POWER MOSFET TRANSISTORS T-39-11

500 Volt, 1.5 Ohm N-Channel

UFN830
UFN831
UFN832
UFN833

FEATURES

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

DESCRIPTION

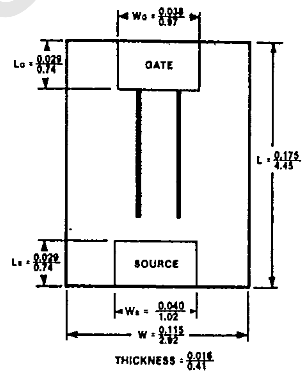
The Unitrode power MOSFET design utilizes the most advanced technology available. This efficient design achieves a very low $R_{DS(on)}$ and a high transconductance.

The Unitrode power MOSFET features all of the advantages of MOS technology such as voltage control, freedom from second breakdown, very fast switching speeds, and thermal stability.

These power MOSFETS are ideally suited for many high-speed, high-power switching applications such as switching power supplies, motor controls, and wide-band and audio amplifiers.

PRODUCT SUMMARY

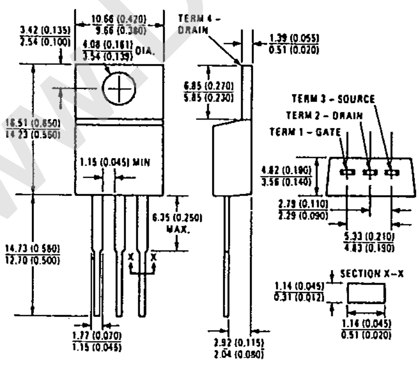
Part Number	V_{DS}	$R_{DS(on)}$	I_D
UFN830	500V	1.5Ω	4.5A
UFN831	450V	1.5Ω	4.5A
UFN832	500V	2.0Ω	4.0A
UFN833	450V	2.0Ω	4.0A



FN-3

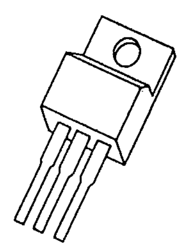
MECHANICAL SPECIFICATIONS

UFN830 UFN831 UFN832 UFN833



Dimensions in Millimeters and (Inches)

TO-220AB



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UFN830 UFN831 UFN832 UFN833

T-39-11

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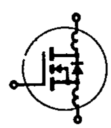
ABSOLUTE MAXIMUM RATINGS

	Parameter	UFN830	UFN831	UFN832	UFN833	Units
V_{DS}	Drain - Source Voltage ①	500	450	500	450	V
V_{DGR}	Drain - Gate Voltage (R_{GS} = 1 MΩ) ①	500	450	500	450	V
I_D @ T_C = 25°C	Continuous Drain Current	4.5	4.5	4.0	4.0	A
I_D @ T_C = 100°C	Continuous Drain Current	3.0	3.0	2.5	2.5	A
I_{DM}	Pulsed Drain Current ③	18	18	16	16	A
V_{GS}	Gate - Source Voltage	± 20				V
P_D @ T_C = 25°C	Max. Power Dissipation	75 (See Fig. 14)				W
	Linear Derating Factor	0.6 (See Fig. 14)				W/K
I_{LM}	Inductive Current, Clamped (See Fig. 15 and 16) L = 100μH	18	18	16	16	A
T_J, T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150				°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				°C

ELECTRICAL CHARACTERISTICS @ T_C = 25°C (Unless otherwise specified)

	Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain - Source Breakdown Voltage	UFN830 UFN832	500	–	–	V	V_{GS} = 0V
		UFN831 UFN833	450	–	–	V	I_D = 250μA
$V_{GS(th)}$	Gate Threshold Voltage	ALL	2.0	–	4.0	V	V_{DS} = V_{GS}, I_D = 250μA
I_{GSS}	Gate-Source Leakage Forward	ALL	–	–	500	nA	V_{GS} = 20V
I_{GSS}	Gate-Source Leakage Reverse	ALL	–	–	-500	nA	V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	ALL	–	–	250	μA	V_{DS} = Max. Rating, V_{GS} = 0V
			–	–	1000	μA	V_{DS} = Max. Rating x 0.8, V_{GS} = 0V, T_C = 125°C
$I_{D(on)}$	On-State Drain Current ②	UFN830 UFN831	4.5	–	–	A	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., V_{GS} = 10V
		UFN832 UFN833	4.0	–	–	A	
$R_{DS(on)}$	Static Drain-Source On-State Resistance ②	UFN830 UFN831	–	1.3	1.5	Ω	V_{GS} = 10V, I_D = 2.5A
		UFN832 UFN833	–	1.5	2.0	Ω	
g_{fs}	Forward Transconductance ②	ALL	2.5	3.25	–	S (℧)	$V_{DS} > I_{D(on)} \times R_{DS(on)}$ max., I_D = 2.5A
C_{iss}	Input Capacitance	ALL	–	600	800	pF	V_{GS} = 0V, V_{DS} = 25V, f = 1.0 MHz See Fig. 10
C_{oss}	Output Capacitance	ALL	–	100	200	pF	
C_{rss}	Reverse Transfer Capacitance	ALL	–	30	60	pF	
$t_{d(on)}$	Turn-On Delay Time	ALL	–	–	30	ns	V_{DD} = 225V, I_D = 2.5A, Z_o = 15Ω See Fig. 17 (MOSFET switching times are essentially independent of operating temperature.)
t_r	Rise Time	ALL	–	–	30	ns	
$t_{d(off)}$	Turn-Off Delay Time	ALL	–	–	55	ns	
t_f	Fall Time	ALL	–	–	30	ns	
Q_g	Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	–	22	30	nC	V_{GS} = 10V, I_D = 6.0A, V_{DS} = 0.8 Max. Rating. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs}	Gate-Source Charge	ALL	–	11	–	nC	
Q_{gd}	Gate-Drain ("Miller") Charge	ALL	–	11	–	nC	
L_D	Internal Drain Inductance	ALL	–	3.5	–	nH	Measured from the contact screw on tab to center of die.
			–	4.5	–	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S	Internal Source Inductance	ALL	–	7.5	–	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.

Modified MOSFET symbol showing the internal device inductances.



THERMAL RESISTANCE

R_{thJC}	Junction-to-Case	ALL	–	–	1.67	K/W	
R_{thCS}	Case-to-Sink	ALL	–	1.0	–	K/W	Mounting surface flat, smooth, and greased.
R_{thJA}	Junction-to-Ambient	ALL	–	–	80	K/W	Free Air Operation

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UFN830 UFN831 UFN832 UFN833

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SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

I_S	Continuous Source Current (Body Diode)	UFN830 UFN831	–	–	4.5	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier. 
		UFN832 UFN833	–	–	4.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	UFN830 UFN831	–	–	18	A	
		UFN832 UFN833	–	–	16	A	
V_{SD}	Diode Forward Voltage ②	UFN830 UFN831	–	–	1.6	V	$T_C = 25°C, I_S = 4.5A, V_{GS} = 0V$
		UFN832 UFN833	–	–	1.5	V	$T_C = 25°C, I_S = 4.0A, V_{GS} = 0V$
t_{rr}	Reverse Recovery Time	ALL	–	800	–	ns	$T_J = 150°C, I_F = 4.5A, dI_F/dt = 100\ A/\mu s$
Q_{RR}	Reverse Recovered Charge	ALL	–	4.6	–	μC	$T_J = 150°C, I_F = 4.5A, dI_F/dt = 100\ A/\mu s$
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.				

