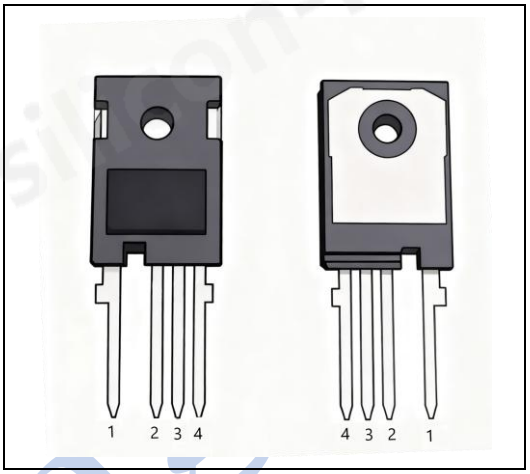
# N-Channel Silicon Carbide Power MOSFET

TO247-4L




## Product summary

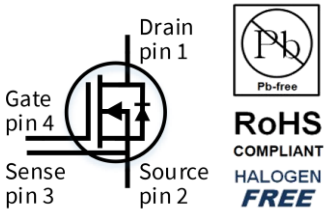
| $V_{DS}$ (V) | $R_{DS(on),typ}$ (mΩ) | $I_D$ (A) |
|---|---|---|
| 1200 | 21 @ $V_{GS}$ = 18 V | 90 |

## Features

- Silicon carbide material with excellent characteristics
- High blocking voltage with low $R_{DS(on)}$
- Fast switching speed with low capacitance
- Low reverse recovery charge
- High power density, system switching frequency and efficiency.

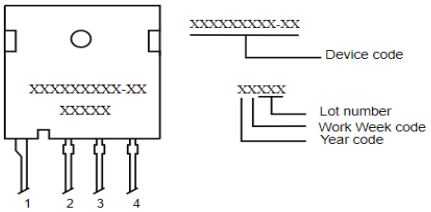
## Applications

- EV battery charger
- High voltage DC/DC converter
- Solar inverters
- Energy storage system







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## Package and ordering information

| Ordering code | Package | Device code |
|---|---|---|
| SCHA2N021JN-AA | TO247-4L | HA2N021JN-AA |

## 1. Maximum ratings

Absolute maximum ratings ($T_C$ = 25℃ unless otherwise specified)

| Parameter | | Symbol | Limit | Unit |
|---|---|---|---|---|
| Drain-source voltage | | $V_{DS}$ | 1200 | V |
| Gate-source voltage | | $V_{GSmax}$ | -10/+22 | |
| Recommended Operation values of Gate-Source voltage | | $V_{GSop}$ | -5...-3/+18 | V |
| Continuous drain current(1) | $V_{GS}$=18 V, $T_C$=25℃ | $I_D$ | 90 | A |
| | $V_{GS}$=18 V, $T_C$=100℃ | | 64 | |
| Pulsed drain current(2) | | $I_{D,pulse}$ | 223 | |
| Power dissipation | $T_C$=25℃ | $P_D$ | 375 | W |
| | $T_C$=100℃ | | 188 | |
| Operating junction and storage temperature range | | $T_J$, $T_{stg}$ | -55 to 175 | ℃ |
| Soldering temperature | | $T_{solder}$ | 260 | |
| Single Pulse Drain–to–Source Avalanche Energy(3) | | $E_{AS}$ | 435 | mJ |

## 2. Thermal resistance ratings

| Thermal resistance ratings | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Max.** | **Unit** |
| Thermal resistance, junction-to-case | Steady state | $R_{\theta JC}$ | 0.40 | ℃/W |

