

## 60V P-Channel Enhancement Mode MOSFET

### ■ DESCRIPTION

The SM409 is P channel enhancement mode power effect transistor which is produced using high cell density advanced trench technology.

The high density process is especially able to minimize on-state resistance. These devices are especially suited for low voltage application power management DC-DC converters.

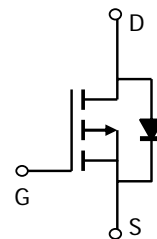
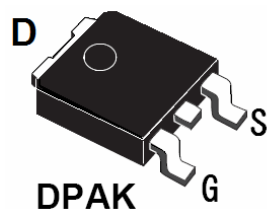
### ■ FEATURE

- ◆ -60V/-26 A,  $R_{DS(ON)}=30\text{ m}\Omega(\text{typ.})@V_{GS}=-10\text{V}$
- ◆ -60V/-20A,  $R_{DS(ON)}=40\text{ m}\Omega(\text{typ.})@V_{GS}=-4.5\text{V}$
- ◆ Super high design for extremely low  $R_{DS(ON)}$
- ◆ Exceptional on-resistance and Maximum DC current capability
- ◆ Full RoHS compliance
- ◆ TO252 package design
- ◆ 100% UIS Tested
- ◆ 100% Rg tested

### ■ APPLICATIONS

- ◆ Power Management
- ◆ DC/DC Converter
- ◆ Load Switch

### ■ PIN CONFIGURATION



**■ ORDERING INFORMATION**

Part Number	Package Code	Package	Shipping
SM409T9RL	409	TO-252	2500EA / T&R

**■ ABSOLUTE MAXIMUM RATINGS (  $T_A = 25^\circ\text{C}$  Unless otherwise noted )**

Parameter	Symbol	Maximum	Units	
Drain-Source Voltage	$V_{DS}$	-60	V	
Gate-Source Voltage	$V_{GS}$	$\pm 20$	V	
Continuous Drain Current <sup>G</sup>	$I_D$	$T_C=25^\circ\text{C}$	-26	
		$T_C=100^\circ\text{C}$	-18	
Pulsed Drain Current <sup>C</sup>	$I_{DM}$	-60	A	
Avalanche Current <sup>C</sup>	$I_{AR}$	-26	A	
Repetitive avalanche energy $L=0.1\text{mH}$ <sup>C</sup>	$E_{AR}$	33.8	mJ	
Power Dissipation <sup>B</sup>	$P_D$	$T_C=25^\circ\text{C}$	60	
		$T_C=100^\circ\text{C}$	30	
Power Dissipation <sup>A</sup>	$P_{DSM}$	$T_A=25^\circ\text{C}$	2.5	
		$T_A=70^\circ\text{C}$	1.6	
Junction and Storage Temperature Range	$T_J, T_{STG}$	-55 to 175	$^\circ\text{C}$	
<b>Thermal Characteristics</b>				
Parameter	Symbol	Typ	Max	Units
Maximum Junction-to-Ambient <sup>A</sup>	$R_{\theta JA}$	16.7	25	$^\circ\text{C/W}$
Maximum Junction-to-Ambient <sup>A</sup>	$R_{\theta JC}$	1.9	2.5	$^\circ\text{C/W}$
Maximum Junction-to-Case <sup>C</sup>				

**Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress rating only and functional device operation is not implied**

**■ ELECTRICAL CHARACTERISTICS** ( $T_A=25^\circ\text{C}$  Unless otherwise noted)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
<b>Static Parameters</b>						
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	$V_{GS}=0V, I_D= -250\mu A$	-60			V
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS}=V_{GS}, I_D= -250\mu A$	-1.0		-2.5	V
$I_{GSS}$	Gate Leakage Current	$V_{DS}=0V, V_{GS}=\pm 25V$			$\pm 100$	nA
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS}=-48V, V_{GS}=0$			-1	uA
		$V_{DS}=-48V, V_{GS}=0$ $T_J=85^\circ\text{C}$			-5	
$R_{DS(ON)}$	Drain-Source On-Resistance	$V_{GS}=-10V, I_D= -20 A$		30	40	m $\Omega$
		$V_{GS}= -4.5V, I_D= -20 A$		40	55	
<b>Source-Drain Diode</b>						
$V_{SD}$	Diode Forward Voltage	$I_S= -1 A, V_{GS}=0V$		0.7	1.3	V
<b>Dynamic Parameters</b>						
$Q_g$	Total Gate Charge	$V_{DS}= -30V$ $V_{GS}= -10V$ $I_D=-20 A$		53		nC
$Q_{gs}$	Gate-Source Charge			12		
$Q_{gd}$	Gate-Drain Charge			13		
$C_{iss}$	Input Capacitance	$V_{DS}= -30V$ $V_{GS}=0V$ $f=1\text{MHz}$		1886		pF
$C_{oss}$	Output Capacitance			540		
$C_{riss}$	Reverse Transfer Capacitance			240		
$T_{d(on)}$	Turn-On Time	$V_{DS}= -30V$ $R_L=1.50\Omega$ $V_{GEN}=-10V$ $R_G=3.0\Omega$		19		nS
$T_r$				15		
$T_{d(off)}$	Turn-Off Time				52	
$T_f$				17		

