



# SSF60R099S2E/SSP60R099S2E

## 600V N-Channel Super-Junction MOSFET Gen-II

### Description

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.

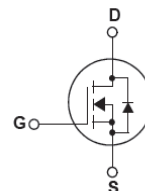
### Features

- Multi-Epi process SJ-FET
- 650V @T<sub>J</sub> = 150 °C
- Typ. RDS(on) = 85mΩ
- Ultra Low Gate Charge (typ. Qg = 54nC)
- 100% avalanche tested

SSF60R099S2E



SSP60R099S2E



### Absolute Maximum Ratings

| Symbol                            | Parameter                                                                                   | SSP60R099S2E | SSF60R099S2E | Unit |
|-----------------------------------|---------------------------------------------------------------------------------------------|--------------|--------------|------|
| V <sub>DSS</sub>                  | Drain-Source Voltage                                                                        | 600          |              | V    |
| I <sub>D</sub>                    | Drain Current<br>-Continuous (TC = 25°C)<br>-Continuous (TC = 100°C)                        | 32*<br>20.2* |              | A    |
| I <sub>DM</sub>                   | Drain Current - Pulsed (Note 1)                                                             | 96           |              | A    |
| V <sub>GSS</sub>                  | Gate-Source voltage                                                                         | ±30          |              | V    |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Energy (Note 2)                                                     | 840          |              | mJ   |
| I <sub>AS</sub>                   | Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max) | 7.5          |              | A    |
| dv/dt                             | Peak Diode Recovery dv/dt (Note 3)                                                          | 15           |              | V/ns |
| dVds/dt                           | Drain Source voltage slope (Vds=480V)                                                       | 50           |              | V/ns |
| P <sub>D</sub>                    | Power Dissipation (TC = 25°C)                                                               | 190          | 37           | 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, 1/16" from Case for 10 Seconds              | 260          |              | °C   |

\* Drain current limited by maximum junction temperature. Maximum duty cycle D=0.75.

### Thermal Characteristics

| Symbol           | Parameter                               | SSP60R099S2E | SSF60R099S2E | Unit |
|------------------|-----------------------------------------|--------------|--------------|------|
| R <sub>θJC</sub> | Thermal Resistance, Junction-to-Case    | 0.65         | 3.4          | °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           | 80           | °C/W |



# Electrical Characteristics TC = 25°C unless otherwise noted

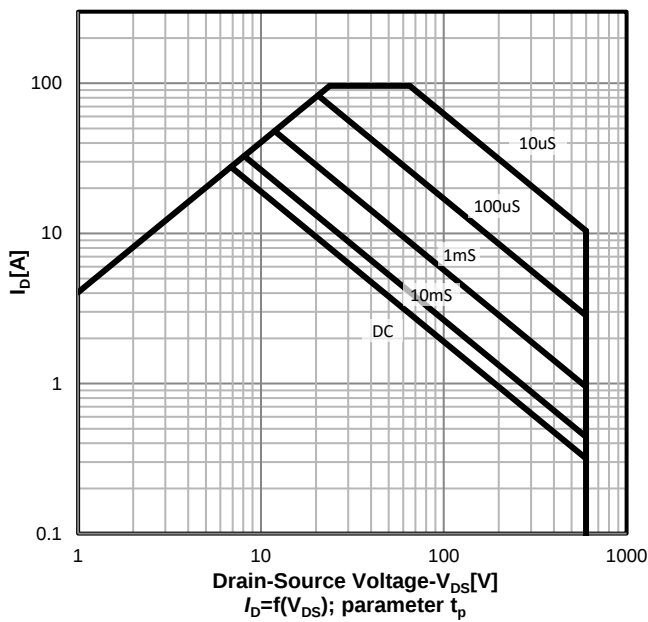
| Symbol                                                 | Parameter                                             | Conditions                                                                                           | Min                 | Typ  | Max      | Unit     |
|--------------------------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------|------|----------|----------|
| Off Characteristics                                    |                                                       |                                                                                                      |                     |      |          |          |
| BV <sub>DSS</sub>                                      | Drain-Source Breakdown Voltage                        | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1mA, T <sub>J</sub> = 25°C                                    | 600                 | -    | -        | V        |
|                                                        |                                                       | V <sub>GS</sub> = 0V, I <sub>D</sub> = 1mA, T <sub>J</sub> = 150°C                                   | 650                 | -    | -        | V        |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>                    | Breakdown Voltage Temperature Coefficient             | I <sub>D</sub> = 1mA, Referenced to 25°C                                                             | -                   | 0.6  | -        | V/°C     |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current                       | V <sub>DS</sub> = 600V, V <sub>GS</sub> = 0V<br>-T <sub>J</sub> = 125°C                              | -                   | -    | 1<br>100 | 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> = 1.5mA                                           | 2.5                 | 3.5  | 4.5      | V        |
| R <sub>DS(on)</sub>                                    | Static Drain-Source On-Resistance                     | V <sub>GS</sub> = 10V, I <sub>D</sub> = 16A                                                          | -                   | 85   | 99       | mΩ       |
| Dynamic Characteristics                                |                                                       |                                                                                                      |                     |      |          |          |
| C <sub>iss</sub>                                       | Input Capacitance                                     | V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V, f = 1.0MHz                                             | -                   | 2250 | -        | pF       |
| C <sub>oss</sub>                                       | Output Capacitance                                    |                                                                                                      | -                   | 98   | -        | pF       |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance                          |                                                                                                      | -                   | 3.3  | -        | pF       |
| Q <sub>g</sub>                                         | Total Gate Charge                                     | V <sub>DS</sub> = 400V, I <sub>D</sub> = 16A, V <sub>GS</sub> = 10V (Note 4)                         | -                   | 54   | -        | nC       |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                    |                                                                                                      | -                   | 15.7 | -        | nC       |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                                     |                                                                                                      | -                   | 19.2 | -        | nC       |
| V <sub>plateau</sub>                                   | Gate plateau voltage                                  |                                                                                                      | -                   | 5.7  | -        | V        |
| R <sub>g</sub>                                         | Gate resistance                                       |                                                                                                      | f=1 MHz, open drain | -    | 1        | -        |
| Switching Characteristics                              |                                                       |                                                                                                      |                     |      |          |          |
| t <sub>d(on)</sub>                                     | Turn-On Delay Time                                    | V <sub>DS</sub> = 400V, I <sub>D</sub> = 16A<br>R <sub>G</sub> = 10Ω, V <sub>GS</sub> = 10V (Note 4) | -                   | 17   | -        | ns       |
| t <sub>r</sub>                                         | Turn-On Rise Time                                     |                                                                                                      | -                   | 11   | -        | ns       |
| t <sub>d(off)</sub>                                    | Turn-Off Delay Time                                   |                                                                                                      | -                   | 86   | -        | ns       |
| t <sub>f</sub>                                         | Turn-Off Fall Time                                    |                                                                                                      | -                   | 12   | -        | ns       |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                       |                                                                                                      |                     |      |          |          |
| I <sub>S</sub>                                         | Maximum Continuous Drain-Source Diode Forward Current |                                                                                                      | -                   | -    | 32       | A        |
| I <sub>SM</sub>                                        | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                                      | -                   | -    | 96       | A        |
| V <sub>SD</sub>                                        | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0V, I <sub>S</sub> = 16A                                                           | -                   | 0.9  | 1.4      | V        |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                 | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 400V, I <sub>S</sub> = 16A, dI <sub>F</sub> /dt =100A/μs     | -                   | 380  | -        | ns       |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                               |                                                                                                      | -                   | 6.1  | -        | μC       |
| I <sub>rrm</sub>                                       | Peak Reverse Recovery Current                         |                                                                                                      | -                   | 32   | -        | A        |

