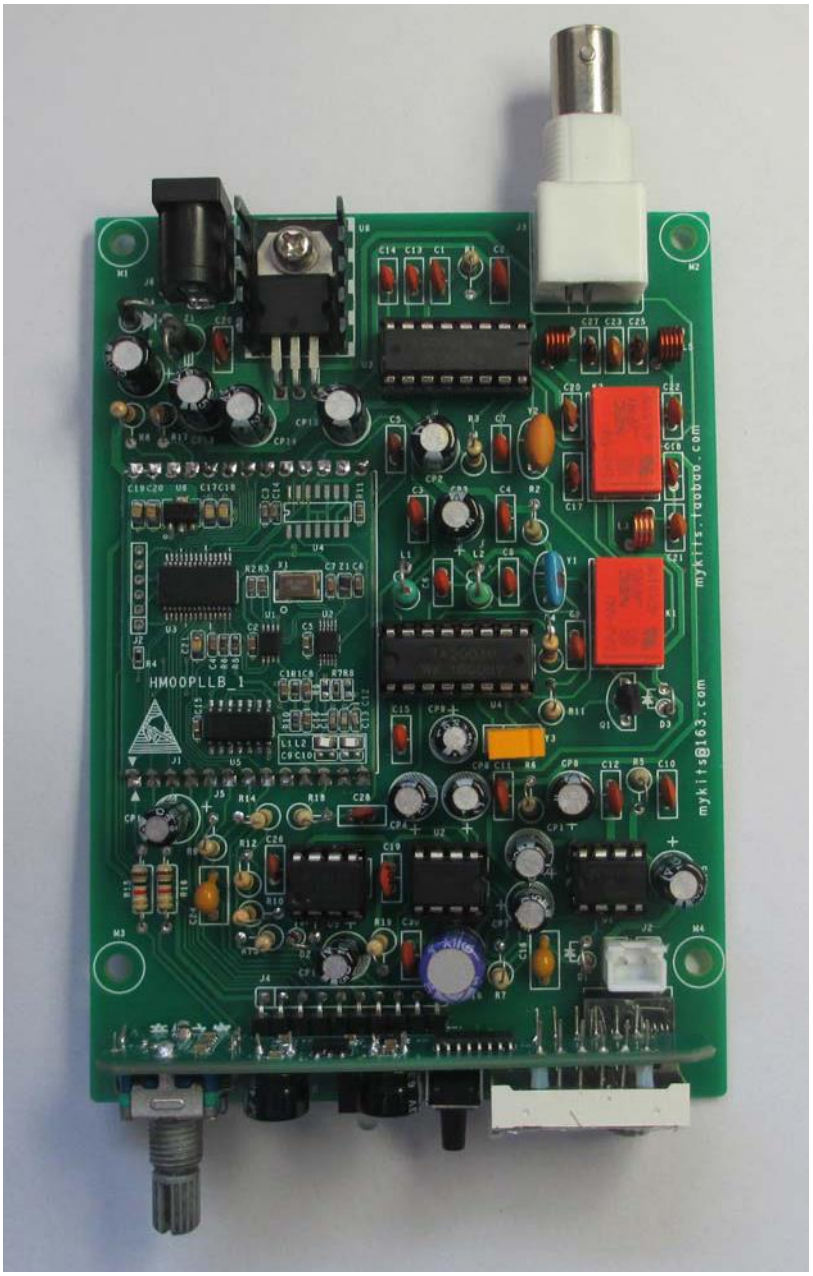
R80 Aviation Band Receiver
Kit Instructions V7.1 EN – Issue A

Overview

This dual-band receiver kit is designed to receive FM broadcast stations as well as radio communications between aircraft and control 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 FM broadcast band has been added to provide additional flexibility in this latest design.

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.

This document described hardware V7.0 and the PCB labelled “HM00ABR C_7”.



