# BCBF120N40M1

## N-Channel Silicon Carbide Power MOSFET

1200 V, 60 A, 40 mΩ

bestirpower

| $BV_{DSS, TJ=25℃}$ | $I_{D, Tc=25℃}$ | $R_{DS(on),typ}$ | $Q_{g,typ}$ |
|---|---|---|---|
| 1200 V | 60 A | 40 mΩ | 109nC |

### Features

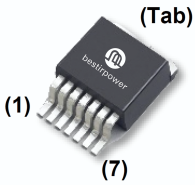
- High switching speed with a low gate charge
- Fast intrinsic diode with low reverse recovery
- Robust Avalanche Capability
- 100% Avalanche Tested
- Pb-free, Halogen Free, and RoHS Compliant

### Benefits

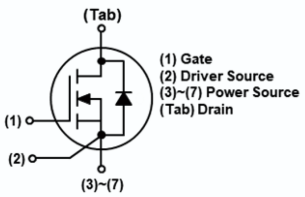
- System efficiency improvement
- Higher frequency applicability
- Increased power density
- Reduced cooling effort

### Applications

- Solar inverter
- EV charging station
- UPS
- Industrial power supply




TO-263-7L




## Absolute Maximum Ratings ($T_J$ = 25℃ unless otherwise noted)

| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{DSS}$ | Drain to Source Voltage | | 1200 | V |
| $V_{GS}$ | Gate to Source Voltage (DC) | | -10 / +22 | V |
| $V_{GSop}$ | Recommended Operation Value | | -5 / +18 | V |
| $I_D$ | Drain Current | Continuous ($V_{GS}$=18V, $T_C$ = 25℃) | 60 | A |
| | | Continuous ($V_{GS}$=18V, $T_C$ = 100℃) | 42 | |
| $I_{DM}$ | Drain Current | Pulsed (Note1) | 160 | A |
| $E_{AS}$ | Avalanche Capability | VDD=100V, VGS=20V, L=2mH | 1000 | mJ |
| $I_{AV}$ | Avalanche Capability | VDD=100V, VGS=20V, L=2mH | 30 | A |
| $P_D$ | Power Dissipation | ($T_C$ = 25℃) | 375 | W |
| | | Derate Above 25℃ | 2.5 | W/℃ |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to 175 | ℃ |

※Note 1 : Limited by maximum junction temperature.

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max. | 0.4 | ℃/W |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 34 | |
| Tsold | Soldering temperature, wave soldering only allowed at leads | 260 | ℃ |

## Electrical Characteristics ($T_J$ = 25℃ unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 1200 | - | - | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | - | 1 | 100 | μA |
| | | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V, $T_J$ = 175℃ | - | 5 | - | |
| $I_{GSS}$ | Gate-Source Leakage Current | $V_{GS}$ = +22 V, $V_{DS}$ = 0 V | - | - | +100 | nA |
| | | $V_{GS}$ = -10 V, $V_{DS}$ = 0 V | - | - | -100 | |

## Electrical Characteristics ($T_J$ = 25℃ unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **On Characteristics** | | | | | | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{GS}$ = $V_{DS}$, $I_D$ = 10 mA | 2.0 | 3.0 | 4.5 | V |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS}$ = 18 V, $I_D$ = 30 A | - | 40 | 56 | mΩ |
| | | $V_{GS}$ = 18 V, $I_D$ = 30 A, $T_J$ = 175℃ | - | 51 | - | |
| | | $V_{GS}$ = 15 V, $I_D$ = 30 A | - | 50 | - | |
| | | $V_{GS}$ = 15 V, $I_D$ = 30 A, $T_J$ = 150℃ | - | 53 | - | |
| | | $V_{GS}$ = 15 V, $I_D$ = 30 A, $T_J$ = 175℃ | - | 59 | - | |
| | | $V_{GS}$ = 18 V, $I_D$ = 40 A | - | 40 | - | |
| | | $V_{GS}$ = 18 V, $I_D$ = 40 A, $T_J$ = 150℃ | - | 54 | - | |
| | | $V_{GS}$ = 18 V, $I_D$ = 40 A, $T_J$ = 175℃ | - | 58 | - | |
| $g_{fs}$ | Transconductance | $V_{DS}$ = 20 V, $I_D$ = 30 A | - | 15 | - | S |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 800 V, $V_{GS}$ = 0V, f = 250 kHz | - | 1960 | - | pF |
| $C_{oss}$ | Output Capacitance | | - | 125 | - | |
| $C_{rss}$ | Reverse Capacitance | | - | 5 | - | |
| $E_{oss}$ | Stored Energy in Output Capacitance | $V_{DS}$ = 0 V to 800 V, $V_{GS}$ = 0 V | - | 50 | - | μJ |
| $C_{o(er)}$ | Energy Related Output Capacitance | | - | 146 | - | pF |
| $C_{o(tr)}$ | Time Related Output Capacitance | | - | 258 | - | |
| $Q_{g(tot)}$ | Total Gate Charge | $V_{DS}$ = 800 V, $I_D$ = 30 A, $V_{GS}$ = -5 V / 18 V | - | 109 | - | nC |
| $Q_{gs}$ | Gate to Source Charge | | - | 28 | - | |
| $Q_{gd}$ | Gate to Drain “Miller” Charge | | - | 35 | - | |
| $R_G$ | Internal Gate Resistance | f = 1MHz, $V_{AC}$=30mV, open drain | - | 3.5 | - | Ω |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | $V_{DS}$ = 800 V, $I_D$ = 30 A, $V_{GS}$ = -5 V / 18 V, $R_G$ = 2.5Ω , FWD : BCH120S020D1, Inductive load | - | 18 | - | ns |
| $t_r$ | Turn-On Rise Time | | - | 13 | - | |
| $t_{d(off)}$ | Turn-Off Delay Time | | - | 35 | - | |
| $t_f$ | Turn-Off Fall Time | | - | 8 | - | |
| $E_{on}$ | Turn-on Switching Energy | | - | 232 | - | μJ |
| $E_{off}$ | Turn-off Switching Energy | | - | 73 | - | |
| $E_{tot}$ | Total Switching Energy | | - | 305 | - | |
| **Source-Drain Diode Characteristics** | | | | | | |
| $I_S$ | Maximum Continuous Diode Forward Current | | - | - | 60 | A |
| $I_{SM}$ | Maximum Pulsed Diode Forward Current | | - | - | 160 | |
| $V_{SD}$ | Diode Forward Voltage | $V_{GS}$ = -5 V, $I_{SD}$ = 30 A | - | 4.2 | - | V |
| $t_{rr}$ | Reverse Recovery Time | $V_{DD}$ = 800 V, $I_{SD}$ = 30 A, $dI_F/dt$ = 3 000 A /μs | - | 22 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 348 | - | nC |
| $t_{rr}$ | Reverse Recovery Time | $V_{GS}$=-5V,$V_{DD}$ = 800 V, $I_{SD}$ = 40 A, $dI_F/dt$ = 4 200 A/μs | - | 13 | - | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | - | 182 | - | nC |
| $I_{rrm}$ | Peak Reverse Recovery Current | | - | 23 | - | A |

