

# MOSFET – N-Channel, SUPERFET®

600 V, 47 A, 70 mΩ

## FCA47N60, FCA47N60-F109

### Description

SUPERFET MOSFET is onsemi'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.

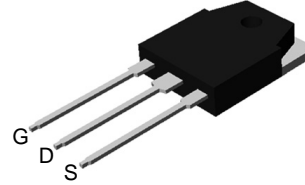
### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 58\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 210\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 420\text{ pF}$ )
- 100% Avalanche Tested

### Applications

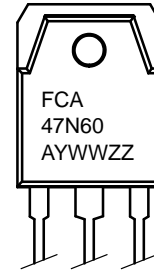
- Solar Inverter
- AC-DC Power Supply

| $V_{DSS}$ | $R_{DS(on)}\text{ MAX}$ | $I_D\text{ MAX}$ |
|-----------|-------------------------|------------------|
| 600 V     | 70 mΩ @ 10 V            | 47 A             |



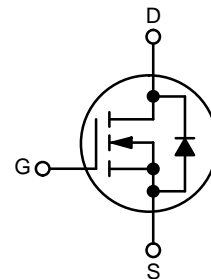
TO-3P-3LD / EIAJ SC-65, ISOLATED  
CASE 340BZ

### MARKING DIAGRAM



FCA47N60 = Specific Device Code  
A = Assembly Location  
YWW = Date Code (Year & Week)  
ZZ = Assembly Lot

### N-CHANNEL MOSFET



### ORDERING INFORMATION

| Part Number   | Package                | Shipping         |
|---------------|------------------------|------------------|
| FCA47N60      | TO-3P-3LD<br>(Pb-Free) | 450 Units / Tube |
| FCA47N60-F109 |                        | 450 Units / Tube |

## FCA47N60, FCA47N60-F109

### ABSOLUTE MAXIMUM RATINGS

| Symbol         | Parameter  | FCA47N60                                   | FCA47N60-F109 | Unit                |
|----------------|--|--|---------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage   |  | 600           | V                   |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 47            | A                   |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 29.7          |                     |
| $I_{DM}$       | Drain Current  |  | 141           | A                   |
| $V_{GSS}$      | Gate-Source Voltage  |  | $\pm 30$      | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                      |  | 1800          | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)   |  | 47            | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)   |  | 41.7          | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)   |  | 4.5           | V/ns                |
| $P_D$          | Power Dissipation  | ( $T_C = 25^\circ\text{C}$ )               | 417           | W                   |
|                |  | - Derate above $25^\circ\text{C}$          | 3.33          | 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 Purpose, 1/8" from Case for 5 Seconds |  | 300           | $^\circ\text{C}$    |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Repetitive Rating: Pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 18\text{ A}$ ,  $R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 47\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} = 380\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .

### THERMAL CHARACTERISTICS

| Symbol          | Parameter                                     | Typ | Max  | Unit                      |
|-----------------|---|-----|------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case, Max.    | -   | 0.3  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient, Max. | -   | 41.7 | $^\circ\text{C}/\text{W}$ |

# FCA47N60, FCA47N60-F109

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol                               | Parameter                                 | Test Conditions  | Min | Typ | Max  | Unit |
|--------------------------------------|---|--|-----|-----|------|------|
| <b>OFF CHARACTERISTICS</b>           |   |  |     |     |      |      |
| BV <sub>DSS</sub>                    | Drain-Source Breakdown Voltage            | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA, T <sub>J</sub> = 25°C  | 600 | -   | -    | V    |
|                                      |   | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA, T <sub>J</sub> = 150°C | -   | 650 | -    |      |
| ΔBV <sub>DSS</sub> / ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 250 μA, Referenced to 25°C                            | -   | 0.6 | -    | V/°C |
| BV <sub>DS</sub>                     | Drain-Source Avalanche Breakdown Voltage  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 47 A                           | -   | 700 | -    | V    |
| I <sub>DSS</sub>                     | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                         | -   | -   | 10   | μA   |
|                                      |   | V <sub>DS</sub> = 480 V, T <sub>C</sub> = 125°C                        | -   | -   | 100  |      |
| I <sub>GSSF</sub>                    | Gate-Body Leakage Current, Forward        | V <sub>GS</sub> = 30 V, V <sub>DS</sub> = 0 V                          | -   | -   | 100  | nA   |
| I <sub>GSSR</sub>                    | Gate-Body Leakage Current, Reverse        | V <sub>GS</sub> = -30 V, V <sub>DS</sub> = 0 V                         | -   | -   | -100 | nA   |

