Yukon Amateur Radio Association
Pixie Workshop, Lesson 1 - The Oscillator

The Pixie transceiver that you will be building over the next few weeks is a remarkable little radio with quite a long history. The original idea central to this transceiver was conceived by George Burt, GM3OXX, in 1982 and since then the elegant simplicity of the design has inspired many others to develop variations and sometimes, improvements, on the original idea. If you want to know more about the Pixie's origins, one of the best sources is "The Pixie File" available at http://www.gqrp.com/The_Sprat_Pixie_File.pdf.

Recently various suppliers have provided incredibly low cost kits that make it even easier to construct a Pixie transceiver. You will be using one of these kits in this series of lessons. You can find the manual for this kit from LXQQFY at http://files.banggood.com/2016/SKU420968%20S-Pixie%20User%20Manual.pdf.

You should be aware that you require an Amateur Radio licence to use a Pixie "on the air". Also, if you already have a licence, the Pixie is not a good substitute for a better, more expensive transceiver - it is CW (i.e. Morse code) only, and has very limited features and performance. Nevertheless, construction of a Pixie can provide an excellent learning experience and the finished transceiver can give great excitement to the operator with the patience and skill to use one to achieve communication over hundreds or thousands of kilometres.

Construction:

In today's lesson you will install J1, D1, D2, C1, C3, C7, R1, R4 and the crystal Y1. These comprise the power supply and oscillator sections of the radio.

1. Install J1, the power connector. This connector is a "barrel connector" of the type often used for power connection. Usually the centre connection is to the positive terminal of the power source and the outer connection the negative terminal. J1 will only fit one way in the board. Solder it in place.

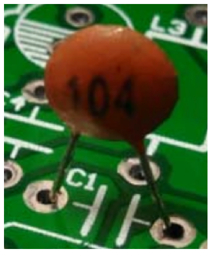
Install D1. This component is a "bridge rectifier". It has four terminals and it matters how they are connected. If you look carefully at the top of D1, you will see that there is a faint + and - marking there. Looking from the top of the board and D1, the + should be oriented to the small + on the circuit board. Insert the four leads in the appropriate holes. Solder them in place and then EXCEPT FOR THE LEAD CLOSEST TO J1, cut off the three protruding leads so that they are flush with the circuit board. Cut the fourth lead off so that it is about 1 to 2 cm long. It provides a convenient place to connect test equipment.

Before going on any further it is a good idea to check that this section of the circuit is working properly. To check, connect power to the J1 and a voltmeter between the long lead of D1 and the connection on the bottom of the board that is marked + on the top side. You should see a positive voltage of about 9 V.

2. Install CP1. This is a 100 µF electrolytic capacitor. It matters which way it is connected - if you get it wrong it may blow up with a bang and lots of smelly smoke. The lead marked - goes to the hole with the hatched marking, as shown in the picture below. Note that the picture shows a 10 µF capacitor, not the 100 µF CP1. Solder it in place.

From this point on Install means put the leads to the component in the appropriate place and solder the connection. Then trim the leads off flush to the circuit board.

3. Install C1, a 0.1 µF ceramic capacitor. It looks something like the picture below. That it is a 0.1 µF capacitor is indicated by the 104 marked in tiny numbers on the side of the capacitor. It does not matter which way it goes into the holes.



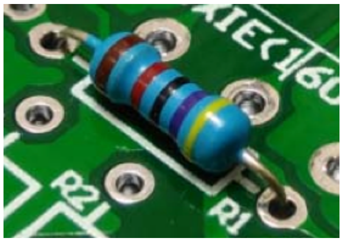
A note on ceramic capacitor labelling:

Starting from left to right, the first two numbers are the first two digits of the capacitor's value. The third number gives the multiplier. The label 104, then, means the capacitor has a value of 10 x 10^4 picofarads (pF) or 10^5 pF where a pF is 10^{-12} of a farad.
Since a microfarad (µF) is 10^{-6} of a farad, instead of writing 10^5 pF the value of this capacitor is usually written as 0.1 µF.

Other examples: a ceramic capacitor written as 471 would be 47 x 10^1 pF or 470 pF, and one marked 101 has a value of 10 x 10^1 pF.

Just to confuse things, however, nanofarads (nF, 10^{-3}F) are sometimes used too, so a capacitor marked 103 is 10 x 10^3 pF = 10^4 pF or 10 nF or 0.01 µF.

