National Semiconductor

LMC6462 Dual/LMC6464 Quad Micropower, Rail-to-Rail Input and Output CMOS Operational Amplifier

General Description

The LMC6462/4 is a micropower version of the popular LMC6482/4, combining Rail-to-Rail Input and Output Range with very low power consumption.

The LMC6462/4 provides an input common-mode voltage range that exceeds both rails. The rail-to-rail output swing of the amplifier, guaranteed for loads down to 25 kΩ, assures maximum dynamic sigal range. This rail-to-rail performance of the amplifier, combined with its high voltage gain makes it unique among rail-to-rail amplifiers. The LMC6462/4 is an excellent upgrade for circuits using limited common-mode range amplifiers.

The LMC6462/4, with guaranteed specifications at 3V and 5V, is especially well-suited for low voltage applications. A quiescent power consumption of 60 µW per amplifier (at V_S = 3V) can extend the useful life of battery operated systems. The amplifier's 150 fA input current, low offset voltage of 0.25 mV, and 85 dB CMRR maintain accuracy in battery-powered systems.

Features

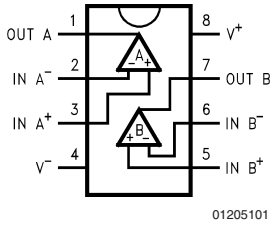
(Typical unless otherwise noted)

- Ultra Low Supply Current 20 µA/Amplifier
- Guaranteed Characteristics at 3V and 5V
- Rail-to-Rail Input Common-Mode Voltage Range
- Rail-to-Rail Output Swing (within 10 mV of rail, V_S = 5V and R_L = 25 kΩ)
- Low Input Current 150 fA
- Low Input Offset Voltage 0.25 mV

Applications

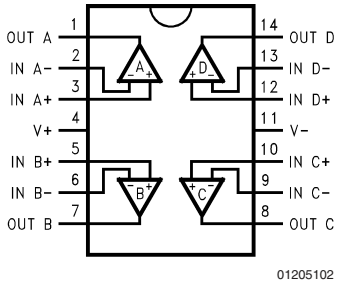
- Battery Operated Circuits
- Transducer Interface Circuits
- Portable Communication Devices
- Medical Applications
- Battery Monitoring

8-Pin DIP/SO



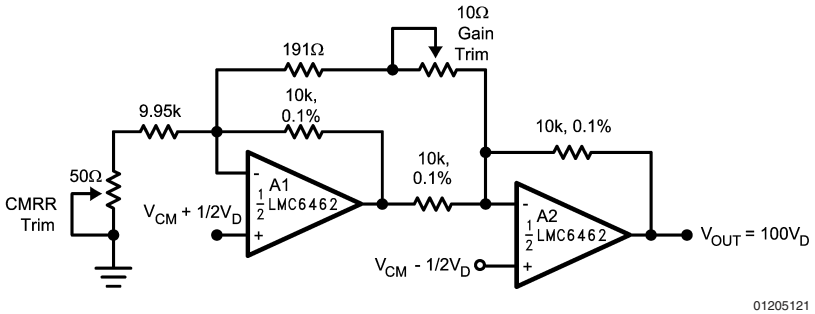
Top View

14-Pin DIP/SO



Top View

Low-Power Two-Op-Amp Instrumentation Amplifier



Absolute Maximum Ratings (Note 1)

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

ESD Tolerance (Note 2)	2.0 kV
Differential Input Voltage	±Supply Voltage
Voltage at Input/Output Pin	$(V^+) + 0.3V$, $(V^-) - 0.3V$
Supply Voltage ($V^+ - V^-$)	16V
Current at Input Pin (Note 12)	±5 mA
Current at Output Pin (Notes 3, 8)	±30 mA
Current at Power Supply Pin	40 mA
Lead Temp. (Soldering, 10 sec.)	260˚C
Storage Temperature Range	−65˚C to +150˚C
Junction Temperature (Note 4)	150˚C

Operating Ratings (Note 1)

Supply Voltage	$3.0V \le V^+ \le 15.5V$
Junction Temperature Range	
LMC6462AM, LMC6464AM	$-55˚C \le T_J \le +125˚C$
LMC6462AI, LMC6464AI	$-40˚C \le T_J \le +85˚C$
LMC6462BI, LMC6464BI	$-40˚C \le T_J \le +85˚C$
Thermal Resistance (θ_{JA})	
N Package, 8-Pin Molded DIP	115˚C/W
M Package, 8-Pin Surface Mount	193˚C/W
N Package, 14-Pin Molded DIP	81˚C/W
M Package, 14-Pin Surface Mount	126˚C/W

