

HF Receiver Platform

A little background information

Many thanks for purchasing this HF Receiver Platform PCB.

This experimenters PCB is available in three forms, 1) bare PCB 2) bare PCB and component set & 3) built & tested unit. These instructions and guide to use, provide all the information required, whatever version has been purchased.

The design provides a fully functional receiver that can be used (as supplied) to receive WWV time signals on 10.0000 MHz, or by addition of a local oscillator a receiver that can be used to monitor the HF bands from approx. 2 MHz – 18 MHz

The receivers open architecture allows experimentation with front end RF amplifiers/pre-selectors, audio processors at the amplifier stage and of course variable oscillator (VFO) experiments. See the 'Experimenter Section' for more on this and other ideas.

Direct Conversion Receiver notes

Direct conversion (DC) receivers take the incoming signal at its signal frequency and process it to the audio amplifier without the need for separate intermediate frequency (IF) oscillators. This has the advantage of being able to resolve AM, CW and SSB signals without the use of a separate BFO, or other oscillators.

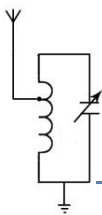
DC receivers are also generally simpler to build and get operational, demonstrate good sensitivity, and are easy to operate. Disadvantages are that DC receivers can be overwhelmed by strong AM signals, and can be prone to AC Hum pickup and microphonics (microphonics is where components on the board act as audio pickups and tapping them can lead to an annoying thump being heard in the speaker).

Our design is very immune to microphonics and AC Hum pickup, it can still pickup strong AM broadcasts especially after dark, however, this can be reduced by installing the PCB in a metal enclosure.

Circuit operation

This design is a Direct Conversion style radio using the common SA602N & LM386 combination.

The receiver is powered by 9-12 volts dc applied to the center positive 5.1mm barrel jack, this voltage is fed via a 1N4001 reverse polarity protection diode to Pin 6 of the LM386 amplifier, then via R2 (270



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Ohms) to a 6.2 volt Zener diode that feeds pin 8 of the SA602N, and also a LM78L05 5 volt regulator that provides 5 volts to the on board block oscillator if used.

The BNC antenna jack connects to the antenna, and feeds the RF gain potentiometer via a 0.1uF capacitor, the RF gain potentiometer acts as a simple signal attenuator. This signal then passes to L3 a 10MHz IF transformer whose secondary connects to pins 1 & 2 of the SA602N, this transformer peaks the incoming RF.

If the on-board 10 MHz block oscillator is being used, the oscillator output, after signal conditioning via L1, L2 and C12, C13, C14 is applied to pins 6 & 7 of the SA602N. A 50 Ohm terminating resistor is included in kits and installed on finished boards to prevent issues created by an the LO port being left unterminated. Received audio then appears at pins 4 & 5 of the SA602N and is fed to the LM386 amplifier via the AF gain potentiometer, which acts as a volume control.

The LM386 is configured in its basic gain form; an extra 10uF electrolytic capacitor can be installed at the C10 position if increased gain is required. Amplified audio appears at the 3.5mm jack socket. This can drive a small 8 Ohm speaker, or smartphone ear buds very satisfactorily. The use of powered computer speakers provides a good solution also.

A Local Oscillator inject SMA socket is also available to allow an external VFO, DDS VFO, or other signal generator to be applied to the receiver.

Please Note:

If an external VFO/DDS is used, the on board block oscillator needs to be removed first.

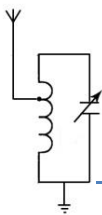
First time use/set-up

As supplied (or if built from the kit components), the receiver is ready to be used. External connections required will be a 12 Volts DC power supply, speaker or headset, antenna, outdoor is preferred, and if possible a ground connection.

Ensure the 10MHz block oscillator is properly seated in its socket, double check the orientation and that oscillator pins are seated in their respective socket pinholes and not bent under.

The antenna is connected to the BNC jack, power is applied to the 5.1mm barrel jack (center positive) and speakers or headset to the 3.5mm jack.

Before actually applying power, set each potentiometer to its mid-point setting, a positive feel detent at the mid-point will help in setting this point.



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Apply power and advance the AF gain potentiometer to a comfortable listening level, the distinctive signal from WWV (or WWVH) should be heard which comprises a regular 'tick' and voice announcements. If no signal is heard, advance the RF gain control towards its maximum position. As the RF gain control is a simple attenuator always set it to the position that allows the best reception of the desired signal and attenuation of any interfering stations.

Remember that WWV transmits on the HF bands; as such it is affected by the same propagation issues that can affect all HF transmissions. On some occasions the signal will be strong and the received signal will be loud and clear – on other occasions it will be weaker and strong hiss or other QRM may be experienced. Reception conditions aside, the time of day can also have a bearing on the quality of the received signal as well as the season. In general, daytime will give best results and Spring/Summer the best days.

Antenna Selection

For best results an outdoor antenna should be used – a dipole strung as high as possible or end fed long wire will give best results. Location in regards to the transmitter location (Fort Collins Colorado for WWV & Hawaii for WWVH) will also have an effect and also orientation of the antenna to the signal transmitter can be worth experimenting with.

An indoor antenna can work as well, locating the antenna in an attic or loft space can improve reception, however, it may also introduce local electrical noise if near household wiring.

Kit Builders Instructions

If you have purchased just the bare PCB or a PCB with the components and intend to assemble the receiver yourself start here.

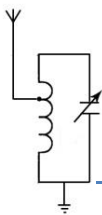
This section will outline the components used and where to purchase the components.

Experienced constructors may want to check out the 'Experimenter Section' before starting so they can consider including some of the suggested modifications.

While the PCB is a relatively simple layout and quite easy to assemble in a few hours of work, it is not a beginners project and some experience with assembling and soldering electronics is recommended.

The chart on the next page details all the components, their PCB location and suggested supplier with order code.

