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March 2014

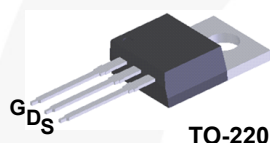
## FCP11N60/FCPF11N60

### General Description

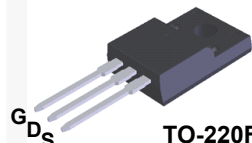
SuperFET® MOSFET is Fairchild Semiconductor's first generation of high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently, SuperFET MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications.

### Features

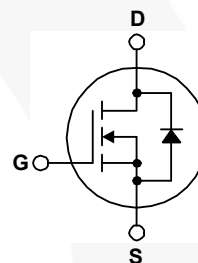
- 650V @ $T_j = 150^\circ\text{C}$
- Typ.  $R_{ds(on)} = 0.32\Omega$
- Ultra low gate charge (typ.  $Q_g = 40\text{nC}$ )
- Low effective output capacitance (typ.  $C_{oss,eff} = 95\text{pF}$ )
- 100% avalanche tested
- RoHS Compliant



TO-220



TO-220F



### Absolute Maximum Ratings

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

| Symbol         | Parameter                                                                     | FCP11N60        | FCPF11N60 | Units               |
|----------------|-------------------------------------------------------------------------------|-----------------|-----------|---------------------|
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | 11              | 11*       | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | 7               | 7*        | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                               | 33              | 33*       | A                   |
| $V_{GSS}$      | Gate-Source Voltage                                                           | $\pm 30$        |           | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 340             |           | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)                                                    | 11              |           | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 12.5            |           | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | 4.5             |           | V/ns                |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 125             | 36        | W                   |
|                | - Derate above $25^\circ\text{C}$                                             | 1.0             | 0.29      | 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                               | FCP11N60 | FCPF11N60 | Units              |
|-----------------|-----------------------------------------|----------|-----------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | 1.0      | 3.5       | $^\circ\text{C/W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink        | 0.5      | --        | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5     | 62.5      | $^\circ\text{C/W}$ |

FCP11N60 / FCPF11N60 — N-Channel SuperFET® MOSFET

## Package Marking and Ordering Information

| Part Number | Top Mark   | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|------------|---------|----------------|-----------|------------|----------|
| FCP11N60    | FCP11N60   | TO-220  | Tube           | N/A       | N/A        | 50 units |
| FCPF11N60   | FCPF11N60  | TO-220F | Tube           | N/A       | N/A        | 50 units |
| FCPF11N60T  | FCPF11N60T | TO-220F | Tube           | N/A       | N/A        | 50 units |

## Electrical Characteristics

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

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

### Off Characteristics

|                                |                                           |                                                                              |     |     |      |                    |
|--------------------------------|-------------------------------------------|------------------------------------------------------------------------------|-----|-----|------|--------------------|
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}, T_J = 25^\circ\text{C}$  | 600 | --  | --   | V                  |
|                                |                                           | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}, T_J = 150^\circ\text{C}$ | --  | 650 | --   | V                  |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$            | --  | 0.6 | --   | $V/^\circ\text{C}$ |
| $BV_{DS}$                      | Drain-Source Avalanche Breakdown Voltage  | $V_{GS} = 0\text{ V}, I_D = 11\text{ A}$                                     | --  | 700 | --   | V                  |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                                 | --  | --  | 1    | $\mu\text{A}$      |
|                                |                                           | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$                             | --  | --  | 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            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$     | 3.0 | --   | 5.0  | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 5.5\text{ A}$          | --  | 0.32 | 0.38 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 40\text{ V}, I_D = 5.5\text{ A}$ (Note 4) | --  | 9.7  | --   | S        |

