TC1034/TC1035

Linear Building Block – Single Operational Amplifiers in SOT Packages

Features

- Tiny SOT-23A Package
- Optimized for Single Supply Operation
- Ultra Low Input Bias Current: Less than 100pA
- Low Quiescent Current: 6µA (Typ.)
  Shutdown Mode: 0.05µA (Typ.) (TC1035)
- Shutdown Mode (TC1035)
- Rail-to-Rail Inputs and Outputs

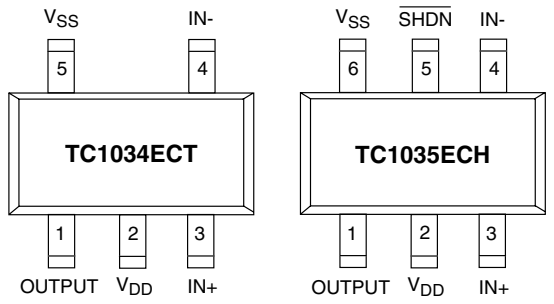
Applications

- Power Management Circuits
- Battery Operated Equipment
- Consumer Products

Device Selection Table

Part Number	Package	Temperature Range
TC1034ECT	5-Pin SOT-23A	-40°C to +85°C
TC1035ECH	6-Pin SOT-23A	-40°C to +85°C

Package Types



NOTE: 5-Pin SOT-23A is equivalent to the EIAJ SC-74A.
6-Pin SOT-23A is equivalent to the EIAJ SC-74.

General Description

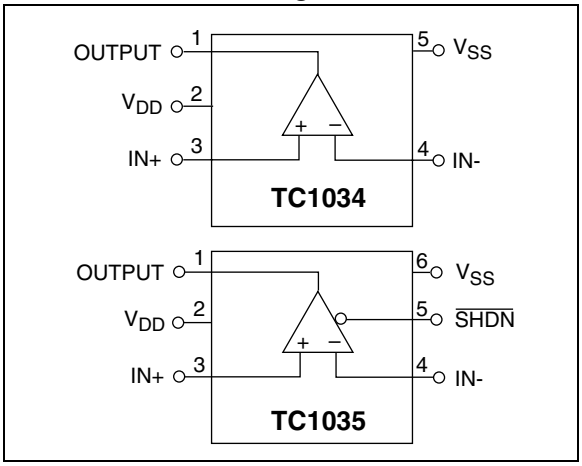
The TC1034/TC1035 are single CMOS operational amplifiers for low power applications.

They have a typical operating supply current of 6µA, which is constant over the supply voltage range of 1.8V to 5.5V. The Op Amp has a rail-to-rail input and output which allows operation at low supply voltages with large input and output signal swings.

An active low shutdown input, $\overline{SHDN}$, is available on the TC1035 and disables the op amp, placing its output in a high-impedance state. The TC1035 draws less than 0.1µA when the shutdown mode is active.

Packaged in a 5-Pin SOT-23A (TC1034) or 6-Pin SOT-23A (TC1035), these single operational amplifiers are ideal for applications requiring high integration, small size and low power.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage 6.0V
Voltage on Any Pin ..... (V_{SS} – 0.3V) to (V_{DD} + 0.3V)
Junction Temperature.....+150°C
Operating Temperature Range.....-40°C to +85°C
Storage Temperature Range .....-55°C to +150°C

*Stresses above 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 above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

TC1034/TC1035 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: T_A = -40° to +85°C and V_{DD} = 1.8V to 5.5V, unless otherwise specified. Typical values apply at 25°C. Minimum and maximum values apply for V_{DD} = 3.0V.

Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
V_{DD}	Supply Voltage	1.8	—	5.5	V	
Shutdown Input (TC1035 Only)						
V_{IH}	Input High Threshold	80% V_{DD}	—	—	V	
V_{IL}	Input Low Threshold	—	—	20% V_{DD}	V	
I_{SI}	Shutdown Input Current **(Note 1)**	—	—	±100	nA	
Op Amp						
I_Q	Supply Current, Operating **(Note 1)**	—	6	10	µA	Output Open, $\overline{SHDN}$ = V_{DD}
I_{SHDN}	Supply Current, Shutdown Mode **(Note 1)**	—	0.05	0.1	µA	$\overline{SHDN}$ = V_{SS}
R_{OUT}(SD)	Output Resistance in Shutdown **(Note 1)**	20	—	—	MΩ	$\overline{SHDN}$ = V_{SS}
C_{OUT}(SD)	Output Capacitance in Shutdown **(Note 1)**	—	—	5	pF	$\overline{SHDN}$ = V_{SS}
T_{SEL}	Select Time (V_{OUT} from $\overline{SHDN}$ = V_{IH}) **(Note 1)**	—	15	—	µsec	R_L=10kΩ to V_{SS}
T_{DESEL}	Deselect Time (V_{OUT} from $\overline{SHDN}$ = V_{IL}) **(Note 1)**	—	20	—	nsec	R_L=10kΩ to V_{SS}
A_{VOL}	Large Signal Voltage Gain	—	100	—	V/mV	R_O = 10kΩ, V_{DD} = 5V
V_{ICMR}	Common Mode Input Voltage Range	V_{SS} – 0.2	—	V_{DD} + 0.2	V	
V_{OS}	Input Offset Voltage **(Note 1)**		±100 ±0.3	±500 ±1.5	µV mV	V_{DD} = 3V, V_{CM} = 1.5V, T_A = 25°C T_A = -40°C to 85°C
I_B	Input Bias Current	-100	50	100	pA	T_A = 25°C; V_{CM} = V_{DD} to V_{SS}
$V_{OS(DRIFT)}$	Input Offset Voltage Drift	—	±4	—	µV/°C	V_{DD} = 3V; V_{CM} = 1.5V
GBWP	Gain Bandwidth Product	—	90	—	kHz	V_{DD} = 1.8V to 5.5V; V_O = V_{DD} to V_{SS}
SR	Slew Rate	—	35	—	mV/µsec	C_L = 100pF, R_L = 1MΩ to GND, Gain = 1, V_{IN} = V_{SS} to V_{DD}
V_{OUT}	Output Signal Swing	V_{SS} + 0.05	—	V_{DD} – 0.05	V	R_L = 10kΩ
CMRR	Common Mode Rejection Ratio	70	—	—	dB	T_A = 25°C; V_{DD} = 5V V_{CM} = V_{DD} to V_{SS}
PSRR	Power Supply Rejection Ratio	80	—	—	dB	T_A = 25°C, V_{CM} = V_{SS} V_{DD} = 1.8V to 5V

Note 1: TC1035 only.

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TC1034/TC1035 ELECTRICAL SPECIFICATIONS (CONTINUED)

Electrical Characteristics: T_A = -40° to +85°C and V_{DD} = 1.8V to 5.5V, unless otherwise specified. Typical values apply at 25°C. Minimum and maximum values apply for V_{DD} = 3.0V.

Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
I_{SRC}	Output Source Current	3	—	—	mA	$V_{IN}+ = V_{DD}$, $V_{IN}- = V_{SS}$ Output Shorted to V_{SS} V_{DD} = 1.8V, Gain =1
I_{SINK}	Output Sink Current	4	—	—	mA	$V_{IN}+ = V_{SS}$, $V_{IN}- = V_{DD}$, Output Shorted to V_{DD} V_{DD} = 1.8V, Gain =1
E_n	Input Noise Voltage	—	10	—	μV_{PP}	0.1Hz to 10Hz
e_n	Input Noise Voltage Density	—	125	—	$nV/\sqrt{Hz}$	1kHz

Note 1: TC1035 only.

