

# 650V 190mohm Super-Junction Power MOSFET

## AKS65N1K9PM

### Description:

This SJ device provides good FOM performance, better EMI for customer application.

### Features:

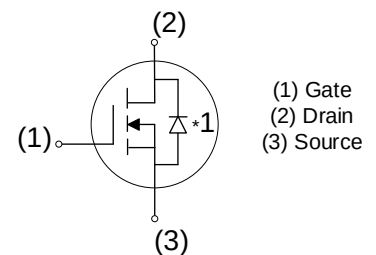
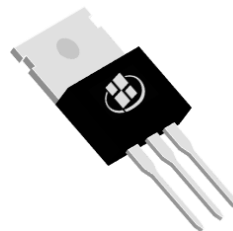
- Low FOM  $R_{DS(ON)} \times Q_G$
- Better EMI
- 100% UIS and Isolation tested
- RoHS compliant (Note 1)
- Halogen-free (Note 1)

### Applications:

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC)

### Key Performance Parameters:

| Parameter                         | Value | Unit       |
|-----------------------------------|-------|------------|
| $V_{DS}$                          | 650   | V          |
| $R_{DS(ON), max} @ V_{GS} = 10 V$ | 190   | m $\Omega$ |
| $I_D$                             | 20    | A          |



### Ordering Information:

| Ordering Code | Package Type | Marking Code | Form | Packing                            |
|---------------|--------------|--------------|------|------------------------------------|
| AKS65N1K9PM   | TO-220       | S65N1K9PM    | Tube | See the detail package information |

### Notes:

1. Contact ALKAIDSEMI sales for detail information

**Maximum Ratings**( $T_A = 25^\circ\text{C}$  unless otherwise noted)

| Symbol         | Parameter                                                        | Value       | Units            |
|----------------|------------------------------------------------------------------|-------------|------------------|
| $V_{DS}$       | Drain-Source Voltage                                             | 650         | V                |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ ) (Note 1) | 20          | A                |
|                | Drain Current -Continuous ( $T_C = 100^\circ\text{C}$ ) (Note 1) | 13          | A                |
| $I_{DM}$       | Drain Current - Pulsed (Note 1,2)                                | 60          | A                |
| $V_{GS}$       | Gate-Source Voltage                                              | $\pm 30$    | V                |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 3)                          | 390         | mJ               |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                   | 208         | W                |
| $dV/dT$        | MOSFET $dv/dt$ ruggedness                                        | 50          | V/ns             |
|                | Reverse diode $dv/dt$                                            | 24          | V/ns             |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                          | -55 to +150 | $^\circ\text{C}$ |

**Thermal Characteristics**

| Symbol          | Parameter                                                     | Value | Units              |
|-----------------|---------------------------------------------------------------|-------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case, Steady-State            | 0.6   | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient Steady State (Note 4) | 55    | $^\circ\text{C/W}$ |

**Notes:**

1. The max drain current rating limited by package and maximum junction temperature
2. Repetitive Rating: Pulse width limited by maximum junction temperature
3.  $L = 10.8\text{ mH}$ ,  $V_{DD} = 150\text{ V}$ ,  $I_{AS} = 8.5\text{ A}$ ,  $R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$ , guarantee by design
4. Mount on minimum PCB layout