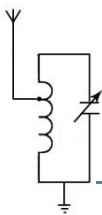
Start by opening the bags of supplied components and checking the items received against the chart. Please contact us immediately if any parts are missing: resalese@gmail.com



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Component Parts List

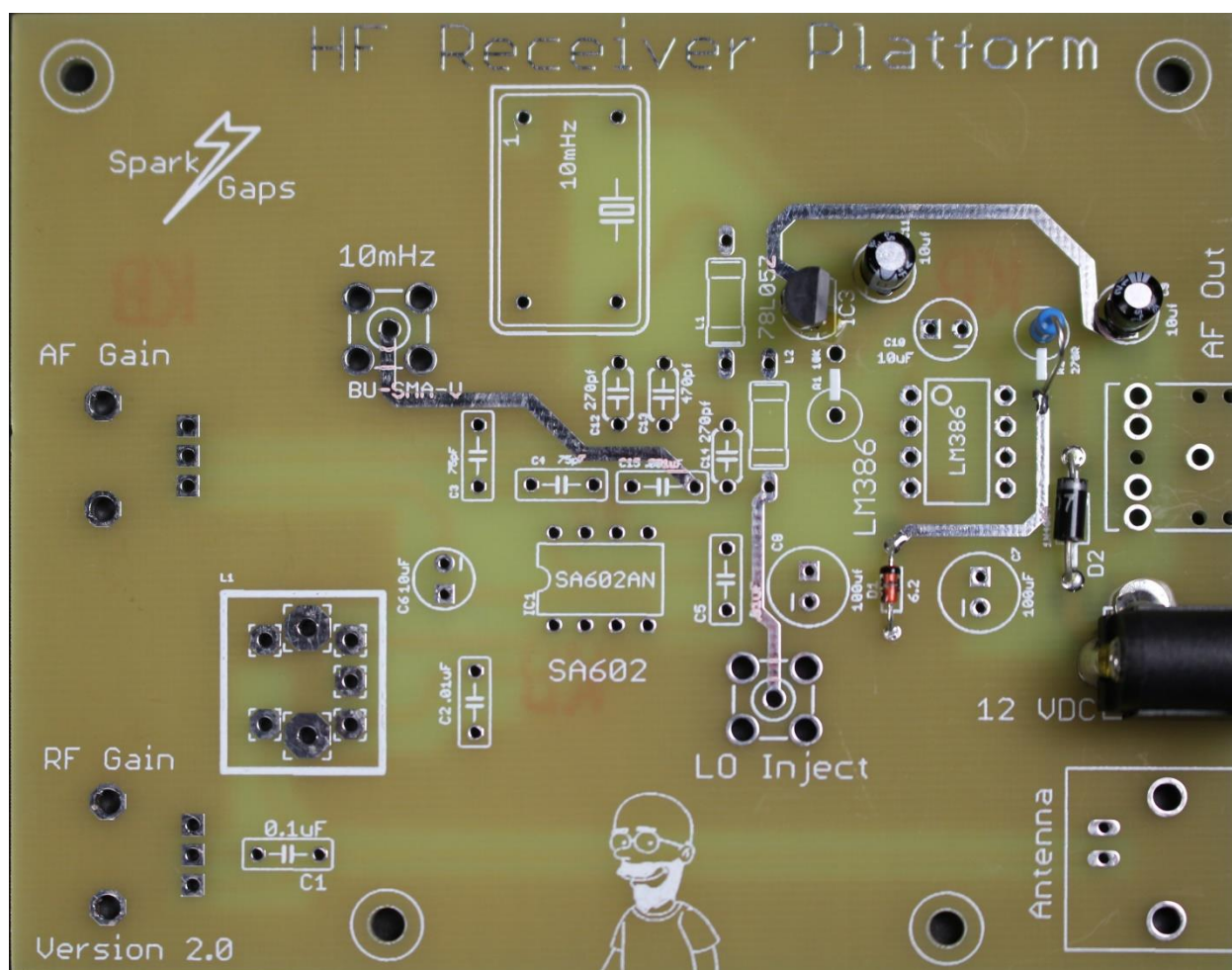
Part N°	Part Location	Part Value	Supplier Name	Supplier Order code	Notes
1	R1	270 Ohm	Mouser	603-MFR505FTE52-270R	
2	R2	10K Ohm	Mouser	Not supplied/installed	Replace with wire link
3	C1	0.1uF	Mouser	581-SR215C104KAATRI	
4	C2	0.01uF	Jameco	15231	
5	C3	75pF	Mouser	80-C322C750JCG	
6	C4	75pF	Mouser	80-C322C750JCG	
7	C5	0.01uF	Jameco	15231	
8	C6	10uF	Jameco	94212	Install to increase AF Gain
9	C7	100uF	Mouser	667-ECA-1VM101	
10	C8	100uF	Mouser	667-ECA-1VM101	
11	C9	10uF	Jameco	94212	
12	C10	10uF	Jameco	94212	
13	C11	10uF	Jameco	94212	
14	C12	270pF	Mouser	810-FK28COG1H271J	
15	C13	470pF	Mouser	810-FK28COG1H471J	
16	C14	270pF	Mouser	810-FK28COG1H271J	
17	C15	0.001uF	Jameco	1947343	
18	L1	1uH	Mouser	70-IM02EB1R0K	
19	L2	1uH	Mouser	70-IM02EB1R0K	
20	L3	421-123 IF	ER	-	Supplied with bare PCB
21	ICI	SA602N	Jameco	1367795	
22	U1	LM386-3	Jameco	24133	
23	QG1	10MHz Xtal	Digikey	CTX772-ND	
24	J1	5.1mm	Jameco	101178	
25	JP1	3.5mm	Mouser	502-35RAPC4BHN2	
26	X1	SMA	Mouser	530-142-0701-201	
27	X2	SMA	Mouser	-	Not supplied/installed
28	Antenna	BNC	Mouser	523-31-5431-10RFX	
29	Socket	Xtal SKT.	Jameco	133006	
30	D1	6.2V Zener	Mouser	512-1N5234BTR	
31	D2	1N4001	Mouser	512-1N4001	
32	-	PCB	ER	ER-WWV-PCB	Supplied with Kits
33	RV1	10K Pot.	Mouser	667-EVU-F3MFL3B14	
34	RV2	10k Pot	Mouser	667-EVU-F3MFL3B14	
35	IC3	78L05	Mouser	511-L78L05ACZ-AP	

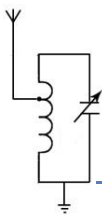


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Stage 1 – Build the Power Supply

Start construction by soldering the diodes D1 & D2 (note orientation) then capacitors C9 & C11, these are also polarized so note orientation as marked on the board. Insert IC3, ensuring the orientation flat on the IC matches the print on the PCB. Now add the resistor R2 and the barrel jack. This completes the power supply section, by applying 12 volts to the barrel jack (center positive) and referring to the Stage 2 photo check the correct voltages are at the test points shown.





