

Test Specifications and Results of ADC components

Spec-00000058. pdf

$$v_i = (a_i \times \text{ADC_vdd}) / 2^{\text{ADC_bit}}$$

$$y = (v_i - x_{\text{offset}}) / \text{gain} + y_{\text{offset}}$$

SMA calculation method

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

range min to max

EMA calculation method

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

WMA calculation method

$$\text{phy} = (y_n \times n) + (y_{n-1} \times (n-1)) + \dots + (y_1 \times 1) / (n + (n-1) + \dots + 1)$$

Non-MA calculation method

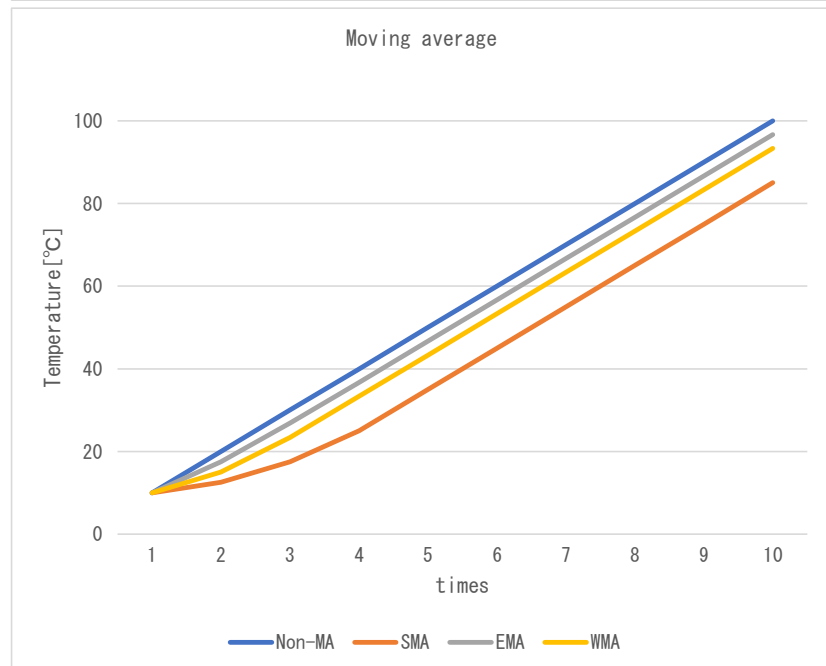
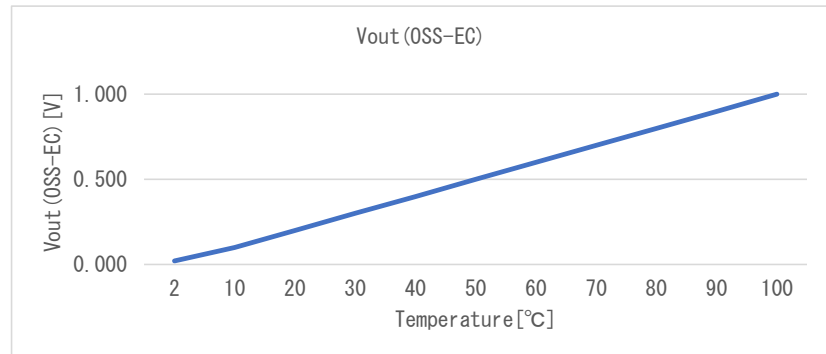
$$\text{phy} = y$$

Date	4-Nov-22
Verifier	Red Dragon

Spec-LM35D. pdf

component data		
x_offset	0.0000	[V]
gain	0.01	[V/°C]
y_offset	0.0	[°C]
max	100.0	[°C]
min	2.0	[°C]

Coefficient		
SMA	n	4
EMA	k	0.75
WMA	m	3

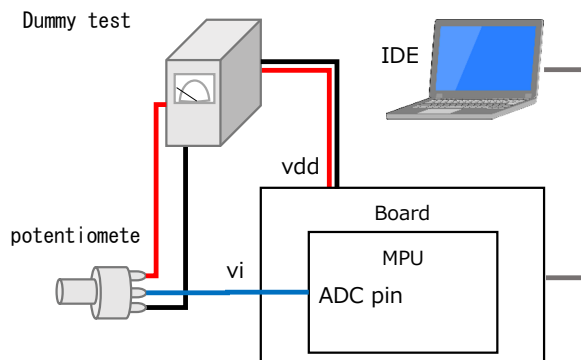


Test environment

Board	NUCLEO-F401RE
MPU	STM32F401RE
CompilerVer	Arm Compiler 6.16
IDE	Mbed Studio 1.4.4
Vdd	3.3 [V]
ADC bit	16 [bit]
ADC pin	A0 -
Component	Dummy

