

# BCZ65N45M2

## N-Channel Silicon Carbide Power MOSFET

650 V, 45 A, 45 mΩ



### Features

- High switching speed with a low gate charge
- Fast intrinsic diode with low reverse recovery
- Robust Avalanche Capability
- 100% Avalanche Tested
- Pb-free, Halogen Free, and RoHS Compliant

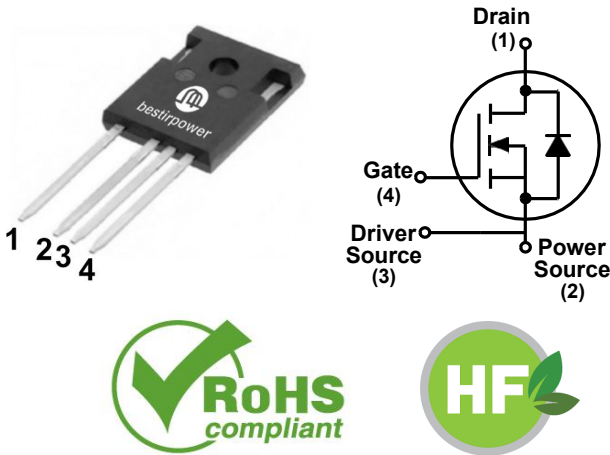
| $BV_{DSS}, T_C=25^{\circ}C$ | $I_D, T_C=25^{\circ}C$ | $R_{DS(on),typ}$ | $Q_{g,typ}$ |
|-----------------------------|------------------------|------------------|-------------|
| 650 V                       | 45 A                   | 45 mΩ            | 55 nC       |

### Benefits

- System efficiency improvement
- Higher frequency applicability
- Increased power density
- Reduced cooling effort

### Applications

- Server & Telecom power
- EV charging station
- Solar inverter / ESS / UPS
- Industrial power supply



### Absolute Maximum Ratings ( $T_C = 25^{\circ}C$ unless otherwise noted)

| Symbol         | Parameter                                                             |                                     | Value      | Unit           |
|----------------|-----------------------------------------------------------------------|-------------------------------------|------------|----------------|
| $V_{DSS}$      | Drain to Source Voltage                                               |                                     | 650        | V              |
| $V_{GS}$       | Gate to Source Voltage (DC)                                           |                                     | -10 / +22  | V              |
| $V_{GSop}$     | Recommended Operation Value                                           |                                     | -5 / +18   | V              |
| $I_D$          | Drain Current                                                         | Continuous ( $T_C = 25^{\circ}C$ )  | 45         | A              |
|                |                                                                       | Continuous ( $T_C = 100^{\circ}C$ ) | 32         |                |
| $I_{DM}$       | Drain Current                                                         | Pulsed (Note1)                      | 120        | A              |
| $P_D$          | Power Dissipation                                                     | ( $T_C = 25^{\circ}C$ )             | 167        | W              |
|                |                                                                       | Derate Above $25^{\circ}C$          | 1.11       | W/ $^{\circ}C$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                               |                                     | -55 to 175 | $^{\circ}C$    |
| $T_L$          | Maximum Lead Temperature for Soldering, 1/8" from Case for 10 Seconds |                                     | 260        | $^{\circ}C$    |

※Note 1 : Limited by maximum junction temperature.

### Thermal Characteristics

| Symbol          | Parameter                                     | Value | Unit          |
|-----------------|-----------------------------------------------|-------|---------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.9   | $^{\circ}C/W$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40    |               |

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

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|--------|-----------|-----------------|-----|-----|-----|------|
|--------|-----------|-----------------|-----|-----|-----|------|

### Off Characteristics

|            |                                   |                                                                       |     |    |      |               |
|------------|-----------------------------------|-----------------------------------------------------------------------|-----|----|------|---------------|
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                              | 650 |    |      | V             |
| $I_{DSS}$  | Zero Gate Voltage Drain Current   | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$                          |     | 1  | 100  | $\mu\text{A}$ |
|            |                                   | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}, T_J = 175^\circ\text{C}$ |     | 10 |      |               |
| $I_{GSS}$  | Gate-Source Leakage Current       | $V_{GS} = +22\text{ V}, V_{DS} = 0\text{ V}$                          |     |    | +100 | nA            |
|            |                                   | $V_{GS} = -10\text{ V}, V_{DS} = 0\text{ V}$                          |     |    | -100 |               |

### On Characteristics

|              |                                      |                                                                                                    |     |      |     |    |
|--------------|--------------------------------------|----------------------------------------------------------------------------------------------------|-----|------|-----|----|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}, I_D = 7.0\text{ mA}$<br>(tested after $V_{GS} = 22\text{V}, 1\text{ ms pulse}$ ) | 2.0 | 2.8  | 4.5 | V  |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 18\text{ V}, I_D = 20\text{ A}$                                                          |     | 45   | 63  | mΩ |
|              |                                      | $V_{GS} = 18\text{ V}, I_D = 20\text{ A}, T_J = 175^\circ\text{C}$                                 |     | 61   |     |    |
| $g_{fs}$     | Transconductance                     | $V_{DS} = 20\text{ V}, I_D = 20\text{ A}$                                                          |     | 13.3 |     | S  |

