

# MOSFET – Power, N-Channel, SUPERFET® III, Easy-Drive 650 V, 24 A, 125 mΩ

## FCMT125N65S3

### General Description

SUPERFET III MOSFET is ON Semiconductor's brand-new high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate.

Consequently, SUPERFET III MOSFET Easy-drive series helps manage EMI issues and allows for easier design implementation.

The Power88 package is an ultra-slim surface-mount package (1 mm high) with a low profile and small footprint (8 × 8 mm<sup>2</sup>). SUPERFET III MOSFET in a Power88 package offers excellent switching performance due to lower parasitic source inductance and separated power and drive sources. Power88 offers Moisture Sensitivity Level 1 (MSL 1).

### Features

- 700 V @ T<sub>J</sub> = 150°C
- Typ R<sub>DS(on)</sub> = 100 mΩ
- Ultra Low Gate Charge (Typ. Q<sub>g</sub> = 49 nC)
- Low Effective Output Capacitance (Typ. C<sub>oss(eff.)</sub> = 406 pF)
- 100% Avalanche Tested
- These Devices are Pb-Free and are RoHS Compliant

### Applications

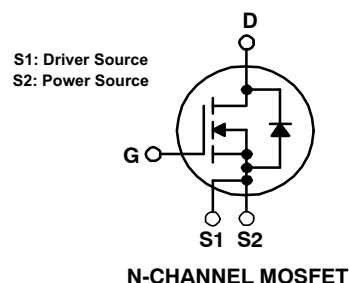
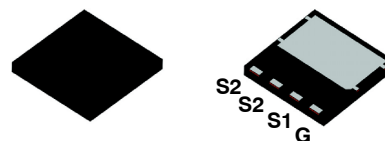
- Telecom / Server Power Supplies
- Industrial Power Supplies
- UPS / Solar



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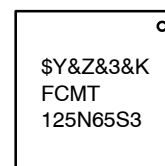
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| V <sub>DSS</sub> | R <sub>DS(on)</sub> MAX | I <sub>D</sub> MAX |
|------------------|-------------------------|--------------------|
| 650 V            | 125 mΩ @ 10 V           | 24 A               |



PQFN4 8X8 2P  
CASE 483AP

### MARKING DIAGRAM



|              |                           |
|--------------|---------------------------|
| \$Y          | = ON Semiconductor Logo   |
| &Z           | = Assembly Plant Code     |
| &3           | = Data Code (Year & Week) |
| &K           | = Lot                     |
| FCMT125N65S3 | = Specific Device Code    |

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# FCMT125N65S3

## ABSOLUTE MAXIMUM RATINGS ( $T_C = 25^\circ\text{C}$ , Unless otherwise noted)

| Symbol         | Parameter                                                      |                                          | Value       | Unit                |
|----------------|----------------------------------------------------------------|------------------------------------------|-------------|---------------------|
| $V_{DSS}$      | Drain to Source Voltage                                        |                                          | 650         | V                   |
| $V_{GSS}$      | Gate to Source Voltage                                         | DC                                       | $\pm 30$    | V                   |
|                |                                                                | AC ( $f > 1\text{ Hz}$ )                 | $\pm 30$    | V                   |
| $I_D$          | Drain Current                                                  | Continuous ( $T_C = 25^\circ\text{C}$ )  | 24          | A                   |
|                |                                                                | Continuous ( $T_C = 100^\circ\text{C}$ ) | 15          |                     |
| $I_{DM}$       | Drain Current                                                  | Pulsed (Note 1)                          | 60          | A                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                        |                                          | 115         | mJ                  |
| $I_{AS}$       | Avalanche Current (Note 2)                                     |                                          | 3.7         | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                           |                                          | 1.81        | mJ                  |
| dv/dt          | MOSFET dv/dt                                                   |                                          | 100         | V/ns                |
|                | Peak Diode Recovery dv/dt (Note 3)                             |                                          | 20          |                     |
| $P_D$          | Power Dissipation                                              | ( $T_C = 25^\circ\text{C}$ )             | 181         | W                   |
|                |                                                                | Derate Above $25^\circ\text{C}$          | 1.45        | 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 s |                                          | 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.  $I_{AS} = 3.7\text{ A}$ ,  $R_G = 25\ \Omega$  starting  $T_J = 25^\circ\text{C}$

