

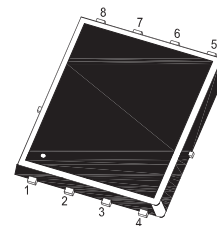
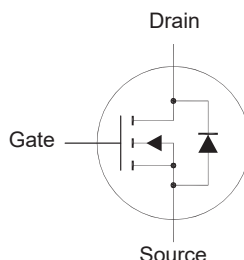
## N-Channel Enhancement Mode MOSFET

### Features

- Advanced trench Cell Design
- Low Thermal Resistance
- Halogen and Antimony Free(HAF), RoHS compliant

### Applications

- DC - DC Converter
- Motor drivers



1.Source 2.Source 3.Source 4.Gate  
5.Drain 6.Drain 7.Drain 8.Drain  
DFN5060 Plastic Package

### Key Parameters

| Parameter                | Value                         | Unit       |
|--------------------------|-------------------------------|------------|
| $BV_{DSS}$               | 40                            | V          |
| $R_{DS(ON)} \text{ Max}$ | 1.9 @ $V_{GS} = 10 \text{ V}$ | m $\Omega$ |
|                          | 3 @ $V_{GS} = 4.5 \text{ V}$  |            |
| $V_{GS(th)} \text{ typ}$ | 2                             | V          |
| $Q_g \text{ typ}$        | 70 @ $V_{GS} = 10 \text{ V}$  | nC         |

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

| Parameter                                        | Symbol         | Value         | Unit             |
|--------------------------------------------------|----------------|---------------|------------------|
| Drain-Source Voltage                             | $V_{DS}$       | 40            | V                |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 20$      | V                |
| Continuous Drain Current                         | $I_D$          | 110           | A                |
|                                                  |                | 69            |                  |
| Peak Drain Current, Pulsed <sup>1)</sup>         | $I_{DM}$       | 320           | A                |
| Avalanche Current                                | $I_{AS}$       | 45            | A                |
| Single Pulse Avalanche Energy <sup>2)</sup>      | $E_{AS}$       | 101           | mJ               |
| Power Dissipation                                | $P_D$          | 35            | W                |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to + 150 | $^\circ\text{C}$ |

### Thermal Characteristics

| Parameter                                                 | Symbol          | Max. | Unit               |
|-----------------------------------------------------------|-----------------|------|--------------------|
| Thermal Resistance from Junction to Case                  | $R_{\theta JC}$ | 3.5  | $^\circ\text{C/W}$ |
| Thermal Resistance from Junction to Ambient <sup>3)</sup> | $R_{\theta JA}$ | 62.5 | $^\circ\text{C/W}$ |

<sup>1)</sup> Pulse Test: Pulse Width  $\leq 100 \mu\text{s}$ , Duty Cycle  $\leq 2\%$ , Repetitive rating, pulse width limited by junction temperature  $T_{J(MAX)} = 150^\circ\text{C}$ .

<sup>2)</sup> Limited by  $T_{J(MAX)}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.1 \text{ mH}$ ,  $R_g = 25 \Omega$ ,  $I_{AS} = 45 \text{ A}$ ,  $V_{GS} = 10 \text{ V}$ .

<sup>3)</sup> Device mounted on FR-4 substrate PC board, 2oz copper, with 1-inch square copper plate in still air.

