10 LED EMF Meter Build (r2)
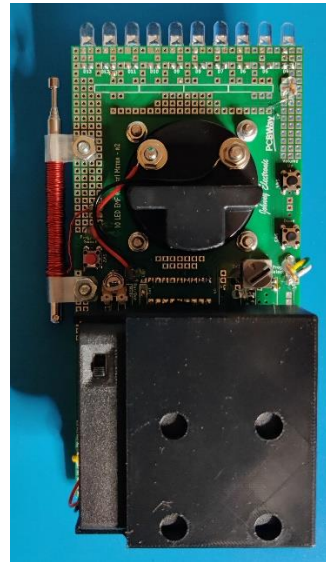
Contents

Description

Assembled EMF Meter – 10 LED

Printed Circuit Board
Front   *Back*
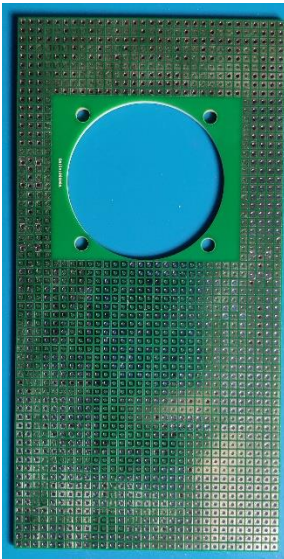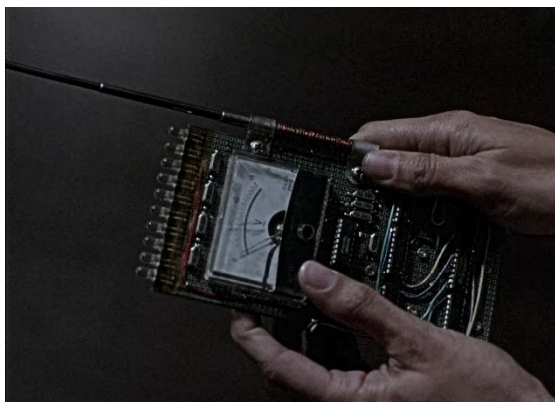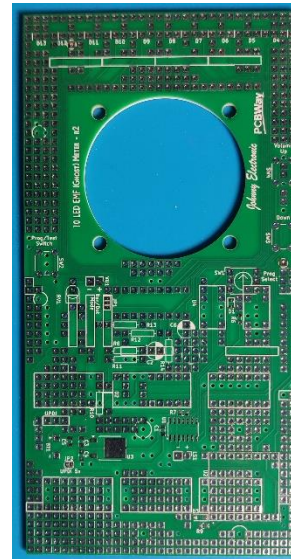
This document describes the assembly of the 10 LED EMF Meter which was made to be a replica of the one used in the Supernatural TV series. This version is based on Olivia's meter from season 4 episode 2.

Olivia's EMF Meter (S4 E2, 2:22 min)

This is a prop only EMF meter that can manually create EMF events by pressing the program/test button or run a selection of pre-programmed sequences (9 unique sequences are available). It does not detect EMF.

Board Details

- Custom PCB Dimensions: 79 mm x 158 mm (Perfboard format on front, SMT/TH layout on back)
- Meter is a DC 0-15 volt
- 10 LEDS in BAR mode
- 9 RF crystals, cosmetic
- LM3914N IC – functional
- 6 random IC's, cosmetic
- Right side mounted antenna, cosmetic
- 2 low voltage signal relays, cosmetic
- Volume Up/Down buttons
- Test/Program button for creating EMF events (9 Pre-programmed events included)
- Rotary selector switch for setting pre-programmed sequence
- ATTiny1604 to control the meter deflections and DFP sound board
- SD card with sound files (Included)
- 4 AA batteries to provide 6v power (Batteries not included)
- Prop or Cosplay use, does not detect real EMF events.

Parts List

See the 10 LED EMF Board BOM (r2) for a detailed list of parts and part suppliers. A link to Github is provided in the References section at the end of this document.

Pre-Assembled Boards

Pre-assembled meters are available on the Tindie store.

Assembly Guide

Caution: Electrostatic discharge (ESD) is a sudden and momentary flow of electric current between two differently-charged objects when brought close together or when the dielectric between them breaks down, often creating a visible spark associated with the static electricity between the objects. [1]

This type of shock can cause damage to ESD sensitive parts such as those used in this build. Proper ESD protection and soldering equipment should be used to prevent damage to parts during assembly and implementation into your project.

