National Semiconductor

LMC6482
CMOS Dual Rail-To-Rail Input and Output Operational Amplifier

General Description

The LMC6482 provides a common-mode range that extends to both supply rails. This rail-to-rail performance combined with excellent accuracy, due to a high CMRR, makes it unique among rail-to-rail input amplifiers.

It is ideal for systems, such as data acquisition, that require a large input signal range. The LMC6482 is also an excellent upgrade for circuits using limited common-mode range amplifiers such as the TLC272 and TLC277.

Maximum dynamic signal range is assured in low voltage and single supply systems by the LMC6482's rail-to-rail output swing. The LMC6482's rail-to-rail output swing is guaranteed for loads down to 600Ω.

Guaranteed low voltage characteristics and low power dissipation make the LMC6482 especially well-suited for battery-operated systems.

LMC6482 is also available in MSOP package which is almost half the size of a SO-8 device.

See the LMC6484 data sheet for a Quad CMOS operational amplifier with these same features.

Features

(Typical unless otherwise noted)

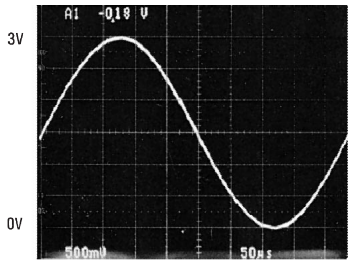
- Rail-to-Rail Input Common-Mode Voltage Range (Guaranteed Over Temperature)
- Rail-to-Rail Output Swing (within 20mV of supply rail, 100kΩ load)
- Guaranteed 3V, 5V and 15V Performance
- Excellent CMRR and PSRR: 82dB
- Ultra Low Input Current: 20fA
- High Voltage Gain (R_L = 500kΩ): 130dB
- Specified for 2kΩ and 600Ω loads
- Available in MSOP Package

Applications

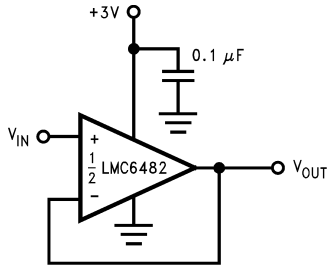
- Data Acquisition Systems
- Transducer Amplifiers
- Hand-held Analytic Instruments
- Medical Instrumentation
- Active Filter, Peak Detector, Sample and Hold, pH Meter, Current Source
- Improved Replacement for TLC272, TLC277

3V Single Supply Buffer Circuit

Rail-To-Rail Input

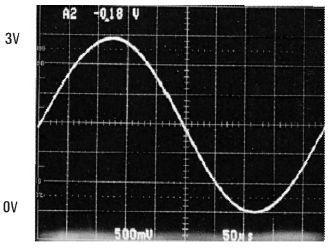


01171301



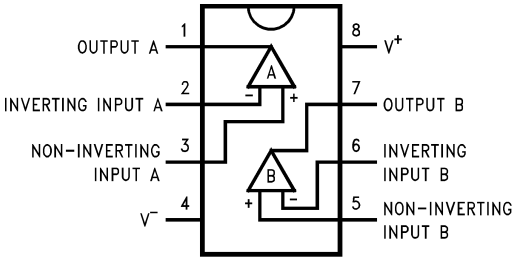
01171302

Rail-To-Rail Output



01171303

Connection Diagram



01171304

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)	1.5kV
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)	±5mA
Current at Output Pin (Notes 3, 8)	±30mA
Current at Power Supply Pin	40mA
Lead Temperature (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 ≤ V+ ≤ 15.5V
Junction Temperature Range	
LMC6482AM	$-55^\circ C \le T_J \le +125^\circ C$
LMC6482AI, LMC6482I	$-40^\circ C \le T_J \le +85^\circ C$
Thermal Resistance (θ_{JA})	
N Package, 8-Pin Molded DIP	90˚C/W
M Package, 8-Pin Surface Mount	155˚C/W
MSOP package, 8-Pin Mini SO	194˚C/W

