# WNSC2M40140R

## N-Channel Silicon Carbide MOSFET

Rev.02 - 19 July 2024

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

- Switching mode power supplies
- UPS & Energy storage system
- Battery formation instrument
- PV MPPT and inverters
- EV charger
- Motor Drives

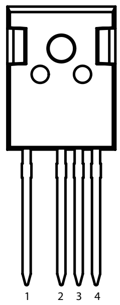
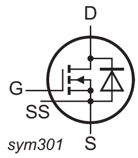
## 4. Quick reference data

**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 | | 1400 | | | V |
| $I_D$ | drain current | $V_{GS}$ = 18 V; $T_{mb}$ = 25 °C | | 91 | | | A |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C, $T_j$ = 175 °C | | 556 | | | 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; $I_D$ = 33 A; $T_j$ = 25 °C | | - | 40 | - | mΩ |
| **Dynamic characteristics** | | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 33 A; $V_{DS}$ = 800 V; $V_{GS}$ = -4 V/18 V; $T_j$ = 25 °C | | - | 115 | - | nC |
| $Q_{GD}$ | gate-drain charge | | | - | 18 | - | nC |
| **Source-drain diode** | | | | | | | |
| $Q_r$ | recovered charge | $I_{SD}$ = 33 A; di/dt = 500 A/µs; $V_{DS}$ = 400 V; $T_j$ = 25 °C | | - | 174 | - | nC |

## 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | D | drain |  |  |
| 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 |
|---|---|---|---|---|---|---|
| WNSC2M40140R | TO247-4L | WNSC2M40140R6Q | Tube | 30 | TO247N-4L | 17-Dec-2021 |

## 7. Marking

**Table 4. Marking codes**

| Type number | Marking codes |
|---|---|
| WNSC2M40140R | WNSC2M 40140R |

# 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 | | 1400 | V |
| $V_{GS,max1}$ | gate-source voltage, maximum static value | DC | | -12 to 24 | V |
| $V_{GS,max2}$ | gate-source voltage, maximum transient value | tp ≤ 0.5 μs, D < 0.01 | | -14 to 28 | V |
| $V_{GS,op}$ | gate-source voltage, recommended operating range | Recommended operational values | | -4 to 18 | V |
| $P_{tot}$ | total power dissipation | $T_{mb}$ = 25 °C, $T_j$ = 175 °C | | 556 | W |
| $I_D$ | drain current | $V_{GS}$ = 18 V; $T_{mb}$ = 25 °C | | 91 | A |
| | | $V_{GS}$ = 18 V; $T_{mb}$ = 100 °C | | 64 | A |
| $I_{DM}$ | peak drain current | pulse width $t_p$ limited by $T_{jmax}$ | Fig.17 | 180 | A |
| $I_S$ | continuous diode current | $V_{GS}$ = -4 V; $T_{mb}$ = 25 °C | | 71 | A |
| $I_{SM}$ | pulse diode current | $V_{GS}$ = -4 V; pulse width $t_p$ limited by $T_{jmax}$ | | 180 | A |
| $E_{as}$ | single pulse drain−to-source avalanche | $I_{AS}$ = 24 A; L = 1 mH; $V_{DD}$ = 100 V; $T_j$ = 25 °C | | 288 | 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 |