### Dynamic Characteristics

|              |                                     |                                                                                                        |  |      |  |               |
|--------------|-------------------------------------|--------------------------------------------------------------------------------------------------------|--|------|--|---------------|
| $C_{iss}$    | Input Capacitance                   | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{V}, f = 250\text{ kHz}$                                        |  | 1238 |  | pF            |
| $C_{oss}$    | Output Capacitance                  |                                                                                                        |  | 137  |  |               |
| $C_{rss}$    | Reverse Capacitance                 |                                                                                                        |  | 7.7  |  |               |
| $E_{oss}$    | Stored Energy in Output Capacitance | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$                                            |  | 13.6 |  | $\mu\text{J}$ |
| $C_{o(er)}$  | Energy Related Output Capacitance   |                                                                                                        |  | 169  |  | pF            |
| $C_{o(tr)}$  | Time Related Output Capacitance     |                                                                                                        |  | 242  |  |               |
| $Q_{g(tot)}$ | Total Gate Charge                   | $V_{DS} = 400\text{ V}, I_D = 20\text{ A},$<br>$V_{GS} = -5\text{ V} / 18\text{ V},$<br>Inductive load |  | 55   |  | nC            |
| $Q_{gs}$     | Gate to Source Charge               |                                                                                                        |  | 16   |  |               |
| $Q_{gd}$     | Gate to Drain "Miller" Charge       |                                                                                                        |  | 14   |  |               |
| $R_G$        | Internal Gate Resistance            | $f = 1\text{MHz}$                                                                                      |  | 2.5  |  | Ω             |

