

Test Specifications and Results of ADC components

Spec-00000057. pdf

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

$$y = (v_i - x_{\text{offset}}) / \text{gain} + y_{\text{offset}} \quad \text{range min to max}$$

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

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

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

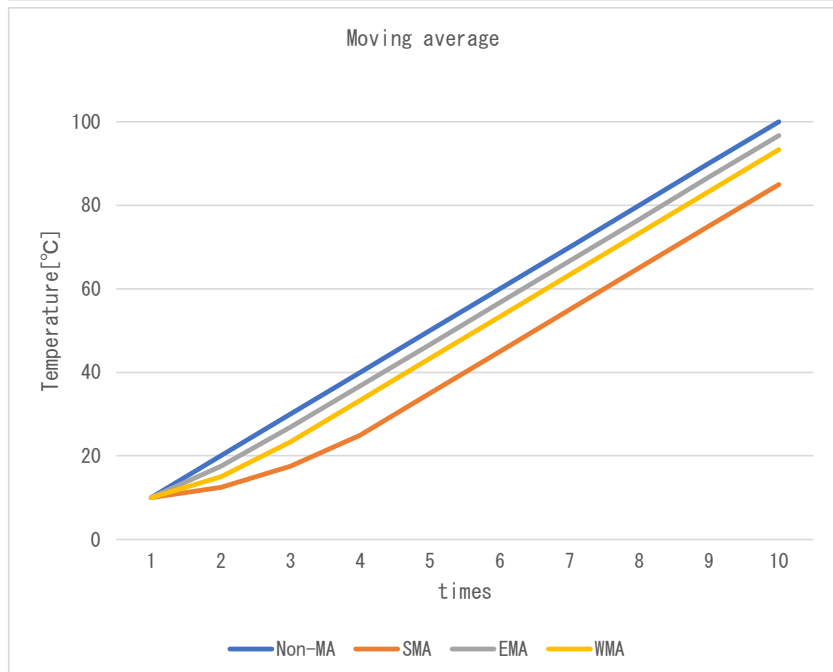
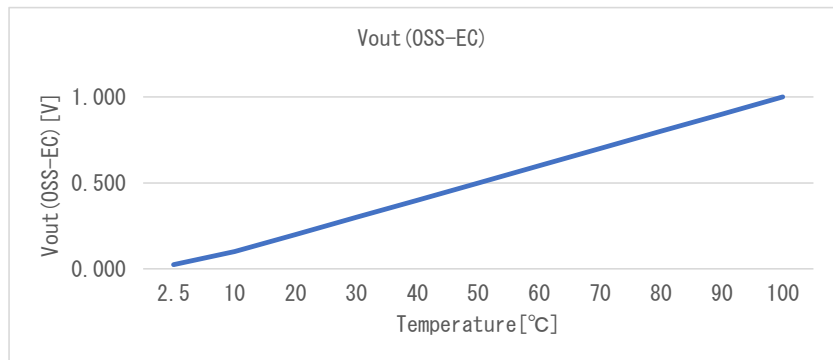
$$\text{Non-MA calculation method} \quad \text{phy} = y$$

| | |
|----------|------------|
| Date | 4-Nov-22 |
| Verifier | Red Dragon |

Spec-LM45B_LM45C. pdf

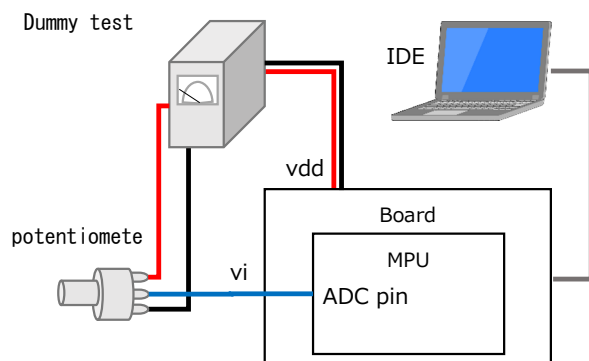
| component data | |
|----------------|-------------|
| x_offset | 0.0000 [V] |
| gain | 0.01 [V/°C] |
| y_offset | 0.0 [°C] |
| max | 100.0 [°C] |
| min | 2.5 [°C] |

| Coefficient | | |
|-------------|---|------|
| SMA | n | 4 |
| EMA | k | 0.75 |
| WMA | m | 3 |



