

## SWITCHING REGULATOR APPLICATIONS

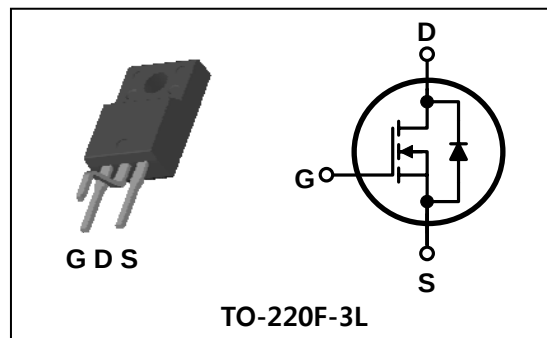
### Features

- High Voltage :  $BV_{DSS}=650V(\text{Min.})$
- Low  $C_{rss}$  :  $C_{rss}=16pF(\text{Typ.})$
- Low gate charge :  $Q_g=35nC(\text{Typ.})$
- Low  $R_{DS(on)}$  :  $R_{DS(on)}=0.85\Omega(\text{Max.})$

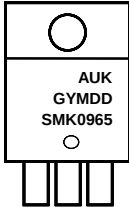
### Ordering Information

| Type No.  | Marking | Package Code              |
|-----------|---------|---------------------------|
| SMK0965FC | SMK0965 | TO-220F-3L<br>(C Forming) |

### PIN Connection



### Marking Diagram

|                                                                                    |                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>Column 1 : Manufacturer</p> <p>Column 2 : Production Information<br/>e.g.) GYMDD</p> <ul style="list-style-type: none"> <li>- . G : Factory management code</li> <li>- . YMDD : Date Code (year, month, date)</li> </ul> <p>Column 3 : Device Code</p> |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Absolute maximum ratings ( $T_C=25^\circ\text{C}$ unless otherwise noted)

| Characteristic                   | Symbol    | Rating                  | Unit             |
|----------------------------------|-----------|-------------------------|------------------|
| Drain-source voltage             | $V_{DSS}$ | 650                     | V                |
| Gate-source voltage              | $V_{GSS}$ | $\pm 30$                | V                |
| Drain current (DC) *             | $I_D$     | $T_C=25^\circ\text{C}$  | 9                |
|                                  |           | $T_C=100^\circ\text{C}$ | 5.5              |
| Drain current (Pulsed) *         | $I_{DM}$  | 36                      | A                |
| Power dissipation                | $P_D$     | 40                      | W                |
| Avalanche current (Single) ②     | $I_{AS}$  | 9                       | A                |
| Single pulsed avalanche energy ② | $E_{AS}$  | 250                     | mJ               |
| Avalanche current (Repetitive) ① | $I_{AR}$  | 9                       | A                |
| Repetitive avalanche energy ①    | $E_{AR}$  | 11.6                    | mJ               |
| Junction temperature             | $T_J$     | 150                     | $^\circ\text{C}$ |
| Storage temperature range        | $T_{stg}$ | -55~150                 |                  |

\* Limited by maximum junction temperature

| Characteristic     | Symbol           | Typ.          | Max. | Unit |
|--------------------|------------------|---------------|------|------|
| Thermal resistance | Junction-case    | $R_{th(J-C)}$ | -    | 3.1  |
|                    | Junction-ambient | $R_{th(J-A)}$ | -    | 62.5 |

