Design Example
Thermostat with MLX90614

Scope

This design example describes an example of a thermostat with a MLX90614 without using a microcontroller. Temperature control is non-contact thanks to the factory calibrated IR thermometer MLX90614.

Applications

- Cooling system
- Heating system
- Alarm system

Related Melexis Products

EVB90614 is the evaluation board which supports the MLX90614 devices

Other Components Needed

C1	100n
C2	100n
C4	1u
C3	1u
C5	10n
C6	10n
C7	10n
C8	470/16
C9	100/10Ts
R1	360/0.6
R2	360/0.6
R3	620
R4	3.3k
R5	100k
R6	330/0.6
R7	10k
R8	1.8k
R9	43k
R10	620
R11	330/0.6
R12	50k
R13	10M
R14	330k
R15	330k
R16	5.1M
R17	15k
R18	27k
R19	16k
R20	0Ω
R21	3.3k
D1	LED R 3MM
D2	BAS21LT1
D3	B8S
D4	LED G 3MM
F1	FUSE
F2	FUSE
J1	CON5
J2	JUMPER
J3	CON2
T1	EE20/4-0.08VA
U1	PVN012/MOC3083
U3	PVN012/MOC3083
U2	74LVC1G86
U4	MLX90614AAA
U5	LTC1041
U6	BC847
U7	LP2980

