USB connector temperature protection IC
Monolithic IC MM3691 Series

Outline

Micro USB (μUSB) is one of the most popular charging connector for current portable devices. Due to exposed terminal and its small size, accident by contamination and/or damage may need to be considered as potential risk of the safety.
Mitsumi MM3691 provides more secure charging function than conventional technology using just PTC/Fuse by detecting abnormal temperature. By considering abnormal voltage drop due to like internal contamination of the connector, MM3691 also has Over-discharge detection function to shutdown extra current.

Features

(1) TH pin detection voltage1 (VDD=5.0V)	4.165V Typ. (0.833×VDD Typ.)	±0.055V
(2) TH pin detection dead time	50ms Typ.	±35%
(3) Low voltage Detect	3.500V Typ.	±0.030V
(4) Low voltage Detect Delay time (function for the pulse charge) is provided.	50ms Typ.	±35% fixed
(5) Reset detection Voltage	1.800V Typ.	±0.100V
(6) Reset release Delay time	64ms Typ.	±35%
(7) Reset release Voltage	3.800V Typ.	±0.050V

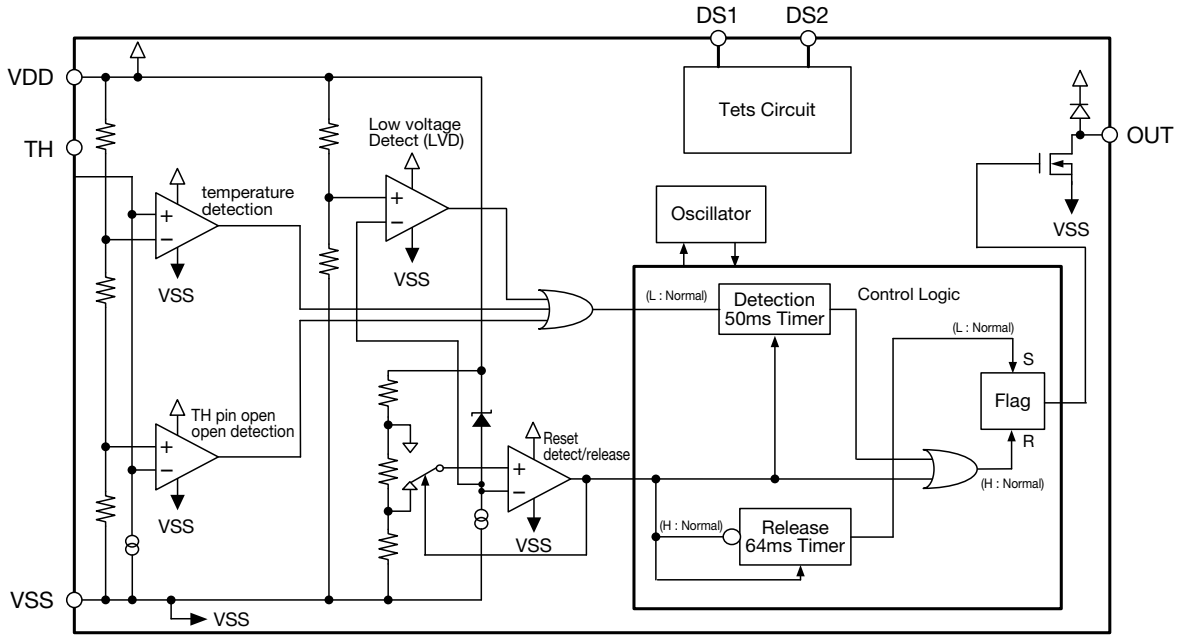
Package

SSON-6A

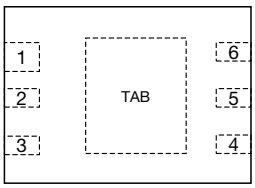
Applications

1. USB Connector for charger

Block Diagram



Pin Assignment



SSON-6A
(TOP VIEW)

1	VDD
2	DS2
3	TH
4	DS1
5	VSS
6	OUT

*1 : Please TAB should be connected to VSS level or electrically open.

