1MHz, Precision, Rail-to-Rail I/O CMOS Operational Amplifier

1 Features

- **High Gain Bandwidth:1MHz**
- **Rail-to-Rail Input and Output ±4.5mV Max Vos**
- **Input Voltage Range: -0.1V to +5.6V with Vs = 5.5V**
- **Supply Range: +2.5V to +5.5V**
- **Specified Up To +125°C**
- **Micro Size Packages: SOT353(SC70-5)**

2 Applications

- **Photodiode Amplification**
- **Active Filter**
- **Test Equipment**
- **Driving A/D Converters**

3 Descriptions

The ZM321BK products offer low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1MHz) and slew rate of 0.45V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The ZM321BK has lower offset, which is guaranteed not upper than ±4.5mV at 25°C with Vs = 5V, V_{CM} = Vs/2.

The devices are ideal for sensor interfaces, active filters and portable applications. The ZM321BK families of operational amplifiers are specified at the full temperature range of −40°C to +125°C under single or dual power supplies of 2.5V to 5.5V.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
ZM321BK	SOT23-5	2.90mm×1.60mm
	SOT353(SC70-5)	2.10mm×1.25mm

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

Table of Contents

4 Revision History

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

VERSION	Change Date	Change Item
A.1	2022/05/24	Initial version completed

5 Package/Ordering Information(1)

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking(2)	MSL(3)	Package Qty
ZM321BKXF	SOT23-5	5	1	-40°C ~125°C	321BK	MSL3	Tape and Reel,3000
ZM321BKXC5	SOT353(SC70-5)	5	1	-40°C ~125°C	321BK	MSL3	Tape and Reel,3000

NOTE:

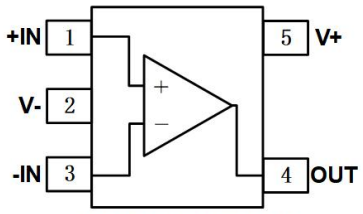
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) 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.

(3) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

6 Pin Configuration and Functions (Top View)

ZM321BK



SOT23-5/SOT353(SC70-5)

Pin Description

NAME	PIN	I/O	DESCRIPTION
	ZM321BK		
	SOT23-5/ SOT353(SC70-5)		
+IN	1	I	Positive (noninverting) input
V-	2	-	Negative (lowest) power supply
-IN	3	I	Negative (inverting) input
OUT	4	O	Output
V+	5	-	Positive (highest) power supply

7 Specifications

7.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
Voltage	Supply, Vs=(V+) - (V-)			7	V
	Signal input pin (2)		(V-)-0.5	(V+) +0.5	
	Signal output pin (3)		(V-)-0.5	(V+) +0.5	
Current	Signal input pin (2)		-10	10	mA
	Signal output pin (3)		-140	140	mA
	Output short-circuit (4)		Continuous		
θ_{JA}	Package thermal impedance (5)	SOT23-5		230	°C/W
		SC70-5		380	
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J			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)Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.
(3)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 ±50mA or less.
(4)Short-circuit to ground, one amplifier per package.
(5)The package thermal impedance is calculated in accordance with JESD-51.
(6)The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	±3000	V
		Machine Model (MM)	±200	

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage，Vs= (V+) - (V-)	Single-supply	2.5		5.5	V
	Dual-supply	±1.25		±2.75	

7.4 Electrical Characteristics

(At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, Full[9]=-40°C to +125°C，unless otherwise noted.)[1]

