ATU and wifi connectivity for the MkII SARC WSPR TX

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1 October 2021

Presentation to the Shirehampton Amateur Radio Club

Background

- Mk II WSPR TX was designed by G3YHV (HW and SW) + SW contributions from G0CJG
- It is, standalone, a capable unit and doesn't need more than an antenna and a power supply for hours of fun
- It is also a nice platform for tinkerers/hackers. G3YHV has chosen a capable PIC chip. There are plenty of unused IO pins and coding space.
- None of the ideas to be presented are "kit ready" but they have all been breadboarded to show basic feasibility
- I'd like to acknowledge ATU code and ESP8266 code shared by Steve, W8TTY. See last slide for details

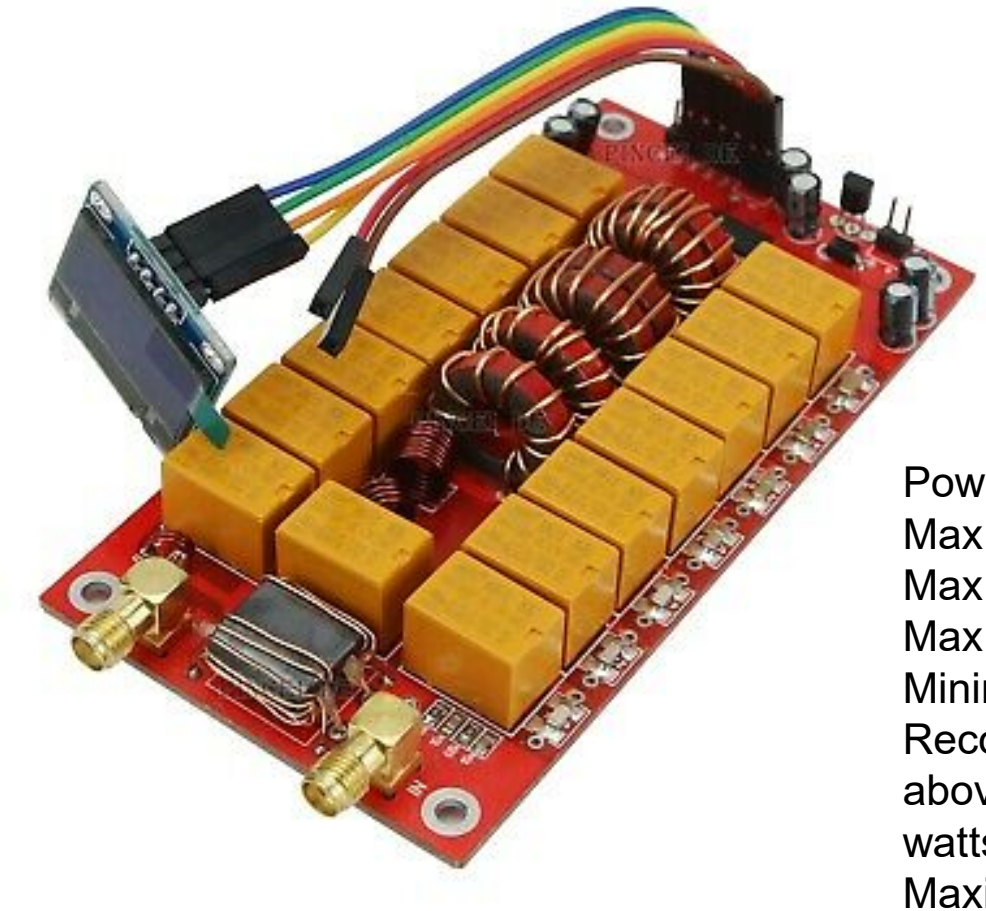
Breadboarded Functions

- Dedicated ATU for the WSPR box
- Set clock from the internet over wifi
- Am I getting out? display latest reports from wsprnet.org using wifi
- Antenna Switch
- DC to DC converter (from 10-40V to 7V)