## ON CHARACTERISTICS

|                     |                                   |   |     |       |      |   |
|---------------------|-----------------------------------|---|-----|-------|------|---|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA | 3.0 | -     | 5.0  | V |
| R <sub>DS(on)</sub> | Static Drain-Source On-Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 23.5 A             | -   | 0.058 | 0.07 | Ω |
| g <sub>FS</sub>     | Forward Transconductance          | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 23.5 A             | -   | 40    | -    | S |

## DYNAMIC CHARACTERISTICS

|                       |                              |   |   |      |      |    |
|-----------------------|------------------------------|---|---|------|------|----|
| C <sub>iss</sub>      | Input Capacitance            | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz  | - | 5900 | 8000 | pF |
| C <sub>oss</sub>      | Output Capacitance           |   | - | 3200 | 4200 | pF |
| C <sub>rss</sub>      | Reverse Transfer Capacitance |   | - | 250  | -    | pF |
| C <sub>oss</sub>      | Output Capacitance           | V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz | - | 160  | -    | pF |
| C <sub>oss eff.</sub> | Effective Output Capacitance | V <sub>DS</sub> = 0 to 400 V, V <sub>GS</sub> = 0 V         | - | 420  | -    | pF |

## SWITCHING CHARACTERISTICS

|                     |                     |  |   |     |      |    |
|---------------------|---------------------|--|---|-----|------|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 300 V, I <sub>D</sub> = 47 A, R <sub>G</sub> = 25 Ω<br>(Note 4)  | - | 185 | 430  | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |  | - | 210 | 450  | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |  | - | 520 | 1100 | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |  | - | 75  | 160  | ns |
| Q <sub>g</sub>      | Total Gate Charge   | V <sub>DS</sub> = 480 V, I <sub>D</sub> = 47 A, V <sub>GS</sub> = 10 V<br>(Note 4) | - | 210 | 270  | nC |
| Q <sub>gs</sub>     | Gate-Source Charge  |  | - | 38  | -    | nC |
| Q <sub>gd</sub>     | Gate-Drain Charge   |  | - | 110 | -    | nC |

## DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

|                 |   |  |   |     |     |    |
|-----------------|---|--|---|-----|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current | -  | - | 47  | A   |    |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     | -  | - | 141 | A   |    |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 47 A   | - | -   | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 47 A, dI <sub>F</sub> /dt = 100 A/μs<br>(Note 4) | - | 590 | -   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |  | - | 25  | -   | μC |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Essentially independent of operating temperature typical characteristics.

