

Discover

HF Radio

Welcome to Worldwide Communications

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- **The information presented here is very general.**

What Does HF Mean?

HF stands for HIGH FREQUENCY

These are the frequencies from 1.8* to 30 MHz or the 160 meter to 10 meter bands.

HF is also known as shortwave.

*160m is actually a Mid Frequency (MF) band but it is included in the Amateur HF bands for ease of discussion.

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Contacts are generally a couple of hundred miles to over several thousand miles.
- Propagation is strongly effected by solar activity.
- Several communication modes are available to use.
SSB, CW, RTTY, SSTV, Digital, AM

HF Band Allocation

Meter Band	Frequency (MHz)	
	CW, RTTY, Data	Voice
160	1.800 - 2.000	
80	3.500 - 3.600	3.600 - 4.000
40	7.000 – 7.125	7.125 - 7.300
30	10.100 - 10.150	
20	14.000 - 14.150	14.150 - 14.350
17	18.068 - 18.110	18.110 - 18.168
15	21.000 - 21.200	21.200 - 21.450
12	24.890 - 24.930	24.930 - 24.990
10	28.000 - 28.300	28.300 - 29.70

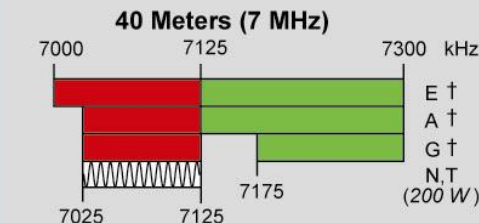
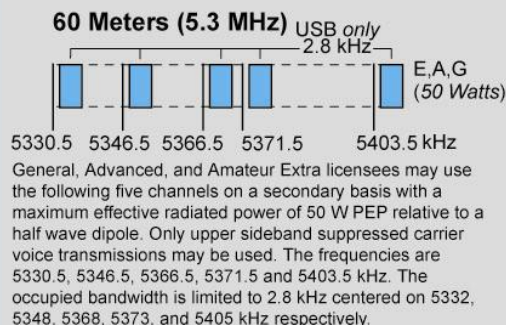
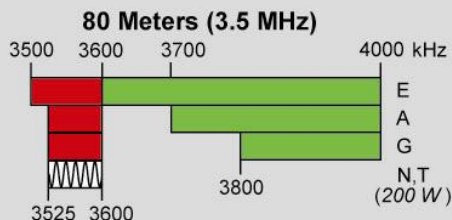
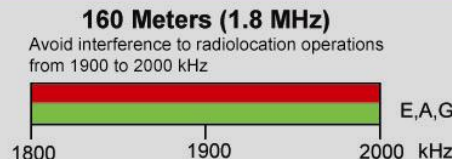
US Amateur Radio Bands

US AMATEUR POWER LIMITS

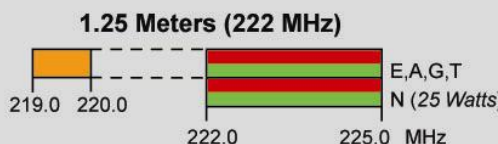
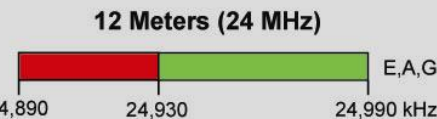
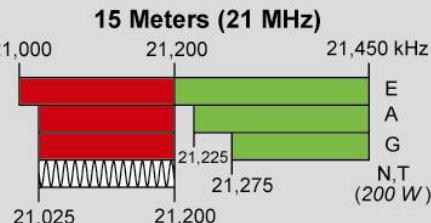
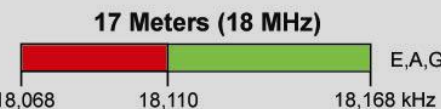
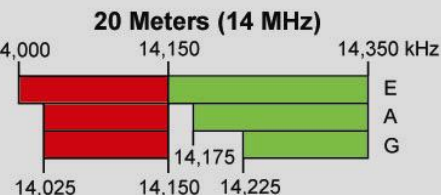
At all times, transmitter power should be kept down to that necessary to carry out the desired communications. Power is rated in watts PEP output. Except where noted, the maximum power output is **1500 Watts**.

