Introduction to SHF and the Revolutionary Icom IC-905

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Icom IC-905 Basics

- 144, 430/440, 1200, 2400, 5600 MHz Bands
- 10 GHz Option Available and 24 GHz Coming Soon
- CW, SSB, AM, FM, RTTY, D-STAR DV/DD and FM-TV (Amateur TV)
- Control Head with PoE Power Supply, Connectivity and Heat Sinks
- Mast Mounted Transceiver Powered by PoE
- GPS-Controlled Oscillator for Ultimate Frequency Stability
- Wideband 50 MHz Span Real-time Spectrum Scope
- SD slot, USB-C, Ethernet LAN and More…

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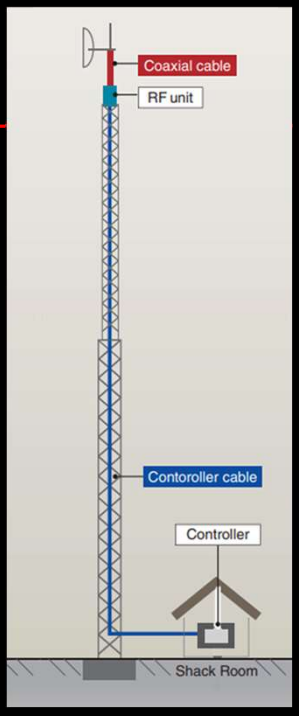
IC-905 Installation Diagram



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The installation is basic: Controller, LAN cable, RF Unit, Short feedlines and Antennas

Why SHF (VHF+)?

- Every license class can participate on VHF+
- Weak signal VHF+ is a different challenge than HF operating
- VHF+ operating is more cooperative
- Antennas are compact and can be quite portable
- All bands have enhancement solutions
  - Not limited to line of sight
- Use the spectrum or lose it
  - 1.2GHz and 3.4Ghz are already at risk
- Plenty of spectrum for all modes, including FM and ATV

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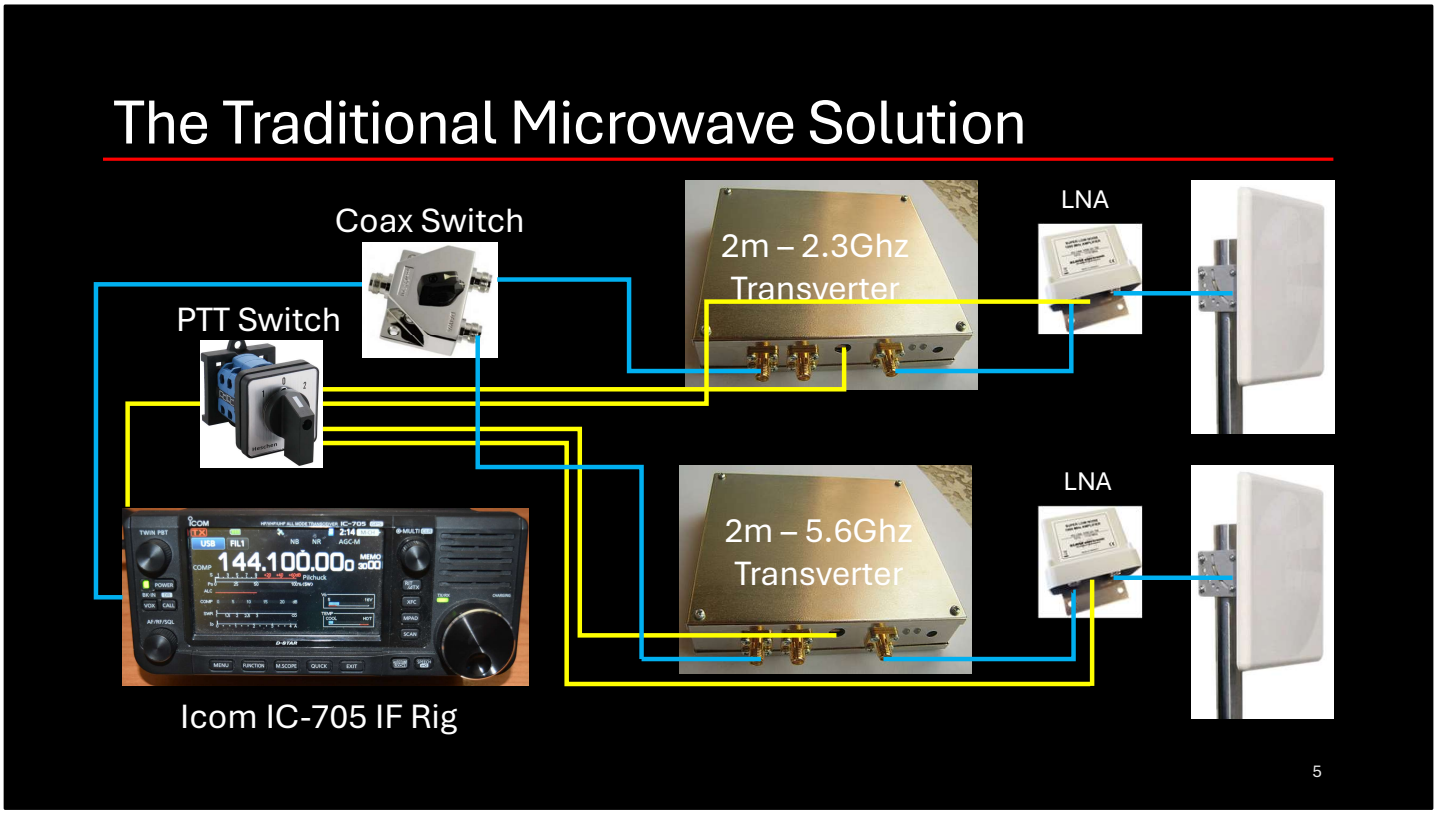

