

**900V, 50A, N-channel SiC power MOSFET**
**General Description:**

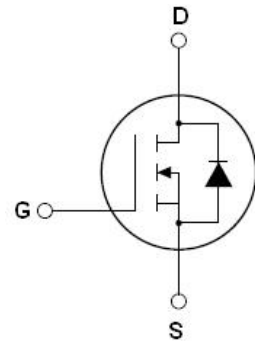
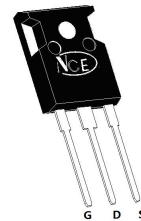
NCES090P050T is a SiC MOSFET that contributes to miniaturization and low power consumption of applications. This product achieves industry-leading low on-resistance without sacrificing short-circuit withstand time.

**Features**

- Low on-resistance
- Fast switching speed
- Fast reverse recovery
- Easy to parallel
- Simple to drive
- Pb-free lead plating ; RoHS compliant

**Application**

- Solar inverters
- DC/DC converters
- Switch mode power supplies
- Induction heating
- Motor drives


**Schematic diagram**

**TO-247-3L**
**Package Marking and Ordering Information**

| Device       | Device Package | Device Marking |
|--------------|----------------|----------------|
| NCES090P050T | TO-247-3L      | NCES090P050T   |

**Absolute Maximum Ratings (T<sub>c</sub>=25°C unless otherwise noted)**

| Parameter  | Symbol                           | Limit                   | Unit |
|--|----------------------------------|-------------------------|------|
| Drain-Source Voltage                               | V <sub>DS</sub>                  | 900                     | V    |
| Gate-Source Voltage,max static voltage             | V <sub>GS</sub>                  | -10 to +24              | V    |
| Gate-Source Voltage,max transient voltage (Note 1) | V <sub>GS</sub>                  | -11 to +26              | V    |
| Drain Current-Continuous (Note 2)                  | I <sub>D</sub>                   | 50                      | A    |
| Drain Current-Continuous(T <sub>c</sub> =100°C)    | I <sub>D</sub> (100°C)           | 35                      | A    |
| Pulsed Drain Current (Note 3)                      | I <sub>DM</sub>                  | 125                     | A    |
| Maximum Power Dissipation                          | P <sub>D</sub>                   | T <sub>vj</sub> = 25°C  | 180  |
|  |                                  | T <sub>vj</sub> = 100°C | 90   |
| Recommended turn-on gate - source drive voltage    | V <sub>GS_on</sub>               | +15 to +18              | V    |
| Recommended turn-off gate - source drive voltage   | V <sub>GS_off</sub>              | -4 to 0                 | V    |
| Virtual junction temperature                       | T <sub>vj</sub>                  | 175                     | °C   |
| Operating Junction and Storage Temperature Range   | T <sub>J</sub> ,T <sub>STG</sub> | -55 To 175              | °C   |

**Thermal Characteristic**

| Symbol          | Parameter                            | Value | Units |
|-----------------|--------------------------------------|-------|-------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to case | 0.83  | °C/W  |

