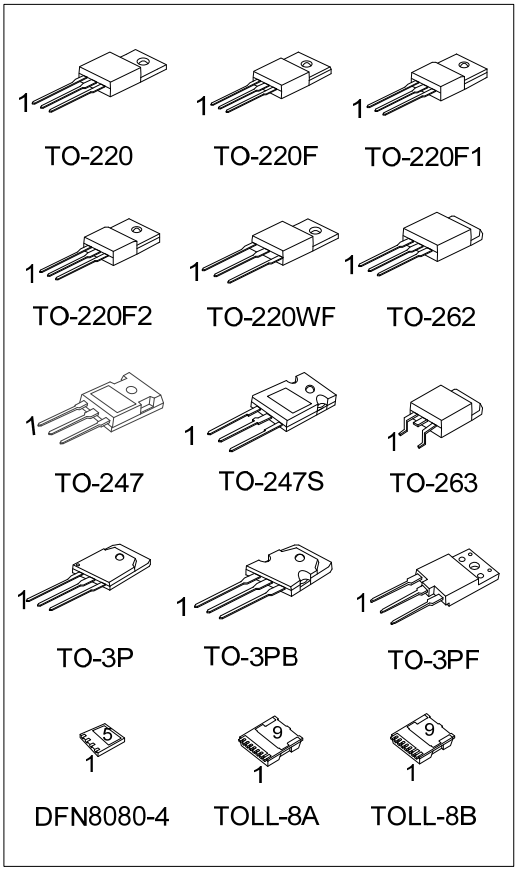
24NM60

Power MOSFET

24A, 600V N-CHANNEL SUPER-JUNCTION MOSFET



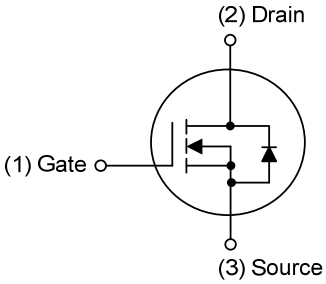
■ DESCRIPTION

The **UTC 24NM60** is a Super Junction MOSFET Structure and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and a high rugged avalanche characteristics. This power MOSFET is usually used at AC-DC converters for power applications.

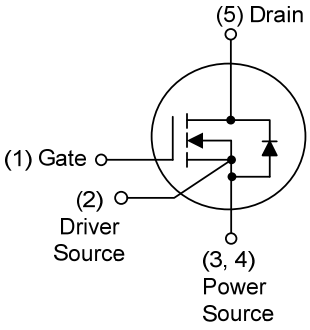
■ FEATURES

* $R_{DS(ON)} \leq 0.16\ \Omega$ @ V_{GS}=10V, I_D=12A
* High Switching Speed
* 100% Avalanche Tested

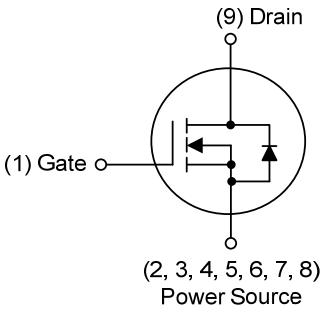
■ SYMBOL



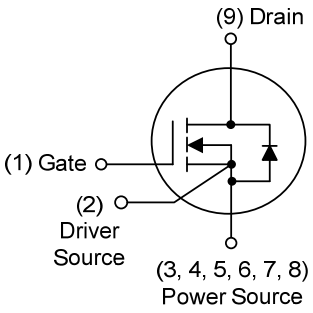
TO-220 / TO-220F / TO-220F1 / TO-220F2
TO-220WF / TO-3P / TO-3PB / TO-3PF
TO-247 /TO-247S / TO-262 / TO-263



