EVALUATION KIT AVAILABLE

TC1034
TC1035

Linear Building Block – Single Operational Amplifiers in SOT Packages

FEATURES

- **Tiny SOT-23A Packages Save Space!**
- **Optimized for Single-Supply Operation**
- **Ultra Low Input Bias Current ..... Less than 100 pA**
- **Low Quiescent Current ..... 6 μA (Typ.)**
  0.05 μA, (Typ.) in Shutdown Mode (TC1035)
- **Shutdown Mode (TC1035)**
- **Rail-to-Rail Inputs and Outputs**

APPLICATIONS

- **Power Management Circuits**
- **Battery Operated Equipment**
- **Consumer Products**

GENERAL DESCRIPTION

The TC1034/1035 are single CMOS operational amplifiers for low-power applications.

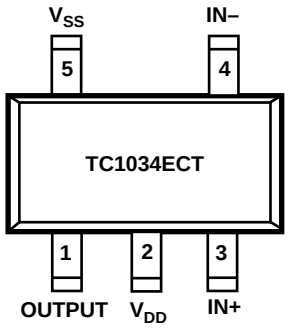
They have a typical operating supply current of 6μA, which is constant over the supply voltage range of 1.8V to 5.5V. The Op Amp has a rail-to-rail input and output which allows operation at low supply voltages with large input and output signal swings.

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.

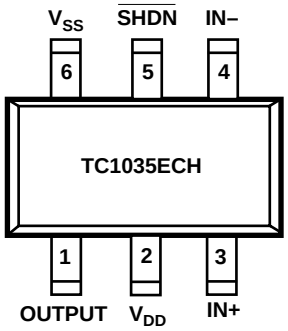
PIN CONFIGURATIONS

5-Pin SOT-23A*



NOTE: *5-Pin SOT-23A is equivalent to EIAJ–SC74A

6-Pin SOT-23A*



NOTE: *6-Pin SOT-23A is equivalent to EIAJ (SC74)

ORDERING INFORMATION

Part No.	Package	Temp. Range
TC1034ECT	5-Pin SOT-23A	–40°C to +85°C
TC1035ECH	6-Pin SOT-23A	–40°C to +85°C
TC1043EV Evaluation Kit for Linear Building Blocks Family		

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage 6.0V
Voltage on Any Pin:
(With Respect to Supplies) .. (V_{SS} – 0.3V) to (V_{DD} +0.3V)
Operating Temperature Range: ..... – 40°C to + 85°C
Storage Temperature Range ..... – 55°C to +150°C
Lead Temperature (Soldering, 10 sec) ..... +260°C

* Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. 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 operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS:

T_A = –40° to +85°C, 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.

