PMBus reporting calibration method

Revision History

Revision	Modified by	Update details	Date
Initial version v1.0	Kiran	PSU Calibration and Specifications	01-02-2021

Contents

Scope of calibration

Every Power supply unit should be calibrated before shipment, which include Vin/Iin/Pin/Vout/Iout/Pout parameters usually.

What is Calibration?

Calibration is a process of comparing a reading on one equipment with reading on another equipment that has been calibrated and referenced to a known set of parameters. The equipment used as a reference should itself be directly traceable to equipment that is calibrated to a national standard.

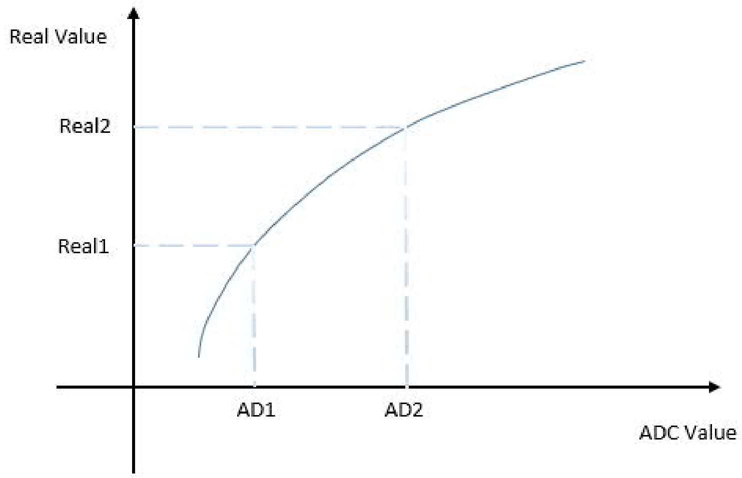
Why does PSU need calibration?

1. Meet customer needs of reporting accuracy (Vin 3% , Iin 5% …)
2. Hardware tolerance of all power supply is different. Theoretically calculated value can't ensure all PSU in regulation range.

This document explains the principle of calibration . Also explains the operational principle of PSU and GUI respectively.

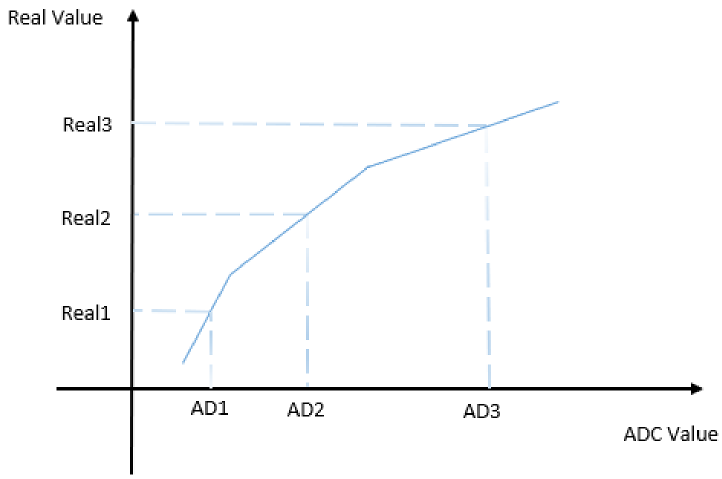
Principle of calibration

Actually the process of calibration is finding the correspondence between real value and ADC value.



Correspondence between ADC value and real value is shown in above curve .

Our aim of calibration will be to find the mathematical formula for the curve , use the gain and offset values of the curve to find the correspondence between real value and ADC value.



If the correspondence is not linear over the full range, we can use differential method to find the several correspondence lines using piecewise approximation as shown above.