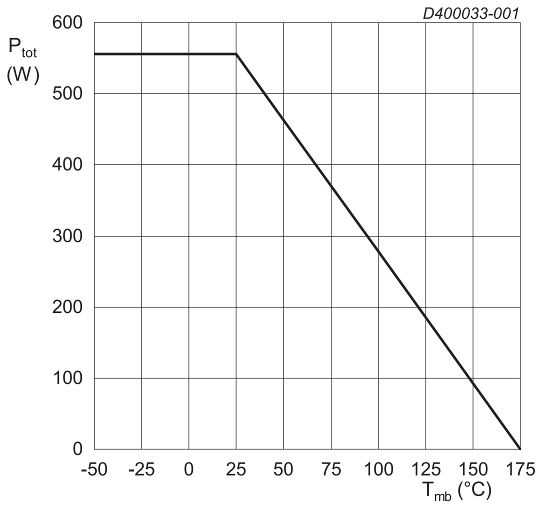



**Fig. 1. Total power dissipation as a function of mounting base temperature; maximum values**

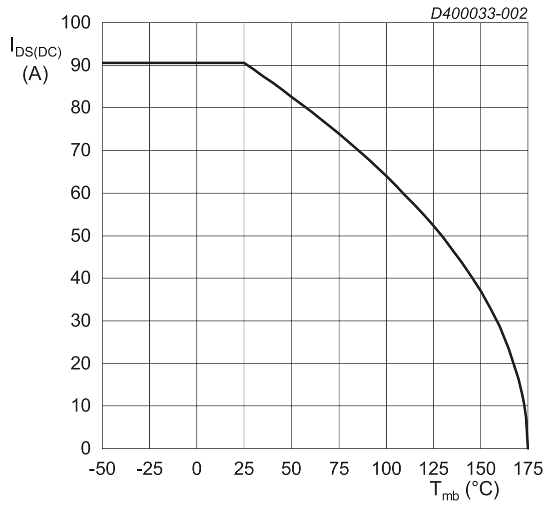



**Fig. 2. Continuous Drain Current as a function of mounting base temperature**

# 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 | | | - | 0.27 | - | 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.

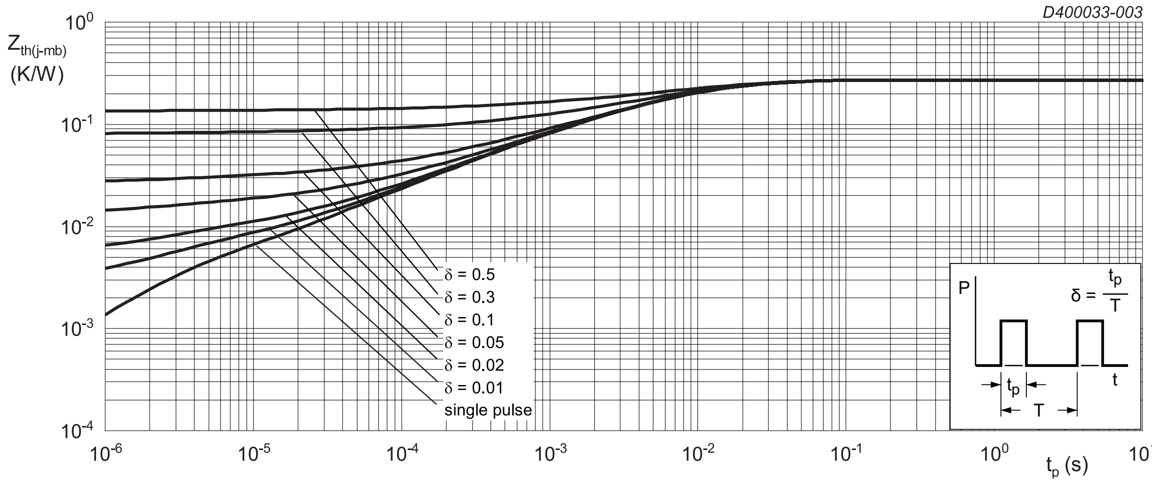
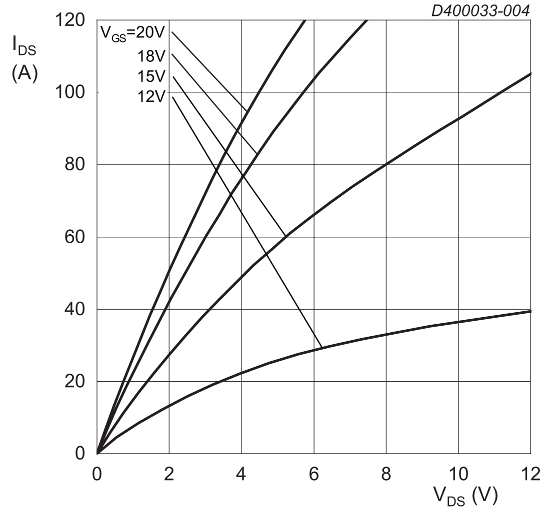