**Electrical Characteristics ( $T_c=25^\circ\text{C}$  unless otherwise noted)**

| Parameter                                    | Symbol       | Condition  | Min                          | Typ  | Max       | Unit      |   |
|--|--------------|--|------------------------------|------|-----------|-----------|---|
| <b>Off Characteristics</b>                   |              |  |                              |      |           |           |   |
| Drain-Source Breakdown Voltage               | $BV_{DSS}$   | $V_{GS}=0V, I_D=100\mu A$  | 900                          |      |           | V         |   |
| Zero Gate Voltage Drain Current              | $I_{DSS}$    | $V_{DS}=900V, V_{GS}=0V$   | $T_{vj} = 25^\circ\text{C}$  | 1    | 80        | $\mu A$   |   |
|  |              |  | $T_{vj} = 175^\circ\text{C}$ | 2    |           |           |   |
| Gate-Body Leakage Current                    | $I_{GSS}$    | $V_{GS}=-10V / +22V, V_{DS}=0V$                                      |                              |      | $\pm 100$ | nA        |   |
| <b>On Characteristics (Note 4)</b>           |              |  |                              |      |           |           |   |
| Gate Threshold Voltage                       | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=6mA$   | $T_{vj} = 25^\circ\text{C}$  | 1.9  | 3.0       | 4.8       | V |
|  |              |  | $T_{vj} = 175^\circ\text{C}$ |      | 2.1       |           |   |
| Drain-Source On-State Resistance             | $R_{DS(on)}$ | $V_{GS}=18V, I_D=20A$  | $T_{vj} = 25^\circ\text{C}$  | 50   | 65        | $m\Omega$ |   |
|  |              |  | $T_{vj} = 175^\circ\text{C}$ | 58   |           |           |   |
| Drain-Source On-State Resistance             | $R_{DS(on)}$ | $V_{GS}=15V, I_D=20A$  | $T_{vj} = 25^\circ\text{C}$  | 63   | 82        | $m\Omega$ |   |
|  |              |  | $T_{vj} = 175^\circ\text{C}$ | 74   |           |           |   |
| Gate input resistance                        | $R_G$        | $f=1MHz, \text{open drain}$  |                              | 2.5  |           | $\Omega$  |   |
| Forward Transconductance                     | $g_{FS}$     | $V_{DS}=20V, I_D=20A$  |                              | 12.5 |           | S         |   |
| <b>Dynamic Characteristics (Note 5)</b>      |              |  |                              |      |           |           |   |
| Input Capacitance                            | $C_{iss}$    | $V_{DS}=500V, V_{GS}=0V, f=1MHz$                                     |                              | 1680 |           | pF        |   |
| Output Capacitance                           | $C_{oss}$    |  |                              | 112  |           | pF        |   |
| Reverse Transfer Capacitance                 | $C_{rss}$    |  |                              | 4.7  |           | pF        |   |
| $C_{oss}$ stored energy                      | $E_{oss}$    |  |                              | 22.3 |           | $\mu J$   |   |
| Output charge                                | $Q_{oss}$    | Calculated by $C_{oss}(f)V_{DS}@1MHz$                                |                              | 120  |           | nC        |   |
| Effective output capacitance, energy related | $C_{o(er)}$  | $V_{DS}=0-500V, V_{GS}=0V$   |                              | 178  |           | pF        |   |
| Effective output capacitance, time related   | $C_{o(tr)}$  | $I_c=\text{constant}, V_{DS}=0-500V, V_{GS}=0V$                      |                              | 240  |           | pF        |   |
| <b>Switching Characteristics (Note 5)</b>    |              |  |                              |      |           |           |   |
| Turn-on Delay Time                           | $t_{d(on)}$  | $V_{DD}=500V, I_D=20A, V_{GS}=+18V / -3V, R_G=2.7\Omega, L=200\mu H$ |                              | 11.3 |           | ns        |   |
| Turn-on Rise Time                            | $t_r$        |  |                              | 16.5 |           | ns        |   |
| Turn-Off Delay Time                          | $t_{d(off)}$ |  |                              | 26.2 |           | ns        |   |
| Turn-Off Fall Time                           | $t_f$        |  |                              | 8.2  |           | ns        |   |
| Turn-on energy                               | $E_{on}$     | $V_{DD}=500V, I_D=20A, V_{GS}=+18V / -3V, R_G=2.7\Omega, L=200\mu H$ | $T_{vj} = 25^\circ\text{C}$  | 90   |           | $\mu J$   |   |
|  |              |  | $T_{vj} = 175^\circ\text{C}$ | 95   |           | $\mu J$   |   |
| Turn-off energy                              | $E_{off}$    | $R_G=2.7\Omega, L=200\mu H$  | $T_{vj} = 25^\circ\text{C}$  | 31   |           | $\mu J$   |   |
|  |              |  | $T_{vj} = 175^\circ\text{C}$ | 35   |           | $\mu J$   |   |
| Total Gate Charge                            | $Q_g$        | $V_{DS}=500V, I_D=20A, V_{GS}=-3/18V$                                |                              | 64   |           | nC        |   |
| Gate-Source Charge                           | $Q_{gs}$     |  |                              | 18   |           | nC        |   |
| Gate-Drain Charge                            | $Q_{gd}$     |  |                              | 17   |           | nC        |   |

**Electrical Characteristics (T<sub>C</sub>=25°C unless otherwise noted)**

| Parameter                                 | Symbol           | Condition   | Min                     | Typ  | Max | Unit |
|---|------------------|---|-------------------------|------|-----|------|
| <b>Drain-Source Diode Characteristics</b> |                  |   |                         |      |     |      |
| Diode Forward Voltage (Note 4)            | V <sub>SD</sub>  | V <sub>GS</sub> =0V, I <sub>SD</sub> =20A   | T <sub>vj</sub> = 25°C  |      | 3.4 | V    |
|   |                  |   | T <sub>vj</sub> = 175°C |      | 3.0 |      |
| Reverse Recovery Time                     | t <sub>rr</sub>  | T <sub>J</sub> = 25°C, I <sub>F</sub> =20A, V <sub>R</sub> =500V,<br>di/dt = 2830A/μs (Note3) |                         | 16.2 |     | ns   |
| Reverse Recovery Charge                   | Q <sub>rr</sub>  |   |                         | 248  |     | nC   |
| Peak reverse recovery current             | I <sub>rrm</sub> |   |                         | 30.1 |     | A    |

**Notes:**

1. t<sub>p</sub> < 500ns, D < 0.01
2. TO220 equivalent. Limited by T<sub>J</sub> max.
3. PW ≤ 10μs, Duty cycle ≤ 1%
4. Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.
5. Guaranteed by design, not subject to production