Key Specifications

Tuning Range : FM band: 88 – 108MHz, AM/Aviation band: 118MHz – 136 MHz
Mode : FM, AM
Supply Voltage : 12V (It is recommended to use linear regulated power supply or battery)
Current Drain : FM band: 120mA, AM band: 160mA (Typical receiver operation)
Antenna Input: 50 ohm unbalanced
Audio Output: 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 one of two bandpass filters (BPF) selected using relay K2, one for the FM broadcast band, the other for the AM/aviation band. This filtered signal then goes to a high-gain RF amplifier in the first TA2003 chip (U3). Each BPF ensures that only signals in the selected band are amplified while other signals above and below the selected band are rejected.

The filtered and amplified signal then passes into the TA2003 first mixer (U3). This mixes the incoming signal with the local oscillator signal provided by the PLL. The frequency of the local PLL oscillator is 10.7MHz higher than the received signal.

The first 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.

In AM/Aviation mode, this filtered signal is sent to the second mixer in the second TA2003 (U4) via relay K1 for conversion to the second IF of 455kHz using an oscillator signal of 10.245MHz generated by the PLL. After internal detection inside U4, the resulting audio signal is then sent to the FM62429 (U2) volume control and on to the LM386 (U1) speaker amplifier.

U2 also controls the level of the audio signal passed to an LMC6482 dual op-amp (U5) which is configured as an audio precision rectifier (U5A) and buffer amplifier (U5B). This stage generates a DC signal (‘AN2’) used by the microcontroller to control the receiver’s squelch (‘MUTE’).

In the FM mode, the first mixer signal is switched to the FM section of the second TA2003 (U4) via relay K1 which also selects the FM receiver mode of U4. U4 demodulates the wideband FM broadcast signal using a 10.7MHz ceramic resonator (Y1) based quadrature detector.

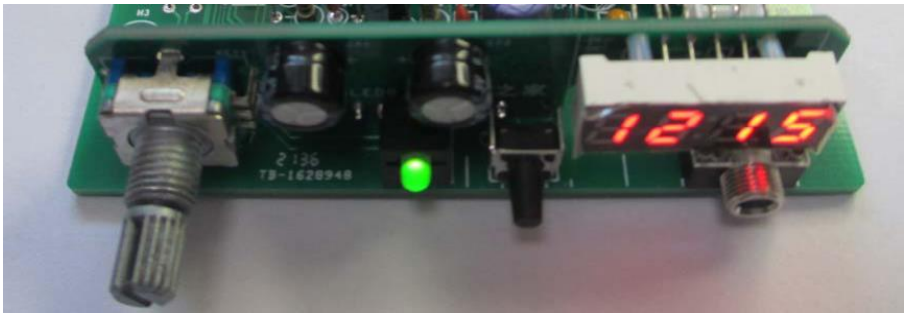
The oscillator signals for the first and second mixers are generated by an Si5351a PLL chip on the PLL daughterboard. This small PCB also contains the microcontroller which controls the receiver, reads the user controls, and drives the display daughterboard.

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 PCB is fitted with a digital display driver. Some other parts must be fitted by the kit builder. The completed assembly is shown below:



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. The display mounting is 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.

Fit the PLL daughterboard after the resistors, capacitors and other low-height parts have been fitted on the main PCB and before the display board is installed. Take great care to align the PLL daughterboard correctly on the main board using the small arrow (▲) marks printed on each board's overlay.

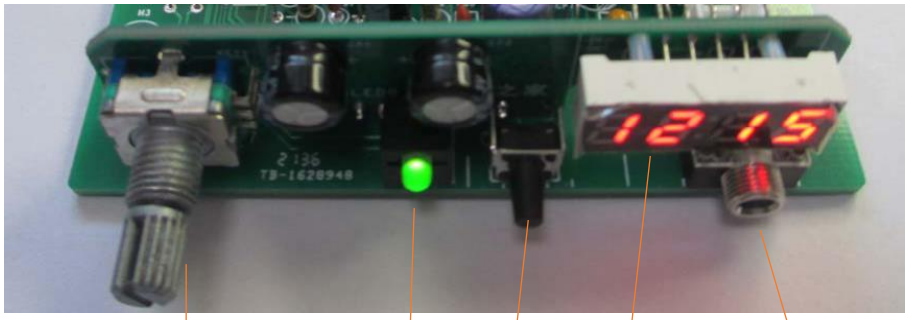
Check your work carefully. If your assembly is correct, connect the power supply. IMPORTANT: **Make sure the positive and negative polarity of the power supply is correct**.

