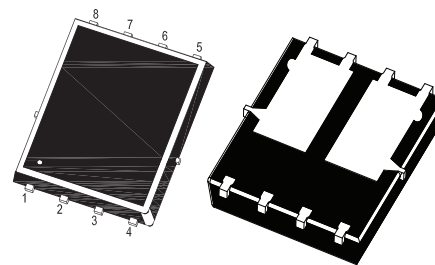
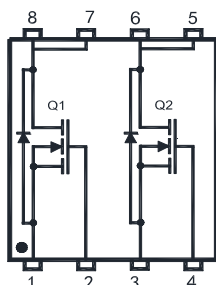


## Dual N-Channel Enhancement Mode MOSFET

### Features

- Low  $R_{DS(ON)}$
- AEC-Q101 Qualified
- Surface-mounted package
- Halogen and Antimony Free(HAF), RoHS compliant



Q1:1.Source 2.Gate 7.Drain 8.Drain  
Q2:3.Source 4.Gate 5.Drain 6.Drain  
DFN5060 Plastic Package

### Application

- DC-DC Power supply

### Key Parameters(Q1/Q2)

| Parameter        | Value                        | Unit |
|------------------|------------------------------|------|
| $BV_{DSS}$       | 40                           | V    |
| $R_{DS(ON)}$ Max | 32 @ $V_{GS} = 10\text{ V}$  | mΩ   |
|                  | 42 @ $V_{GS} = 4.5\text{ V}$ |      |
| $V_{GS(th)}$ typ | 1.6                          | V    |
| $Q_g$ typ        | 9.4 @ $V_{GS} = 10\text{ V}$ | nC   |

### Absolute Maximum Ratings(at $T_a = 25^\circ\text{C}$ unless otherwise specified)(Q1/Q2)

| Parameter                                        | Symbol         | Value                     | Unit             |
|--------------------------------------------------|----------------|---------------------------|------------------|
| Drain-Source Voltage                             | $V_{DS}$       | 40                        | V                |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 20$                  | V                |
| Continuous Drain Current                         | $I_D$          | 14                        | A                |
|                                                  |                | 8.8                       |                  |
|                                                  |                | $T_c = 25^\circ\text{C}$  |                  |
|                                                  |                | $T_c = 100^\circ\text{C}$ |                  |
| Peak Drain Current, Pulsed <sup>1)</sup>         | $I_{DM}$       | 36                        | A                |
| Avalanche Current                                | $I_{AS}$       | 10                        | A                |
| Single Pulse Avalanche Energy <sup>2)</sup>      | $E_{AS}$       | 5                         | mJ               |
| Power Dissipation                                | $P_D$          | 11.9                      | W                |
|                                                  |                | $T_c = 25^\circ\text{C}$  |                  |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to + 150             | $^\circ\text{C}$ |

### Thermal Characteristics(Q1/Q2)

| Parameter                                                 | Symbol          | Max. | Unit               |
|-----------------------------------------------------------|-----------------|------|--------------------|
| Thermal Resistance from Junction to Case                  | $R_{\theta JC}$ | 10.5 | $^\circ\text{C/W}$ |
| Thermal Resistance from Junction to Ambient <sup>3)</sup> | $R_{\theta JA}$ | 65   | $^\circ\text{C/W}$ |

<sup>1)</sup> Pulse Test: Pulse Width  $\leq 100\text{ }\mu\text{s}$ , 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  $T_J = 25^\circ\text{C}$ ,  $L = 0.1\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 10\text{ A}$ ,  $V_{GS} = 10\text{ V}$ .

