Make Sense of The World

GMP102 temperature compensated pressure calculation

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Application note

Please download these data in advance

1. Example Code: GMP102-Ref-Code-master

https://github.com/GlobalMEMS/GMP102-Example-Code-nRF51-DK

2. GMP102_Calibration_Verification_Tool.xlsx

https://github.com/GlobalMEMS/Application-Notes/blob/master/GMP102_Calibration_Verification_Tool.xlsx

Temperature compensated pressure calculation for GMP102

6 steps to calculate calibrated pressure:

1. Get the raw pressure
2. Get the calibrated temperature
3. Read the calibration registers :AAh~BBh
4. Get the parameters : fParam[0]~ fParam[8]
5. Calculate temperature compensated pressure
6. Verify the calculated compensated pressure data by GMP102_Calibration_Verification_Tool.xlsx

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Step1: Get the raw pressure

- The pressure data output is encoded to a 24-bit value and stored across three bytes.
- Data representation is 2's complement, i.e. MSB (bit 23) is the sign bit with 1'b1 representing negative value.

Register 06h~08h: Pressure Data Registers

Addr.	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access	Default
06h	PRESSH	Pressure [23:16]								R	NA
07h	PRESSM	Pressure [15:8]								R	NA
08h	PRESSL	Pressure [7:0]								R	NA

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Step2:
Get the calibrated temperature

- The temperature data output is encoded to a 16-bit value and stored across two bytes. Data representation is 2's complement, i.e. MSB (bit 15) is the sign bit with 1'b1 representing negative value.
- The temperature sensor has sensitivity of 256 LSB/℃. The central value (0x00) stands for 0℃.

Addr.	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access	Default
09h	TEMPH	Temperature[15:8]								R	NA
0Ah	TEMPL	Temperature[7:0]								R	NA

$$T(℃) = \frac{\text{Temperature}[15:0]}{256}$$

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Step3:
Read the calibration registers: AAh~BBh

Calculate the calibrated pressure value with the calibration parameters (AAh~BBh).

User Register Map

Table 4: User Register Map Table

Addr.	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access	Default
00h	RESET	SPI4W	R'ved	RST	0	0	RST	R'ved	SPI4W	RW	0x00
01h	PID	PID[7:0]								R	0x02
02h	STATUS	Reserved				0	0	0	DRDY	R	NA
06h	PRESSH	Pressure [23:16]								R	NA
07h	PRESSM	Pressure [15:8]								R	NA
08h	PRESSL	Pressure [7:0]								R	NA
09h	TEMPH	Temperature[15:8]								R	NA
0Ah	TEMPL	Temperature[7:0]								R	NA
30h	CMD	Reserved				Measure_CTRL[3:0]				RW	0x00
A5h	CONFIG1	Reserved						Raw	Reserved	RW	0x00
A6h	CONFIG2	Reserved					OSR[2:0]			RW	0x1F
AAh ~ BBh	Calib00 ~ Calib17	Calibration data								R	NA

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Step4:

Get the parameters: fParam[ ]

	Sequence	Example: fParam[2]
1	Get gmp102 calibration parameters- Read calibration register AAh~BBh total 18 bytes	
2	Compose 9 calibration parameters from the 18 bytes	AEh AFh
3	Transform the 16-bits composed parameter. Data representation is 2's complement. • The MSB (bit 15) : sign bit 0 indicates to positive (+) 1 indicates to negative(–) • The 2nd to 14th bits : value • The last 2 bits: scale factor Sign / Value / Scale factor Bit15 / Bit14-Bit2 / Bit1-Bit0	AEh AFh EE DD 11101110 11011101 - 10001001001 10^{01} $-1097*10^{01}$
4	Multiplied Calibration Scale Factor (GMP102_CALIB_SCALE_FACTOR[])	10^{-10}
5	Clculate fParam[ ]	fParam[2] =β2= $-1097*10^{01}*10^{-10}=-1.097E-06$

Example

Register	AA	AB	AC	AD	AE	AF	B0	B1
	2D	DD	21	69	EE	DD	26	21

Parameters	β0	β1	β2	β3
	2.935E+04	2.138E-01	-1.097E-06	2.440E-01

```
static const float GMP102_CALIB_SCALE_FACTOR[] = {
                    1.0E+00,
                    1.0E-05,
                    1.0E-10,
                    1.0E-05,
                    1.0E-10,
                    1.0E-15,
                    1.0E-12,
                    1.0E-17,
                    1.0E-21 };
```

GMP102_CALIB_SCALE_FACTOR[2]