TYPICAL CHARACTERISTICS

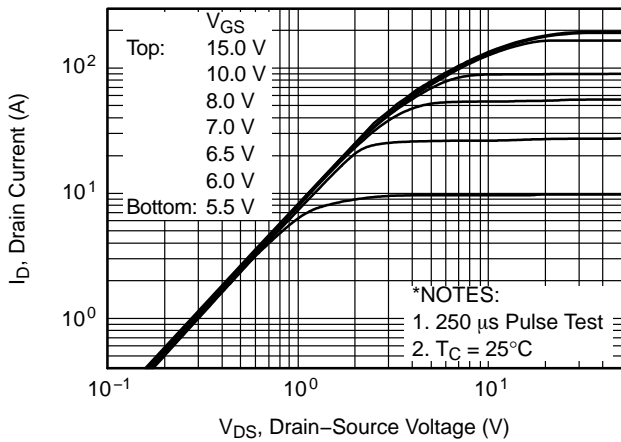


Figure 1. On-Region Characteristics

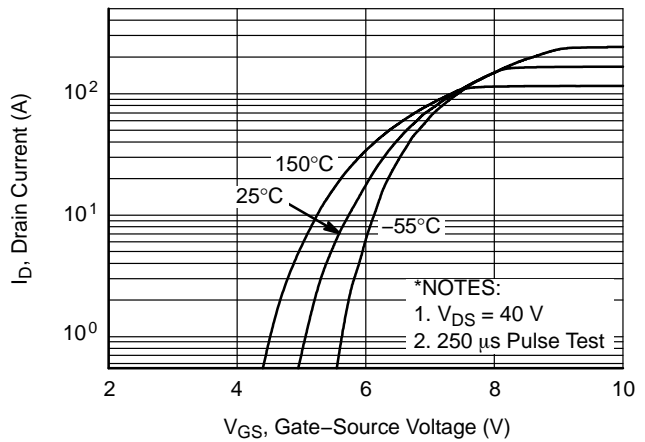


Figure 2. Transfer Characteristics

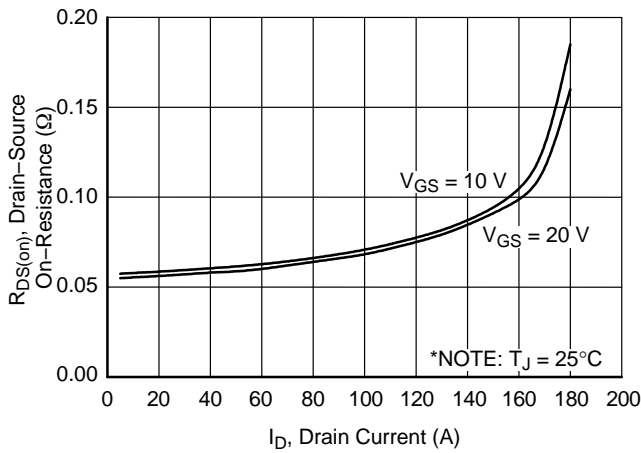


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

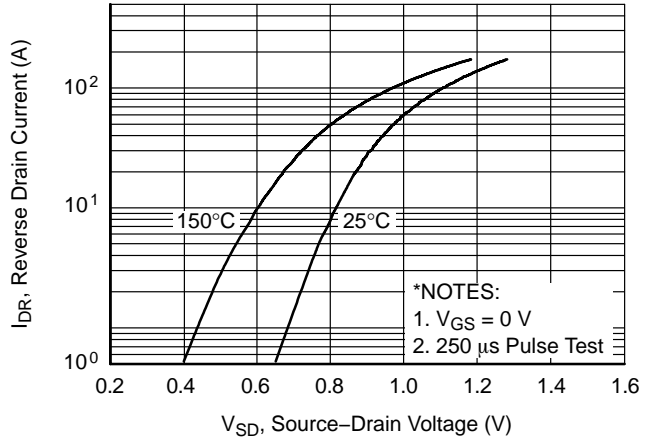


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

