



# FCH190N65F\_F085

## N-Channel SuperFET II FRFET MOSFET

650 V, 20.6 A, 190 mΩ

December  
2014

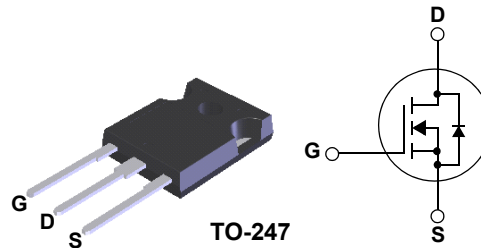
### Features

- Typical  $R_{DS(on)}$  = 148 mΩ at  $V_{GS} = 10$  V,  $I_D = 10$  A
- Typical  $Q_{g(tot)}$  = 63 nC at  $V_{GS} = 10$  V,  $I_D = 10$  A
- UIS Capability
- Qualified to AEC Q101
- RoHS Compliant

### 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 SuperFETII 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.



For current package drawing, please refer to the Fairchild web-site at <https://www.fairchildsemi.com/package-drawings/TO/TO247A03.pdf>

### Application

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



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

| Symbol          | Parameter                                               | Ratings     | Units               |
|-----------------|---------------------------------------------------------|-------------|---------------------|
| $V_{DSS}$       | Drain to Source Voltage                                 | 650         | V                   |
| $V_{GS}$        | Gate to Source Voltage                                  | $\pm 20$    | V                   |
| $I_D$           | Drain Current - Continuous ( $V_{GS}=10$ ) (Note 1)     | 20.6        | A                   |
|                 | Pulsed Drain Current                                    | See Fig 4   | A                   |
| $E_{AS}$        | Single Pulse Avalanche Rating (Note 2)                  | 400         | mJ                  |
| dv/dt           | MOSFET dv/dt                                            | 100         | V/ns                |
|                 | Peak Diode Recovery dv/dt (Note 3)                      | 50          |                     |
| $P_D$           | Power Dissipation                                       | 208         | W                   |
|                 | Derate Above $25^\circ\text{C}$                         | 1.67        | W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$  | Operating and Storage Temperature                       | -55 to +150 | $^\circ\text{C}$    |
| $R_{\theta JC}$ | Maximum Thermal Resistance Junction to Case             | 0.6         | $^\circ\text{C/W}$  |
| $R_{\theta JA}$ | Maximum Thermal Resistance Junction to Ambient (Note 4) | 40          | $^\circ\text{C/W}$  |

### Package Marking and Ordering Information

| Device Marking | Device          | Package | Reel Size | Tape Width | Quantity |
|----------------|-----------------|---------|-----------|------------|----------|
| FCH190N65F     | FCH190N65F_F085 | TO-247  | -         | -          | 30       |

#### Notes:

- 1: Current is limited by bondwire configuration.
- 2: Starting  $T_J = 25^\circ\text{C}$ ,  $L = 50\text{mH}$ ,  $I_{AS} = 4\text{A}$ ,  $V_{DD} = 100\text{V}$  during inductor charging and  $V_{DD} = 0\text{V}$  during time in avalanche.
- 3:  $I_{SD} \leq 10\text{A}$ ,  $di/dt \leq 200\text{ A/us}$ ,  $V_{DD} \leq 380\text{V}$ , starting  $T_J = 25^\circ\text{C}$ .
- 4:  $R_{\theta JA}$  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.  $R_{\theta JC}$  is guaranteed by design, while  $R_{\theta JA}$  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.

**Electrical Characteristics**  $T_J = 25^\circ\text{C}$  unless otherwise noted

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

**Off Characteristics**

|              |                                   |                                                                                                                       |     |   |           |               |
|--------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----|---|-----------|---------------|
| $B_{V_{DS}}$ | Drain to Source Breakdown Voltage | $I_D = 250\mu\text{A}$ , $V_{GS} = 0\text{V}$                                                                         | 650 | - | -         | V             |
| $I_{DSS}$    | Drain to Source Leakage Current   | $V_{DS} = 650\text{V}$ , $T_J = 25^\circ\text{C}$<br>$V_{GS} = 0\text{V}$ , $T_J = 150^\circ\text{C}(\text{Note } 5)$ | -   | - | 10        | $\mu\text{A}$ |
| $I_{GSS}$    | Gate to Source Leakage Current    | $V_{GS} = \pm 20\text{V}$                                                                                             | -   | - | $\pm 100$ | nA            |

