LINZ CENTER OF MECHATRONICS GMBH

Project Documentation DemoApplication

October 21, 2016

Contents

Part I

X2C Model

1 Version Information

1.1 X2C

- X2Cfull: Version 1037

1.2 Operating System

- OS: Windows 7 6.1

1.3 Scilab

- Scilab: Version 5.5.1.1412169962
- Java: Version 1.6.0_41

2 Model Structure

2.1 Xcos Model

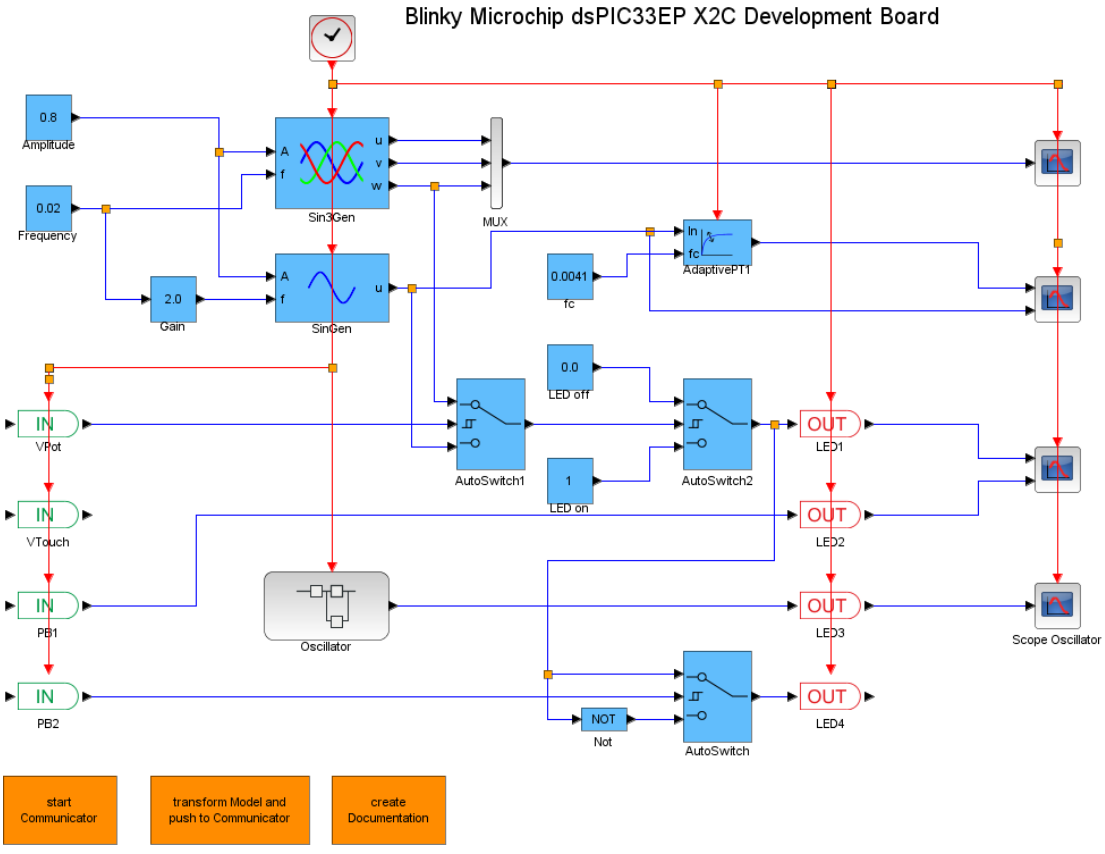


Figure 1: DemoApplication

2.2 Subsystems

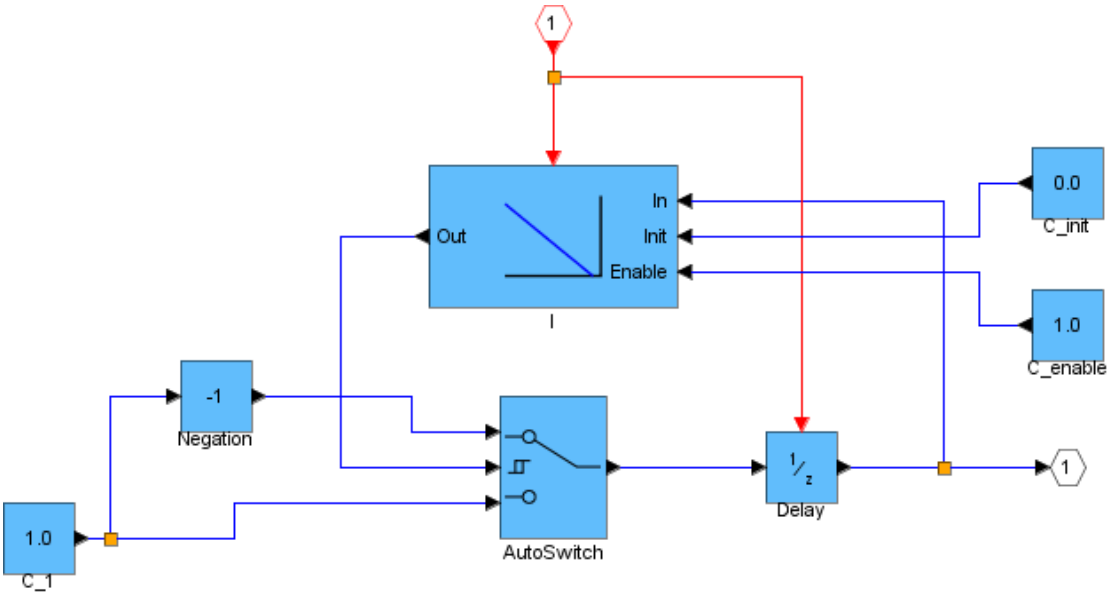


Figure 2: DemoApplication_Oscillator

3 Model Parameter

3.1 Sample Time

Sample Time	
T_S	$100\mu s$

4 Mask Parameter

AdaptivePT1: AdaptivePT1	
V	1.0
fmax	200.0
ts_fact	1.0
method	zoh
Used Implementation	FiP16

Constant: Amplitude	
Value	0.8
Used Implementation	FiP16

AutoSwitch: AutoSwitch	
Thresh_up	0.5
Thresh_down	0.5
Used Implementation	FiP16

AutoSwitch: AutoSwitch1	
Thresh_up	0.6
Thresh_down	0.4
Used Implementation	FiP16

AutoSwitch: AutoSwitch2	
Thresh_up	0.0
Thresh_down	0.0
Used Implementation	FiP16

Constant: Frequency	
Value	0.02
Used Implementation	FiP16

Gain: Gain	
Gain	2.0
Used Implementation	FiP16

Constant: LED off	
Value	0.0
Used Implementation	FiP16

Constant: LED on	
Value	1.0