DFN8080-4



TOLL-8A

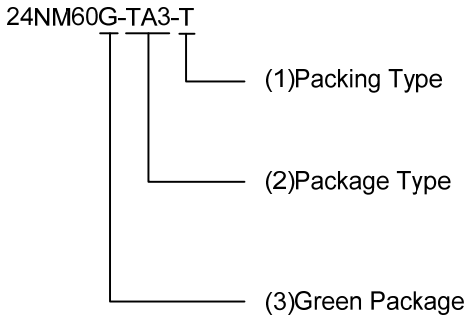


TOLL-8B

■ ORDERING INFORMATION

Ordering Number		Package	Pin Assignment									Packing
Lead Free	Halogen Free		1	2	3	4	5	6	7	8	9	
24NM60L-TA3-T	24NM60G-TA3-T	TO-220	G	D	S	-	-	-	-	-	-	Tube
24NM60L-TF1-T	24NM60G-TF1-T	TO-220F1	G	D	S	-	-	-	-	-	-	Tube
24NM60L-TF2-T	24NM60G-TF2-T	TO-220F2	G	D	S	-	-	-	-	-	-	Tube
24NM60L-TF3-T	24NM60G-TF3-T	TO-220F	G	D	S	-	-	-	-	-	-	Tube
24NM60L-TW1-T	24NM60G-TW1-T	TO-220WF	G	D	S	-	-	-	-	-	-	Tube
24NM60L-T2Q-T	24NM60G-T2Q-T	TO-262	G	D	S	-	-	-	-	-	-	Tube
24NM60L-TQ2-T	24NM60G-TQ2-T	TO-263	G	D	S	-	-	-	-	-	-	Tube
24NM60L-TQ2-R	24NM60G-TQ2-R	TO-263	G	D	S	-	-	-	-	-	-	Tape Reel
24NM60L-T3P-T	24NM60G-T3P-T	TO-3P	G	D	S	-	-	-	-	-	-	Tube
24NM60L-T3B-T	24NM60G-T3B-T	TO-3PB	G	D	S	-	-	-	-	-	-	Tube
24NM60L-T3F-T	24NM60G-T3F-T	TO-3PF	G	D	S	-	-	-	-	-	-	Tube
24NM60L-T47-T	24NM60G-T47-T	TO-247	G	D	S	-	-	-	-	-	-	Tube
24NM65L-T47S-T	24NM65G-T47S-T	TO-247S	G	D	S	-	-	-	-	-	-	Tube
24NM60L-K04-8080-R	24NM60G-K04-8080-R	DFN8080-4	G	S	S	S	D	-	-	-	-	Tape Reel
24NM60L-T8A-R	24NM60G-T8A-R	TOLL-8A	G	S	S	S	S	S	S	S	D	Tape Reel
24NM60L-T8B-R	24NM60G-T8B-R	TOLL-8B	G	S	S	S	S	S	S	S	D	Tape Reel

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

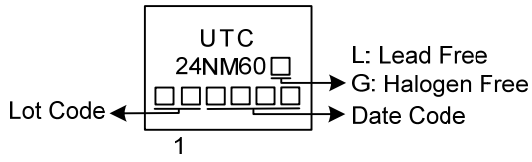
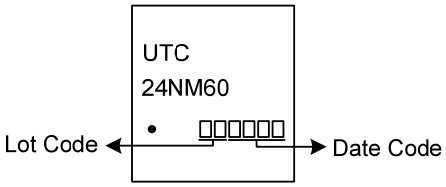
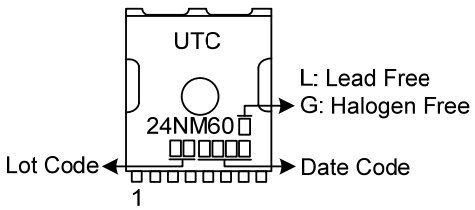


(1) T: Tube, R: Tape Reel

(2) TA3: TO-220, TF1: TO-220F1, TF2: TO-220F2, TF3: TO-220F, TW1: TO-220WF, T2Q: TO-262, TQ2: TO-263, T3P: TO-3P, T3B: TO-3PB, T3F: TO-3PF, T47: TO-247, T47S: TO-247S, K04-8080: DFN8080-4, T8A: TOLL-8A, T8B: TOLL-8B