SARC WSPR box ATU requirements

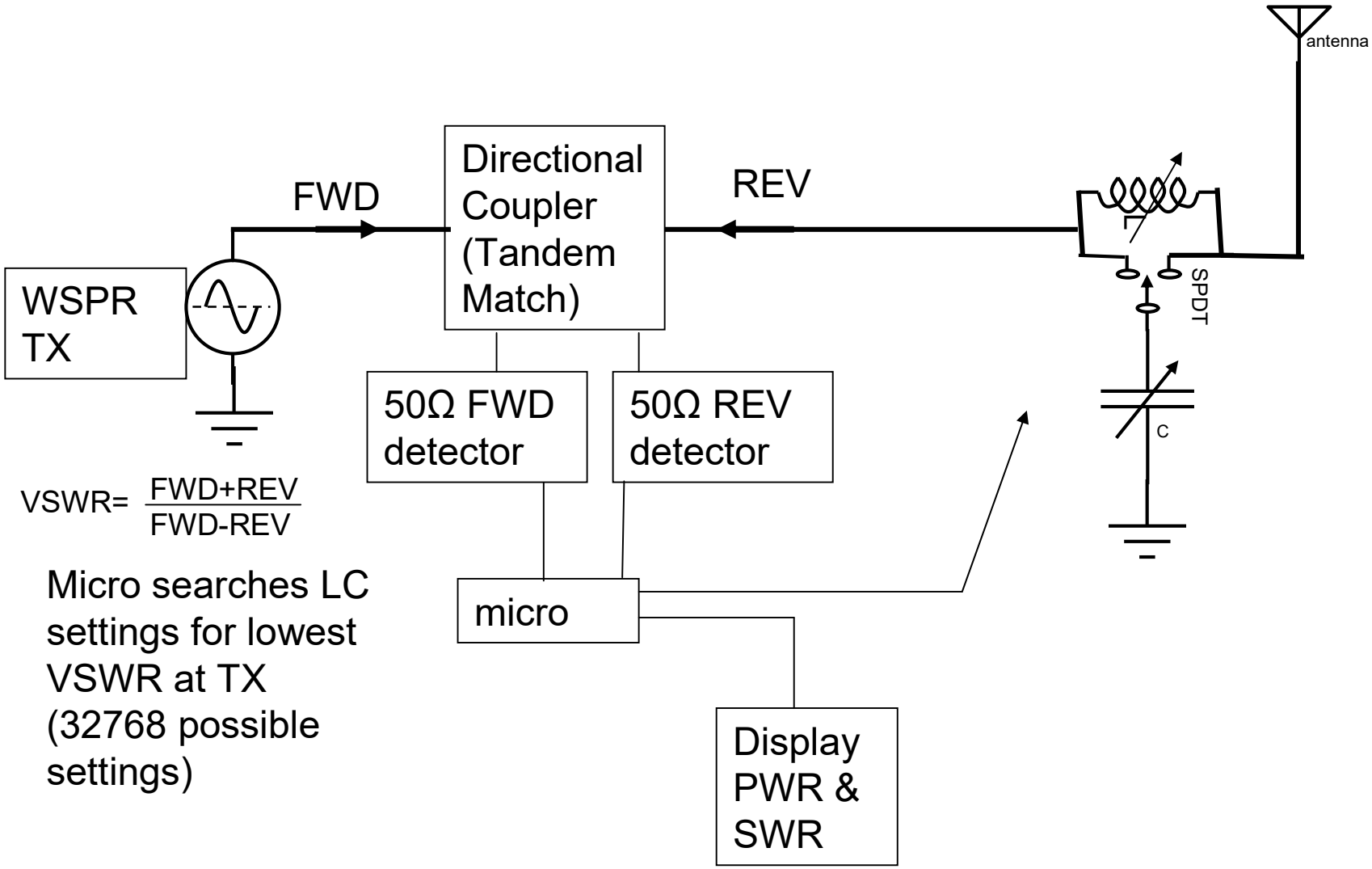
- Only needs to tune for 10 fixed frequencies (1.8-28MHz)
- PA only 100mW class A
  - power reflected from the load won't kill it.
  - ATUs designed for 150W generally won't tune on 100mW
- Must be fully integrated with WSPR box.
  - Once set up for a particular Antenna it should be automatic