Pin Description

Pin No.	Pin Name	Function
1	VDD	The input terminal of the power supply of IC.
2	DS2	Test terminal.Commected to VDD
3	TH	Temperature detection terminal.
4	DS1	Test terminal.Commected to VDD
5	VSS	The input terminal of the ground of IC.
6	OUT	Charge FET control output terminal. Output type is N-MOS Open Drain

Absolute Maximum Ratings

Item	Symbol	Ratings	Units
Supply voltage	VDD	−0.3~16.0	V
OUT terminal voltage	VOUT	VSS−0.3~VDD+0.3	V
Storage temperature	Tstg	−55~125	°C
Power dissipation	Pd	150	mW

Recommended Operating Conditions

Item	Symbol	Ratings	Units
Operating ambient temperature	Topr	−40~85	°C
Operating voltage	Vop	1.6~13.5	V

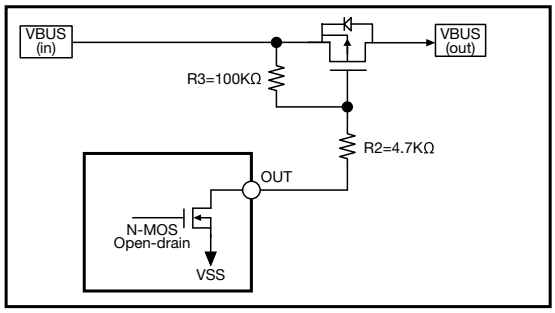
Electrical Characteristics (Except where noted otherwise Ta=25°C)

