

DO NOT COPY

QRP

Bill Shanney, W6QR

December 2017

# DO NOT COPY

## HF Played a Critical Role in the Recent Disasters

- VHF/UHF provided much needed local comm for responder coordination and evacuation center status
  - Cell service was out most places
- HF provided long haul comm for health and welfare traffic
  - Family notifications
  - Supply requests
  - Medical requirements
- Most of this type HF comm can be done with low power
- In poor conditions CW was the only reliable mode

# DO NOT COPY

## QRP Overview

- QRP is one of many “Q” signals developed to make CW operation more efficient. It stands for *Lower Your Power*
  - As a question it means *Shall I Lower My Power?*
- When the QRP ARCI decided to have 5 watts as their low power or QRP standard the name became synonymous with operating with 5 watts or less on CW.
  - There was a period before that when QRP was 100 watts or less
- QRP is not a beginners mode, making contacts with low power is often challenging
- You do not need any special equipment to operate QRP, simply turn your power output down to 5 watts or less

# DO NOT COPY History

- When I was first licensed in 1960, Novice license holders were limited to 75 watts input power. That translates to about 50 watts output. Many young hams couldn't afford commercial radios.
  - There were a lot of WWII surplus radios that were easily modified for ham use
  - There were several companies offering kits
  - Many radios only put out 10-20 watts
- We made contacts and had fun in spite of marginal antennas and low power outputs
- It was this generation of ham that grew up building most of their gear who led the QRP movement that started in the late 1980s
- Doug DeMaw, W1FB (SK), also deserves a lot of credit. The articles he published in *QST* and books he authored described equipment that could be built by the average ham without an engineering degree

# DO NOT COPY History – cont'd

- Kits were readily available in the early 1990s. Performance of these simple radios was quite good
- These were CW only radios
- Most worked on one or two bands and contained narrow crystal filters
- Accessory kits were eventually made available for items like keyers, antenna tuners and audio filters
- QRP clubs sprang up across the country. They offered their own kits, operating events and newsletters. Many are still active.
- NorCal QRP Club was our regional club. Many of their transceiver kits were designed by Wayne Burdick, one of the founders of Elecraft
- HF Pack started after the release of the popular Yaesu FT-817. They popularized walking or hiking with QRP radios. This is mostly SSB.
  - ICOM followed with their popular IC-703 series



# DO NOT COPY

## History – cont'd

- Two companies deserve mentioning since they played a big part in popularizing QRP:
  - Ten Tec and their popular Argonaut series of radios.
  - Heathkit and their HW series of transceiver kits. These were highly modified to improve performance.
  - These radios can be found used for reasonable prices
- Interest seems to have waned a bit around the turn of the century but it never died. New activities like Summits on the Air (SOTA) have popped up that require low power operation
  - Fewer hams are interested in building kits even though this is a great way to learn more about your radio
- Elecraft was founded in 1998 by Wayne Burdick (N6KR) and Eric Swartz (WA6HHQ) to promote *hands-on* ham radio.
  - They initially offered kits and eventually fully built radios
  - Their kits are not for new builders
  - Elecraft high end products are available as partially assembled kits
  - The K3s is available as a basic 10 watt radio and customizable to a full featured high end radio. You can add features when you need or can afford them
  - The KX3 and KX2 high performance low power radios, designed for portable operation, are very popular with the QRP crowd. They operate both CW and SSB
    - Having a better receiver helps when working stations with weak signal levels
    - Built in wide range ATU and keyer

# DO NOT COPY

## Why QRP?

- Contacting local stations does not require a lot of power
  - 5 watts is only 2 S-units down from 100W
- Portable operation from batteries
- Home Brew radios and accessories
  - Design your own
  - Kits
- Emergency communications require minimum power usage
- Stealth
- Challenge
- Digital modes don't need much power
- Sporadic E (Es) doesn't require much power
- Budget reasons

# DO NOT COPY Operating Activities

- Contesting
- DXing
- HF Pack
- Summits On The Air
- Camping/hiking
- Bicycling
- Field day
- Travel





