902 MHz Presentations

- Getting Started on 902 MHz at W5LUA
- Paralleling high power 900 MHz amplifiers by W5LUA
- Review of the W1GHz 902 MHz transverter by N5AC
- 902 MHz Transverter at KA5BOU
- 902 MHz Transverter at NM5M
- 902 MHz Transverter at WB5ZDP
- 902 MHz W0PW Dual Dipole Feed by WW2R
- 902 MHz EME at WA8RJF EN91
- DEMI 902 MHz Transverter demo by W5SXD
The 33 cm Band

- 902 to 928 MHz
- Weak signal work at 902.0 to 902.5 MHz and at 903 to 903.5 MHz east of the Mississippi River
- Weak signal calling frequency for us is 902.1 MHz
- Shared with Part 15 and ISM on a non-interfering basis - Bull
- No commercial store bought radios available for SSB and CW
- Build or buy a transverter to go with your multimode 2M radio or HF transceiver
- Antennas – both loop yagis and standard yagi design available including some pretty simple antennas by Kent WA5VJB
758 MHz LO

NOTE: BEST WAY TO TUNE LO IS TO BREAK CKT 7 PT. B AND ADJUST PRIOR STAGES FOR MAXIMUM 379 MHz. PT. B AND THEN INJECT INTO QS CKT AND ADJUST FOR MAXIMUM 758 MHz OUTPUT.

AJ WARD
9-29-87
WB5LUA
758 MHz LO Parts List

- L3: 1 TURN #14, 1/2" I.D.
- L4, L5: WIRE #24 Gauge as shown in VIEW B
- C1: 100 pF N750 CAP
- C2: 33 pF N7SO CAP
- C3: 3-18 pF CERAMIC VARIABLE
- C4-C10: .8-10 pF PISTON VARIABLE

VIEW A

- VIEW B
- (top output at bend in wire)
WB5LUA 902 MHz Transverter

Built 1987
WB5LUA 902 MHz Transverter
Band Pass Filters for 902 MHz
Components for 902 MHz
N5QGH 902 MHz Transverter using old KK7B no tune transverter
Approach
W5LUA 902 MHz ATF-36077 LNA

Reference Avago
Ap Note 1128
WW2R 902 MHz Transverter
902 MHz PA Module
DEMI 902 MHz Transverter

DEMI Demo by W5SXD
NM5M’s 902 MHz XVTR

902 AMMO CAN TRANSVERTER

- 51 MHz input
- 460 MHz SAW Filter
- 445 MHz IF TX
- INA 10386 MMIC AMP
- 2:1 Divider
- +12 dBm
- SBL 1X Mini Circuits
- 902 MHz SAW FILTER
- ERA 3
- 445 MHz IF OUT RX
- SBL 1X Mini Circuits
- 902 MHz SAW FILTER
- LNA 25 dB Gain
NM5M’s 902 MHz XVTR

TX MIXER

TIMES
9 MULT

TTL OSC

460 MHz SAW FILTER

LNA

902 MHz FILTER
NM5M’s 902 MHz XVTR

MIXER
LNA
IF AMP
IF SWITCH
WB5ZDP 902 MHz Transverter
W1GHZ 902 MHz Transverter

- Inexpensive 2 board approach providing low power and moderate NF
- [http://www.w1ghz.org/MBT/902_MHz_Transverter_for_the_Multiband_Rover.pdf](http://www.w1ghz.org/MBT/902_MHz_Transverter_for_the_Multiband_Rover.pdf)
- Group Buy?
150 Watt Motorola SSPA
Model STF2520A
300 Watt Motorola SSPA
Model SGTF 1038A
1 Watt Low Level Leveling Amplifier Model STF 2540A

This unit is the same form factor as the 150 watt and 300 watts SSPAs – Buyer be aware!
Motorola 150 W and 300 W SSPAs

- [www.vhfsouth.com](http://www.vhfsouth.com) modifications per KD5FZX on both 150W and 300W SSPAs
- Article by N5AC
W5LUA Pair 300W SSPA

50 Amp meters and shunts available from www.allelectronics.com
$12 / meter and $12 / shunt
Back View SSPA
Close-Up Power Dividers
Paralleling two 300 Watt SSPAs at WA8RJF using 90 Degree Hybrid Couplers
Showing Method of Attachment of 24V and PTT at WA8RJF
SMA 90 Degree Hybrid Couplers
Anaren 10014-3 .5 to 1 GHz
3dB 90° Hybrid

Port 2
-109°

Port 3
160.1°

Difference = 160.1 - 109 = 269.1 - 360 = -90.9
MECA 900 MHz 3dB 90° Hybrid
MECA 900 MHz 3dB 90° Hybrid

Port 2 - Port 3

Port 4

Input

Port 2: 36.7°

Port 3: 127.7°

Difference = 127.7° - 36.7° = 91°
ADS Coupler Simulation

- Term Term1 Num=1 Z=50 Ohm
- SBCLIN C Lin2 Subst="SSub1" W=180 mil L=3310 mil
- Term Term2 Num=2 Z=50 Ohm
- Term Term3 Num=3 Z=50 Ohm

S-Parameters

- SP1
  - Start=0.5 GHz
  - Stop=1.5 GHz
  - Step=0.01 GHz

SSub

- SSLB
- SSub1
- Er=1
- Mur=1
- B=500 mil
- T=31 mil
- Cond=1.0E+50
- TanD=0
MECA 900 MHz 3dB 90° Hybrid ADS Simulation

Directivity = Isolation – Coupling = 16.7dB – 3.2dB = 13.5dB not too spectacular but may not be too important since we are not trying to accurately measure return loss but rather just combine amplifiers.

