

## 650V N-Channel Super-Junction MOSFET Gen-II

### Description

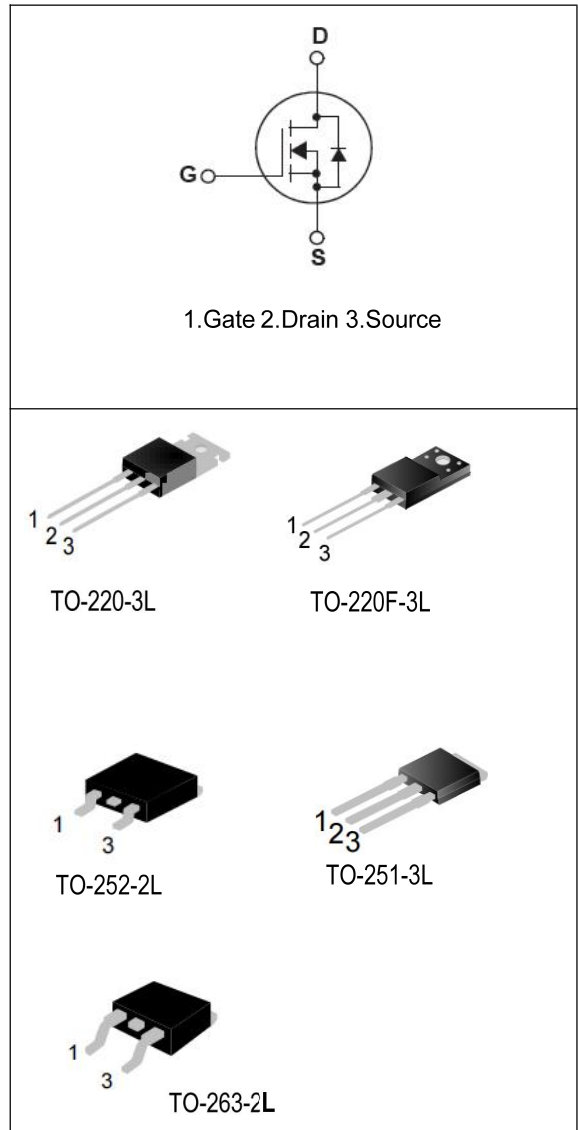
SJ-FET is new generation of high voltage MOSFET family that is utilizing an advanced charge balance mechanism for outstanding low on-resistance and lower gate charge performance.

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
- $700V@T_J=150^{\circ}C$
- $Typ.RDS(on)=1.05\Omega$
- Ultra Low Gate Charge ( $typ.Q_g=10.4nc$ )
- 100% avalanche tseted



### Package Marking and Ordering Information:

| Marking   | Package    | Part #    | Hazardous Substance Control | Packing |
|-----------|------------|-----------|-----------------------------|---------|
| SR65R1K1T | T0-220-3L  | SR65R1K1T | Pb free                     | Tube    |
| SR65R1K1F | T0-220F-3L | SR65R1K1F | Pb free                     | Tube    |
| SR65R1K1D | TO-252-2L  | SR65R1K1D | Halogen free                | Reel    |
| SR65R1K1M | TO-251-3L  | SR65R1K1M | Halogen free                | Tube    |
| SR65R1K1S | T0-263-2L  | SR65R1K1S | Halogen free                | Reel    |

**Absolute Maximum Ratings**

| Symbol   | Parameter  | SR65R1K1T/D/M/S | SR65R1K1F | Unit |
|----------|--|-----------------|-----------|------|
| VDSS     | Drain-Source Voltage   | 650             |           | V    |
| ID       | Drain Current-Continuous(TC=25°C)  | 4.5*            |           | A    |
|          | -Continuous(TC=100°C)  | 2.8*            |           |      |
| IDM      | Drain Current-Pulsed(Note1)  | 18              |           | A    |
| VGSS     | Gate-Source Voltage  | ±30             |           | V    |
| EAS      | Single Pulsed Avalanche Energy(Note2)  | 24              |           | mJ   |
| IAS      | Avalanche current,repitive or not-repitive<br>(pulse width limited by Tj max)  | 1.2             |           | A    |
| DV/DT    | Peak Diode Recovery DV/DT(Note3)   | 15              |           | V/ns |
| DV/DS/DT | Drain Source Voltage Slope(Vds=480V)   | 50              |           | V/ns |
| PD       | Power Dissipation(TC=25°C)   | 43              | 30        | W    |
| TJ,TSTG  | Operating and Storage Temperature Range  | -55to+150       |           | °C   |
| TL       | Maximun Lead Temperature for Soldring<br>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                              | SR65R1K1T/D/M/S | SR65R1K1F | Unit |
|--------|--|-----------------|-----------|------|
| RθJC   | Thermal Resistance,Junction-to-Case    | 3               | 4.2       | °C/W |
| RθCS   | Thermal Resistance,Case-to-Sink Typ    | 0.5             | -         | °C/W |
| RθJA   | Thermal Resistance,Junction-to-Ambient | 62              | 80        | °C/W |

