

# APM2309AC-TRL-VB Datasheet

## P-Channel 30 V (D-S) MOSFET

PRODUCT SUMMARY			
V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω) Typ.	I <sub>D</sub> (A) <sup>a</sup>	Q <sub>g</sub> (Typ.)
- 30	0.046 at V <sub>GS</sub> = - 10 V	- 5.6	11.4 nC
	0.049 at V <sub>GS</sub> = - 6 V	- 5	
	0.054 at V <sub>GS</sub> = - 4.5 V	-4.5	

### FEATURES

- TrenchFET<sup>®</sup> Power MOSFET
- 100 % R<sub>g</sub> Tested



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

### APPLICATIONS

- For Mobile Computing
  - Load Switch
  - Notebook Adaptor Switch
  - DC/DC Converter



ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C, unless otherwise noted)				
Parameter	Symbol	Limit	Unit	
Drain-Source Voltage	V <sub>DS</sub>	- 30	V	
Gate-Source Voltage	V <sub>GS</sub>	± 20		
Continuous Drain Current (T <sub>J</sub> = 150 °C)	I <sub>D</sub>	T <sub>C</sub> = 25 °C	- 5.6	A
		T <sub>C</sub> = 70 °C	- 5.1	
		T <sub>A</sub> = 25 °C	- 5.4 <sup>b,c</sup>	
		T <sub>A</sub> = 70 °C	- 4.3 <sup>b,c</sup>	
Pulsed Drain Current (t = 100 μs)	I <sub>DM</sub>	- 18		
Continuous Source-Drain Diode Current	I <sub>S</sub>	T <sub>C</sub> = 25 °C	- 2.1	
		T <sub>A</sub> = 25 °C	- 1 <sup>b,c</sup>	
Maximum Power Dissipation	P <sub>D</sub>	T <sub>C</sub> = 25 °C	2.5	W
		T <sub>C</sub> = 70 °C	1.6	
		T <sub>A</sub> = 25 °C	1.25 <sup>b,c</sup>	
		T <sub>A</sub> = 70 °C	0.8 <sup>b,c</sup>	
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	- 55 to 150	°C	

THERMAL RESISTANCE RATINGS					
Parameter		Symbol	Typical	Maximum	Unit
Maximum Junction-to-Ambient <sup>b,d</sup>	t ≤ 5 s	R <sub>thJA</sub>	75	100	°C/W
Maximum Junction-to-Foot (Drain)	Steady State	R <sub>thJF</sub>	40	50	

Notes:

- Based on T<sub>C</sub> = 25 °C.
- Surface mounted on 1" x 1" FR4 board.
- t = 5 s.
- Maximum under steady state conditions is 166 °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	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$	-30			V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = -250\text{ }\mu\text{A}$		-19		mV/ $^\circ\text{C}$
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$			4		
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	-0.5		-2.0	V
Gate-Source Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}$			-1	$\mu\text{A}$
		$V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$			-5	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \leq -5\text{ V}, V_{GS} = -10\text{ V}$	-2.5			A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = -10\text{ V}, I_D = -4.4\text{ A}$		0.046		$\Omega$
		$V_{GS} = -6\text{ V}, I_D = -4\text{ A}$		0.049		
		$V_{GS} = -4.5\text{ V}, I_D = -3.6\text{ A}$		0.054		
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = -15\text{ V}, I_D = -3.4\text{ A}$		18		S
<b>Dynamic<sup>b</sup></b>						
Input Capacitance	$C_{iss}$	$V_{DS} = -15\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		1295		pF
Output Capacitance	$C_{oss}$			150		
Reverse Transfer Capacitance	$C_{rss}$			130		
Total Gate Charge	$Q_g$	$V_{DS} = -15\text{ V}, V_{GS} = -10\text{ V}, I_D = -5.4\text{ A}$		24	36	nC
				11.4	17	
Gate-Source Charge	$Q_{gs}$	$V_{DS} = -15\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -5.4\text{ A}$		3.4		
Gate-Drain Charge	$Q_{gd}$			3.8		
Gate Resistance	$R_g$	$f = 1\text{ MHz}$	1.5	7.7	15.4	$\Omega$
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -15\text{ V}, R_L = 3.5\text{ }\Omega$ $I_D \cong -4.3\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\text{ }\Omega$		13	20	ns
Rise Time	$t_r$			4	8	
Turn-Off Delay Time	$t_{d(off)}$			38	57	
Fall Time	$t_f$			6	12	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -15\text{ V}, R_L = 3.5\text{ }\Omega$ $I_D \cong -4.3\text{ A}, V_{GEN} = -4.5\text{ V}, R_g = 1\text{ }\Omega$		28	42	
Rise Time	$t_r$			16	24	
Turn-Off Delay Time	$t_{d(off)}$			30	45	
Fall Time	$t_f$			10	20	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25\text{ }^\circ\text{C}$			-2.1	A
Pulse Diode Forward Current ( $t = 100\text{ }\mu\text{s}$ )	$I_{SM}$				-80	
Body Diode Voltage	$V_{SD}$	$I_S = -4.3\text{ A}, V_{GS} = 0\text{ V}$		-0.8	-1.2	V
Body Diode Reverse Recovery Time	$t_{rr}$	$I_F = -4.3\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^\circ\text{C}$		15	23	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			7	14	nC
Reverse Recovery Fall Time	$t_a$			8		ns
Reverse Recovery Rise Time	$t_b$			7		

