Entering The Exciting World of Amateur Ten GHz

Building an X-band transceiver with a little determination and a radio budget

Brian Thorson, AF6NA

Past Vice-President SBMS

SAN BERNARDINO MICROWAVE SOCIETY

http://www.ham-radio.com/sbms

founded in 1955

A NON-PROFIT TECHNICAL ORGANIZATION DEDICATED TO

THE ADVANCEMENT OF COMMUNICATIONS ABOVE 1 GHz.

W6IFE

Meetings 1st Thursdays
7:00 PM – American Legion Hall – 1024 Main Street – Corona, CA

The Annual SBMS MW Tune-Up

Fairview Park,
Costa Mesa, CA

Microwave Tune-Up Results

SDMG-SBMS2013

July 27, 2013 SDMG-SBMS EIRP/MDS Event						Range Feet	220			89	
10 GHz NB										Path Loss dB	
Call	Dish size "	Output dBm	ERP PM dBm	Atten. Value dB	MDS Gen dBm	Calc Ant Gain	Calc ERP dBm	Meas ERP	Meas-Calc		
N5BF	20.2	35	-11	20	-85	32	67	67	0		
N6EQ	24	35	-10	20	-82	33	68	68	0		
W6DQ	13Db	39	-23	0	-52	13	52	35	-17		
W6QIW	30	39	-12	30	-90	35	74	76	2		
N9RIN	30	38	-15	20	-72	35	73	63	-10		
AF6NA1	33	35	-6	20	-88	36	71	72	1		
AF6NA2	2ND LNA				-89						
AG6QV	18	23	-19	10	-70	31	54	49	-5		
WB6DNX1	17db	30	-18	10	-63	17	47	50	3		
WB6DNX2	13Db	30	-23	10	-59	13	43	45	2		
WB6NOA	24	31	-14	0	-65	33	64	44	-20		
KC6QHP	18	30	-5	10	-84	31	61	63	2		
N9RIN-2	36	36	-9	20	-80	37	73	69	-4		
N6MN	24	23			-54	33	56	58	2		
KB6CJZ	18	25	-14	10	-73	31	56	54	-2		
24 GHz NB										95	200
W6QIW	23	20	-18	30	-76	40	60	63	3		
47GHZ										102	200
K6JEY	12	2	-25	10	-84	40	42	43	1		
W6QIW	17	5	-9	20	-102	43	48	69	20		
79.8 GHZ										107	200
K6JEY	16	-10	-47	0	-45	48	38	36	-2		

SBMS November 2011 Meeting

Mel, WA6JBD Talking about his 35 w 10 GHz TWT and its power supply at the November SBMS meeting.

System EIRP: +84.5 dBm (290 kW)

SBMS is an ARRL-Affiliated Radio Club.

Several SBMS Members have set
10 GHz distance records

Many SBMS members have been
ARRL Microwave Contest Winners

SBMS still holds the record for
the highest 10 GHz contest score.

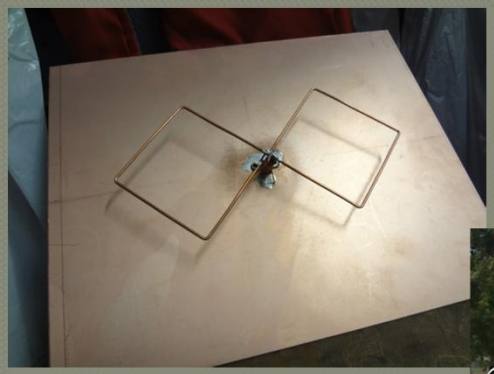
Meetings On-line:
http://www.batc.tv/ch_live.php/atv
repeaters/W6ATN

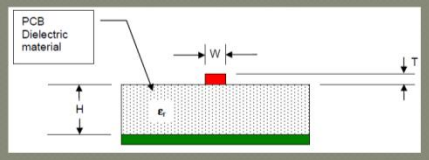
The Thrill of Microwaving

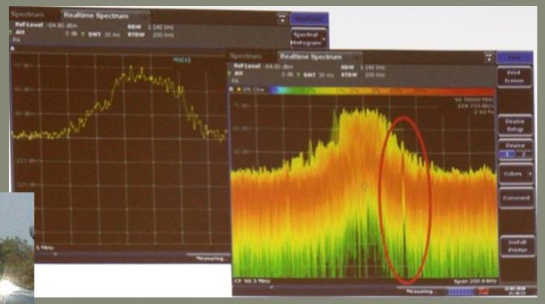
10 GHz means ten billion cycles per second. A billion is hard enough to comprehend in dollars or other quantities. But at "X" and other microwave bands, the physics of electromagnetics is a bit different. Hollow tubes (waveguides) are the best transmission lines, and antennas take on unusual shapes.

Making a QSO is a very special event.

Microwave Stuff







Amateur Microwaves

33 cm		902.0-928.0 MHz:
23 cm		1240-1300 MHz
13 cm	S-Band:	2300-2310 MHz; 2390-2450 MHz
9 cm	C-Band:	3300-3500 MHz
6 cm	C-Band:	5650-5925 MHz
3 cm	X-Band:	10.0-10.5 GHz <<< !!
	K-Band:	24.0-24.25 GHz
	V-Band:	47.0-47.2 GHz
	W-Band:	76.0-81.9 GHz*
		119.98-120.02 GHz
		142-149 GHz
		241-250 GHz
		Above 300 GHz

*76-77 GHz has been suspended temporarily

2012 Contest Results

10 GHz Only Category

For the second year in a row, Gary, WBØLJC led all 78 operators in this class with a score of 75,333. The husband/wife duo of Chris, NØUK and Holly, KØHAC came in 2nd and 3rd. The Top Ten scores in this category were split between 6-land and Ø-land. Activity levels remain healthy in both areas. Many Ø-land operators took part, along with some VE and 8-landers, in an expedition to Lake Superior.

Participation by Call Area

Call Area	# of Entries
6	31
1	19
8	14
0	13
VE	10
4	10
9	6
7	5
3	5
2	2
5	0
DX	0

all of the 37 logs in this category showed activity on 24 GHz. Only four logs showed activity on 47 GHz. Surprisingly, no submitted logs showed operations on 78 GHz. One submitted log showed "light" activity above 300 GHz. Loaner rigs are starting to be available for 24 GHz —

see if sor
for your

Humidity
signals a
worked r
Superior.
Ron, K6
24 GHz t
complete

Top 10 QSOs Completed

10 GHz Only	QSOs	10GHz and Up	QSOs
WBØLJC	351	WØZQ	336
NØUK	305	AA6IW	308
KØHAC	282	K6GZA	254
KD6W	262	K9PW	235
NØAKC	256	N6RMJ	202
KØCQ	239	WB8TGY	162
KCØP	232	AF1T	143
N6NU	231	W1MKY	132
WA2VOI	226	WA8VPD	129
KØMHC	222	KC6QHP	121

Top 10 Scores

10 GHz Only	Score	10 GHz and Up	Score
WBØLJC	78233	WØZQ	76506
NØUK	71078	AA6IW	68446
KØHAC	64168	K6GZA	62992
KD6W	62505	K9PW	47477
NØAKC	58931	N6RMJ	38551
K6ML	55490	AF1T	35712
N6NU	55438	WB8TGY	35102
KØCQ	54801	W1MKY	31021
WA2VOI	51167	WA8VPD	26593
KK6MK	50196	W6QIW	25349

Your Next Project?

