

# MOSFET – N-Channel, SUPERFET<sup>®</sup>, FRFET<sup>®</sup>

**600 V, 20 A, 190 mΩ**

## FCA20N60F

### 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. SUPERFET FRFET MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.

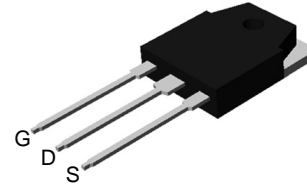
### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 150\text{ m}\Omega$
- Fast Recovery Time (Typ.  $T_{rr} = 160\text{ ns}$ )
- Ultra Low Gate Charge (Typ.  $Q_g = 75\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 165\text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

### Applications

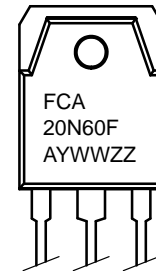
- LCD / LED / PDP TV
- Solar Inverter
- AC-DC Power Supply

$V_{DSS}$	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
600 V	190 mΩ @ 10 V	20 A



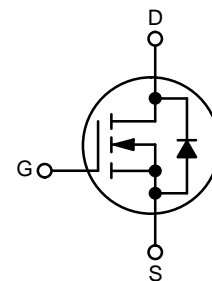
TO-3P-3LD / EIAJ SC-65, ISOLATED  
 CASE 340BZ

### MARKING DIAGRAM



FCA20N60F = Specific Device Code  
 A = Assembly Location  
 YWW = Date Code (Year & Week)  
 ZZ = Assembly Lot

### N-CHANNEL MOSFET



### ORDERING INFORMATION

Part Number	Package	Shipping
FCA20N60F	TO-3P-3LD (Pb-Free)	450 Units / Tube

# FCA20N60F

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C, unless otherwise noted)

Symbol	Parameter	FCA20N60F	Unit
V <sub>DSS</sub>	Drain–Source Voltage	600	V
I <sub>D</sub>	Drain Current	– Continuous (T <sub>C</sub> = 25°C)	20
		– Continuous (T <sub>C</sub> = 100°C)	12.5
I <sub>DM</sub>	Drain Current	– Pulsed (Note 1)	60
V <sub>GSS</sub>	Gate–Source Voltage	±30	V
E <sub>AS</sub>	Single Pulsed Avalanche Energy (Note 2)	690	mJ
I <sub>AR</sub>	Avalanche Current (Note 1)	20	A
E <sub>AR</sub>	Repetitive Avalanche Energy (Note 1)	20.8	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	50	V/ns
P <sub>D</sub>	Power Dissipation	(T <sub>C</sub> = 25°C)	208
		– Derate above 25°C	1.67
T <sub>J</sub> , T <sub>STG</sub>	Operating and Storage Temperature Range	–55 to +150	°C
T <sub>L</sub>	Maximum Lead Temperature for Soldering, 1/8" from Case for 5 Seconds	300	°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<sub>AS</sub> = 10 A, V<sub>DD</sub> = 50 V, R<sub>G</sub> = 25 Ω, starting T<sub>J</sub> = 25°C.
3. I<sub>SD</sub> ≤ 20 A, di/dt ≤ 1200 A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, starting T<sub>J</sub> = 25°C.

## THERMAL CHARACTERISTICS

Symbol	Parameter	FCA20N60F	Unit
R <sub>θJC</sub>	Thermal Resistance, Junction–to–Case, Max.	0.6	°C/W
R <sub>θJA</sub>	Thermal Resistance, Junction–to–Ambient, Max.	40	°C/W

# FCA20N60F

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

Symbol	Parameter	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	–	
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	I <sub>D</sub> = 250 μA, Referenced to 25°C	–	0.6	–	V/°C
BV <sub>DSS</sub>	Drain–Source Avalanche Breakdown Voltage	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 20 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> = 10 A	–	0.15	0.19	Ω
g <sub>FS</sub>	Forward Transconductance	V <sub>DS</sub> = 40 V, I <sub>D</sub> = 10 A	–	17	–	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	–	2370	3080	pF
C <sub>oss</sub>	Output Capacitance		–	1280	1665	pF
C <sub>rss</sub>	Reverse Transfer Capacitance		–	95	–	pF
C <sub>oss</sub>	Output Capacitance	V <sub>DS</sub> = 480 V, V <sub>GS</sub> = 0 V, f = 1.0 MHz	–	65	85	pF
C <sub>oss eff.</sub>	Effective Output Capacitance	V <sub>DS</sub> = 0 to 400 V, V <sub>GS</sub> = 0 V	–	165	–	pF