Test environment

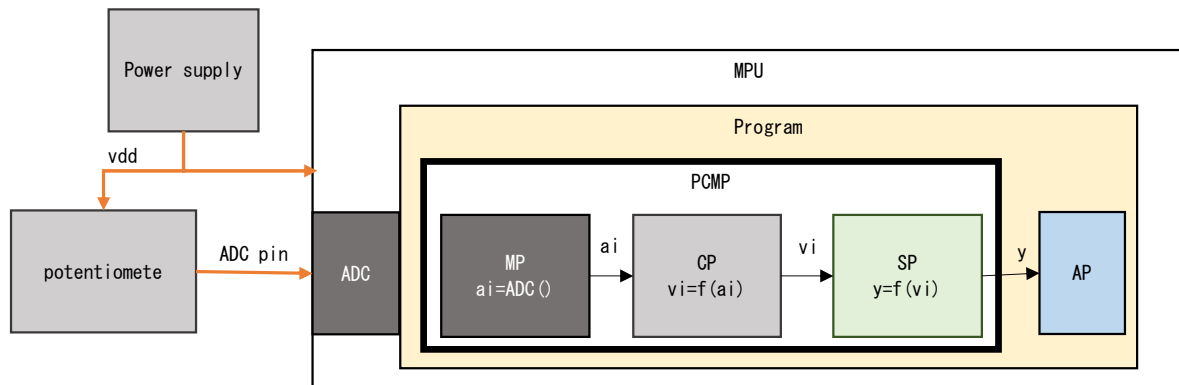
| | |
|-------------|--------------------|
| Board | Mega 2560 Rev3 |
| MPU | ATmega2560 |
| CompilerVer | avr-gcc 7.3.0 |
| IDE | Arduino IDE 1.8.19 |
| Vdd | 5.0 [V] |
| ADC bit | 10 [bit] |
| ADC pin | A0 - |
| Component | Dummy |



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:

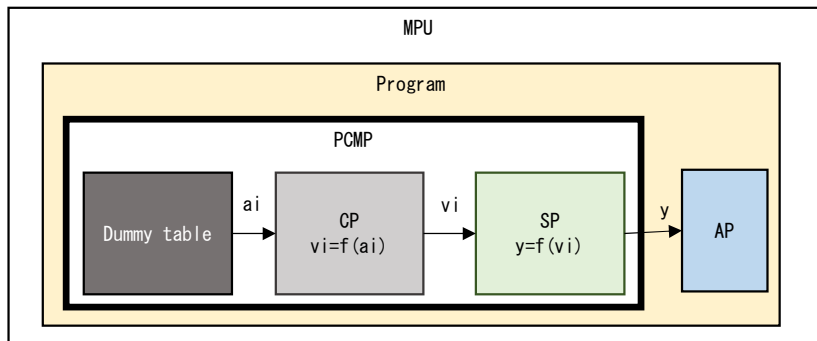


| No. | | ADC pin | ai | vi | p | res. phy | res. sts | Judgment |
|-----|------------|---------|-------|--------|---------|----------|----------|----------|
| 1 | Expected | 0.000 | 0 | 0.000 | 0.000 | 2.500 | 4,002 | OK |
| | Measured | | 0 | 0.000 | 0.000 | 2.500 | 4,002 | |
| | Difference | | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 2 | Expected | 1.333 | 273 | 1.333 | 133.301 | 100.000 | 4,001 | OK |
| | Measured | | 273 | 1.333 | 133.301 | 100.000 | 4,001 | |
| | Difference | | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 3 | Expected | 1.500 | 307 | 1.499 | 149.902 | 100.000 | 4,001 | OK |
| | Measured | | 308 | 1.504 | 150.391 | 100.000 | 4,001 | |
| | Difference | | -1 | -0.005 | -0.488 | 0.000 | 0 | |
| 4 | Expected | 5.000 | 1,024 | 5.000 | 500.000 | 100.000 | 4,001 | OK |
| | Measured | | 1,023 | 4.995 | 499.512 | 100.000 | 4,001 | |
| | Difference | | 1 | 0.005 | 0.488 | 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 | 7 | 0.034 | 3.418 | 3.418 | 4,000 | OK |
| | Measured | 7 | 0.034 | 3.418 | 3.418 | 4,000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 2 | Expected | 6 | 0.029 | 2.930 | 2.930 | 4,000 | OK |
| | Measured | 6 | 0.029 | 2.930 | 2.930 | 4,000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 3 | Expected | 5 | 0.024 | 2.441 | 2.500 | 4,002 | OK |
| | Measured | 5 | 0.024 | 2.441 | 2.500 | 4,002 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 4 | Expected | 6 | 0.029 | 2.930 | 2.930 | 4,000 | OK |
| | Measured | 6 | 0.029 | 2.930 | 2.930 | 4,000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 5 | Expected | 204 | 0.996 | 99.609 | 99.609 | 4,000 | OK |
| | Measured | 204 | 0.996 | 99.609 | 99.609 | 4,000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 6 | Expected | 205 | 1.001 | 100.098 | 100.000 | 4,001 | OK |
| | Measured | 205 | 1.001 | 100.098 | 100.000 | 4,001 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 7 | Expected | 204 | 0.996 | 99.609 | 99.609 | 4,000 | OK |
| | Measured | 204 | 0.996 | 99.609 | 99.609 | 4,000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |

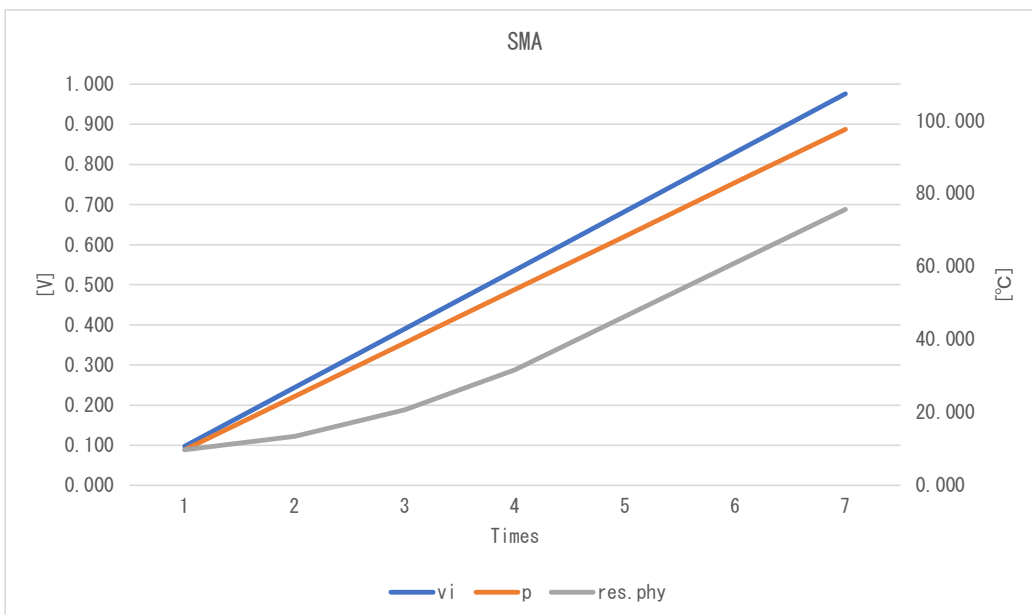
res. sts 4000 Normal
 4001 Max Limiter NG
 4002 Min Limiter NG

