

## 1. General description

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



AEC - Q101 Qualified



## 2. Features and benefits

- Kelvin source configuration
- Low specific on-resistance
- Optimized dynamic performance
- 0V turn-off  $V_{GS}$  for simple gate driving
- 100% UIS Tested
- Easy to parallel
- RoHS compliant
- Automotive Qualified (AEC-Q101)

## 3. Applications

- Automotive on board chargers
- Automotive DC-DC converters
- Automotive electric compressor motor drives
- HV battery management systems

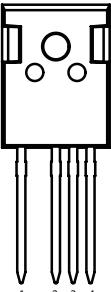
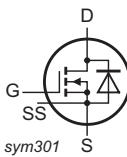
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                         | Parameter                        | Conditions  | Notes | Values     |     |     | Unit               |
|--------------------------------|----------------------------------|---|-------|------------|-----|-----|--------------------|
| <b>Absolute maximum rating</b> |                                  |   |       |            |     |     |                    |
| $V_{DS}$                       | drain-source voltage             | $25^{\circ}\text{C} \leq T_j \leq 175^{\circ}\text{C}$  |       | 1200       |     |     | V                  |
| $I_D$                          | drain current                    | $V_{GS} = 18\text{ V}; T_{mb} = 25^{\circ}\text{C}$   |       | 106.4      |     |     | A                  |
| $P_{tot}$                      | total power dissipation          | $T_{mb} = 25^{\circ}\text{C}, T_j = 175^{\circ}\text{C}$  |       | 652        |     |     | W                  |
| $T_j$                          | junction temperature             |   |       | -55 to 175 |     |     | $^{\circ}\text{C}$ |
| Symbol                         | Parameter                        | Conditions  | Notes | Min        | Typ | Max | Unit               |
| <b>Static characteristics</b>  |                                  |   |       |            |     |     |                    |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 15\text{ V}; I_D = 40\text{ A}; T_j = 25^{\circ}\text{C}$                                       |       | -          | 30  | -   | $\text{m}\Omega$   |
| <b>Dynamic characteristics</b> |                                  |   |       |            |     |     |                    |
| $Q_{G(tot)}$                   | total gate charge                | $I_D = 40\text{ A}; V_{DS} = 800\text{ V}; V_{GS} = -4\text{ V}/18\text{ V}; T_j = 25^{\circ}\text{C}$    |       | -          | 151 | -   | nC                 |
| $Q_{GD}$                       | gate-drain charge                |   |       | -          | 21  | -   | nC                 |
| <b>Source-drain diode</b>      |                                  |   |       |            |     |     |                    |
| $Q_r$                          | recovered charge                 | $I_{SD} = 40\text{ A}; di/dt = 500\text{ A}/\mu\text{s}; V_{DS} = 400\text{ V}; T_j = 25^{\circ}\text{C}$ |       | -          | 129 | -   | 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 |
|-----------------|--------------|-----------------------|----------------|------------------------|-----------------|--------------------|
| WNSC2M30120RA-A | TO247-4L     | WNSC2M30120RA-A6Q     | Tube           | 30                     | TO247N-4L       | 17-Dec-2021        |

## 7. Marking

Table 4. Marking codes

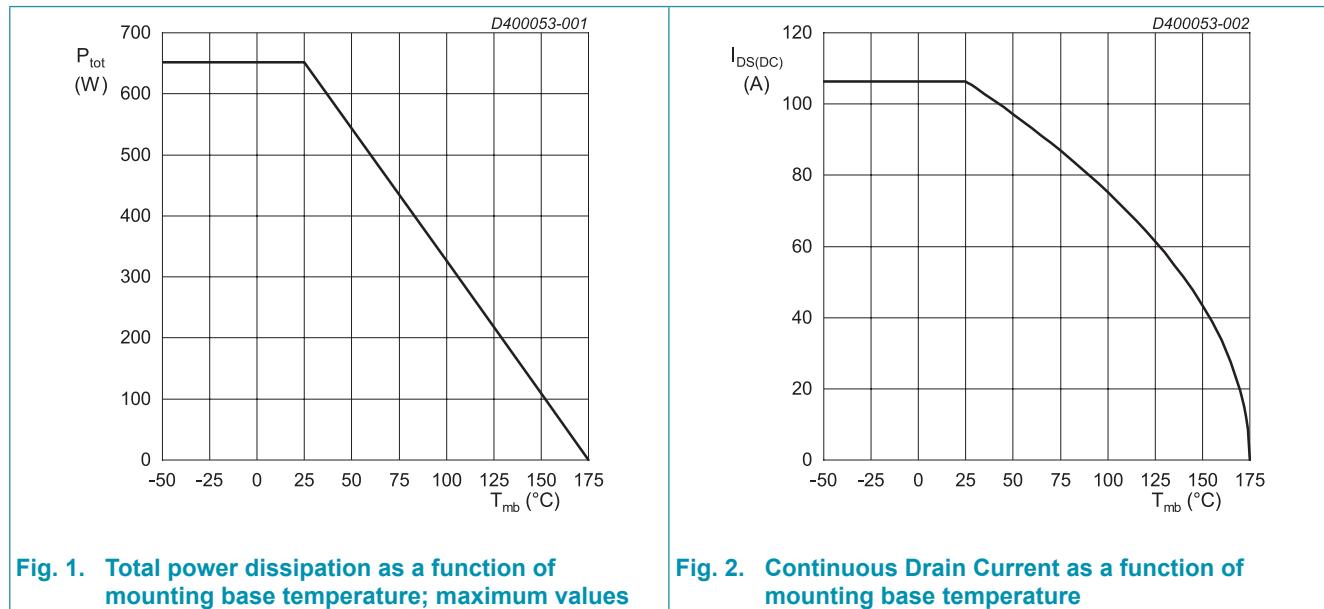
| Type number     | Marking codes       |
|-----------------|---------------------|
| WNSC2M30120RA-A | WNSC2M<br>30120RA-A |

