

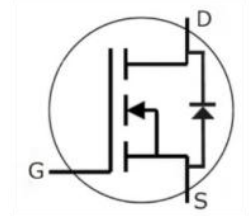
# S1M032120B



TriQSiC™ 1200V Silicon Carbide Power MOSFET G1 ( N Channel Enhancement )

## Features

- High speed switching
- Very low switching losses
- High blocking voltage with low on-resistance
- Temperature independent turn-off switching losses
- Halogen free, RoHS compliant



## Benefits

- Cooling effort reduction
- Efficiency improvement
- Reduced cooling requirements
- Increased power density
- Increased system switching frequency

| Part number | Die size (W x L) mm |
|-------------|---------------------|
| S1M032120B  | 4.986 * 3.74        |

## Applications

- EV motor drive
- PV string inverters
- Solar power optimizer
- Switch mode power supplies

Table 1 Key performance and package parameters

| Type       | V <sub>DS</sub> | I <sub>DS</sub><br>(T <sub>C</sub> = 25°C,<br>R <sub>th(j-c),max</sub> ≤ 0.4 °C/W) | R <sub>DS(on), typ</sub><br>(V <sub>GS</sub> = 15V, I <sub>D</sub> = 40A,<br>T <sub>J</sub> = 25°C) | T <sub>J,max</sub> |
|------------|-----------------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------|
| S1M032120B | 1200V           | 87A                                                                                | 32mΩ                                                                                                | 175°C              |

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## 1、Maximum ratings

**Table 2** Maximum rating ( $T_c = 25^{\circ}\text{C}$  unless otherwise specified)

| Symbol         | Parameter                                     | Value       | Unit               | Test Conditions                                     | Note  |
|----------------|-----------------------------------------------|-------------|--------------------|-----------------------------------------------------|-------|
| $V_{DS,max}$   | Drain source voltage                          | 1200        | V                  | $V_{GS} = 0V, I_D = 100\mu A$                       |       |
| $V_{GS,max}$   | Gate source voltage                           | -8 / +22    | V                  | Absolute maximum values                             | Note1 |
| $V_{GS,pulse}$ | Gate-source voltage,max.<br>transient voltage | -10 / +25   | V                  | $t_p \leq 0.5\mu s, D < 0.01$                       |       |
| $V_{GS,op}$    | Gate source voltage                           | -4 / +15~18 | V                  | Recommended operational values                      |       |
| $I_D$          | Continuous drain current                      | 87          | A                  | $V_{GS} = 15V, T_c = 25^{\circ}\text{C}$            |       |
|                |                                               | 62          |                    | $V_{GS} = 15V, T_c = 100^{\circ}\text{C}$           |       |
| $I_D(pulse)$   | Pulsed drain current                          | 280         | A                  | Pulse width $t_p = 100\mu s$ limited by $T_{J,max}$ |       |
| $T_J, T_{stg}$ | Operating Junction and storage<br>temperature | -55 to +175 | $^{\circ}\text{C}$ |                                                     |       |

