



**Is Now Part of**



**ON Semiconductor®**

**To learn more about ON Semiconductor, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)**

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

# FCP380N60E / FCPF380N60E

## N-Channel SuperFET® II Easy-Drive MOSFET

600 V, 10.2 A, 380 mΩ

### Features

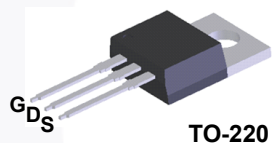
- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 320\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 34\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 97\text{ pF}$ )
- 100% Avalanche Tested
- An Integrated Gate Resistor
- RoHS Compliant

### Applications

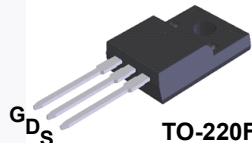
- LCD / LED / PDP TV Lighting
- Solar Inverter
- AC-DC Power Supply

### Description

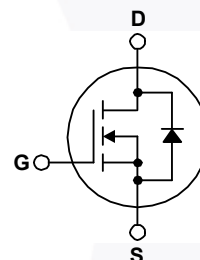
SuperFET® II MOSFET is Fairchild Semiconductor's brand-new high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This technology is tailored to minimize conduction loss, provide superior switching performance,  $dv/dt$  rate and higher avalanche energy. Consequently, SuperFET II MOSFET easy-drive series offers slightly slower rise and fall times compared to the SuperFET II MOSFET series. Noted by the "E" part number suffix, this family helps manage EMI issues and allows for easier design implementation. For faster switching in applications where switching losses must be at an absolute minimum, please consider the SuperFET II MOSFET series.



TO-220



TO-220F



### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted.

| Symbol         | Parameter                                                            | FCP380N60E                                 | FCPF380N60E | Unit             |
|----------------|----------------------------------------------------------------------|--------------------------------------------|-------------|------------------|
| $V_{DSS}$      | Drain to Source Voltage                                              | 600                                        |             | V                |
| $V_{GSS}$      | Gate to Source Voltage                                               | - DC                                       | $\pm 20$    | V                |
|                |                                                                      | - AC (f > 1 Hz)                            | $\pm 30$    |                  |
| $I_D$          | Drain Current                                                        | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 10.2        | A                |
|                |                                                                      | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 6.4         |                  |
| $I_{DM}$       | Drain Current                                                        | - Pulsed (Note 1)                          | 30.6        | A                |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                              | 211.6                                      |             | mJ               |
| $I_{AR}$       | Avalanche Current (Note 1)                                           | 2.3                                        |             | A                |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                 | 1.06                                       |             | mJ               |
| $dv/dt$        | MOSFET $dv/dt$                                                       | 100                                        |             | V/ns             |
|                | Peak Diode Recovery $dv/dt$ (Note 3)                                 | 20                                         |             |                  |
| $P_D$          | Power Dissipation                                                    | ( $T_C = 25^\circ\text{C}$ )               | 106         | W                |
|                |                                                                      | - Derate Above $25^\circ\text{C}$          | 0.85        |                  |
| $T_J, T_{STG}$ | 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                                        |             | $^\circ\text{C}$ |

\*Drain current limited by maximum junction temperature.

### Thermal Characteristics

| Symbol          | Parameter                                     | FCP380N60E | FCPF380N60E | Unit               |
|-----------------|-----------------------------------------------|------------|-------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 1.18       | 4           | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 62.5       | 62.5        |                    |

## Package Marking and Ordering Information

| Part Number | Top Mark    | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|-------------|---------|----------------|-----------|------------|----------|
| FCP380N60E  | FCP380N60E  | TO-220  | Tube           | N/A       | N/A        | 50 units |
| FCPF380N60E | FCPF380N60E | TO-220F | Tube           | N/A       | N/A        | 50 units |