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Stage 2 – Voltage checks

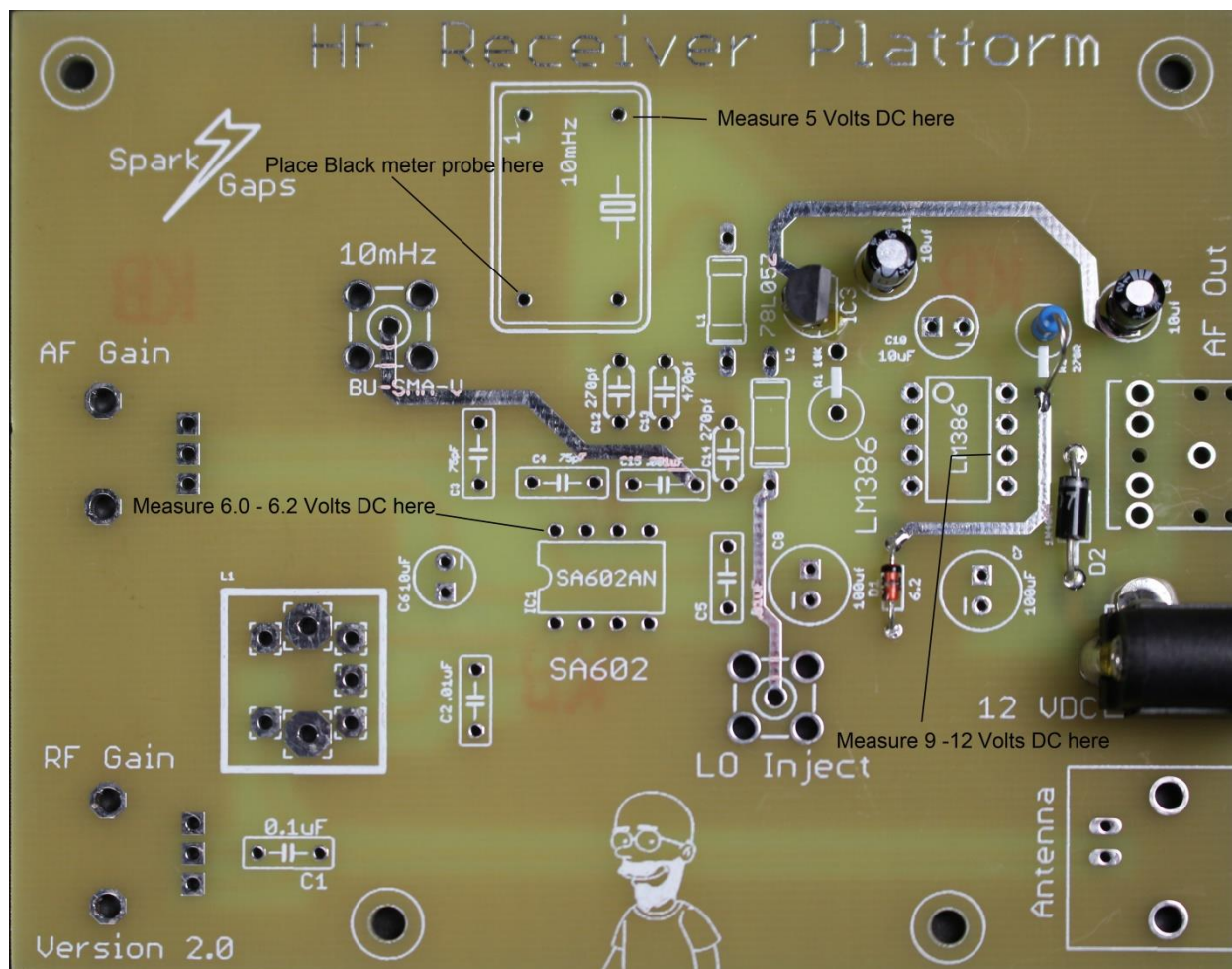
With power applied to the barrel jack, probe the board as indicated with your meter set to 20 volts DC range. Apply the black probe to the ground plane and the positive or Red probe to measure voltages:

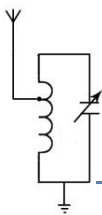
5 Volts DC at the oscillator

Input voltage at Pin 6 of the LM386

6-6.2 Volts at Pin 8 of the SA602N

If all voltages check out correctly, you are ready to move to the next stage, if not recheck your work.





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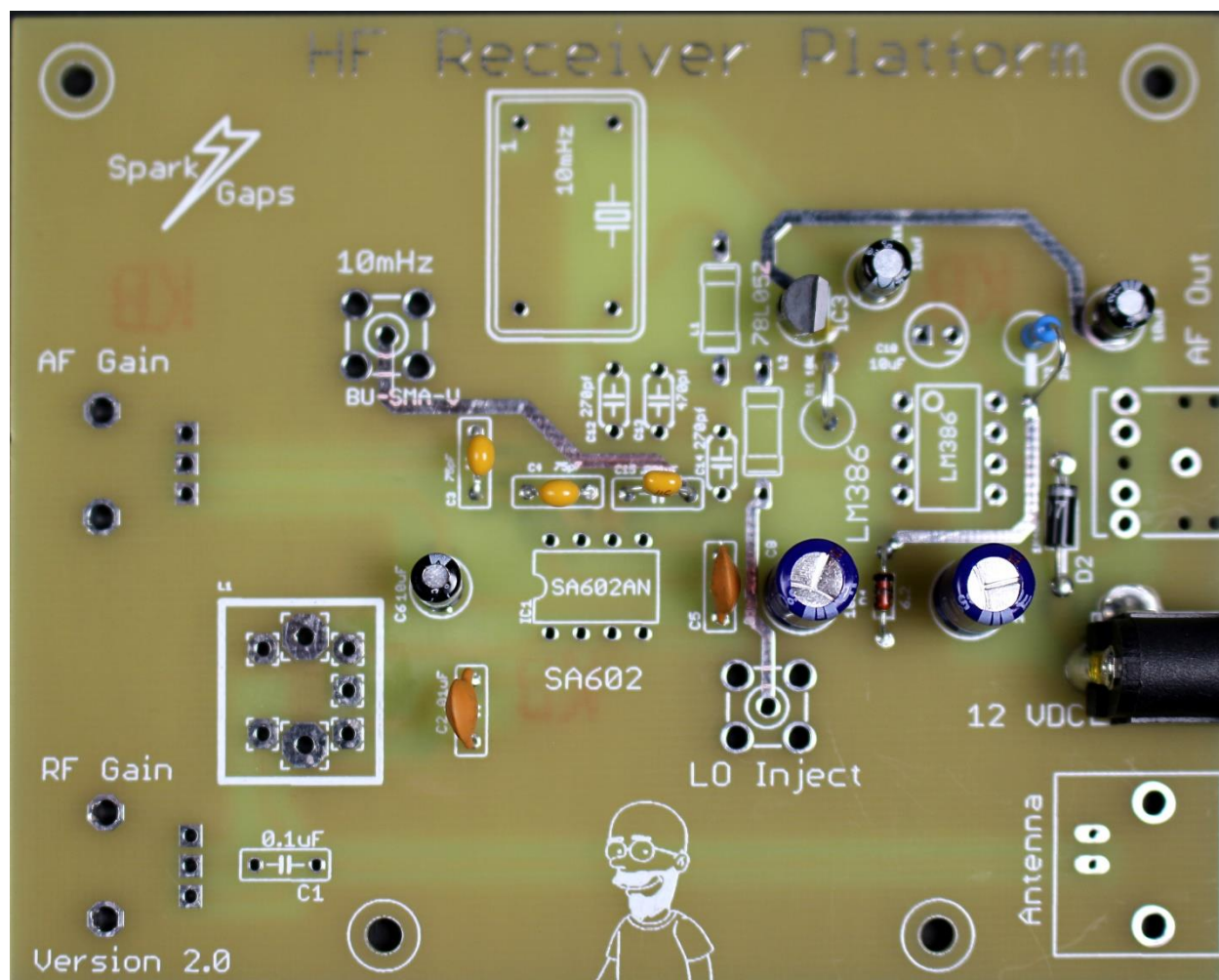
Stage 3 – Add capacitors

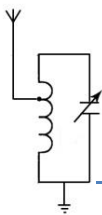
For this stage we are adding C1, C2, C3, C4, C5, C6, C7, C8, C12, C13, C14, and C15. Note C10 is not added, its purpose is to increase the AF amplifier gain, and was not found to be needed.

