Millimetre Bands

Roger Ray G8CUB

Martlesham 2023

Millimetre Bands

47 76 122 134 241 GHz

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47GHz

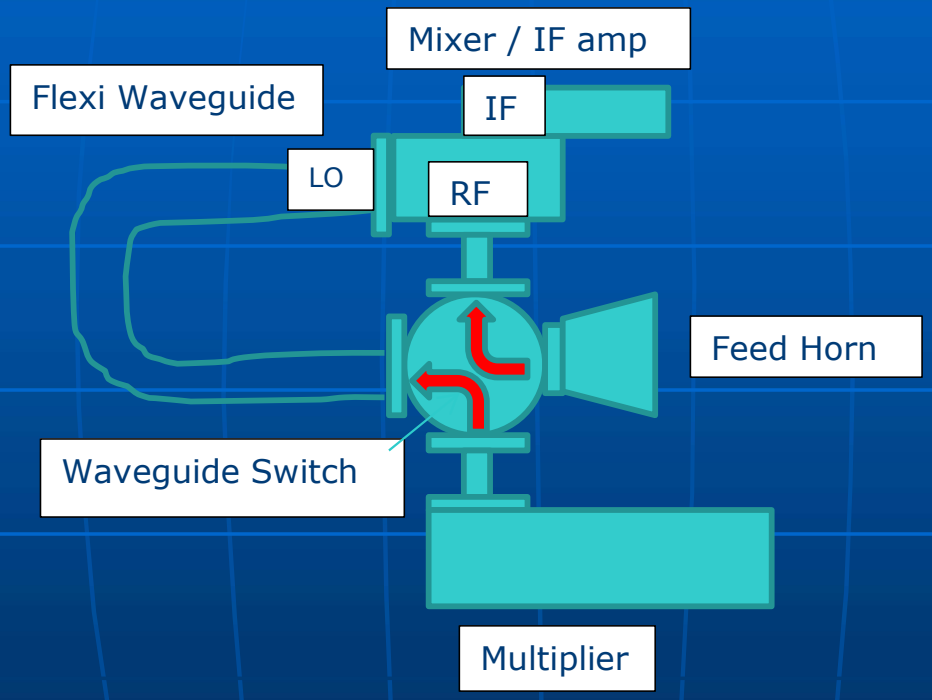
Equipment available

- Kuhne 47GHz transverter
- Home brew. WR-28 mixer LO Pasolink X4 Multiplier
- Sub-harmonic mixer 23.5GHz LO
- Pre-amp Kuhne, Iban EB3FRN
- PA ?

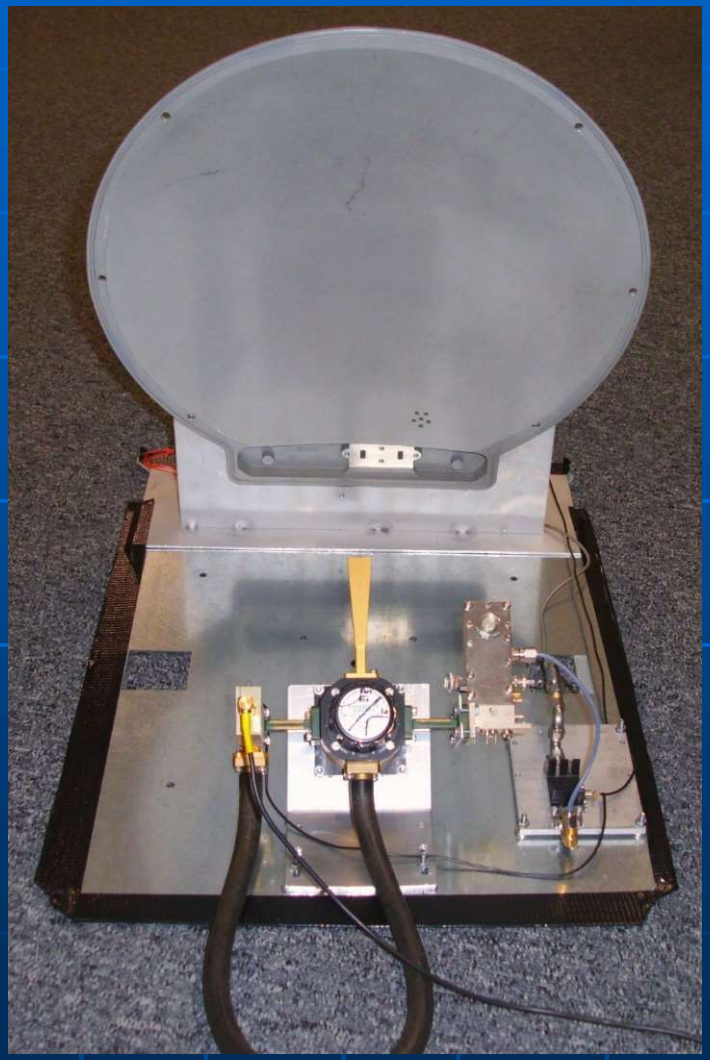
47GHz

Kuhne MKU 47 G2

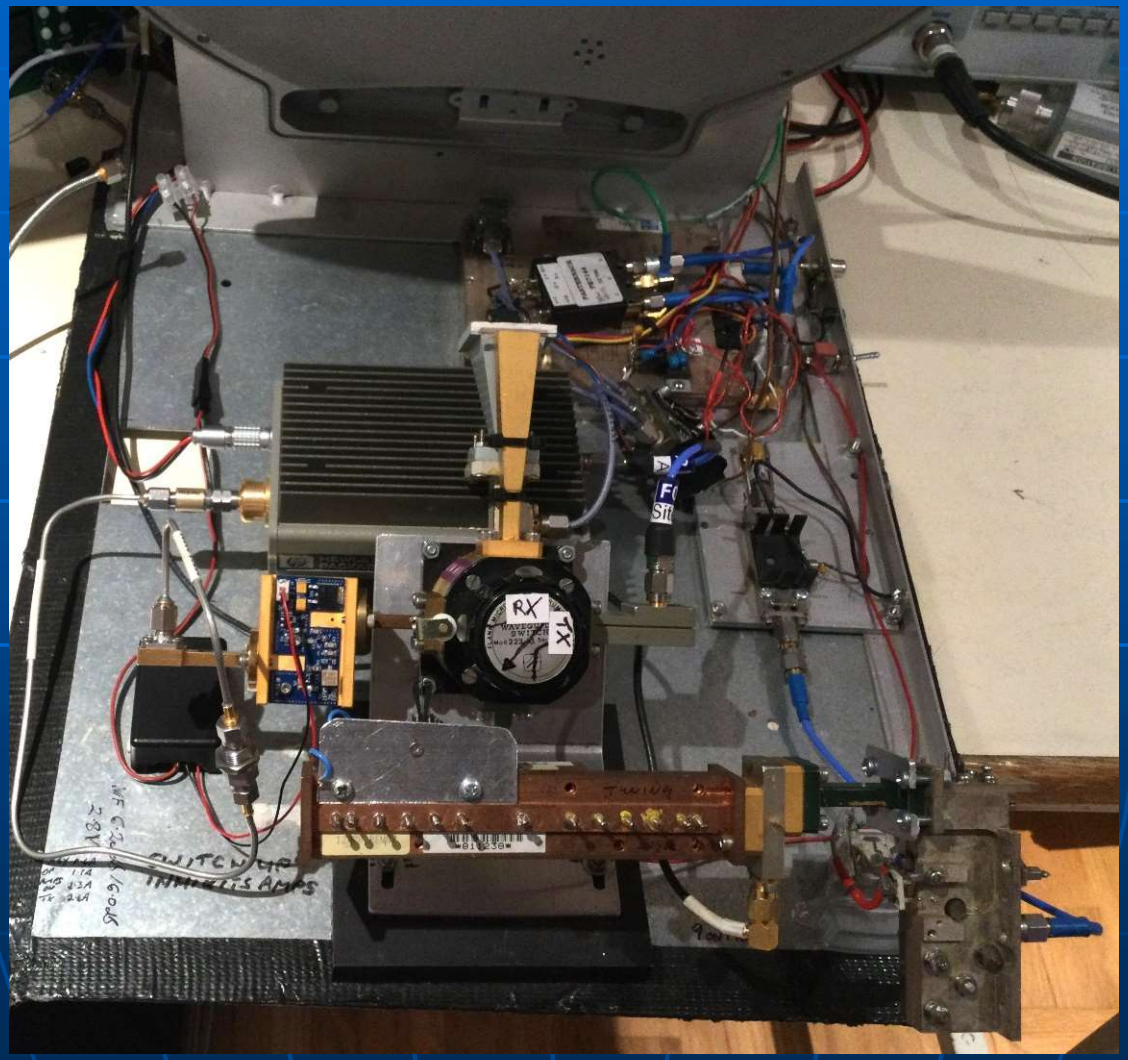
47GHz


Mixer / IF amp
Flexi Waveguide
IF
LO
RF
Feed Horn
Waveguide Switch
Multiplier

47GHz



47GHz



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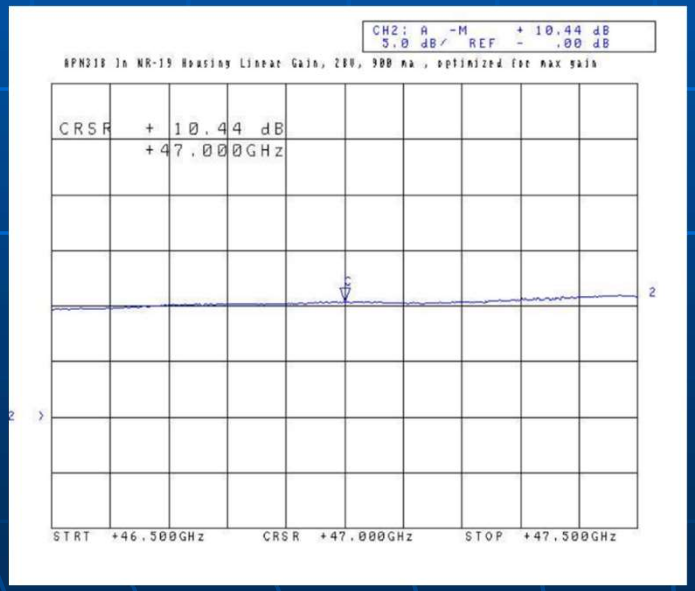
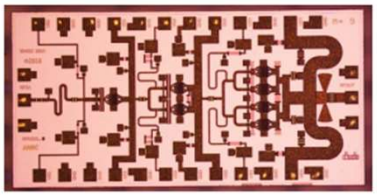
47GHz


24GHz
Standby
47GHz
YAESU
VFOa
CW
432.904.91
HOME
SEL
CLAR
LOCK
PWR
SQL/RF

47GHz PA

APN 319
5W Saturated
2-3W linear?
>45W dissipation!





X = 2.8mm Y = 1.4mm

Applications

- 5G Wireless
- Internet of Things (IoT)
- SatCom Terminals

Product Features

- RF frequency: 47.2 to 51.4 GHz
- Linear Gain: Greater than 16dB
- Psat: 5-6 Watt across the band
- Die Size: : 3.92 mm².
- 0.15um GaN HEMT Process
- 3 mil SiC substrate
- DC Power: 28 VDC @ 1.62 A

Product Description

The APN319 GaN HEMT Power/Driver amplifier is a three-stage Single-ended power device, designed for use in 5G wireless and SatCom Terminals. To ensure rugged and reliable operation, HEMT devices are fully passivated. Both bond pad and backside metallization are Au-based that is compatible with epoxy and eutectic die attach methods.

