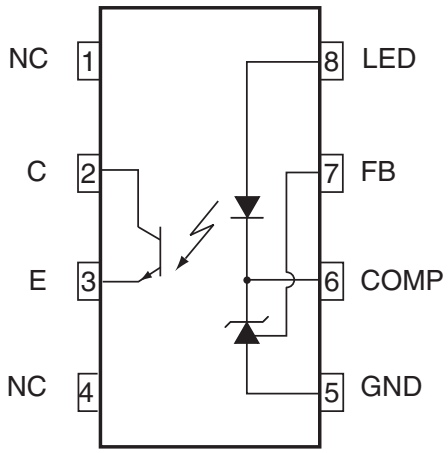
LIA130
Optically Isolated Error Amplifier

Features
- Optocoupler, Precision Reference, and Error Amplifier in a Single Package
- 1.240V ± 1% Reference (@ 25°C)
- Linear Optical Coupler Technology with an Industry Standard 431-type
- CTR 300% to 600% Linearity
- 3750V_{rms} Isolation

Applications
- Power System for Workstations
- Telecom Central Office Supply
- Telecom Bricks

Block Diagram



Description
The LIA130 is an optically isolated amplifier with a 431-type precision programmable shunt reference combined in the same package. The optocoupler portion of the LIA130 comprises a Gallium Arsenide (GaAs) light-emitting diode (LED) optically coupled to a silicon phototransistor. The current transfer ratio of the device is between 300% and 600%.

The combination of features in the LIA130 is optimal for use in isolated AC-to-DC power supplies and DC-to-DC converters. It replaces several discrete components, saves valuable circuit board space, and reduces complexity.

The device is available in DIP and surface-mount packages.

Approvals
- UL Recognized Component: File # E76270
- CSA Certified Component: Certificate # 1305490

Ordering Information

Part #	Description
LIA130	8 Pin DIP (50/Tube)
LIA130S	8-Pin Surface Mount (50/Tube)
LIA130STR	8-Pin Surface Mount (1000/Reel)

Absolute Maximum Ratings (@ 25˚ C)

Parameter	Symbol	Ratings	Units
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Collector Voltage	V_{ECO}	7	V
Input Voltage	V_{LED}	10	V
Input DC Current	I_{LED}	20	mA
Collector Current	I_C	50	mA
Input Power Dissipation [1]	P_D	145	mW
Transistor Power Dissipation [2]	P_D	85	mW
Total Power Dissipation [3]	P_D	145	mW
Storage Temperature	T_{STG}	-55 to +125	°C
Operating Temperature	T_{OPR}	-40 to +85	°C

Absolute Maximum Ratings are stress ratings. Stresses in excess of these ratings can cause permanent damage to the device. Functional operation of the device at conditions beyond those indicated in the operational sections of this data sheet is not implied.

[1] Derate linearly from 25°C at a rate of 2.42 mW/ °C.
[2] Derate linearly from 25°C at a rate of 1.42 mW/ °C.
[3] Derate linearly from 25°C at a rate of 2.42 mW/ °C.

Electrical Characteristics

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Input Characteristics @ 25°C						
LED forward voltage	I_{LED} = 5 mA, $VC_{OMP} = V_{FB}$ (Fig.1)	V_F	0.9	-	1.4	V
Reference voltage	$V_{COMP} = V_{FB}$, I_{LED} = 10 mA, -40 to +85°C (Fig.1)	V_{REF}	1.224	1.24	1.259	V
	$V_{COMP} = V_{FB}$, I_{LED} = 10 mA, 25°C (Fig.1)		1.228	1.24	1.252	
Deviation of V_{REF} over temperature [1]	T_A = -40 to +85°C	$V_{REF\ (DEV)}$	-	77	TBD	mV
Ratio of V_{REF} variation to the output of the error amplifier	I_{LED} = 10 mA, $V_{COMP} = V_{REF}$ to 10 V (Fig.2)	$\Delta V_{REF}/\Delta V_{COMP}$	-	0.002	TBD	mV/V
Feedback input current	I_{LED} = 10 mA, R1 = 10 kΩ (Fig.3)	I_{REF}	-	0.09	TBD	µA
Deviation of I_{REF} over temperature [1]	T_A = -40 to +85°C	$I_{REF\ (DEV)}$	-	0.028	TBD	µA
Minimum drive current	$V_{COMP} = V_{FB}$ (Fig.1)	$I_{LED\ (MIN)}$	-	45	80	µA
Off-state error amplifier current	V_{LED} = 6 V, V_{FB} = 0 (Fig.4)	$I_{(OFF)}$	-	0.001	0.1	µA
Error amplifier output impedance [2]	$V_{COMP} = V_{FB}$, I_{LED} = 0.1 mA to 15 mA, f<1 kHZ	$\lvert Z_{OUT}\rvert$	-	0.22	-	Ω
Output Characteristics @ 25°C						
Collector dark current	V_{CE} = 10V (Fig. 5)	I_{CEO}	-	0.3	50	nA
Collector-emitter voltage breakdown	I_C = 1.0mA	BV_{CEO}	70	-	-	V
Emitter-collector voltage breakdown	I_E = 100 µA	BV_{ECO}	7	-	-	V

