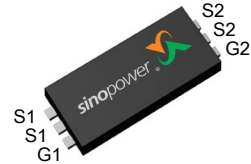


Dual N-Channel Enhancement Mode MOSFET

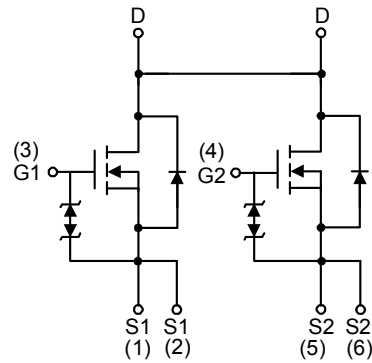
Features

- 20V/8A,
 $R_{DS(ON)} = 17.5m\Omega$ (Max.) @ $V_{GS} = 4.5V$
 $R_{DS(ON)} = 18.5m\Omega$ (Max.) @ $V_{GS} = 4V$
 $R_{DS(ON)} = 22m\Omega$ (Max.) @ $V_{GS} = 3.1V$
 $R_{DS(ON)} = 27.5m\Omega$ (Max.) @ $V_{GS} = 2.5V$
- Reliable and Rugged
- Lead Free and Green Devices Available
(RoHS Compliant)

Pin Description



Top View of TDFN2x5-6



N-Channel MOSFET

Applications

- Power Management in Notebook Computer, Portable Equipment and Battery Powered Systems.

Ordering and Marking Information

APM9988 □□□-□□□ Assembly Material Handling Code Temperature Range Package Code	Package Code QB : TDFN2x5-6 Operating Junction Temperature Range C : -55 to 150 °C Handling Code TR : Tape & Reel (3000ea/reel) Assembly Material G : Halogen and Lead Free Device
APM9988 QB : APM9988 XXXXX	XXXXX - Lot Code

Note: SINOPOWER lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. SINOPOWER lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020D for MSL classification at lead-free peak reflow temperature. SINOPOWER defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

SINOPOWER reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
V _{DSS}	Drain-Source Voltage		20	V
V _{GSS}	Gate-Source Voltage		±12	
I _D	Continue Drain Current	V _{GS} =4.5V	8**	A
I _{DM}	300μs Pulsed Drain Current		40	
I _S	Diode continuous forward current		1.5	A
T _J	Maximum Junction Temperature		150	°C
T _{STG}	Storage Temperature Range		-55 to 150	
P _D	Maximum Power Dissipation	T _A =25°C	3.5	W
		T _A =85°C	1.8	
R _{θJA} *	Thermal Resistance-Junction to Ambient		36	°C/W
R _{θJC} *	Thermal Resistance-Junction to Case		5.6	°C/W

Note : *Surface Mounted on 1in² pad area, $t \leq 10sec$.

** Current limited by bond wire.

Electrical Characteristics ($T_A = 25^{\circ}C$ Unless Otherwise Noted)

Symbol	Parameter	Test Conditions	APM9988QB			Unit
			Min.	Typ.	Max.	
Static Characteristics						
BV _{DSS}	Drain-Source Breakdown Voltage	V _{GS} =0V, I _{DS} =250μA	20	-	-	V
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} =16V, V _{GS} =0V	-	-	1	μA
		T _J =85°C	-	-	30	
V _{GS(th)}	Gate Threshold Voltage	V _{DS} =V _{GS} , I _{DS} =250μA	0.5	0.7	1	V
I _{GSS}	Gate Leakage Current	V _{GS} =±10V, V _{DS} =0V	-	-	±10	μA
R _{DS(ON)} ^a	Drain-Source On-state Resistance	V _{GS} =4.5V, I _{DS} =4A	10.5	12.5	17.5	mΩ
		V _{GS} =4V, I _{DS} =4A	11	13	18.5	
		V _{GS} =3.1V, I _{DS} =4A	11.5	14.5	22	
		V _{GS} =2.5V, I _{DS} =4A	15	18	27.5	
Diode Characteristics						
V _{SD} ^a	Diode Forward Voltage	I _{SD} =1.5A, V _{GS} =0V	-	0.7	1.3	V
t _{rr}	Reverse Recovery Time	I _{SD} =4A, dI _{SD} /dt=100μs	-	15	-	nS
Q _{rr}	Reverse Recovery Charge		-	7	-	nC

