LINZ CENTER OF MECHATRONICS GMBH

Project Documentation DemoApplication

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Part I

X2C Model

1 Version Information

1.1 X2C

- X2Cfull: Version 1194

1.2 Operating System

- OS: Windows 7 6.1

1.3 Scilab

- Scilab: Version 5.5.2.1427793548
- Java: Version 1.6.0_41

2 Model Structure

2.1 Xcos Model

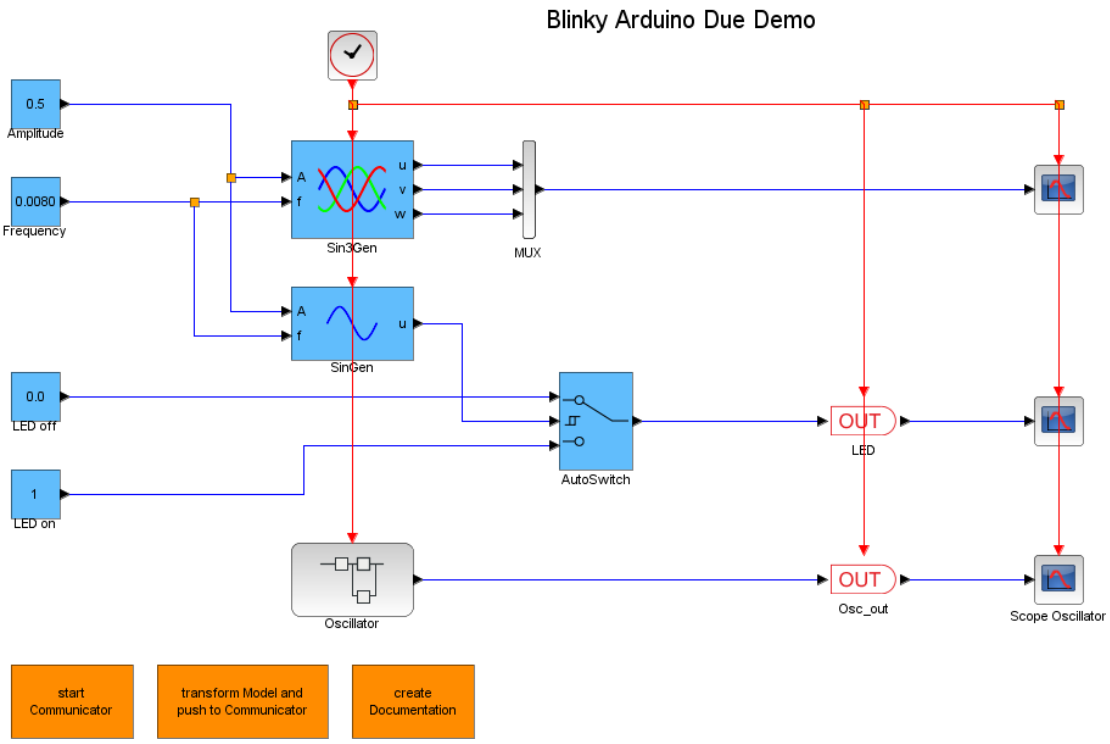

Figure 1: DemoApplication

2.2 Subsystems

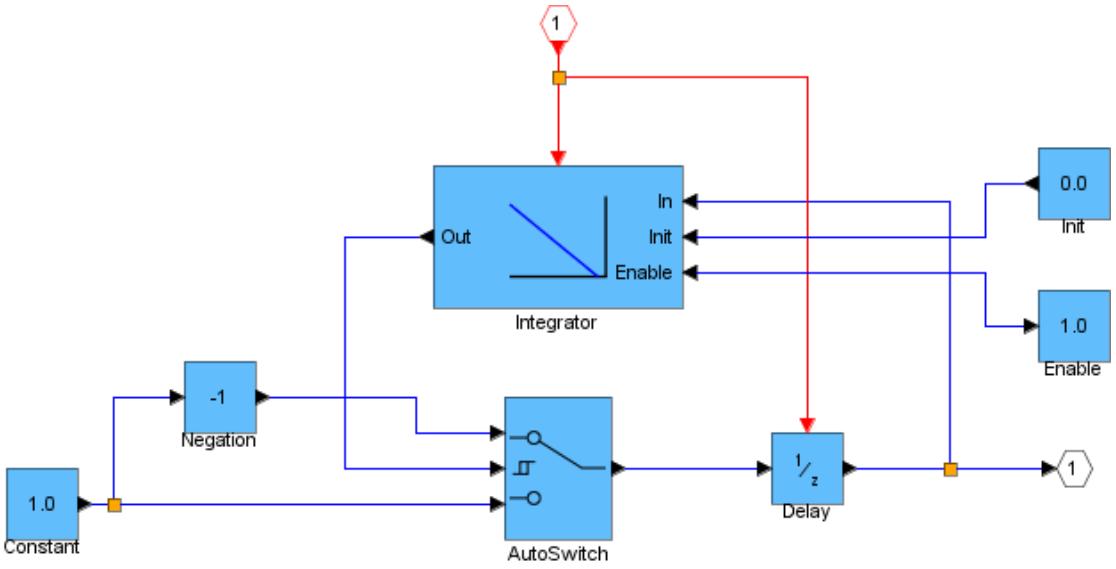

Figure 2: DemoApplication_Oscillator

3 Model Parameter

3.1 Sample Time

Sample Time	
T_S	$100\mu s$

4 Mask Parameter

Constant: Amplitude	
Value	0.5
Used Implementation	FiP16

AutoSwitch: AutoSwitch	
Thresh_up	0.0
Thresh_down	0.0
Used Implementation	FiP16

Constant: Frequency	
Value	0.0080
Used Implementation	FiP16

Constant: LED off	
Value	0.0
Used Implementation	FiP16

Constant: LED on	
Value	1.0
Used Implementation	FiP16

AutoSwitch: Oscillator__AutoSwitch	
Thresh_up	0.5
Thresh_down	-0.5
Used Implementation	FiP16

Constant: Oscillator__Constant	
Value	1.0
Used Implementation	FiP16

Delay: Oscillator__Delay	
ts_fact	1.0
Used Implementation	FiP16

Constant: Oscillator__Enable	
Value	1.0
Used Implementation	Bool

Constant: Oscillator__Init	
Value	0.0
Used Implementation	FiP16

I: Oscillator__Integrator	
Ki	50.0
ts_fact	1.0
Used Implementation	FiP16

Negation: Oscillator__Negation	
Used Implementation	FiP16

Sin3Gen: Sin3Gen	
fmax	1000.0
Offset	0.0
ts_fact	1.0
Used Implementation	FiP16

SinGen: SinGen	
fmax	1000.0
Offset	0.0
Phase	0.0
ts_fact	1.0
Used Implementation	FiP16

Part II
Frame Program Documentation

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6 File Index

6.1 File List

Here is a list of all documented files with brief descriptions:

inc/Hardware.h
Hardware configuration 7

inc/Main.h
Main application 8

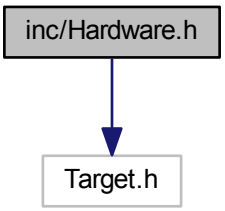
src/asf.h
Autogenerated API include file for the Atmel Software Framework (ASF) 10

7 File Documentation

7.1 inc/Hardware.h File Reference

Hardware configuration.

```
#include "Target.h"
```