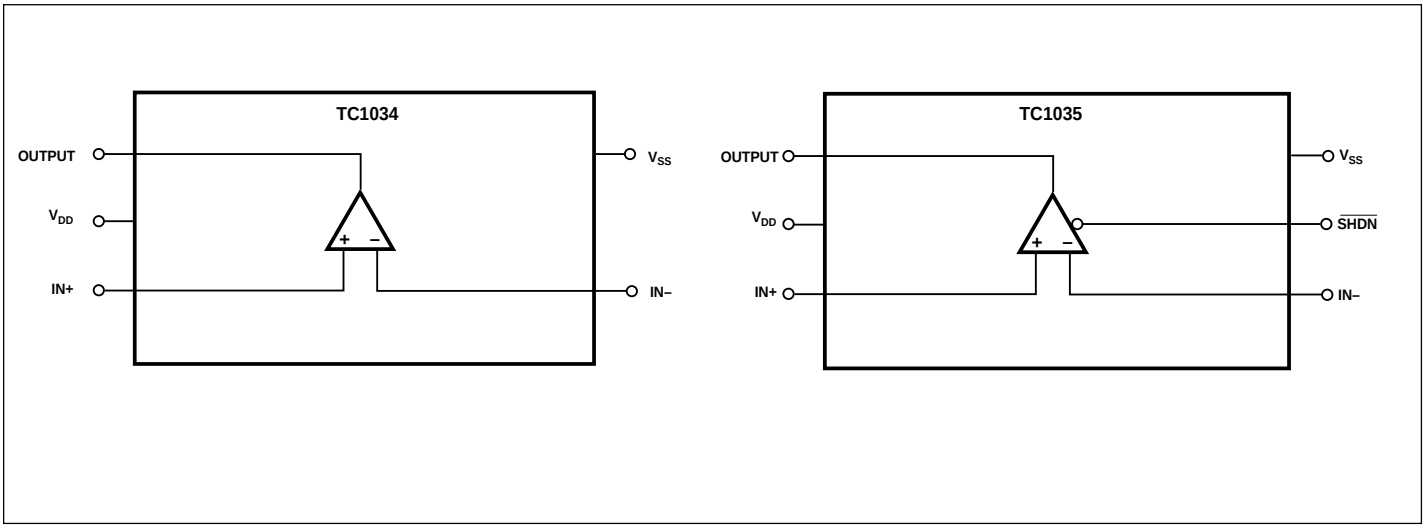
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{DD}	Supply Voltage		1.8	—	5.5	V
Shutdown Input (TC1035 Only)						
V_{IH}	Input High Threshold		80% V_{DD}	—	—	V
V_{IL}	Input Low Threshold		—	—	20% V_{DD}	V
I_{SI}	Shutdown Input Current	(Note 1)	—	—	±100	nA
Op Amp						
I_Q	Supply Current, Operating	Output Open $\overline{SHDN}$ = V_{DD}, (Note 1)	—	6	8	µA
I_{SHDN}	Supply Current, Shutdown Mode (Note 1)	$\overline{SHDN}$ = V_{SS}	—	0.05	0.1	µA
R_{OUT}(SD)	Output Resistance in Shutdown (Note 1)	$\overline{SHDN}$ = V_{SS}	20	—	—	MΩ
C_{OUT}(SD)	Output Capacitance in Shutdown (Note 1)	$\overline{SHDN}$ = V_{SS}	—	—	5	pF
T_{SEL}	Select Time (V_{OUT} from $\overline{SHDN}$ = V_{IH}) (Note 1)	R_L =10KΩ to V_{SS}	—	15	—	µsec
T_{DESEL}	De-select Time (V_{OUT} from $\overline{SHDN}$ = V_{IL}) (Note 1)	R_L =10KΩ to V_{SS}	—	20	—	nsec
A_{VOL}	Large Signal Voltage Gain	R_O = 10 KΩ, V_{DD} = 5V	—	100	—	V/mV
V_{ICMR}	Common Mode Input Voltage Range		V_{SS} – 0.2	—	V_{DD} + 0.2	V
V_{OS}	Input Offset Voltage	V_{DD} = 3V, V_{CM} = 1.5V, T_A = 25°C T_A = –40°C to 85°C		±100 ±0.3	±500 ±1.5	µV mV
I_B	Input Bias Current	T_A = 25°C; V_{CM} = V_{DD} to V_{SS}	–100	50	100	pA
$V_{OS\ (DRIFT)}$	Average Input Offset Voltage Drift	V_{DD} = 3V; V_{CM} = 1.5V	—	4	—	µV/°C
GBWP	Gain-Bandwidth Product	V_{DD} = 1.8 to 5.5V; V_O = V_{DD} to V_{SS}	—	90	—	KHz
SR	Slew Rate	C_L = 100 pF, R_L = 1 MΩ to GND, Gain = 1 V_{IN} = V_{SS} to V_{DD}	—	35	—	mV/µsec
V_{OUT}	Output Signal Swing	R_L = 10 KΩ	V_{SS} + 0.05	—	V_{DD} – 0.05	V
CMRR	Common Mode Rejection Ratio	T_A = 25°C; V_{DD} = 5V; V_{CM} = V_{DD} to V_{SS}	70	—	—	dB
PSRR	Power Supply Rejection Ratio	T_A = 25°C; V_{CM} = V_{SS}; V_{DD} = 1.8V to 5V	80	—	—	dB
I_{SRC}	Output Source Current	V_{IN}+ = V_{DD}, V_{IN} – = V_{SS} Output Shorted to V_{SS} V_{DD} = 1.8V; Gain = 1	3	—	—	mA

