



# GSX11N70E

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

Super Junction MOSFET

700V Super Junction Power Transistor

GSX11N70E

Data Sheet

Ver 1.0

2019-3-20

# 700V 11A Power MOSFET

## Description

GroupSemiconductor(GS) has series Multi-EPI Super-Junction power MOSFET platforms for voltage up 500V to 1000 volts, both with design service and manufacturing capability, including cell, termination design and simulation.

The GS 700V 11A Power MOSFET is a Low voltage N channel Multi-EPI Super-Junction power MOSFET sample with advanced technology to have better characteristics, such as fast switching time, low Ciss and Crss, low on resistance and excellent avalanche characteristics, making it especially suitable for applications which require superior power density and outstanding efficiency.

## Features

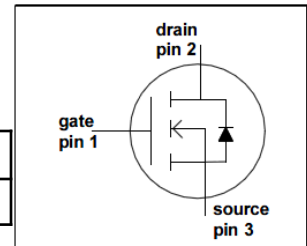
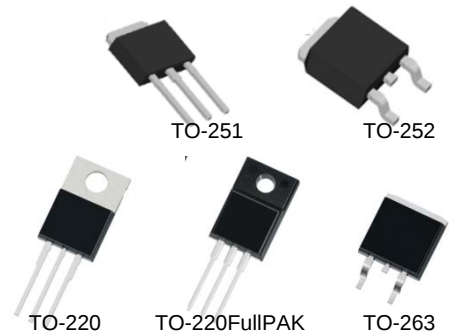
$R_{DS(ON)}=0.45\Omega$  @  $V_{GS} = 10V$

$V_{DS} = 700V$

$I_D$  (@  $V_{GS}=10V$ ) = 6.5A

## PKG

| GSA11N70E     | GSP11N70E | GSB11N70E | GSD11N70E | GSD11N70E |
|---------------|-----------|-----------|-----------|-----------|
| TO-220Fullpak | TO-220    | TO-263    | TO-252    | TO-251    |



## Absolute Maximum Ratings (TC = 25° C, unless otherwise specified)

| Symbol         | Parameter                                                                    | GSP11N70E   | GSA11N70E | Unit |
|----------------|------------------------------------------------------------------------------|-------------|-----------|------|
| $V_{DS}$       | Drain-Source Voltage                                                         | 700         |           | V    |
| $I_D$          | Drain Current -Continuous (TC = 25°C)<br>-Continuous (TC = 100°C)            | 11*<br>7*   |           | A    |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                              | 42          |           | A    |
| $V_{GS}$       | Gate-Source voltage                                                          | ±30         |           | V    |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                      | 260         |           | mJ   |
| $I_{AR}$       | Avalanche Current (Note 1)                                                   | 2           |           | A    |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                         | 1           |           | mJ   |
| $dv/dt$        | Peak Diode Recovery dv/dt (Note 3)                                           | 15          |           | V/ns |
| $dV_{ds}/dt$   | Drain Source voltage slope (Vds=480V)                                        | 50          |           | V/ns |
| $P_D$          | Power Dissipation (TC = 25°C)                                                | 151         | 35        | W    |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                      | -55 to +150 |           | °C   |
| $T_L$          | Max. Lead Temperature for Soldering Purpose,<br>1/8" from Case for 5 Seconds | 300         |           | °C   |

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## ■ Thermal Characteristics

| Symbol          | Parameter                               | GSA11N70E | GSP11N70E | Unit                        |
|-----------------|-----------------------------------------|-----------|-----------|-----------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | 1.2       | 1.2       | $^{\circ}\text{C}/\text{W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink Typ.   | 0.5       | 0.5       | $^{\circ}\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62        | 62        | $^{\circ}\text{C}/\text{W}$ |

| Symbol                    | Parameter                         | Value (TO220) | Unit                        |
|---------------------------|-----------------------------------|---------------|-----------------------------|
| $R_{\theta JA}^{(6)}$     | Maximum Junction-to-Ambient       | 82            | $^{\circ}\text{C}/\text{W}$ |
| $R_{\theta CS}^{(6)}$     | Maximum Case-to-sink              | 0.6           | $^{\circ}\text{C}/\text{W}$ |
| $R_{\theta JC}^{(7),(8)}$ | Maximum Junction-to-Case $\theta$ | 4.1           | $^{\circ}\text{C}/\text{W}$ |