## 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           | $V_{GS} = 0\text{ V}, I_D = 10\text{ mA}, T_J = 25^\circ\text{C}$  | 600 | -    | -         | V                         |
|                                |                                             | $V_{GS} = 0\text{ V}, I_D = 10\text{ mA}, T_J = 150^\circ\text{C}$ | 650 | -    | -         |                           |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient   | $I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$            | -   | 0.67 | -         | $\text{V}/^\circ\text{C}$ |
| $BV_{DS}$                      | Drain to Source Avalanche Breakdown Voltage | $V_{GS} = 0\text{ V}, I_D = 10\text{ A}$                           | -   | 700  | -         | V                         |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current             | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                       | -   | -    | 1         | $\mu\text{A}$             |
|                                |                                             | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$                   | -   | 0.84 | -         |                           |
| $I_{GSS}$                      | Gate to Body Leakage Current                | $V_{GS} = \pm 20\text{ V}, V_{DS} = 0\text{ V}$                    | -   | -    | $\pm 100$ | nA                        |

### On Characteristics

|              |                                      |                                                 |     |      |      |          |
|--------------|--------------------------------------|-------------------------------------------------|-----|------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}, I_D = 250\text{ }\mu\text{A}$ | 2.5 | -    | 3.5  | V        |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 5\text{ A}$        | -   | 0.32 | 0.38 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 20\text{ V}, I_D = 5\text{ A}$        | -   | 10   | -    | S        |

### Dynamic Characteristics

|                 |                               |                                                                             |   |      |      |          |
|-----------------|-------------------------------|-----------------------------------------------------------------------------|---|------|------|----------|
| $C_{iss}$       | Input Capacitance             | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$               | - | 1330 | 1770 | pF       |
| $C_{oss}$       | Output Capacitance            |                                                                             | - | 945  | 1260 | pF       |
| $C_{rss}$       | Reverse Transfer Capacitance  |                                                                             | - | 60   | 90   | pF       |
| $C_{oss}$       | Output Capacitance            | $V_{DS} = 380\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$              | - | 25   | -    | pF       |
| $C_{oss(eff.)}$ | Effective Output Capacitance  | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$                 | - | 97   | -    | pF       |
| $Q_{g(tot)}$    | Total Gate Charge at 10V      | $V_{DS} = 380\text{ V}, I_D = 5\text{ A}, V_{GS} = 10\text{ V}$<br>(Note 4) | - | 34   | 45   | nC       |
| $Q_{gs}$        | Gate to Source Gate Charge    |                                                                             | - | 5.3  | -    | nC       |
| $Q_{gd}$        | Gate to Drain "Miller" Charge |                                                                             | - | 13   | -    | nC       |
| ESR             | Equivalent Series Resistance  | $f = 1\text{ MHz}$                                                          | - | 6    | -    | $\Omega$ |

### Switching Characteristics

|              |                     |                                                                                                    |   |    |     |    |
|--------------|---------------------|----------------------------------------------------------------------------------------------------|---|----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 380\text{ V}, I_D = 5\text{ A}, V_{GS} = 10\text{ V}, R = 4.7\text{ }\Omega$<br>(Note 4) | - | 17 | 44  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                    | - | 9  | 28  | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                    | - | 64 | 138 | ns |
| $t_f$        | Turn-Off Fall Time  | (Note 4)                                                                                           | - | 10 | 30  | ns |

### Drain-Source Diode Characteristics

|                 |                                                          |                                                                                 |   |     |      |    |
|-----------------|----------------------------------------------------------|---------------------------------------------------------------------------------|---|-----|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain to Source Diode Forward Current |                                                                                 | - | -   | 10.2 | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain to Source Diode Forward Current     |                                                                                 | - | -   | 30.6 | A  |
| V <sub>SD</sub> | Drain to Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 5 A                                    | - | -   | 1.2  | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                    | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 5 A,<br>dI <sub>F</sub> /dt = 100 A/μs | - | 240 | -    | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                                  |                                                                                 | - | 3   | -    | μC |

#### Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 2.3\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 5.1\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