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

| Symbol  | Parameter   | Conditions                                      | Min | Typ  | Max      | Unit     |
|---|---|---|-----|------|----------|----------|
| <b>Off Characteristics</b>                                    |   |   |     |      |          |          |
| BVDSS   | Drain-Source Breakdown Voltage                        | VGS=0V, ID=250uA<br>Tj=25°C                     | 650 | -    | -        | V        |
|   |   | VGS=0V, ID=250uA<br>Tj=150°C                    | -   | 700  | -        | V        |
| BVDSS/TJ  | Breakdown Voltage Temperature Coefficient             | ID=250uA, Referenced to 25°C                    | -   | 0.6  | -        | V/°C     |
| IDSS  | Zero Gate Voltage Drain Current                       | VDS=650V, VGS=0V<br>TC=125°C                    | -   | -    | 1<br>100 | uA<br>uA |
| IGSSF   | Gate-Body Leakage Current, Forward                    | VGS=30V, VDS=0V                                 | -   | -    | 100      | nA       |
| IGSSR   | Gate-Body Leakage Current, Reverse                    | VGS=-30V, VDS=0V                                | -   | -    | -100     | nA       |
| <b>On Characteristics</b>                                     |   |   |     |      |          |          |
| VGS(th)   | Gate Threshold Voltage                                | VDS=VGS, ID=250uA                               | 2.0 | 3.0  | 4.0      | V        |
| Rg  | Gate resistance                                       | f=1MHz, open drain                              | -   | 10   | -        | Ω        |
| RDS(on)   | Static Drain-Source On-Resistance                     | VGS=10V, ID=2.3A                                | -   | 1.05 | 1.2      | Ω        |
| <b>Dynamic Characteristics</b>                                |   |   |     |      |          |          |
| Ciss  | Input Capacitance                                     | VDS=200V, VGS=0V,<br>f=1.0MHz                   | -   | 275  | -        | pF       |
| Coss  | Output Capacitance                                    |   | -   | 9.5  | -        | pF       |
| Crss  | Reverse Transfer Capacitance                          |   | -   | 0.2  | -        | pF       |
| <b>Switching Characteristics</b>                              |   |   |     |      |          |          |
| td(on)  | Turn-On Delay Time                                    | VDS=400V, ID=2.3A<br>RG=10Q, VGS=10V<br>(Note4) | -   | 8.5  | -        | ns       |
| tr  | Turn-On Rise Time                                     |   | -   | 12.5 | -        | ns       |
| td(off)   | Turn-Off Delay Time                                   |   | -   | 22   | -        | ns       |
| tf  | Turn-Off Fall Time                                    |   | -   | 16.5 | -        | ns       |
| Qg  | Total Gate Charge                                     | VDS=400V, ID=4.5A<br>VGS=10V, (Note4)           | -   | 10.4 | -        | nc       |
| Qgs   | Gate-Source Charge                                    |   | -   | 2.2  | -        | nc       |
| Qgd   | Gate-Drain Charge                                     |   | -   | 5.1  | -        | nc       |
| <b>Drain-Source Diode Characteristics and Maximum Ratings</b> |   |   |     |      |          |          |
| IS  | Maximum Continuous Drain-Source Diode Forward Current |   | -   | -    | 4.5      | A        |
| ISM   | Maximum Pulsed Drain-Source Diode Forward Current     |   | -   | -    | 18       | A        |
| VSD   | Drain-Source Diode Forward voltage                    | VGS=0V, IS=4.5A                                 | -   | 0.9  | 1.4      | V        |
| Trr   | Reverse Recovery Time                                 | VGS=0V, VDS=400V,<br>IS=2.3A,<br>dIF/dt=100A/us | -   | 170  | -        | ns       |
| Qrr   | Reverse Recovery Charge                               |   | -   | 0.75 | -        | uC       |
| Irrm  | Peak Reverse Recovery Current                         |   | -   | 8.5  | -        | A        |

**NOTES:**

- 1.Repetitive Rating:Pulse width limited by maximum junction temperature.
- 2.ID=IAS,VDD=50V,Starting TJ=25°C.
- 3.ISD≤ID,di/dt≤200A/us,VDD≤BVDSS,Starting TJ=25°C.
- 4.Essentially Independent of Operating Temperature Typical Characteristics.

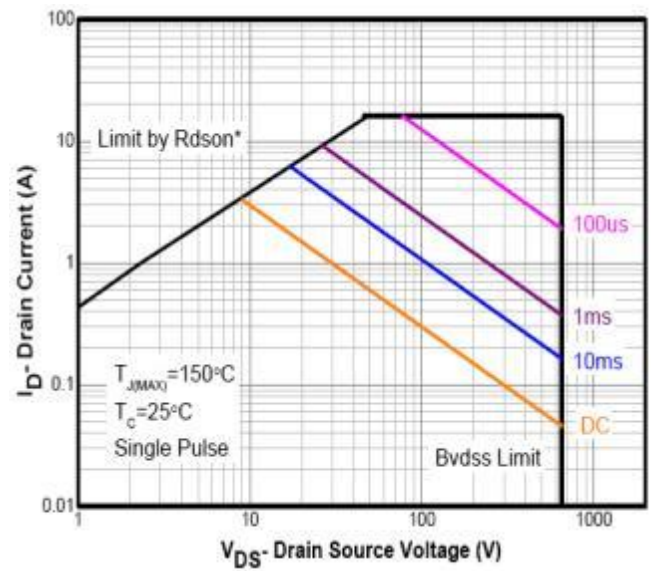
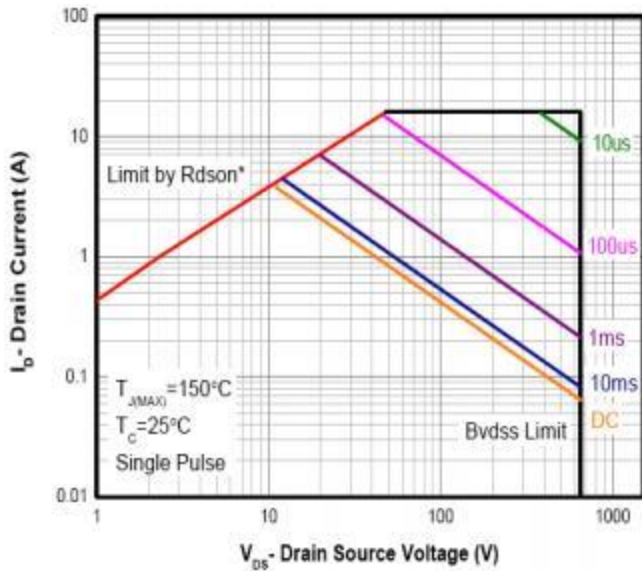
Typical Performance Characteristics