ATU100 (kit widely available)

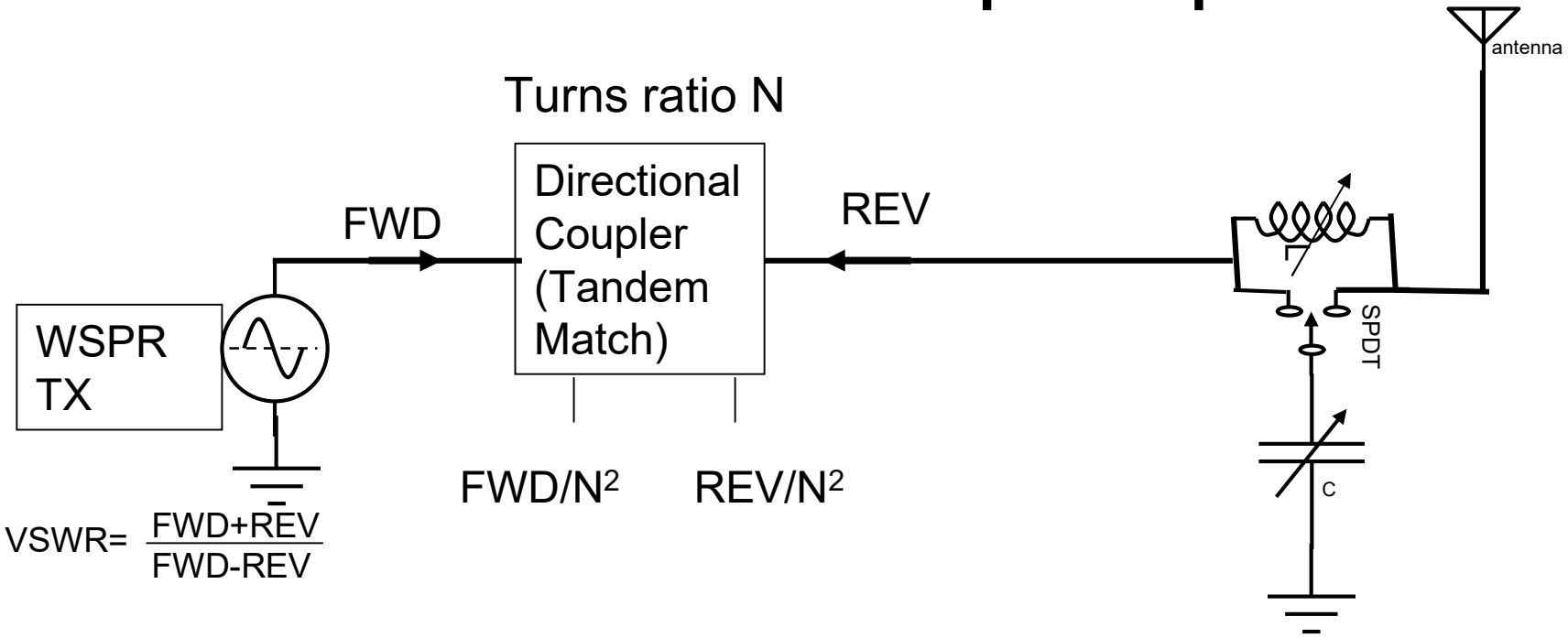


Power supply range: 10 - 15 VDC
Max current : 450mA
Max working power: 100 watts
Max measured power: 150 watts
Minimum power for tuning start: 1 watt
Recommended maximum power while tuning not above 30 watts. (after tuning you can set 100 watts and work on this power)
Maximum inductance set: 8.5 uH
Minimal step for setting inductance: 0.1 uH
Maximum installed capacity: 1870 pF
Minimal step for setting capacity: 10 pF
Uses 7 capacitors and 7 coils
based on PIC 16F1938.

