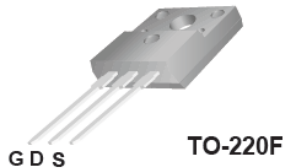


# TSF70R450S1

## 700V 10.5A N-Channel SJ-MOSFET

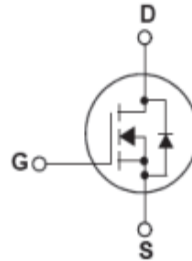
### General Description

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

- 750V @TJ = 150 °C
- Typ. RDS(on) = 0.42Ω
- Ultra Low gate charge (typ. Qg = 38nC)
- 100% avalanche tested



### Absolute Maximum Ratings

| Symbol                            | Parameter                                                                    | Value         | Unit      |
|-----------------------------------|------------------------------------------------------------------------------|---------------|-----------|
| V <sub>DSS</sub>                  | Drain-Source Voltage                                                         | 700           | V         |
| I <sub>D</sub>                    | Drain Current<br>-Continuous (TC = 25°C)<br>-Continuous (TC = 100°C)         | 10.5*<br>6.7* | A         |
| I <sub>DM</sub>                   | Drain Current – Pulsed (Note 1)                                              | 30*           | A         |
| V <sub>GSS</sub>                  | Gate-Source voltage                                                          | ±30           | V         |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                                      | 210           | mJ        |
| I <sub>AR</sub>                   | Avalanche Current (Note 1)                                                   | 1.8           | A         |
| E <sub>AR</sub>                   | Repetitive Avalanche Energy (Note 1)                                         | 0.32          | mJ        |
| dv/dt                             | Peak Diode Recovery dv/dt (Note 3)                                           | 15            | V/ns      |
| P <sub>D</sub>                    | Power Dissipation (TC = 25°C)<br>-Derate above 25°C                          | 31<br>0.3     | W<br>W/°C |
| 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    | 4.0   | °C/W |
| R <sub>θCS</sub> | Thermal Resistance, Case-to-Sink Typ.   | --    | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction-to-Ambient | 80    | °C/W |

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

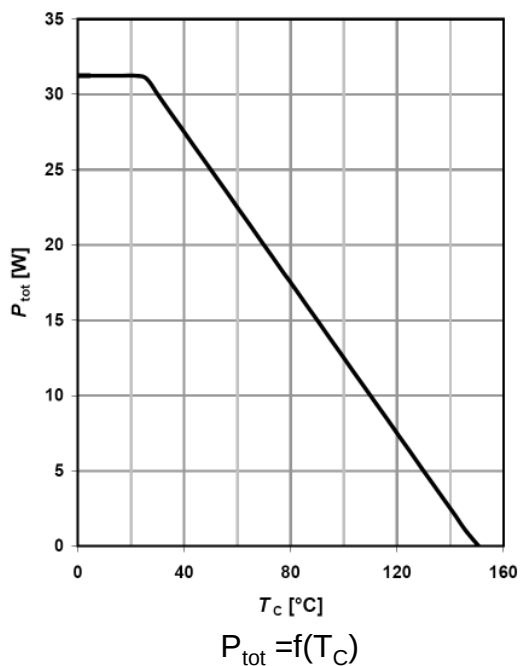
| Symbol                                                 | Parameter                                             | Conditions                                                                           | Min | Typ      | Max     | Unit     |
|--------------------------------------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------|-----|----------|---------|----------|
| 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℃                   | 700 | --       | --      | V        |
|                                                        |                                                       | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 150℃                  | --  | 750      | --      | 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> = 700V, V <sub>GS</sub> = 0V<br>-T <sub>J</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> = 5.5A                                         | --  | 0.42     | 0.45    | Ω        |
| g <sub>FS</sub>                                        | Forward Trans conductance                             | V <sub>DS</sub> = 40V, I <sub>D</sub> = 5.5A (Note 4)                                | --  | 16       | --      | S        |
| R <sub>g</sub>                                         | Gate resistance                                       | f=1 MHz, open drain                                                                  | --  | 3        | --      | Ω        |
| Dynamic Characteristics                                |                                                       |                                                                                      |     |          |         |          |
| C <sub>iss</sub>                                       | Input Capacitance                                     | V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1.0MHz                              | --  | 680      | --      | pF       |
| C <sub>oss</sub>                                       | Output Capacitance                                    |                                                                                      | --  | 240      | --      | pF       |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance                          |                                                                                      | --  | 7        | --      | pF       |
| Switching Characteristics                              |                                                       |                                                                                      |     |          |         |          |
| t <sub>d(on)</sub>                                     | Turn-On Delay Time                                    | V <sub>DD</sub> = 400V, I <sub>D</sub> = 5.5A<br>R <sub>G</sub> = 20Ω(Note 4, 5)     | --  | 15       | --      | ns       |
| t <sub>r</sub>                                         | Turn-On Rise Time                                     |                                                                                      | --  | 10       | --      | ns       |
| t <sub>d(off)</sub>                                    | Turn-Off Delay Time                                   |                                                                                      | --  | 110      | --      | ns       |
| t <sub>f</sub>                                         | Turn-Off Fall Time                                    |                                                                                      | --  | 9        | --      | ns       |
| Q <sub>g</sub>                                         | Total Gate Charge                                     | V <sub>DS</sub> = 480V, I <sub>D</sub> = 5.5A<br>V <sub>GS</sub> = 10V (Note 4, 5)   | --  | 38       | --      | nC       |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                    |                                                                                      | --  | 4        | --      | nC       |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                                     |                                                                                      | --  | 4.2      | --      | nC       |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                       |                                                                                      |     |          |         |          |
| I <sub>S</sub>                                         | Maximum Continuous Drain-Source Diode Forward Current |                                                                                      | --  | --       | 11      | A        |
| I <sub>SM</sub>                                        | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                      | --  | --       | 30      | A        |
| V <sub>SD</sub>                                        | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0V, I <sub>F</sub> = 5.5A                                          | --  | 0.9      | 1.5     | V        |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                 | V <sub>GS</sub> = 0V, I <sub>F</sub> = 5.5A<br>di <sub>F</sub> /dt =100A/μs (Note 4) | --  | 270      | --      | ns       |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                               |                                                                                      | --  | 3.3      | --      | μC       |

