

# Lithium-Ion Battery Charge Control IC

## Monolithic IC MM3439

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### Outline

This IC is a Mitsumi has developed an IC that monitors 3 power supplies constituted by an AC adaptor, the USB port, and lithium ion secondary battery and controls the system drive power supply and the charging. The charging control is adapted to the battery temperature profile. The IC is equipped with safe and highly efficient switch mode charging control to realize optimal power management for the mobile device.

### Features

1. Built-in power switch for switching between AC adaptor/USB, and built-in charging control function.  
The IC controls the power supply from the AC adaptor, USB and lithium ion secondary battery.
2. The power supply is controlled to fit the charging temperature profile for safe and highly efficient charging.  
Thanks to control using I<sup>2</sup>C, the charging temperature profile can be altered.
3. The switch mode charge control format allows a large charging current (Max 2A) to be supported.  
The I<sup>2</sup>C control also allows changes to be made in 100 mA steps.

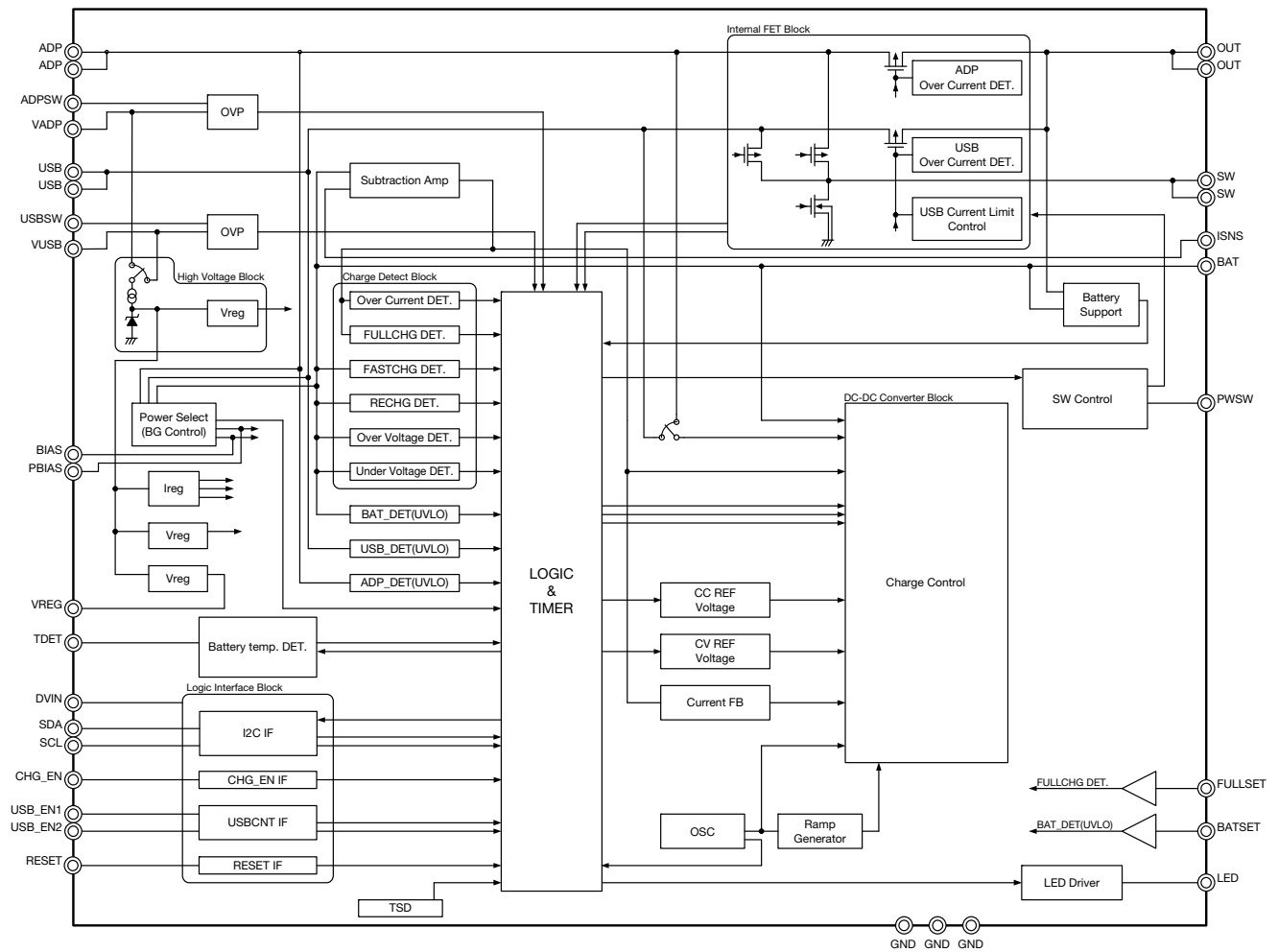
### Package

SQFN-32A

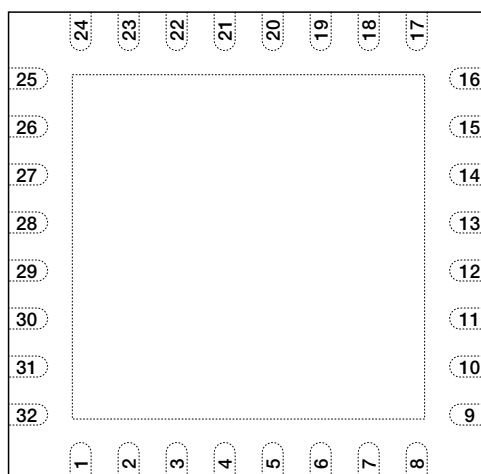
### Applications

1. Mobile phones
2. PDAs
3. Digital still cameras
4. Digital video cameras
5. Portable games
6. Portable music players

## Block Diagram



## Pin Assignment



SQFN-32A  
(TOP VIEW)

|    |         |    |         |
|----|---------|----|---------|
| 1  | ADP     | 17 | ISNS    |
| 2  | ADP     | 18 | RESET   |
| 3  | VADP    | 19 | BAT     |
| 4  | USB_EN1 | 20 | TDET    |
| 5  | SW      | 21 | VREG    |
| 6  | SW      | 22 | BATSET  |
| 7  | USB_EN2 | 23 | FULLSET |
| 8  | ADPSW   | 24 | GND     |
| 9  | GND     | 25 | LED     |
| 10 | GND     | 26 | USBSW   |
| 11 | CHG_EN  | 27 | VUSB    |
| 12 | PBIAS   | 28 | USB     |
| 13 | BIAS    | 29 | USB     |
| 14 | SCL     | 30 | PWSW    |
| 15 | SDA     | 31 | OUT     |
| 16 | DVIN    | 32 | OUT     |

## Pin Description

| Pin No. | Symbol  | I/O | Function                                                                                                                                                                        |
|---------|---------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | ADP     | I   | Power supply input terminal that connects AC adaptor.                                                                                                                           |
| 2       |         |     |                                                                                                                                                                                 |
| 3       | VADP    | I   | Terminal for overvoltage protection (>5.7V) detection at the AC adaptor input.                                                                                                  |
| 4       | USB_EN1 | I   | Current limitation control terminal of USB power SW.<br>It controls with USB_EN2.                                                                                               |
| 5       | SW      | O   | Output terminal that connects inductor for charge buck DCDC converter.                                                                                                          |
| 6       |         |     |                                                                                                                                                                                 |
| 7       | USB_EN2 | I   | Current limitation control terminal of USB power SW.<br>It controls with USB_EN1.                                                                                               |
| 8       | ADPSW   | O   | FET-drive terminal of AC adaptor external switch (Pch-MOSFET).                                                                                                                  |
| 9       | GND     |     | Ground terminal.                                                                                                                                                                |
| 10      |         |     |                                                                                                                                                                                 |
| 11      | CHG_EN  | I   | Charging enable input terminal.                                                                                                                                                 |
| 12      | PBIAS   |     | Internal power supply stabilization terminal. The bypass capacitor is connected.                                                                                                |
| 13      | BIAS    |     | Internal power supply stabilization terminal. The bypass capacitor is connected.                                                                                                |
| 14      | SCL     | I   | Clock input terminal for I <sup>2</sup> C BUS.                                                                                                                                  |
| 15      | SDA     | I/O | Data I/O terminal for I <sup>2</sup> C BUS.                                                                                                                                     |
| 16      | DVIN    | I   | Power supply input terminal for logic I/F part.                                                                                                                                 |
| 17      | ISNS    | I   | Input terminal for charge current detection.<br>The high potential side of the sense resistance is connected.                                                                   |
| 18      | RESET   | I   | Reset input terminal                                                                                                                                                            |
| 19      | BAT     | I   | Input terminal for detection of voltage of battery.<br>Charge current detection input and using combinedly.<br>The low potential side of the detection resistance is connected. |
| 20      | TDET    | I   | Input terminal for detection of battery temperature.<br>The thermistor is connected.                                                                                            |
| 21      | VREG    | O   | Reference voltage output terminal for detection of battery temperature.<br>3.5V <sub>typ.</sub> is output.                                                                      |
| 22      | BATSET  | I   | Set terminal of battery power that permits battery use.<br>The voltage value is set by the breeder resistance between VREG-GND.                                                 |
| 23      | FULLSET | I   | Set terminal of charge completion current.<br>The voltage value is set by the breeder resistance between VREG-GND.                                                              |
| 24      | GND     |     | Ground terminal.                                                                                                                                                                |
| 25      | LED     | O   | LED-drive terminal (Nch open drain output).                                                                                                                                     |
| 26      | USBSW   | O   | FET-drive terminal of USB external switch (Pch-MOSFET).                                                                                                                         |
| 27      | VUSB    | I   | Terminal for input overvoltage protection detection (>5.7V) of USB.                                                                                                             |
| 28      | USB     | I   | Power supply input terminal that connects USB.                                                                                                                                  |
| 29      |         |     |                                                                                                                                                                                 |
| 30      | PWSW    | O   | FET-drive terminal of external power switch (Pch-MOSFET).                                                                                                                       |
| 31      | OUT     | O   | Power supply output terminal for system.                                                                                                                                        |
| 32      |         |     |                                                                                                                                                                                 |

