

Raspberry Pi Enabled ATV/Microwave Test Equipment

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The logo for BATC, consisting of the letters 'BATC' in white on a black rectangular background, which is tilted and surrounded by blue curved lines.

Topics

- The Hardware
- Capabilities
- Test Equipment
- Web Control/view



The logo for BATC, featuring the letters 'BATC' in white on a black rectangular background, which is tilted and surrounded by blue circular motion lines.

BATC

Portsdown 4 Hardware

7 inch Touchscreen

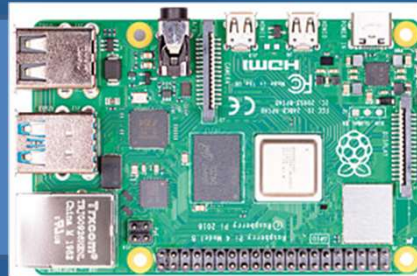
Raspberry Pi 4

Portsdown 4 Hardware

BATC

BATC Portsdown 4 DATV System Main Menu

TX		RX	M2	M3
Modulation	Encoder	Output to	Format	Source
32QPSK	H264	Lime Mini	4:3	PI Cam
Freq	Sym Rate	FEC	Band/Tvtr	Lime Gain
437 MHz	333	2/3	70_cm	88
EasyCap	Caption	Audio	Atten	Att Level
Comp Vid	On	Auto	NONE	-10.00
Preset 1	Preset 2	Preset 3	Preset 4	Store
146.5_333	437_1MS	1255_HD	437-Ugly	Preset



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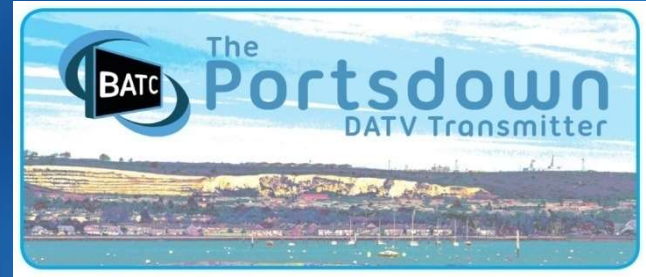
BATC

Portsdown 4 Capabilities

- DVB-S/S2 and DVB-T Transceiver
- SSB/FM/CW Transceiver (Langstone)
- Video Stream Transmitter and Receiver
- Test Equipment
- Utilities

Example Builds





ATV/Microwave Test Equipment



Test Equipment

- BandViewer
- Signal Generator
- Noise Figure Indication
- Noise Level Meter
- Power Meter
- Frequency Sweeper
- XY Display
- DMM Display/logger

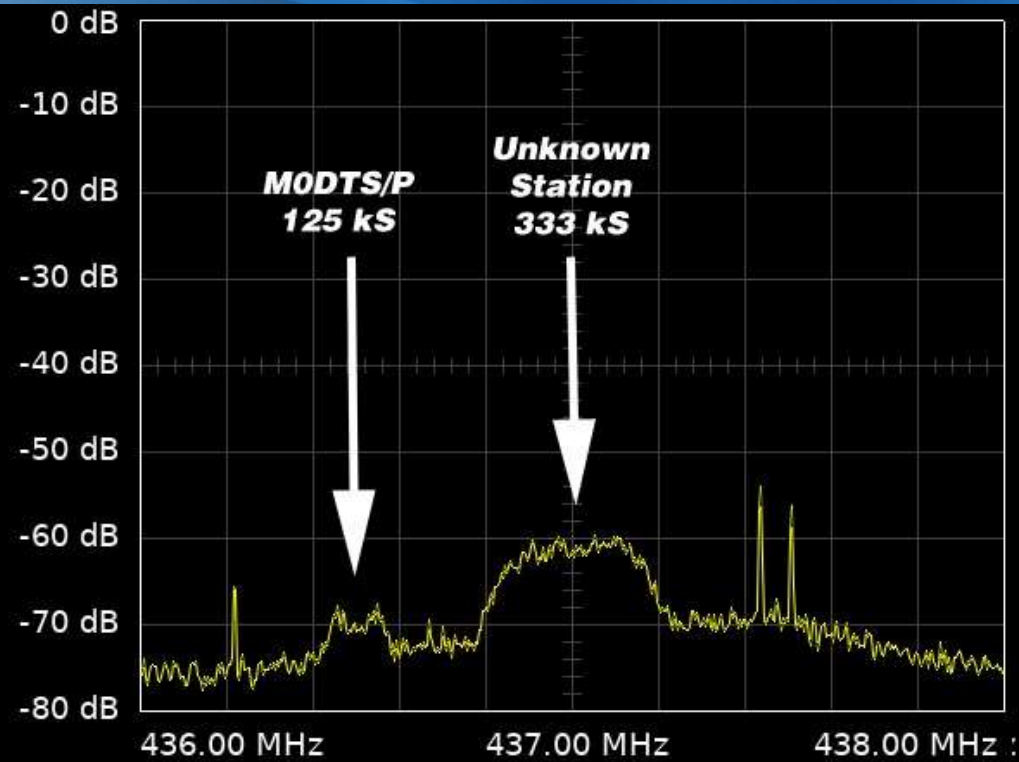


Band Viewer

- Narrow sweep (20 MHz) spectrum analyser
- LimeSDR, Pluto, RSPdx, Airspy R2 or RTL-SDR
- 2 MHz to 30 GHz
- Very useful as a “Panadapter”
- Accurate relative levels
- Dynamic Range Limited by SDR

