KM4470

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

Features at 2.7V

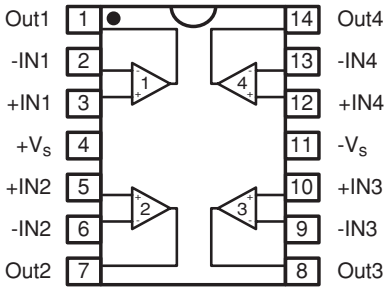
- 136μA supply current per amplifier
- 4.9MHz bandwidth
- Output swings to within 20mV of either rail
- Input voltage range exceeds the rail by >250mV
- 5.3V/μs slew rate
- 16mA short circuit output current
- 21nV/√Hz input voltage noise
- Directly replaces MAX4129, OPA4340, LMV824, and TLV2464 in single supply applications
- Available in TSSOP-14 package

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

KM4470 Package

TSSOP



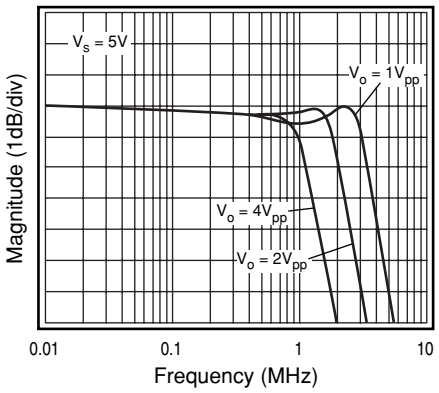
General Description

The KM4470 is an ultra-low cost, low power, voltage feedback amplifier. At 5V, the KM4470 uses only 160μA of supply current per amplifier and is designed to operate from a supply range of 2.5V to 5.5V (±1.25V to 2.75V). The input voltage range exceeds the negative and positive rails.

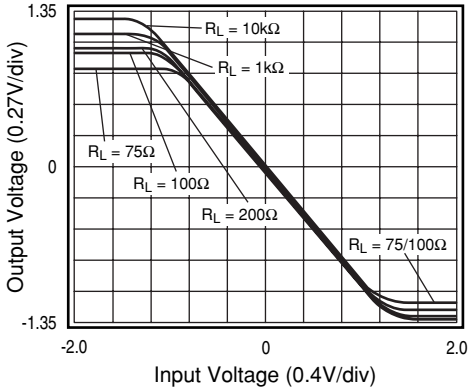
The KM4470 offers high bipolar performance at a low CMOS price. The KM4470 offers superior dynamic performance with a 4.9MHz small signal bandwidth and 5.3V/μs slew rate. The combination of low power, high bandwidth, and rail-to-rail performance make the KM4470 well suited for battery-powered communication/computing systems.

The KM4170 (single) and KM4270 (dual) are also available.

Large Signal Frequency Response



Output Swing vs. Load



KM4470 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	-72		dBc	
3rd harmonic distortion	1V_{pp}, 10kHz	-72		dBc	
THD	1V_{pp}, 10kHz	0.03		%	
input voltage noise	>10kHz	21		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 per channel		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	
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)	+260°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}
14 lead TSSOP	100°C/W

KM4470 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	>10kHz	22		nV/√Hz	
DC Performance					
input offset voltage		1.5		mV	
average drift		15		µV/°C	
input bias current		90		nA	
average drift		40		pA/°C	
power supply rejection ratio	DC	60		dB	
open loop gain	R_L = 10kΩ	80		dB	
quiescent current per channel		160		µA	
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		dB	
Output Characteristics					
output voltage swing	R_L = 10kΩ to V_s/2	0.04 to 4.96		V	
	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	
power supply operating range		5.0	2.5 to 5.5	V	

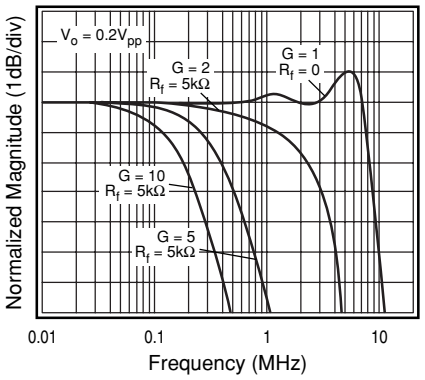
Min/max ratings are based on product characterization and simulation. Individual parameters are tested as noted. Outgoing quality levels are determined from tested parameters.

