Ham Radio – General Exam – Study Notes

Frequency: 300/meter = MHz or 300/MHz = meters
Dipole Antenna: ½ Wave dipole antennas = 468/Frequency
Silicon – Seven letters = diode threshold of .07v
Geranium – 3x3 letters = diode threshold of .03v
NAND and ZERO both four letters
QRQ = Quicker QRS = Slower QRV = ReceiVe
CapACitors pass AC inDuCtors pass DC
Fifteen amp fuse for Fourteen gauge wire
Twenty amp fuse for Twelve gauge wire
AC frequencies increases:
– Coil springs higher (reactance increases) - Capacitor holds back (reactance decreases)
AM – Product Detector Audio – Discriminator BFO – Product Detector
Heterodyne receiver - Mixer Balanced Modulator + Mixer - Filter
20m Data band – 14.070 – 14.100
LC Oscillator – Tank Circuit CW Bandwidth = 150 Hz
SBB Bandwidth = 2,300 Hz FM Bandwidth = +/- 5KHz or +/- 15 KHz

Ohm's Law: E/I*R
Power Law: P/E*I
E – Voltage in Volts
I – Current in Amps
R – Resistance in Ohms
P – Power in Watts

	Series	Parallel
Resistor	Add	Less
Inductor	Add	Less
Capacitor	Less	Add

Unit	Measures
Amp	Current
Farad	Capacitance
Henry	Inductance
Hertz	Frequency
Ohm	Resistance
Watt	Power
Volt	Voltage

Designation		Frequency	Wavelength
ELF	extremely low frequency	3Hz to 30Hz	100'000km to 10'000 km
SLF	superlow frequency	30Hz to 300Hz	10'000km to 1'000km
ULF	ultralow frequency	300Hz to 3000Hz	1'000km to 100km
VLF	very low frequency	3kHz to 30kHz	100km to 10km
LF	low frequency	30kHz to 300kHz	10km to 1km
MF	medium frequency	300kHz to 3000kHz	1km to 100m
HF	high frequency	3MHz to 30MHz	100m to 10m
VHF	very high frequency	30MHz to 300MHz	10m to 1m
UHF	ultrahigh frequency	300MHz to 3000MHz	1m to 10cm
SHF	superhigh frequency	3GHz to 30GHz	10cm to 1cm
EHF	extremely high frequency	30GHz to 300GHz	1cm to 1mm

Maximum 1500 watts PEP, Except 200 watts PEP on 30 meters, 100 watts for beacons

RTTY/data near center of CW allocation but LSB (170Hz shift for amateur RTTY)

80m data 3570-3600 20m RTTY 14.070-14.100 MHz 20m PSK31 14.070

Maximum Symbol Rate for Packet, RTTY, or Data

Below 10 meters (28 MHz)	300 baud	6m and 2m	19.6 kilobaud
10 meter band	1200 baud	1.25m and 70cm	56 kilobaud

Use General privileges immediately with CSCE, add "/AG" to CW call and "SIant AG" on phone

Minimum Channel Separation

CW 150 – 500Hz SSB 3 kHz

Power Multipliers

20dB = 100 fold change

One S-Unit = 6dB = 4 fold change

3dB = 2 fold change

1dB loss = -20.5%

Data Modes

PSK31 uses varicode

RTTY uses 5 bit Baudot with 170Hz shift

Sideband Operation

Below 14 MHz use lower sideband (LSB)

Above 14 MHz use upper sideband (USB)

Propagation

A-index – Long term geomagnetic stability

K-index – Short term geomagnetic stability

Solar Flux – Radio energy at 10.7cm

D layer absorbs, E layer max single hop ~ 1200 miles, F2 layer max single hop ~2500 miles

Low frequencies good at night (no D layer), higher HF work during day (good F layer charge)

Max range on frequency just below MUF, short range just above LUF

UV and X-rays take 8 minutes to arrive, coronal mass ejections (CMEs) take 20-40 hours

