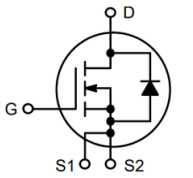
# 40mΩ, 1200V, Silicon Carbide N-Channel Power MOSFET

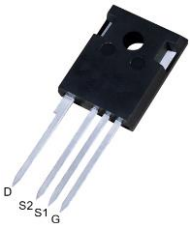
## Description

The LXP SEMI LX1C040N120BY silicon carbide Power MOSFET device has been developed using LXP's advanced and innovative 1st generation SiC MOSFET technology. The device features a very low $R_{DS(on)}$ over the entire temperature range combined with low capacitances and good switching performance, which improve application performance in frequency, energy efficiency, system size and weight reduction.

## Key Features

- Typ. $R_{DS(on)}$ = 40mΩ @ $V_{GS}$ = 18V
- High speed switching performances
- Low Switching Losses
- 100% Avalanche Tested
- EMI Improved Design
- Very fast and robust intrinsic body diode




TO-247-4

## Applications

- DC/DC converter for EV/HEV
- On board charger (OBC)
- Solar Inverters
- Energy Storage Systems
- SMPS (Switch Mode Power Supplies)

## Key performance

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS(T_j=25°C)}$ | 1200 | V |
| $R_{DS(on),\ typ(T_j=25°C,\ I_D=24A,\ V_{GS}=18V)}$ | 40 | mΩ |
| $I_{D(Tj=25°C)}$ | 59 | A |
| $T_{j,\ max}$ | 175 | °C |

## Package Feature

| Order code | Marking | Package | Packing |
|---|---|---|---|
| **LX1C040N120BY** | **LX1C040N120B** | **TO-247-4PIN** | **Tube** |

## 1.Maximum Ratings ($T_j$=25°C unless otherwise specified)

| Parameter | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DSS}$ | 1200 | V |
| Gate-Source Voltage | | $V_{GSS}$ | -10/+22 | V |
| Gate-Source Voltage Recommended Operation Values | | $V_{GSS}$ | -5/+18 | V |
| Gate-Source Transient Voltage ($t_p$ < 1μs, t ≤ 10 hours) | | $V_{GSS}$ | -11/+25 | V |
| Continuous Drain Current | $T_C$ = 25ºC | $I_D$ | 59 | A |
| | $T_C$ = 100ºC | | 42 | |
| Pulsed Drain Current (Note 2) | | $I_{DM}$ | 195 | A |
| Avalanche Energy, Single Pulse (Note 3) | | $E_{AS}$ | 312 | mJ |
| Avalanche Current, Repetitive (Note 2) | | $I_{AR}$ | 25 | A |
| Continuous Diode Forward Current | | $I_S$ | 59 | A |
| Power Dissipation | | $P_{tot}$ | 357 | W |
| Operating Temperature/ Storage Temperature | | $T_J$ | -55~175 | ºC |

Note:

1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. Repetitive Rating: Pulse width limited by maximum junction temperature
3. L = 1mH, $I_{AS}$ = 25A, $V_{DD}$ = 120V, $V_{GS}$ = 18V, $R_g$ = 25Ω, Starting $T_J$ = 25°C

## 2.Thermal characteristics

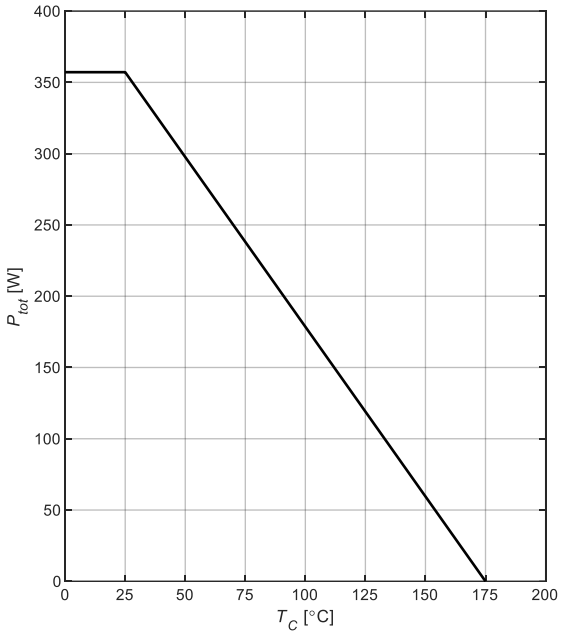
| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance, junction-to-case | $R_{thJC}$ | 0.42 | °C/W |
| Thermal resistance, junction-to-ambient | $R_{thJA}$ | 45 | °C/W |