**On Characteristics**

|              |                                  |                                                                                                                    |     |     |     |                  |
|--------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------------------|
| $V_{GS(th)}$ | Gate to Source Threshold Voltage | $V_{GS} = V_{DS}$ , $I_D = 250\mu\text{A}$                                                                         | 3.0 | -   | 5.0 | V                |
| $r_{DS(on)}$ | Drain to Source On Resistance    | $I_D = 27\text{A}$ , $T_J = 25^\circ\text{C}$<br>$V_{GS} = 10\text{V}$ , $T_J = 150^\circ\text{C}(\text{Note } 5)$ | -   | 148 | 190 | $\text{m}\Omega$ |
|              |                                  |                                                                                                                    | -   | 346 | 401 | $\text{m}\Omega$ |

**Dynamic Characteristics**

|              |                               |                                                                       |   |      |      |          |
|--------------|-------------------------------|-----------------------------------------------------------------------|---|------|------|----------|
| $C_{iss}$    | Input Capacitance             | $V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ ,<br>$f = 1\text{MHz}$   | - | 2447 | 3181 | pF       |
| $C_{oss}$    | Output Capacitance            |                                                                       | - | 2345 | 3048 | pF       |
| $C_{rss}$    | Reverse Transfer Capacitance  |                                                                       | - | 131  | -    | pF       |
| $R_g$        | Gate Resistance               | $f = 1\text{MHz}$                                                     | - | 0.5  | -    | $\Omega$ |
| $Q_{g(TOT)}$ | Total Gate Charge             | $V_{DD} = 380\text{V}$<br>$I_D = 10\text{A}$<br>$V_{GS} = 10\text{V}$ | - | 63   | 82   | nC       |
| $Q_{g(th)}$  | Threshold Gate Charge         |                                                                       | - | 4.3  | 5.6  | nC       |
| $Q_{gs}$     | Gate to Source Gate Charge    |                                                                       | - | 12.6 | -    | nC       |
| $Q_{gd}$     | Gate to Drain "Miller" Charge |                                                                       | - | 28   | -    | nC       |

**Switching Characteristics**

|              |                     |                                                                                            |   |      |     |    |
|--------------|---------------------|--------------------------------------------------------------------------------------------|---|------|-----|----|
| $t_{on}$     | Turn-On Time        | $V_{DD} = 380\text{V}$ , $I_D = 10\text{A}$ ,<br>$V_{GS} = 10\text{V}$ , $R_G = 4.7\Omega$ | - | 40   | 100 | ns |
| $t_{d(on)}$  | Turn-On Delay Time  |                                                                                            | - | 25   | -   | ns |
| $t_r$        | Rise Time           |                                                                                            | - | 14.5 | -   | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                            | - | 64   | -   | ns |
| $t_f$        | Fall Time           |                                                                                            | - | 5    | -   | ns |
| $t_{off}$    | Turn-Off Time       |                                                                                            | - | 69   | 158 | ns |

**Drain-Source Diode Characteristics**

|          |                               |                                                             |   |     |     |    |
|----------|-------------------------------|-------------------------------------------------------------|---|-----|-----|----|
| $V_{SD}$ | Source to Drain Diode Voltage | $I_{SD} = 10\text{A}$ , $V_{GS} = 0\text{V}$                | - | -   | 1.2 | V  |
| $T_{rr}$ | Reverse Recovery Time         | $I_F = 10\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$ | - | 141 | -   | ns |
| $Q_{rr}$ | Reverse Recovery Charge       | $V_{DD} = 520\text{V}$                                      | - | 889 | -   | nC |

**Notes:**

5: The maximum value is specified by design at  $T_J = 150^\circ\text{C}$ . Product is not tested to this condition in production.

