

Thermostat for China magnetic levitation System
[150G/300G Push Down DIY Magnetic Levitation Electronic Module](#)
 PAN, Nov 17, 2023

1. Overview

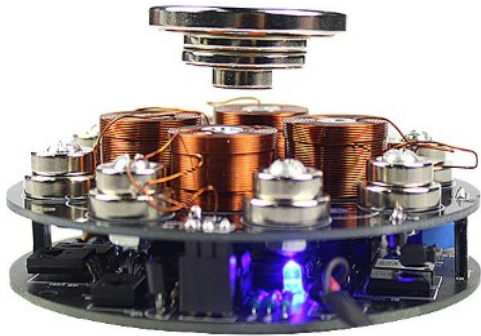


Fig. 1: Levitation System

During levitation the current at 10 V supply is only 0.1 A.
 But during manual setting the levitation magnet the current exceeds 1 A!
 If this process last longer than 2 Minutes, some of the 9 transistors get overheated and destroyed.
 This thermostat monitors the heat of the switch-on PNP transistor and stops the system at temperature over 60 degree Celsius.

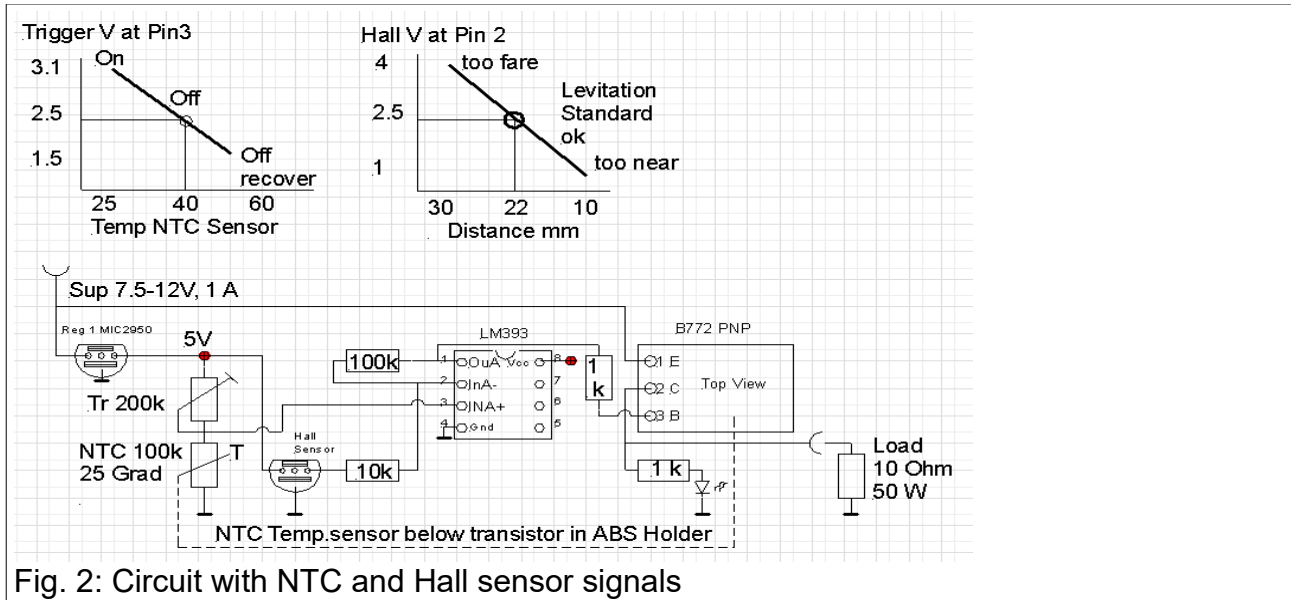


Fig. 2: Circuit with NTC and Hall sensor signals

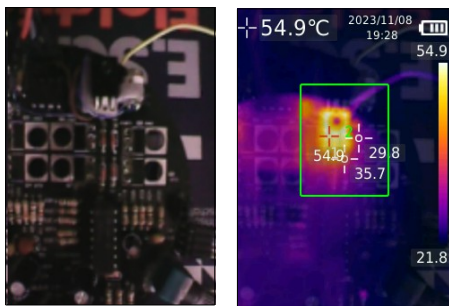


Fig. 3: Temperature shortly after switch-off:
 Transistor on top: 54.9 C
 NTC within holder: 35.7 C
 PCB: 29.8 C