A two tone linearity test uses two non-harmonically related audio tones

Q-Signals and Prosigns

QRP – Low power operation, ~ 5 watts on HF

QRS – Send more slowly

QRQ – Send faster

QSL – Acknowledge receipt

QRV – Ready to receive

KN – Listening for specific station(s)

CL – Closing station

AR – End of message

Wire Sizes

15 amp circuit requires 14 gauge wire - 20 amp circuit requires 12 gauge wire

Series/Parallel	Series	Parallel
Resistors/Inductors	Add - $R_1+R_2+R_3\ldots$	Divide - $1/\ 1/(R_1+1/R_2+1/R_3\ldots)$
Capacitors	Divide - $1/\ 1/(C_1+1/C_2+1/C_3\ldots)$	Add - $C_1+C_2+C_3\ldots$

Reactance

Increases with frequency in a coil, decreases with frequency in a capacitor

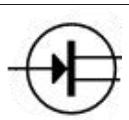
Impedance Matching

Matching impedance between source and load insures max power transfer/highest efficiency

Connectors

DE-9	Serial data	PL-259	RF – Good to ~150MHz
DIN	Multiconductor audio/control	N	Waterproof RF – Good to ~10GHz
RCA	Audio	SMA	Small RF – Good to several GHz

Components

				
Field Effect Transistor	Zener Diode	NPN Transistor	Transformer	Tapped Inductor

Peak Envelope Power

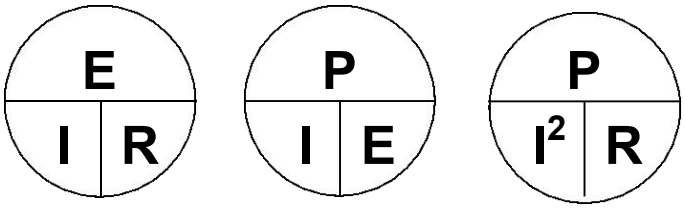
PEP = [(0.707PEV)(0.707PEV)]/RL

Where: PEV = Peak Voltage
RL = Resistive Load

Peak to Peak voltage= 2(Peak voltage)

RMS = .707(Peak voltage)

Ohm's Law and Power Formulas



E = Voltage in Volts
I = Current in Amperes
R = Resistance in Ohms
P = Power in Watts

Cover the value you need and divide or multiply the remaining values as appropriate

