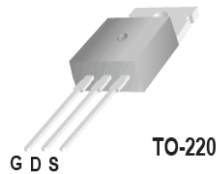


# TSP60R280S1

## 600V 15A N-Channel SJ-MOSFET

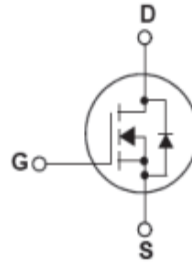
### General Description

Truesemi SJ-FET is new generation of high voltage MOSFET family that is utilizing an advanced charge balance mechanism for outstanding low on-resistance and lower gate charge performance. This advanced technology has been tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate and higher avalanche energy. SJ-FET is suitable for various AC/DC power conversion in switching mode operation for higher efficiency.



### Features

- 650V @TJ = 150 °C
- Typ. RDS(on) = 0.24Ω
- Ultra Low gate charge (typ. Qg = 43nC)
- 100% avalanche tested



### Absolute Maximum Ratings

| Symbol                            | Parameter                                                                    | Value       | Unit |
|-----------------------------------|------------------------------------------------------------------------------|-------------|------|
| V <sub>DSS</sub>                  | Drain-Source Voltage                                                         | 600         | V    |
| I <sub>D</sub>                    | Drain Current -Continuous (TC = 25°C)<br>-Continuous (TC = 100°C)            | 15<br>9.4   | A    |
| I <sub>DM</sub>                   | Drain Current – Pulsed (Note 1)                                              | 45          | A    |
| V <sub>GSS</sub>                  | Gate-Source voltage                                                          | ±30         | V    |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                                      | 284         | mJ   |
| I <sub>AR</sub>                   | Avalanche Current (Note 1)                                                   | 2.4         | A    |
| E <sub>AR</sub>                   | Repetitive Avalanche Energy (Note 1)                                         | 0.43        | mJ   |
| dv/dt                             | Peak Diode Recovery dv/dt (Note 3)                                           | 15          | V/ns |
| P <sub>D</sub>                    | Power Dissipation (TC = 25°C)                                                | 104         | W    |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range                                      | -55 to +150 | °C   |
| T <sub>L</sub>                    | Maximum Lead Temperature for Soldering Purpose, 1/8" from Case for 5 Seconds | 300         | °C   |

\* Drain current limited by maximum junction temperature.

### Thermal Characteristics

| Symbol           | Parameter                               | Value | Unit |
|------------------|-----------------------------------------|-------|------|
| R <sub>θJC</sub> | Thermal Resistance, Junction-to-Case    | 1.2   | °C/W |
| R <sub>θCS</sub> | Thermal Resistance, Case-to-Sink Typ.   | 0.5   | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction-to-Ambient | 62    | °C/W |

