

# MOSFET – N-Channel, DUAL COOL<sup>®</sup> 33, POWERTRENCH<sup>®</sup> 60 V, 40 A, 6.3 mΩ

## FDMC86520DC

### General Description

This N-Channel MOSFET is produced using onsemi's advanced POWERTRENCH process. Advancements in both silicon and DUAL COOL package technologies have been combined to offer the lowest  $r_{DS(on)}$  while maintaining excellent switching performance by extremely low Junction-to-Ambient thermal resistance.

### Features

- DUAL COOL Top Side Cooling PQFN Package
- Max  $r_{DS(on)}$  = 6.3 mΩ at  $V_{GS} = 10\text{ V}$ ,  $I_D = 17\text{ A}$
- Max  $r_{DS(on)}$  = 8.7 mΩ at  $V_{GS} = 8\text{ V}$ ,  $I_D = 14.5\text{ A}$
- High Performance Technology for Extremely Low  $r_{DS(on)}$
- This Device is Pb-Free, Halide Free and RoHS Compliant

### Applications

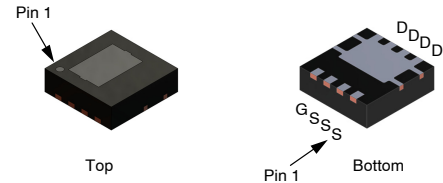
- Primary DC-DC Switch
- Motor Bridge Switch
- Synchronous Rectifier

### MOSFET MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter		Rating	Unit
$V_{DS}$	Drain to Source Voltage		60	V
$V_{GS}$	Gate to Source Voltage		$\pm 20$	V
$I_D$	Drain Current	Continuous $T_C = 25^\circ\text{C}$	40	A
		Continuous (Note 1a) $T_A = 25^\circ\text{C}$	17	
		Pulsed	80	
$E_{AS}$	Single Pulse Avalanche Energy (Note 3)		128	mJ
$P_D$	Power Dissipation	$T_C = 25^\circ\text{C}$	73	W
	Power Dissipation (Note 1a)	$T_A = 25^\circ\text{C}$	3.0	
$T_J, T_{STG}$	Operating and Storage Junction Temperature Range		-55 to +150	$^\circ\text{C}$

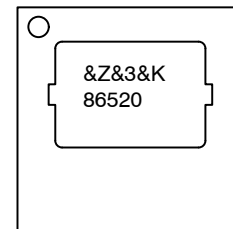
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

$V_{DS}$	$r_{DS(on)}$ MAX	$I_D$ MAX
60 V	6.3 mΩ @ 10 V	40 A
	8.7 mΩ @ 8 V	



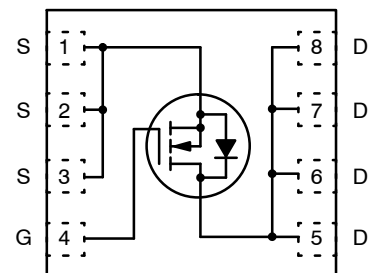
PQFN8 3.3X3.3, 0.65P  
CASE 483AL  
DUAL COOL 33

### MARKING DIAGRAM



&Z = Assembly Plant Code  
&3 = Numeric Date Code  
&K = Lot Code  
86520 = Specific Device Code

### PIN CONNECTIONS



### ORDERING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 6 of this data sheet.

# FDMC86520DC

## THERMAL CHARACTERISTICS

Symbol	Parameter	Ratings	Unit
$R_{\theta JC}$	Thermal Resistance, Junction to Case (Top Source)	4.2	°C/W
$R_{\theta JC}$	Thermal Resistance, Junction to Case (Bottom Drain)	1.7	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1a)	42	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1b)	105	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1i)	17	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1j)	26	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient (Note 1k)	12	

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
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### OFF CHARACTERISTICS

