



# Single-Chip Solution for DVB-T Systems

## CX22702

Conexant's CX22702 is a single-chip coded orthogonal frequency division multiplex (COFDM) demodulator/decoder solution for both 2K and 8K digital video broadcast-terrestrial (DVB-T) systems. Providing exceptional echo performance, the device is ideally suited to receiving the broadcast signal in countries deploying single frequency network (SFN) implementations of the DVB-T system. The cost-effective CX22702 also offers a high level of integration, along with the ability to sample the incoming signal at a high or low intermediate frequency (IF).

Along with COFDM demodulators, Conexant also offers interactive TV decoder products – the CX2249x family – to provide low-cost solutions for the core electronics of platforms deployed in digital terrestrial TV networks. A system solution for a high-end set-top box with integrated hard disk drive (HDD) is shown below in Figure 1.

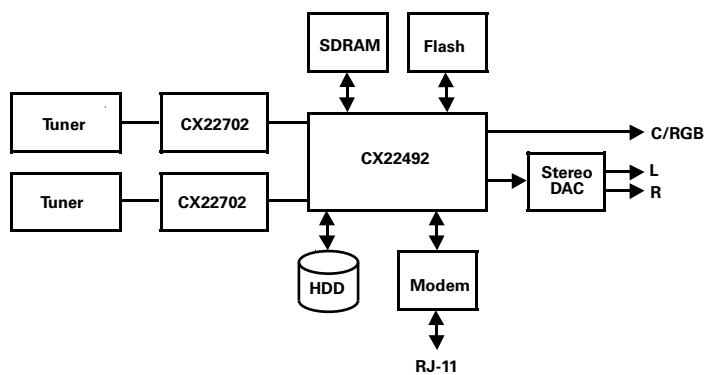


Figure 1. CX22702/CX22492-based set-top box system.

### Distinguishing Features

- Implements entire DVB-T standard
- Optimal performance in an SFN environment
- Excellent AWGN performance < 18.0db (64 QAM, 2/3 code rate)
- Active impulse noise filtering
- Operation using single SAW filter in the IF path

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### Input Signal

The CX22702 can accept an input signal centered at a high IF of either approximately 36.167 MHz (typical for 7 MHz or 8 MHz channels) or 44.1 MHz (for a 6 MHz channel). Alternatively, the input signal could be at a low IF of approximately 4.57 MHz. The input is an analog signal, which is sampled using the internal 10-bit analog-to-digital converter (ADC). The device can meet European requirements for adjacent-channel performance with a single SAW filter. The CX22702 uses digital filters to remove adjacent channel signals (e.g., NICAM). The tuner's automatic gain control (AGC) is controlled via a single or dual sigma-delta feedback. Only a simple RC filter is required to generate the analog control voltage.

### From IF Input to MPEG Output

The CX22702 performs all the functions required to produce an MPEG transport stream output from the IF input. First, it detects impulse interference by performing a proprietary analysis of the OFDM waveform and a detector in the AGC. Then the time domain adapter enables the chip to address 6, 7, and 8 MHz bandwidth channels as well as adapt to different IFs, sample timing and frequency offsets. In addition, the time domain adapter removes adjacent channel interference and removes the cyclic prefix prior to the fast fourier transform (FFT). During channel acquisition, the time domain adapter uses a set of algorithms that allow frequency, sample

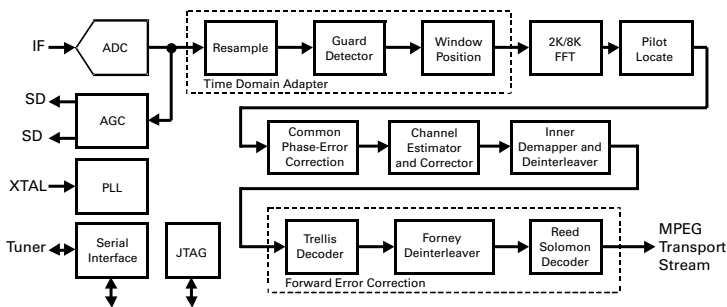
timing, and guard interval lock to be achieved quickly and reliably before switching to a different set of algorithms, which provide good tracking performance. For optimal performance in an SFN, the position of the FFT window is dynamically located to the strongest signal present in the guard interval.

After the FFT, a common phase-error correction is applied prior to channel estimation and correction. Scattered and continual pilot carriers are used to correct channel distortion, fading and phase noise within the carrier bandwidth. The channel estimate also provides Channel State Information (CSI), which passes on to the Viterbi decoder, where it improves performance by identifying bits from data carriers that have undergone severe fading. Additional proprietary error-correction techniques improve further upon the performance. CSI can also mask bits from data carriers that are particularly affected by co-channel analog interference (e.g., PAL/SECAM). The CX22702 uses proprietary memory-efficient algorithms to produce the channel estimate.

By default, the CX22702 initially determines all transmission parameters (including 2K/8K transmission mode and guard interval) from the received signal. These parameters are stored and used to reduce the time needed for subsequent channel acquisitions.



The CX22702 can interface directly to all Conexant TV decoder devices and other commonly available MPEG transport demultiplexer chips, as well as directly to a DVB common interface. The data rate is smoothed to remove gaps introduced by the COFDM guard interval and variation in processing time within the forward-error correction (FEC) circuitry. This allows a stable clock reference to be extracted from the transport stream more quickly, further reducing the overall time before the viewer sees a picture.



