

R60 FM Broadcast and Aviation Band

PLL Receiver Kit

assemble manual

V1.0

Overview

This receiver kit is designed to receive FM broadcast and 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 hardware described in this article is V1.0 and the main PCB labelled "HM00ABRD_1"



Specifications:

Tuning Range : Dual band(88-108MHz, 118-136 MHz)

Mode : FM /AM

Supply Voltage : 12V (It is recommended to use linear regulated power supply or battery)

Current: FM mode 120mA, AM mode 160mA

Speaker: 8 ohm 250mW

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 send the signal into TA2003. The BPF provides full coverage of the 88-108MHz band and the 118-136MHz band. It ensures that only signals in this band are amplified by a LNA in TA2003 while other signals above and below this band are rejected.

The filtered and amplified signal then passes into the first mixer(also in TA2003). The TA2003 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 TA2003 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 TA7640 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 for further amplification and amplitude modulation detection. When in FM mode, the first IFsignal(10.7MHz)is derected sent to the FM DET(in TA7640) .

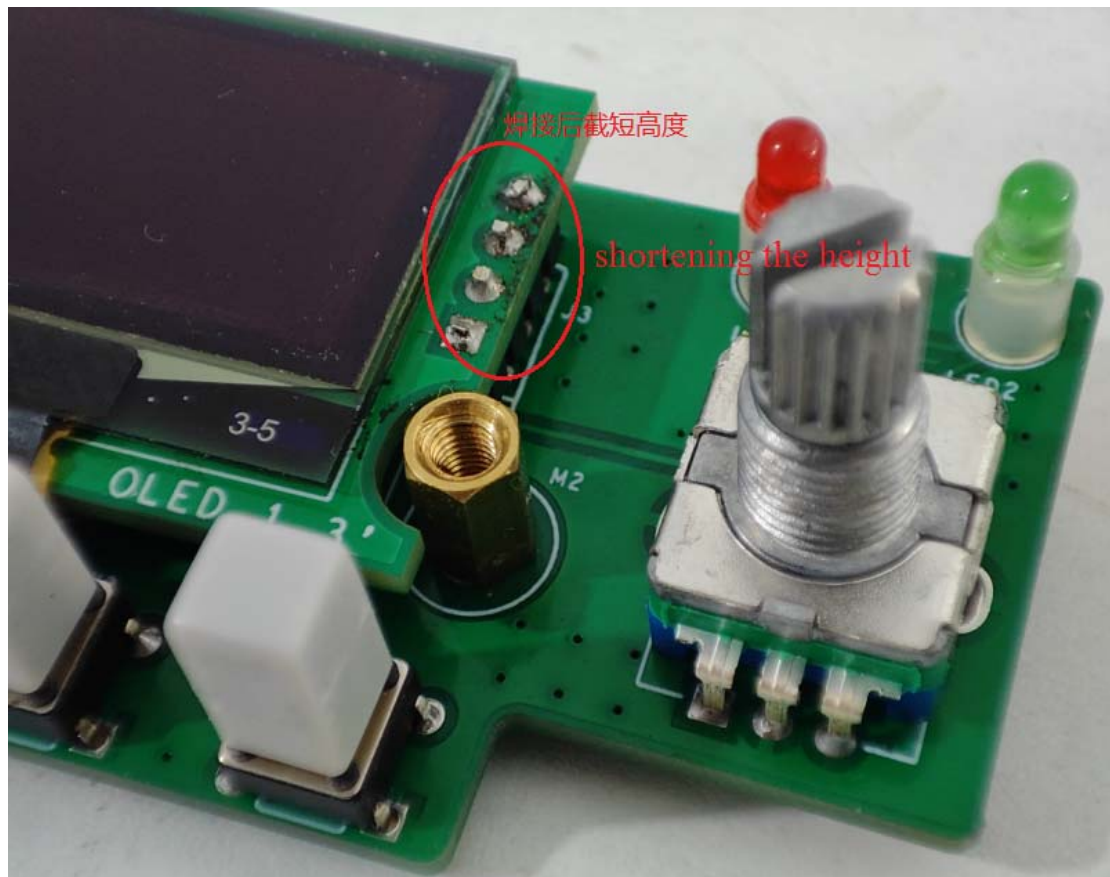
The resulting audio signal is passed to FM62429 which controls the audio volume. The output voice signal is then amplified by LM386 and sent to the speaker/headphones.

Component Selection

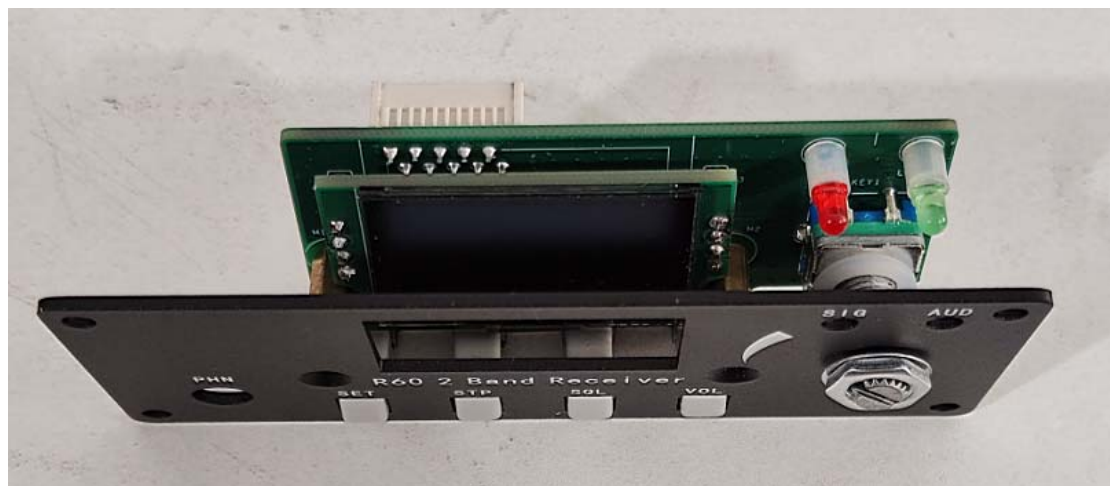
All capacitors less than 1000pF are high-frequency ceramics, capacitors greater than 1uF are aluminum electrolytic capacitors, and all resistors are 1/4W 5% fixed resistors.