$BV_{DSS}$	Drain to Source Breakdown Voltage	$I_D = 250 \mu\text{A}, V_{GS} = 0 \text{ V}$	60	–	–	V
$\frac{\Delta BV_{DSS}}{\Delta T_J}$	Breakdown Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}$ , referenced to $25^\circ\text{C}$	–	30	–	mV/°C
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 48 \text{ V}, V_{GS} = 0 \text{ V}$	–	–	1	$\mu\text{A}$
$I_{GSS}$	Gate to Source Leakage Current	$V_{GS} = \pm 20 \text{ V}, V_{DS} = 0 \text{ V}$	–	–	$\pm 100$	nA

### ON CHARACTERISTICS

$V_{GS(th)}$	Gate to Source Threshold Voltage	$V_{GS} = V_{DS}, I_D = 250 \mu\text{A}$	2.5	3.7	4.5	V
$\frac{\Delta V_{GS(th)}}{\Delta T_J}$	Gate to Source Threshold Voltage Temperature Coefficient	$I_D = 250 \mu\text{A}$ , referenced to $25^\circ\text{C}$	–	–10	–	mV/°C
$r_{DS(on)}$	Static Drain to Source On Resistance	$V_{GS} = 10 \text{ V}, I_D = 17 \text{ A}$	–	5.1	6.3	m $\Omega$
		$V_{GS} = 8 \text{ V}, I_D = 14.5 \text{ A}$	–	6.5	8.7	
		$V_{GS} = 10 \text{ V}, I_D = 17 \text{ A}, T_J = 125^\circ\text{C}$	–	8.2	10.2	
$g_{FS}$	Forward Transconductance	$V_{DS} = 10 \text{ V}, I_D = 17 \text{ A}$	–	49	–	S

### DYNAMIC CHARACTERISTICS

$C_{iss}$	Input Capacitance	$V_{DS} = 30 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	–	2097	2790	pF
$C_{oss}$	Output Capacitance		–	557	745	
$C_{rss}$	Reverse Transfer Capacitance		–	13	40	
$R_g$	Gate Resistance		0.1	0.5	2.5	

### SWITCHING CHARACTERISTICS

$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 30 \text{ V}, I_D = 17 \text{ A}, V_{GS} = 10 \text{ V}, R_{GEN} = 6 \Omega$	–	18	33	ns
$t_r$	Rise Time		–	6.6	14	
$t_{d(off)}$	Turn-Off Delay Time		–	19	35	
$t_f$	Fall Time		–	4	10	
$Q_{g(TOT)}$	Total Gate Charge	$V_{GS} = 0 \text{ V to } 10 \text{ V}, V_{DD} = 30 \text{ V}, I_D = 17 \text{ A}$	–	29	40	nC
		$V_{GS} = 0 \text{ V to } 8 \text{ V}, V_{DD} = 30 \text{ V}, I_D = 17 \text{ A}$	–	23	33	
$Q_{gs}$	Gate to Source Charge	$V_{DD} = 30 \text{ V}, I_D = 17 \text{ A}$	–	12	–	nC
$Q_{gd}$	Gate to Drain "Miller" Charge		–	5.5	–	nC

### DRAIN-SOURCE DIODE CHARACTERISTICS

$V_{SD}$	Source to Drain Diode Forward Voltage	$V_{GS} = 0 \text{ V}, I_S = 17 \text{ A}$ (Note 2)	–	0.83	1.3	V
		$V_{GS} = 0 \text{ V}, I_S = 2.5 \text{ A}$ (Note 2)	–	0.74	1.2	
$t_{rr}$	Reverse Recovery Time	$I_F = 17 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$	–	41	65	ns
$Q_{rr}$	Reverse Recovery Charge		–	23	37	nC

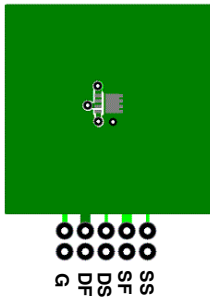
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

**THERMAL CHARACTERISTICS**

R <sub>θJC</sub>	Thermal Resistance, Junction to Case	(Top Source)	4.2	°C/W
R <sub>θJC</sub>	Thermal Resistance, Junction to Case	(Bottom Drain)	1.7	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1a)	42	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1b)	105	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1c)	29	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1d)	40	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1e)	19	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1f)	23	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1g)	30	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1h)	79	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1i)	17	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1j)	26	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1k)	12	
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	(Note 1l)	16	

