# WNSC2M12120R

## N-Channel Silicon Carbide MOSFET

Rev.01 - 24 November 2023 Product data sheet

## 1. General description

Silicon Carbide MOSFET in a TO247-4L plastic package, designed for high frequency, high efficiency systems.

RoHS Halogen-Free Lead-Free

## 2. Features and benefits

- Separate driver source pin
- Low on-resistance
- Fast switching speed
- 0V turn-off gate voltage for simple gate drive
- 100% UIS Tested
- Easy to parallel
- Controllable dV/dt for optimized EMI
- Reduced cooling requirements
- RoHS compliant

## 3. Applications

- Switch Mode Power Supplies
- UPS
- Solar string inverter and solar optimizer
- EV Charger
- Motor Drives

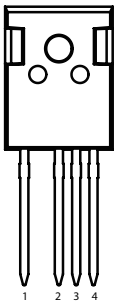
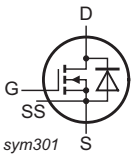
## 4. Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | Notes | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| **Absolute maximum rating** | | | | | | | |
| $V_{DS}$ | drain-source voltage | 25 °C ≤ $T_j$ ≤ 175 °C | | 1200 | | | V |
| $I_D$ | drain current | $V_{GS}$ = 18 V; $T_{mb}$ = 25 °C | | 216 | | | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C, $T_j$ = 175 °C | | 1071 | | | W |
| $T_j$ | junction temperature | | | -55 to 175 | | | °C |
| **Symbol** | **Parameter** | **Conditions** | **Notes** | **Min** | **Typ** | **Max** | **Unit** |
| **Static characteristics** | | | | | | | |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS}$ = 15 V; $I_D$ = 75 A; $T_j$ = 25 °C | | - | 12 | - | mΩ |
| **Dynamic characteristics** | | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 75 A; $V_{DS}$ = 800 V; $V_{GS}$ = -4 V/18 V; $T_j$ = 25 °C | | - | 321 | - | nC |
| $Q_{GD}$ | gate-drain charge | | | - | 57 | - | nC |
| **Source-drain diode** | | | | | | | |
| $Q_r$ | recovered charge | $I_{SD}$ = 50 A; di/dt = 500 A/µs; $V_{DS}$ = 400 V; $T_j$ = 25 °C | | - | 250 | - | nC |

## 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | D | drian |   |   |
| 2 | S | source | | |
| 3 | SS | source sense | | |
| 4 | G | gate | | |
| mb | D | mounting base; connected to drain | | |

## 6. Ordering information

**Table 3. Ordering information**

| Type number | Package Name | Orderable part number | Packing method | Small packing quantity | Package version | Package issue date |
|---|---|---|---|---|---|---|
| WNSC2M12120R | TO247-4L | WNSC2M12120R6Q | Tube | 30 | TO247N-4L | 17-Dec-2021 |

## 7. Marking

**Table 4. Marking codes**

| Type number | Marking codes |
|---|---|
| WNSC2M12120R | WNSC2M<br>12120R |

# 8. Limiting values

**Table 5. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Notes | Values | Unit |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | 25 °C ≤ $T_j$ ≤ 175 °C | | 1200 | V |
| $V_{GS,max}$ | gate-source voltage | | | -12 to 24 | V |
| $V_{GS,op}$ | gate-source voltage | | | -4 to 18 | V |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C, $T_j$ = 175 °C | | 1071 | W |
| $I_D$ | drain current | $V_{GS}$ = 18 V; $T_{mb}$ = 25 °C | | 216 | A |
| | | $V_{GS}$ = 18 V; $T_{mb}$ = 100 °C | | 152.8 | A |
| $I_{DM}$ | peak drain current | pulse width $t_p$ limited by $T_{jmax}$ | Fig.17 | 430 | A |
| $I_S$ | continuous diode current | $V_{GS}$ = -4 V; $T_{mb}$ = 25 °C | | 135 | A |
| $I_{SM}$ | pulse diode current | $V_{GS}$ = -4 V; pulse width $t_p$ limited by $T_{jmax}$ | | 430 | A |
| $E_{as}$ | single pulse drain−to-source avalanche | $I_{AS}$ = 35 A; L = 1 mH; $V_{DD}$ = 100 V; $T_j$ = 25 °C | | 612.5 | mJ |
| $T_{stg}$ | storage temperature | | | -55 to 175 | °C |
| $T_j$ | junction temperature | | | -55 to 175 | °C |
| $T_{sld(M)}$ | peak soldering temperature | | | 260 | °C |

