

MOSFET – N-Channel, DUAL COOL® 33, POWERTRENCH® 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 V, I_D = 17 A
- Max $r_{DS(on)}$ = 8.7 mΩ at V_{GS} = 8 V, I_D = 14.5 A
- High Performance Technology for Extremely Low $r_{DS(on)}$
- This Device is Pb-Free, Halide Free and RoHS Compliant

Applications

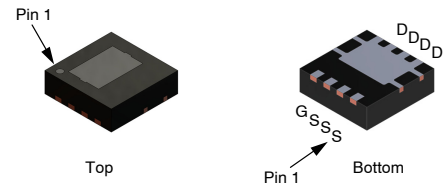
- Primary DC-DC Switch
- Motor Bridge Switch
- Synchronous Rectifier

MOSFET MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

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

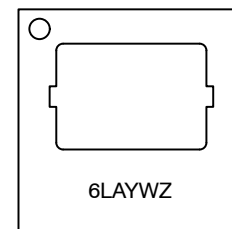
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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



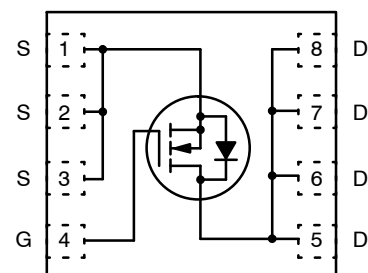
PQFN8 3.3X3.3, 0.65P
CASE 483AL
DUAL COOL 33

MARKING DIAGRAM



6L = Specific Device Code
A = Assembly Plant Code
YW = Date Code (Year and Week)
Z = Lot Code

PIN CONNECTIONS



ORDERING INFORMATION

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

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 |
|--------|-----------|-----------------|------|------|------|------|
|--------|-----------|-----------------|------|------|------|------|

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°C | – | 30 | – | mV/°C |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS} = 48\ \text{V}$, $V_{GS} = 0\ \text{V}$ | – | – | 1 | μA |
| I_{GSS} | Gate to Source Leakage Current | $V_{GS} = \pm 20\ \text{V}$, $V_{DS} = 0\ \text{V}$ | – | – | ± 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°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 Ω |
| | | $V_{GS} = 8\ \text{V}$, $I_D = 14.5\ \text{A}$ | – | 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 | pF |
| C_{rss} | Reverse Transfer Capacitance | | – | 13 | 40 | pF |
| R_g | Gate Resistance | | 0.1 | 0.5 | 2.5 | Ω |

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 |

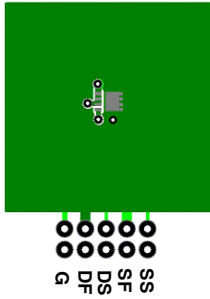
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

THERMAL CHARACTERISTICS

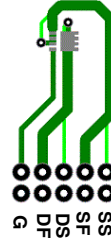
| | | | |
|------------------|---|-----|------|
| R _{θJC} | Thermal Resistance, Junction to Case (Top Source) | 4.2 | °C/W |
| R _{θJC} | Thermal Resistance, Junction to Case (Bottom Drain) | 1.7 | |
| R _{θJA} | Thermal Resistance, Junction to Ambient (Note 1a) | 42 | |
| R _{θJA} | Thermal Resistance,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

NOTES:

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



a. 42°C/W when mounted on a 1 in² 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 in² 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 in² 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 in² 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 in² 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 in² 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_{AS} of 128 mJ is based on starting T_J = 25°C, L = 1 mH, I_{AS} = 16 A, V_{DD} = 54 V, V_{GS} = 10 V, 100% test at L = 0.3 mH, I_{AS} = 24 A.

