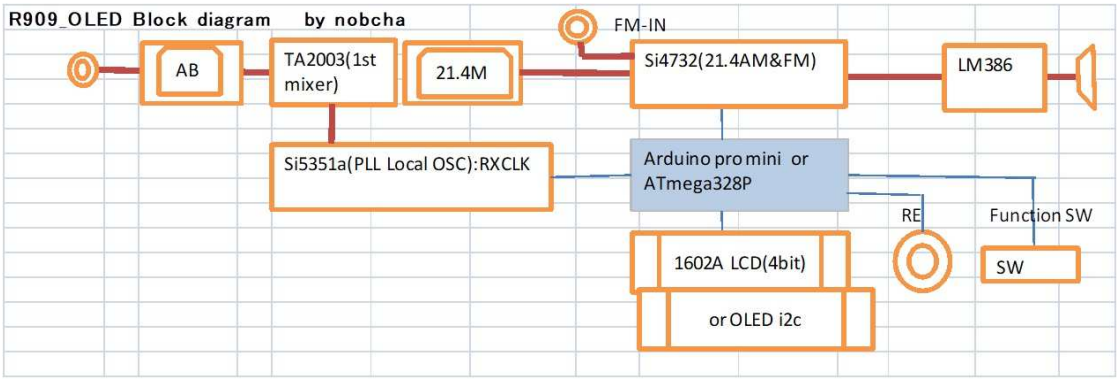
R909-DSP radio (Arduino+Si4732+Si5351a+TA2003+LM386)

2024.04.09 tentative by nobcha

1. PRFACE

-The front view of this radio.

R909-4732(DSP) is a radio for the air band and the FM broadcasting. It is configured with Si5351a, Si4732, and TA2003 mainly. TA2003 and Si5351a are sharing the first mixer and the local oscillator. Si4732 is acting as a mother 21.4MHz receiver for the air band and the FM radio itself. Concerning of PU2CLR's advice, I adopted PU2CLR Si4735/32 library for this sketch. There are some kinds of display version, as SSD and WE1602A. I will introduce OLED version mainly.



-Brock diagram

To operate the radio, you shall use the rotary encoder, encoder push switch, and function switches.

There are two PCBs as Panel and RF. They are connecting by pin header connector. The ATmega328P with the Arduino boot loader, the switches, and the display are locating on the Panel PCB.