Include dependency graph for Hardware.h:



Functions

- void initHardware (void)

  Initialization of hardware peripherals.
- void initSerial (tSerial ∗serial)

  Initialization of serial interface functions.

7.1.1 Detailed Description

Hardware configuration.
Configuration:

- center aligned PWM, 10 kHz
- ADC being automatically started (by hardware) on every PWM period
- ADC complete interrupt executes X2C Update function
- LED 'L' (digital output #13) blink frequency can be controlled by X2C block 'Frequency'
- UART configuration using 115200/8/N/1 for X2C communication

Uses Atmel ASF functions.

7.1.2 Function Documentation

7.1.2.1 void initHardware (void)

Initialization of hardware peripherals.

- UART
- LED
- PWM
- ADC

7.2 inc/Main.h File Reference

Main application.

Functions

- int main (void)

  Main function.
- void mainTask (void)

  Main control task.

7.2.1 Detailed Description

Main application.

7.2.2 Function Documentation

7.2.2.1 int main (void)

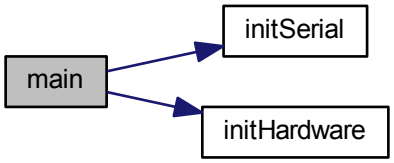
Main function.

Returns

The main function will never return due to the never ending loop.

- initialize system clock
- initialize board
- initialize "integrated monitor":
  - configuration of LNet protocol:
    - Node-ID: 1
    - Buffer size: 255
- initialize serial interface
- initialize hardware
- initialize X2C
- never ending loop -> interrupt driven algorithm

Here is the call graph for this function:



7.2.2.2 void mainTask (void)

Main control task.
Calling rate = 100us

- assign inports (not available in this demo)
- update X2C
- update outports

7.3 src/asf.h File Reference

Autogenerated API include file for the Atmel Software Framework (ASF)

```
#include <adc.h>
#include <compiler.h>
#include <status_codes.h>
#include <gpio.h>
#include <board.h>
#include <ioport.h>
#include <interrupt.h>
#include <pio.h>
#include <pmc.h>
#include <sleep.h>
#include <pwm.h>
#include <parts.h>
#include <exceptions.h>
#include <stdio_serial.h>
#include <sysclk.h>
#include <uart.h>
#include <serial.h>
#include <usart.h>
#include <pio_handler.h>
```

