Moving up to 1.3GHz

- A VHF DXer's guide to the first band above a GHz

Dr John Worsnop G4BAO

RadCom GHz Bands Columnist

RSGB Propagation Studies Committee

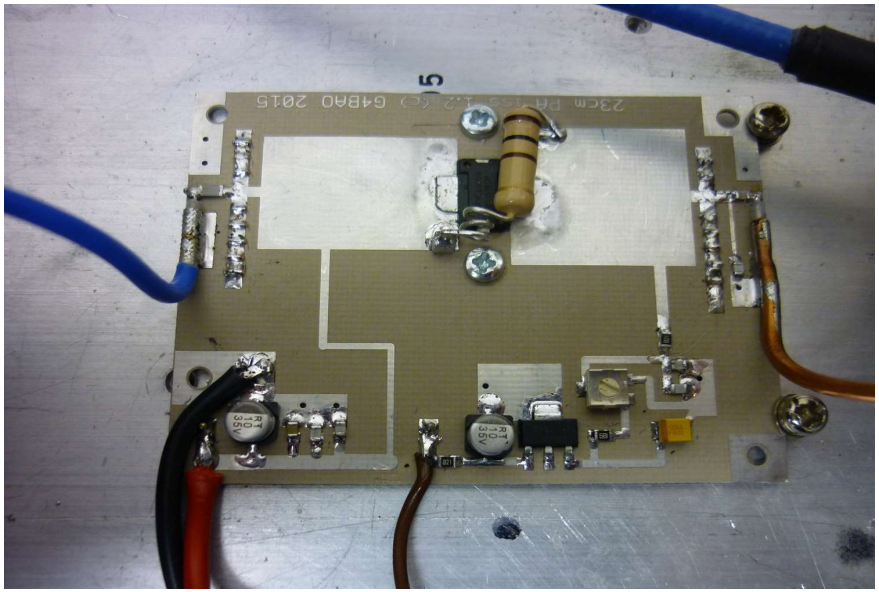
RSGB 2016 Convention

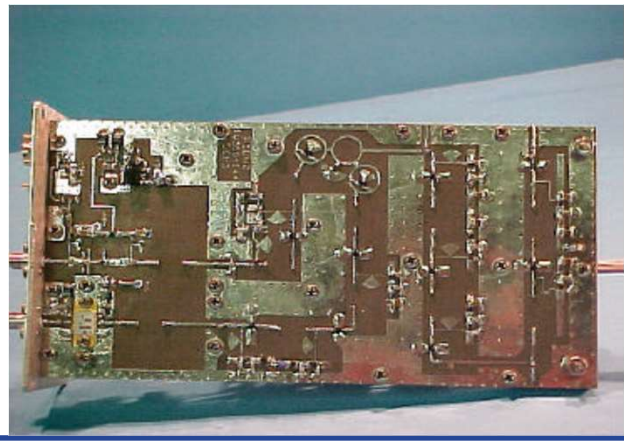
Moving up to 1.3GHz

- “23cms” the lowest of the GHz bands
- Myths and Magic
  - What are you likely to work?
  - What’s the same?
  - What’s different?
- System Engineering above a GHz – what matters

Moving up to 1.3GHz

- Breaking the 3 big GHz myths
  - Ah, but GHz bands are all line of sight!
  - And it's very expensive!
  - And it's too technical for me!





Moving up to 1.3GHz – Breaking the Myths

#1 - But it's all line of sight and hill-topping above a GHz

- May I introduce
- The G4BAO "hole"
  - 4 metres ASL
  - Antenna 8m AGL

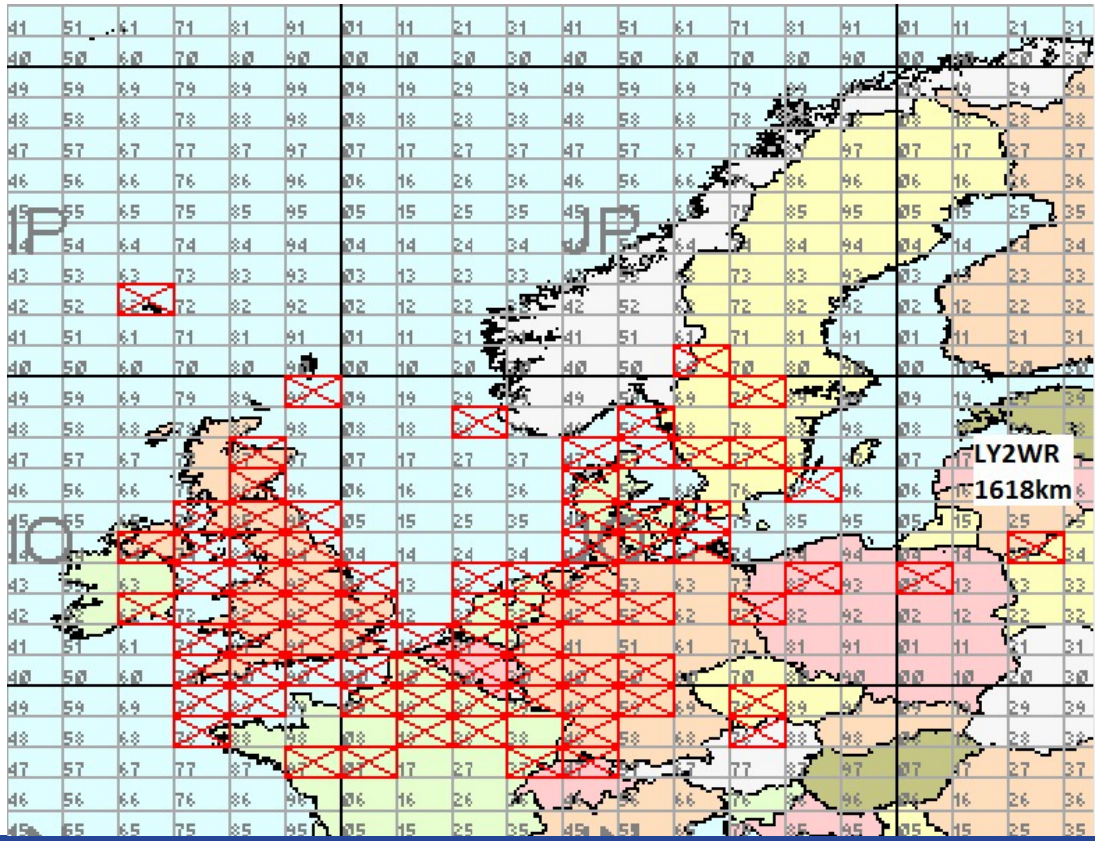
Moving up to 1.3GHz – Breaking the Myths

#1 - But it's all line of sight and hill-topping above a GHz

- My squares map

- 81 squares, 20 DXCCs via terrestrial propagation
- Mostly with just 35 Watts from a hole in the ground

- Including EME, 125 squares, 38 DXCCs total.