## Test Circuit

Fig.1-1 Gate Charge Measurement Circuit



Fig.1-2 Gate Charge Waveform

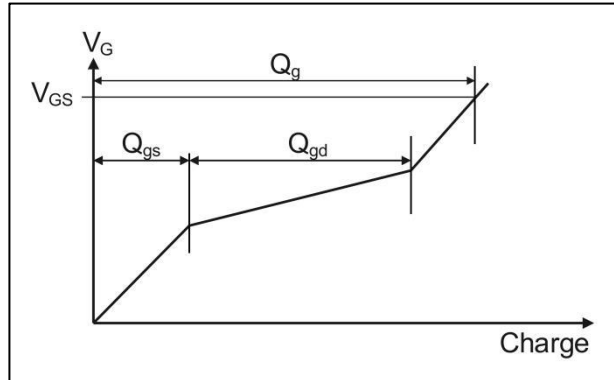


Fig.2-1 Switching Characteristics Measurement Circuit

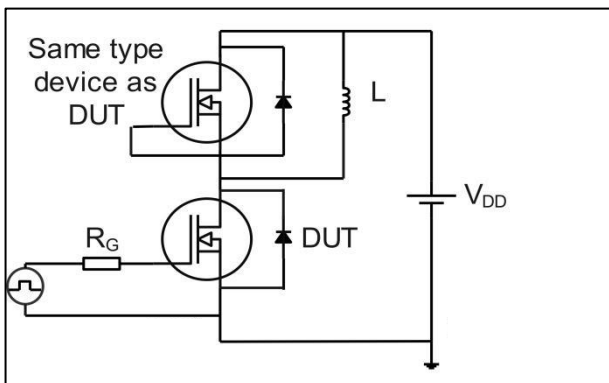
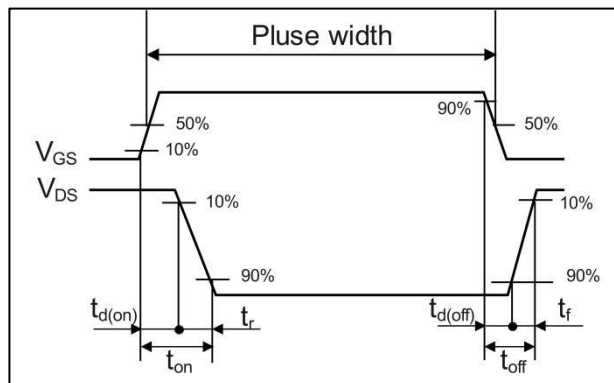


