Test Specifications and Results of ADC components

Spec-00000058.pdf

Date	4-Nov-22
Verifier	Red Dragon

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

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

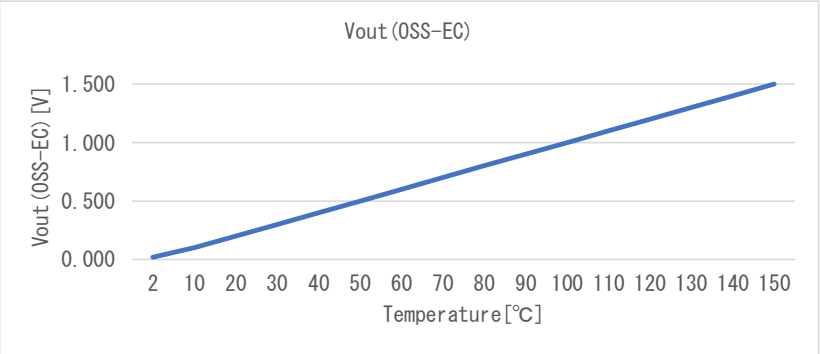
SMA calculation method $phy = (y_n + y_{n-1} + y_{n-2}) / n$

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

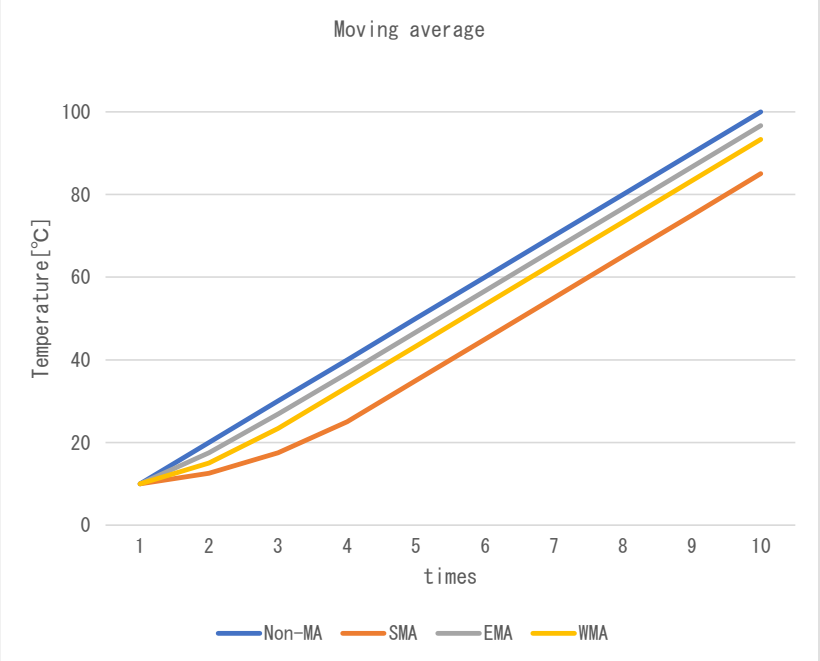
WMA calculation method $phy = ((yn \times n) + (yn-1 \times (n-1)) + \cdots + (y1 \times 1)) / (n + (n-1) + \cdots + 1)$

Non-MA calculation method $phy = y$

Spec-LM35_LM35A.pdf		
component data		
x_offset	0.0000	[V]
gain	0.01	[V/℃]
y_offset	0.0	[℃]
max	150.0	[℃]
min	2.0	[℃]