NOTE: 1. TC1035 Only

ELECTRICAL CHARACTERISTICS: (Cont.) T_A = –40° to +85°C, 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	Test Conditions	Min	Typ	Max	Unit
I_{SINK}	Output Sink Current	V_{IN}+ = V_{SS},V_{IN}– = V_{DD} Output Shorted to V_{DD} V_{DD} = 1.8V; Gain = 1	4	—	—	mA
en	Input Noise Voltage	0.1Hz to 10 Hz	—	10	—	µVpp
	Input Noise Density	1 KHz	—	125	—	nV/√Hz

FUNCTIONAL BLOCK DIAGRAM



PIN DESCRIPTION

TC1034 Pin No.	TC1035 Pin No.	Name	Description
1	1	OUTPUT	Operational Amplifier Output Terminal.
2	2	V_{DD}	Input Supply Voltage.
3	3	IN+	Operational Amplifier Non-Inverting Input Terminal.
4	4	IN–	Operational Amplifier Inverting Input Terminal.
—	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.
5	6	V_{SS}	Ground Terminal.

DETAILED DESCRIPTION

Operational Amplifiers

The TC1034/1035 is one of a series of very low-power, Linear Building Block products targeted at low-voltage, single-supply applications. The TC1034/1035 minimum operating voltage is 1.8V and maximum supply current is only 8 µA. 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 90 KHz with typical slew rates of 35 V/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 currrent of less than 100pA. This makes these devices extremely suitable for precision, low power applications.

TYPICAL APPLICATIONS

The TC1034/1035 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.

Voice Band Receive Filter

The majority of spectral energy for human voices is found to be in a 2.7 KHz frequency band from 300 Hz to 3 KHz. 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 1 shows a unity gain multi-pole Butterworth filter with ripple less than 0.15 dB in the human voice band. The lower 3 dB cut-off frequency is 70 Hz (single order response) while the upper cut-off frequency is 3.5 KHz (fourth order response).

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 6030 Hz. 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 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.