This could be the next challenge for some of you Hams with some experience but who are looking for a new avenue or thrill in Amateur Radio!

N5BF "X-Banding" at Solana Beach

How to explain your (very) "geeky" activity

"Do you have a 4G phone?
… Well, this is 10G."

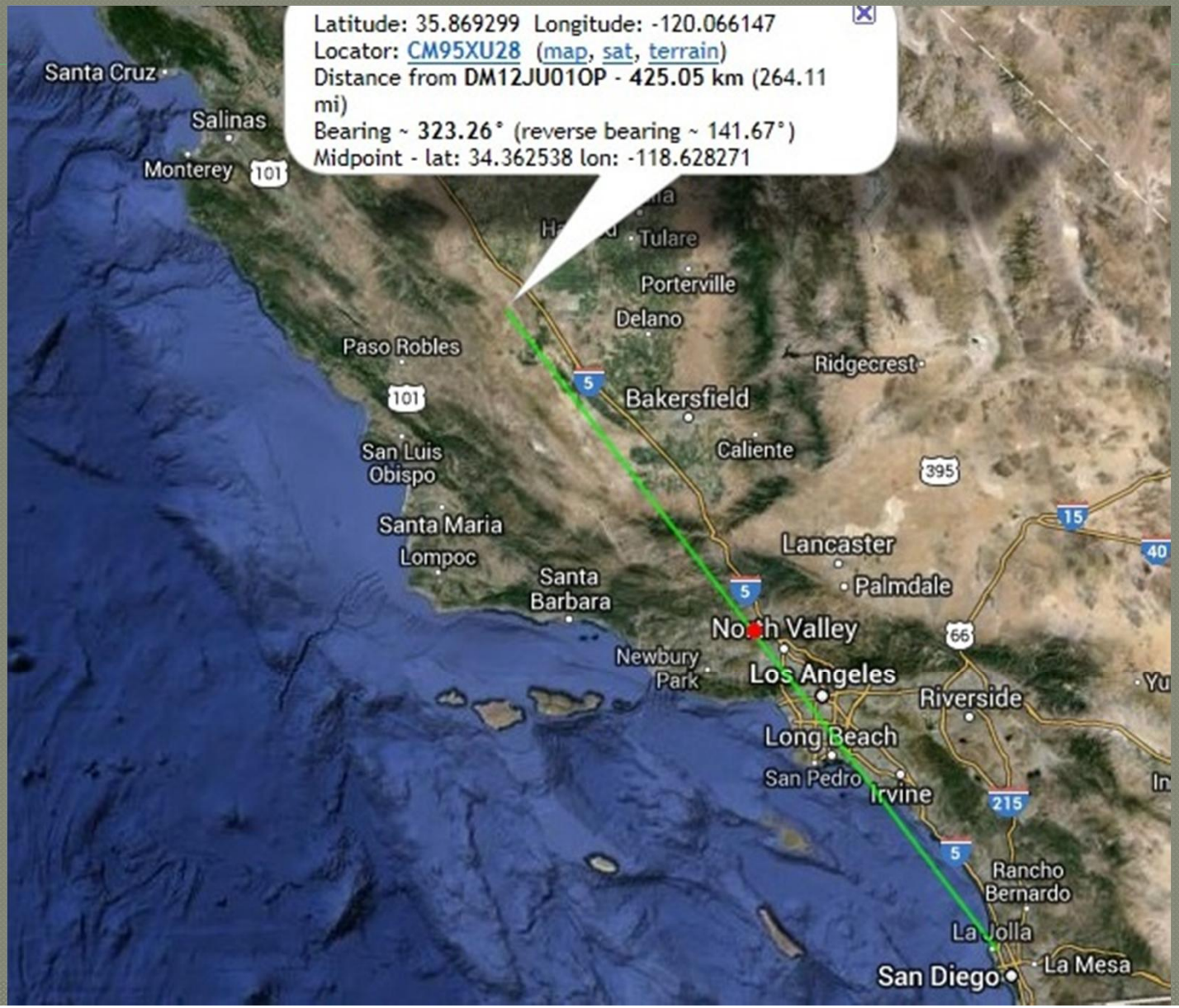
"We are searching for
whales in migration."

"I wish you wouldn't ask me
questions like that, I may
have to call the FBI."

"We are X-banding."

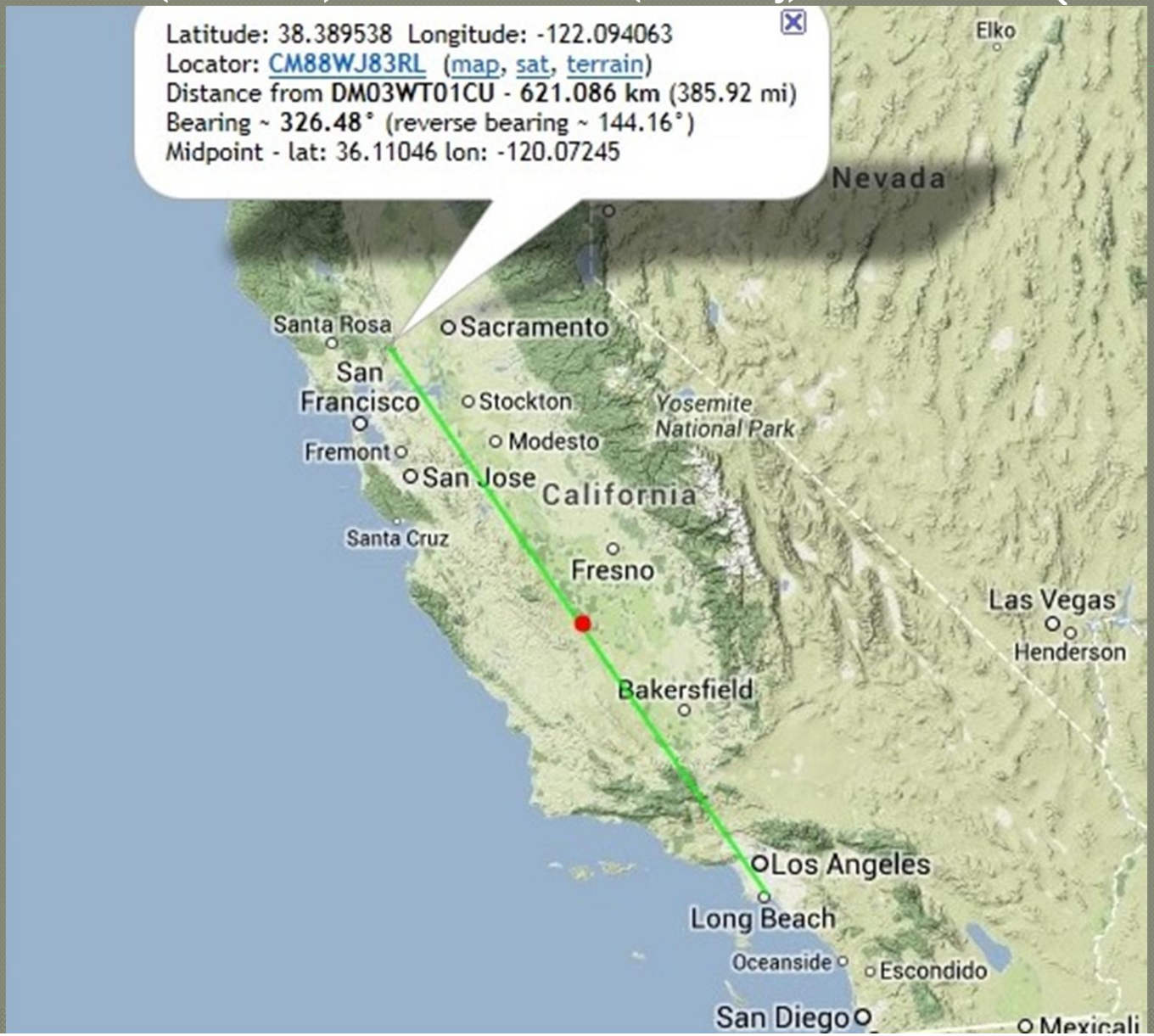
A Recent X-Band QSO

San Diego (DM12JU) to Avenal on 3W at 10368.425 MHz- 426 km



My Longest X-Band QSO

Signal Hill (DM03WT) to Mt. Vaca (CM88WJ) – 623 km (386 mi.)



