KM4170

Tiny, Low Cost, +2.7V & +5V, Rail-to-Rail I/O Amplifier

Features

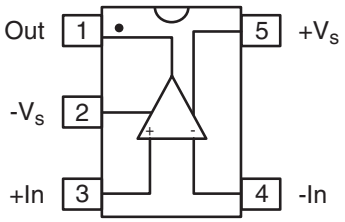
- 136μA supply current
- 4.9MHz bandwidth
- Output swings to within 20mV of either rail
- Input voltage range exceeds the rail by >250mV
- 5.3V/μs slew rate
- 35mA short circuit output current
- 24nV/√Hz input voltage noise
- Directly replaces OPA340, OPA343, and TLV2461 in single supply applications
- Available in SC70 and SOT23-5 package options

Applications

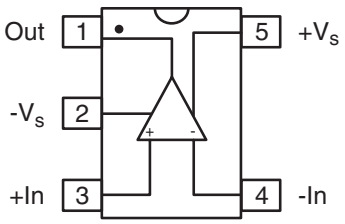
- Portable/battery-powered applications
- PCMCIA, USB
- Mobile communications, cellular phones, pagers
- Notebooks and PDA's
- Sensor Interface
- A/D buffer
- Active filters
- Signal conditioning
- Portable test instruments

KM4170 Packages

SOT23-5



SC70-5

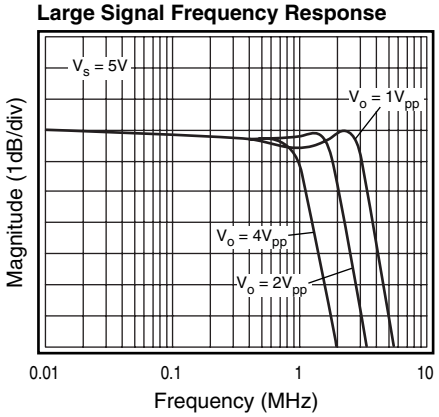


General Description

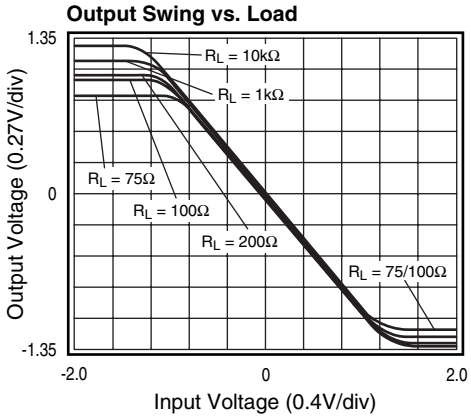
The KM4170 is an ultra-low cost, low power, voltage feedback amplifier. At 5V, the KM4170 uses only 160μA of supply current and is designed to operate from a supply range of 2.5V to 5.5V . The input voltage range exceeds the negative and positive rails.

The KM4170 offers high bipolar performance at a low CMOS price. The KM4170 offers superior dynamic performance with a 4.9MHz small signal bandwidth and 5.3V/μs slew rate. The combination of low power, high bandwidth, and rail-to-rail performance make the KM4170 well suited for battery-powered communication/computing systems.

Large Signal Frequency Response



Output Swing vs. Load



KM4170 Electrical Characteristics (V_s = +2.7V, G = 2, R_L = 10kΩ to V_s/2, R_f = 5kΩ; unless noted)

Parameters	Conditions	TYP	Min & Max	UNITS	NOTES
Case Temperature		+25°C	+25°C		
Frequency Domain Response					
-3dB bandwidth	G = +1, V_O = 0.02V_{pp}	4.9		MHz	1
	G = +2, V_O = 0.2V_{pp}	3.7		MHz	
full power bandwidth	G = +2, V_O = 2V_{pp}	1.4		MHz	
gain bandwidth product		2.2		MHz	
Time Domain Response					
rise and fall time	1V step	163		ns	
overshoot	1V step	<1		%	
slew rate	1V step	5.3		V/μs	
Distortion and Noise Response					
2nd harmonic distortion	1V_{pp}, 10kHz	-75		dBc	
3rd harmonic distortion	1V_{pp}, 10kHz	-76		dBc	
THD	1V_{pp}, 10kHz	0.03		%	
input voltage noise	>1MHz	24		nV/√Hz	
DC Performance					
input offset voltage		0.5	±6	mV	2
average drift		5		μV/°C	
input bias current		90	420	nA	2
average drift		32		pA/°C	
power supply rejection ratio	DC	83	55	dB	2
open loop gain	R_L = 10kΩ	90		dB	
quiescent current		136	190	μA	2
Input Characteristics					
input resistance		12		MΩ	
input capacitance		2		pF	
input common mode voltage range		-0.25 to 2.95		V	
common mode rejection ratio	DC, V_{cm} = 0V to V_s	81	55	dB	2
Output Characteristics					
output voltage swing	R_L = 10kΩ to V_s/2	0.02 to 2.68	0.06 to 2.64	V	2
	R_L = 1kΩ to V_s/2	0.05 to 2.63		V	
	R_L = 200Ω to V_s/2	0.11 to 2.52		V	
output current		±16		mA	
short circuit output current		±35		mA	
power supply operating range		2.7	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) For G = +1, R_f = 0.