## 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                   | $25^\circ\text{C} \leq T_j \leq 175^\circ\text{C}$                                     |       | 1200       | V    |
| $V_{GS,max}$ | gate-source voltage                    | Absolute maximum values  |       | -10 to 22  | V    |
| $V_{GS,op}$  | gate-source voltage                    | Recommended operational values   |       | -4 to 18   | V    |
| $P_{tot}$    | total power dissipation                | $T_{mb} = 25^\circ\text{C}, T_j = 175^\circ\text{C}$                                   |       | 652        | W    |
| $I_D$        |  | $V_{GS} = 18\text{ V}; T_{mb} = 25^\circ\text{C}$                                      |       | 106.4      | A    |
| $I_{DM}$     | peak drain current                     | $V_{GS} = 18\text{ V}; T_{mb} = 100^\circ\text{C}$                                     |       | 75.2       | A    |
| $I_S$        | continuous diode current               | $V_{GS} = -4\text{ V}; T_{mb} = 25^\circ\text{C}$                                      |       | 84.4       | A    |
| $I_{SM}$     | pulse diode current                    | $V_{GS} = -4\text{ V}; \text{pulse width } t_p \text{ limited by } T_{jmax}$           |       | 200        | A    |
| $E_{as}$     | single pulse drain-to-source avalanche | $I_{AS} = 20\text{ A}; L = 1\text{ mH}; V_{DD} = 100\text{ V}; T_j = 25^\circ\text{C}$ |       | 200        | 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   |



## 9. Thermal & Mechanical characteristics

Table 6. Thermal & Mechanical characteristics

| Symbol                | Parameter   | Conditions         | Notes | Min | Typ  | Max | Unit |
|-----------------------|---|--------------------|-------|-----|------|-----|------|
| $R_{th(j\text{-}mb)}$ | thermal resistance from junction to mounting base |                    |       | -   | 0.23 | -   | K/W  |
| $R_{th(j\text{-}a)}$  | 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 recommended.

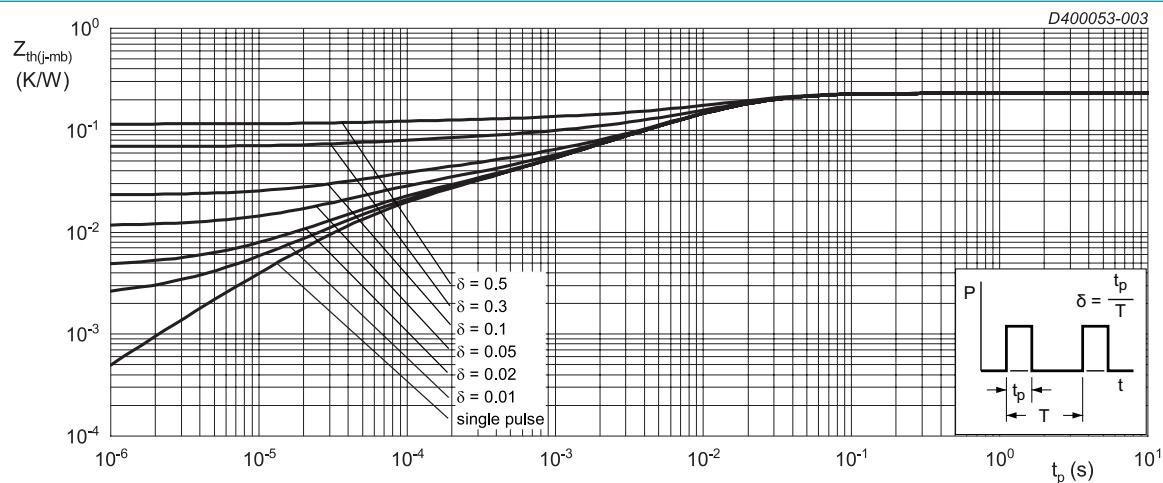
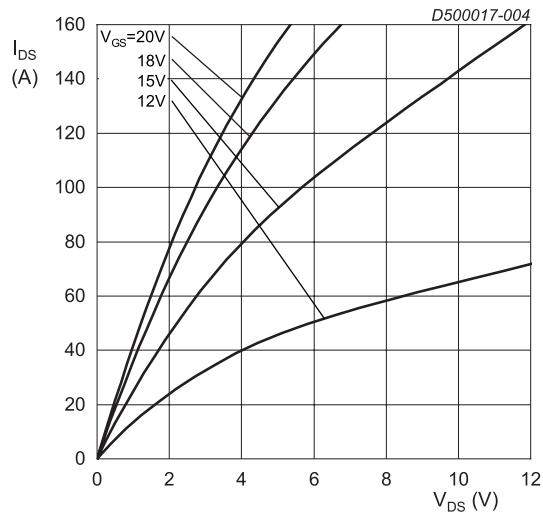


