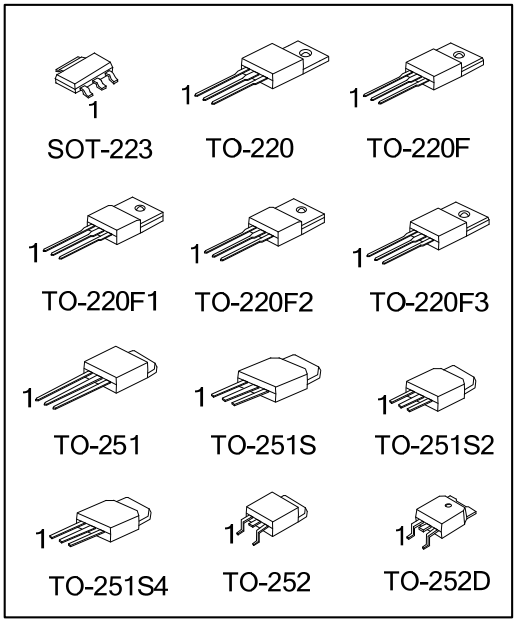
# 2N40K-TA

**Power MOSFET**

## 2.0A, 400V N-CHANNEL POWER MOSFET




### ■ DESCRIPTION

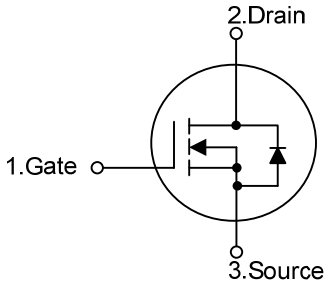
The UTC **2N40K-TA** is a N-channel mode power MOSFET using UTC' s advanced technology to provide customers with a minimum on-state resistance, stable off–state characteristics and superior switching performance. It also can withstand high energy pulse in the avalanche.

The UTC **2N40K-TA** is usually used in general purpose switching applications, motor control circuits and switched mode power supply.

### ■ FEATURES

* $R_{DS(ON)} \leq 2.5\ \Omega$ @ $V_{GS}$=10V, $I_D$=1.25A
* High switching speed
* 100% avalanche tested

