

## Resistor-Programmable SOT Temperature Switches

### Features

- $\pm 0.5^{\circ}\text{C}$  Typical Threshold Accuracy
- $\pm 3.5^{\circ}\text{C}$  (max) Threshold Accuracy ( $0^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ )
- Temperature Threshold Set by a 1% External Resistor
- Low 33 $\mu\text{A}$  Supply Current
- Open-Drain Active Low Output Stage
- Guaranteed Reset Valid to  $V_{\text{CC}} = 0.8\text{V}$
- Pin-Selectable  $2^{\circ}\text{C}$  or  $10^{\circ}\text{C}$  Hysteresis
- SOT-23-5, SOT-23-6, TDFN2X2-8 and ADFN1.5X1.5-6 Packages

### Applications

- $\mu\text{P}$  Temperature Monitoring in High-Speed Computers
- Temperature Control
- Temperature Alarms
- Fan Control
- Automotive

### General Description

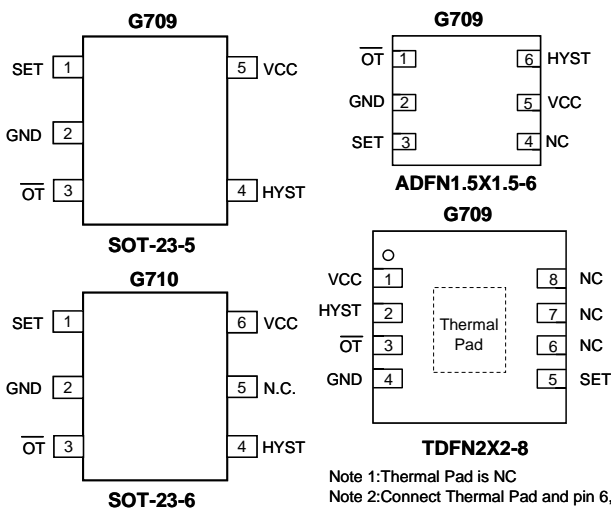
The G709/G710 are fully integrated, resistor programmable temperature switches with thresholds set by an external resistor. They require only one external resistor to set the temperature threshold within a wide  $0^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range. The G709/G710 provides an open-drain, active low output. These switches operate with a  $+2.7\text{V}$  to  $+5.5\text{V}$  single supply while providing a temperature threshold accuracy of  $\pm 0.5^{\circ}\text{C}$  (typ) or  $\pm 3.5^{\circ}\text{C}$  (max). They typically consume 33 $\mu\text{A}$  supply current. Hysteresis is pin selectable to  $2^{\circ}\text{C}$  or  $10^{\circ}\text{C}$ .

### Ordering Information

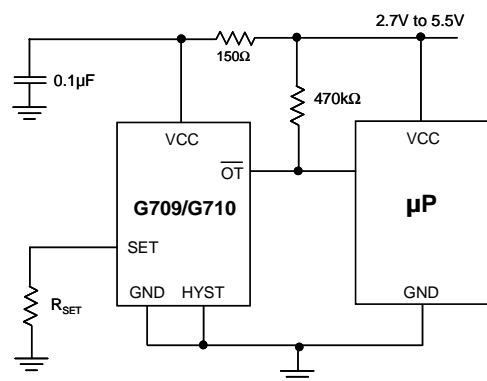
ORDER NUMBER (Pb free/Green)	MARKING	TEMP. RANGE	PACKAGE
G709T1Uf	709xx	$-40^{\circ}\text{C}\sim+125^{\circ}\text{C}$	SOT-23-5
G709RCUf	709	$-40^{\circ}\text{C}\sim+125^{\circ}\text{C}$	TDFN2X2-8
G709A3U	79 xx	$-40^{\circ}\text{C}\sim+125^{\circ}\text{C}$	ADFN1.5X1.5-6
G710TBUf	710xx	$-40^{\circ}\text{C}\sim+125^{\circ}\text{C}$	SOT-23-6

Note: T1 : SOT-23-5 TB : SOT-23-6 A3:ADFN1.5X1.5-6 RC:TDFN2X2-8  
U : Tape & Reel

