Software description of SDR-X V 3.6

1 Preliminary Simplified description

The SDR-x software can be used on several Ham communications projects as described in the following:

- **DDS VFO** application :all functions of a digital DDS VFO based on AD9951 (high performance 14 bit DDS) can be performed: this SW can driver the DDS with many features (sum or subtraction of any IF, suggestion of the Band selector for vintage transceiver as Collins or Drake, insertions of RIT, 20 memory, scanning of memory, dual VFO (A and B), scanning from freq. of VFOA to freq. of VFOB, memory of last band used and so on.
- **STANDARD RTX**: a standard receiver or transceiver with any type of IF in the range 0 to 80 MHz: for this applications this SW, in addition to above features, can be performed a complete control of an input RX/TX front-end, PTT, PTT timing for TX and RX, RX /TX control for BFO (IF modifications for USB, LSB and CW offset), TX Split,CW generation with standard PC keyboard, direct dialling of any freq. with standard PC keyboard. Two type of front-end can be controlled: a) with dedicated filter for each Ham band (K2 Elecraft like); in this case 9 Filter can be switched to select 9 Ham band. b) with continue tuning from 2 MHz to 30 MHz; in this case a 10 bit control (1024 tuning step) perform linear tuning of the preselector (Ciao Radio like) (see my preselector documentations).
- **DIRECT CONVERSION RTX**: a direct conversion RX or RTX: in this case, in addition to the above features, the necessary 4 x nominal freq. can be produced to allow use of I/Q DDS clock (this clock can be produced using my programmed PLD able to generate two square output ¼ of input freq. out of phase of 90° in the range 0-50 MHZ).

This firmware will be always under development so many others functions can be available in the future. Any up-date has available for free if the old PIC is returned, or for the cost of an empty PIC if old PIC isn't returned. Please don't ask for source or object code; I ship only PIC with security bit ON.

A second PIC microprocessor named "expansion" can be necessary for some of the above functions. For link between this two PIC device ("master PIC" and "expansion PIC") a TTL serial connection must be used (only one wire is necessary).

This SW has contained inside a Microchip Flash device PIC18F2620 (64 K flash memory).
To perform the applications above described some others Hardware modules can be used as :

- PIC controller with 2 x 16 Chr LCD display and 8 Key keyboard
- AD9951 board to generate sine from 0 to 200 MHz
- Optional 500 MHz oscillator
- Automatic, continue tuning 1 – 30 MHz antenna preselector (PCB available)
- PLD to generate 2 x I/Q carrier in the range 0 -50 MHz (for DDS running 0-200 MHz)
- SDRx main board (Full SDR receiver with 50 MHz input filter) (PCB available)

See my web pages http://it.geocities.com/giulianoi0cg/ to see documentations of some of the mentioned modules.

1.1 Power-on set-up to enable or disable of SW functions

1.1.1 Functions enabled at power-up when the VFO Key has pressed:

(8 parameter can be changed)

1. **Freq. max**: insert the maximum frequency used in the applications in the range 10 – 199 MHz
2. **IF offsets** : to enable IF positive, negative (freq. generated is Display +/- IF) or I/Q mode (frequency generated is 4 x the display freq. indication) ; to set IF frequency value see the next paragraph
3. **SET DDS CLOCK**: any DDS clock can be programmed in the range 1 MHz – 999 MHz with 1 Hz resolutions (Function Key +/- perform tuning step and Key +/- perform freq. tuning)
4. **S meter On**: Enable ore disable the S meter indication on the LCD display (see schematic for wiring)
5. **ENC**. **SEN**.: perform the tuning encoder sensitivity for the auto step tuning function
6. **SUGGESTION** : this function perform the Band suggestion for the vintage transceiver like Drake R4, Drake TR7, Drake SPR4, Collins or No suggestion
7. **Function MODE menu** : from 1 to 15 . Perform the # of functions in the mode menu. Normally it is not necessary to enable all functions (i.e.: if you are using a receiver, functions related to transmitter are not necessary). See table of all functions mode menu
8. **CFR2:** DDS register CFR2 programming. Value is 0 if the internal PLL is bypassed (used when external oscillator as the 500 MHz osc. is used);Value of 39 is programmed if a 100 MHz oscillator is used . With 39 the x 4 multiplayer has enabled allowing the internal PLL to generate 400 MHz clock. For others multiplayer value see the AD9951 data –sheet.

