

A decorative graphic on the left side of the slide, consisting of a network of thin, light green lines and small circles, resembling a circuit board or a stylized tree structure.

HOW TO GET ON 33CM / 900MHZ

PRESENTED BY: DAVID BROWN – WR6Z

WVARA MONTHLY MEETING – SEPTEMBER 2025

33CM / 900MHZ – WHY?

Yes, its one of the more obscure US amateur bands...

- Use it or loose it, all UHF spectrum is valuable for radio amateurs
- You don't have to spend a lot of money to get on their air
 - Less expensive than 1.2GHz, more gear available
- True DIY band
 - Can't just buy a radio off the shelf and get on the air
 - Fun for experimenting and learning
- Great add on for VHF/UHF contesting!
 - 3pt. contacts and extra multipliers maximize your score

33CM / 900MHZ BAND BACKGROUND

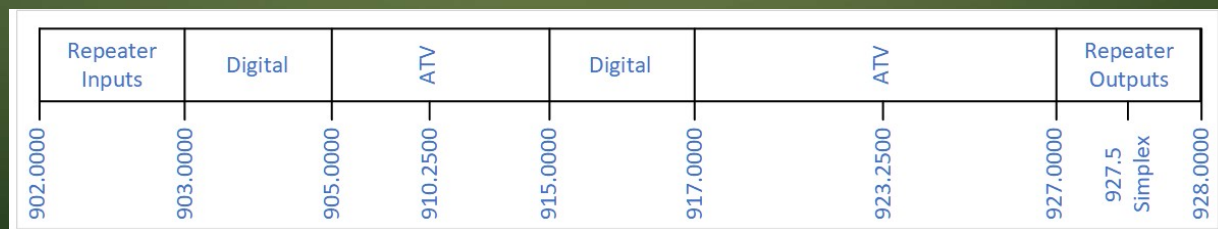
- In 1985 the FCC allocated 902-928MHz to Part 18 ISM devices
 - Allocations in ITU Region 2 only, meaning primarily North America with a few exceptions
 - ISM = Industrial, Medical and Scientific (devices for non-communications purposes)
 - Part 97 US amateurs were granted as secondary users as part of this allocation
 - Part 15 devices were also granted use of this spectrum as a 3rd tier user
 - Cordless phones, wireless networking, consumer electronics, wireless widgets, etc
- As with other spectrum allocations where US amateurs are granted as secondary users:
 - Part 97 devices may not interfere with and must accept interference from Part 18 Primary users
 - Part 15 device may not interfere with Part 18 or Part 97 devices and must accept interference from primary and secondary users

33CM / 902-928MHZ AMATEUR BAND

Open to US all amateur license classes! →

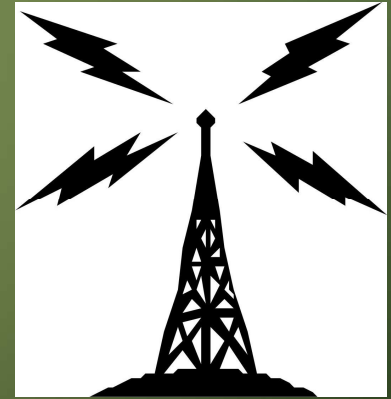


- Emissions - Part 97.305 (33cm): CW, phone, image, RTTY, data, SS
- Some areas of restricted operation and power limits
 - Similar to other UHF bands (420-440MHz)
 - Refer to FCC Part 97.301(n) and Part 97.313(g)
- Band Limits / Band Plan per NARCC: 902MHz to 928MHz



33CM PROPAGATION

- 33cm UHF propagation is very “line of sight”
 - Even more so than 70cm and similar to 23cm
 - If in good line of sight, very little Tx power is needed
- Anything can block or hinder signal paths
 - Trees, buildings, walls can affect propagation
- Signals easily bounce off mountains, buildings or other objects
- Different multipath behavior can be interesting



HOW TO GET ON THE BAND

You will not find 900Mhz radios at your regular ham radio retailer

- No major amateur equipment manufacturers make radios to operate on the 33cm band
 - One exception from Alinco and excluding transverters
- DIY! - Wide array of commercial radios available, but must be converted for amateur use
 - Radios intended for the LMR 896-901MHz(Tx)/935-940MHz(Rx) commercial band
 - For Commercial Radios: Frequencies, modes and functions are not readily front panel accessible
 - Must be pre-programmed via software
 - Conversions run from simple software editing to hardware modifications
- Where to get commercial radio gear:
 - Radios often sold by amateurs through 900MHz Google/Facebook groups, eham, QRZ, etc.
 - Amateur Radio Swap meets
 - Commonly available on ebay – Buyer be aware: Know your model numbers, details and prices!