Weak Signal Work

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Gain
Menu

100%

90%

70%

50%

30%

Back to
Settings

Freeze

Portsdown Band Viewer

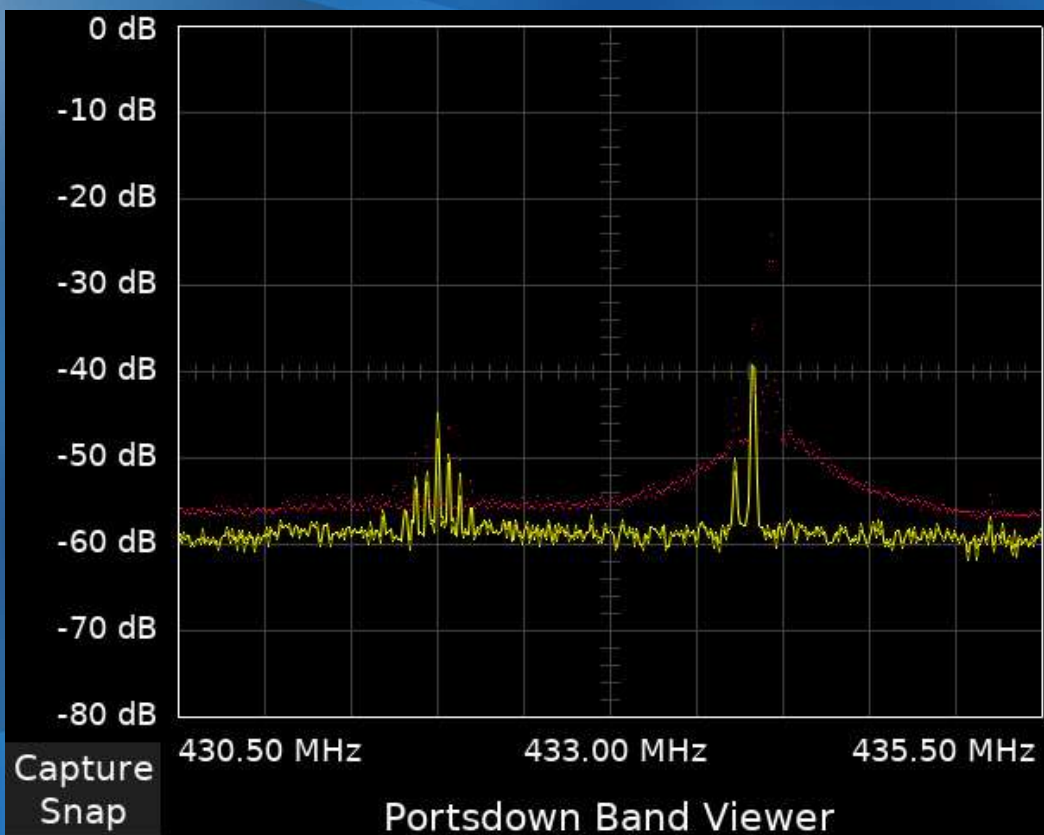
DATV Weak-signal Use

BATC



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Peak Hold



Marker
Menu

Peak

Peak
Hold

Manual

<-

->

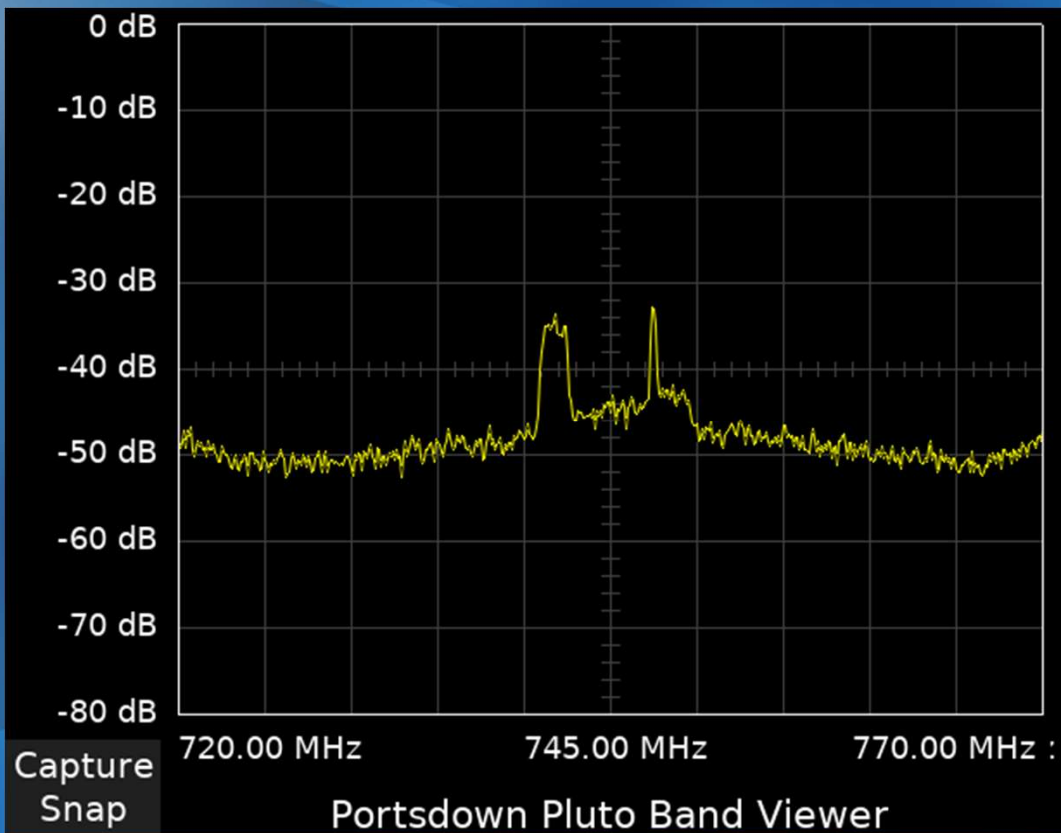
Markers
Off

Return to
Main Menu

Freeze

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Pluto 50 MHz Span



Span
Menu

2 MHz

5 MHz

10 MHz

20

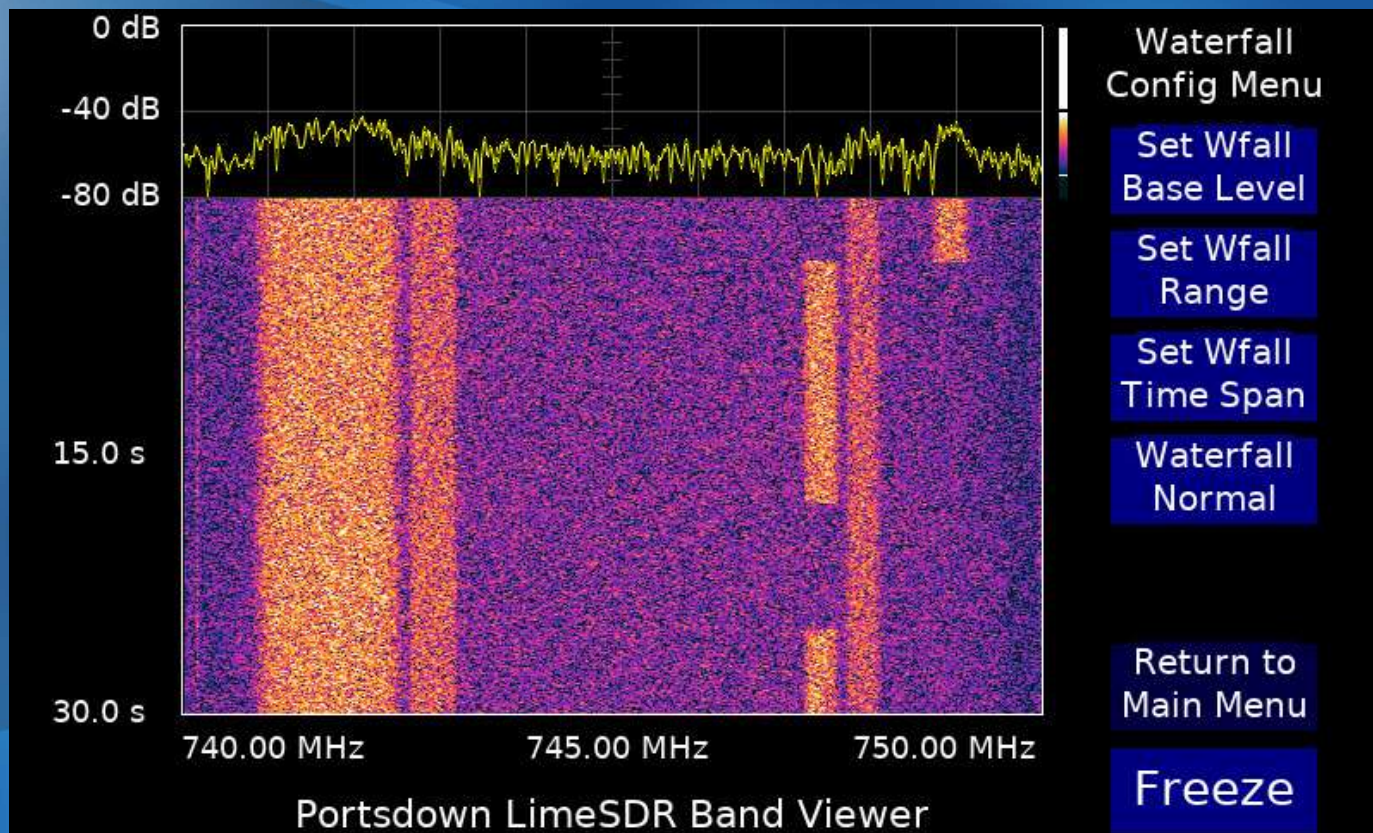
50

Back to
Settings

Freeze

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Waterfall





Signal Generator

- Simple Interface to Multiple Sources
- Approximate Amplitude Calibration using Look-up tables
- Some sources not clean
- Covers 1 Hz to 30 GHz