To scroll and read only the programmed parameters from 1 to 8 the “Band-UP“ key must be used (the fourth key on the right on the bottom line of key)

To store permanently parameters switch off controller and switch ON again without pressing any Key

1.1.2 Functions enabled with power-up when the RIT Key has pressed:

With this set-up it is possible adjust 6 different IF frequency :
LSB RX
LSB TX
USB RX
USB TX
CW RX
CW TX
The IF frequency in TX and RX can be different allowing to use different SSB filter for TX and RX.
A full- setup of all 6 parameters is only necessary if BFO is controlled via Expansion PIC (see 1.3.2.1)
If BFO isn't controlled then, only first two parameter must be programmed (Ie: 9 MHz)

1.1.3 Functions enabled with power-up when the Band- UP Key has pressed:

This key perform only the central HAM band set-up to the default value stored on the PIC memory

1.1.4 SIDE-TONE setup enabled with power-up when Band-dw pressed

This key the Sidetone frequency set-up (range 300-1000 Hz).
Press Val + / - to incncrement / decrement frequency
Press Band- DW to listen frequency
Press Band-UP to store Side-tone frequency

1.2 Operation

key disposition

1.2.1 FUNTION MODE Key (<FUN>)

The **FUN** key scroll UP and Down functions of the following table

MODE MENU	#	**Description**
VFO A=B	0	Set VFO B = VFO A
VFO B=A	1	Set VFO A = VFO B
Mem Read	2	Read the 20 memory bank
Mem. Write	3	Write in the 20 memory bank
Scan A --> B	4	Scan from frequency of VFO A to frequency of VFO B
Scan memory	5	Scan from memory 1 to memory 20
Step tuning	6	Set any step value for tuning in the range 1 Hz - 1 MHz
Lock	7	Lock tuning on / off
Gen. Coverage	8	Skip from MHz to MHz from 1 to 30 MHz to speed general coverage reception
DDS level	9	Vary the DDS level: step 1 dB in the range +7 - -60 dBm
Sleep	10	Sleep the CPU to reduce power consumption and RF interference (CPU has reactivated pushing the functions mode key)
Pre/Att.	11	Turn on and off Preamplifier and Attenuator (Key- : Pre, Key+ : Att)
Preselector	12	preselector tuning, if present, from 5 to 5120 step 5 pF (1024 value)
CW Mode	13	TX Function: enable CW transmission with PC keyboard or standard key (to exit to this mode press the RIT key)
Split mode	14	TX Function: enable Split mode (RX on VFO A , TX on VFO B)
Tx Timer	15	Enable display to indicate TX time

These functions menu must be enabled in the range 1 – 15 at power up (see above)
Ie:
-for a VFO only application program to 10
-For SDR Receiver program to 12
-for Transceiver program to 15

1.2.2 INCREMENT / DECREMENT Key (VAL)

The **Val** key increment or decrement function selected with Function mode Key

1.2.3 VFO Key selection

VFO Key toggle from VFO A to VFO B

1.2.4 RIT key

This key perform the **Rx RIT** function **on** and **off .** When RIT ON is selected the VAL key increment and decrement RIT value from + 2000 Hz to -2000 Hz with 10 Hz step

1.2.5 Band Down and UP (BAND DN UP)

This two key increment or decrement ten HAM band from 1.8 MHZ to 50 MHz

The last frequency used inside the ham bands are recorded in the EEPROM memory.

To reset all amateur Bands to the default value turn ON with the BAND UP key pressed

If the READ MEMORY or WRITE MEMORY menu are selected this two Key increment or decrement the memory instead of Band selection

If Step tuning menu is selected this two key increments Frequency instead Band selection, this function can be useful if Optical encoder isn't installed

1.2.6 Use of PC Keyboard

Several operations can be done with a standard PC keyboard.
The primary use to shortcut of some Function mode menu as described in the following:

1) the arrow **key** ↑ perform : Band-UP
2) the arrow **key** ↓ perform : Band-DW
3) the arrow **key** → perform: tuning step up (1Hz – 1 MHz)
4) the arrow **key** ← perform : tuning step down
5) **Pag.** ↑ **key** perform: Frequency tuning up (same use of optical encoder)
6) **Pag** ↓ **key** perform : frequency tuning down
7) **F key** perform **:** display ask for frequency entry via numeric Key (ie: display ask: **load frq.** you press **: 07 050 000** to recive at 7050 KHz

8) C key perform: enter CW mode (see below the explanation)

9) When CW mode is enabled the **Pag.** ↑ **key** and **Pag** ↓ **key** perform CW speed set-up

When the **C key** is pressed on the PC keyboard the **CW mode** is enabled so any key pressed successively , PIC perform this action:

- Generate the Cw sidetone related the CW symbol as a square wave on the PINs .This tone, filtered with an RC, can be inserted to the AF amplifier to enable side-tone reception on the transceiver speaker
- DDS generate the frequency with the frequency shift programmed on the IF menu related to the IF CW TX frq.
- The PIC pin 10 (PTTX) Generate a logical state "0 " to drive an electronic or mechanical (Rele') to switch antenna and all TX circuitry
- The PIC pin 9 (PTTRX) generate a logical state "1" (5 Vdc) to swith OFF all RX circuitry. (to be noted that the PTTX and PTTRX are 5 mSec delayed to ensure soft switching)

When CW mode is enabled the special Key F1 - F12 generate the following CW message :