PROGRAMMING AND MODIFICATIONS

Basic amateur operation with a commercial radio:

- Narrow FM: 12.5kHz channel spacing, 2.5kHz deviation
- TX ok over full 902-928MHz band
 - TX usually designed to operate from 896-901MHz and 935-940MHz for simplex op.
- RX typically good down at least 926MHz due to 938MHz front end filters
 - It ok – Needed FM voice RX is between 927-928MHz
- Software programming mods:
 - Motorola modification require software hex editing
 - Change limits from 896-901MHz and 935-940MHz to allow 902-928MHz frequency entries in CPS
 - Edit channel frequency data in the active radio codeplug
 - Kenwood software enters frequencies by FCC channel number
 - Radio data file edited to ham frequencies by a freeware program
 - Written by a ham (N2MCI)
 - Skip these procedures and use the latest version of CHIRP!

COMMERCIAL RADIO TERMINOLOGY

- Motorola:

- “CODEPLUG” = radio programming data file (origins in hardware configuration plugs)
- “Direct” Mode = simplex operation
- “Repeater” Mode = Tx/Rx frequency split operation
- Zone = specific memory bank of channels
 - Channel = specific radio channel programmed with a given frequency
- RSS = Radio Service Software (typically DOS based for older radio models)
- CPS = Customer Programming Software (typically windows based for newer radios)

- Kenwood:

- “Talk Around” or T/A = simplex operation
- System = Specific memory bank of channels
- Group = specific radio channel frequency

33CM RADIO MODELS TO LOOK FOR

Amateur Band Specific Radios – the one lone exception:

- Alinco

Commercial Radios:

- Motorola
- Kenwood

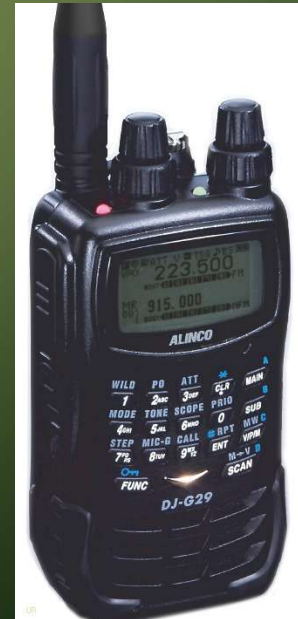
To a lesser extent:

- EF Johnson
- GE
- Harris
- Bendix

ALINCO

DJ-G29T – The only 33cm amateur band specific radio ever made

- Dual band radio covering 220MHz and 900MHz ham bands
 - Tx power: 5W at 222MHz and 2.5W at 912MHz
- Easy frequency entry and display
 - Exactly what you would expect for ham radio
- Easy to obtain software for programming
 - Free from Alinco or buy RT Systems software
- No longer on production ☹... can find used on-line
 - Expect to pay \$400 or more for a used radio in clean condition



MOTOROLA – HANDHELD RADIOS THAT WORK

FM / Analog Handheld Radios: \$10 to less than \$100, free if you get lucky!