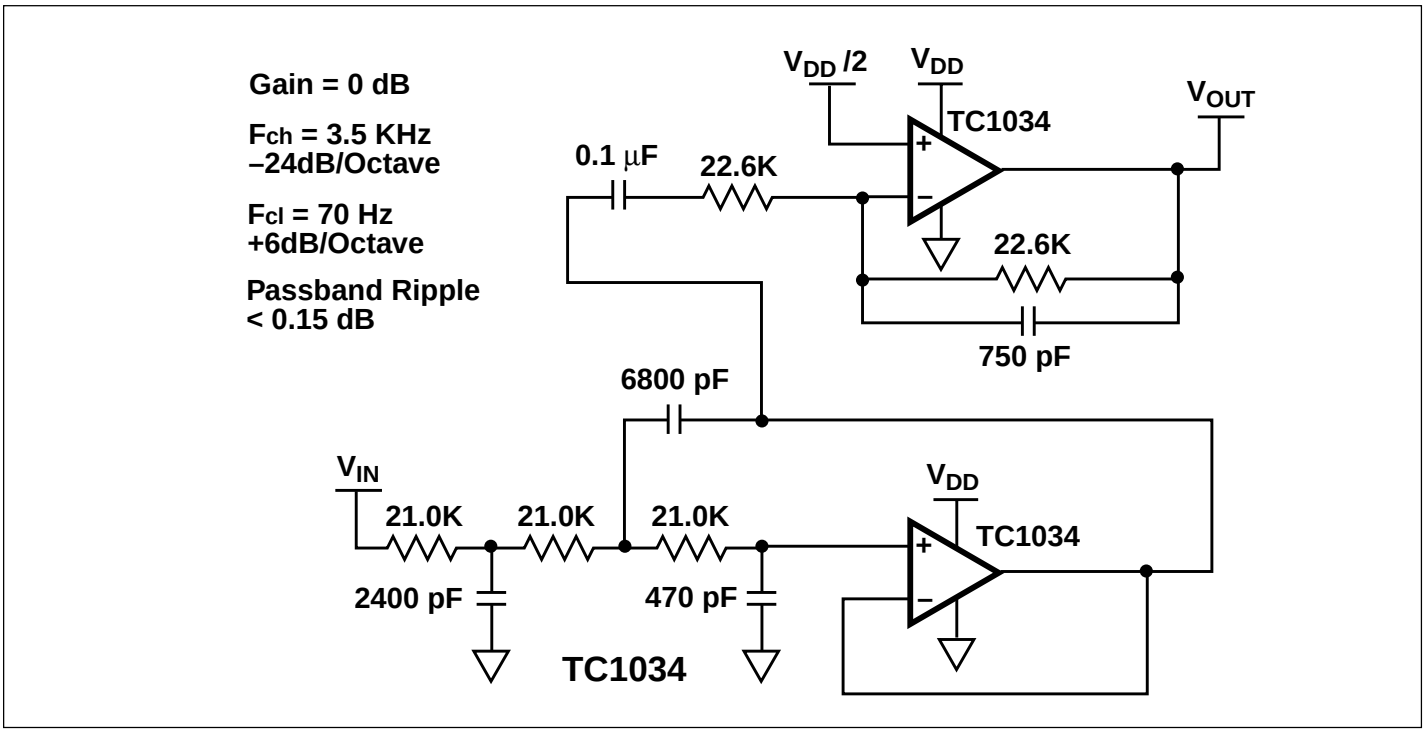


Figure 1. Multi-Pole Butterworth Voice Band Receive Filter

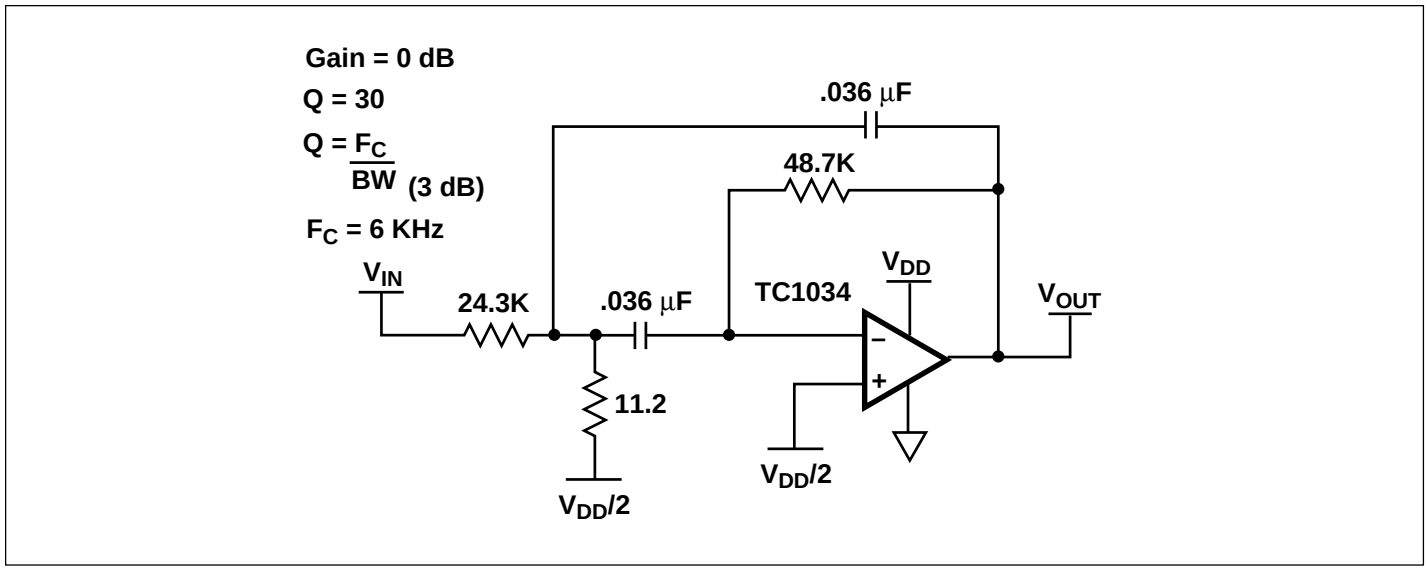
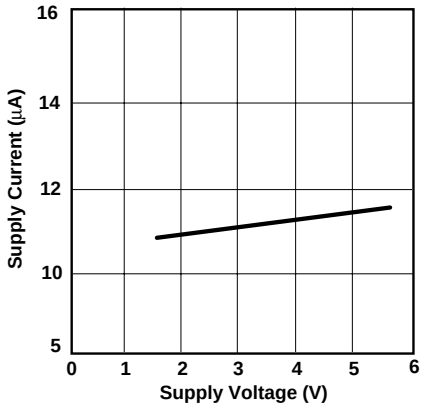