1. The power dissipation PD is based on  $T_J(\text{MAX})=150^{\circ}\text{C}$  in a TO251 package, using junction-to-case thermal resistance.
2. Repetitive rating, pulse width limited by junction temperature  $T_J(\text{MAX})=150^{\circ}\text{C}$ .
3.  $L=1\text{mH}$ , Starting  $T_J=25^{\circ}\text{C}$ .
4.  $L=10\text{mH}$ , starting  $T_J=25^{\circ}\text{C}$ .
5.  $L=60\text{mH}$ , starting  $T_J=25^{\circ}\text{C}$ .
6. The tests are performed with the device with  $T_A=25^{\circ}\text{C}$ .
7. The  $R_{\theta JA}$  is the sum of the thermal impedance from junction to case  $R_{\theta JC}$  and case to ambient.
8. These curves are based on the junction-to-case thermal impedance, assuming a maximum junction temperature of  $T_J(\text{MAX})=150^{\circ}\text{C}$ .

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## ■ Electrical Characteristics (T<sub>J</sub>=25° C unless otherwise specified)

| 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°C             | 700 | --       | --     | V        |
|                                                        |                                                       | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA, T <sub>J</sub> = 150°C            | --  | 750      | --     | V        |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>                    | Breakdown Voltage Temperature Coefficient             | I <sub>D</sub> = 250μA, Referenced to 25°C                                      | --  | 0.6      | --     | V/°C     |
| 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°C         | --  | --<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                                    | --  | 0.4      | 0.45   | Ω        |
| g <sub>FS</sub>                                        | Forward Transconductance                              | V <sub>DS</sub> = 40V, I <sub>D</sub> = 5.5A                                    | --  | 16       | --     | S        |
| Dynamic Characteristics                                |                                                       |                                                                                 |     |          |        |          |
| C <sub>iss</sub>                                       | Input Capacitance                                     | V <sub>DS</sub> = 25V, V <sub>GS</sub> = 0V, f = 1.0MHz                         | --  | 720      | -      | pF       |
| C <sub>oss</sub>                                       | Output Capacitance                                    |                                                                                 | --  | 20       | -      | pF       |
| C <sub>rss</sub>                                       | Reverse Transfer Capacitance                          |                                                                                 | --  | 1.5      | --     | 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)  | --  | 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> = 400V, I <sub>D</sub> = 5.5A<br>V <sub>GS</sub> = 10V (Note 4) | --  | 32       | --     | nC       |
| Q <sub>gs</sub>                                        | Gate-Source Charge                                    |                                                                                 | --  | 4        | --     | nC       |
| Q <sub>gd</sub>                                        | Gate-Drain Charge                                     |                                                                                 | --  | 16       | --     | nC       |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                       |                                                                                 |     |          |        |          |
| I <sub>S</sub>                                         | Maximum Continuous Drain-Source Diode Forward Current |                                                                                 | --  | --       | 9.2    | 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>S</sub> = 5.5A                                     | --  | 0.9      | 1.5    | V        |
| t <sub>rr</sub>                                        | Reverse Recovery Time                                 | V <sub>GS</sub> = 0V, I <sub>S</sub> = 5.5A                                     | --  | 280      | --     | ns       |
| Q <sub>rr</sub>                                        | Reverse Recovery Charge                               | dI <sub>F</sub> /dt =100A/μs                                                    | --  | 3.3      | --     | μC       |

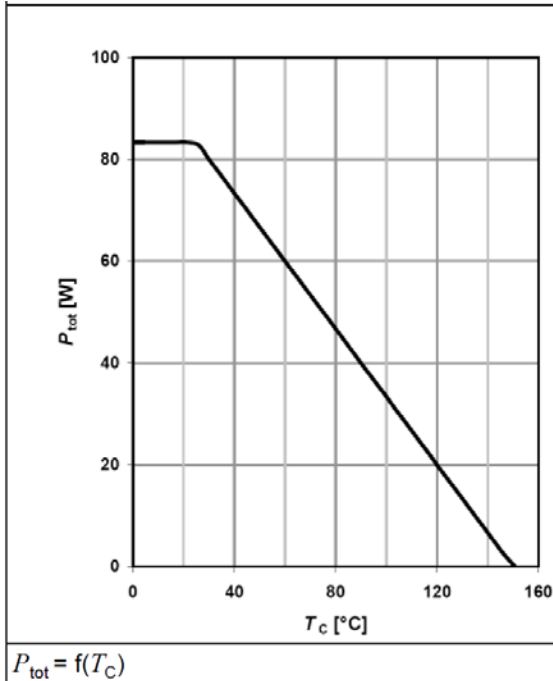
### NOTES:

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. L=60mH, I<sub>AS</sub>=3A, V<sub>DD</sub>=150V, Starting T<sub>J</sub>=25 °C
3. I<sub>SD</sub>≤4.5A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25 °C
4. Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature Typical Characteristics

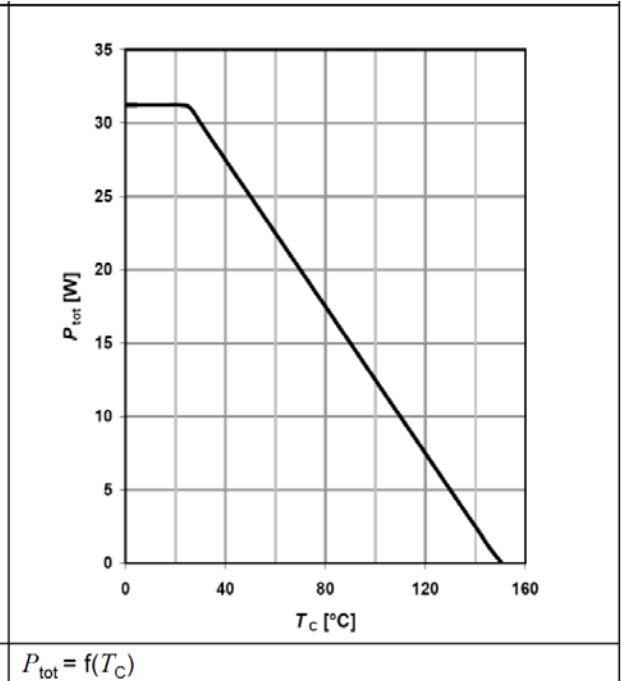
# 700V 11A Power MOSFET

## Typical Performance Characteristics

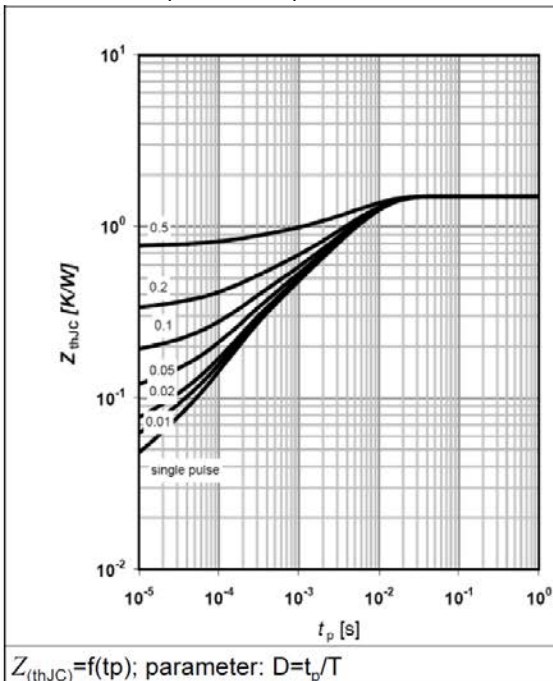
Power dissipation  
TO-220, TO-247, TO-3P