Note 1: when using MOSFET Body Diode  $V_{GS,max} = -4 / +22V$

## 2、Electrical characteristics

### 2.1 Static characteristics

**Table 3** Static characteristics (Tc = 25°C unless otherwise specified)

| Symbol        | Parameter                                | Min. | Typ. | Max. | Unit       | Test Conditions                                         | Note      |
|---------------|------------------------------------------|------|------|------|------------|---------------------------------------------------------|-----------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage           | 1200 | -    | -    | V          | $V_{GS} = 0V, I_D = 100\mu A$                           |           |
| $V_{GS(th)}$  | Gate threshold voltage                   | 2.3  | 2.8  | 3.6  | V          | $V_{DS} = V_{GS}, I_D = 11.5mA$                         | Fig.11    |
|               |                                          | -    | 2.0  | -    | V          | $V_{DS} = V_{GS}, I_D = 11.5mA,$<br>$T_J = 175^\circ C$ |           |
| $I_{DSS}$     | Zero gate voltage drain current          | -    | 1    | 10   | $\mu A$    | $V_{DS} = 1200V, V_{GS} = 0V$                           |           |
| $I_{GSS}$     | Gate source leakage current              | -    | -    | 100  | nA         | $V_{GS} = 15V, V_{DS} = 0V$                             |           |
| $R_{DS(on)}$  | Current drain-source on-state resistance | -    | 32   | 43   | m $\Omega$ | $V_{GS} = 15V, I_D = 40A$                               | Fig.4,5,6 |
|               |                                          | -    | 49   | -    |            | $V_{GS} = 15V, I_D = 40A,$<br>$T_J = 175^\circ C$       |           |
|               |                                          | -    | 27   | 35   |            | $V_{GS} = 18V, I_D = 40A$                               |           |
|               |                                          | -    | 47   | -    |            | $V_{GS} = 18V, I_D = 40A,$<br>$T_J = 175^\circ C$       |           |
| $g_{fs}$      | Transconductance                         | -    | 24   | -    | S          | $V_{DS} = 20V, I_D = 40A$                               | Fig.7     |
|               |                                          | -    | 22   | -    |            | $V_{DS} = 20V, I_D = 40A,$<br>$T_J = 175^\circ C$       |           |
| $R_{g,int}$   | Internal gate resistance                 | -    | 0.6  | -    | $\Omega$   | $V_{AC} = 25mV, f = 1MHz,$<br>open drain                |           |

### 2.2 Dynamic characteristics

**Table 4** Dynamic characteristics (Tc = 25°C unless otherwise specified)

| Symbol    | Parameter           | Min. | Typ. | Max. | Unit    | Test Conditions                                                                    | Note      |
|-----------|---------------------|------|------|------|---------|------------------------------------------------------------------------------------|-----------|
| $C_{iss}$ | Input capacitance   | -    | 2700 | -    | pF      | $V_{DS} = 1000V, V_{GS} = 0V$<br>$T_J = 25^\circ C, V_{AC} = 25mV$<br>$f = 100kHz$ | Fig.17,18 |
| $C_{oss}$ | Output capacitance  | -    | 143  | -    |         |                                                                                    |           |
| $C_{rss}$ | Reverse capacitance | -    | 8.8  | -    |         |                                                                                    |           |
| $E_{oss}$ | Coss stored energy  | -    | 88   | -    | $\mu J$ |                                                                                    | Fig.16    |

## 1200V SiC Power MOSFET

|          |                    |   |    |   |    |                                                  |        |
|----------|--------------------|---|----|---|----|--------------------------------------------------|--------|
| $Q_{gs}$ | Gate source charge | - | 31 | - | nC | $V_{DS} = 800V, V_{GS} = -4/+15V$<br>$I_D = 40A$ | Fig.12 |
| $Q_{gd}$ | Gate drain charge  | - | 34 | - |    |                                                  |        |
| $Q_g$    | Gate charge        | - | 97 | - |    |                                                  |        |

## 2.3 Switching characteristics

Table 5 Dynamic characteristics( $T_c = 25^\circ C$  unless otherwise specified,the data comes from TO-247-4L)

| Symbol               | Parameter                 | Min. | Typ. | Max. | Unit | Test Conditions                                                                                                | Note |
|----------------------|---------------------------|------|------|------|------|----------------------------------------------------------------------------------------------------------------|------|
| E <sub>on</sub>      | Turn on switching energy  | -    | 413  | -    | μJ   | V <sub>DS</sub> = 800V, V <sub>GS</sub> = -4/+15V<br>I <sub>D</sub> = 40A, R <sub>g</sub> = 2.5Ω,<br>L = 120μH |      |
| E <sub>off</sub>     | Turn off switching energy | -    | 60   | -    |      |                                                                                                                |      |
| t <sub>d (on)</sub>  | Turn on delay time        | -    | 16   | -    | ns   |                                                                                                                |      |
| t <sub>r</sub>       | Rise time                 | -    | 21   | -    |      |                                                                                                                |      |
| t <sub>d (off)</sub> | Turn off delay time       | -    | 27   | -    |      |                                                                                                                |      |
| t <sub>f</sub>       | Fall time                 | -    | 9    | -    |      |                                                                                                                |      |

