

CLC5654

Very High Speed, Low Cost, Quad Operational Amplifier

General Description

The CLC5654 is a quad, current feedback operational amplifier that is perfect for many cost sensitive applications that require high performance. This device also offers excellent economy in board space and power, consuming only 5mA per amplifier while providing 70mA of output current capability. Applications requiring significant density of high speed devices such as video routers, matrix switches and high order active filters will benefit from the configuration of the CLC5654 and the low channel-to-channel crosstalk of 70dB at 5MHz.

The CLC5654 provides excellent performance for video applications. Differential gain and phase of 0.03% and 0.03° makes this device well suited for many professional composite video systems, but consumer applications will also be able to take advantage of these features due to the device's low cost. The CLC5654 offers superior dynamic performance with a small signal bandwidth of 450MHz and slew rate of 2000V/μs. These attributes are well suited for many component video applications such as driving RGB signals down significant lengths of cable. These and many other applications can also take advantage of the 0.1dB flatness to 40MHz.

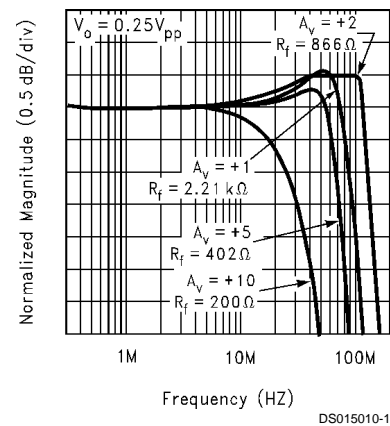
Combining wide bandwidth with low cost makes the CLC5654 an attractive option for active filters. SAW filters are often used in IF filters in the 10's of MHz range, but higher order filters designed around a quad operational amplifier may offer an economical alternative to the typical SAW approach and offer greater freedom in the selection of filter parameters. National Semiconductor's Comlinear Products Group has published a wide array of literature on active filters and a list of these publications can be found on the last page of this datasheet.

- 2000 V/us slew rate
- 5mA/channel supply current
- -71/-82dBc HD2/HD3 (5MHz)
- 0.03%, 0.03° differential gain, phase
- 70mA output current
- 12ns settling to 0.1%

Applications

- High performance RGB video
- Video switchers & routers
- Video line driver
- Active filters
- IF amplifier
- Twisted pair driver/receiver

