

# MOSFET – N-Channel, SUPERFET II, FRFET

600 V, 76 A, 41 mΩ

## FCH041N60F-F085

### Description

SUPERFET® II 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 technology is tailored to minimize conduction loss, provide superior switching performance, dv/dt rate and higher avalanche energy. Consequently SUPERFET II is very well suited for the Soft switching and Hard Switching topologies like High Voltage Full Bridge and Half Bridge DC-DC, Interleaved Boost PFC, Boost PFC for HEV-EV automotive. SUPERFET II FRFET® MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.

### Features

- Typical  $R_{DS(on)}$  = 36 mΩ at  $V_{GS} = 10$  V,  $I_D = 38$  A
- Typical  $Q_{g(tot)}$  = 267 nC at  $V_{GS} = 10$  V,  $I_D = 38$  A
- Low Effective Output Capacitance (Typical  $C_{oss(eff.)}$  = 720 nF)
- 100% Avalanche Tested
- Qualified to AEC Q101 and PPAP Capable
- This Device is Pb-Free and is RoHS Compliant

### Applications

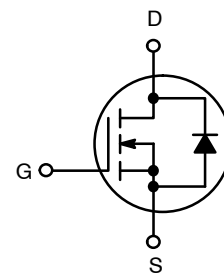
- Automotive On Board Charger
- Automotive DC/DC Converter for HEV



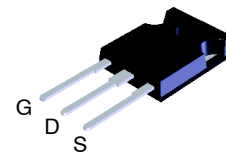
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| $V_{DSS}$ | $R_{DS(on)}$ MAX | $I_D$ MAX |
|-----------|------------------|-----------|
| 600 V     | 41 mΩ            | 76 A      |

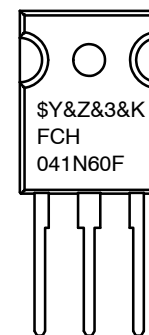


N-Channel MOSFET



TO-247  
CASE 340CK

### MARKING DIAGRAM



|            |                           |
|------------|---------------------------|
| \$Y        | = ON Semiconductor Logo   |
| &Z         | = Assembly Plant Code     |
| &3         | = Data Code (Year & Week) |
| &K         | = Lot Code                |
| FCH041N60F | = Specific Device Code    |

### ORDERING INFORMATION

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

# FCH041N60F–F085

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

| Symbol                            | Parameter                                                               | Ratings     | Unit |
|-----------------------------------|-------------------------------------------------------------------------|-------------|------|
| V <sub>DSS</sub>                  | Drain to Source Voltage                                                 | 600         | V    |
| V <sub>GS</sub>                   | Gate to Source Voltage                                                  | ±20         | V    |
| I <sub>D</sub>                    | Drain Current – Continuous (V <sub>GS</sub> = 10) T <sub>C</sub> = 25°C | 76          | A    |
|                                   | Pulsed Drain Current                                                    | See Fig. 4  |      |
| E <sub>AS</sub>                   | Single Pulsed Avalanche Rating (Note 1)                                 | 2025        | mJ   |
| dv/dt                             | MOSFET dv/dt                                                            | 100         | V/ns |
|                                   | Peak Diode Recovery dv/dt (Note 2)                                      | 50          |      |
| P <sub>D</sub>                    | Power Dissipation                                                       | 595         | W    |
|                                   | Derate Above 25°C                                                       | 4.76        | W/°C |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature (Note 3)                              | –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.

1. Starting T<sub>J</sub> = 25°C, L = 18 mH, I<sub>AS</sub> = 15 A, V<sub>DD</sub> = 100 V during inductor charging and V<sub>DD</sub> = 0 V during time in avalanche.
2. I<sub>SD</sub> ≤ 38 A, di/dt ≤ 200 A/μs, V<sub>DD</sub> ≤ 380 V, starting T<sub>J</sub> = 25°C.
3. R<sub>θJA</sub> is the sum of the junction-to-case and case-to-ambient thermal resistance, where the case thermal reference is defined as the solder mounting surface of the drain pins. R<sub>θJC</sub> is guaranteed by design, while R<sub>θJA</sub> is determined by the board design. The maximum rating presented here is based on mounting on a 1 in<sup>2</sup> pad of 2oz copper.

