Specification document of OSS-EC

BSL No.	00000057		
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1. Overview

This software specification is for OSS-EC for ADC components.
本ソフトウェア仕様は、ADC コンポーネント用 OSS-EC の仕様です。

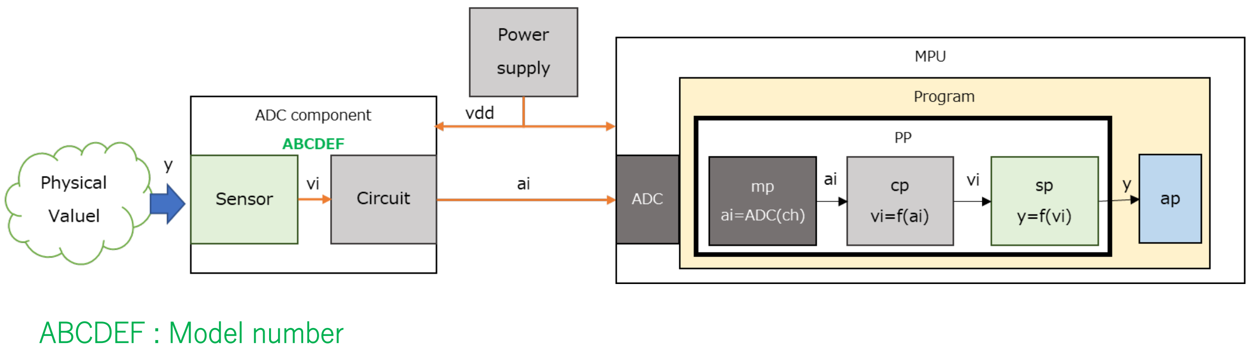
2. Features

- Component type	ADC component
- Number of Components	Single
- Supported OS (HAL)	Arduino
- Calculation	Floating-point
- Conversion type	Linear
- Moving average filter	Moving average filter select (Non,SMA,EMA,WMA)
- Diagnosis	Range (Min to Max)

3. OSS-EC Architecture

The OSS-EC architecture of ADC component (analog output component) is shown in the figure below, according to the component architecture.
ADC コンポーネント（アナログ出力コンポーネント）用 OSS-EC アーキテクチャは、コンポーネントアーキテクチャに合わせ、下図の通りです。

fig. ADC component architecture & OSS-EC architecture



4. Components Software Interface

The sensor output voltage to physical quantity conversion is a linear conversion as in the following equation. The nonlinear conversion is provided in a separate BSL.
センサ出力電圧から物理量変換は、下式のような線形変換とする。尚、非線形変換は、別 BSL にて提供する。

ADC value to voltage value conversion formula

$$vi = (ai \times ADC\_vdd) / 2^{ADC\_bit}$$

Voltage value to physical value conversion formula

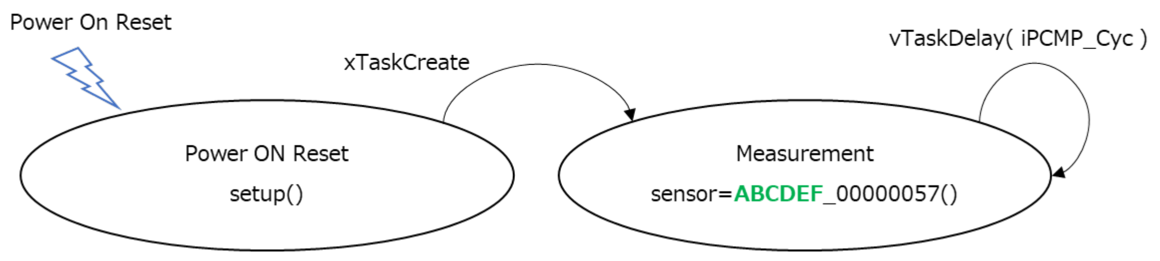
$$y = (vi - x\_offset) / gain + y\_offset \qquad \text{range min to max}$$

y	physical value
ai	A/D conversion value
vi	Sensor output voltage value
ADC_vdd	Sensor supply voltage(Vdd) value
ADC_bit	A/D conversion bit length
x_offset	Sensor output voltage offset value
gain	Voltage value to physical value conversion gain
y_offset	Physical offset value
min	Physical value min
max	Physical value max