Moving up to 1.3GHz – Breaking the Myths

#2 - But its Really Expensive!

- **1.3GHz equipment - New**
- (approx. prices October 2016 assuming you already have a 2m multimode driver)

1296/144 MHz SG lab transverter	£150
23 element Tonna Yagi + coax	£90
Total cost	**£240**
Preamp kit	£60
PA kit	£100
Surplus coax relay	£20
Waterproof Box to put it all in	£20
Total cost	**£440**

A new D - STAR Setup?	
Icom ID-51E handheld	£270
Comet GP-1 antenna	£70
Total cost	**£340**
A decent WARC Bands setup?	
Cushcraft A3WS beam	**£560**
Wideband Scanning?	
Funcube Dongle	£125
Diamond D190 Discone antenna +coax	£100
Total cost	**£225**

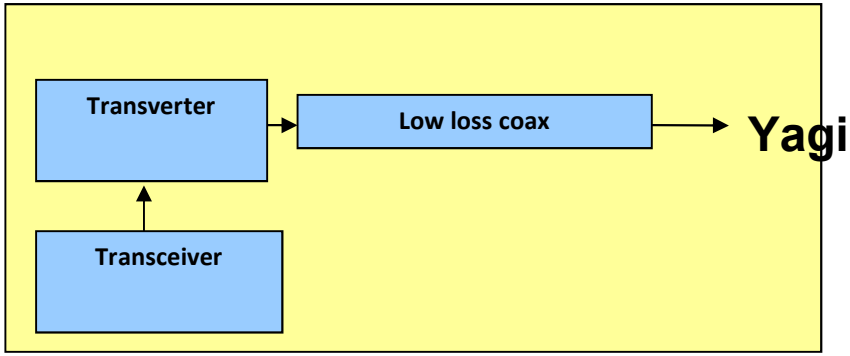
RSGB 2016 Convention

Moving up to 1.3GHz – Breaking the Myths

#3 - But its Too Technical for me!

- **Beginners setup**

- **23cms is JUST the same as 2m as far as equipment is concerned.**
  - **A transceiver, (a transverter) and a Yagi**



Moving up to 1.3GHz

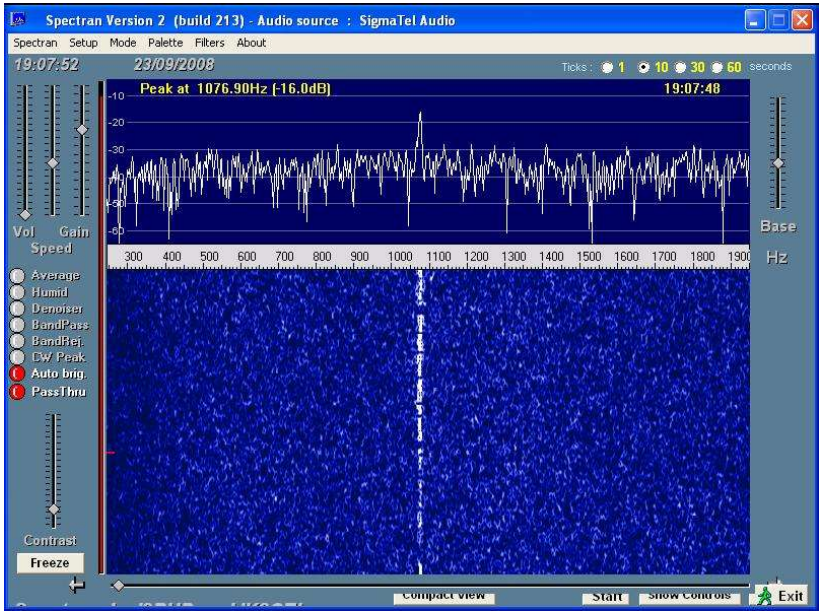
- What's the same?
  - Can still use Yagis/coax feeds
  - IMHO, slightly improved propagation over VHF
- What's different
  - Much less band noise
  - Troposcatter and Aircraft Scatter are much improved
  - Low visual impact antennas
  - Dishes become practical
  - (leading to higher bands with multiband feeds)
  - Fewer "Black Box" solutions, more "Silver Box" solutions
  - Higher gain antennas can generate higher EIRPs
  - Small dish/big Yagi EME becomes practical with JT modes
  - No Es

Moving up to 1.3GHz – DX Propagation modes

- Tropospheric enhancement and Ducting
  - Weather–dependent
  - Enhanced range up to 2500km
  - BIG ADVANTAGE NEAR THE COAST
    - Sea ducts
- Aircraft Scatter
  - 24/7 Over the horizon up to 800km
- Tropo Scatter
  - 24/7 Over the horizon up to 500km
- EME

