

## Complementary N & P-Channel Power MOSFET

### FEATURES

- Low gate charge for fast power switching
- 100% UIS and  $R_g$  tested
- Compliant to RoHS directive 2011/65/EU and in accordance to WEEE 2002/96/EC
- Halogen-free according to IEC 61249-2-21

### APPLICATIONS

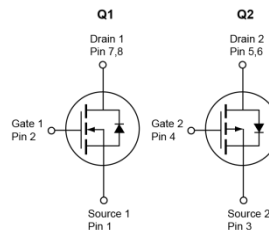
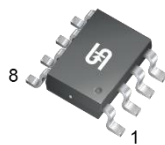
- Building technologies
- DC Fan
- Motor drives

### KEY PERFORMANCE PARAMETERS

| PARAMETER             |                  | TYPE | VALUE | UNIT |
|-----------------------|------------------|------|-------|------|
| $V_{DS}$              |                  | Q1   | 60    | V    |
|                       |                  | Q2   | -60   |      |
| $R_{DS(on)}$<br>(max) | $V_{GS} = 10V$   | Q1   | 103   | mΩ   |
|                       | $V_{GS} = 4.5V$  | Q1   | 122   |      |
|                       | $V_{GS} = -10V$  | Q2   | 180   |      |
|                       | $V_{GS} = -4.5V$ | Q2   | 220   |      |
| $Q_g$                 |                  | Q1   | 4.4   | nC   |
|                       |                  | Q2   | 4.6   |      |



SOP-8



**Note:** MSL 1 (Moisture Sensitivity Level) per J-STD-020

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| PARAMETER                                        |                           | SYMBOL         | Q1           | Q2       | UNIT             |
|--------------------------------------------------|---------------------------|----------------|--------------|----------|------------------|
| Drain-Source Voltage                             |                           | $V_{DS}$       | 60           | -60      | V                |
| Gate-Source Voltage                              |                           | $V_{GS}$       | $\pm 20$     | $\pm 20$ | V                |
| Continuous Drain Current                         | $T_C = 25^\circ\text{C}$  | $I_D$          | 5            | -4       | A                |
|                                                  | $T_A = 25^\circ\text{C}$  |                | 2.5          | -2       |                  |
| Pulsed Drain Current (Note 1)                    |                           | $I_{DM}$       | 20           | -16      | A                |
| Single Pulse Avalanche Current (Note 2)          |                           | $I_{AS}$       | 6.8          | -7       | A                |
| Single Pulse Avalanche Energy (Note 2)           |                           | $E_{AS}$       | 6.9          | 7.4      | mJ               |
| Total Power Dissipation                          | $T_C = 25^\circ\text{C}$  | $P_D$          | 5.7          | 5.7      | W                |
|                                                  | $T_C = 125^\circ\text{C}$ |                | 1.1          | 1.1      |                  |
| Total Power Dissipation                          | $T_A = 25^\circ\text{C}$  | $P_D$          | 1.4          | 1.4      | W                |
|                                                  | $T_A = 125^\circ\text{C}$ |                | 0.3          | 0.3      |                  |
| Operating Junction and Storage Temperature Range |                           | $T_J, T_{STG}$ | - 55 to +150 |          | $^\circ\text{C}$ |

### THERMAL PERFORMANCE

| PARAMETER                                | SYMBOL          | MAXIMUM | UNIT               |
|------------------------------------------|-----------------|---------|--------------------|
| Thermal Resistance – Junction to Case    | $R_{\theta JC}$ | 22      | $^\circ\text{C/W}$ |
| Thermal Resistance – Junction to Ambient | $R_{\theta JA}$ | 88      |                    |

**Thermal Performance Note:**  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistances. The case-thermal reference is defined at the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design. The  $R_{\theta JA}$  limit presented here is based on mounting on a 1 in<sup>2</sup> pad of 2 oz copper.