(3) G: Halogen Free and Lead Free L: Lead Free

■ MARKING

TO-220 / TO-220F / TO-220F1 / TO-220F2 TO-220WF / TO-3P / TO-3PB / TO-3PF TO-247 / TO-247S / TO-262 / TO-263	DFN8080-4
	
TOLL-8A / TOLL-8B	-
	-

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

PARAMETER		SYMBOL	RATINGS	UNIT
Drain-Source Voltage		V_{DSS}	600	V
Gate-Source Voltage		V_{GSS}	±30	V
Drain Current	Continuous	I_D	24	A
	Pulsed (Note 2)	I_{DM}	96	A
Avalanche Current (Note 2)		I_{AR}	5.0	A
Avalanche Energy	Single Pulsed (Note 3)	E_{AS}	725	mJ
Peak Diode Recovery dv/dt		dv/dt	10.5	V/ns
MOSFET dv/dt Ruggedness		dv/dt	50	V/ns
Power Dissipation	TO-220/TO-262 TO-263	P_D	120	W
	TO-220F/TO-220F1 TO-220F2/TO-220WF		36	W
	TO-3P/TO-3PB		155	W
	TO-3PF		58	W
	TO-247/TO-247S		140	W
	DFN8080-4		66	W
	TOLL-8A/TOLL-8B		205	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 = 58 mH, I_{AS} = 5.0A, V_{DD} = 50V, R_G = 25Ω, Starting T_J = 25°C
4. I_{SD} ≤ 24A, di/dt ≤ 200A/μs, V_{DD} ≤ BV_{DSS}, Starting T_J = 25°C

■ THERMAL DATA

PARAMETER		SYMBOL	RATINGS	UNIT
Junction to Ambient	TO-220/TO-220F TO-220F1/TO-220F2 TO-220WF/TO-262 TO-263	θ_{JA}	62.5	°C/W
	TO-3P/TO-3PB TO-3PF		30	°C/W
	TO-247/TO-247S		40	°C/W
	DFN8080-4/TOLL-8A TOLL-8B		35 (Note)	°C/W
Junction to Case	TO-220/TO-262 TO-263	θ_{JC}	1.04	°C/W
	TO-220F/TO-220F1 TO-220F2/TO-220WF		3.47	°C/W
	TO-3P/TO-3PB		0.8	°C/W
	TO-3PF		2.155	°C/W
	TO-247/TO-247S		0.89	°C/W
	DFN8080-4		1.89 (Note)	°C/W
	TOLL-8A/TOLL-8B		0.6 (Note)	°C/W

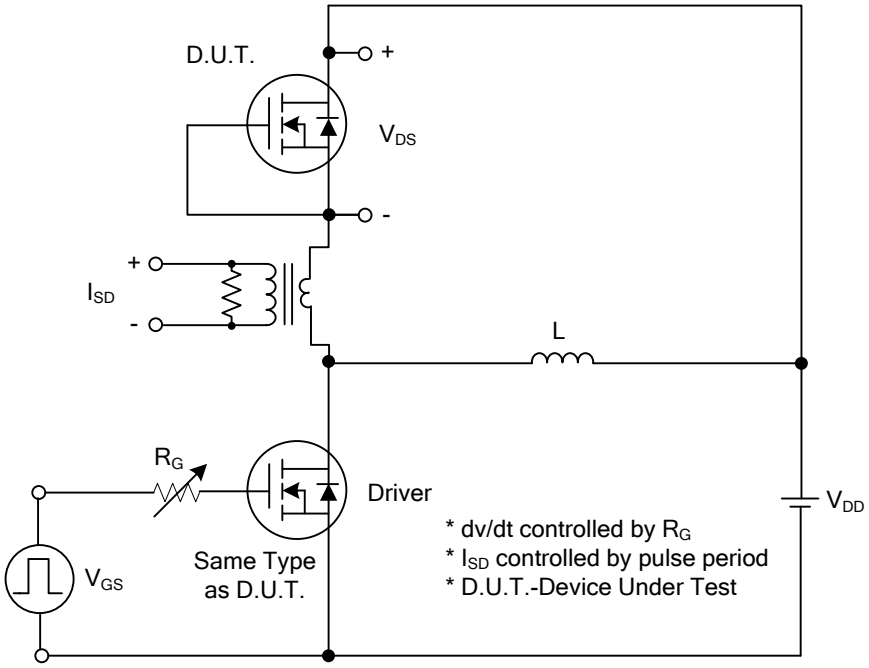
Note: Device mounted on FR-4 substrate P_C board, 2oz copper, with 1inch square copper plate.

