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May 2014

# FCA36N60NF

## N-Channel SupreMOS<sup>®</sup> FRFET<sup>®</sup> MOSFET

600 V, 34.9 A, 95 mΩ

### Features

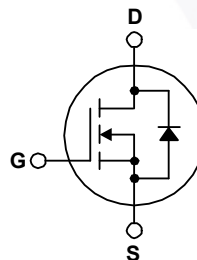
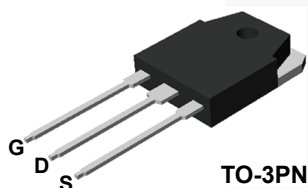
- $R_{DS(on)} = 80 \text{ m}\Omega$  (Typ.) @  $V_{GS} = 10\text{V}$ ,  $I_D = 18 \text{ A}$
- Ultra Low Gate Charge (Typ.  $Q_g = 86 \text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 338 \text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

### Application

- Solar Inverter
- AC-DC Power Supply

### Description

The SupreMOS<sup>®</sup> MOSFET is Fairchild Semiconductor's next generation of high voltage super-junction (SJ) technology employing a deep trench filling process that differentiates it from the conventional SJ MOSFETs. This advanced technology and precise process control provides lowest  $R_{sp}$  on-resistance, superior switching performance and ruggedness. SupreMOS MOSFET is suitable for high frequency switching power converter applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications. SupreMOS FRFET<sup>®</sup> MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.



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

| Symbol         | Parameter                                                            | FCA36N60NF                               | Unit                |
|----------------|----------------------------------------------------------------------|------------------------------------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage                                              | 600                                      | V                   |
| $V_{GSS}$      | Gate to Source Voltage                                               | $\pm 30$                                 | V                   |
| $I_D$          | Drain Current                                                        | Continuous ( $T_C = 25^\circ\text{C}$ )  | A                   |
|                |                                                                      | Continuous ( $T_C = 100^\circ\text{C}$ ) |                     |
| $I_{DM}$       | Drain Current                                                        | Pulsed (Note 1)                          | A                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy                                       | (Note 2)                                 | mJ                  |
| $I_{AR}$       | Avalanche Current                                                    | (Note 1)                                 | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy                                          | (Note 1)                                 | mJ                  |
| dv/dt          | MOSFET dv/dt                                                         | 100                                      | V/ns                |
|                | Peak Diode Recovery dv/dt (Note 3)                                   | 50                                       |                     |
| $P_D$          | Power Dissipation                                                    | ( $T_C = 25^\circ\text{C}$ )             | W                   |
|                |                                                                      | Derate Above $25^\circ\text{C}$          | 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, 1/8" from Case for 5 Seconds | 300                                      | $^\circ\text{C}$    |

### Thermal Characteristics

| Symbol          | Parameter                                     | FCA36N60NF | Unit               |
|-----------------|-----------------------------------------------|------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.40       | $^\circ\text{C/W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case to Heat Sink, Typ.   | 0.24       |                    |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40         |                    |

## Package Marking and Ordering Information

| Part Number | Top Mark   | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|------------|---------|----------------|-----------|------------|----------|
| FCA36N60NF  | FCA36N60NF | TO-3PN  | Tube           | N/A       | N/A        | 30 units |

## Electrical Characteristics

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

### Off Characteristics

|                                |                                           |                                                                                |     |      |           |                    |
|--------------------------------|-------------------------------------------|--------------------------------------------------------------------------------|-----|------|-----------|--------------------|
| $BV_{DSS}$                     | Drain to Source Breakdown Voltage         | $I_D = 1 \text{ mA}$ , $V_{GS} = 0 \text{ V}$ , $T_J = 25^\circ\text{C}$       | 600 | -    | -         | V                  |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 1 \text{ mA}$ , Referenced to $25^\circ\text{C}$                        | -   | 0.60 | -         | $V/^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 480 \text{ V}$ , $V_{GS} = 0 \text{ V}$<br>$T_J = 125^\circ\text{C}$ | -   | -    | 10<br>100 | $\mu\text{A}$      |
| $I_{GSS}$                      | Gate to Body Leakage Current              | $V_{GS} = \pm 30 \text{ V}$ , $V_{DS} = 0 \text{ V}$                           | -   | -    | $\pm 100$ | nA                 |