Additionally, R1 is not installed; please place a wire link here instead.

When completed compare your board to the photo below. Make sure capacitors C7 & C8 which are polarized are in the right orientation.

When you are happy with your work, move onto Stage 4.





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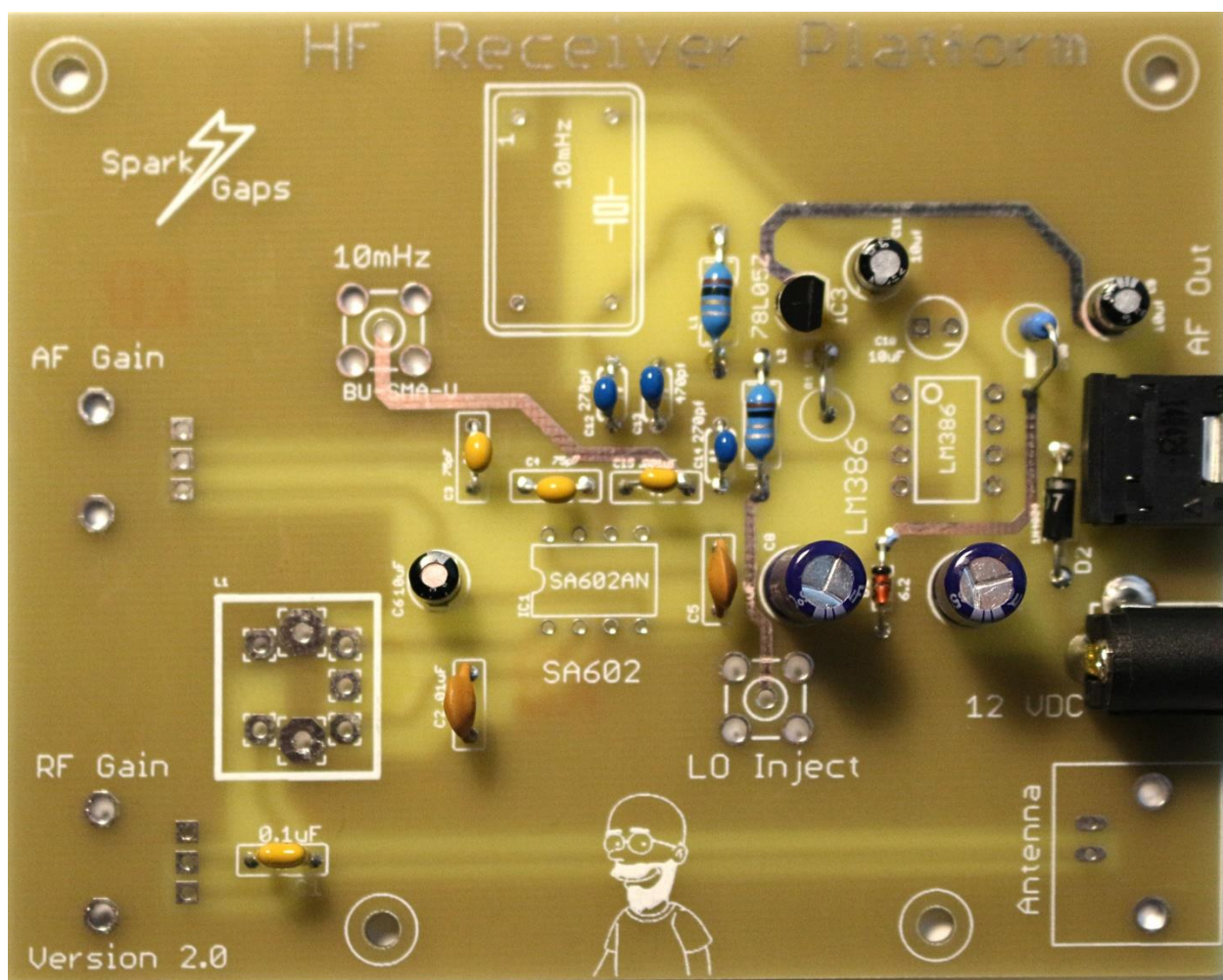
Stage 4 – Inductors

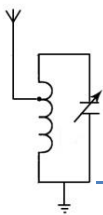
Install inductors marked L1 & L2, these look like resistors so don't get them mixed up with the resistor R2.

Please note that the can inductor is also marked L1 on this release of the PCB

For this stage we have also found that adding the 3.5mm audio jack can be achieved easily at this time.

Compare your board to this photo when complete.