Fig. 3. Transient thermal impedance from junction to mounting base as a function of pulse duration

## 10. Characteristics

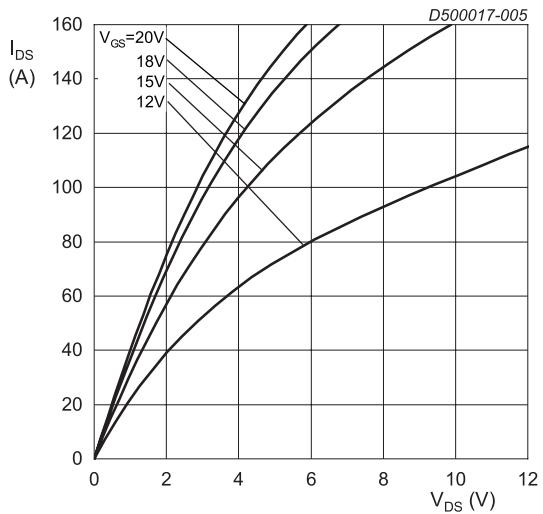
Table 7. Characteristics

| Symbol                         | Parameter                        | Conditions   | Notes  | Min  | Typ  | Max | Unit      |
|--------------------------------|----------------------------------|--|--------|------|------|-----|-----------|
| <b>Static characteristics</b>  |                                  |  |        |      |      |     |           |
| $V_{(BR)DSS}$                  | drain-source breakdown voltage   | $I_D = 100 \mu A; V_{GS} = 0 V; T_j = 25^\circ C$  |        | 1200 | -    | -   | V         |
| $V_{GS(th)}$                   | gate-source threshold voltage    | $I_D = 12 mA; V_{DS} = 10 V; T_j = 25^\circ C$   |        | 1.9  | 2.6  | 3.5 | V         |
|                                |                                  | $I_D = 12 mA; V_{DS} = 10 V; T_j = 175^\circ C$  |        | -    | 1.9  | -   | V         |
| $I_{DSS}$                      | drain leakage current            | $V_{DS} = 1200 V; V_{GS} = 0 V; T_j = 25^\circ C$  |        | -    | 0.2  | 100 | $\mu A$   |
|                                |                                  | $V_{DS} = 1200 V; V_{GS} = 0 V; T_j = 175^\circ C$   |        | -    | 2    | -   | $\mu A$   |
| $I_{GSS}$                      | gate leakage current             | $V_{GS} = 22 V; V_{DS} = 0 V; T_j = 25^\circ C$  |        | -    | 10   | 100 | nA        |
|                                |                                  | $V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25^\circ C$   |        | -    | 10   | 100 | nA        |
| $R_{DS(on)}$                   | drain-source on-state resistance | $V_{GS} = 15 V; I_D = 40 A; T_j = 25^\circ C$  |        | -    | 30   | -   | $m\Omega$ |
|                                |                                  | $V_{GS} = 18 V; I_D = 40 A; T_j = 25^\circ C$  |        | -    | 24   | 40  | $m\Omega$ |
|                                |                                  | $V_{GS} = 18 V; I_D = 40 A; T_j = 175^\circ C$   |        | -    | 48   | -   | $m\Omega$ |
| $R_G$                          | gate resistance                  | $f = 1 MHz; T_j = 25^\circ C$  |        | -    | 0.8  | -   | $\Omega$  |
| $g_{fs}$                       | transconductance                 | $V_{DS} = 20 V; I_D = 40 A; T_j = 25^\circ C$  |        | -    | 27   | -   | S         |
| <b>Dynamic characteristics</b> |                                  |  |        |      |      |     |           |
| $Q_{G(tot)}$                   | total gate charge                | $I_D = 40 A; V_{DS} = 800 V; V_{GS} = -4 V/18 V; T_j = 25^\circ C$   |        | -    | 151  | -   | nC        |
| $Q_{GS}$                       | gate-source charge               |  |        | -    | 63   | -   | nC        |
| $Q_{GD}$                       | gate-drain charge                |  |        | -    | 21   | -   | nC        |
| $C_{iss}$                      | input capacitance                | $V_{DS} = 1000 V; V_{GS} = 0 V; f = 1 MHz; T_j = 25^\circ C$   |        | -    | 3305 | -   | pF        |
| $C_{oss}$                      | output capacitance               |  |        | -    | 139  | -   | pF        |
| $C_{rss}$                      | reverse transfer capacitance     |  |        | -    | 12   | -   | pF        |
| $E_{oss}$                      | Coss stored energy               |  |        | -    | 69.5 | -   | $\mu J$   |
| $t_{d(on)}$                    | turn-on delay time               | $V_{DS} = 800 V; V_{GS} = -4 V/18 V; R_{G(ext)} = 2.4 \Omega; I_D = 40 A; L = 100 \mu H; T_j = 25^\circ C$ |        | -    | 23   | -   | ns        |
| $t_r$                          | rise time                        |  |        | -    | 22   | -   | ns        |
| $t_{d(off)}$                   | turn-off delay time              |  |        | -    | 40   | -   | ns        |
| $t_f$                          | fall time                        |  |        | -    | 8    | -   | ns        |
| $E_{on}$                       | turn-on energy (SiC Diode FWD)   |  | Fig.20 | -    | 257  | -   | $\mu J$   |
| $E_{off}$                      | turn-off energy (SiC Diode FWD)  |  | Fig.20 | -    | 137  | -   | $\mu J$   |
| $E_{on}$                       | turn-on energy (Body Diode FWD)  |  | Fig.20 | -    | 479  | -   | $\mu J$   |
| $E_{off}$                      | turn-off energy (Body Diode FWD) |  | Fig.20 | -    | 175  | -   | $\mu J$   |
| <b>Source-drain diode</b>      |                                  |  |        |      |      |     |           |
| $V_{SD}$                       | source-drain voltage             | $V_{GS} = 0 V; I_{SD} = 20 A; T_j = 25^\circ C$  |        | -    | 3.1  | -   | V         |
|                                |                                  | $V_{GS} = -4 V; I_{SD} = 20 A; T_j = 25^\circ C$   |        | -    | 4.9  | -   | V         |
|                                |                                  | $V_{GS} = -4 V; I_{SD} = 20 A; T_j = 175^\circ C$  |        | -    | 4.3  | -   | V         |
| $t_{rr}$                       | reverse recovery time            | $I_{SD} = 40 A; di/dt = 500 A/\mu s; V_{DS} = 400 V; T_j = 25^\circ C$                                     |        | -    | 33.4 | -   | ns        |
| $Q_r$                          | recovered charge                 |  |        | -    | 129  | -   | nC        |
| $I_{rrm}$                      | reverse recovery current         |  |        | -    | 6.9  | -   | A         |



