

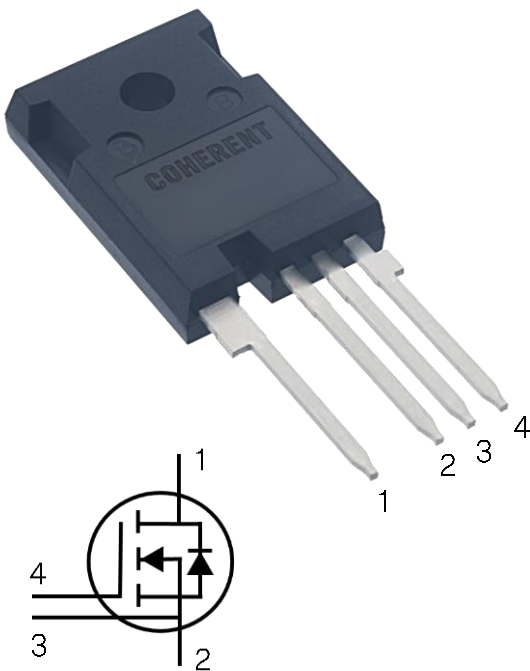
# 1200V, 20mΩ SiC MOSFET

TM3B0020120A

## Datasheet

Coherent Silicon Carbide power MOSFET offers improved efficiency, higher switching frequency and industry-leading 200°C rating

TO 247-4L



1 – Drain  
2 – Source  
3 – Kelvin sense contact  
4 - Gate

- $V_{DSS} = 1200V$
- $R_{DS(ON)} = 20m\Omega$
- $T_{J,max} = 200^{\circ}C$

## KEY FEATURES

- High voltage and low  $R_{DS(ON)}$  up to 200°C
- Fast switching enabled by ultra-low gate resistance
- Very low, temperature invariant switching losses
- Avalanche ruggedness superior to silicon
- Fast body diode for synchronous rectification
- AEC-Q101 qualified
- RoHS compliant
- REACH compliant
- Pb-free

## KEY BENEFITS

- Higher system efficiency, performance and reliability
- Suitable for higher temperature and harsher environment
- Reduces cooling requirements, overall system cost and complexity
- Works in topologies with continuous hard commutation
- Increases power density
- Enable bidirectional topologies



| Part Number  | Package   |
|--------------|-----------|
| TM3B0020120A | TO 247-4L |

**MOSFET Static Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

| Symbol                            | Parameter   | Conditions   | Min  | Typ  | Max     | Units |
|-----------------------------------|---|--|------|------|---------|-------|
| I <sub>D</sub>                    | Continuous Drain Current  | V <sub>GS</sub> =20V, T <sub>C</sub> =25°C, T <sub>J</sub> =200°C  | -    | -    | 115     | A     |
|                                   |   | V <sub>GS</sub> =20V, T <sub>C</sub> =100°C, T <sub>J</sub> =200°C                                       | -    | -    | 87      |       |
|                                   |   | V <sub>GS</sub> =20V, T <sub>C</sub> =125°C, T <sub>J</sub> =200°C                                       | -    | -    | 75      |       |
| I <sub>D,pulse</sub>              | Pulsed Drain Current <sup>1)</sup>                                | T <sub>C</sub> =25°C, T <sub>J</sub> =200°C  | -    | -    | 173     | A     |
| I <sub>D</sub>                    | Continuous Drain Current  | V <sub>GS</sub> =20V, T <sub>C</sub> =25°C, T <sub>J</sub> =175°C  | -    | -    | 109     | A     |
|                                   |   | V <sub>GS</sub> =20V, T <sub>C</sub> =100°C, T <sub>J</sub> =175°C                                       | -    | -    | 77      |       |
|                                   |   | V <sub>GS</sub> =20V, T <sub>C</sub> =125°C, T <sub>J</sub> =175°C                                       | -    | -    | 63      |       |
| P <sub>tot</sub>                  | Power Dissipation   | T <sub>C</sub> =25°C   | -    | -    | 660     | W     |
| V <sub>(BR)DSS</sub>              | Drain-Source Breakdown Voltage                                    | V <sub>GS</sub> =0V, I <sub>DS</sub> =20μA   | 1200 | -    | -       | V     |
| I <sub>DSS</sub>                  | Drain Leakage Current   | V <sub>DS</sub> =1200V, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C  | -    | -    | 20      | μA    |
|                                   |   | V <sub>DS</sub> =1200V, V <sub>GS</sub> =0V, T <sub>J</sub> =200°C                                       | -    | -    | 200     |       |
| I <sub>GSS</sub>                  | Gate-Source Leakage Current                                       | V <sub>GS</sub> = -15/+23V   | -    | -    | 100     | nA    |
| V <sub>GS</sub>                   | Recommended Gate-Source Voltage                                   |  | -    | 20   | -       | V     |
| V <sub>GS,max</sub>               | Maximum Gate-Source Voltage                                       | V <sub>DS</sub> =0V  | -    | -    | -15/+23 |       |
| V <sub>TH</sub>                   | Gate-Source Threshold Voltage                                     | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>DS</sub> =20mA, J=0.1A/cm <sup>2</sup> , T <sub>J</sub> =25°C  | 2.0  | 2.8  | 3.8     |       |
|                                   |   | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>DS</sub> =20mA, J=0.1A/cm <sup>2</sup> , T <sub>J</sub> =175°C | 1.4  | 2.0  | 3.4     |       |
| R <sub>DS(ON)</sub>               | Drain-Source On-Resistance  | V <sub>GS</sub> =20V, I <sub>DS</sub> =26A, J=133A/cm <sup>2</sup> , T <sub>J</sub> =25°C                | -    | 18.5 | 22.4    | mΩ    |
|                                   |   | V <sub>GS</sub> =20V, I <sub>DS</sub> =75A, J=388A/cm <sup>2</sup> , T <sub>J</sub> =25°C                | -    | 19.7 | 24.3    |       |
|                                   |   | V <sub>GS</sub> =20V, I <sub>DS</sub> =26A, J=133A/cm <sup>2</sup> , T <sub>J</sub> =200°C               | -    | 38.1 | 45.7    |       |
|                                   |   | V <sub>GS</sub> =20V, I <sub>DS</sub> =51A, J=265A/cm <sup>2</sup> , T <sub>J</sub> =200°C               | -    | 39.3 | 47.7    |       |
|                                   |   | V <sub>GS</sub> =20V, I <sub>DS</sub> =75A, J=388A/cm <sup>2</sup> , T <sub>J</sub> =200°C               | -    | 40.4 | 49.7    |       |
| g <sub>fs</sub>                   | Forward Transconductance  | I <sub>DS</sub> =75A, V <sub>DS</sub> =10V   | -    | 30   | -       | S     |
| R <sub>GATE,ESR</sub>             | Gate-Source Series Resistance                                     | V <sub>GS</sub> =0V, drain source shorted  | -    | 0.75 | -       | Ω     |
| E <sub>AS</sub>                   | Single Pulse Avalanche Energy                                     | I <sub>D</sub> =30A, L=8mH   | -    | 3.6  | -       | J     |
| R <sub>th,JC</sub>                | Thermal Resistance, Junction-Case                                 | TO247-4L   | -    | 0.22 | 0.27    | °C/W  |
| T <sub>J</sub> , T <sub>stg</sub> | Bare Chip/Discrete Max Junction Operating and Storage Temperature |  | -55  | -    | 200     | °C    |