DC Electrical Characteristics

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

Symbol	Parameter	Conditions		Typ (Note 5)	LMC6482AI Limit (Note 6)	LMC6482I Limit (Note 6)	LMC6482M Limit (Note 6)	Units
V_{OS}	Input Offset Voltage			0.11	0.750 **1.35**	3.0 **3.7**	3.0 **3.8**	mV max
TCV_{OS}	Input Offset Voltage Average Drift			1.0				µV/˚C
I_B	Input Current	(Note 13)		0.02	**4.0**	**4.0**	**10.0**	pA max
I_{OS}	Input Offset Current	(Note 13)		0.01	**2.0**	**2.0**	**5.0**	pA max
C_{IN}	Common-Mode Input Capacitance			3				pF
R_{IN}	Input Resistance			>10				TeraΩ
CMRR	Common Mode Rejection Ratio	$0V \le V_{CM} \le 15.0V$ $V^+ = 15V$		82	70 **67**	65 **62**	65 **60**	dB min
		$0V \le V_{CM} \le 5.0V$ $V^+ = 5V$		82	70 **67**	65 **62**	65 **60**	
+PSRR	Positive Power Supply Rejection Ratio	$5V \le V^+ \le 15V$, $V^- = 0V$ $V_O = 2.5V$		82	70 **67**	65 **62**	65 **60**	dB min
−PSRR	Negative Power Supply Rejection Ratio	$-5V \le V^- \le -15V$, $V^+ = 0V$ $V_O = -2.5V$		82	70 **67**	65 **62**	65 **60**	dB min
V_{CM}	Input Common-Mode Voltage Range	$V^+ = 5V$ and 15V For CMRR ≥ 50dB		V^- − 0.3	− 0.25 **0**	− 0.25 **0**	− 0.25 **0**	V max
				V^+ + 0.3V	V^+ + 0.25 **V^+**	V^+ + 0.25 **V^+**	V^+ + 0.25 **V^+**	V min
A_V	Large Signal Voltage Gain	$R_L = 2k\Omega$ (Notes 7, 13)	Sourcing	666	140 **84**	120 **72**	120 **60**	V/mV min
			Sinking	75	35 **20**	35 **20**	35 **18**	V/mV min
		$R_L = 600\Omega$ (Notes 7, 13)	Sourcing	300	80 **48**	50 **30**	50 **25**	V/mV min
			Sinking	35	20	15	15	V/mV

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)	LMC6482AI Limit (Note 6)	LMC6482I Limit (Note 6)	LMC6482M Limit (Note 6)	Units
				13	**10**	**8**	min
V_O	Output Swing	V^+ = 5V R_L = 2kΩ to $V^+/2$	4.9	4.8 **4.7**	4.8 **4.7**	4.8 **4.7**	V min
			0.1	0.18 **0.24**	0.18 **0.24**	0.18 **0.24**	V max
		V^+ = 5V R_L = 600Ω to $V^+/2$	4.7	4.5 **4.24**	4.5 **4.24**	4.5 **4.24**	V min
			0.3	0.5 **0.65**	0.5 **0.65**	0.5 **0.65**	V max
		V^+ = 15V R_L = 2kΩ to $V^+/2$	14.7	14.4 **14.2**	14.4 **14.2**	14.4 **14.2**	V min
			0.16	0.32 **0.45**	0.32 **0.45**	0.32 **0.45**	V max
		V^+ = 15V R_L = 600Ω to $V^+/2$	14.1	13.4 **13.0**	13.4 **13.0**	13.4 **13.0**	V min
			0.5	1.0 **1.3**	1.0 **1.3**	1.0 **1.3**	V max
I_{SC}	Output Short Circuit Current V^+ = 5V	Sourcing, V_O = 0V	20	16 **12**	16 **12**	16 **10**	mA min
		Sinking, V_O = 5V	15	11 **9.5**	11 **9.5**	11 **8.0**	mA min
I_{SC}	Output Short Circuit Current V^+ = 15V	Sourcing, V_O = 0V	30	28 **22**	28 **22**	28 **20**	mA min
		Sinking, V_O = 12V (Note 8)	30	30 **24**	30 **24**	30 **22**	mA min
I_S	Supply Current	Both Amplifiers V^+ = +5V, $V_O = V^+/2$	1.0	1.4 **1.8**	1.4 **1.8**	1.4 **1.9**	mA max
		Both Amplifiers V^+ = 15V, $V_O = V^+/2$	1.3	1.6 **1.9**	1.6 **1.9**	1.6 **2.0**	mA max