Performance Characteristics (Ta = 25°C)

Specification *	Min	Typ	Max	Unit
Frequency	47.2		51.4	GHz
Linear Gain	10	17	18.5	dB
Input Return Loss	-25	-13	-5	dB
Output Return Loss	-10	-7.5		dB
Psat (PP*)	25**		35.5	dBm
PAE @ Psat (PP*)		11		%
Max PAE (PP*)		11.5		%
Vd1=Vd1a=Vd2=Vd2a=Vd3=Vd3a	20	24	28	V
Vg1, Vg1a, Vg2, Vg2a, Vg3, Vg3a		-3.5		V
Id1+Id1a		100		mA
Id2+Id12a		200		mA
Id3+Id3a		480		mA

* Pulsed-Power On-Wafer unless otherwise noted
** PIN=13 dB instead of 24 dB

Export Information
ECCN: **5A991.g**
HTS (Schedule B) code: **8542.33.0000**

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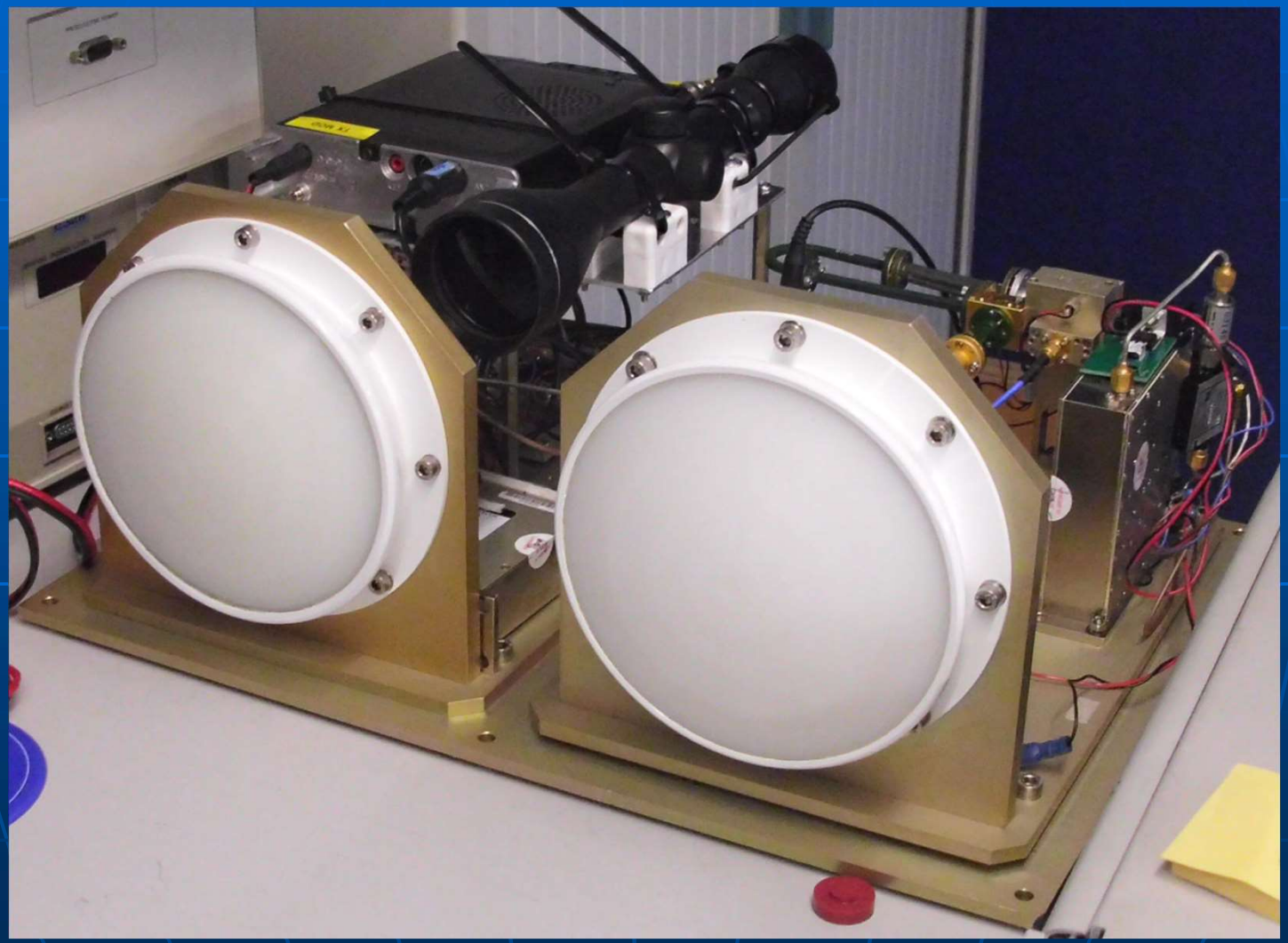
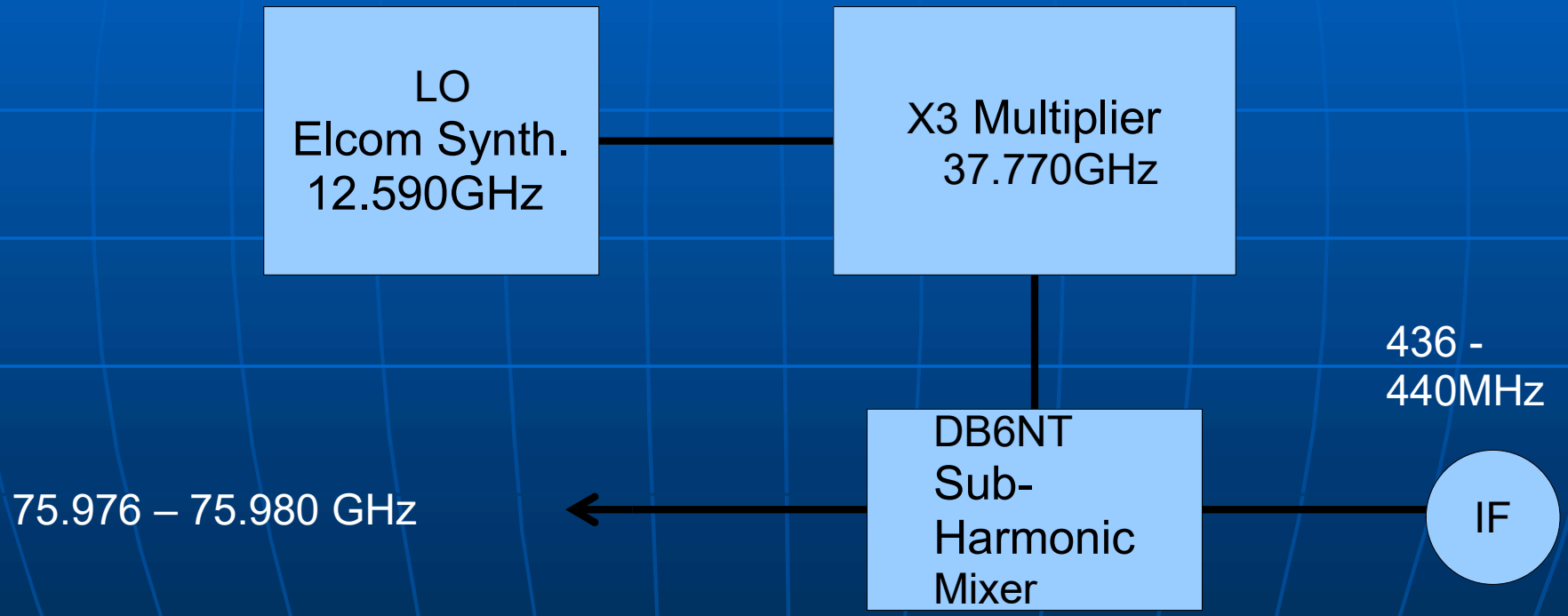
76GHz



