

FCP16N60 Datasheet

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DiGi Electronics Part Number	FCP16N60-DG
Manufacturer	onsemi
Manufacturer Product Number	FCP16N60
Description	MOSFET N-CH 600V 16A TO220-3
Detailed Description	N-Channel 600 V 16A (Tc) 167W (Tc) Through Hole TO-220-3



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DiGi is a global authorized distributor of electronic components.

Purchase and inquiry

Manufacturer Product Number:

FCP16N60

Series:

SuperFET™

FET Type:

N-Channel

Drain to Source Voltage (Vdss):

600 V

Drive Voltage (Max Rds On, Min Rds On):

10V

Vgs(th) (Max) @ Id:

5V @ 250µA

Vgs (Max):

±30V

FET Feature:

-

Operating Temperature:

-55°C ~ 150°C (Tj)

Supplier Device Package:

TO-220-3

Base Product Number:

FCP16

Manufacturer:

onsemi

Product Status:

Not For New Designs

Technology:

MOSFET (Metal Oxide)

Current - Continuous Drain (Id) @ 25°C:

16A (Tc)

Rds On (Max) @ Id, Vgs:

260mOhm @ 8A, 10V

Gate Charge (Qg) (Max) @ Vgs:

70 nC @ 10 V

Input Capacitance (Ciss) (Max) @ Vds:

2250 pF @ 25 V

Power Dissipation (Max):

167W (Tc)

Mounting Type:

Through Hole

Package / Case:

TO-220-3

Environmental & Export classification

RoHS Status:

ROHS3 Compliant

REACH Status:

REACH Unaffected

HTSUS:

8541.29.0095

Moisture Sensitivity Level (MSL):

Not Applicable

ECCN:

EAR99

MOSFET – N-Channel, SUPERFET®

600 V, 16 A, 260 mΩ

FCP16N60, FCPF16N60

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

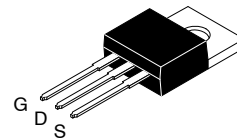
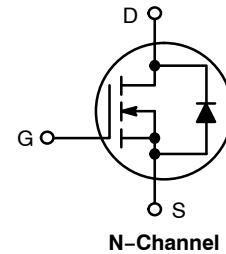
- 650 V @ $T_J = 150^\circ\text{C}$
- $R_{DS(on)} = 220\text{ m}\Omega$ (Typ.)
- Ultra Low Gate Charge (Typ. $Q_g = 55\text{ nC}$)
- Low Effective Output Capacitance (Typ. $C_{oss(eff.)} = 110\text{ pF}$)
- 100% Avalanche Tested
- These are Pb-Free Devices

Applications

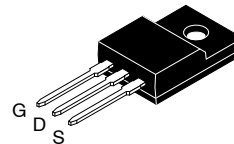
- Solar Inverter
- AC-DC Power Supply

V_{DS}	$R_{DS(on)}\text{ MAX}$	$I_D\text{ MAX}$
600 V	260 mΩ @ 10 V	16 A*

*Drain current limited by maximum junction temperature.

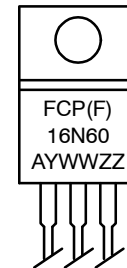


**TO-220-3LD
CASE 340AT**



**TO-220 Fullpack, 3-Lead
/ TO-220F-3SG
CASE 221AT**

MARKING DIAGRAM



FCP(F)16N60	= Specific Device Code
A	= Assembly Location
YWW	= Date Code (Year & Week)
ZZ	= Assembly Lot

ORDERING INFORMATION

Device	Package	Shipping
FCP16N60	TO-220-3	1000 Units / Tube
FCPF16N60	TO-220-3 FullPak	1000 Units / Tube

FCP16N60, FCPF16N60**MOSFET MAXIMUM RATINGS** ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter		FCP16N60	FCPF16N60	Unit
V_{DSS}	Drain-Source Voltage		600		V
I_D	Drain Current	- Continuous ($T_C = 25^\circ\text{C}$)	16	16*	A
		- Continuous ($T_C = 100^\circ\text{C}$)	10.1	10.1*	
I_{DM}	Drain Current	- Pulsed (Note 1)	48	48*	A
V_{GSS}	Gate-Source Voltage		± 30		V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)		450		mJ
I_{AR}	Avalanche Current (Note 1)		16		A
E_{AR}	Repetitive Avalanche Energy (Note 1)		20.8		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)		4.5		V/ns
P_D	Power Dissipation	($T_C = 25^\circ\text{C}$)	167	37.9	W
		- Derate Above 25°C	1.33	0.3	
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		$^\circ\text{C}$

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.

*Drain current limited by maximum junction temperature.

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2. $I_{AS} = 8\text{ A}$, $V_{DD} = 50\text{ V}$, $R_G = 25\ \Omega$, starting $T_J = 25^\circ\text{C}$.
3. $I_{SD} \leq 16\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} \leq BV_{DSS}$, starting $T_J = 25^\circ\text{C}$.

