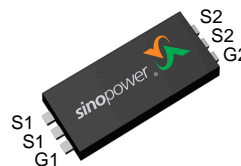


Dual N-Channel Enhancement Mode MOSFET

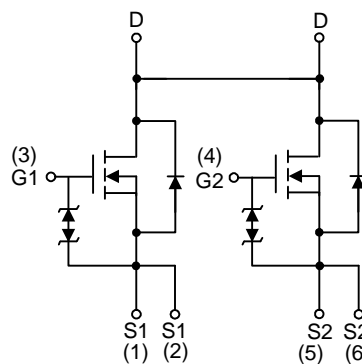
Features

- 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.) @ $V_{GS}=2.5V$
- Super High Dense Cell Design
- 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

| | |
|--|--|
| <p>APM9988 □□□-□□□</p> <ul style="list-style-type: none"> □□□ — Assembly Material □□ — Handling Code □ — Temperature Range □ — Package Code | <p>Package Code QB : TDFN2x5-6</p> <p>Operating Junction Temperature Range C : -55 to 150 °C</p> <p>Handling Code TR : Tape & Reel</p> <p>Assembly Material G : Halogen and Lead Free Device</p> |
| <p>APM9988 QB : • APM9988 XXXXX</p> | <p>XXXXX - Date Code</p> |

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 | 8** | A | |
| I_{DM} | 300 μ s Pulsed Drain Current | | | 40 |
| I_S | Diode continuous forward current | 1.5 | A | |
| T_J | Maximum Junction Temperature | 150 | $^{\circ}$ C | |
| T_{STG} | Storage Temperature Range | -55 to 150 | | |
| P_D | Maximum Power Dissipation | $T_A=25^{\circ}$ C | 3.5 | W |
| | | $T_A=85^{\circ}$ C | 1.8 | |
| $R_{\theta JA}^*$ | Thermal Resistance-Junction to Ambient | 36 | $^{\circ}$ C/W | |
| $R_{\theta JC}^*$ | Thermal Resistance-Junction to Case | 5.6 | $^{\circ}$ 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 | $V_{GS}=0V, I_{DS}=250\mu A$ | 20 | - | - | V |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS}=16V, V_{GS}=0V$ $T_J=85^{\circ}$ C | - | - | 1 | μ A |
| | | | - | - | 30 | |
| $V_{GS(th)}$ | Gate Threshold Voltage | $V_{DS}=V_{GS}, I_{DS}=250\mu A$ | 0.5 | 0.7 | 1 | V |
| I_{GSS} | Gate Leakage Current | $V_{GS}=\pm 10V, V_{DS}=0V$ | - | - | ± 10 | μ A |
| $R_{DS(ON)}^a$ | Drain-Source On-state Resistance | $V_{GS}=4.5V, I_{DS}=4A$ | 10.5 | 12.5 | 17.5 | m Ω |
| | | $V_{GS}=4V, I_{DS}=4A$ | 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 | $I_{SD}=4A, di_{SD}/dt=100\mu s$ | - | 15 | - | nS |
| Q_{rr} | Reverse Recovery Charge | | - | 7 | - | nC |

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

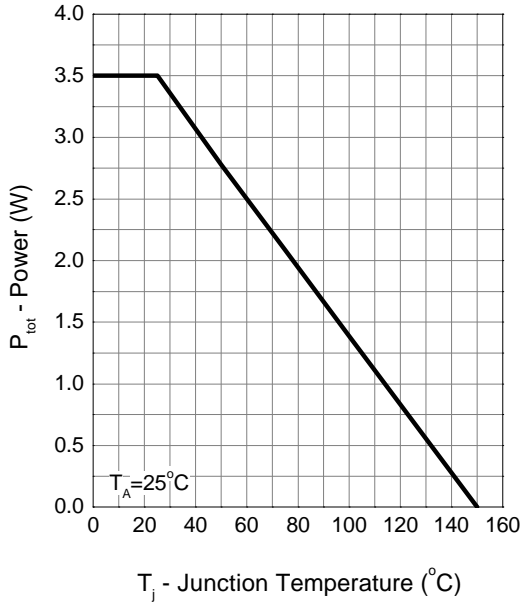
| Symbol | Parameter | Test Conditions | APM9988QB | | | Unit |
|--|------------------------------|--|-----------|------|------|----------|
| | | | Min. | Typ. | Max. | |
| Dynamic Characteristics^b | | | | | | |
| R_G | Gate Resistance | $V_{GS}=0V, V_{DS}=0V, F=1\text{MHz}$ | - | 4 | - | Ω |
| C_{iss} | 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 | $V_{DD}=10V, R_L=10\Omega,$ $I_{DS}=1A, V_{GEN}=4.5V,$ $R_G=6\Omega$ | - | 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 $\leq 300\mu\text{s}$, duty cycle $\leq 2\%$.

