

- ★ Super Low Gate Charge
- ★ 100% EAS Guaranteed
- ★ Green Device Available
- ★ Excellent CdV/dt effect decline
- ★ Advanced trench gate super junction technology

### 650V Super Junction Power MOSFET

#### Product Summary



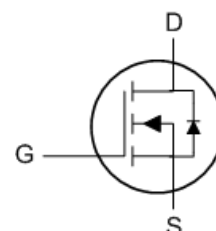
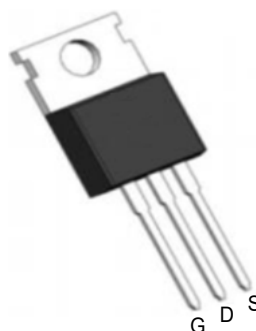
| BVDSS | RDS(ON) | ID  |
|-------|---------|-----|
| 650V  | 0.19Ω   | 20A |

### Description

The XR650SJ24T use super junction technology and design to provide excellent RDS(ON) with low gate charge. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, and industrial power applications.

The XR650SJ24T meet the RoHS and Green Product requirement, 100% EAS guaranteed with full function reliability approved.

#### TO220AB Pin Configuration



### Absolute Maximum Ratings (unless otherwise specified, $T_J=25^{\circ}\text{C}$ )

| Parameter                            | Symbol   | Test conditions                                                   | Parameter values |     |     | Unit |
|--------------------------------------|----------|-------------------------------------------------------------------|------------------|-----|-----|------|
|                                      |          |                                                                   | Min              | Typ | Max |      |
| Drain-source voltage                 | VDS      | --                                                                | 650              | --  | --  | V    |
| Gate-source voltage                  | VGS      | --                                                                | -20              | --  | 20  | V    |
| Continuous drain current             | ID       | TC=25°C                                                           | --               | --  | 20  | A    |
|                                      |          | TC=100°C                                                          | --               | --  | 12  | A    |
| Pulsed drain current (note1)         | IDM      | TC=25°C                                                           | --               | --  | 80  | A    |
| Power dissipation (note2)            | PD       | TC=25°C                                                           | --               | --  | 25  | W    |
| Single Pulsed Avalanche Energy       | EAS      | L=79mH, VDD=100V, RG=25Ω, TJ=25°C                                 | --               | --  | 409 | mJ   |
| Avalanche Current                    | IAS      | --                                                                | --               | --  | 5   | A    |
| Body diode                           | dv/dt    | VDS=0~400V, ISD<=IS, TJ=25°C                                      | --               | --  | 15  | V/ns |
| MOS transistor dv/dt durability      | dv/dt    | VDS=0~480V                                                        | --               | --  | 50  | V/ns |
| Operating Junction Temperature Range | TJ       | --                                                                | -55              | --  | 150 | °C   |
| Storage Temperature Range            | Tstg     | --                                                                | -55              | --  | 150 | °C   |
| Continuous diode forward current     | IS       | TC=25°C, Maximum Continuous Drain to Source Diode Forward Current | --               | --  | 20  | A    |
| Diode pulse current                  | IS,pulse |                                                                   | --               | --  | 80  | A    |
| Maximum diode rectification speed    | di/dt    | VDS=0~400V, ISD<= IS, TJ=25°C                                     | --               | --  | 500 | A/μs |

#### Note:

1. Pulse time:5μs;
2. The dissipated power value will vary with temperature changes, When the temperature exceeds 25 °C, the dissipated power value decreases with every 1 degree increase in temperature: 0.20W/°C ;
3. Pulse test: pulse width≤300μs, Duty cycle≤2%;
4. Basically unaffected by operating temperature.

## 650V Super Junction Power MOSFET

### Thermal Characteristics

| Parameter                           | Symbol            | Test conditions           | Parameter values |     |      | Unit                 |
|-------------------------------------|-------------------|---------------------------|------------------|-----|------|----------------------|
|                                     |                   |                           | Min              | Typ | Max  |                      |
| Thermal Resistance Junction-ambient | $R_{\theta JC}$   | --                        | --               | --  | 5.0  | $^{\circ}\text{C/W}$ |
| Thermal Resistance Junction-Case    | $R_{\theta JA}$   | --                        | --               | --  | 62.5 | $^{\circ}\text{C/W}$ |
| welding temperature                 | $T_{\text{sold}}$ | $15^{+2}_{-0}$ sec, 1time | --               | --  | 260  | $^{\circ}\text{C}$   |