### On Characteristics

|              |                                      |                                                |     |     |     |                  |
|--------------|--------------------------------------|------------------------------------------------|-----|-----|-----|------------------|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}$ , $I_D = 250 \mu\text{A}$    | 3.0 | 3.7 | 5.0 | V                |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10 \text{ V}$ , $I_D = 18 \text{ A}$ | -   | 80  | 95  | $\text{m}\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 20 \text{ V}$ , $I_D = 18 \text{ A}$ | -   | 39  | -   | S                |

### Dynamic Characteristics

|                |                                    |                                                                                          |   |      |      |          |
|----------------|------------------------------------|------------------------------------------------------------------------------------------|---|------|------|----------|
| $C_{iss}$      | Input Capacitance                  | $V_{DS} = 100 \text{ V}$ , $V_{GS} = 0 \text{ V}$ ,<br>$f = 1 \text{ MHz}$               | - | 3191 | 4245 | pF       |
| $C_{oss}$      | Output Capacitance                 |                                                                                          | - | 145  | 195  | pF       |
| $C_{rss}$      | Reverse Transfer Capacitance       |                                                                                          | - | 5    | 8    | pF       |
| $C_{oss}$      | Output Capacitance                 | $V_{DS} = 380 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$                  | - | 81   | -    | pF       |
| $C_{oss,eff.}$ | Effective Output Capacitance       | $V_{DS} = 0 \text{ V}$ to $480 \text{ V}$ , $V_{GS} = 0 \text{ V}$                       | - | 338  | -    | pF       |
| $Q_{g(tot)}$   | Total Gate Charge at 10V           | $V_{DS} = 380 \text{ V}$ , $I_D = 18 \text{ A}$ ,<br>$V_{GS} = 10 \text{ V}$<br>(Note 4) | - | 86   | 112  | nC       |
| $Q_{gs}$       | Gate to Source Gate Charge         |                                                                                          | - | 16   | -    | nC       |
| $Q_{gd}$       | Gate to Drain "Miller" Charge      |                                                                                          | - | 36   | -    | nC       |
| ESR            | Equivalent Series Resistance (G-S) | $f = 1 \text{ MHz}$                                                                      | - | 1.2  | -    | $\Omega$ |

### Switching Characteristics

|              |                     |                                                                                                               |   |    |     |    |
|--------------|---------------------|---------------------------------------------------------------------------------------------------------------|---|----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 380 \text{ V}$ , $I_D = 18 \text{ A}$ ,<br>$V_{GS} = 10 \text{ V}$ , $R_G = 4.7 \Omega$<br>(Note 4) | - | 27 | 64  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                               | - | 17 | 44  | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                               | - | 92 | 194 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                                               | - | 4  | 18  | ns |

### Drain-Source Diode Characteristics

|                 |                                                          |                                                                                  |   |     |     |    |
|-----------------|----------------------------------------------------------|----------------------------------------------------------------------------------|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                                                                  | - | -   | 36  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                                                                  | - | -   | 108 | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 18 A                                    | - | -   | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 18 A,<br>dI <sub>F</sub> /dt = 100 A/μs | - | 166 | -   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                  | - | 1.3 | -   | μC |

#### Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 12 \text{ A}$ ,  $R_G = 25 \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 36 \text{ A}$ ,  $di/dt \leq 1200 \text{ A}/\mu\text{s}$ ,  $V_{DD} = 380 \text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