## Pin Description

| Pin No. | Pin name | Equivalent circuit diagram | Pin No. | Pin name | Equivalent circuit diagram |
|---------|----------|----------------------------|---------|----------|----------------------------|
| 1<br>2  | ADP      |                            | 12      | PBIAS    |                            |
| 3       | VADP     |                            | 13      | BIAS     |                            |
| 4       | USB_EN1  |                            | 14      | SCL      |                            |
| 5<br>6  | SW       |                            | 15      | SDA      |                            |
| 7       | USB_EN2  |                            | 16      | DVIN     |                            |
| 8       | ADPSW    |                            | 17      | ISNS     |                            |
| 11      | CHG_EN   |                            | 18      | RESET    |                            |

| Pin No. | Pin name | Equivalent circuit diagram | Pin No.  | Pin name | Equivalent circuit diagram |
|---------|----------|----------------------------|----------|----------|----------------------------|
| 19      | BAT      |                            | 26       | USBSW    |                            |
| 20      | TDET     |                            | 27       | VUSB     |                            |
| 21      | VREG     |                            | 28<br>29 | USB      |                            |
| 22      | BATSET   |                            | 30       | PWSW     |                            |
| 23      | FULLSET  |                            | 31<br>32 | OUT      |                            |
| 25      | LED      |                            |          |          |                            |

## Absolute Maximum Ratings (Except where noted otherwise Ta=25°C)

| Item                                       |                        | Symbol              | Ratings         | Units |
|--------------------------------------------|------------------------|---------------------|-----------------|-------|
| Storage temperature                        |                        | T <sub>STG</sub>    | -55~+150        | °C    |
| Operating temperature                      |                        | T <sub>OPRMAX</sub> | -35~+85         | °C    |
| VADP, ADPSW, VUSB, USBSW pin input voltage |                        | V <sub>HinMAX</sub> | -0.3~+30        | V     |
| Other pin input voltage                    |                        | V <sub>inMAX</sub>  | -0.3~+6         | V     |
| ADP, USB pin input current                 |                        | I <sub>INMAX</sub>  | 1.5             | A     |
| LED pin sink current                       |                        | I <sub>LEDMAX</sub> | 20              | mA    |
| Power dissipation                          | IC unit                | P <sub>d1</sub>     | 0.35            | W     |
|                                            | Substrate mounting(★1) | P <sub>d2</sub>     | 2.5<br>2.0 (★2) | W     |

note : ★1 Board size : 90 × 90 × 1.6mm Material : grass epoxy Layer : double side Wire rate : 90%

note : ★2 When the back heat spreader unmounting.

## Recommended Operating Conditions

| Item                                   | Symbol           | Ratings   | Units |
|----------------------------------------|------------------|-----------|-------|
| Operating temperature                  | T <sub>OPR</sub> | -20~+75   | °C    |
| ADP, USB Operating voltage             | VDD              | 4.5~5.5   | V     |
| BAT Operating voltage                  | BAT              | 1.05~4.25 | V     |
| DVIN Operating voltage                 | DVIN             | 1.5~5.5   | V     |
| Logic I/F block pin input voltage (★3) | LOGICIF          | 0~DVIN    | V     |
| BATSET pin input voltage               | BATSET           | 1.0~2.0   | V     |
| FULLSET pin input voltage              | FULLSET          | 0.6~1.2   | V     |
| ADP, USB pin input current             | I <sub>IN</sub>  | 0~2.0     | A     |

note : ★3 SDA, SCL, CHG\_EN, USB\_EN1, USB\_EN2, RESET pin

**Electrical Characteristics 1** (Except where noted otherwise Ta=25°C, ADP=USB=5.0V)

| Item                                                       | Symbol               | Measurement conditions                                       | Min.        | Typ.         | Max.        | Units |
|------------------------------------------------------------|----------------------|--------------------------------------------------------------|-------------|--------------|-------------|-------|
| Consumption current 1                                      | ICC                  | ADP mode, USB mode                                           |             | 1.5          | 3.0         | mA    |
| Consumption current 2                                      | ICCBTM               | BAT mode                                                     |             | 30           | 50          | μA    |
| VREG pin output voltage                                    | VREG                 |                                                              | 3.4         | 3.5          | 3.6         | V     |
| VREG pin output current ability                            | IREG                 |                                                              | 2           |              |             | mA    |
| ADP/USB UVLO<br>(V <sub>UVLO</sub> <PSM)                   | V <sub>UVLO</sub>    | ADP/USB=H→L                                                  | 4.1         | 4.2          | 4.3         | V     |
| ADP/USB UVLO<br>hysteresis voltage width (★4)              | V <sub>UVLOW</sub>   | ADP/USB=L→H                                                  | 50          | 100          | 150         | mV    |
| ADP/USB supply voltage control<br>(V <sub>UVLO</sub> <PSM) | PSM                  | ADP/USB=H→L                                                  | 4.2         | 4.3          | 4.4         | V     |
| BAT UVLO                                                   | BAT <sub>UVLO</sub>  | BAT=H→L<br>BATSET=1.5V                                       | TYP<br>-0.1 | BATSET<br>×2 | TYP<br>+0.1 | V     |
| BAT UVLO<br>hysteresis voltage width (★4)                  | BAT <sub>UVLOW</sub> | BAT=L→H<br>BATSET=1.5V                                       | 30          | 85           | 140         | mV    |
| VADP/VUSB OVP                                              | V <sub>VDDH</sub>    | VADP/VUSB=L→H                                                | 5.5         | 5.7          | 5.9         | V     |
| VADP/VUSB OVP<br>hysteresis voltage width (★4)             | V <sub>VDDHW</sub>   | VADP/VUSB=H→L                                                | 50          | 100          | 150         | mV    |
| Current limit of USB pass                                  | I <sub>USB1</sub>    | USB_EN1=H, USB_EN2=L<br>OUT=3.6V                             | 60          | 80           | 100         | mA    |
|                                                            | I <sub>USB2</sub>    | USB_EN1=L, USB_EN2=H<br>OUT=3.6V                             | 420         | 460          | 500         |       |
|                                                            | I <sub>USB2</sub>    | USB_EN1=H, USB_EN2=H<br>Only I <sup>2</sup> C mode, OUT=3.6V | 800         | 850          | 900         |       |
| ADP overcurrent detection (★4)                             | I <sub>ADPMAX</sub>  |                                                              |             | 2.5          |             | A     |