### Dynamic Characteristics

|                       |                              |                                                                       |    |      |      |    |
|-----------------------|------------------------------|-----------------------------------------------------------------------|----|------|------|----|
| $C_{iss}$             | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$  | -- | 1148 | 1490 | pF |
| $C_{oss}$             | Output Capacitance           |                                                                       | -- | 671  | 870  | pF |
| $C_{rss}$             | Reverse Transfer Capacitance |                                                                       | -- | 63   | 82   | pF |
| $C_{oss}$             | Output Capacitance           | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 35   | --   | pF |
| $C_{oss\text{ eff.}}$ | Effective Output Capacitance | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$           | -- | 95   | --   | pF |

### Switching Characteristics

|              |                     |                                                                                            |    |     |     |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------|----|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 300\text{ V}, I_D = 11\text{ A},$<br>$R_G = 25\text{ }\Omega$<br><br>(Note 4, 5) | -- | 34  | 80  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                            | -- | 98  | 205 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                            | -- | 119 | 250 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                            | -- | 56  | 120 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 480\text{ V}, I_D = 11\text{ A},$<br>$V_{GS} = 10\text{ V}$<br><br>(Note 4, 5)   | -- | 40  | 52  | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                            | -- | 7.2 | --  | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                            | -- | 21  | --  | nC |

### Drain-Source Diode Characteristics and Maximum Ratings

|                 |                                                       |                                                                                  |    |     |     |    |
|-----------------|-------------------------------------------------------|----------------------------------------------------------------------------------|----|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |                                                                                  | -- | --  | 11  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                  | -- | --  | 33  | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 11 A                                     | -- | --  | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 11 A,<br>dI <sub>F</sub> / dt = 100 A/μs | -- | 390 | --  | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               | (Note 4)                                                                         | -- | 5.7 | --  | μC |

#### Notes:

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $I_{AS} = 5.5\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 11\text{ A}, dI/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , 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

