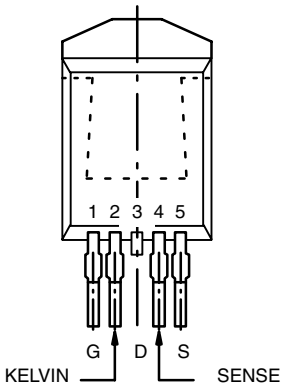
# N-Channel 40-V (D-S) MOSFET with Current Sense Terminal

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{(BR)DSS}$ (V) | $r_{DS(on)}$ (Ω) | $I_D$ (A) |
| 40 | 0.0054 at $V_{GS}$ = 10 V | 60[a] |

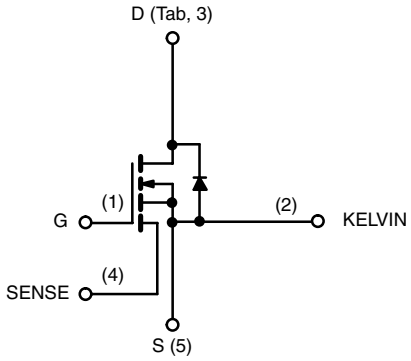
## FEATURES

- TrenchFET® Power MOSFET Plus Temperature Sensing Diode
- 175 °C Junction Temperature
- New Low Thermal Resistance Package

**D²PAK-5**




**Ordering Information:** SUM60N04-05C




N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS $T_C$ = 25 °C, unless otherwise noted | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Limit** | **Unit** |
| Drain-Source Voltage | | $V_{DS}$ | 40 | V |
| Gate-Source Voltage | | $V_{GS}$ | ± 20 | |
| Continuous Drain Current ($T_J$ = 175 °C)[d] | $T_C$ = 25 °C | $I_D$ | 60[a] | A |
| | $T_C$ = 100 °C | | 60[a] | |
| Pulsed Drain Current | | $I_{DM}$ | 250 | |
| Continuous Diode Current (Diode Conduction)[d] | | $I_S$ | 60[a] | |
| Avalanche Current | L = 0.1 mH | $I_{AS}$ | 60[a] | |
| Single Pulse Avalanche Energy[b] | | $E_{AS}$ | 180 | mJ |
| Maximum Power Dissipation[a] | $T_C$ = 25 °C | $P_D$ | 200[c] | W |
| | $T_A$ = 25 °C | | 3.75[d] | |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | - 55 to 175 | °C |

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Limit** | **Unit** |
| Junction-to-Ambient[d] | PCB Mount[d] | $R_{thJA}$ | 40 | °C/W |
| Junction-to-Case | | $R_{thJC}$ | 0.75 | |

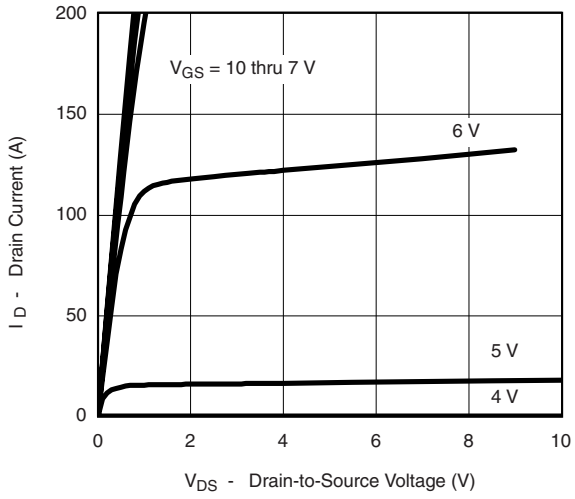
Notes:
a. Package limited.
b. Duty cycle ≤ 1 %.
c. See SOA curve for voltage derating.
d. When mounted on 1" square PCB (FR-4 material).

