

### N-channel Load Switch IC

NO. EA-268-111028

### OUTLINE

The R5540 series are N-channel Load Switch ICs with the low supply current, Typ. 9 $\mu$ A. By using an Nch transistor as a driver transistor, the features of low on resistance and the reverse current protection at off state are realized in these ICs. The gate voltage of the N-channel transistor is supplied from the internal step-up circuit. The R5540 is an ideal switch to supply the power from the secondary power source such as the output of a step-down DC/DC to the load circuit. Since the package for the R5540 is the ultra small-sized DFN(PLP)1010-4F, high density mounting on board is possible.

### FEATURES

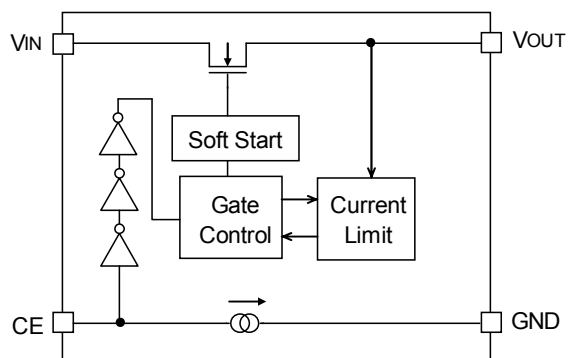
- Built-in an N-channel MOSFET
- Input Voltage Range ..... 0.75V to 3.6V (Code 002)  
..... 0.8V to 3.6V (Code 004)
- Supply Current at Operation ( $I_{OUT}=0mA$ ) ..... Typ. 9 $\mu$ A
- Supply Current at Standby Mode ..... Typ. 0.7 $\mu$ A
- Switch On Resistance ..... Typ. 120m $\Omega$  ( $V_{IN}=1.2V$ )
- Output Current ..... Min. 200mA/ Min. 450mA
- Package ..... DFN(PLP)1010-4F
- Built-in Over- current Sensing Circuit ..... TYP. 350mA/ TYP. 700mA
- Built-in Soft-start function

### APPLICATION

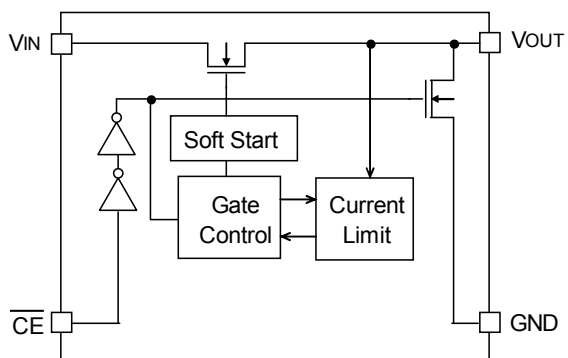
- For secondary power source for electrical appliances such as mobile communication equipments, cameras, VCRs and Camcorders.

## BLOCK DIAGRAMS

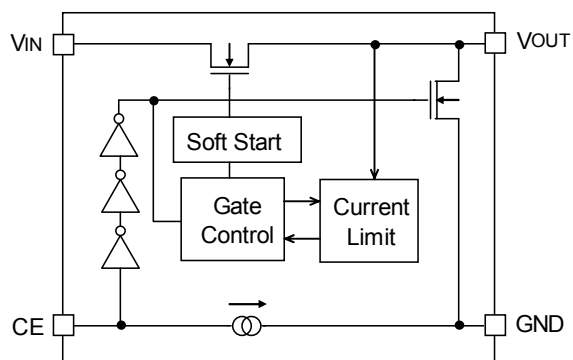
R5540KxxxB



R5540KxxxC



R5540KxxxD



## SELECTION GUIDE

The output current value, the auto-discharge function and the polarity of CE pin from "L" active, "H" active are selectable at the user's request.

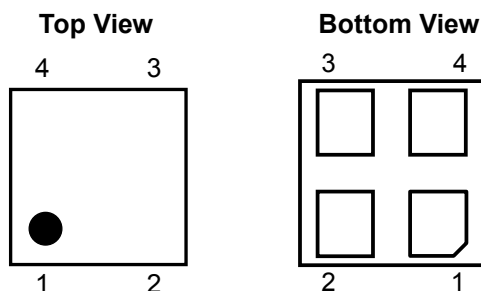
| Product Name  | Package         | Quantity per Reel | Pb Free | Halogen Free |
|---------------|-----------------|-------------------|---------|--------------|
| R5540Kxxx*-TR | DFN(PLP)1010-4F | 10,000pcs         | Yes     | Yes          |

xxx: The output current value can be designated by the following codes.  
 002: Output Current (200mA)  
 004: Output Current (450mA)

\*: Auto-discharge function at off state and the polarity of CE pin are option as follows.  
 B: "H" active, without auto-discharge function at off state  
 C: "L" active, with auto-discharge function at off state  
 D: "H" active, with auto-discharge function at off state

## PIN CONFIGURATIONS

### • DFN(PLP)1010-4F



## PIN DESCRIPTION

### ● R5540K : DFN(PLP)1010-4F

| Pin No | Symbol                      | Pin Description                           |
|--------|-----------------------------|-------------------------------------------|
| 1      | GND                         | Ground Pin                                |
| 2      | $\overline{\text{CE}}$ / CE | Chip Enable Pin ("L" Active / "H" Active) |
| 3      | $V_{\text{IN}}$             | Input Pin                                 |
| 4      | $V_{\text{OUT}}$            | Output Pin                                |

## ABSOLUTE MAXIMUM RATINGS

| Symbol           | Item                                               | Rating             | Unit |
|------------------|----------------------------------------------------|--------------------|------|
| $V_{\text{IN}}$  | Input Voltage                                      | -0.3 to 5.0        | V    |
| $V_{\text{CE}}$  | Input Voltage ( $\overline{\text{CE}}$ / CE Pin)   | -0.3 to 5.0        | V    |
| $V_{\text{OUT}}$ | Output Voltage                                     | -0.3 to 5.0        | V    |
| $I_{\text{OUT}}$ | Output Current                                     | Internally limited | mA   |
| $P_{\text{D}}$   | Power Dissipation<br>(Standard Test Land Pattern)* | 300                | mW   |
| $T_{\text{a}}$   | Ambient Temperature                                | -40 to 85          | °C   |
| $T_{\text{stg}}$ | Storage Temperature                                | -55 to 125         | °C   |

\*) For Power Dissipation, please refer to Power Dissipation to be described.