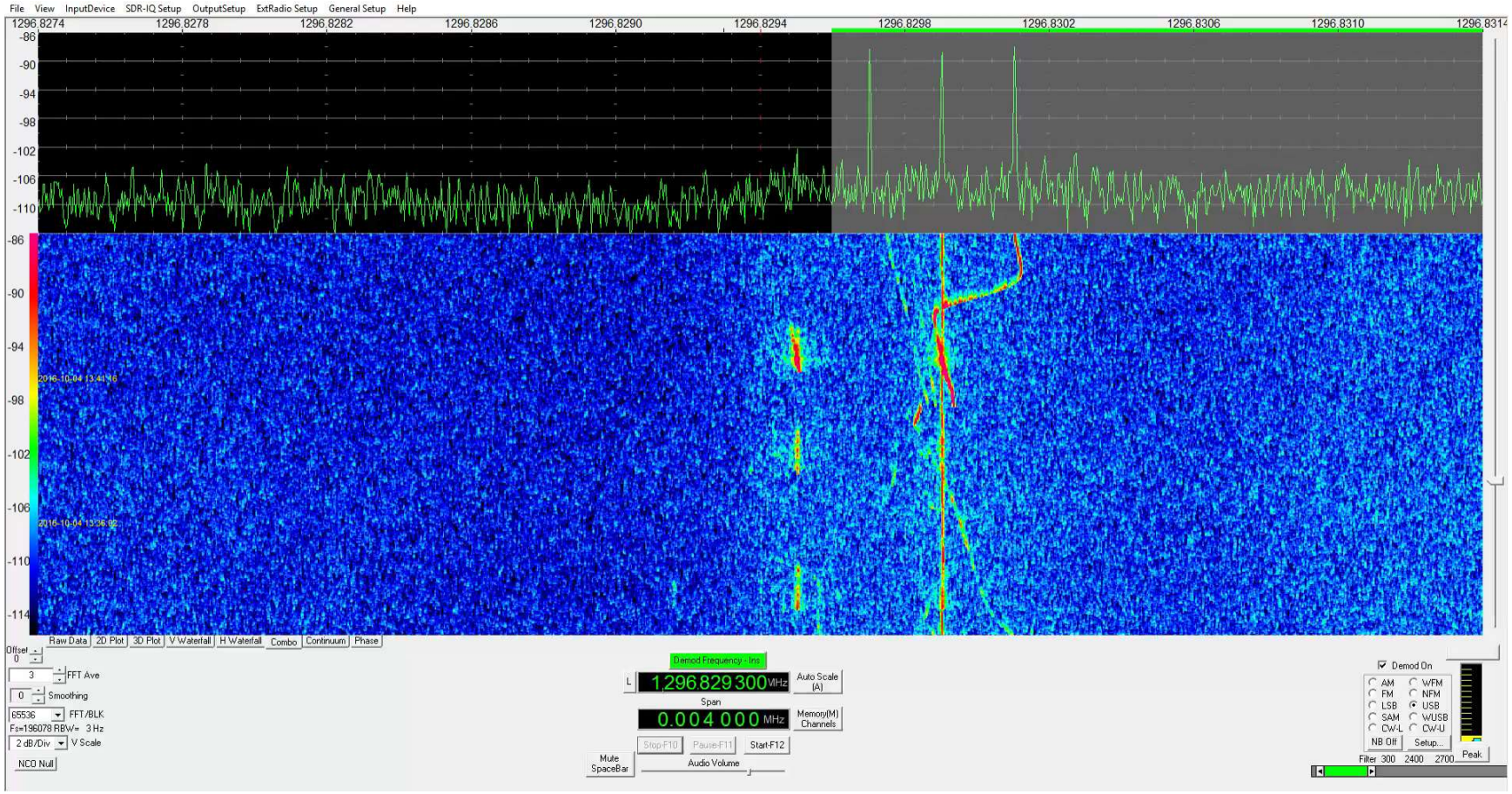
Moving up to 1.3GHz – DX Propagation modes

- LY2WR via Tropo >1600km



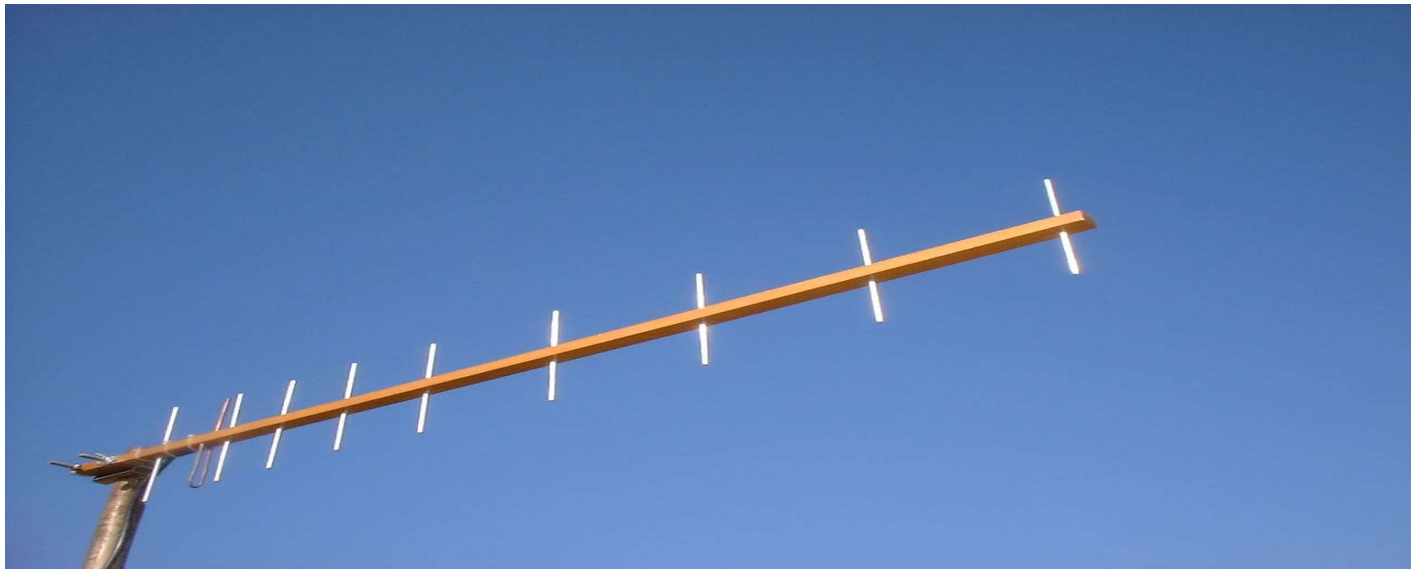
Moving up to 1.3GHz – DX Propagation modes

- GB3MHZ via Aircraft scatter and direct



Moving up to 1.3GHz – Current records

- UK - 2617km G6LEU to EA8XS (1989)
- World – 4143km KH6HME to XE2/N6XQ (1985)
- EME – 18773km PA0SSB to ZL3AAD – (1983)



Moving up to 1.3GHz – It's ALL about System Engineering

- Antenna performance
- System losses
- Receiver performance
  - Signal handling
  - Noise figure
- Transmitter Power

