EDSADC_1
for KIT_AURIX_TC397_TFT
Enhanced Delta-Sigma ADC conversion

AURIX™ TC3xx Microcontroller Training
V1.0.0

Scope of work

The EDSADC is used to convert an external signal to a stream of discrete digital values.

The Enhanced Delta-Sigma ADC (EDSADC) continuously measures an external signal on channel 0, connected to port pin AN2. It converts the analog signal to a data stream and then a global variable is updated to the current conversion result.

Introduction

- The Enhanced Delta-Sigma Analog-to-Digital Converter module (EDSADC) of the AURIX™ TC39x provides a set of up to 14 analog input channels.
- Each converter channel is controlled by a dedicated set of registers, which enables the independent operation of the channels.
- The results of each channel can be stored in a channel-specific result register. They are signed values stored in a 16-bit two's complement format.
- To compensate manufacturing tolerances and adjust the channel to the selected decimation rate, a calibration algorithm is executed automatically by hardware.
- The calibration algorithm can be enabled both during the initialization phase and during operation.

Hardware setup

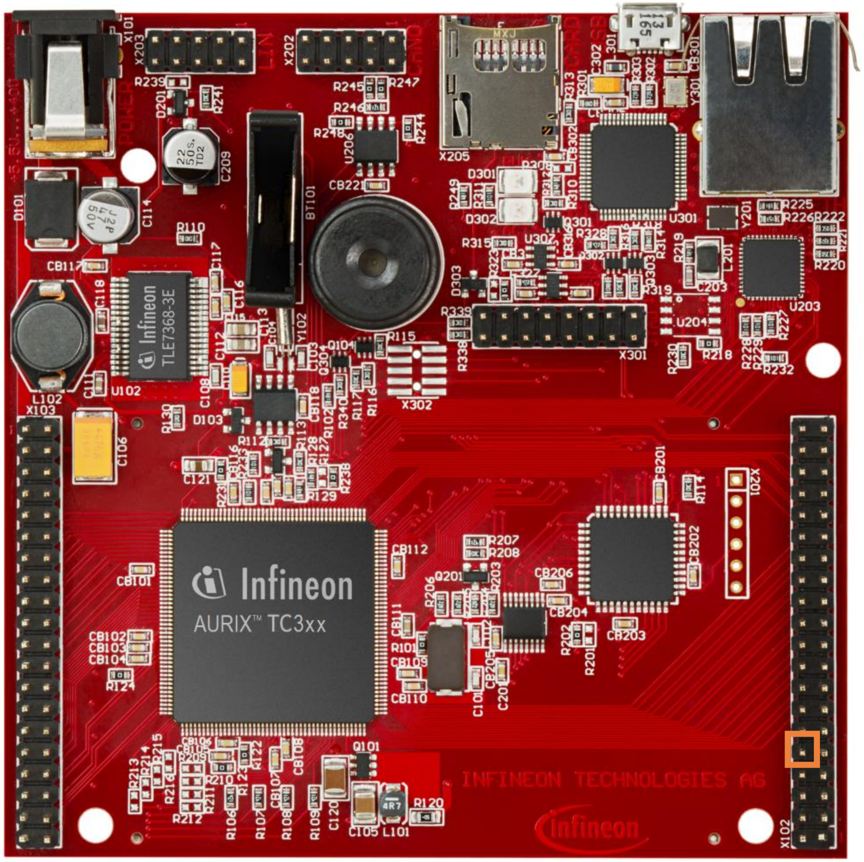
This code example has been developed for the board KIT_A2G_TC397_5V_TFT.

The signal to be measured has to be connected to channel 0 of the EDSADC (port pin AN2).

X102

P14.5	40	39	P14.4
P33.10	38	37	P20.9
P15.7	36	35	P15.6
P15.5	34	33	P15.4
P15.3	32	31	P15.2
P22.3	30	29	P22.2
P22.1	28	27	P22.0
P33.11	26	25	P23.4
P23.3	24	23	P23.2
P23.1	22	21	P23.0
P33.6	20	19	P33.8
P33.12	18	17	P33.1
P33.2	16	15	P33.3
P33.4	14	13	P33.5
AN0	12	11	AN8
AN2	10	9	AN3
AN11	8	7	AN13
AN20	6	5	AN21
GND	4	3	GND
V_UC	2	1	VCC_IN

Channel 0



Implementation

Configuration of the EDSADC module:

Configuration of the EDSADC module is done once in the setup phase by calling the initialization function ***init_EDSADC()***, which contains the following steps:

- EDSADC module configuration
- EDSADC channel configuration

EDSADC module configuration

To configure the EDSADC module, the following steps are done:

1. The module configuration is filled with default values using an instance of the structure ***IfxEdsadc_Edsadc_Config*** and the function ***IfxEdsadc_Edsadc_initModuleConfig()***.
2. The modulator clock is set to be generated independently of the Phase Synchronizer signal.
3. The EDSADC module is then initialized with the function ***IfxEdsadc_Edsadc_initModule()***.

