National Semiconductor

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LM1830 Fluid Detector

General Description

The LM1830 is a monolithic bipolar integrated circuit designed for use in fluid detection systems. The circuit is ideal for detecting the presence, absence, or level of water, or other polar liquids. An AC signal is passed through two probes within the fluid. A detector determines the presence or absence of the fluid by comparing the resistance of the fluid between the probes with the resistance internal to the integrated circuit. An AC signal is used to overcome plating problems incurred by using a DC source. A pin is available for connecting an external resistance in cases where the fluid impedance is of a different magnitude than that of the internal resistor. When the probe resistance increases above the preset value, the oscillator signal is coupled to the base of the open-collector output transistor. In a typical application, the output could be used to drive a LED, loud speaker or a low current relay.

Features

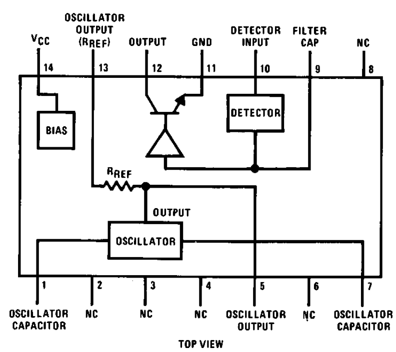
- Low external parts count
- Wide supply operating range
- One side of probe input can be grounded
- AC coupling to probe to prevent plating
- Internally regulated supply
- AC or DC output

Applications

- Beverage dispensers
- Water softeners
- Irrigation
- Sump pumps
- Aquaria
- Radiators
- Washing machines
- Reservoirs
- Boilers

Logic and Connection Diagram

Dual-In-Line Package



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Order Number LM1830N
See NS Package Number N14A

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

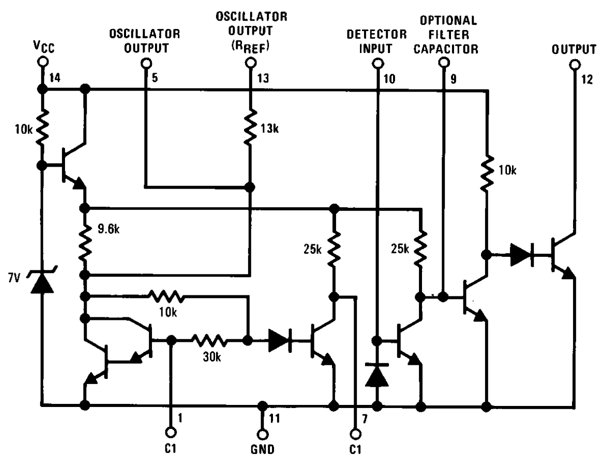
Supply Voltage	28V
Power Dissipation (Note 1)	1400 mW
Output Sink Current	20 mA
Operating Temperature Range	−40°C to +85°C
Storage Temperature Range	−40°C to +150°C
Lead Temp. (Soldering, 10 seconds)	260°C

Electrical Characteristics ($V^+ = 16V$, $T_A = 25°C$ unless otherwise specified)

Parameter	Conditions	Min	Typ	Max	Units
Supply Current			5.5	10	mA
Oscillator Output Voltage					
Low			1.1		V
High			4.2		V
Internal Reference Resistor		8	13	25	kΩ
Detector Threshold Voltage			680		mV
Detector Threshold Resistance		5	10	15	kΩ
Output Saturation Voltage	$I_O = 10$ mA		0.5	2.0	V
Output Leakage	$V_{PIN\ 12} = 16V$			10	μA
Oscillator Frequency	C1 = 0.00 1μF	4	7	12	kHz

Note 1: The maximum junction temperature rating of the LM1830N is 150°C. For operation at elevated temperatures, devices in the dual-in-line plastic package must be derated based on a thermal resistance of 89°C/W.

Schematic Diagram



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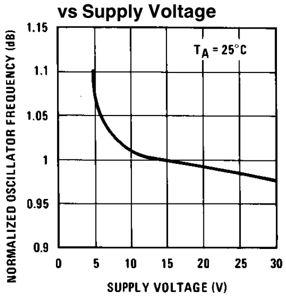
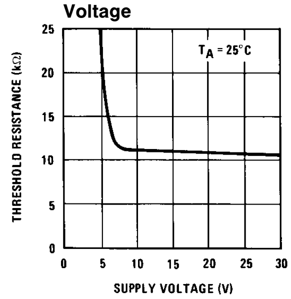
Typical Performance Characteristics