Include dependency graph for asf.h:

7.3.1 Detailed Description

Autogenerated API include file for the Atmel Software Framework (ASF)

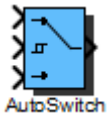
Part III

Used X2C-Blocks

8 Project Specific Blocks

9 Internal Library Blocks

Block: AutoSwitch



Inports	
In1	Input #1
Switch	Input #2: Threshold signal
In3	Input #3

Outports	
Out	Either value of input #1 or input #3 dependent on value of input #2

Mask Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal

Description:

Switch between In1 and In3 dependent on Switch signal:
Switch signal rising: Switch >= Threshold up –> Out = In1
Switch signal falling: Switch < Threshold down –> Out = In3

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Block: Constant

Outports	
Out	Constant output

Mask Parameters	
Value	Constant factor

Description:

Constant value.

Implementations:

Bool	Boolean Integration
FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Block: Delay

Inports	
In	Input In(k)

Outports	
Out	Output Out(k)=In(k-1)

Mask Parameters	
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

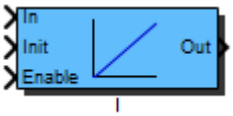
Output delay by one sample time interval.

This block can be used to enable feedback loops in the model.

Implementations:

FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Block: I



Inports	
In	Control error input
Init	Value which is loaded at initialization function call
Enable	Enable == 0: Deactivation of block; Out set to 0 Enable 0->1: Preload of integral part Enable == 1: Activation of block

Outports	
Out	Control value

Mask Parameters	
Ki	Integral Factor
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

I controller:
G(s) = Ki/s = 1/(Ti*s)

Each fixed point implementation uses the next higher integer datatype for the integrational value storage variable.
A rising flank at the *Enable* inport will preload the integrational part with the value present on the *Init* inport.

Transfer function (zero-order hold discretization method):

$$G(z) = K_I T_s \frac{1}{z-1}$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Block: Negation

Inports	
In	Input

Outports	
Out	Negated input value

Description:

Negation of input signal.

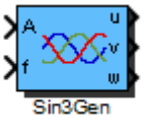
Calculation:

$$Out \quad = \quad -In$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Block: Sin3Gen



Inports	
A	Amplitude
f	Frequency

Outports	
u	Sine wave output phase u
v	Sine wave output phase v
w	Sine wave output phase w

Mask Parameters	
fmax	Maximum Frequency in Hz
Offset	Offset
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

Generation of a 3 sine waves with amplitude (A) and frequency (f).

Calculation fixed point implementation:

$$\begin{aligned} u_k &= A_k \cdot \sin\left(2f_k \cdot f_{max} \cdot kT_S\right) + A_{Offset} \\ v_k &= A_k \cdot \sin\left(2f_k \cdot f_{max} \cdot kT_S - \frac{2\pi}{3}\right) + A_{Offset} \\ w_k &= A_k \cdot \sin\left(2f_k \cdot f_{max} \cdot kT_S + \frac{2\pi}{3}\right) + A_{Offset} \end{aligned}$$

For sine calculation a lookup table with 256 entries is used. This results in a short computation time but with the downside of reduced accuracy for the FiP32 implementation.

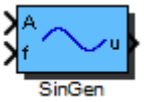
Calculation floating point implementation (parameter *f_max* is ignored):

$$\begin{aligned} u_k &= A_k \cdot \sin\left(2\pi f_k \cdot kT_S\right) + A_{Offset} \\ v_k &= A_k \cdot \sin\left(2\pi f_k \cdot kT_S - \frac{2\pi}{3}\right) + A_{Offset} \\ w_k &= A_k \cdot \sin\left(2\pi f_k \cdot kT_S + \frac{2\pi}{3}\right) + A_{Offset} \end{aligned}$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation

Block: SinGen



Inports	
A	Amplitude
f	Frequency

Outports	
u	Sine wave output

Mask Parameters	
fmax	Maximum Frequency in Hz
Offset	Offset
Phase	Phase [-Pi..Pi]
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

Generation of a sine wave with amplitude (A) and frequency (f).

Calculation fixed point implementation:

$$u_k = A_k \cdot \sin\left(2 f_k \cdot f_{max} \cdot k T_S + \phi_{Phase}\right) + A_{Offset}$$

For sine calculation a lookup table with 256 entries is used. This results in a short computation time but with the downside of reduced accuracy for the FiP32 implementation.

Calculation floating point implementation (parameter *f_max* is ignored):

$$u_k = A_k \cdot \sin\left(2\pi f_k \cdot k T_S + \phi_{Phase}\right) + A_{Offset}$$

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation
Float32	32 Bit Floating Point Implementation
Float64	64 Bit Floating Point Implementation