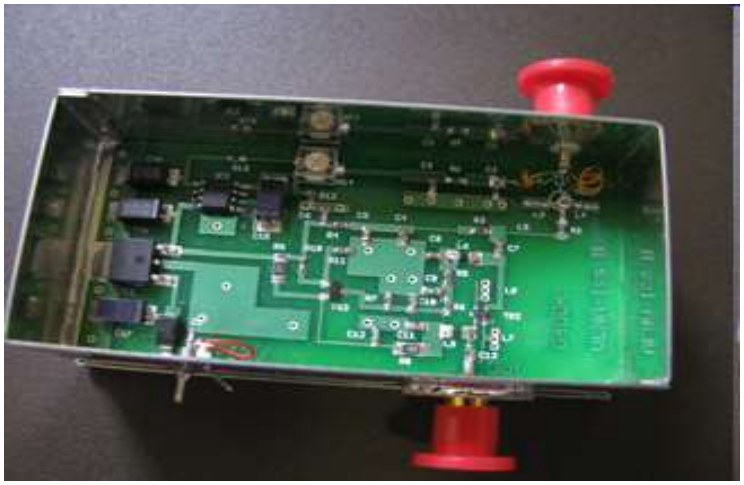


Photo G4DDK

Photo SM4DHN Labetech AB

Moving up to 1.3GHz – Antenna performance

- High gain small antennas are possible
  - 3 metre boom on 144 gives **13dBi**
  - 3 metre boom on 1296 gives **20dBi**
  - 1.2 metre dish on 1296 gives **23dBi**
- Single 28element Yagi
  - Smaller than a typical TV antenna
  - 1.6m long
  - 17dBi

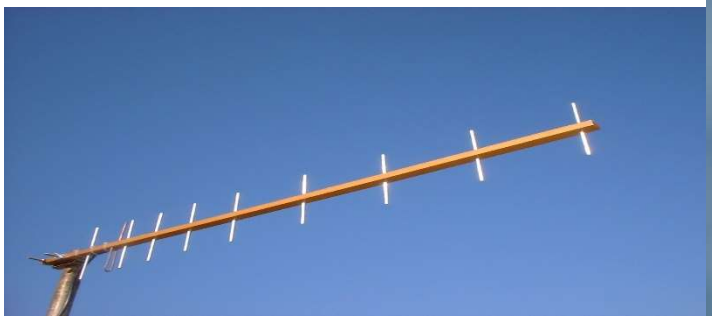
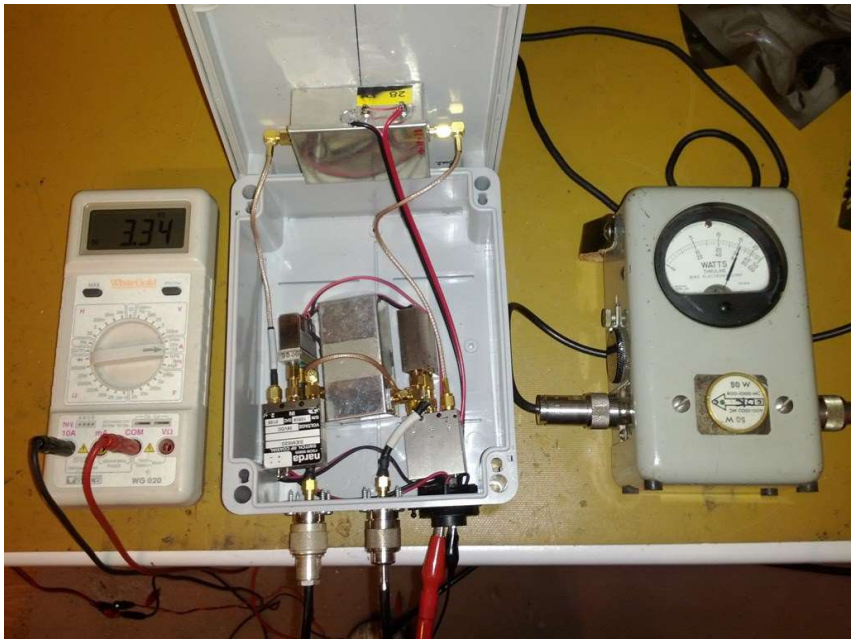


Photo WA5JVB

Moving up to 1.3GHz – System losses

- Loss reduction is king on the GHz Bands
  - RG213 loss at 1.3GHz is 3dB per 10m
  - FSJ4-50 is 1.35dB per 10m
  - M&P ultraflex13 is 1.2dB per 10m
- Use masthead preamps and PAs to reduce losses