## 3.Electrical Characteristics ($T_j$=25°C unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Statistic Characteristics** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 100 μA | 1200 | 1500 | | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | | 1 | 10 | μA |
| Gate-Source Leakage Current | $I_{GSSF}$ | $V_{GS}$ = 22 V, $V_{DS}$ = 0 V | | | 100 | nA |
| | $I_{GSSR}$ | $V_{GS}$ = -10 V, $V_{DS}$ = 0 V | | | -100 | nA |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 10 mA | 2.1 | 2.8 | 3.5 | V |
| Static Drain-Source On-Resistance | $R_{DS(on)}$ | $V_{GS}$ = 18 V, $I_D$ = 24 A | | 40 | 50 | mΩ |
| | | $V_{GS}$ = 18 V, $I_D$ = 24 A, $T_j$ =150 ºC | | 55 | | |
| | | $V_{GS}$ = 18 V, $I_D$ = 24 A, $T_j$ =175 ºC | | 60 | | |
| | | $V_{GS}$ = 15 V, $I_D$ = 24 A | | 55 | 70 | |
| | | $V_{GS}$ = 15 V, $I_D$ = 24 A, $T_j$ =150 ºC | | 65 | | |
| | | $V_{GS}$ = 15 V, $I_D$ = 24 A, $T_j$ =175 ºC | | 70 | | |
| Gate Resistance | $R_G$ | f = 1 MHz，open drain | | 3 | | Ω |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V<br>$V_{DS}$ = 800 V<br>f = 1 MHz | | 3250 | | pF |
| Output Capacitance | $C_{OSS}$ | | | 120 | | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | 9 | | |
| Gate to Source Charge | $Q_{gs}$ | $V_{DS}$ = 800 V<br>$V_{GS}$ = -5 to 18 V<br>$I_D$ = 24 A | | 53 | | nC |
| Gate to Drain Charge | $Q_{gd}$ | | | 27 | | |
| Gate Charge Total | $Q_g$ | | | 128 | | |
| **Switching Characteristics** | | | | | | |
| Turn-on delay time | $T_{d(on)}$ | $V_{DD}$ = 800 V, $I_D$ = 24 A,<br>$R_G$ =2.4 Ω, $V_{GS}$ = -5/+18 V | | 20 | | ns |
| Rise time | $T_r$ | | | 25 | | |
| Turn-off delay time | $T_{d(off)}$ | | | 30 | | |
| Fall time | $T_f$ | | | 12 | | |
| Turn-on switching energy | $E_{on}$ | | | 275 | | μJ |
| Turn-off switching energy | $E_{off}$ | | | 60 | | |
| **Reverse Diode Characteristics** | | | | | | |
| Diode Forward Voltage | $V_{SD}$ | $V_{GS}$ = -5 V, $I_{SD}$ = 24 A | | 3.6 | | V |
| | | $V_{GS}$ = -5 V, $I_{SD}$ = 24 A, Tj=175 ºC | | 3.3 | | |
| Reverse Recovery Time | $t_{rr}$ | $V_R$ = 800 V, $I_F$ = 24 A,<br>di/dt =1000 A/μs | | 23 | | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | | 130 | | nC |
| Peak Reverse Recovery Current | $I_{rrm}$ | | | 12 | | A |