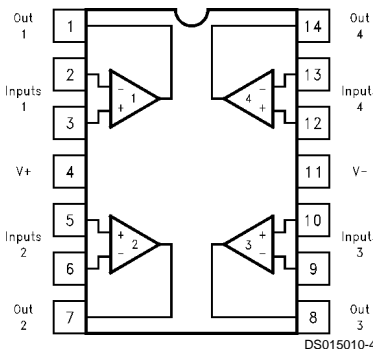
Non-Inverting Frequency Response



Features

- 450MHz small signal bandwidth

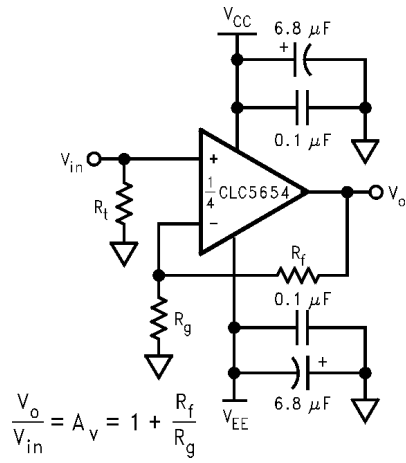
Connection Diagram



Pinout
DIP & SOIC

CLC5654 Very High Speed, Low Cost, Quad Operational Amplifier

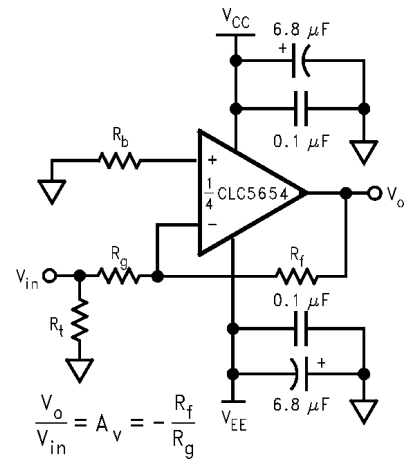
Typical Configurations



$$\frac{V_o}{V_{in}} = A_v = 1 + \frac{R_f}{R_g}$$

DS015010-2

Non-Inverting Gain



$$\frac{V_o}{V_{in}} = A_v = -\frac{R_f}{R_g}$$

DS015010-3

Note: R_t provides DC bias for the non-inverting input. Select R_t to yield desired $R_{in} = R_t \parallel R_g$.

Inverting Gain

Ordering Information

Package	Temperature Range Industrial	Part Number	Package Marking	NSC Drawing
14-pin plastic DIP	-40°C to +85°C	CLC5654IN	CLC5654IN	N14A
14-pin plastic SOIC	-40°C to +85°C	CLC5654IM	CLC5654IM	M14A
		CLC5654IMX		

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ($V_{CC}-V_{EE}$)	+14V
Output Current	95mA
Common-Mode Input Voltage	V_{EE} to V_{CC}
Maximum Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C

Lead Temperature (soldering 10 sec)

+300°C

Operating Ratings

Thermal Resistance		
Package	(θ_{JC})	(θ_{JA})
MDIP	60°C/W	110°C/W
SOIC	55°C/W	125°C/W

Electrical Characteristics(A_V = +2, R_f = 866Ω, R_L = 100Ω, V_S = ±5V, unless specified)

Symbol	Parameter	Conditions	Typ	Min/Max Ratings (Note 2)		Units
Ambient Temperature		CLC5654IN/IM	+25°C	+25°C	-40 to 85°	
Frequency Domain Response						
	-3dB Bandwidth	A _V = 1	450	-	-	MHz
		V _O < 0.5V _{PP}	350	-	-	MHz
		V _O < 5V _{PP}	100	-	-	MHz
	-0.1dB Bandwidth		40	-	-	MHz
	Differential Gain	NTSC, R _L = 150Ω	0.03			dB
	Differential Phase	NTSC, R _L = 150Ω	0.03			dB
Time Domain Response						
	Rise and Fall Time	0.5V Step	1.2	-	-	ns
		5V Step	2.7	-	-	ns
	Settling Time to 0.1%	2V Step	12	-	-	ns
	Overshoot	0.5V Step	7	-	-	%
	Slew Rate		2000	-	-	V/μs
Distortion And Noise Response						
	2nd Harmonic Distortion	2V _{PP} , 5MHz	-71	-	-	dBc
	3rd Harmonic Distortion	2V _{PP} , 5MHz	-82	-	-	dBc
	Equivalent Input Noise					
	Voltage (e _{ni})	>1MHz	3.3	-	-	nV/√Hz
	Non-Inverting Current (i _{bn})	>1MHz	2.5	-	-	pA/√Hz
	Inverting Current (i _{bi})	>1MHz	12	-	-	pA/√Hz
	Crosstalk (Input inferred)	10MHz	76	-	-	dB
Static, DC Performance						
	Input Offset Voltage (Note 3)		2.5	6	11	mV
	Average Drift		18	-	55	μV/°C
	Input Bias Current (Non-Inverting)(Note 3)		6	15	28	μA
	Average Drift		40	-	160	nA/°C
	Input Bias Current (Inverting) (Note 3)		5	12	20	μA
	Average Drift		25	-	120	nA/°C
	Power Supply Rejection Ratio	DC	55	47	45	dB
	Common Mode Rejection Ratio	DC	50	45	43	dB
	Supply Current (per channel) (Note 3)	R _L = ∞	5	6.7	7	mA

Electrical Characteristics (Continued)

($A_V = +2$, $R_f = 866\Omega$, $R_L = 100\Omega$, $V_S = \pm 5V$, unless specified)

