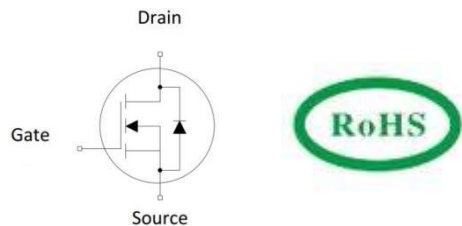


## N-channel 600V, 4A, 1.0Ω Super-Junction Power MOSFET

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |      |                  |      |       |      |             |        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|------------------|------|-------|------|-------------|--------|
| <p><b>Description</b></p> <p>Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFET , designed according to the SJ principle. The resulting device has extremely low on resistance,making it especially suitable for applications which require superior power density and outstanding efficiency.</p> <p><b>Features</b></p> <ul style="list-style-type: none"> <li>◆ Very low FOM <math>R_{DS(on)} \times Q_g</math></li> <li>◆ 100% UIS tested</li> <li>◆ RoHS compliant</li> </ul> <p><b>Applications</b></p> <ul style="list-style-type: none"> <li>◆ Power factor correction (PFC).</li> <li>◆ Switched mode power supplies (SMPS).</li> <li>◆ Uninterrupted power supply (UPS).</li> </ul> | <p><b>Product Summary</b></p> <table> <tr> <td><math>V_{DS} @ T_{j,25^\circ C}</math></td><td>600V</td></tr> <tr> <td><math>R_{DS(on),max}</math></td><td>1.0Ω</td></tr> <tr> <td><math>I_D</math></td><td>4.0A</td></tr> <tr> <td><math>Q_{g,typ}</math></td><td>9.0 nC</td></tr> </table> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>TO-252</p> </div> <div style="text-align: center;">  <p>TO-251</p> </div> <div style="text-align: center;">  <p>TO-220F</p> </div> </div> <div style="text-align: center; margin-top: 20px;">  <p>N-Channel MOSFET</p> </div> | $V_{DS} @ T_{j,25^\circ C}$ | 600V | $R_{DS(on),max}$ | 1.0Ω | $I_D$ | 4.0A | $Q_{g,typ}$ | 9.0 nC |
| $V_{DS} @ T_{j,25^\circ C}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 600V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |      |                  |      |       |      |             |        |
| $R_{DS(on),max}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1.0Ω                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |      |                  |      |       |      |             |        |
| $I_D$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 4.0A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |      |                  |      |       |      |             |        |
| $Q_{g,typ}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9.0 nC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |      |                  |      |       |      |             |        |

### Marking information

| Product     | Package | Marking     | Packing method |
|-------------|---------|-------------|----------------|
| RMA60R1K0SN | TO-252  | RMA60R1K0SN | Reel           |
| RMG60R1K0SN | TO-251  | RMG60R1K0SN | Tube           |
| RMC60R1K0SN | TO-220F | RMC60R1K0SN | Tube           |

### Absolute Maximum Ratings

| Parameter                                               | Symbol         | Value       | Unit |
|---------------------------------------------------------|----------------|-------------|------|
| Drain-Source Voltage                                    | $V_{DSS}$      | 600         | V    |
| Continuous drain current ( $T_C = 25^\circ C$ )         | $I_D$          | 4           | A    |
| ( $T_C = 100^\circ C$ )                                 |                | 2.5         | A    |
| Pulsed drain current <sup>1)</sup>                      | $I_{DM}$       | 12          | A    |
| Gate-Source voltage                                     | $V_{GSS}$      | $\pm 30$    | V    |
| Avalanche energy, single pulse <sup>2)</sup>            | $E_{AS}$       | 50          | mJ   |
| Avalanche current, repetitive <sup>3)</sup>             | $I_{AR}$       | 0.9         | A    |
| Power Dissipation TO-252 /TO-251 ( $T_C = 25^\circ C$ ) | $P_D$          | 37          | W    |
| - Derate above 25°C                                     |                | 0.3         | W/°C |
| Power Dissipation TO-220F ( $T_C = 25^\circ C$ )        | $P_D$          | 30          | W    |
| - Derate above 25°C                                     |                | 0.24        | W/°C |
| Operating and Storage Temperature Range                 | $T_J, T_{STG}$ | -55 to +150 | °C   |
| Continuous diode forward current                        | $I_S$          | 4           | A    |

|                     |               |    |   |
|---------------------|---------------|----|---|
| Diode pulse current | $I_{S,pulse}$ | 12 | A |
|---------------------|---------------|----|---|