2.0 PIN DESCRIPTIONS

The description of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin No. TC1034 (5-Pin SOT-23A)	Symbol	Description
1	OUT	Operational amplifier output.
2	V_{DD}	Positive power supply.
3	IN+	Operational amplifier non-inverting input.
4	IN-	Operational amplifier inverting input.
5	V_{SS}	Negative power supply.

Pin No. TC1035 (6-Pin SOT-23A)	Symbol	Description
1	OUT	Operational amplifier output.
2	V_{DD}	Positive power supply.
3	IN+	Operational amplifier non-inverting input.
4	IN-	Operational amplifier inverting input.
5	$\overline{SHDN}$	Active Low Shutdown Input (TC1035 only). A low input on this pin disables the operational amplifier and places the output terminal in a high-impedance state.
6	V_{SS}	Negative power supply.

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3.0 DETAILED DESCRIPTION

The TC1034/TC1035 is one of a series of very low power, linear building block products targeted at low voltage, single supply applications. The TC1034/TC1035 minimum operating voltage is 1.8V and maximum supply current is only 8µA. The TC1034 is a single op amp in a 5-Pin SOT-23A package, and the TC1035 is a single op amp with shutdown input in a 6-Pin SOT-23A package.

Microchip's op amps are internally compensated to be unity gain stable and have a typical gain bandwidth product of 90kHz with typical slew rates of 35V/msec.

The amplifier's input range extends beyond both supplies by 200mV and the outputs will swing to within several millivolts of the supplies depending on the load current being driven.

Input offset voltage is 500µV max at 25°C with an input bias current of less than 100pA. This makes these devices extremely suitable for precision, low power applications.

4.0 TYPICAL APPLICATIONS

The TC1034/TC1035 lends itself to a wide variety of applications, particularly in battery powered systems. It typically finds applications in power management, processor supervisory and interface circuitry.

4.1 Voice Band Receive Filter

The majority of spectral energy for human voices is found to be in a 2.7kHz frequency band from 300Hz to 3kHz. To properly recover a voice signal in applications such as radios, cellular phones and voice pagers, a low power bandpass filter that is matched to the human voice spectrum can be implemented using Microchip's CMOS op amps. Figure 4-1 shows a unity gain multi-pole Butterworth filter with ripple less than 0.15dB in the human voice band. The lower 3dB cut-off frequency is 70Hz (single order response), while the upper cut-off frequency is 3.5kHz (fourth order response).

4.2 Supervisory Audio Tone (SAT) Filter for Cellular

Supervisory Audio Tones (SAT) provide a reliable transmission path between cellular subscriber units and base stations. The SAT tone functions much like the current/voltage used in land line telephone systems to indicate that a phone is off the hook. The SAT tone may be one of three frequencies: 5970, 6000 or 6030Hz. A loss of SAT implies that channel conditions are impaired and if SAT is interrupted for more than 5 seconds a cellular call is terminated.

Figure 4-2 shows a high Q (30) second order SAT detection bandpass filter using Microchip's CMOS op amp architecture. This circuit nulls all frequencies except the three SAT tones of interest.