Implementation

EDSADC channel configuration

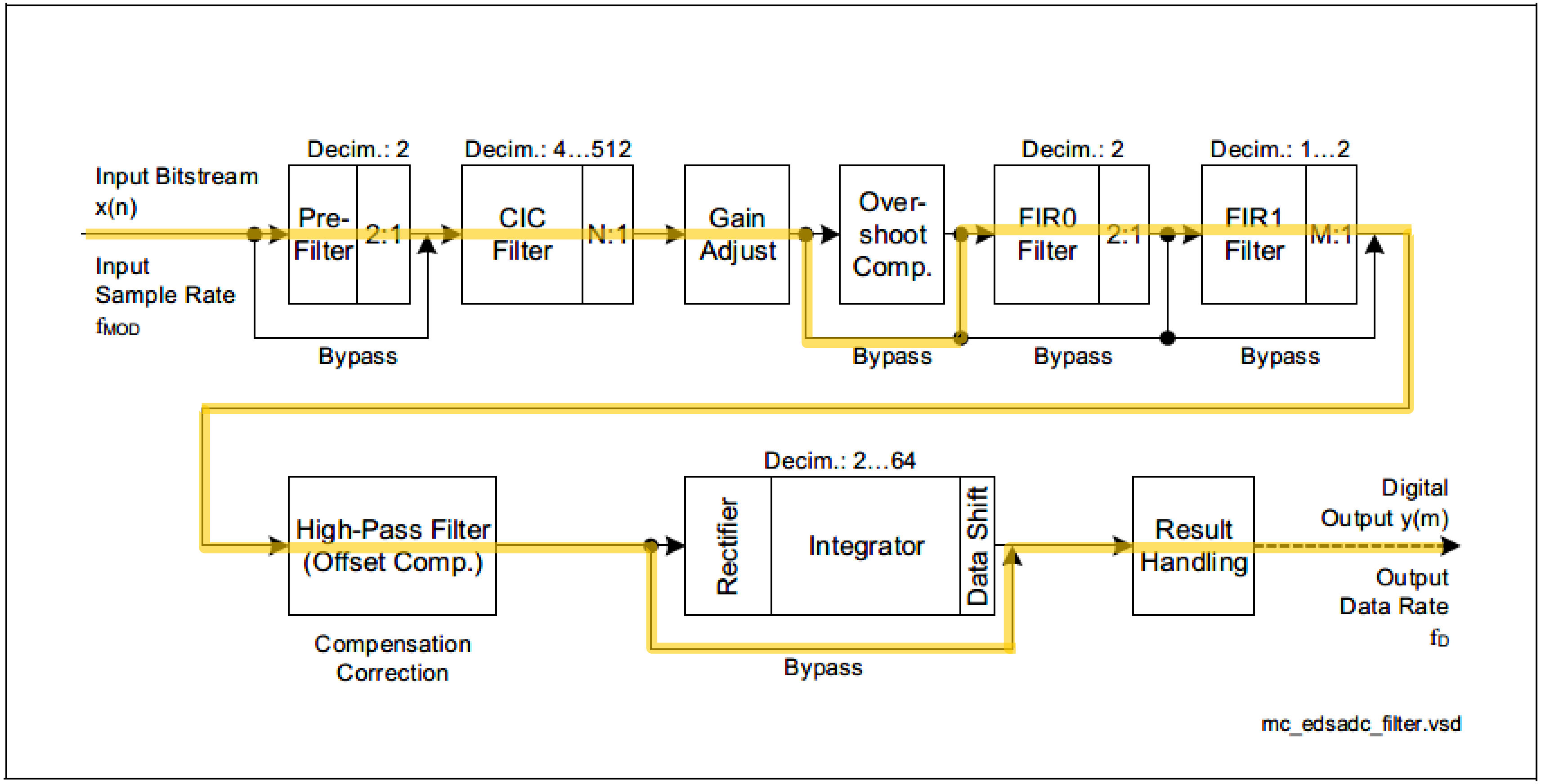
To configure the EDSADC channel, the following steps are done:

1. The channel configuration is created with an instance of the structure ***IfxEdsadc_Edsadc_ChannelConfig*** and filled with default values using the function ***IfxEdsadc_Edsadc_initChannelConfig()***.
2. The comb filter decimation factor and start value are set.
3. The FIR filters in the filter chain are enabled (as shown in Slide 7) and the trigger for starting the calibration during the initialization phase is set.
4. The modulator is configured by setting its frequency and internally connecting the negative input to the ground, in order to configure the conversion in single-ended mode.
5. The channel ID is selected and the calculated Cascaded Integrator Comb (CIC) filter‘s shift and gain factor are set.
6. The intended full-scale value is set (by default, it is set to 25000 after reset).
7. Finally, the channel is initialized with the function ***IfxEdsadc_Edsadc_initChannel()*** and the conversion is started using the function ***IfxEdsadc_Edsadc_startScan()***.