NOTES:

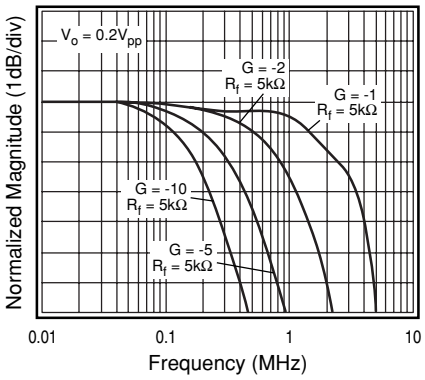
1) For G = +1, R_f = 0.

KM4470 Performance Characteristics (V_S = +2.7, G = 2, R_L = 10kΩ to V_S/2, R_f = 5kΩ; unless noted)

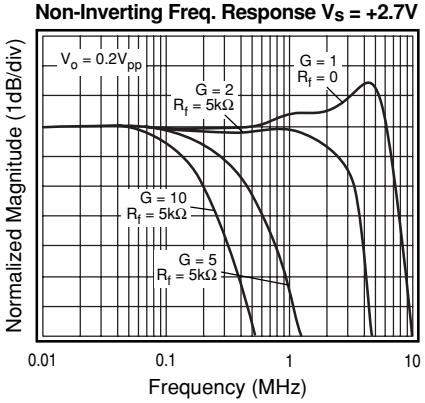
Non-Inverting Freq. Response V_S = +5V



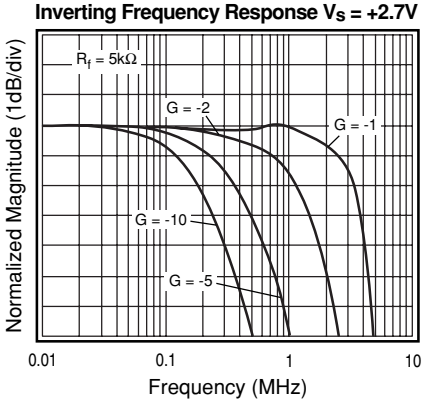
Inverting Frequency Response V_S = +5V



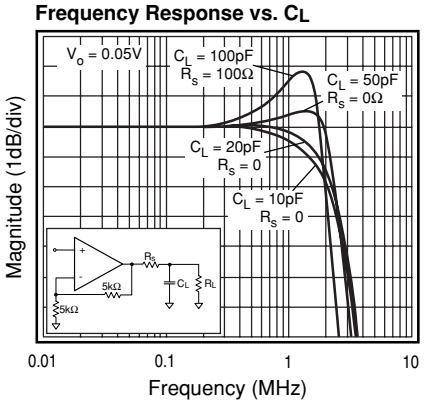
Non-Inverting Freq. Response V_S = +2.7V



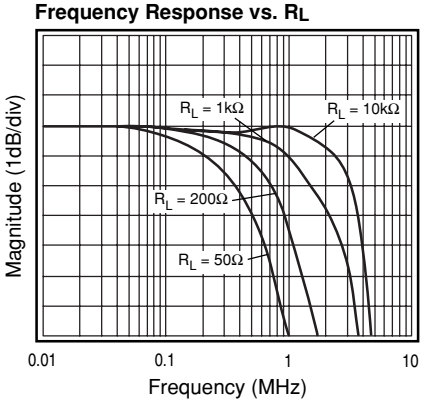
Inverting Frequency Response V_S = +2.7V



