Maglev Plus System

1. Description

The Maglev Plus System is specifically designed to levitate various objects attached to a very strong disc magnet. It can levitate up to 25 g additional mass. The vertical position of the levitating magnet is measured using a linear Hall effect sensor and the current in the electromagnet is controlled using a microcontroller. The system has three push buttons to configure the system to achieve stable levitation with different additional weights. Two of the push buttons are used to change the controller parameters and the third one is used to save the current controller parameters into the nonvolatile flash memory of the microcontroller.

2. Circuit Schematic

The circuit diagram of the system is as shown in Figure 1.

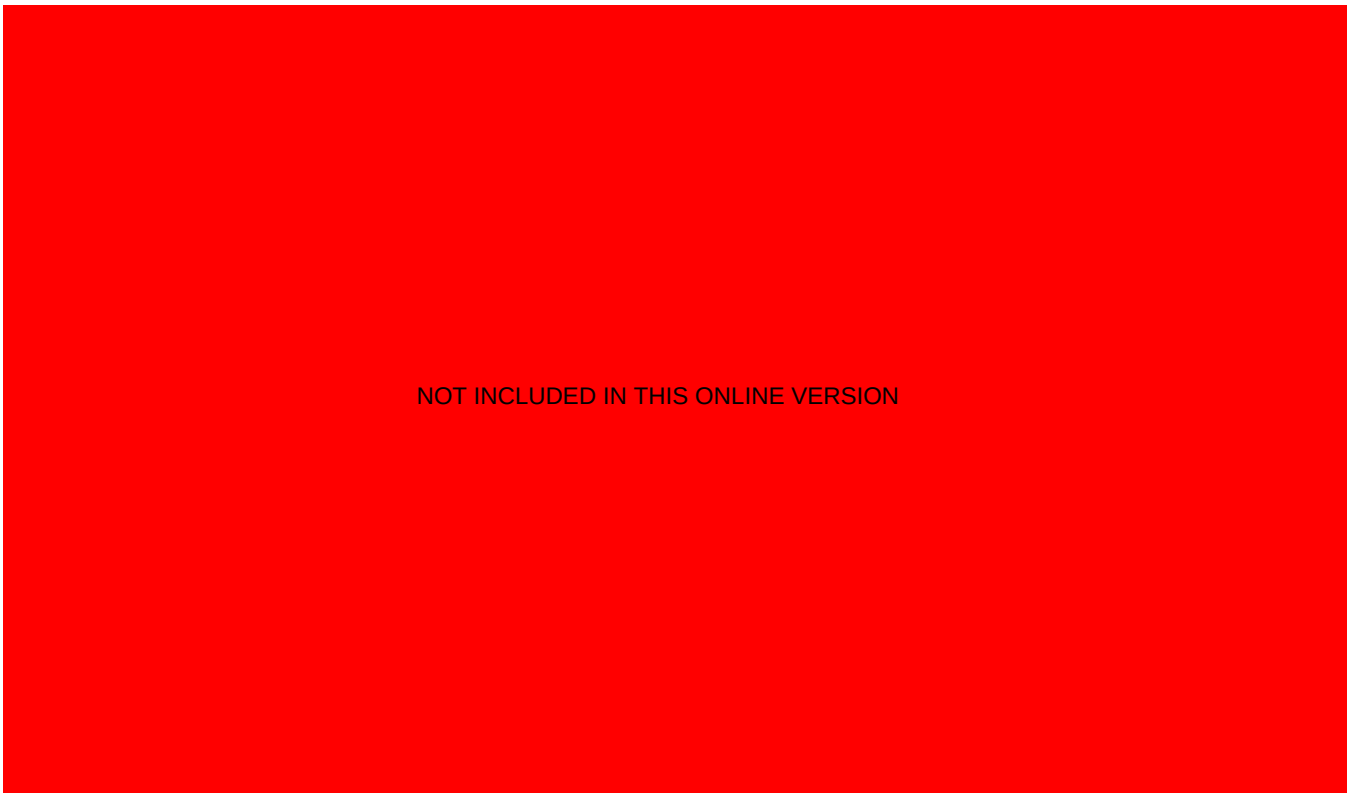


Figure 1. Circuit diagram of the system.