## Thermal Characteristics

| Parameter                                                                              | Symbol          | Value        |         | Unit                 |
|----------------------------------------------------------------------------------------|-----------------|--------------|---------|----------------------|
|                                                                                        |                 | TO252/TO-251 | TO-220F |                      |
| Thermal Resistance, Junction-to-Case                                                   | $R_{\theta JC}$ | 2.8          | 4.4     | $^{\circ}\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient                                                | $R_{\theta JA}$ | 62           | 73      | $^{\circ}\text{C/W}$ |
| Soldering temperature, wave soldering only allowed at leads. (1.6mm from case for 10s) | $T_{solder}$    | 260          | 260     | $^{\circ}\text{C}$   |

## Electrical Characteristics

 $T_c = 25^{\circ}\text{C}$  unless otherwise noted

| Parameter                        | Symbol               | Test Condition                                                                                   | Min.        | Typ.    | Max. | Unit |
|----------------------------------|----------------------|--------------------------------------------------------------------------------------------------|-------------|---------|------|------|
| Static characteristics           |                      |                                                                                                  |             |         |      |      |
| Drain-source breakdown voltage   | BV <sub>DSS</sub>    | V <sub>GS</sub> =0 V, I <sub>D</sub> =250uA                                                      | 600         | -       | -    | V    |
| Gate threshold voltage           | V <sub>GS(th)</sub>  | V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250uA                                         | 2.5         |         | 4.0  | V    |
| Drain cut-off current            | I <sub>DSS</sub>     | V <sub>DS</sub> =600 V, V <sub>GS</sub> =0 V,<br>T <sub>J</sub> = 25°C<br>T <sub>J</sub> = 125°C | -<br>-      | -<br>10 | 1    | μA   |
| Gate leakage current, Forward    | I <sub>GSSF</sub>    | V <sub>GS</sub> =30 V, V <sub>DS</sub> =0 V                                                      | -           | -       | 100  | nA   |
| Gate leakage current, Reverse    | I <sub>GSSR</sub>    | V <sub>GS</sub> =-30 V, V <sub>DS</sub> =0 V                                                     | -           | -       | -100 | nA   |
| Drain-source on-state resistance | R <sub>DS(on)</sub>  | V <sub>GS</sub> =10 V, I <sub>D</sub> =2 A<br>T <sub>J</sub> = 25°C                              | -<br>-<br>- | 0.88    | 1.0  | Ω    |
| Dynamic characteristics          |                      |                                                                                                  |             |         |      |      |
| Input capacitance                | C <sub>iss</sub>     | V <sub>DS</sub> = 100 V, V <sub>GS</sub> = 0 V,<br>f = 1MHz                                      | -           | 315     | -    | pF   |
| Output capacitance               | C <sub>oss</sub>     |                                                                                                  | -           | 27      | -    |      |
| Reverse transfer capacitance     | C <sub>rss</sub>     |                                                                                                  | -           | 1.2     | -    |      |
| Turn-on delay time               | t <sub>d(on)</sub>   | V <sub>DD</sub> = 400V, I <sub>D</sub> = 2A<br>R <sub>G</sub> = 25Ω, V <sub>GS</sub> =10V        | -           | 9.4     | -    | ns   |
| Rise time                        | t <sub>r</sub>       |                                                                                                  | -           | 22.6    | -    |      |
| Turn-off delay time              | t <sub>d(off)</sub>  |                                                                                                  | -           | 36.4    | -    |      |
| Fall time                        | t <sub>f</sub>       |                                                                                                  | -           | 25.4    | -    |      |
| Gate charge characteristics      |                      |                                                                                                  |             |         |      |      |
| Gate to source charge            | Q <sub>gs</sub>      | V <sub>DD</sub> =480 V, I <sub>D</sub> =2A,<br>V <sub>GS</sub> =0 to 10 V                        | -           | 2.1     | -    | nC   |
| Gate to drain charge             | Q <sub>gd</sub>      |                                                                                                  | -           | 3.8     | -    |      |
| Gate charge total                | Q <sub>g</sub>       |                                                                                                  | -           | 9.0     | -    |      |
| Gate plateau voltage             | V <sub>plateau</sub> |                                                                                                  | -           | 5.5     | -    | V    |
| Reverse diode characteristics    |                      |                                                                                                  |             |         |      |      |
| Diode forward voltage            | V <sub>SD</sub>      | V <sub>GS</sub> =0 V, I <sub>F</sub> =2A                                                         | -           | 0.85    | -    | V    |
| Reverse recovery time            | t <sub>rr</sub>      | V <sub>R</sub> =50 V, I <sub>F</sub> =2A,<br>dI <sub>F</sub> /dt=100 A/μs                        | -           | 159     | -    | ns   |
| Reverse recovery charge          | Q <sub>rr</sub>      |                                                                                                  | -           | 0.93    | -    | μC   |
| Peak reverse recovery current    | I <sub>rrm</sub>     |                                                                                                  | -           | 11.2    | -    | A    |

## Notes:

1. Limited by maximum junction temperature, maximum duty cycle is 0.75.
2.  $I_{AS} = 1A$ ,  $V_{DD} = 50V$ , Starting  $T_j = 25^{\circ}C$ .