- Know your model numbers
 - Many 800MHz and 900MHz radio models look the same
 - “W” split radios are 900MHz, “U” split are 800MHz and wont work
- Mods - software hex edit to open band limits and get on the air
- GTX and MTS software require 32-bit PC – wont run on newer PCs

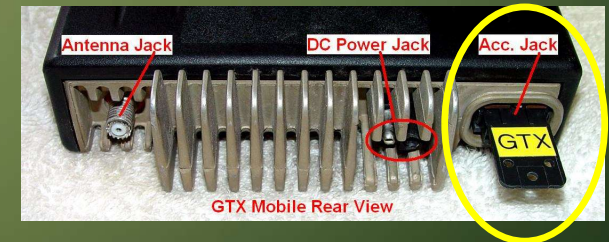
Model Name	Model Number	Tx Power
GTX	H11WCD4CB1AN	3W
MTS2000	H01WCH4PW1CN	3W
MTX9250	AAH25WCH4GB6AN	3W



MOTOROLA – MOBILE RADIOS THAT WORK

Common Mobiles - Analog/FM, most only need modified software

Model Name	Model Number	Tx Power	Display	Cost Range
Maxtrac*	D27MJA7DA6_K	12W	Numeric	Free - \$50
GTX	M11WGD4CB1AN	15W	Numeric	\$25-\$50
GTX	M11WRD4CB1AN	30W	Numeric	\$25-\$75
MCS2000	M01WGL4PW6AN	15W	Numeric	\$25-\$100
MCS2000	M01WJN4PW6AN	30W	Alphanumeric	\$25-\$150
Spectra*	D37KMA/D45KMA	30-35W	Alphanumeric	\$50-\$150



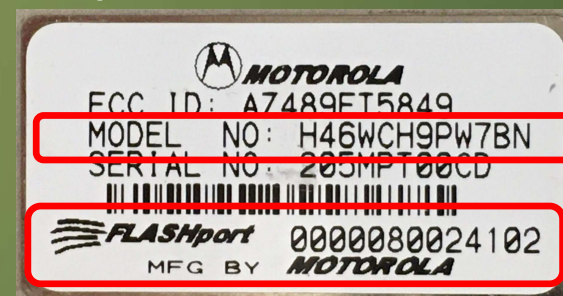
- * Requires hardware and software mods to get best performance
- All models have extensive rear accessory connectors allowing for easy external interfacing
- Software is 32-bit or DOS based, won't run on newer PC's or run using DOSBox



MOTOROLA – MIXED MODE ANALOG / DIGITAL

FM/Analog and P25 Digital Mixed Mode Radios

- All work over 900MHz amateur band with hex edited CPS
- Some models Front Panel Programming (FPP) capable
- Watch out for model numbers and analog only flashcodes
 - RadioReference.com, CS forum and akardam.net flashcode decoders are very useful



Model Name	Model Number	Type	Tx Power	Channels	Cost Range
XTS1500	H66WCD9PW5AN	HT	2.5W	48	\$25-\$150
XTS2500	H46WCH9PW7BN	HT	2.5-3W	870	\$50-\$350
XTL1500	M28WRS9PW1AN	Mobile	30W	48	\$150-\$400
XTL2500	M21WRS9PW1AN	Mobile	30W	Up to 1000	\$250-\$400
APX4000	H51WCH9PW7AN	HT	2.5W	512	\$400-\$700
APX4000XH	H51VCH9PW7AN	HT	2.5W	512	\$450-\$900
APX4500	M22WRS9PW1AN	Mobile	30W	512-1000	\$450-\$1200



Notes:

APX series – mods are available through a ham network for ham use only

MOTOROLA – MIXED MODE ANALOG / DIGITAL

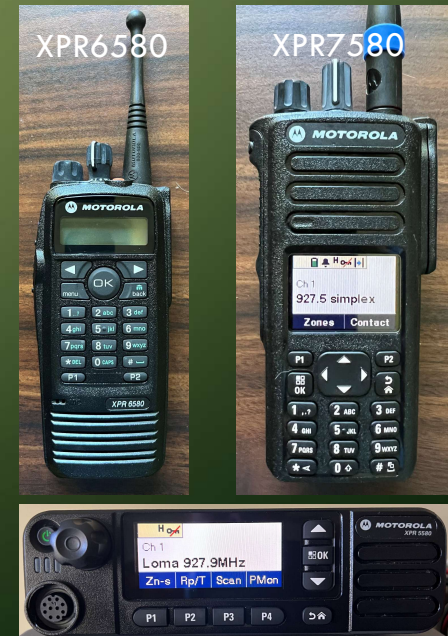
FM/Analog and DMR Mixed Mode Radios

- All work over 900MHz amateur band with hex edited codeplug
 - CPS16 preferred with firmware R2.09 or older, CPS2.0 more difficult to use and edit
- “U” Freq. Split Exception, these radios cover 800/900MHz bands
- Work great for analog/conventional operation. No open SF Bay Area DMR repeaters