### 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.

### 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.

## ELECTRICAL CHARACTERISTICS

$V_{IN} = 0.75$  to  $3.60V$ (Code 002) ,  $0.80$  to  $3.60V$ (Code 004),  $C_{IN} = 1\mu F$ ,  $C_{OUT} = \text{None}$ , unless otherwise noted.

The specification in surrounded by   is guaranteed by design at all temperature range,  $-40^{\circ}C \leq T_a \leq 85^{\circ}C$ .

### R5540Kxxxx

( $T_a=25^{\circ}C$ )

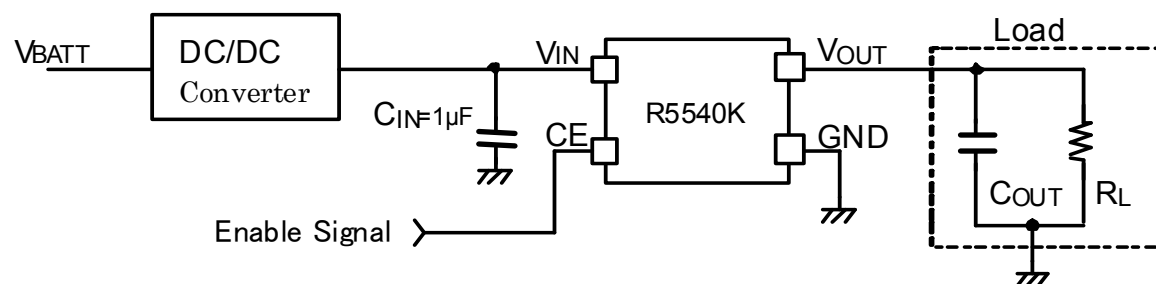
| Symbol            | Item                                                       | Conditions                                                                    |                                                | Min.                                                                               | Typ. | Max.                                                              | Unit |
|-------------------|------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------|------|-------------------------------------------------------------------|------|
| V <sub>IN</sub>   | Input Voltage                                              | Code 002                                                                      |                                                | 0.75                                                                               |      | 3.60                                                              | V    |
|                   |                                                            | Code 004                                                                      |                                                | 0.80                                                                               |      | 3.60                                                              |      |
| R <sub>ON</sub>   | Switch ON Resistance                                       | Code 002                                                                      | V <sub>IN</sub> =1.2V, I <sub>OUT</sub> =200mA |                                                                                    | 120  | 180                                                               | mΩ   |
|                   |                                                            | Code 004                                                                      | V <sub>IN</sub> =1.2V, I <sub>OUT</sub> =450mA |                                                                                    |      |                                                                   |      |
| I <sub>OUT</sub>  | Output Current                                             | Code 002                                                                      |                                                | <span style="border: 1px solid black; padding: 0 2px;">200</span>                  |      |                                                                   | mA   |
| I <sub>OUT</sub>  | Output Current                                             | Code 004                                                                      |                                                | <span style="border: 1px solid black; padding: 0 2px;">450</span>                  |      |                                                                   |      |
| I <sub>SS</sub>   | Supply Current                                             | I <sub>OUT</sub> =0mA *Note1                                                  |                                                |                                                                                    | 9    | 40                                                                | μA   |
| Istandby          | Standby Current                                            | V <sub>OUT</sub> =GND                                                         |                                                | Ta=25°C                                                                            |      | 0.7                                                               | μA   |
|                   |                                                            | V <sub>IN</sub> =1.8V *Note2                                                  |                                                | Ta=85°C                                                                            |      | 5                                                                 |      |
| I <sub>LIM</sub>  | Current Limit                                              | Code 002                                                                      | V <sub>IN</sub> =1.2V                          | 200                                                                                | 350  | 500                                                               | mA   |
| I <sub>LIM</sub>  | Current Limit                                              | Code 004                                                                      |                                                | 450                                                                                | 700  | 1000                                                              |      |
| I <sub>SC</sub>   | Short Current Limit                                        | V <sub>IN</sub> =1.2V, V <sub>OUT</sub> =0V                                   |                                                |                                                                                    | 50   | 100                                                               | mA   |
| I <sub>CE</sub>   | $\overline{CE}$ Input Current                              | C version                                                                     |                                                |                                                                                    | 0.4  |                                                                   | μA   |
| I <sub>CEPD</sub> | CE Pull-down Current                                       | B, D version                                                                  |                                                |                                                                                    | 0.7  |                                                                   | μA   |
| V <sub>CEH</sub>  | CE Input Voltage “H”                                       | V <sub>IN</sub> =2.5V to 3.6V                                                 |                                                | <span style="border: 1px solid black; padding: 0 2px;">1.0</span>                  |      |                                                                   | V    |
|                   |                                                            | V <sub>IN</sub> =1.0V to 2.5V                                                 |                                                | <span style="border: 1px solid black; padding: 0 2px;">0.9</span>                  |      |                                                                   |      |
|                   |                                                            | V <sub>IN</sub> =0.75V to 1.0V                                                |                                                | <span style="border: 1px solid black; padding: 0 2px;">V<sub>IN</sub> x 0.9</span> |      |                                                                   |      |
| V <sub>CEL</sub>  | CE Input Voltage “L”                                       | V <sub>IN</sub> =0.75V to 3.6V                                                |                                                |                                                                                    |      | <span style="border: 1px solid black; padding: 0 2px;">0.4</span> | V    |
| R <sub>LOW</sub>  | Auto-discharge Nch Tr.<br>ON Resistance<br>(Version. C, D) | V <sub>IN</sub> =1.2V<br>*Note2                                               |                                                |                                                                                    | 100  |                                                                   | Ω    |
| tr                | Output Rise Time                                           | V <sub>IN</sub> =1.2V, V <sub>OUT</sub> =10% ~ 90%<br>C <sub>OUT</sub> =0.1μF |                                                |                                                                                    | 73   |                                                                   | μs   |
| t <sub>SC</sub>   | Short Current<br>Response Time                             | V <sub>OUT</sub> =0V                                                          |                                                |                                                                                    | 30   |                                                                   | μs   |

All test categories were tested on the units under the pulse load condition ( $T_j \approx T_a=25^{\circ}C$ ) except Short Current Response Time.

