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# FCH041N60F

## N-Channel SuperFET® II FRFET® MOSFET

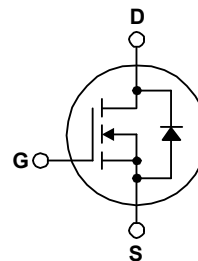
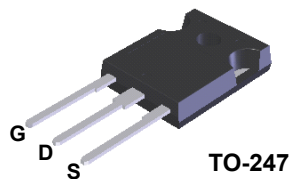
### 600 V, 76 A, 41 mΩ

#### Features

- 650 V @  $T_J = 150^\circ\text{C}$
- Typ.  $R_{DS(on)} = 36\text{ m}\Omega$
- Ultra Low Gate Charge (Typ.  $Q_g = 277\text{ nC}$ )
- Low Effective Output Capacitance (Typ.  $C_{oss(eff.)} = 748\text{ pF}$ )
- 100% Avalanche Tested
- RoHS Compliant

#### 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 MOSFET is very suitable for the switching power applications such as PFC, server/telecom power, FPD TV power, ATX power and industrial power applications. SuperFET II FRFET® MOSFET's optimized body diode reverse recovery performance can remove additional component and improve system reliability.



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

| Symbol         | Parameter  | FCH041N60F                                 | Unit             |
|----------------|--|--|------------------|
| $V_{DSS}$      | Drain to Source Voltage  | 600  | V                |
| $V_{GSS}$      | Gate to Source Voltage   | - DC                                       | $\pm 20$         |
|                |  | - AC ( $f > 1\text{ Hz}$ )                 | $\pm 30$         |
| $I_D$          | Drain Current  | - Continuous ( $T_C = 25^\circ\text{C}$ )  | 76               |
|                |  | - Continuous ( $T_C = 100^\circ\text{C}$ ) | 48.1             |
| $I_{DM}$       | Drain Current  | - Pulsed (Note 1)                          | 228              |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                              | 2025                                       | mJ               |
| $I_{AR}$       | Avalanche Current (Note 1)   | 15   | A                |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                 | 5.95                                       | mJ               |
| $dv/dt$        | MOSFET $dv/dt$   | 100  | V/ns             |
|                | Peak Diode Recovery $dv/dt$ (Note 3)                                 | 50   |                  |
| $P_D$          | Power Dissipation  | ( $T_C = 25^\circ\text{C}$ )               | 595              |
|                |  | - Derate Above $25^\circ\text{C}$          | 4.76             |
| $T_J, T_{STG}$ | 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  | $^\circ\text{C}$ |

#### Thermal Characteristics

| Symbol          | Parameter                                     | FCH041N60F | Unit               |
|-----------------|---|------------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.21       | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40         |                    |

## Package Marking and Ordering Information

| Part Number | Top Mark   | Package | Packing Method | Reel Size | Tape Width | Quantity |
|-------------|------------|---------|----------------|-----------|------------|----------|
| FCH041N60F  | FCH041N60F | TO-247  | Tube           | N/A       | N/A        | 30 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         | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}, T_J = 25^\circ\text{C}$  | 600 | -    | -         | V                  |
|                                |   | $I_D = 10\text{ mA}, V_{GS} = 0\text{ V}, T_J = 150^\circ\text{C}$ | 650 | -    | -         |                    |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 10\text{ mA}$ , Referenced to $25^\circ\text{C}$            | -   | 0.67 | -         | $V/^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                       | -   | -    | 10        | $\mu\text{A}$      |
|                                |   | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$                   | -   | 267  | -         |                    |
| $I_{GSS}$                      | 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               | $V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$ | 3 | -    | 5  | V                |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 38\text{ A}$ | - | 36   | 41 | $\text{m}\Omega$ |
| $g_{FS}$     | Forward Transconductance             | $V_{DS} = 20\text{ V}, I_D = 38\text{ A}$ | - | 64.5 | -  | S                |