## 3. Electrical Characteristics

| Electrical characteristics ($T_C$ = 25 ℃ unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Test conditions** | **Min.** | **Typ.** | **Max.** | **Unit** |
| **Static parameter** | | | | | | |
| Drain to source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 1200 | | | V |
| Gate-source threshold voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 17 mA | 2.0 | 3.0 | 4.5 | V |
| | | $V_{DS}$ = $V_{GS}$, $I_D$ = 17 mA, $T_J$ = 175 ℃ | | 1.9 | | |
| Gate-body leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = -10/+22 V | | | ±100 | nA |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | | | 100 | μA |
| Drain-source on-resistance | $R_{DS(on)}$ | $V_{GS}$ = 18 V, $I_D$ = 45 A | | 21.0 | 29.4 | mΩ |
| | | $V_{GS}$ = 15 V, $I_D$ = 45 A | | 27.5 | | |
| | | $V_{GS}$ = 18 V, $I_D$ = 45 A, $T_J$ = 175 ℃ | | 33.6 | | |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 20 V, $I_D$ = 45 A | | 30.4 | | S |
| | | $V_{DS}$ = 20 V, $I_D$ = 45 A, $T_J$ = 175 ℃ | | 30.6 | | |
| Gate resistance | $R_g$ | f=1 MHz | | 2.5 | | Ω |
| **Dynamic**[4] | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{DS}$ = 800 V, $V_{GS}$ = 0 V, f = 100 kHz | | 2996 | | pF |
| Output capacitance | $C_{oss}$ | | | 179 | | |
| Reverse transfer capacitance | $C_{rss}$ | | | 5 | | |
| Total gate charge | $Q_g$ | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/+18 V, $I_D$ = 45 A | | 135 | | nC |
| Gate-source charge | $Q_{gs}$ | | | 38 | | |
| Gate-drain charge | $Q_{gd}$ | | | 50 | | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DS}$ = 800 V, $I_D$ = 45 A, $V_{GS}$ = -4 V/+18 V, $R_{GEN}$ = 5.6 Ω, L = 84 uH, $L_\sigma$=40 nH, Timing relative to VDS, Inductive load | | 20 | | ns |
| Rise time | $t_r$ | | | 28 | | |
| Turn-off delay time | $t_{d(off)}$ | | | 40 | | |
| Fall time | $t_f$ | | | 11 | | |
| Turn-On Switching Energy (SiC Diode FWD) | $E_{on}$ | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/+18 V, $I_D$ = 45 A, $R_{GEN}$ = 5.6 Ω, L = 84 uH, $L_\sigma$=40 nH, $T_J$ = 25 ℃ | | 819 | | μJ |
| Turn Off Switching Energy (SiC Diode FWD) | $E_{off}$ | | | 268 | | |
| **Reverse Diode Characteristics** | | | | | | |
| Diode forward voltage | $V_{SD}$ | $V_{GS}$ =-3 V, $I_F$ = 45 A | | 4.1 | | V |
| | | $V_{GS}$ =-3 V, $I_F$ = 45 A, $T_J$ = 175 ℃ | | 3.5 | | |
| Reverse recovery time | $t_{rr}$ | $V_{GS}$ =-3 V, $V_{DS}$ = 800 V, $I_F$ = 45 A, di/dt = 3000 A/μs, $T_J$ = 25 ℃ | | 20 | | ns |
| Reverse recovery charge | $Q_{rr}$ | | | 396 | | nC |
| Peak reverse recovery current | $I_{rrm}$ | | | 32 | | A |

Notes

(1) Package limited.

(2) Pulse width limited by maximum junction temperature.

(3) EAS of 435 mJ is based on starting TJ = 25°C; L = 1 mH.

(4) Guaranteed by design, not subject to production testing.

