

R20 FM Broadcast and Aviation Band

PLL Receiver Kit

Assemble Manual V8.0

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 50 km away in unobstructed areas.

The hardware described in this article is V8.0 and the main PCB labelled “HM00ABRB_8”



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: 110mA

Speaker: 8 ohm 250mW

Step:10KHz/100KHz

Circuit Description

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

The signal received by the antenna first enters two bandpass filters, the function of the bandpass filter is to ensure that the 88-108MHz or 118-136MHz signal can enter the TA2003, the other signals are attenuated to the maximum extent, while the TA2003 has a mixer inside, which mixes the received signal and the PLL local oscillator signal.

The switching of bands is done by an RF relay.

The IF of the machine is 10.7MHz, and the signal is sent to 10.7MHz ceramic filter, whose function is to filter out the irrelevant signal generated by mixing, and then it is amplified by 2N2222, after filtering, the signal is sent to TA7613 for further intermediate frequency amplification, detection, and low play, and finally sent to the headset output.

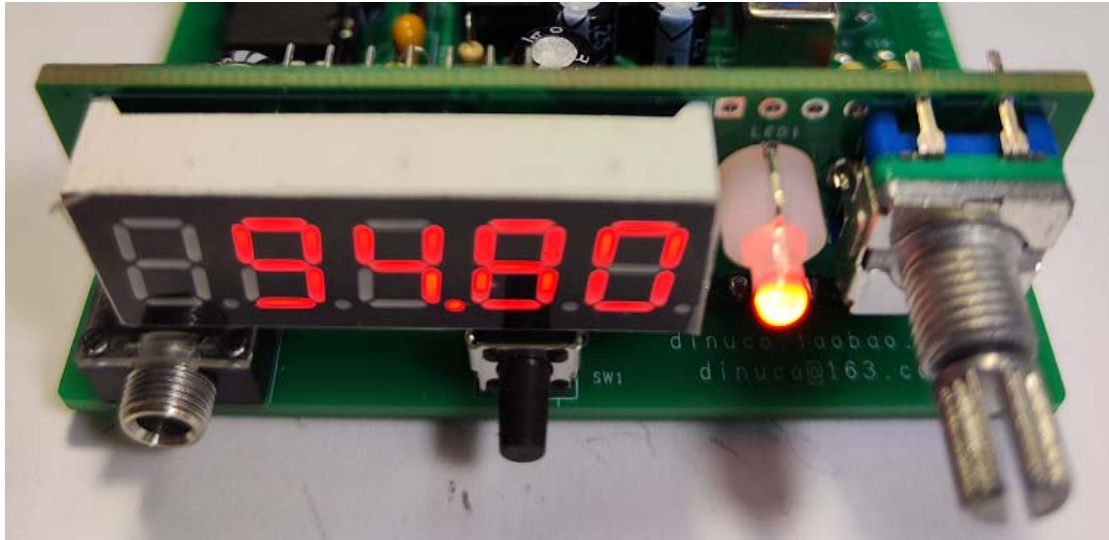
The TA7613 completes FM signal identification and AM signal detection, while the internal audio power amplifier can directly drive low-power speakers.

Component Selection

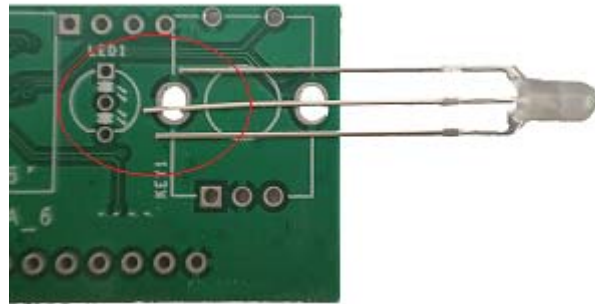
All capacitors less than 1000pF are high-frequency ceramics, capacitors greater than 1uF are aluminum electrolytic capacitors, and all resistors are 1/4W 5% fixed resistors.