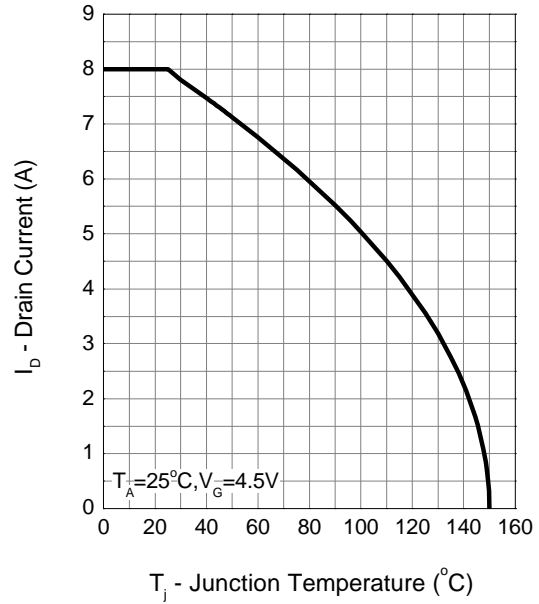
Note b : Guaranteed by design, not subject to production testing.

Typical Operating Characteristics

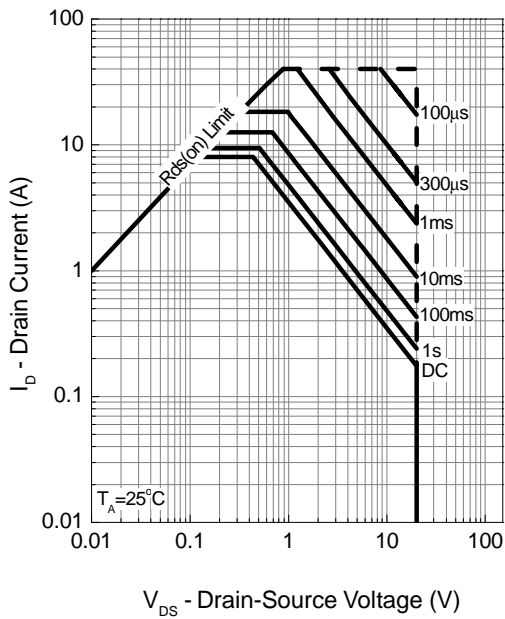
Power Dissipation



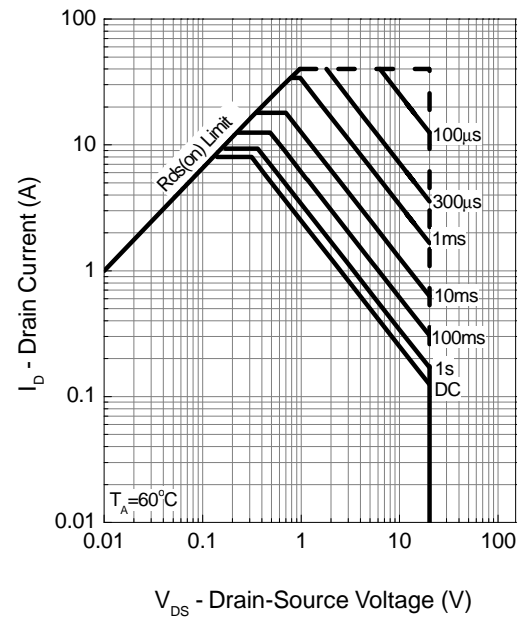