4. Install R1, a 47 k ohm resistor. As for ceramic capacitors, it doesn't matter which way resistors are connected.



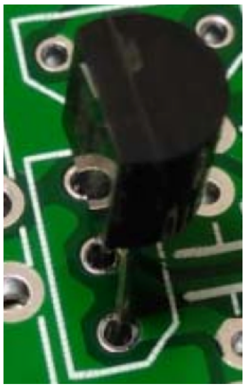
A note on resistor labels:

Resistor values are generally indicated by coloured bands circling the resistor. To read the code the resistor has to be turned the correct way so that the codes read from left to right. Generally, if the resistor is oriented correctly, there is a little more space between the last band on the right and the wire lead compared to that on the left. The coloured bands are black = 0, brown = 1, red = 2, orange = 3, yellow = 4, green = 5, blue = 6, violet = 7, grey = 8, white = 9. As you can see, the middle numbers follow the colours of the rainbow.

It can be tricky to tell the values of resistors provided in this kit using colour codes. Probably the best way to find the correct value is to use the codes to narrow down the selection and then measure with an ohmmeter.

5. Install C3 and C7, both 100 pF capacitors marked 101.

6. Insert the transistor Q1, marked as 9018 into the holes marked for is. It matters how the transistor is connected. The curve of the transistor should match the outline on the circuit board. Push the transistor down as far as it will go without undue forcing, and then solder it in place. Trim off the outer two leads but leave the centre lead long (the base lead) so that test equipment can be connected later.



7. Insert diode D2, a 1N4001 into the holes for D2. Like D1, it matters how this is connected. On one end of D2 you will see a band circling the diode. This band should be oriented in the same direction as the markings on the circuit board as you push the leads through the board. Solder the leads in place but leave the lead connected to the banded end of the diode long i.e. about 1 to 2 cm, so that it is easy to connect test equipment to it later.

8. Install Y1, a 7.023 MHz crystal into the holes marked for it on the circuit board.   It does not matter which way it is connected.

9. Insert C4, a 10 nF capacitor marked 103 into the holes marked for C4. Solder it in place but leave the lead closest to the transistor Q1 long. This completes the construction of the power supply and oscillator sections of the transceiver.

Testing:

1. Make sure none of the leads that were left long on the bottom of the circuit board are touching anything that they shouldn't be and then connect power to the board. Tune a receiver to the region near 7.023 MHz and see if you find the signal from the oscillator. If not, then some troubleshooting will be necessary. If you hear the oscillator - great! How loud it the signal at this **fundamental frequency** of the oscillator?

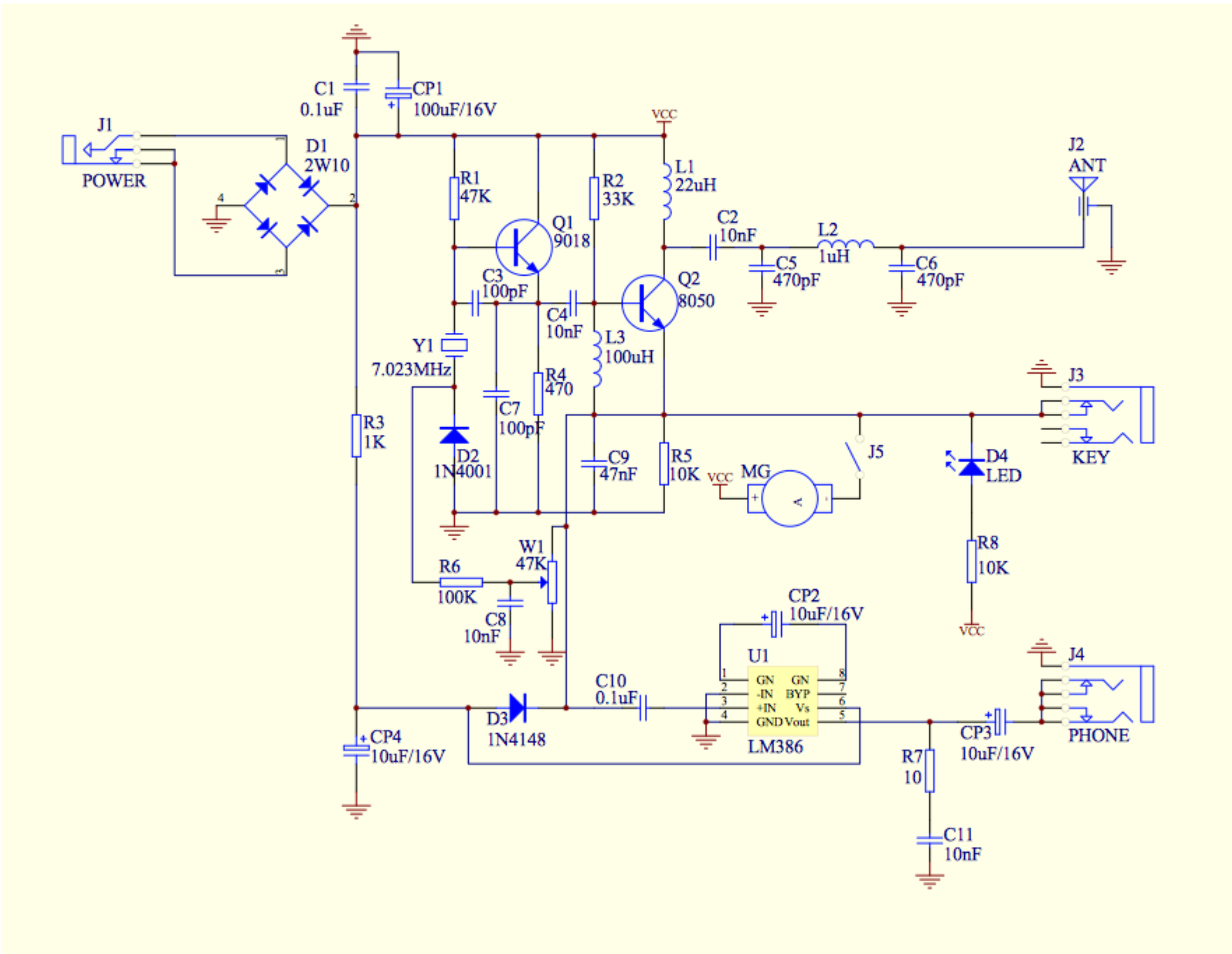
2. Tune the receiver to twice the frequency of the fundamental - the **second harmonic** - at 14.046 MHz. You may have to tune around a bit to find it but you should hear this harmonic. How loud is it?