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Step4
Get the parameters (Code)

```
//Read the calibration registers
        comRslt = gmp102_burst_read(GMP102_REG_CALIB00, u8DataBuf,
GMP102_CALIBRATION_REGISTER_COUNT);

        if(comRslt < GMP102_CALIBRATION_REGISTER_COUNT){
                comRslt = -1;
                goto EXIT;
        }
// Get the parameters
        shift = sizeof(s32)*8 - 16;
        for(i = 0; i < GMP102_CALIBRATION_PARAMETER_COUNT; ++i){
                tmp = (u8DataBuf[2 * i] << 8) + u8DataBuf[2 * i + 1];
                fCalibParam[i] = ((tmp << shift) >> (shift + 2)) * (pow(10, (u8DataBuf[2 * i + 1] &
0x03))) * GMP102_CALIB_SCALE_FACTOR[i];
        }
```

```
static const float GMP102_CALIB_SCALE_FACTOR[] = {
                1.0E+00,
                1.0E-05,
                1.0E-10,
                1.0E-05,
                1.0E-10,
                1.0E-15,
                1.0E-12,
                1.0E-17,
                1.0E-21 };
```

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Step5

Calculate temperature compensated pressure

- **GMP102 temperature and pressure compensation**

param s16T: calibrated temperature in code
param s32P: raw pressure in code
param fParam[]: pressure calibration parameters

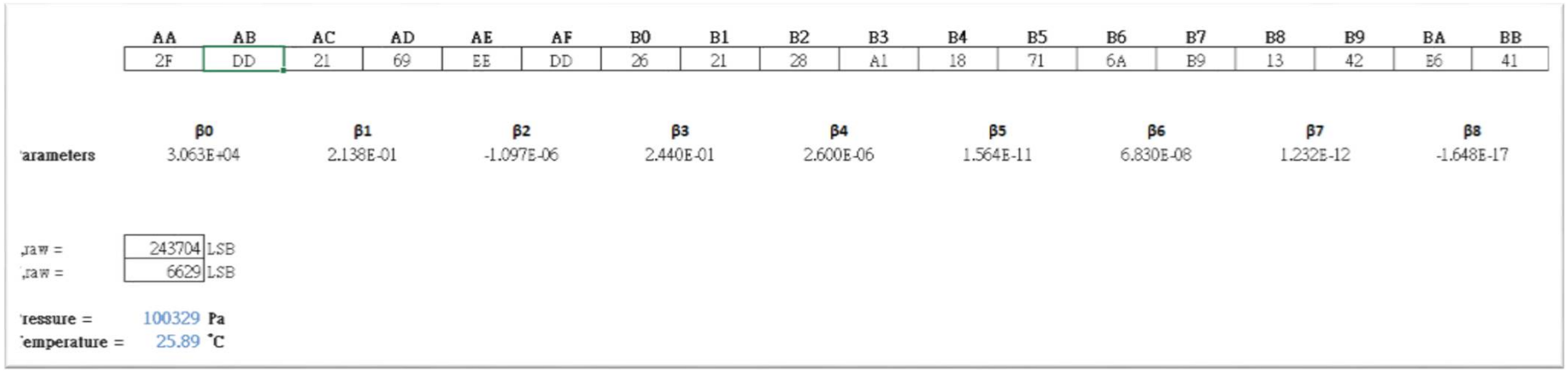
```
*pfP_Pa = \
        fParam[0] + \
        fParam[1]*s16T + \
        fParam[2]*s16T*s16T + \
        fParam[3]*s32P + \
        fParam[4]*s16T*s32P + \
        fParam[5]*s16T*s16T*s32P + \
        fParam[6]*s32P*s32P + \
        fParam[7]*s16T*s32P*s32P + \
        fParam[8]*s16T*s16T*s32P*s32P;
```

Step6
Verify the calibrated pressure

GMP102_Calibration_Verification_Tool.xlsx

The "Calibration Verification" sheet provides a tool to verify your calibration implementation for GMP102 readouts.

1. Put in the calibration registers (AAh~BBh) values read from your GMP102 device.The calibration parameters (β0~β8) will be calculated. Check them against your implementation result.
2. Put in the P and T raw data from the reading of your GMP102 device. The calibrated P(Pa) and T(℃) will be calculated. Check them against your implementation result.



	AA	AB	AC	AD	AE	AF	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB
	2F	DD	21	69	EE	DD	26	21	28	A1	18	71	6A	B9	13	42	E6	41

arameters	β0	β1	β2	β3	β4	β5	β6	β7	β8
	3.063E+04	2.138E-01	-1.097E-06	2.440E-01	2.600E-06	1.564E-11	6.830E-08	1.232E-12	-1.648E-17

raw =	243704	LSB
raw =	6629	LSB
ressure =	100329	Pa
emperature =	25.89	℃