1. The deviation parameters $V_{REF(DEV)}$ and $I_{REF(DEV)}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage, ΔV_{REF}, is defined as:

$$|\Delta V_{REF}|\ (ppm/°C) = \{V_{REF\ (DEV)}/V_{REF}\ (T_A\ 25°C)\}\ X\ 10^6 / \Delta T_A$$

where ΔT_A is the rated operating free-air temperature range of the device.

2. The dynamic impedance is defined as $|Z_{OUT}| = \Delta V_{COMP}/\Delta I_{LED}$. When the device is operating with two external resistors (see Figure 2), the total dynamic impedance of the circuit is given by:

$$|Z_{OUT,\ TOT}| = \Delta V/\Delta I \approx |Z_{OUT}|\ X\ [1 + R1/R2]$$

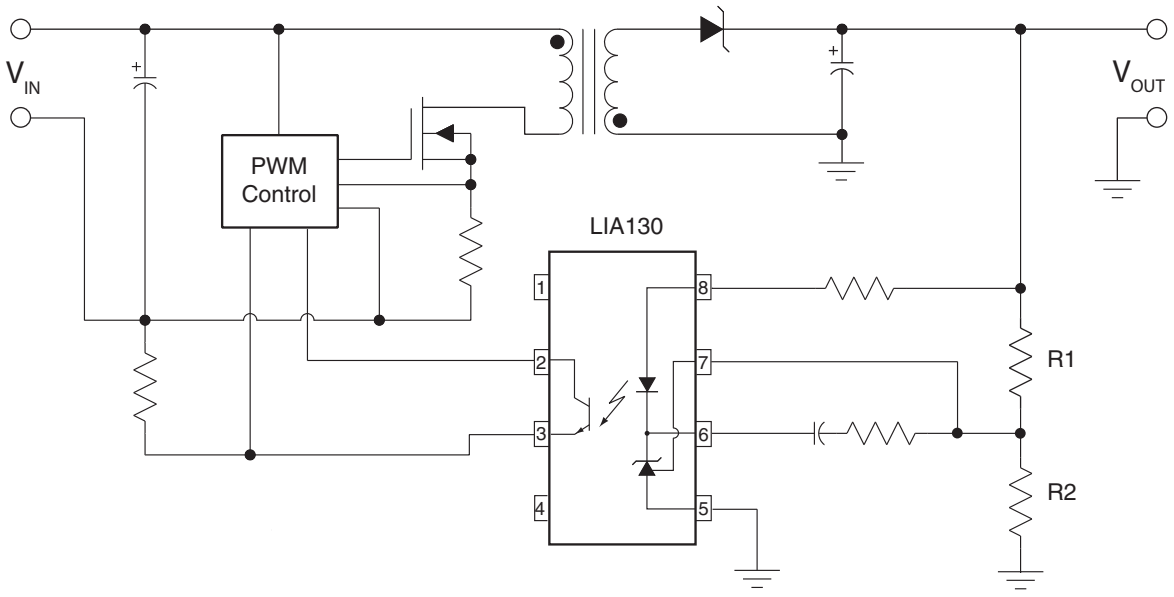
Electrical Characteristics

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Transfer Characteristics @ 25°C						
Current transfer ratio	I_{LED} = 5 mA, V_{COMP} = V_{FB}, V_{CE} = 5 V (Fig. 6)	CTR	300	500	600	%
Collector-emitter saturation voltage	I_{LED} = 10 mA, V_{COMP} = V_{FB}, I_C = 2.5 mA (Fig. 6)	$V_{CE\ (SAT)}$	-	0.099	0.5	V
Isolation Characteristics @ 25°C						
Input-output insulation leakage current [1]	RH = 45%, T_A = 25°C, t = 5s, V_{I-O} = 3000 V_{DC}	I_{I-O}	-	-	1.0	µA
Withstand insulation voltage [1]	RH <= 50%, T_A = 25°C, t = 1 min	V_{ISO}	2500	-	-	V_{rms}
Resistance (input to output) [1]	V_{I-O} = 500 V_{DC}	R_{I-O}	-	10^{12}	-	Ω
Switching Characteristics @ 25°C						
Bandwidth	(Fig. 7)	B_W	-	10	-	kHZ
Common mode transient immunity at output high [2]	I_{LED} = 0 mA, Vcm = 10 V_{PP} R_L = 2.2 kΩ (Fig. 8)	|CMH|	-	TBD	-	kV/µs
Common mode transient immunity at output low [2]	I_{LED} = 10 mA, Vcm = 10 V_{PP} R_L = 2.2 kΩ (Fig. 8)	|CML|	-	TBD	-	kV/µs

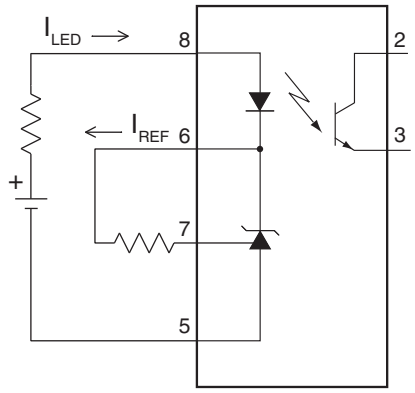
1. Device is considered as a two terminal device: Pins 1, 2, 3 and 4 are shorted together and Pins 5, 6, 7 and 8 are shorted together.

2. Common mode transient immunity at output high is the maximum tolerable (positive) dVcm/dt on the leading edge of the common mode impulse signal, Vcm, to assure that the output will remain high. Common mode transient immunity at output low is the maximum tolerable (negative) dVcm/dt on the trailing edge of the common pulse signal,Vcm, to assure that the output will remain low.

