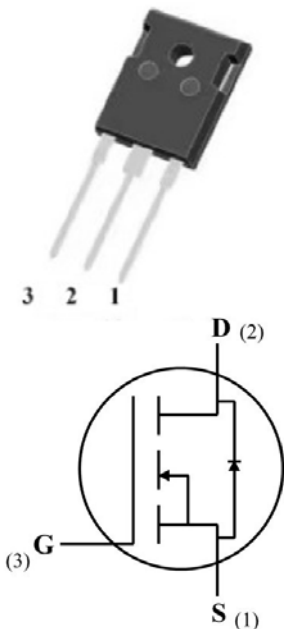


## Silicon Carbide Power MOSFET (N-Channel Enhancement)

|              |       |
|--------------|-------|
| $V_{DS}$     | 1200V |
| $I_D$ (25°C) | 66A   |
| $R_{DS(on)}$ | 33mΩ  |



### Features

- High speed switching
- Essentially no switching losses
- Reduction of heat sink requirements
- Maximum working temperature at 175 °C
- High blocking voltage
- Fast Intrinsic diode with low recovery current
- High-frequency operation
- Halogen free, RoHS compliant

### Typical Applications

Typical applications are in power factor correction(PFC), solar inverter, uninterruptible power supply, motor drives, photovoltaic inverter, electric car and charger.

### Mechanical Data

- **Package:** TO-247AB
- **Terminals:** Tin plated leads
- **Polarity:** As marked

### ■Maximum Ratings (T<sub>c</sub>=25°C Unless otherwise specified)

| PARAMETER                                        | SYMBOL          | UNIT | VALUE        | TEST CONDITIONS                                  | NOTE    |
|--------------------------------------------------|-----------------|------|--------------|--------------------------------------------------|---------|
| Device marking code                              |                 |      | D212040NCTG2 |                                                  |         |
| Drain source voltage<br>@ T <sub>j</sub> =25°C   | $V_{DS,max}$    | V    | 1200         | $V_{GS}=0\text{ V}, I_D=100\mu\text{A}$          |         |
| Gate source voltage<br>@ T <sub>j</sub> =25°C    | $V_{GS,max}$    | V    | -8/+19       | Absolute maximum values                          |         |
| Gate source voltage<br>@ T <sub>j</sub> =25°C    | $V_{GS,op}$     | V    | -4/+15       | Recommended operational values                   | Note1、2 |
| Continuous drain current @ T <sub>c</sub> =25°C  | $I_D$           | A    | 66           | $V_{GS}=15\text{V}, T_c=25^\circ\text{C}$        | Fig.18  |
| Continuous drain current @ T <sub>c</sub> =100°C |                 |      | 48           | $V_{GS}=15\text{V}, T_c=100^\circ\text{C}$       |         |
| Pulsed drain current                             | $I_{D(pulsed)}$ | A    | 120          | Pulse width $t_p$ limited by $T_{j,max}$         | Fig.23  |
| Avalanche energy, Single Pulse                   | $E_{AS}$        | mJ   | 500          | $V_{DD}=75\text{V}, L=10\text{mH}$               |         |
| Power Dissipation                                | $P_{TOT}$       | W    | 333          | $T_c=25^\circ\text{C}, T_j = 175^\circ\text{C}$  | Fig.17  |
| Power Dissipation                                |                 |      | 144          | $T_c=110^\circ\text{C}, T_j = 175^\circ\text{C}$ |         |
| Operating junction and Storage temperature range | $T_j, T_{stg}$  | °C   | -55 to +175  |                                                  |         |
| Soldering temperature                            | $T_L$           | °C   | 260          | 1.6mm (0.063") from case for 10s                 |         |
| Mounting torque                                  | $T_M$           | Nm   | 0.6          | M3 screw Maximum of mounting process: 3          |         |



## ■Static Electrical Characteristics (Tc=25°C unless otherwise specified)

| PARAMTETER                               | SYMBOL        | UNIT       | Min. | Typ. | Max. | Test Conditions                                     | Note        |
|------------------------------------------|---------------|------------|------|------|------|-----------------------------------------------------|-------------|
| Gate threshold voltage                   | $V_{GS(th)}$  | V          | 2.0  | 2.5  | 4.0  | $V_{DS}=V_{GS}$ , $I_D=11.5mA$                      | Fig.4, 11   |
|                                          |               |            |      | 2.0  |      | $V_{DS}=V_{GS}$ , $I_D=11.5mA$ , $T_J=175^{\circ}C$ |             |
| Drain source breakdown voltage           | $V_{(BR)DSS}$ | V          | 1200 |      |      | $V_{GS}=0$ , $I_D=100\mu A$                         |             |
| Zero gate voltage drain current          | $I_{DSS}$     | $\mu A$    |      | 1    | 50   | $V_{DS}=1200V$ , $V_{GS}=0V$                        | Fig.16      |
| Gate source leakage current              | $I_{GSS}$     | nA         |      | 10   | 100  | $V_{GS}=15V$ , $V_{DS}=0V$                          |             |
| Current drain source on-state resistance | $R_{DS(on)}$  | m $\Omega$ |      | 33   | 44   | $V_{GS}=15V$ , $I_D=40A$                            | Fig.5, 6, 7 |
|                                          |               |            |      | 63   |      | $V_{GS}=15V$ , $I_D=40A$ , $T_J=175^{\circ}C$       |             |
| Internal gate resistance                 | $R_g$         | $\Omega$   |      | 1.8  | 5.0  | $f=1MHz$                                            |             |
| Diode forward voltage                    | $V_{SD}$      | V          |      | 5.0  |      | $V_{GS}=-4V$ , $I_{SD}=20A$                         | Fig.8       |
|                                          |               |            |      | 3.3  |      | $V_{GS}=0V$ , $I_{SD}=20A$<br>$T_J=175^{\circ}C$    | Fig.9       |
| Transconductance                         | $g_f$         | S          |      | 26   |      | $V_{DS}=20V$ , $I_D=40A$                            | Fig.4       |
|                                          |               |            |      | 22   |      | $V_{DS}=20V$ , $I_D=40A$ , $T_J=175^{\circ}C$       |             |