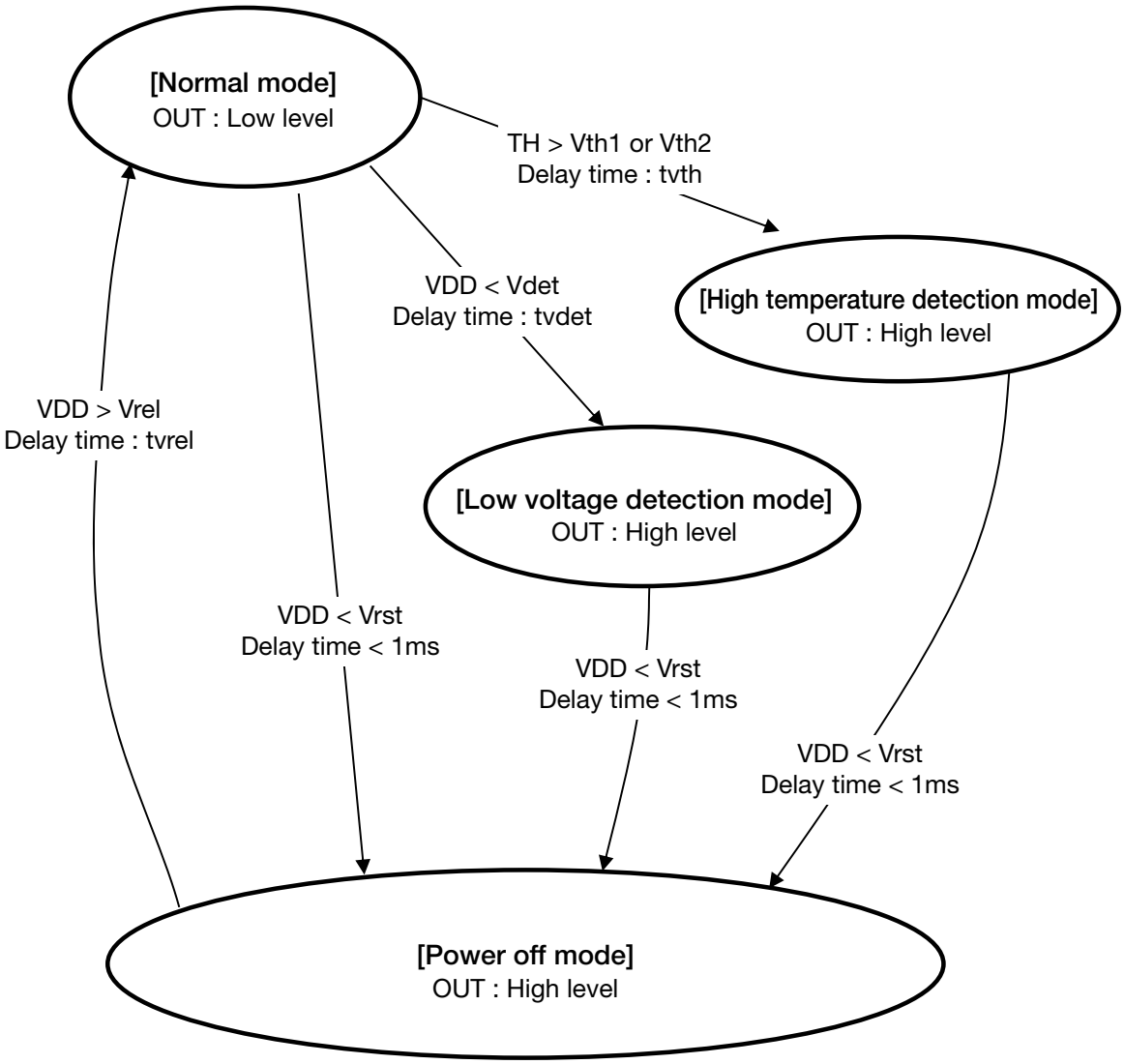
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Consumption current 1	Idd1	VDD=5.0V		8.0	20.0	µA
Consumption current 2	Idd2	VDD=12.0V		12.0	25.0	µA
TH pin input pull down current	Ith	VDD=5.0V, 12.0V TH=0.5×VDD	0.04	0.15	0.30	µA
TH pin detection voltage1	Vth1	VDD=5.0V TH=2.5V–>Vth1	4.110	4.165	4.220	V
TH pin detection voltage2	Vth2	VDD=5.0V, 9.0V, 12.0V TH=0.5×VDD–>Vth2	0.822×VDD	0.833×VDD	0.844×VDD	V
TH pin detection dead time	tvth	VDD=5.0V TH=2.5V–>4.5V	32.5	50	67.5	ms
Low voltage Detect	Vdet	VDD=4.0V–>Vdet TH=0.5×VDD	3.47	3.50	3.53	V
Low voltage Detect Delay time	tvdet	VDD=4.0V–>3.0V TH=0.5×VDD	32.5	50	67.5	ms
Reset detection voltage	Vrst	VDD=5.0V–>Vrst TH=0.5×VDD	1.7	1.8	1.9	V
Reset release voltage	Vrel	VDD=0V–>Vrel TH=0.5×VDD	3.75	3.80	3.85	V
Reset release Delay time	tvrel	VDD=Vrst–>4.0V TH=0.5×VDD	41.6	64.0	86.4	ms
TH pin open detection voltage	Vth_open	VDD=5.0V, 9.0V, 12.0V TH=0.5×VDD–>Vth_open	TYP −70mV	0.03×VDD	TYP +70mV	V
Thermistor open detection Delay time	topen	VDD=5.0V TH=0.5×VDD–>0V	32.5	50	67.5	ms
OUT Low level output voltage	IoutL	VDD=5.0V, VoL=0.5V	250			µA