Model Name	Model Number	Type	Tx Power	Channels	Cost Range
XPR6380	H55UCC9LB1AN	HT	2.5W	32	\$20-\$150
XPR6580	H55UCH9LB1AN	HT	2.5W	1000	\$20-\$150
XPR7380	H56UCC9KB1AN	HT	2.5-3W	32	\$50-\$250
XPR7580	H56UCN9KB1AN	HT	2.5-3W	1000	\$75-\$250
XPR4380	M27UMC9LB1AN	Mobile	30W	32	\$75-\$325
XPR4580	M27UMH9LB1AN	Mobile	30W	1000	\$100-\$380
XPR5580	M28UMN9KA1AN	Mobile	30W	1000	\$100-\$350
XPR5580e	M28UMN9RA1AN	Mobile	30W	1000	\$150-\$350

Notes:

XPR7380e/XPR7580e HT's can not be modified for ham band use



KENWOOD

Kenwood 900MHz radio models: Straight forward – Easy to use

- 900MHz radios have specific model numbers so no confusion
- Kenwood software not hard to obtain
- CHIRP now supports TK-981 programming

Handheld Radios:

Model Name	Modes	Tx Power	FPP	Cost Range
TK-481	Analog FM	2.5W	No	\$50-\$150
NX-411	Analog/NXDN	2.5W	No	\$125-\$400

Mobile Radios:

Model Name	Mode	Tx Power	Tx Freq. Split	Cost Range
TK-981	Analog FM	15W	Any / Custom	\$50-\$350
TK-941	Analog FM	15W	39MHz – simplex	< \$100
TK-931	Analog FM	15-30W	25MHz ok	\$25-\$100
NX-901	Analog/NXDN	15W	Any / Custom	\$200-\$400

- NXDN radios are nice but no SF Bay Area NXDN repeaters
- TK-980, TK-940 and TK-930 are 800MHz radios often listed as 900MHz
Avoid these radios, then will not work for 902-928MHz amateur operation

Kenwood Tri-band Radio

Undocumented Feature:

TM-741/742 UHF 900Hz RX

- Select 440MHz UHF Band
- Select VFO mode
- Press and hold the MHZ button
 - Display changes to 900MHz
 - Press and hold MHZ button again to return to 440MHz
- Hardware mod available to improve Rx sensitivity

KENWOOD TK-981

Great Starter Radio for 900MHz

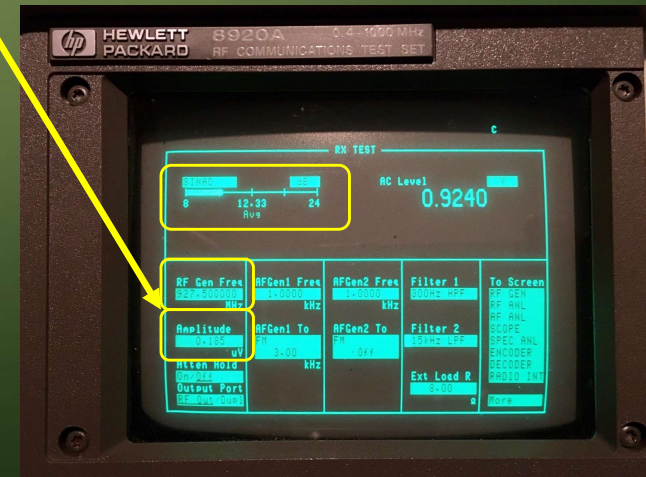
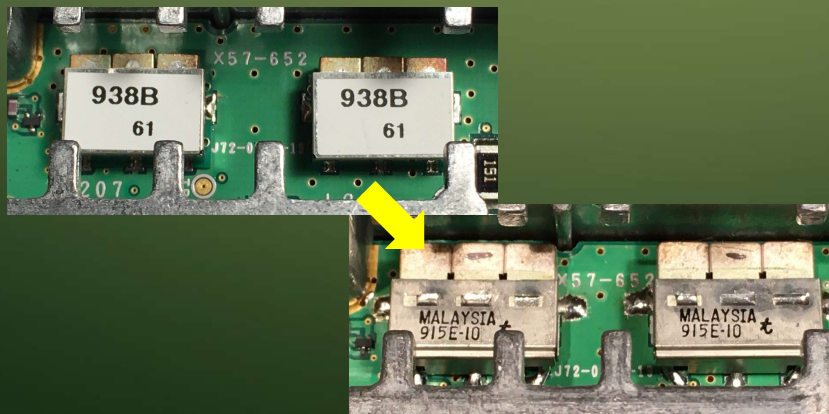


