Nano-Power, CMOS Input, RRIO, Push-Pull Output Comparator

FEATURES

- **Low supply current**
  400nA (TYP) at V_S = 1.4V
- **Low input offset voltage: Vos(max) = ±3mV**
- **Rail-to-Rail Input and output**
- **SUPPLY RANGE: +1.4V to +5.5V**
- **SPECIFIED UP TO +125°C**
- **Micro SIZE PACKAGES: SOT353(SC70-5), SOT23-5**

APPLICATIONS

- **OVERVOLTAGE AND UNDERVOLTAGE DETECTION**
- **MULTIVIBRATORS**
- **OVERCURRENT DETECTION**
- **SYSTEM MONITORING**
- **BATTERY POWERED SYSTEM**

DESCRIPTION

The RS8907 offers a wide supply range, low quiescent current 400nA (TYP), and rail-to-rail inputs. All of these features come in industry-standard and extremely small packages, making this device an excellent choice for low-voltage and low-power applications for portable electronics and industrial systems.

Featuring a push-pull output stage, the RS8907 allows for operation with absolute minimum power consumption when driving any capacitive or resistive load.

The devices are ideal for system monitoring, include tablets, portable medical, smart phones. The RS8907 is specified at the full temperature range of −40°C to +125°C under single power supplies of 1.4V to 5.5V.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS8907	SOT23-5(5)	1.60mm×2.92mm
	SOT353 (SC70-5)	2.10mm×1.25mm

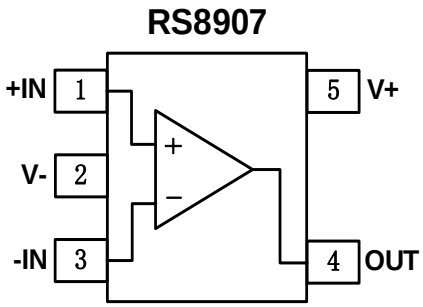
(1) For all available packages, see the orderable addendum at the end of the data sheet.

Revision History

Note: Page numbers for previous revisions may different from page numbers in the current version.

VERSION	Change Date	Change Item
A.5	2022/04/15	1. Change Functional Block Diagram 2. Added TAPE AND REEL INFORMATION 3.Change ELECTRICAL CHARACTERISTICS in Page 3@A.4 Version. 4.Change TYPICAL CHARACTERISTICS in Page 4@A.4 Version. 5. Added Detailed Description

Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN	I/O (1)	DESCRIPTION
	SOT23-5/SOT353(SC70-5)		
+IN	1	I	Noninverting input
V-	2	P	Negative (lowest) power supply
-IN	3	I	Inverting input
OUT	4	O	Output
V+	5	P	Positive (highest) power supply

(1)I=Input, O=Output, P=Power

SPECIFICATIONS

Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

		MIN	MAX	UNIT
Voltage	Supply, Vs=(V+) - (V-)		7	V
	Input pin (IN+, IN-)	(V-)-0.5	(V+) +0.5	
	Signal output pin (2)	(V-)-0.5	(V+) +0.5	
Current	Signal input pin (IN+, IN-)	-10	10	mA
	Signal output pin (2)	-55	55	mA
	Output short-circuit (3)	Continuous		
Temperature	Operating range, T_A	-40	125	°C
	Junction, T_J	-40	150	
	Storage, T_{stg}	-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ±55mA or less.
(3) Short-circuit to ground, one amplifier per package.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	±3000	V
		Machine Model (MM)	±400	

Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage，Vs= (V+) - (V-)	Single-supply	1.4		5.5	V
	Dual-supply	±0.7		±2.75	

Thermal Information:RS8907

THERMAL METRIC (1)		RS8907 5PINS SOT353/(SC70-5)	UNIT
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	214.7	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	127.1	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	60.0	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	33.4	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	59.8	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	°C/W

PACKAGE/ORDERING INFORMATION

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking (1)	Package Qty
RS8907XF	SOT23-5	5	1	-40°C ~125°C	8907	Tape and Reel,3000
RS8907XC5	SOT353(SC70-5)	5	1	-40°C ~125°C	8907	Tape and Reel,3000

NOTE:

(1) There may be additional marking, which relates to the lot trace code information(data code and vendor code)，the logo or the environmental category on the device.