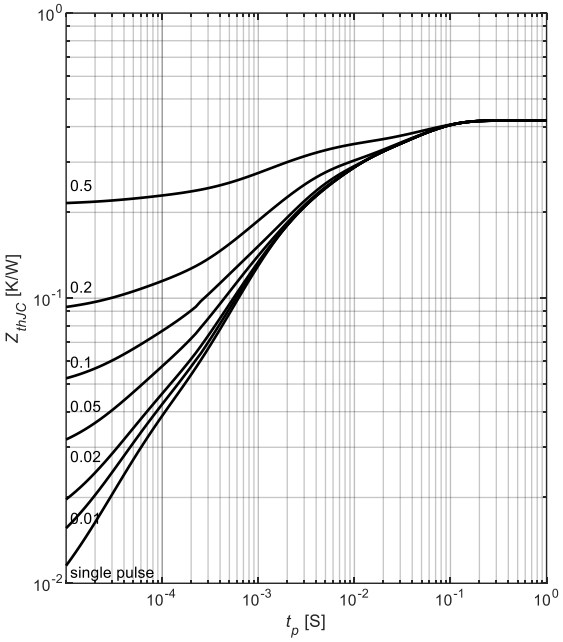
## 4.Electrical characteristic curves

Figure 1: Power dissipation



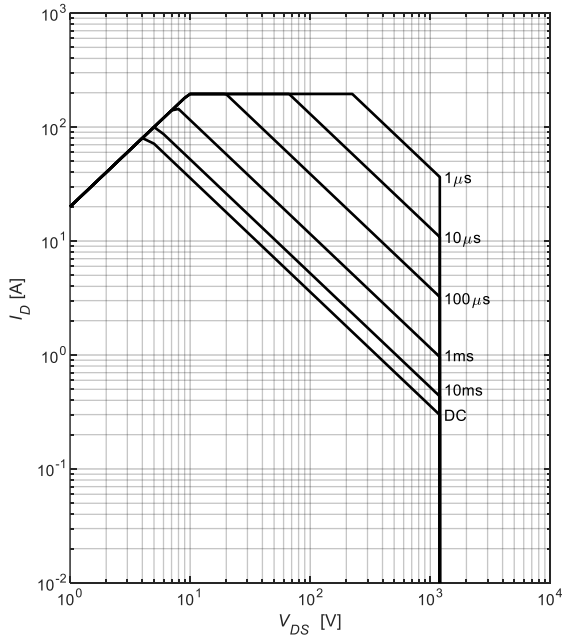

$P_{tot}=f(T_c)$

Figure 2: Transient thermal impedance



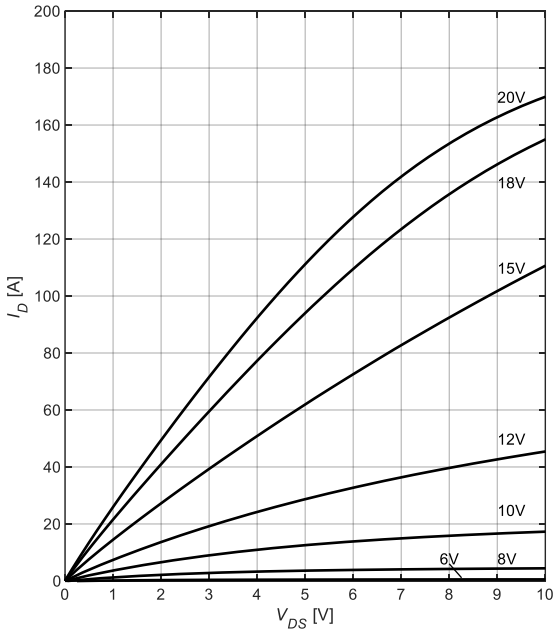

$Z(_{thJC})=f(t_p)$; parameter: $D=t_p/T$

Figure 3: Safe operating area



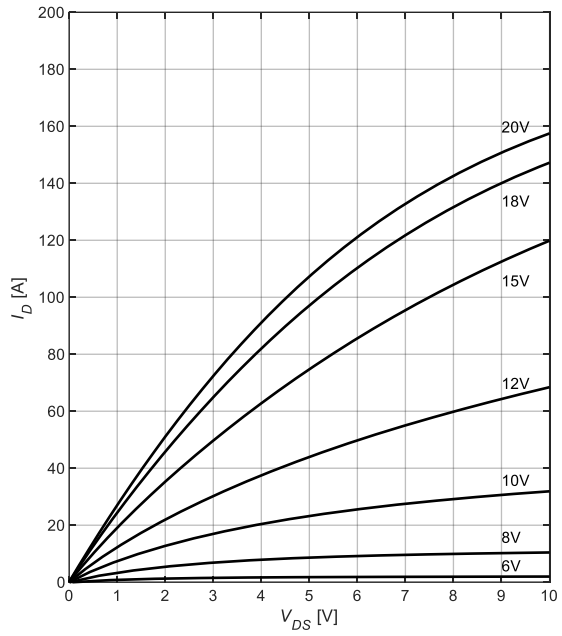

$I_D=f(V_{DS})$; $T_c=25℃$; $V_{GS}>7.5V$; parameter $t_p$

Figure 4: Typ. output characteristics



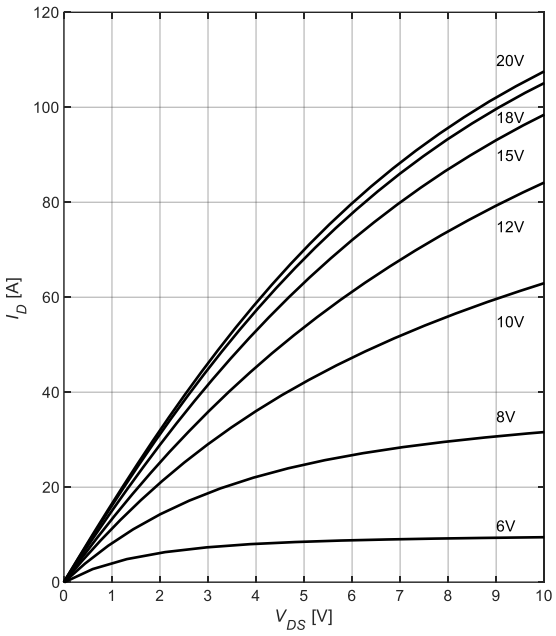

$I_D=f(V_{DS})$; $T_j=-55℃$; parameter: $V_{GS}$

Figure 5: Typ. output characteristics