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

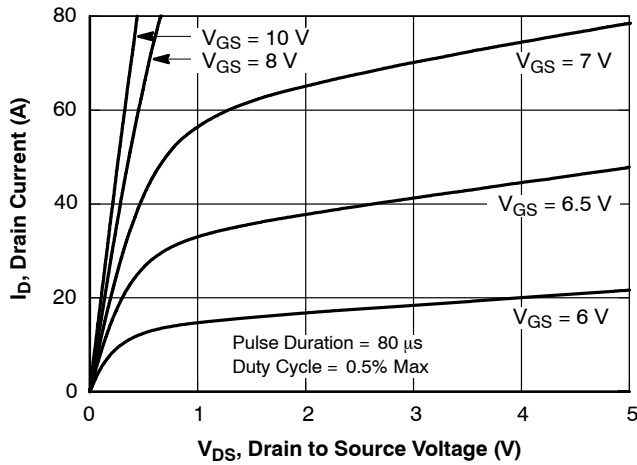


Figure 1. On Region Characteristics

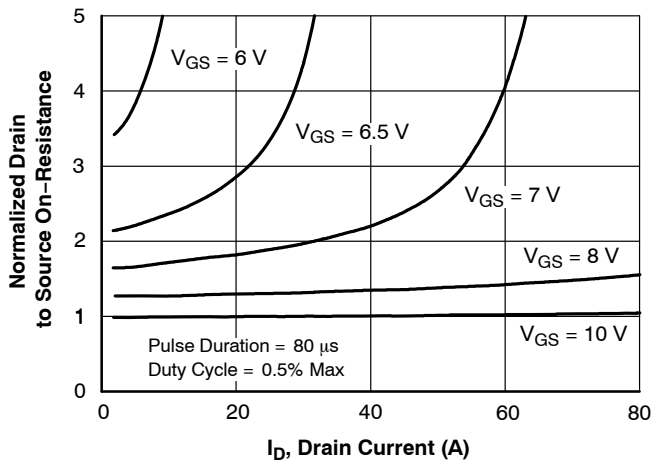


Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

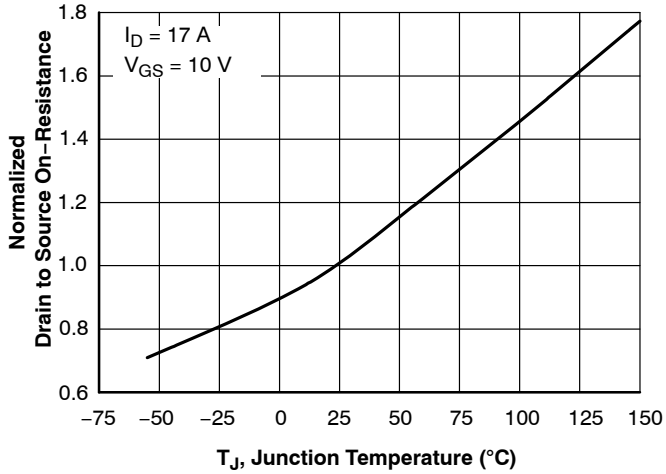


Figure 3. Normalized On Resistance vs. Junction Temperature

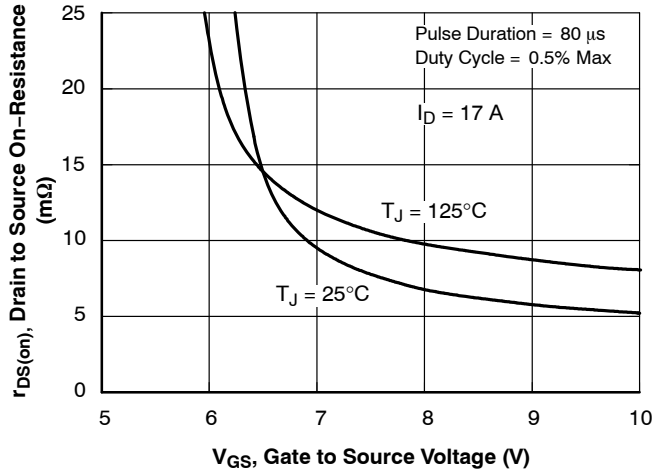


Figure 4. On-Resistance vs. Gate to Source Voltage

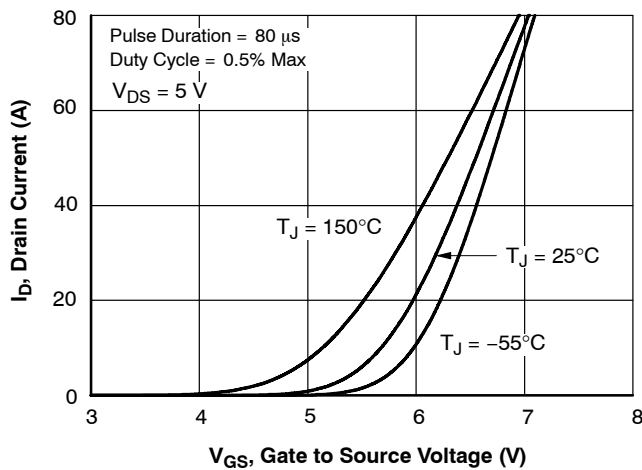