<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(Q1/Q2)

| 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 Leakage Current<br>at $V_{GS} = \pm 16\ \text{V}$                                                                                                                         | $I_{GSS}$    | -      | -          | $\pm 100$ | nA            |
| Gate-Source Threshold Voltage<br>at $V_{DS} = V_{GS}$ , $I_D = 250\ \mu\text{A}$                                                                                               | $V_{GS(th)}$ | 1      | -          | 2.5       | V             |
| Drain-Source On-State Resistance<br>at $V_{GS} = 10\ \text{V}$ , $I_D = 5\ \text{A}$<br>at $V_{GS} = 4.5\ \text{V}$ , $I_D = 3\ \text{A}$                                      | $R_{DS(on)}$ | -<br>- | 27<br>-    | 32<br>42  | m $\Omega$    |
| <b>DYNAMIC PARAMETERS</b>                                                                                                                                                      |              |        |            |           |               |
| Forward Transconductance<br>at $V_{DS} = 5\ \text{V}$ , $I_D = 5\ \text{A}$                                                                                                    | $g_{fs}$     | -      | 7          | -         | S             |
| Gate resistance<br>at $V_{DS} = 0\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                    | $R_g$        | -      | 1.2        | -         | $\Omega$      |
| Input Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                 | $C_{iss}$    | -      | 415        | -         | pF            |
| Output Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                | $C_{oss}$    | -      | 38         | -         | pF            |
| Reverse Transfer Capacitance<br>at $V_{GS} = 0\ \text{V}$ , $V_{DS} = 20\ \text{V}$ , $f = 1\ \text{MHz}$                                                                      | $C_{rss}$    | -      | 33         | -         | pF            |
| Gate charge total<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 4.5\ \text{V}$ | $Q_g$        | -<br>- | 9.4<br>4.4 | -<br>-    | nC            |
| Gate to Source Charge<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$                                                                            | $Q_{gs}$     | -      | 1.8        | -         | nC            |
| Gate to Drain Charge<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$                                                                             | $Q_{gd}$     | -      | 1.7        | -         | nC            |
| Turn-On Delay Time<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$ , $R_g = 1\ \Omega$                                                           | $t_{d(on)}$  | -      | 6          | -         | ns            |
| Turn-On Rise Time<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$ , $R_g = 1\ \Omega$                                                            | $t_r$        | -      | 8          | -         | ns            |
| Turn-Off Delay Time<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$ , $R_g = 1\ \Omega$                                                          | $t_{d(off)}$ | -      | 6          | -         | ns            |
| Turn-Off Fall Time<br>at $V_{DS} = 20\ \text{V}$ , $I_D = 5\ \text{A}$ , $V_{GS} = 10\ \text{V}$ , $R_g = 1\ \Omega$                                                           | $t_f$        | -      | 1.3        | -         | ns            |
| <b>Body-Diode PARAMETERS</b>                                                                                                                                                   |              |        |            |           |               |
| Drain-Source Diode Forward Voltage<br>at $I_S = 5\ \text{A}$ , $V_{GS} = 0\ \text{V}$                                                                                          | $V_{SD}$     | -      | -          | 1.2       | V             |
| Body-Diode Continuous Current                                                                                                                                                  | $I_S$        | -      | -          | 14        | A             |
| Body-Diode Continuous Current, Pulsed                                                                                                                                          | $I_{SM}$     | -      | -          | 36        | A             |
| Body Diode Reverse Recovery Time<br>at $I_S = 5\ \text{A}$ , $di/dt = 100\ \text{A} / \mu\text{s}$                                                                             | $t_{rr}$     | -      | 6.2        | -         | ns            |
| Body Diode Reverse Recovery Charge<br>at $I_S = 5\ \text{A}$ , $di/dt = 100\ \text{A} / \mu\text{s}$                                                                           | $Q_{rr}$     | -      | 2.6        | -         | nC            |