# DO NOT COPY Equipment

- Use your 100W rig with the power turned down. Small radios like the IC-7300 or TS-590SG can be used portable. Their high performance receivers are an asset.
- QRP specific commercial radios (see following chart)
- QRP kit radios (see appendix)

*I suggest starting with a basic 100W radio. The extra power will make more contacts and get you on-the-air experience with signals that are strong enough to copy easily. You will encounter less than ideal conditions that will stretch your abilities at times, but most of your contacts will be solid, both ways. Gradually reduce your power as you become a more skilled operator and use QRP when band conditions are good enough.*

# DO NOT COPY Transceivers

- What are your operating interests?
- What bands do you want to operate?
  - 40M night
  - 20M day
- What modes do you need?
  - CW
  - SSB
  - Digital
- How much power do you want?
  - SSB needs higher power (+15 to 20dB)
  - QRP can be very frustrating
- Is weight an issue?
- What is your budget?
- Will you operate portable?
- I use transceivers with an internal battery pack. I use an external LiFePO battery as my main power in the field and the internal battery as backup.



DO NOT COPY

# A Sampling of Low Power Portable Transceivers

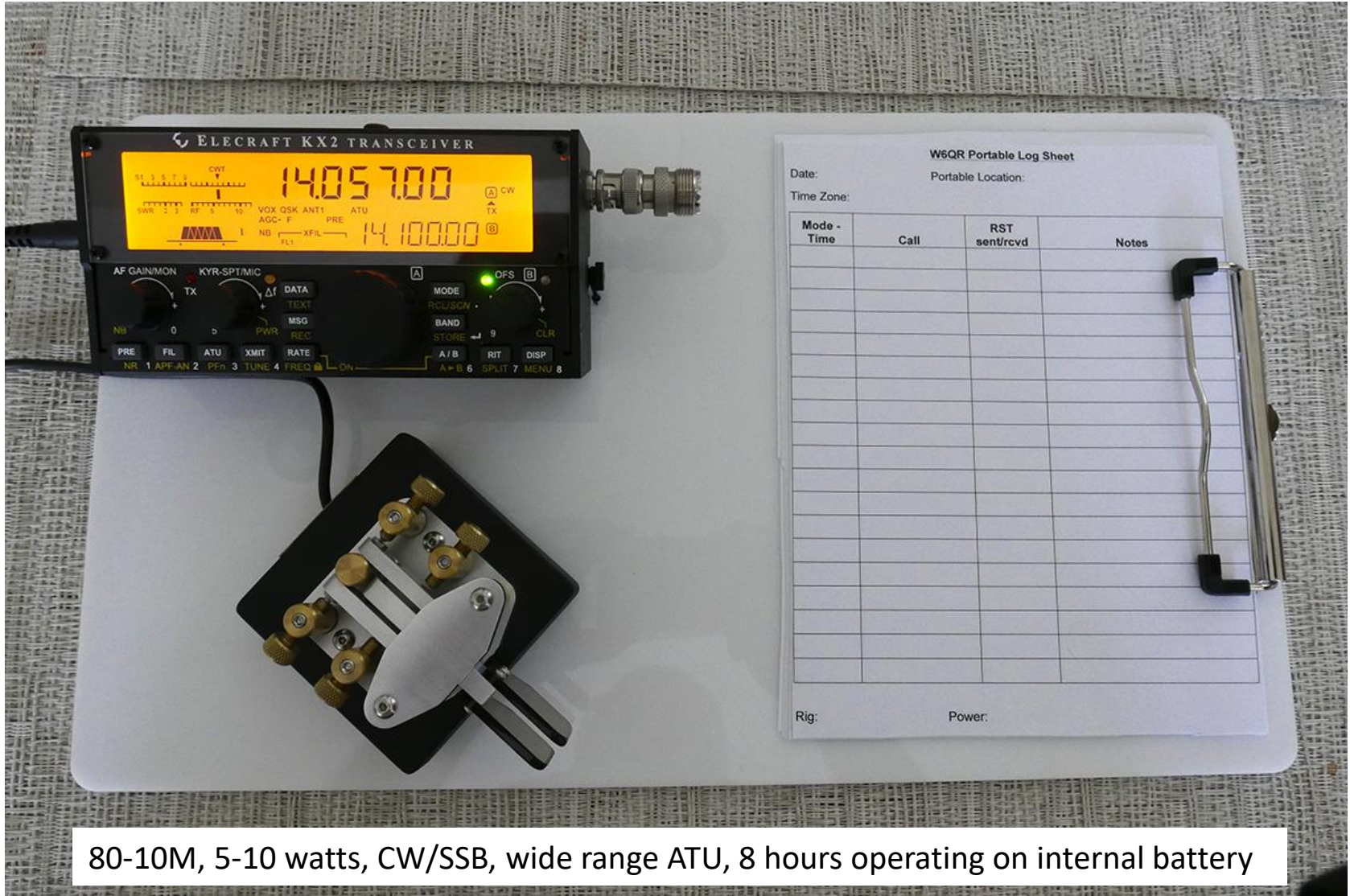
<b>Portable Transceiver Summary</b>						
Manufacturer	Model	Pout (W)	DC Current (ma)		Weight (oz)	Notes
			Receive	Transmit		
Elecraft	KX1	4	36	700	11	Keyer, Tuner, 40/20M, 80/30M options, Kit, CW
	K1	5	55	1000	23	Keyer, Tuner, 2 or 4 bands 80-15M, CW
	KX2	10	150	2000	13	Keyer, Tuner, 80-10M, CW/SSB/Digital
	KX3	15	200	3000	24	Keyer, Tuner, 160-6M, CW/SSB
Hendrick's QRP Kits	PFR3	5	47	800	8	Keyer, Tuner, 40/30/20M, CW only, Kit
Yaesu	FT-817	5	450	2000	41	Keyer, 160-6M, 146/440MHz, CW/SSB/FM
LNR	Mountain Topper	4	15	750	7	Keyer, 40-15M, CW
	LD-5	8	350	2000	19	Keyer, 40-15M, CW/SSB
You Kits (Vibroplex)	HB1B	5	60	800	14	Keyer, 80/40/30/20M

