



1cell Li-ion/Li-polymer battery protection IC

# MM3825 series

## Outline

The MM3825 series are protection IC using high voltage CMOS process for overcharge, overdischarge and overcurrent protection of the rechargeable Lithium-ion or Lithium-polymer battery. The overcharge, overdischarge, discharging overcurrent, charging overcurrent, and short protection of the rechargeable one-cell Lithium-ion or Lithium-polymer battery can be detected. Each of these IC composed of four voltage detectors, short detection circuit, reference voltage sources, oscillator, counter circuit and logical circuits.

## Features

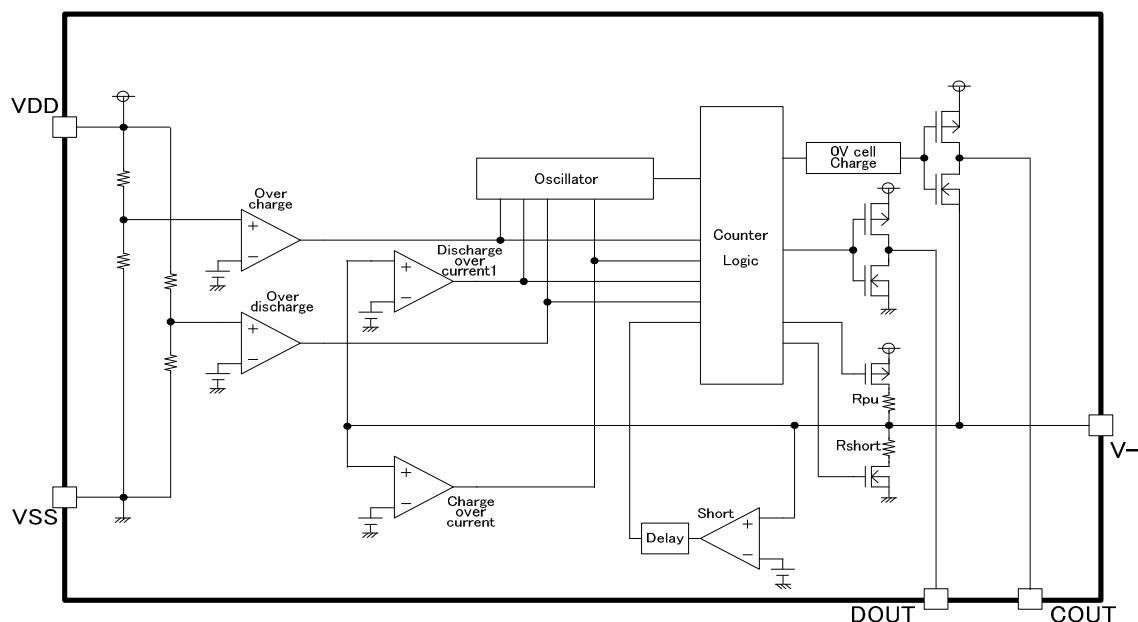
(Unless otherwise specified, Ta=25 degC)

|                                              | Range                                                                                                    | Accuracy                                 |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------|
| •Detection voltage                           |                                                                                                          |                                          |
| Overcharge detection voltage                 | 3.6V to 5.0V, 5mV steps                                                                                  | +/-20mV<br>+/-25mV(Ta=-20 to +60 degC)   |
| Overdischarge detection voltage              | 2.0V to 3.0V, 50mV steps                                                                                 | +/-35mV                                  |
| Discharging overcurrent detection voltage    | 20mV to +300mV, 1mV steps                                                                                | +/-2.5mV<br>+/-3.0mV(Ta=-20 to +60 degC) |
| Charging overcurrent detection voltage       | -20mV to -300mV, 1mV steps                                                                               | +/-2.5mV<br>+/-3.0mV(Ta=-20 to +60 degC) |
| Short detection voltage                      | 70mV to 350mV, 1mV steps                                                                                 | +/-8%                                    |
| 0V battery charge inhibition battery voltage | 1.1V to 2.4V, 0.1V steps                                                                                 | +/-0.1V                                  |
|                                              | 0.9V                                                                                                     | +/-0.3V                                  |
| •0V battery charge function                  | Selectable "Permission" or "inhibition"                                                                  |                                          |
| •Current consumption at Ta=25 degC           |                                                                                                          |                                          |
| Normal mode                                  | 2.5uA typ. 4.0uA max.                                                                                    |                                          |
| Standby mode                                 | 0.1uA max. (Overdischarge latch function enable.)<br>0.5uA max. (Overdischarge latch function disable.)  |                                          |
| MM3825Txx Series                             |                                                                                                          |                                          |
| Normal mode                                  | 2.0uA typ. 3.0uA max.                                                                                    |                                          |
| Standby mode                                 | 0.05uA max. (Overdischarge latch function enable.)<br>0.5uA max. (Overdischarge latch function disable.) |                                          |

