élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

EL4430C/EL4431C/EL4432C
Video Instrumentation Amplifiers

Features

- Fully differential inputs and feedback
  - — Differential input range of ±2V
  - — Common-mode range of ±12V
  - — High CMRR at 4MHz of 70dB
  - — Stable at gains of 1, 2, or 10
- Calibrated and clean input clipping
- 80 Mhz -3dB bandwidth
- 380V/µs slew rate
- 0.02% or ° differential gain or phase
- Operates on ±5 to ±15V supplies with no AC degradation

Applications

- Line receivers
- "Loop-through" interface
- Level translation
- Magnetic head pre-amplification
- Differential-to-single-ended conversion

Ordering Information

Part No.	Temp. Range	Package	Outline #
EL4430CN	-40°C to +85°C	8-pin P-DIP	MDP0031
EL4430CS	-40°C to +85°C	8-lead SO	MDP0027
EL4431CN	-40°C to +85°C	8-pin P-DIP	MDP0031
EL4431CS	-40°C to +85°C	8-lead SO	MDP0027
EL4432CN	-40°C to +85°C	8-pin P-DIP	MDP0031
EL4432CS	-40°C to +85°C	8-lead SO	MDP0027

General Description

The EL4430, 4431, and 4432 are a family of video instrumentation amplifiers which are ideal for line receivers, differential-to-single-ended converters, transducer interfacing, and any situation where a differential signal must be extracted from a background of common-mode noise or DC offset.

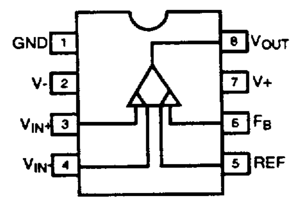
These devices have two differential signal inputs and two differential feedback terminals. The FB terminal connects to the amplifier output, or a divided version of it to increase circuit gain, and the REF terminal is connected to the output ground or offset reference.

The EL4430 is compensated to be stable at a gain of 1 or more, the EL4431 for a gain of 2 or more, and the EL4432 for gains of 10 or more.

The amplifiers have an operational temperature of -40°C to +85°C and are packaged in plastic 8-pin DIP and SO-8.

The EL4430 family is fabricated with Elantec's proprietary complementary bipolar process which gives excellent signal symmetry and is free from latchup.

Connection Diagram



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PRELIMINARY DATA

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Absolute Maximum Ratings (T_A = 25°C)

V+	Positive Supply Voltage	16.5V	I_{OUT}	Continuous Output Current	30mA
V_S	V+ to V- Supply Voltage	33V	P_D	Maximum Power Dissipation	See Curves
V_{IN}	Voltage at any Input or Feedback	V+ to V-		Operating Temperature Range	-40°C to +85°C
ΔV_{IN}	difference between Pairs of Inputs or Feedback	6V		Storage Temperature Range	-60°C to +150°C
I_{IN}	Current into any Input, or Feedback Pin	4mA			

Important Note:

All parameters having Min/Max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality inspection. Elantec performs most electrical tests using modern high-speed automatic test equipment, specifically the LTX77 Series system. Unless otherwise noted, all tests are pulsed tests, therefore T_J=T_C=T_A.

Test Level	Test Procedure
I	100% production tested and QA sample tested per QA test plan QCX0002.
II	100% production tested at T_A = 25°C and QA sample tested at T_A = 25°C, T_{MAX} and T_{MIN} per QA test plan QCX0002
III	QA sample tested per QA test plan QCX0002
IV	Parameter is guaranteed (but not tested) by Design and Characterization Data
V	Parameter is typical value at T_A = 25°C for information purposes only

Open-Loop DC Electrical Characteristics

Power supplies at ±5V, T_A = 25°. For the EL4431, $R_F = R_G$ = 500Ω. For the EL4432, R_F = 900Ω, R_G = 100Ω.