**MOSFET Dynamic Characteristics**

| Symbol       | Parameter                        | Conditions  | Min | Typ  | Max | Units |
|--------------|----------------------------------|---|-----|------|-----|-------|
| $C_{ISS}$    | Input capacitance                | $V_{GS}=0V, V_{DS}=500V, f=100kHz$  | -   | 3982 | -   | pF    |
| $C_{OSS}$    | Output capacitance               |   | -   | 195  | -   |       |
| $C_{RSS}$    | Reverse transfer capacitance     |   | -   | 14   | -   |       |
| $t_{d(on)}$  | Turn-on delay time               | $V_{DS}=600V, V_{GS}=-5/+20V, I_D=75A,$<br>$R_{G(ext)}=5.11\Omega$          | -   | 17   | -   | ns    |
| $t_r$        | Rise time                        |   | -   | 39   | -   |       |
| $t_{d(off)}$ | Turn-off delay time              |   | -   | 38   | -   |       |
| $t_f$        | Fall time                        |   | -   | 12   | -   |       |
| $E_{ON}$     | Turn-on energy                   | $V_{DS}=600V, V_{GS}=-5/+20V, I_D=75A,$<br>$R_{G(ext)}=5.11\Omega, L=1.6mH$ | -   | 0.92 | -   | mJ    |
| $E_{OFF}$    | Turn-off energy                  |   | -   | 0.52 | -   |       |
| $E_{TOT}$    | Total switching energy           |   | -   | 1.44 | -   |       |
| $Q_G$        | Total gate charge <sup>2)</sup>  | $V_{GS}=-5$ to 18V, $I_{DS}=60A, V_{DS}=900V$                               | -   | 172  | -   | nC    |
| $Q_{GS}$     | Gate-source charge <sup>2)</sup> |   | -   | 68   | -   |       |
| $Q_{GD}$     | Gate-drain charge <sup>2)</sup>  |   | -   | 48   | -   |       |

**Diode Characteristics <sup>3)</sup>**

| Symbol    | Parameter                 | Conditions                         | Min | Typ  | Max | Units |
|-----------|---------------------------|------------------------------------|-----|------|-----|-------|
| $I_{SD}$  | Pulsed body diode current | $V_{GS}=0V$                        | -   | -    | 173 | A     |
| $V_{SD}$  | Diode forward voltage     | $V_{GS}=0V, I_{SD}=75A$            | -   | 4.0  | -   | V     |
| $t_{rr}$  | Reverse Recovery Time     | $I_F = 75A, V_R = 600V$            | -   | 24   | -   | ns    |
| $Q_{rr}$  | Reverse Recovery Charge   | @ $di/dt = 3239A/\mu s$            | -   | 386  | -   | nC    |
| $I_{rrm}$ | Peak Reverse Current      | $L_\sigma = 50nH, C_\sigma = 10pF$ | -   | 32.0 | -   | A     |

<sup>1)</sup> Pulse width limited by  $T_{J,max}$ .

<sup>2)</sup>  $Q_{GS}$  and  $Q_{GD}$  values were calculated using the two-curve extraction method shown in Fig. 12.