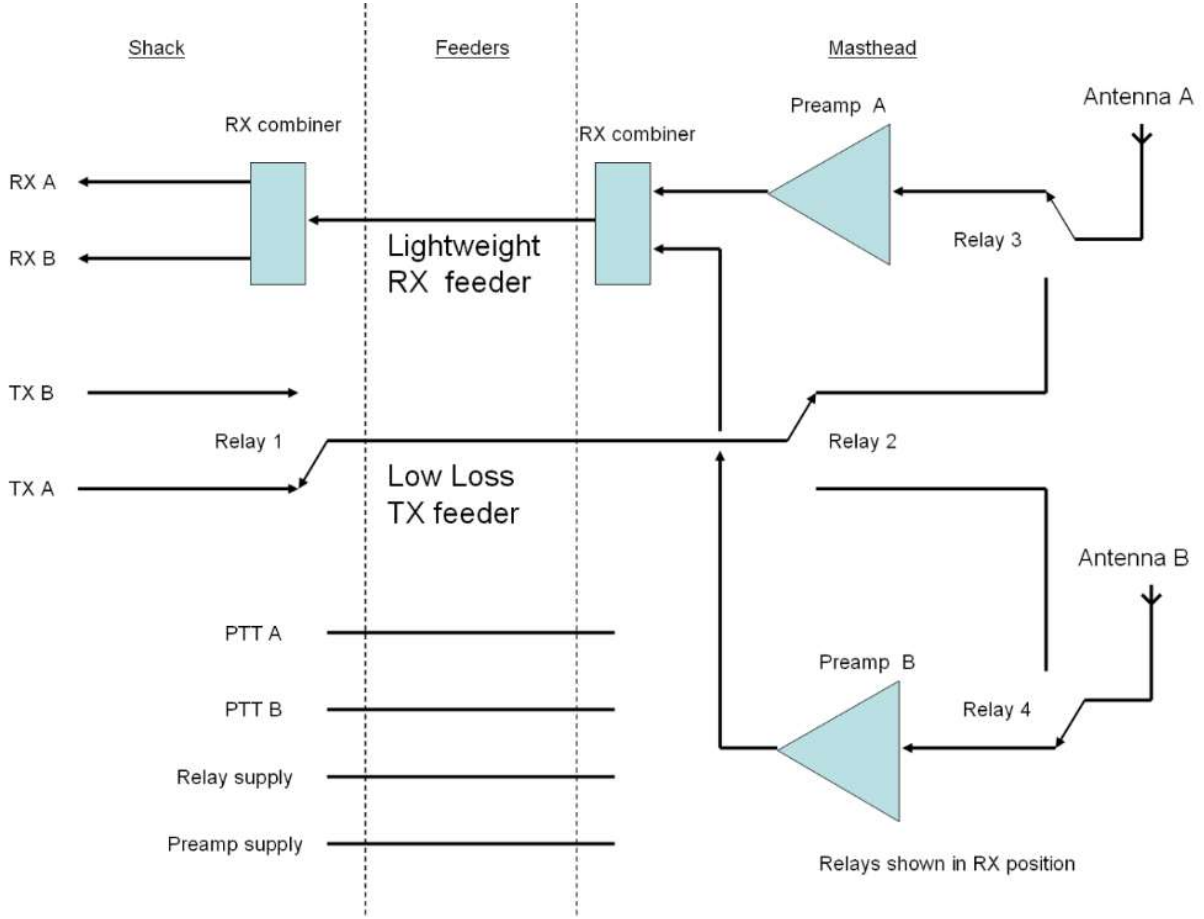


M1BXF's masthead G4BAO PA & G4DDK Preamp with switching - built for G3PYE/P

Photo M1BXF www.geekshed.co.uk

Moving up to 1.3GHz – System losses

- Two Bands, three relays, one low loss feeder

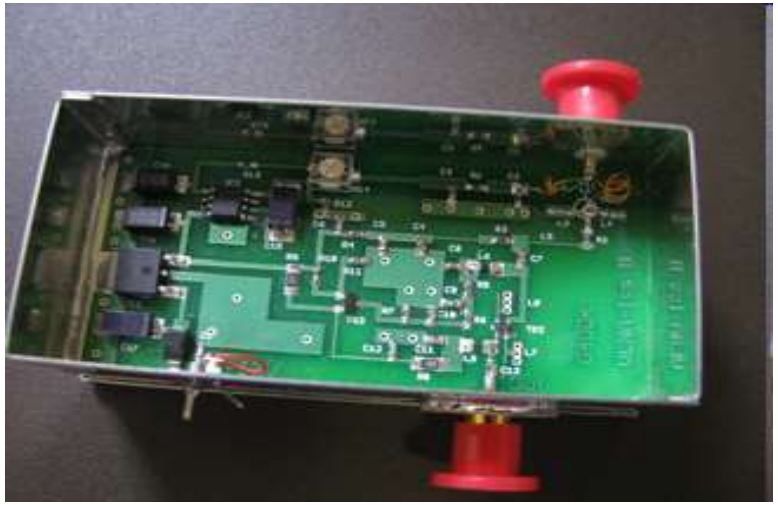


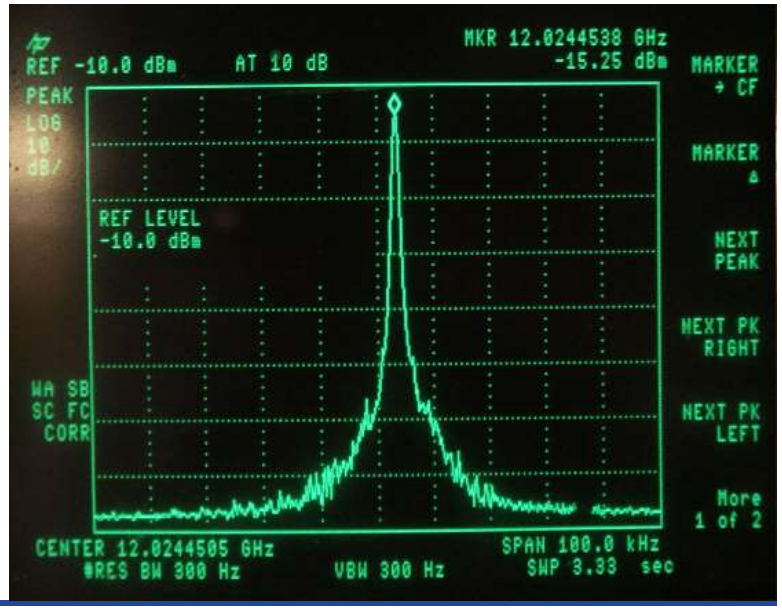
Moving up to 1.3GHz – System losses

- Where are losses crucial?
  - TX loss can be overcome with a bigger PA
- How do losses affect your RX?
  - Noise figure = S/N in – S/N out (in dB)
  - i.e. how much your system degrades the S/N
- Input S/N is determined by your antenna's environment so use low noise antennas
- Output S/N is determined by your system Noise figure

Moving up to 1.3GHz – Receiver performance

- System Noise figure





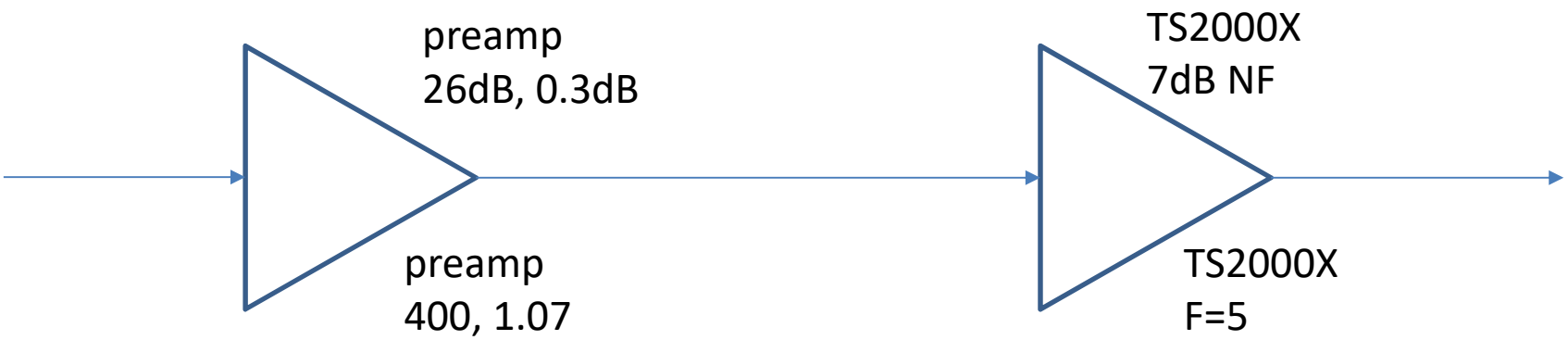
Moving up to 1.3GHz – System Noise factor