76GHz

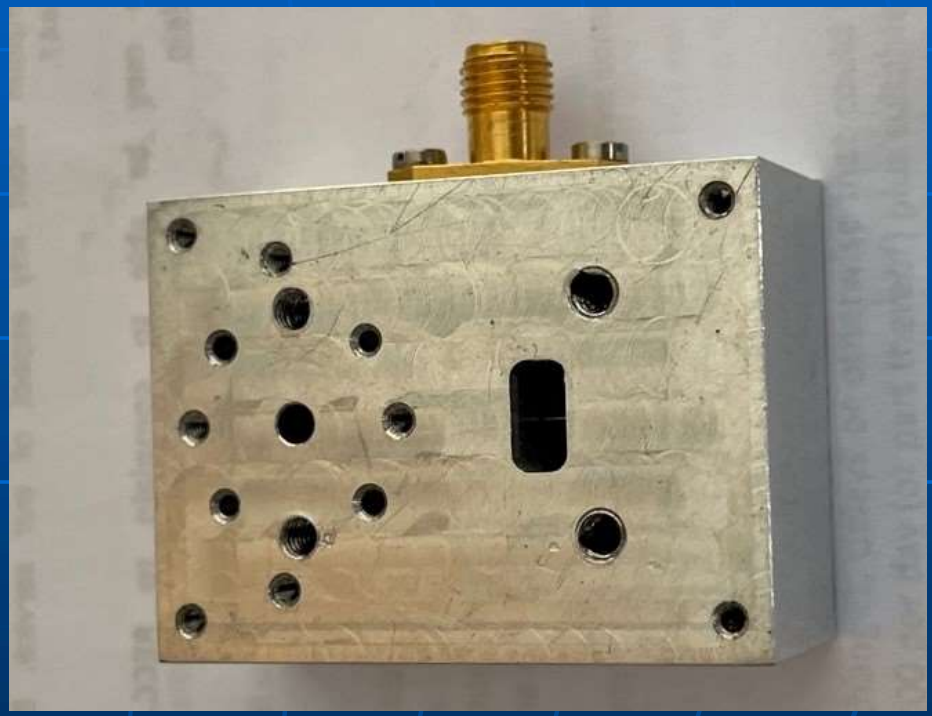
- **76GHz Transverter**



76GHz

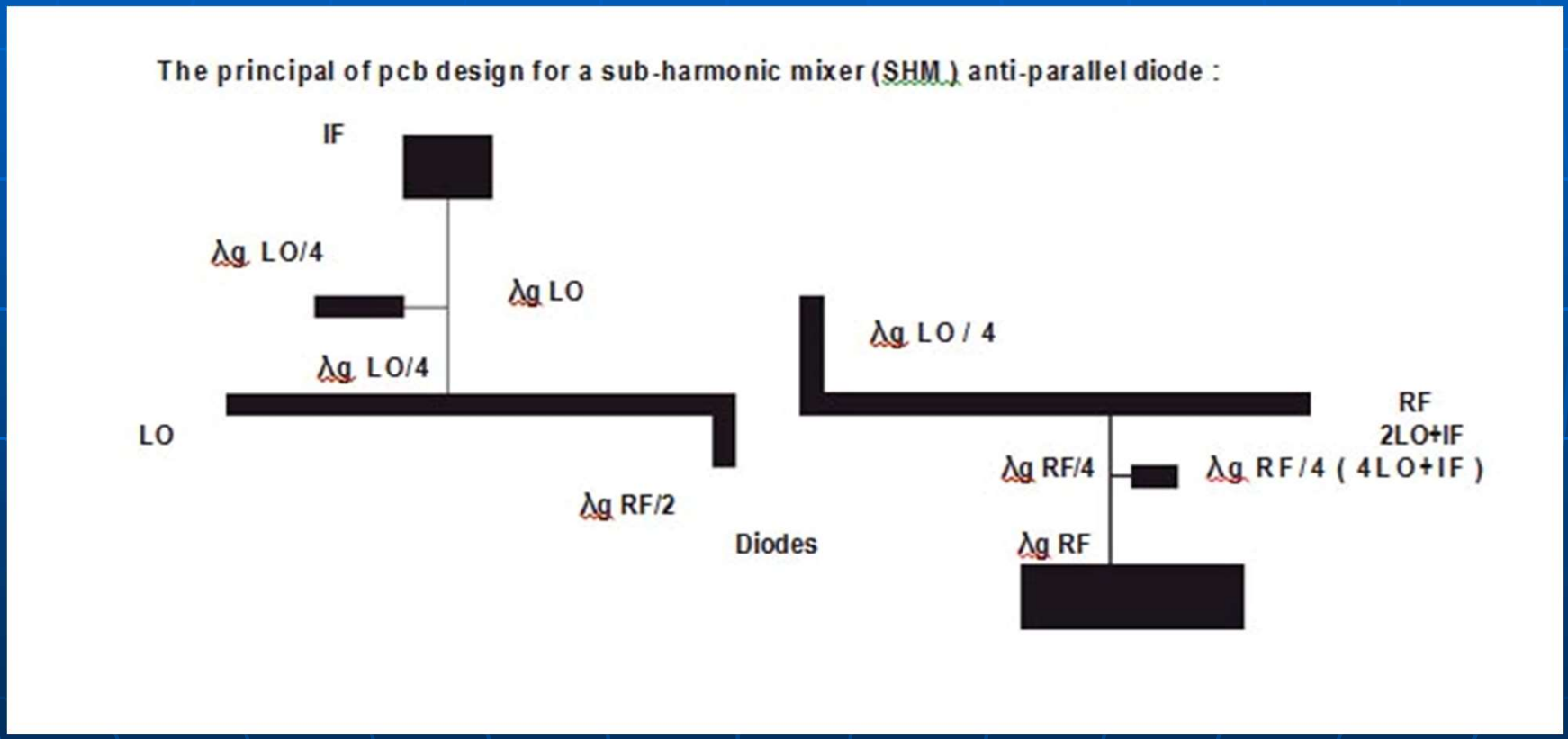

+12V GND +9V
CTR-960459 REV -
19435-101 80719


CMA 382400AUP
P/N 19435-102
RF OUT
REV:#D# 02
RF IN
S/N: 64798
D/C: 0102



76GHz

Sub-harmonic Mixer Diode MA4E1318 Anti-parallel diode



Drive 38GHz +13 to +21dBm 76GHz hole 2.7mm dia.

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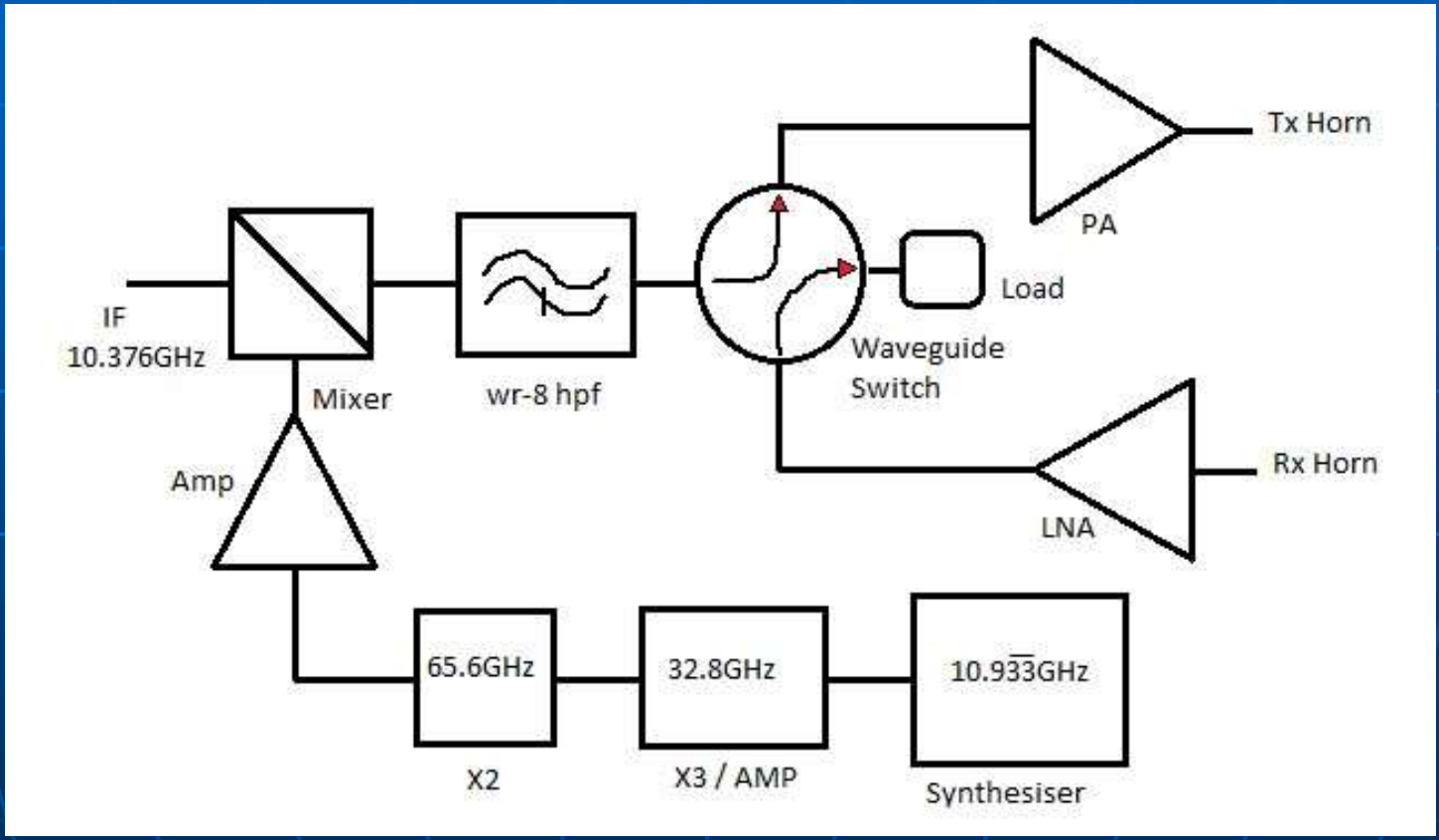
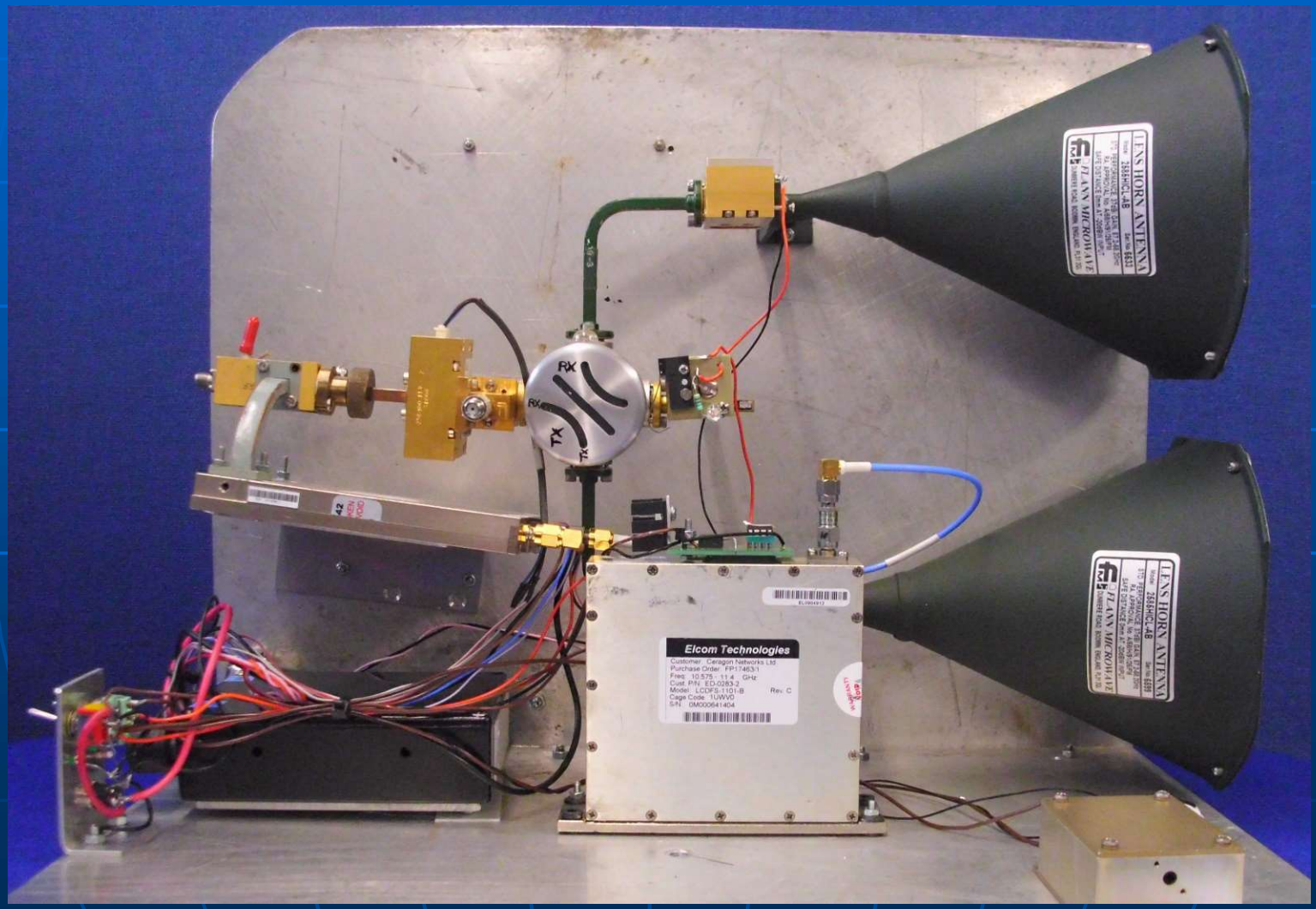
76GHz


Tx Horn
PA
IF
10.376GHz
Mixer
wr-8 hpf
Load
Waveguide
Switch
Amp
Rx Horn
LNA
65.6GHz
32.8GHz
10.933GHz
X2
X3 / AMP
Synthesiser