5V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25˚C$, $V^+ = 5V$, $V^- = 0V$, $V_{CM} = V_O = V^+/2$ and $R_L > 1M$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6462AI LMC6464AI Limit (Note 6)	LMC6462BI LMC6464BI Limit (Note 6)	LMC6462AM LMC6464AM Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		0.25	0.5 **1.2**	3.0 **3.7**	0.5 **1.5**	mV max
TCV_{OS}	Input Offset Voltage Average Drift		1.5				µV/˚C
I_B	Input Current	(Note 13)	0.15	**10**	**10**	**200**	pA max
I_{OS}	Input Offset Current	(Note 13)	0.075	**5**	**5**	**100**	pA max
C_{IN}	Common-Mode Input Capacitance		3				pF
R_{IN}	Input Resistance		>10				Tera Ω
CMRR	Common Mode Rejection Ratio	$0V \le V_{CM} \le 15.0V$, $V^+ = 15V$	85	70 **67**	65 **62**	70 **65**	dB min
		$0V \le V_{CM} \le 5.0V$ $V^+ = 5V$	85	70 **67**	65 **62**	70 **65**	
+PSRR	Positive Power Supply Rejection Ratio	$5V \le V^+ \le 15V$, $V^- = 0V$, $V_O = 2.5V$	85	70 **67**	65 **62**	70 **65**	dB min
−PSRR	Negative Power Supply Rejection Ratio	$-5V \le V^- \le -15V$, $V^+ = 0V$, $V_O = -2.5V$	85	70 **67**	65 **62**	70 **65**	dB min
V_{CM}	Input Common-Mode Voltage Range	$V^+ = 5V$ For CMRR ≥ 50 dB	−0.2	−0.10 **0.00**	−0.10 **0.00**	−0.10 **0.00**	V max
			5.30	5.25 **5.00**	5.25 **5.00**	5.25 **5.00**	V min
		$V^+ = 15V$ For CMRR ≥ 50 dB	−0.2	−0.15 **0.00**	−0.15 **0.00**	−0.15 **0.00**	V max
			15.30	15.25 **15.00**	15.25 **15.00**	15.25 **15.00**	V min

5V DC Electrical Characteristics (Continued)

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, $V_{CM} = V_O = V^+/2$ and R_L > 1M. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions		Typ (Note 5)	LMC6462AI LMC6464AI Limit (Note 6)	LMC6462BI LMC6464BI Limit (Note 6)	LMC6462AM LMC6464AM Limit (Note 6)	Units
A_V	Large Signal Voltage Gain	R_L = 100 kΩ (Note 7)	Sourcing	3000				V/mV min
			Sinking	400				V/mV min
		R_L = 25 kΩ (Note 7)	Sourcing	2500				V/mV min
			Sinking	200				V/mV min
V_O	Output Swing	V^+ = 5V R_L = 100 kΩ to $V^+/2$		4.995	4.990 **4.980**	4.950 **4.925**	4.990 **4.970**	V min
				0.005	0.010 **0.020**	0.050 **0.075**	0.010 **0.030**	V max
		V^+ = 5V R_L = 25 kΩ to $V^+/2$		4.990	4.975 **4.965**	4.950 **4.850**	4.975 **4.955**	V min
				0.010	0.020 **0.035**	0.050 **0.150**	0.020 **0.045**	V max
		V^+ = 15V R_L = 100 kΩ to $V^+/2$		14.990	14.975 **14.965**	14.950 **14.925**	14.975 **14.955**	V min
				0.010	0.025 **0.035**	0.050 **0.075**	0.025 **0.050**	V max
		V^+ = 15V R_L = 25 kΩ to $V^+/2$		14.965	14.900 **14.850**	14.850 **14.800**	14.900 **14.800**	V min
				0.025	0.050 **0.150**	0.100 **0.200**	0.050 **0.200**	V max
I_{SC}	Output Short Circuit Current V+ = 5V	Sourcing, V_O = 0V		27	19 **15**	19 **15**	19 **15**	mA min
		Sinking, V_O = 5V		27	22 **17**	22 **17**	22 **17**	mA min
I_{SC}	Output Short Circuit Current V^+ = 15V	Sourcing, V_O = 0V		38	24 **17**	24 **17**	24 **17**	mA min
		Sinking, V_O = 12V (Note 8)		75	55 **45**	55 **45**	55 **45**	mA min
I_S	Supply Current	Dual, LMC6462 V^+ = +5V, $V_O = V^+/2$		40	55 **70**	55 **70**	55 **75**	µA max
		Quad, LMC6464 V^+ = +5V, $V_O = V^+/2$		80	110 **140**	110 **140**	110 **150**	µA max
		Dual, LMC6462 V^+ = +15V, $V_O = V^+/2$		50	60 **70**	60 **70**	60 **75**	µA max
		Quad, LMC6464 V^+ = +15V, $V_O = V^+/2$		90	120 **140**	120 **140**	120 **150**	µA max