## ■Dynamic Electrical Characteristics (Tc=25°C unless otherwise specified)

| PARAMTETER          | SYMBOL    | UNIT    | Min. | Typ. | Max. | Test Conditions                                                                  | Note       |
|---------------------|-----------|---------|------|------|------|----------------------------------------------------------------------------------|------------|
| Input capacitance   | $C_{iss}$ | pF      |      | 3456 |      | $V_{DS}=1000V$ , $V_{GS}=0V$ , $T_J=25^{\circ}C$ ,<br>$f=100kHz$ , $V_{AC}=25mV$ | Fig.13, 14 |
| Output capacitance  | $C_{oss}$ |         |      | 127  |      |                                                                                  |            |
| Reverse capacitance | $C_{rss}$ |         |      | 7.2  |      |                                                                                  |            |
| Coss stored energy  | $E_{oss}$ | $\mu J$ |      | 69   |      |                                                                                  | Fig.15     |
| Gate source charge  | $Q_{gs}$  | nC      |      | 39   |      | $V_{DS}=800V$ , $V_{GS}=-4/15V$ , $I_D=40A$                                      | Fig.12     |
| Gate drain charge   | $Q_{gd}$  |         |      | 44   |      |                                                                                  |            |
| Gate charge         | $Q_g$     |         |      | 116  |      |                                                                                  |            |

## ■Switching Characteristics (Tc=25°C unless otherwise specified)

| PARAMTETER                | SYMBOL      | UNIT    | Min. | Typ.  | Max. | Test Conditions                                                                  | Note       |
|---------------------------|-------------|---------|------|-------|------|----------------------------------------------------------------------------------|------------|
| Turn on switching energy  | $E_{on}$    | $\mu J$ |      | 835   |      | $V_{DD}=800V$ , $V_{GS}=-4/+15V$ , $I_D=40A$ ,<br>$R_g=2.7\Omega$ , $L=100\mu H$ | Fig.21, 20 |
| Turn off switching energy | $E_{off}$   |         |      | 163.6 |      |                                                                                  |            |
| Turn on delay time        | $t_{d(on)}$ | ns      |      | 15    |      |                                                                                  |            |



|                     |              |    |  |    |  |                                                                        |            |
|---------------------|--------------|----|--|----|--|------------------------------------------------------------------------|------------|
| Rise time           | $t_r$        |    |  | 30 |  |                                                                        |            |
| Turn off delay time | $t_{d(off)}$ | ns |  | 25 |  | $V_{DD}=800V, V_{GS}=-4/+15V, I_D=40A,$<br>$R_g=2.7\Omega, L=100\mu H$ | Fig.21, 20 |
| Fall time           | $t_f$        |    |  | 12 |  |                                                                        |            |