Table 6 Body diode characteristics(The data comes from TO-247-4L)

| Symbol    | Parameter                        | Min. | Typ. | Max. | Unit | Test Conditions                                                                              | Note           |
|-----------|----------------------------------|------|------|------|------|----------------------------------------------------------------------------------------------|----------------|
| $V_{SD}$  | Diode forward voltage            | -    | 3.8  | -    | V    | $V_{GS} = -4V, I_{SD} = 20A$                                                                 | Fig.8,9,<br>10 |
|           |                                  | -    | 3.4  | -    | V    | $V_{GS} = -4V, I_{SD} = 20A$<br>$T_j = 175^\circ C$                                          |                |
| $I_S$     | Continuous diode forward current | -    | 87   | -    | A    | $V_{GS} = -4V, T_c = 25^\circ C$                                                             | Note2          |
| $t_{rr}$  | Reverse recovery time            | -    | 55   | -    | nS   | $V_R = 800V, V_{GS} = -4V$<br>$I_{SD} = 40A$<br>$di/dt = 2281A/\mu s$<br>$T_j = 175^\circ C$ |                |
| $Q_{rr}$  | Reverse recovery charge          | -    | 750  | -    | nC   |                                                                                              |                |
| $I_{rrm}$ | Peak reverse recovery current    | -    | 26   | -    | A    |                                                                                              |                |