Drain Current



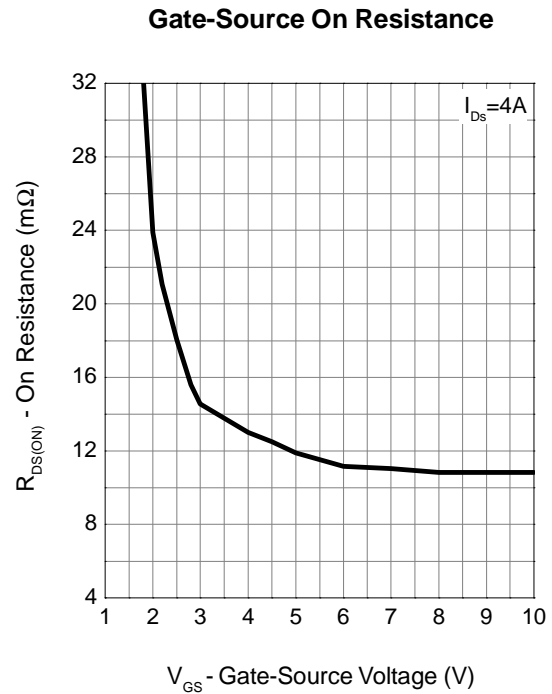
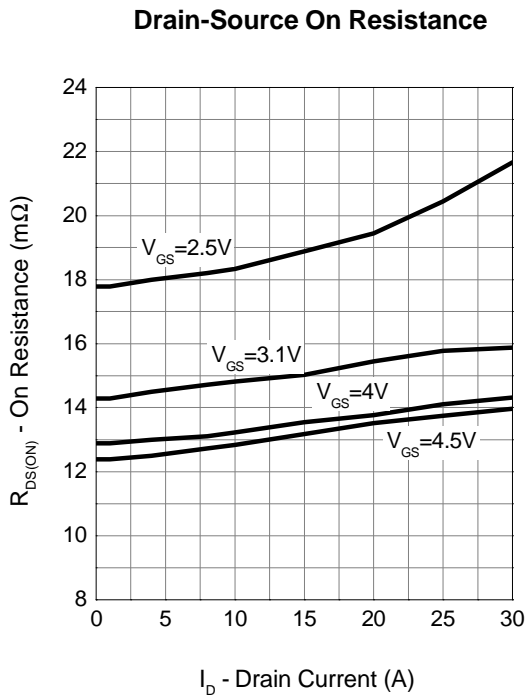
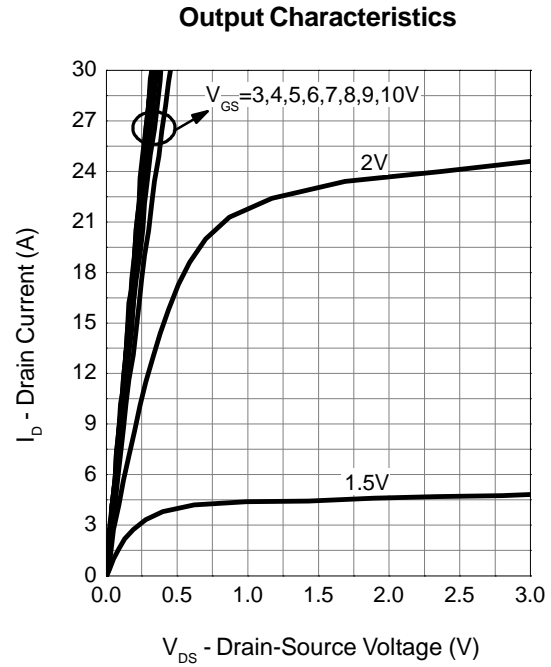
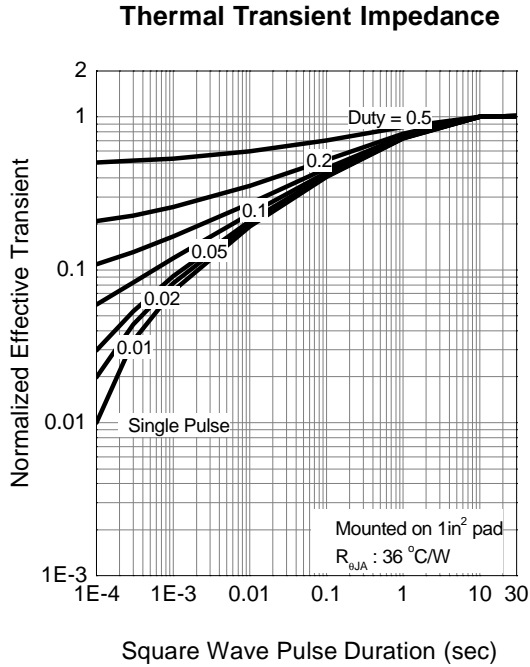
Safe Operation Area ($T_A = 25^{\circ}$ C)