## Electrical Characteristics Diagrams

Figure 1. Output Characteristics

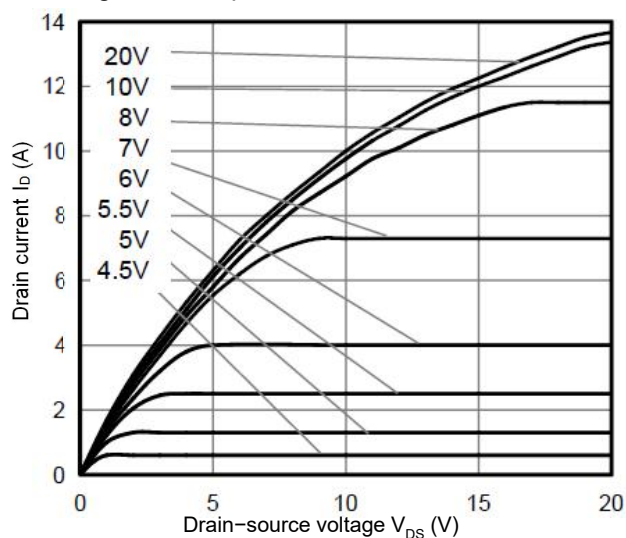


Figure 2. Transfer Characteristics

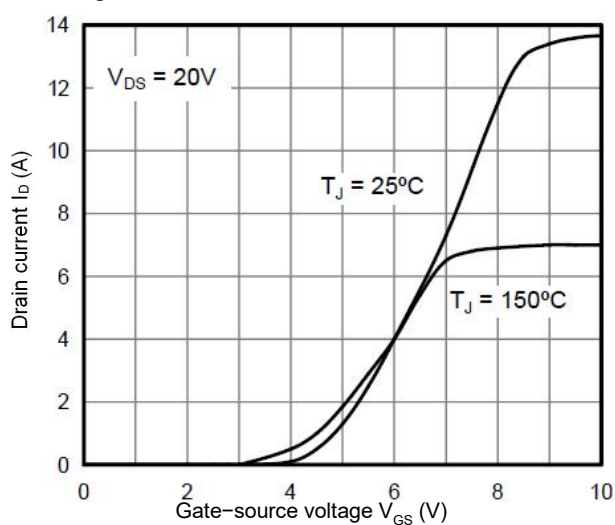


Figure 3. On-Resistance vs. Drain Current

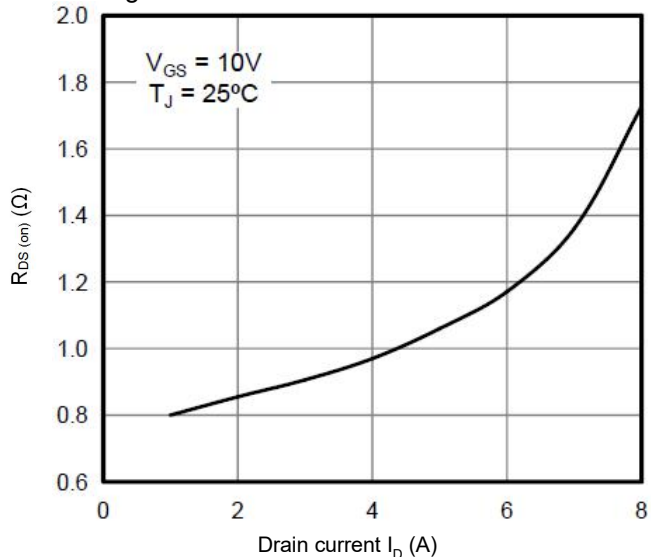


Figure 4. Capacitance Characteristics