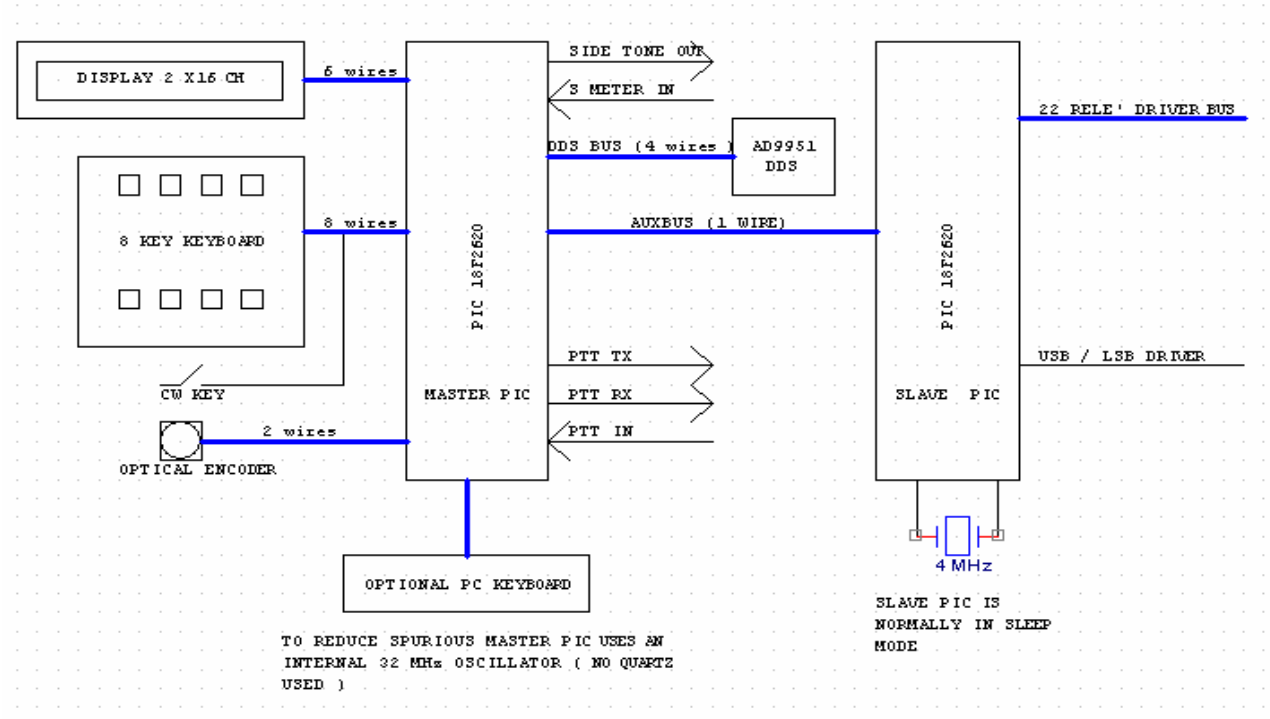
Key	**CW message**
F1	CQ
F2	DE
F3	User programmable (not yet implemented)
F4	RST
F5	QTH
F6	NAME
F7	73
F8	VA
F9	User programmable (not yet implemented)
F10	To be defined
F11	To be defined
F12	To be defined

To **exit from CW mode** any key in the Function mode must be pressed

1.3 Hardware interface

Some example wiring are used in my Hombrew trasceiver

Block diagram of logic part of a generic transceiver using this software

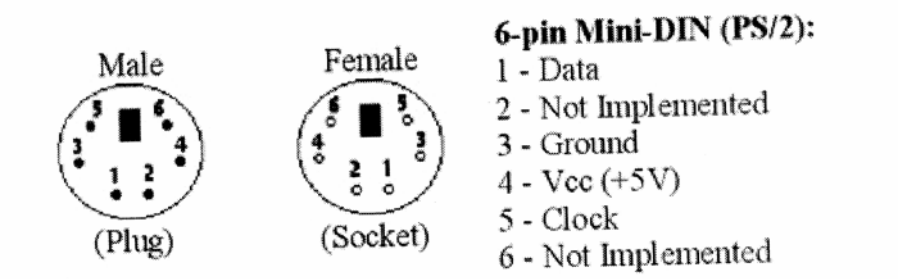


1.3.1 I/O used in the PIC master

I/O	PIN PIC Master	Signal name	I/O description
A0	**2**	VFOA – VFOB/S-meter	Digital input or Analog input (shared)
A1	**3**	Rit	Digital input
A2	**4**	Band UP	Digital input
A3	**5**	Band DOWN	Digital input
A4	**6**	KEY -	Digital input
A5	**7**	KEY + / CW keyer	Digital input Key shared with keyer
A6	**10**	PTTRX: a 32 MHz internal osc. is used (no Quartz)	Digital output: enable RX voltage
A7	**9**	PTTTX : a 32 MHz internal osc. is used (no Quartz)	Digital output: enable TX voltage
B0	**21**	DB4 LCD / data DDS	Digital output shared LCD and DDS
B1	**22**	DB5 LCD / IO update DDS	Digital output shared LCD and DDS
B2	**23**	DB6 LCD	Digital output
B3	**24**	DB7 LCD	Digital output
B4	**25**	RS LCD	Digital output
B5	**26**	FUN+	Digital input
B6	**27**	E LCD	Digital output
B7	**28**	FUNC - / CW side tone out	Digital input/output shared
C0	**11**	AUXBUS	9600 baud Serial out :PIC master to PIC slave data connection
C1	**12**	Encoder ch 1	Optical or mechanical encoder con.
C2	**13**	Encoder ch 2	Optical or mechanical encoder con.
C3	**14**	I/O SYNC DDS	Digital output
C4	**15**	PTT IN	Digital input
C5	**16**	CLK DDS	
C6	**17**	DATA -keyboard	Standard PC keyboard (PS2)
C7	**18**	CLOCK -keyboard	Standard PC keyboard (PS2)