This is a simplified diagram of two transverters tied to a single IF rig. The very LOW LOSS coax has to be switched between the transverters. These transverters have internal T/R switches (not common). Similarly, this LNA has an internal relay. LNAs are necessary to overcome coax losses. Often a remote relay has to pull it out of the circuit and power it down to prevent transmitting through it and burning it out. Sequencers can be used to automate this switching with remote relays but adds wiring complexity.

https://www.w6pql.com/relay_sequencer.htm

Traditional Microwave Issues - Complicated

- Many components with complicated wiring
- Manually switched solutions are simpler/cheaper but error-prone
  - Accidental damage is common when forgetting a switch or connection
- Various transverter and LNA designs create confusion
- Microwave coaxial relays and sequencers are not common
- Many components are only available as boards or kits, no cases
- Not all components are inherently waterproof
- Assembly requires skills, tools, test equipment and time

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Traditional Microwave Issues - Cost

- Each band can be quite expensive to implement
  - Microwave test gear not represented
  - Note the typically low power of transverter
  - Amplifier pricing not shown
  - Average $1500 per band plus IF Rig
  - $4400 for IC-705 with two transverters

Component	Low Price	High Price
Transverter	$299 w/50mW	$889 w/250mW
LNA	$120	$489
Coaxial Relay	$70	$145
Band Decoder	$45	$299
Sequencer	$37	$248
50’ Feedline	$166–LMR600	$270-LDF4

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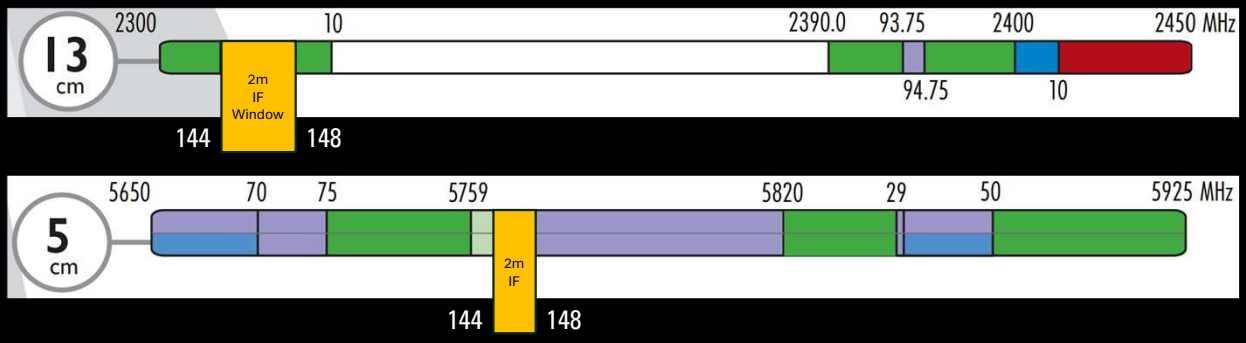
These numbers only account for major components and not all the interfacing and time necessary to assemble all the pieces. The lowest end shown is $737 and the high is $2340. Even the high end is missing pieces and functionality. Best case would be assembling a variety of these components to yield a median price of ~$1500 per band. This doesn’t include the IF radio which would most closely match the Icom IC-705 at ~$1400 at this time. An IC-705 with two transverters yields a system with HF, 6m, 2m, 70cm, 13cm and 5cm coverage for $4400 and still lacks many additional features of the IC-905 (no 23cm, ATV, etc.)