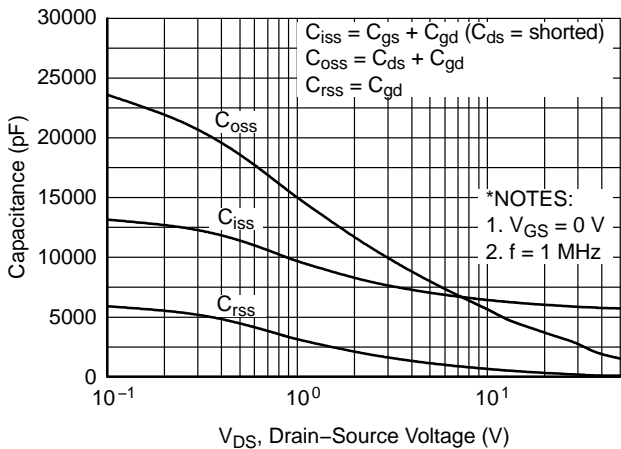


Figure 5. Capacitance Characteristics

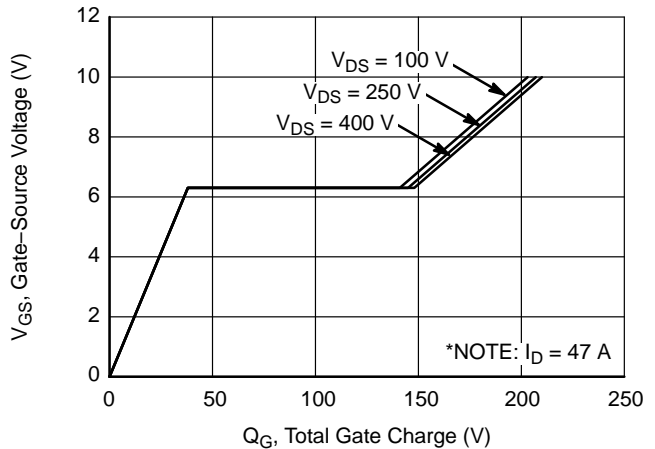
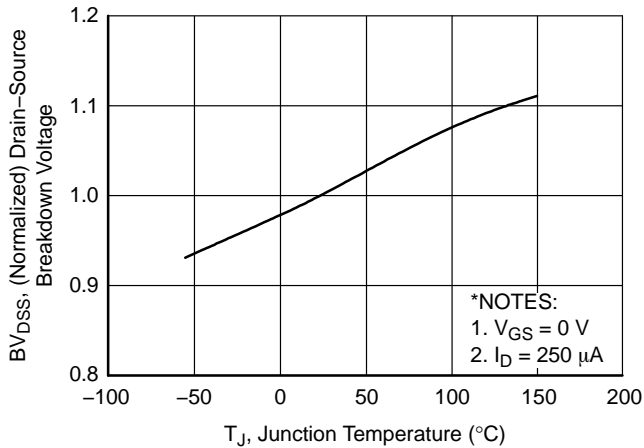


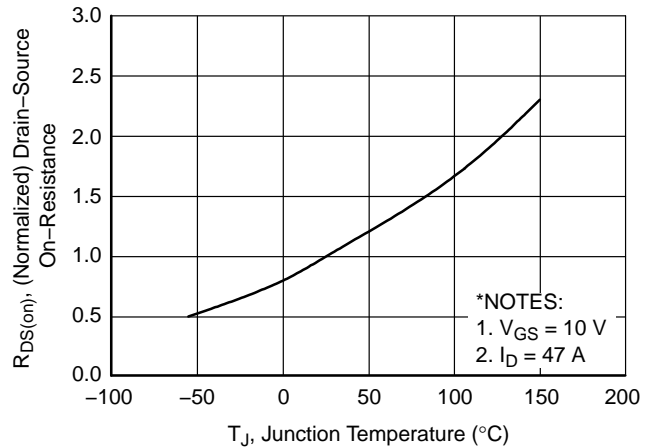
Figure 6. Gate Charge Characteristics

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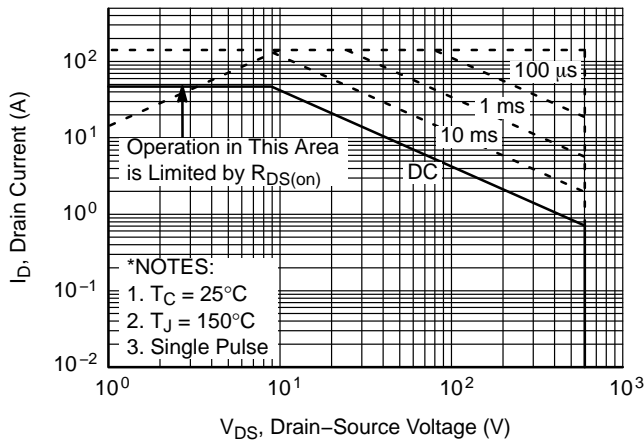
## TYPICAL CHARACTERISTICS (CONTINUED)