## THERMAL CHARACTERISTICS

| Symbol           | Parameter                                     | Ratings | Unit |
|------------------|-----------------------------------------------|---------|------|
| R <sub>θJC</sub> | Thermal Resistance, Junction to Case, Max.    | 0.21    | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient, Max. | 40      |      |

## PACKAGE MARKING AND ORDERING INFORMATION

| Part Number     | Top Marking | Package | Reel Size | Tape Width | Quantity |
|-----------------|-------------|---------|-----------|------------|----------|
| FCH041N60F–F085 | FCH041N60F  | TO–247  | –         | –          | 30       |

# FCH041N60F–F085

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°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> = 250 μA                                  | 600 | – | –    | V  |
| I <sub>DSS</sub>  | Drain to Source Leakage Current   | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 25°C           | –   | – | 10   | μA |
|                   |                                   | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150°C (Note 4) | –   | – | 1    | mA |
| I <sub>GSS</sub>  | Gate to Source Leakage Current    | V <sub>GS</sub> = ±20 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> = 250 μA                    | 3 | 4  | 5  | V  |
| r <sub>DS(on)</sub> | Static Drain to Source On Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 38 A, T <sub>J</sub> = 25°C           | – | 36 | 41 | mΩ |
|                     |                                      | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 38 A, T <sub>J</sub> = 150°C (Note 4) | – | 89 | 98 | mΩ |

### DYNAMIC CHARACTERISTICS

|                        |                               |                                                                        |   |       |     |    |
|------------------------|-------------------------------|------------------------------------------------------------------------|---|-------|-----|----|
| C <sub>iss</sub>       | Input Capacitance             | V <sub>DS</sub> = 100 V, V <sub>GS</sub> = 0 V, f = 1 MHz              | – | 10900 | –   | pF |
| C <sub>oss</sub>       | Output Capacitance            |                                                                        | – | 360   | –   | pF |
| C <sub>rss</sub>       | Reverse Transfer Capacitance  |                                                                        | – | 4.4   | –   | pF |
| C <sub>oss(eff.)</sub> | Effective Output Capacitance  | V <sub>DS</sub> = 0 V to 480 V, V <sub>GS</sub> = 0 V                  | – | 720   | –   | pF |
| R <sub>g</sub>         | Gate Resistance               | f = 1 MHz                                                              | – | 0.7   | –   | Ω  |
| Q <sub>g(TOT)</sub>    | Total Gate Charge             | V <sub>DD</sub> = 380 V, I <sub>D</sub> = 38 A, V <sub>GS</sub> = 10 V | – | 267   | 347 | nC |
| Q <sub>g(th)</sub>     | Threshold Gate Charge         |                                                                        | – | 20    | 26  | nC |
| Q <sub>gs</sub>        | Gate to Source Gate Charge    |                                                                        | – | 59    | –   | nC |
| Q <sub>gd</sub>        | Gate to Drain "Miller" Charge |                                                                        | – | 106   | –   | nC |

### SWITCHING CHARACTERISTICS

|                     |                     |                                                                                                   |   |     |     |    |
|---------------------|---------------------|---------------------------------------------------------------------------------------------------|---|-----|-----|----|
| t <sub>on</sub>     | Turn-On Time        | V <sub>DD</sub> = 380 V, I <sub>D</sub> = 38 A,<br>V <sub>GS</sub> = 10 V, R <sub>G</sub> = 4.7 Ω | – | –   | 242 | ns |
| t <sub>d(on)</sub>  | Turn-On Delay Time  |                                                                                                   | – | 63  | –   | ns |
| t <sub>r</sub>      | Rise Time           |                                                                                                   | – | 48  | –   | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |                                                                                                   | – | 214 | –   | ns |
| t <sub>f</sub>      | Fall Time           |                                                                                                   | – | 33  | –   | ns |
| t <sub>off</sub>    | Turn-Off Time       |                                                                                                   | – | –   | 514 | ns |

### DRAIN–SOURCE DIODE CHARACTERISTICS

|                 |                               |                                                        |   |     |     |    |
|-----------------|-------------------------------|--------------------------------------------------------|---|-----|-----|----|
| V <sub>SD</sub> | Source to Drain Diode Voltage | I <sub>SD</sub> = 38 A, V <sub>GS</sub> = 0 V          | – | –   | 1.2 | V  |
| t <sub>rr</sub> | Reverse Recovery Time         | I <sub>F</sub> = 38 A, dI <sub>SD</sub> /dt = 100 A/μs | – | 219 | –   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge       | V <sub>DD</sub> = 480 V                                | – | 1.9 | –   | 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. The maximum value is specified by design at T<sub>J</sub> = 150°C. Product is not tested to this condition in production.