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

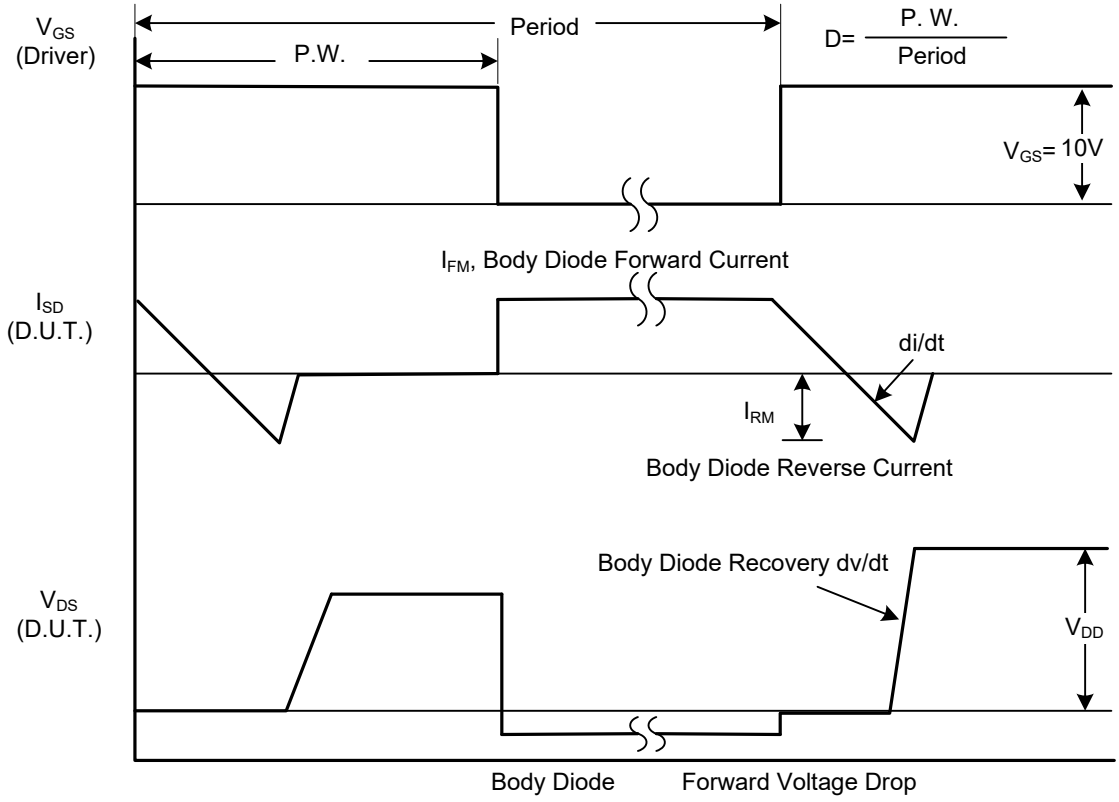
PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OFF CHARACTERISTICS							
Drain-Source Breakdown Voltage		BV_{DSS}	I_D=250μA, V_{GS}=0V	600			V
Drain-Source Leakage Current		I_{DSS}	V_{DS}=600V, V_{GS}=0V			10	μA
Gate- Source Leakage Current	Forward	I_{GSS}	V_{GS}=+30V, V_{DS}=0V			+100	nA
	Reverse		V_{GS}=-30V, V_{DS}=0V			-100	nA
ON CHARACTERISTICS							
Gate Threshold Voltage		$V_{GS(TH)}$	V_{DS}=V_{GS}, I_D=250μA	2.5		4.5	V
Static Drain-Source On-State Resistance		$R_{DS(ON)}$	V_{GS}=10V, I_D=12A		0.145	0.16	Ω
DYNAMIC PARAMETERS							
Input Capacitance		C_{ISS}	V_{GS}=0V, V_{DS}=25V, f=1.0MHz		2000		pF
Output Capacitance		C_{OSS}			1100		pF
Reverse Transfer Capacitance		C_{RSS}			110		pF
SWITCHING PARAMETERS							
Total Gate Charge (Note 1)		Q_G	V_{DS}=480V, V_{GS}=10V, I_D=24A I_G=1mA (Note1, 2)		76		nC
Gate to Source Charge		Q_{GS}			22		nC
Gate to Drain Charge		Q_{GD}			30		nC
Turn-ON Delay Time (Note 1)		$t_{D(ON)}$	V_{DS}=100V, V_{GS}=10V, I_D=24A, R_G=25Ω (Note1, 2)		26		ns
Rise Time		t_R			48.2		ns
Turn-OFF Delay Time		$t_{D(OFF)}$			248		ns
Fall-Time		t_F			112.8		ns
SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS							
Maximum Body-Diode Continuous Current		I_S				24	A
Maximum Body-Diode Pulsed Current		I_{SM}				96	A
Drain-Source Diode Forward Voltage (Note 1)		V_{SD}	I_S=24A, V_{GS}=0V			1.4	V
Body Diode Reverse Recovery Time (Note 1)		t_{rr}	I_S=24A, V_{GS}=0V, dI_F/dt=100A/μs		490		ns
Body Diode Reverse Recovery Charge		Q_{rr}			9.3		μC