Symbol	Parameter	Conditions	Typ	Min/Max Ratings (Note 2)		Units
Miscellaneous Performance						
	Input Resistance (Non-Inverting)		1	0.5	0.25	M Ω
	Input Capacitance (Non-Inverting)		1	2	2	pF
	Common Mode Input Range		± 2.2	± 2.0	± 1.4	V
	Output Voltage Range	$R_L = 150\Omega$	± 2.6	± 2.5	± 2.3	V
	Output Current		70	50	40	mA
	Output Resistance, Closed Loop	DC	0.2	0.3	0.6	m Ω

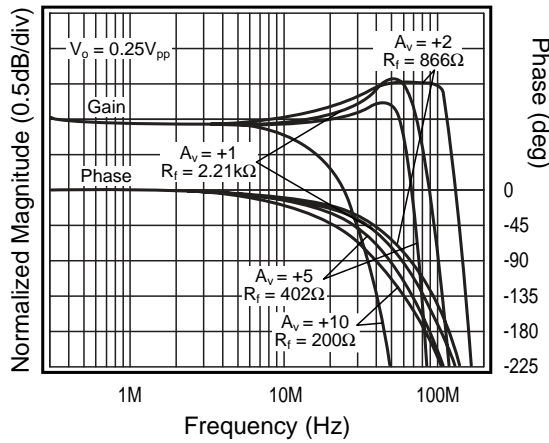
Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" specifies conditions of device operation.

Note 2: Min/max ratings are based on product characterization and simulation. Individual parameters are tested as noted. Outgoing quality levels are determined from tested parameters.

Note 3: AJ-level: spec. is 100% tested at +25°C.

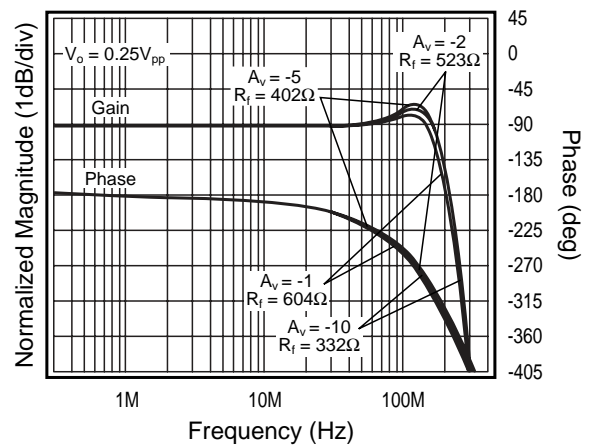
Typical Performance Characteristics ($A_V = +2$, $R_f = 866\Omega$, $R_L = 100\Omega$, $V_S = \pm 5V$, unless specified)