**NOTES:**

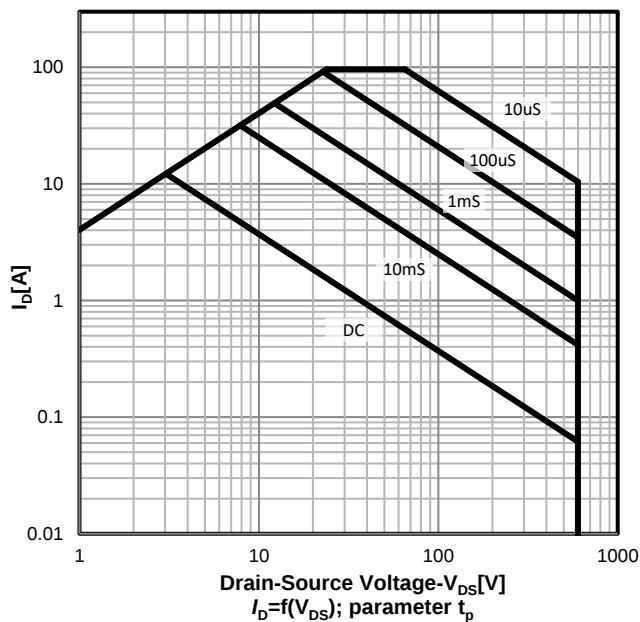
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. I<sub>D</sub>=I<sub>AS</sub>, V<sub>DD</sub>=100V, L=30mH, Starting T<sub>J</sub>=25 °C
3. I<sub>SD</sub>≤I<sub>D</sub>, di/dt ≤ 200A/μs, V<sub>DD</sub>≤BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25 °C
4. Essentially Independent of Operating Temperature Typical Characteristics

# Typical Performance Characteristics

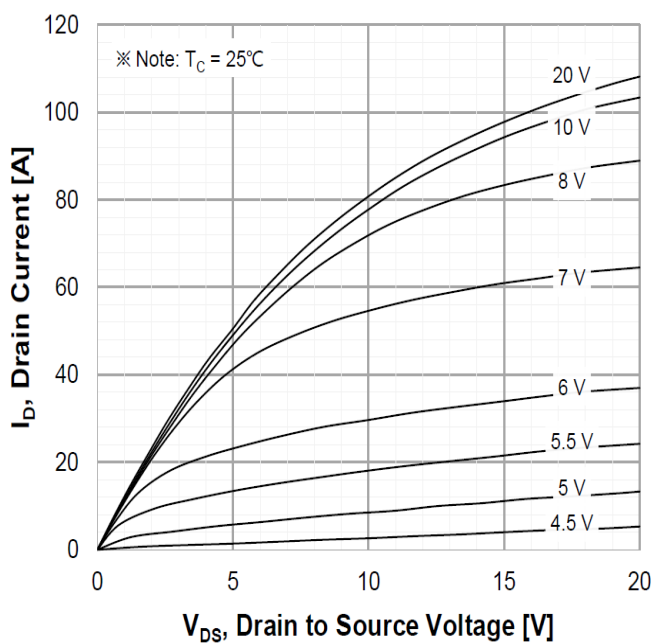
Safe operating area TC=25 °C  
Non-FullPAK