## SWITCHING CHARACTERISTICS

t <sub>d(on)</sub>	Turn–On Delay Time	V <sub>DD</sub> = 300 V, I <sub>D</sub> = 20 A, R <sub>G</sub> = 25 Ω (Note 4)	–	62	135	ns
t <sub>r</sub>	Turn–On Rise Time		–	140	290	ns
t <sub>d(off)</sub>	Turn–Off Delay Time		–	230	470	ns
t <sub>f</sub>	Turn–Off Fall Time		–	65	140	ns
Q <sub>g</sub>	Total Gate Charge	V <sub>DS</sub> = 480 V, I <sub>D</sub> = 20 A, V <sub>GS</sub> = 10 V (Note 4)	–	75	98	nC
Q <sub>gs</sub>	Gate–Source Charge		–	13.5	18	nC
Q <sub>gd</sub>	Gate–Drain Charge		–	36	–	nC

## DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

I <sub>S</sub>	Maximum Continuous Drain–Source Diode Forward Current	–	–	20	A	
I <sub>SM</sub>	Maximum Pulsed Drain–Source Diode Forward Current	–	–	60	A	
V <sub>SD</sub>	Drain–Source Diode Forward Voltage	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A	–	–	1.4	V
t <sub>rr</sub>	Reverse Recovery Time	V <sub>GS</sub> = 0 V, I <sub>S</sub> = 20 A, dI <sub>F</sub> /dt = 100 A/μs	–	160	–	ns
Q <sub>rr</sub>	Reverse Recovery Charge		–	1.1	–	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 PERFORMANCE CHARACTERISTICS