ELECTRICAL CHARACTERISTICS

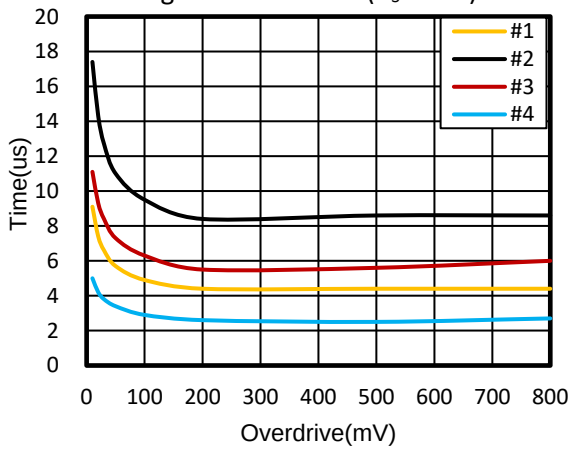
(At T_A = +25°C, Vs=1.4V to 5.5V, V_{CM}=Vs/2, C_L = 15pF, unless otherwise noted.)

PARAMETER		CONDITIONS		RS8907			
				MIN	TYP	MAX	UINTS
POWER SUPPLY							
Vs	Operating Voltage Range			1.4		5.5	V
I_Q	Quiescent Current				400	1500	nA
PSRR	Power-Supply Rejection Ratio	Vs=1.4V to 5.5V, V_{CM}=(V)+0.5V			70		dB
INPUT							
Vos	Input Offset Voltage	V_{CM} =Vs/2	Vs =1.4V		1	6	mV
			Vs =5.0V	-3	1	3	
ΔVos/ΔT	Input Offset Voltage Drift	V_{CM} =Vs/2, -40°C ≤ T_A ≤125°C			2		μV/°C
IB	Input Bias Current				1	10	pA
V_{CM}	Common-Mode Voltage Range	T_A = –40°C to 125°C		(V-)-0.1		(V+)+0.1	V
CMRR	Common-Mode Rejection Ratio	Vs=5.5V, V_{CM} =-0.1 to 5.6V			70		dB
OUTPUT							
V_{OH}	Output Swing From Upper Rail	Vs=1.4V, Io=0.1mA			70	75	mV
		Vs=5.0V, Io=2.5mA			140	170	mV
V_{OL}	Output Swing From Lower Rail	Vs=1.4V, Io=-0.1mA			35	40	mV
		Vs=5.0V, Io=-2.5mA			85	115	mV
I_{SC}	Short Circuit Sink Current	Vs=5.0V			42		mA
	Short Circuit Source Current	Vs=5.0V			38		mA
SWITCHING							
T_{PHL}	Propagation Delay H To L	Vs = 5.0 V, Overdrive = 10 mV			13	20	μs
		Vs = 5.0 V, Overdrive = 100 mV			9	14	
		Vs = 2.5 V, Overdrive = 10 mV			12	18	
		Vs = 2.5 V, Overdrive = 100 mV			8	12	
		Vs = 1.4 V, Overdrive = 10 mV			13	20	
		Vs = 1.4 V, Overdrive = 100 mV			9	14	
T_{PLH}	Propagation Delay L To H	Vs = 5.0 V, Overdrive = 10 mV			30	50	
		Vs = 5.0 V, Overdrive = 100 mV			21	38	
		Vs = 2.5 V, Overdrive = 10 mV			24	45	
		Vs = 2.5 V, Overdrive = 100 mV			15	30	
		Vs = 1.4 V, Overdrive = 10 mV			25	50	
		Vs = 1.4 V, Overdrive = 100 mV			15	30	
T_R	Rise Time	Overdrive = 100 mV			240		ns
T_F	Fall Time	Overdrive = 100 mV			260		ns

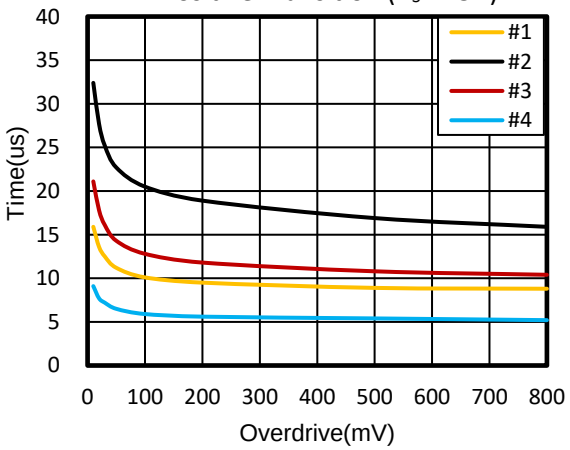
TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, V_{CM} = Vs/2, C_L=15pF unless otherwise noted.