### Electrical Characteristics (T<sub>J</sub>=25 $^{\circ}\text{C}$ unless otherwise specified)

#### Static Characteristics

| Parameter                         | Symbol              | Test conditions                                                                    | Parameter values |      |           | Unit          |
|-----------------------------------|---------------------|------------------------------------------------------------------------------------|------------------|------|-----------|---------------|
|                                   |                     |                                                                                    | Min              | Typ  | Max       |               |
| Drain-Source Breakdown Voltage    | BVDSS               | V <sub>GS</sub> =0V, I <sub>D</sub> =250 $\mu\text{A}$                             | 650              | --   | --        | V             |
| Drain-Source Leakage Current      | I <sub>DSS</sub>    | V <sub>DS</sub> =650V, V <sub>GS</sub> =0V, T <sub>J</sub> =25 $^{\circ}\text{C}$  | --               | --   | 1.0       | $\mu\text{A}$ |
|                                   |                     | V <sub>DS</sub> =650V, V <sub>GS</sub> =0V, T <sub>J</sub> =150 $^{\circ}\text{C}$ | --               | 10   | --        |               |
| Gate-Source Leakage Current       | I <sub>GSS</sub>    | V <sub>GS</sub> = $\pm 20\text{V}$ , V <sub>DS</sub> =0V                           | --               | --   | $\pm 100$ | nA            |
| Gate Threshold Voltage            | V <sub>GS(th)</sub> | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250 $\mu\text{A}$               | 2.0              | --   | 4.0       | V             |
| Static Drain-Source On-Resistance | R <sub>DS(on)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =10A, T <sub>J</sub> =25 $^{\circ}\text{C}$   | --               | 0.19 | 0.24      | $\Omega$      |
|                                   |                     | V <sub>GS</sub> =10V, I <sub>D</sub> =10A, T <sub>J</sub> =150 $^{\circ}\text{C}$  | --               | 0.42 | --        |               |
| Gate Resistance                   | R <sub>G</sub>      | f=1MHz                                                                             | --               | 4.7  | --        | $\Omega$      |

