

**Features**

- Very Low FOM  $R_{DS(on)} \times Q_g$
- Halogen Free. "Green" Device (Note 1)
- Epoxy Meets UL 94 V-0 Flammability Rating
- Lead Free Finish/RoHS Compliant ("P" Suffix Designates RoHS Compliant. See Ordering Information)

**Maximum Ratings**

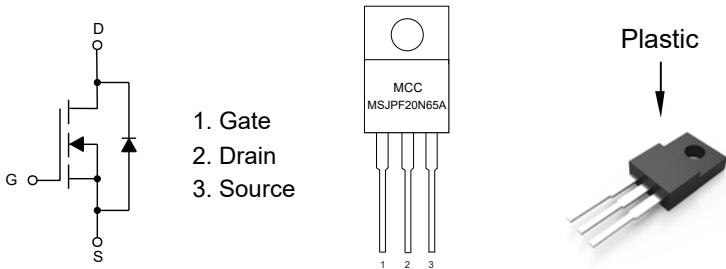
- Operating Junction Temperature Range : -55°C to +150°C
- Storage Temperature Range: -55°C to +150°C
- Thermal Resistance: 5.7°C/W Junction to Case<sup>(Note2)</sup>

| Parameter                                     | Symbol   | Rating | Unit |
|---|----------|--------|------|
| Drain-Source Voltage                          | $V_{DS}$ | 650    | V    |
| Gate-Source Voltage                           | $V_{GS}$ | ±30    | V    |
| Continuous Drain Current                      | $I_D$    | 20     | A    |
| Pulsed Drain Current <sup>(3)</sup>           | $I_{DM}$ | 60     | A    |
| Total Power Dissipation                       | $P_D$    | 34     | W    |
| Single Pulsed Avalanche Energy <sup>(4)</sup> | $E_{AS}$ | 485    | mJ   |

Note:

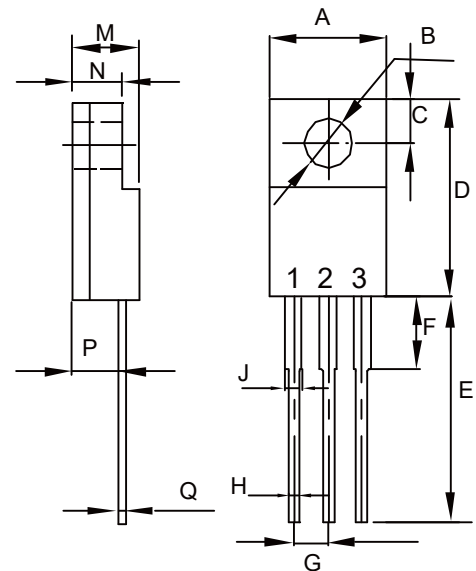
1. Halogen free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
2. Surface Mounted on 1 in<sup>2</sup> pad area, t ≤ 10 sec
3. Pulse Test: Pulse Width ≤ 300us, Duty cycle ≤ 2%.

**Internal Structure and Marking Code**



**N-CHANNEL  
MOSFET**

**TO-220F**



| DIM | DIMENSIONS |       |       |       | NOTE |
|-----|------------|-------|-------|-------|------|
|     | INCHES     |       | MM    |       |      |
|     | MIN        | MAX   | MIN   | MAX   |      |
| A   | 0.390      | 0.421 | 9.90  | 10.70 |      |
| B   | 0.122      | 0.130 | 3.10  | 3.30  | Φ    |
| C   | 0.106      |       | 2.70  |       | TYP. |
| D   | 0.567      | 0.642 | 14.40 | 16.30 |      |
| E   | 0.630      | 0.661 | 16.00 | 16.80 |      |
| F   | 0.134      | 0.150 | 3.40  | 3.80  |      |
| G   | 0.092      | 0.108 | 2.34  | 2.74  |      |
| H   | 0.020      | 0.035 | 0.50  | 0.90  |      |
| J   | 0.043      | 0.056 | 1.10  | 1.42  |      |
| M   | 0.169      | 0.201 | 4.30  | 5.10  |      |
| N   | 0.096      | 0.104 | 2.45  | 2.65  |      |
| P   | 0.083      | 0.126 | 2.10  | 3.20  |      |
| Q   | 0.016      | 0.032 | 0.40  | 0.80  |      |