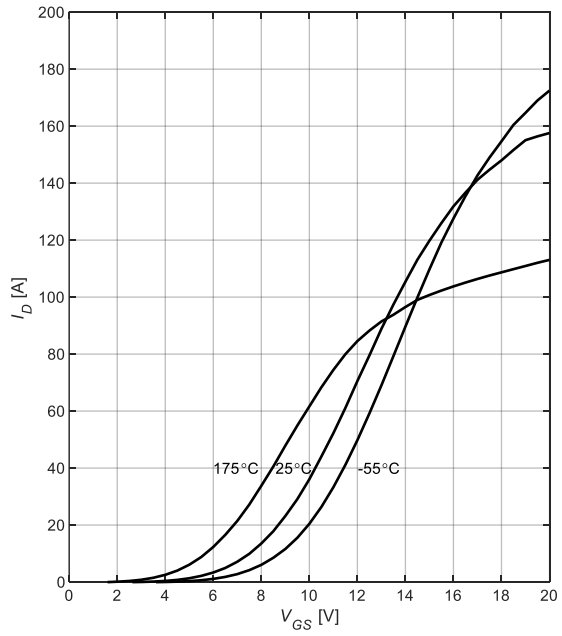

$I_D=f(V_{DS})$; $T_j=25℃$; parameter: $V_{GS}$

Figure 6: Typ. output characteristics



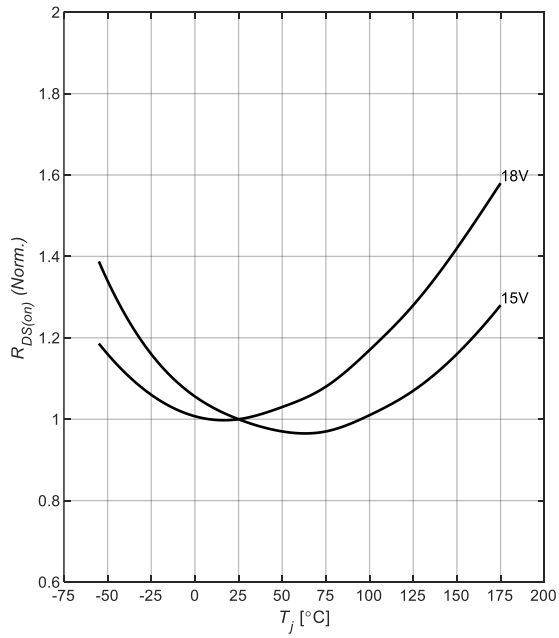

$I_D=f(V_{DS})$; $T_j=175℃$; parameter: $V_{GS}$

Figure 7: Typ. transfer characteristics



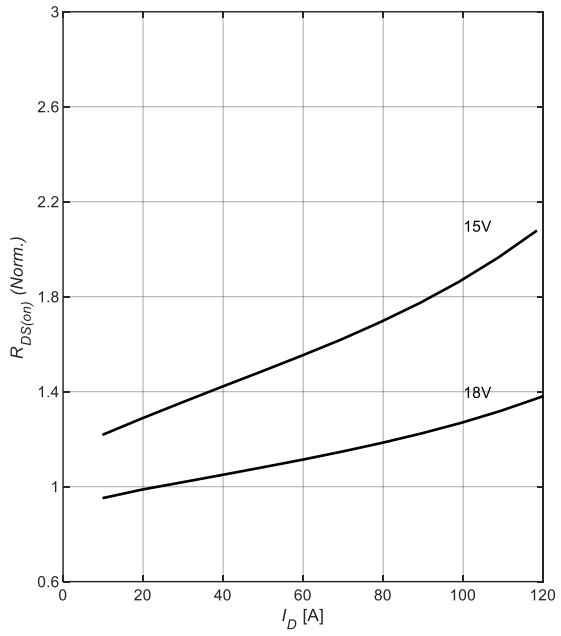

$I_D=f(V_{GS})$; $V_{DS}=10V$; parameter: $T_j$

Figure 8: Norm. Drain-Source On-State Resistance



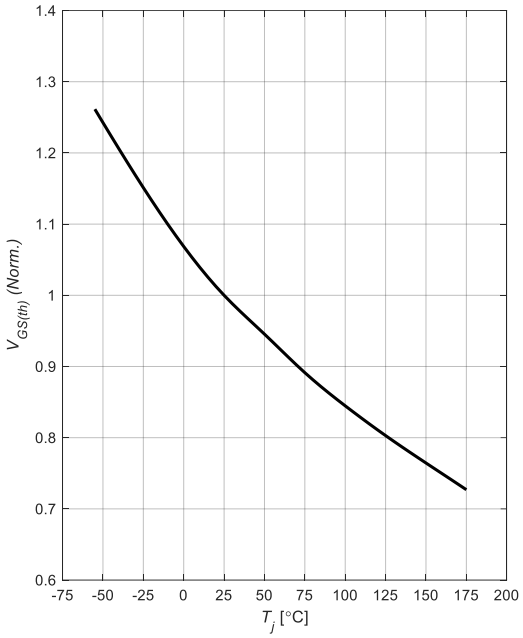

$R_{DS(on)}=f(T_j)$; $I_D=24A$; parameter: $V_{GS}$

Figure 9: Norm. Drain-Source On-State Resistance



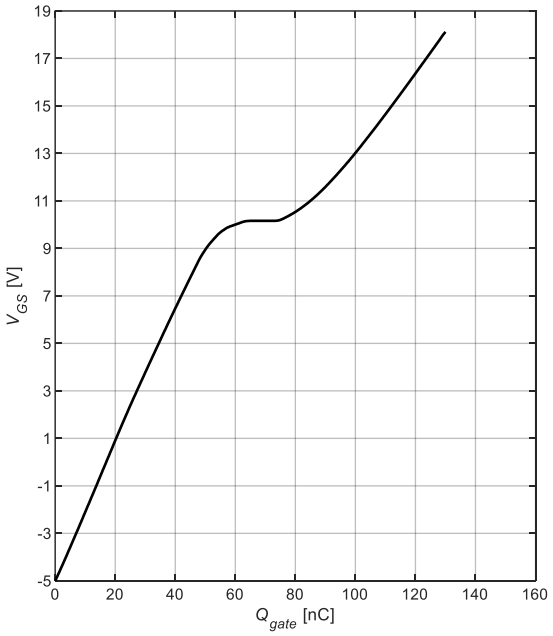