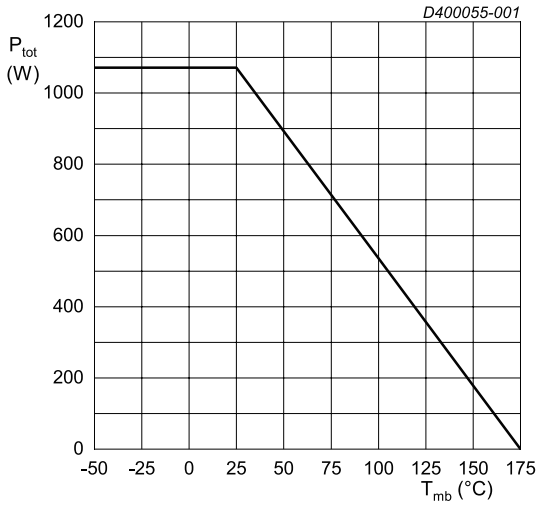



**Fig. 1. Total power dissipation as a function of mounting base temperature; maximum values**

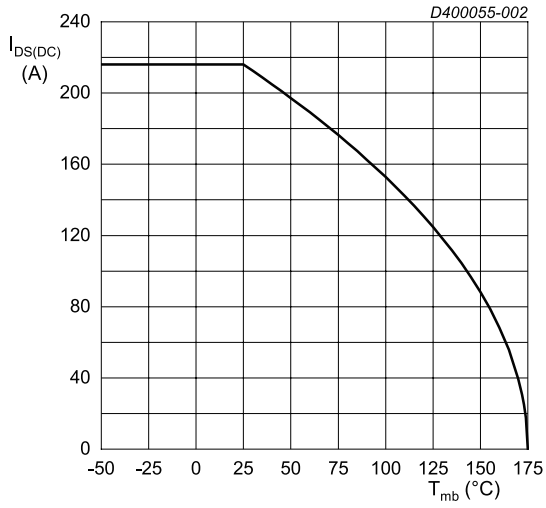



**Fig. 2. Continuous Drain Current as a function of mounting base temperature**

# 9. Thermal & Mechanical characteristics

**Table 6. Thermal & Mechanical characteristics**

| Symbol | Parameter | Conditions | Notes | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | | | - | 0.14 | - | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | | - | 40 | - | K/W |
| $M_d$ | Mounting torque | M3 or 6 - 32 screw | | - | - | 0.6 | Nm |

Note: It is recommended that a metal washer is inserted between screw head and mounting tab.
Do not use self-tapping screws.
Device is ESD sensitive. Handling precautions are recommanded.

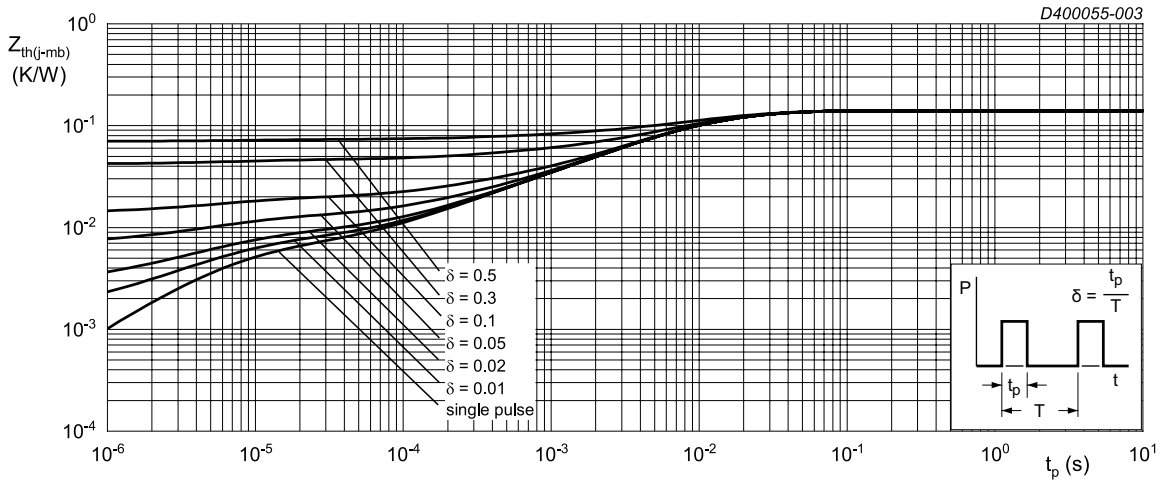
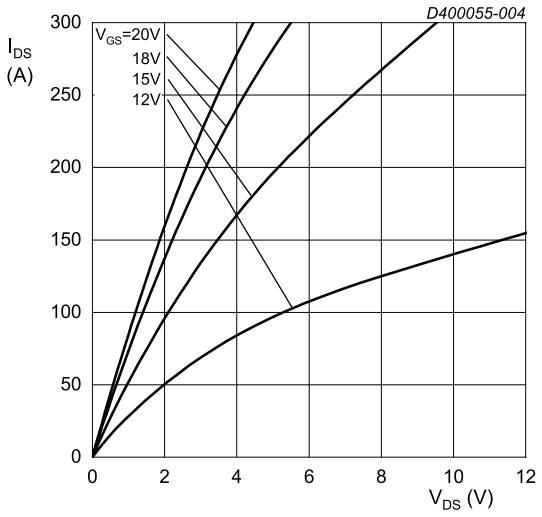