Figure 1. On-Region Characteristics

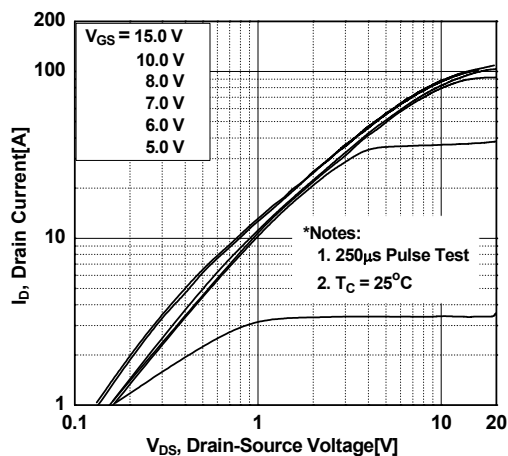


Figure 2. Transfer Characteristics

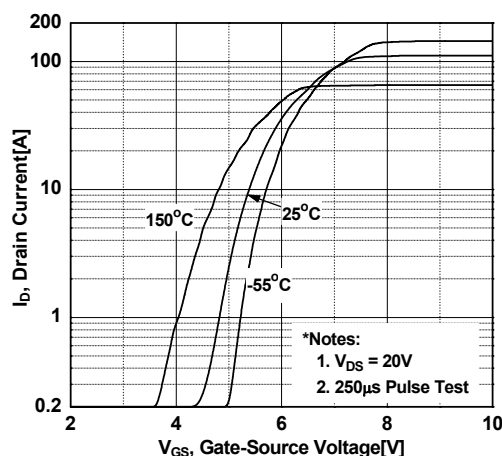


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

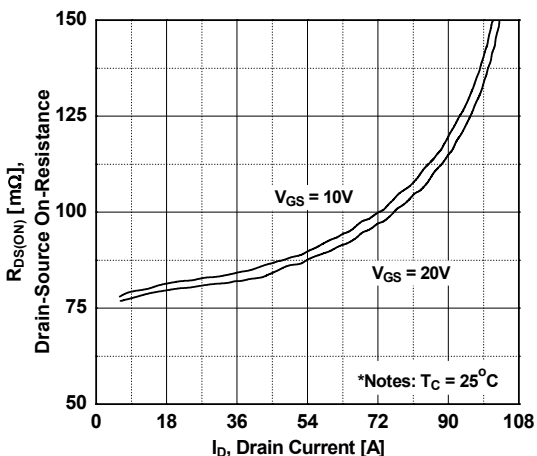


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

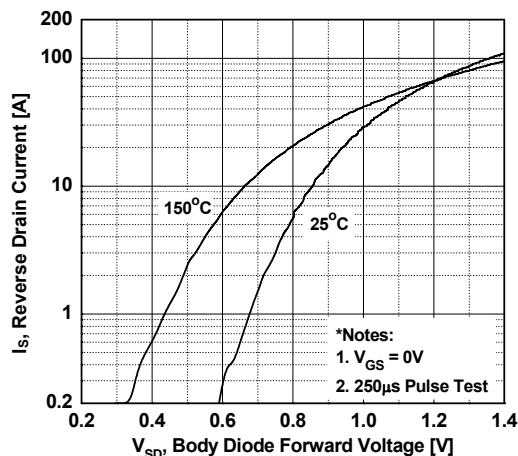


Figure 5. Capacitance Characteristics

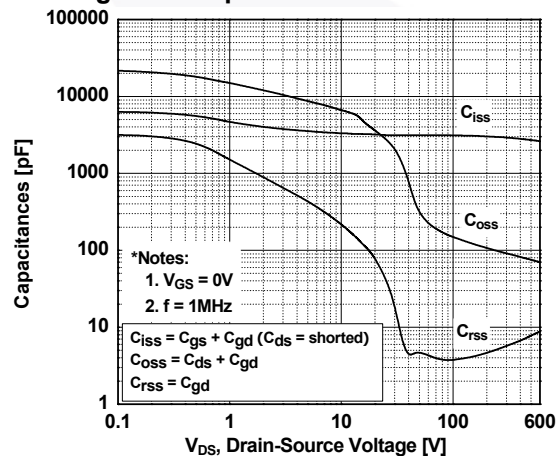
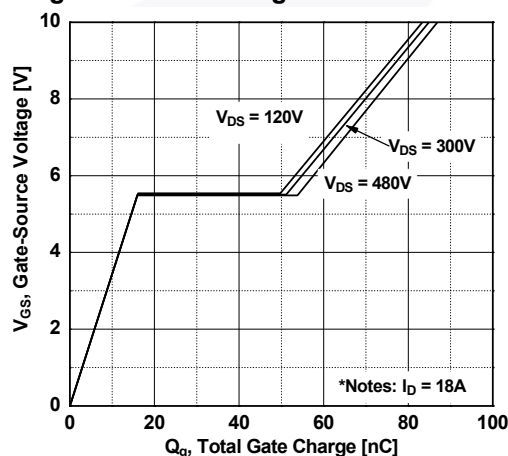