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)	LMC6482AI Limit (Note 6)	LMC6482I Limit (Note 6)	LMC6482M Limit (Note 6)	Units
SR	Slew Rate	(Note 9)	1.3	1.0 **0.7**	0.9 **0.63**	0.9 **0.54**	V/μs min
GBW	Gain-Bandwidth Product	V^+ = 15V	1.5				MHz
ϕ_m	Phase Margin		50				Deg
G_m	Gain Margin		15				dB
	Amp-to-Amp Isolation	(Note 10)	150				dB
e_n	Input-Referred Voltage Noise	F = 1kHz V_{cm} = 1V	37				nV/√Hz
i_n	Input-Referred Current Noise	F = 1kHz	0.03				pA/√Hz

AC 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)	LMC6482AI Limit (Note 6)	LMC6482I Limit (Note 6)	LMC6482M Limit (Note 6)	Units
T.H.D.	Total Harmonic Distortion	F = 10kHz, A_V = –2 R_L = 10kΩ, V_O = 4.1 V_{PP}	0.01				%
		F = 10kHz, A_V = –2 R_L = 10kΩ, V_O = 8.5 V_{PP} V^+ = 10V	0.01				%

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.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6482AI Limit (Note 6)	LMC6482I Limit (Note 6)	LMC6482M Limit (Note 6)	Units
V_{OS}	Input Offset Voltage		0.9	2.0 **2.7**	3.0 **3.7**	3.0 **3.8**	mV max
TCV_{OS}	Input Offset Voltage Average Drift		2.0				µV/˚C
I_B	Input Bias Current		0.02				pA
I_{OS}	Input Offset Current		0.01				pA
CMRR	Common Mode Rejection Ratio	0V ≤ V_{CM} ≤ 3V	74	64	60	60	dB min
PSRR	Power Supply Rejection Ratio	3V ≤ V^+ ≤ 15V, V^- = 0V	80	68	60	60	dB min
V_{CM}	Input Common-Mode Voltage Range	For CMRR ≥ 50dB	V^- –0.25	0	0	0	V max
			V^+ + 0.25	V^+	V^+	V^+	V min
V_O	Output Swing	R_L = 2kΩ to $V^+/2$	2.8				V
			0.2				V
		R_L = 600Ω to $V^+/2$	2.7	2.5	2.5	2.5	V min
			0.37	0.6	0.6	0.6	V max
I_S	Supply Current	Both Amplifiers	0.825	1.2 **1.5**	1.2 **1.5**	1.2 **1.6**	mA max

AC Electrical Characteristics

Unless otherwise specified, V^+ = 3V, V^- = 0V, $V_{CM} = V_O = V^+/2$, and R_L > 1M.

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6482AI Limit (Note 6)	LMC6482I Limit (Note 6)	LMC6482M Limit (Note 6)	Units
SR	Slew Rate	(Note 11)	0.9				V/µs
GBW	Gain-Bandwidth Product		1.0				MHz
T.H.D.	Total Harmonic Distortion	F = 10kHz, A_V = –2 R_L = 10kΩ, V_O = 2 V_{PP}	0.01				%

Note 1: Absolute Maximum Ratings indicate limts 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, 1.5kΩ in series with 100pF. All pins rated per method 3015.6 of MIL-STD-883. This is a Class 1 device rating.

AC Electrical Characteristics (Continued)

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 ±30mA 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.

