EDSADC

Enhanced Delta-Sigma Analog-to-Digital Converter

AURIX™ TC3xx Microcontroller Training
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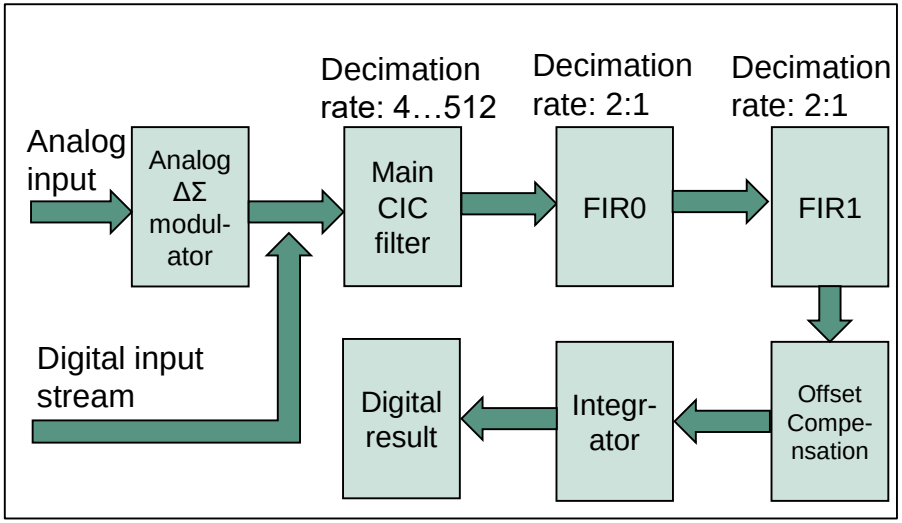
EDSADC
Enhanced Delta-Sigma Analog-to-Digital Converter



Highlights

- ΔΣADC has higher accuracy and is widely used in e.g. engine pressure measurement, fuel injection control etc.
- Demodulator filter chain
- Saves external resolver chip for electro motor control application

Key Features

- Up to 80 dB SNR
- Concatenated hardware filter stages
- Support for resolver application

Customer Benefits

- ENoB accuracy up to 13 bit (related to pass band f_{PB} and modulator frequency f_{MOD})
- Over sampling and filtering by hardware
- Carrier generator included. Rectification, delay compensation by hardware

EDSADC
Up to 80dB SNR

- EDSADC supports up to 40 MHz sampling rate (f_{MOD})
- The accuracy performance is related to which connection mode is used (differential mode is optimal), calibration is done or not, if all filters are enabled. The limitation on pass band should also be considered
- The conversion between SNR (dB) and ENoB (bit) is:

$$ENoB = (SNR - 1.76) / 6.02$$

- In automotive industry, high accuracy ADC results are required for application like combustion engine in-cylinder pressure measurement and fuel injection control etc.

EDSADC
Concatenated hardware filter stages

- EDSADC over samples at modulator frequency f_{MOD}
- Corresponding demodulator is also called filter chain. There are:
  - The Cyclic Integrating Comb (CIC) filter provides the basic filtering and decimation with a selectable decimation rate
  - Two Finite Impulse Response (FIR) filters, allow effective signal shaping by attenuating the upper frequencies of the signal spectrum
  - The high-pass filter provides offset compensation by removing the DC component of the input signal
- Knock detection is one typical automotive application for EDSADC. The filter chain helps signal processing and offloads CPU computation
- In electro motor control application, optionally the user can bypass FIR because
  - FIR generates more group delay
  - Electro motor control application may not need very high SNR

EDSADC
Support for resolver application

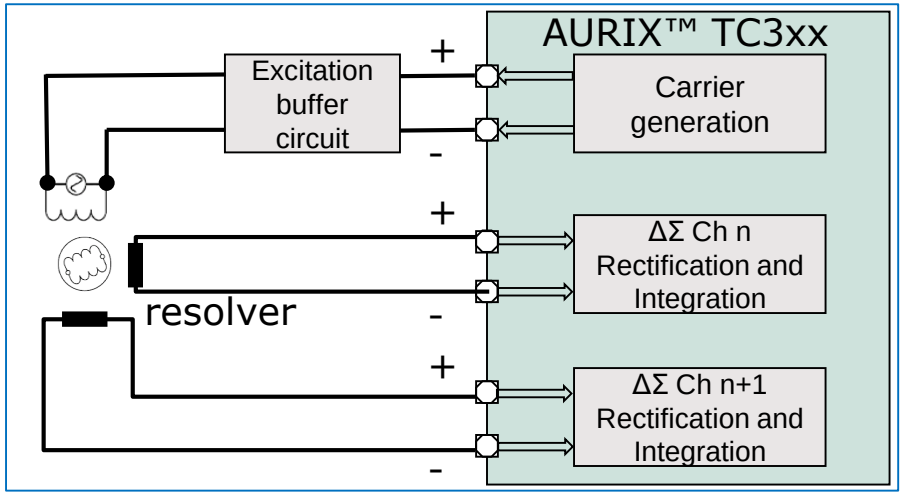
- In electro motor control application, user must know the rotary position. EDSADC offers the posibility of measuring the rotary position, otherwise this has to be done by a resolver sensor, which adds extra cost to the application
- AURIX™ provides carrier generator and integrator to reduce system cost
  - Carrier generator provides excitation sine signal
  - Integrator does carrier elimination
  - Signal delay compensation and rectification also supported
- In safety critical use cases, user may use AURIX™ resolver support together with external resolver sensor for redundancy

EDSADC
System integration

- EDSADC is the same as most other components, connected on System Peripheral Bus (SPB)
- There‘s no dedicated EDSADC pins. All EDSADC pins are overlaid with VADC pins. If necessary, one ADC pin can be converted by both EDSADC and VADC at the same time e.g. to implement redundancy
- It is possible to use EDSADC in
  - differential mode: the positive and negative input pins are connected to differential sensor
  - single ended mode: one pin is connected to sensor and the other pin is internally connected to ground. This causes 6 dB loss compared with differential mode
  - quasi differential mode: one pin is connected to sensor and the other pin is internally connected to common mode voltage (V_{CM}). At the same time the programmable gain is set to factor of 2. The benefit is this brings 3 dB compared with single ended mode
- The internal filter stages can be fed directly by an external modulated datastream if an external DS modulator is used

Application example
Resolver interface implementation

- The carrier generator output is differential
- Excitation buffer converts digital signal to sinusoidal wave
- 2 orthogonally placed coils are excited by the magnetic field of the third coil, which is connected to carrier buffer circuit
- After integrator, carrier is cancelled. With software trigonometric computation, the rotary position can be determined



Overview

- Resolver application occupies the carrier generator and 2 EDSADC channels. One for sine and one for cosine signal
- Dedicated resolver sensor can be saved to reduce system cost

Advantages

- AURIX™ provideds carrier generator and integrator, which are conventionally provided by resolver sensor
- User just needs to implement the external excitation buffer circuit

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