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

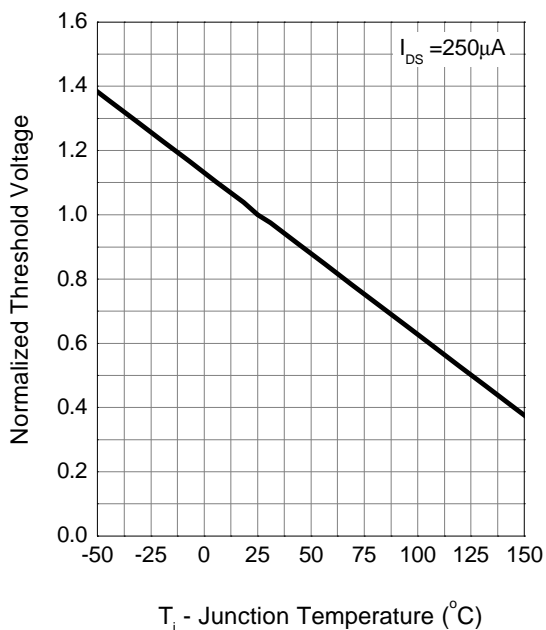


Typical Operating Characteristics (Cont.)

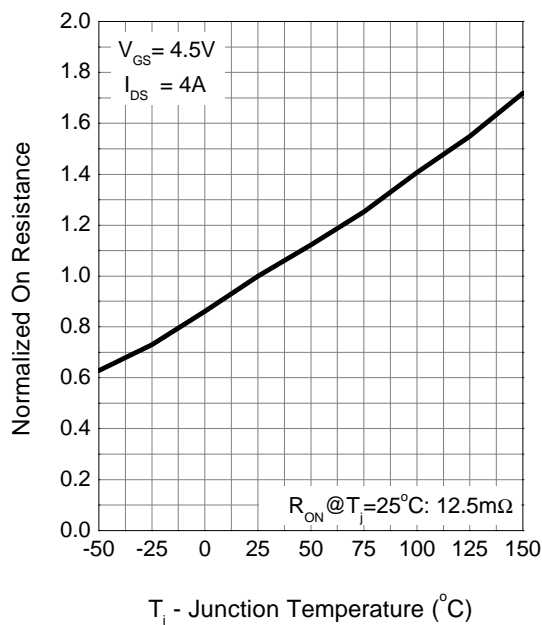


Typical Operating Characteristics (Cont.)