## Electrical Characteristics (T<sub>C</sub>=25°C unless otherwise noted)

| Characteristic                 | Symbol              | Test Condition                                                       | Min. | Typ. | Max. | Unit |
|--------------------------------|---------------------|----------------------------------------------------------------------|------|------|------|------|
| Drain-source breakdown voltage | BV <sub>DSS</sub>   | I <sub>D</sub> =250uA, V <sub>GS</sub> =0V                           | 650  | -    | -    | V    |
| Gate threshold voltage         | V <sub>GS(th)</sub> | I <sub>D</sub> =250uA, V <sub>DS</sub> =V <sub>GS</sub>              | 2.0  | -    | 4.0  | V    |
| Drain-source cut-off current   | I <sub>DSS</sub>    | V <sub>DS</sub> =650V, V <sub>GS</sub> =0V                           | -    | -    | 1    | uA   |
| Gate leakage current           | I <sub>GSS</sub>    | V <sub>DS</sub> =0V, V <sub>GS</sub> =±30V                           | -    | -    | ±100 | nA   |
| Drain-source on-resistance ④   | R <sub>DS(on)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =4.5A                           | -    | 0.72 | 0.85 | Ω    |
| Forward transfer conductance ④ | g <sub>fs</sub>     | V <sub>DS</sub> =10V, I <sub>D</sub> =4.5A                           | -    | 11   | -    | S    |
| Gate Resistance                | R <sub>g</sub>      | V <sub>GS</sub> =0V, V <sub>DS</sub> =0V, f=1MHz                     | 0.5  | 1.5  | 7    | Ω    |
| Input capacitance              | C <sub>iss</sub>    | V <sub>GS</sub> =0V, V <sub>DS</sub> =25V<br>f=1 MHz                 | -    | 2040 | 2550 | pF   |
| Output capacitance             | C <sub>oss</sub>    |                                                                      | -    | 153  | 192  |      |
| Reverse transfer capacitance   | C <sub>rss</sub>    |                                                                      | -    | 16   | 20   |      |
| Turn-on delay time             | t <sub>d(on)</sub>  | V <sub>DD</sub> =300V, I <sub>D</sub> =9A<br>R <sub>G</sub> =25Ω ③④  | -    | 23   | -    | ns   |
| Rise time                      | t <sub>r</sub>      |                                                                      | -    | 69   | -    |      |
| Turn-off delay time            | t <sub>d(off)</sub> |                                                                      | -    | 144  | -    |      |
| Fall time                      | t <sub>f</sub>      |                                                                      | -    | 77   | -    |      |
| Total gate charge              | Q <sub>g</sub>      | V <sub>DS</sub> =520V, V <sub>GS</sub> =10V<br>I <sub>D</sub> =9A ③④ | -    | 35   | 57   | nC   |
| Gate-source charge             | Q <sub>gs</sub>     |                                                                      | -    | 10   | -    |      |
| Gate-drain charge              | Q <sub>gd</sub>     |                                                                      | -    | 9    | -    |      |

## Source-Drain Diode Ratings and Characteristics (T<sub>C</sub>=25°C unless otherwise noted)

| Characteristic            | Symbol          | Test Condition                                                         | Min. | Typ. | Max. | Unit |
|---------------------------|-----------------|------------------------------------------------------------------------|------|------|------|------|
| Source current (DC)       | I <sub>S</sub>  | Integral reverse diode<br>in the MOSFET                                | -    | -    | 9    | A    |
| Source current (Pulsed) ① | I <sub>SM</sub> |                                                                        | -    | -    | 36   |      |
| Forward voltage ④         | V <sub>SD</sub> | V <sub>GS</sub> =0V, I <sub>S</sub> =9A                                | -    | -    | 1.4  | V    |
| Reverse recovery time     | t <sub>rr</sub> | I <sub>S</sub> =9A, V <sub>GS</sub> =0V<br>dI <sub>F</sub> /dt=100A/us | -    | 420  | -    | ns   |
| Reverse recovery charge   | Q <sub>rr</sub> |                                                                        | -    | 4.2  | -    | uC   |

Note ;

- ① Repetitive rating : Pulse width limited by maximum junction temperature
- ② L=5.7mH, I<sub>AS</sub>=9A, V<sub>DD</sub>=50V, R<sub>G</sub>=25Ω, Starting T<sub>J</sub>=25°C
- ③ Pulse Test : Pulse width≤300us, Duty cycle≤2%
- ④ Essentially independent of operating temperature