5V AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, V^+ = 5V, V^- = 0V, $V_{CM} = V_O = V^+/2$ and R_L > 1M. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6462AI LMC6464AI Limit (Note 6)	LMC6462BI LMC6464BI Limit (Note 6)	LMC6462AM LMC6464AM Limit (Note 6)	Units
SR	Slew Rate	(Note 9)	28	15 **8**	15 **8**	15 **8**	V/ms min
GBW	Gain-Bandwidth Product	V^+ = 15V	50				kHz
ϕ_m	Phase Margin		50				Deg
G_m	Gain Margin		15				dB
	Amp-to-Amp Isolation	(Note 10)	130				dB
e_n	Input-Referred Voltage Noise	f = 1 kHz V_{CM} = 1V	80				$nV/\sqrt{Hz}$
i_n	Input-Referred Current Noise	f = 1 kHz	0.03				$pA/\sqrt{Hz}$

3V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_J = 25˚C, V^+ = 3V, V^- = 0V, $V_{CM} = V_O = V^+/2$ and R_L > 1M. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6462AI LMC6464AI Limit (Note 6)	LMC6462BI LMC6464BI Limit (Note 6)	LMC6462AM LMC6464AM Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		0.9	2.0 **2.7**	3.0 **3.7**	2.0 **3.0**	mV max
TCV_{OS}	Input Offset Voltage Average Drift		2.0				µV/˚C
I_B	Input Current	(Note 13)	0.15	**10**	**10**	**200**	pA
I_{OS}	Input Offset Current	(Note 13)	0.075	**5**	**5**	**100**	pA
CMRR	Common Mode Rejection Ratio	$0V \le V_{CM} \le 3V$	74	60	60	60	dB min
PSRR	Power Supply Rejection Ratio	$3V \le V^+ \le 15V$, V^- = 0V	80	60	60	60	dB min
V_{CM}	Input Common-Mode Voltage Range	For CMRR ≥ 50 dB	–0.10	0.0	0.0	0.0	V max
			3.0	3.0	3.0	3.0	V min
V_O	Output Swing	R_L = 25 kΩ to $V^+/2$	2.95	2.9	2.9	2.9	V min
			0.15	0.1	0.1	0.1	V max
I_S	Supply Current	Dual, LMC6462 $V_O = V^+/2$	40	55 **70**	55 **70**	55 **70**	µA
		Quad, LMC6464 $V_O = V^+/2$	80	110 **140**	110 **140**	110 **140**	µA max

3V AC Electrical Characteristics

Unless otherwise specified, $V^+ = 3V$, $V^- = 0V$, $V_{CM} = V_O = V^+/2$ and $R_L > 1M$. **Boldface limits** apply at the temperature extremes.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6462AI LMC6464AI Limit (Note 6)	LMC6462BI LMC6464BI Limit (Note 6)	LMC6462AM LMC6464AM Limit (Note 6)	Units
SR	Slew Rate	(Note 11)	23				V/ms
GBW	Gain-Bandwidth Product		50				kHz

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: Human body model, 1.5 kΩ in series with 100 pF. All pins rated per method 3015.6 of MIL-STD-883. This is a class 2 device rating.

Note 3: Applies to both single supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150˚C. Output currents in excess of ±30 mA over long term may adversely affect reliability.

Note 4: The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board.

Note 5: Typical Values represent the most likely parametric norm.

Note 6: All limits are guaranteed by testing or statistical analysis.