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

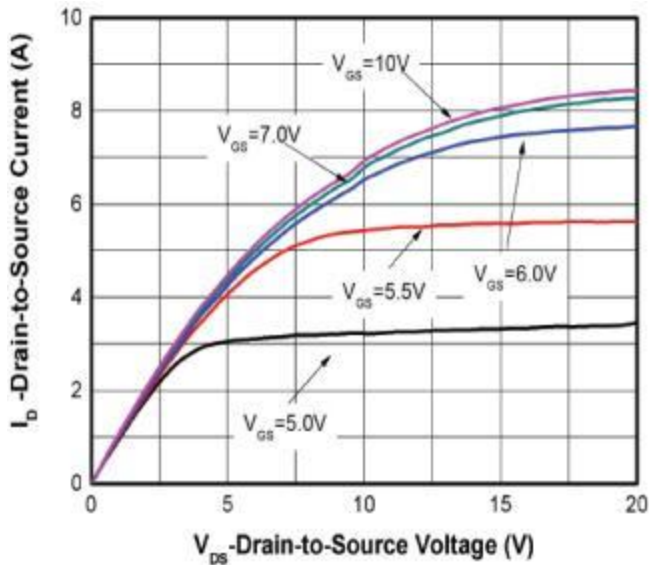
Non FullPAK

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

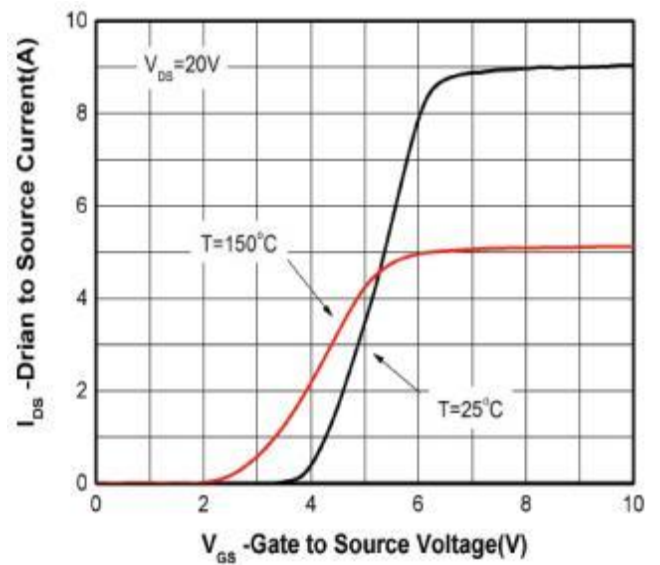
TO-220FullPAK



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

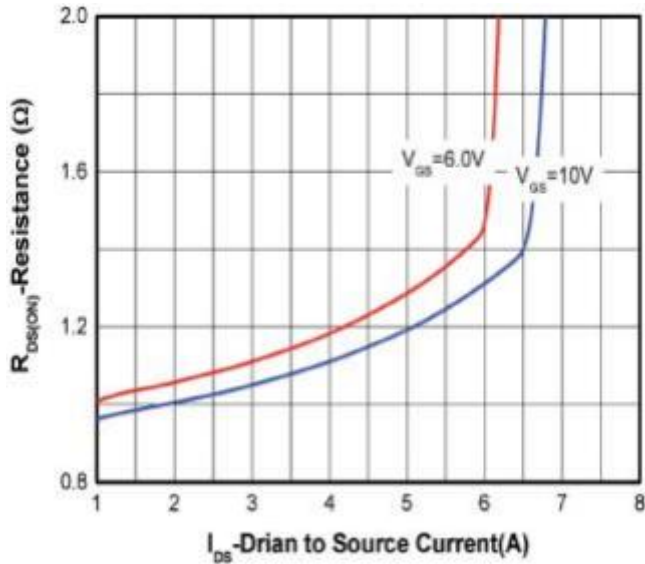


Typ. transfer characteristics

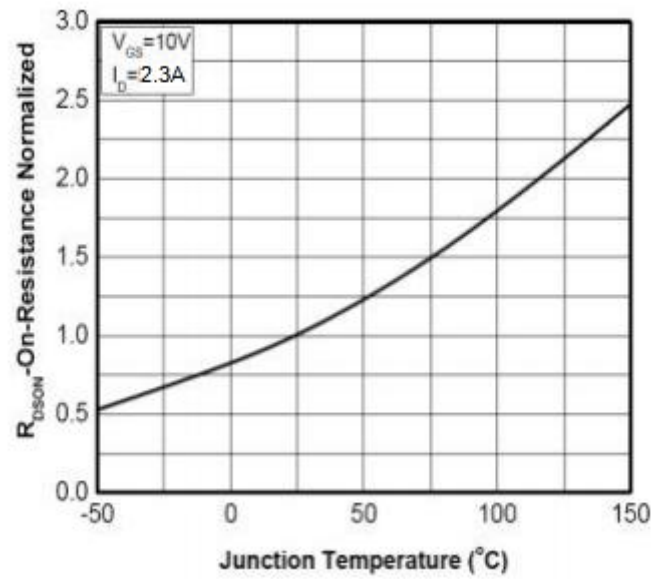


**Typical Performance Characteristics**

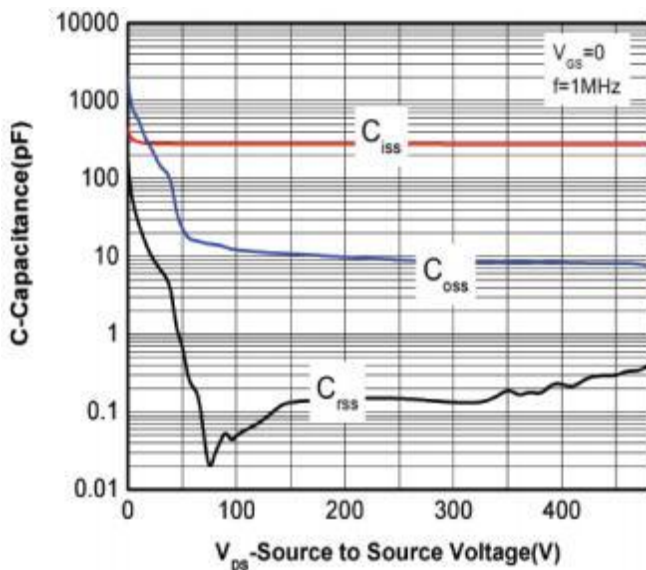