\*Note1  $\overline{CE} = L$  for "L" active,  $CE=H$  for "H" active

\*Note2  $\overline{CE} = H$  for "L" active,  $CE=L$  for "H" active

## TYPICAL APPLICATION

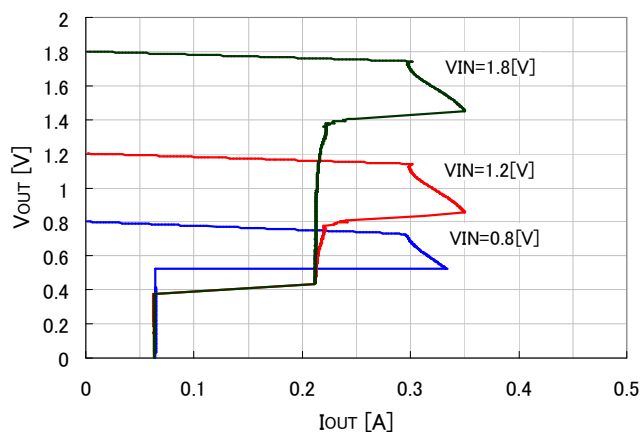


Basically, the R5540K series do not require a bypass capacitor between  $V_{IN}$  and GND, however, considering the spike noise caused by the high side inductor at current limit, use 0.1 $\mu F$  or more capacitor as a bypass capacitor. More capacitance is also acceptable depending on the application.

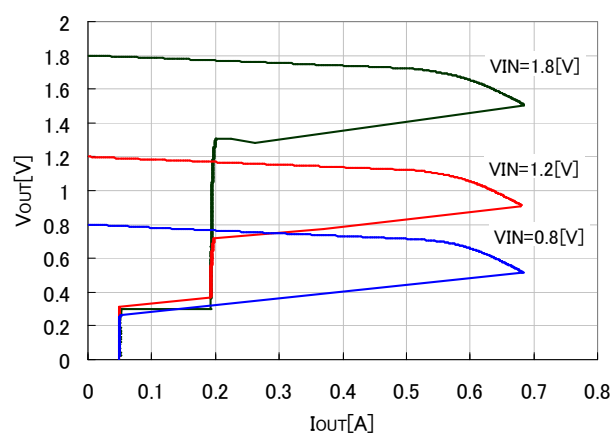
## TYPICAL CHARACTERISTIC

### 1) Output Voltage vs. Output Current $C_{IN}=1\mu F$ , $C_{OUT}=1\mu F$

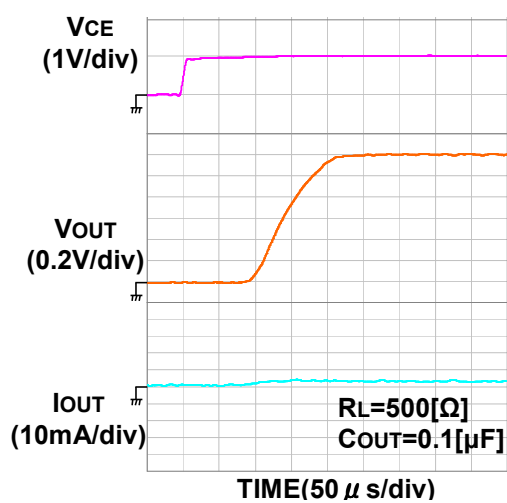
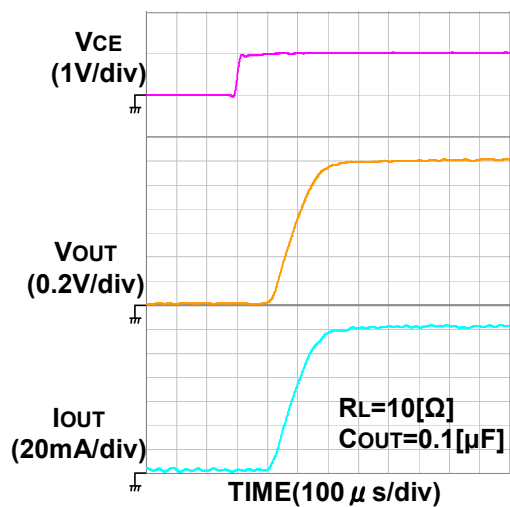
R5540K002x