All models shown have internal batteries except the LNR models. Tuners may be options.

LNR has recently announced some attractive new SDR models.

DO NOT COPY

# W6QR 10 Watt Portable CW Station



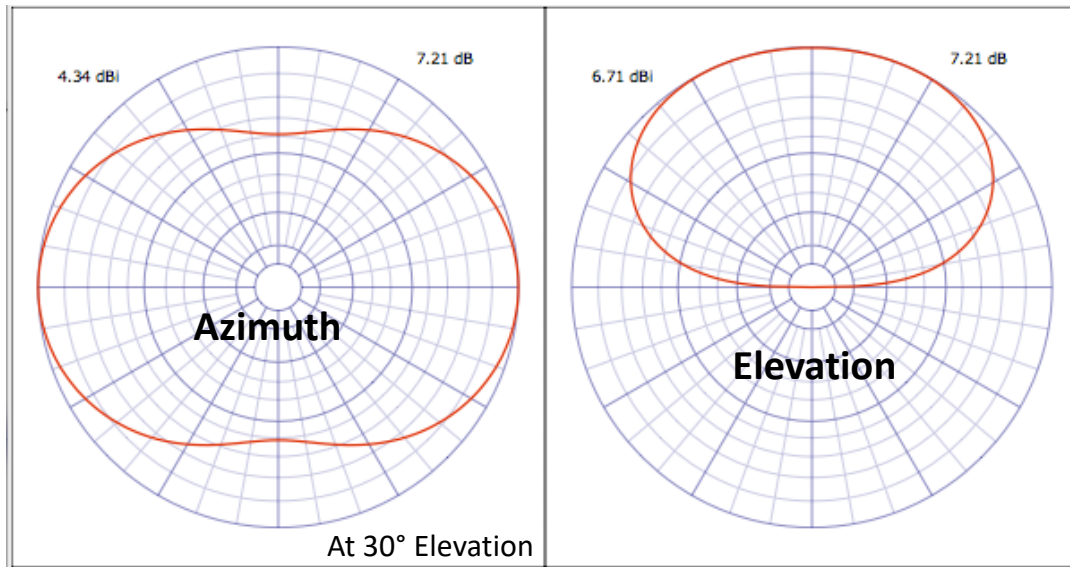
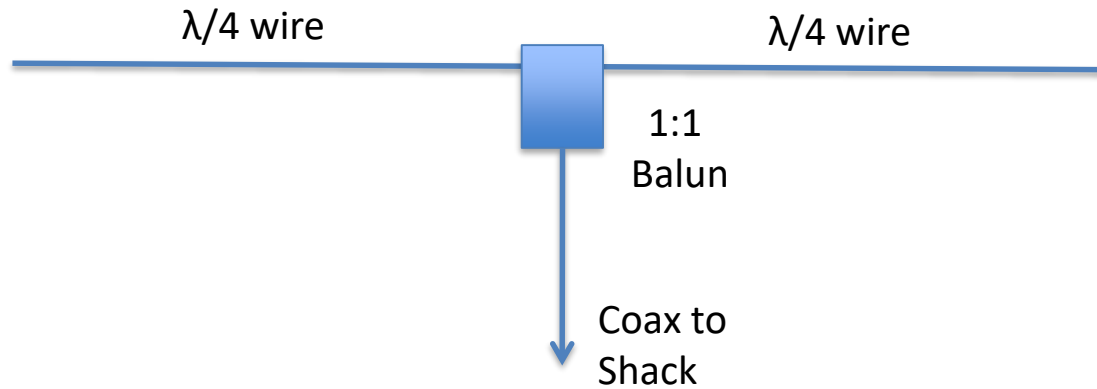
80-10M, 5-10 watts, CW/SSB, wide range ATU, 8 hours operating on internal battery

# DO NOT COPY

## Antenna Overview

- Since there are some new Hams in the club I'm going to make this an HF antenna tutorial
- The antenna couples radio frequency energy to free space in both directions, transmit and receive
- First I'm going to talk about the Dipole Antenna. I'll use that to define the important parameters
- Antenna gain is usually referenced to the radiation from a small point in space called an *Isotropic Radiator*. It radiates equally in all directions
- Adding a wire or other radiating element increases the radiation in some directions and decreases it in others. The increase in radiation in a specific direction is called directivity
  - Gain takes into account antenna efficiency

# DO NOT COPY Half Wave Dipole

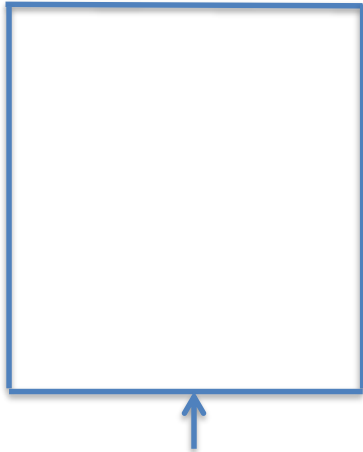


## Dipole Radiation Pattern

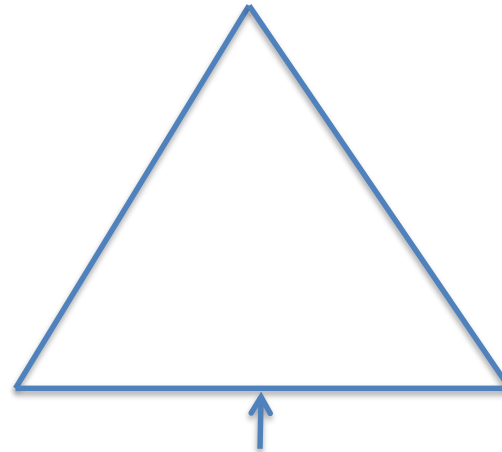
- 40M, 35' above ground
- ~6dB gain added by ground reflections
- Antenna wire along Y-axis
- The pattern is the same for any feed location
- High angle radiation favors local contacts