### Pin Configuration



### Typical Application Circuit



## Absolute Maximum Ratings

Reference to GND Supply Voltage (VCC) . . .	-0.3V to +6V
$\overline{OT}$ . . . . .	-0.3V to +6V
SET, HYST . . . . .	-0.3V to (VCC + 0.3V)
Output Current (all pins) . . . . .	20mA
Input Current (all pins) . . . . .	20mA
Thermal Resistance Junction to Ambient, ( $\theta_{JA}$ )	
SOT-23-5 . . . . .	240°C/W
SOT-23-6 . . . . .	240°C/W
TDFN2X2-8 . . . . .	225°C/W
ADFN1.5X1.5-6 . . . . .	290°C/W

Continuous Power Dissipation ( $T_A = +25^\circ\text{C}$ )	
SOT-23-5 . . . . .	520mW
SOT-23-6 . . . . .	520mW
TDFN2X2-8 . . . . .	550mW
ADFN1.5X1.5-6 . . . . .	430mW
Operating Temperature Range . . . . .	-40°C to +125°C
Junction Temperature . . . . .	+150°C
Storage Temperature Range . . . . .	-65°C to +150°C
Reflow Temperature (soldering, 10s) . . . . .	260°C
ESD Protection . . . . .	2kV

\* Please refer to Minimum Footprint PCB Layout Section.

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.

## Electrical Characteristics

$V_{CC} = +2.7V$  to  $+5.5V$ .

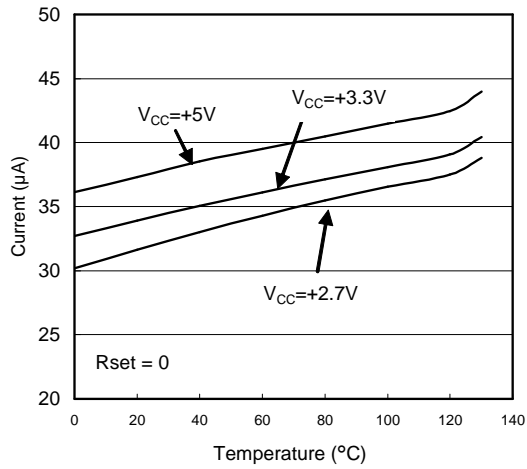
The device is not guaranteed to function outside its operating conditions. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified.

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage Range	$V_{CC}$		2.7	---	5.5	V
Supply Current	$I_{CC}$	$V_{CC}=3.3V$	---	33	55	$\mu A$
Temperature Threshold Accuracy	$\Delta T_{TH}$	$T_A = 0^\circ\text{C}$ to $+125^\circ\text{C}$	-3.5	$\pm 0.5$	3.5	$^\circ\text{C}$
HYST Input Leakage			---	1	---	$\mu A$
HYST Input Threshold	$V_{IH}$		$0.7 \times V_{CC}$	---	---	V
	$V_{IL}$		---	---	$0.3 \times V_{CC}$	V
Open-Drain Output Sink Current	$I_{OT}$	$V_{\overline{OT}} = 0.3V$	5	12	---	mA
Open-Drain Output Leakage Current	$I_{LEAK\_OT}$	$V_{\overline{OT}} = V_{CC}, V_{CC} = 0.5 \sim 5.5V$	---	1	---	$\mu A$