Low 23cm transverter at 50mW
https://www.downeastmicrowave.com/ProductDetails.asp?ProductCode=MINI2304
High 6cm transverter at 250mW https://shop.kuhne-electronic.com/kuhne/en/shop/converter-transverte/transverter/MKU+57+G4++6+cm+Transverter/?card=1857
Low LNA https://www.downeastmicrowave.com/product-p/l5ulna.htm
High LNA https://shop.kuhne-electronic.com/kuhne/en/shop/low-noise-amplifiers/MKU+LNA+572+AF++Super+Low+Noise+Preamplifier/?card=603
Low Coaxial Relay https://www.rfparts.com/relays/relays-coaxrelays.html?dir=asc&limit=all&order=price
High Coaxial Relay https://www.fairviewmicrowave.com/spdt-failsafe-18-ghz-electro-mechanical-relay-switch-indicators-60w-12v-sma-fmsw6351-p.aspx
Band Decoders from DownEast Microwave https://www.downeastmicrowave.com/category-s/1853.htm
Low Sequencer https://w6pql.com/parts_i_can_provide.htm
High Sequencer https://www.m2inc.com/FGS3
Low Feedline https://www.rfparts.com/l600nmhnmh-50.html
High Feedline https://www.bridgecomsystems.com/products/1-2-heliax-feed-line-50ft

Traditional Microwave Issues - Limiting

- IF bandwidth limits available spectrum
  - 10m IF provides 1.7MHz, 2m IF provides 4MHz, 70cm IF yields 20-30 MHz
  - 70MHz of spectrum at 13cm, 275Mhz at 5cm, 500MHz at 3cm!



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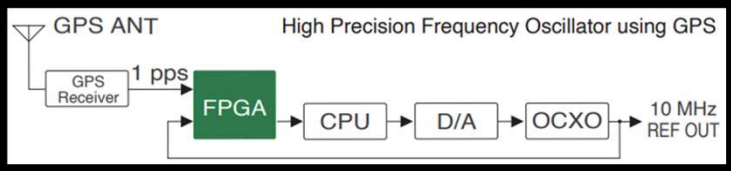
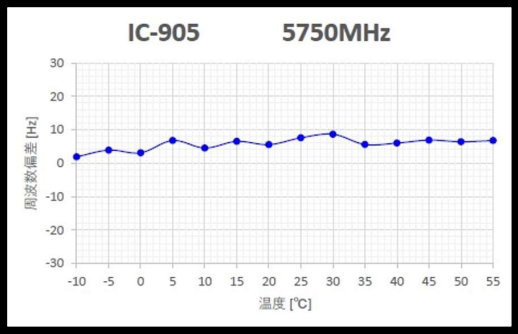
Note these diagrams are not to scale. The actual IF windows are smaller than shown. The IC-905 provides access to the entire amateur allocation, not just a small IF window on each band. Until now, it has been difficult to access significant portions of these allocations. It also places them at risk because it appears the entire allocation is unnecessary and could be better used for another service.

Traditional Microwave Issues - Stability

- Transverter oscillators are often inaccurate/unstable (drift)
- Small oscillator errors are significant at microwave frequencies
  - Errors in the kilohertz are common
  - The spectrum scope is helpful finding these signals
- IC-905 uses a high stability OCXO + GPS GNSS signals as a reference





