter

TDA1307

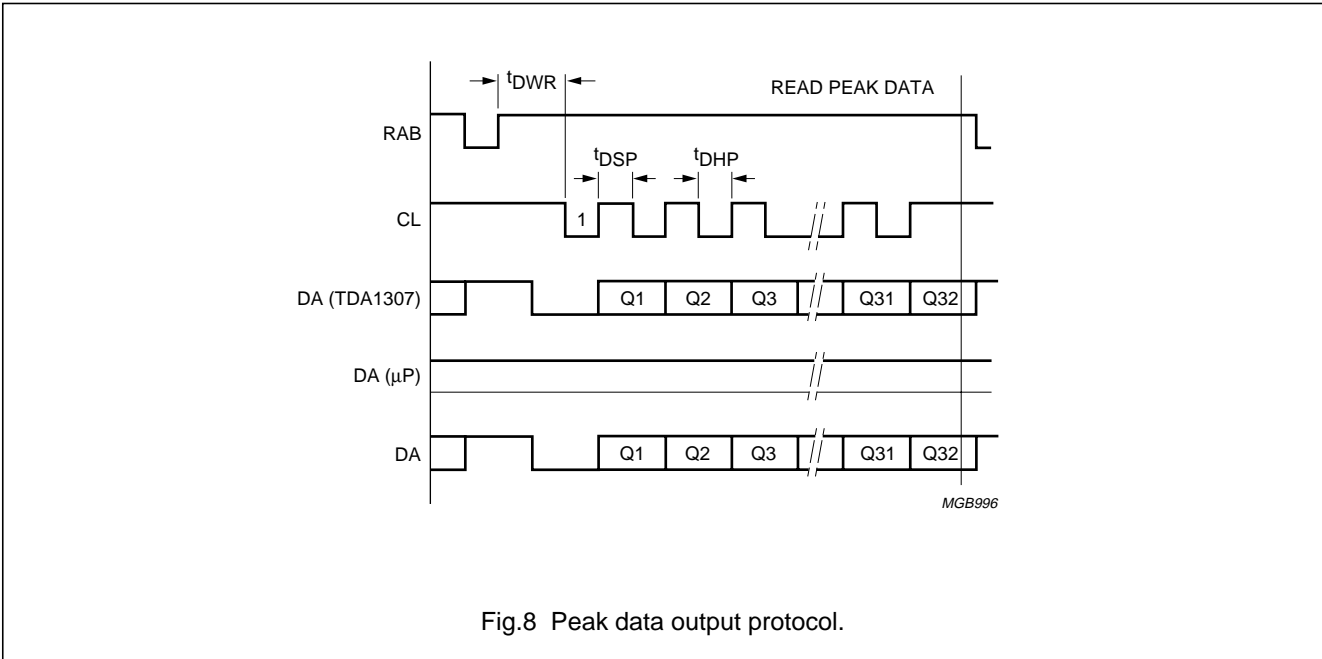


Fig.8 Peak data output protocol.

Multiple format input interface

Data input to the TDA1307 is accepted in four possible formats, I<sup>2</sup>S (with word lengths of up to 20 bits), and Sony formats of word lengths 16, 18 and 20-bit. The general appearance of the allowed formats is given in Fig.9. The selection of a format is achieved through programming of the appropriate bits in the microprocessor register file. Characteristic timing for the input interface is given in the diagram of Fig.10.

SYNCHRONIZATION

For correct data input to reach the central controller of TDA1307, synchronization needs to be achieved to the incoming 1f<sub>s</sub> I<sup>2</sup>S or Sony format input signals. The incoming WS signal is sampled to detect whether its phase transitions occur at the correct synchronous timing instants. This sampling occurs at the TDA1307 internal clock rate, 256f<sub>s</sub>. After one phase transition of WS, the next is expected after a fixed delay, otherwise the condition is regarded as out-of-lock and a reset is performed, this operation is repeated until synchronization is achieved. To allow for slight disturbances causing unnecessary frequent resets, the critical WS transitions are expected within a tolerance window (-4 to +4 periods of the 256f<sub>s</sub> internal sampling clock instants).

The reset action is flagged on the RESYNC (pin 19) output, which may be optionally used for muting or related purposes. RESYNC becomes HIGH the instant a reset is initiated, and remains in that state for at least one sample period (1/f<sub>s</sub>).

ERROR FLAG INPUT EFAB

The error flag input EFAB (pin 4) is intended as request line from the system decoder to the digital filter to indicate erroneous audio samples requiring concealment. A detected HIGH on input EFAB will be relayed by the input interface block to the error concealment block, where the samples flagged as erroneous will be processed accordingly.

High-performance bitstream digital filter

TDA1307

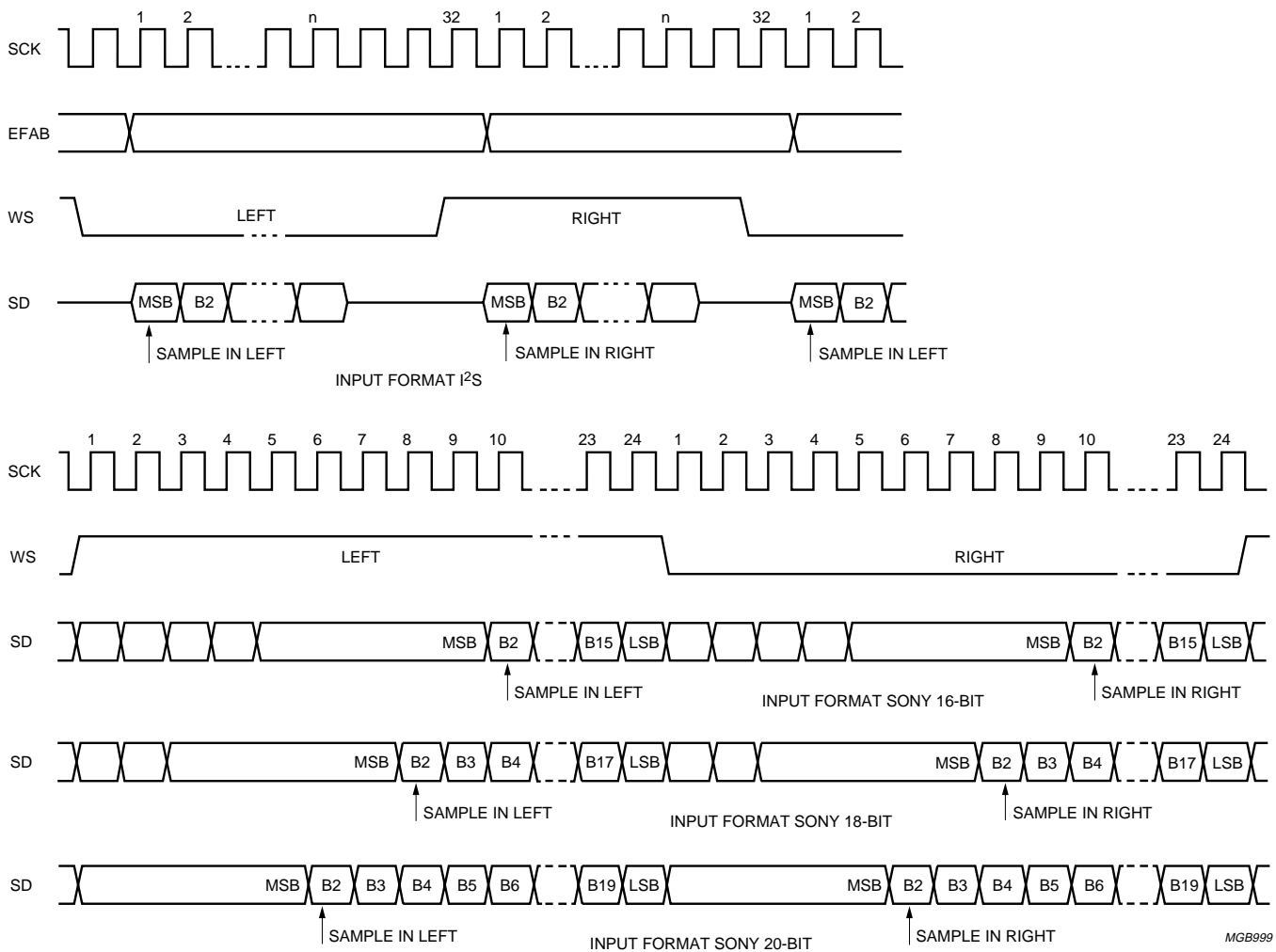
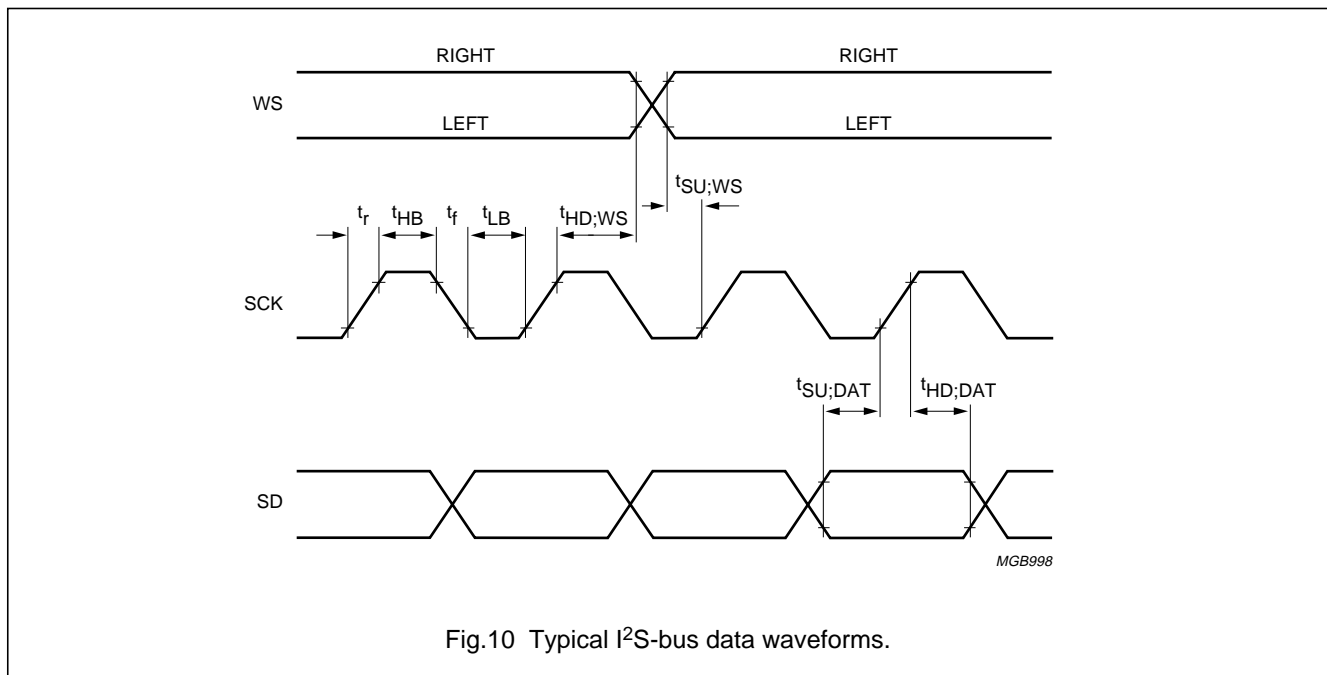


Fig.9 Input formats.