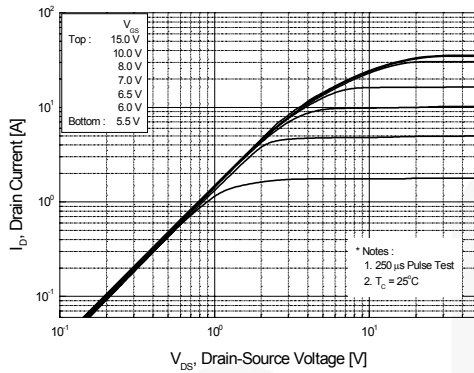


Figure 1. On-Region Characteristics

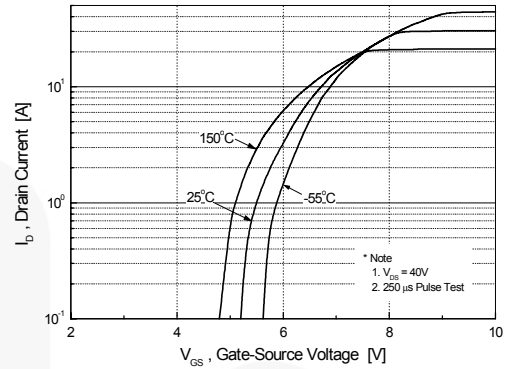


Figure 2. Transfer Characteristics

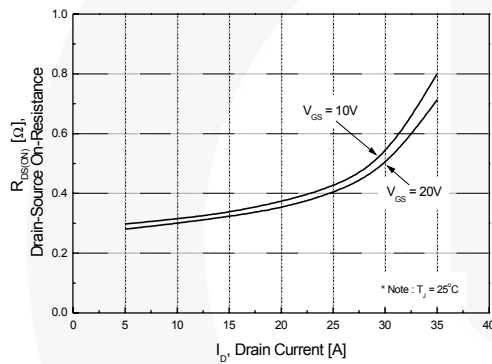


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

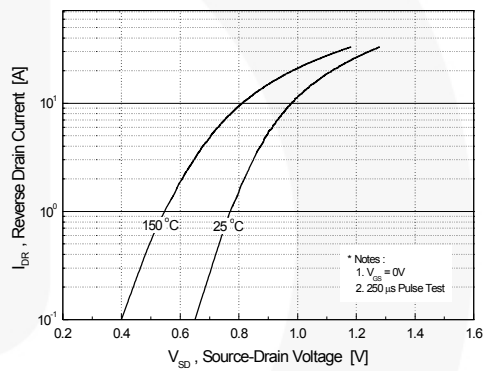


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

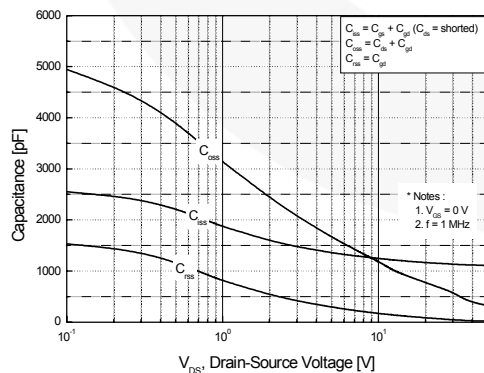


Figure 5. Capacitance Characteristics

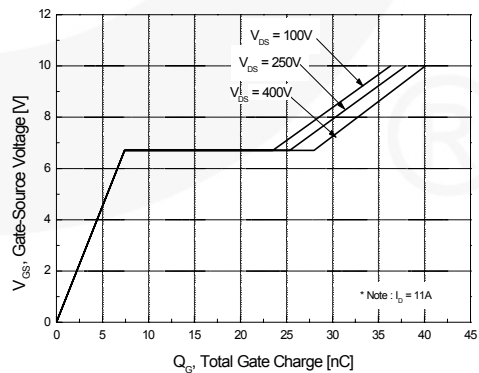
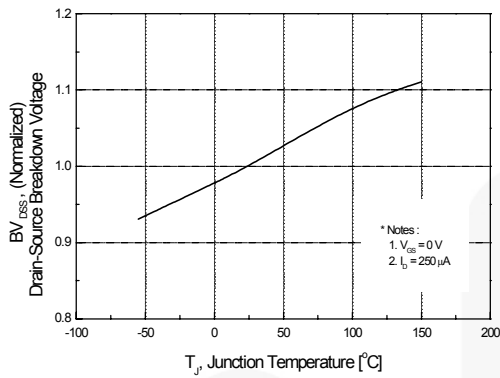
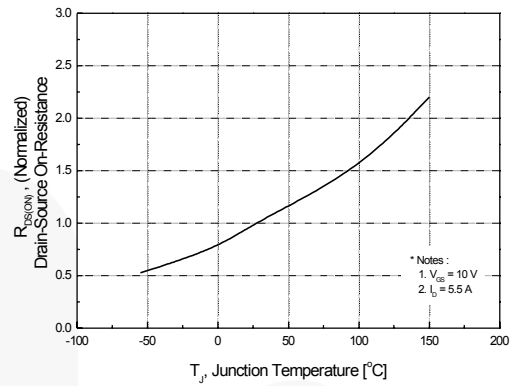


Figure 6. Gate Charge Characteristics

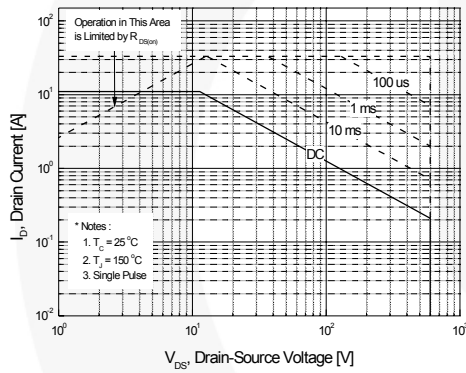
## Typical Characteristics (Continued)