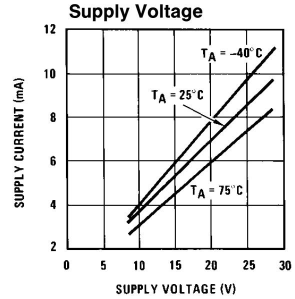
Normalized Oscillator Frequency vs Supply Voltage



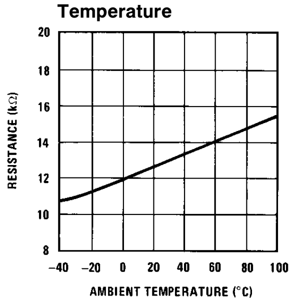
Threshold Resistance vs Supply Voltage



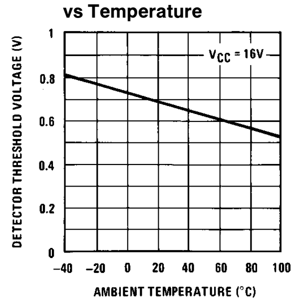
Power Supply Current vs Supply Voltage



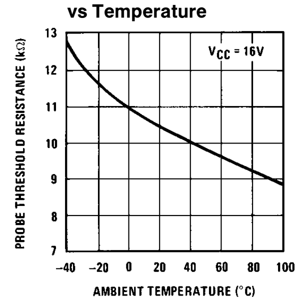
Reference Resistor vs Ambient Temperature



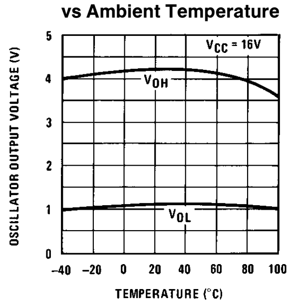
Detector Threshold Voltage vs Temperature



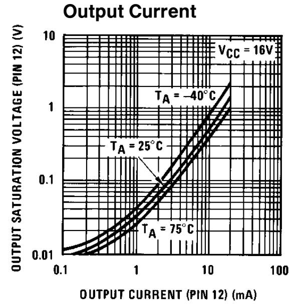
Probe Threshold Resistance vs Temperature



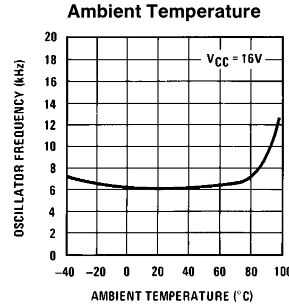
Oscillator V_{OH} and V_{OL} vs Ambient Temperature



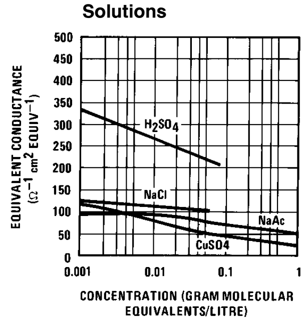
Output Saturation Voltage vs Output Current



Oscillator Frequency vs Ambient Temperature



Equivalent Resistance vs Concentration of Several Solutions



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Application Hints

The LM1830 requires only an external capacitor to complete the oscillator circuit. The frequency of oscillation is inversely proportional to the external capacitor value. Using 0.001μF capacitor, the output frequency is approximately 6 kHz. The output from the oscillator is available at pin 5. In normal applications, the output is taken from pin 13 so that the internal 13k resistor can be used to compare with the probe resistance. Pin 13 is coupled to the probe by a blocking capacitor so that there is no net dc on the probe.

Since the output amplitude from the oscillator is approximately 4 V_{BE}, the detector (which is an emitter base junction) will be turned ''ON'' when the probe resistance to ground is equal to the internal 13 kΩ resistor. An internal diode across the detector emitter base junction provides symmetrical limiting of the detector input signal so that the probe is excited with ± 2 V_{BE} from a 13 kΩ source. In cases where the 13 kΩ resistor is not compatible with the probe resistance range, an external resistor may be added by coupling the probe to pin 5 through the external resistor as shown in *Figure 2*. The collector of the detecting transistor is brought out to pin 9 enabling a filter capacitor to be connected so that the output will switch ''ON'' or ''OFF'' depending on the probe resistance. If this capacitor is omitted, the output will be switched at approximately 50% duty cycle when the probe resistance exceeds the reference resistance. This can be useful when an audio output is required and the output transistor can be used to directly drive a loud speaker. In addition, LED indicators do not require dc excitation. Therefore, the cost of a capacitor for filtering can be saved.

In the case of inductive loads or incandescent lamp loads, it is recommended that a filter capacitor be employed.