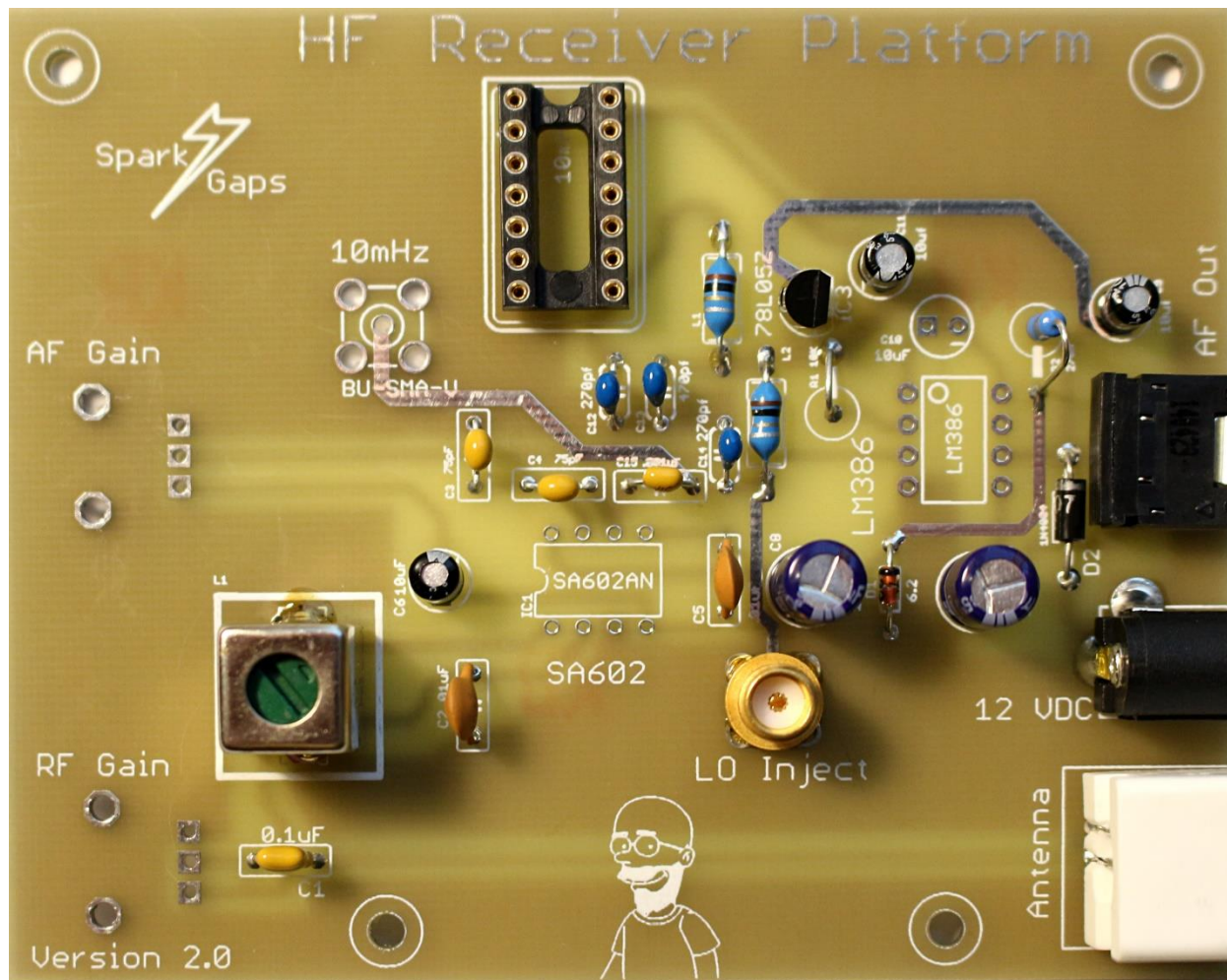


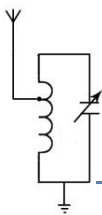
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Stage 5

Add the can inductor (marked L1) it only goes one way; don't forget to solder the can lugs to the ground plane as well. Add the oscillator socket and the vertical mount SMA socket, plus the BNC jack

Compare your board to the photo and move to the next stage if all is OK.



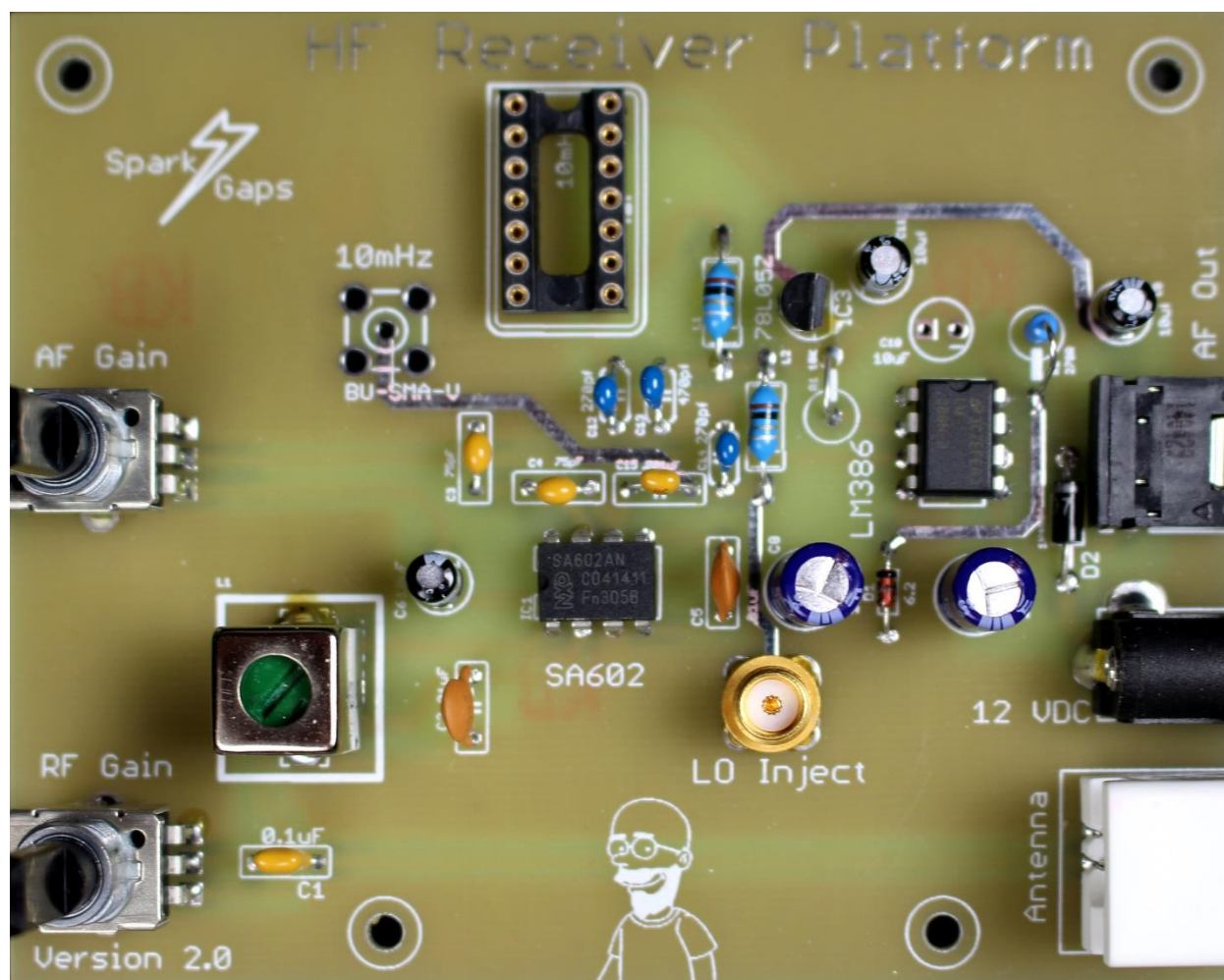


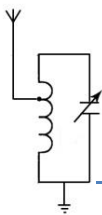
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Stage 6

This is the last construction step. Add the variable potentiometers AF & RF Gain. They are a snug fit to the board, if you are having trouble mounting these try squeezing the mount lugs in slightly when lining up the part just as you insert it. Note that the design allows these pots to be mounted on either side of the board.