Used Implementation	FiP16

Not: Not	
Used Implementation	FiP16

AutoSwitch: Oscillator__AutoSwitch	
Thresh_up	0.5
Thresh_down	-0.5
Used Implementation	FiP16

Constant: Oscillator__C_1	
Value	1.0
Used Implementation	FiP16

Constant: Oscillator__C_enable	
Value	1.0
Used Implementation	FiP8

Constant: Oscillator__C_init	
Value	0.0
Used Implementation	FiP16

Delay: Oscillator__Delay	
ts_fact	1.0
Used Implementation	FiP16

I: Oscillator__I	
Ki	6.05
ts_fact	1.0
Used Implementation	FiP16

Negation: Oscillator__Negation	
Used Implementation	FiP16

Sin3Gen: Sin3Gen	
fmax	100.0
Offset	0.0
ts_fact	1.0
Used Implementation	FiP16

SinGen: SinGen	
fmax	100.0
Offset	0.0
Phase	0.0
ts_fact	1.0
Used Implementation	FiP16

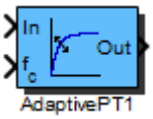
Constant: fc	
Value	0.0041
Used Implementation	FiP16

Part II
Used X2C-Blocks

5 Project Specific Blocks

6 Internal Library Blocks

Block: AdaptivePT1



Inports	
In	Input In(k)
fc	Cutoff frequency

Outports	
Out	Output Out(k)

Mask Parameters	
V	Gain
fmax	Maximum frequency [Hz] (not used in floating point implementations)
ts_fact	Multiplication factor of base sampling time (in integer format)
method	Discretization method