Characteristics at  $T_a = 25^\circ\text{C}$  unless otherwise specified

| Parameter                                                                                                                                                                        | Symbol       | Min.   | Typ.     | Max.      | Unit          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------|----------|-----------|---------------|
| <b>STATIC PARAMETERS</b>                                                                                                                                                         |              |        |          |           |               |
| Drain-Source Breakdown Voltage<br>at $I_D = 250\ \mu\text{A}$                                                                                                                    | $BV_{DSS}$   | 40     | -        | -         | V             |
| Drain-Source Leakage Current<br>at $V_{DS} = 32\ \text{V}$                                                                                                                       | $I_{DSS}$    | -      | -        | 1         | $\mu\text{A}$ |
| Gate-Source Leakage Current<br>at $V_{GS} = \pm 20\ \text{V}$                                                                                                                    | $I_{GSS}$    | -      | -        | $\pm 100$ | nA            |
| Gate-Source Threshold Voltage<br>at $V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$                                                                                                 | $V_{GS(th)}$ | 1.5    | -        | 2.5       | V             |
| Drain-Source On-State Resistance<br>at $V_{GS} = 10\ \text{V}$ , $I_D = 20\ \text{A}$<br>at $V_{GS} = 4.5\ \text{V}$ , $I_D = 10\ \text{A}$                                      | $R_{DS(on)}$ | -<br>- | 1.5<br>- | 1.9<br>3  | m $\Omega$    |
| <b>DYNAMIC PARAMETERS</b>                                                                                                                                                        |              |        |          |           |               |
| Gate Resistance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                      | $R_g$        | -      | 1.9      | -         | $\Omega$      |
| Input Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                   | $C_{iss}$    | -      | 4863     | -         | pF            |
| Output Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                  | $C_{oss}$    | -      | 1985     | -         | pF            |
| Reverse Transfer Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $f = 1\ \text{MHz}$                                                                        | $C_{rss}$    | -      | 70       | -         | pF            |
| Gate Charge Total<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$<br>at $V_{GS} = 4.5\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$ | $Q_g$        | -<br>- | 70<br>32 | -<br>-    | nC            |
| Gate to Source Charge<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$                                                                             | $Q_{gs}$     | -      | 18       | -         | nC            |
| Gate to Drain Charge<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$                                                                              | $Q_{gd}$     | -      | 12       | -         | nC            |
| Turn-On Delay Time<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$ , $R_g = 4.7\ \Omega$                                                          | $t_{d(on)}$  | -      | 37       | -         | ns            |
| Turn-On Rise Time<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$ , $R_g = 4.7\ \Omega$                                                           | $t_r$        | -      | 61       | -         | ns            |
| Turn-Off Delay Time<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$ , $R_g = 4.7\ \Omega$                                                         | $t_{d(off)}$ | -      | 31       | -         | ns            |
| Turn-Off Fall Time<br>at $V_{GS} = 10\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $I_D = 20\ \text{A}$ , $R_g = 4.7\ \Omega$                                                          | $t_f$        | -      | 13       | -         | ns            |
| <b>Body-Diode PARAMETERS</b>                                                                                                                                                     |              |        |          |           |               |
| Drain-Source Diode Forward Voltage<br>at $I_S = 20\ \text{A}$ , $V_{GS} = 0\ \text{V}$                                                                                           | $V_{SD}$     | -      | -        | 1.3       | V             |
| Body-Diode Continuous Current                                                                                                                                                    | $I_S$        | -      | -        | 110       | A             |
| Body-Diode Continuous Current, Pulsed                                                                                                                                            | $I_{SM}$     | -      | -        | 320       | A             |
| Body Diode Reverse Recovery Time<br>at $I_S = 20\ \text{A}$ , $di/dt = 100\ \text{A} / \mu\text{s}$                                                                              | $t_{rr}$     | -      | 45       | -         | ns            |
| Body Diode Reverse Recovery Charge<br>at $I_S = 20\ \text{A}$ , $di/dt = 100\ \text{A} / \mu\text{s}$                                                                            | $Q_{rr}$     | -      | 46       | -         | nC            |