Fig.2-2 Waveforms for Switching Time



Typical Electrical and Thermal Characteristics

Fig.1 Power Dissipation Derating Curve

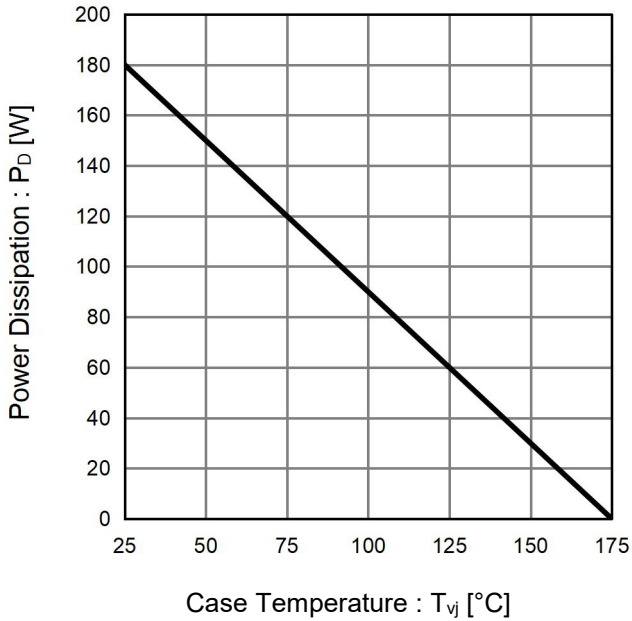


Fig.2 Maximum Safe Operating Area

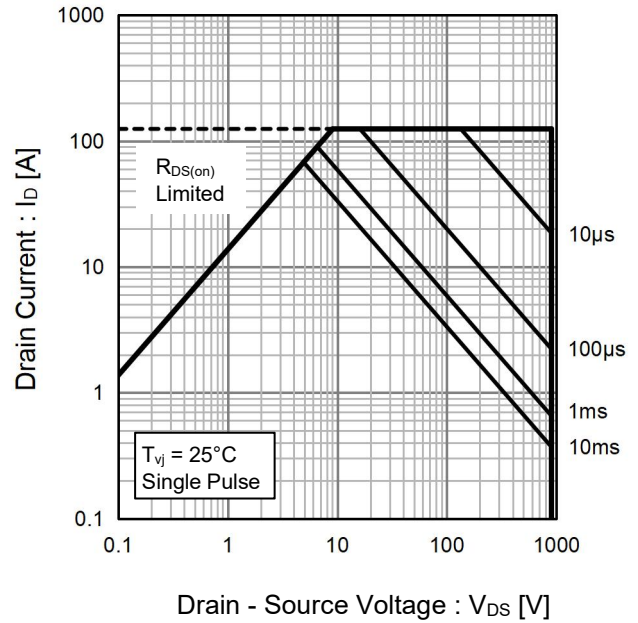


Fig.3 Typical Transient Thermal Impedance vs. Pulse Width

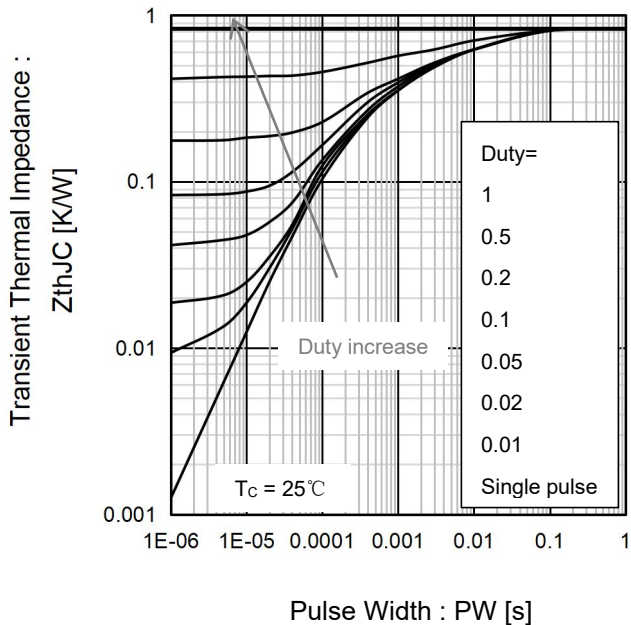


Fig.4  $T_{vj} = 25^{\circ}\text{C}$  Typical Output Characteristics

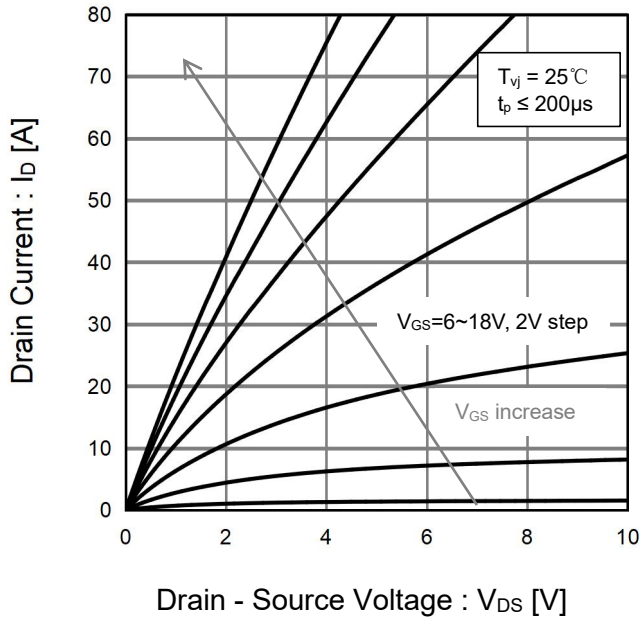


Fig.5  $T_{vj} = 25^{\circ}\text{C}$  3rd Quadrant Characteristics

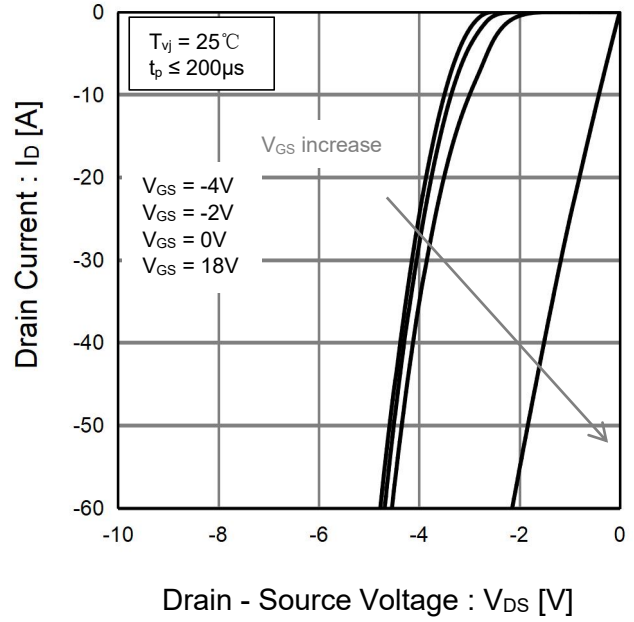