**Figure 2. CX22702 functional block diagram.**

## Applications

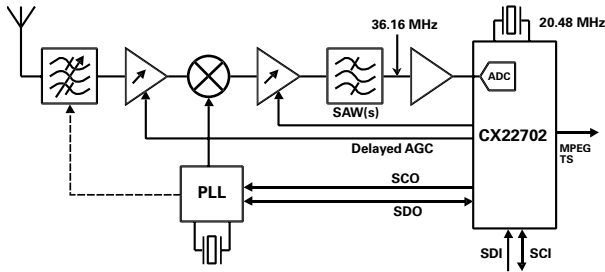
Figure 3 shows a possible application of the CX22702 using a conventional tuner architecture and first IF sampling, where an input signal centered on 36.167 +/- 0.2 MHz is sampled directly. This method greatly reduces the component count in the tuner, allowing a mixer and oscillator to be replaced by an amplifier, which provides the required input level for the ADC. Only one SAW filter is required in this application.

## What is COFDM?

Coded orthogonal frequency division multiplexing (COFDM) is the method adopted by the Digital Video Broadcasting (DVB) Group for digital terrestrial broadcasting. (Here, "terrestrial" refers to land-based, as opposed to satellite broadcasting). To understand what this acronym means, let's break it down into its component parts.

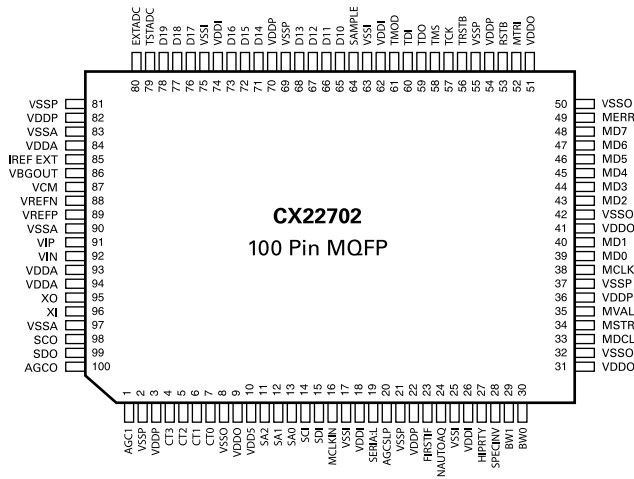
Frequency division multiplexing (FDM) refers to the division of a communications channel into different frequency bands. This is a commonly used technique in analog TV broadcasting, in which different TV stations broadcast on different frequencies. But in analog TV, the carrier frequencies are spaced 6 or 8 MHz apart; in DVB-T, there are 2,048 carriers (with "2K" mode) or 8,192 carriers (using "8K" mode) in a given 6, 7 or 8 MHz band. Using conventional

techniques, carriers spaced this close together would interfere with each other. But because the carriers are "orthogonal", or non-overlapping, they do not. As a TV signal travels between the transmitter and the receiver, it may encounter interference from a variety of sources. In addition, echoes occur as the signal is reflected from hills, buildings, trees and moving objects. These echoes interfere with the signal and cause it to fade. By coding the signal using powerful error-correction techniques (the "coded" in COFDM), data in carriers that have been destroyed by interference can be recovered. Because of these capabilities, COFDM has proven itself superior to other methods of digital terrestrial broadcasting.



**Figure 3. CX22702 possible application (first IF sampling).**

Because many standard tuners have an IF output at about 4.57 MHz (32/7 MHz), the CX22702 can also sample a signal centered on this frequency. Selection is made using either a pin on the device (first IF) or a register. In both cases, adjacent channel interference at the same level as the COFDM signal is removed by digital filtering inside the CX22702.



**Figure 4. CX22702 pin diagram.**

### Product Features

- Implements complete DVB-T (ETS 300 744) standard
- DTG, EACEM and NorDig compliant
- 2K and 8K transmission modes
- Optimized for SFN environments
- Dynamic FFT window positioning
- Active impulse noise filtering
- Input signal can be sampled at high or low IF
- Meets European requirements using single SAW filter
- AWGN performance <18.0dB (64 QAM, 2/3 code rate)
- Excellent CCI PAL performance
- Differential or single-ended integrated 10-bit ADC
- Single or Dual  $\Sigma\Delta$  AGC feedback to tuner
- Four GPIO/  $\Sigma\Delta$  DAC pins
- Internal digital AFC loop (no feedback to tuner)
- Internal digital clock recovery loop (fixed frequency input, no need for VCXO)
- Channel estimation and correction
- Common phase-error correction
- Fast automatic channel-acquisition time
- Maintains and uses channel state information (CSI)
- Serial (I<sup>2</sup>C compatible) host interface
- Can achieve automatic lock from initial frequency offsets of up to 200 kHz
- 6, 7 and 8 MHz channel support
- Serial or parallel MPEG transport stream output suitable for direct connection to transport demux chips (CX22490 TV decoder range)
- Minimal host software required
- JTAG boundary scan
- Low power consumption: < 1.0W
- 100-pin MQFP

[www.conexant.com](http://www.conexant.com)

General Information:

U.S. and Canada: (800) 854-8099

International: (949) 483-6996

Headquarters – Newport Beach

4311 Jamboree Rd, P.O. Box C

Newport Beach, CA 92660-3095

Order# 101557A

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