

EDSADC_1

for KIT_AURIX_TC375_LK

Enhanced Delta-Sigma ADC conversion

AURIX™ TC3xx Microcontroller Training
V1.0.0



[Please read the Important Notice and Warnings at the end of this document](#)

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 3, connected to port pin AN0. It converts the analog signal to a data stream and then a global variable is updated to the current conversion result. The input value is determined by the potentiometer on the board.

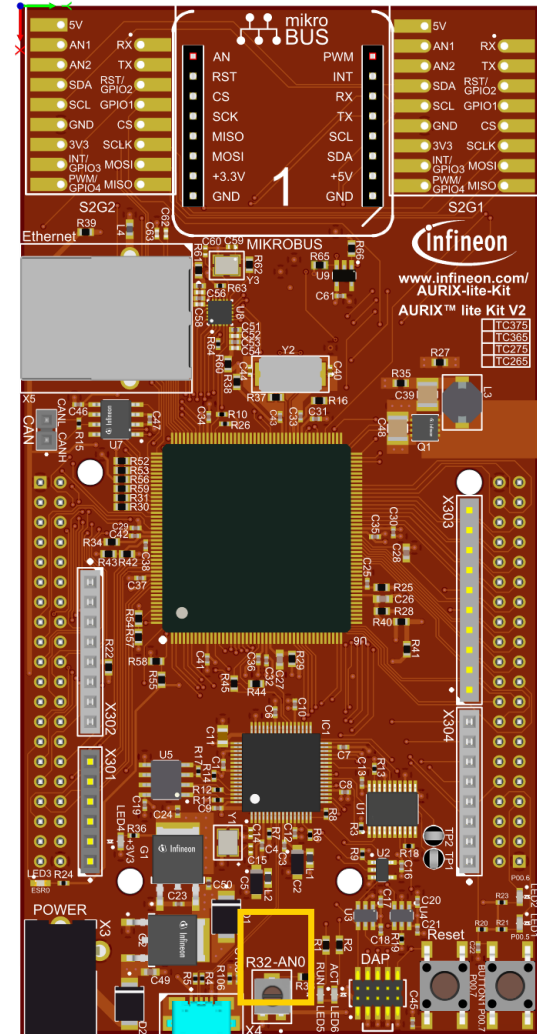
Introduction

- › The Enhanced Delta-Sigma Analog-to-Digital Converter module (EDSADC) of the AURIX™ TC37x provides a set of up to 6 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_TC375_LITE.

In this example, the pin AN0, connected to the board's potentiometer, is used.



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

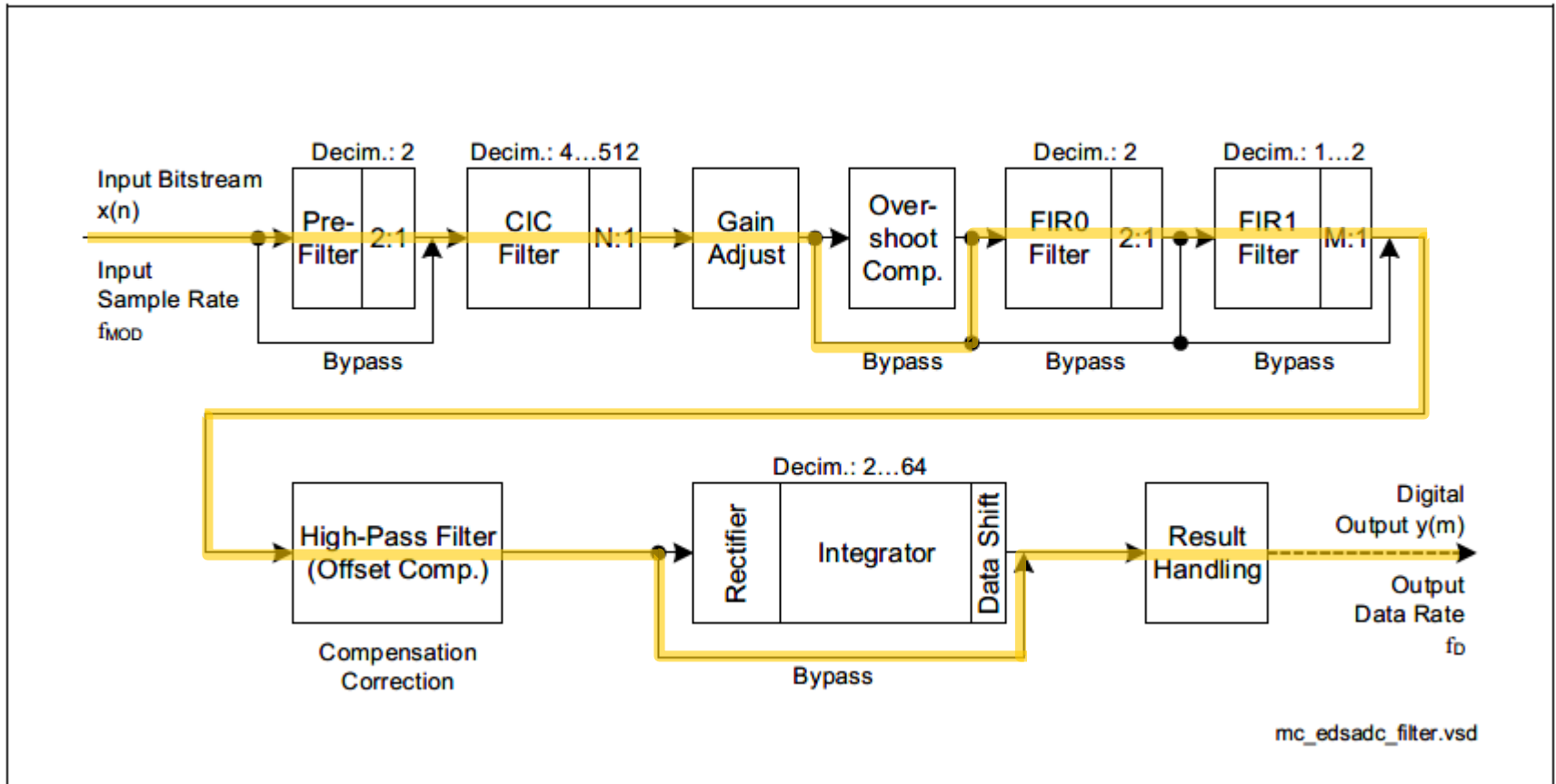
To configure the EDSADC channel, the following steps are done:

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:

$$\langle \text{CICSHIFT} \rangle = \text{roundup}(14 - \log_2(2 * AFS / (N^3 * 4 * FM)))$$

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:

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

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

$$\langle \text{GAINFACTOR} \rangle = \text{truncate}(\text{gain factor} * 4096)$$

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:

$$\begin{aligned}
 \langle \text{CICSHIFT} \rangle &= \text{roundup}(14 - \log_2(2 * AFS / (N^3 * 4 * FM))) \\
 &= \text{roundup}(14 - \log_2(2 * 30000 / (32^3 * 4 * 0,6945))) \\
 &= \text{roundup}(14 - \log_2(0,6591)) \\
 &= \text{roundup}(14 - (-0,6013)) = \text{roundup}(14,6013) = 15
 \end{aligned}$$

- › And the gain correction factor

$$\begin{aligned}
 \text{gain factor} &= (2 * AFS / (N^3 * 4 * FM)) * 2^{\langle \text{CICSHIFT} \rangle - 14} \\
 &= 0,6591 * 2^{15-14} = 0,6591 * 2 = 1,3182
 \end{aligned}$$

Which gives a GAINFACTOR bitfield of

$$\begin{aligned}
 \langle \text{GAINFACTOR} \rangle &= \text{truncate}(\text{gain factor} * 4096) \\
 &= \text{truncate}(1,3182 * 4096) \\
 &= \text{truncate}(5399,3472) = 5399
 \end{aligned}$$

Implementation

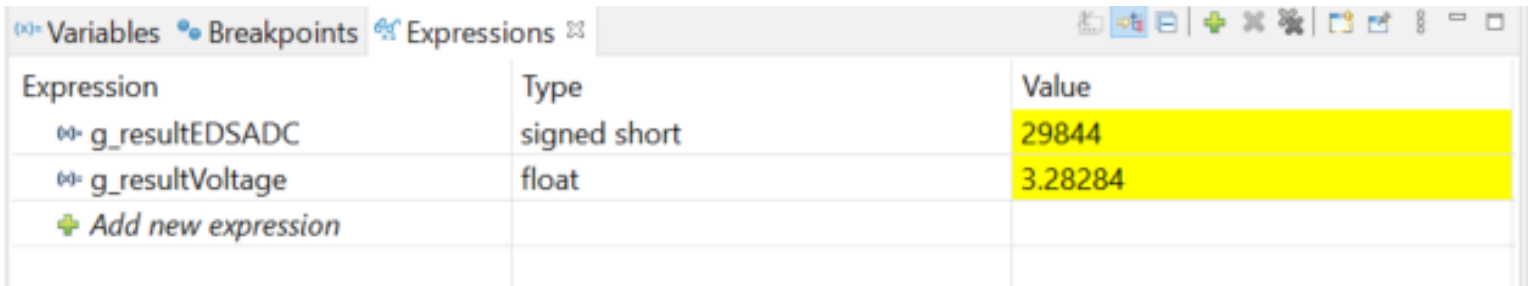
The conversion function:

- › The ***run_EDSADC()*** function is called in the while loop and continuously converts the analog voltage level on channel 3 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 – 3.3V, 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 +3,3 V) is controlled via the potentiometer
- > 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



Expression	Type	Value
g_resultEDSADC	signed short	29844
g_resultVoltage	float	3.28284
+ Add new expression		

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>

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2021-03

Published by

Infineon Technologies AG
81726 Munich, Germany

© 2021 Infineon Technologies AG.
All Rights Reserved.

Do you have a question about this document?

Email: erratum@infineon.com

Document reference

EDSADC_1_KIT_TC375_LK

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics (“Beschaffenheitsgarantie”).

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer’s compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer’s products and any use of the product of Infineon Technologies in customer’s applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer’s technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies office (www.infineon.com).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies’ products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.