THERMAL CHARACTERISTICS

Symbol	Parameter	FCP16N60	FCPF16N60	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	0.75	3.3	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62.5	62.5	

FCP16N60, FCPF16N60**ELECTRICAL CHARACTERISTICS** ($T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
BV_{DSS}	Drain to Source Breakdown Voltage	$I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}, T_J = 25^\circ\text{C}$	600	–	–	V
		$I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}, T_J = 150^\circ\text{C}$	–	650	–	V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}$, Referenced to 25°C	–	0.6	–	$\text{V}/^\circ\text{C}$
BV_{DS}	Drain–Source Avalanche Breakdown Voltage	$V_{GS} = 0 \text{ V}, I_D = 16 \text{ A}$	–	700	–	V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 600 \text{ V}, V_{GS} = 0 \text{ V}$	–	–	1	μA
		$V_{DS} = 480 \text{ V}, T_C = 125^\circ\text{C}$	–	–	10	
I_{GSS}	Gate to Body Leakage Current	$V_{GS} = \pm 30 \text{ V}, V_{DS} = 0 \text{ V}$	–	–	± 100	nA

ON CHARACTERISTICS

$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}, I_D = 250 \mu\text{A}$	3.0	–	5.0	V
$R_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10 \text{ V}, I_D = 8 \text{ A}$	–	0.22	0.26	Ω
g_{FS}	Forward Transconductance	$V_{DS} = 40 \text{ V}, I_D = 8 \text{ A}$	–	11.5	–	S

DYNAMIC CHARACTERISTICS

C_{iss}	Input Capacitance	$V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	–	1730	2250	pF
C_{oss}	Output Capacitance		–	960	1150	pF
C_{rss}	Reverse Transfer Capacitance		–	85	–	pF
C_{oss}	Output Capacitance	$V_{DS} = 480 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	–	45	60	pF
$C_{oss(eff.)}$	Effective Output Capacitance	$V_{DS} = 0 \text{ V to } 400 \text{ V}, V_{GS} = 0 \text{ V}$	–	110	–	pF
Q_g	Total Gate Charge at 10 V	$V_{DS} = 480 \text{ V}, I_D = 16 \text{ A}, V_{GS} = 10 \text{ V}$ (Note 4)	–	55	70	nC
Q_{gs}	Gate to Source Gate Charge		–	10.5	13	nC
Q_{gd}	Gate to Drain “Miller” Charge		–	28	–	nC
ESR	Equivalent Series Resistance	$f = 1 \text{ MHz}$	–	1.7	–	Ω

SWITCHING CHARACTERISTICS

$t_{d(on)}$	Turn–On Delay Time	$V_{DD} = 300 \text{ V}, I_D = 16 \text{ A}, V_{GS} = 10 \text{ V},$ $R_G = 25 \Omega$ (Note 4)	–	42	85	ns
t_r	Turn–On Rise Time		–	130	270	ns
$t_{d(off)}$	Turn–Off Delay Time		–	165	340	ns
t_f	Turn–Off Fall Time		–	90	190	ns

DRAIN–SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

I_S	Maximum Continuous Drain to Source Diode Forward Current	–	–	16	A	
I_{SM}	Maximum Pulsed Drain to Source Diode Forward Current	–	–	48	A	
V_{SD}	Drain to Source Diode Forward Voltage	$V_{GS} = 0 \text{ V}, I_S = 16 \text{ A}$	–	–	1.4	V
t_{rr}	Reverse Recovery Time	$V_{GS} = 0 \text{ V}, I_{SD} = 16 \text{ A}, dI_F/dt = 100 \text{ A}/\mu\text{s}$	–	435	–	ns
Q_{rr}	Reverse Recovery Charge		–	7.0	–	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.