| **MOSFET SPECIFICATIONS** $T_J$ = 25 °C, unless otherwise noted | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Test Conditions** | **Min** | **Typ** | **Max** | **Unit** |
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 40 | | | V |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_{DS}$ = 250 µA | 2.5 | | 4.5 | |
| Gate-Body Leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ± 20 V | | | ± 100 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 40 V, $V_{GS}$ = 0 V | | | 1 | µA |
| | | $V_{DS}$ = 40 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | | | 50 | |
| | | $V_{DS}$ = 40 V, $V_{GS}$ = 0 V, $T_J$ = 175 °C | | | 500 | |
| On-State Drain Current[a] | $I_{D(on)}$ | $V_{DS}$ = 5 V, $V_{GS}$ = 10 V | 120 | | | A |
| Drain-Source On-State Resistance[a] | $r_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 25 A | | 0.0043 | 0.0054 | Ω |
| | | $V_{GS}$ = 10 V, $I_D$ = 25 A, $T_J$ = 125 °C | | | 0.0088 | |
| | | $V_{GS}$ = 10 V, $I_D$ = 25 A, $T_J$ = 175 °C | | | 0.011 | |
| Forward Transconductance[a] | $g_{fs}$ | $V_{DS}$ = 15 V, $I_D$ = 20 A | | 35 | | S |
| **Dynamic[b]** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1 MHz | | 6400 | | pF |
| Output Capacitance | $C_{oss}$ | | | 1100 | | |
| Reversen Transfer Capacitance | $C_{rss}$ | | | 630 | | |
| Total Gate Charge[c] | $Q_g$ | $V_{DS}$ = 20 V, $V_{GS}$ = 10 V, $I_D$ = 25 A | | 115 | 150 | nC |
| Gate-Source Charge[c] | $Q_{gs}$ | | | 35 | | |
| Gate-Drain Charge[c] | $Q_{gd}$ | | | 35 | | |
| Gate Resistance | $R_g$ | f = 1 MHz | | 2.2 | | Ω |
| Turn-On Delay Time[c] | $t_{d(on)}$ | $V_{DD}$ = 20 V, $R_L$ = 0.8 Ω<br>$I_D$ ≅ 25 A, $V_{GEN}$ = 10 V, $R_G$ = 2.5 Ω | | 15 | 20 | ns |
| Rise Time[c] | $t_r$ | | | 150 | 210 | |
| Turn-Off Delay Time[c] | $t_{d(off)}$ | | | 60 | 85 | |
| Fall Time[c] | $t_f$ | | | 80 | 110 | |
| **Source-Drain Diode Ratings and Characteristics** ($T_C$ = 25 °C)[b] | | | | | | |
| Continuous Current | $I_S$ | | | | 60 | A |
| Pulsed Current | $I_{SM}$ | | | | 200 | |
| Forward Voltage[a] | $V_{SD}$ | $I_F$ = 60 A, $V_{GS}$ = 0 V | | 1.0 | 1.5 | V |
| Reverse Recovery Time | $t_{rr}$ | $I_F$ = 60 A, di/dt = 100 A/µs | | 45 | 70 | ns |
| Peak Reverse Recovery Current | $I_{RM(REC)}$ | | | 2.5 | 5 | A |
| Reverse Recovery Charge | $Q_{rr}$ | | | 0.06 | 0.18 | µC |
| **Current Sense Characteristics** | | | | | | |
| Current Sense Ratio | r | $I_D$ = 3.5 A, $V_{GS}$ = 10 V, $R_{SENSE}$ = 2 Ω | 1660 | 1880 | 2100 | |
| Mirror Active Resistance | $r_{m(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 10 mA | | 5.5 | | Ω |

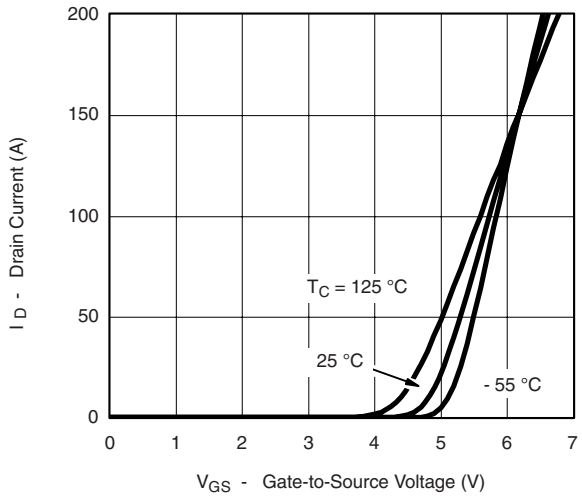
Notes:
a. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %.
b. Guaranteed by design, not subject to production testing.
c. Independent of operating temperature.