**Fig. 3. Transient thermal impedance from junction to mounting base as a function of pulse duration**

# 10. Characteristics

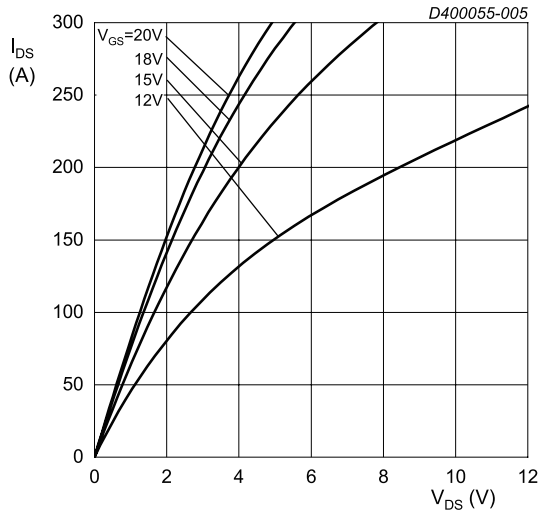
**Table 7. Characteristics**

| Symbol | Parameter | Conditions | Notes | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 100 µA; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | 1200 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 28 mA; $V_{DS}$ = 10 V; $T_j$ = 25 °C | | 1.9 | 2.6 | 3.5 | V |
| | | $I_D$ = 28 mA; $V_{DS}$ = 10 V; $T_j$ = 175 °C | | - | 1.9 | - | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 1200 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | - | 0.2 | 100 | µA |
| | | $V_{DS}$ = 1200 V; $V_{GS}$ = 0 V; $T_j$ = 175 °C | | - | 2 | - | µA |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = 24 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | | - | 10 | 100 | nA |
| | | $V_{GS}$ = -12 V; $V_{DS}$ = 0 V; $T_j$ = 25 °C | | - | 10 | 100 | nA |
| $R_{DS(on)}$ | drain-source on-state resistance | $V_{GS}$ = 15 V; $I_D$ = 75 A; $T_j$ = 25 °C | | - | 12 | - | mΩ |
| | | $V_{GS}$ = 18 V; $I_D$ = 75 A; $T_j$ = 25 °C | | - | 9.8 | 25 | mΩ |
| | | $V_{GS}$ = 18 V; $I_D$ = 75 A; $T_j$ = 175 °C | | - | 19.1 | - | mΩ |
| $R_G$ | gate resistance | f = 1 MHz; $T_j$ = 25 °C | | - | 0.53 | - | Ω |
| $g_{fs}$ | transconductance | $V_{DS}$ = 20 V; $I_D$ = 75 A; $T_j$ = 25 °C | | - | 56 | - | S |
| **Dynamic characteristics** | | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 75 A; $V_{DS}$ = 800 V; $V_{GS}$ = -4 V/18 V; $T_j$ = 25 °C | | - | 321 | - | nC |
| $Q_{GS}$ | gate-source charge | | | - | 115 | - | nC |
| $Q_{GD}$ | gate-drain charge | | | - | 57 | - | nC |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 1000 V; $V_{GS}$ = 0 V; f = 1 MHz; $T_j$ = 25 °C | | - | 6782 | - | pF |
| $C_{oss}$ | output capacitance | | | - | 289 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | | | - | 23 | - | pF |
| $E_{oss}$ | Coss stored energy | | | - | 144.5 | - | µJ |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 800 V; $V_{GS}$ = -4 V/18 V; $R_{G(ext)}$ = 2.4 Ω; $I_D$ = 75 A; L = 100 µH; $T_j$ = 25 °C | | - | 4 | - | ns |
| $t_r$ | rise time | | | - | 36 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | | - | 45 | - | ns |
| $t_f$ | fall time | | | - | 26 | - | ns |
| $E_{on}$ | turn-on energy (SiC Diode FWD) | | Fig.20 | - | 1103 | - | µJ |
| $E_{off}$ | turn-off energy (SiC Diode FWD) | | Fig.20 | - | 229 | - | µJ |
| $E_{on}$ | turn-on energy (Body Diode FWD) | | Fig.20 | - | 1442 | - | µJ |
| $E_{off}$ | turn-off energy (Body Diode FWD) | | Fig.20 | - | 170 | - | µJ |
| **Source-drain diode** | | | | | | | |
| $V_{SD}$ | source-drain voltage | $V_{GS}$ = 0 V; $I_{SD}$ = 37.5 A; $T_j$ = 25 °C | | - | 2.9 | - | V |
| | | $V_{GS}$ = -4 V; $I_{SD}$ = 37.5 A; $T_j$ = 25 °C | | - | 4.7 | - | V |
| | | $V_{GS}$ = -4 V; $I_{SD}$ = 37.5 A; $T_j$ = 175 °C | | - | 4.1 | - | V |
| $t_{rr}$ | reverse recovery time | $I_{SD}$ = 50 A; di/dt = 500 A/µs; $V_{DS}$ = 400 V; $T_j$ = 25 °C | | - | 45.5 | - | ns |
| $Q_r$ | recovered charge | | | - | 250 | - | nC |
| $I_{rrm}$ | reverse recovery current | | | - | 10 | - | A |