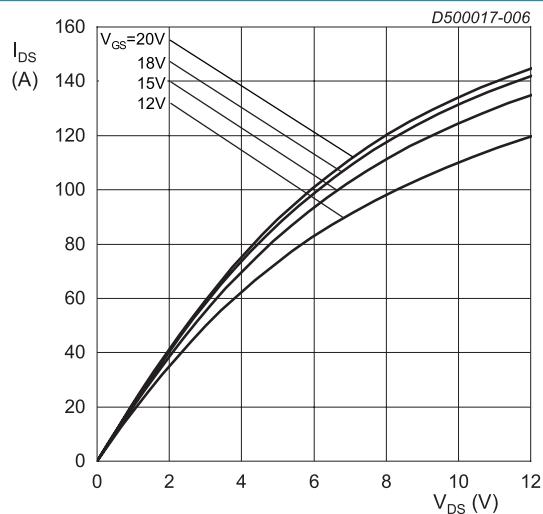
$T_j = -55^\circ\text{C}$ ;  $t_p < 200 \mu\text{s}$

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



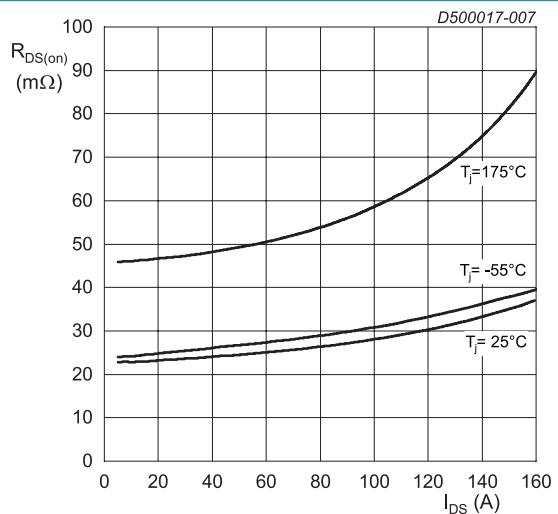
$T_j = 25^\circ\text{C}$ ;  $t_p < 200 \mu\text{s}$

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



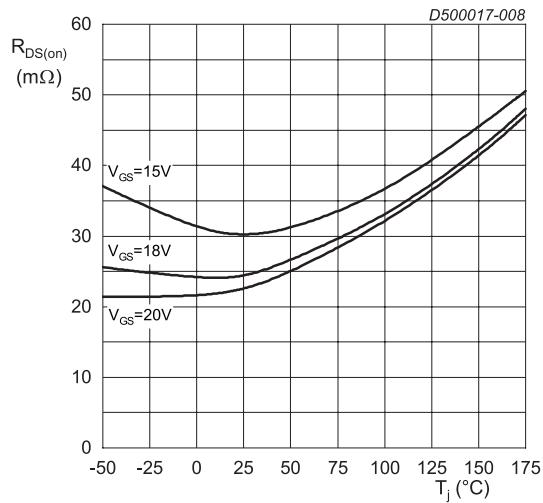
$T_j = 175^\circ\text{C}$ ;  $t_p < 200 \mu\text{s}$