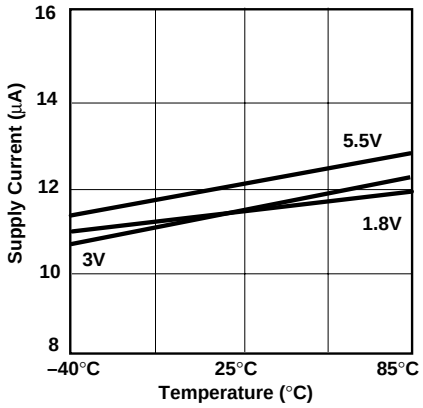
Figure 2. Second Order SAT Bandpass Filter

TYPICAL CHARATERISTICS CURVES

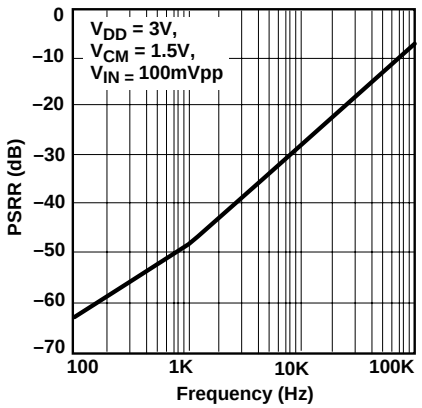
Op-Amp Supply Voltage vs. Supply Current



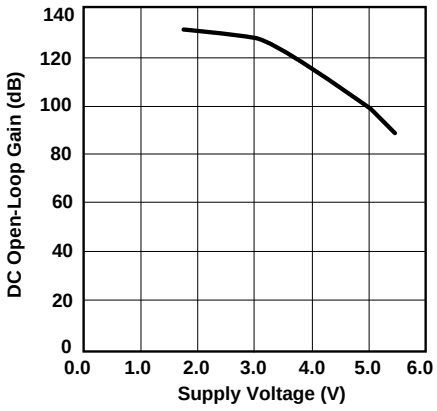
Op-Amp Supply Current vs. Temperature



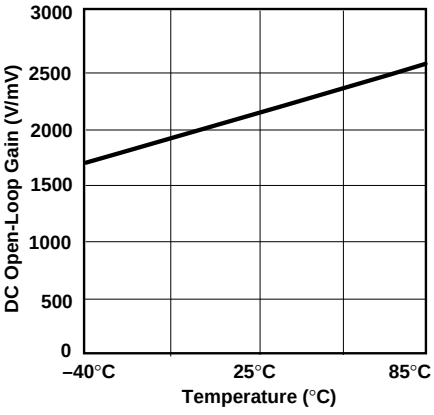
Op-Amp Power Supply Rejection Ratio(PSRR) vs. Frequency



