

Building the Water Alarm

The water alarm consists of 2 modules; the sensor (or sensors), and monitor. Of course, you can build one or many sensor modules. The monitor consists of three channels or zones, but multiple sensors can be placed on each zone. In a RV environment, even a large RV, no more than 9 sensors should ever be required.

In this project, we will build 3 sensors.

We will begin with the modules. The modules are adapted from a design by Nathan Seidle, founder of Sparkfun Electronics. It is public domain, so we are free to use it.

The original design was called H2OhNo! and was a stand-alone sensor. It is no longer available from Sparkfun. However, you can buy the circuit board from OSHPark. If you only need a single sensor, you may wish to build it into a stand-alone configuration.

I have modified the H2OhNo! design by removing the buzzer and battery components, and replaced them with a relay and a supervisory circuit. I also redesigned the sensor paddle, and made the board fit into a potting box.

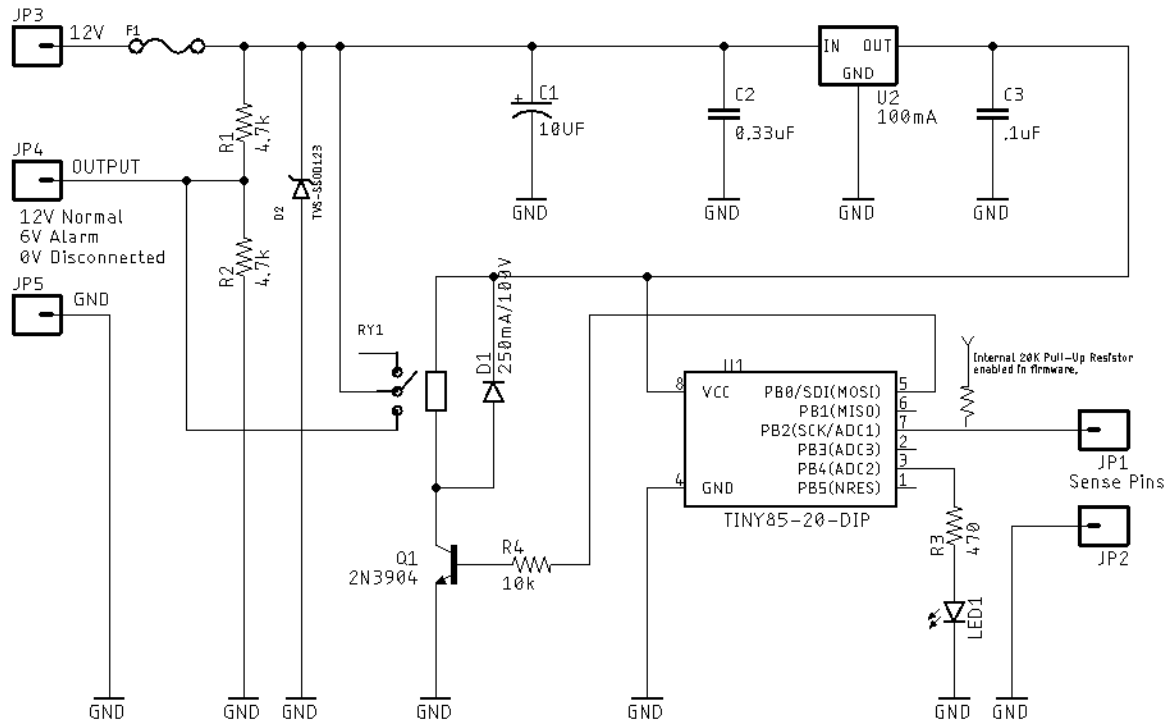
I also modified the logic to work in a multi-sensor environment. In fact, the only thing left from the original design is the excellent low-power capability of the sensor (but I also changed the 1sec wakeup to 9sec).

This project is a SMD (surface mount technology) project, which can be intimidating for some. However, with the proper soldering equipment (I recommend a [Hakko FX888D](#)), and a bit of practice, it isn't extremely difficult.

And there are [SMD Practice Kits](#) that you might want to begin with.

To make the task easier, I am using 1206 size SMD components whenever possible. These are the largest ones you can commonly find. Also, I have enlarged the solder pads on the board for these components to make it easier to solder.

Power comes from monitor. This ensures all sensors are turned off (no parasitic load) when on battery power.



Consult www.RV-Project.Com for further information.

Build the sensor module using normal construction procedures. Note that while SMD components are used (in order to get everything to fit), 1206 size components are used which are larger and therefore easier to solder.

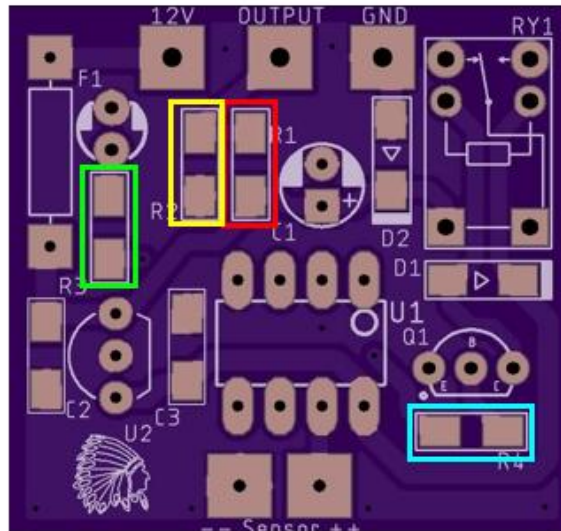
Bill of Materials

Item	Description	Part Number	Source
R1	4.7K SMD Resistor 1206	RMCF1206JT4K70	DigiKey.Com
R2	4.7k SMD Resistor 1206	RMCF1206JT4k70	DigiKey.Com
R3	470 SMD Resistor 1206	RMCF1206JT470R	DigiKey.Com
R4	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com

C1	10uF Electrolytic Capacitor	PIT-1996	Tayda.Com
C2	0.33uF SMD Capacitor 1206	1276-2860-1	DigiKey.Com
C3	0.1uF SMD Capacitor 1206	1276-3084-1	DigiKey.Com
D1	Signal Diode (4148) 1206	1N4148X-TP	DigiKey.Com
D2	TVS Diode 16V	SMF16A	DigiKey.Com
LED1	3mm RED LED	A705	Tayda.Com
U1	ATMEL ATTiny85 Microcontroller	ATTiny85-20PU	Tayda.Com
U2	78L05 Voltage Regulator	78L05ACZ	Tayda.Com
Q1	2N3904	A-111	Tayda.Com
RY1	SPDT Relay 5V	G5V-1-2	DigiKey.Com
F1	1A Fuse	0251001.NRT1L	DigiKey.Com
Box	PolyCase potting box	BF-150275	PolyCase.Com
Potting	Black potting compound	832HD-25ML	Amazon.Com
PCB	Sensor Board	LD-1	OSHPark.Com
PCB	Paddle Board	PaddleBoard	OSHPark.Com

Notice that there is no socket for the ATTiny85. For water-proofness and reliability, we will be potting over the microcontroller, so it must be soldered to the board for maximum continuity. As well, the sketch for the ATTiny85 has been well tested (it is modified from a public-domain commercial project), so no changes should be required.

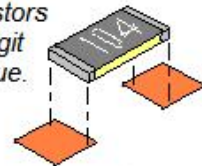
Board Top



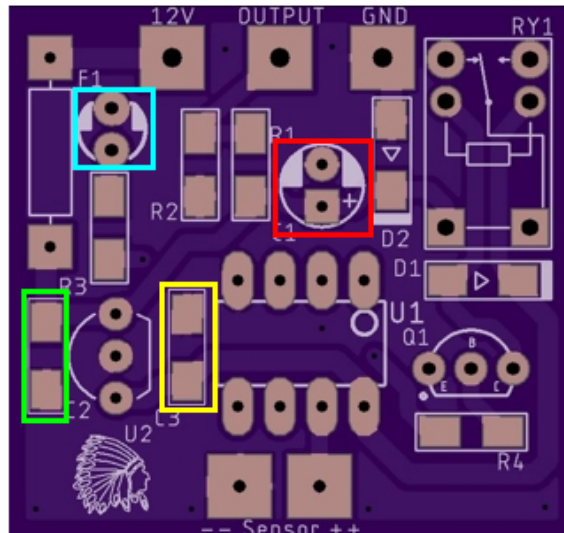
Install the following Surface Mount Components on the top side of the board.

- ☐ Solder a 4.7K (472) resistor at R1 as shown in Red.
- ☐ Solder a 4.7K (472) resistor at R2 as shown in Yellow.
- ☐ Solder a 470 (471) resistor at R3 as shown in Green.
- ☐ Solder a 10K (103) resistor at R4 as shown in Blue.

Surface mount resistors typically have a 3 digit number for their value.