| ELECTRICAL SPECIFICATIONS (T <sub>A</sub> = 25°C unless otherwise noted) |                                                                                                                                                                                                         |                          |      |     |      |      |      |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|------|-----|------|------|------|
| PARAMETER                                                                | CONDITIONS                                                                                                                                                                                              | SYMBOL                   | TYPE | MIN | TYP  | MAX  | UNIT |
| Static                                                                   |                                                                                                                                                                                                         |                          |      |     |      |      |      |
| Drain-Source Breakdown Voltage                                           | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA                                                                                                                                                            | BV <sub>DSS</sub>        | Q1   | 60  | --   | --   | V    |
|                                                                          | V <sub>GS</sub> = 0V, I <sub>D</sub> = -250μA                                                                                                                                                           |                          | Q2   | -60 | --   | --   |      |
| Gate Threshold Voltage                                                   | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250μA                                                                                                                                              | V <sub>GS(TH)</sub>      | Q1   | 1.2 | 1.8  | 2.5  | V    |
|                                                                          | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = -250μA                                                                                                                                             |                          | Q2   | -1  | -1.5 | -2.5 |      |
| Gate-Source Leakage Current                                              | V <sub>GS</sub> = ±20V, V <sub>DS</sub> = 0V                                                                                                                                                            | I <sub>GSS</sub>         | Q1   | --  | --   | ±100 | nA   |
|                                                                          | V <sub>GS</sub> = ±20V, V <sub>DS</sub> = 0V                                                                                                                                                            |                          | Q2   | --  | --   | ±100 | nA   |
| Drain-Source Leakage Current                                             | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 60V                                                                                                                                                             | I <sub>DSS</sub>         | Q1   | --  | --   | 1    | μA   |
|                                                                          | V <sub>GS</sub> = 0V, V <sub>DS</sub> = -60V                                                                                                                                                            |                          | Q2   | --  | --   | -1   |      |
| Drain-Source On-State Resistance <sup>(Note 3)</sup>                     | V <sub>GS</sub> = 10V, I <sub>D</sub> = 2.5A                                                                                                                                                            | R <sub>DS(on)</sub>      | Q1   | --  | 74   | 103  | mΩ   |
|                                                                          | V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 2.3A                                                                                                                                                           |                          |      | --  | 86   | 122  |      |
|                                                                          | V <sub>GS</sub> = -10V, I <sub>D</sub> = -2A                                                                                                                                                            |                          | Q2   | --  | 135  | 180  |      |
|                                                                          | V <sub>GS</sub> = -4.5V, I <sub>D</sub> = -1.7A                                                                                                                                                         |                          |      | --  | 170  | 220  |      |
| Forward Transconductance <sup>(Note 3)</sup>                             | V <sub>DS</sub> = 10V, I <sub>D</sub> = 2.5A                                                                                                                                                            | g <sub>fs</sub>          | Q1   | --  | 10   | --   | S    |
|                                                                          | V <sub>DS</sub> = -10V, I <sub>D</sub> = -2A                                                                                                                                                            |                          | Q2   | --  | 5    | --   |      |
| Dynamic <sup>(Note 4)</sup>                                              |                                                                                                                                                                                                         |                          |      |     |      |      |      |
| Total Gate Charge                                                        | Q1<br>V <sub>DS</sub> = 30V, I <sub>D</sub> = 2.5A<br>Q2<br>V <sub>DS</sub> = -30V, I <sub>D</sub> = -2A                                                                                                | Q <sub>g(VGS=10V)</sub>  | Q1   | --  | 9.4  | --   | nC   |
| Total Gate Charge                                                        |                                                                                                                                                                                                         |                          | Q2   | --  | 9    | --   |      |
|                                                                          |                                                                                                                                                                                                         | Q <sub>g(VGS=4.5V)</sub> | Q1   | --  | 4.4  | --   |      |
| Q2                                                                       |                                                                                                                                                                                                         |                          | --   | 4.6 | --   |      |      |
| Gate-Source Charge                                                       |                                                                                                                                                                                                         | Q <sub>gs</sub>          | Q1   | --  | 1.8  | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 1.2  | --   |      |
| Gate-Drain Charge                                                        |                                                                                                                                                                                                         | Q <sub>gd</sub>          | Q1   | --  | 2.3  | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 2.4  | --   |      |
| Input Capacitance                                                        | Q1<br>V <sub>GS</sub> = 0V, V <sub>DS</sub> = 30V                                                                                                                                                       | C <sub>iss</sub>         | Q1   | --  | 527  | --   | pF   |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 436  | --   |      |
| Output Capacitance                                                       | f = 1.0MHz<br>Q2                                                                                                                                                                                        | C <sub>oss</sub>         | Q1   | --  | 31   | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 32   | --   |      |
| Reverse Transfer Capacitance                                             | V <sub>GS</sub> = 0V, V <sub>DS</sub> = -30V<br>f = 1.0MHz                                                                                                                                              | C <sub>rss</sub>         | Q1   | --  | 4    | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 11   | --   |      |
| Gate Resistance                                                          | f = 1.0MHz                                                                                                                                                                                              | R <sub>g</sub>           | Q1   | 0.5 | 1.8  | 3.6  | Ω    |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | 5   | 17   | 34   |      |
| Switching <sup>(Note 4)</sup>                                            |                                                                                                                                                                                                         |                          |      |     |      |      |      |
| Turn-On Delay Time                                                       | Q1<br>V <sub>GS</sub> = 10V, V <sub>DS</sub> = 30V,<br>I <sub>D</sub> = 2.5A, R <sub>G</sub> = 2Ω<br>Q2<br>V <sub>GS</sub> = -10V, V <sub>DS</sub> = -30V,<br>I <sub>D</sub> = -2A, R <sub>G</sub> = 2Ω | t <sub>d(on)</sub>       | Q1   | --  | 5    | --   | ns   |
| Q2                                                                       |                                                                                                                                                                                                         |                          | --   | 3.4 | --   |      |      |
| Turn-On Rise Time                                                        |                                                                                                                                                                                                         | t <sub>r</sub>           | Q1   | --  | 21   | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 21   | --   |      |
| Turn-Off Delay Time                                                      |                                                                                                                                                                                                         | t <sub>d(off)</sub>      | Q1   | --  | 10   | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 21   | --   |      |
| Turn-Off Fall Time                                                       |                                                                                                                                                                                                         | t <sub>f</sub>           | Q1   | --  | 17   | --   |      |
|                                                                          |                                                                                                                                                                                                         |                          | Q2   | --  | 26   | --   |      |