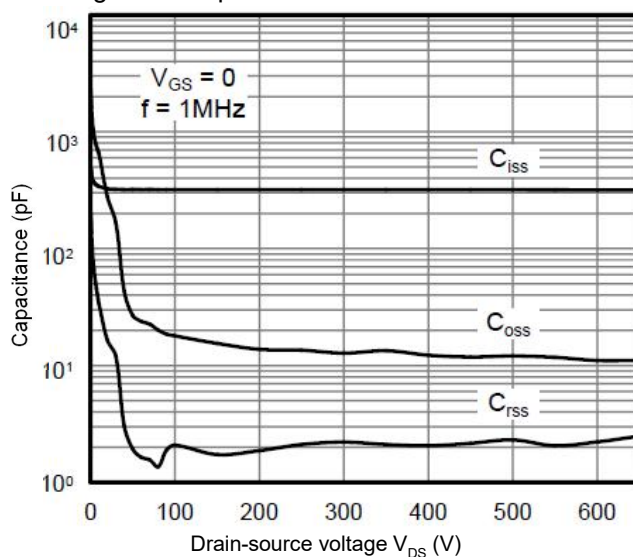


Figure 5. Gate Charge Characteristics

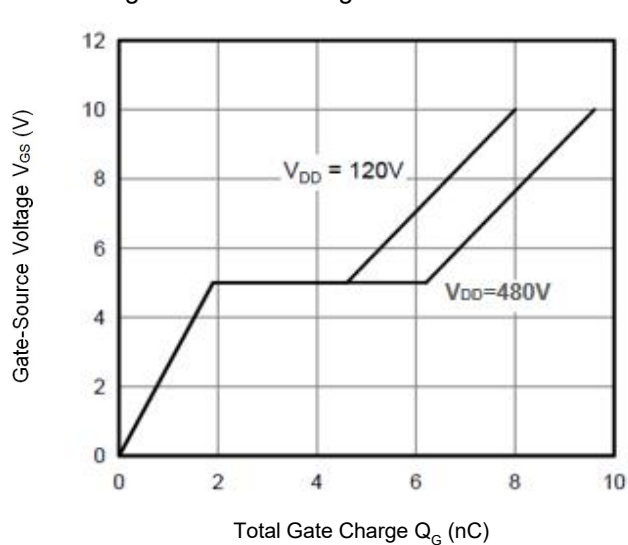


Figure 6. Body Diode Forward Voltage

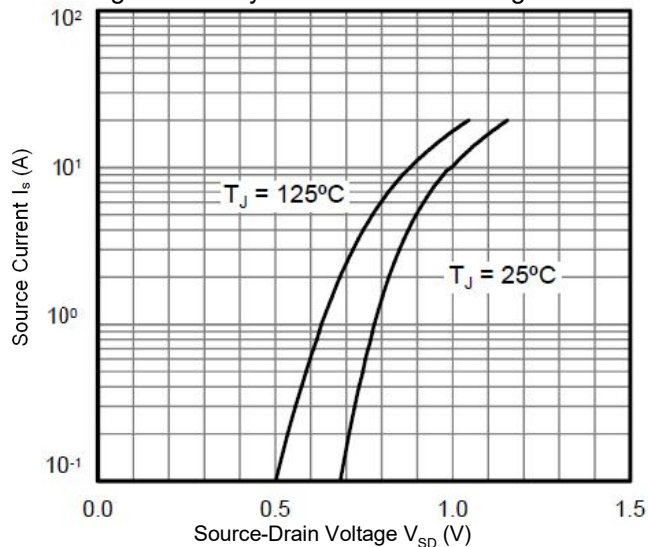


Figure 7. Breakdown Voltage vs. Temperature

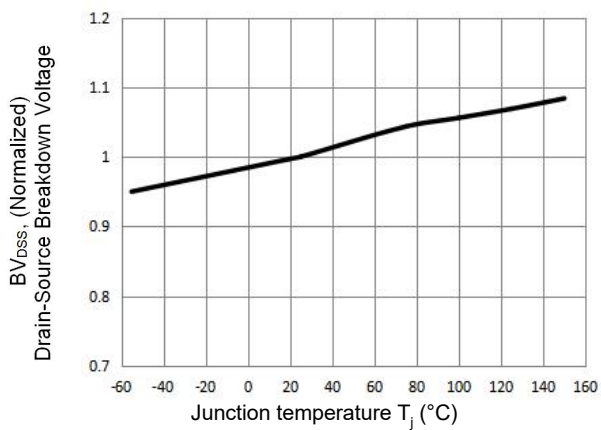