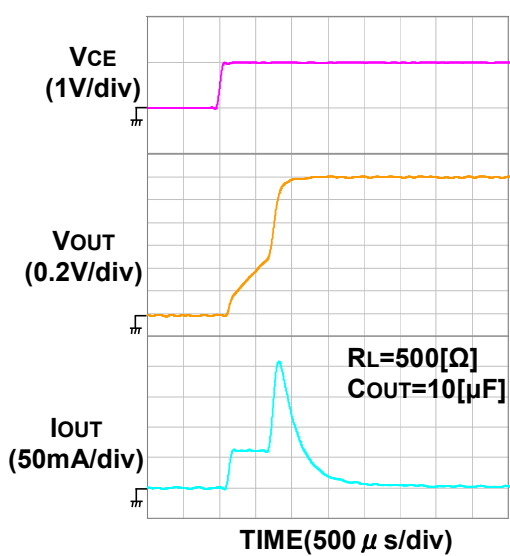
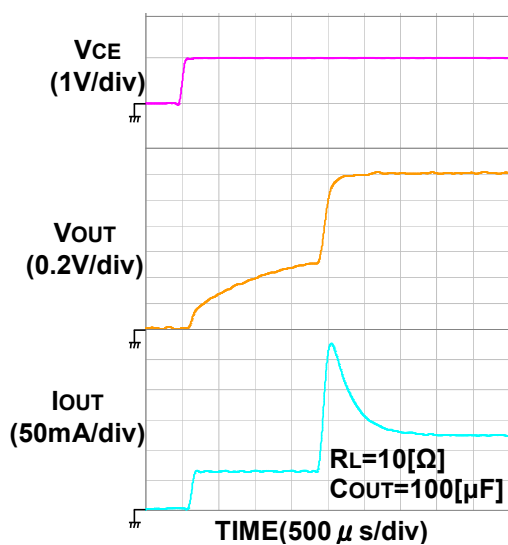
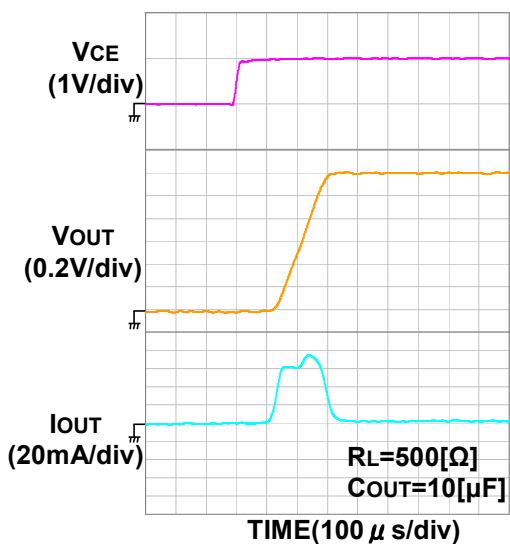
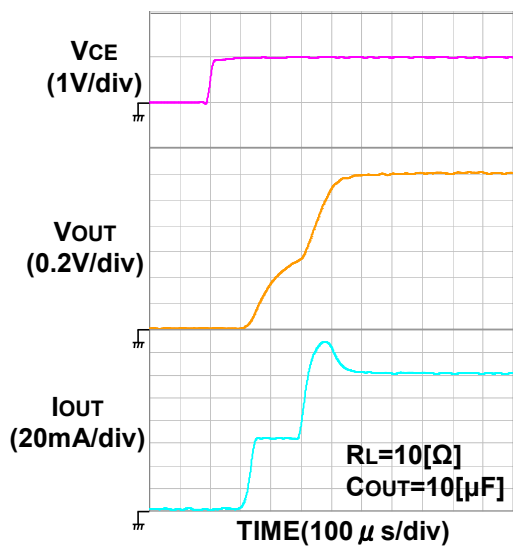
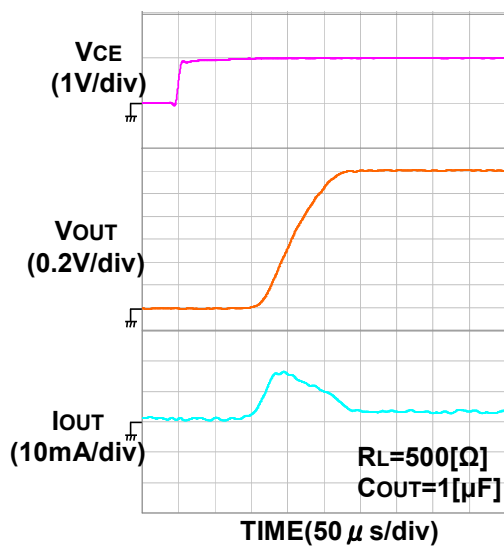
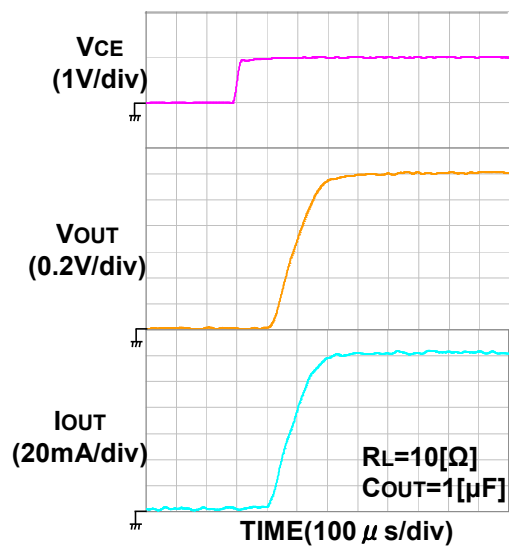


R5540K004x



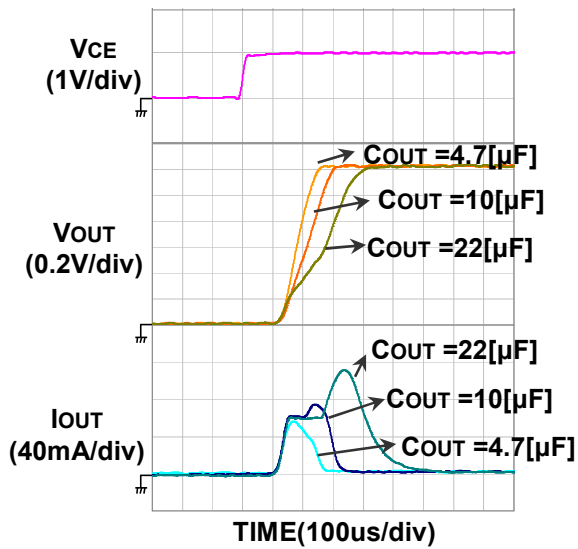
### 2) Turn on waveform (002x, $V_{IN}=1.2V$ , $C_{IN}=1\mu F$ , $T_a=25^\circ C$ )



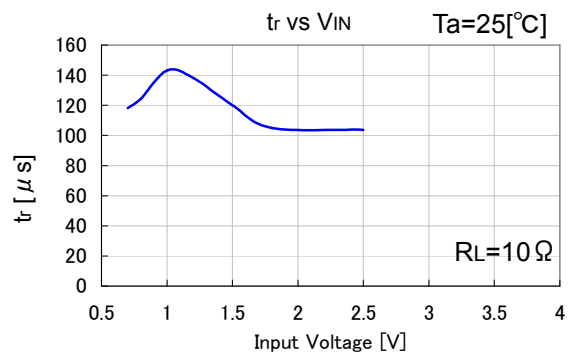




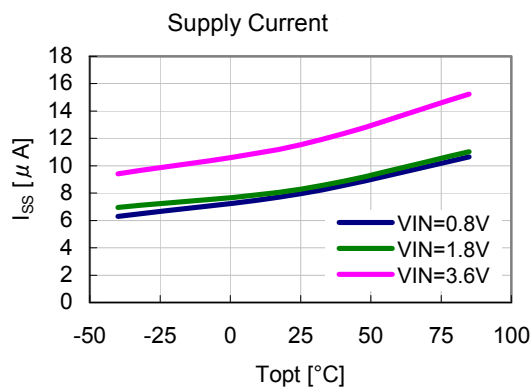
## 3) Inrush current vs. output capacitor (002x)