## Typical Characteristics

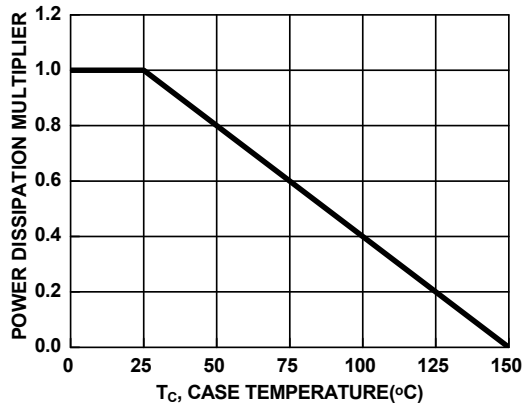


Figure 1. Normalized Power Dissipation vs. Case Temperature

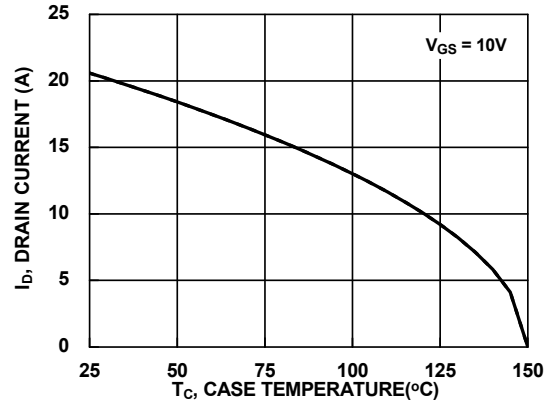


Figure 2. Maximum Continuous Drain Current vs. Case Temperature

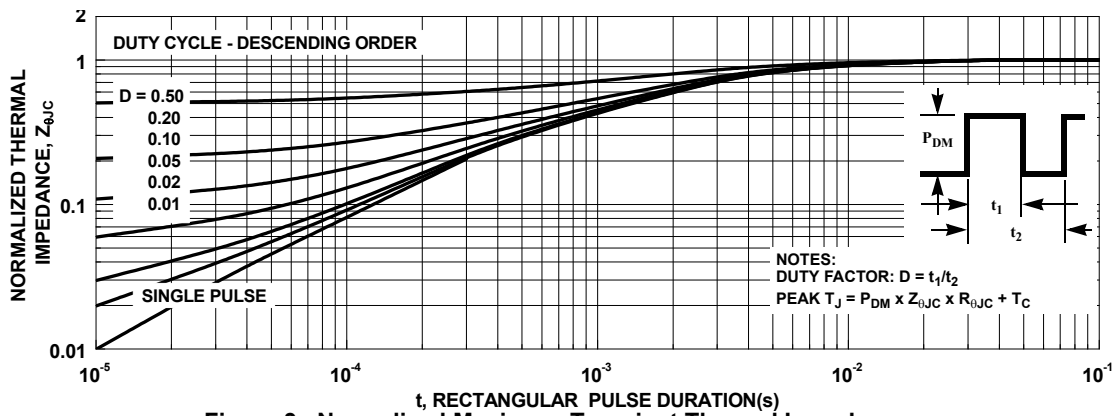


Figure 3. Normalized Maximum Transient Thermal Impedance

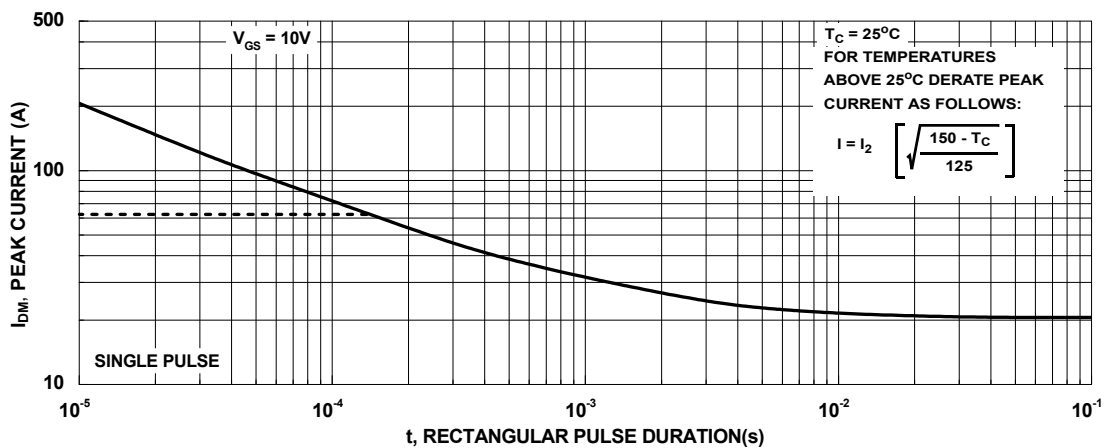