Basic principle of calibration using the mathematical equation of straight line

$y = mx + C$

We can get the correspondence as below :

$Real1 = k1 * ADC1 + b1$

$Real2 = k2 * ADC2 + b2$

$Real3 = k3 * ADC3 + b3$

So the mathematical model can be :

$Real = k * AD + b$

Adding amplification factor :

$$Real_{Amp} * Real = \frac{(Real_{Amp} * AD_{Amp} * k * AD)}{AD_{Amp}} + Real_{Amp} * b$$

$$Real_{Amp} * Real = \frac{(Amp * AD)}{AD_{Amp}} + Offset$$

$Amp = Real_{Amp} * AD_{Amp} * k;$

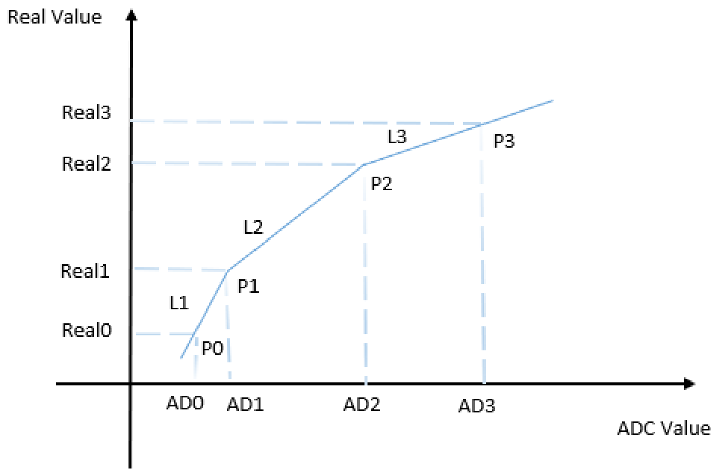
$Offset = Real_{Amp} * b$

In general, we can set $Real_{Amp}$ as 128 and set AD_{Amp} as 512.

We can also adjust these 2 numbers for different parameters.

For GUI : Calculate Amp and Offset value and send them to PSU

GUI can get P1 (AD1 , Real1) , P2 (AD2 , Real2) and P3 (AD3 , Real3) from PSU and measuring equipment.



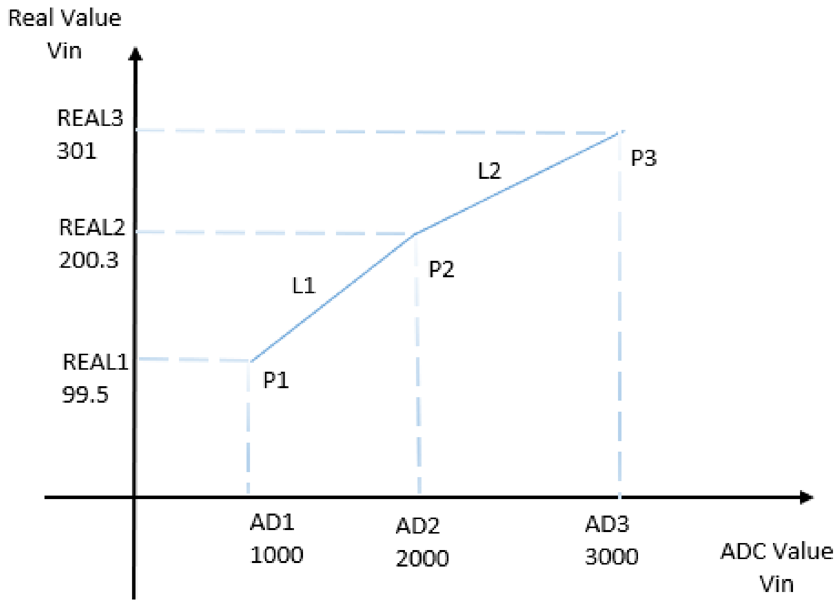
P0 and P1 define L1 and we can calculate Amp0 and Offset0 for Line L1.

Similarly, we can calculate Amp and Offset for L2 and L3 also.

For PSU : Use Amp and Offset to calculate the real value as shown below

ADC value	Formula
ADC value < AD1	128* Real = ((Amp0 * AD) / 512) + Offset0
AD1< ADC value > AD2	128* Real = ((Amp1 * AD) / 512) + Offset1
ADC value > AD2	128* Real = ((Amp2 * AD) / 512) + Offset2

Example to calibrate Vin (Input Voltage)



GUI :

Set Vin as 100Vac , then GUI can read ADC value of input voltage (AD1) from PSU and real value (REAL1) from calibrated meter

Set Vin as 200Vac , then GUI can read ADC value of input voltage (AD2) from PSU and real value (REAL2) from calibrated meter

Set Vin as 300Vac , then GUI can read ADC value input voltage (AD3) from PSU and real value (REAL3) from calibrated meter

For example :

