R80 Aviation Band Receiver
Kit Instructions V6.2 EN

Overview

This receiver kit is designed to receive radio communications between aircraft and towers. With a good antenna (e.g. a multi-element VHF Yagi antenna), it can receive calls between various types of aircraft and towers up to 150 km away in unobstructed areas.

The design of this kit was originally created by “套件之家”("Kit Home"), and the current version is the result of considerable design effort.

The hardware described in this article is V6.0 and the PCB labelled “HM00ABRC_6”

Key Specifications

Tuning Range : 118MHz – 136 MHz
Mode : AM
Supply Voltage : 12V (It is recommended to use linear regulated power supply or battery)
Current Drain : 90mA [SC Note: 110mA when muted and up to 150mA with full audio]

Circuit Description

Refer to the circuit diagram shown on the last page of this document.

The signal received by the antenna passes first through a bandpass filter (BPF) and an MMIC high-gain chip (U2). The BPF provides full coverage of the 118MHz – 136MHz band. It ensures that only signals in this band are amplified by the MMIC while other signals above and below this band are rejected.

The filtered and amplified signal then passes into the NE602 first mixer (U1). The NE602 mixes this with the local oscillator signal provided by the PLL. The frequency of the local PLL oscillator is 10.7MHz higher than the external signal.

The NE602 mixer outputs the sum and difference frequencies to the 10.7MHz ceramic filter. Its function is to filter out the unwanted signals generated by the mixer. The difference frequency equals the first intermediate frequency (IF) signal of 10.7MHz. The sum of the frequencies is rejected by the filter. The filtered signal is then sent to the second mixer in the MC3361 (U5) for conversion to the second IF of 455kHz using the 10.245MHz crystal (Y2) as the oscillator signal for this mixer. This signal is then sent to the TA7640 (U4) for further amplification and amplitude modulation detection.

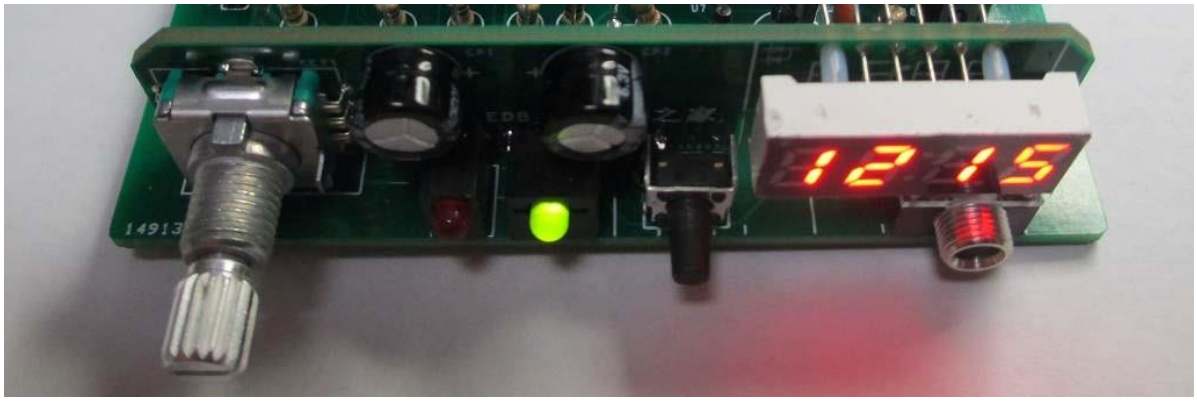
The resulting audio signal is passed to FM62429 (U6) which controls the audio volume. The output from U6 is then amplified by LM386 (U7) and sent to the speaker/headphones. At the same time, a second audio signal from U6 is sent to the MC3361 for squelch control.

Component Selection

All capacitors less than 1000pF are high-frequency ceramics, capacitors greater than 1uF are aluminum electrolytic capacitors, and all resistors are 1/4W 5% fixed resistors.

Soldering Reminder

The 4-digit LED display should be soldered AFTER the rotary encoder and the two stubby electrolytic capacitors have been fitted to the Display PCB, as shown below:



There are four (TINY!) white round spacers about 3mm high in the kit. These are used to fix the height of the LED display above the PCB when soldering the 4-digit LED display in place.

Once completed, and AFTER the two indicator LEDs, pushbutton and audio socket have been installed on the Main PCB, the display board may be mounted on the main PCB using the 10-way right-angle pin strip.