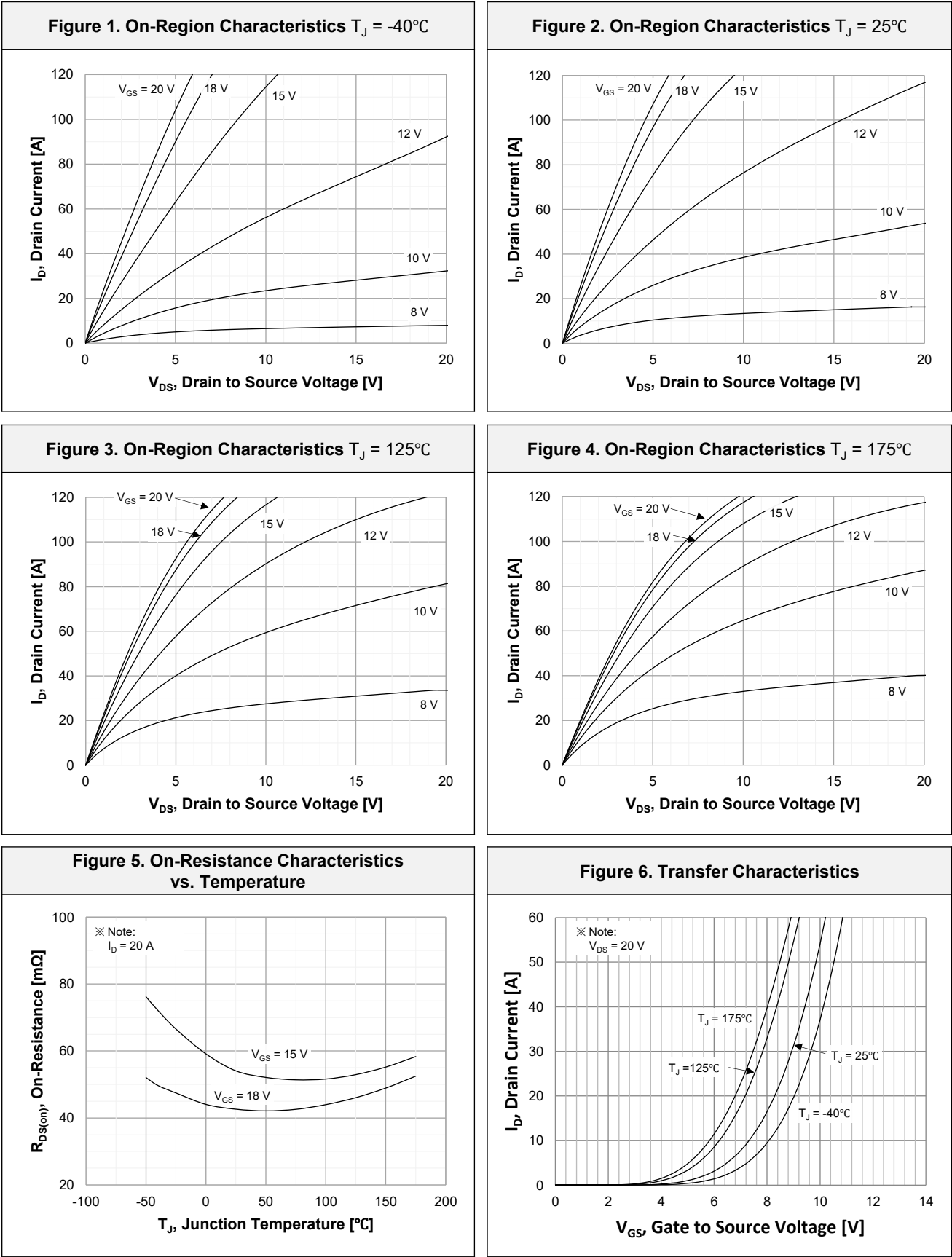
### Switching Characteristics

|              |                           |                                                                                                                                                      |  |      |  |               |
|--------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--|------|--|---------------|
| $t_{d(on)}$  | Turn-On Delay Time        | $V_{DS} = 400\text{ V}, I_D = 20\text{ A},$<br>$V_{GS} = -5\text{ V} / 18\text{ V}, R_G = 5.6\text{ }\Omega,$<br>FWD : PCH65S20D1,<br>Inductive load |  | 13.9 |  | ns            |
| $t_r$        | Turn-On Rise Time         |                                                                                                                                                      |  | 10.8 |  |               |
| $t_{d(off)}$ | Turn-Off Delay Time       |                                                                                                                                                      |  | 27.9 |  |               |
| $t_f$        | Turn-Off Fall Time        |                                                                                                                                                      |  | 6.0  |  |               |
| $E_{on}$     | Turn-on Switching Energy  |                                                                                                                                                      |  | 33.6 |  | $\mu\text{J}$ |
| $E_{off}$    | Turn-off Switching Energy |                                                                                                                                                      |  | 22.8 |  |               |
| $E_{tot}$    | Total Switching Energy    |                                                                                                                                                      |  | 56.4 |  |               |

### Source-Drain Diode Characteristics

|           |                                          |                                                                                                             |  |      |    |
|-----------|------------------------------------------|-------------------------------------------------------------------------------------------------------------|--|------|----|
| $I_S$     | Maximum Continuous Diode Forward Current |                                                                                                             |  | 45   | A  |
| $I_{SM}$  | Maximum Pulsed Diode Forward Current     |                                                                                                             |  | 120  |    |
| $V_{SD}$  | Diode Forward Voltage                    | $V_{GS} = -5\text{ V}, I_{SD} = 20\text{ A}$                                                                |  | 4.4  | V  |
| $t_{rr}$  | Reverse Recovery Time                    | $V_{DD} = 400\text{ V}, I_{SD} = 20\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s},$ Includes $Q_{OSS}$ |  | 17.9 | ns |
| $Q_{rr}$  | Reverse Recovery Charge                  |                                                                                                             |  | 107  | nC |
| $I_{rrm}$ | Peak Reverse Recovery Current            |                                                                                                             |  | 10.1 | A  |

Typical Performance Characteristics



Typical Performance Characteristics

Figure 7. Diode Forward Voltage Characteristics vs. Source-Drain Current  $T_J = -40^{\circ}\text{C}$

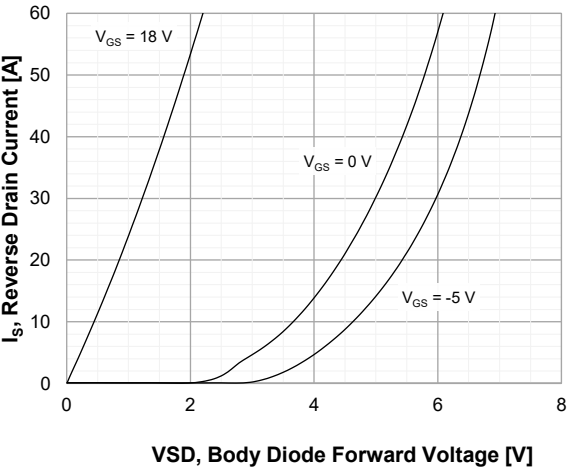


Figure 8. Diode Forward Voltage Characteristics vs. Source-Drain Current  $T_J = 25^{\circ}\text{C}$

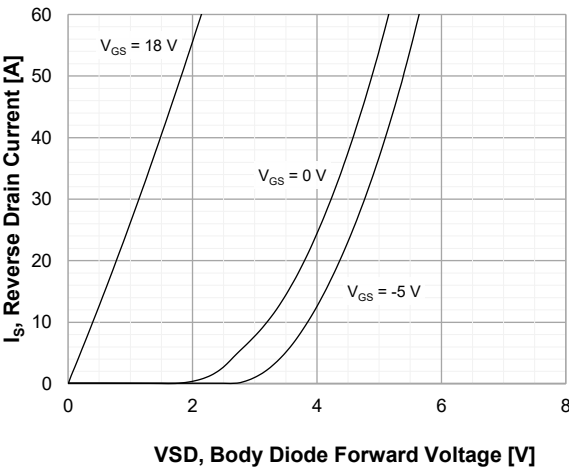


Figure 9. Diode Forward Voltage Characteristics vs. Source-Drain Current  $T_J = 125^{\circ}\text{C}$