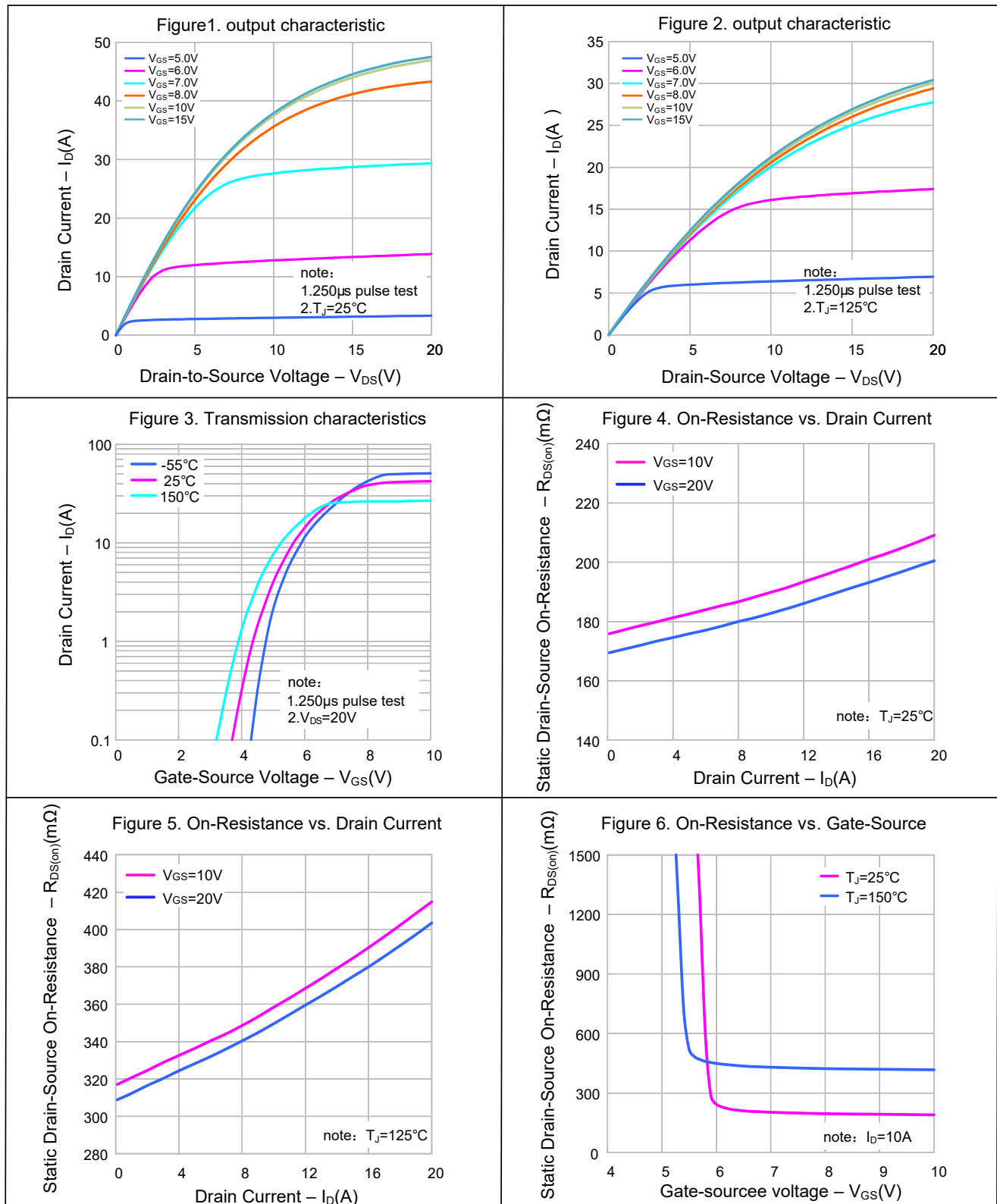
#### Dynamic Characteristics

| Parameter                    | Symbol               | Test conditions                                                                                               | Parameter values |      |     | Unit |
|------------------------------|----------------------|---------------------------------------------------------------------------------------------------------------|------------------|------|-----|------|
|                              |                      |                                                                                                               | Min              | Typ  | Max |      |
| Input Capacitance            | C <sub>iss</sub>     | f=1MHz, V <sub>GS</sub> =0V, V <sub>DS</sub> =100V                                                            | --               | 1153 | --  | pF   |
| Output Capacitance           | C <sub>oss</sub>     |                                                                                                               | --               | 51   | --  |      |
| Reverse Transfer Capacitance | C <sub>rss</sub>     |                                                                                                               | --               | 1.1  | --  |      |
| Turn-On Delay Time           | t <sub>d(on)</sub>   | V <sub>DD</sub> =325V, V <sub>GS</sub> =10V, R <sub>G</sub> =24 $\Omega$ , I <sub>D</sub> =20A<br>(note 3, 4) | --               | 22   | --  | ns   |
| Rise Time                    | t <sub>r</sub>       |                                                                                                               | --               | 54   | --  |      |
| Turn-Off Delay Time          | t <sub>d(off)</sub>  |                                                                                                               | --               | 81   | --  |      |
| Fall Time                    | t <sub>f</sub>       |                                                                                                               | --               | 42   | --  |      |
| Total Gate Charge            | Q <sub>g</sub>       | V <sub>DD</sub> =520V, V <sub>GS</sub> =10V, I <sub>D</sub> =20A<br>(note 3, 4)                               | --               | 31   | --  | nC   |
| Gate-Source Charge           | Q <sub>gs</sub>      |                                                                                                               | --               | 9.2  | --  |      |
| Gate-Drain Charge            | Q <sub>gd</sub>      |                                                                                                               | --               | 14   | --  |      |
| Gate Platform Voltage        | V <sub>plateau</sub> |                                                                                                               | --               | 7.0  | --  | V    |

#### Diode Characteristics

| Parameter                          | Symbol          | Test conditions                                                                                        | Parameter values |     |     | Unit          |
|------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------|------------------|-----|-----|---------------|
|                                    |                 |                                                                                                        | Min              | Typ | Max |               |
| Diode Forward Voltage              | V <sub>SD</sub> | I <sub>S</sub> =20A, V <sub>GS</sub> =0V                                                               | --               | --  | 1.4 | V             |
| Body Diode Reverse Recovery Time   | T <sub>rr</sub> | I <sub>S</sub> =20A, V <sub>GS</sub> =0V, V <sub>R</sub> =50V, dI <sub>F</sub> /dt=100A/ $\mu\text{s}$ | --               | 294 | --  | ns            |
| Body Diode Reverse Recovery Charge | Q <sub>rr</sub> | (note 3)                                                                                               | --               | 4.3 | --  | $\mu\text{C}$ |