Operation

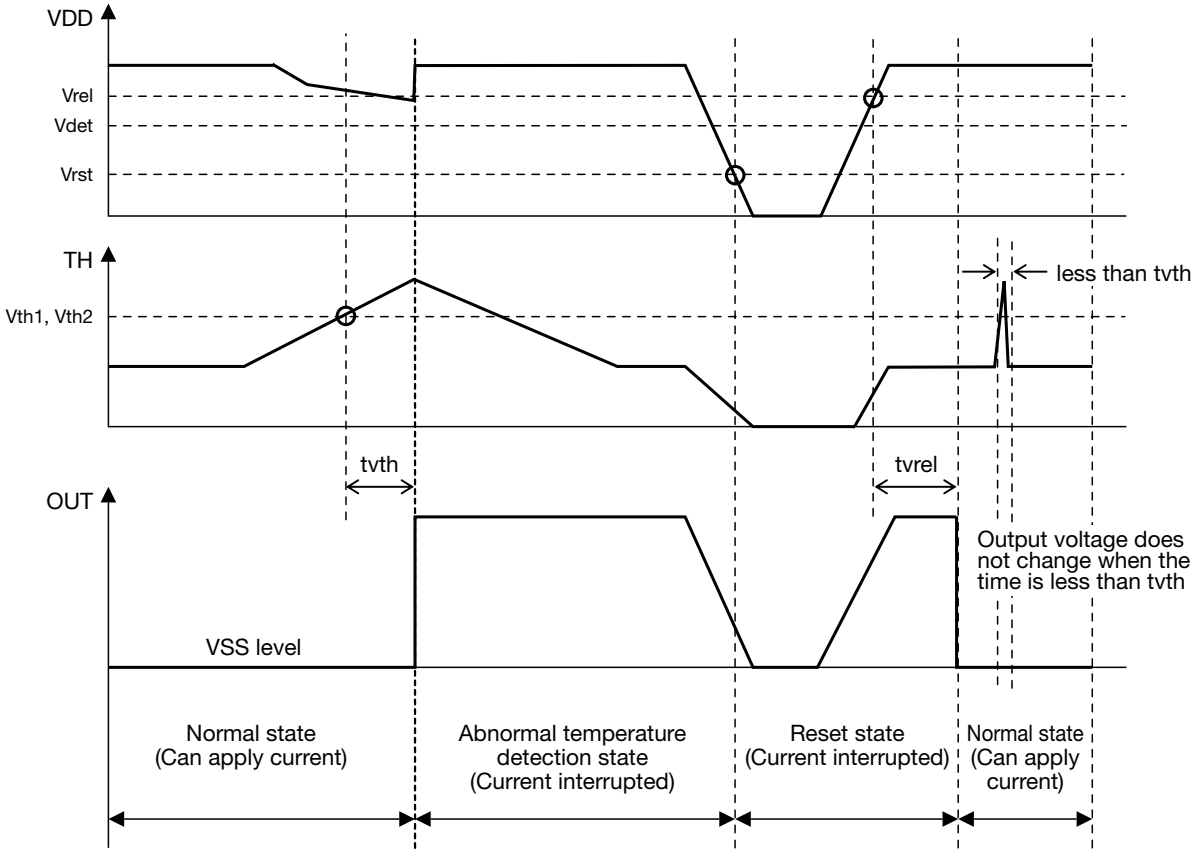
(1) Flow diagram

Following measurement circuit is used for OUT-pin output level.





(2) Temperature detection timing chart



< Abnormal temperature detection >

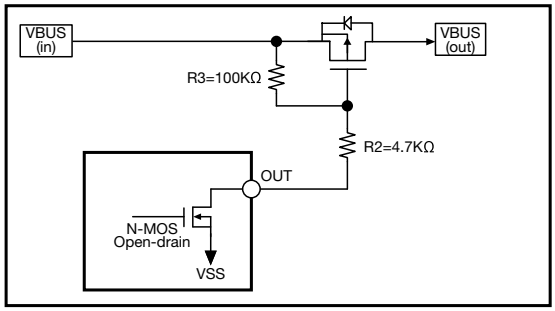
When TH voltage is beyond the setting voltage of TH-pin (Vth1,2), this IC detects abnormal temperature and interrupt external charge FET (P-MOS FET).

Delay time (tvth) is set for abnormal temperature detection.

