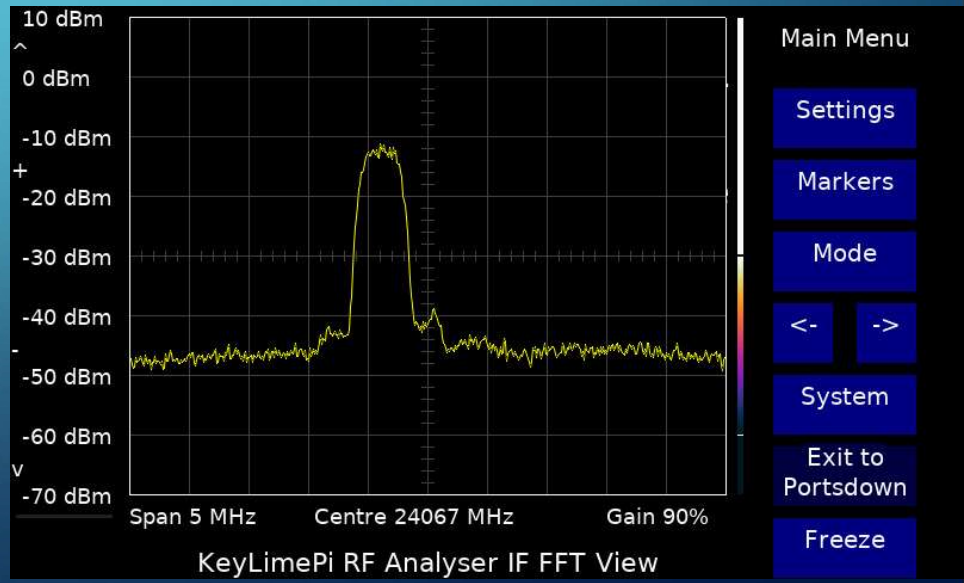
OPTIONS FOR 24 GHZ SPECTRUM ANALYSIS

DAVE CRUMP, G8GKQ

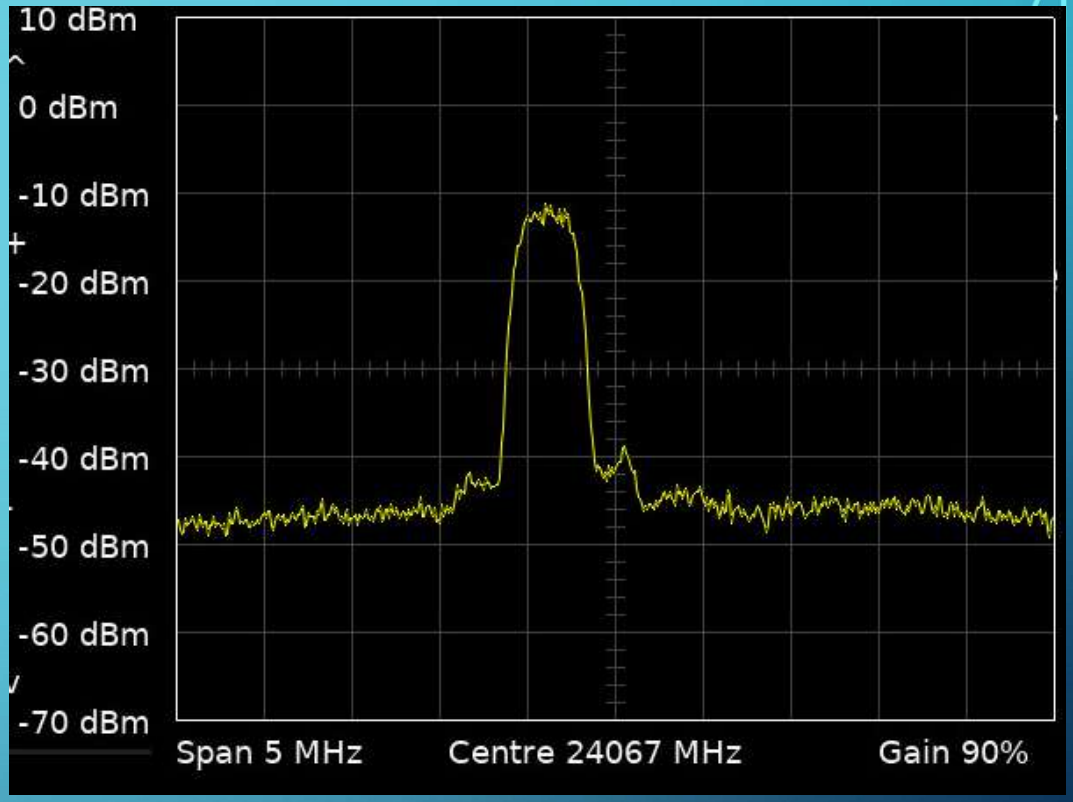


OPTIONS FOR 24 GHZ SPECTRUM ANALYSIS

- Why would you want to look at your 24 GHz Spectrum?
- Capabilities to be considered
- Options
- Conclusion
- Questions

WHY?