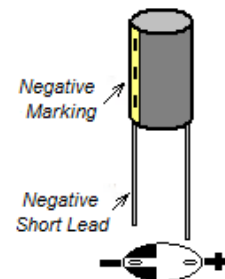
Board Top



Insert Capacitors as shown

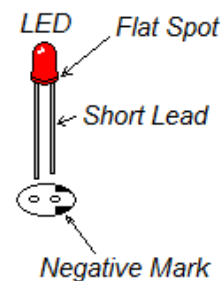
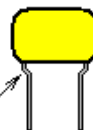
- C1 10 μ F Electrolytic Capacitor shown in Red

Note: Electrolytic Capacitors are polarity sensitive. Make sure the Negative Band on the side of the capacitor matches the Negative (-) symbol on the board.

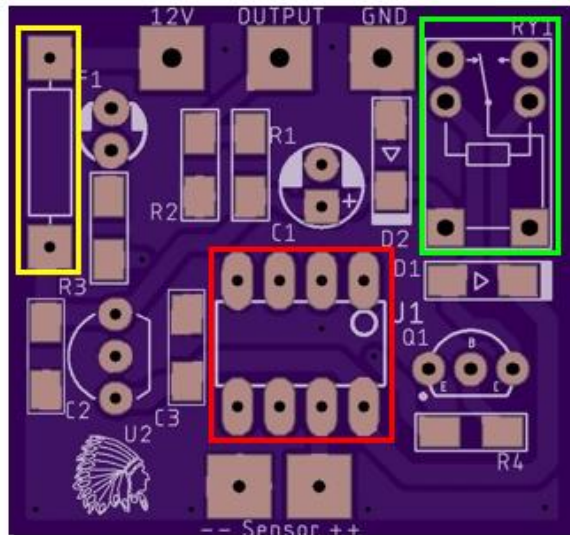


- C2 0.33 μ F Monolythic Ceramic Capacitor (334) shown in Green
- C3 0.1 μ F Monolythic Ceramic Capacitor (104) shown in Yellow
- Red LED as shown in Blue

Sometimes Monolythic Capacitor leads are too wide to be inserted. In this case, slightly bend the leads in.



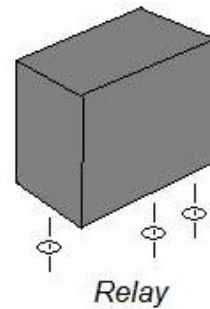
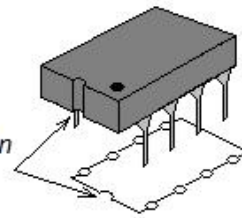
Board Top



May have dot rather than dimple

- ☐ **Bootload an ATTiny85 microcontroller for 8Mhz operation.**
- ☐ **Program the Sensor Board Sketch into the ATTiny85 microcontroller.**
- ☐ **Solder the ATTiny85 microcontroller directly to the board as shown in Red (do not use a socket).**
- ☐ **Solder a Relay to the board as shown in Green.**
- ☐ **Solder a fuse to the board as shown in Yellow.**

Orient Dimples on IC and Board



Wiring the Sensor Board.

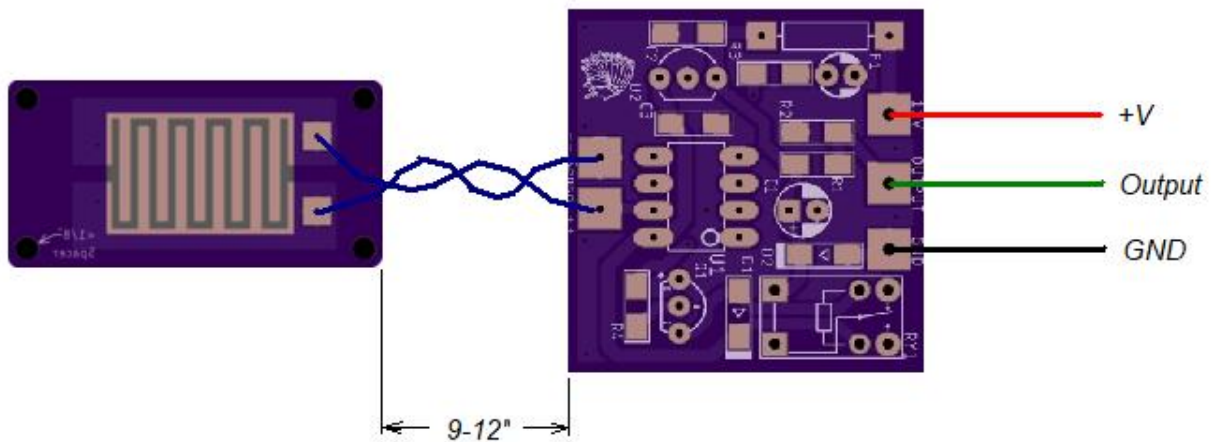
When Wiring the Sensor board, the suggested color code is:

Red = 12V

Green = OUTPUT

Black = GND

This color code corresponds to many 3 wire cable color codes, but feel free to choose any color you see fit. Next, attach two 12" long wires and connect the sensor board to the sensor paddle. It works best if these wires are twisted.



Operational check. Apply 12V to the RED and GROUND to the black wire. The LED should flash a couple of times, then once about every 9 seconds. Upon each 9 second flash, the sensor reads the paddle board for moisture. When the board is not flashing, it is in low-power sleep mode.

Moisten your thumb and place it on the paddle board. When the next 9 second flash occurs, it should detect the moisture then begin to flash the LED rapidly. This will continue until the moisture evaporates.

When the LED begins to flash rapidly, you should hear the Relay contacts close, then open again when the LED stops flashing. You can confirm proper operation by placing a voltmeter on the OUTPUT and GROUND leads. When the sensor board is in standby mode, you should see half of the voltage placed on the RED lead (i.e 6V if you are powering the board with 12V).

When the sensor board goes into alarm mode, the voltage on the OUTPUT lead should increase to the same voltage on the RED lead.

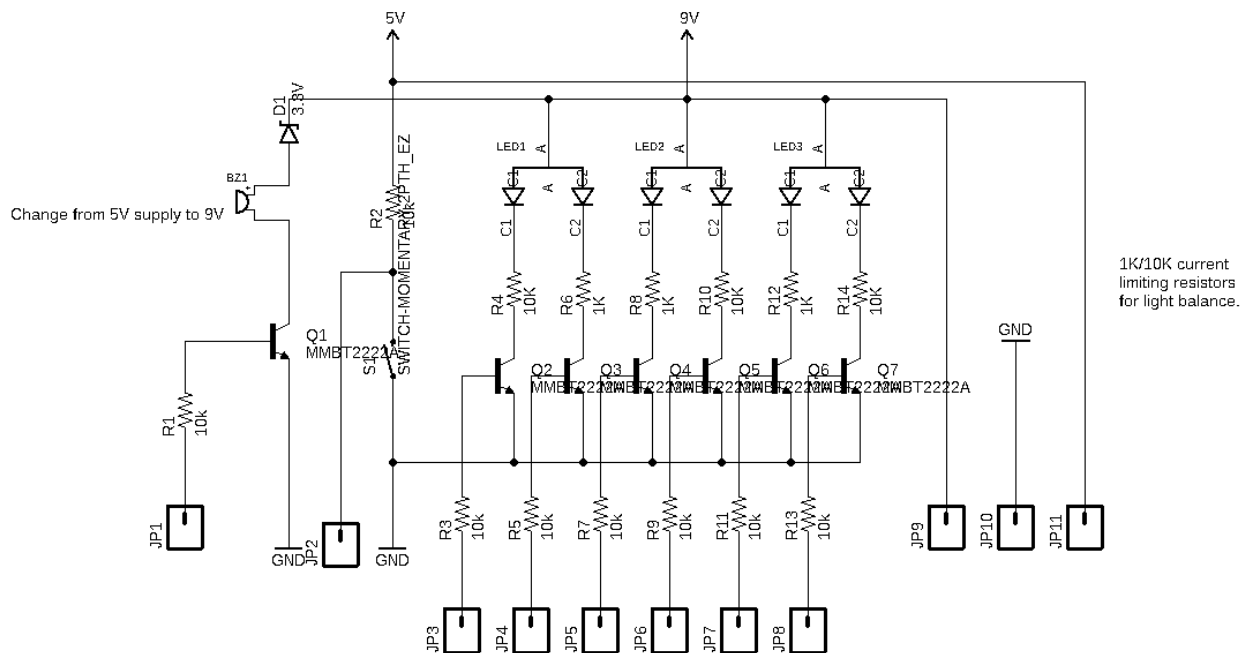
Constructing the Water Leak Monitor

Unlike the sensor boards, the Monitor board is a RV-Project.Com design. It's purpose in life is to read the outputs of the sensors and report any alarms. The monitor has 3 channels; if you are familiar with alarm systems, think of these as ZONES. Like any alarm Zone, you can place more than one sensor on the Zone (however they must be placed in parallel).