### Typical Characteristics



### Typical Characteristics

Figure 7. Normalized  $V_{GS(th)}$  vs.  $T_J$

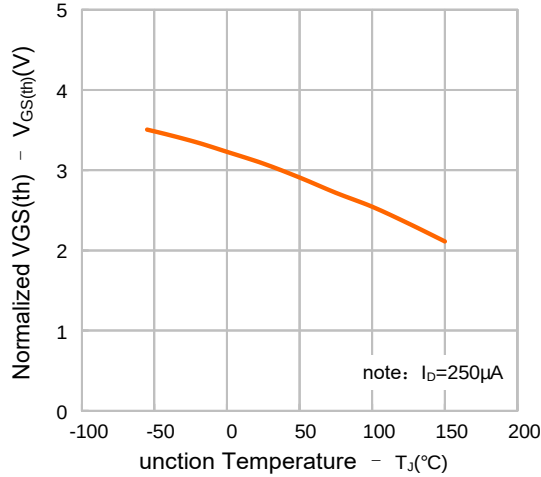


Figure 8. Forward Characteristics Of Reverse

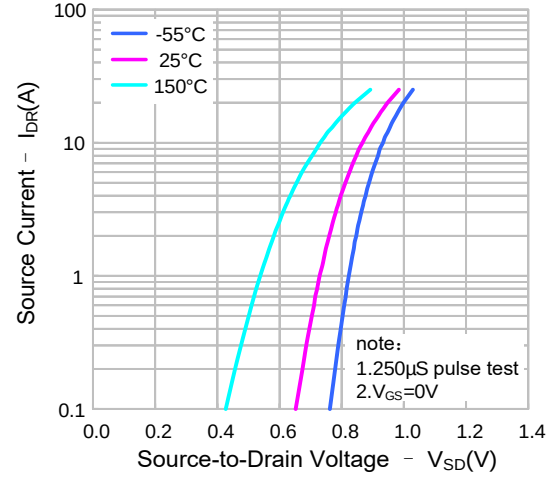


Figure 9. Capacitance Characteristic

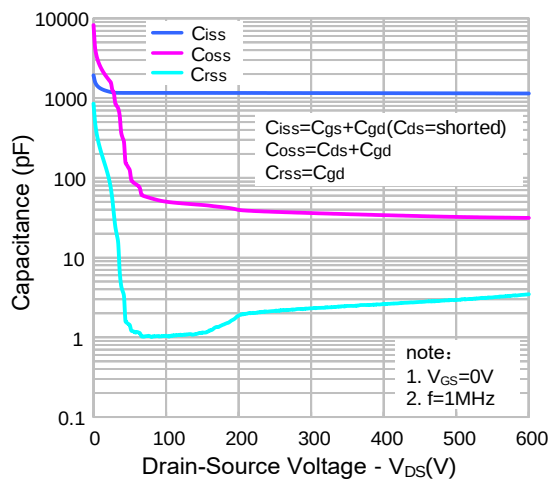


Figure 10. Gate Charge Characteristic