# Typical Performance Characteristics

Figure 1. On-Region Characteristics

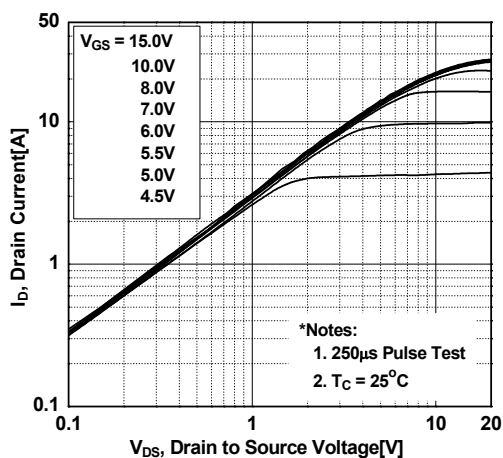


Figure 2. Transfer Characteristics

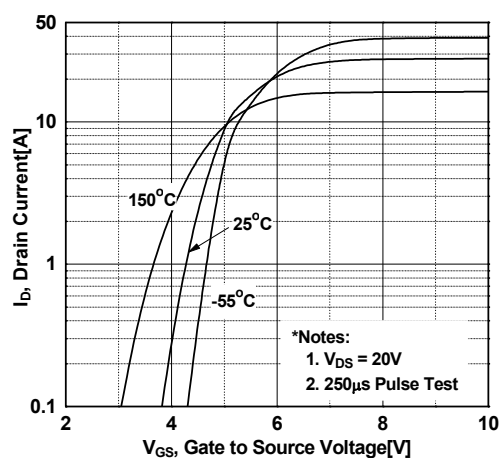


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

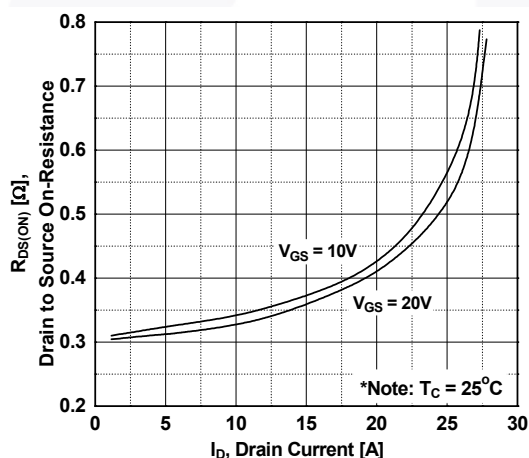


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

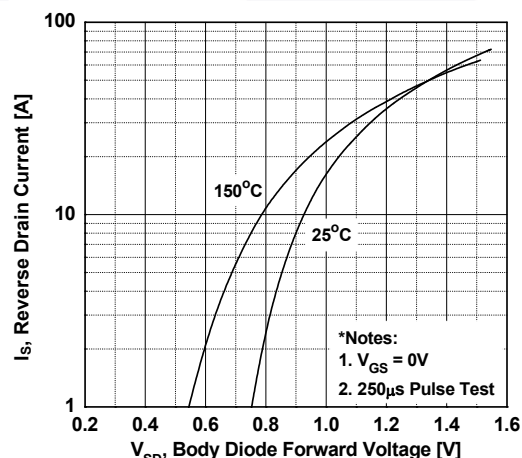


Figure 5. Capacitance Characteristics

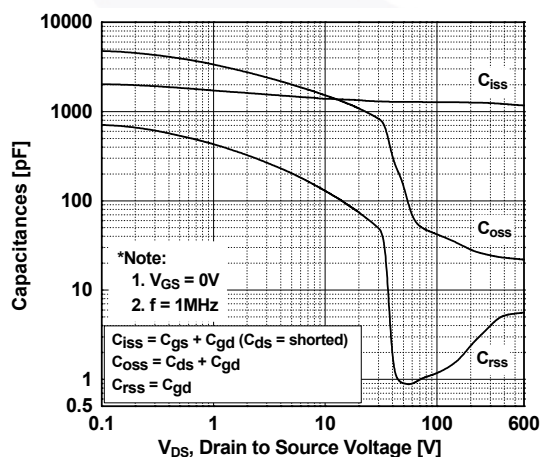
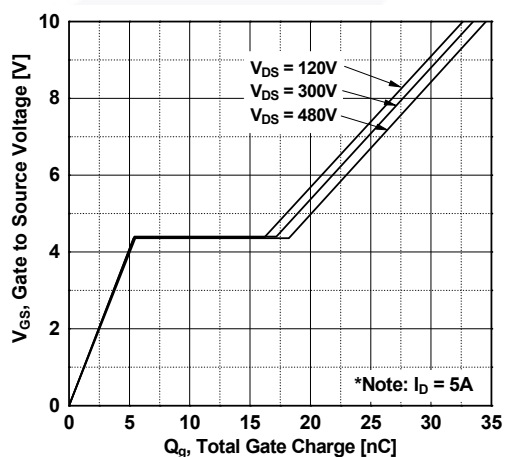
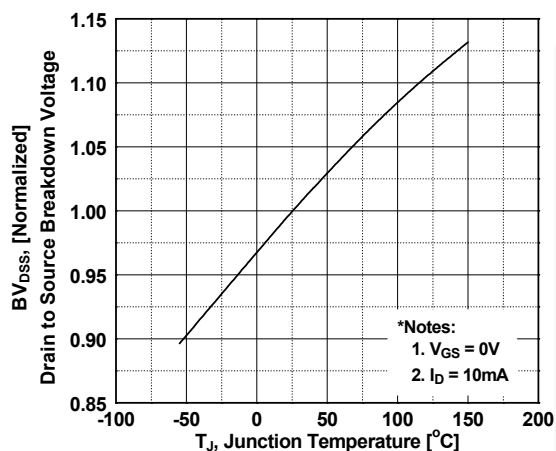