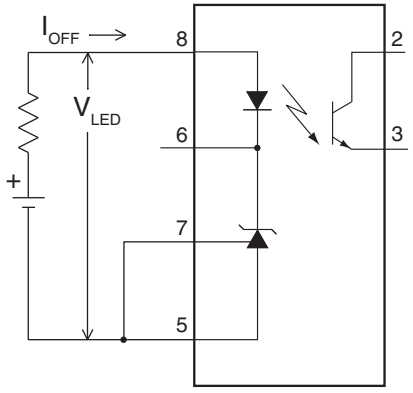
Example Application for the LIA130



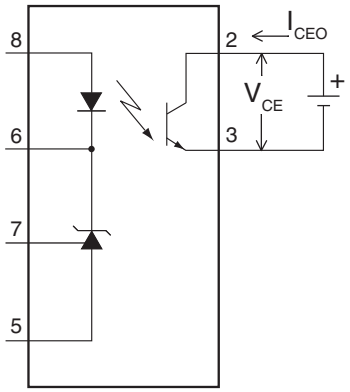
Test Circuits



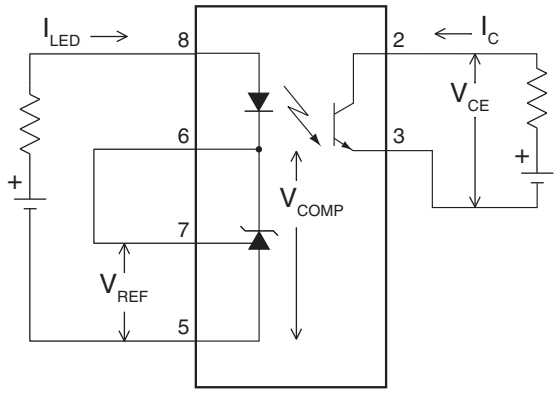
I_{REF} Test Circuit



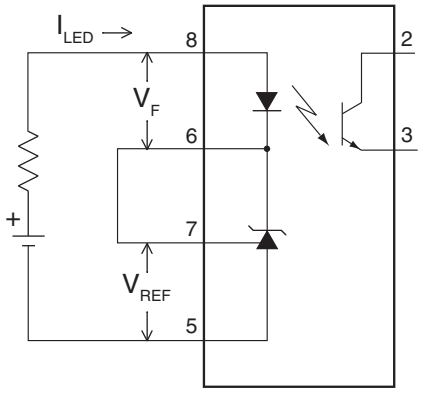
I_{OFF} Test Circuit