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

| Symbol                                                 | Parameter                                          | Test Conditions                                                                                  | Min | Typ   | Max  | Units |
|--------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------|-----|-------|------|-------|
| Static Characteristics                                 |                                                    |                                                                                                  |     |       |      |       |
| BV <sub>DSS</sub>                                      | Drain-Source Breakdown Voltage                     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA<br>T <sub>J</sub> = 25°C                          | 650 |       |      | V     |
|                                                        |                                                    | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA<br>T <sub>J</sub> = 150°C                         | 750 |       |      |       |
| I <sub>DSS</sub>                                       | Zero Gate Voltage Drain Current                    | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V,<br>T <sub>J</sub> = 25°C                         |     |       | 1    | μA    |
|                                                        |                                                    | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V,<br>T <sub>J</sub> = 150°C                        |     |       | 100  |       |
| I <sub>GSS</sub>                                       | Gate Leakage Current                               | V <sub>GS</sub> = ±30 V, V <sub>DS</sub> = 0 V                                                   |     |       | ±100 | nA    |
| V <sub>GS(TH)</sub>                                    | Gate Threshold voltage                             | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                      | 2.6 | 3.3   | 4    | V     |
| R <sub>DS(ON)</sub>                                    | Drain-Source on-state resistance                   | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 10 A                                                    |     | 145   | 190  | mΩ    |
| g <sub>FS</sub>                                        | Forward Transconductance                           | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 4 A                                                     |     | 9     |      | S     |
| Dynamic Characteristics                                |                                                    |                                                                                                  |     |       |      |       |
| C <sub>ISS</sub>                                       | Input capacitance                                  | V <sub>DS</sub> = 100 V, V <sub>GS</sub> = 0 V,<br>F = 1 MHZ                                     |     | 1670  |      | pF    |
| C <sub>OSS</sub>                                       | Output capacitance                                 |                                                                                                  |     | 83.1  |      | pF    |
| C <sub>RSS</sub>                                       | Reverse transfer capacitance                       |                                                                                                  |     | 0.8   |      | pF    |
| R <sub>G</sub>                                         | Gate resistance                                    | F = 1 MHZ                                                                                        |     | 20    |      | Ω     |
| Switching Characteristics                              |                                                    |                                                                                                  |     |       |      |       |
| T <sub>D(ON)</sub>                                     | Turn On Delay Time                                 | V <sub>DS</sub> = 520 V, I <sub>D</sub> = 20 A,<br>V <sub>GS</sub> = 10 V, R <sub>G</sub> = 25 Ω |     | 49.8  |      | ns    |
| T <sub>R</sub>                                         | Rising Time                                        |                                                                                                  |     | 61.4  |      | ns    |
| T <sub>D(OFF)</sub>                                    | Turn Off Delay Time                                |                                                                                                  |     | 195.8 |      | ns    |
| T <sub>F</sub>                                         | Fall Time                                          |                                                                                                  |     | 55.8  |      | ns    |
| Q <sub>G</sub>                                         | Total Gate Charge                                  | V <sub>DS</sub> = 520 V, I <sub>D</sub> = 10 A,<br>V <sub>GS</sub> = 10 V                        |     | 44    |      | nC    |
| Q <sub>GS</sub>                                        | Gate-Source Charge                                 |                                                                                                  |     | 9     |      | nC    |
| Q <sub>GD</sub>                                        | Gate-Drain Charge                                  |                                                                                                  |     | 18    |      | nC    |
| Drain-Source Diode Characteristics and Maximum Ratings |                                                    |                                                                                                  |     |       |      |       |
| I <sub>S</sub>                                         | Maximum Continuous Body-Diode Forward Current      |                                                                                                  |     |       | 20   | A     |
| I <sub>SM</sub>                                        | Maximum Pulsed Body-Diode Forward Current (NOTE 1) |                                                                                                  |     |       | 60   | A     |
| V <sub>SD</sub>                                        | Diode Forward Voltage                              | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 8 A                                                      |     | 0.81  |      | V     |
| T <sub>RR</sub>                                        | Reverse recovery time                              | I <sub>S</sub> = 20 A, dI/dT = 100 A/μS                                                          |     | 350   |      | ns    |
| Q <sub>RR</sub>                                        | Reverse recovery charge                            |                                                                                                  |     | 6.2   |      | μC    |
| I <sub>RM</sub>                                        | Peak Reverse Recovery Current                      |                                                                                                  |     | 36    |      | A     |