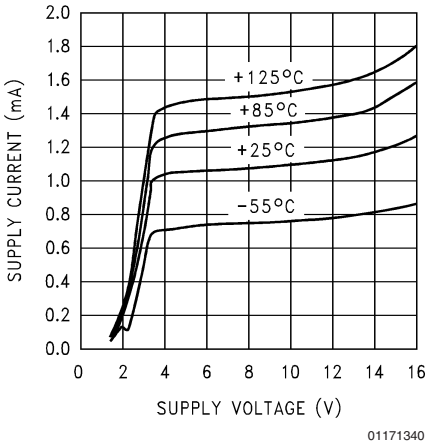
Note 13: Guaranteed limits are dictated by tester limitations and not device performance. Actual performance is reflected in the typical value.

Note 14: For guaranteed Military Temperature parameters see RETS6482X.

Typical Performance Characteristics

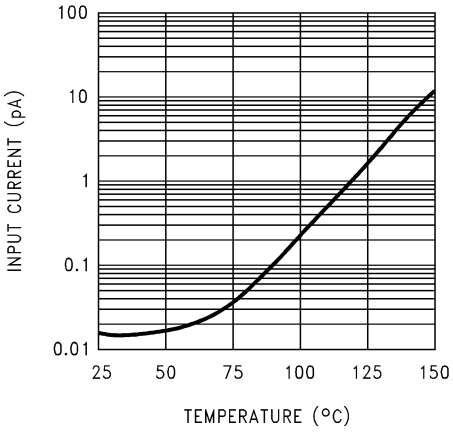
$V_S = +15V$, Single Supply, $T_A = 25˚C$ unless otherwise specified

Supply Current vs. Supply Voltage



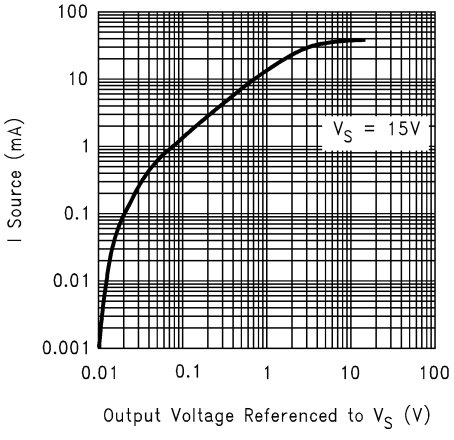
01171340

Input Current vs. Temperature



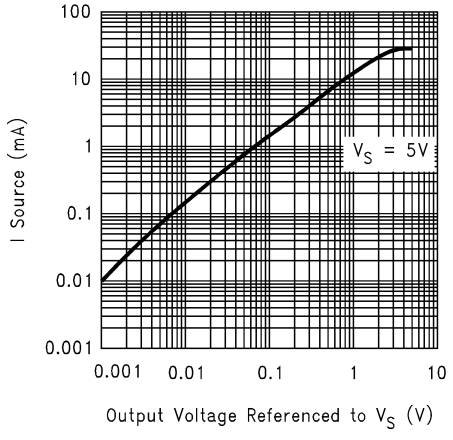
01171341

Sourcing Current vs. Output Voltage



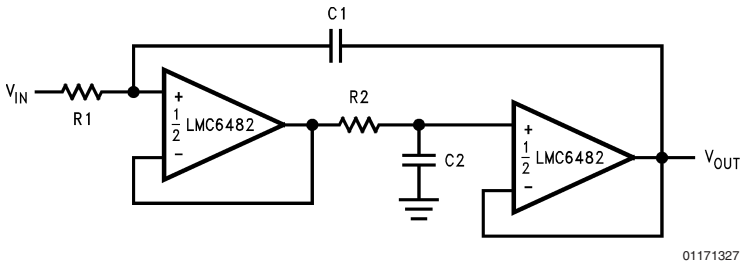
01171342

Sourcing Current vs. Output Voltage



01171343

Typical Single-Supply Applications (Continued)



$$R1 = R2,\ C1 = C2;\ f = \frac{1}{2\pi R1\ C1};\ DF = \tfrac{1}{2}\sqrt{\frac{C_2}{C_1}}\sqrt{\frac{R_2}{R_1}}$$