2) 100% tested at +25°C.

Absolute Maximum Ratings

supply voltage	0 to +6V
maximum junction temperature	+175°C
storage temperature range	-65°C to +150°C
lead temperature (10 sec)	+300°C
operating temperature range (recommended)	-40°C to +85°C
input voltage range	+V_s + 0.5V, -V_s - 0.5V
internal power dissipation	see power derating curves

Package Thermal Resistance

Package	θ_{JA}
5 lead SOT23	256°C/W

KM4170 Electrical Characteristics (V_s = +5V, G = 2, R_L = 10kΩ to V_s/2, R_f = 5kΩ; unless noted)

Parameters	Conditions	TYP	Min & Max	UNITS	NOTES
Case Temperature		+25°C	+25°C		
Frequency Domain Response					
-3dB bandwidth	G = +1, V_O = 0.02V_{pp}	4.3		MHz	1
	G = +2, V_O = 0.2V_{pp}	3.0		MHz	
full power bandwidth	G = +2, V_O = 2V_{pp}	2.3		MHz	
gain bandwidth product		2.0		MHz	
Time Domain Response					
rise and fall time	1V step	110		ns	
overshoot	1V step	<1		%	
slew rate	1V step	9		V/µs	
Distortion and Noise Response					
2nd harmonic distortion	2V_{pp}, 10kHz	-73		dBc	
3rd harmonic distortion	2V_{pp}, 10kHz	-75		dBc	
THD	2V_{pp}, 10kHz	0.03		%	
input voltage noise	>1MHz	27		nV/√Hz	
DC Performance					
input offset voltage		1.5	±8	mV	2
average drift		15		µV/°C	
input bias current		90	450	nA	2
average drift		40		pA/°C	
power supply rejection ratio	DC	60	40	dB	2
open loop gain	R_L = 10kΩ	80		dB	
quiescent current		160	235	µA	2
Input Characteristics					
input resistance		12		MΩ	
input capacitance		2		pF	
input common mode voltage range		-0.25 to 5.25		V	
common mode rejection ratio	DC, V_{cm} = 0V to V_s	85	58	dB	2
Output Characteristics					
output voltage swing	R_L = 10kΩ to V_s/2	0.04 to 4.96	0.08 to 4.92	V	2
	R_L = 1kΩ to V_s/2	0.07 to 4.9		V	
	R_L = 200Ω to V_s/2	0.14 to 4.67		V	
output current		±30		mA	
short circuit output current		±60		mA	
power supply operating range		5.0	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.

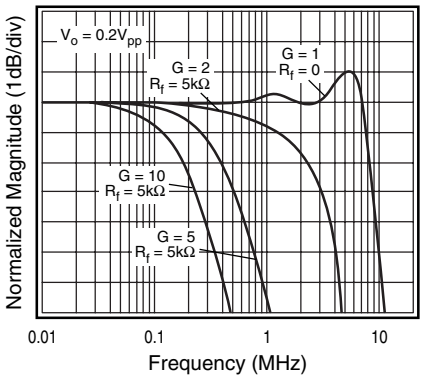
NOTES:

1) For G = +1, R_f = 0.

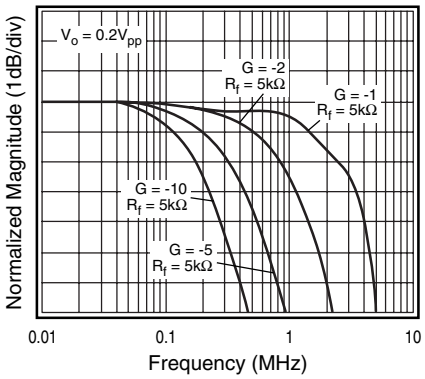
2) 100% tested at +25°C.

