LTC1992-1

Gain of 1 Fully Differential Input/Output Amplifier/Driver

July 2003

FEATURES

- **Differential Inputs**
- **Differential Outputs**
- **Fixed Gain of 1 ± 0.3% (Max) Gain Error from –40°C to 85°C**
- **C_{LOAD} Stable from 0pF to 10,000pF**
- **Adjustable Output Common Mode Voltage**
- **Output Common Mode Level Independent of Input Common Mode Level**
- Low Supply Current 1mA (Max)
- High Output Current 10mA (Min)
- Rail-to-Rail Output Swing
- Specified on a Single 2.7V to ±5V Supply
- DC Offset Voltage <2.5mV (Max)
- 8-Lead MSOP Package

APPLICATIONS

- Differential Driver/Receiver
- Differential Amplification
- Single-Ended to Differential Conversion
- Level Shifting

DESCRIPTION

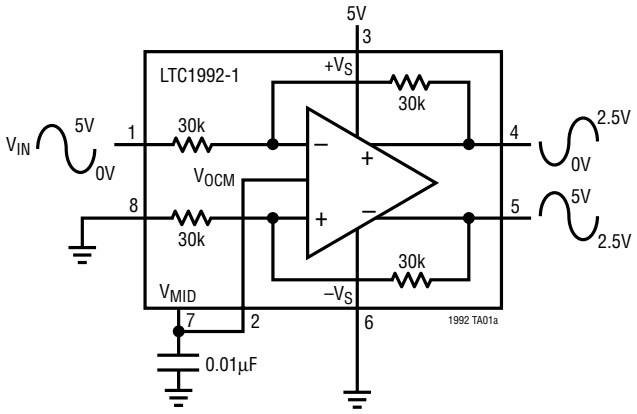
The LTC®1992-1 is a fully differential amplifier with a fixed gain of 1. The LTC1992-1 has a separate internal common mode feedback path for better common mode noise rejection, outstanding output gain and phase balancing and reduced second order harmonics. The V_{OCM} pin sets the output common mode level independent of the input common mode level. This feature makes level shifting of signals easy. The integrated precision gain setting resistors ensure gain accuracy without external components.

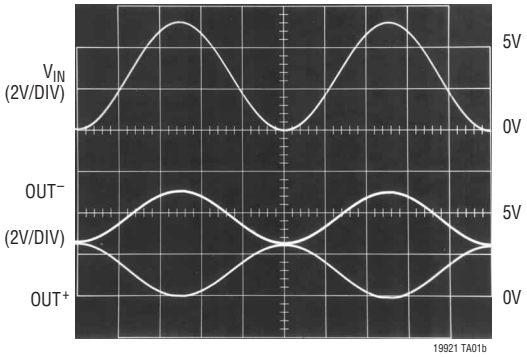
The differential inputs operate with signals ranging from rail-to-rail with a common mode level from the negative supply up to 1.3V from the positive supply. The differential input DC offset is typically 250µV. The rail-to-rail outputs sink and source 10mA. The LTC1992-1 is stable for all capacitive loads up to 10,000pF.

The LTC1992-1 can be used in single-supply applications with supply voltages as low as 2.7V. It can also be used with dual supplies up to ±5V. The LTC1992-1 is available in an 8-pin MSOP package.

TYPICAL APPLICATION

Single-Supply Single-Ended to Differential Conversion



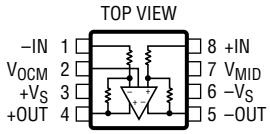


ABSOLUTE MAXIMUM RATINGS

(Note 1)

Total Supply Voltage ($+V_S$ to $-V_S$) 12V
Maximum Voltage on any Pin
..... $(-V_S - 0.3V) \le V_{PIN} \le (+V_S + 0.3V)$
Output Short-Circuit Duration (Note 3) ..... Indefinite
Operating Temperature Range (Note 5)
LTC1992-1CMS8 .....–40°C to 85°C
LTC1992-1IMS8 .....–40°C to 85°C
LTC1992-1HMS8 .....–40°C to 125°C
Specified Temperature Range (Note 6)
LTC1992-1CMS8 .....–40°C to 85°C
LTC1992-1IMS8 .....–40°C to 85°C
LTC1992-1HMS8 .....–40°C to 125°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PACKAGE/ORDER INFORMATION