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

Touch pin 1 of U3 (TA2003) with your finger. 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.

If assembled correctly, no alignment is required in this receiver.



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

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

Connector: DC 2.1mm type

Antennas for the Receiver

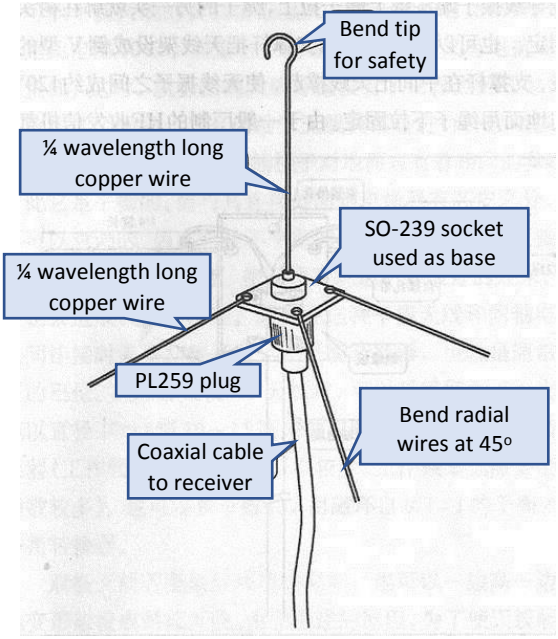
VHF communications are carried out along paths that are close to a straight line. If there is a very large signal from a nearby tower present in the VHF band, any other smaller VHF communications signal you wish to hear from an aircraft can be blocked. You need to pay attention to this when listening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

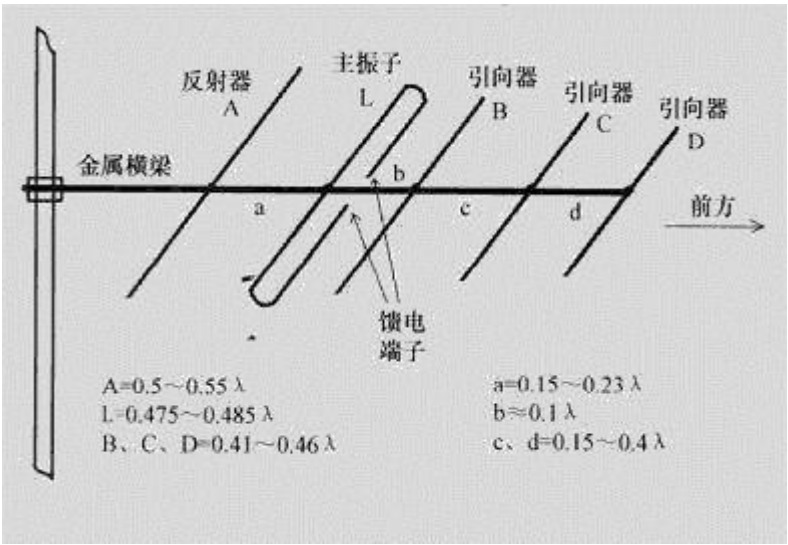
The specific antenna installation reference is as follows:

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 [ZL2PD 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.

ZL2PD Note: Yagi antennas can be made at home but unless your construction and materials 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 for this document does not provide an adequate level of detail for successful DIY construction of a Yagi antenna.

Also, the original drawing shown here appears to illustrate 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’s main receiving lobe. This generally makes the Yagi antenna a poor choice of antenna for this type of

receiver unless you ONLY wish to listen to local airport communications from a specific location more than a few kilometers away.