Effective Date
February 23, 2007

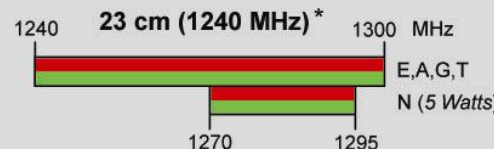
ARRL The national association for
AMATEUR RADIO



† Phone and Image modes are permitted between 7075 and 7100 kHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11). Novice and Technician licensees outside ITU Region 2 may use CW only between 7025 and 7075 kHz. See Section 97.301(e). These exemptions do not apply to stations in the continental US.



*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.



All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

KEY

Note:

CW operation is permitted throughout all amateur bands except 60 meters. MCW is authorized above 50.1 MHz, except for 219-220 MHz. Test transmissions are authorized above 51 MHz, except for 219-220 MHz.

- = RTTY and data
- = phone and image
- = CW only
- = SSB phone
- = USB phone only
- = Fixed digital message forwarding systems only

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb* at www.arrl.org for more detailed band plans.

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- **Because of the ability to communicate over long distances, HF is used by many government, military, and commercial agencies worldwide.**
- **Amateur Radio operators all over the world use HF for the same reasons of being able to communicate over long distances.**

Amateur Radio & HF

- When most people hear the term **ham radio** they generally think of HF or shortwave and long distance communications.

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- General, Advanced and Extra class licensees are permitted to use all available amateur modes on the HF bands.
- General, Advanced and Extra class licensees are also permitted to use full legal power.

How It Works

(Propagation)

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- Just as sailors use the natural forces and currents of wind and water to guide their boats, radio operators use naturally occurring charges in a layer of the atmosphere called the ionosphere to bend and reflect their radio signals.

Why It Works

(The Atmosphere)

- **The Earth's atmosphere is made up of several layers or regions.**

Why It Works

(The Atmosphere)

- The Earth's atmosphere is made up of several layers or regions.
- We are most concerned with the uppermost region called the ionosphere.

*The ionosphere is part of the thermosphere and not a separate layer or region. For our discussion we will only refer to the layers that make up the ionosphere.

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(The Atmosphere)

- The Sun's energy causes atoms in the upper atmosphere to become charged. These charged particles are called ions.

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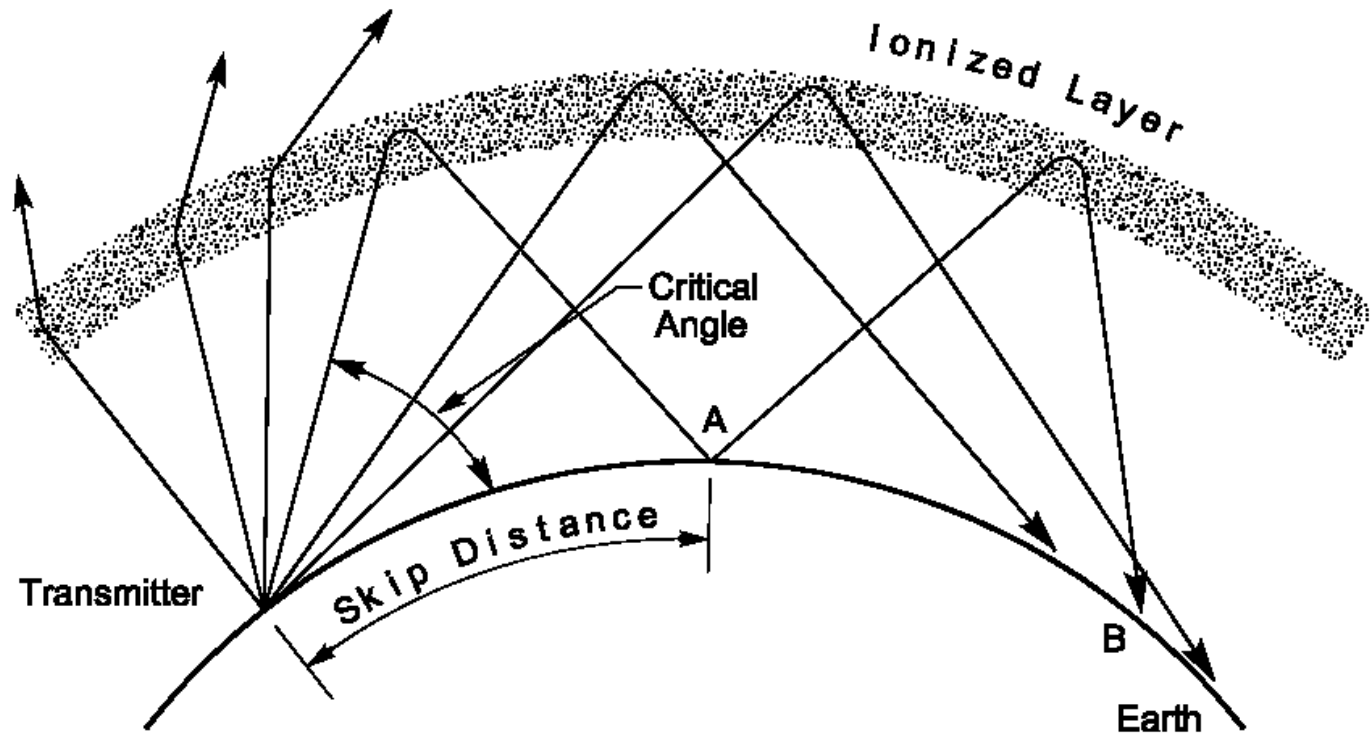
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- The Sun's energy causes atoms in the upper atmosphere to become charged. These charged particles are called ions.
- This charged region of the upper atmosphere is called the ionosphere.
- When a radio wave enters this region of charged particles, its direction of travel is altered.