**Electrical Characteristics @ 25°C (Unless Otherwise Specified)**

| Parameter  | Symbol        | Test Conditions  | Min | Typ  | Max       | Unit       |
|--|---------------|--|-----|------|-----------|------------|
| <b>Static Characteristics</b>                      |               |  |     |      |           |            |
| Drain-Source Breakdown Voltage                     | $V_{(BR)DSS}$ | $V_{GS}=0V, I_D=250\mu A$                                | 650 |      |           | V          |
| Gate-Source Leakage Current                        | $I_{GSS}$     | $V_{DS}=0V, V_{GS}=\pm 30V$                              |     |      | $\pm 100$ | nA         |
| Zero Gate Voltage Drain Current                    | $I_{DSS}$     | $V_{DS}=650V, V_{GS}=0V, T_C=25^\circ C$                 |     |      | 1         | $\mu A$    |
| Gate-Threshold Voltage <sup>(Note 4)</sup>         | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=250\mu A$                            | 2   | 3    | 4         | V          |
| Drain-Source On-Resistance <sup>(Note 4)</sup>     | $R_{DS(on)}$  | $V_{GS}=10V, I_D=10A$                                    |     | 167  | 180       | m $\Omega$ |
| Gate Resistance <sup>(Note 4)</sup>                | $R_G$         | f = 1.0MHz Open Drain                                    |     | 2.2  |           | $\Omega$   |
| <b>Dynamic Characteristics <sup>(Note 5)</sup></b> |               |  |     |      |           |            |
| Input Capacitance                                  | $C_{iss}$     | $V_{DS}=25V, V_{GS}=0V, f=1MHz$                          |     | 1807 |           | pF         |
| Output Capacitance                                 | $C_{oss}$     |  |     | 1214 |           |            |
| Reverse Transfer Capacitance                       | $C_{rss}$     |  |     | 103  |           |            |
| Total Gate Charge                                  | $Q_g$         | $V_{DS}=560V, V_{GS}=10V, I_D=20A$                       |     | 56   |           | nC         |
| Gate-Source Charge                                 | $Q_{gs}$      |  |     | 12   |           |            |
| Gate-Drain Charge                                  | $Q_{gd}$      |  |     | 25   |           |            |
| Turn-On Delay Time                                 | $t_{d(on)}$   | $V_{DD}=350V, I_D=20A$<br>$V_{GS}=10V, R_{GEN}=25\Omega$ |     | 30   |           | ns         |
| Turn-On Rise Time                                  | $t_r$         |  |     | 55   |           |            |
| Turn-Off Delay Time                                | $t_{d(off)}$  |  |     | 167  |           |            |
| Turn-Off Fall Time                                 | $t_f$         |  |     | 103  |           |            |
| <b>Drain-Source Diode Characteristics</b>          |               |  |     |      |           |            |
| Diode Forward Voltage                              | $V_{SD}$      | $V_{GS}=0V, I_S=20A$                                     |     |      | 1.4       | V          |
| Continuous Body Diode Current                      | $I_S$         |  |     |      | 20        | A          |
| Reverse Recovery Time                              | $t_{rr}$      | $V_{DD}=100V,$<br>$I_S=11A,$<br>$di_f/dt = 100A/\mu s$   |     | 332  |           | ns         |
| Reverse Recovery Charge                            | $Q_{rr}$      |  |     | 4901 |           | nC         |
| Peak Reverse Recovery Current                      | $I_{rrm}$     |  |     | 31   |           | A          |

Note:

- 4. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 1\%$ .
- 5. Guaranteed by Design, not Subject to Production.