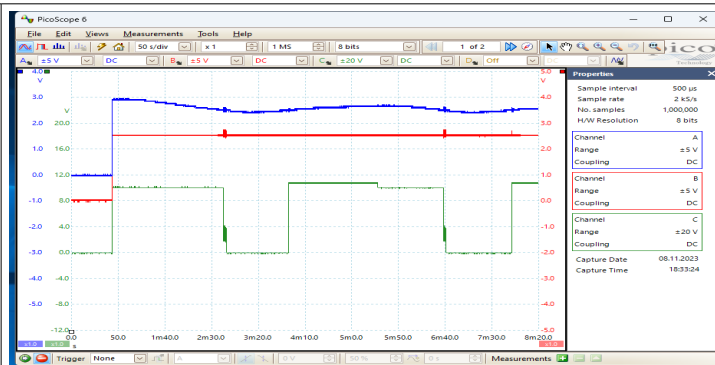


Fig. 4: Stop after 2.5 Minutes, full recover 5 Minutes
 blue: Trigger Level 3V cold, 2.5 V hot
 red: Hall Sensor, 2.5 V at distance 20 mm
 green: Voltage at 10 Ohm load, 10V, 1 A

2. Test Setup

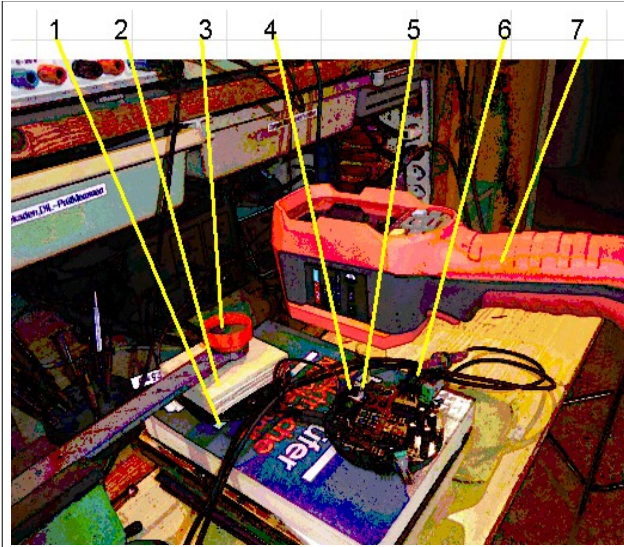


Fig. 5: Levitation System in test

- 1: PCB with Push/Pull magnets (check the magnetic field lines!)
- 2: Spacer, wood 20 mm
- 3: Levitation Magnet, here clamped by lever
- 4: Switch-On PNP transistor
- 5: ABS NTC holder below transistor
- 6: Scope probes
- 7: Thermal Imager camera UTi 690B mounted on tripod

ABS Holder for NTC temperature sensor and Level Trimmer

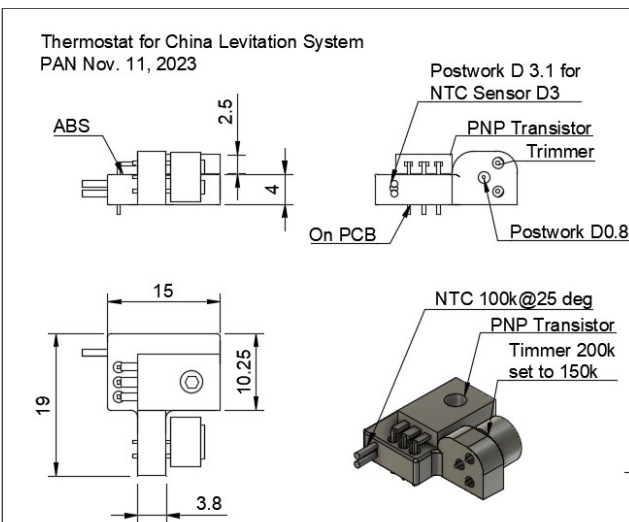


Fig. 6: ABS Holder for NTC Sensor

Comments:

- The Temperature Sensor NTC is clamped between the hot transistor and the PCB
- The heat of the transistor arrives the temperature sensor some seconds later.

This delay can be accepted here

The maximum junction temperature of a bipolar transistor is specified as 150 deg, and the thermostat switches Off before 60 deg!