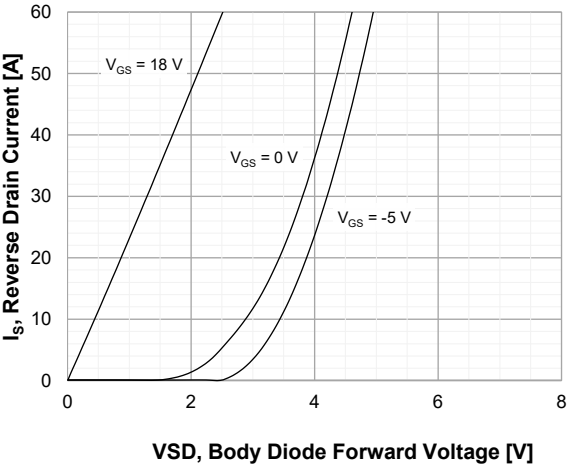


Figure 10. Diode Forward Voltage Characteristics vs. Source-Drain Current  $T_J = 175^{\circ}\text{C}$

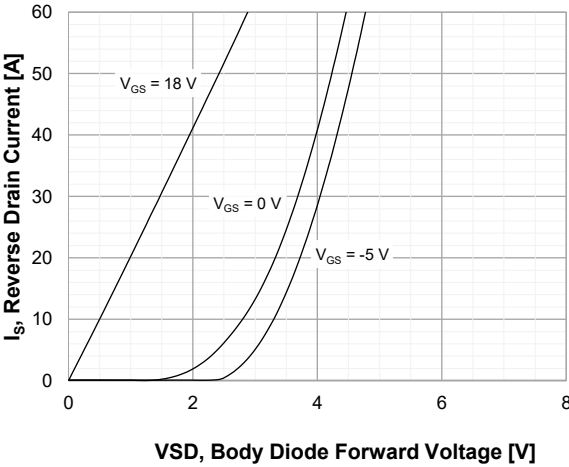


Figure 11. Threshold Voltage vs. Temperature

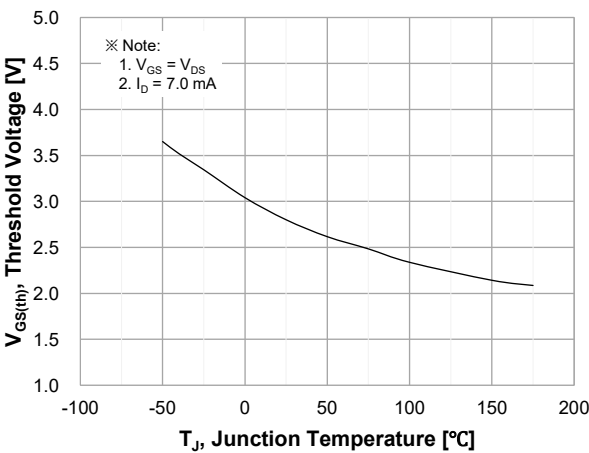
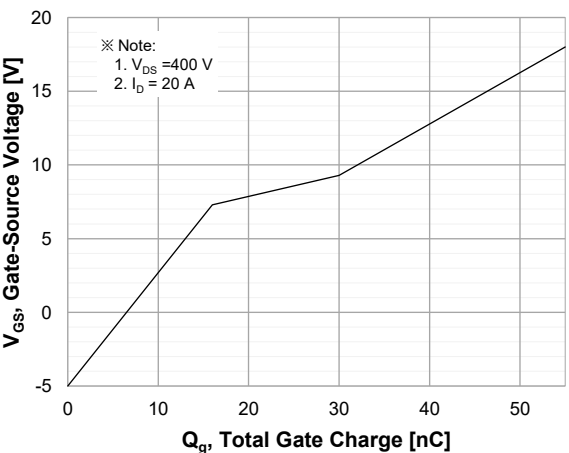


