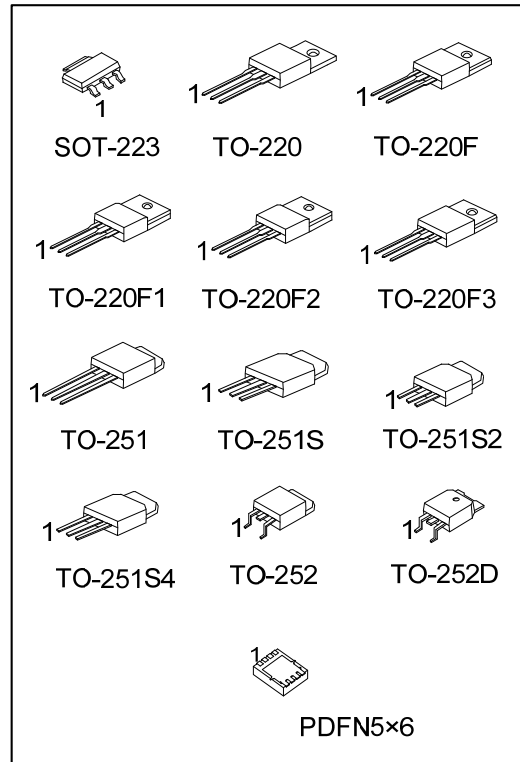
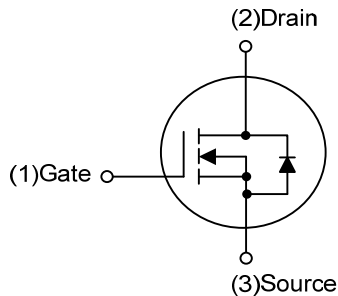


**2N65-CBS****Power MOSFET****2.0A, 650V N-CHANNEL  
POWER MOSFET****DESCRIPTION**

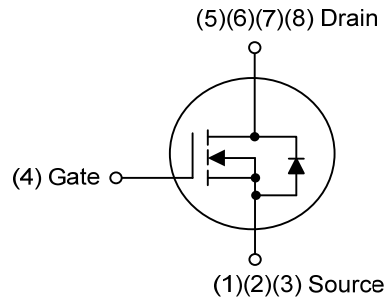
The UTC **2N65-CBS** is a high voltage power MOSFET and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient AC to DC converters and bridge circuits.

**FEATURES**

- \*  $R_{DS(ON)} \leq 9.5 \Omega$  @  $V_{GS}=10V$ ,  $I_D=1.0A$
- \* Fast switching capability
- \* Avalanche energy specified
- \* Improved dv/dt capability, high ruggedness

**SYMBOL**

TO-220/TO-220F/TO-220F1/TO-220F2  
TO-220F3/TO-251/TO-251S/TO-251S2  
TO-251S4/TO-252/TO-252D/SOT-223

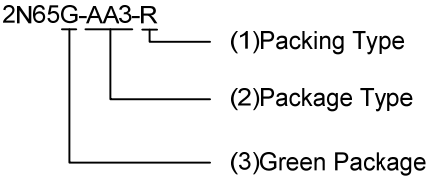


PDFN5x6

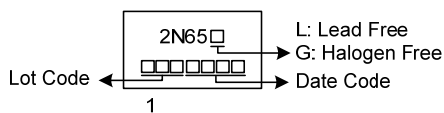
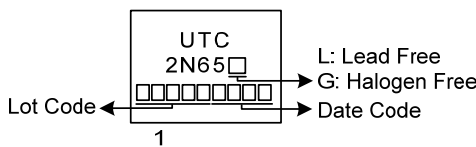
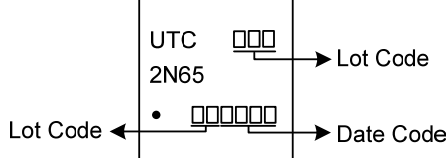
## ORDERING INFORMATION

