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AC Motion Sensor Light with E931.97

The 931.97 is well suited for motion sensor lights.

The requirements for this application are
- Good range (>10m)
- Responsive detection of humans
- adjustable detection range
- adjustable timing
- daylight sensor
- reliable operation

The unit can be used indoors or outdoors. It should not face direct sunlight as the material of the Fresnel lens may loose efficiency over time. Exposure to sudden temperature changes, hot and cold air movement and moving objects in the field of view may result in switching the light on in the absence of human movement / presence.

The type of lens, the mounting height, the enclosure and the insulation against temperature changes of the detector have the most influence on the usable detection range.

Functions and Implementations
For details referring to components, see fig 1.

Motion Detection
The E931.97 contains a second order band pass filter for the signal processing. Together with the circuitry required to operate the analog PIR detector, once achieves a 3rd order high pass filter function and a second order low pass filter function. The filter removes unwanted out of band signals.

In order to switch the REL output (load on), the circuit must observe 2 consecutive signal pulses above the threshold within a time window of 4s. There must also be a change in polarity between the 2 pulses.

The LED output indicates whenever the trigger threshold is exceeded. The REL output becomes active, once movement has been detected (load on). The REL output remains active, until no further movement is detected and the user defined On Time has lapsed. The On Time is calculated from the moment, where no further motion is detected.

If the signal from the detector is more than twice as high as the threshold, the E931.97 will switch the REL output immediately.

Relay Switching
The unit is configured for normally open relays. Motion will cause the load to be switched on.

Connection of PIR Detector
The PIR detector contains a pyro ceramic, which is connected to the gate of a JFET. The drain terminal needs to be connected to a positive supply voltage (2V to 12V) and the source requires a resistor to ground. The JFET provides the impedance conversion from the internal pyro ceramic to the external load. The DC voltage on the source can be between 0.1V and >1V, depending on detector type, supplier and operating conditions – specifically the temperature. The PIR detector generates a relatively small signal of some 100uV as a result of movement. The signal value depends to a large extend on the lens, the size and temperature of the moving object and the distance of the object to the detector.

Resistor R9 is the source resistor for the detector. The supplier recommends values between 50k and 150k. For very low power applications, many users choose much higher resistor values.
Capacitor C6 reduces any RF signal coupled from the environment onto the source of the detector as it would result in noise due to the demodulation across the source gate diode inside the detector. Some detector manufacturers have this capacitor already integrated.

Capacitor C5 in conjunction with resistor R8 removes any DC content from the detector output signal. The CR combination is selected to act as a first order HP filter to remove unwanted lower frequency content. The value for resistor R8 should be a few times higher than resistor R9 to avoid any attenuation of the signal. The inverting PIR input (NPIRIN) is connected to GND.

It is important, that the noise on the drain voltage of the PIR detector is below 1mV as the drain source voltage attenuation is only 30 dB in the frequency band of interest.

Supply voltage regulation
The unit is supplied with mains voltage. The capacitor C1 generates the required voltage drop from the mains voltage to the voltage on the bridge rectifier. Resistor R2 is for surge protection. The voltage on the bridge rectifier is defined by the Zener diode Z1 voltage behind the bridge rectifier and the voltage drop across the diodes in the bridge rectifier.

The poorly stabilized DC voltage (VREL) on the Zener diode supplies the PIR controller through R3. The integrated shunt regulator on the E931.97 limits the supply voltage to 3V on the IC and the PIR detector. The maximum shunt current can be 5mA. The voltage range for the unregulated supply is primarily defined by the value and the power rating of the resistor R3 and the total current consumption of the circuitry connected to the regulated supply. Capacitors C3 and C4 are supply bypass capacitors to eliminate transients on the supply voltage of the E931.97 and the PIR detector.

Range / Sensitivity Adjustment
The DC voltage on the SENS input defines the threshold of the comparators. 0V results in 50uV peak, >0.25*VDD results in 460uV. The range is covered with a resolution of 127 equal steps. RV3 in conjunction with R5 is provided for adjustment.