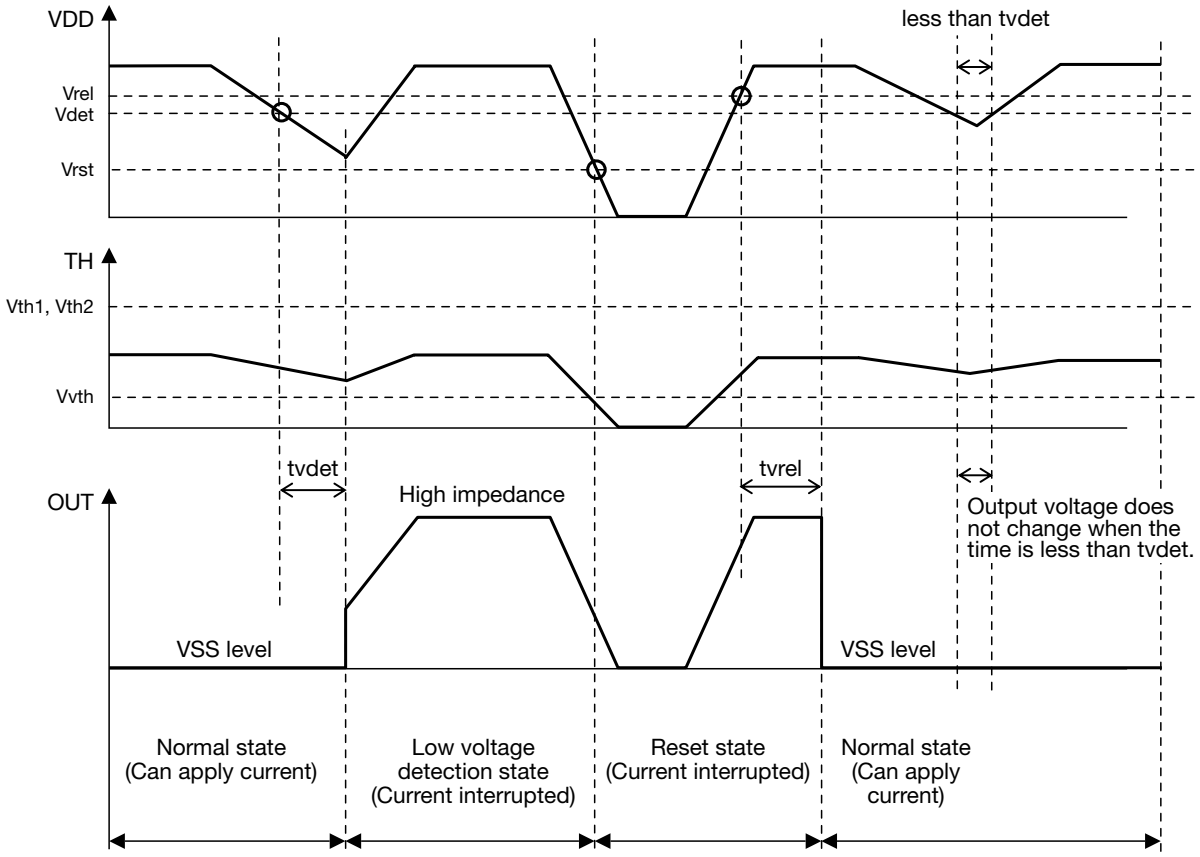
After abnormal temperature detection, even when the detection temperature is decreased, abnormal state is maintained.

The reintroduction of the power supply is necessary to usually return to a state from an abnormal temperature detection state. The power supply voltage returns to a normal state in things more than the reset cancellation voltage from less than 0v(reset detection voltage (Vrst)).

Following measurement circuit is used for the above timing chart.



(3) Low voltage detection timing chart



< Low voltage detection >

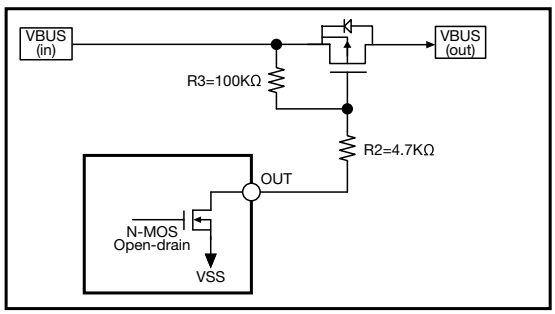
This IC detects low voltage detection state and interrupts charging FET(P-MOS FET) when power supply voltage (VDD) is decreased and below overdischarge detection voltage (Vdet).

Delay time (tvdet) is set for low voltage detection.