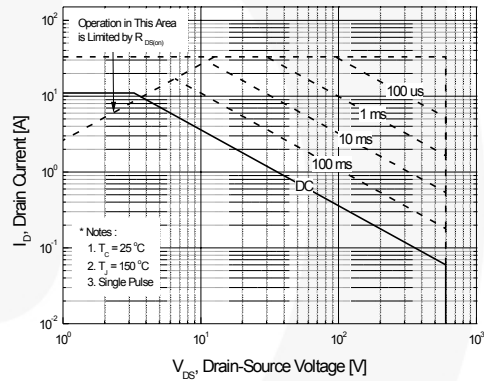
**Figure 7. Breakdown Voltage Variation vs. Temperature**



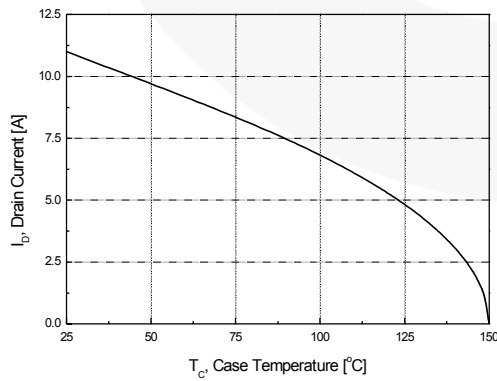
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9-1. Maximum Safe Operating Area for FCP11N60**