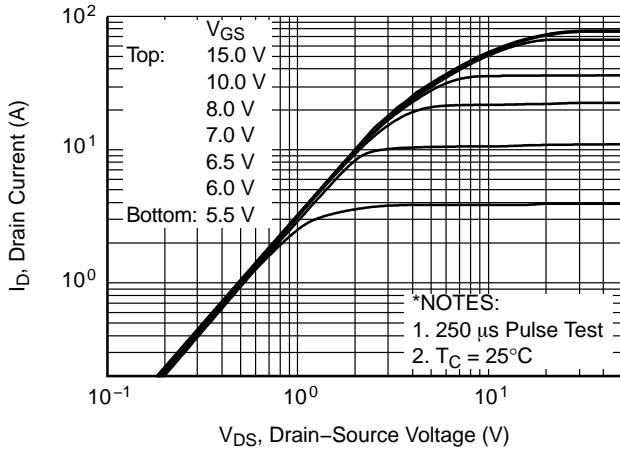


Figure 1. On-Region Characteristics

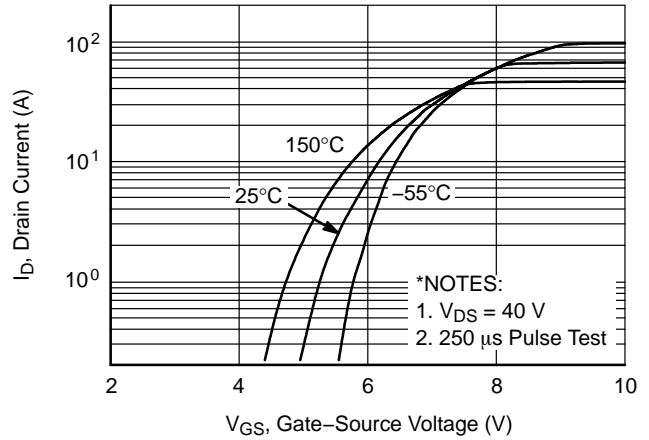


Figure 2. Transfer Characteristics

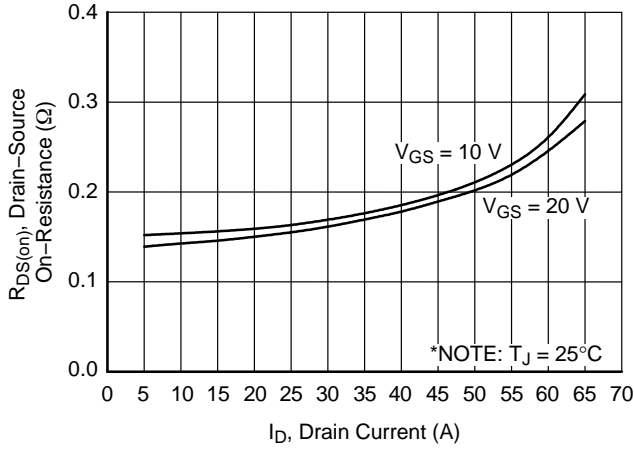


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

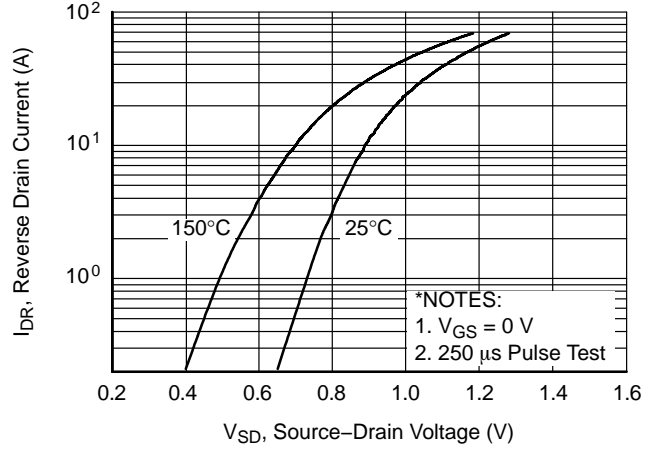


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

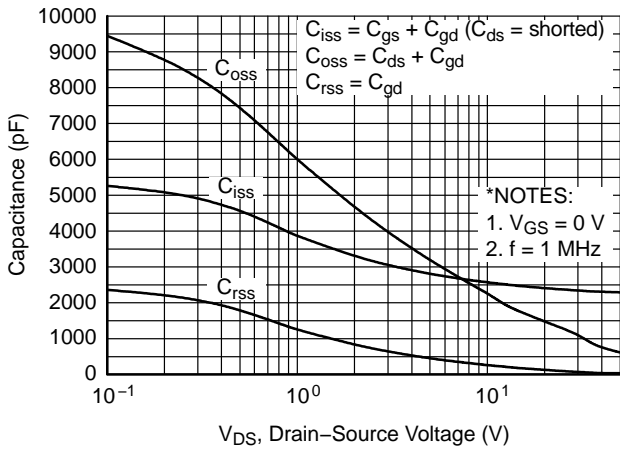


Figure 5. Capacitance Characteristics

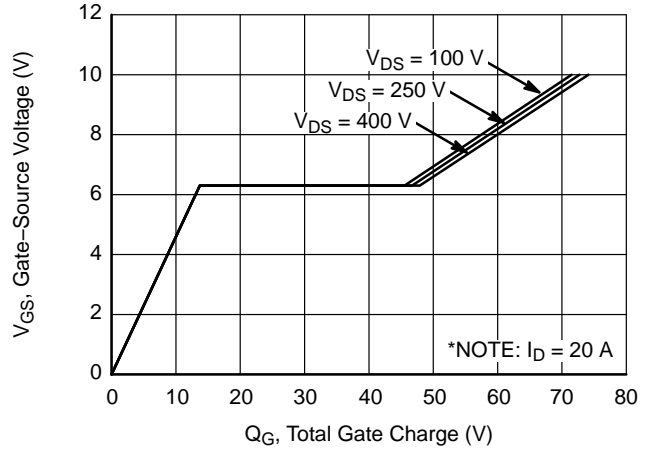
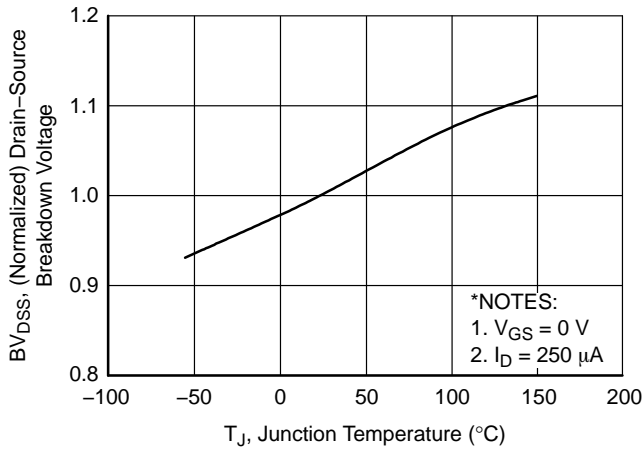