Assembly and Alignment

Test all transistors, resistors, and capacitors with a multimeter before installing all components, then install all components according to the circuit diagram and the markings on the PCB.

Generally, fit the components in the order of lowest to highest height above the PCB. At the same time, install sockets for the integrated circuits. This avoids the need to solder the main integrated circuits.

Check your work carefully. If your assembly is correct, connect the power supply. IMPORTANT: Make sure the positive and negative polarity of the power supply is correct.

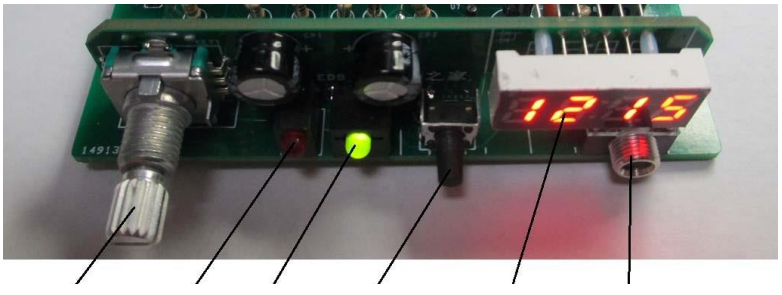
Plug a pair of Walkman-type earphones into the earphone socket. You should hear white noise.

Touch pin 2 of the NE5204 with your hand. The earphone noise should increase indicating that the receiving function is basically normal.

Now, connect a piece of insulated stranded copper wire about 60 cm long to the antenna socket. You should hear the noise increase significantly. This means that the receiver is basically operating correctly.

The parts that need to be aligned in this receiver are L1, L2 and T1. If you do not have a suitable signal generator for this band, it is recommended that you find a 125MHz crystal oscillator, power it up, and connect the clock output to a piece of wire. Adjust the frequency of the receiver to 125.0MHz, and then carefully adjust L1, L2 and T1 to achieve the strongest and clearest signal.

When the receiver is first turned on, it will default to a factory-set frequency of 121.5MHz, which is the general aviation emergency frequency. If you are close to suitable signals, you can connect the antenna and directly listen to this signal in order to adjust L1, L2 and T1.



From left to right, the knobs and buttons of this machine are: tuning knob, signal received LED (signal strength indicator), Mode indicator LED, Mode selection button, and the headphone jack.

The power plug and connection details for this receiver are as follows:

Connector: DC 2.1mm type

Antennas for the Receiver

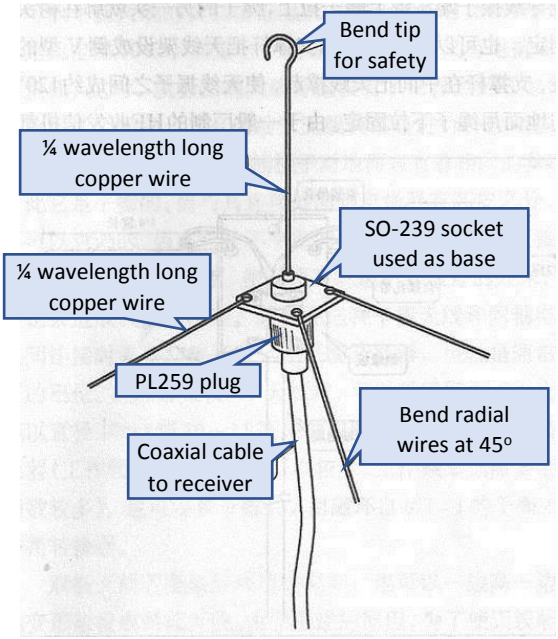
VHF communications are carried out along paths that are close to a straight line. If there is a very large signal from a nearby tower present in the VHF band, any other smaller VHF communications signal you wish to hear from an aircraft can be blocked. You need to pay attention to this when listening to the tower signal. It is better to listen to the signal of the aircraft as they arrive and depart from an airport.

Because the height of the aircraft close to the airport can be anywhere from several hundred metres to several kilometers in altitude, the signal can cover a long distance. At the same time, for better results, it is recommended to use an external high antenna, such as a 1/4 wavelength (about 60 cm) ground plane (GP) antenna, or better still, use a VHF multi-element Yagi antenna. In short, you need a suitable antenna to match the actual environment to achieve good results!

