As the roll out of digital TV accelerates, DTV receiver manufacturers are looking for improved performance, flexibility and cost reductions to meet the demands of the consumer market. Philips' latest reference design meets these stringent requirements, using two new ICs, the second generation TDA8961 VSB demodulator and the TDA8980 integrated ATSC/NTSC TV input processor

ATSC/NTSC digital TV front-end chipset

Second generation chipset

Applications

- Digital ATSC/NTSC-compliant TV receivers and Set Top Converters
- DTV-equipped PC/multimedia applications

Tightly integrated, flexible DTV front-end

- Second generation ATSC/NTSC channel decoding chipset
- Greatly reduced chip count due to single-chip ATSC/NTSC TV input processor providing NTSC TV decoding and VSB IF downconversion
- Analog source selection and format conversion

High performance reception

- Urban reception improvement
- Unique co-channel filter to reduce interference from strong NTSC signals
- Ability to handle very long static echoes (up to 80 µs) in conjunction with external software

Complete ATSC (VSB)/NTSC channel decoding solution with just two ICs

This chipset combines Philips' long experience in analog TV with our innovative approach to DTV, creating an outstanding system solution showcasing Philips' mixed signal technology expertise and offering very high levels of integration, performance and flexibility. Designed for analog and digital TV systems in North America and other ATSC countries, the chipset enables manufacturers to design systems offering end-users significantly improved reception at an attractive price.

The two key chips featured are the TDA8980 TV input processor and the TDA8961 8-VSB demodulator/decoder for the ATSC DTV standard. Designed specifically to reduce the chip count of first generation front-ends, the TDA8980 eliminates many components by integrating NTSC decoding, an IF circuit, picture and sound demodulation and VSB downconversion, all into a single device.

This chipset gives true design flexibility, with the TDA8980 offering both analog and digital capability, with comprehensive analog source selection and also providing format conversion. This ensures glueless support for the many legacy inputs a digital hybrid receiver is likely to require.

Benefiting from real-world experience of VSB reception, Philips' second generation VSB demodulator handles the many problems caused by man-made and naturally occurring echoes. Intelligent techniques in the decoder allow it to cope with the delays and reflections caused by indoor environments full of objects and moving people. Its maximum equalizer length of 80 µs in conjunction with external software allows the receiver to cope with very long static echoes. Patented NTSC co-channel interference technology prevents strong NTSC signals from interfering with their less powerful DTV counterparts on the same channel, without the noise penalty associated with regular comb filter schemes.

COMPLETE REFERENCE DESIGN FOR HYBRID ATSC/NTSC RECEIVER FRONT-ENDS

This reference design demonstrates a complete solution for building hybrid ATSC/NTSC receiver front-ends for HDTV sets, STBs and PC/multimedia applications, using just two highly integrated, second generation ICs.

TDA8980HL ATSC/NTSC TV INPUT PROCESSOR

Key features

- NTSC-M colour decoder tuned with a 12 MHz reference crystal (or external clock signal)
- VSB IF circuit for pre-processing DTV signals
- Alignment-free PLL demodulator Vision IF circuit without external components
- Sound IF amplifier with separate input for single reference QSS mode and separate AGC circuit
- Alignment-free FM sound demodulator generates the input signal for a BTSC stereo decoder
- Video source selection with 2 external CVBS or Y/C inputs and an independently switchable output
- Two 10-bit video ADCs for converting selected YUV signals (video mode) or downconverted I&Q signals (VSB mode)
- Two 16-bit audio A/D converters and I²S formatter
- Up to four stereo analog inputs and one I²S input
- ITU656 or VSB formatter
- Direct input to video ADCs

Integrating many components into a single chip, the TDA8980HL is designed for both TV and multimedia applications. Containing an NTSC-M colour decoder, an IF circuit and ADCs for audio and video, it can also generate a 'mixed down' I signal for demodulation of a digital broadcast VSB input. An I²C-bus controlled internal switch enables the device to switch between analog NTSC and digital 8-VSB IF signals.

