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**USB HIGH-SIDE POWER SWITCH**

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NO.EA-091-130827

**OUTLINE**

The R5520H is CMOS-based high-side MOSFET switch IC for Universal Serial Bus (USB) applications. Low ON Resistance (Typ.100mΩ) and low supply current (Typ.20μA at active mode) are realized in this IC.

An over-current limit circuit, thermal shutdown circuit, and an under voltage lockout circuit are built-in as protection circuits. Further, a delay circuit for flag signal after detecting over-current, is embedded to prevent miss-operation of error flag because of inrush current. The R5520H is ideal for applications of protection for USB power supply.

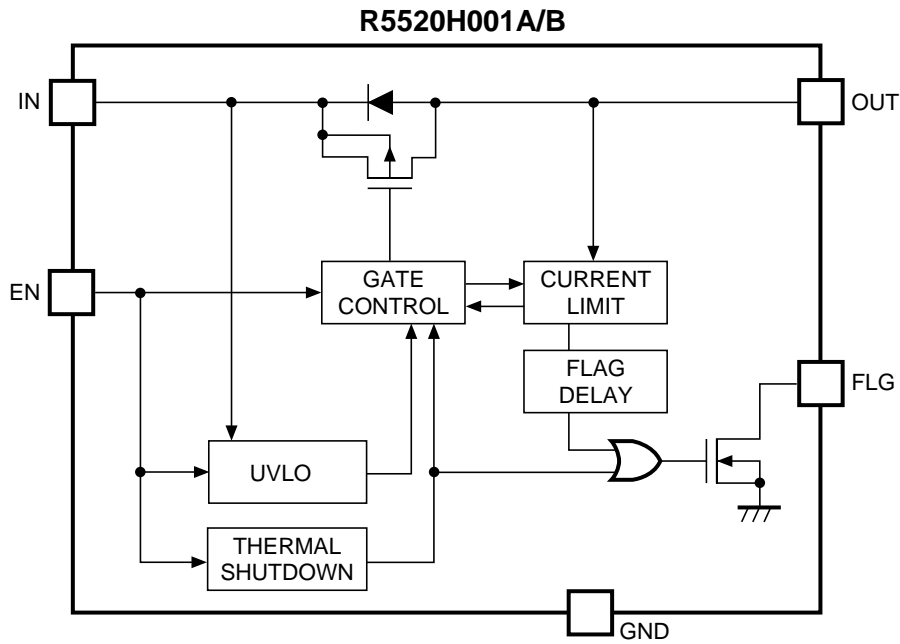
**FEATURES**

- Built-in P-channel MOSFET Switch
- Supply Current .....Typ. 20μA (at Active Mode)
- Switch ON Resistance .....Typ. 100mΩ
- Output Current.....Min. 500mA
- Flag Delay Time .....Typ. 10ms.
- Over- Current Limit / Short Circuit Protection
- Built-in Under Voltage Lockout (UVLO) Function
- Built-in Thermal Shutdown Protection
- Built-in Soft-start Function
- Package .....SOT-89-5

**APPLICATIONS**

- USB Peripherals
- Notebook PCs

**BLOCK DIAGRAMS**



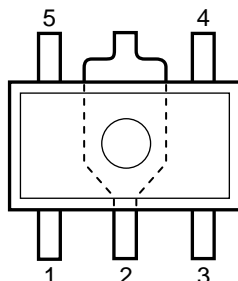
**SELECTION GUIDE**

The logic of the enable pin for the ICs can be selected at the user's request.

| Product Name  | Package  | Quantity per Reel | Pb Free | Halogen Free |
|---|----------|-------------------|---------|--------------|
| R5520H001*-T1-FE  | SOT-89-5 | 1,000 pcs         | Yes     | Yes          |
| * : Designation of the logic of the enable pin.<br>(A) "L" active<br>(B) "H" active |          |                   |         |              |

## PIN DESCRIPTIONS

### • SOT-89-5



| Pin No | Symbol | Pin Description             |
|--------|--------|-----------------------------|
| 1      | EN     | Enable Pin                  |
| 2      | GND    | Ground Pin                  |
| 3      | FLG    | FLG pin (Open Drain Output) |
| 4      | IN     | Power Supply Pin            |
| 5      | OUT    | Output Pin                  |

## ABSOLUTE MAXIMUM RATINGS

| Symbol    | Item                                       | Rating               | Unit |
|-----------|--|----------------------|------|
| $V_{IN}$  | Input Voltage                              | 6.0                  | V    |
| $V_{EN}$  | Enable Pin Input Voltage                   | -0.3 to $V_{IN}+0.3$ | V    |
| $V_{FLG}$ | Flag Voltage                               | -0.3 to 6.0          | V    |
| $I_{FLG}$ | Flag Current                               | 14                   | mA   |
| $V_{OUT}$ | Output Voltage                             | -0.3 to $V_{IN}+0.3$ | V    |
| $I_{OUT}$ | Output Current                             | Internal Limited     |      |
| $P_D$     | Power Dissipation <sup>*1</sup> (SOT-89-5) | 900                  | mW   |
| $T_a$     | Operating Temperature Range                | -40 to 85            | °C   |
| $T_{stg}$ | Storage Temperature Range                  | -55 to 125           | °C   |

<sup>\*1</sup> For Power Dissipation, please refer to PACKAGE INFORMATION.