| Item                                                  | Symbol               | Measurement conditions                                                             | Min. | Typ. | Max. | Units |
|-------------------------------------------------------|----------------------|------------------------------------------------------------------------------------|------|------|------|-------|
| USB overcurrent detection (★4)                        | I <sub>USBMAX</sub>  |                                                                                    |      | 2.5  |      | A     |
| Forced charge current range                           | I <sub>FRCHG</sub>   | RSNS=0.2Ω(★6)                                                                      | 100  |      | 200  | mA    |
| Forced charge current accuracy                        | A <sub>FRCHG</sub>   | RSNS=0.2Ω<br>IFRCCHG=180mA(★6)                                                     | -40  |      | +40  | %     |
| Pre-charge current range                              | I <sub>PRECHG</sub>  | RSNS=0.2Ω(★6)                                                                      | 100  |      | 200  | mA    |
| Pre-charge current accuracy                           | A <sub>PRECHG</sub>  | RSNS=0.2Ω<br>IPRECHG=180mA(★6)                                                     | -30  |      | +30  | %     |
| Fast charge current range                             | I <sub>FSTCHG</sub>  | RSNS=0.2Ω(★6)                                                                      | 100  |      | 2000 | mA    |
| Fast charge current accuracy                          | A <sub>FSTCHG</sub>  | RSNS=0.2Ω<br>IFSTCHG=1800mA(★6)                                                    | -5   |      | +5   | %     |
| Detect full charge current range                      | I <sub>DETFULL</sub> | RSNS=0.2Ω, I <sup>2</sup> C bus default                                            | 120  |      | 240  | mA    |
| Detect full charge current accuracy1                  | A <sub>DETFULL</sub> | RSNS=0.2Ω, I <sup>2</sup> C bus default<br>FULLSET=0.6V<br>IDETFULL=120mA          | -30  |      | +30  | %     |
| Detect full charge current accuracy2                  | A <sub>DETFULL</sub> | RSNS=0.2Ω, at I <sup>2</sup> C bus control<br>FULLSET=0.6V<br>IDETFULL=60mA, 240mA | -50  |      | +50  | %     |
| BAT pin current of overcurrent detection              | I <sub>HC</sub>      | RSNS=0.2Ω                                                                          |      | 2.5  |      | A     |
| BAT pin over discharge voltage detection              | V <sub>LV</sub>      | BAT=H→L                                                                            | 0.95 | 1.05 | 1.15 | V     |
| BAT pin voltage of precharge detection                | V <sub>P</sub>       | BAT=L→H                                                                            | 2.8  | 2.9  | 3.0  | V     |
| Hysteresis voltage width of pre-charge detection (★4) | V <sub>PW</sub>      |                                                                                    | 25   | 50   | 100  | mV    |

| Item                                                                   | Symbol      | Measurement conditions          | Min.           | Typ.           | Max.           | Units |
|------------------------------------------------------------------------|-------------|---------------------------------|----------------|----------------|----------------|-------|
| BAT pin voltage for CV control<br>( $V_{BAT1} > V_{BAT2} > V_{BAT3}$ ) | $V_{BAT1}$  | $VT_2 < TDET \leq VT_5$         | 4.17           | 4.20           | 4.23           | V     |
|                                                                        | $V_{BAT2}$  | $VT_5 < TDET \leq VT_6$         | 4.05           | 4.10           | 4.15           |       |
|                                                                        | $V_{BAT3}$  | $VT_5 < TDET \leq VT_6$         | 4.00           | 4.05           | 4.10           |       |
| BAT pin voltage of re-charge detection                                 | $V_R$       | BAT=H→L                         | 3.85           | 3.90           | 3.95           | V     |
| BAT pin voltage of overvoltage detection                               | $V_{OV}$    | BAT=L→H                         | 4.30           | 4.35           | 4.40           | V     |
| Battery temperature<br>detection TDET pin<br>voltage (★5)              | $V_{T1}$    | TDET=L→H<br>−30°C±6°C detection | VREG<br>×0.893 | VREG<br>×0.919 | VREG<br>×0.940 | V     |
|                                                                        | $V_{T2}$    | TDET=L→H<br>2°C±2°C detection   | VREG<br>×0.697 | VREG<br>×0.714 | VREG<br>×0.731 | V     |
|                                                                        | $V_{T3}$    | TDET=L→H<br>12°C±2°C detection  | VREG<br>×0.604 | VREG<br>×0.623 | VREG<br>×0.642 | V     |
|                                                                        | $V_{T4}$    | TDET=H→L<br>43°C±2°C detection  | VREG<br>×0.330 | VREG<br>×0.345 | VREG<br>×0.360 | V     |
|                                                                        | $V_{T5}$    | TDET=H→L<br>48°C±2°C detection  | VREG<br>×0.294 | VREG<br>×0.308 | VREG<br>×0.322 | V     |
|                                                                        | $V_{T6}$    | TDET=H→L<br>58°C±2°C detection  | VREG<br>×0.232 | VREG<br>×0.243 | VREG<br>×0.255 | V     |
|                                                                        | $V_{T7}$    | TDET=H→L<br>80°C±6°C detection  | VREG<br>×0.124 | VREG<br>×0.143 | VREG<br>×0.165 | V     |
| Hysteresis voltage width of<br>battery temp. detection (★4)            | $V_{VTHW}$  | VT2, VT3, VT4, VT5, VT6         | 1              | 3              | 5              | °C    |
| LED pin output voltage                                                 | $V_{LED}$   | $I_{LED}=10\text{mA}$           |                |                | 0.4            | V     |
| LED pin sink current                                                   | $I_{LED}$   |                                 | 10             |                |                | mA    |
| ADP power SW ON resistance (★4)                                        | $ADP_{RON}$ | ADP=5.0V                        |                |                | 0.3            | Ω     |
| USB power SW ON resistance (★4)                                        | $USBR_{ON}$ | USB=5.0V                        |                |                | 0.3            | Ω     |

| Item                                                | Symbol               | Measurement conditions       | Min.  | Typ.  | Max.  | Units |
|-----------------------------------------------------|----------------------|------------------------------|-------|-------|-------|-------|
| Oscillator frequency                                | fosc                 |                              | 0.8   | 1.0   | 1.2   | MHz   |
| First time delay                                    | T <sub>1STINT</sub>  |                              | 102.4 | 128.0 | 153.6 | ms    |
| BAT pull time                                       | T <sub>DISTCHG</sub> |                              | 102.4 | 128.0 | 153.6 | ms    |
| Forced charge time                                  | T <sub>1STCHG</sub>  |                              | 204.8 | 256.0 | 307.2 | ms    |
| Voltage detection delay                             | T <sub>Vdetect</sub> |                              | 102.4 | 128.0 | 153.6 | ms    |
| Pre-charge safety timer                             | T <sub>PRECHG</sub>  | I <sup>2</sup> C bus default | 5760  | 7200  | 8640  | s     |
| Fast charge safety timer                            | T <sub>FSTCHG</sub>  | I <sup>2</sup> C bus default | 37440 | 46800 | 56160 | s     |
| Full charge detection delay time                    | T <sub>DETFULL</sub> |                              | 336.0 | 448.0 | 560.0 | ms    |
| Re-charge detection delay time                      | T <sub>R</sub>       |                              | 42.0  | 56.0  | 70.0  | ms    |
| BAT pin current of overcurrent detection delay time | I <sub>HC</sub>      |                              | 42.0  | 56.0  | 70.0  | ms    |
| BAT pin over discharge voltage detection delay time | V <sub>LV</sub>      |                              | 42.0  | 56.0  | 70.0  | ms    |
| BAT pin overvoltage detection delay time            | T <sub>OV</sub>      |                              | 42.0  | 56.0  | 70.0  | ms    |
| ADP/USB overcurrent detection delay time (*4)       | T <sub>OC</sub>      |                              | 42.0  | 56.0  | 70.0  | ms    |
| ADP/USB/BAT under voltage lockout delay time        | T <sub>UV</sub>      |                              | 84.0  | 112.0 | 140.0 | ms    |
| Temp. detection delay time                          | T <sub>TDET</sub>    |                              | 42.0  | 56.0  | 70.0  | ms    |

