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FAN4174

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

Features at +5V

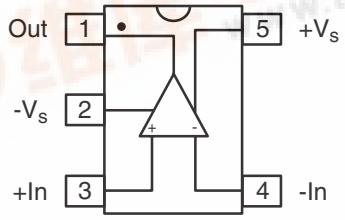
- 200µA supply current per amplifier
- 3.7MHz bandwidth
- Output swing to within 10mV of either rail
- Input voltage range exceeds the rails
- 3V/µs slew rate
- 25nV/√Hz input voltage noise
- Competes with OPA340 and TLV2461
- Package options (SC70-5 and SOT23-5)
- Fully specified at +2.7V and +5V supplies

Applications

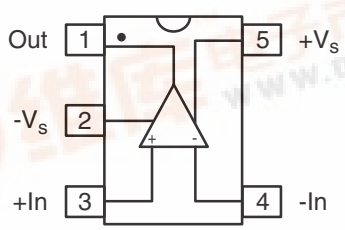
- Portable/battery-powered applications
- PCMCIA, USB
- Mobile communications, cellular phones, pagers
- Notebooks and PDA's
- Sensor interface
- A/D buffer
- Active filters
- Signal conditioning
- Portable test instruments

Pin Assignments

SOT23



SC70

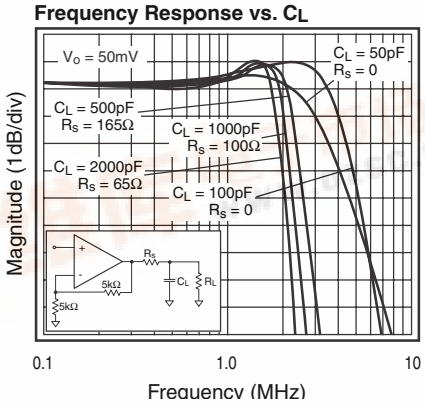


Description

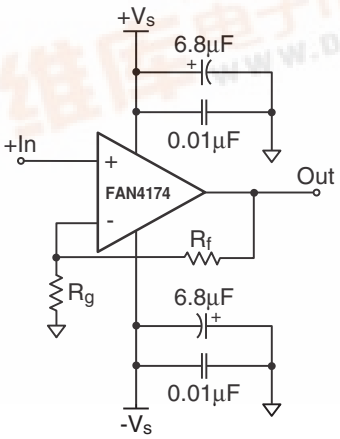
The FAN4174 is a single, ultra-low cost, voltage feedback amplifier with CMOS inputs that consumes only 200µA of supply current while providing ±33mA of output short circuit current. The FAN4174 is designed to operate from 2.5V to 5V supplies. The common mode voltage range extends beyond the negative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

The FAN4174 is designed on a CMOS process and provides 3.7MHz of bandwidth and 3V/µs 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.