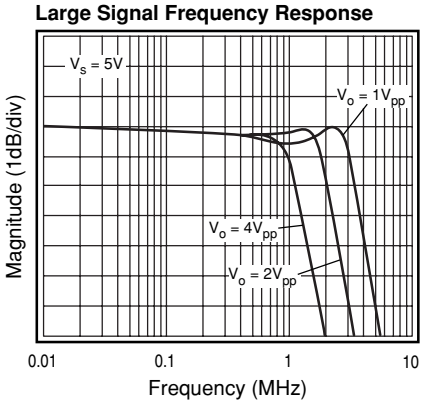
Frequency Response vs. C_L



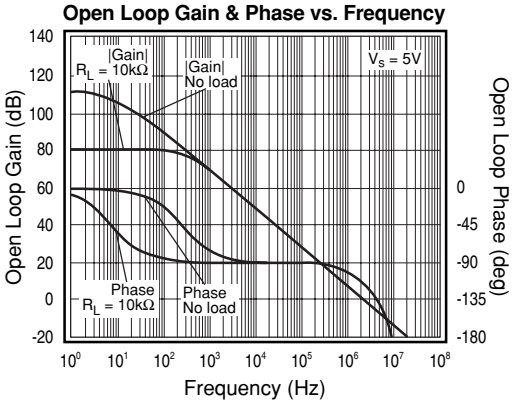
Frequency Response vs. R_L



Large Signal Frequency Response

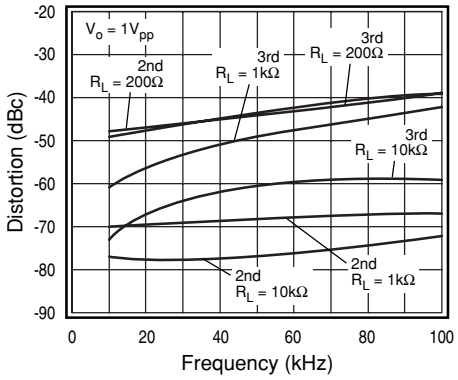


Open Loop Gain & Phase vs. Frequency

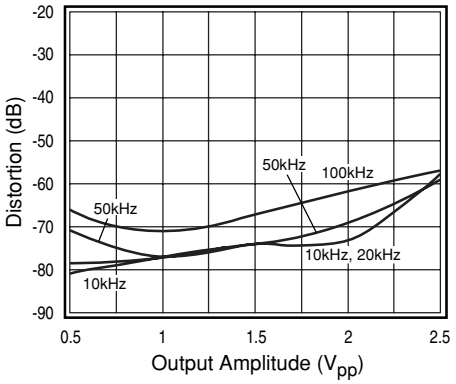


KM4470 Performance Characteristics (V_s = +2.7V, G = 2, R_L = 10kΩ to V_s/2, R_f = 5kΩ; unless noted)

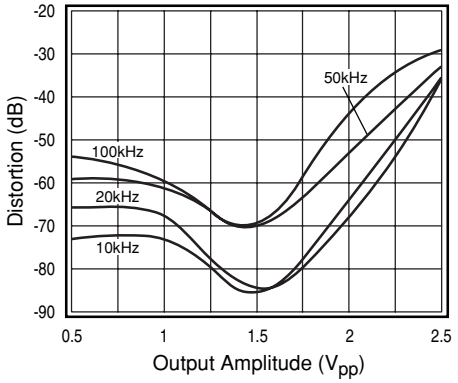
2nd & 3rd Harmonic Distortion; V_S = +2.7V