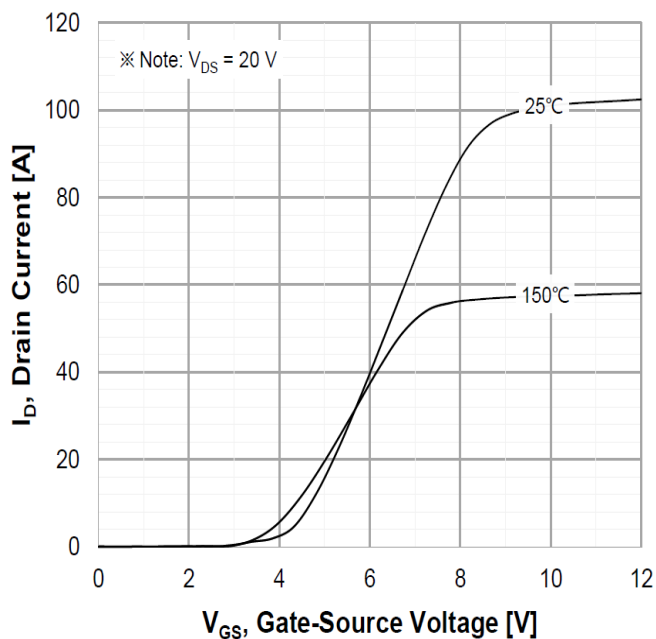
Safe operating area TC=25 °C  
TO-220FullPAK