**Fig. 3. Transient thermal impedance from junction to mounting base as a function of pulse duration**

## 10. Characteristics

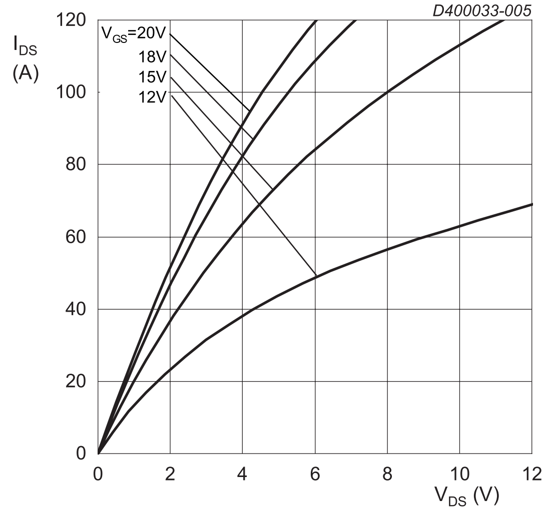
### Table 7. Characteristics

| 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 | | 1400 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = 10 mA; $V_{DS}$ = 10 V; $T_j$ = 25 °C | | 1.9 | 2.6 | 3.5 | V |
| | | $I_D$ = 10 mA; $V_{DS}$ = 10 V; $T_j$ = 175 °C | | - | 1.9 | - | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = 1400 V; $V_{GS}$ = 0 V; $T_j$ = 25 °C | | - | 0.2 | 100 | μA |
| | | $V_{DS}$ = 1400 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; $I_D$ = 33 A; $T_j$ = 25 °C | | - | 40 | - | mΩ |
| | | $V_{GS}$ = 18 V; $I_D$ = 33 A; $T_j$ = 25 °C | | - | 33 | 45 | mΩ |
| | | $V_{GS}$ = 18 V; $I_D$ = 33 A; $T_j$ = 175 °C | | - | 56 | - | mΩ |
| $R_G$ | gate resistance | f = 1 MHz; $T_j$ = 25 °C | | - | 1 | - | Ω |
| $g_{fs}$ | transconductance | $V_{DS}$ = 20 V; $I_D$ = 33 A; $T_j$ = 25 °C | | - | 20 | - | S |
| **Dynamic characteristics** | | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = 33 A; $V_{DS}$ = 800 V; $V_{GS}$ = -4 V/18 V; $T_j$ = 25 °C | | - | 115 | - | nC |
| $Q_{GS}$ | gate-source charge | | | - | 47 | - | nC |
| $Q_{GD}$ | gate-drain charge | | | - | 18 | - | nC |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 1000 V; $V_{GS}$ = 0 V; f = 1 MHz; $T_j$ = 25 °C | | - | 2450 | - | pF |
| $C_{oss}$ | output capacitance | | | - | 108 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | | | - | 11 | - | pF |
| $E_{oss}$ | Coss stored energy | | | - | 54 | - | μJ |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 800 V; $V_{GS}$ = -4 V/18 V; $R_{G(ext)}$ = 5 Ω; $I_D$ = 33 A; L = 100 μH; $T_j$ = 25 °C | | - | 17 | - | ns |
| $t_r$ | rise time | | | - | 10 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | | - | 42 | - | ns |
| $t_f$ | fall time | | | - | 16 | - | ns |
| $E_{on}$ | turn-on energy (Body Diode FWD) | | Fig.20 | - | 472 | - | μJ |
| $E_{off}$ | turn-off energy (Body Diode FWD) | | Fig.20 | - | 124 | - | μJ |
| **Source-drain diode** | | | | | | | |
| $V_{SD}$ | source-drain voltage | $V_{GS}$ = 0 V; $I_{SD}$ = 16.5 A; $T_j$ = 25 °C | | - | 3.5 | - | V |
| | | $V_{GS}$ = -4 V; $I_{SD}$ = 16.5 A; $T_j$ = 25 °C | | - | 5.0 | - | V |
| | | $V_{GS}$ = -4 V; $I_{SD}$ = 16.5 A; $T_j$ = 175 °C | | - | 4.3 | - | V |
| $t_{rr}$ | reverse recovery time | $I_{SD}$ = 33 A; di/dt = 500 A/μs; $V_{DS}$ = 400 V; $T_j$ = 25 °C | | - | 52 | - | ns |
| $Q_r$ | recovered charge | | | - | 174 | - | nC |
| $I_{rrm}$ | reverse recovery current | | | - | 6.8 | - | A |