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

## ELECTRICAL CHARACTERISTICS

## • R5520H001A/B

Ta=25°C

| Symbol            | Item                                   | Conditions                                   | Min. | Typ. | Max. | Unit |
|-------------------|--|--|------|------|------|------|
| V <sub>IN</sub>   | Input Voltage                          |  | 4.0  |      | 5.5  | V    |
| I <sub>DD1</sub>  | Supply Current 1                       | Active <sup>*1</sup> , OUT=open              |      | 20   | 60   | μA   |
| I <sub>DD2</sub>  | Supply Current 2                       | OFF <sup>*2</sup> , OUT=open                 |      | 0.5  | 5.0  | μA   |
| R <sub>ON</sub>   | Switch On Resistance                   | V <sub>IN</sub> =5V, I <sub>OUT</sub> =500mA |      | 100  | 140  | mΩ   |
|                   |  | V <sub>IN</sub> =4V, I <sub>OUT</sub> =500mA |      | 110  | 150  | mΩ   |
| t <sub>ON</sub>   | Output Turn-on Delay                   | R <sub>L</sub> =10Ω                          |      | 2    | 12   | ms   |
| t <sub>OFF</sub>  | Output Turn-off Delay                  | R <sub>L</sub> =10Ω                          |      | 5    | 20   | μs   |
| V <sub>UVLO</sub> | UVLO Threshold                         | V <sub>IN</sub> =increasing                  | 2.1  | 2.4  | 2.7  | V    |
|                   |  | V <sub>IN</sub> =decreasing                  |      | 2.2  |      | V    |
| I <sub>TH</sub>   | Current Limit Threshold                | Ramped Load                                  |      | 1.2  | 2.0  | A    |
| I <sub>LIM</sub>  | Short Current Limit                    | V <sub>OUT</sub> =0V                         | 0.50 | 0.75 | 1.00 | A    |
| t <sub>FD</sub>   | Over Current Flag Delay                | From Over Current to FLG="L"                 | 5    | 10   | 20   | ms   |
| T <sub>TS</sub>   | Thermal Shutdown Temperature Threshold | T <sub>j</sub> =increasing                   |      | 135  |      | °C   |
|                   |  | T <sub>j</sub> =decreasing                   |      | 125  |      |      |
| I <sub>EN</sub>   | Enable Pin Input Current               |  |      | 0.01 | 1.00 | μA   |
| V <sub>EN1</sub>  | Enable Pin Input Voltage 1             | V <sub>EN</sub> =increasing                  | 2.4  |      |      | V    |
| V <sub>EN2</sub>  | Enable Pin Input Voltage 2             | V <sub>EN</sub> =decreasing                  |      |      | 0.8  | V    |
| I <sub>LO</sub>   | Output Leakage Current                 |  |      | 1    | 10   | μA   |
| V <sub>LF</sub>   | Flag "L" Output Voltage                | I <sub>SINK</sub> =1mA                       |      |      | 0.4  | V    |
| I <sub>FOF</sub>  | Flag Off Current                       | V <sub>FLAG</sub> =5.5V                      |      | 0.05 | 2.00 | μA   |

<sup>\*1</sup> EN=L (R5520H001A), EN=H (R5520H001B)

<sup>\*2</sup> EN=H (R5520H001A), EN=L (R5520H001B)

## RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

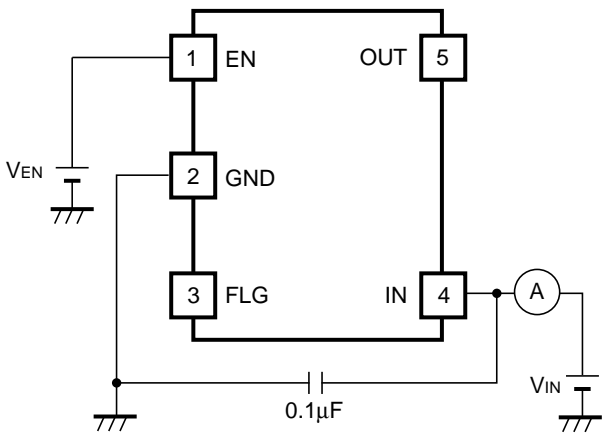
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

## OPERATION

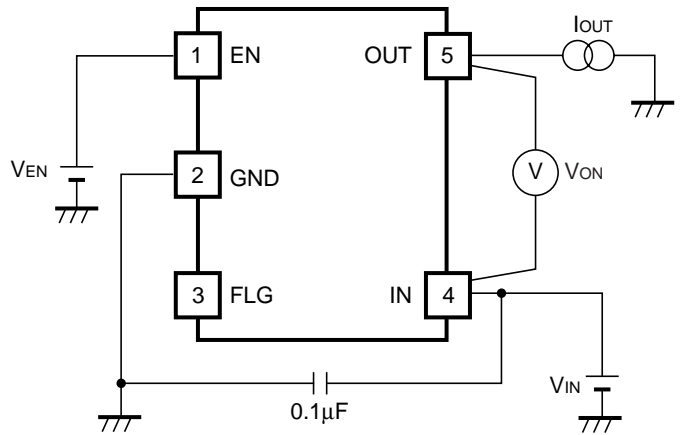
This explanation is based on the typical application.

- (1) There is a parasitic diode between source and drain of the switch transistor. (Refer to the block diagram.) Because of this, in both cases of enable and disable, if the voltage of OUT pin is higher than IN pin, current flows from OUT to IN.
- (2) In case that OUT pin and GND is short, if over-current would continue, the temperature of the IC would increase drastically. If the temperature of the IC is beyond 135°C, the switch transistor turns off and the FLG pin level becomes "L". Then, when the temperature of the IC decreases equal or lower than 125°C, the switch transistor turns on and FLG becomes "H". Unless the abnormal situation of OUT pin is removed, the switch transistor repeats on and off.  
Refer to the 21) over-current protection operation in the typical characteristics.
- (3) Over-current level is set internally in the IC. There are three types of response against over-current:
  - ① Under the condition that OUT pin is short or large capacity is loaded, if the IC is enabled, the IC becomes constant current state. After the flag delay time passes, FLG becomes "L", that means over current state. Refer to the 20) current limit transient response of typical characteristics.
  - ② While the switch transistor is on, if OUT pin is short or large capacity is loaded, until the current limit circuit responds, large transient current flows. After the transient current is beyond the over-current detector threshold and delay time of the flag passes, FLG becomes "L", that means over current state. Refer to the 22), 23) over-current limit transient response of typical characteristics.
  - ③ In the case that load current gradually increases, the IC is not into the constant current state until the current is beyond over current limit. Once the level is beyond the over current detector threshold, load current is limited into over current limit level. Note that load current continuously flows until the load current is beyond the over-current detector threshold.
- (4) FLG pin is Nch Open drain output. If the over-current or over-temperature is detected, FLG becomes "L". If over-current is detected, FLG becomes "L" after the flag delay time  $t_{FD}$  passes. Therefore flag signal is not out with inrush current.
- (5) UVLO circuit prevents that the switch transistor turns on until the input voltage is beyond 2.4V. UVLO circuit can operate when the IC is enabled.