## High-performance bitstream digital filter

TDA1307

Fig.10 Typical I<sup>2</sup>S-bus data waveforms.**Error concealment, interpolation and muting**

The error concealment functional block performs three functions:

1. interpolation of up to eight consecutive erroneous audio samples flagged as such by input EFAB
2. attenuation
3. muting of incoming audio, both the latter if so activated by means of the microprocessor registers.

Furthermore, as these functions constitute error processing functions, operation of any of these functions is reported to the digital output DOBM by setting the validity flag.

**EIGHT-SAMPLE INTERPOLATION**

Incoming audio samples may be visualized as entering a memory pipeline, nine audio sample instants in depth, upon entering the error concealment block. Any audio samples marked as erroneous by the flag input EFAB will be reconstructed by linear approximation from the values of the adjacent correct samples (the last correct sample still available, and the next correct sample). The linear interpolation is started as soon as a correct sample becomes available within nine sampling instants. Should a flagged erroneous condition persevere for over eight sampling instants, then the last correct sample will be held for as long as necessary, i.e. until the next correct sample enters the pipeline. The linear approximation is then

initiated over the maximum interpolation interval of eight sampling instants.

**ATTENUATION**

The concealment block incorporates a digital  $-12$  dB attenuation function intended to be used in program search or other player actions that may generate audible transitional effects such as loud clicks. The attenuate function is activated by means of bit ATT in the microprocessor register file. Setting this bit to logic 1 causes the next audio sample (attenuate never takes action on incomplete samples) to be attenuated with immediate effect (the validity flag of the digital audio output DOBM is set).

The interpolation facility is called upon when an attenuate command is given while the incoming data is flagged as invalid by EFAB. If no more than eight samples in succession are invalid, attenuate may take immediate effect (this causes the output value to ramp linearly to the final attenuated level). If nine or more samples in a row are flagged erroneous, attenuation is postponed and the last good sample held, until the next good sample becomes available. Upon that instant, the output ramps linearly, over the maximum interpolation time span, to the attenuated first correct sample. Releasing attenuate (bit ATT reset to 0) always has immediate effect (i.e. the next complete audio sample will pass unattenuated).

# High-performance bitstream digital filter

# TDA1307

### MUTING

The digital mute of the error concealment block immediately (i.e. on the next whole audio sample) sets the input to the digital filter to all zeros, regardless of any other current action in the error concealment block. The digital mute function is activated by means of bit DIM in the microprocessor register file. Setting this bit to logic 1 causes the next audio sample to be muted (the validity flag of the digital audio output DOBM is set).

Releasing the digital mute function (resetting bit DIM to 0) will cause the output of the error concealment block to approach the unaffected audio sample value by linear approximation, on the condition that the mute action spanned at least 8 consecutive audio samples. If there are samples in error at the time of releasing mute, the release action is postponed until good data becomes available, after which the linear ramp can be made over the maximum interpolation time span.

### Digital output (DOBM)

The DOBM block constructs a biphas modulated digital audio output signal which complies to the IEC standard 958, to be used as a digital transmission link between digital audio systems. A variety of inputs are combined, arranged and modulated to finally form the output biphas-mark sequence. The inputs are the following:

- left and right audio data, word length 20-bit, as delivered by the error concealment block

- the Validity flag as output by the error concealment block
- subcode information, as acquired by input via pins SBDA (pin 6) and SBCL (pin 5)
- sampling frequency information as set by means of bits FS1 and FS0 in the microprocessor register file.

As the digital output function is not always required, and can give rise to interference problems in high-quality audio conversion systems, the DOBM output can be switched **on** or **off** by means of pin DSTB (digital output standby, 13). Leaving DSTB open-circuit will cause it to pull HIGH and deactivate the DOBM output; tying DSTB LOW enables the digital output function.

The programming of bits FS1 and FS0 is specified in Table 5 under section "Microprocessor interface". The DOBM block of TDA1307 translates the settings of these bits to the appropriate corresponding information in the digital audio output sequence (as specified by IEC 958).

The inputs SBDA (subcode data, 6) and SBCL (subcode clock, 5) allow for the merging of subcode data into the output DOBM signal. The input sequence via these inputs is defined as 10-bit burst words, arranged as illustrated in Fig.11; the bit nomenclature corresponds to that used in the IEC standard 958. Both subcode data and clock signals are normally supplied by the decoder of the digital audio system (e.g. SAA7310).

For set-up and hold timing of the SBDA and SBCL inputs, restrictions identical to the audio data inputs are valid.

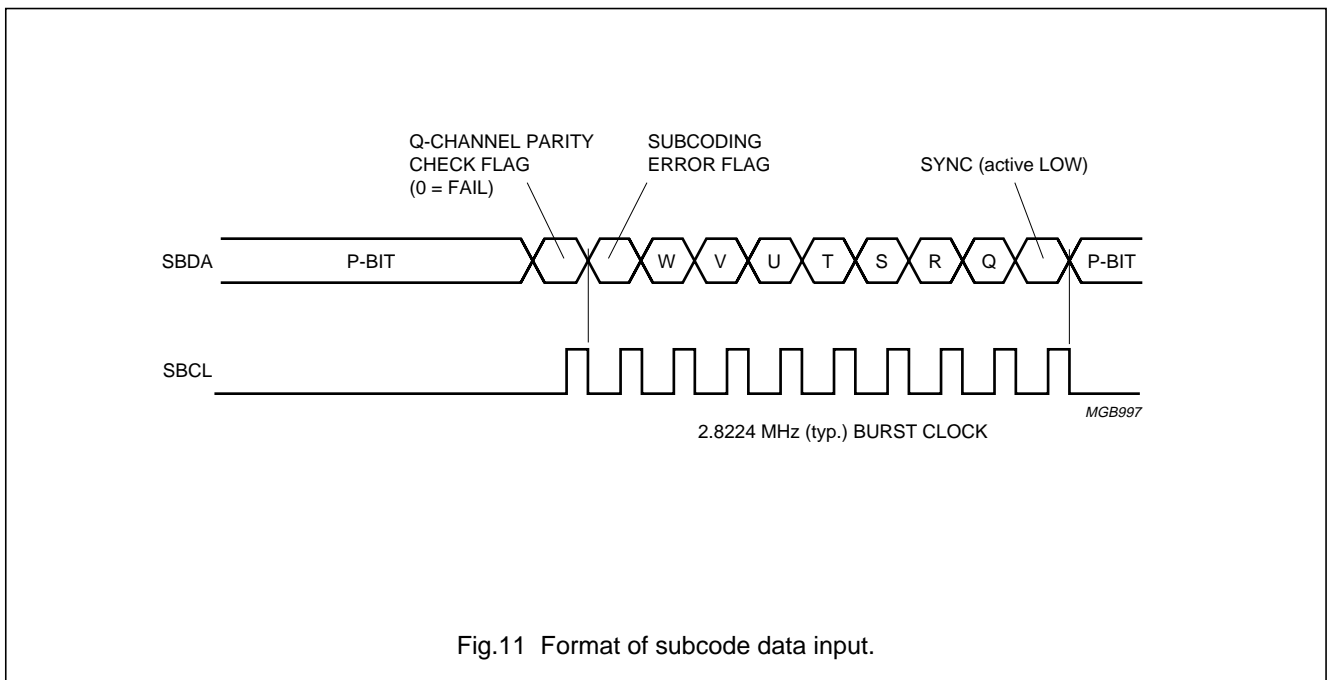


Fig.11 Format of subcode data input.



## High-performance bitstream digital filter

## TDA1307

### Digital silence detection

The TDA1307 is designed to detect digital silence conditions in channels left and right, separately, and report this via two separate output pins, one for each channel, DSL (pin 11) and DSR (pin 12). This function is implemented to allow for external manipulation of the audio signal upon absence of program material, such as muting or recorder control. The TDA1307 itself does not influence the audio signal as a result of digital silence; the sole function of this block is detection, and any further treatment must be accomplished externally.

An active LOW output is produced at these pins if the corresponding channel carries either all zeroes for at least 8820 consecutive audio samples (200 ms for  $f_s = 44.1$  kHz).

The digital silence detection block receives its left and right audio data from the error concealment block (implying that a digital mute action will produce detection of a digital silence condition), and passes it unaffected to the next signal processing stage, the de-emphasis block.

### De-emphasis filter

The TDA1307 incorporates selectable digital de-emphasis filters, dimensioned to produce, with extreme accuracy, the de-emphasis frequency characteristics for each of the three possible sample rates 32, 44.1 and 48 kHz. As a 20-bit dynamic range is maintained throughout the filter, considerable margin is kept with respect to the normal CD resolution of 16-bit i.e. the digital de-emphasis of TDA1307 is a truly valid alternative to analog de-emphasis in high-performance digital audio systems.

Selection of the de-emphasis filters is performed via the microprocessor interface, bits DEMC1 and DEMC0, for which the programming is given in Table 3.

### Oversampling digital filter

The oversampling digital filter in the digital audio reconstruction system is of paramount influence to the fidelity of signal reproduction. Not only must the filter deliver a desired stop-band suppression while sustaining a certain tolerated pass-band ripple, but it must also be capable of faithfully reproducing signals of high energy content, such as signals of high level and frequency, square wave-type signals and impulse-like signals (all of these examples have their counterparts in actual music program material). Filters optimized only towards pass-band ripple and stop-band suppression are capable of entering states of overload because of the clustered energy content of these signals, thus introducing audible

degradations in processing the mentioned types of excitations. To dimension a high-fidelity digital filter, a balance must be established between filter steepness and overload susceptibility.

The oversampling digital filter function in the TDA1307 is designed, in combination with the noise shaper, to deliver the highest fidelity in signal reproduction possible. Not only are stop-band suppression and pass-band ripple parameters to the design, but also the prevention of detrimental artifacts of too extreme filtering: impulse and high-level overload responses. The outcome is a patented design excelling in natural response to most conceivable audio stimuli. It is realized as a series of three half-band filters, each oversampling by a ratio of two, thus achieving an eight times oversampled and interpolated data output to be input to the noise shaper. Each stage has a finite impulse response with symmetrical coefficients, which makes for a linear phase response. Filter stages 1, 2 and 3 incorporate 119, 19 and 11 delay taps respectively. To maintain an output accuracy of 20 bits, an internal data path word length of 39 bits is used to supply the required headroom in multiplications. Requantization back to 20-bit word length is performed by noise shaping (thus effectively preventing rounding errors in so far as they have effect in the audio frequency band), at the output of each filter section.