Relay Switching Time
The time, how long the relay output is active after no further motion is detected, can be adjusted the same way as the sensitivity.
A range of 2s to approx. 4000s is provided. RV2 is provided for adjustment.

Instead if trim pots, once can use fixed resistors, if no adjustment is required.

Calculation of component values

R6, R5, RV2 and RV3:
1 / (1+ R6/RV2) must yield slightly more that 0.25 to ensure full range for On Time.
1 / (1+ R5/RV3) must yield slightly more that 0.25 to ensure full range for Sensitivity.

Choose preferred value for RV3 and RV2 first.

R7 < R(relay coil) * β(Q1)
RV1 depends on CDS1
R4 to avoid excessive current, when RV1 adjusted to 0 and full daylight.

R2 = 47k to 150k, power consumption is uncritical in this application.
R8 > 5 * R9
C5 > 1/(2*π*fo*R8), fo = cut off frequency (0.2Hz)

R1 < (47V-3V)/Imax
Imax = I(U1)+I(RV1)+I(R5)+I(R6)+I(R7)+100uA

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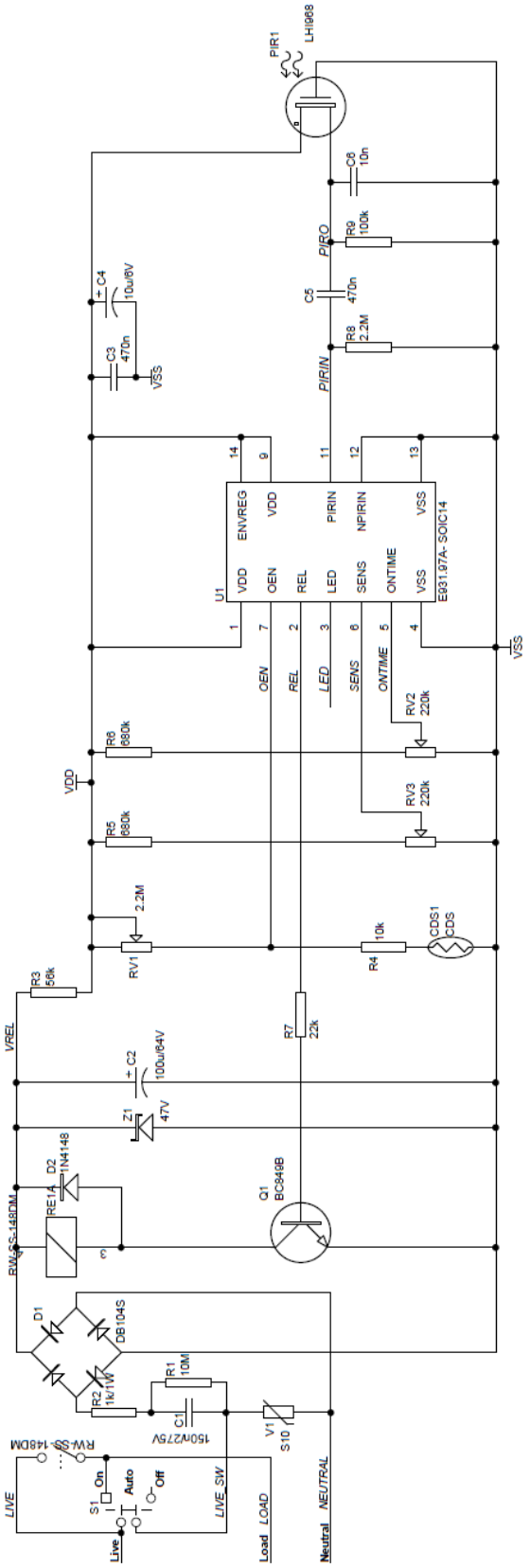