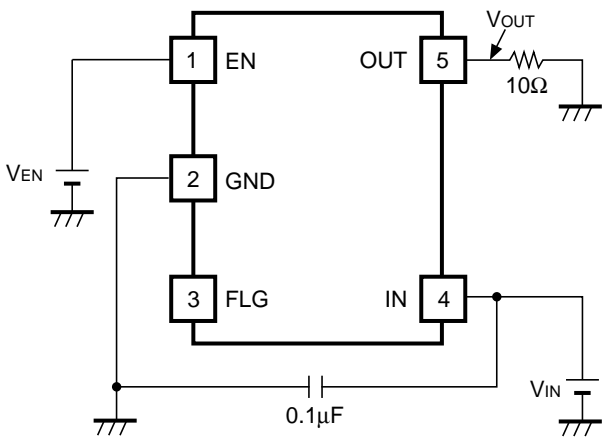
**TEST CIRCUIT**



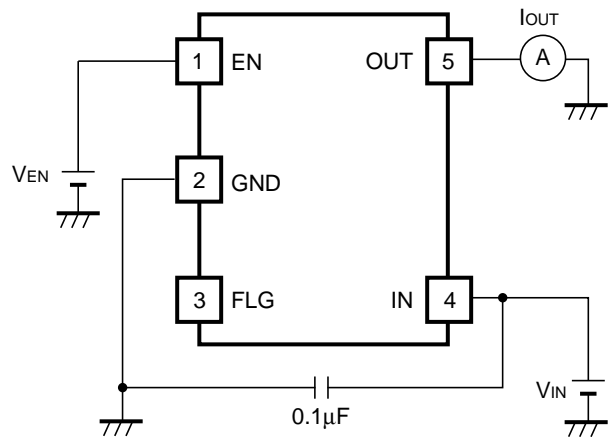
**Supply Current Test Circuit**



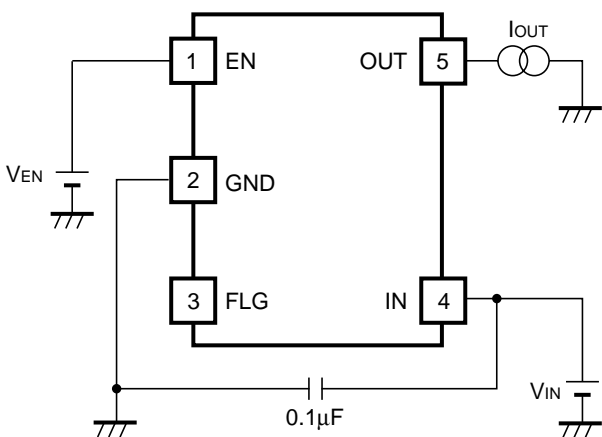
**Switch On Resistance Test Circuit**



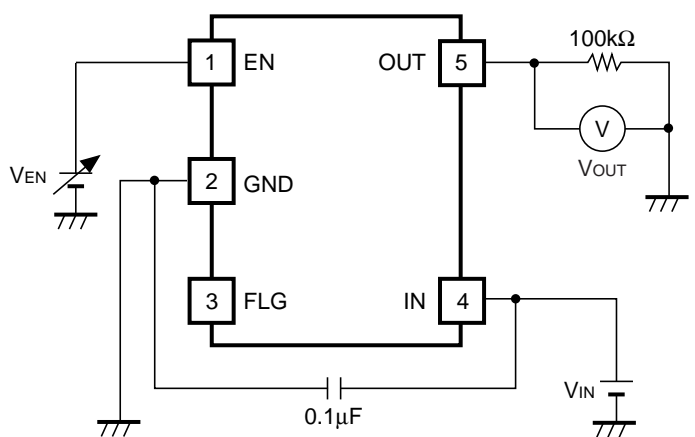
**Output On Time Test Circuit**



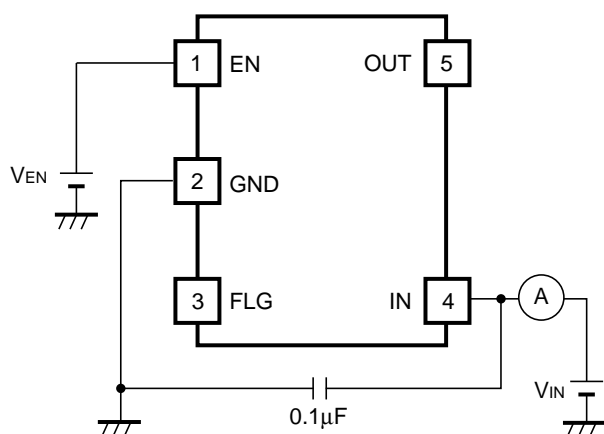
**Over-current Limit Test Circuit**



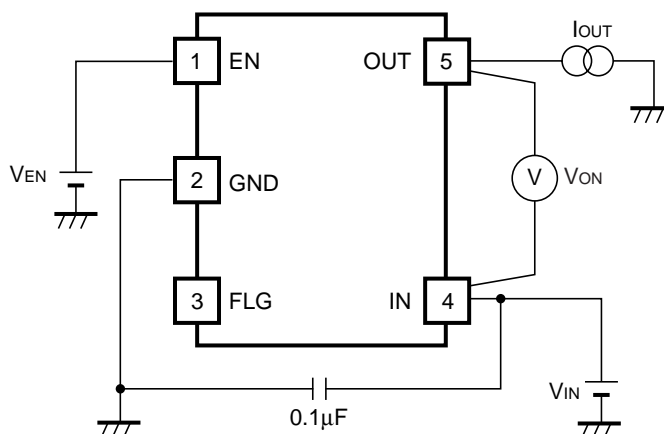
**Over-current Threshold Test Circuit**



**Enable Input Voltage Test Circuit**

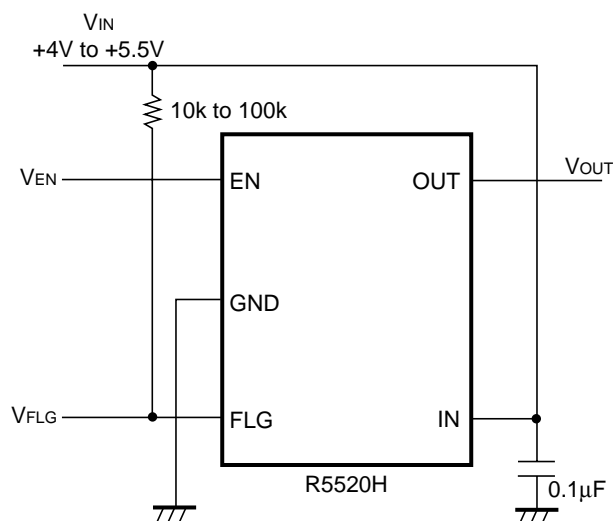


Flag Output Delay Time Test Circuit



UVLO Threshold Test Circuit

## TYPICAL APPLICATION



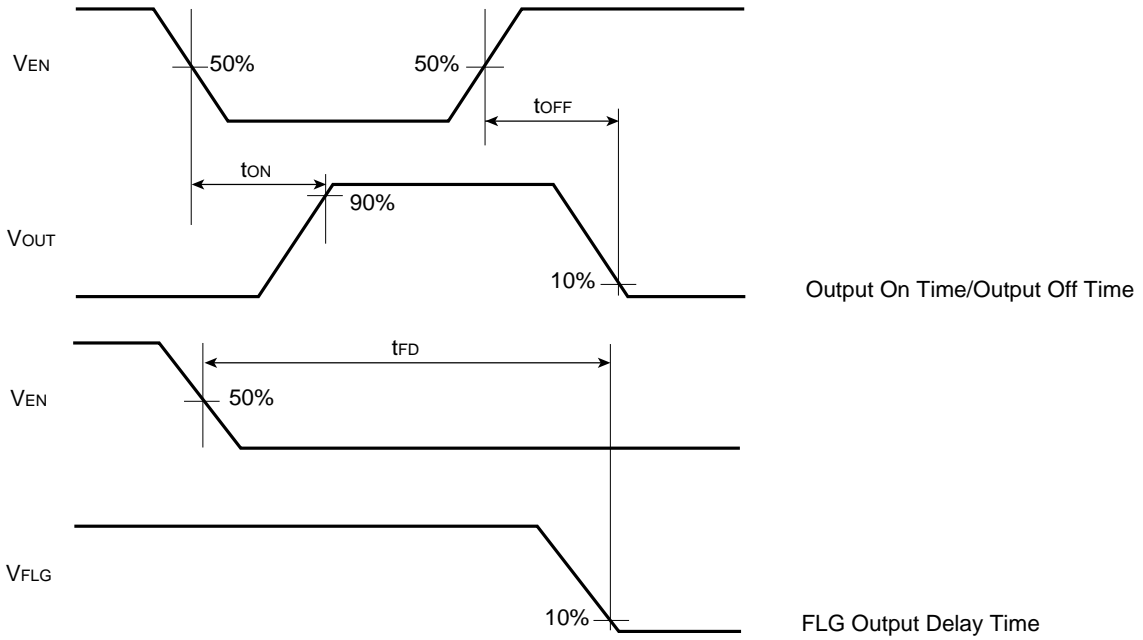
R5520H001A/B

## TECHNICAL NOTES

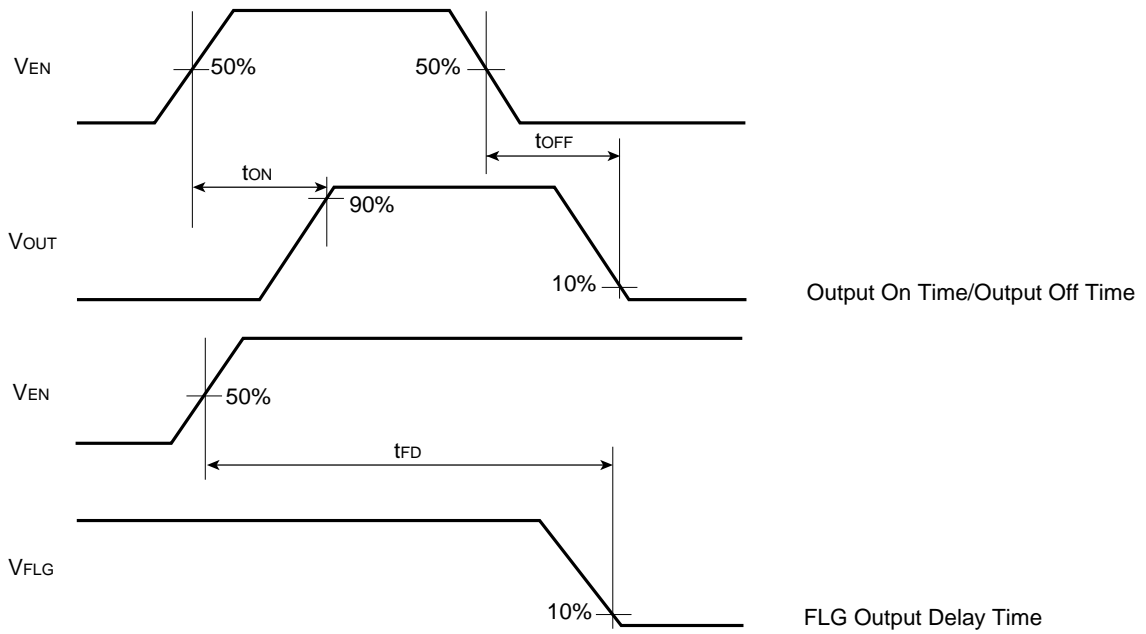
- Put a capacitance range from  $0.1\mu\text{F}$  to  $1\mu\text{F}$  bypass capacitor between IN pin and GND pin of the IC. Without a bypass capacitor, in case of output short, because of the high side inductance of IN pin, ringing may be generated and it might be a cause of an unstable operation.
