

## Features

- Excellent  $R_{DS(ON)}$  and Low Gate Charge
- 100% UIS Tested
- 100%  $\Delta V_{DS}$  Tested
- Halogen-free; RoHS-compliant

## Applications

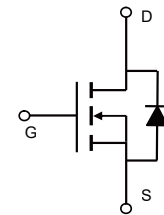
- Load Switch
- PWM Application
- Power Management

## Product Summary

| Parameters                     | Value | Unit       |
|--------------------------------|-------|------------|
| $V_{DSS}$                      | 200   | V          |
| $V_{GS(th\_Typ)}$              | 3.1   | V          |
| $I_D(@V_{GS}=10V)$             | 109   | A          |
| $R_{DS(ON\_Typ)}(@V_{GS}=10V)$ | 9.1   | m $\Omega$ |



TO-263



Schematic

## Ordering Information

| Device       | Marking   | MSL | Form      | Package | Reel(pcs) | Per Carton (pcs) |
|--------------|-----------|-----|-----------|---------|-----------|------------------|
| VSM109N20-T3 | VSM109N20 | 3   | Tape&Reel | TO-263  | 800       | 4000             |

## Absolute Maximum Ratings (@ $T_C = 25^\circ\text{C}$ unless otherwise specified)

| Symbol         | Parameter                                     | Value                                                 | Unit             |
|----------------|-----------------------------------------------|-------------------------------------------------------|------------------|
| $V_{DS}$       | Drain-to-Source Voltage                       | 200                                                   | V                |
| $V_{GS}$       | Gate-to-Source Voltage                        | $\pm 20$                                              | V                |
| $I_D$          | Continuous Drain Current                      | $T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$ | A                |
| $I_{DM}$       | Pulsed Drain Current <sup>(1)</sup>           | Refer to Fig.4                                        | A                |
| $E_{AS}$       | Single Pulsed Avalanche Energy <sup>(2)</sup> | 1006                                                  | mJ               |
| $P_D$          | Power Dissipation                             | $T_C = 25^\circ\text{C}$<br>$T_C = 100^\circ\text{C}$ | W                |
| $T_J, T_{STG}$ | Junction & Storage Temperature Range          | -55 to 150                                            | $^\circ\text{C}$ |