## Package type

|             |                         |
|-------------|-------------------------|
| •SSON-6J/6M | 1.40 × 1.40 × 0.55 [mm] |
| •SON-6C     | 2.00 × 1.60 × 0.55 [mm] |

## Block Diagram



## Package and pin configuration

| SSON-6J/6M | Pin No. | Symbol | Function                                      |
|------------|---------|--------|-----------------------------------------------|
|            | 1       | NC     | No connection                                 |
|            | 2       | COUT   | Charge FET control terminal                   |
|            | 3       | DOUT   | Discharge FET control terminal                |
|            | 4       | VSS    | Negative power supply voltage input terminal  |
|            | 5       | VDD    | Positive power supply voltage input terminal  |
|            | 6       | V-     | Negative power supply voltage input terminal. |

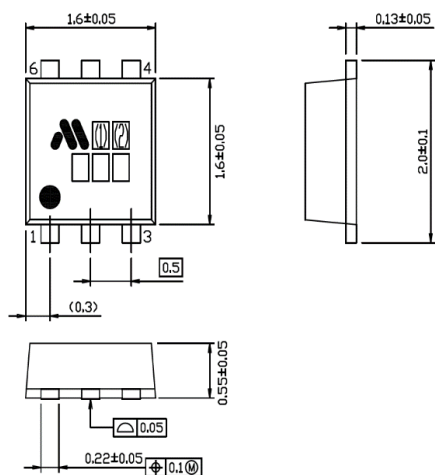
| SON-6C | Pin No. | Symbol | Function                                      |
|--------|---------|--------|-----------------------------------------------|
|        | 1       | NC     | No connection                                 |
|        | 2       | COUT   | Charge FET control terminal                   |
|        | 3       | DOUT   | Discharge FET control terminal                |
|        | 4       | VSS    | Negative power supply voltage input terminal  |
|        | 5       | VDD    | Positive power supply voltage input terminal  |
|        | 6       | V-     | Negative power supply voltage input terminal. |

