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Car Stereo Designer's Guide

2004/2005

PHILIPS



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Introduction

Audio capability remains one of the essential ‘extras’ built into any vehicle, and an area in which Philips continues to innovate and build upon its leading reputation.

Aware of major factors such as upgradeability, functionality and quality, our total system capability helps you manage your design more easily. We have the widest selection of car audio solutions including state-of-the-art tuners and optical storage ICs, and a huge range of supporting devices, offering you the best value for any cost / performance framework.

This practical guide contains details on many of our dedicated car stereo IC solutions and supporting products. Arranged in five sections, essential information is presented in a clear, concise format – you’ll find exactly what you need, easily and quickly. The first section illustrates several typical system examples, indicating the various options available to you for both key and supporting ICs.

Section two is divided into chapters devoted to the major device types. These are Tuners, Signal Processors (Analog and Digital), Amplifiers and Voltage Regulators, and Optical Storage ICs as well as dedicated Digital Radio ICs. Details are given on each of our key products or families, covering:

- Brief description
- Key features list
- Table of key parameters
- Block diagram

Finally, section three contains tabulated data on a large range of supporting products and you can find an overview of the various package options and package outlines currently in use by Philips in our car stereo portfolio in section four.

All values quoted for parametric data are typical unless indicated otherwise.

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Purchase of Philips I²C components conveys a license under the Philips I²C patent to use the components in the I²C system, provided the system conforms to the I²C specifications defined by Philips. This specification can be downloaded in PDF format at <http://www.semiconductors.philips.com/i2c/facts>



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Reference designs

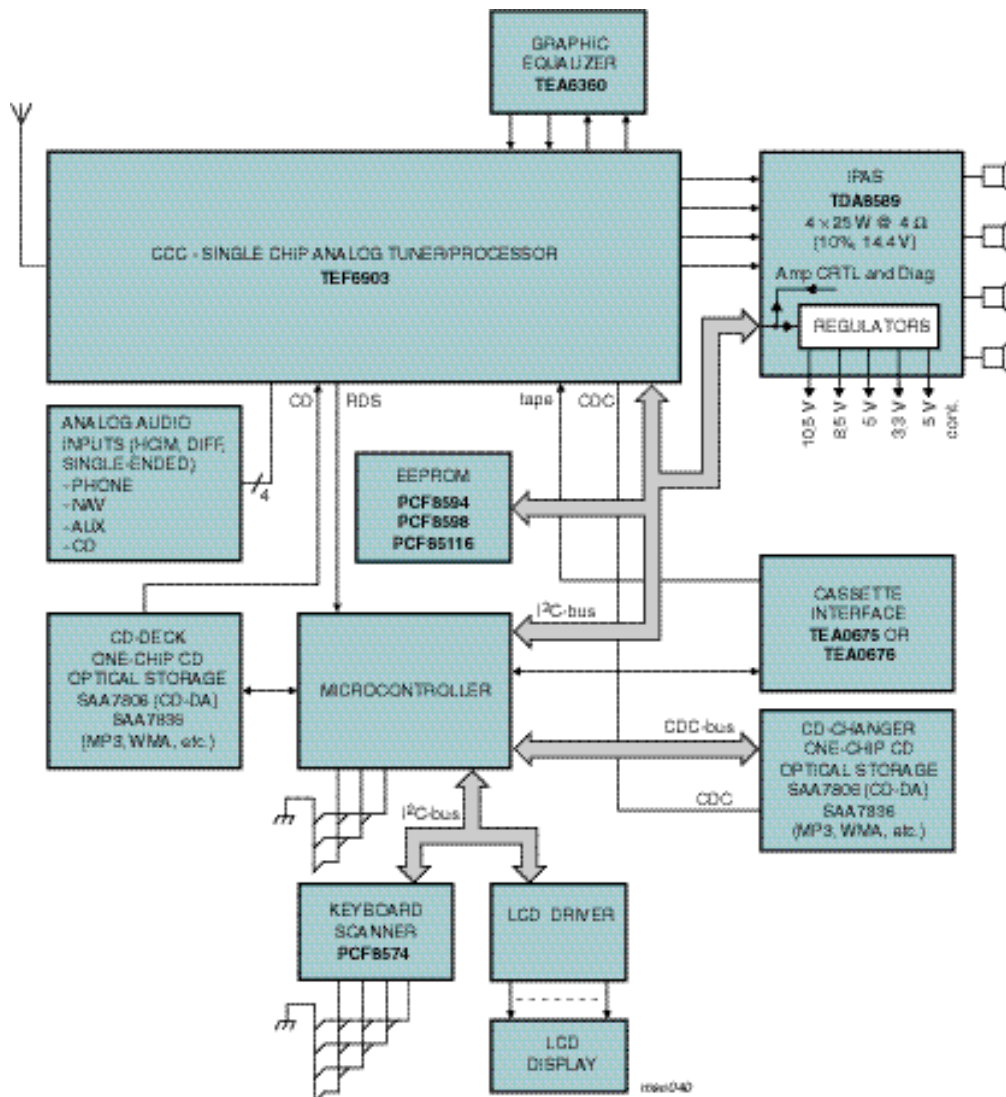
1. Reference designs

With Philips long history in car stereo, in addition to an extensive range of cost-effective and leading-edge products and technologies, we have built up a significant knowledge base of complete car stereo systems. This ensures you have optimized solutions to meet your needs. It also helps drive Philips' next generation product developments to meet changing market requirements and technological advancements around the world.

Drawing on this system knowledge allows Philips to illustrate how you can develop a range of complete car stereos. From mainstream stereos using proven analog signal processing right up to state-of-the-art double tuner concepts incorporating the latest advances in digital signal processing that are capable of handling terrestrial or satellite-based analog and digital radio signals and data services.

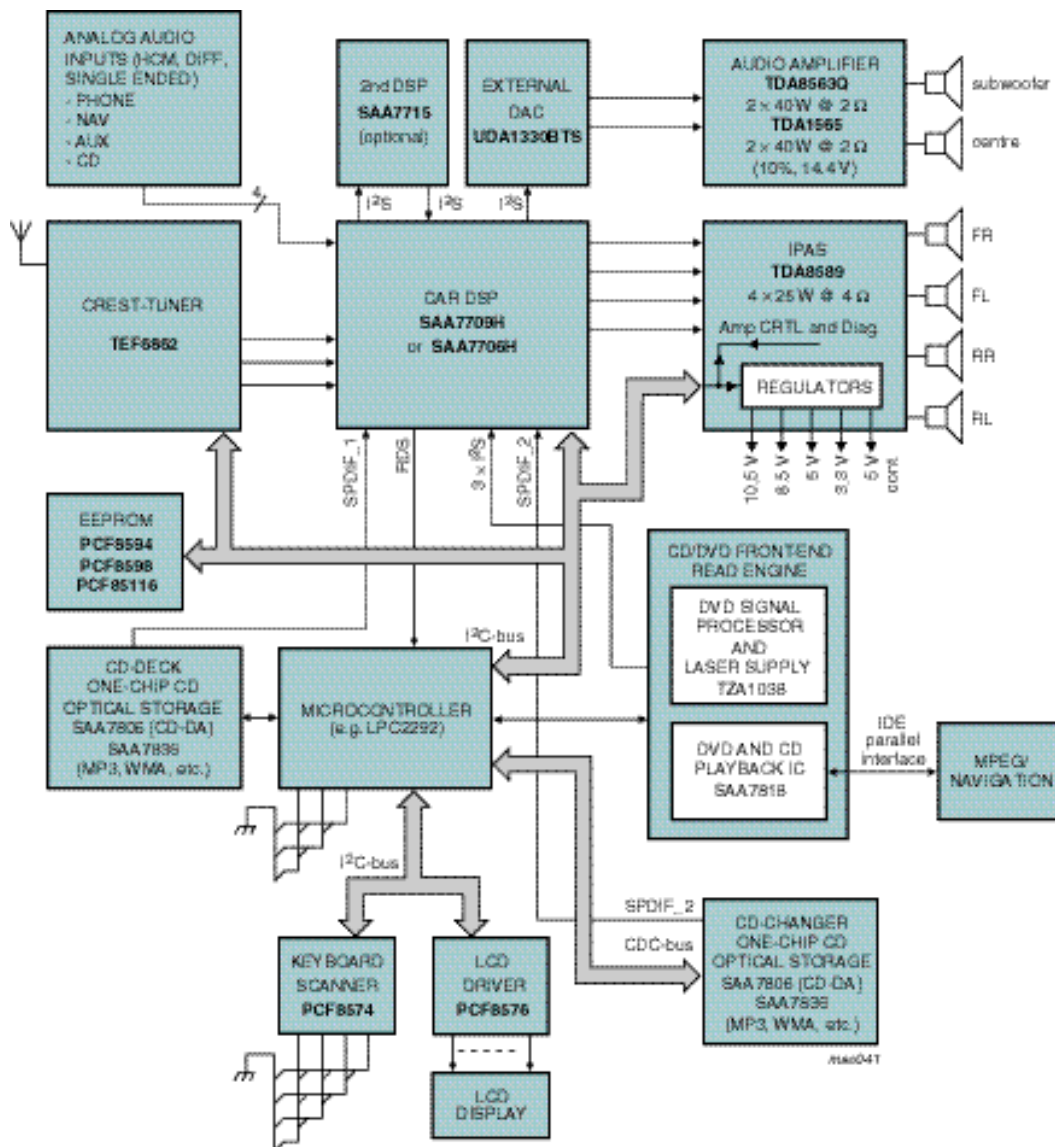
1.1 High performance analog car radio

The single chip TEA6903 analog tuner and signal processor combination is targeted at the mainstream car stereo market. Incorporating all the necessary features for a typical car radio receiver including an integrated RDS demodulator, this fully analog system delivers an unbeatable price/performance solution. With the addition of the TDA8589 integrated amplifier and voltage stabilizer, manufacturers have a fully working radio system from antenna to speakers, with the complete signal path controlled via the I²C-bus.



1.2 High performance DSP-based car radio

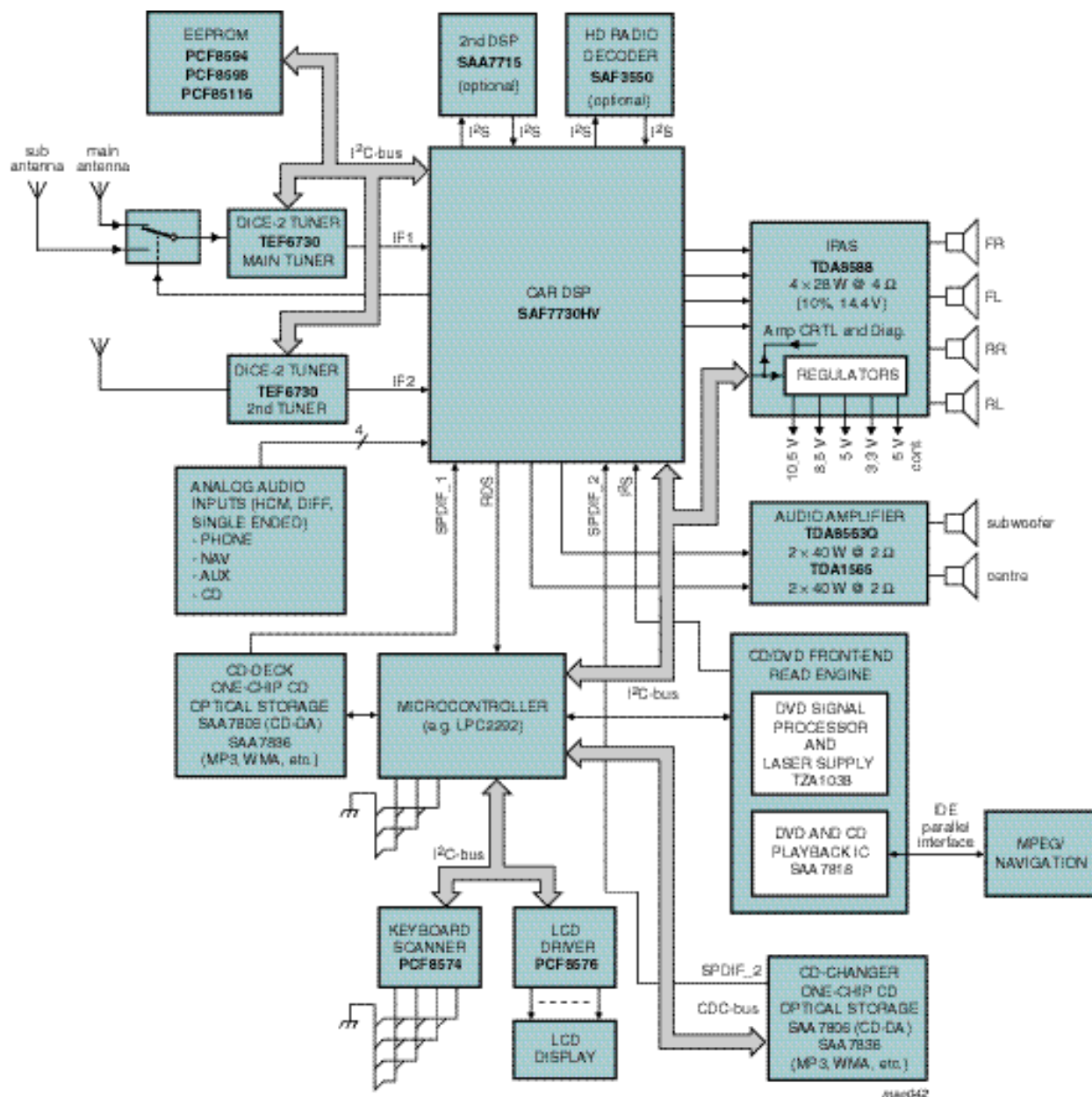
With this high-performance solution, consumers will hear the benefit of Philips long experience in designing car audio systems from antenna to speaker. The TEA6862 provides an innovative step in high-quality tuner technology, incorporating Philips' PACS (Precision Adjacent Channel Suppression) and an integrated variable bandwidth IF filter system to deliver by far the best-in-class tuner performance. By combining it with the SAA7709 or the SAA7706 (full rear seat audio functionality), in effect you create a core solution for high-performance car stereos with features including multiple equalizer function, Dolby, RDS and a long list of adaptable features fully customer controlled via the I²C-bus. The TDA8589 fully integrated stabilizer and 4 x 25 W amplifier completes this high-end system, delivering a quality sound experience from a state-of-the-art receiver.



1.3 Double tuner concept

As the mobile audio world tunes into new digital receiver architectures, Philips ensures our customers are at the forefront of developments with the latest in digital technologies for car stereos. The combination of the front-end TEF6730 and Philips Automotive Software Radio DSP, the SAA7730, provides a complete IF and sound processing solution from the antenna to the audio amplifier. High-quality digital reception can easily be added to this design with the inclusion of Philips SAF3550 HD Radio™ processor.

The introduction of a real dual front-end system dramatically reduces the disturbing influence of dynamic reception. In addition, this solution offers a significant range of optional hardware and software features, including support for third party software such as Philips Software 'Pure Studio' and SRS' Circle Surround II™. Once again the TDA8588 completes the picture with full I²C control over the regulated voltages and 4 x 28 W amplification.





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Focus products

2.1 Tuners

Ever since we introduced the In-Car Entertainment (ICE) family, Philips has been at the forefront of car radio developments. The technology of these initial tuners has evolved to create our high-performance 'NICE-PACS' and CREST ICs, delivering a total AM/FM front-end system solution for global applications. High integration, lower system cost, best-in-class radio reception and embedded IF signal processing are some of the many benefits of these tuner solutions. Furthermore, built-in PACS (Precision Adjacent Channel Suppression) functionality ensures maximum clarity from stereo and RDS reception under adverse conditions, so your designs achieve the highest quality sound.

The most recent generation of digital IF tuners like the TEF6730 and One-Chip solutions like the TEF690x family, continue to build on our excellent front-end expertise to offer customers worldwide a complete portfolio of tuner solutions.

TEF6862HL

Car radio tuner with enhanced selectivity

The TEF6862HL is a single-chip car radio tuner for AM, FM and weather band reception. It provides AM double conversion for LW, MW and full range SW (11 m – 120 m bands), with IF1 = 10.7 MHz and IF2 = 450 kHz. The IC performs FM double conversion with integrated image rejection for both IF1 and IF2, and features an integrated, variable bandwidth IF filter and automatic bandwidth control algorithm (PACS), offering flexibility via the I²C bus.

FM USA, FM Europe, FM Japan, FM Eastern Europe and weather band reception is achieved, and all FM bands can be selected using high side or low side LO injection in the FM mixer 1. The tuning system includes crystal oscillator, VCO, PLL synthesizer and state machine for non time-critical control of search, preset change and Alternative Frequency check via a microcontroller.

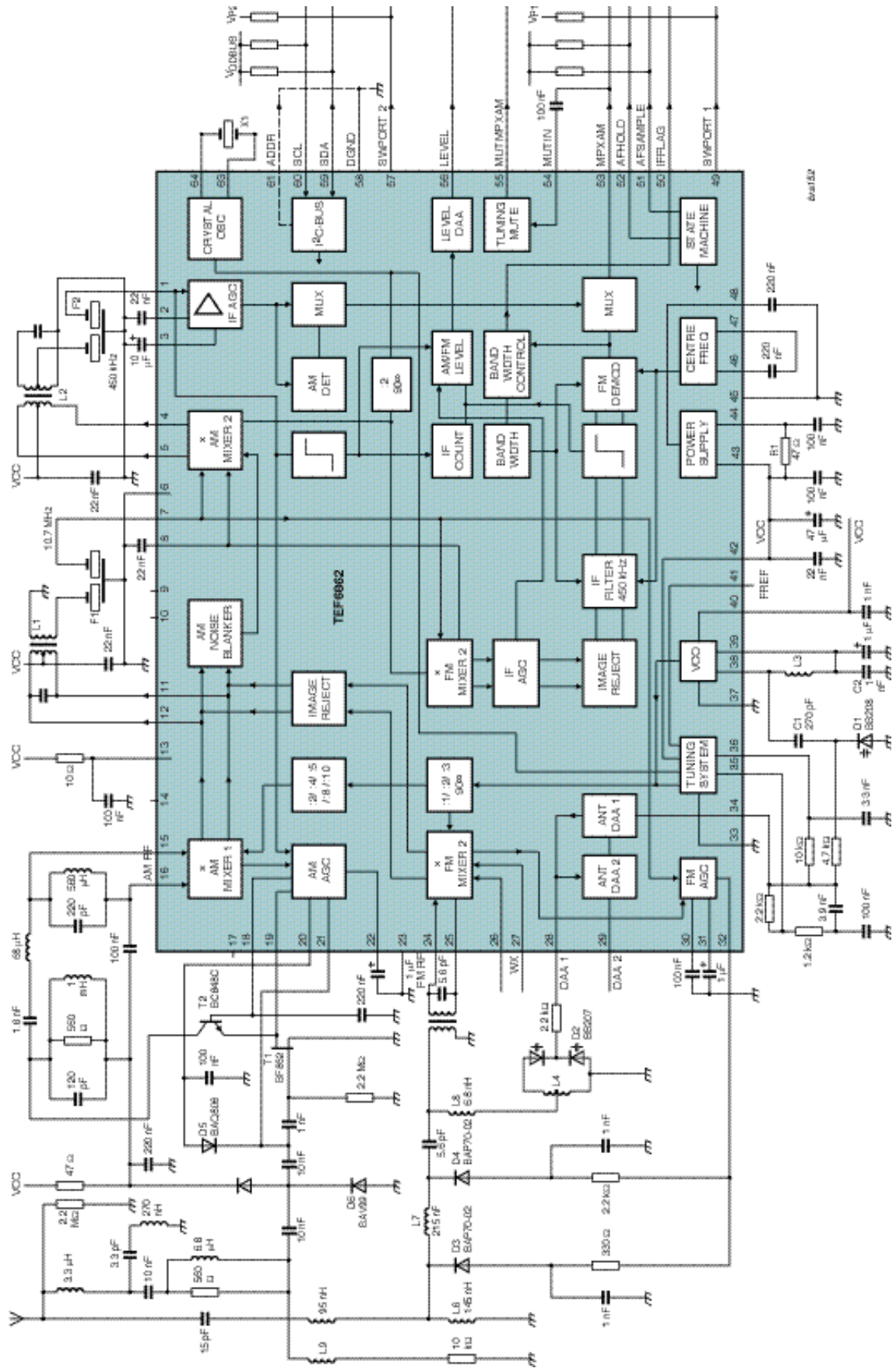
This highly integrated solution incorporates FM demodulator and FM IF channel filter, delivering high modulation handling and high selectivity for enhanced adjacent channel selectivity. Together with reducing external component count, the TEF6862HL enables designers to achieve lower power dissipation and cost while achieving world-class tuner performance.

