

## HM10N65D / HM10N65F

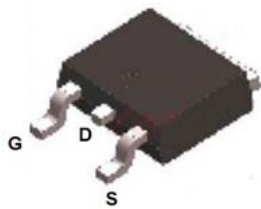
### 650V N-Channel MOSFET

#### General Description

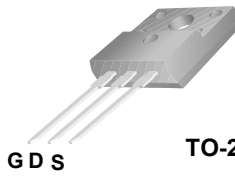
This Power MOSFET is produced using SL semi's advanced planar stripe DMOS technology. This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switched mode power supplies, active power factor correction based on half bridge topology.

#### Features

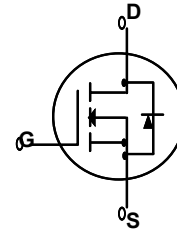
- 10A, 650V,  $R_{DS(on)} = 1.09\Omega$  @  $V_{GS} = 10V$
- Low gate charge (typical 52nC)
- High ruggedness
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



TO-263-2L



TO-220F



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

| Symbol         | Parameter                                                                     | HM10N65D    | HM10N65F | Units               |
|----------------|-------------------------------------------------------------------------------|-------------|----------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                          | 650         |          | V                   |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | 10          | 10*      | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | 7           | 7        | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                               | 30          | 30 *     | A                   |
| $V_{GSS}$      | Gate-Source Voltage                                                           | $\pm 30$    |          | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 865         |          | mJ                  |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 23.1        |          | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | 4.5         |          | V/ns                |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 231         | 54       | W                   |
|                | - Derate above $25^\circ\text{C}$                                             | 1.85        | 0.43     | W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                       | -55 to +150 |          | $^\circ\text{C}$    |
| $T_L$          | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | 300         |          | $^\circ\text{C}$    |

\* Drain current limited by maximum junction temperature.

#### Thermal Characteristics

| Symbol          | Parameter                               | HM10N65D | HM10N65F | Units              |
|-----------------|-----------------------------------------|----------|----------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | 0.54     | 2.33     | $^\circ\text{C/W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink Typ.   | 0.5      | --       | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5     | 62.5     | $^\circ\text{C/W}$ |

## Electrical Characteristics

$T_C = 25^\circ\text{C}$  unless otherwise noted

| Symbol                         | Parameter                                 | Test Conditions                                                   | Min | Typ | Max  | Units                     |
|--------------------------------|-------------------------------------------|-------------------------------------------------------------------|-----|-----|------|---------------------------|
| <b>Off Characteristics</b>     |                                           |                                                                   |     |     |      |                           |
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$               | 650 | --  | --   | V                         |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | --  | 0.7 | --   | $\text{V}/^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$                      | --  | --  | 1    | $\mu\text{A}$             |
|                                |                                           | $V_{DS} = 520\text{ V}, T_C = 125^\circ\text{C}$                  | --  | --  | 10   | $\mu\text{A}$             |
| $I_{GSSF}$                     | Gate-Body Leakage Current, Forward        | $V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$                       | --  | --  | 100  | nA                        |
| $I_{GSSR}$                     | Gate-Body Leakage Current, Reverse        | $V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$                      | --  | --  | -100 | nA                        |

## On Characteristics

|              |                                   |                                                 |     |      |      |          |
|--------------|-----------------------------------|-------------------------------------------------|-----|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 2.0 | --   | 4.0  | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 6.0\text{ A}$      | --  | 0.87 | 1.09 | $\Omega$ |

## Dynamic Characteristics

|           |                              |                                                                      |    |      |    |    |
|-----------|------------------------------|----------------------------------------------------------------------|----|------|----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 1850 | -- | pF |
| $C_{oss}$ | Output Capacitance           |                                                                      | -- | 180  | -- | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                      | -- | 20   | -- | pF |