The successive half-band filter stages are, for efficiency, distributed over the audio data processing path: DC-filtering, peak value reading and volume control are performed between stages 1 and 2 (the  $2f_s$  domain).

### DC-cancelling filter

A mechanism for optionally eliminating potential DC content of incoming audio data is implemented in the TDA1307 for three main reasons. Most importantly because it is called for by the implementation of volume control in the TDA1307. An audio signal that is to be subjected to volume control (multiplication by a controlled attenuation factor) should be free of offset, otherwise the controlled multiplication will produce the undesired side effect of modulating the average DC content. The second reason is supplied by the implementation of audio peak data read-out in the TDA1307. As the peak value is obtained from the absolute value of the audio data referenced to zero DC level, its accuracy is impaired by the presence of residual DC information, progressively so for lower audio levels. The third reason is brought about by application of the noise shaper. To optimize the dynamic behaviour of the noise shaper especially for low-level signals, it is supplied a predefined offset, sometimes referred to as DC dither. Taking no precautions against DC

# High-performance bitstream digital filter

# TDA1307

content of the source audio data may render the DC dither potentially ineffective.

In applications where the DC content of the audio information may be expected, application of the selectable DC filter may be opted for. It is implemented as a first-order high-pass filter with a corner frequency of 2 Hz. Control of the DC filter is achieved by accessing the appropriate bits DCEN (DC filter enable) and DCSH (DC filter sample or hold) in the microprocessor register file. The principle of operation is illustrated in Fig.12. The output of the DC filter, referred to in the diagram as 'audio output' always equals the audio input subtracted by the output of the low-pass branch. Depending on the control bit DCSH, this subtraction value is either the last value held constant or a value continuously adapting to incoming DC content. The DC filter is effectively switched **on** or **off** via control bit DCEN, which selects the input of the low-pass section either to be the audio input data (the output of the low-pass section will settle to the low frequency content of the audio data so that the filter is **on**) or a preset value of zero (low-pass output will settle to zero meaning 'filter **off**'). The constant mode is implemented to provide a mode in which a stable subtraction value is guaranteed; in this mode however the high-pass function is inhibited so there is no adaptation to changes in the DC content of the incoming source information.

### Peak detection

The TDA1307 provides a convenient way to monitor the peak value of the audio data, for left and right channels individually, by way of read-out via the microprocessor interface. Peak value monitoring has its applications

mainly in digital volume unit measurement and display, and in automatic recording level control. The peak level measurement of the TDA1307 occurs with a resolution of 16-bit, providing a dynamic range amply suitable for all practical applications.

The output of the peak detection block is a register of two 16-bit words, one for each channel, representing the absolute value of the accumulated peak value, accessible via the microprocessor interface. The peak detection block continuously monitors the audio information arriving from the DC-cancelling filter, comparing its absolute value to the value currently stored in the peak register. Any new value greater than the currently held peak value will cause the register to assume the new, greater value. Upon a peak request (for which the protocol is described in section "Peak data output protocol"), the contents of the peak register are transferred to the microprocessor interface. After a read action, the peak register will be reset, and the collection of new peak data started.

The peak detection block receives data that has been processed by the first half-band stage of the oversampling interpolating digital filter (in the  $2f_s$  domain, but the peak detection 'samples' at  $1f_s$  for efficiency). This means that the scaling applied in this first half-band stage is noticeable in the measured peak value. The frequency-independent attenuation factor of the first half-band filter equals 0.175 dB - this results in a possible range for the output peak value of 0 to 32114. When the audio signal may be expected to carry DC content, use of the DC cancelling filter of TDA1307 is recommended, to ensure correct and accurate peak detection.

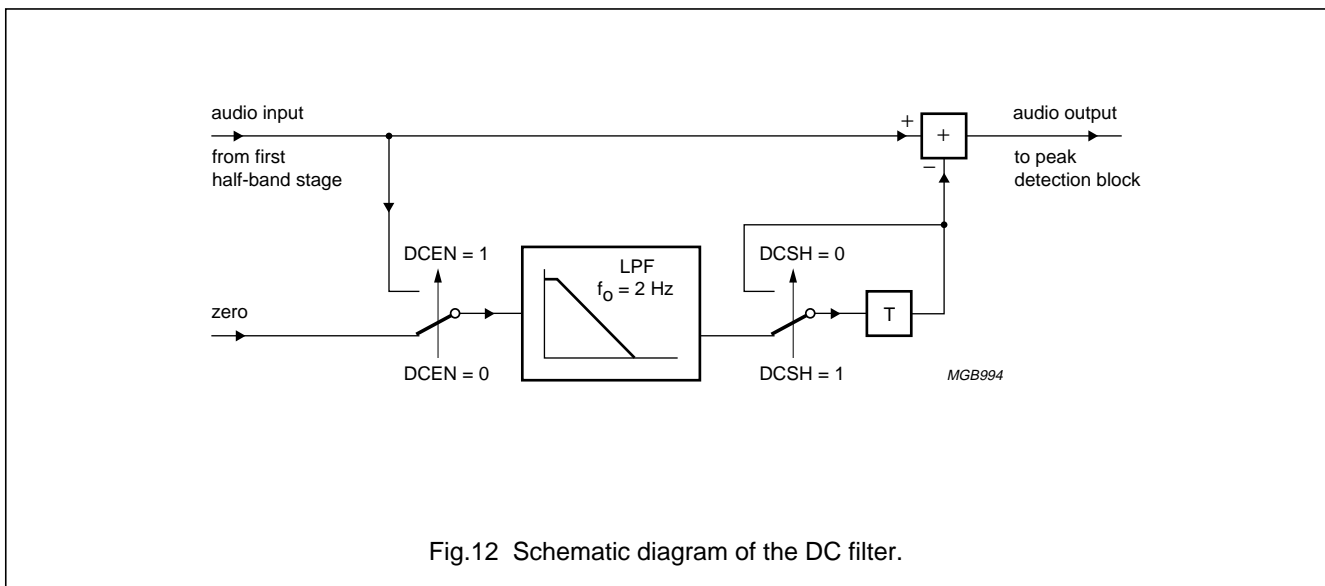


Fig.12 Schematic diagram of the DC filter.

High-performance bitstream digital filter

TDA1307

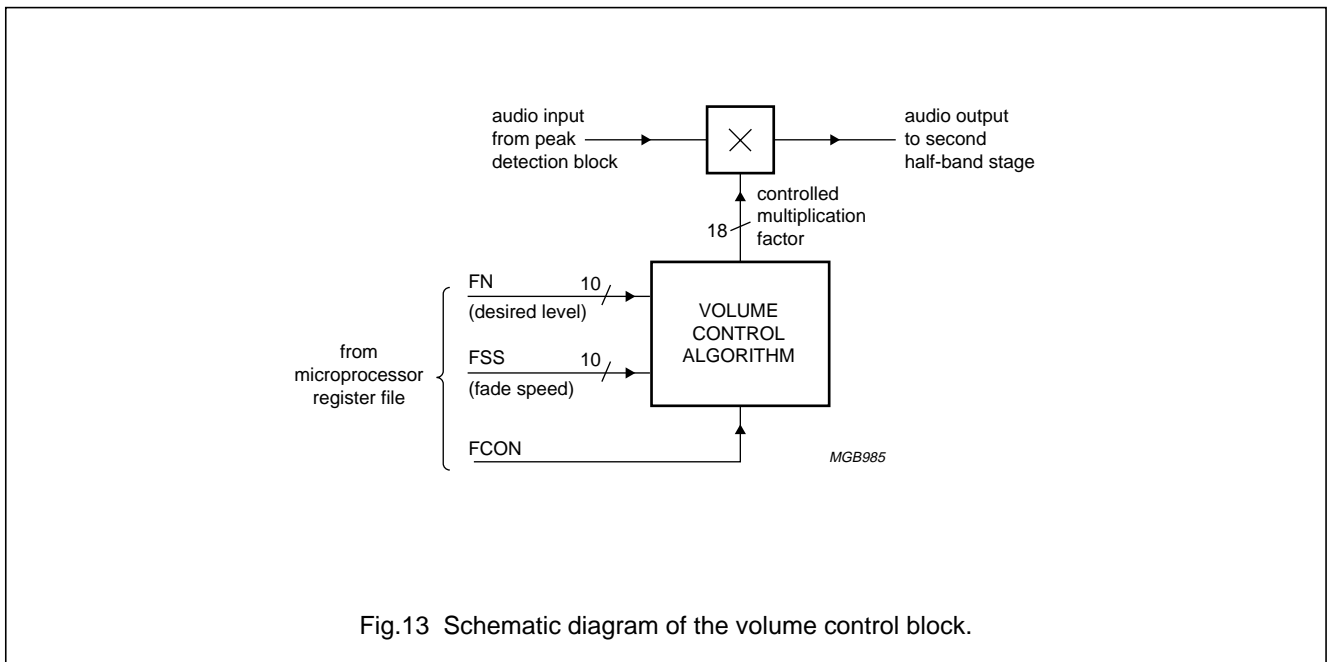


Fig.13 Schematic diagram of the volume control block.

**Fade function and volume control**

One of the main features of TDA1307 is a patented, advanced digital volume control with inherent fading function, exhibiting an accuracy and smoothness unsurpassed in presently available digital filters. Only the desired volume and the fade speed need to be instructed to the TDA1307, which can be realized in a single instruction via the microprocessor interface. The volume control function then autonomously performs automatic fade in or fade out to the desired volume by a natural, exponential approach. It allows for volume control to an accuracy of 0.1 dB over the range from 0 dB of full scale to beyond -100 dB. The speed of approach can be set over a wide range, varying from less than one second to over 23 seconds for a complete fade. Furthermore the fade algorithm manages the additional fading resolution, in excess of the 0.1 dB available for the volume desired level, needed to ensure gradual changes in volume at all times. Figure 13 illustrates the volume control block.

Three data entities in the microprocessor register file pertain to the volume control block: a 10-bit control value for the desired volume (bits FN9 to FN0), a 10-bit control value for the fade speed (bits FSS9 to FSS0), and the fade function override bit, FCON. The volume control word ranges from 0 (representing a desired volume level of 0 dB) to 1023 (representing maximum desired volume level of zero or -∞ dB). For values 1 to 1023, an LSB change of the volume control word represents 0.1 dB change of volume level. In changing from one volume level to the next desired volume level, the volume control block

calculates and applies intermediate volume levels according to an exponential approach curve. The speed at which the approach curve progresses is determined by the value of the fade speed control word, FSS. FSS + 2 is the amount of time delay applied, in units of audio sample instants, before a next value on the exponential curve is calculated and applied.