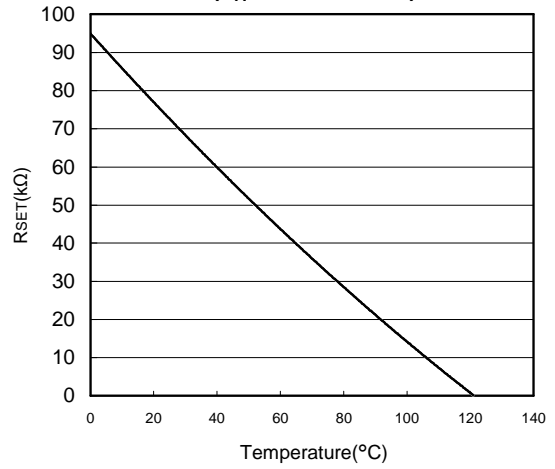
**Typical Operating Characteristics**

$V_{CC} = +5V$

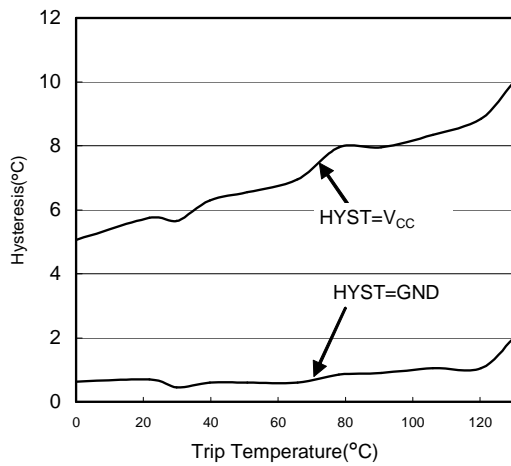
**Supply Current vs. Temperature**



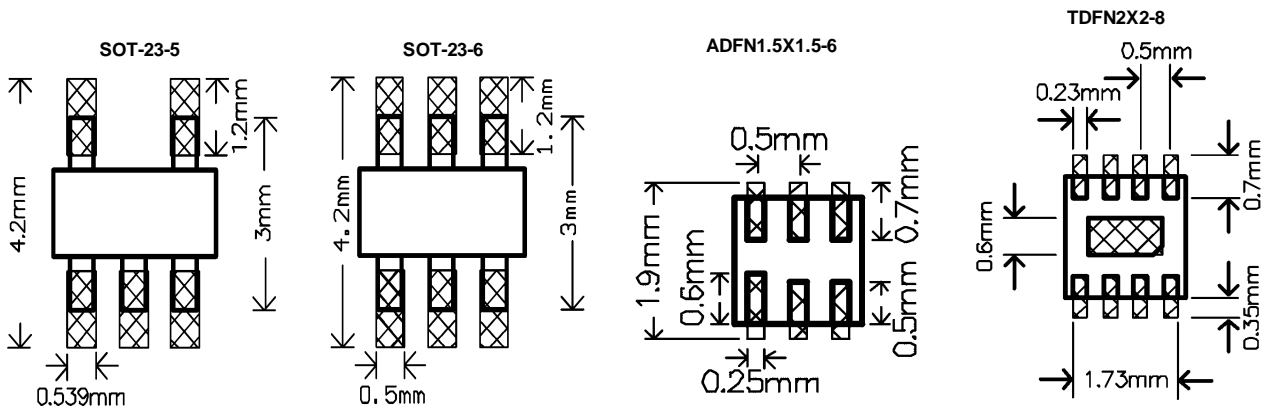
**RSET vs. Temperature**  
( $T_A = 0^\circ C$  to  $125^\circ C$ )



**Hysteresis vs. Trip Temperature**



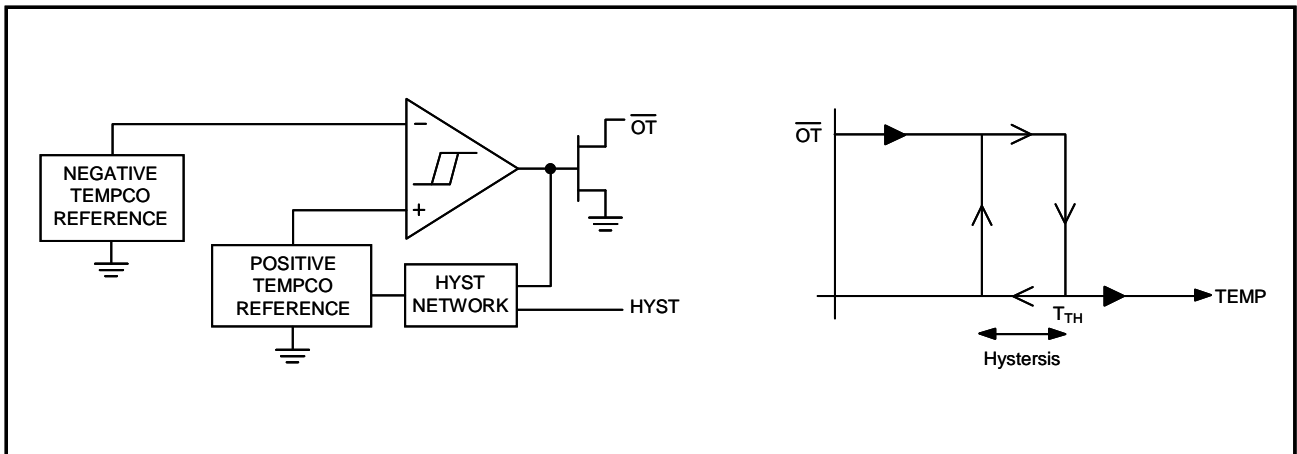
**Minimum Footprint PCB Layout Section**