**NOTES:**

1. R<sub>θJA</sub> is determined with the device mounted on a FR-4 board using a specified pad of 2 oz copper as shown below. R<sub>θJC</sub> is guaranteed by design while R<sub>θCA</sub> is determined by the user's board design.



a. 42°C/W when mounted on a 1 in<sup>2</sup> pad of 2 oz copper



b. 105°C/W when mounted on a minimum pad of 2 oz copper

- c. Still air, 20.9 × 10.4 × 12.7 mm Aluminum Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- d. Still air, 20.9 × 10.4 × 12.7 mm Aluminum Heat Sink, minimum pad of 2 oz copper
- e. Still air, 45.2 × 41.4 × 11.7 mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- f. Still air, 45.2 × 41.4 × 11.7 mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, minimum pad of 2 oz copper
- g. 200FPM Airflow, No Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- h. 200FPM Airflow, No Heat Sink, minimum pad of 2 oz copper
- i. 200FPM Airflow, 20.9 × 10.4 × 12.7 mm Aluminum Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- j. 200FPM Airflow, 20.9 × 10.4 × 12.7 mm Aluminum Heat Sink, minimum pad of 2 oz copper
- k. 200FPM Airflow, 45.2 × 41.4 × 11.7 mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, 1 in<sup>2</sup> pad of 2 oz copper
- l. 200FPM Airflow, 45.2 × 41.4 × 11.7 mm Aavid Thermalloy Part # 10-L41B-11 Heat Sink, minimum pad of 2 oz copper

2. Pulse Test: Pulse Width < 300 μs, Duty cycle < 2.0%.  
 3. E<sub>AS</sub> of 128 mJ is based on starting T<sub>J</sub> = 25°C, L = 1 mH, I<sub>AS</sub> = 16 A, V<sub>DD</sub> = 54 V, V<sub>GS</sub> = 10 V, 100% test at L = 0.3 mH, I<sub>AS</sub> = 24 A.

TYPICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

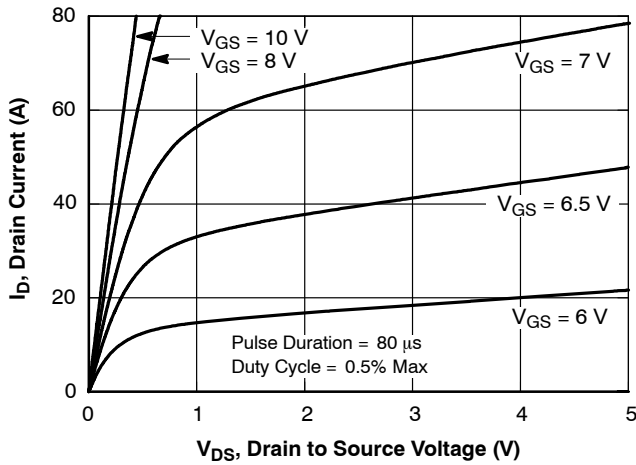


Figure 1. On Region Characteristics

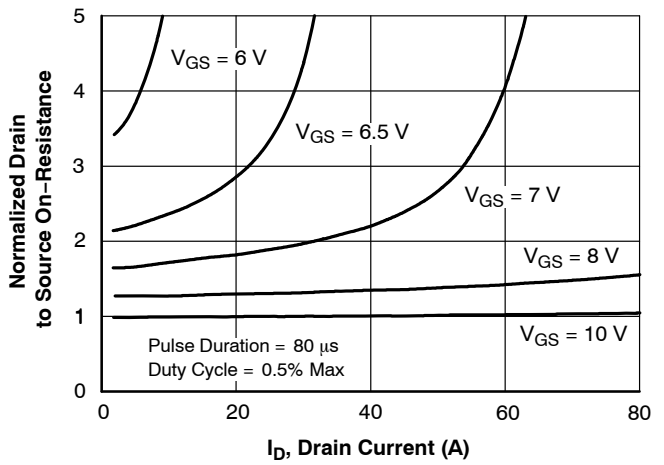


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

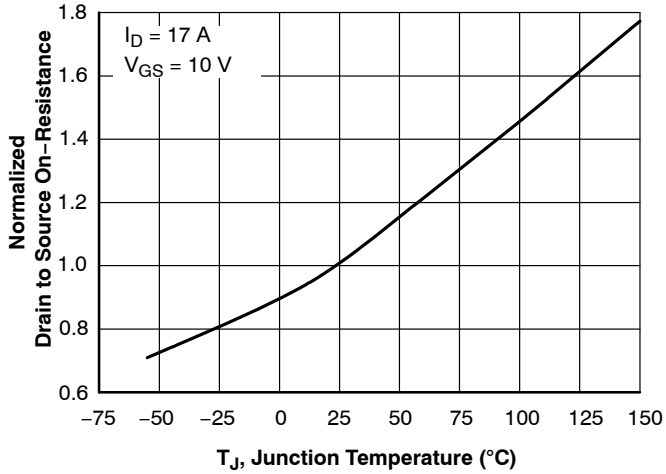


Figure 3. Normalized On Resistance vs. Junction Temperature

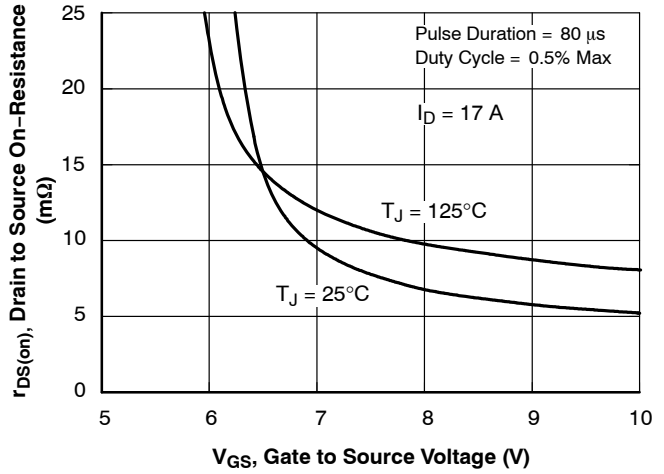


Figure 4. On-Resistance vs. Gate to Source Voltage

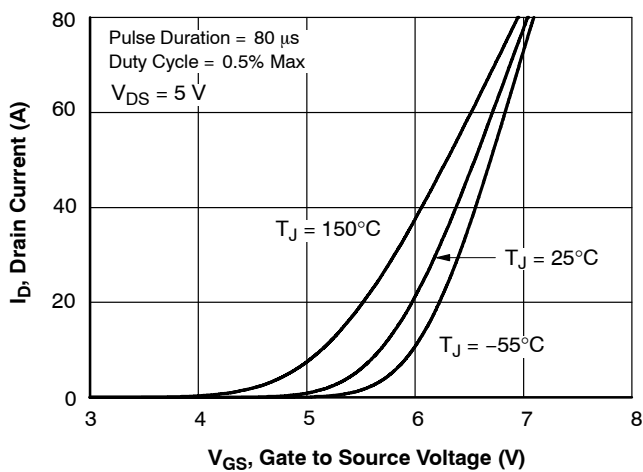


Figure 5. Transfer Characteristics

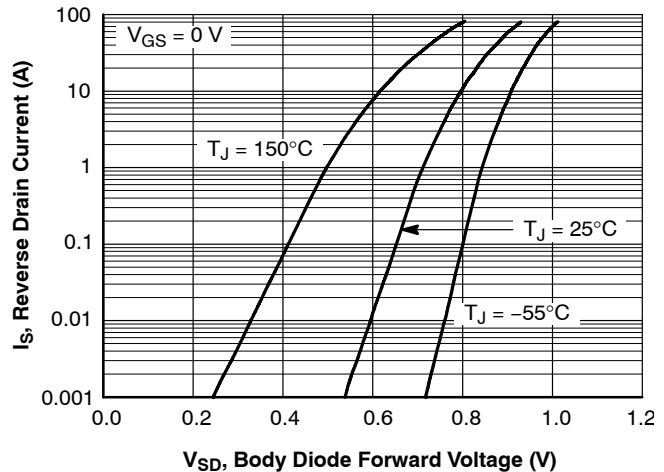


Figure 6. Source to Drain Diode Forward Voltage vs. Source Current

TYPICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