Frequency Response vs. C_L



Typical Application



Electrical Specifications at +2.7V

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Frequency Domain Response					
UGBW	-3dB Bandwidth	G = +1		4		MHz
BW_{SS}	-3dB Bandwidth			2.5		MHz
GBWP	Gain Bandwidth product			4		MHz
	Time Domain Response					
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/µs
	Distortion and Noise Response					
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/√Hz
	DC Performance					
V_{IO}	Input Offset Voltage[1]		-6	0	+6	mV
dV_{IO}	Average Drift			2.1		µV/°C
I_{bn}	Input Bias Current			5		pA
PSRR	Power Supply Rejection Ratio[1]	DC	50	73		dB
A_{OL}	Open Loop Gain	DC		98		dB
I_S	Quiescent Current Per Amplifier[1]			200	300	µA
	Input Characteristics					
R_{IN}	Input Resistance			10		GΩ
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[1]	DC, V_{CM} = 0V to 2.2V	50	65		dB
	Output Characteristics					
V_O	Output Voltage Swing[1]	R_L = 10kΩ to V_S/2	0.03	0.01 to 2.69	2.65	V
		R_L = 1kΩ 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 = 10kΩ to V_S/2, R_F = 5kΩ; unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
	Frequency Domain Response					
UGBW	-3dB Bandwidth	G = +1		3.7		MHz
BW_{SS}	-3dB Bandwidth			2.3		MHz
GBWP	Gain Bandwidth product			3.7		MHz
	Time Domain Response					
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/µs
	Distortion and Noise Response					
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/√Hz
	DC Performance					
V_{IO}	Input Offset Voltage[1]		-8	0	+8	mV
dV_{IO}	Average Drift			2.9		µV/°C
I_{bn}	Input Bias Current			5		pA
PSRR	Power Supply Rejection Ratio[1]	DC	50	73		dB
A_{OL}	Open Loop Gain	DC		102		dB
I_S	Quiescent Current Per Amplifier[1]			200	300	µA
	Input Characteristics					
R_{IN}	Input Resistance			10		GΩ
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[1]	DC, V_{CM} = 0V to V_S	58	73		dB
	Output Characteristics					
V_O	Output Voltage Swing[1]	R_L = 10kΩ to V_S/2	0.03	0.01 to 4.99	4.95	V
		R_L = 1kΩ to V_S/2		0.1 to 4.9		V
I_{SC}	Short Circuit Output Current			±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

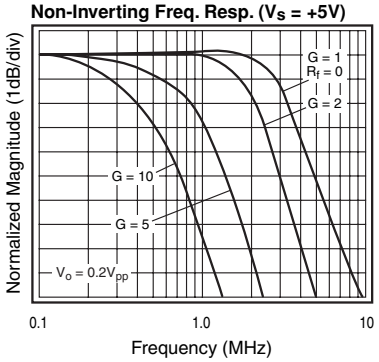
Parameter	Min	Typ	Max	Units
Junction Temperature			175	°C
Storage Temperature Range	-65		+150	°C
Lead Temperature (Soldering, 10s)			+300	°C
Thermal Resistance (θ_{JA}), 5 Lead SOT23[1]		256		°C/W
Thermal Resistance (θ_{JA}), 5 Lead SC70[1]		331.4		°C/W

Note:
1. Package thermal resistance (θ_{JA}), JDEC standard multi-layer test boards, still air.

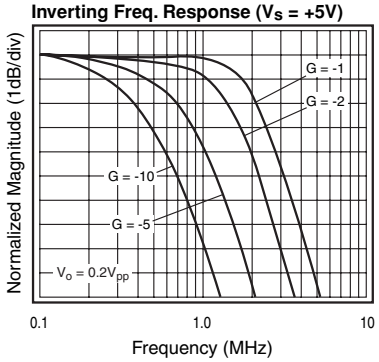
Typical Performance Characteristics

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

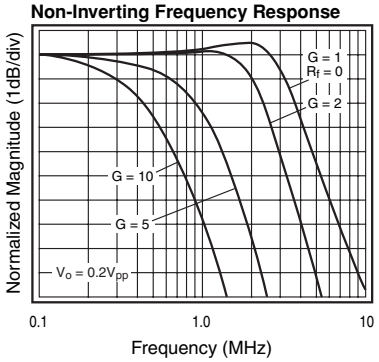
Non-Inverting Freq. Resp. (V_S = +5V)



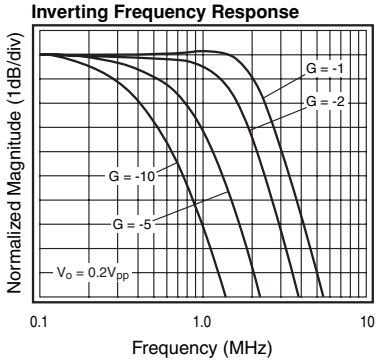
Inverting Freq. Response (V_S = +5V)