3.  $I_{SD} \leq 12\text{ A}$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$

## THERMAL CHARACTERISTICS

| Symbol          | Parameter                                              | Value | Unit                      |
|-----------------|--------------------------------------------------------|-------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.             | 0.69  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. (Note 4) | 45    |                           |

4. Device on 1 in<sup>2</sup> pad 2 oz copper pad on 1.5 × 1.5 in. board of FR-4 material.

## ORDERING INFORMATION

| Device       | Marking      | Package | Reel Size | Tape Width | Quantity <sup>†</sup> |
|--------------|--------------|---------|-----------|------------|-----------------------|
| FCMT125N65S3 | FCMT125N65S3 | PQFN8   | 13"       | 13.3 mm    | 3000 Units            |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# FCMT125N65S3

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

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

### OFF CHARACTERISTICS

|                                     |                                           |                                                                      |     |      |      |      |
|-------------------------------------|-------------------------------------------|----------------------------------------------------------------------|-----|------|------|------|
| BV <sub>DSS</sub>                   | Drain to Source Breakdown Voltage         | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 25°C  | 650 |      |      | V    |
|                                     |                                           | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA, T <sub>J</sub> = 150°C | 700 |      |      | V    |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temperature Coefficient | I <sub>D</sub> = 1 mA, Referenced to 25°C                            |     | 0.68 |      | V/°C |
| I <sub>DSS</sub>                    | Zero Gate Voltage Drain Current           | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V                       |     |      | 10   | μA   |
|                                     |                                           | V <sub>DS</sub> = 520 V, T <sub>C</sub> = 125°C                      |     | 1.35 |      |      |
| I <sub>GSS</sub>                    | Gate to Body Leakage Current              | 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>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 0.59 mA | 2.5 |     | 4.5 | V  |
| R <sub>DS(on)</sub> | Static Drain to Source On Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 12 A                |     | 100 | 125 | mΩ |
| g <sub>FS</sub>     | Forward Transconductance             | V <sub>DS</sub> = 20 V, I <sub>D</sub> = 12 A                |     | 16  |     | S  |

### DYNAMIC CHARACTERISTICS

|                        |                                   |                                                                                    |  |      |  |    |
|------------------------|-----------------------------------|------------------------------------------------------------------------------------|--|------|--|----|
| C <sub>iss</sub>       | Input Capacitance                 | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, f = 1 MHz                          |  | 1920 |  | pF |
| C <sub>oss</sub>       | Output Capacitance                |                                                                                    |  | 44   |  | pF |
| C <sub>oss(eff.)</sub> | Effective Output Capacitance      | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                              |  | 406  |  | pF |
| C <sub>oss(er.)</sub>  | Energy Related Output Capacitance | V <sub>DS</sub> = 0 V to 400 V, V <sub>GS</sub> = 0 V                              |  | 63   |  | pF |
| Q <sub>g(tot)</sub>    | Total Gate Charge at 10V          | V <sub>DS</sub> = 400 V, I <sub>D</sub> = 12 A, V <sub>GS</sub> = 10 V<br>(Note 5) |  | 49   |  | nC |
| Q <sub>gs</sub>        | Gate to Source Gate Charge        |                                                                                    |  | 12   |  | nC |
| Q <sub>gd</sub>        | Gate to Drain "Miller" Charge     |                                                                                    |  | 22   |  | nC |
| ESR                    | Equivalent Series Resistance      | f = 1 MHz                                                                          |  | 0.5  |  | Ω  |

### SWITCHING CHARACTERISTICS

|                     |                     |                                                                                                               |  |     |  |    |
|---------------------|---------------------|---------------------------------------------------------------------------------------------------------------|--|-----|--|----|
| t <sub>d(on)</sub>  | Turn-On Delay Time  | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 12 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 4.7 Ω<br>(Note 5) |  | 22  |  | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |                                                                                                               |  | 22  |  | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |                                                                                                               |  | 60  |  | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |                                                                                                               |  | 5.8 |  | ns |