### Dynamic Characteristics

|                 |                               |  |          |       |       |          |
|-----------------|-------------------------------|--|----------|-------|-------|----------|
| $C_{iss}$       | Input Capacitance             | $V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$   | -        | 10800 | 14365 | pF       |
| $C_{oss}$       | Output Capacitance            |  | -        | 324   | 430   | pF       |
| $C_{riss}$      | Reverse Transfer Capacitance  |  | -        | 4.5   | -     | pF       |
| $C_{oss}$       | Output Capacitance            | $V_{DS} = 380\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$   | -        | 185   | -     | pF       |
| $C_{oss(eff.)}$ | Effective Output Capacitance  | $V_{DS} = 0\text{ V to } 480\text{ V}, V_{GS} = 0\text{ V}$      | -        | 748   | -     | pF       |
| $Q_{g(tot)}$    | Total Gate Charge at 10V      | $V_{DS} = 380\text{ V}, I_D = 38\text{ A}, V_{GS} = 10\text{ V}$ | -        | 277   | 360   | nC       |
| $Q_{gs}$        | Gate to Source Gate Charge    |  | -        | 65.3  | -     | nC       |
| $Q_{gd}$        | Gate to Drain "Miller" Charge |  | (Note 4) | -     | 116   | -        |
| ESR             | Equivalent Series Resistance  | $f = 1\text{ MHz}$   | -        | 1.0   | -     | $\Omega$ |

### Switching Characteristics

|              |                     |   |          |     |     |     |
|--------------|---------------------|---|----------|-----|-----|-----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 380\text{ V}, I_D = 38\text{ A}, V_{GS} = 10\text{ V}, R_G = 4.7\ \Omega$ | -        | 63  | 136 | ns  |
| $t_r$        | Turn-On Rise Time   |   | -        | 66  | 142 | ns  |
| $t_{d(off)}$ | Turn-Off Delay Time |   | -        | 244 | 498 | ns  |
| $t_f$        | Turn-Off Fall Time  |   | (Note 4) | -   | 53  | 116 |

### Drain-Source Diode Characteristics

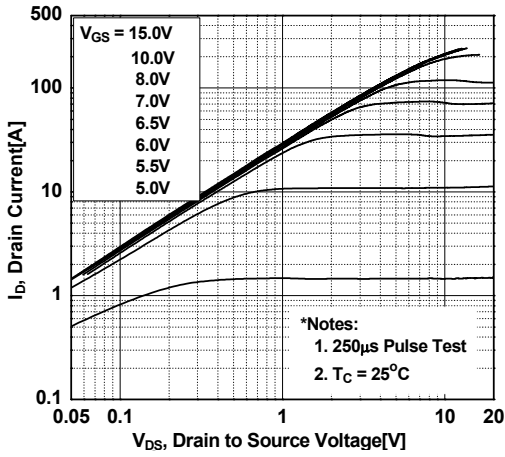
|          |  |   |   |      |     |               |
|----------|--|---|---|------|-----|---------------|
| $I_S$    | Maximum Continuous Drain to Source Diode Forward Current | -   | - | 77   | A   |               |
| $I_{SM}$ | Maximum Pulsed Drain to Source Diode Forward Current     | -   | - | 231  | A   |               |
| $V_{SD}$ | Drain to Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_{SD} = 38\text{ A}$                                     | - | -    | 1.2 | V             |
| $t_{rr}$ | Reverse Recovery Time                                    | $V_{GS} = 0\text{ V}, I_{SD} = 38\text{ A}, di_F/dt = 100\text{ A}/\mu\text{s}$ | - | 214  | -   | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                                  |   | - | 1.79 | -   | $\mu\text{C}$ |