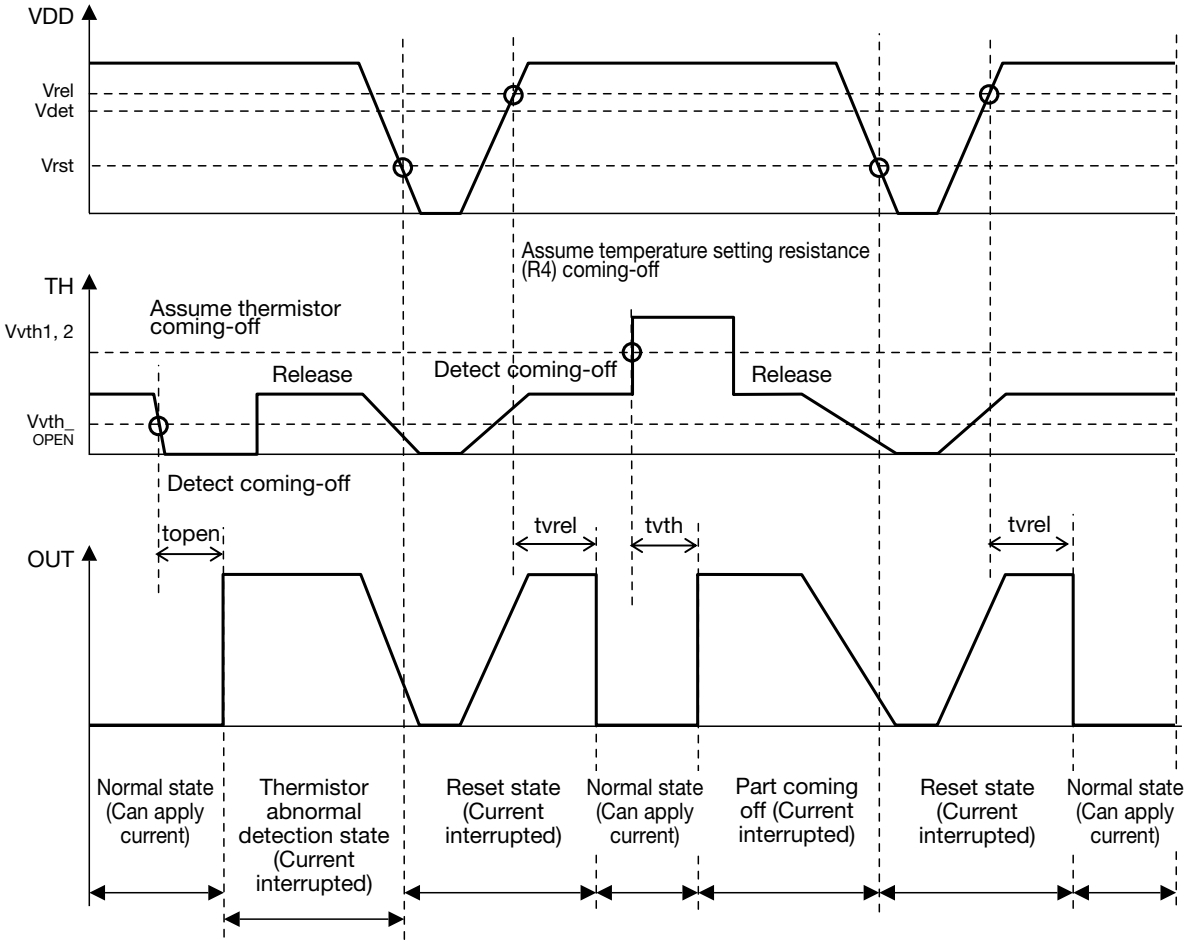
After low voltage detection state, even when the battery voltage is increased, low voltage detection state is maintained.

The reintroduction of the power supply is necessary to usually return to a state from a low voltage detection state. The power supply voltage returns to a normal state in things more than the reset cancellation voltage from less than 0v(reset detection voltage (Vrst)).

Following measurement circuit is used for the above timing chart.



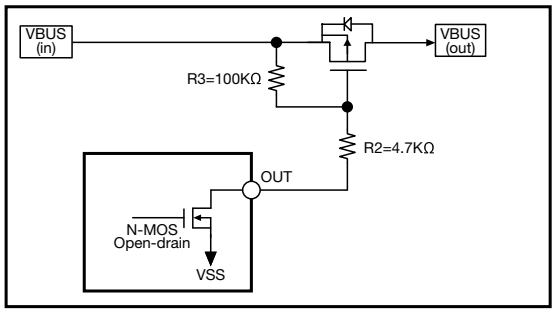
(4) IC operation of NTC Thermistor and R4 are out during