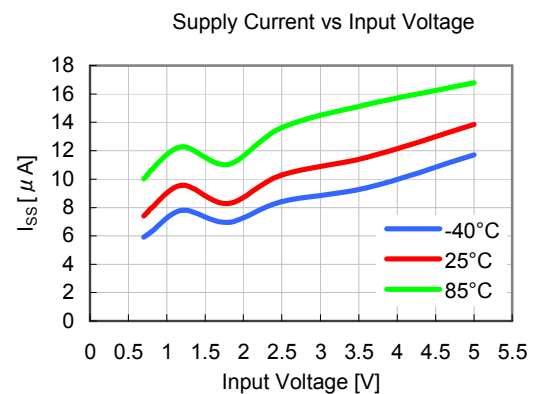
## 4) Input voltage vs. Turn-on speed



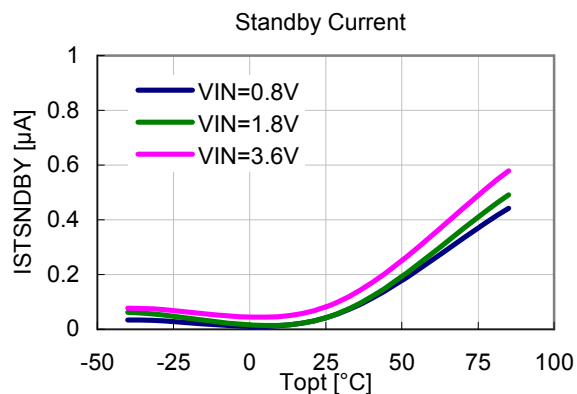
## 5) Supply current vs. Temperature



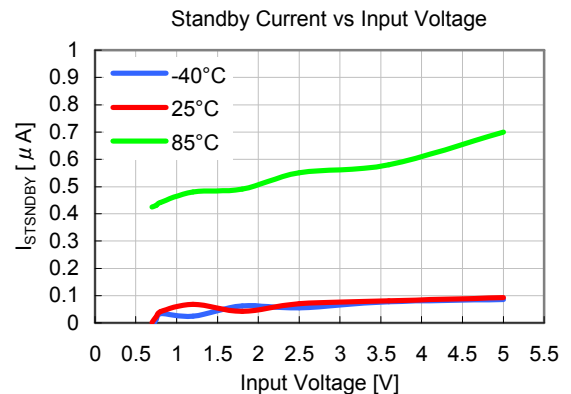
## 6) Standby current vs. Input voltage



## 7) Standby Current vs. Temperature

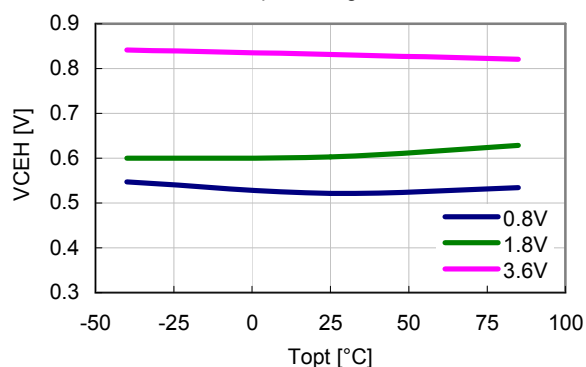


## 8) Standby current vs. Input voltage

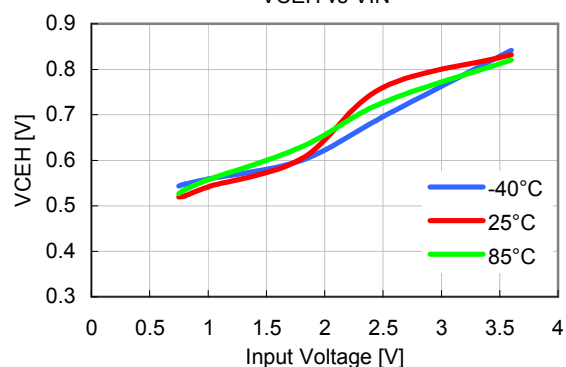


**9) CE Input voltage "H" vs. Temperature**

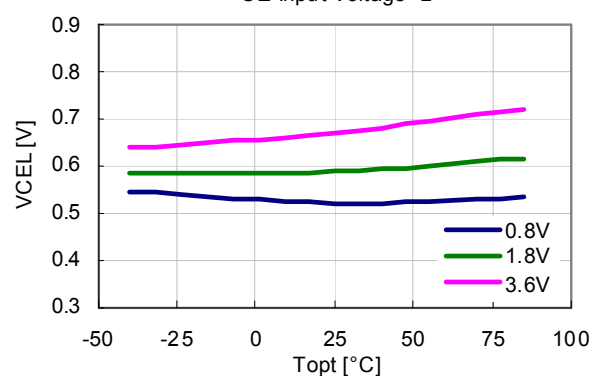
CE Input Voltage "H"

**10) CE Input voltage "H" vs. VDD**

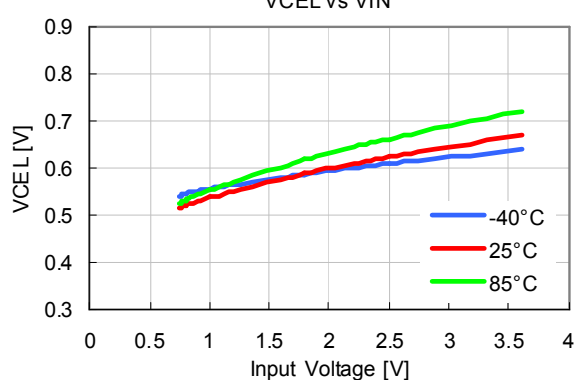
VCEH vs VIN

**11) CE Input voltage "L" vs. Temperature**

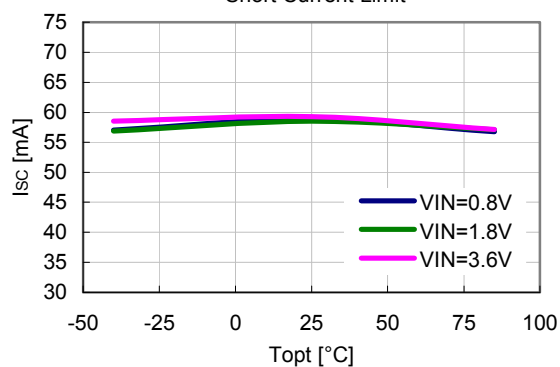
CE Input Voltage "L"