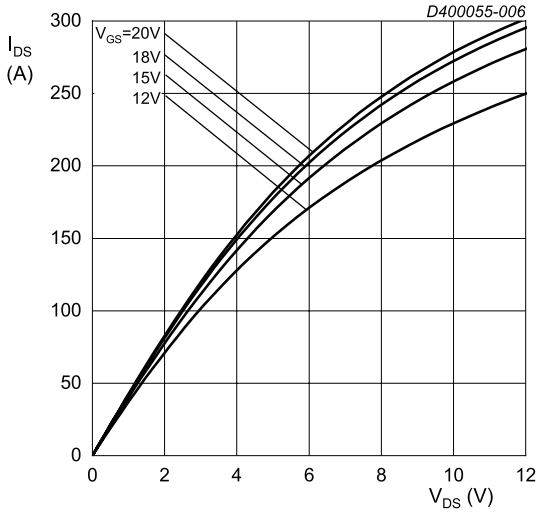

$T_j$ = -55 °C; $t_p$ < 200 µs

**Fig. 4. Output characteristics; drain current as a function of drain-source voltage; typical values**



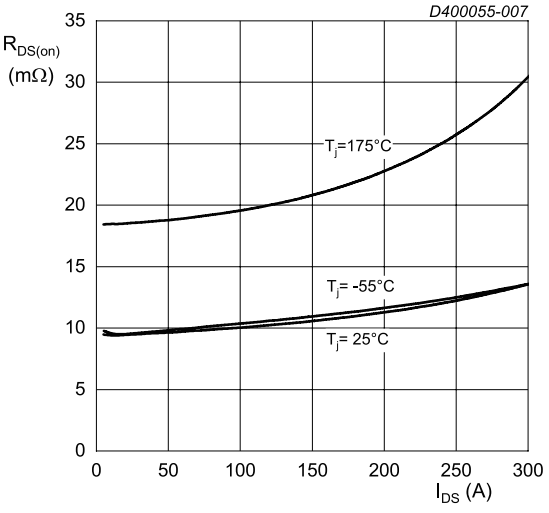

$T_j$ = 25 °C; $t_p$ < 200 µs

**Fig. 5. Output characteristics; drain current as a function of drain-source voltage; typical values**



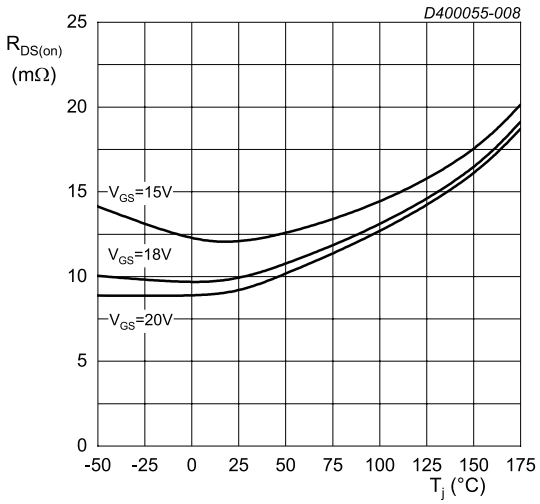

$T_j$ = 175 °C; $t_p$ < 200 µs