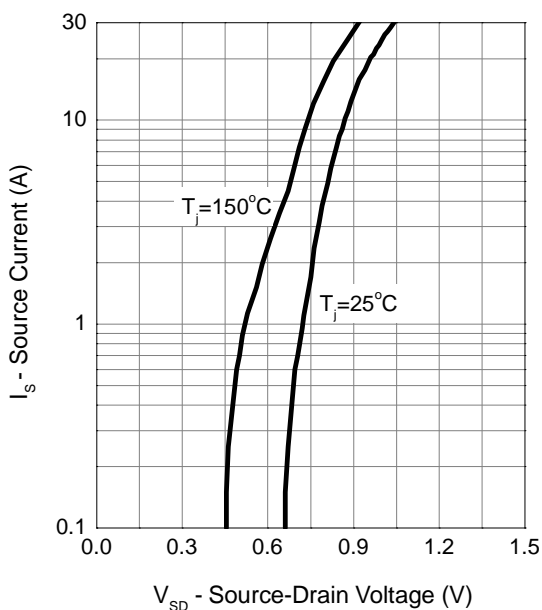
Gate Threshold Voltage



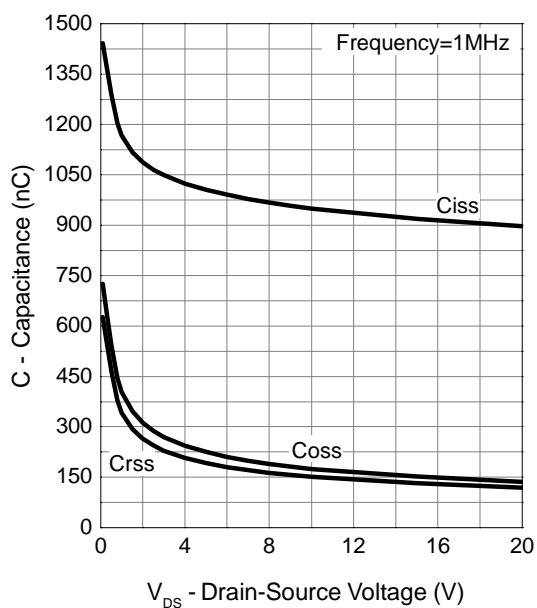
Drain-Source On Resistance



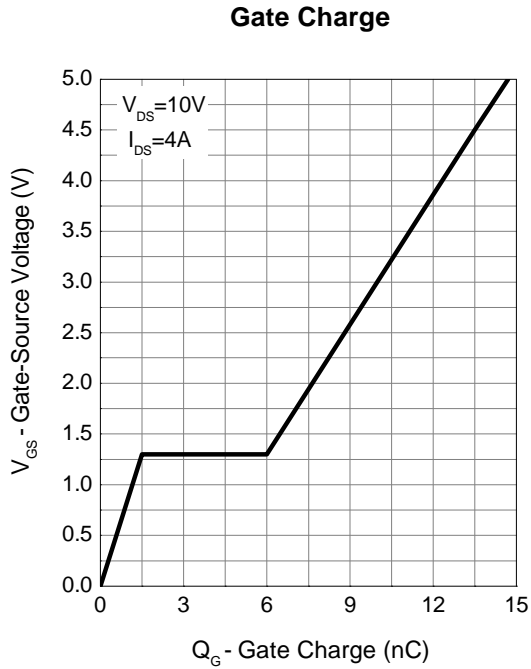
Source-Drain Diode Forward



Capacitance

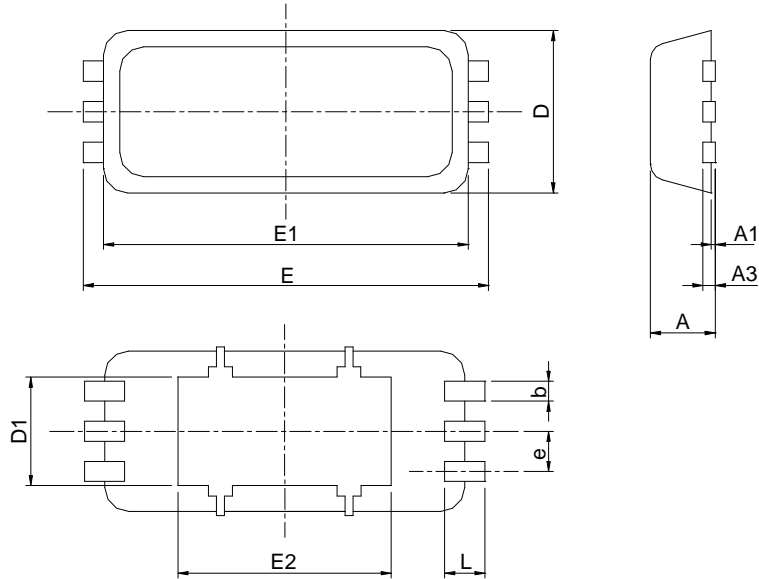


Typical Operating Characteristics (Cont.)