- 2 stages with gains G1, G2 and F1, F2 (not in dB)
- Noise figure (dB) = 10 log(noise factor)

- Overall gain =G1xG2
- Overall Noise factor = F1 + (F2-1)/G1 +… (Fn-1)/G1G2..Gn
- (Fris equation)
- Second stage contribution mainly determined by first stage gain

Moving up to 1.3GHz – System Noise factor

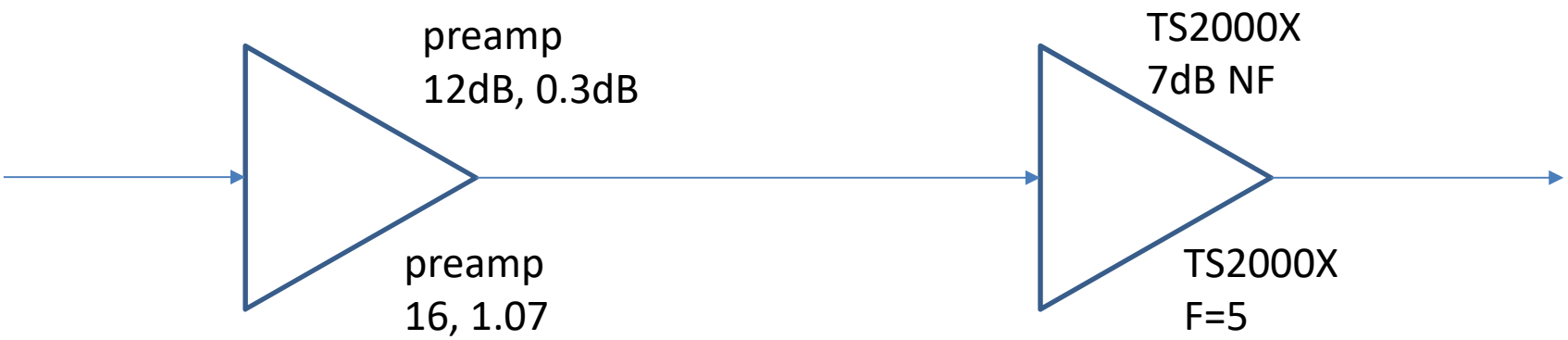
- Practical example - Preamp gain = 26dB



- Overall Noise factor F = 1.07 + (5-1)/400 = 1.08
- Overall Noise figure = 10logF = 0.33 dB
-
- 2nd stage adds just ***0.03dB*** to NF

Moving up to 1.3GHz – System Noise figure

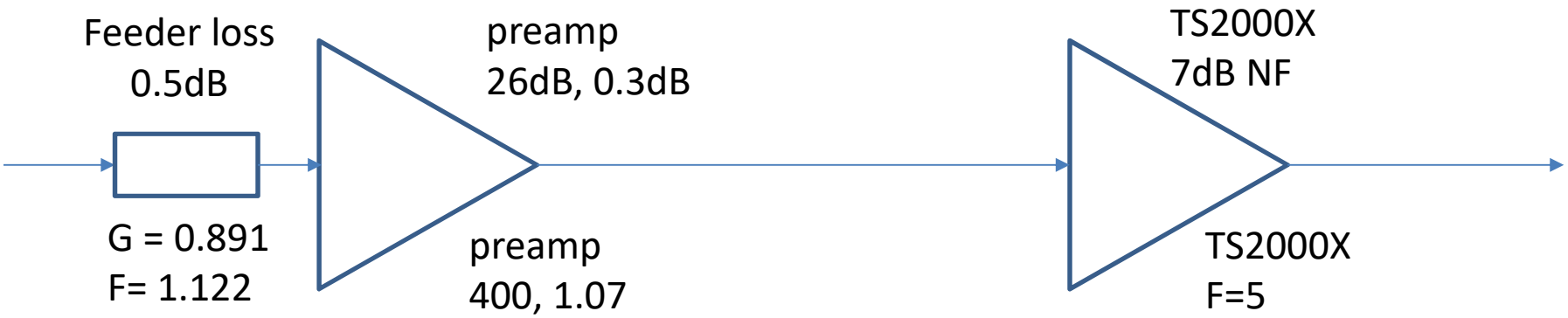
- Practical example - Preamp gain = 12dB



- Overall Noise factor = 1.07 + (5-1)/16 = 1.32
- Overall Noise figure = 1.2 dB
-
- Same 2nd stage now adds ***0.9dB*** to NF!

Moving up to 1.3GHz – System Noise figure

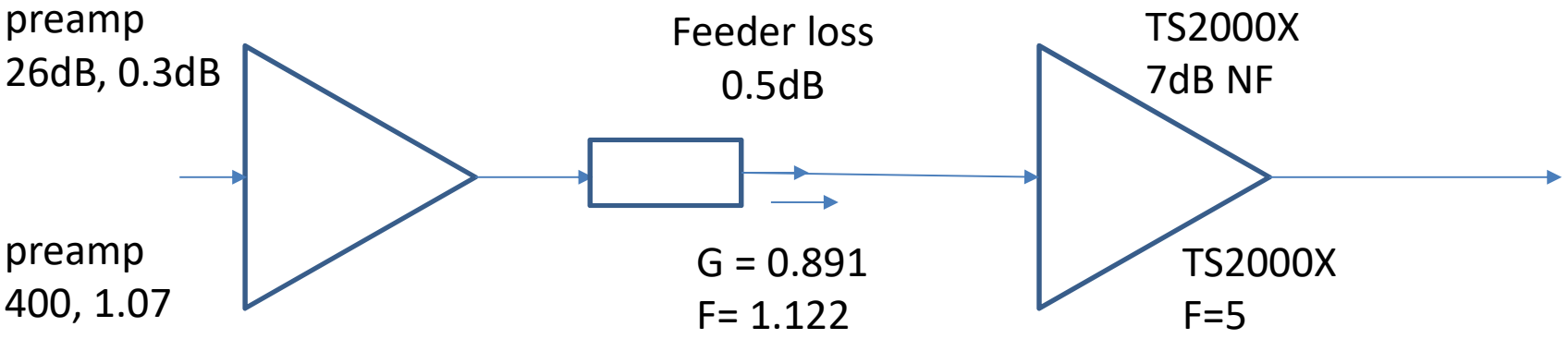
- Practical example – passive losses,
- NF(dB) = loss (dB)