- Small, compact, good display with 1000 memory channels
- Two Versions spelled out clearly of the rear model number plate:
 - TK-981 Ver. 1 – uses DOS based programming software
 - TK-981 Ver. 2 – uses modern windows software (KPG-49D) or CHIRP
 - Old 15W PA models – Serial Numbers < 60600000
 - New 30W capable PA models – Serial Numbers > 60600001
- Can program standard 25MHz offset or custom TX offset frequencies
- Front panel buttons customized via software
- 15W output, adjustable via software

TK-981 MODS FOR THE EXPERIMENTER

RX Filter Swap - Change 938MHz front end filters to 915MHz

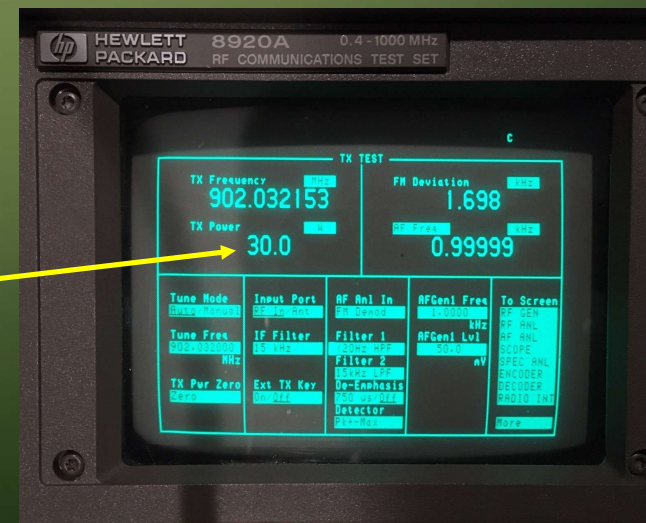
- Open up Rx to 916-928MHz and allow 12MHz Repeater offsets
- Improved RX sensitivity at 927.5MHz
 - Rx 12dB SINAD sensitivity spec is 0.25uV. Typically measure 0.22uV at 927.5MHz
 - Filter swap can increase sensitivity to 0.18uV at 927.5MHz (a 2-3dB improvement)
 - Good for weak signals during a contest



TK-981 MODS FOR THE EXPERIMENTER

“TK-981H” - TX Power mod 15W to 30W

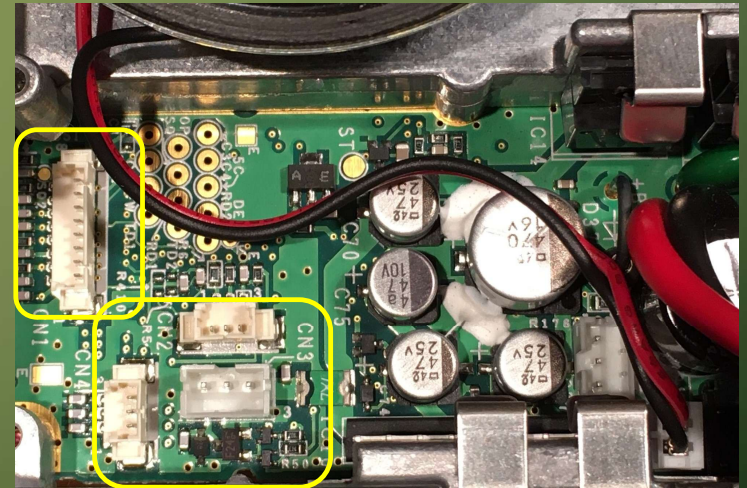
- Swap TK-981 Chassis for high power long heat sink from other HG models
- Older Ver.2 models require PA swap + a few parts and re-chassis
- Newer models only need chassis swap and turn up the power through software
 - S/N: 60600001 and higher