## Electrical Characteristics Curves(Q1/Q2)

Fig. 1 Typical Output Characteristics

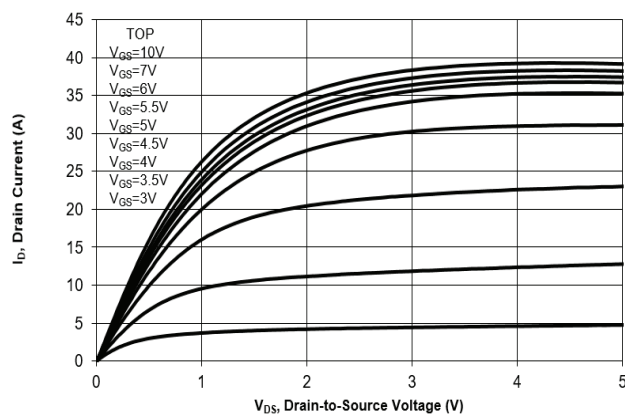


Fig. 2 Typical Transfer Characteristics

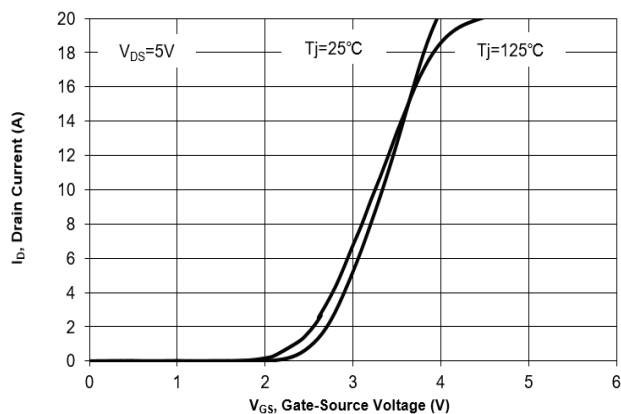


Fig. 3 on-Resistance vs Drain Current

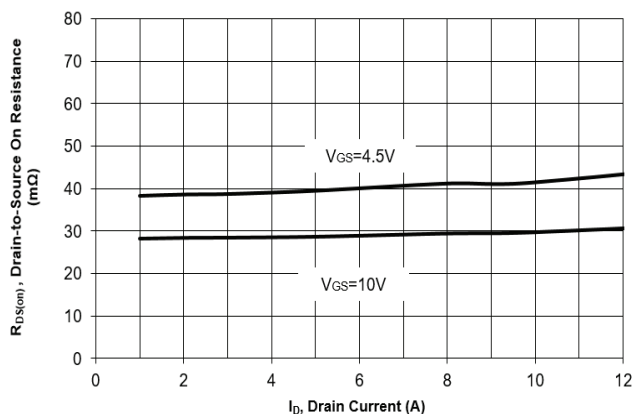


Fig. 4 on-Resistance vs. Gate to Source Voltage

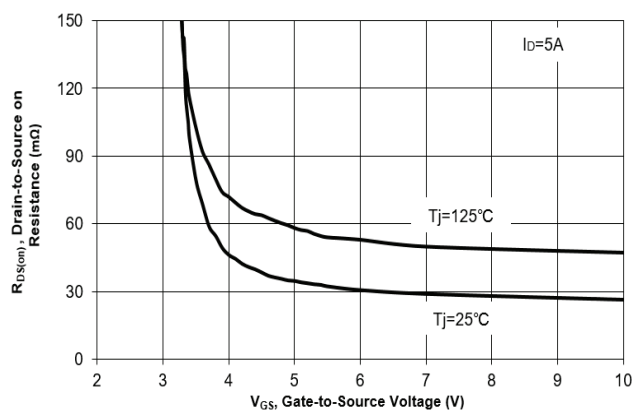


Fig. 5 on-Resistance vs.  $T_J$

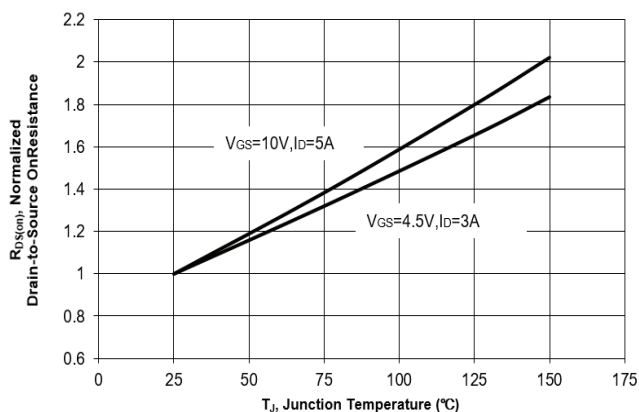
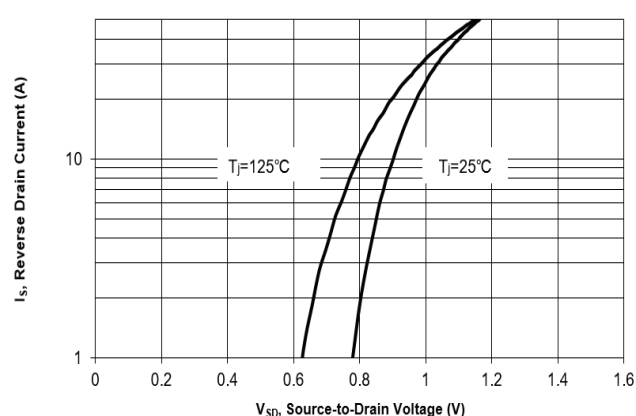