Typ. Drain-source on-state resistance



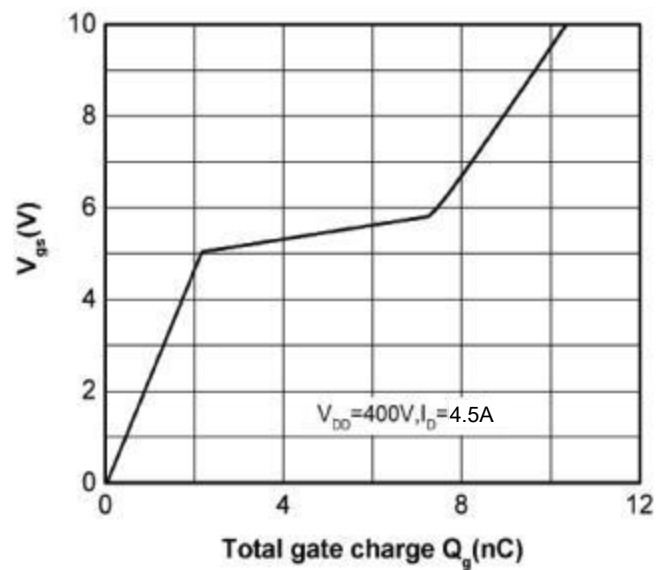
Normalized on resistance vs temperature



Typ. capacitances



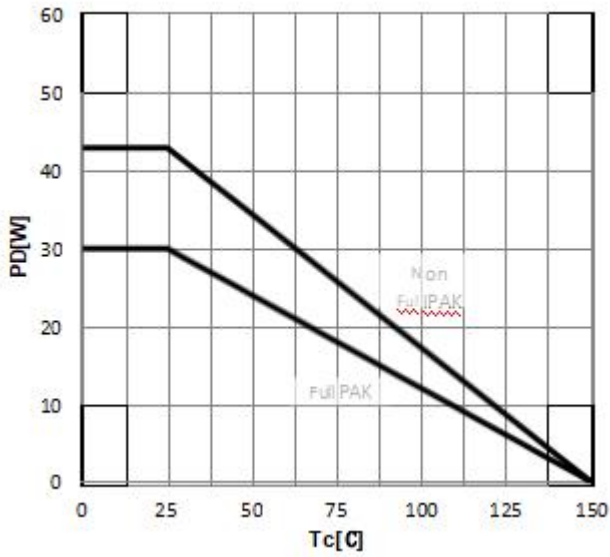
Typ. gate charge characteristics



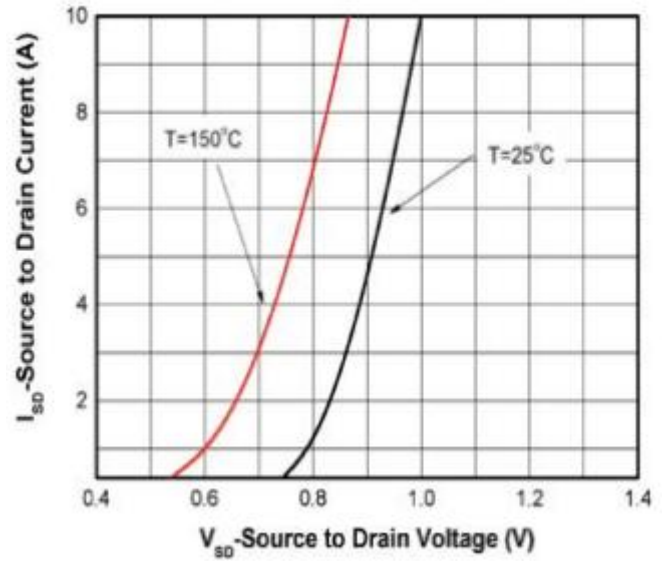


**Typical Performance Characteristics**

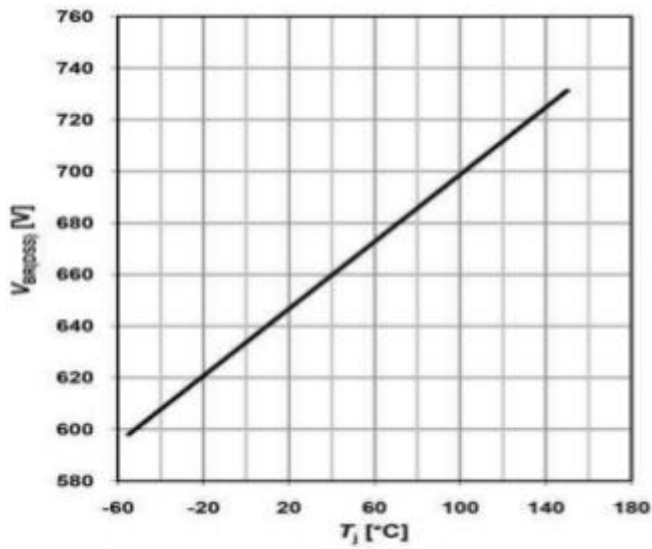
Power dissipation



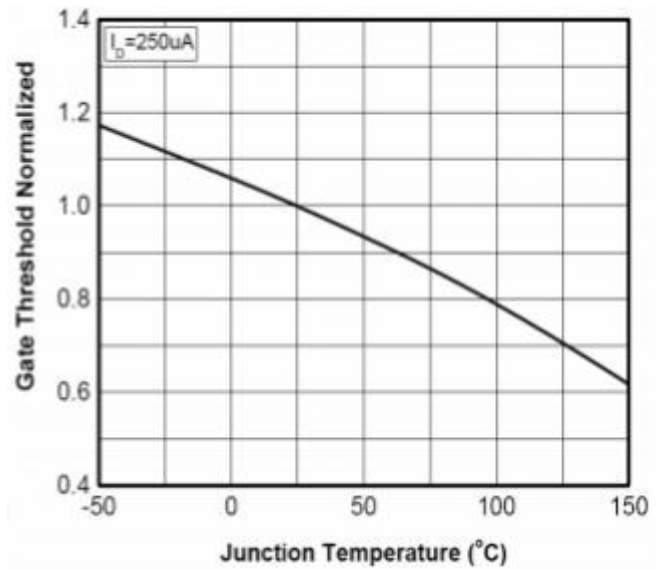
Forward characteristics of reverse diode