Electrical Characteristics (Cont.) (T_A = 25°C Unless Otherwise Noted)

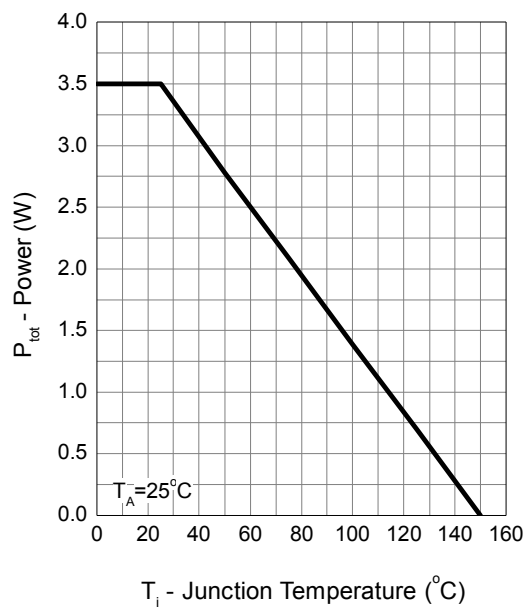
Symbol	Parameter	Test Conditions	APM9988QB			Unit
			Min.	Typ.	Max.	
Dynamic Characteristics ^b						
R _G	Gate Resistance	V _{GS} =0V,V _{DS} =0V,F=1MHz	-	4	-	Ω
C _{iss}	Input Capacitance	V _{GS} =0V, V _{DS} =10V, Frequency=1.0MHz	-	950	-	pF
C _{oss}	Output Capacitance		-	175	-	
C _{rss}	Reverse Transfer Capacitance		-	150	-	
t _{d(ON)}	Turn-on Delay Time	V _{DD} =10V, R _L =10Ω, I _{DS} =1A, V _{GEN} =4.5V, R _G =6Ω	-	6	12	ns
t _r	Turn-on Rise Time		-	11	21	
t _{d(OFF)}	Turn-off Delay Time		-	48	87	
t _f	Turn-off Fall Time		-	21	39	
Gate Charge Characteristics ^b						
Q _g	Total Gate Charge	V _{DS} =10V, V _{GS} =4.5V, I _{DS} =4A	-	13.5	-	nC
Q _{gs}	Gate-Source Charge		-	1.5	-	
Q _{gd}	Gate-Drain Charge		-	4.5	-	

Note a : Pulse test ; pulse width≤300μs, duty cycle≤2%.

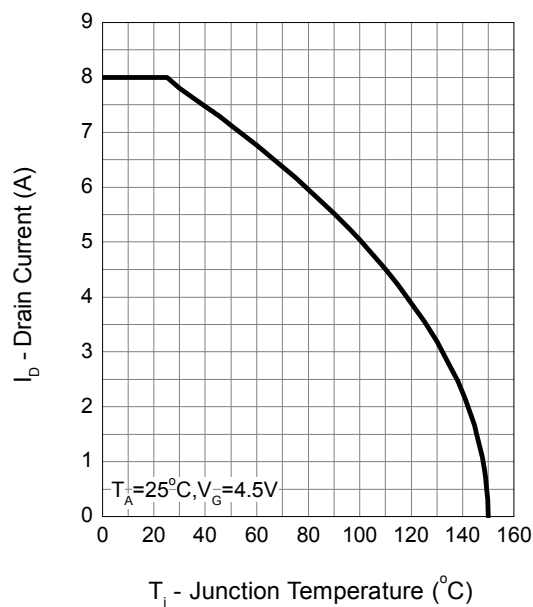
Note b : Guaranteed by design, not subject to production testing.

