uSOTA_+ATU　Manual

（V1.01）

uSOTA_+ATU is modified from uSDX SOTA ATU open source hardware designed by WB2CBA.uSDX SOTA_ATU modifying a QCX transceiver for SDR SSB based on the open source work QCX-SSB and Automatic Antenna Tuner Unit is a miniaturized clone of David Fainitski, N7DDC's infamous 7X7 automatic antenna tuner unit adapted for QRP operation up to 10 watts.

Here is PE1NNZ Guido's github web page where all started from:
https://github.com/threeme3/QCX-SSB
https://github.com/threeme3/QCX-SSB/blob/feature-rx-improved
Download latest firmware from this link:
https://github.com/threeme3/usdx/blob/master/usdx.ino

1. Introduction:

This is a HF QRP SSB/CW transceiver with ATU.The utra-small size is easy to carry to outdoor use,using two OLED12832 screens.Support to connect to PC and use FT8,JS8,FT4 and other digital mode software control,support CW automatic decoding. This transceiver kit includes a large number of features defined by the firmware in the ATmega328P microcontroller chip. The following is a brief summary of the features to explore and enjoy. Read the subsequent sections for more detailed information on these features.

2. Feature:

- 8 band coverage 80m/60m/40m/30m/20m/17m/15m/10m
- Excellent PCB layout design in line with high-frequency circuit design principles to ensure excellent performance
- Can reach 3-5W power in 8 bands and reserve TO-220/SMD(ILRI2060) pads required for upgrades
- High emission efficiency, 80m/60m/40m/30m/20m efficiency is higher than 85%,/17m/15m efficiency is higher than 80%,10m efficiency is higher than70%
- High-precision KDS brand TCXO,frequency accuracy is better than 1ppm,frequency stability is better than 0.5ppm
- An Aluminum enclosure! Which protects all the electronics as it should be. So you can easily toss it into your backpack and you don't have to worry about damage.
- Utra-small size : Small enough to fit even in your jacket pocket and easy to travel with. It is 100 mm*90 mm*57 mm(3.9"*3.5"*2.2")(excluding protruding parts)
- Rich interfaces(CAT/PTT OUT ,MIC/PTT(KEY),HEADPHONE, SPK/MIC)
- Slide switch and USB-TTL(USB/CAT) interface)
- Front panel key(ATU):BYPASS,TUNE,AUTO
- Front panel key(TRX):MENU,MODE
- It has SDR I/Q output pin header on PCB which can be extended with a 3.5 mm jack cord to connect a PC soundcard audio line input to decode with various SDR software as any SDR dongle

- It has a PTT OUT jack driven with a Solid State opto coupled relay capable of driving 500 mA relays for example an external RF Power Amplifier relay directly.
- All LPF parts and ATU parts use 100V COG/NPO capacitors
- Use original genuine KEMET and OMRON small signal relays
- Use original genuine LM4562 or LM833 OPA chip
- External 13.8v maximum power,
- BNC antenna interface
- All-aluminum knobs and silicone key

3. List of Features:

- Simple,fun and versatlle QRP SSB HF transceiver with embedded DSP and SDR functions;
- EER Class-E driven SSB transmit-stage
- Approximately 5W PEP SSB output from 13.8 supply
- All-mode support:USB,LSB,CW,AM,FM
- DSP filter:4000,2500,1700,500,200,100,50 Hz passband
- DSP features:AGC(Automatic Gain Control),NR(Noise-reduction),VXO(Voice-triggered Xmit),ATT(Attentuators),TX noise gate,Tx drive control,volume control,dBm/s-meter.
- SSB opposite side-band/carrier suppression Transmit:better than -45dBc, IMD3 (two-tone) -33dBc,Receive:better than -50 dBc
- Multiband support,continuously tunable through bands 160m-10m(and from 20kHz..99MHz with loss in performance)
- Open source firmware,but with Arduino IDE;allow experimentation,new features can be added, contributions can be shared via Github,software-complexity:2000 lines of code
- Software-based VOX that can be used fast FullBreak-IN(QSK and semi-QSK operation) or assist in RX/TX switching for operating digital modes(no CAT or PTT interface required),external PTT output/PA control with TX-delay
- Simple to install modification with 8 component changes and 8 wires
- Lightweight and loe-cost transceiver design:because of the EER-transmitter class-E stage It is highly power-efficient(no bulky heatsinks required),and has a simple design(no complex balanced linear power amplifer required