Assembly Planning

This assembly uses a mix of surface mount and through hole parts. All surface mount parts are 0805 or larger size. A fine tip soldering iron is useful along with some small 0.015" flux core solder and extra flux if needed. See the references section for a YouTube video link on assembling this board.

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[1] Definition provided by From Wikipedia, the free encyclopedia. For more information on ESD see
https://en.wikipedia.org/wiki/Electrostatic_discharge

PCB Assembly

- PCB assembly can be completed in any order.
- There are 7 holes that will need to be drilled into the PCB before assembly can begin. This was done to allow for other customizations so feel free to adapt as you like. See the top layout guide for suggested hole locations.
- The schematic will help in assembly of the bottom section. There is a design layout guide for the top to place the non-functional parts.
- There are also images of the board partially assembled with the battery pack removed so you can see the component placements.
- Hot glue is used to secure wire connections for added support and cover wire clamps.

Bottom

If you will be following my original layout then begin by drilling the 7 holes in the PCB (2 - 9/64" holes for antenna mounts, 5 - 1/8" holes for 3mm battery hardware and one 3mm screw/nut) . Then I recommend starting with the assembly of the back PCB and mounting all the surface mount parts first. Use the Placement Guide below for component values. Continue the back assemble with the through hole resistors and capacitors. Determine if you want BAR or DOT mode for the LED display and make a solder bridge to select. *JP1 pins 1& 2 will select BAR* and *pins 2 & 3 for DOT mode*. I'll then move on to soldering RV1 and the 4 switches. Note that the rotary switch will need to be placed on the bottom side but soldered from the top. Last install the DFPlayer. The DFPlayer will need to be soldered from the top side **but before soldering apply the modification below (Mod1).**
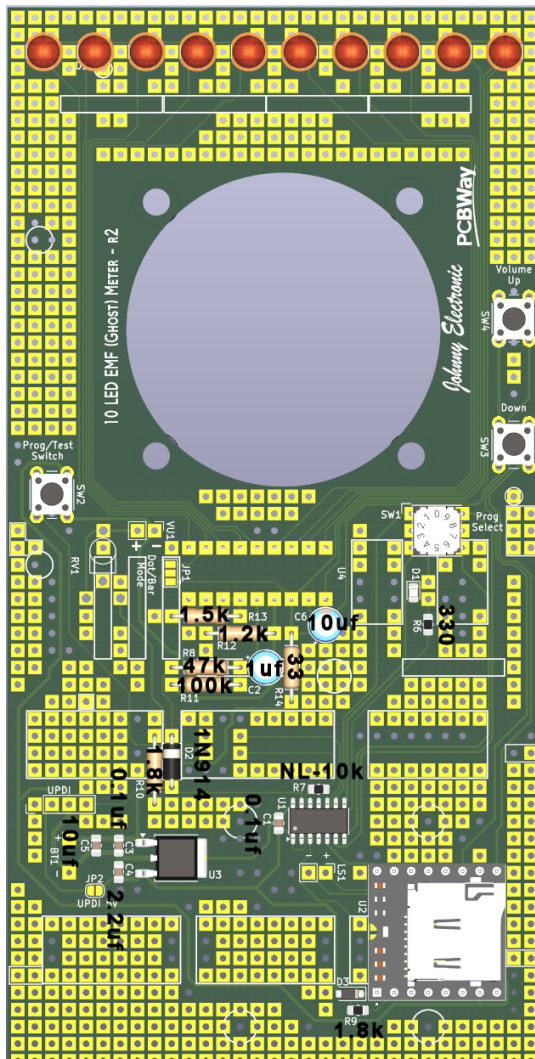
Component Placement Guide

Mod 1

This modification allows the saving of the volume level between power cycles. To do this the ATTiny1604 needs a connection to the DFplayer. Solder a wire from the ATTiny1604 pin 4 to the DFPlayer pin 3. If you have not soldered in the DFPlayer the wire can be inserted in the pad hole for pin 3. You can now solder in the DFPlayer module.

Top

The LM3914N and LEDS are the only functional parts installed on the top of the board. Look at the placement guide for the placement for the LM3914N. There is also a very light silk screen image on the top of the board. Install it on the top and solder from the bottom. The LEDS also mount from the top and solder on the bottom side. The bottom silk screen will show the LED locations and a small line notes the cathode. LED D4-8 have the cathode to the left top view and D9-13 will be on the right. For added LED support I also solder one LED wire to a top pad to secure in place.