The total duration of an exponential fade operation is the product of the desired amount of volume change ΔFN (in LSBs of the 10-bit control word) and the amount of delay per fade step FSS (in LSB times seconds), expressed as follows:

$$t_{\text{fade, exp, total}} = \Delta FN \times \frac{(FSS + 2)}{f_s}$$

where  $f_s$  is the base-band sampling frequency.

Thus the longest fade time achievable, occurring in the event of maximum desired volume change ΔFN = 1023, slowest speed setting FSS = 1023, and in the event that  $f_s = 44.1$  kHz, is 23.7 seconds.

To smooth out fast volume changes however, the TDA1307 fade function adds extra resolution to the volume control by gradually changing from one exponential step to the next, by a linear transition. Whereas the 10-bit FN-value could not accomplish discrete attenuation steps finer than 0.1 dB, the linear transitional approach enhances volume change resolution to 15-bit. The volume level therefore never changes faster than one LSB of the 15-bit attenuation factor per audio sample. As soon as the linear transition reaches the value

## High-performance bitstream digital filter

TDA1307

determined by the exponential approach, the attenuation value remains stable until the next exponential value is due, which will again initially be approached linearly. For exponential fade speeds higher than the linear approach can follow, the approach remains linear unless the exponential approach curve is intersected. For fast volume decrease, the start of the approach will be linear, whereas for a fast volume increase, the course of the fade approach will be exponential at first, then saturating to linear.

The fastest fade speed, for large volume changes, is therefore determined by the linear approach. For a maximum volume change at maximum speed, follows a fade time of  $(2^{15} - 1)/44\,100 = 0.74$  seconds.

For immediate return to the maximum volume level without altering the volume and fade speed settings, bit FCON in the register file can be used. With this bit set to 1, the fade function is active and operates as described above. Resetting FCON to 0 will immediately deactivate the fade function, that is, return the volume level to maximum at the start of the next audio sample. Changing state of FCON from 0 to 1 will cause a fade according to the current settings of volume and speed control words FN and FSS.

In Fig.14, a few fading examples illustrate the operation of the TDA1307 advanced digital volume control.

### Dither and scaling

Prior to input to the noise shaper, final preprocessing is performed upon the eight times oversampled and interpolated audio data stream in the form of scaling and dither addition. The fixed scaling factor, a frequency-independent attenuation of 3 dB, is applied to the signal in order to provide the noise shaper with sufficient headroom. The application of dither is optional, selectable by means of bit DIT in the microprocessor register file.

With DIT set to 1, fixed dither levels of value  $2^{-6} + 2^{-5}$  and  $2^{-6} - 2^{-5}$  are added alternately to the audio signal, at an alternation rate of  $4f_s$ . This amounts to a combination of an AC dither signal of frequency  $4f_s$  and amplitude  $-24$  dB of full-scale, with a DC dither (offset) of 3.125% of full-scale peak amplitude. With DIT set to 0, no dithering, AC or DC, is performed.

Although the addition of dither is made selectable in the TDA1307, it is generally recommended for use always, as dither is essential to the accurate conversion of low-level signals and reproduction of silence conditions by noise-shaping circuits.

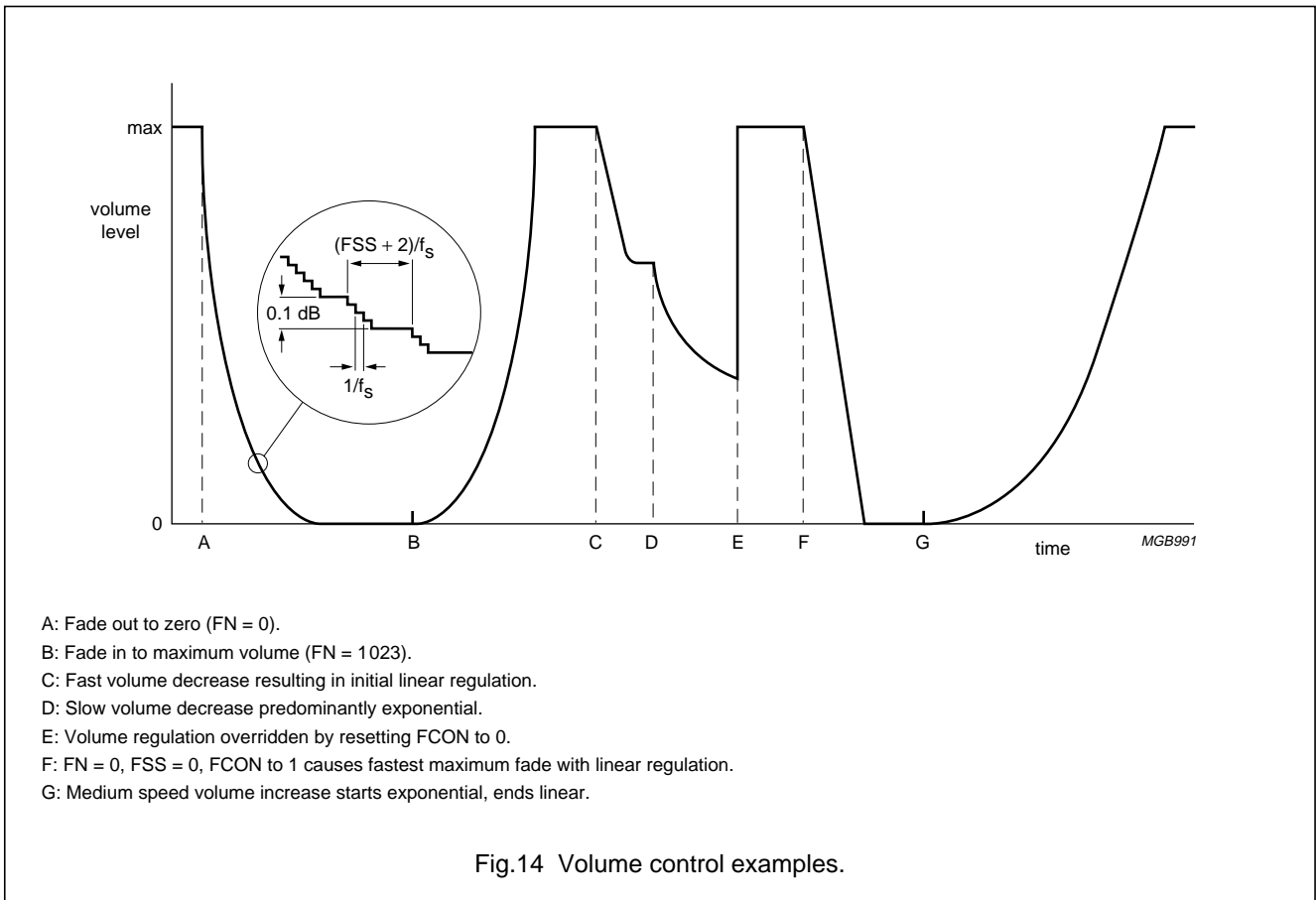
### Third and fourth order noise shaping

The noise shaper constitutes the final audio processing stage of TDA1307, which takes the eight times oversampled and interpolated audio data stream from the digital filter as input, and by extreme oversampling and 1-bit end quantization processes the signal so that it can be converted to analog by a one-bit digital-to-analog converter. The order of the noise shaper is selectable, between 3rd and 4th order, by means of the register file bit NS (NS = 0: 3rd order, NS = 1: 4th order). Together with the final oversampling ratio, the noise shaper order determines the dynamic range (or accuracy) that the noise shaper can achieve (the oversampling ratio will depend on the system clock frequency and application mode used). Table 6 gives the dynamic range of the noise shaper as a function of these two parameters.

Figures 15 and 16 show noise spectral density simulations of the third and fourth order noise shaper respectively, with a stimulus frequency of 1 kHz at a level of  $-10$  dB<sub>f<sub>s</sub></sub>, for  $192 \times 44.1$  kHz oversampling. From the slope of the shaped noise spectrum outside the audio band, the order of noise shaping is apparent. It is important to note that, in contrast to normal fourth-order noise shaping, where an audio post-filter of equal order would be needed to compensate the slope of the quantization noise, the fourth-order noise shaper of the TDA1307 actually only needs third order post-filtering to obtain the same amount of stop-band suppression as with third order. The noise density of the fourth order noise shaper starts at a lower level for low frequencies, and only slightly exceeds the third-order curve in the 200 to 300 kHz region.