Examples: $P = I \times E$ $P = I^2 \times R$ $P = E^2 / R$

Gates

AND Gate Output is high only when both inputs high

NOR Gate Output is low when either or both inputs are high

Antenna Lengths

Dipole Length $L\ (Ft) = \frac{468}{F\ (MHz)}$

¼λ Vertical $L\ (Ft) = \frac{234}{F\ (MHz)}$

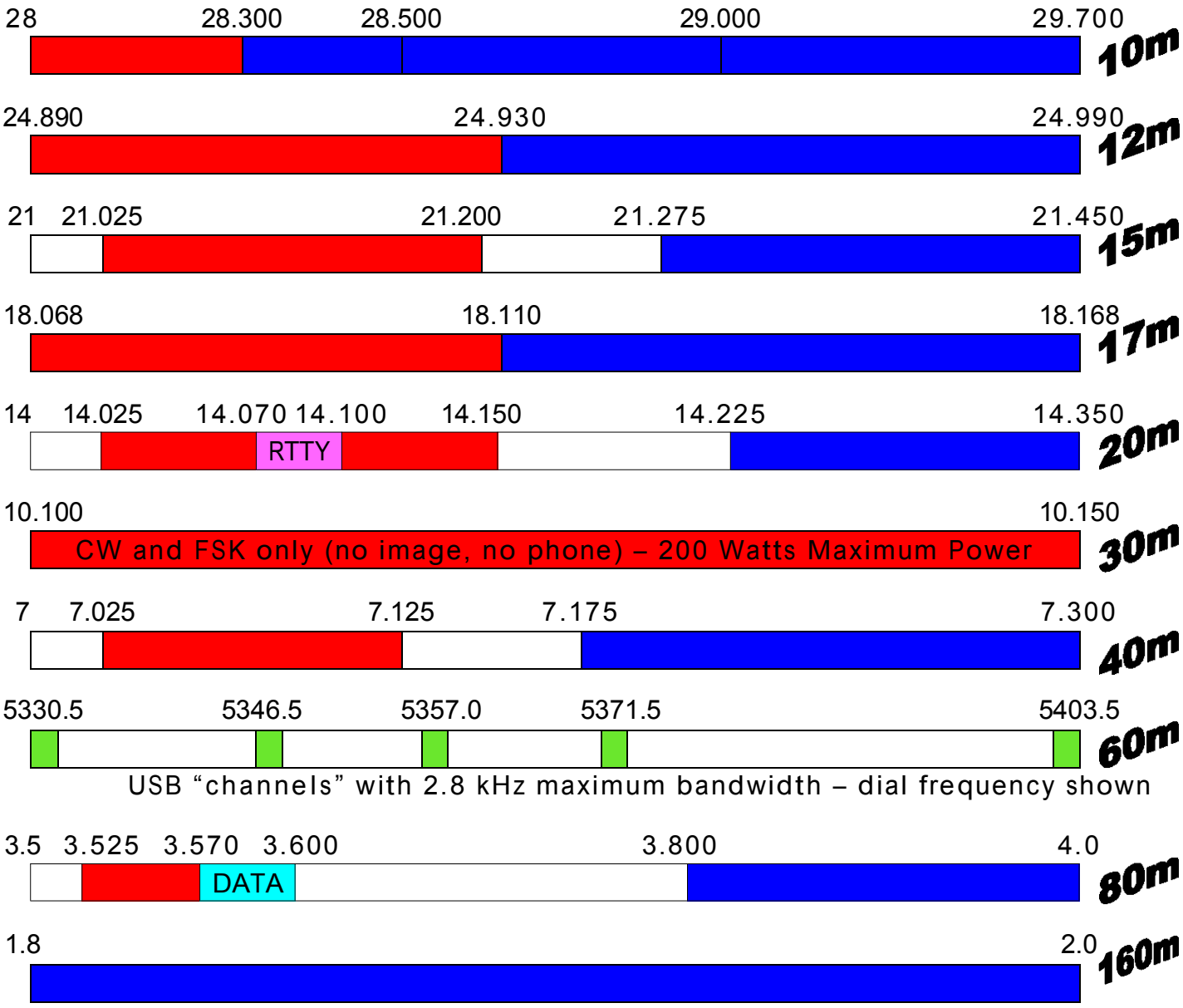
L is Length in Feet and F is Frequency in MHz

Divide Full Wave Loop by 4 for one side of Quad Loop

Divide Full Wave Loop by 3 for one side of Delta Loop

3 element yagi maximum theoretical gain is 9.7dBi

General Class License HF Band Allocations



Legend

- CW, FSK
- Voice, SSTV, Fax
- CW/RTTY
- USB Only
- CW/DATA

Notes

- Bolded areas appear in the question pool. There are more details in the HF band plans as published by the ARRL but this is limited to the segments relevant to the General exam.
- General Class licensees may use up to 1500 watts PEP except:
  - 200 watts maximum on 30 meters
  - 100 watts allowed for propagation beacons

- The 80m band is often broken into the 80m CW portion and 75m voice portion. This more accurately reflects the actual wavelengths used and differentiates voice from CW use.
- The light blue data on 80m is a part of the CW band segment where data occurs. Similarly, the magenta area on 20m is the RTTY subband with PSK31 activity focused at 14.070.