FCP16N60, FCPF16N60

TYPICAL PERFORMANCE CHARACTERISTICS

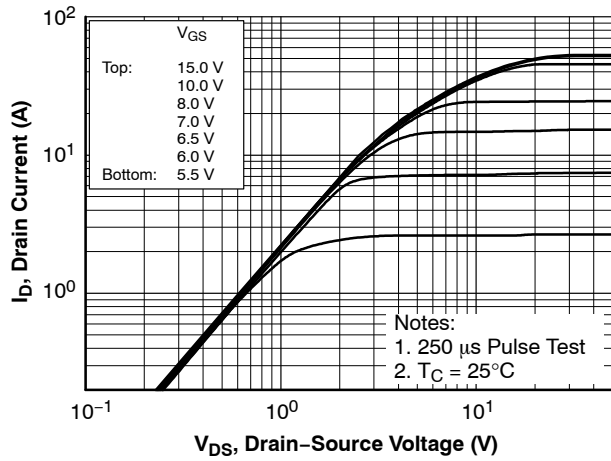


Figure 1. On-Region Characteristics

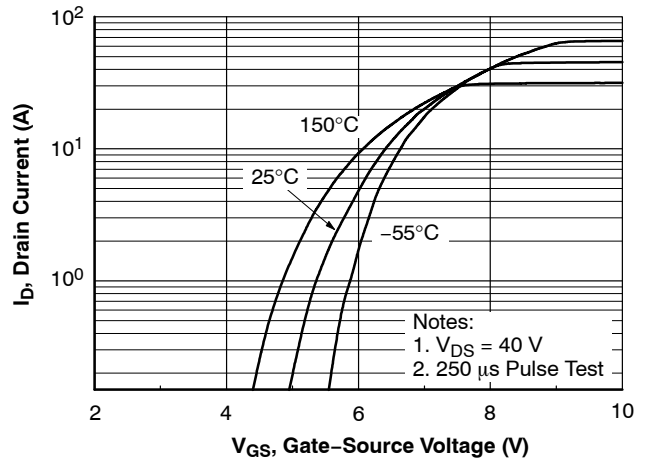


Figure 2. Transfer Characteristics

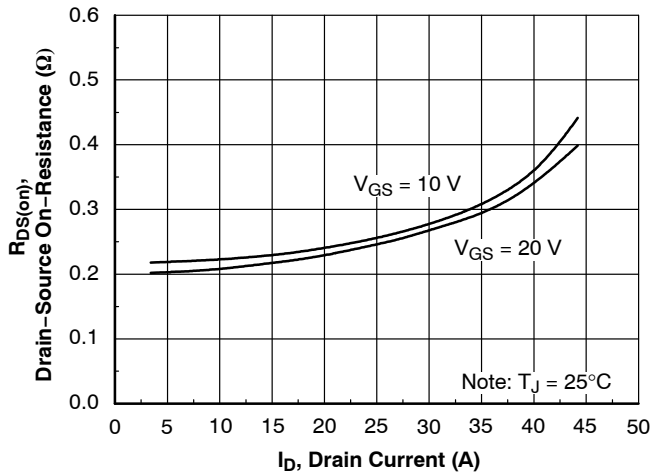


Figure 3. On-Resistance Variation vs. Drain Current and Gate voltage

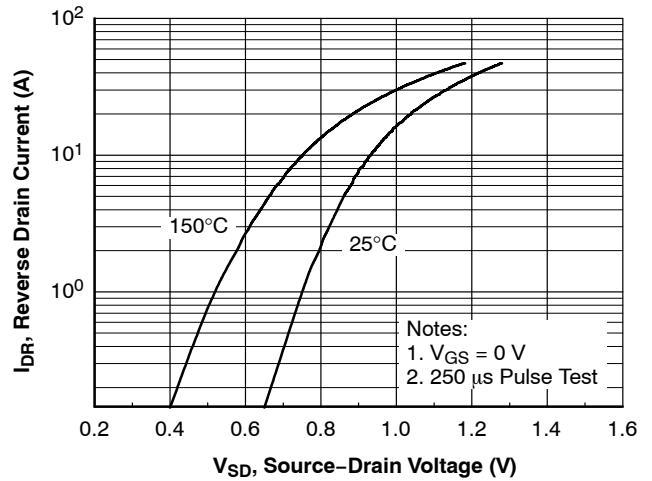


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

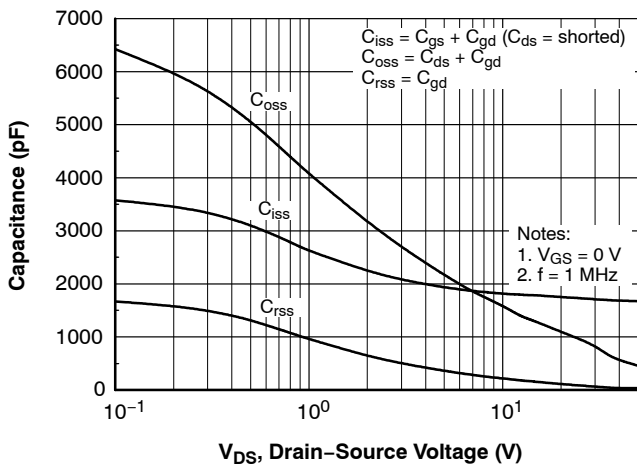


Figure 5. Capacitance Characteristics

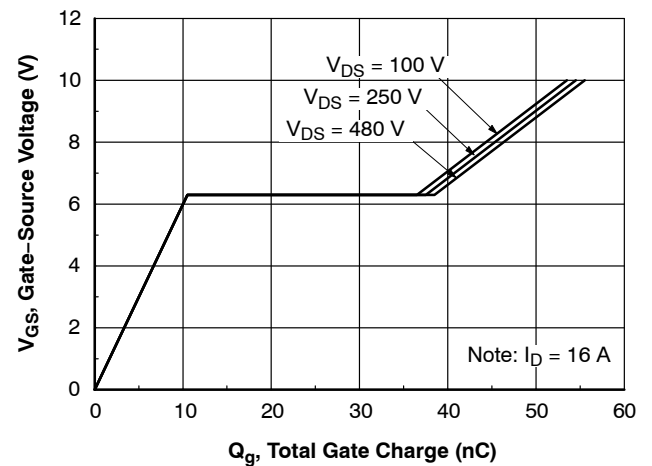