| Ordering Number |               | Package  | Pin Assignment |   |   |   |   |   |   |   | Packing   |
|-----------------|---------------|----------|----------------|---|---|---|---|---|---|---|-----------|
| Lead Free       | Halogen Free  |          | 1              | 2 | 3 | 4 | 5 | 6 | 7 | 8 |           |
| 2N65L-AA3-R     | 2N65G-AA3-R   | SOT-223  | G              | D | S | - | - | - | - | - | Tape Reel |
| 2N65L-TA3-T     | 2N65G-TA3-T   | TO-220   | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TF3-T     | 2N65G-TF3-T   | TO-220F  | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TF1-T     | 2N65G-TF1-T   | TO-220F1 | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TF2-T     | 2N65G-TF2-T   | TO-220F2 | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TF3T-T    | 2N65G-TF3T-T  | TO-220F3 | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TM3-T     | 2N65G-TM3-T   | TO-251   | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TMS-T     | 2N65G-TMS-T   | TO-251S  | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TMS2-T    | 2N65G-TMS2-T  | TO-251S2 | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TMS4-T    | 2N65G-TMS4-T  | TO-251S4 | G              | D | S | - | - | - | - | - | Tube      |
| 2N65L-TN3-R     | 2N65G-TN3-R   | TO-252   | G              | D | S | - | - | - | - | - | Tape Reel |
| 2N65L-TND-R     | 2N65G-TND-R   | TO-252D  | G              | D | S | - | - | - | - | - | Tape Reel |
| 2N65L-P5060-R   | 2N65G-P5060-R | PDFN5×6  | S              | S | S | G | D | D | D | D | Tape Reel |

Note: Pin Assignment: G: Gate D: Drain S: Source

|                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>2N65G-AA3-R</p> <p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Green Package</p> | <p>(1) T: Tube, R: Tape Reel</p> <p>(2) AA3: SOT-223, TA3: TO-220, TF3: TO-220F, TF1: TO-220F1, TF2: TO-220F2, TF3T: TO-220F3, TM3: TO-251, TMS: TO-251S, TMS2: TO-251S2, TMS4: TO-251S4, TN3: TO-252, TND: TO-252D, P5060: PDFN5×6</p> <p>(3) G: Halogen Free and Lead Free, L: Lead Free</p> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## MARKING

| PACKAGE                                                                                                            | MARKING                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SOT-223                                                                                                            |  <p>2N65□</p> <p>Lot Code → Date Code</p> <p>1</p> <p>L: Lead Free<br/>G: Halogen Free</p>         |
| TO-220 / TO-220F<br>TO-220F1 / TO-220F2<br>TO-220F3 / TO-251<br>TO-251S / TO-251S2<br>TO-251S4 / TO-252<br>TO-252D |  <p>UTC<br/>2N65□</p> <p>Lot Code → Date Code</p> <p>1</p> <p>L: Lead Free<br/>G: Halogen Free</p> |
| PDFN5×6                                                                                                            |  <p>UTC 2N65</p> <p>Lot Code → Date Code</p>                                                       |

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

| PARAMETER                          |                                                       | SYMBOL           | RATINGS    | UNIT |
|------------------------------------|-------------------------------------------------------|------------------|------------|------|
| Drain-Source Voltage               |                                                       | V <sub>DSS</sub> | 650        | V    |
| Gate-Source Voltage                |                                                       | V <sub>GSS</sub> | ±30        | V    |
| Avalanche Current (Note 2)         |                                                       | I <sub>AR</sub>  | 1.6        | A    |
| Drain Current                      | Continuous                                            | I <sub>D</sub>   | 2.0        | A    |
|                                    | Pulsed (Note 2)                                       | I <sub>DM</sub>  | 4          | A    |
| Avalanche Energy                   | Single Pulsed (Note 3)                                | E <sub>AS</sub>  | 25         | mJ   |
| Peak Diode Recovery dv/dt (Note 4) |                                                       | dv/dt            | 4.2        | V/ns |
| Power Dissipation                  | SOT-223                                               | P <sub>D</sub>   | 2          | W    |
|                                    | TO-220                                                |                  | 45         | W    |
|                                    | TO-220F/TO-220F1<br>TO-220F2/TO-220F3                 |                  | 15         | W    |
|                                    | TO-251/TO-251S<br>TO-251S2/TO-251S4<br>TO-252/TO-252D |                  | 25         | W    |
|                                    | PDFN5×6                                               |                  | 22         | W    |
|                                    |                                                       |                  |            |      |
| Junction Temperature               |                                                       | T <sub>J</sub>   | +150       | °C   |
| Storage Temperature                |                                                       | T <sub>STG</sub> | -55 ~ +150 | °C   |

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. Repetitive Rating : Pulse width limited by maximum junction temperature.