## Pin Description

PIN				NAME	FUNCTION
G709 SOT-23-5	G709 TDFN2X2-8	G709 ADFN1.5X1.5-6	G710 SOT-23-6		
1	5	3	1	SET	Temperature Set Point, Connect an external 1% resistor from SET to GND to set trip point.
2	4	2	2	GND	Ground
3	3	1	3	$\overline{OT}$	Open-Drain Active Low Output.
4	2	6	4	HYST	Hysteresis Selection. Hysteresis is 10°C for HYST = V <sub>CC</sub> , 2°C for HYST = GND.
	6,7,8	4	5	NC	Not Connected.
5	1	5	6	VCC	Power-Supply Input.

## Block Diagram



## Detailed Description

The G709/G710 fully integrated temperature switches incorporate two temperature-dependent references and one comparator. One reference exhibits a positive temperature coefficient, and the other has a negative temperature coefficient. The temperature at which the two reference voltages are equal determines the temperature trip point. Pin-selectable 2°C or 10°C hysteresis keeps the output from oscillating when the temperature is close to the threshold. The G709/G710 has an active-low, open-drain output structure.

The G709/G710 are programmable for a wide range of temperature thresholds from 0°C to +125°C. The temperature threshold is set by an external resistor between SET and GND. The G709 output easily interfaces with a microprocessor ( $\mu\text{P}$ ) reset input.

### Hysteresis Input

The HYST pin is a CMOS-compatible input that selects hysteresis at either a high level (10°C for HYST = VCC) or a low level (2°C for HYST = GND). Hysteresis prevents the output from oscillating when the temperature is near the trip point. **Do not leave HYST unconnected.** Connect HYST to GND or VCC. Other input voltages cause increased supply current or abnormal function.

## Applications Information

### Set-Point Resistor

To set the trip-point temperature, connect a resistor between SET and GND. The resistor's value is determined either from the RSET vs. Temperature graphs (see *Typical Operating Characteristics*) or from the equations below.

To set the temperature trip point from 0°C to +125°C, use the following equation:

$$R_{\text{SET}}(\text{k}\Omega) = 0.0012T^2 - 0.9308T + 96.147$$

where T is the trip temperature in Centigrade.  $R_{\text{SET}}$  is the set-point resistance.

### Thermal Considerations

The G709/G710 supply current is typically 33 $\mu\text{A}$ . When used to drive high-impedance loads, the devices dissipate negligible power; therefore, the die temperature is essentially the same as the package temperature. The key to accurate temperature monitoring is good thermal contact between the G709/G710 package and the device being monitored. In some applications, the SOT-23 packages may be small enough to fit underneath a socketed  $\mu\text{P}$ , allowing the device to monitor the  $\mu\text{P}$ 's temperature directly. Use the monitor's output to reset the  $\mu\text{P}$ , assert an interrupt, or trigger an external alarm. Accurate temperature monitoring depends on the thermal resistance between the device being monitored and the G709/G710 die.

The rise in die temperature due to self-heating is given by the following formula:

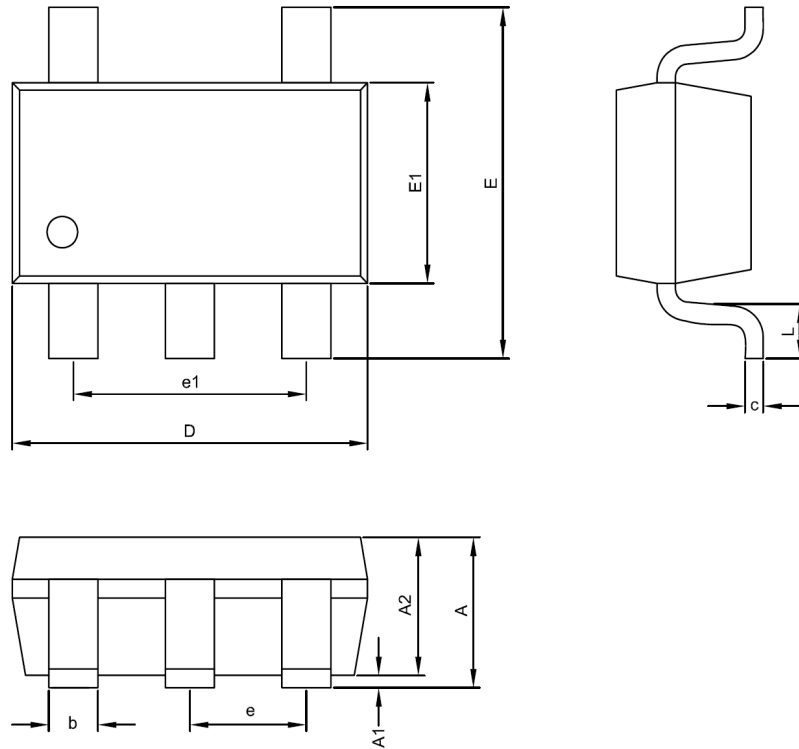
$$\Delta T_J = P_{\text{DISS}} \times \theta_{\text{JA}}$$

where PDISS is the power dissipated by the G709/G710, and  $\theta_{\text{JA}}$  is the package's thermal resistance. The typical thermal resistance is 115°C/W for the SOT-23 package. To limit the effects of self-heating, minimize the output currents.

### Power Noise Filtering

To reduce trig point error caused by power noise, place a 150 $\Omega$  resistor and 0.1 $\mu\text{F}$  capacitor as the low pass filter for  $V_{\text{CC}}$ .

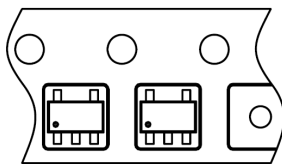
## Package Information



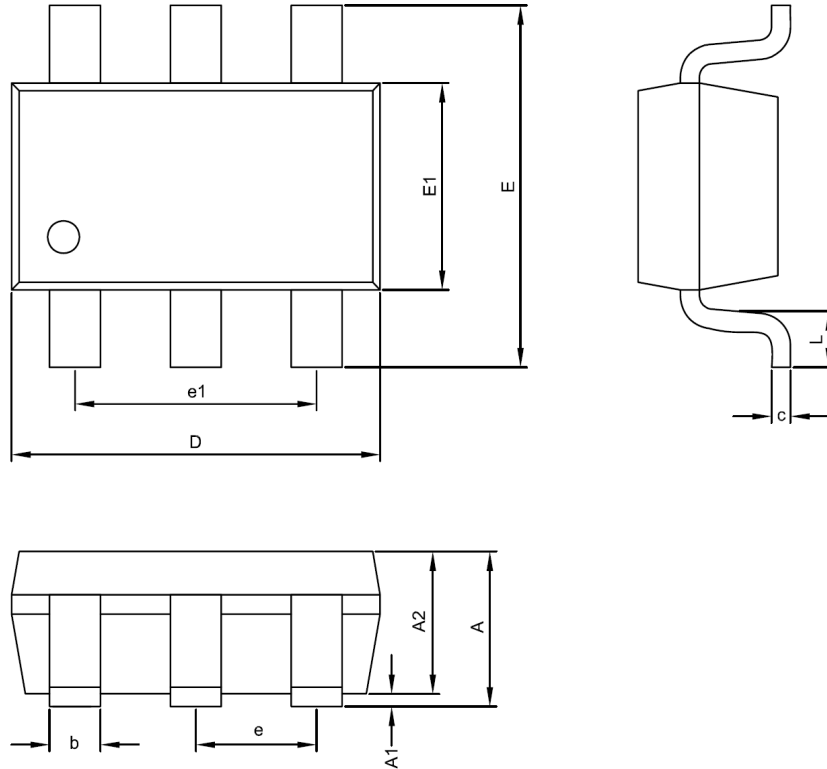
SOT-23-5 (T1) Package

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.00	1.10	1.45	0.039	0.043	0.057
A1	0.00	---	0.15	0.000	---	0.006
A2	1.00	1.10	1.30	0.039	0.043	0.051
D	2.70	2.90	3.10	0.106	0.114	0.122
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
c	0.08	0.15	0.25	0.003	0.006	0.010
b	0.30	0.40	0.50	0.012	0.016	0.020
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
L	0.30	0.45	0.60	0.012	0.018	0.024