ATU100


antenna
FWD
Directional
Coupler
(Tandem
Match)
REV
WSPR
TX
SPDT
50Ω FWD
detector
50Ω REV
detector
C
VSWR= FWD+REV / FWD-REV
Micro searches LC
settings for lowest
VSWR at TX
(32768 possible
settings)
micro
Display
PWR &
SWR

ATU100 Effect of Tandem Match turns ratio on coupled power



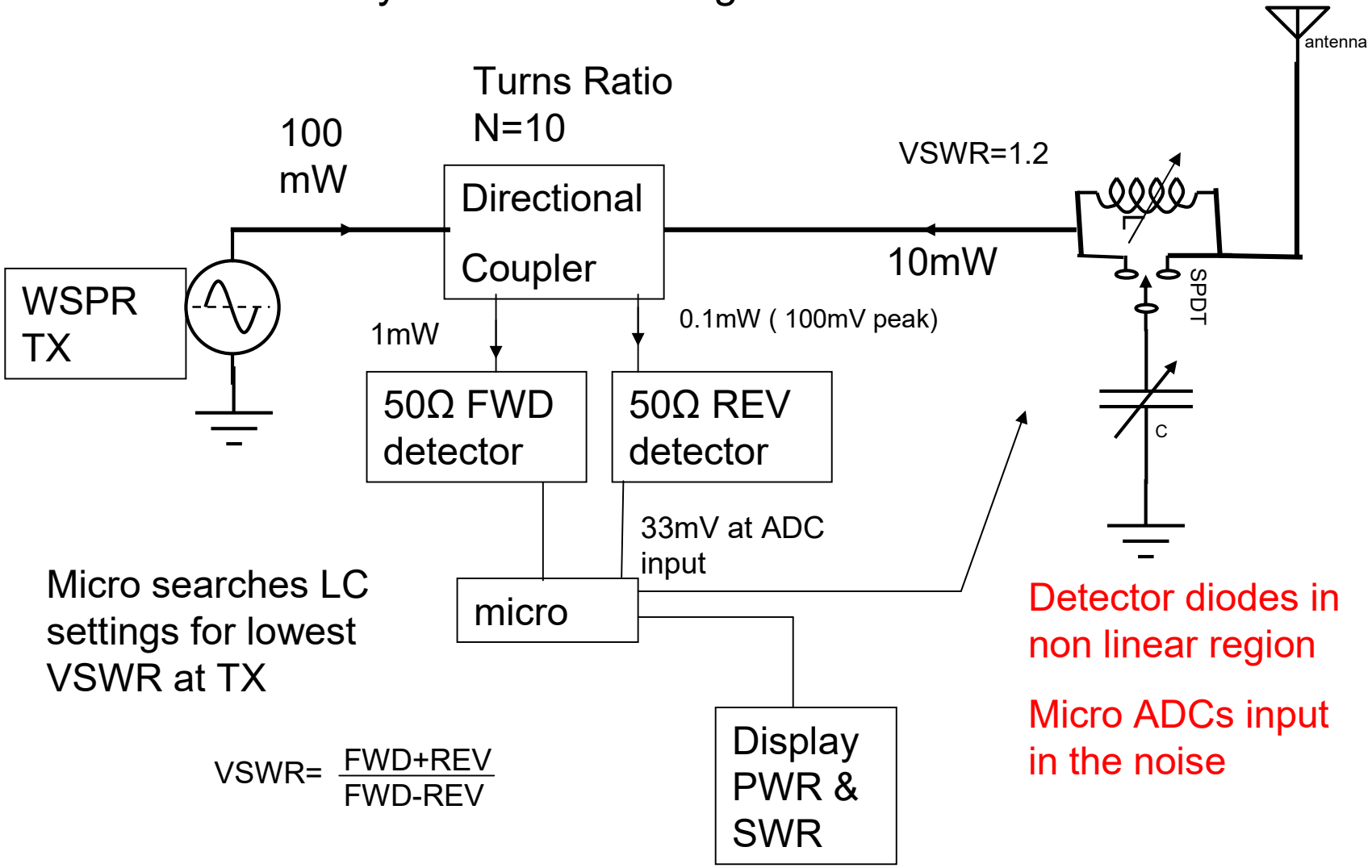
ATU100 documentation recommends changing N from 10 to 5 to reduce needed tune power from 5W to 1W