Non-Inverting Frequency Response



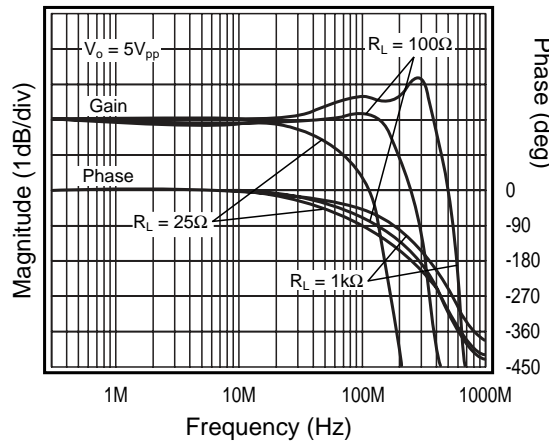
DS015010-5

Inverting Frequency Response



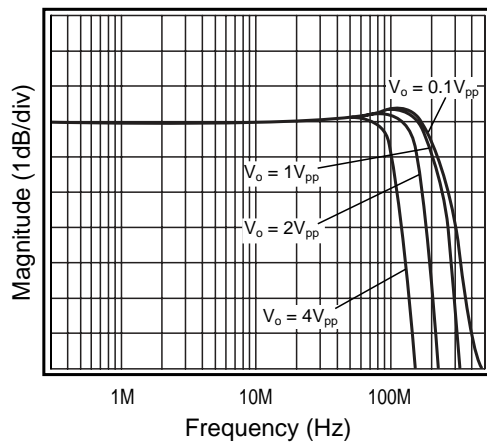
DS015010-6

Frequency Response vs. R_L



DS015010-7

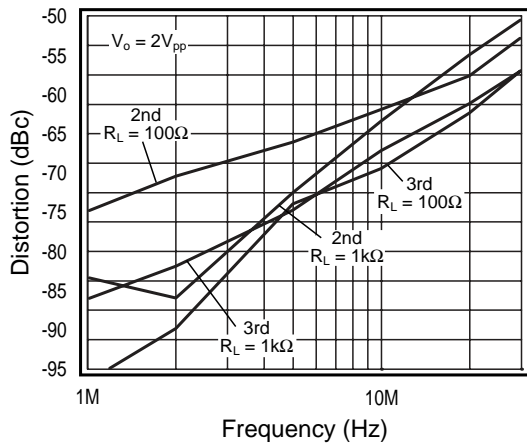
Frequency Response vs. V_o



DS015010-8

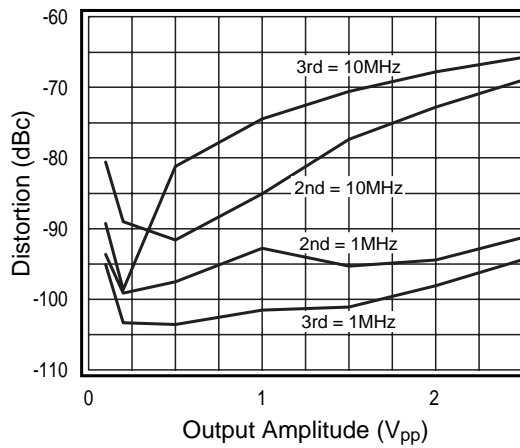
Typical Performance Characteristics ($A_V = +2$, $R_f = 866\Omega$, $R_L = 100\Omega$, $V_s = \pm 5V$, unless specified) (Continued)