$R_{DS(on)}=f(I_D)$; $T_j=25℃$; parameter: $V_{GS}$

Figure 10: Norm. gate threshold voltage



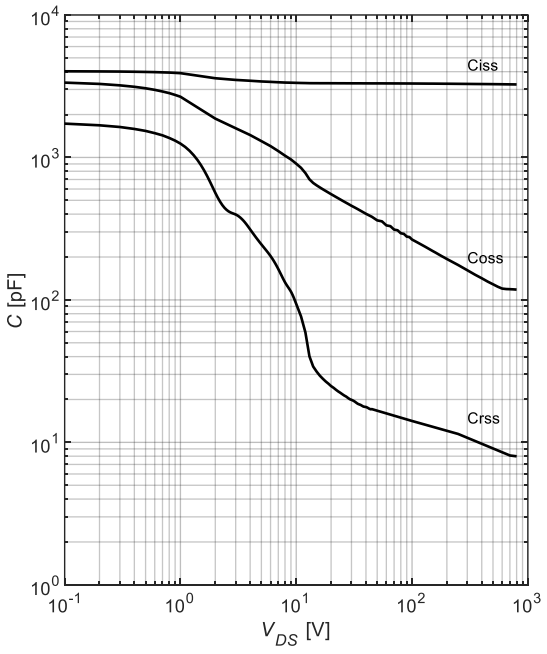

$V_{GS(th)}=f(T_j)$; $V_{DS}=V_{GS}$, $I_D=10mA$

Figure 11: Typ. gate charge



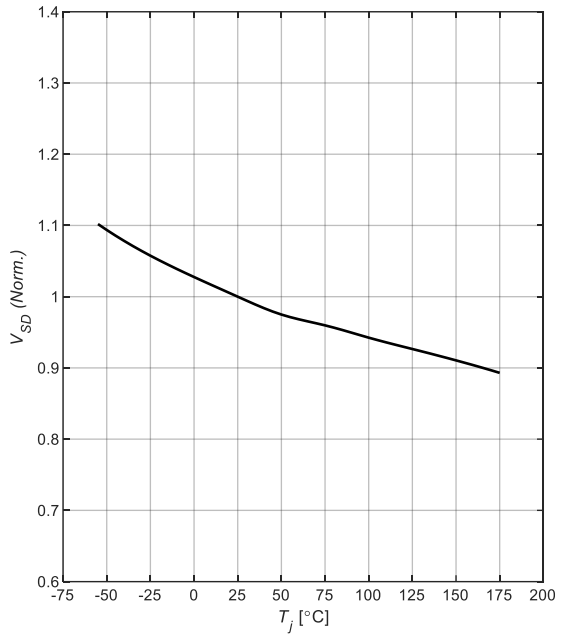

$V_{GS}=f(Q_{gate})$, $V_{DS}=800V$, $I_D=24A$ pulsed

Figure 12: Typ. capacitances



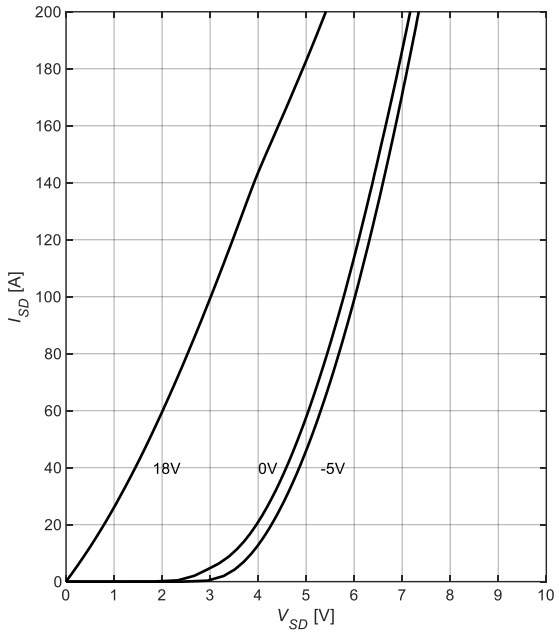

$C=f(V_{DS})$; $V_{GS}=0$; f=1MHz

Figure 13: Norm. reverse diode forward voltage



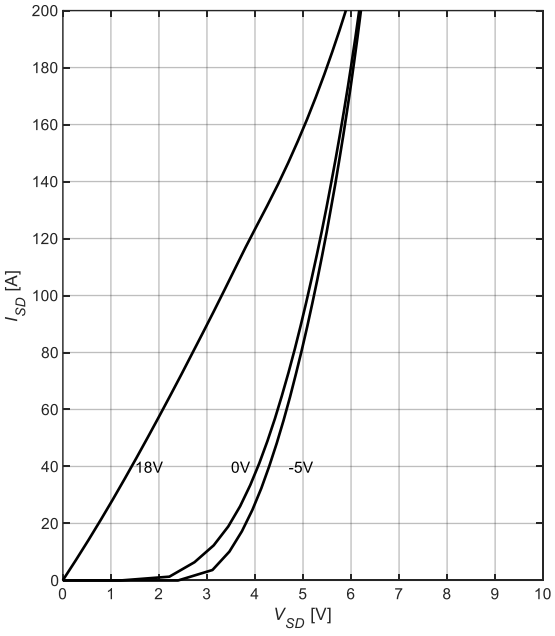

$V_{SD}=f(T_j)$; $I_{SD}=24A$; $V_{GS}=-5V$