## Thermal Characteristics

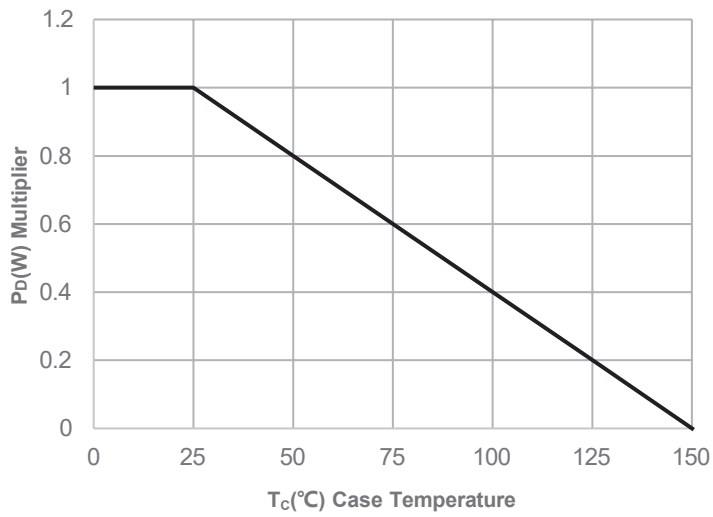
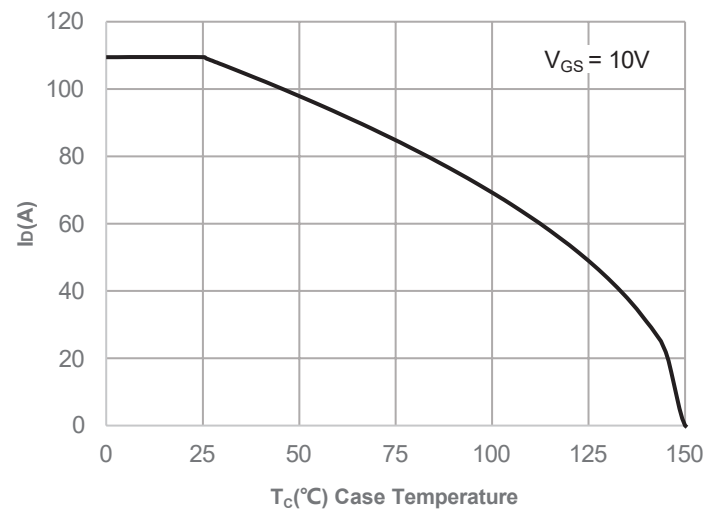
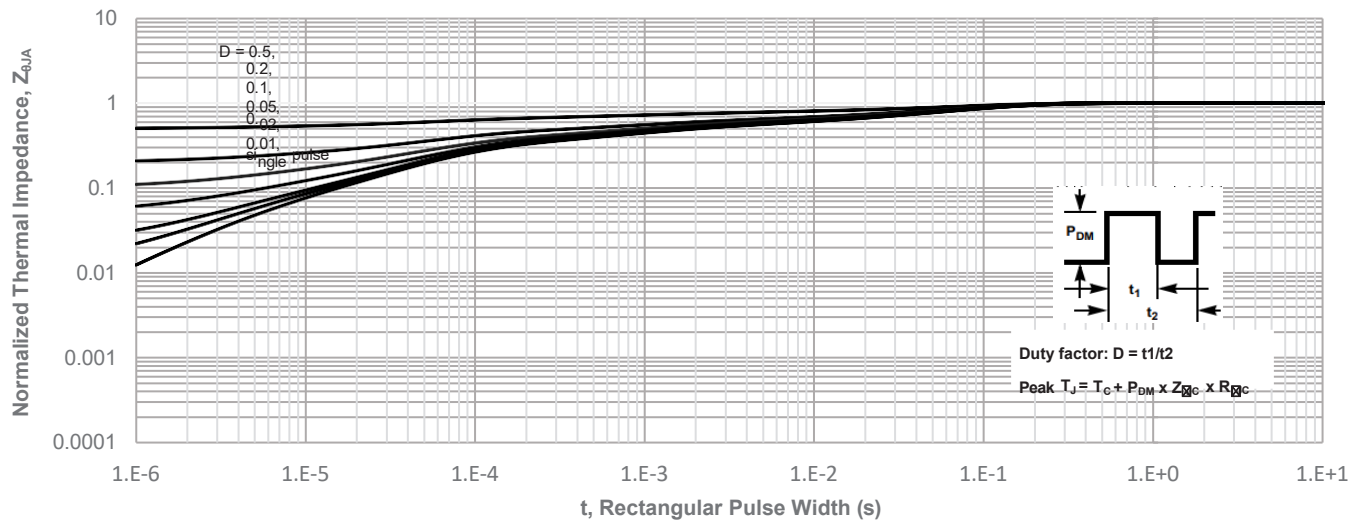
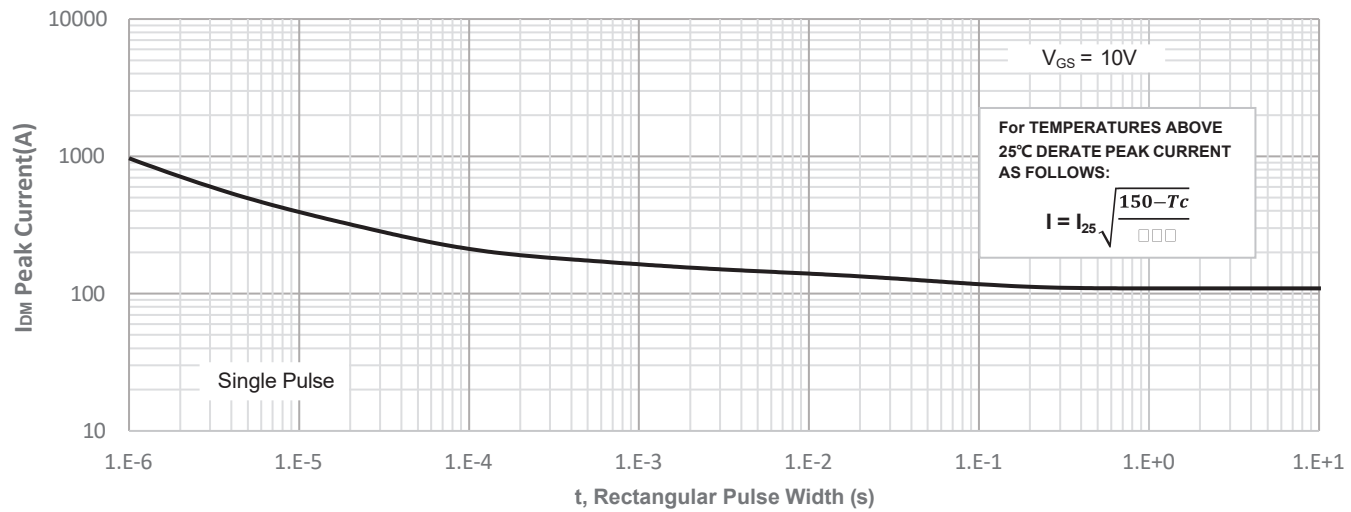
| Symbol          | Parameter                                              | Max | Unit               |
|-----------------|--------------------------------------------------------|-----|--------------------|
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient <sup>(3)</sup> | 63  | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case                   | 0.4 |                    |