Figure 5. Transfer Characteristics

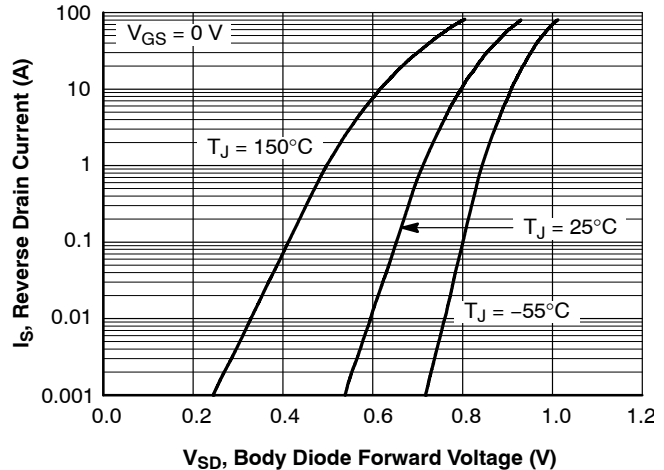


Figure 6. Source to Drain Diode Forward Voltage vs. Source Current

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

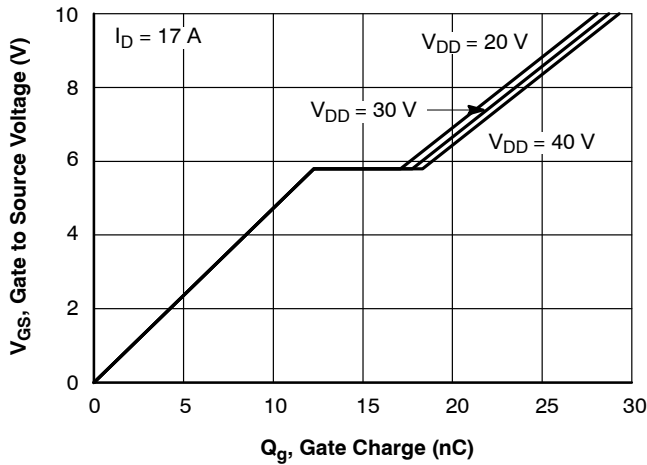


Figure 7. Gate Charge Characteristics

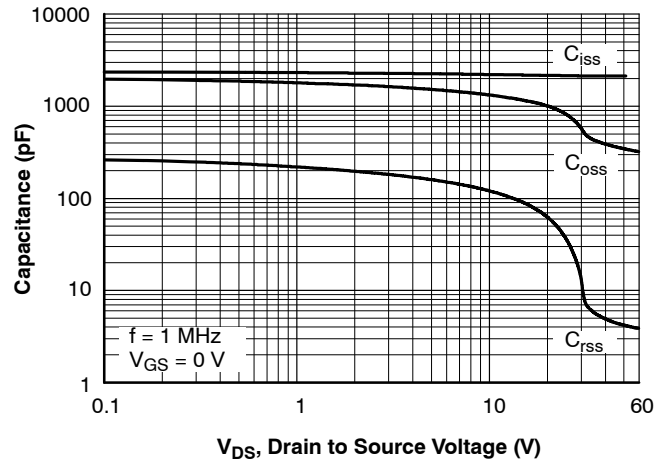


Figure 8. Capacitance vs. Drain to Source Voltage

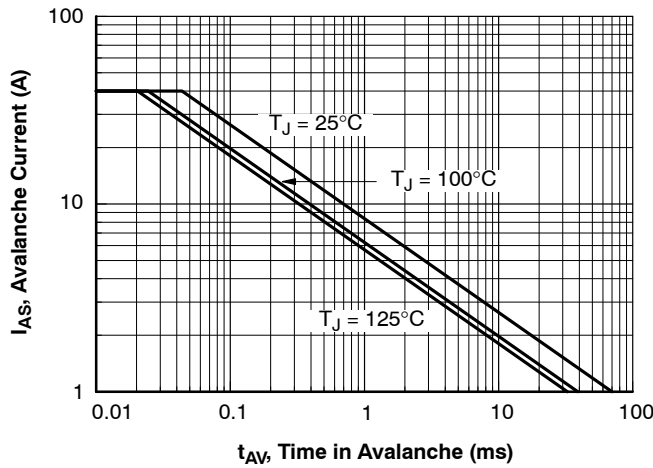