Figure 6. Gate Charge Characteristics

FCP16N60, FCPF16N60

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

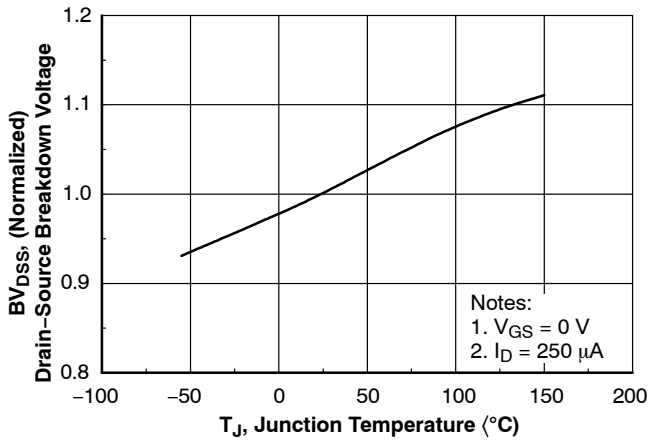


Figure 7. Breakdown Voltage Variation vs. Temperature

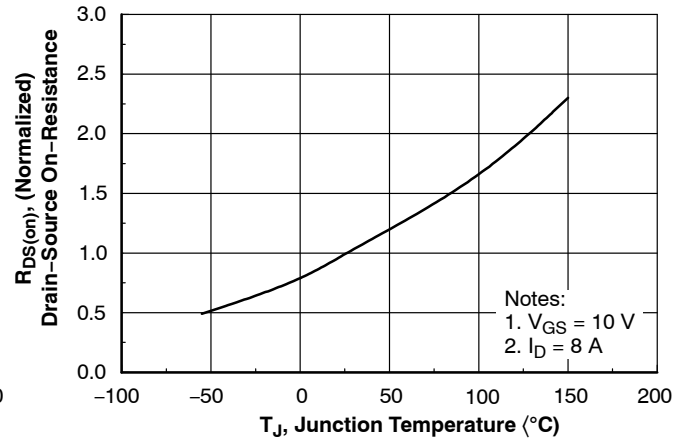


Figure 8. On-Resistance Variation vs. Temperature

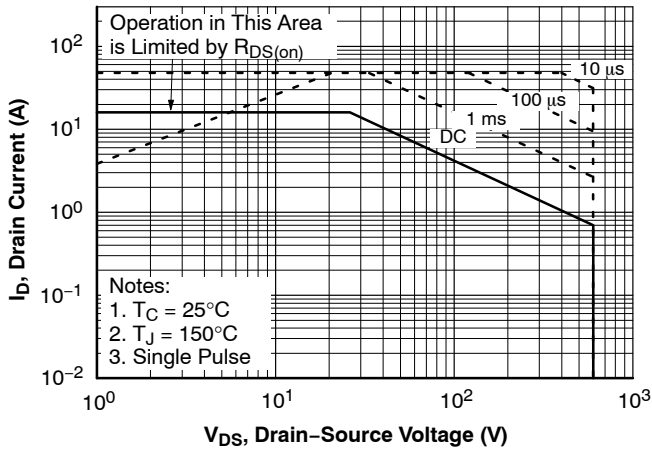


Figure 9. Maximum Safe Operating Area for FCP16N60

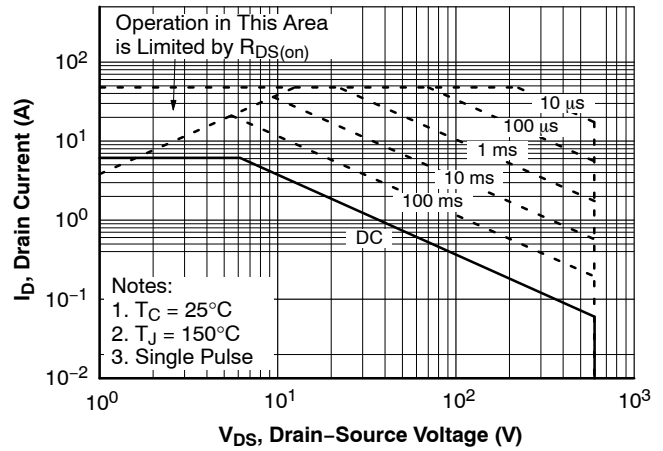


Figure 10. Maximum Safe Operating Area for FCPF16N60

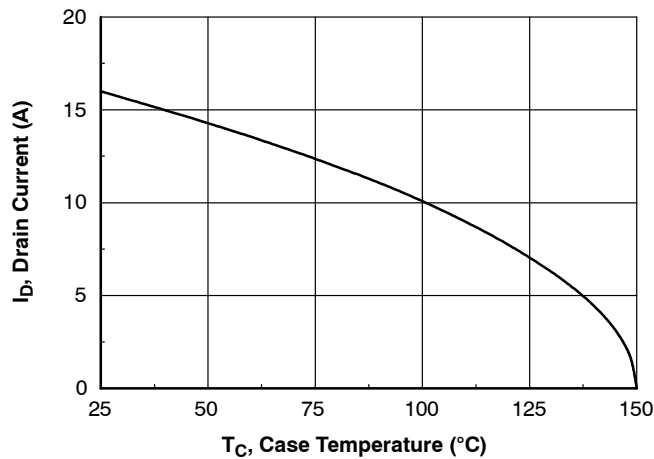