-Inside of R909-DSP radio

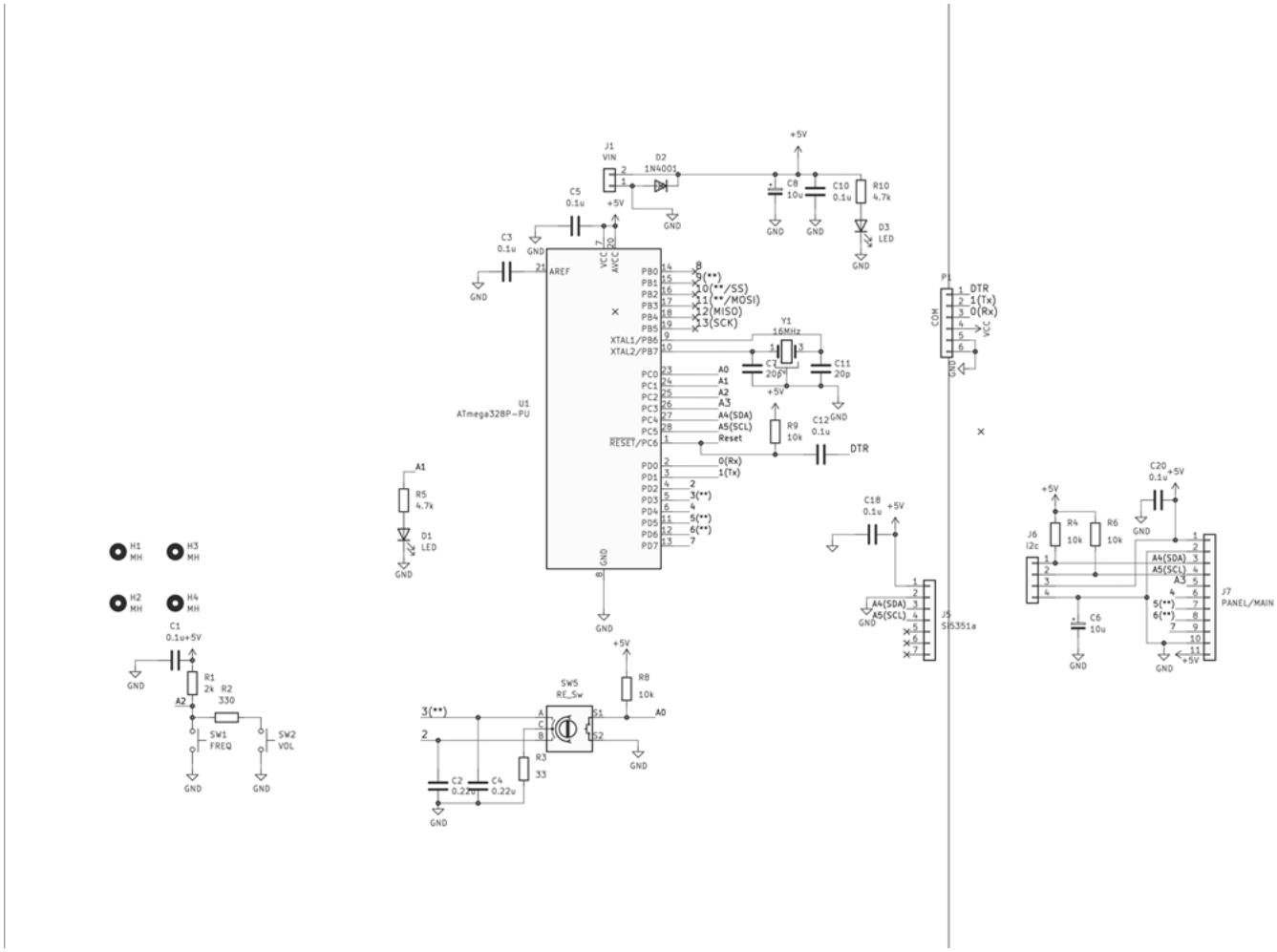
2. The details of R909-4732

2.1 Specification

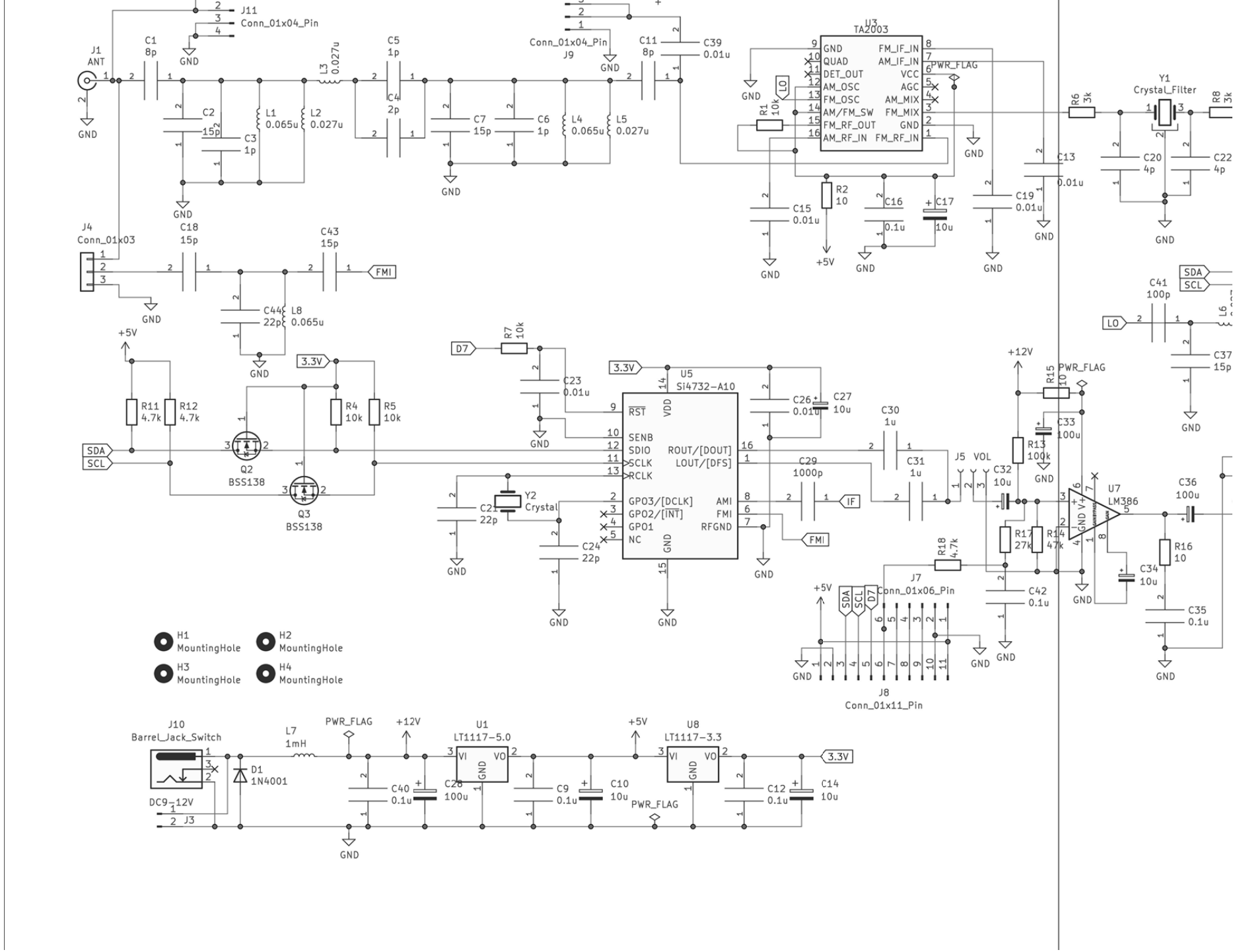
.Band coverage Air band AM; 118-136MHz, FM: 76-109MHz
.Sensitivity -85dBm
.Power supply DC+12V about 110 mA
.Audio output 1W max, 2.5 jack
.Case size 38h x 88w x 100d, weight: about 250grm

2.2 Circuit and PCBs

There are 2 PCBs of RF and CPU. RF PCB is containing the front end filter, TA2003 mixer, Si4732 radio, Si5351a frequency module, LM386 audio AMP, and the power circuit. CPU PCB is holding ATmega328P with boot loader, OLED display module, and the switches.