Drain-source breakdown voltage



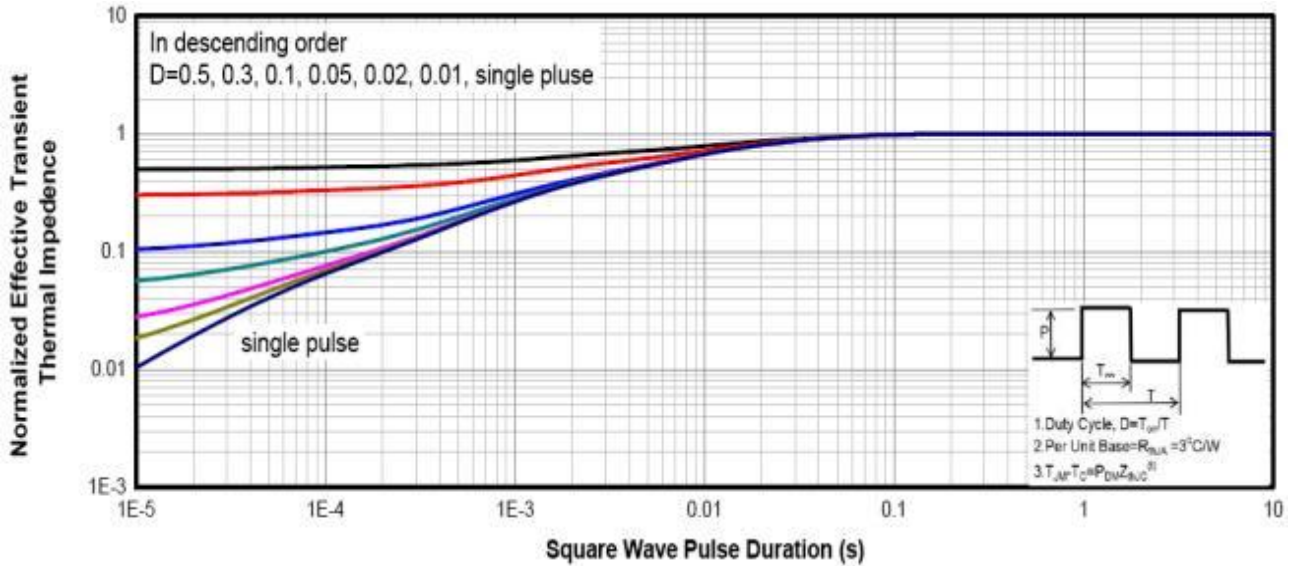
Normalized VGS(th) characteristics



**Typical Performance Characteristics**

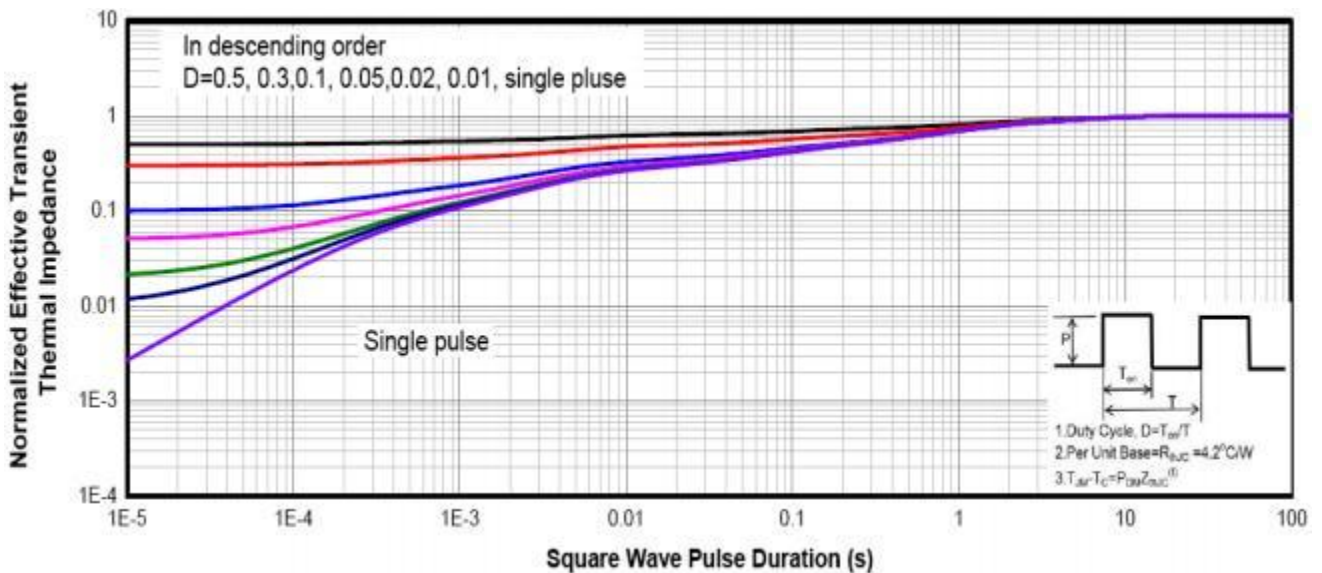
Max. transient thermal impedance

Non FullPAKNon



Max. transient thermal impedance