Figure 8. On-Resistance vs. Temperature

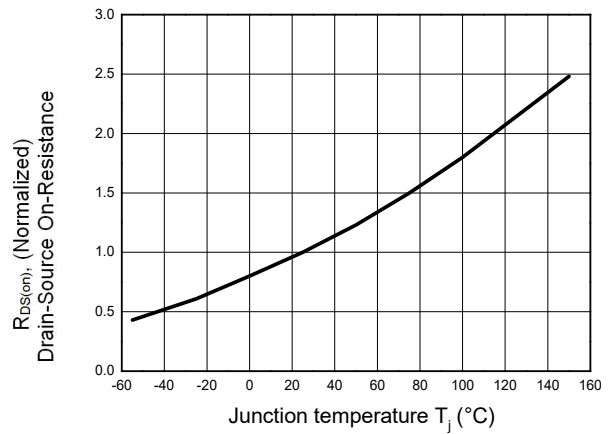


Figure 9. Maximum Safe Operating Area  
TO-252/TO-251

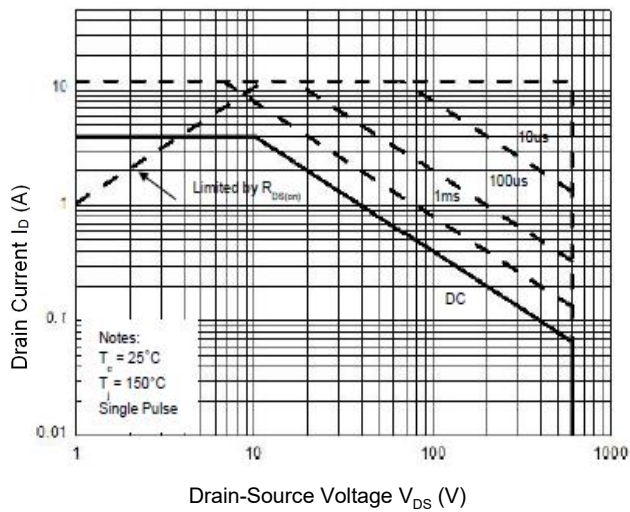
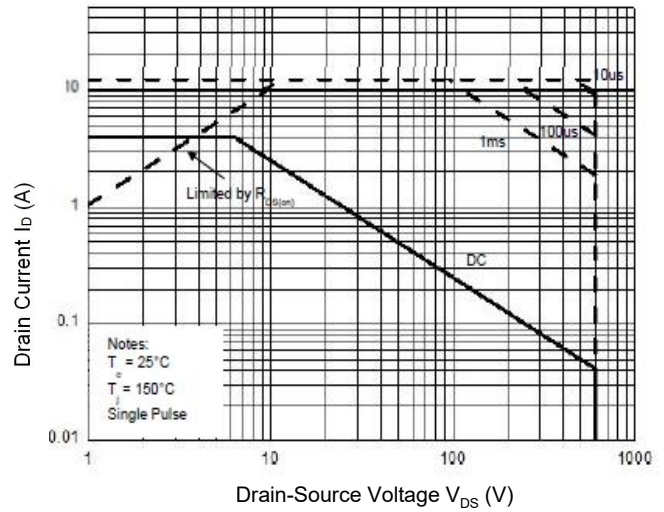
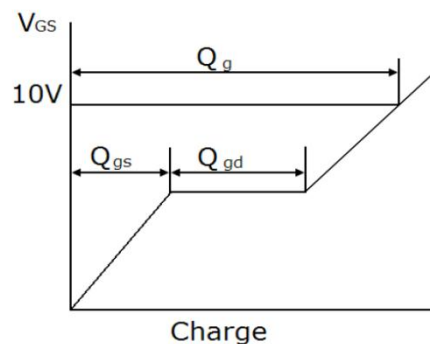
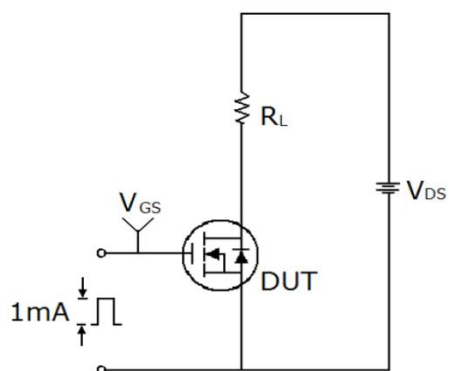