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** (25 °C, unless otherwise noted)



**Output Characteristics**



**Transfer Characteristics**



**On-Resistance vs. Drain Current**



**Capacitance**



**Gate Charge**



**On-Resistance vs. Junction Temperature**

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



**Source-Drain Diode Forward Voltage**



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



**Threshold Voltage**



**Single Pulse Power (Junction-to-Ambient)**

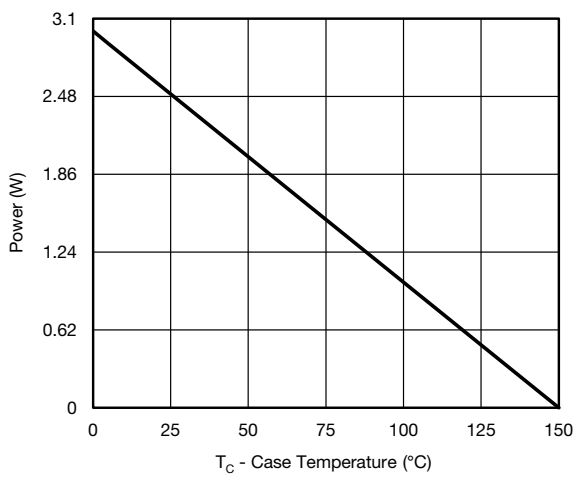


**Safe Operating Area, Junction-to-Ambient**

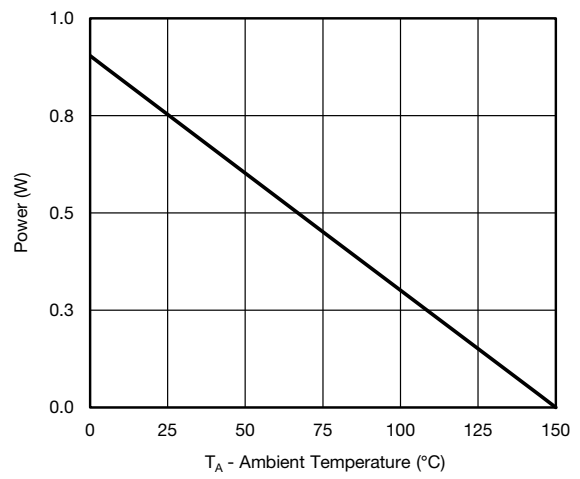
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



**Current Derating\***



**Power, Junction-to-Foot**



**Power, Junction-to-Ambient**

\* The power dissipation P<sub>D</sub> is based on T<sub>J(max.)</sub> = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

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



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



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

**SOT-23 (TO-236): 3-LEAD**



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	0.89	1.12	0.035	0.044
A <sub>1</sub>	0.01	0.10	0.0004	0.004
A <sub>2</sub>	0.88	1.02	0.0346	0.040
b	0.35	0.50	0.014	0.020
c	0.085	0.18	0.003	0.007
D	2.80	3.04	0.110	0.120
E	2.10	2.64	0.083	0.104
E <sub>1</sub>	1.20	1.40	0.047	0.055
e	0.95 BSC		0.0374 Ref	
e <sub>1</sub>	1.90 BSC		0.0748 Ref	
L	0.40	0.60	0.016	0.024
L <sub>1</sub>	0.64 Ref		0.025 Ref	
S	0.50 Ref		0.020 Ref	
q	3°	8°	3°	8°

ECN: S-03946-Rev. K, 09-Jul-01  
DWG: 5479

RECOMMENDED MINIMUM PADS FOR SOT-23



Recommended Minimum Pads  
Dimensions in Inches/(mm)



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