-CPU circuit diagram


J1
ANT
C1
8p
C2
15p
C3
1p
L1
0.065u
L2
0.027u
L3
0.027u
C4
2p
C5
1p
C6
1p
C7
15p
L4
0.065u
L5
0.027u
C11
8p
C39
0.01u
J9
Conn_01x04_Pin
J11
Conn_01x04_Pin
U3
TA2003
GND
QUAD
DET_OUT
AM_OSC
FM_OSC
AM/FM_SW
FM_RF_OUT
AM_RF_IN
FM_IF_IN
AM_IF_IN
VCC
AGC
AM_MIX
FM_MIX
GND
FM_RF_IN
PWR_FLAG
LO
R1
10k
R2
10
C13
0.01u
C15
0.01u
C16
0.1u
C17
10u
C19
0.01u
R6
3k
R8
3k
Y1
Crystal_Filter
C20
4p
C22
4p
J4
Conn_01x03
C18
15p
C43
15p
FMI
C44
22p
L8
0.065u
+5V
3.3V
R11
4.7k
R12
4.7k
R4
10k
R5
10k
Q2
BSS138
Q3
BSS138
SDA
SCL
D7
R7
10k
C23
0.01u
U5
Si4732-A10
RST
VDD
SENB
SDIO
SCLK
RCLK
GPO3/[DCLK]
GPO2/[INT]
GPO1
NC
ROUT/[DOUT]
LOUT/[DFS]
AMI
FMI
RFGND
C26
0.01u
C27
10u
C29
1000p
IF
C30
1u
C31
1u
J5
VOL
C32
10u
C21
22p
Y2
Crystal
C24
22p
+12V
R15
10
PWR_FLAG
C33
100u
R13
100k
R14
47k
R17
27k
U7
LM386
C36
100u
R16
10
C34
10u
C35
0.1u
C42
0.1u
R18
4.7k
J7
Conn_01x06_Pin
J8
Conn_01x11_Pin
C41
100p
L6
C37
15p
H1
MountingHole
H2
MountingHole
H3
MountingHole
H4
MountingHole
J10
Barrel_Jack_Switch
DC9-12V
J3
D1
1N4001
L7
1mH
PWR_FLAG
+12V
U1
LT1117-5.0
VI
VO
GND
C40
0.1u
C28
100u
C9
0.1u
C10
10u
+5V
U8
LT1117-3.3
C12
0.1u
C14
10u
3.3V
GND

-RF circuit diagram

2.3 Operation

Operation is depending on the rotary encoder and the rotary encoder's push switch. There are 3 modes, to select a function (FUNC), to change parameter at every function mode, and to memory the parameter into EEPROM. FUNC mode is to select every function. You shall select the function by rotating and determine the one by single pushing. In every function mode you can change the parameter by rotating and store the parameter on to EEPROM by double pushing. To escape out from every function mode to push rotary encoder switch single. Rotating, one pushing, and two pushing is the identical operation for this sketch.

There are 10 major functions in this radio machine control.

.Func: To decide every function

.FRQ: To determine the frequency stepped by the step frequency

.STP: To select the step frequency from 10Hz, 1kHz, 10kHz, 100kHz, 1MHz, and 25kHz