5. Usage Scenes
   The usage scenario of the ADC component is assumed to be a scene to be measured in cycles or events.
   ADC コンポーネントの利用シーンは、周期またはイベントでの計測するシーンを想定する。

6. State flow
   The state flow of the ADC component shall be as shown in the figure below from the usage scenes.
   ADC コンポーネントの状態遷移は、利用シーンから下図の通りです。

fig. ADC component state flow

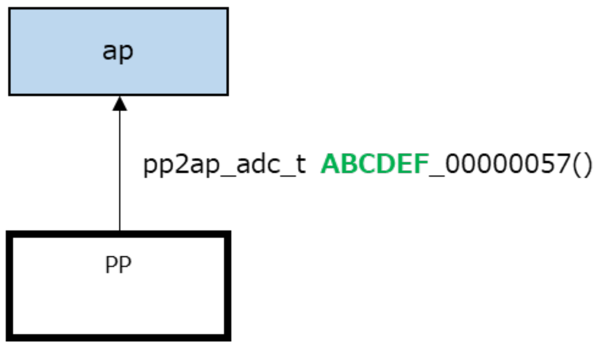


7. API

The API is shown in the figure below.

API は、下図の通りです。

fig 3. API



```
typedef struct
{
        uint32                  sts;                // Diagnosis result of range min to max
        float32                 phy;                // Sensor physical value
}pp2ap_adc_t;
```

8. Outline specifications

The outline specifications of BSL00000057 are as follows
BSL00000057 の概略仕様は、下記の通りです。

1） Analog value read
2） Converts analog values to voltage values
3） Convert voltage values to physical values
4） Range min to max

wk	range min to max	
res.sts	Normal	iNormal
	More than maximum value	iMax_NG
	Below minimum value	iMin_NG

5） Moving average filter select

Select a moving average according to the value of iMA.

#define iMA	iSMA	Simple moving average filter
#define iMA	iEMA	Exponential moving average filter
#define iMA	iWMA	Weighted moving average filter
#define iMA	iNonMA	Non-moving average filter

SMA calculation method

$phy = (y_n + y_{n-1} + y_{n-2} \cdots) / n$

n : iABCDEF_SMA_num

EMA calculation method

$phy = (y \times k) + (phy_{n-1} \times (1 - k))$

k : iABCDEF_EMA_K

WMA calculation method

$phy = ((y_n \times 1) + (y_{n-1} \times 2) + (y_{n-2} \times 3) \cdots) / (1 + 2 + 3 \cdots)$

n : iABCDEF_WMA_num

```
#include "user_define.h"
#include "oss_ec.h"
static uint32 lib_f32_MaxMin( float32* , float32 , float32 );
#if     iMA == iSMA                             // Simple moving average filter
static float32 lib_f32_SMA( float32 , sma_f32_t* );
#elif   iMA == iEMA                             // Exponential moving average filter
static float32 lib_f32_EMA( float32 , ema_f32_t* );
#elif   iMA == iWMA                             // Weighted moving average filter
static float32 lib_f32_WMA( float32 , wma_f32_t* );
#else                                           // Non-moving average  filter
#endif

// ADC Initialize Function
void adc_ini( void )
{
        analogReference( iVref );
}

// ADC Main Function
pp2ap_adc_t pp_00000057( tbl_adc_t tbl )
{
        pp2ap_adc_t res;

        // MP A/D value read
        uint16  ai = analogRead( tbl.pin );                         1)
        // CP A/D value to Voltage value conversion
        float32 vi = ( ai * iADC_vdd ) / ( 1<<iADC_bit );           2)
        // SP Voltage value to Physical value : linear conversion
        float32 wk = (( vi - tbl.xoff ) / tbl.gain ) + tbl.yoff;    3)
        // range (Min to Max)
        res.sts = lib_f32_MaxMin( &wk , tbl.max , tbl.min );        4)
        // Moving average filter select                             5)
#if     iMA == iSMA     // Simple moving average filter
        res.phy = lib_f32_SMA( wk , tbl.sma );
#elif   iMA == iEMA     //  Exponential moving average filter
        res.phy = lib_f32_EMA( wk , tbl.ema );
#elif   iMA == iWMA     // Weighted moving average filter
        res.phy = lib_f32_WMA( wk , tbl.wma );
#else                   // Non-moving average filter
        res.phy = wk;
#endif
        return( res );
}
```

9. Example

An example using XYZ's ABCDEF is shown below.