- Recommended pull-up resistance value range of flag pin is from  $10\text{k}\Omega$  to  $100\text{k}\Omega$ .

# TIMING CHART

## • R5520H001A



## • R5520H001B





## PACKAGE INFORMATION

### POWER DISSIPATION (SOT-89-5)

Power Dissipation ( $P_D$ ) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

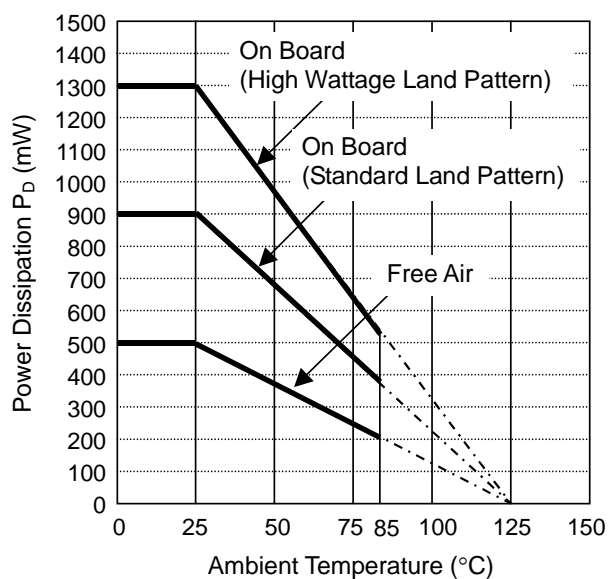
#### Measurement Conditions

|                  | High Wattage Land Pattern                            | Standard Land Pattern                                |
|------------------|--|--|
| Environment      | Mounting on Board (Wind velocity=0m/s)               | Mounting on Board (Wind velocity=0m/s)               |
| Board Material   | Glass cloth epoxy plastic (Double sided)             | Glass cloth epoxy plastic (Double sided)             |
| Board Dimensions | 30mm × 30mm × 1.6mm                                  | 50mm × 50mm × 1.6mm                                  |
| Copper Ratio     | Top side : Approx. 20% ,<br>Back side : Approx. 100% | Top side : Approx. 10% ,<br>Back side : Approx. 100% |
| Through-hole     | φ0.85mm × 10pcs                                      | -  |