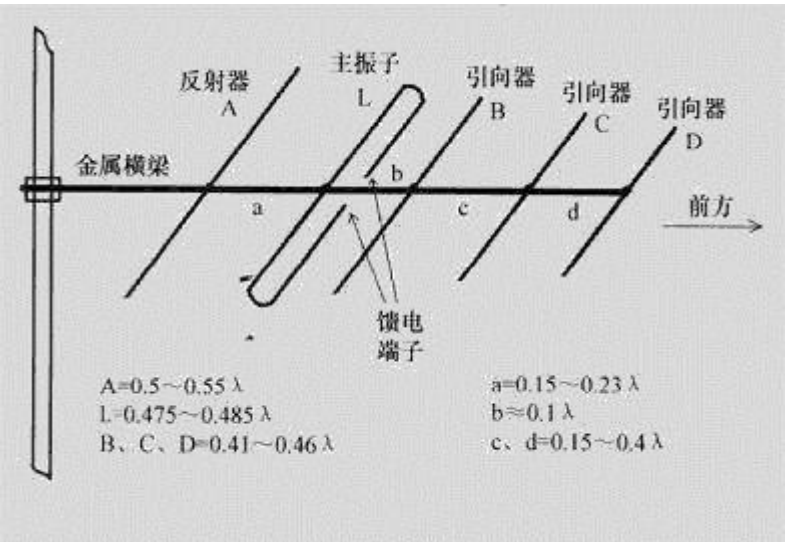
The specific antenna installation reference is as follows:

For beginners, it is recommended to use the GP antenna or Yagi antenna. These two antennas are relatively simple and readily homemade. The diagram below shows the GP antenna comprising several metal elements, an RF socket and plug (typically a PL259 plug on the coaxial cable running to the receiver and a matching SO239 socket).

A GP antenna is the abbreviation for ground plane antenna. This kind of antenna is also called vertically polarised grounded quarter-wavelength antenna. It is a commonly used vertically polarized omnidirectional antenna. It consists of a vertical radiating element and 3-4 horizontal or downward slanted antenna elements [SC Note: Each should be about 600mm long]. The GP antenna has a simple structure and is easy to set up. It does not need a rotator. It is generally used as a fixed radio antenna and it is simple to make.



The picture below shows the Yagi antenna. This antenna has good directivity and high gain.



The metal mast should be at the rear of the Yagi antenna. This ensures the mast will not have a significant impact on the antenna radiation field. In the diagram, λ is the wavelength. The antenna can be assembled after calculating the length of the director, the reflector and the other antenna elements, and the spacing a, b, c, and d.

SC Note: Yagi antennas can be homemade but unless it precisely duplicates an existing proven Yagi antenna design, a DIY Yagi is unlikely to achieve a good result. The information shown in the original Chinese text here does not provide an adequate level of detail for successful DIY construction.

Also, the drawing appears to show a horizontally polarized antenna. This does not match the typical vertical polarization used on VHF aviation radio services.

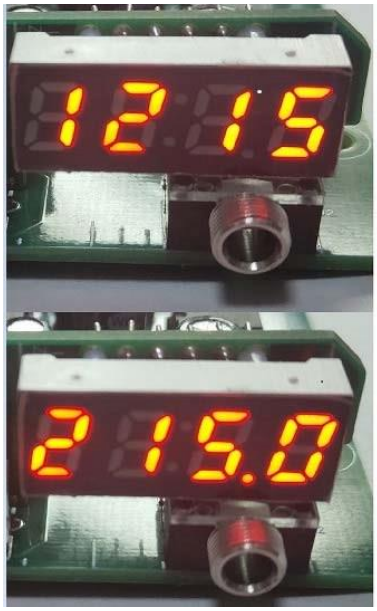
Finally, a Yagi antenna is highly directional usually aimed at signals close to the ground. Aviation signals usually come from any angle of the compass, and most often, at angles well above the Yagi. This generally makes the Yagi antenna a poor antenna for this receiver unless you ONLY wish to listen to local airport communications from a location more than a few kilometers away.

Installation in an Enclosure

The circuit board can be conveniently mounted in a standard aluminum case with dimensions 88mm x 30mm x 120mm (Note: This case is NOT included in this kit. Please purchase it yourself if you need it).

SC Note: A plastic box may also be used because this receiver is very stable and free from any detuning due to nearby objects.