2-2. Moving average test

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

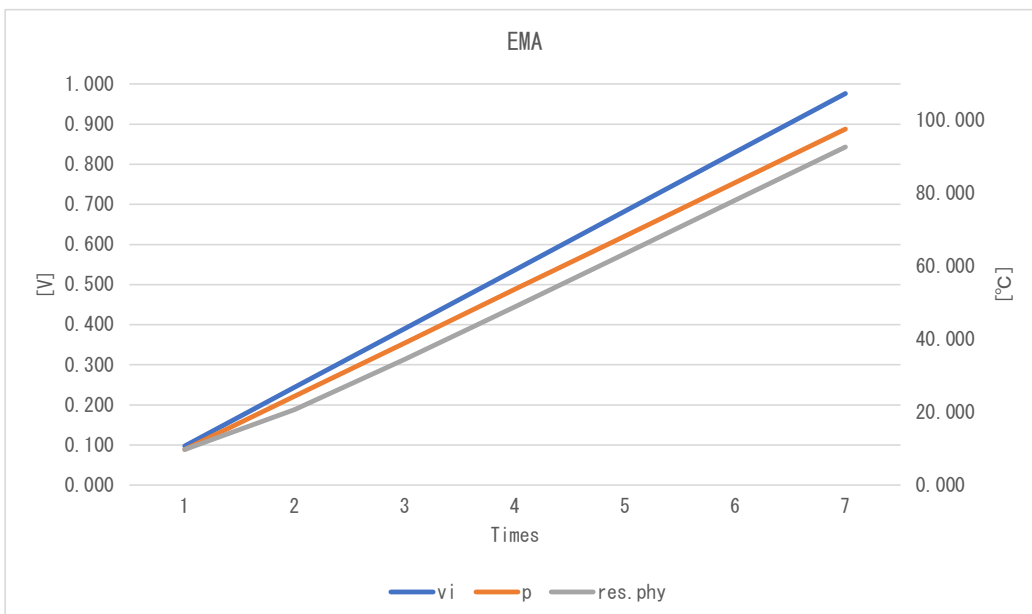
SMA

| | No. | Dummy a_i | v_i | p | res. phy | res. sts | Judgment |
|---|------------|-------------|-------|--------|----------|----------|----------|
| 1 | Expected | 20 | 0.098 | 9.766 | 9.766 | 4.000 | OK |
| | Measured | 20 | 0.098 | 9.766 | 9.766 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 2 | Expected | 50 | 0.244 | 24.414 | 13.428 | 4.000 | OK |
| | Measured | 50 | 0.244 | 24.414 | 13.428 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 3 | Expected | 80 | 0.391 | 39.063 | 20.752 | 4.000 | OK |
| | Measured | 80 | 0.391 | 39.063 | 20.752 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 4 | Expected | 110 | 0.537 | 53.711 | 31.738 | 4.000 | OK |
| | Measured | 110 | 0.537 | 53.711 | 31.738 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 5 | Expected | 140 | 0.684 | 68.359 | 46.387 | 4.000 | OK |
| | Measured | 140 | 0.684 | 68.359 | 46.387 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 6 | Expected | 170 | 0.830 | 83.008 | 61.035 | 4.000 | OK |
| | Measured | 170 | 0.830 | 83.008 | 61.035 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 7 | Expected | 200 | 0.977 | 97.656 | 75.684 | 4.000 | OK |
| | Measured | 200 | 0.977 | 97.656 | 75.684 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |



EMA

| | No. | Dummy ai | vi | p | res. phy | res. sts | Judgment |
|---|------------|----------|-------|--------|----------|----------|----------|
| 1 | Expected | 20 | 0.098 | 9.766 | 9.766 | 4.000 | OK |
| | Measured | 20 | 0.098 | 9.766 | 9.766 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 2 | Expected | 50 | 0.244 | 24.414 | 20.752 | 4.000 | OK |
| | Measured | 50 | 0.244 | 24.414 | 20.752 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 3 | Expected | 80 | 0.391 | 39.063 | 34.485 | 4.000 | OK |
| | Measured | 80 | 0.391 | 39.063 | 34.485 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 4 | Expected | 110 | 0.537 | 53.711 | 48.904 | 4.000 | OK |
| | Measured | 110 | 0.537 | 53.711 | 48.904 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 5 | Expected | 140 | 0.684 | 68.359 | 63.496 | 4.000 | OK |
| | Measured | 140 | 0.684 | 68.359 | 63.496 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 6 | Expected | 170 | 0.830 | 83.008 | 78.130 | 4.000 | OK |
| | Measured | 170 | 0.830 | 83.008 | 78.130 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 7 | Expected | 200 | 0.977 | 97.656 | 92.775 | 4.000 | OK |
| | Measured | 200 | 0.977 | 97.656 | 92.775 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |



WMA

| | No. | Dummy ai | vi | p | res. phy | res. sts | Judgment |
|---|------------|----------|-------|--------|----------|----------|----------|
| 1 | Expected | 20 | 0.098 | 9.766 | 9.766 | 4.000 | OK |
| | Measured | 20 | 0.098 | 9.766 | 9.766 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 2 | Expected | 50 | 0.244 | 24.414 | 17.090 | 4.000 | OK |
| | Measured | 50 | 0.244 | 24.414 | 17.090 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 3 | Expected | 80 | 0.391 | 39.063 | 29.297 | 4.000 | OK |
| | Measured | 80 | 0.391 | 39.063 | 29.297 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 4 | Expected | 110 | 0.537 | 53.711 | 43.945 | 4.000 | OK |
| | Measured | 110 | 0.537 | 53.711 | 43.945 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 5 | Expected | 140 | 0.684 | 68.359 | 58.594 | 4.000 | OK |
| | Measured | 140 | 0.684 | 68.359 | 58.594 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 6 | Expected | 170 | 0.830 | 83.008 | 73.242 | 4.000 | OK |
| | Measured | 170 | 0.830 | 83.008 | 73.242 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |
| 7 | Expected | 200 | 0.977 | 97.656 | 87.891 | 4.000 | OK |
| | Measured | 200 | 0.977 | 97.656 | 87.891 | 4.000 | |
| | Difference | 0 | 0.000 | 0.000 | 0.000 | 0 | |