- Peaking up a signal
- Checking for Spurii
  - Close-in
  - Out-of-band
- Checking for frequency stability
- Looking at Linearity



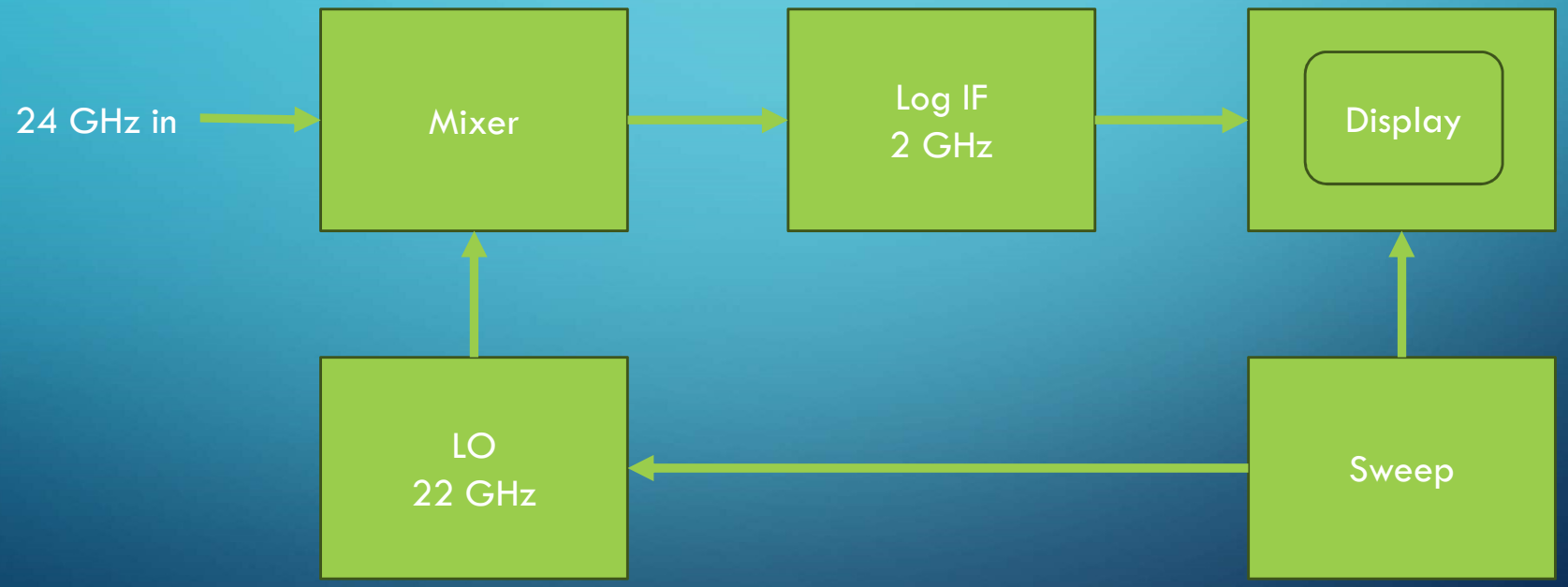
CAPABILITIES TO BE CONSIDERED

- Scan Width (kHz, MHz or GHz)
- Resolution bandwidth
- Sensitivity
- Frequency Stability
- Ability to identify spurii