3. L=30mH, I<sub>AS</sub>=1.3A, V<sub>DD</sub>=50V, R<sub>G</sub>=25 Ω, Starting T<sub>J</sub> = 25°C

4. I<sub>SD</sub>≤2.0A, di/dt≤200A/μs, V<sub>DD</sub> ≤ BV<sub>DSS</sub>, Starting T<sub>J</sub> = 25°C

### ■ THERMAL DATA

| PARAMETER           |                                                       | SYMBOL          | RATINGS  | UNIT |
|---------------------|-------------------------------------------------------|-----------------|----------|------|
| Junction to Ambient | SOT-223                                               | θ <sub>JA</sub> | 150      | °C/W |
|                     | TO-220/TO-220F<br>TO-220F1/ TO-220F2<br>TO-220F3      |                 | 62.5     | °C/W |
|                     | TO-251/TO-251S<br>TO-251S2/TO-251S4<br>TO-252/TO-252D |                 | 110      | °C/W |
|                     | PDFN5×6                                               |                 | 75       | °C/W |
|                     |                                                       |                 |          |      |
|                     |                                                       |                 |          |      |
| Junction to Case    | SOT-223                                               | θ <sub>JC</sub> | 62.5     | °C/W |
|                     | TO-220                                                |                 | 2.77     | °C/W |
|                     | TO-220F/TO-220F1<br>TO-220F2/TO-220F3                 |                 | 8.33     | °C/W |
|                     | TO-251/TO-251S<br>TO-251S2/TO-251S4<br>TO-252/TO-252D |                 | 5 (Note) | °C/W |
|                     | PDFN5×6                                               |                 | 5.7      | °C/W |
|                     |                                                       |                 |          |      |

Note: The data tested by surface mounted on a 1 inch<sup>2</sup> FR-4 board with 2OZ copper.

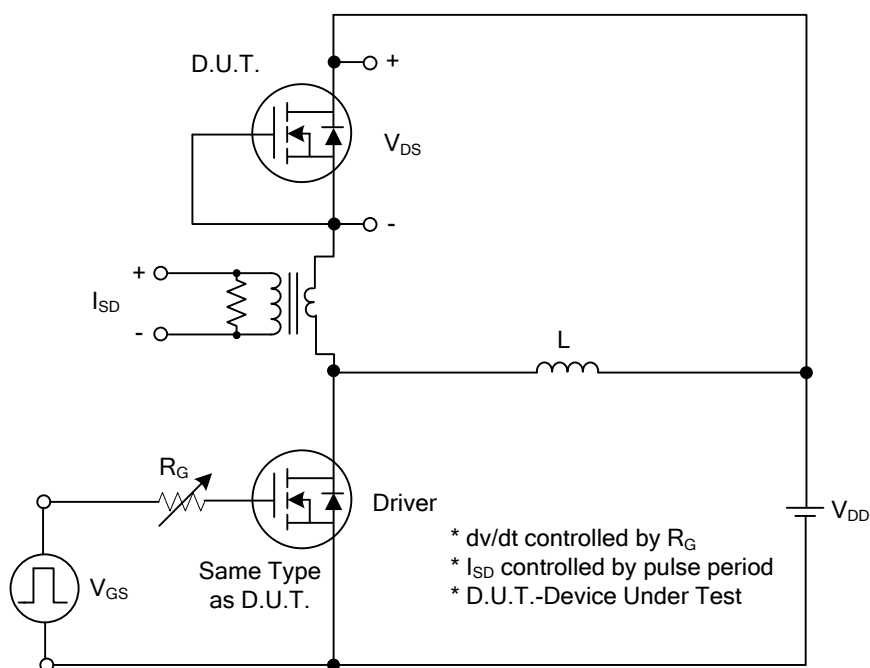
■ **ELECTRICAL CHARACTERISTICS** ( $T_J=25^{\circ}\text{C}$ , unless otherwise specified)