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



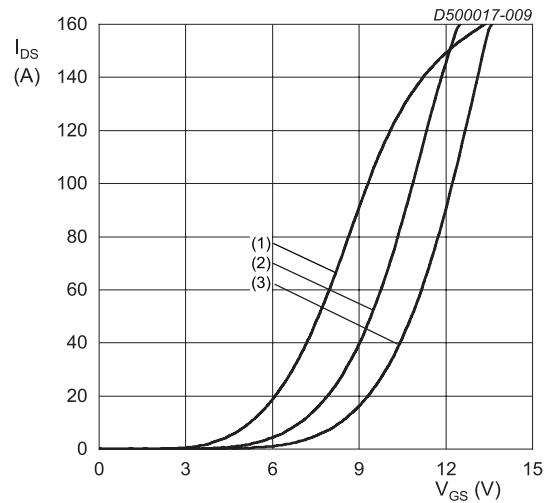
$V_{GS} = 18 \text{ V}$ ;  $t_p < 200 \mu\text{s}$

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



$I_{DS} = 40 A$ ;  $t_p < 200 \mu s$

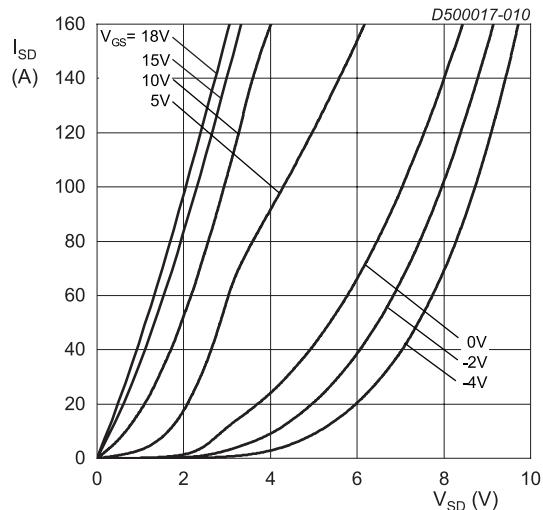
Fig. 8. Drain-source on-state resistance as a function of junction temperature



$V_{DS} = 20 V$ ;  $t_p < 200 \mu s$

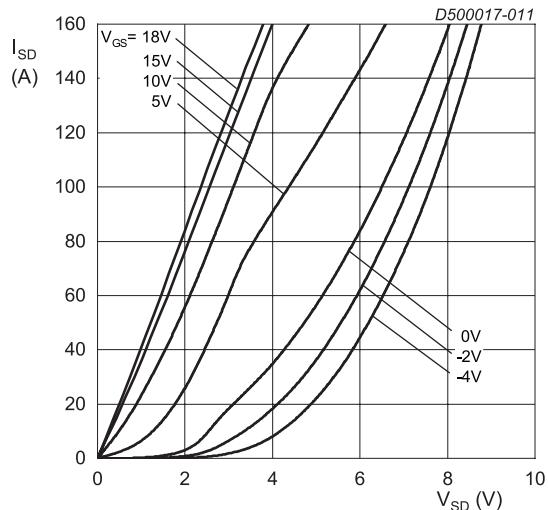
- (1)  $T_j = 175^\circ C$
- (2)  $T_j = 25^\circ C$
- (3)  $T_j = -55^\circ C$

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



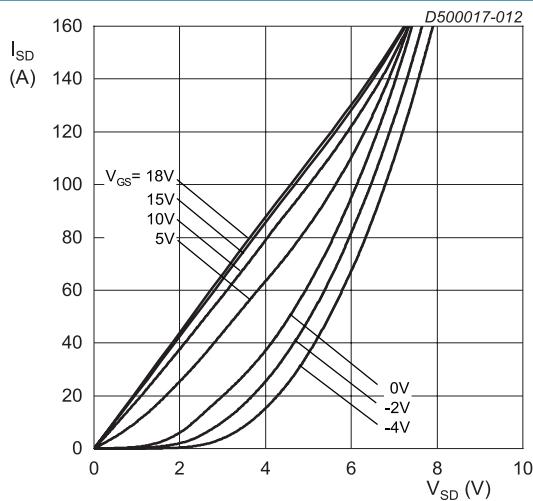
$T_j = -55^\circ C$ ;  $t_p < 200 \mu s$