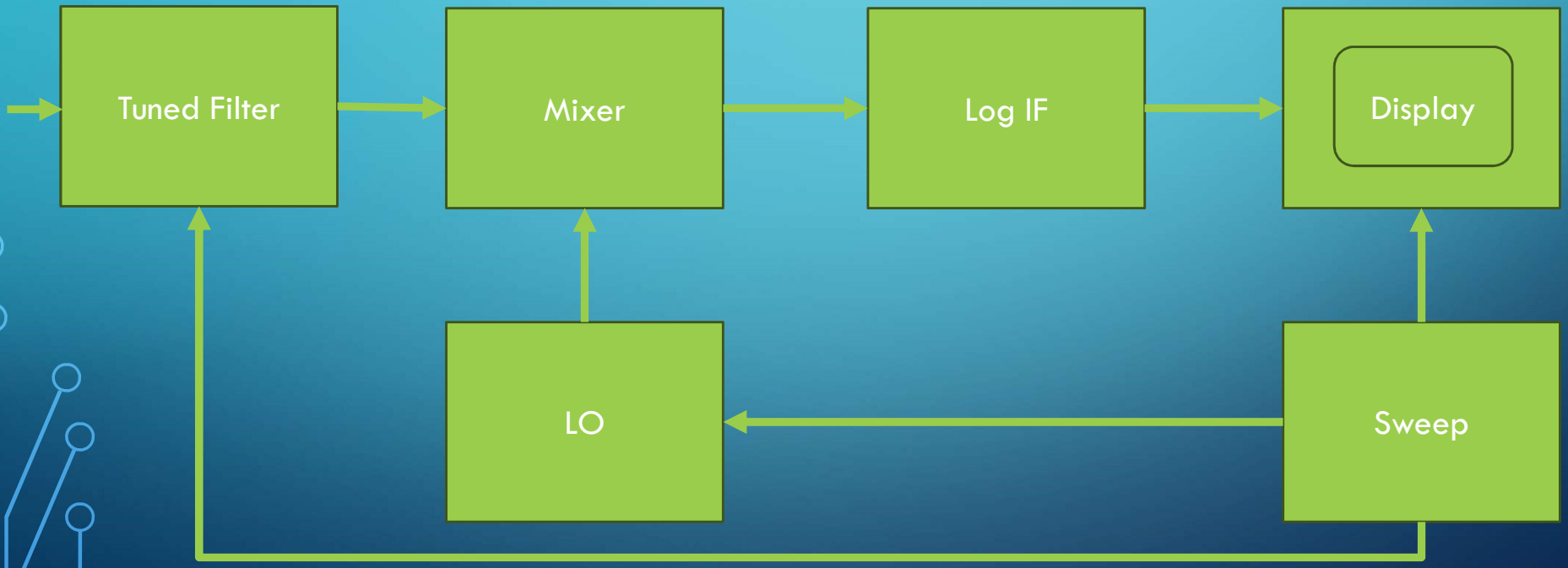
TECHNIQUES

- Swept LO (fundamental or harmonic)
- Swept input filter
- Fixed LO with lower frequency SA
- Fixed LO with IQ Mixer and SDR