Figure 6. Gate Charge Characteristics

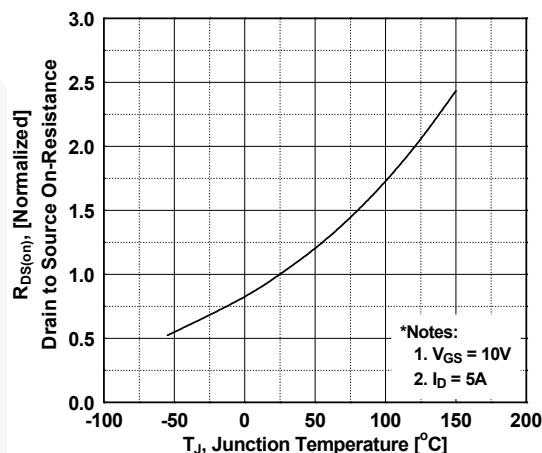


## Typical Performance Characteristics (Continued)

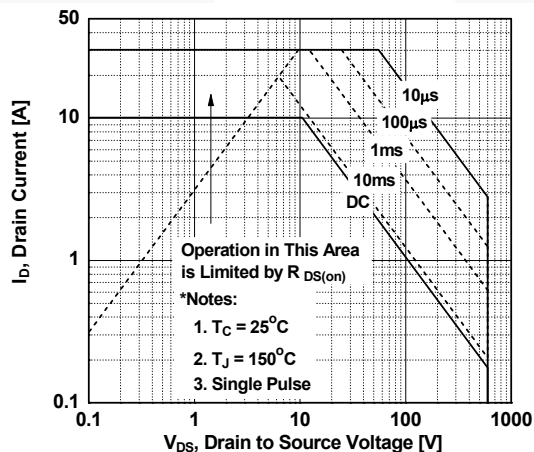
**Figure 7. Breakdown Voltage Variation vs. Temperature**



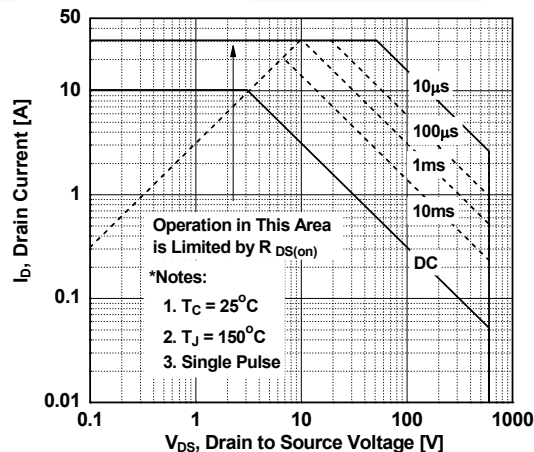
**Figure 8. On-Resistance Variation vs. Temperature**