Typical Circuit

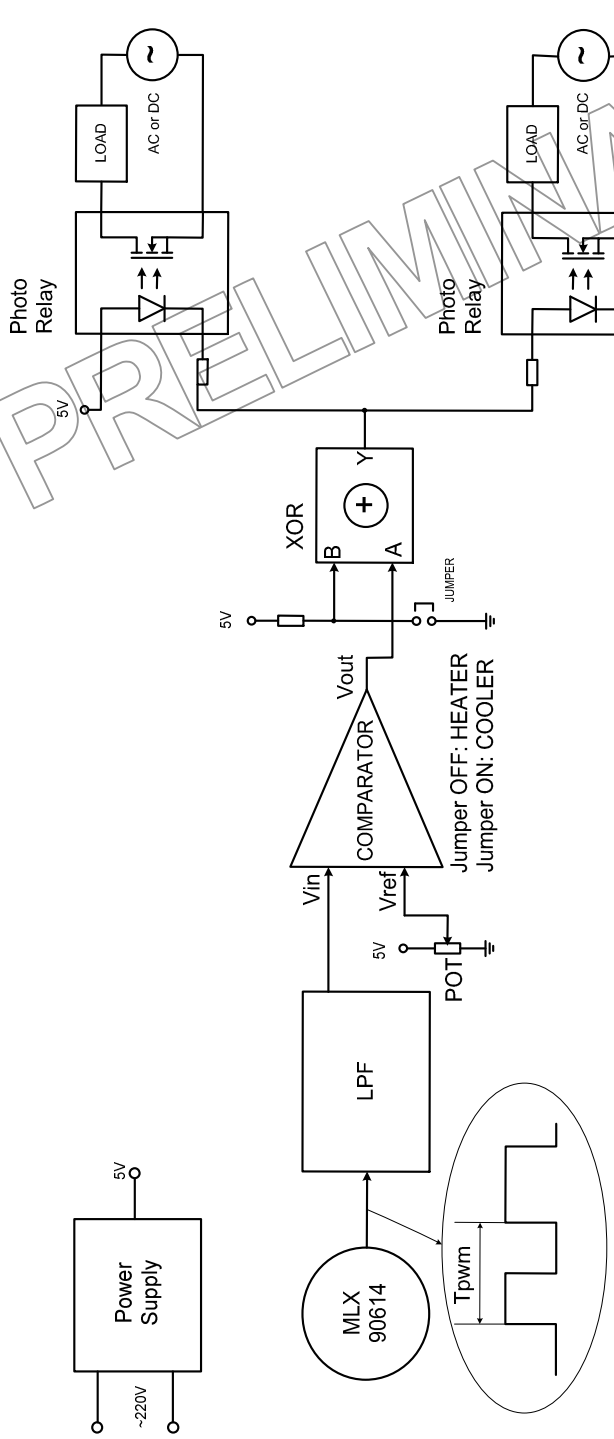


Fig. 1: Block Diagram

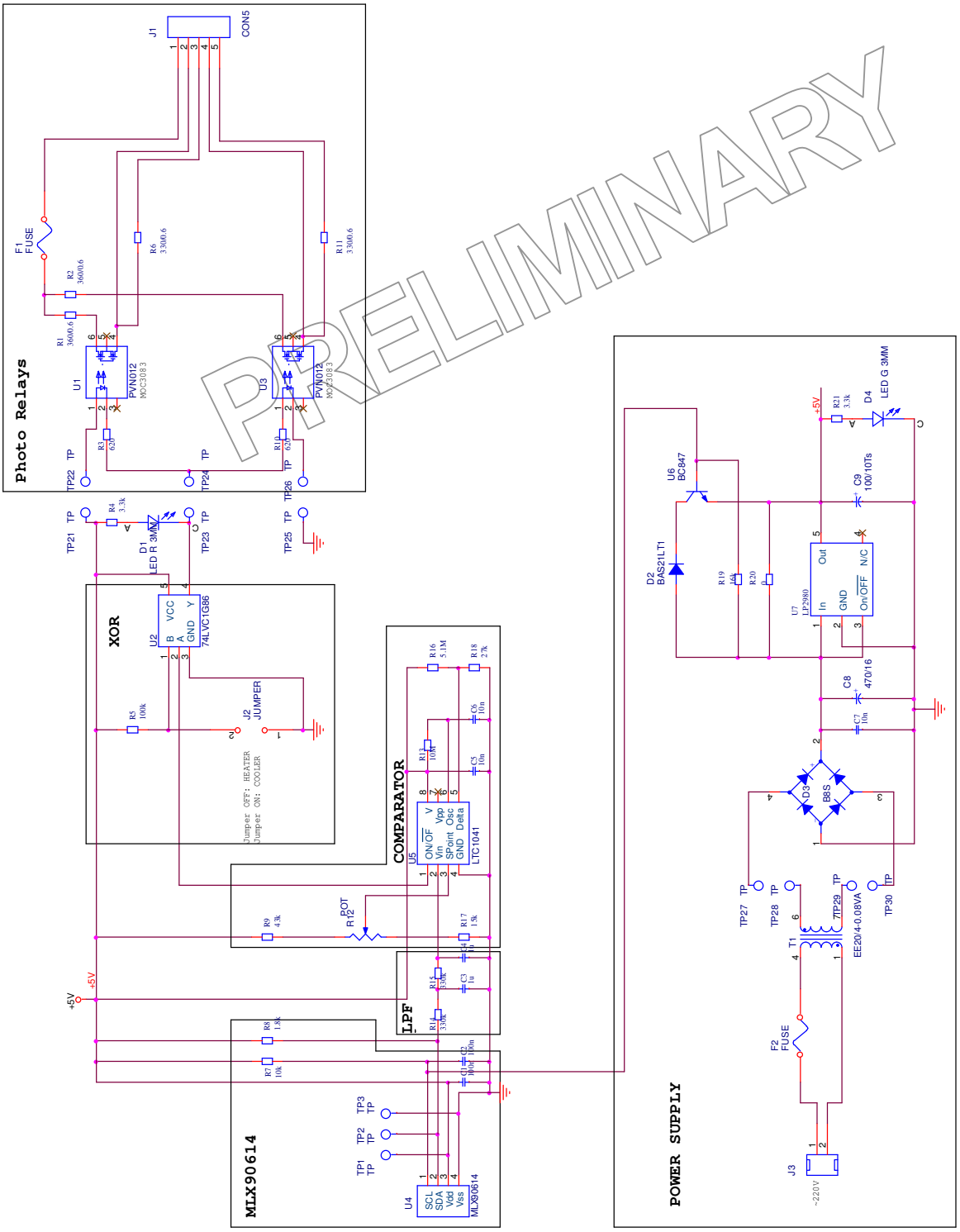


Fig. 2: Schematic diagram

Explanation

MLX90614 has thermostat mode with programmable threshold and hysteresis. Once set in the on-chip EEPROM this mode will operate without the need of microcontroller. However, versatile change of setpoint might be an issue (because of the need of supporting keyboard, display and SMBus Master to change the EEPROM value). An easy way to implement that function is described herein – a simple potentiometer is used to set the threshold.