| <b>ELECTRICAL SPECIFICATIONS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise noted) |                                                            |          |      |     |     |     |      |
|-------------------------------------------------------------------------------------|------------------------------------------------------------|----------|------|-----|-----|-----|------|
| PARAMETER                                                                           | CONDITIONS                                                 | SYMBOL   | TYPE | MIN | TYP | MAX | UNIT |
| <b>Source-Drain Diode</b>                                                           |                                                            |          |      |     |     |     |      |
| Forward Voltage (Note 3)                                                            | $V_{GS} = 0\text{V}, I_S = 2.5\text{A}$                    | $V_{SD}$ | Q1   | --  | --  | 1   | V    |
|                                                                                     | $V_{GS} = 0\text{V}, I_S = -2\text{A}$                     |          | Q2   | --  | --  | -1  |      |
| Reverse Recovery Time                                                               | Q1<br>$I_S = 2.5\text{A}, dI/dt = 100\text{A}/\mu\text{s}$ | $t_{rr}$ | Q1   | --  | 14  | --  | ns   |
|                                                                                     |                                                            |          | Q2   | --  | 11  | --  |      |
| Reverse Recovery Charge                                                             | Q2<br>$I_S = -2\text{A}, dI/dt = 100\text{A}/\mu\text{s}$  | $Q_{rr}$ | Q1   | --  | 10  | --  | nC   |
|                                                                                     |                                                            |          | Q2   | --  | 6   | --  |      |

**Notes:**

- Current limited by package.
- Q1 :  $L = 0.3\text{mH}$ ,  $V_{GS} = 10\text{V}$ ,  $V_{DD} = 30\text{V}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 6.8\text{A}$ , Starting  $T_J = 25^\circ\text{C}$   
Q2 :  $L = 0.3\text{mH}$ ,  $V_{GS} = -10\text{V}$ ,  $V_{DD} = -30\text{V}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = -7\text{A}$ , Starting  $T_J = 25^\circ\text{C}$
- Pulse test: Pulse Width  $\leq 300\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- Switching time is essentially independent of operating temperature.

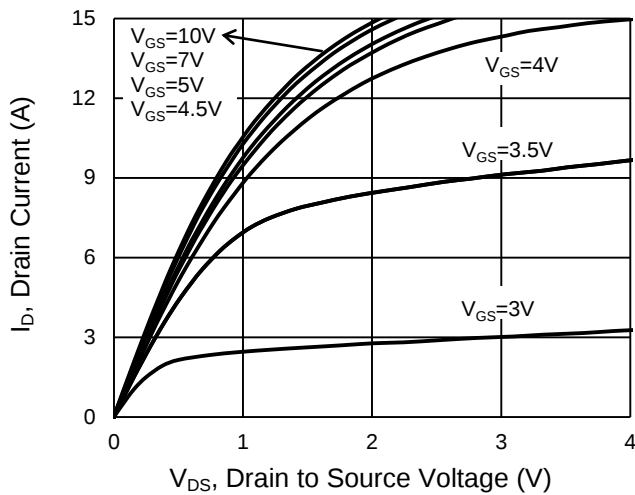
**ORDERING INFORMATION**

| ORDERING CODE | PACKAGE | PACKING             |
|---------------|---------|---------------------|
| TSM8588CS RLG | SOP-8   | 2,500pcs / 13" Reel |

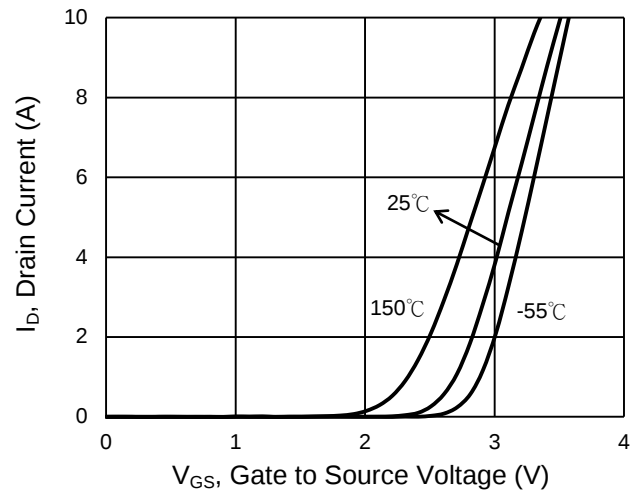
## CHARACTERISTICS CURVES (Q1 N-Channel)