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	Meters	Frequency	Frequencies	Voice	Power	RTTY	Notes
HF	160m	1.8MHz	1800-2000 kHz	LSB	1500w	300	Night Owl
	80m	3.5MHz	**3525 - 3600kHz** and **3800-4000kHz**	LSB	200w	300	Evenings & Nights
	60m	5.4MHz	5 channels **2.8kHz** wide	LSB	100w	300	USB Channels
	40m	7MHz	7025-7125 and **7175-7300kHz**	LSB	200w	300	Best Days & Evenings
	30m	10.1MHz	10100-10150kHz **(CW & Data)**		200w	300	CW & Data
	20m	14MHz	14025-14150 kHz and **14225-14350** kHz	USB	1500w	300	Best Days & Nights
	17m	18MHz	18068-18168 kHz	USB	1500w	300	Best Days & Evenings
	15m	21MHz	21025-21200 kHz and **21275-21450** kHz	USB	200w	300	Best Days
	12m	24MHz	**24890-24990** kHz	USB	1500w	300	Best Days
	10m	28MHz	**28000-29700** kHz	USB	200w	1200	Best Days
VHF	6m	50MHz	50-54 MHz	USB	1500w	19.6k	
	2m	144MHz	144-148 MHz	USB	1500w	19.6k	
	1.25m	222MHz	222-225 MHz	USB	1500w	56k	
UHF	.70m	420MHz	420-450 MHz	USB	1500w	56k	
	.33m	902MHz		USB	1500w		
	.23m	1240MHz	1240-1300 MHz	USB	1500w		

Ham Radio – Technician Exam – Study Notes

The following pages contain information extracted from the question pool. Information is on this sheet because it simply requires memorization and addresses multiple questions in the pool. To prepare for the class, read through this information and memorize as much as possible in advance. There are also practice tests available online at https://www.hamradiolicenseexam.com/. These practice tests use the actual FCC question pool and provide a sample of the material covered in a real test.

Technician Class Frequency Privileges (1500 watt PEP max)

These are the frequencies allocated for us to Technician class operators after passing the written (element 2) exam. There is an inverse proportional relationship between frequency and wavelength. Longer wavelengths have lower frequencies. There are several frequency to wavelength conversion questions using the formula shown.

Identification

All operators must identify themselves with their FCC callsign every 10 minutes while talking and at the end of a transmission or it is an illegal "unidentified transmission". There is no requirement to ID at the beginning – it only helps the other operator. CW (morse code) at less than 20 words per minute is always an acceptable way to ID.

License Period

An amateur license is valid for 10 years. It can be renewed no earlier than 90 days in advance. There is a two year renewal grace period during which time the license is not valid but can be renewed with no loss of privileges (no retest). Transmitting during the grace period is not allowed.

Good Amateur Practices

The radio spectrum is a shared resource and the FCC rules are largely based on "play nicely with others". Good Amateur Practice is exactly that. They include "listen before transmitting" to insure the frequency isn't already being used. Use the minimum power necessary (use your inside voice). If you want to break into a conversation in progress, you simply give your callsign between exchanges, the word "break" is only used to indicate emergency traffic. Additionally, Amateur Radio also cannot compete with commercial services so there is no broadcasting, business or music allowed (music can only be transmitted as incidental to a Space Shuttle/ISS rebroadcast).

Filters

Appropriate filters should be built into transmitters and receivers. Transmitters may need an additional low pass filter to remove unwanted harmonics that would affect TVs. TVs and FM radios may need a high pass filter to remove large amounts of HF frequency radiation that can overload them. Hams are only responsible for clean transmissions, not poor receiver design.

Repeater Frequency Separation (Split)

Repeaters are often placed on hilltops to extend the range of mobile and portable stations (handhelds). They listen on one frequency and simultaneously retransmit on another. The difference between transmit and receive frequencies is called "split" and varies for each band. All new radios know the split for each band but older units may not.

Bandwidth

Bandwidth determines how much spectrum a signal occupies. Narrower signals tend to be more efficient and have longer range.