TYPICAL CHARACTERISTICS

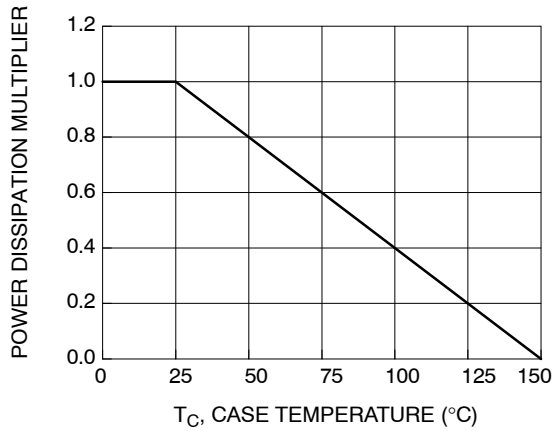


Figure 1. Normalized Power Dissipation vs. Case Temperature

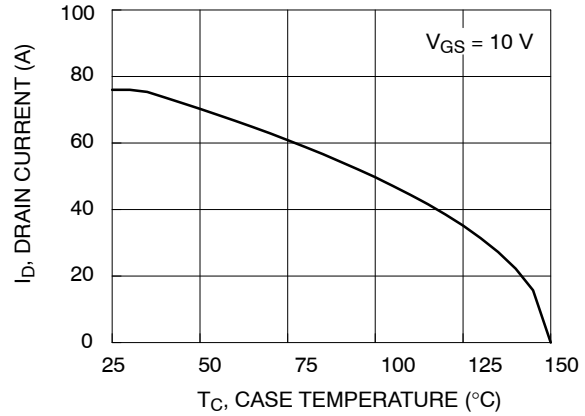


Figure 2. Maximum Continuous Drain Current vs. Case Temperature

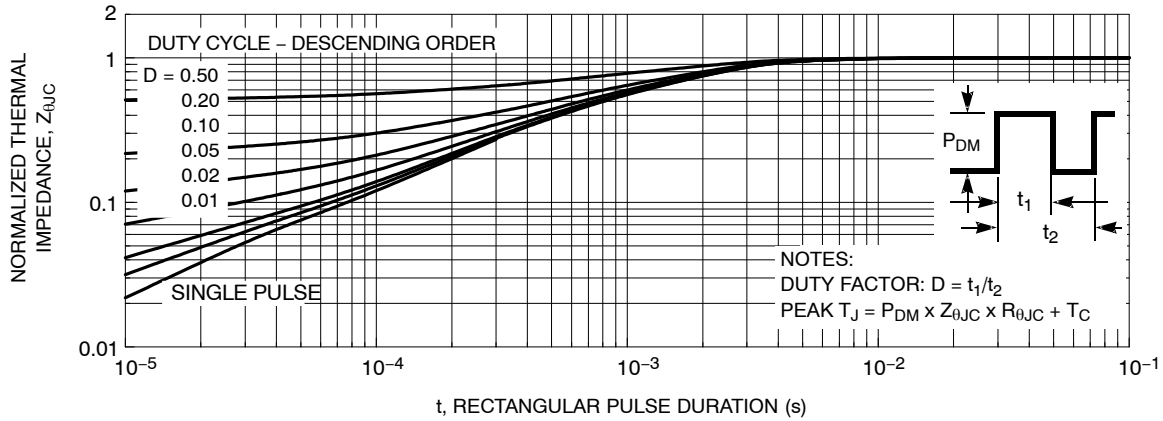


Figure 3. Normalized Maximum Transient Thermal Impedance

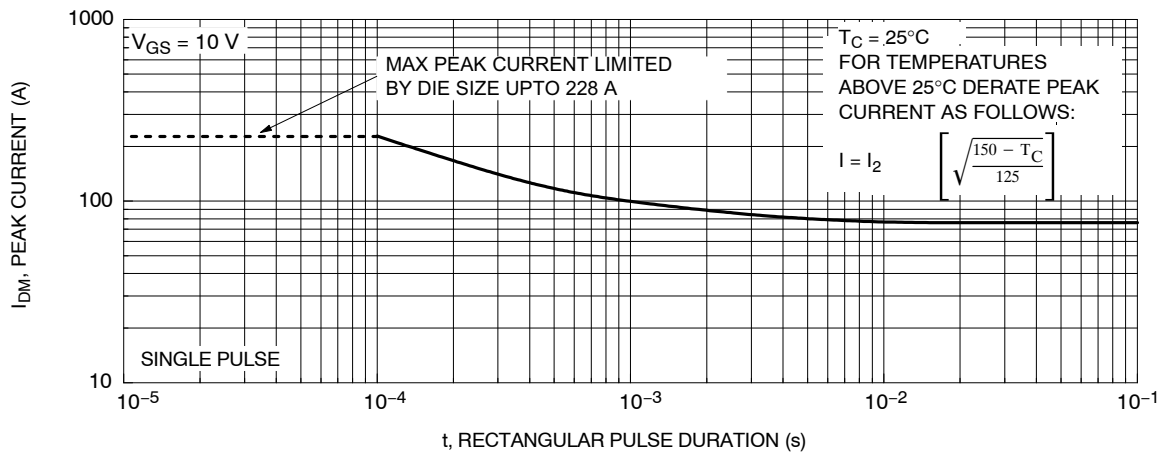


Figure 4. Peak Current Capability

## TYPICAL CHARACTERISTICS (continued)

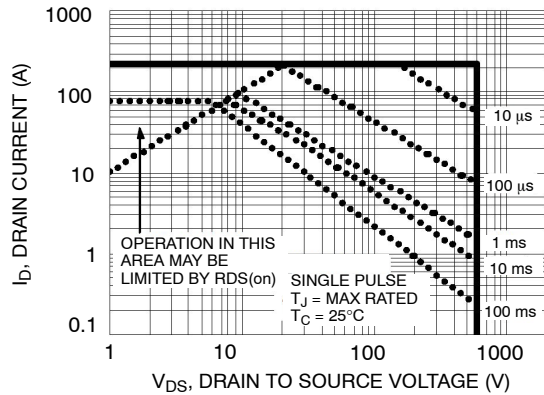