That way, each Channel or Zone can monitor one or more sensors. Since the sensors are powered by the Monitor board, there is a limit to the number of sensors it can handle. While each sensor requires around 1mA in normal operation, it can consume as much as 50mA in alarm mode.

The monitor can supply around 750mA of current to the sensors, so in theory, up to 15 sensors can be used, but I should think for most RVs, 3 to 6 sensors would be adequate.

Construction of the monitor consists of two circuit boards and a front panel. The first board to be shown is the display board.



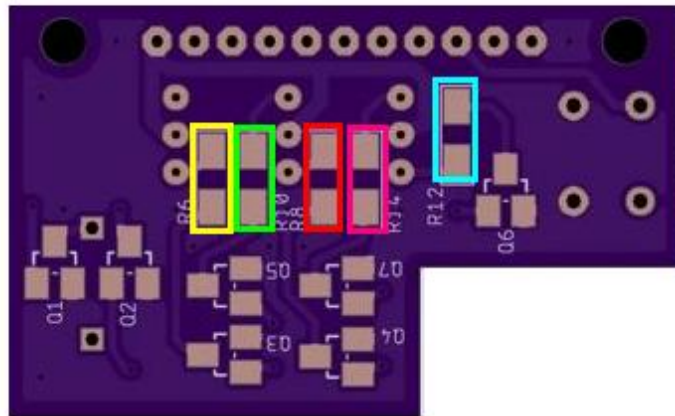
Bill of Materials

Item	Description	Part Number	Source
R1	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R2	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R3	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R4	1k SMD Resistor 1206	RMCF1206JT1K00	DigiKey.Com
R5	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R6	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R7	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R8	1k SMD Resistor 1206	RMCF1206JT1K00	DigiKey.Com
R9	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R10	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R11	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R12	1k SMD Resistor 1206	RMCF1206JT1K00	DigiKey.Com
R13	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R14	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
Buzzer	Active Buzzer See Note 1	TMB12A05	Amazon
SW1	Tactile Switch	A-5147	TaydaElectronics.Com
Q1	SMD Transistor	MMBT2222A-7-F	Digikey.Com
Q2	SMD Transistor	MMBT2222A-7-F	Digikey.Com
Q3	SMD Transistor	MMBT2222A-7-F	Digikey.Com
Q4	SMD Transistor	MMBT2222A-7-F	Digikey.Com
Q5	SMD Transistor	MMBT2222A-7-F	Digikey.Com
Q6	SMD Transistor	MMBT2222A-7-F	Digikey.Com
Q7	SMD Transistor	MMBT2222A-7-F	Digikey.Com
LED1	3MM Red-Green LED Note 2	Generic	Amazon.Com
LED2	3MM Red-Green LED Note 2	Generic	Amazon.Com
LED3	3MM Red-Green LED Note 2	Generic	Amazon.Com
PCB	Display Board	Water Alarm Display	OSHPark.Com

Note1: The buzzer must be an active buzzer. Passive buzzers also exist. An active buzzer works when a DC voltage is applied to the terminals. A Passive buzzer works like a speaker, and requires an audio signal. Unfortunately, suppliers of these generic items don't know the difference and you might order an active buzzer, but receive a passive buzzer.

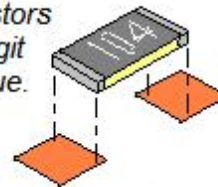
Note 2: The LEDs do not display the RED color at the same intensity as the GREEN color. For this reason, the values of R4, R8, and R12 are different. You may wish to experiment with different values to obtain the LED intensity you desire. Also, these LEDs are available in constant and blinking versions. Make sure you get the constant on version.

Board Bottom

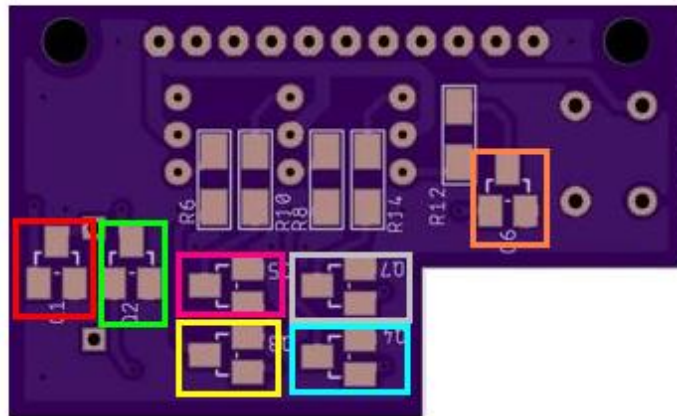


- ☐ Solder a 1K SMD 1206 Resistor (102) at location RED
- ☐ Solder a 1K SMD 1206 Resistor (102) at location BLUE
- ☐ Solder a 10K SMD 1206 Resistor (103) at location YELLOW
- ☐ Solder a 10K SMD 1206 Resistor (103) at location GREEN
- ☐ Solder a 10K SMD 1206 Resistor (103) at location VIOLET

Surface mount resistors typically have a 3 digit number for their value.

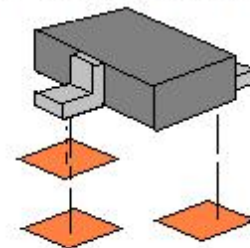


Board Bottom

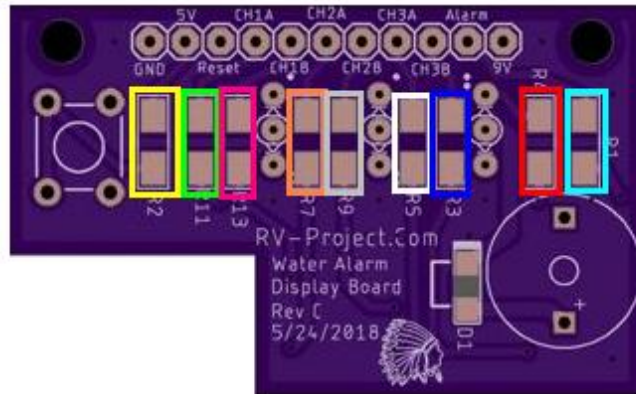


- ☐ Solder a MMBT2222 Transistor at location RED
- ☐ Solder a MMBT2222 Transistor at location GREEN
- ☐ Solder a MMBT2222 Transistor at location YELLOW
- ☐ Solder a MMBT2222 Transistor at location BLUE
- ☐ Solder a MMBT2222 Transistor at location VIOLET
- ☐ Solder a MMBT2222 Transistor at location ORANGE
- ☐ Solder a MMBT 2222 Transistor at location GREY

SMD Transistor Orientation

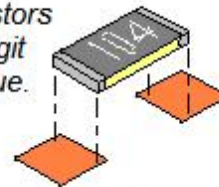


Board Top

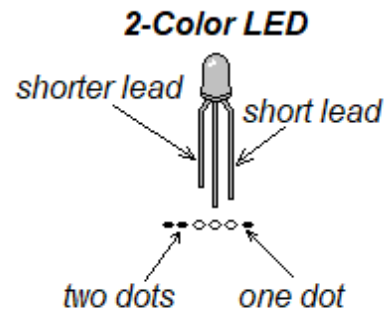
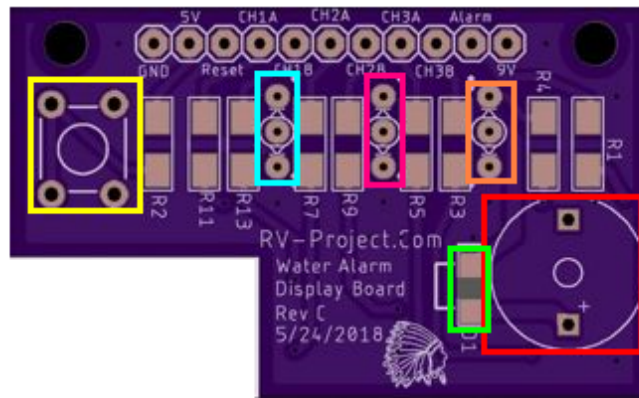


- ☐ Solder a 1K SMD 1206 Resistor (102) at location RED
- ☐ Solder a 10K SMD 1206 Resistor (103) at location YELLOW
- ☐ Solder a 10K SMD 1206 Resistor (103) at location GREEN
- ☐ Solder a 10K SMD 1206 Resistor (103) at location VIOLET
- ☐ Solder a 10K SMD 1206 Resistor (103) at location BLUE
- ☐ Solder a 10K SMD 1206 Resistor (103) at location ORANGE
- ☐ Solder a 10K SMD 1206 Resistor (103) at location GREY
- ☐ Solder a 10K SMD 1206 Resistor (103) at location WHITE
- ☐ Solder a 10K SMD 1206 Resistor (103) at location DARK BLUE

Surface mount resistors typically have a 3 digit number for their value.