PARAMETER		CONDITIONS	T_J	ZM321BK			UNITS
				MIN	TYP	MAX	
POWER SUPPLY							
Vs	Operating Voltage Range		25°C	2.5		5.5	V
I_Q	Quiescent Current/Amplifier		25°C		85	140	μA
PSRR	Power-Supply Rejection Ratio	Vs=2.5V to 5.5V, V_{CM}=(V-)+0.5V	25°C	70	75		dB
			Full	64			
INPUT							
Vos	Input Offset Voltage	V_{CM}=0V to 3.5V	25°C	-4.5	±0.8	4.5	mV
Vos TC	Input Offset Voltage Average Drift	-40°C to 125°C			2		μV/°C
IB	Input Bias Current		25°C		10		pA
Ios	Input Offset Current		25°C		10		pA
V_{CM}	Common-Mode Voltage Range	Vs= 5.5V	25°C	-0.1		5.6	V
CMRR	Common-Mode Rejection Ratio	Vs= 5.5V, V_{CM} =-0.1V to 4V	25°C	65	85		dB
			Full	62			
		Vs= 5.5V, V_{CM} =-0.1V to 5.6V	25°C	58	80		
			Full	56			
OUTPUT							
A_{OL}	Open-Loop Voltage Gain	R_L=2KΩ, Vo= 0.15V to 4.85V	25°C	85	95		dB
			Full	75			
		R_L=10KΩ, Vo= 0.05V to 4.95V	25°C	88	100		
			Full	80			
	Output Swing From Rail	R_L=2KΩ	25°C		25		mV
		R_L=10KΩ			8		
Iout	Output Current Source		25°C		120		mA
FREQUENCY RESPONSE							
SR	Slew Rate		25°C		0.45		V/μs
GBP	Gain-Bandwidth Product		25°C		1		MHz
PM	Phase Margin		25°C		64		°
ts	Setting Time,0.1%				1.3		μs
	Overload Recovery Time	V_{IN}·Gain≥V_S			2.3		μs
NOISE							
en	Input Voltage Noise Density	f = 1KHz	25°C		22		nV/√Hz
		f = 10KHz	25°C		20		nV/√Hz

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.
(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
(4) This parameter is ensured by design and/or characterization and is not tested in production.
(5) Positive current corresponds to current flowing into the device.
(6) The maximum power dissipation is a function of TJ(MAX), RθJA, and TA. The maximum allowable power dissipation at any ambient temperature is PD = (T J(MAX) - TA) / RθJA. All numbers apply for packages soldered directly onto a PCB.
(7) Short circuit test is a momentary test.
(8) Number specified is the slower of positive and negative slew rates.

(9) Specified by characterization only.