Fig.6  $T_{vj} = 175^{\circ}\text{C}$  Typical Output Characteristics

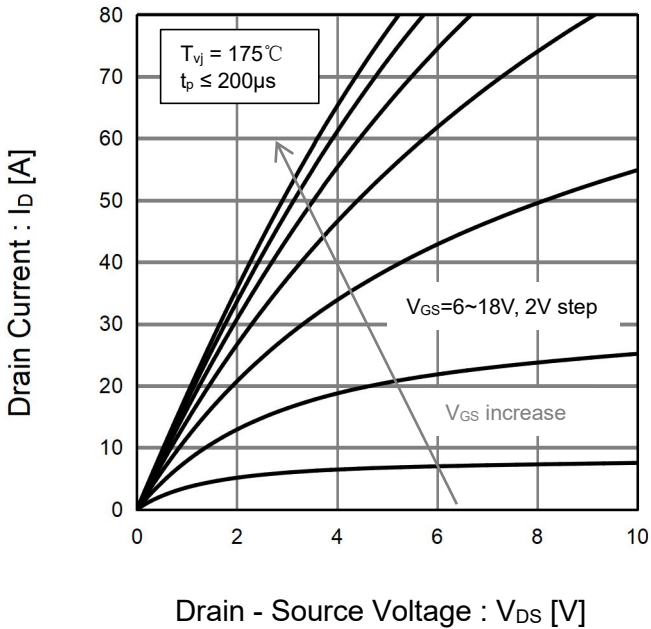


Fig.7  $T_{vj} = 175^{\circ}\text{C}$  3rd Quadrant Characteristics

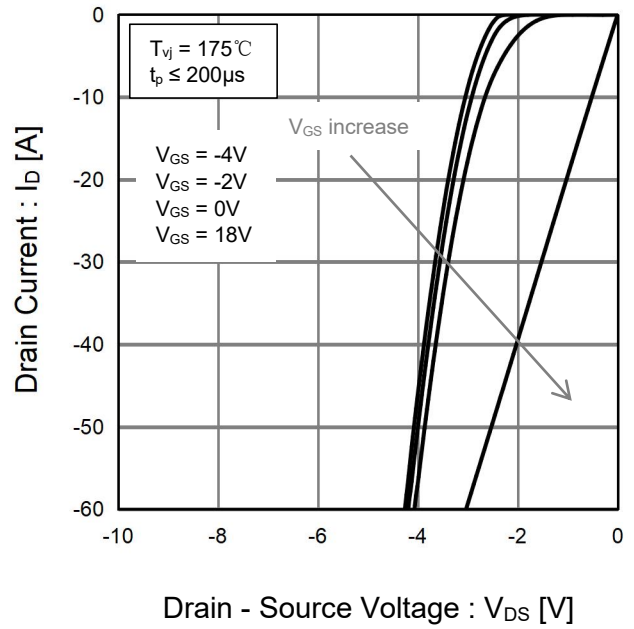


Fig.8 Typical Transfer Characteristics

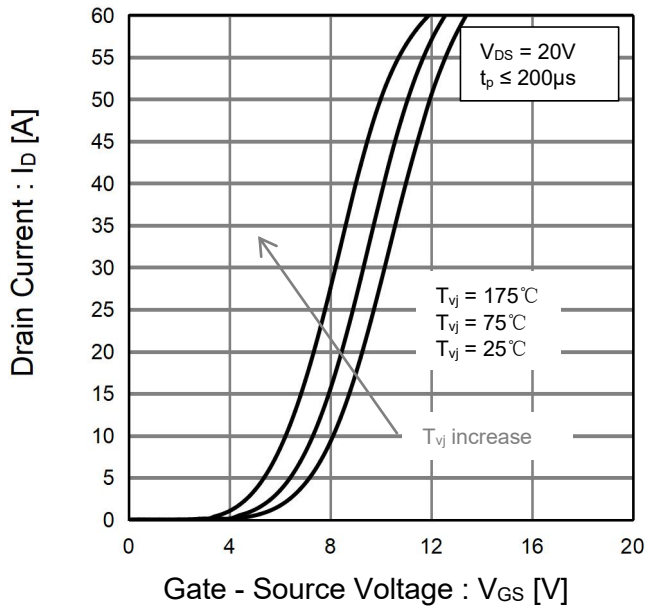


Fig.9 Static Drain - Source On - State Resistance vs. Gate - Source Voltage

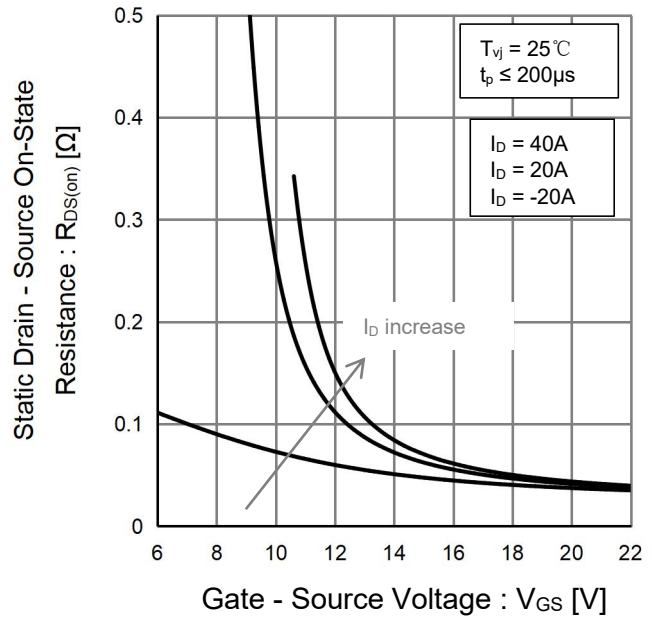


Fig.10 Static Drain - Source On - State Resistance vs. Drain Current

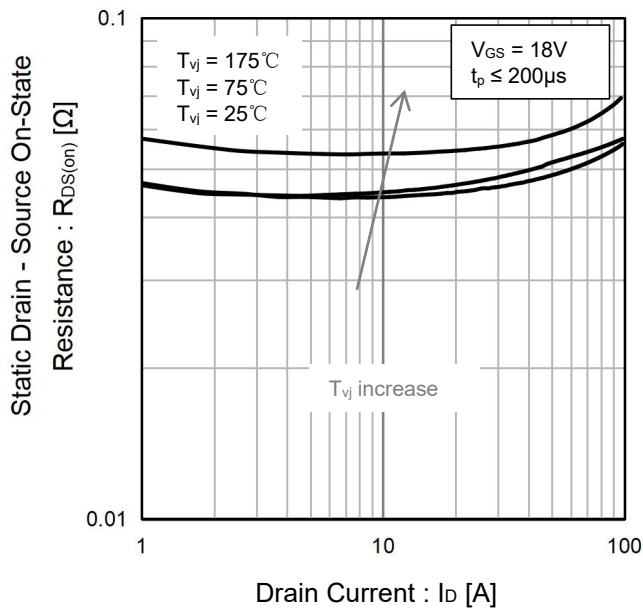


Fig.11 Static Drain - Source On - State Resistance vs. Virtual Junction Temperature