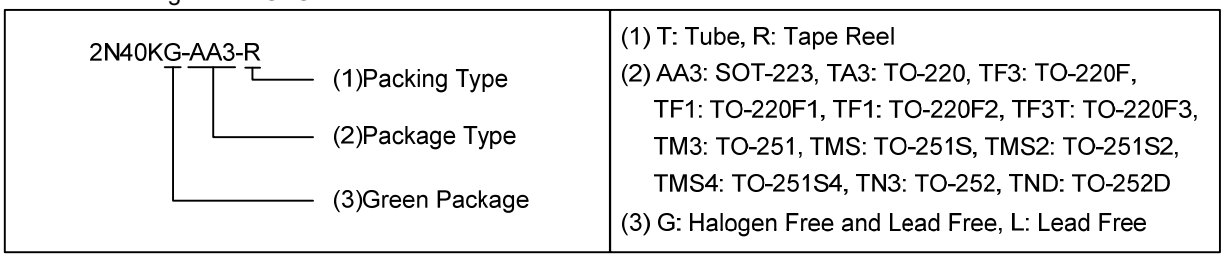
### ■ SYMBOL



## ■ ORDERING INFORMATION

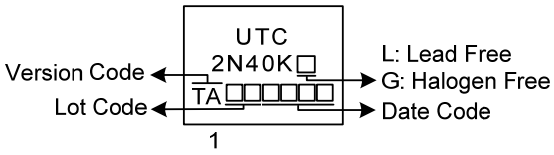
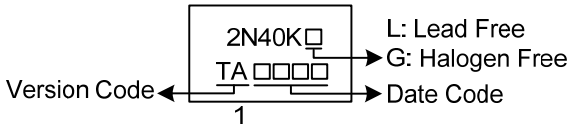
| Ordering Number | | Package | Pin Assignment | | | Packing |
|---|---|---|---|---|---|---|
| Lead Free | Halogen Free | | 1 | 2 | 3 | |
| 2N40KL-AA3-R | 2N40KG-AA3-R | SOT-223 | G | D | S | Tape Reel |
| 2N40KL-TA3-T | 2N40KG-TA3-T | TO-220 | G | D | S | Tube |
| 2N40KL-TF3-T | 2N40KG-TF3-T | TO-220F | G | D | S | Tube |
| 2N40KL-TF1-T | 2N40KG-TF1-T | TO-220F1 | G | D | S | Tube |
| 2N40KL-TF2-T | 2N40KG-TF2-T | TO-220F2 | G | D | S | Tube |
| 2N40KL-TF3T-T | 2N40KG-TF3T-T | TO-220F3 | G | D | S | Tube |
| 2N40KL-TM3-T | 2N40KG-TM3-T | TO-251 | G | D | S | Tube |
| 2N40KL-TMS-T | 2N40KG-TMS-T | TO-251S | G | D | S | Tube |
| 2N40KL-TMS2-T | 2N40KG-TMS2-T | TO-251S2 | G | D | S | Tube |
| 2N40KL-TMS4-T | 2N40KG-TMS4-T | TO-251S4 | G | D | S | Tube |
| 2N40KL-TN3-R | 2N40KG-TN3-R | TO-252 | G | D | S | Tape Reel |
| 2N40KL-TND-R | 2N40KG-TND-R | TO-252D | G | D | S | Tape Reel |

Note: Pin Assignment: G: Gate D: Drain S: Source




(1) T: Tube, R: Tape Reel
(2) AA3: SOT-223, TA3: TO-220, TF3: TO-220F, TF1: TO-220F1, TF1: TO-220F2, TF3T: TO-220F3, TM3: TO-251, TMS: TO-251S, TMS2: TO-251S2, TMS4: TO-251S4, TN3: TO-252, TND: TO-252D
(3) G: Halogen Free and Lead Free, L: Lead Free

## ■ MARKING

| TO-220 / TO-220F / TO-220F1 / TO-220F2 TO-220F3 / TO-251 / TO-251S / TO-251S2 TO-251S4 / TO-252 / TO-252D | SOT-223 |
|---|---|
|  |  |

## ■ ABSOLUTE MAXIMUM RATINGS ($T_C$=25°C, unless otherwise specified)

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DSS}$ | 400 | V |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Drain Current | Continuous | $I_D$ | 2 | A |
| | Pulsed | $I_{DM}$ | 8 | A |
| Single Pulsed Avalanche Energy | | $E_{AS}$ | 85 | mJ |
| Peak Diode Recovery dv/dt (Note 4) | | dv/dt | 5.1 | V/ns |
| Power Dissipation | SOT-223 | $P_D$ | 5 | W |
| | TO-220 | | 60 | W |
| | TO-220F/TO-220F1<br>TO-220F2/ TO-220F3 | | 20 | W |
| | TO-251/TO-251S<br>TO-251S2/TO-251S4<br>TO-252/TO-252D | | 43 | W |
| Junction Temperature | | $T_J$ | +150 | °C |
| Storage Temperature | | $T_{STG}$ | -55 ~ +150 | °C |

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. Repetitive Rating: Pulse width limited by maximum junction temperature.
3. L = 42.5mH, $I_{AS}$ = 2.0A, $V_{DD}$ = 50V, $R_G$ = 25Ω, Starting $T_J$ = 25°C
4. $I_{SD}$ ≤ 2.0A, di/dt ≤ 200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C

## ■ THERMAL DATA

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Junction to Ambient | SOT-223 | $\theta_{JA}$ | 150(Note) | °C/W |
| | TO-220/TO-220F<br>TO-220F1/TO-220F2<br>TO-220F3 | | 62.5 | °C/W |
| | TO-251/TO-251S<br>TO-251S2/TO-251S4<br>TO-252/TO-252D | | 110 | °C/W |
| Junction to Case | SOT-223 | $\theta_{JC}$ | 25 (Note) | °C/W |
| | TO-220 | | 2.08 | °C/W |
| | TO-220/TO-220F<br>TO-220F1/TO-220F2<br>TO-220F3 | | 6.25 | °C/W |
| | TO-251/TO-251S<br>TO-251S2/TO-251S4<br>TO-252/TO-252D | | 2.9 (Note) | °C/W |

Note: Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch square copper plate.