IC-905（OCXO）

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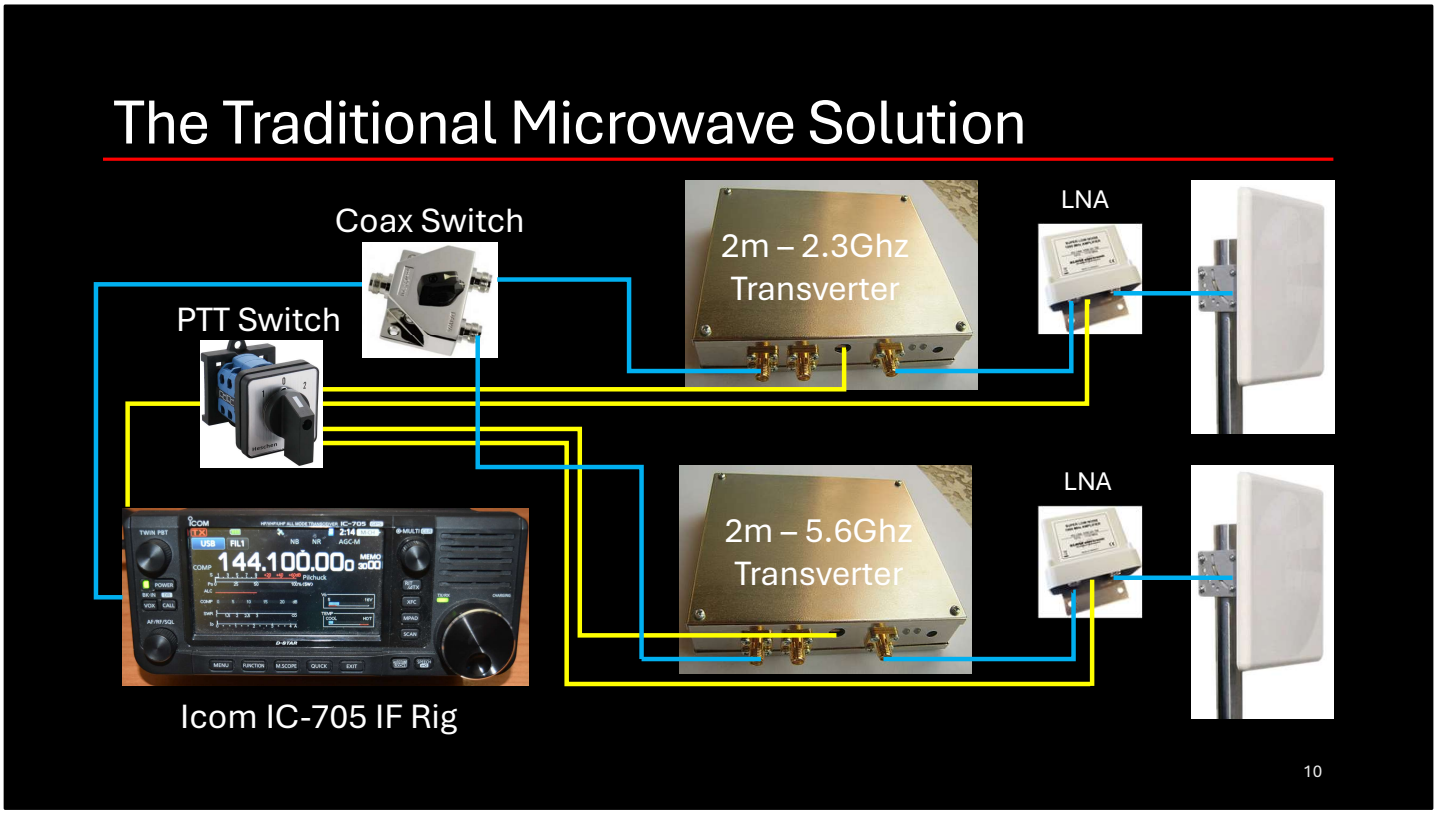
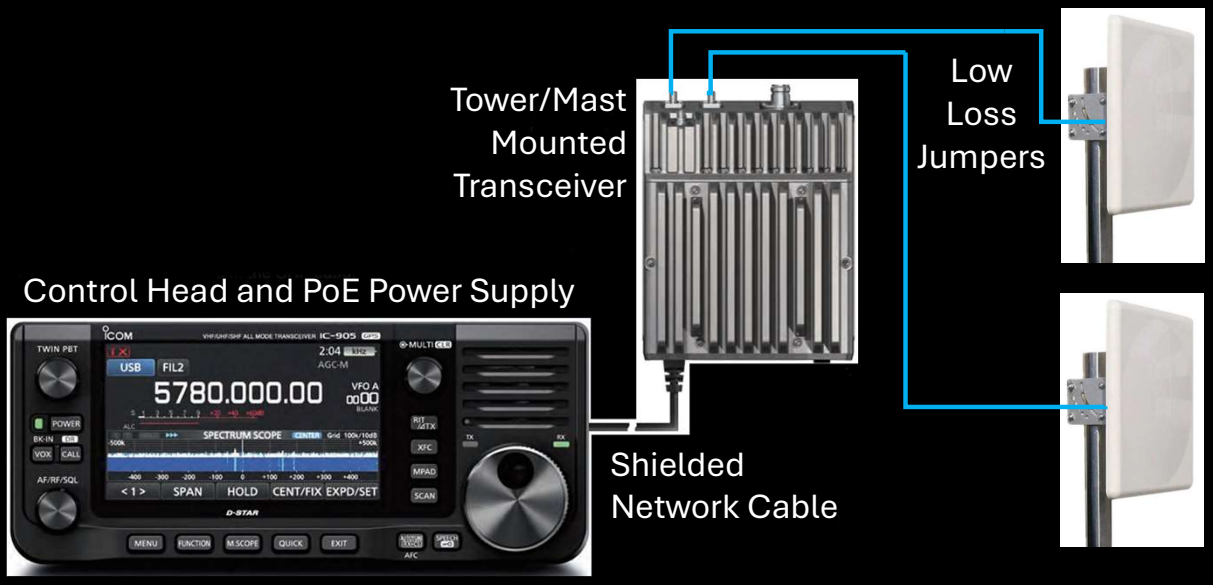
The IC-905 not only uses OCXO, which boasts high frequency stability, but also uses a method based on GPS and GNSS signals, enabling extremely stable frequency management. Even high-performance OCXOs experience gradual changes in frequency over temperature and aging. In the case of a typical OCXO, the annual deviation is 0.3 ppm, and in 10 years it is 1.5 ppm. At 5.6 GHz, the deviation is as much as 8.4 kHz in 10 years. The IC-905 uses GPS GNSS signals as a reference to achieve high accuracy and high stability over a long period of time.