1.3.2 Connection of a PC Keyboard

Keyboard must be connected to C6 (Pin 17 PIC) for clock and C7 (Pin 18 PIC) for Data It is also necessary to supply 5 V to the keyboard.
Is very important to insert a pull-up resistor between pin 17 and pin 20 of PIC (remember that keyboard connector has the same numbering of PIC)



PS2 connector

1.3.3 Connection of optical encoder

The optical encoder must be connected as in the following table

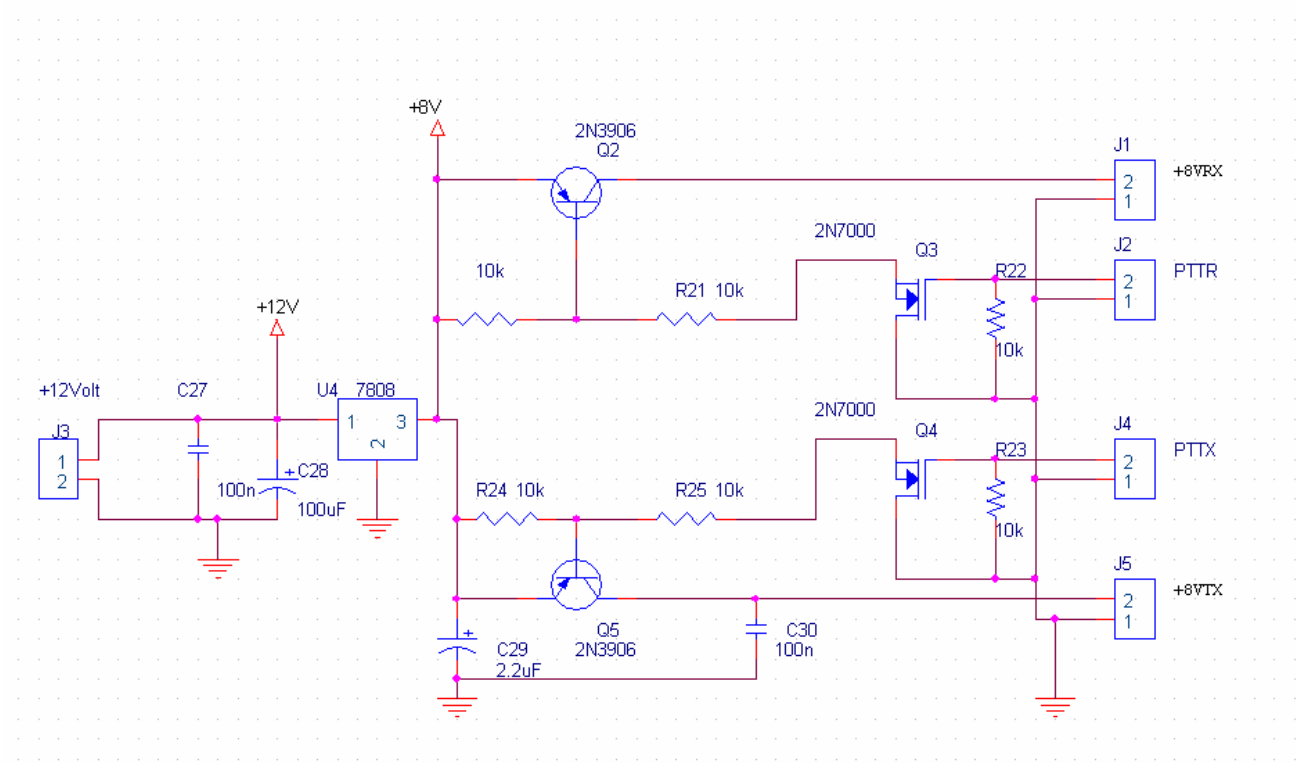
Function	**Signal**	**Pin**
Enc. Channel 1	Portc.1	12
Enc. Channel 2	Port.c.2	13
Encoder Gnd	GND	8-19
Encoder +5V	+5V	20

1.3.4 Interconnections of PIC controller to DDS

J7 connector is near DDS PCB border

DDS board I0CG	Wire colour	PIC pins	DDS Signal
J1-2	Blue	22	IO-Update
J1-3	White	21	Data
J7-3	Red	16	Sclk
J7-4	Black	14	Iosy