**12) CE Input voltage "L" vs. VDD**

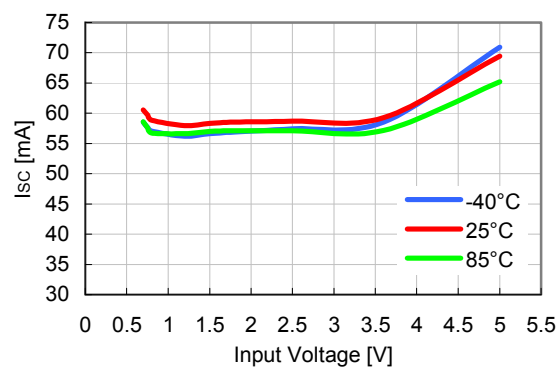
VCEL vs VIN

**13) Short current limit vs. Temperature**

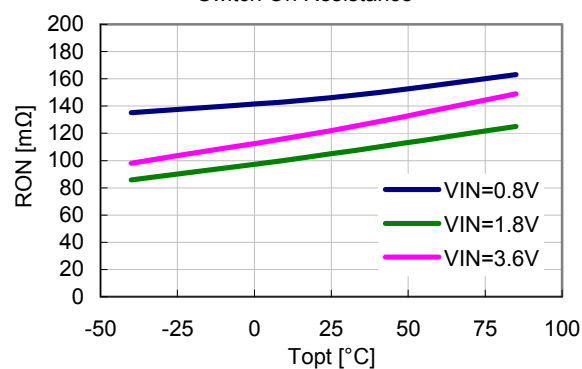
Short Current Limit

**14) Short current limit vs. Input voltage**

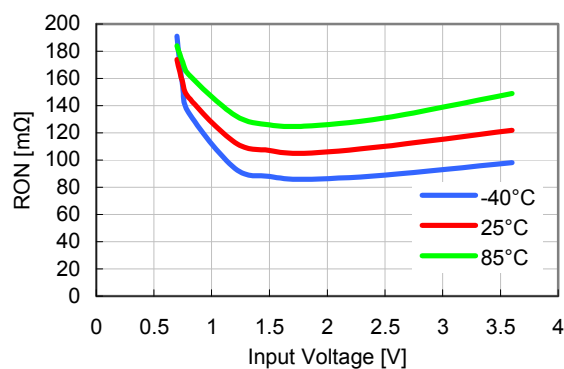
Isc vs VIN

**15) Switch on resistance vs. Temperature**

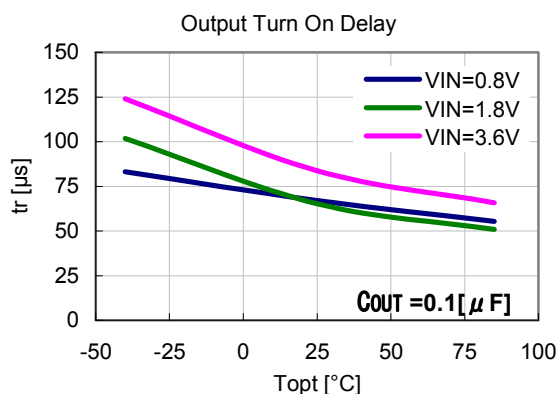
Switch On Resistance

**16) Switch on resistance vs. Input voltage**

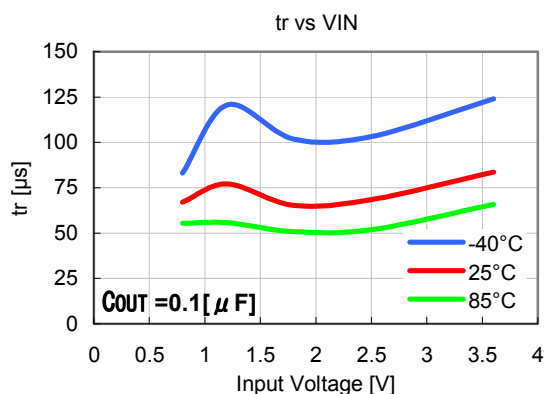
RON vs VIN



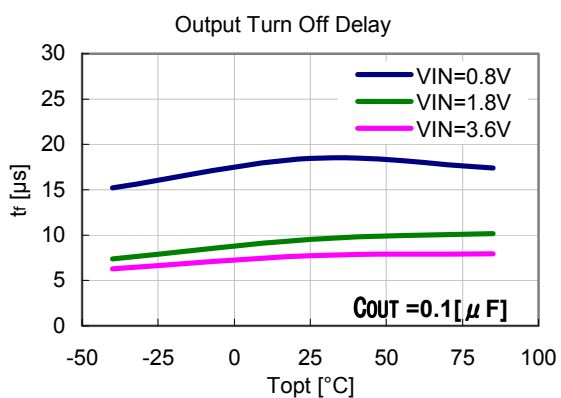
## 17) Output Rise time vs. Temperature



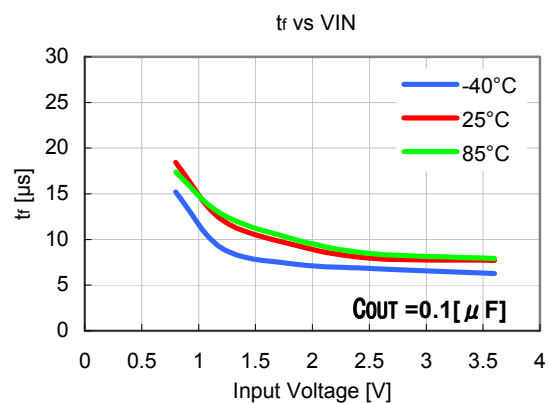
## 18) Output Rise time vs. Input voltage