KM4170 Performance Characteristics (V_s = +2.7, G = 2, R_L = 10kΩ to V_s/2, R_f = 5kΩ; unless noted)

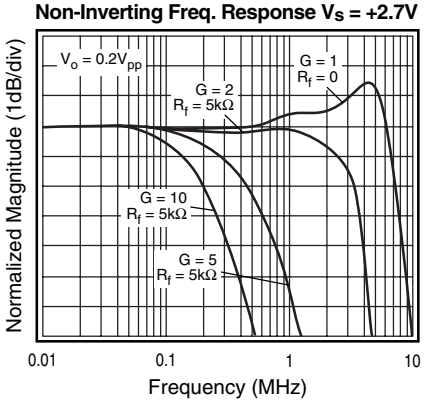
Non-Inverting Freq. Response V_S = +5V



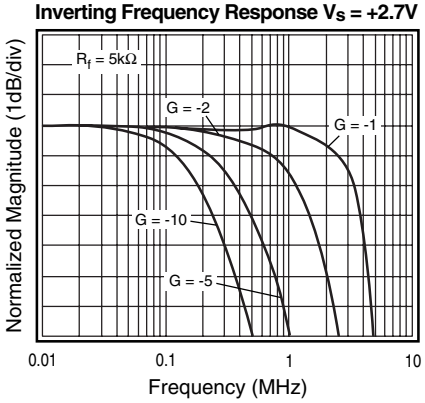
Inverting Frequency Response V_S = +5V



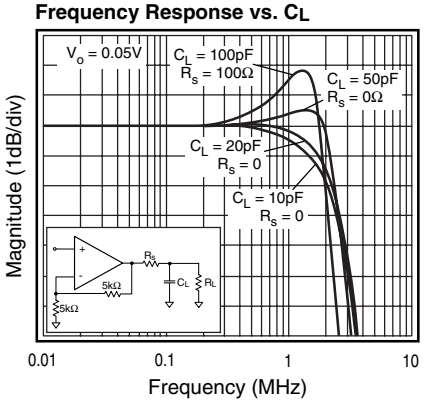
Non-Inverting Freq. Response V_S = +2.7V



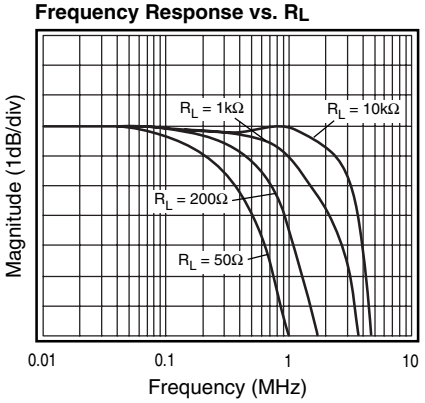
Inverting Frequency Response V_S = +2.7V