### SOURCE-DRAIN DIODE CHARACTERISTICS

|                 |                                                          |                                                                                    |  |     |    |
|-----------------|----------------------------------------------------------|------------------------------------------------------------------------------------|--|-----|----|
| I <sub>S</sub>  | Maximum Continuous Source to Drain Diode Forward Current |                                                                                    |  | 24  | A  |
| I <sub>SM</sub> | Maximum Pulsed Source to Drain Diode Forward Current     |                                                                                    |  | 60  | A  |
| V <sub>SD</sub> | Source to Drain Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 12 A                                      |  | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>DD</sub> = 400 V, I <sub>SD</sub> = 12 A,<br>dI <sub>F</sub> /dt = 100 A/μs |  | 345 | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                    |  | 5.7 | 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.

5. Essentially independent of operating temperature typical characteristics.

TYPICAL PERFORMANCE CHARACTERISTICS

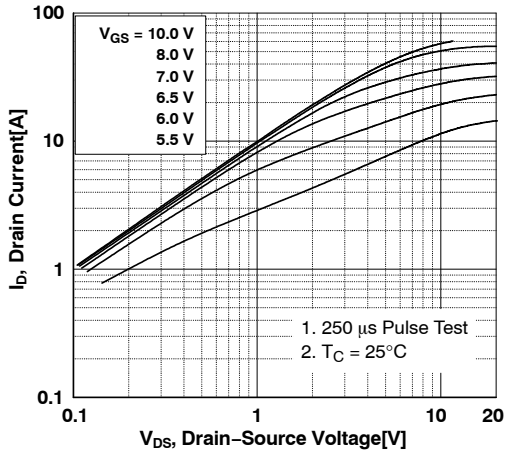


Figure 1. On-Region Characteristics

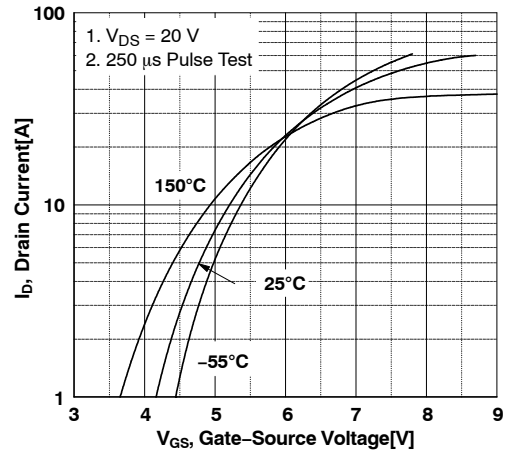


Figure 2. Transfer Characteristics

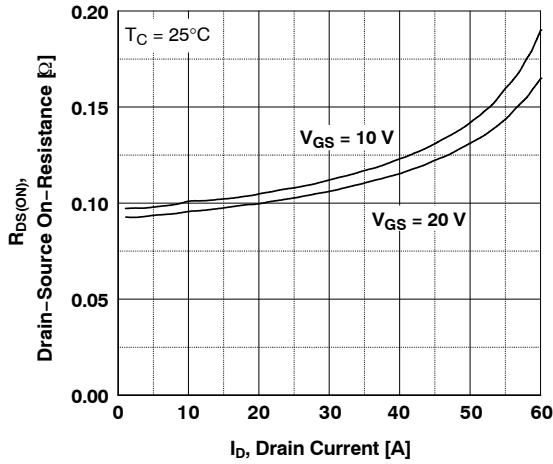


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

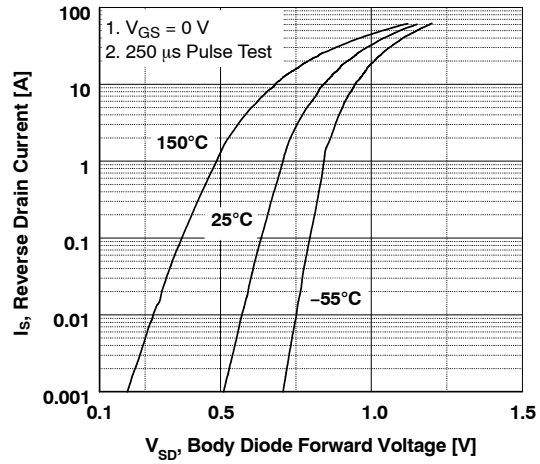


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

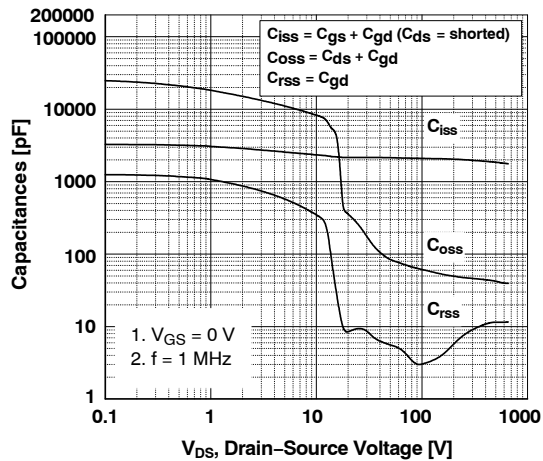


Figure 5. Capacitance Characteristics