Note2 : When using SiC Body Diode the maximum recommended  $V_{GS} = -4V$

### 3、Electrical characteristic diagrams

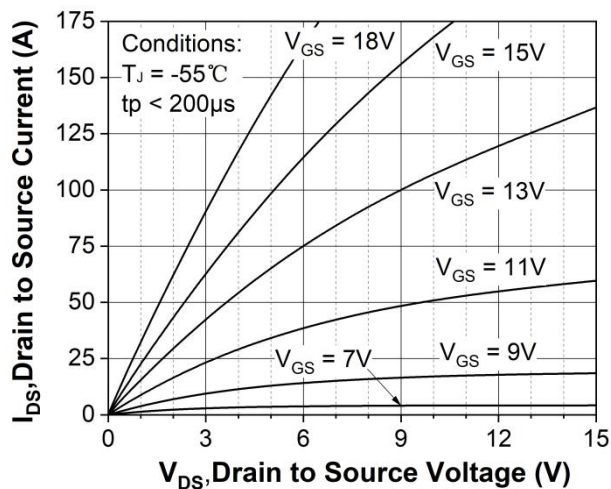


Figure 1. Output characteristics  $T_J = -55^\circ\text{C}$

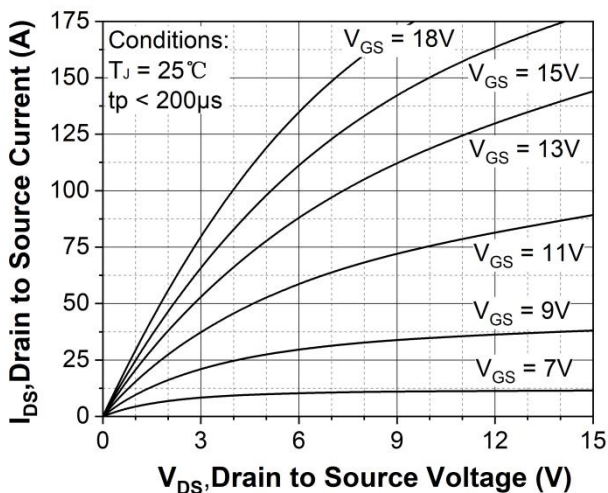


Figure 2. Output characteristics  $T_J = 25^\circ\text{C}$

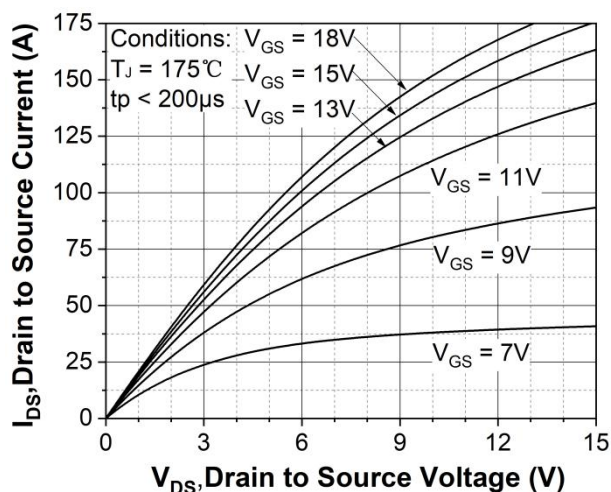


Figure 3. Output characteristics  $T_J = 175^\circ\text{C}$

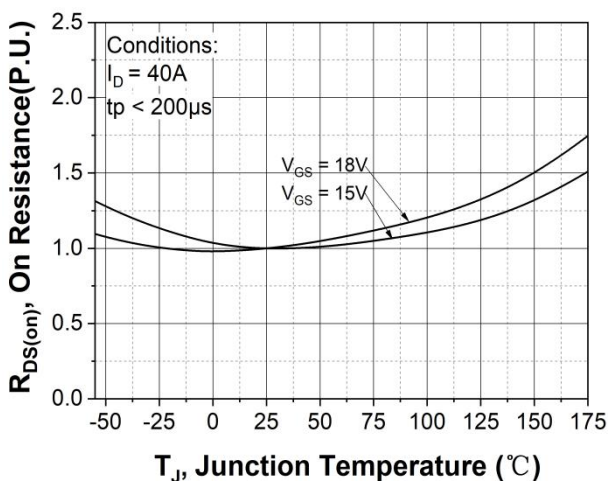


Figure 4. Normalized on-resistance vs. temperature

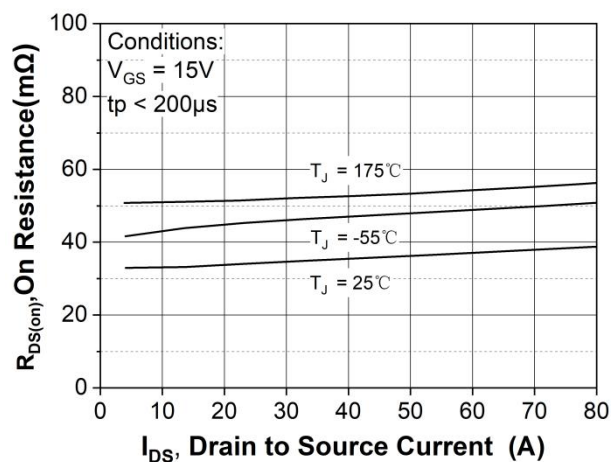


Figure 5. On-resistance vs. drain current

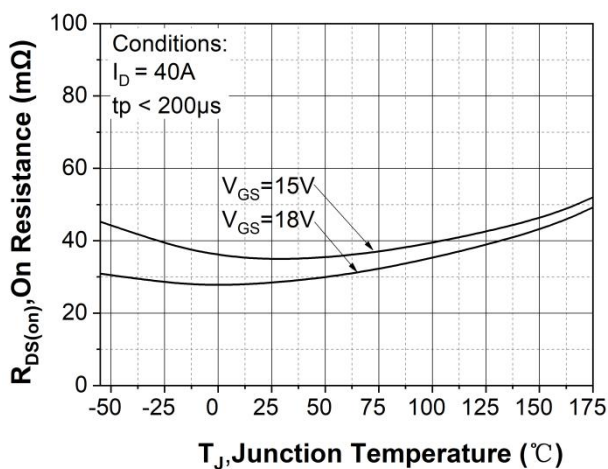