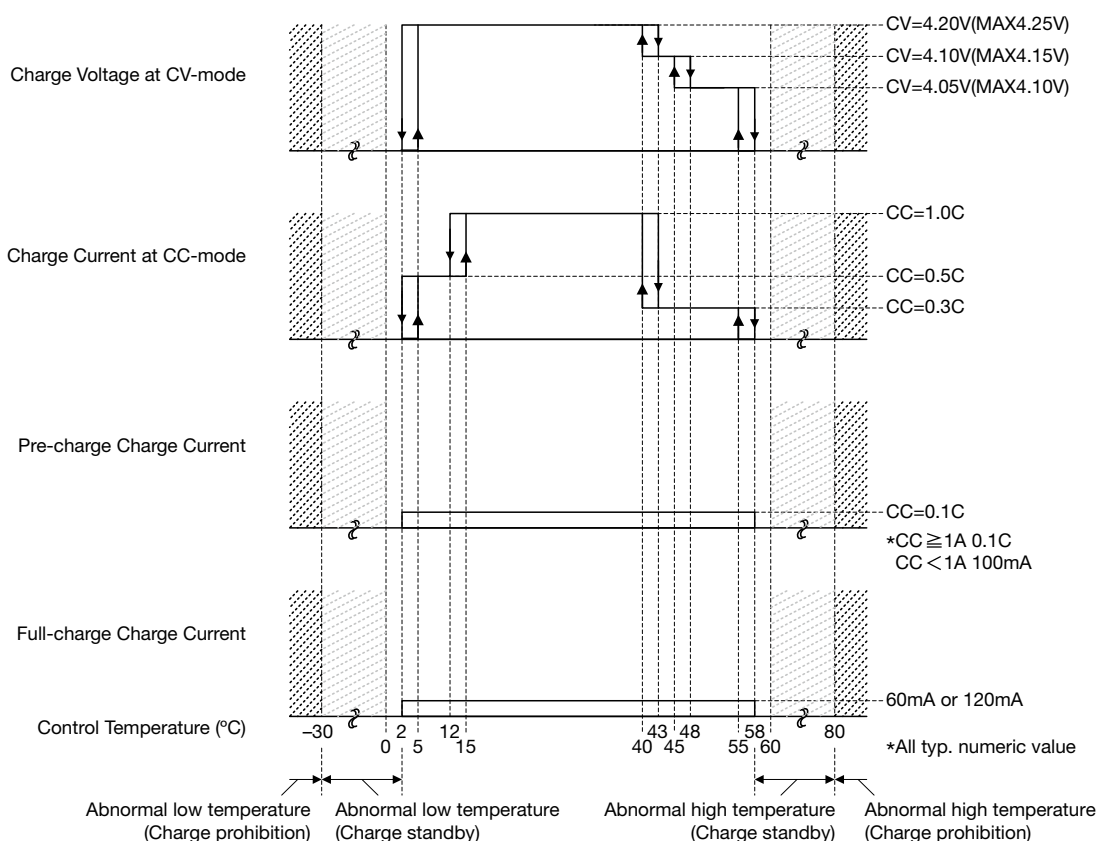
| Item                            | Symbol             | Measurement conditions        | Min.         | Typ.  | Max.  | Units |
|---------------------------------|--------------------|-------------------------------|--------------|-------|-------|-------|
| LED blinking cycle              | T <sub>BL1</sub>   | When blinking (0.25Hz) is set | 0.200        | 0.250 | 0.300 | Hz    |
|                                 | T <sub>BL2</sub>   | When blinking (0.5Hz) is set  | 0.400        | 0.500 | 0.600 |       |
|                                 | T <sub>BL3</sub>   | When blinking (1Hz) is set    | 0.800        | 1.000 | 1.200 |       |
|                                 | T <sub>BL4</sub>   | When blinking (2Hz) is set    | 1.600        | 2.000 | 2.400 |       |
|                                 | T <sub>BL5</sub>   | When blinking (4Hz) is set    | 3.200        | 4.000 | 4.800 |       |
|                                 | T <sub>BL6</sub>   | When blinking (8Hz) is set    | 6.400        | 8.000 | 9.600 |       |
| CHG_EN "L"-level input voltage  | V <sub>CEL</sub>   |                               | 0            |       | 0.3   | V     |
| CHG_EN "H"-level input voltage  | V <sub>CEH</sub>   |                               | DVIN<br>-0.3 |       | DVIN  | V     |
| CHG_EN pin input current        | I <sub>CE</sub>    | DVIN=1.8V<br>H input          |              |       | 2.5   | μA    |
| USB_EN1 "L"-level input voltage | V <sub>USB1L</sub> |                               | 0            |       | 0.3   | V     |
| USB_EN1 "H"-level input voltage | V <sub>USB1H</sub> |                               | DVIN<br>-0.3 |       | DVIN  | V     |
| USB_EN1 pin input current       | I <sub>USB1</sub>  | DVIN=1.8V<br>H input          |              |       | 2.5   | μA    |
| USB_EN2 "L"-level input voltage | V <sub>USB2L</sub> |                               | 0            |       | 0.3   | V     |
| USB_EN2 "H"-level input voltage | V <sub>USB2H</sub> |                               | DVIN<br>-0.3 |       | DVIN  | V     |
| USB_EN2 pin input current       | I <sub>USB2</sub>  | DVIN=1.8V<br>H input          |              |       | 2.5   | μA    |
| RESET "L"-level input voltage   | V <sub>RSTL</sub>  |                               | 0            |       | 0.3   | V     |
| RESET "H"-level input voltage   | V <sub>RSTH</sub>  |                               | DVIN<br>-0.3 |       | DVIN  | V     |
| RESET pin input current         | I <sub>RST</sub>   | DVIN=1.8V<br>H input          |              |       | 2.5   | μA    |

| Item                                            | Symbol | Measurement conditions          | Min. | Typ. | Max. | Units |
|-------------------------------------------------|--------|---------------------------------|------|------|------|-------|
| Temperature of chip temperature limiting1 (*4)  | TCL1   | at I <sup>2</sup> C bus control | 75   | 85   | 95   | °C    |
| Temperature of chip temperature limiting2 (*4)  | TCL2   | I <sup>2</sup> C bus default    | 125  | 135  | 145  | °C    |
| Temperature of thermal shutdown (*4)            | TSD    |                                 | 140  | 150  | 160  | °C    |
| Hysteresis temperature of thermal shutdown (*4) | TSDh   |                                 |      | 25   |      | °C    |

note : \*4 guaranteed by design

note : \*5 Temperature detection is the setting value at B-Value 3380K (25/50°C)(NCP15XH103F03RC made by MURATA MANUFACTURING).

The battery temperature profile (I<sup>2</sup>Cbus is default) when this thermistor use is a figure below.



note : \*6 About the range and accuracy to be able to set the charging current.

When RSNS is 0.2Ω, the Forced charge current, the pre-charge current, and the fast charge current are the relations of the table below. It is possible to select No. according to the I2C control. Accuracy excluding No.18 becomes a design certification.

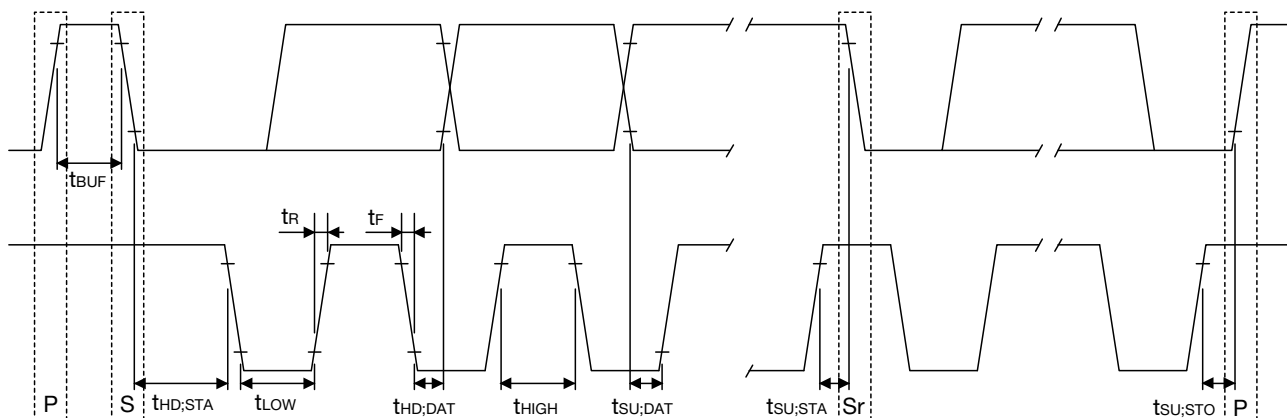
| No. | Forced charge current | Pre-charge current | Fast charge current |
|-----|-----------------------|--------------------|---------------------|
| 1   | 100mA ± 40%           | 100mA ± 40%        | 100mA ± 40%         |
| 2   | 100mA ± 40%           | 100mA ± 40%        | 200mA ± 30%         |
| 3   | 100mA ± 40%           | 100mA ± 40%        | 300mA ± 20%         |
| 4   | 100mA ± 40%           | 100mA ± 40%        | 400mA ± 15%         |
| 5   | 100mA ± 40%           | 100mA ± 40%        | 500mA ± 15%         |
| 6   | 100mA ± 40%           | 100mA ± 40%        | 600mA ± 10%         |
| 7   | 100mA ± 40%           | 100mA ± 40%        | 700mA ± 10%         |
| 8   | 100mA ± 40%           | 100mA ± 40%        | 800mA ± 10%         |
| 9   | 100mA ± 40%           | 100mA ± 40%        | 900mA ± 7.5%        |
| 10  | 100mA ± 40%           | 100mA ± 40%        | 1000mA ± 7.5%       |
| 11  | 110mA ± 40%           | 110mA ± 30%        | 1100mA ± 7.5%       |
| 12  | 120mA ± 40%           | 120mA ± 30%        | 1200mA ± 7.5%       |
| 13  | 130mA ± 40%           | 130mA ± 30%        | 1300mA ± 5%         |
| 14  | 140mA ± 40%           | 140mA ± 30%        | 1400mA ± 5%         |
| 15  | 150mA ± 40%           | 150mA ± 30%        | 1500mA ± 5%         |
| 16  | 160mA ± 40%           | 160mA ± 30%        | 1600mA ± 5%         |
| 17  | 170mA ± 40%           | 170mA ± 30%        | 1700mA ± 5%         |
| 18  | 180mA ± 40%           | 180mA ± 30%        | 1800mA ± 5%         |
| 19  | 190mA ± 40%           | 190mA ± 30%        | 1900mA ± 5%         |
| 20  | 200mA ± 40%           | 200mA ± 30%        | 2000mA ± 5%         |

note : If the IC is damaged and control is no longer possible, its safety can not be guaranteed.  
Please protect with something other than this IC.

note : If adjacent terminals are shorted or each terminal is short with VDD or GND, there is a possibility that the IC malfunctions.