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

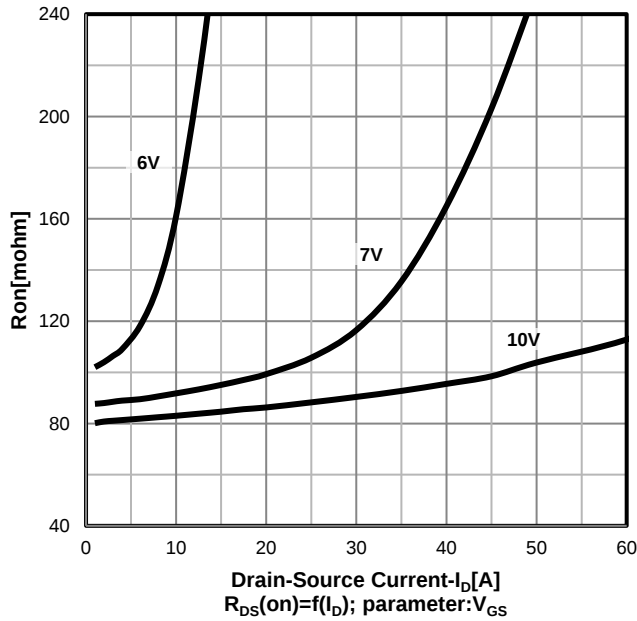


Transfer characteristics

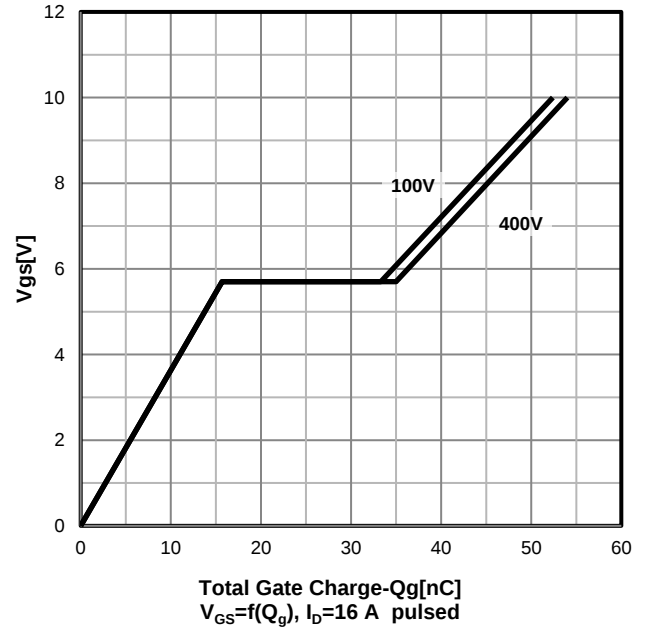


# Typical Performance Characteristics

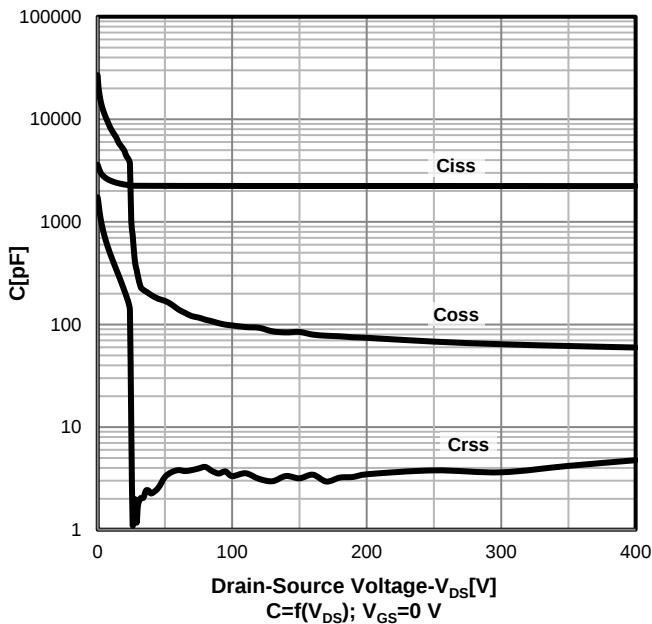
Typ. drain-source on-state resistance



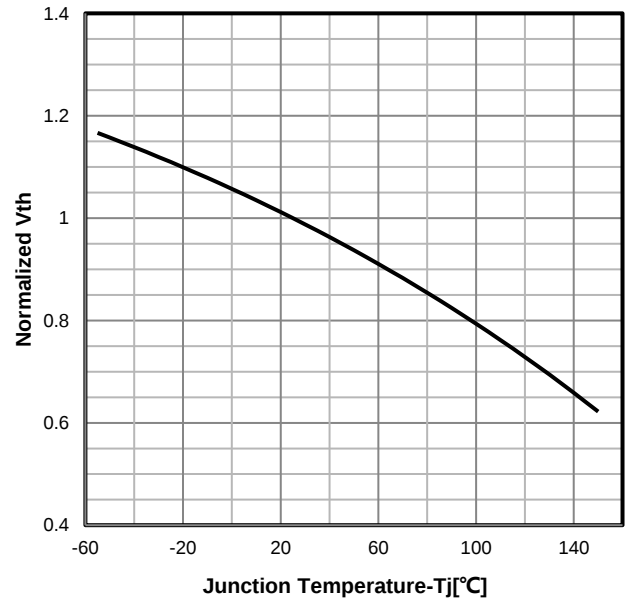
Typ. gate charge characteristics