TK-981 MODS FOR THE EXPERIMENTER

Accessory Port for External Interface

- Connections for
 - TX Audio/Mic, RX audio/Speaker, PTT, COS
 - Radio on/off (ignition switch)
 - Data – TXD/RXD, GPIO
 - Switched 13.8V power (up to 750mA) & GND
- Many Possible Uses
 - Interface for repeater control
 - Alltstar node / MMDVM Hotspot
 - Remote base / Remote radio control
 - Packet / Data link radio



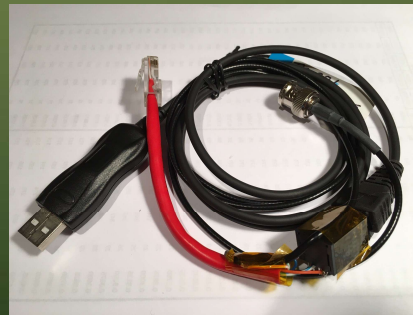
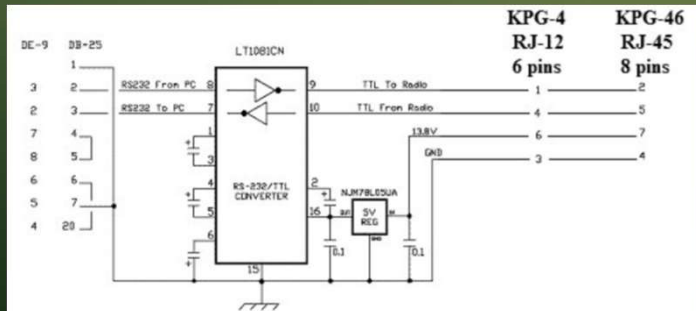
PROGRAMMING AND INTERFACE CABLES

Buy or DIY programming cables

- Buy – Typically \$15-\$45 on line depending upon the radio
 - USB and serial programming cables readily available
- DIY – Schematics / Plans on-line for just about any cable
 - Save \$\$
 - Helps if you start with a USB – Serial (RS-232) adaptor/dongle



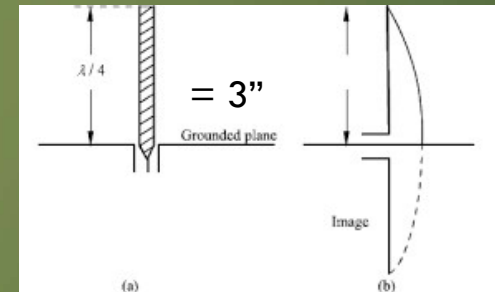
Tripp-Lite USB-DB-9 Serial Dongle
Model: USA-19HS



ANTENNAS

Antennas for 33cm are small and cute

- A quarter wave vertical is only 3" tall at 915MHz
- Great for limited space or low-profile installations
- Many commercial antennas can be bought on-line cheap!
 - Surplus Part 15 commercial 902-928MHz antennas
 - Commercial band 896-960MHz LMR antennas



Inexpensive 902-928MHz Yagi



3dB Gain
No Ground Plane

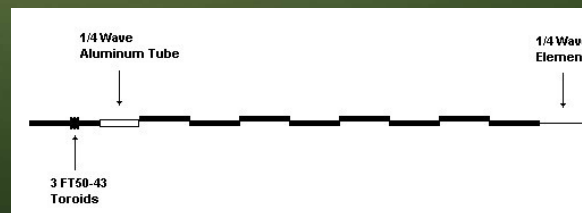
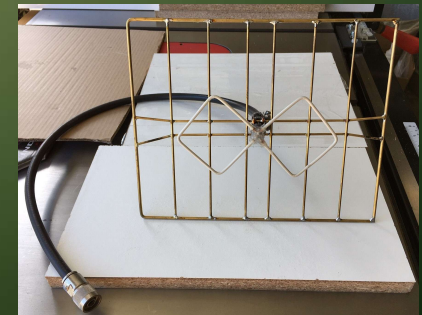