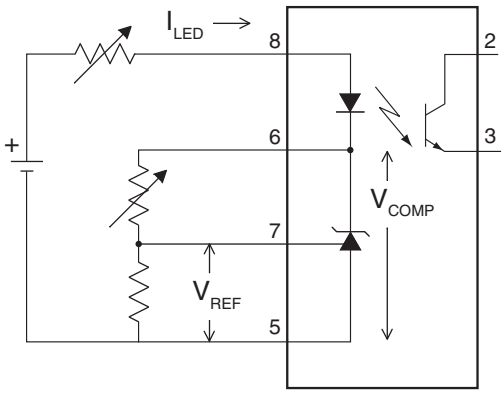
I_{CEO} Test Circuit



CTR, $V_{CE\text{-}sat}$ Test Circuit

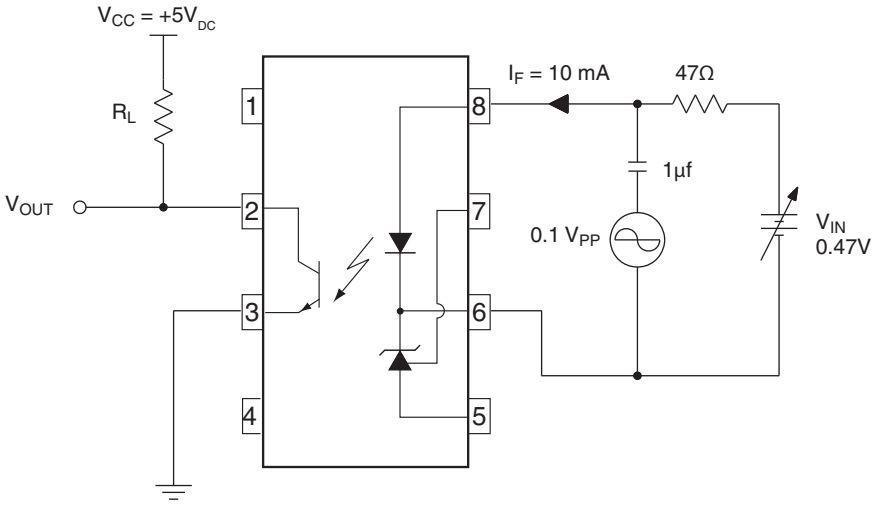


V_{REF}, V_F, $I_{LED\text{-}min}$ Test Circuit

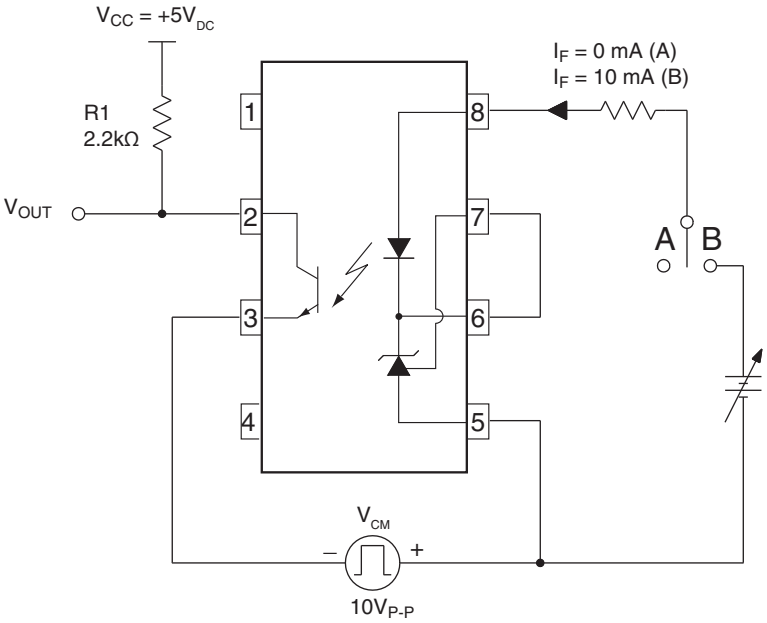


ΔV_{REF} / ΔV_{COMP} Test Circuit

Test Circuits (cont.)