Radio waves change direction when they enter the ionosphere



The Ionosphere

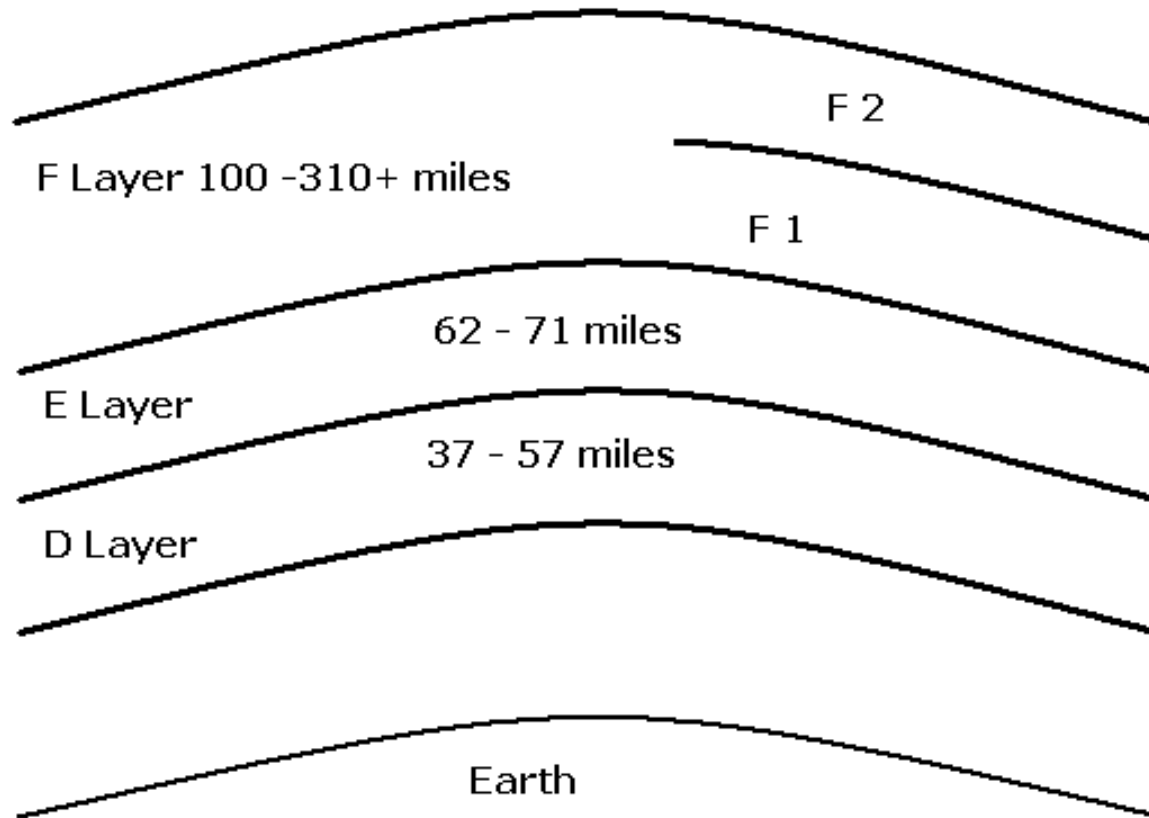
- The ionosphere is broken up into layers.
- These layers are the **D**, **E** and **F** layers.*