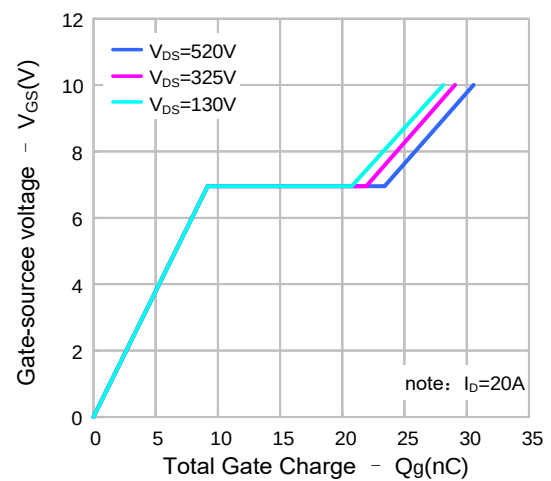


Figure 11. Normalized BVDSS vs. Temperature

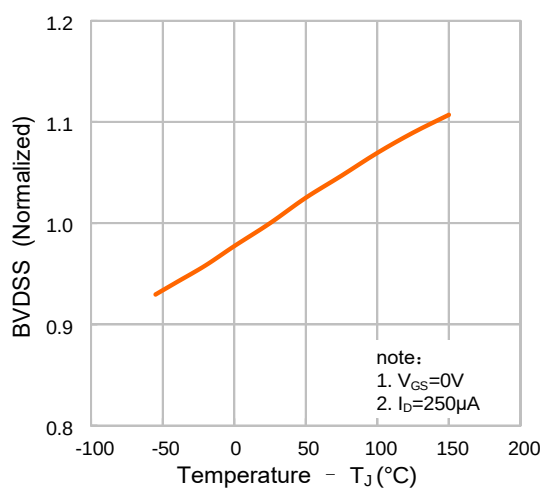
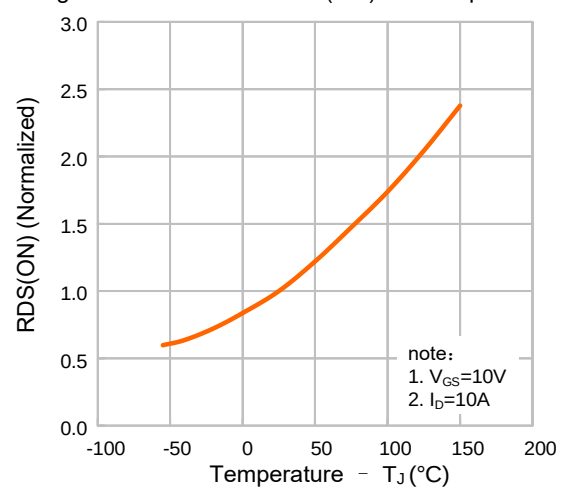
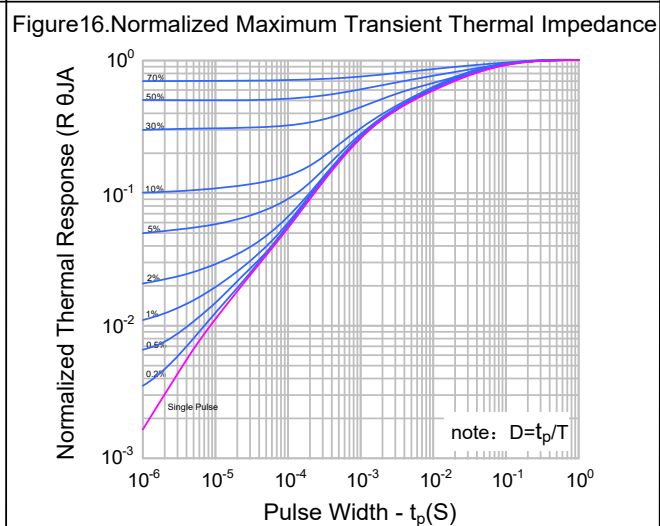
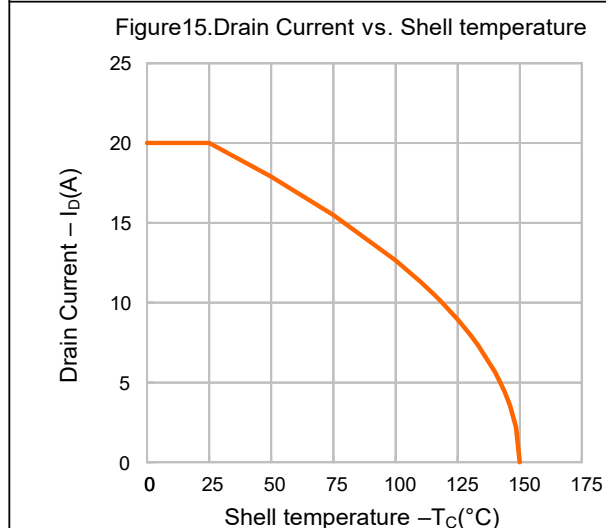
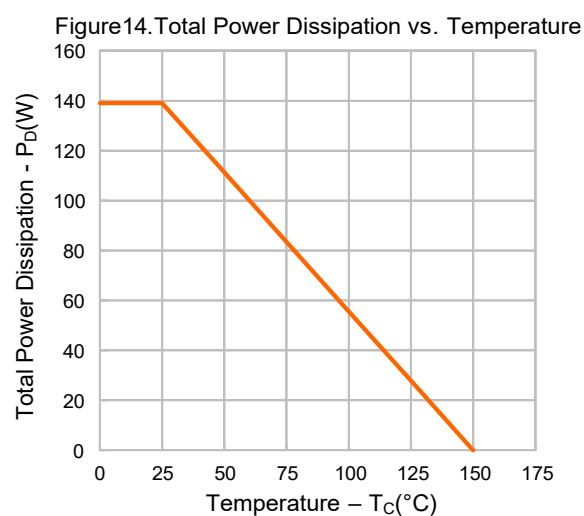
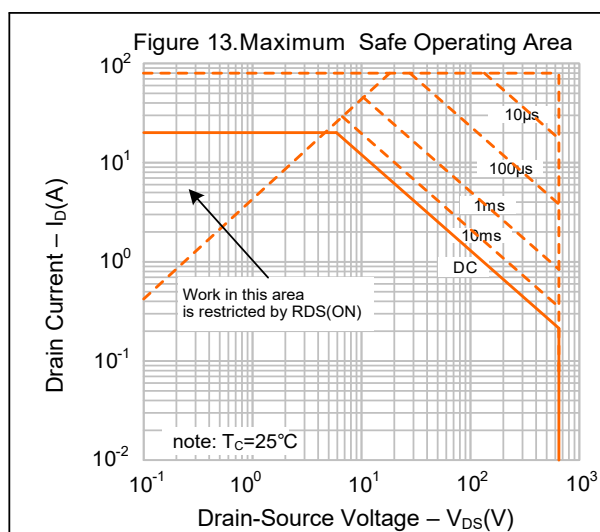