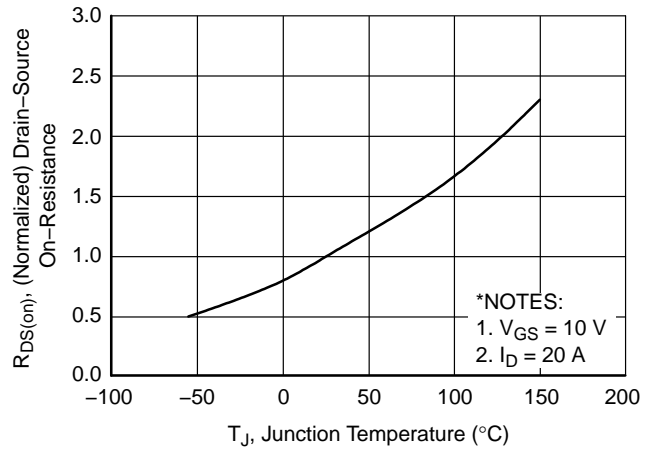
Figure 6. Gate Charge Characteristics

# FCA20N60F

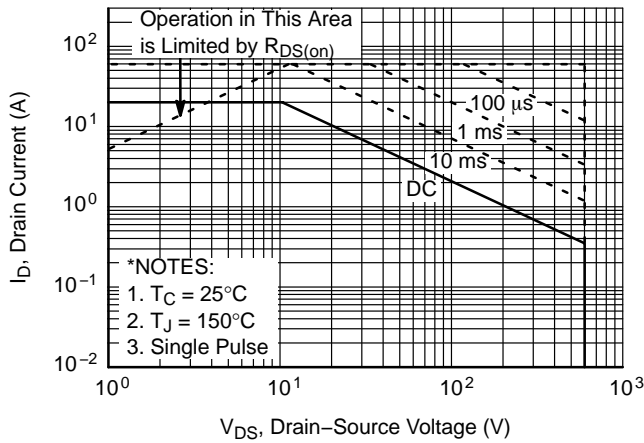
## TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)



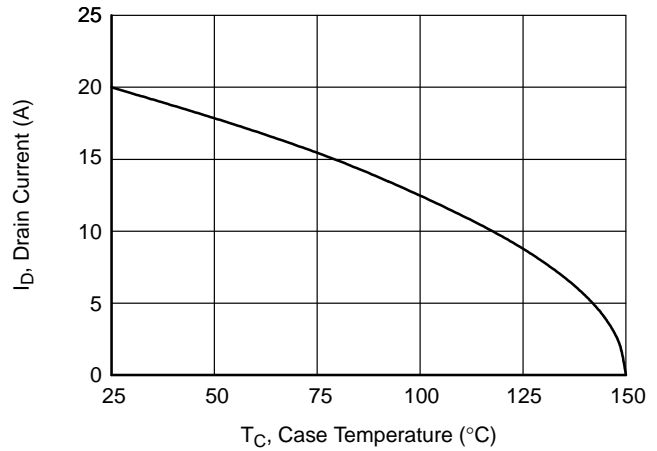
**Figure 7. Breakdown Voltage Variation vs. Temperature**



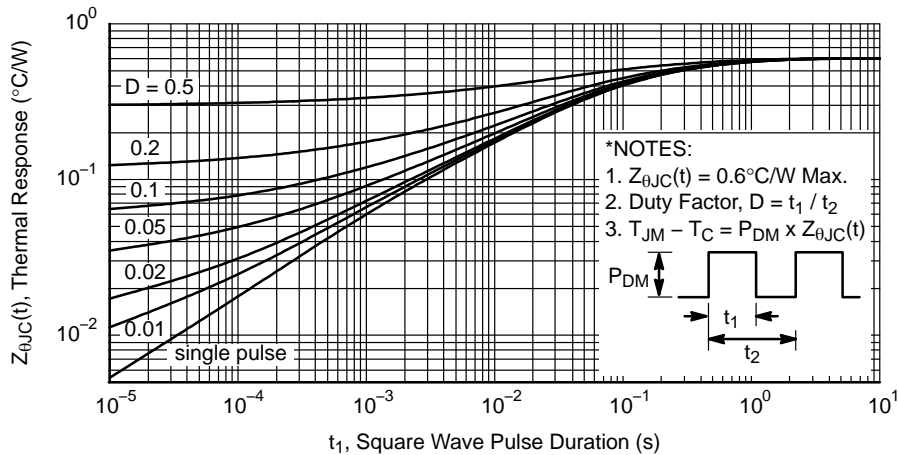
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**