Note 7: $V^+ = 15V$, $V_{CM} = 7.5V$ and R_L connected to 7.5V. For Sourcing tests, $7.5V \le V_O \le 11.5V$. For Sinking tests, $3.5V \le V_O \le 7.5V$.

Note 8: Do not short circuit output to V^+, when V^+ is greater than 13V or reliability will be adversely affected.

Note 9: $V^+ = 15V$. Connected as Voltage Follower with 10V step input. Number specified is the slower of either the positive or negative slew rates.

Note 10: Input referred, $V^+ = 15V$ and $R_L = 100\ k\Omega$ connected to 7.5V. Each amp excited in turn with 1 kHz to produce $V_O = 12\ V_{PP}$.

Note 11: Connected as Voltage Follower with 2V step input. Number specified is the slower of either the positive or negative slew rates.

Note 12: Limiting input pin current is only necessary for input voltages that exceed absolute maximum input voltage ratings.

Note 13: Guaranteed limits are dictated by tester limitations and not device performance. Actual performance is reflected in the typical value.

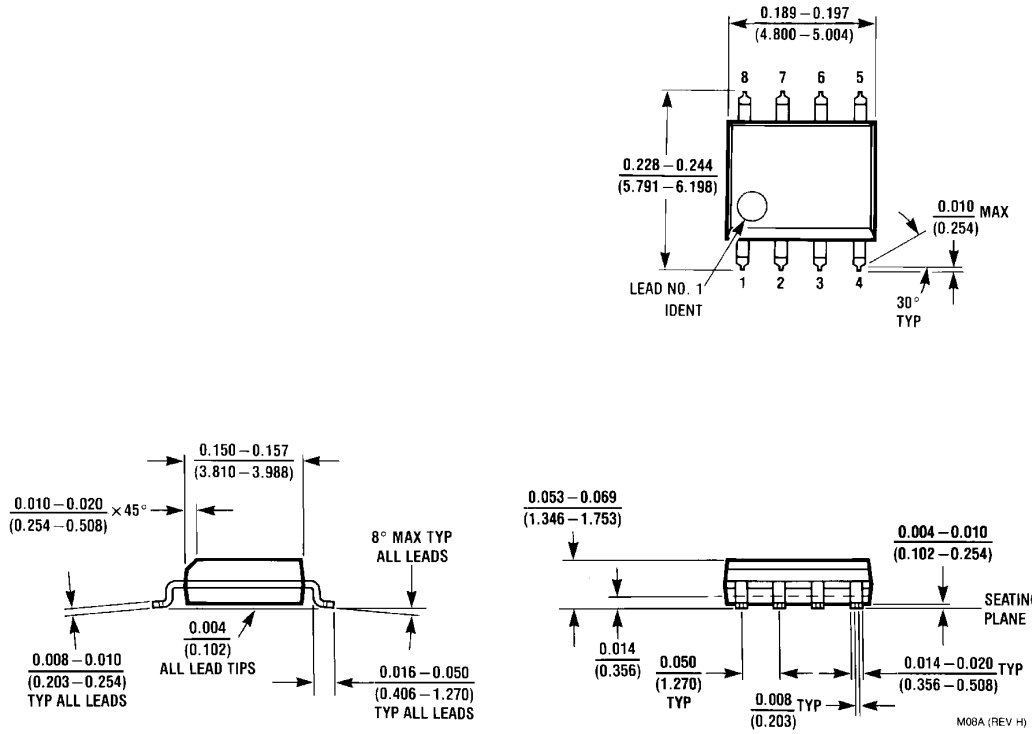
Note 14: For guaranteed Military Temperature Range parameters see RETSMC6462/4X.

