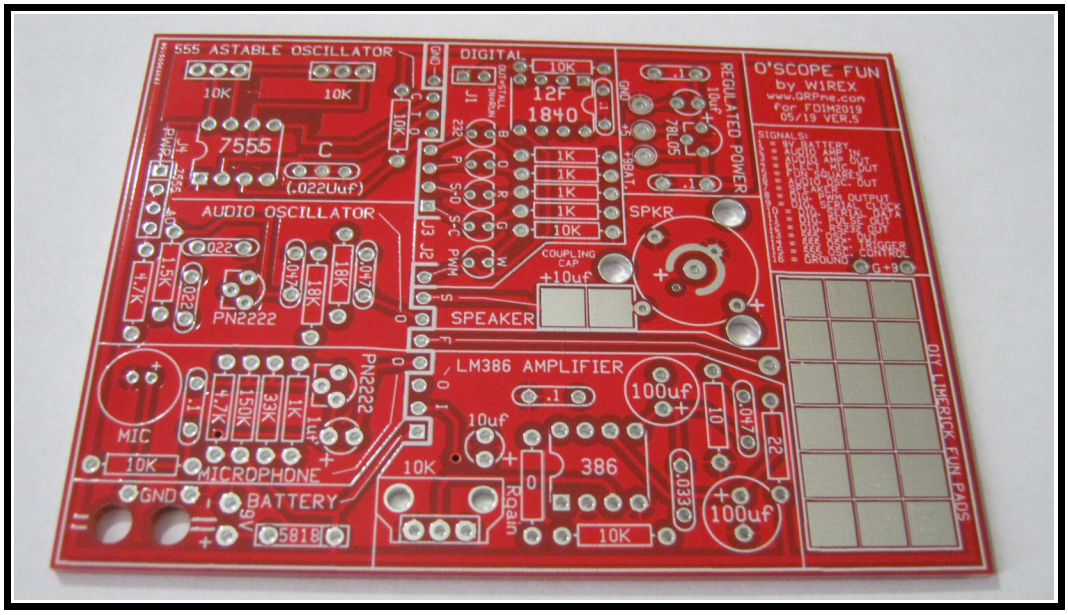
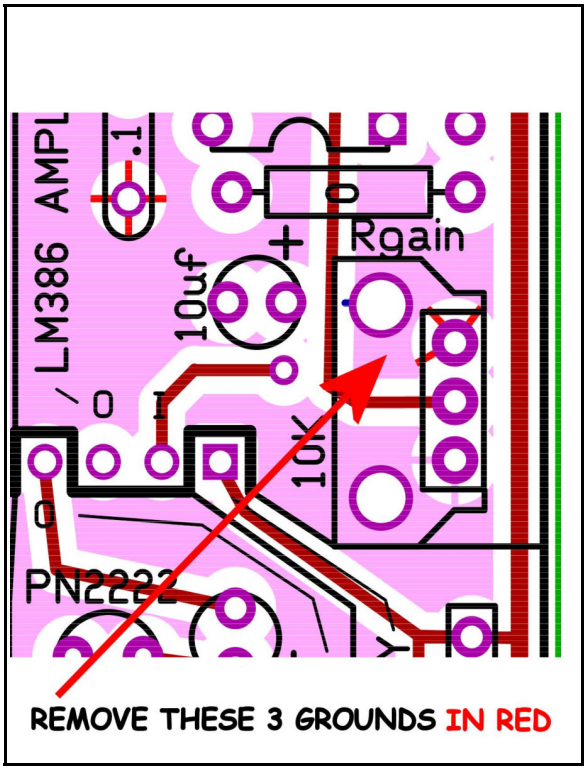
O*Scope FUN kit

Building hints:
Like all my recent Buildathon kits, the actual part values are shown on the silk screen instead of designators as it is easier to build that way! Typical QRPme Buildathon boards could be built without any instructions....at all. Unless there is a ppcb problem. In this case, the FDIM 2019 O*Scope FUN board has a small issue...