| PARAMETER                               |         | SYMBOL              | TEST CONDITIONS                                                                                     | MIN | TYP | MAX  | UNIT |
|-----------------------------------------|---------|---------------------|-----------------------------------------------------------------------------------------------------|-----|-----|------|------|
| OFF CHARACTERISTICS                     |         |                     |                                                                                                     |     |     |      |      |
| Drain-Source Breakdown Voltage          |         | BV <sub>DSS</sub>   | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA                                                        | 650 |     |      | V    |
| Drain-Source Leakage Current            |         | I <sub>DSS</sub>    | V <sub>DS</sub> = 650V, V <sub>GS</sub> = 0V                                                        |     |     | 10   | μA   |
| Gate-Source Leakage Current             | Forward | I <sub>GSS</sub>    | V <sub>GS</sub> = 30V, V <sub>DS</sub> = 0V                                                         |     |     | 100  | nA   |
|                                         | Reverse |                     | V <sub>GS</sub> = -30V, V <sub>DS</sub> = 0V                                                        |     |     | -100 | nA   |
| ON CHARACTERISTICS                      |         |                     |                                                                                                     |     |     |      |      |
| Gate Threshold Voltage                  |         | V <sub>GS(TH)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA                                          | 2.0 |     | 4.0  | V    |
| Static Drain-Source On-State Resistance |         | R <sub>DS(ON)</sub> | V <sub>GS</sub> = 10V, I <sub>D</sub> =1.0A                                                         |     |     | 9.5  | Ω    |
| DYNAMIC CHARACTERISTICS                 |         |                     |                                                                                                     |     |     |      |      |
| Input Capacitance                       |         | C <sub>ISS</sub>    | V <sub>DS</sub> =25V, V <sub>GS</sub> =0V,<br>f =1MHz                                               |     | 158 |      | pF   |
| Output Capacitance                      |         | C <sub>OSS</sub>    |                                                                                                     |     | 19  |      | pF   |
| Reverse Transfer Capacitance            |         | C <sub>RSS</sub>    |                                                                                                     |     | 2.1 |      | pF   |
| SWITCHING CHARACTERISTICS               |         |                     |                                                                                                     |     |     |      |      |
| Total Gate Charge                       |         | Q <sub>G</sub>      | V <sub>DS</sub> =520V, V <sub>GS</sub> =10V, I <sub>D</sub> =2A<br>I <sub>G</sub> =1mA (Note 1, 2)  |     | 10  |      | nC   |
| Gate-Source Charge                      |         | Q <sub>GS</sub>     |                                                                                                     |     | 4   |      | nC   |
| Gate-Drain Charge                       |         | Q <sub>GD</sub>     |                                                                                                     |     | 1.5 |      | nC   |
| Turn-On Delay Time                      |         | t <sub>D(ON)</sub>  | V <sub>DS</sub> =100V, V <sub>GS</sub> =10V, I <sub>D</sub> =2A,<br>R <sub>G</sub> =25Ω (Note 1, 2) |     | 4   |      | ns   |
| Turn-On Rise Time                       |         | t <sub>R</sub>      |                                                                                                     |     | 14  |      | ns   |
| Turn-Off Delay Time                     |         | t <sub>D(OFF)</sub> |                                                                                                     |     | 54  |      | ns   |
| Turn-Off Fall Time                      |         | t <sub>F</sub>      |                                                                                                     |     | 34  |      | ns   |
| DRAIN-SOURCE DIODE CHARACTERISTICS      |         |                     |                                                                                                     |     |     |      |      |
| Continuous Drain-Source Current         |         | I <sub>S</sub>      |                                                                                                     |     |     | 2.0  | A    |
| Pulsed Drain-Source Current             |         | I <sub>SM</sub>     |                                                                                                     |     |     | 4.0  | A    |
| Drain-Source Diode Forward Voltage      |         | V <sub>SD</sub>     | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 2.0 A                                                      |     |     | 1.4  | V    |
| Body Diode Reverse Recovery Time        |         | t <sub>rr</sub>     | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = 2.0 A,                                                     |     | 175 |      | ns   |
| Body Diode Reverse Recovery Charge      |         | Q <sub>rr</sub>     | dI <sub>F</sub> /dt=100A/μs                                                                         |     | 0.7 |      | μC   |