## 4. Electrical characteristics diagrams

Fig.1 Typ. output characteristics at -55℃

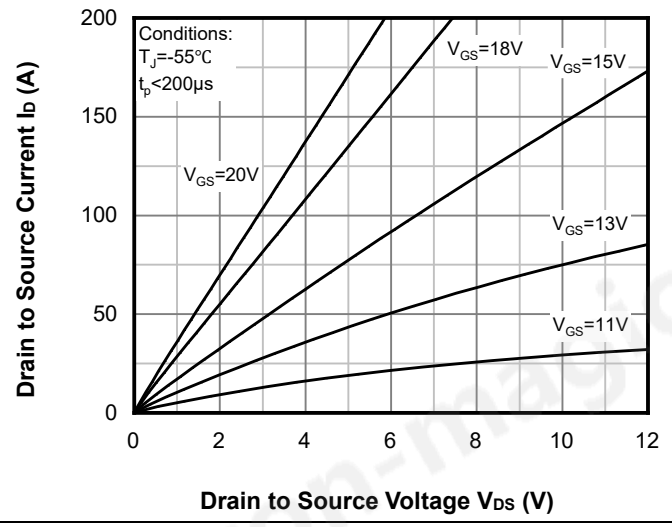



Fig.2 Typ. output characteristics at 25℃

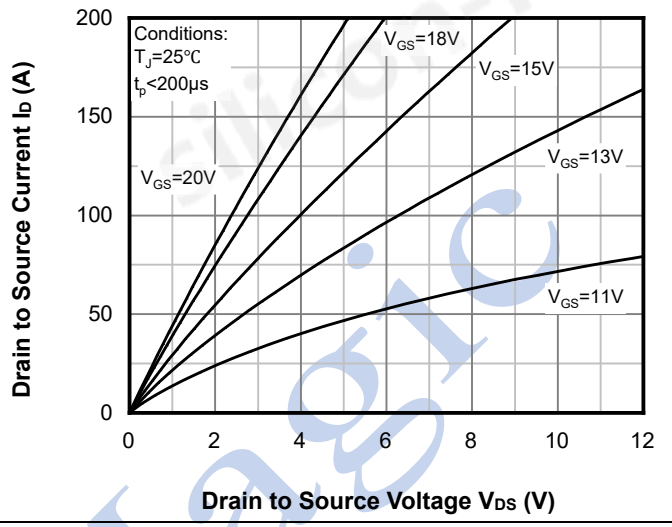



Fig.3 Typ. output characteristics at 175℃

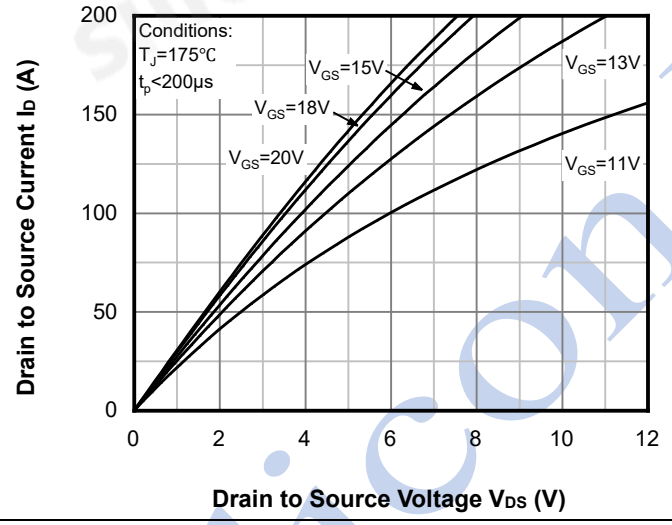



Fig.4 Normalized on-resistance vs junction temperature

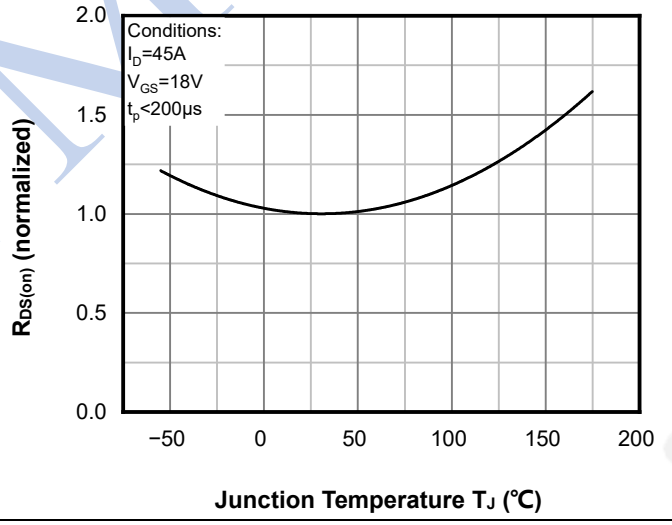



Fig.5 Typ. on-resistance vs drain current