The remaining Crystals (9), IC's (6) and Relays (2) are all non-functional cosmetic parts. Follow the layout guide if using my suggestions.

A couple of notes on these components.

- The relay to the left side is over the rotary switch. Cut the two relay pins that hit the switch flush to the relay case. You only need to solder a couple pins at each side to mount them.
- Most of the IC's can be installed with out issue. I soldered all IC's from the top for a more uniform look. There are silk screen markings on the bottom for suggested IC placement. The IC in the bottom left side has a few pins that conflict with the MP3 player and they need to be cut so they just touch the top of the IC pad when installed.
- Crystals also have the silk screen pattern on the bottom side of the board. You can also use the layout guide for placement. The Crystal case should have a slight gap between it and the PCB where other components have been soldered underneath. It is important the any pins from mounted components are cut very short so they do not short with the case of the crystals.

Antenna, Coil Assembly and Mounting

For an example of wrapping the antenna wire see my video [EMF Meter Replica Build - Part 2](#).

A coil of wire is wrapped around a telescopic antenna. I used 26 AWG red enameled wire to wrap around the antenna. Before wrapping the antenna with wire, you will want to attach the p-clips with 6-32 3/8" screws with nuts. You will need to drill holes into the PCB for the antenna to be mounted (Mentioned previously). Then align the P-clips to the hole positions but do not mount it to the board. Once you have the p-clips aligned tighten the nuts so the clips do not move. You can now start wrapping the enameled wire between the two p-clips. You can start/end the wrap from either end.
- Make the first layer wrap tight and uniform around the antenna. On the second pass feel free to add multiple layers and give it a non-uniform look much like a free-handed wire wrap.
    - Mount the antenna/coil using P-Clips. 3D files are also available for printing these.
- You can solder the wire ends to one of the bottom spare pads to make it look functional. A silk screen boarder marks a possible location.

Attach Speaker

- Connect the speaker to LS1 pads of the bottom PCB. I suggest the speaker be hot glued to either the bottom of the PCB (Keeping clearance for the battery holder standoffs) or the back of the battery pack holder but you may see other options.

Mounting Battery Pack

- Use the AA battery pack holder as a drilling template to drill 4 holes (1/8") into the PCB for mounting. Look at the reference layout for proper positioning.
- If mounting the speaker to the battery holder use hot glue to mount keeping some clearance for the standoffs.. Make sure you have enough wire to allow the battery pack to attach to the PCB.
- Use either 4-40 or M3 screws to mount the battery pack holder with a minimum of 8-10mm standoffs. I've provided a 3D file of a 4-AA battery pack holder so it can be mounted to this board.

Mounting Meter

- The DC meter is mounted in the cutouts/holes provided in the PCB.
- The meter does need to be modified by removing the internal resistor and soldering the wire directly to the terminal. There is a video available for the first 10 LED meter guide.
- Connect the meter wires noting the proper polarity. For revision r2 the silk screen polarity is reversed.

Adding Cosmetic Wires

- The available images for this meter are limited. I've made some guesses as to wiring for the meter front. All wires are non-functional so placement is at the builder's discretion. See "Assembly Images" for suggested wire routes.

Sound Files (MP3)

The sound files are stored in a folder named /mp3 on the SD card. Six files are available but only five are used in the program for the EMF meter. This table lists the files, functionality, and associated code define. The sound files are available in Github (The same files are used for the EMF Meter Build and they are available from that folder under /mp3). The link is in the references section at the end of this document.

File Name	Define Name	Function
0001_emf start.mp3	EMF_TONE_START	Initial startup when a signal is detected or test button pressed
0002_emf low short.mp3	EMF_TONE_LOW	Used for mid-point signals that are neither high or low
0003_emf steady short.mp3	EMF_TONE_STEADY	Not used
0004_emf steady long.mp3	EMF_TONE_STEADYL	High tone when signal reaches maximum
0005_emf steady end.mp3	EMF_TONE_END	Signal going back down to off
0006_emf power up.mp3	EMF_POWER_UP	Used for initial setup/power on (5 LED Meter)
0007_emf power up2.mp3	EMF_CHARGE_UP	Used for initial setup/power on (10 LED meter)