Key features

- **High dynamic range FM front-end mixer (including USA weather band conversion) with inherent image rejection switchable from low side to high side LO injection via the I²C bus**
- **Integrated AM/FM front-end AGC pin diode drive circuit - keyed AGC function in FM; cascode AGC function in AM**
- **Integrated FM channel selection filter with continuous variable bandwidth provides low distortion and high selectivity**
- **Fully integrated FM demodulator with low distortion**
- **All alignments via I²C bus**
- **Software controlled flag outputs**
- **AM noise blanker (detection at IF1 and blanking at IF2)**
- **Crystal oscillator for all internal reference frequencies**
- **Tuning system with low phase noise LC oscillator and fast synthesizer PLL tuning with in-lock detection for fast frequency jumps for inaudible RDS updating and search tuning**
- **Sequential state machine for preset change, search and inaudible Alternative Frequency updating via soft slope tuning mute circuit allows non time-critical microcontroller operation**
- **Two hardware programmable I²C bus addresses**
- **AM IF2 output for AM stereo applications**

Key parameters

Supply voltage			8.5 V
	FM	AM	
Supply current	103 mA	95 mA	
SN ratio overall	63 dB	58 dB	
Sensitivity	1.8 μ V	45 μ V	
THD overall	0.2%	0.5%	
Package			LQFP64



TEF690x

Integrated car radio tuner with audio processing

Philips' one-chip TEF690x car radio ICs combine FM/AM tuner, stereo decoder, weak signal processing and audio processing, helping simplify design-in and reduce system cost. They also feature an integrated variable bandwidth IF filter and automatic bandwidth control algorithm (PACS) as well as an optional RDS/RBDS demodulator for radio data reception. Audio signal processing allows flexible source selection, volume, balance, fader and inaudible tuning mute. The devices can be controlled via 400 kHz fast-mode I²C bus and include autonomous tuning functions for easy control without critical microcontroller timing.

FM tuning performs double conversion to IF1 = 10.7 MHz and IF2 = 450 kHz, with integrated image rejection for both IF1 and IF2, and an integrated channel filter with variable bandwidth control is included. The TEF690x series covers FM USA, FM Europe, FM Japan and FM Eastern Europe reception. AM capability covers LW, MW and full range SW (11 m to 120 m bands), the AM tuner also incorporates IF1 and IF2 double conversion with integrated AM front-end.

This highly integrated solution will be available in the following versions:

- **TEF6901: RD(B)S demodulation**
- **TEF6902: without RD(B)S**
- **TEF6903: RD(B)S demodulation and optional connection of external effector or NAV/BEEB input with additional pin for input select**
- **TEF6904: optional connection of external effector or NAV/BEEB input with additional pin for input select**

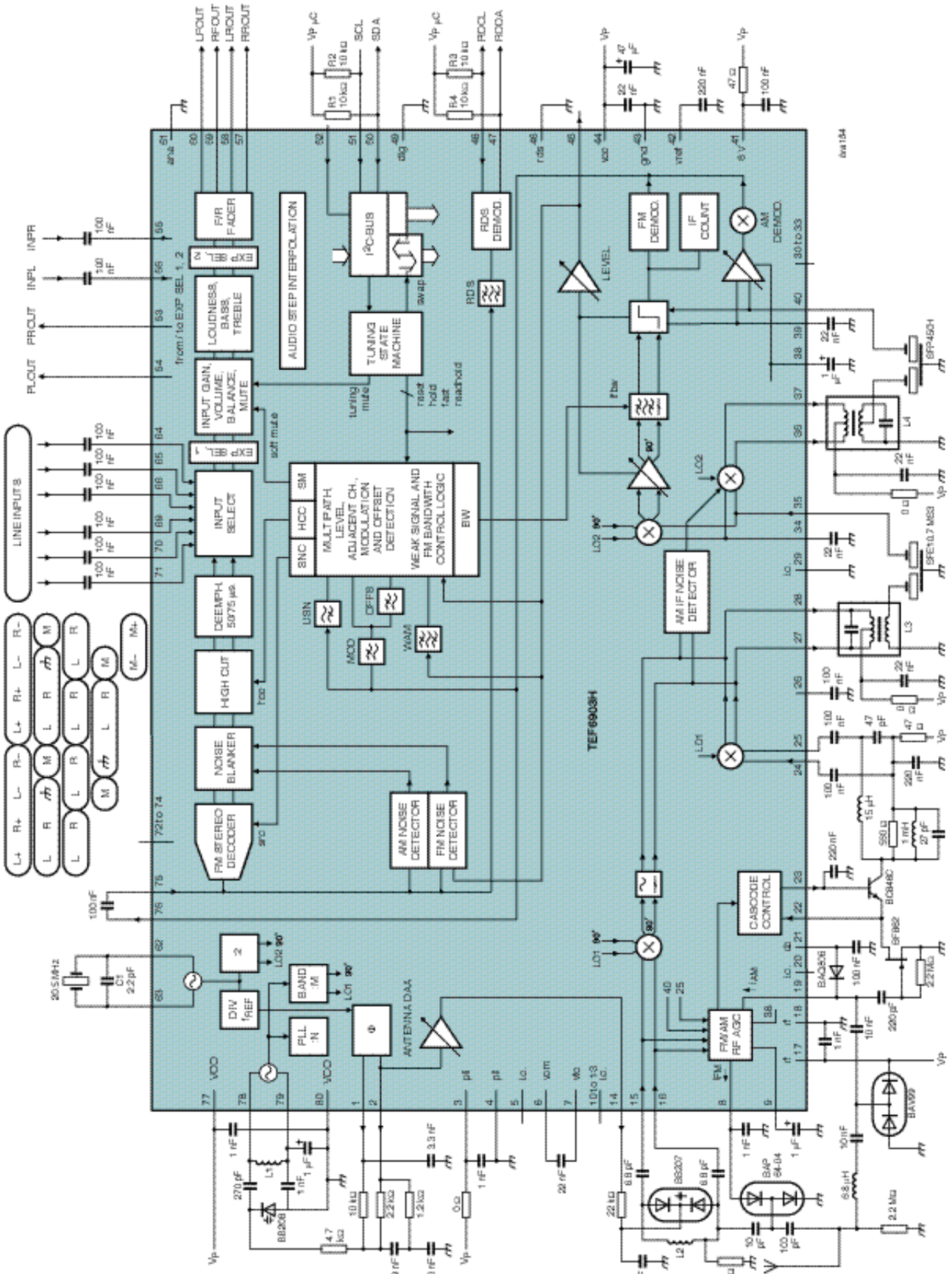
Key features

- **High dynamic range FM front-end mixer with inherent image rejection switchable from low side to high side LO injection via the I²C bus**
- **Integrated AM/FM front-end AGC pin diode drive circuit - keyed AGC function in FM; cascade AGC function in AM**
- **Integrated FM channel selection filter with continuous variable bandwidth provides low distortion and high selectivity**

- **Fully integrated FM demodulator with low distortion**
- **All alignments via I²C bus**
- **AM noise blanker (detection at IF1 and blanking at IF2 and audio) and FM noise blanker (adaptive detection at MPX and level)**
- **Crystal oscillator for all internal reference frequencies**
- **Tuning system with low phase noise LC oscillator and fast synthesizer PLL tuning with in-lock detection for fast frequency jumps for inaudible RDS updating and search tuning**
- **Sequential state machine for preset change, search and inaudible Alternative Frequency updating via soft slope tuning mute circuit allows non time-critical microcontroller operation**
- **Two hardware programmable I²C bus addresses**
- **Fully integrated stereo decoder with high immunity to birdy noise**
- **FM and AM weak signal processing: stereo blend, high cut control and soft mute**
- **Integrated RDS/RBDS radio data demodulator (optional)**
- **Flexible audio input source selection (configurable via the I²C bus)**
- **Integrated audio processing with treble, bass and loudness, volume, balance and fader controls and Audio Step Interpolation (ASI) for pop-free function**
- **Optional connection for external sound processor or NAV/BEEP input (only in TEF6903/04)**
- **'CD' dynamics compression**
- **VU-meter audio level read-out**

Key parameters

Supply voltage	8.5 V	
	FM	AM
Supply current	105 mA	100 mA
SN ratio	63 dB	58 dB
Sensitivity	2 µV	50 µV
THD	0.6%	0.5%
Package	QFP64 / QFP80	



TEF6730

Digital IF car radio front-end

The TEF6730HL car radio tuner front-end for digital-IF reception incorporates a variety of functionality and reduces external component count down to only 75 parts. For example the highly integrated FM image rejection allows a single tuned circuit without image notch, eliminating the need for an RF coil. The IC is specially designed to complement digital-IF DSP back-ends from Philips' SAF773x and SAF778x families, enabling optimum partitioning of functions and interfacing signals.

Capable of receiving 65 to 108 MHz and weather band, its FM tuner features single conversion to IF = 10.7 MHz and integrated image rejection. The AM tuner features single conversion to the same IF, with an integrated AM front-end capable of LW, MW and full SW reception. A combined AM/FM IF AGC amplifier provides a suitable IF signal to the A/D converter in the companion IF DSP.

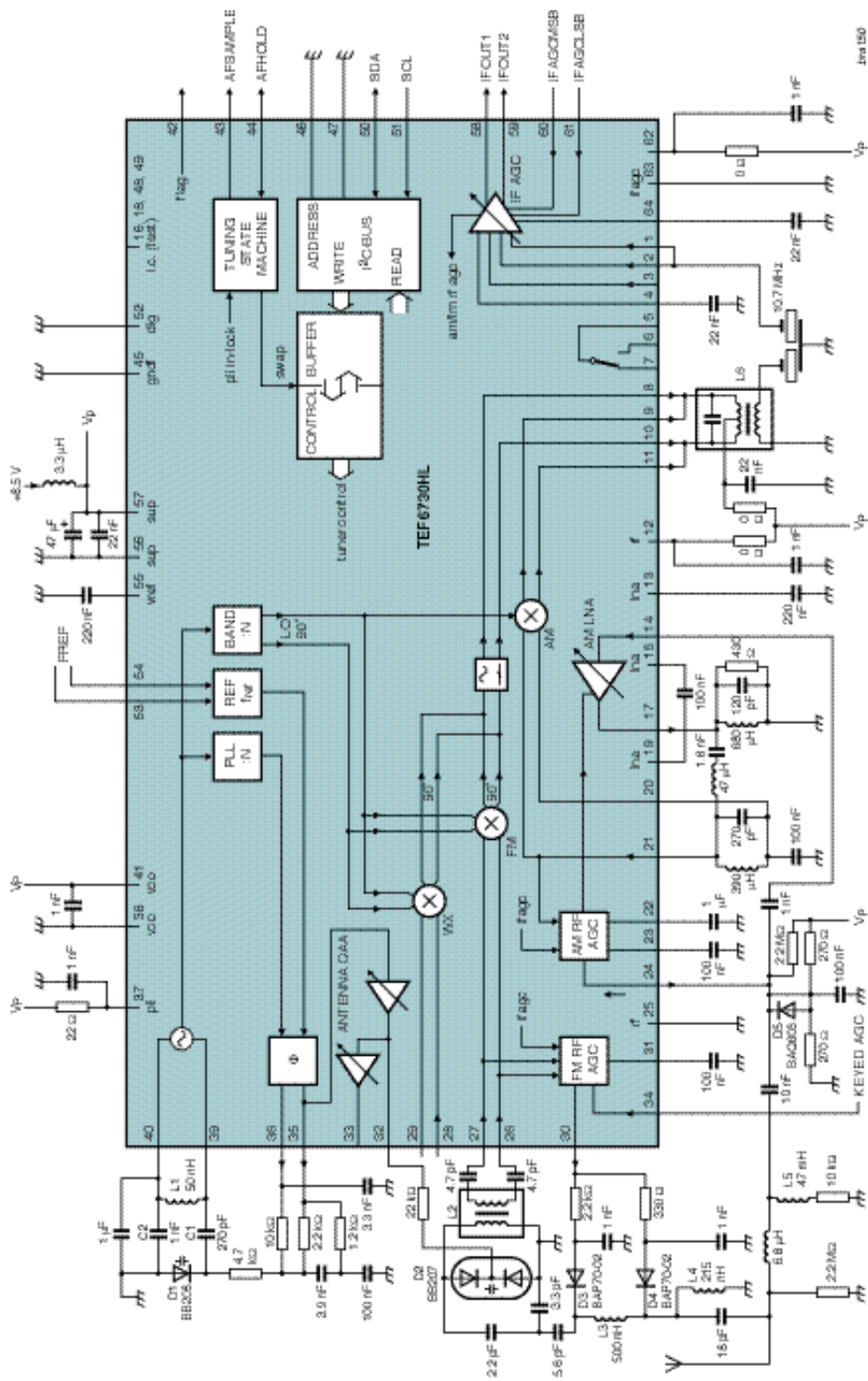
The device can be controlled via the fast-mode I²C bus (400 kHz) and includes autonomous tuning functions for easy control without critical microcontroller timing.

Key features

- **High dynamic range FM front-end mixer (including USA weather band conversion) with inherent image rejection switchable from low side to high side LO injection via I²C bus**
- **Integrated AM front-end LNA**
- **Integrated AM/FM front-end AGC pin diode drive circuit**
 - **keyed AGC function in FM**
- **All alignments via I²C bus**
- **Software controlled flag output**
- **Tuning system with low phase noise LC oscillator and fast synthesizer PLL tuning with in-lock detection for fast frequency jumps for inaudible RDS updating and search tuning**
- **Sequential state machine for preset change, search and inaudible Alternative Frequency updating via soft slope tuning mute circuit allows non time-critical microcontroller operation**
- **Four hardware programmable I²C bus addresses**
- **AM/FM IF AGC amplifier with wide dynamic range, gain controlled from IF DSP**
- **Input for HD Radio FM and AM narrow band applications**
- **Two antenna DAAs for automatic alignment**
- **Reference clock frequency from Car DSP - no front-end crystal required**
- **Improved antenna diversity due to identical reference clocks from Car DSP**

Key parameters

Supply voltage	8.5 V	
	FM	AM
Supply current	80 mA	110 mA
SN ratio	63 dB	>60 dB
Sensitivity	2 μ V	50 μ V
THD	0.2%	0.2%
Package	HTQFP64	



2.2 Analog Signal Processors

Delivering excellent price / performance ratios, Philips' top-class TEF689x car radio ASPs require few external components (only system coupling / decoupling), simplifying design-in and reducing overall cost. The ICs feature advanced analog processing, together with the high quality and control benefits of digital processing and integrated RDS capability. The digital control enables fine tuning of bass, treble, balance and so forth without impairing sound quality, while other digital operations filter out any noise from the input signal. And ensuring a clean audio path throughout, the analog audio processing is founded on low-noise MOS technology.

TEF6890H, TEF6892H + TEF6894H

High performance signal processors

These highly integrated car radio processors are monolithic BiMOS ICs providing stereo decoding, weak signal processing and noise blanking for AM and FM tuning, together with source selector, tone / volume control and RDS / RBDS demodulator. The TEF6892H also features RDS / RBDS decoding, enabling reliable extraction of block data – different modes can be selected to suit particular application needs.

- TEF6890: R(B)DS demodulation
- TEF6892: R(B)DS demodulation/decoding
- TEF6894: no R(B)DS

Supplied in small PCB footprint QFP44 package, the fully pin compatible TEF689x family requires no external components except coupling capacitors for signal inputs / outputs.

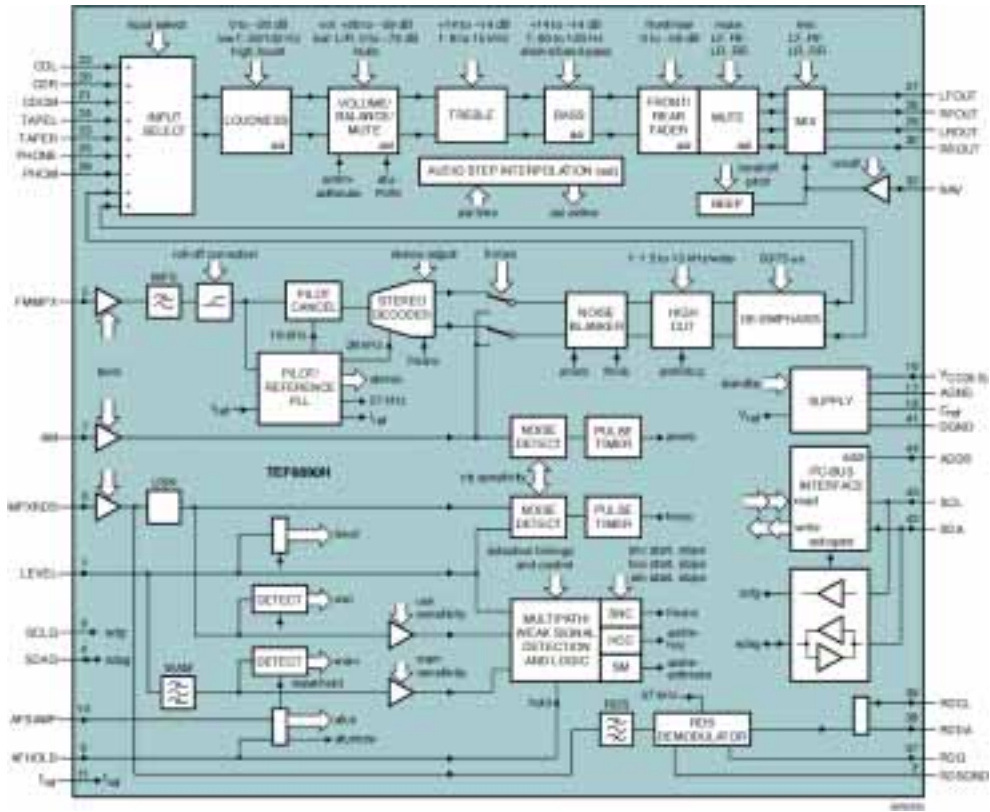
Key features

- **RDS demodulator: no external crystal necessary when used with TEA684x tuner ICs (TEF6890)**
- **RDS / RBDS decoder with memory for two RDS data blocks provides block synchronization, error correction and flywheel function (TEF6892)**
- **FM stereo decoder with high immunity to birdy noise and excellent pilot rejection**
- **Integrated IF roll-off correction, controllable via I²C-bus**
- **Fully integrated AM and FM noise blanking**
- **FM weak signal processing with detectors for level information, Ultrasonic Noise (USN) and Wideband AM (WAM)**
- **FM processing with soft mute, stereo blend and HCC**
- **AM weak signal processing with detectors for level information**
- **AM processing with soft mute and High Cut Control (HCC)**
- **Detector sensitivity and start / slope of control functions set via I²C-bus**
- **Weather band de-emphasis**

- **Full support of tuner AF update functions with TEA684X tuner ICs: FM audio processing holds the detectors for the FM weak signal processing in their present state during RDS updating**
- **Common mode rejection**
- **Fast mode 400 kHz I²C-bus, interfaces to logic levels ranging from 2.5 to 5 V**
- **Gated I²C-bus loop through to tuner IC**
 - **eases PCB layout (crosstalk)**
 - **allows 100 kHz/400 kHz mix**
 - **low bus load reduces crosstalk**
 - **buffered I/O circuit**
 - **supply voltage shift allowed between both buses**
 - **'Shortgate' function offers easy control with automatic gating of a single transmission; suitable for TEA684X**
- **'Autogate' function offers transparent microcontroller control with automatic on / off gating (programmable address)**
- **Quad source selector**
- **Integrated tone control and audio filters**
- **Audio controls with Audio Step Interpolation (ASI) for pop-free volume, fade, bass, mute etc.**
- **Navigation (NAV) input**

Key parameters

Supply current	normal mode	28 mA
Stereo decoder path	channel separation	40 dB (min)
	S/N ratio	75 dB (min)
	THD	0.3% (max)
Audio signal processing	channel separation	80 dB
	noise voltage (weighted)	12 μ V
	THD	0.01%
	maximum input voltage	2 V _{RMS}
	maximum output voltage	2 V _{RMS}
Package		QFP44



2.3 Digital Signal Processors

Ever more car radio units have a DSP at their heart – the signal processing engine capable of handling today's program content with the cost, performance and quality everyone needs. Philips' dedicated DSP ICs provide designers with highly integrated, powerful and economical solutions – as you would expect from the market leader. They also offer flexibility, incorporating extensive functionality and including the most advanced processing algorithms. Fully integrated IF processing is also featured, significantly reducing external filtration circuitry.