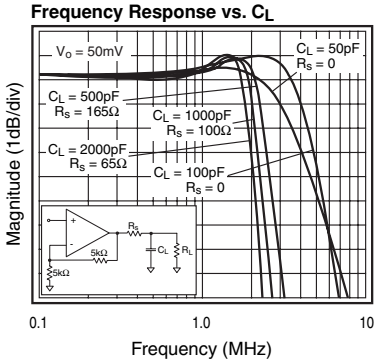
Non-Inverting Frequency Response



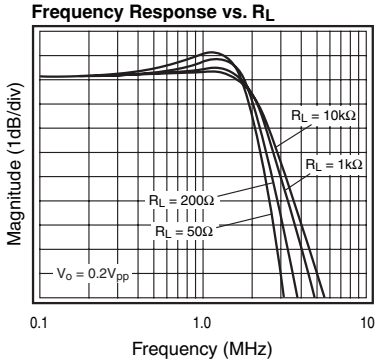
Inverting Frequency Response



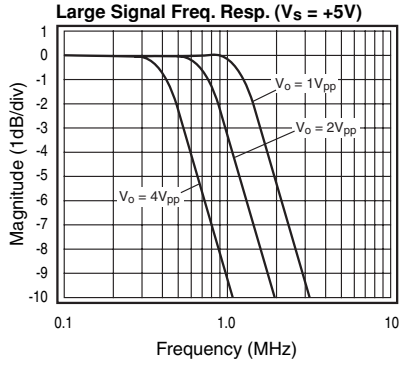
Frequency Response vs. C_L



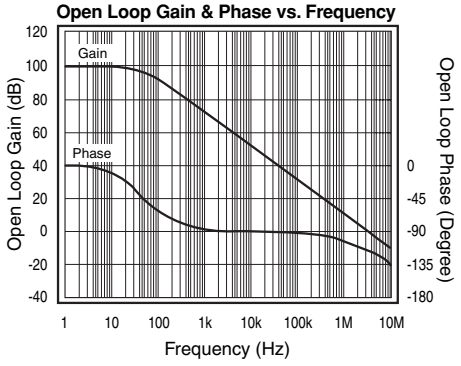
Frequency Response vs. R_L



Large Signal Freq. Resp. (V_S = +5V)