Fig. 10. Body diode forward characteristics; typical values



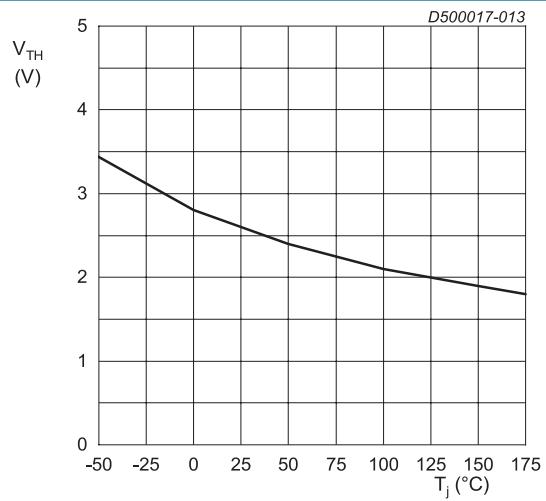
$T_j = 25^\circ C$ ;  $t_p < 200 \mu s$

Fig. 11. Body diode forward characteristics; typical values



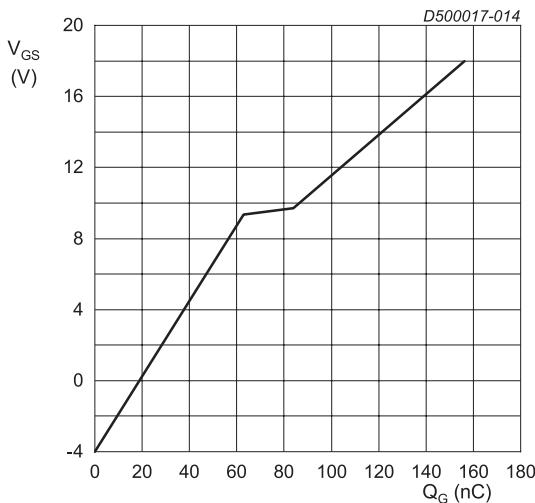
$T_j = 175^\circ\text{C}$ ;  $t_p < 200 \mu\text{s}$

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



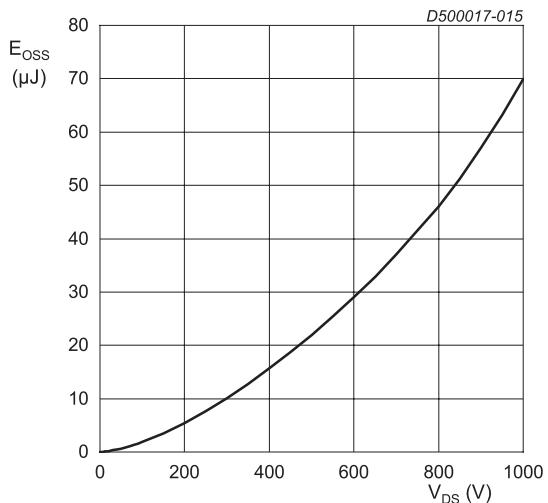
$V_{DS} = 10 \text{ V}$ ;  $I_{DS} = 12 \text{ mA}$

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

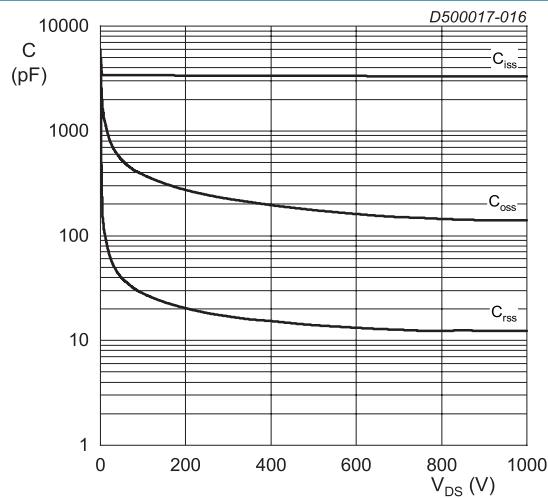


$I_{DS} = 40 \text{ A}$ ;  $I_{GS} = 0.1 \text{ mA}$ ;  $V_{DS} = 800 \text{ V}$ ;  $T_j = 25^\circ\text{C}$