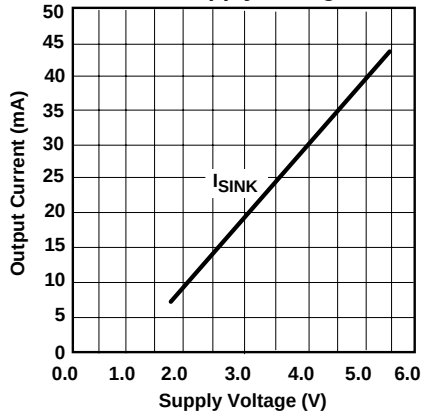
Op-Amp DC Open-Loop Gain vs. Supply Voltage



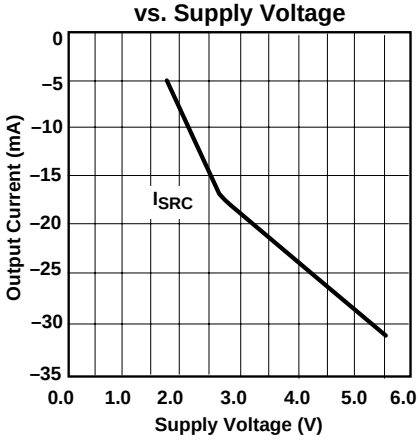
Op-Amp DC Open-Loop Gain vs. Temperature



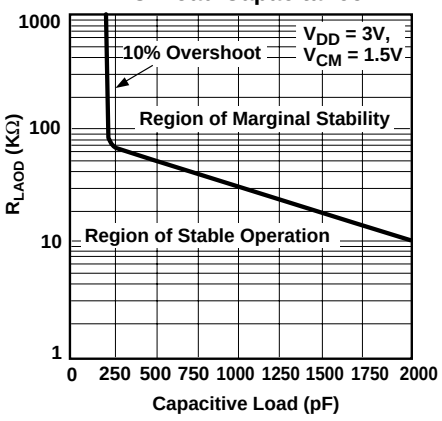
Op-Amp Short-Circuit Current vs. Supply Voltage



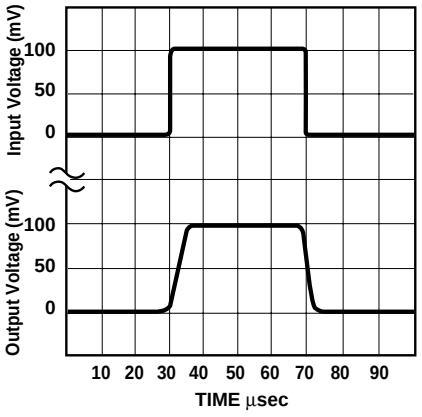
Op-Amp Short-Circuit Current vs. Supply Voltage



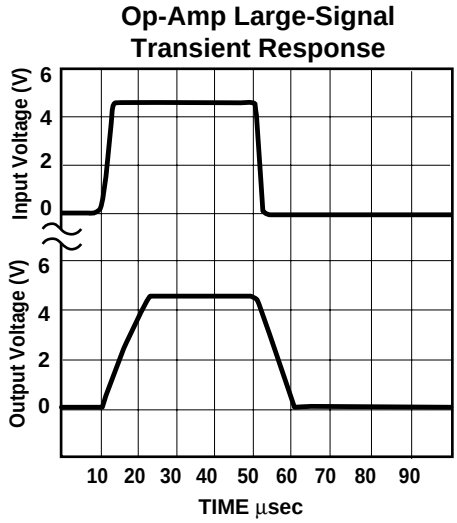
Op-Amp Load Resistance vs. Load Capacitance