.MEM: To set the memory channel number for EEPROM 50channels

.SCN: To scan the memory channel number for EEPROM 50channels

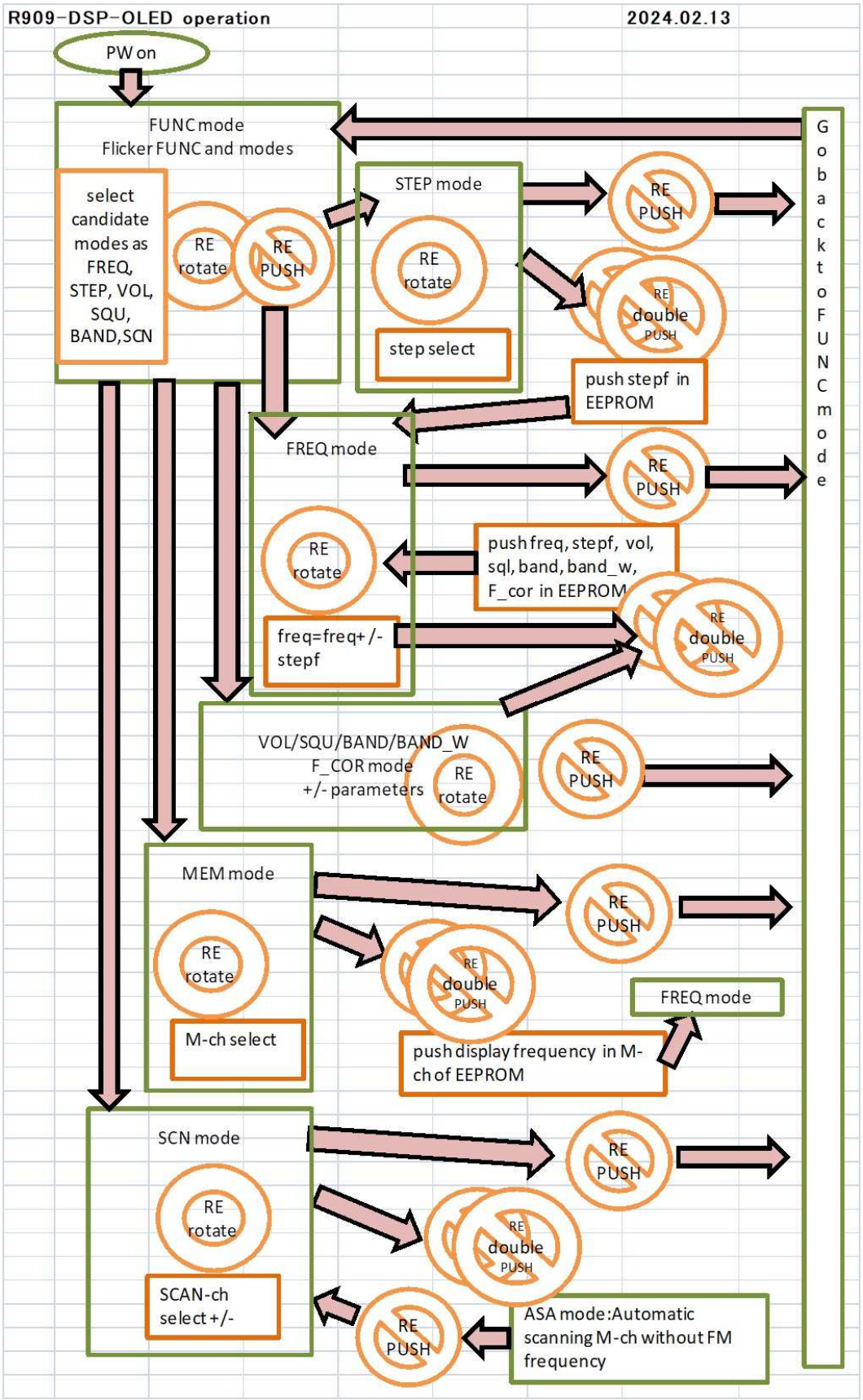
.VOL: To control volume level

.SQU: To control squelch level

.BAND: To alternate AM or FM

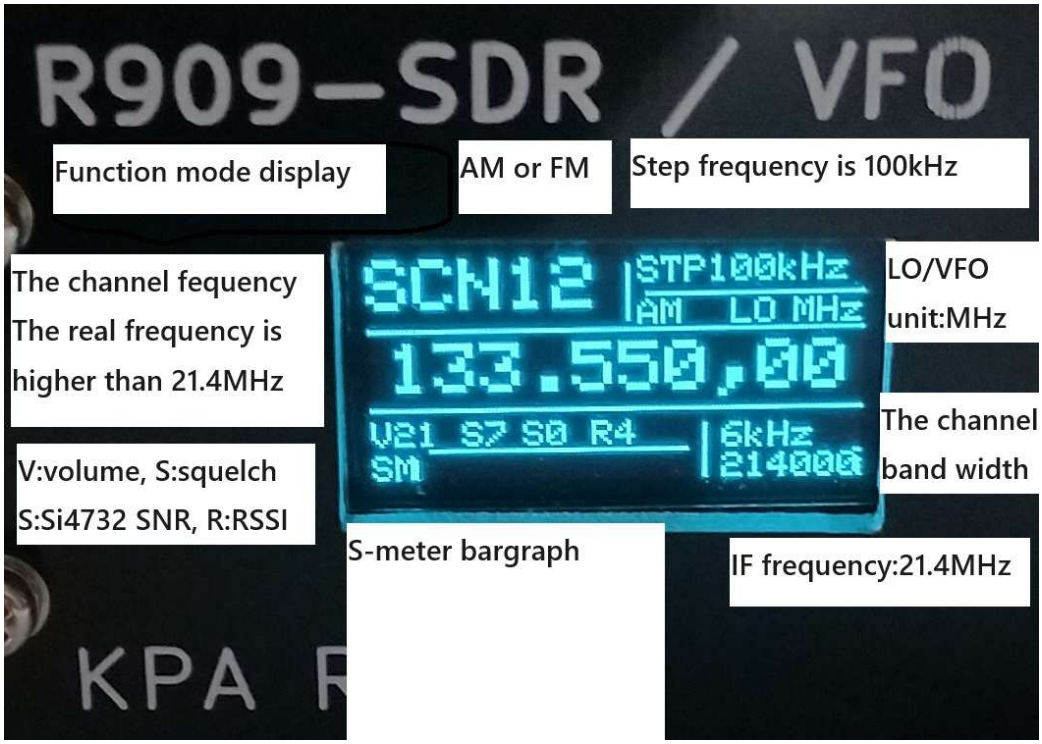
.BAND_W: To select the band width frequency from 1Hz, 1.5kHz, 2kHz, 4kHz, and 6kHz