High-performance bitstream digital filter

TDA1307

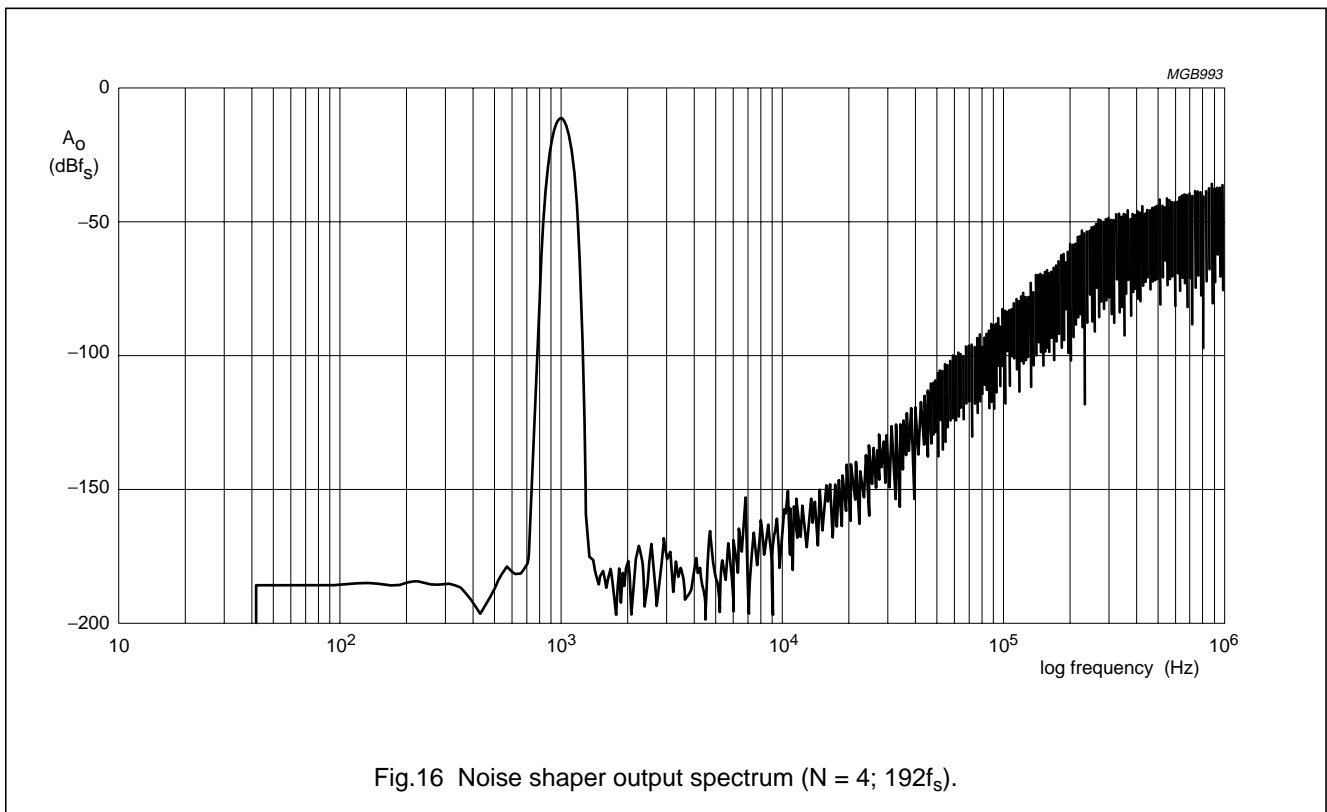
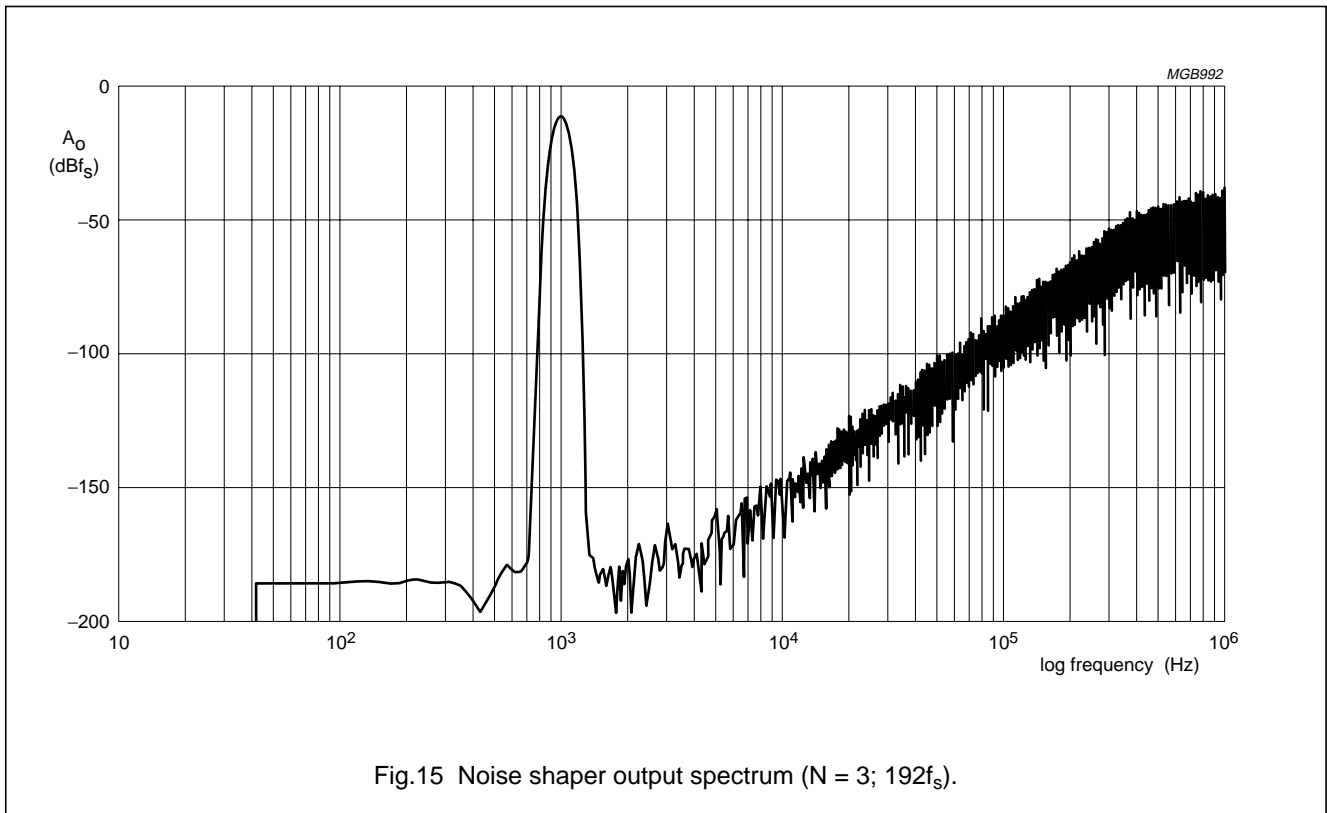


**Table 6** Noise shaper dynamic range

OVERSAMPLING/ORDER	3rd ORDER	4th ORDER
128f <sub>s</sub>	105 dB	118 dB
192f <sub>s</sub>	117 dB	134 dB

High-performance bitstream digital filter

TDA1307



## High-performance bitstream digital filter

TDA1307

**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{DD}$	supply voltages (pins 8, 21, 24, 29, 32 and 41)		-0.5	+6.5	V
$V_I$	maximum input voltage	note 1	-0.5	$V_{DD} + 0.5$	V
$I_{IK}$	DC clamp input diode current	$V_I < -0.5$ V or $V_I > V_{DD} + 0.5$ V	-	$\pm 10$	mA
$I_{OK}$	DC output clamp diode current; (output type 4 mA)	$V_O < -0.5$ V or $V_O > V_{DD} + 0.5$ V	-	$\pm 20$	mA
$I_O$	DC output source or sink current; (output type 4 mA)	$-0.5$ V $< V_O < V_{DD} + 0.5$ V	-	$\pm 20$	mA
$I_{DD}, I_{SS}$	DC $V_{DD}$ or GND current per supply pin		-	$\pm 50$	mA
$P_{O, cell}$	power dissipation per output (type 4 mA)		-	50	mA
$T_{stg}$	storage temperature		-55	+150	°C
$T_{amb}$	operating ambient temperature		-20	+70	°C
$V_{es}$	electrostatic handling	100 pF; 1.5 k $\Omega$	-2000	+2000	V

**Note**

- Input voltage should not exceed 6.5 V.

**THERMAL CHARACTERISTICS**

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th j-a}$	thermal resistance from junction to ambient in free air	39	K/W

## High-performance bitstream digital filter

TDA1307

**CHARACTERISTICS** $V_{DD} = 4.5$  to  $5.5$  V;  $V_{SS} = 0$  V;  $T_{amb} = -20$  to  $+70$  °C and oscillator frequency 33.8688 MHz; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supplies</b>						
$V_{DDC1,2,3}$	supply voltage (pins 8, 21 and 41)		4.5	5.0	5.5	V
$V_{DDOSC}$	supply voltage (pin 24)		4.5	5.0	5.5	V
$V_{DDAR}$	supply voltage (pin 32)		4.5	5.0	5.5	V
$V_{DDAL}$	supply voltage (pin 29)		4.5	5.0	5.5	V
$V_{diff}$	maximum difference between supplies		–	–	tbf	V
$I_{DDC1,2,3}$	supply current (pins 8, 21 and 41)	$V_{DD} = 5$ V	–	75	–	mA
$I_{DDOSC}$	supply current (pin 24)	$V_{DD} = 5$ V	–	2	–	mA
$I_{DDAR}$	supply current (pin 32)	$V_{DD} = 5$ V	–	2	–	mA
$I_{DDAL}$	supply current (pin 29)	$V_{DD} = 5$ V	–	1	–	mA
<b>Inputs</b>						
CLC1, CLC2, EFAB, SCK, WS, SD, SBCL, DA, SBDA, CDCC, TEST1 AND TEST2						
$V_{IL}$	LOW level input voltage	note 1	–	–	$0.3V_{DD}$	V
$V_{IH}$	HIGH level input voltage	note 1	$0.7V_{DD}$	–	–	V
$I_{LI}$	input leakage current	note 2	–1	–	+1	$\mu$ A
$R_I$	input resistance	note 3	17	–	134	k $\Omega$
$C_I$	input capacitance		–	–	10	pF
CL, RAB, POR, DSTB AND MODE						
$V_{IL}$	LOW level input voltage	note 1	–	–	$0.2V_{DD}$	V
$V_{IH}$	HIGH level input voltage	note 1	$0.8V_{DD}$	–	–	V
$R_I$	input resistance	note 3	17	–	134	k $\Omega$
$C_I$	input capacitance		–	–	10	pF
<b>Outputs</b>						
CDEC AND CMIC (TYPE 4 MA)						
$V_{OL}$	LOW level output voltage	$I_{OL} = 4$ mA	–	–	0.5	V
$V_{OH}$	HIGH level output voltage	$I_{OH} = -4$ mA	$V_{DD}-0.5$	–	–	V
$C_L$	load capacitance		–	–	30	pF
CDAC (TYPE TBF MA)						
$V_{OL}$	LOW level output voltage	$I_{OL} = 8$ mA	–	–	0.5	V
$V_{OH}$	HIGH level output voltage	$I_{OH} = -8$ mA	$V_{DD}-0.5$	–	–	V
$C_L$	load capacitance		–	–	100	pF