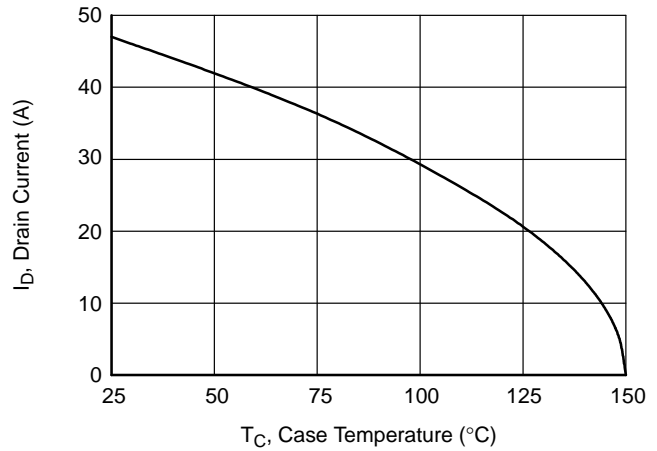
**Figure 7. Breakdown Voltage Variation vs. Temperature**



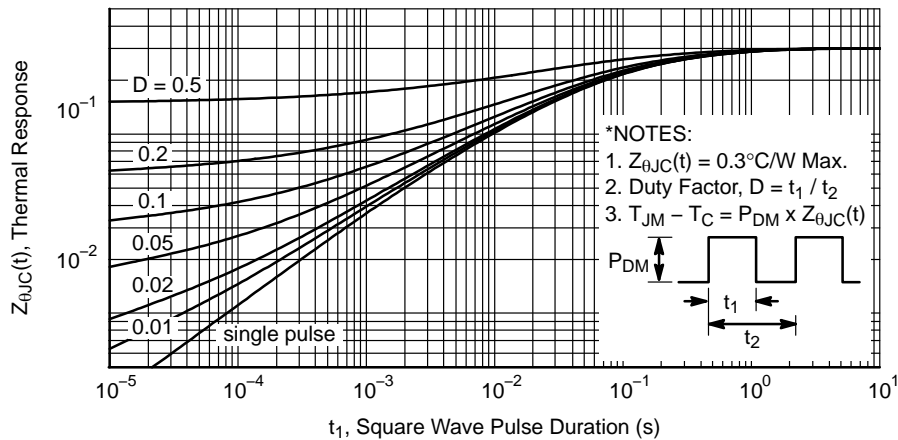
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Safe Operating Area**



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



**Figure 11. Transient Thermal Response Curve**

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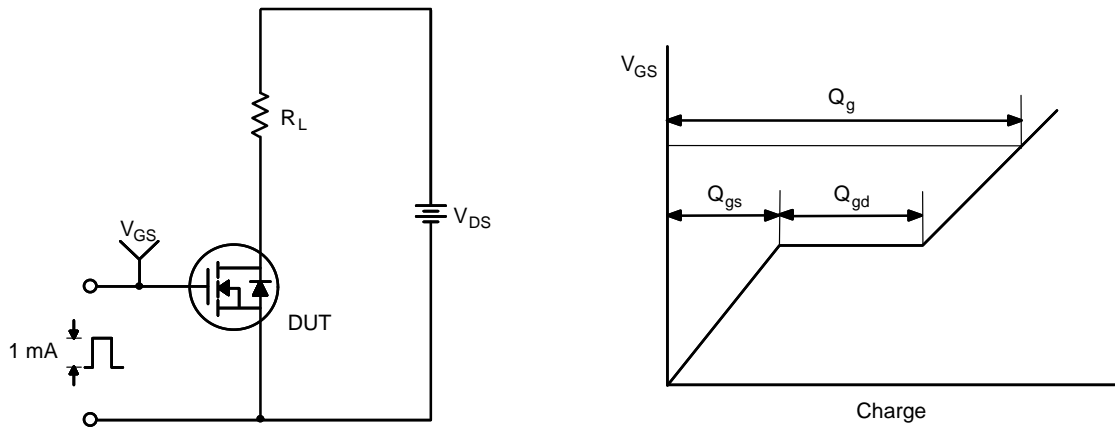