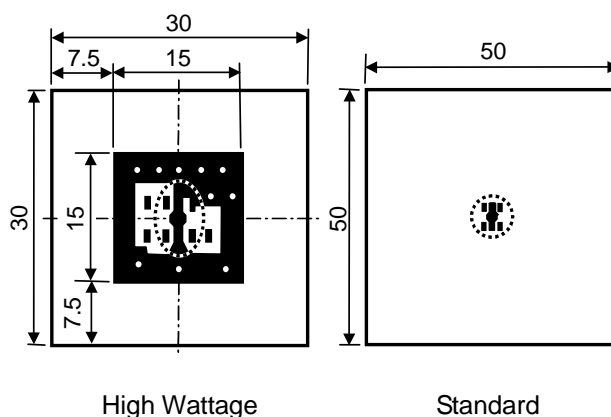
#### Measurement Result

( $T_a=25^{\circ}\text{C}$ ,  $T_{j\text{max}}=125^{\circ}\text{C}$ )

|                    | High Wattage Land Pattern | Standard Land Pattern | Free Air |
|--------------------|---------------------------|-----------------------|----------|
| Power Dissipation  | 1300mW                    | 900mW                 | 500mW    |
| Thermal Resistance | 77°C/W                    | 111°C/W               | 200°C/W  |



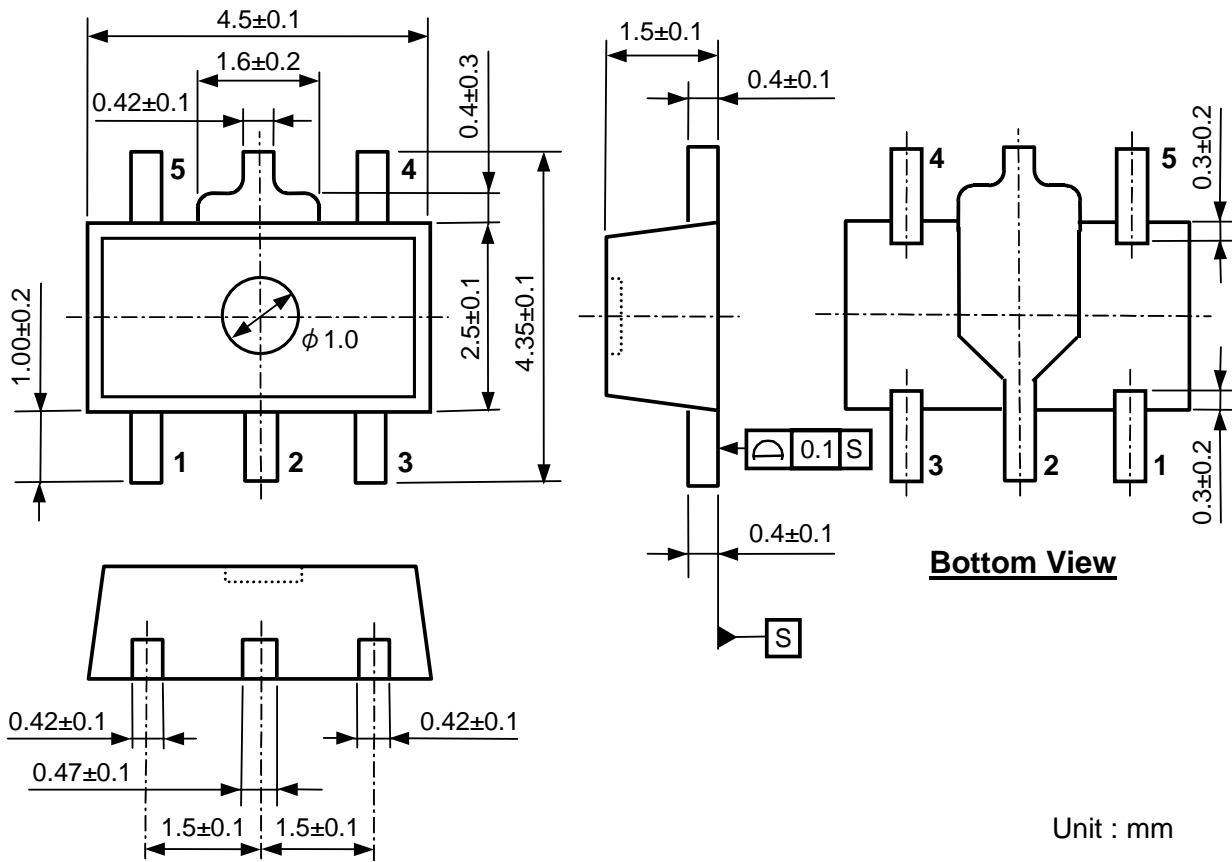
Power Dissipation



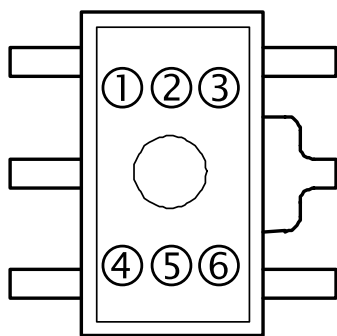
Measurement Board Pattern

○ IC Mount Area (Unit : mm)

**PACKAGE DIMENSIONS (SOT-89-5)**



**MARK SPECIFICATION (SOT-89-5)**



①②③④ : Product Code ...

**Refer to MARK SPECIFICATION TABLE (SOT-89-5)**

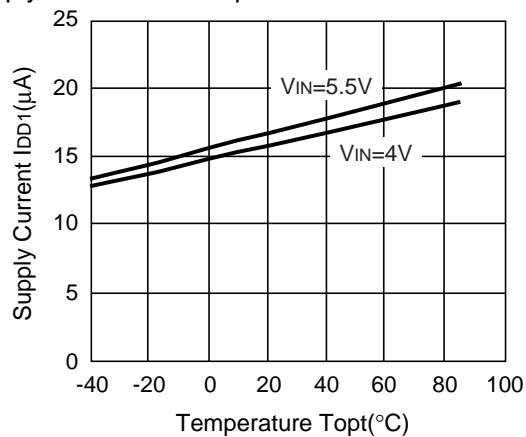
⑤⑥ : Lot Number ... Alphanumeric Serial Number

**MARK SPECIFICATION TABLE (SOT-89-5)**

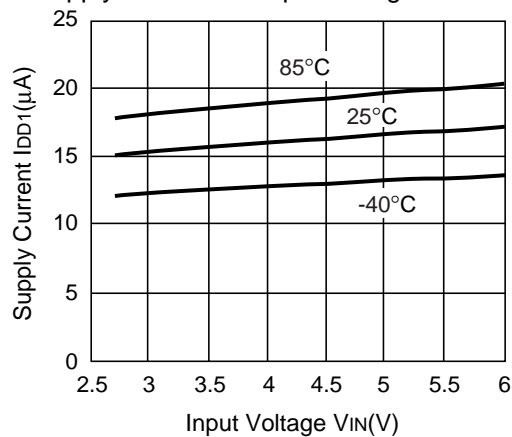
| Product Name | ①②③④    |
|--------------|---------|
| R5520H001A   | F 0 1 A |
| R5520H001B   | F 0 1 B |