<sup>3)</sup> We recommend the use of body diode in synchronous rectification mode with repetitive conduction during switch commutation dead-time  $\leq 1\mu s$ . Our long term (up to 13,000 hours) continuous switching test results show excellent reliability and forward voltage stability, indicating it is safe to use the body diode in this mode.

Figure 1. Output characteristics

$$I_D = f(V_{DS}, V_{GS}); T_J = 25^\circ\text{C}$$

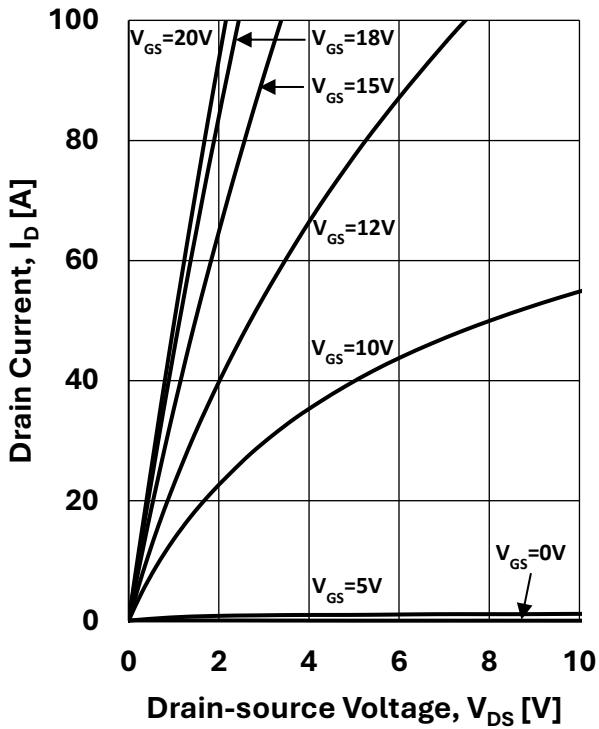


Figure 2. Output characteristics

$$I_D = f(V_{DS}, V_{GS}); T_J = 200^\circ\text{C}$$

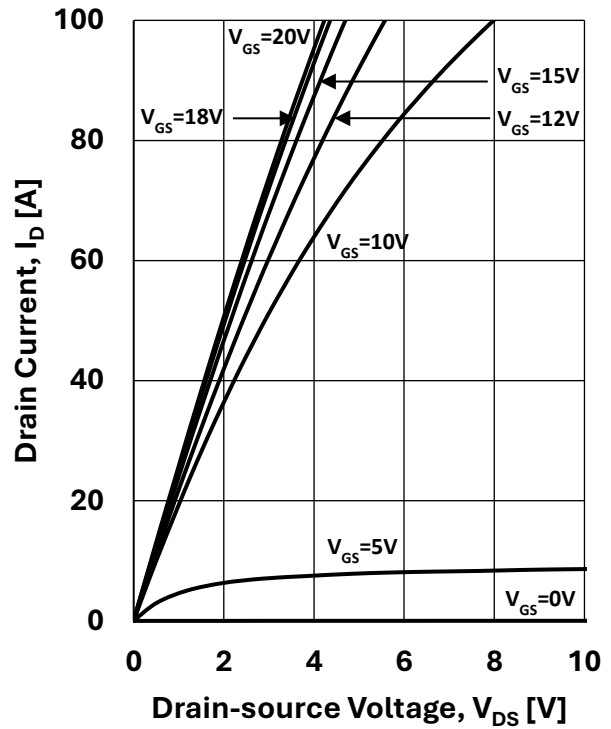