## Switching Characteristics

|              |                     |                                                                                            |    |      |    |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------|----|------|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 325\text{ V}, I_D = 10\text{ A},$<br>$R_G = 25\text{ }\Omega$<br><br>(Note 4, 5) | -- | 30   | -- | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                            | -- | 90   | -- | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                            | -- | 140  | -- | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                            | -- | 90   | -- | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 520\text{ V}, I_D = 10\text{ A},$<br>$V_{GS} = 10\text{ V}$<br><br>(Note 4, 5)   | -- | 52   | -  | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                            | -- | 8.5  | -- | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                            | -- | 20.0 | -- | nC |

## Drain-Source Diode Characteristics and Maximum Ratings

|                 |                                                       |                                               |    |     |     |    |
|-----------------|-------------------------------------------------------|-----------------------------------------------|----|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |                                               | -- | --  | 10  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     |                                               | -- | --  | 30  | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 10 A  | -- | --  | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 10 A, | -- | 430 | --  | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               | dI <sub>F</sub> / dt = 100 A/μs (Note 4)      | -- | 5.0 | --  | μC |

### Notes:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 11.0\text{ mH}, I_{AS} = 10\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 10\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$
5. Essentially independent of operating temperature

## Typical Characteristics

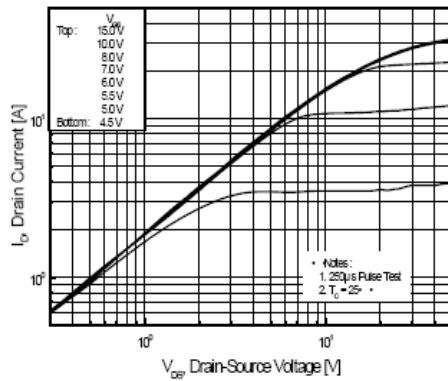


Figure 1. On-Region Characteristics

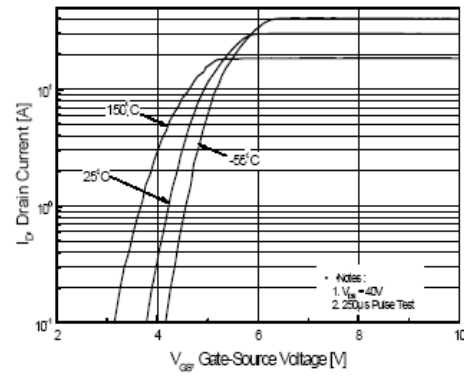


Figure 2. Transfer Characteristics

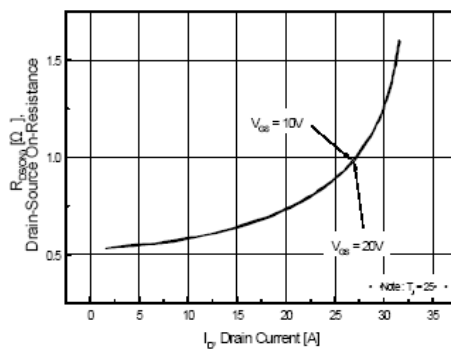


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

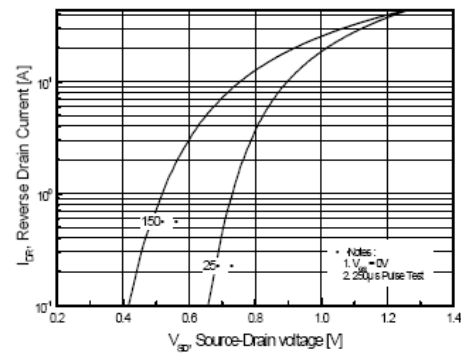


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

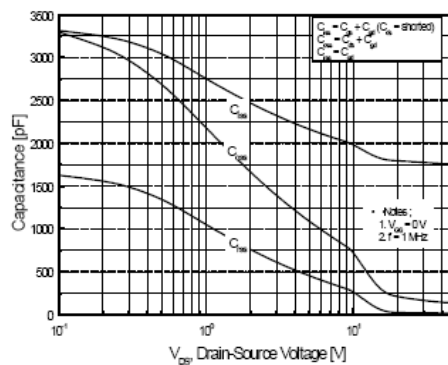


Figure 5. Capacitance Characteristics

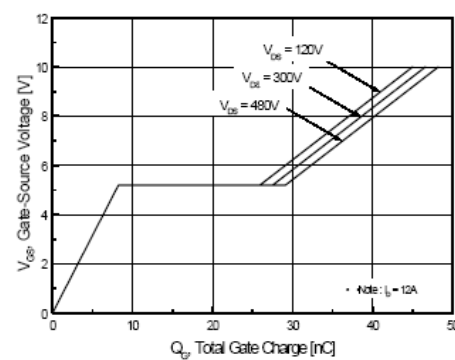


Figure 6. Gate Charge Characteristics

Typical Characteristics (Continued)

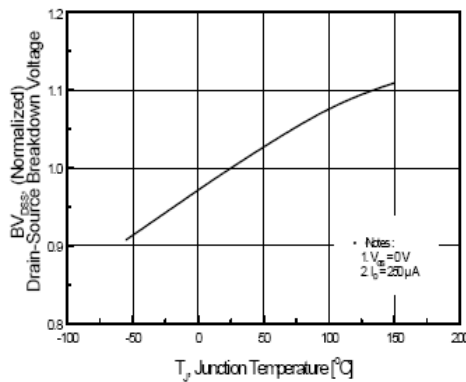


Figure 7. Breakdown Voltage Variation vs Temperature

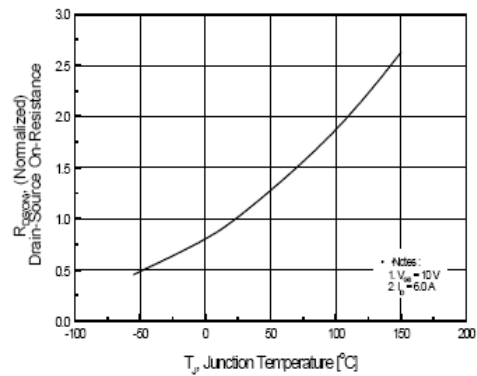


Figure 8. On-Resistance Variation vs Temperature

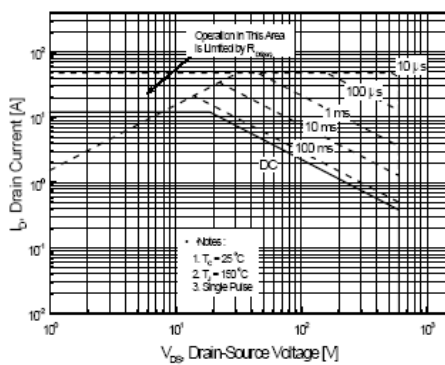


Figure 9-1. Maximum Safe Operating Area for HM10N65D

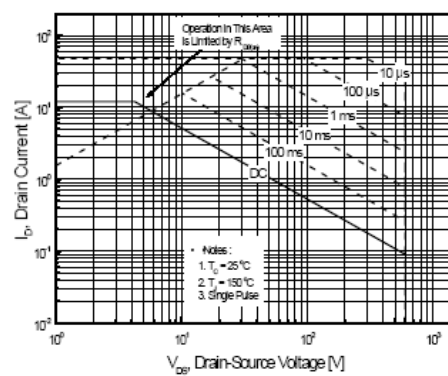


Figure 9-2. Maximum Safe Operating Area for HM10N65F

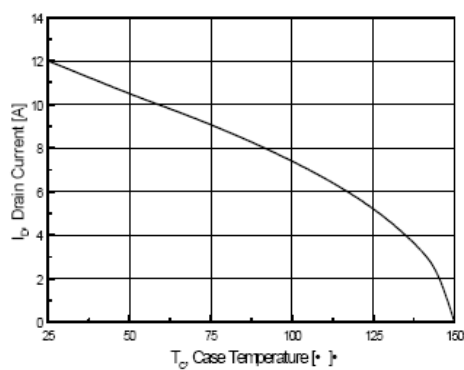


Figure 10. Maximum Drain Current vs Case Temperature

Typical Characteristics (Continued)