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

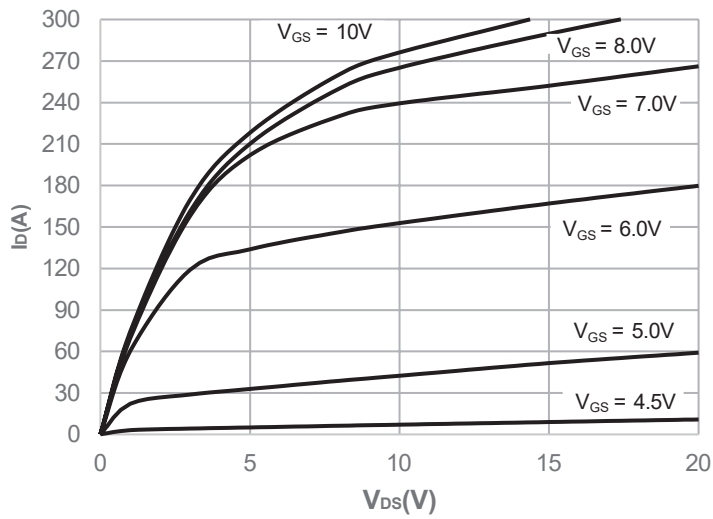
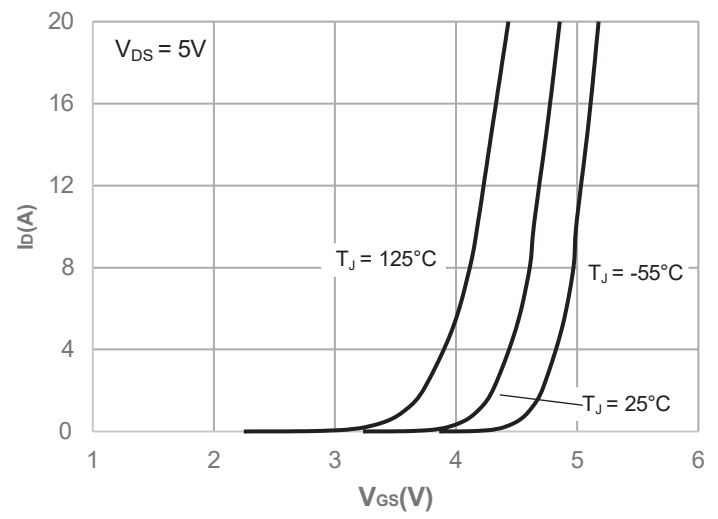
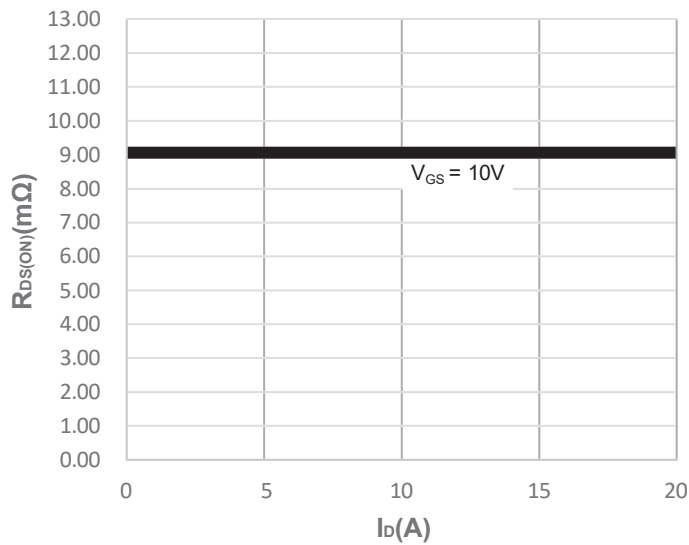
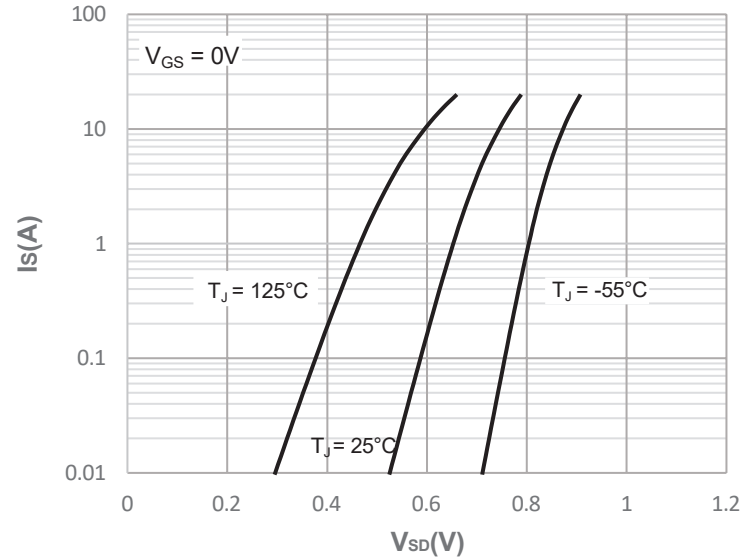
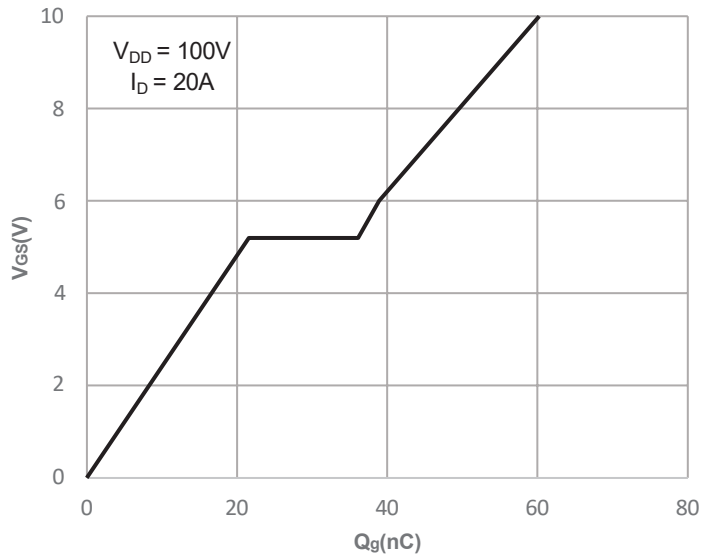
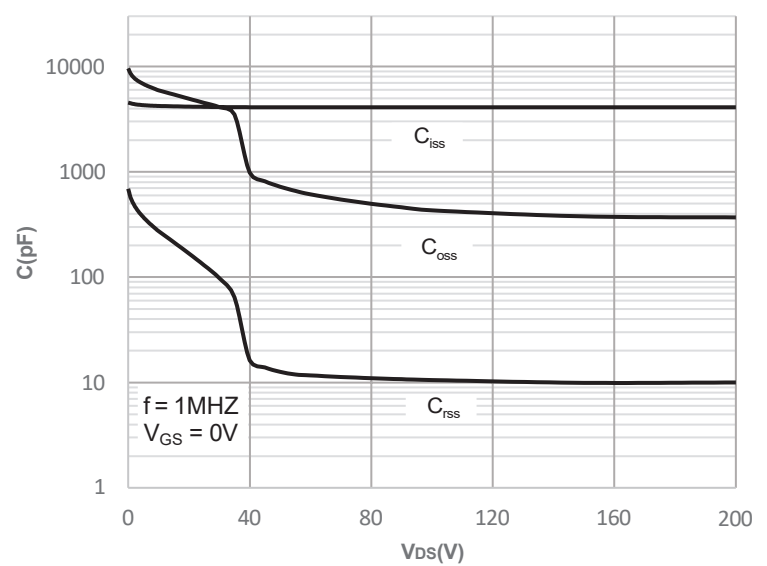
| Symbol                     | Parameter                                        | Conditions                                                                                      | Min. | Typ. | Max. | Unit |
|----------------------------|--------------------------------------------------|-------------------------------------------------------------------------------------------------|------|------|------|------|
| Off Characteristics        |                                                  |                                                                                                 |      |      |      |      |
| V <sub>(BR)DSS</sub>       | Drain-Source Breakdown Voltage                   | I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0V                                                   | 200  | -    | -    | V    |
| I <sub>DSS</sub>           | Zero Gate Voltage Drain Current                  | V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V                                                    | -    | -    | 1.0  | μA   |
| I <sub>GSS</sub>           | Gate-Body Leakage Current                        | V <sub>DS</sub> = 0V, V <sub>GS</sub> = ±20V                                                    | -    | -    | ±100 | nA   |
| On Characteristics         |                                                  |                                                                                                 |      |      |      |      |
| V <sub>GS(th)</sub>        | Gate Threshold Voltage                           | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                     | 2.2  | 3.1  | 4.0  | V    |
| R <sub>DS(ON)</sub>        | Static Drain-Source ON-Resistance <sup>(4)</sup> | V <sub>GS</sub> = 10V, I <sub>D</sub> = 20A                                                     | -    | 9.1  | 10.7 | mΩ   |