Fig.1 shows the basic idea of such a thermostat with MLX90614. The MLX90614 IR thermometer works in PWM mode. The PWM output passes Low Pass Filter (LPF). The output voltage of the LPF is proportional to the temperature measured by the MLX90614. Further this voltage Vin is compared with a reference voltage Vref. The BANG-BANG controller LTC1041 is used in this design, with a transfer function shown on Fig. 3.

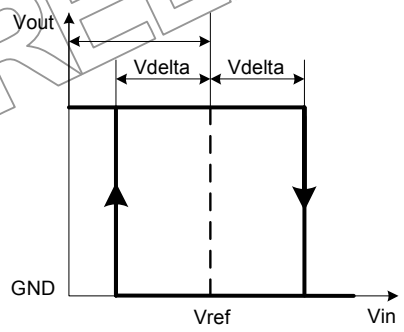


Fig. 3

When Vin < (Vref-Vdelta) the output of the LTC1041 is HIGH and when Vin > (Vref+Vdelta) the output is LOW. For versatility the output of the LTC1041 passes an Exclusive OR (XOR) gate. The truth table of this element is given in Table 1. The output of the logical element depends on the JUMPER. When the JUMPER is ON the XOR's output follows the comparator's output and when JUMPER is OFF the XOR's output is opposite of the comparator's output. XOR's output controls photo relays intended to drive loads or trigger higher power switches like triacs.

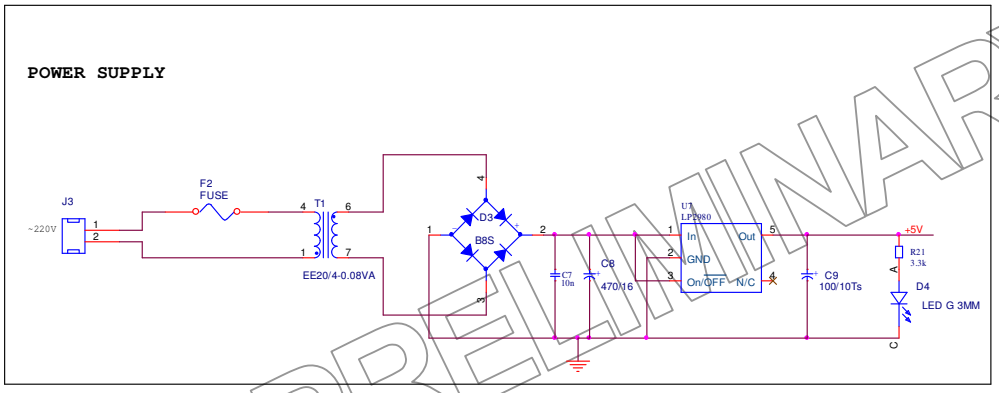
Table 1

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

With jumper J2 left open high object temperature will turn the U3 on. Thus a thermostat can be built with a heater controlled by the U1 (and jumper opened).

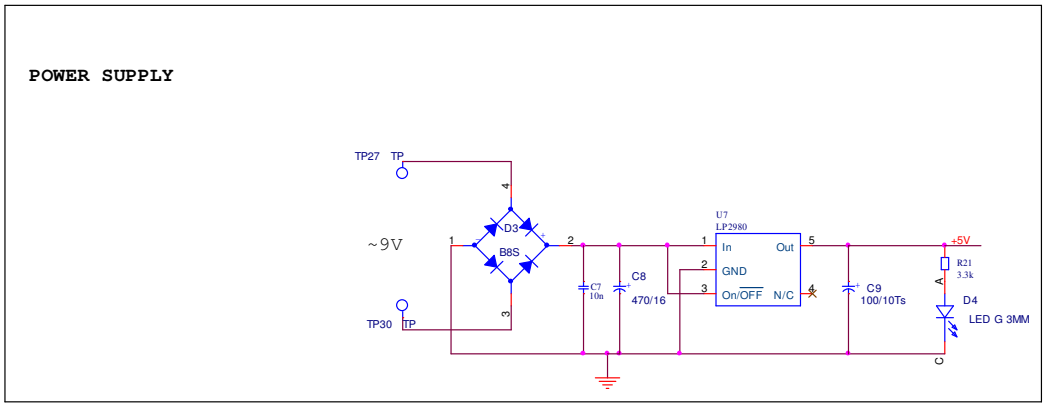
Schematic diagram of the thermostat is given on Fig. 2. The Power Supply is also designed to be versatile. The module can use different power sources as shown on the following schematic diagrams.