**Electrical Characteristics TC = 25 °C unless otherwise noted**

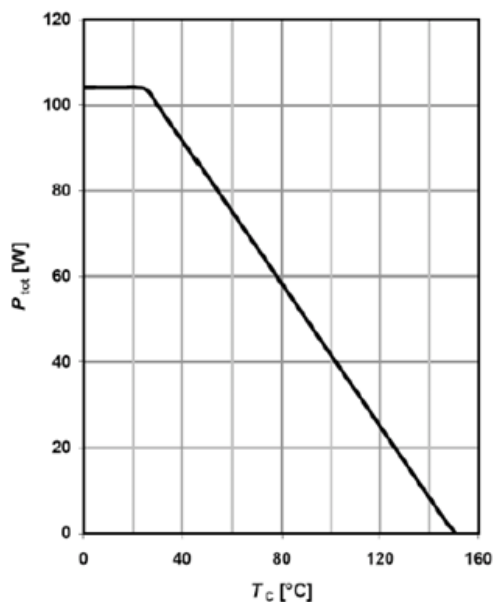
| Symbol                                                 | Parameter                                             | Conditions                                                                           | Min | Typ      | Max     | Unit     |
|--------------------------------------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------|-----|----------|---------|----------|
| Off Characteristics                                    |                                                       |                                                                                      |     |          |         |          |
| BV <sub>DSS</sub>                                      | Drain-Source Breakdown Voltage                        | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 25℃                   | 600 | --       | --      | V        |
|                                                        |                                                       | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 150℃                  | --  | 650      | --      | V        |
| ΔBV <sub>DSS</sub> / ΔT <sub>J</sub>                   | Breakdown Voltage Temperature Coefficient             | I <sub>D</sub> = 250μA, Referenced to 25℃                                            | --  | 0.6      | --      | V/℃      |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current                       | V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V<br>-T <sub>C</sub> = 150℃               | --  | --<br>10 | 1<br>-- | μA<br>μA |
| I <sub>GSSF</sub>                                      | Gate-Body Leakage Current, Forward                    | V <sub>GS</sub> = 30V, V <sub>DS</sub> = 0V                                          | --  | --       | 100     | nA       |
| I <sub>GSSR</sub>                                      | Gate-Body Leakage Current, Reverse                    | V <sub>GS</sub> = -30V, V <sub>DS</sub> = 0V                                         | --  | --       | -100    | nA       |
| On Characteristics                                     |                                                       |                                                                                      |     |          |         |          |
| V <sub>GS(th)</sub>                                    | Gate Threshold Voltage                                | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA                           | 2.5 | --       | 4.5     | V        |
| R <sub>DS(on)</sub>                                    | Static Drain-Source On-Resistance                     | V <sub>GS</sub> = 10V, I <sub>D</sub> = 7.5A                                         | --  | 0.24     | 0.28    | Ω        |
| g <sub>FS</sub>                                        | Forward Trans conductance                             | V <sub>DS</sub> = 40V, I <sub>D</sub> = 15A (Note 4)                                 | --  | 16       | --      | S        |
| R <sub>g</sub>                                         | Gate resistance                                       | f=1 MHz, open drain                                                                  | --  | 3.5      | --      | Ω        |
| Dynamic Characteristics                                |                                                       |                                                                                      |     |          |         |          |
| C <sub>iss</sub>                                       | Input Capacitance                                     | V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V,<br>f = 1.0MHz                           | --  | 800      | --      | pF       |
| C <sub>oss</sub>                                       | Output Capacitance                                    |                                                                                      | --  | 340      | --      | pF       |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance                          |                                                                                      | --  | 10       | --      | pF       |
| Switching Characteristics                              |                                                       |                                                                                      |     |          |         |          |
| t <sub>d(on)</sub>                                     | Turn-On Delay Time                                    | V <sub>DD</sub> = 400V, I <sub>D</sub> = 7.5A<br>R <sub>G</sub> = 20Ω(Note 4, 5)     | --  | 13       | --      | ns       |
| t <sub>r</sub>                                         | Turn-On Rise Time                                     |                                                                                      | --  | 11       | --      | ns       |
| t <sub>d(off)</sub>                                    | Turn-Off Delay Time                                   |                                                                                      | --  | 100      | --      | ns       |
| t <sub>f</sub>                                         | Turn-Off Fall Time                                    |                                                                                      | --  | 12       | --      | ns       |
| Q <sub>g</sub>                                         | Total Gate Charge                                     | V <sub>DS</sub> = 480V, I <sub>D</sub> = 7.5A<br>V <sub>GS</sub> = 10V (Note 4, 5)   | --  | 43       | --      | nC       |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                    |                                                                                      | --  | 5        | --      | nC       |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                                     |                                                                                      | --  | 22       | --      | nC       |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                       |                                                                                      |     |          |         |          |
| I <sub>S</sub>                                         | Maximum Continuous Drain-Source Diode Forward Current |                                                                                      | --  | --       | 15      | A        |
| I <sub>SM</sub>                                        | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                      | --  | --       | 45      | A        |
| V <sub>SD</sub>                                        | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0V, I <sub>F</sub> = 7.5A                                          | --  | 0.9      | 1.5     | V        |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                 | V <sub>GS</sub> = 0V, I <sub>F</sub> = 7.5A<br>di <sub>F</sub> /dt =100A/μs (Note 4) | --  | 345      | --      | ns       |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                               |                                                                                      | --  | 4.5      | --      | μC       |

**NOTES:**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS}=2.4A, V_{DD}=50V$ , Starting  $T_J=25^\circ C$
3.  $I_{SD}\leq 15A, di/dt \leq 200A/\mu s, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ C$
4. Pulse Test: Pulse width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$
5. Essentially Independent of Operating Temperature Typical Characteristics