| Dynamic Characteristics    |                                                  |                                                                                                 |      |      |      |      |
| R <sub>g</sub>             | Gate Resistance                                  | f = 1MHz                                                                                        | -    | 4.6  | -    | Ω    |
| C <sub>iss</sub>           | Input Capacitance                                | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 100V,<br>f = 1MHz                                       | 2920 | 4089 | 5520 | pF   |
| C <sub>oss</sub>           | Output Capacitance                               |                                                                                                 | 307  | 429  | 580  | pF   |
| C <sub>rss</sub>           | Reverse Transfer Capacitance                     |                                                                                                 | 8    | 11   | 14   | pF   |
| Q <sub>g</sub>             | Total Gate Charge                                | V <sub>GS</sub> = 0 to 10V<br>V <sub>DS</sub> = 100V, I <sub>D</sub> = 20A                      | 43   | 60   | 81   | nC   |
| Q <sub>gs</sub>            | Gate Source Charge                               |                                                                                                 | 15   | 22   | 29   | nC   |
| Q <sub>gd</sub>            | Gate Drain("Miller") Charge                      |                                                                                                 | 10   | 15   | 20   | nC   |
|                            |                                                  |                                                                                                 |      |      |      |      |
| Switching Characteristics  |                                                  |                                                                                                 |      |      |      |      |