Philips has taken Car DSPs one-step further with the Software radio and audio DSP, which draws on Philips' leadership and proven library of car radio IP blocks to deliver a highly flexible mix of hardware and software functionality. The result is a unique single-chip solution between tuner and amplifier that replaces fixed hardware design blocks by fully flexible DSP solutions. A growing range of best-in-class software functionality for both radio and audio processing – such as signal conditioning, noise immunity and acoustic effects – enables a range of customizable features and functionality to meet individual requirements and new market demands.

SAA7706H

Car radio DSP

The SAA7706H performs a wide array of signal processing with dual media support, enabling independent audio sources and separate control for front and rear seats. Depending on the signal source, processing is implemented either before AM and FM outputs, or at the CD, tape and phono inputs.

Key DSP functions

- Interference absorption
- FM and AM stereo decoding
- RDS demodulation
- FM and AM weak signal processing (soft mute, sliding stereo and high cut)
- Dolby-B noise reduction
- CD de-emphasis
- Volume, balance, fader, tone and dynamics compression controls

The IAC (Interference Absorption Circuit) detects and suppresses ignition interference by analyzing the high frequency content of the MPX signal. Discrimination between real and interference components is achieved using a special Philips patented fuzzy logic, incorporating advanced algorithms based on probability calculations. The characteristics of the IAC's detectors can be adapted to accept different FM front-ends.

A 5th order noise shaper operating at $64 f_s$ ensures an excellent SNR and an FSDAC (Filter Stream DAC) converts the noise shaper's 1-bit datastream to an analog voltage. The FSDAC requires no post-filter due to its inherent filter function and it is designed to deliver very high signal-to-noise performance with low clock jitter sensitivity.

The RDS demodulator recovers clock and data information from the MPX signal, with optional 16-bit buffering, and provides interfacing for microcontroller operation.

Digital inputs are 5 V tolerant and all analog inputs have high GSM immunity, while two mono Common-Mode Rejection Ratio (CMRR) input stages are built-in for voice signals from phone and navigation inputs, with mixing of both at the DAC front outputs. The SAA7706H is easy to design in and requires very few external components, as well as being pin compatible with the SAA7705 and SAA7708 ICs.

Key features – hardware

- **Five bitstream 3rd-order sigma-delta ADCs with anti-aliasing broadband input filter**
- **One bitstream 1st-order sigma-delta ADC with anti-aliasing broadband input filter**
- **Four bitstream DACs with 128-fold oversampling and noise shaping**
- **Integrated semi-digital filter; no external post filter required for DAC**
- **Dual media support for separate front seat and rear seat signal sources and separate control**
- **Simultaneous radio and audio processing**
- **Digital FM stereo decoder and interference suppression**
- **RDS demodulation via separate ADC; with buffered output option**
- **Two stereo CMRR input stages (CD-walkman and CD-changer etc.)**
- **Analog single-ended TAPE and AUX input**
- **Separate AM-left and AM-right inputs for external AM stereo decoder**
- **One digital input: I²S-bus or LSB-justified format**
- **Two SPDIF digital inputs**
- **Co-DSP support in I²S or LSB-justified format**
- **Short-circuit protected audio output**
- **I²C-bus controlled (including fast mode)**
- **MOST bus interfacing**
- **Phase-locked loop derives internal clocks from one common fundamental crystal oscillator**
- **Combined AM/FM level input**

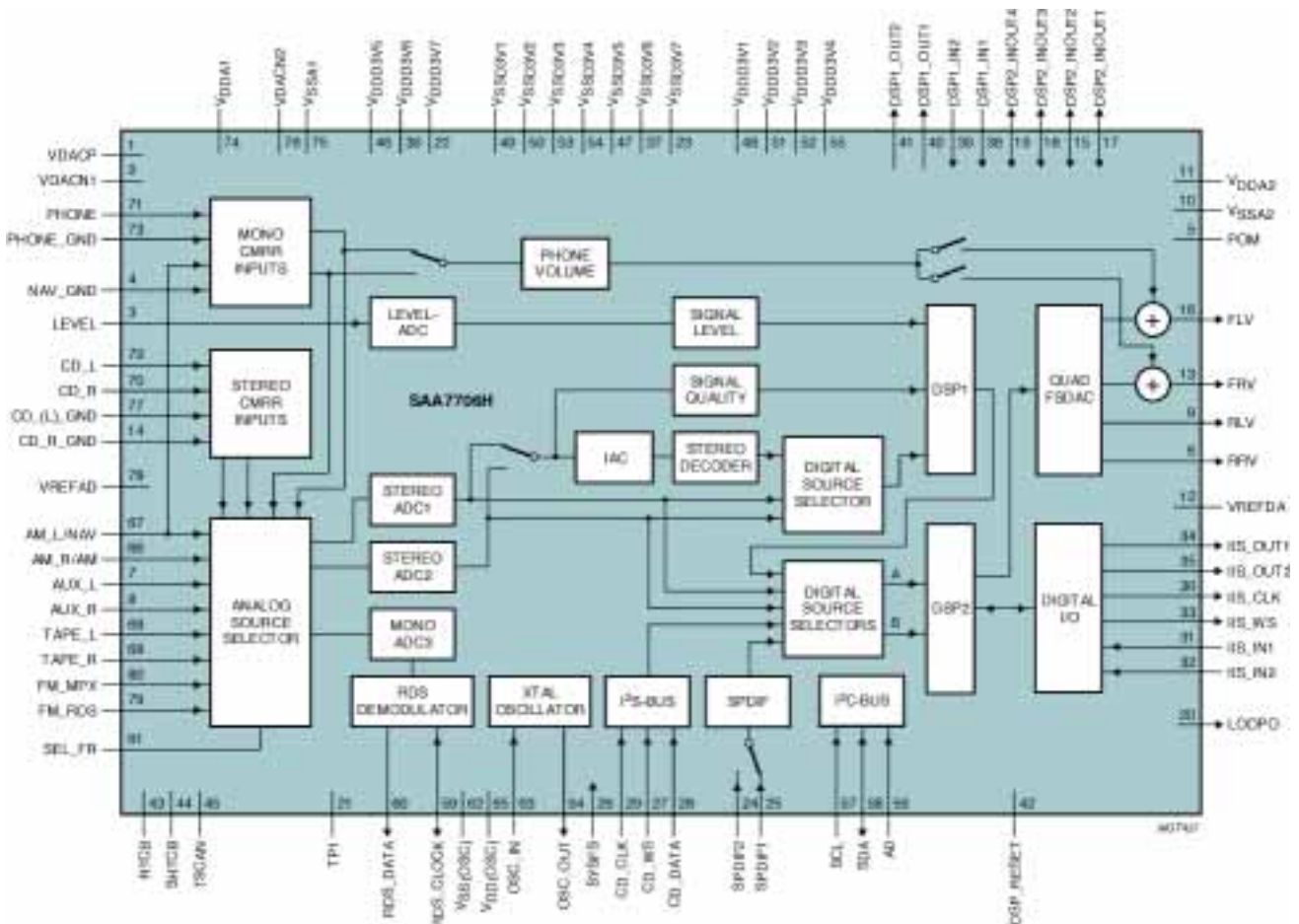
Key features – software

- Improved FM weak signal processing
- Integrated 19 kHz MPX filter; de-emphasis and stereo detection
- Electronic adjustments: FM / AM level, FM channel separation, Dolby® level
- Baseband audio processing (treble, bass, balance, fader and volume)
- Four channel 5-band parametric equalizer
- 9-band mono audio spectrum analyzer
- Extended beep functions with tone sequencer for phone rings
- Dynamic loudness or bass boost
- Audio level monitor
- Tape equalization and Music Search System (MSS) detection for tape
- Dolby-B tape noise reduction (at 44.1 kHz only)
- Dynamics compression available in all modes
- CD de-emphasis processing
- Voice-over possibility for phone and navigation signals
- Improved AM signal processing
- Digital AM CQUAM stereo decoder
- Digital AM interference suppression

- Soft audio mute
- RDS update processing: pause detection, mute and signal-quality sensor-freeze
- General purpose tone generator
- Noise generator allows for frequency response measurements
- Boot-up ROM for fast start-up
- Signal level, noise and multipath detection for AM or FM signal quality information
- AM co-channel and adjacent channel detection

Parameters

Supply voltage	3.3 V
Digital supply current	110 mA
Analog supply current	40 mA
THD	-85 dB
Maximum conversion input level:	
FM MPX	0.368 V _{RMS} at THD < 1%
CD/TAPE/AUX/AM	0.660 V _{RMS} at THD < 1%
Package	QFP80



SAA7709H

Car radio DSP

The advanced SAA7709H DSP combines powerful hardware and software features to provide comprehensive digital signal processing in car radio systems. Processing is performed prior to power amplification and, depending on the signal source, either after AM and FM MPX signal demodulation or tape input stages.

Key functions

- Interference absorption
- Stereo decoding
- RDS demodulation and decoding
- FM and AM weak signal processing (soft-mute, sliding stereo, etc.)
- Dolby-B tape noise reduction
- Audio controls (volume, balance, fader and tone)

With some restrictions, two different stereo channels can be processed and there are four independent analog output channels.

Together with easy design-in of the IC itself, the SAA7709H requires few additional external components. Also, high pin compatibility exists with the SAA7704, SAA7705, SAA7706 and SAA7708 DSPs, with only incidental minor replacements needed.

Key features – hardware

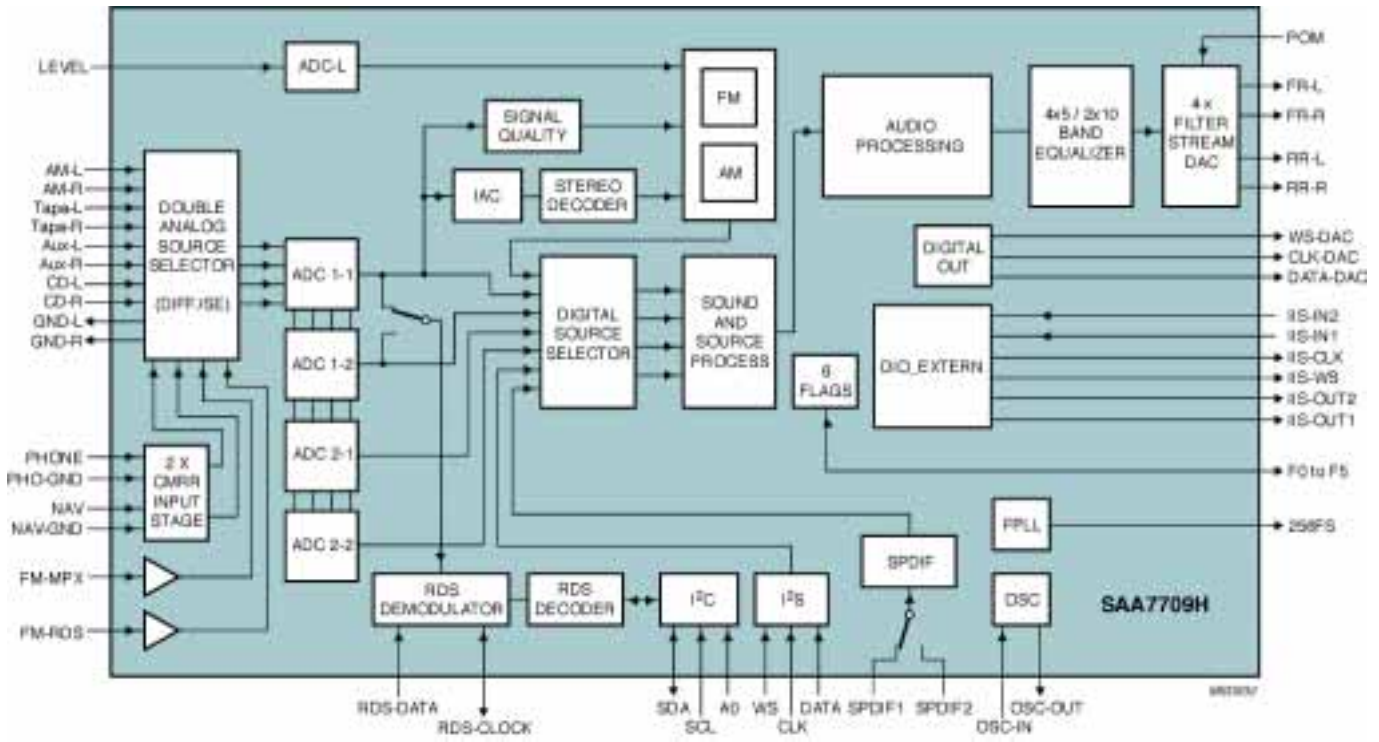
- Four bitstream 3rd order and one bitstream 1st order Sigma-Delta ADCs with anti aliasing broadband input filter
- Four bitstream DACs with 128-fold oversampling and noise shaping
- Four channel, 5-band I²C controlled parametric equalizer
- Integrated semi-digital filter, no external post filter required for D/A conversion
- Stereo I²S output with 256 F_s clock for connection to an external DAC
- Limited dual media support, allowing limited separate front- and rear-seat signal sources and separate control
- Digital FM stereo decoder and interference suppression
- RDS demodulation decoding via separate ADC, with buffered output option via I²C
- Four switchable stereo CMRR or differential inputs for CD-walkman, CD-changer etc.
- Analog single-ended tape input
- Separate AM left and right inputs for external AM stereo decoder
- One digital input: I²S or LSB justified format
- Two digital inputs: SPDIF format at F_s = 48 kHz maximum
- Audio output short circuit protected
- I²C bus controlled (including fast mode)
- PLL derived internal clock for DAC and other IC components from a digital input word select
- Combined AM/FM level input

Key features – software

- Improved FM weak signal processing
- Integrated 19 kHz MPX filter and de-emphasis
- Electronic adjustments: FM/AM level, FM channel separation, Dolby level
- Dynamic loudness or bass boost
- Phone and navigation audio mixing and processing in DSP
- 9-band mono audio spectrum analyzer
- Audio level meter
- Music Search System detection for tape (MSS)
- CD dynamics compressor/expander
- CD de-emphasis processing
- Large volume jumps e-power interpolated for smooth volume steps
- Improved AM processing with IAC
- Extended beep functions with tone sequencer
- Pause detection for RDS updates
- Signal level, noise and multipath detection for AM/FM signal quality information

Parameters

Supply voltage	3.3 V
Digital supply current	110 mA
Analog supply current	40 mA
Total power dissipation	510 mW
THD FM MPX inputs	-70 dB (1 kHz 0.368 V _{rms} , BW = 19 kHz)
THD CD, tape, aux, phone, AM inputs	-85 dB (1 kHz 0.55 V _{rms} , BW = 20 kHz)
SNR FM MPX input stereo	81 dB (1 kHz, BW = 40 kHz, gain = 0 dB)
SNR CD, tape, aux, phone, AM inputs	84 dB (1 kHz, BW = 20 kHz)
Package	QFP80



SAF7730HV

Software radio and audio DSP

Integrating two independent radio reception paths, the SAF7730HV dual IF car radio and audio DSP provides a unique single-chip solution between tuner and amplifier. The IC is specially designed to complement Philips' TEF6730 digital-IF car radio front-end, enabling optimum partitioning of functionality.

The SAF7730 has a powerful suite of advanced IF signal and audio processing options. This includes sophisticated functions such as phase diversity and stereo generation from a mono source. State-of-the-art features such as enhanced equalization and delay-time management ensure superior audio processing, while integrated PACS, multipath detection and suppression, and antenna diversity contribute to best-in-class radio performance. Many of the SAF7730's inherent functions are software based. For a more comprehensive list of these features, see the following section on software functionality.

Key features

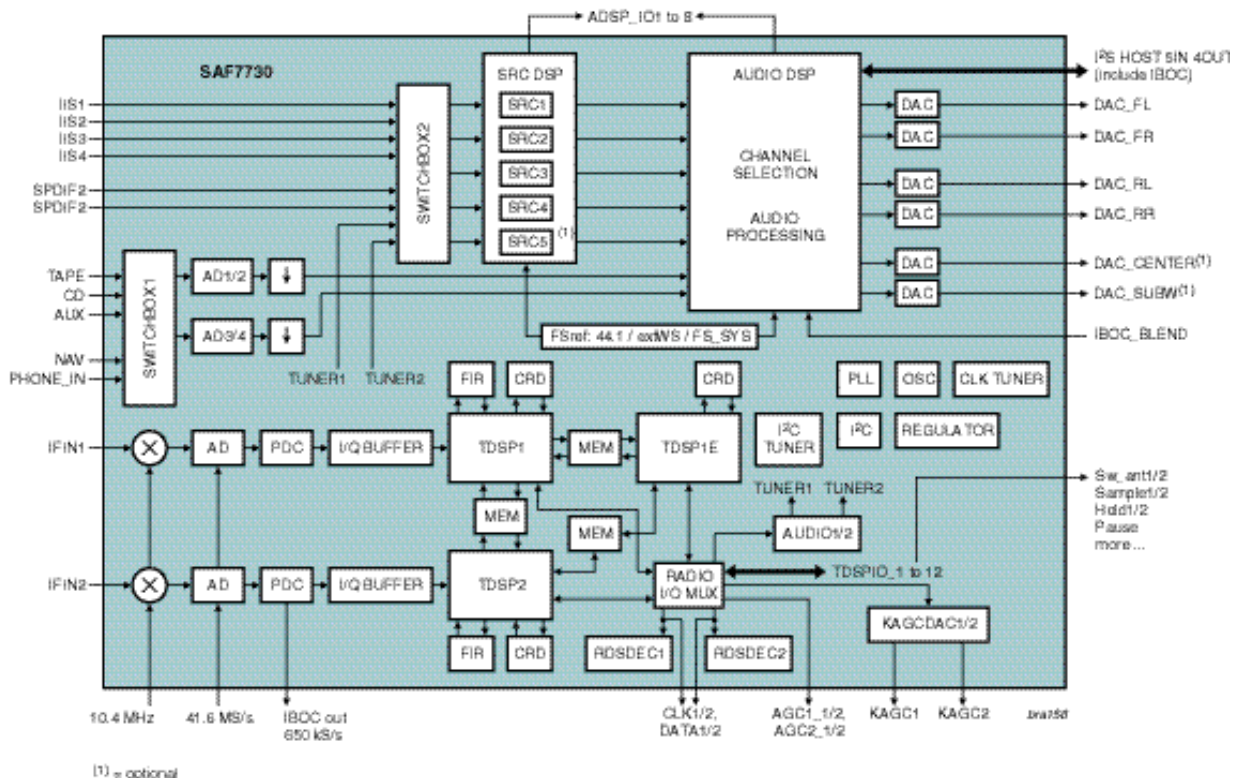
- Single-chip digital system solution for single and double tuner applications
- 650 MIPS for radio and audio processing
- Best-in-class radio reception with integrated digital PACS
- Digital interface for co-processor and upgradeable with HD Radio applications
- Simple customization
- Software-controllable radio and audio settings
- Supports Philips Software 'Pure Studio' and SRS' Circle Surround II™ along with a wide range of other 3rd party software, such as Dedekind's LEF (Life Enhancement Filter) algorithm

Standard and optional hardware features

- Two 5th order Sigma-Delta IF ADCs for FM/AM/WB and FM/AM IBOC at 10.7 MHz
- IF signal quadrature mixing and downsampling and signal level generation
- Wideband output for external IBOC decoding
- Two RDS decoders
- Four Bitstream 3rd order audio Sigma-Delta Audio ADCs with anti-aliasing broadband input filter
- Four single ended and two high common mode or differential analog inputs selectable to be routed to the 4 Audio ADs
- Six multibit sigma delta DACs with 128-fold oversampling and noise shaping
- Host I²S I/O port with 4 outputs and 5 inputs, with option for slaving the DSP to external master sample rate
- Four independent I²S inputs and two independent SPDIF inputs with 5 channel Sample Rate Conversion

Key parameters

Dynamic Range IF – ADs	97 dB
IF-AD third order (-9dB FS signal intermodulation)	98 dB
Audio AD THD+N	-80 dB
Audio AD SNR	90 dBA
Audio DA THD+N/S at FS	-76 dB
Audio DA THD+N/S at -60 dB FS	-44 dBA
Audio DA SNR at digital silence	105 dBA
Audio DA AC output voltage	1 Vrms
Package	HLQFP144



Software functionality

At the heart of Philips' software radio DSP devices – such as the SAF7730 – lies powerful software-driven functionality. As well as providing advanced radio and audio features, this also enhances ease-of-design and creates a highly flexible and scalable solution, enabling implementation of a single platform across a global application range. The following lists some of the features which are available either as standard or advanced options for the SAF7730.