In a typical application where the device is employed for sensing low water level in a tank, a simple steel probe may be inserted in the top of the tank with the tank grounded. Then when the water level drops below the tip of the probe, the resistance will rise between the probe and the tank and the alarm will be operated. This is illustrated in *Figure 3*. In situations where a non-conductive container is used, the probe may be designed in a number of ways. In some cases a simple phono plug can be employed. Other probe designs include conductive parallel strips on printed circuit boards.

It is possible to calculate the resistance of any aqueous solution of an electrolyte for different concentrations, provided the dimensions of the electrodes and their spacing is known.

The resistance of a simple parallel plate probe is given by:

$$R = \frac{1000}{c.p} \bullet \frac{d}{A}\ \Omega$$

where A = area of plates (cm^2)

d = separation of plates (cm)

c = concentration (gm. mol. equivalent/litre)

p = equivalent conductance (Ω^{-1} cm^2 equiv. $^{-1}$)

(An equivalent is the number of moles of a substance that gives one mole of positive charge and one mole of negative charge. For example, one mole of NaCl gives $Na^{+} + Cl^{-}$ so the equivalent is 1. One mole of $CaCl_2$ gives $Ca^{++} + 2Cl^{-}$ so the equivalent is 1/2.)

Usually the probe dimensions are not measured physically, but the ratio d/A is determined by measuring the resistance of a cell of known concentration c and equivalent conductance of 1. A graph of common solutions and their equivalent conductances is shown for reference. The data was derived from D.A. MacInnes, ''The Principles of Electrochemistry,'' Reinhold Publishing Corp., New York., 1939.

In automotive and other applications where the power source is known to contain significant transient voltages, the internal regulator on the LM1830 allows protection to be provided by the simple means of using a series resistor in the power supply line as illustrated in *Figure 4*. If the output load is required to be returned directly to the power supply because of the high current required, it will be necessary to provide protection for the output transistor if the voltages are expected to exceed the data sheet limits.

Although the LM1830 is designed primarily for use in sensing conductive fluids, it can be used with any variable resistance device, such as light dependent resistor or thermistor or resistive position transducer.

The following table lists some common fluids which may and may not be detected by resistive probe techniques.

Conductive Fluids	Non-Conductive Fluids
City water	Pure water
Sea water	Gasoline
Copper sulphate solution	Oil
Weak acid	Brake fluid
Weak base	Alcohol
Household ammonia	Ethylene glycol
Water and glycol mixture	Paraffin
Wet soil	Dry soil
Coffee	Whiskey