| t <sub>d(on)</sub>         | Turn-On DelayTime                                | V <sub>GS</sub> = 10V, V <sub>DD</sub> = 100V<br>I <sub>D</sub> = 20A, R <sub>GEN</sub> = 2.7 Ω | -    | 14   | -    | ns   |
| t <sub>r</sub>             | Turn-On Rise Time                                |                                                                                                 | -    | 37   | -    | ns   |
| t <sub>d(off)</sub>        | Turn-Off DelayTime                               |                                                                                                 | -    | 67   | -    | ns   |
| t <sub>f</sub>             | Turn-Off Fall Time                               |                                                                                                 | -    | 30   | -    | ns   |
| Body Diode Characteristics |                                                  |                                                                                                 |      |      |      |      |
| I <sub>S</sub>             | Maximum Continuous Body Diode Forward Current    |                                                                                                 | -    | -    | 109  | A    |
| I <sub>SM</sub>            | Maximum Pulsed Body Diode Forward Current        |                                                                                                 | -    | -    | 438  | A    |
| V <sub>SD</sub>            | Body Diode Forward Voltage                       | V <sub>GS</sub> = 0V, I <sub>S</sub> = 20A                                                      | -    |      | 1.2  | V    |
| t <sub>rr</sub>            | Body Diode Reverse Recovery Time                 | I <sub>F</sub> = 20A, di/dt = 100A/us                                                           | 140  | 196  | 265  | ns   |
| Q <sub>rr</sub>            | Body Diode Reverse Recovery Charge               |                                                                                                 | -    | 702  | -    | nC   |