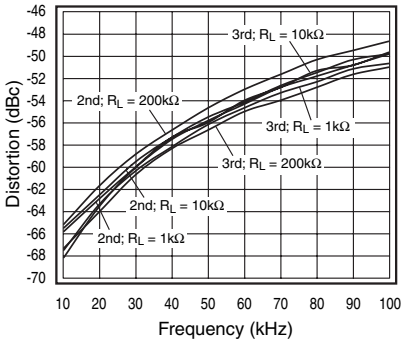
Open Loop Gain & Phase vs. Frequency



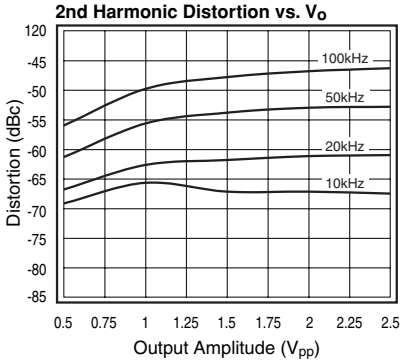
Typical Performance Characteristics

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

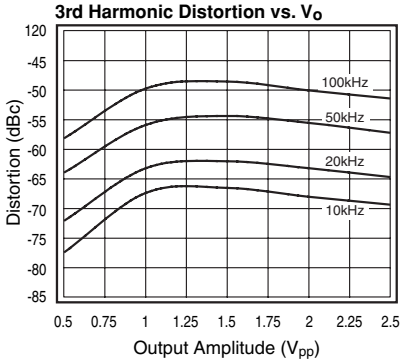
2nd & 3rd Harmonic Distortion



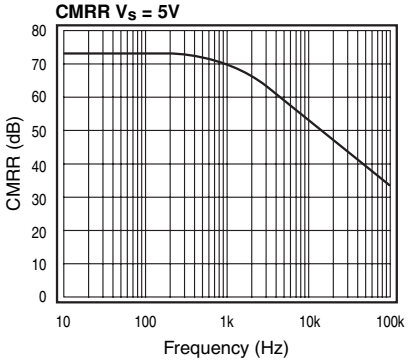
2nd Harmonic Distortion vs. V_O



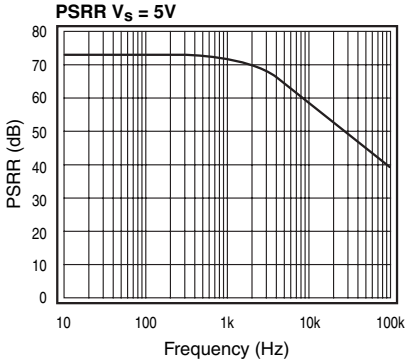
3rd Harmonic Distortion vs. V_O



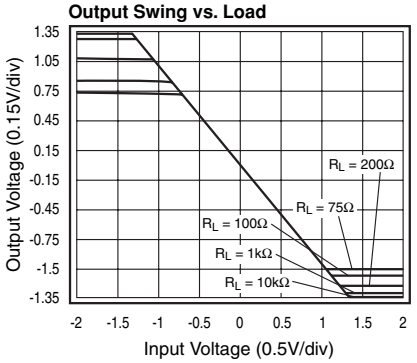
CMRR V_S = 5V



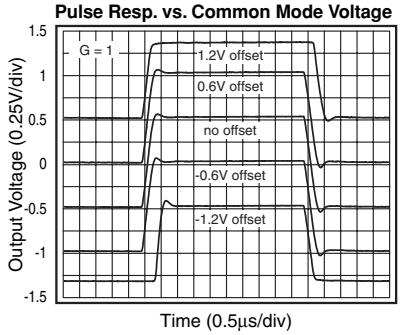
PSRR V_S = 5V



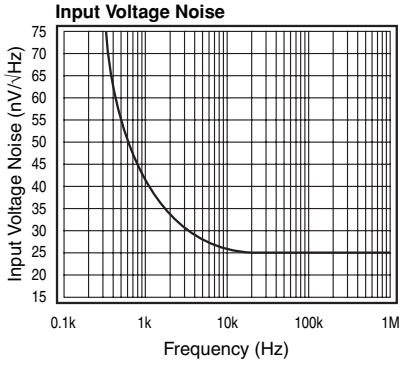
Output Swing vs. Load



Pulse Resp. vs. Common Mode Voltage



Input Voltage Noise



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.

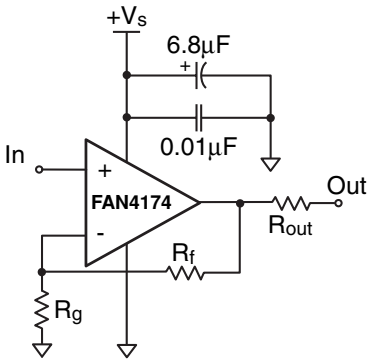


Figure 1: Typical Non-inverting Configuration

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 ±5mA as shown in Figure 2.

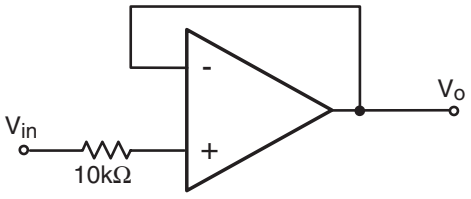


Figure 2: Circuit for Input Current Protection

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.

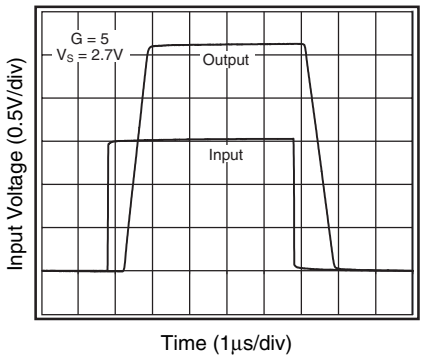


Figure 3: Overdrive Recovery

Driving Capacitive Loads

The *Frequency Response vs. C_L* 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. C_L* 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.