Figure 12. Gate Charge Characteristics



Typical Performance Characteristics

Figure 13. Stored Energy in Output Capacitance

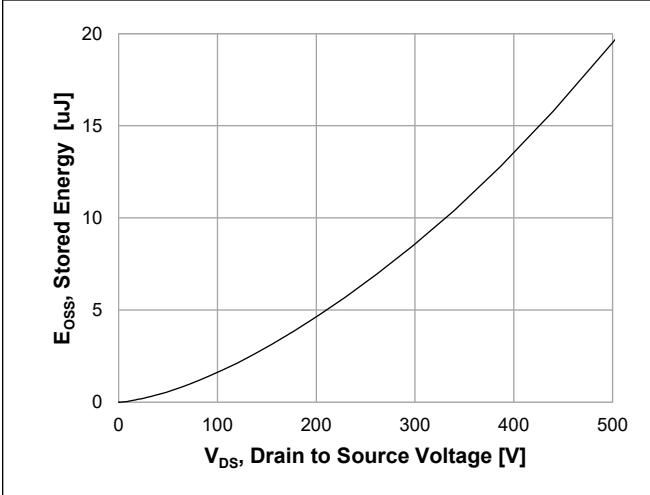


Figure 14. Capacitance Characteristics

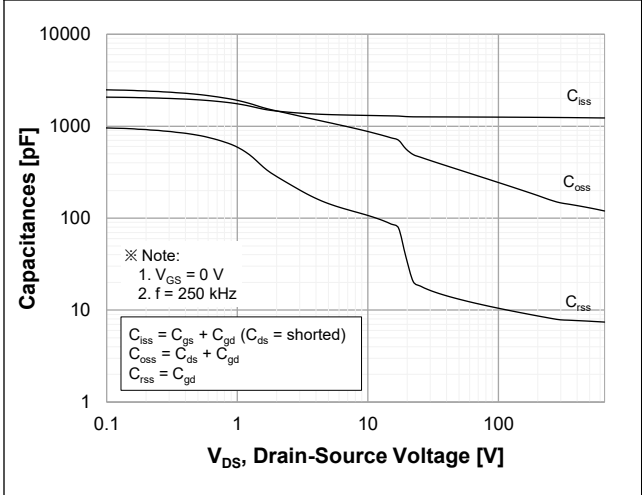


Figure 15. Continuous Drain Current Derating vs. Case Temperature

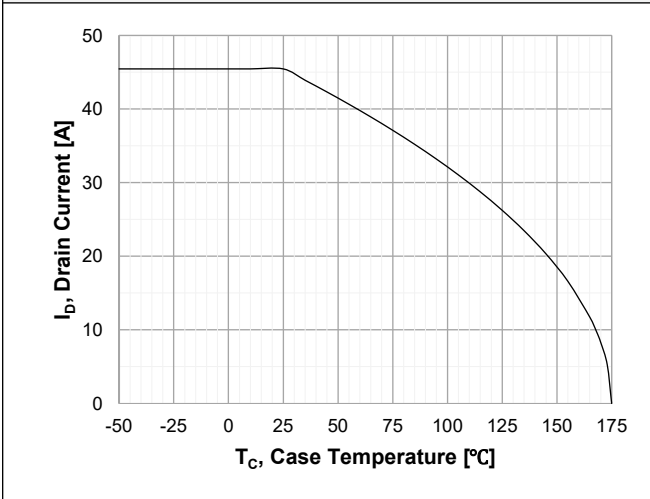


Figure 16. Maximum Power Dissipation Derating vs. Case Temperature

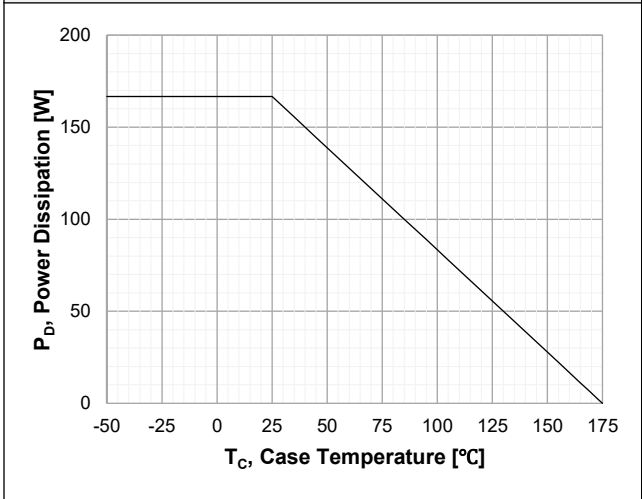


Figure 17. Typ. Switching Losses vs. Drain Current