Soldering Reminder

The display board needs to be welded with digital LED and connector plug-in by itself. After installation, the following figure is shown:



Pay more attention to the LED direction:



Assembly and Adjustment

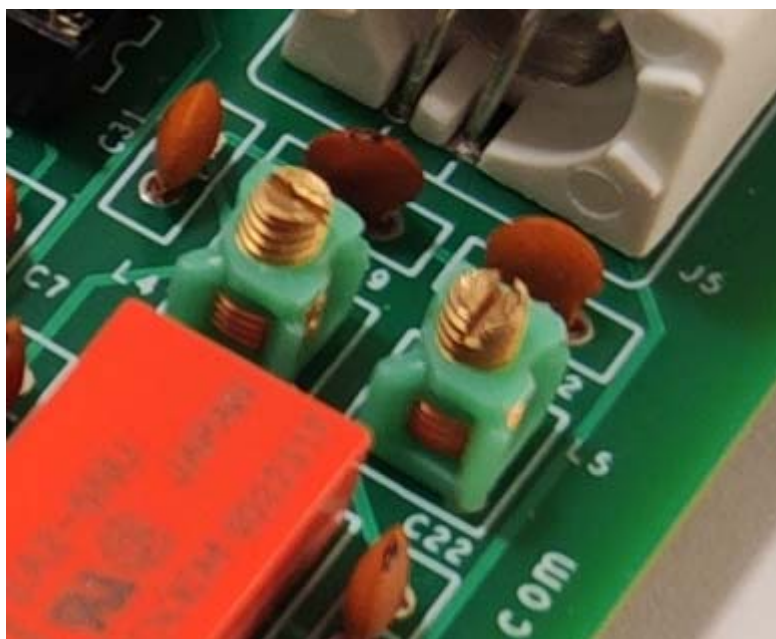
Test all transistors, resistors and capacitors with a multimeter before installing all components. Then install all components against the circuit diagram and the markings on the PCB board.

Generally follow the low to high order of installation. At the same time, install a socket for the integrated circuit, which can effectively avoid welding the core integrated circuit. Everything is in order, check and connect the power supply, the positive and negative polarity of the power supply must not be connected wrong.

Plug the walkman headset into the headphone socket, and you can hear white noise when you power it on. Attach a section of flexible wire about 3 meters to the antenna, and the noise will be heard significantly larger, which means that the RF channel is basically OK.

Debugging steps without instrument:

- 1 Procedure 1 Connect a 60cm cable to the antenna socket and power on the cable.
- 2 The default FM mode of the machine, the display frequency is 94.80, you can gently press the encoder, set the machine to a local FM radio station.
- 3 At this time, the ear will appear broadcast sound, adjust T1 so that the noise is the highest and the noise is the lowest.
- 4 Press the encoder again for more than 3 seconds, switch to AM mode, and adjust the copper core of the inductor L4 and L5 to the position about to be twisted .



Do not screw the core in T1. It is recommended to use a non-inductive driver or a plastic driver for adjustment.

The requirements of the power plug (5.5/2.1) 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.

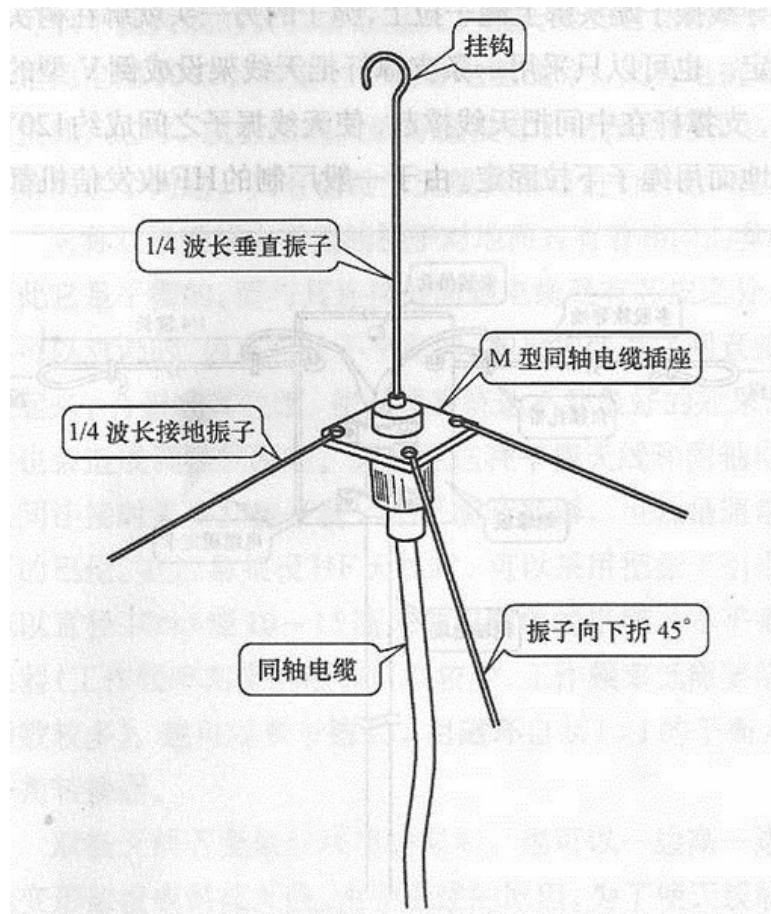
Because the height of the aircraft close to the airport can be anywhere from several hundred metres to several kilometers in altitude, the signal can cover a long distance. At the same time, for better results, it is recommended to use an external high antenna, such as a 1/4 wavelength (about 60 cm)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