Figure 5. Forward Bias Safe Operating Area

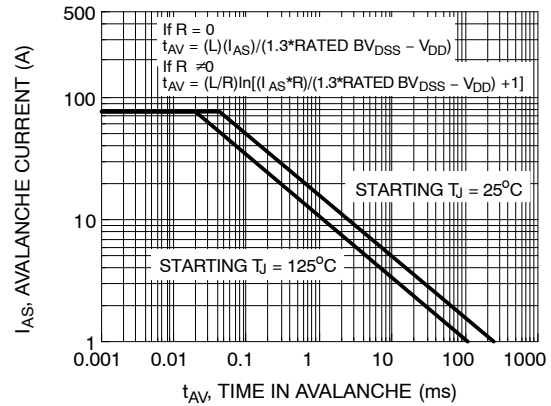


Figure 6. Unclamped Inductive Switching Capability

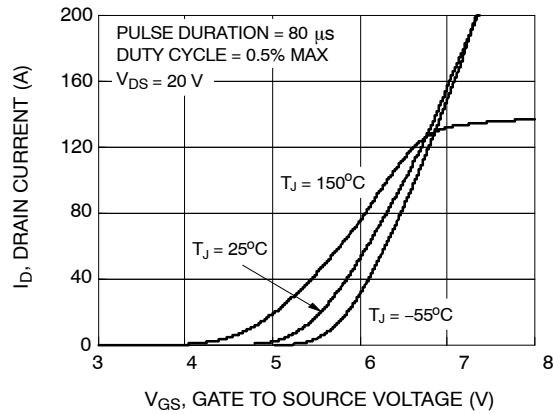


Figure 7. Transfer Characteristics

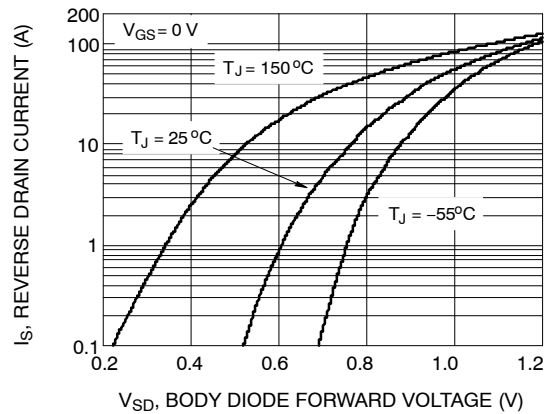


Figure 8. Forward Diode Characteristics

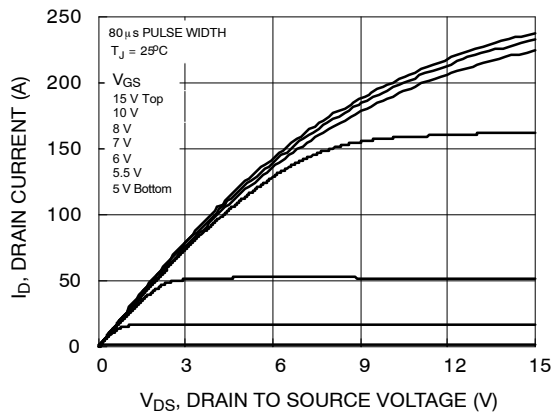


Figure 9. Saturation Characteristics

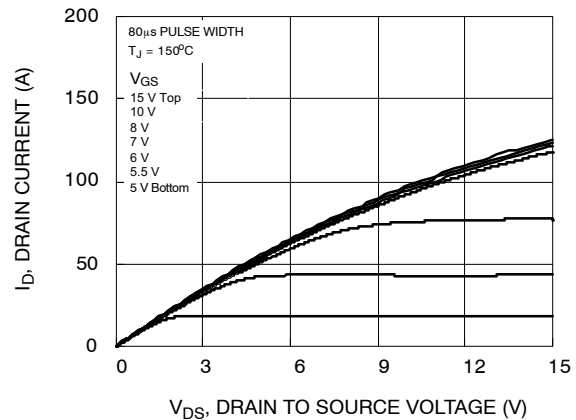


Figure 10. Saturation Characteristics

TYPICAL CHARACTERISTICS (continued)