Typical Applications $V_{CC} = 16V$

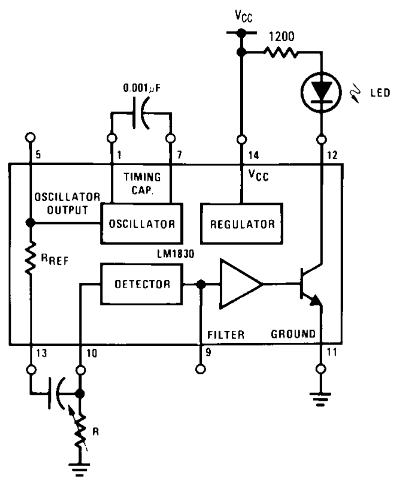


FIGURE 1. Test Circuit

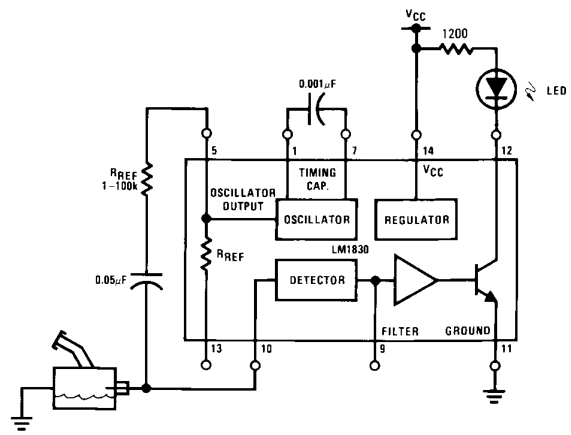


FIGURE 2. Application Using External Reference Resistor

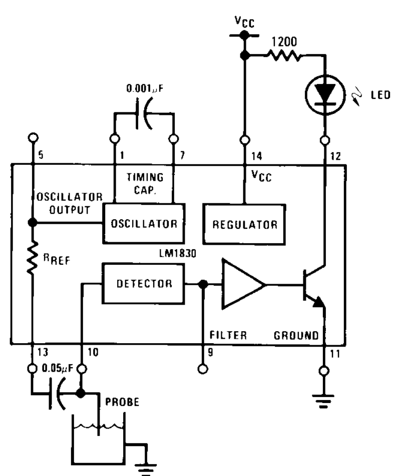
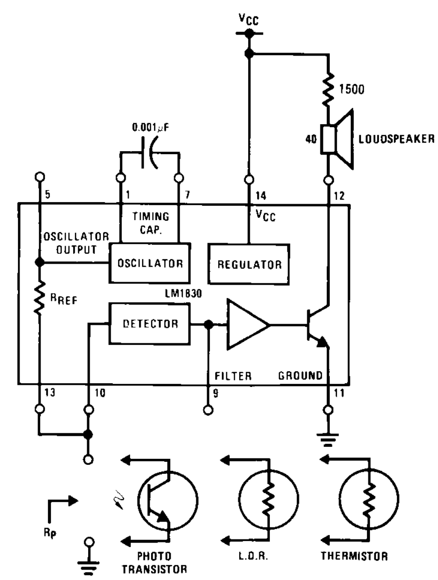


FIGURE 3. Basic Low Level Warning Device with LED Indication



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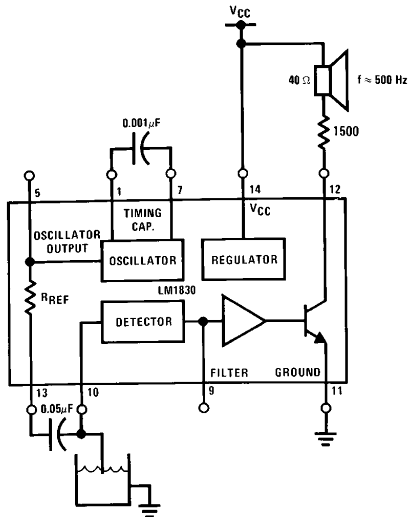
Output is activated when R_p is approximately greater than ⅓ R_{REF}

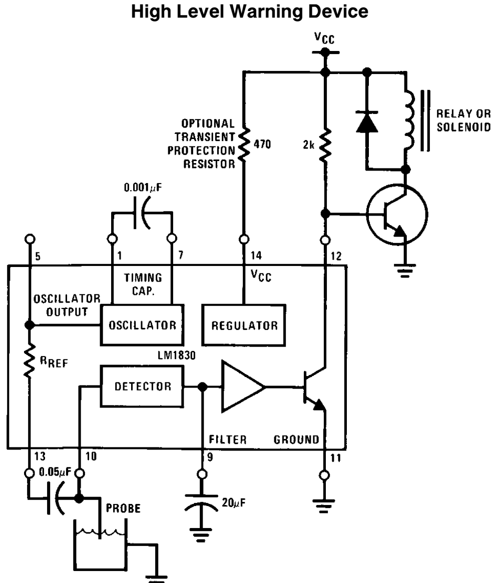
FIGURE 4. Direct Coupled Applications

Typical Applications V_{CC} = 16V (Continued)

Low Level Warning with Audio Output



High Level Warning Device



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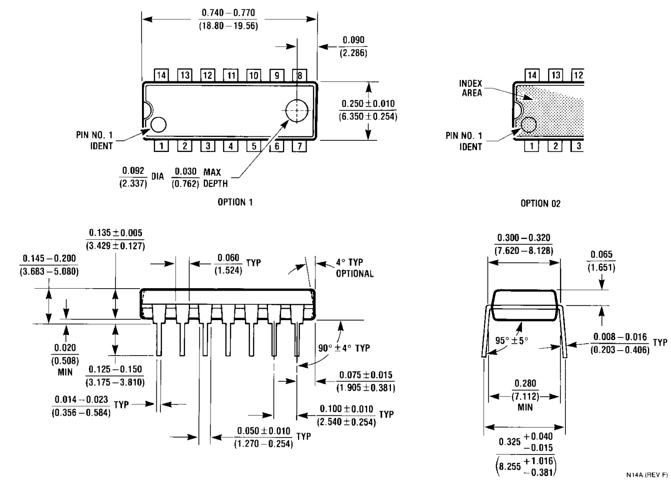
The Output is suitable for driving a sump pump
or opening a drain valve, etc.

Physical Dimensions inches (millimeters)



Molded Dual-In-Line Package (N)
Order Number LM1830N
NS Package Number N14A

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