Standard and optional radio software

- Switching antenna diversity
- Phase antenna diversity
- Enhanced multipath
- FM processing
 - includes noise blanking, weak signal handling and variable bandwidth control (digital PACS)
- AM processing
 - includes noise blanking and weak signal handling
- Audio correlation
- Support for radio data systems including RBDS

Standard and optional audio software

- Dual media (rear seat audio)
- CD de-emphasis
- Super positioning of primary / secondary channels
- Compressor / expander
- 6 channel audio processing
- Graphic equalizer
- Spectrum analyzer
- Delay time management
- Incredible mono
 - Transforms a mono signal into stereo, enhancing the listening experience from either broadcast or recorded mono source material. One of the main advantages is a widening of the stereo field, increasing the sound's spatial quality.
- Stereo++
 - Compensates for poorly defined stereo content from recorded sources or bad broadcast transmission, the Stereo++ module expands the source signal to improve stereo output.
- Adaptive UltraBass 2
 - Not a simple bass boost, this clever audio processing effect extends the low frequency range of acoustic systems. This makes the sound from small loudspeakers more impressive, giving the impression of larger, more powerful speakers.
- Elevation
 - Lifts the sound from speakers with a low physical location has the illusion of emanating from a higher position. This can be controlled to match the specific audio environment of any car model.

2.4 Audio amplifiers and voltage regulators

You'll find a Philips solution for virtually any car audio power or voltage regulation application. Unique expertise in amplifier and regulator design, breadth of product and technology portfolio together with innovative single-chip IPAS (Integrated Power Amplifier and Stabilizer) solutions all add up to an unparalleled automotive device offering.

Combining a high power audio amplifier with multiple-output voltage regulators on a single IC, IPAS is a simple idea that offers substantial benefits including shorter design-in cycle times and reduced system cost. IPAS ICs also incorporate extra functionality such as protections and diagnostics.

2.4.1 Integrated Power Amplifier and Stabilizer (IPAS) TDA8588AJ/BJ/J, TDA8589AJ/BJ

IPAS (Integrated Power Amplifier and Stabilizer) represents a major breakthrough that shortens your design-in cycle times and reduces total system cost. A simple idea – integrating voltage regulator and high power audio amplifier on a single IC – that delivers functionality previously requiring two or more ICs; made possible through Philips' leading process technology expertise.

For example, the TDA8588 is an I²C-bus controlled multiple output voltage regulator combined with a quad power BTL audio power amplifier (4 x 50 W). Each amplifier can be configured in line driver mode and information on each amplifier and speaker can be read separately via the I²C-bus. The device also features five highly-stable regulators, two power switches and a reset output (which can interface to an optional microcontroller) all in a small, space-saving package. Delivering high power and stable voltage regulation, it is a complete, cost-effective solution for your car radio applications.

Key features

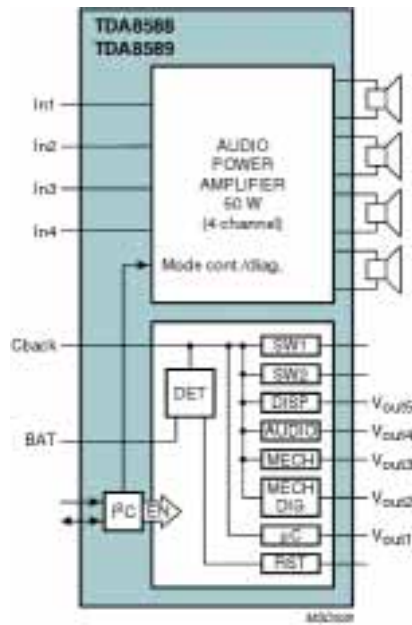
- **On-chip quad 50 W (TDA8588) or 45 W (TDA8589) audio amplifiers**
- **2 Ohm load up to 16 V battery voltage, 4 Ohm load up to 18 V**
- **Programmable clip detect: 2% or 10%**
- **Programmable thermal pre-warning**
- **Independent short circuit protection per channel**
- **All outputs short circuit proof to ground, supply voltage and across the load**
- **Soft thermal clipping prevents audio holes**

Regulator features

- **Four fixed and one variable voltage regulators**
- **Two power switches for antenna and amplifier**
- **3.3 V and 5 V microcontroller and DSP supplies**
- **Low dropout voltage output stages**
- **Low quiescent current, typically 120 μ A**
- **High supply voltage ripple rejection**
- **Low noise**
- **Reset output with adjustable reset delay time**
- **Back-up functionality**
- **Battery detection**
- **Reverse polarity safe**
- **Load dump, thermal and foldback current limit protection**
- **Can withstand output voltages up to 18 V**

IPAS Overview

Types	TDA8588AJ/BJ/J	TDA8589AJ/BJ
P (W), R _L =4 Ohm, 15V (square wave)	4 x 50	4 x 45
THD (%) @ 1 W / 4 Ohm	0.003	0.003
Gain (dB)	26	26
SVRR (dB)	68	68
Noise (μ V)	55	55
Clip-detection	2.0% or 10%	2.0% or 10%
Vreg 1	0-8.3 or 8.5-8.7/350 mA	0-8.3 or 8.5-8.7/350 mA
Vreg 2	3.3 or 5.0V/350 mA	3.3 or 5.0V/350 mA
Vreg 3	3.3 or 5.0V/300 mA	3.3 or 5.0V/300 mA
Vreg 4	0-5;6+7; 8.6 V/800 mA	0-5;6+7; 8.6 V/ 800 mA
Vreg 5	0-6 or 7 +8.2 or 9+9.5 or 10.10.5 12.5 *V _p /400 mA	0-6 or 7 +8.2 or 9+9.5 or 10.10.5 12.5 *V _p /400 mA
Power switch 1 cont/pulse	400 mA	400 mA
Power switch 2 cont/pulse	400 mA	400 mA
Package	DBS 37	DBS 37



2.4.2. Stand-alone audio power amplifiers

Quad amplifiers

TDA8569Q and TDA8571J

Both TDA8569Q and TDA8571J are integrated class A/B power amplifiers housed in a 23-lead SIL package. The TDA8571J contains four matched, high power amplifiers in BTL configuration, each with a gain of 34 dB and delivering 4 x 40 W (EIAJ) output into a 4 Ohm load. Similarly, each of the TDA8569Q's identical amplifiers offers 26 dB gain providing an output power of 4 x 25 W into a 4 Ohm load.

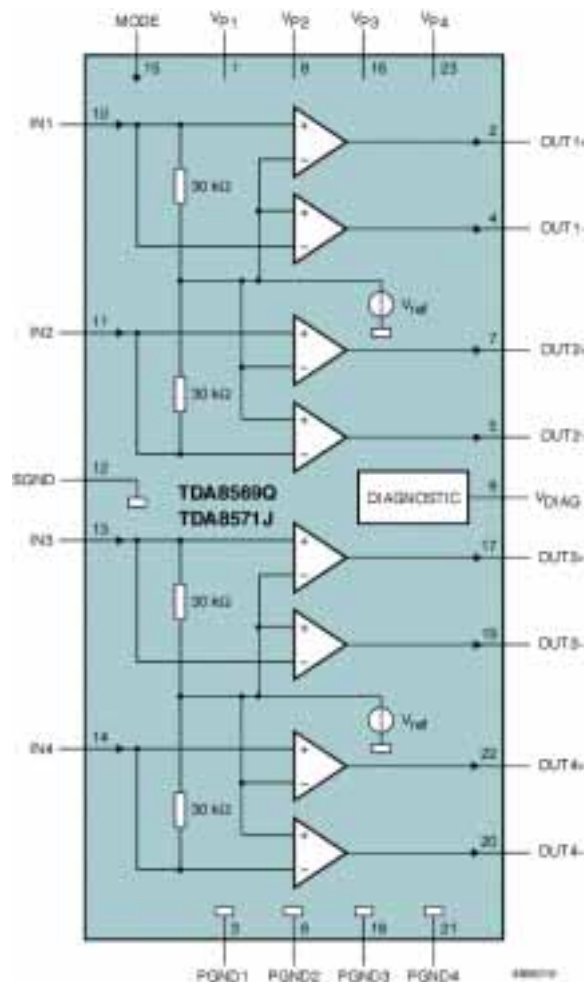
Key features

- Capable of driving 2 Ohm loads (TDA8569)
- Requires very few external components
- Fixed gain
- Diagnostic facility including distortion, short-circuit and temperature pre-warning
- Operating, mute and standby select switch
- Load dump protection
- Short-circuit safe to ground, to supply voltage and across load
- Low power dissipation in any short-circuit condition

- Thermal protection
- Reverse polarity safe
- ESD protection
- No switch-on / switch-off thump
- Flexible leads
- Low thermal resistance
- TDA8569Q pin compatible with TDA8567Q; TDA8571J pin compatible with TDA8568Q (except for gain)

Parameters

	TDA8569Q	TDA8571J
Output power (THD = 10%)	25 W	40 W
Supply voltage	14.4 V	14.4 V
Repetitive peak output current	7.5 A (max)	7.5 A (max)
Total quiescent current	230 mA	200 mA
Input impedance	30 kOhm	30 kOhm
Supply voltage ripple rejection	60 dB	34 dB
Closed loop voltage gain	26 dB	50 dB
DC output offset voltage (MUTE)	150 mV	80 mV
Package	DBS23P	DBS23P



TDA8592J/Q, TDA8593J/Q

A complementary quad audio power amplifier, the TDA8592 incorporates four independent amplifiers in BTL configuration, although each amplifier can be configured in line driver mode (SE output) with a gain of 20 dB. Through the I²C-bus the diagnostic information of each amplifier and speaker can be read separately. Protected against short circuit, over temperature and open ground and open V_p connections, even with a short on one amplifier channel, all the other channels will operate normally. A microcontroller can switch off the short circuited channel via the I²C-bus (enable bit) to reduce potential audio plops.

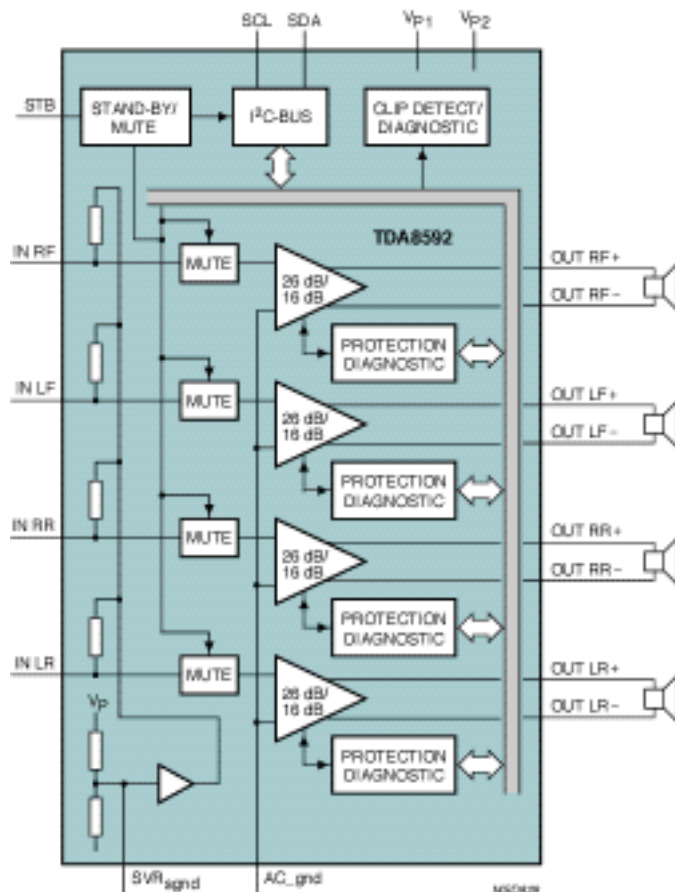
Key features

- 4 x 50 W (EIAJ), 15.2 V audio amplifiers
- Internally fixed 26 dB gain
- No switching thumps for on / off, standby / mute and mute / operating
- Low supply voltage mute for fast-mute voltage drops
- Line driver mode (20 dB single-ended out)
- Single mode control pin (standby, operating, mute/on)

- Diagnostic output for clip information
- Programmable clip detection of 1% or 4%
- Soft thermal clipping to prevent audio holes
- Programmable thermal pre-warning
- Output short-circuit indication; short to battery and ground
- Independent short-circuit protection per channel
- ESD, thermal and Overvoltage protections
- Reverse polarity safe; withstands up to 18 V at output
- DBS27 low thermal resistance package

Parameters

Quiescent current	200 mA
Power output (4 Ohm)/EIAJ	50 W (TDA8592); 45 W (TDA8593)
THD	0.1% (max)
Noise output voltage (amplifier mode)	55 µV
Noise output voltage (line driver mode)	25 µV



Dual amplifiers

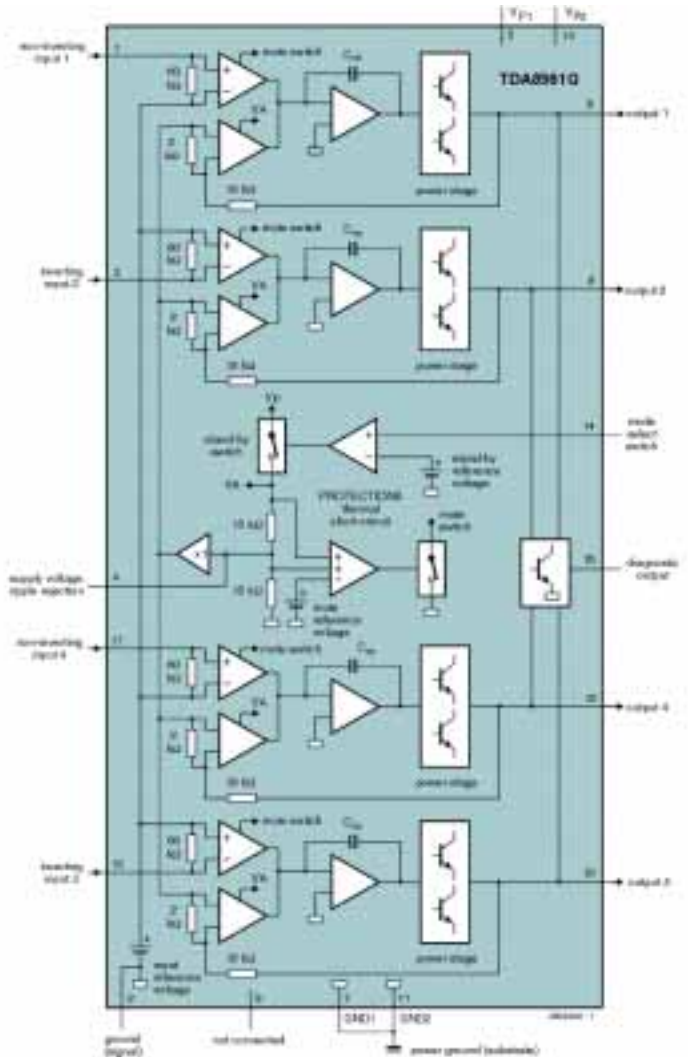
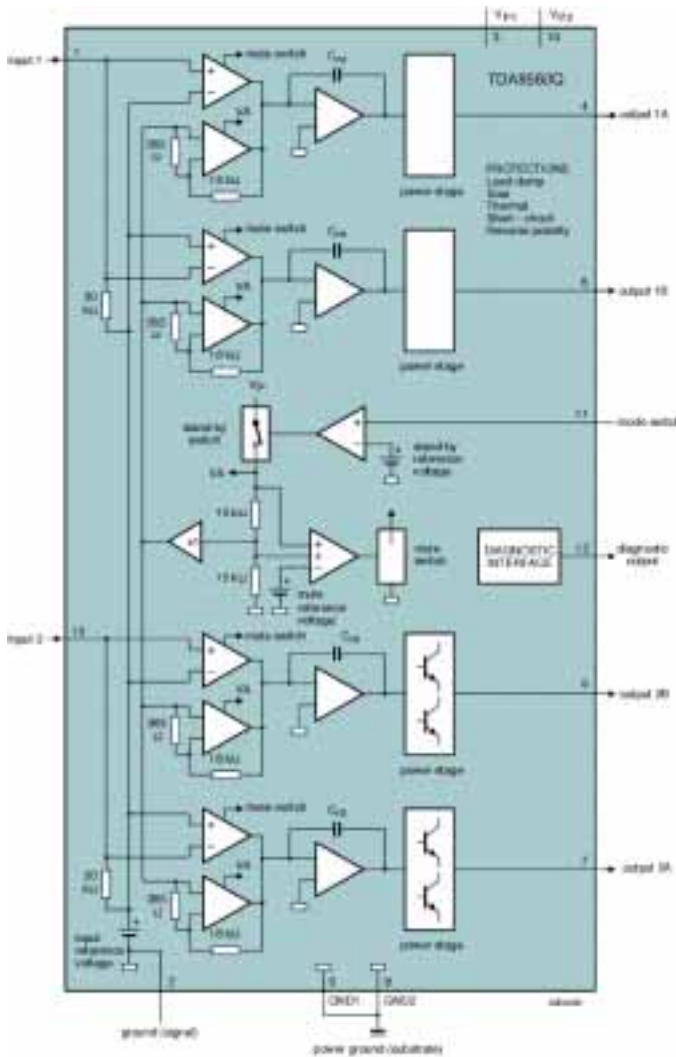
TDA8560/1/3/6

The TDA8560/1/3/6 car radio amplifiers provide a wide range of stereo BTL and single-ended configuration options, offering a variety of output powers. These integrated class A/B output devices are suitable for either 2 Ohm or 4 Ohm loads and are supplied in 13- or 17-lead SIL packages.