① T_J = 25°C to 150°C. ② Pulse Test: Pulse width ≤ 300μs, Duty Cycle ≤ 2%. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

Fig. 1 — Typical Output Characteristics

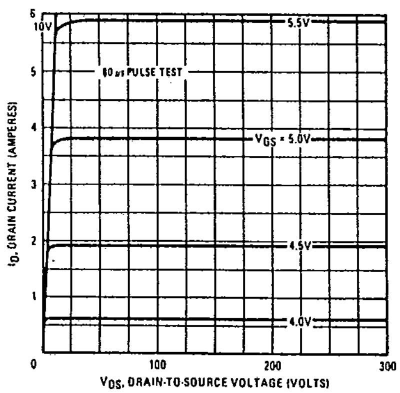

Fig. 2 — Typical Transfer Characteristics

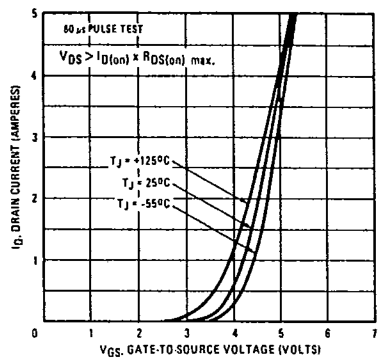

Fig. 3 — Typical Saturation Characteristics

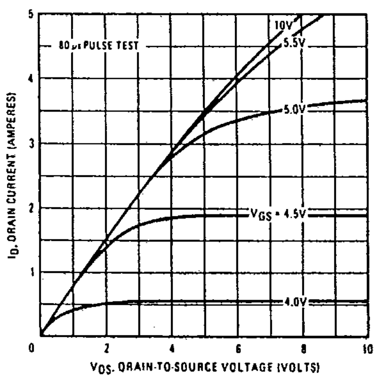

Fig. 4 — Maximum Safe Operating Area

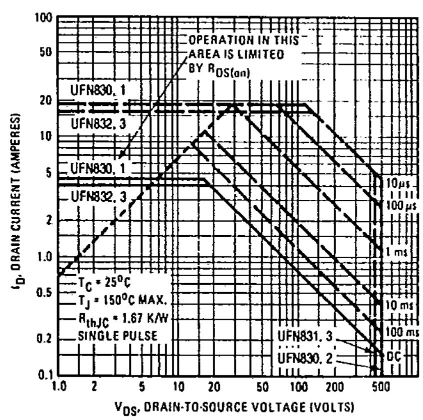

Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