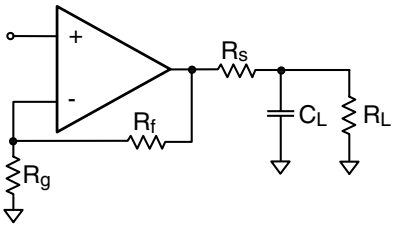


Figure 4: Typical Topology for driving a capacitive load

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 6.8µF and 0.01µF ceramic capacitors
- Place the 6.8µF capacitor within 0.75 inches of the power pin
- Place the 0.01µF 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.

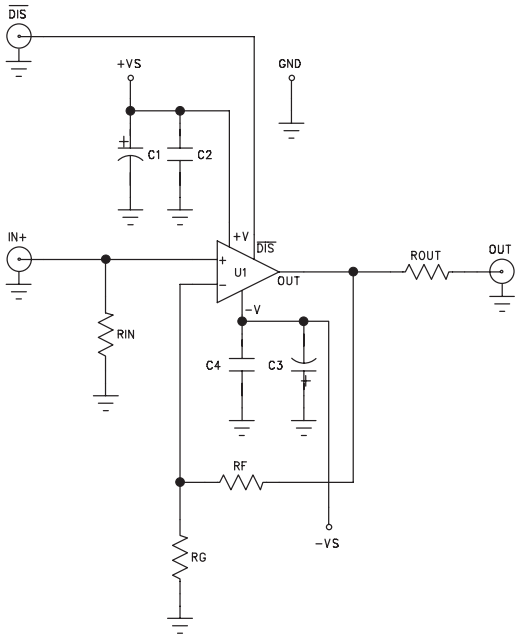


Figure 5: FAN4174 Evaluation Board Schematic

Evaluation Board Layout

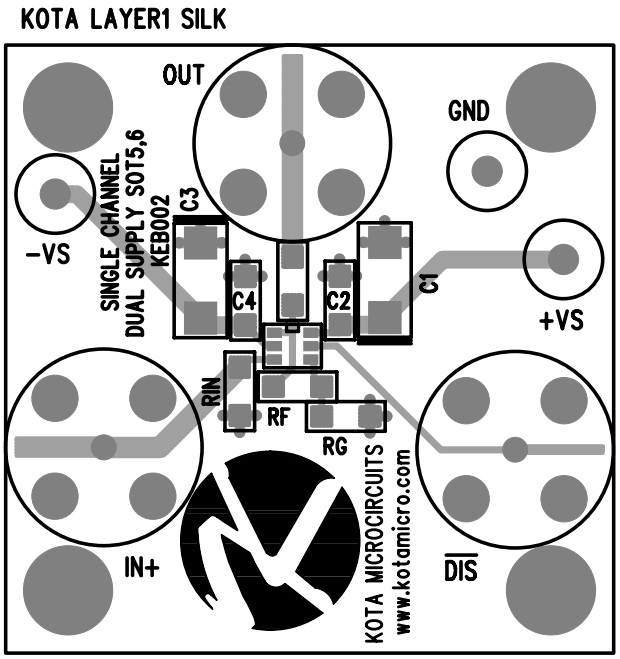


Figure 6a: KEB002 (top side)