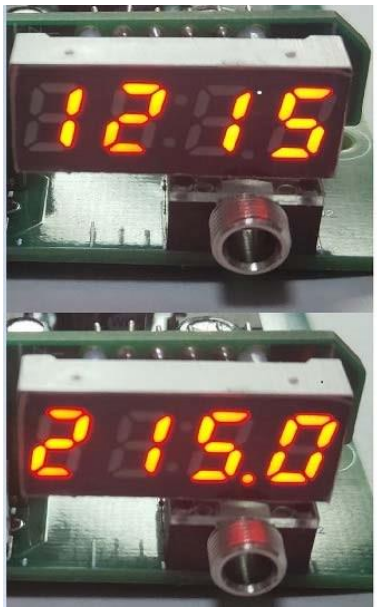
Installation in an Enclosure

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).

ZL2PD 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.



100KHz步进

10KHz步进

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 **briefly**, 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.

When you turn on the power to the receiver, it will always start in the AM/Aviation band. If you need to switch to the FM broadcast band, press in the adjusting knob and keep it depressed **for more than 5 seconds**. When you then release the knob, the receiver will switch to the FM broadcast band. Repeat this to return to the AM/Aviation band.

On the FM band, if the frequency is tuned by more than 15 within 3 seconds, the receiver will automatically enter the "shuttle" function. At this time, the status light will change to red to show means this function has been activated. The tuning knob will now change the frequency in steps of 1MHz. If you do not turn the knob then, after 3 seconds, the shuttle function will automatically turn off and the red light will go out.

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 greater the received signal required to unmute the receiver to allow aviation communication to be heard). If this is set to 0, the squelch is disabled and audio is enabled all the time. (This is the recommended setting while listening to FM to avoid frequent squelch activity)

The front panel green light also indicates the squelch function. When it is off, it means the squelch has muted the audio output (No valid signal is present), and when it is lit, it means a suitable signal has been received and the audio output is enabled.

Press the Setting Select button again. This will display 4_68, which is the 25MHz clock frequency offset setting. The default factory-set clock frequency offset is 68, and the default step size is 100Hz. The default PLL reference frequency is therefore 25 000 000 + 68*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 Setting 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.