Figure 12. Normalized  $R_{DS(ON)}$  vs. Temperature

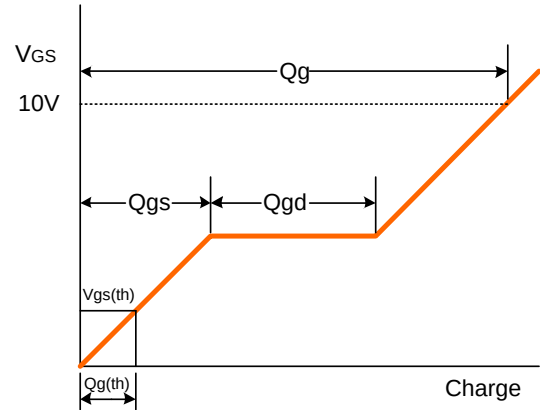
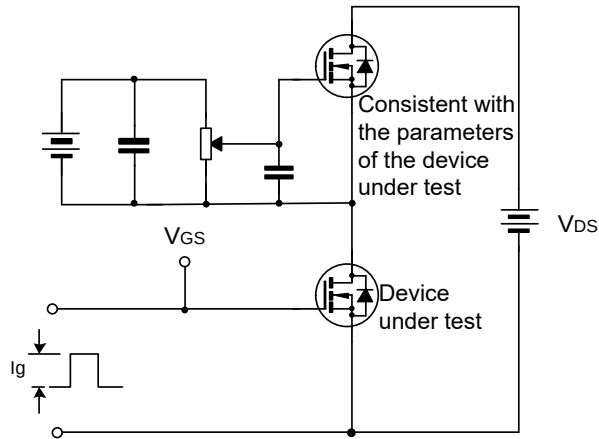


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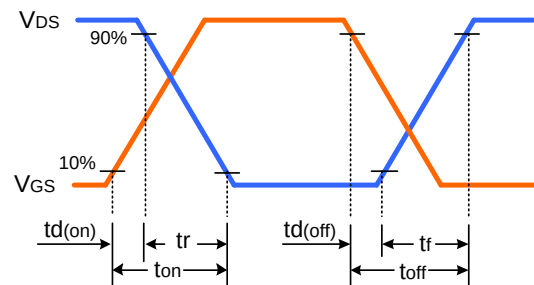
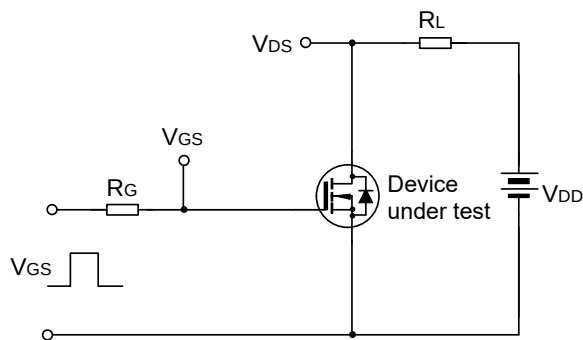
### Typical Characteristics