6dB Gain
Colinear

ANTENNAS

DIY - Make your own – it's not difficult and very inexpensive

- Simple quarter wave using a bulkhead N connector and a few inches of wire – cost about \$1
- Bi-Quad antennas are easy to make, wideband and forgiving to match
 - Directional wide band gain antenna
 - Typical 9dB Gain, 60-degree beam width
 - Several plans and dimension calculators in-line
- Co-Linear – not hard to make from coax scraps and PVC pipe
 - Omni-directional gain antenna
 - Plans and calculators on-line



FEEDLINE AND CONNECTORS

At 900MHz everything effects signal path loss.....

Connectors - N connectors are most common

- Assume up to 1 dB loss for every connector
- Use high-quality adaptors when needed

Feedline – Use High Quality Cable!

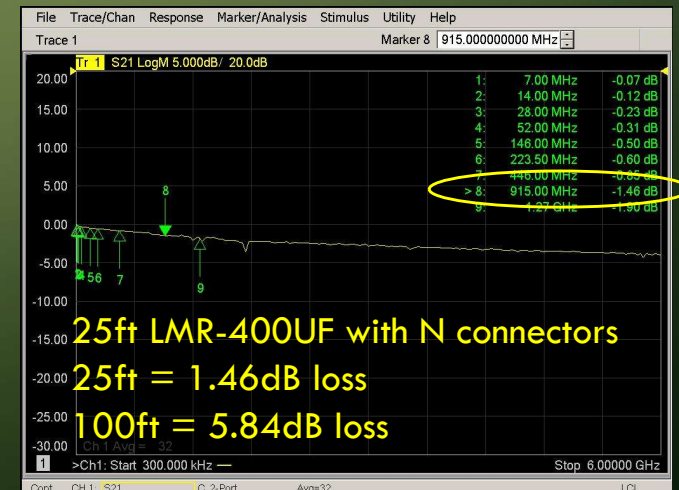
- LMR-400, LMR-600 or better recommended
 - LMR-400 has almost 6dB loss / 100ft
- Use Hardline if available to you
- RG-58, RG-8x only for mobile installations



N Connector – Yes



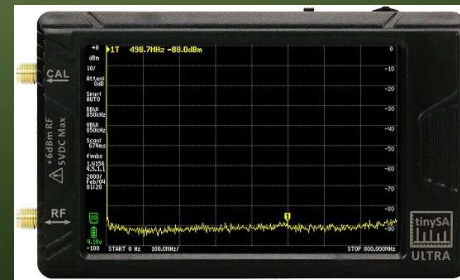
UHF / PL-259 – No



TESTING AND EQUIPMENT

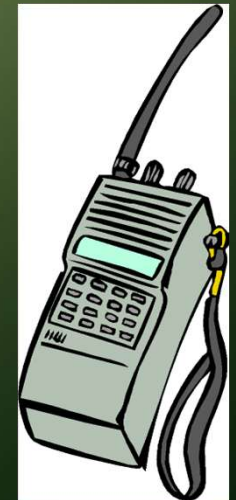
Testing and Equipment can be a challenge

- Most amateur test gear won't operate at 900MHz
- Creativity can get you around this obstacle
- Radios might require alignment after programming or hardware modifications
 - VCO adjustments can usually done with a DVM while observing freq. operation
- For basic radio and antenna testing, a Bird 43 wattmeter is a great option
 - Can measure RF output power, VSWR can be calculated based on forward and reverse power measurements
- NanoVNA's and tinySA's that operate up to 1GHz or higher are great tools to use