**NOTES:**

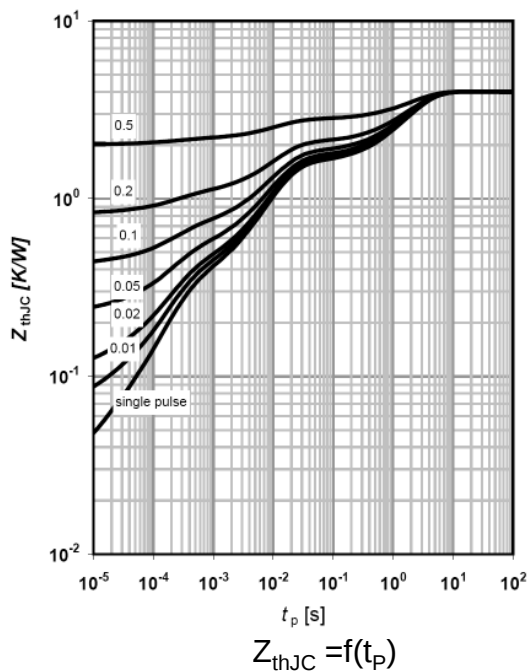
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS}=1.8A, V_{DD}=50V$ , Starting  $T_J=25^\circ C$
3.  $I_{SD}\leq 10.5A, di/dt \leq 200A/\mu s, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ C$
4. Pulse Test: Pulse width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$
5. Essentially Independent of Operating Temperature Typical Characteristics