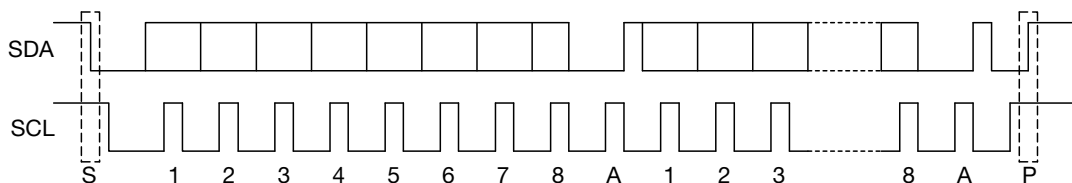
## Electrical Characteristics 2 (Except where noted otherwise Ta=25°C, ADP=USB=5.0V)

| Item                         | Symbol               | Measurement conditions | Min.         | Typ. | Max.         | Units |
|------------------------------|----------------------|------------------------|--------------|------|--------------|-------|
| [I <sup>2</sup> C condition] |                      |                        |              |      |              |       |
| Input voltage L              | V <sub>IL</sub>      |                        | 0            |      | DVIN<br>×0.3 | V     |
| Input voltage H              | V <sub>IH</sub>      |                        | DVIN<br>×0.7 |      | DVIN         | V     |
| SDA low level output voltage | V <sub>OL</sub>      | SDA sink 3mA           | 0            |      | 0.4          | V     |
| High level input current     | I <sub>IH</sub>      | SDA, SCL=4.5V          | -10          |      | 10           | μA    |
| Low level input current      | I <sub>IL</sub>      | SDA, SCL=0.4V          | -10          |      | 10           | μA    |
| Clock frequency              | f <sub>SCL</sub>     |                        |              |      | 400          | kHz   |
| Data transfer wait time      | t <sub>BUF</sub>     |                        | 1.3          |      |              | μs    |
| SCL start hold time          | t <sub>HD; STA</sub> |                        | 0.6          |      |              | μs    |
| SCL low level hold time      | t <sub>LOW</sub>     |                        | 1.3          |      |              | μs    |
| SCL high level hold time     | t <sub>high</sub>    |                        | 0.6          |      |              | μs    |
| Start condition setup        | t <sub>SU; STA</sub> |                        | 0.6          |      |              | μs    |
| SDA data hold time           | t <sub>HD; DAT</sub> |                        | 0            |      |              | μs    |
| SDA data setup time          | t <sub>SU; DAT</sub> |                        | 100          |      |              | ns    |
| SDA,SCL rise time            | t <sub>r</sub>       |                        |              |      | 300          | ns    |
| SDA,SCL fall time            | t <sub>f</sub>       |                        |              |      | 300          | ns    |
| Stop condition setup time    | t <sub>SU; STO</sub> |                        | 0.6          |      |              | μs    |



## I<sup>2</sup>C BUS

### [About I<sup>2</sup>C BUS]



I<sup>2</sup>C BUS is inter bus system controlled by 2 lines (SDA,SCL).

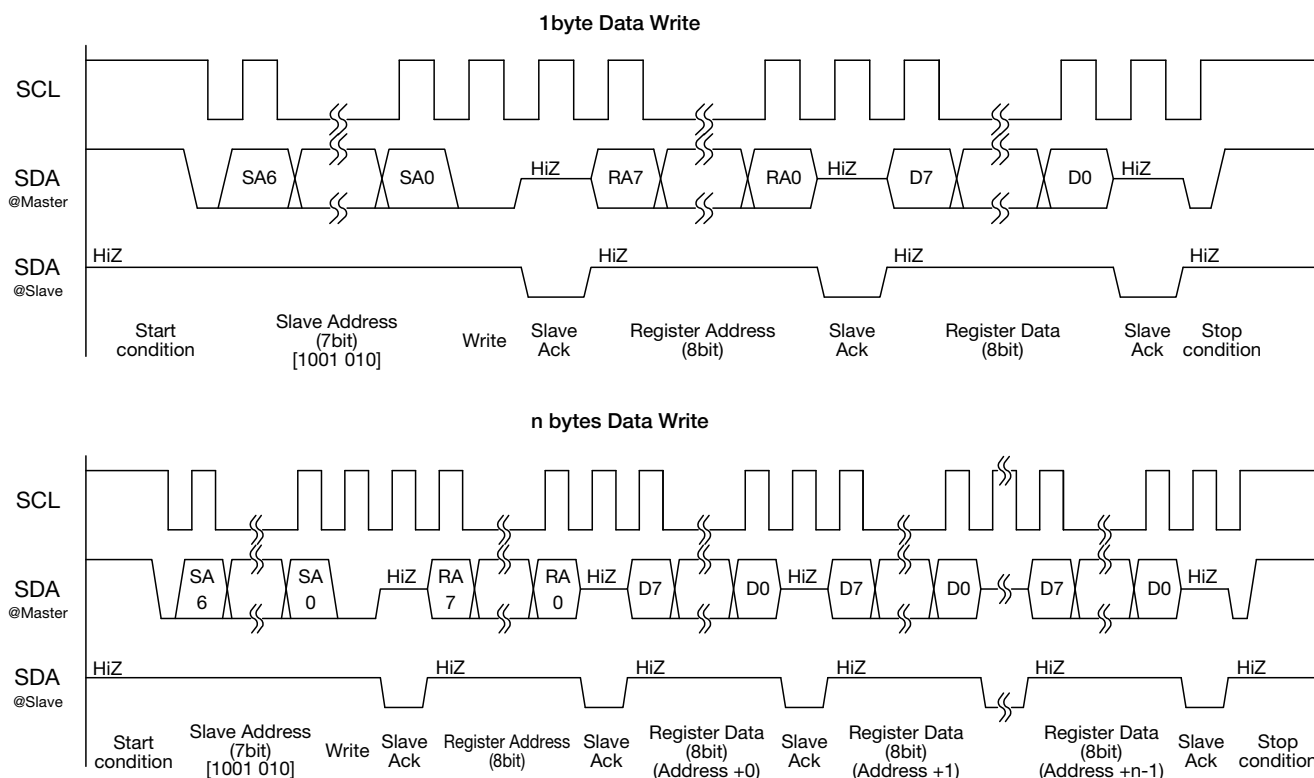
Data are transmitted and received in the units of byte and Acknowledge.

It is transmitted by MSB first from the Start condition.

### [Control registers]

Control registers are data sent from the master for determining the conditions.

The data format is set as shown in the following figure.



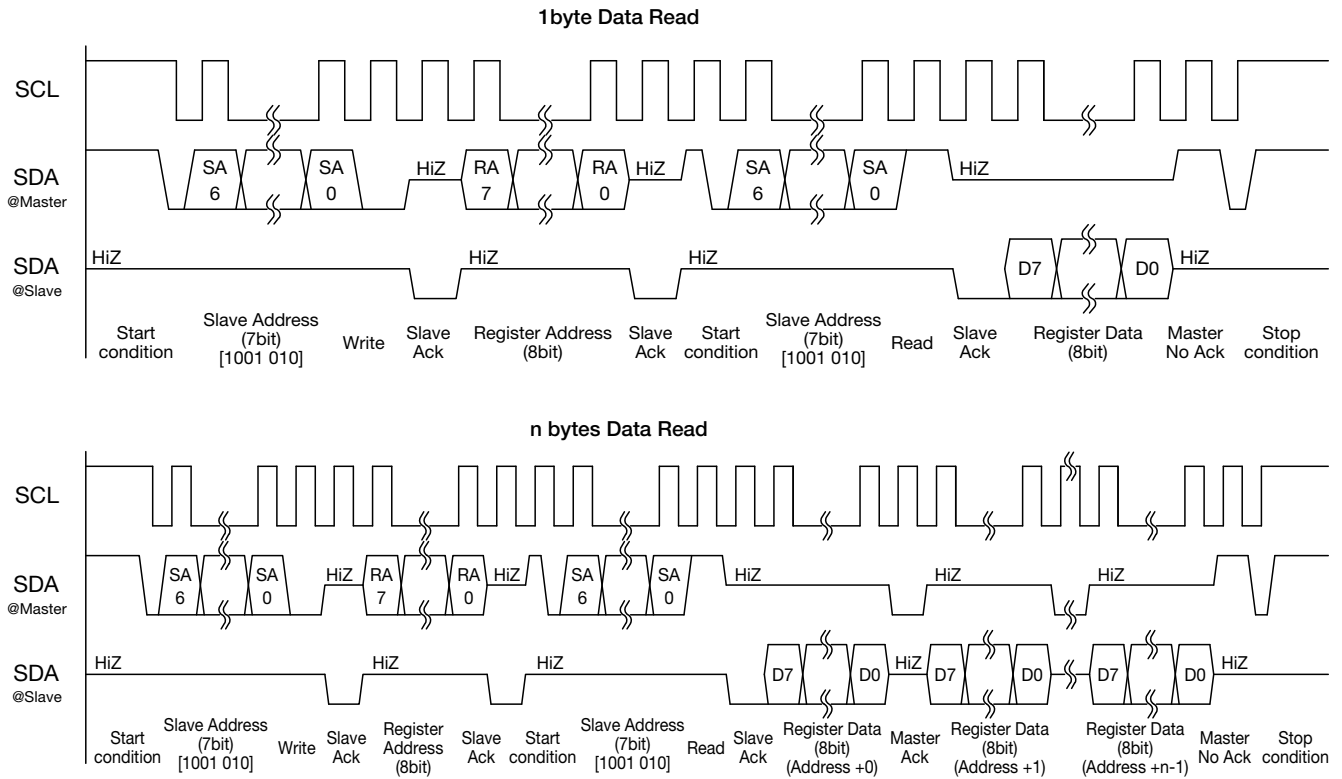
Out of the Address byte, first 7 bit are assigned to the slave address, while the residual 1 bit is assigned to the R/W bit. Set the R/W bit to 0 when data are used control registers.