76GHz



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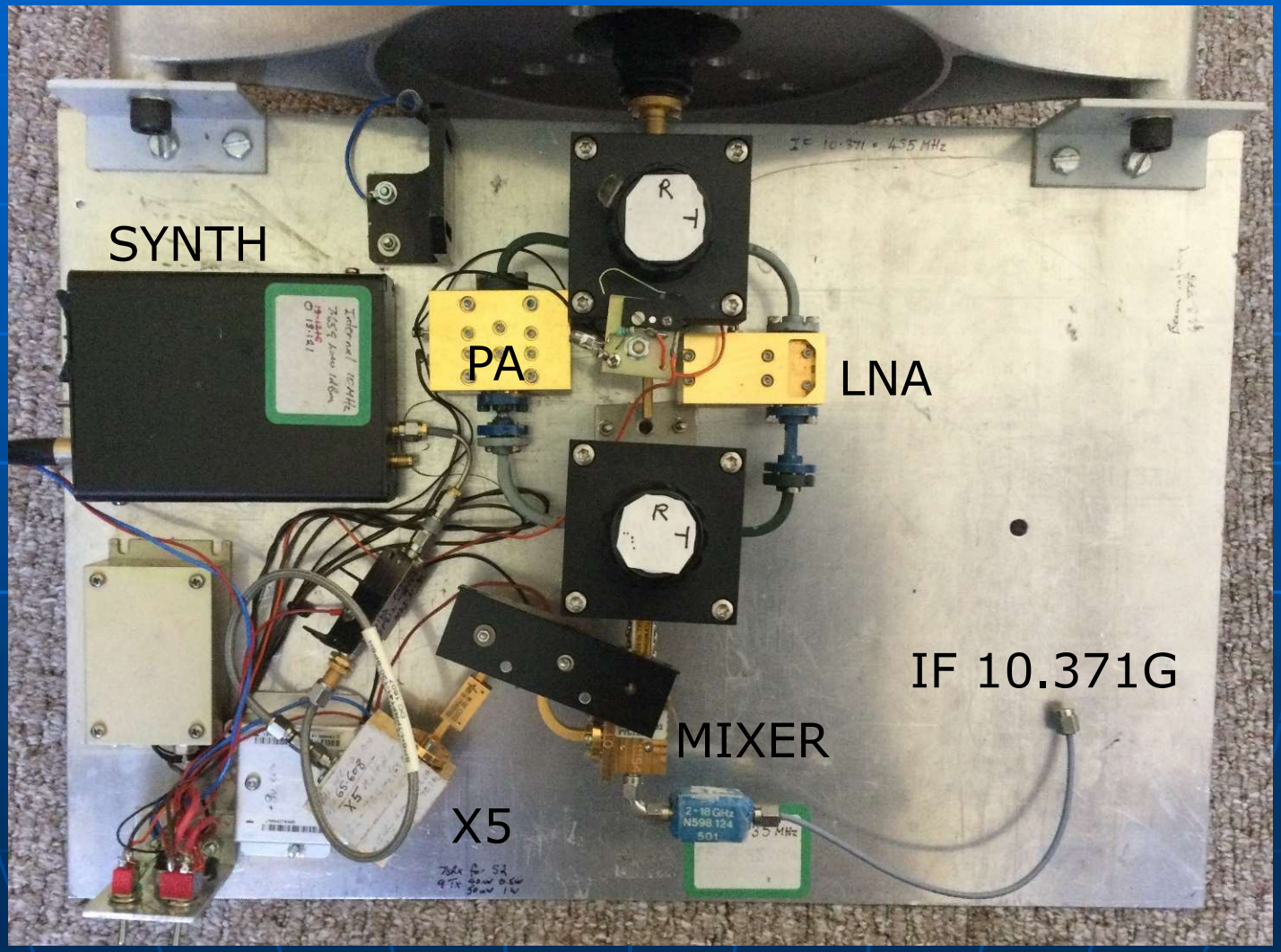
76GHz



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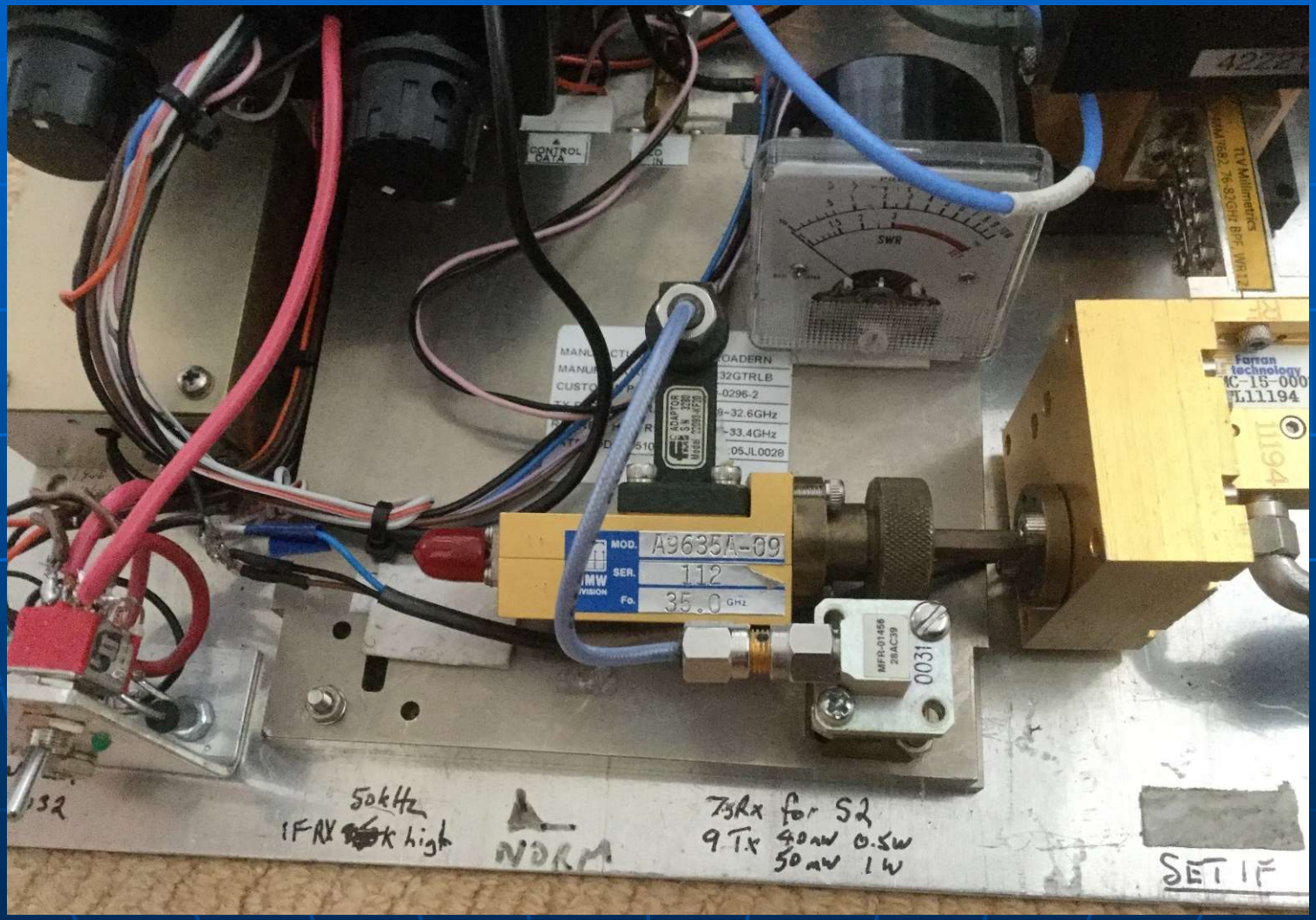
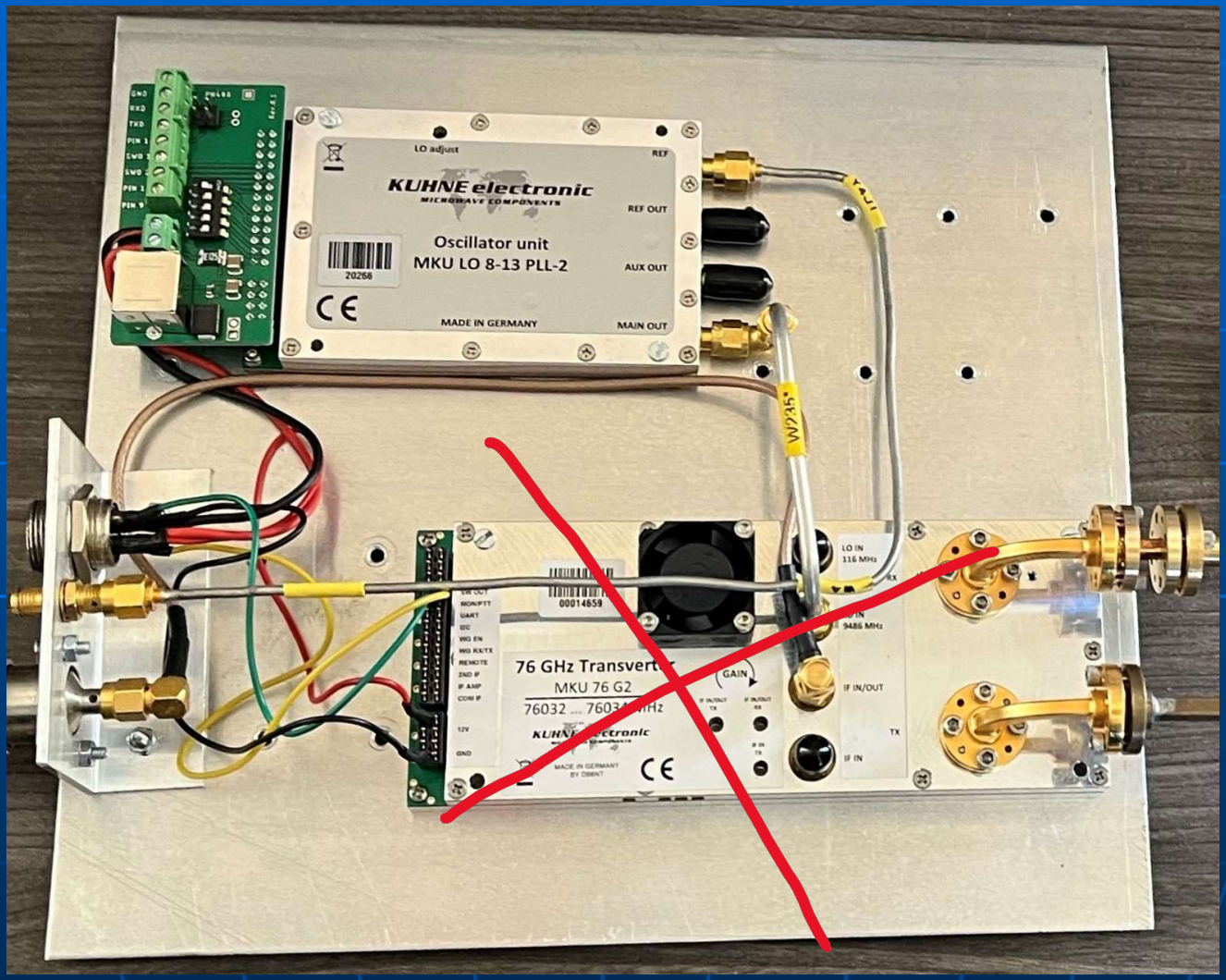
76GHz


MOD. A9635A-09
SER. 112
Fo. 35.0 GHz
50kHz
IFRX
high
NORM
79Rx for S2
9Tx 40mW 0.5W
50mW 1W
SET IF

76GHz



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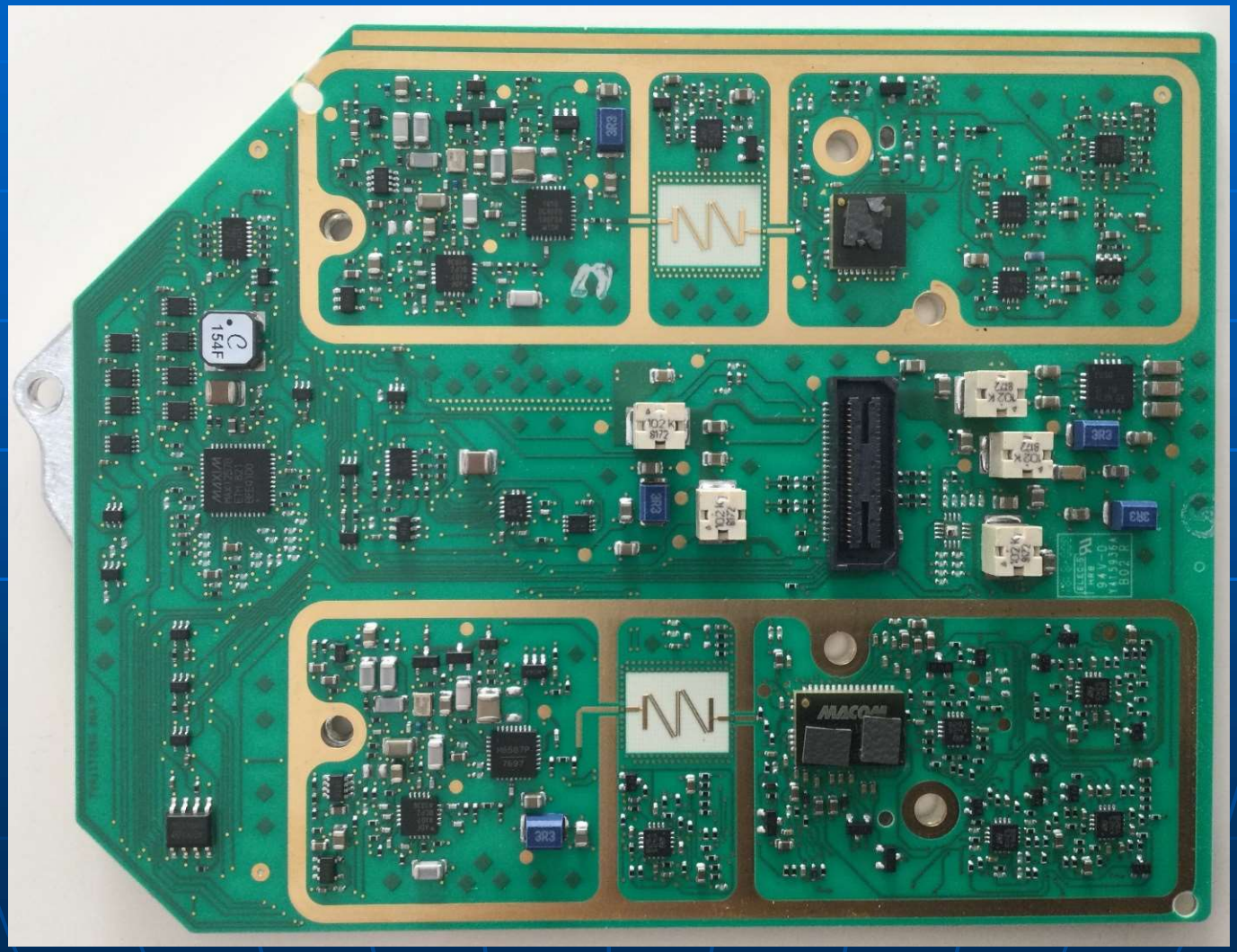
76GHz