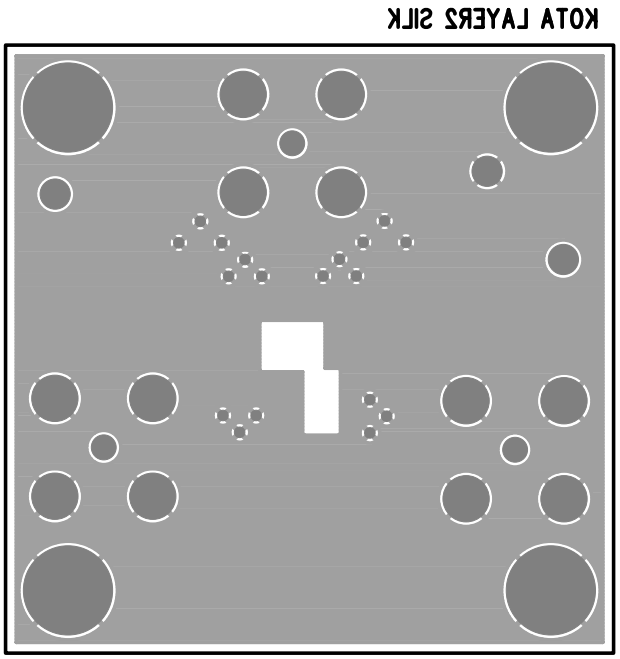
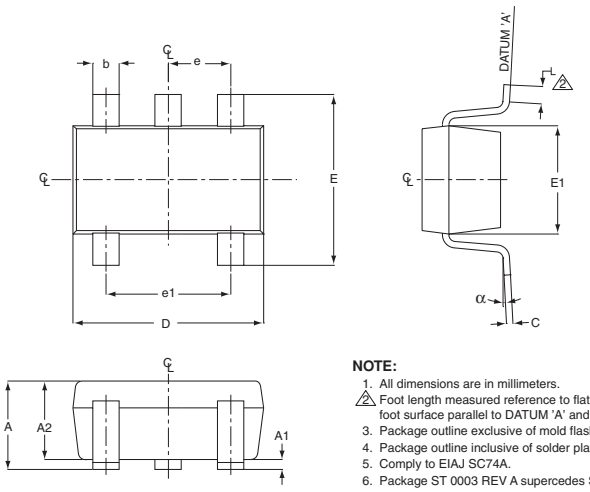


Figure 6b: KEB002 (bottom side)

Packaging Dimensions

SOT-23

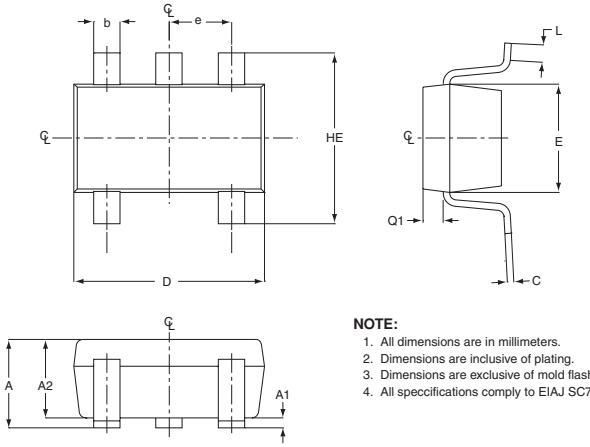


SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.25	0.50
C	0.09	0.20
D	2.80	3.10
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 ref	
e1	1.90 ref	
α	0°	10°

NOTE:

1. All dimensions are in millimeters.
2. Foot length measured reference to flat foot surface parallel to DATUM 'A' and lead surface.
3. Package outline exclusive of mold flash & metal burr.
4. Package outline inclusive of solder plating.
5. Comply to EIAJ SC74A.
6. Package ST 0003 REV A supercedes SOT-D-2005 REV C.

SC70



SYMBOL	MIN	MAX
e	0.65 BSC	
D	1.80	2.20
b	0.15	0.30
E	1.15	1.35
HE	1.80	2.40
Q1	0.10	0.40
A2	0.80	1.00
A1	0.00	0.10
A	0.80	1.10
c	0.10	0.18
L	1.10	0.30

NOTE:

1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold flashing and metal burr.
4. All speccifications comply to EIAJ 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.