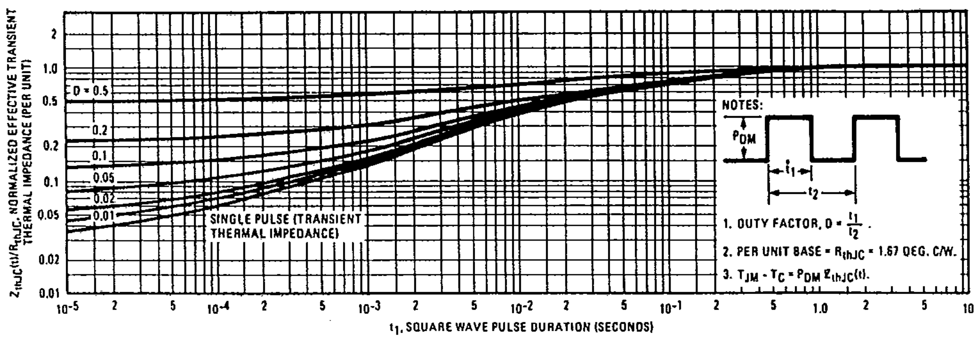

Fig. 6 – Typical Transconductance Vs. Drain Current

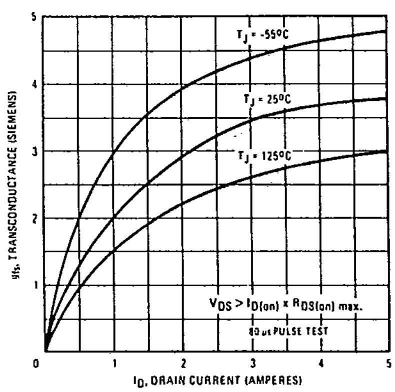

Fig. 7 – Typical Source-Drain Diode Forward Voltage

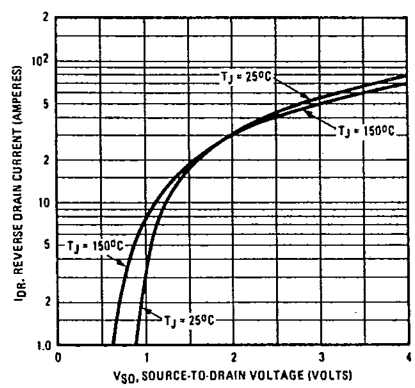

Fig. 8 – Breakdown Voltage Vs. Temperature

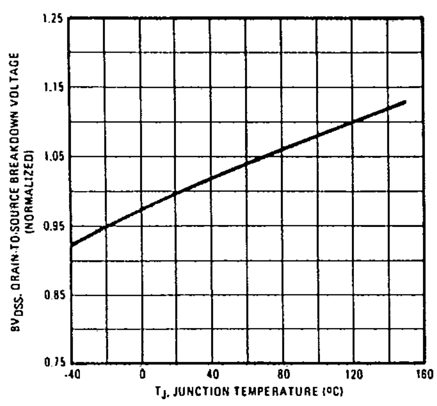

Fig. 9 – Normalized On-Resistance Vs. Temperature

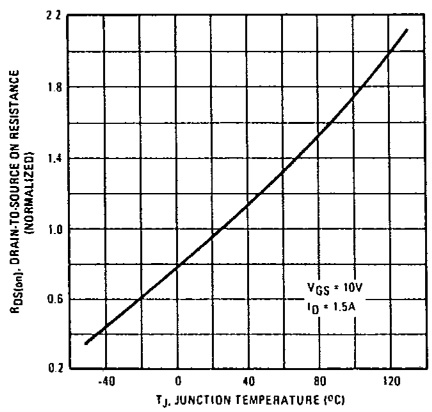

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Fig. 10 – Typical Capacitance Vs. Drain-to-Source Voltage