Board Top

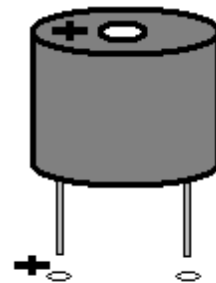
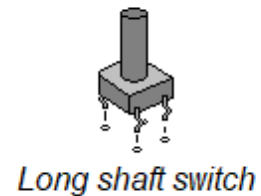


- ☐ Solder a buzzer at location shown in RED
- ☐ Solder a jumper wire at location shown in GREEN
- ☐ Solder a switch at location shown in YELLOW

INSERT but DO NOT SOLDER a LED at the following locations:

- ☐ LED at location shown in BLUE
- ☐ LED at location shown in VIOLET
- ☐ LED at location shown in ORANGE

Note: If the buzzer is too loud, remove the jumper (GREEN location), and insert a small value resistor (47 ohm, etc).



Some Buzzers have a polarity (+) mark, some do not.

Front Panel Assembly

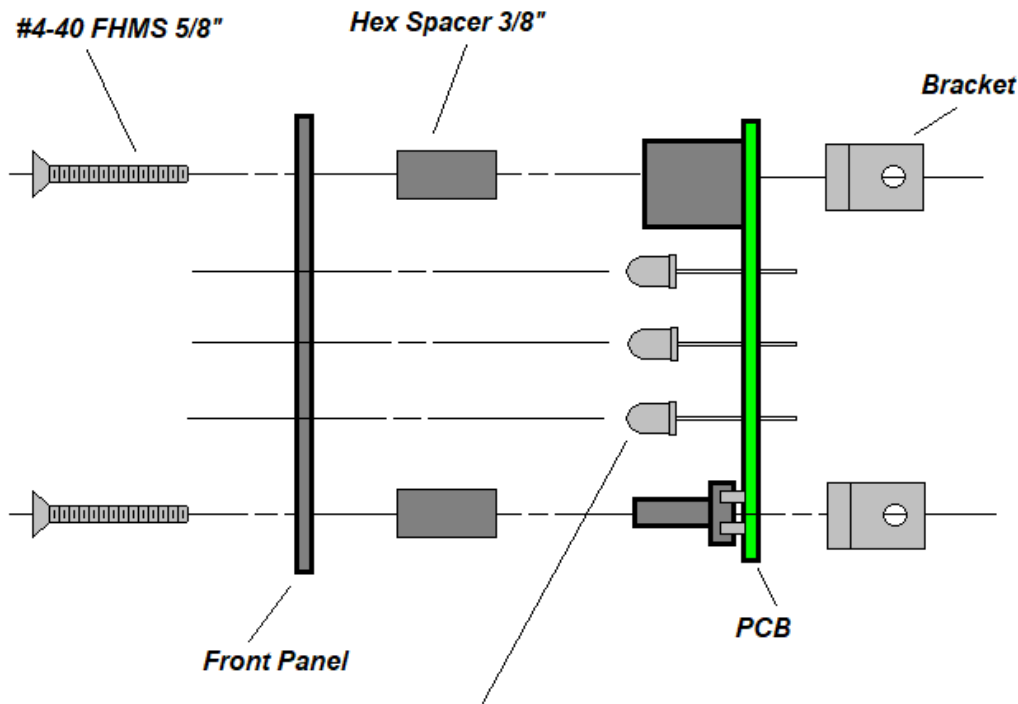
Assembly of the display board to the front panel comes next. For this part, you will need the following items:

Bill of Materials

Item	Description	QTY	Part Number	Source
Bracket	Right Angle Bracket 4-40	2	621	DigiKey.Com
Standoff	Hex standoff 3/8"	2	3458	DigiKey.Com
Screw	Flat Head Screw Note 1	2	FHMS #4-40 x 5/8"	Amazon.Com
Screw	Pan Head Screw Note 1	2	PHMS #4-40 x 3/8"	Amazon.Com
Panel	Front Panel Note 2	1	WA-1	Panel Template

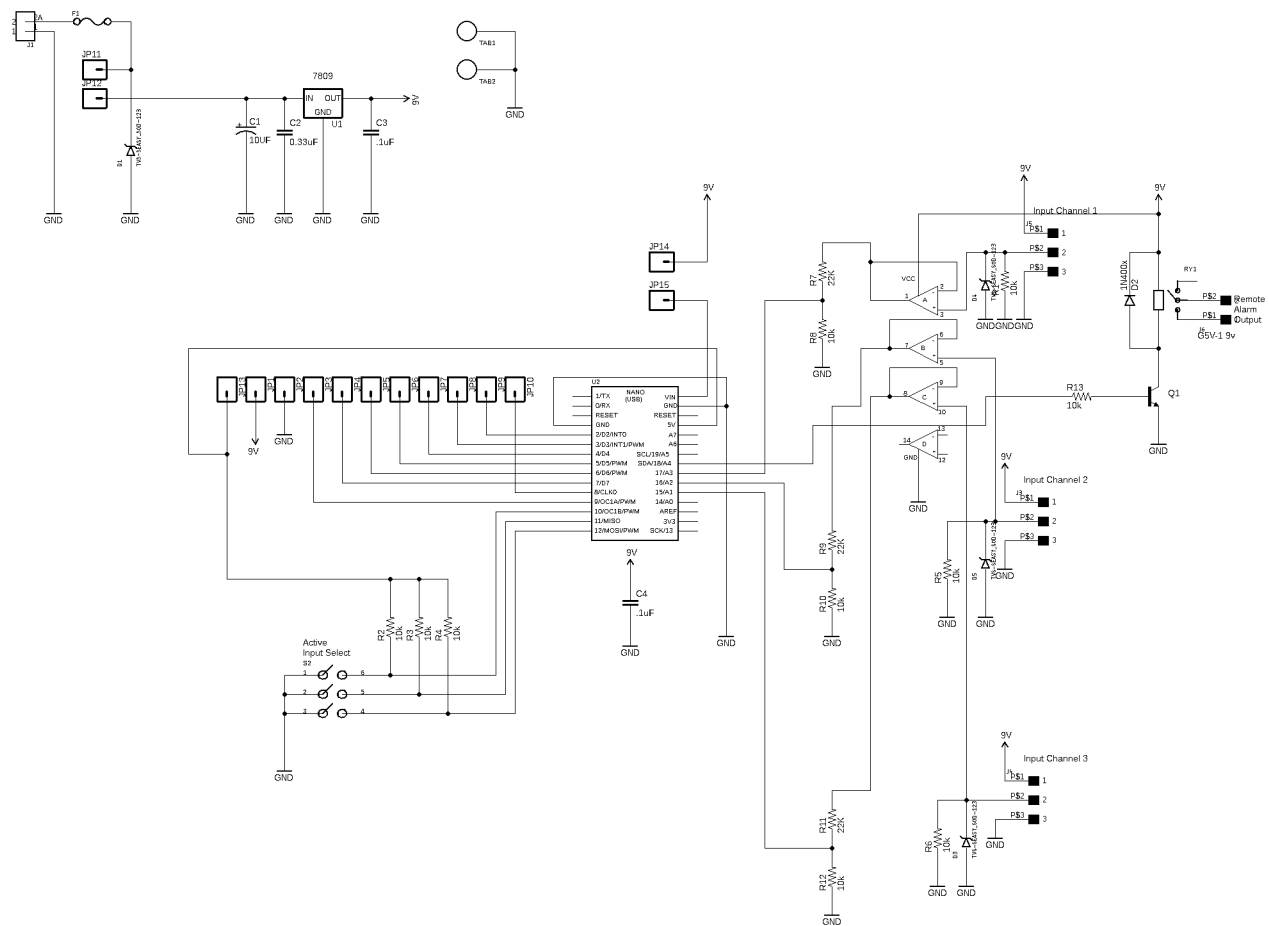
Note1: Local purchase of hardware often results in cost savings.

Note 2: Order from Front Panel Express. See [RV-Project.Com Panel Template Page](#) for details.



After attaching Front Panel to the Printed Circuit Board with the hardware shown, push the three LEDs into the backside of the mounting holes as far as they will go, then solder to the PCB.

Construction of the Monitor Board.