Parameter	Description		Min.	Typ.	Max.	Test Level	Units
V_{DIFF}	Differential input voltage - Clipping (V_{CM} = 0)	EL4430/32	2.0	2.3		I	V
		EL4432	0 30	0.35		I	V
	0 1% nonlinearity	EL4430/31		1.8		V	V
		EL4432		0.30		V	V
V_{CM}	Common-mode range (V_{DIFF} = 0)	V_S = ±5V	±2	±3 0		I	V
		V_S = ±15V	±12	±13 0		I	V
V_{OS}	Input offset voltage	EL4430/31		2	8	I	mV
		EL4432		0 5	2	I	mV
I_B	Input bias current (IN+, IN-, REF, and FB terminals)			12	20	I	µA
I_{OS}	Input offset current between IN+ and IN- and between REF and FB			0.2	2	I	µA
R_{IN}	Input resistance	EL4430/31	100	230		I	kΩ
		EL4432	20	38		I	kΩ
CMRR	Common-mode rejection ratio		70	90		I	dB
E_G	Gain error, excluding feedback resistors	EL4430/31	-0 7	-0.2	+0 3	I	%
		EL4432	-1.2	-0.2	+0.3	I	%
V_O	Output voltage swing	EL4430, V_S = ±5V	±2	±2.8		I	V
		V_S = ±15V	±12	±12.8		I	V
		EL4431/32, V_S = ±5V	±2.5	±3.0		I	V
		V_S = ±15V	±12.5	±13.0		I	V
I_{SC}	Output short-circuit current		40	90		I	mA
I_S	Supply current, V_S = ±15V			13.5	16	I	mA

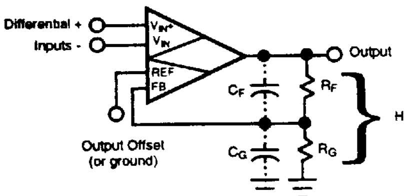
Closed-Loop AC Electrical Characteristics

Power supplies at ±12V, $T_A = 25°C$, $R_L = 500\Omega$ for the EL4430 / EL4432, $R_L = 150\Omega$ for the EL3341, $C_L = 15pF$. For the EL4431, $R_F = R_G = 500\Omega$. for the EL4432, $R_F = 900\Omega$, $R_G = 100\Omega$

Parameter	Description		Min.	Typ.	Max.	Test Levels	Units
BW, -3dB	-3dB small-signal bandwidth	EL4430		82		V	MHz
		EL4431		80		V	MHz
		EL4432		60		V	MHz
BW, ±0.1dB	0 1dB flatness bandwidth	EL4430		20		V	MHz
		EL4431		14		V	MHz
		EL4432		25		V	MHz
Peaking	Frequency response peaking	EL4430		0.6		V	dB
		EL4431		1.0		V	dB
		EL4432		0.1		V	dB
SR	Slew rate, V_{OUT} between -2V and +2V	All		380		V	V/µs
V_N	Input-referred noise voltage density	EL4430/31		26		V	nV/rt-Hz
		EL4432		7		V	nV/rt-Hz
dG	Differential gain error, Voffset between	EL4430		0 02		V	%
	-0.7V and +0 7V	EL4431, RL = 150Ω		0.04		V	%
dθ	Differential gain error, Voffset between	EL4430		0 02		V	(°)
	-0 7V and +0.7V	EL4431, RL = 150Ω		0 08		V	(°)
T_S	Settling time, to 0 1% from a 4V step	EL4430		48		V	ns

Applications Information

The EL4430 family is designed to convert a fully differential input to a single-ended output. It has two sets of inputs; one which is connected to the signal and does not respond to its common-mode level, and another which is used to complete a feedback loop with the output. Here is a typical connection:



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The gain of the feedback divider is H. The transfer function of the part is

$$V_{OUT} = A_O \times ((V_{IN}+) - (V_{IN}-) + (V_{REF} - V_{FB})).$$

V_{FB} is connected to V_{OUT} through a feedback network, so $V_{FB} = H \times V_{OUT}$. A_O is the open-loop gain of the amplifier, and is about 600 for the EL4430 and EL4431, and is about 3300 for the EL4432. The large value of A_O drives

$$(V_{IN}+) - (V_{IN}-) + (V_{REF} - V_{FB}) \Rightarrow 0.$$

Rearranging and substituting for V_{FB}

$$V_{OUT} = ((V_{IN}+) - (V_{IN}-) + V_{REF})/H.$$

Thus, the output is equal to the difference of the V_{IN}'s and offset by V_{REF}, all gained up by the feedback divider ratio. The input impedance of the FB terminal (equal to R_{IN} of the input terminals) is in parallel with an R_G, and raises circuit gain slightly.

The EL4430 is stable for a gain of 1 (a direct connection between V_{OUT} and FB) or more; the EL4431 for gains of 2 or more; and the EL4432 for gains of 10 or more. It is important to keep the feedback divider's impedance at the FB terminal low so that stray capacitance does not diminish the loop's phase margin. The pole caused by the parallel of resistors R_F and R_G and stray capacitance should be at least 200 Mhz; typical strays of 3pF thus require a feedback impedance of 270Ω or less. Two 510Ω resistors are acceptable for a gain of 2; 300Ω and 2700Ω make a good gain-of-10 divider. Alternatively, a small capacitor across R_F can be used to create more of a frequency-compensated divider. The value of the capacitor should scale with the parasitic capacitance at the -input. It is also practical to place small capacitors across both the feedback resistors (whose values maintain the desired gain) to swamp out parasitics. For instance, two 10pF capacitors (for a gain of 2) across equal divider resistors will dominate parasitic effects and allow a higher divider resistance.