Figure 4. Peak Current Capability

## Typical Characteristics

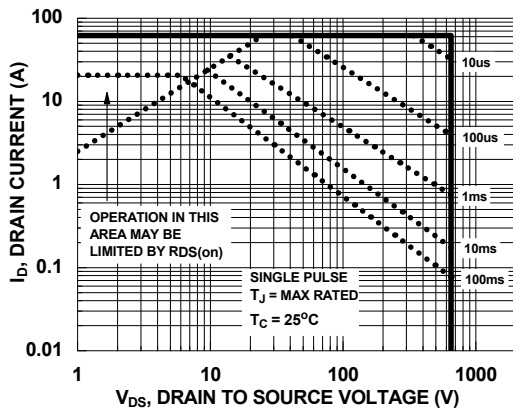


Figure 5. Forward Bias Safe Operating Area

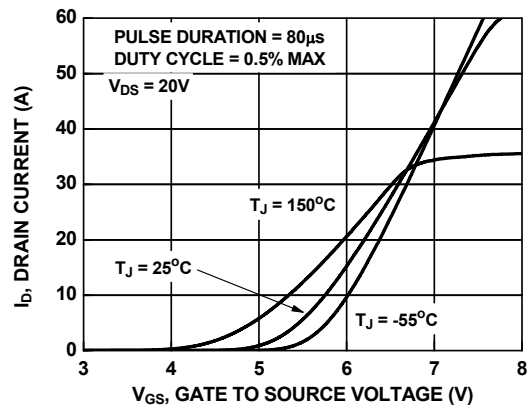


Figure 6. Transfer Characteristics

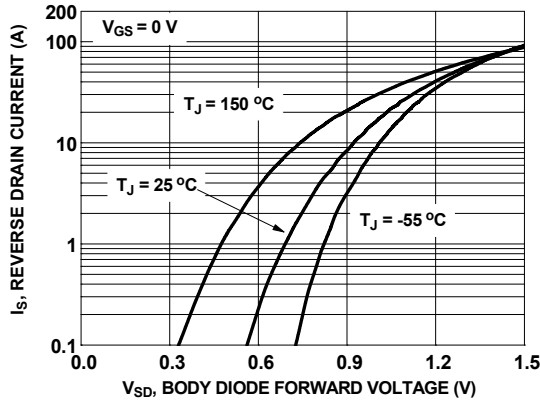


Figure 7. Forward Diode Characteristics

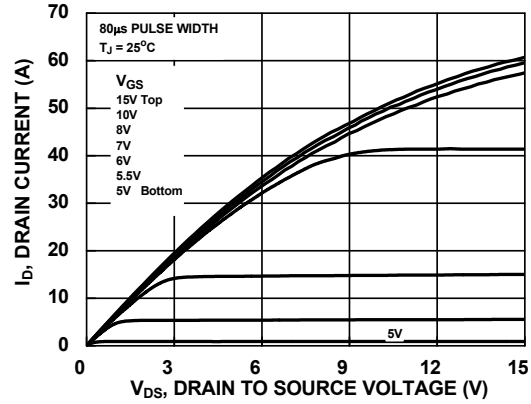


Figure 8. Saturation Characteristics