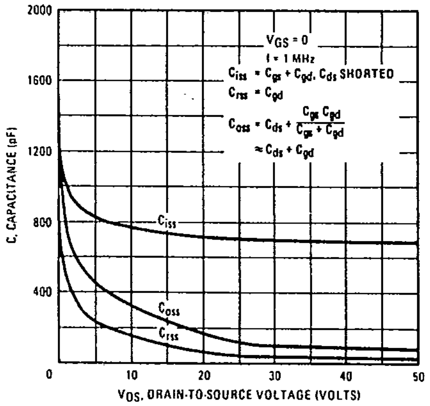


Fig. 11 – Typical Gate Charge Vs. Gate-to-Source Voltage

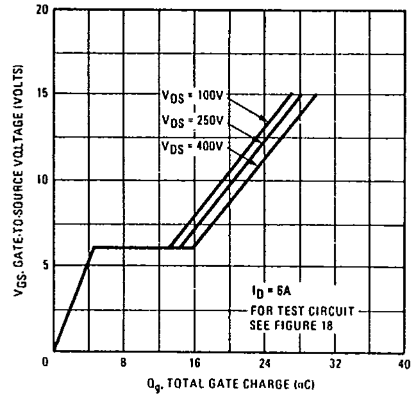


Fig. 12 – Typical On-Resistance Vs. Drain Current

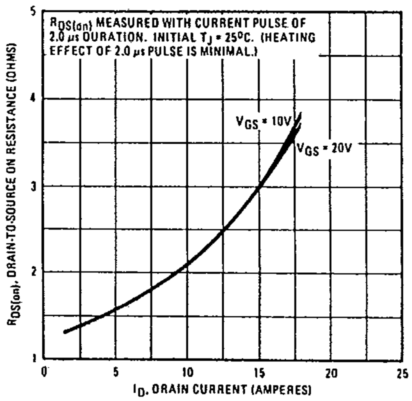


Fig. 13 – Maximum Drain Current Vs. Case Temperature

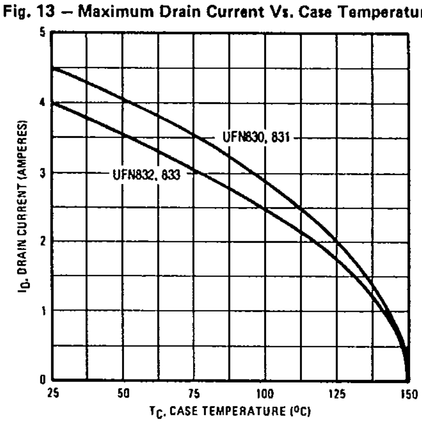


Fig. 14 – Power Vs. Temperature Derating Curve

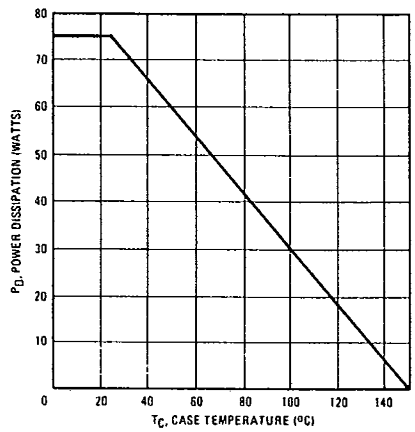


Fig. 15 — Clamped Inductive Test Circuit

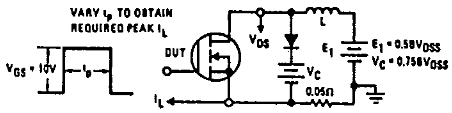


Fig. 16 — Clamped Inductive Waveforms

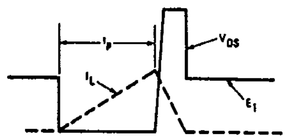


Fig. 17 — Switching Time Test Circuit

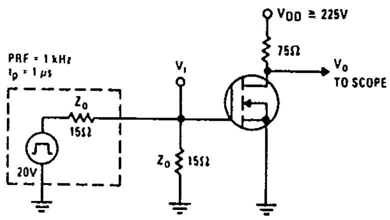
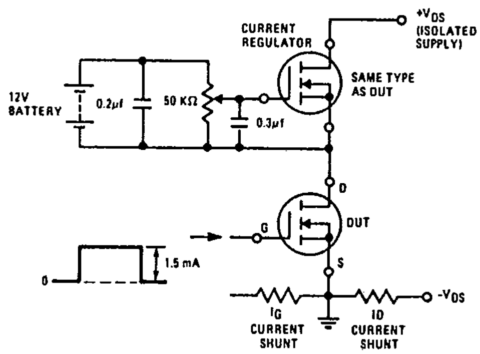


Fig. 18 — Gate Charge Test Circuit



TO-220 PACKAGE MOUNTING AND THERMAL CONSIDERATIONS

TH-1

T-90-20

The leads of the TO-220 rectifiers and Schottky diodes may be formed, but they are not intended to be flexible or ductile enough for unrestrained lead wrapping.

The figures show the typical device and hardware recommended. Several typical configurations of lead forming are illustrated.

The advantages of mounting the flange to the printed circuit board is that improved thermal heat transfer allows operating at higher levels of power dissipation. The individual specification sheets give the safe operating area as a function of a case temperature.

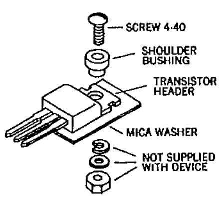


Figure A. Device and Hardware for Insulated Mounting.

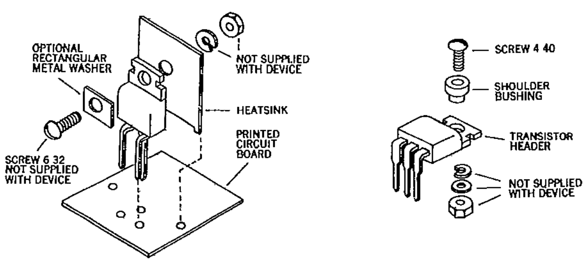


Figure B. Two Alternative Configurations for Axial Strain Relief and Electrical Isolation.