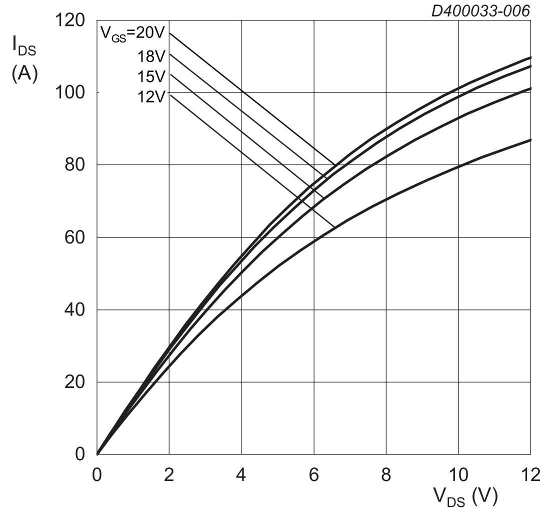

$T_j$ = -55 °C; $t_p$ < 200 µs

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



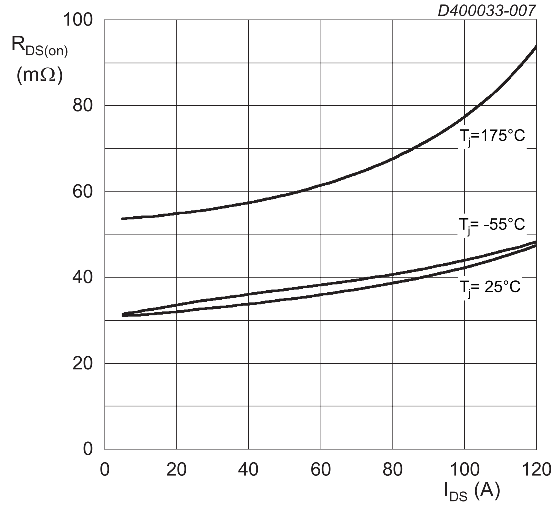

$T_j$ = 25 °C; $t_p$ < 200 µs

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



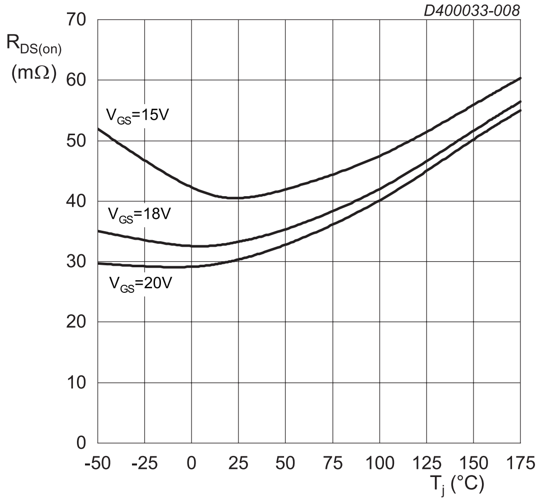

$T_j$ = 175 °C; $t_p$ < 200 µs

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



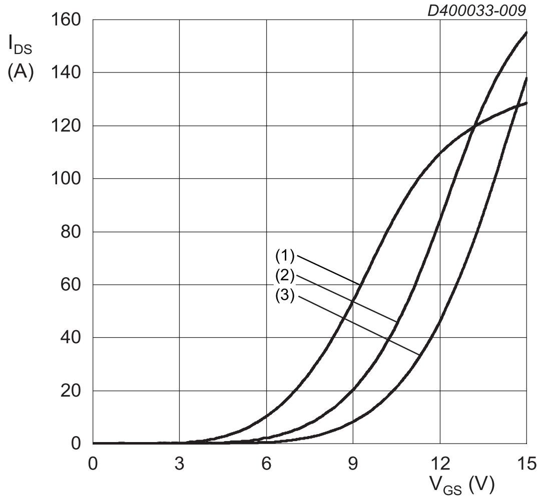

$V_{GS}$ = 18 V; $t_p$ < 200 µs

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



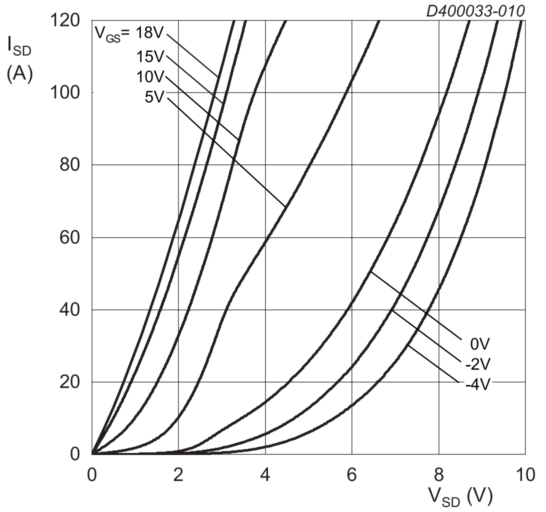

$I_{DS}$ = 33 A; $t_p$ < 200 µs

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



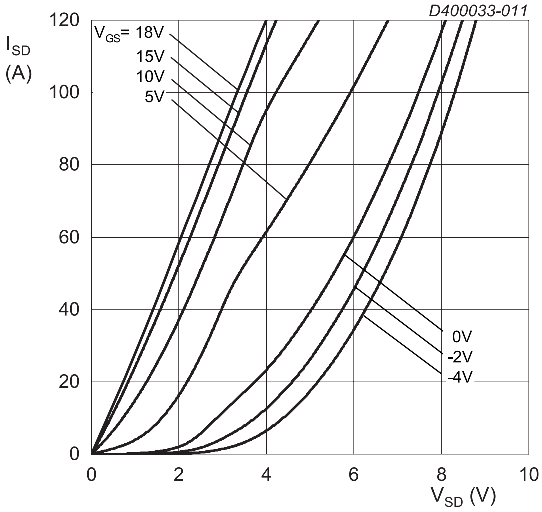

$V_{DS}$ = 20 V; $t_p$ < 200 µs
(1) $T_j$ = 175 °C
(2) $T_j$ = 25 °C
(3) $T_j$ = -55 °C