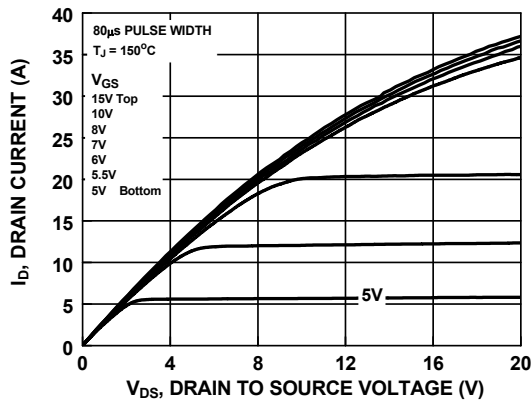


Figure 9. Saturation Characteristics

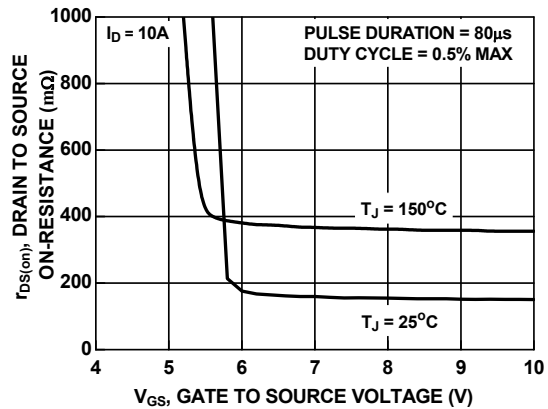


Figure 10.  $R_{DS(on)}$  vs. Gate Voltage

## Typical Characteristics

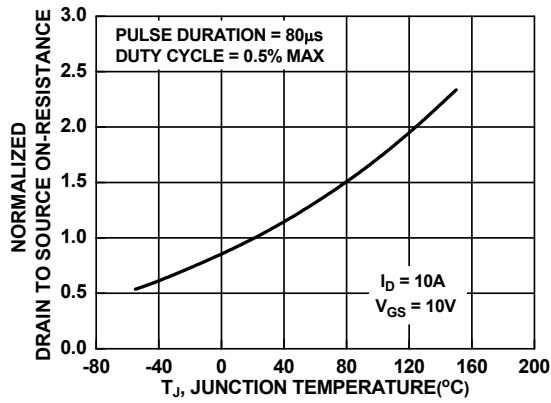


Figure 11. Normalized  $R_{DS(on)}$  vs. Junction Temperature

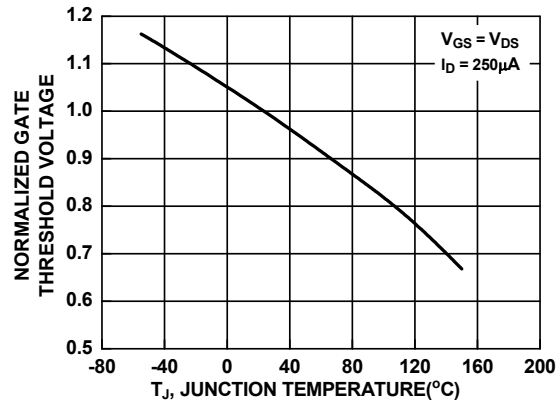