#### Notes:

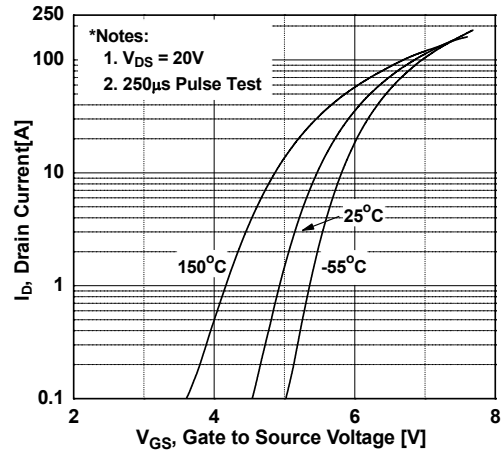
1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 15\text{ A}, R_G = 25\ \Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 38\text{ A}, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq 380\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .
4. Essentially independent of operating temperature typical characteristics.

## Typical Performance Characteristics

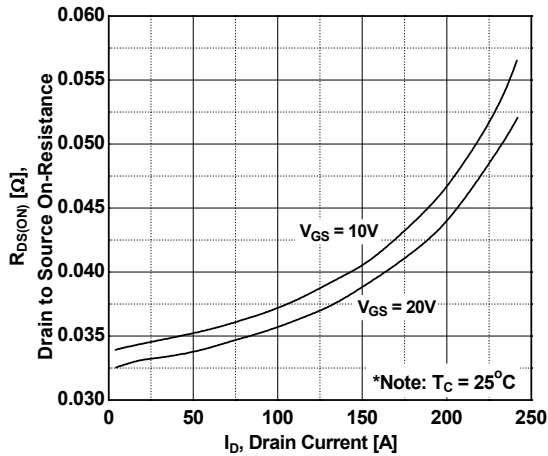
**Figure 1. On-Region Characteristics**



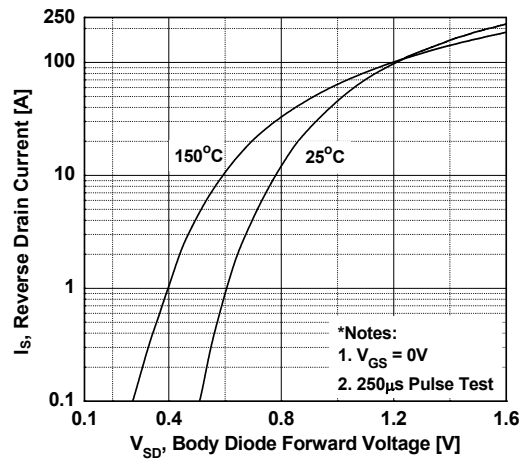
**Figure 2. Transfer Characteristics**



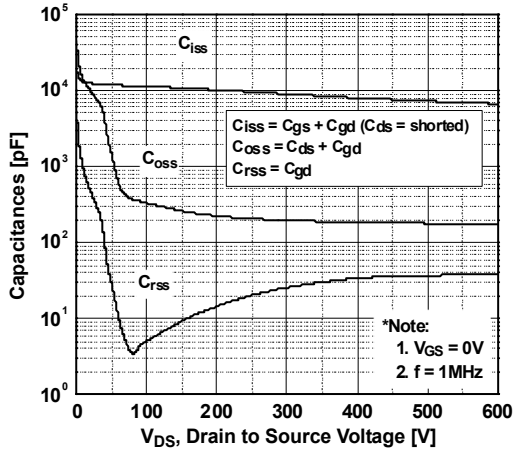
**Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage**



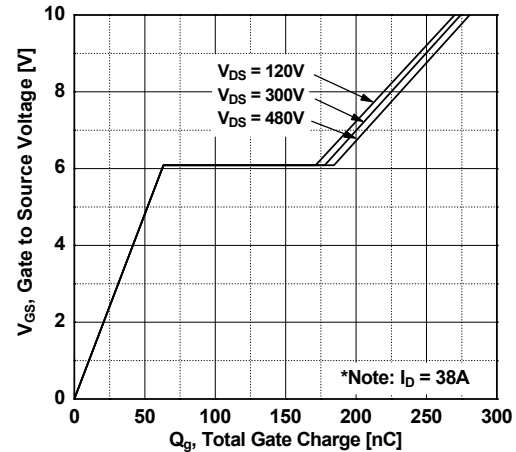
**Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature**