*There is no A, B, or C layer. These were reserved for possible future discoveries.

The Ionosphere

- The ionosphere is broken up into layers.
- These layers are the **D**, **E** and **F** layers.*
*There is no A, B, or C layer. These were reserved for possible future discoveries.
- The Sun's UV radiation charges these layers and this affects radio waves and how they travel.

The Layers of the Ionosphere



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- D-layer effect is less on 40m, slight on 20m and inconsequential on the higher frequencies.

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- The Sun's ionization of the upper atmosphere and creation of the D layer is what "closes" the low bands during the day.
- The disappearance of the D layer at sunset "opens" the low bands and they will remain open throughout the night.

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- **Ionization of the E layer occurs rapidly after sunrise and diminishes quickly after sunset. Minimum ionization of the E layer is after midnight, local time.**
- **Like the D-layer, the E-layer absorbs long wavelength signals during the day.**

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- **The E layer effects other Amateur bands above 30 MHz but for now we will limit our discussion to the HF bands.**

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- The F layer is responsible for most of our long distance communications.
- Because this region is so far away from the Earth's surface it is less dense than the other regions.

The F Layer

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- It often takes a while for noticeable effects of the Sun's radiation to develop but the charges can last long after sunset.
- During the day in summertime the Sun's radiation can cause the F layer to become two separate layers called F-1 and F-2 layers.

The lower F-1 layer doesn't last long after sunset.

The F Layer

- The effects of the Sun on the ionosphere change as the seasons change because the angle between the Sun and the Earth changes throughout the yearly cycle.

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- The effects of the Sun on the ionosphere change as the seasons change because the angle between the Sun and the Earth changes throughout the yearly cycle.
- In the summer, during periods of high solar activity, it is not unusual to see bands like 10 and 15 meters stay open until midnight and 20 meters stay open all night.

Choosing a Band

- **80 Meters** — Best at night
- **40 Meters** — Best near Dawn/Dusk
- **20 Meters** — Best during the day
- **15 Meters** — Best during the day during higher part of sunspot cycle
- **10 Meters** — Best during the day during higher part of sunspot cycle

Sub Bands

- **License class restrictions**
 - Extras get it all
 - Generals only some.
 - Some of the best DX is in the Extra sub bands; a good reason to upgrade.
 - Stay 3KHz away from Band Edges
- **Mode Restrictions**
 - Can't operate phone or SSTV in a CW subband.
 - Can't operate digital (PSK31, RTTY, et.) in a phone subband.

Sub Bands

160 Meters (1.8-2.0 MHz):

1.800 - 2.000	CW
1.800 - 1.810	Digital Modes
1.810	CW QRP
1.843-2.000	SSB, SSTV and other wideband modes
1.910	SSB QRP
1.995 - 2.000	Experimental
1.999 - 2.000	Beacons