Figure 14: Typ. reverse conduction characteristics



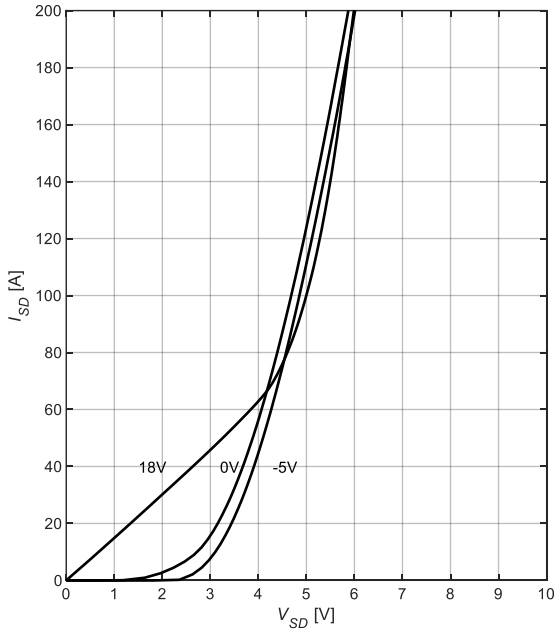

$I_{SD}=f(V_{SD})$; $T_j=-55℃$; parameter: $V_{GS}$

Figure 15: Typ. reverse conduction characteristics



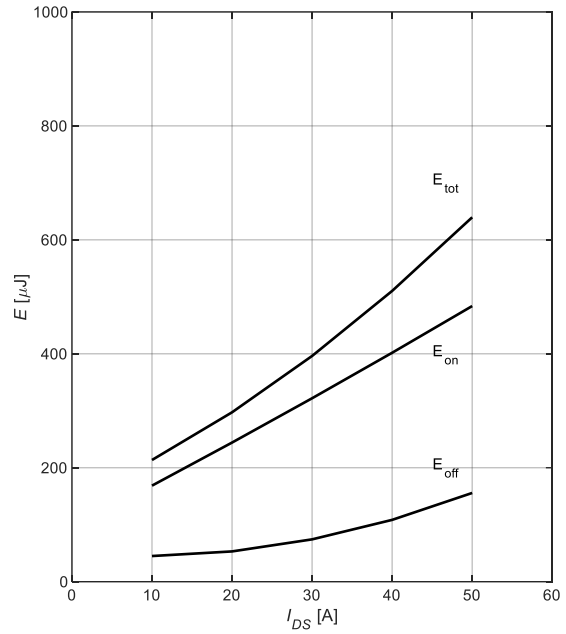

$I_{SD}=f(V_{SD})$; $T_j=25℃$; parameter: $V_{GS}$

Figure 16: Typ. reverse conduction characteristics



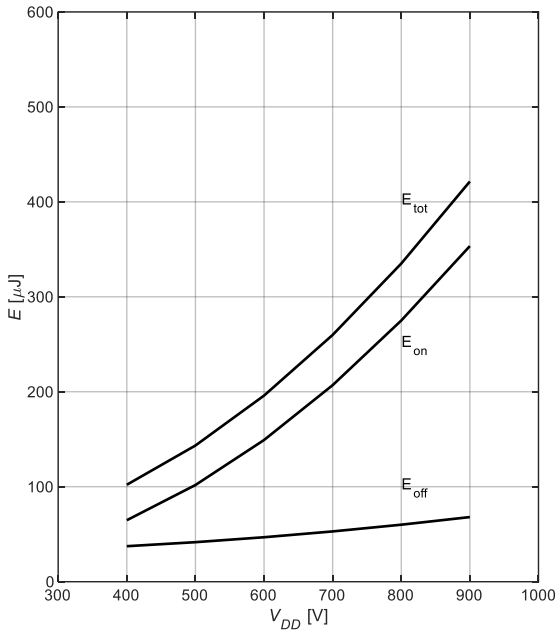

$I_{SD}=f(V_{SD})$; $T_j=175℃$; parameter: $V_{GS}$

Figure 17: Typ. switching energy losses



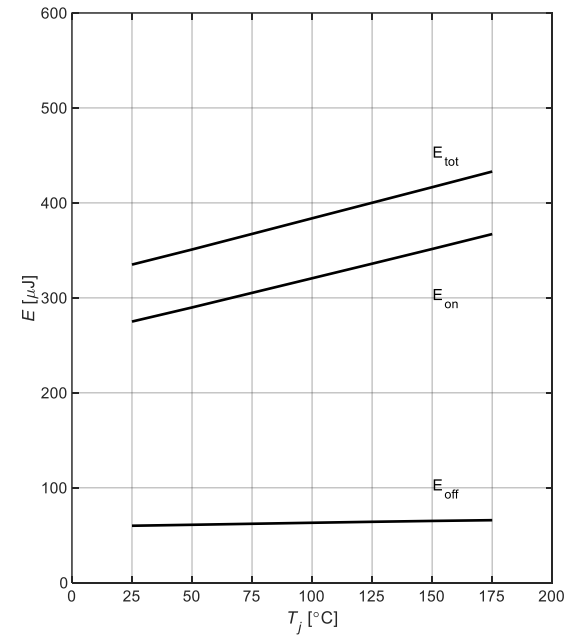

E=f($I_{DS}$); $V_{DD}$=800V; $V_{GS}$=-5/+18V; $R_G$ =2.4Ω; $T_j$= 25°C