With this approach To tune on 100mW would require N= 1.414

This would unfortunately dissipate half the forward power in the forward detector

ATU100 out of the box

Why does QRP tuning fail? Some clues….



$$VSWR = \frac{FWD+REV}{FWD-REV}$$

QRP tuning solutions

1. Change the detectors from half wave to full wave and add some DC gain before the micro ADC
2. Use an offline resistive bridge detector (as in the MFJ269 SWR meter)
3. Dump the tandem match and maximize antenna current rather than reduce VSWR

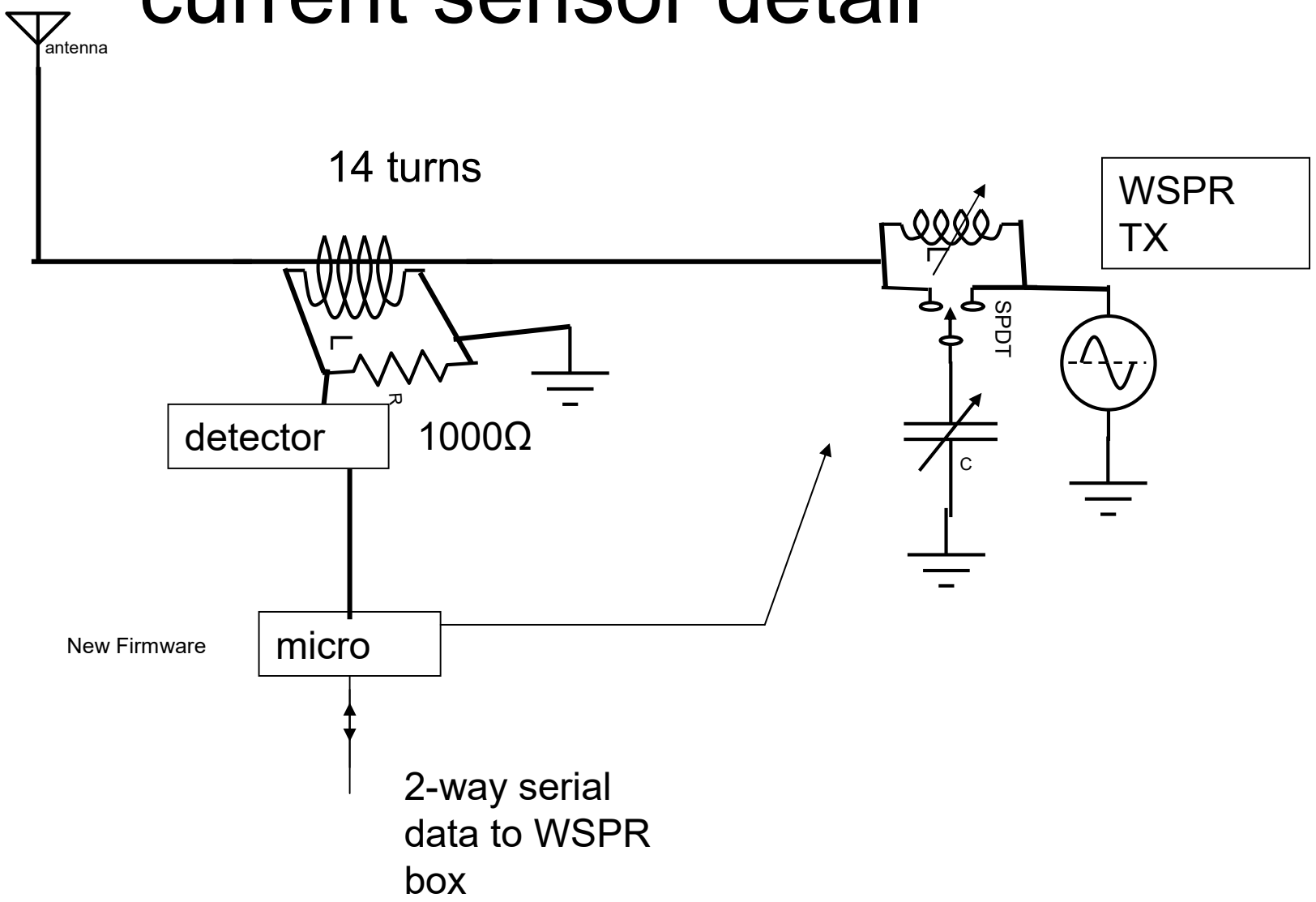
Approach 1 & 2 require an extra PCB whereas 3 only
requires a few changes on the ATU100 board