80 Meters (3.5-4.0 MHz):

3.590	RTTY/Data DX
3.570-3.600	RTTY/Data
3.790-3.800	DX window
3.845	SSTV
3.885	AM calling frequency

40 Meters (7.0-7.3 MHz):

7.040	RTTY/Data DX
7.080-7.125	RTTY/Data
7.171	SSTV
7.290	AM calling frequency

30 Meters (10.1-10.15 MHz):

10.130-10.140	RTTY
10.140-10.150	Packet

2 Meters (144-148 MHz):

144.00-144.05	EME (CW)
144.05-144.10	General CW and weak signals
144.10-144.20	EME and weak-signal SSB
144.200	National calling frequency
144.200-144.275	General SSB operation
144.275-144.300	Propagation beacons
144.30-144.50	New OSCAR subband
144.50-144.60	Linear translator inputs
144.60-144.90	FM repeater inputs
144.90-145.10	Weak signal and FM simplex (145.01,03,05,07,09 are widely used for packet)
145.10-145.20	Linear translator outputs
145.20-145.50	FM repeater outputs
145.50-145.80	Miscellaneous and experimental modes
145.80-146.00	OSCAR subband
146.01-146.37	Repeater inputs
146.40-146.58	Simplex
146.52	National Simplex Calling Frequency
146.61-146.97	Repeater outputs
147.00-147.39	Repeater outputs
147.42-147.57	Simplex
147.60-147.99	Repeater inputs

Equipment

- **Transceiver**

- Borrow one to start.
- Go with knobs instead of layers of menus to start.

- **Antenna**

- Multiband Dipole (Alpha Delta, etc) easiest to start with as it's a close 50 ohm match to transceiver.

- **Antenna tuner**

- Autotuners - ones by LDG are easiest to start with.

Logging

- **Not required, but you'll want to do it.**
- **You'll need it to apply for awards.**
- **Paper log is OK to start.**
- **Computer logging**
 - Helps keep track of progress towards Awards.
 - Logger32 and other free ones are fine.
 - Can integrate with Internet DX Cluster spots to find rare countries on the air.

Logging

DXtreme Station Log - Multimedia Edition (4W3DX)

File Edit Search Modules Outgoing QSL Audio Incoming QSL Reports Tools Help

Station Log | Station Information | *Verification Status | Comments - Station + QSO | User Defined Fields

Station Log

Call sign: 4W3DX DX: 8541.95 nm
 City: Dili S/P:
 County: Dili Grid:
 Entity: Timor-Leste
 IOTA: OC-148 Continent: Oceania
 Timor Island (Main Island Only)
 CQ Zone: 28 Name: Thor

Frequency, Band, and Mode
 Freq: 14002 kHz Band: 20 Meters
 Mode: CW Continuous Wave

Signal Quality and Audio
 Sent: 599 Received: 599
 File: 4w3dx

Equipment Used
 Rig: IC-746PRO Icom IC-746PRO
 Ant: 2-El PV 20-Meter 2-El Phased Verticals
 Acc: MFJ-969 MFJ-969 Antenna Tuner
 Pwr: 100 100 Watts

Date and Time
 Date: Jan 01 2005 Start: 11:54
 End: 11:54

Click the OK button to save the log entry. Jan 01 2005 16:20

DATE TIME	STATION CALLED	CALLED BY	MIS. PRES. OR DIAL	MIS. SIGNAL EST	MY SIGNAL EST	FREQ. MHz	EMUL. SIGN. TYPE	POWER INPUT WATTS	TIME OF ENDING QSO	OTHER DATA	NAME	S	R
10/15/71													
0130	W4VPL	X	14	-	-	14	A3A	180	0150	Ann - mrl Jones			
0130	W8IBU	X	3.5	559	359	3.527	A2	180	0505	John, Westchester, Ohio	RZ		
10/20	W8USE	ONX				14.330	A	180					
1735	X	W9HPP	210	589	579	2165	A1	170	1749	MT	LEN J		
2230	W8HSS	X	16.3	119	019		A1	180	2259	AK			
2110	CR	W5ENM	14				A3A	180	2424	W8FAR - CRAVE CHASE, MICHIGAN - State, Mich			
2427	CR	X	21				X	X	2439	CE20X - CHILE - Enderby			
10/16/71													
1830	DJIBP	X	21				A1	180		NO GO	MOORE		
1900	2P1GDS	X	21				A3A	180		Jamboree Stn - Zambie			
1908	CG		7										
1910	WASTE	X	7	59	59	7			1918	Clyde -	San Antonio		
10/17/71													
0208	VE3FME	X	7.174	559	559	7.174	A1	180	0225	Brett Essex, Ont.	MMR		
10/18/71													
0245	W3AKC		14.28	58	58	14	A3A	180	2355	Martin J Pittsburgh Pa			
10/21													
2100	W8HSS	X	14.28				A3A	180	2130				
10/22													
1713	WTHPP	X	21	579	569	057	A1	170	1731		JW		
10/24/71													
0056	KV6PMR	X	21.359	59	59	21.359	A3A	180	0056	SERIAL NAVY STN.	MMR		
0133	EA415	X	14.043	339	589	14.043	A1	180	0153	NIKE - MADRID, SPAIN	MMR		
0209	F2JG	X	14.040	579	579	14.040	A1	180	0220	BOB - MILANO, ITALY	MMR		
2040	CR	W4TMP	21	589	599	21	A1	180					
1015	CR	W8KH5	21				A1		2030	JOE Ridgeville Ohio			
2040		W4VBT	21		579	21	A1		2110	JM; ROANOKE, Va	RZ		