- Overall Noise factor = 1.122 + (1.07-1)/0.891 + (5-1)0.891x400
- 1.122 + 0.0786 + 0.0112 = 1.212
- Overall Noise figure = ***0.83 dB***
-
- So the 0.5dB feeder loss adds directly to the system noise figure
-

Moving up to 1.3GHz – System Noise figure

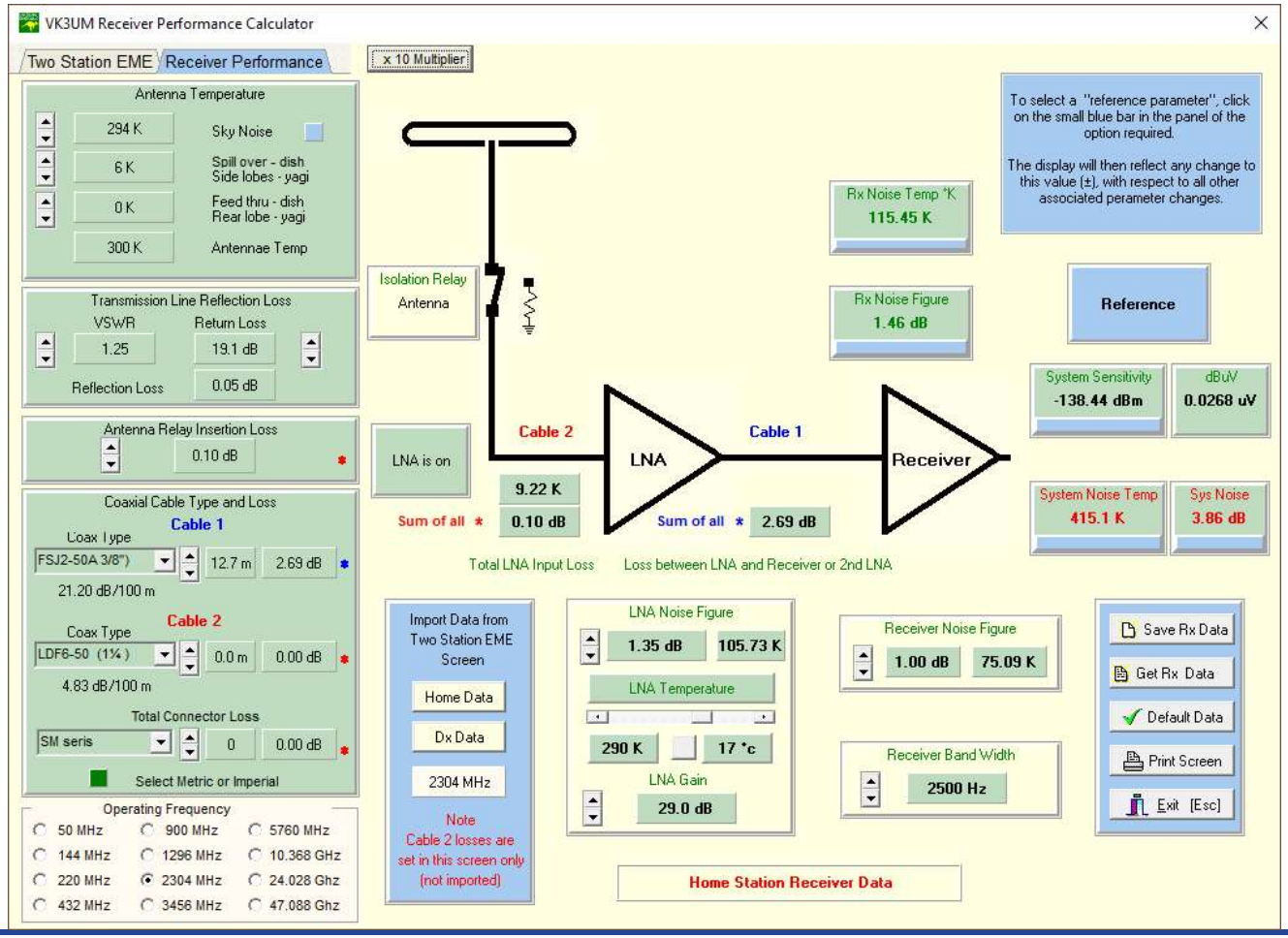
- Practical example – passive losses,
- Now with loss after preamp



- Overall Noise factor = 1.07 + (1.122-1)/400 + (5-1)0.891x400
- 1.07 + 0.00305 + 0.0112 = 1.071
- Overall Noise figure = ***0.3 dB***
-
- So the 0.5dB feeder loss after the preamp can be ignored
-

Moving up to 1.3GHz – System Noise figure

- So how important is noise figure really?
- Use VK3UM RX performance calculator www.vk3um.com



Moving up to 1.3GHz – System Noise figure

- Effect of Antenna noise (Sky temperature)

- RX Noise figure F=1.45 dB Cold sky 10K sensitivity = -142.4 dBm
- RX Noise figure F=0.45 dB Cold sky 10K sensitivity = -147.9 dBm

- 5.5dB improvement

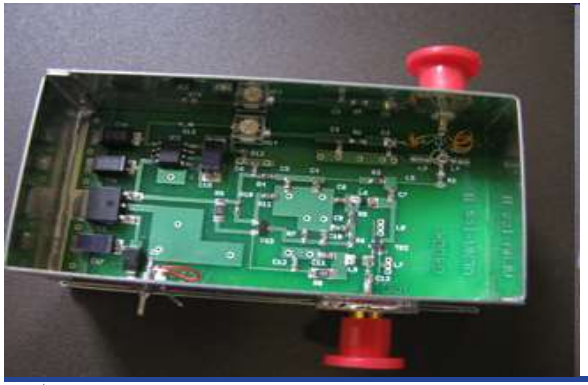
- RX Noise figure F=1.45 dB Horizon sky 294K sensitivity = -138.4 dBm
- RX Noise figure F=0.45 dB Horizon sky 294K sensitivity = -139.4 dBm

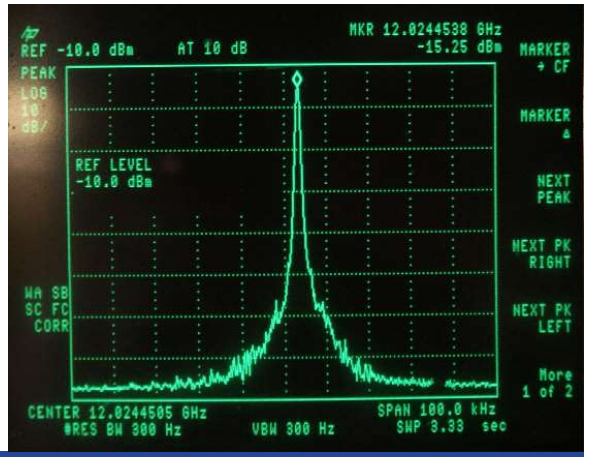
- Only 1dB improvement
- Noise figure less crucial on terrestrial systems
- Aim for 1dB NF overall