Coupled port leads by 90 degrees
Or direct port lags by 90 degrees
Broad band Response of the Ideal 90 Degree Hybrid

Also known as a “Backward Wave” Coupler

Amplitude response repeats at 3fo, 5fo, 7fo, etc.
Phase difference remains constant at 90 degrees regardless of frequency!
In reality discontinuities and parasitics can create imbalances
Cascade of 2 couplers

Termination 1
- Term
- Term1
- Num=1
- Z=50 Ohm

Termination 2
- Term
- Term2
- Num=2
- Z=50 Ohm

Termination 3
- Term
- Term3
- Num=3
- Z=50 Ohm

Termination 4
- Term
- Term4
- Num=4
- Z=50 Ohm

SBCLLN CLin2
- Subst="SSub1"
- W=180 mil
- S=37 mil
- L=3310 mil

SBCLLN CLin3
- Subst="SSub1"
- W=180 mil
- S=37 mil
- L=3310 mil

Graph showing dB(S(3,1)), dB(S(2,1)), and dB(S(4,1)) vs. freq, GHz.

- m1, freq=900.0 MHz, dB(S(2,1))=-0.393
- m2, freq=900.0 MHz, dB(S(4,1))=-38.510
- m5, freq=900.0 MHz, dB(S(3,1))=-28.191
Cascade of 2 couplers with Open Circuit on one Port1

Through Loss = 6.5 dB
Power at isolated port down only 6.5 dB, need 50 ohm load that can handle this at least temporarily. In addition some power is also available at the “other” output port of the coupler – none of this is very good!
Cascade of 2 couplers with 1 and 3 dB attenuators in one path

**1 dB**

- m5
- freq = 900.0 MHz
- dB(S(2,1)) = -27.219

**3 dB**

- m5
- freq = 900.0 MHz
- dB(S(2,1)) = -32.051

**m2**

- freq = 900.0 MHz
- dB(S(4,1)) = -32.051

**m1**

- freq = 900.0 MHz
- dB(S(3,1)) = -33.422

**m3**

- freq = 900.0 MHz
- dB(S(3,1)) = -18.343

**m4**

- freq = 900.0 MHz
- dB(S(3,1)) = -1.741

**m5**

- freq = 900.0 MHz
- dB(S(4,1)) = -27.219
Cascade of 2 couplers with 10 and 45 degree offset in one path

10 degree offset

45 degree offset

m5

freq=900.0MHz
dB(S(2,1))=-0.429

dB(S(3,1))=-19.919

dB(S(4,1))=-31.472

m1

freq=900.0MHz
dB(S(2,1))=-0.429

dB(S(3,1))=-19.919

m2

freq=900.0MHz
dB(S(2,1))=-0.429

dB(S(3,1))=-19.919

dB(S(4,1))=-31.472

m5

freq=900.0MHz
dB(S(2,1))=-1.137

dB(S(3,1))=-7.941

m1

freq=900.0MHz
dB(S(2,1))=-1.137

dB(S(3,1))=-7.941

m2

freq=900.0MHz
dB(S(2,1))=-20.145

freq=900.0MHz
dB(S(3,1))=-7.941

dB(S(4,1))=-20.145

freq=900.0MHz
dB(S(3,1))=-7.941

dB(S(4,1))=-20.145
Single coupler with both outputs open circuited

All power is reflected back to port 4.
Termination on port 4 must be capable of handing the entire available driver power.
Optimizing Power Output

Best solution is to adjust amplitude and phase to keep current drawn by each amp as equal as possible when amps are driven to full power.

Try flipping hybrids.

Add some line length.

Adjust load on output coupler isolated port.

Each amp has some form of adjustable attenuator on its input.
W0PW EIA Dual Dipole Feed

Diagram:

- **Dipole length trim**
  - 1" lengths of 5/32" brass tubing
  - Extend 3/8" out of ends of dipole elements

- **Center conductor**
  - 3/8" brass tube
  - Shorted to one side of dipole conductor

- **Dipole elements**
  - 3/8" dia brass tubing
  - 2 1/2" long

- **Split balance**
  - 1 1/4" dia.

- **TOP VIEW**

- **Reflector**
  - Aluminum plate
  - 13 3/4" square
  - 3/8" thick

- **DUAL DIPOLE DISH FEED**
  - FOR 902 MHz
  - (NOT TO SCALE)
W0PW EIA Dual Dipole Feed

DUAL DIPOLE DISH FEED
FOR
902 MHz.
(NOT TO SCALE)

3½ phasing lines end view

"Slug" of ½” Teflon
To strengthen split balun. Tape over outside with Teflon tape to hold in place.

4:1 split balun
3/4 slot 3.273” long

Outer conductor
Brass tube 1/32” OD (¼” wall)

Brass washer soldered to brass tube

Reflector plate

50 Ohm coax length of a few inches terminated in "N" connector (UG58U)
902 MHz W0PW EIA Dual Dipole Feed @ W5LUA
WA8RJF 3M Dish on 902 MHz
Dual Dipole Feed for 902 MHz
Built by WW2R
Side View of Dual Dipole Feed
Return Loss of 902 MHz Dual Dipole Feed
WW2R 3M Dish on 902 MHz
902 MHz Feed at WW2R
Waterproofing Feed at WW2R
Summary

• Questions?
• Group buys?