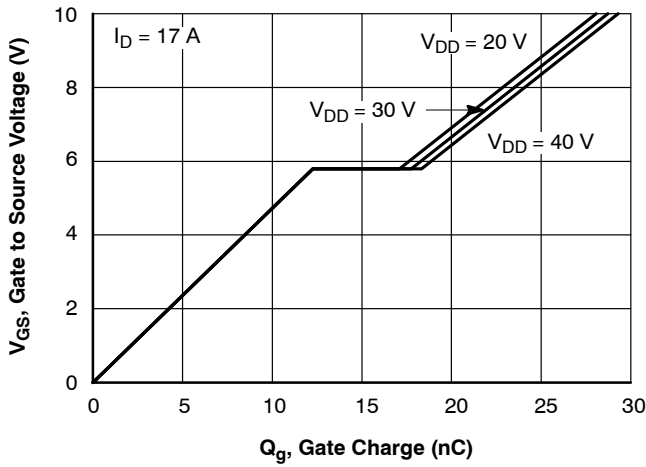


Figure 7. Gate Charge Characteristics

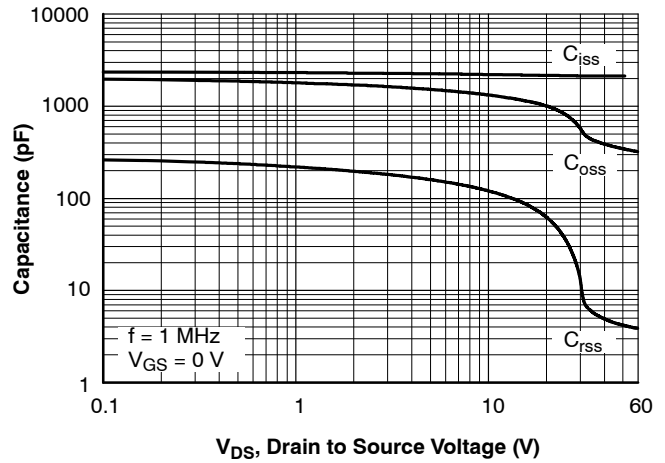


Figure 8. Capacitance vs. Drain to Source Voltage

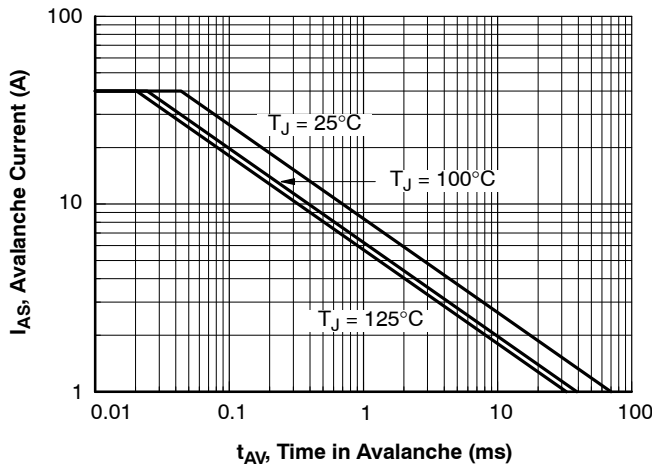


Figure 9. Unclamped Inductive Switching Capability

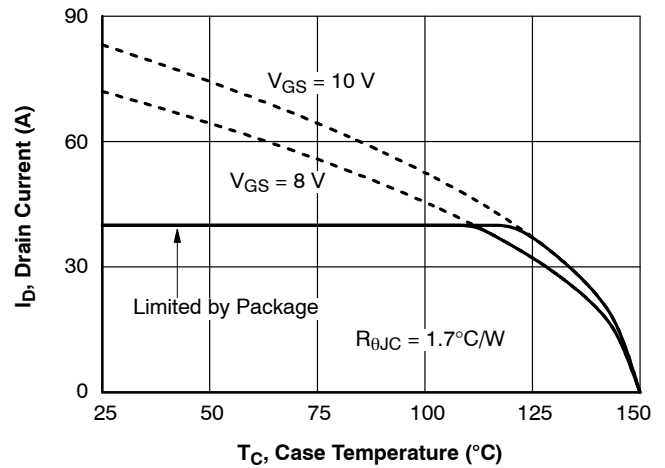


Figure 10. Maximum Continuous Drain Current vs Case Temperature

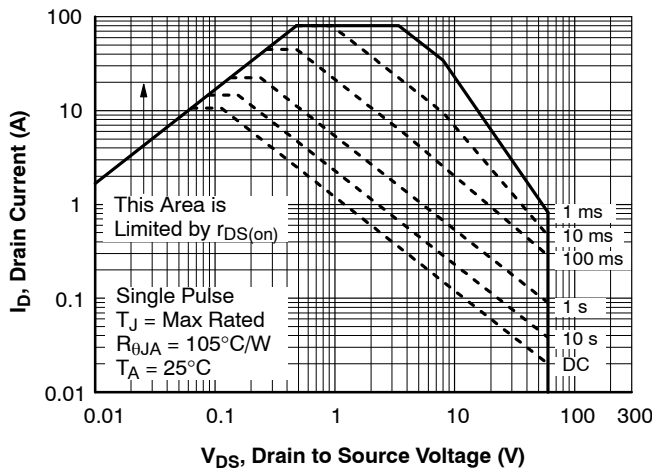


Figure 11. Forward Bias Safe Operating Area

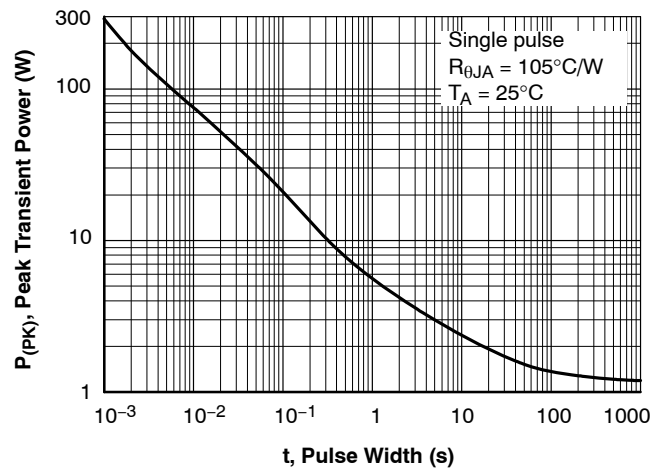


Figure 12. Single Pulse Maximum Power Dissipation

# FDMC86520DC

## TYPICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (continued)

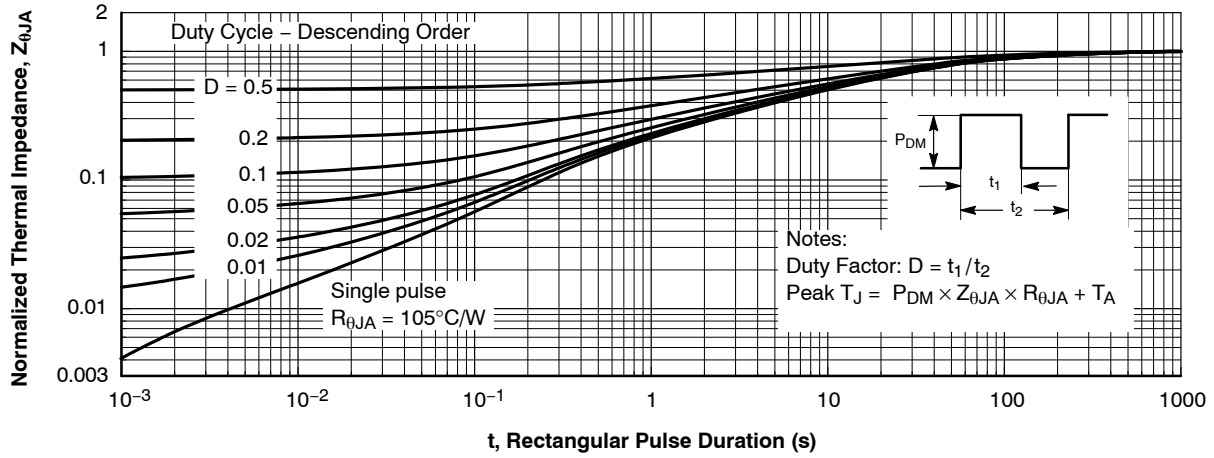