## Electrical Characteristics Diagrams

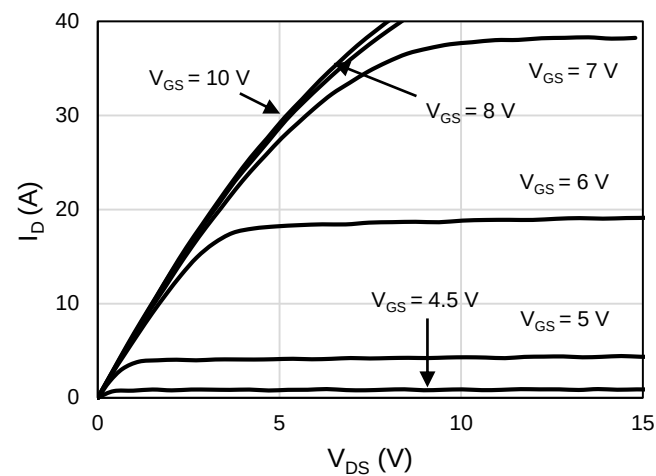


Figure 1: On-Region Characteristics

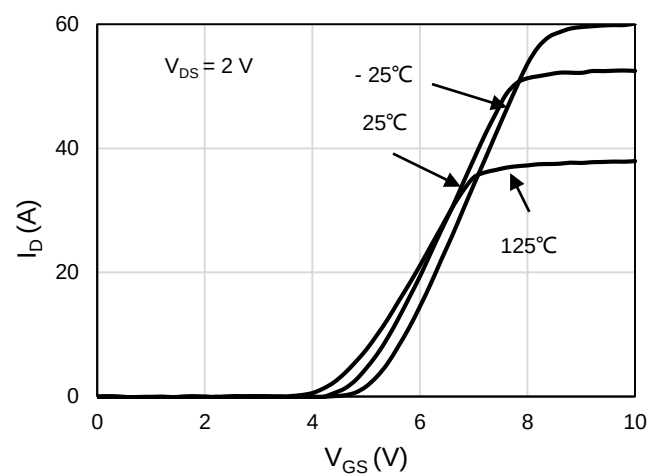


Figure 2: Transfer Characteristics

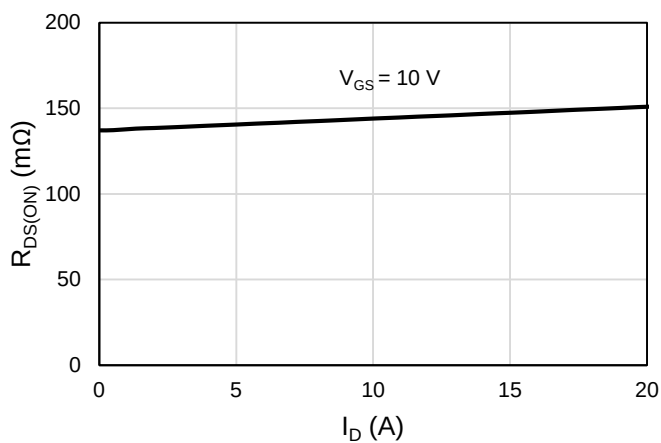


Figure 3: On-Resistance vs. Drain Current and Gate Voltage

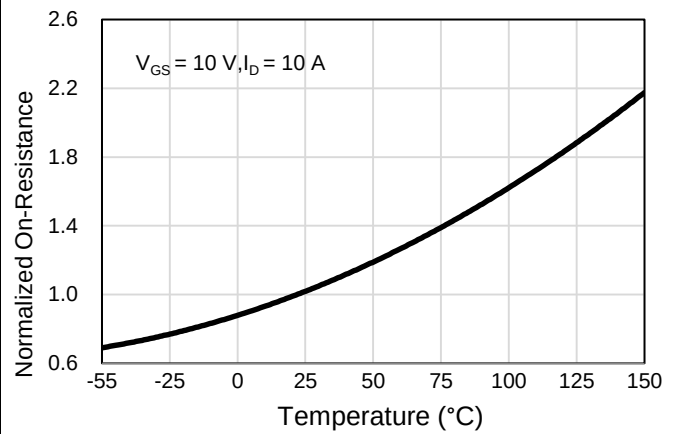


Figure 4: On-Resistance vs. Junction Temperature