**Fig. 6. Output characteristics; drain current as a function of drain-source voltage; typical values**



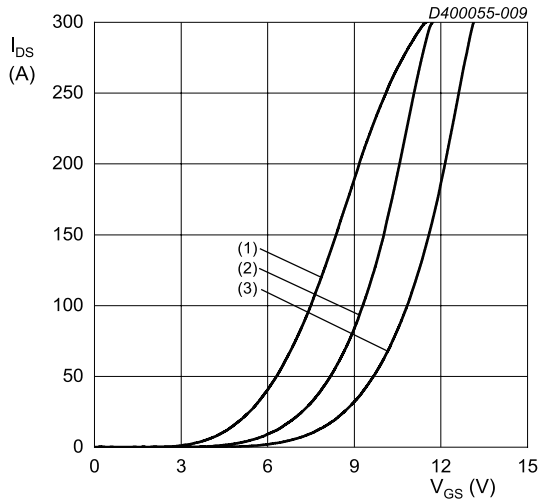

$V_{GS}$ = 18 V; $t_p$ < 200 µs

**Fig. 7. Drain-source on-state resistance as a function of drain current; typical values**



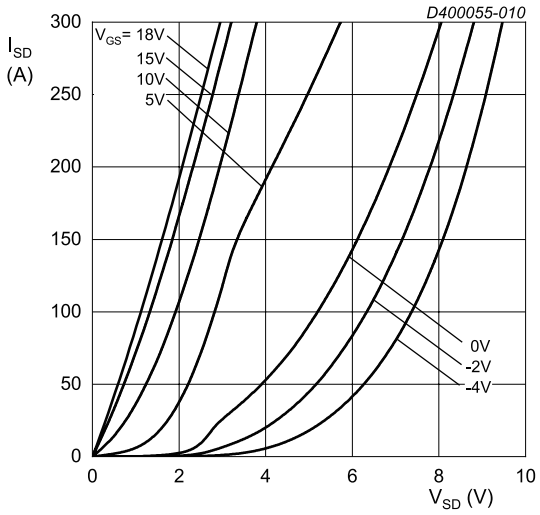

$I_{DS}$ = 75 A; $t_p$ < 200 µs

**Fig. 8. Drain-source on-state resistance as a function of junction temperature**



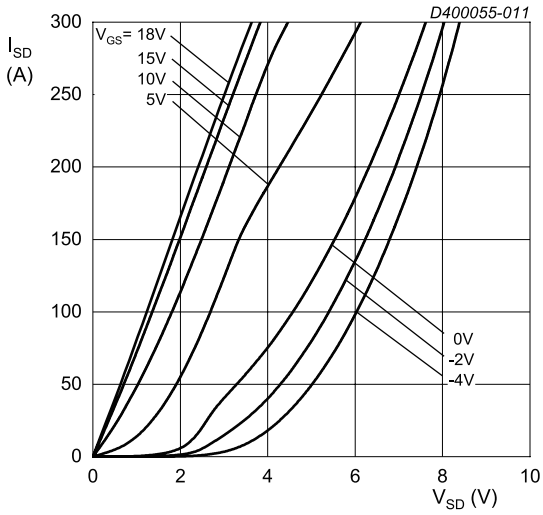

$V_{DS}$ = 20 V; $t_p$ < 200 µs
(1) $T_j$ = 175 °C
(2) $T_j$ = 25 °C
(3) $T_j$ = -55 °C