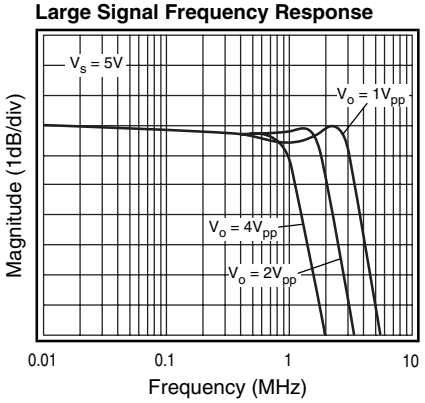
Frequency Response vs. C_L



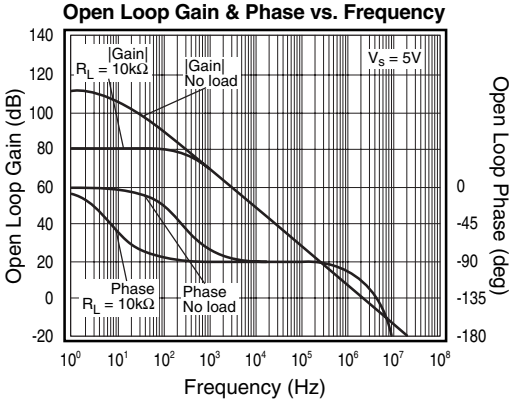
Frequency Response vs. R_L



Large Signal Frequency Response

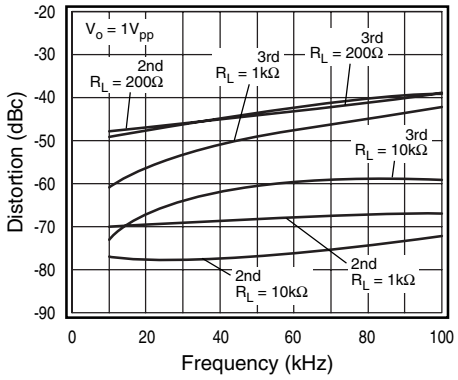


Open Loop Gain & Phase vs. Frequency

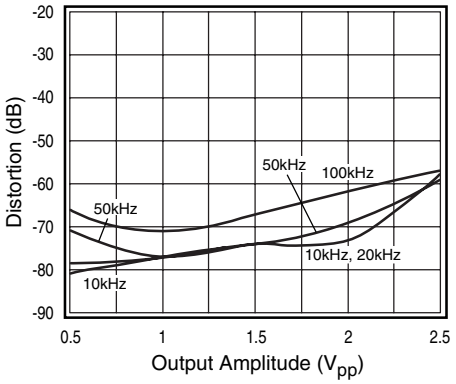


KM4170 Performance Characteristics (V_s = +2.7V, G = 2, R_L = 10kΩ to V_s/2, R_f = 5kΩ; unless noted)

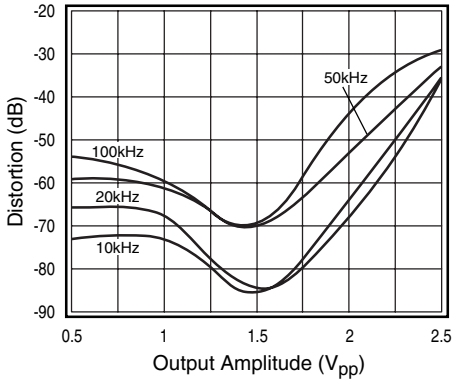
2nd & 3rd Harmonic Distortion; V_S = +2.7V



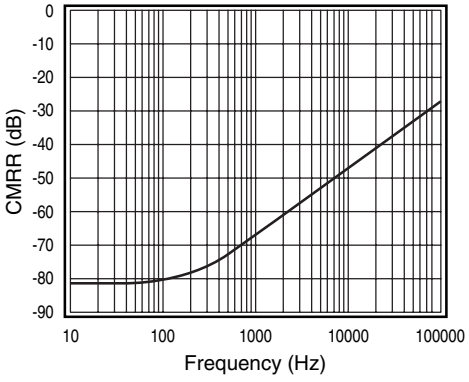
2nd Harmonic Distortion vs. V_O



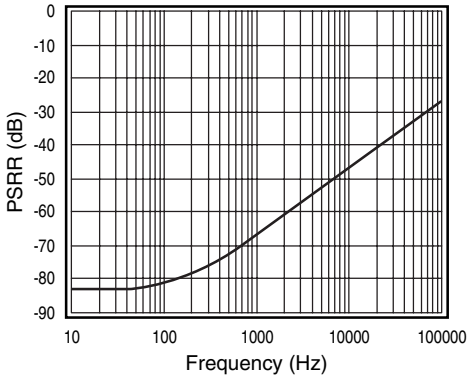
3rd Harmonic Distortion vs. V_O



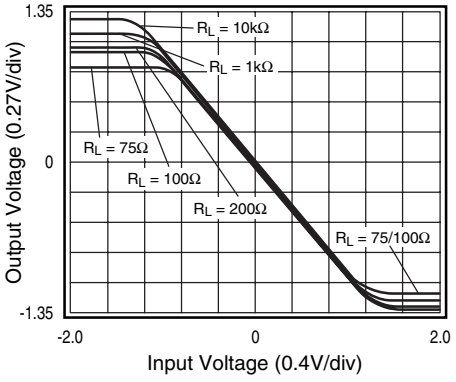
CMRR



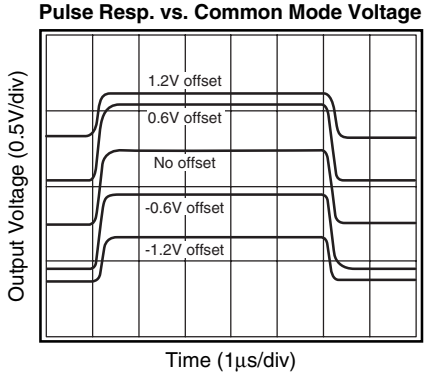
PSRR



Output Swing vs. Load



Pulse Resp. vs. Common Mode Voltage



General Description

The KM4170 is single supply, general purpose, voltage-feedback amplifier. The KM4170 is fabricated on a complimentary bipolar process, features a rail-to-rail input and output, and is unity gain stable.