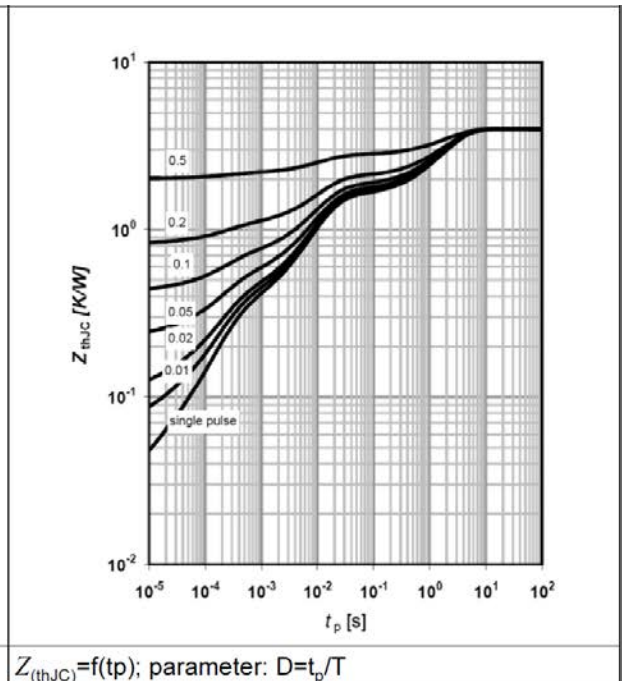
Power dissipation  
TO-220F



Max. transient thermal impedance  
TO-220, TO-247, TO-3P



Max. transient thermal impedance  
TO-220F

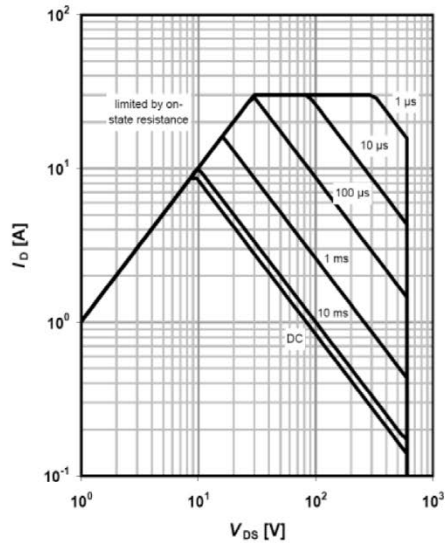


# 700V 11A Power MOSFET

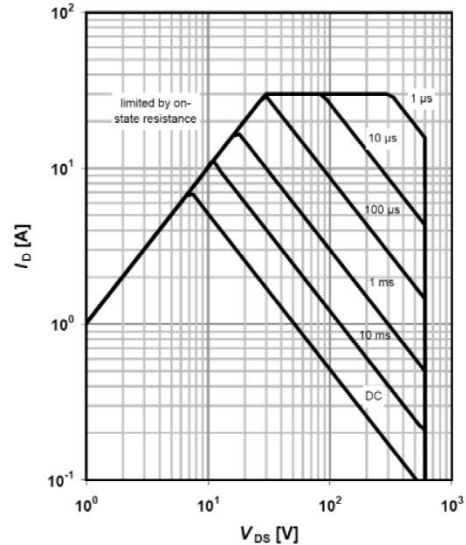
## Typical Performance Characteristics

Safe operating area  $T_C=25\text{ }^{\circ}\text{C}$   
 TO-220, TO-247, TO-3P

Safe operating area  $T_C=25\text{ }^{\circ}\text{C}$   
 TO-220F



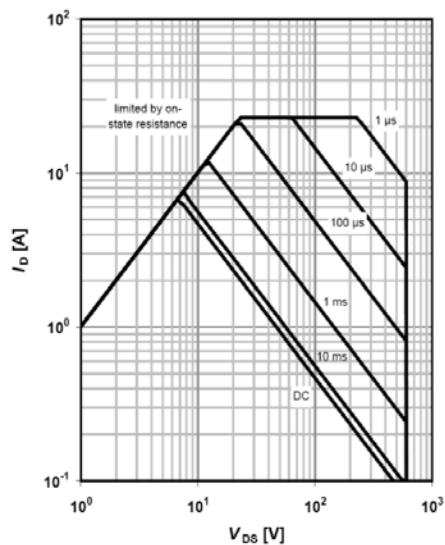
$I_D=f(V_{DS}); T_C=25\text{ }^{\circ}\text{C}; D=0; \text{parameter } t_p$



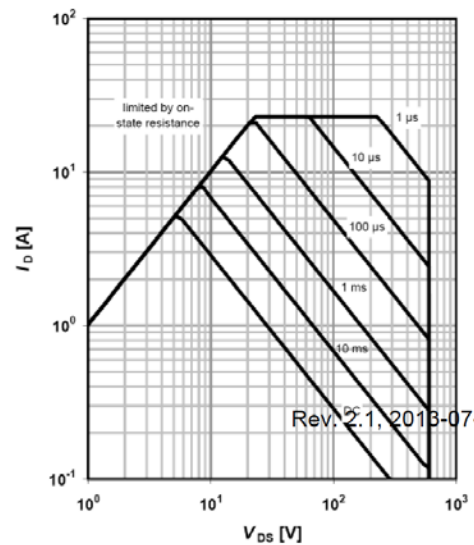
$I_D=f(V_{DS}); T_C=25\text{ }^{\circ}\text{C}; D=0; \text{parameter } t_p$