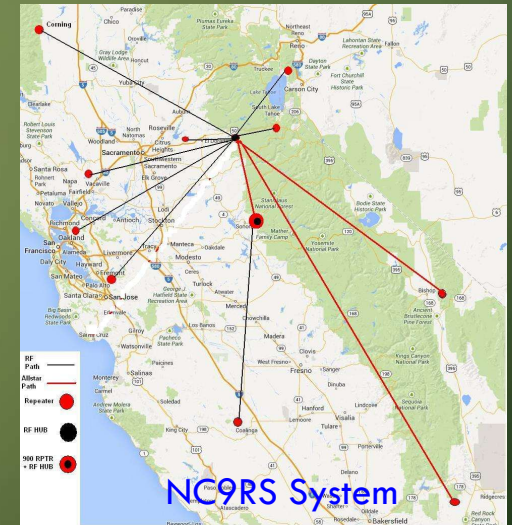
OPERATING

- Narrowband FM (NFM) operation is standard:
 - 12.5kHz channel spacing / 2.5kHz deviation
- Simplex
 - National simplex calling frequency: 927.5MHz
 - Optional PL 151.4Hz or 100.0Hz
 - Listen for activity during VHF/UHF contest weekends!
- Repeaters
 - Analog FM and P25 digital systems on the air in the Bay Area
 - All use PL or DPL encode and decode, P25 systems typically use NAC 293
 - 25MHz offset with 12.5kHz channel spacing
 - Inputs: 902.0125MHz to 902.9875MHz
 - Outputs: 927.0125MHz to 927.9875MHz
 - Note – many repeaters use non-standard input frequencies to avoid interference



BAY AREA REPEATERS YOU CAN USE

- RepeaterBook and RadioReference listings are not always accurate for 900MHz repeaters!
 - NARCC and NC9RS Facebook group usually more up to date for listings of repeaters on the air
- WR6Z – Loma Prieta
 - Analog FM and P25 digital dual mode repeater (P25 for local traffic)
 - 927.9MHz / Input 902.0375MHz, DPL 411 / P25 NAC 293, Allstar Node: 40036
 - Often linked to other 900MHz systems – NC9RS and K5TRA via Allstar
- NC9RS - All 900MHz System
 - All Analog FM with one common input frequency for most of the system
 - Allstar linked wide area linked system covering northern California and beyond
 - W6SRR input on Mt. Allison (above Milpitas) 927.1875MHz / Input 902.0125 pl 94.8Hz
- WB6OTX – PAARA East San Jose Hills
 - Analog FM located in the East San Jose Hills
 - 927.0750MHz / Input 902.0750MHz, PL 107.2 / P25 NAC 293
- N6NMZ
 - Analog / FM Located somewhere 2000ft above Los Gatos. 927.15MHz / Input -25MHz pl 156.7 Hz
 - Linked system to various 2m, 1.25m and 70cm repeater through out Northern California
- WW6BAY – Analog FM, 927.8625MHz / Input -25MHz, DPL 023 (crossband to 2m/70cm)
- WI6H - Analog FM and P25 digital – Inputs in SF (Sutro), East Bay Hills



RESOURCES

- General:

- [Google.com](https://www.google.com) - Once again, google can be your friend to find 900MHz parts, manuals and info on-line
- www.repeater-builder.com – vast site with technical information, manuals and how-to
- [RadioReference.com Forums](http://www.radio-reference.com) – Radio Reference Forum, Motorola and kenwood radio discussions
- <https://communications.support/> - Commercial radio discussion forum, has lots of info on how to fix issues with radios
- <https://wiki.w9cr.net> – W9CR wiki page, lots of great information and downloads

- Kenwood Specific:

- www.kw902.com – One stop source for all things related to Kenwood 900MHz gear by Alex, KD6VPH

- Motorola Specific:

- www.batlabs.com – large site with discussion forum for all things Motorola, old and new

- Google Groups and Facebook

- [PNW-902MHz@groups.io](https://groups.io/g/PNW-902MHz), [AR902MHz@groups.io](https://groups.io/g/AR902MHz)
- Facebook Groups: NC9RS, 33cm/902MHz Amateur Radio Users

GO GET A 900MHZ RADIO AND ON THE AIR!

Questions?

Thanks for listening

73, Dave – WR6Z

Contact: wr6z@arrl.net