1.3.5 Cabling PTT to the MASTER PIC

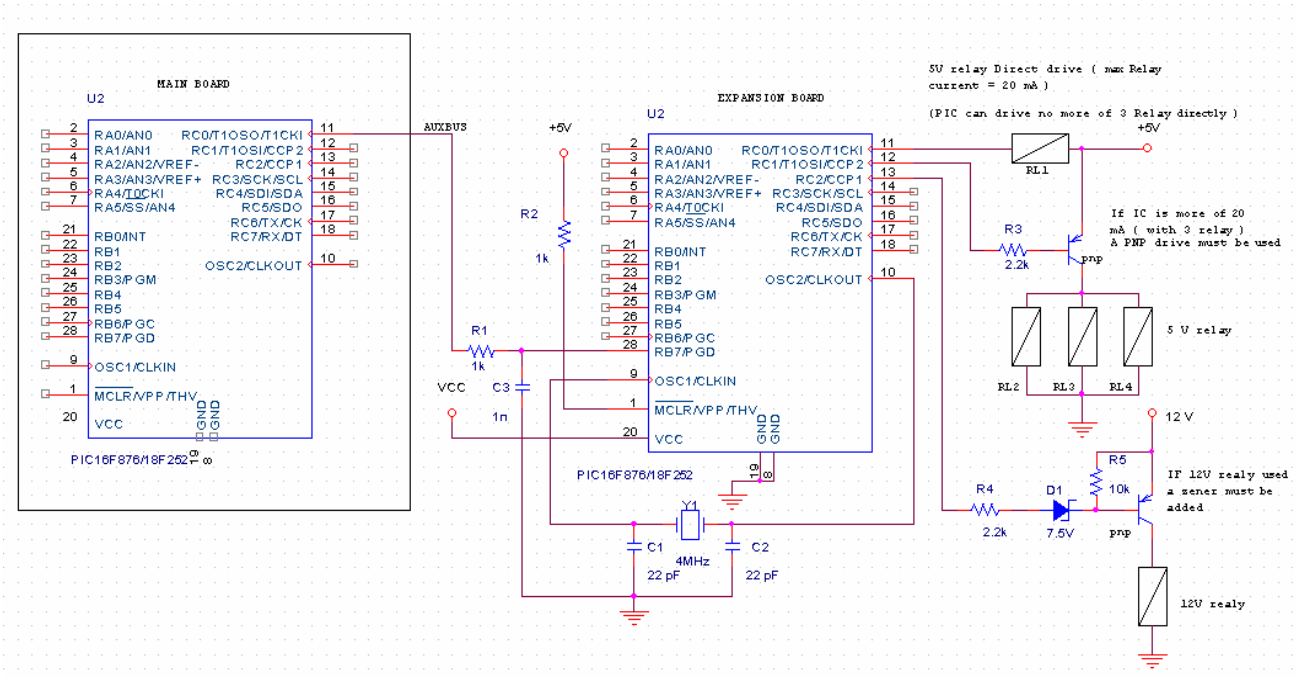


Example of wiring of PTT to drive all RX and TX circuitry

PTTRX = Pin 9 of Master PIC
PTTX = Pin 10 of Master PIC

1.3.6 Expansion PIC connections

The following schematics are only for Example. I haven't made any PCB of this part.



See the connection between Main PIC Board and Expansion PIC board
See also how 5V or 12 V relay can be connected directly to the Expansion Board.
This relay can be used to switch RX Front-end filter or TX low pass Filter

I/O used in the Expansion PIC (RX Front-end filter and TX low pass filter are (like Elecraft K2) **Sw name = ESP_EL**

I/0	PIN MICRO	FUNTIONS
RC2	13	30 and 20 low pass
RC3	14	80 m low pass
RC4	15	40 m low pass
Rc5	16	17 e 15 m low pass
Rc6	17	12 e 10 m low pass
Rc7	18	LSB = 1, USB = 0
RB0	21	Add C to tune 15 and 10 m Front-end filter to 17 and 12 m bands
RB1	22	Front-end 10 m (tuned to 12 m with RB0=0)
RB2	23	Front-end 15 m (tuned to 17 m with RB0= 1)
RB3	24	Front-end 20 m (tuned to 30 m with RB5= 1)
RB4	25	Front-end 40 m
RB5	26	Add C to tune 80 and 20 m Front-end filter to 160 and 30 m bands
RB6	27	Front-end 80 m (tuned to 160 m with RB5=1)
RB7	28	AUXBUS

Table with I/O to interface a standard driver board(Sw ESP_std)