The dipole is the best basic antenna for HF QRP operating

# DO NOT COPY Loops



Feedpoint



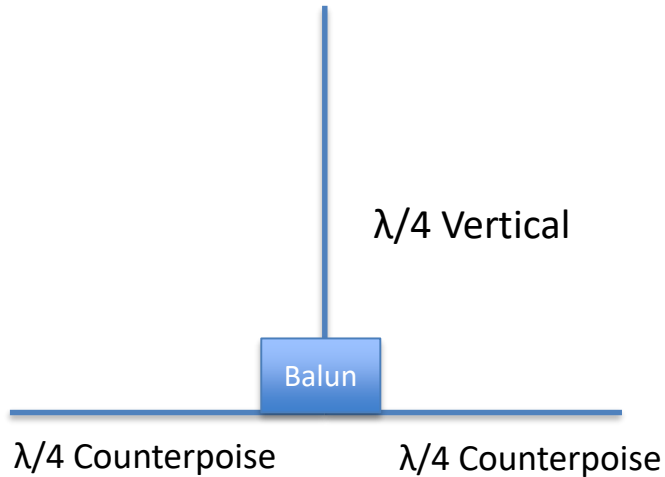
Feedpoint

- Full wavelength circumference is best
- 2:1 Balun at feedpoint ( $Z_a \sim 100\Omega$ )
- Pattern basically the same as a dipole at the same average height
- $\sim 1.5\text{dB}$  more gain
- Pick up less noise since they have no open ends
- Feedpoint for horizontal polarization shown, may be fed for vertical polarization with lower radiation angles but less gain
- Small Loops also work well

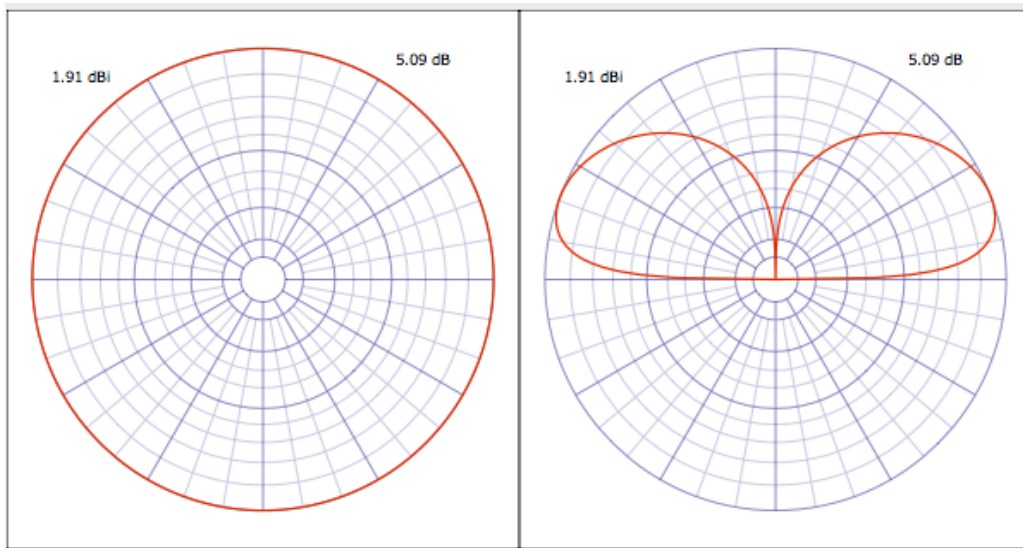
Full wave loops have advantages but require more space than a dipole

# DO NOT COPY

## Quarter Wave Vertical



- The analysis shows 40M performance with 16 counterpoise wires
- Lower gain than a dipole
- Lower radiation angles
- Less high angle radiation, poor for local contacts