## Electrical Characteristic Curves

Fig. 1  $I_D - V_{DS}$

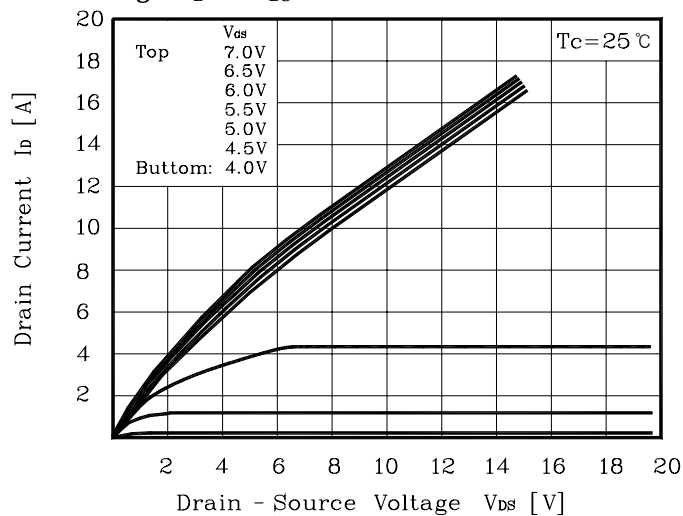


Fig. 2  $I_D - V_{GS}$

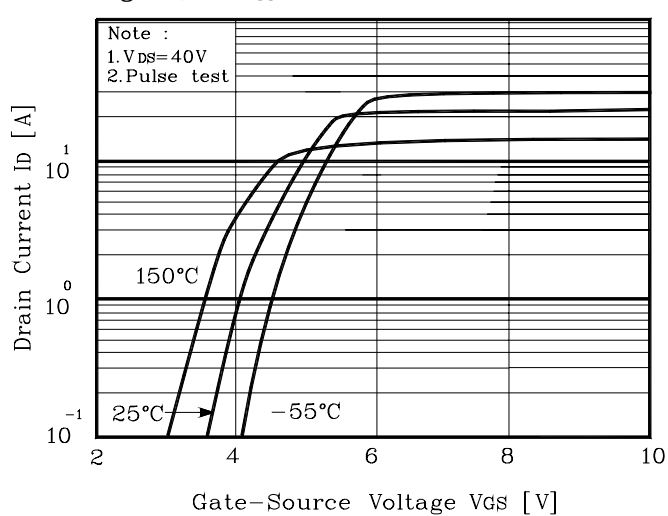


Fig. 3  $R_{DS(on)} - I_D$

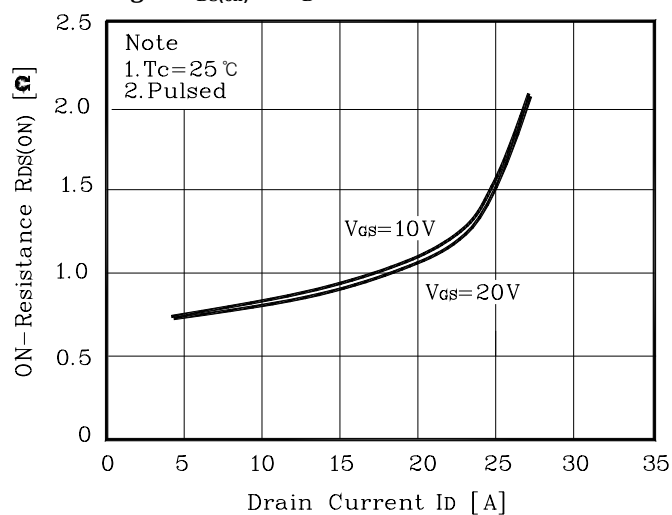