Ohm's Law and Power Formulas

The circles are designed as a memory tool to help you remember the formulas. The first circle is Ohm's law. To use them, simply cover the value you want and solve remaining equation. To solve for E (voltage or Electromotive force), cover it up and multiply current in amperes times resistance in ohms. To solve for resistance, cover R and divide voltage

in volts by current in amperes. All the formulas are listed below. Blank paper is provided for the test and participants are allowed to write down whatever they need.

Unit Conversions

These are basic metric conversions. Notice they involve moving the decimal place some number of digits right or left. 1,000 Kilohertz = 1 Megahertz.

Frequencies

Radios and telephones are both designed to carry Voice Frequencies between 300-3000 Hertz. Radio Waves generally begin at a range above human hearing at 20,000 Hertz

Radio Modes

The simplest radio signal is just a single frequency. By turning that radio wave on and off, it's possible to send morse code (CW). Amplitude Modulation is the simplest voice modulation scheme but it's not very efficient because it has two identical (redundant) sidebands with the voice information and the radio carrier that doesn't contain any information. Amateur radios often use Single Sideband (SSB) transmissions that are spectrally (space) and power efficient by removing one of the AM sidebands and the carrier before transmission. This leaves either the upper or lower sideband (USB/LSB). Convention dictates that lower sideband (LSB) signals are used below 10MHz and upper sideband (USB) is used above 10MHz.

Q Signals

Q Signals are shorthand created for morse code operators. Many of these have found their way into voice operations as well. The bolded items are asked specifically.

SWR

SWR stands for Standing Wave Ratio and is a measure of how well the antenna is matched to the radio. A 1:1 SWR means all the radio output power is being transferred to the antenna and is ideal. A high SWR can overheat the radio so most radios have circuitry that lowers output levels as SWR increases.

Antenna Lengths

The dipole is the basic "T" shaped antenna, similar to what is supplied with FM stereos that tack to the wall. The top of the antenna is a half wavelength for the desired frequency and the feed line (coax) can be any length. There are a number of vertical antenna designs but the ¼ wave is the basic design. Use the wavelength formula to calculate wavelength for the desired frequency. A dipole will be half that length and the ¼ vertical will be 1/4th that wavelength. Multiply this by 39 to convert meters to inches.

There is also mention of yagis, quads and dish antennas. All of these designs are very directional. Yagis have multiple elements like TV antennas. Quads are big loops and can also be made into multi-element antennas. These multi-element designs are generally referred to as "beams".

Radio Functions

This section refers to actual knobs and buttons on an amateur radio (and many others). Tuning is accomplished via the tuning knob known as VFO (Variable Frequency Oscillator) knob, Up/Down buttons or a keypad on the radio. Receiver Incremental Tune (RIT) allows fine-tuning of the receiver without affecting the transmit frequency. The Squelch function is designed to keep the radio quiet when there is no signal present.

Technician License Examination - Study Sheet

Technician Class Frequency Privileges (1500 watt PEP max)

6 meters	50-54 MHz
2 meters	144-148 MHz
1.25 meters	222-225 MHz - (219-220 MHz point-to-point digital links)
70 centimeters	420-450 MHz - (435-438 MHz satellite subband, 446.000 MHz FM calling)
23 centimeters	1240-1300 MHz

Bands are organized with narrow modes near the bottom.

$$\text{Wavelength (meters)} = \frac{300}{\text{Frequency(MHz)}}$$

(CW)

Valid US callsigns start with A, K, N or W and contain 1 digit (0-9).

The Federal Communications Commission (FCC) regulates radio use in the US, the International Telecommunication Union (ITU) organizes radio operations internationally.

License Period – 10 years with 2 year grace and can renew 90 days before expiration.

Know Local, Remote and Automatic control of a transmitter.

A Club must have at least 4 members to be eligible for club license.

Identification - Must ID every 10 minutes and at the end of transmission – CW <20WPM OK

Good Amateur Practices

Listen before transmitting, just transmit callsign to break into a conversation, minimum power. Amateur Radio allows no broadcasting, no music transmissions, no codes/ciphers intended to obscure a message, no swearing, no ethnic/racial slurs and no business.