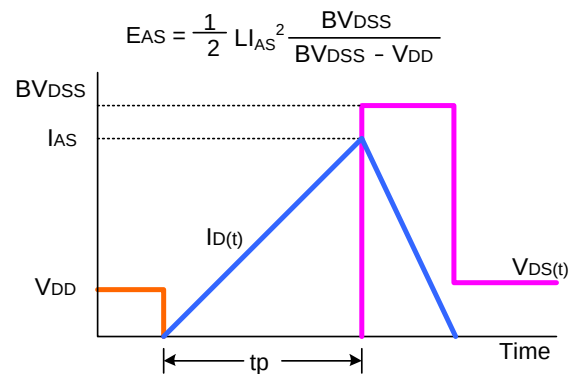
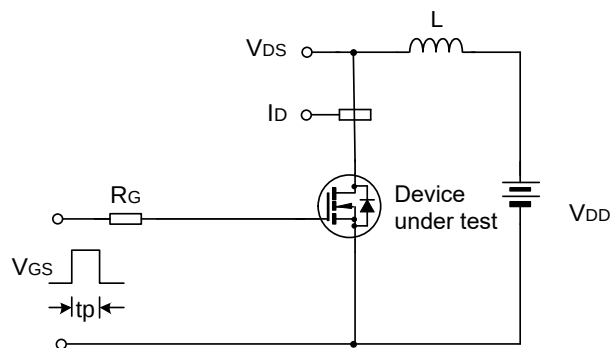
### Gate Charge Test Circuit & Waveform



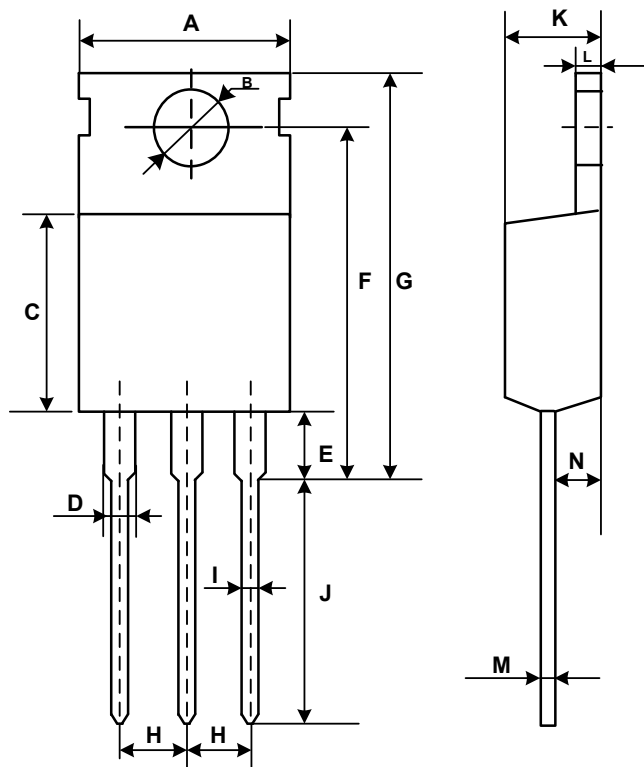
### Switching Test Circuit & Waveforms



### Unclamped Inductive Switching Test Circuit & Waveforms



Mechanical Dimensions for TO-220



COMMON DIMENSIONS

| SYMBOL | MM       |       |
|--------|----------|-------|
|        | MIN      | MAX   |
| A      | 9.70     | 10.30 |
| B      | 3.40     | 3.80  |
| C      | 8.80     | 9.40  |
| D      | 1.17     | 1.47  |
| E      | 2.60     | 3.50  |
| F      | 15.10    | 16.70 |
| G      | 19.55MAX |       |
| H      | 2.54REF  |       |
| I      | 0.70     | 0.95  |
| J      | 9.35     | 11.00 |
| K      | 4.30     | 4.77  |
| L      | 1.20     | 1.45  |
| M      | 0.40     | 0.65  |
| N      | 2.20     | 2.60  |