

# N-Channel 20 V (D-S) MOSFET

## PRODUCT SUMMARY

| $V_{DS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) | $I_D$ (A) | $Q_g$ (Typ.) |
|--------------|---------------------------|-----------|--------------|
| 20           | 0.089 at $V_{GS} = 4.5$ V | 1.32      | 5.2          |
|              | 0.098 at $V_{GS} = 2.5$ V | 1.26      |              |
|              | 0.121 at $V_{GS} = 1.8$ V | 1.13      |              |

## FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET® Power MOSFET
- 100 %  $R_g$  Tested
- Compliant to RoHS Directive 2002/95/EC

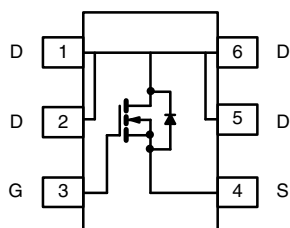


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

## APPLICATIONS

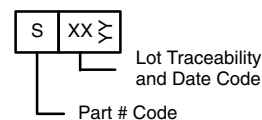
- Load Switch for Portable Devices

SC-89 (6-LEADS)



Top View

Marking Code



Ordering Information: Si1056X-T1-GE3 (Lead (Pb)-free and Halogen-free)

## ABSOLUTE MAXIMUM RATINGS ( $T_A = 25$ °C, unless otherwise noted)

| Parameter                                               | Symbol         | Limit                 | Unit |
|---------------------------------------------------------|----------------|-----------------------|------|
| Drain-Source Voltage                                    | $V_{DS}$       | 20                    | V    |
| Gate-Source Voltage                                     | $V_{GS}$       | $\pm 8$               |      |
| Continuous Drain Current ( $T_J = 150$ °C) <sup>a</sup> | $I_D$          | 1.32 <sup>b, c</sup>  | A    |
|                                                         |                | 1.05 <sup>b, c</sup>  |      |
| Pulsed Drain Current                                    | $I_{DM}$       | 6                     |      |
| Avalanche Current                                       | $I_{AS}$       | 8                     |      |
| Repetitive Avalanche Energy                             | $E_{AS}$       | 3.2                   | mJ   |
| Continuous Source-Drain Diode Current                   | $I_S$          | 0.2 <sup>b, c</sup>   | A    |
| Maximum Power Dissipation <sup>a</sup>                  | $P_D$          | 0.236 <sup>b, c</sup> | W    |
|                                                         |                | 0.151 <sup>b, c</sup> |      |
| Operating Junction and Storage Temperature Range        | $T_J, T_{stg}$ | - 55 to 150           | °C   |

## THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol     | Typical | Maximum | Unit |
|---------------------------------------------|------------|---------|---------|------|
| Maximum Junction-to-Ambient <sup>b, d</sup> | $R_{thJA}$ | 440     | 530     | °C/W |
|                                             |            | 540     | 650     |      |

Notes:

- Based on  $T_C = 25$  °C.
- Surface mounted on 1" x 1" FR4 board.
- $t = 5$  s.
- Maximum under steady state conditions is 650 °C/W.