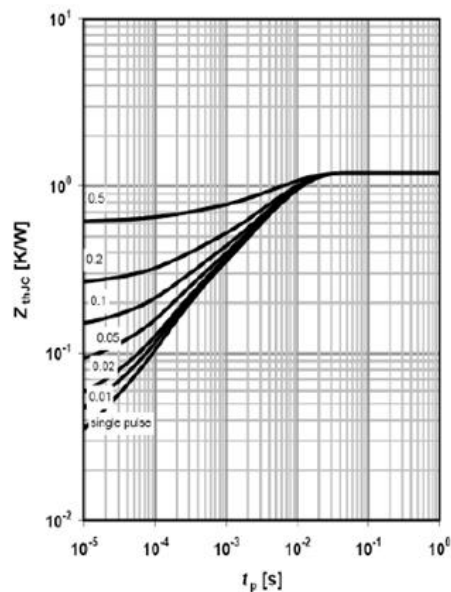
# Typical Performance Characteristics

Power dissipation



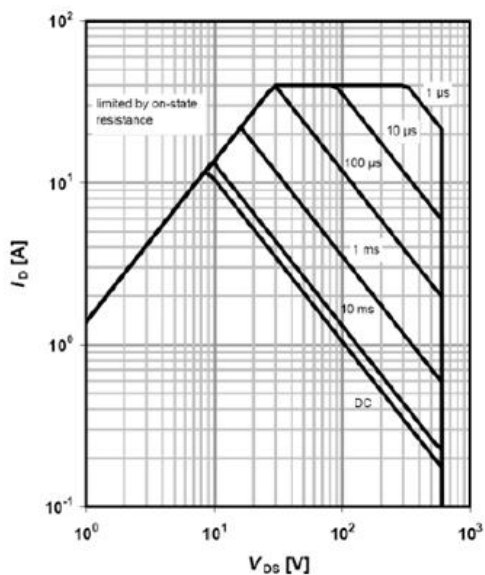
$$P_{tot} = f(T_c)$$

Max. transient thermal impedance



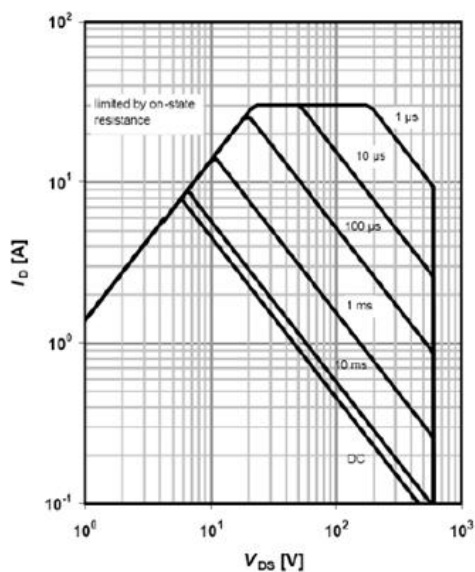
$$P_{tot} = f(T_c)$$

Safe operating area  $T_c = 25^\circ\text{C}$



$$I_D = f(V_{DS}); T_c = 25^\circ\text{C}; V_{GS} > 7\text{V}; D=0; \text{parameter } t_p$$

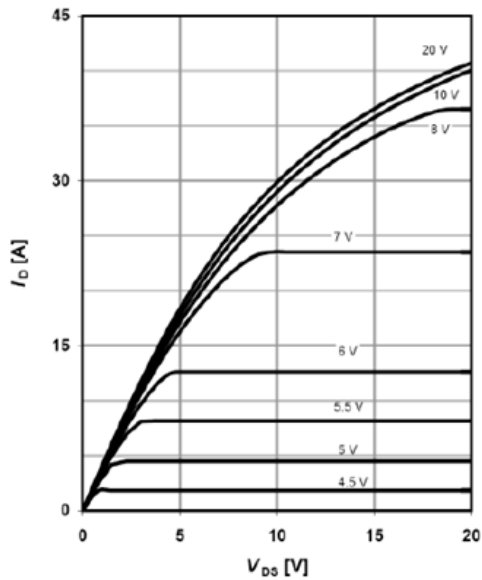
Safe operating area  $T_c = 80^\circ\text{C}$



$$I_D = f(V_{DS}); T_c = 80^\circ\text{C}; V_{GS} > 7\text{V}; D=0; \text{parameter } t_p$$