Normal operating voltage

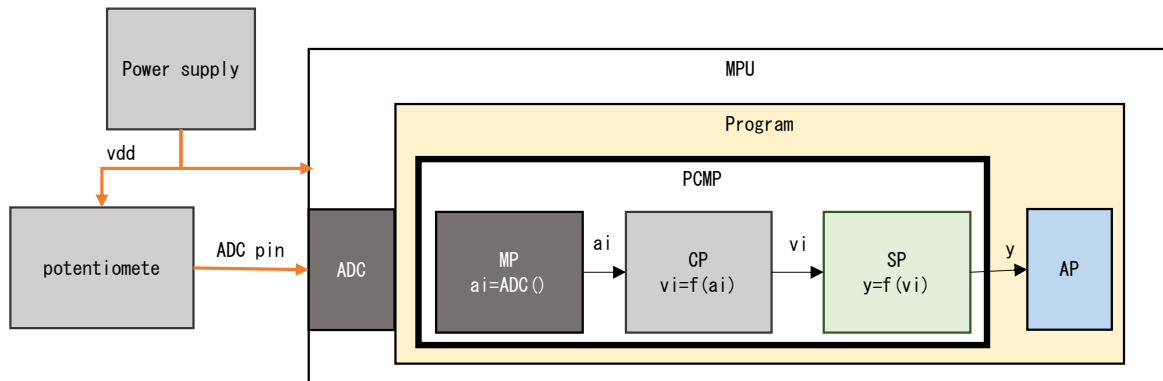
Vdd	5.0 [V]
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Test Method

1. Coupling test with variable resistors

As shown in the figure below, the voltage is varied by a variable resistor to check if the temperature calculation results match the specifications. Non-MA mode:



※Use a 3.3V board instead of a 5V board because we do not have a board with 5V Vdd, although it is a 5V product

Data with 3.3V board

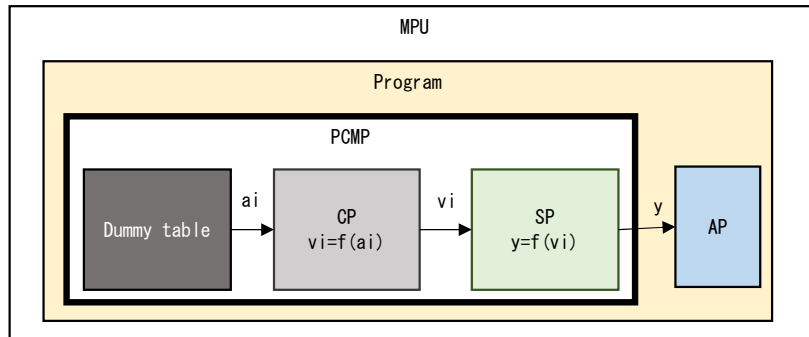
x_offset	0.0000 [V]
gain	0.01 [V/°C]
y_offset	0.0 [°C]

No.	ADC pin	ai	vi	p	res.phy	res.sts	Judgment
1	0.000	0	0.000	0.000	2.000	4,002	OK
		32	0.002	0.161	2.000	4,002	
		-32	-0.002	-0.161	0.000	0	
2	1.300	25,817	1.300	129.999	100.000	4,001	OK
		25,830	1.301	130.064	100.000	4,001	
		-13	-0.001	-0.065	0.000	0	
3	1.500	29,789	1.500	150.000	100.000	4,001	OK
		29,783	1.500	149.969	100.000	4,001	
		6	0.000	0.030	0.000	0	
4	3.300	65,536	3.300	330.000	100.000	4,001	OK
		65,535	3.300	329.995	100.000	4,001	
		1	0.000	0.005	0.000	0	

res.sts 4,000 Normal
 4,001 Max Limiter NG
 4,002 Min Limiter NG

2. Detail of replacing ADC value test

As shown in the figure below, change the MP layer to the value read from the Dummy table as shown in the test, and perform the following detailed test.