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Signal Generator

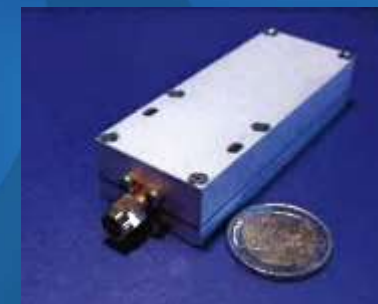
- Sources

- Pluto SDR - 6 GHz
- Pluto SDR x5 - 30 GHz
- LimeSDR Mini - 3.5 GHz
- ADF4351 - 4.4 GHz
- ADF5355 - 13.6 GHz
- AD9850 - 1 Hz to 50 MHz

- Elcom Source



- Nort SLO



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Sig Gen Control

Portsdown Signal Generator Control Panel

Lime Mini

OFF

Cal Lime

Exit

ON

+ + + + + + + + +
1,255.000,000

- - - - - - - - -

+ +
+ 1.5 dBm

- -

Save

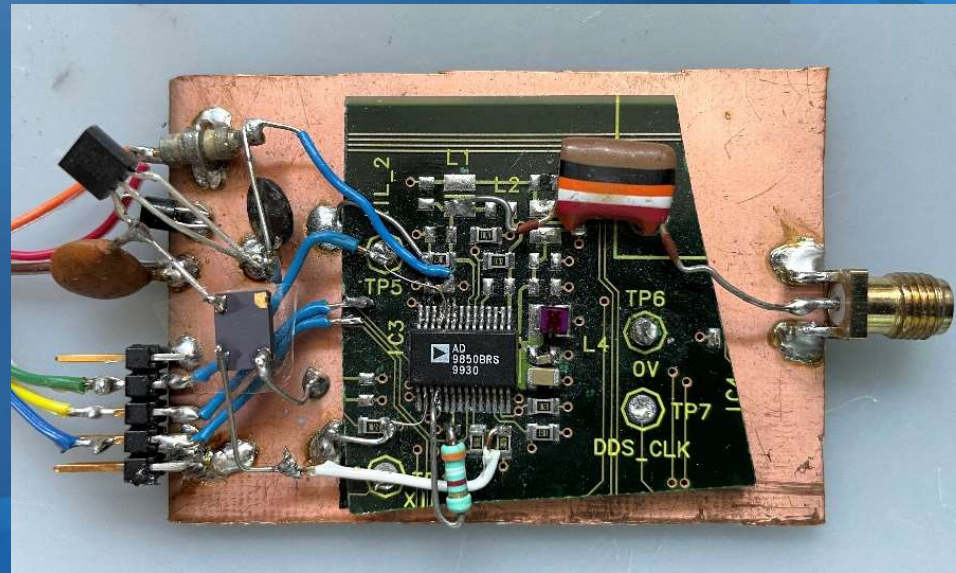
Recall

Lime Gain = 77

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LF Signal Generator

- AD9850 DDS Covers 1 Hz – 50 MHz



The logo for BATC (Bristol Astronomy Technology Centre) is located in the top left corner. It consists of the letters 'BATC' in white, bold, sans-serif font, set against a dark blue, trapezoidal background. This background is surrounded by several concentric, glowing blue circles of varying sizes, creating a sense of depth and motion.

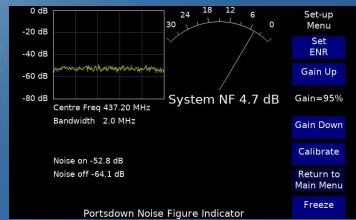
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Noise Figure Indication

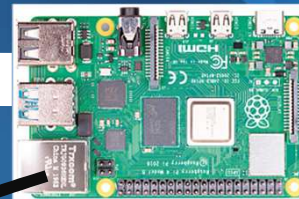
- Use a Noise Source switched at ~ 4 Hz
- Measure Average Noise Power On & Off
- Calculate Noise Figure
- After calibration, calculate gain
- Pluto or LimeSDR



NF Measurement – How?



Display Ribbon Cable

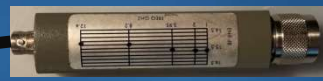


USB Cable

3v3 Switching Signal



28v



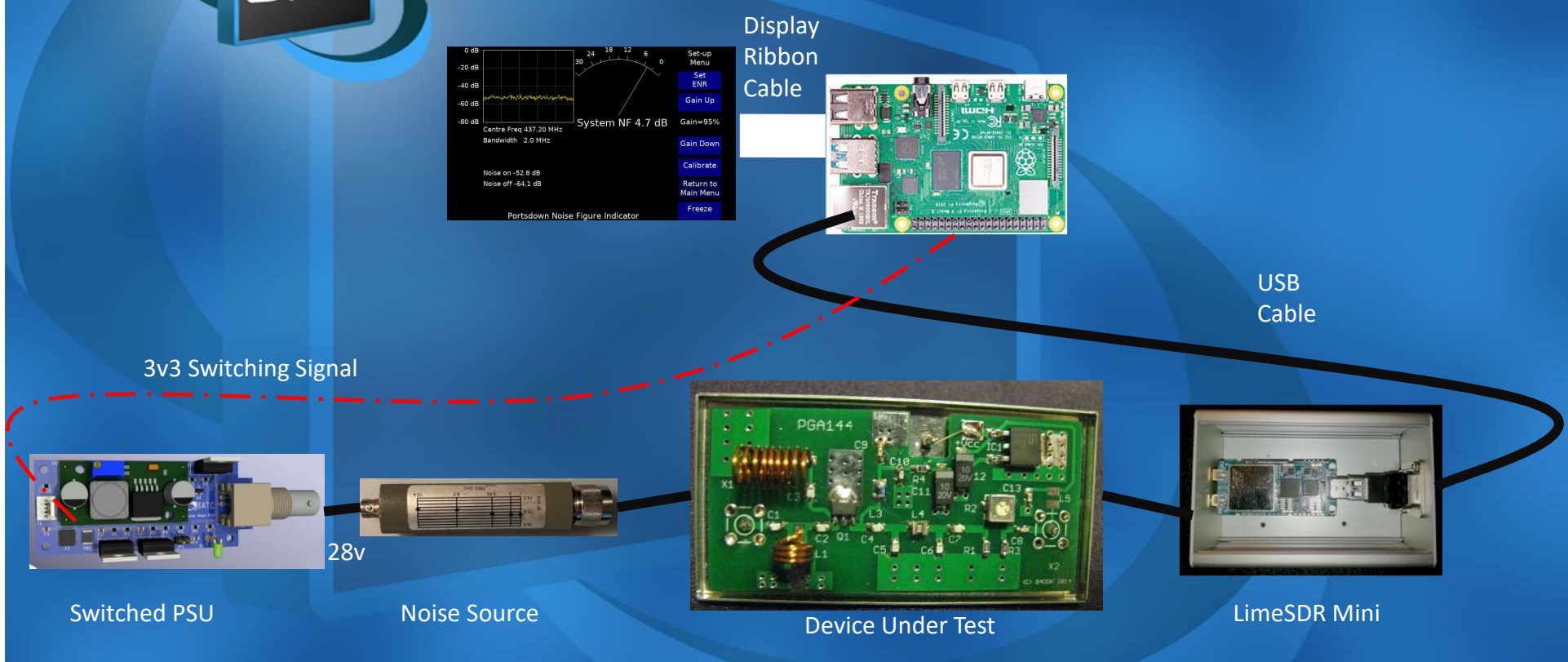
Noise Source



Device Under Test



LimeSDR Mini



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Noise Figure Notes

- SDR must be operating in linear region
- No significant signals in bandwidth
- Bandwidth?
- Minimise digital noise locally

Noise Source



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- Calibrated Noise Sources are rare
- RF Design BBGen (ENR 24 dB 5 GHz) £84
add External Attenuator ?
- RF Design RXGen (ENR 10 dB 2.4 GHz)
Available from G3AAF (£60 BATC Members)
- Homebrew?