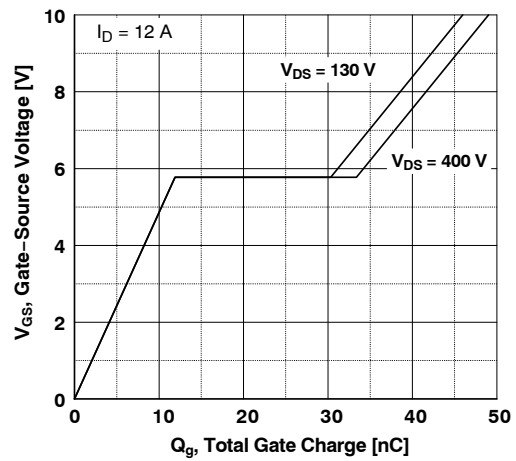


Figure 6. Gate Charge Characteristics

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

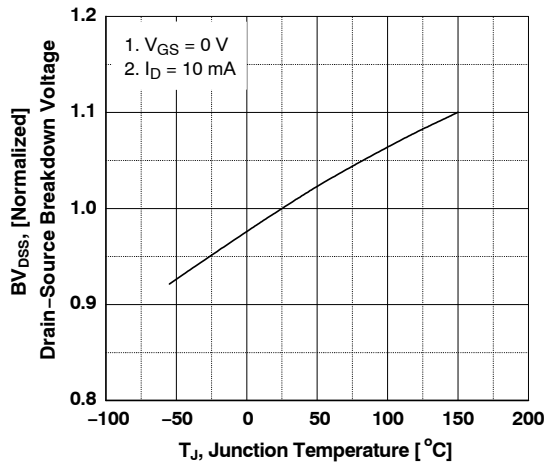


Figure 7. Breakdown Voltage Variation vs. Temperature

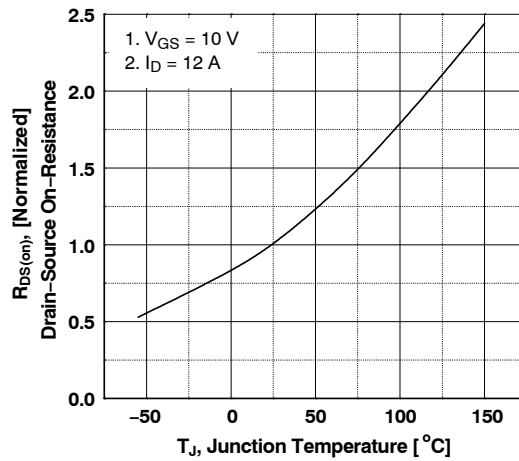


Figure 8. On-Resistance Variant vs. Temperature

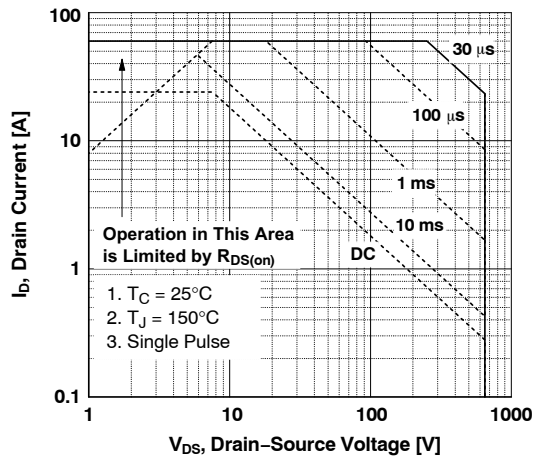


Figure 9. Maximum Safe Operation Area

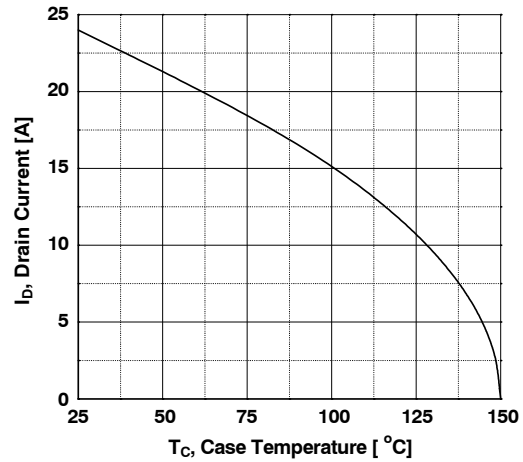


Figure 10. Maximum Drain Current vs. Case Temperature

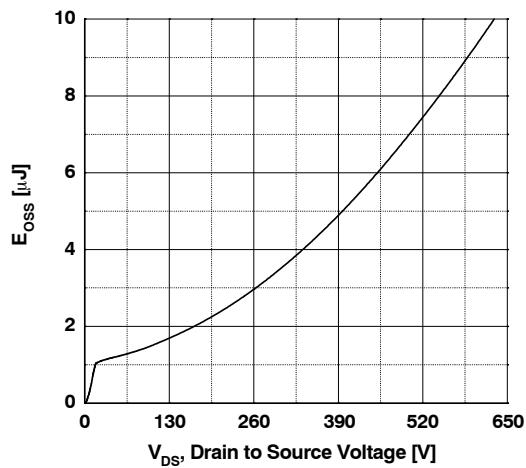


Figure 11.  $E_{OSS}$  vs. Drain to Source Voltage

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

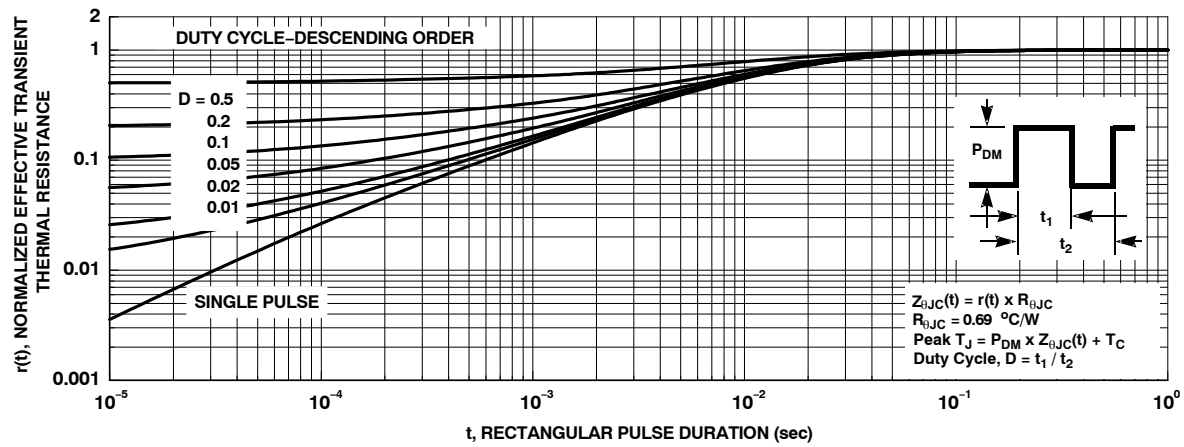


Figure 12. Transient Thermal Response Curve

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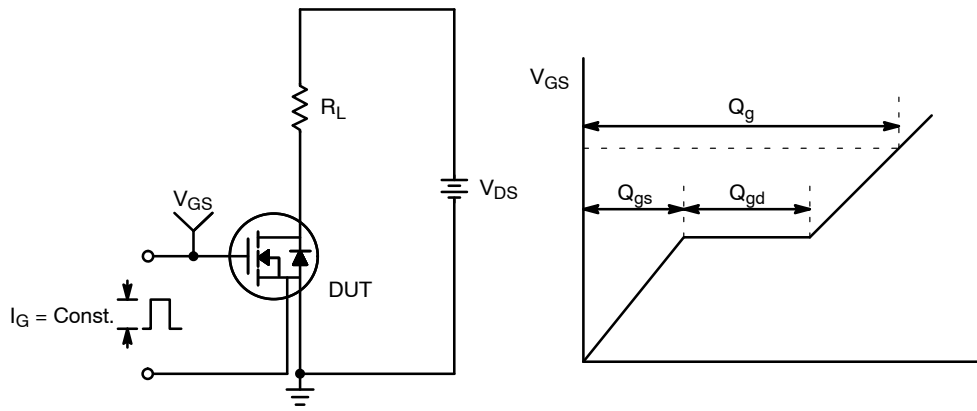