Operation



When the power is turned on, the Mode LED light glows green, and the digital display will show a series of numbers. This means that the (tuning knob) encoder is in the Frequency Tuning mode (The default mode). If you turn the tuning control, you can see that the number on the right will change continuously, displaying numbers like 1215 for a received frequency of 121.5MHz.

This power-on default mode also sets tuning in 100kHz steps. So, when it displays 1215, this frequency is 121.5MHz (i.e. 1215 * 100kHz).

If you press in the tuning knob, it will switch to 10kHz step tuning. Since the display can only show 4 digits, the highest digit “1” will now not be displayed. This display will now show, say, 215.0 when the selected frequency is 121.50MHz. (i.e. 12150*10kHz). If you turn the tuning knob, the frequency will change in 10kHz steps. If you need to return to 100kHz step tuning, just briefly press the tuning knob again.

Press the Setting Select button. After release, the Mode LED light will glow red to show that the tuning control is now in Setting Adjustment mode. The display will now show 2_XX. The value ‘2’ indicates the audio volume setting can be adjusted. The last two digits shown here as XX represent the volume level. When the power is turned on the first time, the factory setting for volume will be displayed i.e. 2_10. The receiver volume can be set from 0 to 25. The larger the number, the higher the volume.

Press the Setting Select button again. After release, the display will now show 3_XX, the last two digits representing the squelch threshold level. This value can be set from 0 to 25. The larger the number, the higher the threshold (That is, the higher will be the level of the received signal required to unmute the receiver to allow aviation communication to be heard).

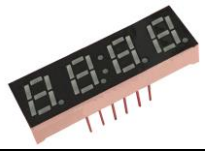
Press the Select button again. This will display 4_33, which is the 25MHz clock frequency offset setting. The default factory-set clock frequency offset is 33, and the default step size is 100Hz. The default PLL reference frequency is therefore 25 000 000 + 33*100Hz. If you find an error in the receiving frequency, you can use a frequency counter to measure the 25MHz clock frequency on the PLL board. You may then adjust the clock frequency deviation according to the measured value.

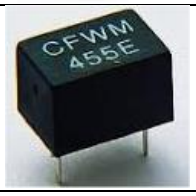
Pressing the Select button once more will return the display to the Frequency Adjustment mode.

In the Setting Adjustment mode, if you don’t press the pushbutton or rotate the encoder (tuning knob), the receiver will automatically return to the Frequency Tuning mode after about 3 seconds. Also, about 3 seconds after finishing the frequency or volume adjustment, the processor will automatically write the currently set frequency and volume into the internal EEPROM, and use this new value next time it is powered on.

This receiver is also equipped with a red Signal Strength indicator. This LED will turn on after receiving a suitably strong signal (Usually a signal of about -90dBm or more).