TO-220FullPAK



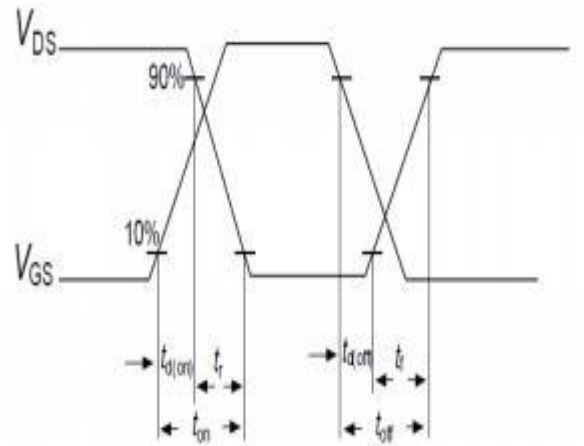
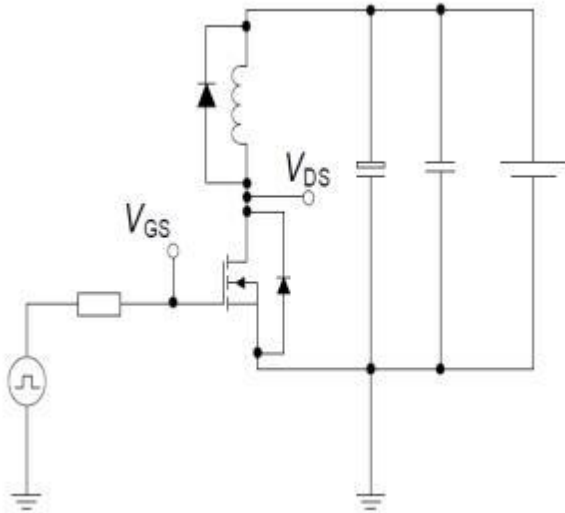


**Test circuits**

Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load

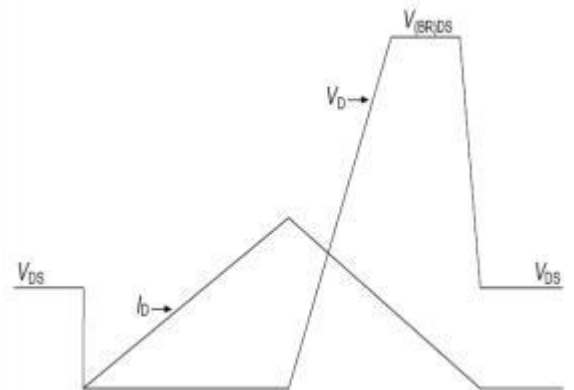
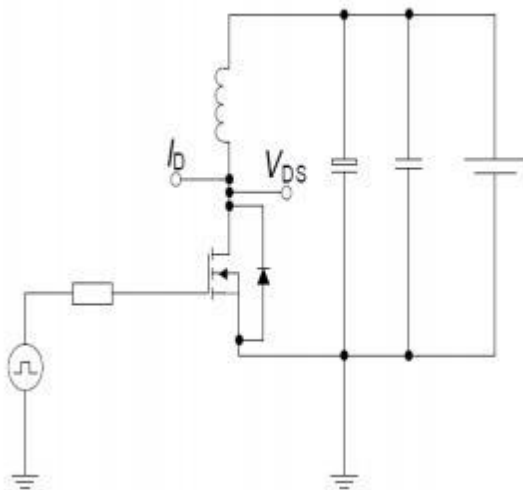
Switching time waveform