2nd & 3rd Harmonic Distortion



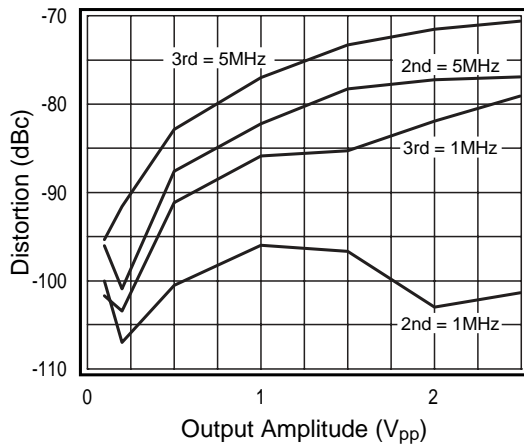
DS015010-9

2nd & 3rd Harmonic Distortion, $R_L = 1k\Omega$



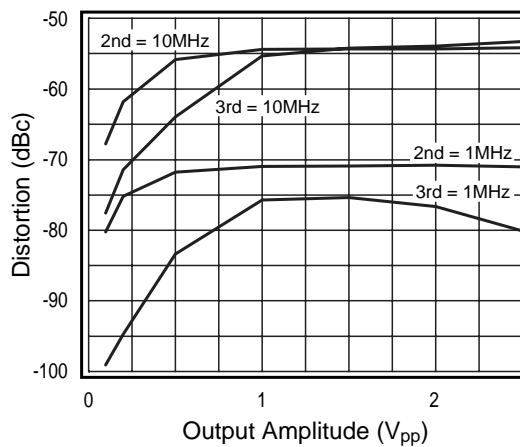
DS015010-10

2nd & 3rd Harmonic Distortion, $R_L = 100\Omega$



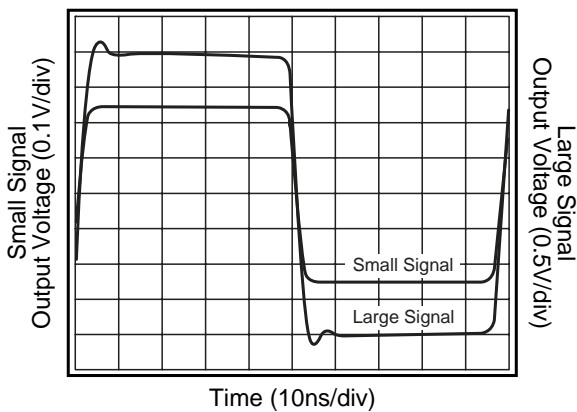
DS015010-11

2nd & 3rd Harmonic Distortion, $R_L = 25\Omega$



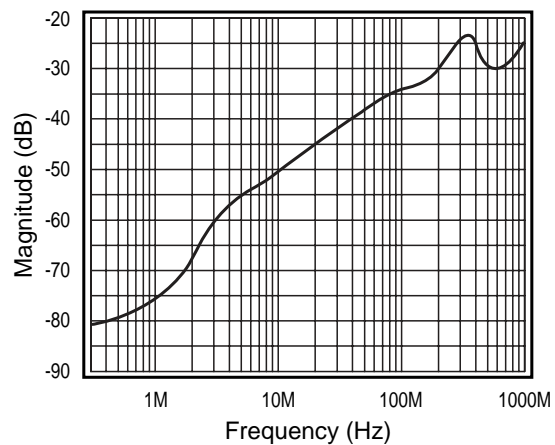
DS015010-12

Large & Small Signal Pulse Response



DS015010-13

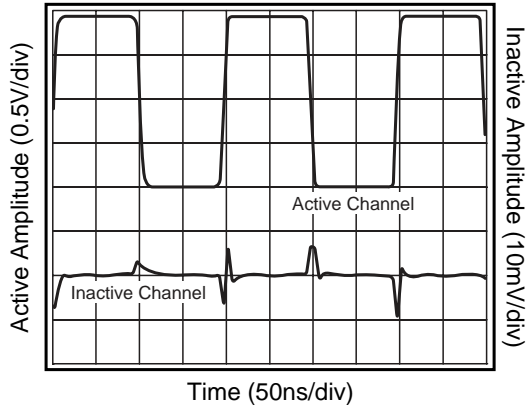
All Hostile Crosstalk



DS015010-14

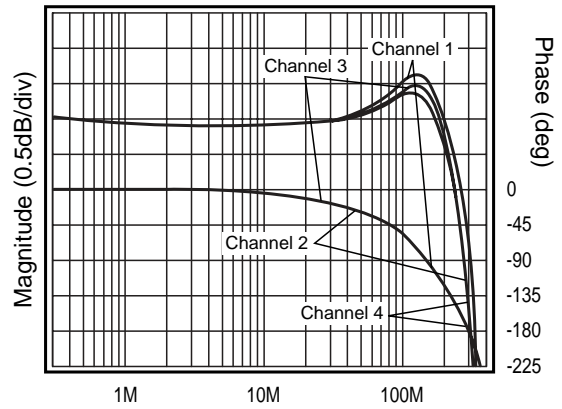
Typical Performance Characteristics ($A_V = +2$, $R_f = 866\Omega$, $R_L = 100\Omega$, $V_s = \pm 5V$, unless specified) (Continued)