Figure 6. On-resistance vs. temperature

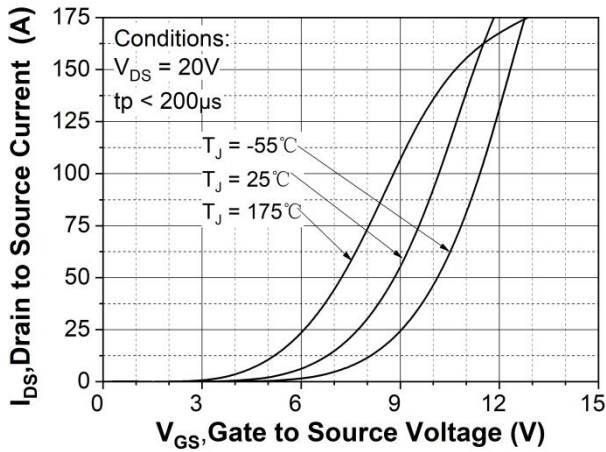


Figure 7. Transfer characteristic for various junction temperatures

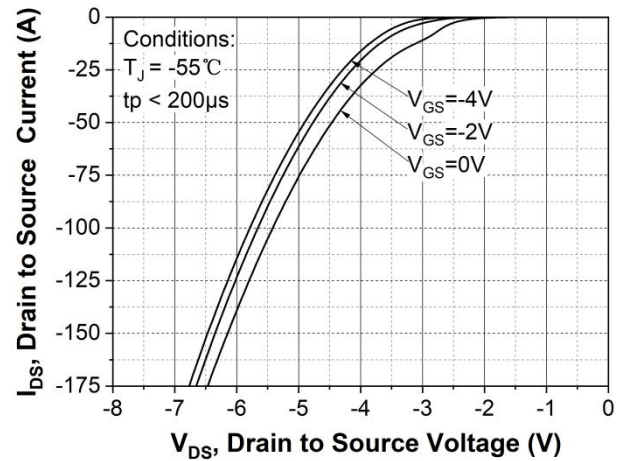


Figure 8. Body diode characteristic at  $T_J = -55^\circ C$

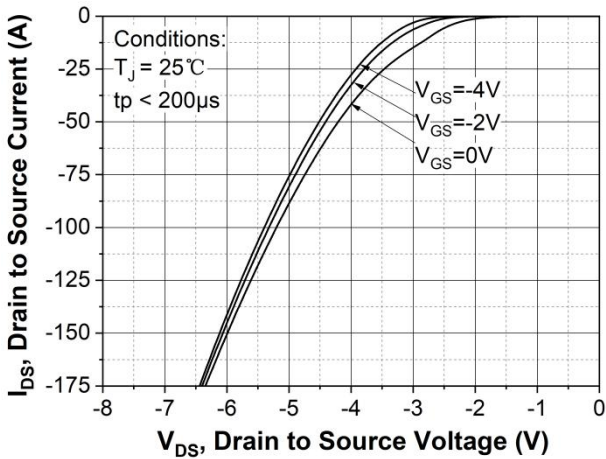


Figure 9. Body diode characteristic at  $T_J = 25^\circ C$

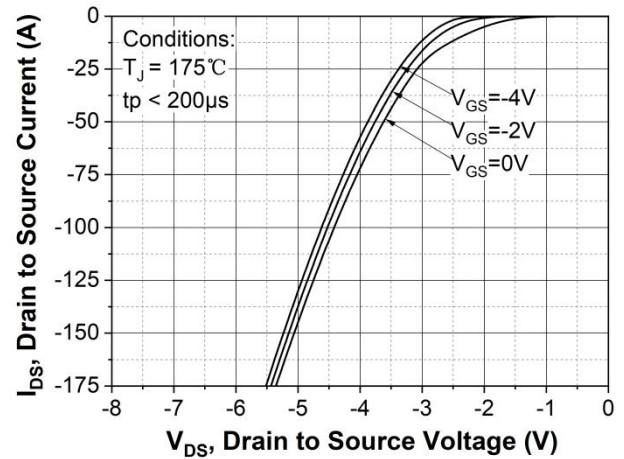


Figure 10. Body diode characteristic at  $T_J = 175^\circ C$

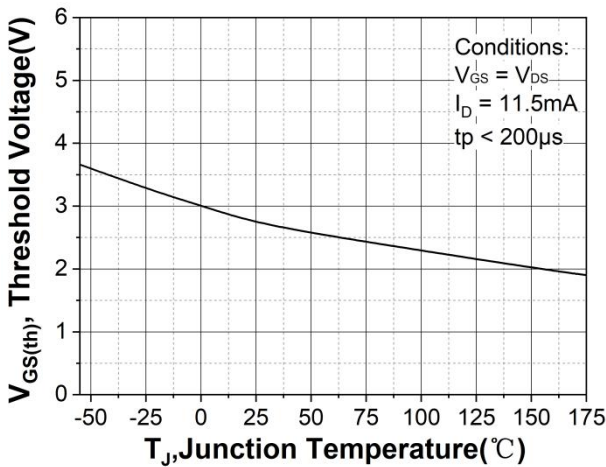


Figure 11. Threshold voltage vs. temperature

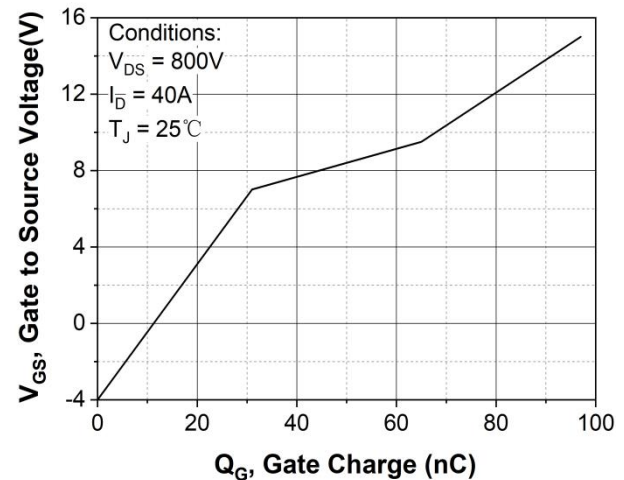


Figure 12. Gate charge characteristic