## Typical Performance Characteristics

**Figure 1. On-Region Characteristics** $T_J$ = -40℃

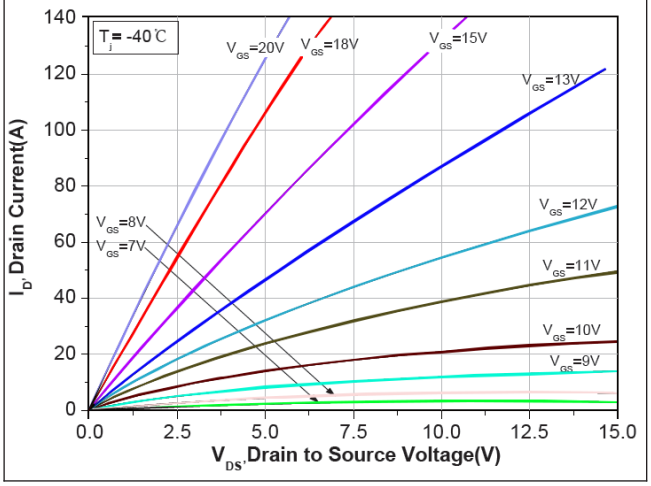



**Figure 2. On-Region Characteristics** $T_J$ = 25℃

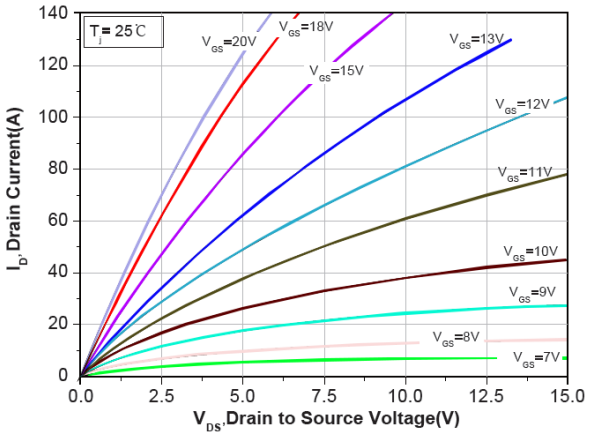



**Figure 3. On-Region Characteristics** $T_J$ = 175℃

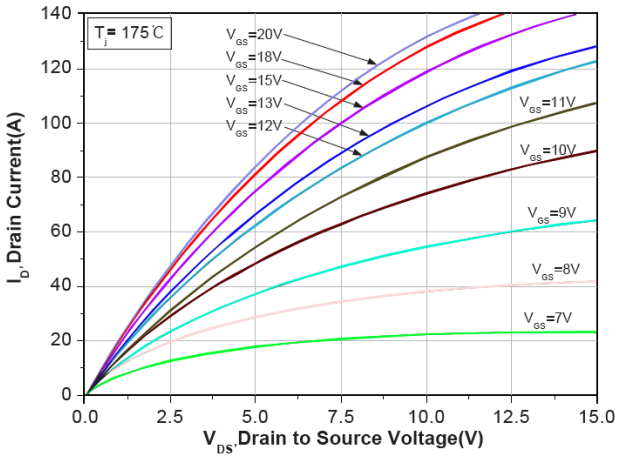



**Figure 4. Normalized On-Resistance Characteristics vs. Temperature**

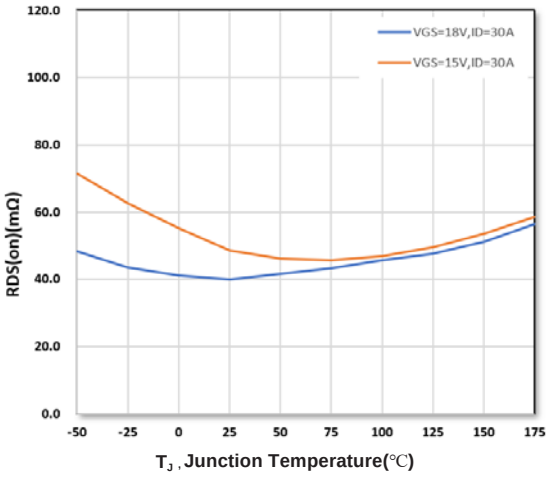



**Figure 5. Transfer Characteristics**

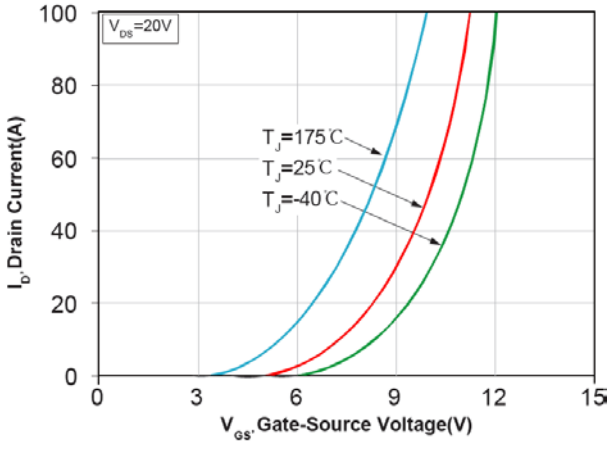
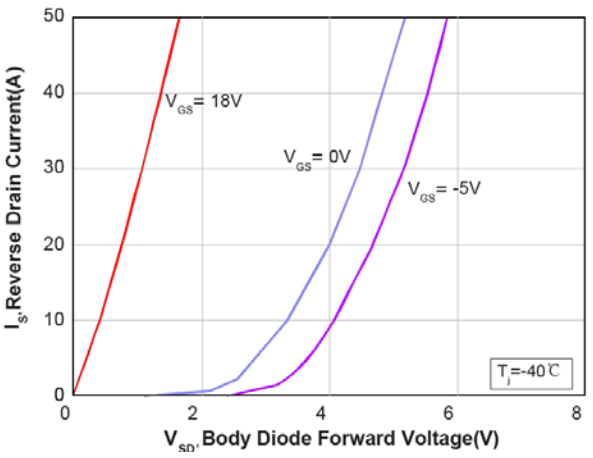