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FIGURE 4-1: MULTI-POLE BUTTERWORTH VOICE BAND RECEIVE FILTER

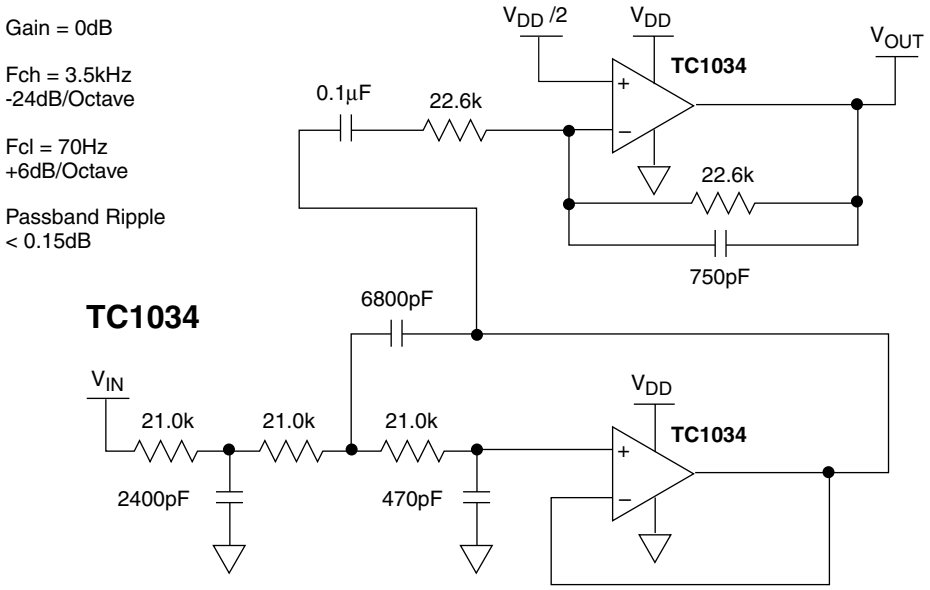
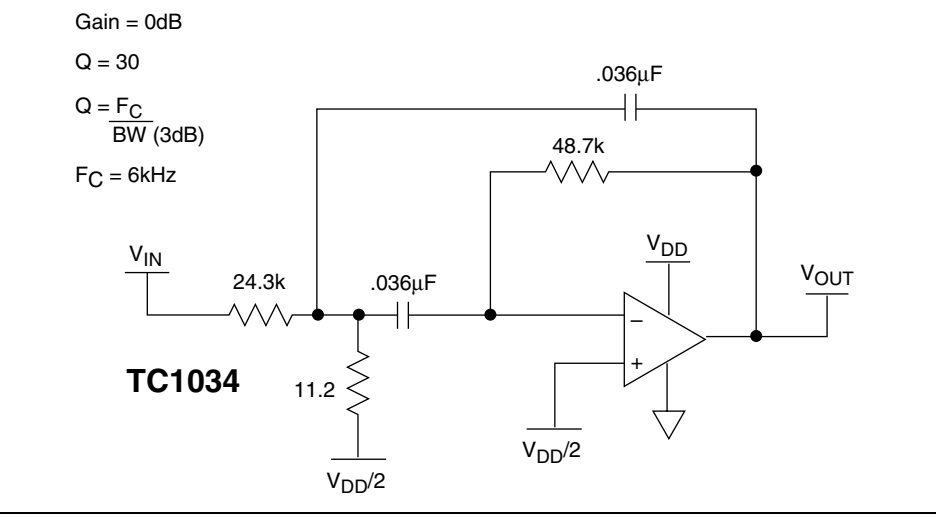


FIGURE 4-2: SECOND ORDER SAT BANDPASS FILTER

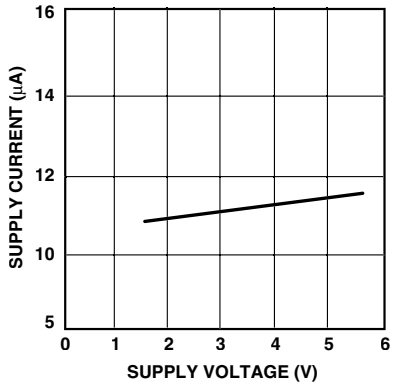


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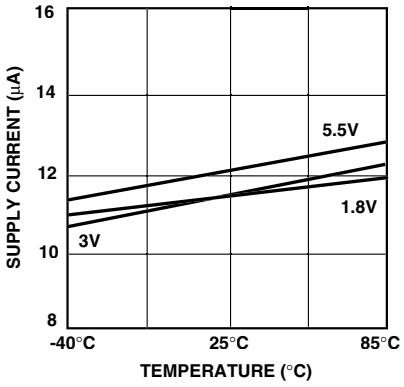
5.0 TYPICAL CHARACTERISTICS

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. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