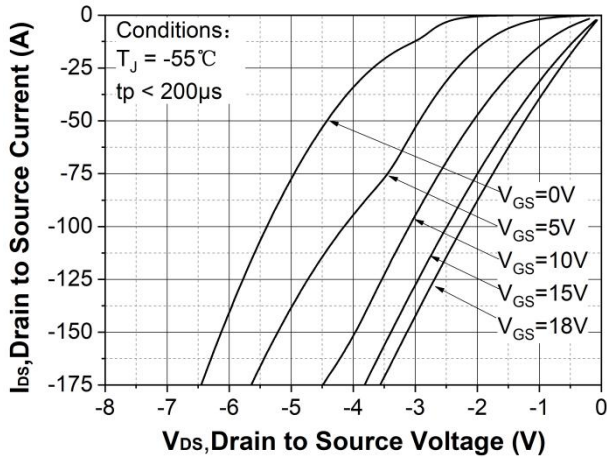


Figure 13. 3rd quadrant characteristic at  $T_J = -55\text{ }^{\circ}\text{C}$

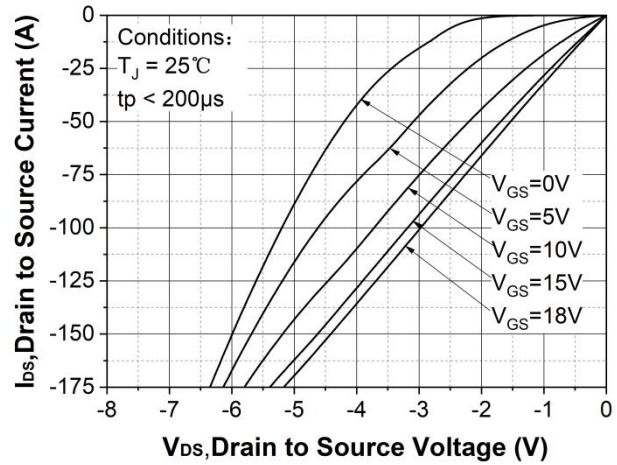


Figure 14. 3rd quadrant characteristic at  $T_J = 25\text{ }^{\circ}\text{C}$

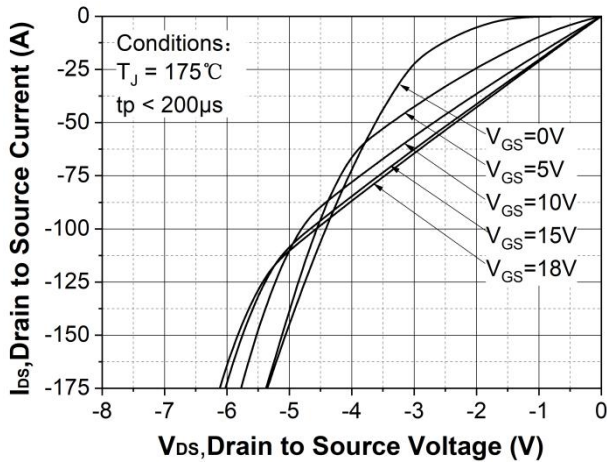


Figure 15. 3rd quadrant characteristic at  $T_J = 175\text{ }^{\circ}\text{C}$

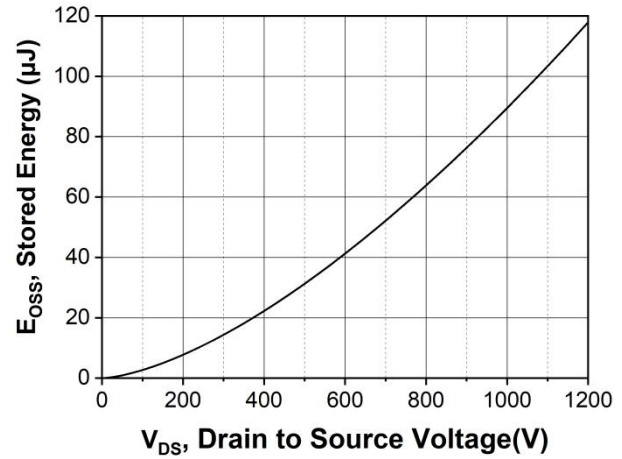


Figure 16. Output capacitor stored energy

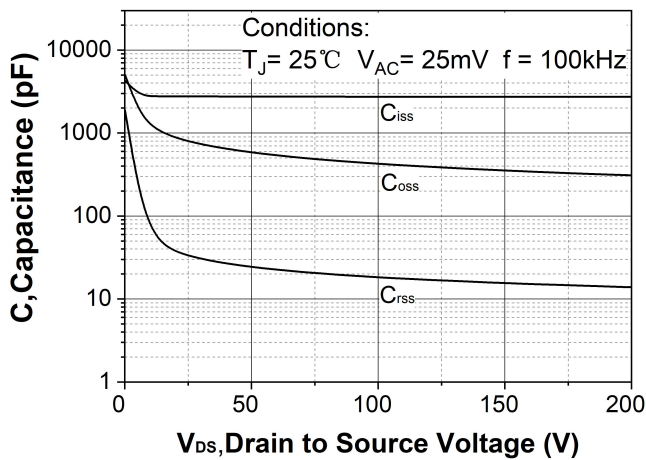


Figure 17. Capacitances vs. drain-source voltage (0 - 200V)

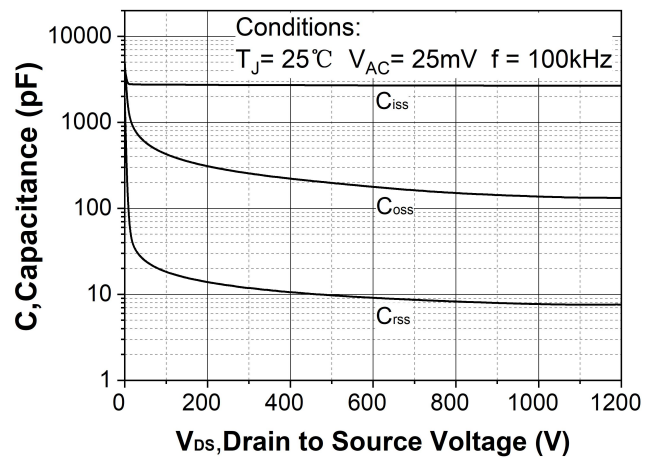


Figure 18. Capacitances vs. drain-source voltage (0 - 1200V)