Circuit improvement for thermostat

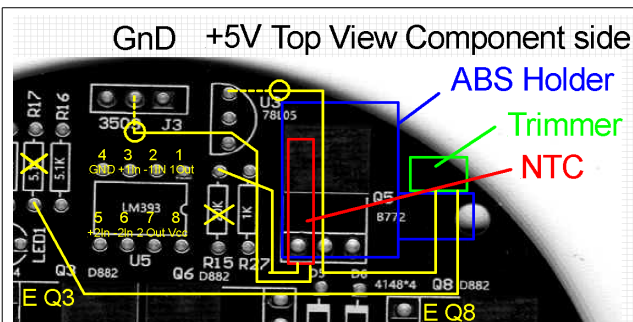


Fig. 6: Circuit Bottom PCB with Thermostat

- Drill 2 D0.8 holes into the bottom PCB
- Connect Trimmer to +5V and at the lower borehole for the removed R17
- Connect NTC to GnD and at the upper borehole for the removed R15

3. Thermostat simulation with LTspice

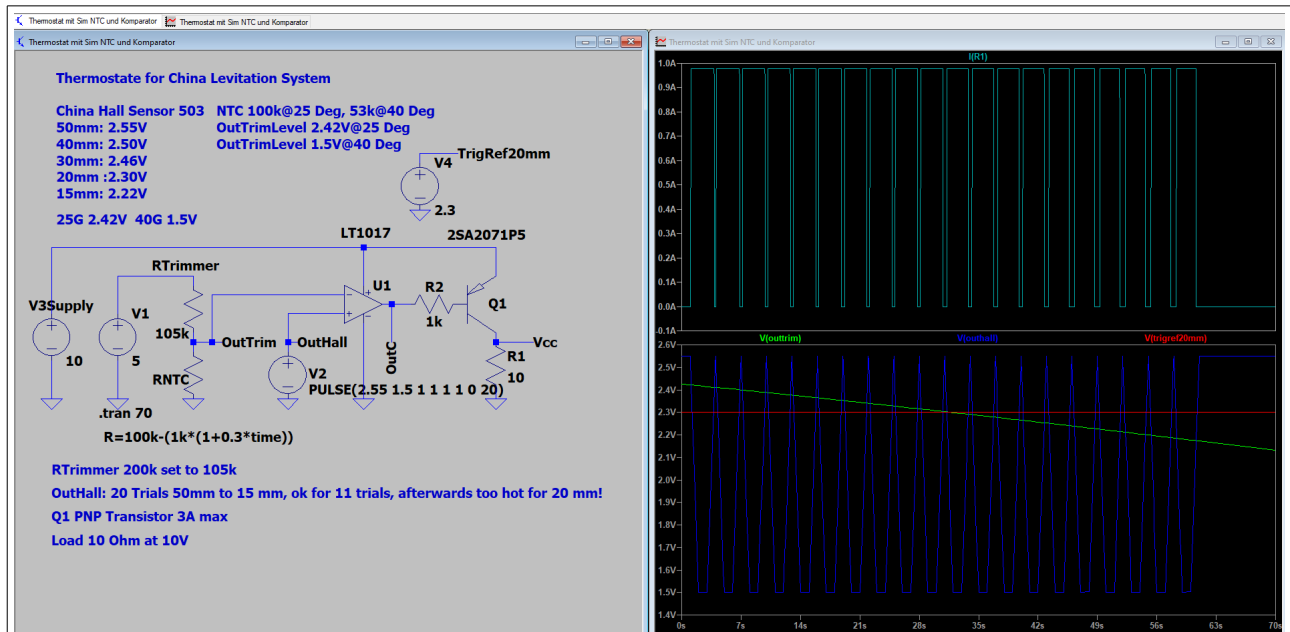


Fig.7. Thermostat circuit with NTC Sensor and Hall Distance Sensor

NTC: 25 up to 40 Deg, creating a decreasing ON-Level

Hall Sensor: 11 successful trials for the nominal operation distance 20 mm

- Nominal operation temperature : 25 Deg up to 40 Deg
- Load switched On if levitation magnet distance < 20 mm, good levitation!
- Heat above 40 Deg: Levitation Magnet pushed away, circuit idle, no restart possible
- The hot PNP transistor with its NTC needs to cool down for 2 Minutes before restart

Some additional notes:

The NTC is NOT in direct thermal contact to the heating PNP Transistor!
 The NTC is mounted in a ABS plate below the “cool” PCB and heating transistor.
 This means that the heat transfer from transistor to NTC is retarded.

With a transistor current of 1 A the NTC reaches 40 Deg after about 2.5 minutes:
 Power OFF!, but the monitored transistor above reaches a temperature > 50 Deg.

The heat of the now switched-off transistor flows furthermore to the NTC, increasing its temperature up to about 50 Deg and reducing the trigger level < 2 V

The cooling time to <40 Deg is about 1 minute, but a full recovering to <25 Deg lasts about 5 minutes, see Fig. 4.

About the circuit:

The NTC is simulated here by a time depending resistor and the Hall sensor by a repeating triangular pulse signals for 50 to 15 mm distance

The comparator is here not the installed LM393, but by the alternative LT 1017 from the comparator list.

This circuit may be applied in future designs with nearby delicate thermal sources!