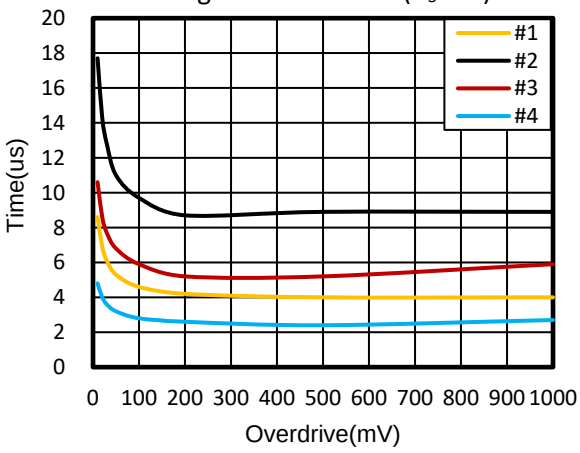
Response Time vs Input Overdrives
Negative Transition (V_S=2.5V)



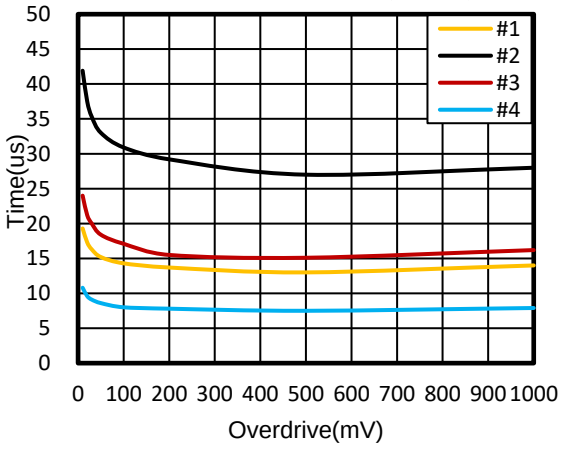
Response Time vs Input Overdrives
Positive Transition (V_S=2.5V)



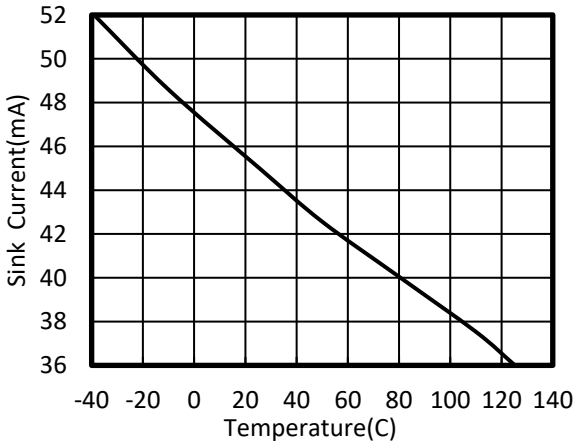
Response Time vs Input Overdrives
Negative Transition (V_S=5V)



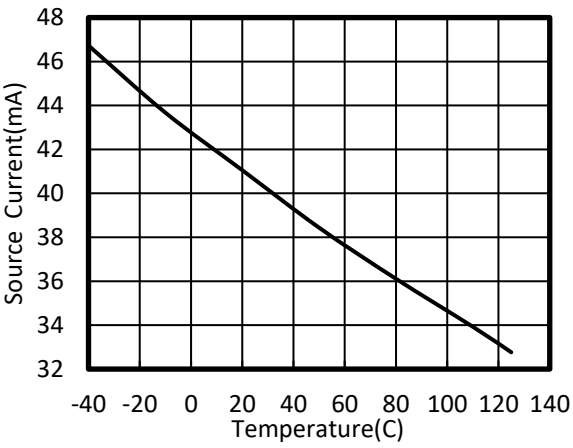
Response Time vs Input Overdrives
Positive Transition (V_S=5V)