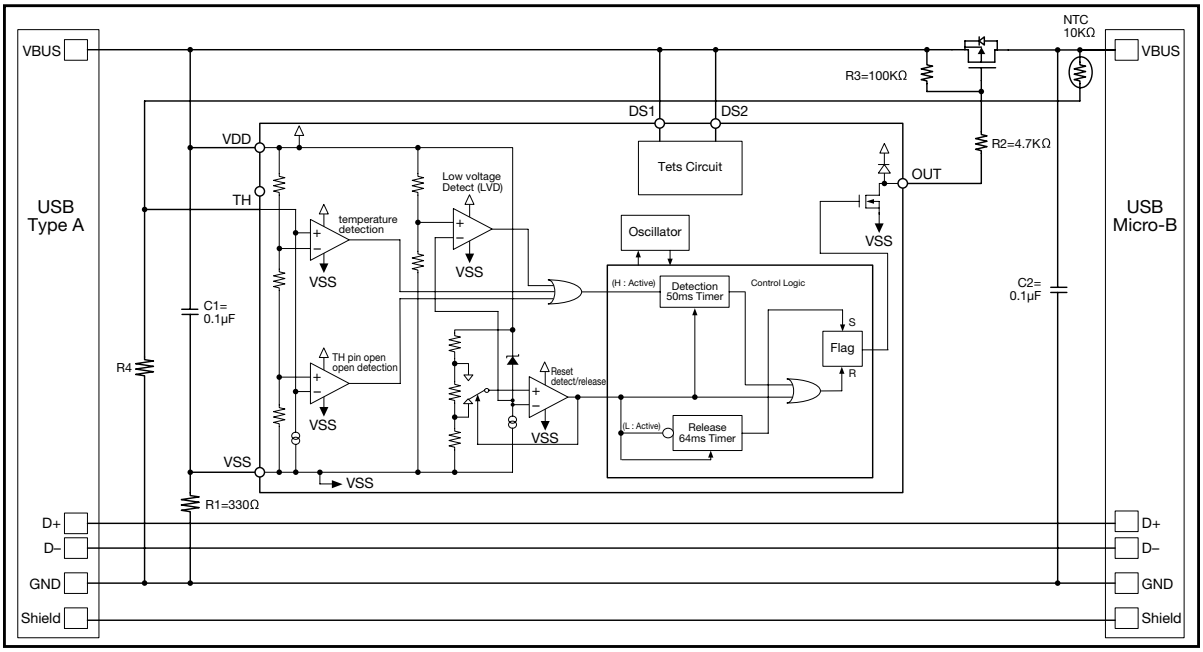
< Operation during part coming off >

When a part or some parts (such as NTC thermistor or R4) come off after mounting on board, this IC interrupt current FET(P-MOS FET) and maintain the state (Fail-Safe function).

Following measurement circuit is used for the above timing chart.



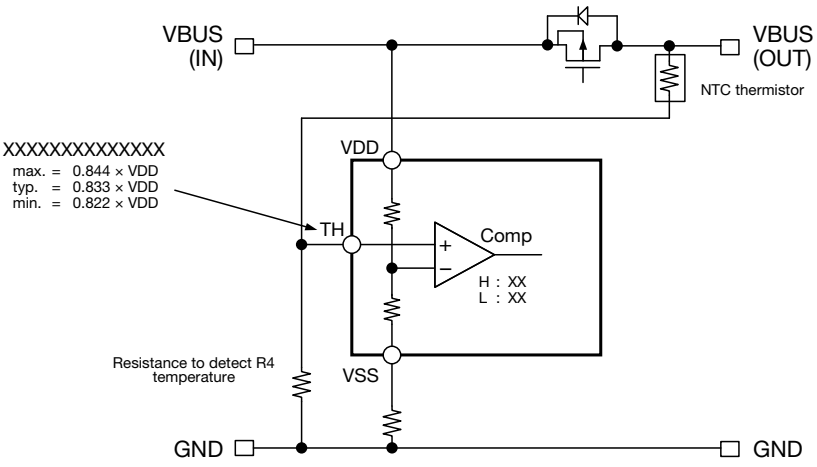
Application Circuit



- These circuits are typical examples provided for reference purposes, so in actual applications, the circuit constants, conditions and operations should be thoroughly studied.
- Mitsumi Electric Co., Ltd. assumes no responsibility for any trouble or damage as a result of the use of these circuits.liable for any such problem, nor grant a license therefore.