Figure 6. Gate Charge Characteristics



## Typical Performance Characteristics (Continued)

Figure 7. Breakdown Voltage Variation vs. Temperature

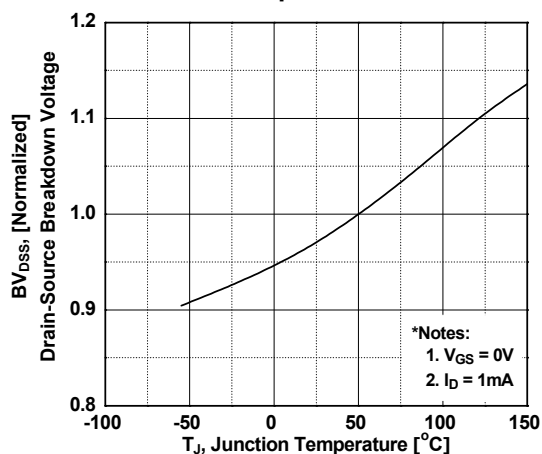


Figure 8. On-Resistance Variation vs. Temperature

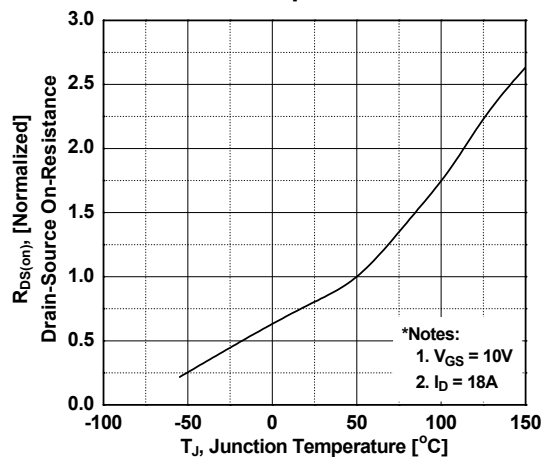


Figure 9. Maximum Safe Operating Area

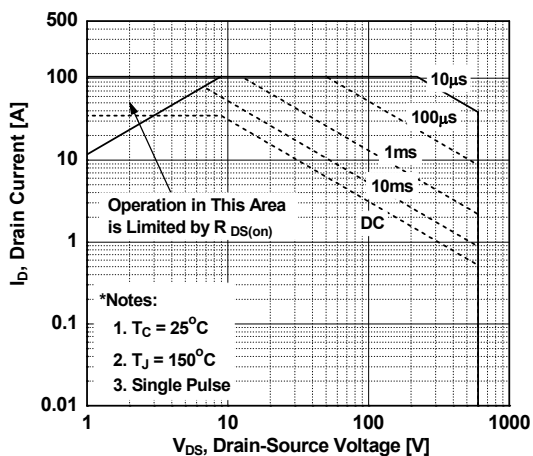


Figure 10. Maximum Drain Current vs. Case Temperature

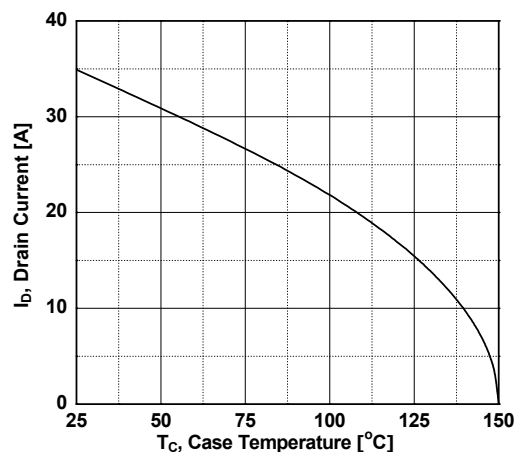
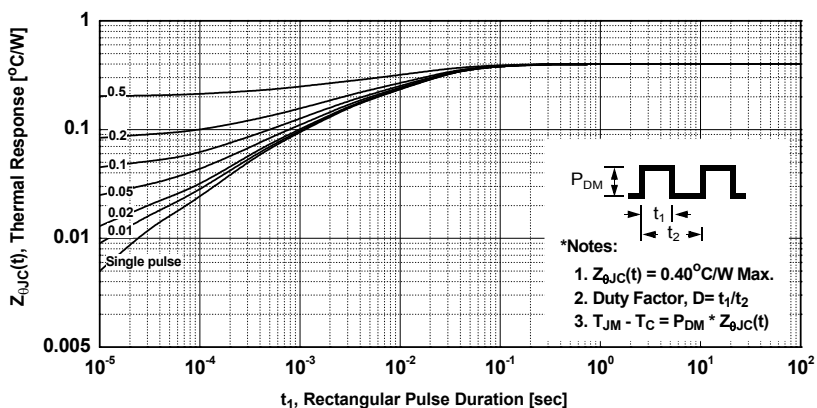