Figure 12. Gate Charge Test Circuit & Waveform

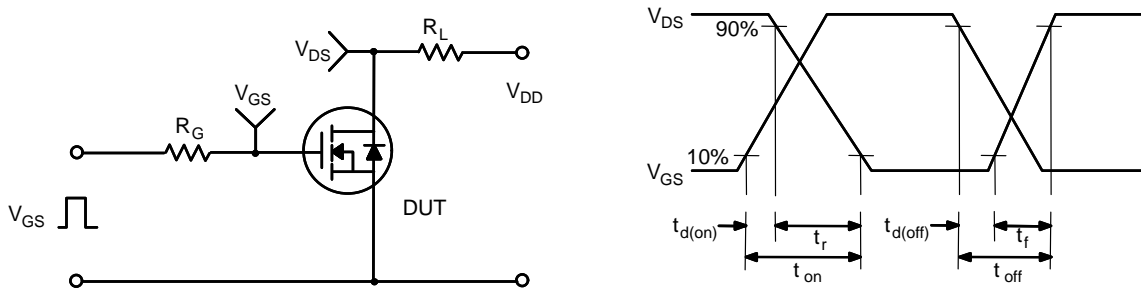


Figure 13. Resistive Switching Test Circuit & Waveforms

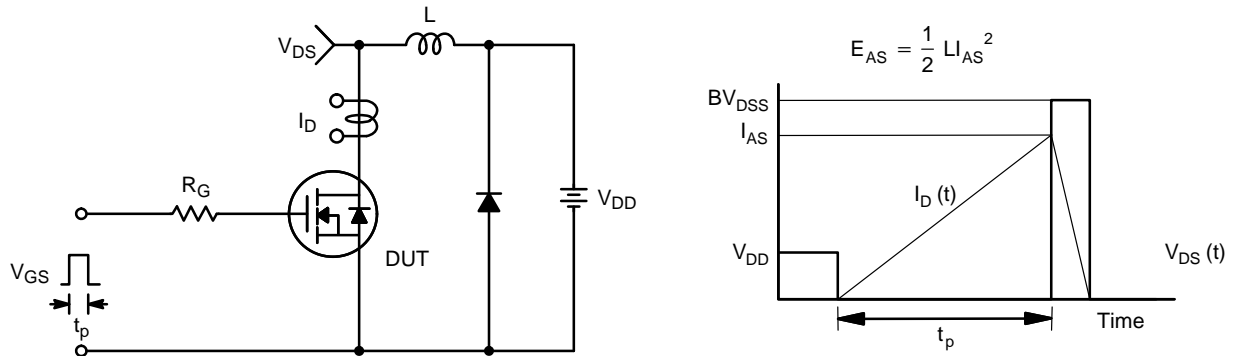
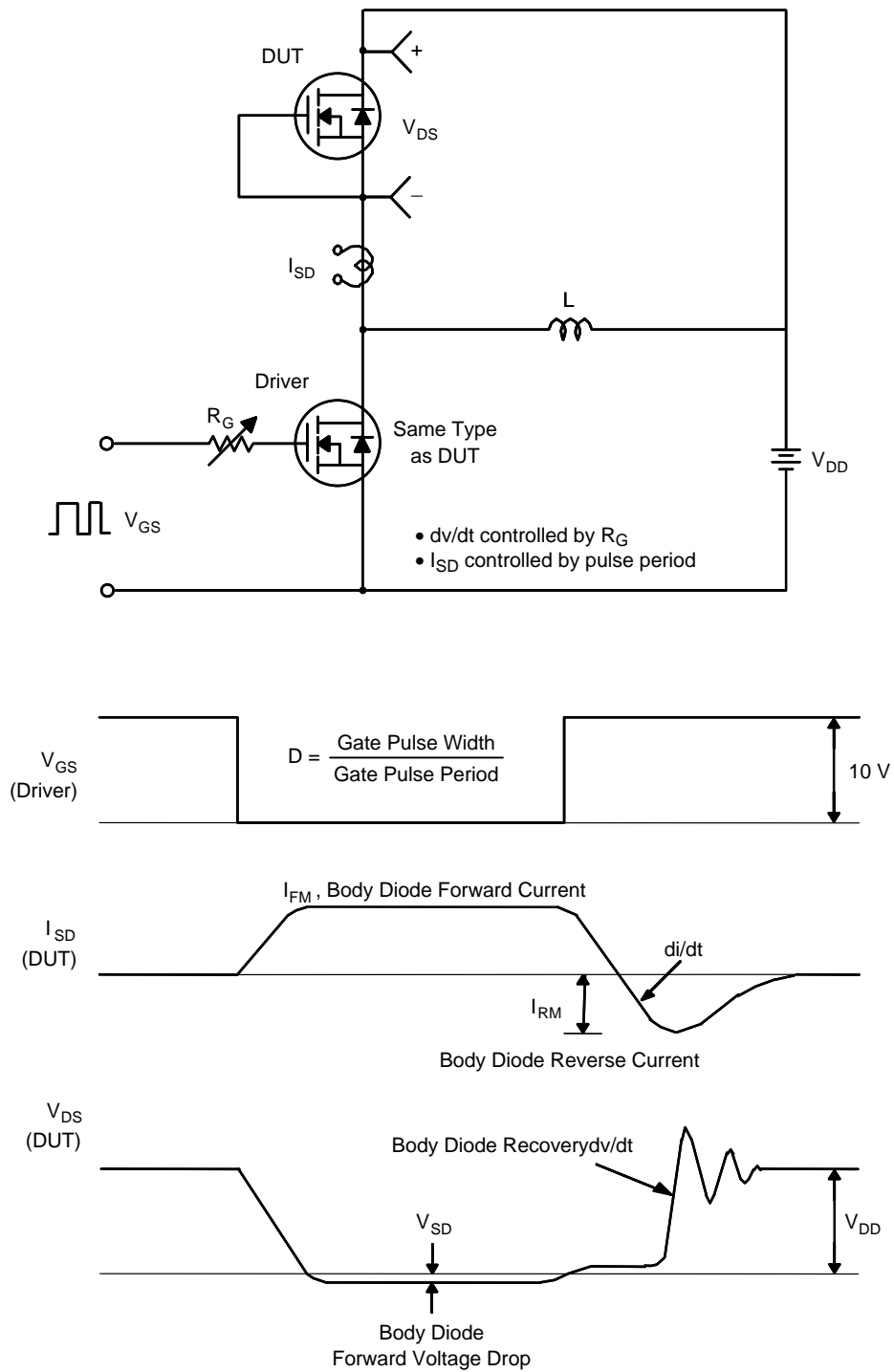