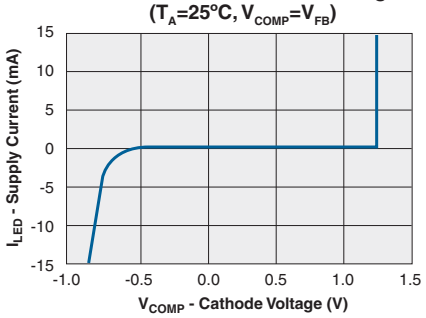
Frequency Response



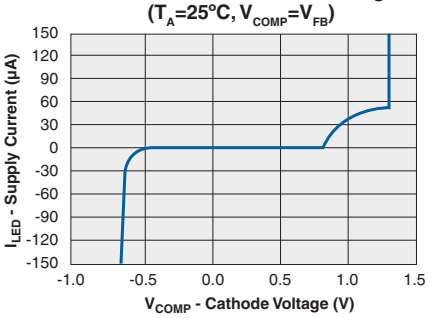
CMH and CML

PERFORMANCE DATA*

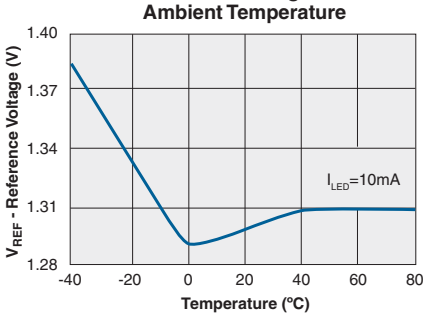
LIA130
LED Current vs. Cathode Voltage
(T_A=25°C, V_{COMP}=V_{FB})



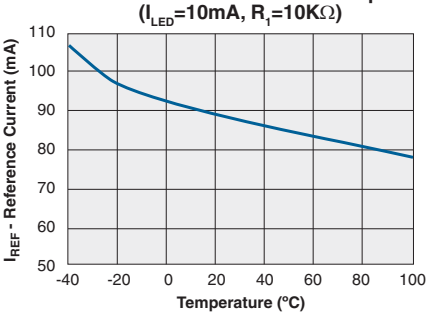
LIA130
LED Current vs. Cathode Voltage
(T_A=25°C, V_{COMP}=V_{FB})



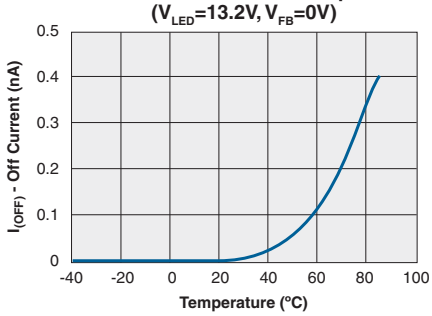
LIA130
Reference Voltage vs. Ambient Temperature



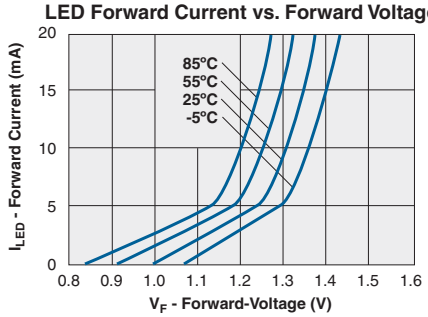
LIA130
Reference Current vs. Ambient Temperature
(I_{LED}=10mA, R_1=10KΩ)



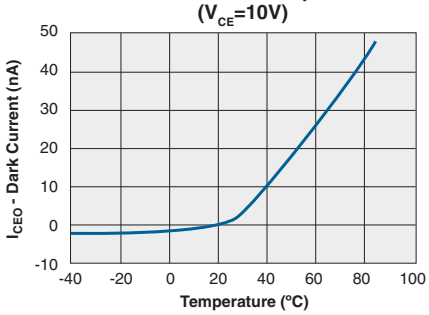
LIA130
Off Current vs. Ambient Temperature
(V_{LED}=13.2V, V_{FB}=0V)



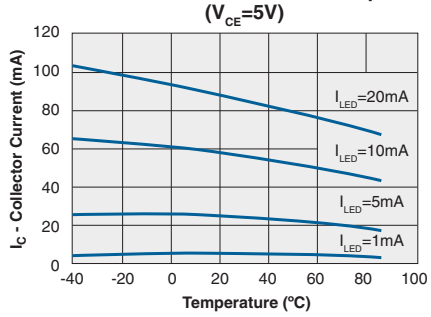
LIA130
LED Forward Current vs. Forward Voltage