Figure 11. Transient Thermal Response Curve



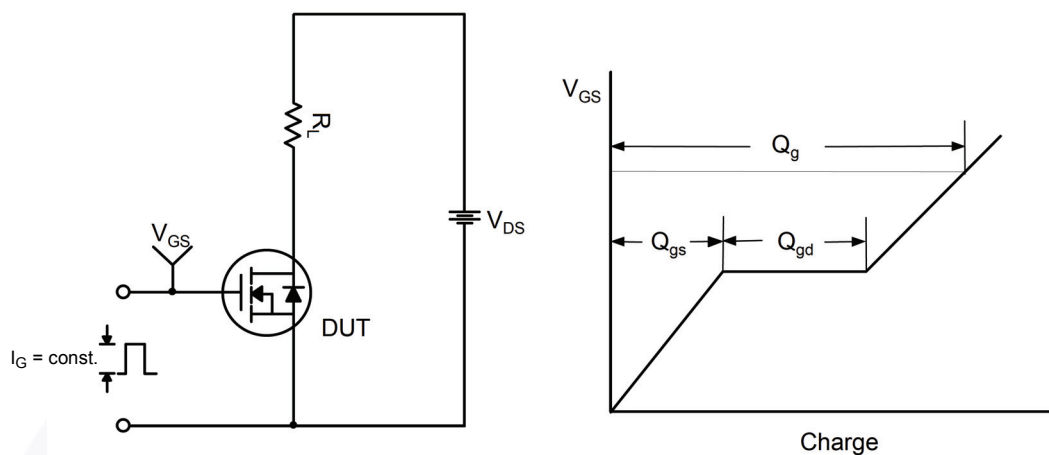


Figure 12. Gate Charge Test Circuit & Waveform

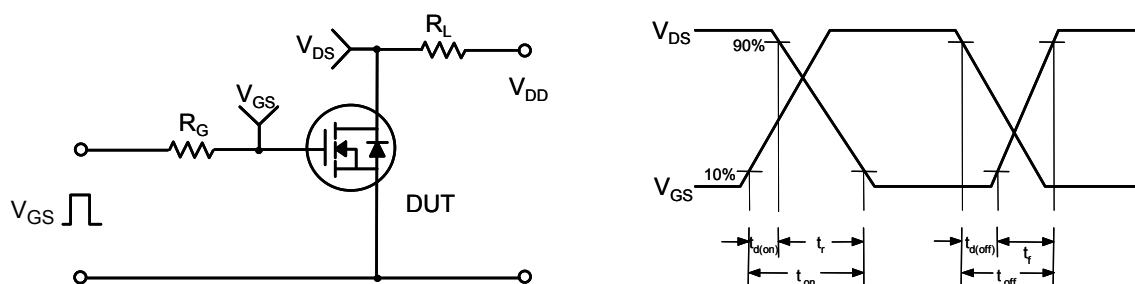


Figure 13. Resistive Switching Test Circuit & Waveforms