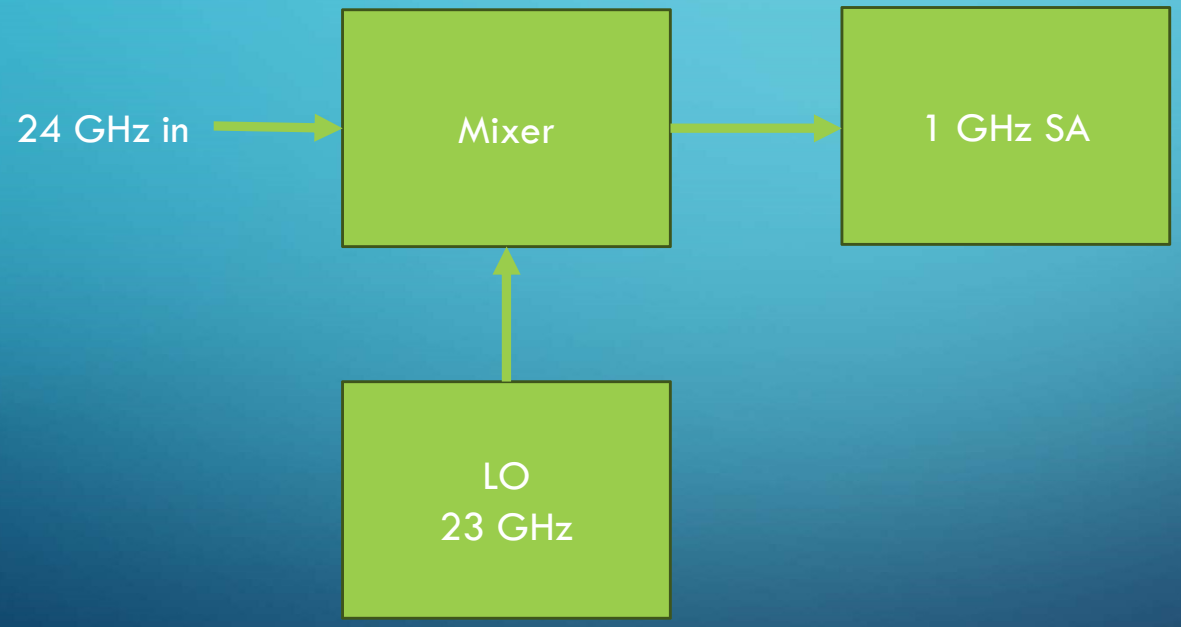
SWEPT LOCAL OSCILLATOR



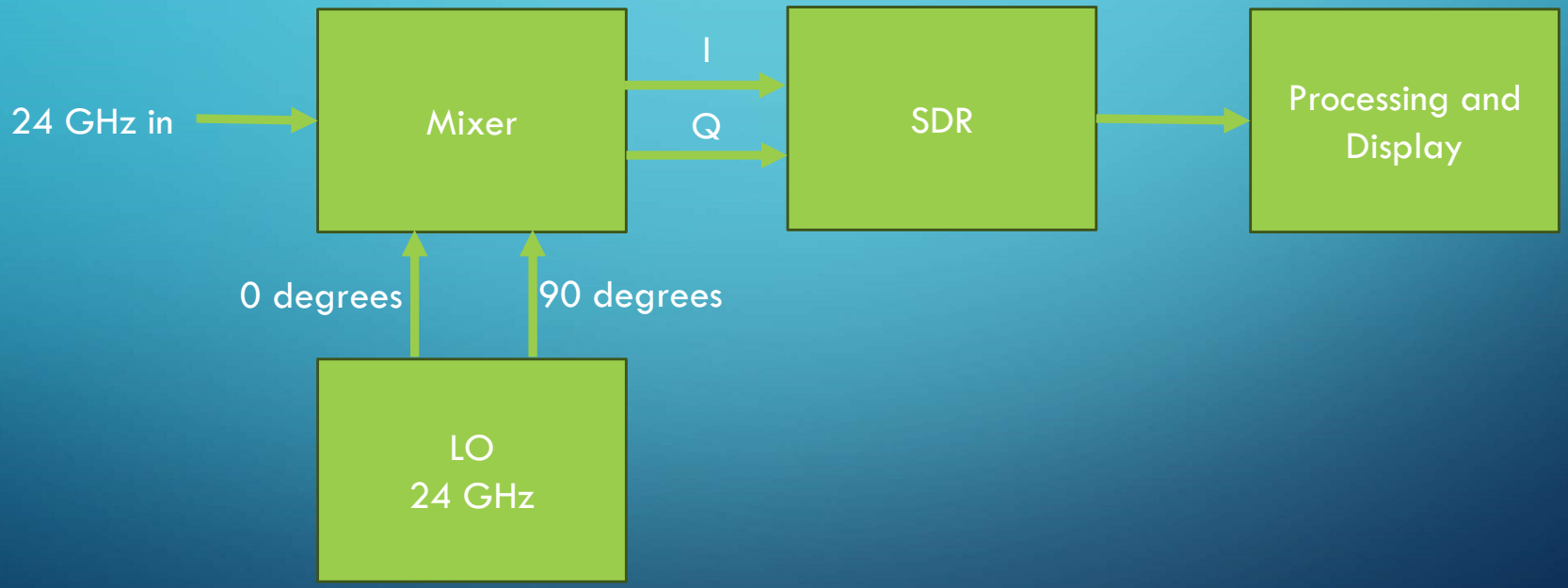
SWEPT LOCAL OSCILLATOR WITH FILTER



FIXED LO WITH LOWER FREQUENCY SA



FIXED LO WITH IQ MIXER AND SDR



OPTIONS (1) - COMMERCIAL

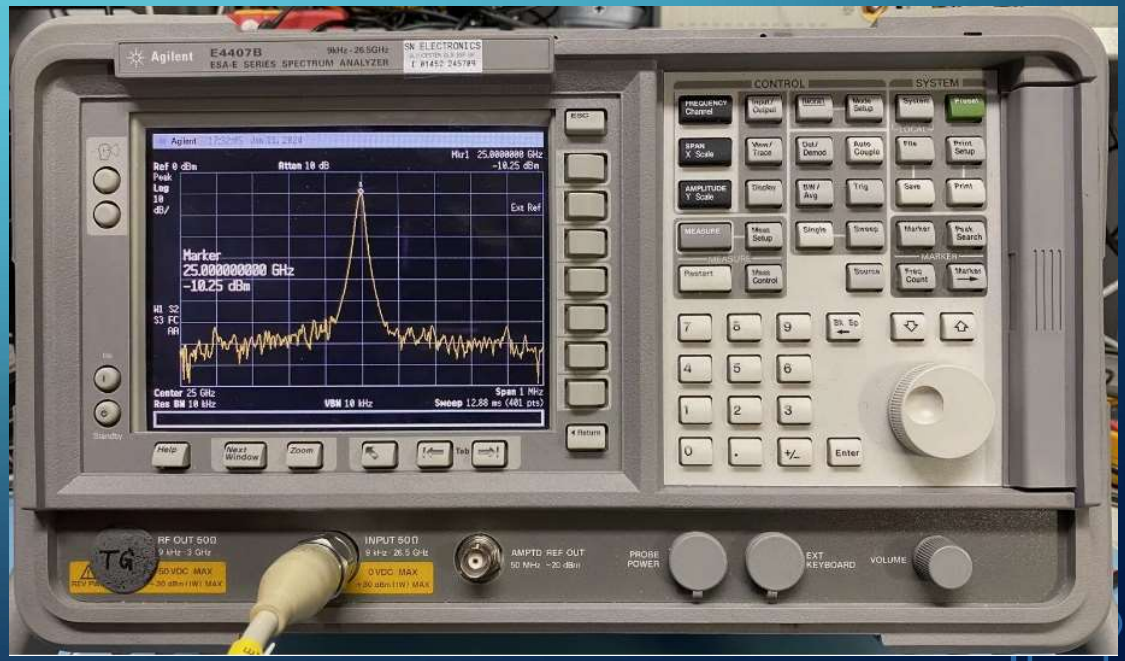
- Commercial 26.5 GHz Spectrum Analyser
- Commercial 18/22 GHz Spec An with External Mixer
- Commercial 22 GHz Analyser with undocumented 24 GHz capability
- Commercial 18/21 GHz Spec An on higher LO harmonic