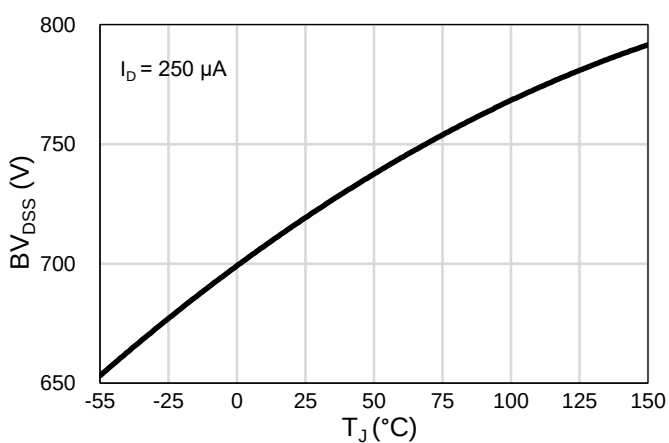


Figure 5: Break Down vs. Junction Temperature

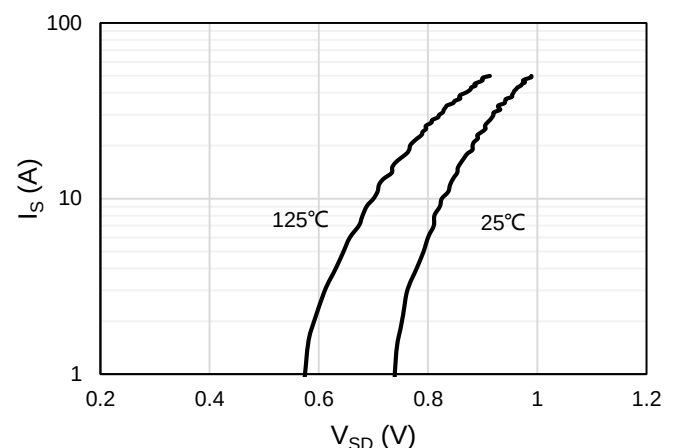


Figure 6: Body-Diode Characteristics

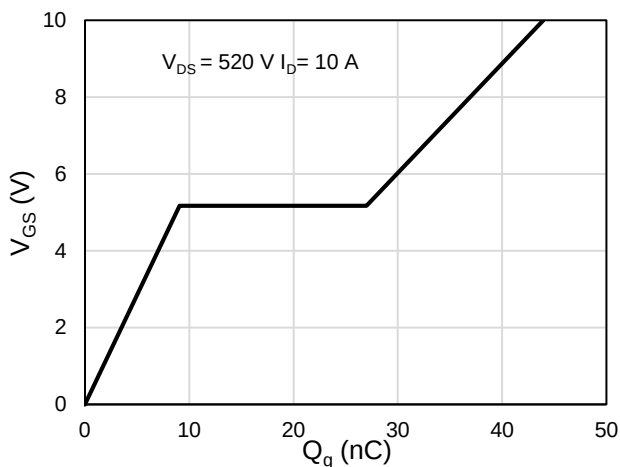


Figure 7: Gate-Charge Characteristics

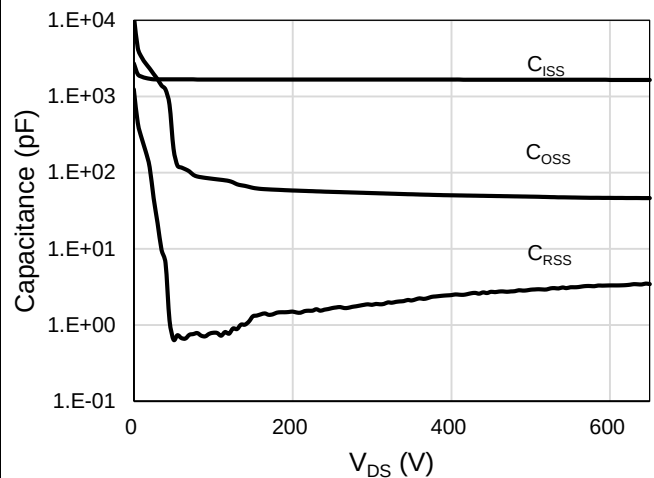


Figure 8: Capacitance Characteristics

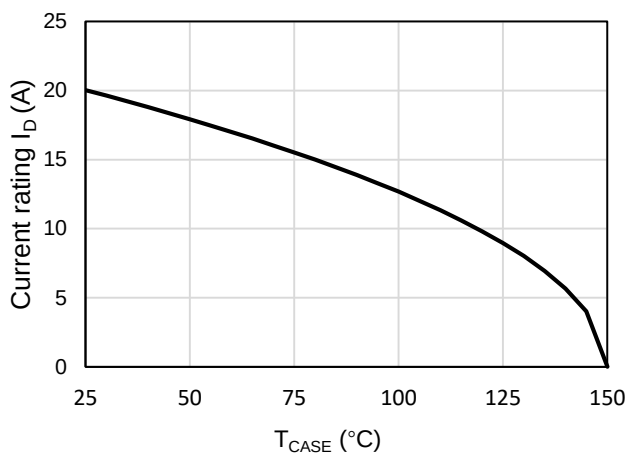