Figure 13. Gate Charge Test Circuit & Waveform

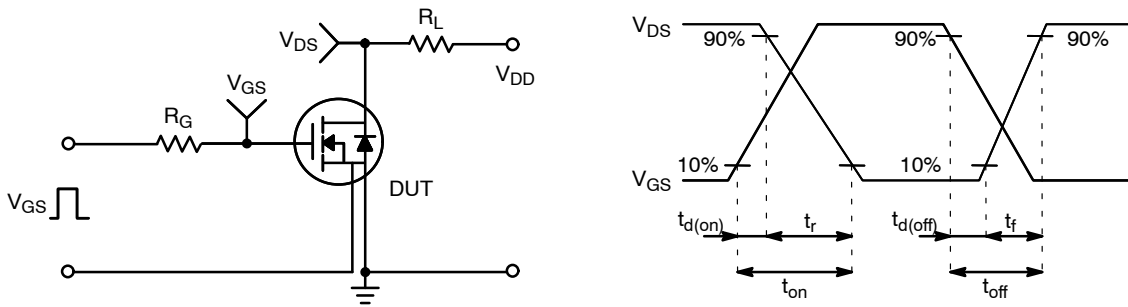


Figure 14. Resistive Switching Test Circuit & Waveforms

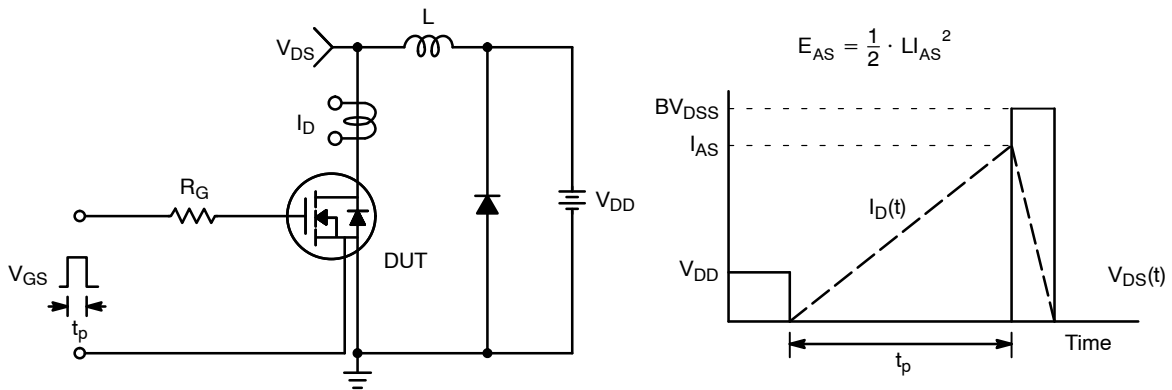


Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms

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