Fig. 6 Typical Body Diode Forward Characteristics



## Electrical Characteristics Curves(Q1/Q2)

Fig. 7 Typical Junction Capacitance

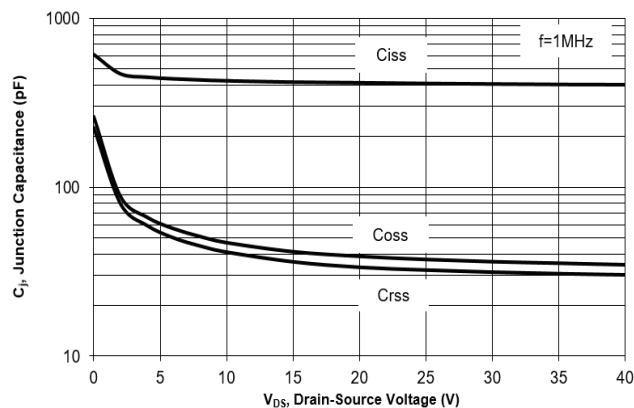


Fig. 8 Drain-Source Leakage Current vs.  $T_j$

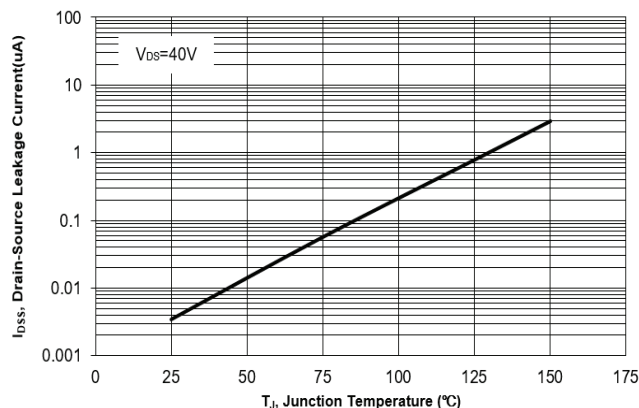