Figure 3. Threshold voltage

$$V_{TH} = f(T_J); V_{DS} = V_{GS}; I_D = 20\text{mA}$$

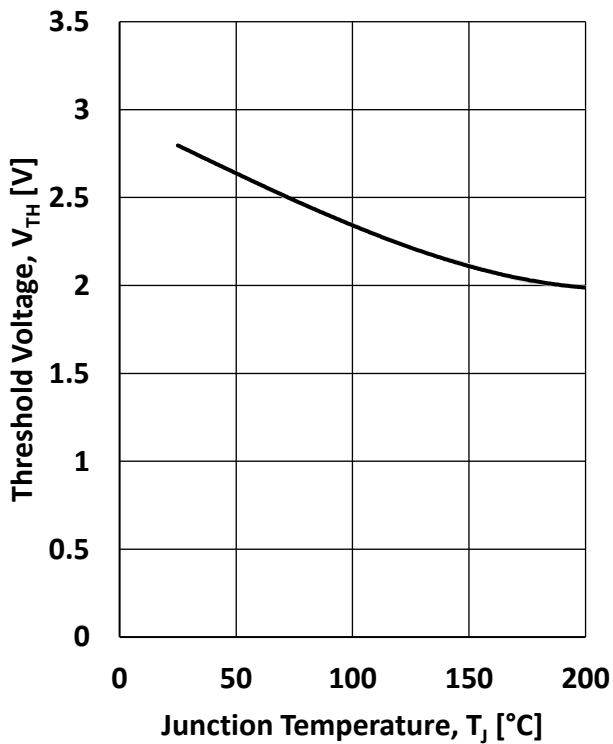


Figure 4. Drain-source on-state resistance

$$R_{DS(ON)} = f(T_J); I_D = 75\text{A}$$

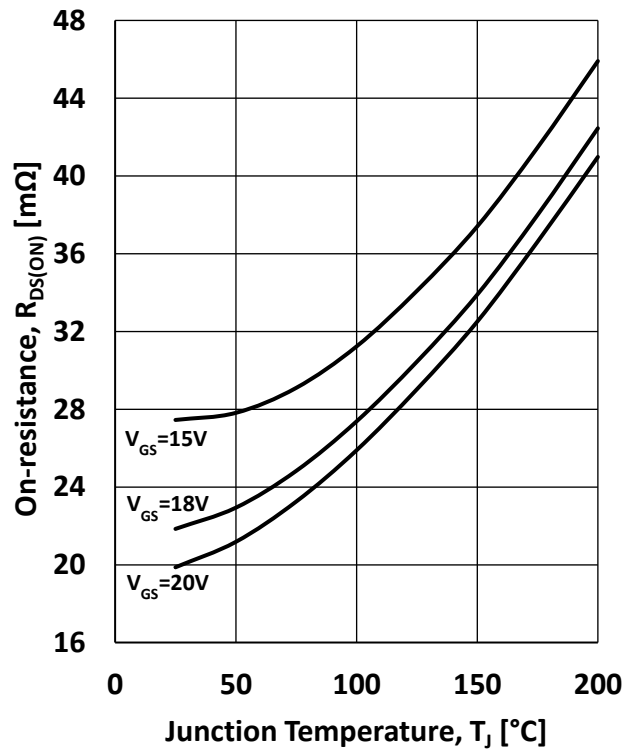


Figure 5. Drain-source on-state resistance  
 $R_{DS(ON)}=f(I_D)$ ;  $T_J=25^\circ\text{C}$

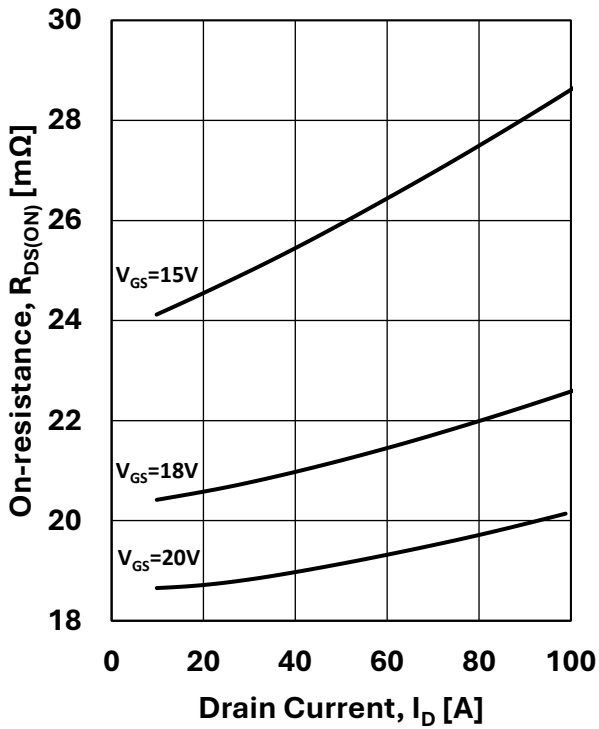


Figure 6. Drain-source on-state resistance  
 $R_{DS(ON)}=f(T_J)$ ;  $V_{GS}=20\text{V}$

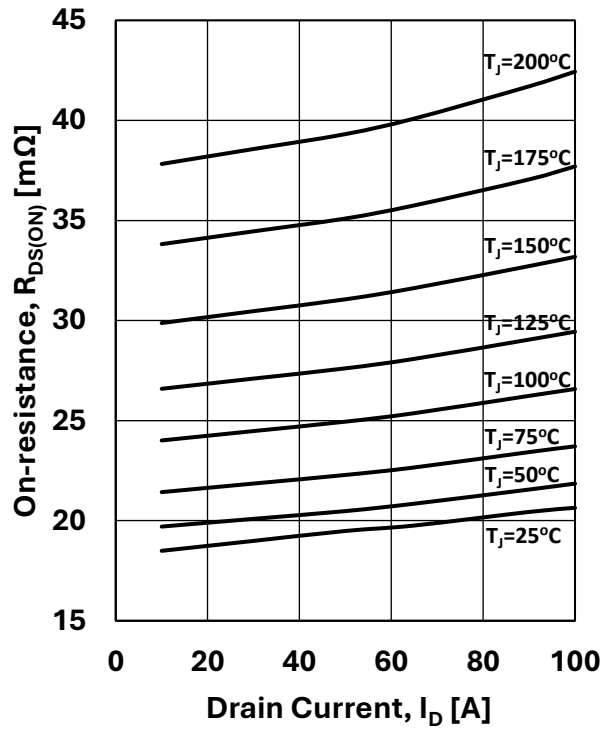


Figure 7. Third quadrant characteristics  
 $I_D=f(V_{DS}, V_{GS})$ ;  $T_J=25^\circ\text{C}$