STEP 0. MOD THE PCB
A small error developed in the rush to get the Ver5 pcb fabbed in time for the Buildathon. I missed the top grounding rays when reversing the action of the amplifiier section's volume pot. There are 3 grounding 'rays' to the topside ground plane that still remain on the top side of the pcb. You need to carefully remove the 3 rays with either an X-acto knife or Dremel with a TINY burr bit. I used a small diamond round burr bit I purchased from Lowes to remove the rays on the boards built in the Buildathon. Those of you who 'Grabbed and Go-ed' need to remove the 3 rays....carefully... in order NOT to cut other good traces on the pcb or your fingers. Two small parallel cuts across the trace and application of a hot iron to the trace section between the cuts will lift that tiny section right off the board. The cuts prevent the heat from the iron travelling down the trace so the middle section heats up nice and hot which releases the glue holding it to the fiberglass.


LM386 AMPL
.1
10uf
Rgain
10K
PN2222
REMOVE THESE 3 GROUNDS IN RED

STEP 1. SORT & ORGANIZE ALL THE PARTSYou should sort all the parts and compare them to the Bill of Materials. I have added the identification particulars to the parts list to help perform the sort. Sorting the parts ONCE at the start of the build drastically shortens the build time.

HINT: When sorting parts to check against the BOM, quickly scan through the list and grab the BIG easily identified parts first. Transfer them to a designated spot and continue going after the easy pickings first. Scan the list again looking for unique items that only have 1 or 2 parts. Before you know it, you are left with only a few items which have bigger quantities and can usually be sorted just by comparing them with others in the remaining parts pile. Sorting the parts just ONCE at the begginning of the build will save you lots of time during the build.

FDIM 2019 BUILDATHON PROJECT: O*SCOPE FUN KIT

DESCRIPTION	QTY	GOT	MARKINGS ON PART
10K vert.adj .1” spc in-line trimmer	2		T93YA 10K 10% on the side
10K 9mm potentiometer	1		10K on the back side
0 ohm resistor *	1		single black stripe = 0
10 ohm resistor	1		BROWN-BLACK-BLACK
22 ohm resistor	1		RED-RED-BLACK
1K ohm resistor *	5		BROWN-BLACK-BLACK-BROWN on blue body
1.5K ohm resistor	1		BROWN-GREEN-RED
4.7K ohm resistor *	2		YELLOW-VIOLET-RED on blue body
10K ohm resistor *	5		BROWN-BLACK-ORANGE on blue body
18K ohm resistor	2		BROWN-GRAY-ORANGE
33K ohm resistor	1		ORANGE-ORANGE-ORANGE
150K ohm resistor	1		BROWN-GREEN-BLACK-ORANGE on blue body
* = **preformed leads**			
.022uf capacitor	3		223 in very tiny lettering
.033uf capacitor	1		333 in very tiny lettering
.047uf capacitor	3		473 in very tiny lettering
.1uf capacitor	5		104 on paper tape
1uf capacitor	1		1uf 50V – WATCH polarity on install
10uf capacitor	3		10uf 25V – WATCH polarity on install
100uf capacitor	2		100uf 35V – WATCH polarity on install
blue LED	1		match flat side of LED with silk screen outline
yellow LED	1		match flat side of LED with silk screen outline
green LED	1		match flat side of LED with silk screen outline
red LED	1		match flat side of LED with silk screen outline
white LED	1		match flat side of LED with silk screen outline
1N5818 diode	1		1N5818 – WATCH polarity on install
PN2222 transistor	2		PN2222 – match silk screen outline
7555 timer IC	1		7555 IPAZ – match silk screen outline
LM78L05	1		LM78l05 – match silk screen outline
12F1840 microcontroller	1		12F1840 – match silk screen outline
LM386-4 audio amp IC	1		LM386-4 – match silk screen outline
electret microphone	1		
Cem-1201 (50) speaker	1		CEM 1201 (50)
8 pin IC socket	3		match notch with outline
8 pin .1”spacing straight male header	2		
4 pin .1”spacing straight male header	1		
2 pin .1”spacing straightmale header	1		
2 pin .1” jumper	2		
9 volt battery snap	2		
2.1mm to screw term adapter	1		
M-M molex jumper wires	5		
rubber stick on feet	4		
printed circuit board	1		

ASSEMBLY SEQUENCE:

Start off mounting all the resistors then proceed to the sockets, monolithic caps and then progressively higher components. Tall items like the headers, electrolytic caps and potentiometer should be added last.