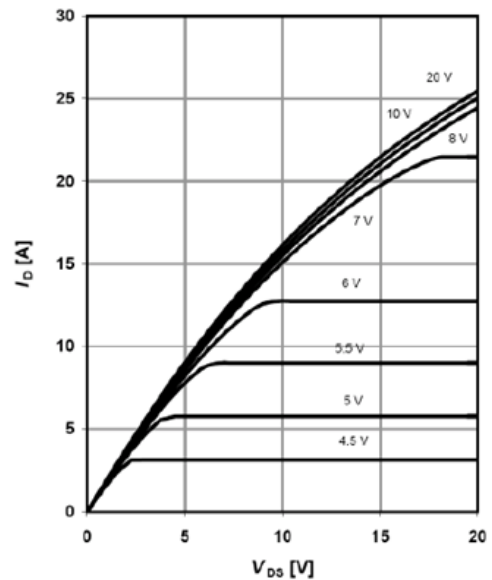
# Typical Performance Characteristics

Typ. output characteristics  $T_j=25^\circ\text{C}$



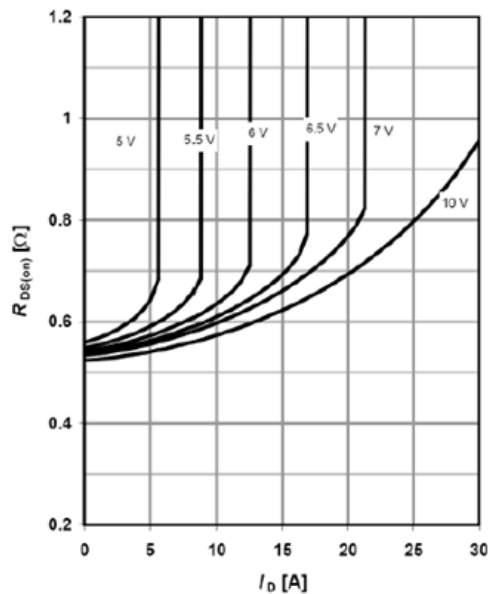
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}; \text{parameter: } V_{GS}$$

Typ. output characteristics  $T_j=125^\circ\text{C}$



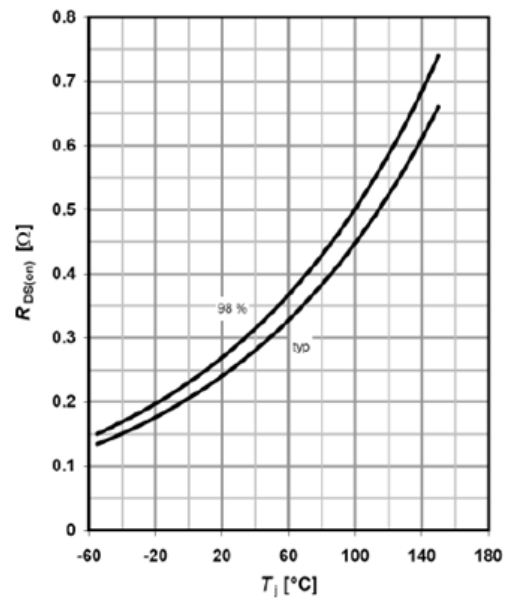
$$I_D = f(V_{DS}); T_j = 125^\circ\text{C}; \text{parameter: } V_{GS}$$