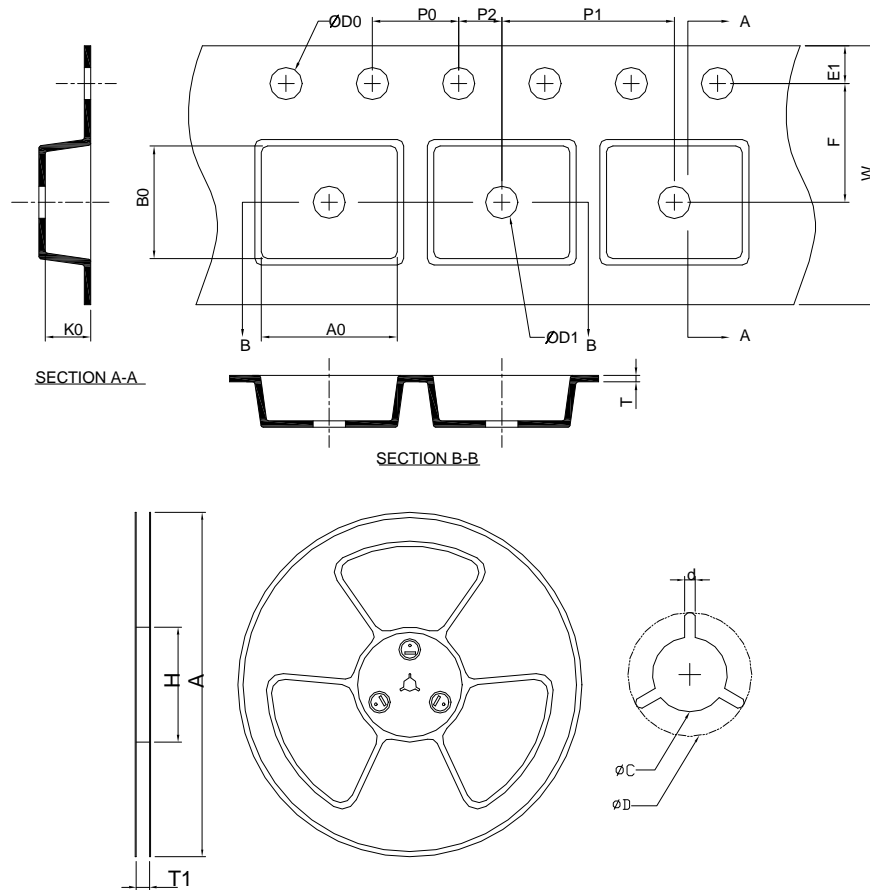
Package Information

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 |

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 |

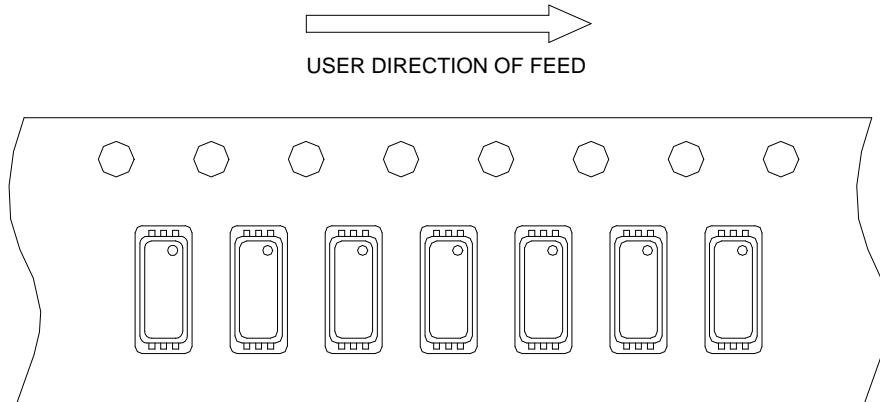
(mm)