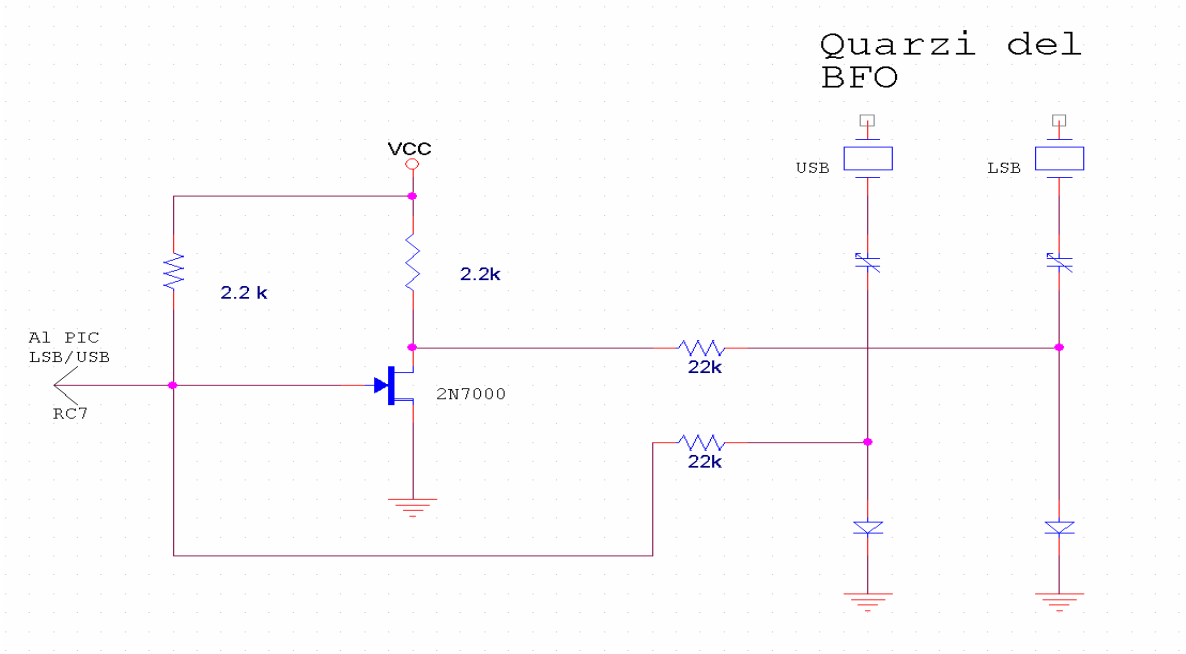
To any I/O is available command to drive 9 Ham band (160 to 10 m)

The logica level 0 enable the relevant Band Filter (see the examples)

I/0	PIN MICRO	FUNTIONS
RC2	**13**	Comando banda 12 m
RC3	**14**	Comando banda 10 m
RC4	**15**	
Rc5	**16**	
Rc6	**17**	
Rc7	**18**	LSB = 0, USB = 1
RB0	**21**	Comando banda 160 m
RB1	**22**	Comando banda 80 m
RB2	**23**	Comando banda 40 m
RB3	**24**	Comando banda 30 m
RB4	**25**	Comando banda 20 m
RB5	**26**	Comando banda 17 m
RB6	**27**	Comando banda 15 m
RB7	**28**	Auxbus. Segnale seriale per comandare il PIC tramite PIC Master
RA5	**7**	Comando Cw : 0 = Cw attivo, 1= Cw off

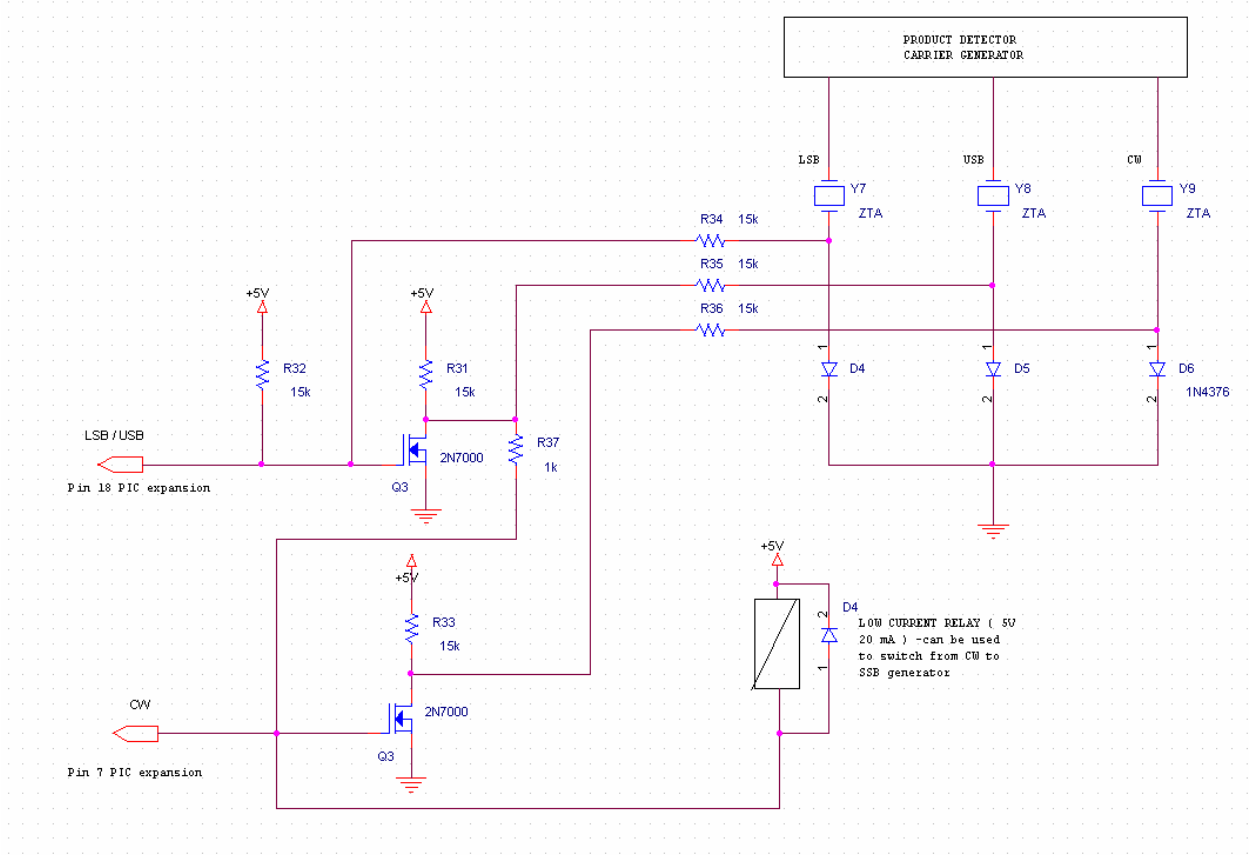
See in the last page of this document the Schematic of standard preselettore driver board