The 2011 ARRL 10 GHZ and UP Contest:

AF6NA - 40,674 Points – 7th Place in the U.S.

LINE-OF-SIGHT ??

Hey, isn't microwave just
"line-of-sight" communications?

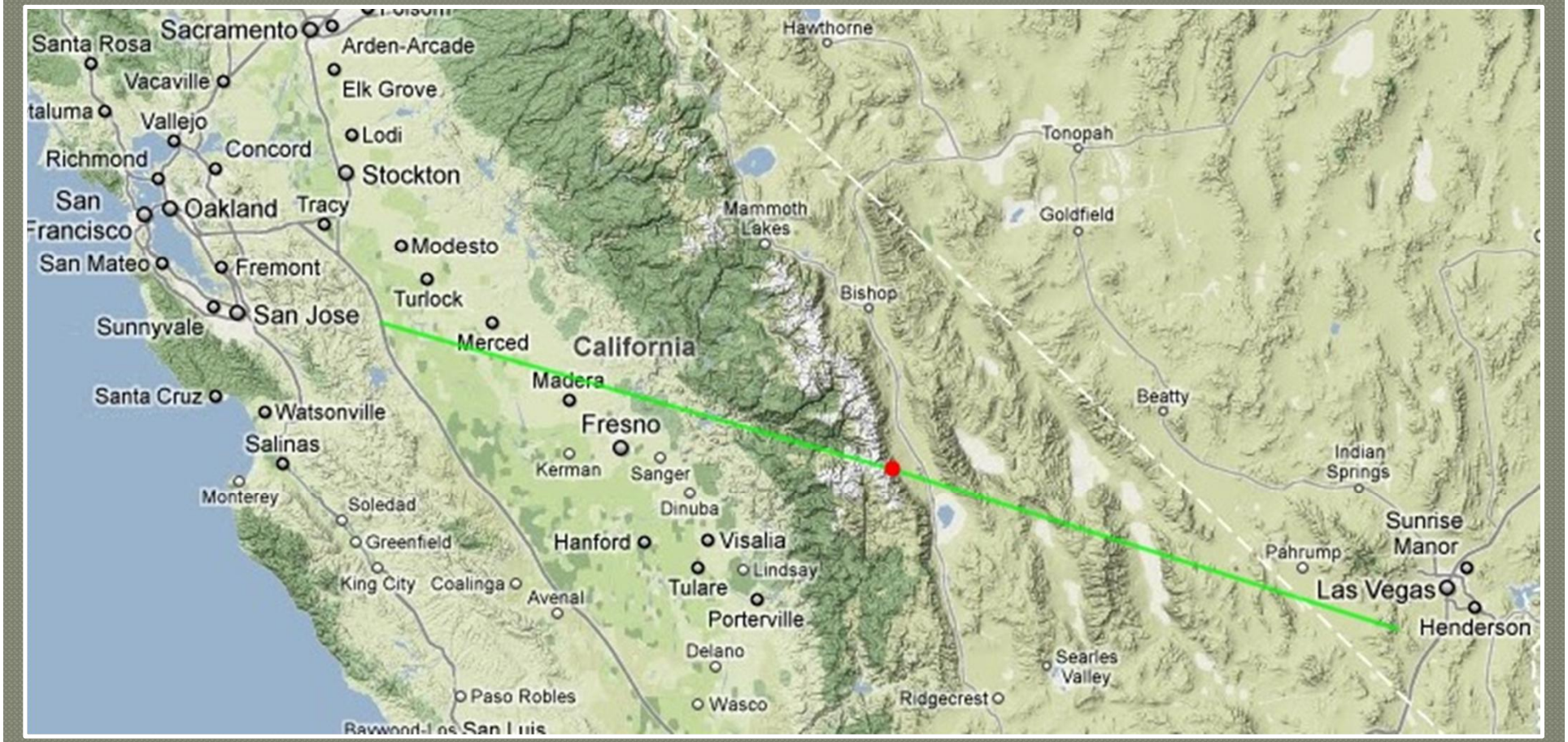
YES and NO

How did I work Mt. Potosi in Las Vegas from
Los Banos, CA, (529 km)
shooting over the north slope of Mt. Whitney,
the tallest peak
in the contiguous 48 states ???

It's in my log. WA6JBD and WA6CDR

Over Mt. Whitney

Los Banos to Mt. Potosi – 529 km (329 mi.)



Microwaves Over Mt. Whitney??!!