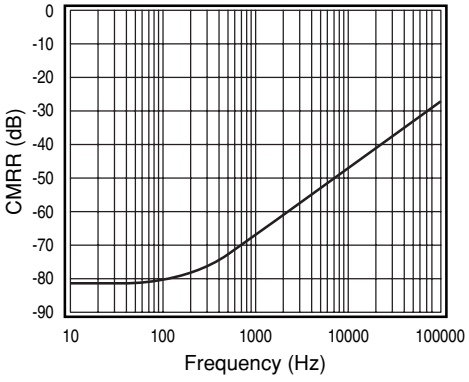
2nd Harmonic Distortion vs. V_O



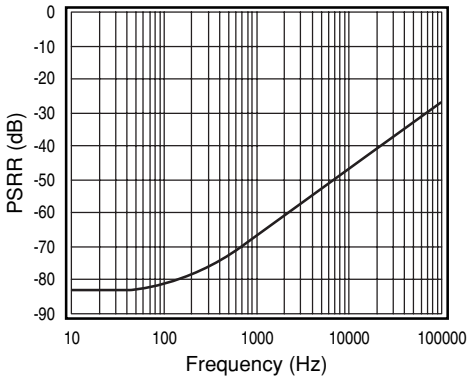
3rd Harmonic Distortion vs. V_O



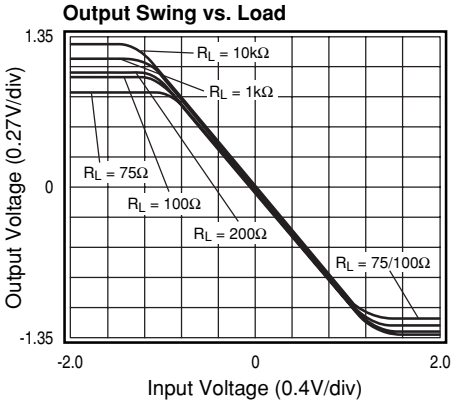
CMRR



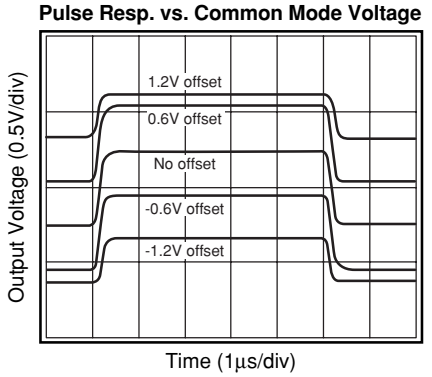
PSRR



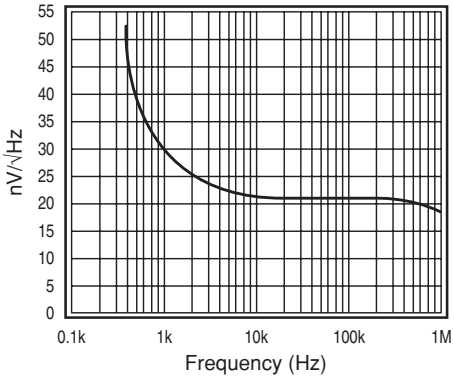
Output Swing vs. Load



Pulse Resp. vs. Common Mode Voltage



Input Voltage Noise



General Description

The KM4470 is single supply, general purpose, voltage-feedback amplifier. The KM4470 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.

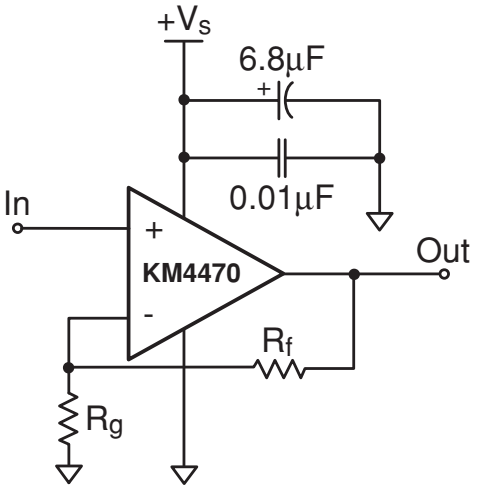


Figure 1: Typical Non-inverting Configuration

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.

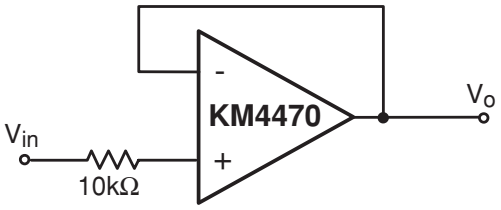


Figure 2: Circuit for Input Current Protection

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 KM4470 will typically recover in less than 50ns from an overdrive condition. Figure 3 shows the KM4470 in an overdriven condition.

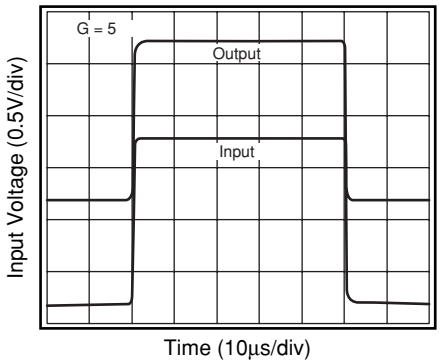


Figure 3: Overdrive Recovery

Driving Capacitive Loads

The ***Frequency Response vs. C_L*** plot, illustrates the response of the KM4470. 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 KM4470 can easily drive a 50pF capacitive load without a series resistance.

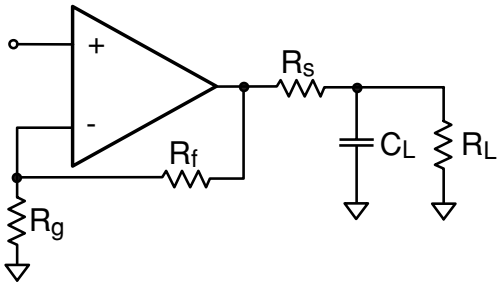


Figure 4: Typical Topology for driving a capacitive load

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 KM4470 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.