Unclamped inductive load test circuit waveform

Unclamped inductive load test circuit

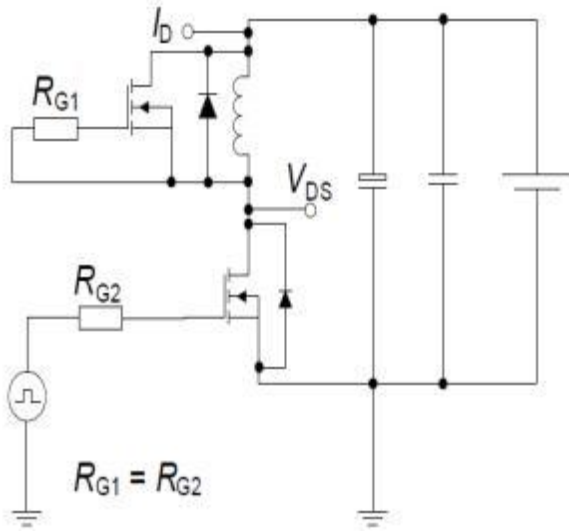
Unclamped inductive waveform



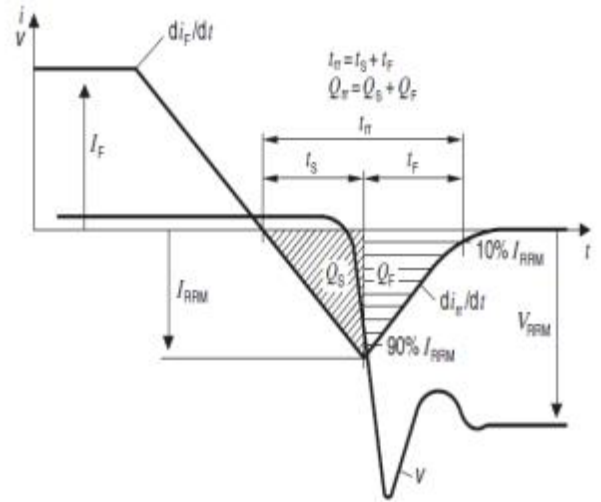
## Test circuits

### Test circuit and waveform for diode characteristics

Test circuit for diode characteristics

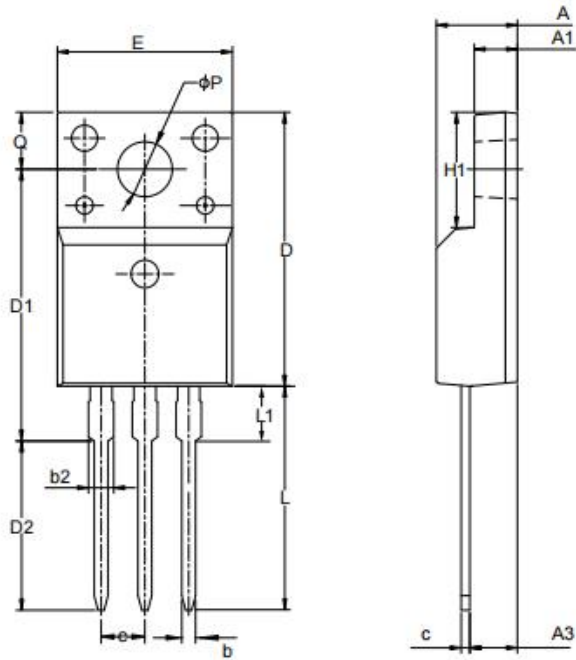


Diode recovery waveform

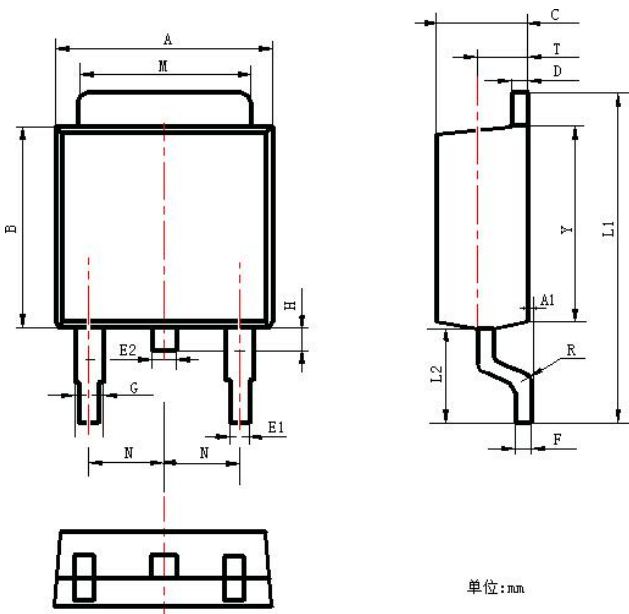


**Package Outline**

TO-220 Full PAK

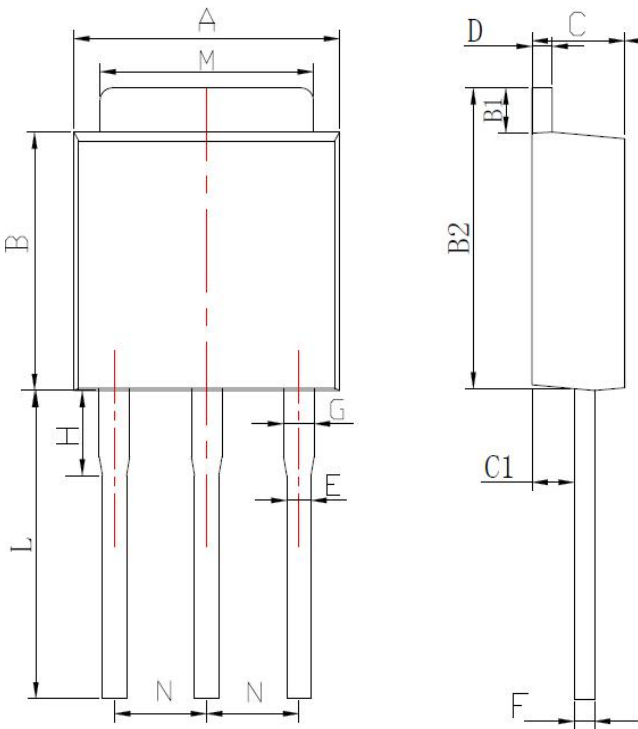


| COMMON DIMENSIONS |            |       |       |
|-------------------|------------|-------|-------|
| Items             | Values(mm) |       |       |
|                   | MIN        | NOM   | MAX   |
| A                 | 4.42       | 4.7   | 5.02  |
| A1                | 2.3        | 2.54  | 2.8   |
| A3                | 2.5        | 2.76  | 3.1   |
| b                 | 0.7        | 0.8   | 0.9   |
| b2                | --         | --    | 1.47  |
| c                 | 0.35       | 0.5   | 0.65  |
| D                 | 15.25      | 15.87 | 16.25 |
| D1                | 15.3       | 15.75 | 16.3  |
| D2                | 9.3        | 9.8   | 10.3  |
| E                 | 9.73       | 10.16 | 10.36 |
| e                 | 2.54BSC    |       |       |
| H1                | 6.4        | 6.68  | 7     |
| L                 | 12.48      | 12.98 | 13.48 |
| L1                | --         | --    | 3.5   |
| øP                | 3          | 3.18  | 3.4   |
| Q                 | 3.05       | 3.3   | 3.55  |