Approach 3
Minimizing the reflected power is important for a 100W solid state class AB amp
But not so important for a 100mW class A amp. So dump the Tandem Match.

Maximizing the antenna current compensates for frequency related change in the output impedance of the PA as well as antenna impedance changes

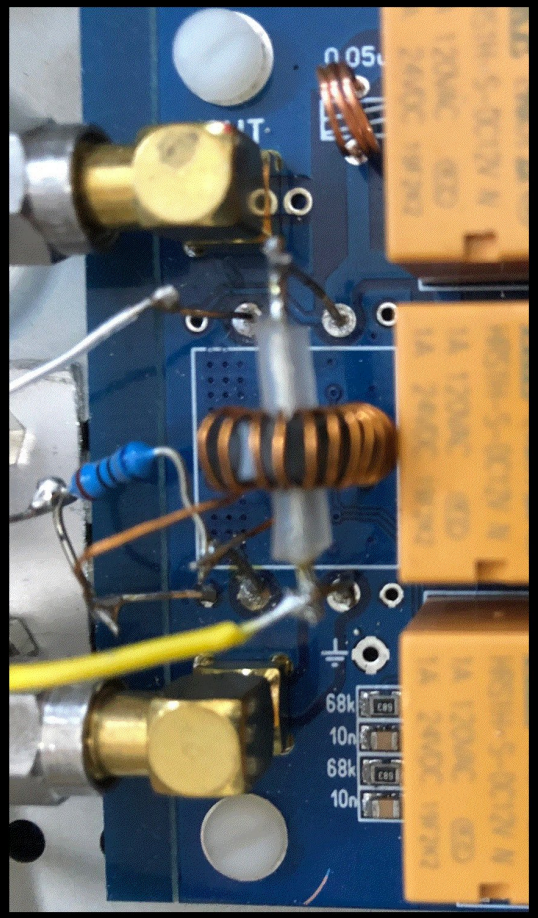
The current detector with an input impedance of 1000 Ohm should dissipate 10% of the input power and put about 3V across the detector diode.