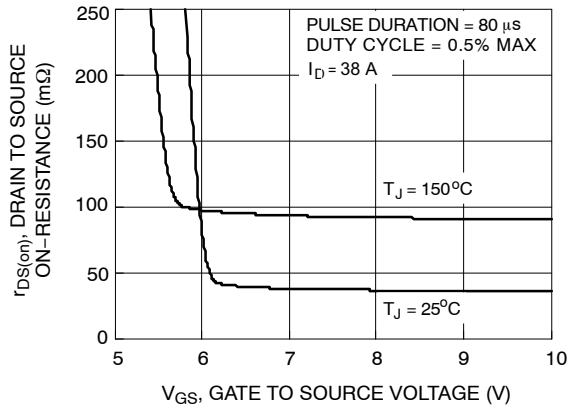


Figure 11.  $R_{DS(on)}$  vs. Gate Voltage

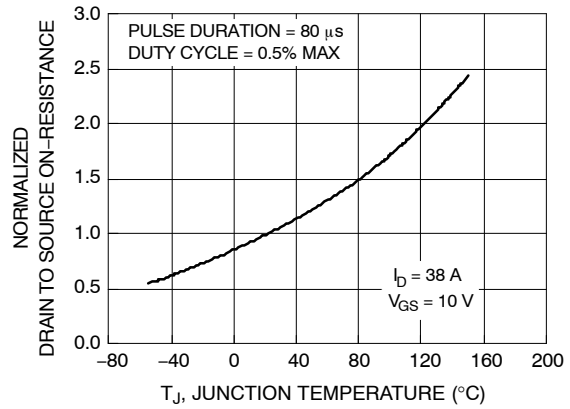


Figure 12. Normalized  $R_{DS(on)}$  vs. Junction Temperature

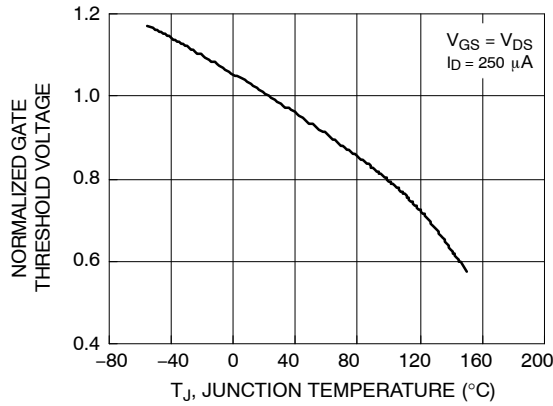


Figure 13. Normalized Gate Threshold Voltage vs. Temperature