| <b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted) |                         |                                                                                                                                        |      |        |           |                              |
|--------------------------------------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------|--------|-----------|------------------------------|
| Parameter                                                                            | Symbol                  | Test Conditions                                                                                                                        | Min. | Typ.   | Max.      | Unit                         |
| <b>Static</b>                                                                        |                         |                                                                                                                                        |      |        |           |                              |
| Drain-Source Breakdown Voltage                                                       | $V_{DS}$                | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                 | 20   |        |           | V                            |
| $V_{DS}$ Temperature Coefficient                                                     | $\Delta V_{DS}/T_J$     | $I_D = 250\text{ }\mu\text{A}$                                                                                                         |      | 18.2   |           | $\text{mV}/^{\circ}\text{C}$ |
| $V_{GS(th)}$ Temperature Coefficient                                                 | $\Delta V_{GS(th)}/T_J$ |                                                                                                                                        |      | - 2.71 |           |                              |
| Gate-Source Threshold Voltage                                                        | $V_{GS(th)}$            | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                     | 0.35 |        | 0.95      | V                            |
| Gate-Source Leakage                                                                  | $I_{GSS}$               | $V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 8\text{ V}$                                                                                      |      |        | $\pm 100$ | nA                           |
| Zero Gate Voltage Drain Current                                                      | $I_{DSS}$               | $V_{DS} = 20\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                         |      |        | 1         | $\mu\text{A}$                |
|                                                                                      |                         | $V_{DS} = 20\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 85\text{ }^{\circ}\text{C}$                                                    |      |        | 10        |                              |
| On-State Drain Current <sup>a</sup>                                                  | $I_{D(on)}$             | $V_{DS} \geq 5\text{ V}$ , $V_{GS} = 4.5\text{ V}$                                                                                     | 6    |        |           | A                            |
| Drain-Source On-State Resistance <sup>a</sup>                                        | $R_{DS(on)}$            | $V_{GS} = 4.5\text{ V}$ , $I_D = 1.32\text{ A}$                                                                                        |      | 0.074  | 0.089     | $\Omega$                     |
|                                                                                      |                         | $V_{GS} = 2.5\text{ V}$ , $I_D = 1.26\text{ A}$                                                                                        |      | 0.082  | 0.098     |                              |
|                                                                                      |                         | $V_{GS} = 1.8\text{ V}$ , $I_D = 1.13\text{ A}$                                                                                        |      | 0.093  | 0.121     |                              |
| Forward Transconductance                                                             | $g_{fs}$                | $V_{DS} = 10\text{ V}$ , $I_D = 1.32\text{ A}$                                                                                         |      | 7.5    |           | S                            |
| <b>Dynamic<sup>b</sup></b>                                                           |                         |                                                                                                                                        |      |        |           |                              |
| Input Capacitance                                                                    | $C_{iss}$               | $V_{DS} = 10\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                    |      | 400    |           | pF                           |
| Output Capacitance                                                                   | $C_{oss}$               |                                                                                                                                        |      | 70     |           |                              |
| Reverse Transfer Capacitance                                                         | $C_{rss}$               |                                                                                                                                        |      | 40     |           |                              |
| Total Gate Charge                                                                    | $Q_g$                   | $V_{DS} = 10\text{ V}$ , $V_{GS} = 5\text{ V}$ , $I_D = 1.32\text{ A}$                                                                 |      | 5.8    | 8.7       | nC                           |
| Gate-Source Charge                                                                   | $Q_{gs}$                | $V_{DS} = 10\text{ V}$ , $V_{GS} = 4.5\text{ V}$ , $I_D = 1.32\text{ A}$                                                               |      | 5.2    | 7.8       |                              |
| Gate-Drain Charge                                                                    | $Q_{gd}$                |                                                                                                                                        |      | 0.83   |           |                              |
| Gate Resistance                                                                      | $R_g$                   |                                                                                                                                        |      | 0.71   |           |                              |
| Turn-On Delay Time                                                                   | $t_{d(on)}$             | $V_{DD} = 10\text{ V}$ , $R_L = 9.52\text{ }\Omega$<br>$I_D \equiv 1.05\text{ A}$ , $V_{GEN} = 4.5\text{ V}$ , $R_g = 1\text{ }\Omega$ |      | 3.8    | 5.7       | $\Omega$                     |
| Rise Time                                                                            | $t_r$                   |                                                                                                                                        |      | 6.8    | 10.2      |                              |
| Turn-Off Delay Time                                                                  | $t_{d(off)}$            |                                                                                                                                        |      | 19     | 28.5      |                              |
| Fall Time                                                                            | $t_f$                   |                                                                                                                                        |      | 18     | 27        |                              |
|                                                                                      |                         |                                                                                                                                        |      | 6      | 9         |                              |
| <b>Drain-Source Body Diode Characteristics</b>                                       |                         |                                                                                                                                        |      |        |           |                              |
| Pulse Diode Forward Current <sup>a</sup>                                             | $I_{SM}$                |                                                                                                                                        |      |        | 6         | A                            |
| Body Diode Voltage                                                                   | $V_{SD}$                | $I_S = 1.0\text{ A}$                                                                                                                   |      | 0.8    | 1.2       | V                            |
| Body Diode Reverse Recovery Time                                                     | $t_{rr}$                | $I_F = 1.0\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}$                                                                              |      | 10.0   | 15        | nC                           |
| Body Diode Reverse Recovery Charge                                                   | $Q_{rr}$                |                                                                                                                                        |      | 3.5    | 5.3       | ns                           |
| Reverse Recovery Fall Time                                                           | $t_a$                   |                                                                                                                                        |      | 6.6    |           |                              |
| Reverse Recovery Rise Time                                                           | $t_b$                   |                                                                                                                                        |      | 3.4    |           |                              |