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

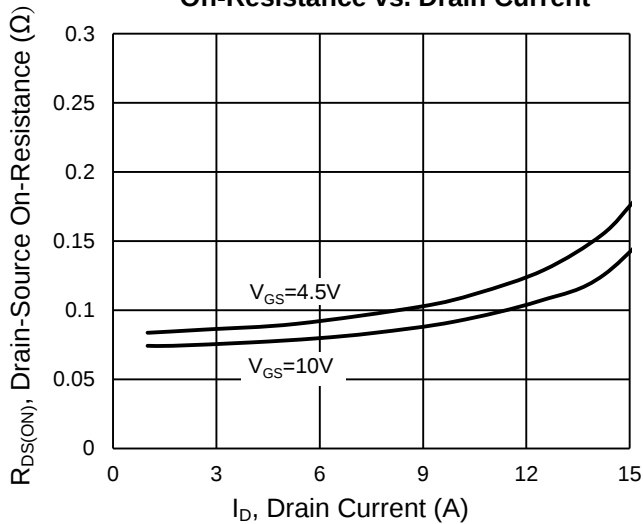
**Output Characteristics**



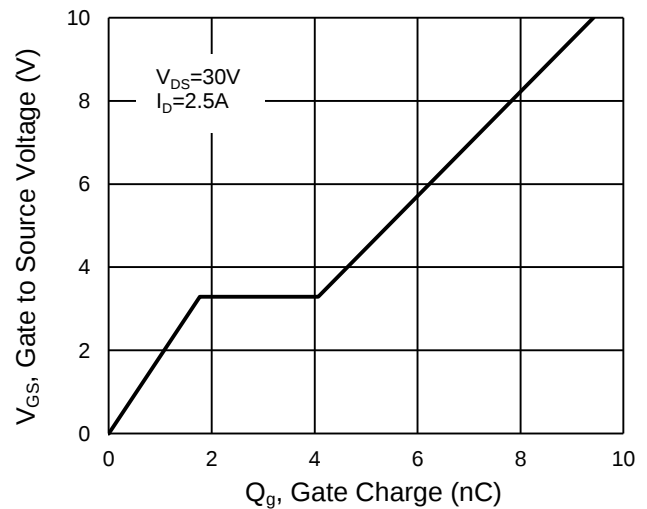
**Transfer Characteristics**



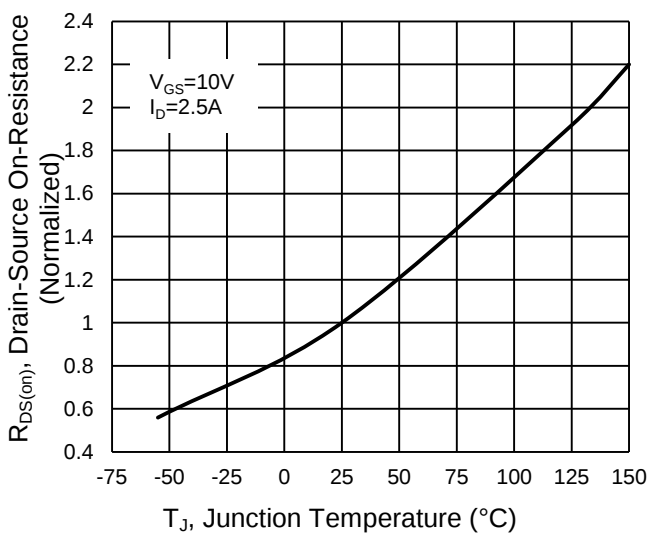
**On-Resistance vs. Drain Current**



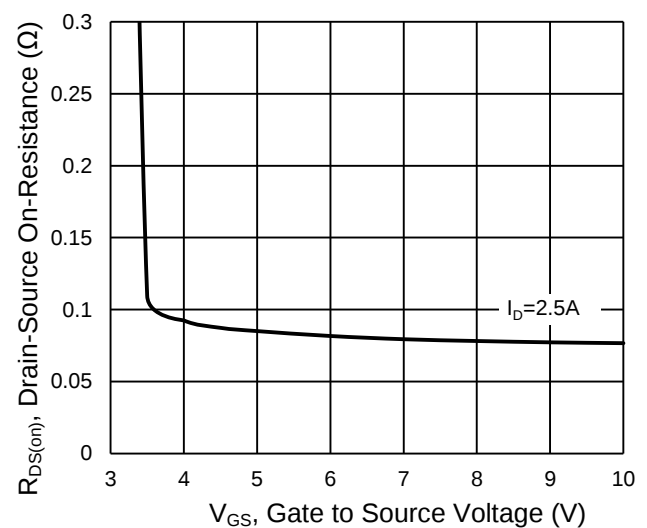
**Gate-Source Voltage vs. Gate Charge**



**On-Resistance vs. Junction Temperature**

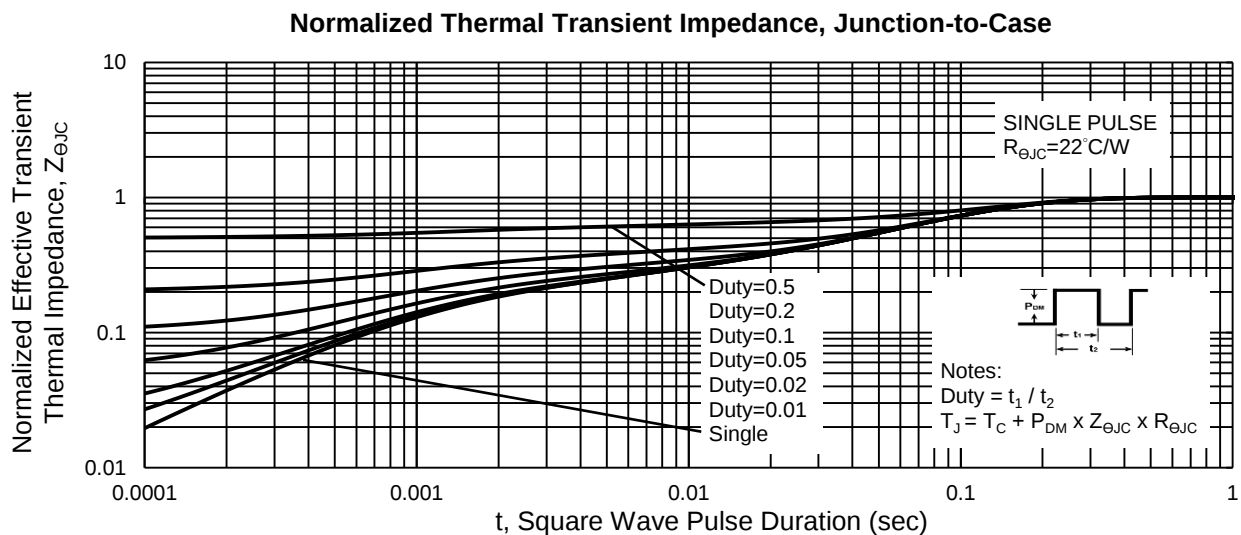