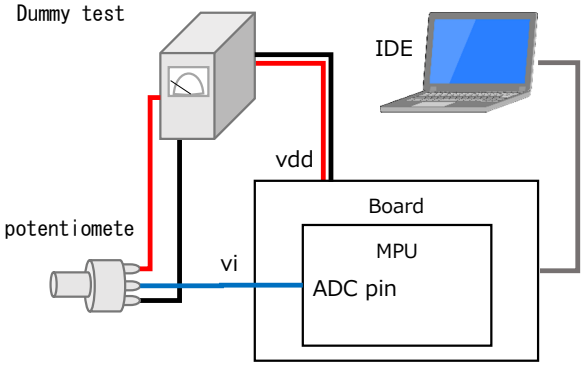


Coefficient		
SMA	n	4
EMA	k	0.75
WMA	m	3



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

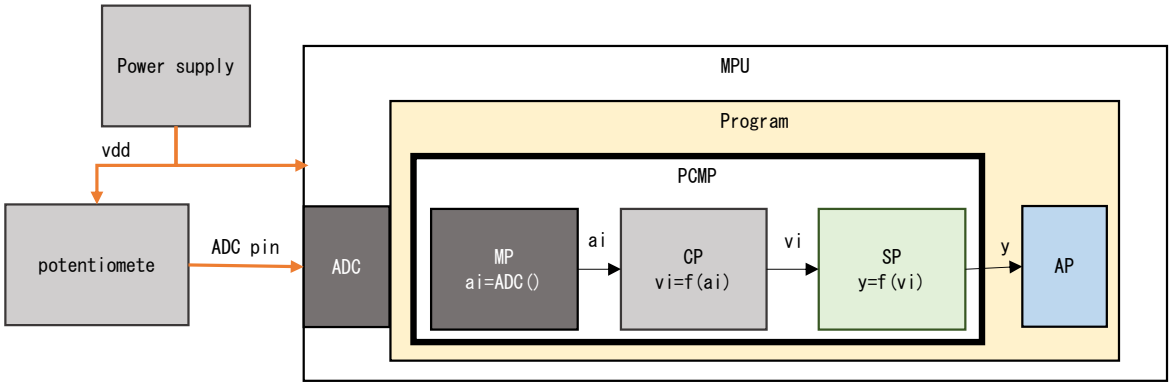
Normal operating voltage		
Vdd	5.0	[V]



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

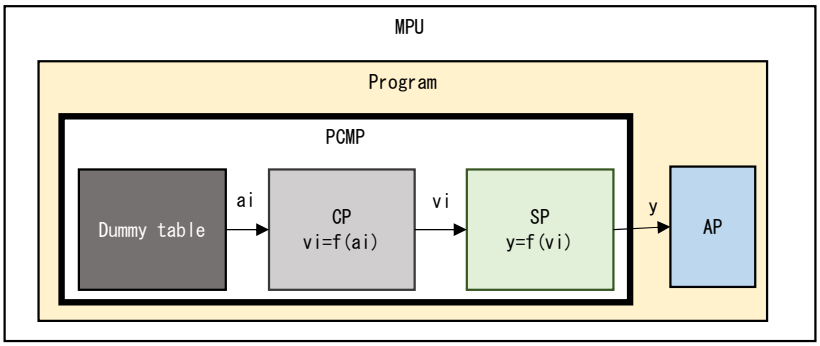
Data with 3.3V board		
x_offset	0.0000	[V]
gain	0.01	[V/℃]
y_offset	0.0	[℃]]

No.		ADC pin	ai	vi	p	res.phy	res.sts	Judgment
1	Expected	0.000	0	0.000	0.000	2.000	4,002	OK
	Measured		32	0.002	0.161	2.000	4,002	
	Difference		-32	-0.002	-0.161	0.000	0	
2	Expected	1.300	25,817	1.300	129.999	129.999	4,000	OK
	Measured		25,878	1.303	130.306	130.306	4,000	
	Difference		-61	-0.003	-0.307	-0.307	0	
3	Expected	1.500	29,789	1.500	150.000	150.000	4,000	OK
	Measured		29,703	1.496	149.567	149.567	4,000	
	Difference		86	0.004	0.433	0.433	0	
4	Expected	3.300	65,536	3.300	330.000	150.000	4,001	OK
	Measured		65,535	3.300	329.995	150.000	4,001	
	Difference		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 ai according to Dummy table as shown in the table below, and check Max/Min limiters and diagnostic results. Non-MA mode.