.F_COR: To correct the basic crystal 25MHz frequency error



-Operation flow

Display contents on OLED is below.



-Youtube video

2.4 About sketches

Some libraries and common sketches are included. Many thanks for providing those materials. They are PU2CLR's 4735 library, Adafruits OLED libraries, TJ lab's Si5351a sketch, and Ben Buxton's rotary encoder library.

https://github.com/Nobcha/R909-SDR/R909-SDR-OLED_test3.ino

There are the diagnostic sketches for testing the hardware, as i2c scanner and USB serial controlling Si4732.

https://github.com/Nobcha/R909-SDR/i2c_scanner_R909PANEL.zip

https://github.com/Nobcha/R909-SDR/SI4735_01_POC_5351.ino

3. How to assemble the PCB and to combine PCBs with module.

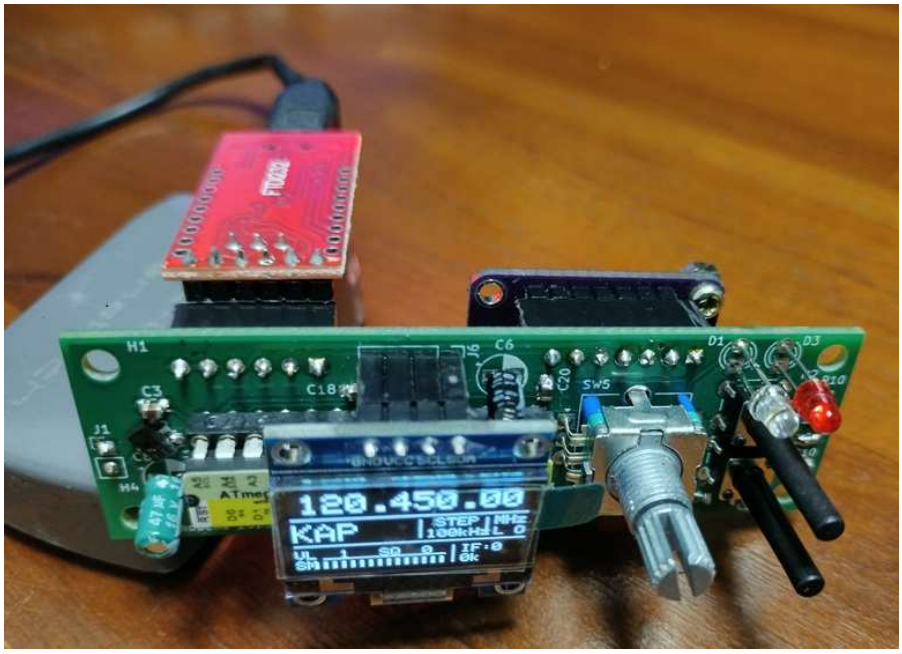
3.1 CPU PCB

You shall gather the parts on the list. There are some optional parts. Please judge depending on your plan.