# Typical Performance Characteristics

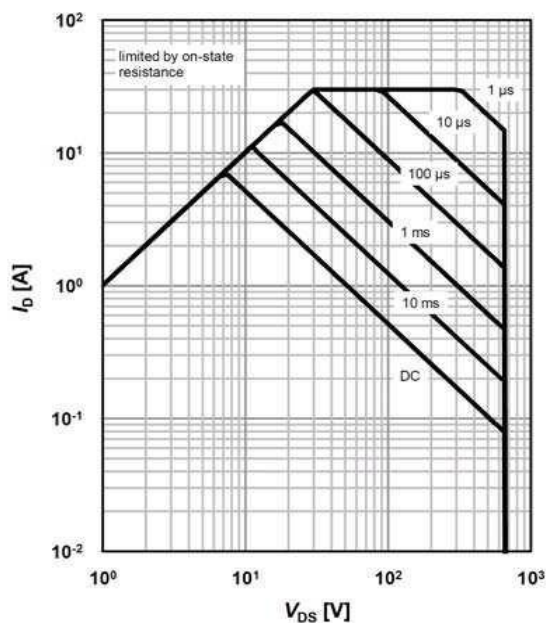
Power dissipation



Max. transient thermal impedance

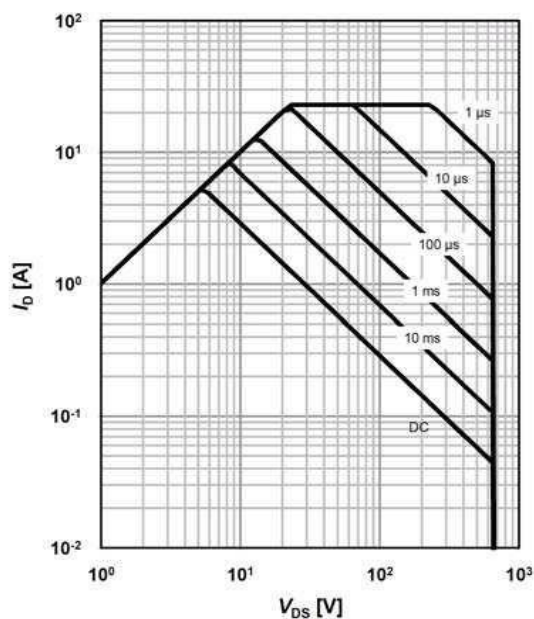


Safe operating area  $T_C = 25^\circ\text{C}$



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

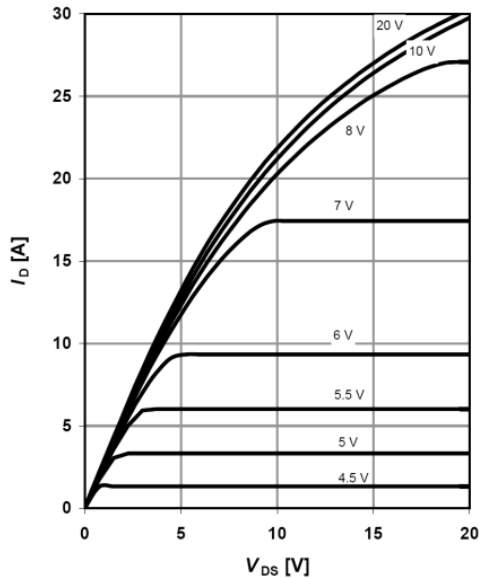
Safe operating area  $T_C = 80^\circ\text{C}$