- ✧ Fully digital and software-based SSB transmit-stage:samples microphone-input and reconstruct a SSB-signal by controlling the phase of the SI5351 PLL(through tiny frequency changes over 800kbits I2C) and the amplitude of the PA (through PWM of the PA key-shaping circuit)
- ✧ Fully digital and software-based SDR receiver-stages (optionally) : samples I/Q(complex) signal from Quadrature Sampling Detector digital mixer, and performs a 90-degree phase-shift mathematically in software(Hilbert-transform) and cancels out one side-band by adding them
- ✧ Three independent switchable analog front-end receiver attenuators(0dB,-13dB,-20dB, -33dB, -53dB,-60dB,-70dB)
- ✧ Receiver Noise floor MDS:-135dBm at 28MHz(in 200Hz BW)
- ✧ Receiver Front-end selectivity :steep -45dB/decade roll-off +/-2kHz from tuned-frequency
- ✧ Blocking dynamic range:20kHz offset 123dB,2kHz offset 78 dB
- ✧ CW decoder,Straight/lambic-A/B keyer
- ✧ VFO A/B + RIT and Split, and corresponding relay band-filter switching via I2c
- ✧ ATU-Maximum working throughput: 10 watts
- ✧ ATU-Minimum power required to start tuning: 1 watts
- ✧ ATU-The minimum possible measured power: 0.1 watts
- ✧ ATU-Measurement step: 0.1 Watt
- ✧ ATU-Accuracy of power measurement: 10%
- ✧ ATU-Maximum installed inductance: 8.42 µH
- ✧ ATU-The minimum installation step of inductance: 0.05 µH
- ✧ ATU-Maximum installed capacity: 1869 pF
- ✧ ATU-Minimum capacitance installation step: 10 pF

4. Connector definition (Some helpful tips on usage of connectors) :

✓ Front panle

- Slide switch：

  left is PROG,right is CAT,（ some maybe have wrong silk mark in 1st hardware early version）

- USB-TTL interface：

  Match GND and DTR pins with corresponding GND and DTR pins on uSOTA_+ATU USB to TTL header, From left to right: **DTR/PTT,RXD,TXD NC,NC,GND**

✓ BACK panle

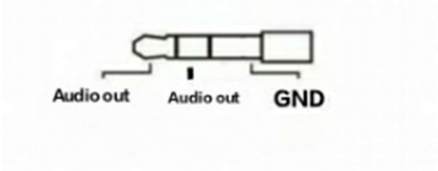
- Headphone Jack:

Headphone connector is 3.5 mm standard TRS jack.

Tip – Audio out

Ring – Audio out

Sleeve– GND



This jack audio output is lowered with a 470 ohm resistor to suit feeding straight into PC mic input, earphones etc.

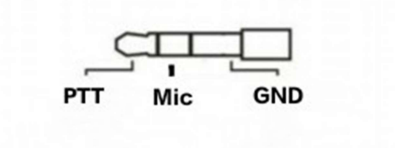
- MIC/PTT(KEY) Jack:

This jack is also 3.5 mm standard audio jack in TRS combination.

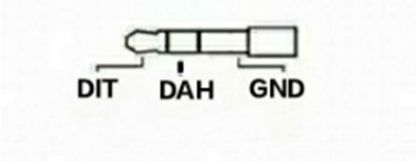
Tip – Mic input

Ring – PTT

Sleeve – GND



In CW KEY INPUT MODE:



Tip- DAH

Ring- DIT

Sleeve – GND

- SPK/MIC Jack:

This is a 4 pole jack configured as TRRS.

This is used to connect a hand Speaker/Microphone combination and uses BAOFENG UV-3R handheld cheap speaker/microphone.

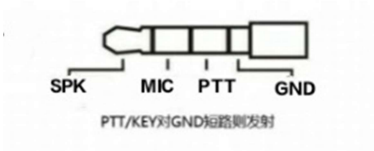
Connection points are as follows:

TIP :SPEAKER

RING 1:MIC

RING 2:PTT

SLEEVE: Gnd



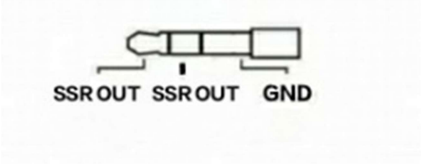
- PTT OUT Jack(1st hardware version)

This jack uses 3.5 mm standard audio jack.

TIP :OUT pin of SSR to external device

RING: OUT pin of SSR to external device

SLEEVE: GND



- CAT/PTT OUT Jack(2nd hardware version)

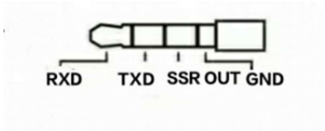
This is a 4 pole 3.5 mm jack configured as TRRS

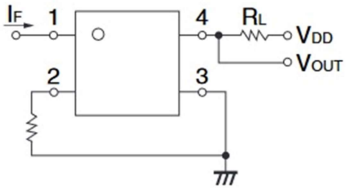
TIP :RXD

RING1 :TXD

RING2: OUT pin of SSR to external device

SLEEVE: GND





This might give an idea how a relay should be connected to output of SSR. Basically it will be inserted between Tip or ring and VCC of external device to switch on and off. This might be a relay of a Power amplifier. Also sleeve of jack should be connected to gnd of external device.