## High-performance bitstream digital filter

TDA1307

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>DOR, DOL, NDOR AND NDOL (TYPE CUSTOM MA)</b>						
V <sub>OL</sub>	LOW level output voltage	I <sub>OL</sub> = 2 mA	–	–	0.5	V
V <sub>OH</sub>	HIGH level output voltage	I <sub>OH</sub> = –2 mA	V <sub>DD</sub> –0.5	–	–	V
C <sub>L</sub>	load capacitance		–	–	100	pF
<b>DOBM (TYPE 12 MA)</b>						
V <sub>OL</sub>	LOW level output voltage	I <sub>OL</sub> = 12 mA	–	–	0.5	V
V <sub>OH</sub>	HIGH level output voltage	I <sub>OH</sub> = –12 mA	V <sub>DD</sub> –0.5	–	–	V
C <sub>L</sub>	load capacitance		–	–	50	pF
<b>DSR, DSL AND RESYNC (TYPE 2 MA)</b>						
V <sub>OL</sub>	LOW level output voltage	I <sub>OL</sub> = 2 mA	–	–	0.5	V
V <sub>OH</sub>	HIGH level output voltage	I <sub>OH</sub> = –2 mA	V <sub>DD</sub> –0.5	–	–	V
C <sub>L</sub>	load capacitance		–	–	50	pF
<b>DA (TYPE 2 MA)</b>						
V <sub>OL</sub>	LOW level output voltage	I <sub>OL</sub> = 2 mA	–	–	0.5	V
V <sub>OH</sub>	HIGH level output voltage	I <sub>OH</sub> = –2 mA	V <sub>DD</sub> –0.5	–	–	V
C <sub>L</sub>	load capacitance		–	–	50	pF
R <sub>Lint</sub>	internal load resistance		17	–	134	kΩ
<b>Crystal oscillator</b>						
<b>INPUT: XTAL1</b>						
g <sub>m</sub>	mutual conductance	f = 2 MHz	–	0.4	–	mS
G <sub>v</sub>	small-signal voltage gain	G <sub>v</sub> = g <sub>m</sub> × R <sub>O</sub>	–	72	–	
I <sub>LI</sub>	input leakage current	note 2	–1	–	+1	μA
C <sub>I</sub>	input capacitance		–	10	–	pF
<b>Timing</b>						
f <sub>XTAL</sub>	operating frequency		33.8688			MHz
<b>SCK, WS, DATA, SBDA, SBCL AND EFAB (SEE FIGS 8 AND 9)</b>						
f <sub>CL</sub>	SBCL clock frequency	note 3	–	–	64f <sub>s</sub>	Hz
f <sub>SCK</sub>	SCK clock frequency		–	–	64f <sub>s</sub>	Hz
f <sub>WS</sub>	WS clock frequency		–	f <sub>XTAL</sub> /768	–	Hz
t <sub>LB</sub>	clock time LOW		110	–	–	ns
t <sub>HB</sub>	clock time HIGH		110	–	–	ns
t <sub>r</sub>	input rise time		–	–	20	ns
t <sub>f</sub>	input fall time		–	–	20	ns
t <sub>SU:DAT</sub>	data set-up time		20	–	–	ns
t <sub>HD:DAT</sub>	data hold time		0	–	–	ns
t <sub>SU:WS</sub>	WS set-up time		20	–	–	ns
t <sub>HD:WS</sub>	WS hold time		0	–	–	ns

## High-performance bitstream digital filter

TDA1307

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
MICROCONTROLLER INTERFACE (SEE FIGS 6 AND 7)						
$f_{CK}$	CL input clock frequency		–	–	$46f_s$	kHz
$t_{CKL}$	input clock time LOW		2.0	–	–	$\mu\text{s}$
$t_{CKH}$	input clock time HIGH		2.0	–	–	$\mu\text{s}$
$t_{DSM}$	microprocessor data set-up time after CL LOW-to-HIGH transition		1.0	–	–	$\mu\text{s}$
$t_{DHM}$	microprocessor data hold time after CL LOW-to-HIGH transition		2.0	–	–	$\mu\text{s}$
$t_{DSP}$	peak data set-up time after CL LOW-to-HIGH transition		2.0	–	–	$\mu\text{s}$
$t_{DHP}$	peak data hold time after CL LOW-to-HIGH transition		2.0	–	–	$\mu\text{s}$
$t_{dRW}$	delay to write after read		2.0	–	–	$\mu\text{s}$
$t_{dWR}$	delay to read after write		2.0	–	–	$\mu\text{s}$
DOBM CIRCUIT						
$f_{DOBM}$	data output frequency		–	$128f_s$	–	Hz
$t_r$	output rise time	$C_L = 50 \text{ pF}$	–	–	10	ns
$t_f$	output fall time	$C_L = 50 \text{ pF}$	–	–	10	ns
$t_{SU;DAT}$	data set-up time		40	–	–	ns
$t_{HD;DAT}$	data hold time		5	–	–	ns
CLOCK GENERATOR CIRCUIT (NOTE 4)						
$f_{XTAL1}$	XTAL1 input clock frequency	slave mode	–	$256f_s$	–	Hz
$f_{CDEC}$	CDEC output clock frequency		–	$256f_s$	–	Hz
$f_{CMIC}$	CMIC output clock frequency		–	$96f_s$	–	Hz

**Notes**

1. Minimum  $V_{IL}$ , maximum  $V_{IH}$  are peak values to allow for transients.
2.  $I_{I(\min)}$  measured at  $V_I = 0 \text{ V}$ ;  $I_{I(\max)}$  measured at  $V_I = V_{DD}$ ; not valid for pins with pull-up/pull-down resistors.
3.  $I_{I(\min)}$  measured at  $V_I = 0 \text{ V}$  (pull-up);  $I_{I(\max)}$  measured at  $V_I = V_{DD}$  (pull-down); valid for pins with pull-up/pull-down resistors.
4. Crystal frequency: 33.8688 MHz ( $768f_s$ ), the oscillator circuit oscillates at a frequency that is approximately 0.01% above the crystal frequency.

**QUALITY SPECIFICATION**

In accordance with "SNW-FQ-611E". The numbers of the quality specification can be found in the "Quality Reference Handbook". This handbook can be ordered using the code 9397 750 00192.

## High-performance bitstream digital filter

## TDA1307

## APPLICATION INFORMATION

## Application modes

TDA1307 can be used as a digital reconstruction filter for CD, DCC, DAB and DAT applications. The configuration for these different applications is given in Table 7.

**Table 7** Application modes

MODE	CDCC	CRYSTAL	CLOCK INPUT	BITSTREAM OUTPUT	SAMPLING FREQUENCY
CD	1	$768f_s$	–	$192f_s$	44.1 kHz
DCC	0	–	$256f_s$	$128f_s$	32.0 or 44.1 or 48.0 kHz
DAB	0	–	$256f_s$	$128f_s$	32.0 kHz
DAT	0	–	$256f_s$	$128f_s$	32.0 or 44.1 or 48.0 kHz

The crystal frequency for TDA1307, when operating in master mode, is  $768f_s$  ( $f_s = 44.1$  kHz). TDA1307 can also operate in slave mode, in which the clock input receives a clock signal of  $256f_s$  ( $f_s = 32.0, 44.1$  or  $48.0$  kHz). In the latter configuration, no resonator is connected to TDA1307.

## Basic application

Figures 17 to 20 show the connections for an example of a complete bitstream reconstruction system, using TDA1307 together with TDA1547, as implemented in a demonstration application printed-circuit board. Figure 15 shows the connections pertaining to TDA1307. Both master and slave operation is possible, by setting of switches J1 and J2, and by programming the desired mode and frequency divisions by switch block SW1. Both test pins of TDA1307 are tied to ground in order to obtain immunity to crosstalk from the adjacent clock output CDAC. At pin POR (pin 20), an RC-timing network presets a typical power-on-reset LOW-time (10 ms for an instantaneously setting 5 V supply).

## Typical application with TDA1547 Bitstream DAC

The high-quality one-bit audio data stream produced by the TDA1307 is optimally converted to analog using the TDA1547 high-performance bitstream digital-to-analog converter. The TDA1547 takes the data outputs DOL (pin 27) and DOR (pin 33) of the TDA1307 as input, clocked by TDA1307 output CDAC (pin 35), and converts the digital data to 'one-bit' analog values (positive reference value and negative reference value) through a differentially configured high-speed, high-accuracy switched capacitor network.

This differential application can be further enhanced to a double-differential application, combining the assertive data outputs with the complementary data outputs NDOL (pin 28) and NDOR (pin 34) into a set of two TDA1547s, by which it is possible to achieve additional noise margin. The application of Figs 17 to 19 is an example of a differential application. A schematic diagram of the double differential mode application is illustrated in Fig.20.