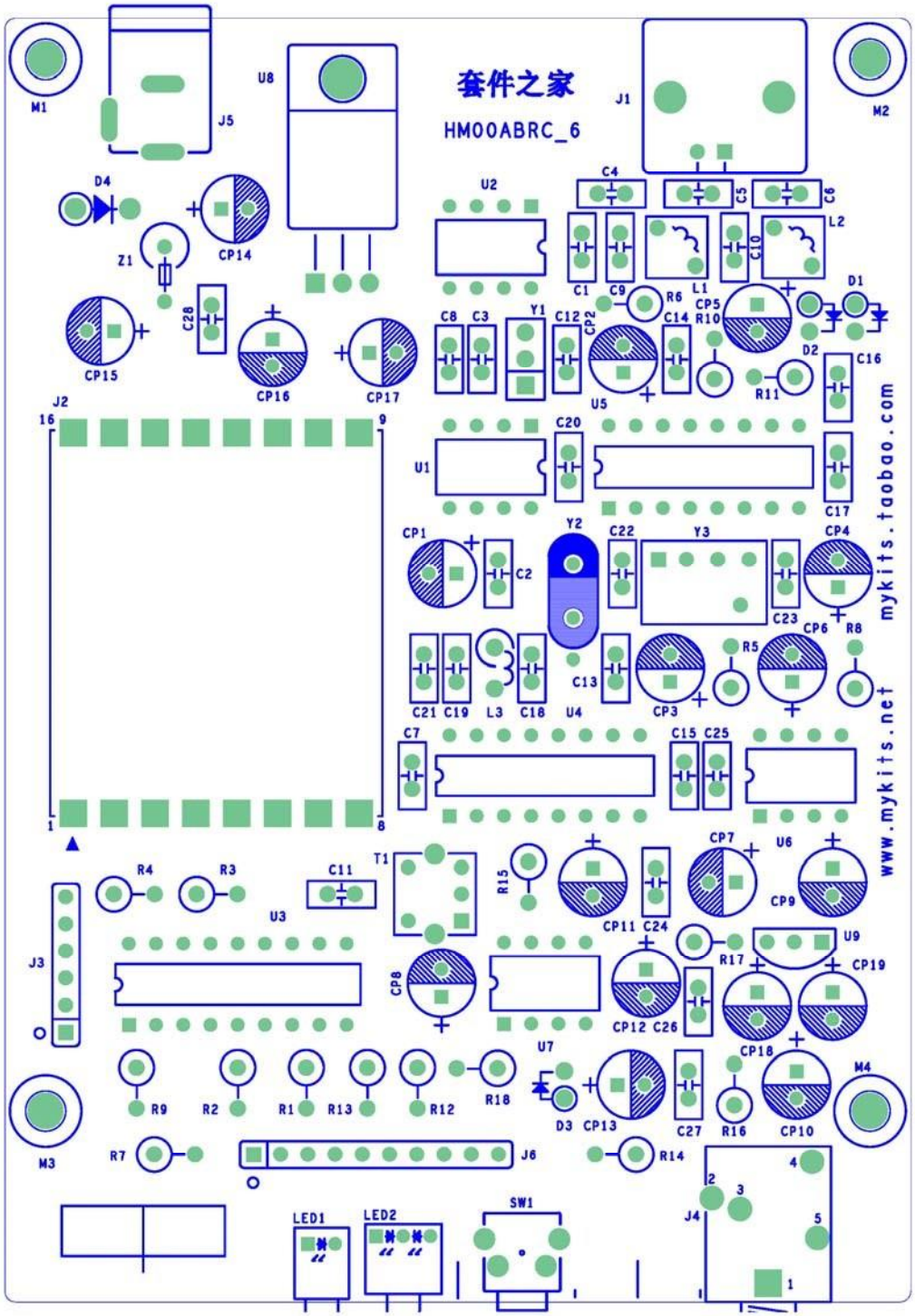
Parts List

1/4W 5% Resistors		
R1, R2, R3, R4, R8, R9	10k	Brown Black Orange Gold
R5, R16, R17	10R	Brown Black Black Gold
R6, R11	220k	Red Red Yellow Gold
R7, R10, R12, R13, R14	1k	Brown Black Red Gold
R15, R18	47k	Yellow Violet Orange Gold
Inductors		
L1, L2	5x5	
L3	100uH	
T1	7x7mm IF transformer	
Z1	Ferrite bead RF choke	
Ceramic Capacitors		
C1, C2, C11, C12, C13, C16, C19, C21, C23, C25, C26, C27, C28	0.1uF 100nF 104	
C3, C8, C14, C15, C18, C24	0.01uF 10nF 103	
C4, C6	8.2pF	
C5	2.7pF	
C7, C17	100pF	
C9, C10	15pF	
C20	47pF	
C22	120pF	
Electrolytic Capacitors		
CP1, CP2, CP4, CP6, CP7, CP8, CP9, CP11	10uF/25V	
CP3, CP10, CP12, CP14, CP15, CP16, CP17, CP18, CP19	100uF/25V	
CP5, CP13	1uF/25V	
Diodes		
D1, D2, D3	1N4148	
D4	1N4001	
LED1	3mm Red LED	Two leads
LED2	3mm Red/Green LED	Three leads
DISPLAY	4-digit 7-segment LED display	

Integrated Circuits		
U1	NE602	RF mixer 8 pin DIL
U2	NE5204	RF amplifier MMIC 8 pin DIL
U3	PIC18F1320	Microcontroller 18 pin DIL
U4	TA7640	16 pin DIL
U5	MC3361	16 pin DIL
U6	FM62429	8 pin DIL
U7	LM386	Audio amplifier 8 pin DIL
U8	7805	5V 1A regulator TO-220
U9	78L05	5V 100mA regulator TO-92
Ceramic Filters and Crystals		
Y1	10.7MHz ceramic filter	 The dot marks pin 1. This MUST be installed in the location for pin 1 shown on the PCB.
Y2	10.245MHz crystal	
Y3	455kHz ceramic filter	
Connectors		
J1	BNC socket	Antenna input
J2	Denotes PCB connections	For PLL module
J3	6-way pin strip	CON6
J4	3.5mm audio stereo jack	For speaker or earphones
J5	DC socket 2.1mm type	12V input
J6	10-way right-angle pin strip	CON10
Miscellaneous		
SW1	Pushbutton	
Receiver PCB – 1 off	Forms main board for receiver	
Display PCB/module – 1 off	Partially assembled - To be fitted with rotary encoder and 2 x 470u/6.3V electrolytic capacitors	
PLL PCB – 1 off	Preassembled - To be mounted on the main PCB)	