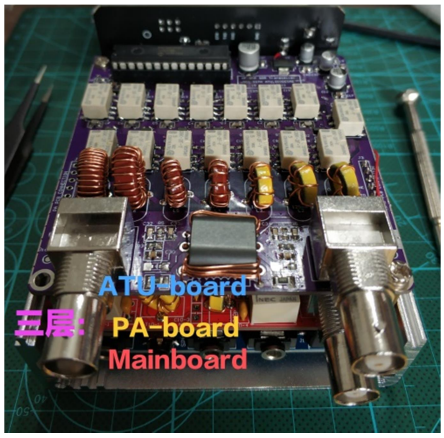
This PTT OUT function can be used only with version m firmware(or above)which will be released soon as it is controlled by firmware and delays can be introduced between activating SSR and actual transmission from menu screen. It turns on when PTT is activated.

- **SDR I/Q output header: (inner/no Jack)**

I and Q outputs from uSDX to feed into a PC soundcard mic input and using a PC SDR software like HDSDR to receive and waterfall functions.

5. Photos:

- **Transceiver&PCB**



- **Mic&Speaker&PTT: BaoFeng UV-3R**
- **DC Adaptor:13.8VDC/2.5A**
- **BNC-SL16**
- **BNC-BNC RF Cable**
- **Hexagon wrench**(2mm and 2.5mm)


HF QRP SDR TRANSCEIVER
uSDX_ATU
ATU
TRX
CAT
PROG
USB-TTL
8 BAND

（下一页：菜单）

6. Operation

Currently,the following functions have been assigned to shortcut buttons (L=MENU, E=encoder, R=EXIT) and menu-items:

Menu Item	Function	Button
1.1 Volume	Audio level (0..13) & power-off/on (tum left)	**E +turn**
1.2 Mode	Modulation(LSB,USB,CW,AM,FM)	**R**
1.3 Filter BW	Audio passband (Full,300..3000,300..2400,300..1800,500,200,100,50 Hz),this also controls the SSB TX BW	**R double**
1.4 Band	Band-switch to pre-defined CW/FT8 fregs (80,60.40,30,20,17,15.12,10.6m)	**E double**
1.5 Tuning Rate	Tuning step size 10M,1M,0.5M,100k,10k,1k,0.5k,100,10,1	**E or E long**
1.6 VFO Mode	Selects different VFO,or RX/TX split-VFO (A,B,Split)	**2x R long**
1.7 RIT	RX in transit (ON,OFF)	**R long**
1.8 AGC	Automatic Gain Control (ON,OFF)	
1.9 NR	Noise-reduction level (0-8),load-pass & smooth	
1.10 ATT	Analog Attenuator(0，-13，-20,-33，-40，-53,-60,-73 dB)	
1.11 ATT2	Digital Attenuator in CIC-stage (0-16) in steps of 6dB	
1.12 S-meter	Type of S-Meter(OFF,dBm,S,S-bar)	
2.1 CW Decoder	Enable/disable CW Decoder (ON,OFF)	
2.4 Semi QSK	On TX silents RX on CW sign and word spaces	
2.5 Keyer speed	CW Keyer speed in Paris-WPM (1..35)	
2.6 Keyer mode	Type of keyer (Iambic-A,-B,Straight)	
2.7 Keyer swap	to swap keyer DIH, DAH inputs (ON,OFF)	
2.8 Practice	to disable TX for practice purposes (ON,OFF)	
3.1 VOX	Voice Operated Xmit (ON,OFF)	
3.2 Noise Gate	Audio threshold for SSB TX and VOX (0-255)	
3.3 TX Drive	Transmit audio gain (0-8) in steps of 6dB,8=constant amplitude for SSB	
3.4 TX Delay	Delays TX to allow PA relay to be fully switched on before TX (0-255 ms)	
4.1 CQ Interval	Idle time in seconds before new CQ Message is given (0-60)	
4.2 CQ Message	CQ Message text, pressing left-button in menu will start sending	
8.1 PA Bias min	PA amplitude PWM level (0-255) for representing 0% RF output	
8.2 PABias max	PA amplitude PWM level (0-255) for representing 100% RF output	
8.3 Ref freq	Actual si5351 crystal frequency, used for frequency-calibration	
8.4 IQ Phase	RX I/Q phase offset in degrees (0..180 degrees)	
10.1 Backlight	Display backlight (ON,OFF)	
power-up	Reset to factory settings	**E long**
main	Tune frequency(20kHz..99MHz)	**turn**
main	Quick menu	**L +turn**
main	Menu enter	**L**
RIT	RIT back	**R**
menu	Menu back	**R**