Figure 18: Typ. switching energy losses



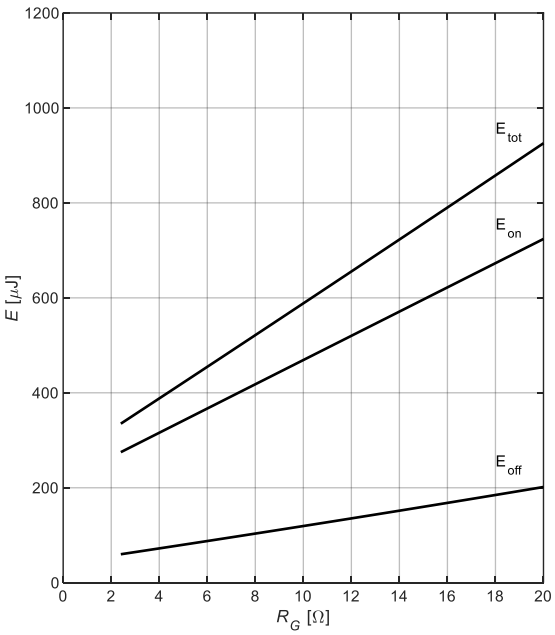

E=f($V_{DD}$); $V_{GS}$=-5/+18V; $R_G$ =2.4Ω; $I_D$=24A

Figure 19: Typ. switching energy losses




E=f($T_j$); $V_{DD}$=800V; $V_{GS}$=-5/+18V; $R_G$ =2.4Ω; $I_D$=24A

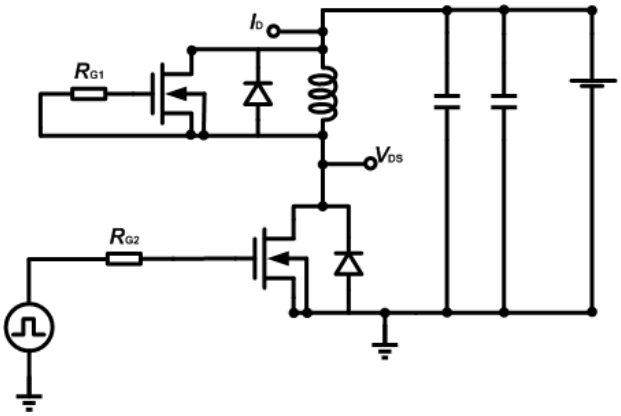
Figure 20: Typ. switching energy losses

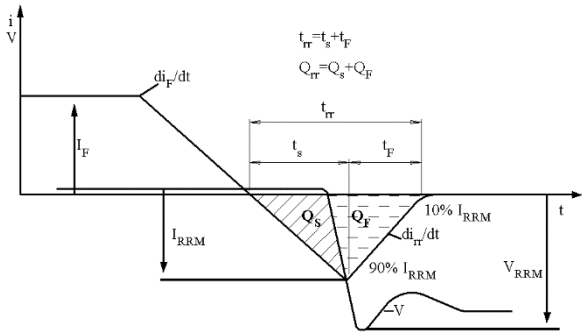



E=f($R_G$); $V_{DD}$=800V; $V_{GS}$=-5/+18V; $I_D$=24A

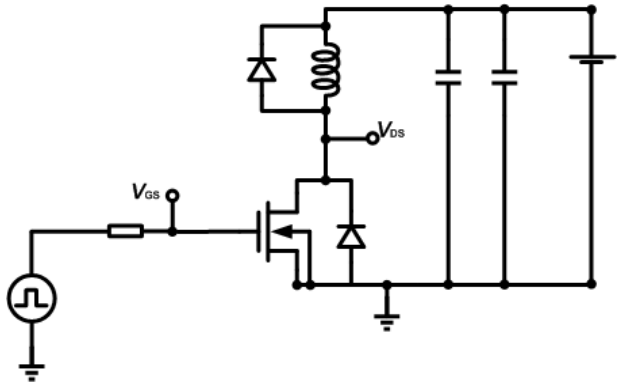
## 5.Test Circuits

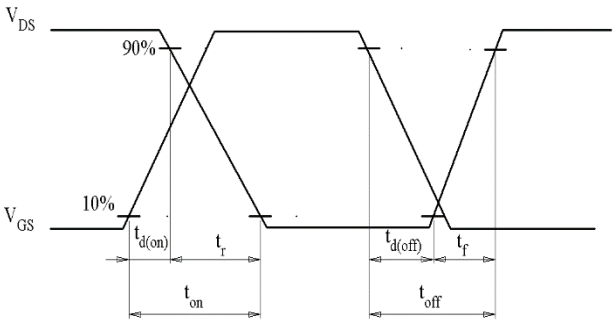
### 1) Test circuit and waveform for diode characteristics