**Figure 6. Diode Forward Voltage Characteristics vs. Source-Drain Current $T_J$ = -40℃**



## Typical Performance Characteristics

**Figure 7. Diode Forward Voltage Characteristics vs. Source-Drain Current $T_J$ = 25℃**

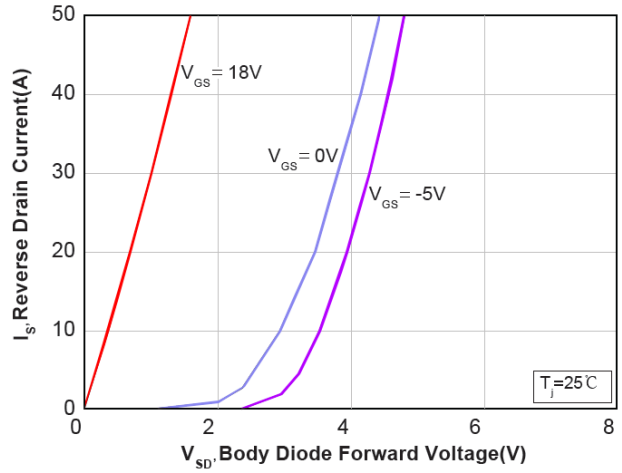



**Figure 8. Diode Forward Voltage Characteristics vs. Source-Drain Current $T_J$ = 175℃**

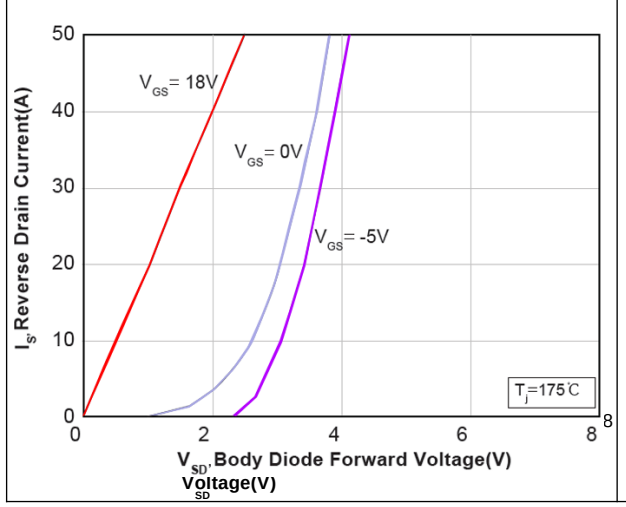



**Figure 9. Threshold Voltage vs. Temperature**

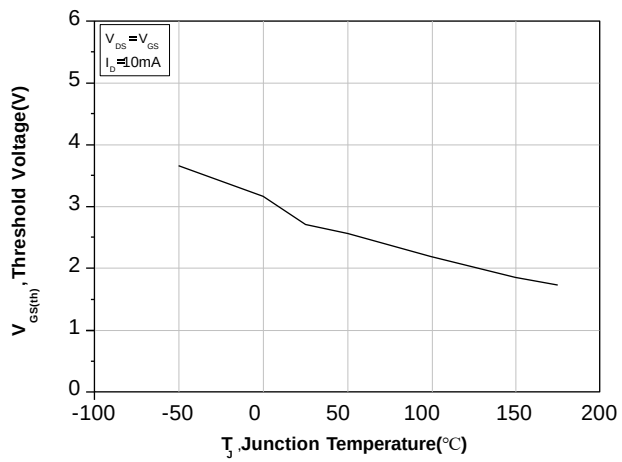



**Figure 10. Gate Charge Characteristics**

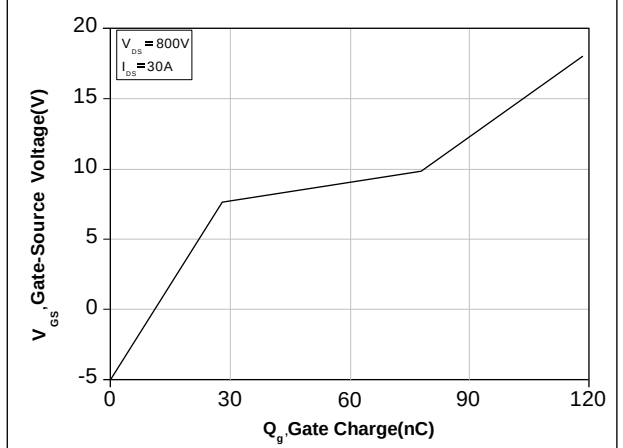



**Figure 11. Stored Energy in Output Capacitance (0~800V)**

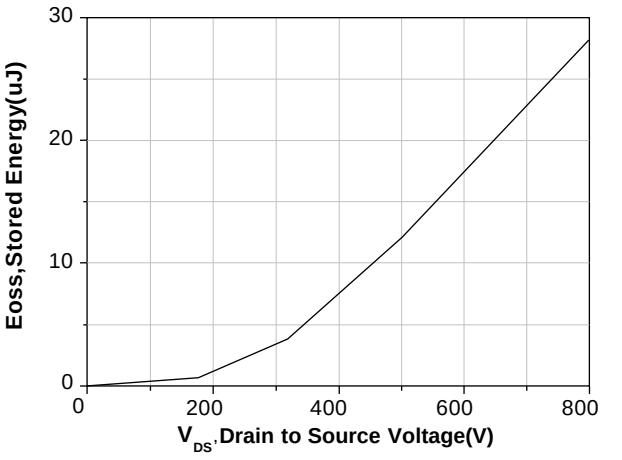
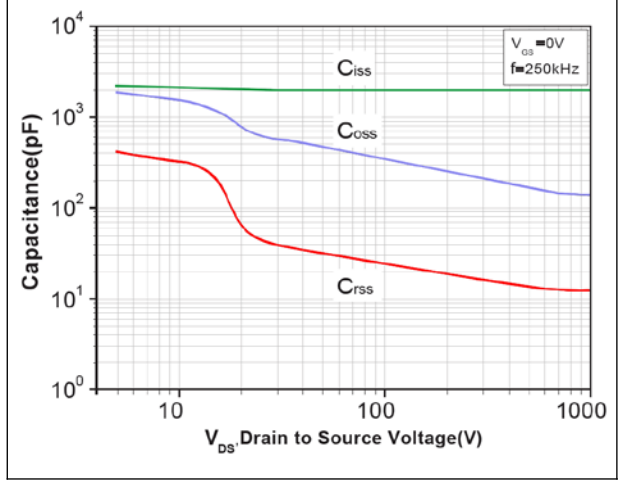