Fig. 9  $V_{(BR)DSS}$  vs. Junction Temperature

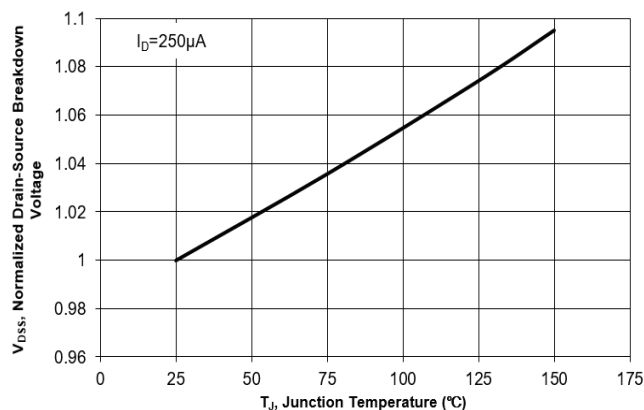


Fig. 10 Gate Threshold Variation vs.  $T_j$

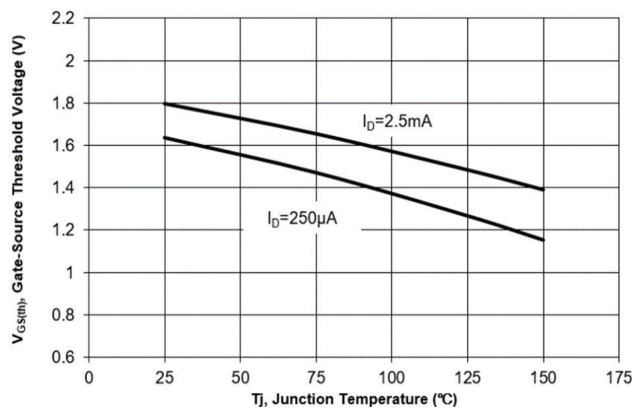


Fig. 11 Gate Charge

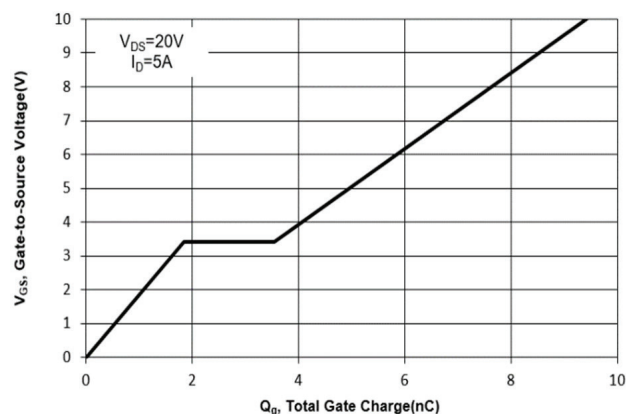