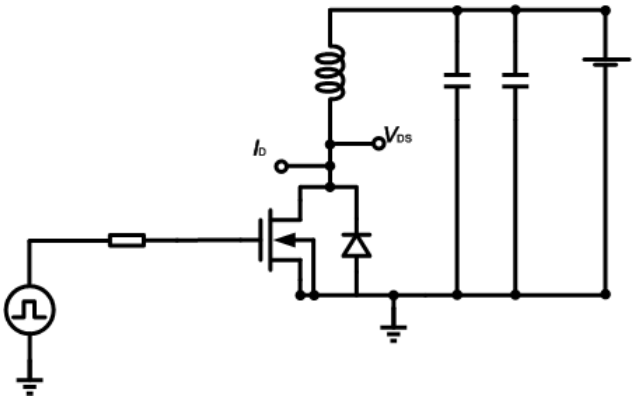



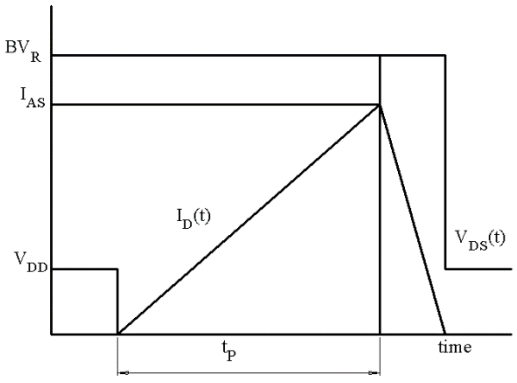

### 2) Switch time test circuit



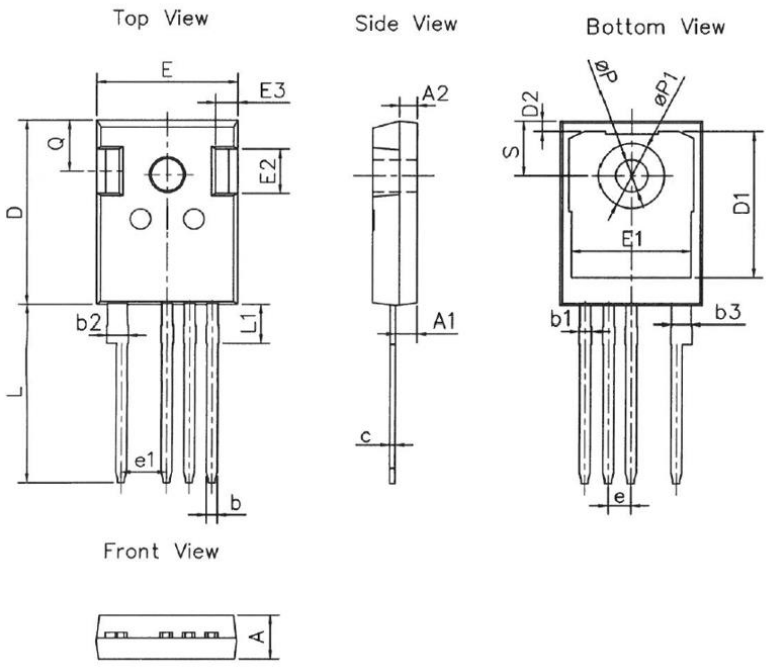




### 3) Unclaimed inductive switching test circuit & waveforms



## 6.Package outline dimensions




| Dimension unit:[mm] | | | |
|---|---|---|---|
| SYMBOL | MIN | NOM | MAX |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.21 | 2.41 | 2.61 |
| A2 | 1.85 | 2.00 | 2.15 |
| b | 1.11 | 1.21 | 1.36 |
| b1 | 1.11 | 1.37 | 1.57 |
| b2 | 2.24 | 2.40 | 2.60 |
| b3 | 2.11 | 2.21 | 2.36 |
| c | 0.51 | 0.60 | 0.75 |
| D | 20.70 | 20.90 | 21.30 |
| D1 | 15.92 | 16.22 | 16.52 |
| D2 | 1.00 | 1.20 | 1.35 |
| E | 15.50 | 15.80 | 16.10 |
| E1 | 13.00 | 13.30 | 13.60 |
| E2 | 4.80 | 5.00 | 5.20 |
| E3 | 2.30 | 2.50 | 2.70 |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| L | 19.62 | 19.92 | 20.22 |
| L1 | – | – | 4.30 |
| øP | 3.40 | 3.60 | 3.80 |
| øP1 | – | – | 7.30 |
| Q | 5.40 | 5.80 | 6.20 |
| S | 6.20 BSC | | |

## 7.Revision History

| Revision | Description | Date |
|---|---|---|
| 1.0 | Initial version | 2023/12/06 |
| | | |

## IMPORTANT NOTICE

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