Typ. capacitances

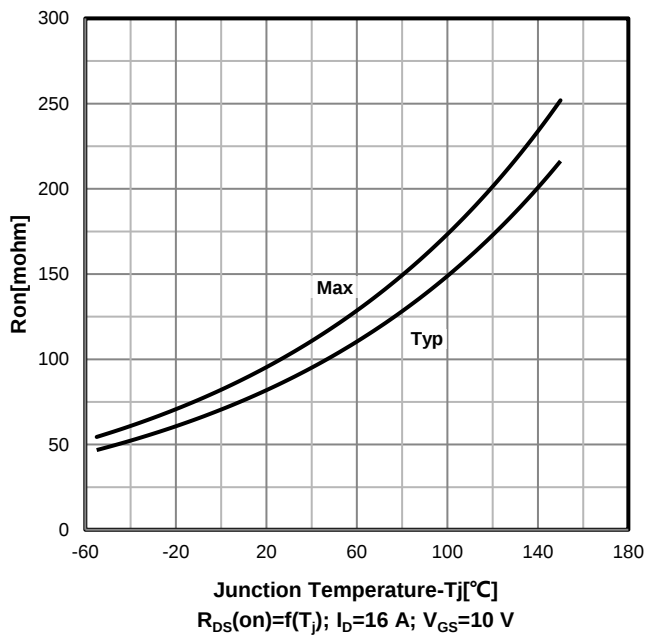


Normalized  $V_{GS(th)}$  characteristics

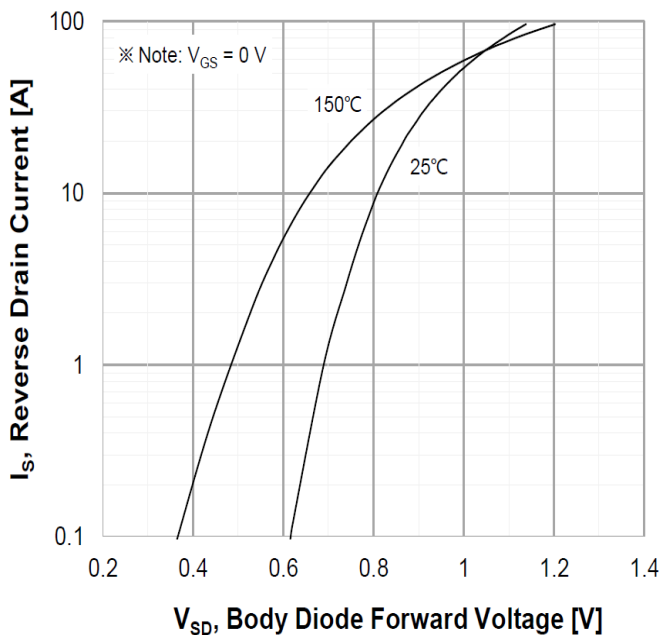


# Typical Performance Characteristics

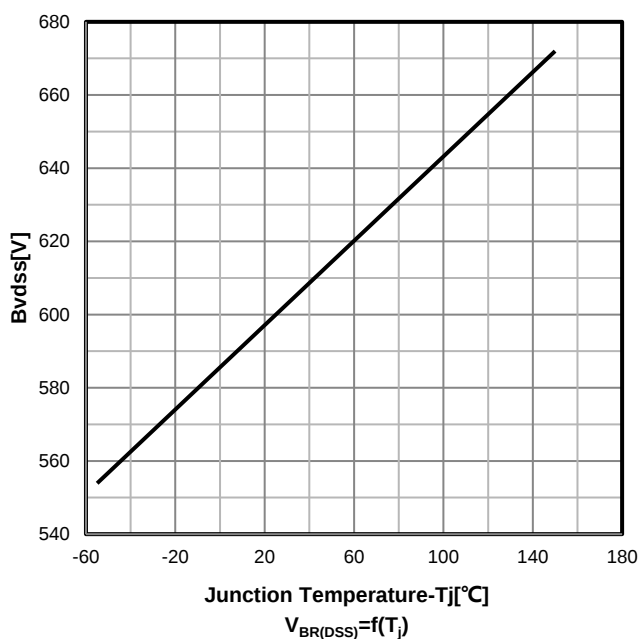
On-resistance vs temperature



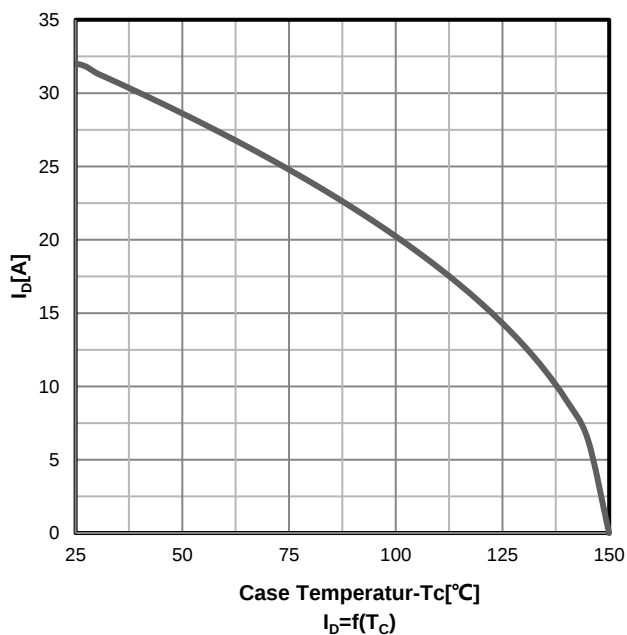
Forward characteristics of reverse diode