Filters

Spurious emissions/harmonics (your problem) require low-pass filter at transmitter.
RF/frontend/fundamental overload (their problem) requires high-pass filter at TV receiver.

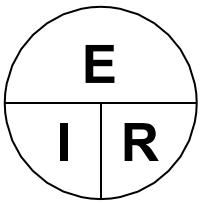
Repeater Frequency Separation (Split)

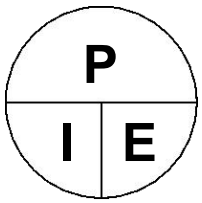
2 meter band	600 kHz
70 centimeter band	5.0 MHz

Bandwidth

CW signal	150 Hz
SSB signal	2-3 kHz
FM signal	5-15 kHz
TV (NTSC) signal	6 MHz

Ohm's Law and Power Formulas





E = Voltage in Volts
I = Current in Amperes
R = Resistance in Ohms
P = Power in Watts

Cover the value you need and divide or multiply the remaining values as appropriate.
Examples:

E = I x R	I = E / R	R = E / I
P = I x E	I = P / E	E = P / I

Unit Conversions

Mega	10^{6}	1,000,000	Micro	10^{-6}	0.000001	Pico	10^{-12}	0.000000000001
Kilo	10^{3}	1,000	Milli	10^{-3}	0.001	Nano	10^{-9}	0.000000001

Voice Frequencies are 300-3000Hz and Radio Waves are >20,000Hz.

Measuring Units

Frequency	Hertz	Resistance	Ohm
Current	Ampere	Power	Watt
Electromotive Force	Volts		

Radio Modes

Amplitude Modulation (AM), Single Sideband (SSB) and Code (CW) are all related.
A product detector is used for SSB/CW reception, a discriminator is used for FM.
FM antenna polarization is vertical by convention (best for cars), SSB/CW is horizontal
Upper Sideband (USB) is used above about 10 MHz
Continuous Tone Coded Squelch System (CTCSS) uses subaudible tone to unmute receiver

Q Signals

QRM	Man-made noise	QRN	Atmospheric noise
QSY	Change frequency	QTH	Current/home location

CQ means calling any station.

Respond with *station callsign* (this is) *your callsign.*

Emergency Communications

RACES only serves government agencies and ARES serves government and NGO groups.
Messages contain name of sender in the preamble, no more than 25 words and a check.

A 3dB change is double, 6db is quadruple and 10dB is a ten-fold increase.

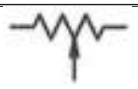
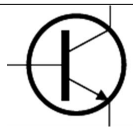
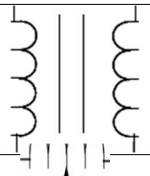
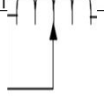
Inductors store energy in a magnetic field. Capacitors store energy in an electric field.
A Bipolar Transistor has an emitter. A Field Effect Transistor has a gate.

SWR of 1:1 is perfect and near 2:1 transmitters generally start reducing power output.

Antenna Types
Half Wave Dipole
Quarter Wave Vertical

$$\text{Wavelength (meters)} = \frac{300}{\text{Frequency(MHz)}}$$

Schematic Symbols

Resistor		Capacitor		SPST Switch	
Variable Resistor		Lamp		LED	
Transistor		Transformer		Antenna	
Battery		Variable Inductor			