FIGURE 25. Rail-to-Rail Single Supply Low Pass Filter

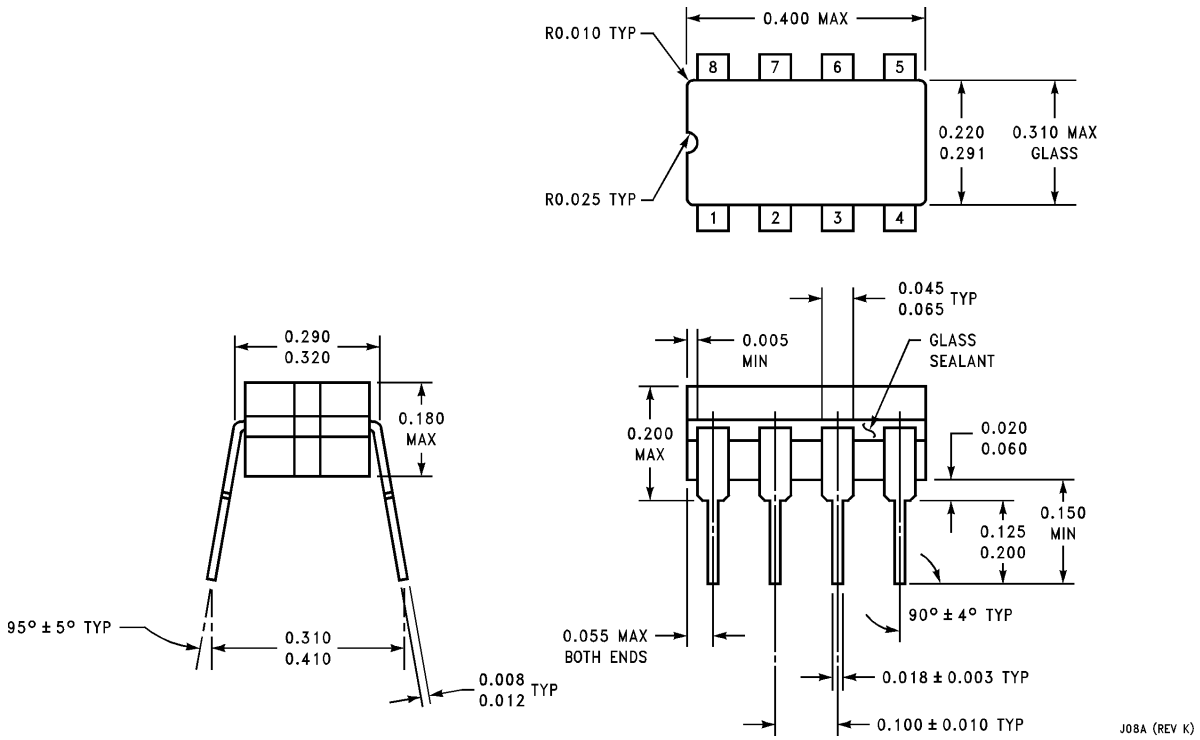
The low pass filter circuit in *Figure 25* can be used as an anti-aliasing filter with the same voltage supply as the A/D converter.

Filter designs can also take advantage of the LMC6482 ultra-low input current. The ultra-low input current yields negligible offset error even when large value resistors are used. This in turn allows the use of smaller valued capacitors which take less board space and cost less.