- Notes:
1. Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature.
  2.  $E_{AS}$  condition: Starting  $T_J = 25^\circ\text{C}$ ,  $V_{DD} = 100\text{V}$ ,  $V_G = 10\text{V}$ ,  $R_G = 25\text{ohm}$ ,  $L = 3\text{mH}$ ,  $I_{AS} = 25.9\text{A}$ ,  $V_{DD} = 0\text{V}$  during time in avalanche.
  3.  $R_{\theta JA}$  is measured with the device mounted on FR-4 substrate PC board, 2oz copper, with minimum recommended pad layout.
  4. Pulse Test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 0.5\%$ .

## Typical Performance Characteristics

**Figure 1: Power De-rating**

**Figure 2: Current De-rating**

**Figure 3: Normalized Maximum Transient Thermal Impedance**

**Figure 4: Peak Current Capacity**


## Typical Performance Characteristics

**Figure 5: Output Characteristics**

**Figure 6: Typical Transfer Characteristics**

**Figure 7: On-resistance vs. Drain Current**

**Figure 8: Body Diode Characteristics**

**Figure 9: Gate Charge Characteristics**

**Figure 10: Capacitance Characteristics**


## Typical Performance Characteristics

Figure 11: Normalized Breakdown voltage vs. Junction Temperature

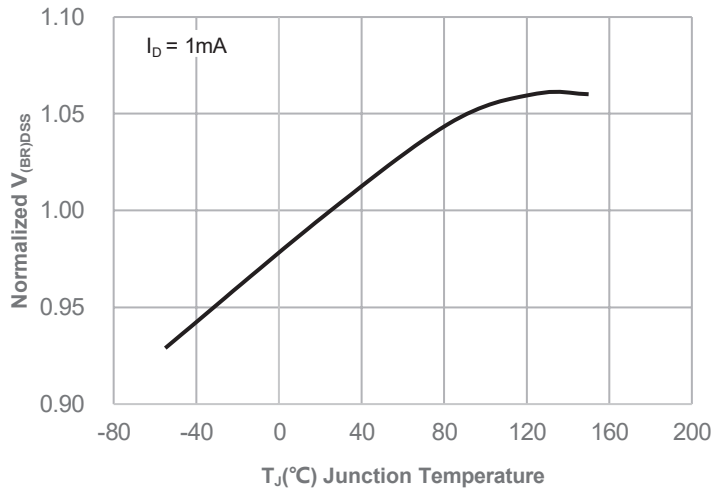


Figure 12: Normalized on Resistance vs. Junction Temperature

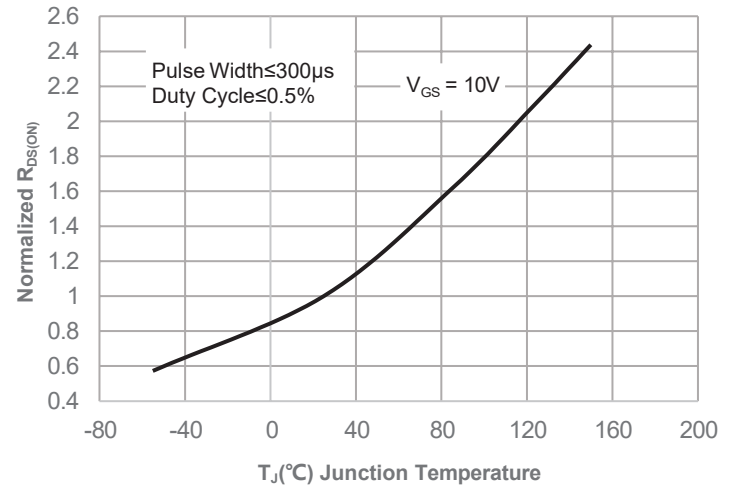


Figure 13: Normalized Threshold Voltage vs. Junction Temperature

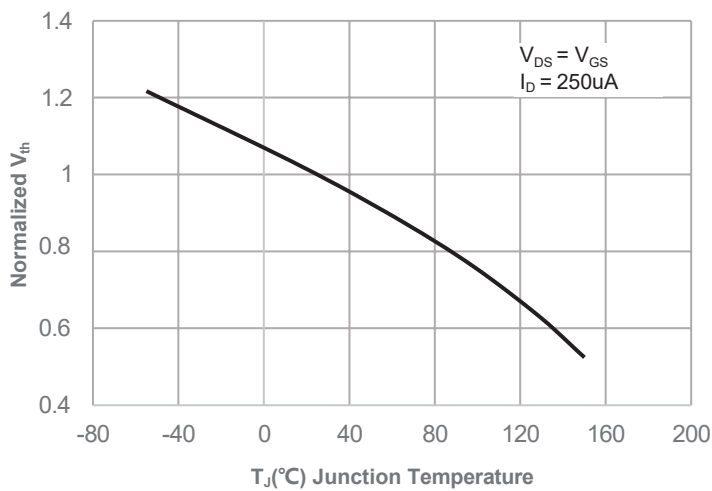


Figure 14:  $R_{DS(ON)}$  vs.  $V_{GS}$

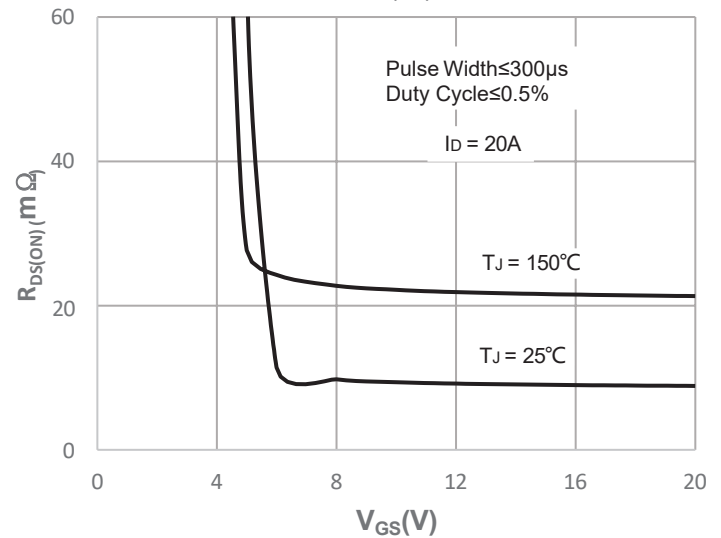
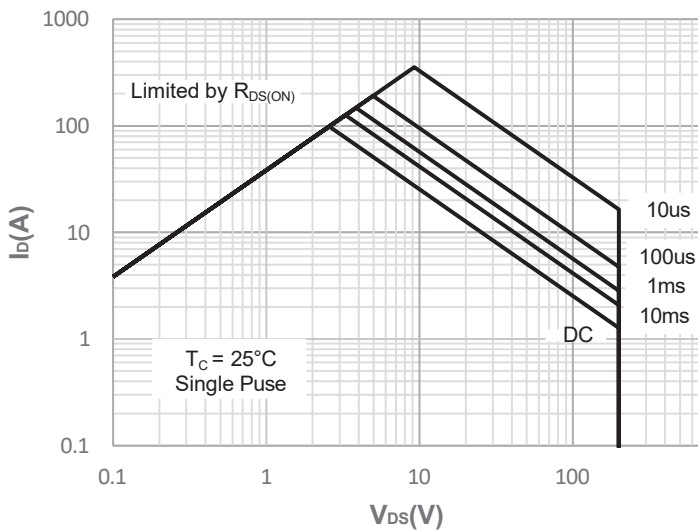
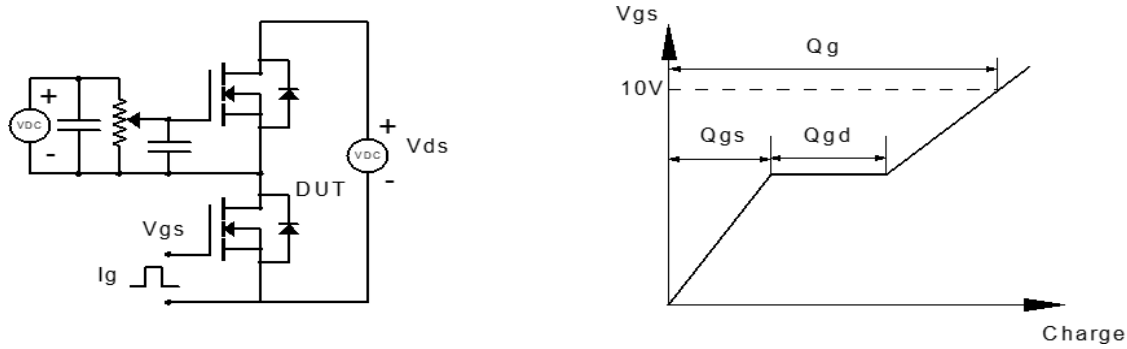