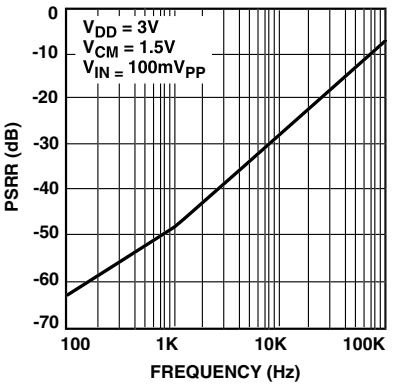
Op Amp Supply Voltage vs. Supply Current



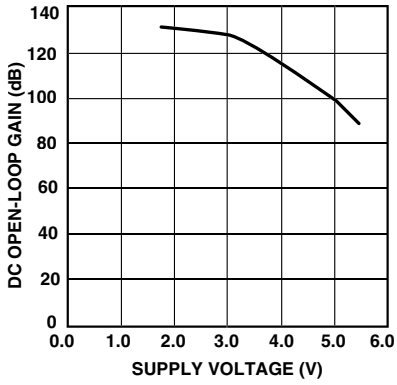
Op Amp Supply Current vs. Temperature



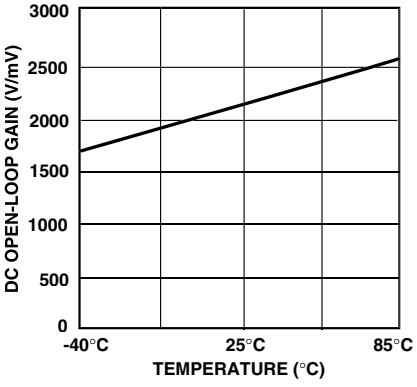
Op Amp Power Supply Rejection Ratio (PSRR) vs. Frequency



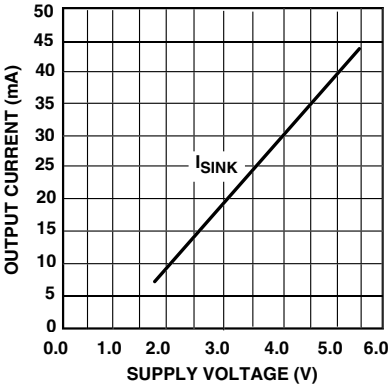
Op Amp DC Open-Loop Gain vs. Supply Voltage



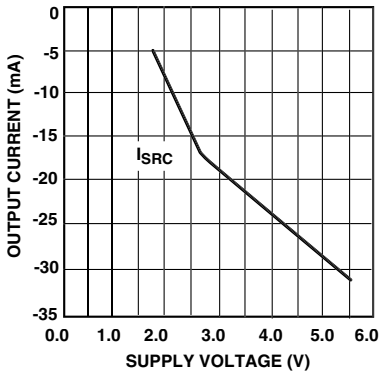
Op Amp DC Open-Loop Gain vs. Temperature



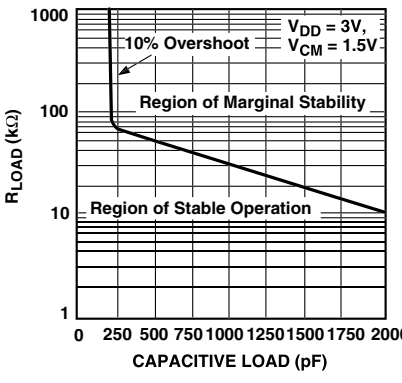
Op Amp Short-Circuit Current vs. Supply Voltage



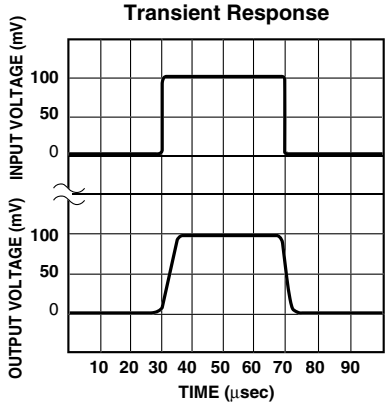
Op Amp Short-Circuit Current vs. Supply Voltage