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



**Figure 11. Transient Thermal Response Curve**

# FCA20N60F

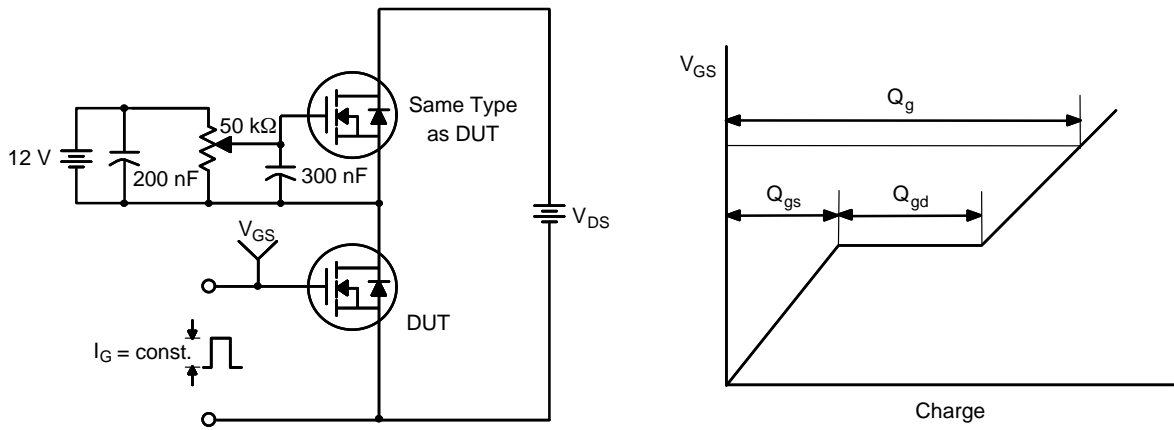


Figure 12. Gate Charge Test Circuit & Waveform