The address of this IC is 94H. Please refer to "Register map" for the control contents of control registers and switches.

### [Status registers]

Status registers are data to inform the master of the IC status.

The data format is set as shown in the following figure.



Out of the Address byte, first 7 bit are assigned to the slave address, while the residual 1 bit is assigned to the R/W bit. Set the R/W bit to 1 when data are used status registers. The address of MM3439 is 95H.

Please refer to "Register map" for the control contents of control registers and switches.

### [About the control terminal]

CHG\_EN(11pin), USB\_EN1(4pin), USB\_EN2(7pin) and RESET(18pin) are terminals that input H signal (DVIN) or L signal (GND) to decide the state of MM3439. As for the content controlled with these control terminals, the thing controlled by using I<sup>2</sup>C BUS is possible.

Please refer to "Control table" for the relation between the control terminal and I<sup>2</sup>C BUS.

[Register map]

|                  |     | b07                               | b06                   | b05 | b04                             | b03                   | b02                              | b01                    | b00 | Remarks    |
|------------------|-----|-----------------------------------|-----------------------|-----|---------------------------------|-----------------------|----------------------------------|------------------------|-----|------------|
| Slave Address    |     | 1                                 | 0                     | 0   | 1                               | 0                     | 1                                | 0                      | R/W | R=1<br>W=0 |
| Register Address | 00h |                                   | Charging status       |     |                                 |                       | Charge error                     |                        |     | Read only  |
|                  | 01h |                                   | Mode distinction      |     |                                 |                       | Temperature of battery           |                        |     |            |
|                  | 02h | State of each terminal connection |                       |     |                                 |                       |                                  | State of power pass SW |     |            |
|                  | 03h |                                   | Full charge detection |     | ADP/USB charge existence        |                       | Each mode transition prohibition |                        |     |            |
|                  | 04h | CHG_EN                            | USB_EN                |     |                                 | Control of chip temp. |                                  | Internal timer setting |     | Read/Write |
|                  | 05h | ADP/USB Priority                  | 2~12°C CV setting     |     | 2~12°C CC setting (ADP charge)  |                       |                                  |                        |     |            |
|                  | 06h | RESET                             | 12~43°C CV setting    |     | 12~43°C CC setting (ADP charge) |                       |                                  |                        |     |            |
|                  | 07h | Re-charge                         | 43~48°C CV setting    |     | 43~48°C CC setting (ADP charge) |                       |                                  |                        |     |            |
|                  | 08h | Supply voltage control            | 48~58°C CV setting    |     | 48~58°C CC setting (ADP charge) |                       |                                  |                        |     |            |
|                  | 09h | LED display when charging         |                       |     | 2~12°C CC setting (USB charge)  |                       |                                  |                        |     |            |
|                  | 0Ah | LED display when temp. stands by  |                       |     | 12~43°C CC setting (USB charge) |                       |                                  |                        |     |            |
|                  | 0Bh | LED display when battery abnormal |                       |     | 43~48°C CC setting (USB charge) |                       |                                  |                        |     |            |
|                  | 0Ch | LED display when full charged     |                       |     | 48~58°C CC setting (USB charge) |                       |                                  |                        |     |            |
|                  | F0h | Test mode                         |                       |     |                                 |                       |                                  |                        |     |            |
|                  | F1h | Test mode                         |                       |     |                                 |                       |                                  |                        |     |            |
|                  | F2h | Test mode                         |                       |     |                                 |                       |                                  |                        |     |            |

## ■ Control table

Register Address : 00H

| b06 | b05 | b04 | Charging status            |
|-----|-----|-----|----------------------------|
| 0   | 0   | 0   | Charge OFF                 |
| 0   | 0   | 1   | Battery connection judging |
| 0   | 1   | 0   | Pre-charge                 |
| 0   | 1   | 1   | Fast charge                |
| 1   | 0   | 0   | Full charge                |
| 1   | 0   | 1   | Re-charge                  |

Register Address : 00H

| b02 | b01 | b00 | Charge error                  |
|-----|-----|-----|-------------------------------|
| 0   | 0   | 0   | No error                      |
| 0   | 0   | 1   | Pre-charge time-out           |
| 0   | 1   | 0   | Fast charge time-out          |
| 0   | 1   | 1   | Overvoltage of battery        |
| 1   | 0   | 0   | Battery overdischarge         |
| 1   | 0   | 1   | Battery overcurrent           |
| 1   | 1   | 0   | The battery temp. is abnormal |
| 1   | 1   | 1   | Thermal shutdown              |

Register Address : 01H

| b06 | b05 | b04 | Mode distinction    |
|-----|-----|-----|---------------------|
| 0   | 0   | 0   | Standby             |
| 0   | 0   | 1   | ADP mode            |
| 0   | 1   | 0   | USB mode            |
| 0   | 1   | 1   | BAT mode            |
| 1   | 0   | 0   | ADP charge mode     |
| 1   | 0   | 1   | USB charge mode     |
| 1   | 1   | 0   | USB-BAT common mode |

Register Address : 01H

| b02 | b01 | b00 | Temperature of battery |
|-----|-----|-----|------------------------|
| 0   | 0   | 0   | ~ -30°C                |
| 0   | 0   | 1   | -30~-2°C               |
| 0   | 1   | 0   | 2~12°C                 |
| 0   | 1   | 1   | 12~43°C                |
| 1   | 0   | 0   | 43~48°C                |
| 1   | 0   | 1   | 48~58°C                |
| 1   | 1   | 0   | 58~80°C                |
| 1   | 1   | 1   | 80°C ~                 |

**Register Address : 02H – State of each terminal connection**

| b07 | ADP connection |
|-----|----------------|
| 0   | None           |
| 1   | Connects       |

| b06 | USB connection |
|-----|----------------|
| 0   | None           |
| 1   | Connects       |

| b05 | Battery B+ |
|-----|------------|
| 0   | None       |
| 1   | Connects   |

| b04 | Battery TH |
|-----|------------|
| 0   | None       |
| 1   | Connects   |

**Register Address : 02H – State of power SW**

| b01 | ADP voltage |
|-----|-------------|
| 0   | No error    |
| 1   | Overvoltage |

| b00 | USB voltage |
|-----|-------------|
| 0   | No error    |
| 1   | Overvoltage |

**Register Address : 03H – Full charge detection setting**

| b06 | b05 | Setting of full charge detect |
|-----|-----|-------------------------------|
| 0   | 0   | 1time FULLSET                 |
| 0   | 1   | <b>* Two time FULLSET</b>     |
| 1   | 0   | Four time FULLSET             |
| 1   | 1   | Prepositive holding           |

**Register Address : 03H – ADP/USB charge existence**

| b04 | ADP charge Presence |
|-----|---------------------|
| 0   | ADP non-charge      |
| 1   | ADP charge          |

| b03 | USB charge Presence |
|-----|---------------------|
| 0   | USB non-charge      |
| 1   | USB charge          |

**\* Bold-faced type under line of read/write resistor is default.**

Register Address : 03H – Each mode transition prohibition

| b02 | Battery use mode       |
|-----|------------------------|
| 0   | Transition permission  |
| 1   | Transition prohibition |

| b01 | ADP use mode           |
|-----|------------------------|
| 0   | Transition permission  |
| 1   | Transition prohibition |

| b00 | USB use mode           |
|-----|------------------------|
| 0   | Transition permission  |
| 1   | Transition prohibition |

Register Address : 04H

| b07 | CHG_EN                      |
|-----|-----------------------------|
| 0   | <b>* Charge prohibition</b> |
| 1   | Charge permission           |