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

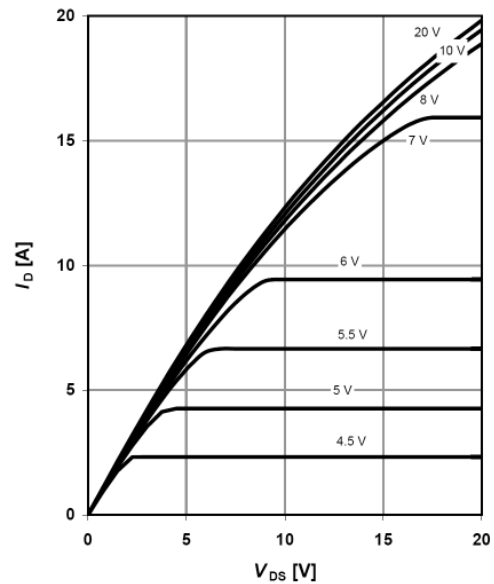
# Typical Performance Characteristics

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



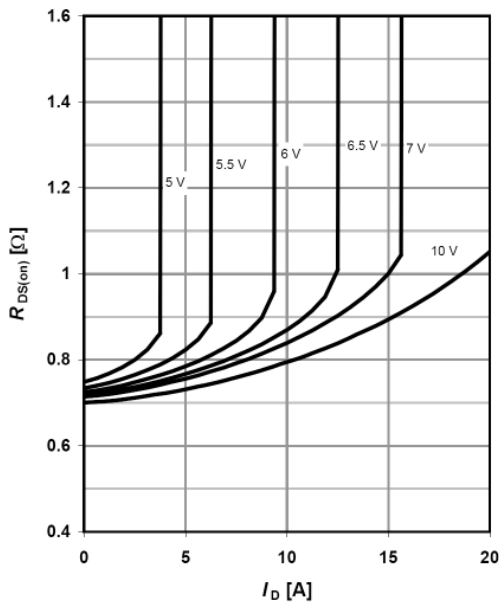
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}; \text{parameter: } V_{GS}$$

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



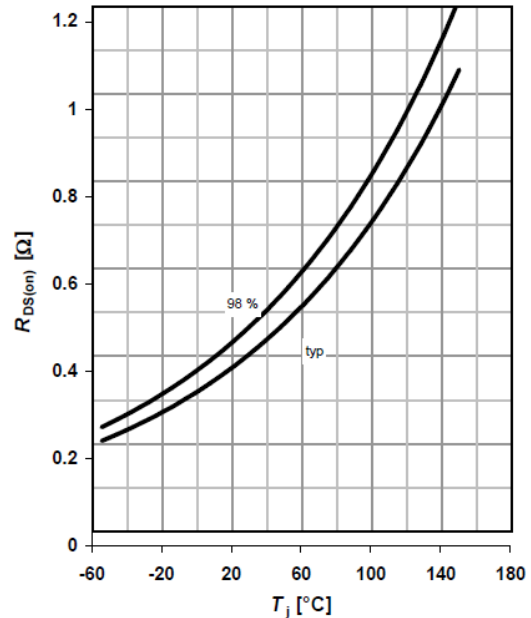
$$I_D = f(V_{DS}); T_j = 125^\circ\text{C}; \text{parameter: } V_{GS}$$