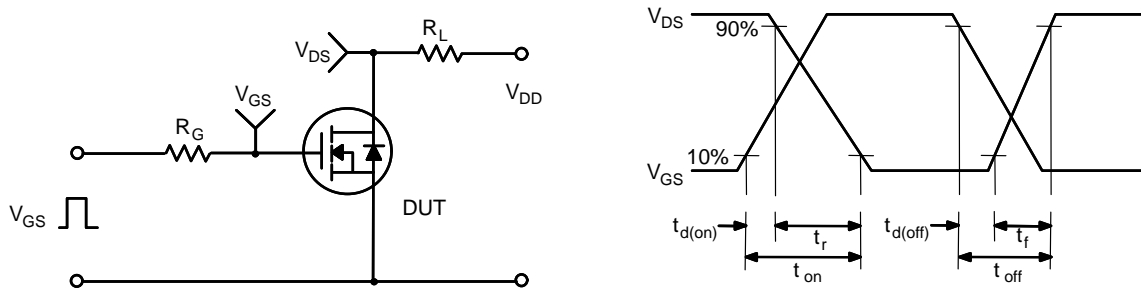


Figure 13. Resistive Switching Test Circuit & Waveforms

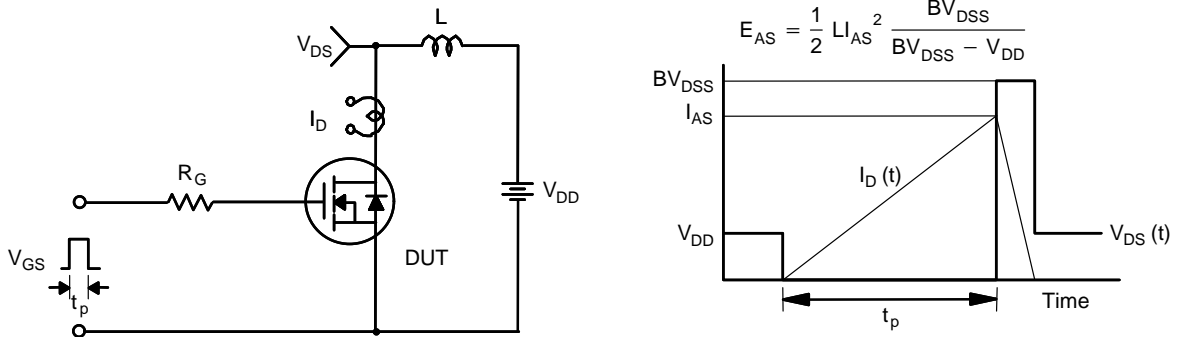
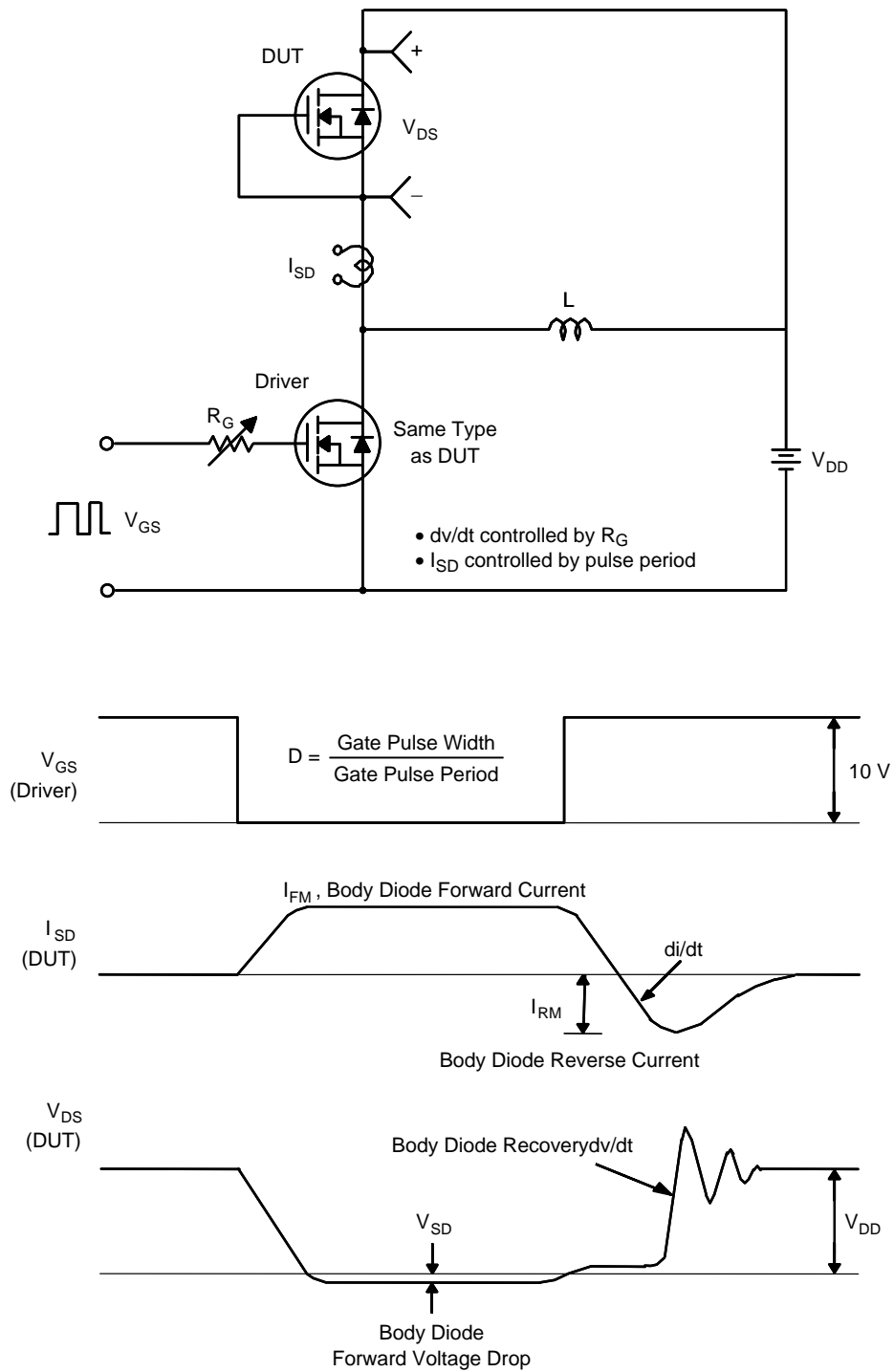