XYZ 社製 ABCDEF を用いた例は、下記の通りです。

```
void ap( void* pvParameters )
{
        pp2ap_adc_t   sensor;
        float         pressure;         // Pressure [kPa]
        unsigned long diagnosis;        // Diagnosis result
                                        //   Normal=iNormal,Max NG=iMax_NG,Min NG=iMin_NG
        // ABCDEF sensor read
        do{
                // Read of Pressure Sensor
                sensor = ABCDEF_00000057();
                pressure  = sensor.phy;
                diagnosis = sensor.sts;
                // Sensor Application
                // Application cycle wait
                vTaskDelay( iPCMP_Cyc );
        }while(true);
}
```

10. File configuration

The file configuration of this OSS-EC is shown in the table below.

Folder name	File name	Summary
XYZ_ABCDEF_00000057	ABCDEF.cpp	ABCDEF const data file
	ABCDEF.h	ABCDEF define header file
	ABCDEF_00000057.cpp	ABCDEF code file
	user_setting.h	User setting header file
	pp_00000057.cpp	BSL00000057 code file
	oss_ec.h	BSL00000057 OSS-EC header file
	License.txt	OSS-EC license text file
	Spec-00000057.pdf	This specification pdf file
	Spec-ABCDEF.pdf	ABCDEF component software specification pdf file
XYZ_ABCDEF_00000057/sample	sample.ino	Sample code file

11. User setting

User configuration is done by user_setting.h. Select the moving average method, remove the comments as shown below. Also, change the coefficient of each moving average to match the product.

```
#define iADC_bit          10U           // MPU ADC bit
#define iADC_vdd          5.0F          // MPU Vdd Configures the reference voltage [V]
#define iVref             DEFAULT       // Configures the reference voltage
                                        // DEFAULT: the default analog reference of 5 volts (on 5V Arduino boards)
                                        //          or 3.3 volts (on 3.3V Arduino boards)
#define iABCDEF_pin       A0            // ADC pin of ABCDEF
```

Case : Non-moving average filter select

```
#define iMA                    iNonMA       // Non-moving average filter
//#define iMA                   iSMA          // Simple moving average filter
//#define iMA                   iEMA          // Exponential moving average filter
//#define iMA                   iWMA          // Weighted moving average filter
//#define iABCDEF_SMA_num      4U            // Simple moving average number & buf size
//#define iABCDEF_EMA_K        0.25F         // Exponential Smoothing Factor
//#define iABCDEF_WMA_num      4U            // Weighted moving average number & buf size
```

Case : Simple moving average filter

```
//#define iMA                   iNonMA          // Non-moving average filter
#define iMA                    iSMA           // Simple moving average filter
//#define iMA                   iEMA            // Exponential moving average filter
//#define iMA                   iWMA            // Weighted moving average filter
#define iABCDEF_SMA_num       4U             // Simple moving average number & buf size
         CAUTION : iABCDEF_SMA_num > 0
//#define iABCDEF_EMA_K        0.25F           // Exponential Smoothing Factor
//#define iABCDEF_WMA_num      4U              // Weighted moving average number & buf size
```

Case : Exponential moving average filter

```
//#define iMA                   iNonMA          // Non-moving average filter
//#define iMA                   iSMA            // Simple moving average filter
#define iMA                    iEMA           // Exponential moving average filter
//#define iMA                   iWMA            // Weighted moving average filter
//#define iABCDEF_SMA_num      4U              // Simple moving average number & buf size
#define iABCDEF_EMA_K         0.25F          // Exponential Smoothing Factor
         CAUTION : 0.0 < iABCDEF_EMA_K < 1.0
//#define iABCDEF_WMA_num      4U              // Weighted moving average number & buf size
```

Case : Weighted moving average filter

```
//#define iMA                   iNonMA          // Non-moving average filter
//#define iMA                   iSMA            // Simple moving average filter
//#define iMA                   iEMA            // Exponential moving average filter
#define iMA                    iWMA           // Weighted moving average filter
//#define iABCDEF_SMA_num      4U              // Simple moving average number & buf size
//#define iABCDEF_EMA_K        0.25F           // Exponential Smoothing Factor
#define iABCDEF_WMA_num       4U             // Weighted moving average number & buf size
         CAUTION : iABCDEF_WMA_num > 0

#define iABCDEF_ma            iMA
```