## Taping Specification



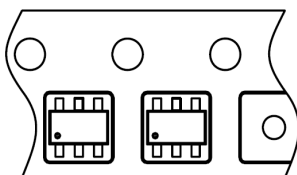
PACKAGE	Q'TY/REEL
SOT-23-5	3,000 ea



**SOT-23-6 (TB) Package**

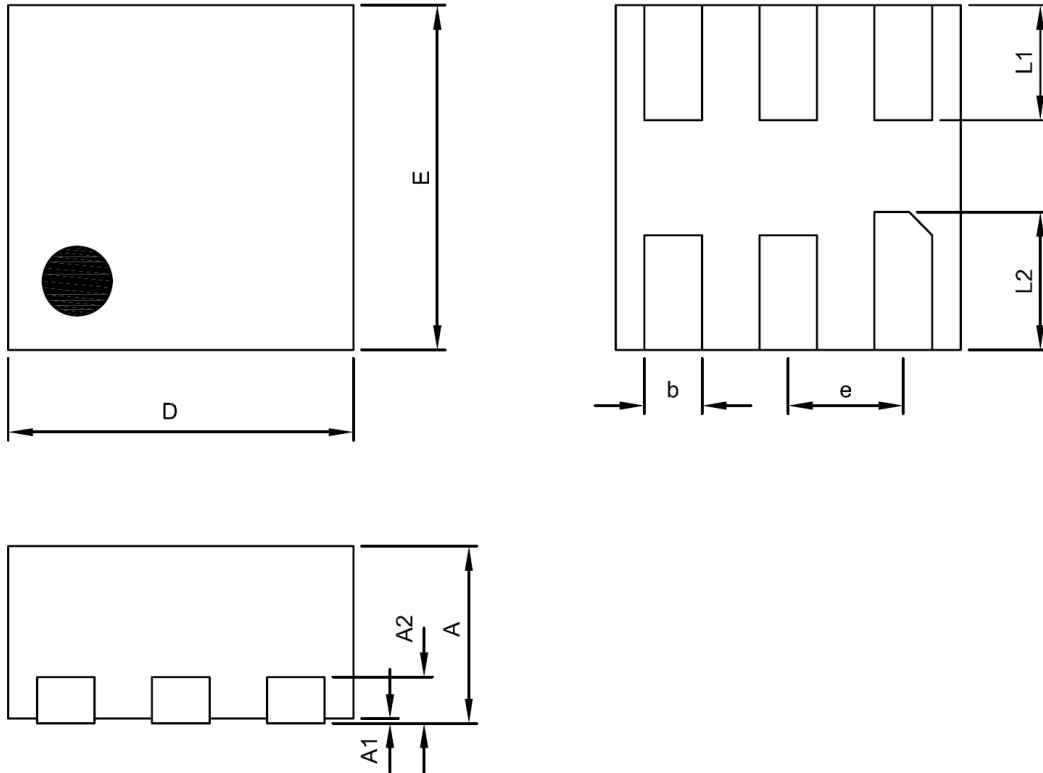
Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.00	1.10	1.45	0.039	0.043	0.057
A1	0.00	---	0.15	0.000	---	0.006
A2	1.00	1.10	1.30	0.039	0.043	0.051
D	2.70	2.90	3.10	0.106	0.114	0.122
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
c	0.08	0.15	0.25	0.003	0.006	0.010
b	0.30	0.40	0.50	0.012	0.016	0.020
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
L	0.30	0.45	0.60	0.012	0.018	0.024