Figure 12. Normalized Gate Threshold Voltage vs. Temperature

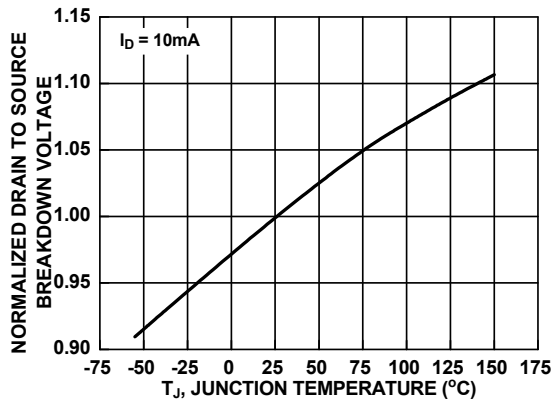


Figure 13. Normalized Drain to Source Breakdown Voltage vs. Junction Temperature

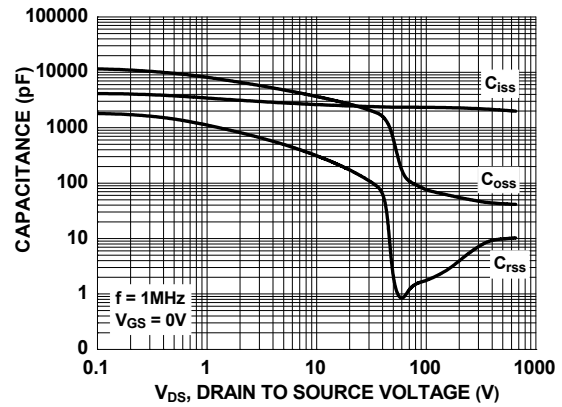


Figure 14. Capacitance vs. Drain to Source Voltage

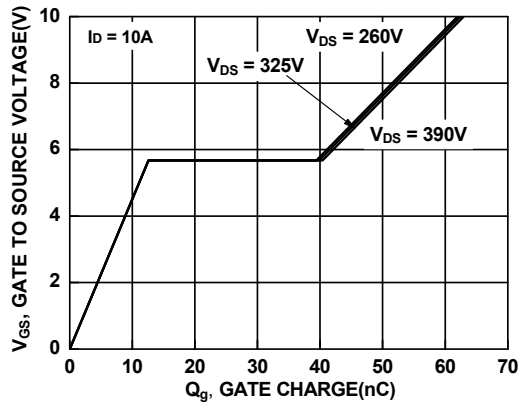


Figure 15. Gate Charge vs. Gate to Source Voltage

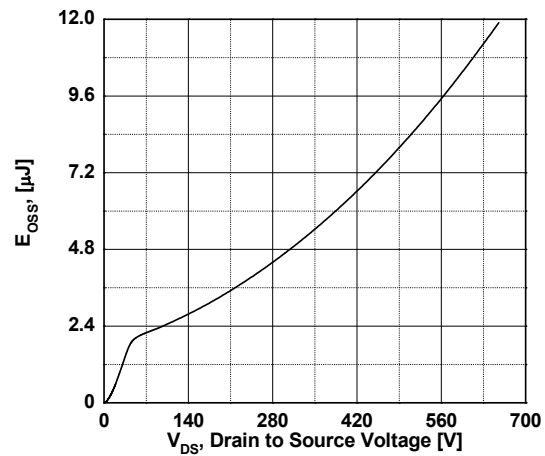