Key features

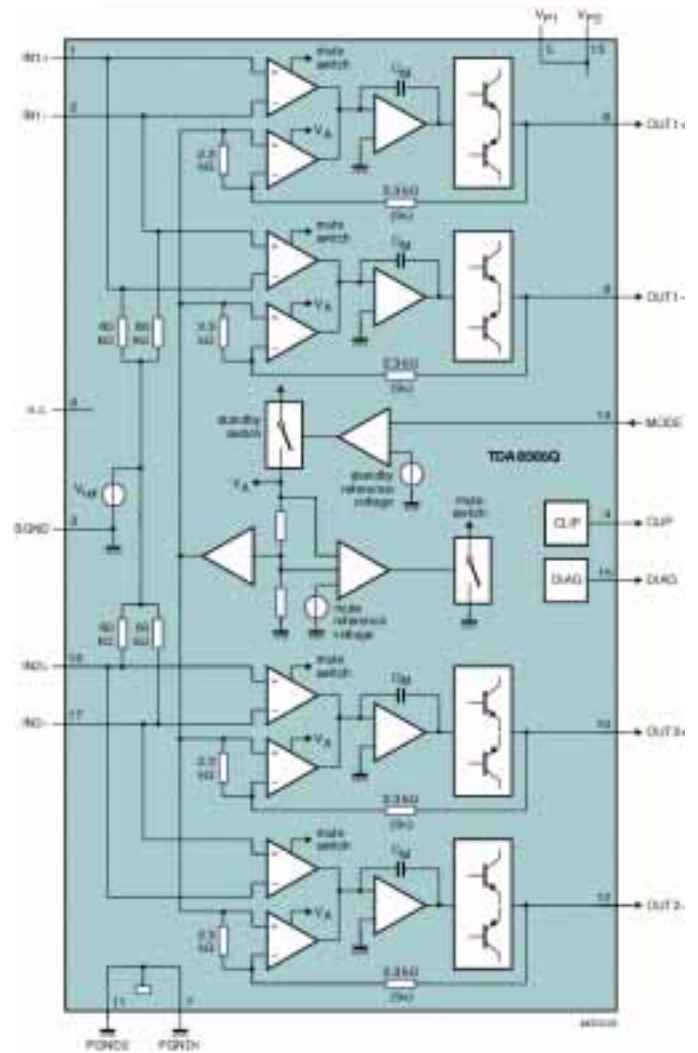
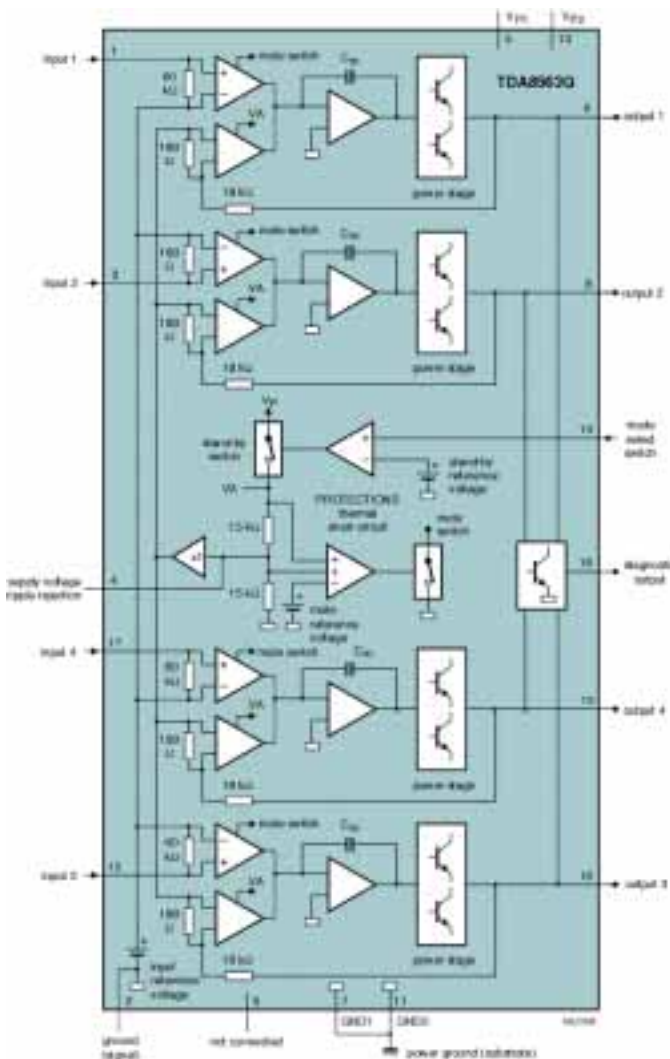
- Very few external components needed
- 4 Ohm and 2 Ohm load impedance
- Fixed gain
- Differential inputs (TDA8566)
- Diagnostic facility including distortion, short-circuit and temperature detection
- Operating, mute and standby select switch
- Quad single-ended or stereo BTL option (TDA8561)
- Load dump protection

- Short-circuit safe to ground, to supply voltage and across load
- Thermal and ESD protection, and reverse polarity safe
- Identical inputs (TDA8561, TDA8562 and TDA8563)
- Low power dissipation in any short-circuit condition
- No switch-on / switch-off thump
- Flexible leads
- Low thermal resistance



Parameters

Types	TDA8560Q	TDA8561Q/TH	TDA8563Q/AQ	TDA8566Q/TH
Configuration	BTL	BTL or SE	BTL	BTL
P_O (W)				
@ 10% $R_L = 4 \text{ Ohm}$, 14.4V	2 x 25	2 x 24 or 4 x 7	2 x 25	2 x 25
THD (1 W/ 4 Ohm)	0.05	0.05	0.05	0.05
Gain (dB)	40	20/26	26	26
SVRR (dB)	>40	>48	>50	>50
Offset (mV)	<200	<150	<150	100
Noise (μV)	200	70	85	85
Clip-detection	10%	10%	10% / 2.2%	10%
Packages	SIL13	SIL17/HSOP20	SIL13	SIL17/HSOP20



Dual amplifier

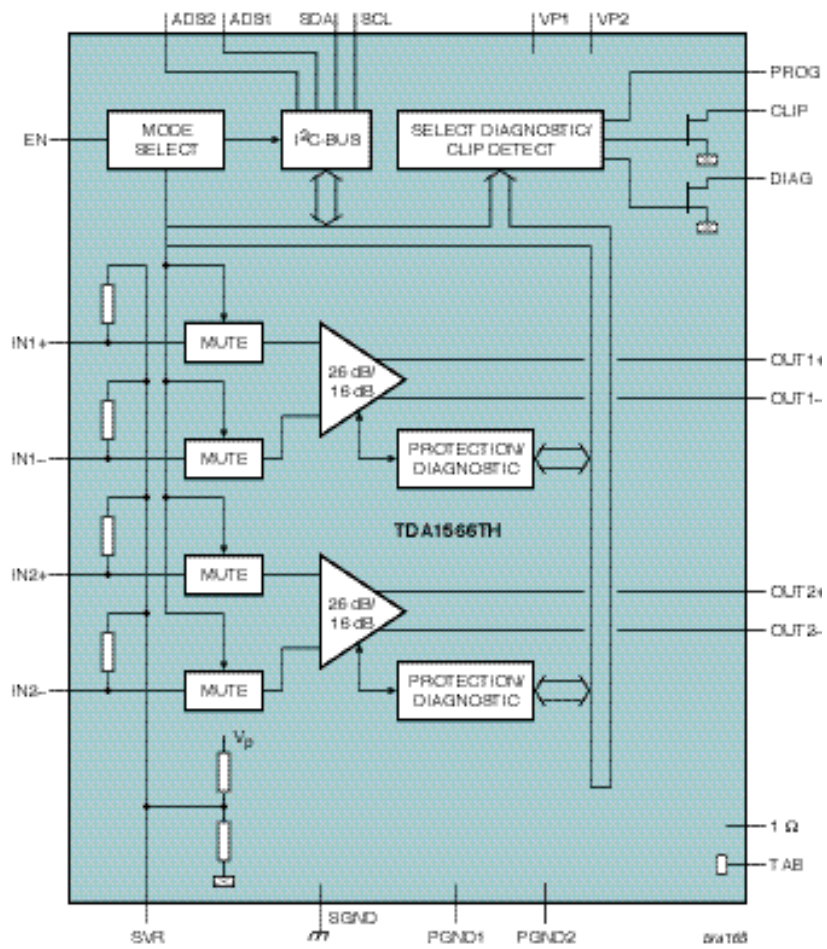
TDA1566TH

I²C-controlled dual amplifier with load diagnostic features

Manufactured in advanced BCDMOS technology, the TDA1566TH is a complementary dual BTL audio power amplifier delivering dual 46 W / 2 Ohm (THD = 10%) or mono 92 W / 1 Ohm (THD = 10%) output. It contains two independent amplifiers in BTL configuration which can be switched individually in either line driver mode, with 16 dB gain, or amplifier mode, with 26 dB gain. Both channels can be switched in parallel to drive a load of 1 Ohm. When operating in 1 Ohm the outputs of both channels should be hard wired externally. Through the I²C bus temperature and clip level diagnostics are fully programmable and which information is shown on the diagnostic pin can be selected. The status of each amplifier – output offset, load or no load, short circuit or speaker falsely connected – and the nature of the load – DC speaker, line driver or AC coupled load – can be read for each channel separately. The device is pin compatible with the TDA8566TH1.

Key features

- I²C and non-I²C modes (3.3 V and 5 V compliant)
 - 4 hardware programmable I²C addresses controlled by 2 pins
 - Dual bridge 4 Ohm or 2 Ohm load, or mono bridge 1 Ohm load
 - Low offset
 - Pop-free standby / mute / operating mode transitions
 - Speaker fault detection
- In I²C mode:
 - DC load detection: open, short, present
 - AC load (tweeter) detection
 - load detected during start-up with gain selected accordingly, without pop
 - programmable gain: 26 dB and 16 dB, selectable per channel
 - fully programmable diagnostic levels
 - clip detect: 3%, or 10%
 - thermal pre-warning
 - select information on the diag pin
 - clip information on each channel can be directed to the diag pin separately
 - independent thermal-, clip- or load fault enabling on diag pin
 - Independent short circuit protection per channel
 - Loss of ground and open V_p safe (peak current limited to 50A with a supply decoupling capacitor of 3 x 2200 μF maximum)
 - All outputs short circuit proof to ground, +V_p supply voltage and across the load
 - All pins short circuit proof to ground
 - Temperature controlled gain reduction to prevent audio holes at high junction temperatures
 - Low battery voltage detection



Single amplifiers TDA1560Q and TDA1562Q class H power amplifiers

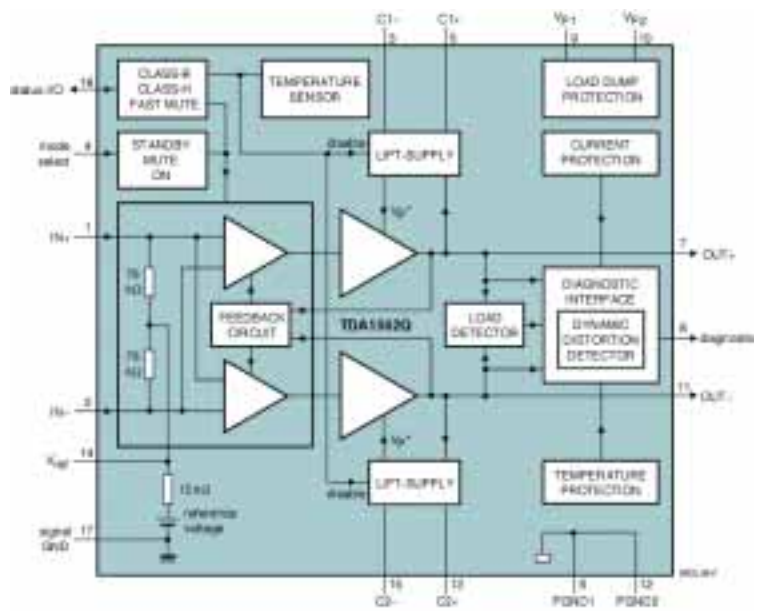
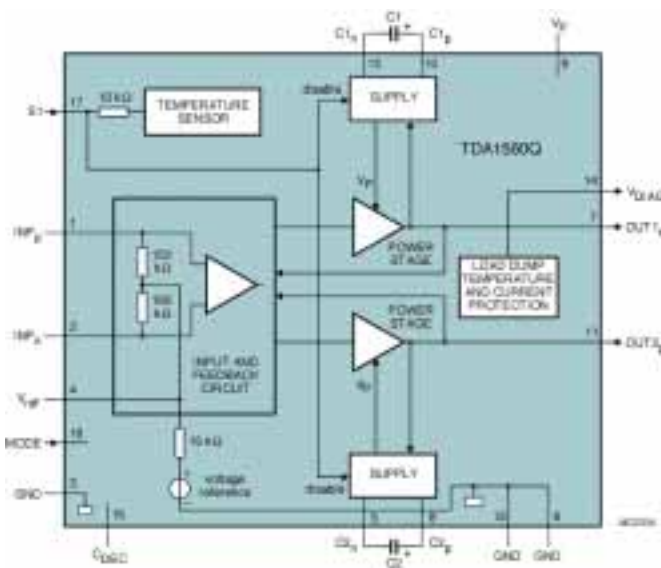
The TDA1560Q and TDA1562Q ICs are monolithic integrated BTL class H power amplifiers, reducing heat losses by about 50% for music signals when compared with integrated class A/B. The TDA1560Q is rated at 40 W output into an 8 Ohm load, while the high efficiency TDA1562Q delivers up to 70 W output with 4 Ohm loading. Ideal in car radio and booster systems, the TDA1562Q is also suitable for mains operated equipment. Both amplifiers feature a diagnostic facility which includes output short-circuits, open load detection and temperature protection. In addition, the TDA1562Q incorporates a Dynamic Distortion Detector (DDD).

Key features

- Few external components required
- Fixed gain
- Mode select switch
- Low power dissipation when used for music signals
- Differential inputs with high common mode rejection (TDA1562Q)
- Quick start option for car-telephony, navigation etc. (TDA1562Q)
- Load dump protection
- Short-circuit safe to ground, to supply voltage and across load

- Switches to low output power in event of excessive heatsink temperatures
- Fast mute on supply voltage drops (TDA1562Q)
- Thermal and ESD protection
- No switch-on / switch-off thump
- Diagnostic facility
- Flexible leads

Parameters	TDA1560Q	TDA1562Q
Output power (THD = 10%)	40 W ($R_L = 8 \text{ Ohm}$)	70 W ($R_L = 4 \text{ Ohm}$)
Output power (THD = 0.5%)	30 W ($R_L = 8 \text{ Ohm}$)	55 W ($R_L = 4 \text{ Ohm}$)
Supply voltage	14.4 V	14.4 V
Total quiescent current	100 mA	110 mA
THD (output power = 20 W)	-	0.06%
Input impedance	300 kOhm	150 kOhm (differential)
Voltage gain	30 dB	26 dB
Supply voltage ripple rejection ($f_1 = 100 \text{ Hz}$ to 10 kHz; $R_S = 0 \text{ Ohm}$)	55 dB	70 dB
CMRR	-	80 dB
Package	DBS17P	DBS17P



TDA1564/TDA1565 run-cool stereo power amplifier

Containing two identical 25 W amplifiers with differential inputs, the TDA1564 minimizes heat dissipation by switching from SE to BTL mode when high output voltage swings are needed, saving as much as 70% compared to conventional class B designs. A diagnostic facility provides several outputs including temperature pre-warning and clip detection at 2.5% THD.

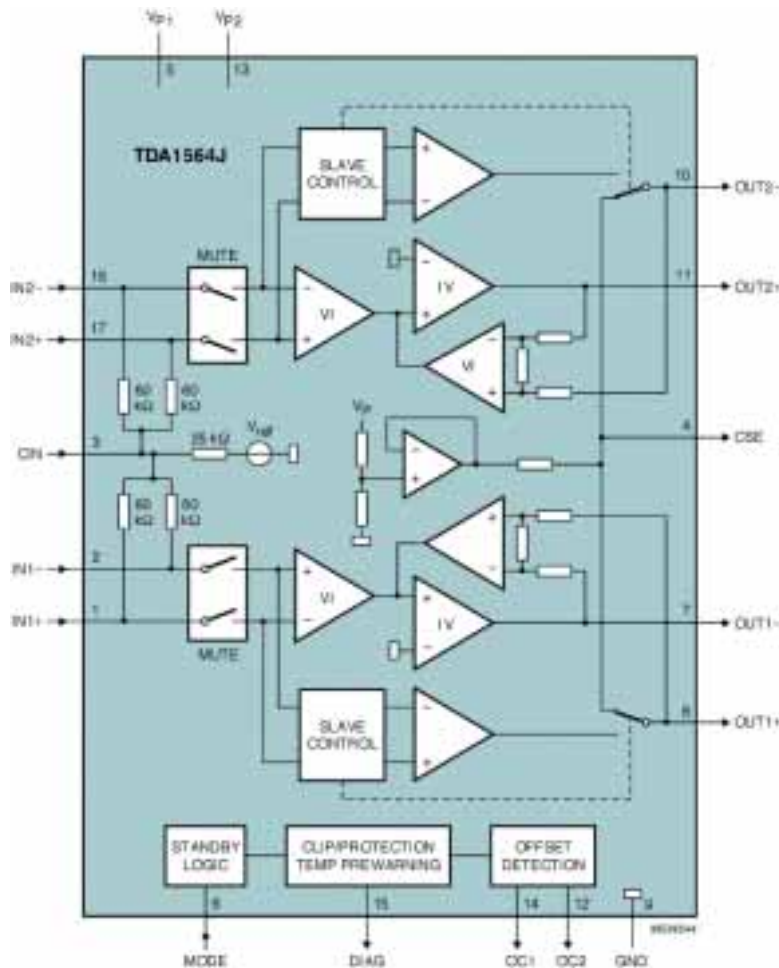
Key features

- Low heat dissipation due to SE to BTL mode switching
- Differential inputs with high CMRR
- Mute/standby/operating (mode select pin)
- Load dump protection circuit
- Short-circuit safe to ground, to supply voltage and across load
- Loudspeaker protection circuit
- Offset detection for each channel
- Device switches to SE operation at excessive junction temperatures
- Thermal protection at high junction temperature (170 °C)

- Clip detection at THD = 2.5%
- Diagnostic information (clip/protection/pre-warning/offset)

Parameters

TDA1564 power output	($R_L = 4 \text{ Ohm}$)
	25 W (10% THD); 20 W = (2.5% THD)
TDA1565 power output	($R_L = 2 \text{ Ohm}$)
	40 W (10% THD); 31 W = (0.5% THD)
Supply voltage	14.4 V
Total quiescent current	95 mA
Input impedance	120 kOhm
Supply voltage ripple rejection	65 dB
CMRR	80 dB
Voltage gain	26 dB
Package	DBS17P (TDA1564J) HSOP20 (TDA1564TH, TDA1565TH)



2.4.3. Multi-output voltage regulators TDA3681J/TH, TDA3682ST, TDA3683J

The TDA3681 is a multiple output voltage regulator with power switch and ignition buffer. It incorporates one 3.3 V, one 8.5 V and two 5 V regulators and can be used either with or without a microcontroller. The output stages of all switchable regulators feature extremely low noise behaviour and good stability, even with very small value output capacitors.