## Taping Specification

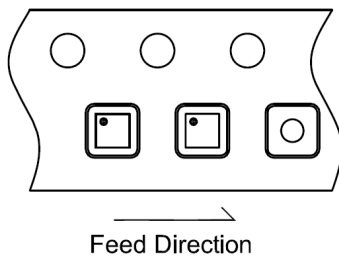


Feed Direction

PACKAGE	Q'TY/REEL
SOT-23-6	3,000 ea

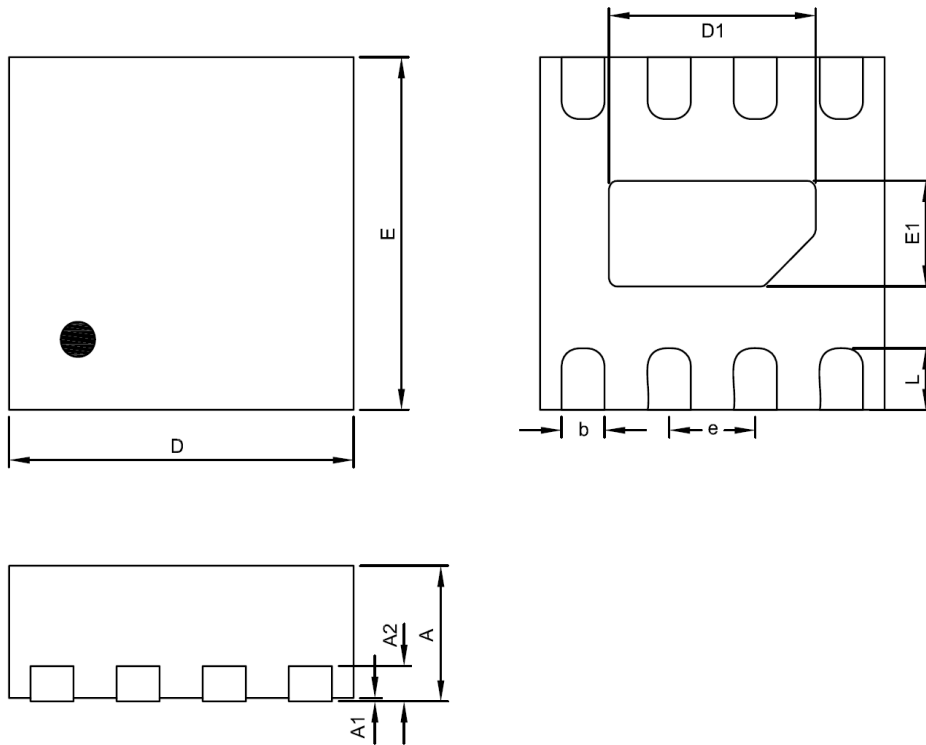

**ADFN1.5X1.5-6 (A3) Package**

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.0276	0.0295	0.0315
A1	0.00	---	0.05	0.0000	---	0.0020
A2	0.19	0.20	0.21	0.0075	0.0079	0.0083
D	1.45	1.50	1.55	0.0570	0.0590	0.0610
E	1.45	1.50	1.55	0.0570	0.0590	0.0610
b	0.20	0.25	0.30	0.0079	0.0098	0.0118
e	0.50 BSC			0.0197 BSC		
L1	0.45	0.50	0.55	0.0177	0.0197	0.0217
L2	0.55	0.60	0.65	0.0217	0.0236	0.0256

**Taping Specification**


PACKAGE	Q'TY/REEL
ADFN1.5X1.5-6	3,000 ea

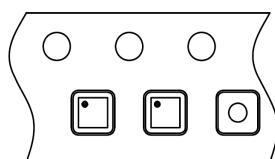




**TDFN2X2-8 (RC) Package**

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.0276	0.0295	0.0315
A1	0.00	---	0.05	0.0000	---	0.0020
A2	0.19	0.20	0.21	0.0075	0.0079	0.0083
D	1.95	2.00	2.05	0.0768	0.0787	0.0807
E	1.95	2.00	2.05	0.0768	0.0787	0.0807
D1	1.15	1.20	1.25	0.0453	0.0472	0.0492
E1	0.55	0.60	0.65	0.0217	0.0236	0.0256
b	0.18	0.23	0.28	0.0071	0.0091	0.0110
e	0.50 BSC			0.0197 BSC		
L	0.30	0.35	0.40	0.0118	0.0138	0.0157

## Taping Specification



PACKAGE	Q'TY/REEL
TDFN2X2-8	3,000 ea

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