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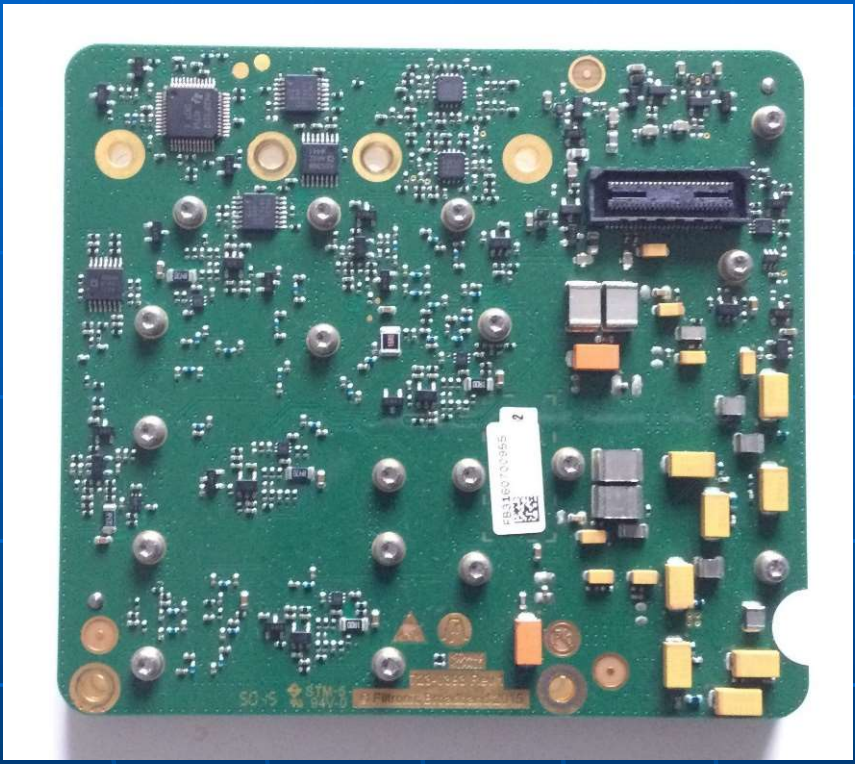
76GHz



Filtronic Orpheus e-band
150mW

Martlesham 2023

76GHz

Orpheus
TA406 & TA407 E Band Transceivers

Filtronic

Features

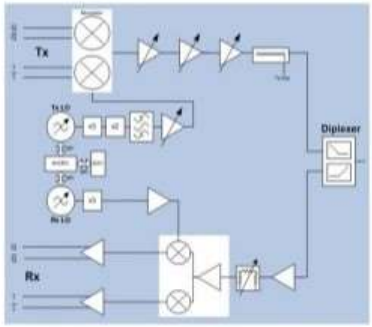
- Fully integrated 71/81 to 76/86 GHz modules
- High Tx output power
- 2GHz baseband bandwidth
- Low phase noise –112dBc/Hz at 1MHz
- Supports 256QAM modulation
- Integrated Diplexer
- Single T/R port for antenna interface
- Single connector modem interface
- 100% tested- ODU ready
- Small Form Factor
- Highly linear Rx

Description

Orpheus E-Band transceiver modules provide a turn-key solution for carrier grade mobile backhaul applications. Each module contains all the transmit and receive functions necessary for the RF section of an E Band link and provides a simple connection to a high data rate full duplex modem. The integrated diplexer connects directly to an antenna of choice via a standard WR12 interface. Internal, low phase noise VCOs are settable via an SPI interface in 31.25MHz steps to support ECC/ITU channel arrangements

- Proven system performance — 10 Gbps demonstrated with spectral efficient 256QAM modulation.
- Field proven technology — tens of thousands of Filtronic millimetre wave transceivers deployed worldwide.

Orpheus modules are designed for easy incorporation into ODUs for rapid time to market with minimal customer engineering resource.



Orpheus transceiver block diagram

Filtronic
NETPark, Thomas Wright Way, Sedgefield, Co Durham, TS21 3FD
Tel. +44 (0) 1740 625165
email: sales@filtronic.com

Orpheus
TA406 & TA407 E Band Transceivers

Filtronic

Outline Specification

Over Baseplate operating temperature –33 to +75C
All RF parameters referenced to antenna port (inclusive of diplexer loss)

Parameter	Note	Min	Typ	Max	Units
Tx Frequency	TA 406 TA 407	71 81		76 86	GHz
Baseband Bandwidth				2.0	GHz
Tx Baseband input power		-17		-7.5	dBm
Tx Power control range		20			dB
P_{sat}			22		dBm
Tx ALC accuracy		-2		2	dB
Output IP3 @ 16dBm		23	29		dBm
I/Q Gain imbalance	Tx and Rx	-3		+3	dB
I/Q Phase imbalance	Tx and Rx	-10		+10	degrees
I/Q impedance - differential	Tx and Rx		100		Ohms
Tx LO Cancellation			-30	-5	dBc
Tx Sideband suppression			-40	-20	dBc
Rx Frequency	TA 406 TA 407	81 71		86 76	GHz
Rx Noise Figure	High gain mode		7	10	dB
Rx Gain High mode		22	25	28	dB
Rx Gain Low mode		14.5	17.5	20.5	dB
Rx Gain accuracy reported over SPI		-1.5		+1.5	dB
RF input power				-23	dBm
Input IP3	Low Gain mode	-10	-7		dBm
Phase Noise	100kHz 1MHz			-89 -112	dBc/Hz
LO frequency step	Tx and Rx	31.25			MHz

Power Supplies

Voltage (V)	Max Current (mA)	Tolerance (±)	Abs' max voltage (V)
5.1	2850	2%	5.5
3.3	150	2%	3.6
2.8	800	2%	3.0
18	25	2%	20
-5	50	2%	-5.5

Filtronic
NETPark, Thomas Wright Way, Sedgefield, Co Durham, TS21 3FD
Tel. +44 (0) 1740 625165
email: sales@filtronic.com
Information herein subject to change without notice or obligation

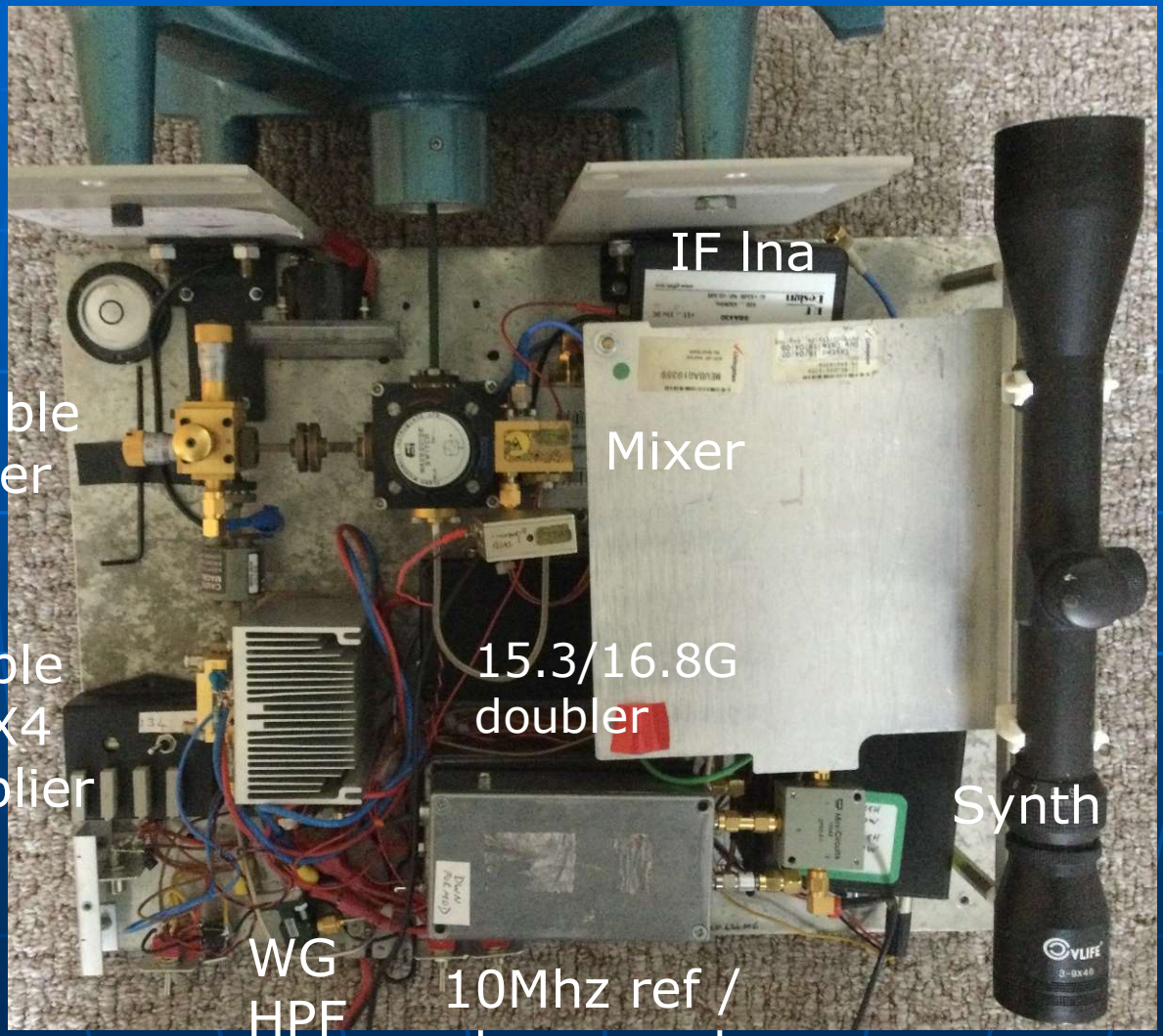
122GHz

- VK 122GHz System
- Home brew
- X3 from multiplier
- X2 sub-harmonic mixer
- Fundamental mixer wr-10?
- Separate TX 5mW+
- New VK 122 / 134 System