SINK CURRENT vs TEMPERATURE



SOURCE CURRENT vs TEMPERATURE

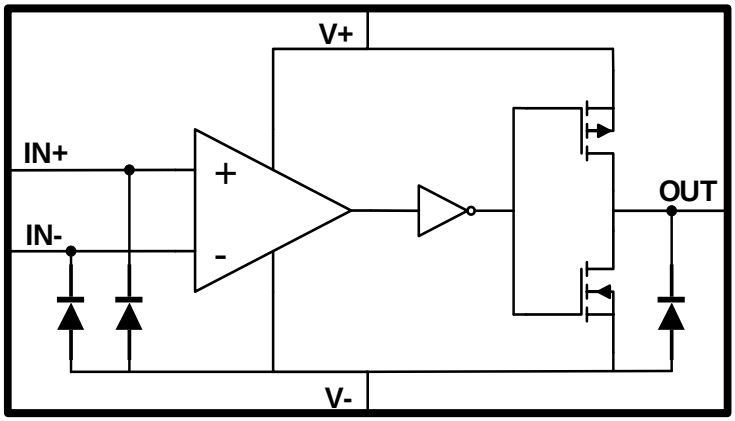


Detailed Description

Overview

The RS8907 devices are single-channel, Nano-power comparators with a push-pull output stage. Operating from 1.4V to 5.5V and consuming only 400nA. The push-pull output of the RS8907 supports rail-to-rail output swing and interfaces with TTL/CMOS logic.

Functional Block Diagram



Feature Description

The RS8907 devices are Nano-Power comparators that can operate at low voltages. The RS8907 feature a rail-to-rail input stage capable of operating up to 100 mV beyond the VCC power supply rail.

Input Stage

The RS8907 has rail-to-rail input common-mode voltage range. It can operate at any differential input voltage within this limit as long as the differential voltage is greater than zero. A differential input of zero volts may result in oscillation.

The differential input stage of the comparator is a pair of PMOS and NMOS transistors, therefore, no current flows into the device. The input bias current measured is the leakage current in the MOS transistors and input protection diodes. This low bias current allows the comparator to interface with a variety of circuitry and devices with minimal concern about matching the input resistances.

Output Stage

The RS8907 has a MOS push-pull rail-to-rail output stage. The push-pull transistor configuration of the output keeps the total system power consumption to a minimum. The only current consumed by the RS8907 is the less than 1μA supply current and the current going directly into the load. No power is wasted through the pullup resistor when the output is low. The output stage is specifically designed with dead time between the time when one transistor is turned off and the other is turned on (break-before-make) to minimize shoot through currents. The internal logic controls the break-before-make timing of the output transistors. The break-before-make delay varies with temperature and power condition.

Output Current

Even though the RS8907 uses less than 1μA supply current, the outputs are able to drive very large currents. The RS8907 can source up to 38mA and can sink up to 42mA, when operated at 5V supply. This large current handling capability allows driving heavy loads directly.

Application Information

The RS8907 is an ultra-low-power comparator with a typical power supply current of 400nA. It has the best-in class power supply current versus propagation delay.

Typical Applications

Square Wave Generator

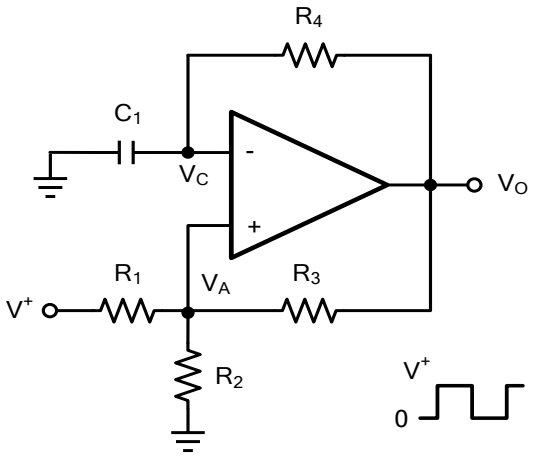


Figure 1. Square Wave Generator Schematic

Design Requirements

A typical application for a comparator is as a square wave oscillator. The circuit in Figure 1 generates a square wave whose period is set by the RC time constant of the capacitor C1 and resistor R4. The maximum frequency is limited by the large signal propagation delay of the comparator and by the capacitive loading at the output, which limits the output slew rate.