Add the mixer IC (SA602) and audio IC (LM38). You can use tape to hold them down or adhesive putty such as Elmer's adhesive putty for children, a small blob works well and removes cleanly. Observe correct orientation of the LM386 & SA602N.





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Stage 7 – Check & Test

If you have used our stage method to build the kit, your receiver is now ready to be put to work. First carefully check the board over visually and make sure all the solder joints look good, if any appear a little suspect, reflow and make them good. Check that the polarized capacitors are in the right way round, plus the chips are also in the right way round. Correct any errors.

If you are happy with your work, prepare a center positive 5.1mm jack to mate with the power socket, connect an antenna to the BNC jack, plug in a headset (smartphone earbuds work well) or powered computer speakers, to the 3.5mm jack

Plug in the supplied block oscillator, be careful to orient it correctly, with the square corner in the top left of the socket, also make sure the pins are in the holes and not bent out or under.

Set the AF and RF gain to their mid points (they have a midpoint detent to help), apply power. You should hear a hiss, advance the AF gain pot to a comfortable listening volume, you should now be hearing the tick of WWV. If not advance the RF gain control until the tick is heard.

To get the best signal strength, the can inductor (L1) will need to be adjusted, using a non-metallic adjuster (preferred) slowly turn the core to peak the signal strength

The AF & RF controls are designed to be installed either on the component side or solder side. If mounting in a box, mounting the controls on the solder side is a good idea.

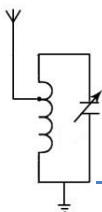
Due to this mount option, the controls work clockwise to increase gain when mounted on the solder side or anti-clockwise when mounted on the component side.

This completes the receiver in its most basic form. For suggestions on improvements and extra things that can be done with this platform, please check out the experimenter section.

Stage 8 - Problems and Issues

This is a tested design which we have built and ‘abused’ so it should work first time, however, if nothing is heard or no hiss is heard, remove the power plug, and follow these suggestions:

1. Recheck all components for good solder joints. Use a magnifier to get a better look if needed.
2. Have all component leads been soldered, a common issue is a non-soldered lead.
3. Recheck the orientation of C7, C8, C9, and C11.
4. Are the IC’s installed the right way?
5. Does the board have power; recheck the voltages, also, check the plug is center positive.
6. Try another speaker or headset.
7. Are the controls fully anti-clockwise if the pots are mounted on the component side or fully clockwise if mounted on the solder side?



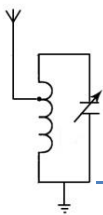
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Experimenter Ideas

In its most basic, supplied form, the receiver is a capable performer, and can deliver the signal of WWV well, which in itself can be useful as a beat frequency for frequency measurements; however, the platform also has opportunities to be used as the basis for improvements and RF experiments.

The following notes are suggestions, I'm sure you can come up with a lot more ideas.

- Add a local oscillator.** As supplied a 10 MHz block oscillator is installed on the board, however, a vertical SMA socket is also installed, marked LO Inject. By removing the block oscillator a signal can be injected via this SMA LO Inject socket from a signal generator or other signal producing device, such as a DDS. This receiver platform has been tested with several types successfully. The N3ZI DDS2 works well as do the commonly available AD9850 type DDS from eBay.
It is possible that while the SA602 can be driven directly by the output of the DDS, a small buffer amplifier may also be needed. This can be a simple 1 or 2 transistor buffer, such as shown in the appendix.
Using an external oscillator or DDS produces a wideband receiver capable of tuning from approx. 2 MHz to about 18 MHz
- Using a tunable AF filter.** As supplied the receiver has good audio, however, like many simple receivers it does lack selectivity. Adding an out board AF filters at the speaker jack is one possibility or a filter can be added between the SA602 and the LM386. This mod will need the trace coming from the SA602 pin 4 to be cut and a small gap created to allow the filter to be inserted. A variety of filter designs exist and have been shown to create a useful improvement especially when receiving Morse (CW)
- BCI Filter.** One drawback of the direct conversion receiver is that a local or not so local high power broadcast station can blanket the receiver on all bands and prevent good reception. A BCI filter at the antenna jack is often a good solution. A simple filter is shown in the appendix that has proven satisfactory for reducing BCI. Additionally adding a 10uF electrolytic capacitor on the bottom (trace) side of the PCB between Pin 7 (positive of the electrolytic) and ground of the LM386 can also help to bypass or reduce this interference.
- RF Pre-selector.** While the receiver has good sensitivity (measured at) a pre-selector can help pull out weak signals and in some cases bring in signals on an otherwise dead sounding band. A variety of circuit options exist for a Pre-selector.
- Simple Transceiver.** A local oscillator can be used to drive both the receiver and a simple transmitter, to create a transceiver. Some TR switching would be needed of course.
- Other ideas.** This open receiver platform can be the test bed for numerous other experiments, in particular antenna experiments, and allows the learning by doing principles of Amateur Radio to be explored in quite a bit of depth. Enjoy and happy experimenting.