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 Board	Description	Products
KEB012	Quad Channel, Dual Supply, 14 lead TSSOP	KM4470IP14

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

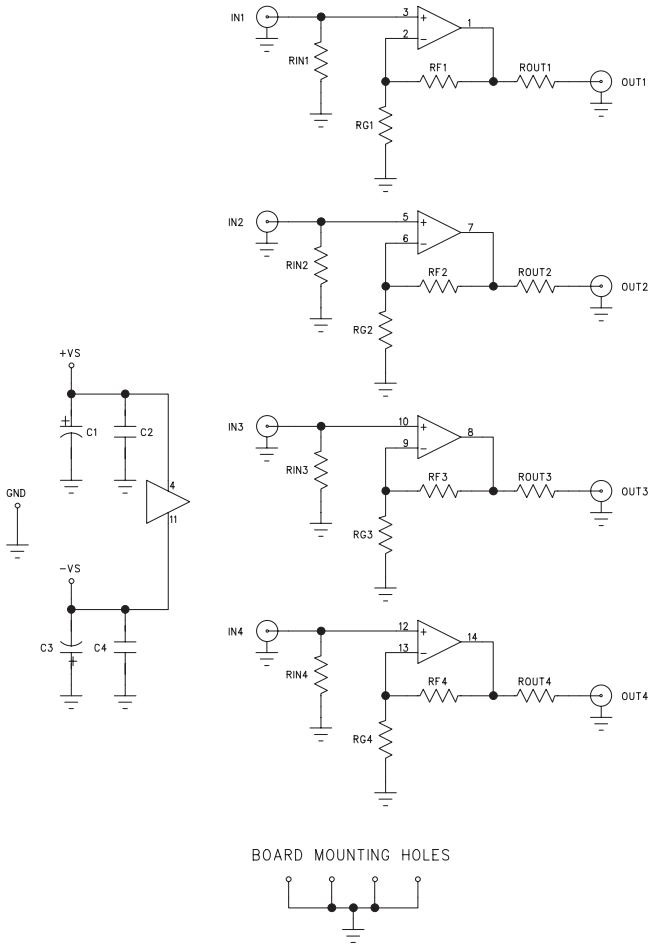


Figure 5: Evaluation Board Schematic

KM4470 Evaluation Board Layout

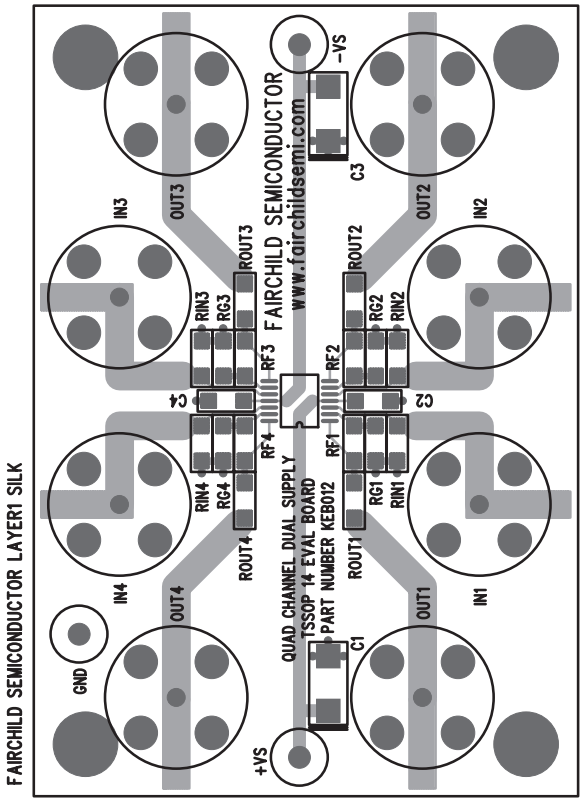


Figure 6a: KEB012 (top side)