**Figure 5. Capacitance Characteristics**

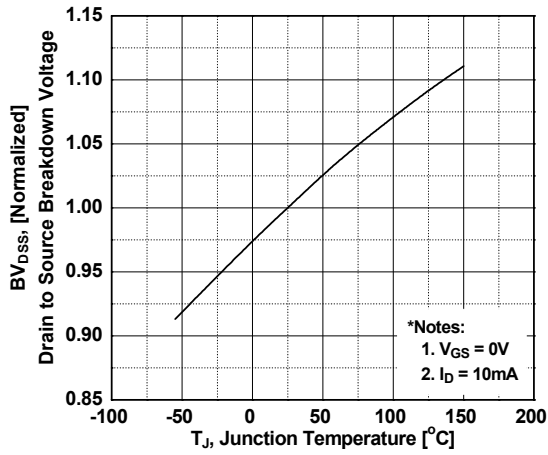


**Figure 6. Gate Charge Characteristics**

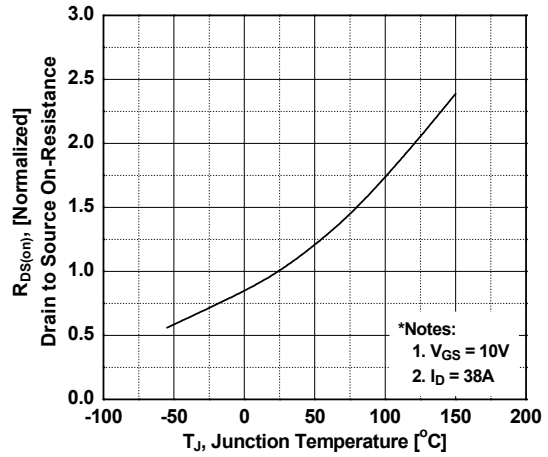


**Typical Performance Characteristics** (Continued)

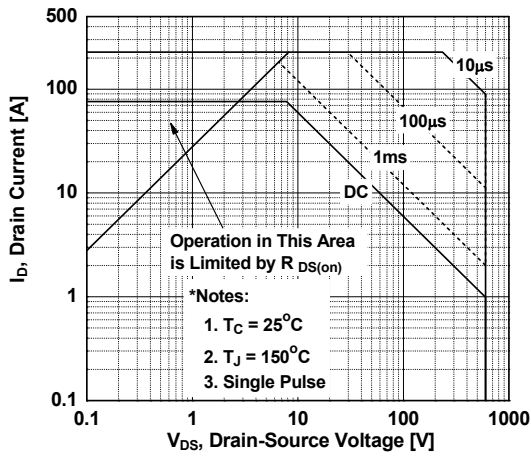
**Figure 7. Breakdown Voltage Variation vs. Temperature**



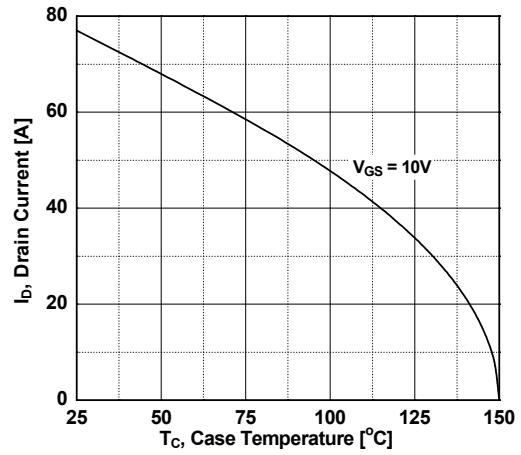
**Figure 8. On-Resistance Variation vs. Temperature**