Key features – general

- **Second supply pin for regulators 3 and 4 to reduce power dissipation (eg. via a DC-to-DC converter)**
- **Supply voltage range from -18 to +50 V**
- **Hold outputs including load dump and temperature protection**
- **Reset (push-pull output stage) for regulator 2 and hold output (open-collector output)**
- **Adjustable reset delay time**
- **High supply voltage ripple rejection**
- **Backup capacitor for regulator 2**

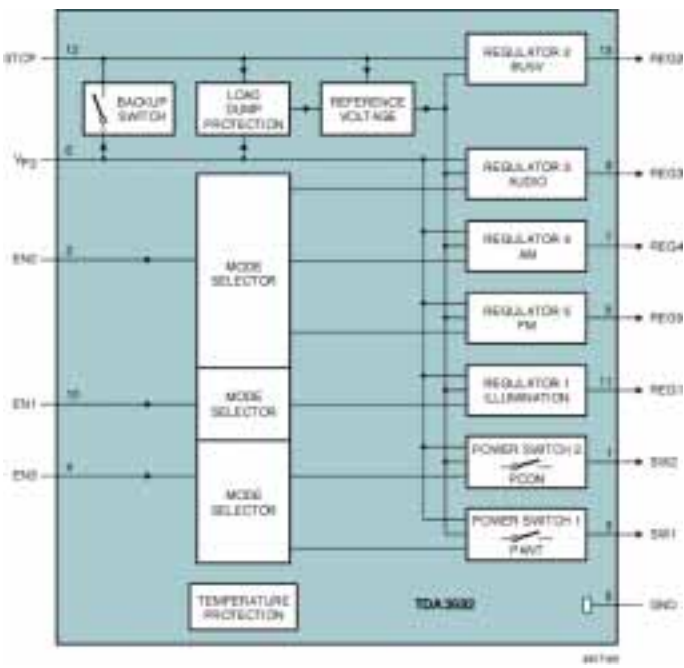
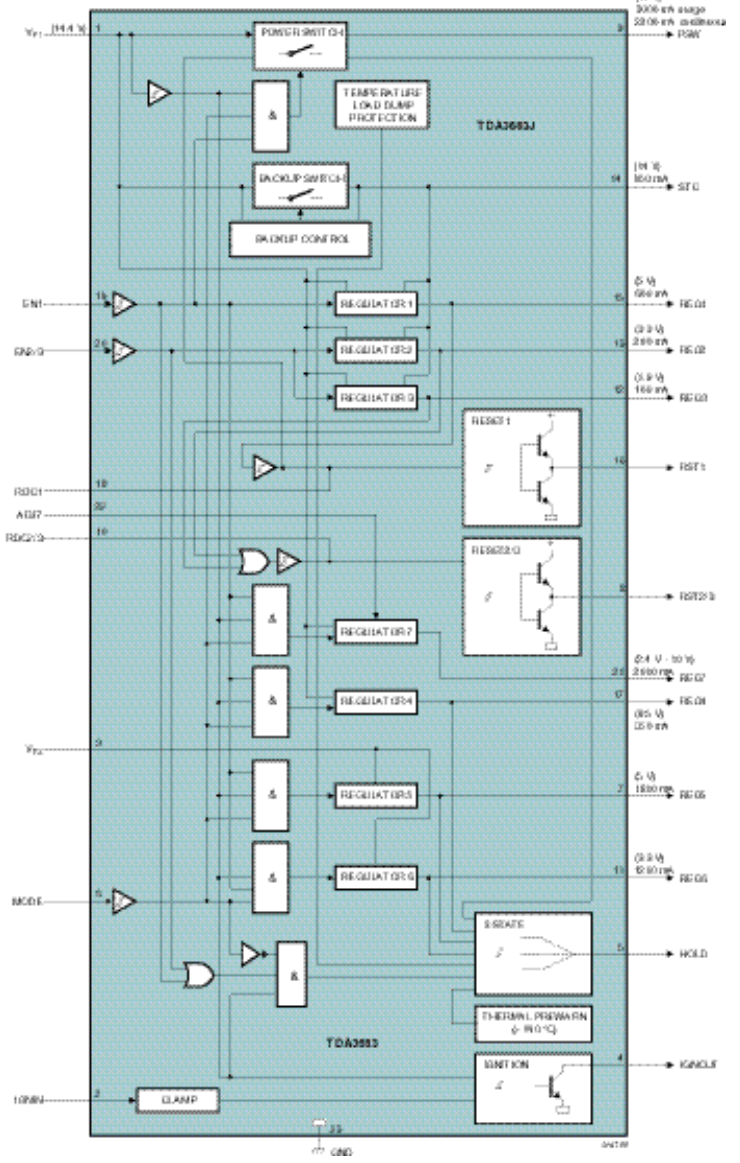
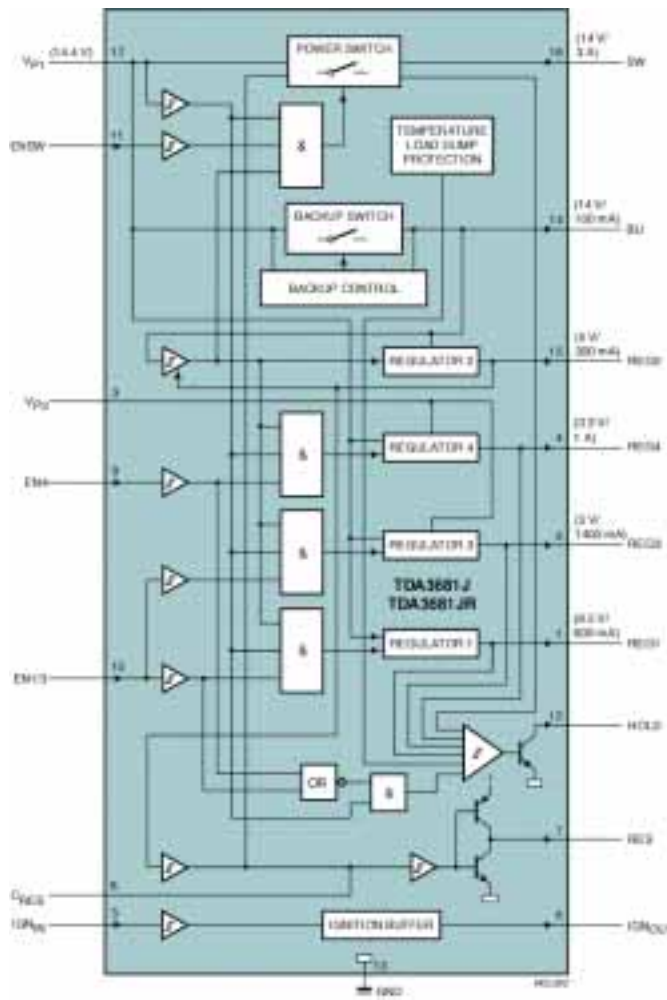
Key features – protections

- **Reverse polarity safe (down to -18 V without high reverse current)**

- **Able to withstand voltages up to 18 V at the outputs (supply line may be short-circuited)**
- **ESD protection on all pins**
- **Load dump and thermal protections**
- **Foldback current limit protection for regulators**
- **Delayed second current limit protection for the power switch (at short circuit)**

Parameters

	TDA3681J/TH	TDA3682ST	TDA3683J
Regulator 1	8.5/600	10.3/250	5.0/600
Regulator 2	5/300	5/300	3.3/200
Regulator 3	5/1400	8.2/200	1.9/100
Regulator 4	3.3/1000	8.2/50	8.5/350
Regulator 5	-	8.2/50	5.0/1800
Regulator 6	-	-	3.3/1200
Regulator 7	-	-	2.4-10/2000
Output voltage tolerance	5%	5%	5%
Power switch 1	3 A / 1.8 A	0.55 A	1 A / 2.2 A
Power switch 2	-	0.55 A	-
Quiescent current (standby)	80 µA	80 µA	30 µA (sleep)
Package	SIL17P / HSOP20	RDBS13P	DBS23P



TDA3601/8 and TDA3615/8

These multiple output voltage regulators are designed for use with or without microcontrollers. All the members of this family incorporate a host of protection features including load dump, thermal, foldback current limit and ESD as well as reverse polarity safe.

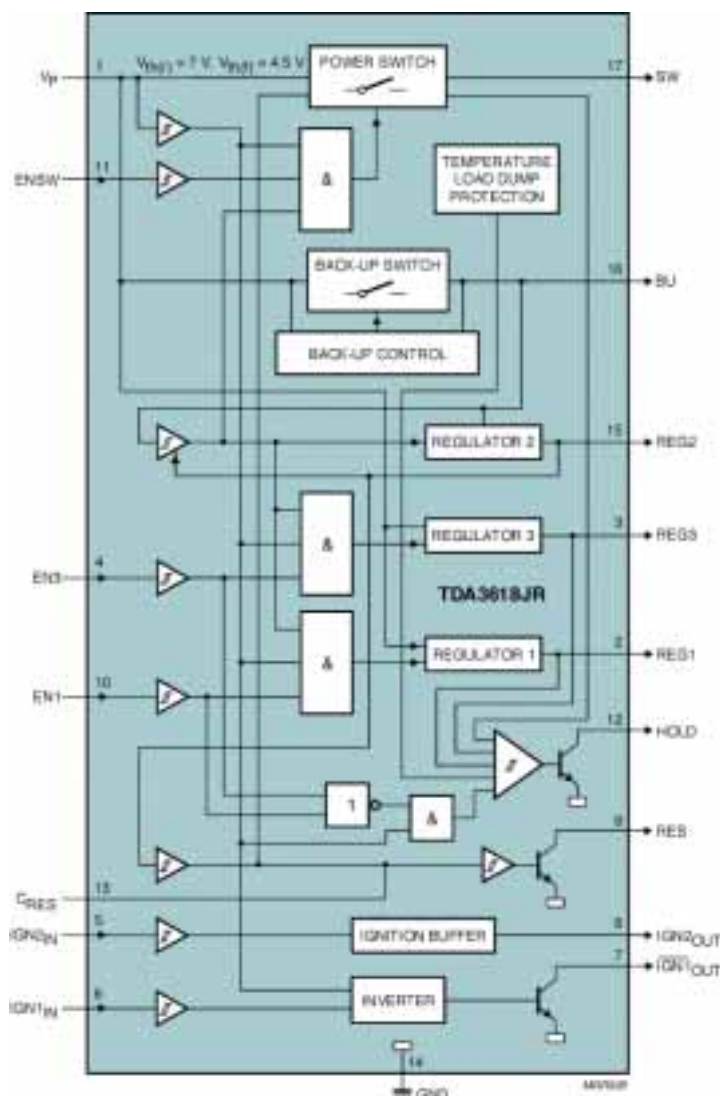
- TDA3601: six fixed output regulators
- TDA3608: three fixed output regulators with one power switch
- TDA3615: six fixed output regulators with three power switches
- TDA3618: three fixed output regulators with one power switch and ignition buffers

Key features

- **Low quiescent current**
- **High ripple rejection**
- **Reset output (inverted reset output on TDA3608AQ)**
- **Hold output (TDA3608 and TDA3618)**
- **Adjustable reset delay time (TDA3608 and TDA3618)**
- **Protected power switches (not TDA3601)**

Quick reference data

	TDA3601	TDA3602	TDA3615	TDA3618
Reg. 1	5 / 20*	8.5 / 250	5 / 50*	9 / 600
Reg. 2	2.1 / 200	5 / 140	2.851 / 300	5 / 300*
Reg. 3	5 / 150	5 / 50*	5 / 450	5 / 750
Reg. 4	9.5 / 150		9.5 / 100	
Reg. 5	9.5 / 200		9.5 / 150	
Reg. 6	9.75 / 200		9.5 / 150	
Power switch	-	-	1.7 / 0.55 A	3 / 1.8 A
Quiescent current (standby)	1.2 mA	280 μ A	110 μ A	310 μ A
Package	SIL-13P	SIL-9MP	SIL-17P	SIL-17P



2.5 HD Radio™ processor solutions

Helping you stay in front with the latest developments in high quality sound, Philips paves the way to interference-free, in-car CD-quality digital sound with a host of information services. Integrating seamlessly with existing radio designs, the SAF3550 HD Radio processor adds high quality digital AM and FM functionality to our complete car radio portfolio. This cost-effective baseband processor for HD Radio sets enables listeners to take advantage of the installed base of HD Radio stations already delivering digital audio broadcasts and wireless data services.

HD Radio key benefits

- Digital signal transmitted simultaneous to analog in existing broadcaster allocated channel (hybrid mode: digital side bands)
- Compatible with current infrastructure at transmitter and receiver
- Smooth transition period for broadcasters and radio makers

SAF3550

HD Radio™ processor

A highly integrated circuit for demodulating and processing IBOC signals, the SAF3550 HD Radio processor shares the same platform as Philips' high-performance automotive radio chipsets such as the SAF7730 Car DSP and its respective TEF6730 tuner. The SAF3550 provides designers with a simple and inexpensive way to add HD Radio capabilities to the receiver, making a simple upgrade path to high quality digital AM and FM audio. Functionality includes audio decompression and data processing, while multiple serial interfaces ensure flexible integration into the system.

The SAF3550 provides a fully optimized hardware and software solution. All the standard algorithms needed for basic HD Radio functionality are realized in hardware, while additional and advanced functions are implemented in software. This provides a flexible and updateable approach, ensuring designs can keep pace with future requirements. Its high performance processor core provides audio decompression and all necessary data, control and interface functions, with external FLASH and SDRAM memories used to store the chip firmware and IBOC signal processing. This cost-effective, single-chip solution also offers the smallest footprint for this type of device.

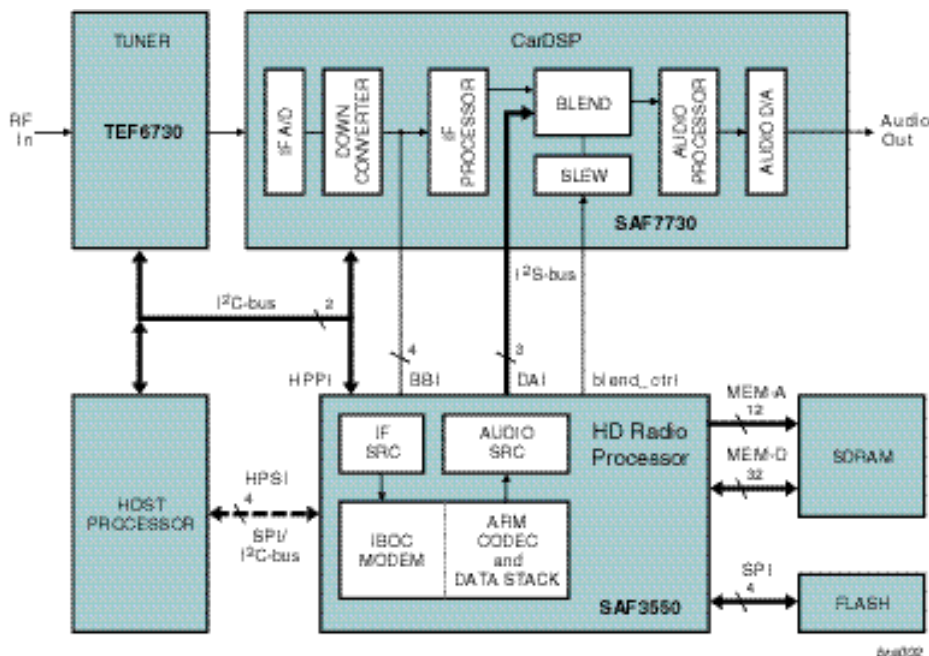
Part of a complete system concept that helps create interference-free sound in the car, the SAF3550 takes full advantage of HD Radio benefits including CD-quality audio from HD Radio FM broadcasts and FM-quality using HD Radio AM. The chip supports data services such as album information, as well as future functionalities of replay facilities, a second program channel, customized station content and local traffic information.

Key features

- HD Radio digital baseband processing
- IBOC (In-Band On-Channel) decoding for AM/FM hybrid and all-digital modes
- blend control generation for hybrid modes
- HD Codec (HDC) audio decompression
- MPS (Main Program Service) and PAD (Program Associated Data) data decoder
- SIS (Station Information Service) data decoder
- Compatible, dedicated interface to CarDSPs (SAF7730)
- SDRAM controller supports up to 128 Mbit SDRAM
- Internal clock oscillator and 4 internal PLLs
- Programmable baseband input sample rate converter (I²S based)
- Programmable audio output sample rate converter supporting 8 to 48 Kbytes/s with internal or external clock
- Serial FLASH SPI interface
- Primary and secondary serial interfaces for the receiver host processor based on industry standard I²C and SPI
- UART port and auxiliary I²C/SPI interface for application or diagnostics
- Compact 144 pin package HLQFP144

Key parameters

Supply voltage	3.3 and 1.8 V
Supply current	33 mA @ 3.3 V 625 mA @ 1.8 V
Power dissipation (max)	1.4 W
Supported input baseband sample rates	650 and 675 ksamples/sec
Digital audio interface modes	Master and slave
Package	HLQFP144



2.6 Storage

World-class CD solutions have long been a feature of our car stereo capability. Today CD players have largely replaced tape units in the car, while other optical storage media such as DVD-ROM are also becoming customary accessories. Unlike many suppliers, Philips can combine long-term expertise from many areas – including consumer and PC markets – to deliver proven, state-of-the-art products that are ideal for the automotive environment.

This means our highly integrated storage ICs incorporate comprehensive functionality and utilize powerful software to deliver flexible, high performance solutions. Philips next-generation CD solutions for example are fully compliant with today's compressed audio standards to support MP3 and WMA (Windows Media Audio) playback. Alongside these ICs we have extended our offering to include DVD audio playback, so you can choose the functionality you need to support advanced, or future, automotive applications.

SAA7326 (CD10 II)

Digital servo processor, CD decoder and integrated DAC

Integrating CD decoder, digital servo and bitstream DAC functionality on a single chip, the SAA7326 offers an ideal solution for automotive CD audio. Combined with the TZA1026 data amplifier and laser supply circuit it forms the CD10 II audio chipset, a complete system solution for CD applications. All standard decoder functions are implemented digitally on-chip, and both decoder and servo elements are software compatible with the SAA737x (CD7) design.

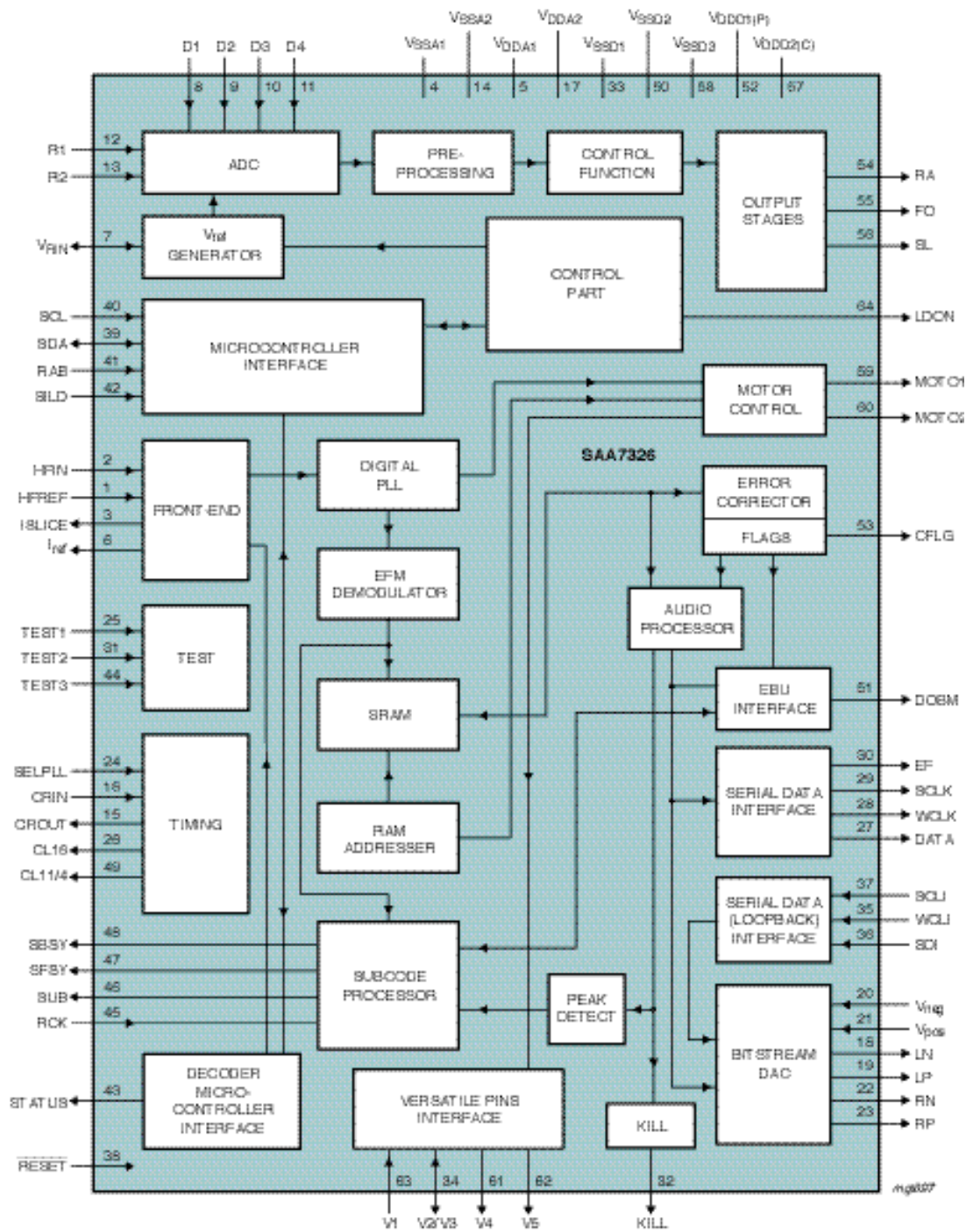
Key features

- Extended operating ambient temperature range -40 to +85 °C
- Integrated bitstream DAC with differential outputs, operating at 96 fs with 3rd-order noise shaper
- DAC performance -90 dB SN typical
- Separate serial I/O interfaces allow data 'loopback' mode for using on-board DAC with external Electronic Shock Absorption (ESA) systems
- Up to 2 times speed mode
- Lock-to-disc mode
- Full error correction strategy, t = 2 and e = 4
- Full CD graphics interface
- All standard decoder functions implemented digitally on-chip
- FIFO overflow concealment for rotational shock resistance
- Digital audio interface (EBU), audio and data
- 2 and 4 times oversampling integrated digital filter, including fs mode
- Audio data peak level detection
- Kill interface for external DAC deactivation during digital silence
- All SAA737x (CD7) digital servo and high-level functions
- Low focus noise
- Same playability performance as SAA737x (CD7)
- Automatic closed-loop gain control available for focus and radial loops
- Pulsed sledge support
- Electronic damping of fast radial actuator during long jump
- Microcontroller loading LOW
- High-level servo control option
- High-level mechanism monitor
- Communication may be via TDA1301/SAA7345 compatible bus or I²C bus
- On-chip clock multiplier allows the use of 8.4672, 16.9344 or 33.8688 MHz crystals or ceramic resonators

Key parameters

Supply voltage	3.3 V
Supply current	20 mA (1x speed) 25 mA (2x speed)
DAC SNR	90 dB
DAC (THD + N)/S	-83 dB
Operating temperature	-40 to +85 °C
Package	QFP64

Supply of this Compact Disc IC does not convey an implied license under any patent right to use this IC in any Compact Disc application.