**Figure 12. Capacitance Characteristics**



## Typical Performance Characteristics

**Figure 13. Continuous Drain Current Derating vs. Case Temperature**

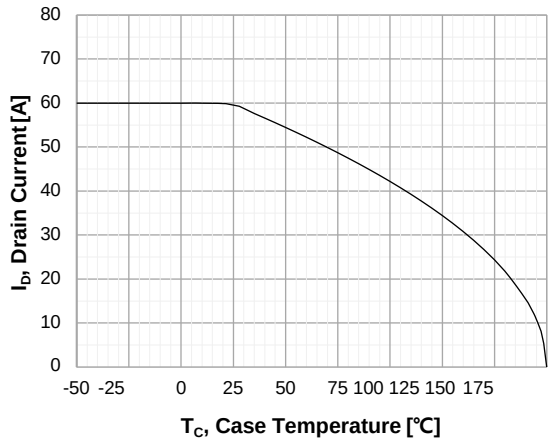



**Figure 14. Maximum Power Dissipation Derating vs. Case Temperature**

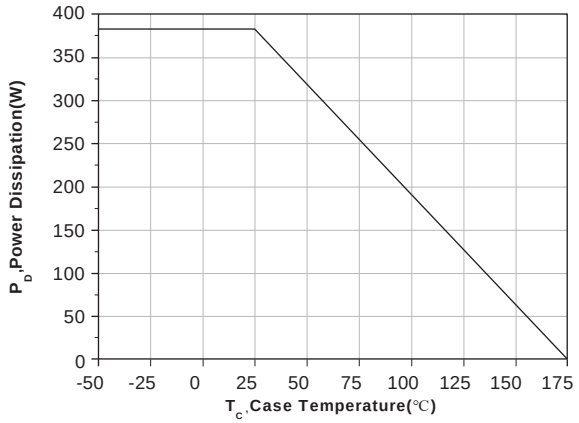



**Figure 15. Typ. Switching losses vs. Drain current**

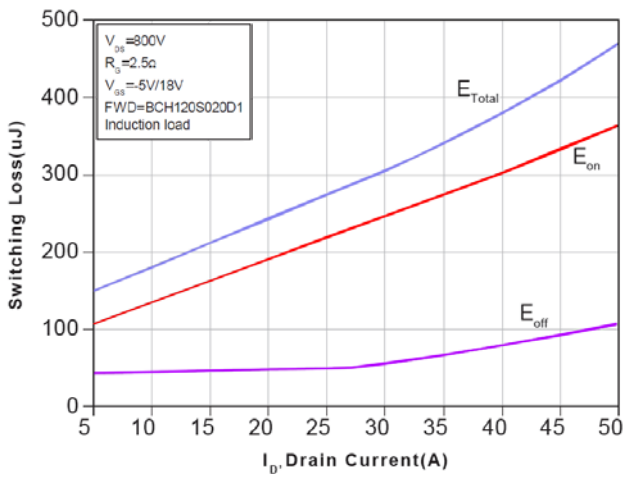



**Figure 16. Typ. Switching losses vs. Gate resistance**

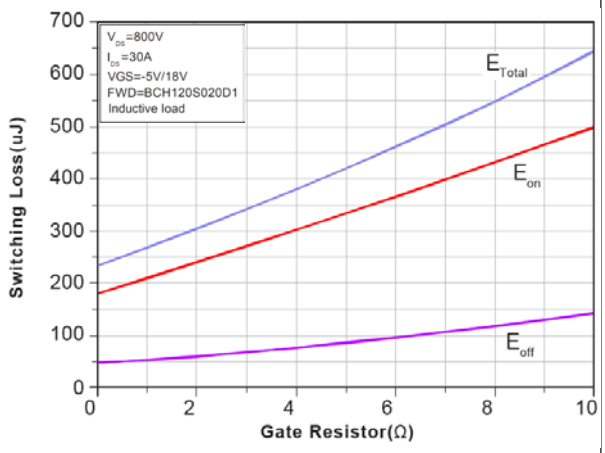



**Figure 17. Typ. Switching losses vs. Drain current**

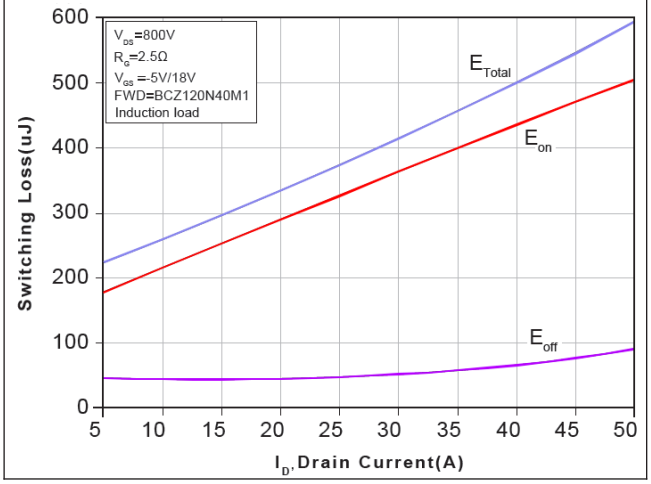
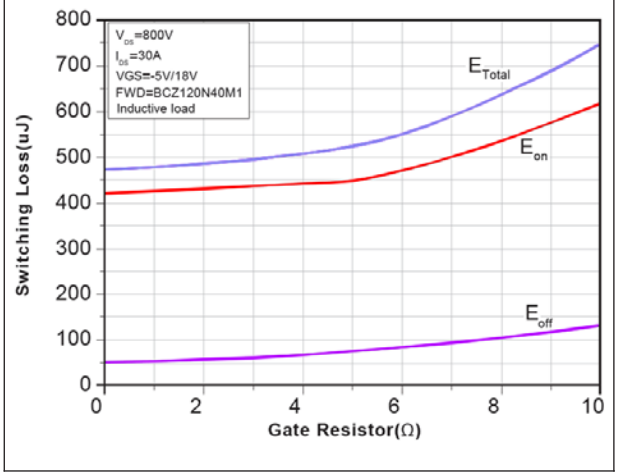