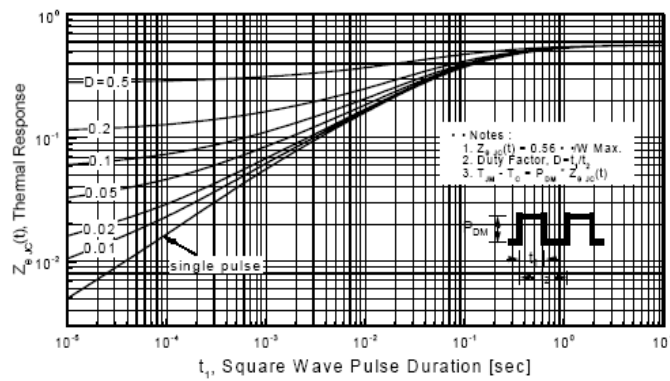


Figure 11-1. Transient Thermal Response Curve  
for HM10N65D

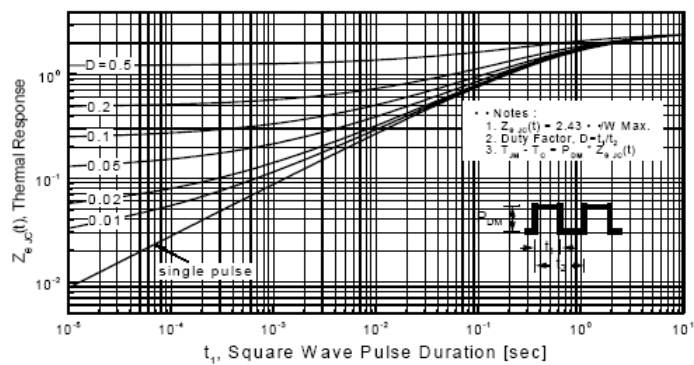
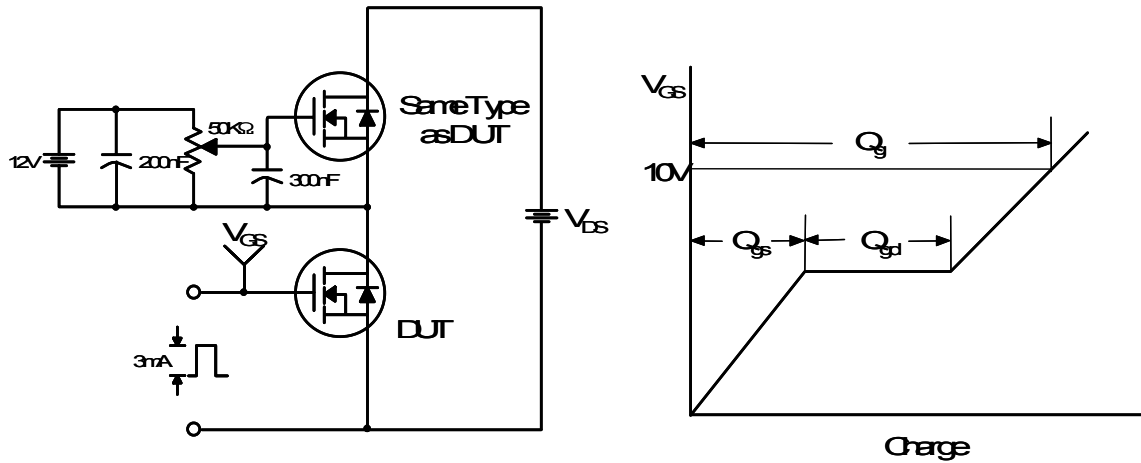
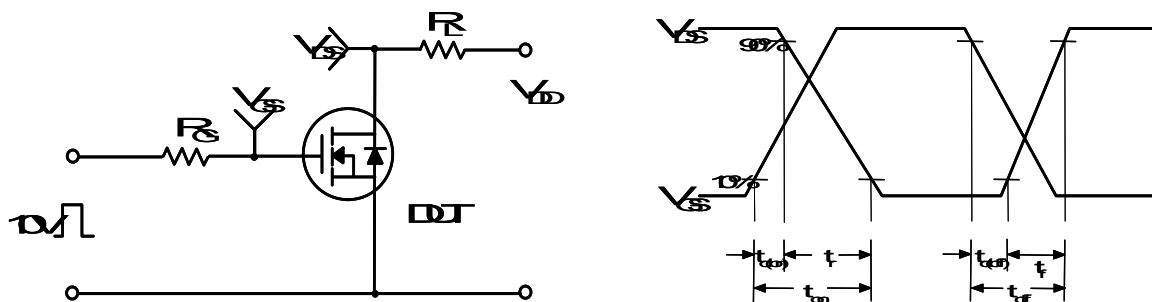