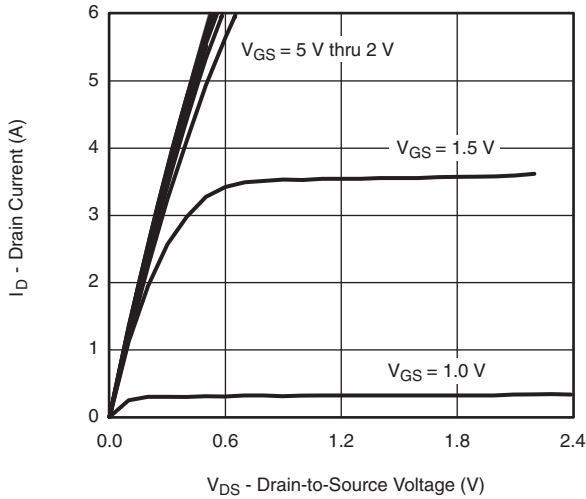
Notes:

a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

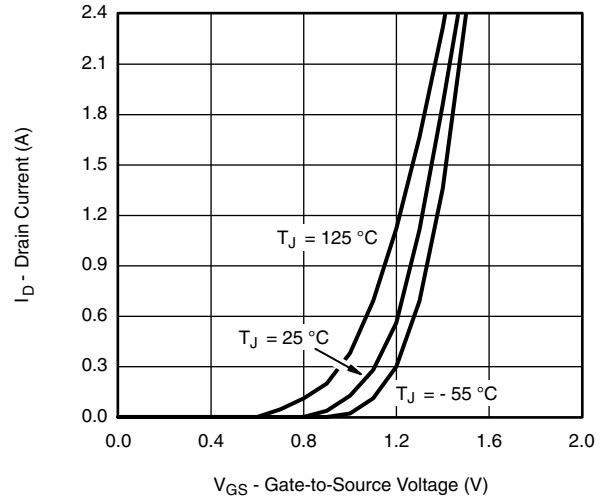
b. Guaranteed by design, not subject to production testing.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

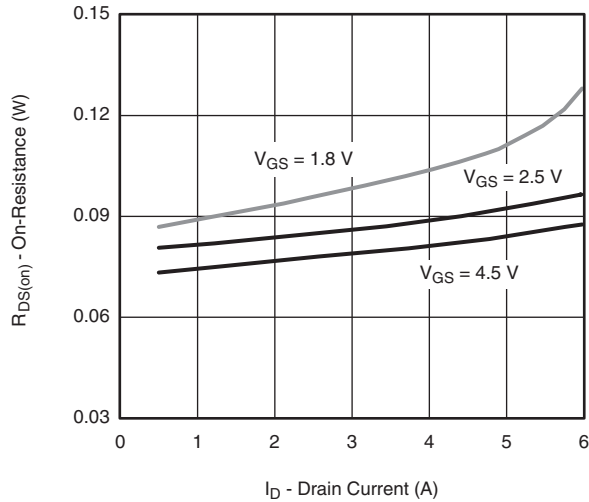
## TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



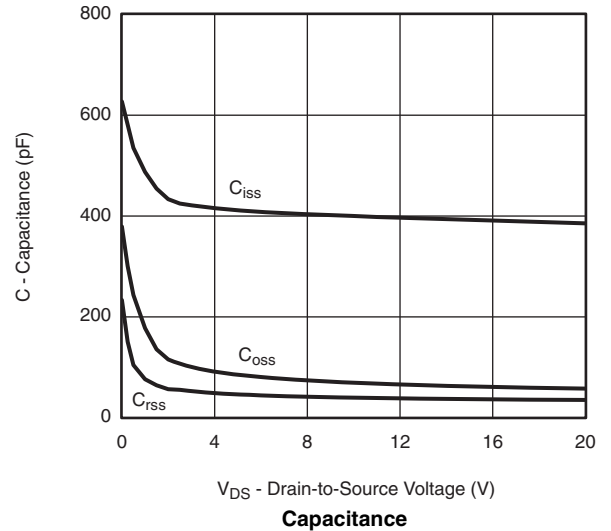
Output Characteristics



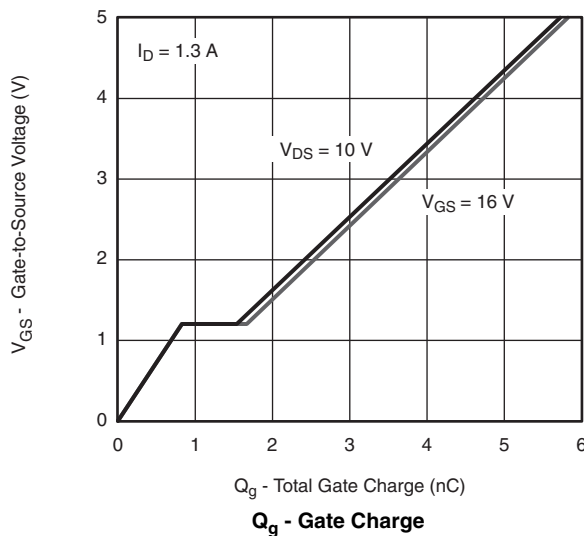
Transfer Characteristics Curves vs. Temperature