Fig. 4  $I_S - V_{SD}$

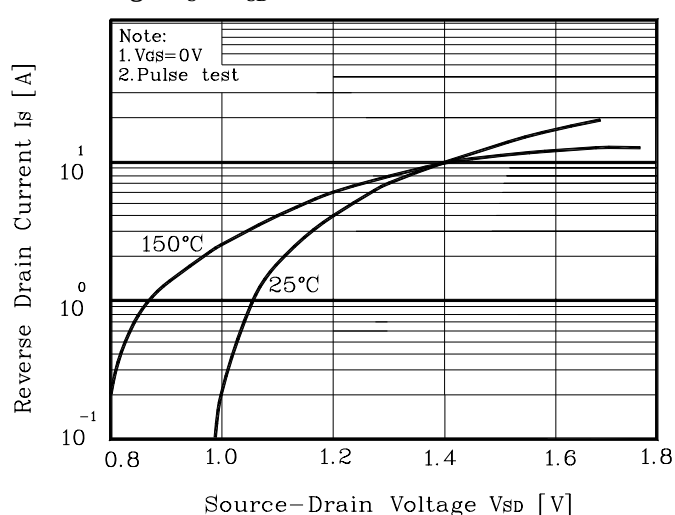


Fig. 5 Capacitance -  $V_{DS}$

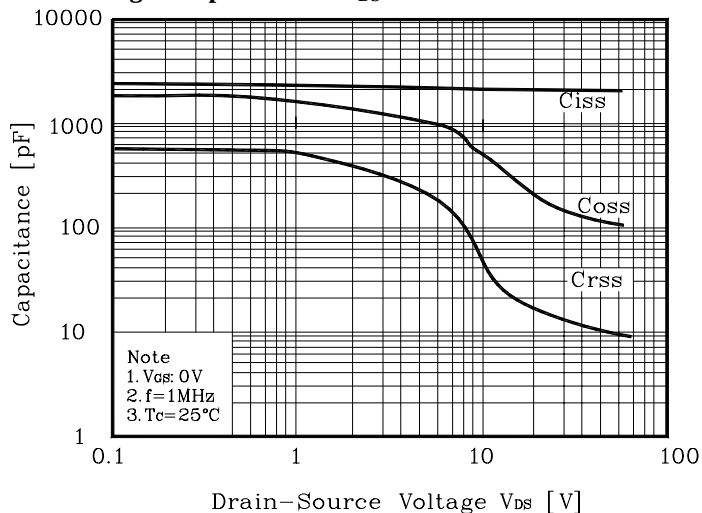
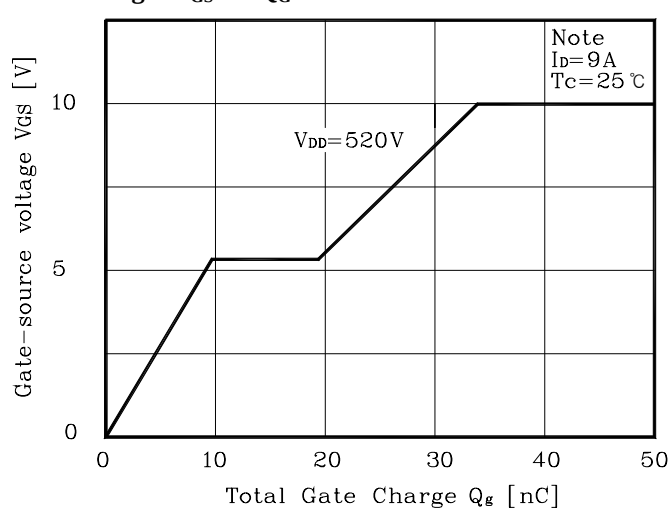
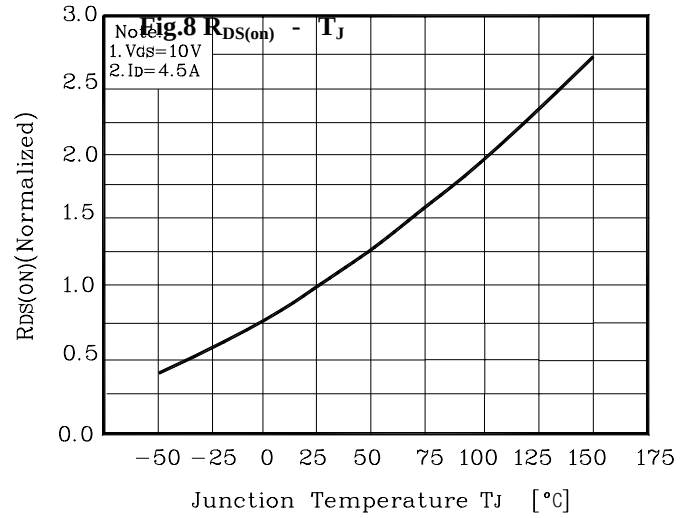
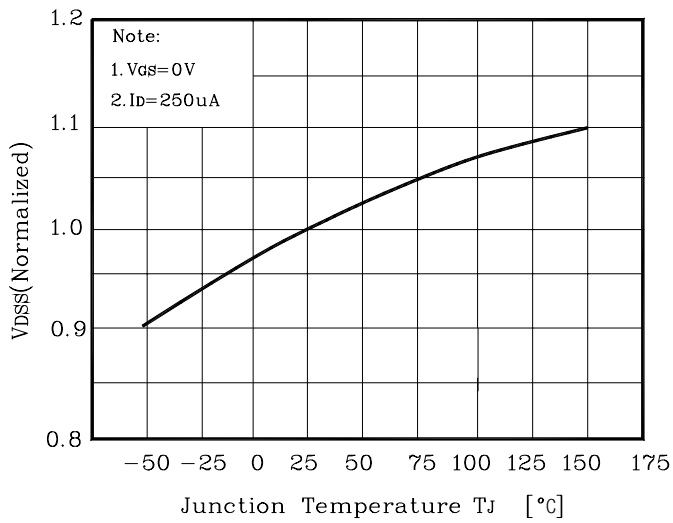