Typical Operating Characteristics

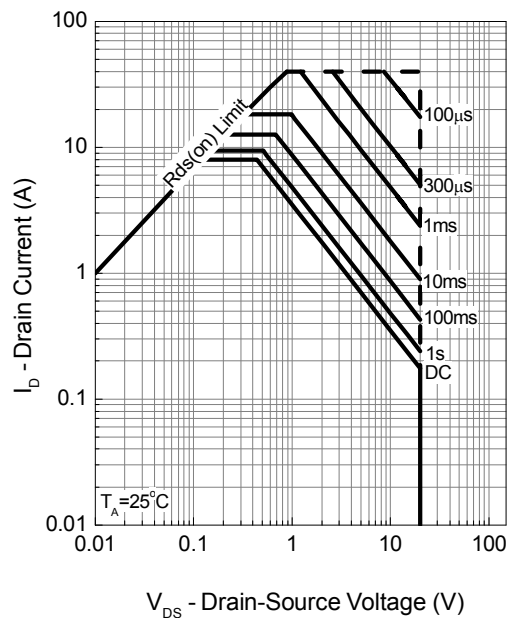
Power Dissipation



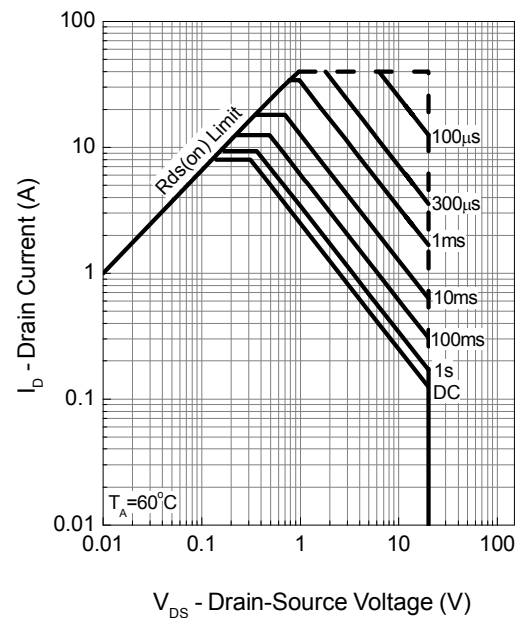
Drain Current



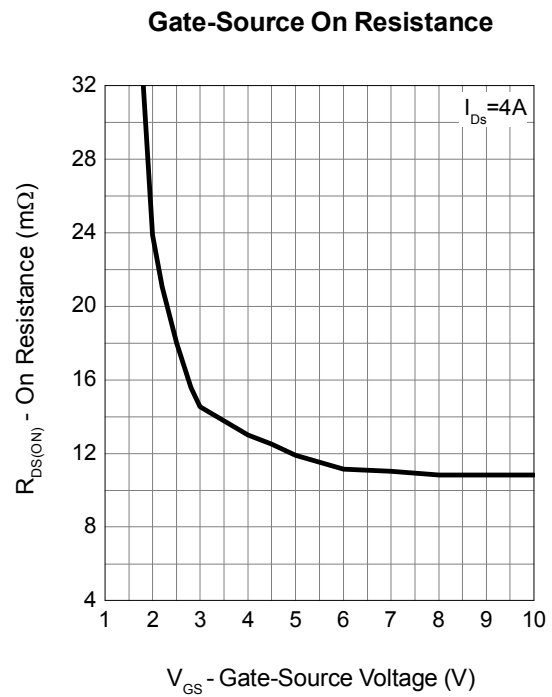