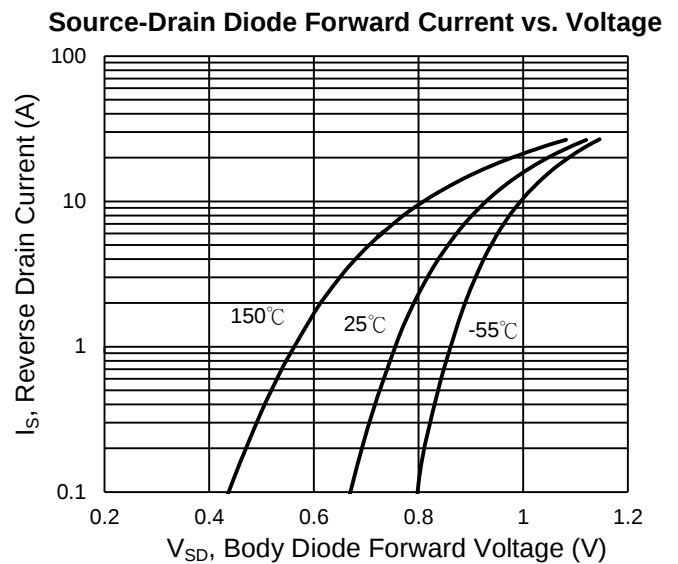
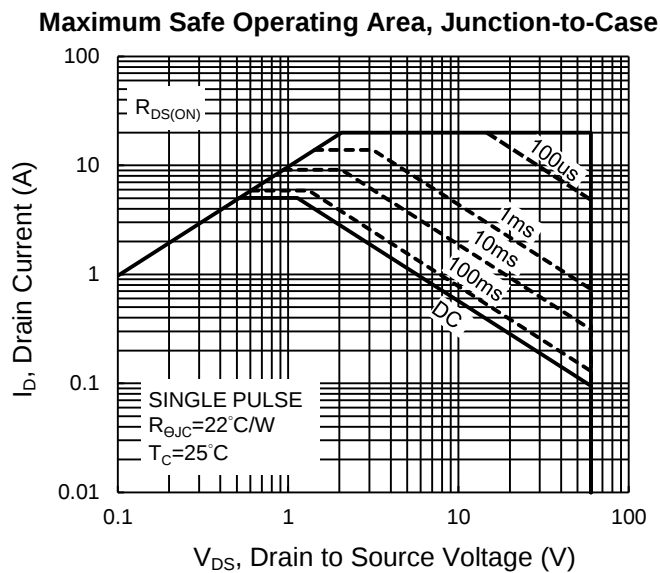
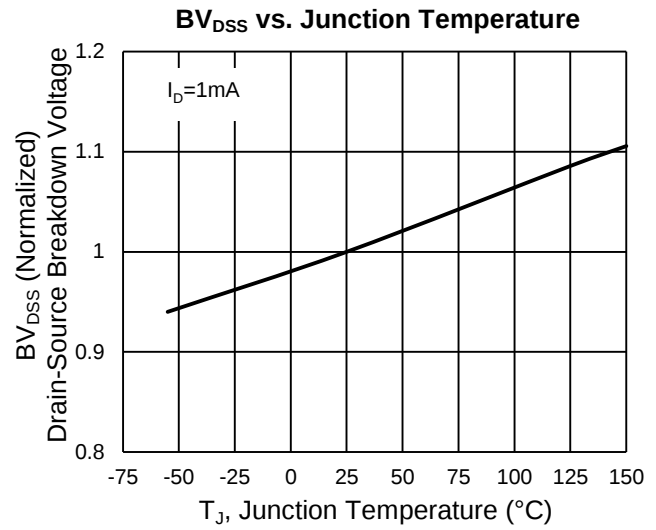
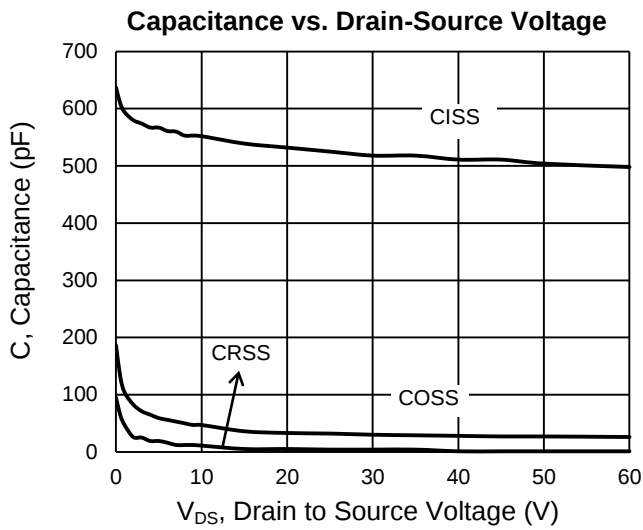


**On-Resistance vs. Gate-Source Voltage**



## CHARACTERISTICS CURVES

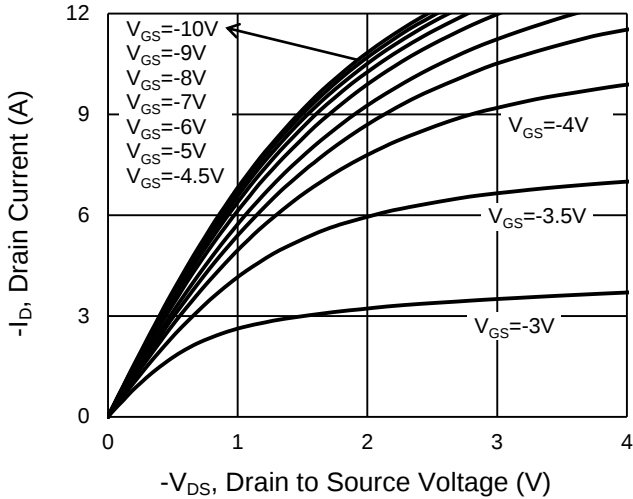
( $T_A = 25^\circ\text{C}$  unless otherwise noted)