Figure 10. Maximum Safe Operating Area  
TO-220F

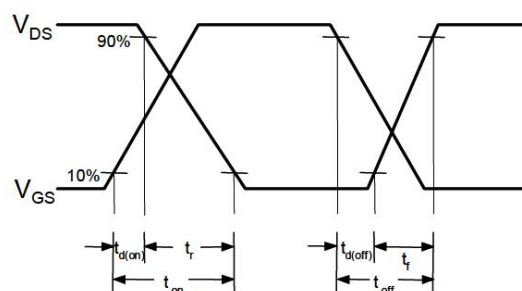
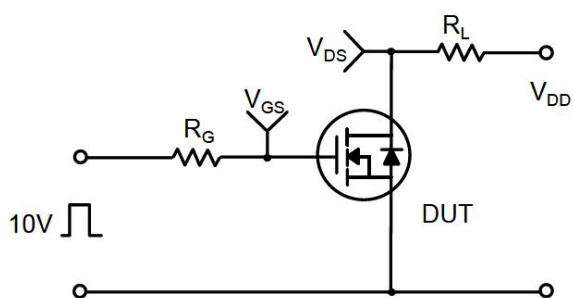


## Test Circuits

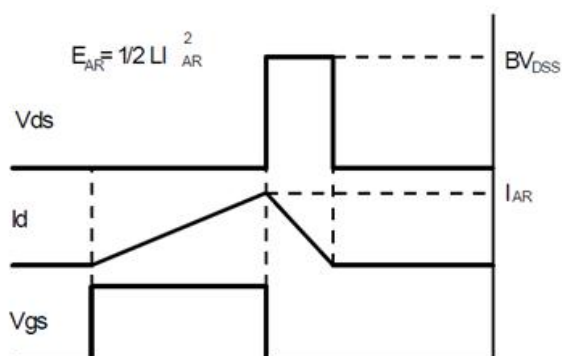
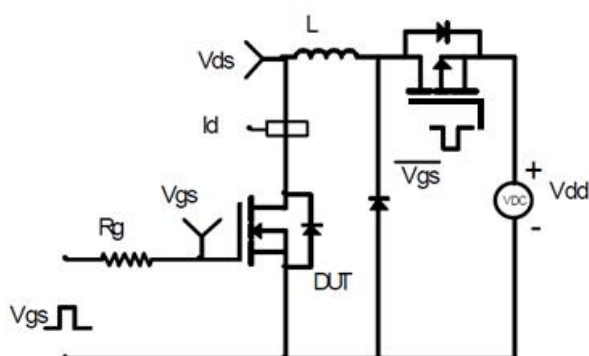
### Gate Charge Test Circuit & Waveform