Register Address : 04H

| b06 | b05 | b04 | USB_EN                                   |
|-----|-----|-----|------------------------------------------|
| 0   | 0   | 0   | <b>* USB use prohibition</b>             |
| 0   | 0   | 1   | 100mA limitation                         |
| 0   | 1   | 0   | 500mA limitation                         |
| 0   | 1   | 1   | 900mA limitation                         |
| 1   | 0   | 0   | Unrestricted<br>(overcurrent protection) |
| 1   | 0   | 1   | Prepositive holding                      |
| 1   | 1   | 0   | Prepositive holding                      |
| 1   | 1   | 1   | Prepositive holding                      |

\* **Bold-faced type under line of read/write resistor is default.**

Register Address : 04H

| b03 | b02 | Chip temperature limiting |
|-----|-----|---------------------------|
| 0   | 0   | No control                |
| 0   | 1   | 85°C                      |
| 1   | 0   | <b>* 135°C</b>            |
| 1   | 1   | Prepositive holding       |

Register Address : 04H

| b01 | b00 | Setting of internal timer |
|-----|-----|---------------------------|
| 0   | 0   | 0.25 times                |
| 0   | 1   | 0.5 times                 |
| 1   | 0   | <b>* one times</b>        |
| 1   | 1   | Timer reset               |

Register Address : 05H – 2 ~ 12°C CV Setting

Register Address : 06H – 12 ~ 43°C CV Setting

Register Address : 07H – 43 ~ 48°C CV Setting

Register Address : 08H – 48 ~ 58°C CV Setting

| b06 | b05 | CV Setting          |
|-----|-----|---------------------|
| 0   | 0   | 4.20V               |
| 0   | 1   | 4.10V               |
| 1   | 0   | 4.05V               |
| 1   | 1   | Prepositive holding |

Register Address : 05H

| b07 | ADP/USB priority      |
|-----|-----------------------|
| 0   | USB priority          |
| 1   | <b>* ADP priority</b> |

\* Refer to the profile of temperature of battery for the default value of CV setting.

Register Address : 06H

| b07 | RESET                  |
|-----|------------------------|
| 0   | <b>* Release RESET</b> |
| 1   | RESET                  |

Register Address : 07H

| b07 | Re-charge                      |
|-----|--------------------------------|
| 0   | Re-charge permission           |
| 1   | <b>* Re-charge prohibition</b> |

Register Address : 08H

| b07 | Supply voltage control          |
|-----|---------------------------------|
| 0   | No control                      |
| 1   | <b>* Supply voltage control</b> |

\* **Bold-faced type under line of read/write resistor is default.**

Register Address : 05H – 2 ~ 12°C CC setting (ADP charge)

Register Address : 06H – 12 ~ 43°C CC setting (ADP charge)

Register Address : 07H – 43 ~ 48°C CC setting (ADP charge)

Register Address : 08H – 48 ~ 58°C CC setting (ADP charge)

Register Address : 09H – 2 ~ 12°C CC setting (USB charge)

Register Address : 0AH – 12 ~ 43°C CC setting (USB charge)

Register Address : 0BH – 43 ~ 48°C CC setting (USB charge)

Register Address : 0CH – 48 ~ 58°C CC setting (USB charge)

| b04 | b03 | b02 | b01 | b00 | CC setting                  |
|-----|-----|-----|-----|-----|-----------------------------|
| 0   | 0   | 0   | 0   | 0   | 0mA (Charge OFF)            |
| 0   | 0   | 0   | 0   | 1   | 100mA                       |
| 0   | 0   | 0   | 1   | 0   | 200mA                       |
| 0   | 0   | 0   | 1   | 1   | 300mA                       |
| 0   | 0   | 1   | 0   | 0   | 400mA                       |
| 0   | 0   | 1   | 0   | 1   | 500mA                       |
| 0   | 0   | 1   | 1   | 0   | 600mA                       |
| 0   | 0   | 1   | 1   | 1   | 700mA                       |
| 0   | 1   | 0   | 0   | 0   | 800mA                       |
| 0   | 1   | 0   | 0   | 1   | 900mA                       |
| 0   | 1   | 0   | 1   | 0   | 1000mA                      |
| 0   | 1   | 0   | 1   | 1   | 1100mA                      |
| 0   | 1   | 1   | 0   | 0   | 1200mA                      |
| 0   | 1   | 1   | 0   | 1   | 1300mA                      |
| 0   | 1   | 1   | 1   | 0   | 1400mA                      |
| 0   | 1   | 1   | 1   | 1   | 1500mA                      |
| 1   | 0   | 0   | 0   | 0   | 1600mA                      |
| 1   | 0   | 0   | 0   | 1   | 1700mA                      |
| 1   | 0   | 0   | 1   | 0   | 1800mA                      |
| 1   | 0   | 0   | 1   | 1   | 1900mA                      |
| 1   | 0   | 1   | 0   | 0   | 2000mA                      |
| 1   | 0   | 1   | 0   | 1   | 0.5times setting of 12~43°C |
| 1   | 0   | 1   | 1   | 0   | 0.3times setting of 12~43°C |
| 1   | 0   | 1   | 1   | 1   | 0.1times setting of 12~43°C |
| 1   | 1   | 0   | 0   | 0   | Prepositive holding         |
| 1   | 1   | 0   | 0   | 1   | Prepositive holding         |
| 1   | 1   | 0   | 1   | 0   | Prepositive holding         |
| 1   | 1   | 0   | 1   | 1   | Prepositive holding         |
| 1   | 1   | 1   | 0   | 0   | Prepositive holding         |
| 1   | 1   | 1   | 0   | 1   | Prepositive holding         |
| 1   | 1   | 1   | 1   | 0   | Prepositive holding         |
| 1   | 1   | 1   | 1   | 1   | Prepositive holding         |

★ Register Address 06H/0AH is prepositive holding.

★ Refer to the profile of temperature of battery for the default value of CC setting.

★ The value of the current of the above table is a value at the sense resistance 0.2Ω.

Register Address : 09H

| b07 | b06 | b05 | LED display when charging |
|-----|-----|-----|---------------------------|
| 0   | 0   | 0   | Turning off               |
| 0   | 0   | 1   | Blinking (0.25Hz)         |
| 0   | 1   | 0   | <b>* Blinking (0.5Hz)</b> |
| 0   | 1   | 1   | Blinking (1Hz)            |
| 1   | 0   | 0   | Blinking (2Hz)            |
| 1   | 0   | 1   | Blinking (4Hz)            |
| 1   | 1   | 0   | Blinking (8Hz)            |
| 1   | 1   | 1   | Lighting                  |

Register Address : 0AH

| b07 | b06 | b05 | LED display temperature standby |
|-----|-----|-----|---------------------------------|
| 0   | 0   | 0   | Turning off                     |
| 0   | 0   | 1   | <b>* Blinking (0.25Hz)</b>      |
| 0   | 1   | 0   | Blinking (0.5Hz)                |
| 0   | 1   | 1   | Blinking (1Hz)                  |
| 1   | 0   | 0   | Blinking (2Hz)                  |
| 1   | 0   | 1   | Blinking (4Hz)                  |
| 1   | 1   | 0   | Blinking (8Hz)                  |
| 1   | 1   | 1   | Lighting                        |

Register Address : 0BH

| b07 | b06 | b05 | LED display when abnormal battery |
|-----|-----|-----|-----------------------------------|
| 0   | 0   | 0   | Turning off                       |
| 0   | 0   | 1   | Blinking (0.25Hz)                 |
| 0   | 1   | 0   | Blinking (0.5Hz)                  |
| 0   | 1   | 1   | Blinking (1Hz)                    |
| 1   | 0   | 0   | <b>* Blinking (2Hz)</b>           |
| 1   | 0   | 1   | Blinking (4Hz)                    |
| 1   | 1   | 0   | Blinking (8Hz)                    |
| 1   | 1   | 1   | Lighting                          |

Register Address : 0CH

| b07 | b06 | b05 | LED display when full charge |
|-----|-----|-----|------------------------------|
| 0   | 0   | 0   | <b>* Turning off</b>         |
| 0   | 0   | 1   | Blinking (0.25Hz)            |
| 0   | 1   | 0   | Blinking (0.5Hz)             |
| 0   | 1   | 1   | Blinking (1Hz)               |
| 1   | 0   | 0   | Blinking (2Hz)               |
| 1   | 0   | 1   | Blinking (4Hz)               |
| 1   | 1   | 0   | Blinking (8Hz)               |
| 1   | 1   | 1   | Lighting                     |

**\* Bold-faced type under line of read/write resistor is default.**

Control table of control terminal and I<sup>2</sup>C control using together

| Control terminal | I <sup>2</sup> C Control | Charge permission control |
|------------------|--------------------------|---------------------------|
| CHG_EN (11pin)   | CHG_EN (04h_b07)         |                           |
| L                | 0                        | Charge prohibition        |
| H                | *                        | Charge permission         |
| *                | 1                        | Charge permission         |

( \* : Don't care)