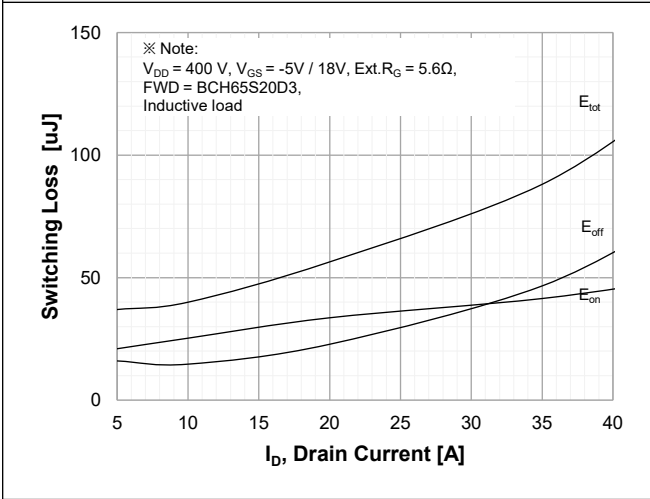
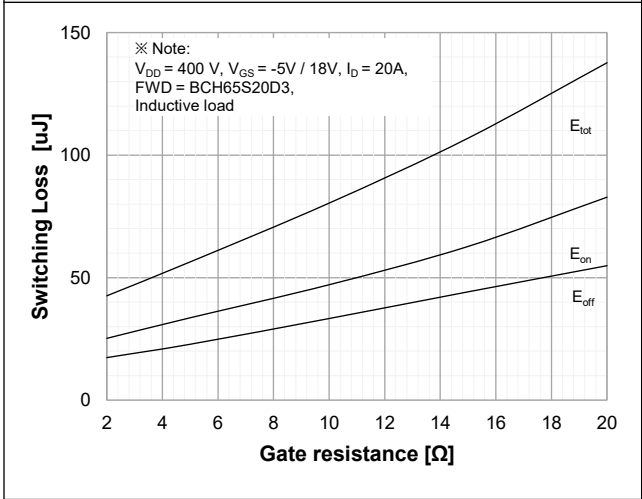


Figure 18. Typ. Switching Losses vs. Gate Resistance



Typical Performance Characteristics

Figure 19. Typ. Switching Losses vs. Drain Current

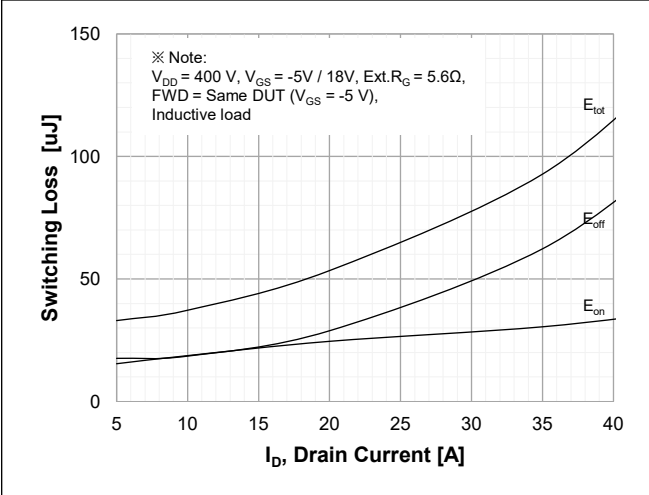


Figure 20. Typ. Switching Losses vs. Gate Resistance

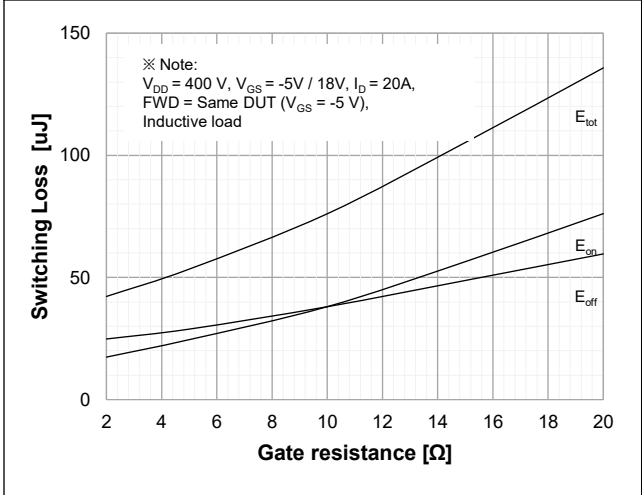


Figure 21. Maximum Safe Operating Area

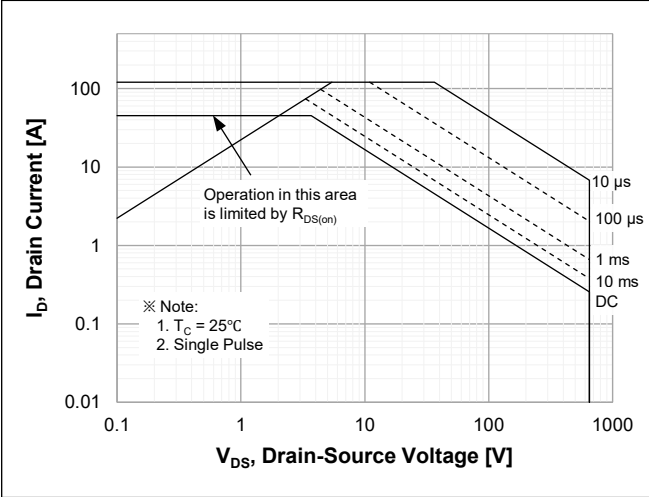
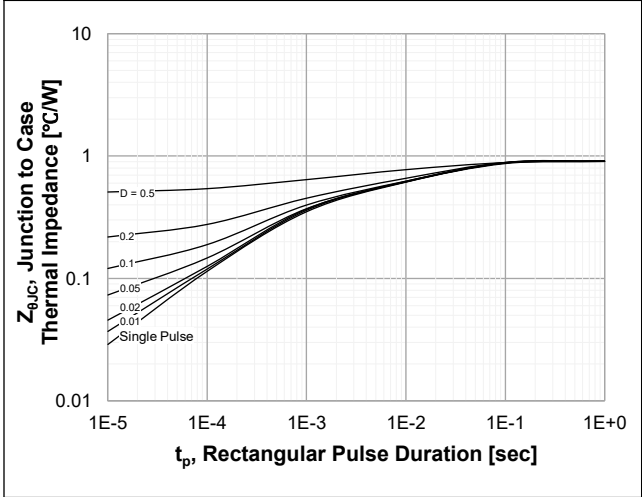