Figure 9. Unclamped Inductive Switching Capability

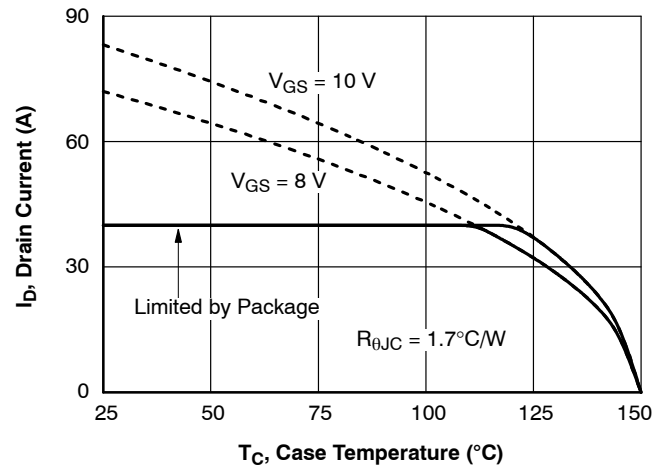


Figure 10. Maximum Continuous Drain Current vs Case Temperature

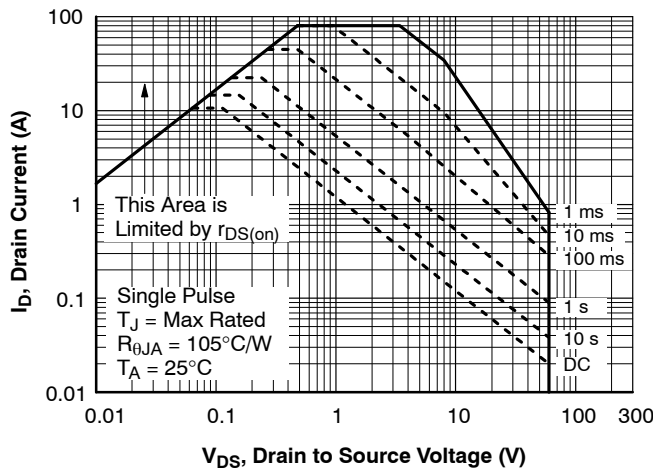


Figure 11. Forward Bias Safe Operating Area

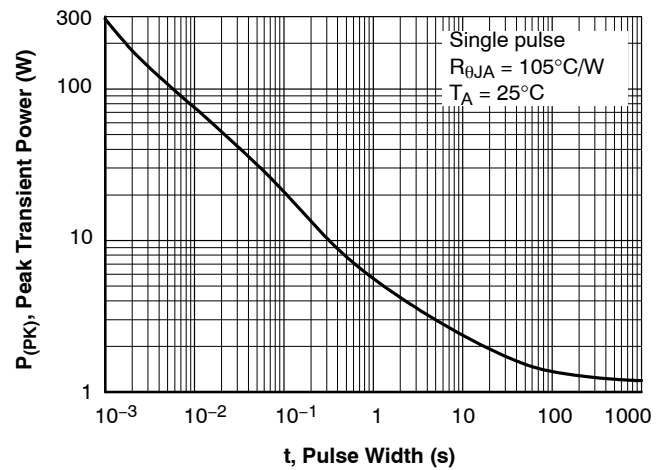


Figure 12. Single Pulse Maximum Power Dissipation

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

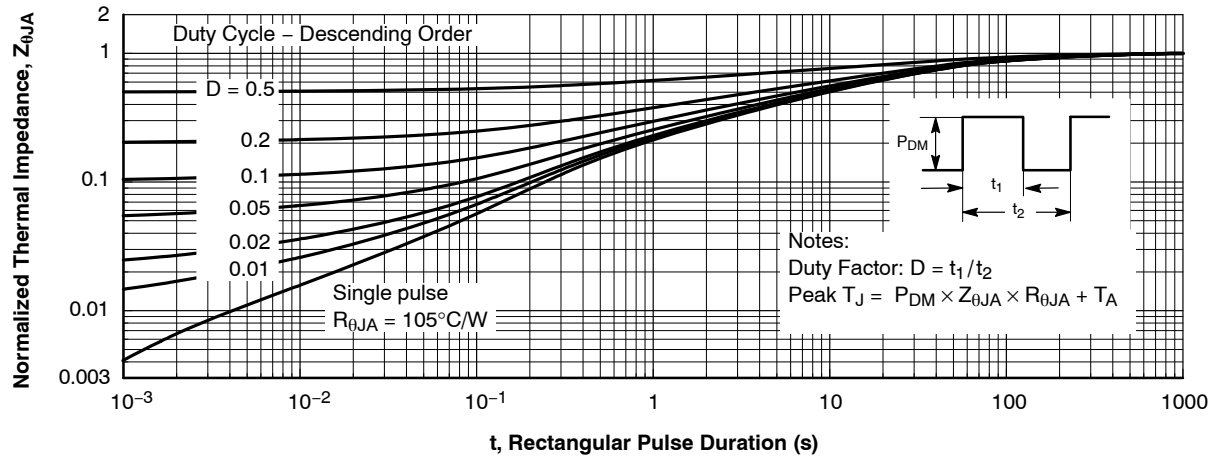
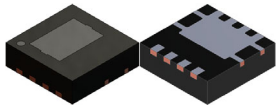