1.3.7 Expansion PIC connections to drive USB and LSB quartz of product detector



Example of possible schematic for the USB /LSB control via the expansion PIC.
Note that, if transceiver haven't a dedicate BFO Quarz and CW filter, the LSB quartz must be used as reference for the CW TX shift

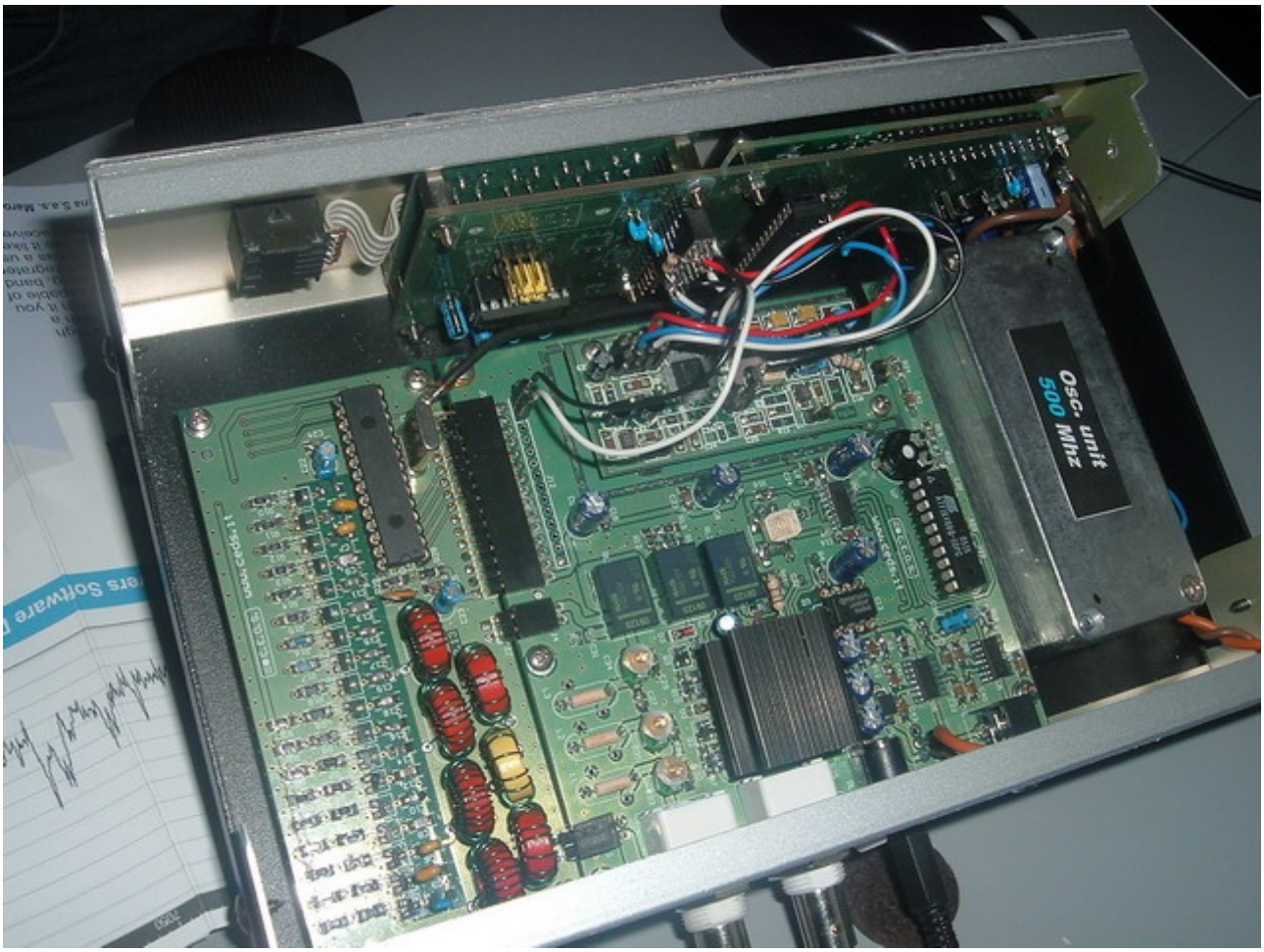
1.3.8 Expansion PIC connections to drive USB and LSB and CW quartz