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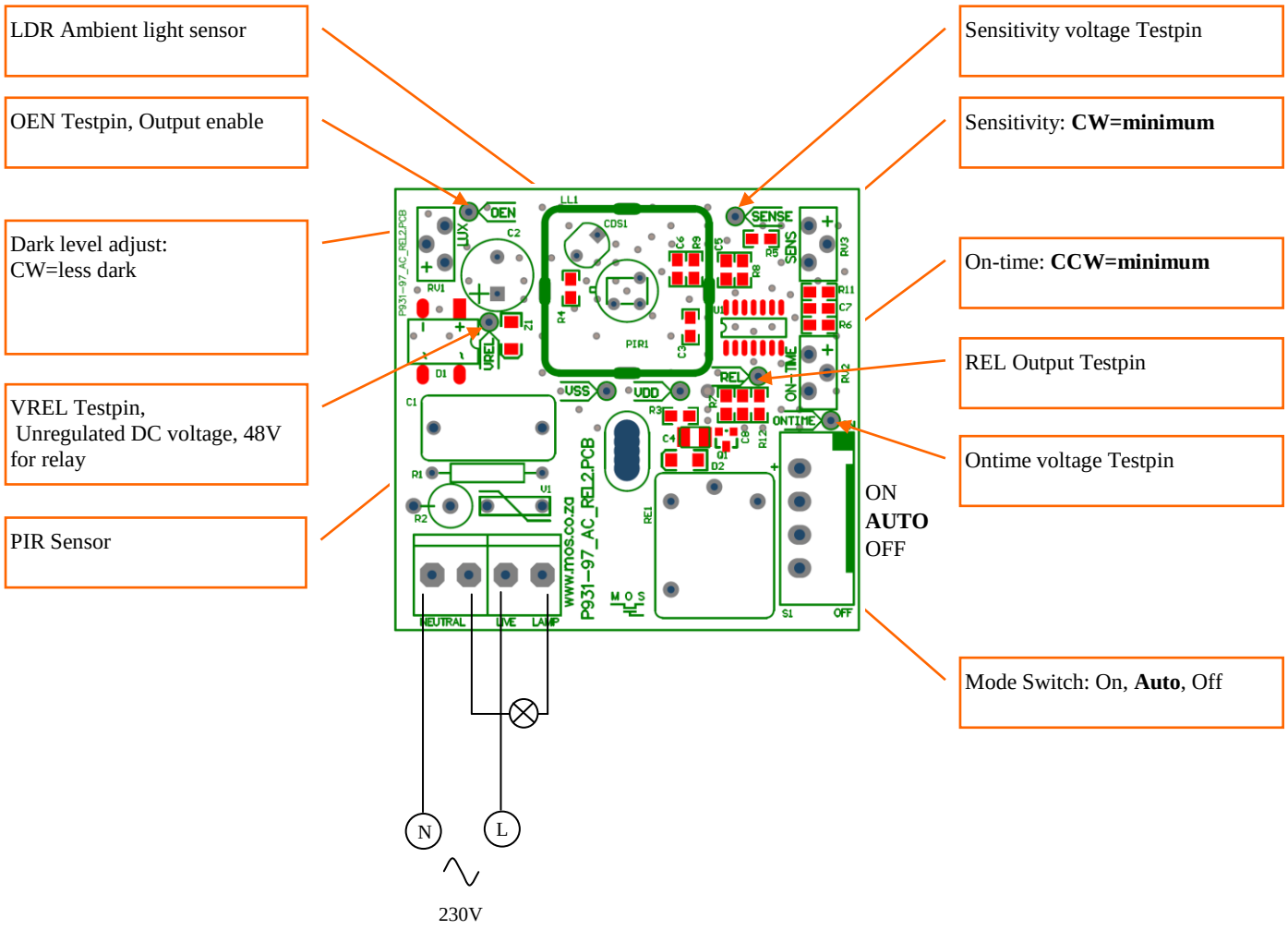
PCB Top View



CW = Clockwise
CCW = Counter Clockwise


2M2
SENSE
220K90
220K90
3070-44
GOODSKY
RW-SS-148DM
CDS1
PIR1