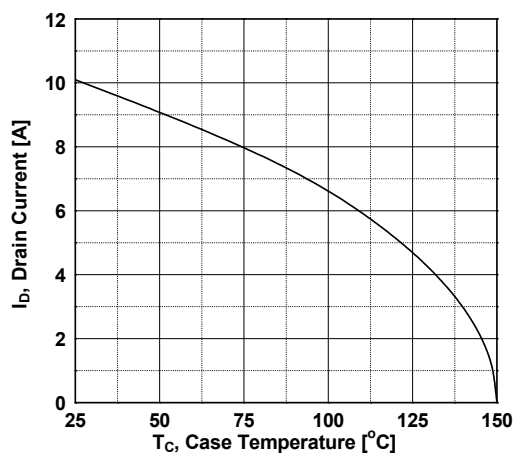
**Figure 9. Maximum Safe Operating Area for FCP380N60E**



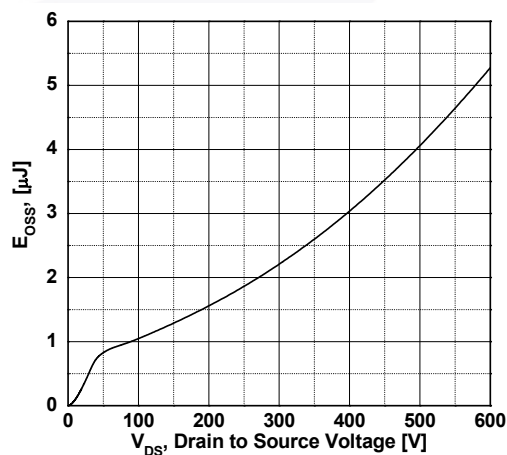
**Figure 10. Maximum Safe Operating Area for FCPF380N60E**



**Figure 11. Maximum Drain Current vs. Case Temperature**



**Figure 12. E\_oss vs. Drain to Source Voltage**



## Typical Performance Characteristics (Continued)

Figure 13. Transient Thermal Response Curve for FCP380N60E

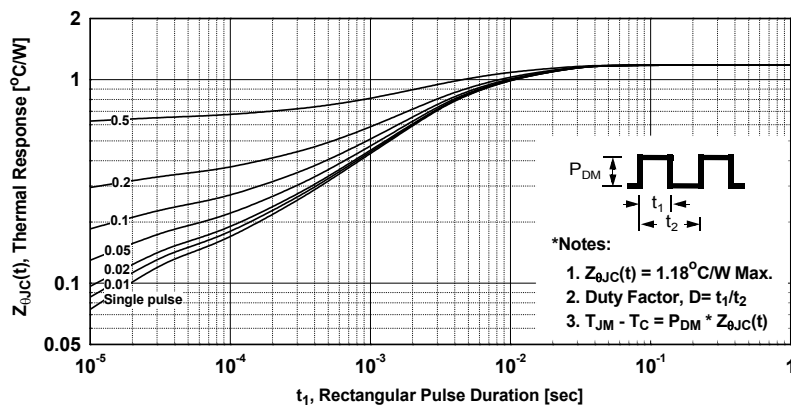
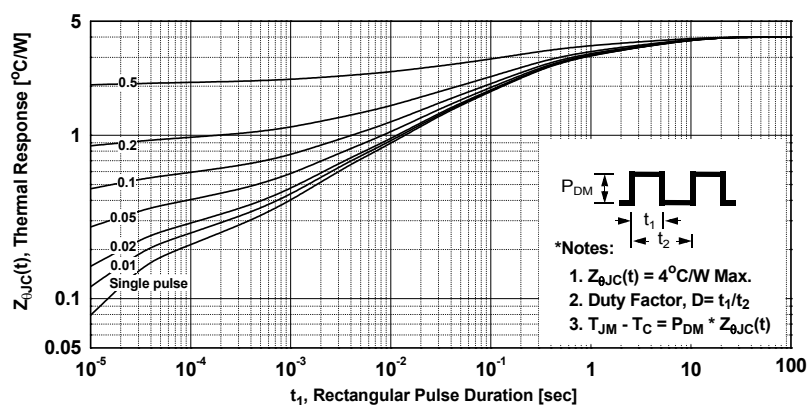