Detailed Design Procedure

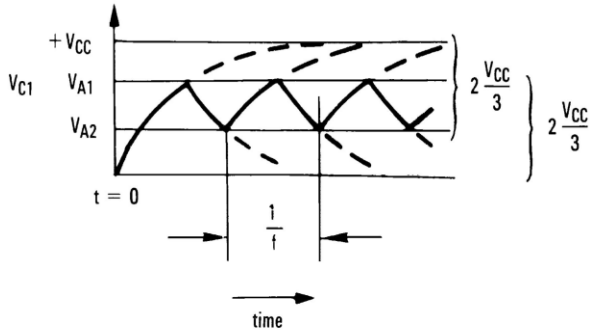


Figure 2. Square Wave Oscillator

Typical Applications(continued)

Consider the output of Figure 2 to be high to analyze the circuit. That implies that the inverted input (V_C) is lower than the noninverting input (V_A). This causes the C_1 to be charged through R_4, and the voltage V_C increases until it is equal to the noninverting input. The value of V_A at this point is in Equation 1.

$$V_{A1} = \frac{V_{CC} \times R_2}{R_2 + R_1 \| R_3} \quad \text{.....(1)}$$

If $R_1 = R_2 = R_3$ then $V_{A1} = 2\ V_{CC}/3$

At this point the comparator switches pulling down the output to the negative rail. The value of V_A at this point, as shown in Equation 2:

$$V_{A2} = \frac{V_{CC}(R_2 \| R_3)}{R_1 + (R_2 \| R_3)} \quad \text{.....(2)}$$

If $R_1 = R_2 = R_3$ then $V_{A2} = V_{CC}/3$ The capacitor C_1 now discharges through R_4, and the voltage V_C decreases until it is equal to V_{A2}, at which point the comparator switches again, bringing it back to the initial stage. The time period is equal to twice the time it takes to discharge C_1 from $2\ V_{CC}/3$ to $V_{CC}/3$, which is given by $R_4C_1 \times \ln 2$. Hence the formula for the frequency is given by Equation 3:

$$F=1/(2\times R_4\times C_1\times \ln 2) \quad \text{.....(3)}$$

Application Curves

Figure 3 shows the simulated results of an oscillator using the following values:

1. $R_1 = R_2 = R_3 = R_4 = 100\ k\Omega$
2. $C_1 = 100\ pF$, $C_L = 20\ pF$
3. V+ = 5 V, V– = GND
4. C_{STRAY} (not shown) from Va to GND = 10 pF

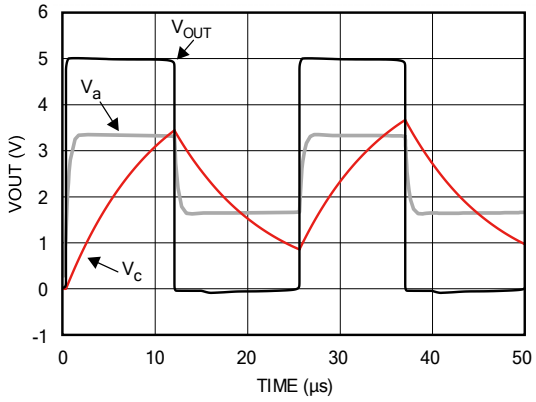
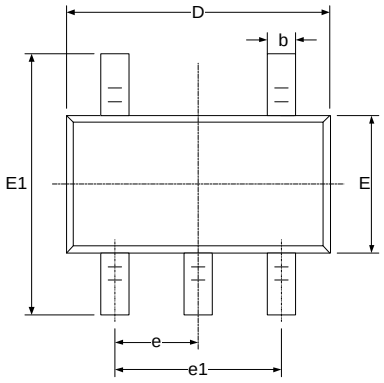
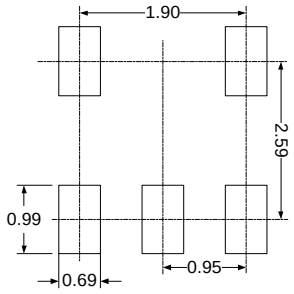