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

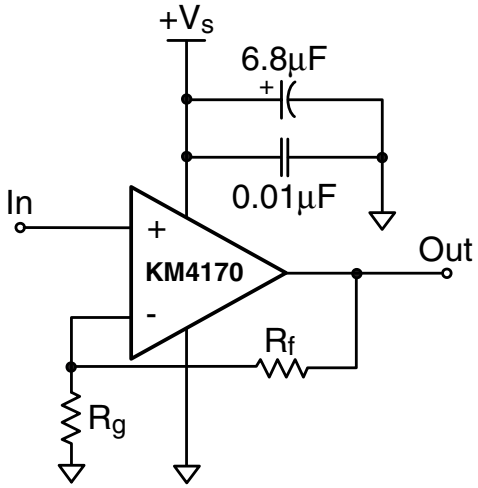


Figure 1: Typical Non-inverting Configuration

Input Common Mode Voltage

The common mode input range extends to 250mV below ground and to 250mV above V_S, 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.

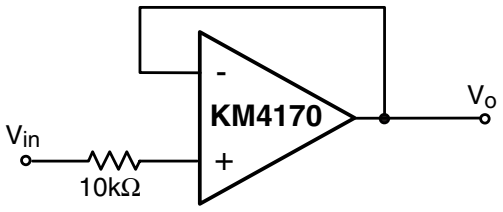


Figure 2: Circuit for Input Current Protection

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. It 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 over-driven and by how much the ranges are exceeded. The KM4170 will typically recover in less than 50ns from an overdrive condition. Figure 3 shows the KM4170 in an overdriven condition.

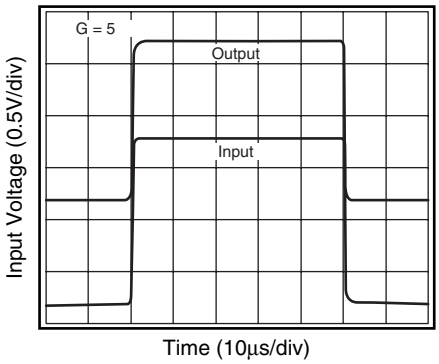


Figure 3: Overdrive Recovery

Driving Capacitive Loads

The ***Frequency Response vs. C_L*** plot, illustrates the response of the KM4170. 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. As the plot indicates, the KM4170 can easily drive a 50pF capacitive load without a series resistance.

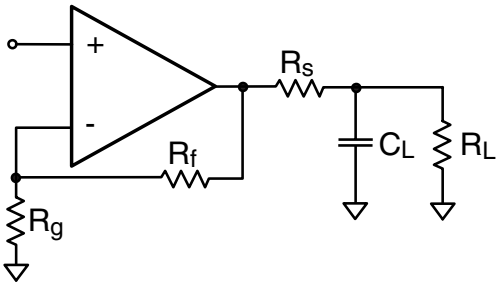


Figure 4: Typical Topology for driving a capacitive load

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 KM4170 requires a 510Ω 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.

Evaluation Board Information

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

Eval Board	Description	Products
KEB002	Single Channel, Dual Supply, 5 and 6 lead SOT23	KM4170IT5
KEB011	Single Channel, Dual Supply, 5 and 6 lead SC70	KM4170IS5