**Figure 18. Typ. Switching losses vs. Gate resistance**



## Typical Performance Characteristics

**Figure 19. Maximum Safe Operating Area**

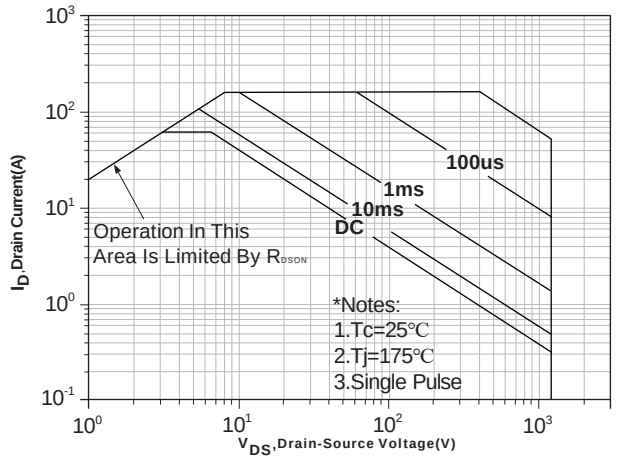



**Figure 20. Transient Thermal Response Curve**

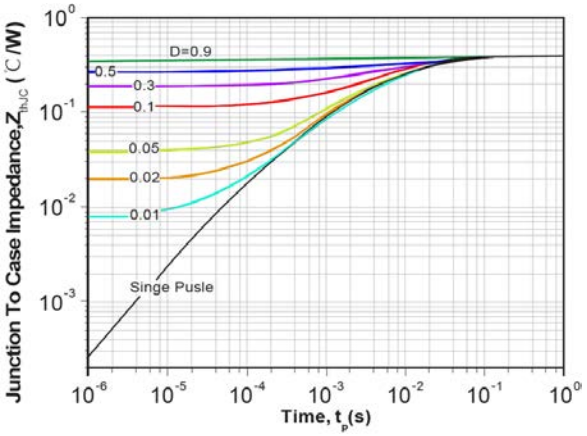



**Figure 21. On-Resistance vs. Drain Current For Various Temperature**

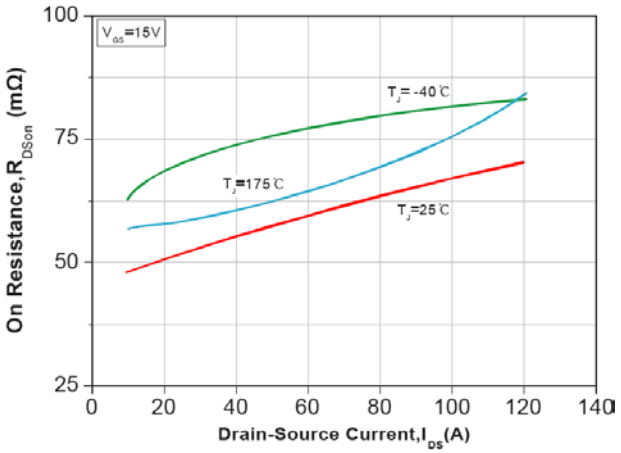



**Figure 22. On-Resistance vs. Temperature For Various Gate Voltage**

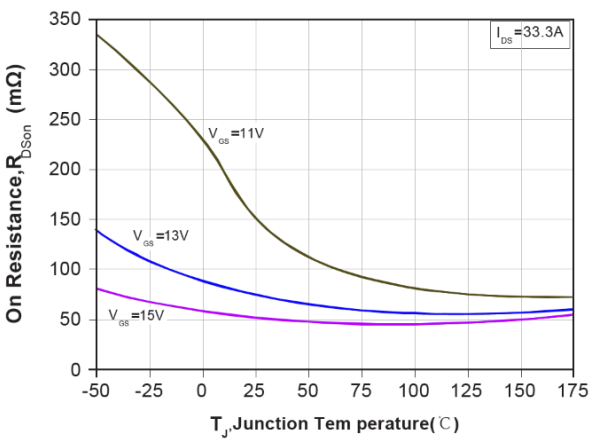



**Figure 23. 3rd Quadrant Characteristic at -40℃**

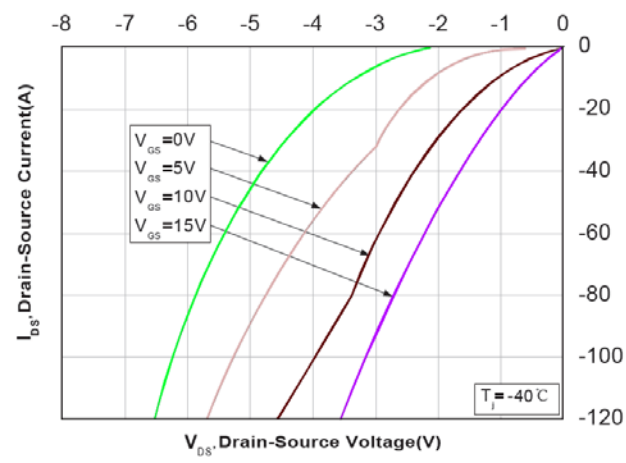
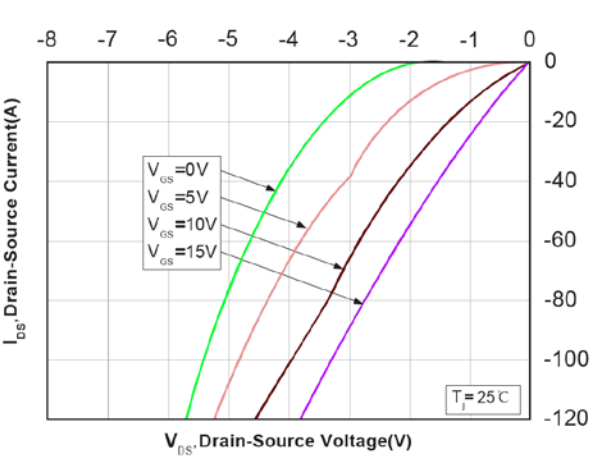