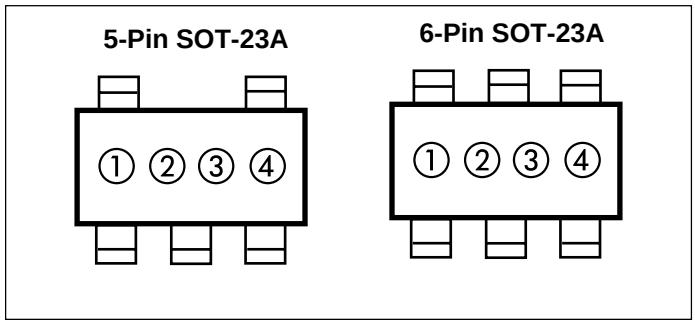
Op-Amp Small-Signal Transient Response



TYPICAL CHARATERISTICS CURVES



MARKINGS



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

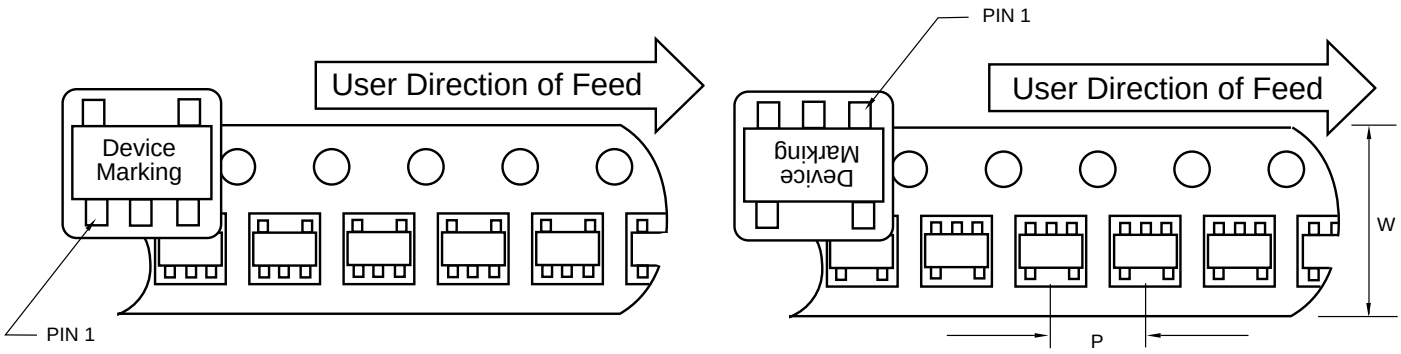
TC1034/1035 (V)	Code
TC1034ECT	AE
TC1035ECH	AF

③ represents year and quarter code

④ represents lot ID number

TAPING FORM

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



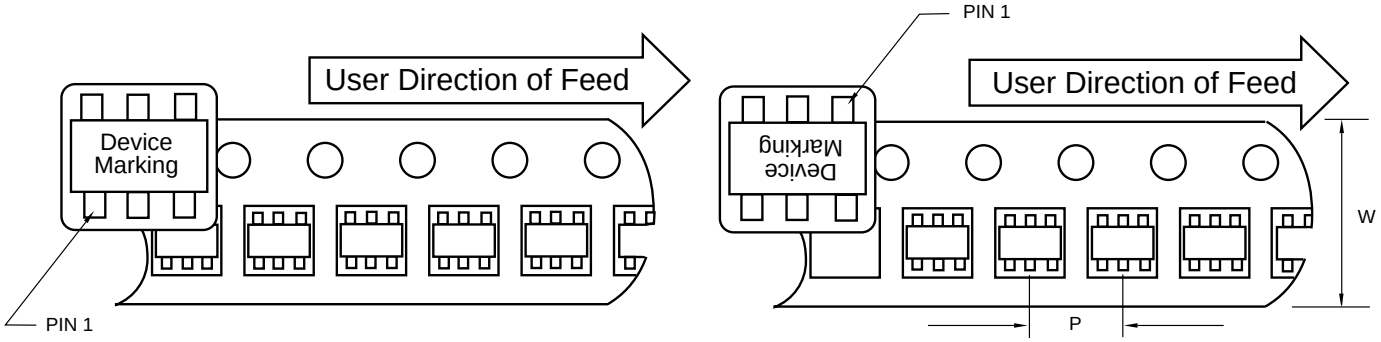
Standard Reel Component Orientation
TR Suffix Device
(Mark Right Side Up)