OPTIONS (2) - AMATEUR

- ~23 GHz LO and mixer into 1 GHz Spec An
- 24 GHz RX Converter into a 1296/432/144 Spec An
- Pluto 5th Harmonic mode
- Modify Commercial 22 GHz Spec An to work at 24 GHz

COMMERCIAL 26.5 GHZ SPECTRUM ANALYSER

- Agilent E4407B - about £5K in the UK



CAPABILITIES - E4407B

- Display Width – Many GHz
- Resolution bandwidth – Down to kHz
- Sensitivity - Fair
- Frequency Stability - Good
- Ability to identify spurii – Very Good

COMMERCIAL 18/22 GHZ SPEC AN WITH EXTERNAL MIXER

- HP8565A and HP 8569A have connections for an external mixer
- HP 11517A covers 18 – 40 GHz
- No input filtering
- Delicate

CAPABILITIES – EXTERNAL MIXER

- Display Width – Many GHz
- Resolution bandwidth – Down to kHz
- Sensitivity - Fair
- Frequency Stability – Depends on SA
- Ability to identify spurii – Poor

COMMERCIAL 22 GHZ ANALYSER WITH UNDOCUMENTED 24 GHZ CAPABILITY

- Noel reports that his HP 8562A works at 24 GHz
- £1500 - £2000

CAPABILITIES – SA BEYOND RANGE

- Display Width – Many GHz
- Resolution bandwidth – Down to kHz
- Sensitivity – Depends!
- Frequency Stability – Depends on SA
- Ability to identify spurii – Reasonable

COMMERCIAL 18/21 GHZ SPEC AN ON A HIGHER LO HARMONIC

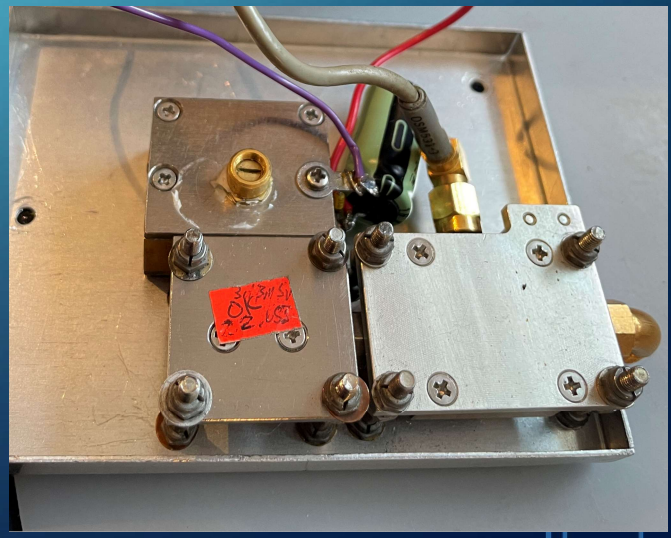
- HP8559A Has no input filter. LO runs up to 6 GHz
- Set dial to 19240 MHz. LO is 5411 MHz
- 5th Harmonic is 27055 MHz
- Subtract 3007 MHz IF
- See 24048 MHz

CAPABILITIES – SA ON HIGHER HARMONIC

- Display Width – Many GHz
- Resolution bandwidth – Down to kHz
- Sensitivity – Depends!
- Frequency Stability – Depends on SA
- Ability to identify spurii – Not so good

23 GHZ LO AND MIXER INTO 1 GHZ SPEC AN

- 18 GHz mixers work surprisingly well
- M95A



CAPABILITIES – 23 GHZ LO AND MIXER

- Display Width – 1 GHz
- Resolution bandwidth – Down to kHz
- Sensitivity – Can be good
- Frequency Stability – Depends on Gunn
- Ability to identify spurii – Reasonable