Bill of Materials

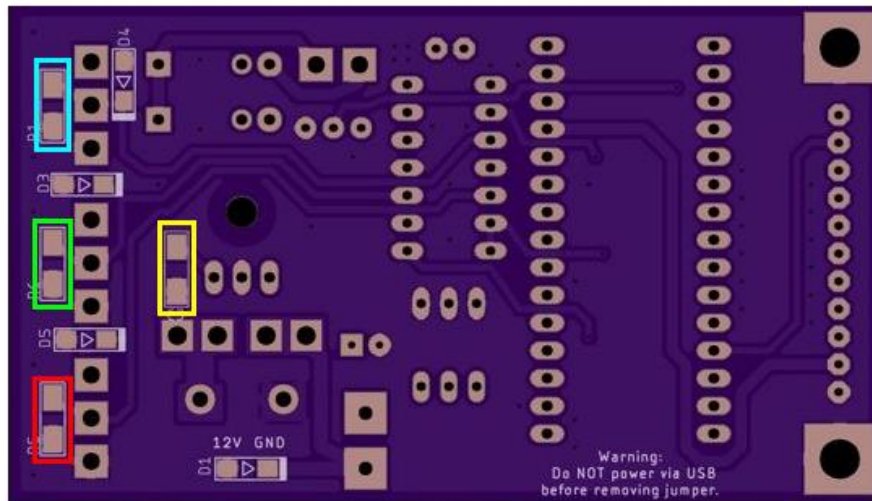
Item	Description	Part Number	Source
R1	10K SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R2	10K SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R3	10K SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R4	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R5	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R6	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R7	22K SMD Resistor 1206	RMCF1206JT22K0	DigiKey.Com
R8	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R9	22K SMD Resistor 1206	RMCF1206JT22K0	DigiKey.Com
R10	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R11	22K SMD Resistor 1206	RMCF1206JT22K0	DigiKey.Com
R12	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
R13	10k SMD Resistor 1206	RMCF1206JT10K0	DigiKey.Com
C1	10uF Electrolytic Capacitor	PIT-1996	TaydaElectronics.Com
C2	0.33uF SMD Capacitor 1206	1276-2860-1	DigiKey.Com
C3	0.1uF SMD Capacitor 1206	1276-3084-1	DigiKey.Com
C4	0.1uF SMD Capacitor 1206	1276-3084-1	DigiKey.Com
D1	TVS Diode 16V	SMF16A	DigiKey.Com
D2	Signal Diode (4148) 1206	1N4148X-TP	DigiKey.Com
D3	TVS Diode 16V	SMF16A	DigiKey.Com
D4	TVS Diode 16V	SMF16A	DigiKey.Com
D5	TVS Diode 16V	SMF16A	DigiKey.Com
U1	LM7809 Voltage Regulator	L7809CV	TaydaElectronics.Com
U2	Arduino Nano Microcontroller	Nano 3.0 (5V)	Amazon.Com
U3	LM324 Quad Op Amp	A-046	TaydaElectronics.Com
Q1	2N3904	A-111	TaydaElectronics.Com
RY1	SPDT Relay 9V	G5V-1-2 DC9	DigiKey.Com
Misc	Female Header Pins (15 pin x 2)	A-1669	TaydaElectronics.Com
Misc	Heat Sink	TO-220 Heatsink	Amazon.Com
Misc	Fuse Holder	3544-2	DigiKey.Com
F1	Fuse – Automotive Mini	1A ATM	Amazon.Com
J1	Kf7.62-2 Connector	Kf7.62 Generic	Amazon.Com
J3	3 Pin Wafer Connector Rt Angle	A-786	TaydaElectronics.Com
J4	3 Pin Wafer Connector Rt Angle	A-786	TaydaElectronics.Com
J5	3 Pin Wafer Connector Rt Angle	A-786	TaydaElectronics.Com
J6	2Pin Wafer Connector	A-776	TaydaElectronics.Com
Misc	3 Pin Housing for Above (3 req'd)	A-795	TaydaElectronics.Com
	2 Pin Housing for Above	A-794	TaydaElectronics.Com

Misc	Pins for above (11 req'd)	A-803	TaydaElectronics.Com
J1	3Pin Wafer Connector (optional)	A-805	TaydaElectronics.Com
Misc	3Pin Wafer Socket (optional)	A-827	TaydaElectronics.Com
Misc	Pins for Socket (2 req'd – optional)	A-837	TaydaElectronics.Com
SW1	3 Position DiP Switch	A-5017	TaydaElectronics.Com
SW2	SPST Rocker Switch (Front Panel)	Generic 0.6"x0.4"	Amazon.Com
Misc	0.1 Male Header	A-197	TaydaElectronics.Com
Misc	Shorting Block	A-1324	TaydaElectronics.Com
PCB	Monitor Board	Water Alarm	OSHPark.Com

Notes:

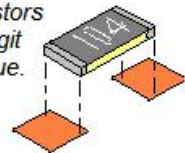
1. There are many clones of the Arduino Nano 3.0. Make sure they are 5V. And you can often buy multiple items at a higher discount.
2. Consider purchasing additional (spare) pins for wafer connectors.
3. J1 is an optional connector for SW2. See the individual build sheet for details.

Board Bottom

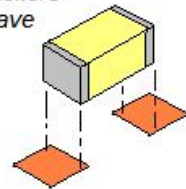


- ☐ Install a 10K SMD 1206 Resistor (103) at location RED
- ☐ Install a 10K SMD 1206 Resistor (103) at location GREEN
- ☐ Install a 10K SMD 1206 Resistor (103) at location BLUE
- ☐ Install a 0.1uF SMD 1206 Capacitor at location YELLOW

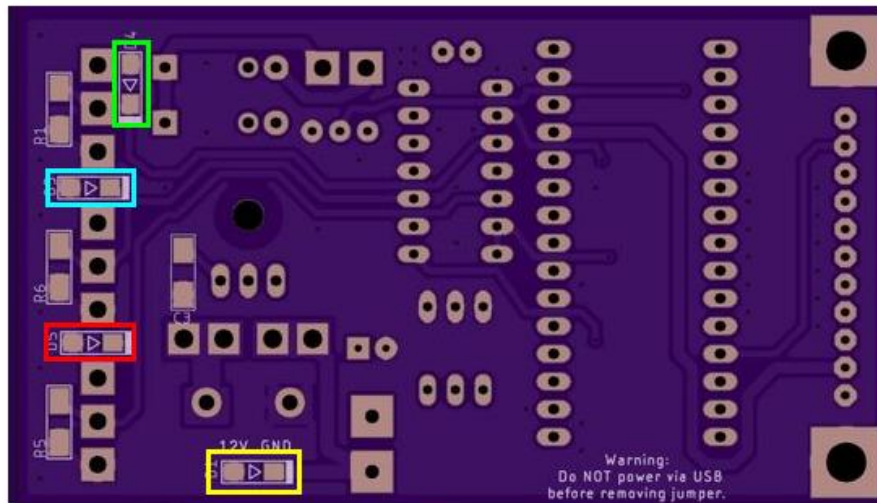
Surface mount resistors typically have a 3 digit number for their value.



Surface mount capacitors typically DO NOT have any markings.

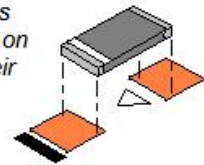


Board Bottom

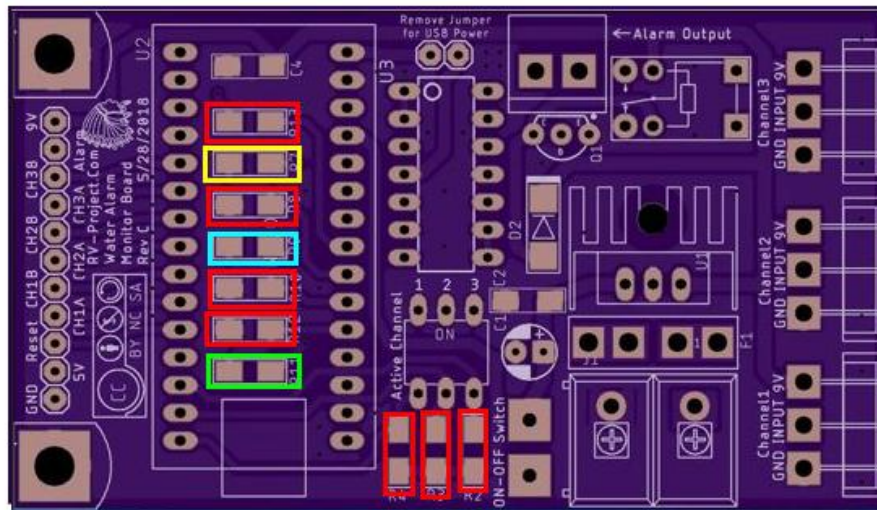


- ☐ Install a SMF16A TVS Diode at location RED
- ☐ Install a SMF16A TVS Diode at location GREEN
- ☐ Install a SMF16A TVS Diode at location BLUE
- ☐ Install a SMF16A TVS Diode at location YELLOW

Surface mount Diodes typically have a band on one end indicating their polarity.