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

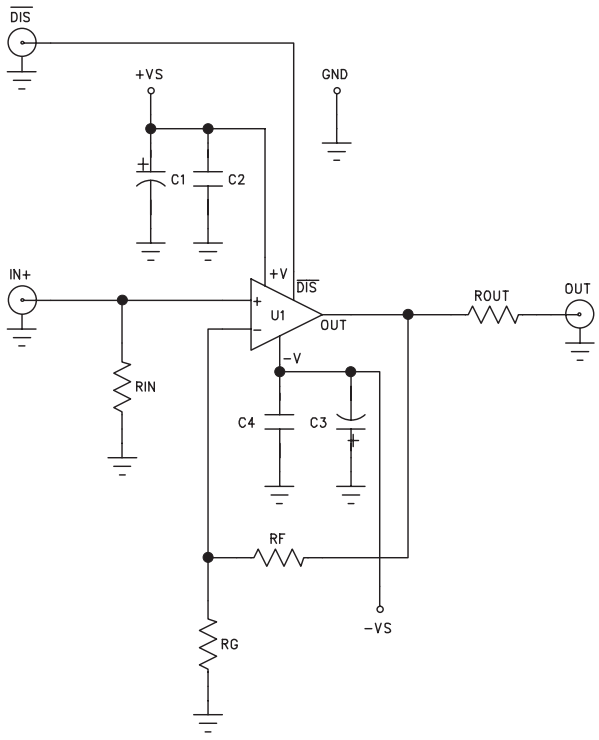


Figure 5: Evaluation Board Schematic

KM4170 Evaluation Board Layout

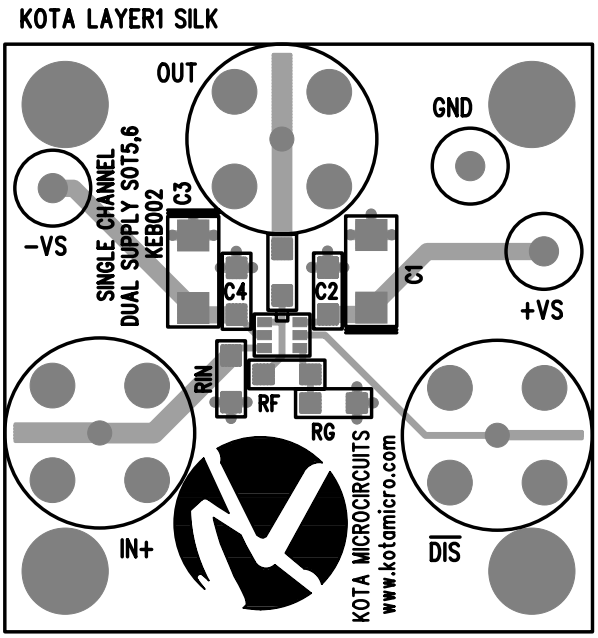


Figure 6a: KEB002 (top side)

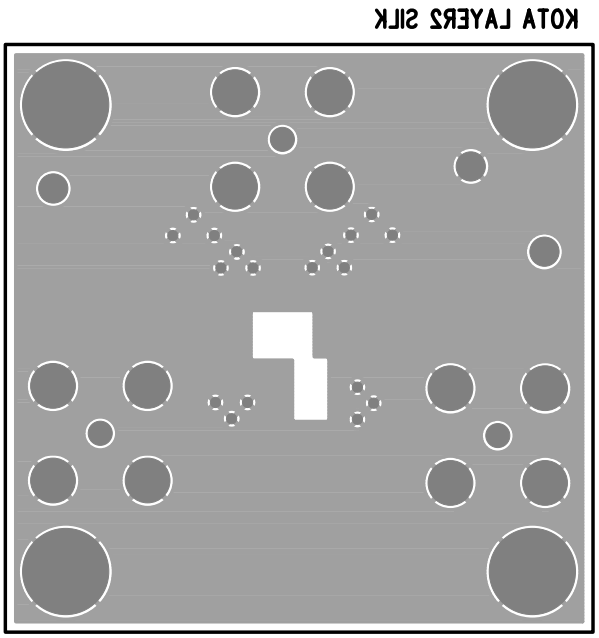


Figure 6b: KEB002 (bottom side)

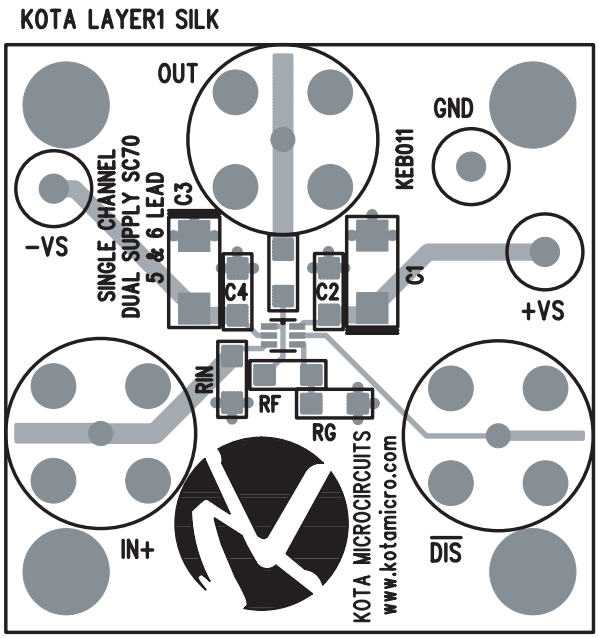


Figure 6c: KEB011 (top side)