7.5 Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

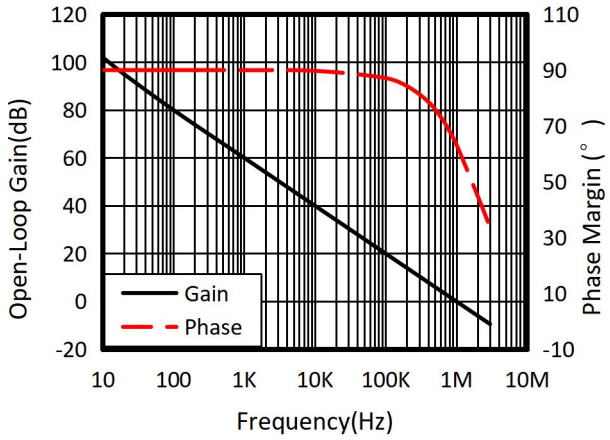


Figure 1. Open-Loop Gain and Phase vs Frequency

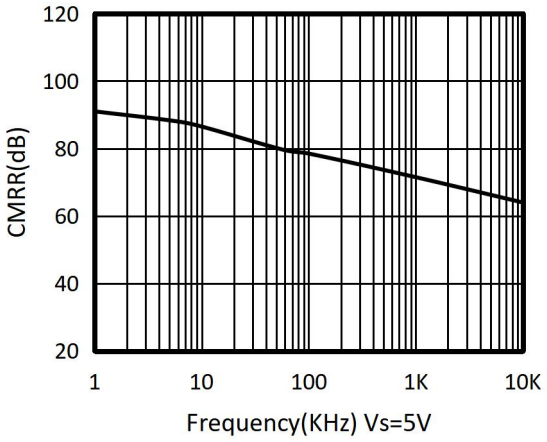


Figure 2. Common−Mode Rejection Ratio vs Frequency

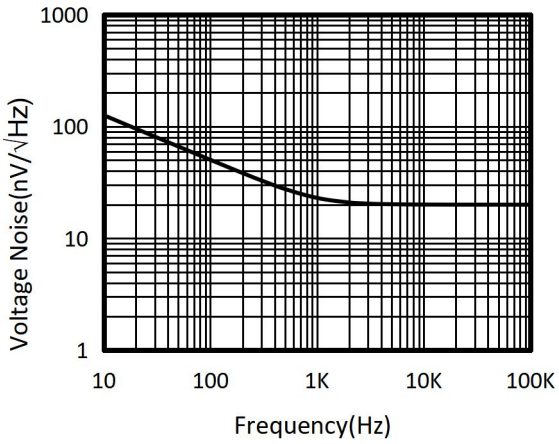


Figure 3. Input Voltage Noise Spectral Density vs Frequency

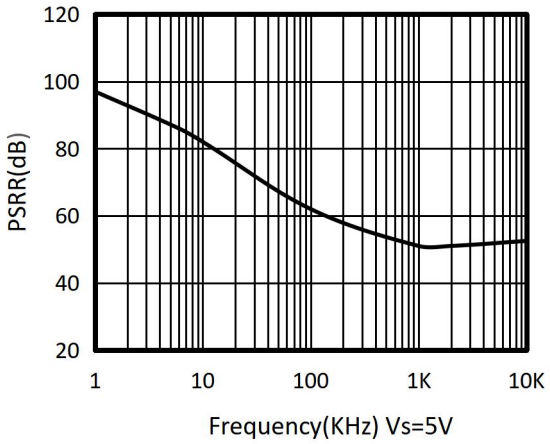


Figure 4. Power−Supply Rejection Ratio vs Frequency

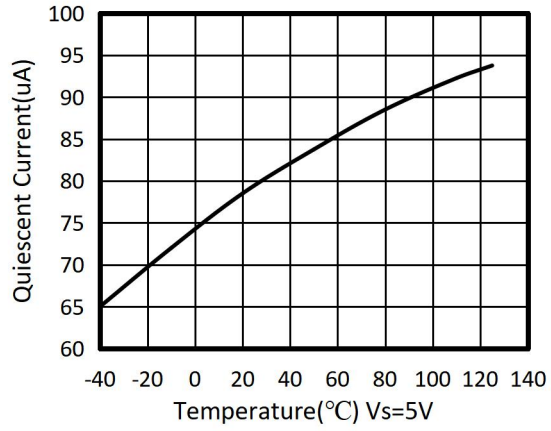


Figure 5. Quiescent Current vs temperature

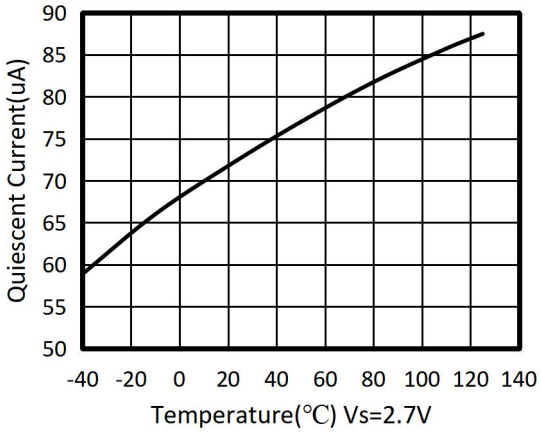


Figure 6. Quiescent Current vs temperature

Typical Characteristics

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

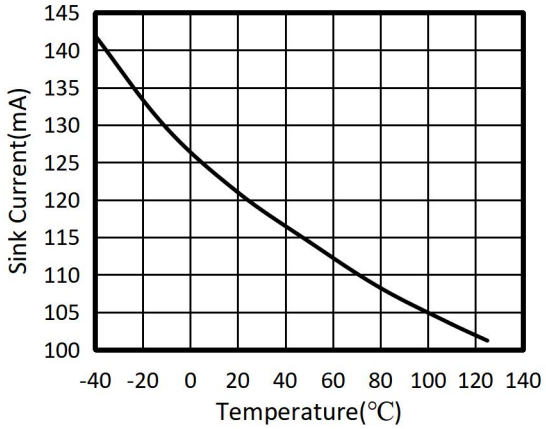


Figure 7. Sink Current vs Temperature

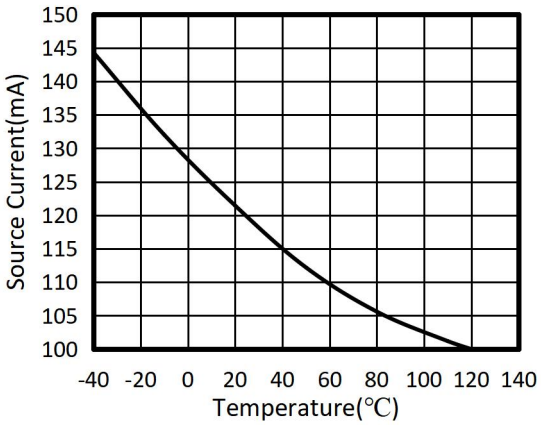


Figure 8. Source Current vs Temperature

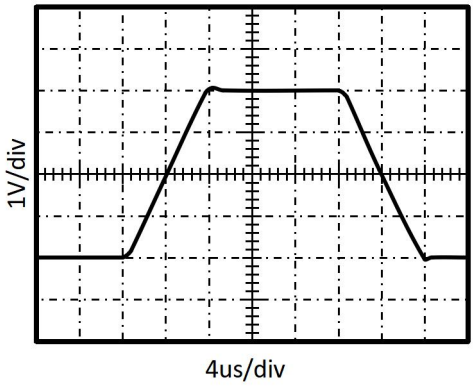


Figure 9. Large−Signal Step Response

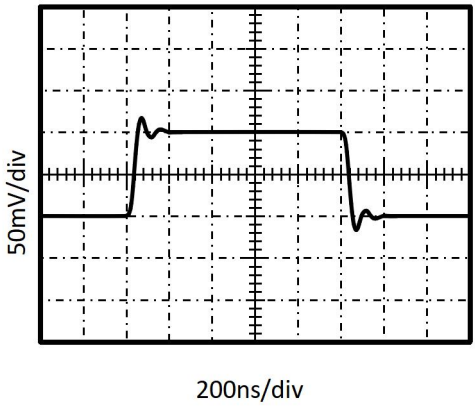


Figure 10. Small−Signal Step Response