MS8 PACKAGE
8-LEAD PLASTIC MSOP

T_{JMAX} = 150°C, θ_{JA} = 250°C/W

ORDER PART NUMBER
LTC1992-1CMS8 LTC1992-1IMS8 LTC1992-1HMS8
MS8 PART MARKING
LTACJ LTACM LTAFZ

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. $+V_S$ = 5V, $-V_S$ = 0V, $V_{INCM} = V_{OUTCM} = V_{OCM}$ = 2.5V, unless otherwise noted. V_{OCM} is the voltage on the V_{OCM} pin. V_{OUTCM} is defined as $(V_{+OUT} + V_{–OUT})/2$. V_{INCM} is defined as $(V_{+IN} + V_{–IN})/2$. V_{INDIFF} is defined as $(V_{+IN} – V_{–IN})$. $V_{OUTDIFF}$ is defined as $(V_{+OUT} – V_{–OUT})$. Typical values are at T_A = 25°C.

SYMBOL	PARAMETER	CONDITIONS		LTC1992-1CMS8 LTC1992-1IMS8 MIN	TYP	MAX	LTC1992-1HMS8 MIN	TYP	MAX	UNITS
G_{DIFF}	Differential Gain				1			1		V/V
	Differential Gain Error		●		±0.1	±0.3		±0.1	±0.35	%
	Differential Gain Nonlinearity				50			50		ppm
	Differential Gain Temperature Coefficient		●		35			35		ppm/°C
V_{OSDIFF}	Differential Offset Voltage (Amplifier Input Referred)(Note 7)	V_S = 2.7V	●		±0.25	±2.5		±0.25	±4	mV
		V_S = 5V	●		±0.25	±2.5		±0.25	±4	mV
		V_S = ±5V	●		±0.25	±2.5		±0.25	±4	mV
$\Delta V_{OSDIFF}/\Delta T$	Differential Offset Voltage Drift (Amplifier Input Referred)(Note 7)	V_S = 2.7V	●		10			10		µV/°C
		V_S = 5V	●		10			10		µV/°C
		V_S = ±5V	●		10			10		µV/°C
e_n	Input Referred Noise Voltage Density	f = 1kHz			45			45		nV/√Hz
R_{IN}	Input Resistance, Single-Ended +IN, –IN Pins		●	22.5	30	37.5	22	30	38	kΩ
V_{INCMR}	Input Signal Common Mode Range	V_S = 5V			–0.1V to 4.9V			–0.1V to 4.9V		V
CMRR	Common Mode Rejection Ratio (Amplifier Input Referred)(Note 7)	V_{INCM} = –0.1V to 3.7V	●	55	60		55	60		dB
PSRR	Power Supply Rejection Ratio (Amplifier Input Referred)(Note 7)	V_S = 2.7V to ±5V	●	75	80		72	80		dB
G_{CM}	Common Mode Gain(V_{OUTCM}/V_{OCM})				1			1		
	Common Mode Gain Error		●		±0.1	±0.3		±0.1	±0.35	%
	Output Balance Error($\Delta V_{OUTCM}/(V_{OUTDIFF})$	$V_{OUTDIFF}$ = –2V to +2V	●		–85	–60		–85	–60	dB
V_{OSCM}	Common Mode Offset Voltage ($V_{OUTCM} – V_{OCM}$)	V_S = 2.7V	●		±0.5	±12		±0.5	±15	mV
		V_S = 5V	●		±1	±15		±1	±17	mV
		V_S = ±5V	●		±2	±18		±2	±20	mV
$\Delta V_{OSCM}/\Delta T$	Common Mode Offset Voltage Drift	V_S = 2.7V	●		10			10		µV/°C
		V_S = 5V	●		10			10		µV/°C
		V_S = ±5V	●		10			10		µV/°C

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. $+V_S$ = 5V, $-V_S$ = 0V, V_{INCM} = V_{OUTCM} = V_{OCM} = 2.5V, unless otherwise noted. V_{OCM} is the voltage on the V_{OCM} pin. V_{OUTCM} is defined as $(V_{+OUT} + V_{-OUT})/2$. V_{INCM} is defined as $(V_{+IN} + V_{-IN})/2$. V_{INDIFF} is defined as $(V_{+IN} – V_{-IN})$. $V_{OUTDIFF}$ is defined as $(V_{+OUT} – V_{-OUT})$. Typical values are at T_A = 25°C.