ATU100 QRP
current sensor detail

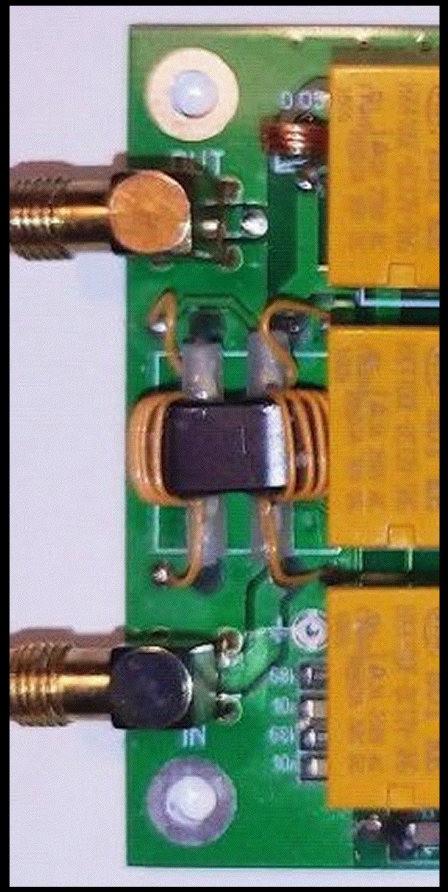


ATU100 mods for current sensor

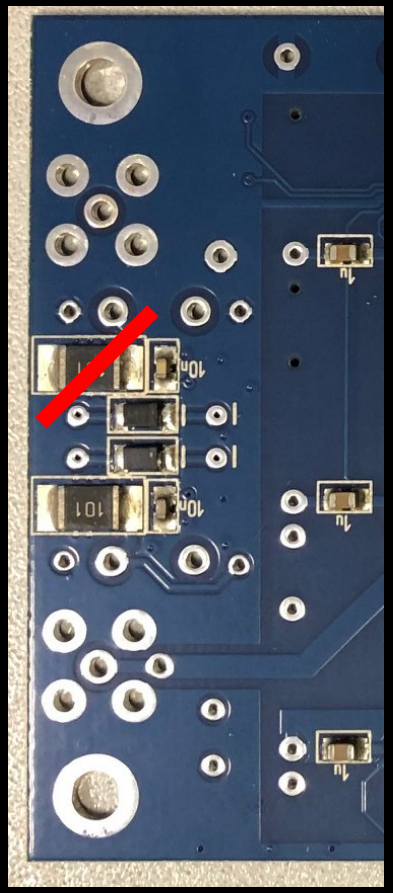
Modified



Original

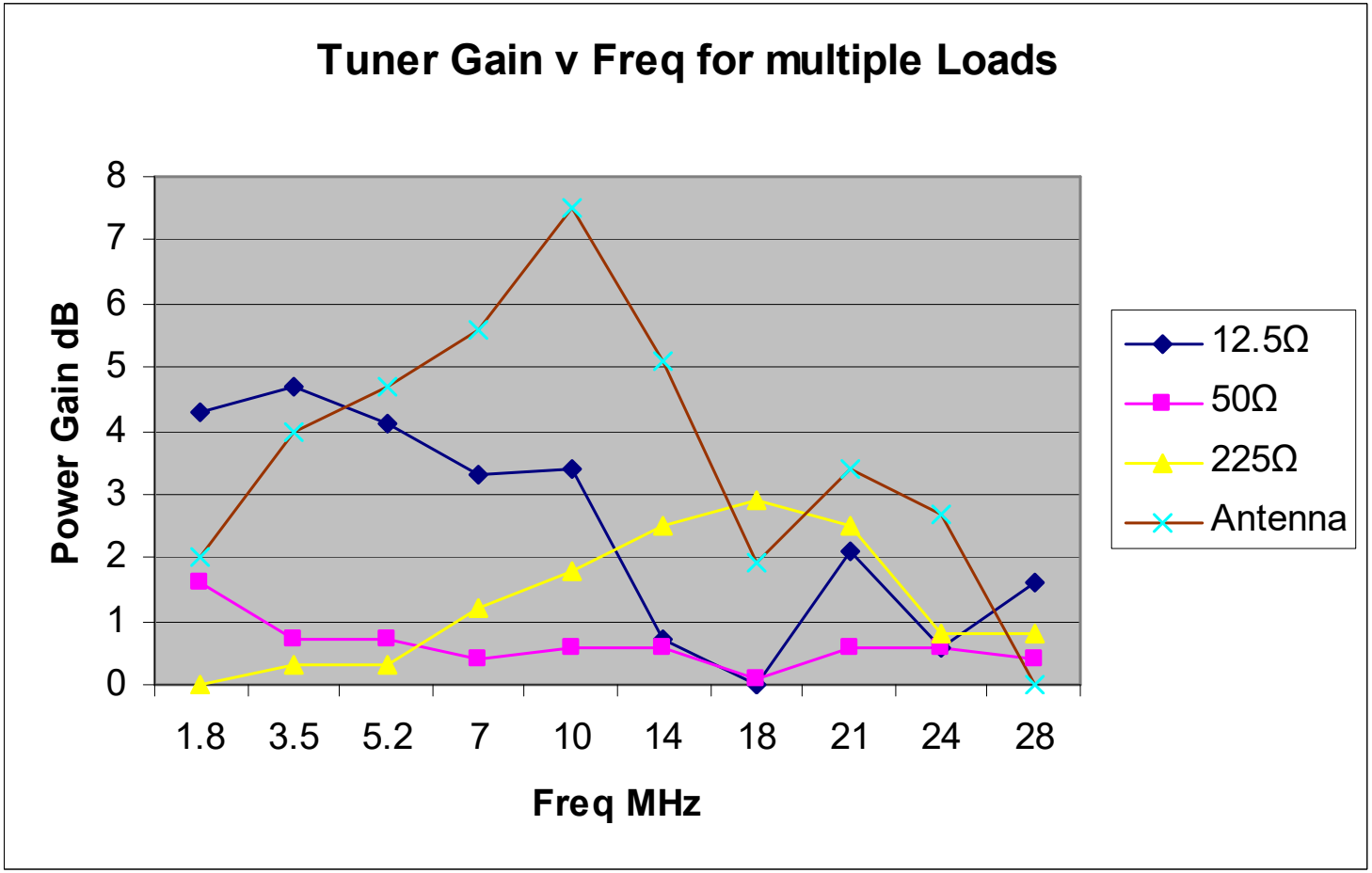


Remove Resistor



Performance of current sensor ATU

The tuner gain with the antenna load is the significant result



Antenna is a 30m Doublet

ATU100 integration with the SARC WSPR TX

- The ATU tuning is done during WSPR SETUP only. It takes a couple of minutes. The optimum values for each band with the selected antenna are stored in the ATU
- In normal WSPR operation on each band change the ATU is automatically commanded to retrieve and set the stored value.
- The WSPR TX uses slow speed serial data at logic levels to send commands to the ATU100 and to read data returned.
- The ATU100 firmware was written in Proton Basic.

Wifi connectivity for the WSPR box

Wifi interface and processor
for about £5-10

Nodemcu Esp8266

Code written
using Arduino
environment

Lots of pins – but
only use 4, vcc,
gnd, serial in and
serial out

WSPR time
combine NTP over wifi and RTC

- NTP network time protocol
- RTC realtime clock
- If NTP service available the RTC is set on every power-up or every 24 hours during continuous operation
- Don’t need to use the house wifi, you can use the hotspot on your phone

Am I getting out?

- We generally use wsprnet.org in a browser or one of the phone apps (eg wspr watch)
- However would be nice to get an immediate readout from the WSPR box itself
- Using the ESP8266 wifi connection the box retrieves WSPRNET reports after each TX.
- Displays number of reports and distance of furthest report.

W8TTY acknowledgement

- Steve, W8TTY, kindly shared his experimental ATU100 C++ project code that works under the MPE (free) development platform from which I learned a lot.
- I subsequently used the Proton basic environment for my ATU code because I was more familiar with it.
- Steve also shared details of his use of the ESP8266 to control an ATU which inspired me to pursue wifi connectivity for the WSPR box