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

■ TEST CIRCUITS AND WAVEFORMS



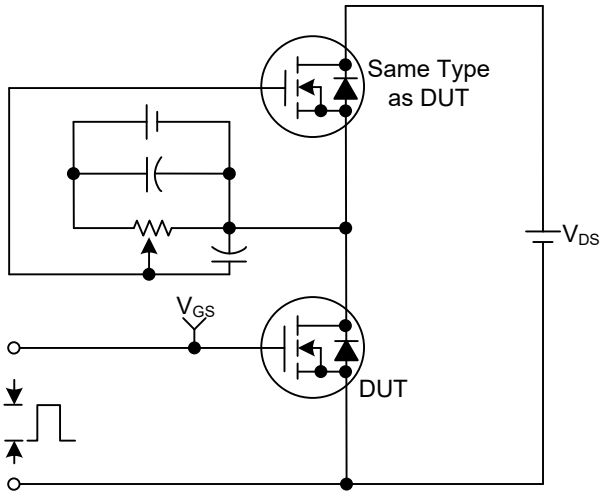
Peak Diode Recovery dv/dt Test Circuit



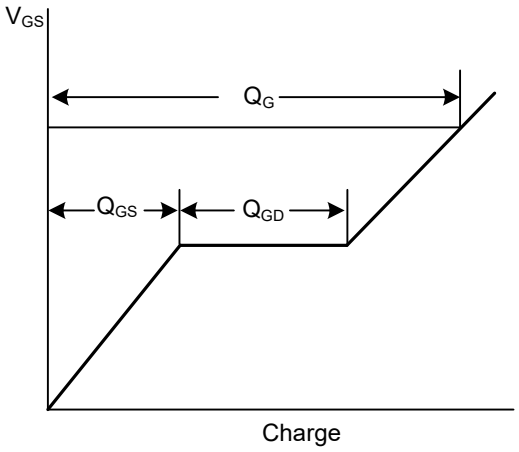
Peak Diode Recovery dv/dt Waveforms

■ TEST CIRCUITS AND WAVEFORMS

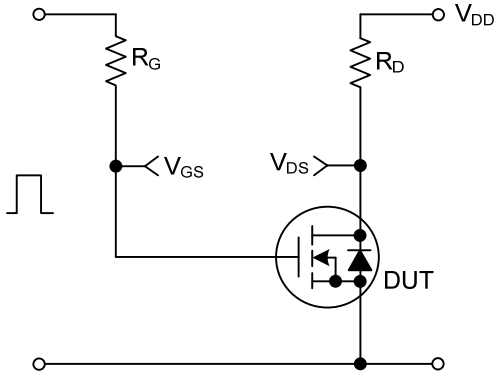
Gate Charge Test Circuit



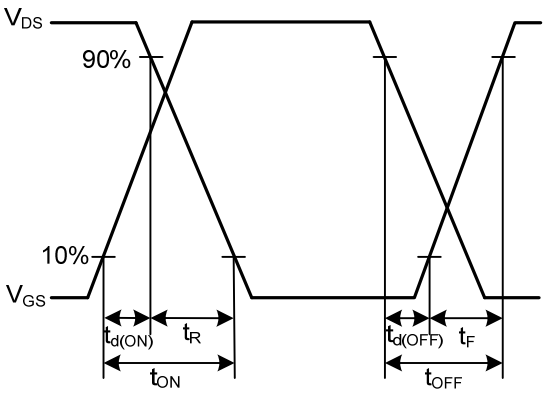
Gate Charge Waveforms



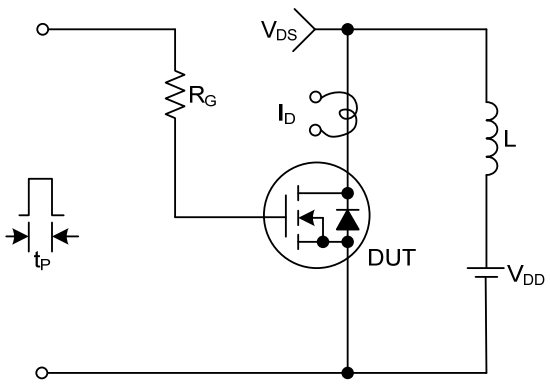