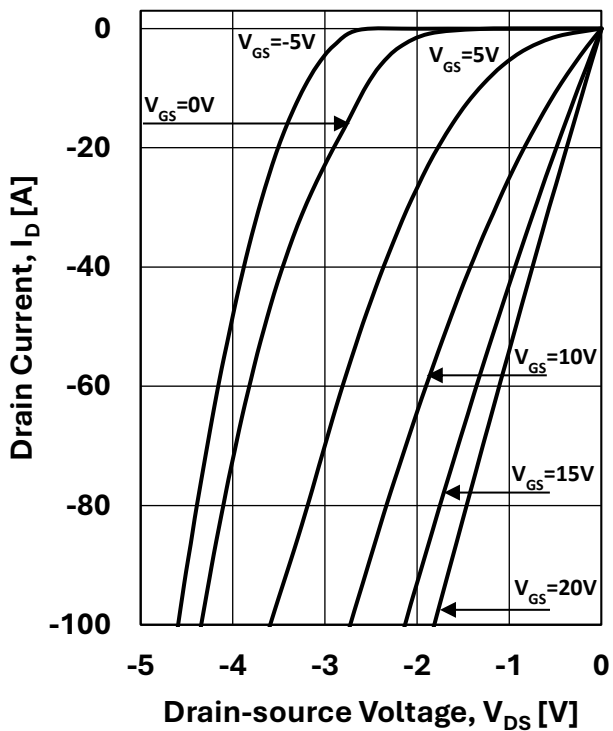


Figure 8. Third quadrant characteristics  
 $I_D=f(V_{DS}, V_{GS})$ ;  $T_J=200^\circ\text{C}$

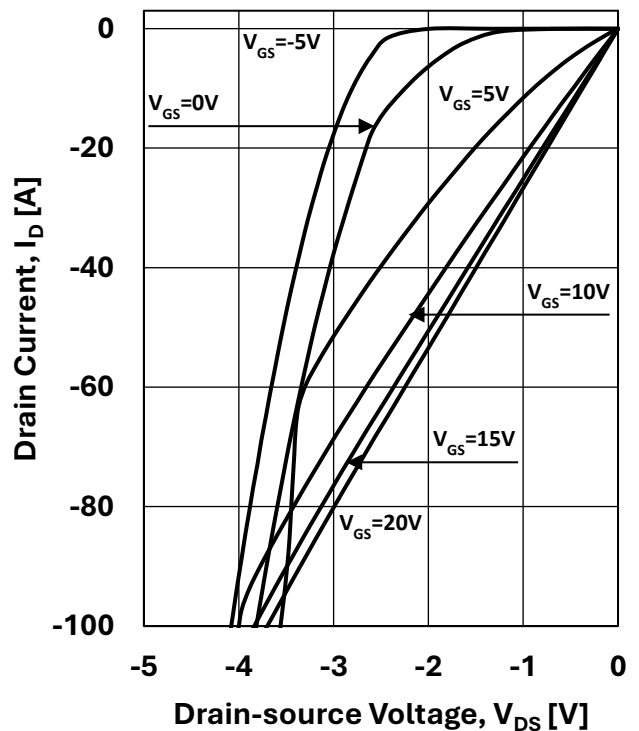


Figure 9. Capacitances

$C=f(V_{DS}); f=100\text{kHz}$

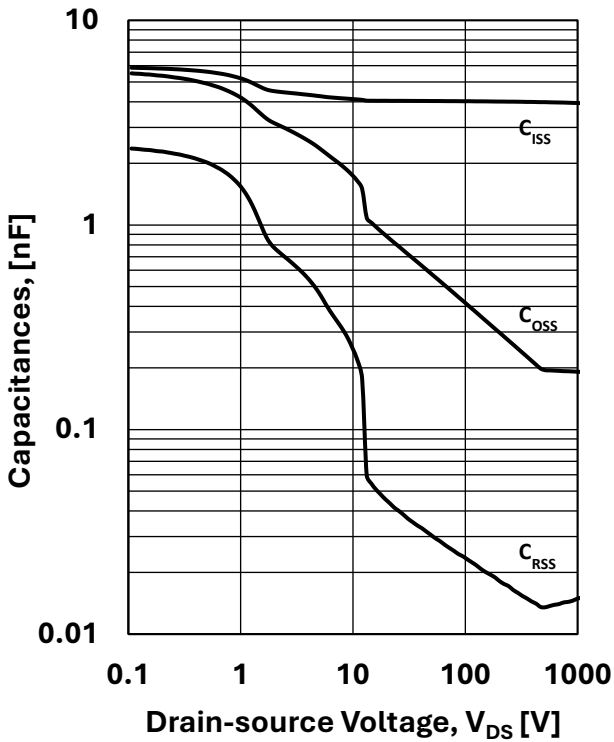


Figure 10. Inductive switching energies (see Fig. 17)