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



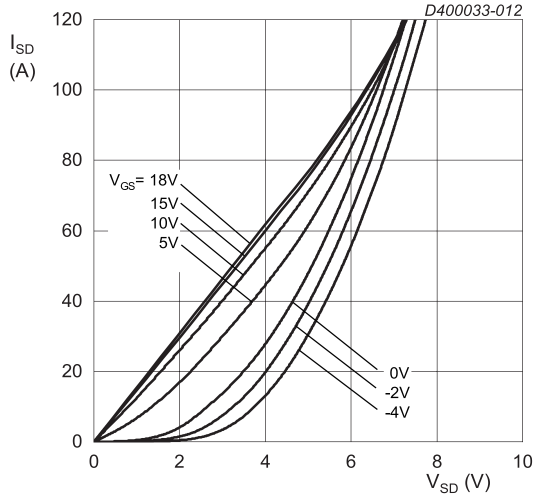

$T_j$ = -55 °C; $t_p$ < 200 µs

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



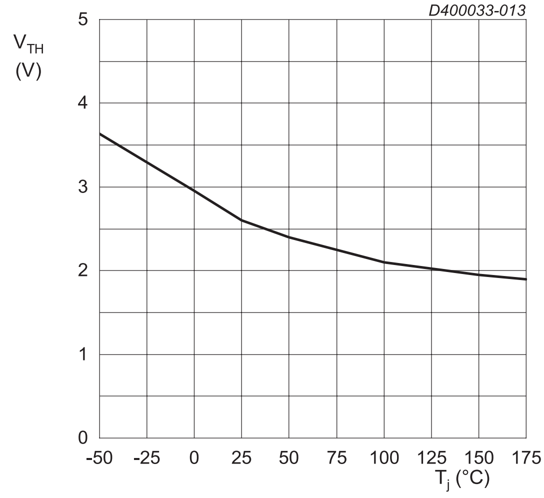

$T_j$ = 25 °C; $t_p$ < 200 µs

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



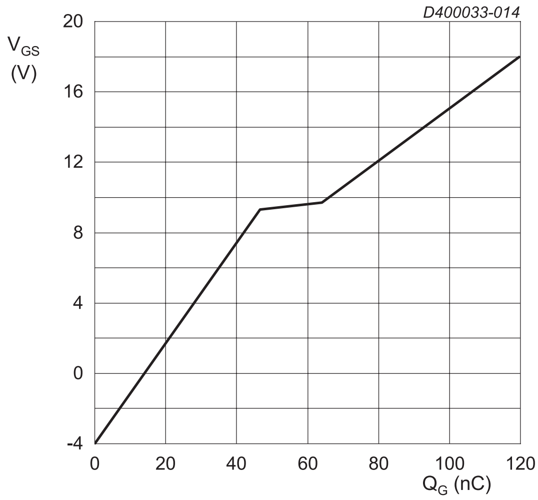

$T_j$ = 175 °C; $t_p$ < 200 μs

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




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