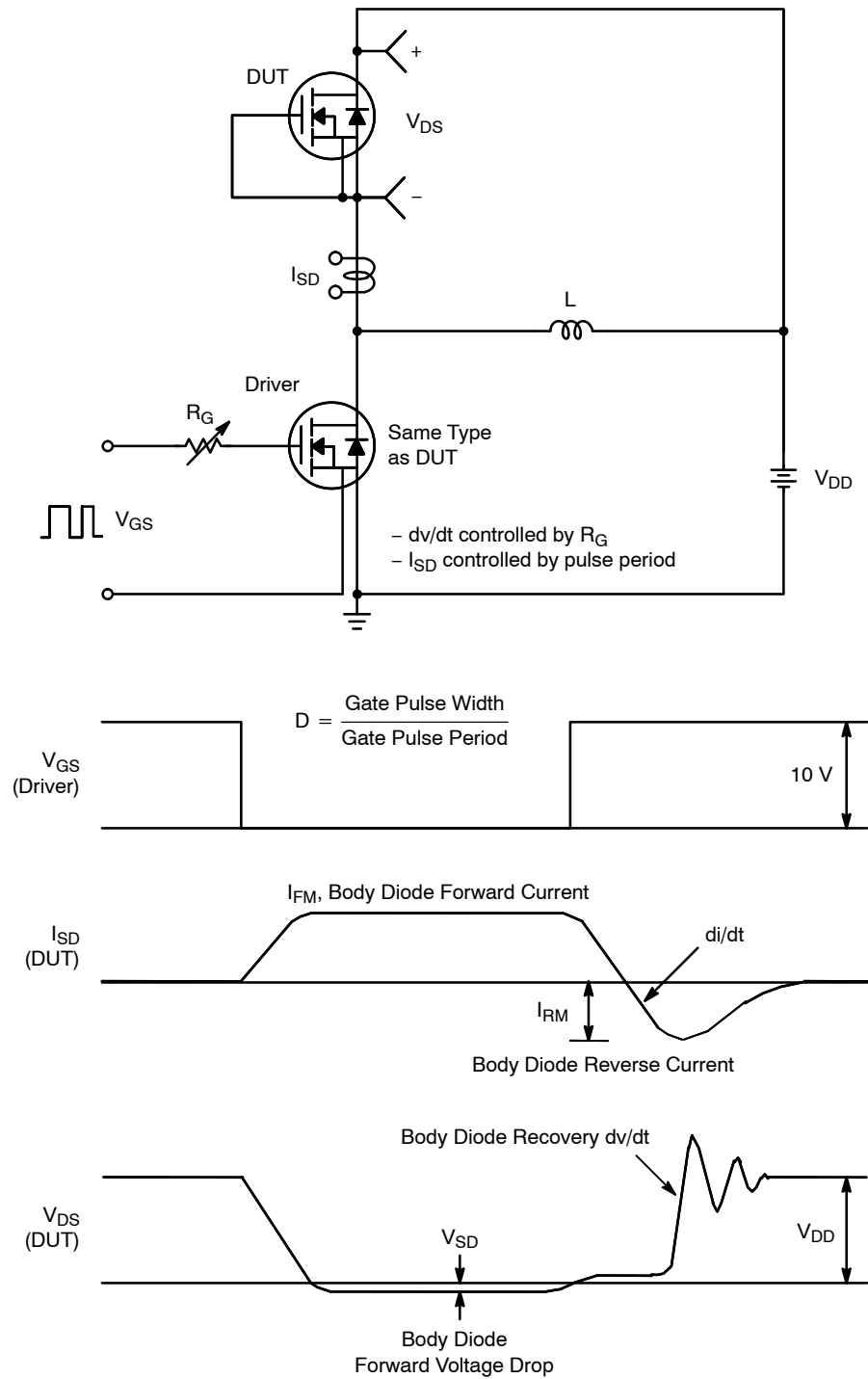
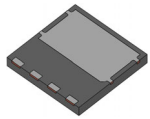


**Figure 16. Peak Diode Recovery dv/dt Test Circuit & Waveforms**

# MECHANICAL CASE OUTLINE

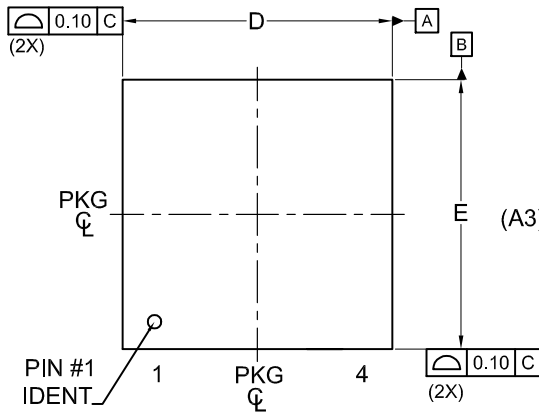
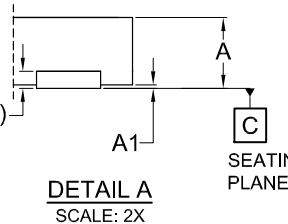
## PACKAGE DIMENSIONS