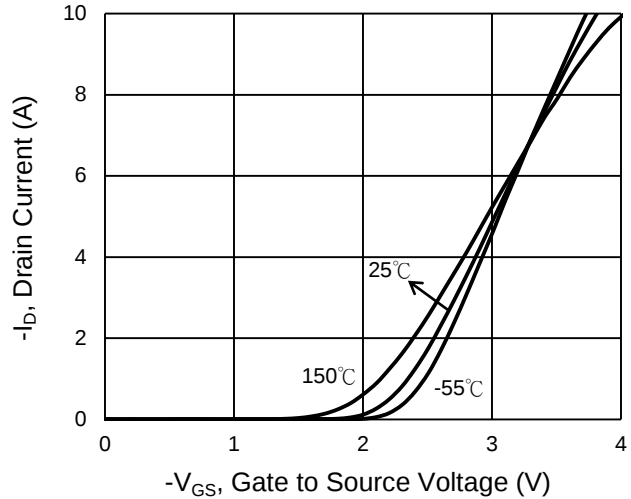
## CHARACTERISTICS CURVES (Q2 P-Channel)

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

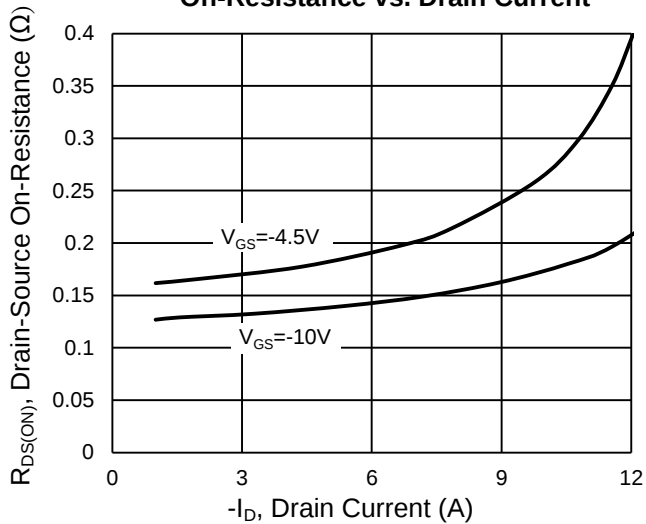
**Output Characteristics**



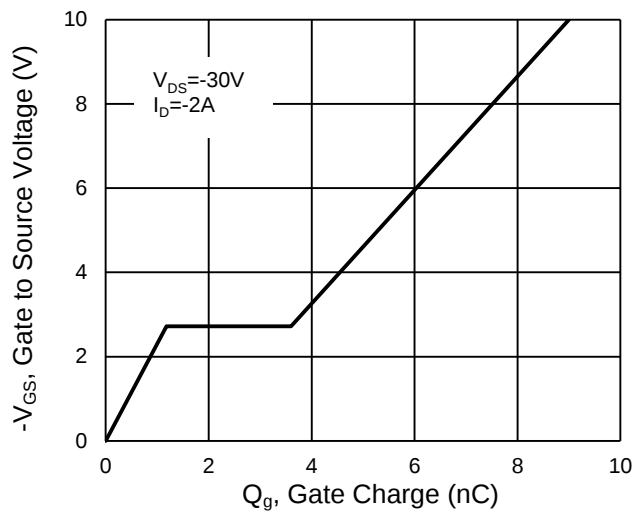
**Transfer Characteristics**



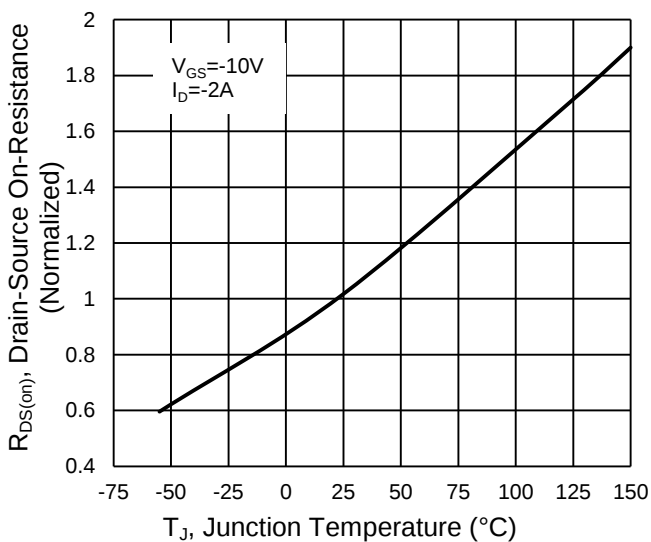
**On-Resistance vs. Drain Current**



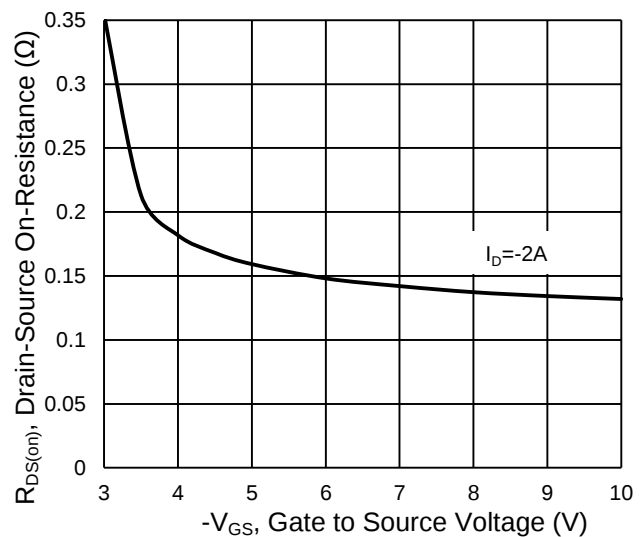