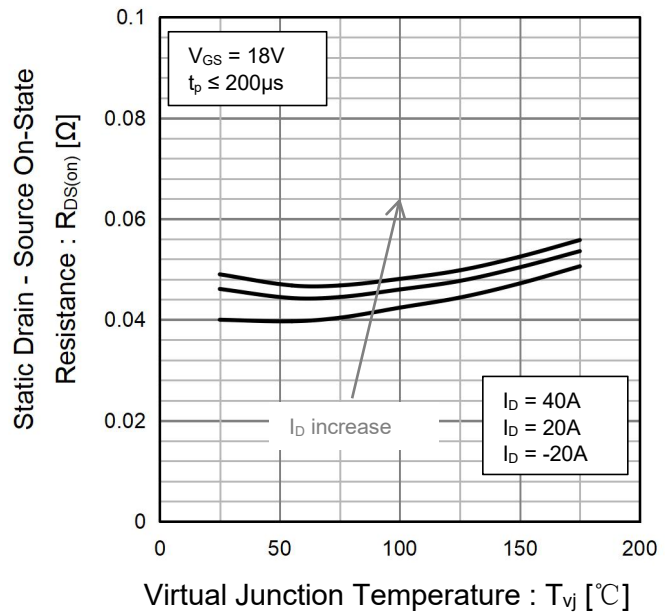


Fig.12 Body Diode Forward Voltage vs. Gate - Source Voltage

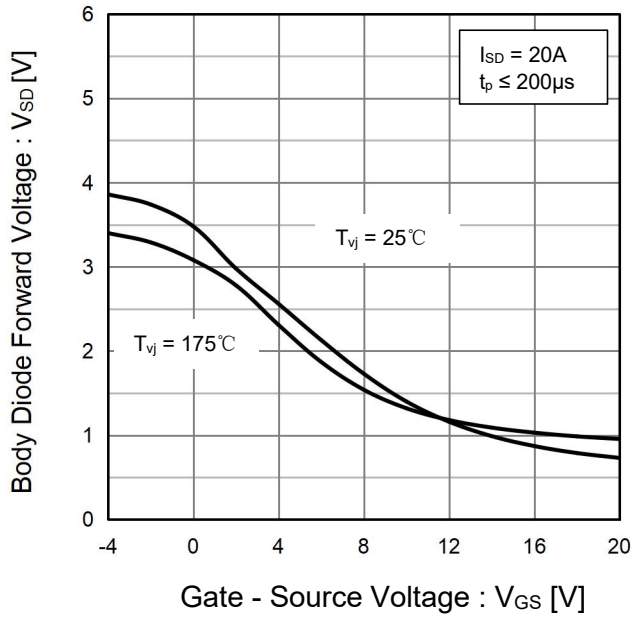


Fig.13 Gate Threshold Voltage vs. Virtual Junction Temperature

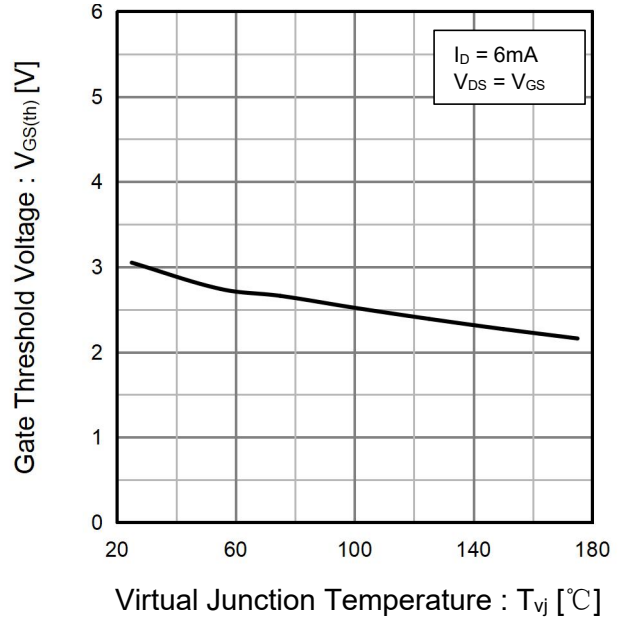


Fig.14 Typical Capacitance vs. Drain - Source Voltage

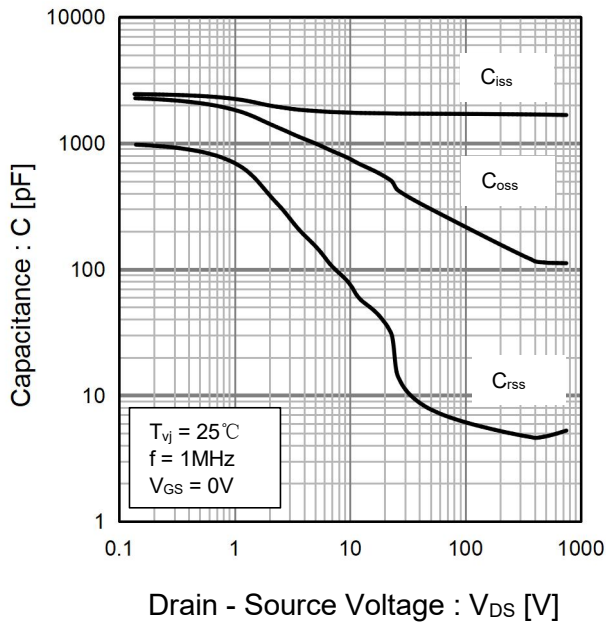


Fig.15 Coss Stored Energy

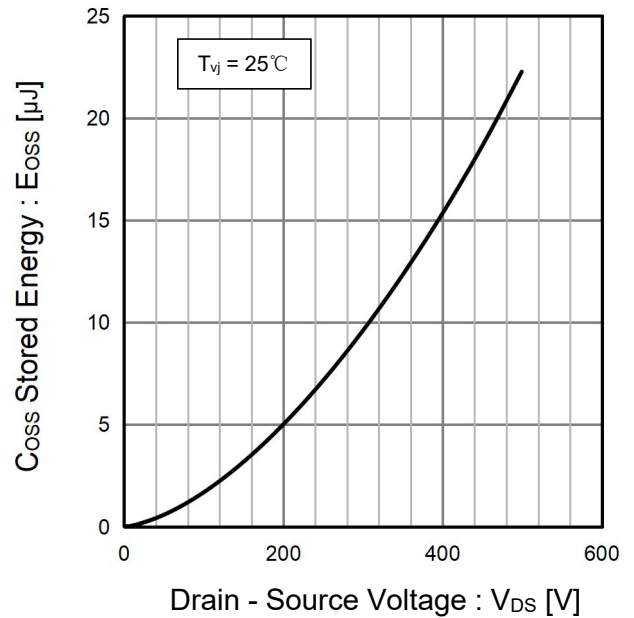


Fig.16 Dynamic Input Characteristics

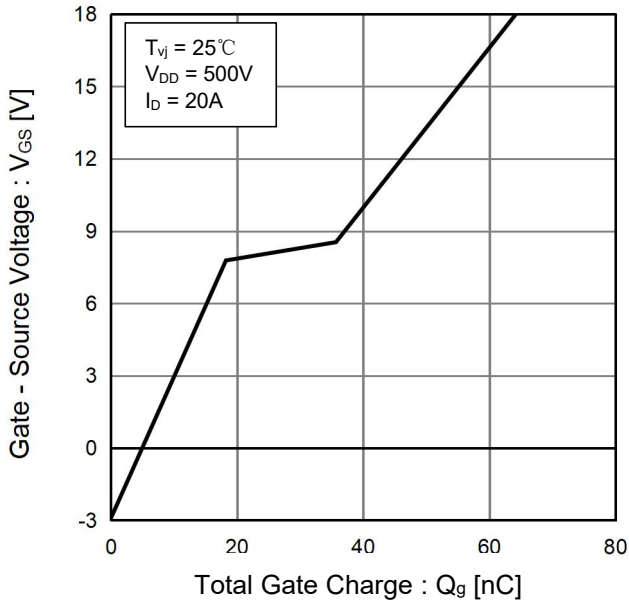


Fig.17 Typical Switching Time vs. External Gate Resistance

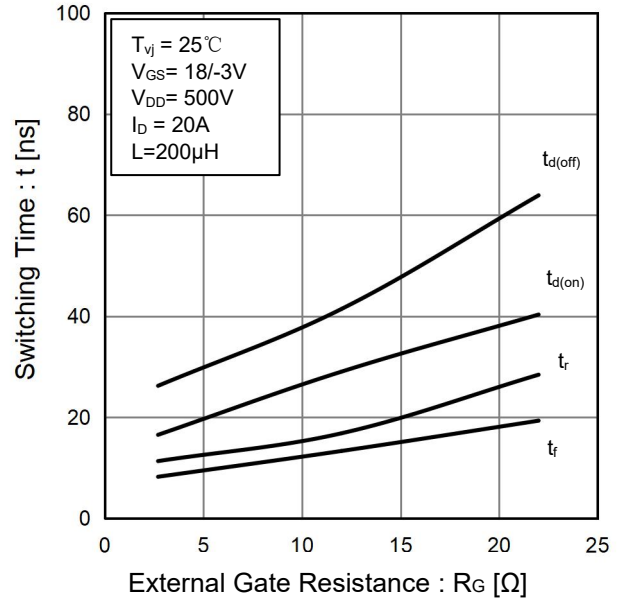


Fig.18 Typical Switching Energy vs. External Gate Resistance

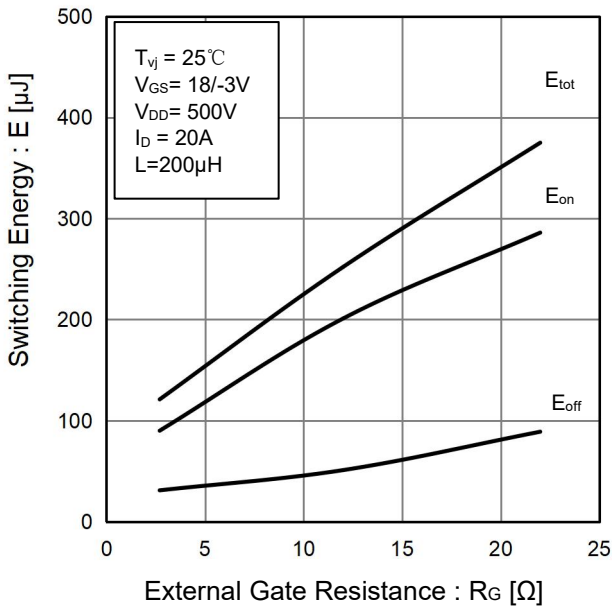


Fig.19 Typical Switching Energy vs. Drain Current

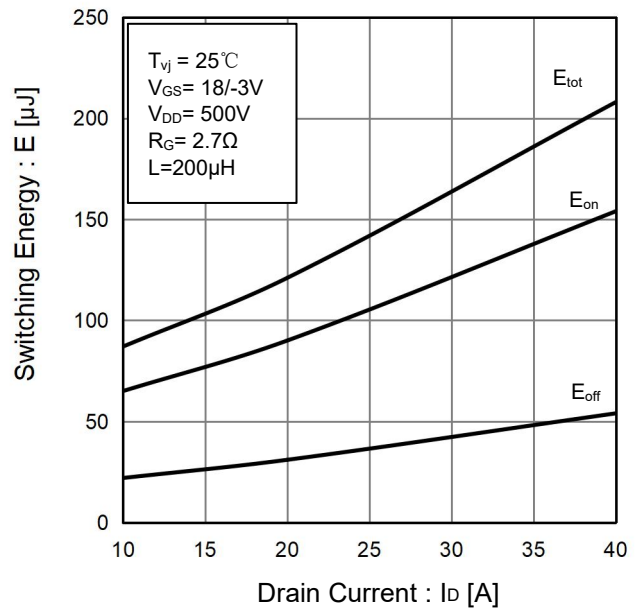
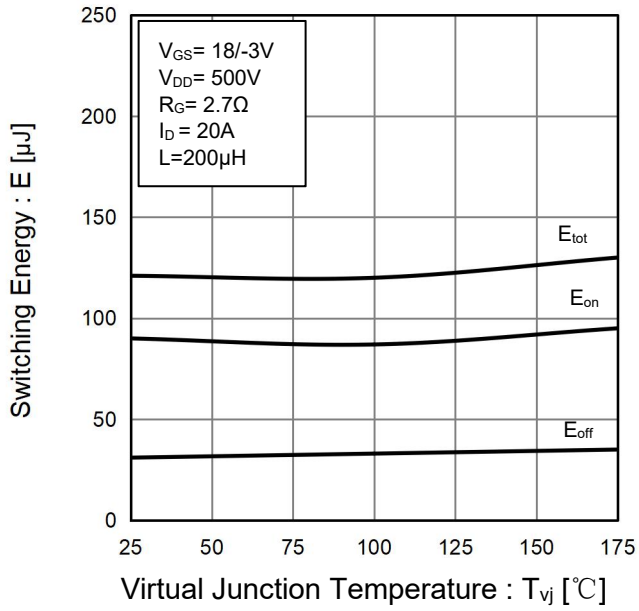
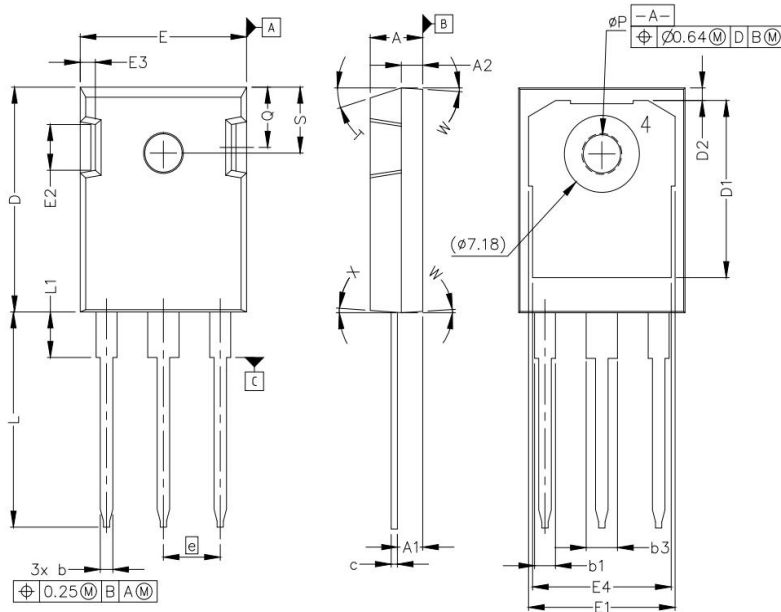


Fig.20 Typical Switching Energy vs. Virtual Junction Temperature



## TO-247-3L Package Information



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |      |