**Fig. 9. Transfer characteristics; drain current as a function of gate-source voltage; typical values**



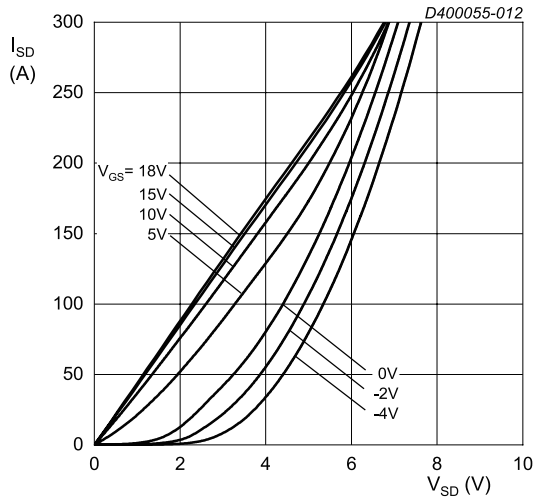

$T_j$ = -55 °C; $t_p$ < 200 µs

**Fig. 10. Body diode forward characteristics; typical values**



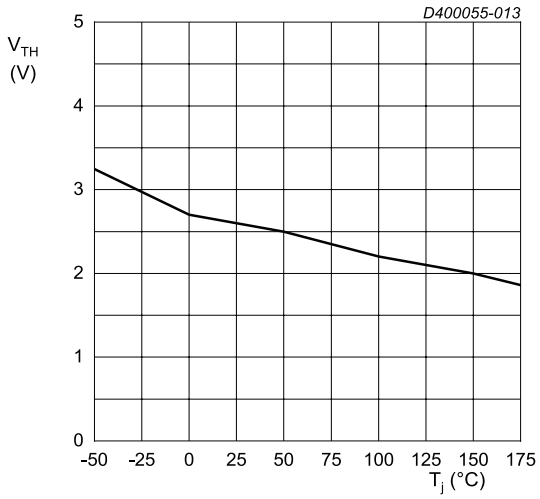

$T_j$ = 25 °C; $t_p$ < 200 µs

**Fig. 11. Body diode forward characteristics; typical values**



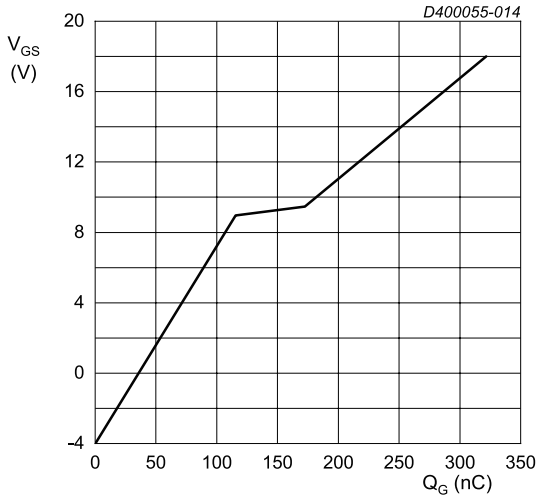

$T_j$ = 175 °C; $t_p$ < 200 µs

**Fig. 12. Body diode forward characteristics; typical values**




$V_{DS}$ = 10 V; $I_{DS}$ = 28 mA

**Fig. 13. Threshold voltage as a function of junction temperature**




$I_{DS}$ = 75 A; $I_{GS}$ = 0.1 mA; $V_{DS}$ = 800 V; $T_j$ = 25 °C

**Fig. 14. Gate-source voltage as a function of gate charge; typical values**

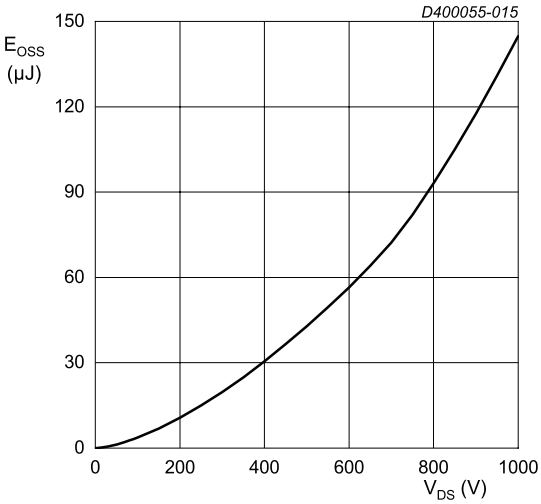
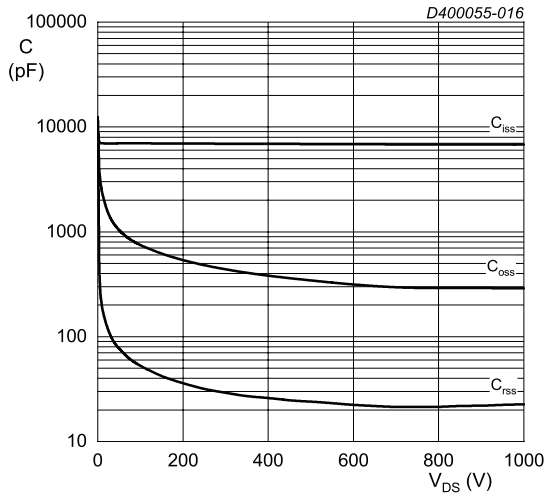
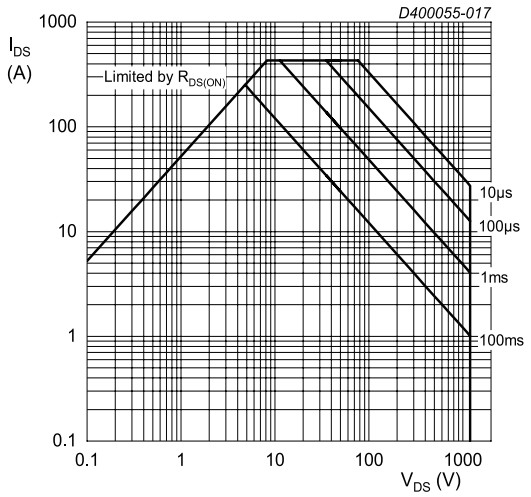