**■Body diode characteristics** ( $T_c=25^\circ C$  unless otherwise specified )

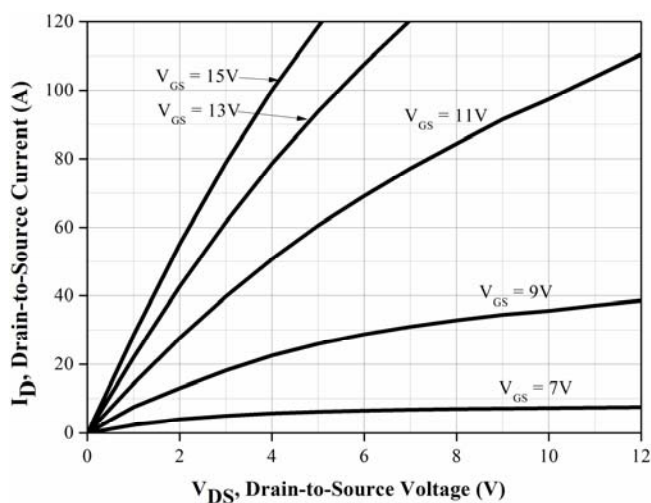
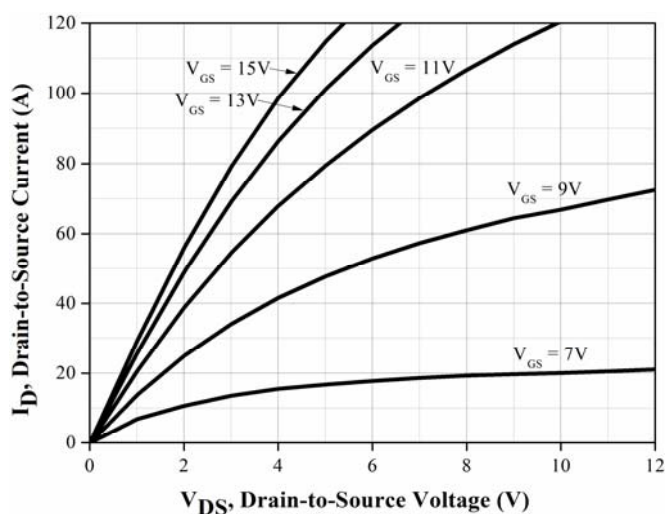
| PARAMETER                        | SYMBOL    | UNIT | Min. | Typ. | Max. | Test Conditions                                         | Note  |
|----------------------------------|-----------|------|------|------|------|---------------------------------------------------------|-------|
| Diode forward voltage            | $V_{SD}$  | V    |      | 5.0  |      | $V_{GS}=-4V, I_{SD}=20A$                                | Fig.8 |
|                                  |           |      |      | 3.3  |      | $V_{GS}=0V, I_{SD}=20A, T_J=175^\circ C$                | Fig.9 |
| Continuous diode forward current | $I_S$     | A    |      | 66   |      | $T_c=25^\circ C$                                        | Note1 |
| Reverse recovery time            | $t_{rr}$  | nS   |      | 27   |      | $V_R=800V, V_{GS}=-4V, I_D=40A,$<br>$di/dt=2250A/\mu S$ |       |
| Reverse recovery charge          | $Q_{rr}$  | nC   |      | 478  |      |                                                         |       |
| Peak reverse recovery current    | $I_{rrm}$ | A    |      | 27   |      |                                                         |       |

Note 1: When using SiC Body Diode the maximum recommended  $V_{GS} = -4V$ 

Note 2: MOSFET can also safely operate at 0/15 V

**■Thermal Characteristics** ( $T_a=25^\circ C$  Unless otherwise specified )

| PARAMETER          | SYMBOL           | UNIT         | Typ. |
|--------------------|------------------|--------------|------|
| Thermal resistance | $R_{\theta J-C}$ | $^\circ C/W$ | 0.45 |

**■Typical Characteristics**Figure 1. Output Characteristics  $T_J = -55^\circ C$ Figure2. Output Characteristics  $T_J = 25^\circ C$