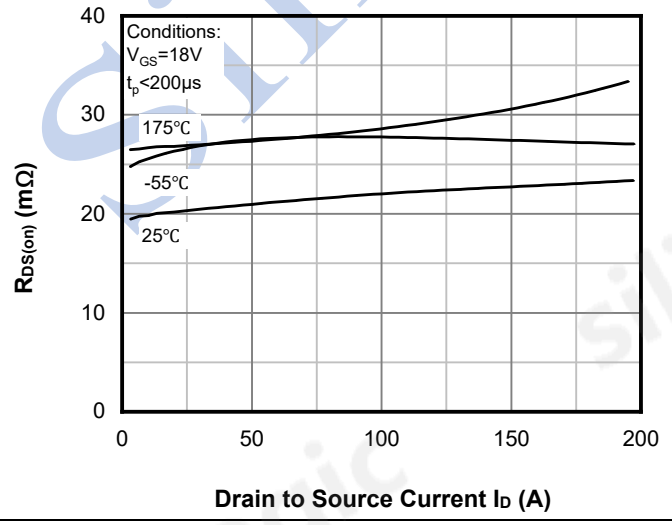



Fig.6 Typ. transfer characteristics

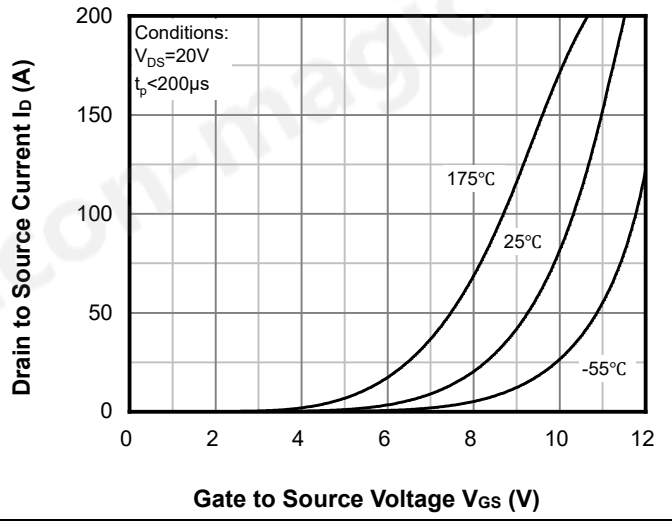


Fig.7 Typ. forward characteristics of body diode at -55℃

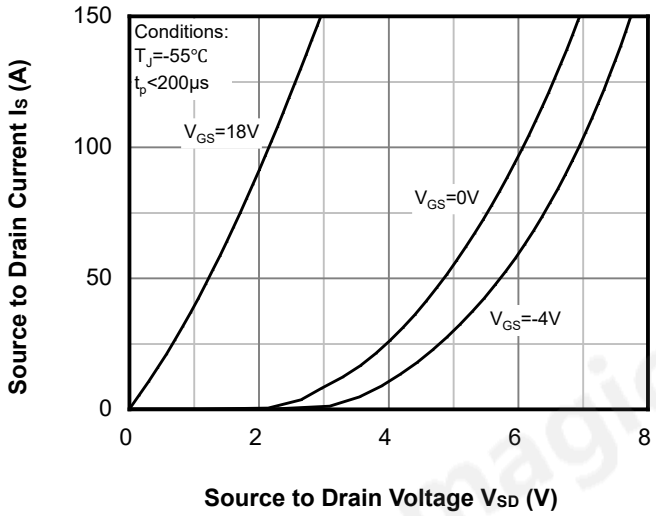



Fig.8 Typ. forward characteristics of body diode at 25℃

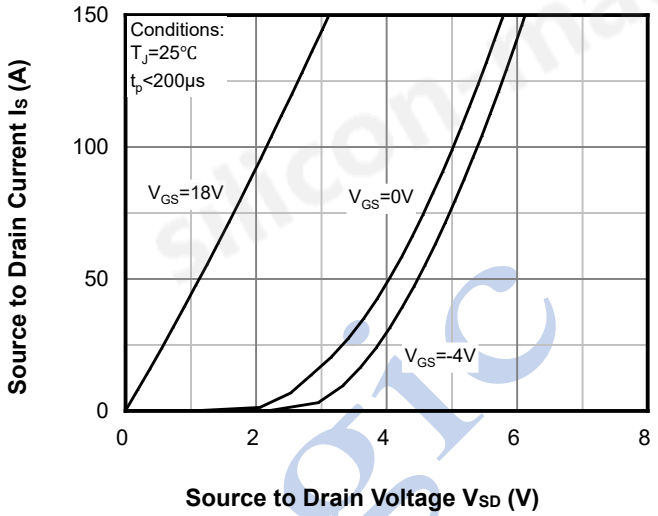



Fig.9 Typ. forward characteristics of body diode at 175℃

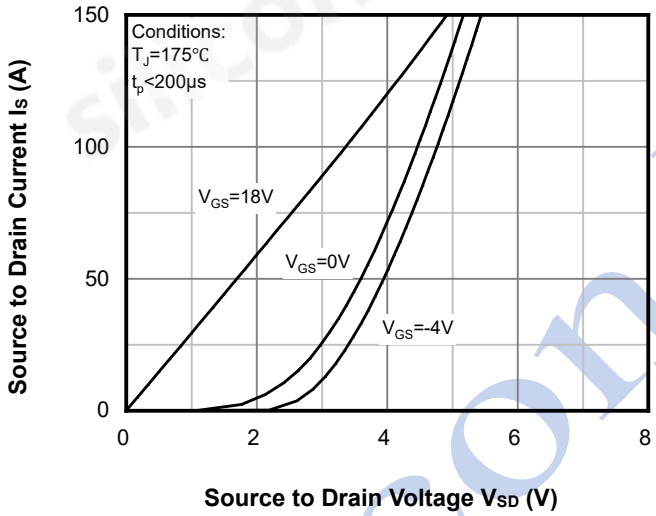



Fig.10 Typ. threshold voltage vs junction temperature