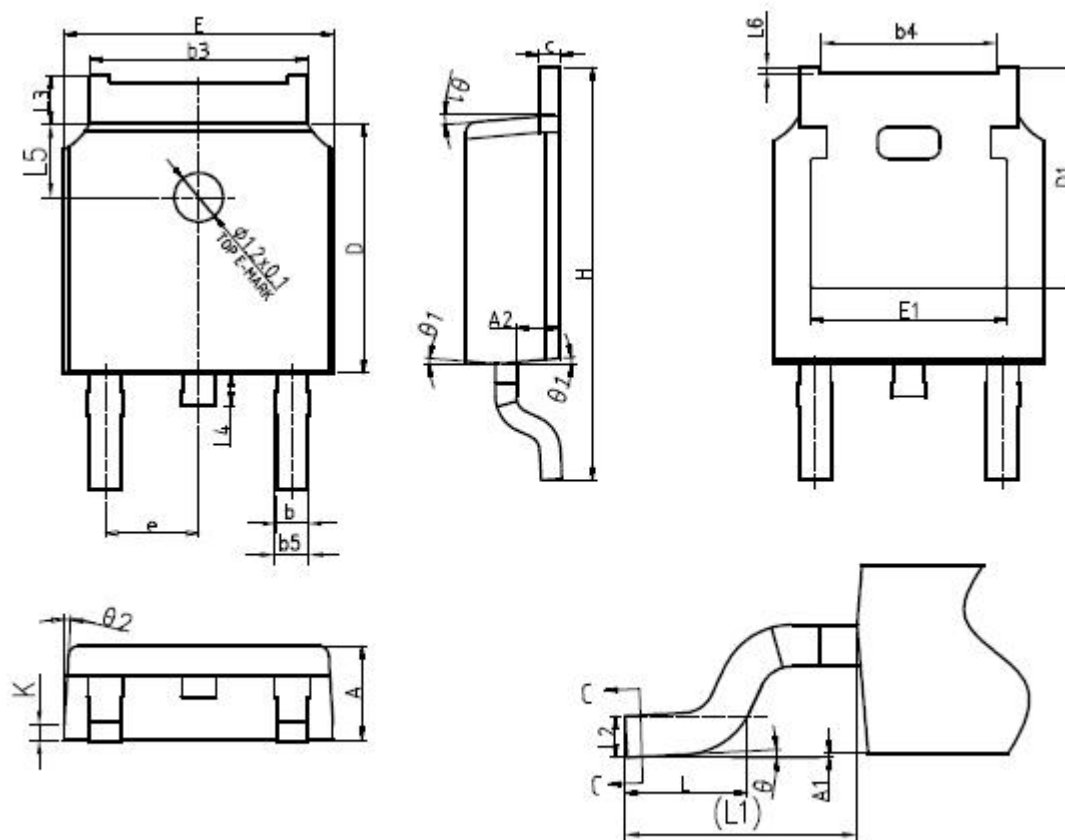
### Switching Test Circuit & Waveform



### Unclamped Inductive Switching Test Circuit & Waveform



Mechanical Dimensions for TO-252

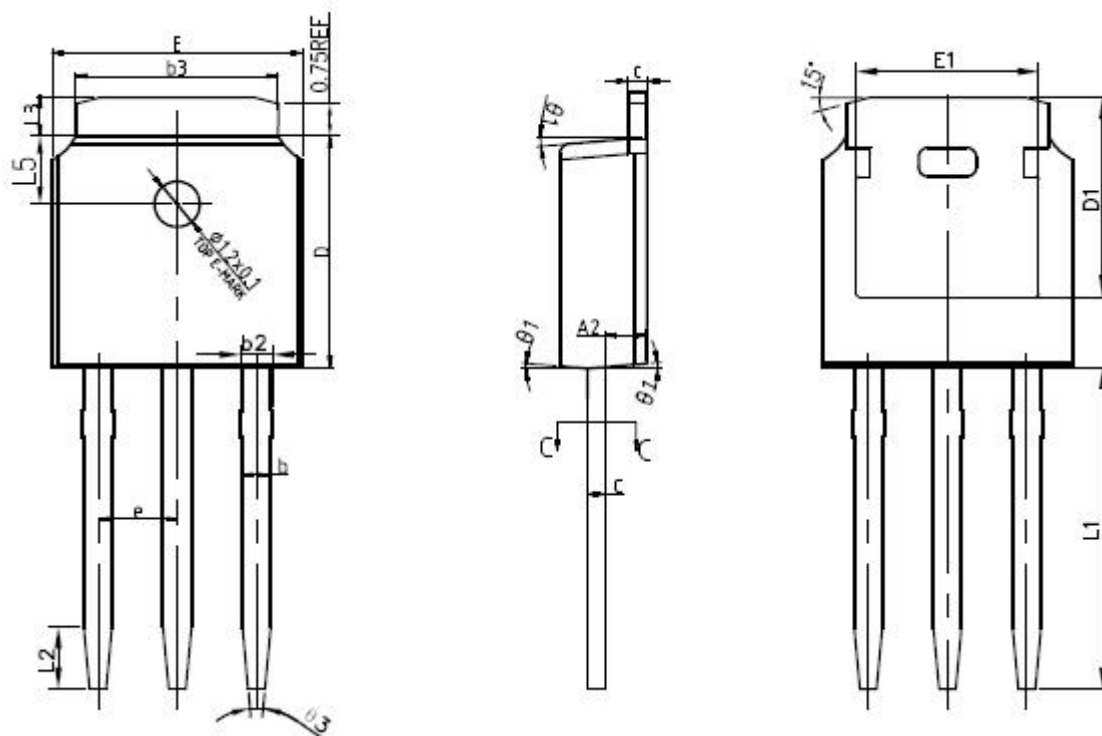


单位: mm

| SYMBOL | mm      |      |      |
|--------|---------|------|------|
|        | MIN     | NOM  | MAX  |
| *A     | 2.20    | 2.30 | 2.38 |
| *A1    | 0.00    | -    | 0.10 |
| A2     | 0.97    | 1.07 | 1.17 |
| *b     | 0.72    | 0.78 | 0.85 |
| b1     | 0.71    | 0.76 | 0.81 |
| *b3    | 5.23    | 5.33 | 5.46 |
| b4     | 4.27    | 4.32 | 4.37 |
| b5     | 0.72    | 0.88 | 0.93 |
| *c     | 0.47    | 0.53 | 0.58 |
| c1     | 0.46    | 0.51 | 0.56 |
| *D     | 6.00    | 6.10 | 6.20 |
| D1     | 5.30REF |      |      |