**Gate-Source Voltage vs. Gate Charge**



**On-Resistance vs. Junction Temperature**



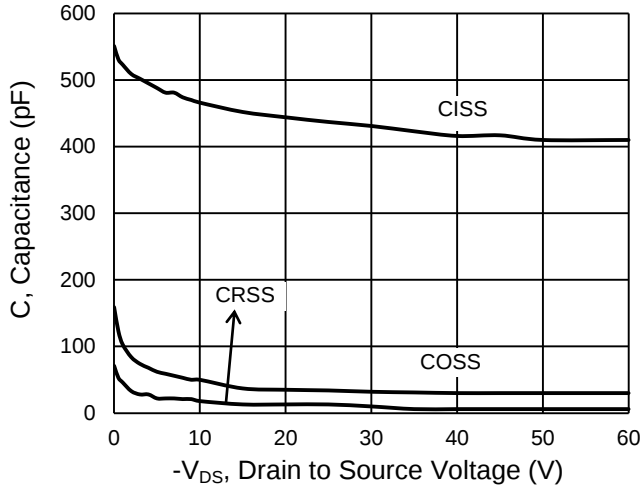
**On-Resistance vs. Gate-Source Voltage**



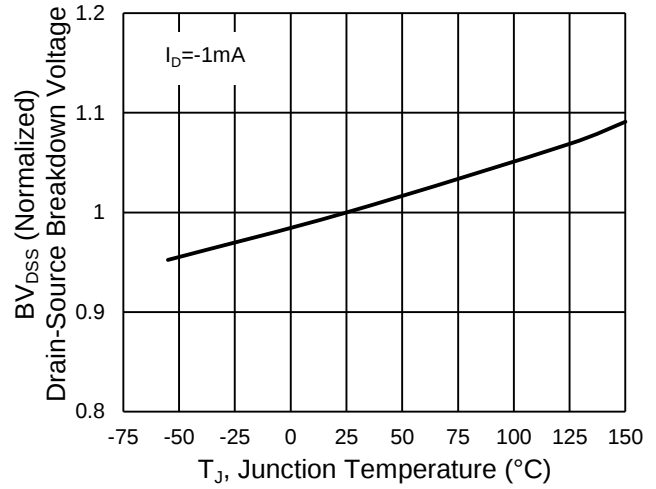
## CHARACTERISTICS CURVES

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

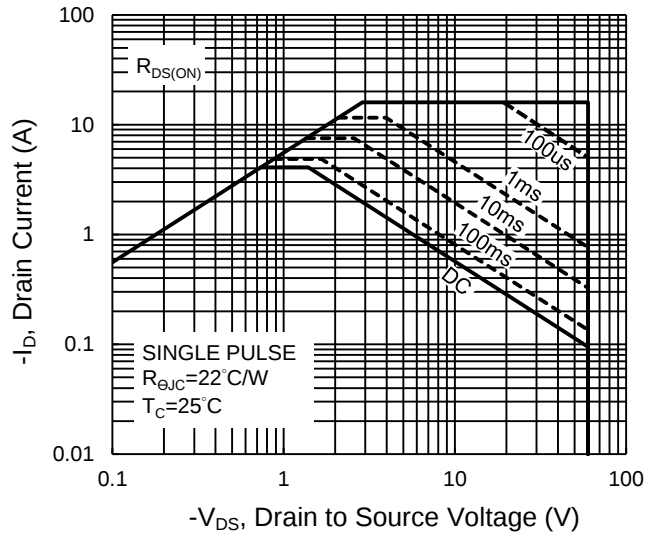
**Capacitance vs. Drain-Source Voltage**



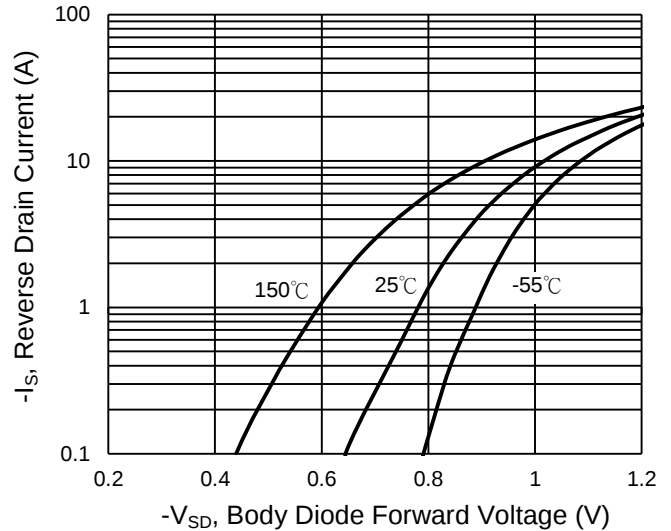
**$BV_{DSS}$  vs. Junction Temperature**