Figure 14. Transient Thermal Response Curve FOR FCPF380N60E



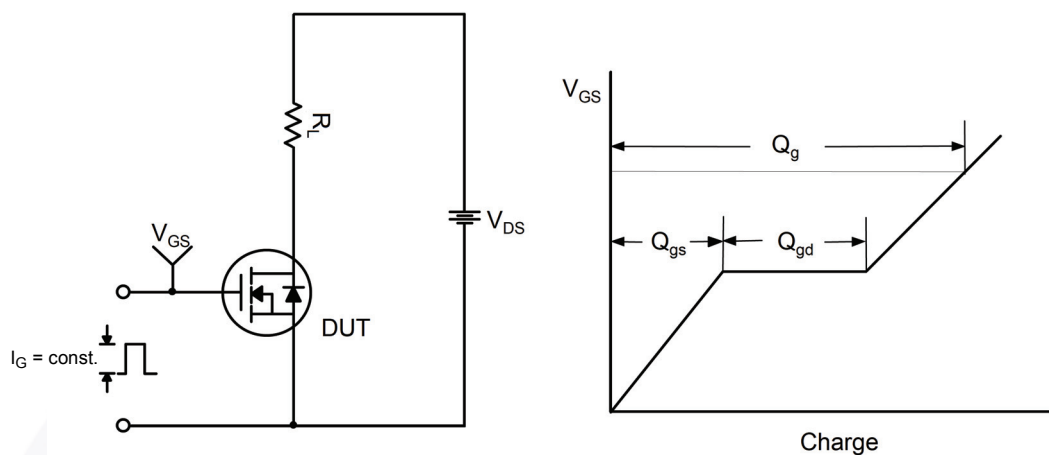


Figure 15. Gate Charge Test Circuit & Waveform

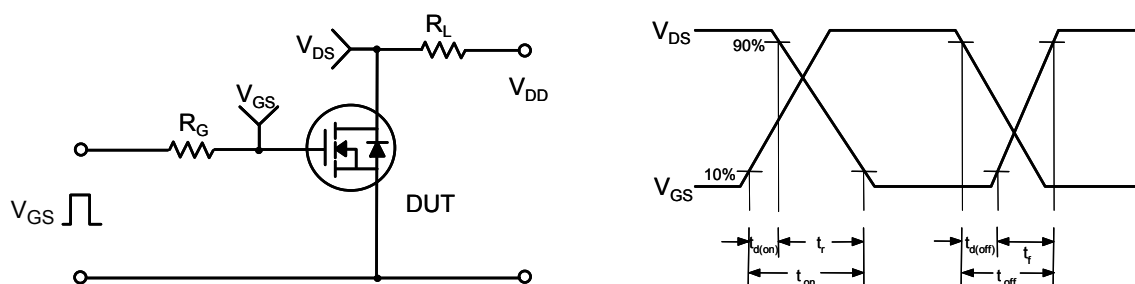


Figure 16. Resistive Switching Test Circuit & Waveforms

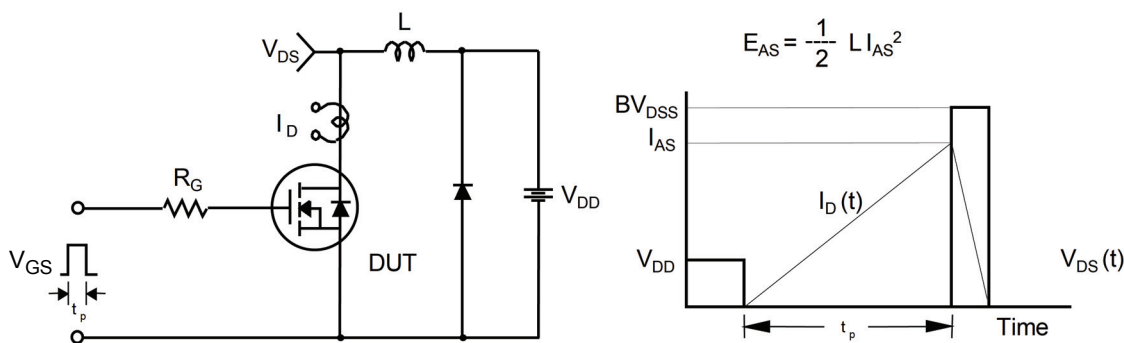


Figure 17. Unclamped Inductive Switching Test Circuit & Waveforms

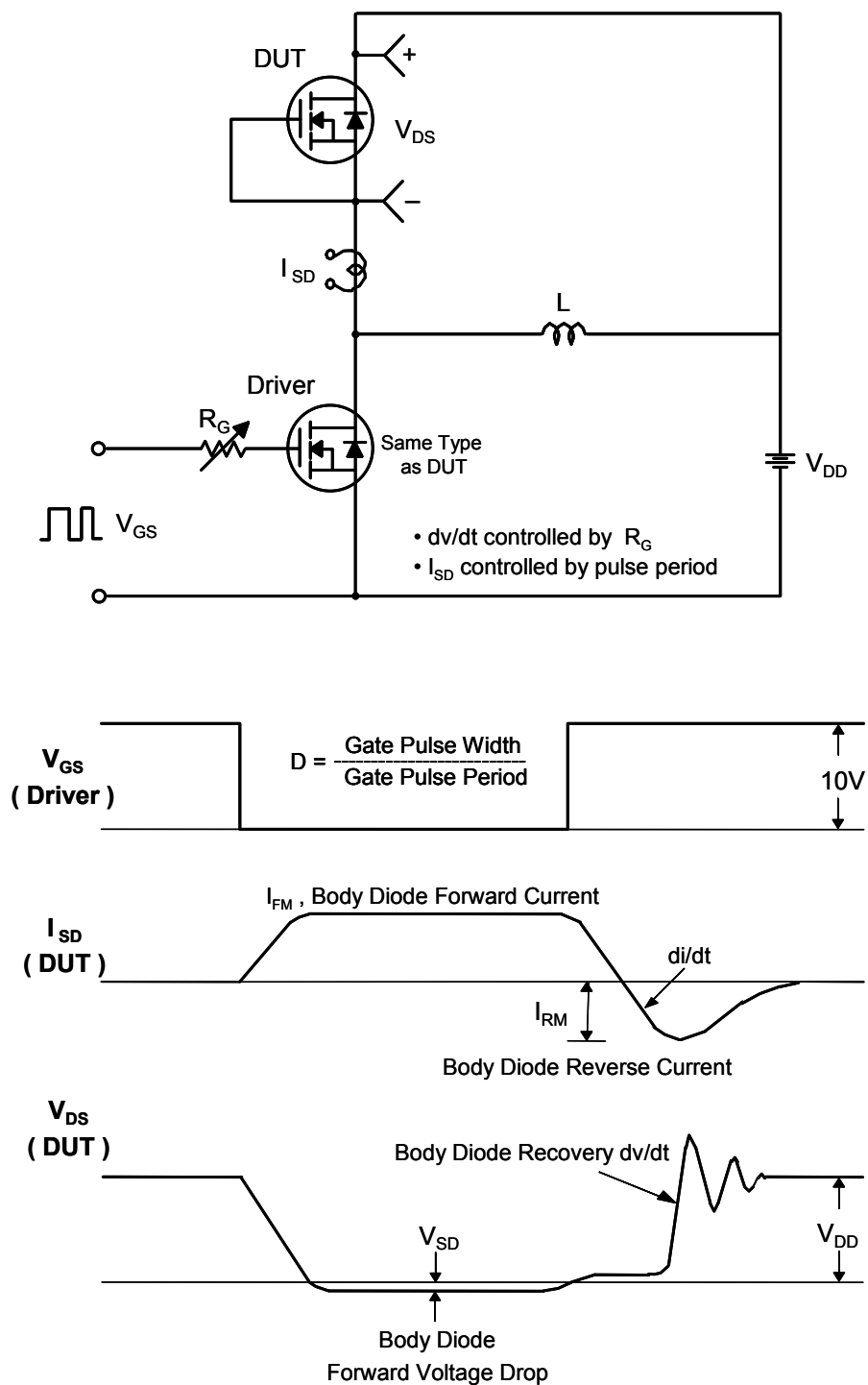