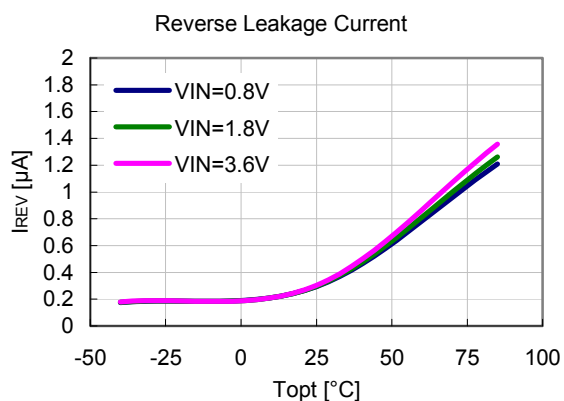
## 19) Output Fall time vs. Temperature



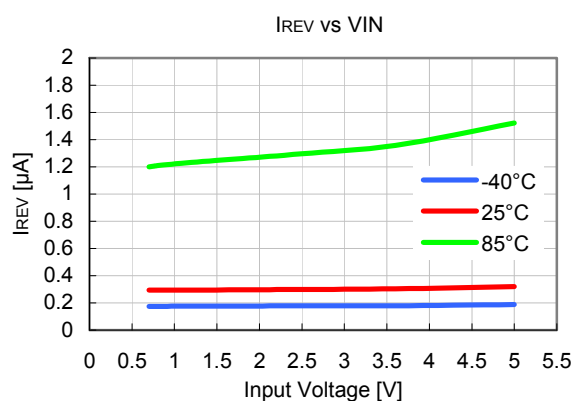
## 20) Output Fall time vs. Input voltage



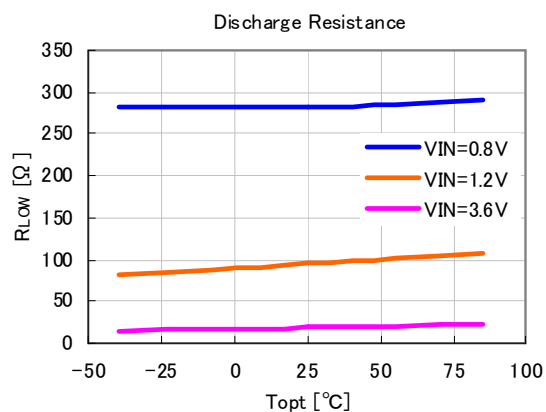
## 21) Reverse leakage current vs. Temperature



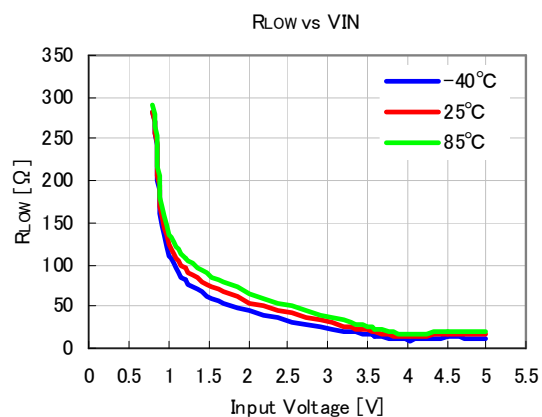
## 22) Reverse leakage current vs. Input voltage



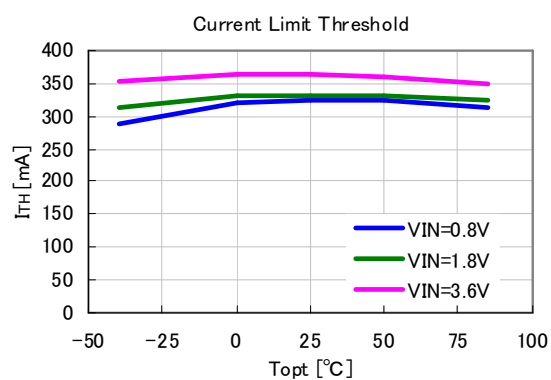
## 23) Discharge resistance vs. Temperature



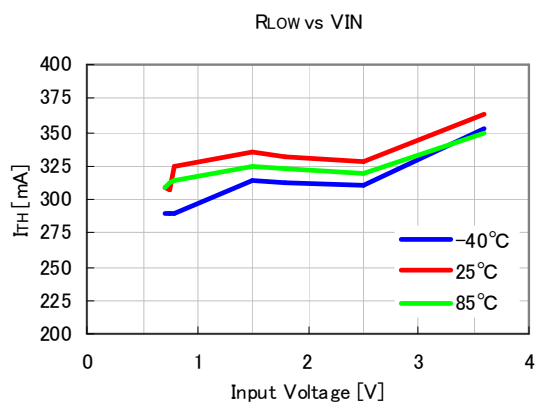
## 24) Discharge resistance vs. Input voltage



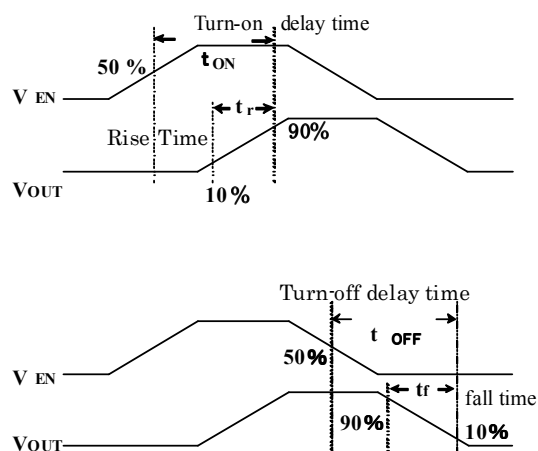
## 25) Current limit vs. Temperature (002x)