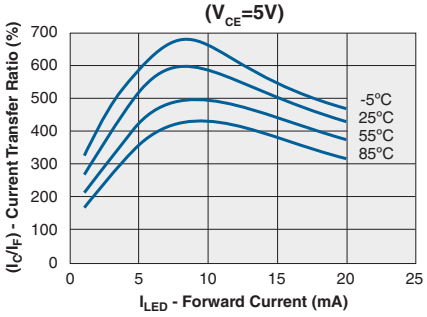
LIA130
Dark Current vs. Temperature
(V_{CE}=10V)



LIA130
Collector Current vs. Ambient Temperature
(V_{CE}=5V)



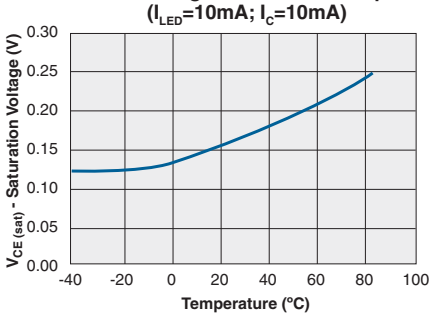
LIA130
Current Transfer Ratio vs LED Current
(V_{CE}=5V)



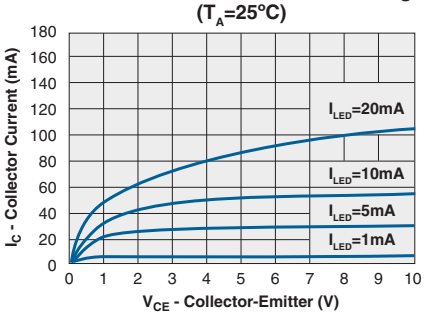
*The Performance data shown in the graphs above is typical of device performance. For guaranteed parameters not indicated in the written specifications, please contact our application department.

PERFORMANCE DATA*

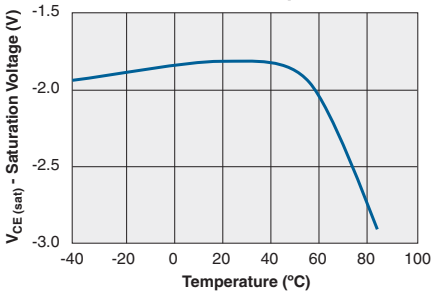
LIA130
Saturation Voltage vs. Ambient Temperature
(I_{LED}=10mA; I_C=10mA)



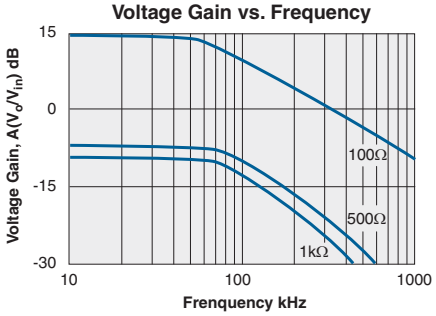
LIA130
Collector Current vs. Collector Voltage
(T_A=25°C)



LIA130
Delta V_{REF} / Delta V_{COMP}
vs. Ambient Temperature



LIA130
Voltage Gain vs. Frequency



*The Performance data shown in the graphs above is typical of device performance. For guaranteed parameters not indicated in the written specifications, please contact our application department.

The LIA130

The LIA130 is essentially an optically isolated error amplifier. It comprises three of the necessary components to form an isolated power supply: an optocoupler, an error amplifier, and a reference voltage device. The LIA130 is the functional equivalent of a 431 series shunt voltage regulator plus an optocoupler in the same package.

LED Pin

The LED within the LIA130 is powered by a sample of the output voltage that is being regulated. Typically, a resistor divider is provided to keep this voltage sample within the operating range of the LED and its series resistor. As the output voltage changes, the LED light output changes, which provides a changing error voltage from the phototransistor output of the LIA130. The sampled voltage must be at least 1.24V (the reference voltage) plus 1.5V (the LED voltage drop) or a minimum of 2.74 volts. The sampled voltage can also be provided from a slaved secondary winding of the transformer rather than a resistor divider.

There must be a current-limiting resistor in series with the LED pin to keep the current flow through the LED within its operating range for all expected sampled output levels. This resistor must be selected along with the resistor in series with the output phototransistor.