TZA1026 (CD10 II)

Data amplifier and laser supply IC

The TZA1026 contains RF amplifier and automatic laser power control circuit. The pre-amplifier forms a versatile, programmable interface for voltage output CD mechanisms to Philips' CD10 (SAA7326) digital servo processor. Wide RF bandwidth makes the TZA1026 suitable for CD-A/V and CD-R/W applications with a data rate up to $n = 4$ times speed, and the adaptable RF gain accepts CD-A/V or CD-R/W discs. Equalizer adjustment via the equalizer/speed select signal offers $n = 1$ or $n = 2$ times speed, while for $n = 4$ times speed the RF is not equalized.

Using external resistors, the TZA1026 can be adapted to a wide range of voltage output mechanisms. The ALPC circuit maintains control over the laser diode current and can accommodate N- or P-substrate monitor diodes. With an on-chip reference voltage generator, a constant and stabilized output power is ensured independent of ageing. A separate, low voltage supply connection for the laser allows the internal power dissipation to be reduced, and the laser output current range can be optimized for the laser diode with a single external resistor. When a DC-to-DC converter is used, the adjustable output current range can compensate for the extra gain thereby introduced into the ALPC control loop.

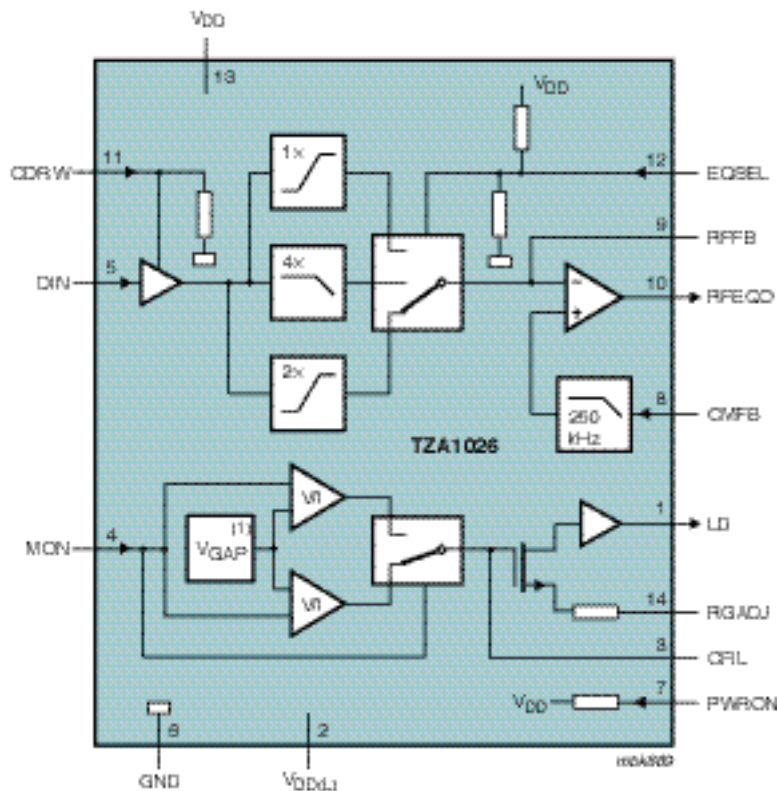
Key features

- Supports a wide range of voltage output mechanisms
- RF amplifier with data rates up to $n = 4$ times speed
- Programmable RF gain for CD-Audio/Video (CD-A/V) and CD-R/W discs

- Adjustable equalizer for $n = 1$ or $n = 2$ times speed
- Fully Automatic Laser Power Control (ALPC) including stabilization and a separate laser supply voltage for power efficiency
- Adjustable ALPC output current range
- Automatic N- or P-substrate monitor diode selection
- Adjustable laser bandwidth and switch-on current slope using external capacitor
- Protection circuit to prevent laser damage due to supply voltage dip
- Optimized interconnection between data amplifier and CD10Auto (SAA7326)
- Wide supply voltage and temperature range
- Power-down switch to reduce power consumption during standby
- Low power consumption

Key parameters

Supply voltage and laser supply voltage	2.7 to 5.5 V
Supply current	3 mA
Quiescent supply current	40 μ A (max)
RF THD	-50 dB
RF power supply ripple rejection	40 dB
Operating temperature	-40 to +85 $^{\circ}$ C
Package	SO14



SAA7826

CD audio decoder, digital servo and filterless DAC with integrated pre-amp and laser control

Significantly reducing external component count, the SAA7826 CD audio decoder IC combines the functionality of the SAA732x with the pre-amplifier and laser control functions of the TZA102x. The device also removes the need for an external diode signal pre-amplifier.

Helping reduce system power consumption, two standby modes can be set: CD stop, where most I/O functions are switched off, and CD pause which switches off audio output features.

Enabling the SAA7826 to be optimized for your application, the high-pass filter, equalizing filter, HF gain and adaptive slicer are all register programmable.

Key features

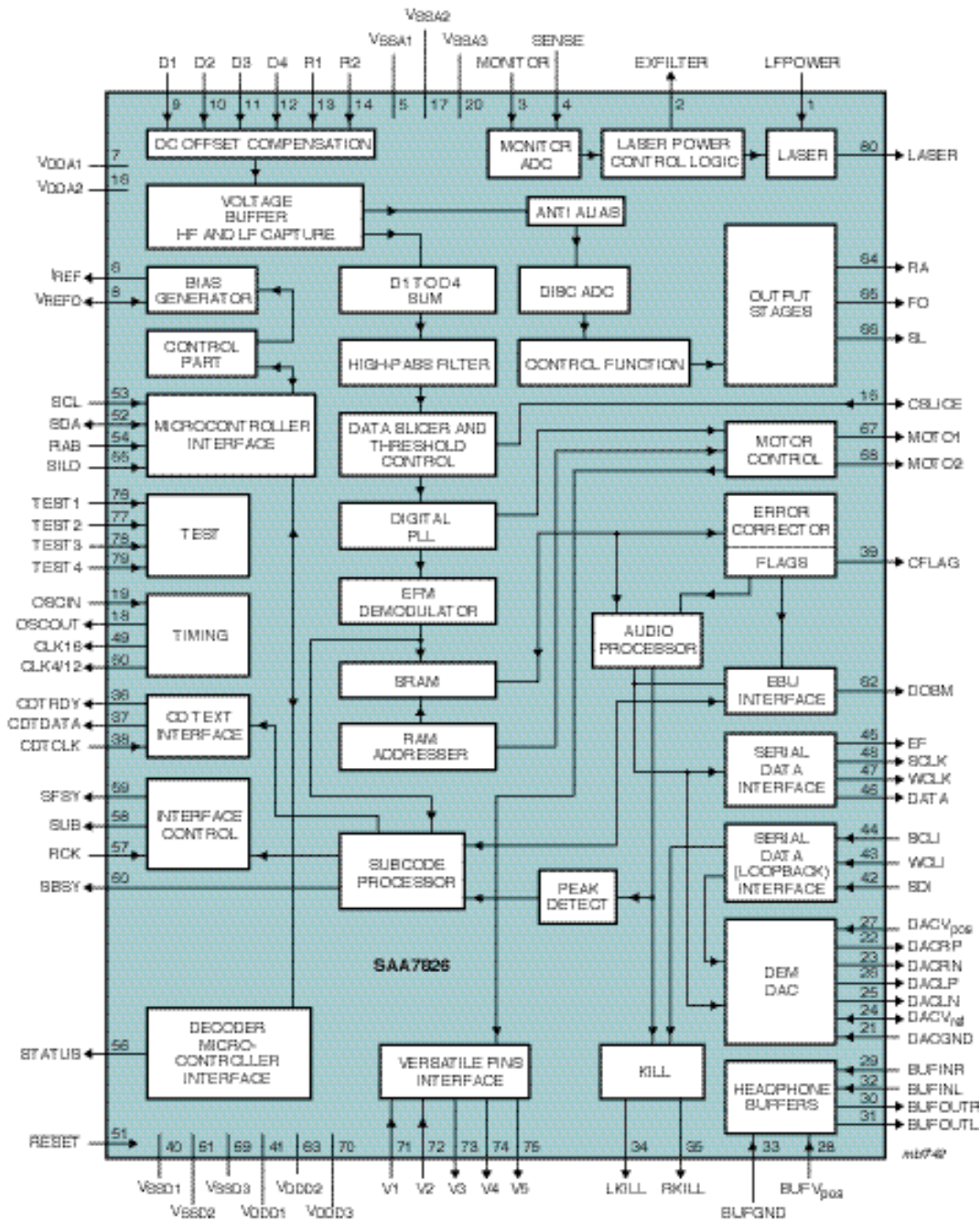
- Decoder and servo elements based on the SAA732X design (original features maintained)
- Software compatibility with SAA732X, new features controlled from new shadow registers
- 1x, 2x and 4x speed
- LF (servo) signals converted to digital representations by 6 oversampling bitstream ADCs
- HF part summed from signals D1 to D4 and converted to a digital signal by a data slicer
- On-chip buffering and filtering of diode signals from the mechanism for signal optimization
- Selectable DC offset cancellation of quiescent mechanism voltages and dark currents
- On-chip laser power control (up to 120 mA)
- Laser on/off control, including 'soft' start control (zero to nominal power in 1 ms)
- Monitor control and feedback circuit maintains nominal output power throughout laser life
- Dynamic element matching DAC with minimum external components

- DAC performance of -80 dB (THD + N) and 90 dB S/N A-weighted
- Separate left and right channel digital silence detection available on KILL pins
- Digital silence detection on internal data and loopback (external) data
- 5 versatile pins, 2 inputs and 3 outputs
- Integrated CD text decoder with separate microcontroller interface
- Dedicated 4 MHz or 12 MHz clock output for microcontroller (configurable)
- Configured for N-sub monitor diode
- On-chip clock multiplier allowing use of 8.4672 MHz crystal or ceramic resonator
- M1 version has an EBU mute function allowing independent muting of data while maintaining the SPDIF frame structure

Key parameters

Digital supply voltage	1.8 V
Analog supply voltage	3.3 V
Digital supply current	38 mA (1x speed) 39 mA (2x speed) 40 mA (4x speed)
Crystal frequency	8.4672 MHz
DAC S/N	90 dB
Operating temperature	-40 to +85 °C
Package	LQFP80

Supply of this Compact Disc IC does not convey an implied license under any patent right to use this IC in any Compact Disc application.



SAA7806

CD audio IC with ARM7TDMI microprocessor

The SAA7806 is a single chip solution aimed at automotive CD applications and combines CD audio decoder, digital servo, audio DAC, pre-amp, laser driver and integrated ARM7TDMI microprocessor. Derived from the SAA7817 DVD decoder IC, the channel decoder design has been improved and optimized specifically for CD audio (e.g. improved CD playability). The digital servo, analog pre-amp, laser driver and audio DAC blocks are likewise improved versions of those used by the SAA7826 IC. Further enhancements ensure integrated system functionality and reduced system cost, while the IC's generic architecture forms the basis of future variants optimized for different CD applications.

Key features

- 32 bit embedded ARM7 RISC microprocessor supporting both 32 bit and 16 bit ('Thumb') instruction sets
- Register structure utilizes complete 32 bit bandwidth of the integrated microprocessor bus architecture
- Slave mode supporting synchronization of CD playback speed to an input IIS clock
- Integrated digital HF/Mirror detector with peak, amplitude and offset measurement
- Integrated LCD controller/driver
- Integrated CD-Text decoder
- 'Filterless' pseudo-bitstream audio DAC
 - THD -80 dB and SNR 90 dB, with minimal external components
- 1x, 2x, 4x & 6x decode speed, CLV or CAV modes
- QFP100 package with 0.65 mm pin pitch.
- Separate left and right channel digital silence detect

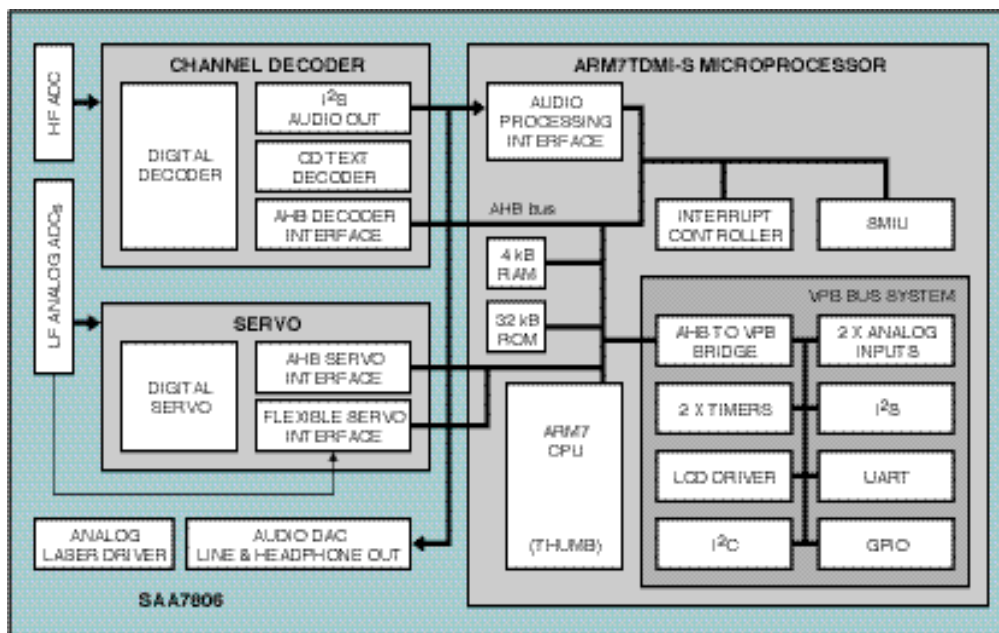
available on KILL pins

- Digital silence detection available on loopback data from external source as well as internal data
- Separate line and headphone outputs for audio DAC
- Loop back mode allows use of integrated DAC with external IIS/EIAJ sources
- Compatible with voltage mode mechanisms
- On-chip buffering and filtering of diode signals from mechanism optimizes signals for decoder and servo parts
- Eye pattern monitor system to observe selectable points within the analogue pre-amp
- Current and average jitter values available via registers
- On-chip laser power control, up to 120 mA
- Configured for Nsub monitor diode
- All digital input pins are 5 V tolerant

Supply of this Compact Disc IC does not convey an implied license under any patent right to use this IC in any Compact Disc application.

Key parameters

Digital supply voltage – core	1.8 V
Digital supply voltage – peripherals	3.3 V
Analog supply voltage	3.3 V
Crystal Oscillator	8.4672 – 16.9344 MHz
Real time clock oscillator	32 KHz
DAC SNR (A weighted)	-90 dB
Total Harmonic distortion @1KHz (THD)	-80 dB
Total Power dissipation (1x speed)	302 mW
Operating temperature	-40 to +85 °C
Package	QFP100



SAA7836

CD audio IC with integrated MP3/WMA decoder

The SAA7836 single-chip CD audio decoder solution incorporates on-chip MP3 and WMA decoding, digital servo, audio DAC, sample rate converter, pre-amp, laser driver and integrated ARM7TDMI-S microprocessor. Targeted at a range of compressed audio CD applications, its design is derived from the SAA7806 decoder IC, with additions to allow low cost system implementation of MP3 and WMA decoding.

Key features

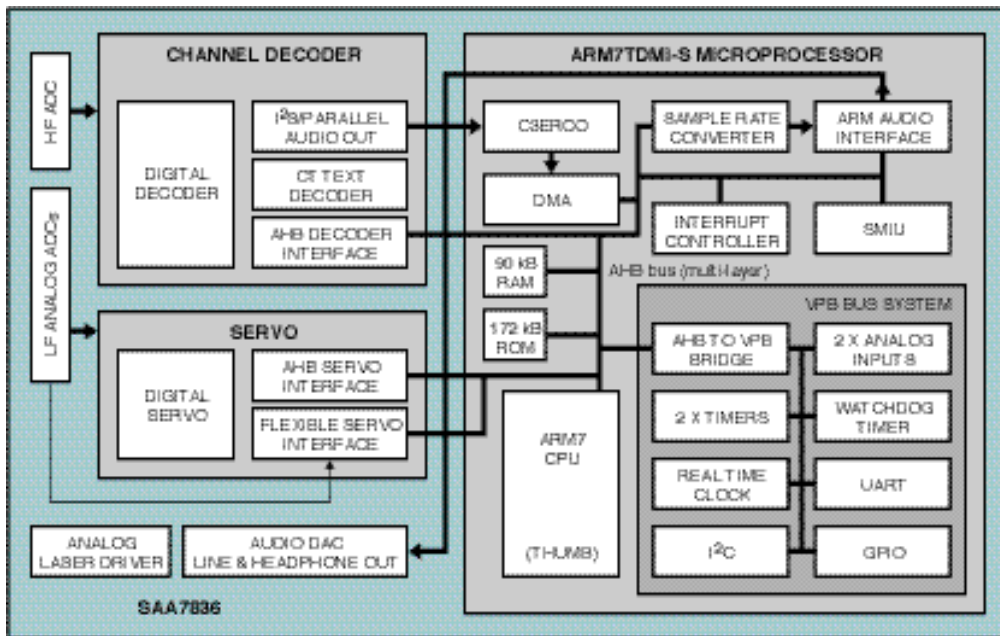
- 32 bit embedded ARM7 RISC microprocessor (80 MHz / 72 MIPS maximum)
- Mask programmed internal ROM for microprocessor
- Programmable clock frequency for ARM microprocessor
- Block decoder hardware to perform C3 error correction
- MP3 and WMA decoding with all necessary ROM and RAM space on-chip
- Sample rate converter circuit (input range 8 kHz to 48 kHz, output 44.1 kHz)
- Watchdog timer
- I²S, SP-DIF, subcode (V4) and subcode sync outputs
- 32 GPIOs (tbf) and two standard UART channels
- I²C interface configurable for master or slave modes, supporting 100 kbits/s and 400 kbits/s
- Integrated digital HF/Mirror detector with peak, amplitude and offset measurement
- Integrated CD-Text decoder
- Up to 6x decode speed, CLV or CAV modes
- 'Filterless' pseudo-bitstream audio DAC with minimal external components
- Stereo line outputs for audio DAC
- LF (servo) signals converted to digital representations by Sigma-Delta ADC's shared between pairs of channels to minimize dc offset between channels
- HF part summed and converted to digital signals by HF 6-bit ADC
- Selectable DC offset cancellation of quiescent mechanism voltages and dark currents
- Hardware support for a sledge stepper motor
- Support for microprocessor control of radial, focus and sledge control loops
- Eye pattern monitor system to observe selectable points within the analog pre-amp
- Current and average jitter values available via registers

- On chip laser power control, up to maximum currents of 120 mA
- Laser on-off control, including "soft" start control - zero to nominal output power in 1 ms
- Monitor control and feedback circuit to maintain nominal output power throughout the life of laser
- Configured for Nsub monitor diode
- Embedded flash version for code development and debug programmed via JTAG interface
- All digital input pins are 5 V tolerant
- QFP100 package with 0.65 mm pin pitch

Supply of this Compact Disc IC does not convey an implied license under any patent right to use this IC in any Compact Disc application.