Resistive Switching Test Circuit



Resistive Switching Waveforms

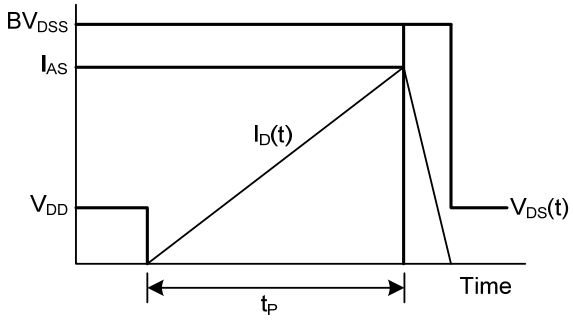


Unclamped Inductive Switching Test Circuit



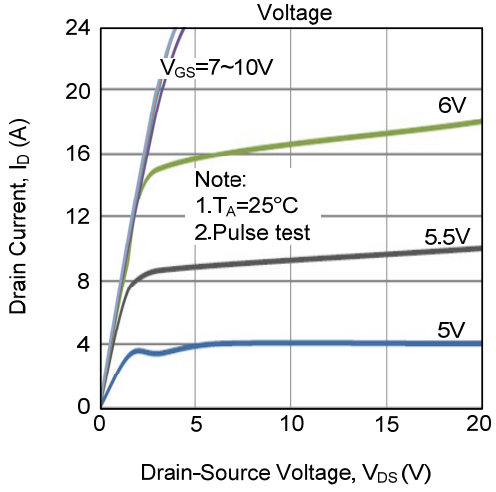
Unclamped Inductive Switching Waveforms

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

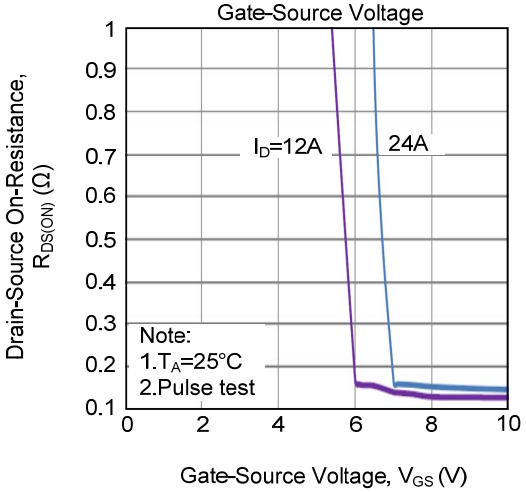


■ TYPICAL CHARACTERISTICS

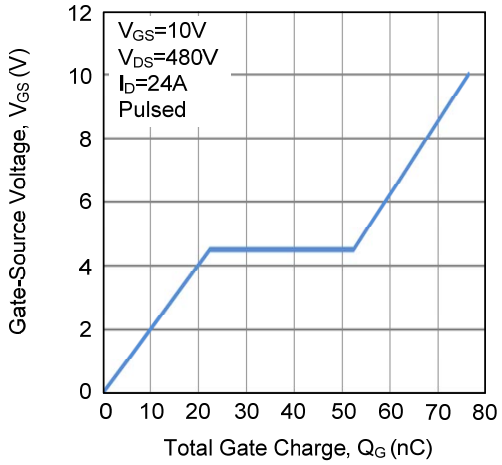
Drain Current vs. Drain-Source Voltage



