

# FAN4174

## Single, Ultra-Low Cost, Rail-to-Rail I/O, CMOS Amplifier

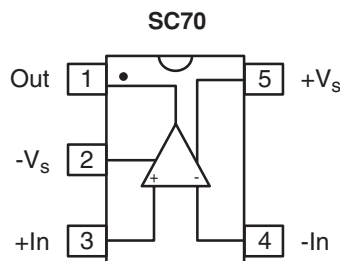
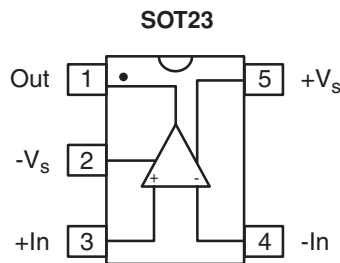
### Features at +5V

- 200 $\mu$ A supply current per amplifier
- 3.7MHz bandwidth
- Output swing to within 10mV of either rail
- Input voltage range exceeds the rails
- 3V/ $\mu$ s slew rate
- 25nV/ $\sqrt{\text{Hz}}$  input voltage noise
- Competes with OPA340 and TLV2461
- Package options (SC70-5 and SOT23-5)
- Fully specified at +2.7V and +5V supplies

### Applications

- Portable/battery-powered applications
- PCMCIA, USB
- Mobile communications, cellular phones, pagers
- Notebooks and PDA's
- Sensor interface
- A/D buffer
- Active filters
- Signal conditioning
- Portable test instruments

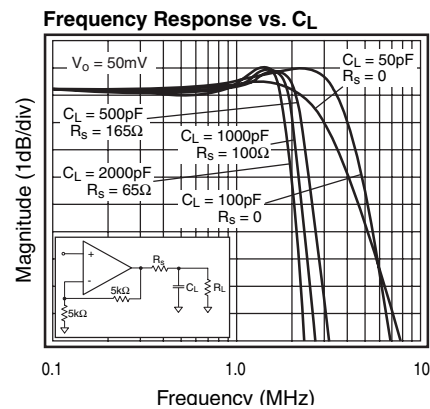
### Pin Assignments



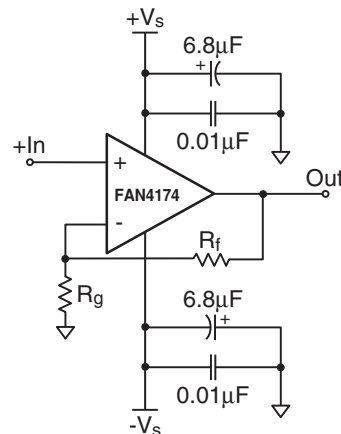
### Description

The FAN4174 is a single, ultra-low cost, voltage feedback amplifier with CMOS inputs that consumes only 200 $\mu$ A of supply current while providing  $\pm 33$ mA of output short circuit current. The FAN4174 is designed to operate from 2.5V to 5V supplies. The common mode voltage range extends beyond the negative and positive rails.

The FAN4174 is designed on a CMOS process and provides 3.7MHz of bandwidth and 3V/ $\mu$ s of slew rate at a supply voltage of +5V. The combination of low power, rail-to-rail performance, low voltage operation, and tiny package options make the FAN4174 well suited for use in many general purpose and battery powered applications.