HINT: Inserting several parts in different locations on the board before flipping it over to solder them in will also greatly speed up your build. If you are building at home, speeding up the process is not that big an issue. In the Buildathon event, if you want to have plenty of time to go visit the Club Night activities, getting the build done in time to play with the scope & O*Scope FUN board combo before heading off to Club Night is a good thing.

I suggest that while you are working on each part type, install one part in say each section of the board before flipping it over to solder them in place. Putting a single part in several sections at a time will keep them spead out enough so that there won't be a problem sneaking the soldering iron tip into position to solder each part with contending with interferance from other part leads. Insert a part, spead the leads apart slightly where they exit the bottom of the board to keep them in place when you turn the board over. Repeat for about 3 or 4 parts or whatever you are comfortable with and then flip the board over. Make sure the parts don't slip down and are still close to the pcb and then solder them in. Clip the leads off with FLUSH cutting pliers. Make sure you put you fingertip on the end of the leads before you cut it, to insure it doesn't go flying into you bench neighbors eye, before you actually cut the lead. This keeps you lead in your area and easy to clean up. Don't let them fly or fall onto the carpet below either! It is not good manors to leave clipped leads in the area when you leave. Be neat. Be nice to the hotel and their future guests. Don't leave electronic crud behind after your build.

Resistors: there are 20 resistors so you should be able to completely solder all resistors in about 4 or 5 board flips.

Monolithic Caps: There are 12 little yellow monolithic caps so you should be able to knock those off in 3 or 4 board flips. Save the electrolytic caps for a little later...

Sockets: Solder the 3 sockets in a single batch. You only need to bend a single pin on each side of each socket to hold it in place for soldering. I typically look for a pin with a trace coming out straight out (in either direction) and bend that lead in the direction of

the eminating trace. You don't need to bend it flat but you need to try to bend the leads on both sides of a socket in OPPOSITE directions in ordeer to hold it securely....either away from each other or towards each other.

Misc. parts; You can install several miscellaneous parts at a time too. 1N5818 at the battery snap, the LEDs, microphone element, aluminum electrolytic caps, transistors, voltage regulator etc.

Now comes all the wobbly parts: Headers, pots, speaker, etc.

Header connectors: The header connectors I chose for the O*Scope FUN board have what they calle kinked pin leads so they take a little persuasion to install them in the holes but they will stay in place when you flip the pcb over to solder. HOWEVER, you should only solder 1 pin of each connector, then turn it over to see if it is still nice and vertical and perpendicular to the board before you solder all the remaining pins. Soldering all 8 pins in and then finding the connector at some rakish angle when you flip it back over is not a good thing. Reworking connectors is much easier when only 1 connection is soldered is much more goodier than doing the same when 8 pins are fully soldered!!

Odd balls: You can start on all the odd ball things that make the board even more wobbly when you are trying to solder. Trimmer pots, volume pot, transistors, voltage regulator,

Solder in a ground loop at the battery snap location using a piece of cut off component lead.

Battery snap.