High-performance bitstream digital filter

TDA1307

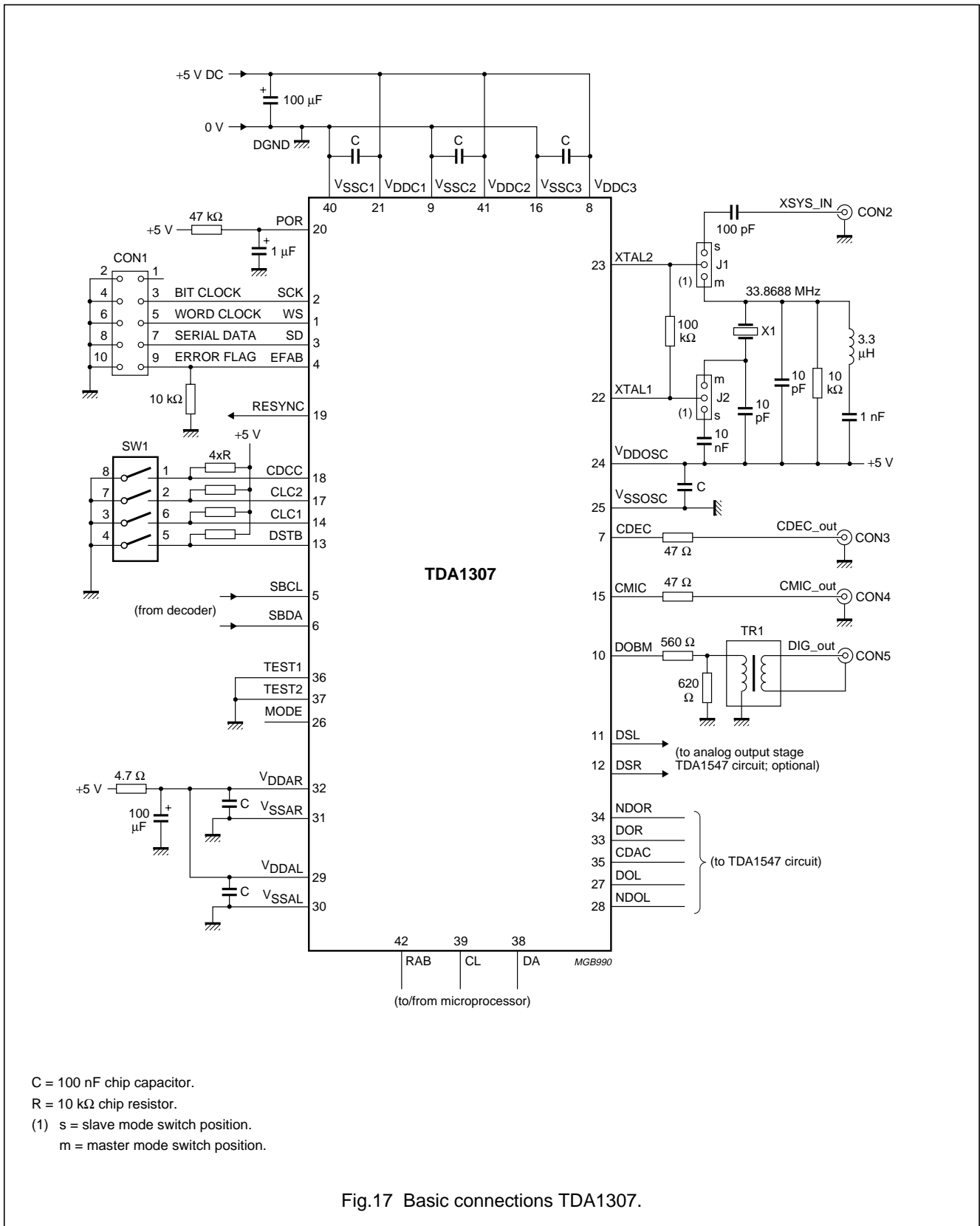
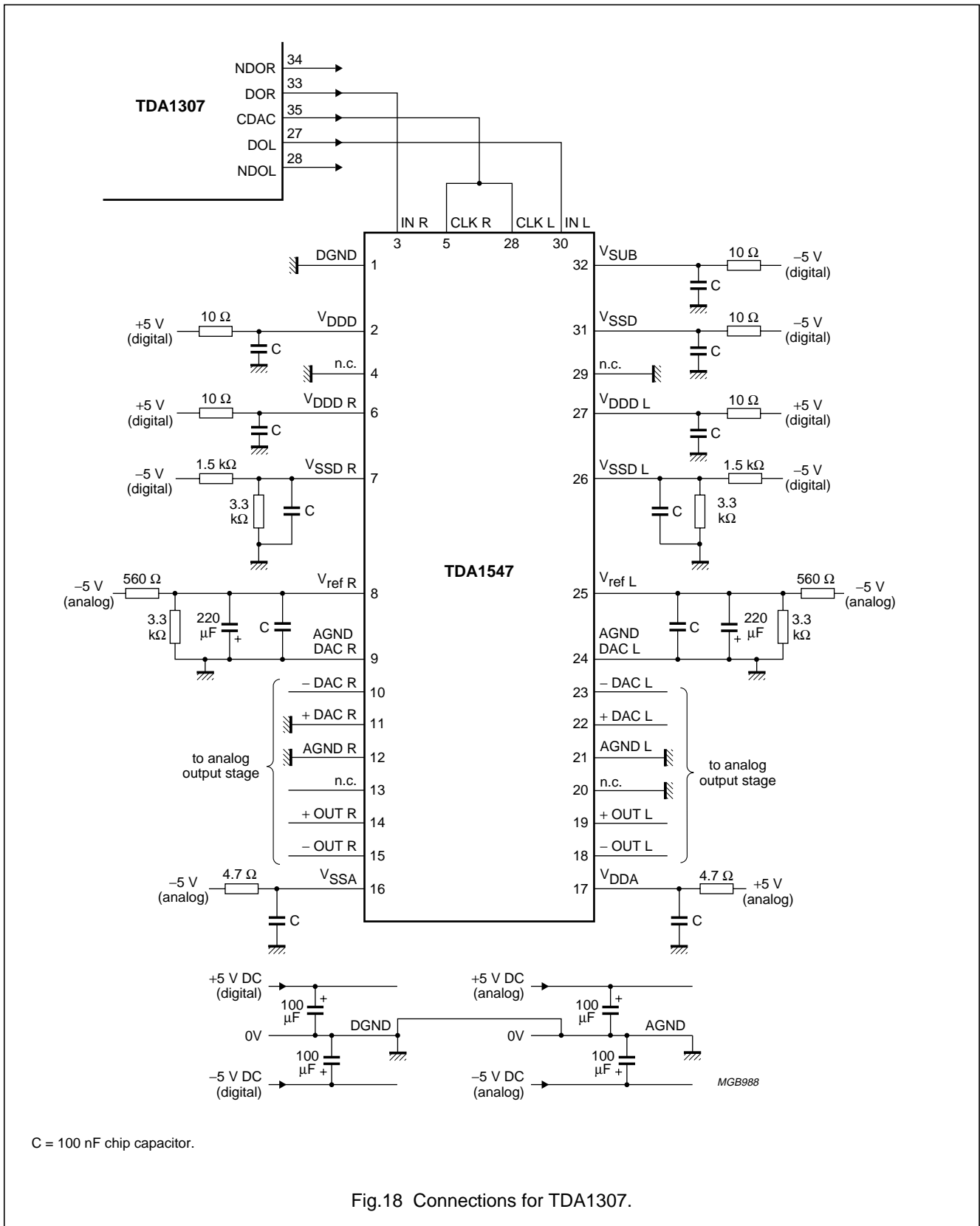


Fig.17 Basic connections TDA1307.

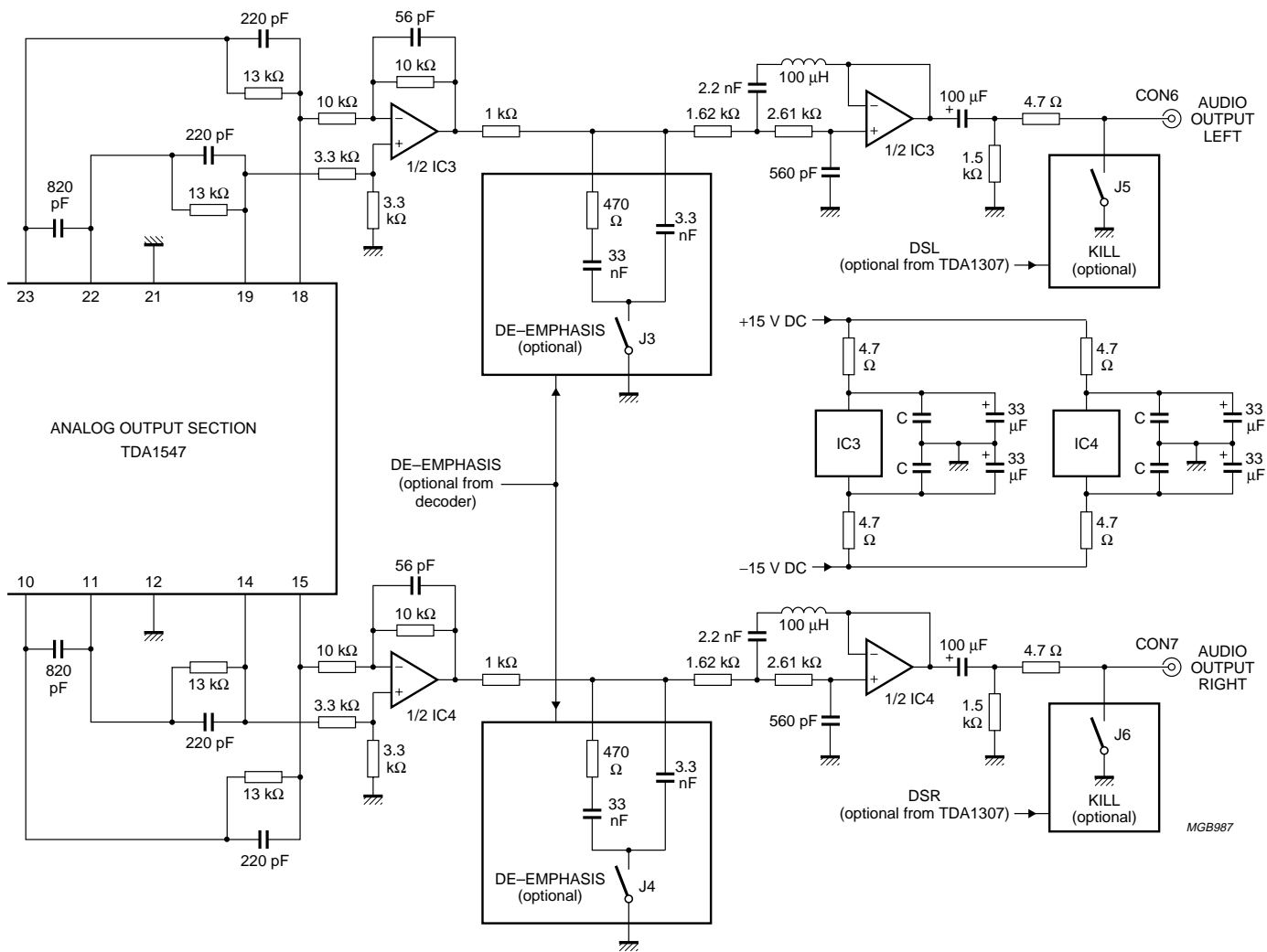
High-performance bitstream digital filter

TDA1307



High-performance bitstream digital filter

TDA1307



C = 100 nF chip capacitor.  
 IC3 = IC4 = NE5532(A) or equivalent.

Fig.19 Connections for output section of TDA1307.

# High-performance bitstream digital filter

# TDA1307

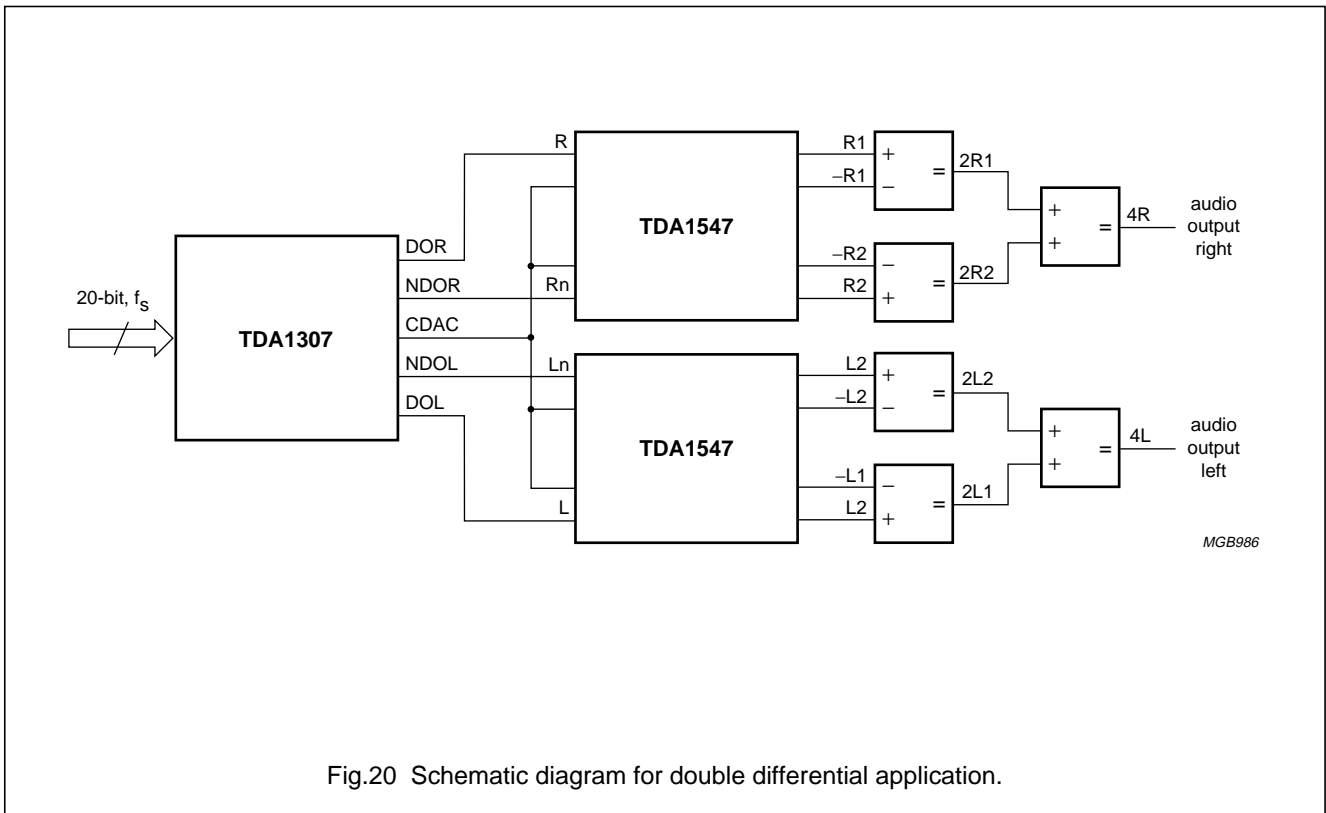


Fig.20 Schematic diagram for double differential application.