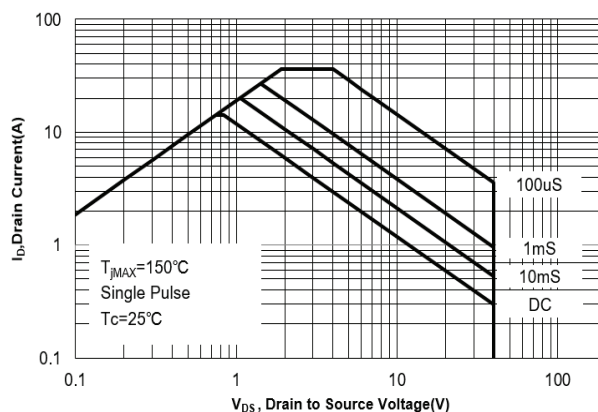
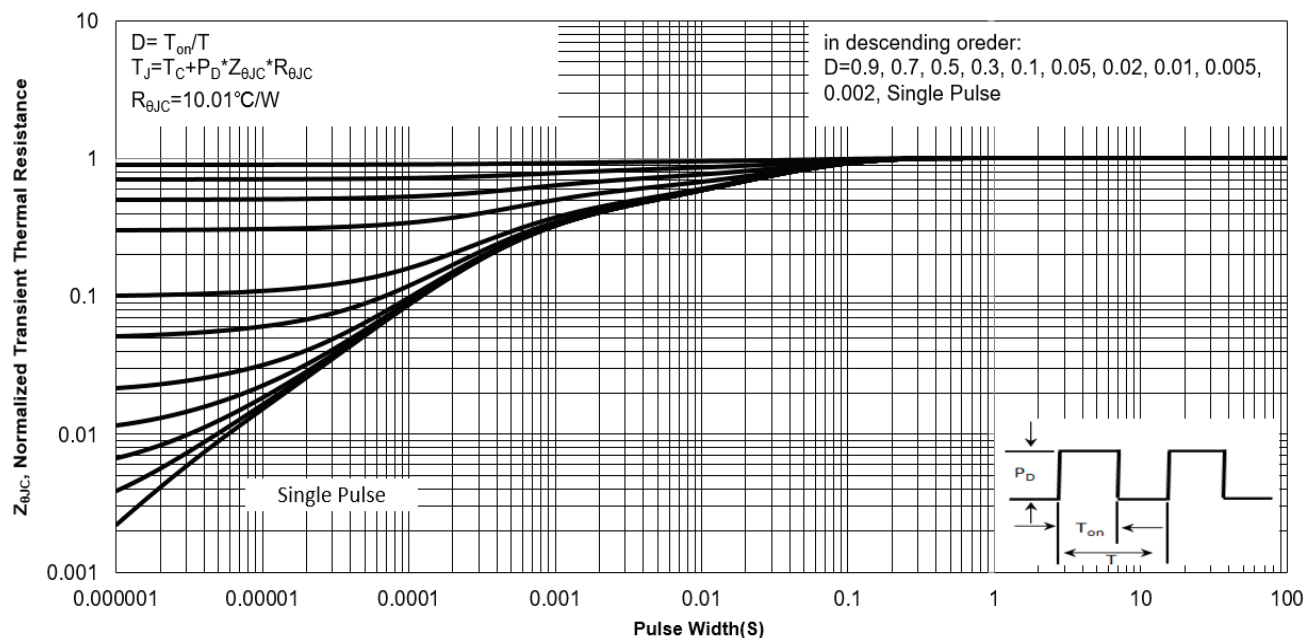
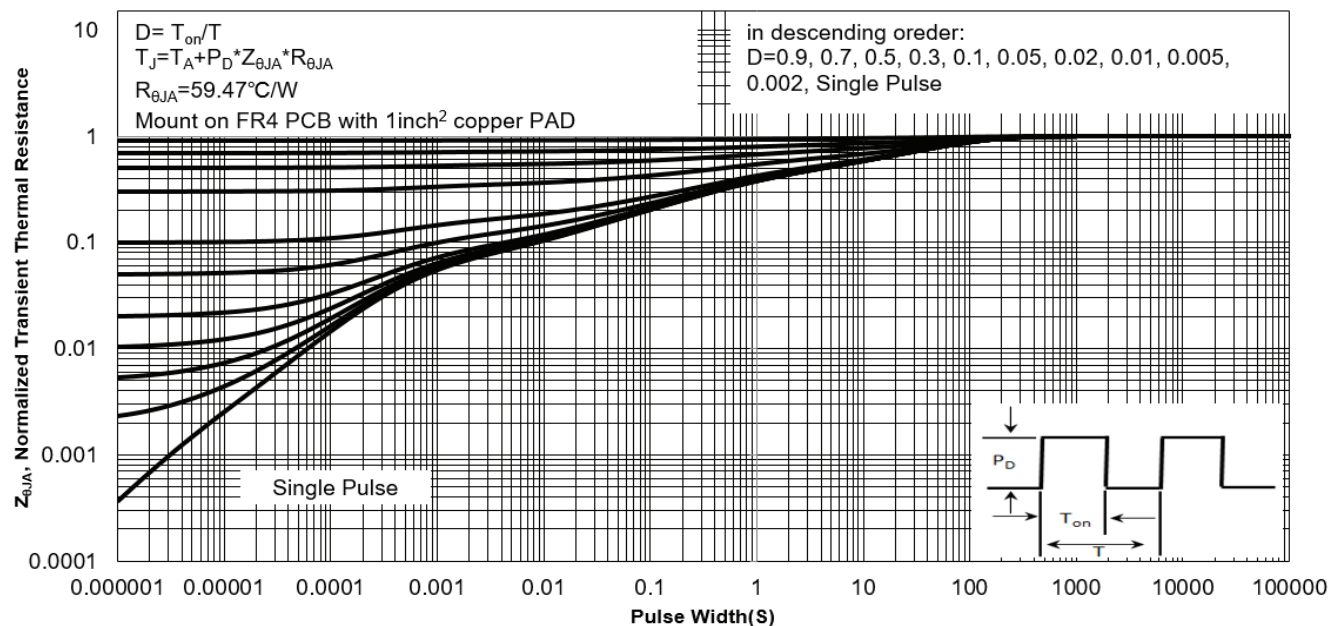


Fig. 12 Safe Operation Area



**Electrical Characteristics Curves(Q1/Q2)**
**Fig.13 Normalized Maximum Transient Thermal Impedance( $z_{\theta JC}$ )**