Ordering Information

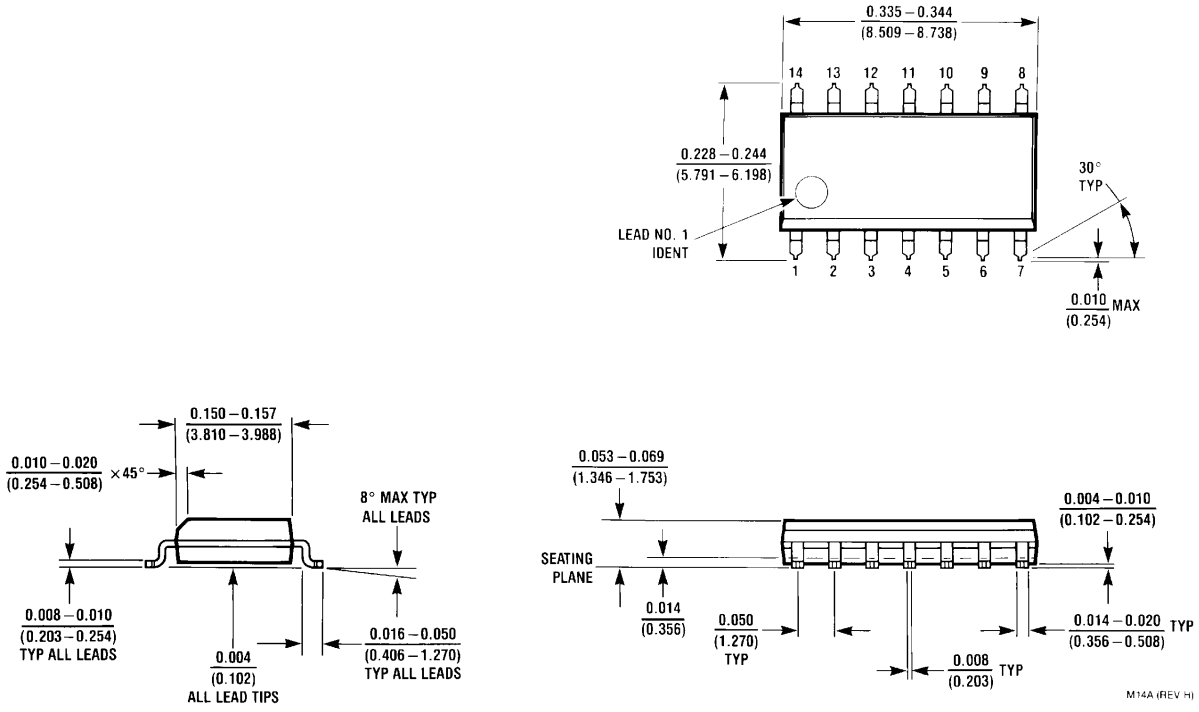
Package	Temperature Range		Transport Media	NSC Drawing
	Military −55˚C to +125˚C	Industrial −40˚C to +85˚C		
8-Pin Molded DIP		LMC6462AIN	40 Units/Rail	N08E
		LMC6462BIN		
8-Pin SO-8		LMC6462AIM	95 Units/Rail	M08A
		LMC6462BIM		
		LMC6462AIMX	2.5k Tape and Reel	
		LMC6462BIMX		
14-Pin Molded DIP		LMC6464AIN	25 Units/Rail	N14A
		LMC6464BIN		
14-Pin SO-14		LMC6464AIM	55 Units/Rail	M14A
		LMC6464BIM		
		LMC6464AIMX	2.5k Tape and Reel	
		LMC6464BIMX		
8-Pin Ceramic DIP	LMC6462AMJ-QML		Rails	J08A
14-Pin Ceramic DIP	LMC6464AMJ-QML		Rails	J14A
14-Pin Ceramic SOIC	LMC6464AMWG-QML		Trays	WG14A

Physical Dimensions inches (millimeters)