### Typical Application



## Electrical Specifications at +2.7V

( $V_S = +2.7V$ ,  $G = 2$ ,  $R_L = 10k\Omega$  to  $V_S/2$ ,  $R_F = 5k\Omega$ ; unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>Frequency Domain Response</b>						
UGBW	-3dB Bandwidth	$G = +1$		4		MHz
BW <sub>SS</sub>	-3dB Bandwidth			2.5		MHz
GBWP	Gain Bandwidth product			4		MHz
<b>Time Domain Response</b>						
$t_R$ , $t_F$	Rise and Fall Time	$V_O = 1.0V$ step		300		ns
OS	Overshoot	$V_O = 1.0V$ step		5		%
SR	Slew Rate	$V_O = 3V$ step, $G = -1$		3		V/ $\mu s$
<b>Distortion and Noise Response</b>						
HD2	2nd Harmonic Distortion	$V_O = 1V_{pp}$ , 10kHz		-66		dBc
HD3	3rd Harmonic Distortion	$V_O = 1V_{pp}$ , 10kHz		-67		dBc
THD	Total Harmonic Distortion	$V_O = 1V_{pp}$ , 10kHz		0.1		%
$e_n$	Input Voltage Noise			26		nV/ $\sqrt{Hz}$
<b>DC Performance</b>						
$V_{IO}$	Input Offset Voltage <sup>1</sup>		-6	0	+6	mV
$dV_{IO}$	Average Drift			2.1		$\mu V/^\circ C$
$I_{bn}$	Input Bias Current			5		pA
PSRR	Power Supply Rejection Ratio <sup>1</sup>	DC	50	73		dB
$A_{OL}$	Open Loop Gain	DC		98		dB
$I_S$	Quiescent Current Per Amplifier <sup>1</sup>			200	300	$\mu A$
<b>Input Characteristics</b>						
$R_{IN}$	Input Resistance			10		$G\Omega$
$C_{IN}$	Input Capacitance			1.4		pF
CMIR	Input Common Mode Voltage Range	typical		-0.3 to 2.6		V
CMRR	Common Mode Rejection Ratio <sup>1</sup>	DC, $V_{CM} = 0V$ to $2.2V$	50	65		dB
<b>Output Characteristics</b>						
$V_O$	Output Voltage Swing <sup>1</sup>	$R_L = 10k\Omega$ to $V_S/2$	0.03	0.01 to 2.69	2.65	V
		$R_L = 1k\Omega$ to $V_S/2$		0.05 to 2.55		V
$I_{SC}$	Short Circuit Output Current			+12/-34		mA
$V_S$	Power Supply Operating Range			2.5 to 5.5		V

Min/max ratings are based on product characterization and simulation. Individual parameters are tested as noted. Outgoing quality levels are determined from tested parameters.