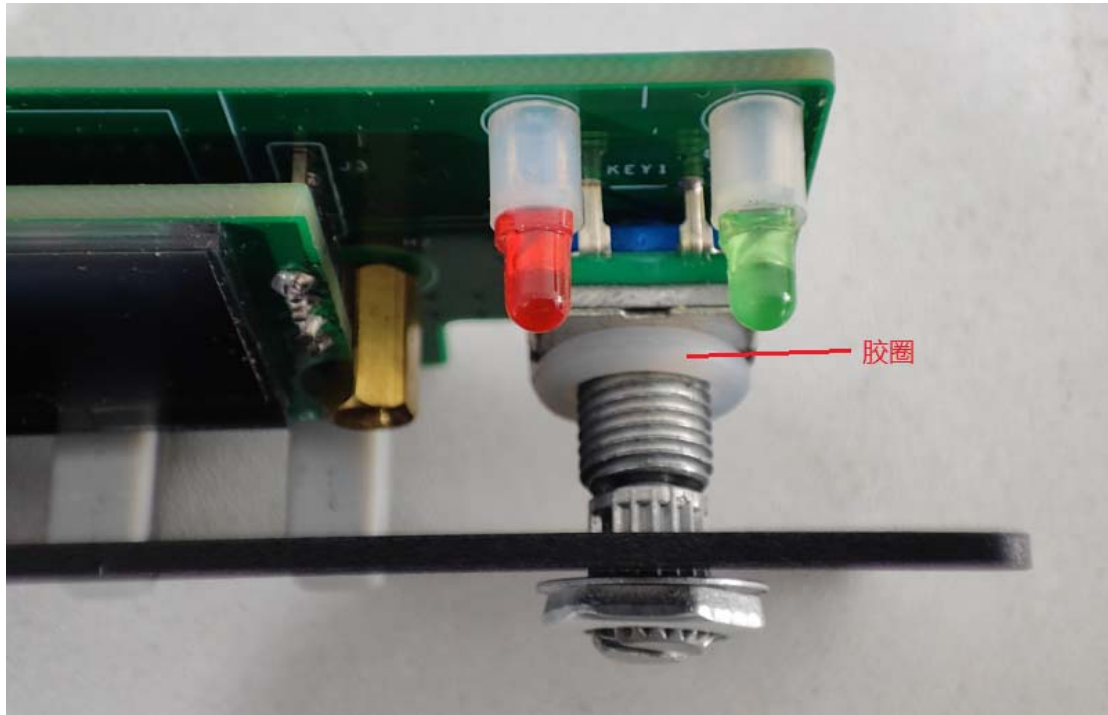
Soldering Reminder

1 First weld the two 4-PIN connection pins on the OLED back board, and pay attention to shortening the height of the row pins after welding to avoid touching the panel during installation. After installation, the following figure is shown:

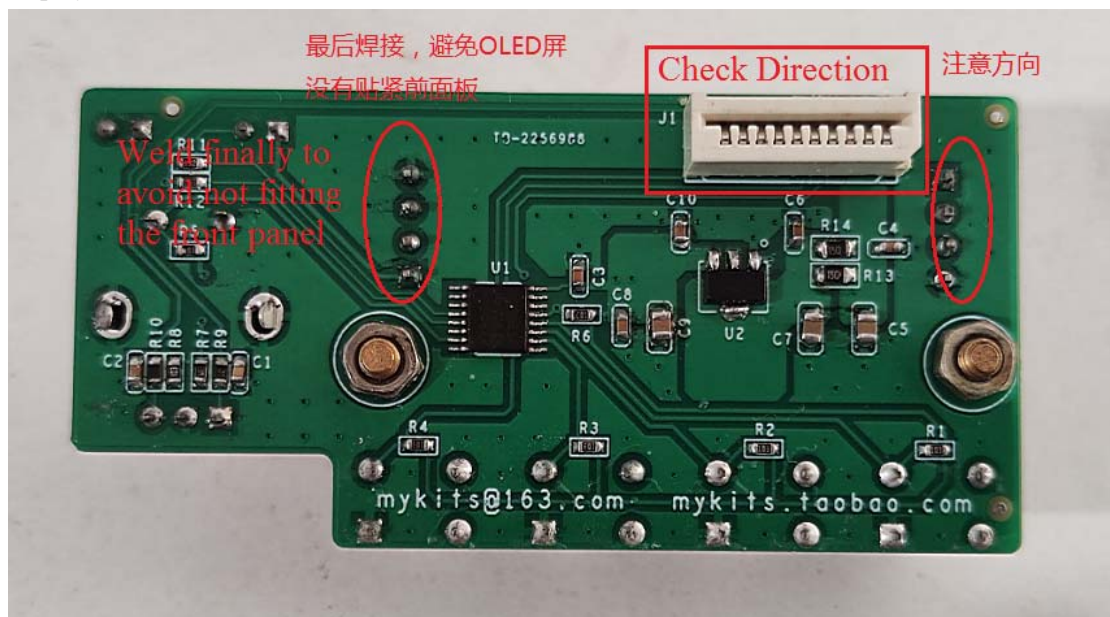


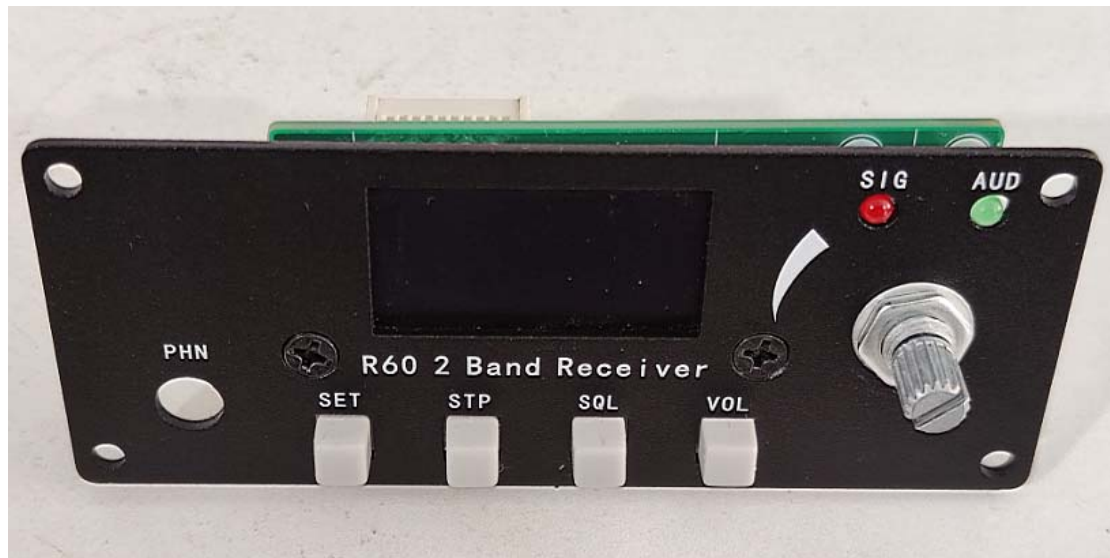
2 Do not weld the OLED display board with the OLED back board! After assembling the whole unit together, secure the two M3*6 countersunk screws on the panel.





After the OLED back board is closely fitted to the front panel, solder the needles on the OLED display board