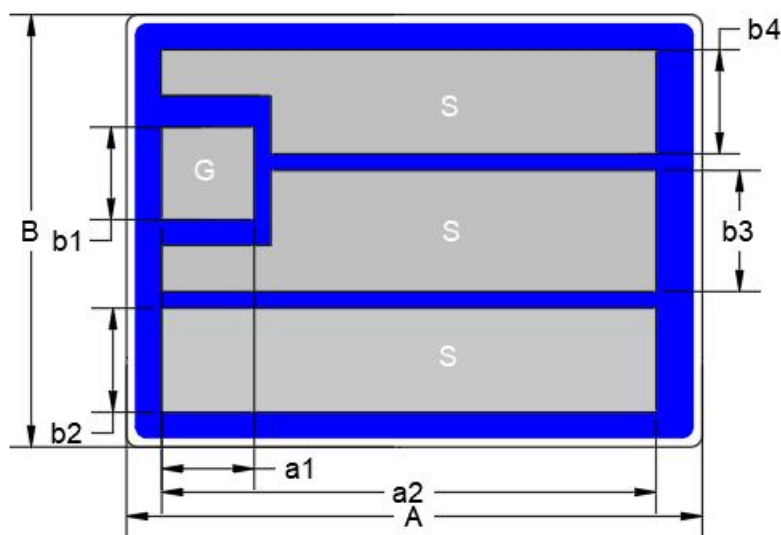


## 4、Mechanical parameters

### 4.1 Dimensions and metallization

| Parameter                            | Typical value | Unit | Metallization |
|--------------------------------------|---------------|------|---------------|
| Die size (W x L)                     | 4.986 * 3.74  | mm   |               |
| Gate pad size (W x L)                | 0.8 * 0.8     | mm   |               |
| Die thickness                        | 200           | μm   |               |
| Top side (source gate) metallization | 4             | μm   | Ti/Al         |
| Back side (drain) metallization      | 1             | μm   | Ti/Ni/Ag      |