3. Operating Conditions

- Supply voltage range: 7.5 V DC
- Ambient temperature: 10 °C to 60 °C (50 °F to 140 °F)

4. Operating Instructions

Plug the power adapter into a suitable power outlet. The LED should light up when power is applied. Hold the levitating magnet with the desired object attached about 2 cm (3/4") below the

electromagnet while the power is on. If the orientation of the magnet is not correct, it will try to turn around.

The system has three push buttons labeled as A, B and C to adjust the controller parameters to levitate different additional weights. Use the push button B to move the levitating object up and push button C to move the levitating object down until achieving stable levitation. Press the push button A to save the current configuration if desired. The LED will flash 5 times to indicate that the current configuration is saved. If the current configuration is not saved, then it will be lost when the power is cycled. If the current configuration is saved, then the system will levitate the same additional mass until it is re-programmed for different additional mass. The programming can be done up to 100000 times (typical).

5. Kit Assembly

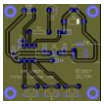
The electromagnetic levitation kit requires both electrical and mechanical assembly. Assembly instructions are detailed below.

5.1. Items Required (not included)

Soldering iron 	Solder wire 	Needle-nose pliers 	Diagonal cutter 
Screw driver 	Super glue 		

5.2 Parts Included

1 x PIC12F1571  U1	1 x LM78L05 5 V regulator  U2	1 x OH49E Hall effect sensor  U3	1 x NTD4963N MOSFET  Q1
1 x 1N5817 Schottky diode  D1	1 x LED  LED	1 x 1 kΩ resistor  R1	1 x 15 mH inductor (coil)  L1
3 x 100 nF capacitor (104)  C1, C2, C5	1 x 1 µF capacitor (105)  C3	1 x 10 µF capacitor (106)  C4	3 x tactile switch  A, B, C
1 x power jack  PWR	1 x 2 pin header  COIL	1 x 3 pin header  SENS	1 x 2-conductor cable  K1

1 x 7.5 V power adapter  V1	1 x 2" x 2" PCB  P1	1 x aluminum base  A1	1 x aluminum piece  A2
4 x nylon spacer  H1, H2, H3, H4	6 x 4-40 screw  S1, S2, S3, S4, S5, S6	1 x flat-top screw  S7	1 x screw with anchor  N1
1 x magnet  M1	4 x self-adhesive rubber  F1, F2, F3, F4	1 x self adhesive rubber  F5	1 x clear plastic piece  P1

5.3 Assembly Instructions

Electrical assembly

- Mount the components U1, U2, Q1, D1, R1, C1, C2, C3, C4, C5, A, B, C, LED, PWR connector, COIL header and SENS header on the PCB as shown in Figure 2. The orientations of U1, U2, Q1, D1 and LED are important and they should be mounted according to their footprints on the top side of the PCB. The orientations of R1, C1, C2, C3, C4 and C5 are not important.
- Solder each component carefully and trim its leads if necessary using the diagonal cutter.
- Solder the 2-conductor cable to the coil (the blue cable to the outer lead and the red cable to the inner lead).

Mechanical assembly

- Stick the rubber feet under the base aluminum block to prevent it from scratching, and mount the PCB on top of the base using 4 x 4-40 machine screws and 4 nylon spacers as shown in Figure 3.
- Fasten the L-shaped aluminum piece to the base block using 2 x 4-40 machine screws as shown in Figure 3.
- Fasten the coil using the screw and anchor as shown in Figure 3.
- Glue the wider side of the Hall effect sensor to the bottom of the coil symmetrically by using the clear plastic piece in between the coil and sensor.
- Stick the self adhesive rubber to the bottom of the coil to protect both the Hall effect sensor and coil.