**Figure 24. 3rd Quadrant Characteristic at 25℃**



## Typical Performance Characteristics

**Figure 25. 3rd Quadrant Characteristic at 175℃**

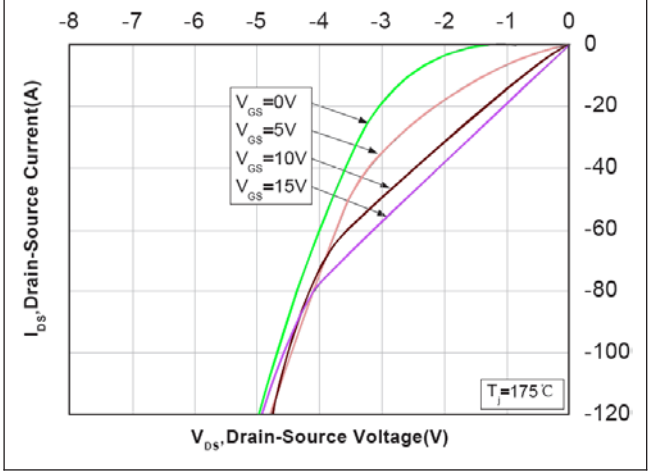



**Figure 26. Capacitance vs. Drain-Source Voltage(0~200V)**

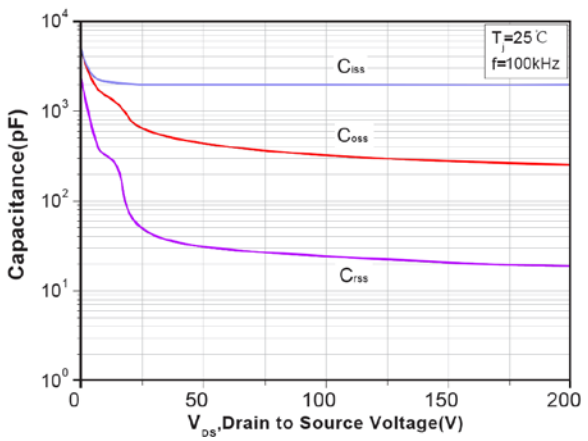



**Figure 27. Capacitance vs. Drain-Source Voltage(0~1200V)**

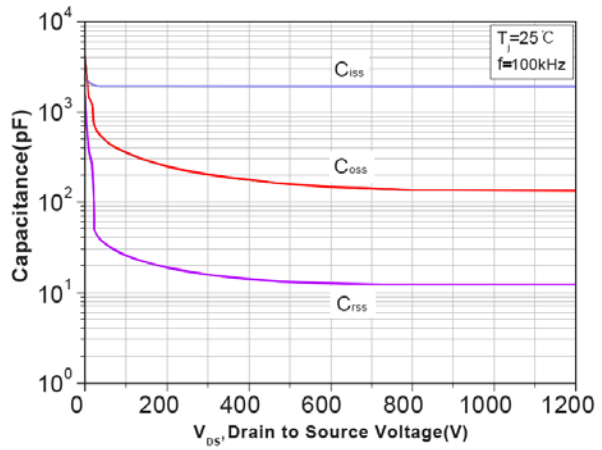



**Figure 28. Clamped Inductive Switching Energy vs. Drain current(VDS=600V)**

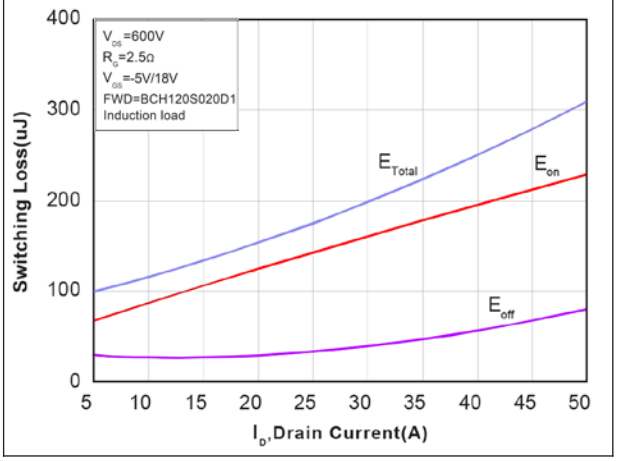



**Figure 29. Clamped Inductive Switching Energy vs. Temperature**

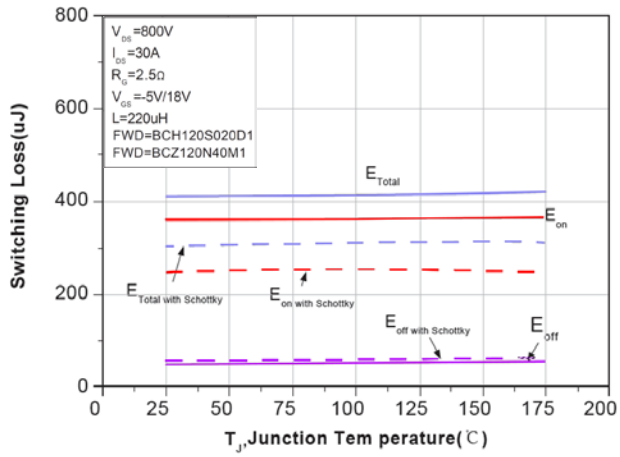
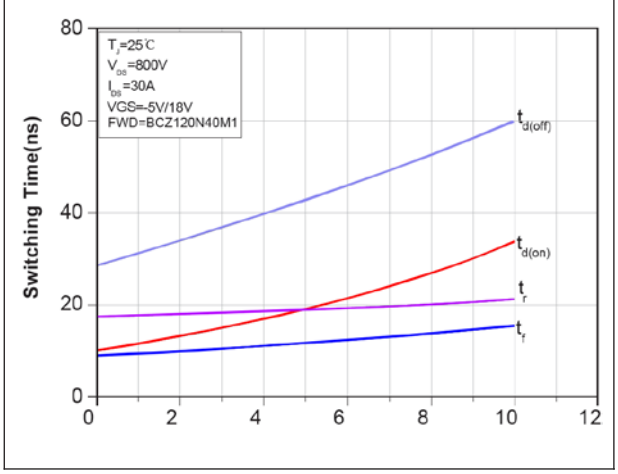