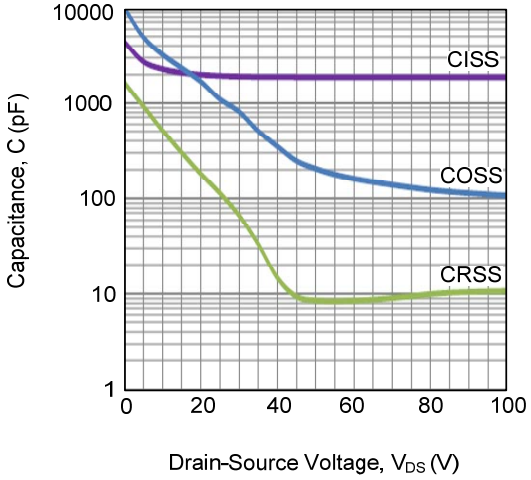
Drain-Source On-Resistance vs. Gate-Source Voltage



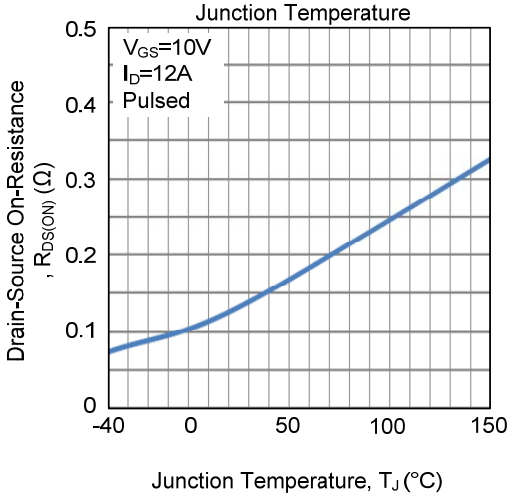
Gate Charge Characteristics



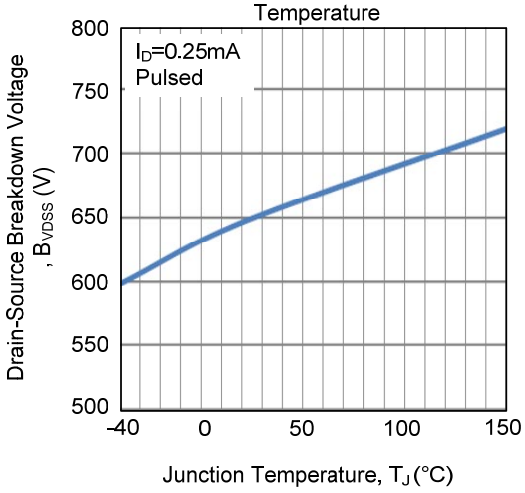
Capacitance Characteristics



Drain-Source On-Resistance vs. Junction Temperature

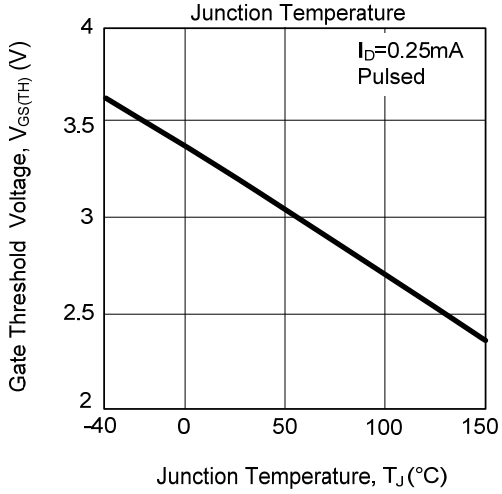


Breakdown Voltage vs. Junction Temperature

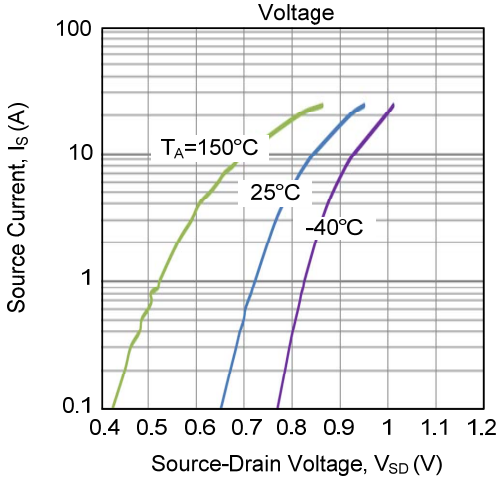


■ TYPICAL CHARACTERISTICS (Cont.)