After receiving the kit, please check the parts carefully to confirm that all components are present. If you have any questions, please contact the kit supplier.

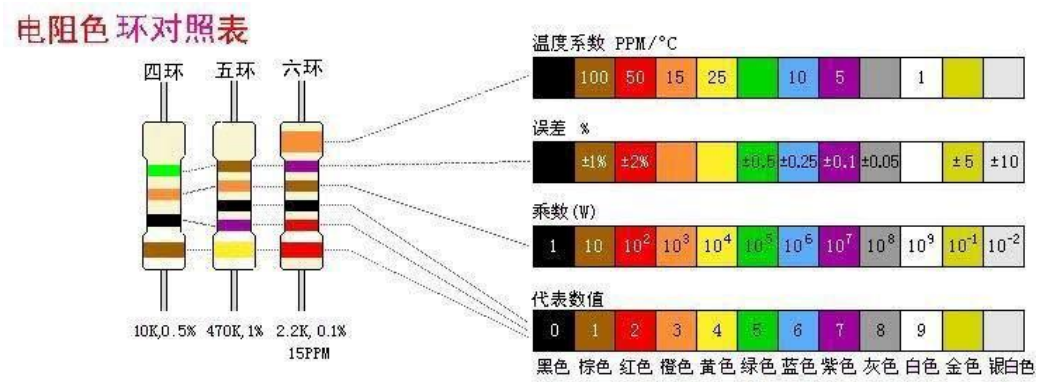
PCB Assembly Drawing



Please note pin 1 of Y1 (10.7MHz ceramic filter). It must be installed in the correct direction!

Resistor Color Codes and Ceramic Capacitor Identification

Resistors are marked using colored bands. Most resistors are 5% accuracy parts and marked with four bands. Less common 1% accuracy resistors are marked with 5 color rings. The following table can be used to read the value of these resistors:



The capacitance of ceramic capacitors is generally denoted in units of pF (p meaning pico or 10^-12). However, some parts are directly labeled, such as 1000p, 220p, etc.

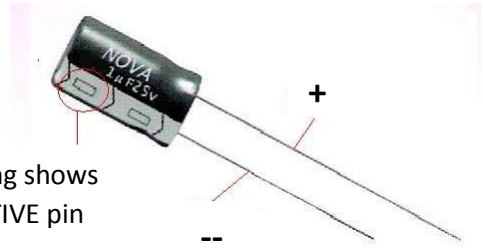
Most are labelled in exponential terms, such as 102,221. The first two digits are two most significant digits of the capacitor's value, the last digit being the number of zeros added after these digits. For example, "102" means that the leading digits are 10, while 2 means that 2 more zeros are added, i.e. 1000pF. Similarly, "221" means that the leading digits are 22, and 1 means that one further zero is added, i.e. 220pF.

62 here means 62pF

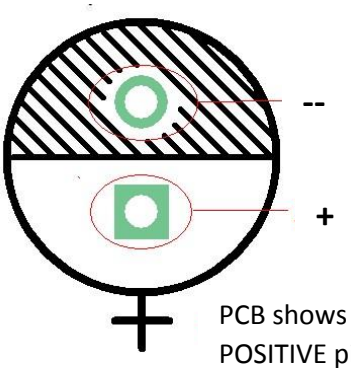
102 here means 1000pF

Polarity of Electrolytic Capacitors

Electrolytic capacitors are polarised. Please make sure that the positive and negative pins of these capacitors correspond correctly to the PCB markings when inserting these parts.