ATTiny1604 Programming

The ATTiny device uses UPDI for programming. You will need to connect a proper programmer to load the Arduino code. I have available from my Tindie store a soft touch programming cable for UPDI so a header is not needed. It works with a CH340 serial USB and the Arduino IDE.
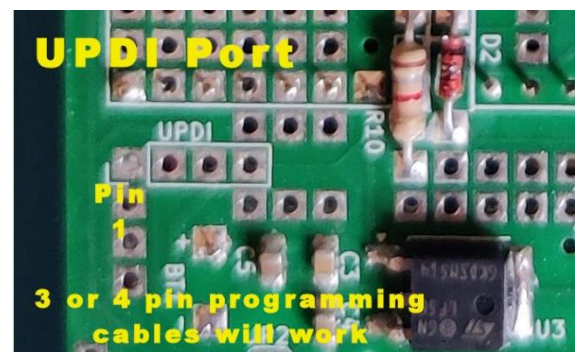
EMF Meter Adjustments and Power Up

1. Before powering up the meter check for any shorts by doing an ohm measurement across the +/- battery connector.
2. Adjust the meter potentiometer to the midpoint.
3. Insert SD card with audio files in to the DFPlayer.
4. Removing the AA battery pack from the holder is easiest by pulling the battery pack straight out from the holder. For installation you should be able to slide the pack back into the holder aligning it between the two fingers.
5. Install the AA batteries and flip the power pack switch on.
6. With in a second you should see the meter briefly deflect and a sound from the DFPlayer.
7. Press and hold the Test/Program Button and you should see the LEDS and VU Meter deflect and some sound effects.
8. Set the rotary selector switch to the #1 position and quick press the test switch. Adjust the meter potentiometer (RV1) for a full scale deflection of the DC meter. Repeat as needed.
9. Using a long button press you can manually make EMF events.
10. A quick button press will run the pre-programmed EMF event sequences. An LED will light when a programmed sequence is running. With the rotary switch at 0 each press will play the next pre-programmed sequence. With the rotary switch set to 1-9 each press will play that selected sequence.
11. While pressing the Test/Program button check that the Volume Up/Down buttons are functional.
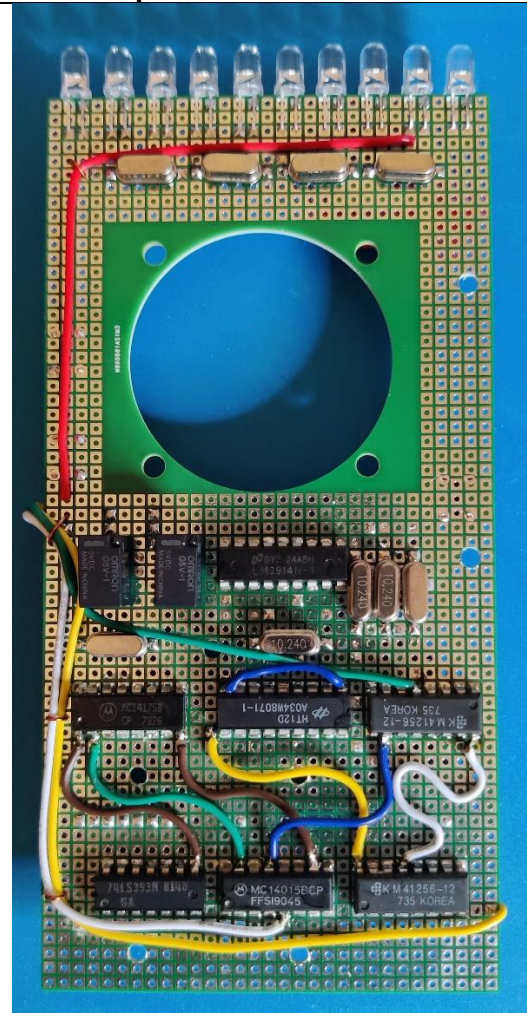
Assembly Images