*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.*

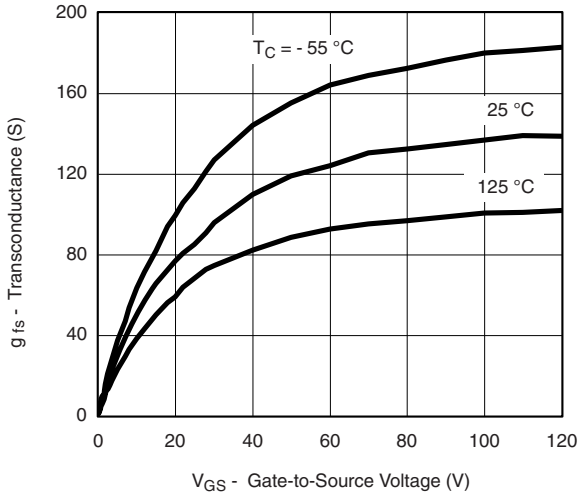
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



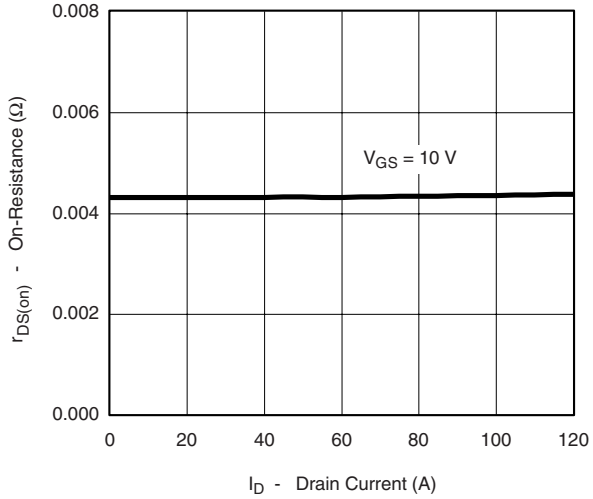

**Output Characteristics**



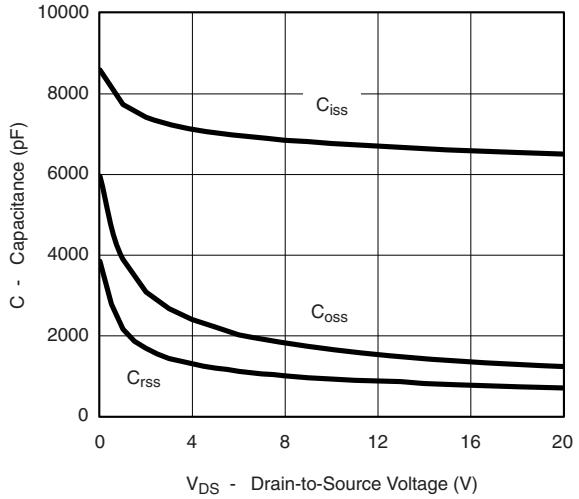

**Transfer Characteristics**



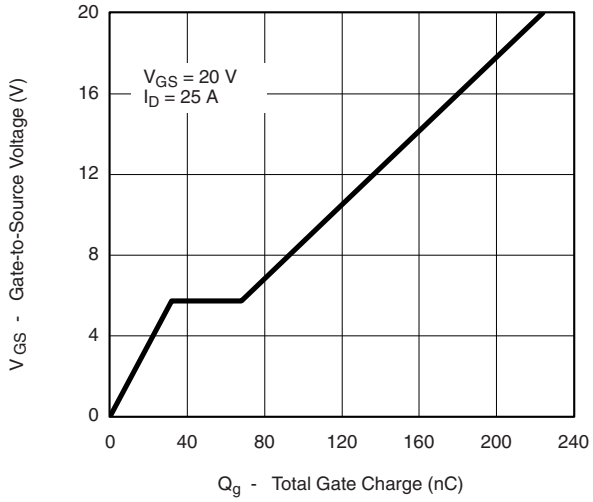