Most Susceptible Channel Pulse Coupling



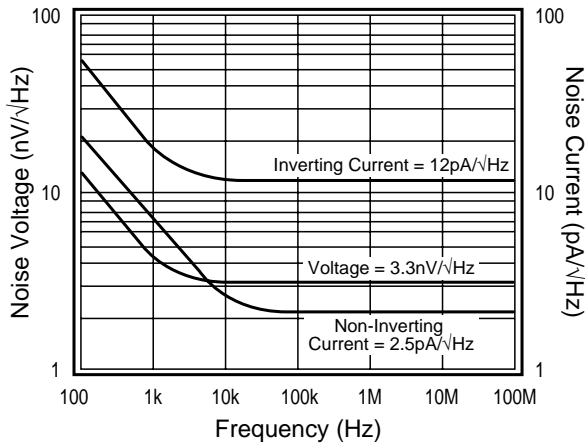
DS015010-15

Channel to Channel Gain Matching



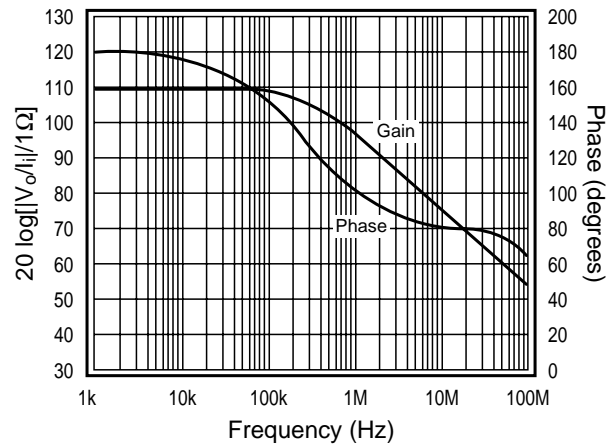
DS015010-16

Equivalent Input Noise



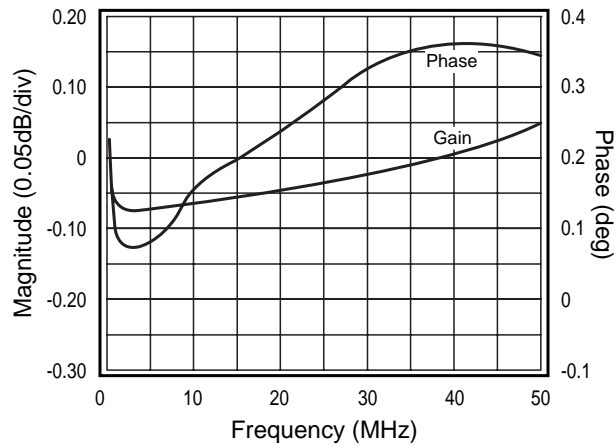
DS015010-17

Open-Loop Transimpedance Gain, Z(s)



DS015010-18

Gain Flatness & Linear Phase



DS015010-19

Application Division

Current Feedback Amplifiers

Some of the key features of current feedback technology are:

- Independence of AC bandwidth and voltage gain
- Inherently stable at unity gain
- Adjustable frequency response with R_f
- High slew rate
- Fast settling

Current feedback operation can be described using a simple equation. The voltage gain for a non-inverting or inverting current feedback amplifier is approximated by Equation 1.

$$\frac{V_o}{V_i} = \frac{A_v}{1 + \frac{R_f}{Z(j\omega)}} \quad (1)$$

where:

A_v is the closed loop DC voltage gain

R_f is the feedback resistor

$Z(j\omega)$ is the open loop transimpedance gain

The denominator of Equation 1 is approximately equal to 1 at low frequencies. Near the -3dB corner frequency, the interaction between R_f and $Z(j\omega)$ dominates the circuit performance. The value of the feedback resistor has a large affect on the circuits performance. Increasing R_f has the following affects:

- Decreases loop gain
- Decreases bandwidth
- Reduces gain peaking
- Lowers pulse response overshoot

- Affects frequency response phase linearity

Layout Considerations

A proper printed circuit layout is essential for achieving high frequency performance. National provides evaluation boards for the CLC5654 (CLC730024-DIP, CLC730031-SOIC) and suggests their use as a guide for high frequency layout and as an aid for device testing and characterization. General layout and supply bypassing play major roles in high frequency layout:

- Include $6.8\mu\text{F}$ tantalum and $0.1\mu\text{F}$ ceramic capacitors on both supplies.
- Place the $6.8\mu\text{F}$ capacitors within 0.75 inches of the power pins.
- Place the $0.1\mu\text{F}$ capacitors less than 0.1 inches from the power pins.
- 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.
- Use flush-mount printed circuit board pins for prototyping, never use high profile DIP sockets.