2-1. Max/Min range test

Vary a_i according to Dummy table as shown in the table below, and check Max/Min limiters and diagnostic results. Non-MA mode.

No.		Dummy a_i	v_i	p	res. phy	res. sts	Judgment
1	Expected	264	0.020	2.014	2.014	4,000	OK
	Measured	264	0.020	2.014	2.014	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	263	0.020	2.007	2.007	4,000	OK
	Measured	263	0.020	2.007	2.007	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	262	0.020	1.999	2.000	4,002	OK
	Measured	262	0.020	1.999	2.000	4,002	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	263	0.020	2.007	2.007	4,000	OK
	Measured	263	0.020	2.007	2.007	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	13,107	1.000	99.998	99.998	4,000	OK
	Measured	13,107	1.000	99.998	99.998	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	13,108	1.000	100.006	100.000	4,001	OK
	Measured	13,108	1.000	100.006	100.000	4,001	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13,107	1.000	99.998	99.998	4,000	OK
	Measured	13,107	1.000	99.998	99.998	4,000	
	Difference	0	0.000	0.000	0.000	0	

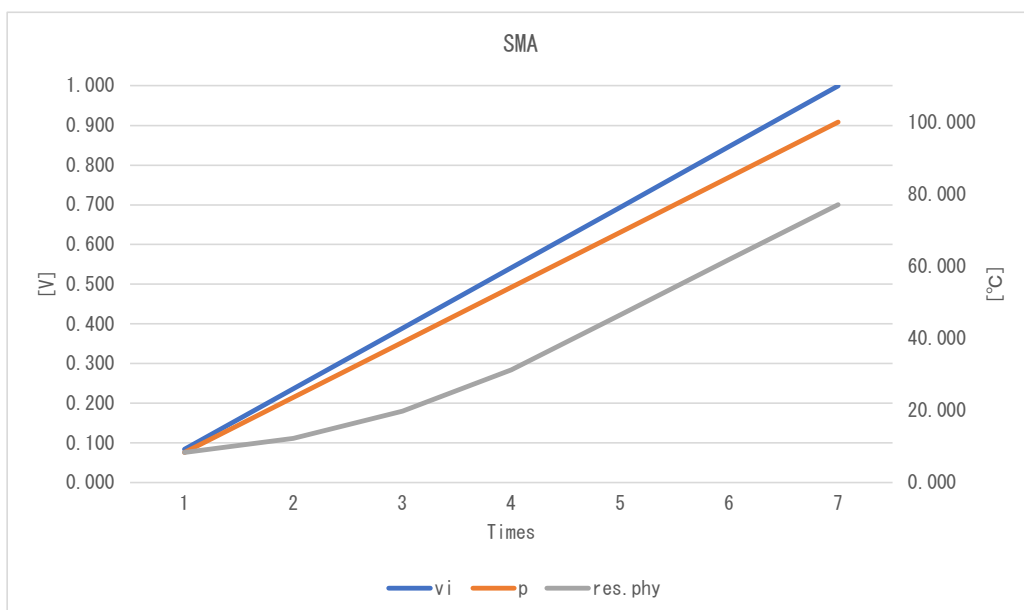
res. sts 4000 Normal
 4001 Max Limiter NG
 4002 Min Limiter NG

2-2. Moving average test

Check each Filter by changing ai according to the Dummy table as shown in the table below.