unless otherwise noted

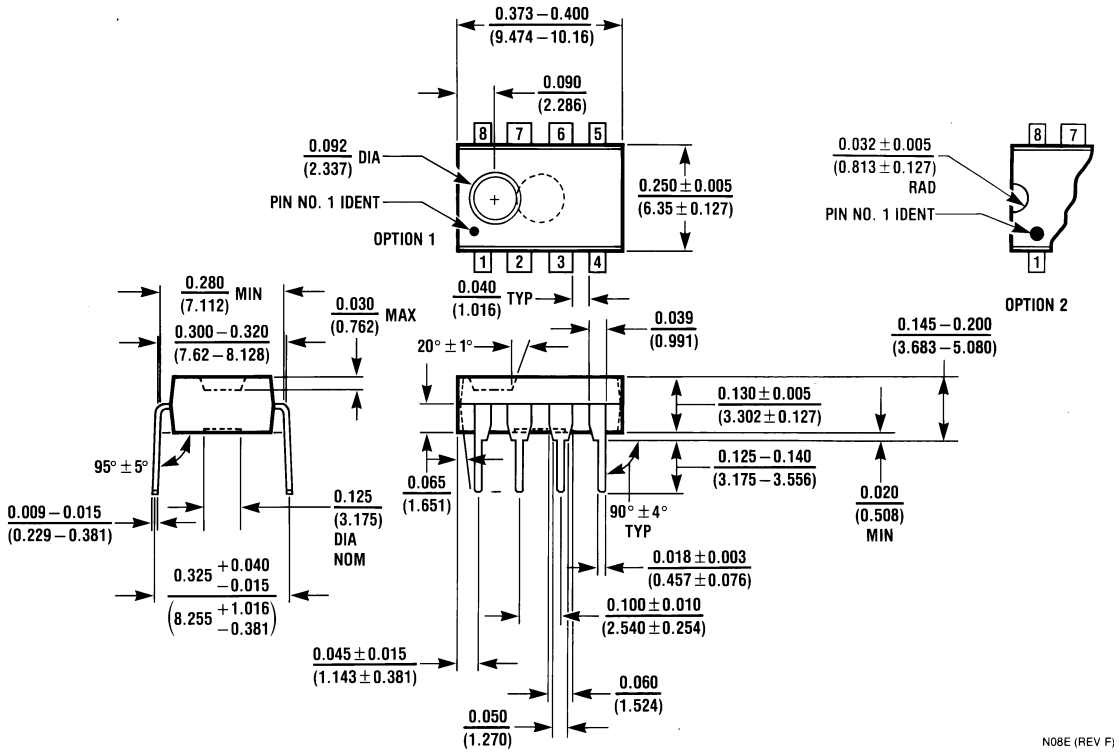


8-Pin Small Outline Package
NS Package Number M08A

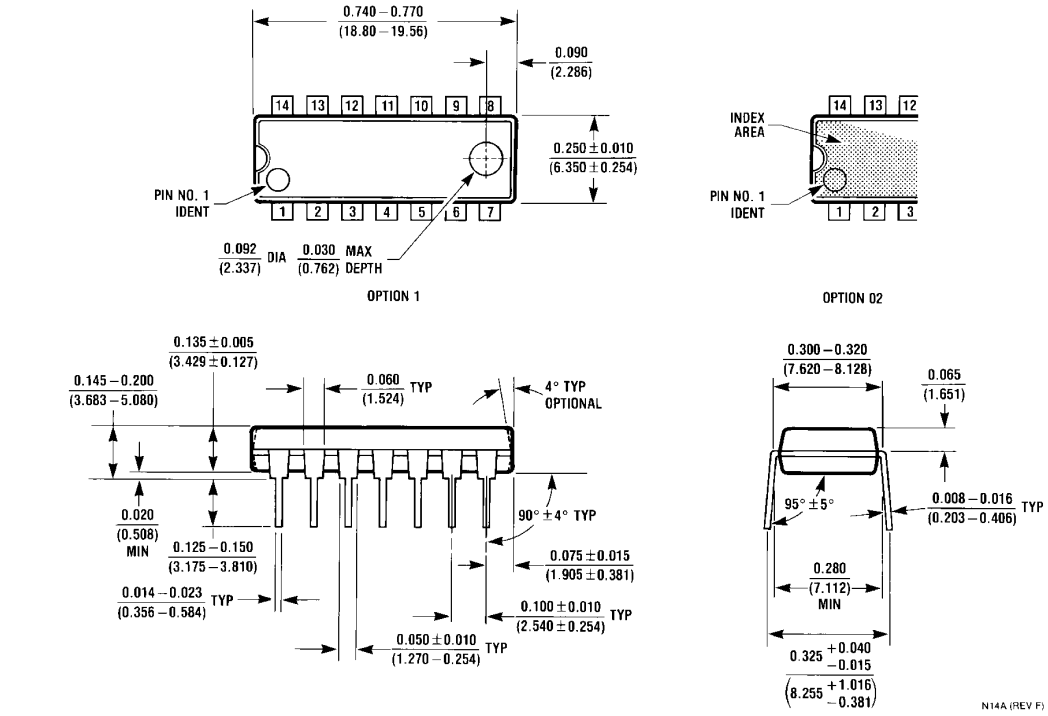


14-Pin Small Outline Package
NS Package Number M14A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



8-Pin Molded Dual-In-Line Package
NS Package Number N08E



14-Pin Molded Dual-In-Line Pacakge
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