### Notes:

1. 100% tested at 25°C.

## Electrical Specifications at +5V

( $V_S = +5V$ ,  $G = 2$ ,  $R_L = 10k\Omega$  to  $V_S/2$ ,  $R_F = 5k\Omega$ ; unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>Frequency Domain Response</b>						
UGBW	-3dB Bandwidth	$G = +1$		3.7		MHz
$BW_{SS}$	-3dB Bandwidth			2.3		MHz
GBWP	Gain Bandwidth product			3.7		MHz
<b>Time Domain Response</b>						
$t_R, t_F$	Rise and Fall Time	$V_O = 1.0V$ step		300		ns
OS	Overshoot	$V_O = 1.0V$ step		5		%
SR	Slew Rate	$V_O = 3V$ step, $G = -1$		3		V/ $\mu s$
<b>Distortion and Noise Response</b>						
HD2	2nd Harmonic Distortion	$V_O = 1V_{pp}$ , 10kHz		-80		dBc
HD3	3rd Harmonic Distortion	$V_O = 1V_{pp}$ , 10kHz		-80		dBc
THD	Total Harmonic Distortion	$V_O = 1V_{pp}$ , 10kHz		0.02		%
$e_n$	Input Voltage Noise			25		nV/ $\sqrt{Hz}$
<b>DC Performance</b>						
$V_{IO}$	Input Offset Voltage <sup>1</sup>		-8	0	+8	mV
$dV_{IO}$	Average Drift			2.9		$\mu V/^\circ C$
$I_{bn}$	Input Bias Current			5		pA
PSRR	Power Supply Rejection Ratio <sup>1</sup>	DC	50	73		dB
$A_{OL}$	Open Loop Gain	DC		102		dB
$I_S$	Quiescent Current Per Amplifier <sup>1</sup>			200	300	$\mu A$
<b>Input Characteristics</b>						
$R_{IN}$	Input Resistance			10		G $\Omega$
$C_{IN}$	Input Capacitance			1.2		pF
CMIR	Input Common Mode Voltage Range	typical		-0.3 to 5.3		V
CMRR	Common Mode Rejection Ratio <sup>1</sup>	DC, $V_{CM} = 0V$ to $V_S$	58	73		dB
<b>Output Characteristics</b>						
$V_O$	Output Voltage Swing <sup>1</sup>	$R_L = 10k\Omega$ to $V_S/2$	0.03	0.01 to 4.99	4.95	V
		$R_L = 1k\Omega$ to $V_S/2$		0.1 to 4.9		V
$I_{SC}$	Short Circuit Output Current			$\pm 33$		mA
$V_S$	Power Supply Operating Range			2.5 to 5.5		V