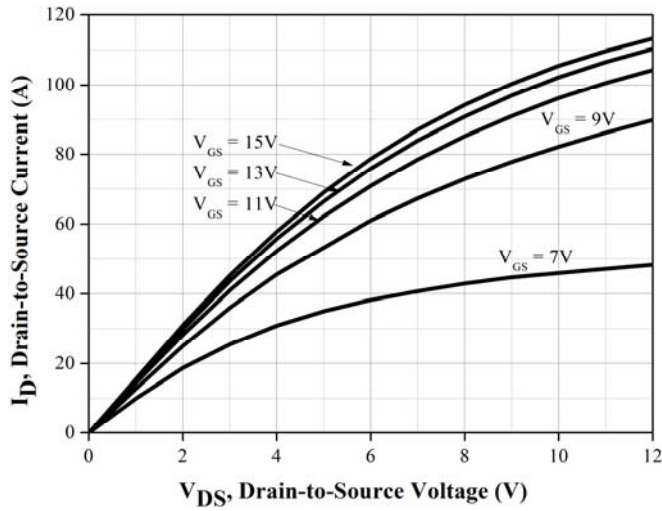


Figure 3. Output Characteristics  $T_j = 175^\circ\text{C}$

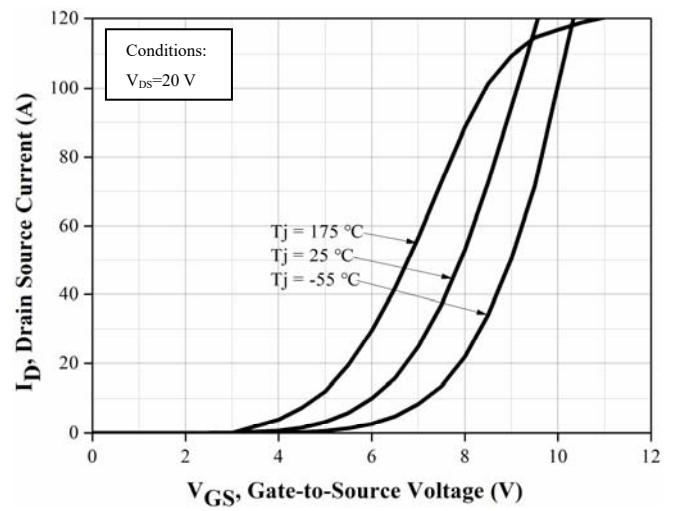


Figure 4. Transfer Characteristics for various junction temperature

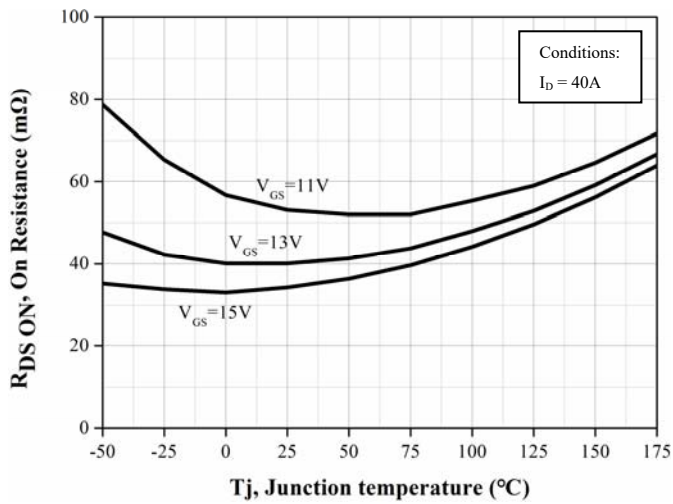


Figure 5. On-resistance vs. temperature for various gate voltage

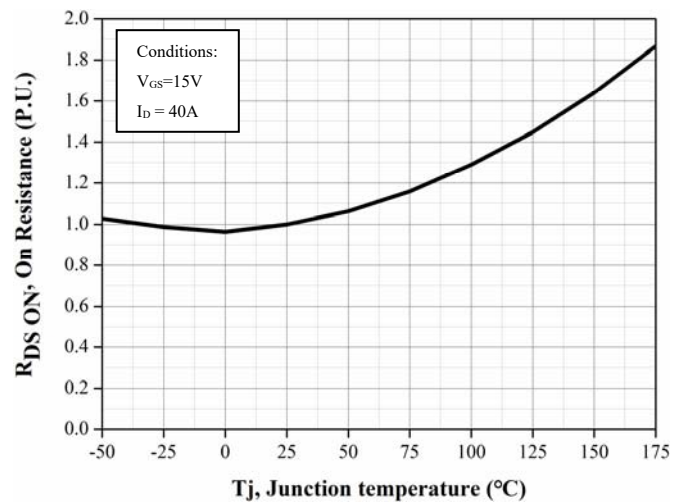


Figure 6. Normalized on-resistance vs. temperature

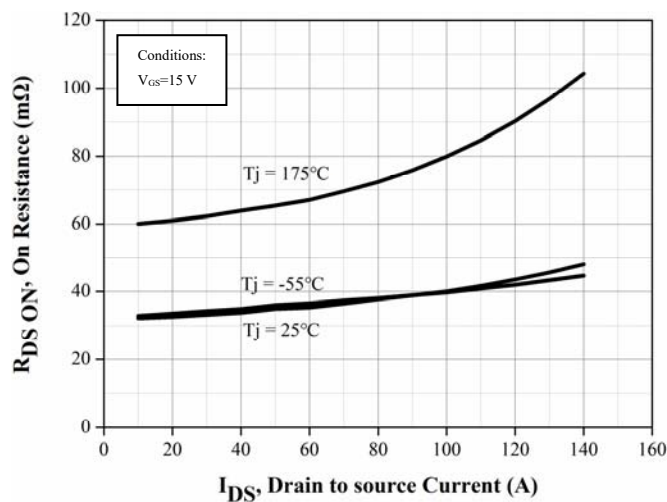


Figure 7. On-resistance vs. drain current

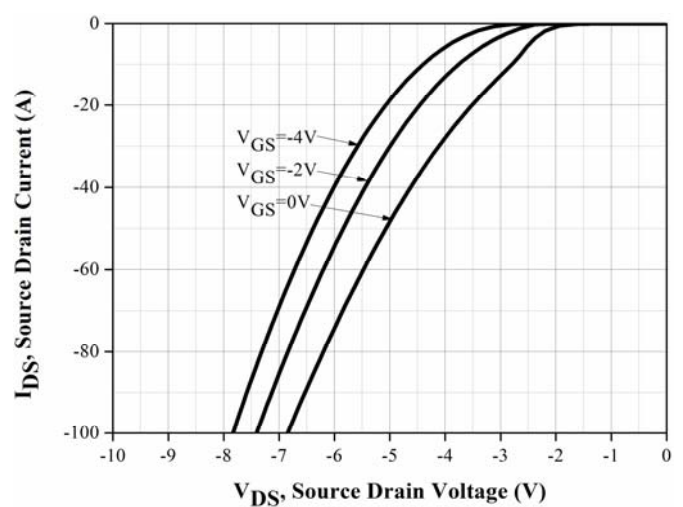