Figure 11-2. Transient Thermal Response Curve  
for HM10N65F

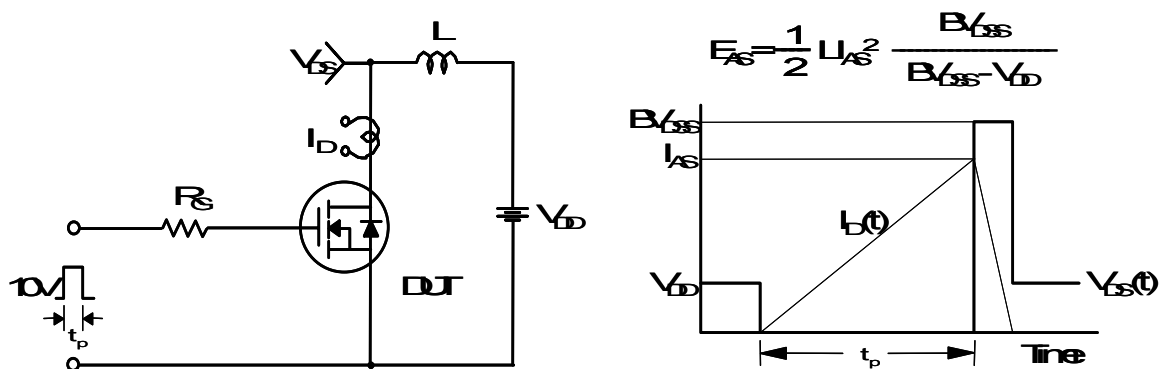
Gate Charge Test Circuit & Waveform



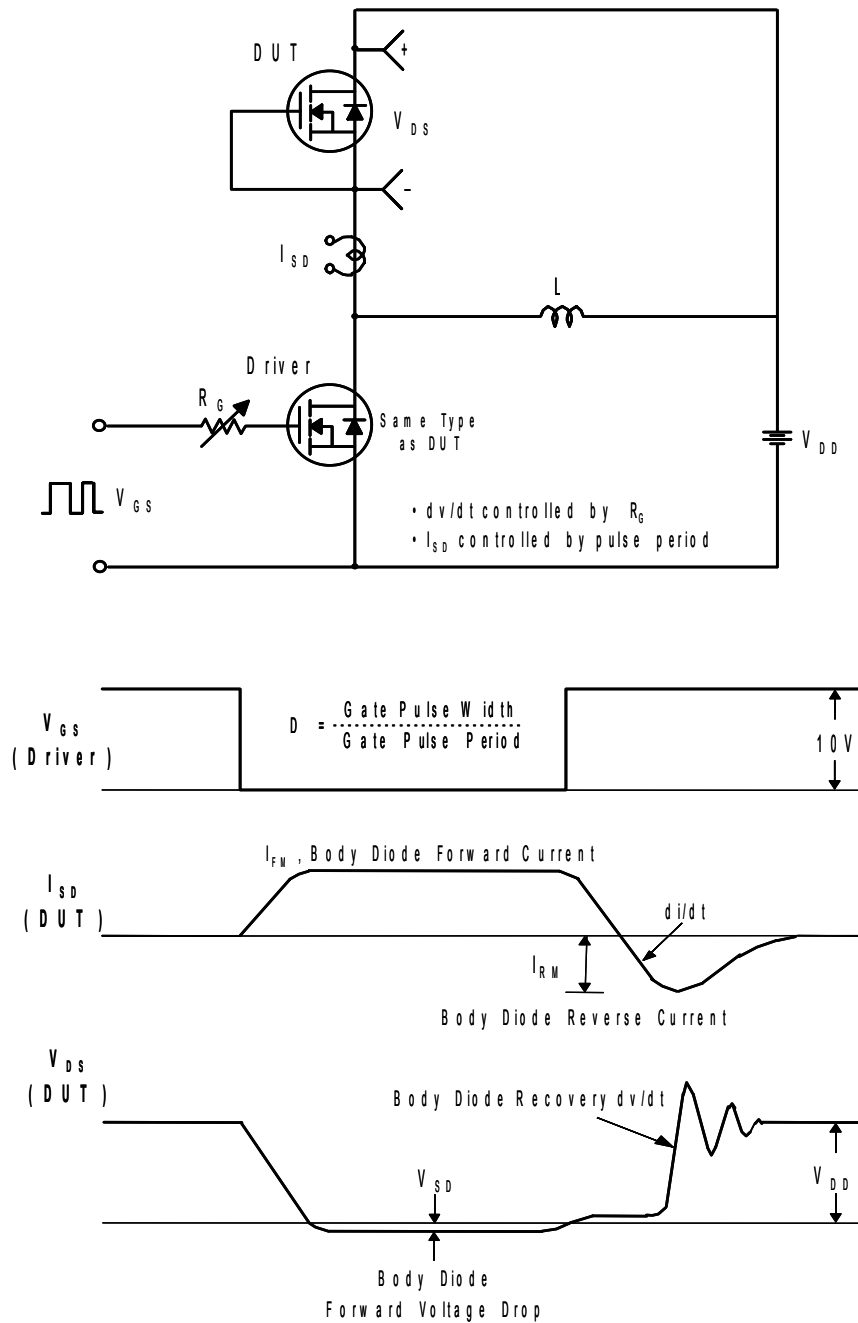
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms



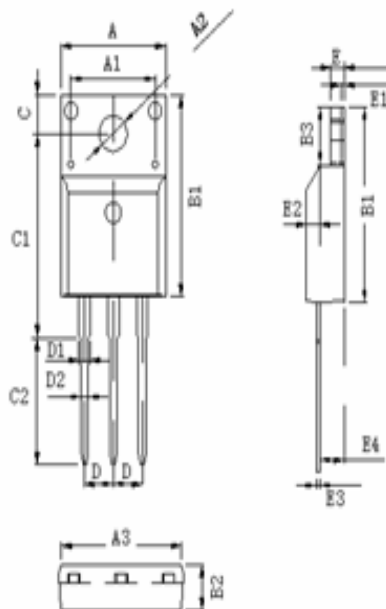
Peak Diode Recovery dv/dt Test Circuit & Waveforms