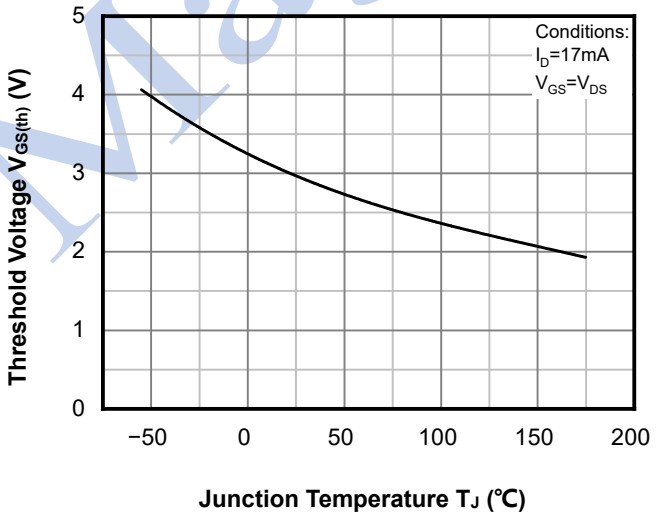



Fig.11 Typ. gate charge

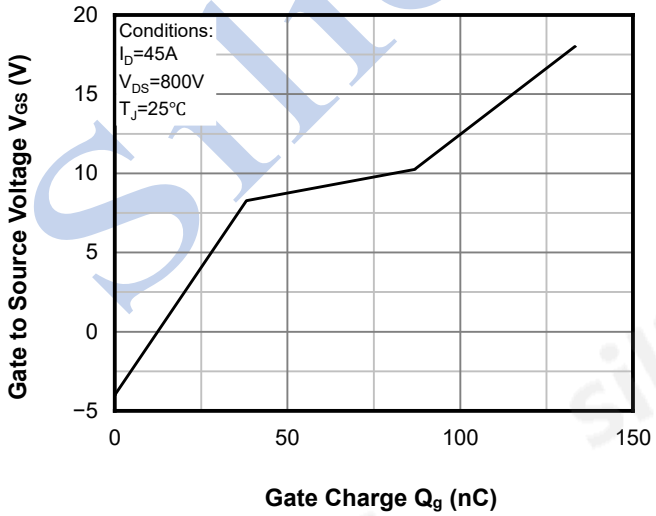



Fig.12 Typ. 3rd quadrant characteristics at -55℃

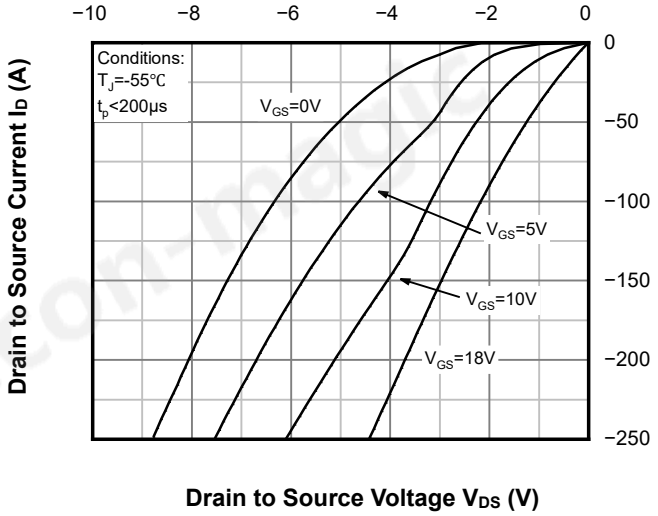


Fig.13 Typ. 3rd quadrant characteristics at 25℃

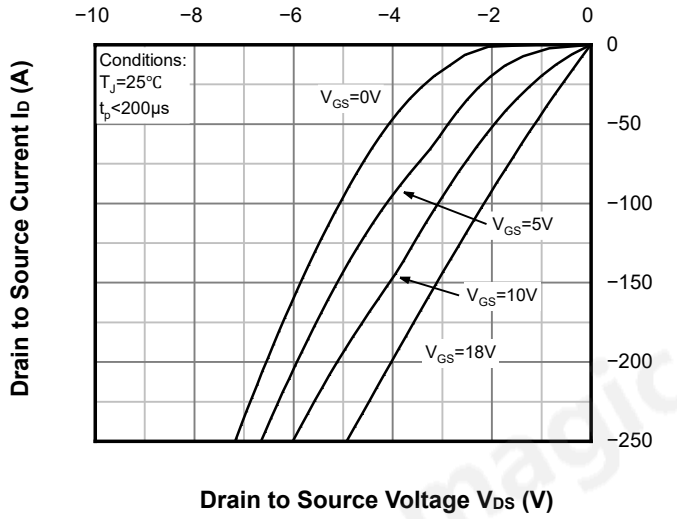



Fig.14 Typ. 3rd quadrant characteristics at 175℃

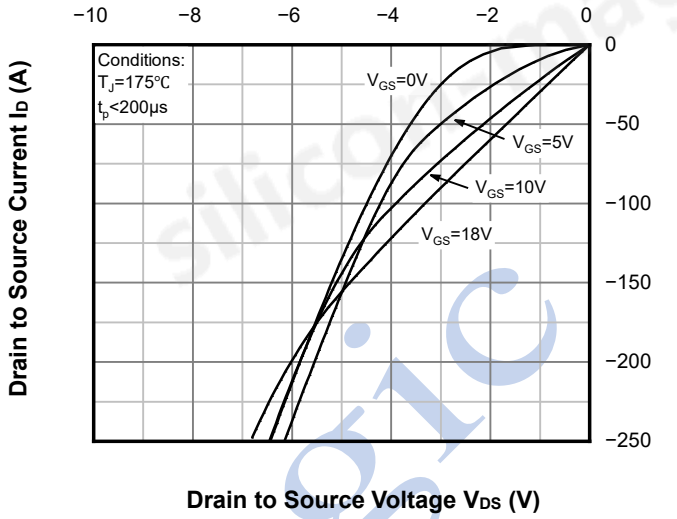



Fig.15 Typ. Capacitance (0~200V)