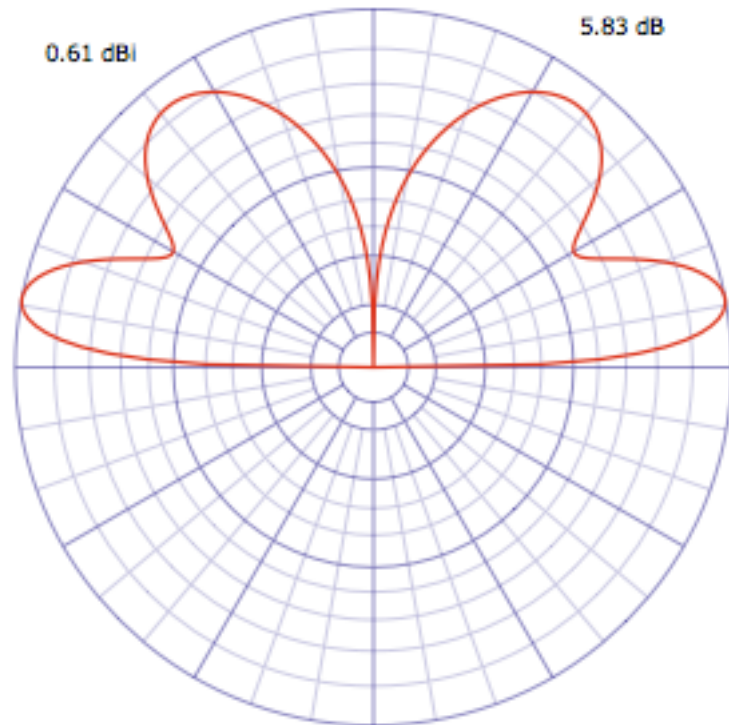
DO NOT COPY

## Elevated Vertical (20M @ 17')

Elevating the vertical requires fewer radials. Multiple vertical lobes will be different band-by-band.

This does permit having your antenna in the clear, not radiating directly into your home.

The popular “No Radials” verticals will exhibit the same behavior. For many hams they are a better antenna than a ground mounted vertical. I do not recommend the new versions that include 80M, the bandwidth is narrow and tuning is difficult.



The “No Radials” verticals work best close to ground  
I would not mount them higher than 10'

# DO NOT COPY

## Dipole vs. Vertical Antenna Comparison

Radiation Angle (degrees)	Single Hop Distance (miles)		Antenna Gain (dB)	
	f1 layer	f2 layer	Vertical on Gnd	Dipole @ $\lambda/4$
5	1200	2300	-2	-8
10	800	2000	1	-3
20	500	1200	2	2
30	300	800	2	5
40	240	650	0	6
50	200	500	-2	7
60	200	400	-4	7

Note: A dipole at  $\lambda/2$  matches the low angle performance of a vertical, but it also has an overhead null. Low antennas are best for local communications. DX is usually multi-hop at radiation angles between 3-20 degrees.

# DO NOT COPY

## Antenna Summary

- A low dipole is the best antenna for local contacts. At QRP power levels you will make more local contacts
  - Inverted-V
  - End Fed Half Wave
- The next best antenna is a loop
  - Horizontal polarization
  - Small loops work well
- Verticals are poor for local QSOs
  - Little high angle radiation
  - Good for DX



W4OP 48" Loop (LNR) is more efficient on 40M than the common 36" loops

# DO NOT COPY

## Antenna Related Stuff

- At QRP power levels you don't want extra loss between your antenna and the transmitter
- Resonant antennas with a low VSWR are the best performers
- VSWR losses on even good coax add up fast, keep your antenna VSWR <2:1
- Antenna tuners do not reduce these VSWR losses, they just match the impedance to 50Ω
- Multi-band antennas using ladder line feed are OK if you use a balanced line tuner in your shack. You still have VSWR losses but they are much lower.
- Baluns prevent unwanted feedline radiation that can distort your antenna pattern and cause problems in your shack

