

LMC6484

CMOS Quad Rail-to-Rail Input and Output Operational Amplifier

General Description

The LMC6484 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 LMC6484 is also an excellent upgrade for circuits using limited common-mode range amplifiers such as the TLC274 and TLC279.

Maximum dynamic signal range is assured in low voltage and single supply systems by the LMC6484's rail-to-rail output swing. The LMC6484's rail-to-rail output swing is guaranteed for loads down to 600Ω.

Guaranteed low voltage characteristics and low power dissipation make the LMC6484 especially well-suited for battery-operated systems.

See the LMC6482 data sheet for a Dual CMOS operational amplifier with these same features.

Features

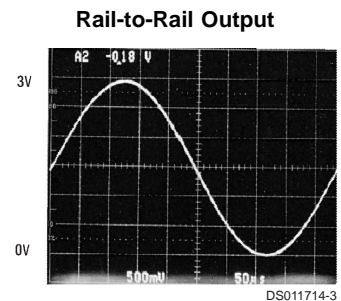
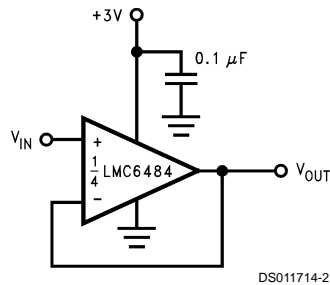
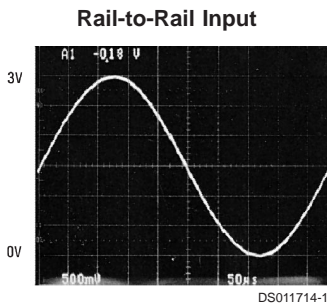
(Typical unless otherwise noted)

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

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 TLC274, TLC279

3V Single Supply Buffer Circuit



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 ≤ V ⁺ ≤ 15.5V
Junction Temperature Range	
LMC6484AM	-55°C ≤ T _J ≤ +125°C
LMC6484AI, LMC6484I	-40°C ≤ T _J ≤ +85°C
Thermal Resistance (θ _{JA})	
N Package, 14-Pin Molded DIP	70°C/W
M Package, 14-Pin Surface Mount	110°C/W

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)	LMC6484AI Limit (Note 6)	LMC6484I Limit (Note 6)	LMC6484M Limit (Note 6)	Units	
V _{OS}	Input Offset Voltage		0.110	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	100	pA max	
I _{OS}	Input Offset Current	(Note 13)	0.01	2.0	2.0	50	pA max	
C _{IN}	Common-Mode Input Capacitance		3				pF	
R _{IN}	Input Resistance		>10				Tera Ω	
CMRR	Common Mode Rejection Ratio	0V ≤ V _{CM} ≤ 15.0V, V ⁺ = 15V	82	70 67	65 62	65 60	dB min	
		0V ≤ V _{CM} ≤ 5.0V V ⁺ = 5V	82	70 67	65 62	65 60		
+PSRR	Positive Power Supply Rejection Ratio	5V ≤ V ⁺ ≤ 15V, V ⁻ = 0V, V _O = 2.5V	82	70 67	65 62	65 60	dB min	
-PSRR	Negative Power Supply Rejection Ratio	-5V ≤ V ⁻ ≤ -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 ≥ 50 dB	V ⁻ - 0.3	-0.25 0	-0.25 0	-0.25 0	V max	
			V ⁺ + 0.3	V ⁺ + 0.25 V⁺	V ⁺ + 0.25 V⁺	V ⁺ + 0.25 V⁺	V min	
A _v	Large Signal Voltage Gain	R _L = 2kΩ (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 = 600Ω (Notes 7, 13)	Sourcing	300	80 48	50 30	50 25	V/mV min
			Sinking	35	20 13	15 10	15 8	V/mV min

DC Electrical Characteristics (Continued)