122GHz

- VK Revolutionised Operation!
- Best receive option
- Combine with High Power TX?
- Allows much experimentation with antennas
- New VK 122 / 134 boards see later

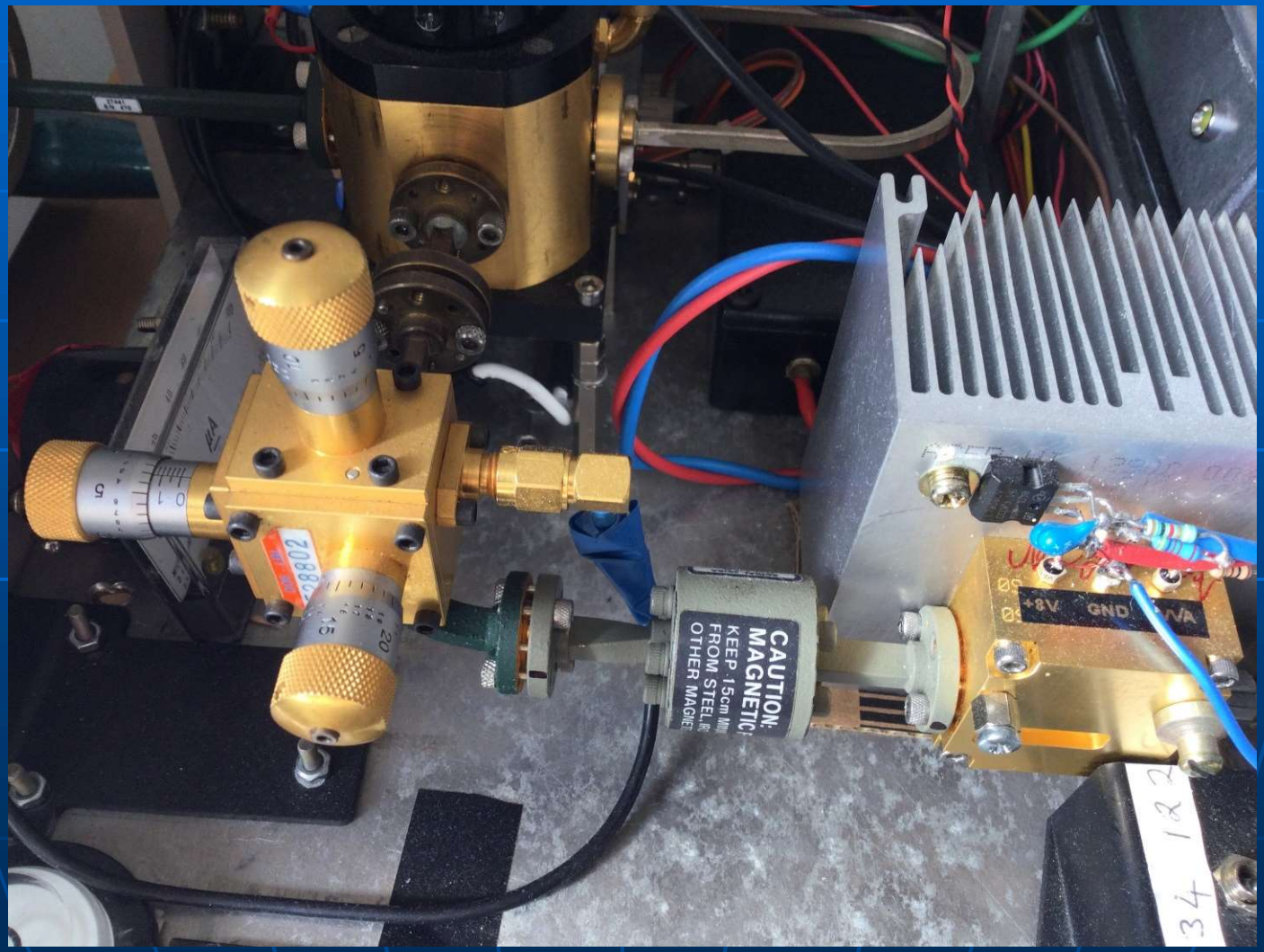
122/134GHz



tuneable
doubler

Variable
gain X4
Multiplier

122/134GHz



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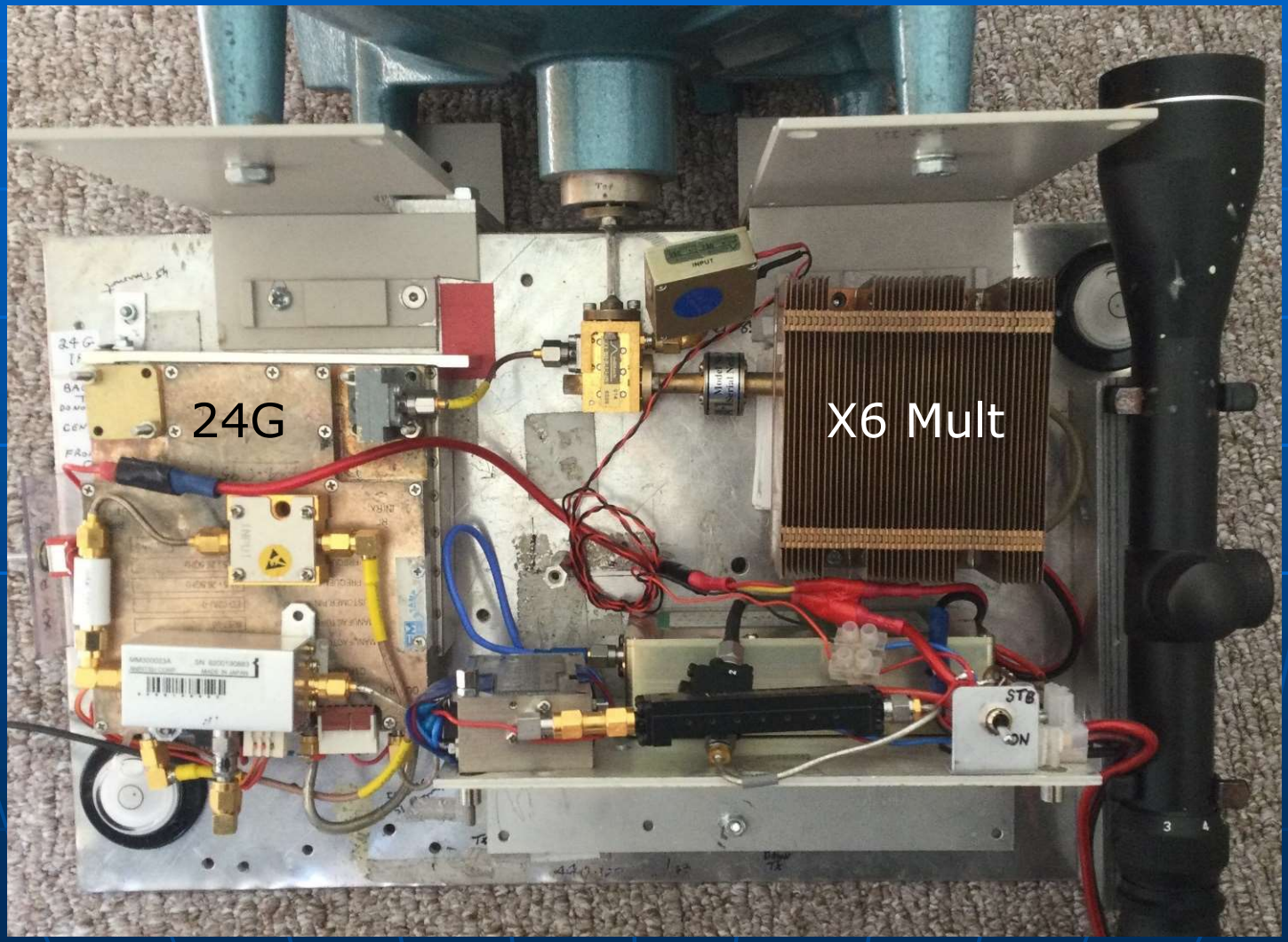
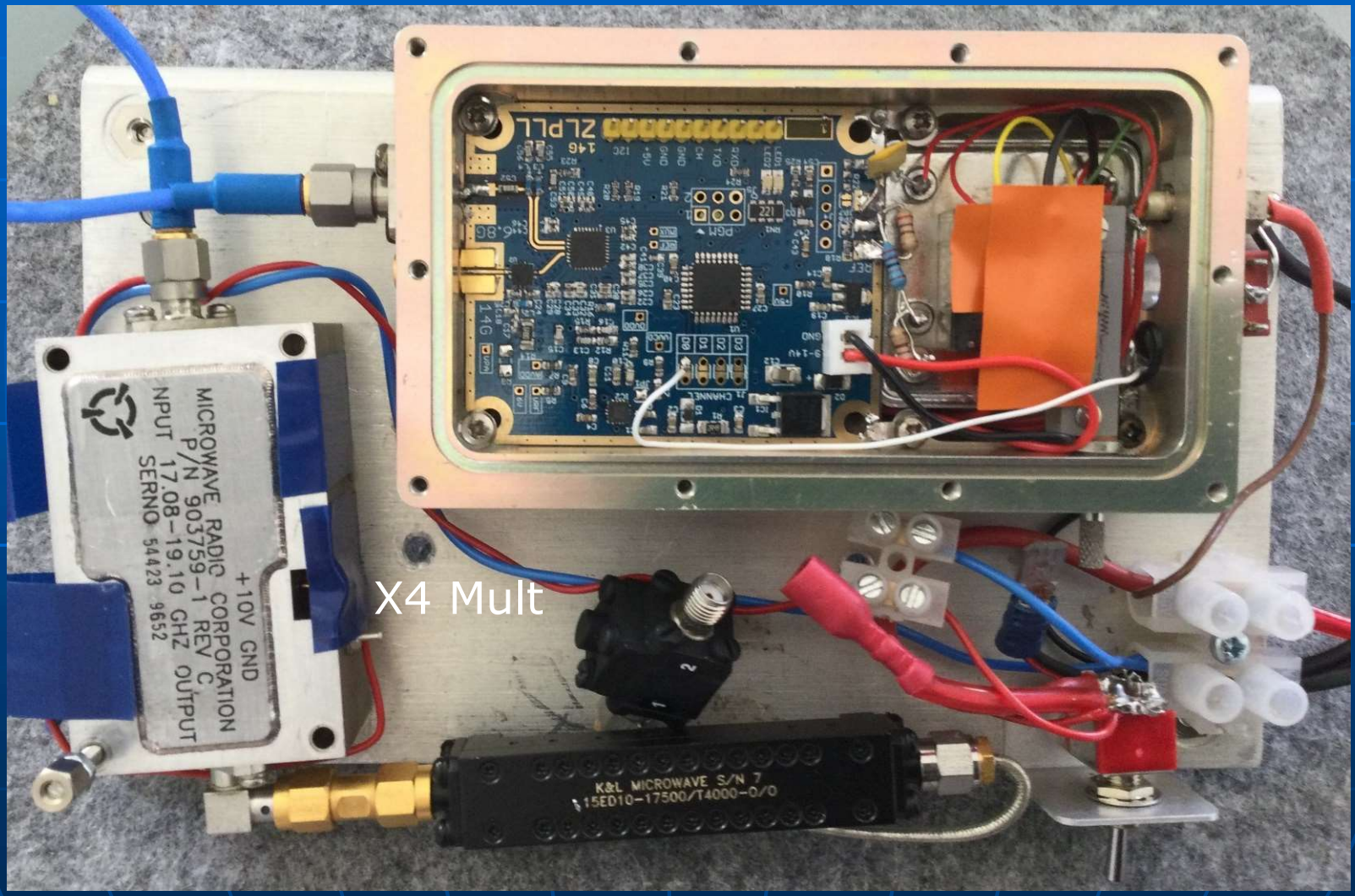
122/134GHz