Figure 22. Transient Thermal Response Curve



Typical Performance Characteristics

Figure 23. Inductive Load Switching Test Circuit and Waveforms

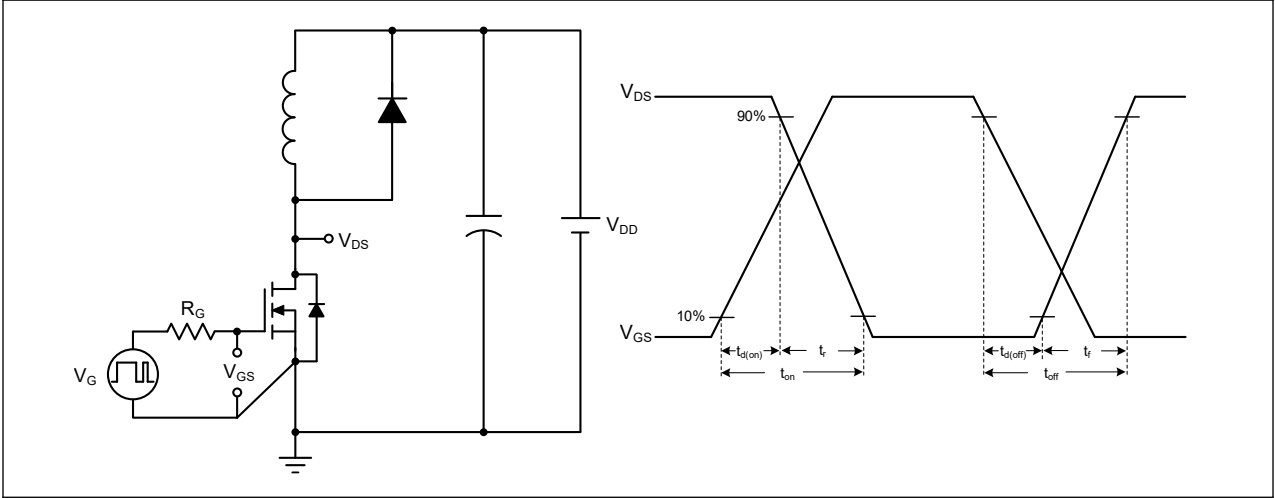
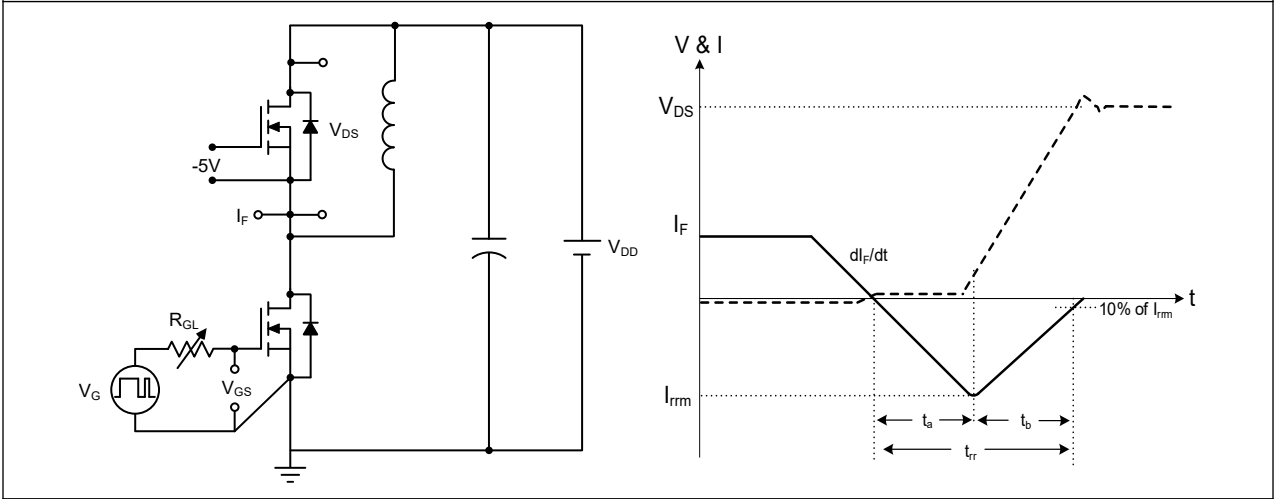
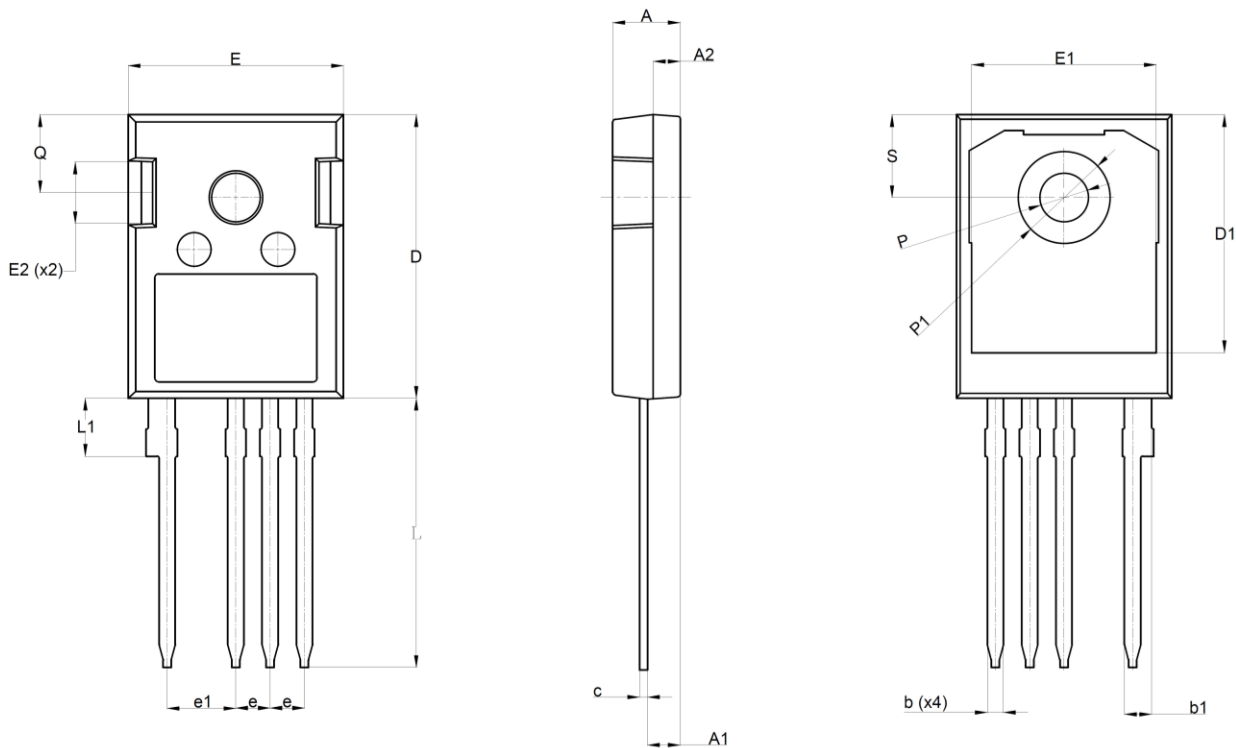