Min/max ratings are based on product characterization and simulation. Individual parameters are tested as noted. Outgoing quality levels are determined from tested parameters.

### Notes:

1. 100% tested at 25°C.

**Absolute Maximum Ratings** (beyond which the device may be damaged)

Parameter	Min	Max	Units
Supply Voltage	0	6	V
Input Voltage Range	$-V_S - 0.5V$	$+V_S + 0.5V$	V

**Note:**

Functional operation under any of these conditions is NOT implied. Performance and reliability are guaranteed only if operating conditions are not exceeded.

**Recommended Operating Conditions**

Parameter	Min	Typ	Max	Units
Operating Temperature Range (Recommended)	-40		+85	°C

**Reliability Information**

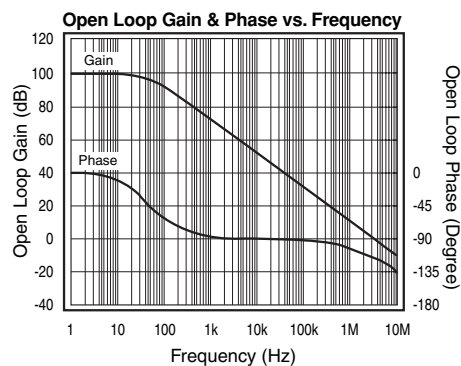
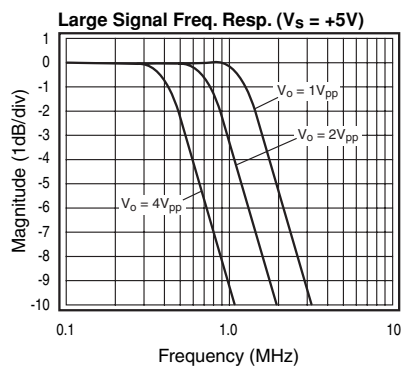
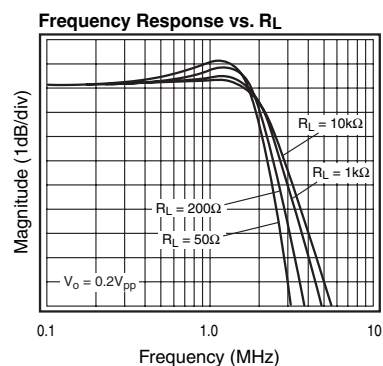
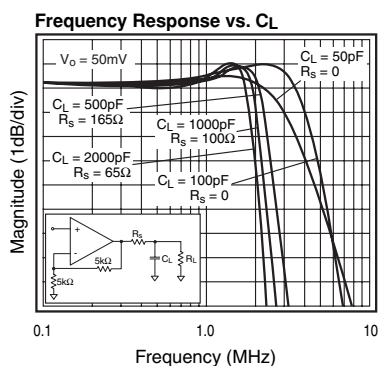
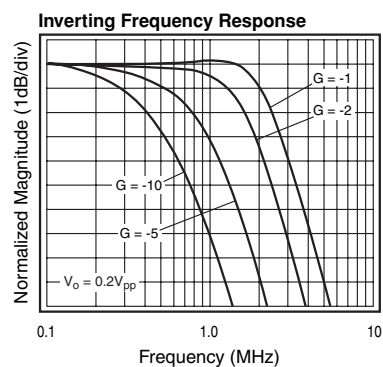
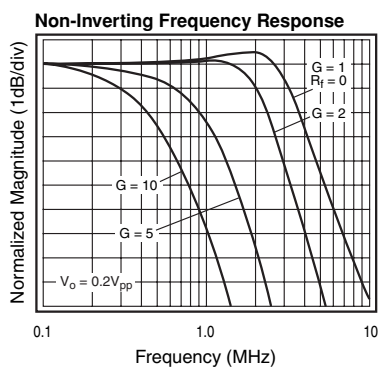
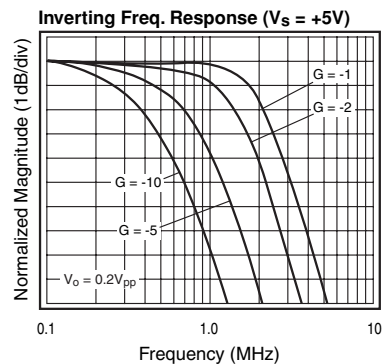
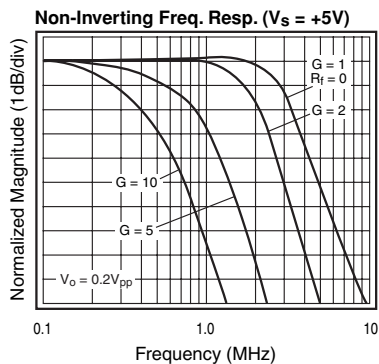
Parameter	Min	Typ	Max	Units
Junction Temperature			175	°C
Storage Temperature Range	-65		+150	°C
Lead Temperature (Soldering, 10s)			+300	°C
Thermal Resistance ( $\theta_{JA}$ ), 5 Lead SOT23 <sup>1</sup>		256		°C/W
Thermal Resistance ( $\theta_{JA}$ ), 5 Lead SC70 <sup>1</sup>		331.4		°C/W