Typ. drain-source on-state resistance



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

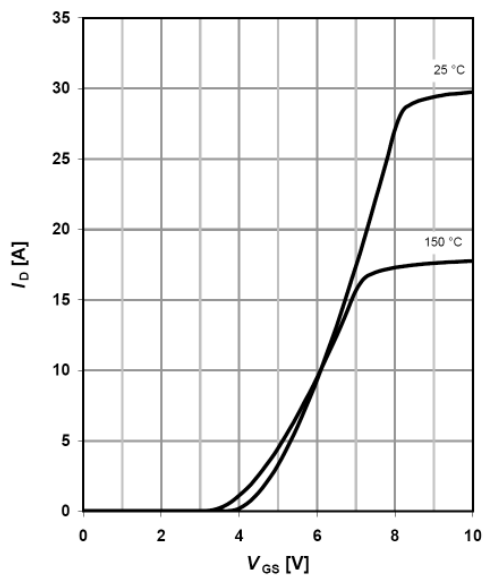
Typ. drain-source on-state resistance



$$R_{DS(on)} = f(T_j); I_D = 3.2\text{A}; V_{GS} = 10\text{V}$$

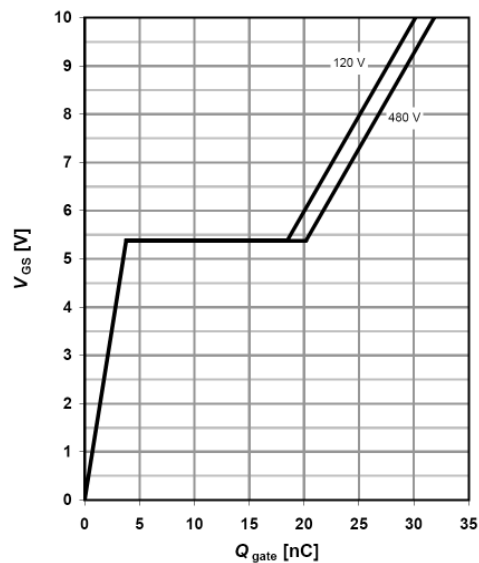
# Typical Performance Characteristics

Typ. transfer characteristics



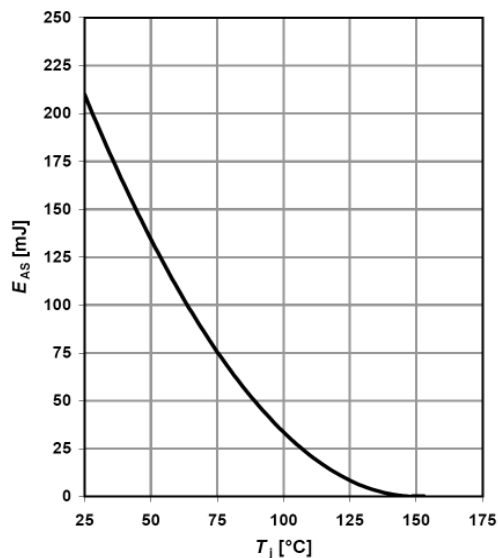
$$I_D = f(V_{GS}); V_{DS} = 20V$$

Typ. gate charge



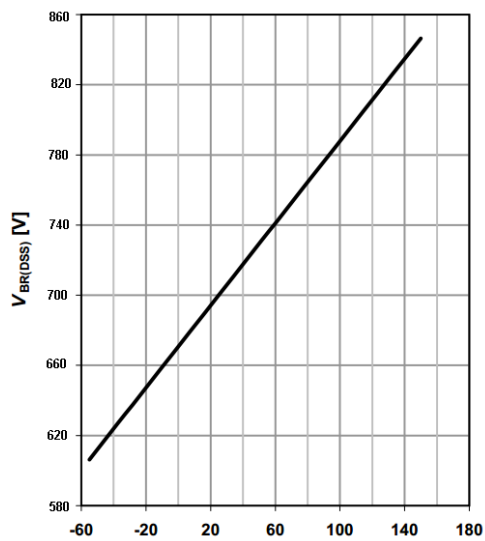
$$V_{GS} = f(Q_g), I_D = 4.8 A \text{ pulsed}$$