BENDING THE LEADS

Whenever the leads of the T-220 are to be formed, whether by a special fixture or by the use of long-nosed pliers, several important considerations must be followed. Internal damage to the device or lead damage may result if any or all of these precautions are not considered.

1. Minimum bend distance between the plastic body and the bend is ⅛ inch.
2. The minimum radius of the bend is 1/16 inch.
3. Avoid repeating bending at the same flexure point.
4. Whenever possible, use one of the lead forming configurations which relieve strain induced by mechanical or thermal loads.
5. Leads should not be bent greater than 90 degrees.
6. Avoid axial pulling or bending that would induce axial strain. The maximum axial component is 4 pounds.
7. Forming fixtures or pliers should not touch the plastic case because axial strain of ≅.005" could cause irreversible internal damage.
8. The leads must be fully restrained during the lead forming operation to prevent relative movement between the body and the leads.

SOLDERING INTO THE CIRCUIT

The leads on the TO-220 are solderable; however, there are a few precautions that must be observed.

1. Soldering temperature must not exceed 270°C.
2. Maximum soldering temperature must not be applied for more than 5 seconds.
3. Maximum soldering temperature should not be applied closer than ⅛ inch from the plastic body of the device.

TO-220 PACKAGE MOUNTING AND THERMAL CONSIDERATIONS

MOUNTING THE FLANGE

Flange mounting is recommended for maximum power handling applications. A 6-32 machine screw is recommended. Eyeletting (hollow rivet) is acceptable if care is taken not to distort the flange. For insulated mount, a 4-40 screw and a shoulder bushing is recommended (see figure). Suggested material for bushings are: Diallphthalate, fiber-glass-filled nylon, or fiber-glass-filled polycarbonate. Note unfilled nylon should be avoided. The flange should not be directly soldered because the use of lead-tin could produce temperatures in excess of the maximum storage temperature. See the individual specification for the device.

Check list and summary for flange mounting:

1. Use recommended hardware.
2. Always fasten the flange prior to lead soldering.
3. Do not allow the forming tool to come in contact with the plastic body.
4. Maximum mounting torque is 8 inch-pounds.
5. Avoid modifying the flange by machining and do not use oversized screws.
6. Provide axial and transverse strain relief of the leads.
7. Use recommended insulation bushings. Avoid materials that exhibit hot-creep problems.

Thermal Considerations TO-220 Power Diodes

Thermal Resistance, Case to Ambient;
Free Air, No Heatsink .... 60°C/W typical
Thermal Capacitance
of Package .... 4.8 watt-seconds/°C
Thermal Time Constant .... 305 seconds

Device Type	$I_{F\,(AV)}$	Thermal Resistance Junction Case °C/W
UES1401-4	8	2.5
UES1501-4	16	1.5
USD635-50	6	3.0
USD835-50	12	2.4
USD935-50	16	2.0

Note: When using a 2 mil MICA washer for electrical isolation, add 0.4°C/W to heatsink thermal resistance.

Thermal joint compound should be used at the interface of the TO-220 flange and the heatsink to which it is attached.

Consider a TO-220 power rectifier with a thermal resistance junction to case of 1.5°C/W. The junction temperature produced depends upon the mounting conditions and power dissipated in the circuit. The table shows junction temperature resulting from 15W of dissipation when mounted on an infinite heatsink at 100°C with different methods of interfacing.

Interface Condition Between Case and Heatsink	Thermal Resistance Case-Heatsink °C/W	Junction Temperature °C
Assumed direct, ideal metallic contact (no interference)	0.0	122
1 mil air gap*	1.2	140
Thermal compound; Tab screw torqued at 8 inch-pound	0.09	124
2 mil mica washer with thermal compound applied to both surfaces; tab screw torqued at 8 inch pound	0.58	131

* A film of air one mil in length has the thermal resistance of ≃ 1.2°C/W.

When using a small heat sink in free air one must consider the additional thermal resistance of the heat sink to ambient and operate at an appropriate power level. For example with an 18°C/W rated sink and thermal compound as above the device will have a junction temperature of 123°C when operating at 5W in an ambient of 25°C free air.

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