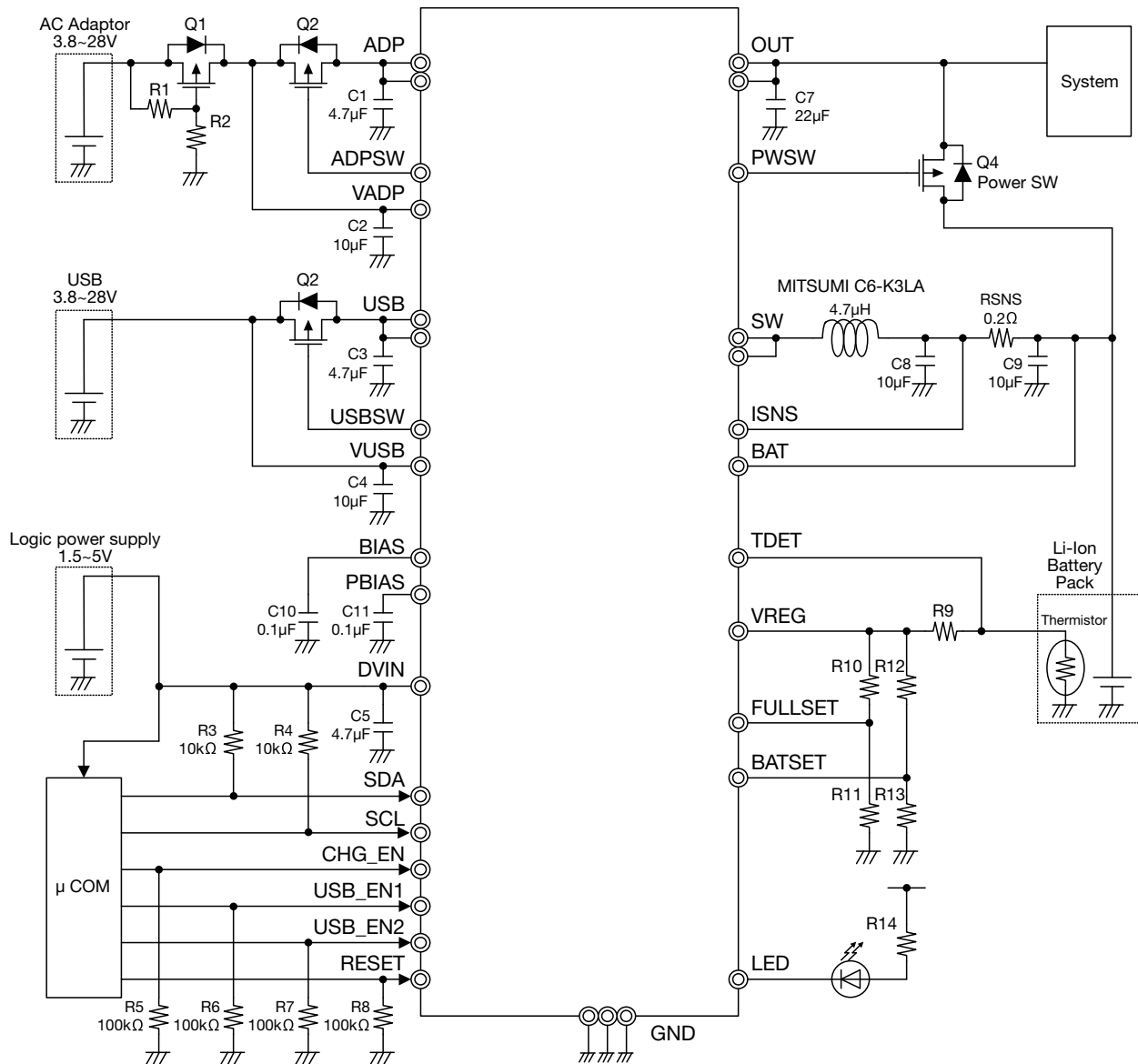
| Control terminal |                | I <sup>2</sup> C Control<br>USB_EN (04h_b06~b04)                                                       |
|------------------|----------------|--------------------------------------------------------------------------------------------------------|
| USB_EN1 (4pin)   | USB_EN2 (7pin) |                                                                                                        |
| L                | L              | USB use prohibition. I <sup>2</sup> C Control is invalid.                                              |
| H                | L              | USB current limitation value is 100mA. I <sup>2</sup> C Control is invalid.                            |
| L                | H              | USB current limitation value is 500mA. I <sup>2</sup> C Control is invalid.                            |
| H                | H              | I <sup>2</sup> C Control is effective. USB current limitation automatic operation change is effective. |

| Control terminal | I <sup>2</sup> C Control | Reset control |
|------------------|--------------------------|---------------|
| RESET (18pin)    | RESET (06h_b07)          |               |
| L                | 0                        | Reset release |
| H                | *                        | Reset         |
| *                | 1                        | Reset         |

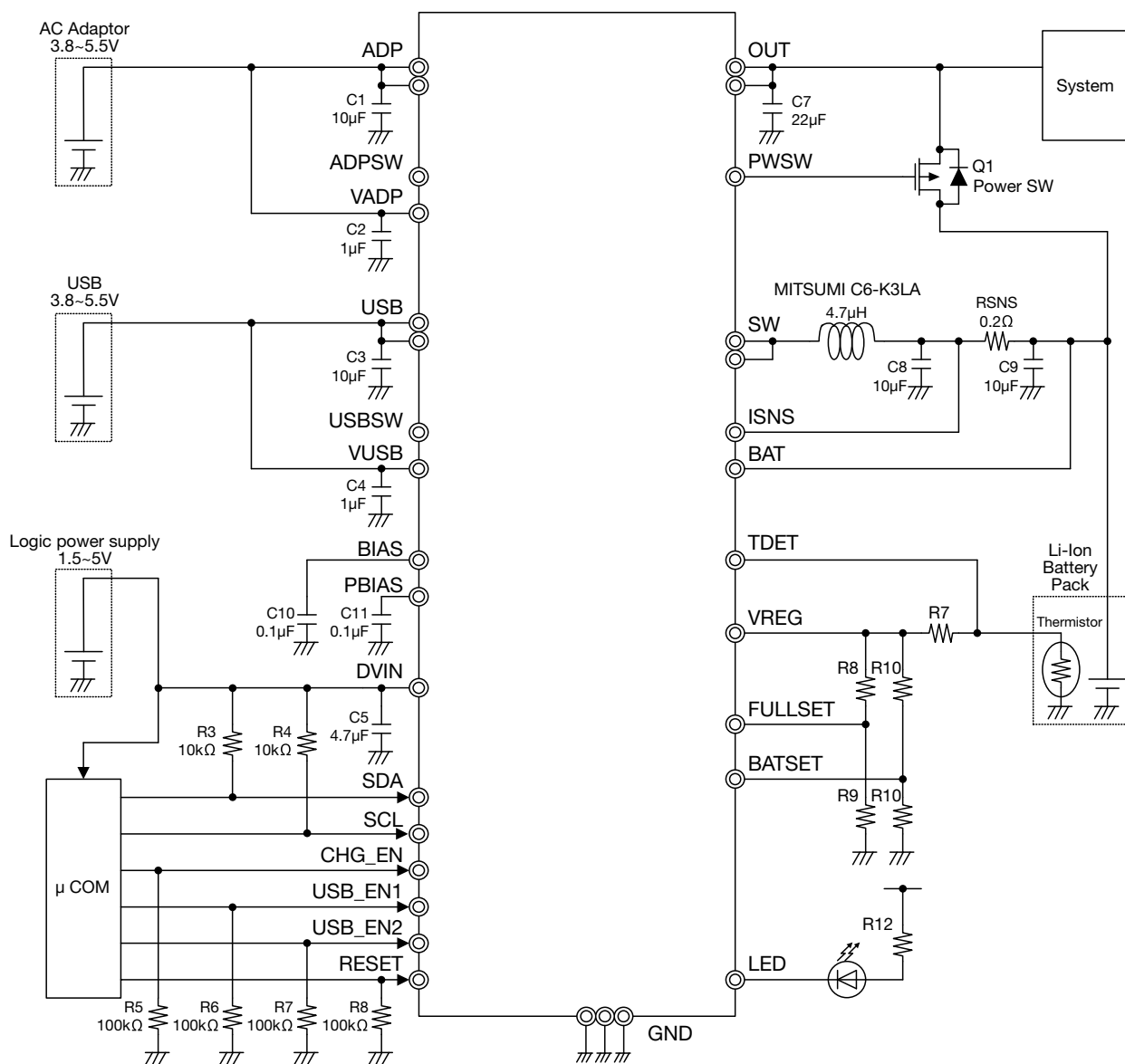
( \* : Don't care)

## Application Circuit

(1) When use input OVP and the reverse-connected prevention circuit.



(2) Input OVP and the prevention circuit of reverse-connection for unused.



- These circuits are typical examples provided for reference purposes, so in actual applications, the circuit constants, conditions and operations should be thoroughly studied.
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