122/134GHz

ADF5355 - 100MHz Ref



X4 Mult

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134GHz

- Dubus designs
- Boards (source was Kuhne)
- Housing / diodes DL2AM
- X4 Broadern modules
- ‘sub-harmonic’ mixer
- Fundamental mixer
- TX CW / FM / Opera

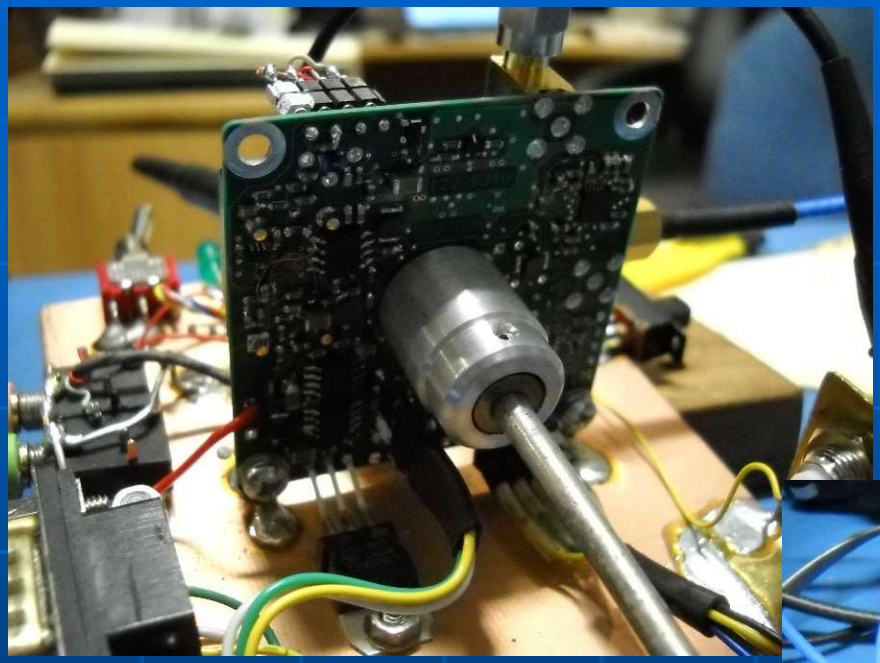
134GHz

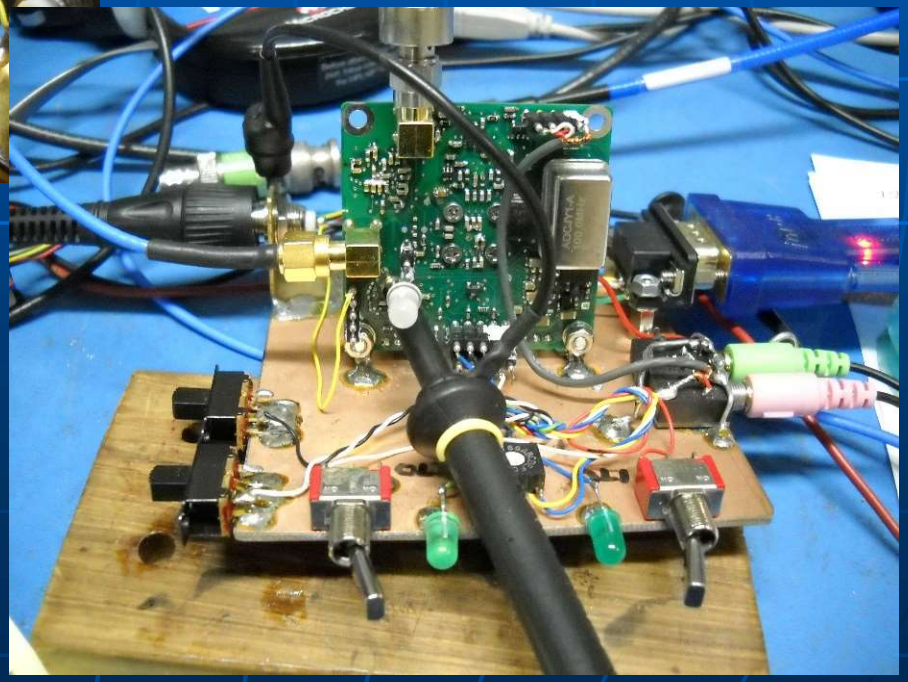
- VK System, Next Game Changer?
- Longer paths than 122
- Alignment for 122
- Separate TX 5mW possible?

New VK 122/134GHz

- Operation on both 122G and 134G bands
- Cleaner L.O. (Better Phase noise)
- Smaller L.O. Tuning steps due to use of upgraded PLL chip ADF
- Frequency disciplining using either 1pps or 10MHz input
- User serial re-programming of all channel frequencies
- Built in auto switching I/Q quadrature combiner for improved RX performance
- Same PCB mechanical footprint as older 122G only boards
- High quality 100MHz oven reference oscillator on board

122/134G VK





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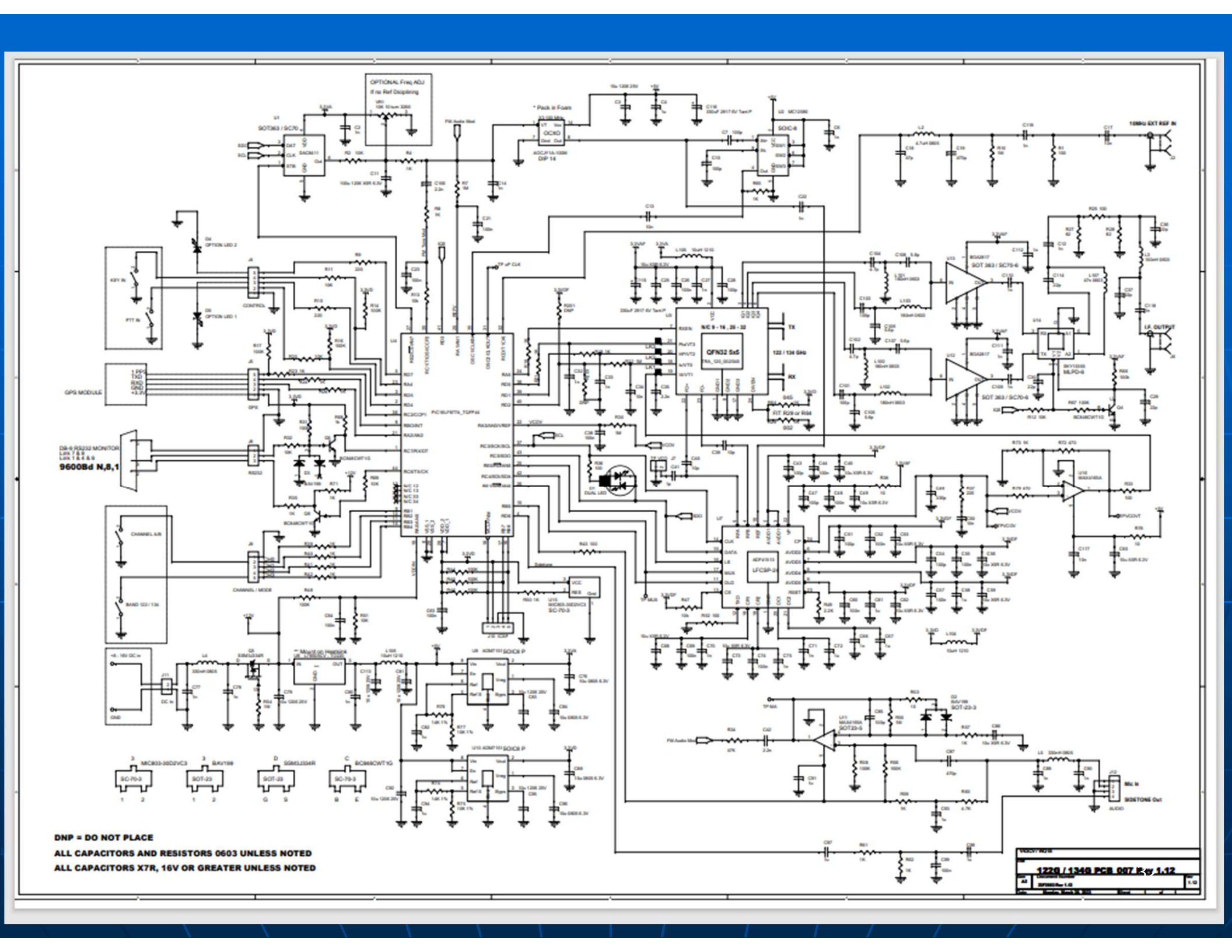
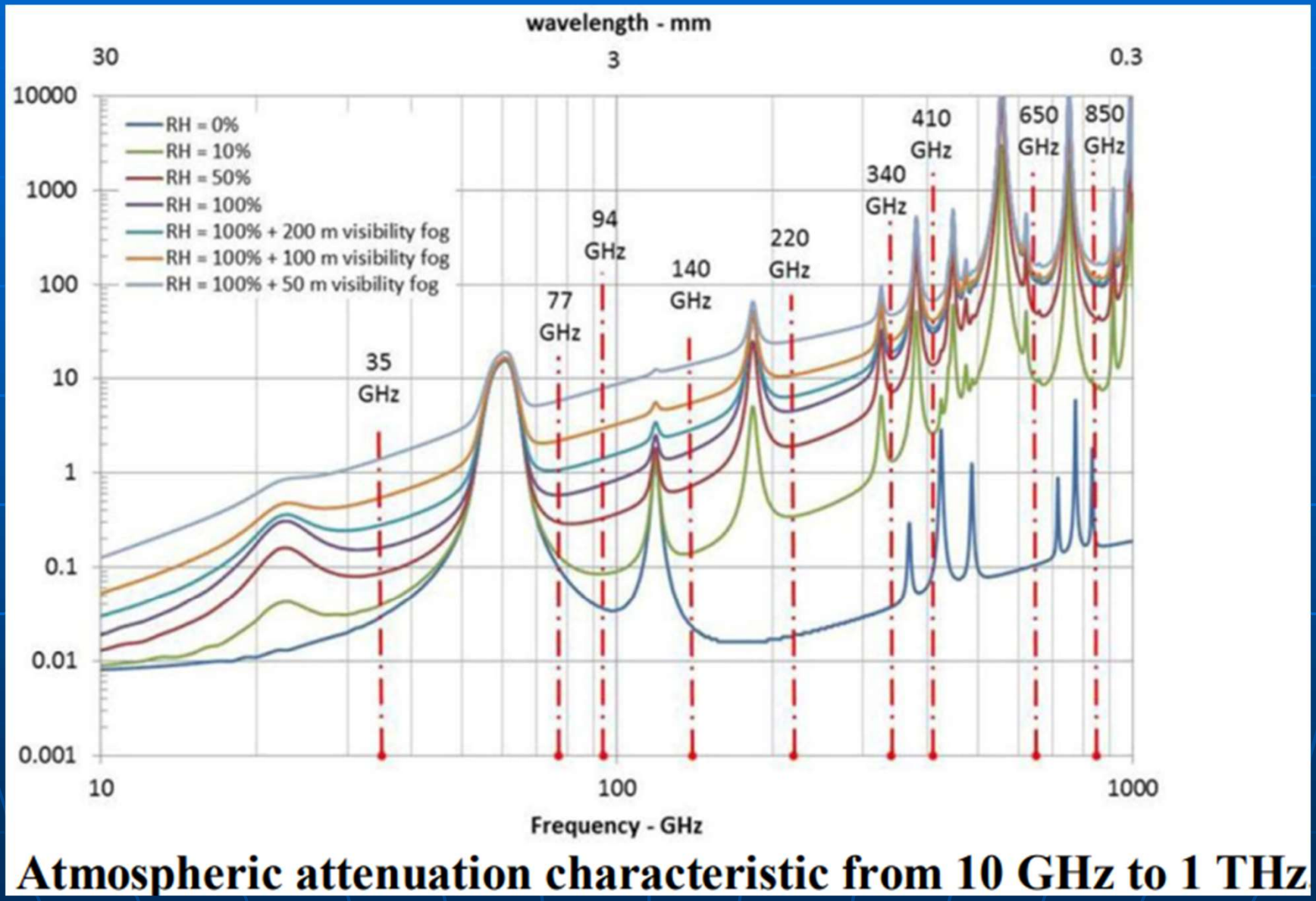
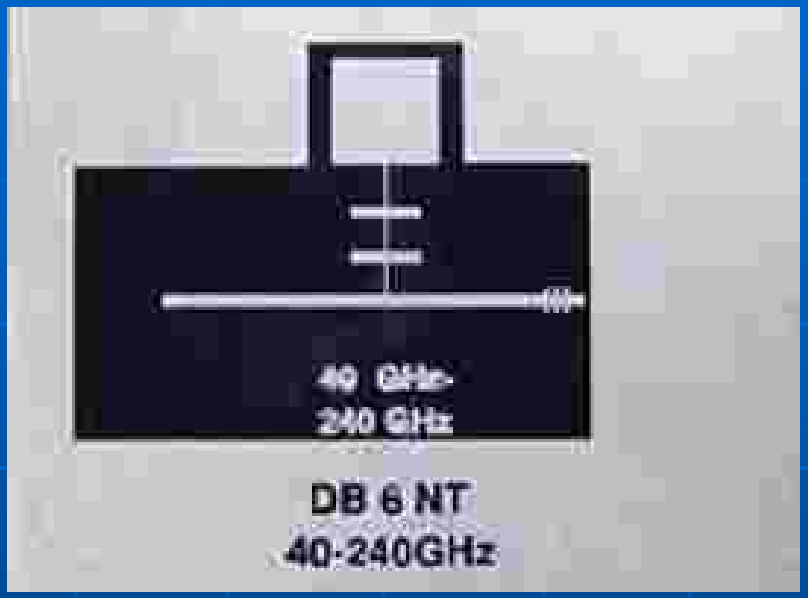