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Noise Source Switching PSU



- Commercial sources need 28v
- RF Design Sources need 12v or 13.5v
- Needs to be a clean supply
- BATC design (and PCB) available

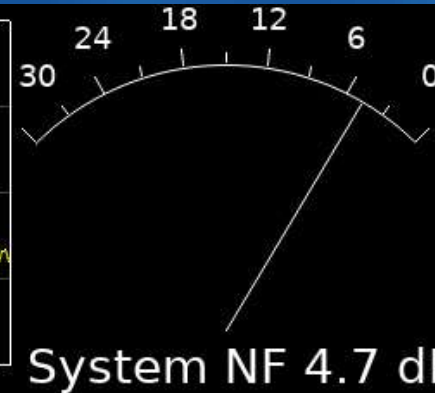
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Noise Figure Application



Centre Freq 437.20 MHz
Bandwidth 2.0 MHz

Noise on -52.8 dB
Noise off -64.1 dB



Set-up
Menu

Set
ENR

Gain Up

Gain=95%

Gain Down

Calibrate

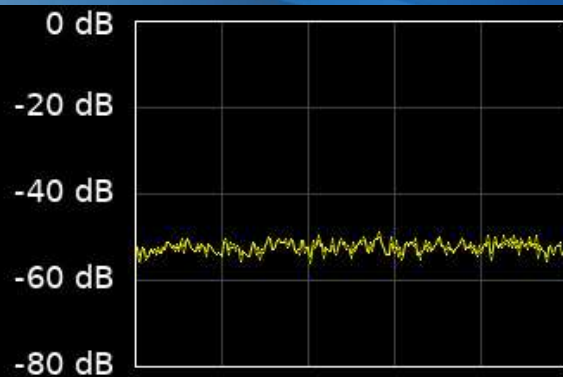
Return to
Main Menu

Freeze

Portsdwn Noise Figure Indicator

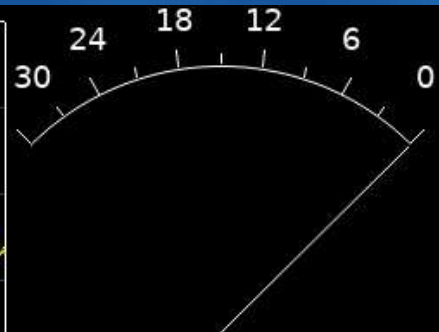
BATC

Calibration



Centre Freq 437.20 MHz
Bandwidth 2.0 MHz

Noise on -52.8 dB
Noise off -64.1 dB



Device NF -0.1 dB

Device gain -0.0 dB

Set-up
Menu

Set
Input ENR

Gain Up

Gain=95%

Gain Down

Calibrated

Return to
Main Menu

Freeze

Portsdown Noise Figure Indicator

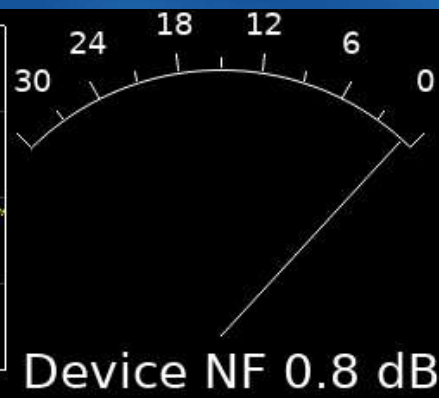
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Device Gain and NF



Centre Freq 437.20 MHz
Bandwidth 2.0 MHz

Noise on -29.8 dB
Noise off -44.9 dB



Device gain 23.2 dB

Set-up
Menu

Set
Input ENR

Gain Up

Gain=95%

Gain Down

Calibrated

Return to
Main Menu

Freeze

Portsdwn Noise Figure Indicator

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Noise Figure Notes

- Not an exact science
- Beware LimeSDR Digital Noise
- Use attenuators for error-checking
- Beware changing source VSWR between noise on and noise off

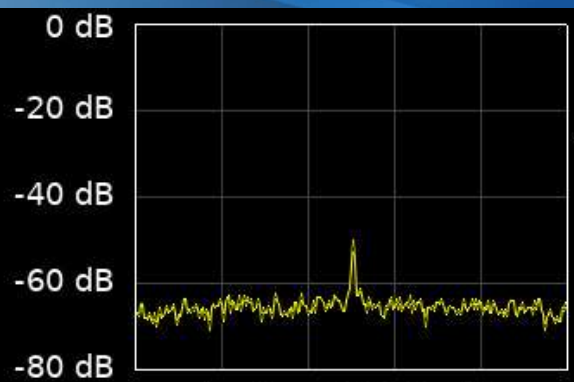


Noise Level Meter

- Indicates average noise power
- Relative or Absolute
- Can indicate carrier level
- Relative to Noise or Absolute
- Pluto or LimeSDR

Sun Noise (Absolute)

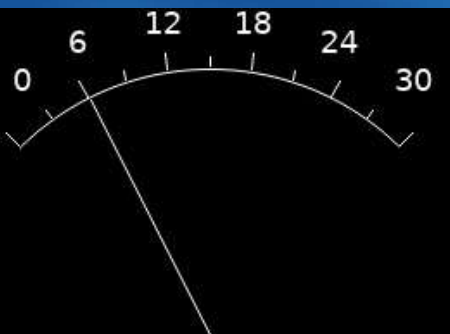
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Centre Freq 740.00 MHz
Bandwidth 500.0 kHz