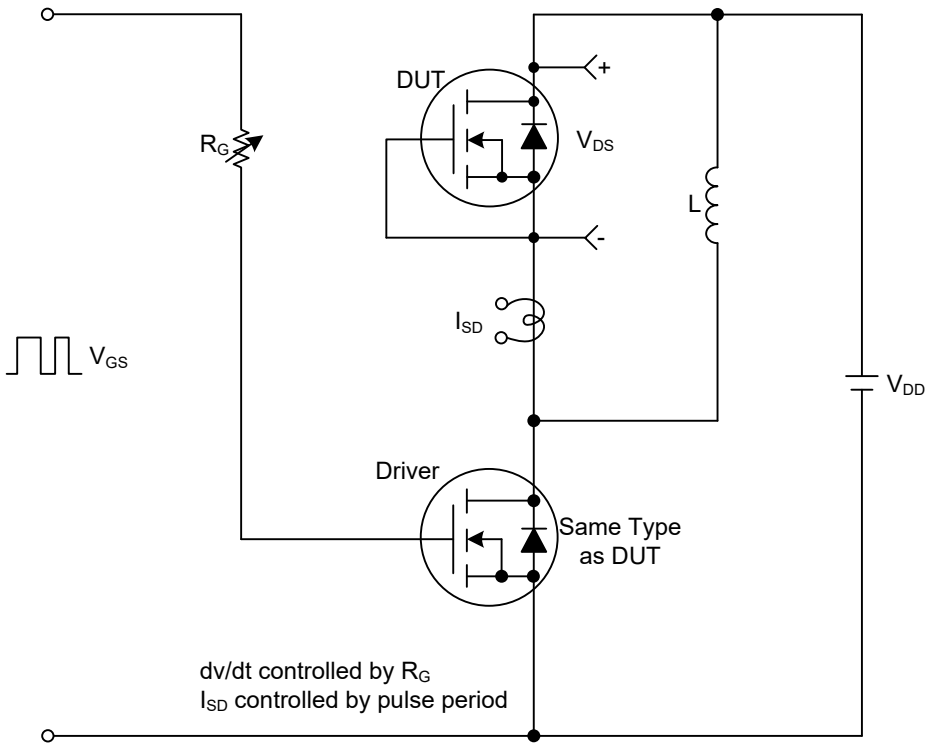
## ■ ELECTRICAL CHARACTERISTICS ($T_J$=25°C, unless otherwise specified)