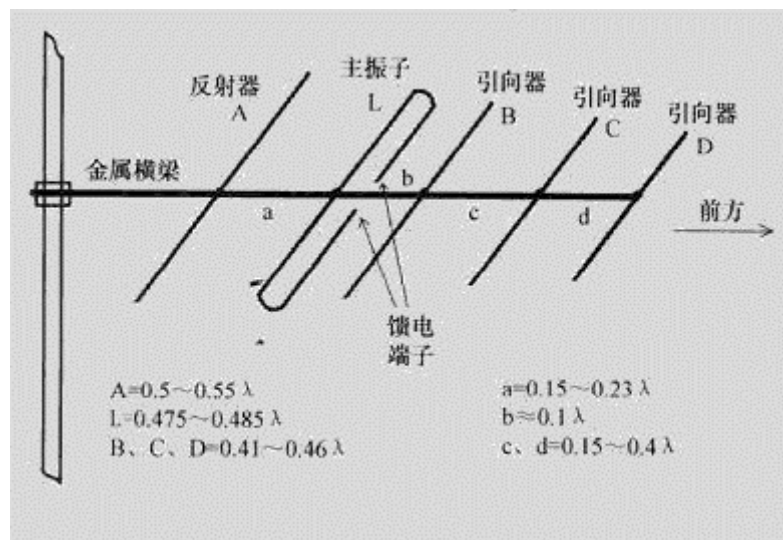
For beginners, it is recommended to use the GP antenna or Yagi antenna. These two antennas are relatively simple and readily homemade. The diagram below shows the GP antenna comprising several metal elements, an RF socket and plug (typically a PL259 plug on the coaxial cable running to the receiver and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

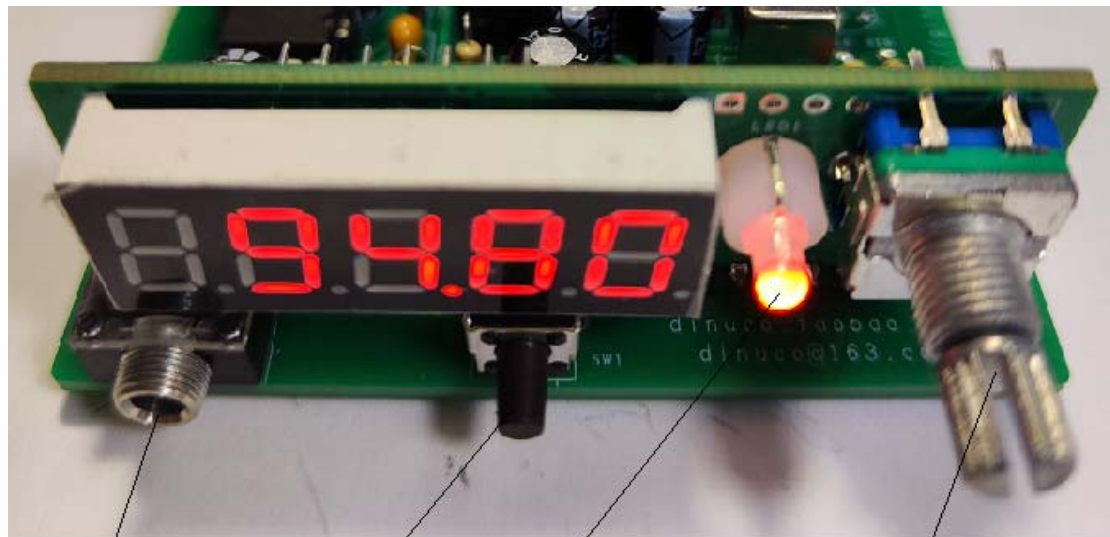
other antenna elements, and the spacing a, b, c, and d.