Drain-source breakdown voltage

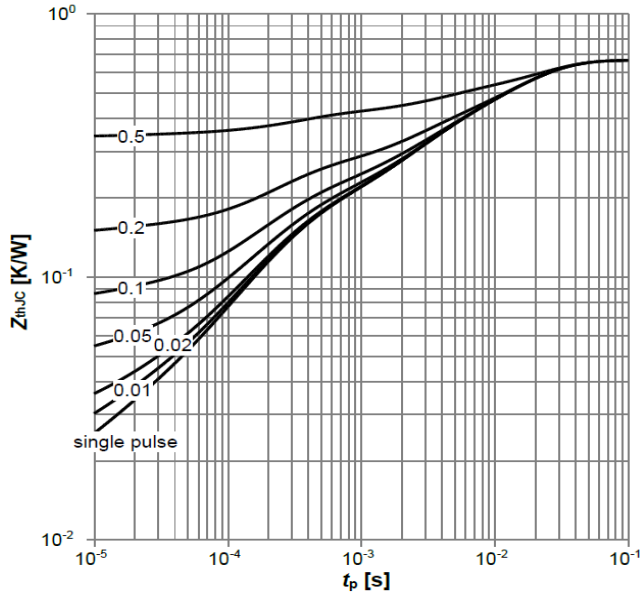


Drain current vs temperature

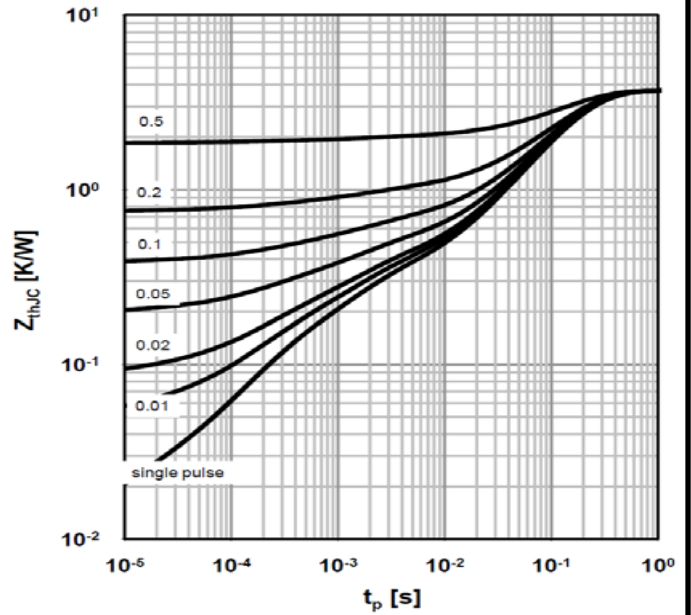


# Typical Performance Characteristics

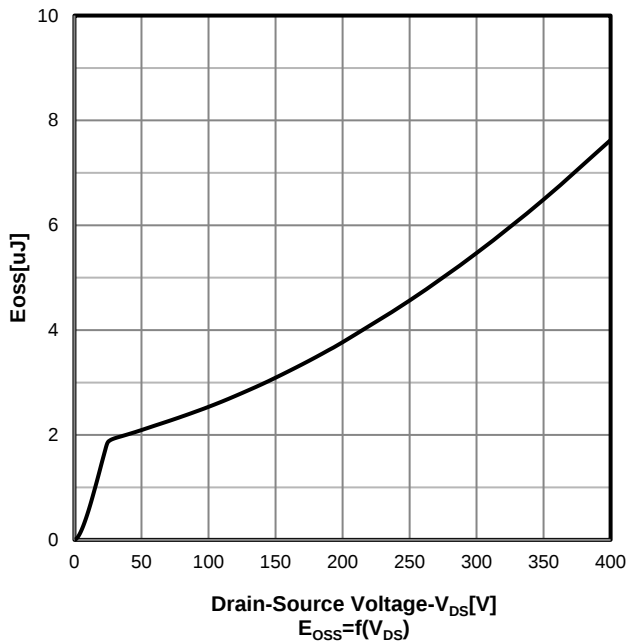
Max. transient thermal impedance  
parameter:  $D=t_p/T$ ; Non-FullPAK



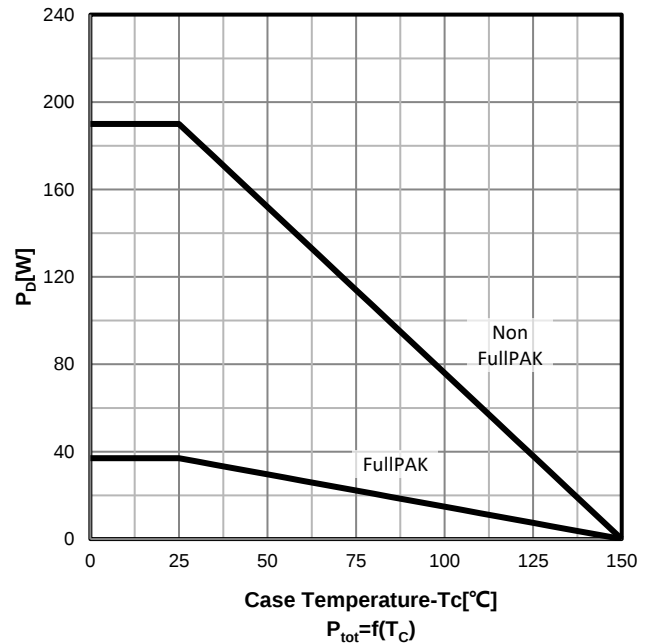
Max. transient thermal impedance  
parameter:  $D=t_p/T$ ; TO-220FullPAK