SYMBOL	PARAMETER	CONDITIONS		LTC1992-1CMS8 LTC1992-1IMS8 MIN	TYP	MAX	LTC1992-1HMS8 MIN	TYP	MAX	UNITS
V_{OUTCMR}	Output Signal Common Mode Range (Voltage Range for the V_{OCM} Pin)		●	$(-V_S)$ + 0.5V		$(+V_S)$ – 1.3V	$(-V_S)$ + 0.5V		$(+V_S)$ – 1.3V	V
R_{INVOCM}	Input Resistance, V_{OCM} Pin				500			500		MΩ
I_{BVOCM}	Input Bias Current, V_{OCM} Pin	V_S = 2.7V to ±5V			2			2		pA
V_{MID}	Voltage at the V_{MID} Pin		●	2.44	2.50	2.56	2.43	2.50	2.57	V
V_{OUT}	Output Voltage, High (Note 2)	V_S = 2.7V, Load = 10k,10nF	●	2.60	2.69		2.60	2.69		V
		V_S = 2.7V, Load = 5mA	●	2.50	2.61		2.50	2.61		V
		V_S = 2.7V,Load = 10mA	●	2.29	2.52		2.29	2.52		V
	Output Voltage, Low (Note 2)	V_S = 2.7V, Load = 10k,10nF	●		0.02	0.10		0.02	0.10	V
		V_S = 2.7V, Load = 5mA	●		0.10	0.25		0.10	0.25	V
		V_S = 2.7V, Load = 10mA	●		0.20	0.35		0.20	0.41	V
	Output Voltage, High (Note 2)	V_S = 5V, Load = 10k,10nF	●	4.90	4.99		4.90	4.99		V
		V_S = 5V, Load = 5mA	●	4.85	4.90		4.80	4.90		V
		V_S = 5V, Load = 10mA	●	4.75	4.81		4.70	4.81		V
	Output Voltage, Low (Note 2)	V_S = 5V, Load = 10k,10nF	●		0.02	0.10		0.02	0.10	V
		V_S = 5V, Load = 5mA	●		0.10	0.25		0.10	0.30	V
		V_S = 5V, Load = 10mA	●		0.20	0.35		0.20	0.42	V
	Output Voltage, High (Note 2)	V_S = ±5V, Load = 10k,10nF	●	4.90	4.99		4.85	4.99		V
		V_S = ±5V, Load = 5mA	●	4.85	4.89		4.80	4.89		V
		V_S = ±5V, Load = 10mA	●	4.65	4.80		4.60	4.80		V
	Output Voltage, Low (Note 2)	V_S = ±5V, Load = 10k,10nF	●		–4.98	–4.90		4.98	–4.85	V
		V_S = ±5V, Load = 5mA	●		–4.90	–4.75		4.90	–4.75	V
		V_S = ±5V, Load = 10mA	●		–4.80	–4.65		4.80	–4.55	V
I_{SC}	Output Short-Circuit Current Sourcing (Notes 2,3)	V_S = 2.7V, V_{OUT} = 1.35V	●	20	30		20	30		mA
		V_S = 5V, V_{OUT} = 2.5V	●	20	30		20	30		mA
		V_S = ±5V, V_{OUT} = 0V	●	20	30		20	30		mA
	Output Short-Circuit Current Sinking (Notes 2,3)	V_S = 2.7V, V_{OUT} =1.35V	●	13	30		13	30		mA
		V_S = 5V, V_{OUT} = 2.5V	●	13	30		13	30		mA
		V_S = ±5V, V_{OUT} = 0V	●	13	30		13	30		mA
SR	Slew Rate (Note 4)		●	0.25	0.75		0.25	0.75		V/µs
GBW	Gain-Bandwidth Product	f_{TEST} = 180kHz			3			3		MHz
V_S	Supply Voltage Range		●	2.7		11	2.7		11	V
I_S	Supply Current	V_S = 2.7V to 5V			0.65	1.0		0.65	1	mA
			●		0.75	1.2		0.8	1.5	mA
		V_S = ±5V			0.70	1.2		0.7	1.2	mA
			●		0.80	1.5		0.9	1.8	mA

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: Output load is connected to the midpoint of the $+V_S$ and $-V_S$ potentials. Measurement is taken single-ended, one output loaded at a time.

Note 3: A heat sink may be required to keep the junction temperature below the absolute maximum when the output is shorted indefinitely.