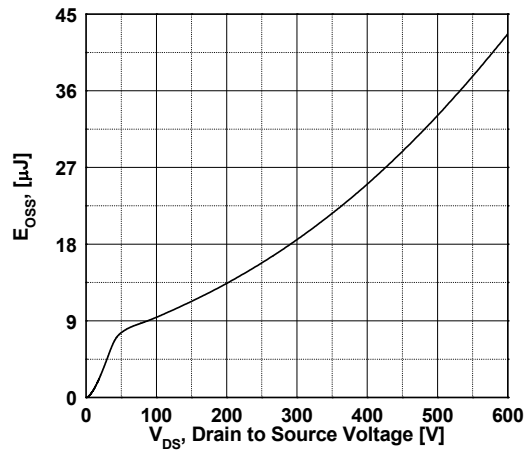
**Figure 9. Maximum Safe Operating Area**



**Figure 10. Maximum Drain Current vs. Case Temperature**

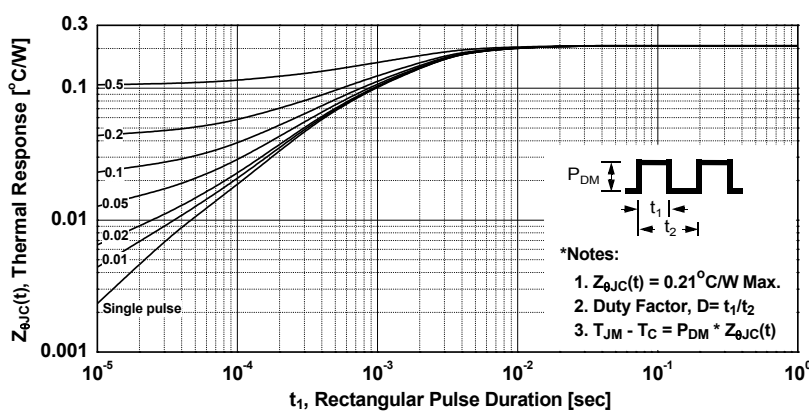


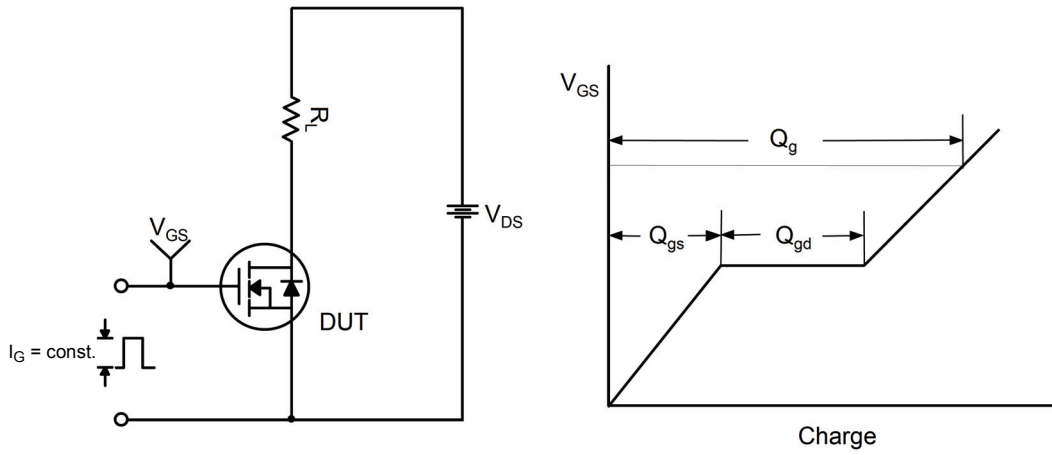
**Figure 11. E\_oss vs. Drain to Source Voltage**



