LD209A

Metal Proximity Detector IC

Description

The LD209A (analog CS209A) is a bipolar monolithic integrated circuit for use in metal detection/proximity sensing applications.

The IC (see block diagram) contains two on-chip current regulators, oscillator and low-level feedback circuitry, peak detection/demodulation circuit, a comparator and two complementary output stages.

The oscillator, along with an external LC network, provides controlled oscillations where amplitude is highly dependent on the Q of the LC tank. During low Q conditions, a variable low-level feedback circuit provides drive to maintain oscillation. The peak demodulator senses the negative portion of the oscillator envelop and provides a demodulated waveform as input to the comparator. The comparator sets the states of the complementary outputs by comparing the input from the demodulator to an internal reference. External loads are required for the output pins.

A transient suppression circuit is included to absorb negative transients at the tank circuit terminal.

Features

- Separate Current Regulator for Oscillator
- Negative Transient Suppression
- Variable Low-Level Feedback
- Improved Performance over Temperature
- 6mA Supply Current Consumption at VCC = 12V
- Output Current Sink Capability: 20mA at 4VCC
  100mA at 24VCC

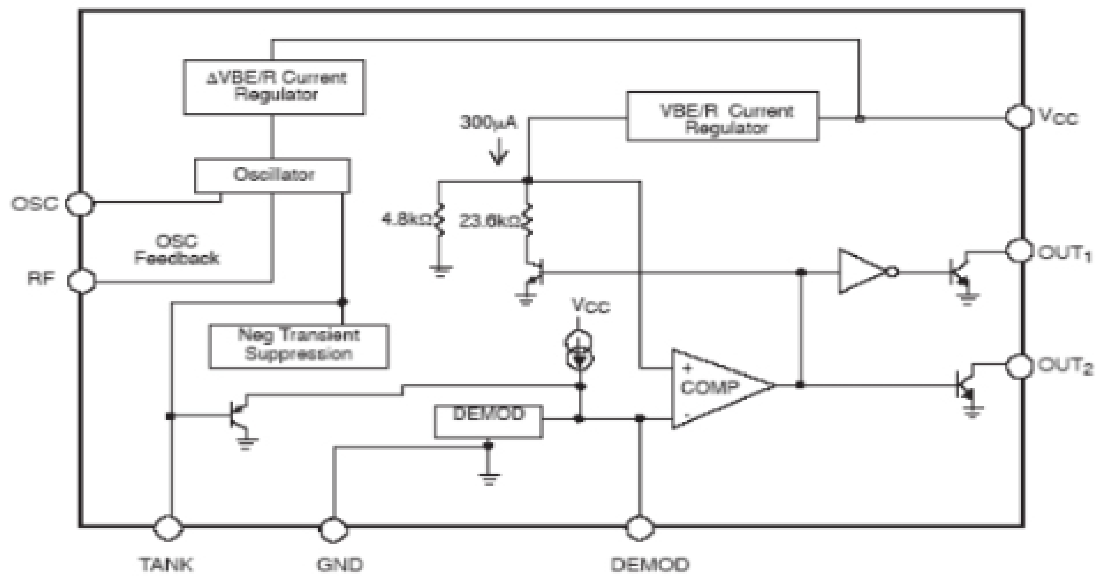
Ordering Information

Package	Remarks
DIP8	Tubed, Pb-free
SOP8	Tubed, Reeled, Pb-free
SOP14	Tubed, Reeled, Pb-free

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply Voltage		24	V
Power Dissipation (TA = 125℃)		200	mW
Storage Temperature Range		- 55 to +165	℃
Junction Temperature		- 40 to +150	℃
Electrostatic Discharge (except TANK pin)		2	kV
Lead Temperature Soldering Wave Solder (through hole styles only) Reflow (SMD styles only)	10 sec. max, 260℃ peak 60 sec. max above 183℃, 230℃peak		

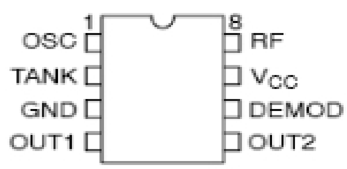
Block Diagram



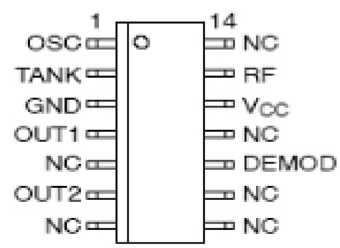
Electrical Characteristics: (–40℃ ≤ T_A ≤ +125℃, unless otherwise specified.)