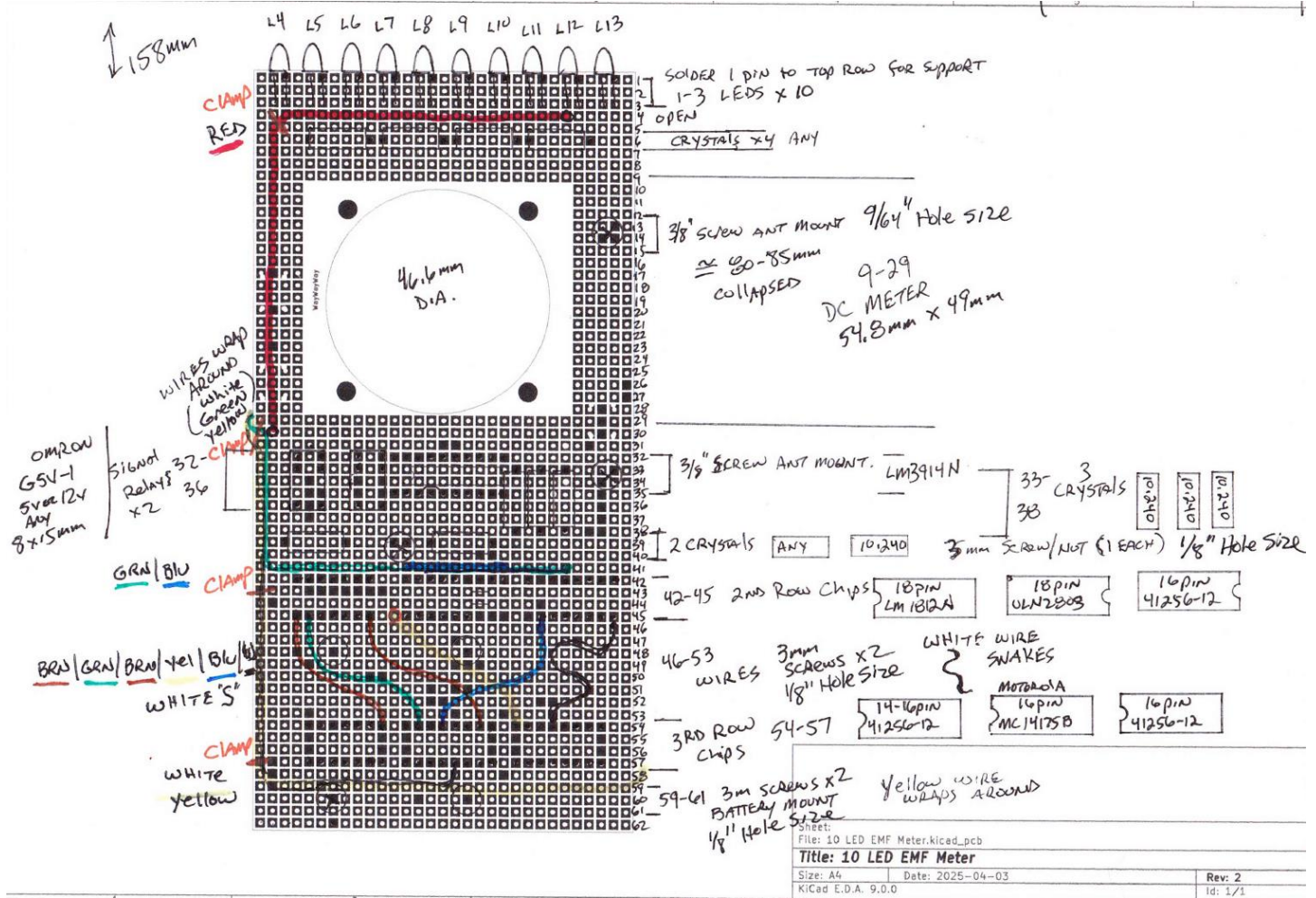## Partial Assembly
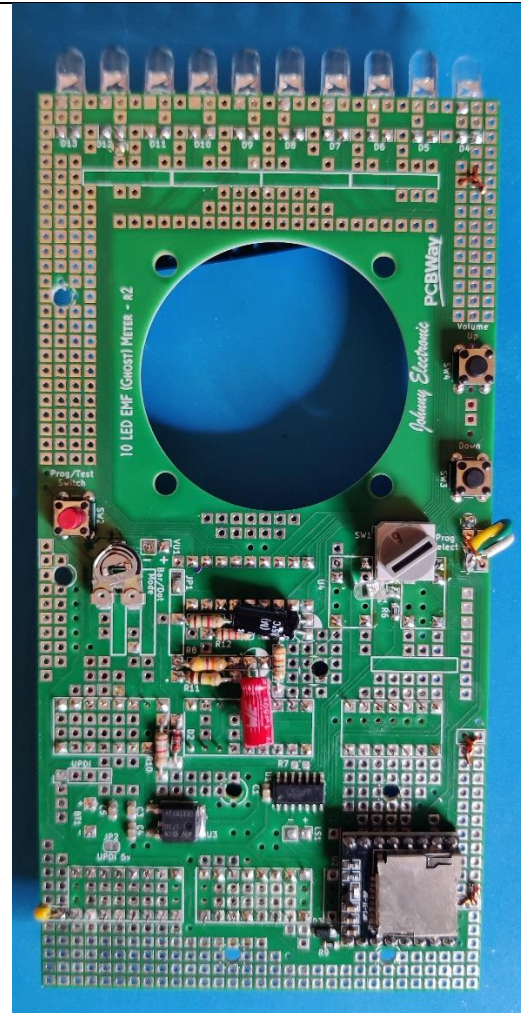
Meter Bottom	Meter Top