Figure 11. Maximum Drain Current vs. Case Temperature

+

FCP16N60, FCPF16N60

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

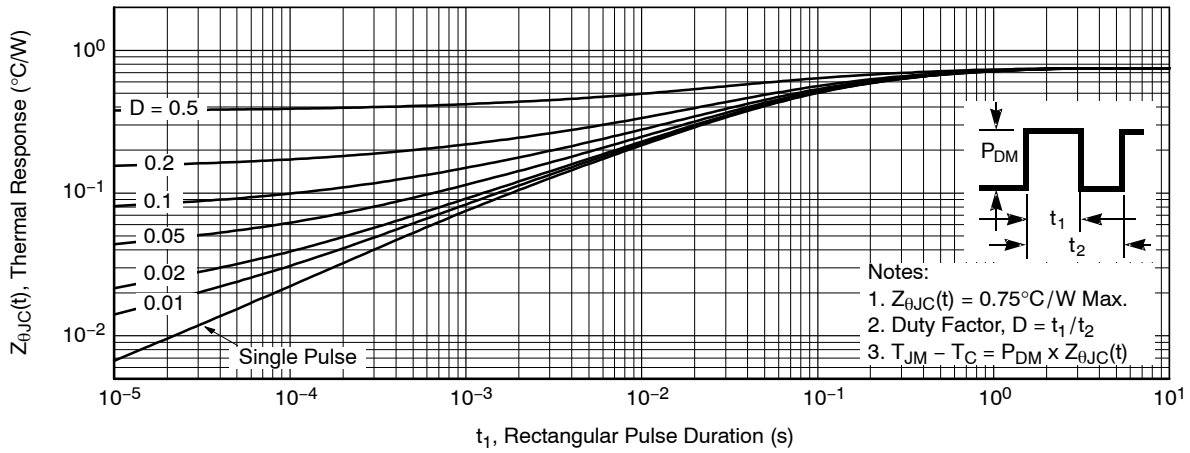


Figure 12. Transient Thermal Response Curve for FCP16N60

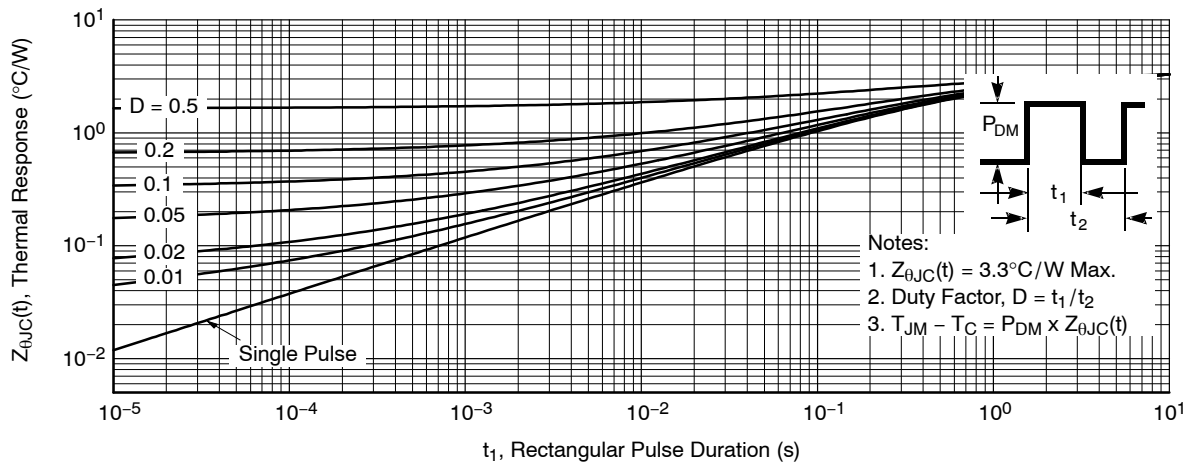


Figure 13. Transient Thermal Response Curve for FCPF16N60

FCP16N60, FCPF16N60

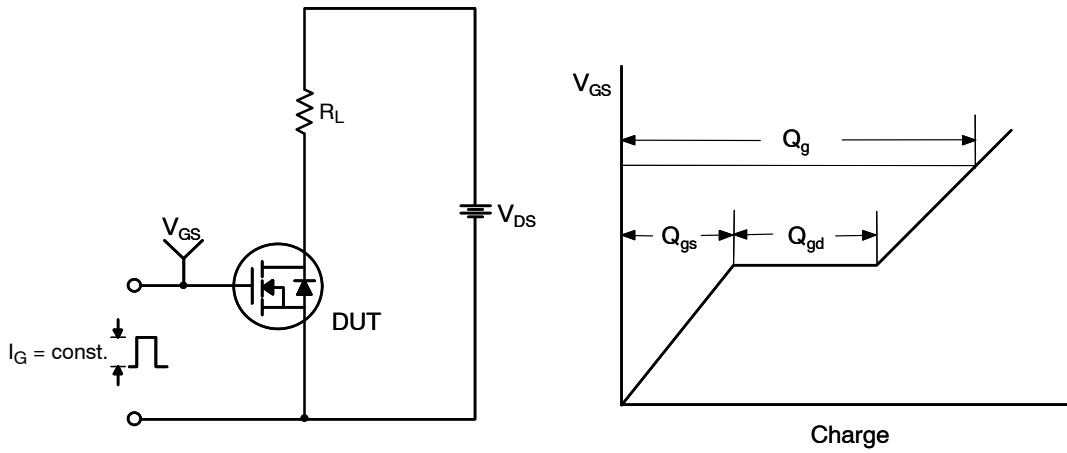


Figure 14. Gate Charge Test Circuit & Waveform

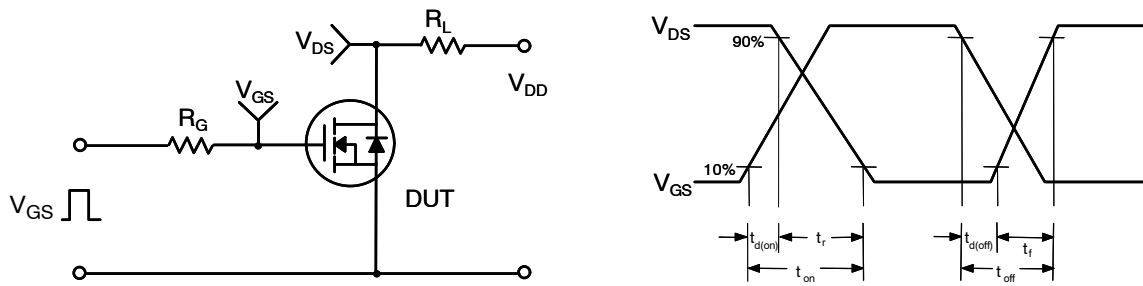


Figure 15. Resistive Switching Test Circuit & Waveforms