Safe operating area  $T_C=80\text{ }^{\circ}\text{C}$   
 TO-220, TO-247, TO-3P

Safe operating area  $T_C=80\text{ }^{\circ}\text{C}$   
 TO-220F



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



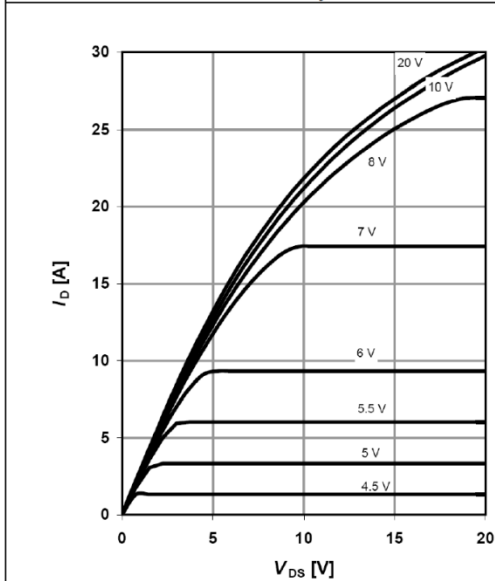
$I_D=f(V_{DS}); T_C=80\text{ }^{\circ}\text{C}; D=0; \text{parameter } t_p$

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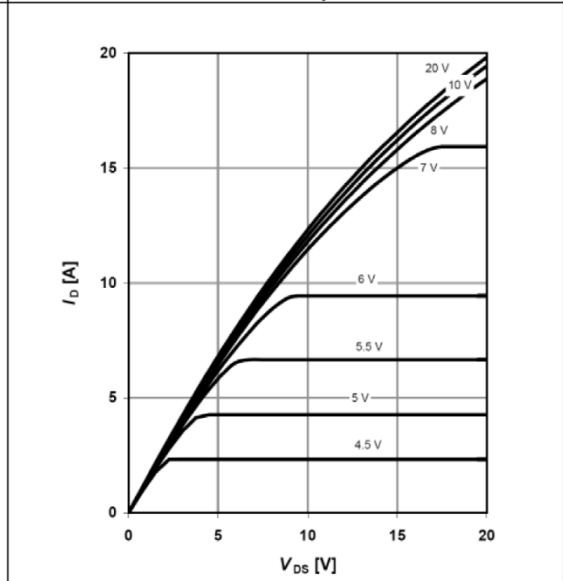
## Typical Performance Characteristics

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



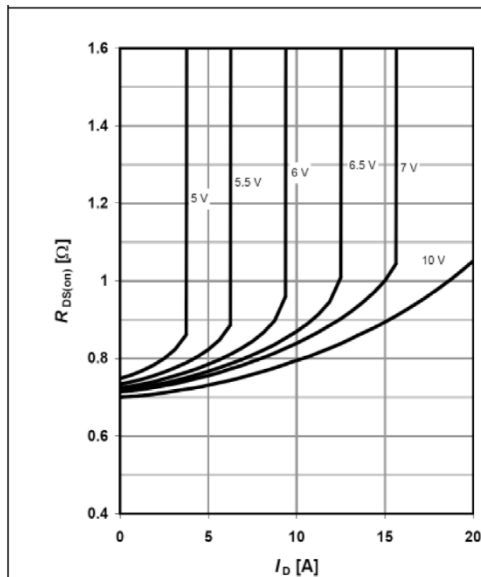
$I_D=f(V_{DS}); T_j=25\text{ }^{\circ}\text{C}; \text{parameter: } V_{GS}$

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



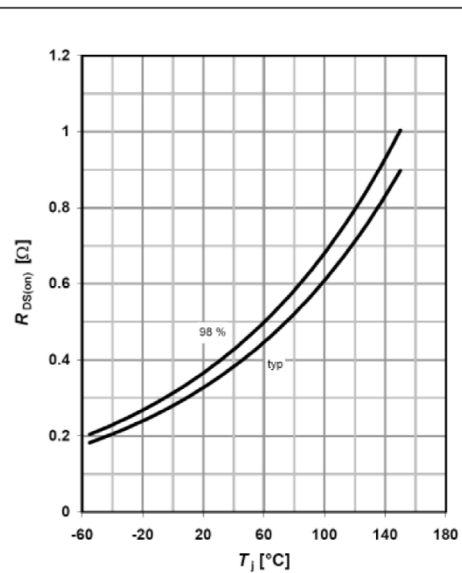
$I_D=f(V_{DS}); T_j=125\text{ }^{\circ}\text{C}; \text{parameter: } V_{GS}$