Figure 8. Body diode characteristic at  $T_j = 25^\circ\text{C}$

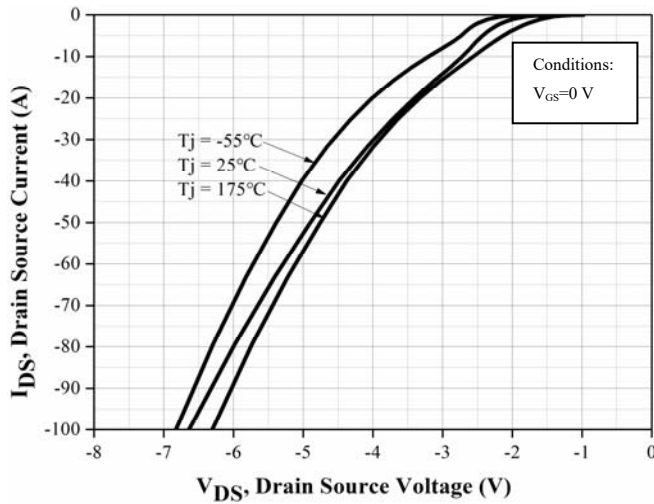


Figure 9. Body diode characteristic

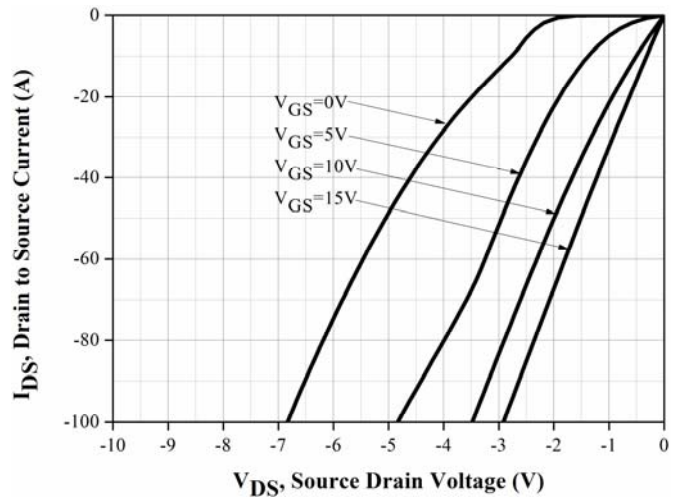


Figure 10. 3<sup>rd</sup> quadrant characteristic at  $T_j = 25\text{ }^{\circ}\text{C}$

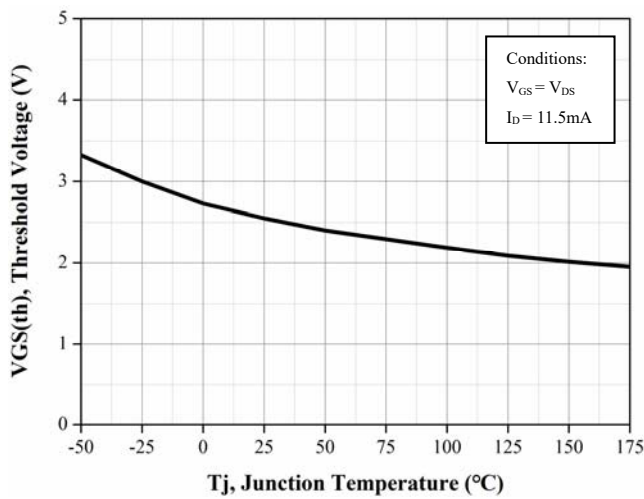


Figure 11. Threshold voltage vs. temperature

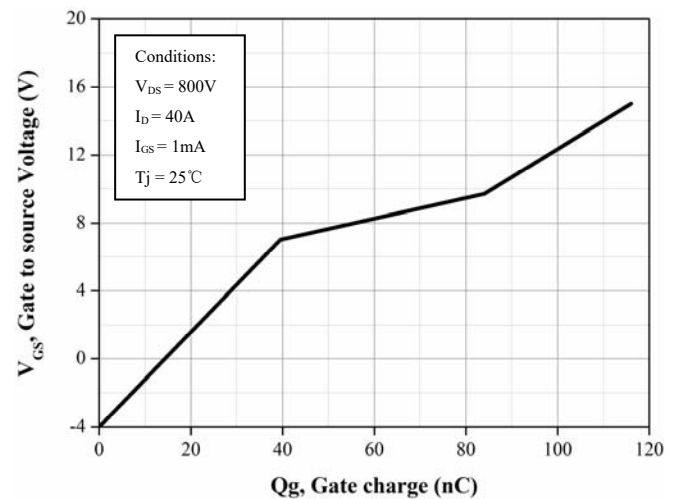


Figure 12. Gate charge characteristic

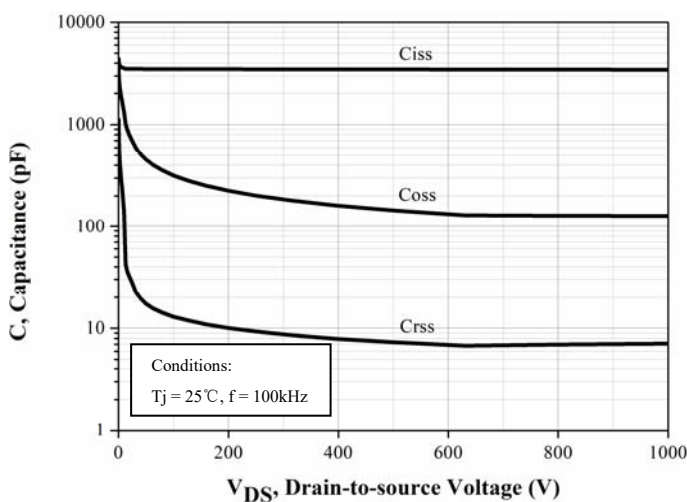


Figure 13. Capacitances vs. drain source voltage (0-1000V)