## Electrical Characteristics Curves

Fig. 1 Typical Output Characteristics

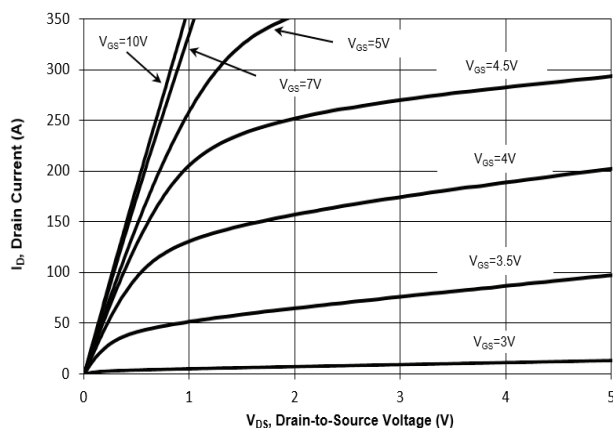


Fig. 2 Typical Transfer Characteristics

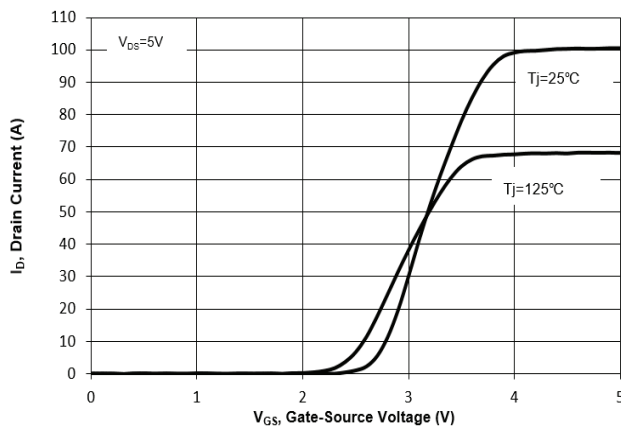


Fig. 3 on-Resistance vs. Drain Current

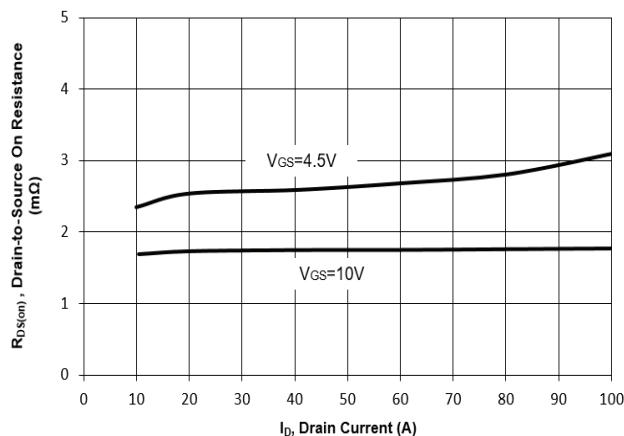


Fig. 4 on-Resistance vs. Gate to Source Voltage

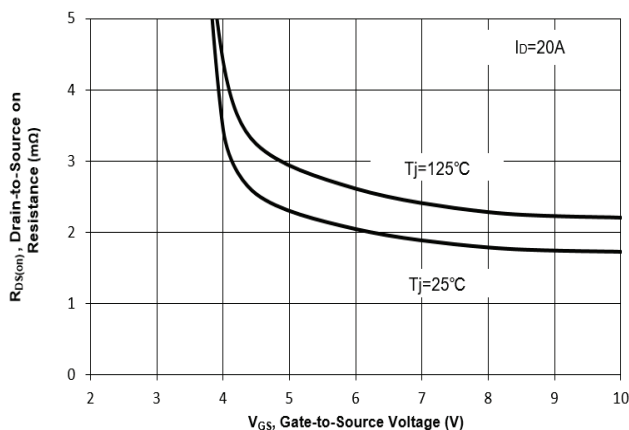


Fig. 5 on-Resistance vs.  $T_J$

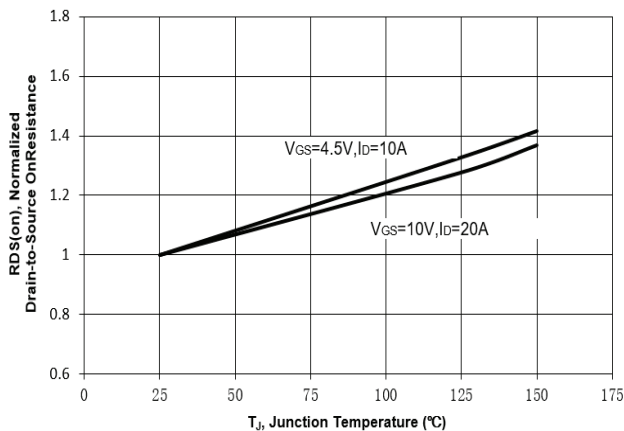
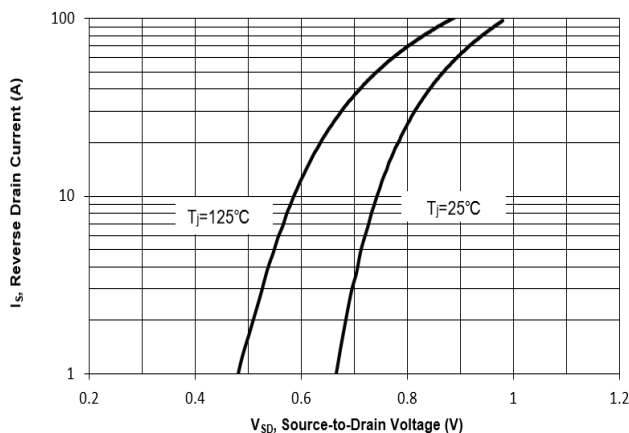