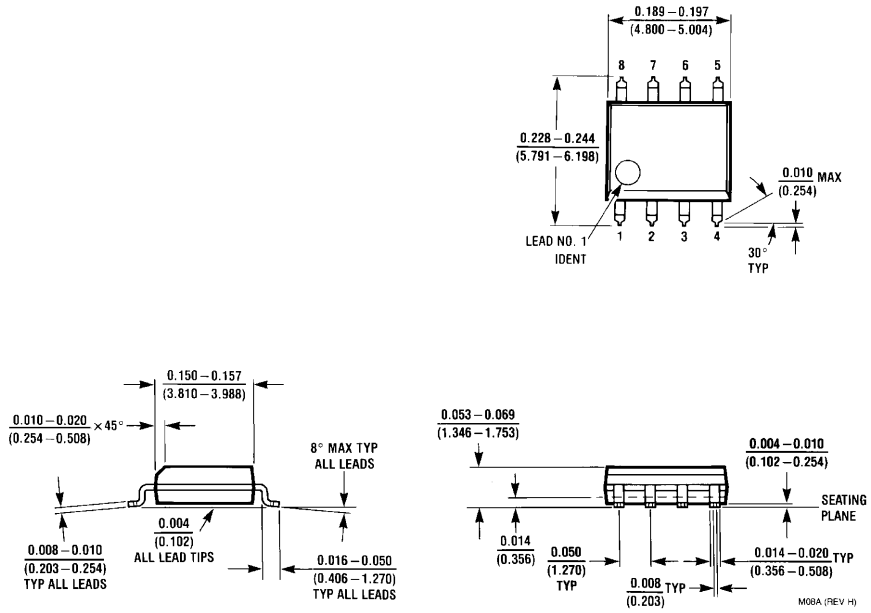
Ordering Information

Package	Temperature Range		NSC Drawing	Transport Media	Package Marking
	Military −55˚C to +125˚C	Industrial −40˚C to +85˚C			
8-Pin Molded DIP		LMC6482AIN, LMC6482IN	N08E	Rail	LMC6482MN, LMC6482AIN, LMC6482IN
8-pin Small Outline		LMC6482AIM, LMC6482AIMX LMC6482IM, LMC6482IMX	M08A	Rail Tape and Reel	LMC6482AIM, LMC6482IM
8-pin Ceramic DIP	LMC6482AMJ/883		J08A	Rail	LMC6482AMJ/883Q5962-9453401MPA
8-pin Mini SO		LMC6482IMM LMC6482IMMX	MUA08A	Rail Tape and Reel	A10