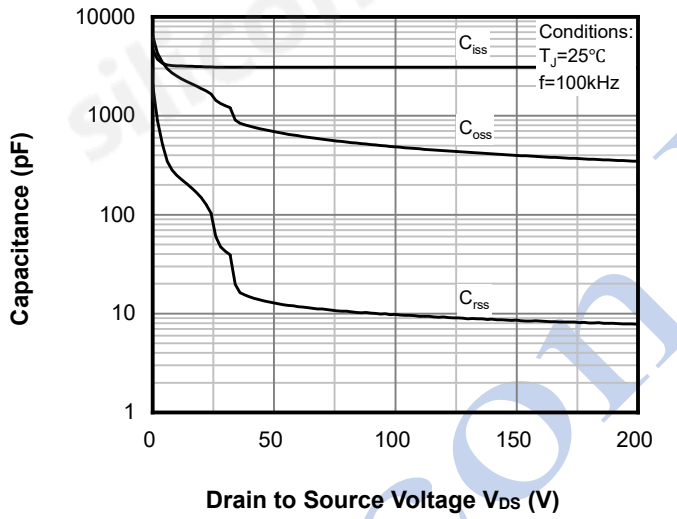



Fig.16 Typ. Capacitance (0~1200V)

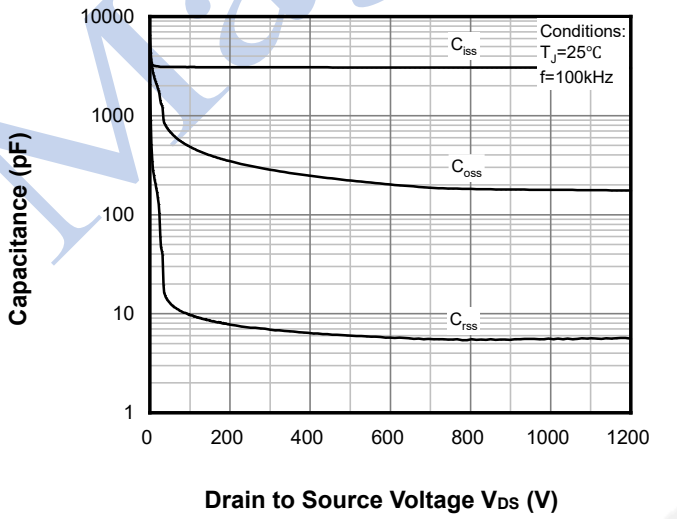



Fig.17 Safe operating area

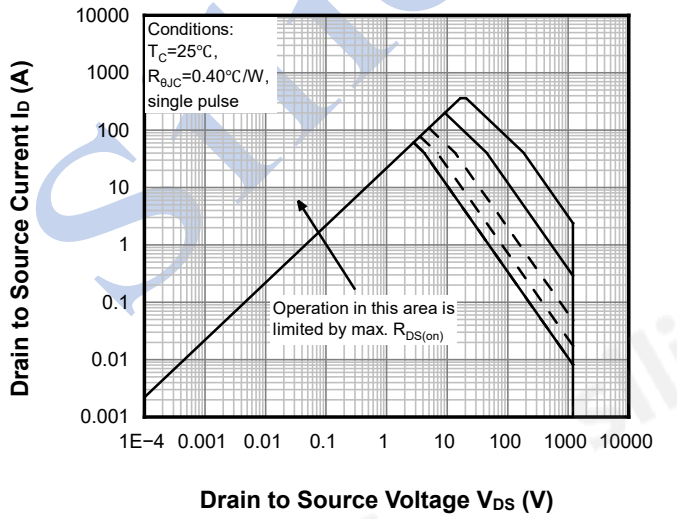



Fig.18 Max. power dissipation vs case temperature

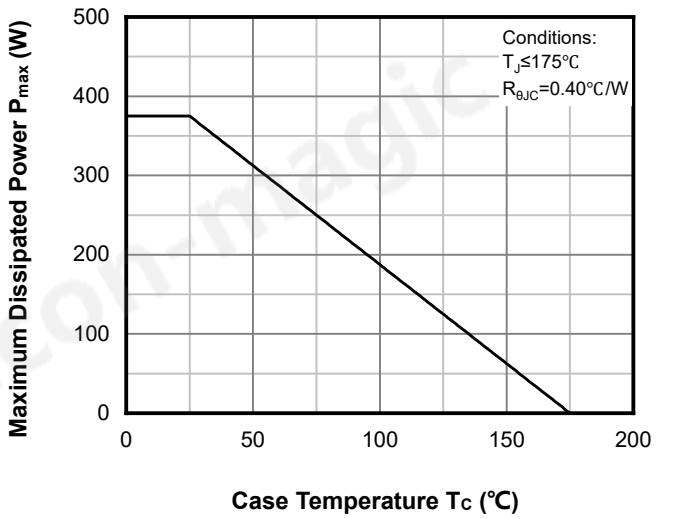


**Fig.19 Max. continuous drain current vs. case temperature**

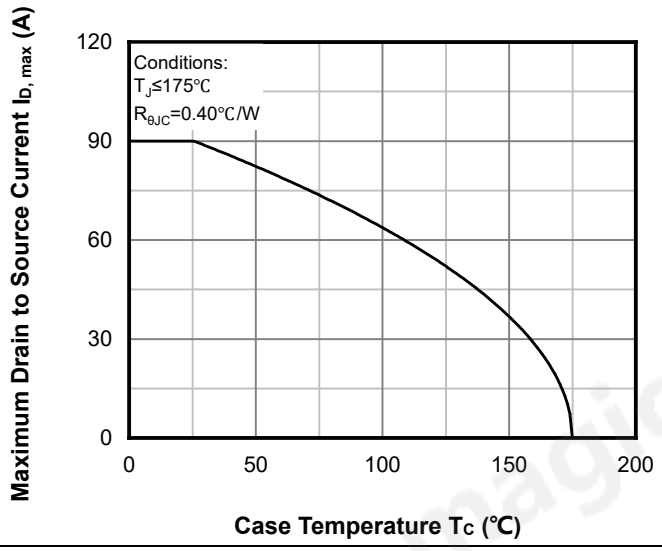



**Fig.20 Clamped Inductive Switching Energy vs temperature**

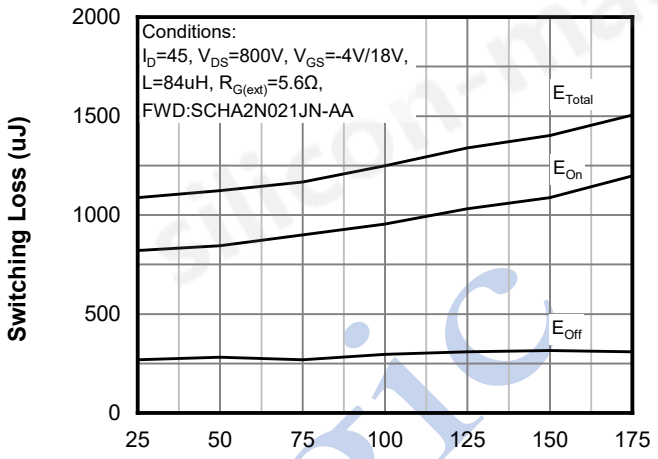



**Fig.21 Clamped Inductive Switching Energy vs Drain Current**

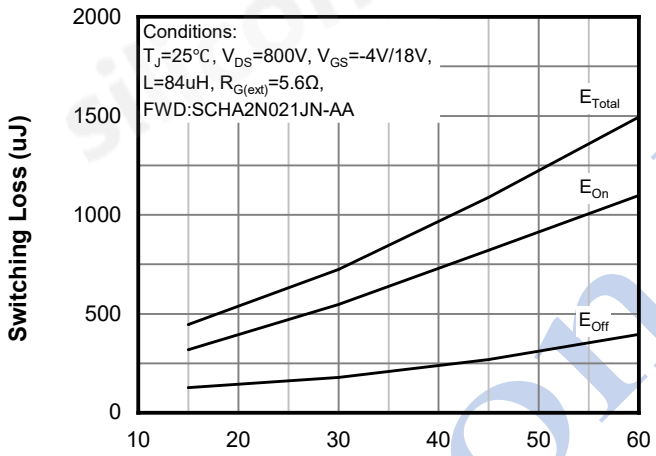