Chassis mounting

This circuit board can be conveniently placed in a standard aluminum profile case with a size of 76mm*35mm*100mm (this case is not included in this kit, please purchase it yourself if necessary).

Instructions for use

1 After the machine is powered on for the first time, the machine is in frequency adjustment mode by default, and the digital LED displays numbers, representing the frequency value. Turn the encoder and the frequency should follow. Short press the encoder, the step value should change (not in use of the digitizer turns black). The panel displays the following:



音频输出
Audio output

SET按钮
SET Button

声音输出指示
Lighting means Audio output

频率/VOL调节
Adjust the
Frequency and VOL

短按 步进切换 Short press Change STEP

长按 切换波段 Long press Change the Band

2 Do not press the SET button first, rotate the encoder to see whether the display frequency of the digital LED display changes.

3 Connect the antenna, press the SET button, then C1_15 is displayed, keep pressing the button, exit the configuration mode when C4_68 is displayed, and enter the working mode again. All modes are described as follows:

C1 15 Sound setting, default 15, can be adjusted between 0 and 25, the louder with the value.

C2 15 Squelch threshold setting, default 15, can be adjusted between 0-25, the larger mean the stronger audio signal.

C3 50 IF frequency setting, default 50 (unit: 200Hz), can be adjusted between 0 and 99, indicating that the IF frequency is 10690000 Hz+50*200Hz.

C4 68 25MHz Clock offset. The default value is 68 (unit: 100Hz). The default frequency is






25,000 000Hz+68*100Hz. If there are some wander in the receiving frequency, the 25MHz clock frequency on the PLL small board can be measured by the frequency meter, and the clock frequency offset can be adjusted according to the test value.



Note: C3 C4 can only be set with instruments and experience, and the modified value will not take effect immediately. You need to exit the configuration mode and adjust the working frequency to take effect.

Because it takes time to configure the EEPROM in the MCU, do not power off at will during configuration to avoid misoperation.

If the configuration is wrong, do not panic, hold down the SET key, re-power on, the machine will be restored to the default setting according to the SET key state.