Input Connections

The input transistors can be driven from resistive and capacitive sources, but are capable of oscillation when presented with an inductive input. It takes about 80nH of series inductance to make the inputs actually oscillate, equivalent to 4″ of unshielded wiring or about 6″of unterminated input transmission line. The oscillation has a characteristic frequency of 500 Mhz. Often, placing one's finger (via a metal probe) or an oscilloscope probe on the input will kill the oscillation. Normal high-frequency construction obviates any such problems, where the input source is reasonably close to the mux-amp input. If this is not possible, one can insert series resistors of approximately 51Ω to de-Q the inputs.

Signal Amplitudes

Signal input common-mode voltage must be between (V-)+3V and (V+)-3V to ensure linearity. Additionally, the differential voltage on any input stage must be limited to ±6V to prevent damage. The differential signal range is ±2V in the EL4430 and EL4431 and 0.35V in the EL4432. The input range is substantially constant with temperature.

The Ground Pin

The ground pin draws only 6μA maximum DC current, and may be biased anywhere between (V-) +2.5V and (V+) -3.5V. The ground pin is connected to the IC's substrate and frequency compensation components. It serves as a shield within the IC and enhances CMRR over frequency, and if connected to

Power Supplies

The instrumentation amplifiers work well on any supplies from ±3V to ±15. The supplies may be of different voltages as long as the requirements of the Gnd pin are observed (see the Ground Pin section for a discussion). The supplies should be bypassed close to the device with short leads. 4.7µF tantalum capacitors are very good, and no smaller bypasses need be placed in parallel. Capacitors as low as 0.01µF can be used if small load currents flow.

Single-polarity supplies, such as +12V with +5V can be used, where the ground pin is connected to +5V and V- to ground. The inputs and outputs will have to have their levels shifted above ground to accommodate the lack of negative supply.

The dissipation of the mux-amps increases with power supply voltage, and this must be compatible with the package chosen. This is a close estimate for the dissipation of a circuit:

$$P_D = 2\times V_S \times I_S, \max + (V_S - V_O) \times V_O/R_{PAR}$$

where I_S, max is the maximum supply current
V_S is the ± supply voltage (assumed equal)
V_O is the output voltage
R_{PAR} is the parallel of all resistors loading the output

For instance, the EL4431 draws a maximum of 16mA and we might require a 2V peak output into 150Ω and a 270Ω + 270Ω feedback divider. The R_{PAR} is 117Ω. The dissipation with ±5V supplies is 201mW. The maximum supply voltage that the device can run on for a given P_D and the other parameter is

$$V_S, \max = (P_D + V_O^2/R_{PAR})/(2I_S + V_O/R_{PAR})$$

The maximum dissipation a package can offer is

$$P_D, \max = (T_D, \max - T_A \max)/R_{TH}$$

where T_D,max is the maximum die temperature, 150°C for reliability, less to retain optimum electrical performance.
T_A, max is the ambient temperature, 70°C for commercial and 85°C for industrial range.
R_{TH} is the thermal resistance of the mounted package, obtained fromdatasheet dissipation curves.

The more difficult case is the SO-8 package. With a maximum die temperature of 150°C and a maximum ambient temperature of 85°C, the 65°C temperature rise and package thermal resistance of 170°C/W gives a dissipation of 382mW at 85°C. This allows a maximum supply voltage of ±8.5V for the EL4431 operated in our example. If an EL4430 were driving a light load ($R_{PAR} \rightarrow \infty$), it could operate on ±15V supplies at a 70°C maximum ambient.

Output Loading

The output stage of the mux-amp is very powerful. It typically can source 80mA and sink 120mA. Of course, this is too much current to sustain and the part will eventually be destroyed by excessive dissipation or by metal traces on the die opening. The metal traces are completely reliable while delivering the 30mA continuous output given in the Absolute Maximum Ratings table in this datasheet, or higher purely transient currents.

Gain or gain accuracy degrades only 10% from no load to 100Ω load. Heavy resistive loading will degrade frequency response and video distortion for loads <100Ω

Capacitive loads will cause peaking in the frequency response. If capacitive loads must be driven, a small-valued series resistor can be used to isolate it (12Ω to 51Ω should suffice). A 22Ω series resistor will limit peaking to 2.5dB with even a 220pF load.