14,497 feet

10 GHz World Record: 2696km (Almost 1700 Miles)

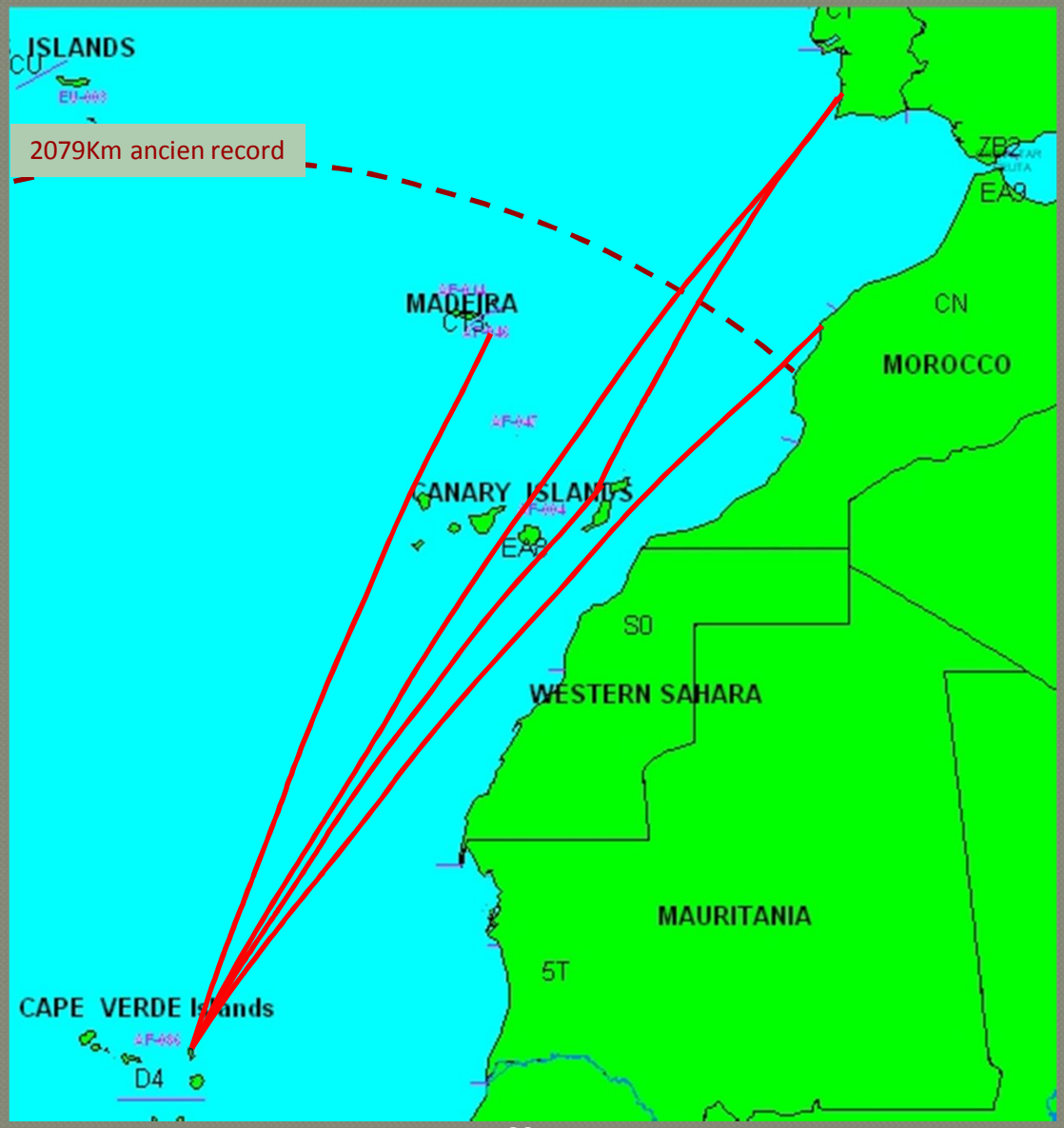
Cape Verde Islands to Portugal

Set July 10th, 2010 by Swiss "Hyperatlantica" Team

HB9AZN, Pierre-Andre Probst

Planification

Trafic avec les partenaires CT / CN / EA8 / CT3



How Do I Get Some of This 10 G Excitement?

The B.Y.O.R. Method

"Build Your Own Radio" (BYOR):
An Amateur Radio Tradition

- Building a radio from available parts is one of the greatest of Ham radio traditions.
- Microwave amateur radios are not available off the shelf from any manufacturers.
- This is really one of the most rewarding parts of becoming a microwave ham.
- No two radios are exactly alike, they all have their own design, shape factor, performance specs, strengths and weaknesses.

Start with what you already have..

A "QRP" Radio

Most amateurs have a "QRP" radio, that is, a low-power radio. The Yaesu FT-817 is a great unit and many experienced microwavers prefer it as an "IF" radio

144 MHz "IF" radios:

Yaesu FT-290 MKII
2M (144 MHz)

Kenwood TR-751A
2M (144 MHz)

A "QRP" Radio

From Tom Curlee, SBMS

TR-751 - $250.00

FT-290R - $100.00

Repair units - $100.00

An abandoned DBS or FTA dish

Many people have an old satellite dish they no longer use, such as a Dish Network or DirecTV dish attached to the side of the house.

Try to find one with the feed assembly in place.

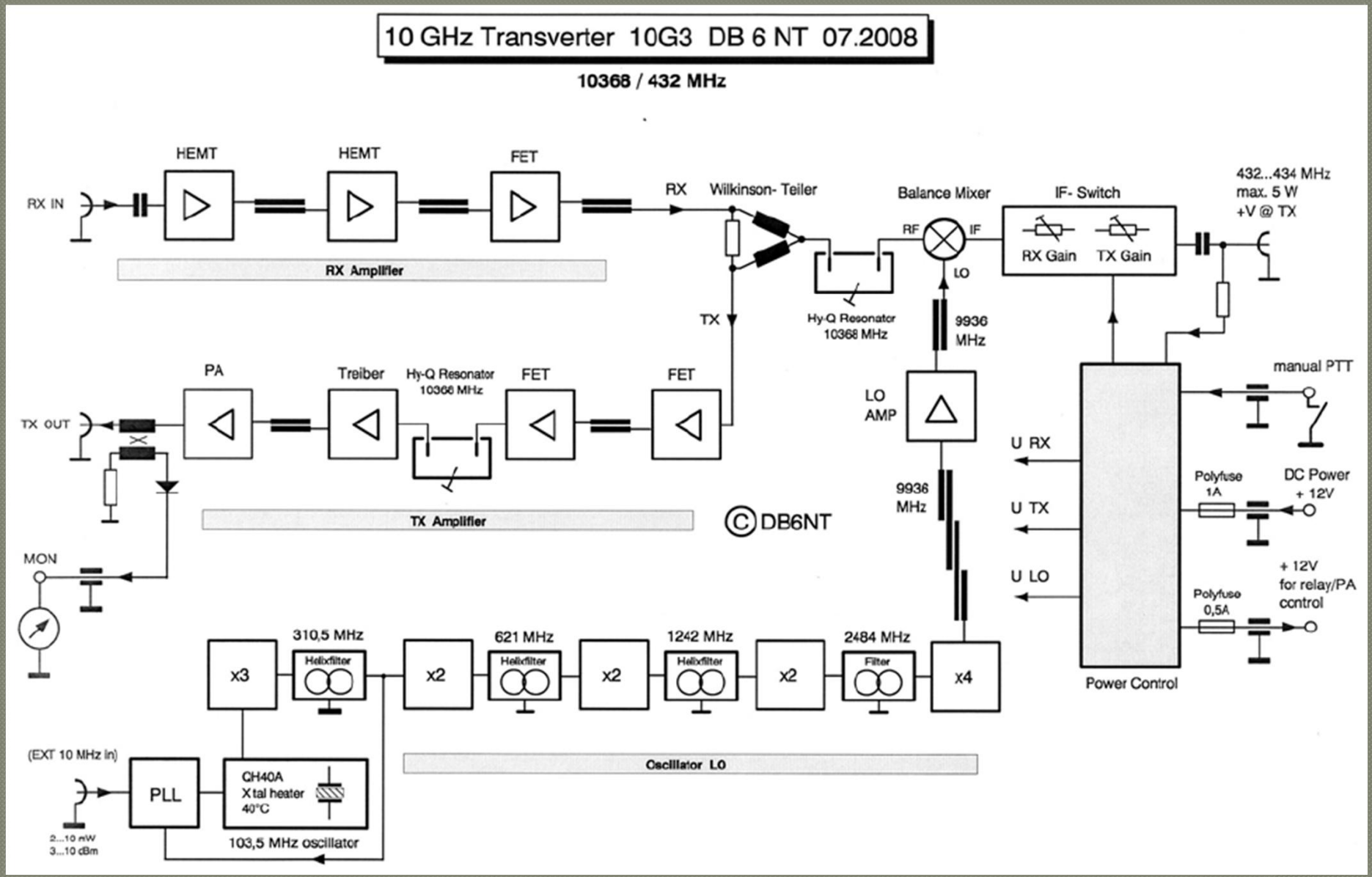
That way, you don't have to do so much math to find the focal point.

$ FREE !!