PHONETIC ALPHABET

- Use words to represent letters
- First letter corresponds to the letter
- Prevents confusion on a radio, “B” can sound much like “D”

“B” Bravo

“D” Delta

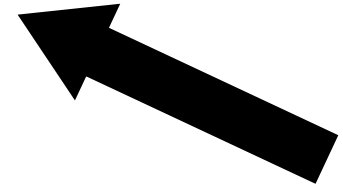
Alpha

Delta

7seven

Delta

Delta



THIS IS A CALL SIGN

PHONETIC ALPHABET

A Alpha	B Bravo	C Charlie	D Delta	E Echo	F Foxtrot
G Golf	H Hotel	I India	J Juliet	K Kilo	L Lima
M Mike	N November	O Oscar	P Papa	Q Quebec	R Romeo
S Sierra	T Tango	U Uniform	V Victor	W Whiskey	X X-Ray
		Y Yankee	Z Zulu		

NUMBERS

0 ZEE-ROE

1 WUN

2 TOO

3 THU-REE

4 FOWER

5 FIFE

6 SIX

7 SAY-VEN

8 ATE

9 NINER

10 WUN - ZEE-ROE

11 WUN - WUN

“Q” SIGNALS

The Q-code are a list of signals abbreviating a detailed question or answer.

The Q code is a standardized collection of three-letter message encodings, all starting with the letter "Q",

Agreed upon by the International Telecommunication Union (ITU), is used worldwide on radiotelegraph.

“Q” SIGNALS

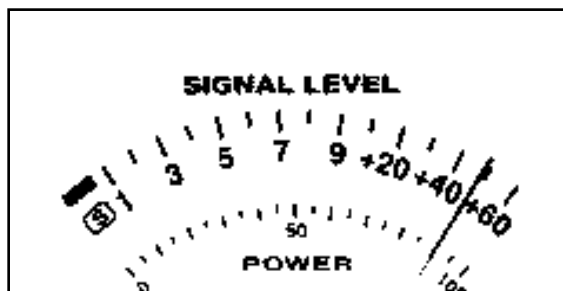
- **QRM** “I’m being interfered with” Man Made (e.g. jamming)
- **QRN** “I’m troubled by static” Non Man Made interference
- **QSO** “A contact is in progress” (i.e. *thanks for the QSO*)
- **QSY** “Change frequency” (*QSY to 14.210*)
- **QTH** “My location is” *My QTH is Spokane Valley, Washington*
- **QSL** “I acknowledge” *I understand, Roger ...*
- **QST** “Attention all radio amateurs”

RST SIGNALS

Readability, Strength, Tone

A short way to describe or give a signal or reception report (i.e. radio check) based upon your “S” meter reading and what you actually hear.

