



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

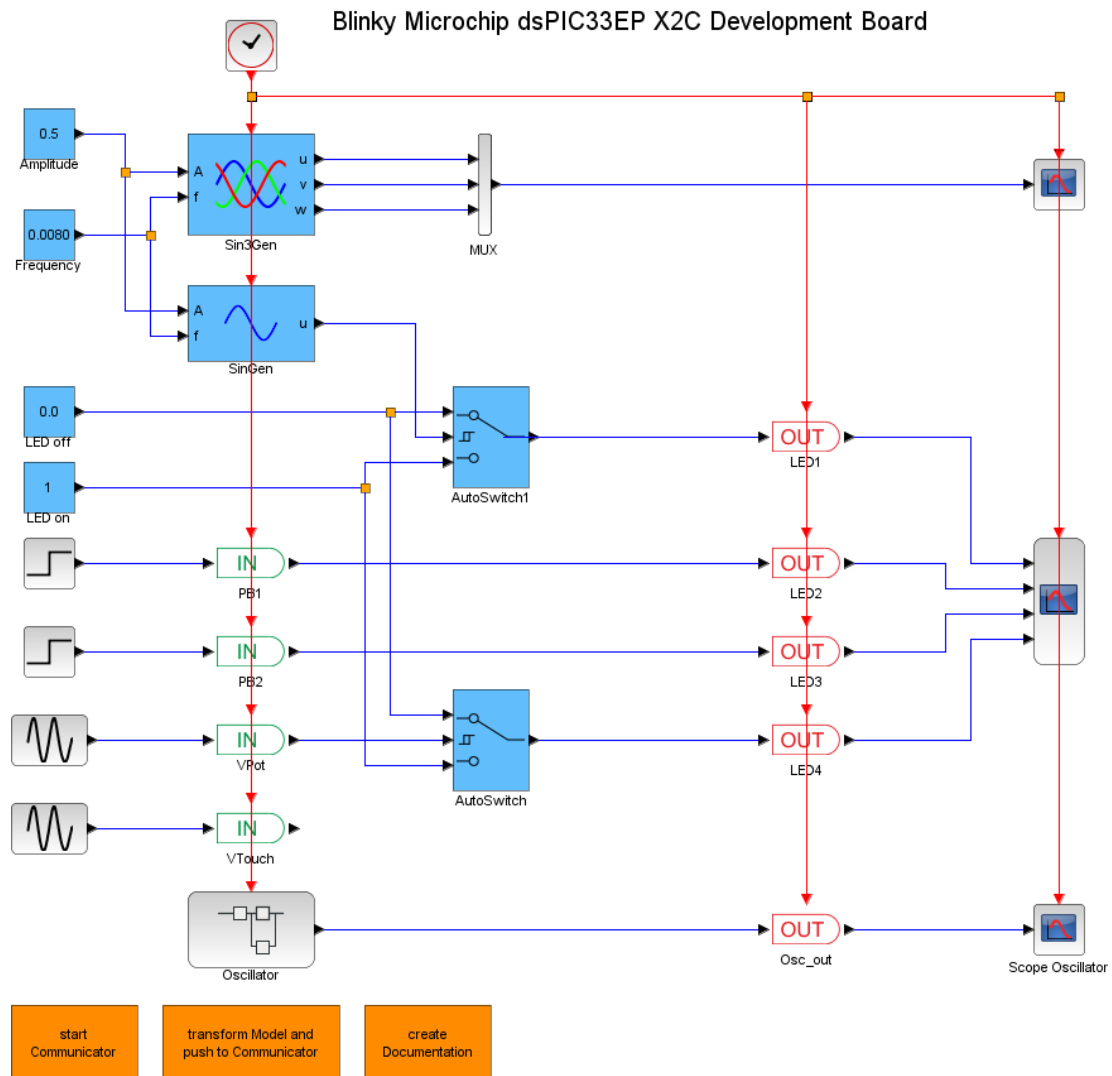


Figure 1: DemoApplication

2.2 Subsystems

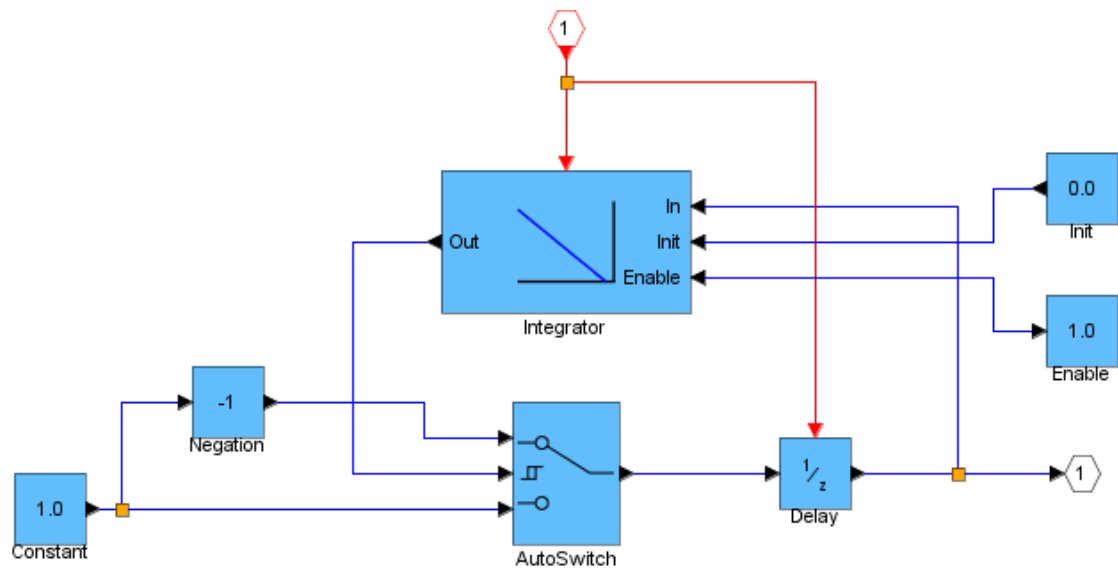


Figure 2: DemoApplication_Oscillator

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	0.6
Thresh_down	0.4
Used Implementation	FiP16

AutoSwitch: AutoSwitch1	
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

5 File Index

5.1 File List

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

inc/Hardware.h	
Hardware initialization	8
inc/Main.h	
Main application	9
inc/Traps.h	
Trap handling	11

6 File Documentation

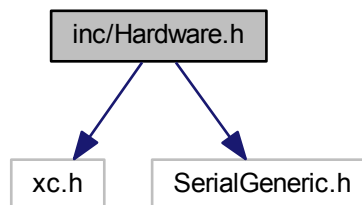
6.1 inc/Hardware.h File Reference

Hardware initialization.

```
#include <xc.h>
```

```
#include "SerialGeneric.h"
```

Include dependency graph for Hardware.h:



Functions

- void [initHardware](#) (void)
Hardware initialization.
- void [initSerial](#) (tSerial *serial)
Initialization of serial interface.

6.1.1 Detailed Description

Hardware initialization.

6.1.2 Function Documentation

6.1.2.1 void initHardware (void)

Hardware initialization.

- Configuration of oscillator
 - Internal oscillator (fast RC oscillator with PLL)
 - fCY = 40MHz (39.98MHz)
- Configuration of IO ports
- Configuration of serial port
 - Baudrate: 115.2kB/s
 - Data bits: 8
 - Parity: none
 - Stop bits: 1
- Configuration of ADC
 - 10 bit mode
 - internal RC clock source
 - continuous sampling and auto conversion
 - channel scan AN0, AN1
- Configuration of Timer 1 unit for sampling time (100us)

6.1.2.2 void initSerial (tSerial * *serial*)

Initialization of serial interface.

Parameters

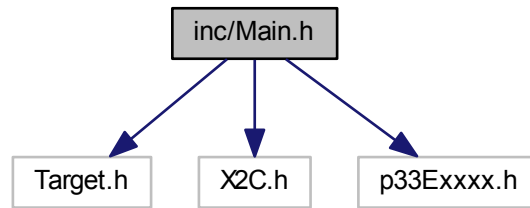
<i>serial</i>	Serial interface object.
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6.2 inc/Main.h File Reference

Main application.

```
#include "Target.h"
#include "X2C.h"
#include <p33Exxxx.h>
```

Include dependency graph for Main.h:



Functions

- `int main (void)`
Main function.
- `void mainTask (void)`
Main control task.

6.2.1 Detailed Description

Main application.

6.2.2 Function Documentation

6.2.2.1 `int main (void)`