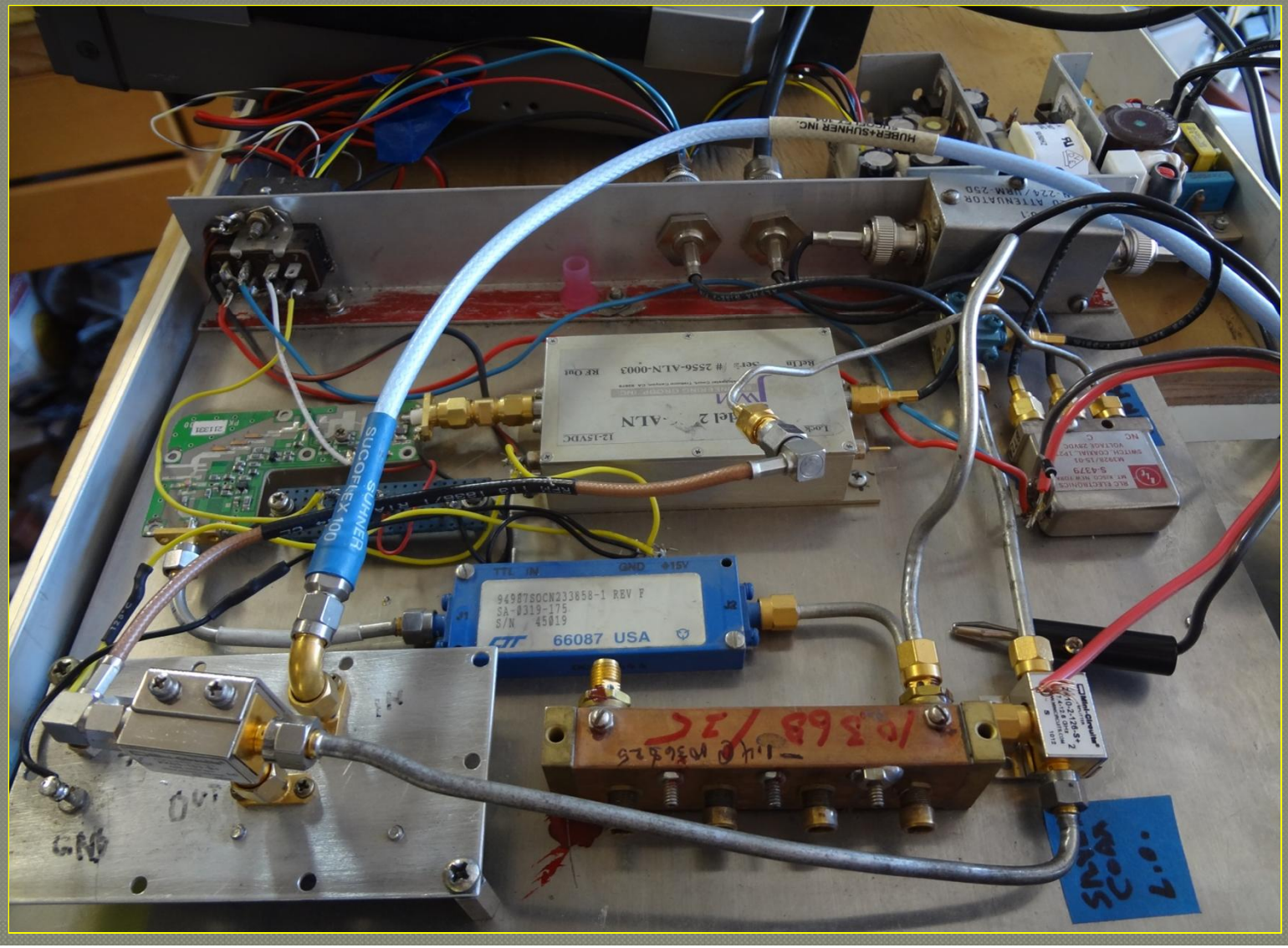
Next, get a "transverter"

- A transverter is the heart of the system.
- DB6NT from Kuhne Electronics GMBH
- 280mW / 1.2 dB NF …About $650 US plus shipping from Germany
- http://www.kuhne-electronic.de/en/products.html
- Down East Microwave (DEMI)
- 3W/1.5 dB NF …… $775
- http://www.downeastmicrowave.com/

From 2M or 432 MHz to 10 GHz:

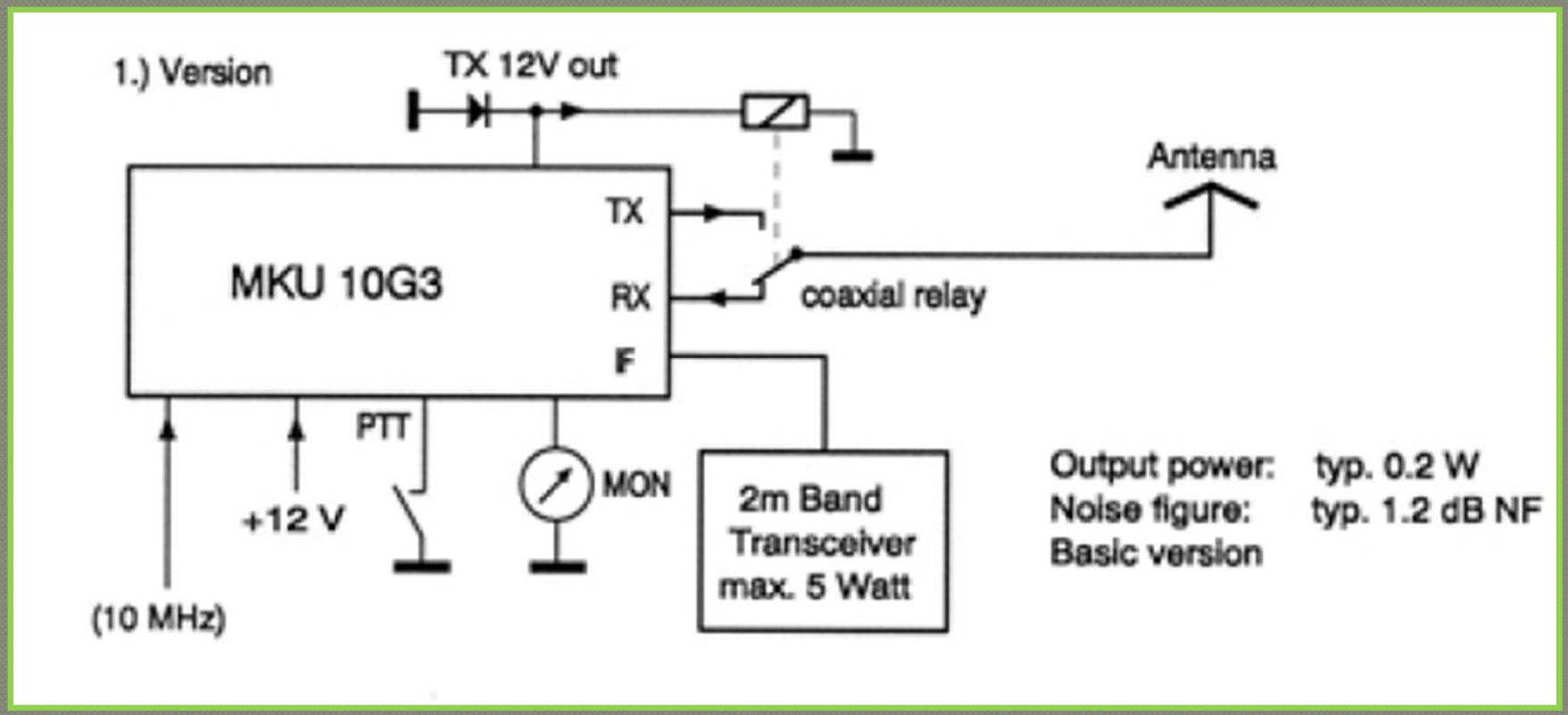


A 10 GHz Transverter From Parts



A Microwave System Plan

- A simple 280 mW radio will make many QSOs (DB6NT based system shown)