Coss stored energy

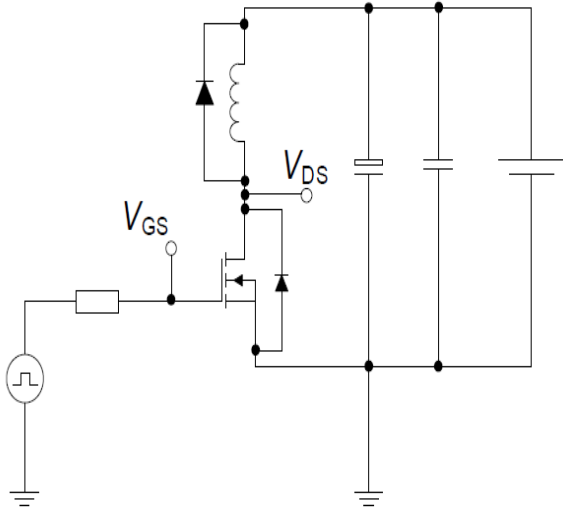


Power dissipation

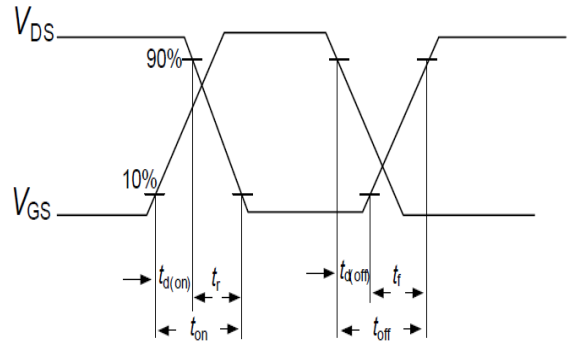


## Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

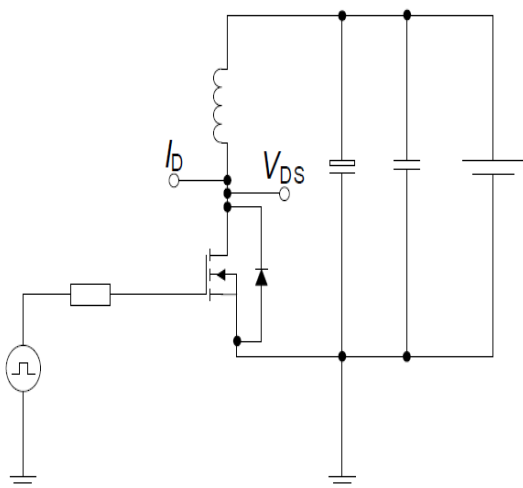


Switching time waveform

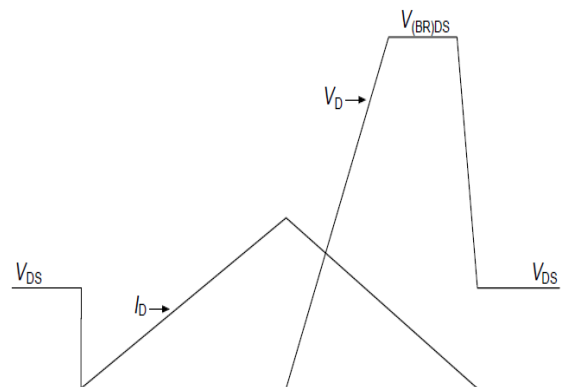


## Unclamped inductive load test circuit and waveform

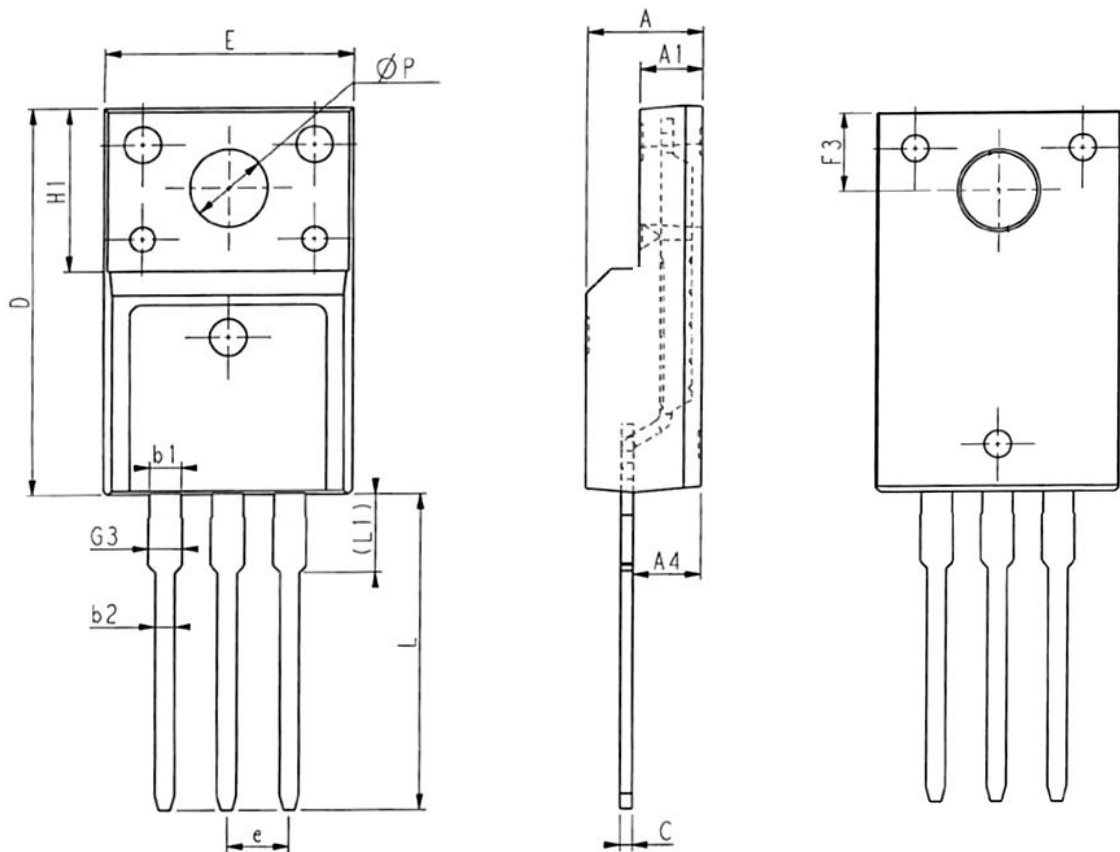
Unclamped inductive load test circuit



Unclamped inductive waveform

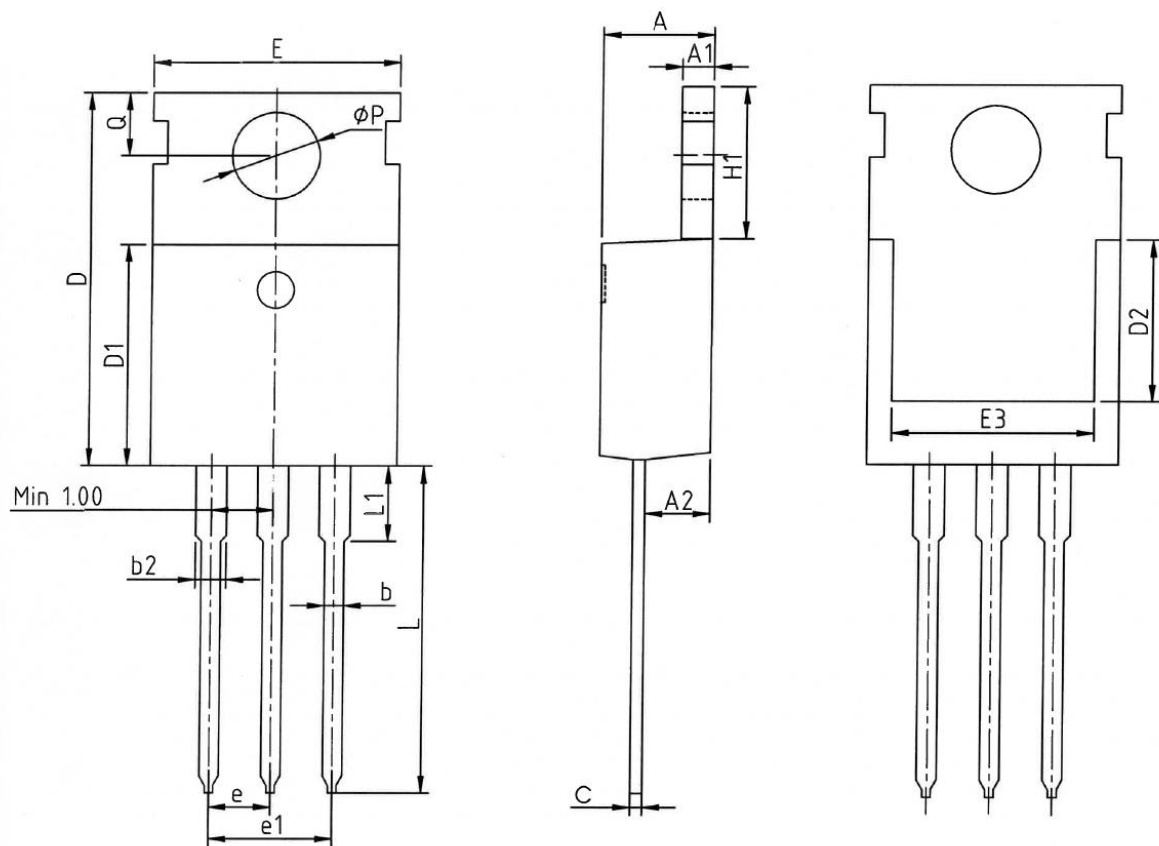






COMMON DIMENSIONS

| SYMBOL | UNIT(mm) |       |       |
|--------|----------|-------|-------|
|        | MIN      | NOM   | MAX   |
| E      | 9.86     | 10.16 | 10.36 |
| A      | 4.50     | 4.70  | 4.90  |
| A1     | 2.34     | 2.54  | 2.84  |
| A4     | 2.56     | 2.76  | 2.96  |
| C      | 0.35     | 0.50  | 0.65  |
| D      | 15.50    | 15.87 | 16.25 |
| H1     | 6.70REF  |       |       |
| e      | 2.54BSC  |       |       |
| L      | 12.60    | 12.98 | 13.35 |
| L1     | 3.03     | 3.23  | 3.43  |
| ΦP     | 3.00     | 3.20  | 3.40  |