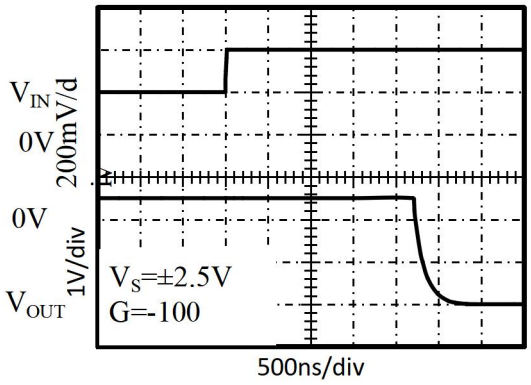


Figure 11. Positive Overvoltage Recovery

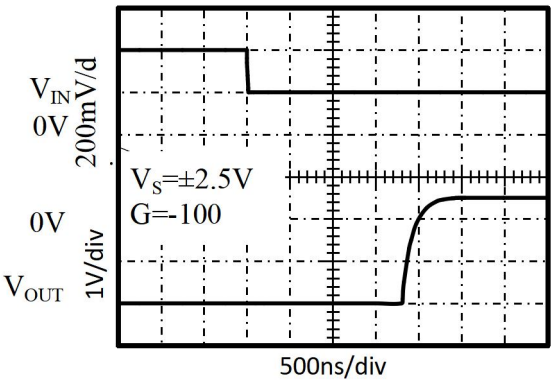


Figure 12. Negative Overvoltage Recovery

9 Application and Implementation

Information in the following applications sections is not part of the Z-Micro component specification, and Z-Micro does not warrant its accuracy or completeness. Z-Micro's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Note

The ZM321BK is high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V (±1.25V to ±2.75V). Supply voltages higher than 7V (absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Good layout practice mandates use of a 0.1uF capacitor place closely across the supply pins.

10 Layout

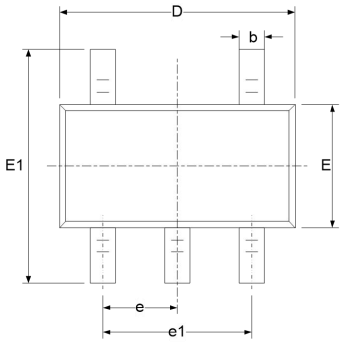
10.1 Layout Guideline

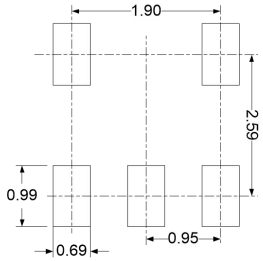
Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1uF capacitor closely across the supply pins.

These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI susceptibility.