No.		Dummy ai	vi	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	19,660	1.500	149.994	149.994	4,000	OK
	Measured	19,660	1.500	149.994	149.994	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	19,661	1.500	150.002	150.000	4,001	OK
	Measured	19,661	1.500	150.002	150.000	4,001	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	19,660	1.500	149.994	149.994	4,000	OK
	Measured	19,660	1.500	149.994	149.994	4,000	
	Difference	0	0.000	0.000	0.000	0	

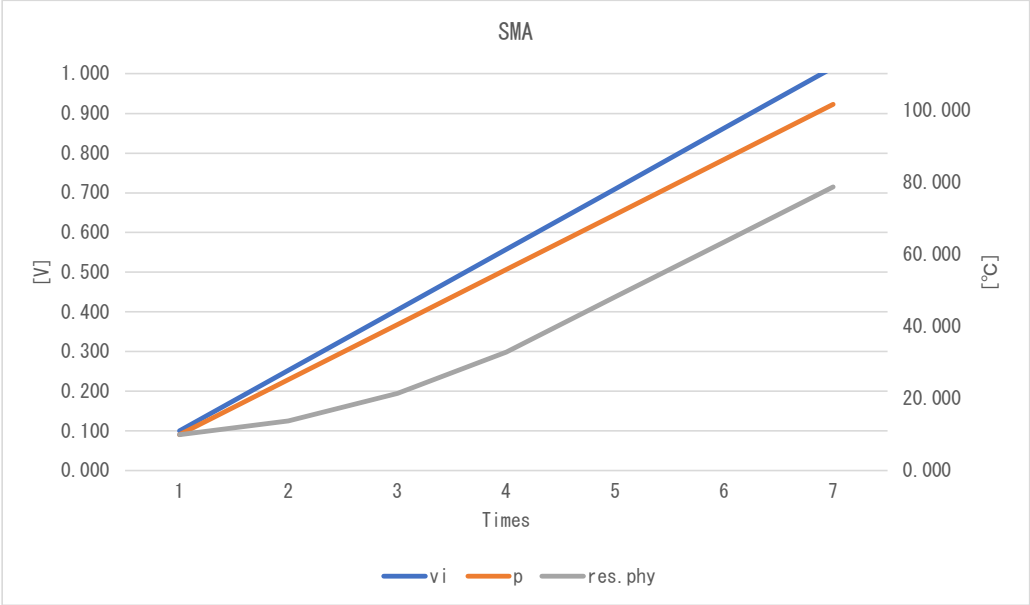
res.sts	4000	Normal
	4001	Max Limiter NG
	4002	Min Limiter NG