Perfboard Layout

Full version is available from GitHub
10_LED_EMF_Meter_Replica/r2/doc/Top_Layout_Guide.pdf

L4 L5 L6 L7 L8 L9 L10 L11 L12 L13

↕ 158mm

CLAMP
RED

46.6mm DIA.

SOLDER 1 PIN to TOP ROW for SUPPORT
1-3 LEDS x 10
OPEN
CRYSTALS x4 ANY

3/8" SCREW ANT MOUNT 9/64" Hole Size
≃ 60-85mm COLLAPSED
9-29
DC METER
54.8mm x 49mm

OMRON
G5V-1
5V or 12V
ANY
8x15mm

Signal Relays x2

WIRES WRAP AROUND (White, Green, Yellow)

CLAMP

3/8" SCREW ANT MOUNT.   LM3914N

33 38   3 CRYSTALS   10,240 10,240 10,240

2 CRYSTALS   ANY   10,240   3mm SCREW/NUT (1 EACH) 1/8" Hole Size

GRN/BLU
CLAMP

42-45 2ND ROW CHIPS   18 PIN LM1812A   18 PIN ULN2803   16 PIN 41256-12

BRN/GRN/BRN/YEL/BLU/
WHITE'S'

46-53 WIRES   3mm SCREWS x2 1/8" Hole Size   WHITE WIRE SNAKES

3RD ROW CHIPS 54-57   14-16 PIN 41256-12   MOTOROLA 16 PIN MC14175B   16 PIN 41256-12

CLAMP
WHITE
YELLOW

59-61 3m SCREWS x2 BATTERY MOUNT 1/8" Hole Size

Yellow WIRE WRAPS AROUND

Sheet:
File: 10 LED EMF Meter.kicad_pcb
Title: 10 LED EMF Meter
Size: A4   Date: 2025-04-03   Rev: 2
KiCad E.D.A. 9.0.0   Id: 1/1

References

- **Github: Development board documentation, schematics, and related files.**
  - **https://github.com/JohnnyElectronic/EMF_Meters/**
  - **EMF_Meters/10_LED_EMF_Meter_Replica/r2/**
- **YouTube: Board assembly and project videos that are related to this project.**
  - **https://www.youtube.com/@Johnny_Electronic**
- **Tindie Store**
  - **https://www.tindie.com/stores/johnnyelectronic/**

Revisions

R1.1	First board release, First document release
R1.2	Includes both build and user guides
R2	First r2 board release, first document release Added BCD switch for pre-programmed sequence selection. Now uses ATTiny1604 w/ UPDI.
R2.1	Add additional details to DC meter section, removal of internal resistor.
R2.2	Added a component placement guide

Disclaimer

This information is provided "as-is" with no representation or warranty of any kind whether express or implied. However, I've tried to make this document (as well as the supporting videos) as useful and accurate as possible. If you find something that is incorrect or confusing, please let me know as I would like to make the correction so others will not have the same issue.