Figure 9: Current De-rating

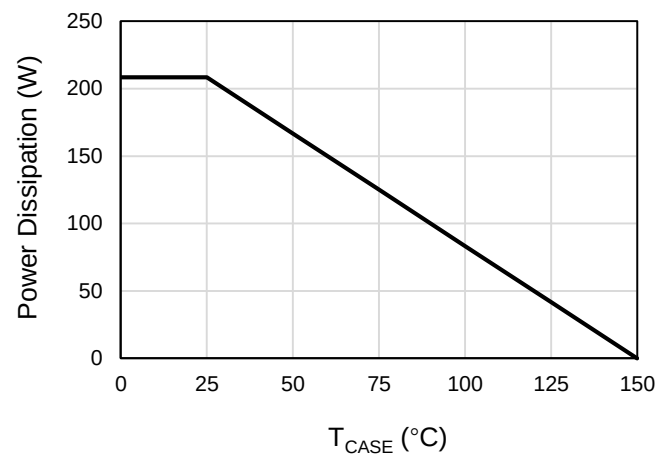


Figure 10: Power De-rating

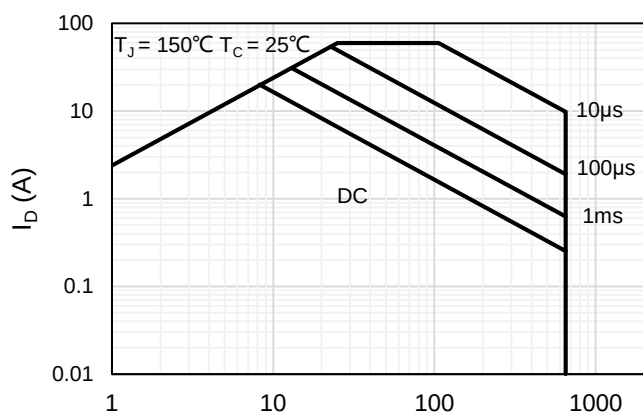


Figure 11: Maximum Forward Biased Safe Operating Area

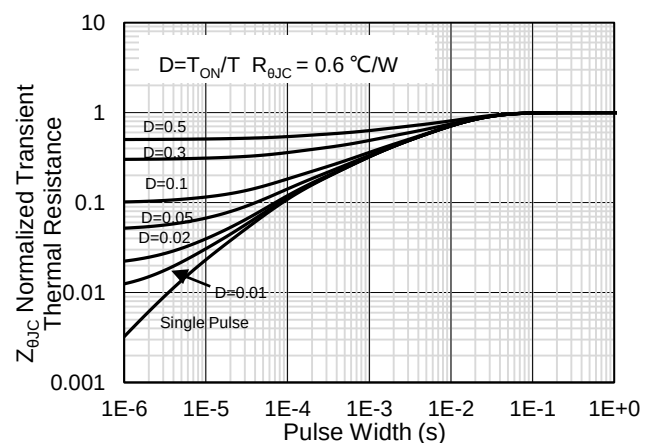


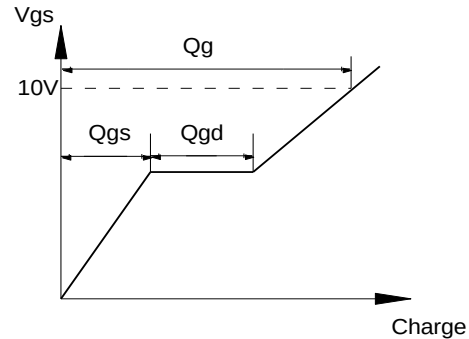
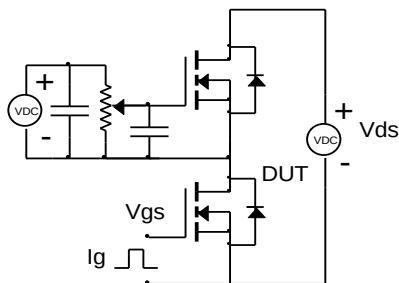
Figure 12: Normalized Maximum Transient Thermal Impedance