All the previous functions are provided by the iLLD header ***IfxEdsadc_Edsadc.h***.

Implementation

Configured filter chain



Implementation

Factors calculation

- To achieve a correct calibration, the values for the CIC shift and gain factor must be calculated according to the intended full-scale value and the selected decimation factor.

- The value for the CIC shift is determined by the formula:

  <CICSHIFT> = roundup$(14 - \log_2(2 * AFS\ /\ (N^3 * 4 * FM))$

  where
  - N is the selected decimation factor
  - AFS is the intended calibrated full-scale value (it refers to the analog full-scale $V_{IN} = V_{AREF}$)
  - FM is the modulator gain factor (when using the on-chip modulator FM = 0,6945)

- The gap that comes from the rounding in the above formula is closed by computing the corresponding gain correction factor:

  gain factor = $(2 * AFS\ /\ (N^3 * 4 * FM)) * 2^{(<CICSHIFT>-14)}$

  That is then multiplied by 4096 and truncated to be stored in the GAINFACTOR bitfield of GAINCORR register

  <GAINFACTOR> = truncate(gain factor * 4096)

Implementation

Example calculation

- For example, using the on-chip modulator (thus FM = 0,6945), selecting a decimation factor N = 32 and an intended full-scale value AFS = 30000

- The value for the CIC shift is determined by the formula:

$$\text{<CICSHIFT>} = \text{roundup}(14 - \log_2(2 * AFS\ /\ (N^3 * 4 * FM))$$
$$= \text{roundup}(14 - \log_2(2 * 30000/(32^3 * 4 * 0{,}6945))$$
$$= \text{roundup}(14 - \log_2(0{,}6591))$$
$$= \text{roundup}(14 - (-0{,}6013)) = \text{roundup}(14{,}6013) = 15$$

- And the gain correction factor

$$\text{gain factor} = (2 * AFS\ /\ (N^3 * 4 * FM)) * 2^{(<CICSHIFT>-14)}$$
$$= 0{,}6591 * 2^{15-14} = 0{,}6591 * 2 = 1{,}3182$$

Which gives a GAINFACTOR bitfield of

$$\text{<GAINFACTOR>} = \text{truncate(gain factor * 4096)}$$
$$= \text{truncate(1,3182 * 4096)}$$
$$= \text{truncate(5399,3472) = 5399}$$

Implementation

The conversion function:

- The ***run_EDSADC()*** function is called in the while loop and continuously converts the analog voltage level on channel 0 to a digital value.

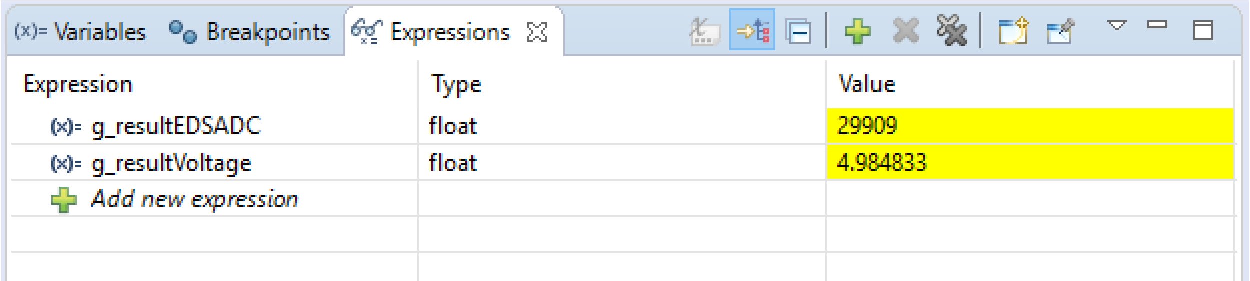
- The function ***IfxEdsadc_Edsadc_getMainResult()*** from the iLLD header ***IfxEdsadc_Edsadc.h*** is used to get the latest analog to digital conversion. The digital result of EDSADC is stored in two's complement format.

- Finally, the voltage value is calculated scaling the EDSADC raw value to the range 0 - 5V, considering the intended full-scale value set in the configuration.

Run and Test

After code compilation and flashing the device, perform the following steps:

- The signal to be measured (0 V to +5 V) should be connected to the port pin AN2.
- In order to get the global variable in a stable state, the debugger should be paused or a breakpoint should be inserted in the function ***run_EDSADC()***.
- The measured value can be watched through the debugger in the ***g_resultEDSADC*** variable and the converted value in the ***g_resultVoltage*** variable.



References

- AURIX™ Development Studio is available online:
- https://www.infineon.com/aurixdevelopmentstudio
- Use the „*Import...*“ function to get access to more code examples.

- More code examples can be found on the GIT repository:
- https://github.com/Infineon/AURIX_code_examples

- For additional trainings, visit our webpage:
- https://www.infineon.com/aurix-expert-training

- For questions and support, use the AURIX™ Forum:
- https://www.infineonforums.com/forums/13-Aurix-Forum

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