Typ. drain-source on-state resistance



$$R_{DS(on)} = f(I_D); T_j = 125^\circ\text{C}; \text{parameter: } V_{GS}$$

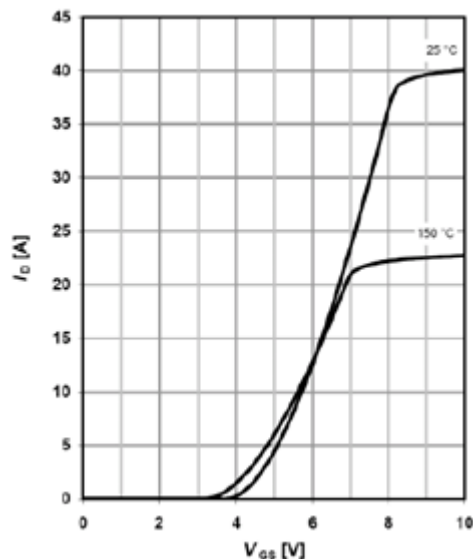
Typ. drain-source on-state resistance



$$R_{DS(on)} = f(T_j); I_D = 6.5\text{ A}; V_{GS} = 10\text{ V}$$

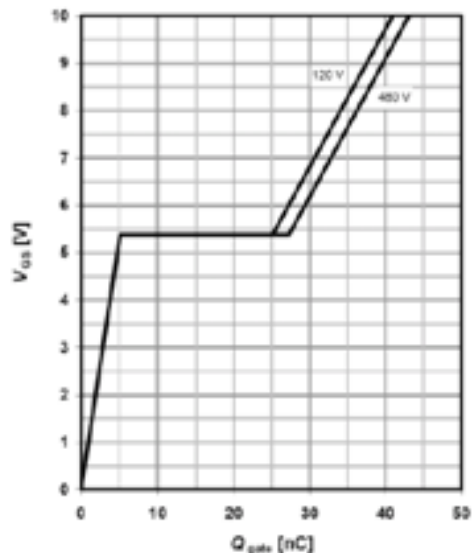
# Typical Performance Characteristics

Typ. transfer characteristics



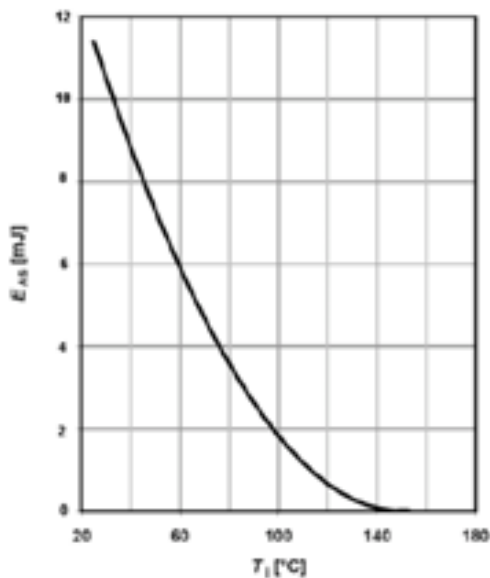
$$I_D = f(V_{GS}); V_{DS} = 20V$$

Typ. gate charge



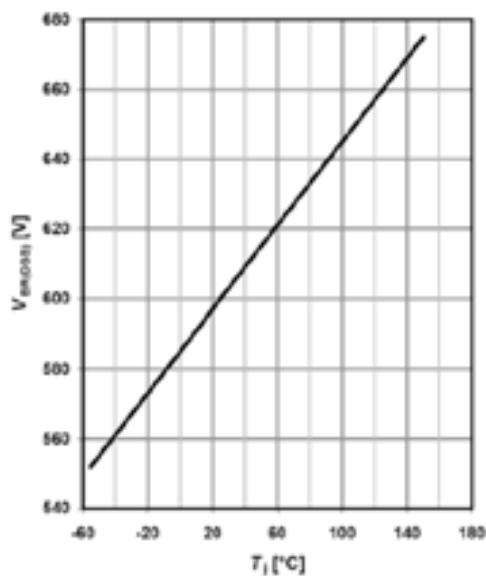
$$V_{GS} = f(Q_g), I_D = 6.5A \text{ pulsed}$$