Fig. 6  $V_{GS} - Q_g$

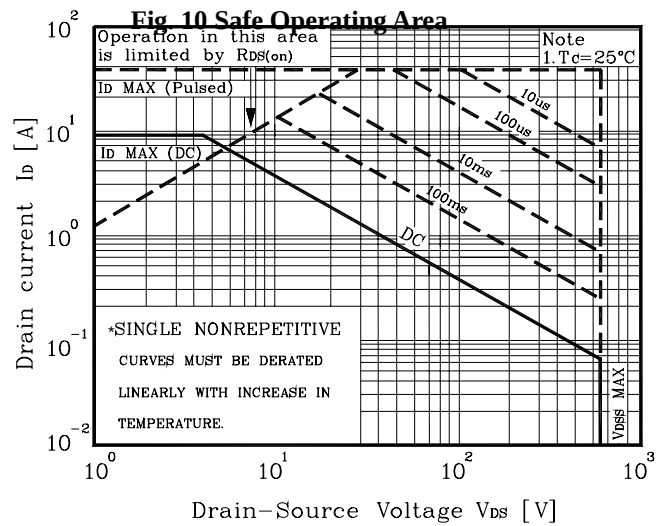
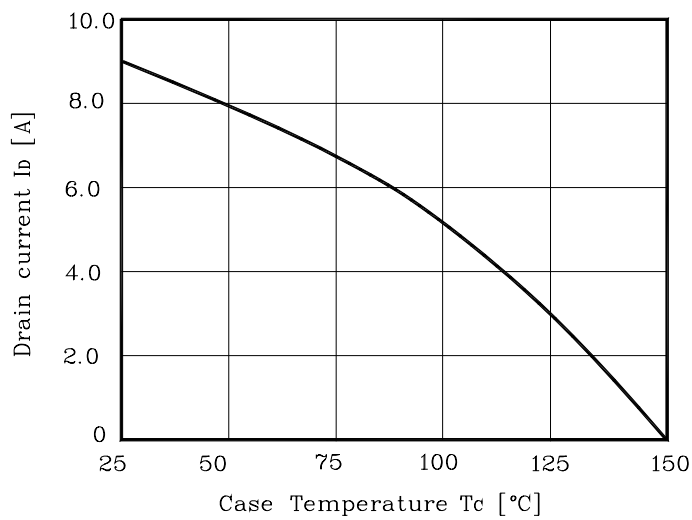