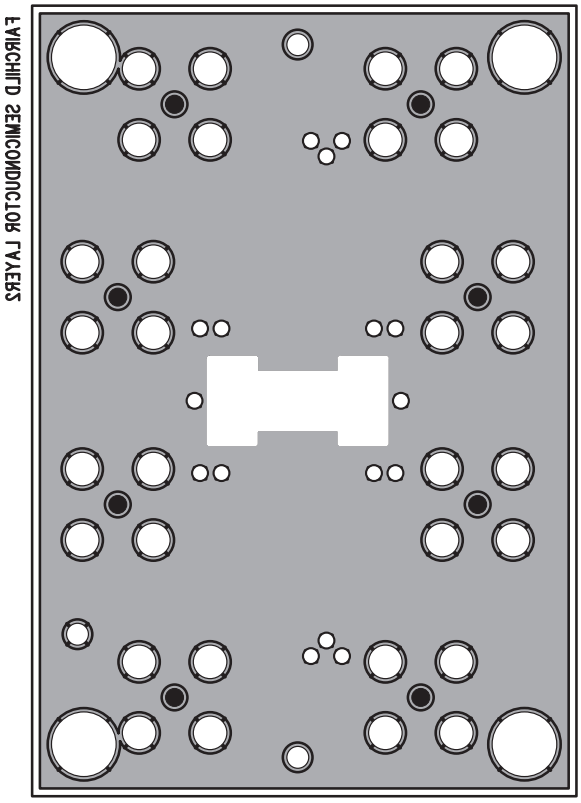


Figure 6b: KEB012 (bottom side)

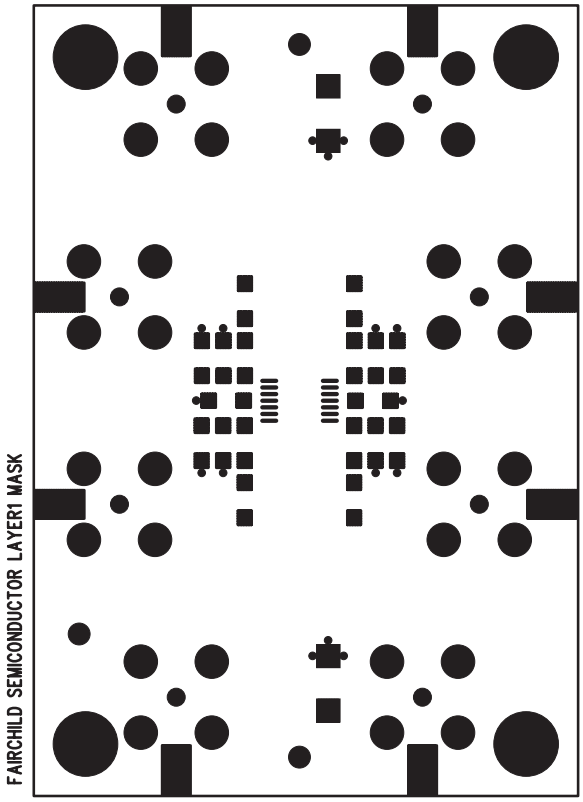


Figure 6c: KEB012 (layer1 mask)