24 GHZ RX CONVERTER INTO A 1296/432/144 SPEC AN

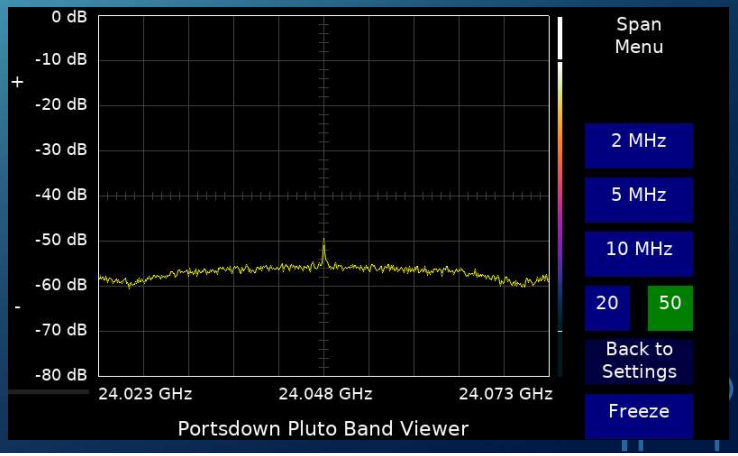
- Use your receive converter with a spectrum analyser
- Use an SA or BandViewer or SatSAGen on the IF
- Needs a very good attenuator on the front end

CAPABILITIES – 24 GHZ RX CONVERTER

- Display Width – 10 -100 MHz
- Resolution bandwidth – Down to kHz
- Sensitivity – Very good (too good?)
- Frequency Stability – very good
- Ability to identify spurii – close-in only

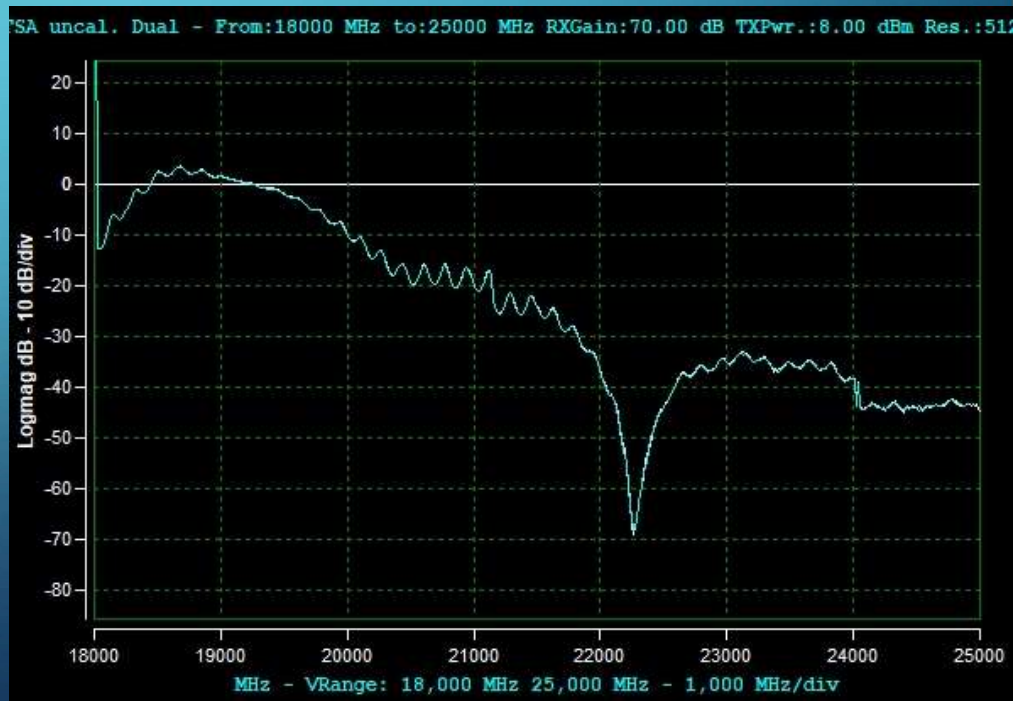
PLUTO 5TH HARMONIC MODE

- The Pluto SDR receives well on the 5th Harmonic of the LO
- Set the Frequency to 4809.6 MHz and you will see 24048 MHz
- IF is not multiplied
- BandViewer does the maths for you



PLUTO 5TH HARMONIC MODE - PITFALLS

- IW1EPY discovered that poor soldering of the SMAs can cause a notch near 24 GHz
- Using SatSAGen
- SMA centre pin was not soldered to edge of PCB