**Note: 1. Pulse test: pulse width $\leq$ 300uS, duty cycle $\leq$ 2%**

**2.Static parameters are based on package level with recommended wire bonding**

■ **TYPICAL CHARACTERISTICS** (25°C Unless Note)

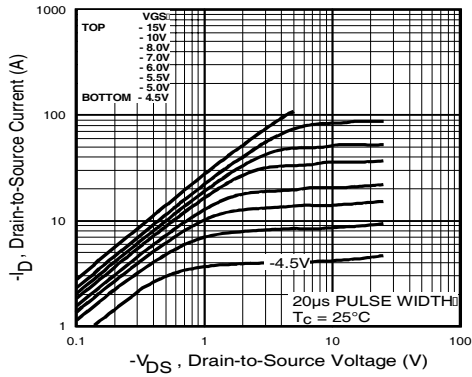


Fig 1. Typical Output Characteristics

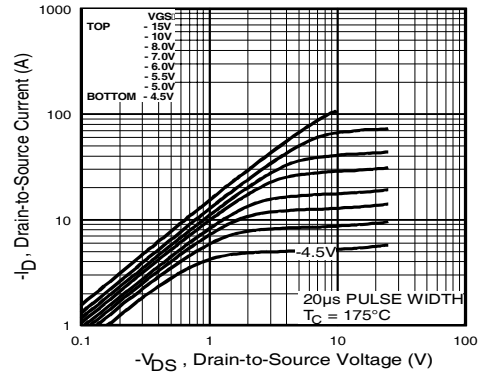


Fig 2. Typical Output Characteristics

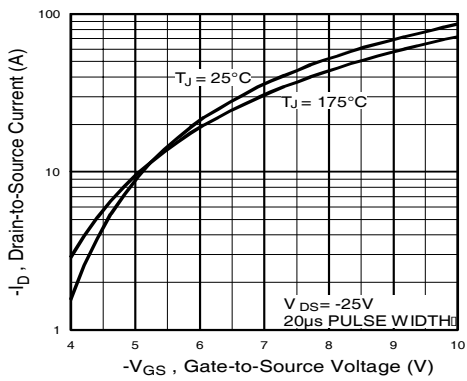


Fig 3. Typical Transfer Characteristics

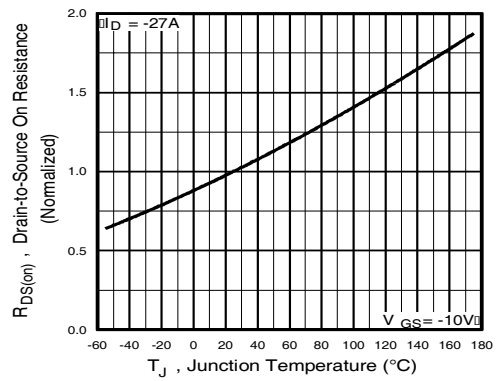