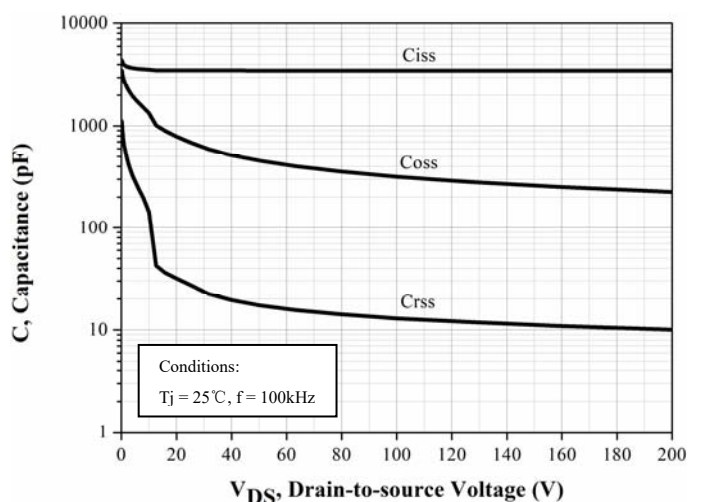


Figure 14. Capacitances vs. drain source voltage (0-200V)

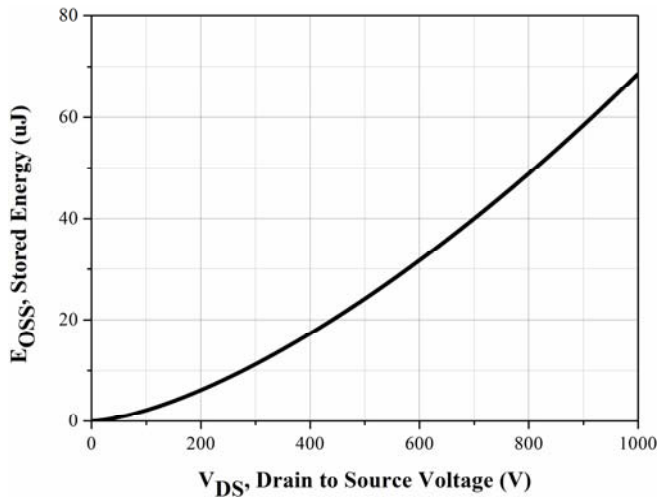


Figure 15. Output capacitor stored energy

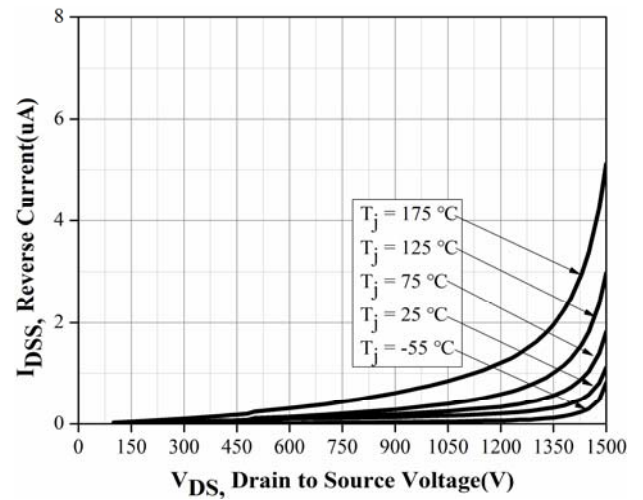


Figure 16. Reverse characteristics vs.  $T_j$

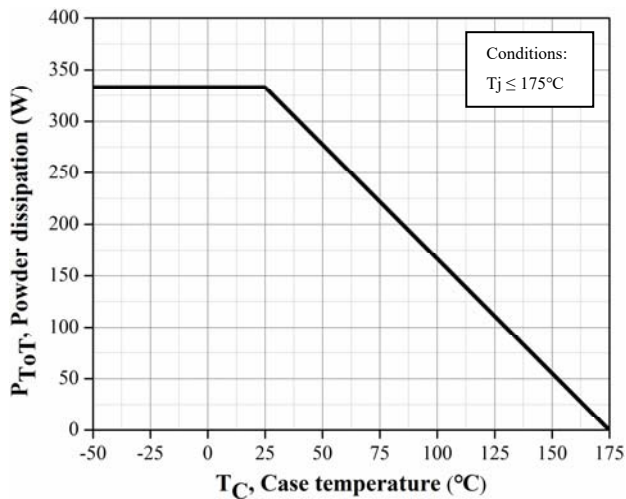


Figure 17. Maximum power dissipation derating vs. case temperature

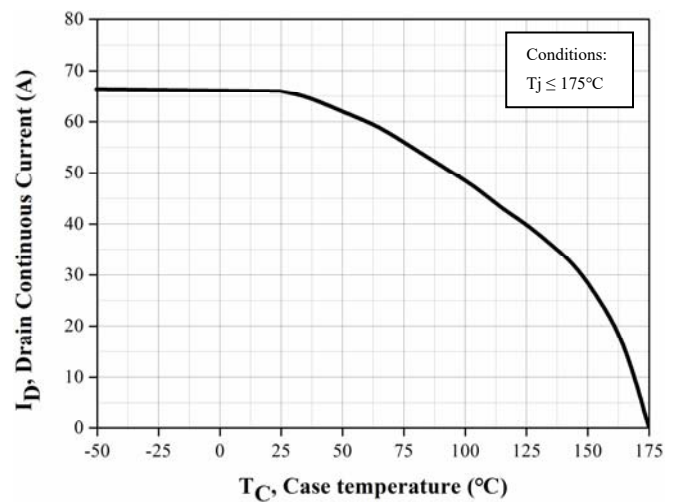


Figure 18. Continuous drain current derating vs. case temperature

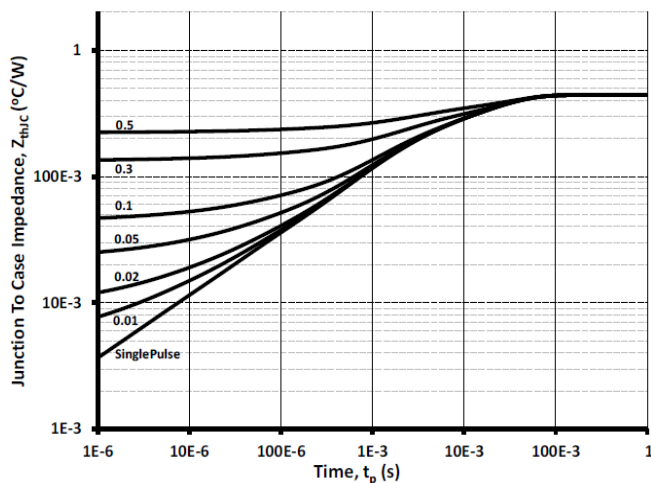


Figure 19. Transient thermal impedance (junction - case)