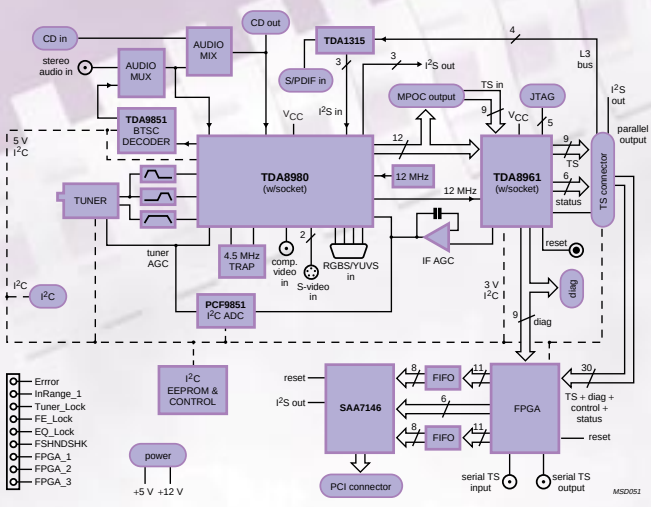
When decoding NTSC, the chip digitizes the audio signals into an I²S stream using on-chip audio stereo 16-bit ADCs, and the video information into an ITU656 stream via the on-chip video ADCs. An incoming 6 MHz wide 8-VSB IF signal is downconverted to a low IF, centred at 4 MHz, which is digitized using an on-chip 10-bit ADC and gluelessly interfaced to the VSB demodulator for further processing. In a typical application, the TDA8980 handles AGC, eliminating the need for external components such as an op-amp loop integrator.

It has an internal 2-D adaptive comb filter for NTSC, and a YUV interface allows simple connection of additional picture enhancement ICs such as a 3-D comb filter. For sound decoding, external devices - a BTSC sounder decoder, for example - can be connected.

TDA8961 DTV DEMODULATOR/DECODER

General features

- One-chip ATSC-compliant demodulator and concatenated Trellis (Viterbi)/Reed-Solomon decoder with de-interleaver and de-randomizer
- Parallel (8-bit) or serial MPEG2 transport stream output
- On-board I²C-bus interface
- MPEG2 serial transport stream input



8-VSB demodulator

- On-chip digital tuner AGC control
- Integrated digital Square-Root Raised-Cosine (half Nyquist) filter with 11.5 % roll-off
- Fully internal carrier recovery loop with programmable loop filter
- No need for external VCXO and DAC due to internal sample rate converter
- Fully internal symbol timing recovery with programmable loop filters

Adaptive equalizer

- Feed forward including a decision feedback equalizer (DFE)
- Standard range: -2.3 μs to +22.5 μs (up to 80 μs in conjunction with external software)
- Adaptation based on ATSC field sync (trained) and/or 8-VSB data (blind)
- Additional complex equaliser to cope with highly dense urban multipath
- Patented adaptive NTSC co-channel filter technology, with low/zero insertion loss

On-chip FEC

- Trellis (Viterbi) decoder
- Rate 2/3 (Rate 1/2 Ungerboeck-code-based)
- (207, 187, T=10) Reed-Solomon decoder
- Internal convolutional de-interleaving
- ATSC standard-based de-randomizer

The TDA8961 is an ATSC-compliant device with forward error correction, accepting 8-VSB modulated signals with the additional ability to apply the VSB IC AGC control output directly to the tuner. The combination of the TDA8980 and TDA8961 requires only one 12 MHz crystal and when the TDA8980 is performing NTSC decoding, the TDA8961 can be set in a feed-through mode, enabling ITU656 data to appear at the MPEG2 transport stream output for feeding to the graphics display IC. The demodulator can also act as an MPEG2 Transport Stream switcher for an additional serial stream.

After the TDA8961 has performed internal carrier recovery, Nyquist filtering and symbol timing recovery, it carries out adaptive equalization using the ATSC field sync (trained equalization) and/or the 8-VSB data itself (blind equalization). This uses a decision feedback equalizer (DFE) structure.
Once trellis decoding is complete, the stream is de-interleaved with a convolutional de-interleaver with on-chip memory.
The Reed-Solomon decoder is ATSC-compliant, with a length of 207, and it can correct up to 10 bytes. After the decoded stream is de-randomized using a pseudo-random bit sequence (PRBS), it outputs an 8-bit parallel or a serial MPEG2 transport stream for subsequent de-multiplexing.

TD1536 tuner

Able to handle ATSC terrestrial signals as well as NTSC and QAM, the TD1536 offers flat frequency response, low oscillator phase noise and excellent large signal handling characteristics. Optimized for handling high adjacent channel levels, through on-board selectivity adjustment (SAW filter), the TD1536 also provides internal automatic gain control (AGC), minimizing design-in effort. The TD1536's low output impedance makes it capable of driving several SAW filters (for example, second VSB and NTSC SAWs). It is powered from a single 5V supply.

SAA7146A PCI bridge

For PC/multimedia applications, the reference design includes the option to include the SAA7146A PCI bridge. This device features high performance 2D scaling, resulting in very few artefacts even when pictures are reduced to icon size, making it ideal for windowing and high-end applications. It also has a hardware vanity picture function and by performing most of the video processing on-board, the SAA7146A helps reduce load on the CPU, maintaining high overall system performance. In addition to the PCI-bus, it supports a variety of interfaces including two ITU-R 656 ports, an Intel/Motorola 8/16-bit DEBI (Digital Expansion Bus Interface), I^2C and I^2S bus connectors, and a 4-bit general purpose interface.

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