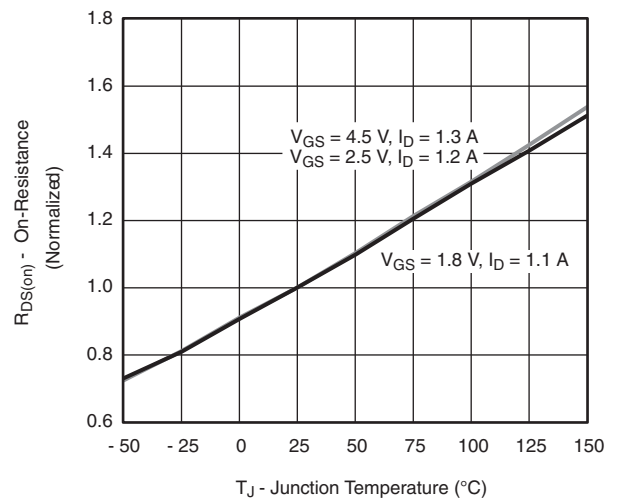
On-Resistance vs. Drain Current



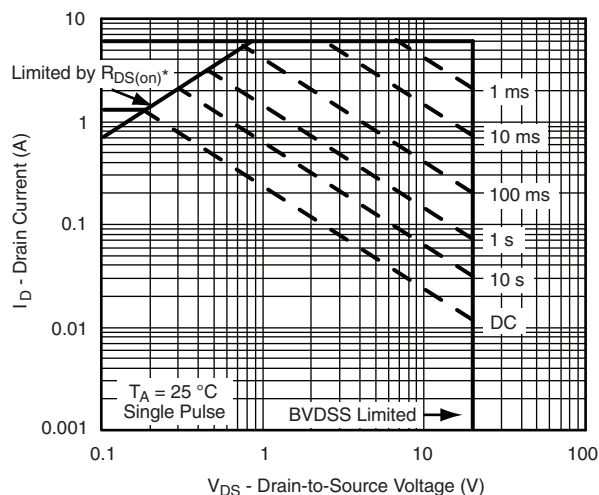
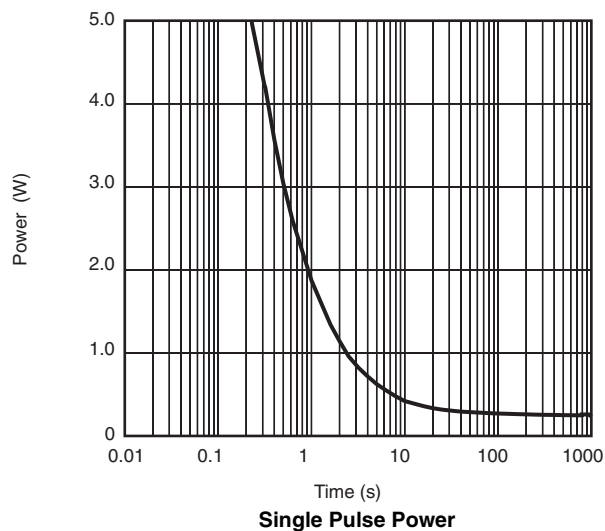
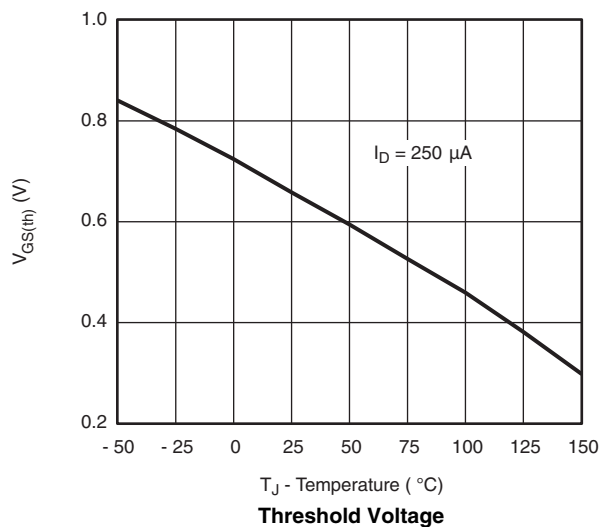
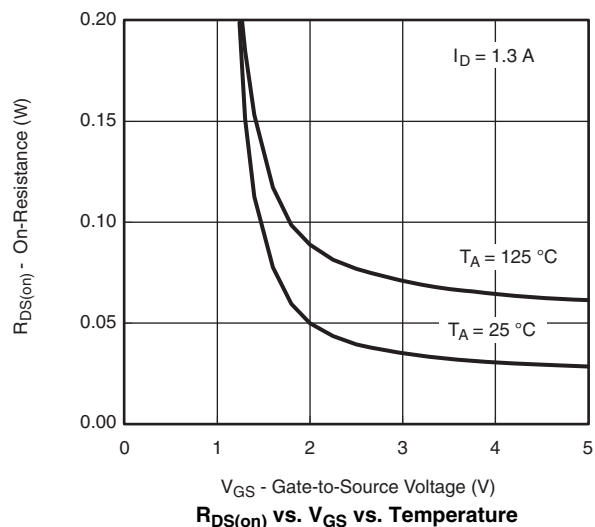
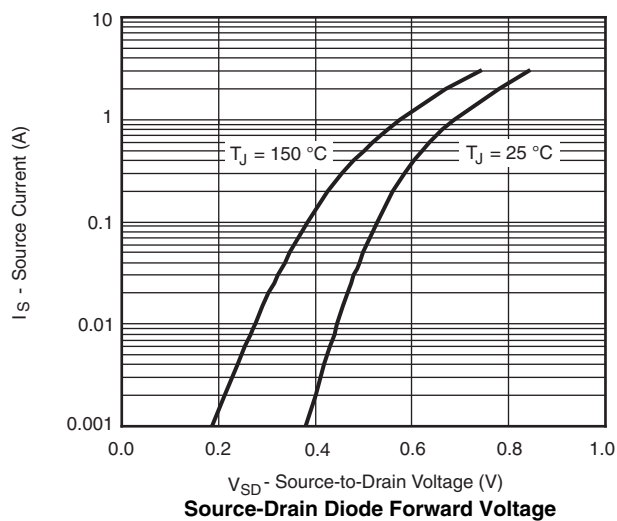
Capacitance