220V (110V) AC:



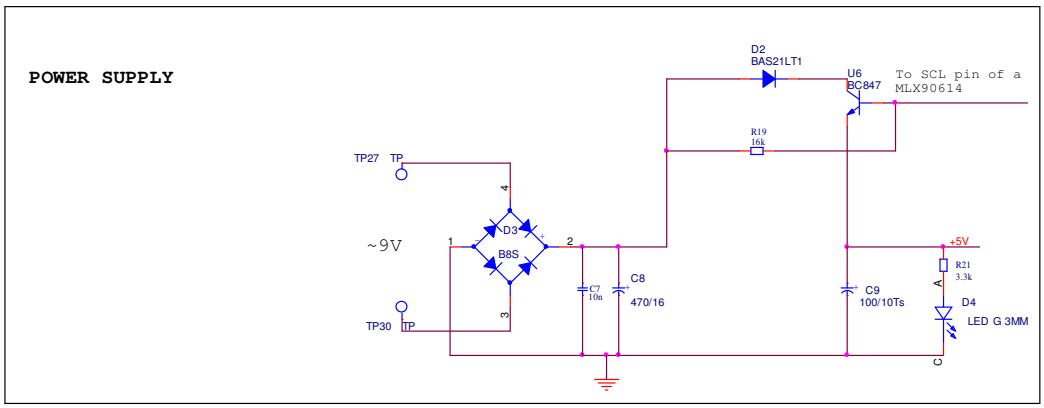
External 9V AC/DC:

The external LDO regulator is used:

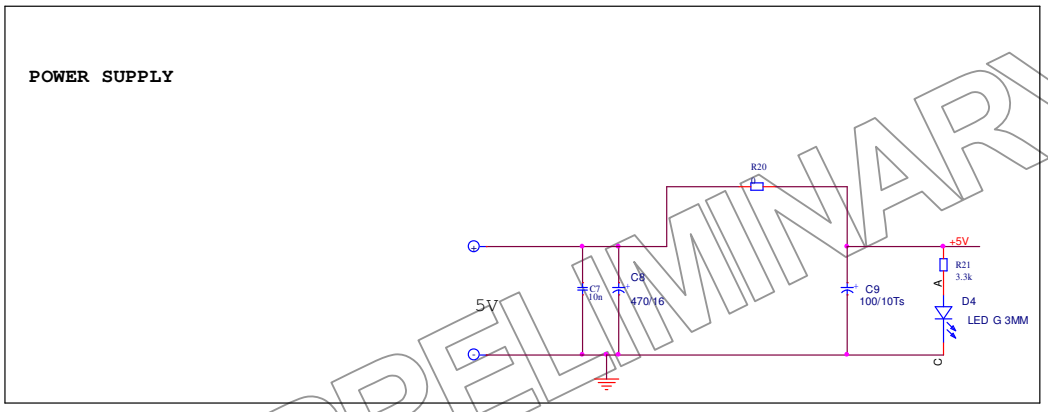


or

The zener diode integrated in the MLX90614 (5V version, SCL pin to Vss pin) can also be used:



External 5V DC:

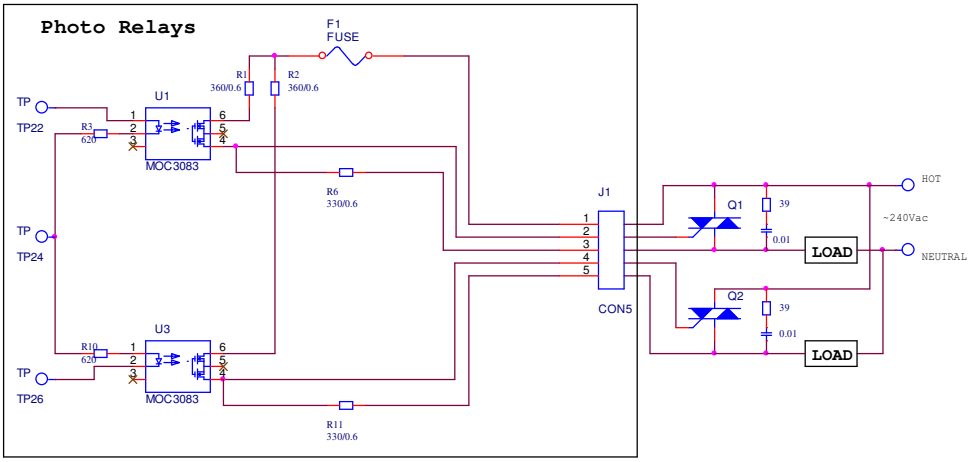


The MLX90614 can be configured in PWM Open Drain or Push Pull. In the latter case the resistor R8 is not needed.

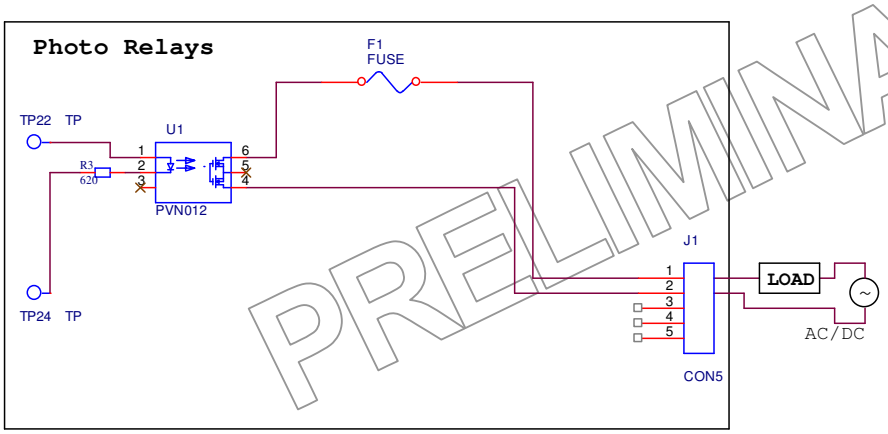
The LPF filter consists of R14, R15, C3 and C4. The output signal is fed to pin 2 (Vin) of the LTC1041. On pin 3 (SPoint) the reference voltage Vref (from the divider R9-R12-R17) sets the threshold. Vref can be adjusted with the potentiometer R12. R9 and R17 set the adjustment range. The divider consisting of R16 and R18 defines the hysteresis (see Vdelta on Fig. 3). The output of the LTC1041 through the logical element Exclusive OR (74LVC1G86) drives two photo relays (the presence of the both relays simultaneously is not mandatory). Different types photo relays can be used.

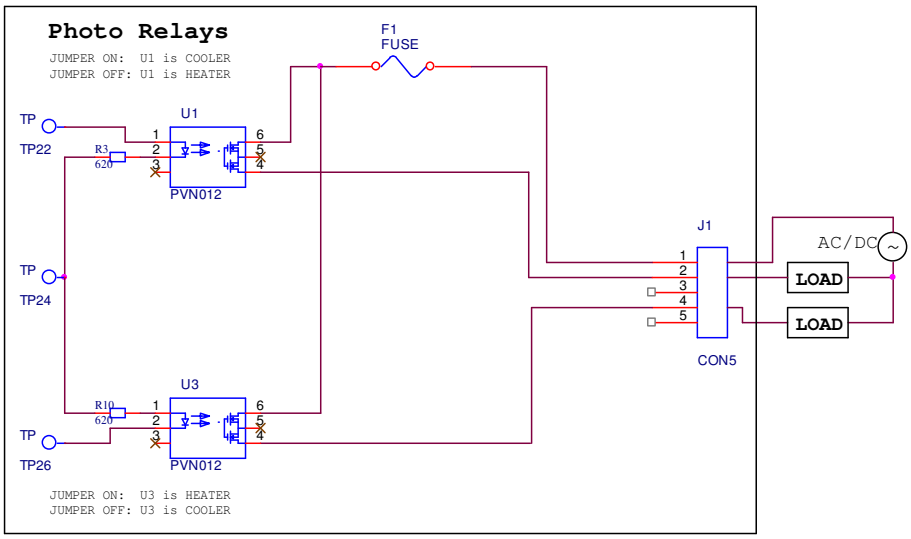
Different output configurations are shown below. The pinout of the output solid state relays / opto-couplers is valid for large number of relays.