### 4.2 Layout



| Symbol | Dimension / mm |
|--------|----------------|
| B      | 3.740          |
| b1     | 0.800          |
| b2     | 0.900          |
| b3     | 0.950          |
| b4     | 0.900          |
| A      | 4.986          |
| a1     | 0.800          |
| a2     | 4.286          |

### 5、 Test conditions

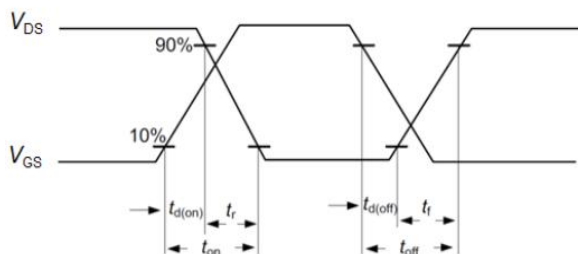


Figure A. Definition of switching times

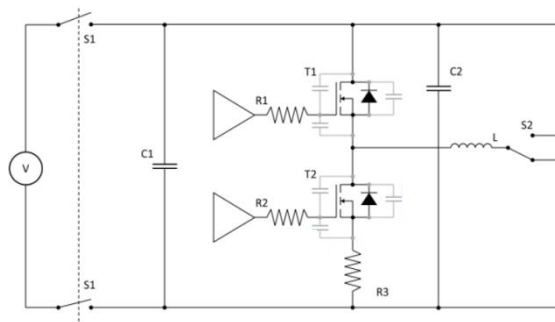


Figure B. Dynamic test circuit

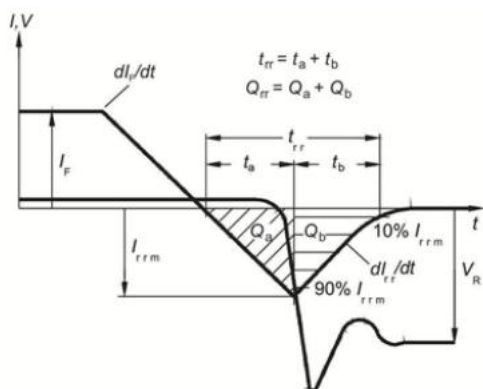


Figure C. Definition of body diode switching characteristics

## Revision history

| Document version | Date of release | Document stage | Description of changes |
|------------------|-----------------|----------------|------------------------|
| V01_00           | 2022-12-30      | ---            | ---                    |
| V01_01           | 2023-04-05      | ---            | ---                    |
| V01_02           | 2023-09-15      | ---            | ---                    |
| V01_03           | 2024-10-25      | ---            | ---                    |
| V02_00           | 2025-04-09      | ---            | ---                    |
| V02_01           | 2025-12-04      | ---            | ---                    |
| V02_02           | 2025-12-26      | Final          | ---                    |

## Attention

### 1. RoHS compliance

The levels of RoHS restricted materials in this product are below the maximum concentration values (also referred to as the threshold limits) permitted for such substances, or are used in an exempted application, in accordance with EU Directive 2011/65/ EC (RoHS2), as implemented January 2, 2013.

### 2. REACH compliance

REACH substances of high concern (SVHCs) information is available for this product. Since the European Chemical Agency (ECHA) has published notice of their intent to frequently revise the SVHC listing for the foreseeable future, please contact a Sichain representative to insure you get the most up-to-date REACH SVHC Declaration. REACH banned substance information (REACH Article 67) is also available upon request.

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7. Except as otherwise explicitly approved by Sichain in a written document signed by authorized representatives of Sichain, Sichain' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.
8. For use of our products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a Sichain representatives, for example but not limited to: transportation equipment, primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, and power transmission systems.