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

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6484AI Limit (Note 6)	LMC6484I Limit (Note 6)	LMC6484M Limit (Note 6)	Units	
V_O	Output Swing	$V^+ = 5\text{V}$ $R_L = 2\text{ k}\Omega$ to $V^+/2$	4.9	4.8	4.8	4.8	V	
			0.1	0.18	0.18	0.18	V	
		$V^+ = 5\text{V}$ $R_L = 600\Omega$ to $V^+/2$	4.7	4.5	4.5	4.5	V	
			0.3	0.5	0.5	0.5	V	
		$V^+ = 15\text{V}$ $R_L = 2\text{ k}\Omega$ to $V^+/2$	14.7	14.4	14.4	14.4	V	
			0.16	0.32	0.32	0.32	V	
	$V^+ = 15\text{V}$ $R_L = 600\Omega$ to $V^+/2$	14.1	13.4	13.4	13.4	V		
		0.5	1.0	1.0	1.0	V		
	I_{SC}	Output Short Circuit Current $V^+ = 5\text{V}$	Sourcing, $V_O = 0\text{V}$	20	16	16	16	mA
			Sinking, $V_O = 5\text{V}$	15	11	11	11	mA
	I_{SC}	Output Short Circuit Current $V^+ = 15\text{V}$	Sourcing, $V_O = 0\text{V}$	30	28	28	28	mA
			Sinking, $V_O = 12\text{V}$ (Note 8)	30	30	30	30	mA
I_S	Supply Current	All Four Amplifiers $V^+ = +5\text{V}$, $V_O = V^+/2$	2.0	2.8	2.8	2.8	mA	
		All Four Amplifiers $V^+ = +15\text{V}$, $V_O = V^+/2$	2.6	3.0	3.0	3.0	mA	

AC Electrical Characteristics

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

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6484A Limit (Note 6)	LMC6484I Limit (Note 6)	LMC6484M Limit (Note 6)	Units
SR	Slew Rate	(Note 9)	1.3	1.0	0.9	0.9	V/ μs
GBW	Gain-Bandwidth Product	$V^+ = 15\text{V}$	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	$f = 1\text{ kHz}$ $V_{\text{CM}} = 1\text{V}$	37				nV/ $\sqrt{\text{Hz}}$
i_n	Input-Referred Current Noise	$f = 1\text{ kHz}$	0.03				pA/ $\sqrt{\text{Hz}}$

AC Electrical Characteristics (Continued)

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

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6484A Limit (Note 6)	LMC6484I Limit (Note 6)	LMC6484M Limit (Note 6)	Units
T.H.D.	Total Harmonic Distortion	$f = 1\text{ kHz}$, $A_V = -2$ $R_L = 10\text{ k}\Omega$, $V_O = 4.1\text{ V}_{\text{PP}}$	0.01				%
		$f = 10\text{ kHz}$, $A_V = -2$ $R_L = 10\text{ k}\Omega$, $V_O = 8.5\text{ V}_{\text{PP}}$ $V^+ = 10\text{V}$	0.01				%

DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_J = 25^\circ\text{C}$, $V^+ = 3\text{V}$, $V^- = 0\text{V}$, $V_{\text{CM}} = V_O = V^+/2$ and $R_L > 1\text{M}$

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6484AI Limit (Note 6)	LMC6484I Limit (Note 6)	LMC6484M 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				$\mu\text{V}/^\circ\text{C}$
I_B	Input Bias Current		0.02				pA
I_{OS}	Input Offset Current		0.01				pA
CMRR	Common Mode Rejection Ratio	$0\text{V} \leq V_{\text{CM}} \leq 3\text{V}$	74	64	60	60	dB min
PSRR	Power Supply Rejection Ratio	$3\text{V} \leq V^+ \leq 15\text{V}$, $V^- = 0\text{V}$	80	68	60	60	dB min
V_{CM}	Input Common-Mode Voltage Range	For CMRR $\geq 50\text{ dB}$	$V^- - 0.25$	0	0	0	V max
			$V^+ + 0.25$	V^+	V^+	V^+	V min
V_O	Output Swing	$R_L = 2\text{ k}\Omega$ to $V^+/2$	2.8				V
			0.2				V
		$R_L = 600\Omega$ 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	All Four Amplifiers	1.65	2.5 3.0	2.5 3.0	2.5 3.2	mA max

AC Electrical Characteristics

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

Symbol	Parameter	Conditions	Typ (Note 5)	LMC6484AI Limit (Note 6)	LMC6484I Limit (Note 6)	LMC6484M 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	$f = 10\text{ kHz}$, $A_V = -2$ $R_L = 10\text{ k}\Omega$, $V_O = 2\text{ V}_{\text{PP}}$	0.01				%

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 k Ω in series with 100 pF. All pins rated per method 3015.6 of MIL-STD-883. This is a class 2 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 ±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, $7.5V \leq V_O \leq 11.5V$. For Sinking tests, $3.5V \leq V_O \leq 7.5V$.