**Fig.14 Normalized Maximum Transient Thermal Impedance( $z_{\theta JA}$ )**


## Test Circuits(Q1/Q2)

Fig.1-1 Switching times test circuit

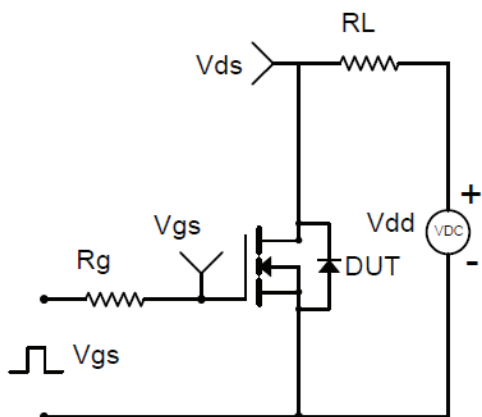


Fig.1-2 Switching Waveform

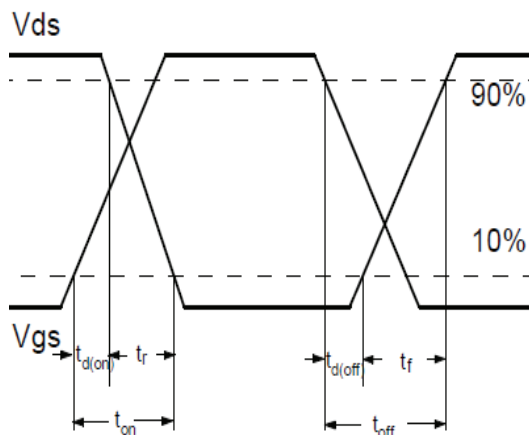


Fig.2-1 Gate charge test circuit

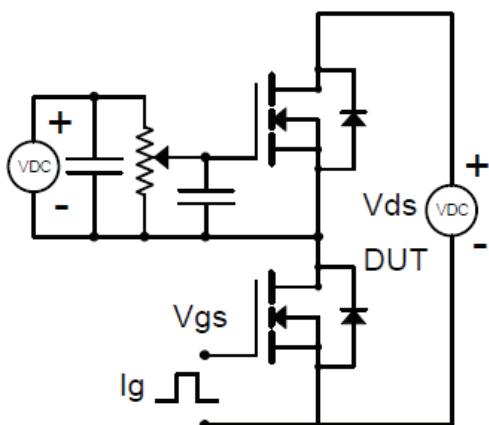


Fig.2-2 Gate charge waveform

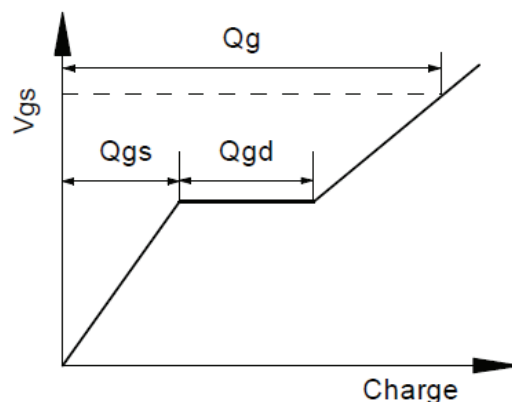


Fig.3-1 Avalanche test circuit

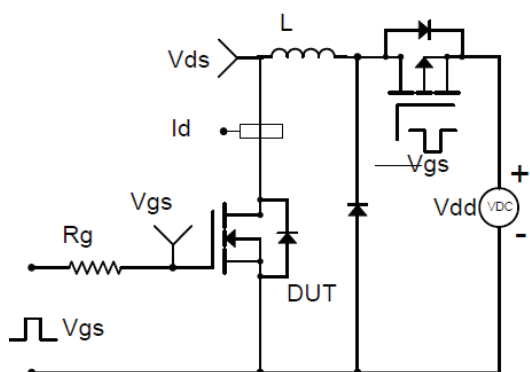
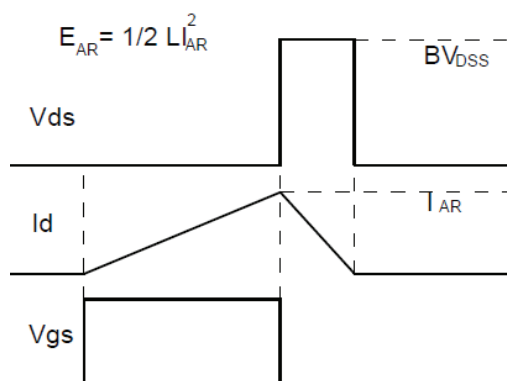
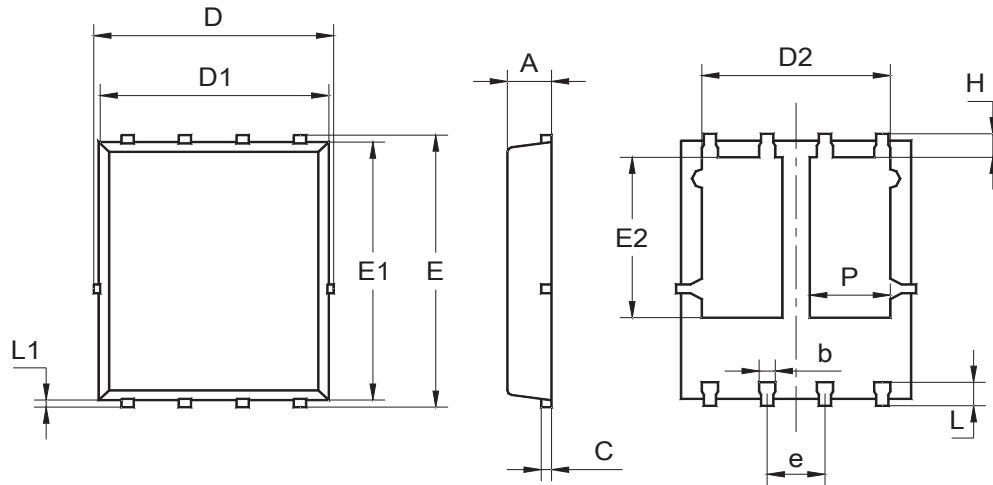


Fig.3-2 Avalanche waveform



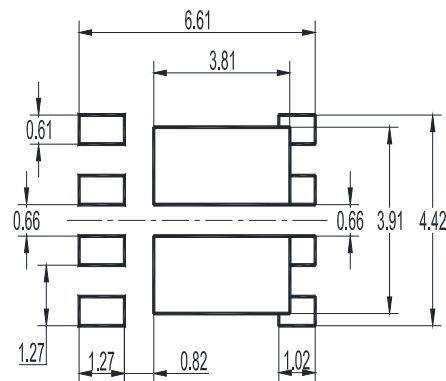
Package Outline Dimensions (Units: mm)

DFN5060



| Unit | A           | b            | C            | D           | D1         | D2          | E            | E1       | E2           | e            | L            | L1          | H            | P          |
|------|-------------|--------------|--------------|-------------|------------|-------------|--------------|----------|--------------|--------------|--------------|-------------|--------------|------------|
| mm   | 1.12<br>0.9 | 0.51<br>0.33 | 0.34<br>0.11 | 5.26<br>4.7 | 5.1<br>4.7 | 4.5<br>3.56 | 6.25<br>5.75 | 6<br>5.6 | 3.66<br>3.18 | 1.37<br>1.17 | 0.71<br>0.35 | 0.2<br>0.06 | 0.71<br>0.35 | 2.3<br>1.7 |

Recommended Soldering Footprint



Packing information

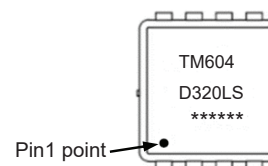
| Package | Tape Width (mm) | Pitch   |               | Reel Size |      | Per Reel Packing Quantity |
|---------|-----------------|---------|---------------|-----------|------|---------------------------|
|         |                 | mm      | inch          | mm        | inch |                    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

Marking information

" TM604D320LS " = Part No.

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

Font type: Arial



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