This meter is for entertainment purposes only and there is no representation as to the accuracy of the meter readings.
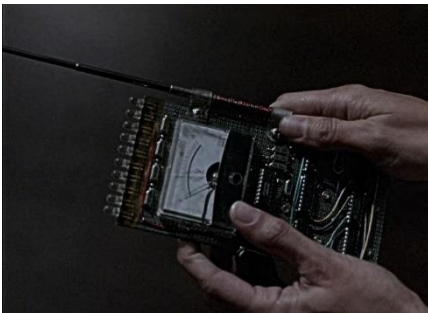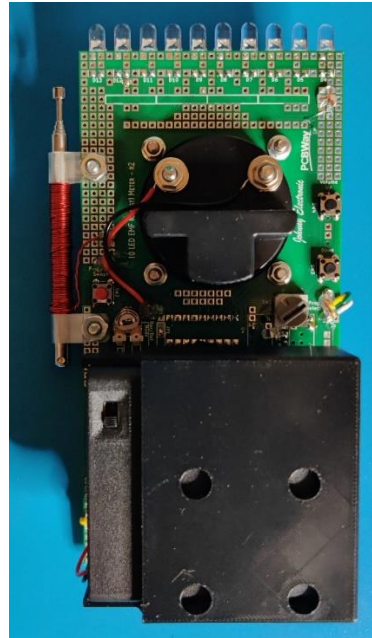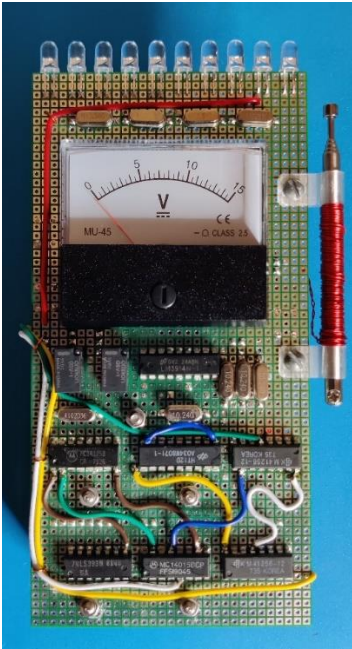
Feel free to email me any time for issues you may have with this build.
johnnyelectronic1@gmail.com

Legal note

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10 LED EMF Meter User Guide (r2)

This meter is based on Olivia's meter from season 4 episode 2 of the Supernatural TV series. This is a prop only EMF meter that can manually create EMF events by pressing the program switch or it can run a selection of pre-programmed sequences. It does not detect real EMF.

**Olivia's EMF Meter (S4 E2, 2:22 min)**

Meter Details

- PCB Dimensions: 79 mm x 158 mm
- Meter is a DC 0-15 volt
- 10 LEDS in BAR mode
- 9 RF crystals, cosmetic
- LM3914N IC – functional
- 6 random IC's, cosmetic
- Right side mounted antenna, cosmetic
- 2 low voltage signal relays, cosmetic
- Volume Up/Down switches
- Test/Program switch for creating EMF events (9 Pre-programmed events included)
- Rotary selector switch for setting pre-programmed sequence
- ATTiny1604 to control the meter deflections and DFP sound board
- SD card with MP3 sound files
- 4 AA batteries needed to provide 6v power
- Prop or Cosplay use, does not detect real EMF signals.

Meter Operation

If you purchased an assembled unit then all adjustments have already been made and a programmed SD card has been included. Otherwise review the EMF Meter Adjustments and Power Up section in the build guide.

- Install the batteries in the battery pack if you have not already done so.
  - To remove the battery pack just pull it straight out from the holder.
  - To insert slide the pack in so the power switch is facing out and the clasps are at the edges of the pack. Slide in until it locks into place.
- Check that the SD card is inserted properly. It should clink into the slot.
- If the battery pack power switch is not on, move it to the ON position.
- You should see the meter deflect briefly and the EMF start up sound is played.
- Use the Test/Program switch to create an EMF event.
  - Holding the switch will begin to deflect the meter. The effect can vary by using a shorter or longer press of the switch. When held for a longer duration the meter level will fluctuate between higher values for a more realistic effect.
  - A quick switch press will trigger one of the pre-programmed EMF event sequences. A blue LED will light when a programmed sequence is running.
  - With the selector switch at 0, each quick press will play the next sequence in order.
  - With the selector at 1-9 that sequence will play for each switch press.
- There is a VOLUME UP and DOWN to control the meter sound.
  - The sound level will be retained between power cycles if after adjustment a long press of the Program/Test switch is completed. If the level stored was too low it will be reset on the next power cycle.
- Review the remaining sections for adjustments of the meter.
- This meter was designed as a novelty item