Noise now -65.7 dB
Baseline -71.7 dB

History span 100 sec



Noise Delta 6.0 dB



Set-up
Menu

Set
Baseline

Gain Up

Gain=95%

Gain Down

Establish
Baseline

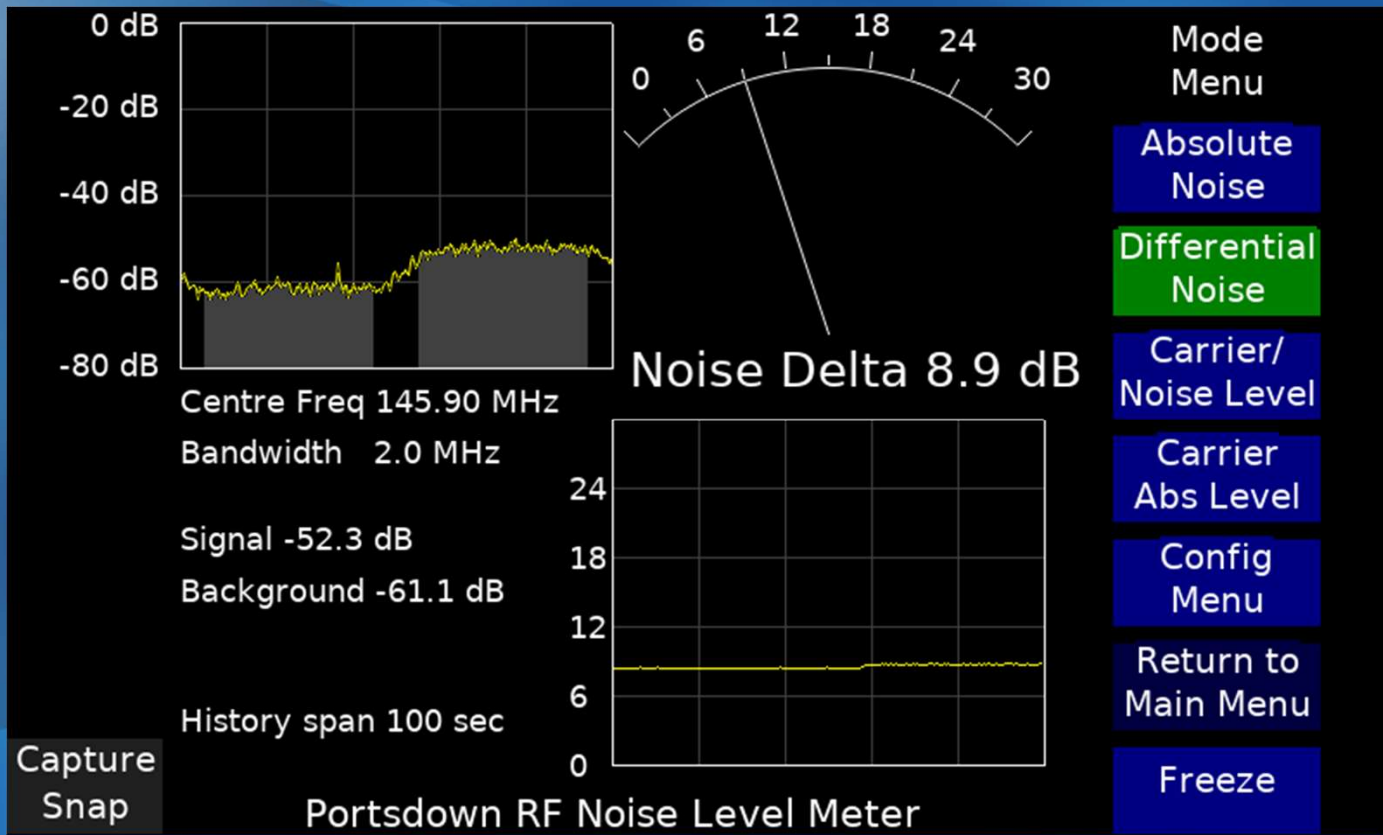
Return to
Main Menu

Freeze

Portsmouth RF Noise Level Meter

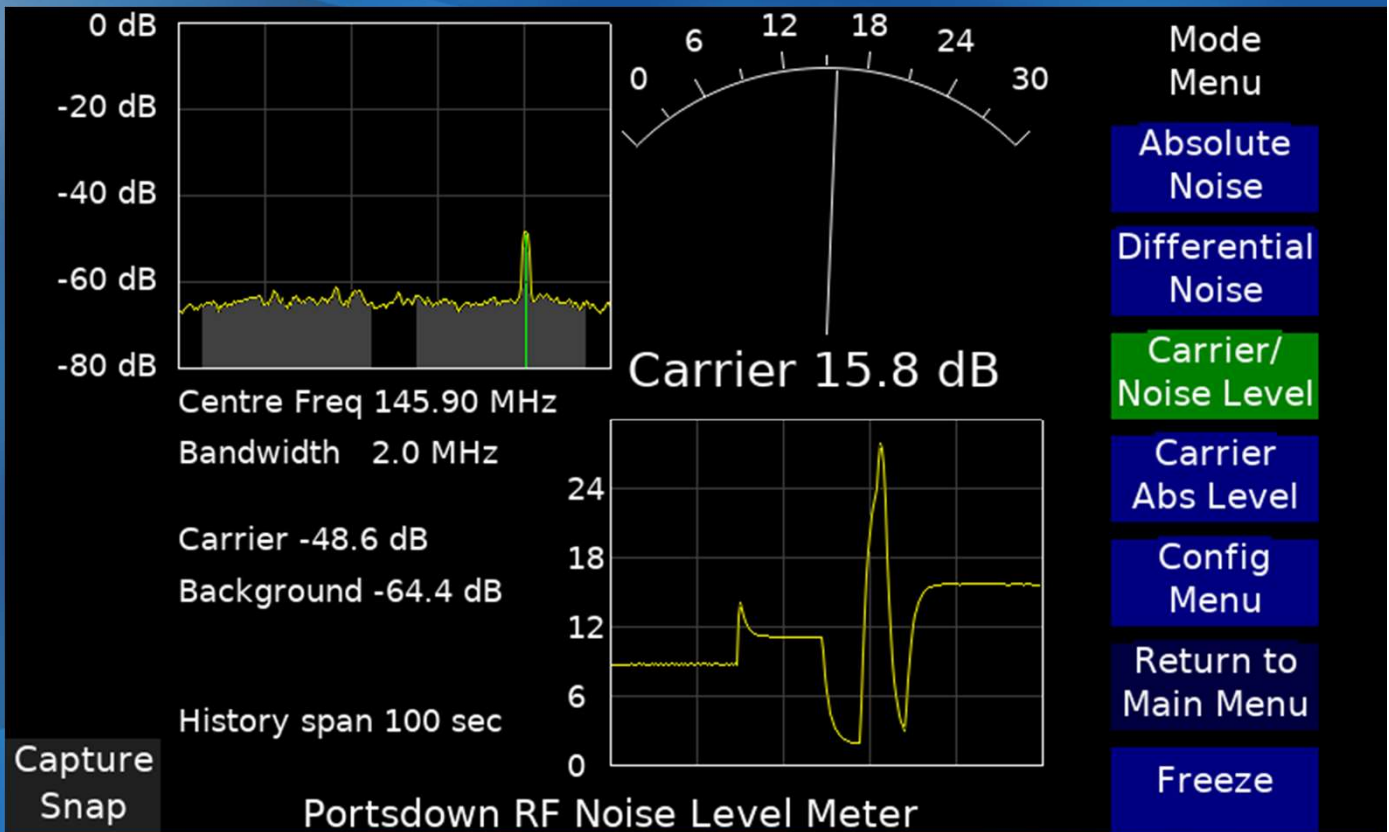
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Relative Noise



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Carrier to Noise Level



Absolute Carrier Level

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0 dB
-20 dB
-40 dB
-60 dB
-80 dB

Centre Freq 145.90 MHz

Carrier 11.4 dB

0 6 12 18 24 30

Mode Menu

- Absolute Noise
- Differential Noise
- Carrier/Noise Level
- Carrier Abs Level**
- Config Menu
- Return to Main Menu
- Freeze