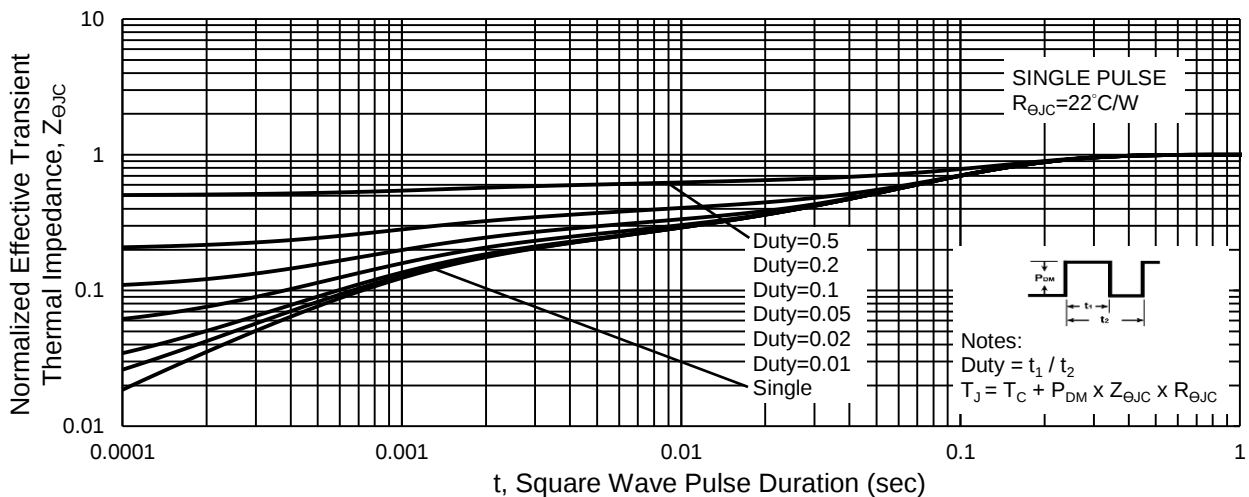
**Maximum Safe Operating Area, Junction-to-Case**



**Source-Drain Diode Forward Current vs. Voltage**

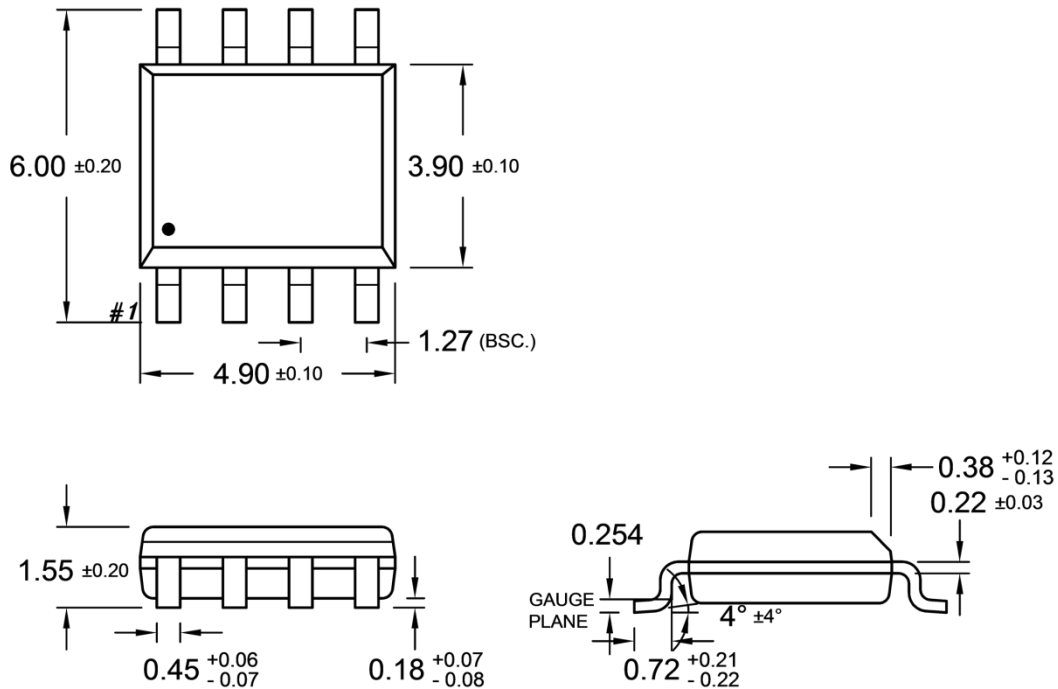


**Normalized Thermal Transient Impedance, Junction-to-Case**

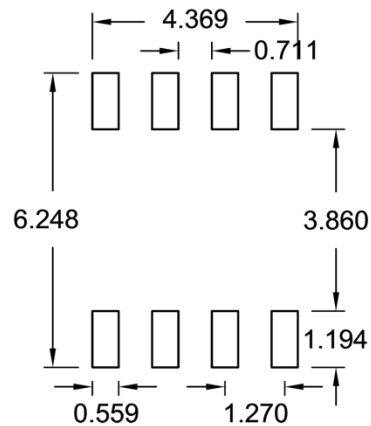


**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

**SOP-8**



**SUGGESTED PAD LAYOUT** (Unit: Millimeters)



**MARKING DIAGRAM**



Y = Year Code  
WW = Week Code (01~52)  
L = Lot Code (1~9,A~Z)  
F = Factory Code

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