Reverse Reel Component Orientation
RT Suffix Device
(Mark Upside Down)

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

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



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

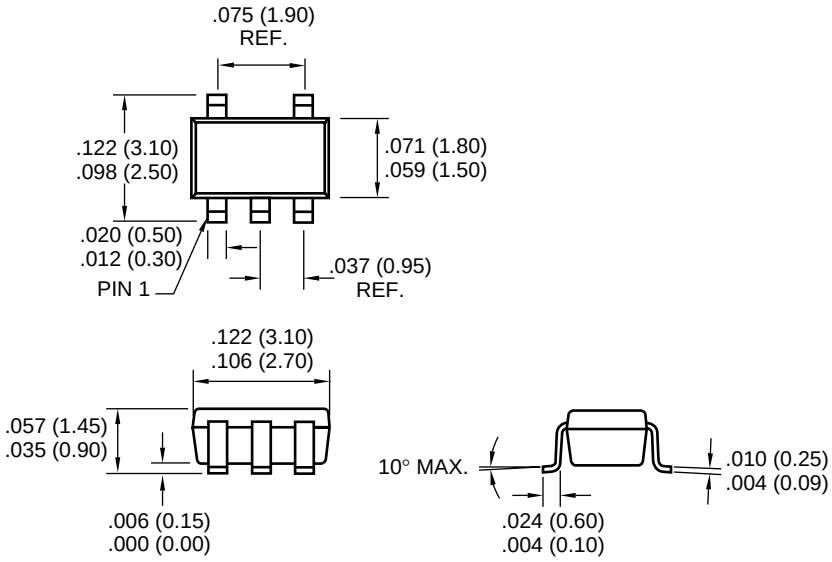
Reverse Reel Component Orientation
For RT Suffix Device
(Mark Upside Down)

Carrier Tape, Number of Components Per Reel and Reel Size

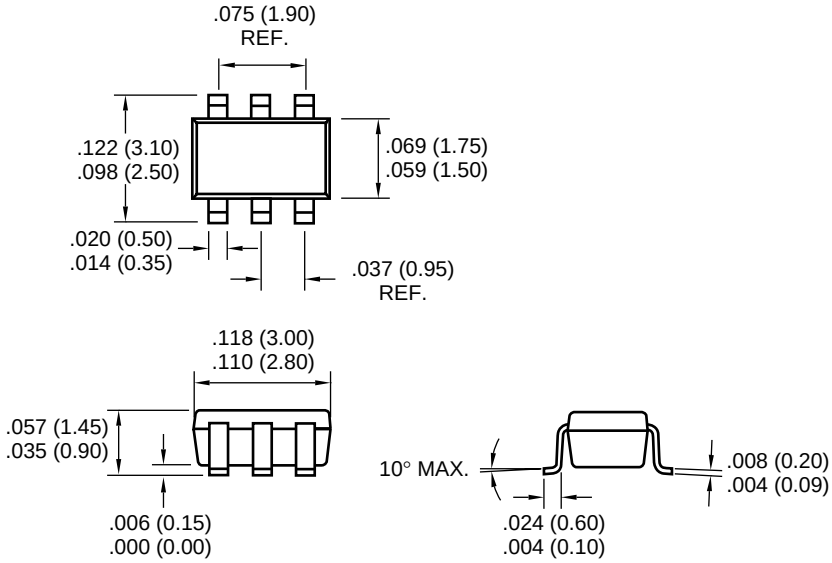
Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
6-Pin SOT-23A	8 mm	4 mm	3000	7 in

PACKAGE DIMENSIONS

5-Pin SOT-23A (EIAJ SC-74A)



6-Pin SOT-23A (EIAJ SC-74)



Dimensions: inches (mm)

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