## Package dimensions

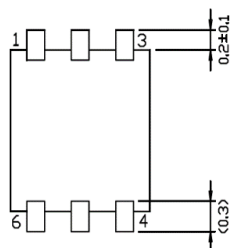
Unit:mm

### SON-6C

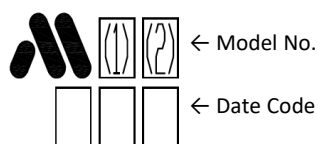
Top View



Bottom View

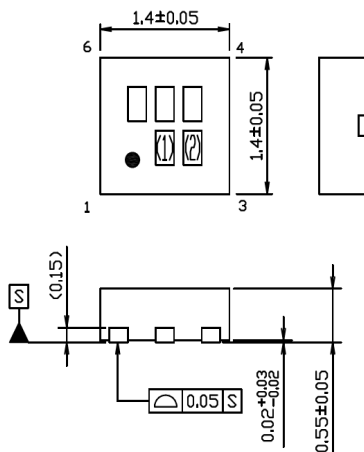


Marking Contents / SON-6C

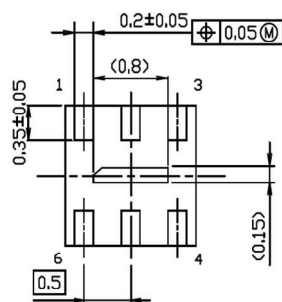


### SSON-6J

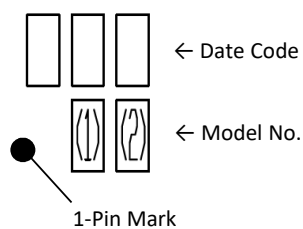
Top View



Bottom View

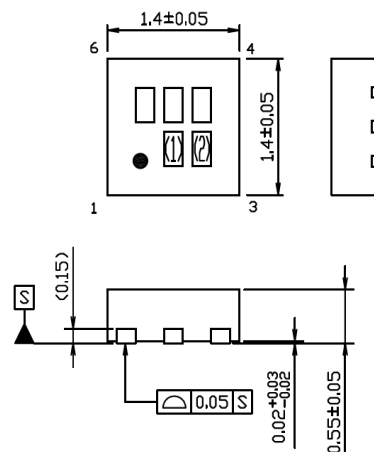


Marking Contents / SSON-6J

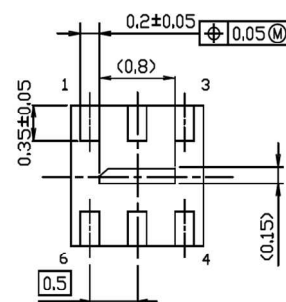


### SSON-6M

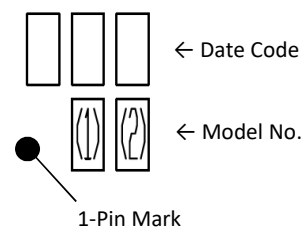
Top View



Bottom View



Marking Contents / SSON-6M





## Absolute Maximum Ratings

| Parameter           | Symbol | Rating             | Unit |
|---------------------|--------|--------------------|------|
| Supply voltage      | VDD    | -0.3 to 12         | V    |
| V- terminal         | V-     | VDD-28 to VDD+0.3  | V    |
| COOUT terminal      | VCOUT  | VDD-28 to VDD+0.3  | V    |
| DOOUT terminal      | VDOUT  | VSS-0.3 to VDD+0.3 | V    |
| Storage temperature | Tstg   | -55 to +125        | degC |

## Recommended Operating Conditions

| Parameter                     | Symbol | Rating     | Unit |
|-------------------------------|--------|------------|------|
| Operating ambient temperature | Topr   | -40 to +85 | degC |
| Operating voltage             | Vop    | 1.5 to 5.5 | V    |

## Electrical characteristics

(Unless otherwise specified, Ta=25 degC)

| Item                                         | Unit  | Symbol   | Note                      | Min         | Typ     | Max         |
|----------------------------------------------|-------|----------|---------------------------|-------------|---------|-------------|
| Operating voltage                            | V     | Vop      |                           | 1.5         | -       | 5.5         |
| Operating Ambient temperature                | degC  | Ta       |                           | -40         | -       | 85          |
| Discharge overcurrent release resistance     | kohms | Rshort   | VDD=3.6V, V-=2.0V         | Rshort*0.6  | Rshort  | Rshort*2.0  |
| V- terminal pull-up resistances              | kohms | Rpu      | VDD=2.0V, V-=0V           | Rpu*0.5     | Rpu     | Rpu*2.0     |
| COOUT L level output voltage                 | V     | VcoL     | Icout=30uA, VDD=4.5V      | -           | 0.1     | 0.5         |
| COOUT H level output voltage                 | V     | VcoH     | Icout=-30uA, VDD=4.0V     | VDD-0.5     | VDD-0.1 | -           |
| DOOUT L level output voltage                 | V     | VdoL     | Idout=30uA, VDD=2.0V      | -           | 0.1     | 0.5         |
| DOOUT H level output voltage                 | V     | VdoH     | Idout=-30uA, VDD=4.0V     | VDD-0.5     | VDD-0.1 | -           |
| Current consumption                          | uA    | Idd      | VDD=4.0V, V-=0V           | -           | 2.5     | 4           |
| Current consumption at stand-by              | uA    | Is       | VDD=2.0V *3               | -           | -       | 0.1         |
|                                              |       |          | VDD=2.0V *4               | -           | 0.3     | 0.5         |
| 0V battery charge permission charger voltage | V     | Vst      | Vst=VDD-V-, VDD=0V *1     | -           | -       | 1.2         |
| 0V battery charge inhibition battery voltage | V     |          | Vst=VDD-VSS, V-=0V *2     | Vst-0.1     | Vst     | Vst+0.1     |
| Overcharge detection voltage                 | V     | Vdet1    | Ta=-20 to 60degC, V-=0V   | Vdet1-0.020 | Vdet1   | Vdet1+0.020 |
| Overcharge release voltage                   | V     | Vrel1    | *5                        | Vrel1-0.030 | Vrel1   | Vrel1+0.030 |
| Overdischarge detection voltage              | V     | Vdet2    | V-=0V                     | Vdet1-0.035 | Vdet2   | Vde1+0.035  |
| Overdischarge release voltage                | V     | Vrel2    | In case Vdet2=Vrel2 *3 *5 | Vrel2-0.035 | Vrel2   | Vrel2+0.050 |
|                                              |       |          | In case Vdet2≠Vrel2 *4 *5 | Vdet1-0.065 |         | Vdet1+0.090 |
| Discharging overcurrent detection voltage    | V     | Vdet3    | VDD=3.6V, V-=0V *6        | Vdet3-ΔV    | Vdet3   | Vdet3+ΔV    |
| Charging overcurrent detection voltage       | V     | Vdet4    | VDD=3.6V, V-=0V *6        | Vdet4-ΔV    | Vdet4   | Vdet4+ΔV    |
| Short detection voltage                      | V     | Vshort   | VDD=3.6V                  | Vshort*0.92 | Vshort  | Vshort*1.08 |
| Overcharge detection delay time              | ms    | t Vdet1  |                           | tVdet1*0.8  | t Vdet1 | tVdet1*1.2  |
| Overdischarge detection delay time           | ms    | t Vdet2  |                           | tVdet2*0.8  | t Vdet2 | tVdet2*1.2  |
| Discharging overcurrent detection delay time | ms    | t Vdet3  |                           | tVdet3*0.8  | t Vdet3 | tVdet3*1.2  |
| Charging overcurrent detection delay time    | ms    | t Vdet4  |                           | tVdet4*0.8  | t Vdet4 | tVdet4*1.2  |
| Short detection delay time                   | us    | t Vshort |                           | tVshort*0.7 | tVshort | tVshort*1.4 |