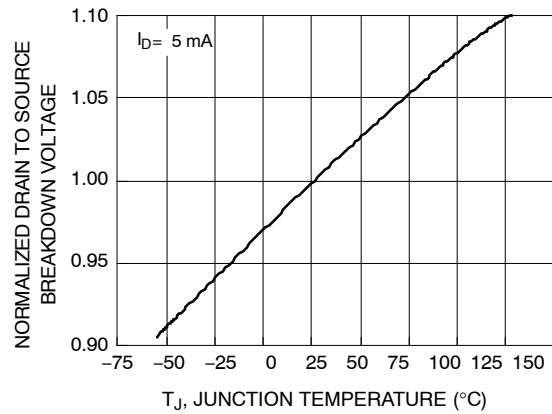


Figure 14. Normalized Drain to Source Breakdown Voltage vs. Junction Temperature

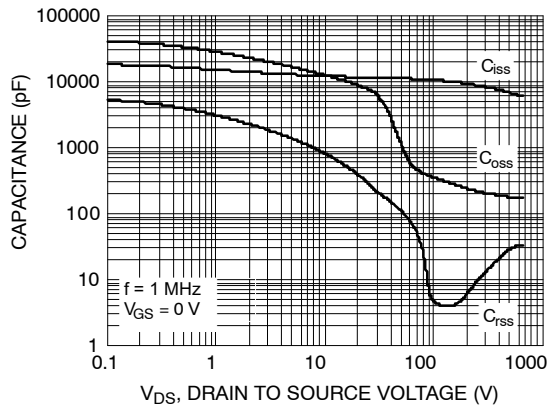


Figure 15. Capacitance vs. Drain to Source Voltage

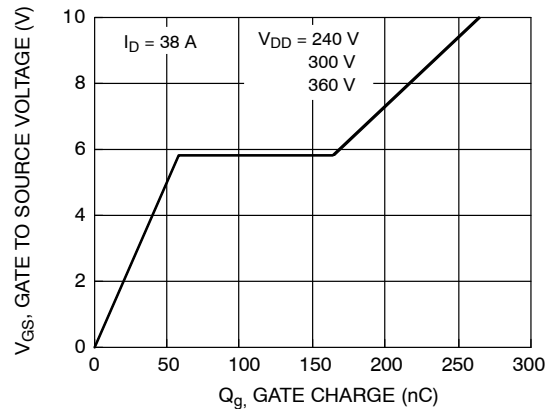


Figure 16. Gate Charge vs. Gate to Source Voltage