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

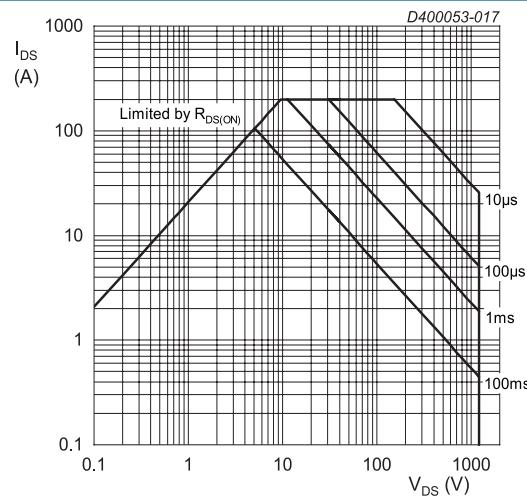


**Fig. 15. Output capacitor stored energy as a function of drain-source voltage**



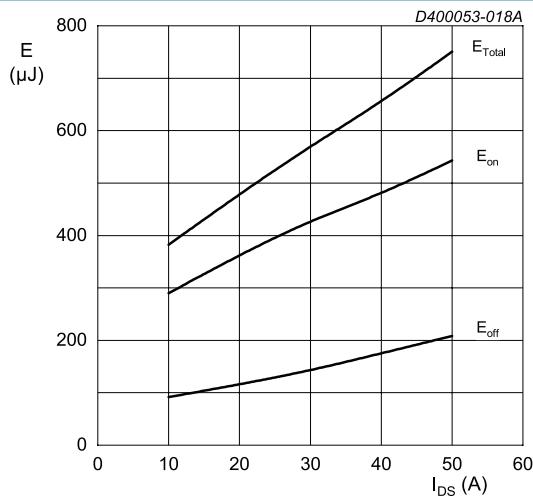
$V_{DS} = 0 - 1000$  V  
 $T_j = 25$  °C;  $V_{AC} = 25$  mV;  $f = 1$  MHz

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



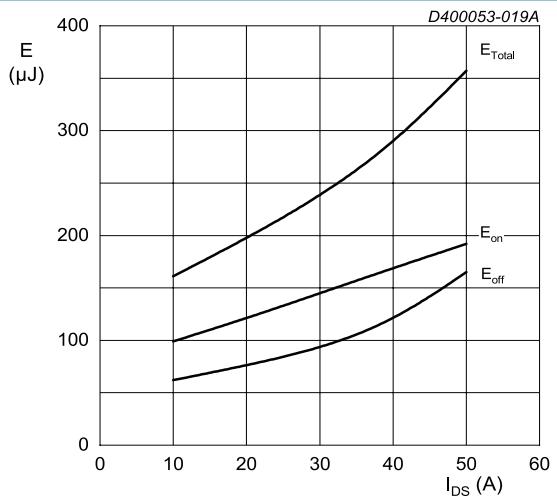
$T_j = 25$  °C;  $D = 0$   
Parameter:  $t_p$

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



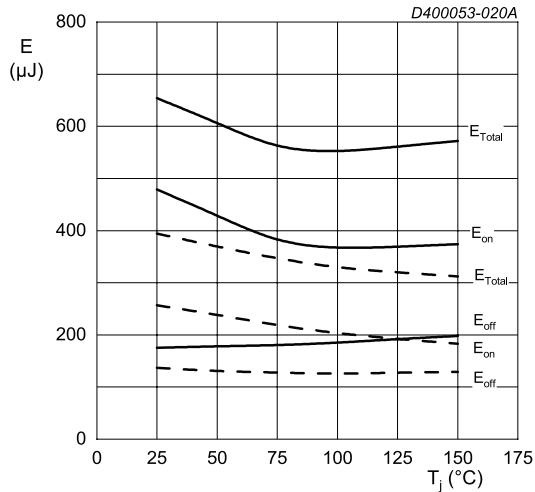
$T_j = 25$  °C;  $V_{DD} = 800$  V;  $R_{G(ext)} = 2.4$  Ω;  
 $V_{GS} = -4$  V/18 V;  $L = 100$  μH  
FWD = WNSC2M30120RA-A

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



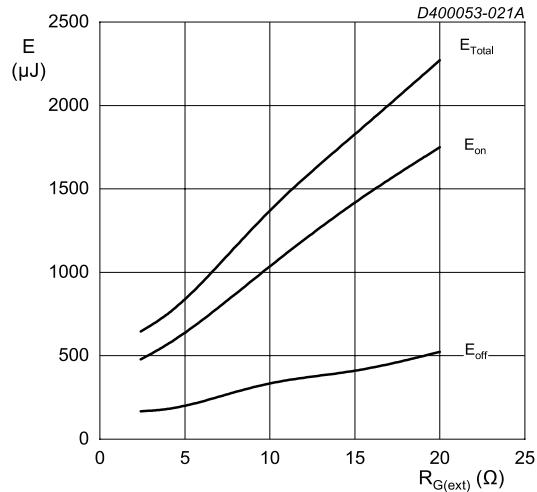
$T_j = 25$  °C;  $V_{DD} = 600$  V;  $R_{G(ext)} = 2.4$  Ω;  
 $V_{GS} = -4$  V/18 V;  $L = 100$  μH  
FWD = WNSC2M30120RA-A

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



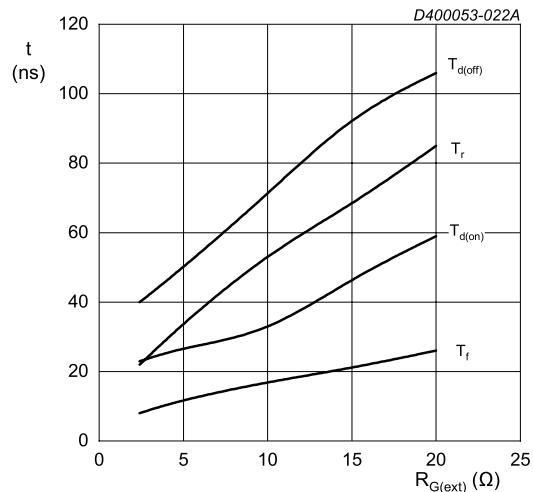
$I_{DS} = 40 \text{ A}$ ;  $V_{DD} = 800 \text{ V}$ ;  $R_{G(ext)} = 2.4 \Omega$ ;  
 $V_{GS} = -4 \text{ V}/18 \text{ V}$ ;  $L = 100 \mu\text{H}$   
FWD = WNSC2M30120RA-A  
FWD = WNSC2D101200(— · —)