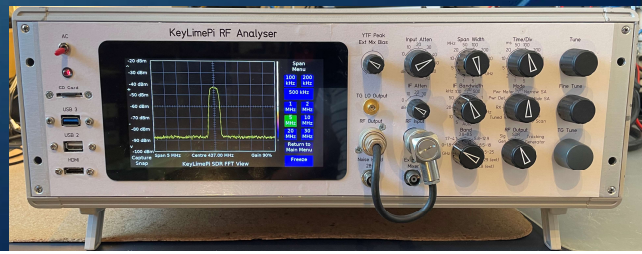


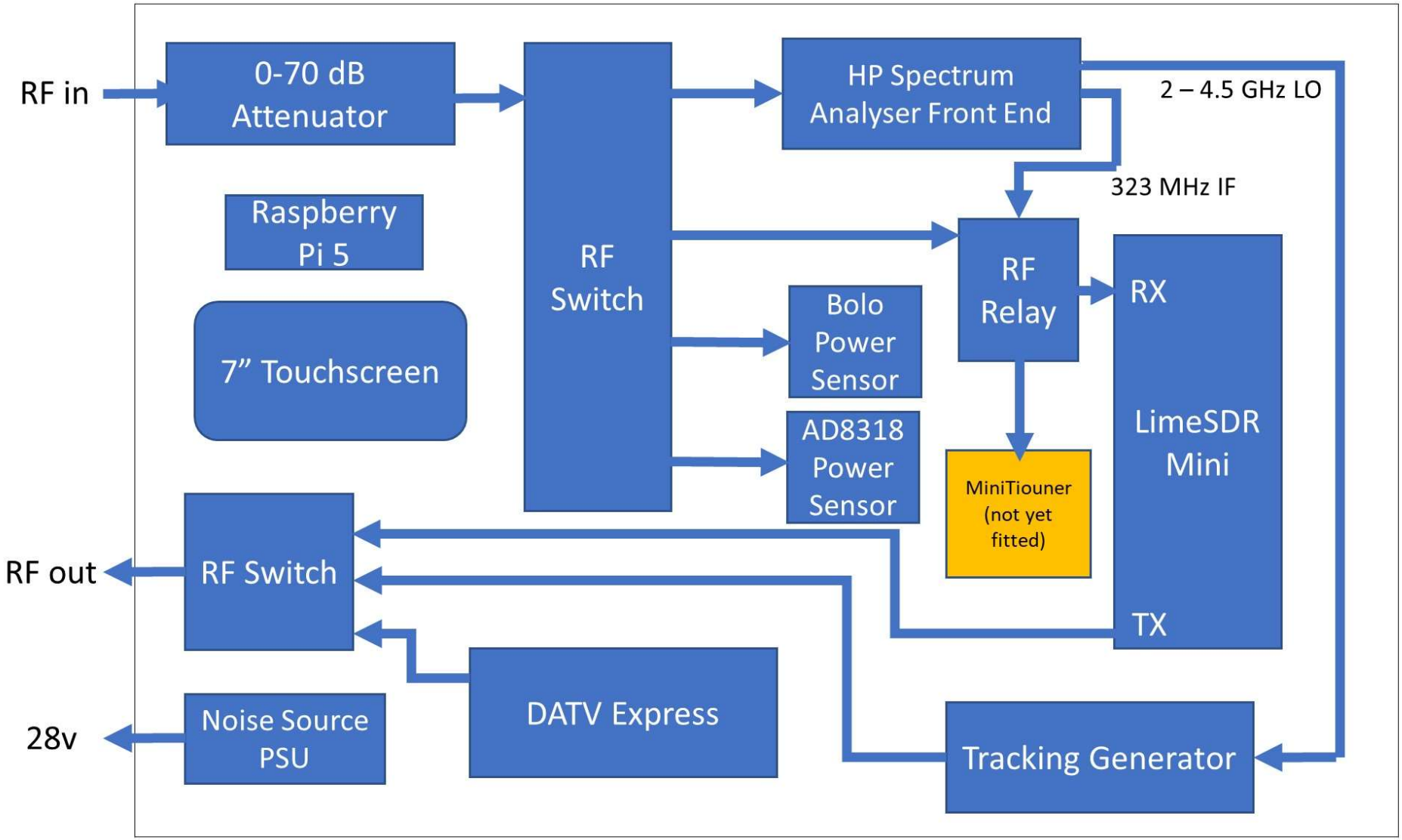
CAPABILITIES – PLUTO 5TH HARMONIC MODE

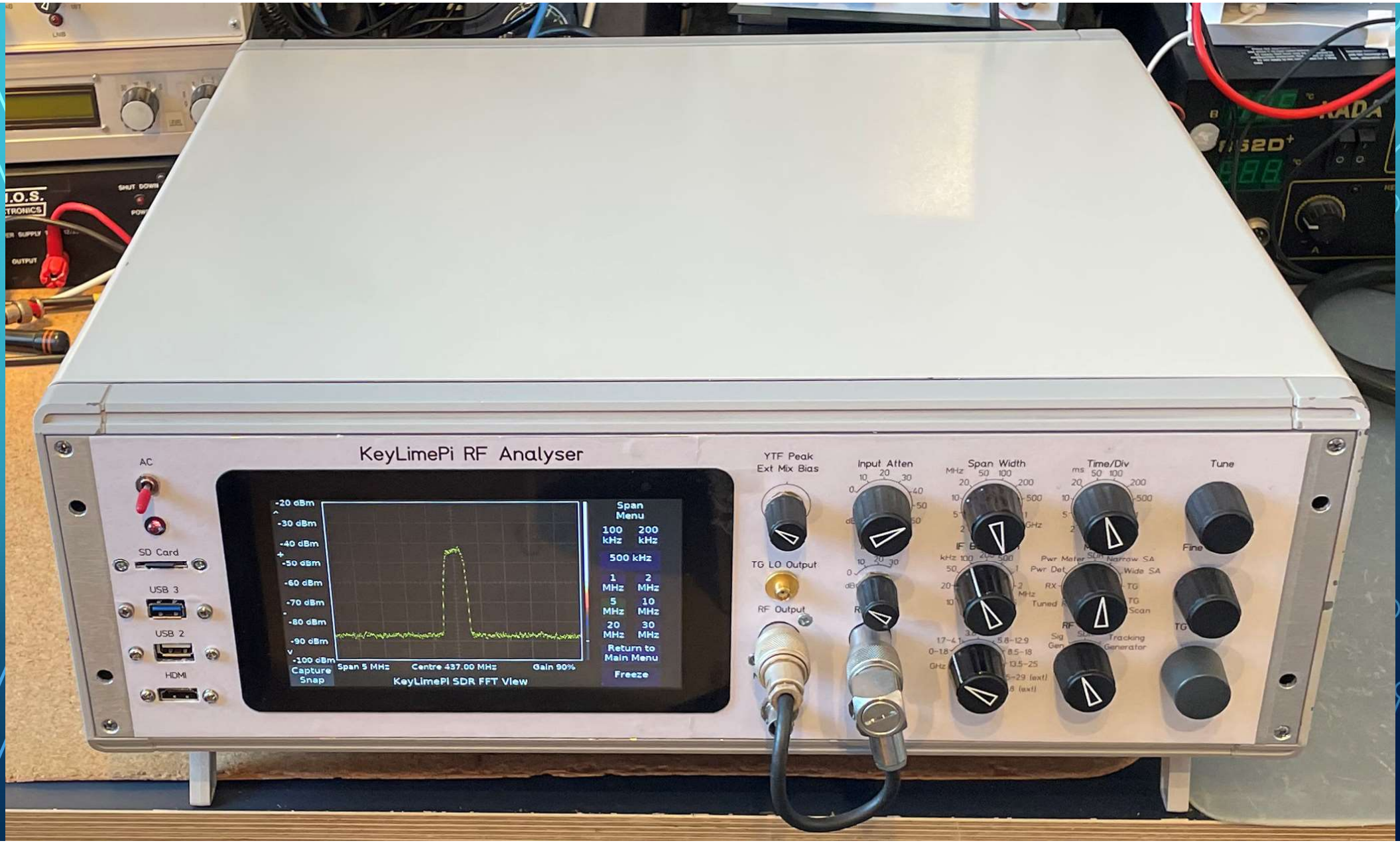
- Display Width – 50 MHz
- Resolution bandwidth – Down to 4 kHz
- Sensitivity – Good
- Frequency Stability – very good
- Ability to identify spurii – close-in good

MODIFY COMMERCIAL 22 GHZ SPEC AN TO WORK AT 24 GHZ

- A good SA has a Yig Filter and a Yig LO. Sometimes these go higher than their spec
- HP 8565A worked for me. The Yig filter went to 25 GHz, and by changing the IF, I could make the 5th harmonic of the LO work up to 25 GHz.




RF in
0-70 dB Attenuator
HP Spectrum Analyser Front End
2 – 4.5 GHz LO
323 MHz IF
Raspberry Pi 5
RF Switch
RF Relay
RX
7” Touchscreen
Bolo Power Sensor
AD8318 Power Sensor
LimeSDR Mini
MiniTiouner (not yet fitted)
RF out
RF Switch
TX
DATV Express
28v
Noise Source PSU
Tracking Generator


KeyLimePi RF Analyser
AC
SD Card
USB 3
USB 2
HDMI
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
-100 dBm
Capture Snap
Span 5 MHz
Centre 437.00 MHz
Gain 90%
KeyLimePi SDR FFT View
Span Menu
100 kHz
200 kHz
500 kHz
1 MHz
2 MHz
5 MHz
10 MHz
20 MHz
30 MHz
Return to Main Menu
Freeze
YTF Peak
Ext Mix Bias
TG LO Output
RF Output
Input Atten
Span Width
Time/Div
Tune
Fine
TG
RF

CAPABILITIES – UPGRADE COMMERCIAL SA

- Display Width – 5 GHz
- Resolution bandwidth – Down to 200 Hz
- Sensitivity – Noise Floor about -40 dBm
- Frequency Stability – not brilliant
- Ability to identify spurii – good

CONCLUSION

- There are many ways to view your signal at 24 GHz
- SDRs make it really easy
- Or you can spend lots of money
- Or you can spend lots of time, and learn a lot….

QUESTIONS