An “S” meter is used to measure relative signal strength in a receiver



Poor

Good

RST = READABILITY

SIGNAL STRENGTH

TONE

1 - 5

1 - 9

1 - 9

RST SIGNALS

A qualitative assessment of how easy or difficult it is to correctly copy the information being sent

- 1** Unreadable
- 2** Barely readable, occasional words distinguishable
- 3** Readable with considerable difficulty
- 4** Readable with practically no difficulty
- 5** Perfectly readable

RST SIGNALS

An assessment of how powerful the received signal is at the receiving location

- 1** Faint signal, barely perceptible
- 2** Very weak
- 3** Weak
- 4** Fair
- 5** Fairly good
- 6** Good
- 7** Moderately strong
- 8** Strong
- 9** Very strong signals

RST SIGNALS

Used only in Morse code and digital transmissions therefore omitted during voice operations

- 1 Very rough and broad
- 2 Very rough, very harsh and broad
- 3 Rough, tone, rectified but not filtered
- 4 Rough note, some trace of filtering
- 5 Filtered rectified, but strongly ripple-modulated
- 6 Filtered tone, definite trace of ripple modulation
- 7 Near pure tone, trace of ripple modulation
- 8 Near perfect tone, slight trace of modulation
- 9 Perfect tone, no trace of ripple or modulation of any kind

RST SIGNALS

AN RST OF 599 BEST READING *i.e.* “you’re 59”

- 11 = Unreadable and barely perceptible
- 57 = Perfectly readable, moderately strong
- 33 = Readable, some difficulty, weak in strength
- 59 **plus 20db** = Signal strength is 20 db’s over strength 9 *i.e.* “your 20 over 9”
- RST of 459 = Quite readable, fair strength, perfect tone (tone is usually used for CW)
- RST of 579 = Perfectly readable, moderately strong, perfect tone
- An increase of power **4 times** will raise you “S” meter by **ONE “S” unit**
- Thus to raise the meter from **S8 to S9** you power on a transmitter would need to increase power **4 times**

Signal Reports

- **RST – Readability, Strength, Tone**
 - 599 on CW & Digital is best
 - 59 on Phone is best (Tone doesn't apply)
- **QSB** – fading
- **QRM** – adjacent station interference
- **QRN** – atmospheric or local noise
- **Never tell anyone they're "full quieting" unless you're working FM**
- **In a contest, everyone is 59 or 599!**
- **73 – Best wishes / Good Bye (not 73's)**

Major Amateur HF Activities

(other than just rag chewing)

- **DXing – Collecting Countries**
 - About 337 radio “countries” are possible
- **Awards**
 - Worked All Continents (WAC)
 - Worked All States (WAS)
 - DX Century Club (DXCC) – 100 countries
 - Islands on the Air (IOTA) – 100 islands
 - County Hunters – try to work all 3000 US counties

Major Amateur HF Activities

(other than just rag chewing)

- **Contesting – Rapid fire contacts**
 - Even if you aren't into competition, contest weekends are a great way to work rare countries or states for awards.
 - Rules are online and vary.
 - Learn the “exchange”, which may be your state, section (SNJ) or a contest contact serial number (start with 001).

Answering a Contact

- **Listen** for someone calling CQ.
- When he stops, say your call – “AD7DD”
- Record your signal report and his name
- When he says “Over” or “back to you”, give him his signal report, your name and location and “Over”.
- Have a conversation if he continues, but don’t be surprised if non-English speakers politely end the conversation with “best wishes to you and your family” at that point. The little English they know is probably more than the Croatian you speak.
- End your contact by giving your call sign.

Initiating a Contact

- Look for a open frequency that you're allowed to transmit on. Avoid Band and sub-band edges.
- **Listen!**
- Ask "Is the frequency in use?"
- **Listen!**
- Say CQ six times and your callsign three times.
 - "CQ CQ CQ, CQ CQ CQ, This AD7DD, Alpha Delta Seven Delta Delta, AD7DD calling CQ and standing by"
- **Listen!**

Idiots and Abuse

- **Real simple – Just QSY (change frequency) and don't respond.**
- **Don't be a band cop.**
- **It's a hobby.**
- **Have fun!**

Antenna's



Antenna's



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Ground Radials



Ground Radials



Ground Radials



Ground Radials



Ground Radials



Ground Radials



Ground



Station



Summary

- **It's magic talking around the world!**
- **Buy a copy of the ARRL Operating Manual. It will answer most of your questions.**
- **Try different things when you get bored or frustrated.**
- **Ask questions.**

HF is FUN!

With a 100 watt transceiver and a simple wire antenna you can start to communicate and make friends with other hams all over the country or the world.

**Aaron Noack
AD7DD**