Devices Per Unit

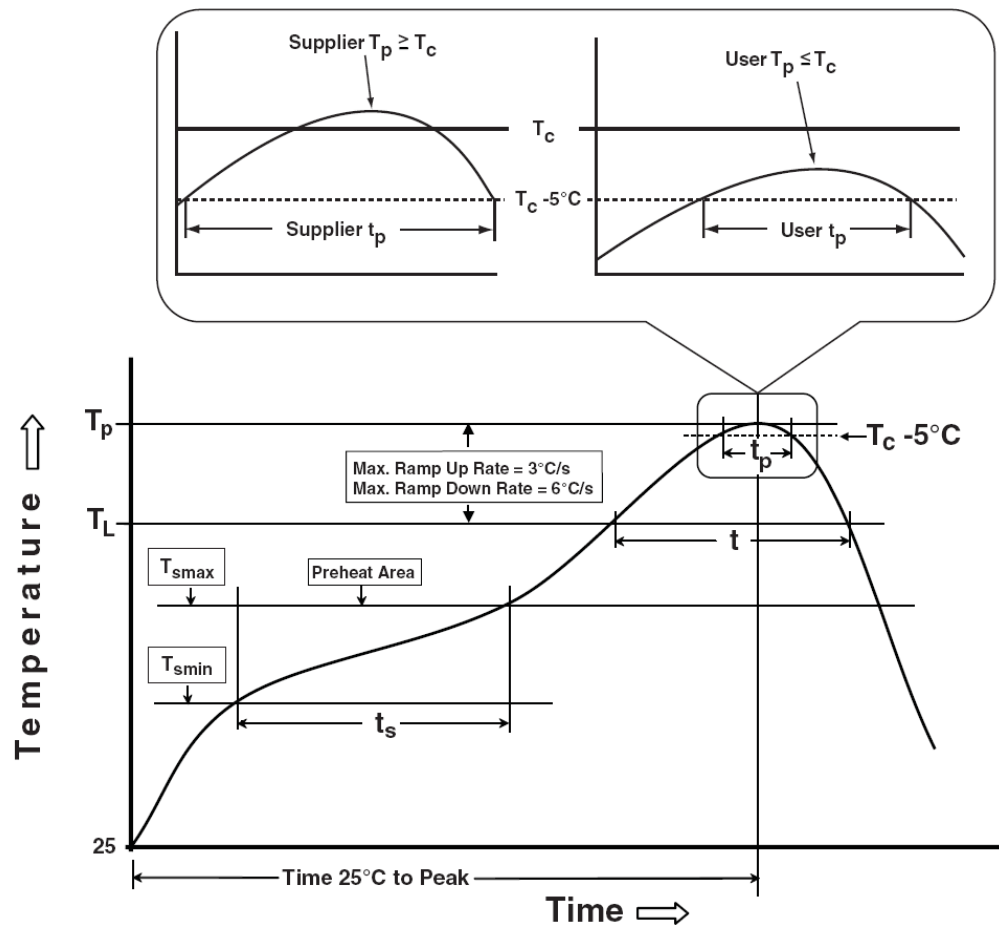
| Package Type | Unit | Quantity |
|--------------|-------------|----------|
| TDFN2x5-6 | Tape & Reel | 3000 |

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}) | 100 °C | 150 °C |
| Temperature max (T_{smax}) | 150 °C | 200 °C |
| Time (T_{smin} to T_{smax}) (t_s) | 60-120 seconds | 60-120 seconds |
| Average ramp-up rate (T_{smax} to T_p) | 3 °C/second max. | 3°C/second max. |
| Liquidous temperature (T_L) | 183 °C | 217 °C |
| Time at liquidous (t_L) | 60-150 seconds | 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 |
| HOLT | JESD-22, A108 | 1000 Hrs, Bias @ 125°C |
| PCT | JESD-22, A102 | 168 Hrs, 100%RH, 2atm, 121°C |
| TCT | JESD-22, A104 | 500 Cycles, -65°C~150°C |

Customer Service

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