Physical Dimensions inches (millimeters) unless otherwise noted

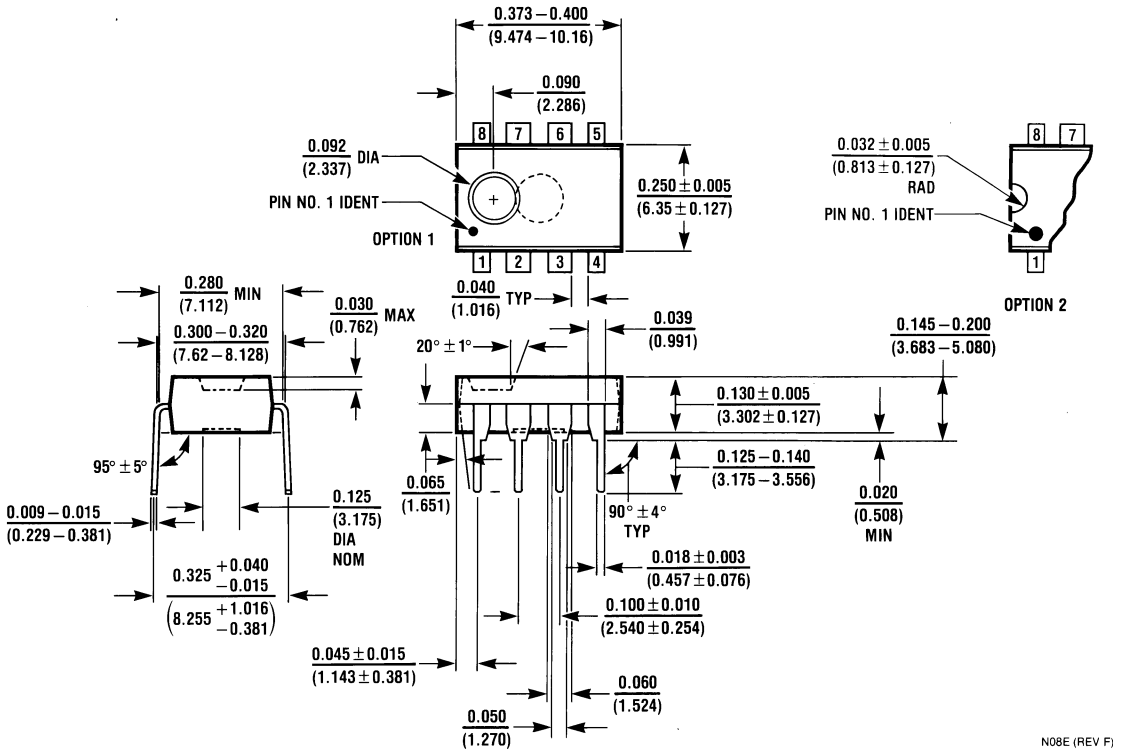


8-Pin Ceramic Dual-In-Line Package
Order Number LMC6482AMJ/883
NS Package Number J08A

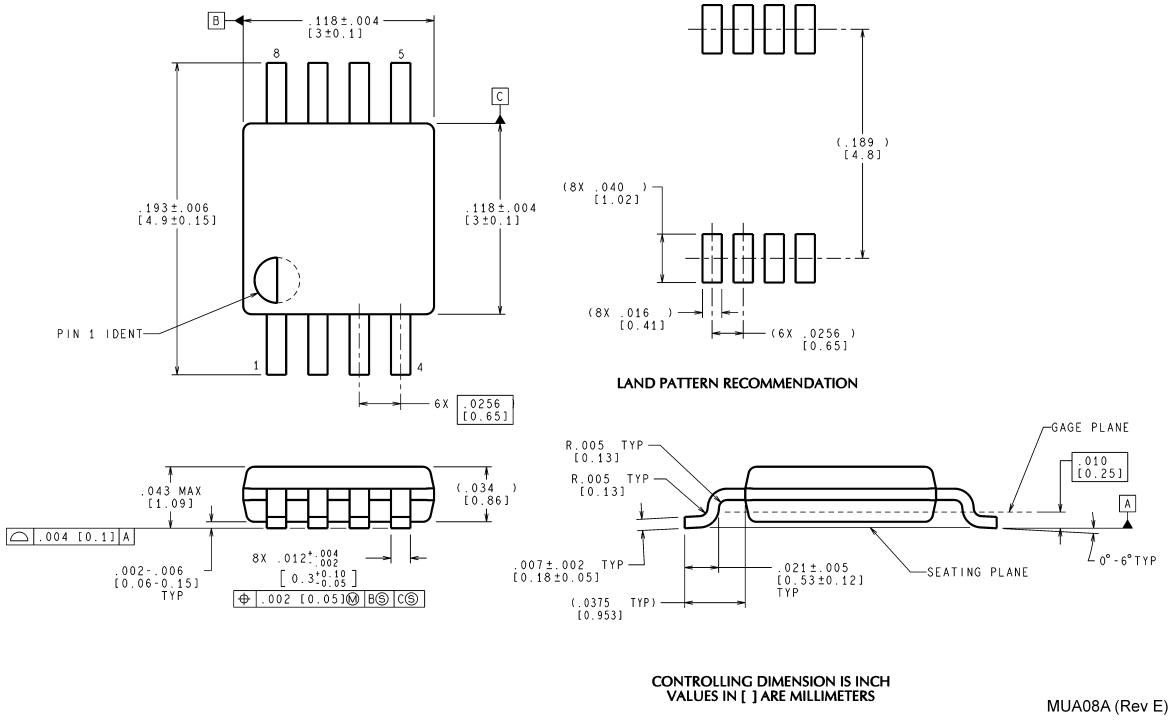


8-Pin Small Outline Package
Order Package Number LMC6482AIM, LMC6482AIMX, LMC6482IM or LMC6482IMX
NS Package Number M08A

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



8-Pin Molded Dual-In-Line Package
Order Package Number LMC6482AIN, LMC6482IN
NS Package Number N08E



8-Lead Mini Small Outline Molded Package, JEDEC
Order Number LMC6482IMM, or LMC6482IMMX
NS Package Number MUA08A