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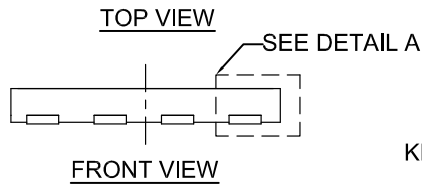
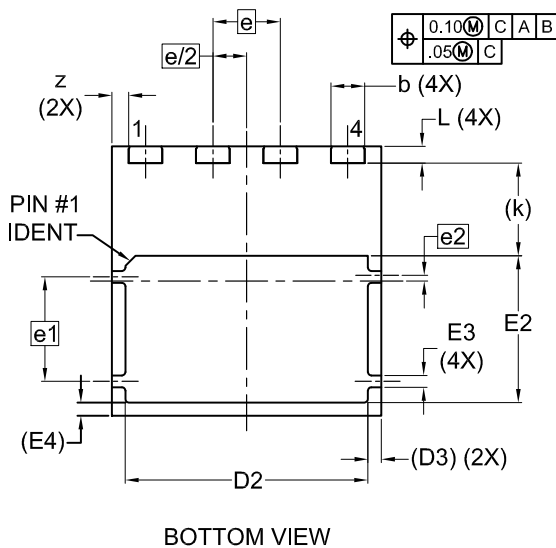
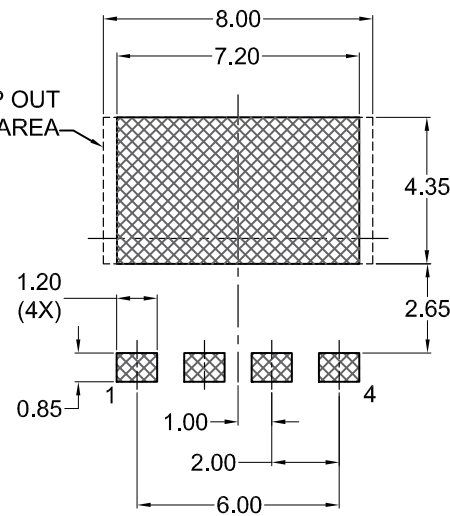
**PQFN4 8X8, 2P**  
CASE 483AP  
ISSUE A

DATE 06 JUL 2021



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE EXPOSED PADS AS WELL AS THE TERMINALS.
4. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. SEATING PLANE IS DEFINED BY THE TERMINALS. "A1" IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.
6. IT IS RECOMMENDED TO HAVE NO TRACES OR VIAS WITHIN THE KEEP OUT AREA.



| DIM | MILLIMETERS |      |      |
|-----|-------------|------|------|
|     | MIN.        | NOM. | MAX. |
| A   | 0.90        | 1.00 | 1.10 |
| A1  | 0.00        | -    | 0.05 |
| A3  | 0.20 REF    |      |      |
| b   | 0.90        | 1.00 | 1.10 |
| D   | 7.90        | 8.00 | 8.10 |
| D2  | 7.10        | 7.20 | 7.30 |
| D3  | 0.40 REF    |      |      |
| E   | 7.90        | 8.00 | 8.10 |
| E2  | 4.25        | 4.35 | 4.45 |
| E3  | 0.25        | 0.35 | 0.45 |
| E4  | 0.40 REF    |      |      |
| e   | 2.00 BSC    |      |      |
| e/2 | 1.00 BSC    |      |      |
| e1  | 3.10 BSC    |      |      |
| e2  | 0.17 BSC    |      |      |
| k   | 2.75 REF    |      |      |
| L   | 0.40        | 0.50 | 0.60 |

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

|                  |               |                                                                                                                                                                                  |
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