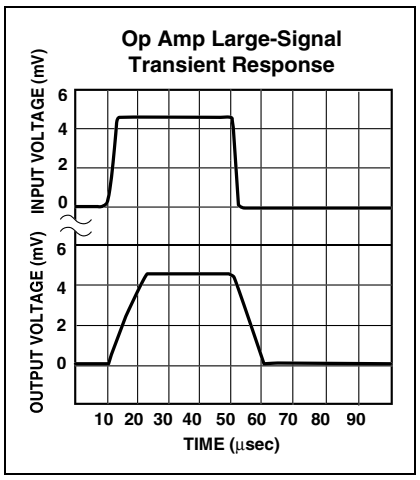
Op Amp Load Resistance vs. Load Capacitance



Op Amp Small-Signal Transient Response



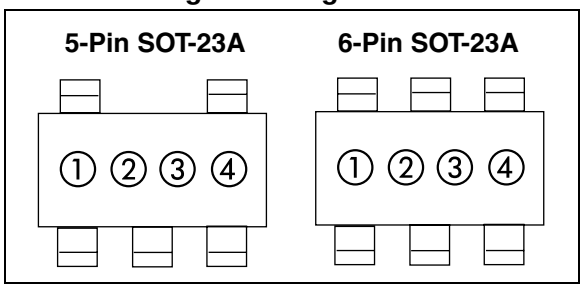
5.0 TYPICAL CHARACTERISTICS (CONTINUED)



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6.0 PACKAGING INFORMATION

6.1 Package Marking Information



1 and 2 = part number code + temperature range and voltage

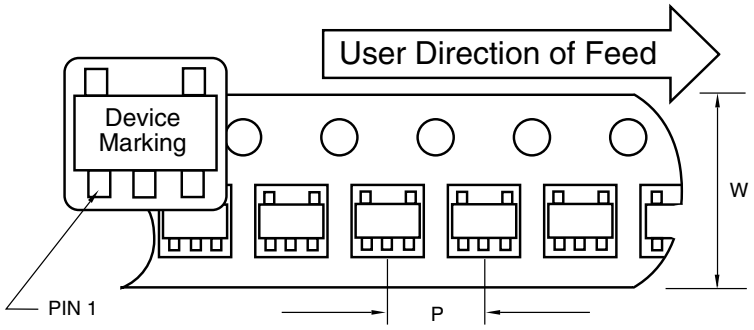
TC1034/TC1035 (V)	Code
TC1034ECT	AE
TC1035ECH	AF

3 = year and quarter code

4 = lot ID number

6.2 Taping Form

Component Taping Orientation for 5-Pin SOT-23A (EIAJ SC-74A) Devices



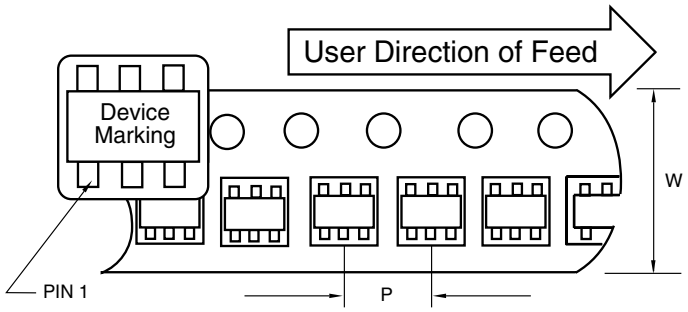
Standard Reel Component Orientation
TR Suffix Device
(Mark Right Side Up)

Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
5-Pin SOT-23A	8 mm	4 mm	3000	7 in

6.2 Taping Form (Continued)

Component Taping Orientation for 6-Pin SOT-23A (EIAJ SC-74) Devices



Standard Reel Component Orientation
For TR Suffix Device
(Mark Right Side Up)