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




$I_{DS}$ = 33 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**

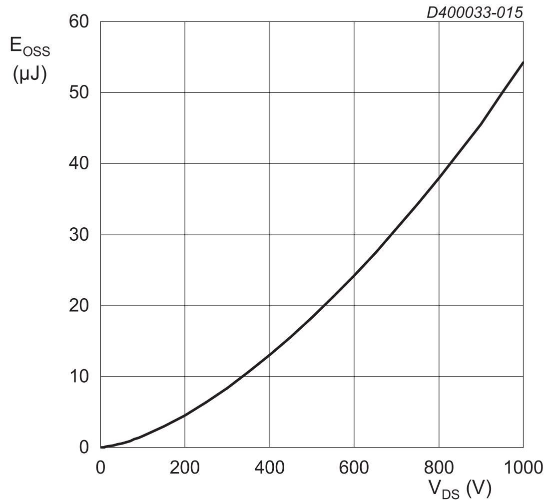
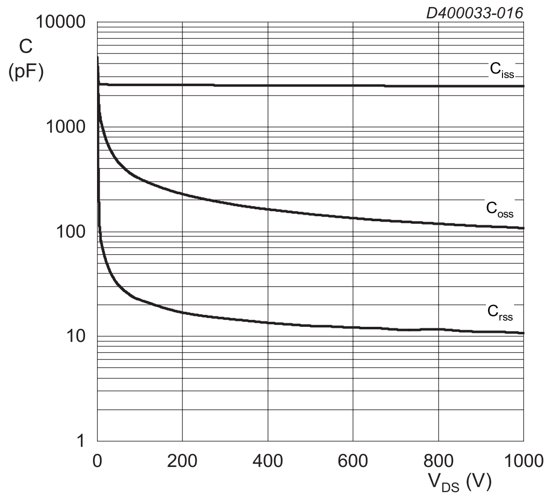


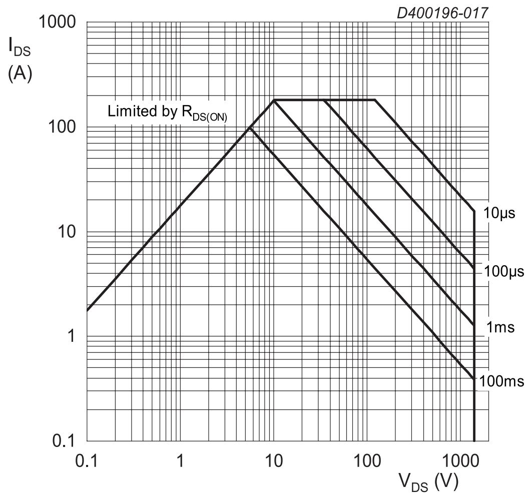

**Fig. 15. Output capacitor stored energy as a function of drain-source voltage**




$V_{DS}$ = 0 - 1000 V

$T_j$ = 25 °C; $V_{AC}$ = 25 mV; f = 1 MHz

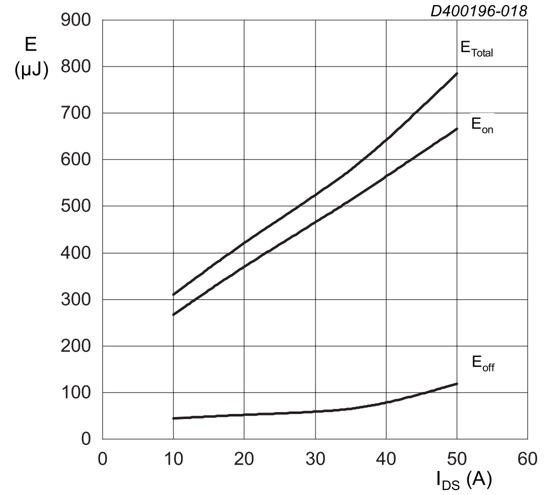
**Fig. 16. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**