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 $R_L = 100\text{ k}\Omega$ 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.

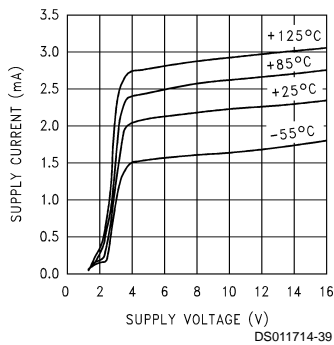
Note 12: Limiting input pin current is only necessary for input voltages that exceed absolute maximum input voltage ratings.

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

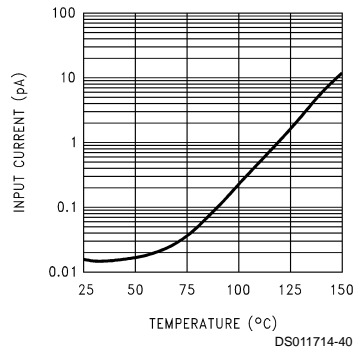
Note 14: For guaranteed Military Temperature Range parameters see RETSMC6484X.

Typical Performance Characteristics $V_S = +15V$, Single Supply, $T_A = 25^\circ\text{C}$ unless otherwise specified

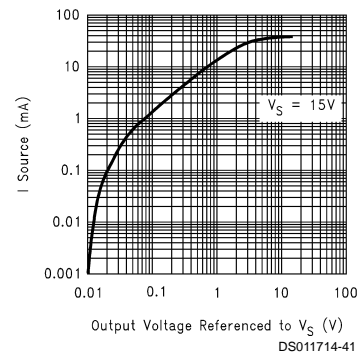
Supply Current vs Supply Voltage



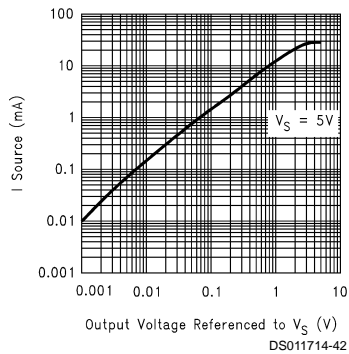
Input Current vs Temperature



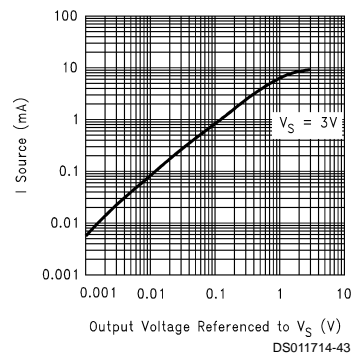
Sourcing Current vs Output Voltage



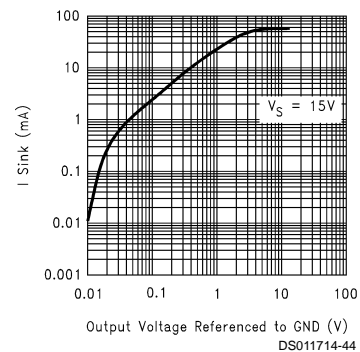
Sourcing Current vs Output Voltage



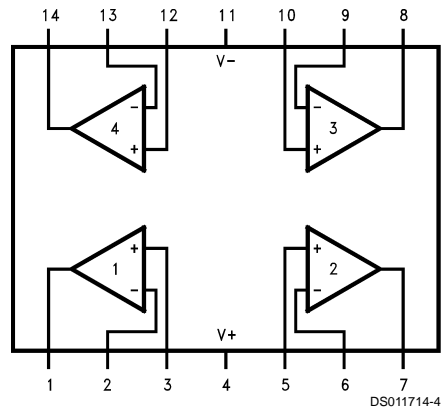