|--------|---------------------------|-------|----------------------|------|
|        | Min.                      | Max.  | Min.                 | Max. |
| A      | 4.83                      | 5.21  | 0.19                 | 0.21 |
| A1     | 2.29                      | 2.54  | 0.09                 | 0.10 |
| A2     | 1.91                      | 2.16  | 0.08                 | 0.09 |
| b      | 1.07                      | 1.33  | 0.04                 | 0.05 |
| b1     | 1.91                      | 2.41  | 0.08                 | 0.10 |
| b3     | 2.87                      | 3.38  | 0.11                 | 0.13 |
| c      | 0.55                      | 0.68  | 0.02                 | 0.03 |
| D      | 20.80                     | 21.10 | 0.82                 | 0.83 |
| D1     | 16.25                     | 17.65 | 0.64                 | 0.70 |
| D2     | 0.95                      | 1.25  | 0.04                 | 0.05 |
| E      | 15.75                     | 16.13 | 0.62                 | 0.64 |
| E1     | 13.10                     | 14.15 | 0.52                 | 0.56 |
| E2     | 3.68                      | 5.10  | 0.15                 | 0.20 |
| E3     | 1.00                      | 1.90  | 0.04                 | 0.08 |
| E4     | 12.38                     | 13.43 | 0.49                 | 0.53 |
| e      | 5.44 BSC                  |       | 0.21 BSC             |      |
| L      | 19.81                     | 20.32 | 0.78                 | 0.80 |
| L1     | 4.10                      | 4.40  | 0.16                 | 0.17 |
| ØP     | 3.51                      | 3.65  | 0.14                 | 0.15 |
| Q      | 5.49                      | 6.00  | 0.22                 | 0.24 |
| S      | 6.04                      | 6.30  | 0.24                 | 0.25 |
| T      | 17.5° REF                 |       |                      |      |
| W      | 3.5° REF                  |       |                      |      |
| X      | 4° REF                    |       |                      |      |

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