Key parameters

Digital supply voltage – core	1.8 V
Digital supply voltage – peripherals	3.3 V
Analog supply voltage	3.3 V
Crystal Oscillator	8.4672 – 16.9344 MHz
Real time clock oscillator	32 KHz
DAC SNR (A weighted)	t.b.f.
Total Harmonic distortion @1KHz (THD)	t.b.f.
Total Power dissipation (1x speed)	t.b.f.
Operating temperature	-40 to +85 °C
Package	QFP100



SAA7818

DVD and CD playback IC

Suitable for 6x DVD and 18x CD playback applications, the SAA7818HL has a wealth of new features that enable superior playability in both CD and DVD modes.

An embedded microcontroller operates as a 33 or 67 MHz equivalent 80C51, interfacing to the channel decoder, block decoder and servo processor. The block decoder incorporates a DVD video authentication module and supports up to 64 Mbit of external SDRAM memory. Data output configurations include I²S-bus, ATAPI and UDE, while the external memory can be bypassed altogether, creating a bufferless ATAPI or UDE data path solution.

The channel decoder has selectable differential and single-ended HF inputs, which are compatible with the TZA1036 and TZA1038 devices. There is an option to output the data as raw I²S-bus via some programmable data I/O pins. With increased tap setting for the PLL equalizer compared with the SAA7816 device and enhanced playability of black dots and scratches, overall playability has been greatly improved. More benefits come from a new defect detector that allows holding the HF PLL frequency and slicer settings over a defect. Together with an additional limit equalizer, these lead to improved tolerance to continuity errors in DVD playback mode.

An upgraded servo processor now includes an improved defect detection and handling process, together with an integrated envelope detection circuit and DC offset compensation on the diode inputs.

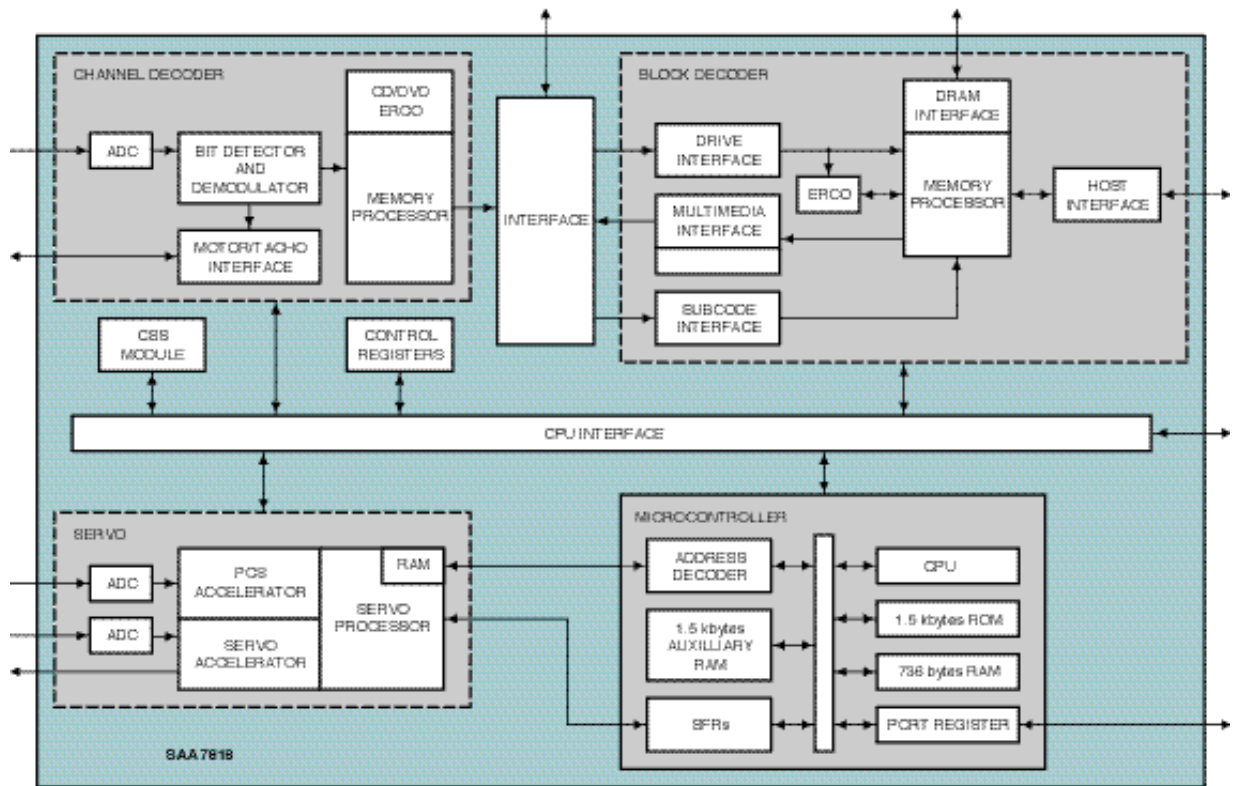
Key features

- **CD-ROM, CDr, CD-DA, VCD, SVCD, CD-I, photo CD and DVD video formats**
- **6x DVD-ROM and 18x CD-ROM playback capability**
- **Real-time error detection and correction in hardware for CD-ROM mode**
- **Embedded DVD video authentication module**
- **Supports up to 64 Mbit external SDRAM memory**
- **Supports ATAPI and synchronous UDE interfaces**
 - configurable as generic DMA interface
- **Selectable differential and single-ended HF inputs, compatible with TZA1033 and TZA1035**
- **Internal 8-bit ADC**
- **Digital PLL and slicer for HF clock regeneration**
- **Supports EFM and EFM+ demodulation**
- **Full CD error correction strategy; t = 2 and e = 4**
- **On-chip CD error corrector memory with ± 8 frame jitter margin**
- **Built-in hardware for double pass DVD error corrector**
- **I²S-bus output available via programmable pins**
- **Enhanced playability of black dots and scratches with improved defect detector**
- **Improved tolerance to continuity errors in DVD play mode**
- **Digital high-pass filter on HF input, with programmable cut-off frequencies**
- **Advanced motor control loop allows CAV, CLV and pseudo-CLV playback**
- **Motor control via incoming bitstream or tacho, with support for 3-pin and 1-pin tacho control**
- **Supports audio playback via DRAM buffer, allowing audio discs to be played at higher speeds**
- **IEC 958 (SPDIF, AES/EBU and DOBM) output**
- **4x oversampling filter, digital volume control, attenuator and mute**

Supply of this Compact Disc IC does not convey an implied license under any patent right to use this IC in any Compact Disc application.

Key parameters

Digital supply voltage – core	1.8 V
Digital supply voltage – pad cells	3.3 V
Analog supply current	65 mA
Sample rate / crystal frequency	8.4672 MHz
Operating temperature	-40 to +85 °C
Package	LQFP208



TZA1038HW

Advanced analog DVD signal processor and laser supply

The TZA1038 is a fully integrated analog pre-processor and laser supply circuit for DVD and CD read-only players. Incorporating data amplifiers, several options for radial tracking and focus control, it forms a versatile, programmable interface between single light path voltage output DVD or CD mechanisms to Philips' SAA7818 playback IC.

With a dynamic range that can be optimized for LF servo and RF data paths, this combined pre-amplifier and processor provides an ideal solution for playback of all DVD and CD formats. The gain in both channels can be programmed separately and so guarantees optimal playability for all disc types. DC content compensation techniques provide fast settling after disc errors and the RF path is fully DC coupled.

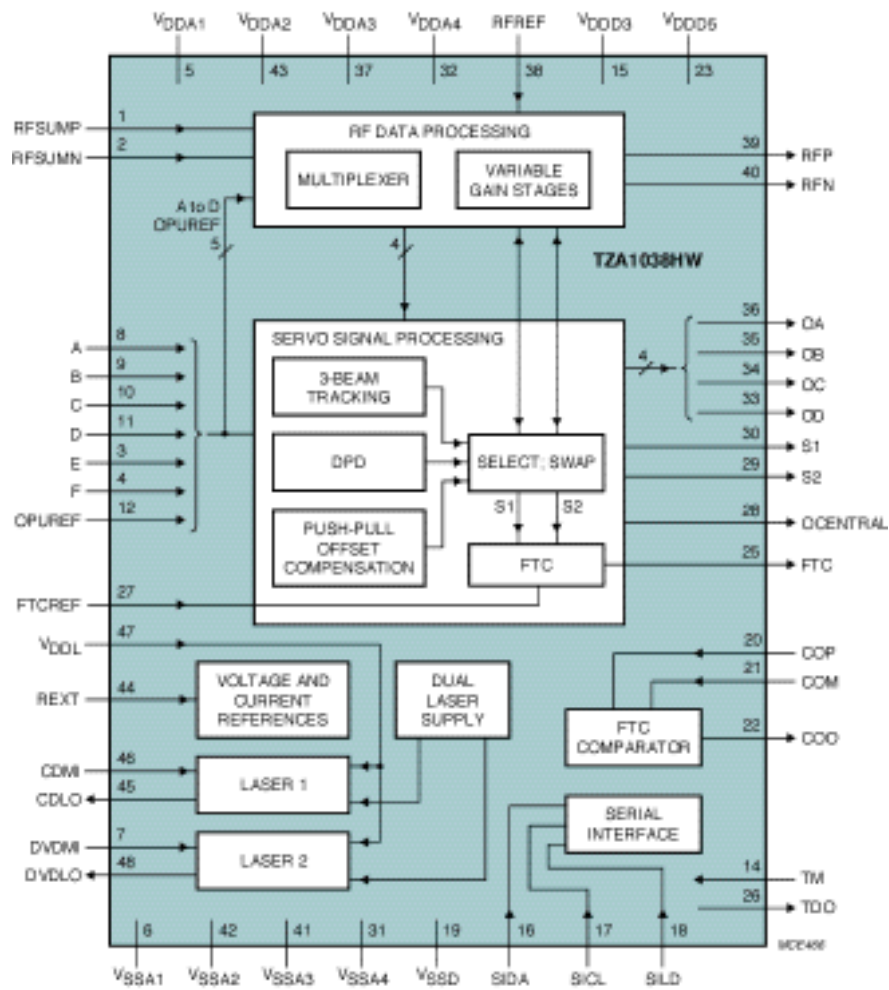
Capable of accommodating astigmatic, single Foucault and double Foucault detectors the TZA1038 can be used with P-type lasers with N-sub or P-sub monitor diodes. After an initial adjustment, the circuit will maintain control over the laser diode current. With an on-chip reference voltage generator, a constant stabilized output power is ensured and is independent of ageing, while an internal Power-on reset circuit ensures a safe start-up condition.

Key features

- Operates with DVD-ROM, DVD+RW, DVD-RW, CD-ROM and CD-RW
- Operates up to 64 x CD-ROM and 12 x DVD-ROM
- RF data amplifier with wide, fine pitch programmable noise filter and equalizer equivalent to 64 x CD or 12 x DVD
- Programmable RF gain for DVD-ROM, CD-RW and CD-ROM applications (approximately 50 dB range to cover a large range of disc-reflectivity and OPUs)
- Additional RF sum input
- Balanced RF data signal transfer
- Universal photodiode IC interface using internal conversion resistors and offset cancellation
- Input buffers and amplifiers with low-pass filtering
- Three different tracking servo strategies:
 - conventional three-beam tracking for CD
 - differential Phase Detection (DPD) for DVD-ROM, including option to emulate traditional drop-out detection: Drop-Out Concealment (DOC)
 - advanced push-pull with dynamic offset compensation
- Enhanced signal conditioning in DPD circuit for optimal tracking performance under noisy conditions
- Radial error signal for Fast Track Counting (FTC)
- RF only mode: servo outputs can be set to 3-state, while RF data path remains active
- Radial servo polarity switch
- Flexible adaption to different light pen configurations
- Two fully automatic laser controls for red and infrared lasers, including stabilization and an on/off switch
- Automatic selection of monitor diode polarity
- Digital interface with 3 and 5 V compatibility

Key parameters

Analog supply voltage	5 V
Digital supply voltage	2.7 to 5.5 V
Supply current (without laser supply)	98 mA
Programmable RF gain	6 to 49 dB
Operating temperature	-40 to +85 °C
Package	HTQFP48





Semiconductors

Additional products

3. Additional products

As a complete supplier of silicon for car stereos, Philips Semiconductors also offers a wide range of ICs from AM/FM radio receiver front-ends and LCD display drivers to complete solutions for CD and tape drives and a myriad of discrete semiconductors.

Radio receiver/RF/IF ICs

AM front-ends

TDA1572T

FM front-ends

TDA1575T

FM IF modulators

TDA1576(T) FM-IF amplifier/demodulator circuit
TDA1596(T) IF amplifier/demodulator for FM car radio receivers

MPX tuners

TEA6840H AM/FM car radio IC
TEA6845H AM/FM car radio IC with mirrored pinning
TEA6848 AM/FM car radio IC with PACS

Digital IF tuners

TEF6721 Digital IF car radio front-end

Two-chip AM/FM radio with stereo decoder

TEA6811 Front-end and PLL synthesizers for car radios
TEA6822T In Car Entertainment (ICE) car radio

Discrete semiconductors for receivers

BAQ806 RF attenuator in SOD106
BAP70-02 Silicon Pin diode in SOD523 (I-IGIA, UFP)
BAP70-03 Silicon Pin diode in SOD323 (UMD2, I-IEIA, URP)
BB156 FM / VCO varicap for Nice concept (RFS)
BB208 FM / VCO varicap for Crest concept (RFS)
BB201 FM varicap for Nice concept (RFS)
BB207 FM varicap for Crest concept (RFS)
BB200 FM varicap for Mobile phone (RFS)
BB202 FM varicap for Mobile phone (RFS), successor
BF862 AM pre-amplifier in SOT23

Analog signal processing

TEA6360 Car radio 5-band equalizer
TEA6320 Sound fader control
TEA6880 Analog signal processor with rear seat audio

Dolby ICs

TEA0675(T) Dual Dolby B-type noise reduction circuit for playback applications

Audio cassette recorder

TEA0676T Dual pre-amplifier and equalizer for reverse tape decks

RDS signal demodulators/decoders

SAA6581T RDS demodulator
SAA6588(T) RDS demodulator and decoder

I/O expander

PCF8574 /A 8 I/O for keyboard scanner
PCF8575 16 I/O for keyboard scanner
PCF8575C 16 I/O automotive specific
PCA9500 8-bit GPIO with 2 Kbit EEPROM
PCA9501 8-bit GPIO / keyboard scanner with 2 Kbit EEPROM
PCA9530/50 2-bit LED dimmer / blinker
PCA9531/51 8-bit LED dimmer / blinker
PCA9532/52 16-bit LED dimmer / blinker
PCA9533/53 4-bit LED dimmer / blinker
PCA9534/54/54A 8-bit GPIO / keyboard scanner
PCA9535/55 16-bit GPIO / keyboard scanner
PCA9536 4-bit GPIO
PCA9537 4-bit GPIO / keyboard scanner with reset
PCA9538 8-bit GPIO / keyboard scanner with reset
PCA9539 16-bit GPIO / keyboard scanner with reset
PCA9557 8-bit GPIO with reset

CD circuits

SAA7373GP Digital servo processor and Compact Disc decoder (CD7)
SAA7377GP Digital servo processor and Compact Disc decoder (CD7)
TDA7073A(T) Dual BTL power driver

Clock/calendar circuits

PCF8583 Real time clock (RTC) plus RAM
PCF8563 Real time clock (RTC)
PCA8565 PCF8563 real time clock (RTC) variant with extended temperature range (125 °C)

Non-volatile memories

PCF85103C-2 2 Kbit EEPROM with alternate I²C-bus address
PCF8582C-2 2 Kbit EEPROM
PCF8594C-2 4 Kbit EEPROM
PCF8598C-2 8 Kbit EEPROM
PCF85116-3 16 Kbit EEPROM

LCD display drivers

PCF8577C	LCD direct/duplex driver with up to 32 / 64 LCD segment drive capability
PCF8566	LCD driver for 24 to 96 segment
PCF8576 /C /D	LCD driver for 40 to 160 segments
PCF8578	LCD driver for 256 to 384 segments
PCF8579	LCD extension for PCF8578
PCF8562	LCD driver for 128 segments
PCF2113X	LCD 2 line x 12 character display driver



Semiconductors

Packages

4. Packages

Package version	Package name	Description	
SOT108-1	SO14	Plastic small outline package; 14 leads; body width 3.9 mm	
SOT109-1	SO16	Plastic small outline package; 16 leads; body width 3.9 mm	
SOT142-1	SIL9MP	Plastic single in-line medium power package; 9 leads	
SOT162-1	SO16	Plastic small outline package; 16 leads; body width 7.5 mm	
SOT163-1	SO20	Plastic small outline package; 20 leads; body width 7.5 mm	
SOT243-1	DBS17P	Plastic DIL-bent-SIL power package; 17 leads (lead length 12 mm)	
SOT307-2	QFP44	Plastic quad flat package; 44 leads (lead length 1.3 mm); body 10 x 10 x 1.75 mm	
SOT314-2	LQFP64	Plastic low profile quad flat package; 64 leads; body 10 x 10 x 1.4 mm	
SOT315-1	LQFP80	Plastic low profile quad flat package; 80 leads; body 12 x 12 x 1.4 mm	
SOT317-2	QFP100	Plastic quad flat package; 100 leads (lead length 1.95 mm); body 14 x 20 x 2.8 mm	

Package version	Package name	Description	
SOT318-1	QFP80	Plastic quad flat package; 80 leads (lead length 1.95 mm); body 14 × 20 × 2.7 mm; high stand-off height	
SOT319-5	QFP64	Plastic quad flat package; 64 leads (lead length 1.95 mm); body 14 × 20 × 2.8 mm	
SOT397-1	HSOP20	Plastic, heatsink small outline package; 20 leads	
SOT411-1	DBS23P	Plastic DIL-bent-SIL power package; 23 leads (straight lead length 3.2 mm)	
SOT418-1	HSOP20	Plastic, heatsink small outline package; 20 leads	
SOT459-1	LQFP208	Plastic low profile quad flat package; 208 leads; body 28 × 28 × 1.4 mm	
SOT521-1	DBS27P	Plastic DIL-bent-SIL power package; 27 leads (lead length 7.7 mm)	
SOT528-1	RDBS13P	Plastic rectangular-DIL-bent-SIL power package; 13 leads	
SOT566-1	HSOP24	Plastic, heatsink small outline package; 24 leads	
SOT612-1	HLQFP144	Plastic thermal enhanced low profile quad flat package; 144 leads; body 20 × 20 × 1.4 mm; exposed die pad	
SOT725-1	DBS37P	Plastic DIL-bent-SIL power package; 37 leads (lead length 6.8 mm)	

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BB156	FM / VCO varicap for Nice concept (RFS)	62
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