## TYPICAL CHARACTERISTICS

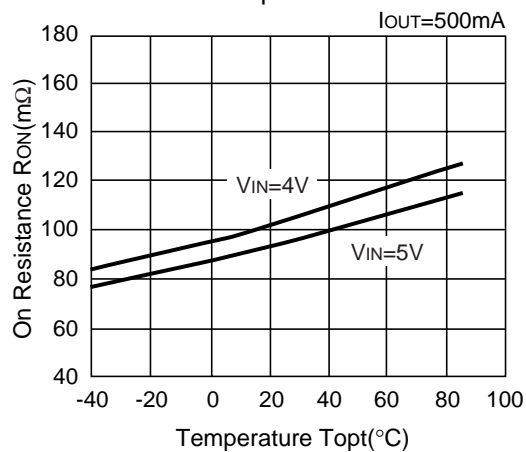
1) Supply Current vs. Temperature



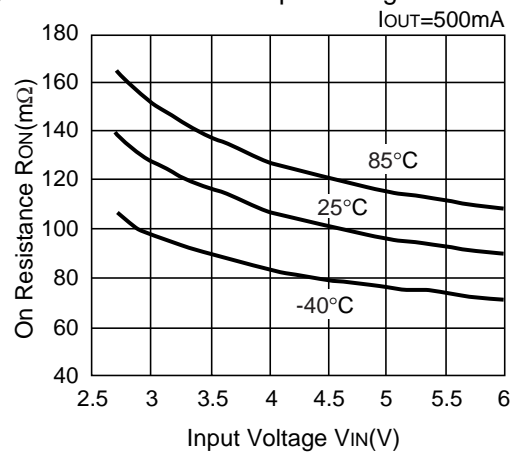
2) Supply Current vs. Input Voltage



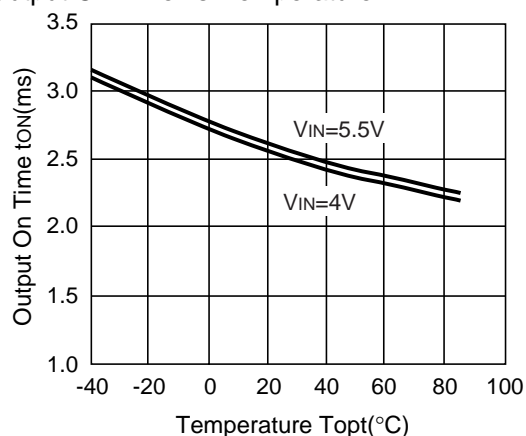
3) On Resistance vs. Temperature



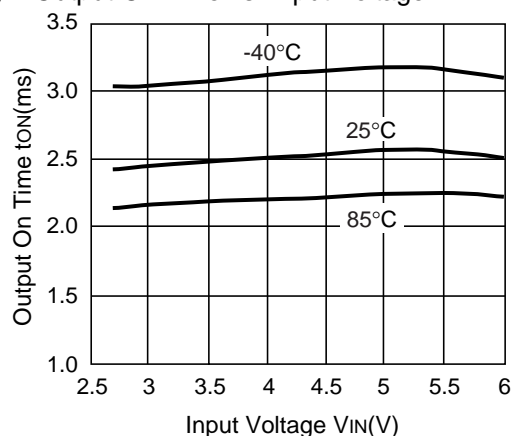
4) On Resistance vs. Input Voltage



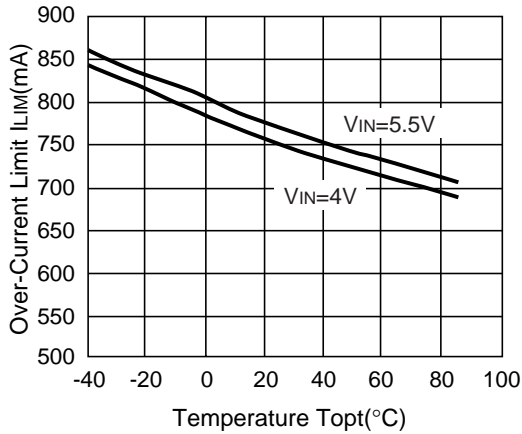
5) Output On Time vs. Temperature



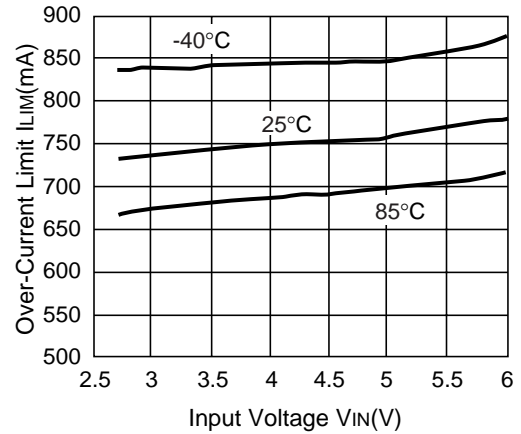
6) Output On Time vs. Input Voltage



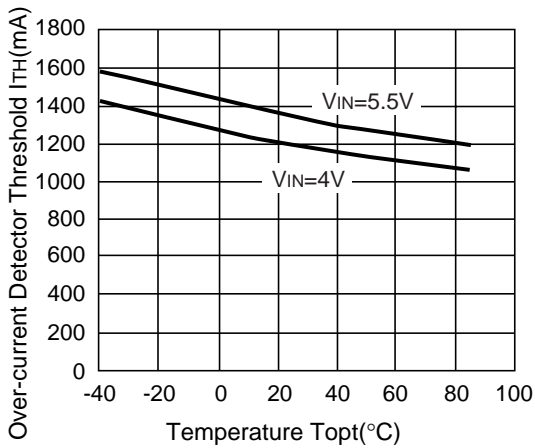
7) Over-current limit vs. Temperature



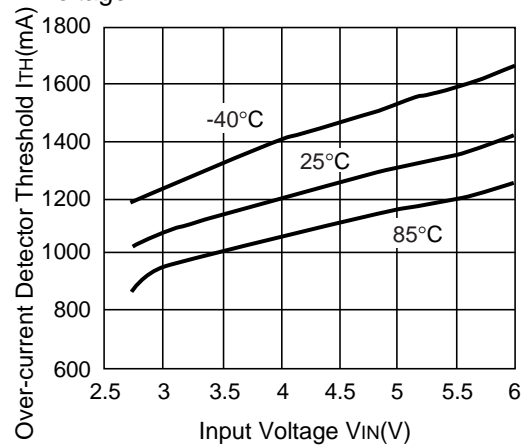
8) Over-current limit vs. Input Voltage



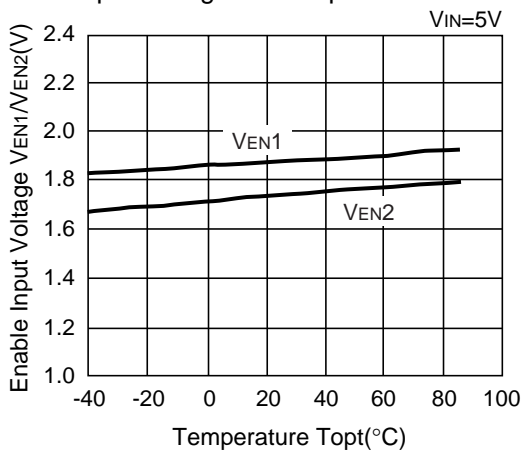
9) Over-current Detector Threshold vs. Temperature