## Electrical Characteristic Curves

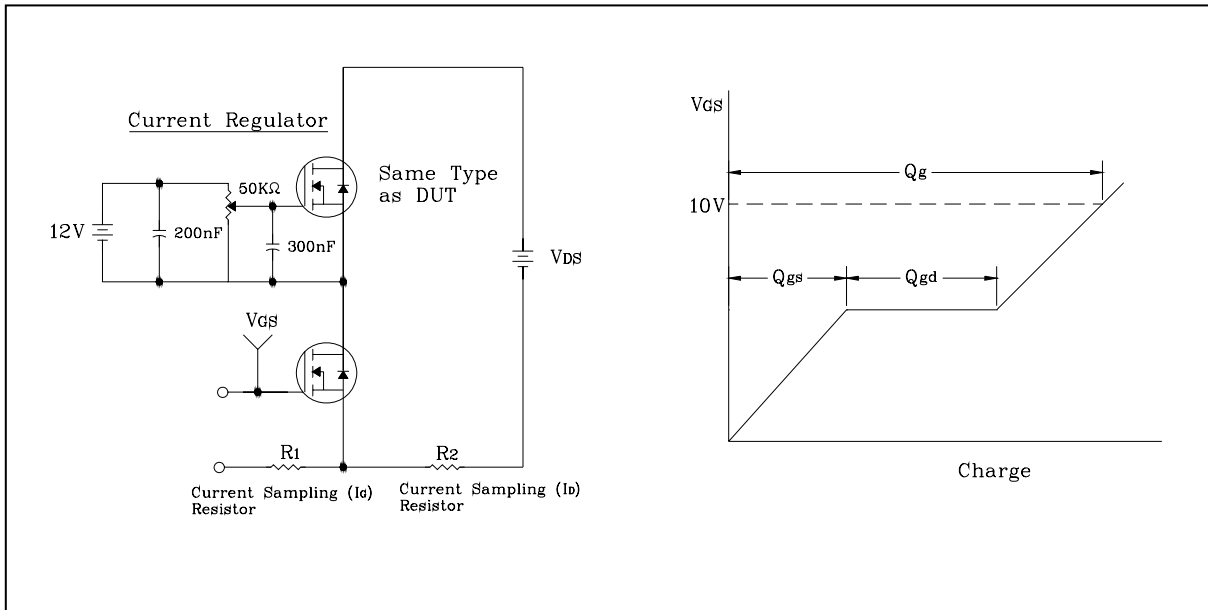
**Fig. 7  $V_{DS} - T_J$**



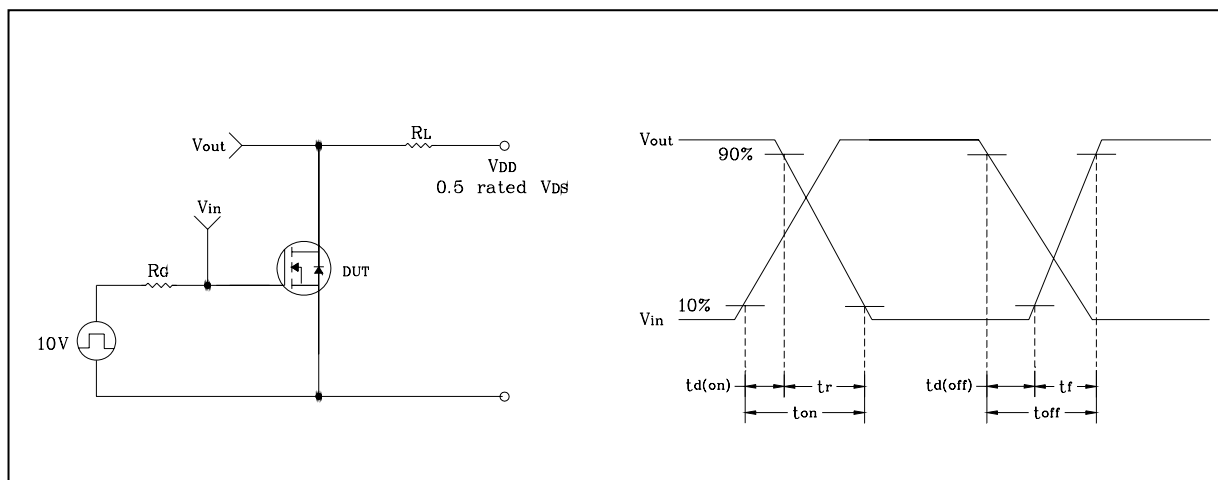
**Fig. 9  $I_D - T_C$**



**Fig. 11 Gate Charge Test Circuit & Waveform**