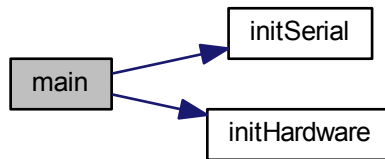
Main function.

Returns

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

- 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:



6.2.2.2 void mainTask (void)

Main control task.

Calling rate = 100us

- assign inports
- update X2C
- update outports

6.3 inc/Traps.h File Reference

Trap handling.

6.3.1 Detailed Description

Trap handling.

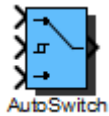
Part III

Used X2C-Blocks

7 Project Specific Blocks

8 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 \geq Threshold up \rightarrow Out = In1

Switch signal falling: Switch $<$ Threshold down \rightarrow 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



Outputs	
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 $In(k)$
Outputs	
Out	Output $Out(k)=In(k-1)$
Mask Parameters	
ts_fact	Multiplication factor of base sampling time (in integer format)

Description:

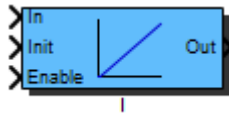
Output delay by one sample time interval.

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

Outputs	
Out	Control value

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

Description:

I controller:

$$G(s) = K_i/s = 1/(T_i \cdot s)$$

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

Outputs	
Out	Negated input value

Description:

Negation of input signal.

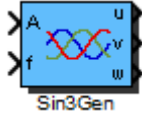
Calculation:

$$Out = -In$$

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

Outputs	
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:

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

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.

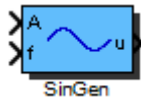
Calculation floating point implementation (parameter f_{max} is ignored):

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

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:

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

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):

$$u_k = A_k \cdot \sin(2\pi f_k \cdot kT_S + \phi_{Phase}) + A_{Offset}$$

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