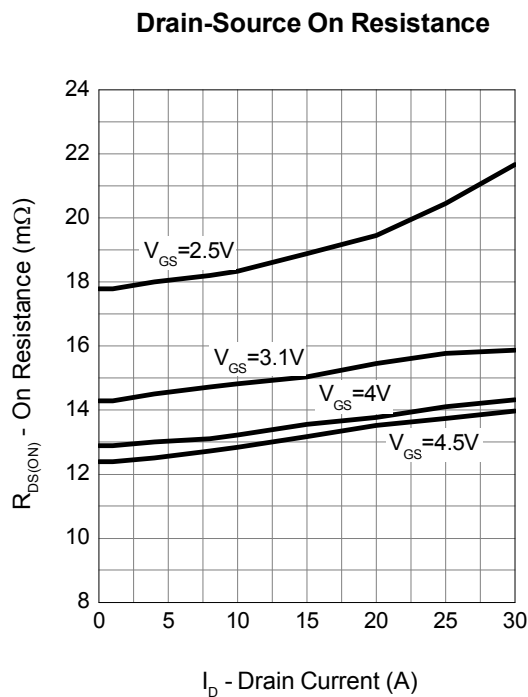
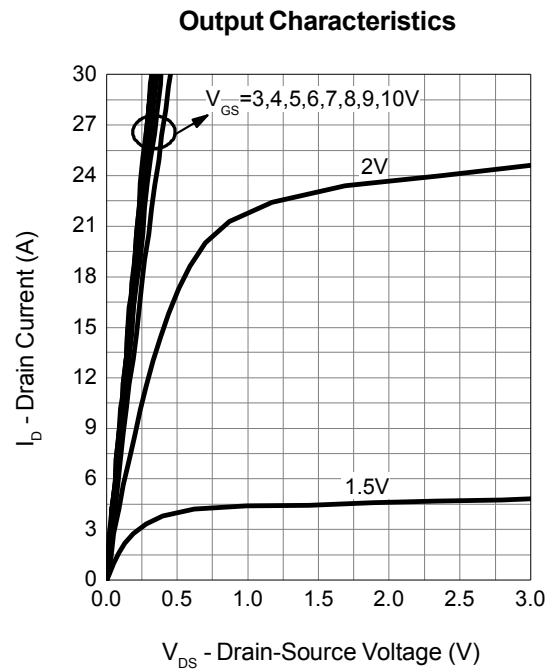
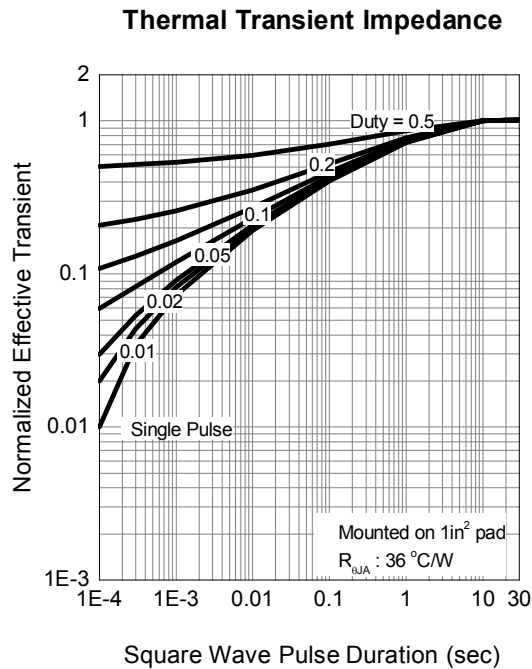
Safe Operation Area ($T_A = 25^{\circ}\text{C}$)