**Transconductance**




**On-Resistance vs. Drain Current**

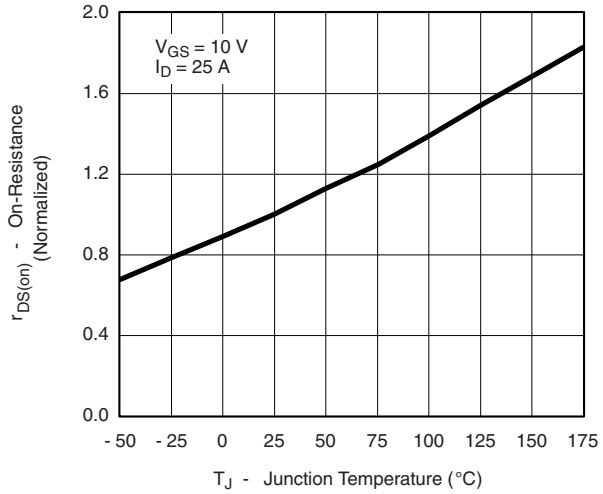



**Capacitance**

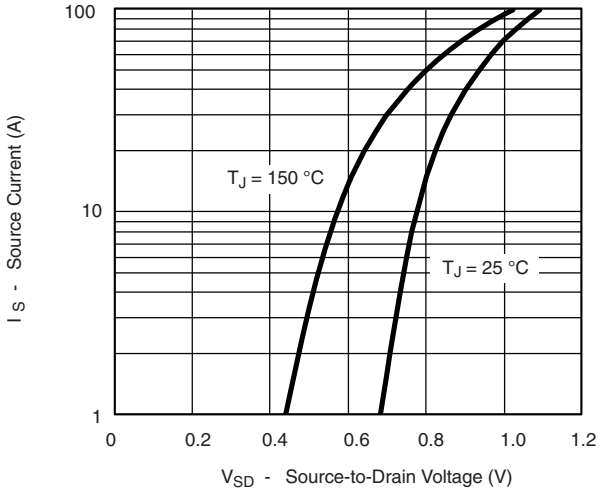



**Gate Charge**

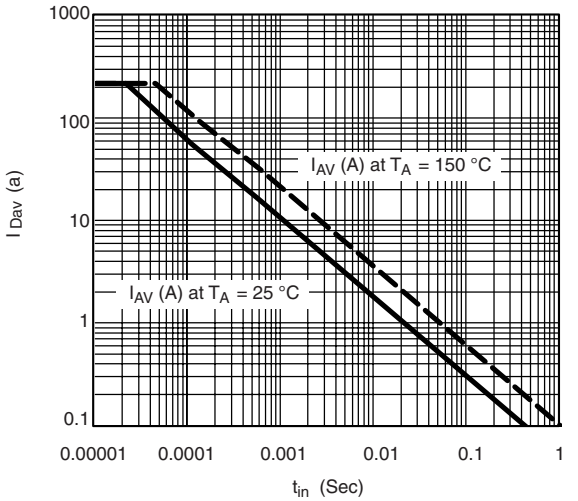
## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