Note 4: Slew Rate is measured single-ended. The numbers listed are also single-ended and the differential slew rate would double the listed numbers.

Note 5: The LTC1992-1CMS8, LTC1992-1IMS8 and LTC1992-1HMS8 are guaranteed functional over the extended operating temperature range of –40°C to 125°C.

Note 6: The LTC1992-1CMS8 is guaranteed to meet the specified performance limits over the 0°C to 70°C temperature range and is designed, characterized and expected to meet the specified performance from –40°C to 85°C but is not tested or QA sampled at these temperatures. LTC1992-1IMS8 is guaranteed to meet specified performance limits over the –40°C to 85°C temperature range. The LTC1992-1HMS8 is guaranteed to meet the specified performance limits over the –40°C to 125°C temperature range.

Note 7: Differential Offset Voltage, Differential Offset Voltage Drift, CMRR and PSRR are referred to the internal amplifier's input to allow for direct comparison with discrete amplifiers. The LTC1992-1 is an inverting topology with a gain of one. The output referred offset is two times the amplifiers input offset.

PIN FUNCTIONS

–IN, +IN (Pins 1, 8): Inverting and Noninverting Inputs of the Amplifier. These pins are connected to on-chip gain setting resistors. The input resistors are nominally 30k.

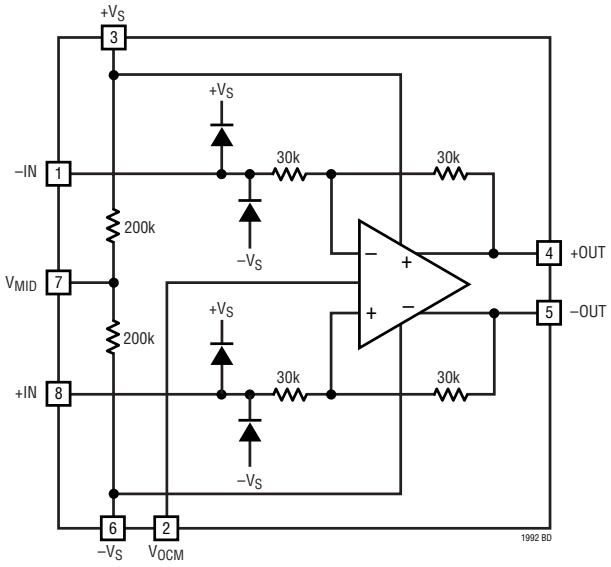
V_{OCM} (Pin 2): Output Common Mode Voltage Set Pin. The voltage on this pin sets the output signal's common voltage level. The output common mode level is set independent of the input common mode level. This is a high impedance input and must be connected to a known and controlled voltage. It must never be left floating.

$+V_S$, $–V_S$ (Pins 3, 6): The $+V_S$ and $–V_S$ power supply pins should be bypassed with 0.1µF capacitors to an adequate analog ground or ground plane. The bypass capacitors should be located as closely as possible to the supply pins.

+OUT, –OUT (Pins 4, 5): The Positive and Negative Outputs of the Amplifier. These rail-to-rail outputs are designed to drive capacitive loads up to 10,000pF.

V_{MID} (Pin 7): Mid-Supply Reference. This pin is connected to an on-chip resistive voltage divider (two 200k ±25% resistors) to provide a mid-supply reference. This provides a convenient way to set the output common mode voltage level at half-supply. If used for this purpose, the pin should be bypassed with a 0.1µF capacitor to ground and connected to V_{OCM} (Pin 2). If this reference voltage is not used, leave the pin floating.

BLOCK DIAGRAM



RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1565-31	650kHz Continuous Time, Linear Phase Lowpass Filter	7th Order Lowpass Filter, Differential Inputs/Output
LTC1566-1	Low Noise 2.3MHz Continuous Time Lowpass Filter	7th Order Lowpass Filter, Differential Inputs/Output
LTC1992	Fully Differential Input/Output Amplifier/Driver	Low Power, Adjustable Gain
LTC1992-2	Fully Differential Input/Output Amplifier/Driver	Gain = 2
LT6600-10	Very Low Noise, Differential Amplifier and 10MHz Lowpass Filter	Fully Differential Amplifier with 4th Order Lowpass Filter
LT6600-20	Very Low Noise, Differential Amplifier and 20MHz Lowpass Filter	Fully Differential Amplifier with 4th Order Lowpass Filter

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