$E_{ON}=f(I_D); E_{OFF}=f(I_D); E_{TOT\_SW}=f(I_D)$

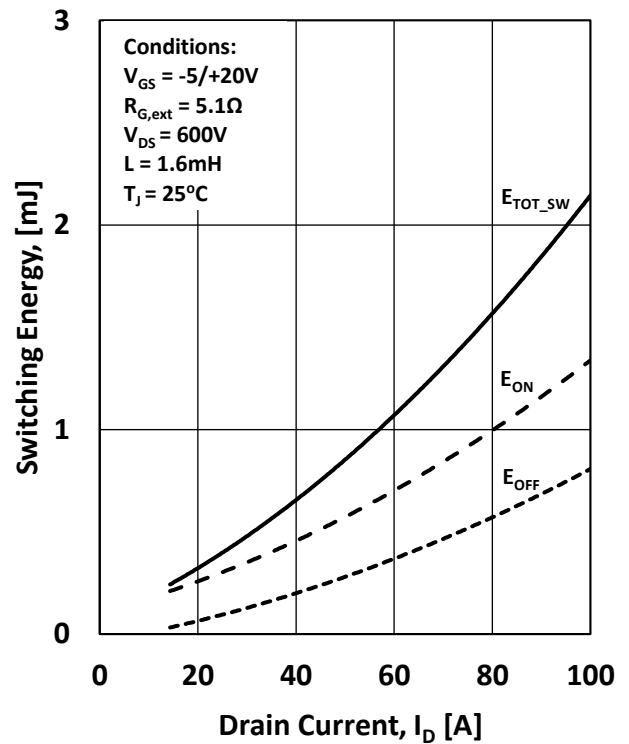


Figure 11. Typical unclamped inductive switching waveforms  $I_D=f(t); V_{DS}=f(t)$

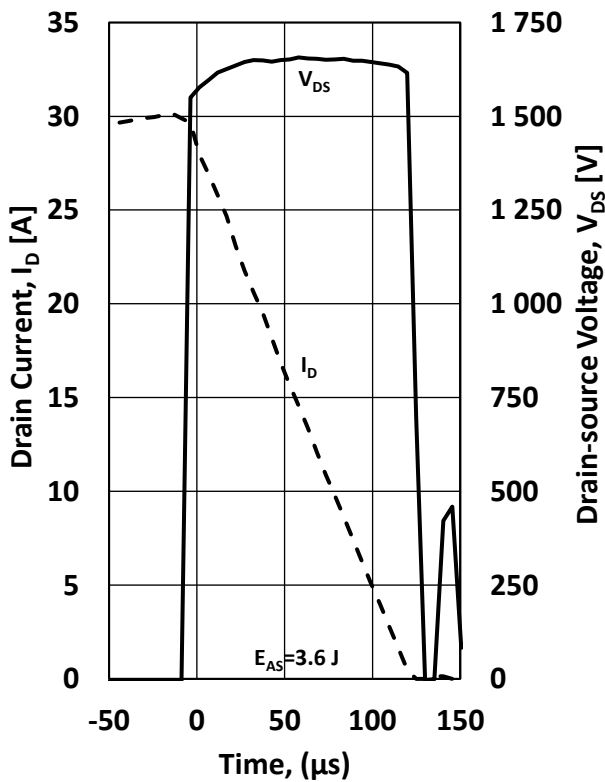


Figure 12. Gate charge

$V_{GS}=(-5 \dots +18\text{V}); V_{DS}=900\text{V}; I_{DS}=60\text{A}; T_J=25^\circ\text{C}$