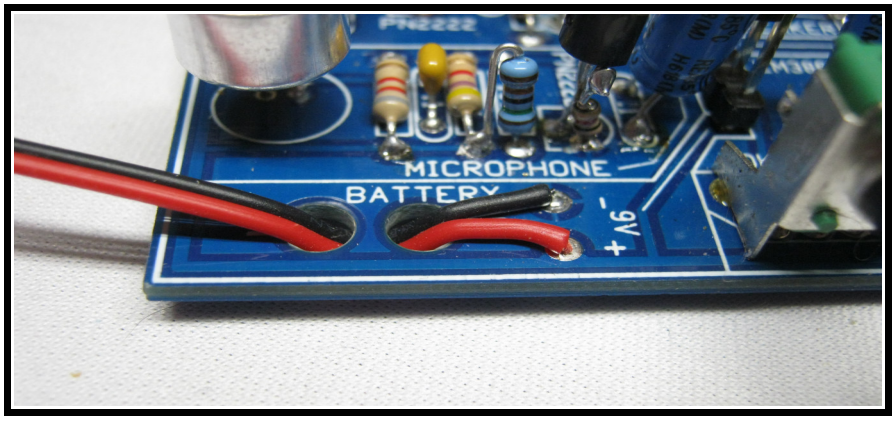
Stick on feet.

Add anythin else left in your parts pile....if you can find an appropriate place to put it.....

The oscilloscope grounding clip was intended to be connected to pin8 of the second header. The alligator style ground clip has a tendency to either fall off or short over to pin7. A fix can be made by cutting one of the dual female jumper leads in half and stripping one end to attach the ground lead and then inserting the other end onto the pin8 ground. Another solution would be to make a nice ground lead connection loop over at the regulated 5 volt power section. Tack one side of a loop to the grounded end of the .1uf cap and the other side of the loop in the gnd solder pad. I find the ground lead of

the oscilloscope to be pretty short so using the ½ jumper lead fix is what I use.

Operation:
Power comes in to the board through the battery snap and goes to all sections of the board except the PIC12F1840 micro-controller The regulated power section provides the +5V supply voltage to the micro.



In case you haven't seen this before, running the 9v battery snap leads down and then back up a pair of holes makes a nice strain relief to keep the fragile leads from breaking.

The microphone section is quite sensitive and provides a nice signal for the audio amplifier section. If you connect the audio amp to the speaker, you can readily 'demonstrate' audio feedback! The volume pot on the amp has to be set quite low for this hose-up to work.

The audio oscillator section is a twin-tee oscillator making a very clean 750+/- Hz sine wave signal at a low signal level (approx. 1V p-p) perfect to connect to the amplifier section. Of course, you can put an oscilloscope probe on the output of the oscillator and the scope will calculate and display the frequency of the oscillator. Press & hold the OK button for about 2 seconds and the scope will turn on the digital information overlay. Pressing & holding the OK buttin again, will turn the overlay back off.

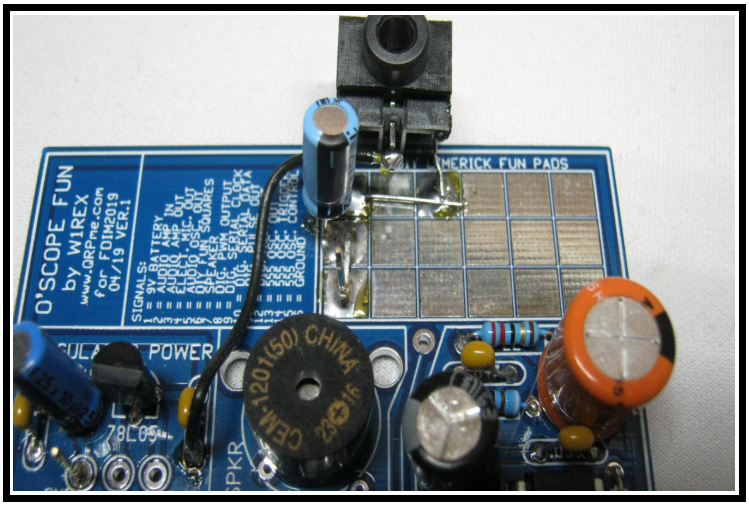
The 7555 astable oscillator generates a high level (9V) square wave. It can easily leak enough signal into the amplifier to create a background hum. The only way to turn off the 555 is to pull the chip. The Buildathon Ver5 board will have a header/jumper combo to turn on/off power to both the audio oscillator and 555 astable oscillator sections. Adjusting the 2 trimmer potentiometers changed both the frequency of the square wave and the duty cycle. Scoping the output signal pin will give you a nice clean square wave. Scoping the Trigger pin lets you look at the nice exponential capacitor charge/discharge signal. The Control pin doesn't yield much to look at unless you replace the 7555 with a