| F3     | 3.10     | 3.30  | 3.50  |
| G3     | 1.20     | 1.35  | 1.60  |
| b1     | 1.18     | 1.28  | 1.43  |
| b2     | 0.70     | 0.80  | 0.95  |



COMMON DIMENIONS

| SYMBOL   | MIN      | NOM   | MAX   |
|----------|----------|-------|-------|
| A        | 4.37     | 4.57  | 4.70  |
| A1       | 1.25     | 1.30  | 1.40  |
| A2       | 2.20     | 2.40  | 2.60  |
| b        | 0.70     | 0.80  | 0.95  |
| b2       | 1.17     | 1.27  | 1.47  |
| c        | 0.45     | 0.50  | 0.60  |
| D        | 15.10    | 15.60 | 16.10 |
| D1       | 8.80     | 9.10  | 9.40  |
| D2       | 5.50     | 6.30  | 7.10  |
| E        | 9.70     | 10.00 | 10.30 |
| E3       | 7.00     | 7.80  | 8.60  |
| e        | 2.54 BSC |       |       |
| e1       | 5.08 BSC |       |       |
| H1       | 6.25     | 6.50  | 6.85  |
| L        | 12.75    | 13.50 | 13.80 |
| L1       | -        | 3.10  | 3.40  |
| $\Phi P$ | 3.40     | 3.60  | 3.80  |
| Q        | 2.60     | 2.80  | 3.00  |



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