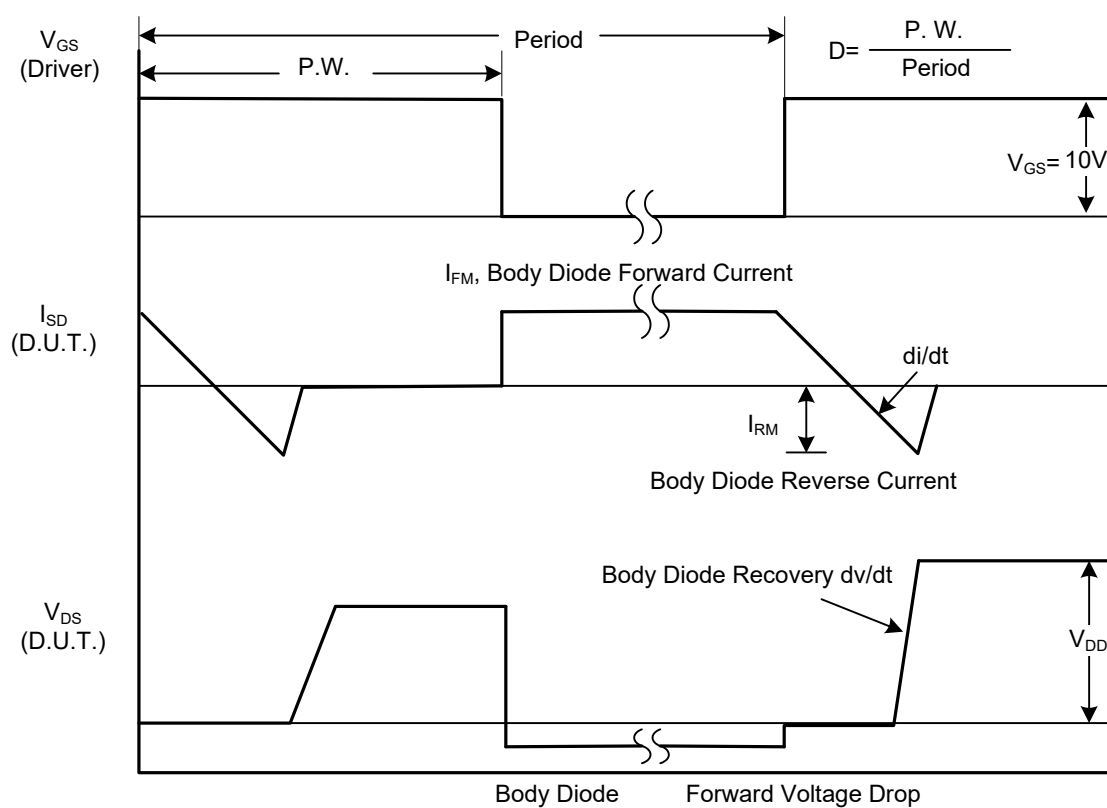
Notes: 1. Pulse Test: Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$ .