Fig. 6 Typical Body-Diode Forward Characteristics



## Electrical Characteristics Curves

Fig. 7 Typical Junction Capacitance

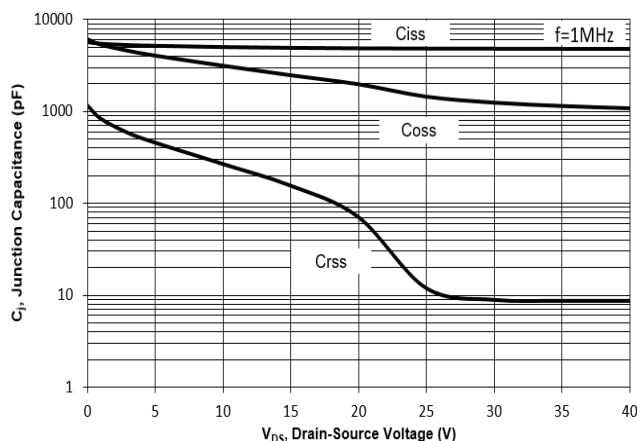


Fig. 8 Drain-Source Leakage Current vs.  $T_j$

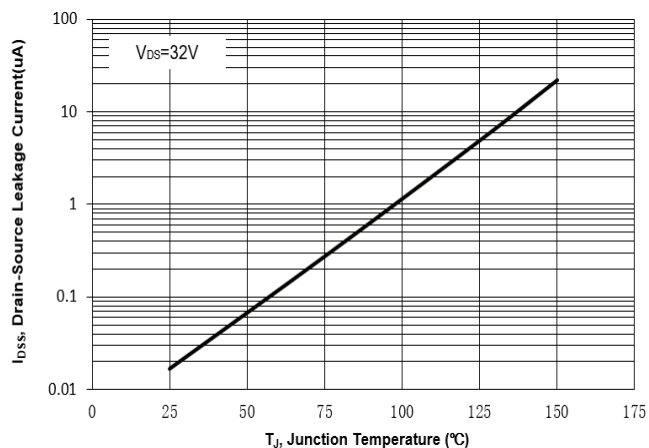


Fig. 9  $V_{(BR)DSS}$  vs. Junction Temperature