Avalanche energy



$$E_{AS} = f(T_J); I_D = 6.5A; V_{DD} = 50V$$

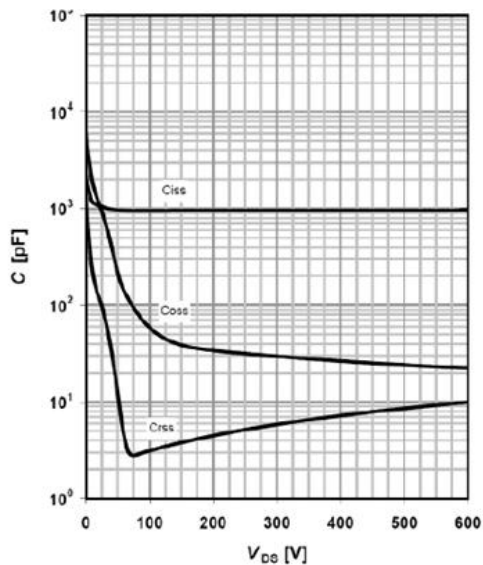
Drain-source breakdown voltage



$$V_{BR(DSS)} = f(T_J); I_D = 0.25mA$$

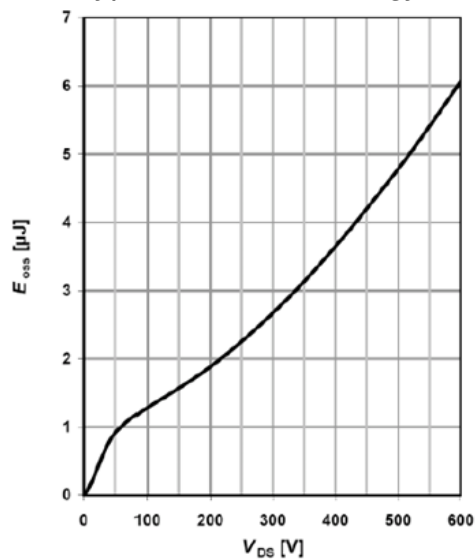
# Typical Performance Characteristics

Typ. capacitances



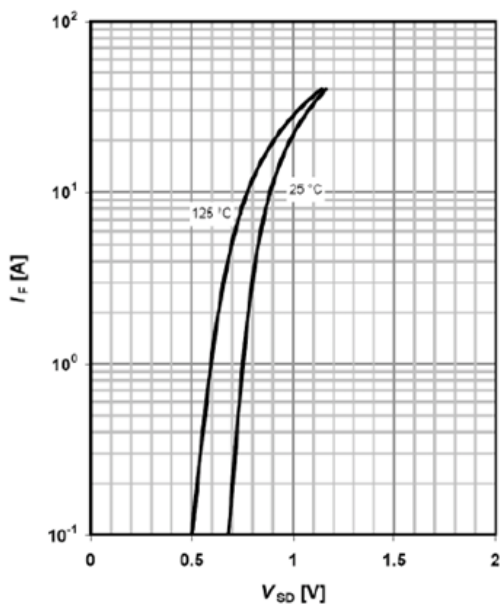
$$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$$

Typ. *Coss* stored energy



$$E_{OSS}=f(V_{DS})$$

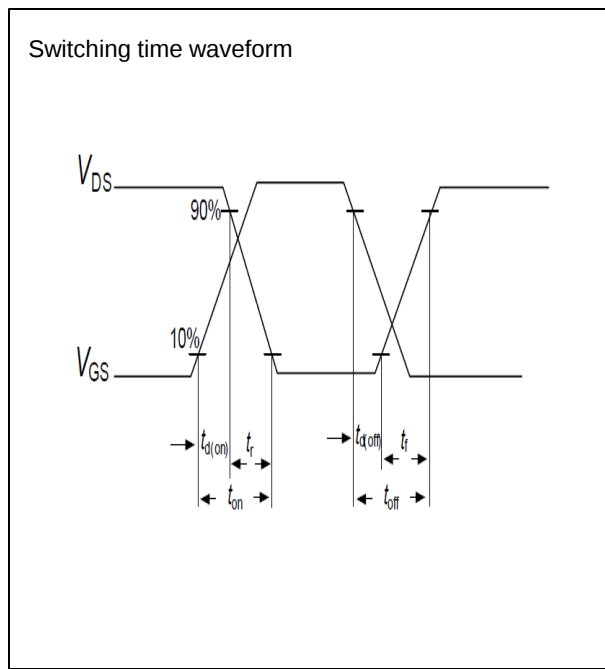
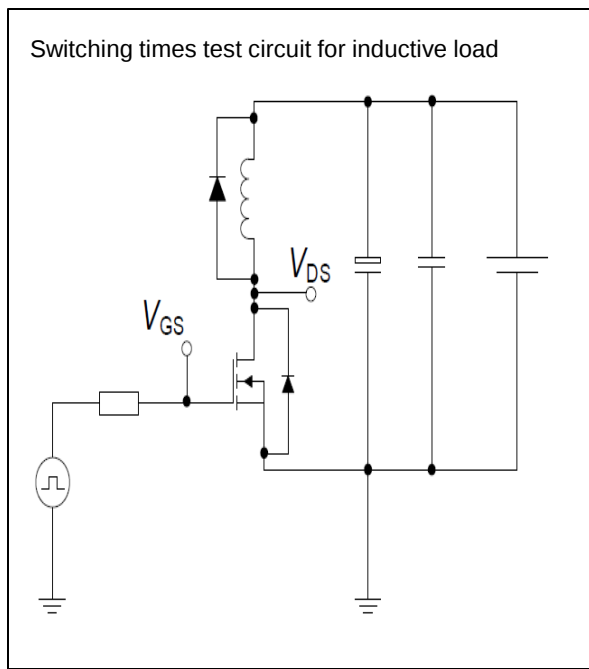
Forward characteristics of reverse diode