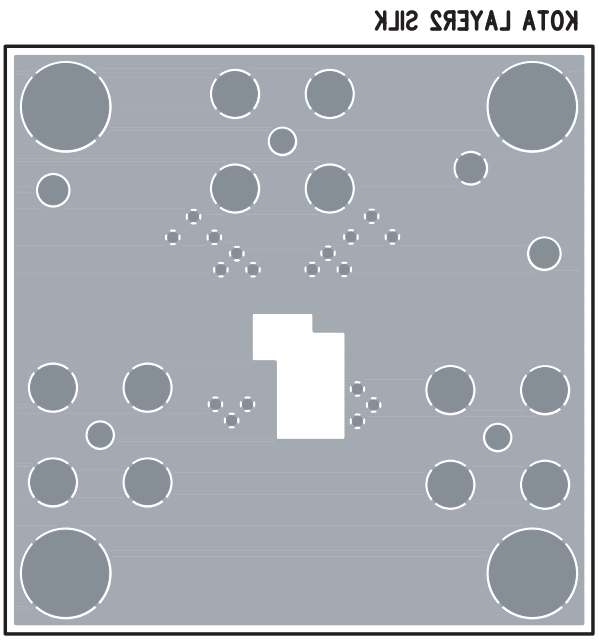
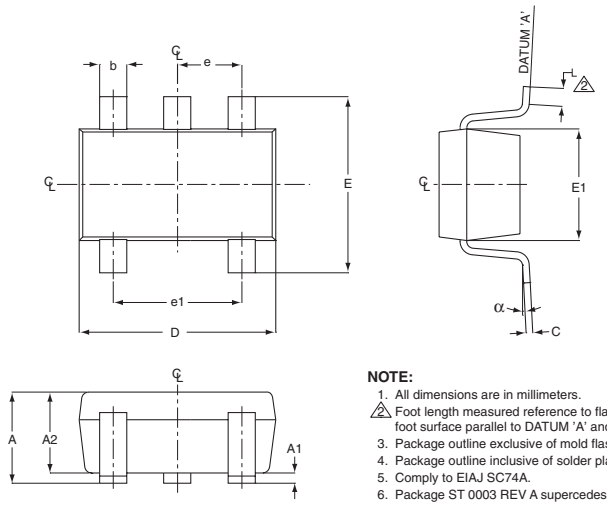


Figure 6d: KEB011 (bottom side)

KM4170 Package Dimensions

SOT23-5

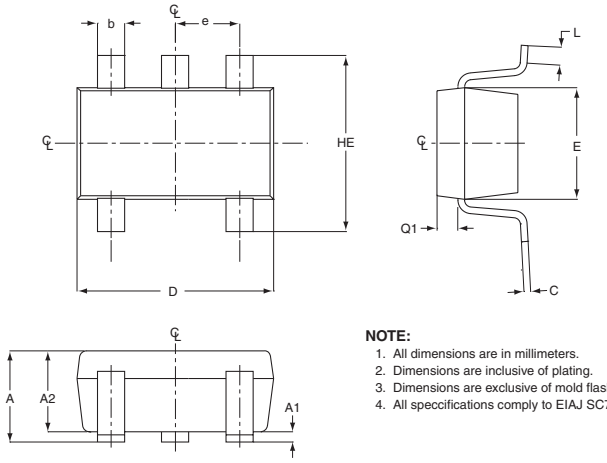


SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.25	0.50
C	0.09	0.20
D	2.80	3.10
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.55
e	0.95 ref	
e1	1.90 ref	
α	0°	10°

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	Package	Container	Pack Qty
KM4170	KM4170IT5	SOT23-5	Partial Reel	<3000
KM4170	KM4170IT5TR3	SOT23-5	Reel	3000
KM4170	KM4170IS5	SC70-5	Partial Reel	<3000
KM4170	KM4170IS5TR3	SC70-5	Reel	3000

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