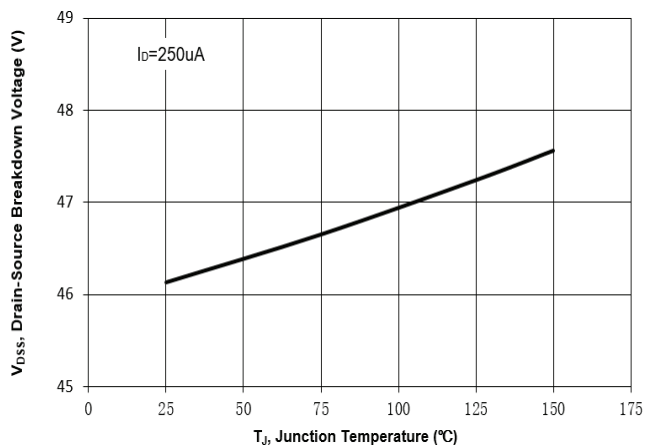


Fig. 10 Gate Threshold Variation vs.  $T_j$

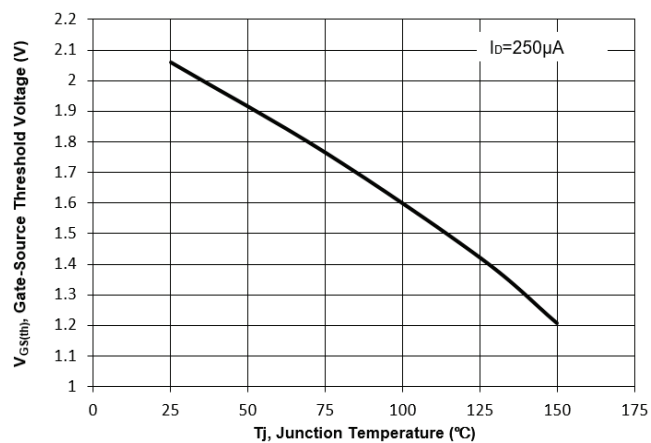


Fig. 11 Gate Charge

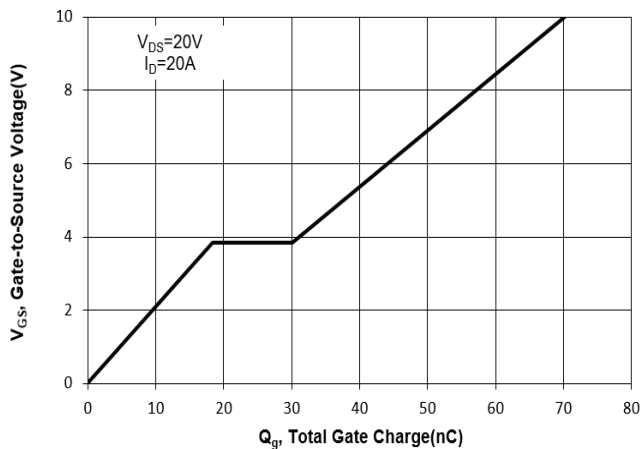
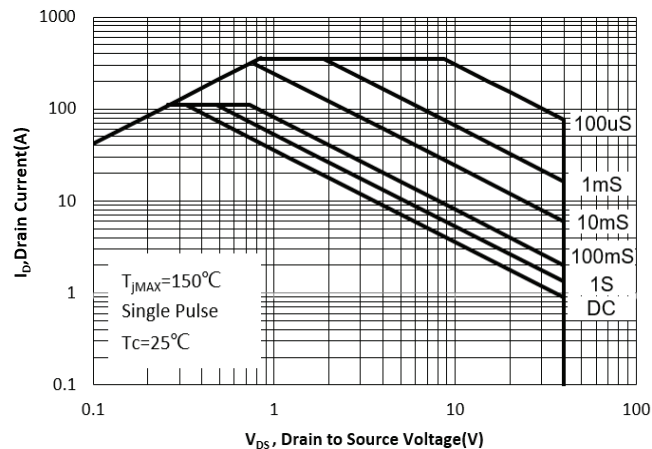
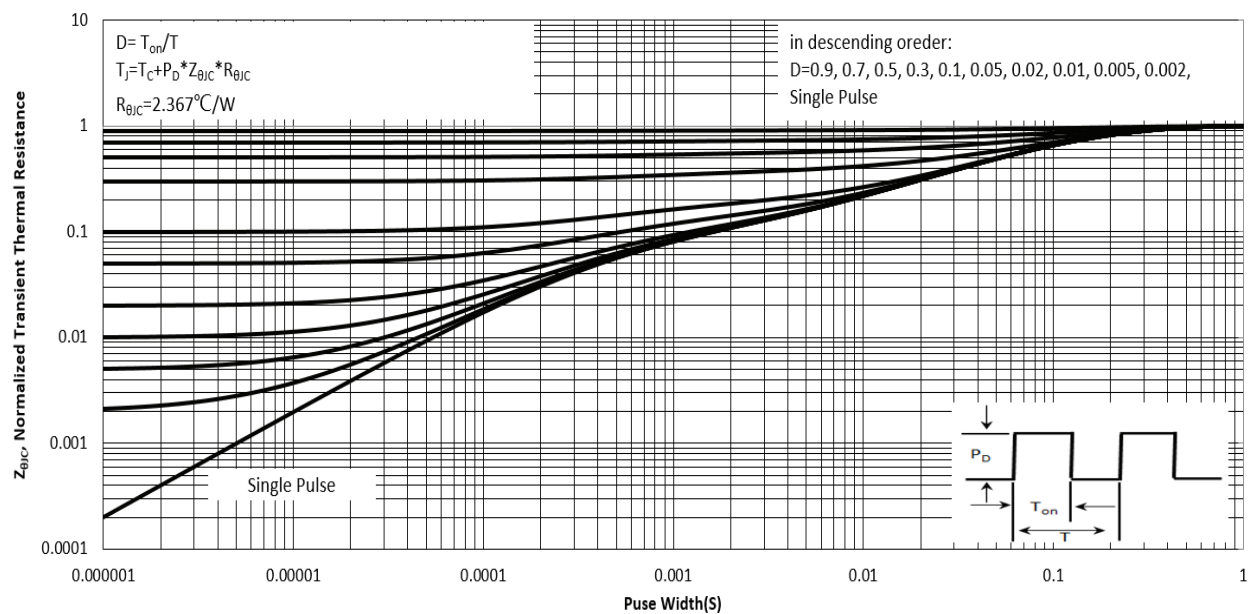