Figure 14. Unclamped Inductive Switching Test Circuit & Waveforms

$$E_{AS} = \frac{1}{2} L I_{AS}^2 \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

# FCA20N60F



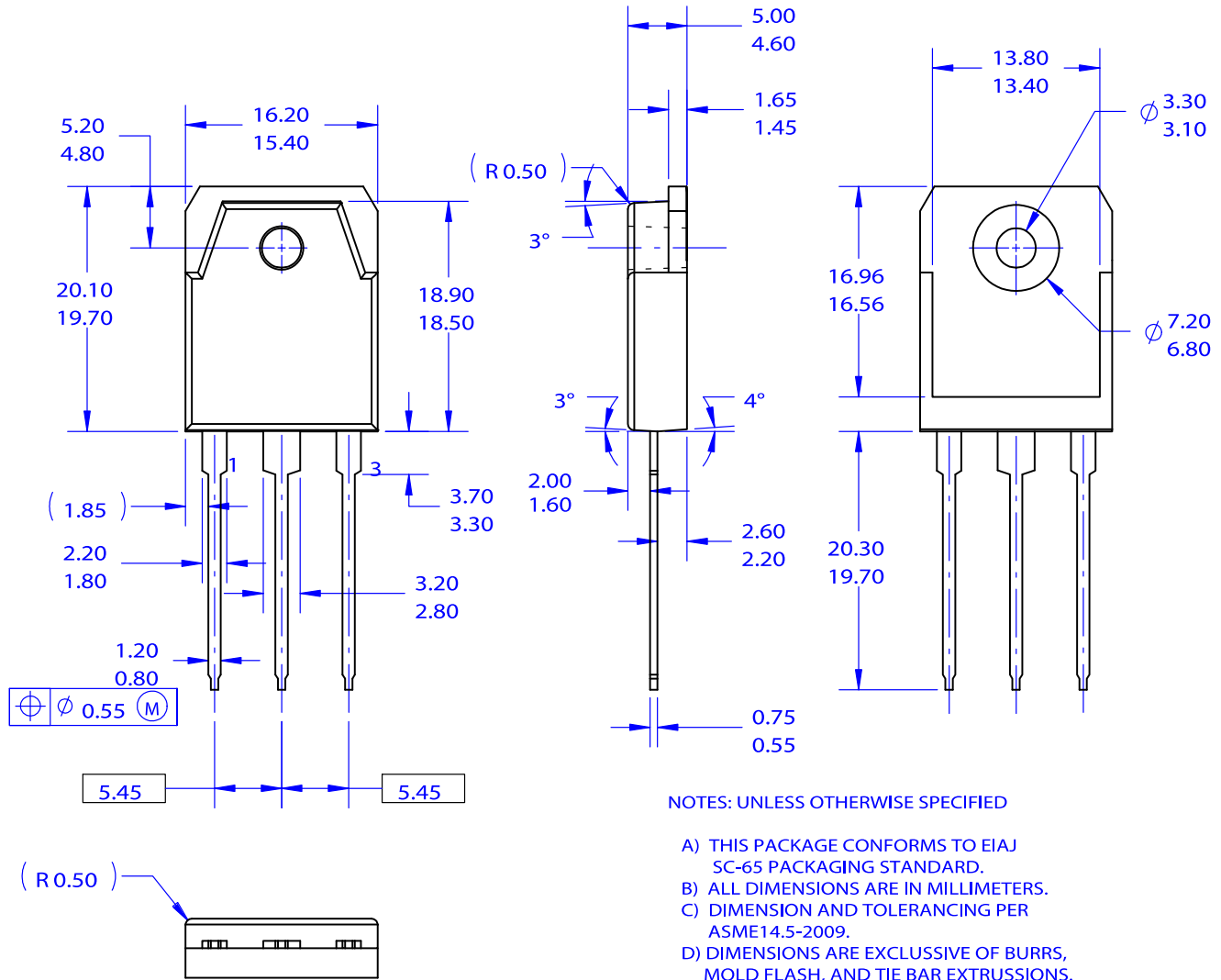
**Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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


DATE 31 OCT 2016



NOTES: UNLESS OTHERWISE SPECIFIED

- A) THIS PACKAGE CONFORMS TO EIAJ SC-65 PACKAGING STANDARD.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSION AND TOLERANCING PER ASME14.5-2009.
- D) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.

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