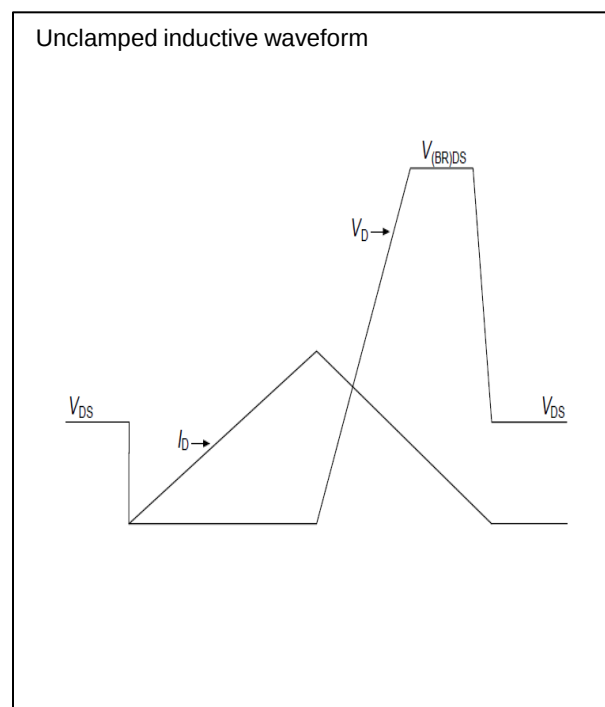
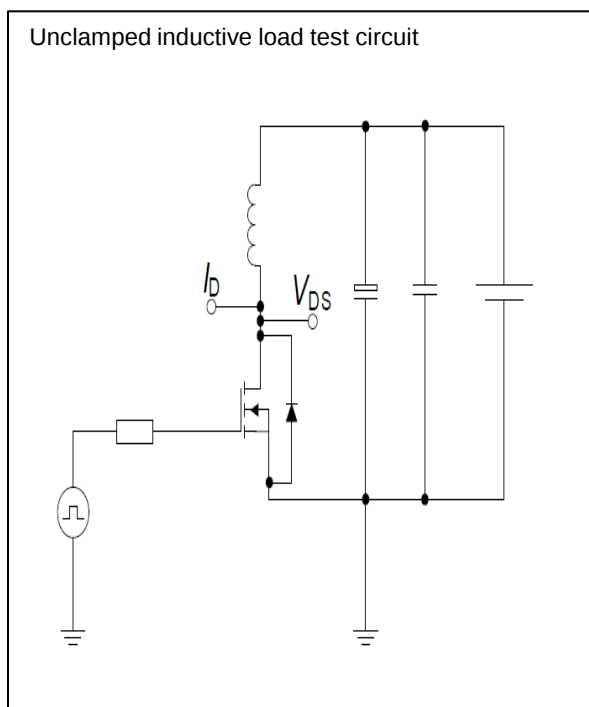
$$I_F=f(V_{SD}); \text{ parameter: } T_j$$

# Test circuits

## Switching times test circuit and waveform for inductive load



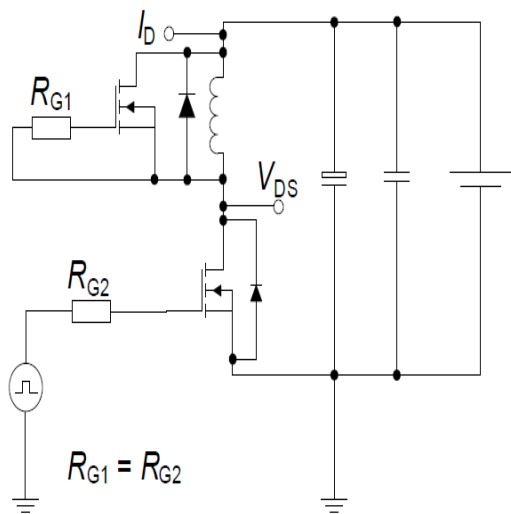
## Unclamped inductive load test circuit and waveform