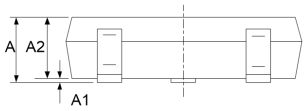
11 Pacakge Outline Dimensions

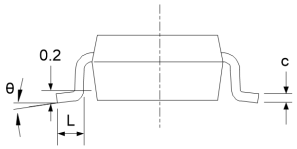
SOT23-5





RECOMMENDED LAND PATTERN (Unit: mm)



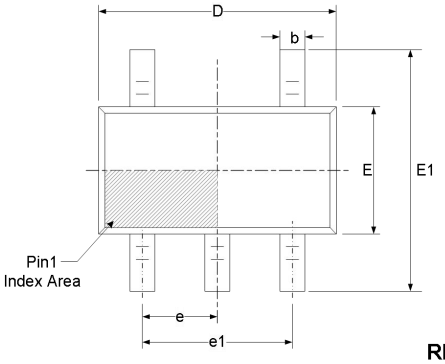


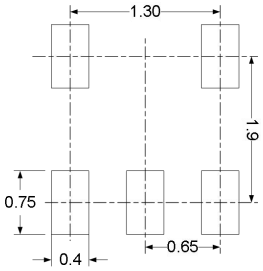
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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

NOTE:

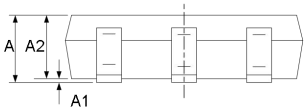
A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

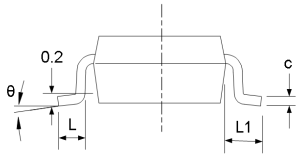
SOT353(SC70-5)





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°

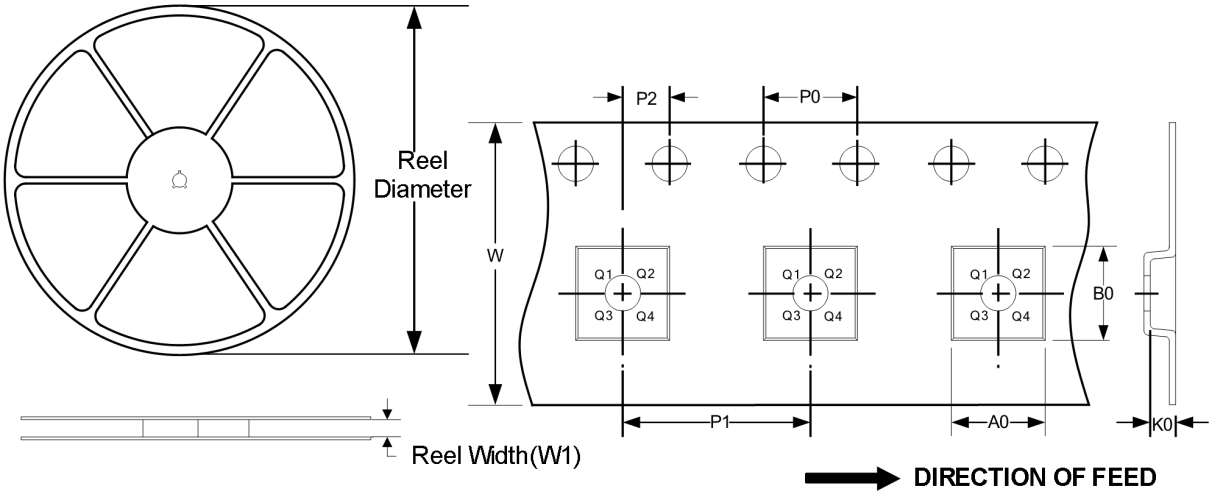
NOTE:

A. This drawing is subject to change without notice.
B. Plastic or metal protrusions of 0.15mm maximum per side are not included.
C. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

12 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

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

IMPORTANT NOTICE AND DISCLAIMER

Z-Micro will accurately and reliably provide technical and reliability data (including data sheets), design resources (including reference designs), application or other design advice, WEB tools, safety information and other resources, without warranty of any defect, and will not make any express or implied warranty, including but not limited to the warranty of merchantability Implied warranty that it is suitable for a specific purpose or does not infringe the intellectual property rights of any third party.

These resources are intended for skilled developers designing with Z-Micro products You will be solely responsible for: (1) Selecting the appropriate products for your application; (2) Designing, validating and testing your application; (3) Ensuring your application meets applicable standards and any other safety, security or other requirements; (4) Z-Micro and the Z-Micro logo are registered trademarks of Z-Micro. All trademarks are the property of their respective owners; (5) For change details, review the revision history included in any revised document. The resources are subject to change without notice. Our company will not be liable for the use of this product and the infringement of patents or third-party intellectual property rights due to its use.