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

$$E_{AS} = \frac{1}{2} L I_{AS}^2$$

# FCA47N60, FCA47N60-F109



**Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

# MECHANICAL CASE OUTLINE

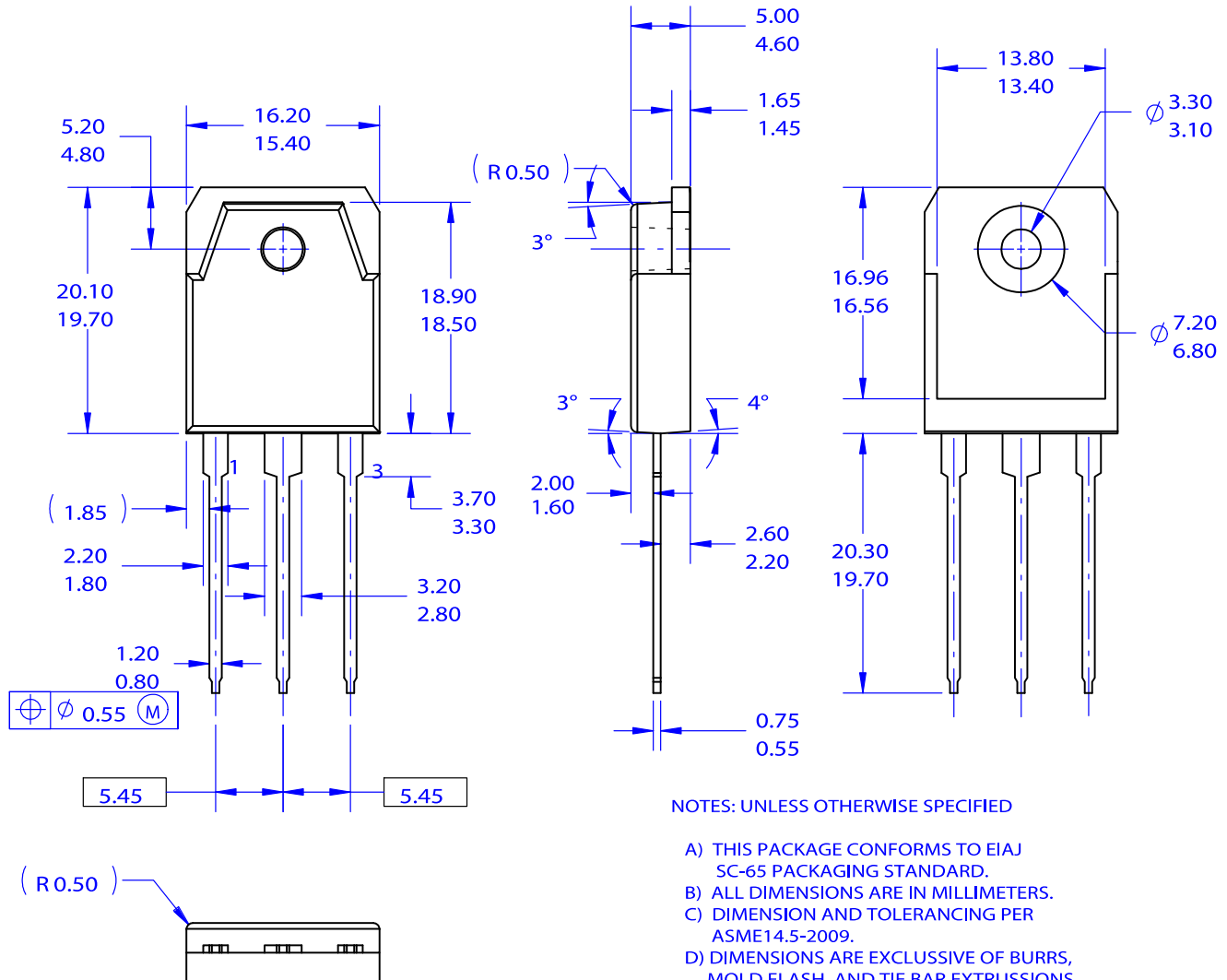
## PACKAGE DIMENSIONS

ON Semiconductor®



### TO-3P-3LD / EIAJ SC-65, ISOLATED CASE 340BZ ISSUE O

DATE 31 OCT 2016



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