Description:

First order low pass with adaptive cut off frequency:
G(s) = V/(s/(2*pi*fc) + 1)

Transfer function (zero-order hold discretization method):

$$G(z) = V\frac{1-e^{-2\pi f_c T_s}}{z-e^{-2\pi f_c T_s}}$$

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

Implementation: FiP8

Name	FiP8
ID	3408
Revision	0.1
C filename	AdaptivePT1_FiP8.c
H filename	AdaptivePT1_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
w_scale	Calculation base for wc: -2*pi*Ts*fmax
gain	Gain
sfr	Shift factor for gain
in_old	In(k-1)

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *In;
      int8            *fc;
      int8            Out;
      int8            w_scale;
      int8            gain;
      uint8           sfr;
      int8            in_old;
} ADAPTIVEPT1_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	3409
Revision	1
C filename	AdaptivePT1_FiP16.c
H filename	AdaptivePT1_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
w_scale	Calculation base for wc: -2*pi*Ts*fmax
gain	Gain
sfr	Shift factor for gain
in_old	In(k-1)

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *In;
      int16           *fc;
      int16           Out;
      int16           w_scale;
      int16           gain;
      uint8           sfr;
      int16           in_old;
} ADAPTIVEPT1_FIP16;
```

Implementation: FiP32

Name FiP32
ID 3410
Revision 0.1
C filename AdaptivePT1_FiP32.c
H filename AdaptivePT1_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
w_scale	Calculation base for wc: -2*pi*Ts*fmax
gain	Gain
sfr	Shift factor forgain
in_old	In(k-1)

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           *In;
      int32           *fc;
      int32           Out;
      int32           w_scale;
      int32           gain;
      uint8           sfr;
      int32           in_old;
} ADAPTIVEPT1_FIP32;
```

Implementation: Float32

Name	Float32
ID	3411
Revision	0.1
C filename	AdaptivePT1_Float32.c
H filename	AdaptivePT1_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
w_scale	Calculation base for wc: -2*pi*Ts*fmax
gain	Gain
in_old	In(k-1)

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *In;
      float32         *fc;
      float32         Out;
      float32         w_scale;
      float32         gain;
      float32         in_old;
} ADAPTIVEPT1_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	3412
Revision	0.1
C filename	AdaptivePT1_Float64.c
H filename	AdaptivePT1_Float64.h

64 Bit Floating Point Implementation

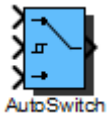
Controller Parameters	
w_scale	Calculation base for wc: -2*pi*Ts*fmax
gain	Gain
in_old	In(k-1)

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *In;
      float64         *fc;
      float64         Out;
      float64         w_scale;
```

```
    float64         gain;
    float64         in_old;
} ADAPTIVEPT1_FLOAT64;
```

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

Implementation: FiP8

Name	FiP8
ID	128
Revision	0.1
C filename	AutoSwitch_FiP8.c
H filename	AutoSwitch_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *In1;
      int8            *Switch;
      int8            *In3;
      int8            Out;
      int8            Thresh_up;
      int8            Thresh_down;
      int8            Status;
} AUTOSWITCH_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	129
Revision	0.1
C filename	AutoSwitch_FiP16.c
H filename	AutoSwitch_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *In1;
      int16           *Switch;
      int16           *In3;
      int16           Out;
      int16           Thresh_up;
      int16           Thresh_down;
      int8            Status;
} AUTOSWITCH_FIP16;
```

Implementation: FiP32

Name FiP32
ID 130
Revision 0.1
C filename AutoSwitch_FiP32.c
H filename AutoSwitch_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           *In1;
      int32           *Switch;
      int32           *In3;
      int32           Out;
      int32           Thresh_up;
      int32           Thresh_down;
      int8            Status;
} AUTOSWITCH_FIP32;
```

Implementation: Float32

Name Float32
ID 131
Revision 0.1
C filename AutoSwitch_Float32.c
H filename AutoSwitch_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *In1;
      float32         *Switch;
      float32         *In3;
      float32         Out;
      float32         Thresh_up;
```

```
    float32         Thresh_down;
    int8            Status;
} AUTOSWITCH_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	132
Revision	0.1
C filename	AutoSwitch_Float64.c
H filename	AutoSwitch_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
Thresh_up	Threshold level for rising switch signal
Thresh_down	Threshold level for falling switch signal
Status	Current hysteresis state

Data Structure:

```
typedef struct {
    uint16          ID;
    float64         *In1;
    float64         *Switch;
    float64         *In3;
    float64         Out;
    float64         Thresh_up;
    float64         Thresh_down;
    int8            Status;
} AUTOSWITCH_FLOAT64;
```

Block: Constant

Outports	
Out	Constant output

Mask Parameters	
Value	Constant factor

Description:

Constant value.

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

Implementation: FiP8

Name	FiP8
ID	48
Revision	0.3
C filename	Constant_FiP8.c
H filename	Constant_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            Out;
      int8            K;
} CONSTANT_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	49
Revision	0.3
C filename	Constant_FiP16.c
H filename	Constant_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           Out;
      int16           K;
} CONSTANT_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	50
Revision	0.3
C filename	Constant_FiP32.c
H filename	Constant_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           Out;
      int32           K;
} CONSTANT_FIP32;
```

Implementation: Float32

Name Float32
ID 51
Revision 0.1
C filename Constant_Float32.c
H filename Constant_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         Out;
      float32         K;
} CONSTANT_FLOAT32;
```

Implementation: Float64

Name Float64
ID 52
Revision 0.1
C filename Constant_Float64.c
H filename Constant_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
K	Constant factor

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         Out;
      float64         K;
} CONSTANT_FLOAT64;
```

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

Implementation: FiP16

Name	FiP16
ID	3425
Revision	0.1
C filename	Delay_FiP16.c
H filename	Delay_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
    uint16        ID;
```

```
    int16           *In;
    int16           Out;
    int16           In_old;
} DELAY_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	3426
Revision	0.1
C filename	Delay_FiP32.c
H filename	Delay_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In;
    int32           Out;
    int32           In_old;
} DELAY_FIP32;
```

Implementation: Float32

Name	Float32
ID	3427
Revision	0.1
C filename	Delay_Float32.c
H filename	Delay_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
    uint16          ID;
    float32         *In;
    float32         Out;
    float32         In_old;
} DELAY_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	3428
Revision	0.1
C filename	Delay_Float64.c
H filename	Delay_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
In_old	Input value from previous cycle

Data Structure:

```
typedef struct {
     uint16         ID;
     float64        *In;
     float64        Out;
     float64        In_old;
} DELAY_FLOAT64;
```

Block: Gain

Inports	
In	Input

Outports	
Out	Amplified input

Mask Parameters	
Gain	Gain factor in floating point format

Description:

Amplification of input by gain factor.

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

Implementation: FiP8

Name	FiP8
ID	16
Revision	1.0
C filename	Gain_FiP8.c
H filename	Gain_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
V	Gain factor
sfr	Shift factor

Data Structure:

```
typedef struct {
    uint16          ID;
    int8            *In;
```

```
    int8            Out;
    int8            V;
    int8            sfr;
} GAIN_FIP8;
```

Implementation: FiP16

Name FiP16
ID 17
Revision 1.0
C filename Gain_FiP16.c
H filename Gain_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
V	Gain factor
sfr	Shift factor

Data Structure:

```
typedef struct {
    uint16          ID;
    int16           *In;
    int16           Out;
    int16           V;
    int8            sfr;
} GAIN_FIP16;
```

Implementation: FiP32

Name FiP32
ID 18
Revision 1.0
C filename Gain_FiP32.c
H filename Gain_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
V	Gain factor
sfr	Shift factor

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In;
```

```
    int32           Out;
    int32           V;
    int8            sfr;
} GAIN_FIP32;
```

Implementation: Float32

Name	Float32
ID	19
Revision	0.1
C filename	Gain_Float32.c
H filename	Gain_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
V	Gain factor

Data Structure:

```
typedef struct {
    uint16          ID;
    float32         *In;
    float32         Out;
    float32         V;
} GAIN_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	20
Revision	0.1
C filename	Gain_Float64.c
H filename	Gain_Float64.h

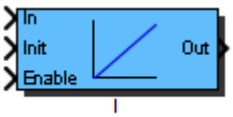
64 Bit Floating Point Implementation

Controller Parameters	
V	Gain factor

Data Structure:

```
typedef struct {
    uint16          ID;
    float64         *In;
    float64         Out;
    float64         V;
} GAIN_FLOAT64;
```

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

Implementation: FiP8

Name FiP8
ID 3200
Revision 1.0
C filename I_FiP8.c
H filename I_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
b0	Integral coefficient
sfr	Shift factor for I coefficient b0
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *In;
      int8            *Init;
      int8            *Enable;
      int8            Out;
      int8            b0;
      int8            sfr;
      int16           i_old;
      int8            enable_old;
} I_FIP8;
```

Implementation: FiP16

Name FiP16
ID 3201
Revision 1.0
C filename I_FiP16.c
H filename I_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
b0	Integral coefficient
sfr	Shift factor for I coefficient b0
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
```

```
    uint16          ID;
    int16           *In;
    int16           *Init;
    int8            *Enable;
    int16           Out;
    int16           b0;
    int8            sfr;
    int32           i_old;
    int8            enable_old;
} I_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	3202
Revision	1.0
C filename	I_FiP32.c
H filename	I_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
b0	Integral coefficient
sfr	Shift factor for I coefficient b0
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *In;
    int32           *Init;
    int8            *Enable;
    int32           Out;
    int32           b0;
    int8            sfr;
    int64           i_old;
    int8            enable_old;
} I_FIP32;
```

Implementation: Float32

Name	Float32
ID	3203
Revision	0.1
C filename	I_Float32.c
H filename	I_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
b0	Integral coefficient
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
     uint16          ID;
     float32         *In;
     float32         *Init;
     int8            *Enable;
     float32         Out;
     float32         b0;
     float32         i_old;
     int8            enable_old;
} I_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	3204
Revision	0.1
C filename	I_Float64.c
H filename	I_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
b0	Integral coefficient
i_old	Integrator value from previous cycle
enable_old	Enable value of previous cycle

Data Structure:

```
typedef struct {
     uint16          ID;
     float64         *In;
     float64         *Init;
     int8            *Enable;
     float64         Out;
     float64         b0;
     float64         i_old;
     int8            enable_old;
} I_FLOAT64;
```

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

Implementation: FiP8

Name	FiP8
ID	5040
Revision	0.1
C filename	Negation_FiP8.c
H filename	Negation_FiP8.h

8 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    int8            *In;
    int8            Out;
} NEGATION_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	5041
Revision	0.1
C filename	Negation_FiP16.c
H filename	Negation_FiP16.h

16 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
     uint16          ID;
     int16           *In;
     int16           Out;
} NEGATION_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	5042
Revision	0.1
C filename	Negation_FiP32.c
H filename	Negation_FiP32.h

32 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
     uint16          ID;
     int32           *In;
     int32           Out;
} NEGATION_FIP32;
```

Implementation: Float32

Name	Float32
ID	5043
Revision	0.1
C filename	Negation_Float32.c
H filename	Negation_Float32.h

32 Bit Floating Point Implementation

Data Structure:

```
typedef struct {
     uint16          ID;
     float32         *In;
```

```
    float32         Out;
} NEGATION_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	5044
Revision	0.1
C filename	Negation_Float64.c
H filename	Negation_Float64.h

64 Bit Floating Point Implementation

Data Structure:

```
typedef struct {
    uint16          ID;
    float64         *In;
    float64         Out;
} NEGATION_FLOAT64;
```

Block: Not

Inports	
In	

Outports	
Out	

Description:

Logical inverter block.

Implementations:

FiP8	8 Bit Fixed Point Implementation
FiP16	16 Bit Fixed Point Implementation
FiP32	32 Bit Fixed Point Implementation

Implementation: FiP8

Name	FiP8
ID	224
Revision	0.1
C filename	Not_FiP8.c
H filename	Not_FiP8.h

8 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *In;
      int8            Out;
} NOT_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	225
Revision	0.1
C filename	Not_FiP16.c
H filename	Not_FiP16.h

16 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
     uint16          ID;
     int16           *In;
     int16           Out;
} NOT_FIP16;
```

Implementation: FiP32

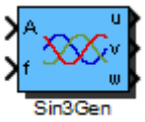
Name	FiP32
ID	226
Revision	0.1
C filename	Not_FiP32.c
H filename	Not_FiP32.h