2. Essentially independent of operating temperature.

## ■ TEST CIRCUITS AND WAVEFORMS

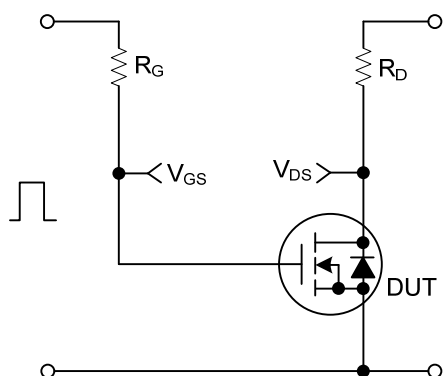


**Peak Diode Recovery dv/dt Test Circuit**

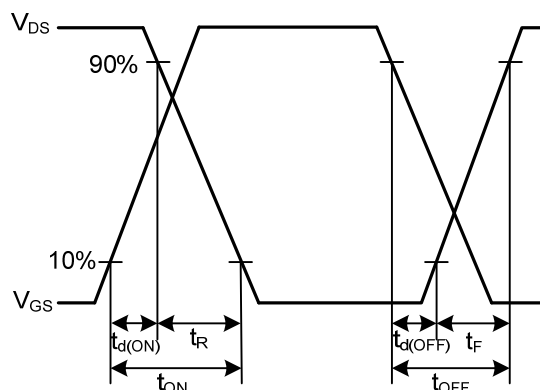


**Peak Diode Recovery dv/dt Waveforms**

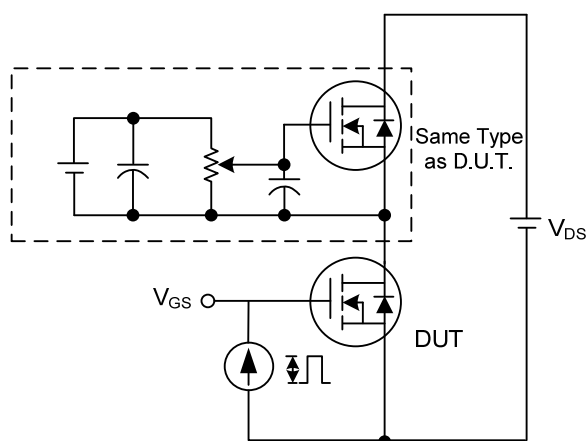
## ■ TEST CIRCUITS AND WAVEFORMS



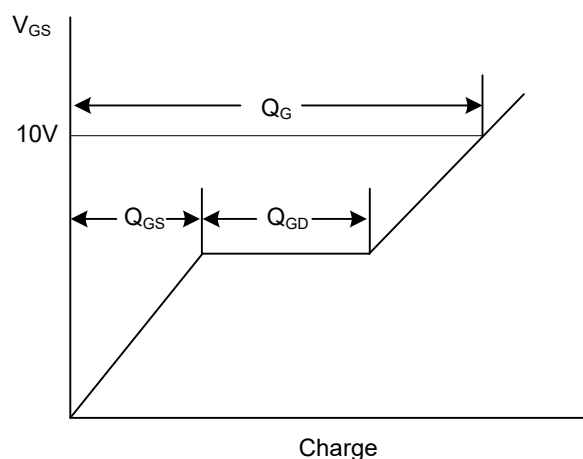
Switching Test Circuit