$T_j$ = 25 °C; D = 0

Parameter: $t_p$

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

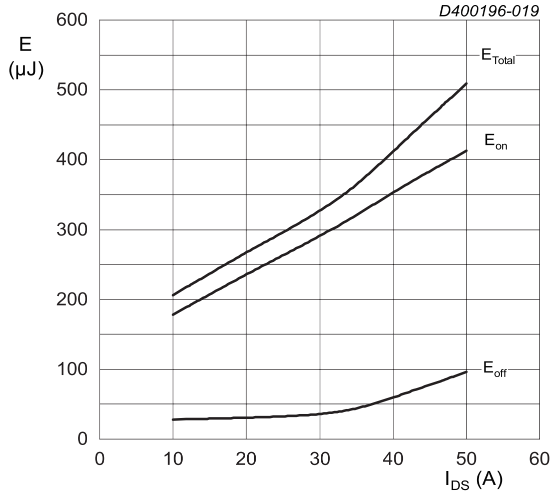



$T_j$ = 25 °C; $V_{DD}$ = 800 V; $R_{G(ext)}$ = 5.1 Ω;

$V_{GS}$ = -4 V/18 V; L = 100 μH

FWD = WNSC2M40140R

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

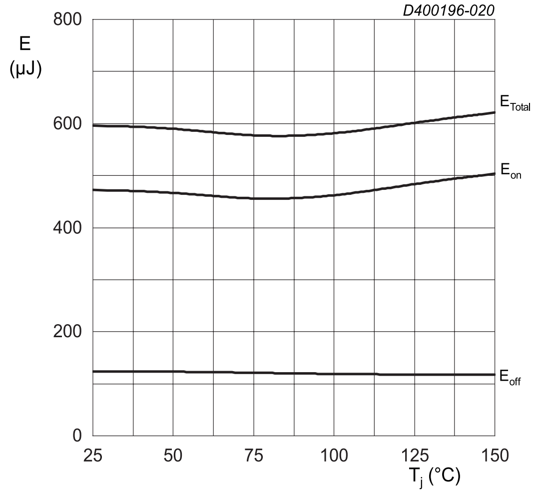



$T_j$ = 25 °C; $V_{DD}$ = 600 V; $R_{G(ext)}$ = 5.1 Ω;