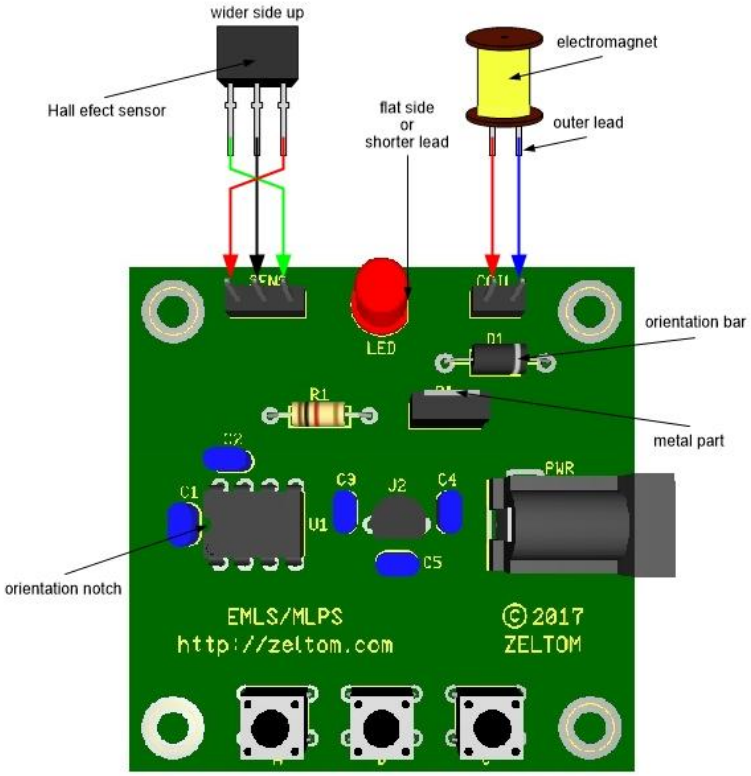


Figure 2. Electrical assembly.

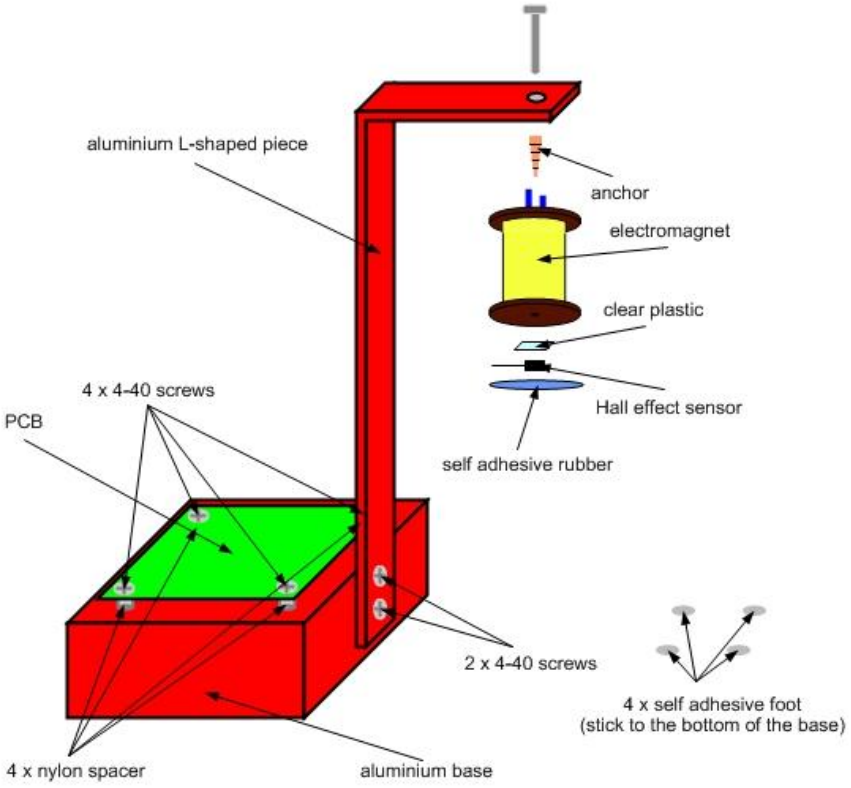


Figure 3. Mechanical assembly.

6. Calibration

The Hall effect sensor of the system can be calibrated in a special calibration mode to eliminate possible slight sensor misalignment that may occur during the mechanical assembly. The programming mode is activated if button A is pressed and held before applying power to the system. In this mode, the LED flashes 4 times and the system saves the calibration data into the nonvolatile flash memory of the microcontroller. The magnet must be kept far away from the system during the calibration mode until the LED turns continuously on (do not power off the system until the LED is on). The system can be calibrated up to 100000 times (typical).

7. Troubleshooting

- Make sure that the electrical and mechanical components are assembled correctly.
- Check the wiring and ensure that the wires are connected correctly.
- If the LED is not lit, check the power adapter connections.
- If the LED is lit but the magnet does not levitate, use the push buttons to adjust the controller.
- If the magnet still does not levitate, check the connections of the coil and the sensor.