Active Filter Application Notes

OA-21 Simplified Component Pre-Distortion for High Speed Active Filters

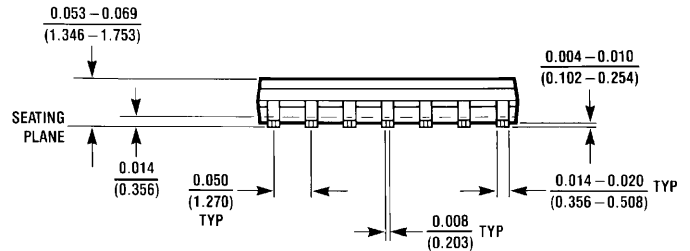
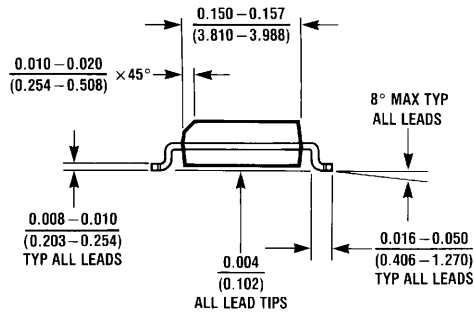
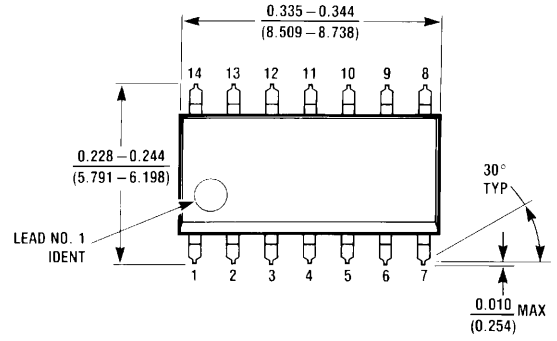
OA-26 Designing High-Speed Active Filters

OA-27 Low-Sensitivity, Lowpass Filter Design

OA-28 Low-Sensitivity, Bandpass Filter Design with Tuning Method

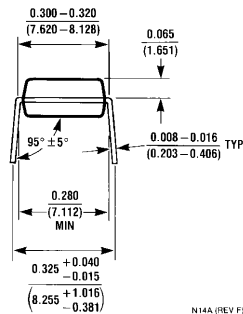
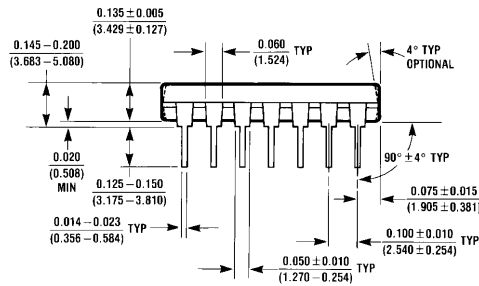
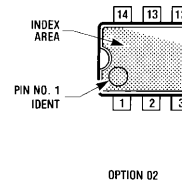
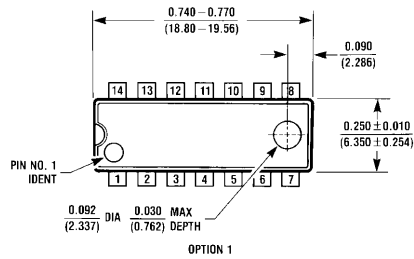
OA-29 Low-Sensitivity, Highpass Filter Design with Parasitic Compensation

Physical Dimensions inches (millimeters) unless otherwise noted



M14A (REV H)

14-Pin SOIC
NS Package Number M14A



N14A (REV F)

14-Pin MDIP
NS Package Number N14A

Notes

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



National Semiconductor Corporation
Americas
Email: support@nsc.com

www.national.com

National Semiconductor Europe

Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Response Group

Tel: 65-2544466
Fax: 65-2504466
Email: ap.support@nsc.com

National Semiconductor Japan Ltd.

Tel: 81-3-5639-7560
Fax: 81-3-5639-7507