Typ. drain-source on-state resistance



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

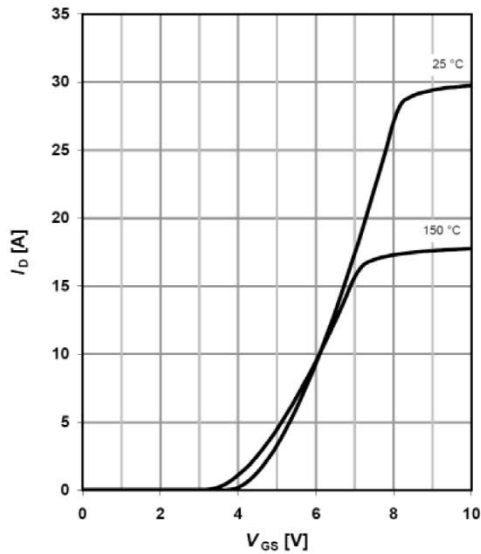
Typ. drain-source on-state resistance



$R_{DS(on)}=f(T_j); I_D=3.8\text{ A}; V_{GS}=10\text{ V}$

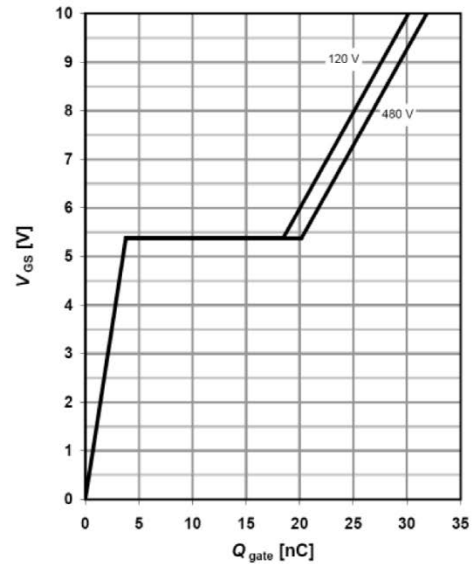
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Typ. transfer characteristics