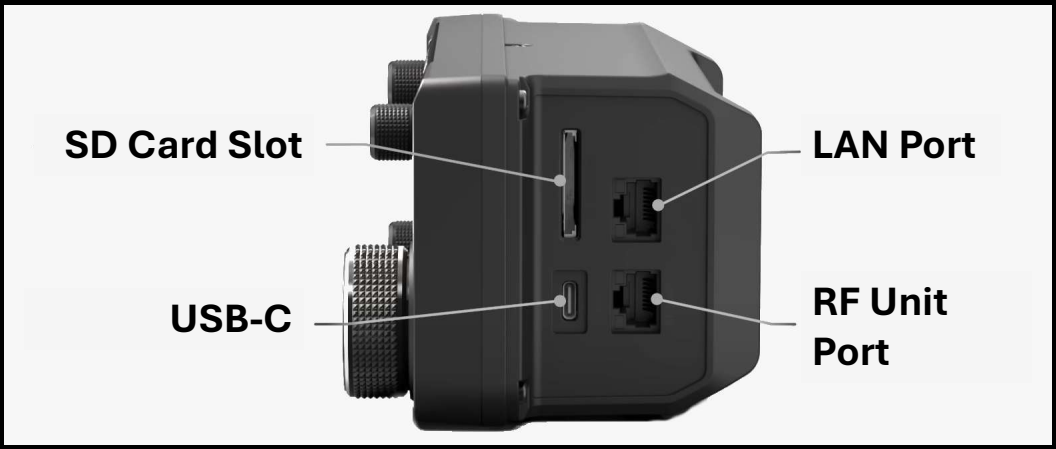
Look again at the traditional solution

Icom IC-905, A Better Way



Full spectrum available, not limited by IF bandwidth
GPS-Controlled Oscillator for ultimate frequency stability
Spectrum scope allows finding those transverter users

Controller – Right Side



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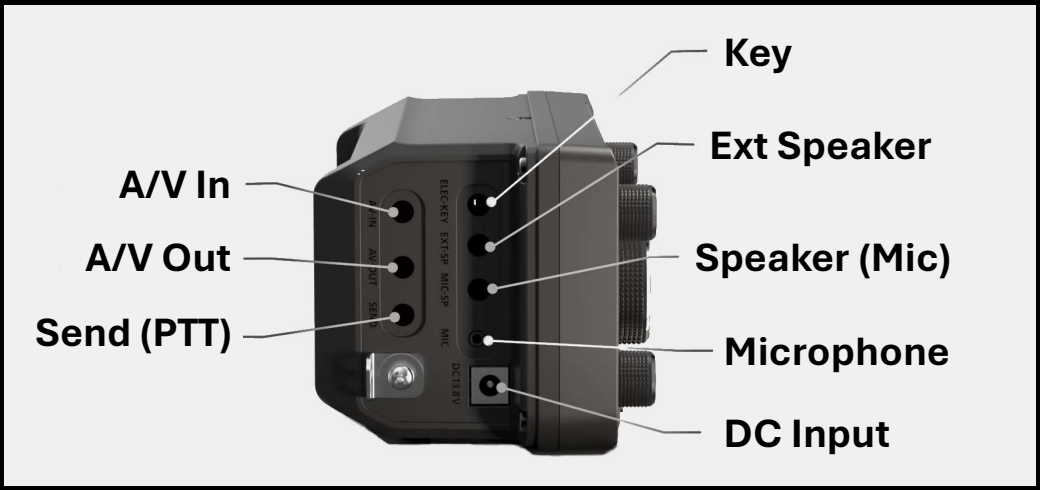
Controller – Left Side



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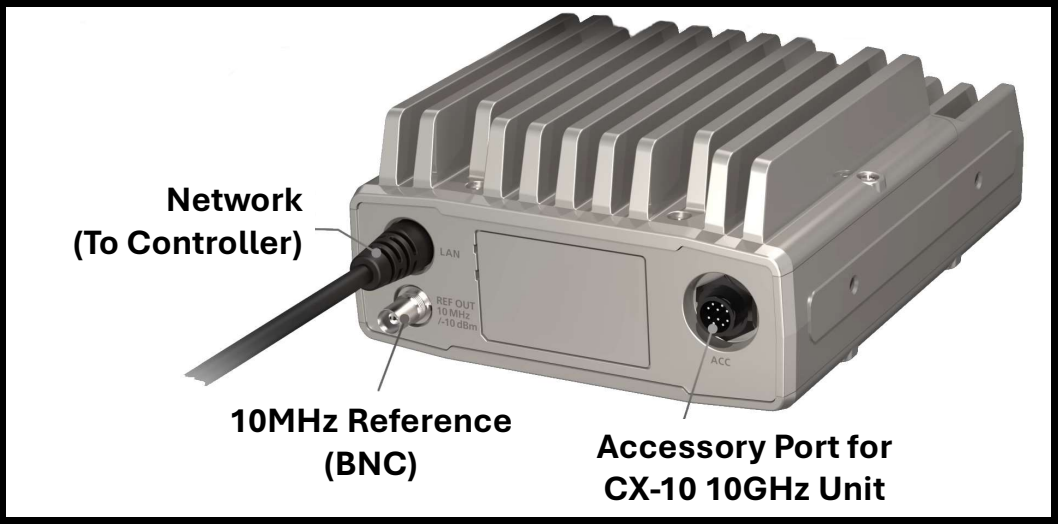
RF Unit - Bottom