Fig. 12 Safe Operation Area



## Electrical Characteristics Curves

Fig. 13 Normalized Maximum Transient Thermal Impedance( $Z_{\theta JC}$ )



## Test Circuits

Fig.1-1 Switching times test circuit

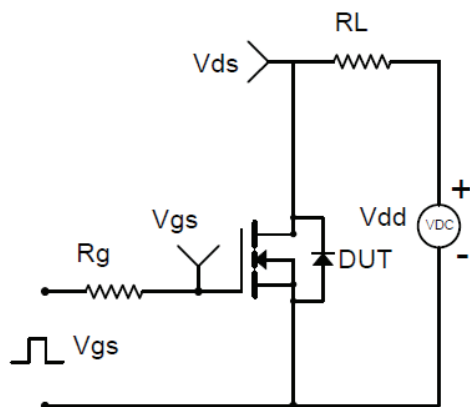


Fig.1-2 Switching Waveform

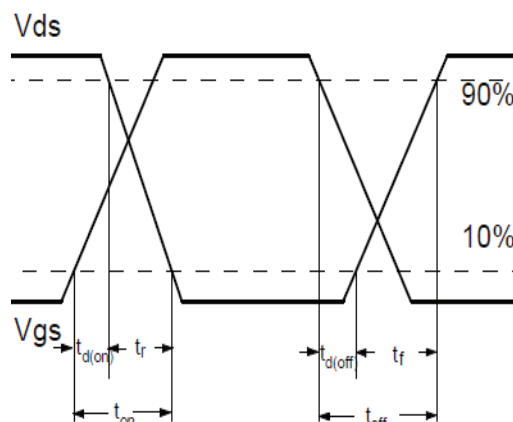


Fig.2-1 Gate charge test circuit

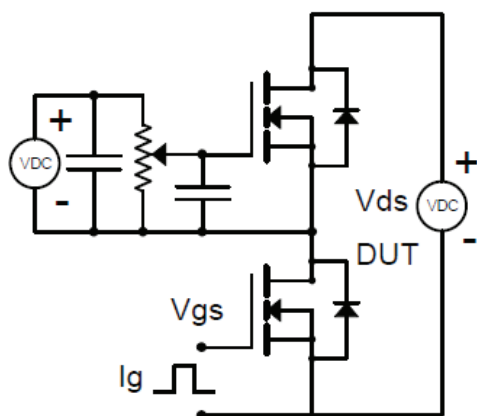


Fig.2-2 Gate charge waveform

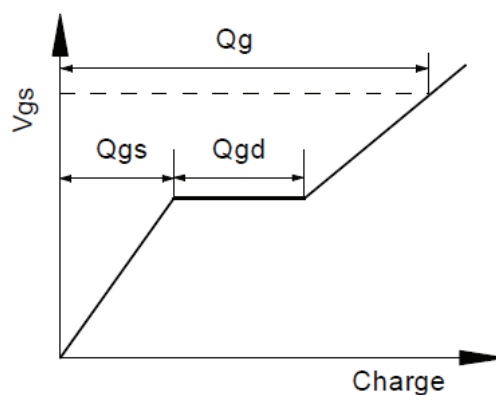


Fig.3-1 Avalanche test circuit

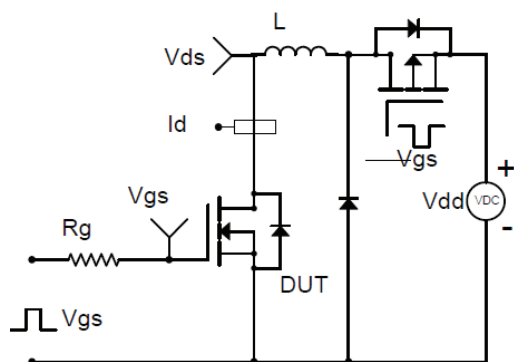
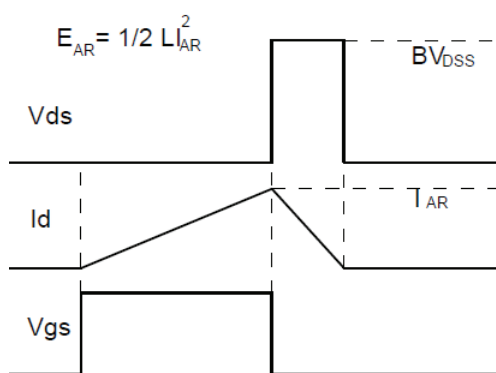
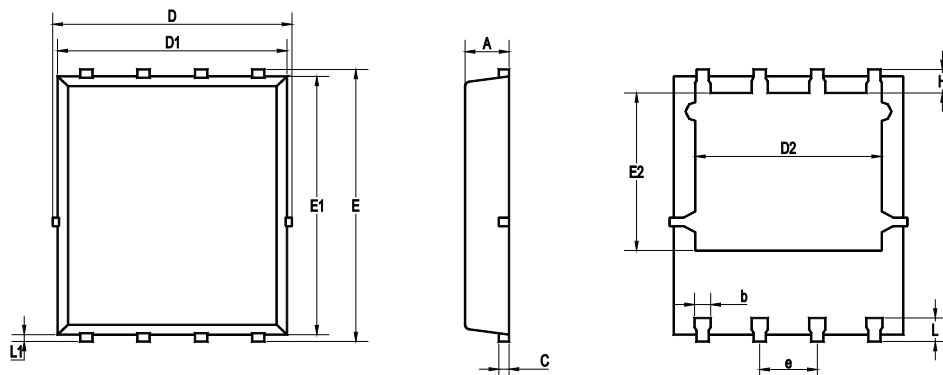


Fig.3-2 Avalanche waveform



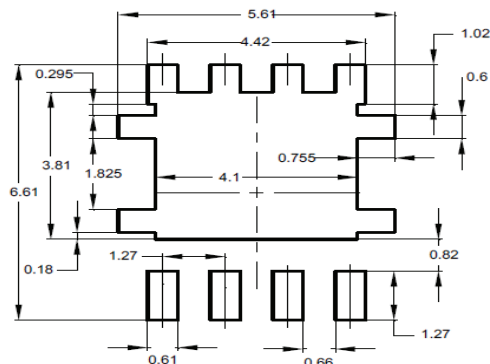
Package Outline Dimensions (Units: mm)

DFN5060



| UNIT | A    | b    | C    | D    | D1  | D2   | E    | E1  | E2   | e    | L    | L1   | H    |
|------|------|------|------|------|-----|------|------|-----|------|------|------|------|------|
| mm   | 1.12 | 0.51 | 0.34 | 5.26 | 5.1 | 4.5  | 6.25 | 6   | 3.66 | 1.37 | 0.71 | 0.2  | 0.71 |
|      | 0.9  | 0.33 | 0.11 | 4.7  | 4.7 | 3.56 | 5.75 | 5.6 | 3.18 | 1.17 | 0.35 | 0.06 | 0.35 |

Recommended Soldering Footprint



Packing information

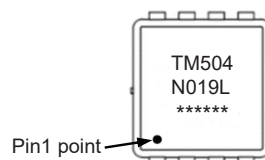
| Package | Tape Width (mm) | Pitch   |               | Reel Size |      | Per Reel Packing Quantity |
|---------|-----------------|---------|---------------|-----------|------|---------------------------|
|         |                 | mm      | inch          | mm        | inch |                           |
| DFN5060 | 12              | 8 ± 0.1 | 0.315 ± 0.004 | 330       | 13   | 5,000                     |

Marking information

" TM504N019L " = Part No.

" \*\*\*\*\* " = Date Code Marking

Font type: Arial



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