Avalanche energy



$$E_{AS} = f(T_j); I_D = 1.8 A; V_{DD} = 50 V$$

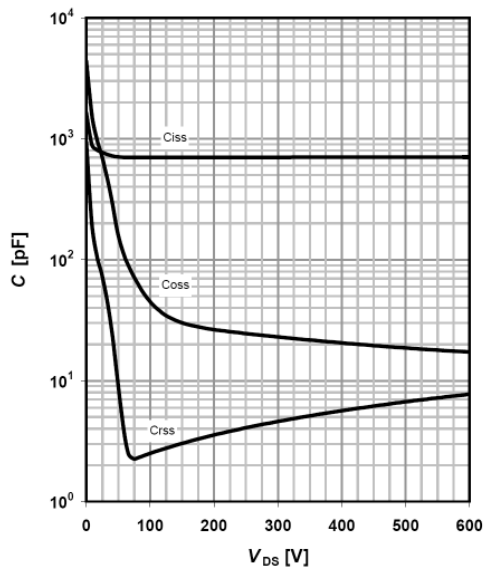
Drain-source breakdown voltage



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

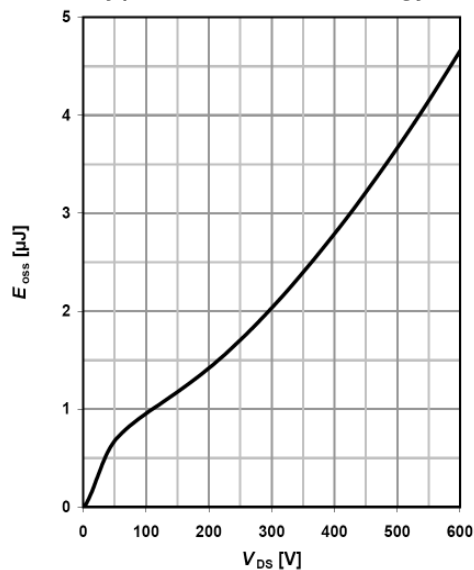
# Typical Performance Characteristics

Typ. capacitances



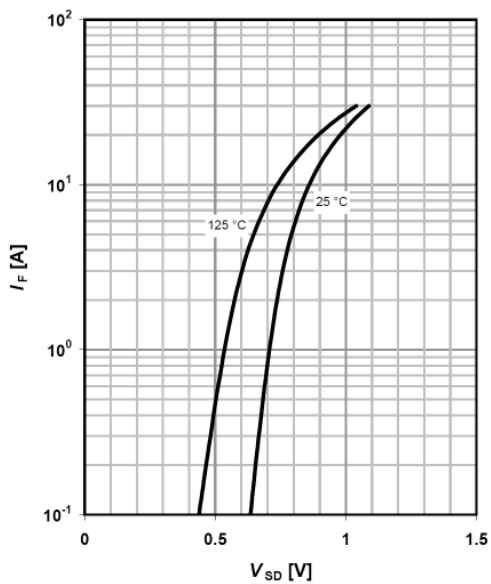
$$C=f(V_{DS}); V_{GS}=0 \text{ V}; f=1 \text{ MHz}$$

Typ.  $C_{oss}$  stored energy



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

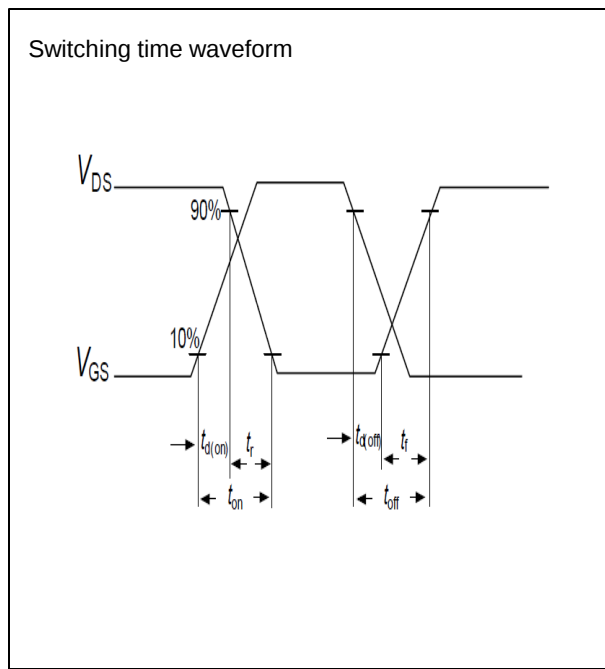
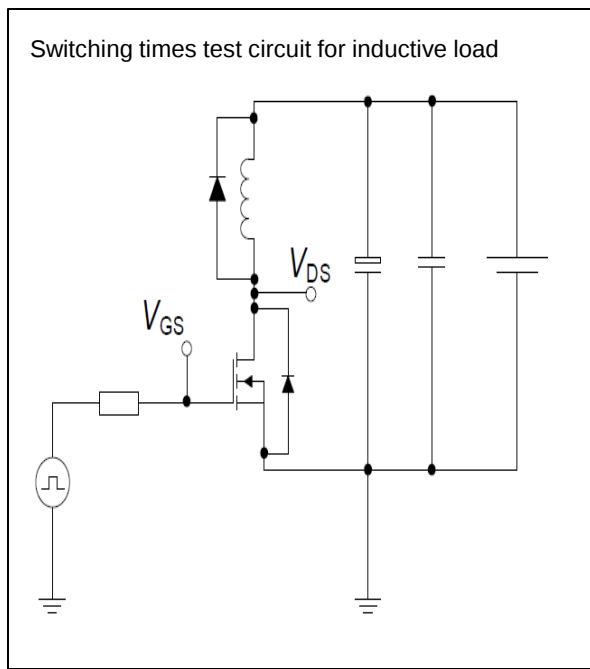
Forward characteristics of reverse diode