**Fig. 12 Resistive Switching Test Circuit & Waveform**



**Fig. 13  $E_{AS}$  Test Circuit & Waveform**

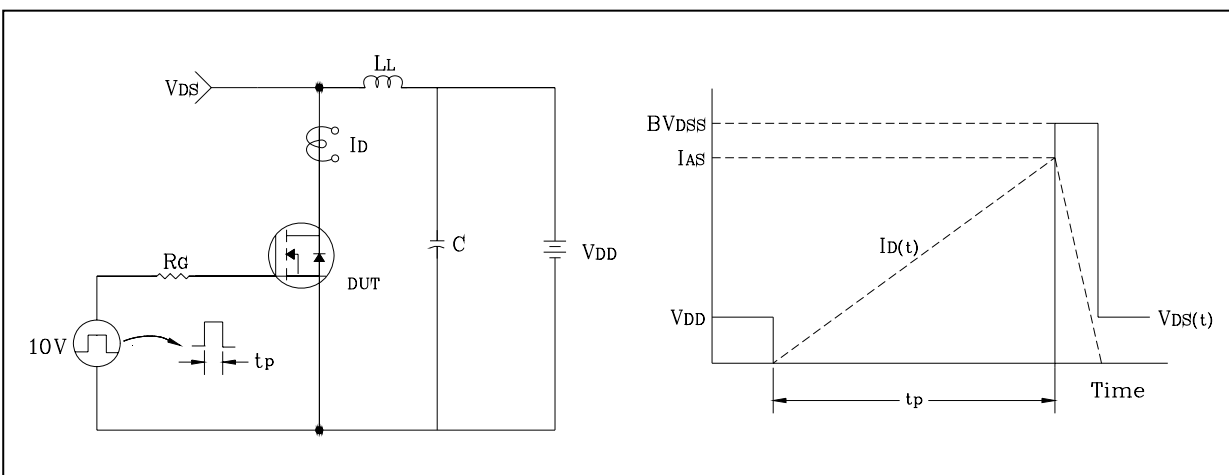
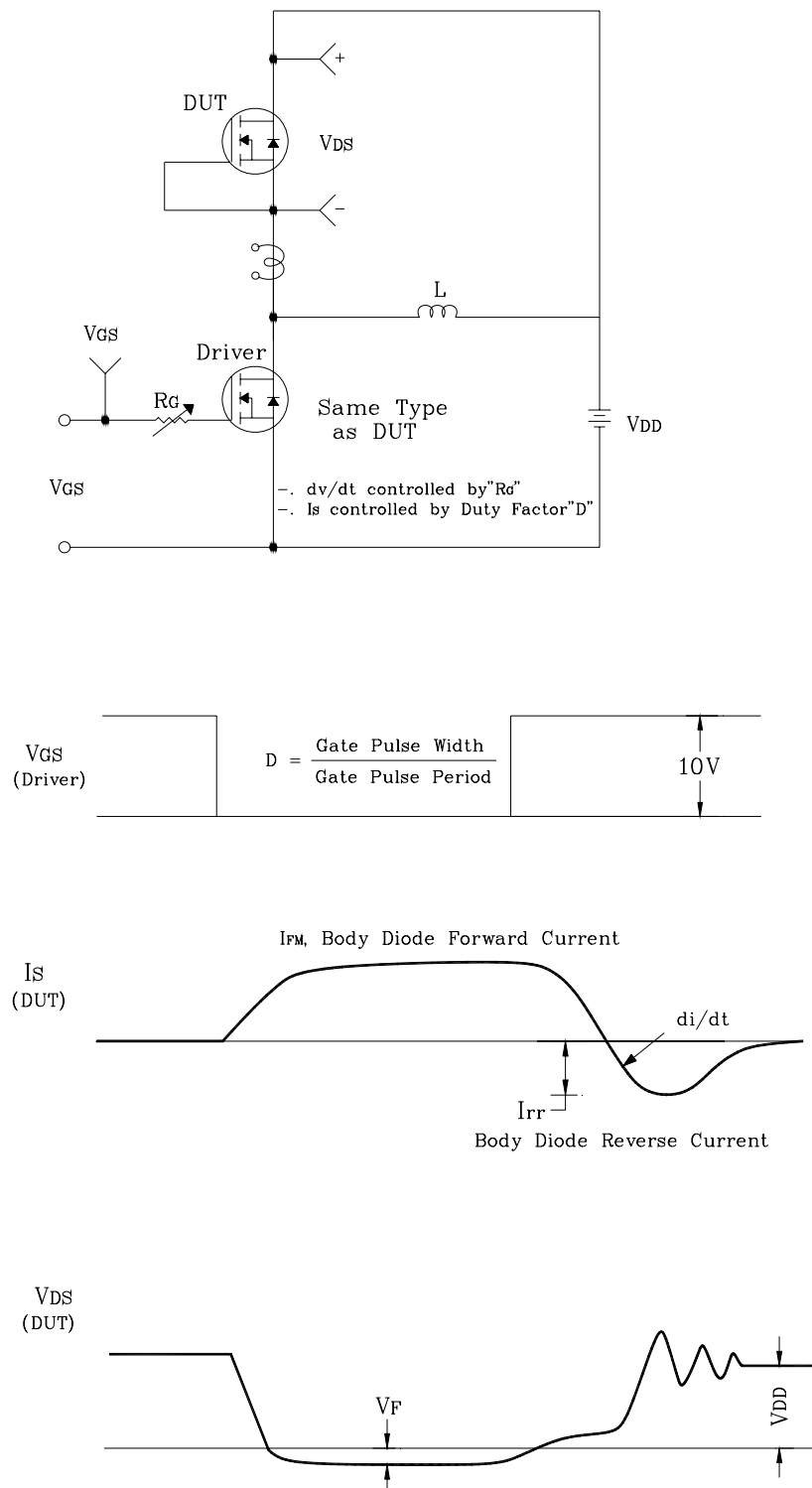
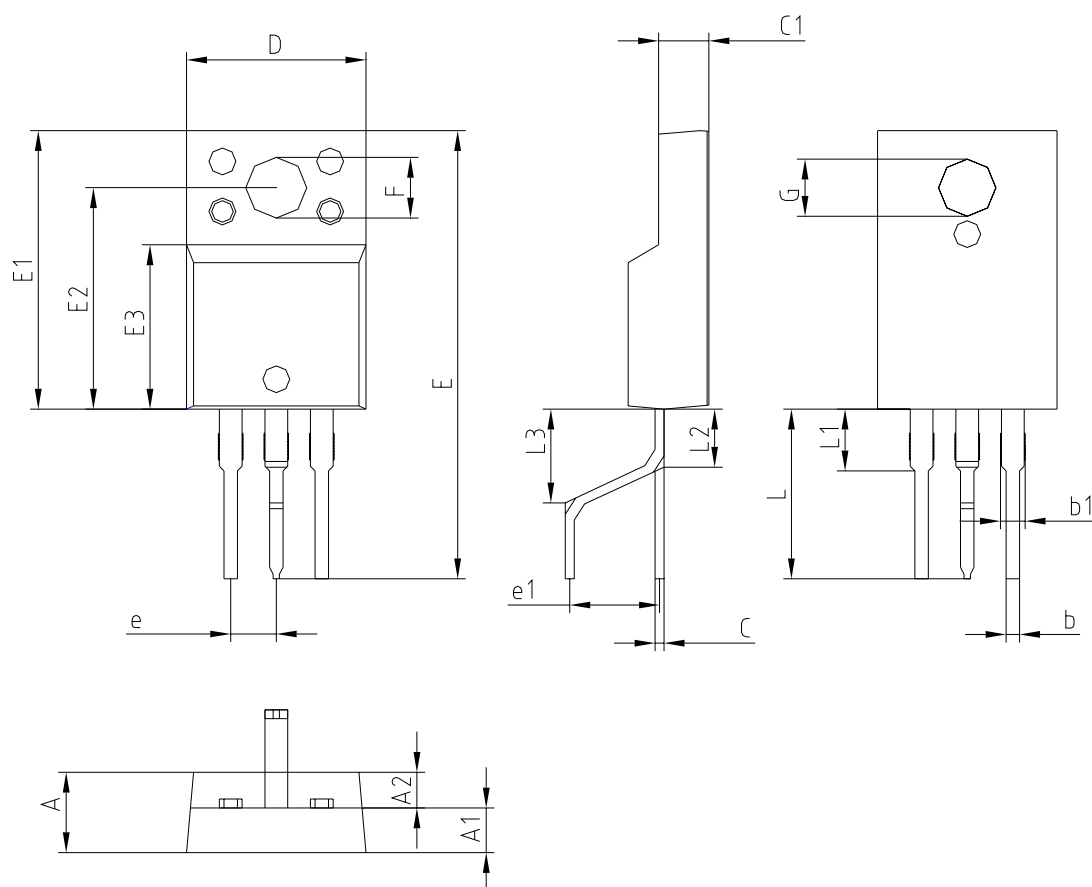