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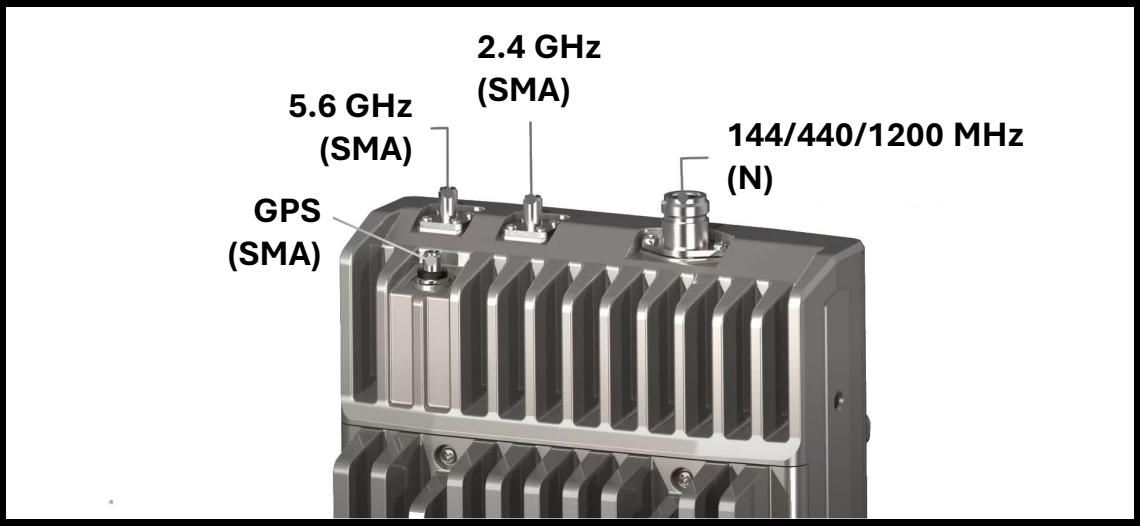
RF Unit - Top



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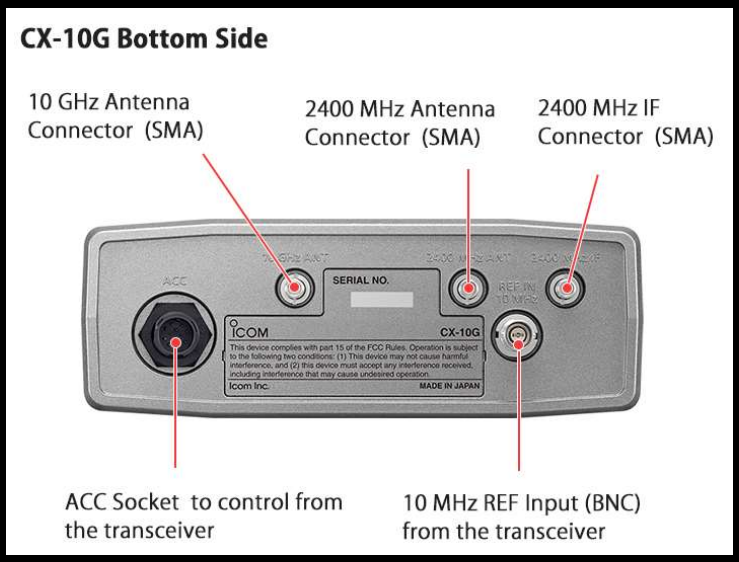
CX-10 10GHz Transverter



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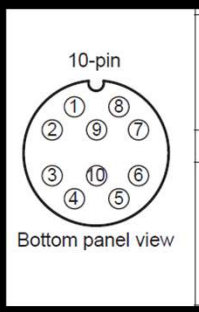
There is a 2.4GHz IF and control/power cable from the IC-905 RF unit. Note that using the IC-905 as a 2.4GHz IF rig does not cause the loss of that band. There is a switch inside the CX-10 that allows pass-through of the 2.4GHz or 10Ghz. Both outputs are present on the CX-10.

What about Preamps and Amplifiers?

- Mast mounting reduces the need for preamps
- Amplifiers need to be at/on tower and environmentally sealed
- PTT and ALC lines available via accessory connector



7	ALC	ALC voltage input.		Input impedance: 10 kΩ or more Input level: –4 ~ 0 V Input voltage: 30 V or less Input current: 0.5 mA or less
8	GND	Connects to ground.		–
9	SEND	Input	When this pin goes to ground, the transceiver transmits.	Voltage: 30 V or less Reverse voltage: 80 V Open circuit voltage: 5 V Voltage (TX): –0.5 ~ +0.8 V Current flow: Maximum 2.27 mA
		Output	This pin goes low when the transceiver transmits.	