Using MOC3083: The MOC3081, MOC3082 and MOC3083 devices are designed for use with a triac in the interface of logic systems to equipment powered from 240 Vac lines.
With the jumper J2 left open thermostat application is possible with upper opto-coupler (U1) controlling a heater and/or the lower one (U3) controlling a cooler.



Using PVN012: It is ideally suited for switching high currents or low level signals without distortion or injection of electrical noise. The shown connection allows maximum continuous load current 2.5A. With a single opto-coupler U1 the module will operate as a thermostat with a heater and jumper J2 open or a cooler and shorted J2.

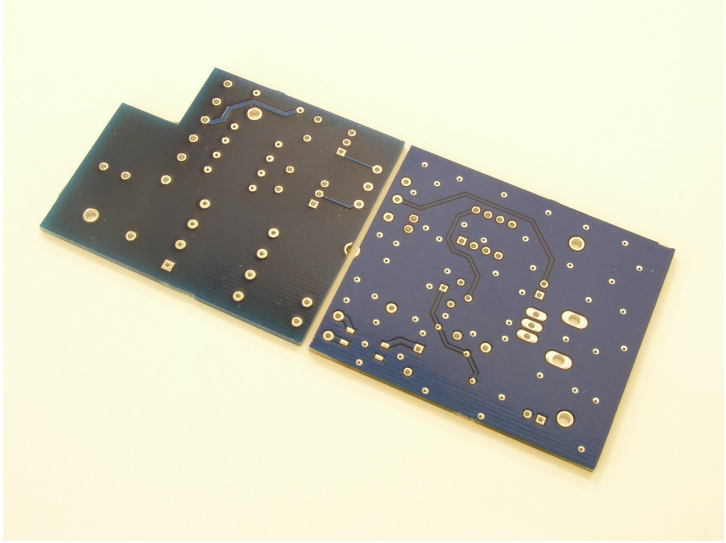




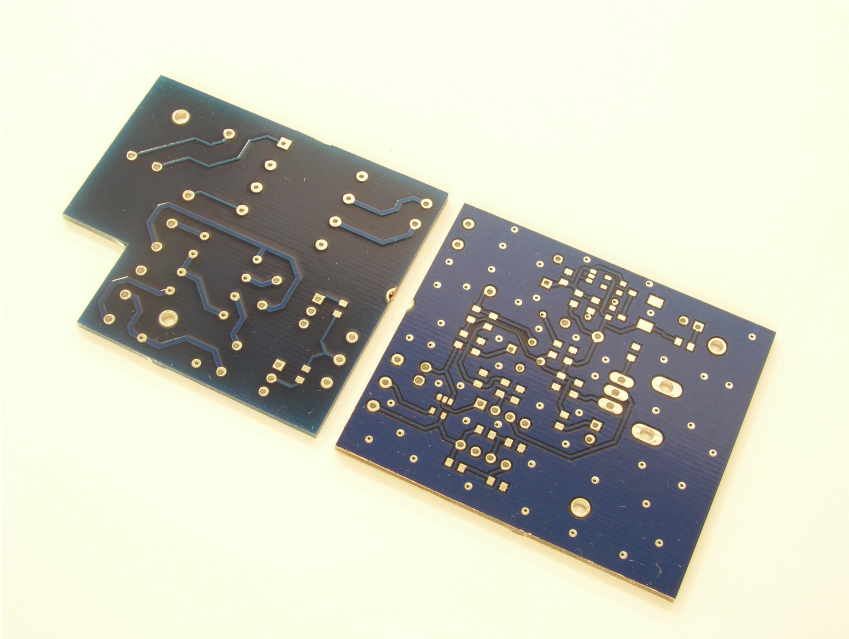
PCBs overview

The described design is implemented on the PCB shown below. It contains two units, power supply and the thermostat itself. Voltage regulator is present on the thermostat part thus allowing a local power source to be used instead of power line.