Characteristics

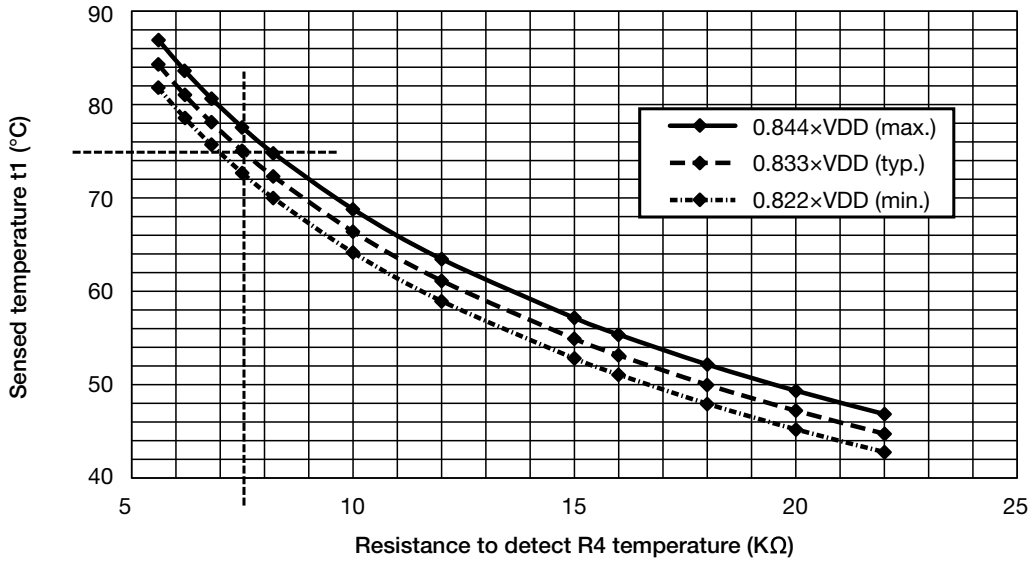
(1) Calculation example1



< Reference >

NTC thermistor : NCP21XV103J03RA (Murata Manufacturing Co., Ltd.)
R=10KΩ ±1% : Reference value: B constant number (25°C-80°C)=3930
t1(Detection temperature) = 75°C, t0(Reference temperature)=25°C

Relationship between temperature setting detection and detecting temperature when measurement circuit and the part described are used.



R : Resistance value for thermistor standard (25°C)
RT : Thermistor resistance when temperature is t1
R4 : Resistance to detect R4 temperature
Calculation example in R4=7.5KΩ
RT=R4*(1-0.833)/0.833 = 1.5KΩ
B : Thermistor standard (B constant number)

Formula for detection temperature (t1)

$$\text{Detection temperature(t1)} = \frac{1}{\frac{\ln(RT/R)}{B} + (1/(273.15+25))} - 273.15 \rightarrow t1 = 75.13°C$$

(2) Calculation example2

R : Resistance value for thermistor standard (25°C)
RT : Thermistor resistance when temperature is t1
R4 : Resistance to detect R4 temperature
B : Thermistor standard (B constant number)

< Reference >

NTC thermistor : NCP21XV103J03RA (Murata Manufacturing Co., Ltd.)
R=10KΩ ±1% : Reference value: B constant number (25°C-80°C)=3930
t1(Detection temperature) = 75°C, t0(Reference temperature)=25°C

STEP1

$$RT = R \cdot \exp \cdot B \cdot \left(\frac{1}{273.15+t1} - \frac{1}{273.15+t0} \right)$$

$$RT = 10K\Omega \cdot \exp \cdot 3930 \cdot \left(\frac{1}{273.15+75} - \frac{1}{273.15+25} \right)$$

$$RT = 1.506K\Omega$$

STEP2

$$R4 = RT \left(\frac{0.833}{1-0.833} \right)$$

$$R4 = 1.506K\Omega \left(\frac{0.833}{1-0.833} \right)$$

$$R4 = 7.512K\Omega \fallingdotseq 7.5K\Omega \text{ (E24 series)}$$