Figure 16.  $E_{oss}$  vs. Drain to Source Voltage

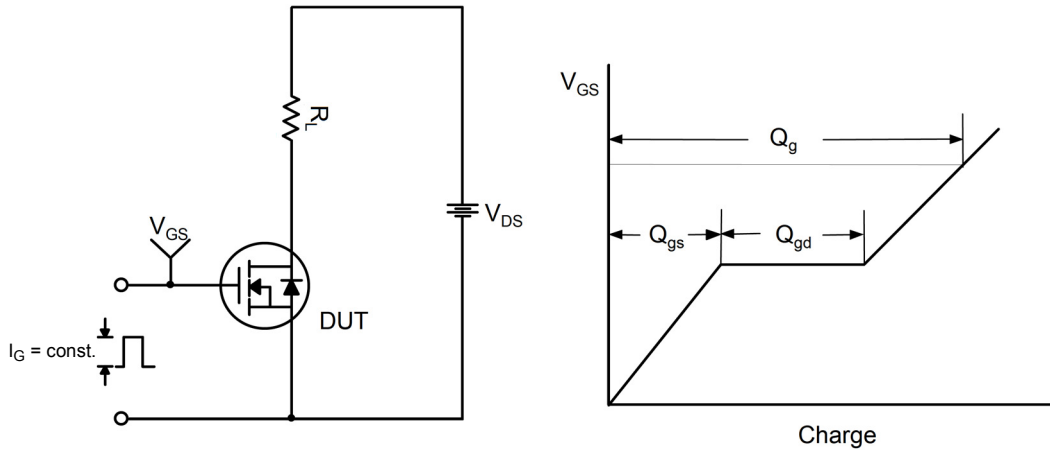


Figure 17. Gate Charge Test Circuit & Waveform

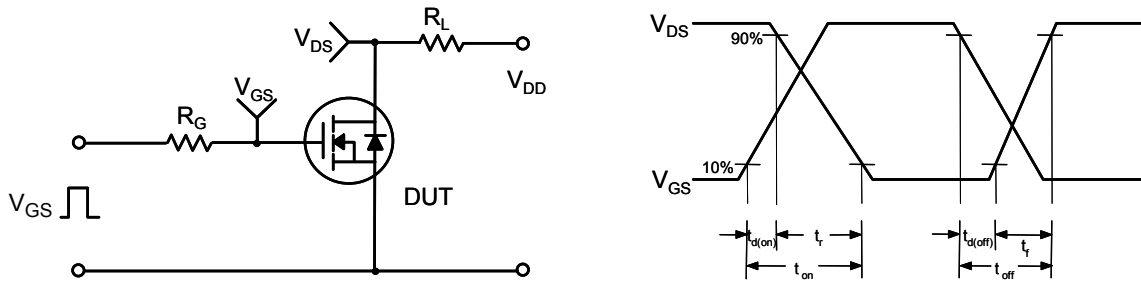


Figure 18. Resistive Switching Test Circuit & Waveforms

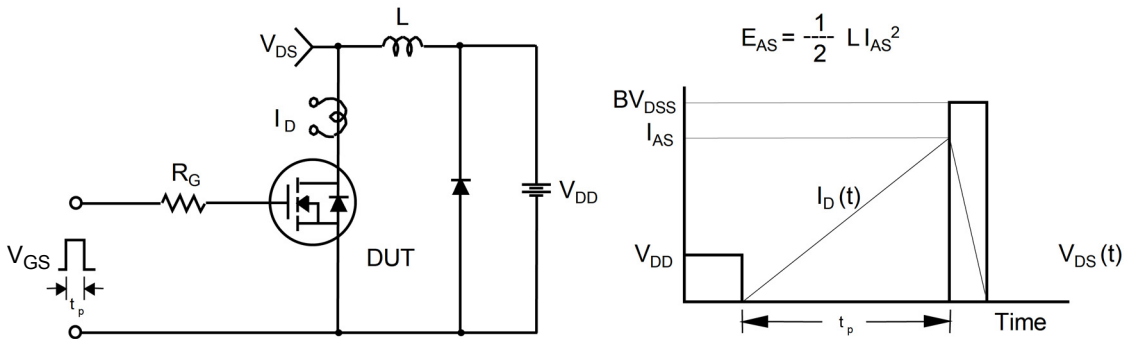
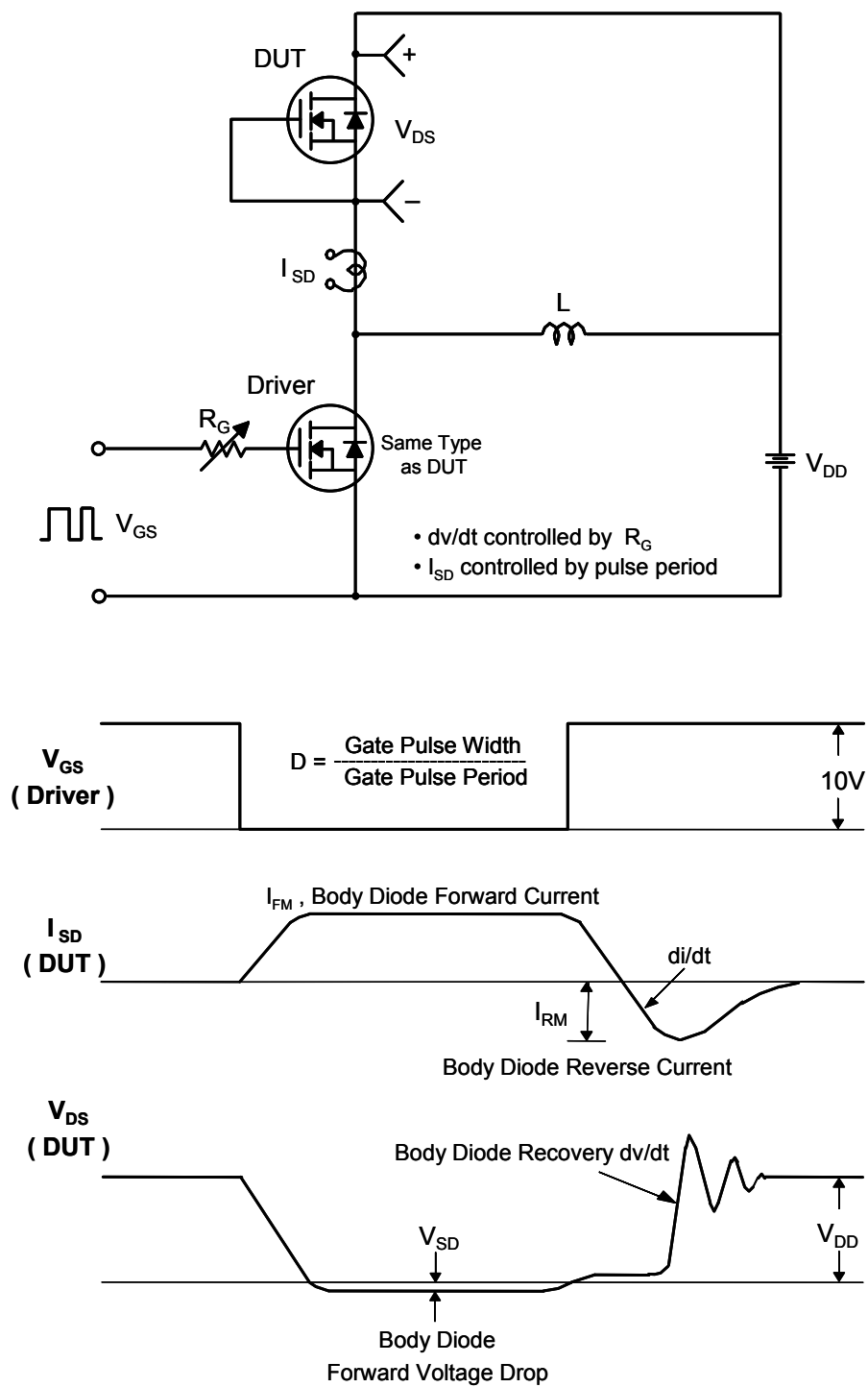
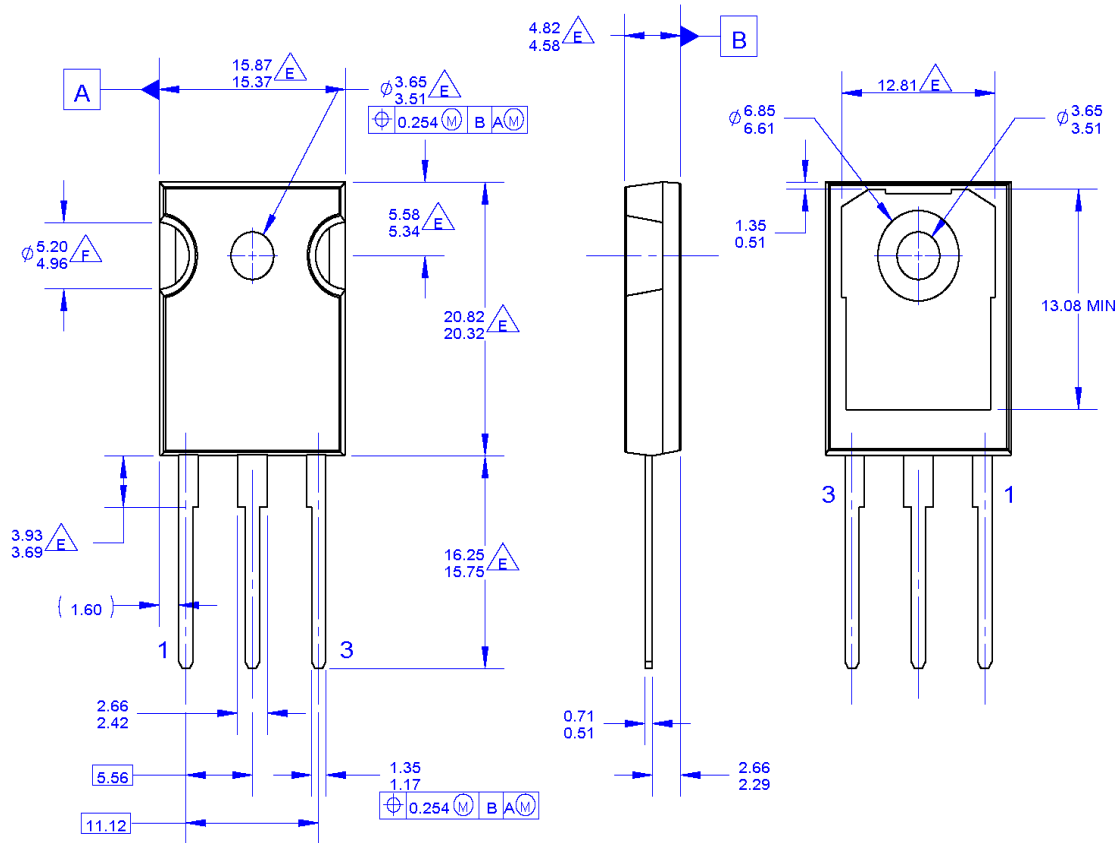