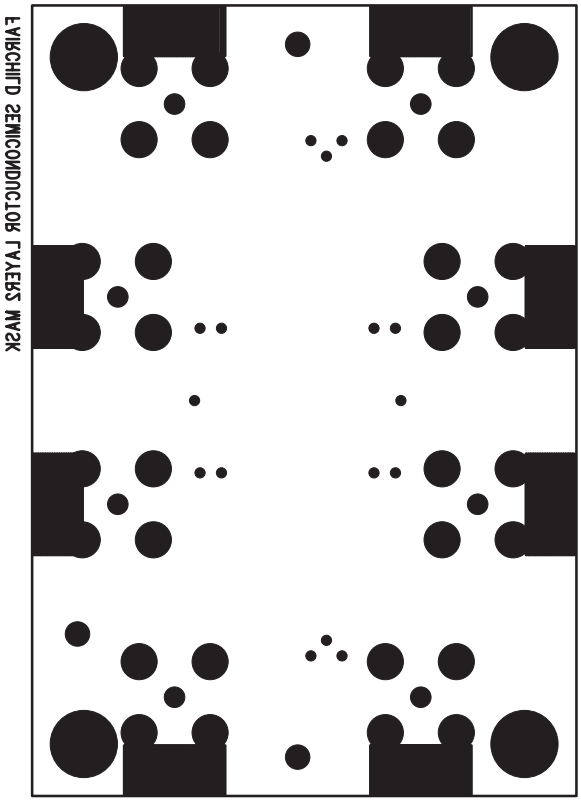
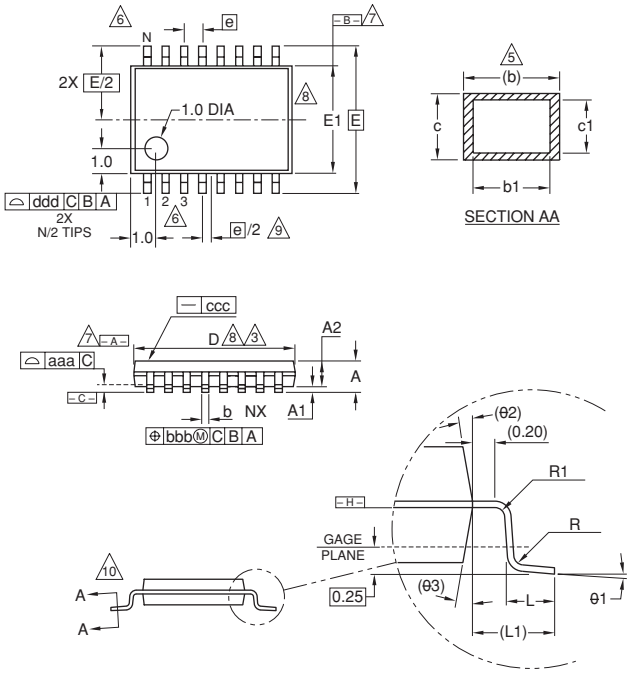


Figure 6d: KEB012 (layer2 mask)

KM4470 Package Dimensions

TSSOP



TSSOP-14			
SYMBOL	MIN	NOM	MAX
A	–	–	1.10
A1	0.05	–	0.15
A2	0.85	0.90	0.95
L	0.50	0.60	0.75
R	0.09	–	–
R1	0.09	–	–
b	0.19	–	0.30
b1	0.19	0.22	0.25
c	0.09	–	0.20
c1	0.09	–	0.16
θ1	0°	–	8°
L1	1.0 REF		
aaa	0.10		
bbb	0.10		
ccc	0.05		
ddd	0.20		
e	0.65 BSC		
θ2	12° REF		
θ3	12° REF		

8 Lead			
SYMBOL	MIN	NOM	MAX
D	2.90	3.0	3.10
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	8		

14 Lead			
SYMBOL	MIN	NOM	MAX
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	14		

16 Lead			
SYMBOL	MIN	NOM	MAX
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	16		

20 Lead			
SYMBOL	MIN	NOM	MAX
D	6.50	6.50	6.60
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	20		

24 Lead			
SYMBOL	MIN	NOM	MAX
D	7.70	7.80	7.90
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	24		

28 Lead			
SYMBOL	MIN	NOM	MAX
D	9.50	9.70	9.80
E1	4.30	4.40	4.50
E	6.4 BSC		
e	0.65 BSC		
N	28		

NOTES:

1 All dimensions are in millimeters (angle in degrees).

2 Dimensioning and tolerancing per ASME Y14.5–1994.

3 Dimensions "D" does not include mold flash, protusions or gate burrs. Mold flash protusions or gate burrs shall not exceed 0.15 per side .

4 Dimension "E1" does not include interlead flash or protusion. Interlead flash or protusion shall not exceed 0.25 per side.

5 Dimension "b" does not include dambar protusion. Allowable dambar protusion shall be 0.08mm total in excess of the "b" dimension at maximum material condition. Dambar connot be located on the lower radius of the foot. Minimum space between protusion and adjacent lead is 0.07mm for 0.5mm pitch packages.

6 Terminal numbers are shown for reference only.

7 Datums – A – and – B – to be determined at datum plane – H –.

8 Dimensions "D" and "E1" to be determined at datum plane – H –.

9 This dimensions applies only to variations with an even number of leads per side. For variation with an odd number of leads per side, the "center" lead must be coincident with the package centerline, Datum A.

10 Cross sections A – A to be determined at 0.10 to 0.25mm from the leadtip.

Ordering Information

Model	Part Number	Package	Container	Pack Qty
KM4470	KM4470IP14	TSSOP-14	Rail	95
	KM4470IP14TR3	TSSOP-14	Reel	2500

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