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

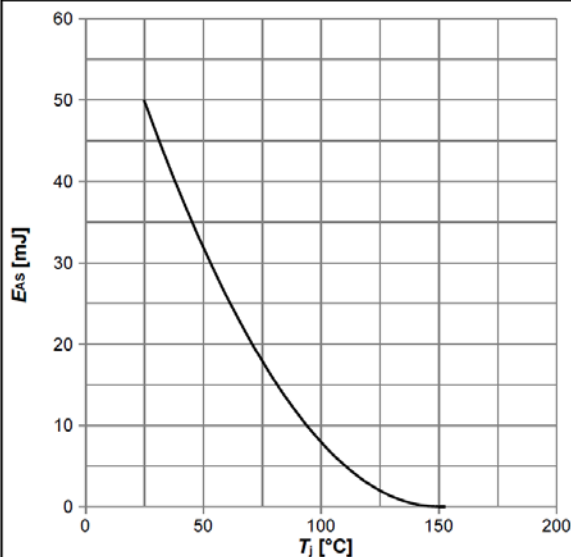
Typ. gate charge



$V_{GS}=f(Q_{gate}), I_D=4.8A$  pulsed

Avalanche energy

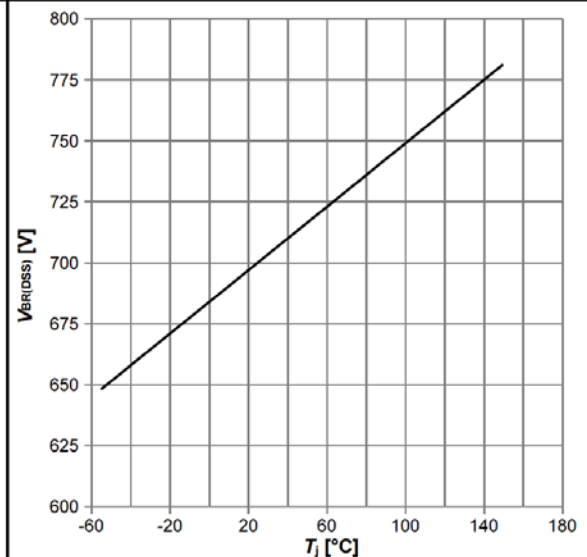
Avalanche energy



$E_{AS}=f(T_j); I_D=1.0 A; V_{DD}=50 V$

Drain-source breakdown voltage

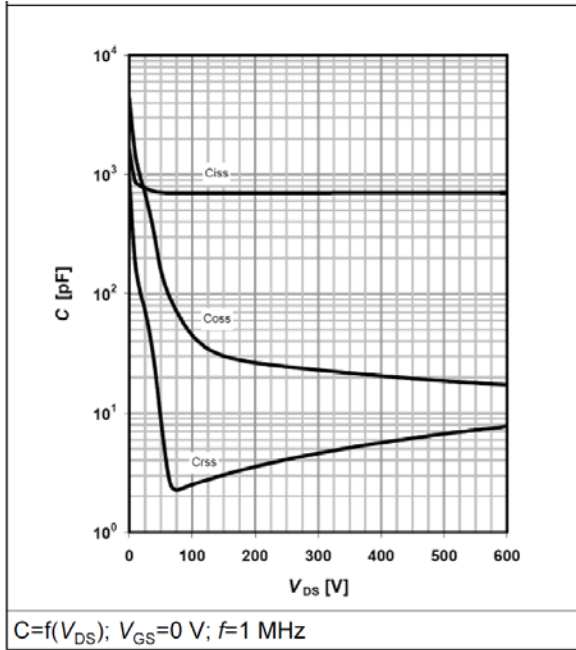
Drain-source breakdown voltage



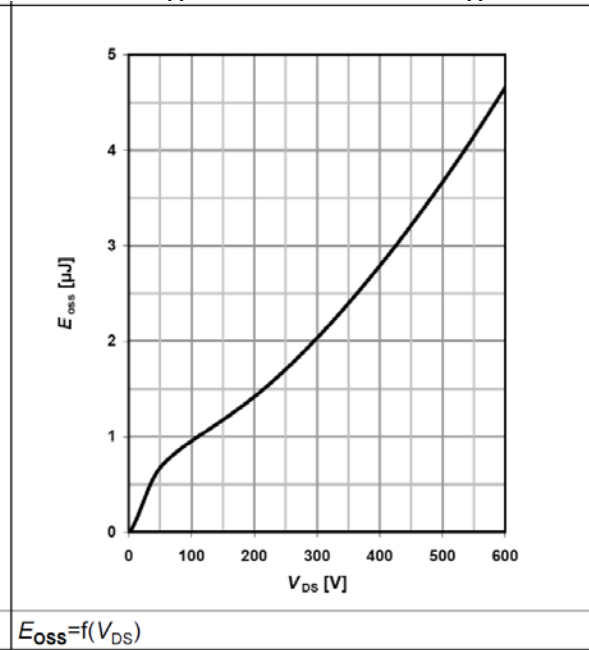
$V_{BR(DSS)}=f(T_j); I_D=1.0 mA$

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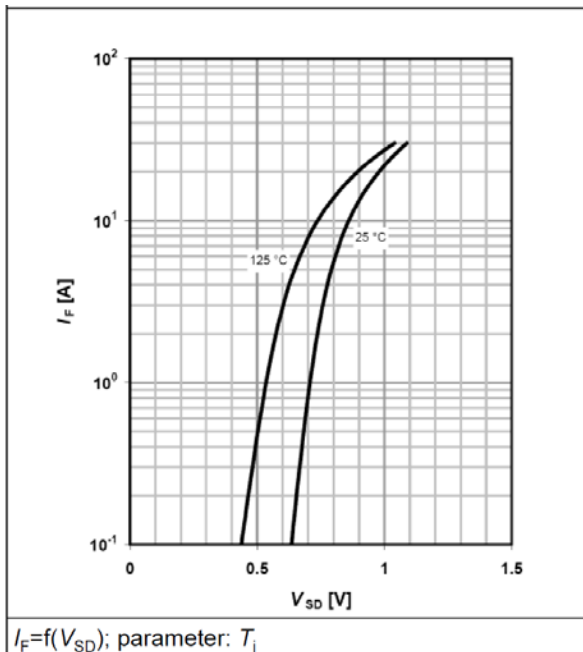
Typ. capacitances



Typ.  $C_{oss}$  stored energy

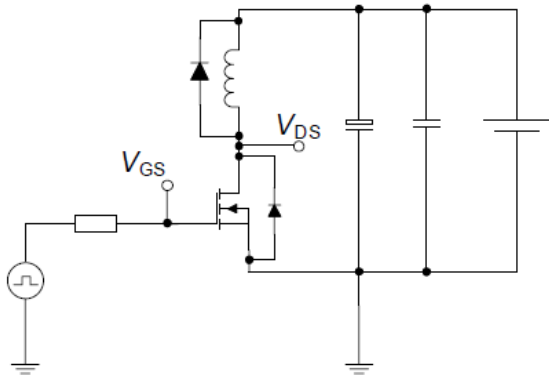
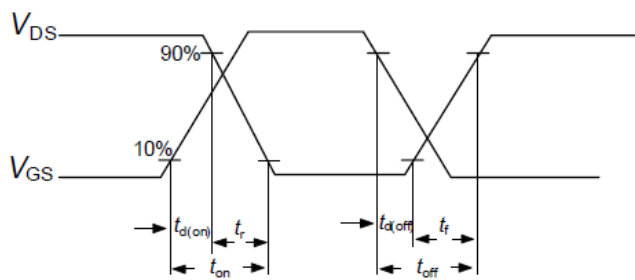