Frequency Bands

HF	3 - 30 MHz	100m - 10m
VHF	30 - 300 MHz	10m – 1m
UHF	300 - 3000 MHz	1m – 10cm

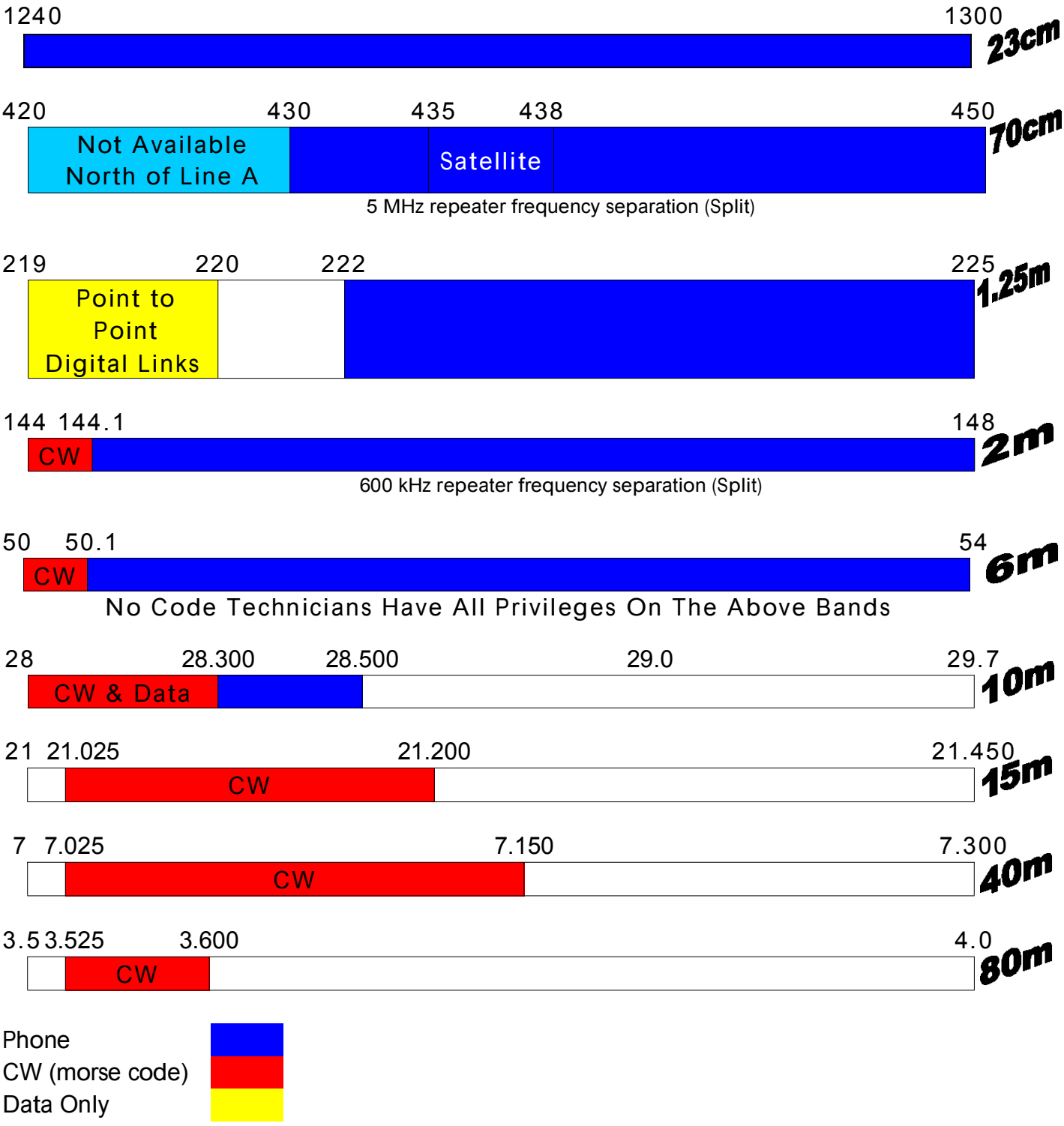
Radio Functions

RIT – Receiver Incremental Tune

Squelch mutes receiver

VFO Knob changes operating frequency

Technician Class License Band Allocations



Notes

The HF (80m-10m) privileges shown are informational purposes only – they are not on the Technician test. Technician Licensees may use up to 1500 watts PEP on the VHF and higher bands. Technician Licensees are limited to 200 watts on the HF bands.