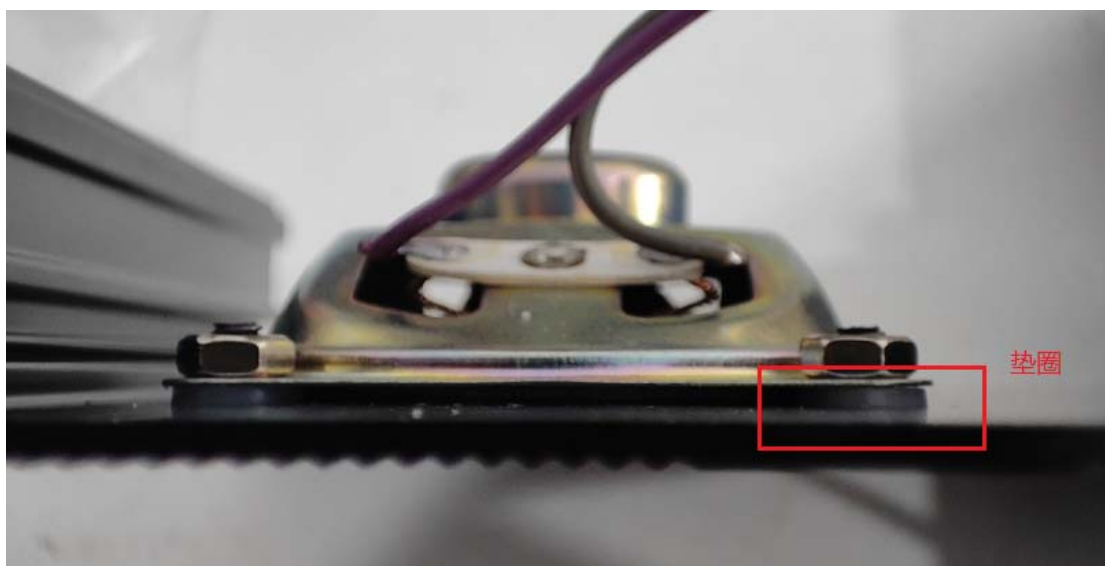


Rear panel assembly



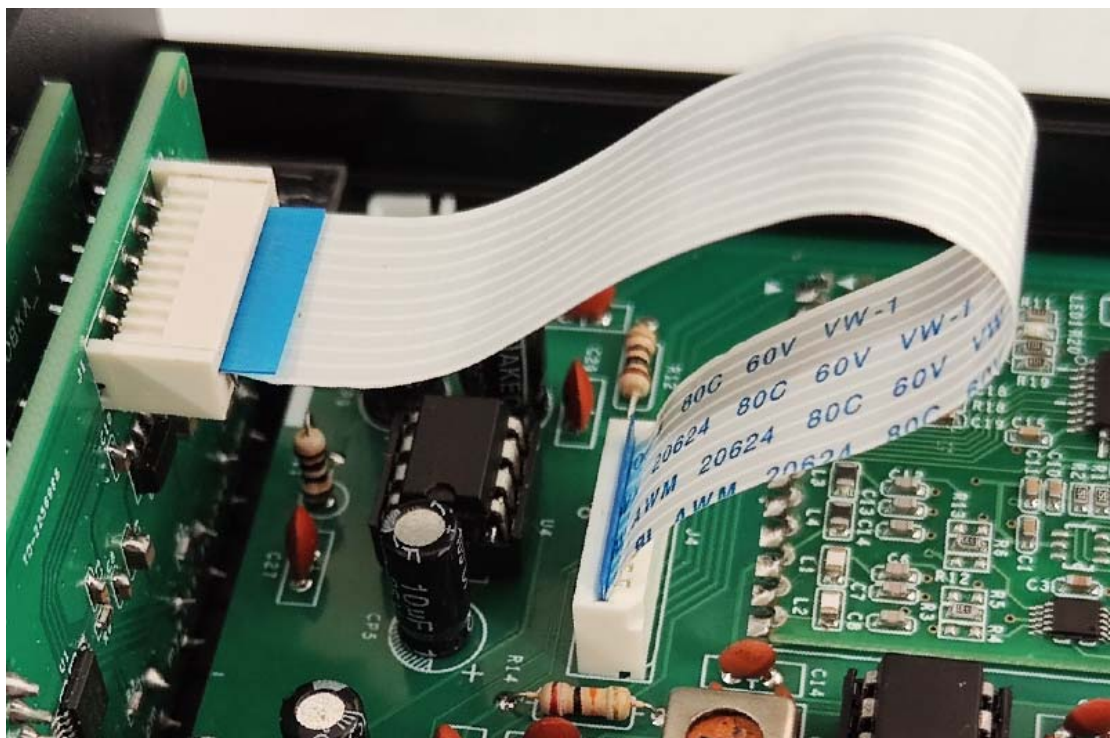


Speaker assembly





The connection between the front panel and the mother board, pay attention to the direction of the FPC connector, do not install the reverse!



制作调试

安装所有元件前先将所有的晶体管、电阻、电容用万用表测试一遍。然后对照电路图和

PCB 板上的标识安装所有元件。一般依从低到高的次序安装。同时给集成电路安装插座，这样可以有效避免将核心的集成电路焊坏。一切妥当，检查无误后接上电源，电源的正负极性一定不要接错。耳机插座上插入随身听耳机，应该可以听到白噪声。用手触摸天线输入端，耳机噪声会变大说明接收功能基本正常。然后给天线接上一段 60 厘米左右的软线，会听到噪声明显变大，意味射频通道基本没问题。

没有仪表的情况下，将铜柱调节到接近快旋出的位置。

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.

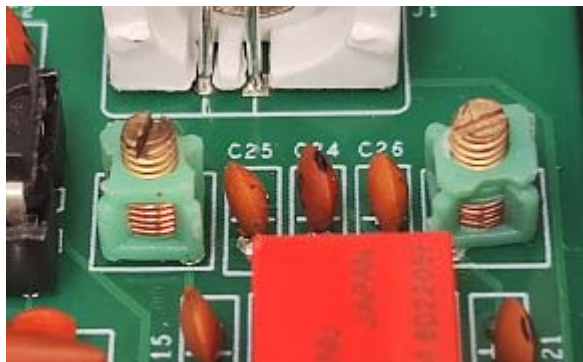
Generally, fit the components in the order of lowest to highest height above the PCB. At the same time, install sockets for the integrated circuits. This avoids the need to solder the main integrated circuits.

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.

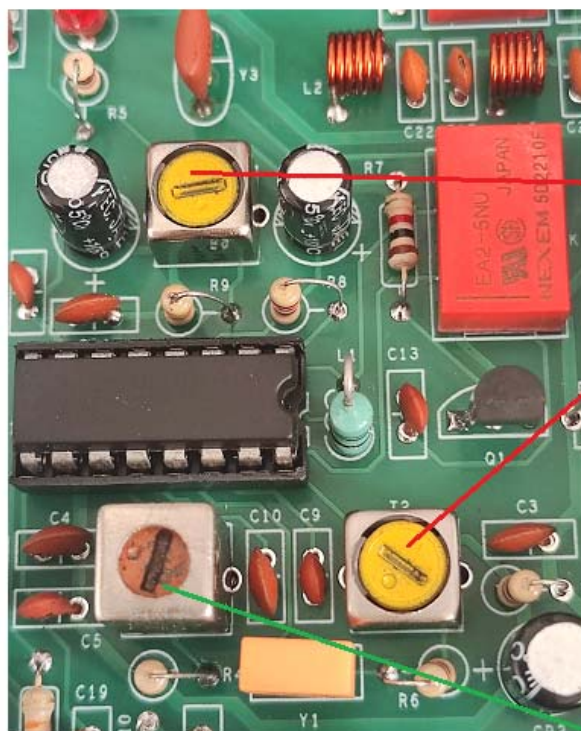
Plug a pair of Walkman-type earphones into the earphone socket. You should hear white noise.

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.

First you can set the receiver in FM mode, then The adjust the L1, L2 and T1. If you do not have a suitable signal generator for this band, it is recommended to adjust the copper core to rotate out quickly, like the photo is below.



Adjust red IF transformer to sound the most. Then short press the knob to select the receiving aviation band, and then adjust the yellow IF transformer to maximum sound.



切换到航空波段
后，
调节到对应频
率，依次调节到
接收声音最大为
止

接收调频广播时，调节
到声音最大时为止

Panel functions are below.



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



Usage method

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.