32 Bit Fixed Point Implementation

Data Structure:

```
typedef struct {
     uint16          ID;
     int32           *In;
     int32           Out;
} NOT_FIP32;
```

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:

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

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):

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

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

Implementation: FiP8

Name	FiP8
ID	432
Revision	1.0
C filename	Sin3Gen_FiP8.c
H filename	Sin3Gen_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
    uint16          ID;
    int8            *A;
    int8            *f;
    int8            u;
    int8            v;
    int8            w;
    int8            delta_phi;
    int8            offset;
    int8            phi;
} SIN3GEN_FIP8;
```

Implementation: FiP16

Name	FiP16
ID	433
Revision	1.0
C filename	Sin3Gen_FiP16.c
H filename	Sin3Gen_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *A;
      int16           *f;
      int16           u;
      int16           v;
      int16           w;
      int16           delta_phi;
      int16           offset;
      int16           phi;
} SIN3GEN_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	434
Revision	1.0
C filename	Sin3Gen_FiP32.c
H filename	Sin3Gen_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int32           *A;
      int32           *f;
      int32           u;
      int32           v;
      int32           w;
      int32           delta_phi;
      int32           offset;
      int32           phi;
} SIN3GEN_FIP32;
```

Implementation: Float32

Name	Float32
ID	435
Revision	0.1
C filename	Sin3Gen_Float32.c
H filename	Sin3Gen_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *A;
      float32         *f;
      float32         u;
      float32         v;
      float32         w;
      float32         delta_phi;
      float32         offset;
      float32         phi;
} SIN3GEN_FLOAT32;
```

Implementation: Float64

Name	Float64
ID	436
Revision	0.1
C filename	Sin3Gen_Float64.c
H filename	Sin3Gen_Float64.h

64 Bit Floating Point Implementation

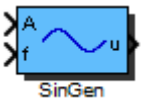
Controller Parameters	
delta_phi	Angle increment
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *A;
      float64         *f;
```

```
    float64         u;
    float64         v;
    float64         w;
    float64         delta_phi;
    float64         offset;
    float64         phi;
} SIN3GEN_FLOAT64;
```

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:

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

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):

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

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

Implementation: FiP8

Name FiP8
ID 416
Revision 1.0
C filename SinGen_FiP8.c
H filename SinGen_FiP8.h

8 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int8            *A;
      int8            *f;
      int8            u;
      int8            delta_phi;
      int8            phase;
      int8            offset;
      int8            phi;
} SINGEN_FIP8;
```

Implementation: FiP16

Name FiP16
ID 417
Revision 1.0
C filename SinGen_FiP16.c
H filename SinGen_FiP16.h

16 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      int16           *A;
      int16           *f;
```

```
    int16           u;
    int16           delta_phi;
    int16           phase;
    int16           offset;
    int16           phi;
} SINGEN_FIP16;
```

Implementation: FiP32

Name	FiP32
ID	418
Revision	1.0
C filename	SinGen_FiP32.c
H filename	SinGen_FiP32.h

32 Bit Fixed Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
    uint16          ID;
    int32           *A;
    int32           *f;
    int32           u;
    int32           delta_phi;
    int32           phase;
    int32           offset;
    int32           phi;
} SINGEN_FIP32;
```

Implementation: Float32

Name	Float32
ID	419
Revision	0.1
C filename	SinGen_Float32.c
H filename	SinGen_Float32.h

32 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      float32         *A;
      float32         *f;
      float32         u;
      float32         delta_phi;
      float32         phase;
      float32         offset;
      float32         phi;
} SINGEN_FLOAT32;
```

Implementation: Float64

Name Float64
ID 420
Revision 0.1
C filename SinGen_Float64.c
H filename SinGen_Float64.h

64 Bit Floating Point Implementation

Controller Parameters	
delta_phi	Angle increment
phase	Angle offset
offset	Amplitude offset
phi	Current angle

Data Structure:

```
typedef struct {
      uint16          ID;
      float64         *A;
      float64         *f;
      float64         u;
      float64         delta_phi;
      float64         phase;
      float64         offset;
      float64         phi;
} SINGEN_FLOAT64;
```