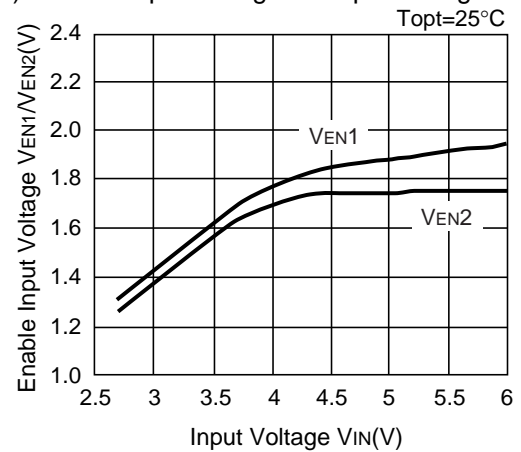
10) Over-current Detector Threshold vs. Input Voltage



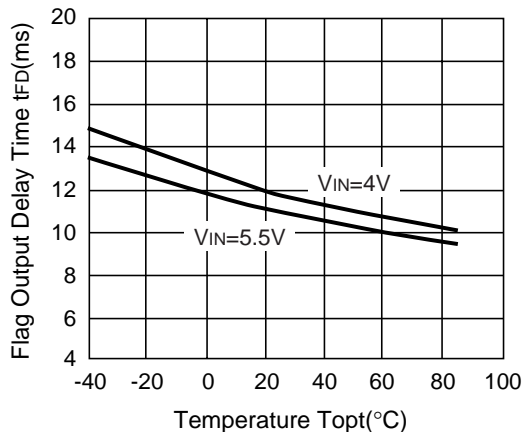
11) Enable Input Voltage vs. Temperature



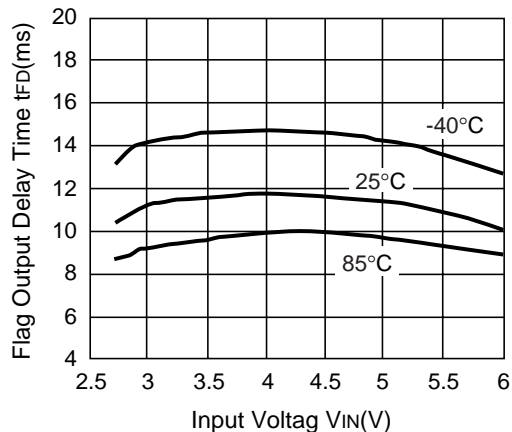
12) Enable Input Voltage vs. Input Voltage



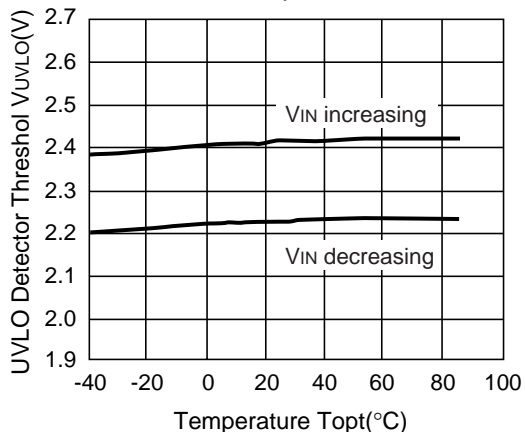
13) Flag Output Delay Time vs. Temperature



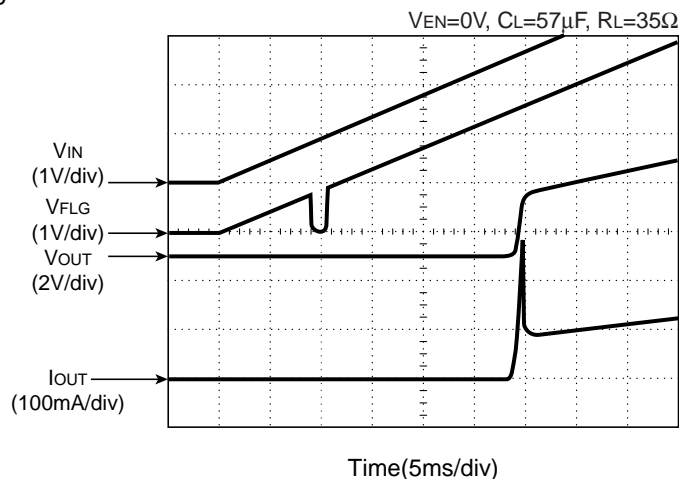
14) Flag Output Delay Time vs. Input Voltage