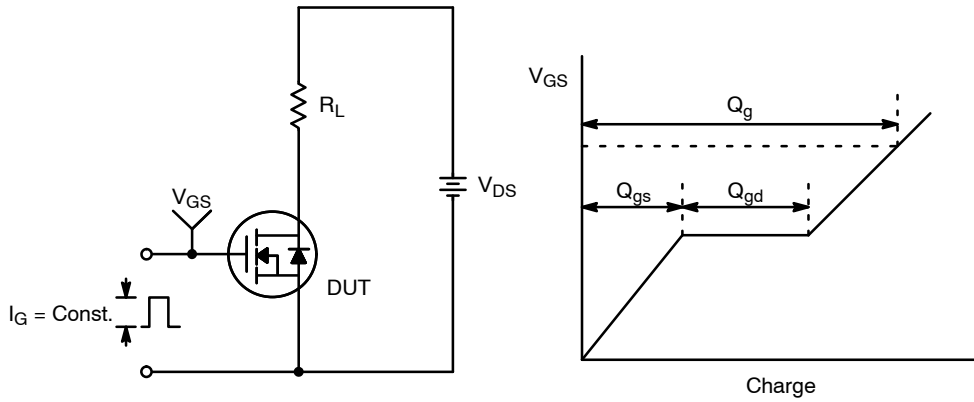


Figure 17. Gate Charge Test Circuit & Waveform

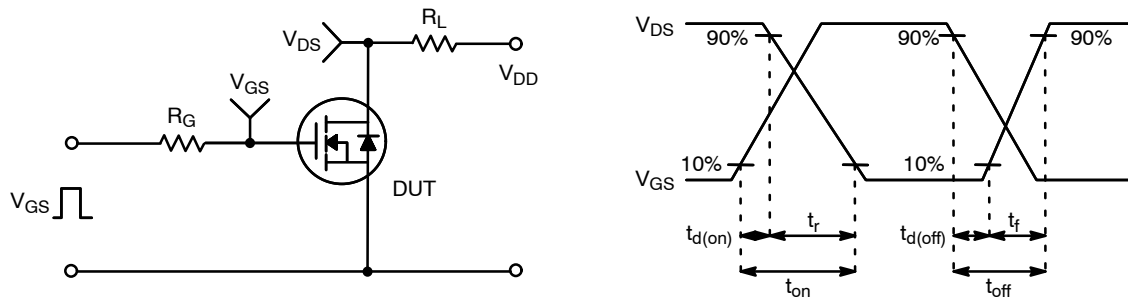


Figure 18. Resistive Switching Test Circuit & Waveforms

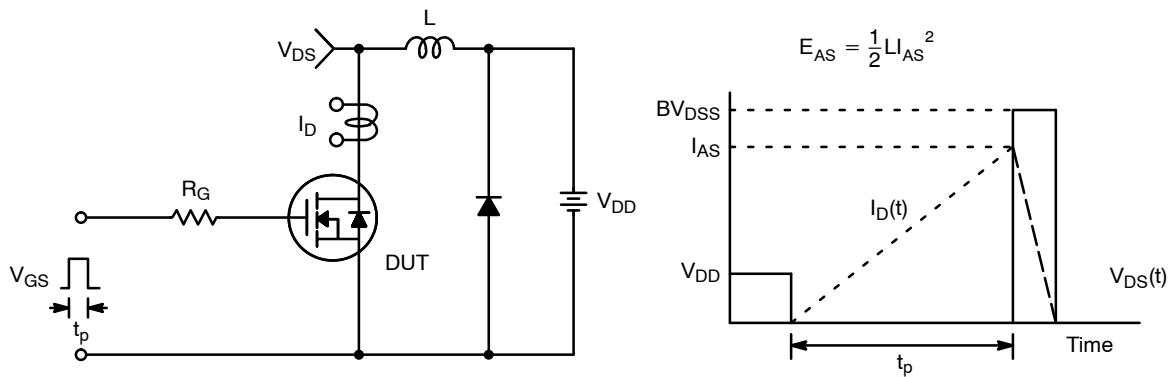
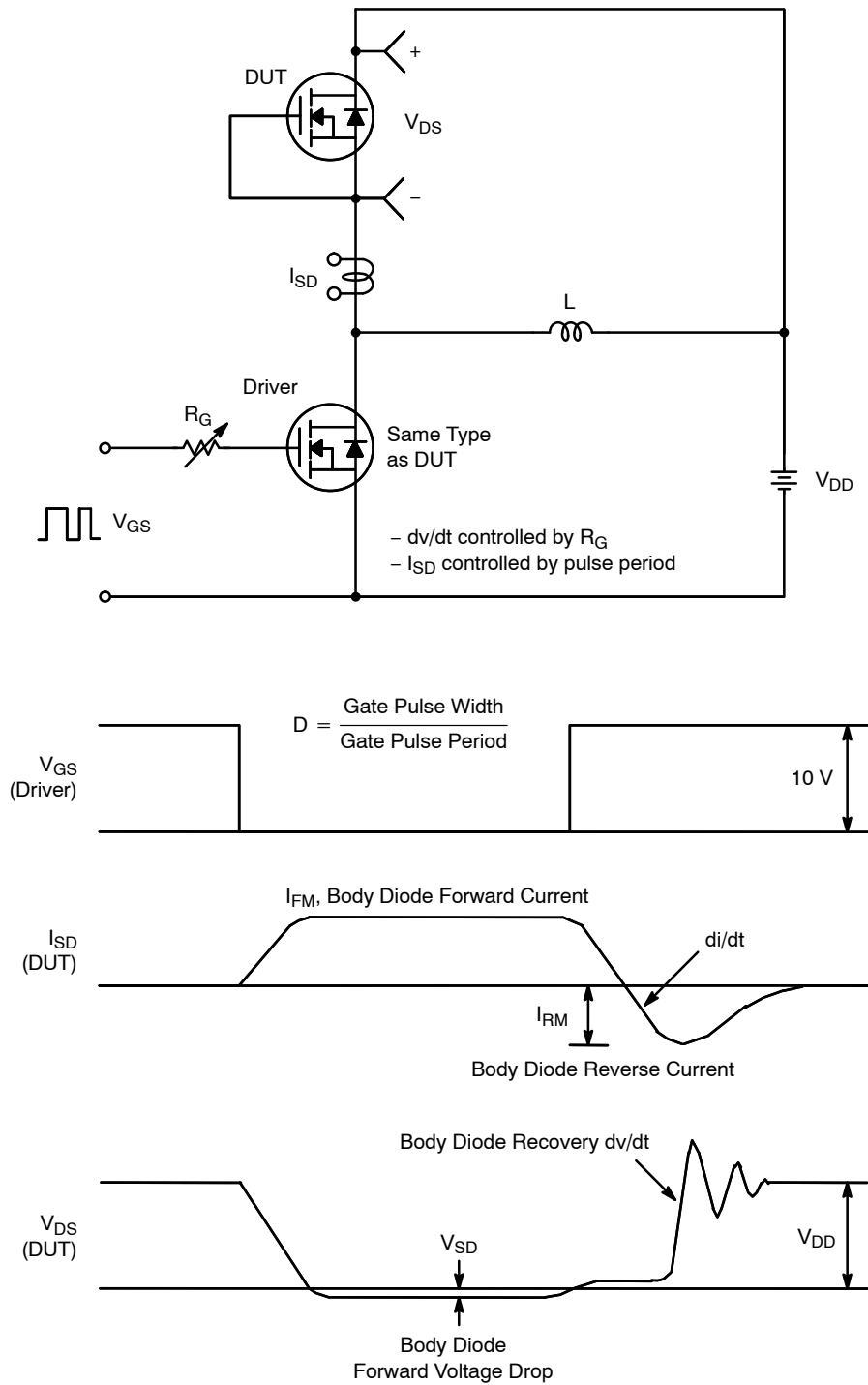