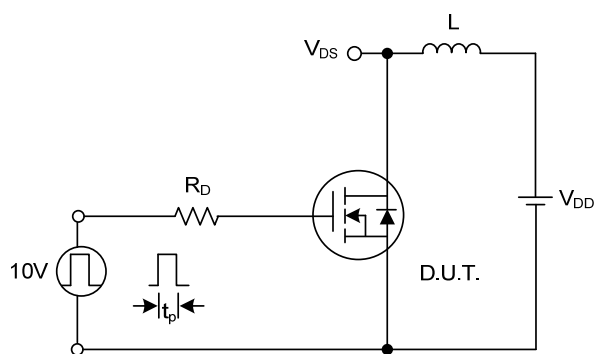
Switching Waveforms



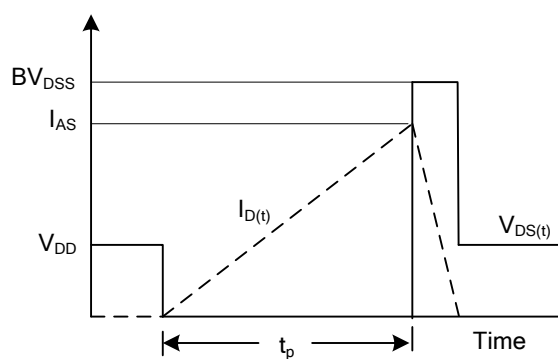
Gate Charge Test Circuit



Gate Charge Waveform

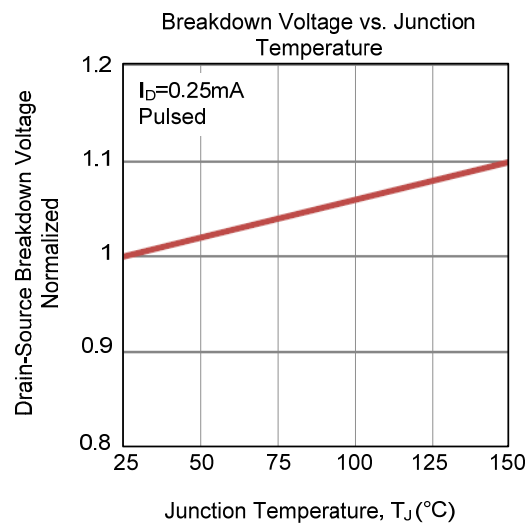
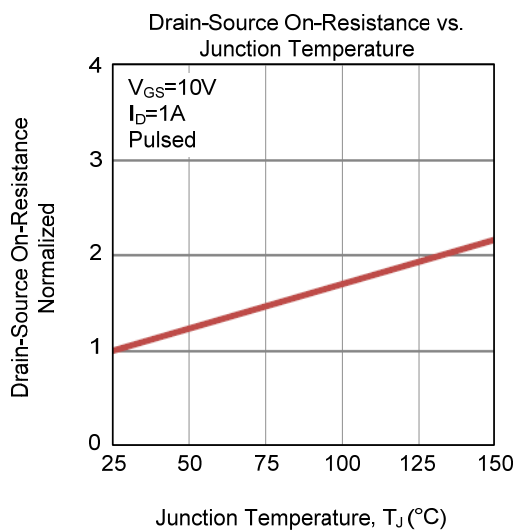
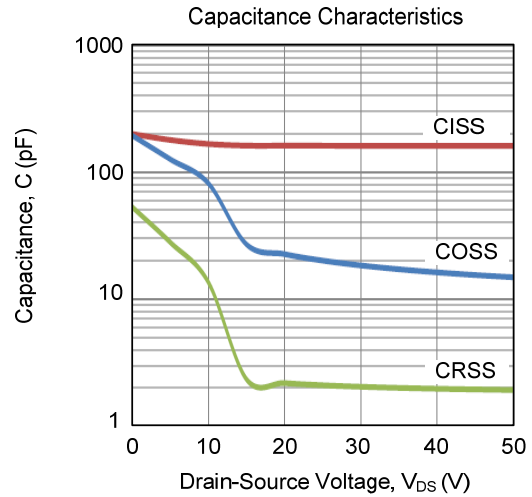
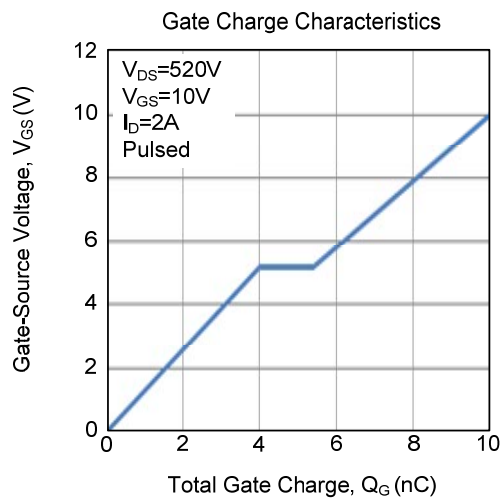
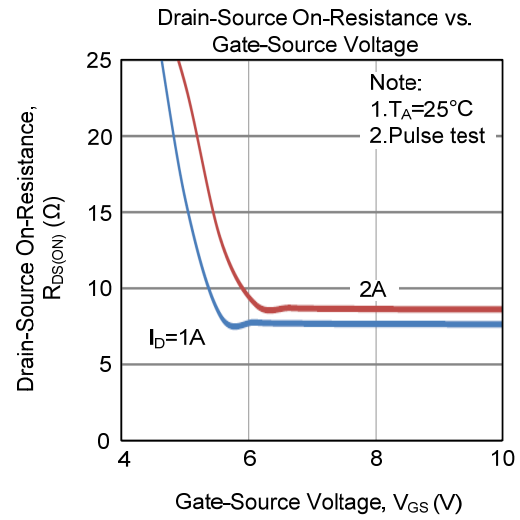
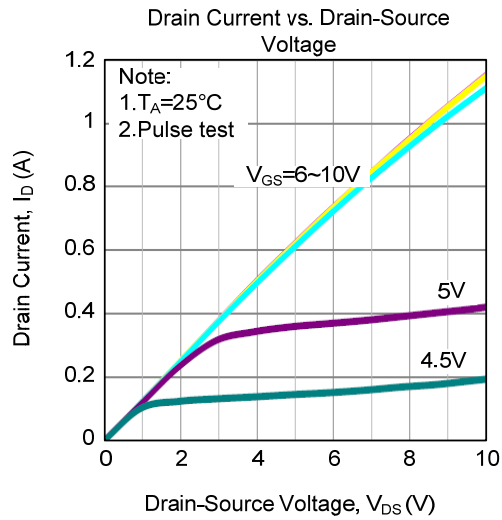