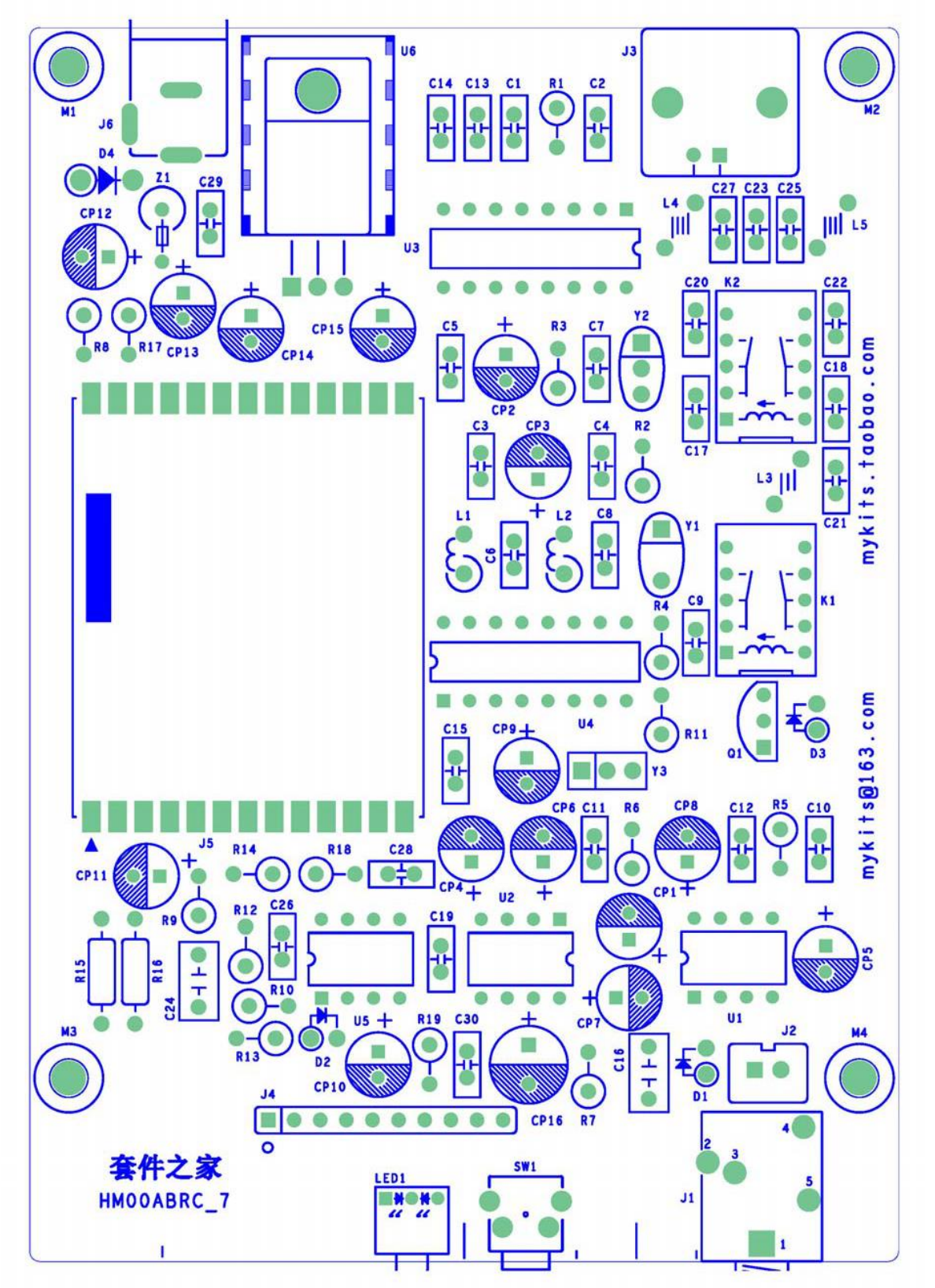
Parts List

1/4W 5% Resistors		
R1, R2, R5, R6	10R	Brown Black Black Gold
R15	51R	Green Brown Black Gold
R3, R9, R11, R13, R15, R16, R18	1k	Brown Black Red Gold
R4, R8, R10, R12, R17	10k	Brown Black Orange Gold
R7	47k	Yellow Violet Orange Gold
R14	100k	Brown Black Yellow Gold
Inductors		
L1	1mH	
L2	100uH	
L3	3.5T - 0.7mm diam wire	
L4, L5	4.5T - 0.7mm diam wire	
Z1	Ferrite bead RF choke	
Ceramic Capacitors		
C1, C2, C3, C4, C10, C11, C12, C19, C29, C30	0.1uF 100nF 104	
C6, C7, C13, C14, C15, C26	0.01uF 10nF 103	
C8, C9	4n7	
C16, C24	1uF	
C23	2.7pF	
C20, C22	8.2pF	
C25, C27	15pF	
C21	27pF	
C17, C18	33pF	
C5, C28	100pF	
Electrolytic Capacitors		
CP1, CP4, CP6, CP7, CP10	10uF/25V	
CP2, CP3, CP5, CP8, CP12, CP13, CP14, CP15	100uF/25V	
CP9, CP11	47uF/25V	
CP16	220uF/6.3V	
Diodes		
D1, D2, D3	1N4148	
D4	1N4001	
LED1	3mm Red/Green LED	Three leads
DISPLAY	4-digit 7-segment LED display	