Package Dimensions

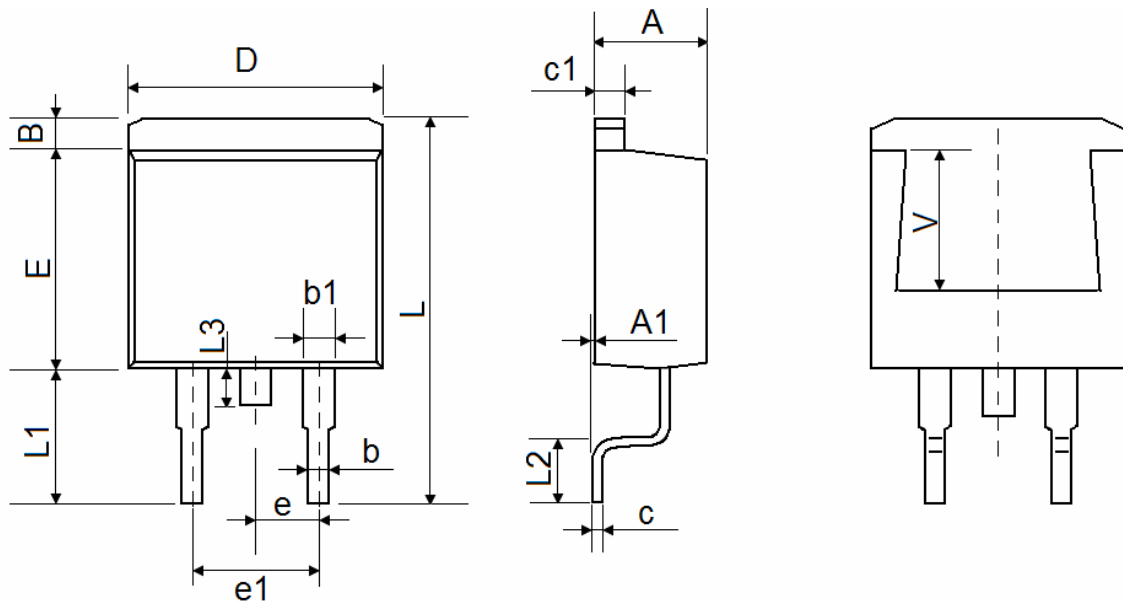
TO-220F

TO-220F 外形尺寸图



| DIM. | MILLIMETERS. |
|------|--------------|
| A    | 10.03 ± 0.20 |
| A1   | 7.00         |
| A2   | 3.12 ± 0.10  |
| A3   | 9.70 ± 0.20  |
| B1   | 15.75 ± 0.20 |
| B2   | 4.72 ± 0.20  |
| B3   | 6.70 ± 0.20  |
| C    | 3.30 ± 0.10  |
| C1   | 15.80 ± 0.20 |
| C2   | 9.80 ± 0.2   |
| D    | Typical 2.54 |
| D1   | 1.47 (MAX)   |
| D2   | 0.80 ± 0.10  |
| E    | 2.55 ± 0.20  |
| E1   | 0.70         |
| E2   | 1.00 × 45°   |
| E3   | 0.50         |
| E4   | 2.80 ± 0.20  |

TO-263-2L Package Information



| Symbol | Dimensions In Millimeters |        | Dimensions In Inches |       |
|--------|---------------------------|--------|----------------------|-------|
|        | Min.                      | Max.   | Min.                 | Max.  |
| A      | 4.470                     | 4.670  | 0.176                | 0.184 |
| A1     | 0.000                     | 0.150  | 0.000                | 0.006 |
| B      | 1.170                     | 1.370  | 0.046                | 0.054 |
| b      | 0.710                     | 0.910  | 0.028                | 0.036 |
| b1     | 1.170                     | 1.370  | 0.046                | 0.054 |
| c      | 0.310                     | 0.530  | 0.012                | 0.021 |
| c1     | 1.170                     | 1.370  | 0.046                | 0.054 |
| D      | 10.010                    | 10.310 | 0.394                | 0.406 |
| E      | 8.500                     | 8.900  | 0.335                | 0.350 |
| e      | 2.540 TYP.                |        | 0.100 TYP.           |       |
| e1     | 4.980                     | 5.180  | 0.196                | 0.204 |
| L      | 15.050                    | 15.450 | 0.593                | 0.608 |
| L1     | 5.080                     | 5.480  | 0.200                | 0.216 |
| L2     | 2.340                     | 2.740  | 0.092                | 0.108 |
| L3     | 1.300                     | 1.700  | 0.051                | 0.067 |
| V      | 5.600 REF                 |        | 0.220 REF            |       |