Safe Operation Area ($T_A = 60^{\circ}\text{C}$)

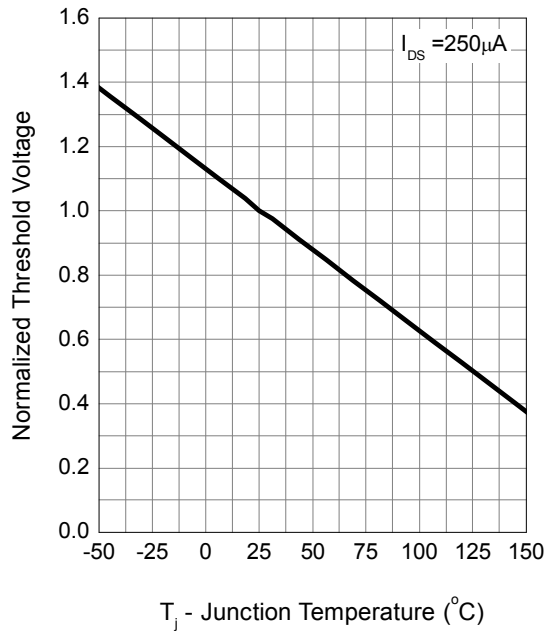


Typical Operating Characteristics (Cont.)

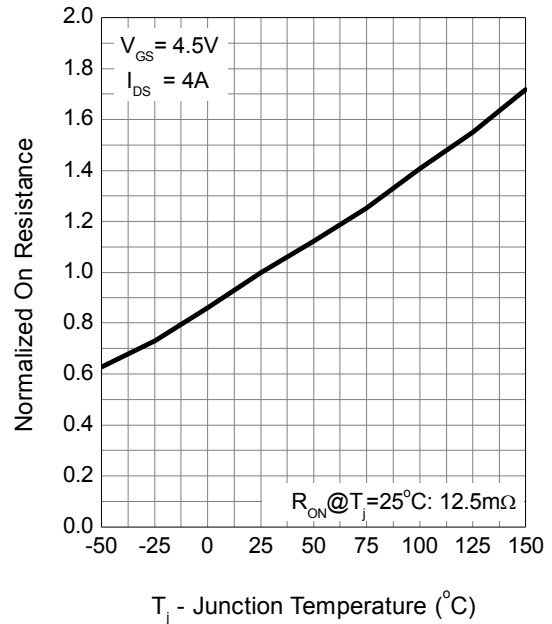


Typical Operating Characteristics (Cont.)