Semiconductors		
Q1	8050	NPN transistor TO-92
U1	LM386 (DIP8)	Audio amplifier (Fit IC socket)
U2	FM62429 (DIP8)	Volume control (Fit IC socket)
U3, U4	TA2003 (DIP16)	AM/FM radio IC (Fit IC socket)
U5	LMC6482 (DIP8)	Op-amp (Fit IC socket)
U6	7805	5V 1A regulator TO-220
Ceramic Filters and Crystals		
Y1	10.7MHz ceramic resonator	
Y2	10.7MHz ceramic filter	
Y3	455kHz ceramic filter	
Connectors		
J1	3.5mm audio stereo jack	AUX For speaker or earphones
J2	Speaker socket	SPK
J3	BNC socket	Antenna input
J4	10-way right-angle pin strip	Connects Display PCB to the main PCB
J5	PLL daughterboard connections	** Circuit reference only – No component required **
J6	DC socket 2.1mm type	12V input
Miscellaneous		
SW1	Pushbutton	
K1, K2	Relay	EA2-5V
Heatsink	For U6	
Heatsink hardware	Nut and bolt set for mounting heatsink for U6 to main PCB	
Receiver PCB – 1 off	Main PCB board for receiver	
Display PCB – 1 off	Partially assembled - Must be fitted with rotary encoder and 2 x 470u/6.3V electrolytic capacitors – See instructions above	
PLL PCB – 1 off	Preassembled - To be mounted on the main PCB	

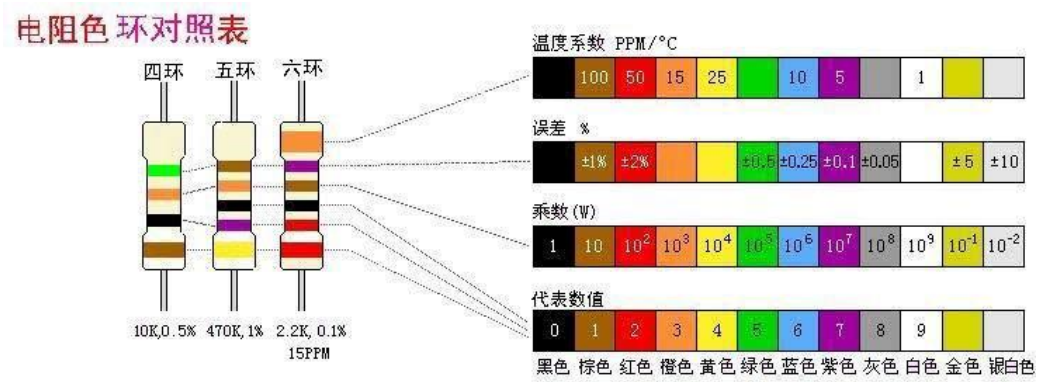
After receiving the kit, please check the parts carefully to confirm that all components are present. If you have any questions, please contact the kit supplier.

PCB Assembly Drawing



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.

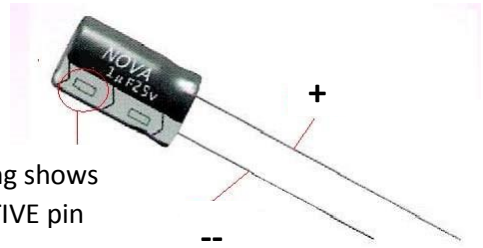
Most are labelled in exponential terms, such as 102,221. The first two digits are two most significant digits of the capacitor's value, the last digit being the number of zeros added after these digits. For example, "102" means that the leading digits are 10, while 2 means that 2 more zeros are added, 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

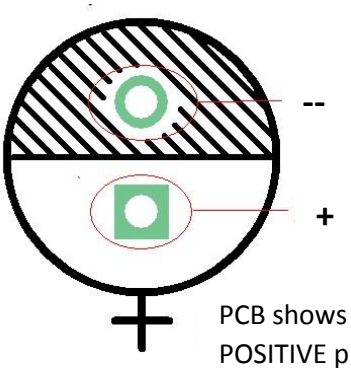
102 here means 1000pF

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.



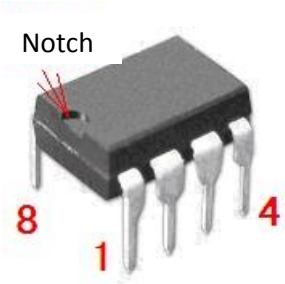
Marking shows
NEGATIVE pin



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

R80航空波段接收机电路图（V7.0）
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