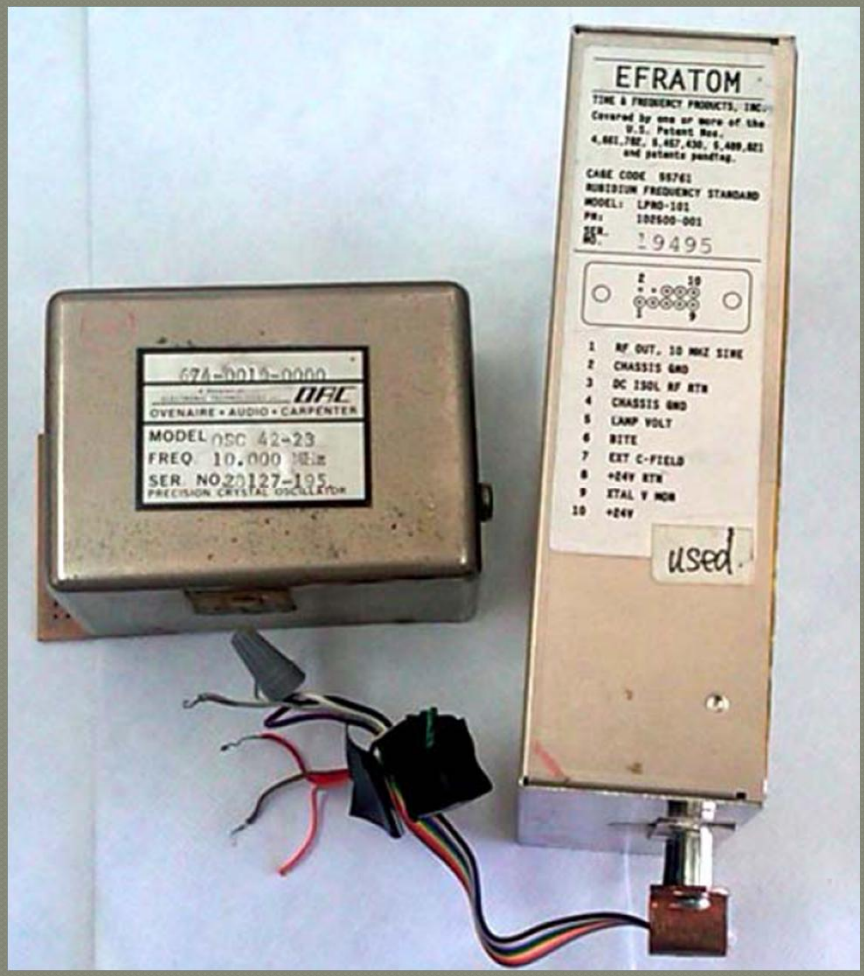


Frequency Stability

A high stability "master oscillator" will be necessary to tune in SSB signals at X-band.

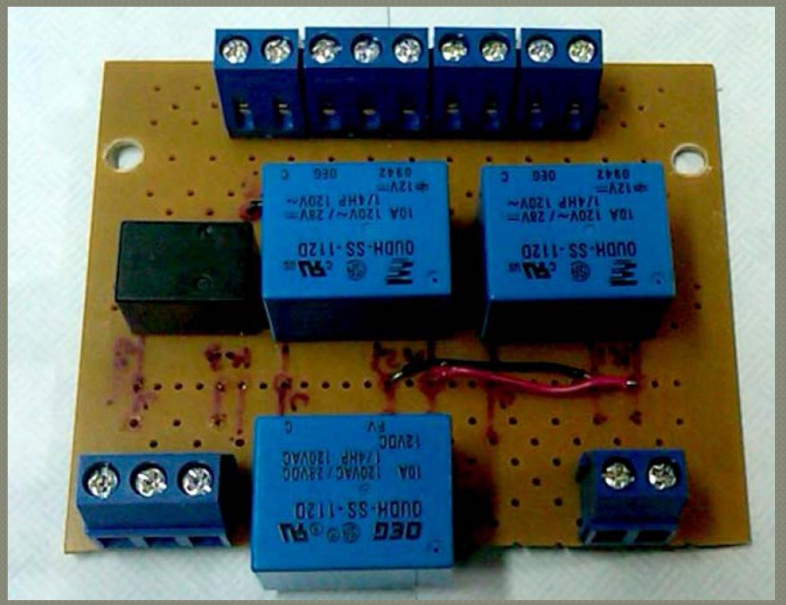
A Rubidium or "Rubi" and an OCXO are shown

$ 99.00 on eBay



An Interface / Sequencer

- Getting the transverter, the T/R switch, the cooling fans, (power amp), and everything to switch on when you press the "PTT" button may take a little creativity and electronic design.
- I used relays from Radio Shack
- Solid State Sequencers are available



Microwave Plumbing

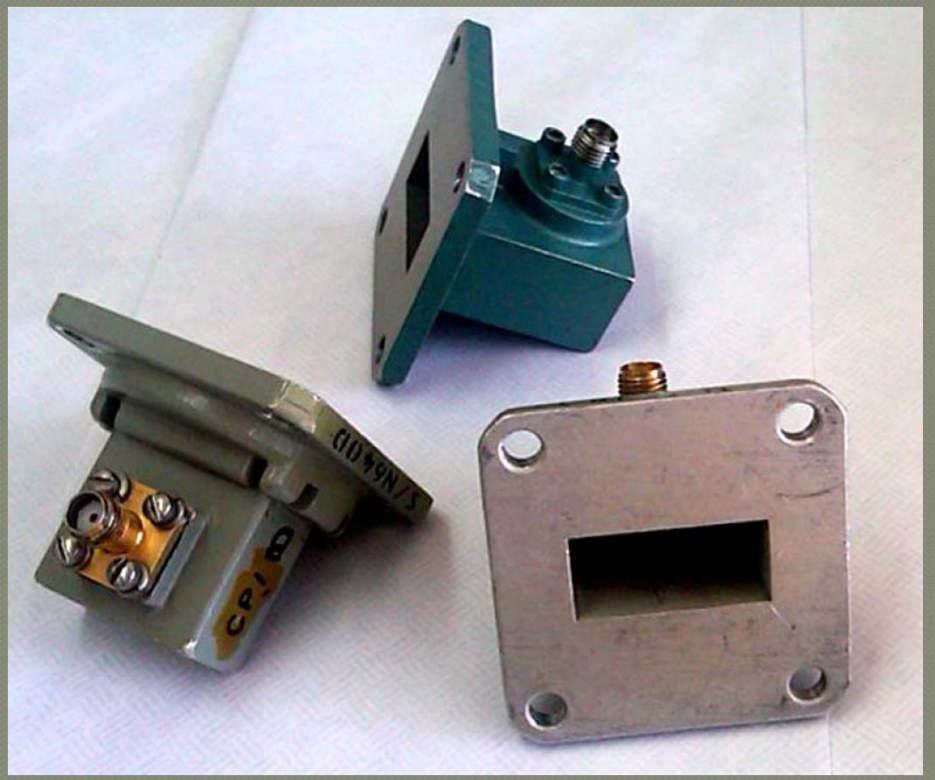
- Waveguide is the best transmission line for the microwave bands. WR-90 is the best for 10.368 GHz. (3/4" copper pipe)

Microwave Coax

- 'Semi-rigid' coax, such as UT-141T, is rated for microwave frequencies, but is more lossy than waveguide.