Moving up to 1.3GHz – Receiver performance

- System Noise figure - contributors
  - Minimise losses in front of the preamp
  - Filters must be low loss
  - Higher gain = lower 2nd stage contribution
  - Can use lossy RX feeders on 2 feeder systems

- Watch out for first and second stage overload
  - From out of band TV and cellular transmitters
  - Filters AFTER preamp if possible





Moving up to 1.3GHz – Transmitter power

- 1-10W – good for local working, Tropo DX in lifts
  - Simple, cheap, no external switching or specialist components required
- 50 - 100W – Aircraft /Tropo Scatter now possible
  - Range up to 500km. JT EME with 2m dish to big stations
- 100- 400W – Aircraft/Tropo Scatter now easy
  - Range up to 800km. CW EME with 2m dish or JT with 2 Yagis to big stations
  - Care needed! Relays, preamp protection, high power components

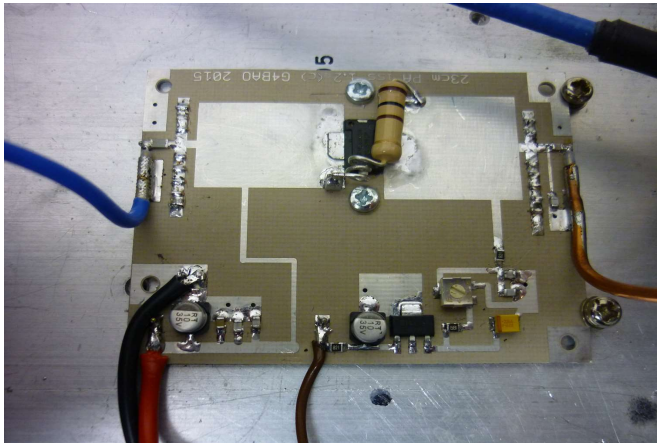


Photo G4BAO

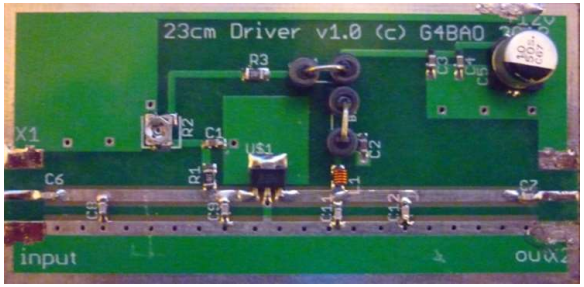


Photo SM4DHN Labetech AB

Moving up to 1.3GHz – Summing it all up

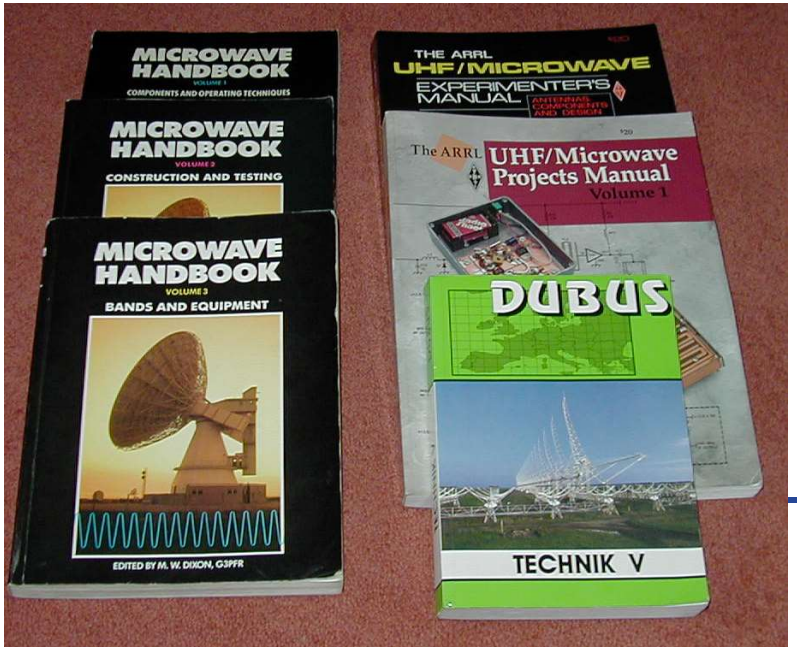
- Don't believe all the myths
- "23" is a great band for "covert" operation
  - small antennas
- "23" is a great band for a noisy VHF site
- Site is not everything
  - Good System Engineering can help an average site
- There is an option from a poor site – EME
- System Engineering is everything

Moving up to 1.3GHz – Summing it all up

- **System Engineering is everything**
  - Losses are important
  - Keep losses low between front end and antenna
  - Use a masthead preamp
  - Avoid overloading from in and out of band signals
  - Use a RX filter – After the preamp if you can
  - Consider a dual feeder system to simplify switching
  - Then easy to split off RX to multiple receivers / SDRs
  - Oh yes……. And use a band spectrum display/SDR

Find out more…

- Search the internet. There are hundreds of great amateur microwave websites
- Buy or borrow basic microwave books
- Visit a microwaver at home or out in a portable contest or activity day… you'll be made very welcome
- (dates shown on www.microwavers.org/operating/
- Follow @UKGHZ on Twitter
- Look at the UKuG Youtube channel at http://bit.ly/294OYnM



www.microwavers.org

UKuG

www.rsgb.org

RSGB 2016 Convention

UK Microwave Group

Nearly 450 members

- ONLY £6 a year membership
- "Chipbank"
  - Free surface mount components
- Scatterpoint – monthly e-magazine
- Member's Loan equipment
  - for 5.7, 10, 24 and 76GHz
- Beacon Hardware and other project funding available
- Support for clubs wanting to start on the GHz Bands
- For local committee contact, see UKuG web site www.microwavers.org

UK Microwave Group

UKuG currently supports 5 main Round Tables each year

- Martlesham (near Ipswich)
- Finningley (nr Doncaster)
- Harwell (near Didcot)
- Burntisland (near Edinburgh)
- Crawley (Sussex)