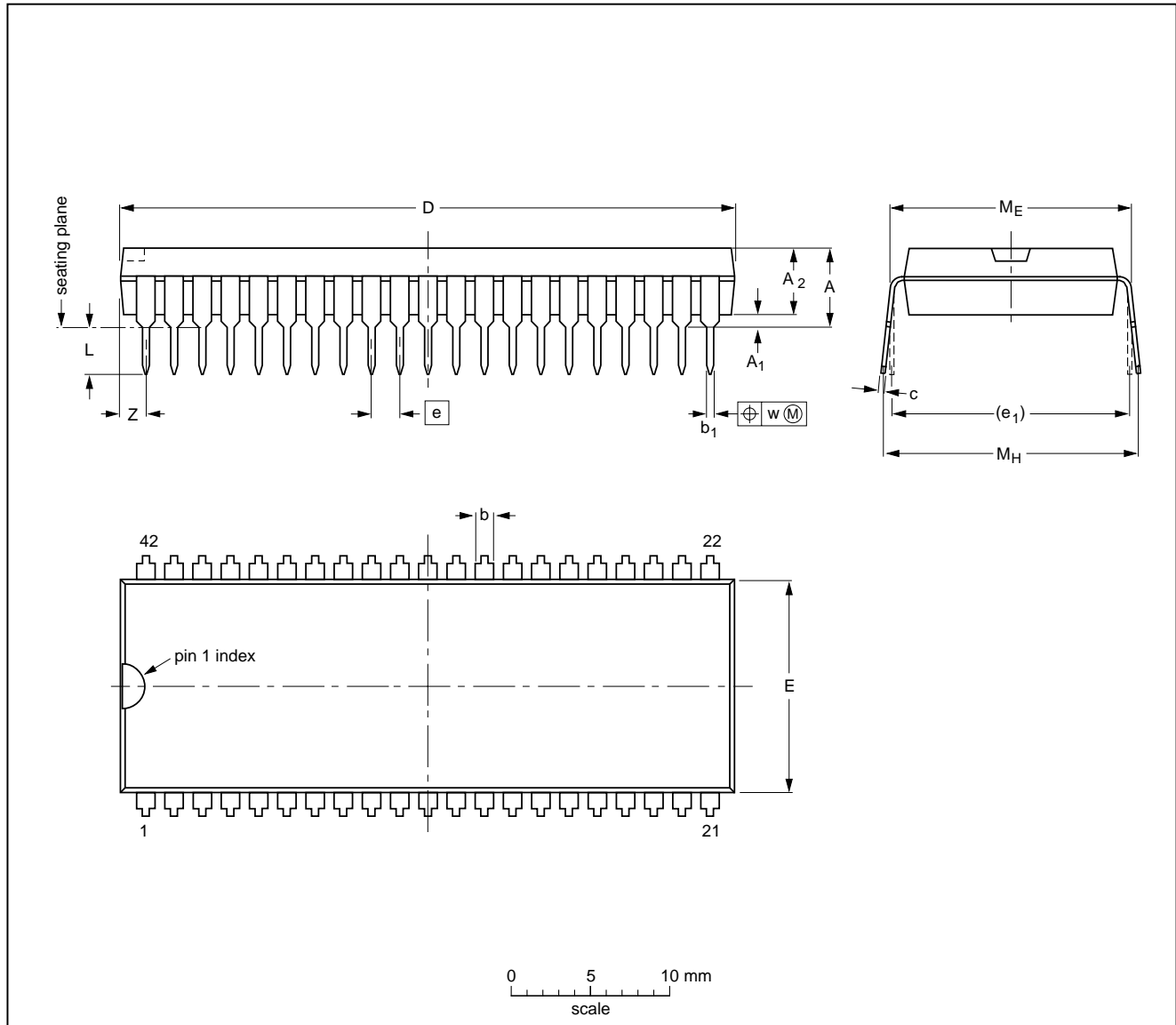
# High-performance bitstream digital filter

TDA1307

## PACKAGE OUTLINE

SDIP42: plastic shrink dual in-line package; 42 leads (600 mil)

SOT270-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	z <sup>(1)</sup> max.
mm	5.08	0.51	4.0	1.3 0.8	0.53 0.40	0.32 0.23	38.9 38.4	14.0 13.7	1.778	15.24	3.2 2.9	15.80 15.24	17.15 15.90	0.18	1.73

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT270-1						90-02-13 95-02-04



## High-performance bitstream digital filter

TDA1307

### SOLDERING

#### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "IC Package Databook" (order code 9398 652 90011).

#### Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ( $T_{stg\ max}$ ). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

#### Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

### DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Short-form specification	The data in this specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

### LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

High-performance bitstream digital filter

TDA1307

---

**NOTES**

High-performance bitstream digital filter

TDA1307

---

**NOTES**

# Philips Semiconductors – a worldwide company

**Argentina:** see South America

**Australia:** 34 Waterloo Road, NORTH RYDE, NSW 2113,  
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

**Austria:** Computerstr. 6, A-1101 WIEN, P.O. Box 213, Tel. +43 160 1010,  
Fax. +43 160 101 1210

**Belarus:** Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,  
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

**Belgium:** see The Netherlands

**Brazil:** see South America

**Bulgaria:** Philips Bulgaria Ltd., Energoproject, 15th floor,  
51 James Bourchier Blvd., 1407 SOFIA,  
Tel. +359 2 689 211, Fax. +359 2 689 102

**Canada:** PHILIPS SEMICONDUCTORS/COMPONENTS,  
Tel. +1 800 234 7381

**China/Hong Kong:** 501 Hong Kong Industrial Technology Centre,  
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,  
Tel. +852 2319 7888, Fax. +852 2319 7700

**Colombia:** see South America

**Czech Republic:** see Austria

**Denmark:** Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,  
Tel. +45 32 88 2636, Fax. +45 31 57 0044

**Finland:** Sinikalliontie 3, FIN-02630 ESPOO,  
Tel. +358 9 615800, Fax. +358 9 61580920

**France:** 4 Rue du Port-aux-Vins, BP317, 92156 SURESNES Cedex,  
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

**Germany:** Hammerbrookstraße 69, D-20097 HAMBURG,  
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

**Greece:** No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,  
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

**Hungary:** see Austria

**India:** Philips INDIA Ltd, Band Box Building, 2nd floor,  
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,  
Tel. +91 22 493 8541, Fax. +91 22 493 0966

**Indonesia:** see Singapore

**Ireland:** Newstead, Clonskeagh, DUBLIN 14,  
Tel. +353 1 7640 000, Fax. +353 1 7640 200

**Israel:** RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,  
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

**Italy:** PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,  
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

**Japan:** Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,  
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

**Korea:** Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,  
Tel. +82 2 709 1412, Fax. +82 2 709 1415

**Malaysia:** No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,  
Tel. +60 3 750 5214, Fax. +60 3 757 4880

**Mexico:** 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,  
Tel. +9-5 800 234 7381

**Middle East:** see Italy

**Netherlands:** Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,  
Tel. +31 40 27 82785, Fax. +31 40 27 88399

**New Zealand:** 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,  
Tel. +64 9 849 4160, Fax. +64 9 849 7811

**Norway:** Box 1, Manglerud 0612, OSLO,  
Tel. +47 22 74 8000, Fax. +47 22 74 8341

**Philippines:** Philips Semiconductors Philippines Inc.,  
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,  
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

**Poland:** Ul. Lukiska 10, PL 04-123 WARSZAWA,  
Tel. +48 22 612 2831, Fax. +48 22 612 2327

**Portugal:** see Spain

**Romania:** see Italy

**Russia:** Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,  
Tel. +7 095 755 6918, Fax. +7 095 755 6919

**Singapore:** Lorong 1, Toa Payoh, SINGAPORE 1231,  
Tel. +65 350 2538, Fax. +65 251 6500

**Slovakia:** see Austria

**Slovenia:** see Italy

**South Africa:** S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,  
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,  
Tel. +27 11 470 5911, Fax. +27 11 470 5494

**South America:** Rua do Rocio 220, 5th floor, Suite 51,  
04552-903 São Paulo, SÃO PAULO - SP, Brazil,  
Tel. +55 11 821 2333, Fax. +55 11 829 1849

**Spain:** Balmes 22, 08007 BARCELONA,  
Tel. +34 3 301 6312, Fax. +34 3 301 4107

**Sweden:** Kottbygatan 7, Akalla, S-16485 STOCKHOLM,  
Tel. +46 8 632 2000, Fax. +46 8 632 2745

**Switzerland:** Allmendstrasse 140, CH-8027 ZÜRICH,  
Tel. +41 1 488 2686, Fax. +41 1 481 7730

**Taiwan:** Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,  
TAIPEI, Taiwan Tel. +886 2 2134 2865, Fax. +886 2 2134 2874

**Thailand:** PHILIPS ELECTRONICS (THAILAND) Ltd.,  
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,  
Tel. +66 2 745 4090, Fax. +66 2 398 0793

**Turkey:** Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,  
Tel. +90 212 279 2770, Fax. +90 212 282 6707

**Ukraine:** PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,  
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

**United Kingdom:** Philips Semiconductors Ltd., 276 Bath Road, Hayes,  
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

**United States:** 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,  
Tel. +1 800 234 7381

**Uruguay:** see South America

**Vietnam:** see Singapore

**Yugoslavia:** PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,  
Tel. +381 11 625 344, Fax. +381 11 635 777

**For all other countries apply to:** Philips Semiconductors, Marketing & Sales Communications,  
Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

**Internet:** <http://www.semiconductors.philips.com>

© Philips Electronics N.V. 1997

SCA55

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

513061/25/02/pp36

Date of release: 1996 Jan 08

Document order number: 9397 750 02844

*Let's make things better.*

**Philips**  
Semiconductors



**PHILIPS**