Sourcing Current vs Output Voltage



Sinking Current vs Output Voltage



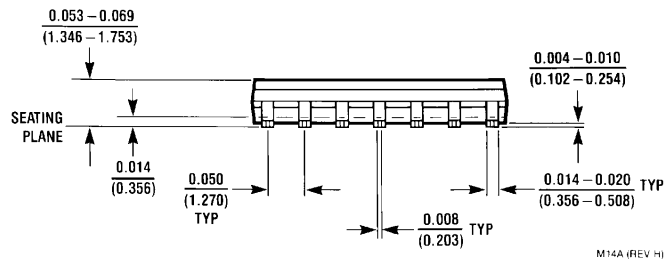
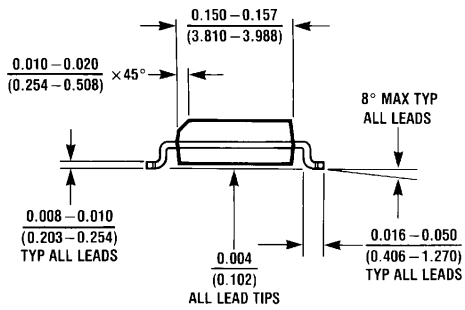
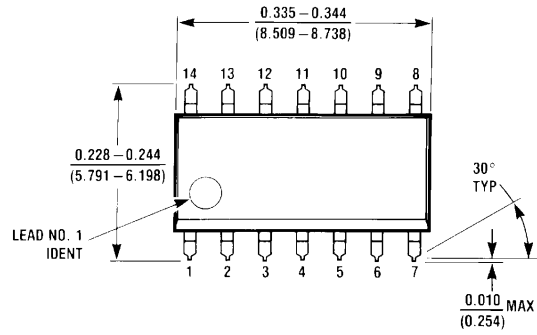
Connection Diagram



Ordering Information

Package	Temperature Range		NSC Drawing	Transport Media
	Military -55°C to +125°C	Industrial -40°C to +85°C		
14-pin Molded DIP		LMC6484AIN LMC6484IN	N14A	Rail
14-pin Small Outline		LMC6484AIM, AIMX LMC6484IM, IMX	M14A	Rail Tape and Reel
14-pin Ceramic DIP	LMC6484AMJ/883		J14A	Rail

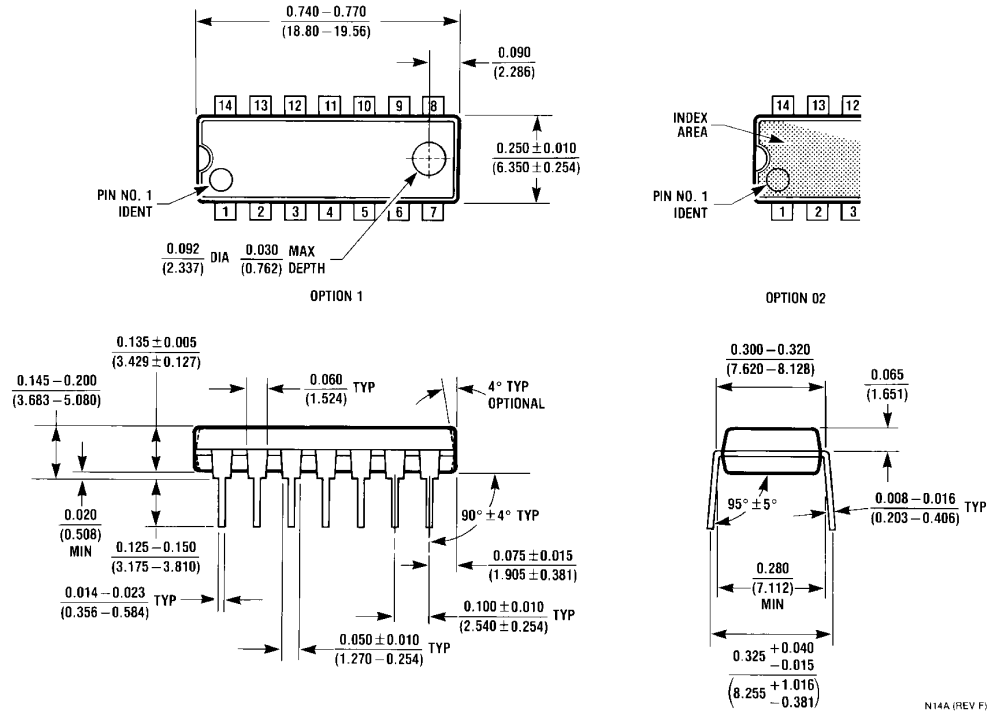
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



M14A (REV H)

14-Pin Small Outline
Order Package Number LMC6484AIM, LMC6484AIMX, LMC6484IM or LMC6484IMX
NS Package Number M14A

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



14-Pin Molded DIP
Order Package Number LMC6484AIN, LMC6484IN or LMC6484MN
NS Package Number N14A

N14A (REV F)

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