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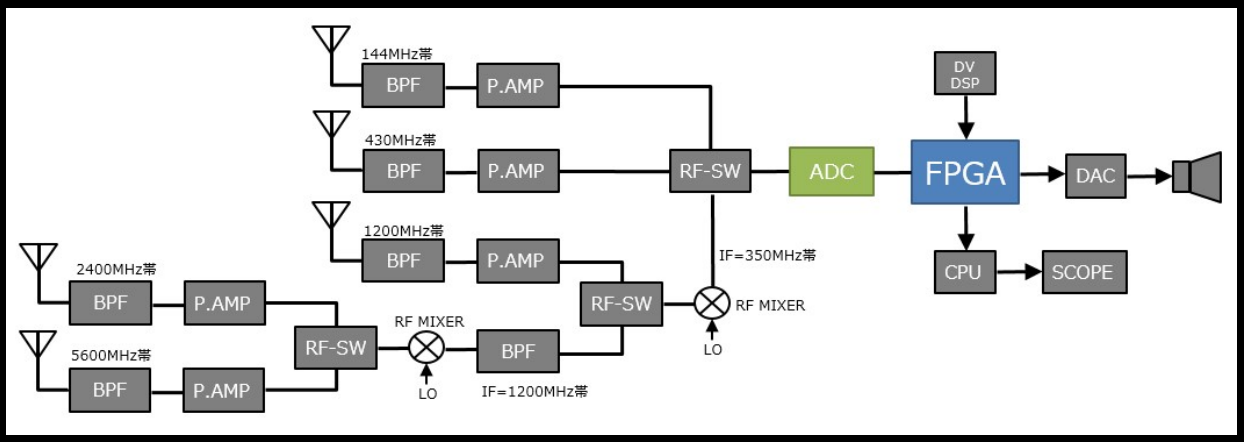
Adding accessories would require a fairly standard sequencer and potentially a band decoder. These would be 3rd party products.

Icom IC-905 Architecture



The basic hardware configuration of the transceiver system is based on the IC-9700, which covers the 144/430/1200 MHz bands. The FPGA for RF signal processing, the ADC for RF direct digital sampling in the receive stage, and the DAC in the transmit stage use the same devices as the IC-9700. Therefore, in the 144/430MHz band, reception: RF direct digital method, transmission: DAC direct output method, It is a method that does not involve a so-called analog RF mixer. The 1200 MHz band is a single-conversion configuration with IF = 350 MHz band via a single-stage RF mixer similar to the IC-9700.

As in the 144/430MHz band, the RF signal processing for processing this IF is RF direct digital method and transmission: DAC direct output method. For bands above 2400/5600 MHz, the IF is set to the 1200 MHz band, taking advantage of the transceiver path in the 1200 MHz band. For example, the 2400/5600MHz band can be said to be "a configuration in which a transverter compatible with the 2400/5600MHz band is connected to the ANT terminal of the IC-9700". The IC-905 combines these frequency configuration circuit blocks in a single package housing.

Next is the 10 GHz band, but this is an optional unit with a separate enclosure connected to the ANT terminal of the 2400 MHz band of the IC-905. In other words, the IF is configured to be 2400 MHz. In terms of frequency configurations of 1200 MHz and above, if we consider the basic transceiver system in the IF = 350 MHz band in the IC-905 as the base unit, the frequency configuration is single conversion in the 1200 MHz band, double conversion in the 2400/5600 MHz band, and triple conversion in the 10 GHz band.

But Who Will I Talk With?

- Weak signal operators
  - Contest weekends can be very busy
  - Digital modes offer interesting opportunities
- Amateur Television (ATV) users
  - Many 5.8GHz “FPV transmitters” available on Amazon
- Satellites
  - Future AMSAT satellites will support “5 and Dime” (5 and 10 GHz)
- Repeaters
  - FM and DSTAR DV/DD Mode

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There are often organized groups around these activities. The IC-905 offers these opportunities and more.

Weak Signal VHF+

- Most activity on contest weekends
  - Look for local VHF+ groups and nets
- Many operator classes available for contesting
  - Single Operator - Low Power, High Power, Portable, 3-Bands, FM-Only
  - Rover stations - Classic, Limited, Unlimited
  - Multioperator - Limited, Unlimited
- Simple contest exchange (Call, Grid Square, e.g. “N7SS CN98”)
- More points per QSO for higher bands
- Scoring is QSO points x Grid points