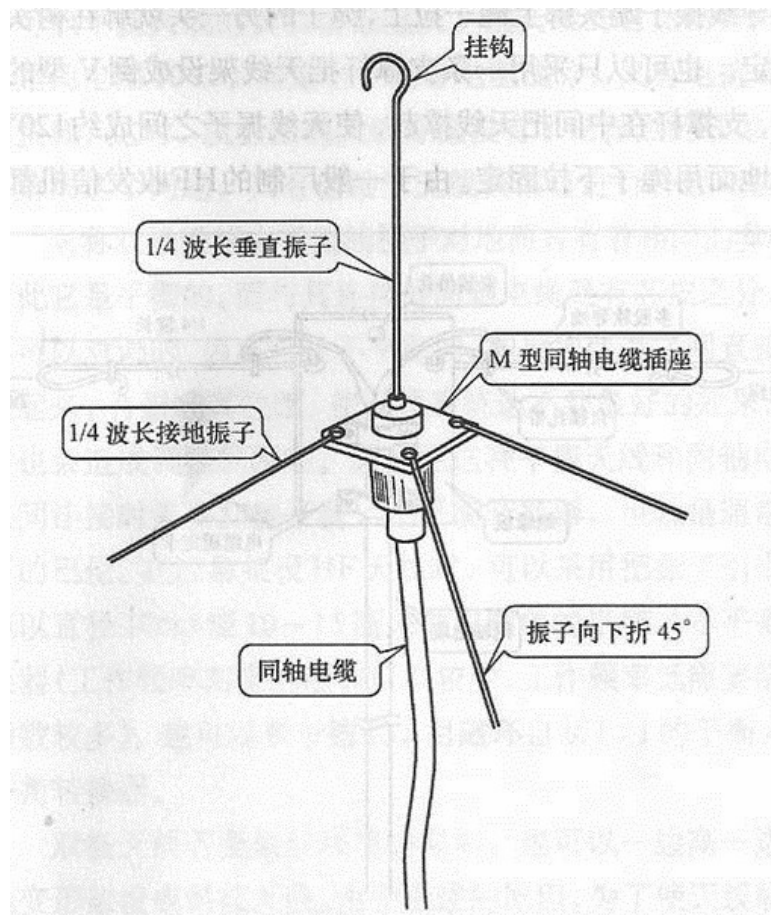
Because the height of the aircraft close to the airport can be anywhere from several hundred metres to several kilometers in altitude, the signal can cover a long distance. At the same time, for better results, it is recommended to use an external high antenna, such as a 1/4 wavelength (about 60 cm) 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:

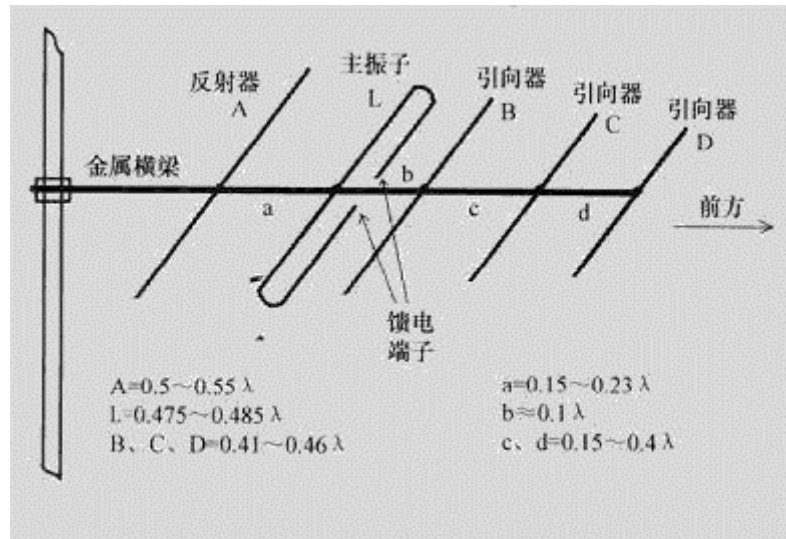
For beginners, it is recommended to use the GP antenna or Yagi antenna. These two antennas are relatively simple and readily homemade. The diagram below shows the GP antenna comprising several metal elements, an RF socket and plug (typically a PL259 plug on the coaxial

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. 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 .

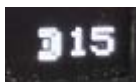
Instructions for use

After normal power-on, the OLED screen displays normally, and the encoder is in frequency adjustment mode by default. At this time, press the STP key, and you can see that the triangle below the number will keep moving, representing that the step is constantly changing.

Pressing the SQL key changes the S letter, indicating that the encoder knob is currently in Adjust Squelch (SQL) mode. Press the SQL key again, and the S letter will restore the power-on state, indicating that the encoder knob is in adjust frequency mode.



Press the VOL key and the speaker symbol changes, indicating that the encoder knob is currently in Volume adjustment (VOL) mode. Press the VOL key again, and the speaker symbol will resume the power on state, indicating that the encoder knob is in the adjustment frequency mode.



Press the SET key and the display will switch to the CH menu, > representing the currently selected item, adjusting the encoder will change the selection.



Under the CH menu, there are two CH items by default, and the four keys are:

SET press once to switch to the next menu

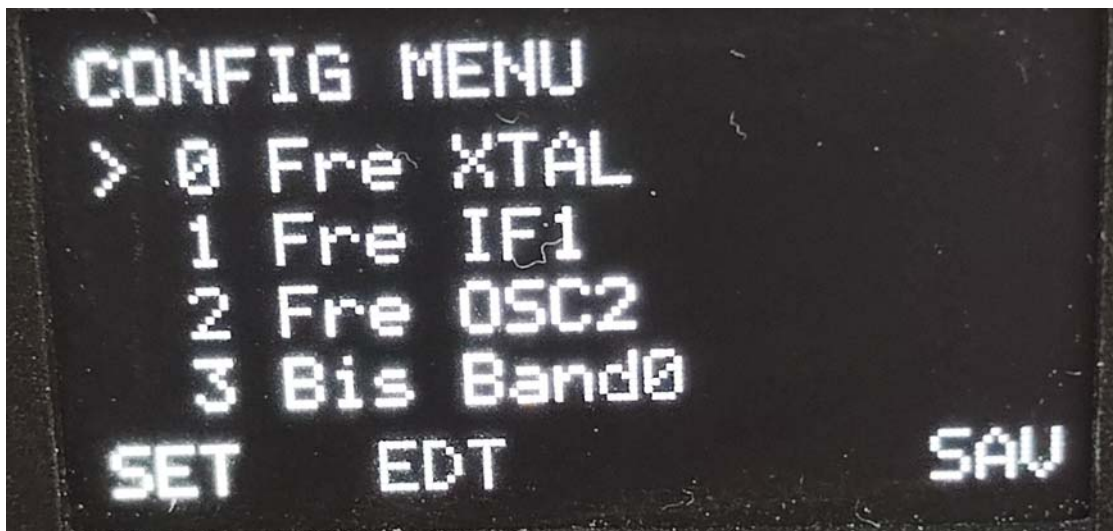
LCK Lock key, press this key, the currently selected CH entry will be locked, will not be deleted. Pressing it again will cancel the lock.

DEL Delete key. If the selected entry is not locked, press this key to delete the current CH entry. The CH table has at least one entry and cannot be completely empty.

SAV saves the current CH table and still exists after power failure.

Under this menu, press the encoder button, all unlocked CH entries will be deleted, and the automatic search function will be activated, and the CH table will be automatically filled after the search is completed.

Pressing the SET key will bring you to the Configuration menu, > represents the currently selected item, selecting Encoder will change the selection. Currently there are 0-6 items.



There are 3 buttons under this menu,

SET press once to switch to the next menu

EDT press once to edit the selected item (the encoder rotates to modify the operation), and press again to end the editing

SAV Saves the parameter Settings

This interface is used for experienced personnel with instruments to perform operations.

0 XTAL Frequency. The default frequency is 250060, which indicates 250060 x 100Hz. Can be modified according to the actual measurement.

1 If frequency. The default value is 107000, which indicates 107000 x 100Hz.

2 The default value is 102450, which indicates 102450 x 100Hz.

3 Band 0 (FM broadcast), the signal strength threshold is 1600 by default, which means that the automatic search station is valid and the SIG light is on when the AD sampling exceeds 1600.

4 Band 1 (aviation band), the signal strength threshold, the default 1600, indicates that the AD sampling exceeds 1600, the automatic search station is effective and the SIG light is lit.

5 Volume threshold, which is used to squelch.

6 Restore to Factory Settings.

Press the SET key to enter the information menu.



Press the SET key again to exit the initial menu.。



Attention:

Under the initial menu, long press the SET key for more than 3 seconds to switch between VFO mode and MEM mode.



In VFO mode, if you need to save a frequency and hold down the STP key for more than 3 seconds, the current frequency key is written into the CH table.


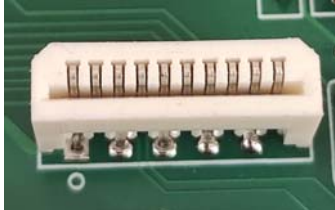
Under the initial menu, the machine will automatically write the current set band, mode, frequency, volume, and squelch into the internal EEPROM, which will be used directly when the next power on.

Parts List

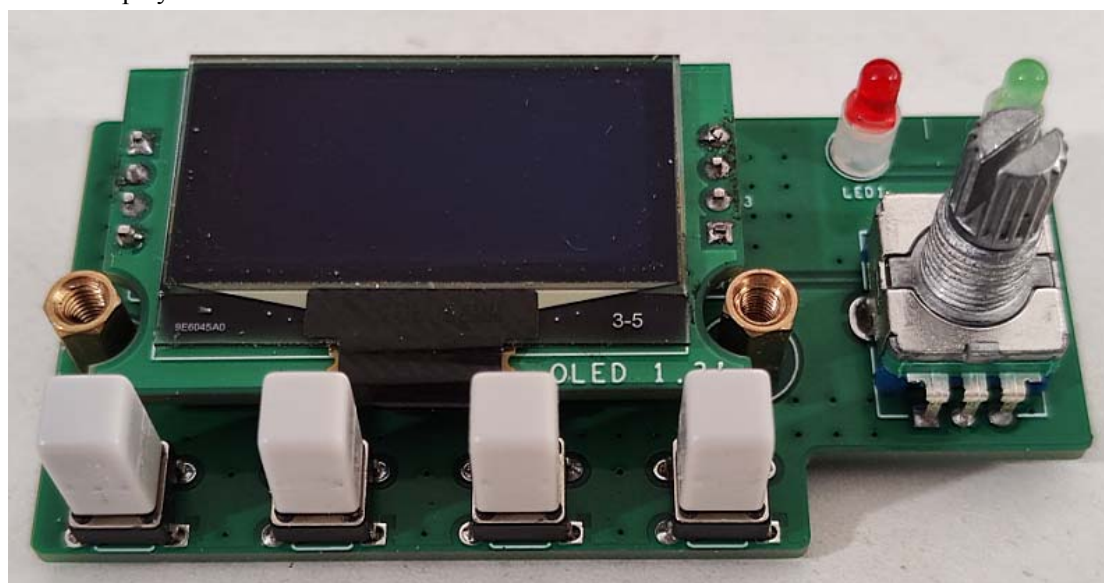
Main board

1/4W 5% Resistors		
R1,R2,R13	100	
R3,R5,R7	1K	
R4	4.7K	
R6,R8	220	
R9	47K	
R10,R14	10K	
R11,R12	10	
Beads, inductors, transformers		
L1	100uH	色环电感
L2,L3	0.7mm-3.5T	
L4,L5	5x5-4.5T	
T1	7X7-10.7MHz	
T2,T3	7X7-455KHz	