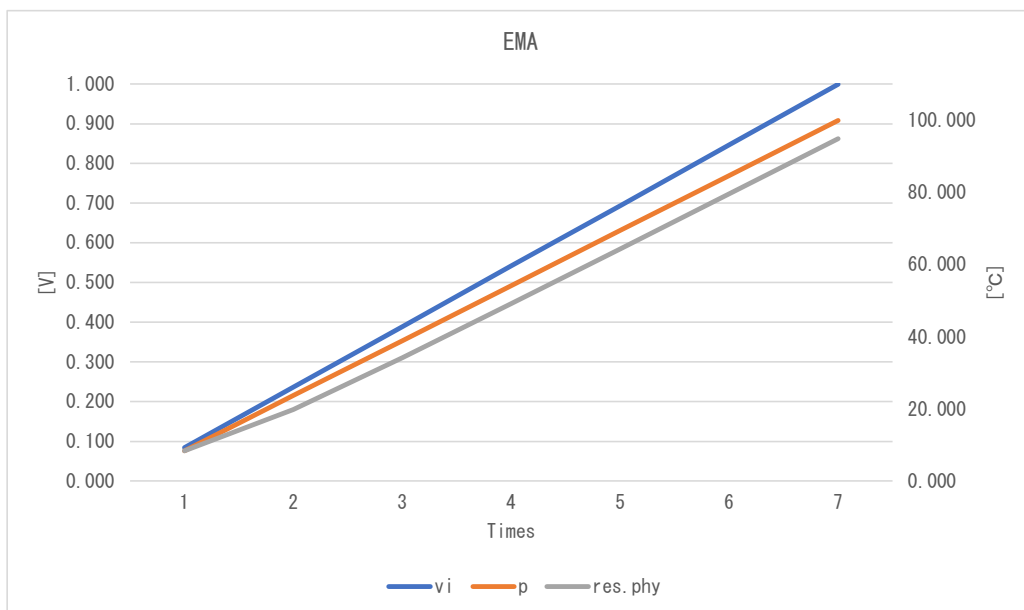
SMA

No.		Dummy ai	vi	p	res. phy	res. sts	Judgment
1	Expected	1, 100	0.084	8.392	8.392	4,000	OK
	Measured	1, 100	0.084	8.392	8.392	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	3, 100	0.237	23.651	12.207	4,000	OK
	Measured	3, 100	0.237	23.651	12.207	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	5, 100	0.389	38.910	19.836	4,000	OK
	Measured	5, 100	0.389	38.910	19.836	4,000	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	7, 100	0.542	54.169	31.281	4,000	OK
	Measured	7, 100	0.542	54.169	31.281	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	9, 100	0.694	69.427	46.539	4,000	OK
	Measured	9, 100	0.694	69.427	46.539	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	11, 100	0.847	84.686	61.798	4,000	OK
	Measured	11, 100	0.847	84.686	61.798	4,000	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13, 100	0.999	99.945	77.057	4,000	OK
	Measured	13, 100	0.999	99.945	77.057	4,000	
	Difference	0	0.000	0.000	0.000	0	



EMA

	No.	Dummy ai	vi	p	res. phy	res. sts	Judgment
1	Expected	1, 100	0.084	8.392	8.392	4,000	OK
	Measured	1, 100	0.084	8.392	8.392	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	3, 100	0.237	23.651	19.836	4,000	OK
	Measured	3, 100	0.237	23.651	19.836	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	5, 100	0.389	38.910	34.142	4,000	OK
	Measured	5, 100	0.389	38.910	34.142	4,000	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	7, 100	0.542	54.169	49.162	4,000	OK
	Measured	7, 100	0.542	54.169	49.162	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	9, 100	0.694	69.427	64.361	4,000	OK
	Measured	9, 100	0.694	69.427	64.361	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	11, 100	0.847	84.686	79.605	4,000	OK
	Measured	11, 100	0.847	84.686	79.605	4,000	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13, 100	0.999	99.945	94.860	4,000	OK
	Measured	13, 100	0.999	99.945	94.860	4,000	
	Difference	0	0.000	0.000	0.000	0	



WMA

	No.	Dummy ai	vi	p	res. phy	res. sts	Judgment
1	Expected	1, 100	0.084	8.392	8.392	4,000	OK
	Measured	1, 100	0.084	8.392	8.392	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	3, 100	0.237	23.651	16.022	4,000	OK
	Measured	3, 100	0.237	23.651	16.022	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	5, 100	0.389	38.910	28.737	4,000	OK
	Measured	5, 100	0.389	38.910	28.737	4,000	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	7, 100	0.542	54.169	43.996	4,000	OK
	Measured	7, 100	0.542	54.169	43.996	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	9, 100	0.694	69.427	59.255	4,000	OK
	Measured	9, 100	0.694	69.427	59.255	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	11, 100	0.847	84.686	74.514	4,000	OK
	Measured	11, 100	0.847	84.686	74.514	4,000	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13, 100	0.999	99.945	89.773	4,000	OK
	Measured	13, 100	0.999	99.945	89.773	4,000	
	Difference	0	0.000	0.000	0.000	0	