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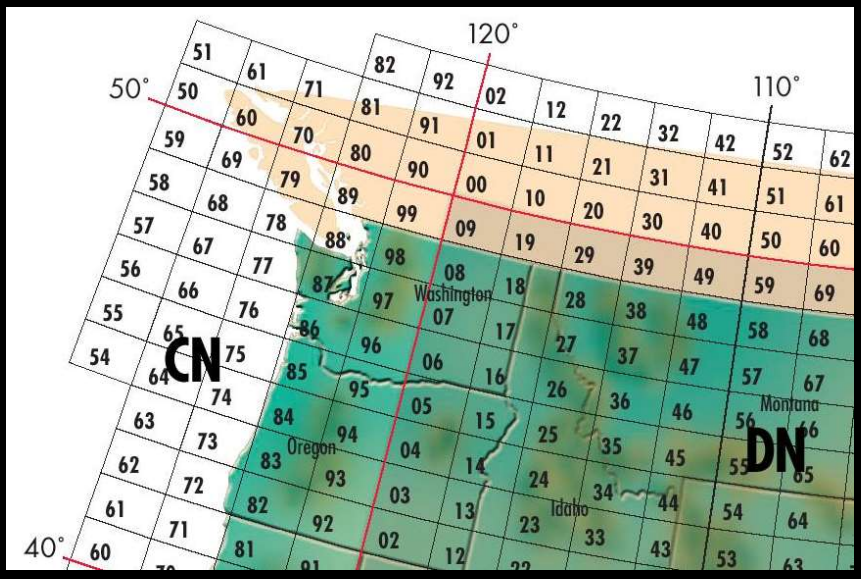
VHF contest rules are a bit different than Field Day. There are no extra points for using different modes. A QSO is a QSO regardless of mode. If you work someone SSB, there are no additional points for CW. Some guys carry paddles to get through where SSB won’t (particularly on the upper bands).

The scoring is graduated and changes a little bit for the January contest. Generally, 1 pt for 6m or 2m QSOs, 2 pts for 222 or 432, etc. This encourages people to get some capability in the upper bands to snag the higher points. The IC-905 offers the ability to maximize the higher point bands.

Maidenhead Grids

- 1 Grid point for each grid contacted per band
- 1 Grid point for each grid activated



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This grid map is courtesy Icom America and is downloadable from their web site at http://www.icomamerica.com.

VHF/UHF Century Club (VUCC) Award

- The minimum number of grid locators needed to initially qualify for each individual band award is as follows:
  - 50 MHz, 144 MHz and Satellite — 100 Credits
  - 222 MHz and 432 MHz — 50 Credits
  - 902 MHz and 1296 MHz — 25 Credits
  - 2.3 GHz — 10 Credits
  - 3.4 GHz, 5.7 GHz, 10 GHz — 5 Credits
- 50 - 1296 MHz and Satellite, all contacts must be made from locations no more than 200 km apart
- SHF contacts must be from within a 300-meter diameter circle

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VUCC Rules - https://www.arrl.org/files/file/Awards/VUCC_Rules_July_2023.pdf

Digital Modes - WSJT

- FT4, FT8 for very weak signals
- JT6M for ionospheric scatter
- JT65 for EME at VHF/UHF, and for HF skywave propagation
- WSPR - Weak Signal Propagation Reporter
  - Sends and receives low-power transmissions to test propagation paths
  - Users with internet access can watch results in real time at WSPRnet

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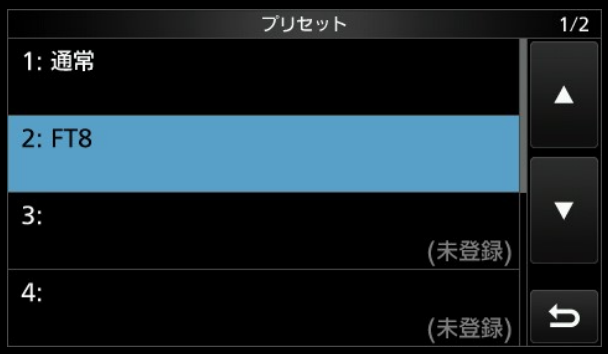
WSPR (pronounced "whisper") stands for "Weak Signal Propagation Reporter." This program is designed for sending and receiving low-power transmissions to test propagation paths on the MF and HF bands. Users with internet access can watch results in real time at WSPRnet.

Digital Modes – FT8 Preset

- Weak signal digital modes are very effective for microwaves
- Troposcatter, aircraft scatter provide enhancements



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The IC-905 is also equipped with an easy setting function that is convenient for FT8 operation in the SHF band. FT8, which is capable of low-power DX communication, has become popular mainly in the HF band, but in recent years, the number of operators in the 430 MHz and 1200 MHz bands has increased. On the other hand, it was said that the FT8 was difficult to operate even with a frequency drift of several hertz, but the IC-905 pursued high precision and high stability, and as a result, FT8 operation was possible in the SHF band as well. In the future, we expect that the FT8 of the IC-905 will play an active role in DX communication in the SHF band. For the FT8, you can set the necessary items at once by touching [Preset] in the MENU of the IC-905 and selecting the FT8. Also, when returning to normal mode from FT8, you can switch smoothly by simply selecting [Normal].

Amateur Television (ATV)

- Plenty of bandwidth available
- Compatible with many inexpensive 5.8 GHz First Person View (FPV) transmitters available on Amazon

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Satellites

- The next generation of AMSAT satellites are called GOLF
  - Greater Orbit, Larger Footprint
- GOLF satellites will include a “five and dime” transponder
  - C band (5.6 GHz) uplink and X band (10 GHz) downlink
- A more typical VHF (144 MHz), UHF (435 MHz) transponder is also planned

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References

- Icom IC-905 page https://www.icomamerica.com/lineup/products/IC-905/
- Groups.io https://groups.io/g/ic-905

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