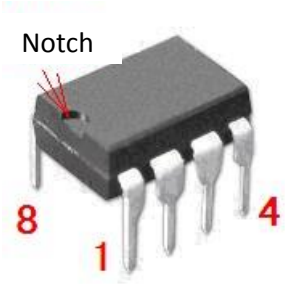
Marking shows
NEGATIVE pin



PCB shows
POSITIVE pin

IC Identification

e.g. 8-pin Dual In Line (DIL) type:

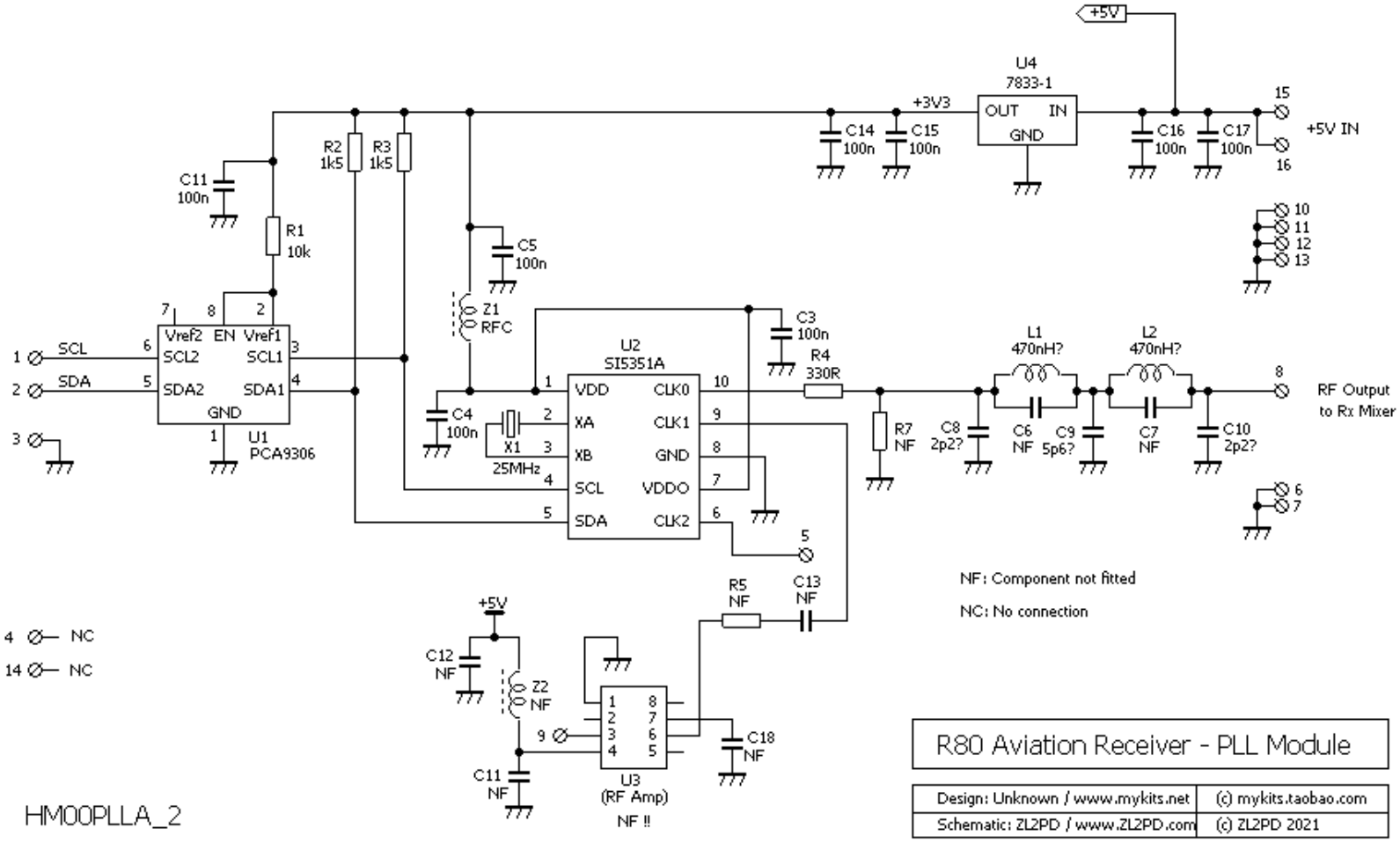


Identification of Transistors and Diodes

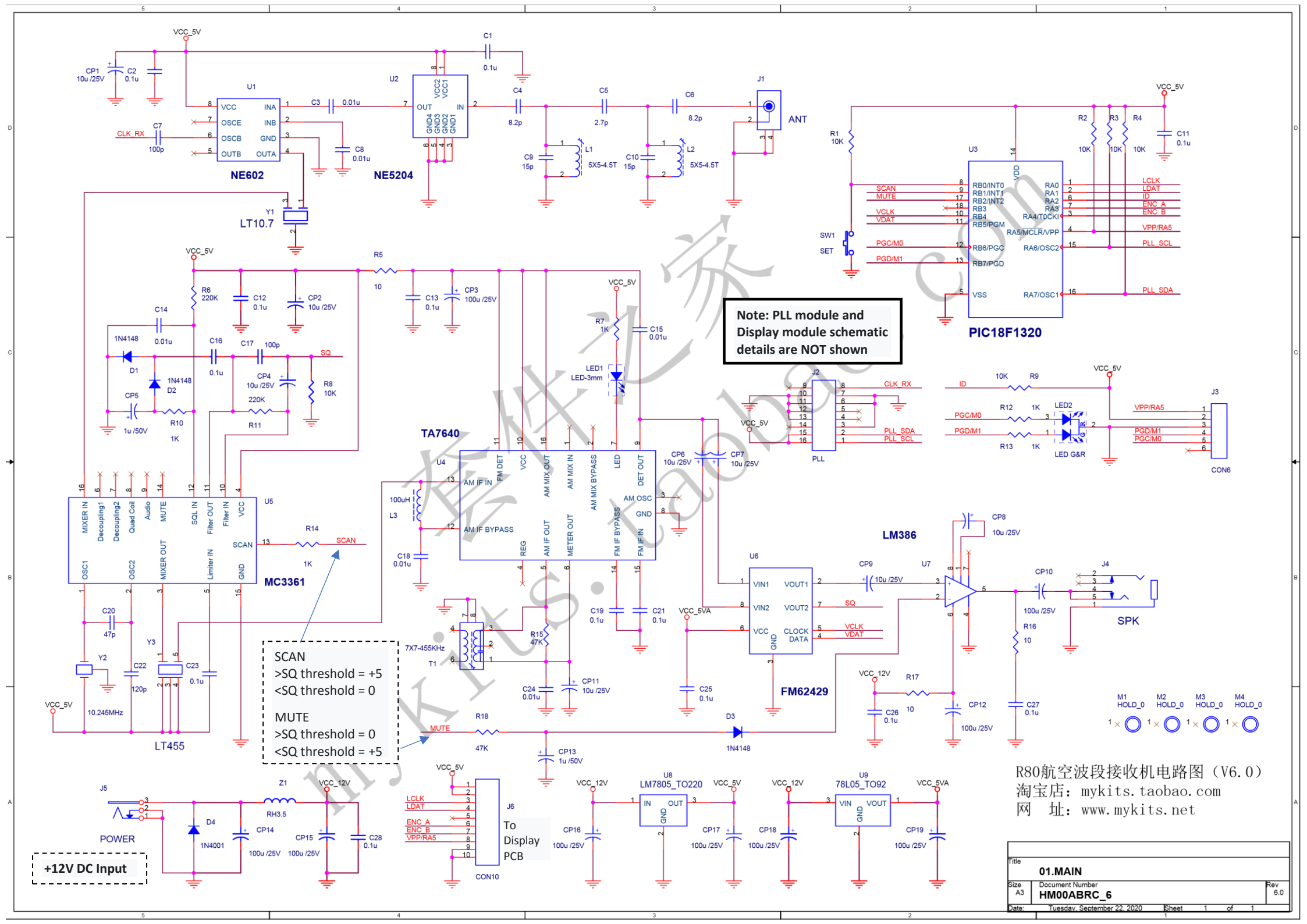
TO-92 package pin arrangement

1N4148 diode polarity

1N4001 diode polarity



Note: The circuit details shown on this page are provided for servicing purposes only. No kit construction is required.


NE602
NE5204
LT10.7
PIC18F1320
TA7640
MC3361
LT455
FM62429
LM386
SPK
ANT
PLL
CON6
CON10
POWER
+12V DC Input
To Display PCB
LM7805_TO220
78L05_TO92
Note: PLL module and Display module schematic details are NOT shown
SCAN
>SQ threshold = +5
<SQ threshold = 0
MUTE
>SQ threshold = 0
<SQ threshold = +5
R80航空波段接收机电路图（V6.0）
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01.MAIN
HM00ABRC_6
Tuesday, September 22, 2020