Capture Snap

11.4

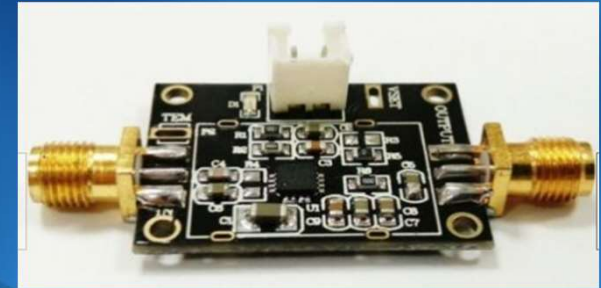
24
18
12
6
0

Portsdown RF Noise Level Meter

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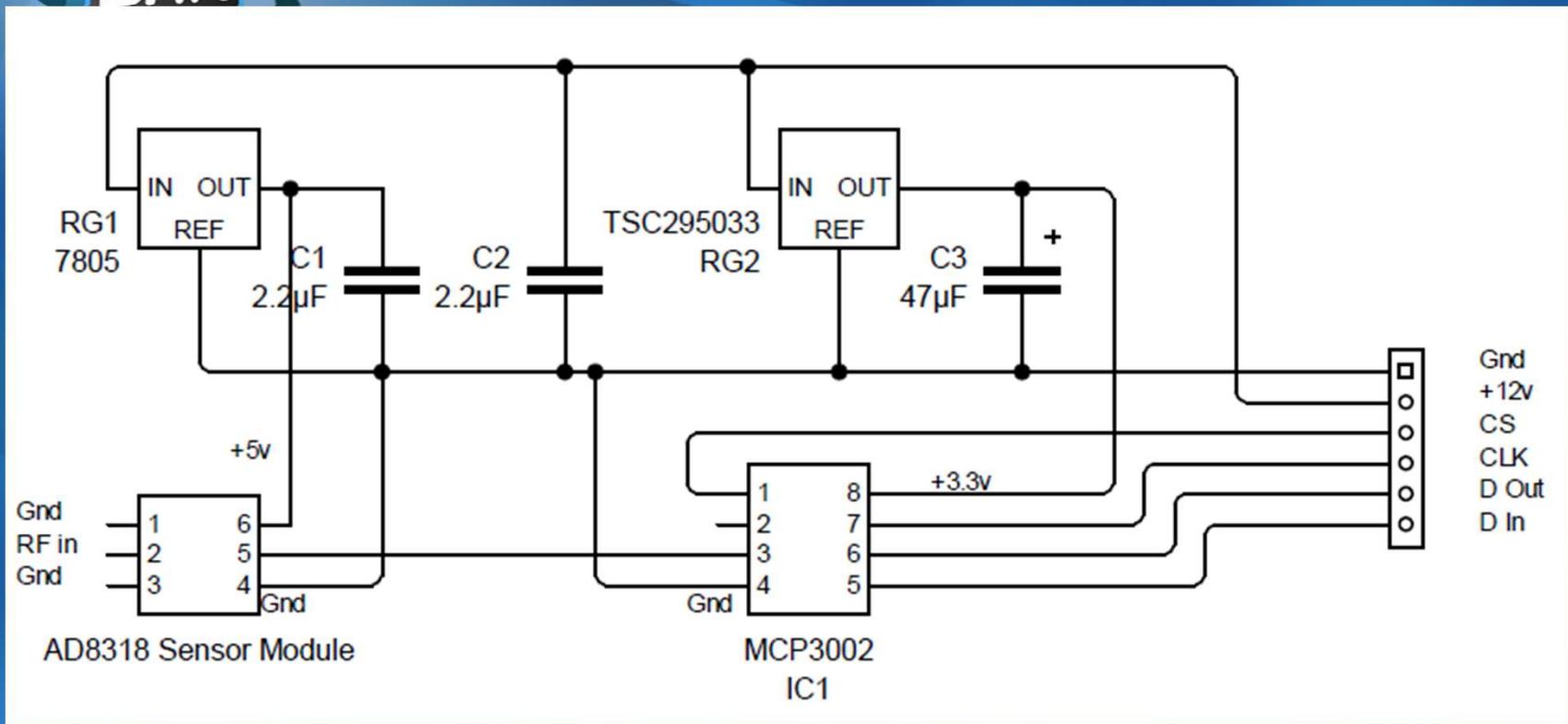
Power Meter

- Needs external sensor
- AD8318
- MCP3002 A-D
- More sensors in future



Power Meter Circuit

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Meter Face



Sensor: ad8318-3

Portdown Power Meter

Main Menu

Settings

dBm

Mode

<-

->

System

Exit to
Portdown

Freeze



Power Meter Features

- Needle has “inertia”
- Selectable Ranges - dBm or mW
- Look-up table for linearity
- Calibration Factors can be entered
- Direct reading with attenuators
- An alignment tool – not an HP432!



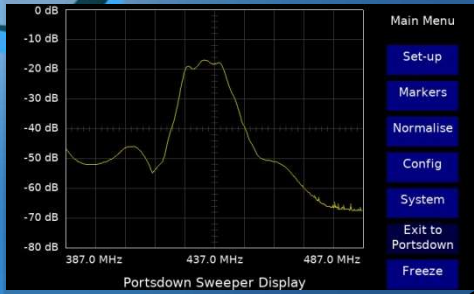
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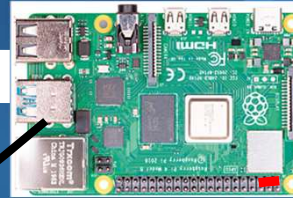
RF Sweeper

- Combine the Signal Generator with the Power Meter
- Add some automation
- Frequency Response Sweeper

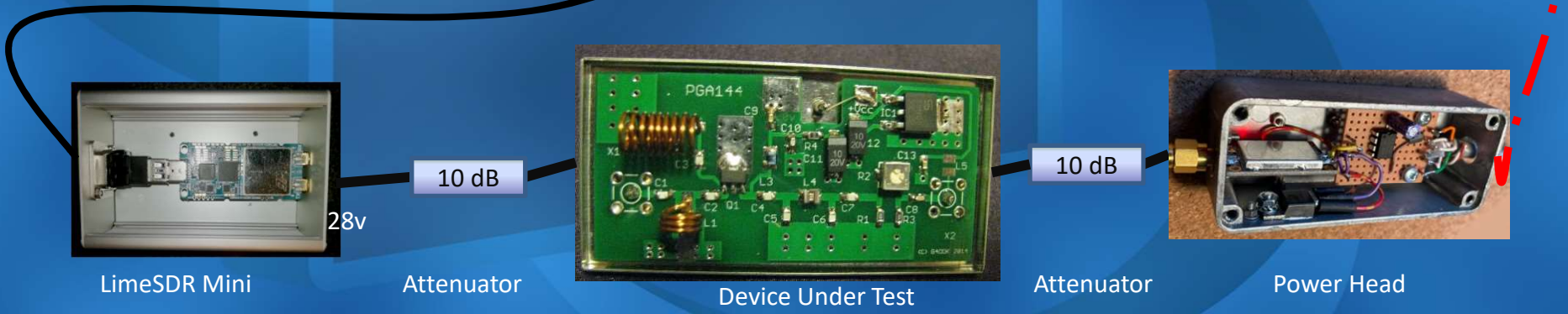
Sweeper - How?



Display
Ribbon
Cable

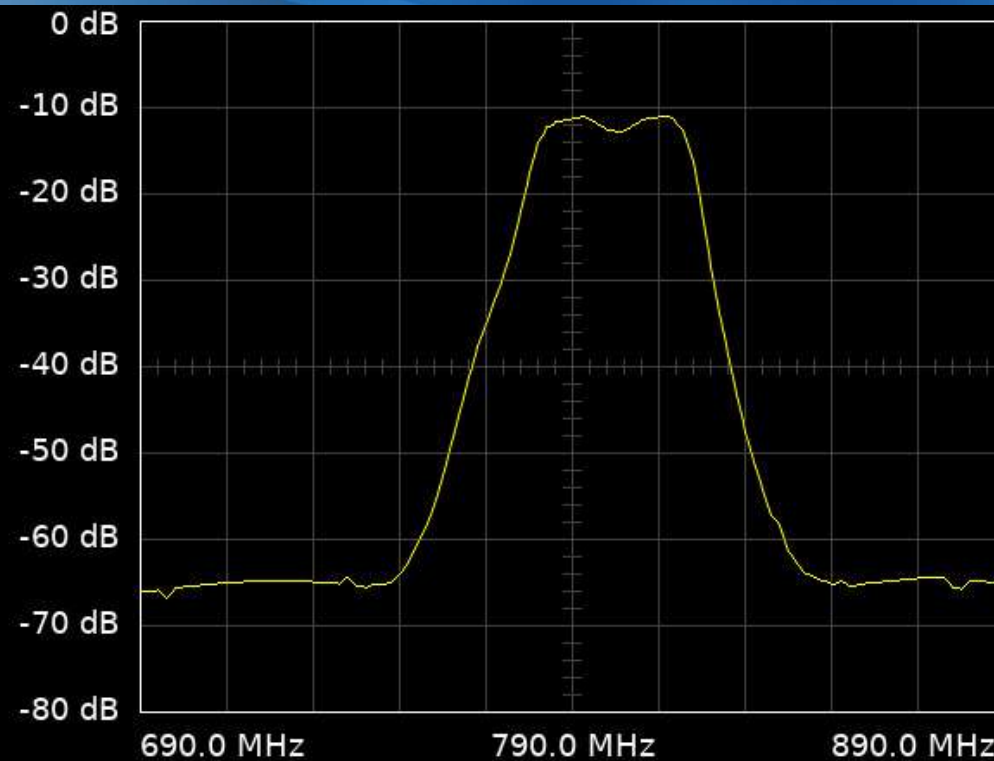


USB
Cable



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Checking a Filter



Portsdown Sweeper Display

Main Menu

Set-up

Markers

Normalised

Config

System

Exit to
Portsdown

Freeze

Sweeper Limitations

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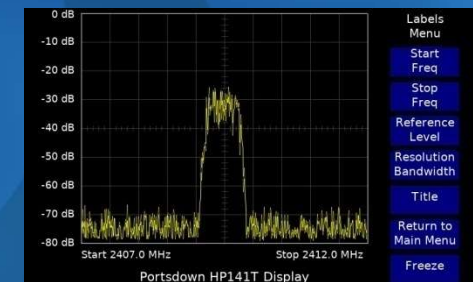
- Slow scan speed – Reduce samples?
- Responds to Spurii from Source
 - LimeSDR 3rd Harmonic 15 dB down?
- LimeSDR source only at present