1.4 My homebrew projects using this software

My all bands transceiver 1.8 -30 MHz (traditional one conversion using DDS instead of PLL)

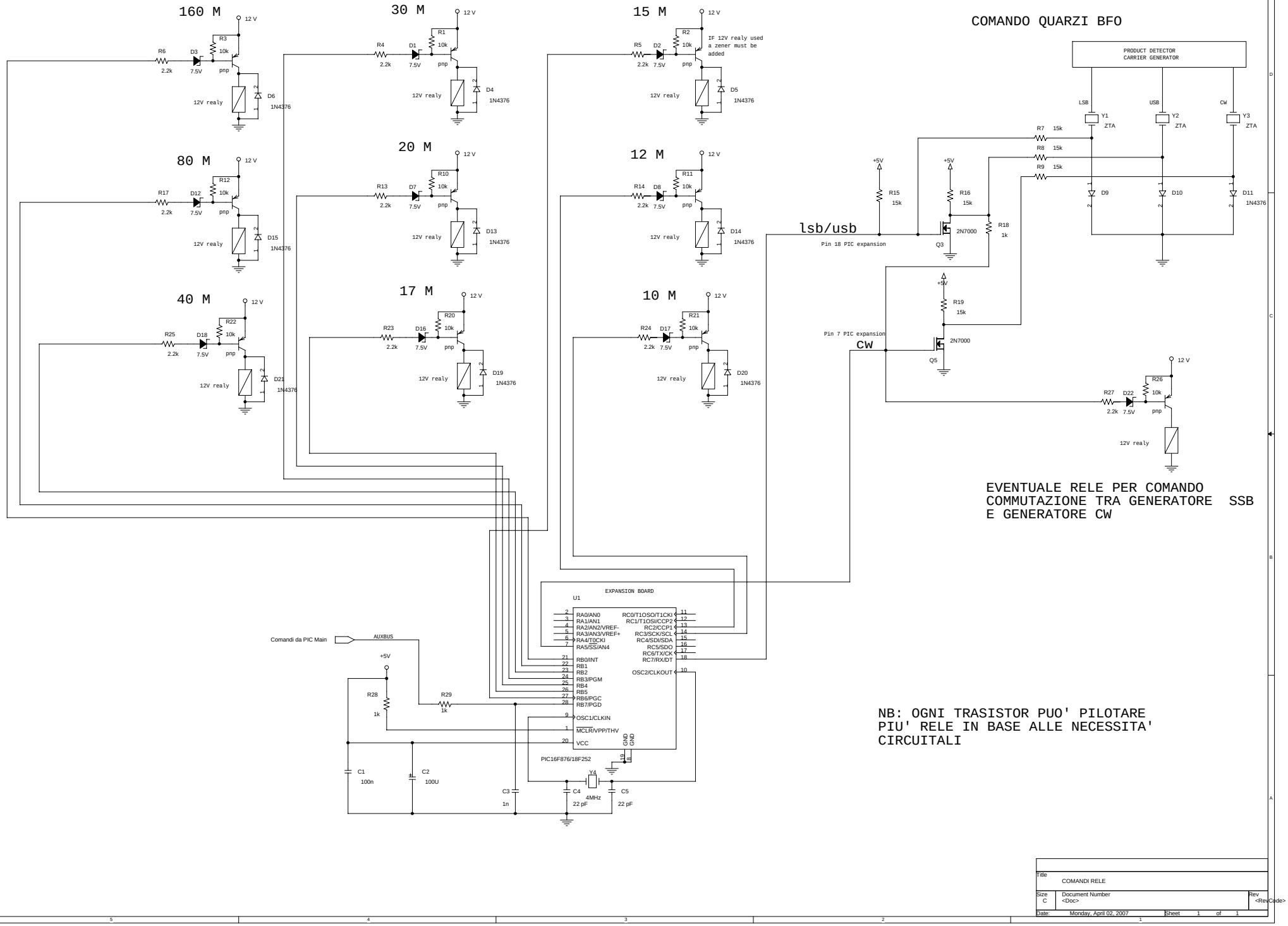
My all band (HF + 50 MHz) SDR receiver



Inside my SDR receiver

See the automatic preselector on the left , the SDR main board at the centre with the DDS board fitted, the 500 MHz osc. at the right and the PIC panel on top of photo

PIASTRA COMANDO RELE DI BANDA



Title	COMANDI RELE	
Size C	Document Number <Doc>	Rev <RevCode>
Date: Monday, April 02, 2007	Sheet 1 of 1	