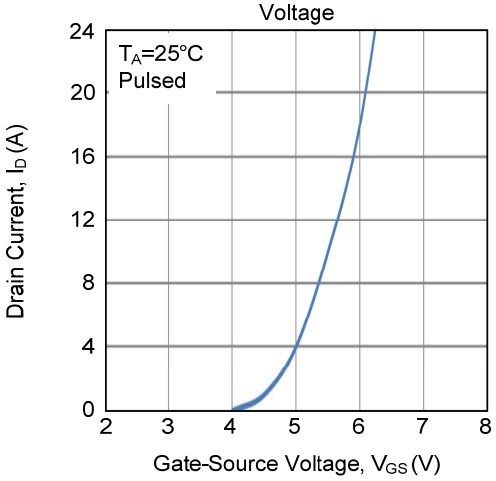
Gate Threshold Voltage vs. Junction Temperature



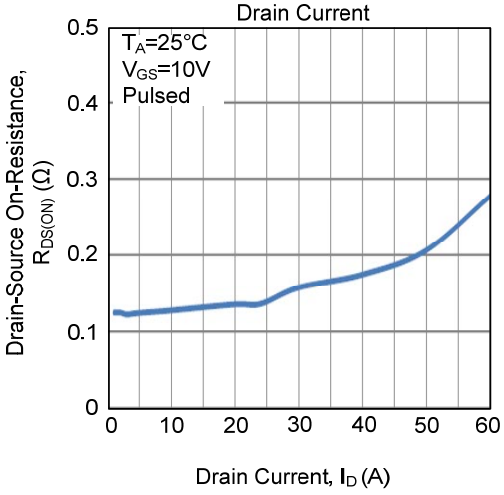
Source Current vs. Source-Drain Voltage



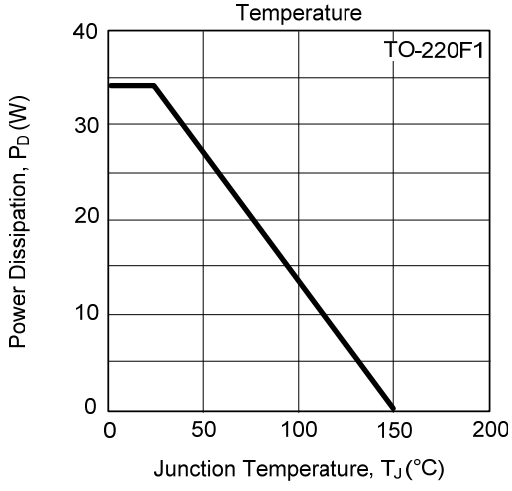
Drain Current vs. Gate-Source Voltage



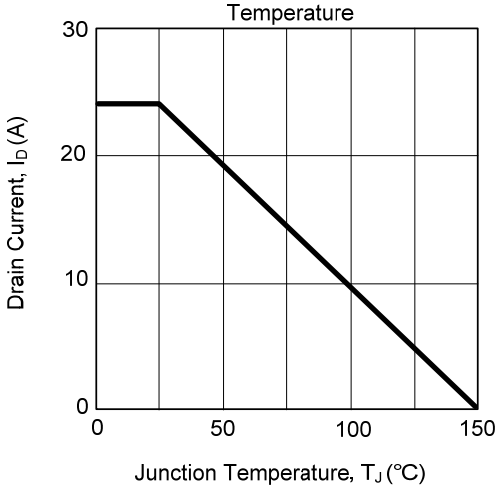
Drain-Source On-Resistance vs. Drain Current



Power Dissipation vs. Junction Temperature



Drain Current vs. Junction Temperature



■ TYPICAL CHARACTERISTICS (Cont.)