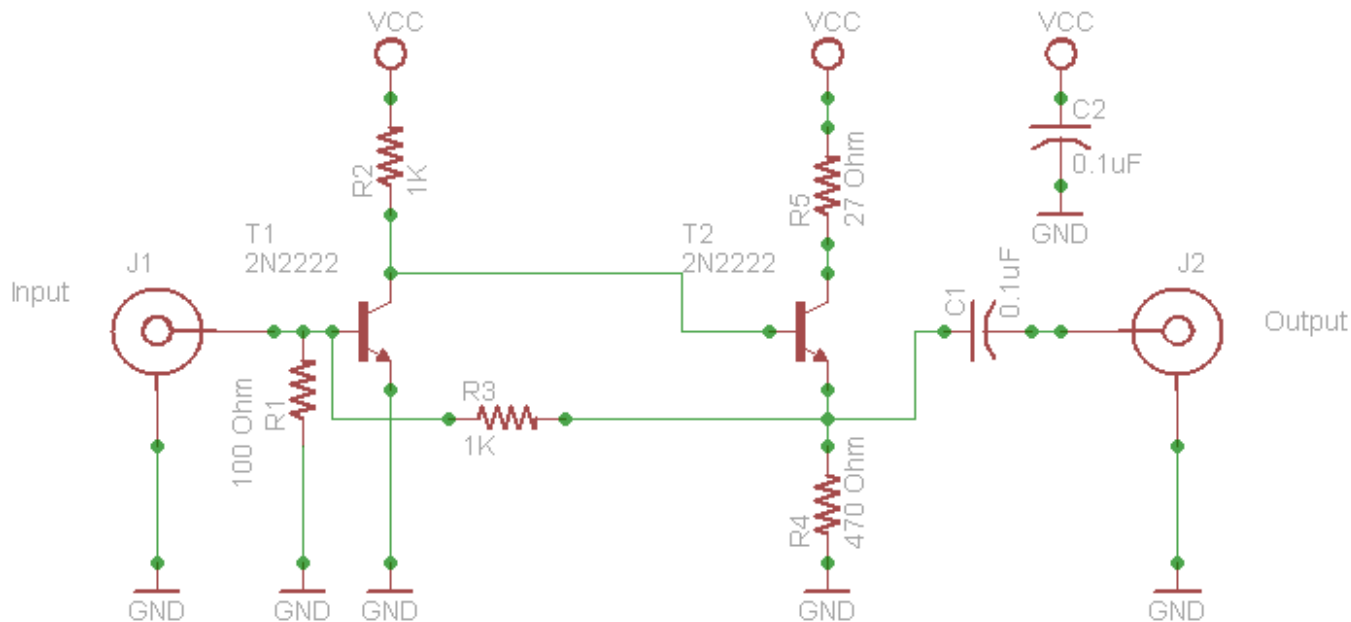


Appendix

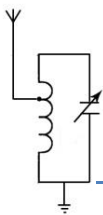
DDS Buffer Amplifier

This simple buffer will provide ample amplification for add on VFO/DDS that do not provide sufficient drive levels:

DDS/VFO Buffer Amp.
Connect between DDS
and Receiver Local Osc.
Runs well from 12 VDC



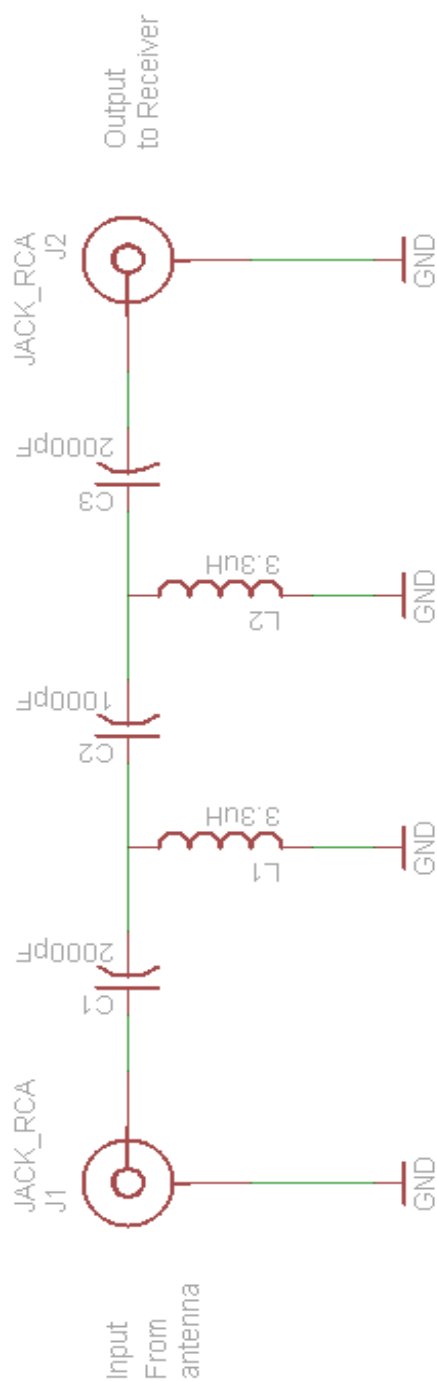
A 2N2222 transistor is specified; however any general purpose NPN transistor will suffice – may be built Manhattan style.



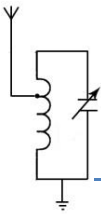
BCI Filter

The following filter can be fitted at the antenna plug and has been shown to reduce interference.

Filter is best assembled in metal enclosure.

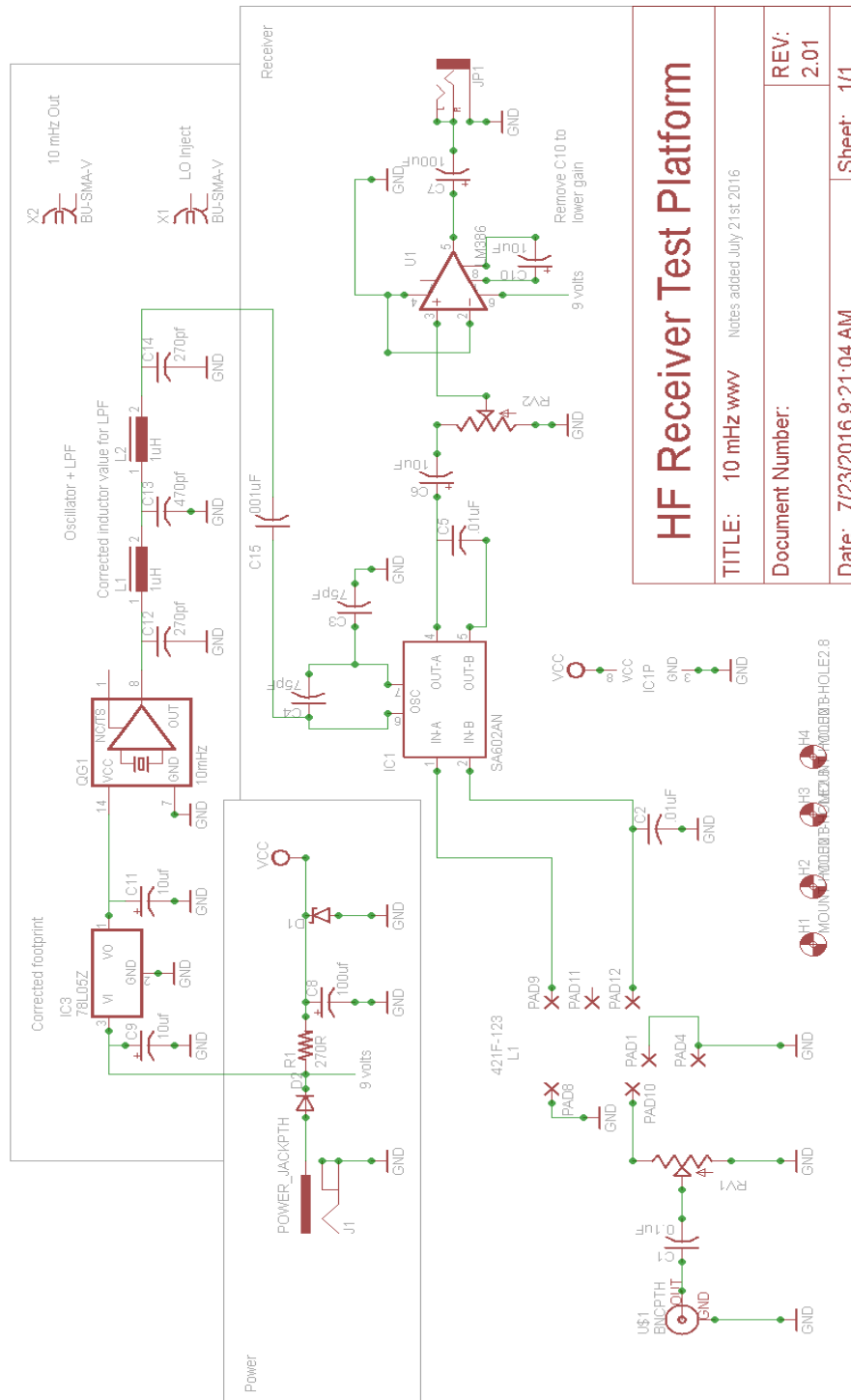


BCI Filter capacitors are silver mica
Coils L1 & L2 are 26 turns of #30
on a T50/2