**Note:**

1. Package thermal resistance ( $\theta_{JA}$ ), JEDEC standard multi-layer test boards, still air.

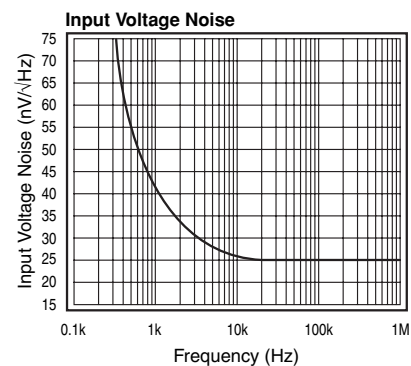
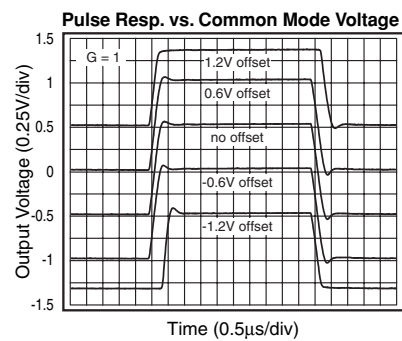
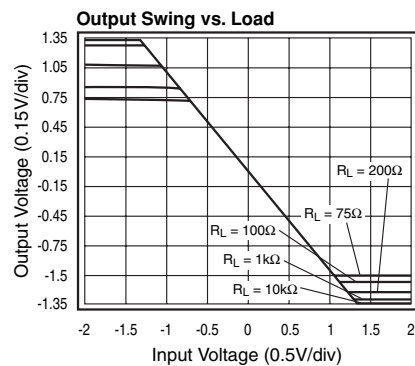
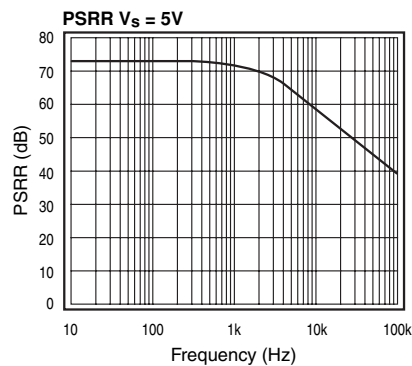
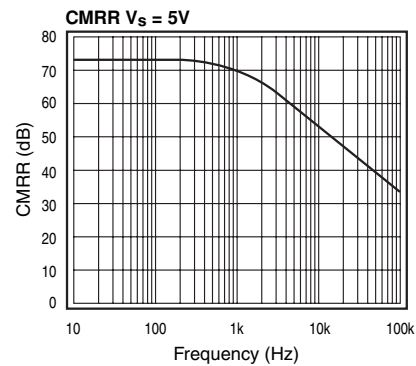
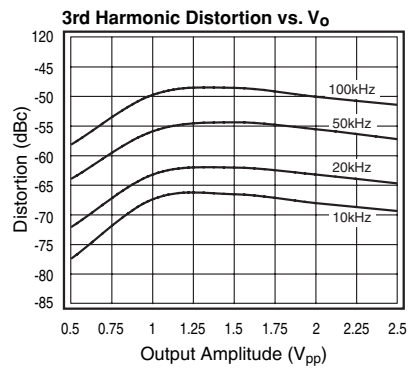
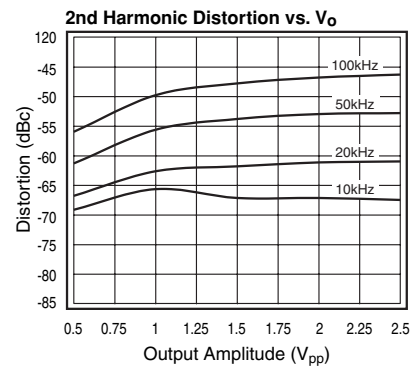
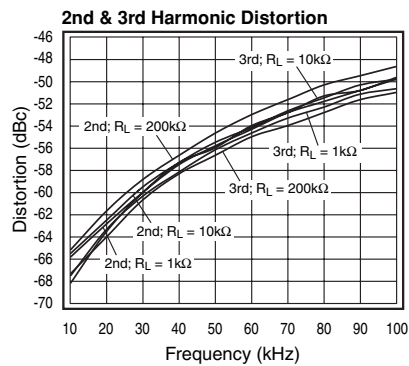
## Typical Performance Characteristics

( $V_S = +2.7V$ ,  $G = 2$ ,  $R_L = 10k\Omega$  to  $V_S/2$ ,  $R_F = 5k\Omega$ ; unless otherwise noted)



## Typical Performance Characteristics

( $V_S = +2.7V$ ,  $G = 2$ ,  $R_L = 10k\Omega$  to  $V_S/2$ ,  $R_F = 5k\Omega$ ; unless otherwise noted)



## Application Information

### General Description

The FAN4174 amplifier is a single supply, general purpose, voltage-feedback amplifier. Fabricated on a bi-CMOS process. The FAN4174 features a rail-to-rail input and output and is unity gain stable.

The typical non-inverting circuit schematic is shown in Figure 1.