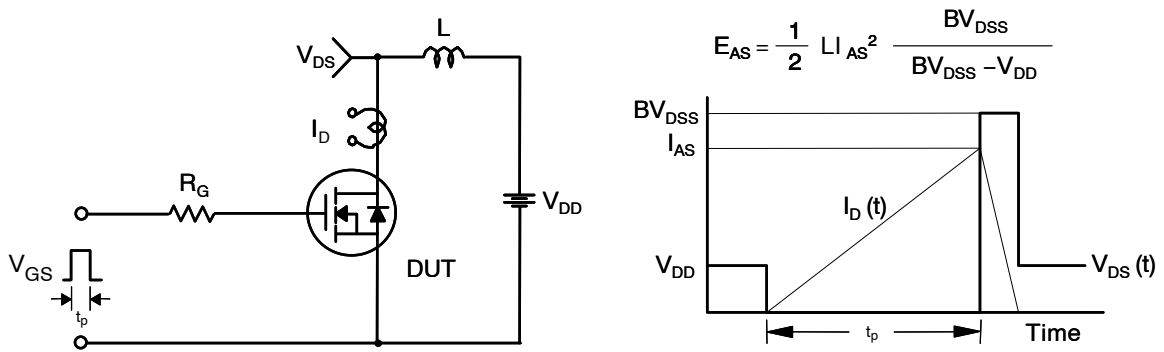


Figure 16. Unclamped Inductive Switching Test Circuit & Waveforms

FCP16N60, FCPF16N60

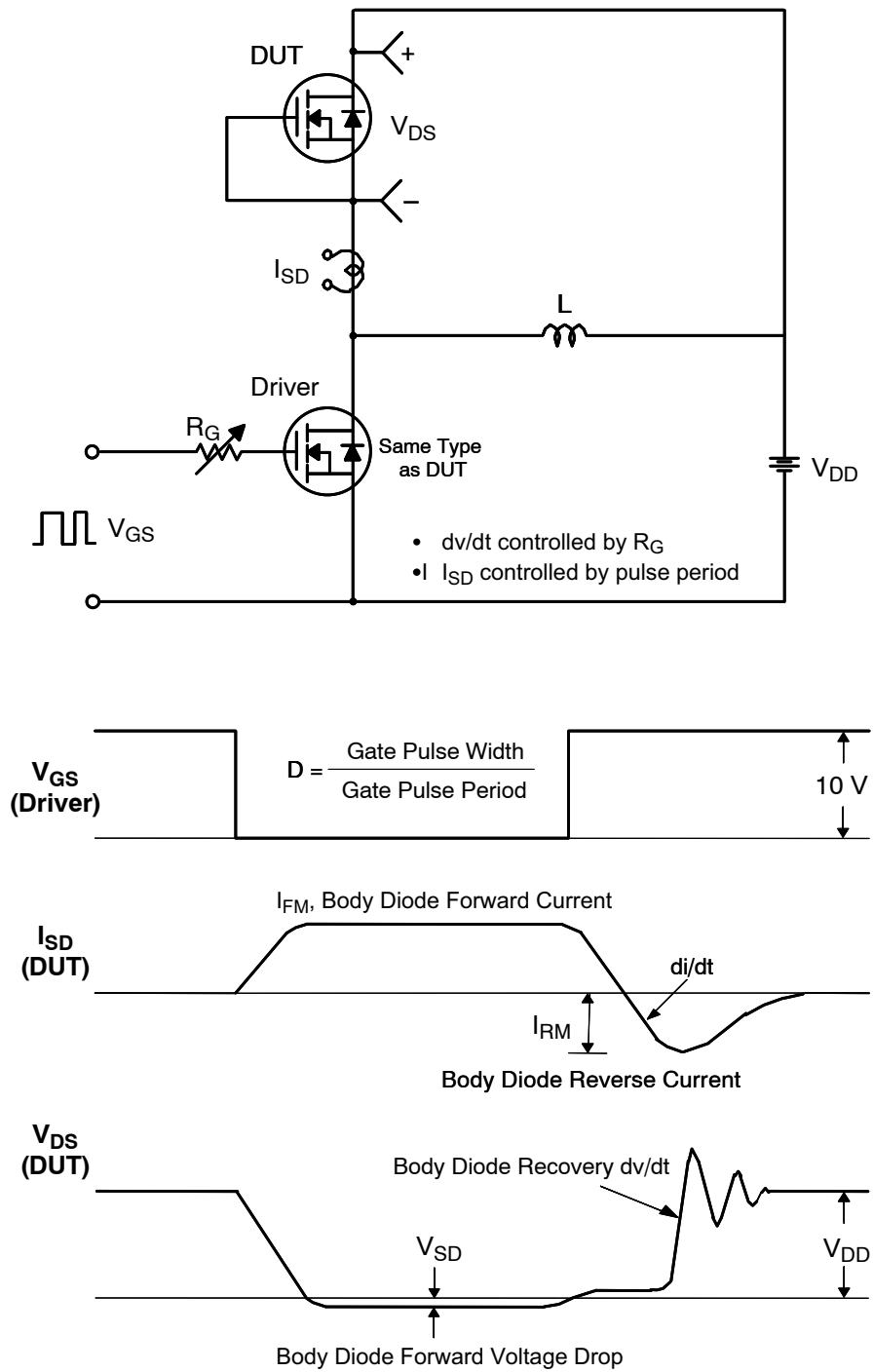


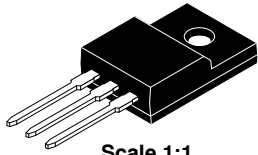
Figure 17. Peak Diode Recovery dv/dt Test Circuit & Waveforms



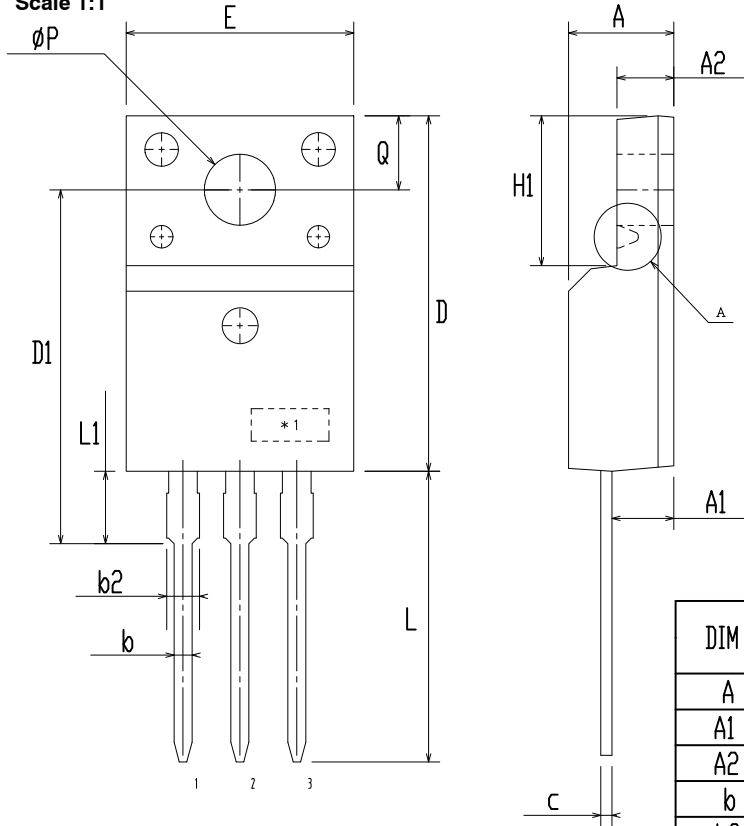
**MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS**

**TO-220 Fullpack, 3-Lead / TO-220F-3SG
CASE 221AT
ISSUE B**

DATE 19 JAN 2021



Scale 1:1



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.50	4.70	4.90
A1	2.56	2.76	2.96
A2	2.34	2.54	2.74
b	0.70	0.80	0.90
b2	~	~	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.60	15.80	16.00
E	9.96	10.16	10.36
e	2.34	2.54	2.74
F	~	0.84	~
H1	6.48	6.68	6.88
L	12.78	12.98	13.18
L1	3.03	3.23	3.43
∅ P	2.98	3.18	3.38
∅ P1	~	1.00	~
Q	3.20	3.30	3.40

NOTES:

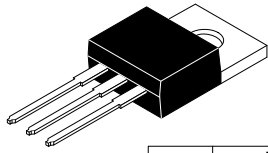
- A. DIMENSION AND TOLERANCE AS ASME Y14.5-2009
- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUCTIONS.
- C. OPTION 1 - WITH SUPPORT PIN HOLE
OPTION 2 - NO SUPPORT PIN HOLE