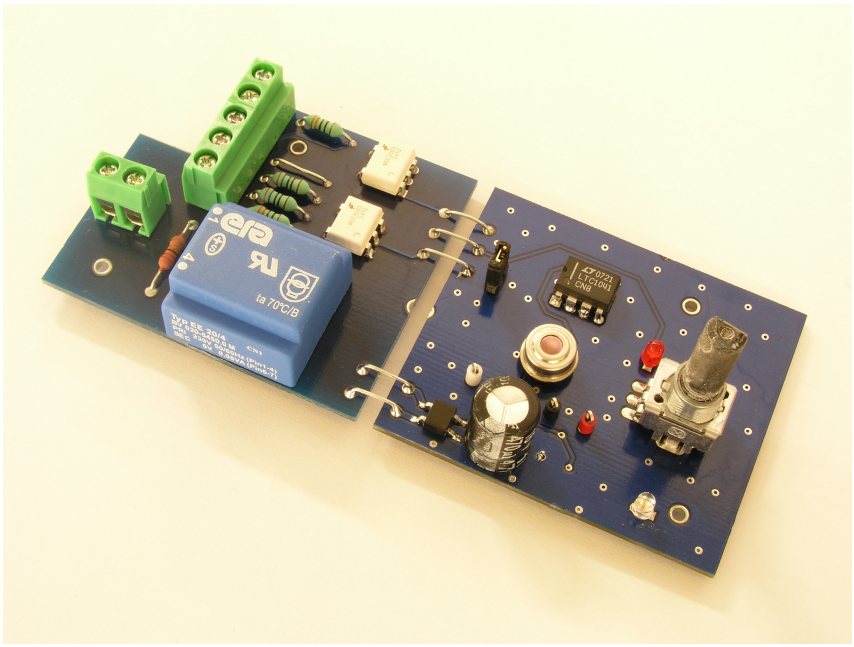
Unassembled: Top view



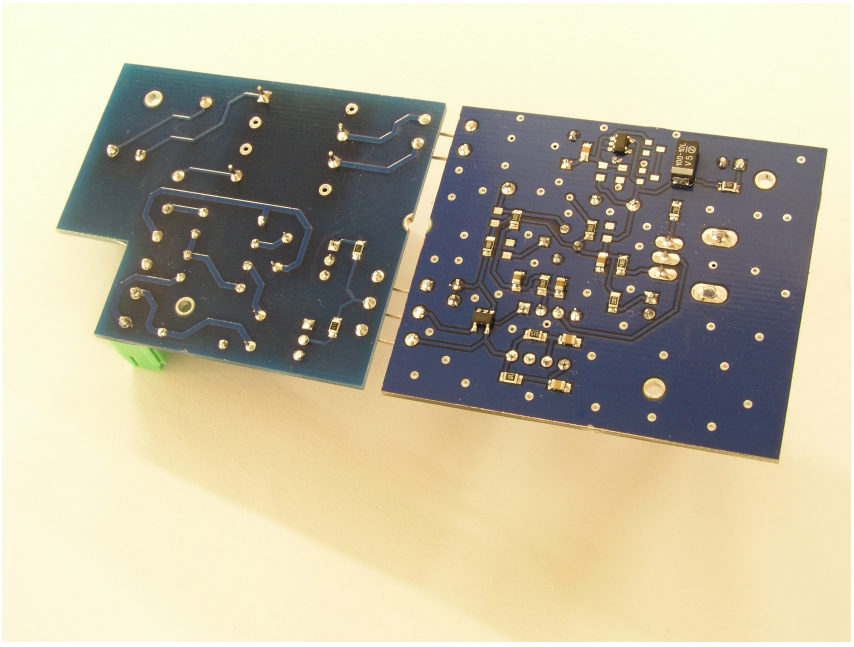
Unassembled: Bottom view



Assembled: Top view



Assembled: Bottom view



Conclusion

The shown schematic is just an example of simple thermostat with adjustable set point with MLX90614. It is designed to be versatile and easy to adapt to different application requirements.

References

1. IR thermometer MLX90614 family datasheet
2. LTC1041 datasheet
3. 74LVC1G86 datasheet
4. Series PVN012 datasheet
5. MOC3081/82/83 datasheet
6. LP2980 datasheet
7. Laminated Transformers Type EE20/4-0.08VA datasheet