**Figure 30. Switching Times vs. $R_{G(ext)}$**



## Typical Performance Characteristics

**Figure 31. Switching Times vs. $R_{G(ext)}$**

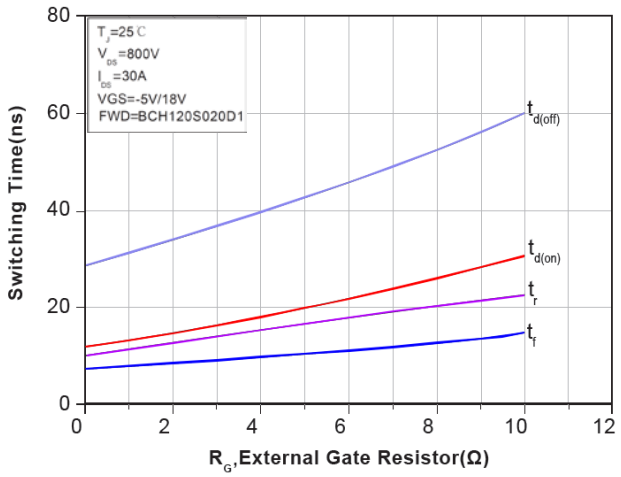



**Figure 32. Stored Energy in Output Capacitance (0~1200V)**

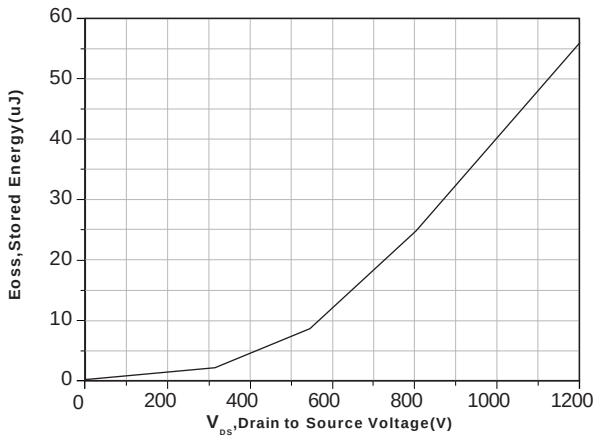



**Figure 33. Inductive Load Switching Test Circuit and Waveforms**

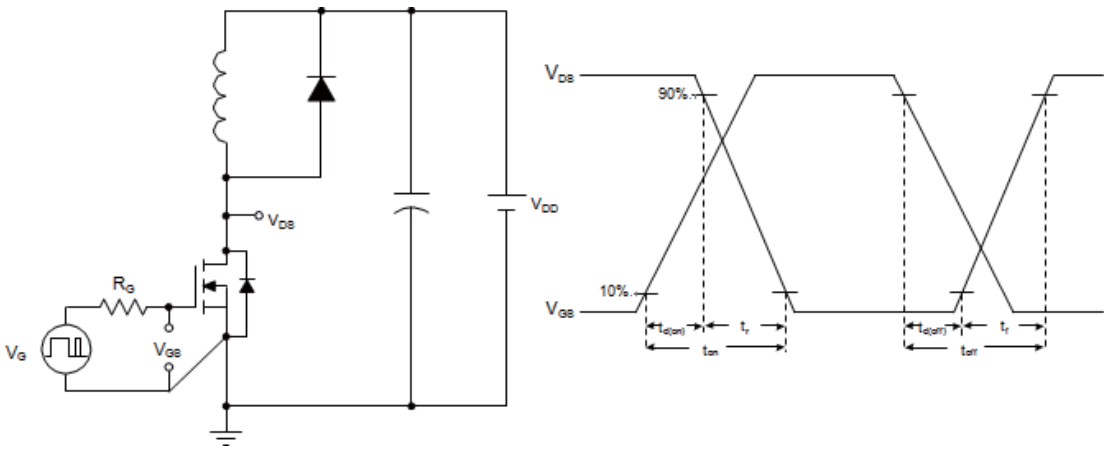
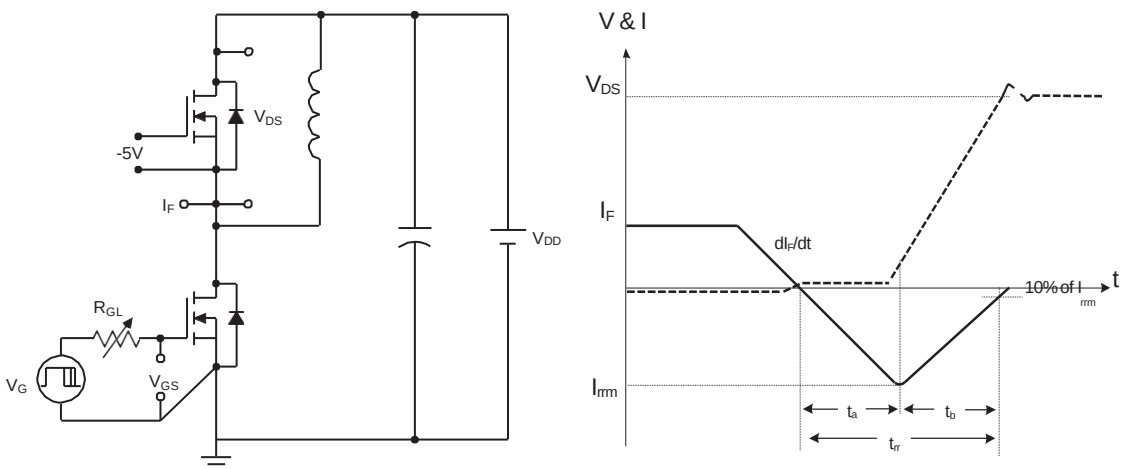