AD1 = 1000	REAL1 = 99.5
AD2 = 2000	REAL2 = 200.3
AD3 = 3000	REAL3 = 301

This example will show 2 point calibration

GUI calculation :

Line 1 $128 * 99.5 = Amp0 * 1000 / 512 + Offset0$

$128 * 200.3 = Amp0 * 2000 / 512 + Offset0$

Line 1 $128 * 200.3 = Amp1 * 2000 / 512 + Offset1$

$128 * 301 = Amp1 * 3000 / 512 + Offset1$

Result : Amp0 = 6606.0288 Offset0 = -166.4

Amp1 = 6599.4752 Offset1 = -140.8

GUI will send the result to PSU and PSU will save the Amp and Offset values in EEPROM

PSU :

If Vin ADC value = 1500 (1500 < AD2) , so use Line L1 formula

128 * Real = Amp0 * AD / 512 + Offset0

128 * Real = 6606.0288 * 1500 / 512 – 166.4

Result : Real = 149.9 V

If Vin ADC value = 2600 (AD2 < 2600 < AD3) , so use Line L2 formula

128 * Real = Amp1 * AD / 512 + Offset1

128 * Real = 6599.4752 * 2600 / 512 – 140.8

Result : Real = 260.72 V

Key considerations

1. ADC value for calibration should be an average value (at least 32 ADC samples)

2. As mentioned above , Amp = 128*512*k = 65536*k . Offset = 128* b

Amp and Offset are both signed 16-bit data, their value range are -32768 to 32767 . So k's value range is [-0.5 , 0.49998] , b's value in the range is [-256 , 255.992] . Please check the value of k and b whether in range before using. If not , adjust the amplification factor.

Reporting Parameters

Monitoring requirements :

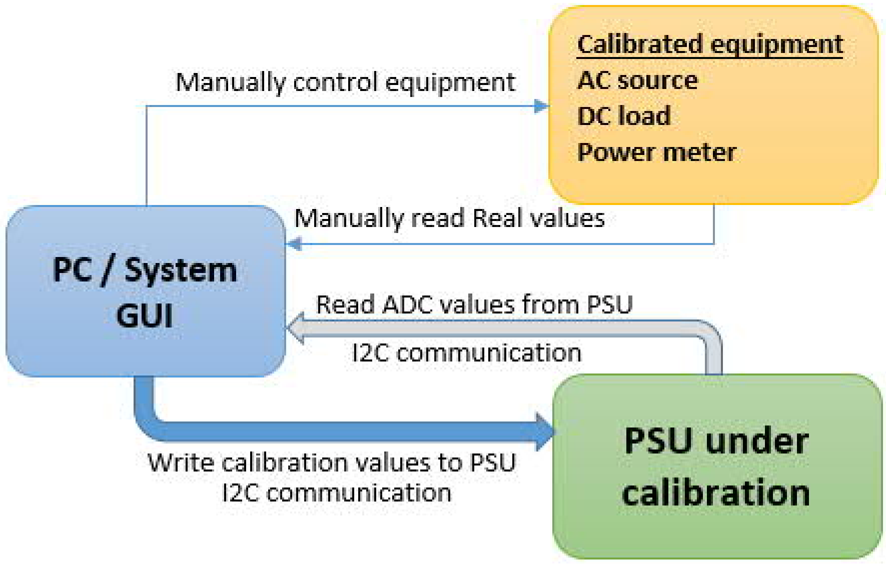
- Output Power parameters : Vout , Iout , Pout
- Input Power parameters : Vin , Iin , Pin
- Thermal parameters : Fan speed , Temperature

Accuracy specification requirements:

Parameters	Accuracy
Output Voltage	+/- 3%
Output Current	+/- 5% (20% - 100%) +/- 8% (< 20%)
Output Power	+/- 5% (20% - 100%) +/- 8% (< 20%)
Input Voltage	+/- 5%
Input Current	+/- 5% (20% - 100%) +/- 8% (< 20%)
Input Power	+/- 5% (>20%) +/- 8% (<20%)
Temperature	+/- 2 deg
Fan Speed	+/- 500 RPM

Calibration Setup

Manual Calibration: Calibrated meter readings will be manually entered in GUI to calibrate the PSU parameters and meet reporting accuracy.



Auto Calibration: Calibrated meter readings will be communicated via serial communication to GUI to calibrate the PSU parameters and meet reporting accuracy.