Figure 13. Junction-to-Ambient Transient Thermal Response Curve

### PACKAGE MARKING AND ORDERING INFORMATION

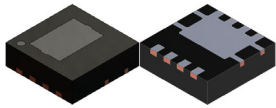
Device	Device Marking	Package	Reel Size	Tape Width	Quantity
FDMC86520DC	86520	DUAL COOL 33	13"	12 mm	3000 Units

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# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®

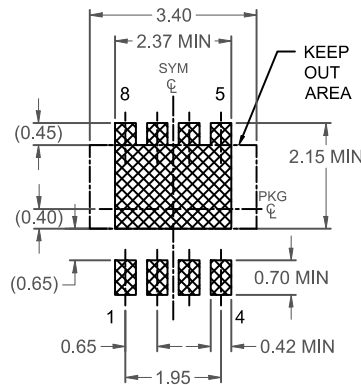
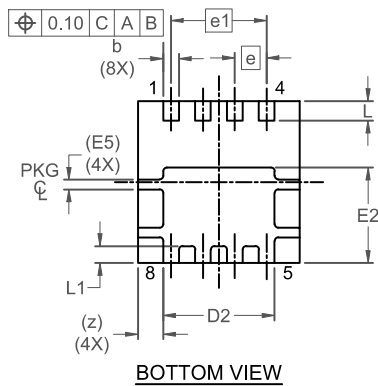
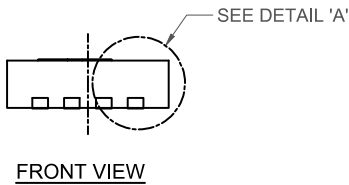
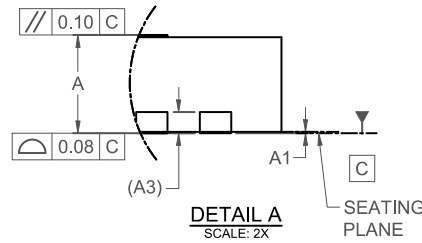
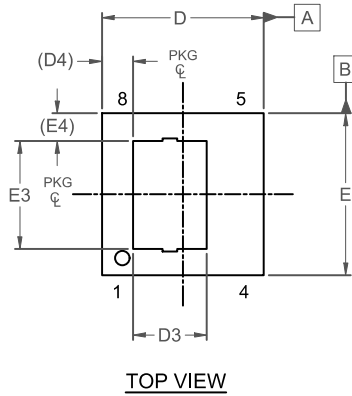


### PQFN8 3.3X3.3, 0.65P

#### CASE 483AL

#### ISSUE A

DATE 01 JUN 2021



LAND PATTERN RECOMMENDATION

\*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ON SEMICONDUCTOR SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

NOTES:

- A. PACKAGE STANDARD REFERENCE: JEDEC MO-240, ISSUE A, VAR. BA, DATED OCTOBER 2002 CONTROLLING
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.
- D. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.90	1.00	1.10
A1	0.00	-	0.05
b	0.27	0.32	0.37
A3	0.20 REF		
D	3.20	3.30	3.40
D2	2.17	2.27	2.37
D3	1.40	1.55	1.70
D4	0.63 REF		
E	3.20	3.30	3.40
E2	1.90	2.00	2.10
E3	2.10	2.25	2.40
E4	0.56 REF		
E5	0.20 REF		
e	0.65 BSC		
e1	1.95 BSC		
L	0.30	0.40	0.50
L4	0.29	0.39	0.49
z	0.52 REF		

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