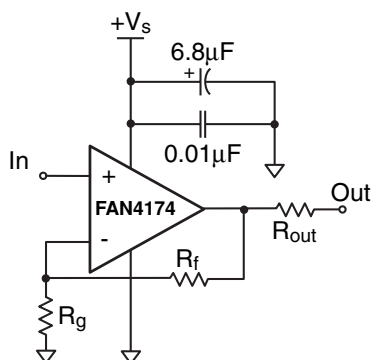


Figure 1: Typical Non-inverting Configuration

### Input Common Mode Voltage

The common mode input range extends to 300mV below ground and to 100mV above Vs, in single supply operation. Exceeding these values will not cause phase reversal. However, if the input voltage exceeds the rails by more than 0.5V, the input ESD devices will begin to conduct. The output will stay at the rail during this overdrive condition. If the absolute maximum input voltage (700mV beyond either rail) is exceeded, externally limit the input current to  $\pm 5\text{mA}$  as shown in Figure 2.

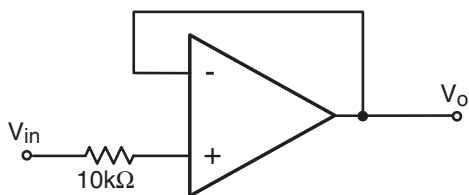


Figure 2: Circuit for Input Current Protection

### Power Dissipation

The maximum internal power dissipation allowed is directly related to the maximum junction temperature. If the maximum junction temperature exceeds 150°C, some performance degradation will occur. If the maximum junction temperature exceeds 175°C for an extended time, device failure may occur.

### Overdrive Recovery

Overdrive of an amplifier occurs when the output and/or input ranges are exceeded. The recovery time varies based on whether the input or output is overdriven and by how much the ranges are exceeded. The FAN4174 will typically recover in less than 500ns from an overdrive condition. Figure 3 shows the FAN4174 amplifier in an overdriven condition.

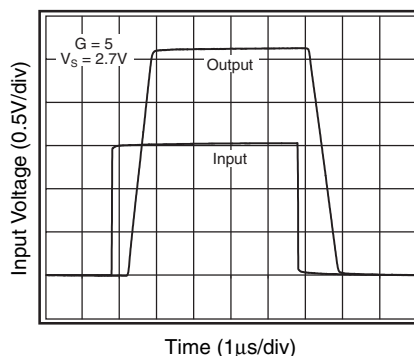


Figure 3: Overdrive Recovery

### Driving Capacitive Loads

The *Frequency Response vs. CL* plot, illustrates the response of the FAN4174 amplifier family. A small series resistance ( $R_s$ ) at the output of the amplifier, illustrated in Figure 4, will improve stability and settling performance.  $R_s$  values in the *Frequency Response vs. CL* plot were chosen to achieve maximum bandwidth with less than 2dB of peaking. For maximum flatness, use a larger  $R_s$ . Capacitive loads larger than 500pF require the use of  $R_s$ .

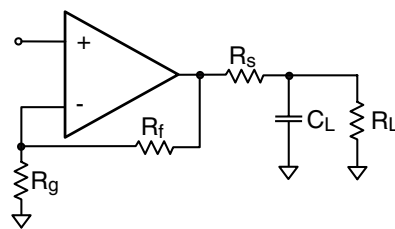


Figure 4: Typical Topology for driving a capacitive load

Driving a capacitive load introduces phase-lag into the output signal, which reduces phase margin in the amplifier. The unity gain follower is the most sensitive configuration. In a unity gain follower configuration, the FAN4174 amplifier family requires a 300Ω series resistor to drive a 100pF load.

## Layout Considerations

General layout and supply bypassing play major roles in high frequency performance. Fairchild has evaluation boards to use as a guide for high frequency layout and as aid in device testing and characterization. Follow the steps below as a basis for high frequency layout:

- Include 6.8 $\mu$ F and 0.01 $\mu$ F ceramic capacitors
- Place the 6.8 $\mu$ F capacitor within 0.75 inches of the power pin
- Place the 0.01 $\mu$ F capacitor within 0.1 inches of the power pin
- Remove the ground plane under and around the part, especially near the input and output pins to reduce parasitic capacitance
- Minimize all trace lengths to reduce series inductances

Refer to the evaluation board layouts shown in Figure 6 for more information.

