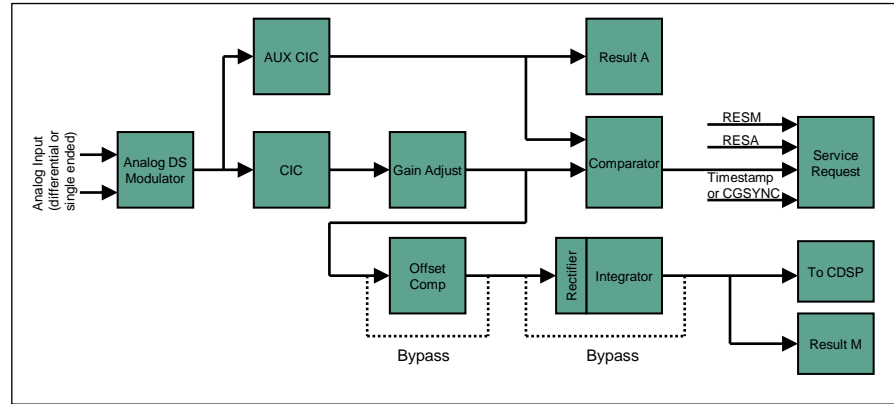# DSADC
Delta-Sigma Analog-to-Digital Converter

AURIX™ TC4xx Microcontroller

V1.0.0 2024-09

Please read the Important Notice and Warnings at the end of this document

DSADC
Delta-Sigma Analog-to-Digital Converter

Highlights

› Cascaded Integrator Comb (CIC) filter decimation up to 1024
› Gain correction and offset compensation
› Signal rectification, carrier cancellation and integration
› Event signaling to interrupt router and boundary flag connection to GTM and eGTM

Key Features

Up to 86 dB SNR

External Modulator support (MOD)

Customer Benefits

› ENoB accuracy up to 14 bit (related to pass band (f_{PB}) and modulator frequency (f_{MOD}))

› Support external isolated DSADC modulator
› Separate pin not to waste DSADC core resource
› Manchester decoder to save one clock signal

› DSADC supports up to 40 MHz sampling rate (f_{MOD})
› The accuracy performance depends onw:
  – which connection mode is used (differential mode is optimal)
  – If calibration is done or not
  – if all filters are enabled
  – the limitation on pass band
› 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.

DSADC
External Modulator support (EXMOD)

› For inverter application, the phase current is usually measured between a small shunt resistor by an isolated DS modulator to be post processed by AURIX™

› AURIX™ uses a separate pin in order not to consume the costly DSADC core resource

› Possible configuration:

  – Data and Clock from External Modulator to AURIX™

  – Data from External Modulator, clock send from AURIX™ to External Modulator

  – Only Data using Machestor decoding from External Modulator to AURIX™ (not in AURIX™ TC49 A step)
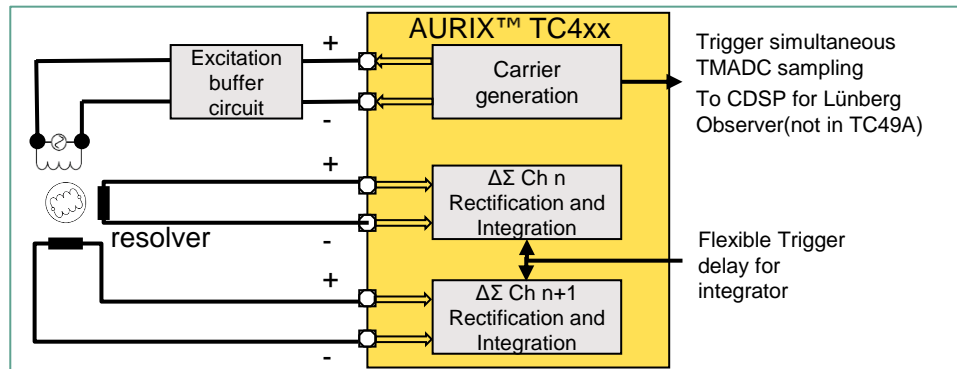
DSADC
System integration