**Fig.22 Clamped Inductive Switching Energy vs $R_{G(ext)}$**

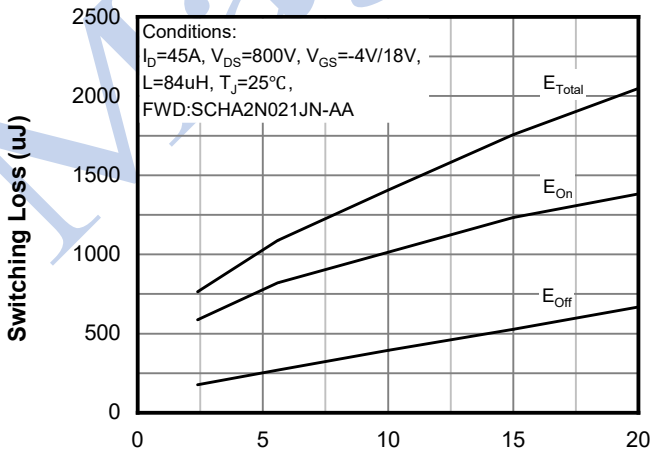
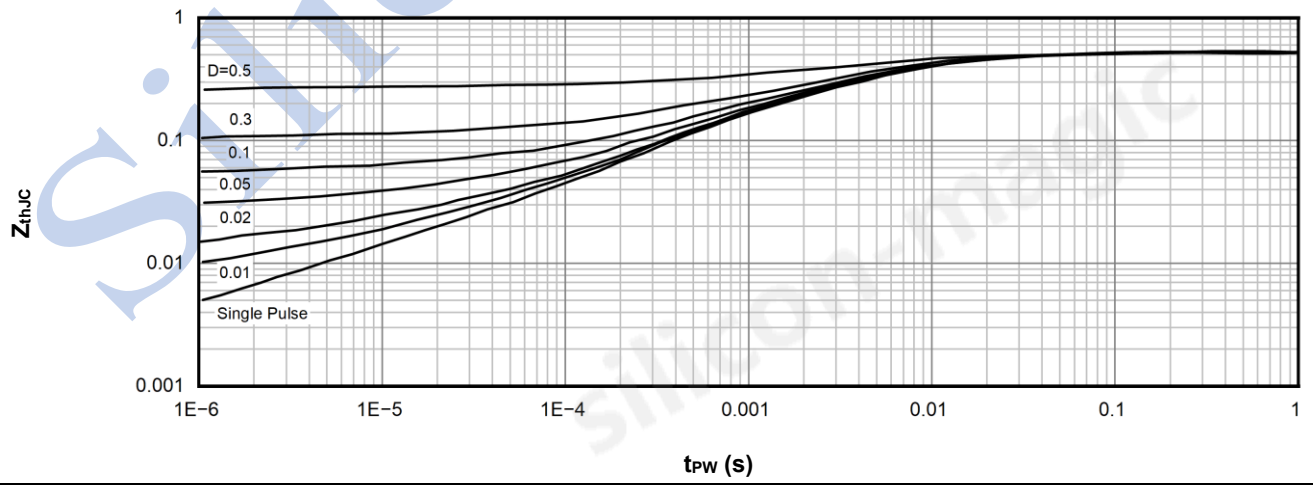
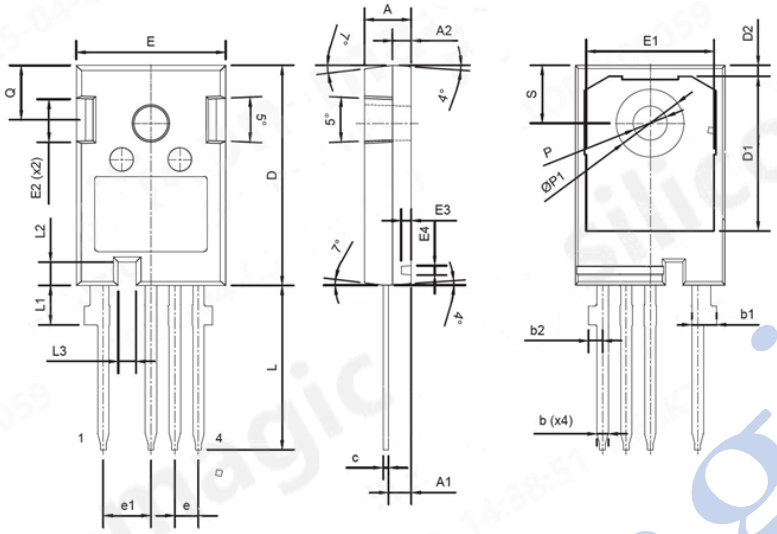



**Fig.23 Transient thermal impedance from junction to case**



## 5. Package outline dimensions




| Dim | Millimeters | | |
|---|---|---|---|
| | Min | Nom | Max |
| A | 4.82 | 5.02 | 5.22 |
| A1 | 2.29 | 2.42 | 2.54 |
| A2 | 1.90 | 2.00 | 2.10 |
| b | 1.10 | 1.20 | 1.30 |
| b1 | 2.52 | 2.67 | 2.81 |
| b2 | 1.40 | 1.50 | 1.60 |
| c | 0.50 | 0.60 | 0.70 |
| D | 23.35 | 23.45 | 23.55 |
| D1 | 16.26 | 16.46 | 16.66 |
| D2 | 0.99 | 1.19 | 1.39 |
| E | 15.75 | 15.94 | 16.13 |
| E1 | 13.46 | 13.66 | 13.86 |
| E2 | 4.32 | 4.58 | 4.78 |
| E3 | 1.05 | 1.10 | 1.25 |
| E4 | 0.95 | 1.00 | 1.15 |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| L | 17.37 | 17.57 | 17.72 |
| L1 | 3.97 | 4.19 | 4.41 |
| L2 | 2.35 | 2.50 | 2.65 |
| L3 | 1.73 | 1.88 | 2.03 |
| P | 3.56 | 3.61 | 3.66 |
| P1 | 7.15 | 7.20 | 7.25 |
| Q | 5.49 | 5.79 | 6.09 |
| S | 6.17 BSC | | |

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