Parameters	Test Conditions / Pins	Min.	Typ.	Max.	Unit
Supply Current I_{CC}	V_{CC} = 4V V_{CC} = 12V V_{CC} = 24V		3.5 6.0 11.0	6.0 11.6 20.0	mA
Tank Current	V_{CC} = 20V	-550	-300	-100	μA
Demodulator Charge Current	V_{CC} = 20V	-60	-30	-10	μA
Output Leakage Current	V_{CC} = 24V		0.01	10.0	μA
Output V_{SAT}	V_{CC} = 4V, I_S = 20mA V_{CC} = 24V, I_S = 100mA		60 200	200 500	mV
Oscillator Bias	V_{CC} = 20V	1.1	1.9	2.5	V
Feedback Bias	V_{CC} = 20V	1.1	1.9	2.5	V
Osc - Rf Bias	V_{CC} = 20V	-250	100	550	mV
Protect Voltage	I_{TANK} = -10mA	-10.0	-8.9	-7.0	V
Detect Threshold		720	1440	1950	mV
Release Threshold		550	1200	1700	mV

Package Pin Description



SOP8&DIP8

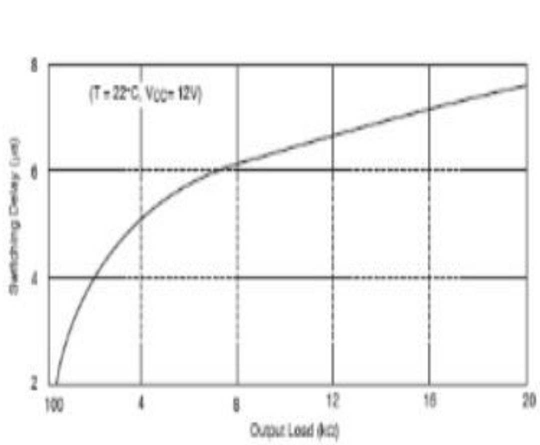


SOP14

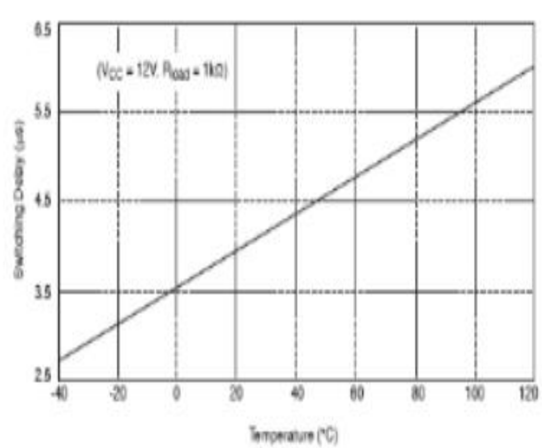
Package Pin		Pin Symbol	Function
DIP8 & SO8	SO14		
1	1	OSC	Adjustable feedback resistor connected between OSC and RF sets detection range.
2	2	TANK	Connects to parallel tank circuit.
3	3	Gnd	Test point or zero adjustment.
4	4	OUT1	Complementary open collector output; When OUT1 = LOW, metal is present.
5	6	OUT2	Complementary open collector output; When OUT2 = HIGH, metal is present.
6	10	DEMOD	Input to comparator controlling OUT1 and OUT 2.
7	12	V_{CC}	Supply voltage.
8	13	RF	Adjustable feedback resistor connected between OSC and RF set detection range.
	5,7,8,9,11,14	NC	No connection.

Typical Performance Characteristics

Output Switching Delay vs. Output Load



Output Switching Delay vs. Temperature



Principle of Operation

The LD209A is a metal detector circuit which operates on the principle of detecting a reduction in Q of an inductor when it is brought into close proximity of metal. The LD209A contains an oscillator set up by an external parallel resonant tank and a feedback resistor connected between OSC and RF. (See Test and Applications Diagram) The impedance of a parallel resonant tank is highest when the frequency of the source driving it is equal to the tank's resonant frequency. In the LD209A the internal oscillator operates close to the resonant frequency of the tank circuit selected. As a metal object is brought close to the inductor, the amplitude of the voltage across the tank gradually begins to drop. When the envelope of the oscillation reaches a certain level, the IC causes the output stages to switch states.

The detection is performed as follows: A capacitor connected to DEMOD is charged via an internal 30μA current source. This current, however, is diverted away from the capacitor in proportion to the negative bias generated by the tank at TANK. Charge is therefore removed from the capacitor tied to DEMOD on every negative half cycle of the resonant voltage. (See Figure 1) The voltage on the capacitor at DEMOD, a DC voltage with ripple, is then directly compared to an internal 1.44V reference. When the internal comparator trips it turns on a transistor which places a 23.6kΩ resistor in parallel to the 4.8kΩ. The resulting reference then becomes approximately 1.2V. This hysteresis is necessary for preventing false triggering.

The feedback potentiometer connected between OSC and RF is adjusted to achieve a certain detection distance range. The larger the resistance the greater the trip-point distance (See graph Demodulator Voltage vs Distance for Different RF). Note that this is a plot representative of one particular set-up since detection distance is dependent on the Q of the tank. Note also from the graph that the capacitor voltage corresponding to the greatest detection distance has a higher residual voltage when the metal object is well outside the trip point. Higher values of feedback resistance for the same inductor Q will therefore eventually result in a latched -ON condition because the residual voltage will be higher than the comparator's thresholds.

As an example of how to set the detection range, place the metal object at the maximum distance from the inductor the circuit is required to detect, assuming of course the Q of the tank is high enough to allow the object to be within the IC's detection range. Then adjust the potentiometer to obtain a lower resistance while observing one of the LD209A outputs return to its normal state (see Test and Applications Diagram). Readjust the potentiometer slowly toward a higher resistance until the outputs have switched to their tripped condition. Remove the metal and confirm that the outputs switch back to their normal state. Typically the maximum distance range the circuit is capable of detecting is around 0.3 inch. The higher the Q, the higher the detection distance.