Fig 4. Normalized On-Resistance Vs. Temperature

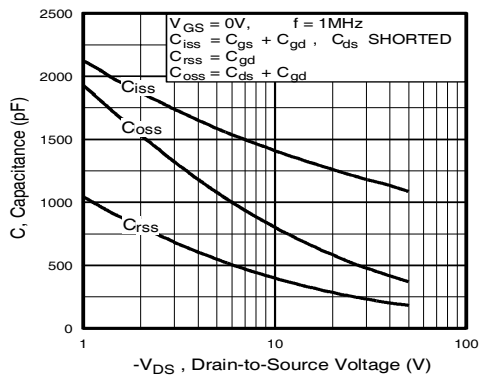


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

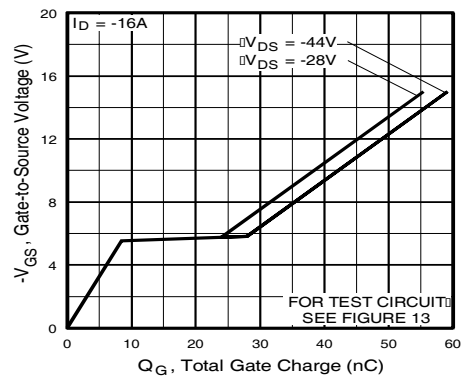
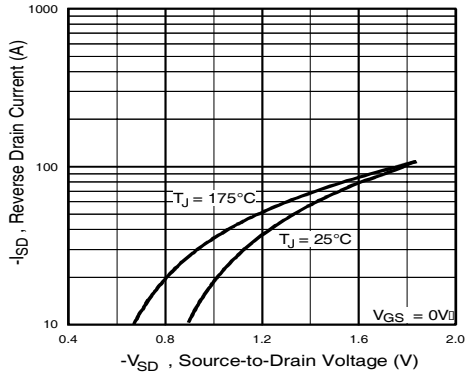
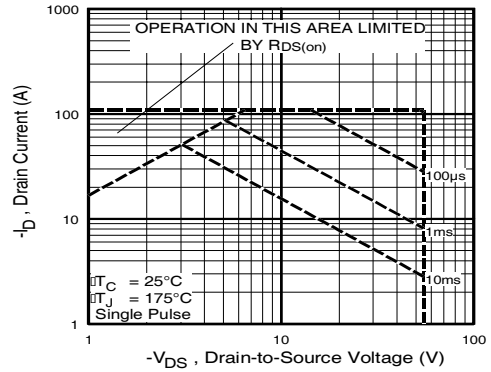


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

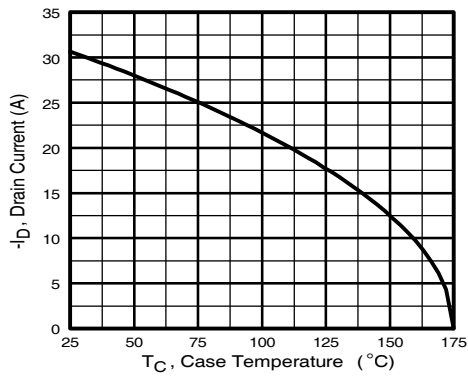
■ **TYPICAL CHARACTERISTICS** (continuous)



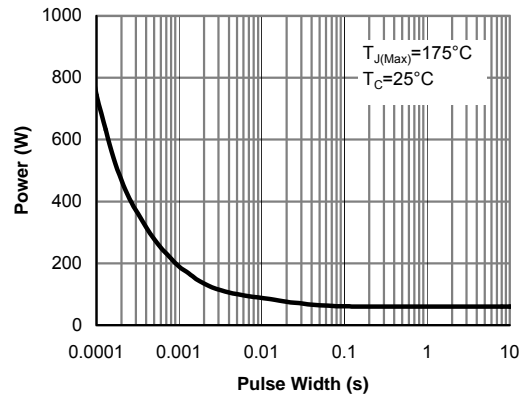
**Fig 7.** Typical Source-Drain Diode Forward Voltage