$V_{GS}$ = -4 V/18 V; L = 100 μH

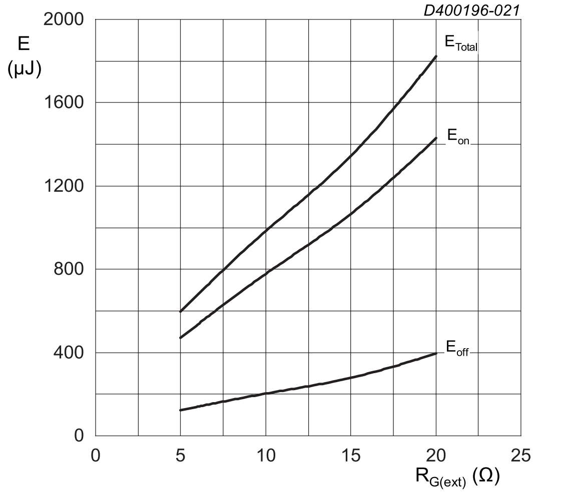
FWD = WNSC2M40140R

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



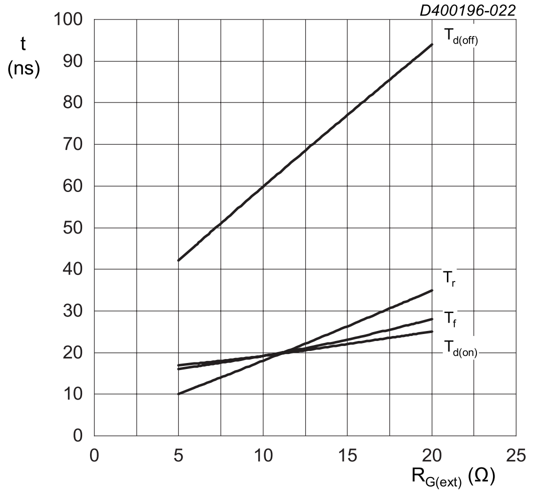

$I_{DS}$ = 33 A; $V_{DD}$ = 800 V; $R_{G(ext)}$ = 5.1 Ω;
$V_{GS}$ = -4 V/18 V; L = 100 μH
FWD = WNSC2M40140R

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




$T_j$ = 25 °C; $V_{DD}$ = 800 V; $I_{DS}$ = 33 A; $V_{GS}$ = -4 V/18 V
FWD = WNSC2M40140R; L = 100 μH

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




$T_j$ = 25 °C; $V_{DD}$ = 800 V; $I_{DS}$ = 33 A; $V_{GS}$ = -4 V/18 V
FWD = WNSC2M40140R; L = 100 μH

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

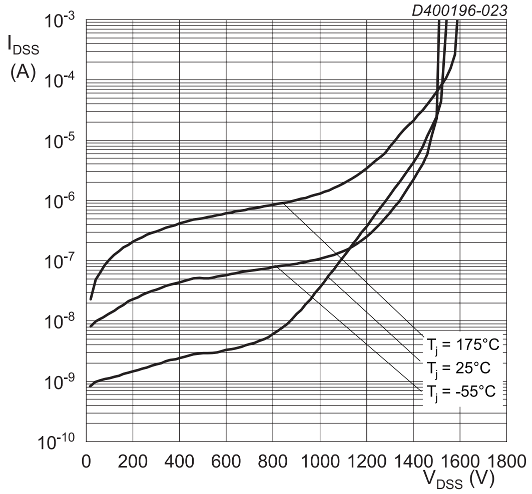
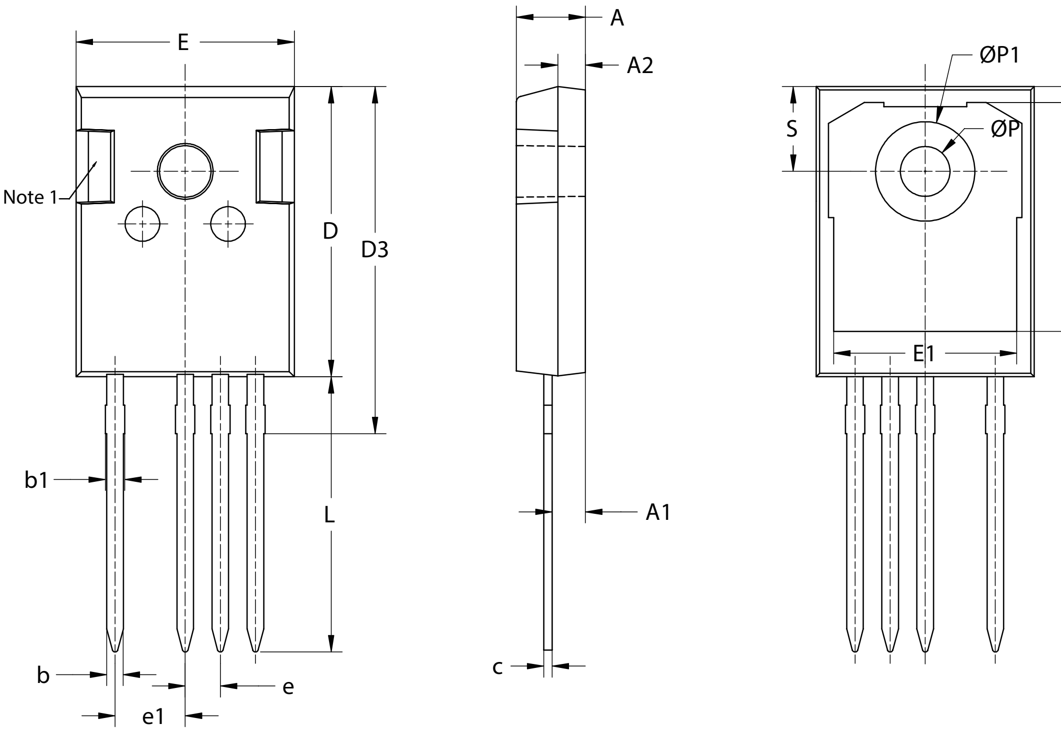


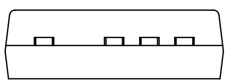

**Fig. 23. Breakdown voltage vs. Temperature**

# 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) | |
| | NOM | | | | | | | | | | | | | 2.54 | 5.08 | | | | (6.15) |
| | 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".
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## 13. Contents





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