› Carrier generator can trigger:
  - Time-Multiplexed Analog-to-Digital Converter (TMADC) on the peak values of the carrier pattern
  - Converter Digital Signal Processing (CDSP)
› Analog Supervision signals from DSADC to input of monitoring samplers in TMADC
› HW trigger sources are:
  › Generic Timer Module - GTM (up to 36)
  › Enhanced Generic Timer Module - eGTM (10)
  › PORTS (up to 8)
  › External Request Unit - ERU (up to 8)
  › Carrier generator (1)
› Boundary Flags are connected to GTM & eGTM through central ADC MUX
› Main Result register of DSADC & EXMOD can be mapped to input of CDSP
› Service Request going to IR
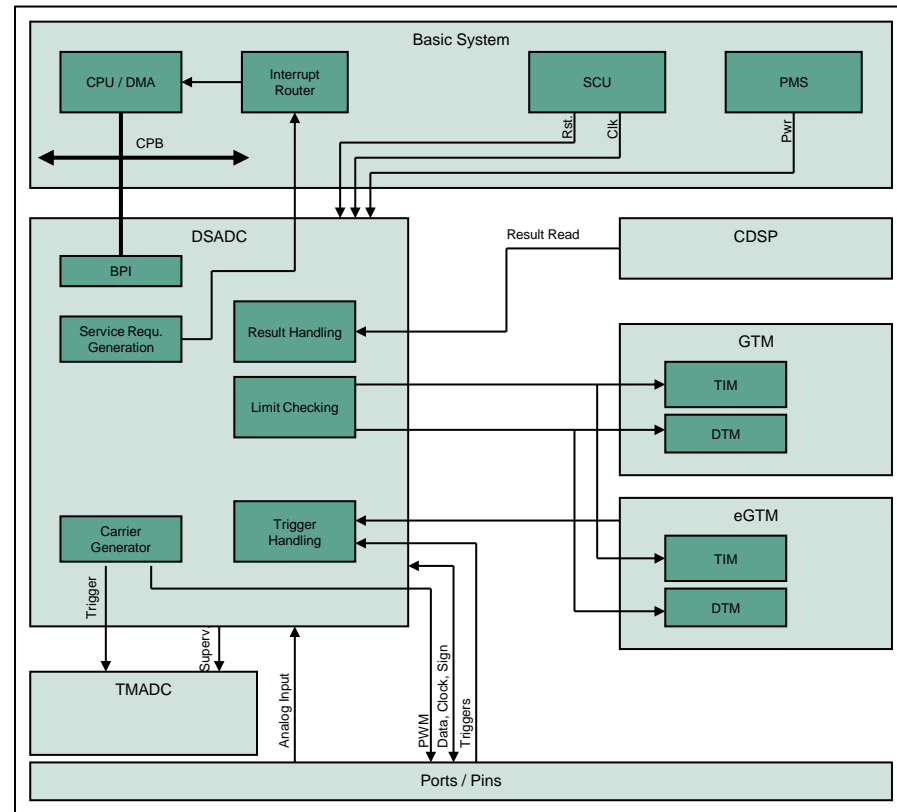
Application Example
Enhanced Resolver Support

› 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 or Lünberg Observer of CDSP, the rotary position can be determined

Overview

› Resolver application occupies the carrier generator and 2 DSADC channels: one for sine and one for cosine signals

› Dedicated resolver sensor can be saved to reduce system cost

› Trigger of Integrator can be delayed

› Simultaneously trigger TMADC sampling

Advantage

› AURIX™ provides carrier generator and integrator, which are conventionally provided by resolver sensor

› User just needs to implement the external excitation buffer circuit

› Hardware delay of integrator can be compensated to improve angle calculation accuracy

› To reach ASIL-D by the redudent path

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