Figure 13. Junction-to-Ambient Transient Thermal Response Curve

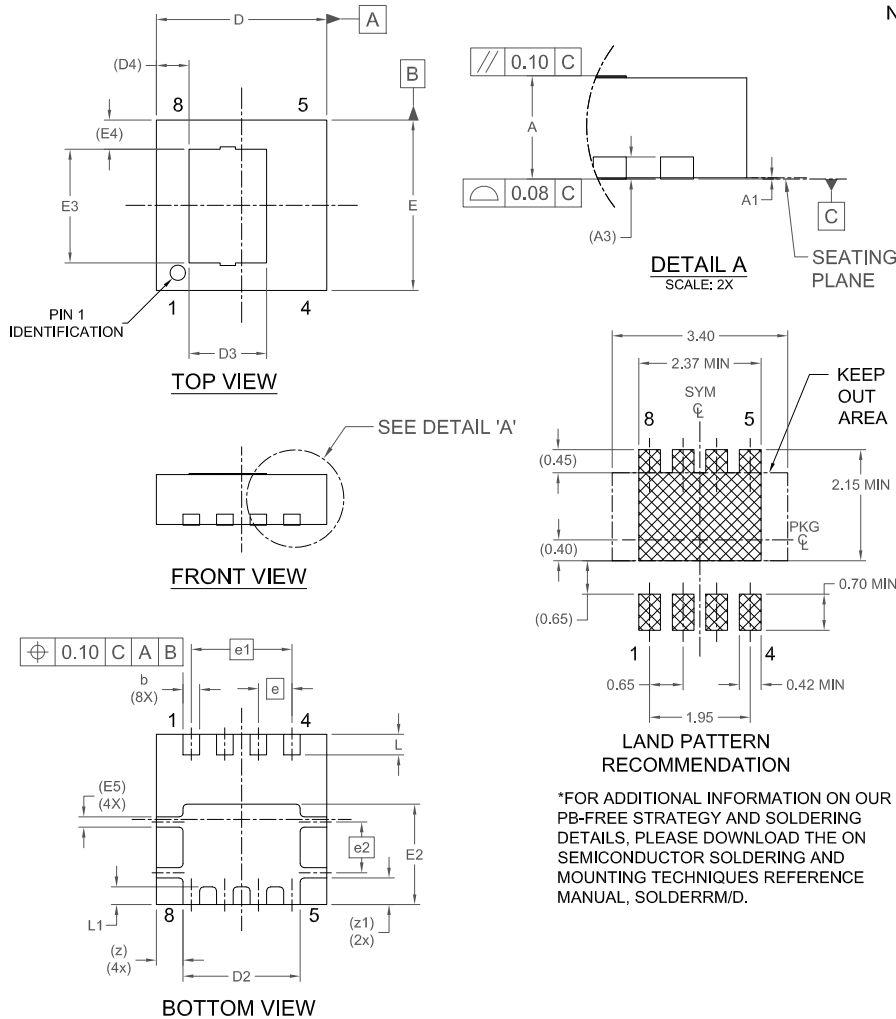
PACKAGE MARKING AND ORDERING INFORMATION

| Device | Device Marking | Package | Reel Size | Tape Width | Quantity |
|-------------|----------------|--------------|-----------|------------|------------|
| FDMC86520DC | 6L | DUAL COOL 33 | 13" | 12 mm | 3000 Units |



PQFN8 3.30x3.30x1.00, 0.65P
CASE 483AL
ISSUE B

DATE 20 DEC 2023

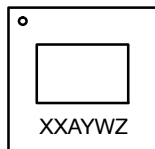


NOTES:

- A. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS DO NOT INCLUDE BURRS OR MOLD FLASH. MOLD FLASH OR BURRS DOES NOT EXCEED 0.10MM.

| 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 | | |
| e2 | 0.98 BSC | | |
| L | 0.30 | 0.40 | 0.50 |
| L4 | 0.29 | 0.39 | 0.49 |
| z | 0.52 REF | | |
| z1 | 0.52 REF | | |

GENERIC MARKING DIAGRAM*



XX = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
Z = 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.

| | | |
|-------------------------|------------------------------------|--|
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