**Figure 9-2. Maximum Safe Operating Area for FCPF11N60**



**Figure 10. Maximum Drain Current vs. Case Temperature**

## Typical Characteristics (Continued)

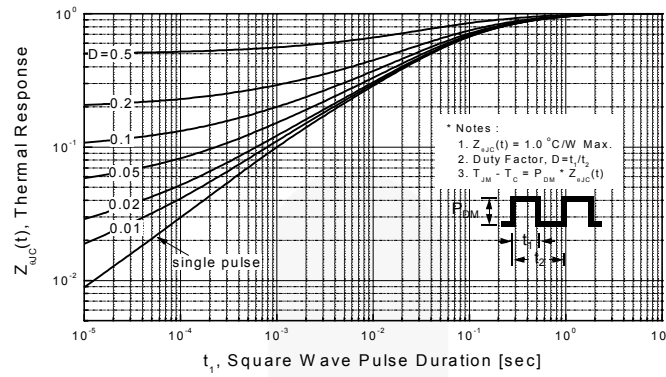


Figure 11-1. Transient Thermal Response Curve for FCP11N60

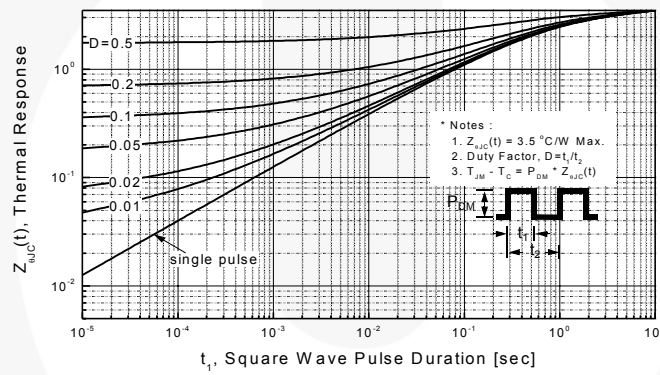