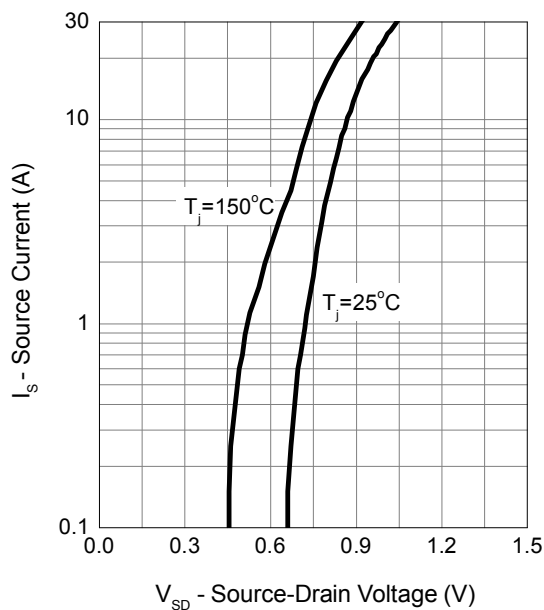
Gate Threshold Voltage



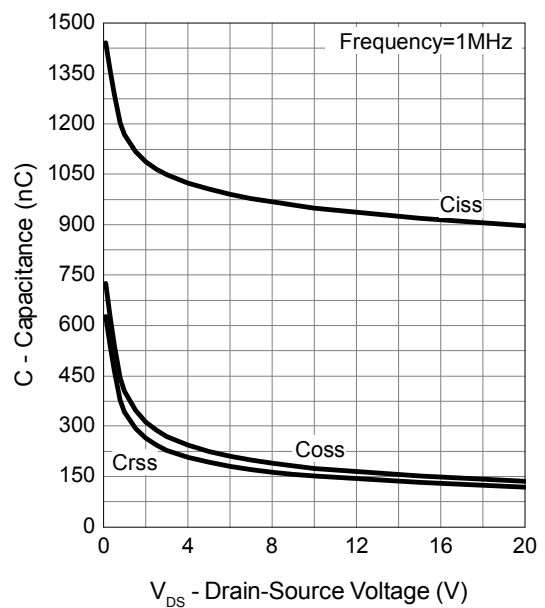
Drain-Source On Resistance



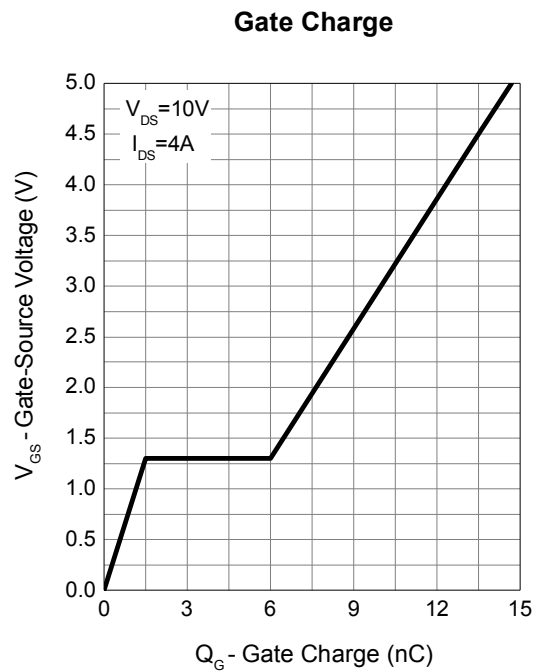
Source-Drain Diode Forward



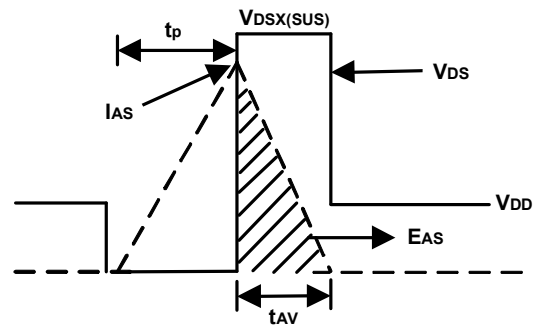
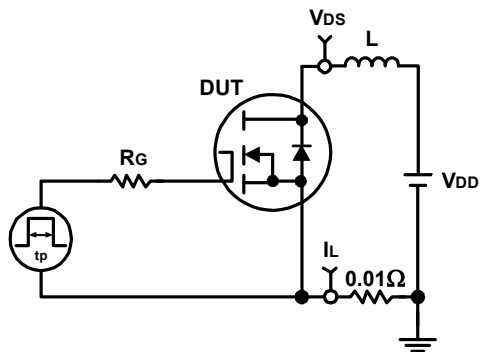
Capacitance



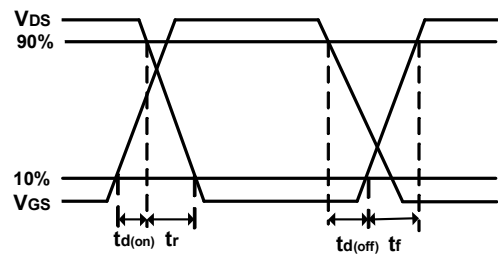
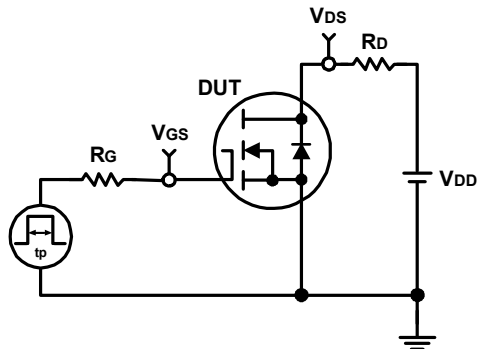
Typical Operating Characteristics (Cont.)