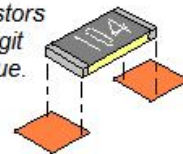


Board Top

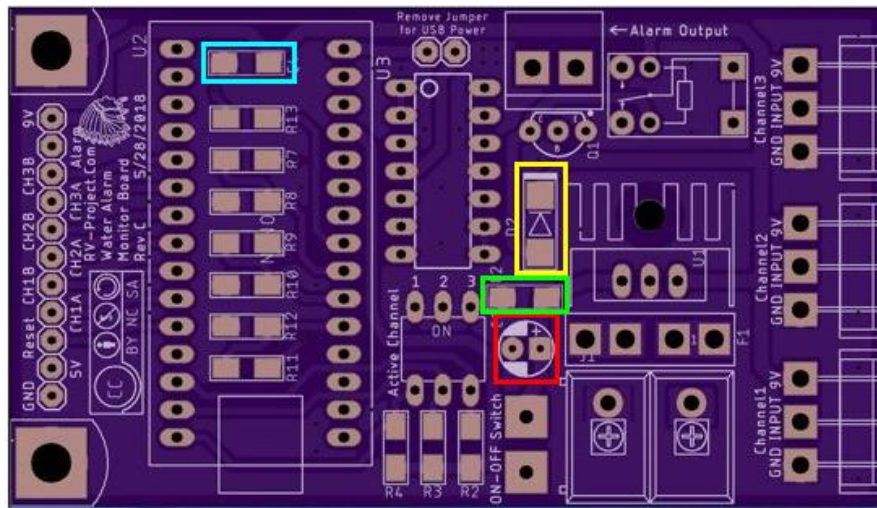


- ☐ Install a 10K SMD 1206 Resistor (103) at 7 locations shown in Red
- ☐ Install a 22K SMD 1206 Resistor (223) as shown in Green
- ☐ Install a 22K SMD 1206 Resistor (223) as shown in Blue
- ☐ Install a 22K SMD 1206 Resistor (223) as shown in Yellow

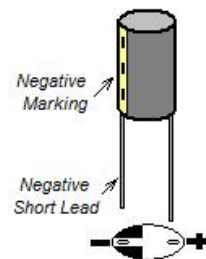
Surface mount resistors typically have a 3 digit number for their value.



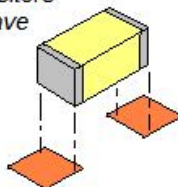
Board Top



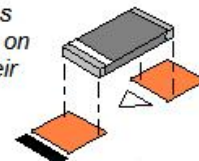
- ☐ Install a 10uF Capacitor at location shown in RED
- ☐ Install a 0.33uF Capacitor at location shown in GREEN
- ☐ Install a 0.1uF Capacitor at location shown in BLUE
- ☐ Install a 1N4148 Diode at location shown in YELLOW



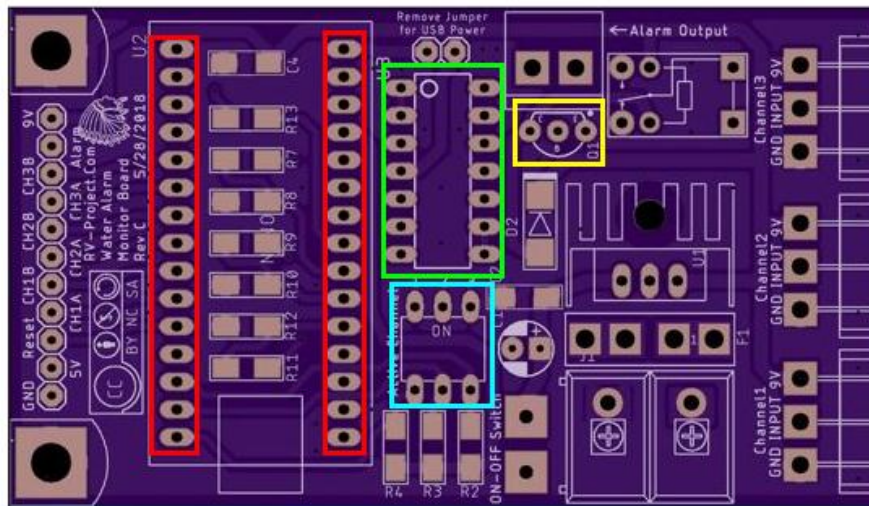
Surface mount capacitors typically DO NOT have any markings.



Surface mount Diodes typically have a band on one end indicating their polarity.



Board Top

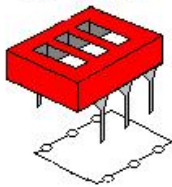


- ☐ Install 2ea 15 pin female header connectors shown in RED
- ☐ Install the LM324 OpAmp as shown in GREEN
- ☐ Install the 3 position DiP Switch in location BLUE
- ☐ Install the 2N3904 Transistor in location YELLOW

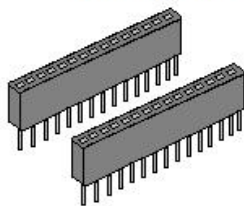
Transistor outline matches
outline on board



DiP Switch

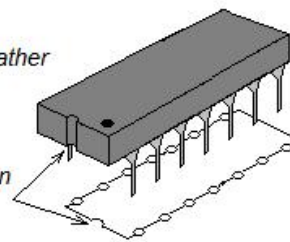


15 Pin Socket

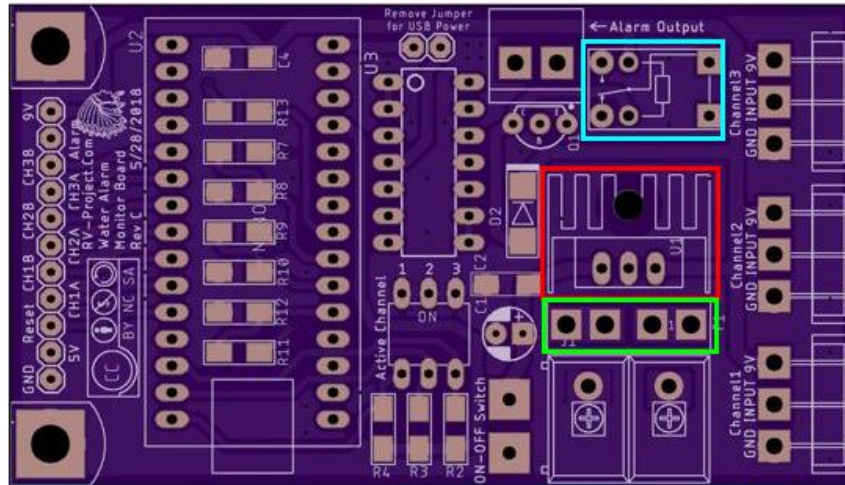


May have dot rather than dimple

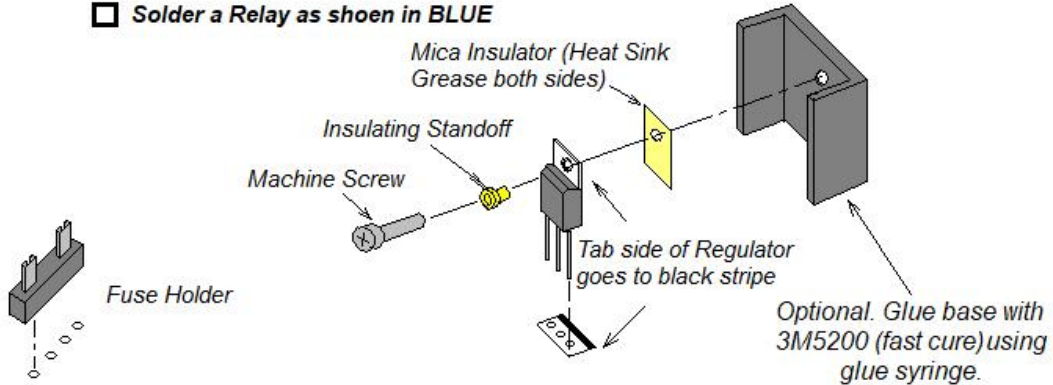
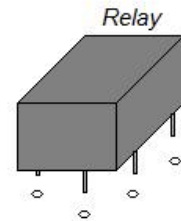
Orient Dimples on
IC and Board



Board Top



- ☐ Solder Voltage Regulator (9V) to circuit board as shown in RED.
- ☐ Glue base of heat-sink with fast cure 3M5200
- ☐ Solder fuse holder as shown in GREEN
- ☐ Insert a 1A ATM fuse into the Fuse Holder.
- ☐ Solder a Relay as shown in BLUE

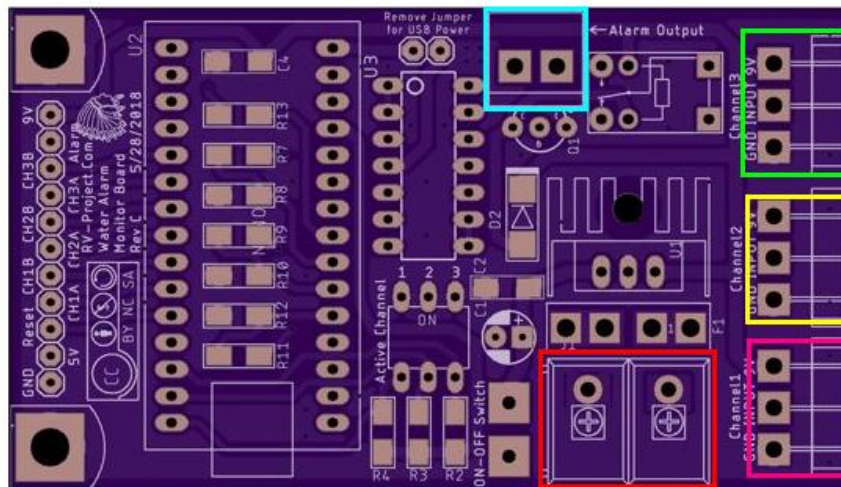


Bill of Materials (optional)

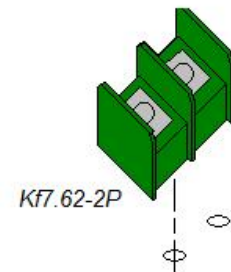
Item	Description	Part Number	Source
Glue	Fast Cure Silastic/Adhesive	3M5200 (Red Tube)	Amazon.Com
Misc	Glue Applicator	RMCF1206JT10K0	Amazon.Com
Grease	Heat Sink Grease	Generic	Amazon.Com

Note: Heatsink grease only required for Mica Insulators. Silicone insulators do not need grease.