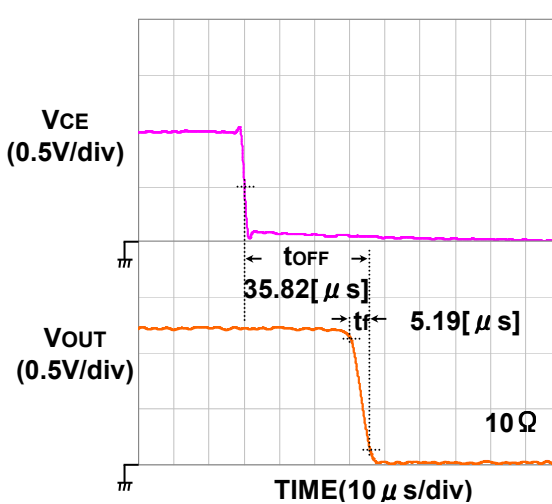
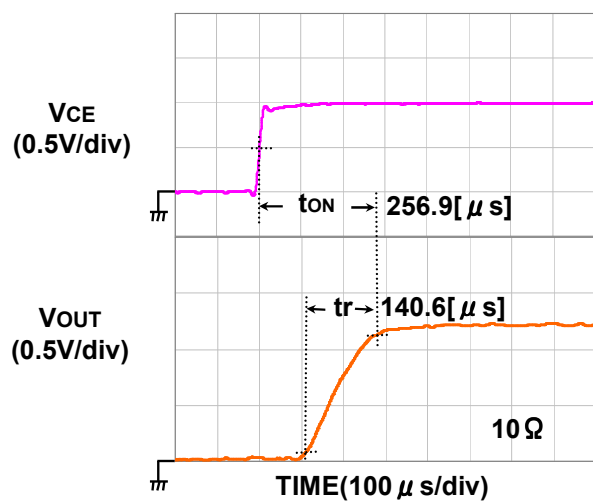
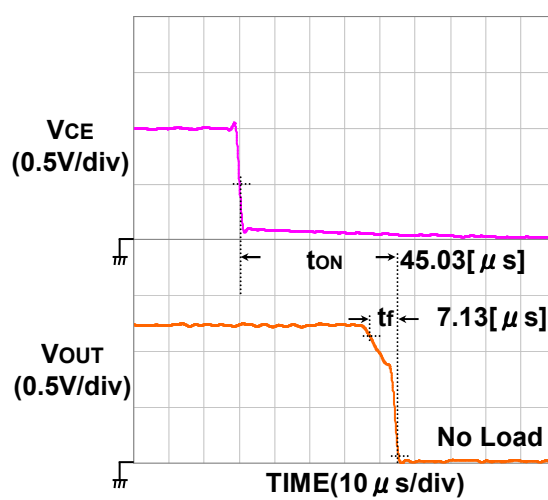
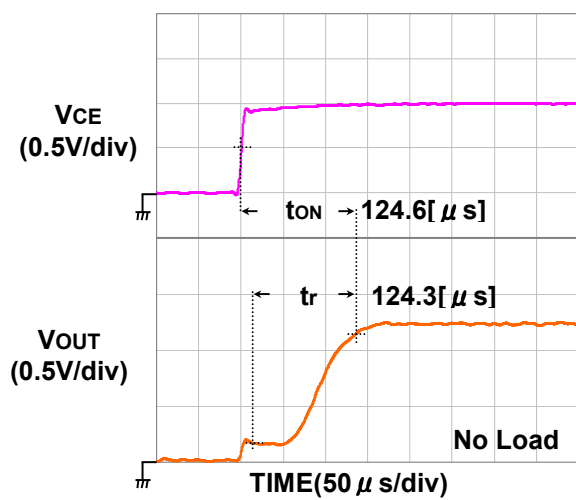


## 26) Current limit vs. Input voltage (002x)



## TIMING CHART



Turn-on/ turn-off waveform ( $V_{IN} = 1.2[V]$ )

## POWER DISSIPATION (DFN(PLP)1010-4F)

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

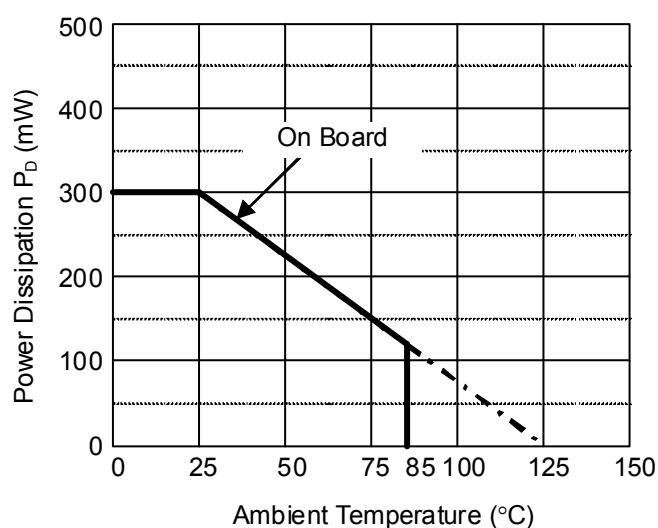
### Measurement Conditions

|                  |                                               |
|------------------|-----------------------------------------------|
|                  | Standard Land Pattern                         |
| Environment      | Mounting on Board (Wind velocity=0m/s)        |
| Board Material   | Glass cloth epoxy plastic (Double sided)      |
| Board Dimensions | 40mm×40mm×1.6mm                               |
| Copper Ratio     | Top side: Approx. 50%, Back side: Approx. 50% |
| Through-holes    | φ 0.54mm×24pcs                                |

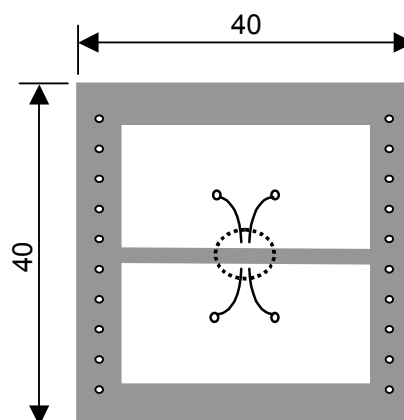
### Measurement Result

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

|                    |                                                                          |
|--------------------|--------------------------------------------------------------------------|
|                    | Standard Land Pattern                                                    |
| Power Dissipation  | 300mW                                                                    |
| Thermal Resistance | $\theta_{ja}=(125-25^{\circ}\text{C})/0.3\text{W}=330^{\circ}\text{C/W}$ |
|                    | $\theta_{jc}=48^{\circ}\text{C/W}$                                       |



**Power Dissipation**



**Measurement Board Pattern**

○ IC Mount Area (Unit : mm)



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