FB Pin

The LIA130, when connected as shown in the Typical Application Circuit, will regulate the output voltage so that the voltage on its FB pin is 1.24V. Set the values of the two voltage divider resistors, R1 and R2 in this way:

$$R1/R2 = (V_{OUT} / V_{REF}) - 1$$

The value of R1 is set by the input offset current, 0.8µA. 1% accuracy is obtained when the value of R1 satisfies this formula:

$$((V_{OUT} - 1.24) / R1) > 80\mu A$$

GND Pin

Connect the GND pin of the LIA130 to the secondary ground of the converter.

NC Pins

The NC (not connected) pins have no internal connection and must not have any connection to the secondary side, as this might compromise the primary-to-secondary isolation.

COMP Pin

The frequency response of the converter can be optimized for the particular application by placing a compensation network between the COMP pin and the FB pin of the LIA130. In a system with a typical low-bandwidth requirement, only a 0.1µF capacitor might be needed.

If the system has more critical bandwidth requirements, then measurements must be made of the system's loop. See “Practical Design of Power Supplies” by Ron Lenk, IEEE Press, 1998, for an excellent description.

C & E Pins

The output phototransistor of the LIA130 provides the isolated and amplified error signal that represents the DC output level of the converter. Typically, the collector of the phototransistor will be pulled up to voltage and the emitter will be grounded.

The value of the collector's pull-up resistor and the value of the LED current-limiting resistor must be determined together with respect to the input voltage range of the PWM circuitry. The variation in CTR of the LIA130 must also be taken into account.

As an example, consider first that the minimum CTR of the LIA130 is 300%. If the current-limiting resistor of the LED is set to allow a maximum current through the LED of 1mA when the converter output is at a nominal 15 volts:

$$R_{LED} = (15V - 2.74V) / 0.001A = 12.260k\Omega$$

then a minimum of 3mA will flow through the collector pull-up resistor. If the collector is pulled up to 12V and the PWM has an internal reference voltage of 5V, then the minimum resistor value is:

$$R_{PULLUP} > (12V - 5V) / 0.003A > 2.333k\Omega$$

[Standard values can be selected for R_{LED} and R_{PULLUP} and the small differences then re-calculated.]

MANUFACTURING INFORMATION

Soldering

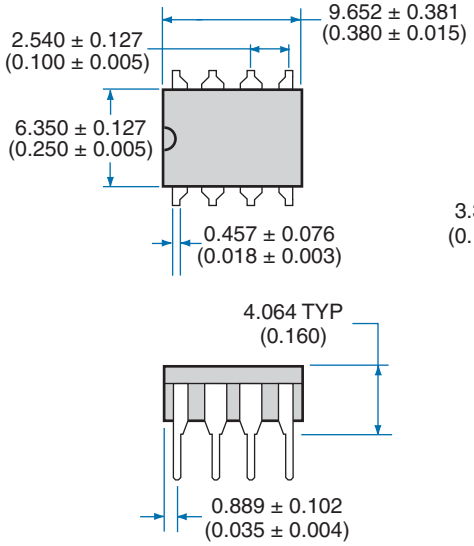
For proper assembly, the component must be processed in accordance with the current revision of IPC/JEDEC standard J-STD-020. Failure to follow the recommended guidelines may cause permanent damage to the device resulting in impaired performance and/or a reduced lifetime expectancy.

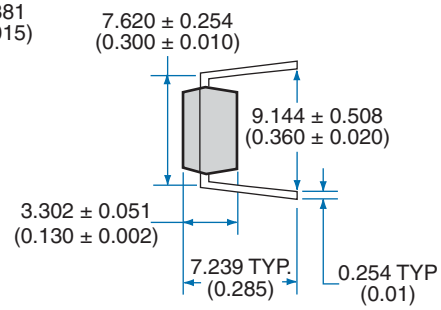
Washing

Clare does not recommend ultrasonic cleaning or the use of chlorinated solvents.