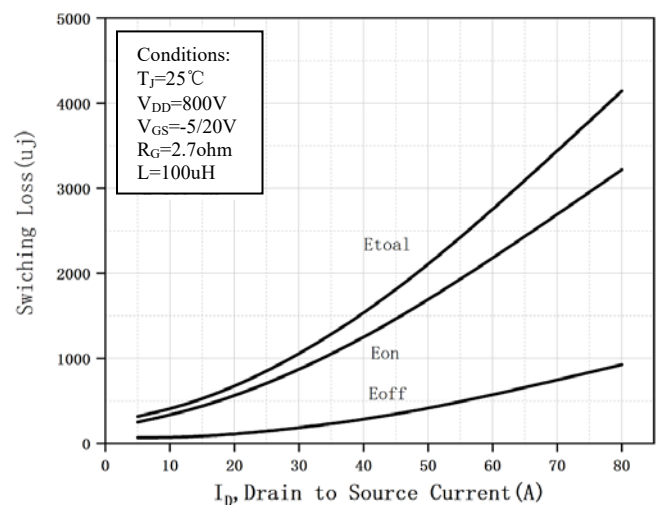


Figure 20. Clamped Inductive switching energy vs. drain current

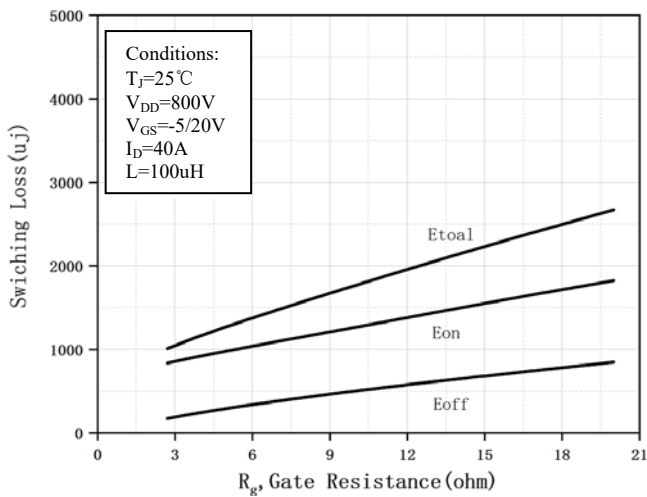


Figure 21. Clamped inductive switching energy vs.  $R_g$

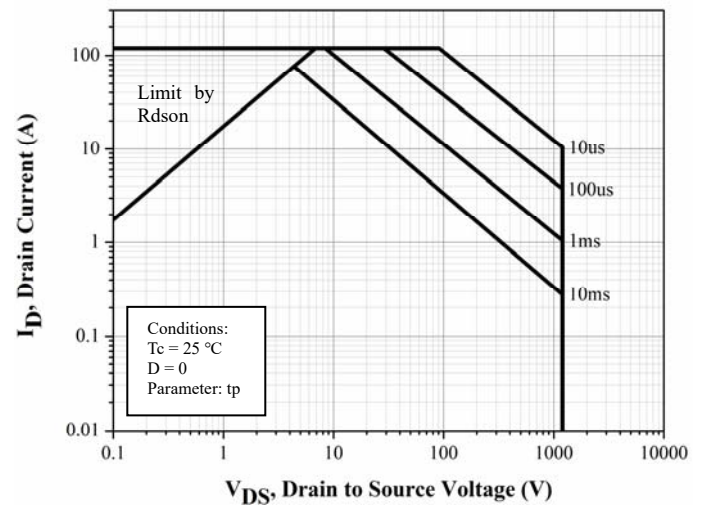


Figure 22. Safe Operating Area

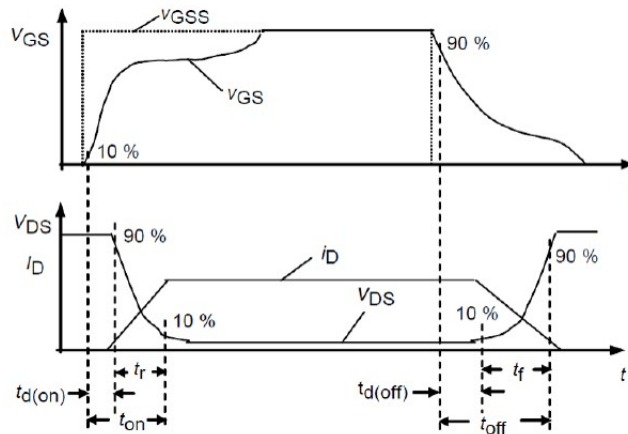


Figure 23. Switching Times Definition

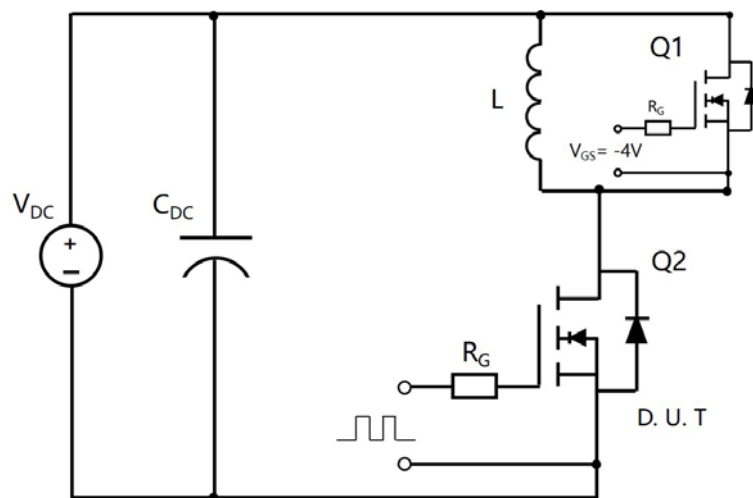
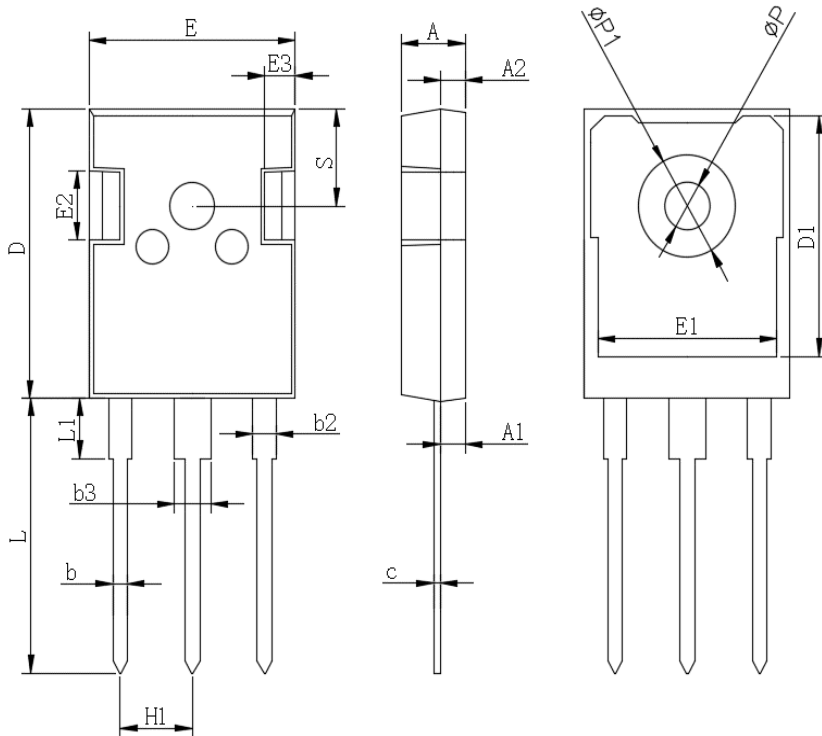


Figure 24. Clamped Inductive Switching Waveform Test Circuit

## ■Outline Dimensions

**TO-247AB**



| TO-247AB |         |       |
|----------|---------|-------|
| Dim      | Min     | Max   |
| A        | 4.80    | 5.20  |
| A1       | 2.21    | 2.61  |
| A2       | 1.85    | 2.15  |
| b        | 1.0     | 1.4   |
| b2       | 1.91    | 2.21  |
| C        | 0.5     | 0.7   |
| D        | 20.70   | 21.30 |
| D1       | 16.25   | 16.85 |
| E        | 15.50   | 16.10 |
| E1       | 13.0    | 13.6  |
| E2       | 4.80    | 5.20  |
| E3       | 2.30    | 2.70  |
| L        | 19.62   | 20.22 |
| L1       | -       | 4.30  |
| ΦP       | 3.40    | 3.80  |
| ΦP1      | -       | 7.30  |
| S        | 6.15TYP |       |
| H1       | 5.44TYP |       |
| b3       | 2.80    | 3.20  |



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