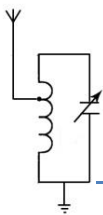
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Receiver Schematic



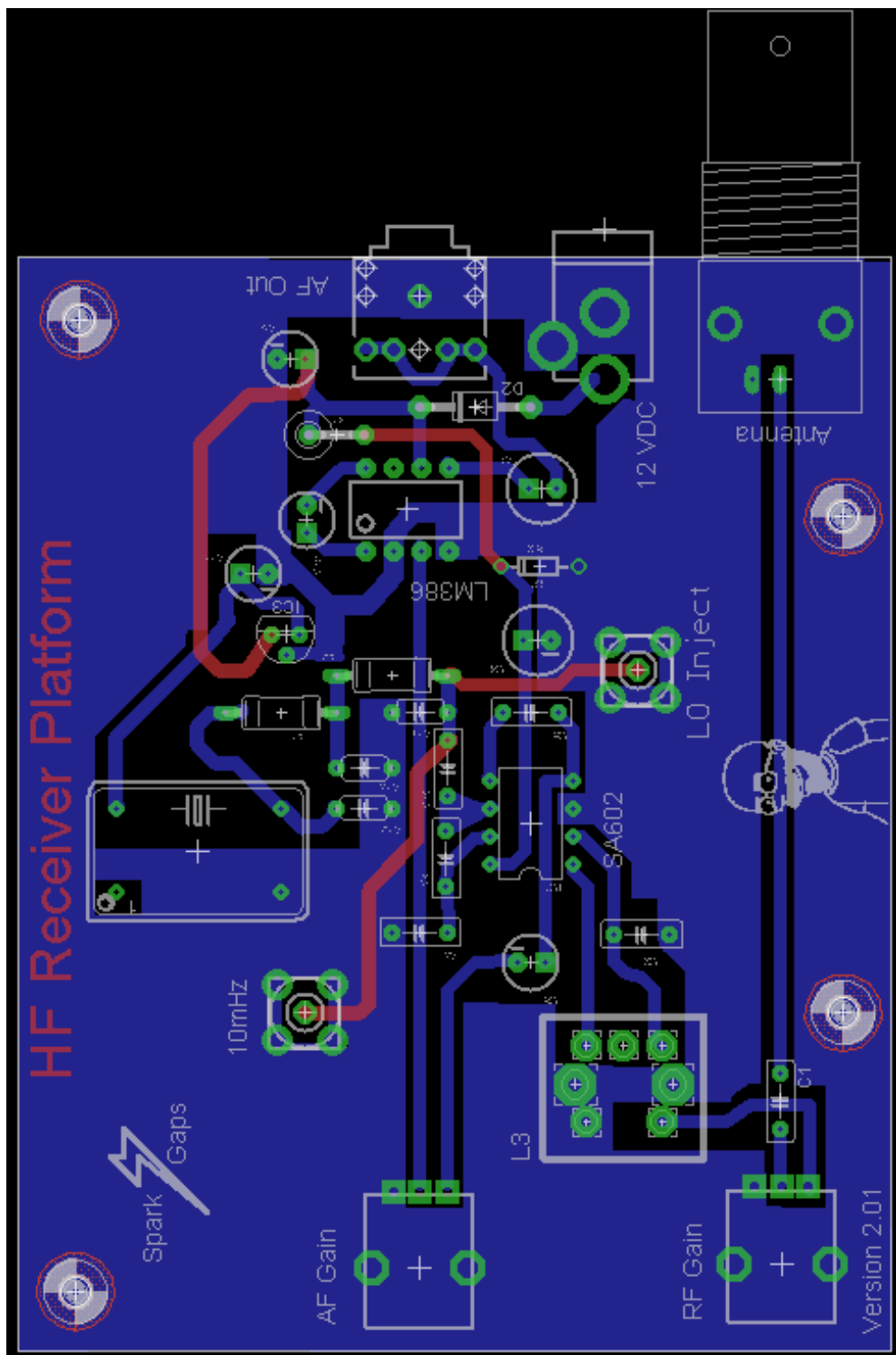
HF Receiver Test Platform

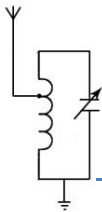
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Document Number:	REV: 2.01
Date: 7/23/2016 9:21:04 AM	Sheet: 1/1



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Receiver PCB

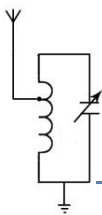




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Final words & notes

1. Receiver sensitivity was measured with a Wavetek 3001 and was found to be better than 0.1uV.
2. Enclosing the finished PCB in a metal box is recommended, a suitable enclosure is the Hammond 1550M, available from Mouser Electronics as part number 546-1550M.
3. The unpopulated SMA port has a copy of the oscillator frequency present that could be used for driving a digital dial, via a 0.1uF coupling capacitor.
4. For information about WWV : <http://www.nist.gov/pml/div688/grp40/www.cfm>
5. Any questions or comments to; resalese@gmail.com



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The small Print

DISCLAIMER

Any person who constructs or works on electronic equipment may be exposed to hazards, including physical injury, the risk of electric shock or electrocution.. These hazards can result in health problems, injury, or death. Only qualified persons who understand and are willing to bear these risks themselves should attempt the construction of electronic equipment. By purchasing this item, the buyer acknowledges these risks.

There is a risk of electric shock, electrocution, burns, or fires that is inherent in the construction and use of electronic equipment. By purchasing this item, the buyer acknowledges these risks.

IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE including, but not limited to, property damage, personal injury, death or legal expenses. Buyer's recovery from Seller for any claim shall not exceed the purchase price paid by Buyer for the goods, irrespective of the nature of the claim, whether in warrant, contract or otherwise. By purchasing this item, BUYER AGREES TO INDEMNIFY, DEFEND AND HOLD SELLER HARMLESS FROM ANY CLAIMS BROUGHT BY ANY PARTY REGARDING ITEMS SUPPLIED BY SELLER AND INCORPORATED INTO THE BUYER'S PRODUCT.