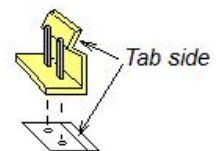
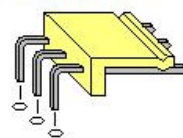
Board Top



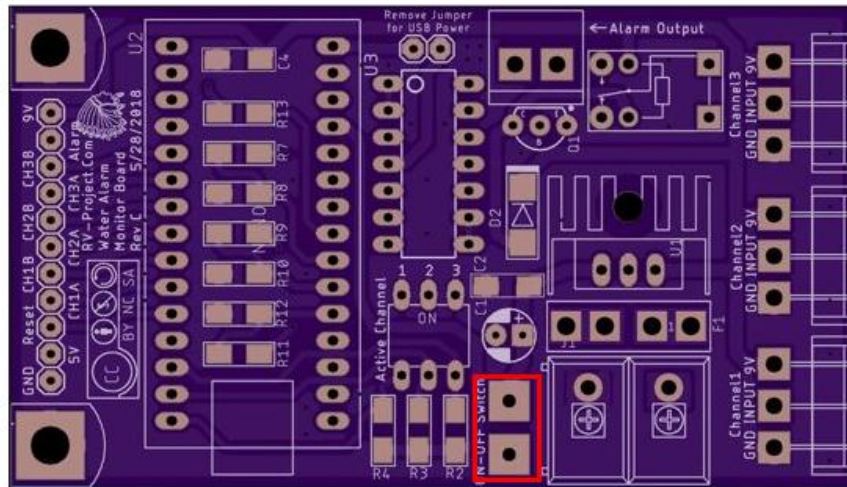
- ☐ Insert a Kf7-62 terminal strip at location RED
- ☐ Insert a 2-Pin Vertical Wafer Connector at location BLUE
- ☐ Insert a 3-Pin Wafer Connector at location GREEN
- ☐ Insert a 3-Pin Wafer Connector at location YELLOW
- ☐ Instet a 3-Pin Wafer Connector at location VIOLET



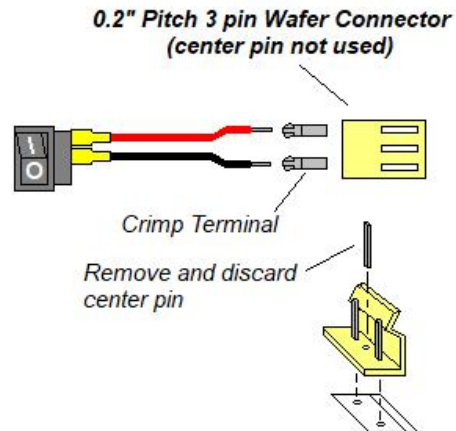
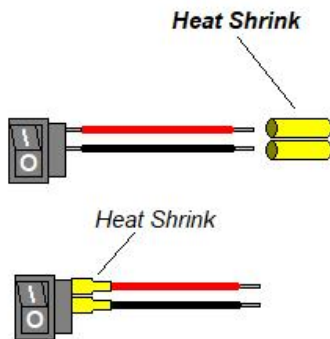
Horizontal Wafer

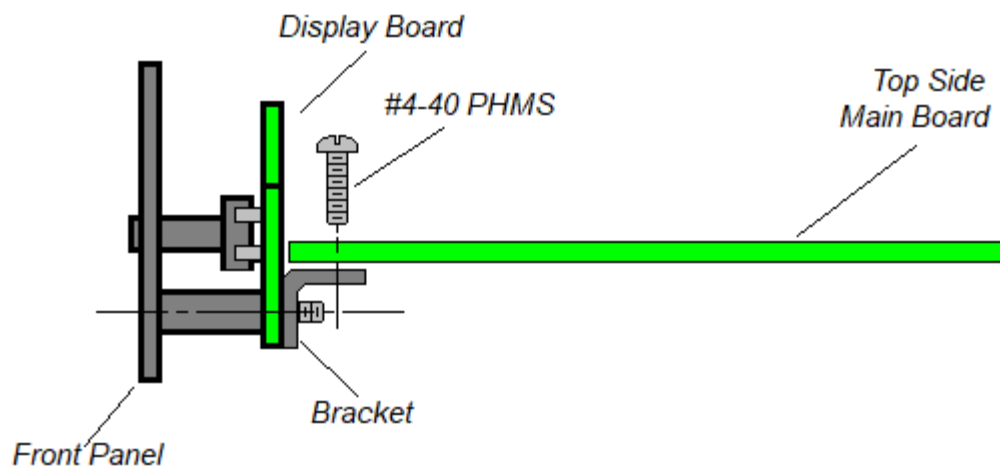


Board Top

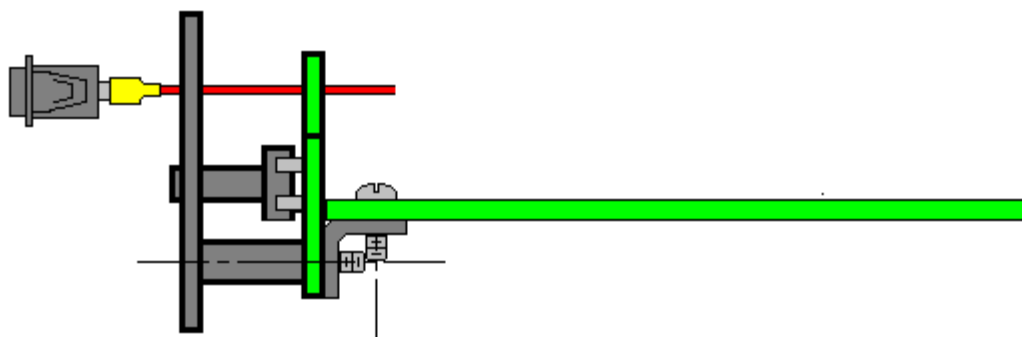


- ☐ Attach a 4" long Red and Black wire (22AWG) to the rocker switch.
- ☐ Apply heat shrink to rocker switch terminals.
- ☐ Option 1. solder rocker switch pigtails to board at location RED
- ☐ Option 2. Crimp on a 3 pin 0.2" pitch Wafer connector to switch pigtail.
- ☐ Option 2 (continued) remove center pin of 3 Pin Male Wafer connector and solder to board at location RED (polarity does not matter).