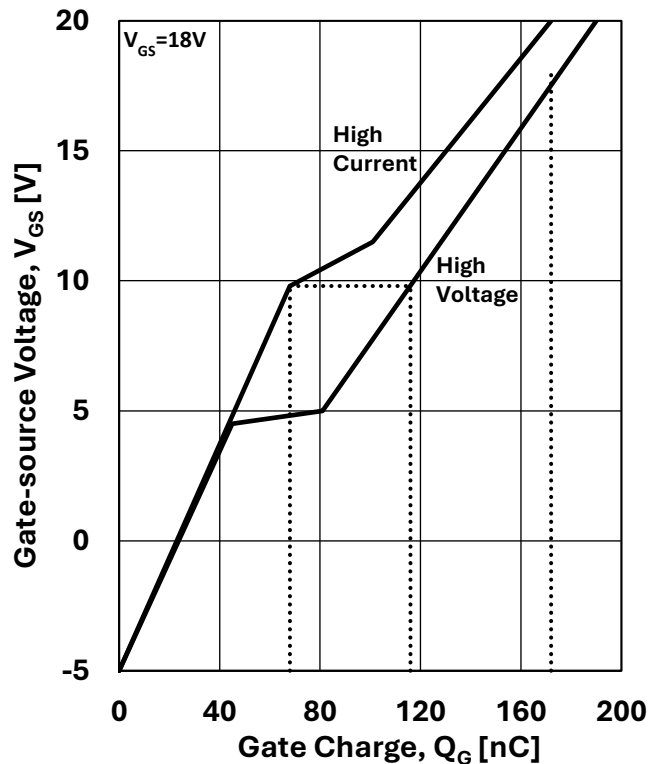


Figure 13. Transfer characteristics

$$I_D = f(V_{GS}); V_{DS} = 10V$$

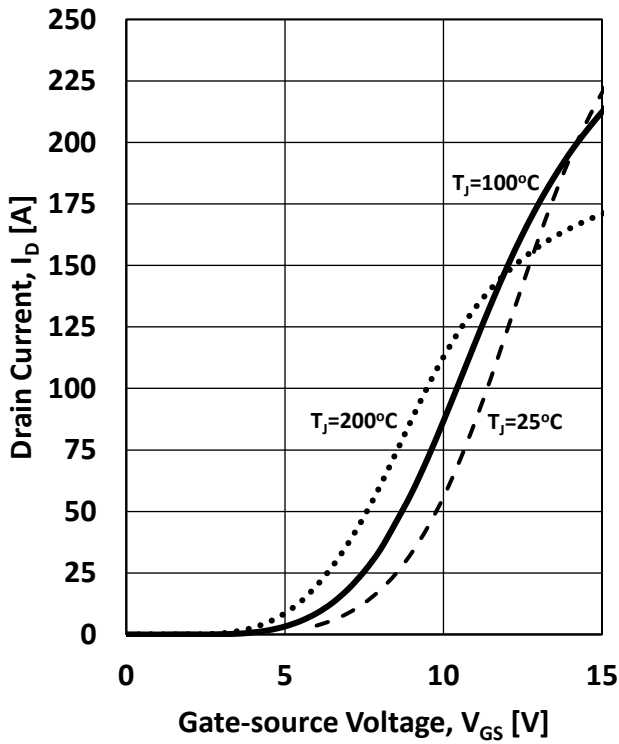


Figure 14. Power dissipation

$$P_{tot} = f(T_C)$$

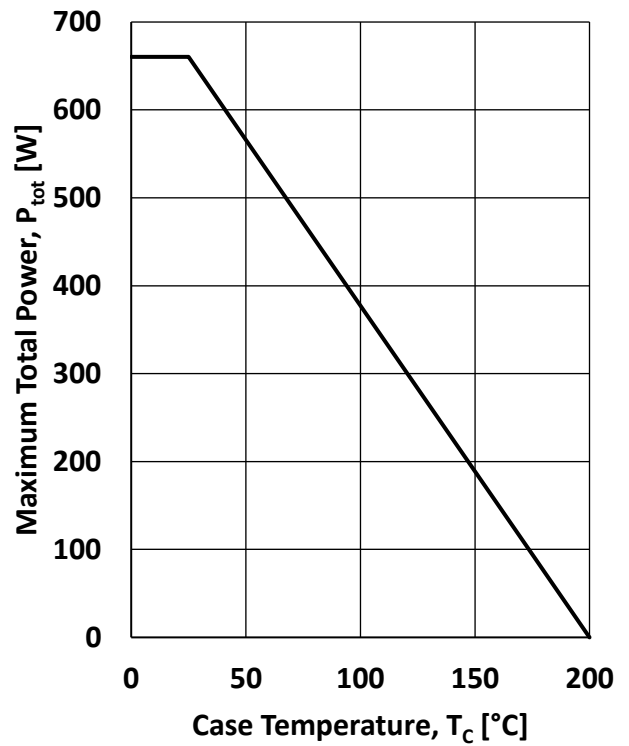


Figure 15. Transient thermal impedance

$$Z_{th,jc} = f(t_p, D); D = t_p / (\text{period})$$

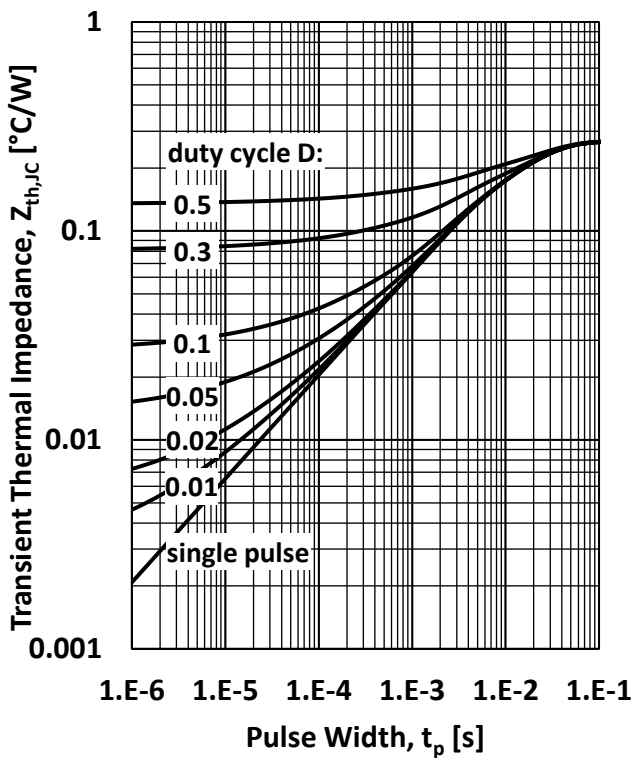


Figure 16. Safe operating area

$$I_D = f(V_{DS}, t_p); T_C = 25^\circ C; D = 0 \text{ (single pulse)}$$

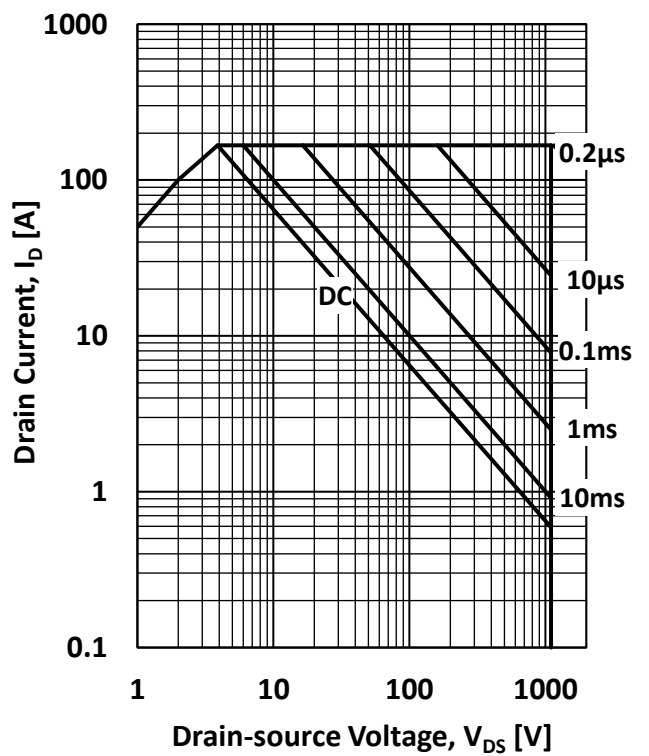


Figure 17. Clamped inductive switching test circuit

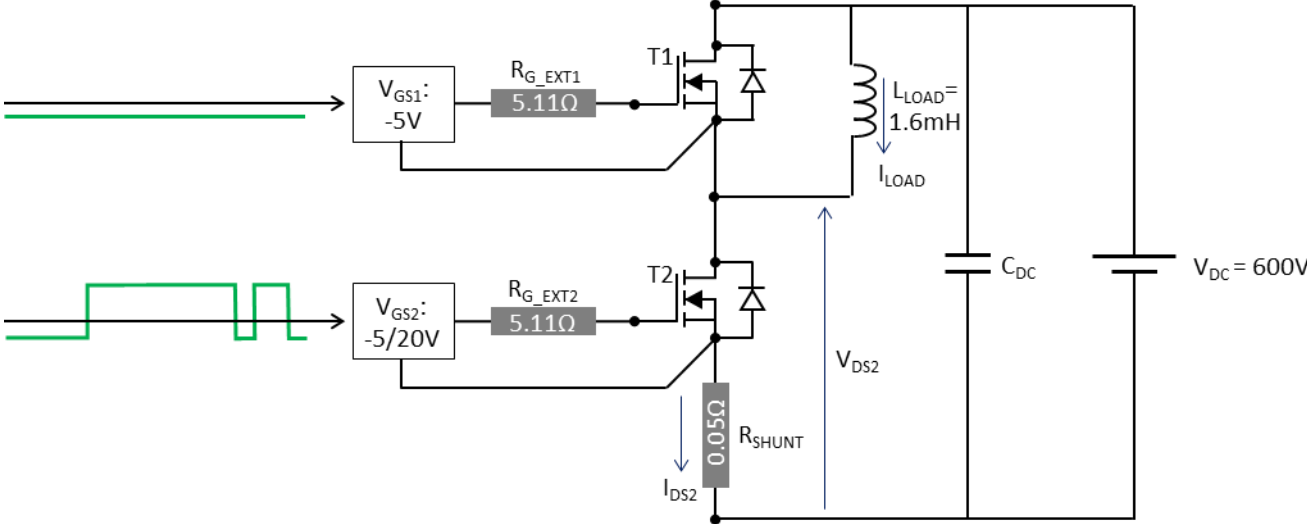
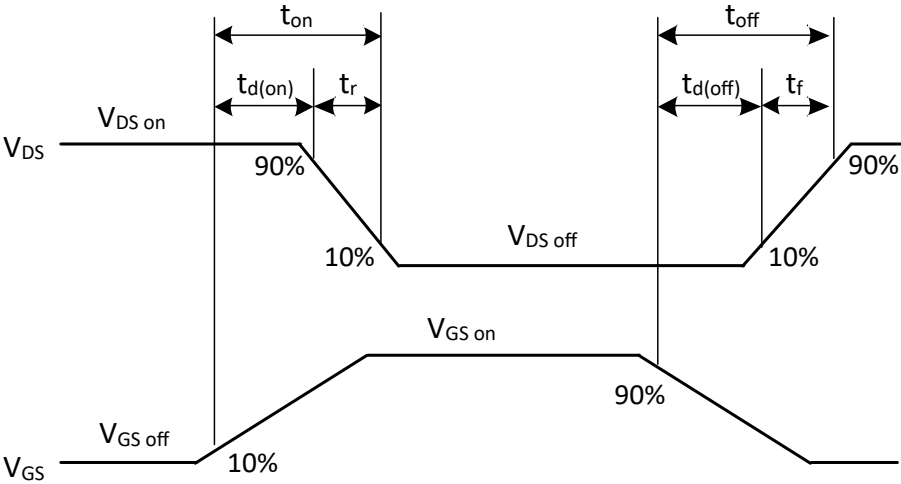


Figure 18. Switching waveforms for transition times







**Handling**

These devices are sensitive to electrostatic discharge and proper handling procedures are recommended. Please refer to ESD standard.

**Revision History TM3B0020120A**

| Reference | Date       | Description                                      |
|-----------|------------|--|
| v1.0      | 2023-01-05 | Release of preliminary datasheet                 |
| v2.0      | 2024-05-27 | Release of final version                         |
| v2.1      | 2024-10-21 | Fig.3, Fig.5, Fig.10, Fig.13, Fig.19 corrections |

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