**Fig. 15. Output capacitor stored energy as a function of drain-source voltage**



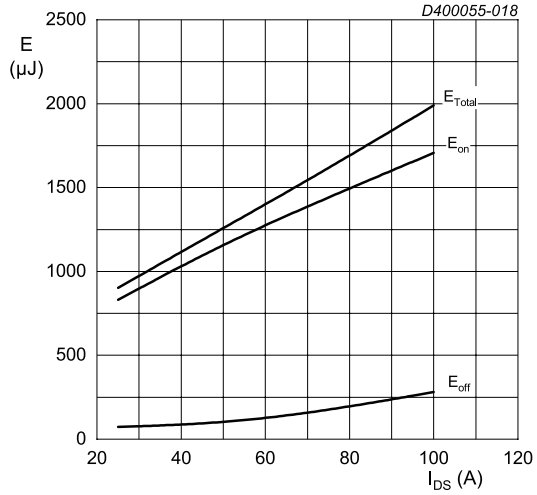

$V_{DS}$ = 0 - 1000 V
$T_j$ = 25 °C; $V_{AC}$ = 25 mV; f = 1 MHz

**Fig. 16. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**



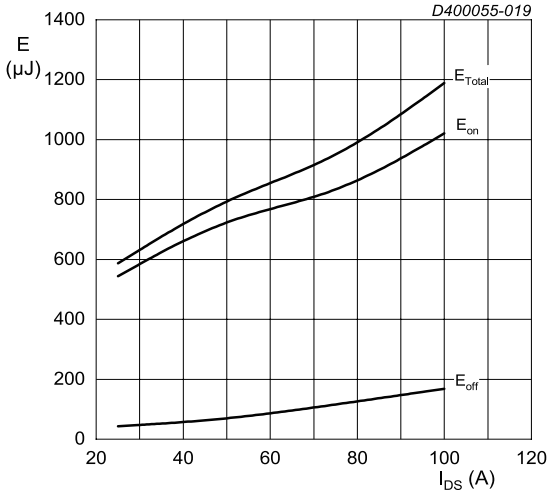

$T_j$ = 25 °C; D = 0
Parameter: $t_p$

**Fig. 17. Forward bias safe operating area**



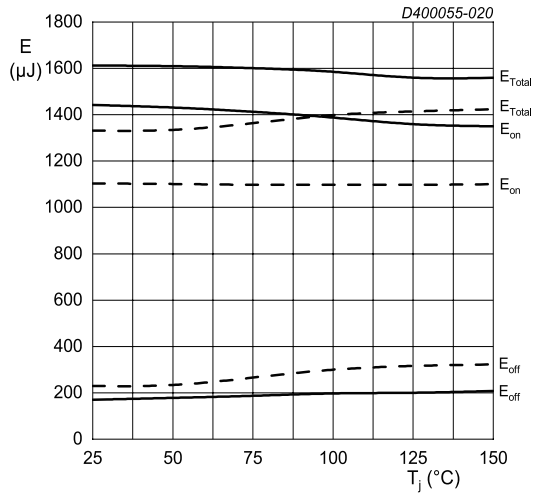

$T_j$ = 25 °C; $V_{DD}$ = 800 V; $R_{G(ext)}$ = 2.4 Ω;
$V_{GS}$ = -4 V/18 V; L = 100 µH
FWD = WNSC2M12120R

**Fig. 18. Clamped Inductive Switching Energy as a function of drain current**



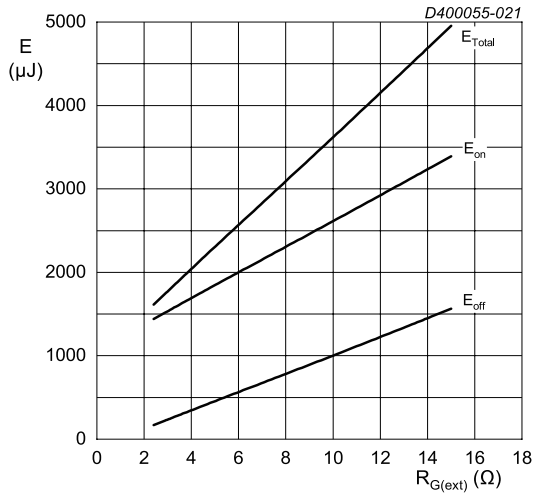

$T_j$ = 25 °C; $V_{DD}$ = 600 V; $R_{G(ext)}$ = 2.4 Ω;
$V_{GS}$ = -4 V/18 V; L = 100 µH
FWD = WNSC2M12120R

**Fig. 19. Clamped Inductive Switching Energy as a function of drain current**



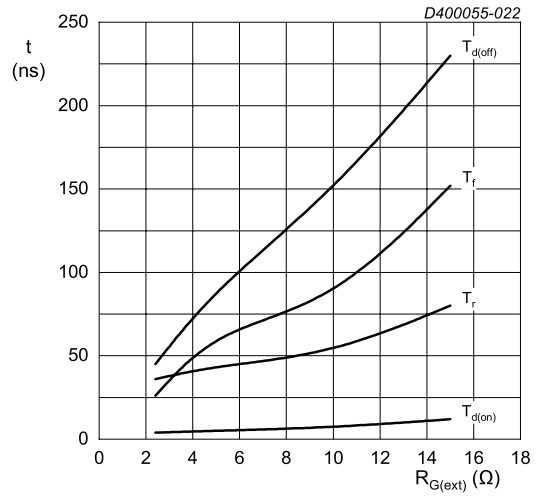

$I_{DS}$ = 75 A; $V_{DD}$ = 800 V; $R_{G(ext)}$ = 2.4 Ω;
$V_{GS}$ = -4 V/18 V; L = 100 µH
FWD = WNSC2M12120R
FWD = WNSC2D501200W(- - -)