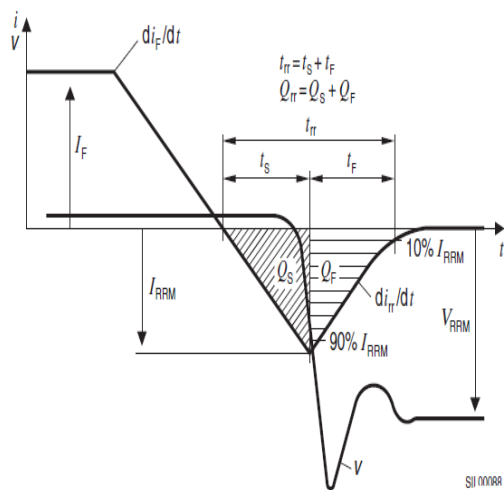
# Test circuits

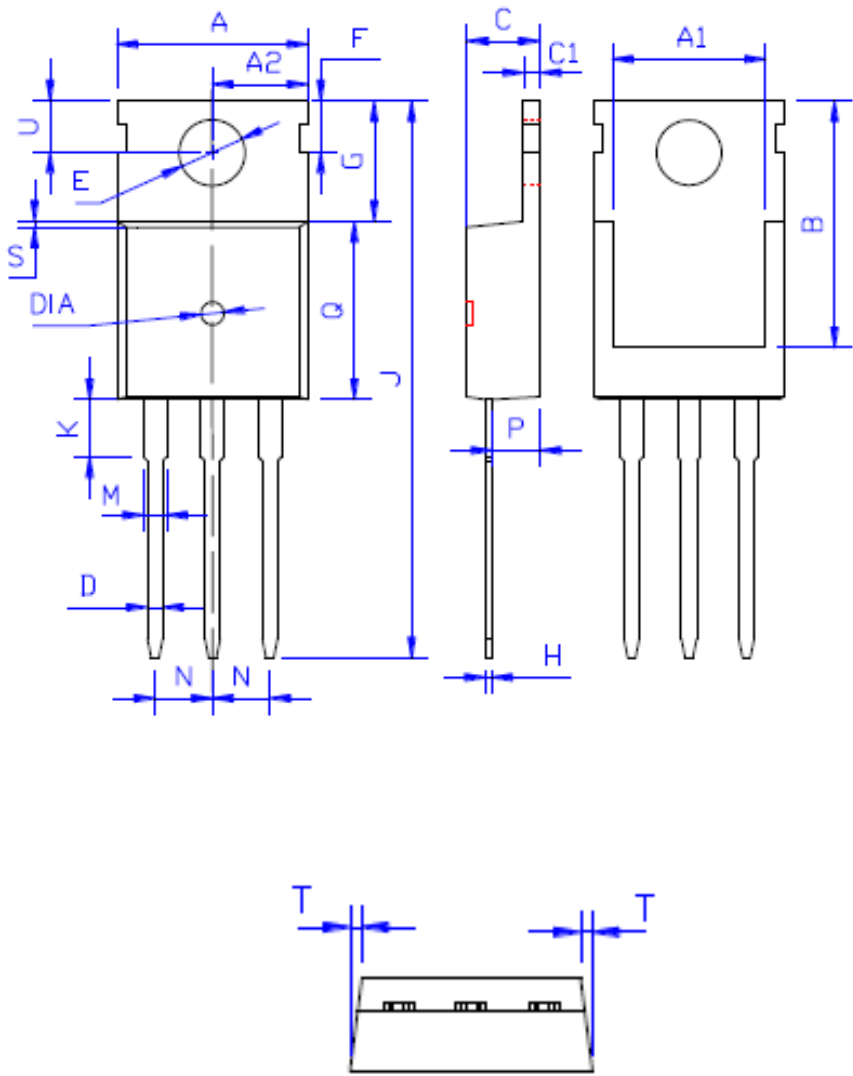
## Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



Diode recovery waveform





| DIM | MILLIMETERS                      |
|-----|----------------------------------|
| A   | 10.00±0.30                       |
| A1  | 8.00±0.30                        |
| A2  | 5.00±0.30                        |
| B   | 13.20±0.40                       |
| C   | 4.50±0.20                        |
| C1  | 1.30±0.20                        |
| D   | 0.80±0.20                        |
| E   | 3.60±0.20                        |
| F   | 3.00±0.30                        |
| G   | 6.60±0.40                        |
| H   | 0.50±0.20                        |
| J   | 28.88±0.50                       |
| K   | 3.00±0.30                        |
| M   | 1.30±0.30                        |
| N   | Typical 2.54                     |
| P   | 2.40±0.40                        |
| Q   | 9.20±0.40                        |
| S   | 0.25±0.15                        |
| T   | 0.25±0.15                        |
| U   | 2.80±0.30                        |
| DIA | 宽 1.50±0.10<br>深 0.50 <b>MAX</b> |