When evaluating only one channel, complete the following on the unused channel:

1. Ground the non-inverting input
2. Short the output to the inverting input

## Evaluation Board Information

The following evaluation boards are available to aid in the testing and layout of this device:

Eval Bd	Description	Products
KEB002	Single Channel, Dual Supply, 5 and 6 lead SOT23	FAN4174AS5X
KEB011	Single Channel, Dual Supply, 5 and 6 lead SC70	FAN4174AP5X

Evaluation board schematics are shown in Figures 5 and layouts are shown in Figure 6a and 6b.

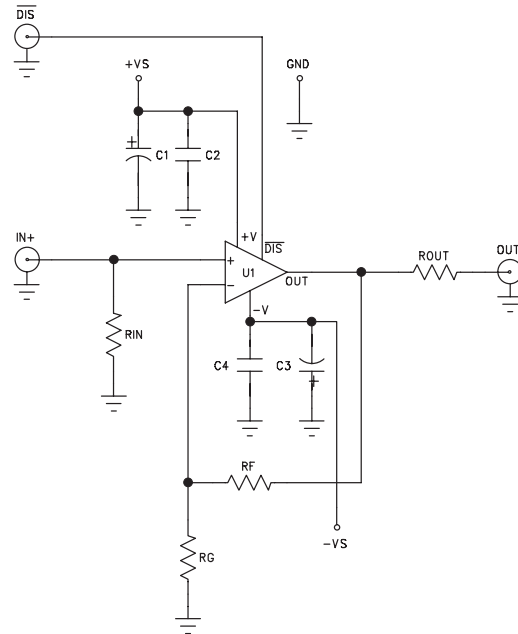


Figure 5: FAN4174 Evaluation Board Schematic



## Evaluation Board Layout

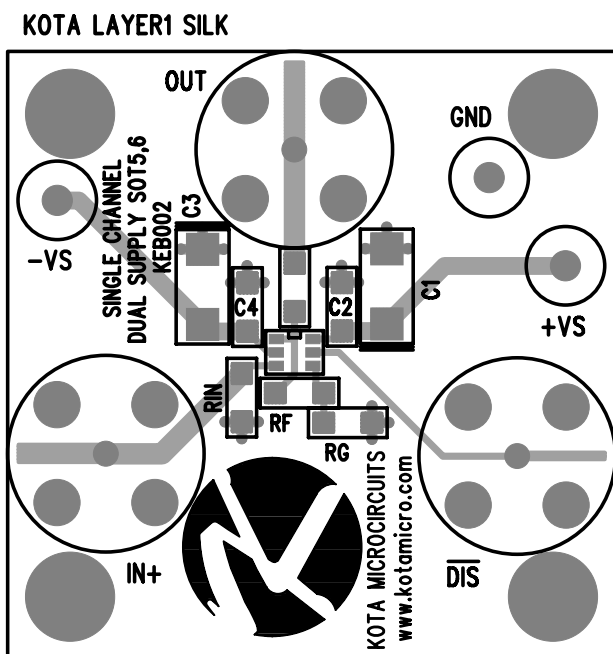


Figure 6a: KEB002 (top side)