**Notes:**

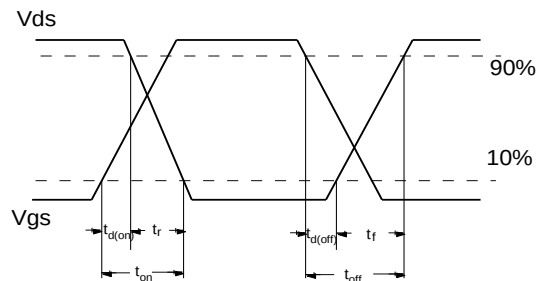
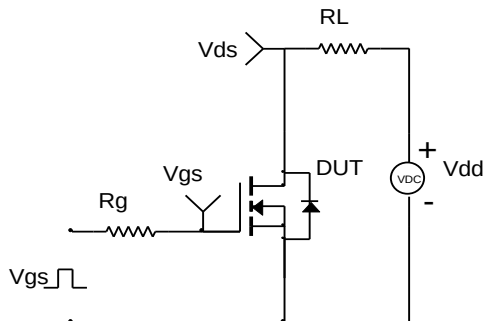
1. Pulse Test: Pulse width  $\leq 300 \mu s$ , Duty cycle  $\leq 2\%$
2. Essentially independent of operating temperature

## Test Circuit and Waveform

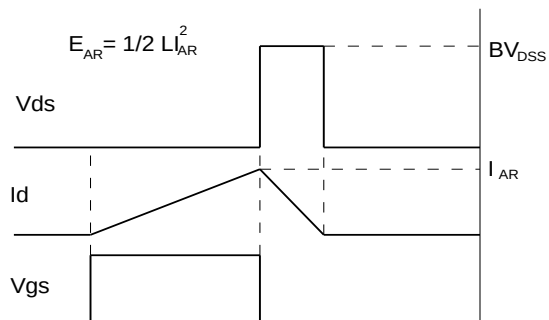
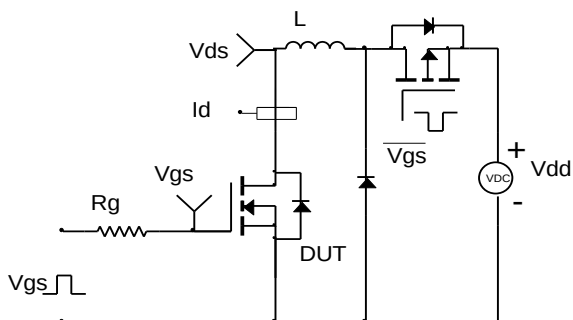
Gate Charge Test Circuit & Waveform



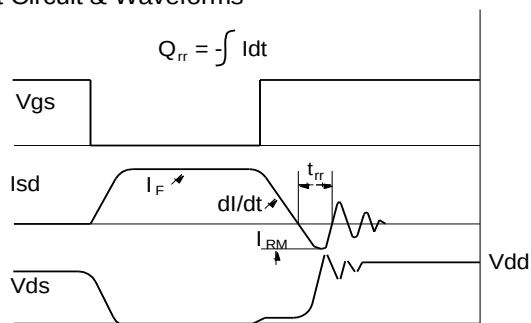
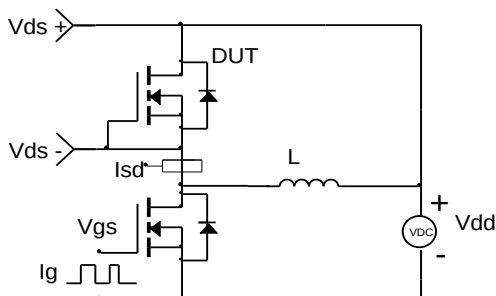
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



## Revision History

| Revision | Release Date | Remark |
|----------|--------------|--------|
| Rev.1.1  | 2023-04-10   |        |

## Disclaimer

The information given in this document describes the independent performance of the product, but similar performance is not guaranteed under other working conditions, and cannot be guaranteed when installed with other products or equipment. To achieve the required performance of the product in actual scenarios, the customer should conduct a complete application test to assess the functionality of the product.

Alkaidsemi assumes no responsibility for equipment failures result from using products at values that exceed the ratings, operating conditions, or other parameters listed in the product specifications.

The product described in this specification is not applicable for aerospace or other applications which requires high reliability. Customers using or selling these products for use in medical, life-saving, or life-sustaining applications do so at their own risk and agree to fully indemnify.

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