Avalanche Test Circuit and Waveforms

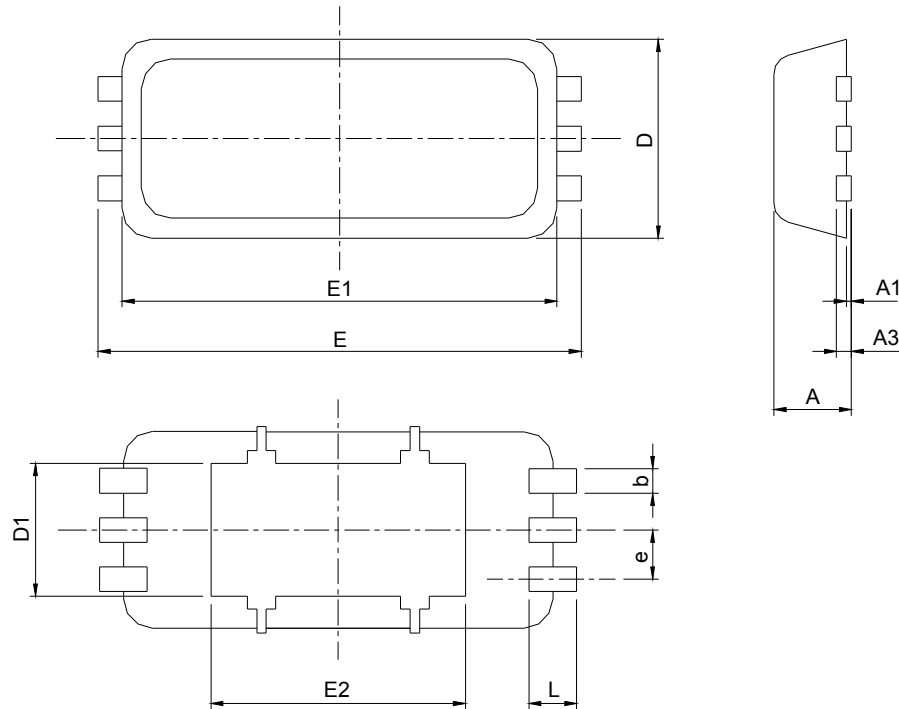


Switching Time Test Circuit and Waveforms



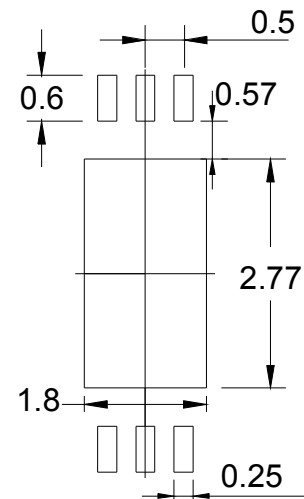
Package Information

TDFN2x5-6



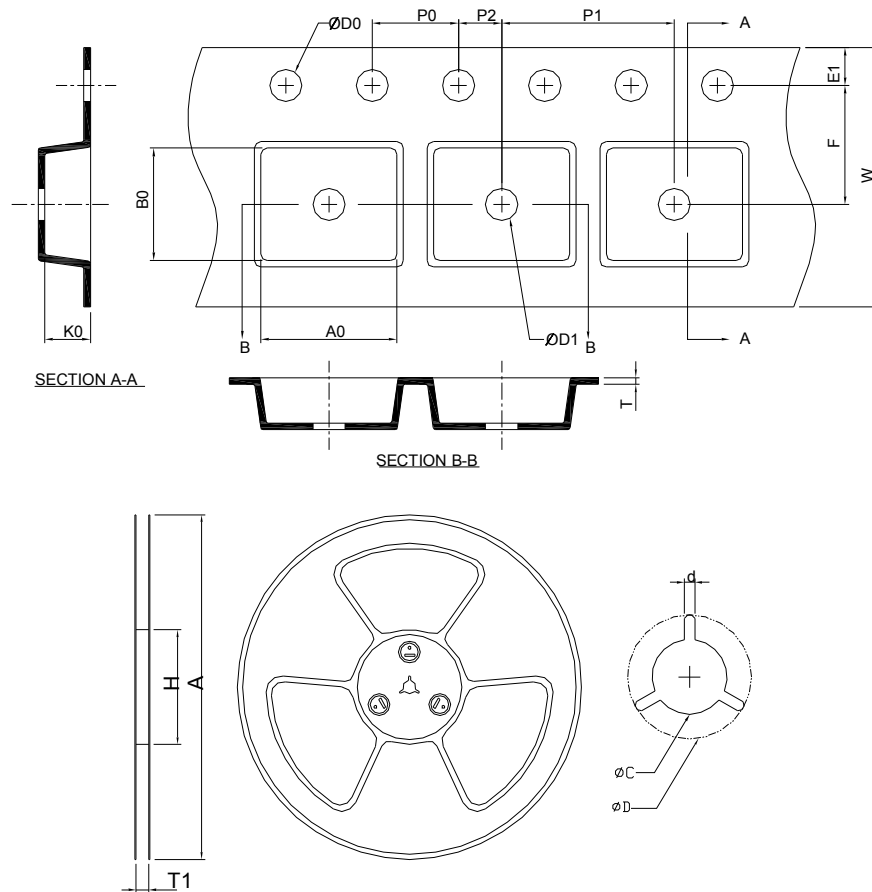
SYMBOL	TDFN2x5-6			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
A3	0.10	0.20	0.004	0.008
b	0.20	0.30	0.008	0.012
D	1.90	2.10	0.075	0.083
D1	1.30	1.55	0.051	0.061
E	4.80	5.20	0.189	0.205
E1	4.40	4.60	0.173	0.181
E2	2.60	2.95	0.102	0.116
e	0.50 BSC		0.020 BSC	
L	0.40	0.60	0.016	0.024