Fig. 1 - Typical Output Characteristics

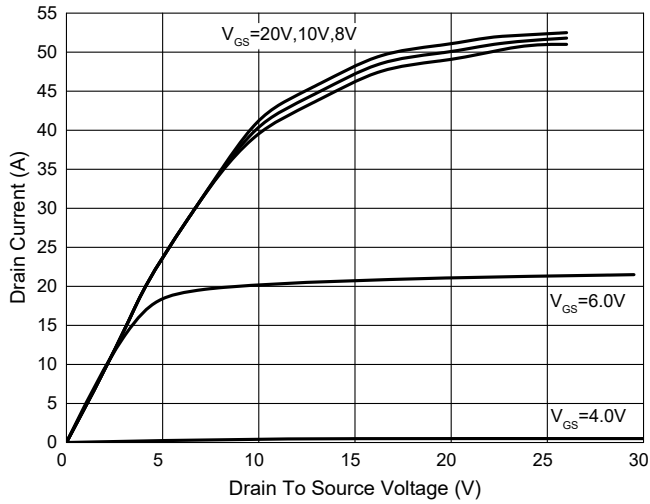


Fig. 2 - Normalized On Resistance Characteristics

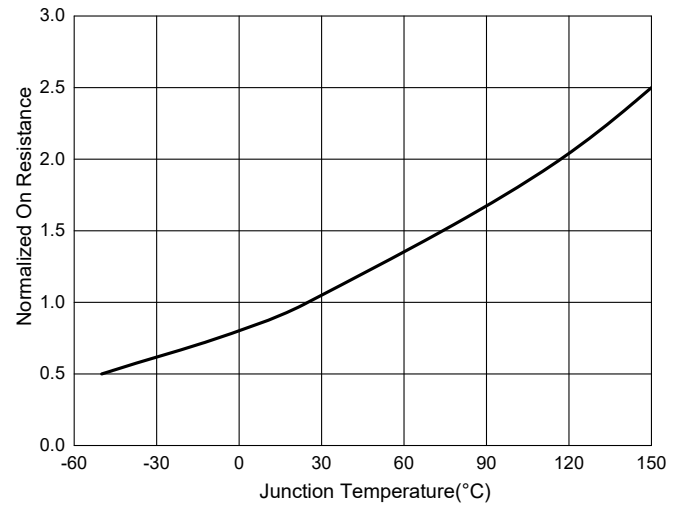


Fig. 3 -  $R_{DS(ON)}$  vs  $I_D$

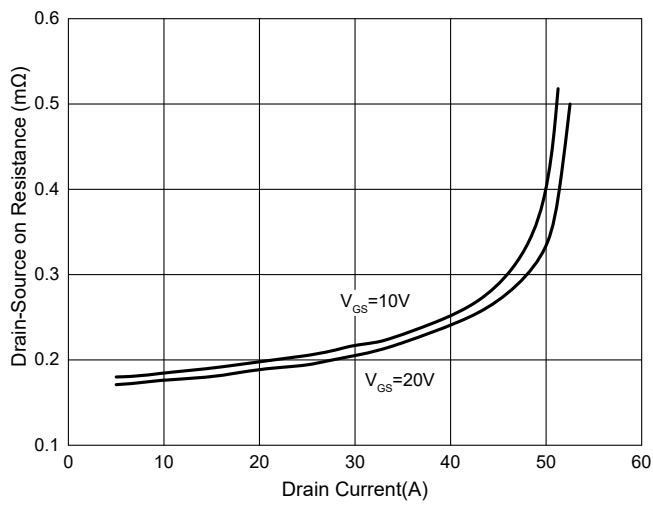


Fig. 4 - Capacitance Characteristics

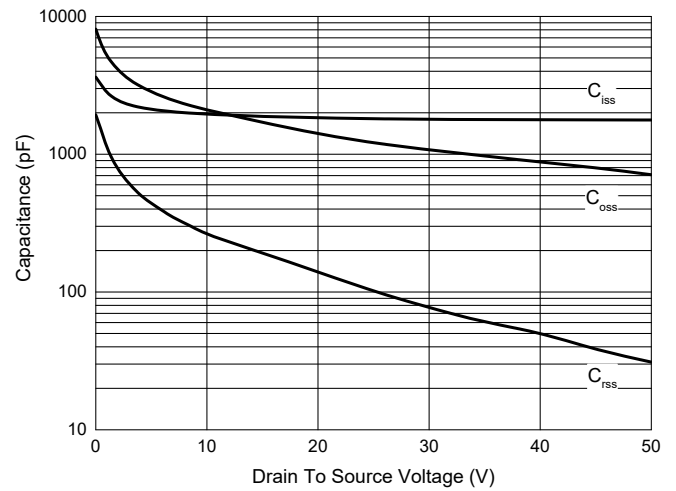


Fig. 5- Gate Charge

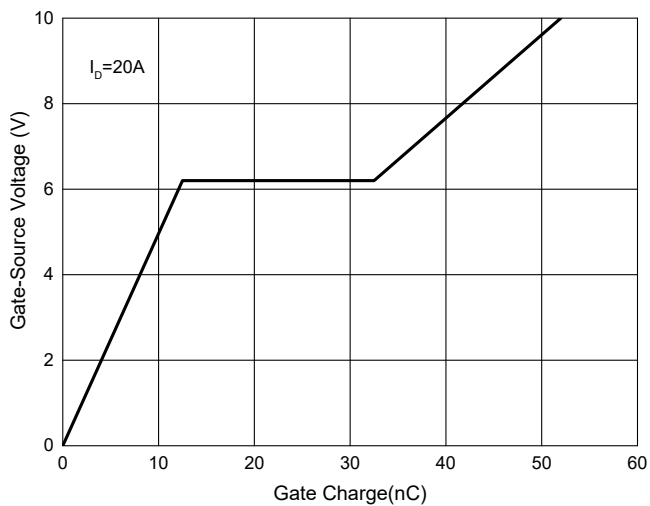