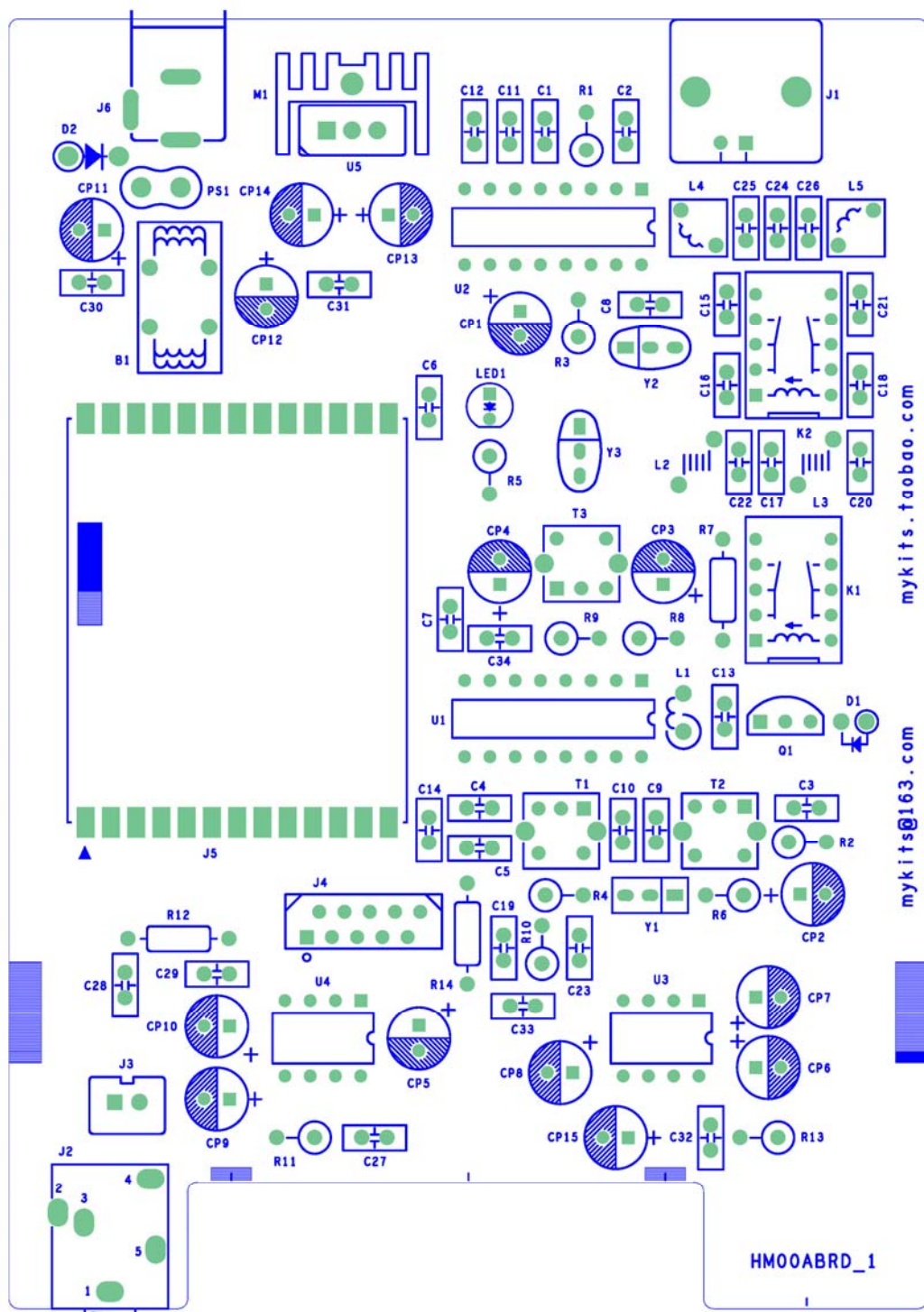
B1	T120604 共模线圈	
Chip capacitance		
C1,C2,C3,C4,C10,C13,C27,C28,C29,C30,C31,C32,C34	0.1uF(104)	
C5,C7,C8,C9,C11,C12,C33	0.01uF(103)	
C6,C14	100pF	
C15,C21	8.2pF	
C16,C18	12pF	
C17	3.9pF	
C19,C23	4700pF(472)	
C20,C22,C25,C26	15pF	
C24	2.7pF	
Electrolytic capacitance		
CP1,CP2,CP9,CP10,CP11,CP12,CP13,CP14,CP15	100uF /25V	
CP3,CP4,CP5,CP6,CP7,CP8	10uF /25V	
Transistor		
D1	1N4148	
D2	1N4001	
Q1	8050	TO92
IC		
U1	TA7640 (DIP16)	Have IC socket
U2	TA2003 (DIP16)	Have IC socket
U3	FM62429 (DIP8)	Have IC socket
U4	LM386 (DIP8)	Have IC socket
U5	7805 (TO220)	
Crystals and filters		
Y1	455KHz Ceramic filter	

Y2,Y3	10.7MHz Ceramic filter	
Other components 其他元件		
J1	BNC (Q9)	
J2	3.5mm stereo socket	PHN (insert phn)
J3	Speaker socket	SPK
J4	FPCsocket	
PS1	Power wiring	
K1,K2	relay	EA2-5V
Blank PCB board × 1pcs		
Heat sink × 1、M3 screw × 1		

OLED display board is belw



PCB Assembly Drawing



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:

电阻色环对照表

四环	五环	六环	温度系数 PPM/°C
10K, 0.5%	470K, 1%	2.2K, 0.1%	误差 %
		15PPM	
			乘数 (W)
			代表数值
			黑色 棕色 红色 橙色 黄色 绿色 蓝色 紫色 灰色 白色 金色 银白色

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

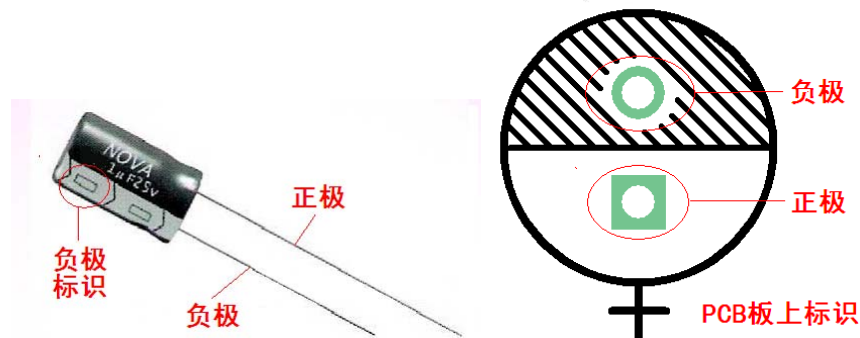


102 here means

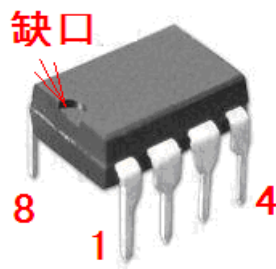
1000pF

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.



IC Identification



8 脚直插管脚排列

Identification of Transistors and Diodes



TO-92 package pin arrangement



1N4148 diode polarity

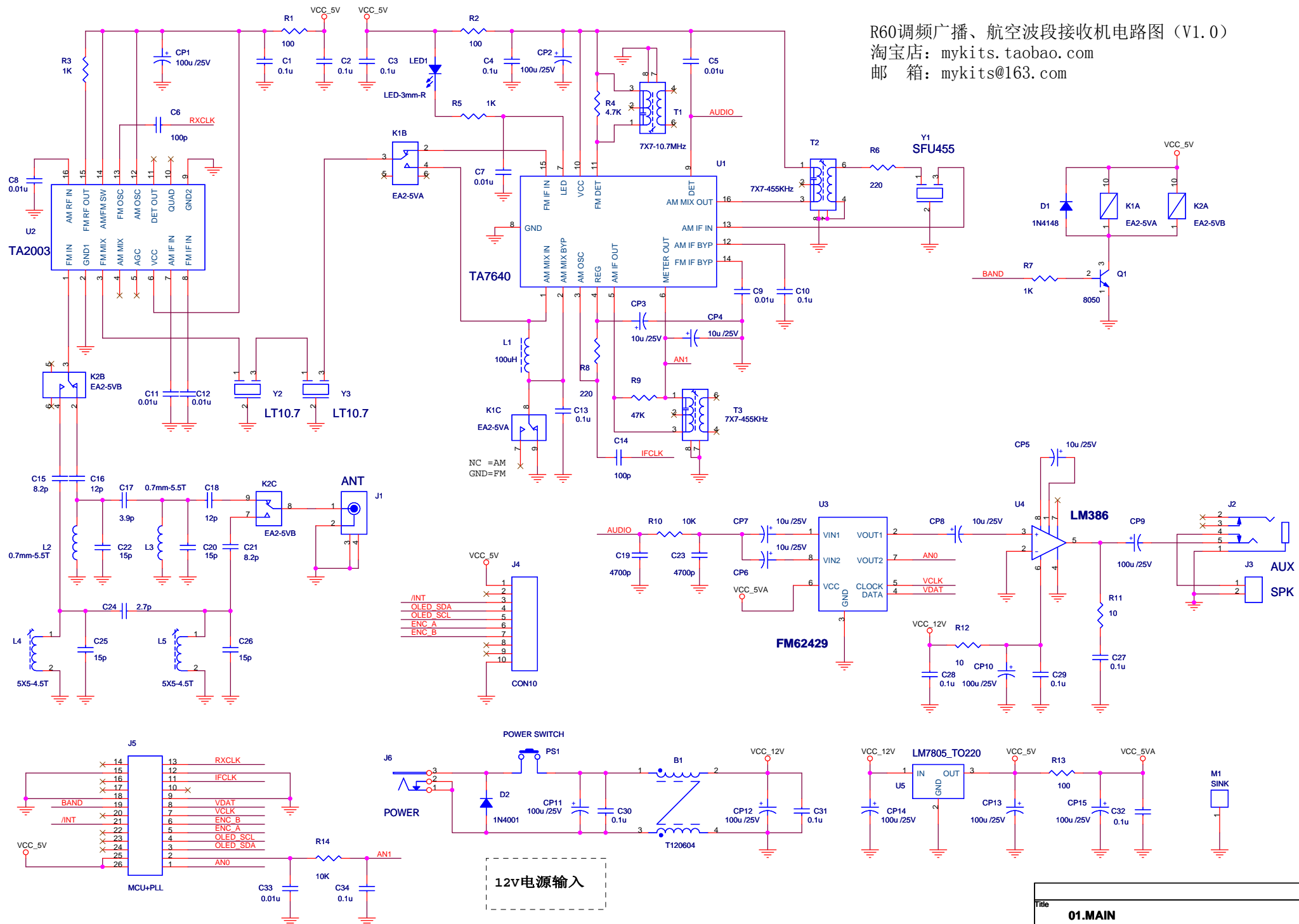


1N4001 diode polarity

R60调频广播、航空波段接收机电路图 (V1.0)

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Title		
01.MAIN		
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A3	HM00ABRD_1	1.0
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