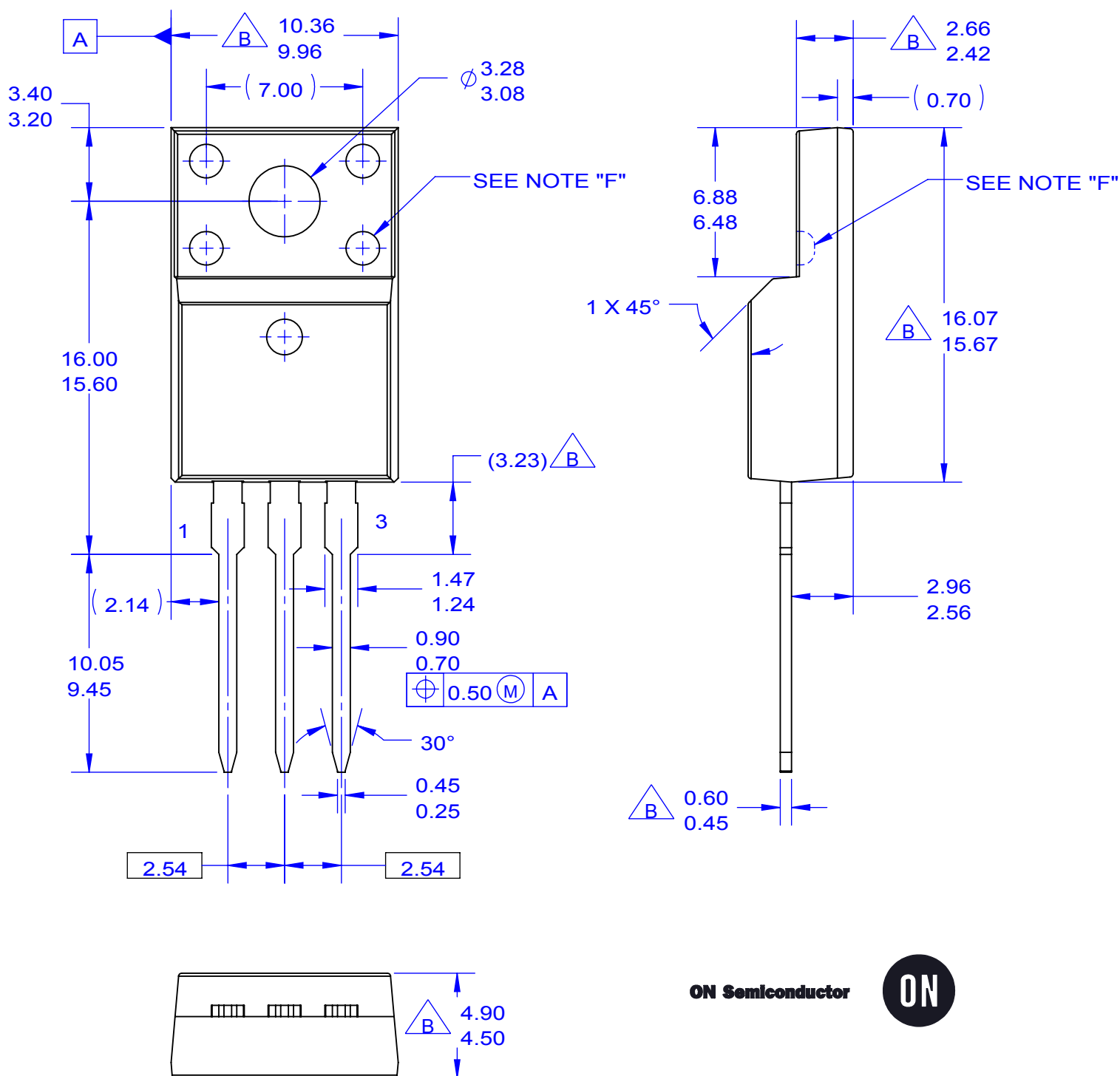


Figure 18. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms







ON Semiconductor



#### NOTES:

- A. EXCEPT WHERE NOTED CONFORMS TO EIAJ SC91A.
- B. DOES NOT COMPLY EIAJ STD. VALUE.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
- E. DIMENSION AND TOLERANCE AS PER ASME Y14.5-1994.
- F. OPTION 1 - WITH SUPPORT PIN HOLE.  
OPTION 2 - NO SUPPORT PIN HOLE.
- G. DRAWING FILE NAME: TO220M03REV5

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada

**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910

**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)

**Order Literature:** <http://www.onsemi.com/orderlit>

For additional information, please contact your local  
Sales Representative