Fig. 6 - Normalized On Resistance Characteristics

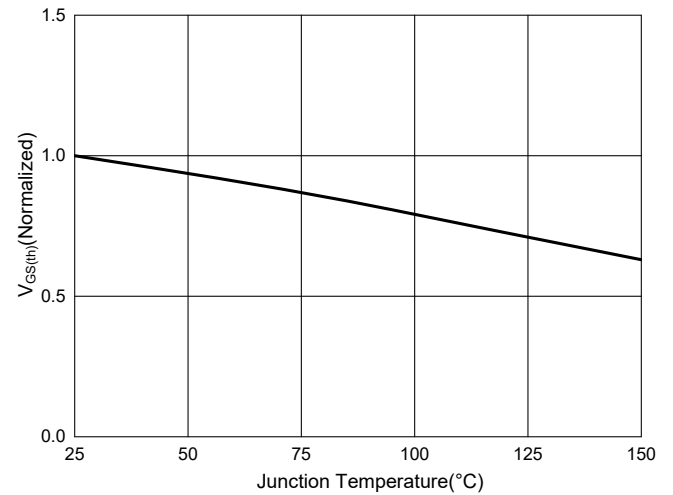
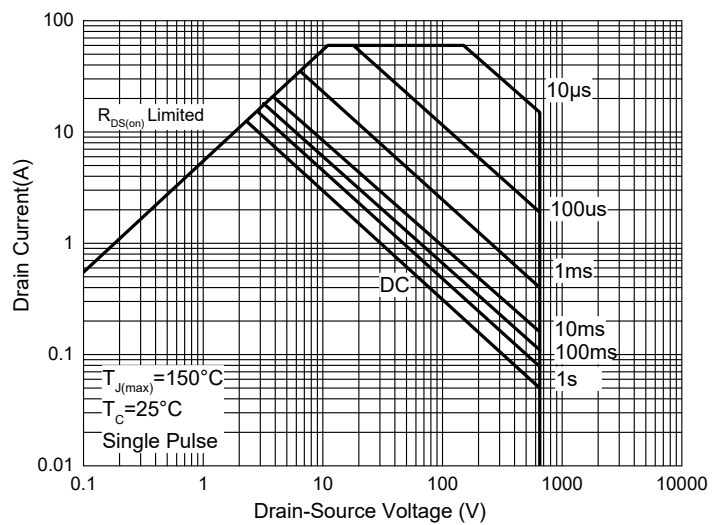


Fig. 7 - Safe Operation Area



## Ordering Information

| Device         | Packing                                |
|----------------|--|
| Part Number-BP | Bulk: 50pcs/Tube; 1Kpcs/Box; 5Kpcs/Ctn |

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