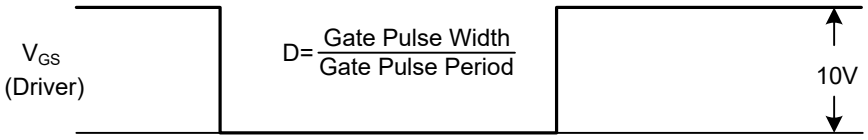
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $I_D$=250μA, $V_{GS}$=0V | 400 | | | V |
| Drain-Source Leakage Current | $I_{DSS}$ | $V_{DS}$=400V, $V_{GS}$=0V | | | 1 | μA |
| Gate- Source Leakage Current | $I_{GSS}$ | $V_{GS}$=±30V, $V_{DS}$=0V | | | ±200 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{DS}$=$V_{GS}$, $I_D$=250μA | 2.0 | | 4.0 | V |
| Static Drain-Source On-State Resistance | $R_{DS(ON)}$ | $V_{GS}$=10V, $I_D$=1.25A | | | 2.5 | Ω |
| **DYNAMIC PARAMETERS** | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$=0V, $V_{DS}$=25V, f=1.0MHz | | 276 | | pF |
| Output Capacitance | $C_{OSS}$ | | | 40 | | pF |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | 4 | | pF |
| **SWITCHING PARAMETERS** | | | | | | |
| Total Gate Charge | $Q_G$ | $V_{DS}$=320V, $I_D$=2.0A, $V_{GS}$=10V (Note 1, 2) | | 13 | | nC |
| Gate-Source Charge | $Q_{GS}$ | | | 4 | | nC |
| Gate-Drain Charge | $Q_{GD}$ | | | 3 | | nC |
| Turn-ON Delay Time | $t_{D(ON)}$ | $V_{DD}$=100V, $I_D$=2.0A, $R_G$ =25Ω (Note 1, 2) | | 4 | | ns |
| Rise Time | $t_R$ | | | 18 | | ns |
| Turn-OFF Delay Time | $t_{D(OFF)}$ | | | 22 | | ns |
| Fall-Time | $t_F$ | | | 21 | | ns |
| **SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS** | | | | | | |
| Maximum Body-Diode Continuous Current | $I_S$ | $T_C$=25°C | | | 2.0 | A |
| Drain-Source Diode Forward Voltage | $V_{SD}$ | $I_S$=2.5A, $V_{GS}$=0V | | | 1.2 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $I_S$=2.0A, $V_{GS}$=0V, $dI_F/dt$=100A/μs (Note 1) | | 159 | | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | | 738 | | nC |

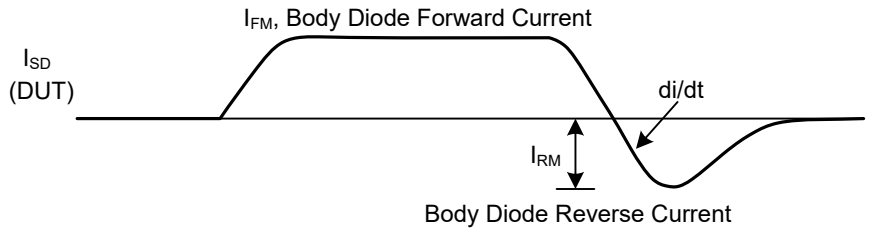
Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%.
2. Essentially independent of operating temperature.