'regular' 555 timer. An ordinary 555 has a little crud on the Control pin due to switching currents inside the timer chip. The 7555 is a more sophisticated chip with cleaner switching transients. The output of the 7555 chip in on pin 5 of header #2. Like the audio oscillator, the frequency of the astable oscillator can be measured and displayed by the little DSO Shell scope.

The audio amplifier section is pretty straight forward: a LM386 audio amplifier with all the little bells & whistles circuits added. Feed in a proper signal from the microphone or audio oscillator circuit and everything is Jake. Hose in the 555 output and you will overdrive it convincingly....which makes for interesting output signals.

The speaker section has a miniscule speaker for cost reasons. You could replace it with an external one. The 10uf coupling cap is mounted on FUN pads for easy changing for either testing or demonstration purposes.

The FUN pad section is for making personal additions to the FUN board. I quickly added a separate header pin, 10uf coupling cap and a miniature stereo jack to use headphones with the board or jack it out to an external speaker. There is a convenient +9v and ground pad next to the FUN pads in case you might need power to a FUN circuit.



Its hard to see in the picture but there is a header pin right between the 10uf decoupling cap and the CEM speaker....

Mike, N2HTT, quickly came up with a different hose up. He added a jack to key the audio oscillator into the amplifier section then on to the speaker to act as a code practice oscillator. Indeed, the twin tee audio oscillator circuit came from an earlier QRPme project performing that exact same function. This was the intent of the whole header/jumper scenario. Make a board with signals useful to learn how to use an oscilloscope but be useful beyond that too.

The regulated power section makes +5 out of +9 and delivers it to the micro-controller and the +5V pad just below the regulator. There are +9, +5 and ground pads just under the voltage regulator in case you need those voltages elsewhere...like at the FUN pads.

That leaves the digital section as the last section on the board. The micro-controller is used to deliver 5 different types of digital signals. These digital signals are designed to test the scope learner's ability to capture and decipher fleeting signals. I say fleeting because the micro is in a loop that is constantly changing the data. When the R/S (Run/Stall) jumper is shorting the header pins, the loop cycles through a prescribed data loop. ASCII data on the 232 pin is presented in TTL RS232 format and runs through the alphabet from A to Z. Use the single trace mode to capture a 'packet' of data and then decipher the ASCII data. When the R/S jumper is pulled, the micro continues to output data on all the digital output pins, but the looping is stalled so the data is constant. Insert the jumper and the loop continues. Each 'stop' in the loop causes the micro-controller to send the following sequence of data:

232: TTL level RS232 ASCII data from 'A' to 'Z'. The RS232 format is 2400 baud, 1 start bit, 7 data bits, no parity bit and inverted level. At 2400 baud, each transmission bit is about .4 msec each so a complete RS232 data 'packet' is about 3.2 msec long.

S-D & S-C: High Speed Clocked serial shift data: The same ASCII data without start/parity/stop bits is sent out the S-D & S-C pins. The 8 data bits are sent out the S-D pin while the clock pulses that latch each data bit into a 'virtual' shift register are sent out the S-C pin. Each clock pulse is about 20 msec wide.

P = A variable calculated width pulse based on the value of the ASCII data. Each pulse is 100 msec + ASCII value wide so between 165 msec and 191 msec.

PWM = a 25Khz TTL level pulse width modulated signal stepping from approximately 10 to 100% in 10 steps.

The micro-controller then pauses for .5 sec, checks the run/stall jumper and performs another loop with the exact same data if the jumper is NOT there. If the jumper IS still installed, the ASCII value is incremented by 1, the PWM duty cycle is incremented by 10% and another loop is performed using the NEW data.

Enjoy!

Rex W1REX