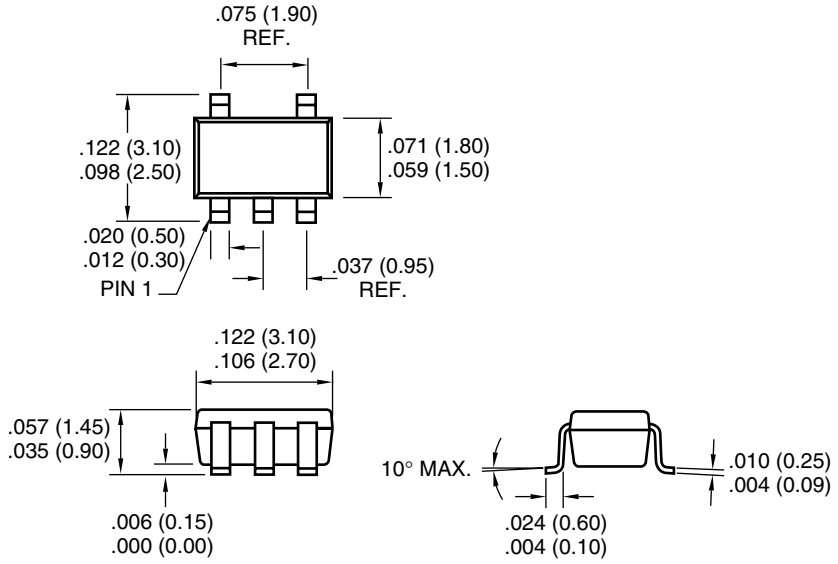
Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
6-Pin SOT-23A	8 mm	4 mm	3000	7 in

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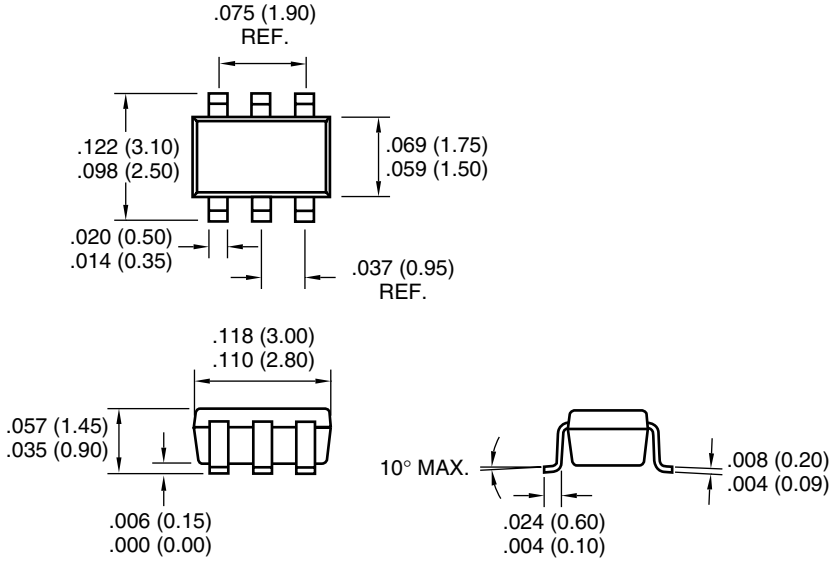
6.3 Package Dimensions

SOT-23A-5



Dimensions: inches (mm)

SOT-23A-6



Dimensions: inches (mm)

NOTES:

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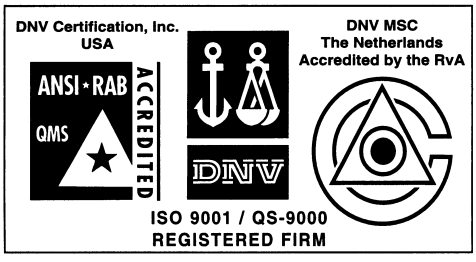
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