Fig. 14 Diode Reverse Recovery Time Test Circuit & Waveform



## Outline Dimension

unit: mm



| SYMBOL | MILLIMETERS |         |         | NOTE |
|--------|-------------|---------|---------|------|
|        | MINIMUM     | NOMINAL | MAXIMUM |      |
| A      | —           | —       | 4.60    |      |
| A1     | 2.45        | 2.50    | 2.55    |      |
| A2     | 1.95        | 2.00    | 2.05    |      |
| b      | 0.65        | 0.75    | 0.85    |      |
| b1     | 1.07        | 1.27    | 1.47    |      |
| C      | 0.40        | 0.50    | 0.60    |      |
| C1     | 2.70        | 2.80    | 2.90    |      |
| D      | 9.90        | 10.00   | 10.10   |      |
| E      | 24.61       | —       | 25.61   |      |
| E1     | 15.50       | 15.60   | 15.70   |      |
| E2     | 12.30       | 12.40   | 12.50   |      |
| E3     | 9.15        | 9.20    | 9.25    |      |
| F      | 3.30        | 3.40    | 3.50    |      |
| G      | 3.10        | 3.20    | 3.30    |      |
| e      | 2.54 BSC    |         |         |      |
| e1     | 4.70        | 5.00    | 5.30    |      |
| L      | 9.01        | —       | 10.01   |      |
| L1     | 3.46 BSC    |         |         |      |
| L2     | 3.26 BSC    |         |         |      |
| L3     | 5.26 BSC    |         |         |      |

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