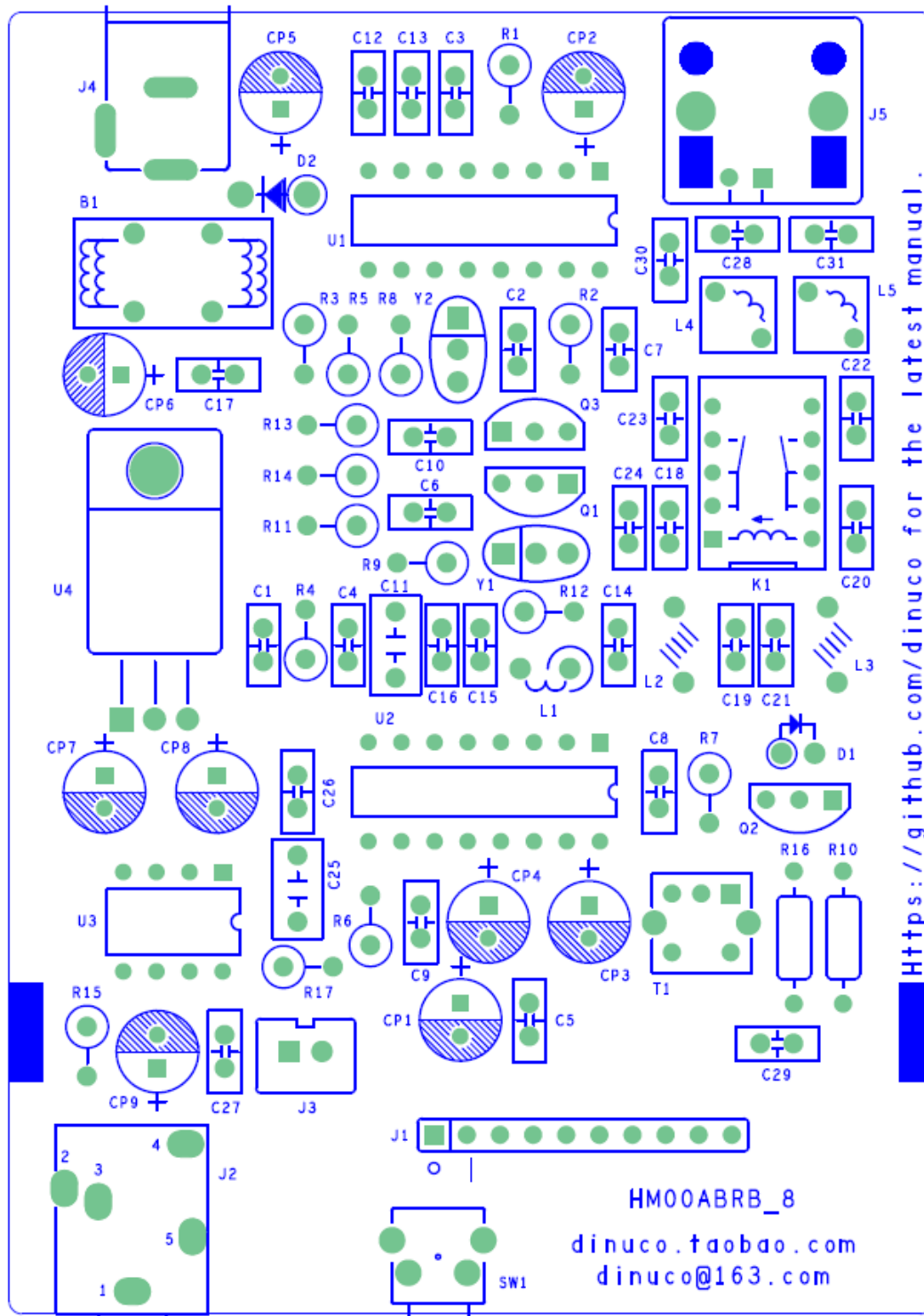
Parts List

1/4W 5% Resistors		
R1,R11,R15	100	
R2,R9,R10,R12	1K	
R3,R4,R14	10	
R5	220	
R6,R13,,R16	10K	
R7,R8,R17	22K	
Beads, inductors, transformers		
L1	100uH	
L2,L3	0.7mm-3.5T	
L4,L5	5x5-4.5T	
T1	7X7-10.7MHz	
B1	T120604 Common-mode coil	
Chip capacitance		
C1,C2,C3,C4,C6,C8,C10,C17,C26,C27	0.1uF(104)	
C5	100pF(101)	

C7,C12,C13,C14,C15,C29	0.01uF(103)	
C9,C16	4700pF(472)	
C18,C20	12pF	
C19	3.9pF	
C21,C24,C30,C31	15pF	
C22,C23	8.2pF	
C28	2.7pF	
C11,C25	3.3uF/50V	
Electrolytic capacitance		
CP1,CP5,CP6,CP9	220u /25V	
CP2,CP3,CP4,CP7,CP8	100uF /25V	
Transistor		
D1	1N4148	
D2	1N4001	Or 1N4007 etc
Q1,Q3	2N2222	
Q2	8050	
IC		
U1	TA2003 (DIP16)	Have IC socket
U2	TA7613 (DIP16)	Have IC socket
U3	FM62429 (DIP8)	Have IC socket
U4	7805 /TO220	
Crystals and filters		
Y1,Y2	10.7MHz	
Other components		
J1	CON10 socket	Connected to the LED display board
J2	3.5mm stereo socket	PHN (audio output)
J3	Speaker socket	SPK
J4	Power socket	5.5/2.1

J5	BNC	
K1	relay	EA2-5V
SW1	Button	
Blank PCB board × 1pcs		
The display board includes a circuit board, a 3mm LED, a digital LED display, and an encoder.		