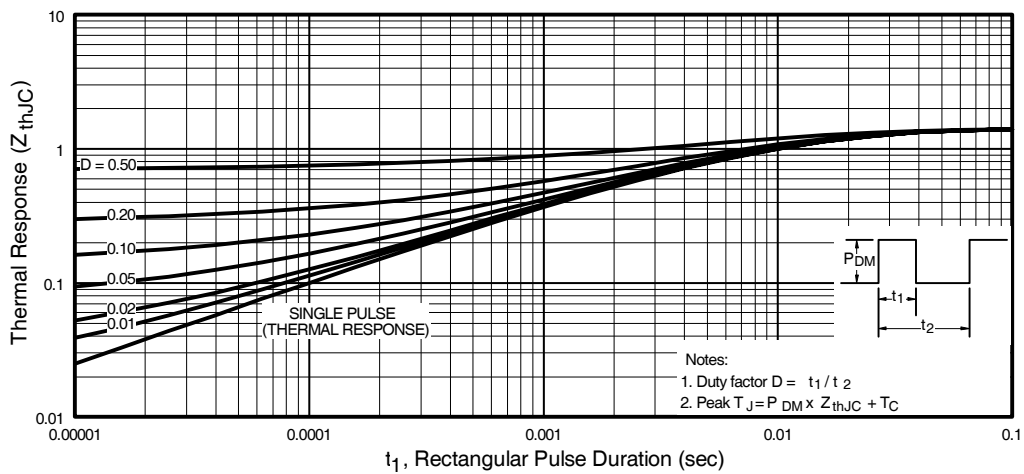
**Fig 8.** Maximum Safe Operating Area



**Fig 9.** Maximum Drain Current Vs. Case Temperature



**Figure 10:** Single Pulse Power Rating Junction-to-Case (Note F)

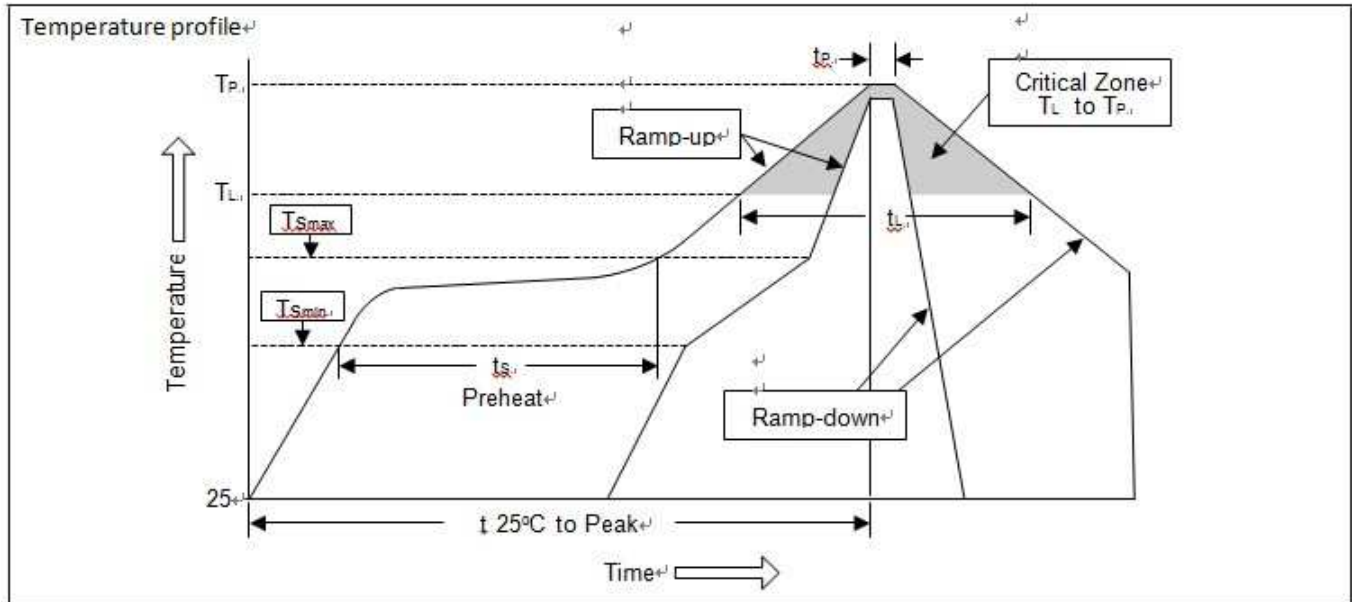




## ■ SOLDERING METHODS FOR UNIVERCHIP

Storage environment Temperature=10°C~35°C Humidity=65%±15%

Reflow soldering of surface mount device



Profile Feature	Sn-Pb Eutectic Assembly	Pb free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	<3°C/sec	<3°C/sec
Preheat		
-Temperature Min ( $T_{Smin}$ )	100°C	150°C
-Temperature Max ( $T_{Smax}$ )	150°C	200°C
-Time (min to max) ( $t_s$ )	60~120 sec	60~180 sec
$T_{Smax}$ to $T_L$		
-Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above		
-Temperature ( $T_L$ )	183°C	217°C
-Time ( $t_L$ )	60~150 sec	60~150 sec
Peak Temperature ( $T_P$ )	240°C+0/-5°C	260°C+0/-5°C
Time within 5°C of actual Peak Temperature ( $t_p$ )	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<6 minutes