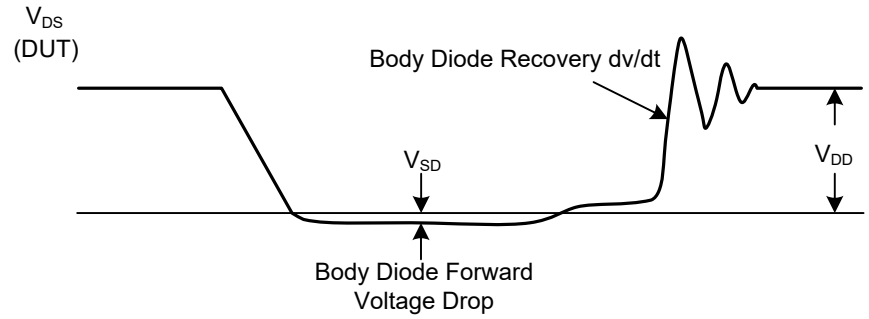
## ■ TEST CIRCUITS AND WAVEFORMS

Peak Diode Recovery dv/dt Test Circuit & Waveforms



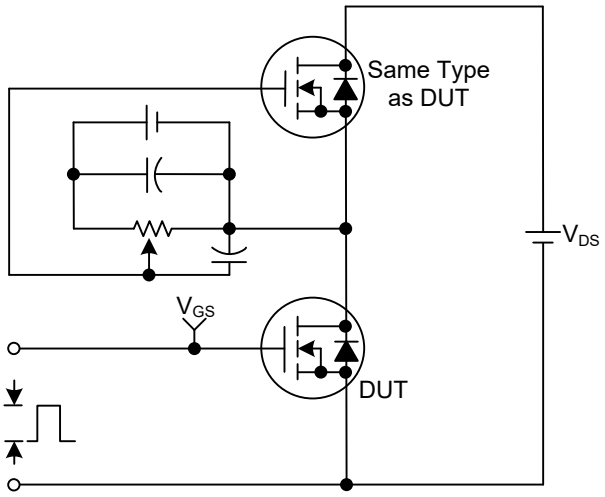



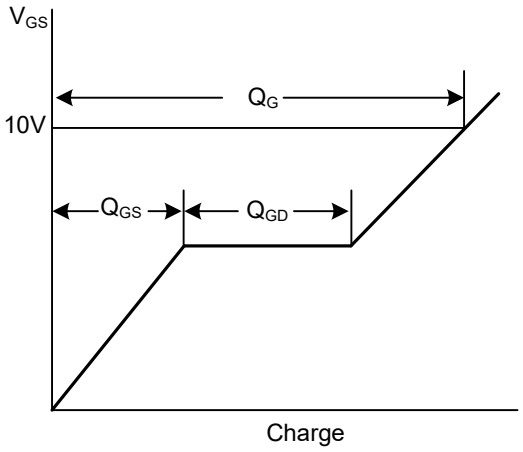



## ■ TEST CIRCUITS AND WAVEFORMS

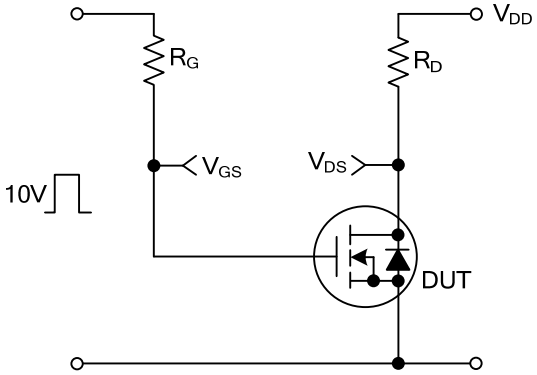
Gate Charge Test Circuit



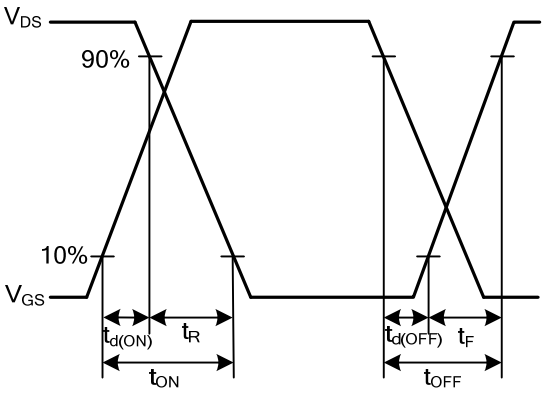

Gate Charge Waveforms



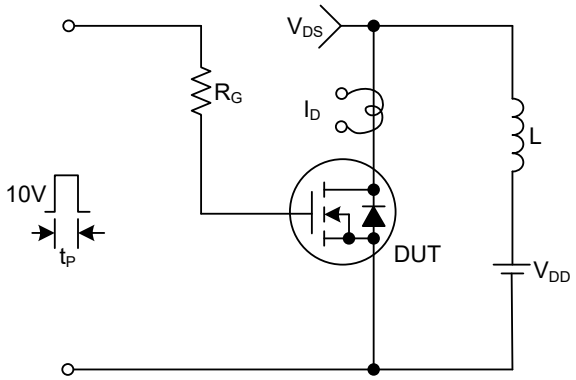