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DESCRIPTION:	TO-220 FULLPACK, 3-LEAD / TO-220F-3SG	PAGE 1 OF 1

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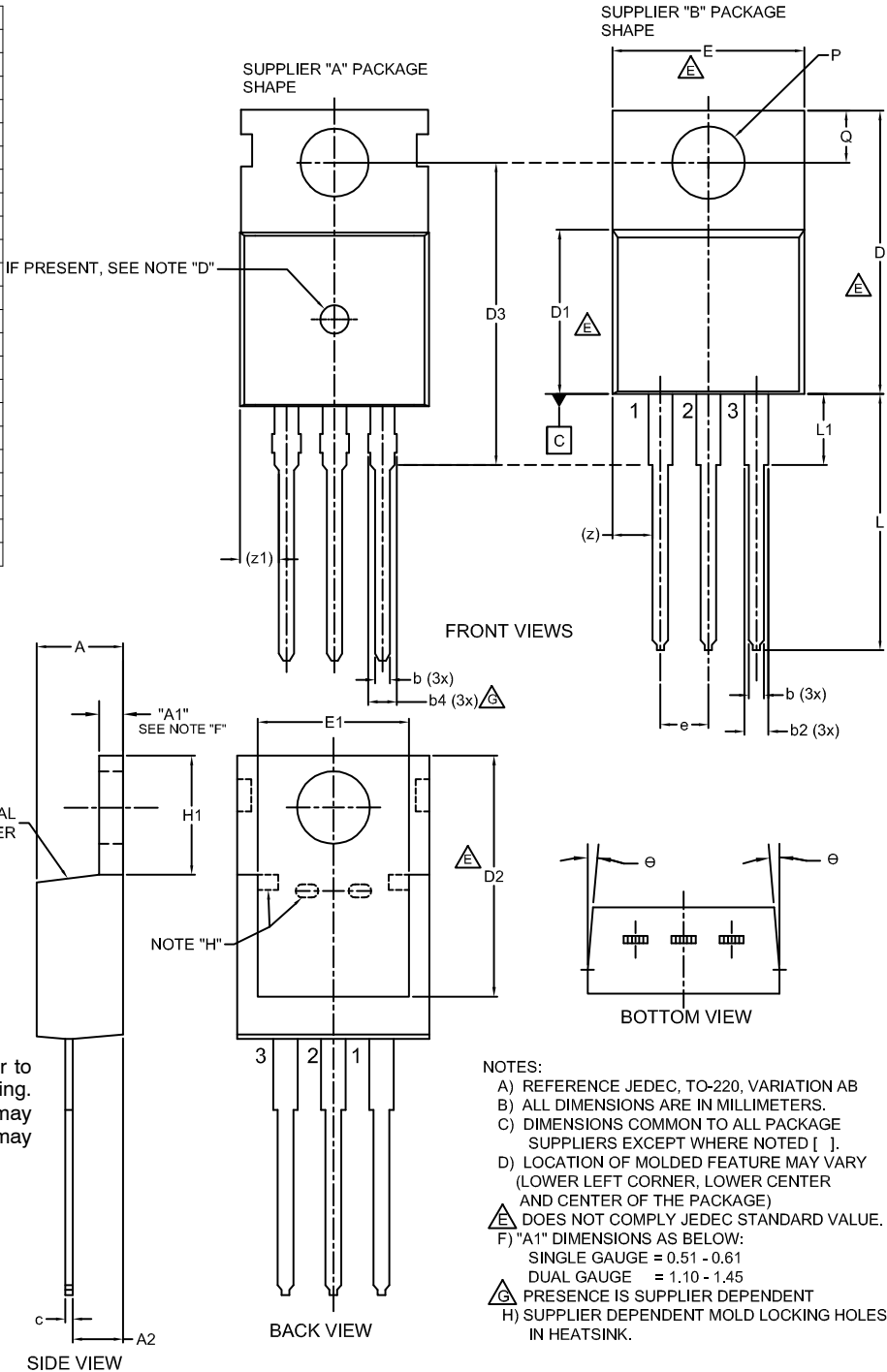
**MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS**



**TO-220-3LD
CASE 340AT
ISSUE B**

DATE 08 AUG 2022

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	4.00	--	4.70
A1	SEE NOTE "F"		
A2	2.10	--	2.85
b	0.55	--	1.00
b2	1.10	--	1.62
b4	1.42	--	1.62
c	0.36	--	0.60
D	13.90	--	16.30
D1	8.13	--	9.40
D2	11.50	--	14.30
D3	15.42	--	16.51
E	9.65	--	10.67
E1	7.59	--	8.65
e	2.40	--	2.67
H1	6.06	--	6.69
L	12.70	--	14.04
L1	2.70	--	4.10
P	3.50	--	4.00
Q	2.50	--	3.40
z	2.13 REF		
z1	2.06 REF		
θ	3°	--	5°



GENERIC MARKING DIAGRAM*



XXXX = Specific Device Code
 A = Assembly Location
 Y = Year
 WW = Work Week
 ZZ = Assembly Lot Code

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

NOTES:

- A) REFERENCE JEDEC, TO-220, VARIATION AB
- 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)
- ⚠ DOES NOT COMPLY JEDEC STANDARD VALUE.
- F) "A1" DIMENSIONS AS BELOW:
 SINGLE GAUGE = 0.51 - 0.61
 DUAL GAUGE = 1.10 - 1.45
- ⚠ PRESENCE IS SUPPLIER DEPENDENT
- H) SUPPLIER DEPENDENT MOLD LOCKING HOLES IN HEATSINK.

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DESCRIPTION:	TO-220-3LD	PAGE 1 OF 1

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