\*1 In case 0V battery charge function "Permission".

\*2 In case 0V battery charge function "inhibition".

\*3 Overdischarge mode latch function "Enable".

\*4 Overdischarge mode latch function "Disable".

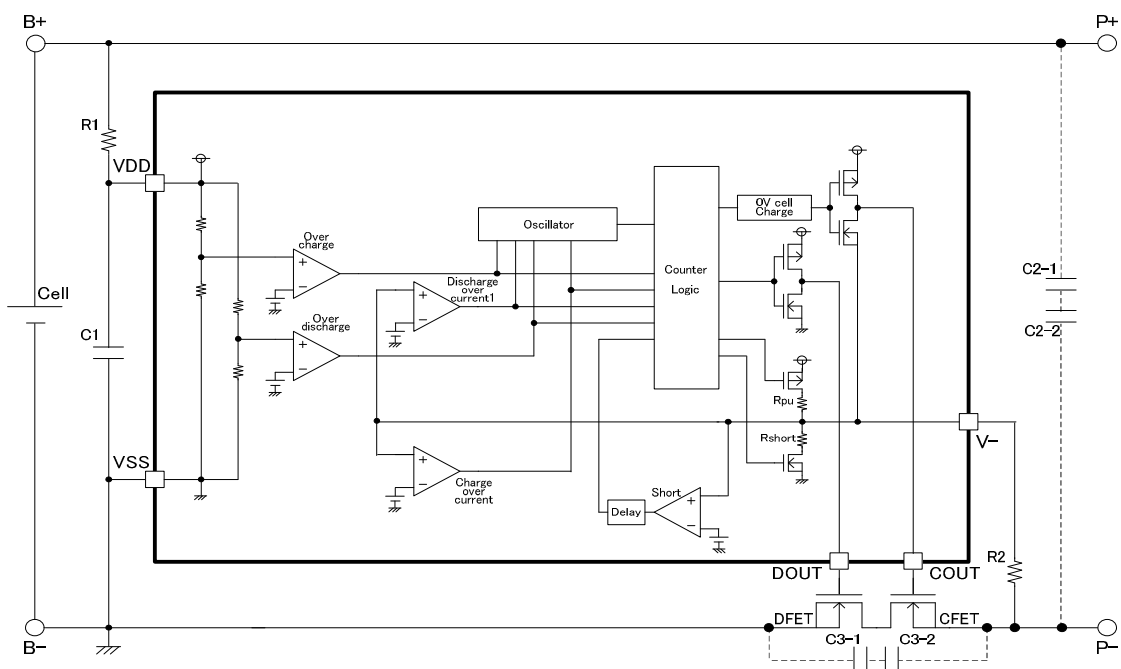
\*5 Please refer to each specifications for release condition.

\*6 Current detection voltage Accuracy





## Typical application circuit



| Symbol | Part        | Min.   | Typ.  | Max.  | Purpose                                      |
|--------|-------------|--------|-------|-------|----------------------------------------------|
| R1     | Resistor    | -      | 100Ω  | 1.0kΩ | For voltage fluctuation, For ESD             |
| C1     | Capacitor   | 0.01uF | 0.1uF | 1.0uF | For voltage fluctuation                      |
| R2     | Resistor    | -      | 1.0kΩ | 1.0kΩ | Current limit for charger reverse connection |
| C2     | Capacitor   | -      | 0.1uF | -     | For exogenous noise                          |
| C3     | Capacitor   | -      | 0.1uF | -     | For exogenous noise                          |
| DFET   | Nch MOS FET | -      | -     | -     | Charge and discharge control                 |
| CFET   |             |        |       |       |                                              |

### Application hints

R1 and C1 stabilize a supply voltage fluctuation. However, the detection voltage rises by the current consumption of IC when R1 is too large, and please use 1kohm or less for R1. Please use 0.01uF or more for C1 to stabilize the operation.