Figure 24. Peak Diode Recovery dv/dt Test Circuit and Waveforms



Package Outlines  
TO-247-4L



| SY<br>M<br>B<br>O<br>L | Common                   |       |       |
|------------------------|--------------------------|-------|-------|
|                        | DIMENSIONS<br>MILLIMETER |       |       |
|                        | MIN.                     | NOM.  | MAX.  |
| A                      | 4.80                     | 5.00  | 5.20  |
| A1                     | 2.29                     | 2.42  | 2.54  |
| A2                     | 1.90                     | 2.00  | 2.10  |
| b                      | 1.10                     | 1.20  | 1.30  |
| b1                     | 1.86                     | 2.01  | 2.15  |
| c                      | 0.50                     | 0.60  | 0.70  |
| D                      | 20.90                    | 21.00 | 21.10 |
| D1                     | 17.43                    | 17.63 | 17.83 |
| E                      | 15.75                    | 15.94 | 16.13 |
| E1                     | 13.46                    | 13.66 | 13.86 |
| E2                     | 4.32                     | 4.58  | 4.83  |
| e                      | 2.54 BSC.                |       |       |
| e1                     | 5.08 BSC.                |       |       |
| L                      | 19.80                    | 19.95 | 20.10 |
| L1                     | -                        | -     | 4.30  |
| P                      | 3.56                     | 3.61  | 3.66  |
| P1                     | 6.75                     | 6.80  | 6.85  |
| Q                      | 5.38                     | 5.79  | 6.20  |
| S                      | 6.15 BSC.                |       |       |

**Package Marking and Ordering Information**

| Part Number | Top Marking | Package  | Packing Method | Quantity |
|-------------|-------------|----------|----------------|----------|
| BCZ65N45M2  | BCZ65N45M2  | TO247-4L | Tube           | 30 units |

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