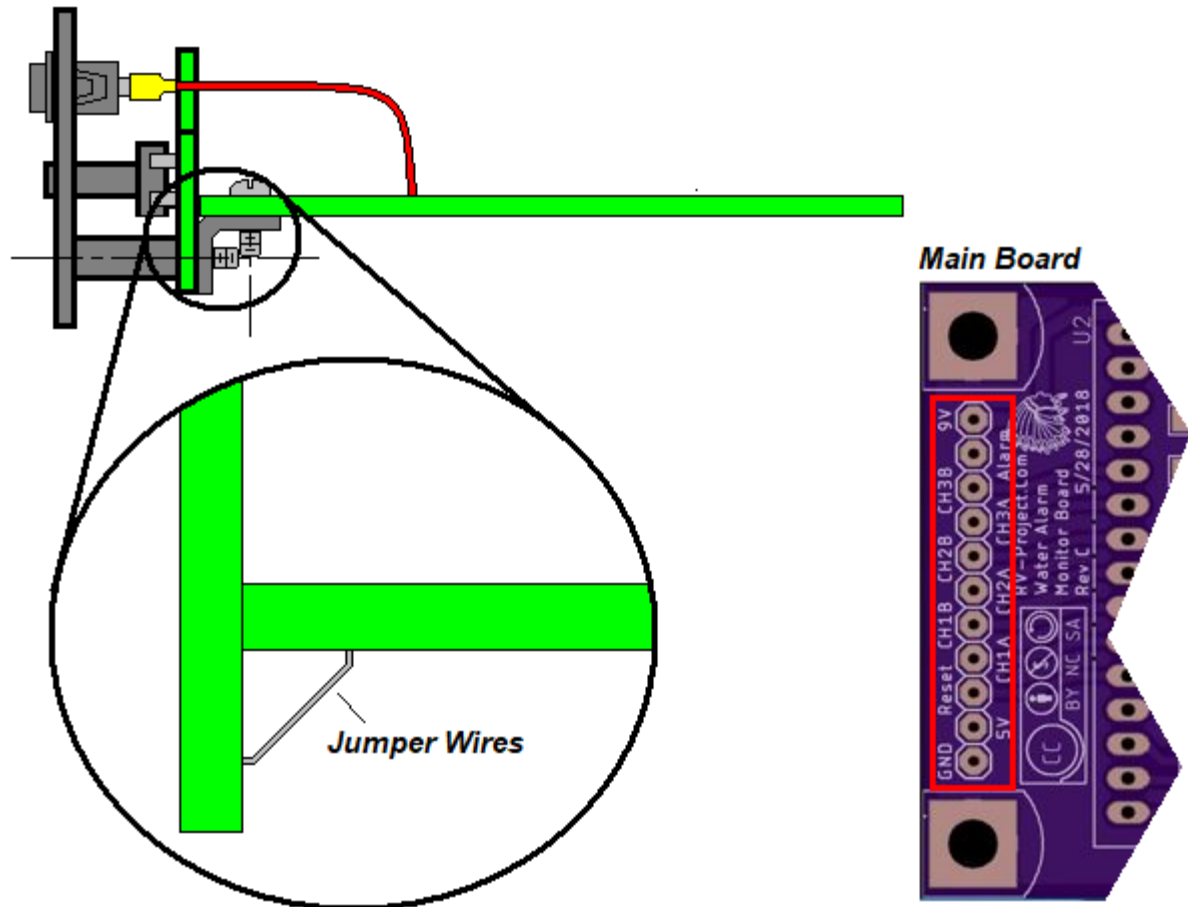




- ☐ **Attach Main Board to Front Panel/Display Board assembly using 4-40 hardware specified earlier**



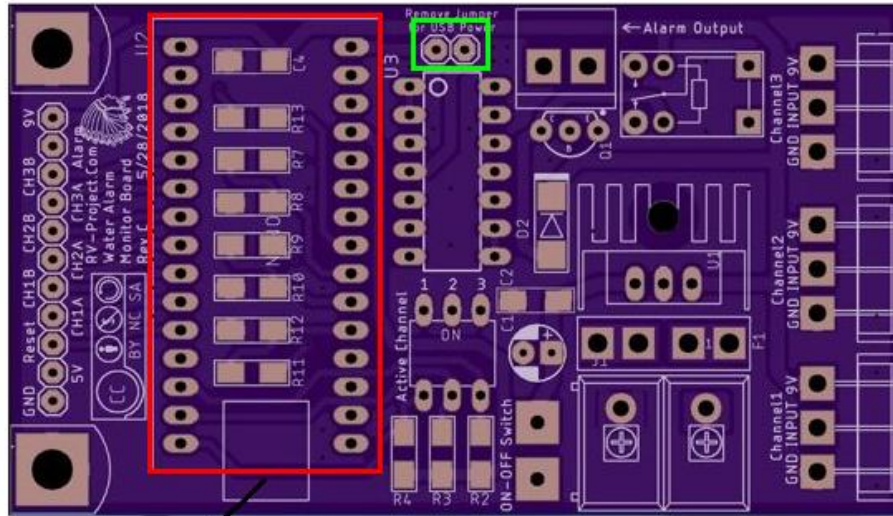
- ☐ **Snap the Rocker Switch into the front panel, then attach the wires to the main board using the option you decided on in the last step.**



- Cut 11 solid core 24AWG wires, 2" long and solder them to the Pads between the Main Board and Display Board.

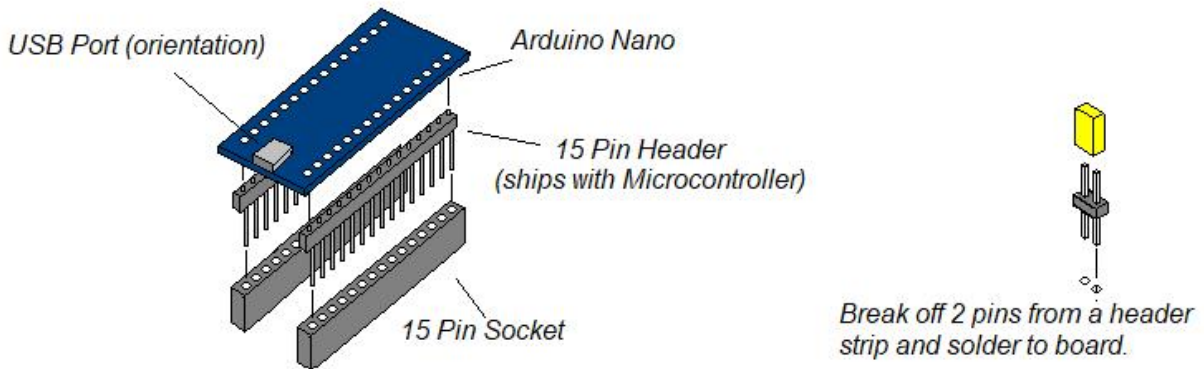
The pads are marked; GND, 5V, RESET, CH1A, CH1B, CH2A, CH2B, CH3A, CH3B, ALARM, 9V, shown in RED.

Board Top



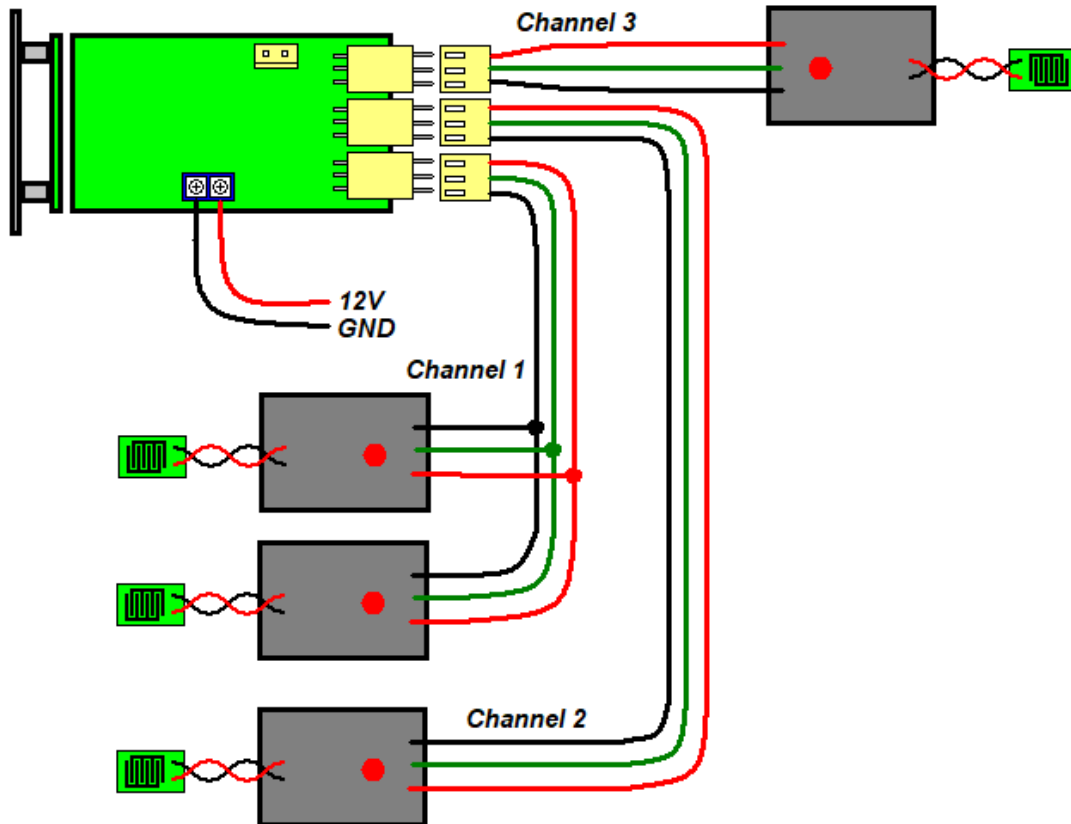
USB Port (orientation)

- ☐ Push 15Pin Header (2ea) into socket, then solder Arduino Nano to the header. as shown an RED. Be sure USB is oriented on the board as shown.
- ☐ Solder 2 pin header on board at GREEN, then attach a shorting block to header.



When programming the Arduino Nano, disable power from the main board by turning off the rocker switch, then detaching the shorting pin on the header strip (location GREEN). This allows the Nano to be powered by the USB cable when attached.

Connection Example



In this connection scenario, there is a single sensor attached to Channel 2, and 3, and two sensors attached in parallel to Channel 1. Sensors can be attached in any combination of parallel connections.

The 2-pin connector shown at the top of the main board are dry relay contacts, for remote signaling when an alarm condition exists.

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