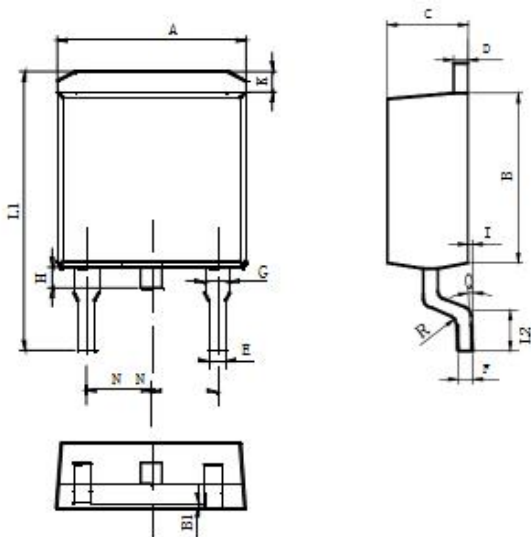
**TO-252-2L**


单位: mm

| COMMON DIMENSIONS |            |      |      |
|-------------------|------------|------|------|
| Items             | Values(mm) |      |      |
|                   | MIN        | NOM  | MAX  |
| A                 | 6.3        | 6.5  | 6.9  |
| A1                | 0          | -    | 0.16 |
| B                 | 5.7        | -    | 6.3  |
| C                 | 2.1        | 2.3  | 2.5  |
| D                 | 0.3        | 0.5  | 0.7  |
| E1                | 0.6        | 0.65 | 0.9  |
| E2                | 0.7        | 0.65 | 1    |
| F                 | 0.3        | 0.5  | 0.6  |
| G                 | 0.7        | 0.9  | 1.2  |
| L1                | 9.6        | 10   | 10.5 |
| L2                | 2.7        | -    | 3.1  |
| H                 | 0.4        | -    | 1    |
| M                 | 5.1        | 5.2  | 5.5  |
| N                 | 2.09       | 2.2  | 2.49 |
| R                 | 0.3        |      |      |
| T                 | 1.4        | -    | 1.6  |
| Y                 | 5.1        | 5.9  | 6.3  |

**Package Outline**
**TO-251-3L**


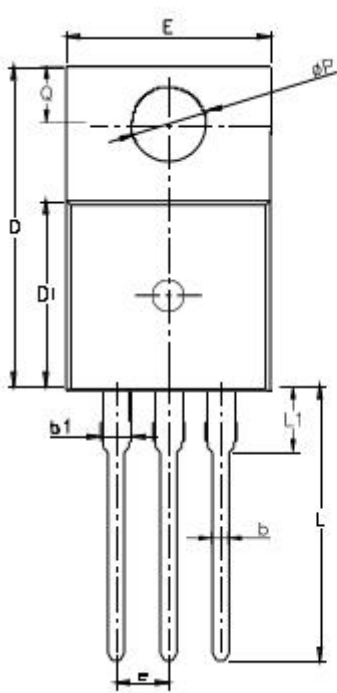
| COMMON DIMENSIONS |            |      |      |
|-------------------|------------|------|------|
| Items             | Values(mm) |      |      |
|                   | MIN        | NOW  | MAX  |
| A                 | 6.3        | 6.5  | 6.9  |
| B                 | 5          | 5.2  | 6.3  |
| B1                | 0.7        | 1.1  | 1.3  |
| B2                | 6.8        | 7.2  | 7.4  |
| C                 | 2.1        | 2.3  | 2.5  |
| C1                | 0.9        | -    | 1.2  |
| D                 | 0.3        | 0.5  | 0.6  |
| E                 | 0.5        | 0.65 | 0.86 |
| F                 | 0.3        | 0.5  | 0.6  |
| G                 | 0.7        | -    | 1    |
| H                 | 1.4        | 2    | 2.4  |
| L                 | 9          | 9.4  | 9.8  |
| M                 | 5.1        | 5.2  | 5.5  |
| N                 | 2.09       | 2.2  | 2.49 |

**TO-263-2L**


| COMMON DIMENSIONS |            |      |      |
|-------------------|------------|------|------|
| Items             | Values(mm) |      |      |
|                   | MIN        | NOW  | MAX  |
| A                 | 9.8        | 10   | 10.4 |
| B                 | 8.9        | 9.6  | 9.5  |
| B1                | 0          | -    | 0.1  |
| C                 | 4.4        | 4.5  | 4.8  |
| D                 | 1.16       | 1.4  | 1.5  |
| E                 | 0.7        | 0.75 | 0.95 |
| F                 | 0.3        | 0.45 | 0.6  |
| G                 | 1.07       | 1.38 | 1.47 |
| H                 | 1.3        | -    | 1.8  |
| K                 | 0.95       | 1    | 1.37 |
| L1                | 14.5       | 15.2 | 16.5 |
| L2                | 1.6        | 2    | 2.3  |
| I                 | 0          | -    | 0.2  |
| Q                 | 0°         | 3°   | 8°   |
| R                 | 0.4        |      |      |
| N                 | 2.35       | 2.4  | 2.7  |

**Package Outline**

TO-220-3L



| Items | COMMON DIMENSIONS |       |      |
|-------|-------------------|-------|------|
|       | Values(mm)        |       |      |
|       | MIN               | NOM   | WAX  |
| A     | 4.3               | 4.5   | 4.7  |
| A1    | 1                 | 1.3   | 1.5  |
| A2    | 1.8               | 2.4   | 2.8  |
| b     | 0.6               | 0.8   | 1    |
| b1    | 1                 | -     | 1.6  |
| c     | 0.3               | -     | 0.7  |
| D     | 15.1              | 15.7  | 16.1 |
| D1    | 8.1               | 9.2   | 10   |
| F     | 9.6               | 9.9   | 10.4 |
| e     | 2.54BSC           |       |      |
| H1    | 6.1               | 6.5   | 7    |
| L     | 12.6              | 13.08 | 13.6 |
| L1    |                   |       | 3.95 |
| ΦP    | 3.4               | 3.7   | 3.9  |
| Q     | 2.6               |       | 3.2  |