RECOMMENDED LAND PATTERN



UNIT: mm

Carrier Tape & Reel Dimensions

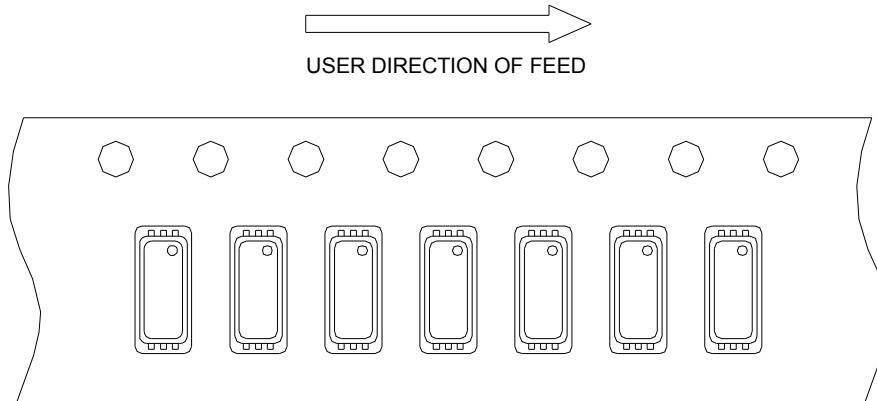


Application	A	H	T1	C	d	D	W	E1	F
TDFN2x5-6	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.20	1.75±0.10	5.5±0.10
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.0±0.10	4.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	2.41±0.20	5.34±0.20	1.10±0.20

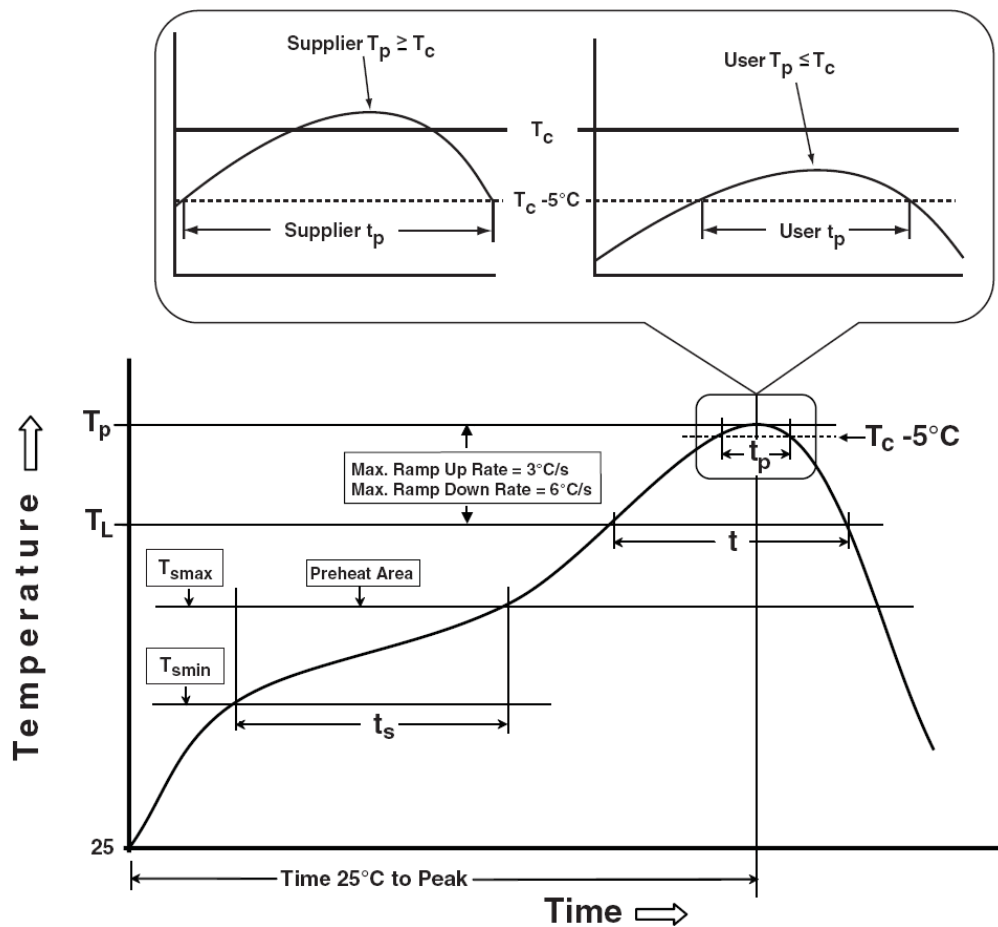
(mm)

Taping Direction Information

TDFN2x5-6



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_p)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HTRB	JESD-22, A108	1000 Hrs, 80% of VDS max @ T_{jmax}
HTGB	JESD-22, A108	1000 Hrs, 100% of VGS max @ T_{jmax}
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C

Customer Service

Sinopower Semiconductor, Inc.

5F, No. 6, Dusing 1st Rd., Hsinchu Science Park,
Hsinchu, 30078, Taiwan
TEL: 886-3-5635818 Fax: 886-3-5642050