Typical Performance Characteristics (Continued)

Figure 12. Transient Thermal Response Curve





**Figure 13. Gate Charge Test Circuit & Waveform**



**Figure 14. Resistive Switching Test Circuit & Waveforms**



**Figure 15. Unclamped Inductive Switching Test Circuit & Waveforms**

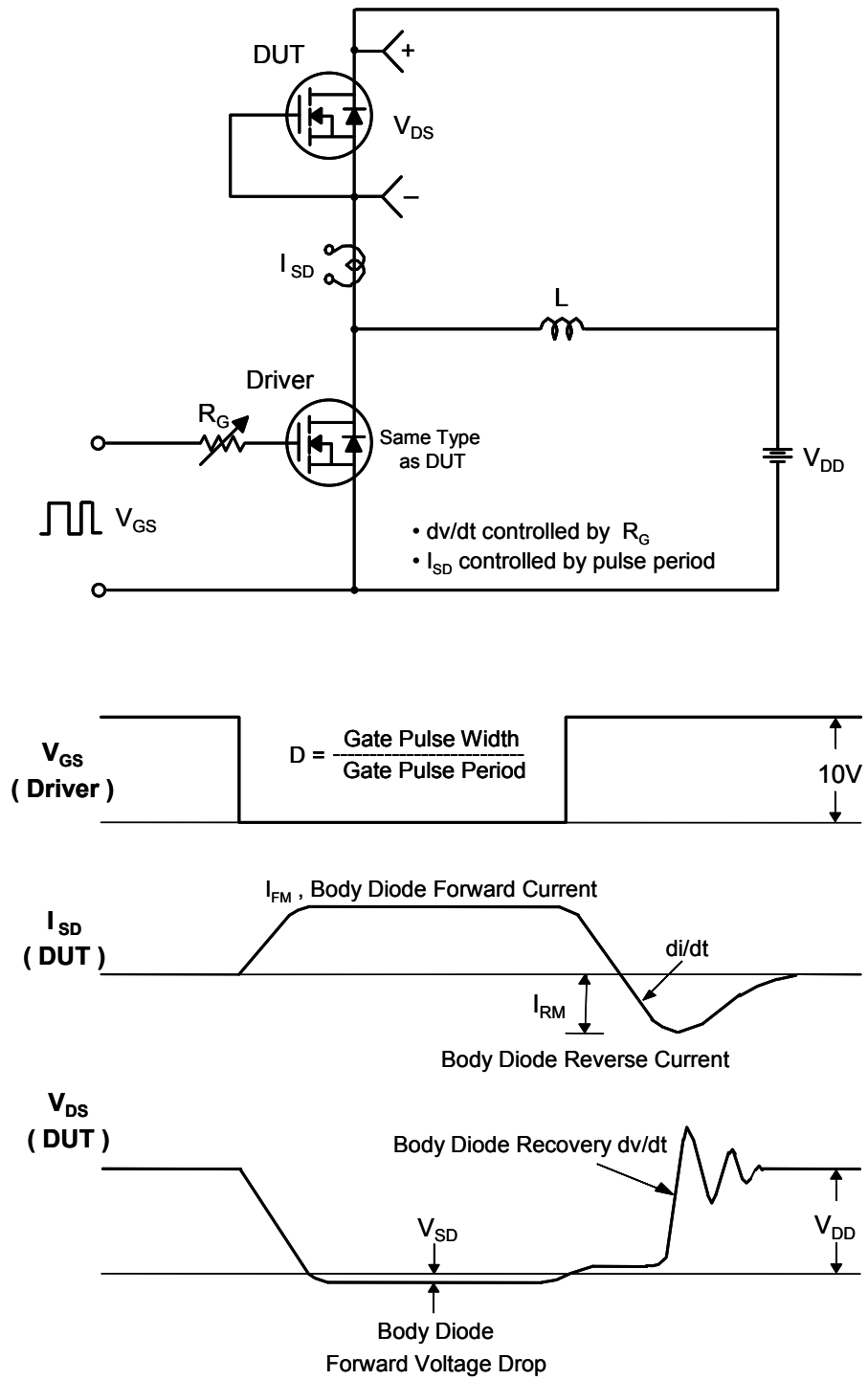
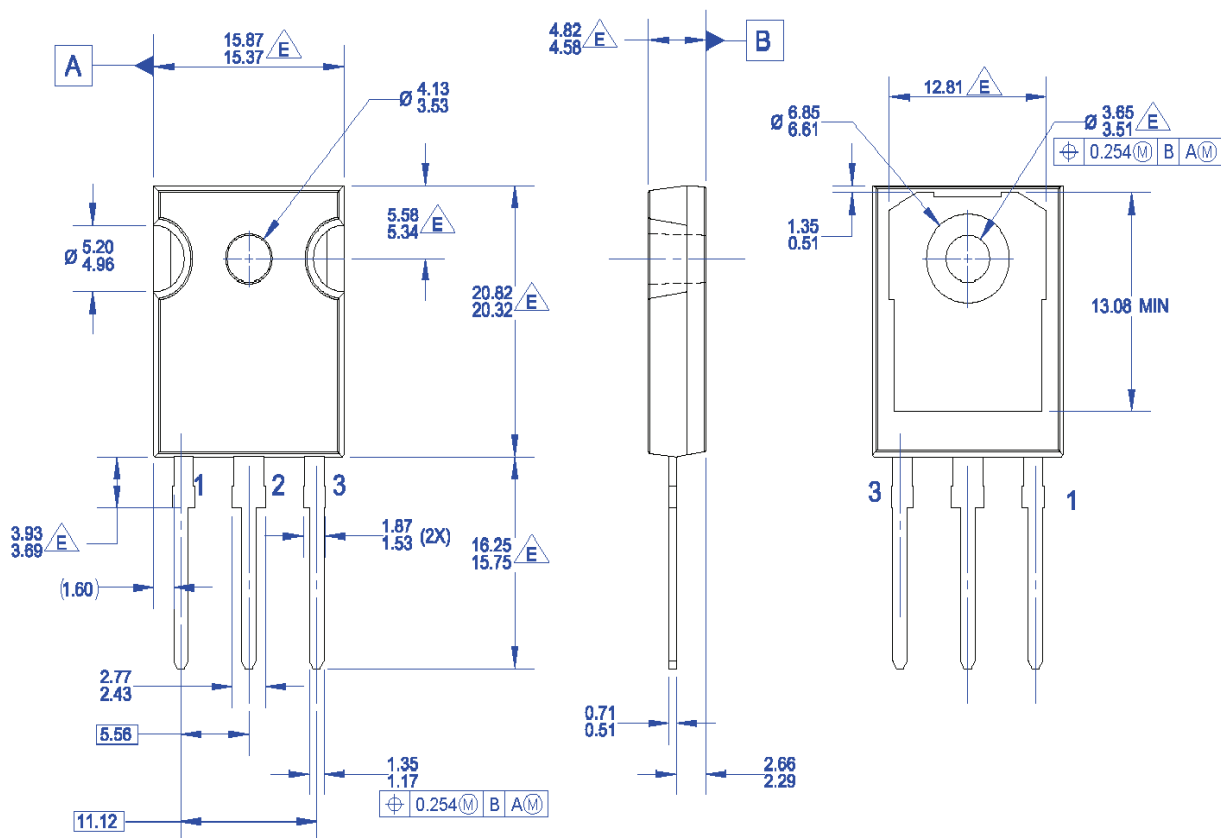


Figure 16. Peak Diode Recovery  $dv/dt$  Test Circuit & Waveforms



## Mechanical Dimensions



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