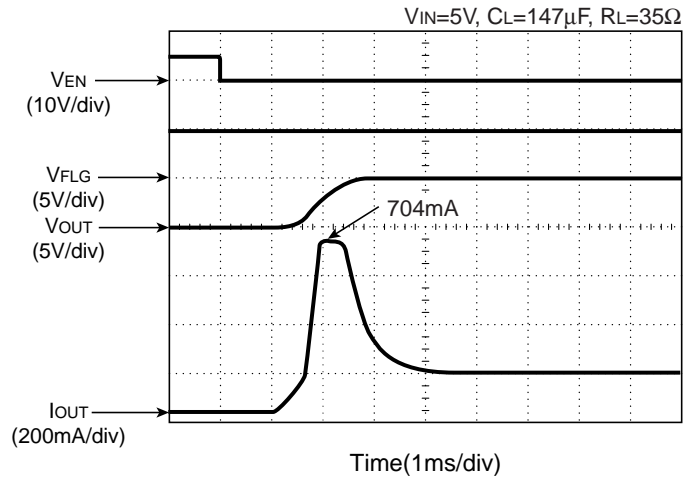
15) UVLO Threshold vs. Temperature



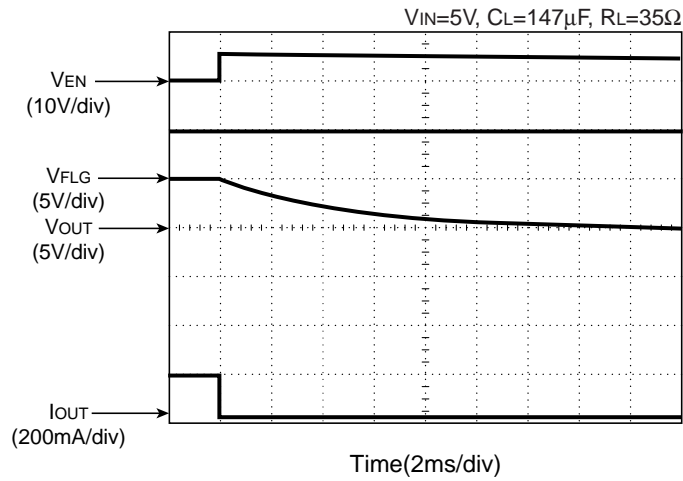
16) UVLO at  $V_{IN}$  increasing



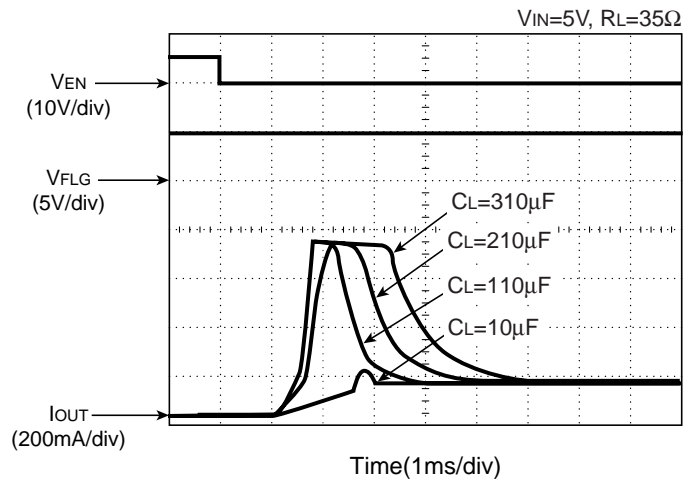
17) Turn-on response



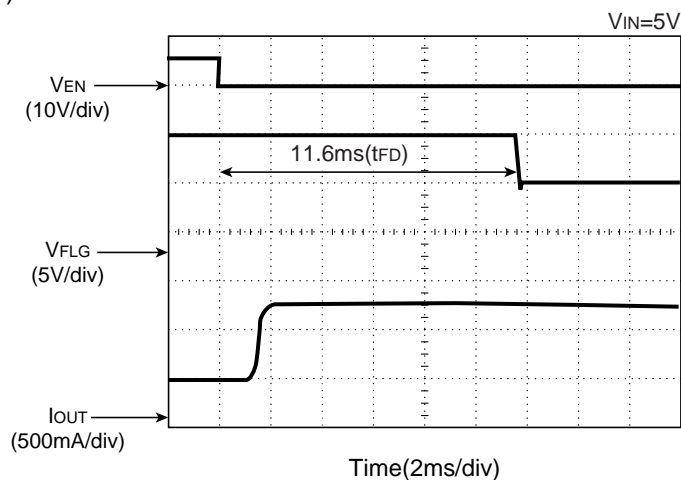
18) Turn off Response



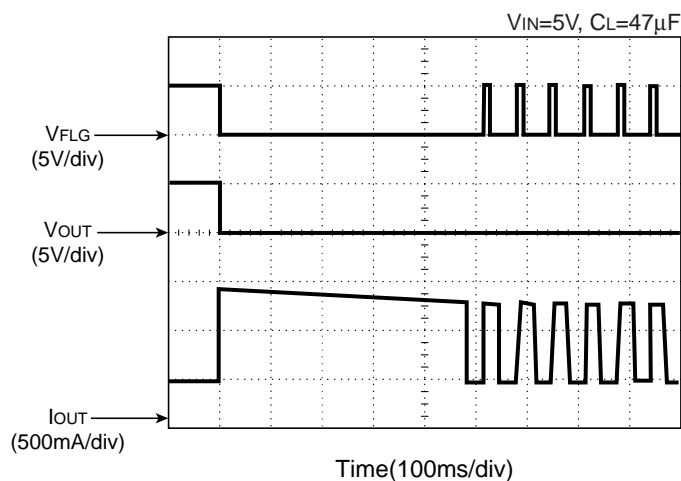
19) Inrush current



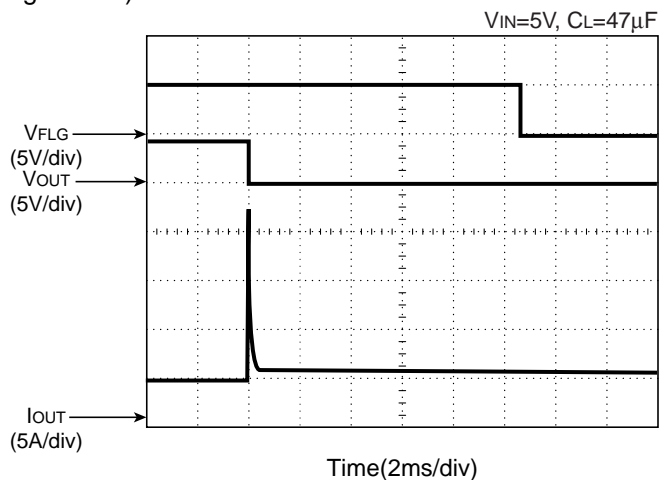
20) Current Limit Transient Response  
(Case: Enable to Short)



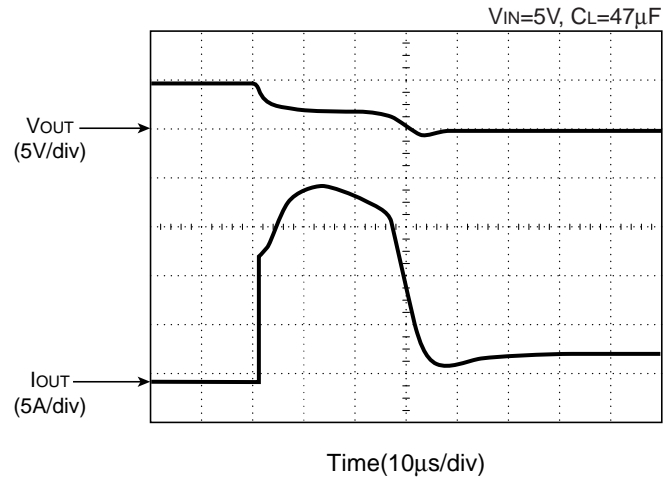
21) Thermal Shutdown



22) Current Limit Transient Response  
(Case: Output short during enable)



23) Zoomed in 22)







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9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI.
11. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



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