Resistive Switching Test Circuit




Resistive Switching Waveforms

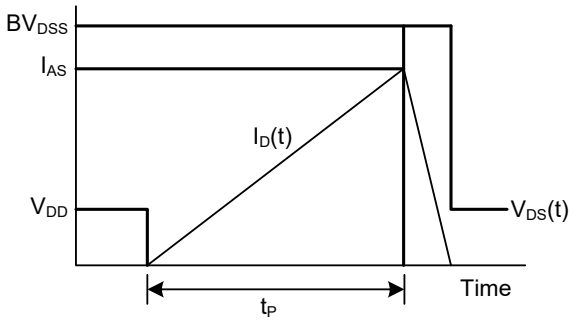



Unclamped Inductive Switching Test Circuit

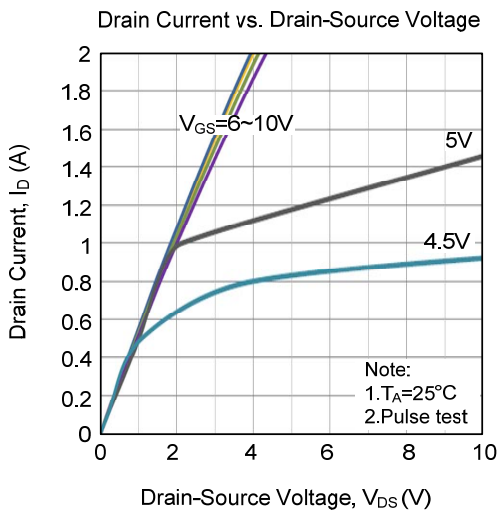


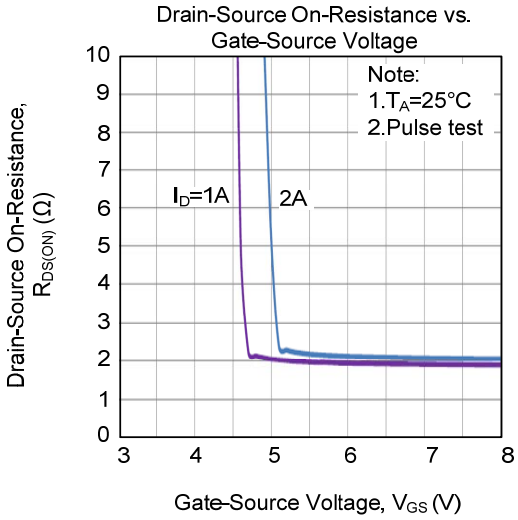

Unclamped Inductive Switching Waveforms

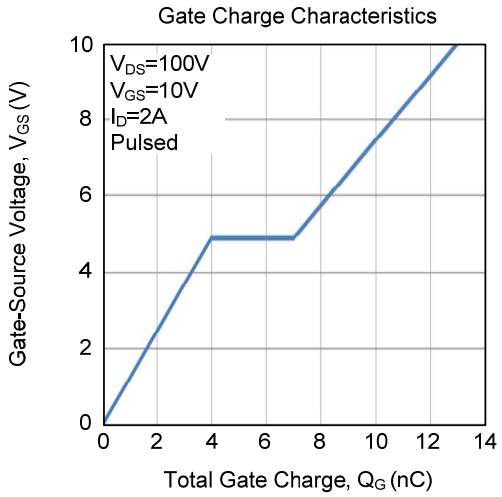
$$E_{AS}=\frac{1}{2}LI_{AS}^{2}\frac{BV_{DSS}}{BV_{DSS}-V_{DD}}$$