OPTIONAL Freq ADJ
If no Ref Disciplining
* Pack in Foam
OCXO
DIP 14
QFN32 5x5
TX
122 / 134 GHz
RX
PIC16LF1574_TQFP44
ADF4153
LFCSP-24
SOT 363 / SC70-6
SOT-23-3
SOT-23-5
SC-70-3
SOIC8 P
GPS MODULE
DB-9 RS232 MONITOR
Link 7 & 8
Link 1 & 4 & 6
9600Bd N,8,1
CHANNEL A/B
BAND 122 / 134
CHANNEL / MODE
KEY IN
PTT IN
CONTROL
OPTION LED 2
OPTION LED 1
DUAL LED
1.0Hz EXT REF IN
I.F. OUTPUT
Mic In
SIDETONE Out
AUDIO
DNP = DO NOT PLACE
ALL CAPACITORS AND RESISTORS 0603 UNLESS NOTED
ALL CAPACITORS X7R, 16V OR GREATER UNLESS NOTED
1229 / 1349 PCB 007 Rev 1.12



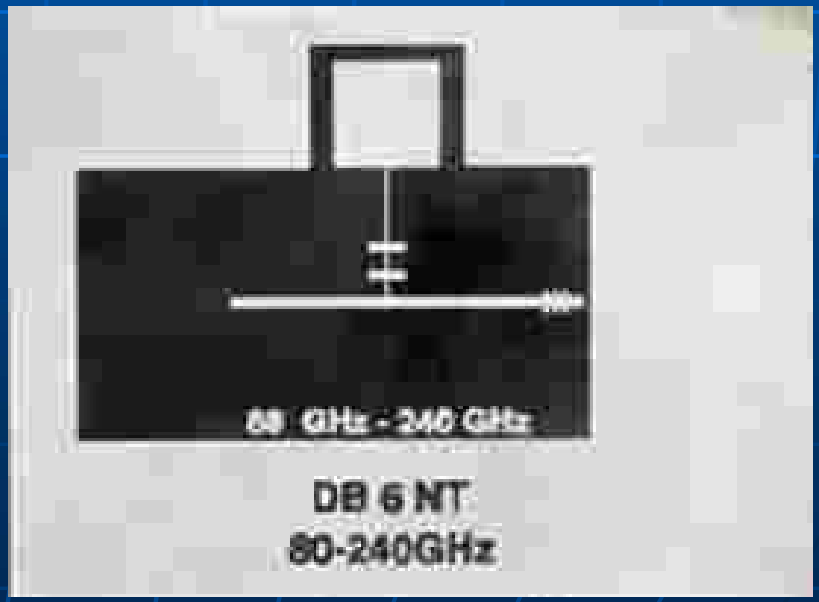
Atmospheric attenuation characteristic from 10 GHz to 1 THz

241 GHz equipment choices



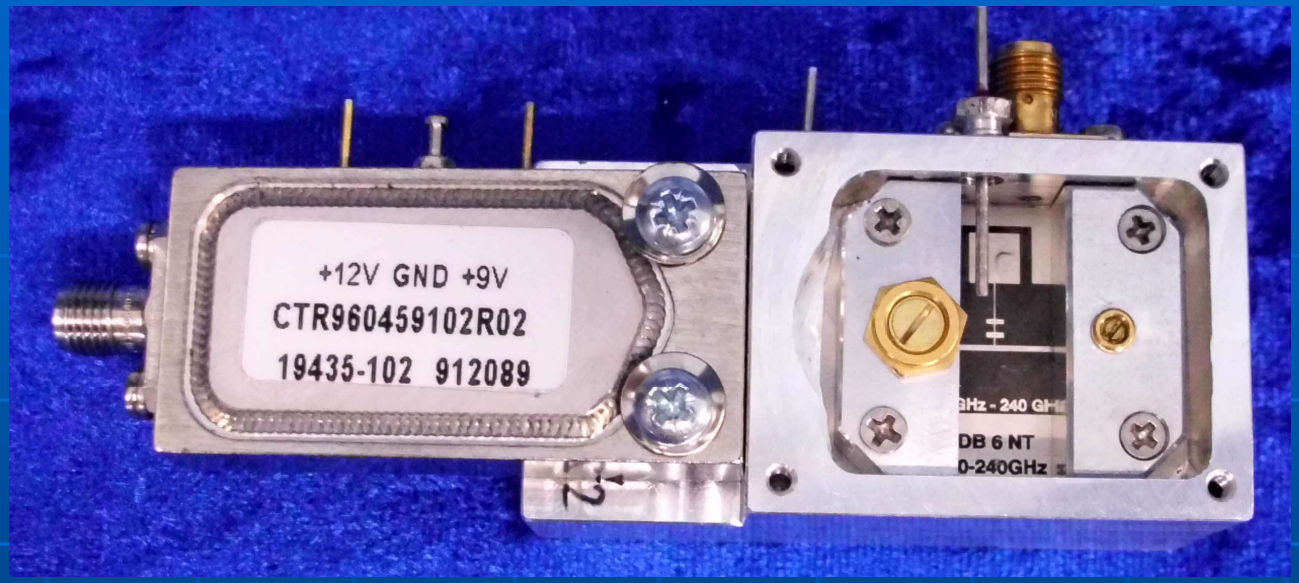
WR28 IP
1mm WG OP
DUBUS 1.2009
241 GHz Transverter
DL2AM

3mm WG IP
1mm WG OP
DUBUS 1.2009
241 GHz Transverter
DL2AM



Aluminium block available from DL2AM for these boards

241 GHz receive mixer



This mixer is based on the DL2AM design and uses an aluminium block with a 1mm waveguide hole. It is designed to accommodate a CMA382400AUP module for 40 GHz.

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Operating Frequencies

- 47GHz 47,088.200
- 76GHz 75,976.200 (76,032.200)
- 122GHz 122,400 (122.256)
- 134GHz 134,400
- 241GHz 241,020
- >275GHz 288,000

Waveguide as HPF

- Fco (GHZ) = 150/a

Where a = longest dimension in mm

- Fco (GHZ) = 176/d

Where d = diameter in mm

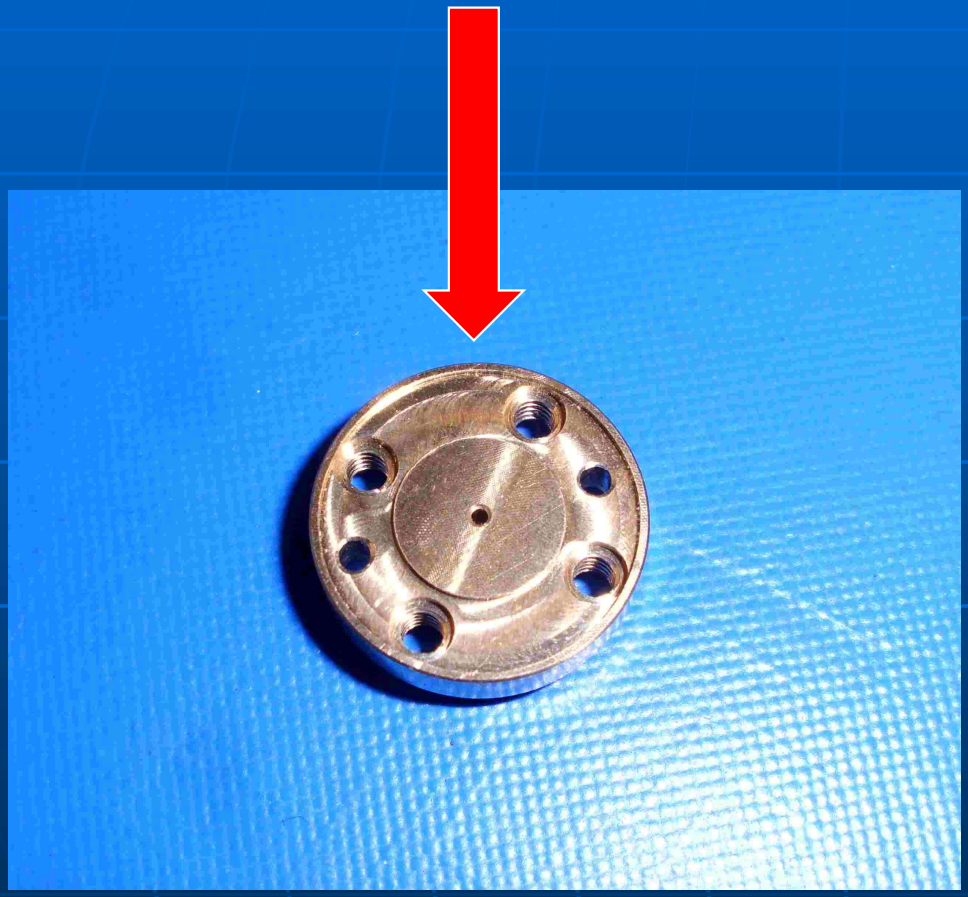
2.7mm round cut-off 65 GHz
1.7mm round cut-off 104 GHz
1.0mm round cut-off 176 GHz

Waveguide as HPF

- WR-03
- 225 to 325 GHz - Cut off at 173 GHz
- Inside dimensions 0.86 x 0.43 mm

241 GHz Test Antenna

- 1 mm hole in standard blank UG flange



When is the best time to operate on Millimetre Bands?

On all millimetre wave bands where water vapour adds to the path loss, the best time is when the dew point is low.

This normally means that the temperature is coldest. Preferably cold and dry.

VK3UM software can be used to predict atmosphere absorption.

G8AGN's weather box is very useful in the field

UK first 76GHz Beacon?

Eggardon Hill IO80QR
Directional along South coast

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76GHz Beacon ‘proposed’

- 75,976,800
- 100mW
- 24dBi horn (25W eirp)
- CW / JT4
- 250m asl

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