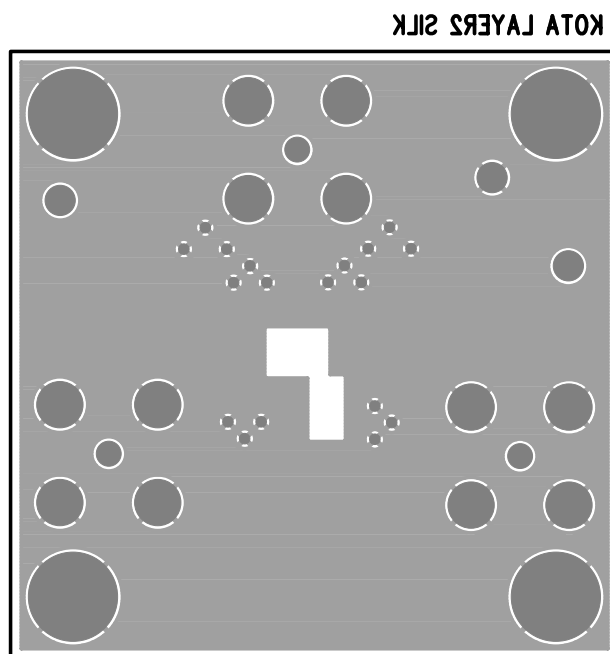
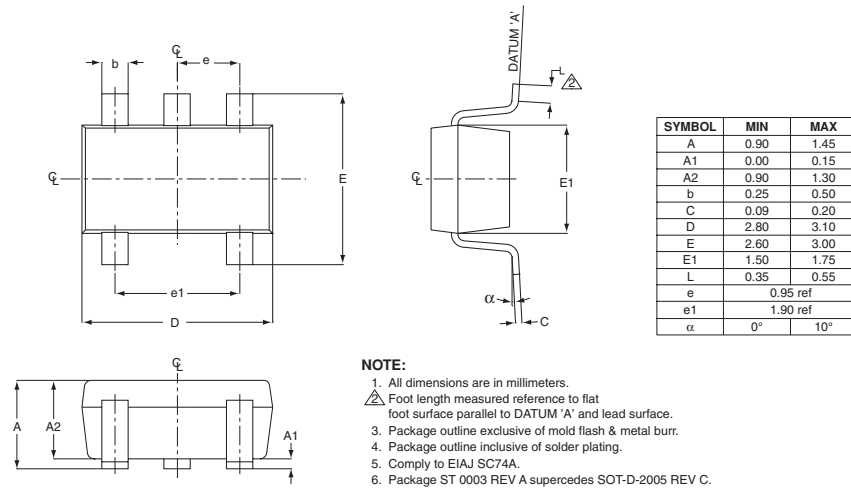


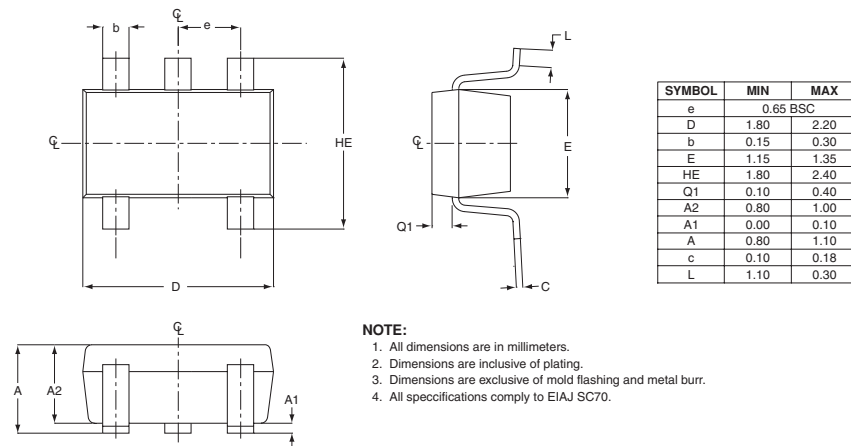
Figure 6b: KEB002 (bottom side)

## Packaging Dimensions



### SOT-23



### SC70



## Ordering Information

Model	Part Number	Lead Free	Package	Container	Pack Qty
FAN4174	FAN4174IS5X_NL		SOT23-5	Reel	3000
FAN4174	FAN4174IP5X_NL		SC70-5	Reel	3000

Temperature range for all parts: -40°C to +85°C.

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