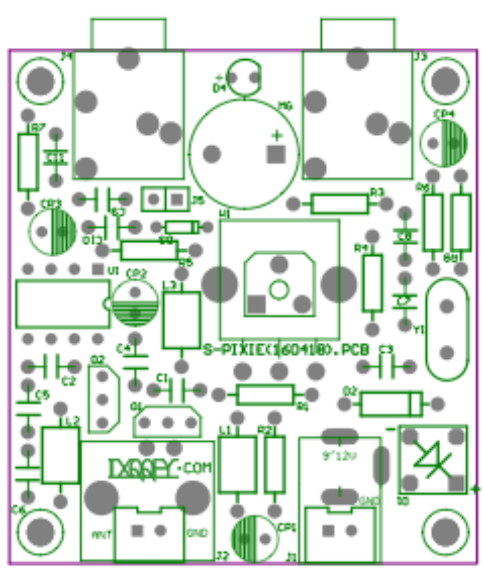
3. Look for the **third and fourth harmonics**. Do you find them? At what frequencies and loudness?

4. Connect the probe for one channel of an oscilloscope to the long lead that you left on the output end of C4. Draw a sketch of the waveform you see and estimate its peak to peak voltage. Leave this probe connected for this test and test 5.

5. Connect the probe for the second channel of the oscilloscope to the middle lead of the transistor (the base). Estimate the peak to peak voltage and compare the phases of the two signals shown on the oscilloscope.

6. Leave the probe for the second channel of the oscilloscope to the middle lead of the transistor. Connect the other channel to the banded end of the diode D2. Draw and label the waveforms you see. Estimate the peak to peak voltages of the two waveforms and compare their phases.


J1
POWER
D1
2W10
C1
0.1uF
CP1
100uF/16V
VCC
R1
47K
R2
33K
L1
22uH
Q1
9018
Q2
8050
C2
10nF
L2
1uH
C5
470pF
C6
470pF
J2
ANT
C3
100pF
C4
10nF
Y1
7.023MHz
L3
100uH
R4
470
C7
100pF
R3
1K
D2
1N4001
C9
47nF
R5
10K
MG
J5
D4
LED
J3
KEY
W1
47K
R6
100K
C8
10nF
R8
10K
CP2
10uF/16V
U1
GN
-IN
+IN
GND
BYP
Vs
Vout
LM386
C10
0.1uF
D3
1N4148
CP4
10uF/16V
CP3
10uF/16V
J4
PHONE
R7
10
C11
10nF


S-PIXIE(160418).PCB
9~12V
ANT
GND