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

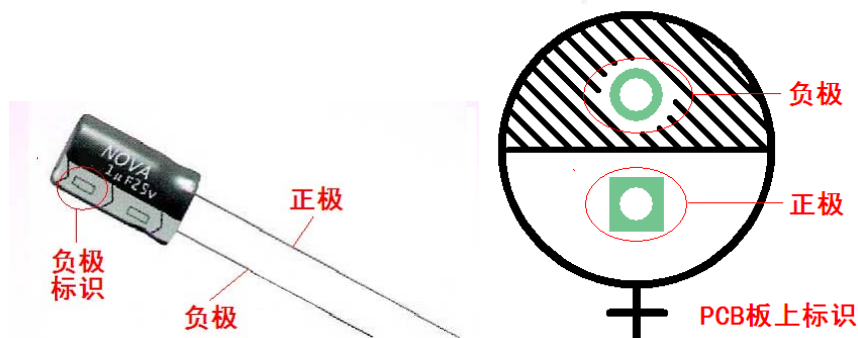


102 here means

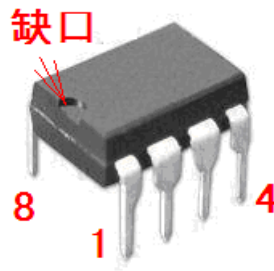
1000pF

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

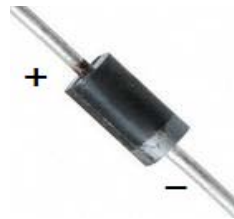
Identification of Transistors and Diodes