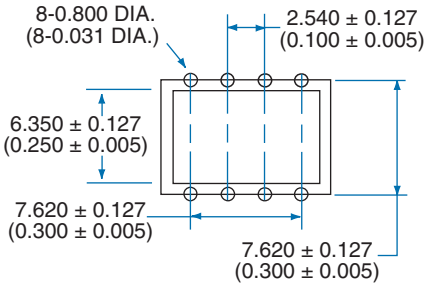
MECHANICAL DIMENSIONS

8-Pin DIP Through-Hole Package



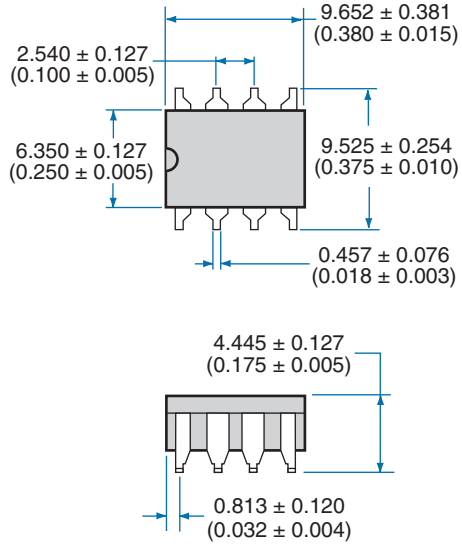


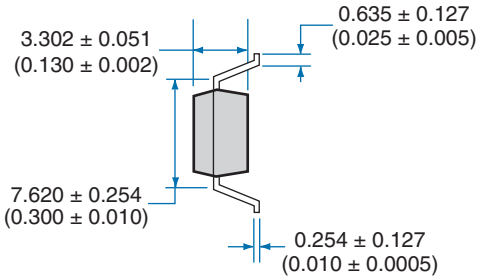
PC Board Pattern



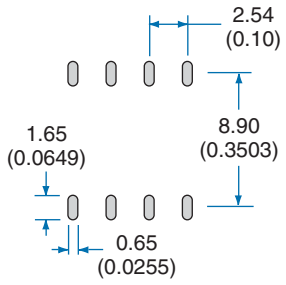
Dimensions
mm
(inches)

8-Pin Surface Mount Package





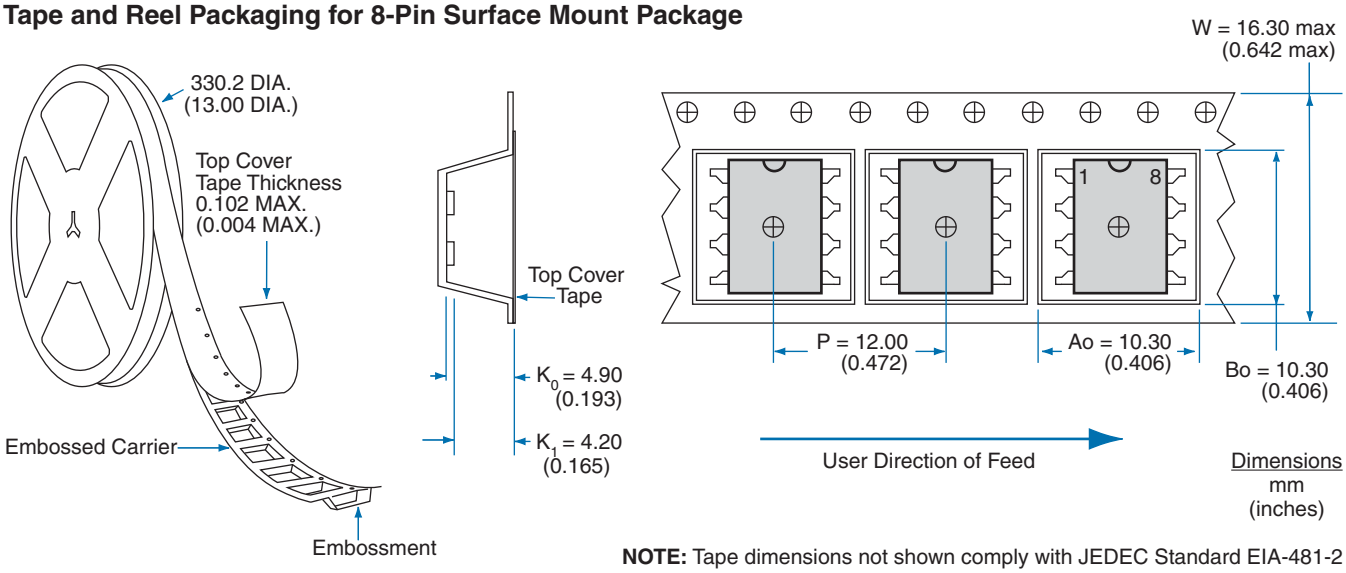
Recommended PCB Land Pattern



Dimensions
mm
(inches)

MECHANICAL DIMENSIONS (Cont.)

Tape and Reel Packaging for 8-Pin Surface Mount Package



NOTE: Tape dimensions not shown comply with JEDEC Standard EIA-481-2

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Specification: DS-LIA130-R00C
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11/17/09