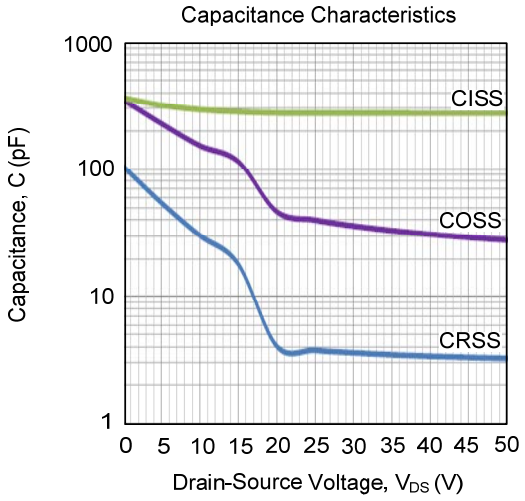


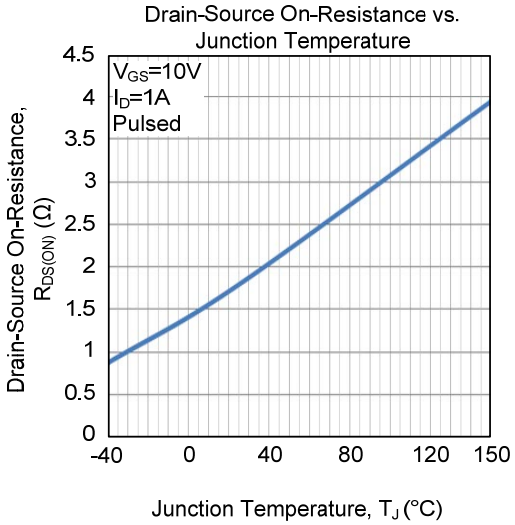
## ■ TYPICAL CHARACTERISTICS

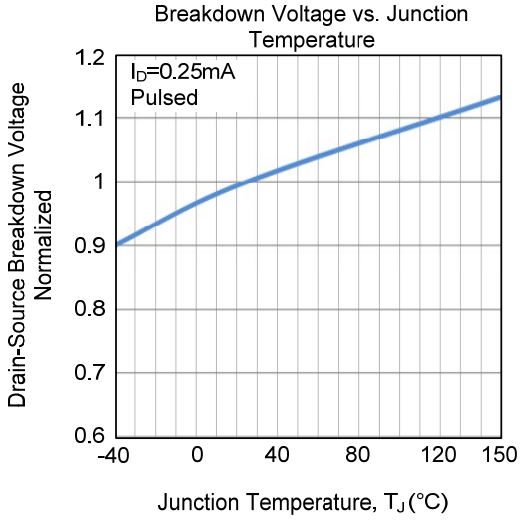


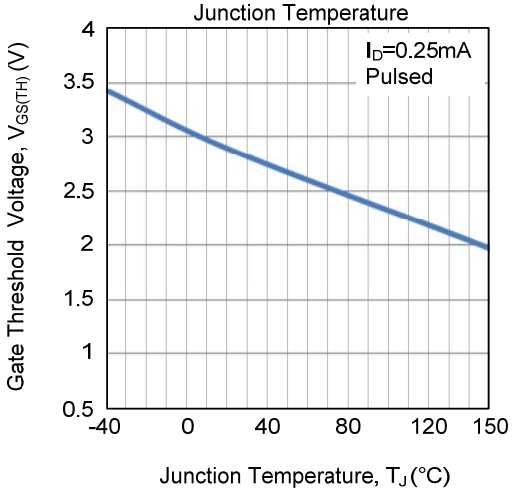



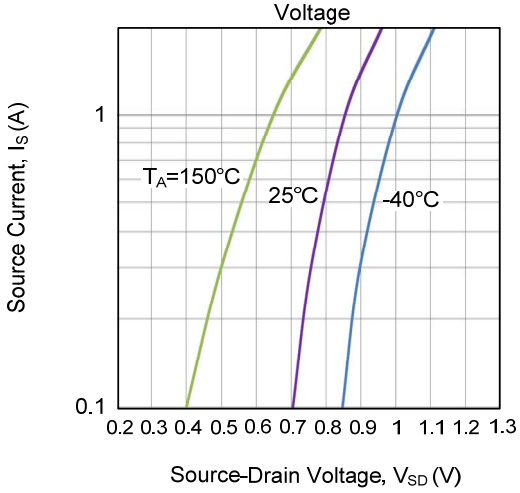



## ■ TYPICAL CHARACTERISTICS (Cont.)

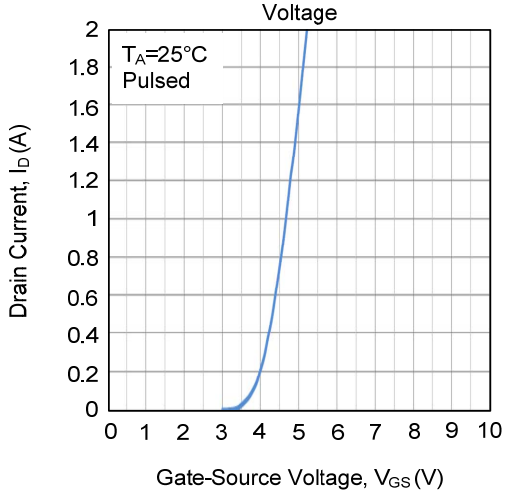
Gate Threshold Voltage vs. Junction Temperature