Figure 19. Unclamped Inductive Switching Test Circuit & Waveforms



## Mechanical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. PACKAGE REFERENCE: JEDEC TO-247, ISSUE E, VARIATION AB, DATED JUNE, 2004.
- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DRAWING CONFORMS TO ASME Y14.5 - 1994

$\triangle E$  DOES NOT COMPLY JEDEC STANDARD VALUE

$\triangle F$  NOTCH MAY BE SQUARE

G. DRAWING FILENAME: MKT-TO247A03\_REV03

**Figure 21. TO-247, Molded, 3-Lead, Jedec Variation AB**

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MicroFET™  
MicroPak™  
MicroPak2™  
MillerDrive™  
MotionMax™  
MotionGrid®  
MTi®  
MTx®  
MVN®  
mWSaver®  
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PowerTrench®  
PowerXS™  
Programmable Active Droop™  
QFET®  
QS™  
Quiet Series™  
RapidConfigure™  
  
Saving our world, 1mW/W/kW at a time™  
SignalWise™  
SmartMax™  
SMART START™  
Solutions for Your Success™  
SPM®  
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SuperSOT™-6  
SuperSOT™-8  
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SyncFET™  
Sync-Lock™

  
TinyBoost®  
TinyBuck™  
TinyCalc™  
TinyLogic®  
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TinyPower™  
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