There are used the surface mounting CRs on this PCB. You shall solder the surface mounting CRs at

first. Please take care of the parts which must be soldered on B side.
https://github.com/Nobcha/R909-SDR/R909-SDR-Panel_OLED_bom.pdf

Next the crystal and the aluminum capacitors are soldered. ATmega328P should be mounted with the IC socket to be replaced as needed. J and J are used on demanded. The switches and LEDs are mounted to take care of combining with the front panel PCB.
The assembled PCB could be tested by i2c scanning sketch. When the OLED shows its own i2c address of 0x10 on it, testing result is OK.

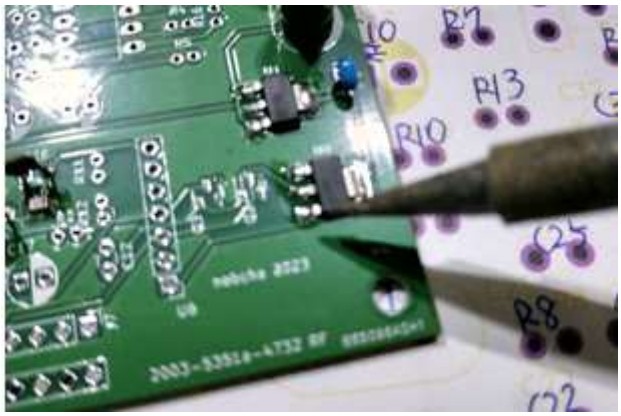


-Photo of assembled PANEL PCB

3.2 RF PCB
You shall gather the parts on the list. There are some optional parts. Please judge depending on your plan.
https://github.com/Nobcha/R909-SDR/R909-SDR-Panel_OLED_bom.pdf

Prior to solder the parts you shall wind the coils. You should wire 4 air core coils and 1 troidul coil as below.
https://github.com/Nobcha/R909-SDR/coils_R909-SDR.pdf

At first you shall solder the surface mounting parts as Si4732, SGA2751 and some LCs.



After then you solder the DIP type LCR and pin header connecters.

If you would like to check digital connection between PANEL and RF PCB, you can use i2c scanner program. When you find Si4732 address of 0x60, it works well. And USB serial controlling Si4732 sketch is useful to tune RF coils.

3.3 To tune

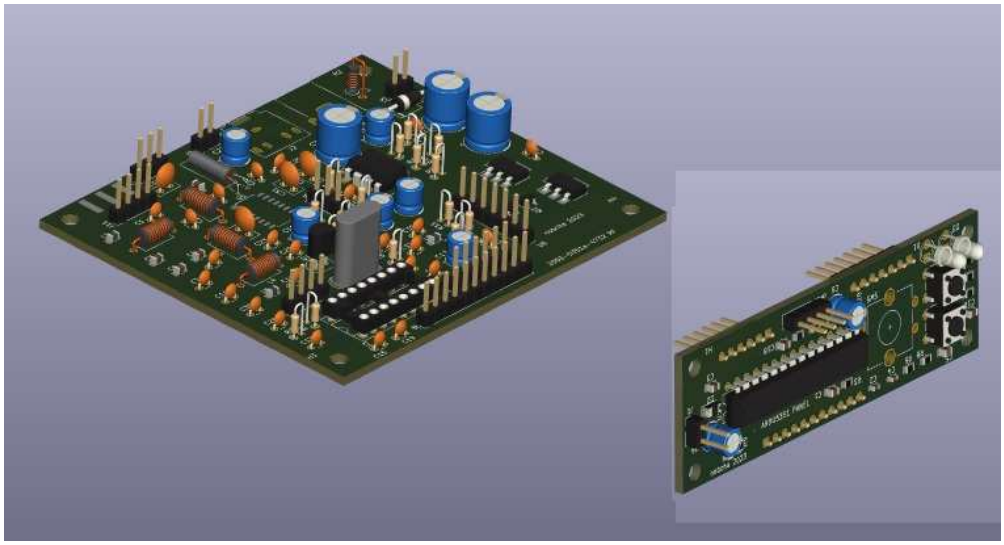
To tune the coils, you shall use nano VNA.