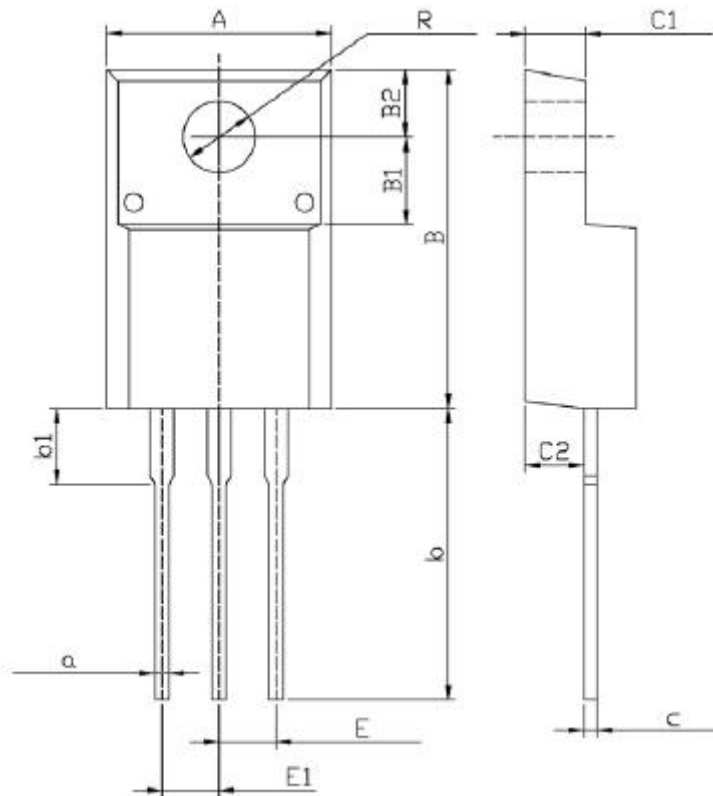
|              |          |       |       |
|--------------|----------|-------|-------|
| *E           | 6.50     | 6.60  | 6.70  |
| E1           | 4.70     | 4.83  | 4.92  |
| *e           | 2.286BSC |       |       |
| L            | 1.40     | 1.50  | 1.70  |
| L1           | 2.90REF  |       |       |
| L2           | 0.51BSC  |       |       |
| *L3          | 0.90     | -     | 1.25  |
| *L4          | 0.60     | 0.80  | 1.00  |
| L5           | 1.70     | 1.80  | 1.90  |
| L6           | 0        | 0.047 | 0.123 |
| $\theta$     | 0°       | -     | 8°    |
| * $\theta_1$ | 5°       | 7°    | 9°    |
| $\theta_2$   | 5°       | 7°    | 9°    |
| K            | 0.40REF  |       |       |

Mechanical Dimensions for TO-251



| SYMBOL | MM       |      |      |
|--------|----------|------|------|
|        | MIN      | NOM  | MAX  |
| *A     | 2.20     | 2.30 | 2.38 |
| *A2    | 0.97     | 1.07 | 1.17 |
| *b     | 0.72     | 0.78 | 0.85 |
| b1     | 0.71     | 0.76 | 0.81 |
| *b2    | 0.72     | 0.88 | 0.95 |
| *b3    | 5.23     | 5.33 | 5.46 |
| *c     | 0.47     | 0.53 | 0.58 |
| c1     | 0.46     | 0.51 | 0.56 |
| *D     | 6.00     | 6.10 | 6.20 |
| D1     | 5.30REF  |      |      |
| *E     | 6.50     | 6.60 | 6.70 |
| E1     | 4.70     | 4.83 | 4.92 |
| *e     | 2.286BSC |      |      |
| *L1    | 9.20     | 9.40 | 9.60 |
| L2     | 1.25     | 1.35 | 1.45 |
| *L3    | 0.90     | 1.02 | 1.25 |
| L5     | 1.70     | 1.80 | 1.90 |
| *0 1   | 5°       | 7°   | 9°   |
| 0 2    | 5°       | 7°   | 9°   |
| 0 3    | 11°      | 13°  | 15°  |
| K      | 0.40REF  |      |      |

Mechanical Dimensions for TO-220F



| Symbol | Dimensions In Millimeters |      | Symbol | Dimensions In Millimeters |      |
|--------|---------------------------|------|--------|---------------------------|------|
|        | Min                       | Max  |        | Min                       | Max  |
| C      | 4.3                       | 4.7  | b1     | 2.9                       | 3.9  |
| A      | 9.7                       | 10.3 | a      | 0.55                      | 0.75 |
| B      | 14.7                      | 15.3 | E      | 2.29                      | 2.79 |
| B1     | 3.8                       | 4.0  | E1     | 2.29                      | 2.79 |
| B2     | 2.9                       | 3.1  | C1     | 2.5                       | 2.9  |
| R      | 3.0                       | 3.4  | C2     | 2.5                       | 2.7  |
| b      | 12.5                      | 13.5 | c      | 0.5                       | 0.7  |