Meter Settings
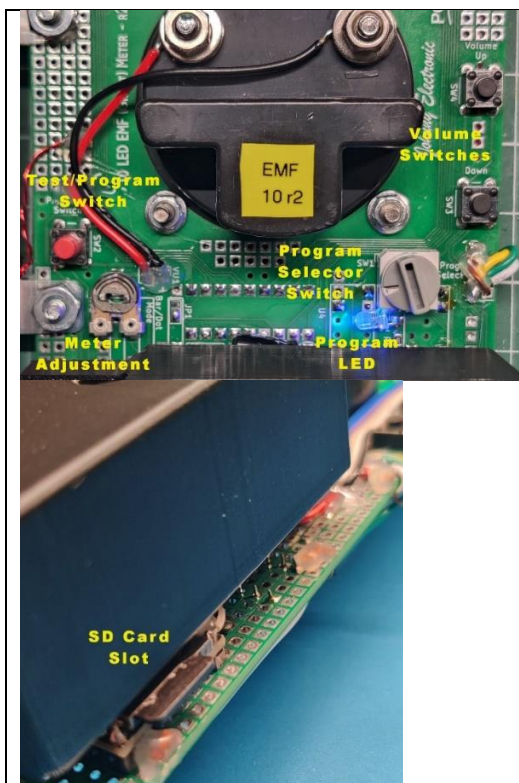
Left Back Side of Meter
Test/Program Switch (Red)
- Long press will create EMF sounds and meter deflections
- Quick press triggers pre-programmed EMF sequences.

Meter Adjustment – Adjusts the maximum meter deflection. CW increases deflection.

Right Back Side of Meter
Volume Control Switches (Black)
Up/Down – Used to control the volume level of the meter sound

Program Selector – Selects 1-9 pre-programmed sequences. 0 runs the next sequence after last one run.

Program LED (Blue) – This LED indicates that one of the pre-programmed sequences is running.

SD Card – Contains sound files for meter operation. If you do not hear any sound check that the SD card is inserted properly. Press in to release and insert. You should hear a click when inserting.

Pre-programmed Sequences (1-9 pre-programmed sequences available)

1. High,End - Start, High 1.4 second, End (Also used for meter adjustments)
2. Highs,Lows,End - Start, High 1 second, Low, End, 2 cycles
3. High,Low,High,End - Start, High 1.5 second, End, Start, low, High 0.5 second, Higher 2 seconds, End
4. Single Mid/Low/End - Start, Mid, End
5. Dual chirps - Start, Low1, Low2, End, Pause 0.5 seconds, Start, Low1, Low2, End
6. Start/Long Mid/Low/End - Start, Low, High 2 second, Low1, Low2, End
7. Olivias S4 E2 sequence – 16.5 second sequence inspired by episode
8. Deans S1 E11 sequence – 15.4 second sequence inspired by episode
9. S4 E13 sequence - Low tone / High tone, lots of meter movement

SD Card (Sound Files, MP3)

The sound files are stored in a folder named /mp3 on the SD card. Six files are available but only five are used in the program for the EMF meter. This table lists the files, functionality, and associated code define. The sound files are available in Github. The link is in the references section at the end of this document.

File Name	Define Name	Function
0001_emf start.mp3	EMF_TONE_START	Initial startup when a signal is detected or test button pressed, 0.238s
0002_emf low short.mp3	EMF_TONE_LOW	Used for mid-point signals that are neither high or low, 0.238s
0003_emf steady short.mp3	EMF_TONE_STEADY	Short High tone - Not used
0004_emf steady long.mp3	EMF_TONE_STEADYL	Long high tone when signal reaches maximum, 1.435s
0005_emf steady end.mp3	EMF_TONE_END	Signal going back down to off, 0.282s
0006_emf power up.mp3	EMF_POWER_UP	Used for initial setup/power on (5 LED meter)
0007_emf power up2.mp3	EMF_CHARGE_UP	Used for initial setup/power on (10 LED meter)

Troubleshooting Issues

No sound – Check that the SD card is installed and inserted properly
Sound stops or is erratic – Check the batteries. If they get too low the MP3 player will quit responding.

References

- **Github: Development board documentation, schematics, and related files.**
    - **https://github.com/JohnnyElectronic/EMF_Meters/**
- **YouTube: Board assembly and project videos that are related to this project.**
    - **https://www.youtube.com/@Johnny_Electronic**

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Feel free to email me any time for issues you may have with this build.
johnnyelectronic1@gmail.com