$Q_g$  - Gate Charge



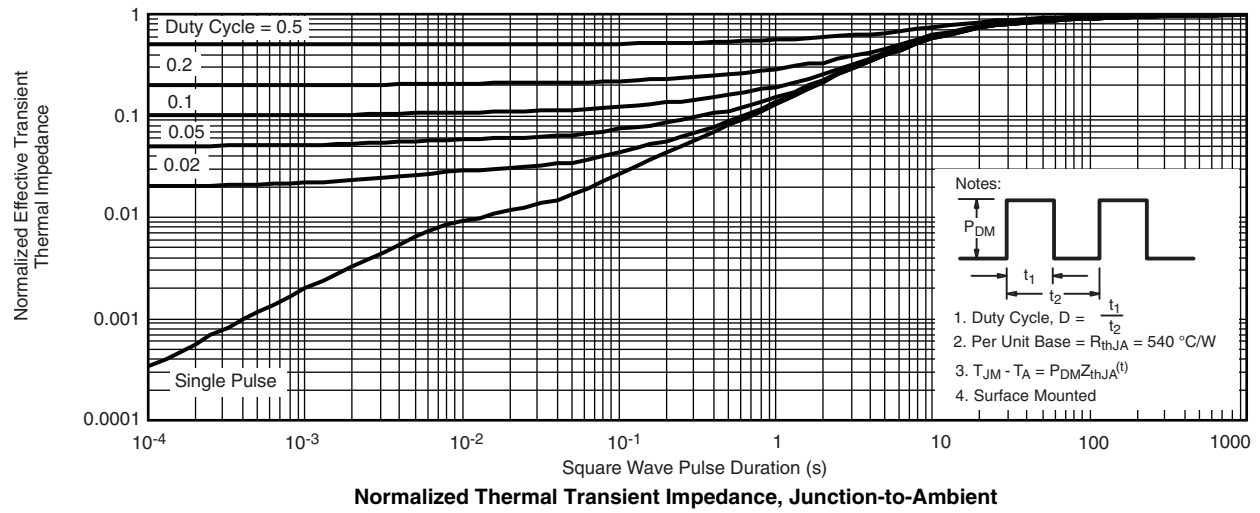
On-Resistance vs. Junction Temperature

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

\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

**Safe Operating Area, Junction-to-Ambient**

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



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## RECOMMENDED MINIMUM PADS FOR SC-89: 6-Lead



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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