Figure 11-2. Transient Thermal Response Curve for FCPF11N60

Figure 12. Gate Charge Test Circuit & Waveform

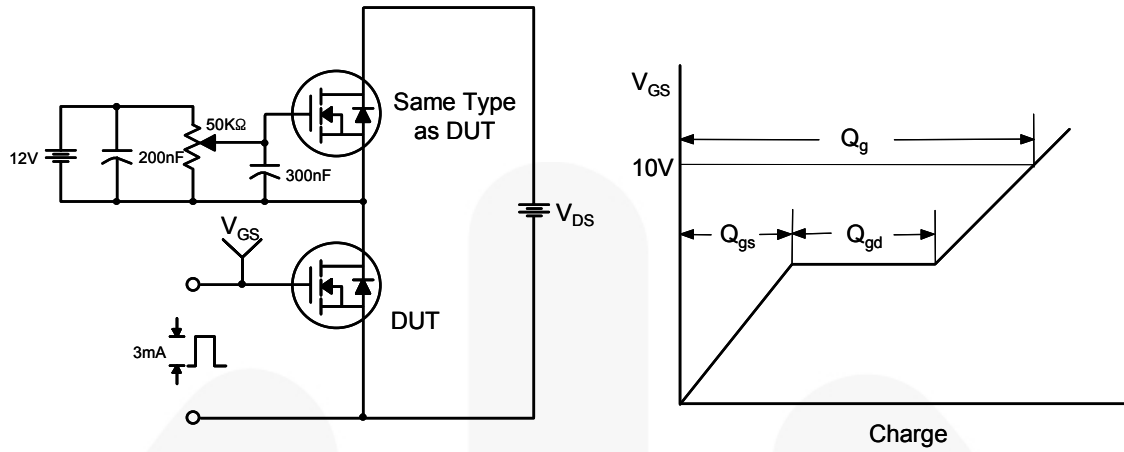


Figure 13. Resistive Switching Test Circuit & Waveforms

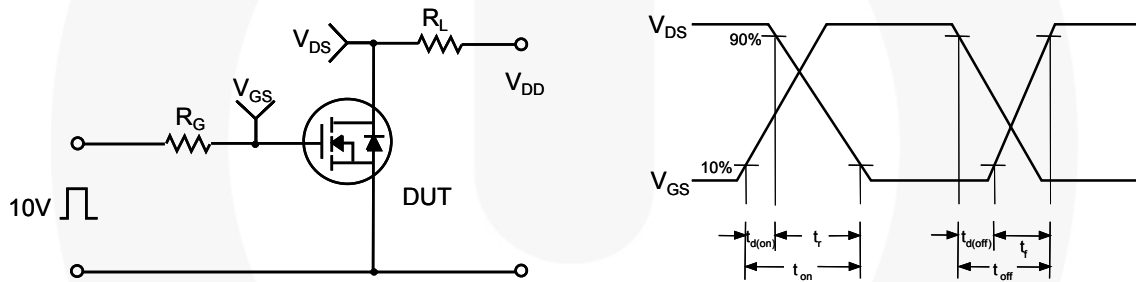
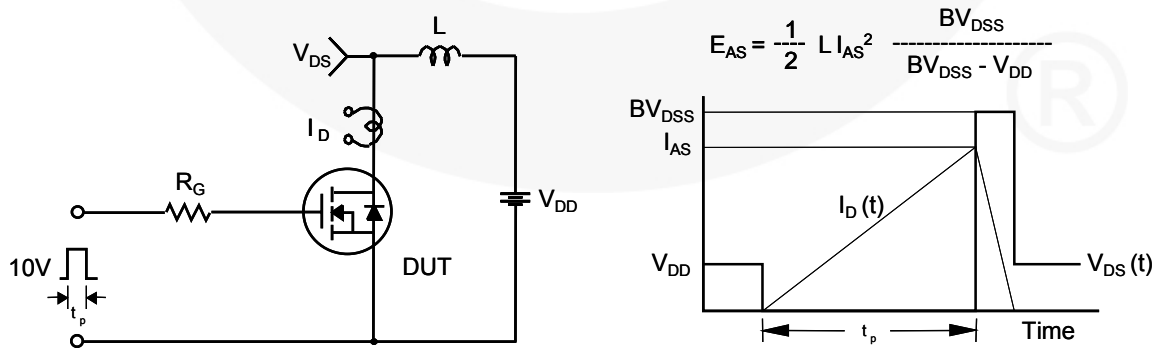
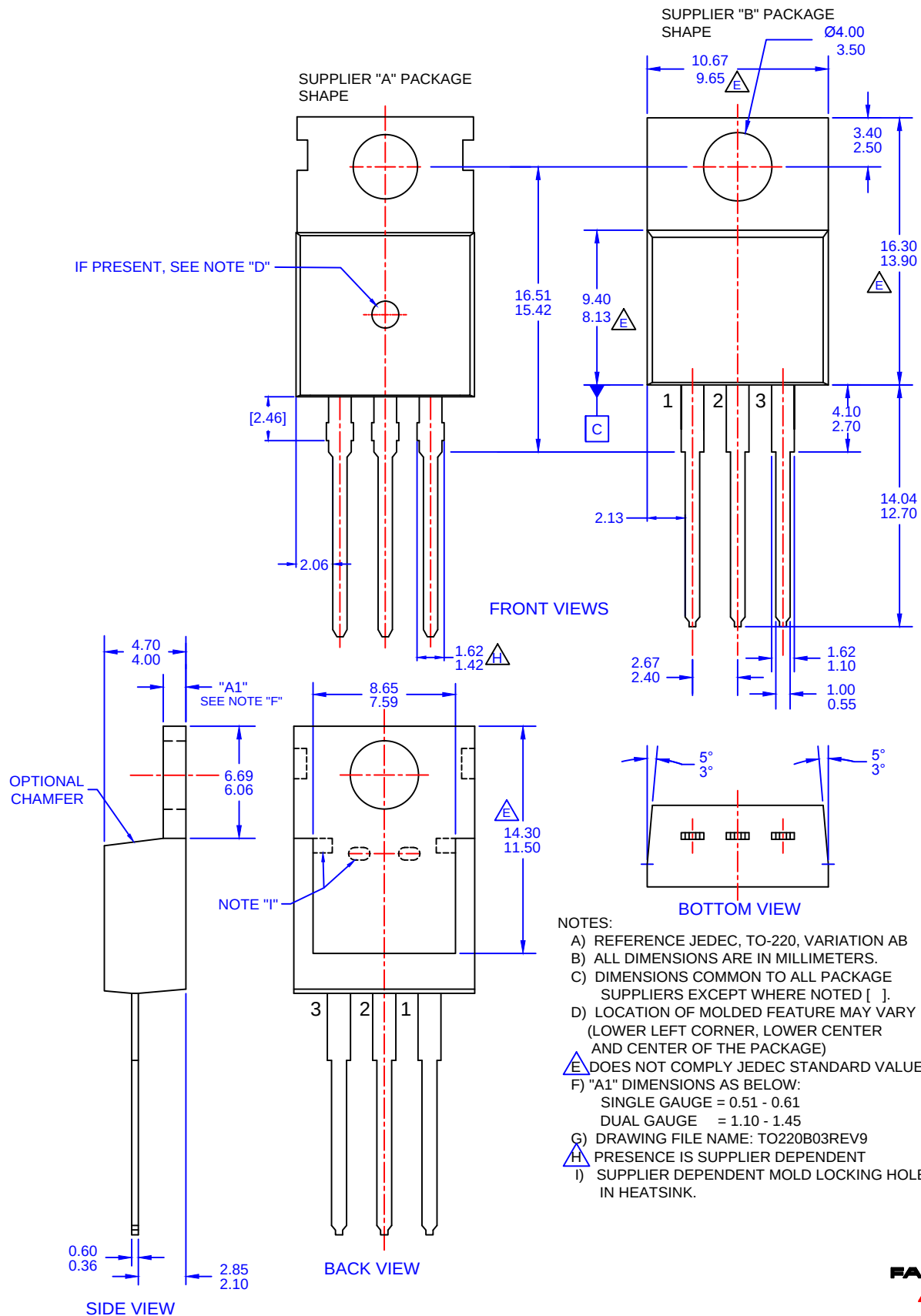