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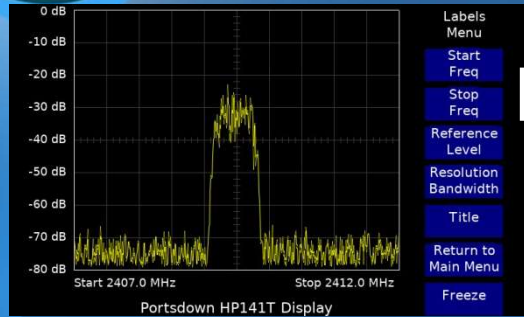
XY Display

- For use with HP141T or HP8559
- Portsdown with added 2 IC interface
- Provides
 - 500 x 400 pixel image
 - Screen Capture and Freeze
 - Normalisation

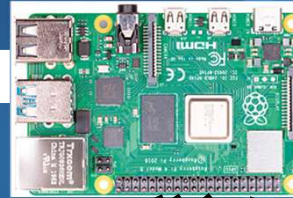


XY Display – How?

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Display Ribbon Cable



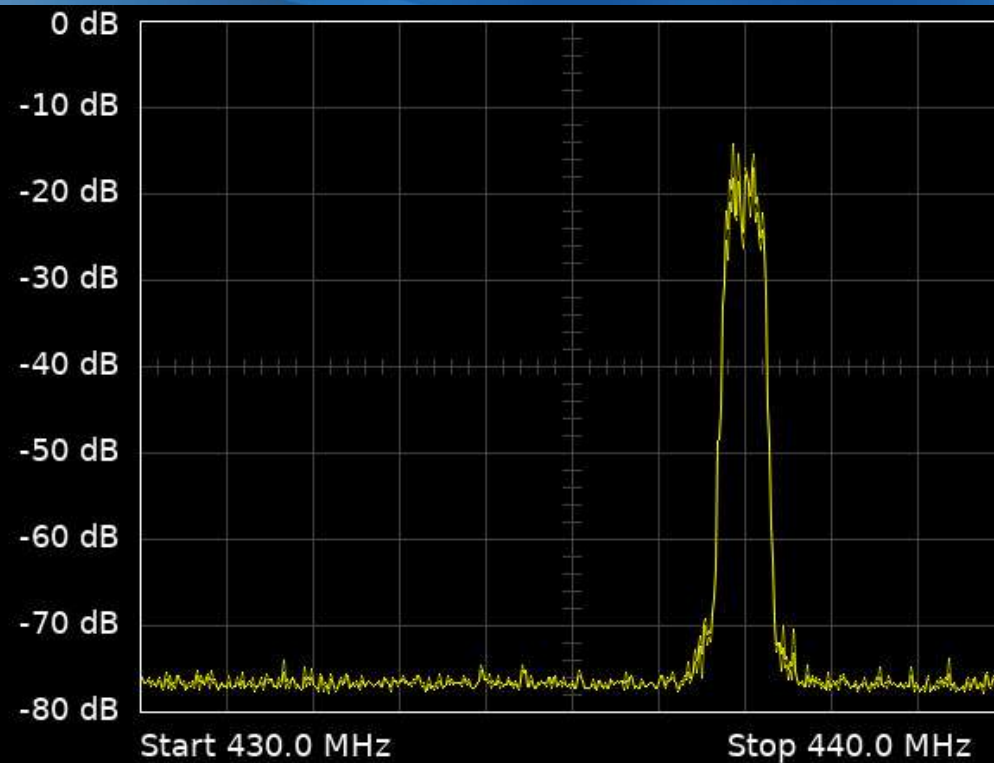
spi Data



Y input
Interface
X input

BATC

Typical Plot



Labels
Menu

Start
Freq

Stop
Freq

Reference
Level

Resolution
Bandwidth

Title

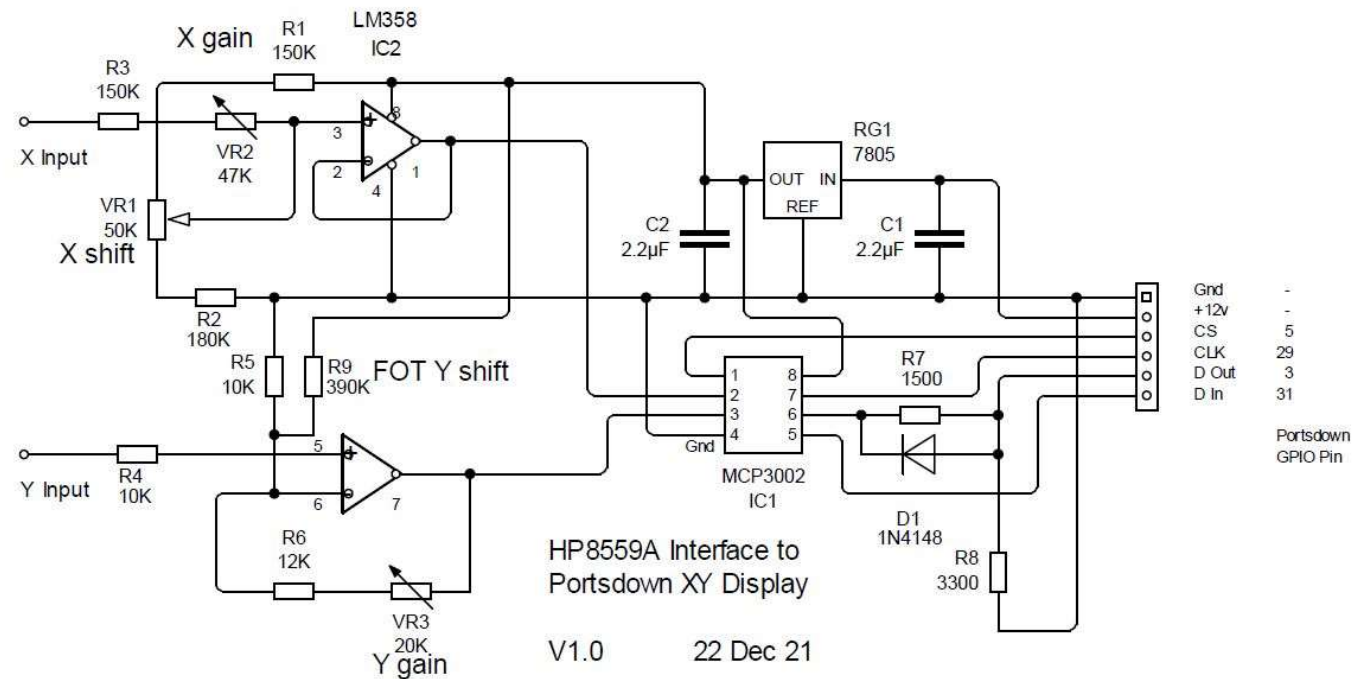
Return to
Main Menu

Freeze

Portsdown HP8559A Display

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XY Interface Circuit



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DMM Display and Logger

- Uses Parkside PDM300 Meter (£11.99 Lidl)
- Add an opto-isolator on serial output
- Enables large/remote/web display
- Logger and Battery calculator