**Fig. 20. Clamped Inductive Switching Energy as a function of junction temperature**




$T_j$ = 25 °C; $V_{DD}$ = 800 V; $I_{DS}$ = 75 A; $V_{GS}$ = -4 V/18 V
FWD = WNSC2M12120R; L = 100 µH

**Fig. 21. Clamped Inductive Switching Energy as a function of external gate resistance**




$T_j$ = 25 °C; $V_{DD}$ = 800 V; $I_{DS}$ = 75 A; $V_{GS}$ = -4 V/18 V
FWD = WNSC2M12120R; L = 100 µH

**Fig. 22. Switching time as a function of external gate resistance**

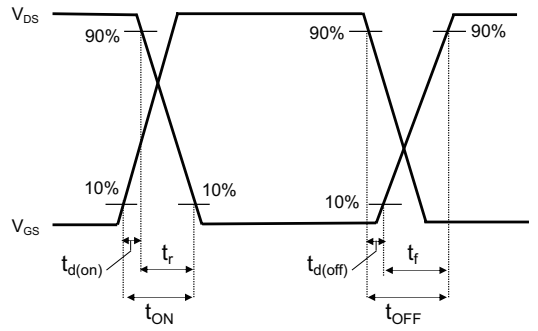
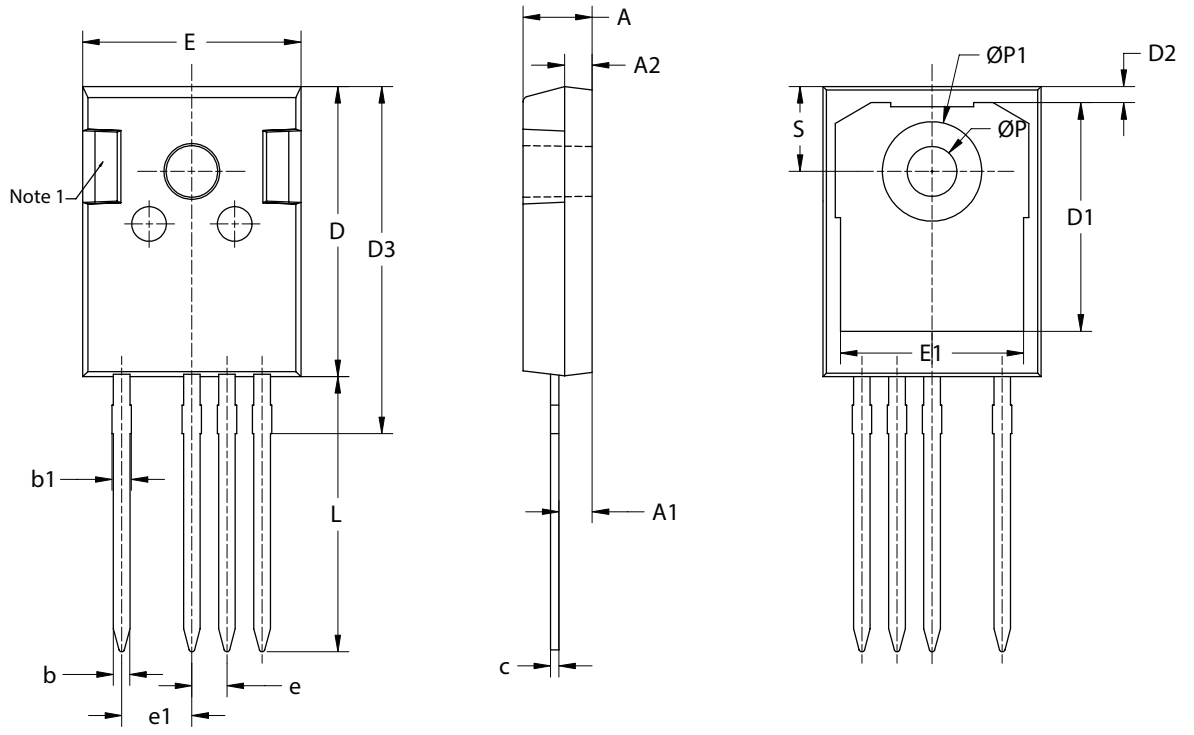


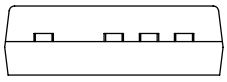

**Fig. 23. Switching time definition**

## 11. Package outline

Plastic single-ended through-hole package; heatsink mounted;1 mounting hole; 4 leads TO-247 TO247-4L




TOP VIEW SIDE VIEW BOTTOM VIEW



SIDE VIEW

| UNIT | | A | A1 | A2 | b | b1 | c | D | D1 | D2 | D3 | E | E1 | e | e1 | L | P | P1 | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | MAX | 5.10 | 2.51 | 2.10 | 1.30 | 1.80 | 0.70 | 21.10 | 16.85 | 1.35 | 25.27 | 15.90 | 13.50 | 2.64 | 5.18 | 20.10 | 3.70 | (7.40) | (6.15) |
| | NOM | | | | | | | | | | | | | 2.54 | 5.08 | | | | |
| | MIN | 4.90 | 2.31 | 1.90 | 1.10 | 1.10 | 0.50 | 20.90 | 16.25 | 1.05 | 24.97 | 15.70 | 13.10 | 2.44 | 4.98 | 19.80 | 3.50 | - | |

Note:
1. Metal exposed with Sn plating.
2. All dimensions do not include mold flash & gate remain

# 12. Legal information

## Data sheet status

| Document status [1][2] | Product status [3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.ween-semi.com.

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For more information, please visit: http://www.ween-semi.com
For sales office addresses, please send an email to: salesaddresses@ween-semi.com
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