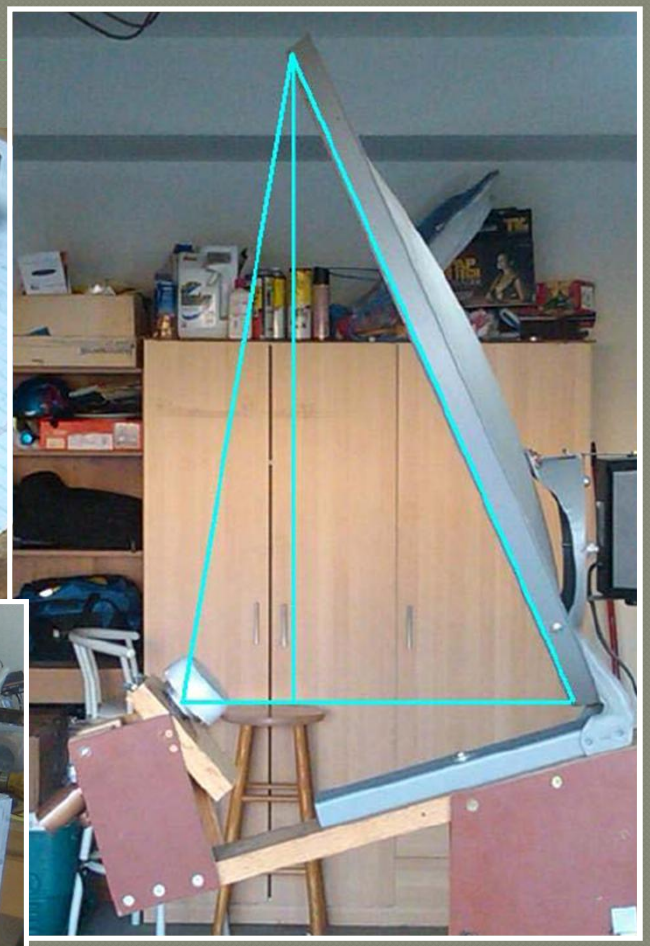
WR-90 to SMA Transitions

- Waveguide-to-Coax transitions are used near the Antenna feed point to convert from coax to the waveguide so the microwave power can be applied to the reflector.



Assembling the Parts

- Feed Horn Assembly
- T-R Switching
- Antenna focal point
- D.C. Supplies



Power Loss: The Microwave Challenge

- Microwaves are a very "elusive" quantity - losing half a dB here and a dB there in a microwave system is very easy to do.
- Use the best semi-rigid coax and the shortest lengths possible.
- Avoid getting "kinks" in the semi-rigid, and dents in the waveguides.
- Losses on the receive side can seriously affect your minimum discernable signal (MDS).

Close To The Dish

- To minimize power losses, microwave frequency components should be located as close to the reflector feed as possible.
- K6JEY has a great example of this.

Focus on the focus

- Your best time investment will be spent getting **high efficiency** out of the reflector antenna and feed system.
- The lowest cost and lowest noise gain you have in your microwave system is your antenna. If you take care to put the feedhorn at the right spot and point the feedhorn correctly, your antenna gain will be maximized and noise minimized.
- If you just "rough it in" the antenna will perform poorly. The receive system will be noisy, making it hard to receive weaker signals and expensive microwave Watts will be wasted.

Focus on the focus

- Getting the focus and feed angles correct will take a bit of geometry and algebra.
- Paul Wade, W1GHZ, has done extensive research work into microwave reflector antennas and has published excellent tutorial material on his website:

  http://www.w1ghz.org/antbook/contents.htm

- Additional information on offsets and feeds is also helpful.

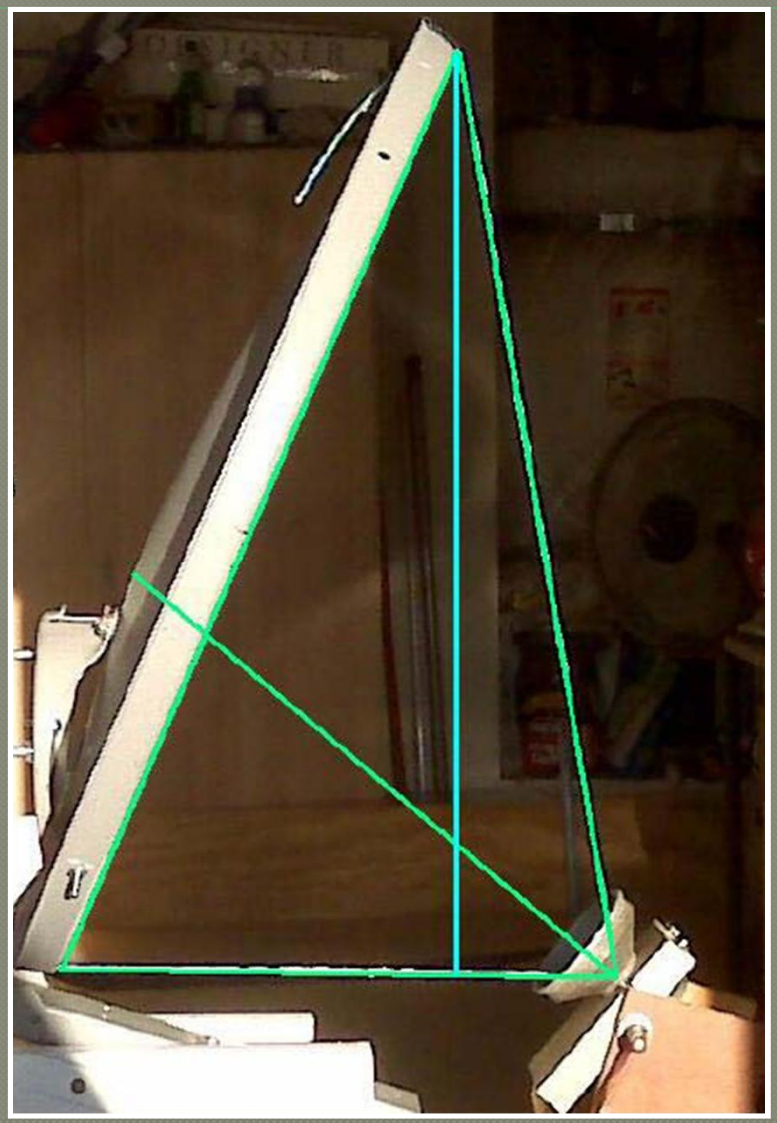
Focus on the focus

- W1GHZ developed a very useful method of finding the focal point with a string.
- The string is marked with the calculated values of focal length and illumination angle

Offset Reflector Geometry

- When making measurements on your dish, measure to the edges of the reflective surface, rather than the outside lip of the sheet metal. This will yield better agreement with calculated values.