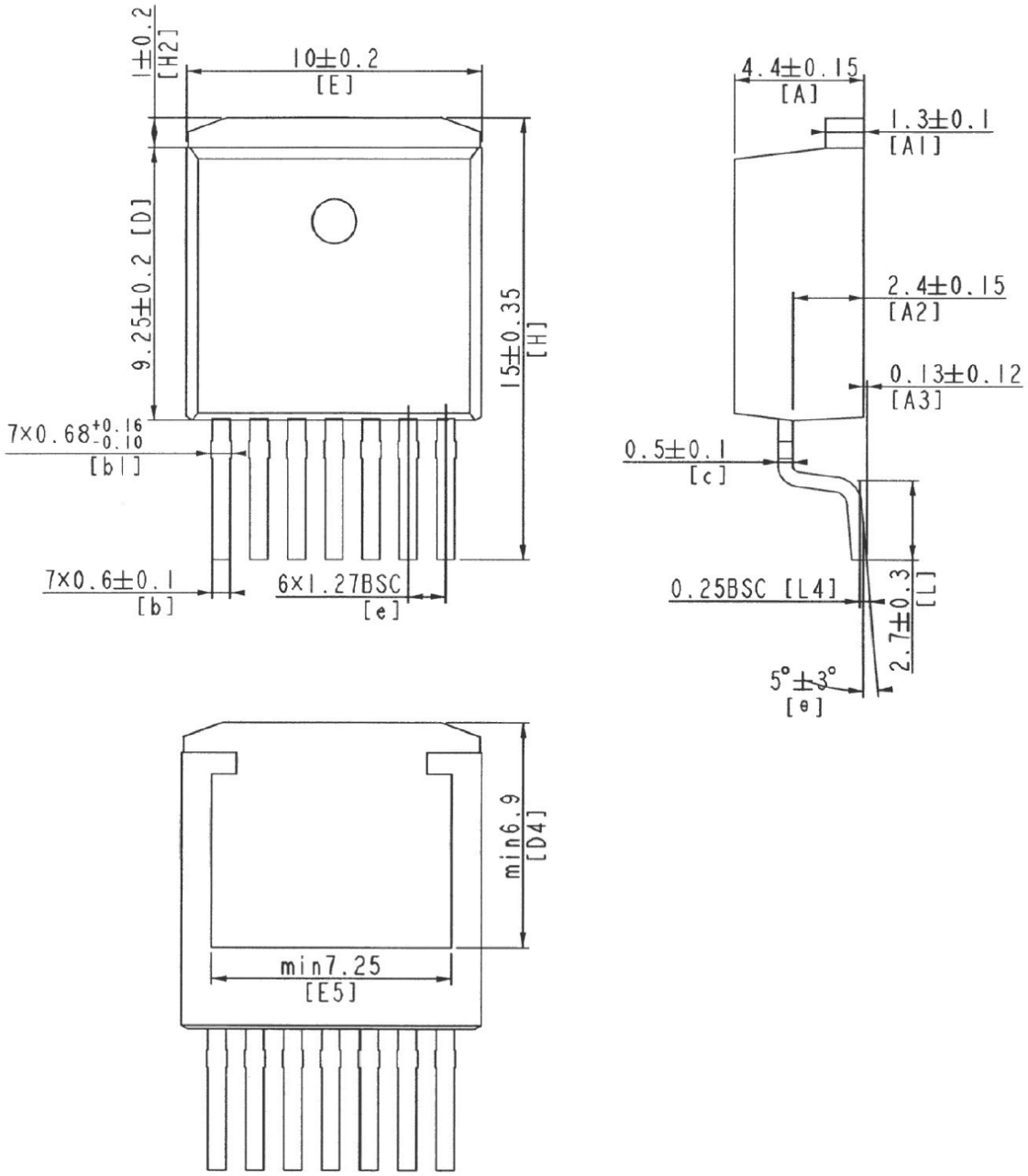



**Figure 34. Peak Diode Recovery dv/dt Test Circuit and Waveforms**



## Package Outlines

# TO263-7L




* Dimensions in millimeters

## Package Marking and Ordering Information

| Part Number | Top Marking | Package | Packing Method | Quantity |
|---|---|---|---|---|
| BCBF120N40M1 | BCBF120N40M1 | TO263-7L | Tape & Reel | 800 units |

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