Forward characteristics of reverse diode

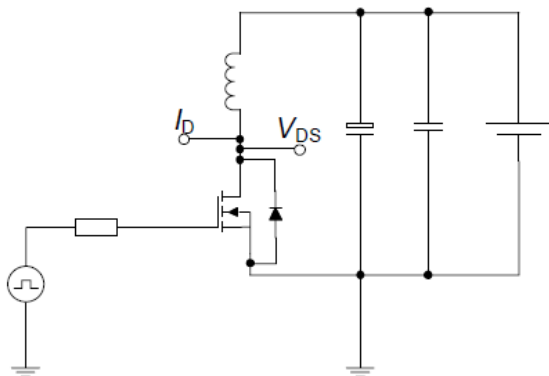
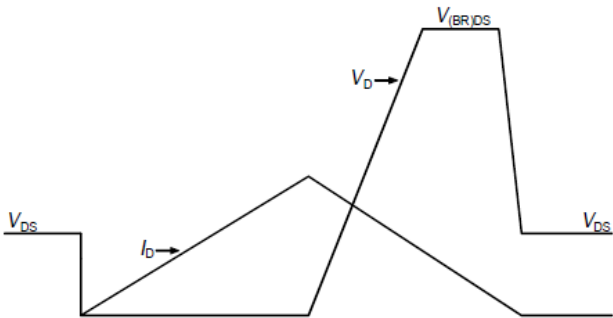


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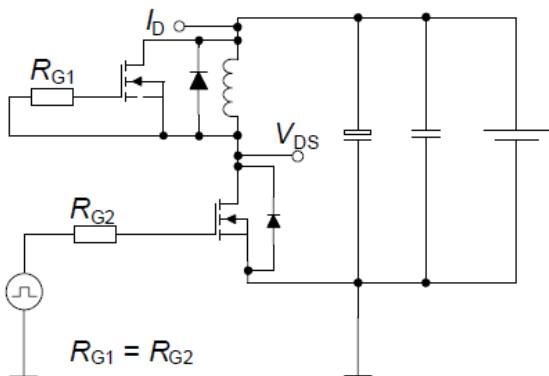
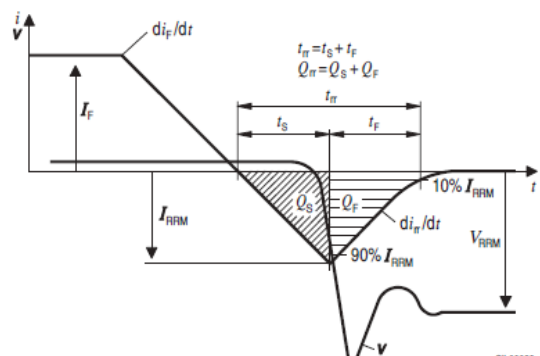
**Table 20** Switching times test circuit and waveform for inductive load

| Switching times test circuit for inductive load                                  | Switching time waveform                                                            |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|  |  |

**Table 21** Unclamped inductive load test circuit and waveform

| Unclamped inductive load test circuit                                             | Unclamped inductive waveform                                                         |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  |  |

**Table 22** Test circuit and waveform for diode characteristics

| Test circuit for diode characteristics                                                                                 | Diode recovery waveform                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><math>R_{G1} = R_{G2}</math></p> |  <p><math>t_{rr} = t_s + t_f</math><br/><math>Q_{rr} = Q_s + Q_f</math></p> <p><math>I_{RRM}</math>, <math>V_{RRM}</math>, <math>10\% I_{RRM}</math>, <math>90\% I_{RRM}</math></p> <p><math>di_F/dt</math>, <math>I_F</math>, <math>t_s</math>, <math>t_{rr}</math>, <math>t_f</math>, <math>t_{tr}</math></p> <p><math>Q_s</math>, <math>Q_f</math></p> <p><math>di_{rr}/dt</math></p> <p>SIL00088</p> |