Unclamped Inductive Switching Test Circuit

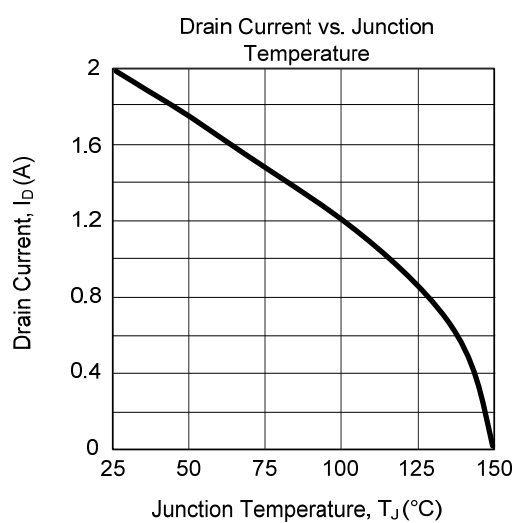
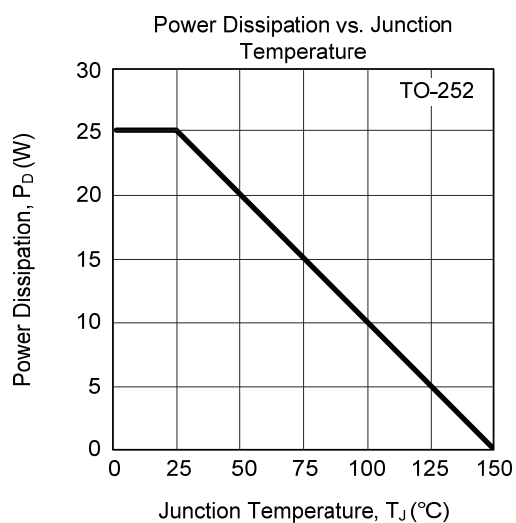
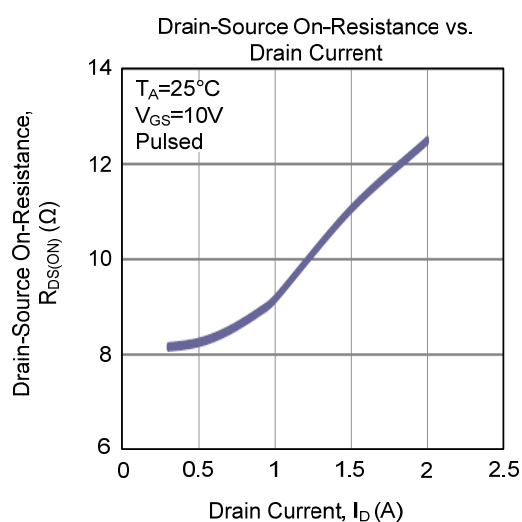
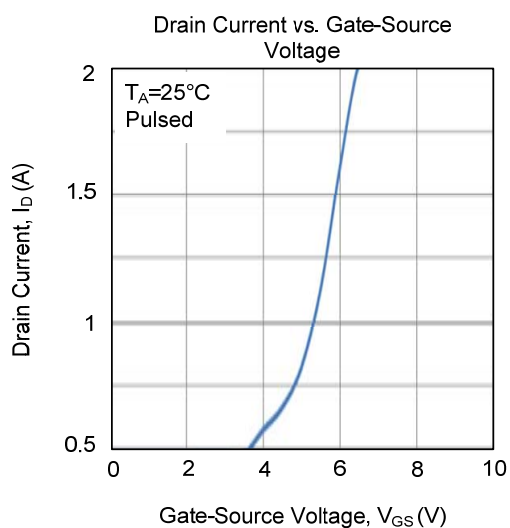
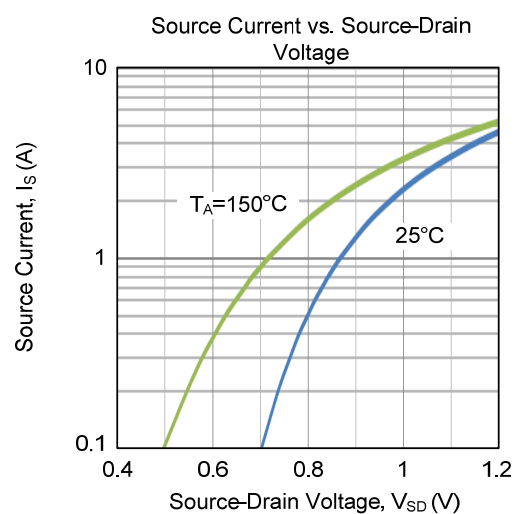
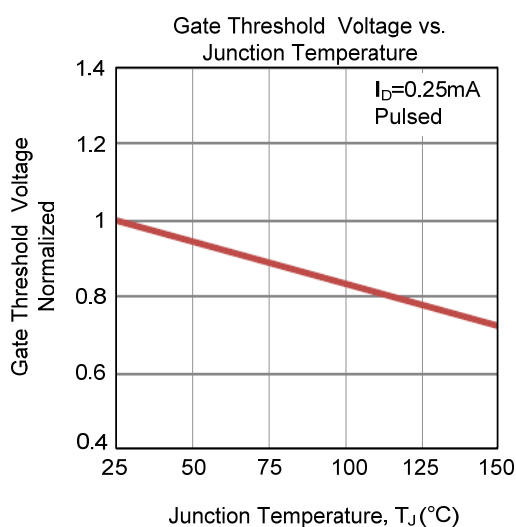


Unclamped Inductive Switching Waveforms

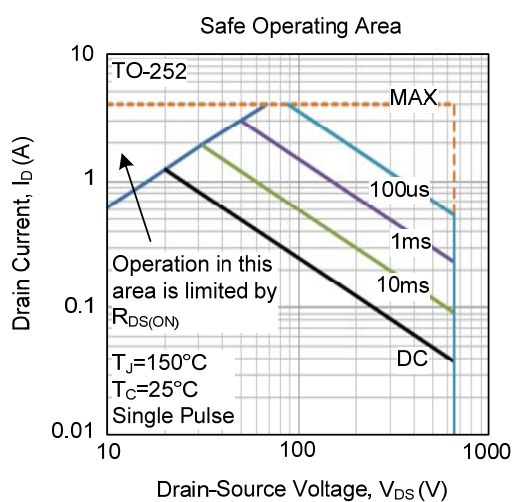
## TYPICAL CHARACTERISTICS



### ■ TYPICAL CHARACTERISTICS (Cont.)



## ■ TYPICAL CHARACTERISTICS (Cont.)



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