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DMM Display

12.07

Capture
Snap

Main Menu

Settings

dBm

Mode

<-

->

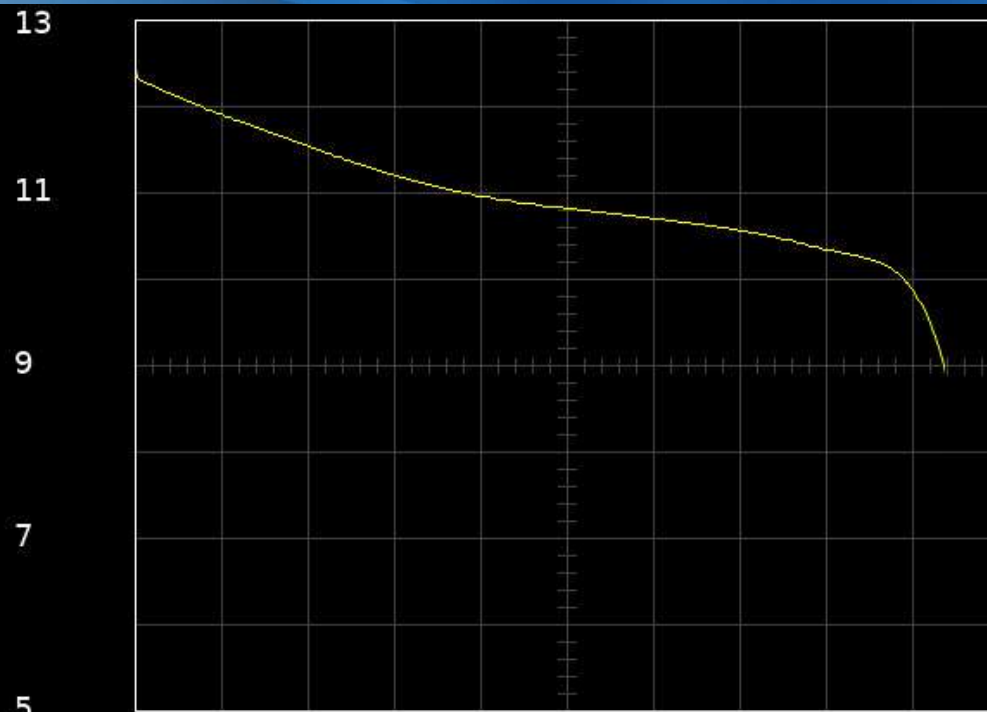
System

Exit to
Portsdown

Freeze

BATC

DMM Display



Actions
Menu 9

Load OFF

Start
Test

Reset
Test

Test
Complete

Save
.csv file

Return to
Main Menu

Freeze

Portsmouth Digital Multimeter Display

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Easy Wifi Connect

Select one of these WiFi Networks:

Page 1 of 1

- 1 TNSCAPE9C02B
- 2 PixienetG
- 3 DIRECT-8y-FireTV_7fd5
- 4 Hidden Network
- 5 PixienetG

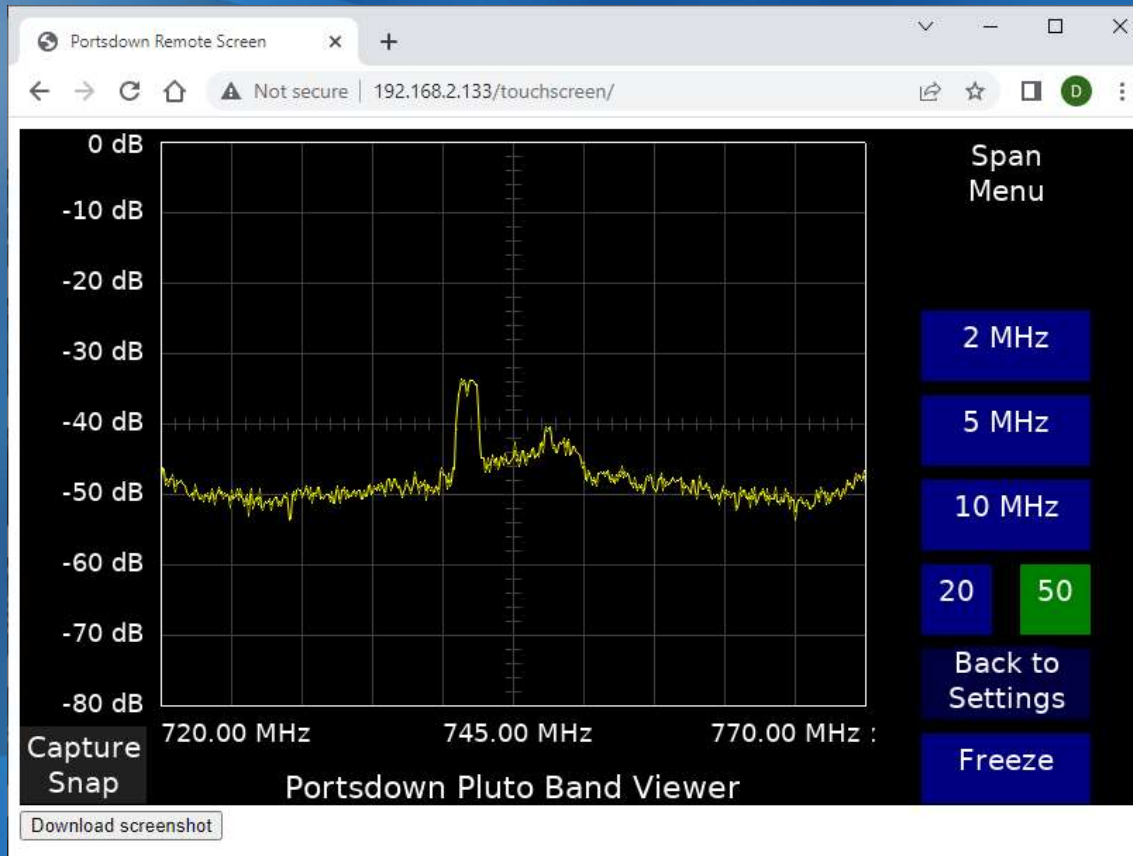
Previous Page

Cancel

Select

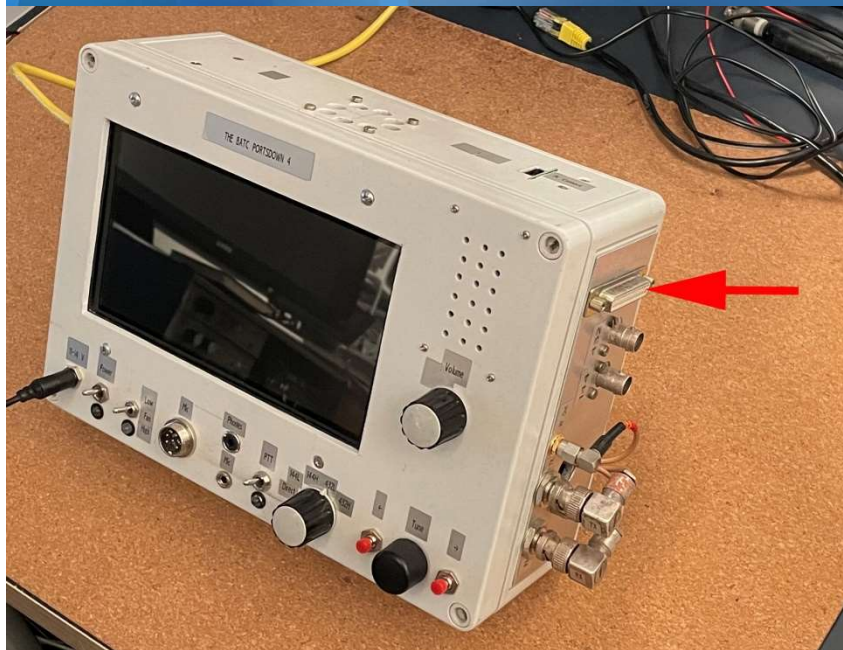
Next Page

Web Control or view



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Portsdown Interface



- Single interface for spi Power, Serial and Data
- Defined in CQ-TV



Summary

- Raspberry Pi, Touchscreen and peripherals provide a very capable platform for RF activities
- Peripherals **MUST** be the exact type – its not like Windows
- Open source (with one exception – DVB-T RX)
- BATC Wiki is primary information source
- Go and play with the applications and hardware



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Questions