# DO NOT COPY

## VSWR Losses for Coax Cables

Frequency	VSWR	Loss in dB for 50' of coax		
(MHz)		RG-58	RG-8x	RG-213
7	2:1	0.8	0.5	0.3
	3:1	1	0.6	0.4
	5:1	1.5	0.9	0.7
	10:1	2.5	1.5	1.3
14	2:1	1.2	0.7	0.5
	3:1	1.5	0.9	0.6
	5:1	2.1	1.3	1
	10:1	3.4	2.2	1.7
21	2:1	1.4	0.9	0.6
	3:1	1.8	1.1	0.8
	5:1	2.5	1.7	1.2
	10:1	4	2.8	2

A loss of 0.5dB is 10% or 0.5 watt at QRP levels. 1dB is a 1 watt loss.

# DO NOT COPY QRP Operating

- The most popular mode is CW due to its signal to noise advantage
  - An SSB signal needs to be at least 16dB stronger to be readable
  - SSB is popular for HF Pack and SOTA activations
- There are informal QRP frequencies on all the ham bands. Many OPs monitor these, so call CQ even if you hear no activity. I've listed these in the appendix.
  - Best bands are 40 and 20M
  - These have the best balance of signal strength and noise
- If you call CQ do not sign /QRP. Many stations won't answer.
- Call anyone you hear CQing just like you do with your 100W station (no /QRP). If you hear them at say S-7, you will be S-5 which is usually good copy

# DO NOT COPY CW vs. SSB

- Lets say you have a modest QRP radio that has bandwidths down to 250Hz. We will use that for the CW bandwidth
- SSB requires about 2500Hz bandwidth for decent audio quality
- The biggest difference is noise, an SSB signal requires 10 times the bandwidth of a CW signal. That translates to 10dB more noise.
- The second difference is required Signal-to-Noise-Ratio or SNR
  - CW can be copied right down to the noise level
  - SSB requires about 6dB SNR for good intelligibility
- That means CW has a ~16dB advantage over SSB
  - 5W CW is roughly equivalent to 200W SSB
  - Comfortable rag chewing
- If you are willing to accept a bit less voice fidelity that number can be reduced to 13dB, but that still requires 100W for SSB
  - Contesting or DXing

# DO NOT COPY

## QRP Operating – cont'd

- Operator types
  - Classic, uses home made transceiver and simple wire antennas
  - Neo Classic, uses a commercial transceiver and simple wire antennas
  - Competitive, uses a commercial transceiver with a big Yagi up 75'
  - Masochist, operates QRP on 160M
- QRP contests are often designed to be fun
  - Less serious than traditional HF contests
  - Some require lengthy exchanges
  - Scoring based on power, home made vs. commercial rigs, weight of rig + accessories, etc.



# DO NOT COPY

## References

- The best QRP book available today is *ARRLs Low Power Communication* by Rich Arland, K7SZ (4<sup>th</sup> Edition)
- The ARRL also has other books for those interested in QRP projects
- The *ARRL Antenna Book* (23<sup>rd</sup> Edition) should be in every ham's library

# DO NOT COPY

## Appendix

- QRP Operating Frequencies (US version)

<b>Band</b>	<b>CW</b>	<b>SSB</b>
160M	1.810 MHz	1.910 MHz
80	3.56 3.710 (Novice)	3.985
40	7.04 7.110 (Novice)	7.285
30	10.106	
20	14.06	14.285
17	18.096	18.13
15	21.06 21.110 (Novice)	21.385
12	24.906	24.95
10	28.06 28.110 (Novice)	28.885 28.385 (Novice)
6	50.06	50.885
2	144.06	144.285

DO NOT COPY  
Appendix – QRP Vendors

- QRPARCI is the largest QRP organization. Their website is a great source for information. They have a great list of QRP suppliers at the url below:
  - <http://www.qrparci.org/links/grp-kits-bits-and-supplies>
- These are mostly small companies and they often run out of things, close due to the sole proprietor getting sick, discontinue products when parts are no longer available....you get the picture.

DO NOT COPY

Have Fun

Questions: [w6qr@arrl.net](mailto:w6qr@arrl.net)