## Lineup

| MODEL        | PKG     | OV charge  | Protection mode latch function |               |                       | Hys-Cancel |               | Overcharge detection voltage | Overcharge release voltage | Overdischarge detection voltage | Overdischarge release voltage | Discharging overcurrent detection voltage | Charging overcurrent detection voltage | Short detection voltage1 |
|--------------|---------|------------|--------------------------------|---------------|-----------------------|------------|---------------|------------------------------|----------------------------|---------------------------------|-------------------------------|-------------------------------------------|----------------------------------------|--------------------------|
|              |         |            | Overcharge                     | Overdischarge | Discharge overcurrent | Overcharge | Overdischarge | Vdet1 [V]                    | Vrel1 [V]                  | Vdet2 [V]                       | Vrel2 [V]                     | Vdet3 [mV]                                | Vdet4 [mV]                             | Vshort [mV]              |
|              |         |            |                                |               |                       |            |               |                              |                            |                                 |                               |                                           |                                        |                          |
| MM3825ACCYLE | SON-6C  | 0.9        | Disable                        | Disable       | Disable               | Enable     | Disable       | 4.475                        | 4.275                      | 2.500                           | 2.900                         | 20.0                                      | -20.0                                  | 70.0                     |
| MM3825CM1RRE | SSON-6J | 1.1        | Disable                        | Enable        | Disable               | Enable     | Enable        | 4.275                        | 4.175                      | 2.400                           | 2.400                         | 90.0                                      | -25.0                                  | 250.0                    |
| MM3825CM3YRE | SON-6C  | 0.9        | Disable                        | Enable        | Disable               | Enable     | Enable        | 4.475                        | 4.275                      | 2.700                           | 2.700                         | 45.0                                      | -45.0                                  | 145.0                    |
| MM3825CN3YRE | SON-6C  | Permission | Disable                        | Enable        | Disable               | Enable     | Enable        | 4.475                        | 4.275                      | 2.500                           | 2.500                         | 30.0                                      | -30.0                                  | 105.0                    |
| MM3825TM3YRE | SON-6C  | 0.9        | Disable                        | Disable       | Disable               | Enable     | Disable       | 4.475                        | 4.275                      | 2.500                           | 2.800                         | 60.0                                      | -60.0                                  | 190.0                    |
| MM3825TM4RRE | SSON-6J | 2.1        | Disable                        | Enable        | Disable               | Enable     | Enable        | 4.200                        | 4.000                      | 2.800                           | 2.800                         | 50.0                                      | -50.0                                  | 150.0                    |
| MM3825TN1YRE | SON-6C  | Permission | Disable                        | Enable        | Disable               | Enable     | Enable        | 4.495                        | 4.295                      | 2.500                           | 2.500                         | 45.0                                      | -45.0                                  | 150.0                    |

## Delay time

| MODEL        | t Vdet1 [s] | t Vrel1 [ms] | t Vdet2 [ms] | t Vrel2 [ms] | t Vdet3 [ms] | t Vrel3 [ms] | t Vdet4 [ms] | t Vrel4 [ms] | t short [us] |
|--------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| MM3825ACCYLE | 1.024       | 16.00        | 64.00        | 1.00         | 16.00        | 1.00         | 16.00        | 1.00         | 280          |
| MM3825CM1RRE | 1.024       | 16.00        | 32.00        | 1.00         | 24.00        | 1.00         | 8.00         | 1.00         | 250          |
| MM3825CM3YRE | 1.024       | 16.00        | 32.00        | 1.00         | 16.00        | 1.00         | 8.00         | 1.00         | 280          |
| MM3825CN3YRE | 1.024       | 16.00        | 32.00        | 1.00         | 8.00         | 1.00         | 8.00         | 1.00         | 280          |
| MM3825TM3YRE | 1.024       | 16.00        | 20.00        | 1.00         | 12.00        | 1.00         | 8.00         | 1.00         | 280          |
| MM3825TM4RRE | 1.024       | 8.00         | 128.00       | 1.00         | 8.00         | 1.00         | 8.00         | 1.00         | 280          |
| MM3825TN1YRE | 1.024       | 16.00        | 32.00        | 1.00         | 32.00        | 1.00         | 8.00         | 1.00         | 280          |