TO-92 package pin arrangement



1N4148 diode polarity

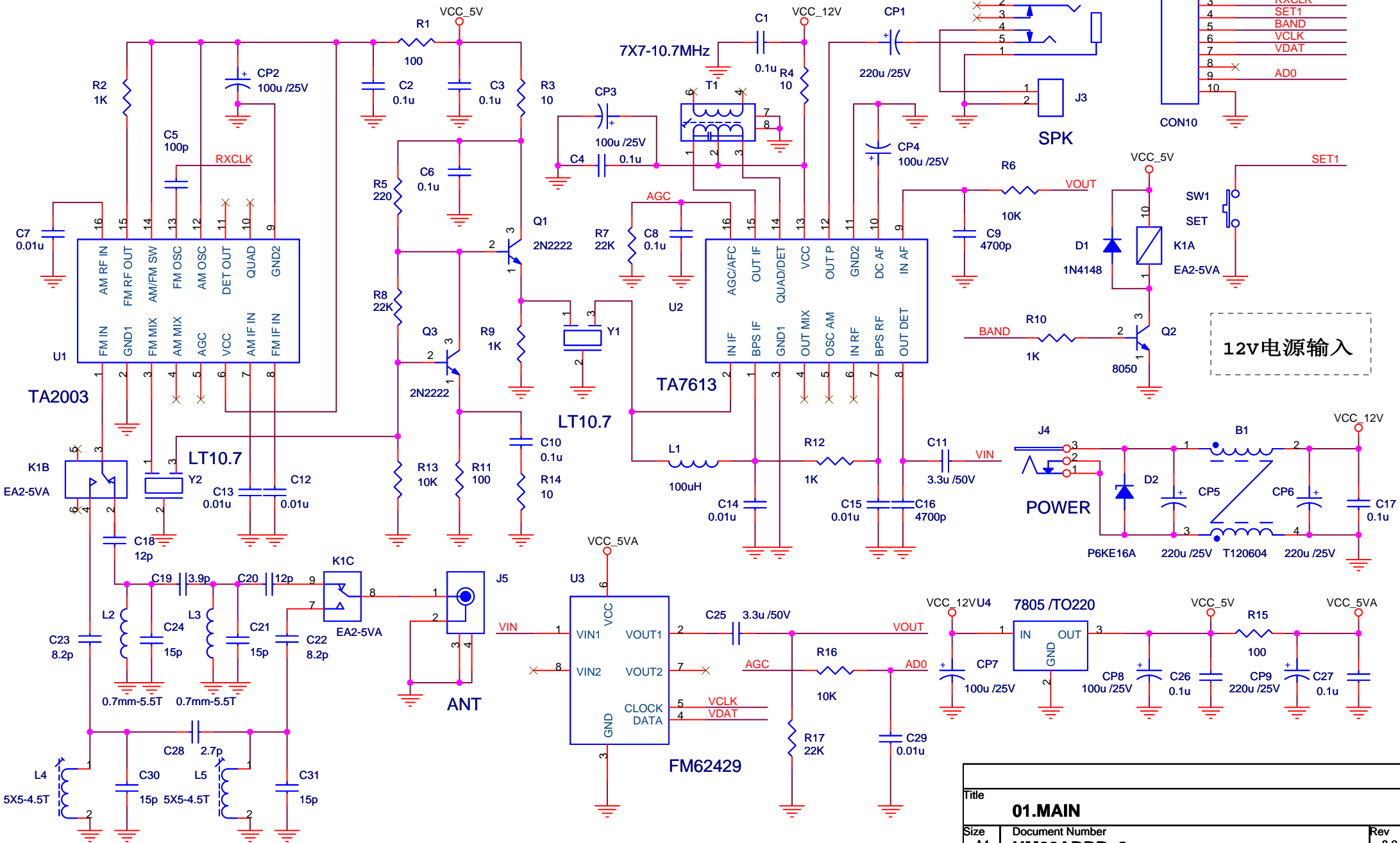


P6KE16A diode polarity

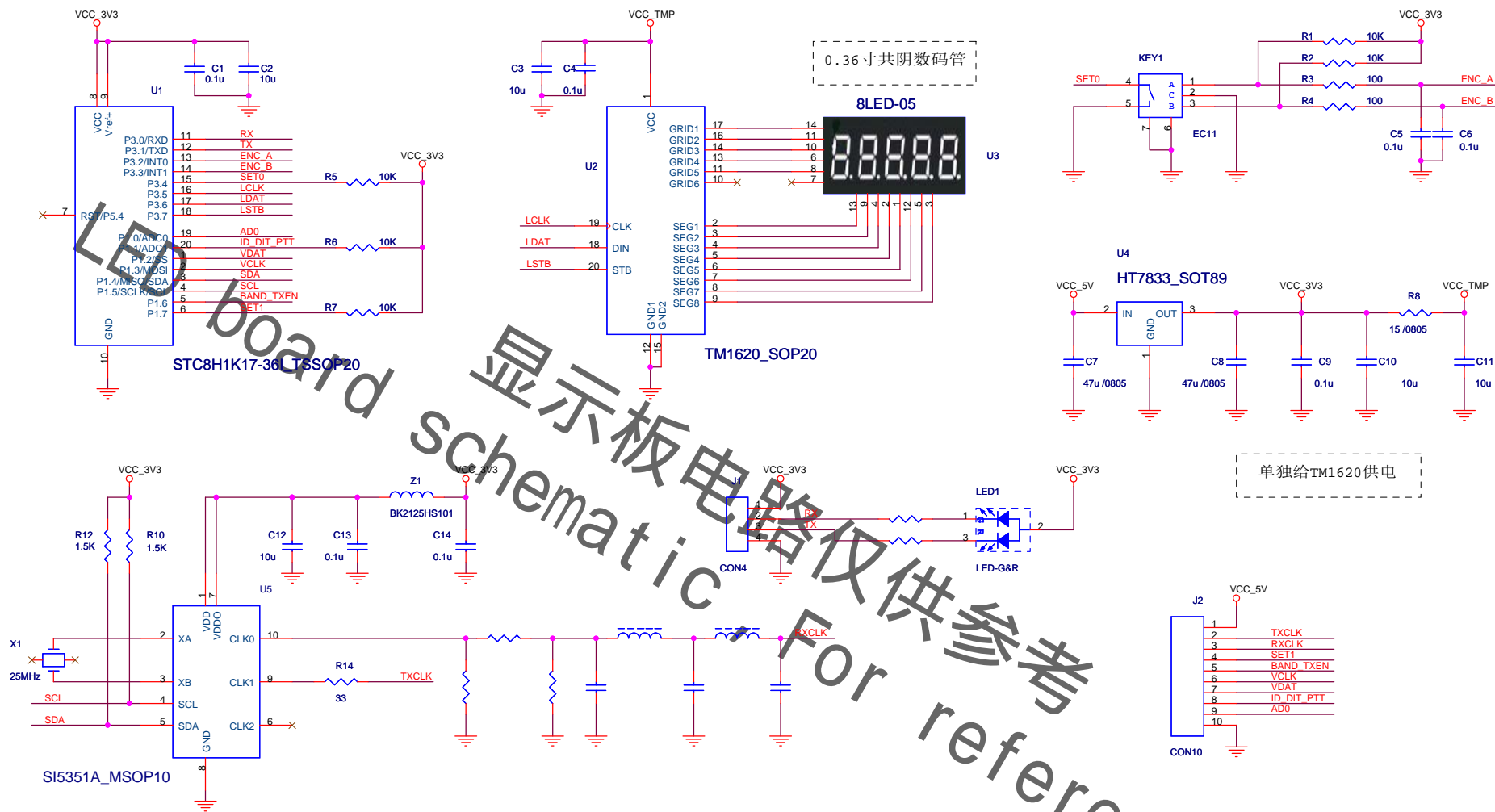
R20 调频广播/航空波段接收机电路图 (V8.0)

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A3	HM00LEDA_6	6.0
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