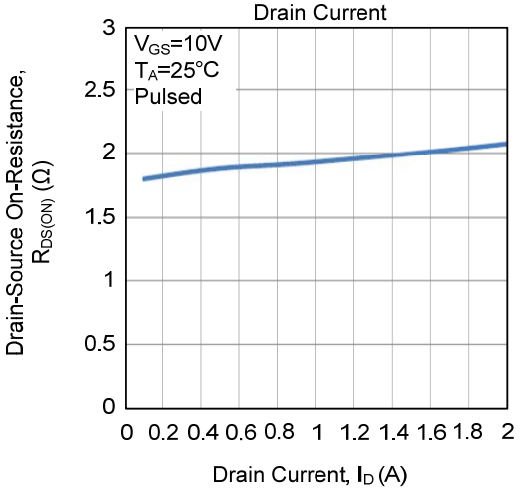

Source Current vs. Source-Drain Voltage



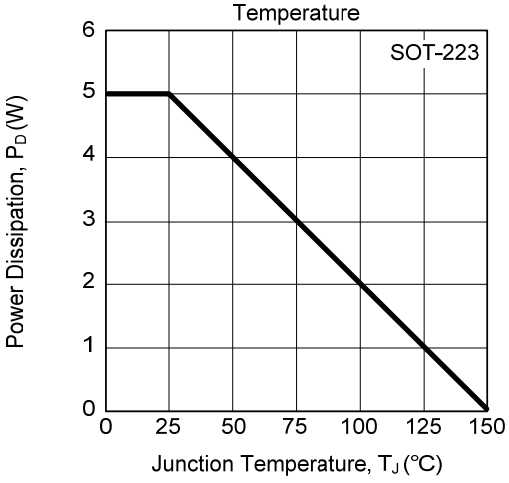

Drain Current vs. Gate-Source Voltage



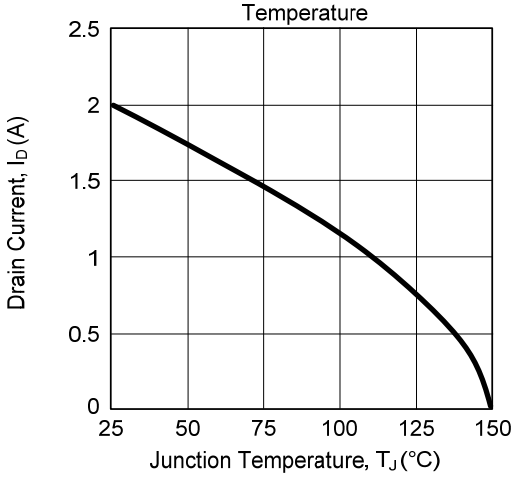

Drain-Source On-Resistance vs. Drain Current




Power Dissipation vs. Junction Temperature




Drain Current vs. Junction Temperature



## ■ TYPICAL CHARACTERISTICS (Cont.)