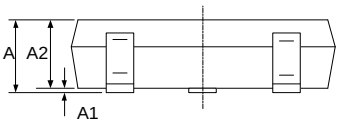
Figure 3. Square Wave Oscillator Output Waveform

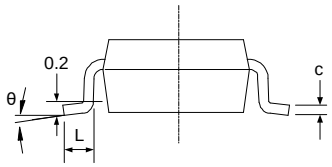
PACKAGE OUTLINE DIMENSIONS
SOT23-5





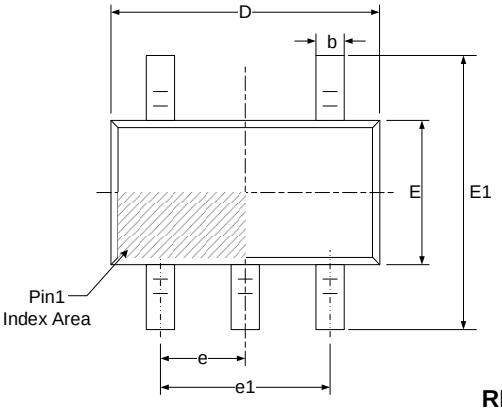
RECOMMENDED LAND PATTERN (Unit: mm)

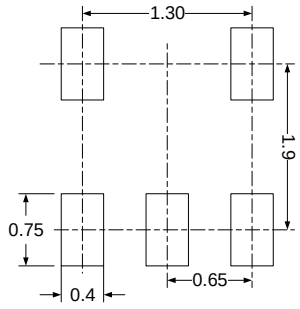




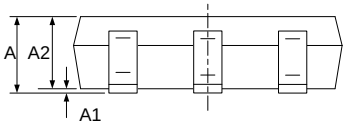
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

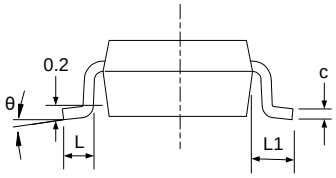
SOT353(SC70-5)





RECOMMENDED LAND PATTERN (Unit: mm)



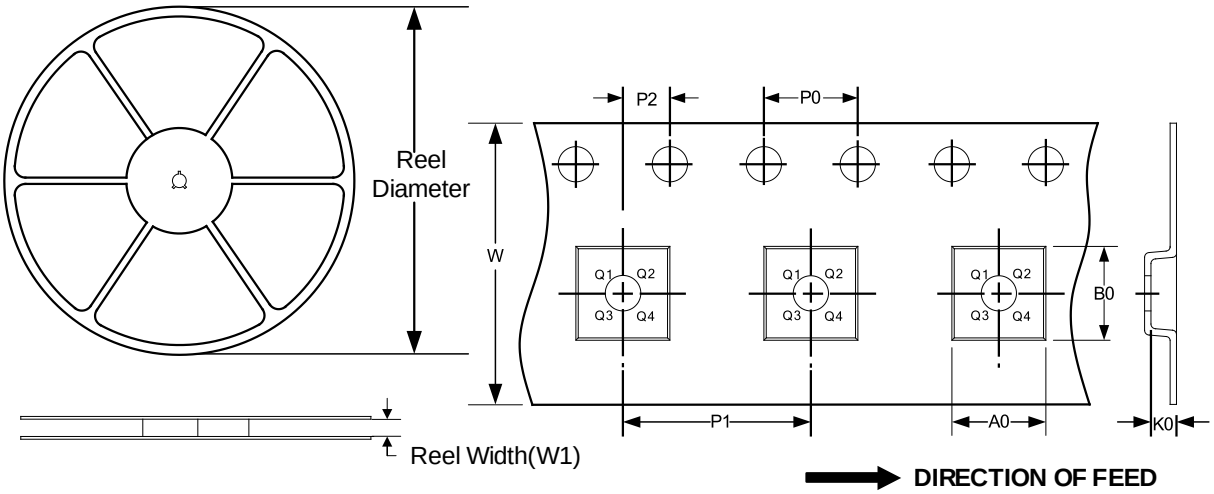


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650(BSC)		0.026(BSC)	
e1	1.300(BSC)		0.051(BSC)	
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7”	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOT353(SC70-5)	7”	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3

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