2-2. Moving average test

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

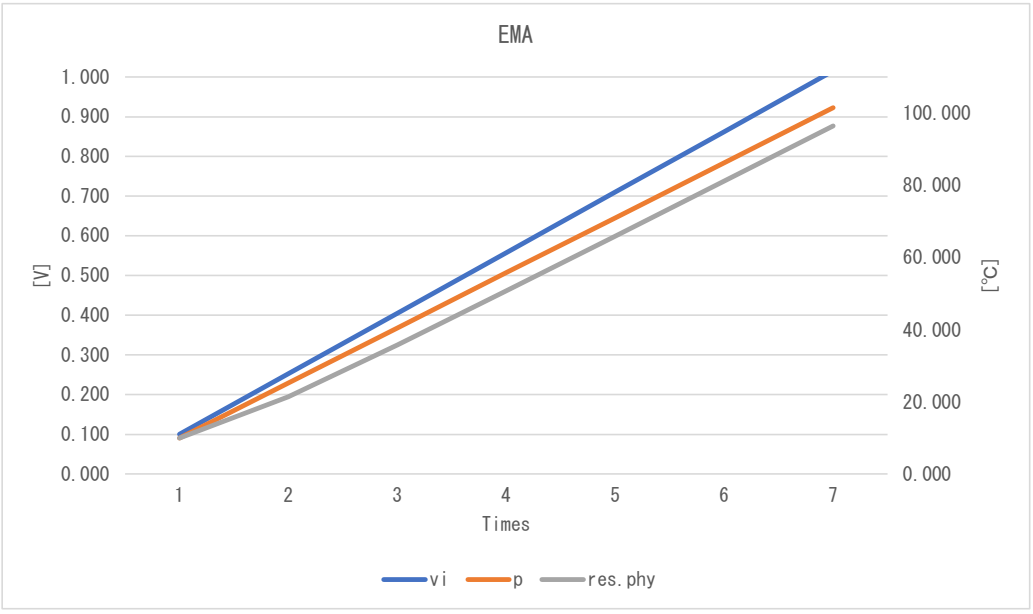
SMA

No.		Dummy ai	vi	p	res.phy	res.sts	Judgment
1	Expected	1,310	0.100	9.995	9.995	4,000	OK
	Measured	1,310	0.100	9.995	9.995	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	3,310	0.253	25.253	13.809	4,000	OK
	Measured	3,310	0.253	25.253	13.809	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	5,310	0.405	40.512	21.439	4,000	OK
	Measured	5,310	0.405	40.512	21.439	4,000	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	7,310	0.558	55.771	32.883	4,000	OK
	Measured	7,310	0.558	55.771	32.883	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	9,310	0.710	71.030	48.141	4,000	OK
	Measured	9,310	0.710	71.030	48.141	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	11,310	0.863	86.288	63.400	4,000	OK
	Measured	11,310	0.863	86.288	63.400	4,000	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13,310	1.015	101.547	78.659	4,000	OK
	Measured	13,310	1.015	101.547	78.659	4,000	
	Difference	0	0.000	0.000	0.000	0	



EMA

No.		Dummy ai	vi	p	res.phy	res.sts	Judgment
1	Expected	1,310	0.100	9.995	9.995	4,000	OK
	Measured	1,310	0.100	9.995	9.995	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	3,310	0.253	25.253	21.439	4,000	OK
	Measured	3,310	0.253	25.253	21.439	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	5,310	0.405	40.512	35.744	4,000	OK
	Measured	5,310	0.405	40.512	35.744	4,000	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	7,310	0.558	55.771	50.764	4,000	OK
	Measured	7,310	0.558	55.771	50.764	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	9,310	0.710	71.030	65.963	4,000	OK
	Measured	9,310	0.710	71.030	65.963	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	11,310	0.863	86.288	81.207	4,000	OK
	Measured	11,310	0.863	86.288	81.207	4,000	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13,310	1.015	101.547	96.462	4,000	OK
	Measured	13,310	1.015	101.547	96.462	4,000	
	Difference	0	0.000	0.000	0.000	0	



WMA

No.		Dummy ai	vi	p	res.phy	res.sts	Judgment
1	Expected	1,310	0.100	9.995	9.995	4,000	OK
	Measured	1,310	0.100	9.995	9.995	4,000	
	Difference	0	0.000	0.000	0.000	0	
2	Expected	3,310	0.253	25.253	17.624	4,000	OK
	Measured	3,310	0.253	25.253	17.624	4,000	
	Difference	0	0.000	0.000	0.000	0	
3	Expected	5,310	0.405	40.512	30.340	4,000	OK
	Measured	5,310	0.405	40.512	30.340	4,000	
	Difference	0	0.000	0.000	0.000	0	
4	Expected	7,310	0.558	55.771	45.598	4,000	OK
	Measured	7,310	0.558	55.771	45.598	4,000	
	Difference	0	0.000	0.000	0.000	0	
5	Expected	9,310	0.710	71.030	60.857	4,000	OK
	Measured	9,310	0.710	71.030	60.857	4,000	
	Difference	0	0.000	0.000	0.000	0	
6	Expected	11,310	0.863	86.288	76.116	4,000	OK
	Measured	11,310	0.863	86.288	76.116	4,000	
	Difference	0	0.000	0.000	0.000	0	
7	Expected	13,310	1.015	101.547	91.375	4,000	OK
	Measured	13,310	1.015	101.547	91.375	4,000	
	Difference	0	0.000	0.000	0.000	0