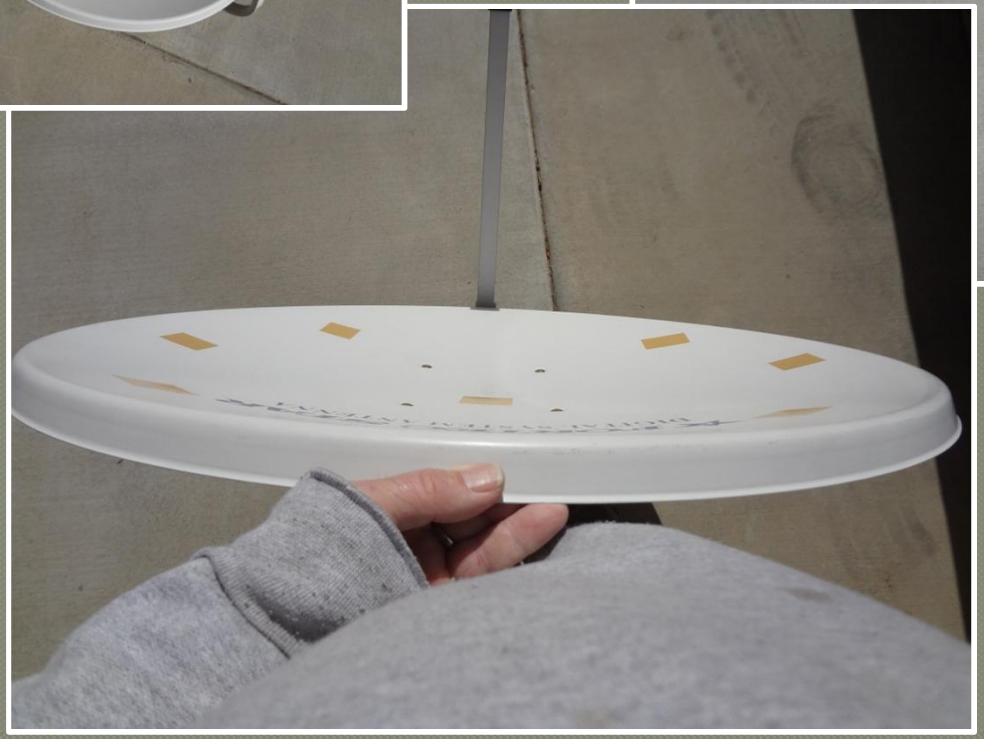
Pointing the Feedhorn



- Bisect the offset reflector vertical illumination angle and that's the spot to point at, not the center of the reflector.

Focus on the focus

My latest Offset:



A Word About "Tinkering"

Assembling and de-bugging a microwave radio is a very time-consuming and gratifying activity….

…. So much so, that some Hams have turned it into a multiple-year project, and some haven't finished yet!

The Goal: GOTA!

Well-Built Radios

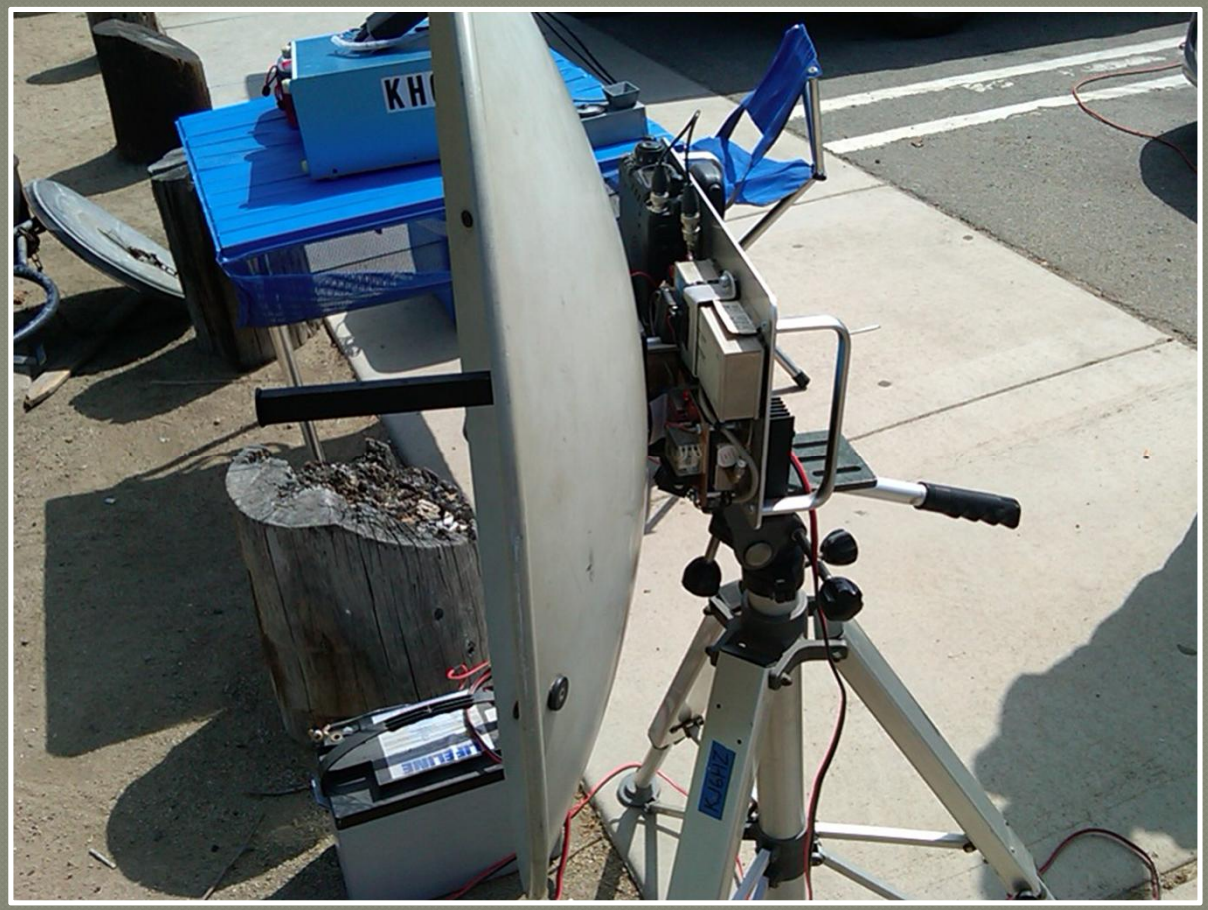
- A well-built microwave radio is one that works well not only in the lab, but has been ruggedized to take a car ride all weekend and not fall apart en-route.
- Should be able to arrive at a roving location and be on the air in less than 10 minutes.

Examples of Well-Built Radios

- Steve, W6QIW: Close to the Feed

Examples of Well-Built Radios

- John, KJ6HZ Has all parts on one plate



The SBMS Microwave Tune-Up

- Every year on the last weekend of July
- Fairview Park, Costa Mesa, CA
- EIRP and MDS measurements

The Big Event:

ARRL 10 GHz and Up Contest

What's A Ham To Do?

- Attend SBMS meetings and get acquainted
- GOTA – Get On The Air with a 10 GHz Rig
- Make it 'rugged'' enough to withstand a ride in your car / truck, etc.
- Partner with another experienced and successful operator for the contest
- Try it before you say it can't be done

Questions?

help is available from SBMS members

SBMS Web Site

http://www.ham-radio.com/sbms/

Meetings every 1st Thursday of the month

7:00 PM
The American Legion Hall
1024 Main Street
Corona, CA