Figure 19. Unclamped Inductive Switching Test Circuit & Waveforms

# FCH041N60F-F085



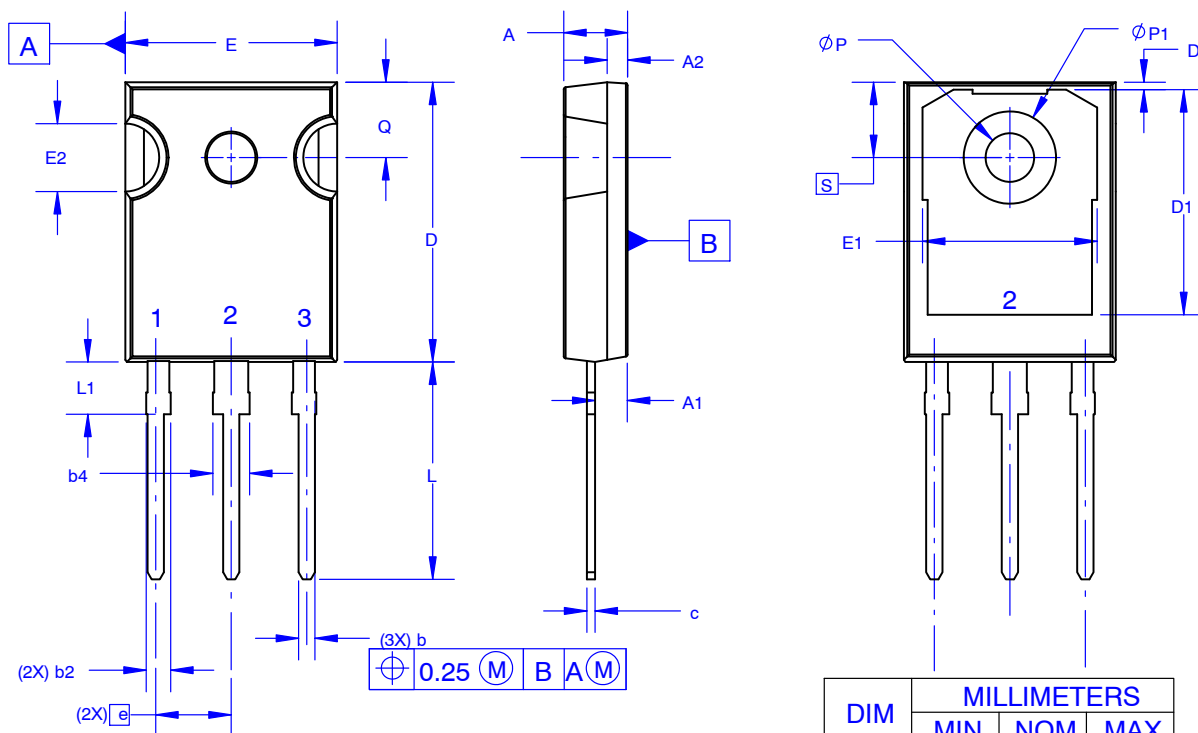
**Figure 20. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms**

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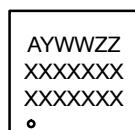
**TO-247-3LD SHORT LEAD**  
**CASE 340CK**  
**ISSUE A**

DATE 31 JAN 2019



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.  
B. ALL DIMENSIONS ARE IN MILLIMETERS.  
C. DRAWING CONFORMS TO ASME Y14.5 - 2009.  
D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.  
E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

**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.

| DIM       | MILLIMETERS |       |       |
|-----------|-------------|-------|-------|
|           | MIN         | NOM   | MAX   |
| A         | 4.58        | 4.70  | 4.82  |
| A1        | 2.20        | 2.40  | 2.60  |
| A2        | 1.40        | 1.50  | 1.60  |
| b         | 1.17        | 1.26  | 1.35  |
| b2        | 1.53        | 1.65  | 1.77  |
| b4        | 2.42        | 2.54  | 2.66  |
| c         | 0.51        | 0.61  | 0.71  |
| D         | 20.32       | 20.57 | 20.82 |
| D1        | 13.08       | ~     | ~     |
| D2        | 0.51        | 0.93  | 1.35  |
| E         | 15.37       | 15.62 | 15.87 |
| E1        | 12.81       | ~     | ~     |
| E2        | 4.96        | 5.08  | 5.20  |
| e         | ~           | 5.56  | ~     |
| L         | 15.75       | 16.00 | 16.25 |
| L1        | 3.69        | 3.81  | 3.93  |
| $\phi P$  | 3.51        | 3.58  | 3.65  |
| $\phi P1$ | 6.60        | 6.80  | 7.00  |
| Q         | 5.34        | 5.46  | 5.58  |
| S         | 5.34        | 5.46  | 5.58  |

|                         |                              |                                                                                                                                                                                  |
|-------------------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>TO-247-3LD SHORT LEAD</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                               |

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