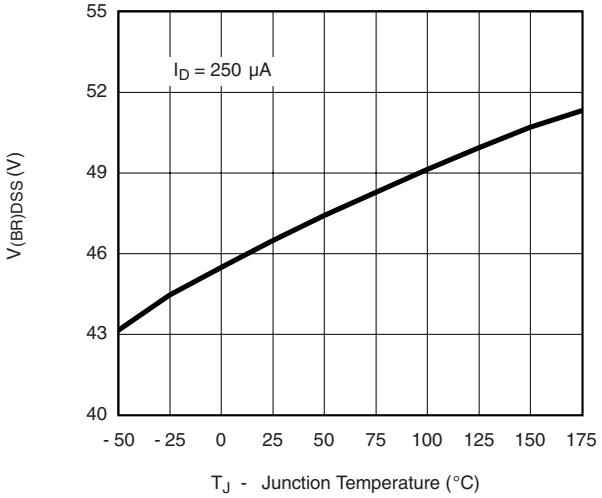

**On-Resistance vs. Junction Temperature**



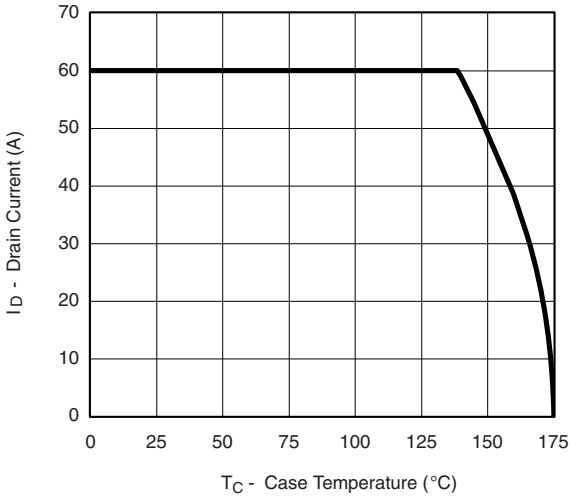

**Source-Drain Diode Forward Voltage**



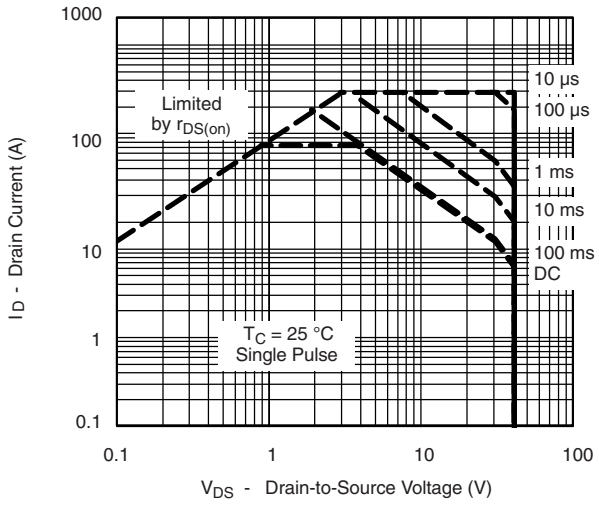

**Avalanche Current vs. Time**




**Drain Source Breakdown vs. Junction Temperature**

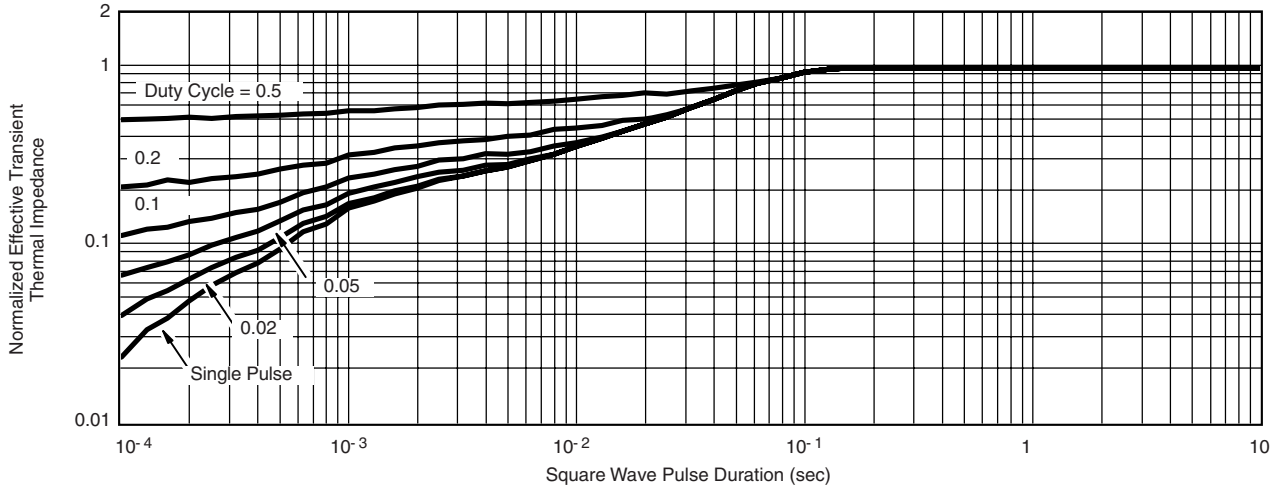



**Maximum Avalanche and Drain Current vs. Case Temperature**



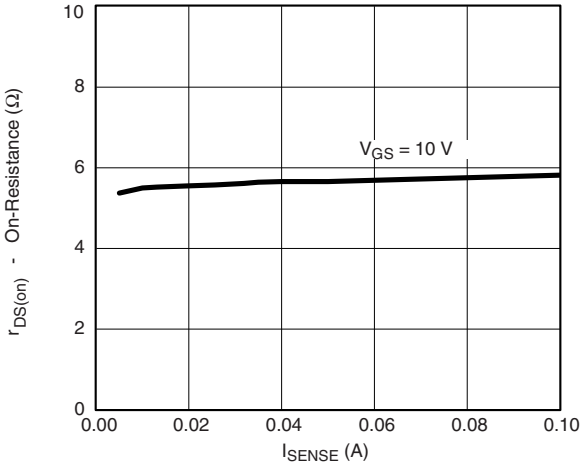

**Safe Operating Area**

## THERMAL RATINGS

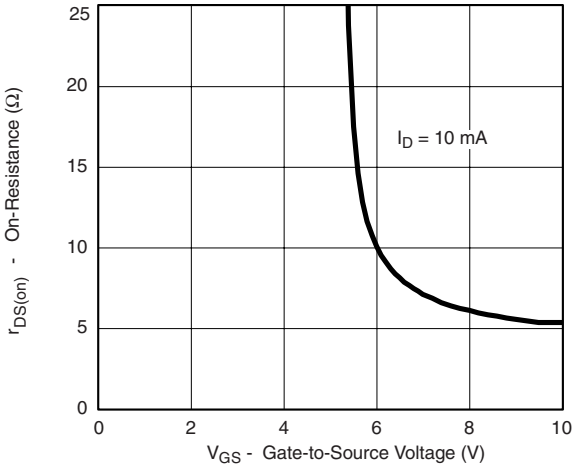