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms



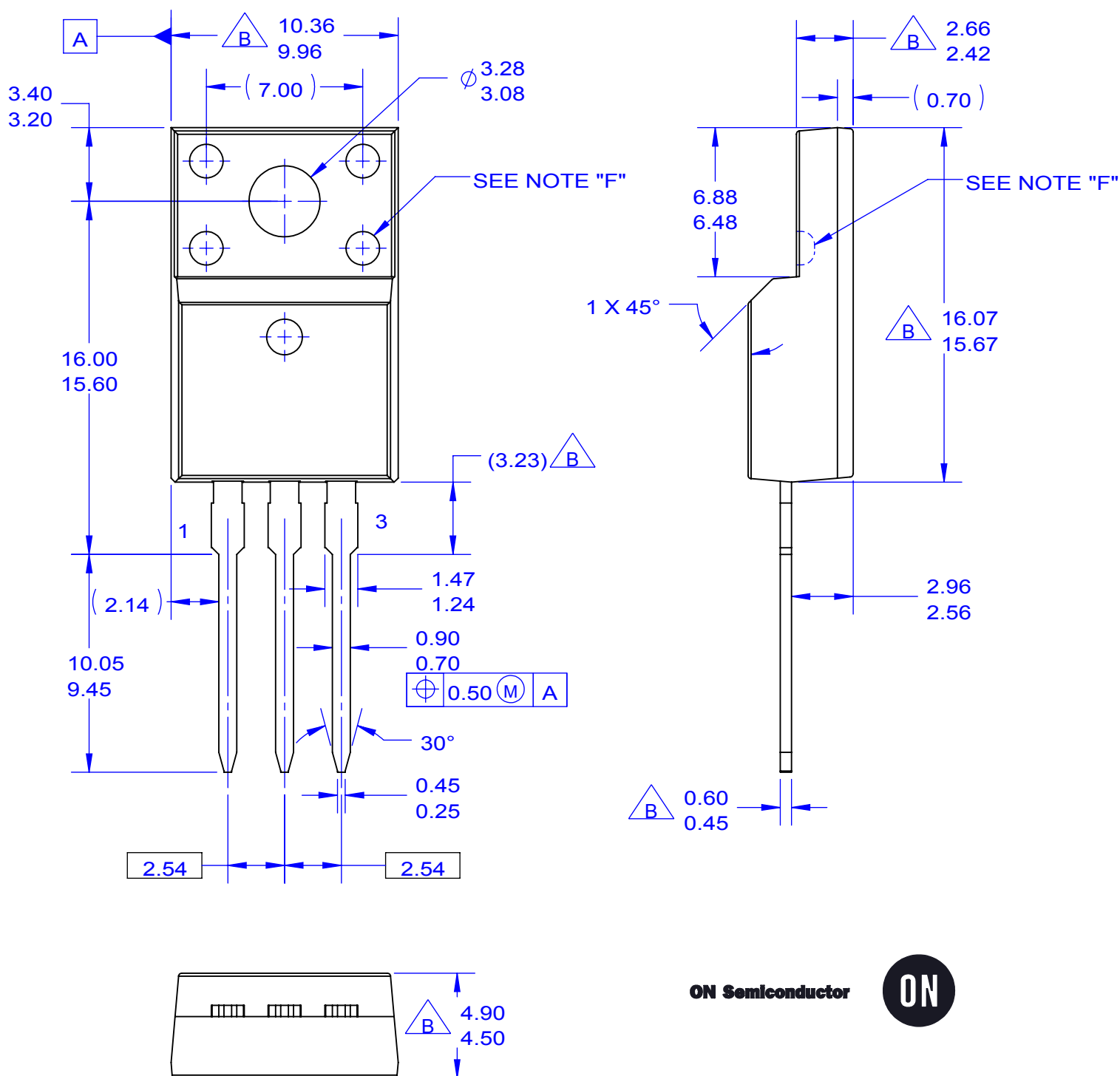






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- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS COMMON TO ALL PACKAGE SUPPLIERS EXCEPT WHERE NOTED [ ].
- D) LOCATION OF MOLDED FEATURE MAY VARY (LOWER LEFT CORNER, LOWER CENTER AND CENTER OF THE PACKAGE)
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DUAL GAUGE = 1.10 - 1.45
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OPTION 2 - NO SUPPORT PIN HOLE.
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