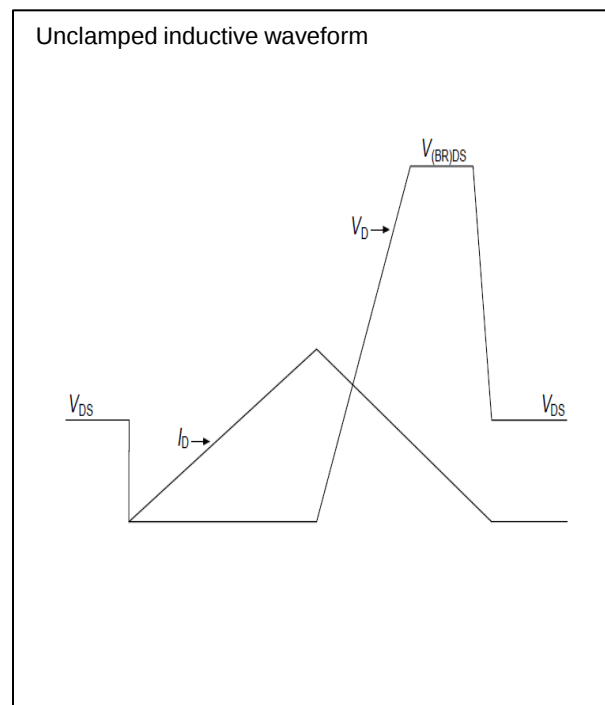
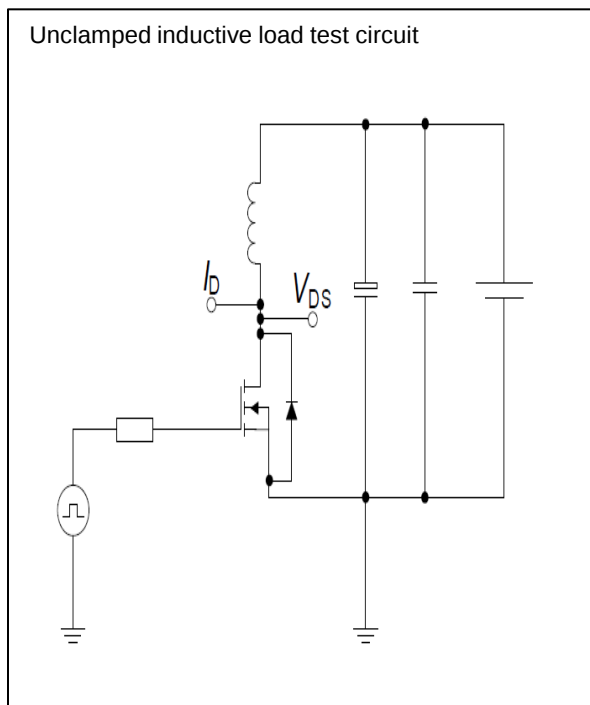
$$I_F=f(V_{SD}); \text{ parameter: } T_j$$

# Test circuits

## Switching times test circuit and waveform for inductive load



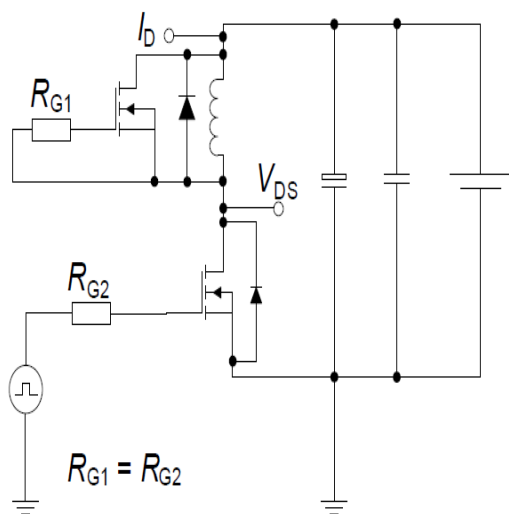
## Unclamped inductive load test circuit and waveform