**Normalized Thermal Transient Impedance, Junction-to-Case**

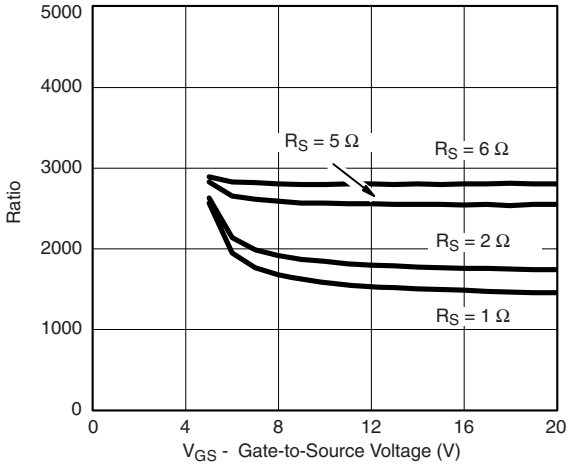
## SENSE DIE TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted




**On-Resistance vs. Sense Current**




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




**Current Ratio ($I_{(MAIN)/IS}$) vs. Gate-Source Voltage (Figure 1)**

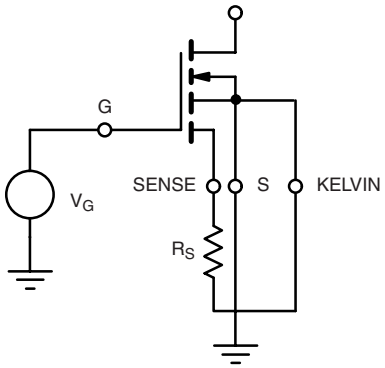



**Figure 1.**

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