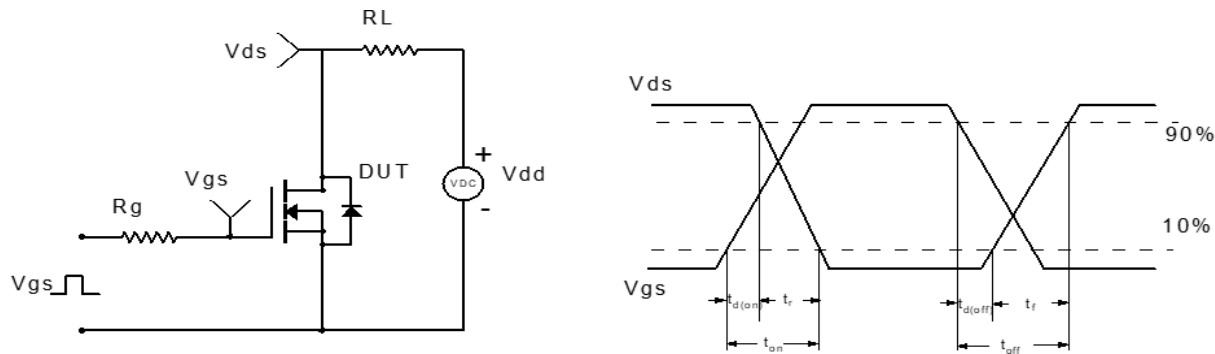
Figure 15: Maximum Safe Operating Area



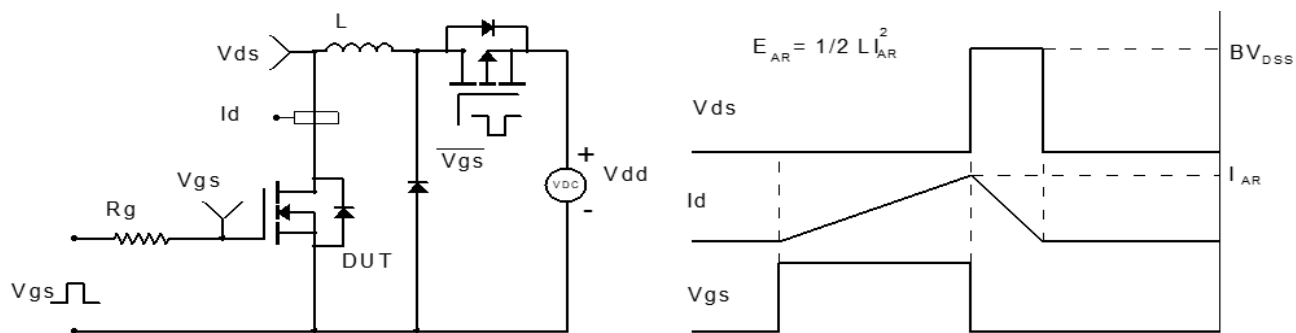
## Test Circuit



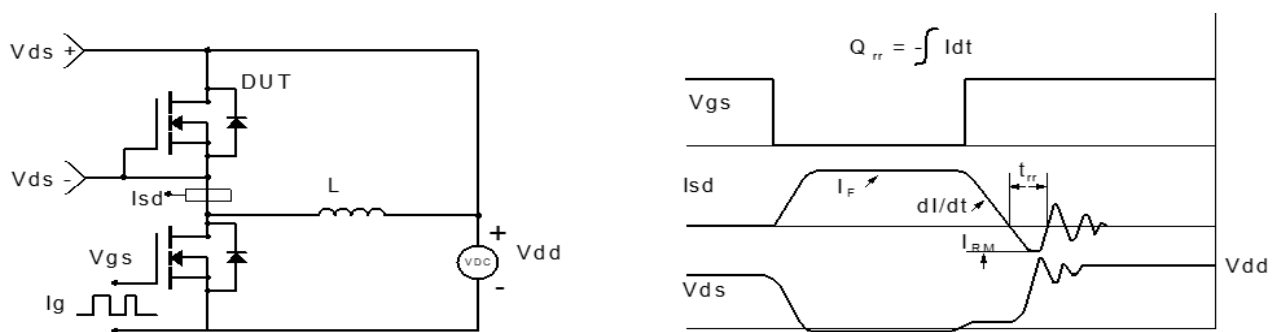
**Figure 1: Gate Charge Test Circuit & Waveform**



**Figure 2: Resistive Switching Test Circuit & Waveform**



**Figure 3: Unclamped Inductive Switching Test Circuit & Waveform**



**Figure 4: Diode Recovery Test Circuit & Waveform**