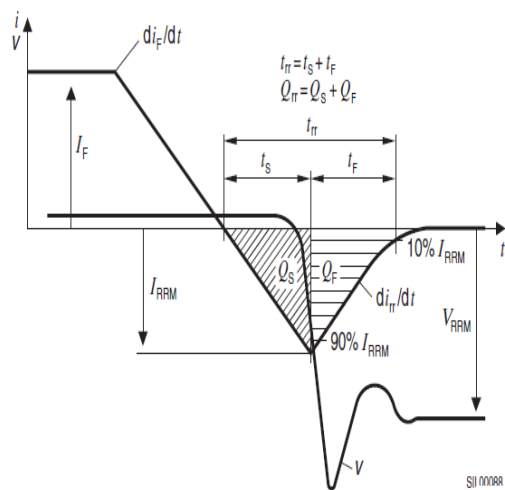
# Test circuits

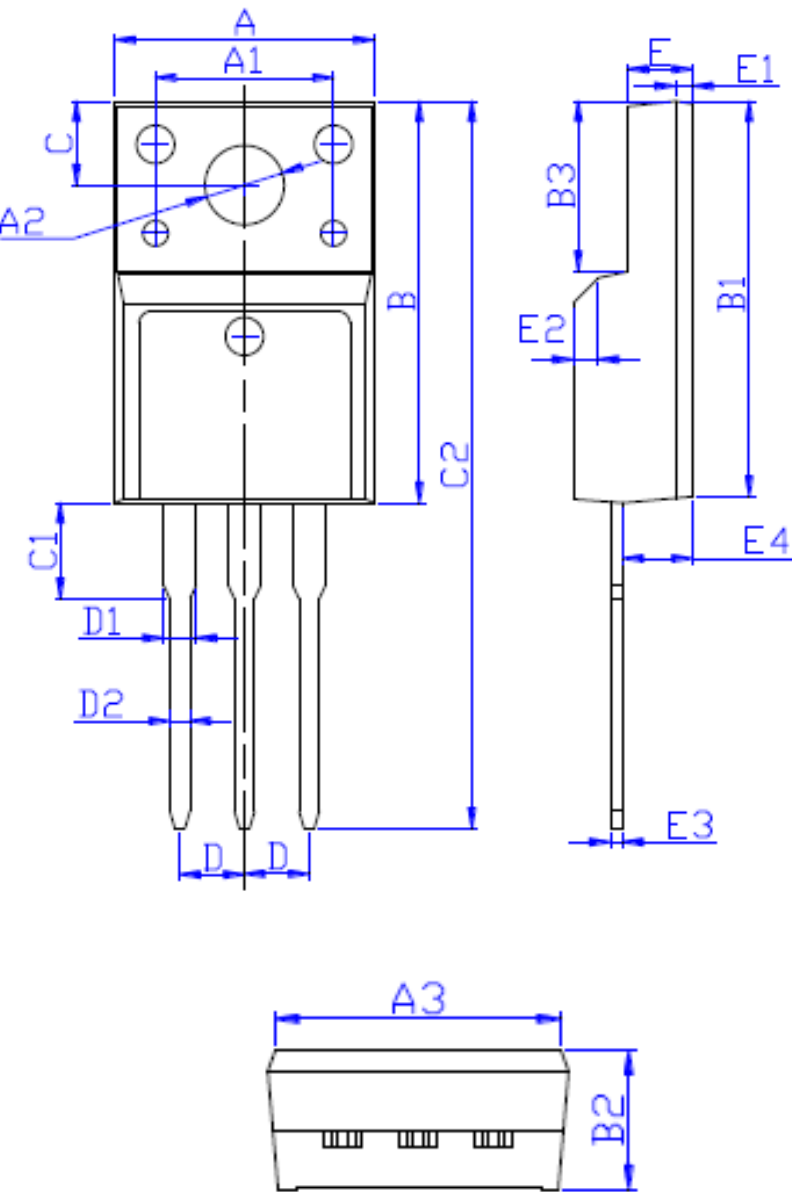
## Test circuit and waveform for diode characteristics

Test circuit for diode characteristics



Diode recovery waveform





| DIM | MILLIMETERS  |
|-----|--------------|
| A   | 10.16±0.30   |
| A1  | 7.00±0.20    |
| A2  | 3.12±0.20    |
| A3  | 9.70±0.30    |
| B   | 15.90±0.50   |
| B1  | 15.60±0.50   |
| B2  | 4.70±0.30    |
| B3  | 6.70±0.30    |
| C   | 3.30±0.25    |
| C1  | 3.25±0.30    |
| C2  | 28.70±0.50   |
| D   | Typical 2.54 |
| D1  | 1.47 (MAX)   |
| D2  | 0.80±0.20    |
| E   | 2.55±0.25    |
| E1  | 0.70±0.25    |
| E2  | 1.0×45°      |
| E3  | 0.50±0.20    |
| E4  | 2.75±0.30    |