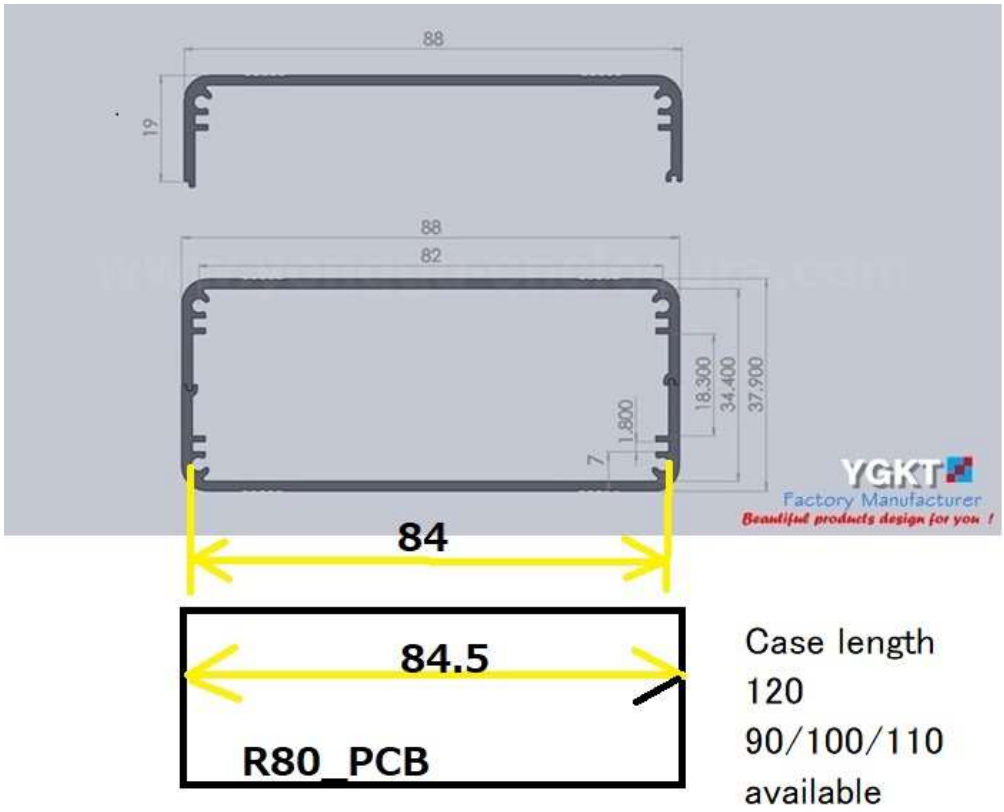
You may use the signal generator or some other RF signal source of about 120MHz or so.

If you hold tiny SA ultra, please set it as a RF generator mode.

3. To install the PCBs in the case

The size of PCBs is intended to be installed into 38x88x120 aluminum case.





RF PCB shall be loaded into 84.5mm spacing graves

4. References and thanks

I'm much thanking Mr.Jason,9H5BM to give me the idea of this project, PU2CLR and JF3HZB to show me sketch examples, Cesar Sound to give me display layout example, and many people.

Jason kits,9H5BM:https://www.facebook.com/profile.php?id=100012257914763
Ricardo Lima Caratti,pu2clr:https://github.com/pu2clr
上保 徹志 (Tetsuji Uebo),JF3HZB:https://tj-lab.org/2017/03/13/si5351/
CesarSound:https://www.hackster.io/CesarSound/10khz-to-225mhz-vfo-rf-generator-with-si5351-version-2-bfa619

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