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



$T_j = 25 \text{ °C}$ ;  $V_{DD} = 800 \text{ V}$ ;  $I_{DS} = 40 \text{ A}$ ;  $V_{GS} = -4 \text{ V}/18 \text{ V}$   
FWD = WNSC2M30120RA-A;  $L = 100 \mu\text{H}$

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



$T_j = 25 \text{ °C}$ ;  $V_{DD} = 800 \text{ V}$ ;  $I_{DS} = 40 \text{ A}$ ;  $V_{GS} = -4 \text{ V}/18 \text{ V}$   
FWD = WNSC2M30120RA-A;  $L = 100 \mu\text{H}$

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

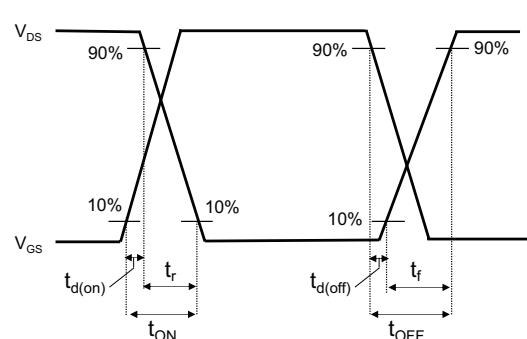
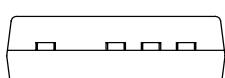
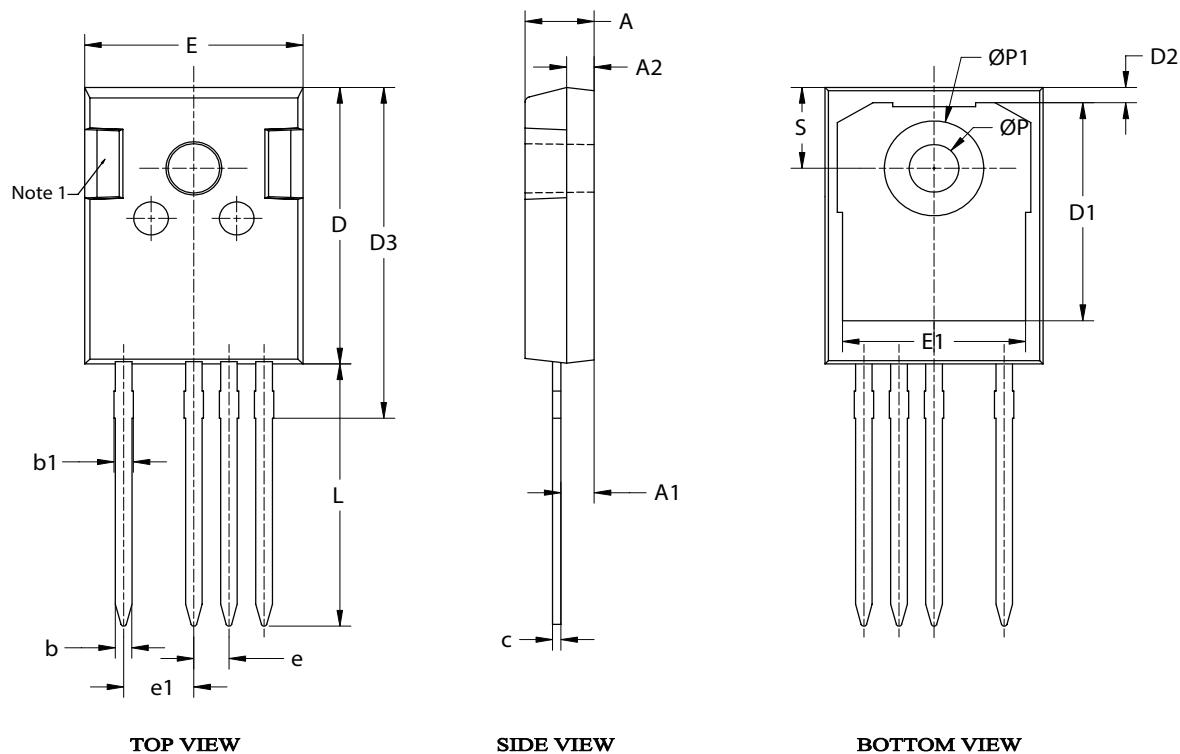


Fig. 23. Switching time definition

## 11. Package outline

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

TO247-4L



**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 | 2.31 | 1.90 | 1.10 | 1.10 | 0.50 | 20.90 | 16.25 | 1.05  | 24.97 | 15.70 | 13.10 | 2.44  | 5.08 | 19.80 | 3.50  | -    | (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 | -      | (6.15) |

**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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