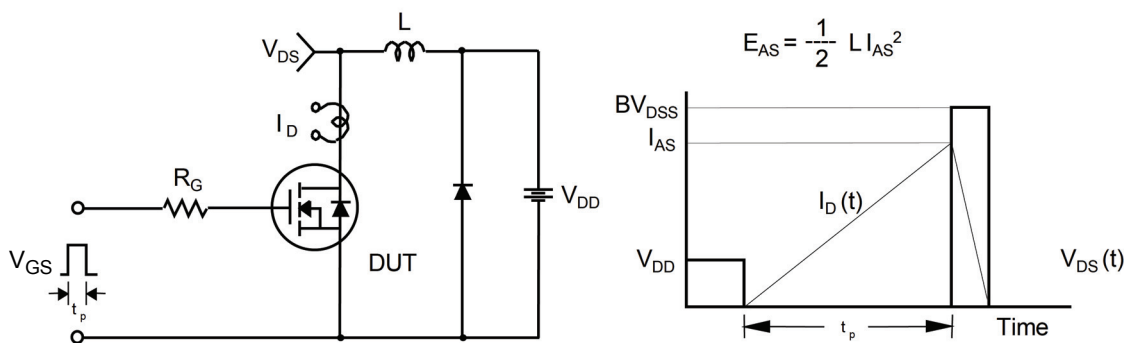
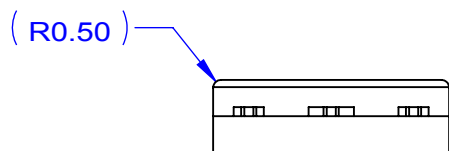
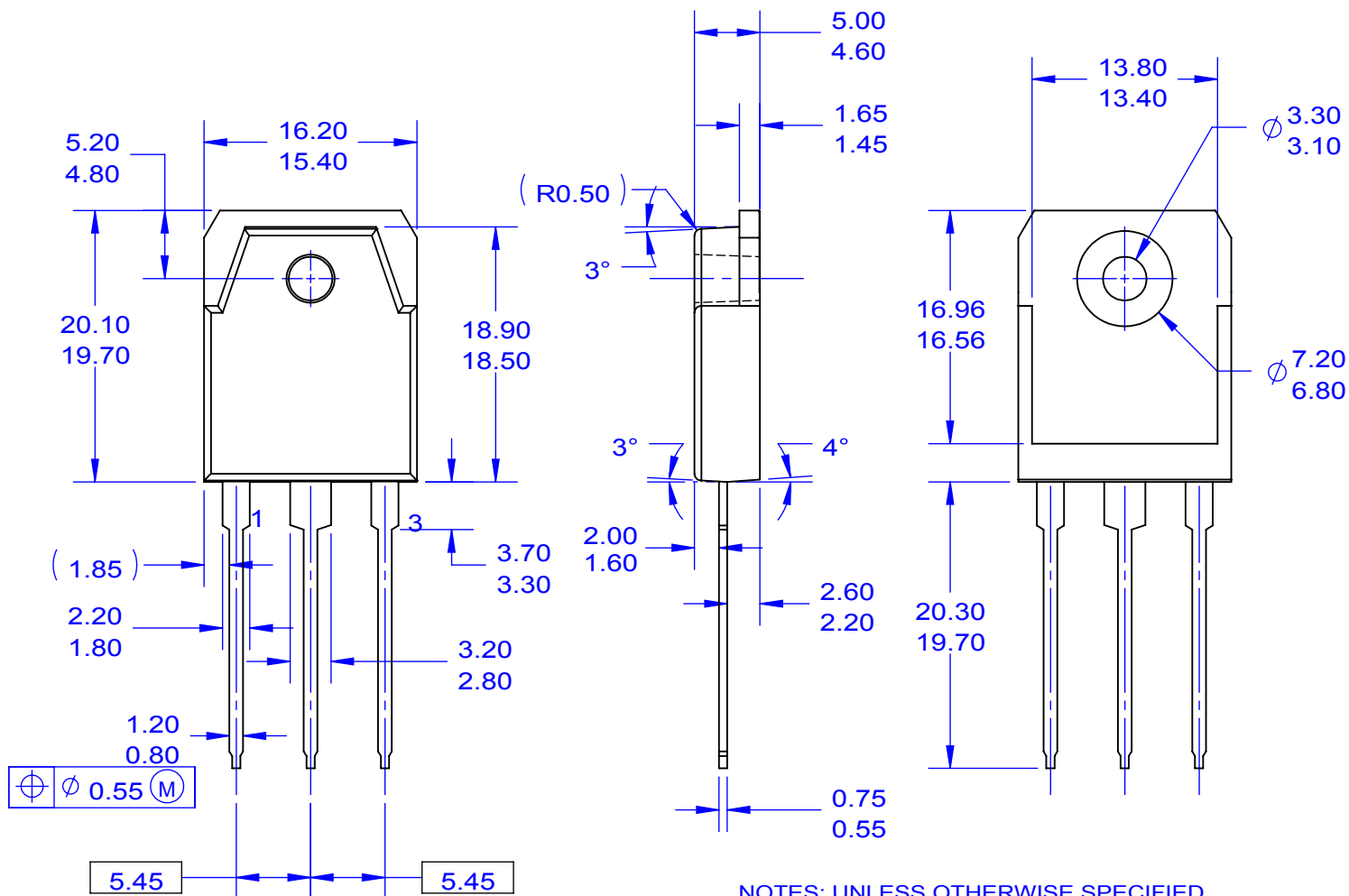


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms







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