General License Class
Training Guide
2023-2027

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Contents

	Pool Questions	Exam Questions
G1 – Commission Rules	54	5
G2 – Operating Procedures	60	5
G3 – Radio Wave Propagation	37	3
G4 – Amateur Radio Practices	60	5
G5 – Electrical Principles	40	3
G6 – Circuit Components	23	2
G7 – Practical Circuits	38	3
G8 – Signals and Emissions	43	3
G9 – Antennas and Feed Lines	46	4
G0 – Electrical and RF Safety	25	2
Totals	426	35

Questions that were deleted from the question pool:

G1C08, G1C10, G1E09, G6B09, G9C06, G9D13

How to use this guide

How the guide is laid out:

All questions from the question pool have been converted into statements using the same words. The statements include the exact wording of the answers highlighted in **bold**.

The statements are grouped by syllabus sub-element section*, not in question order, grouping related information together.

*Sub-element sections – G1A, G1B, G1C, … (see Table of Contents)

Studying for exam:

- Read the statements for a sub-element section.
- Try answering the questions for that section.
- Use the guide to help you if you are not sure of the answer.
- Repeat till you are comfortable.
- Go to the next section and repeat.
- After each sub-element, try answering the questions for that sub-element.
- After completing all sub-elements, try an online practice exam.
- Once you consistently pass with a +80%, you will have the confidence to take a real exam.
- Good Luck

Online Practice Exam Sites: Some sites are free, but some you pay for.

- AA9PW FCC Exam Practice — www. aa9pw.com/radio
- ARRL Ham Radio License Exam Practice — www.arrl.org/exam-practice
- eHam.net — www.eham.net/exams
- HamExam.org — www. hamexam.org
- QRZ.com — www.qrz.com/hamtest/

Don't worry about the Math - Simple math or just memorize the answers.

Exam Types

Online Exams: Computer generates a random exam from the question pool, one question from each sub-element section.

Written Exams: Are pre-printed exams with five versions with one question from each subelement section.

Guide information taken from:

- ARRL Ham Radio General License Manual
- AD7FO's Amateur Radio General License Syllabus
- the Internet.

G1 - Commission Rules (5 Exam Questions)

G1A – General class control operator frequency privileges; primary and secondary allocations

Control operator frequency privileges

The HF and/or MF amateur bands that have portions where the General class licensees cannot transmit are the **80 meters, 40 meters, 20 meters, and 15 meters**. G1A01

The HF bands segments that are exclusively allocated to Amateur Extra licensees are the **80 meters, 40 meters, 20 meters, and 15 meters**. G1A08

The bands in which phone operations are prohibited is the **30 meters**. G1A02

The bands in which image transmissions are prohibited is the **30 meters**. G1A03

The amateur bands that are restricted to communication only on specific channels, rather than frequency ranges is the **60 meters**. G1A04

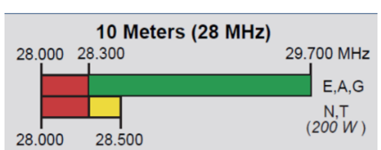
The following frequencies are where General class licensees are prohibited from operating as control operator, **7.125 MHz to 7.175 MHz.** G1A05

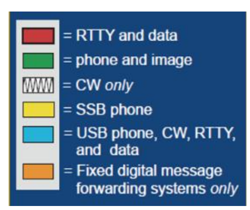
When the FCC rules designate the amateur service as a secondary user on a band then **Amateur stations must not cause harmful interference to primary users and must accept interference from primary users**. G1A06

When General class licensees are not permitted to use the entire voice portion of a band, the portion of the voice segment that is available to them is **The upper frequency portion**. G1A11

The amateur frequencies that stations with a General class control may transmit CW emissions in the 10-meter band are **The entire band**. G1A07

Trick Question





The following frequency is within the General class portion of the 15-meter band, **21300 kHz**. G1A09

The portion of the 10-meter band that is available for repeater use is **The portion above 29.5 MHz**. G1A10

G1B – Antenna structure limitations; good engineering and good amateur practice; beacon operation; prohibited transmissions; retransmitting radio signals

Antenna structure limitations

The maximum height above ground for an antenna structure not near a public use airport without requiring notification to the FAA and registration with the FCC is **200 feet**. G1B01

The conditions that state and local governments are permitted to regulate amateur radio antenna structures are that **Amateur Service communications must be reasonably accommodated, and regulations must constitute the minimum practical to accommodate a legitimate purpose of the state or local entity**. G1B06

Beacon operation

The purpose of a beacon station, as identified in the FCC rules, is for the **Observation of propagation and reception**. G1B03

A condition that beacon stations must comply is **No more than one beacon station may transmit in the same band from the same station location**. G1B02

The HF frequencies that automatically controlled beacons are permitted is **28.20 MHz to 28.30 MHz**. G1B09

The power limit for beacon stations are **100 watts PEP output**. G1B10

PEP = Permissible Envelope Power, the average of an RF signal during one complete cycle at the peak of a signal's modulated envelope

Prohibited transmissions

The transmissions that are permitted for all amateur stations are the **Occasional retransmission of weather and propagation forecast information from US government stations**. G1B04

The one-way transmissions that are permitted are **Transmissions to assist with learning the International Morse code**. G1B05

The FCC determines "good engineering and good amateur practice," as applied to the operation of an amateur station in all respects not covered by the Part 97 rules. G1B11

The restrictions on the use of abbreviations or procedural signals in the amateur service are **They may be used if they do not obscure the meaning of a message**. G1B07

It is permissible to communicate with amateur stations in countries outside the areas administered by the Federal Communications Commission **When the contact is with amateurs in any country except those whose administrations have notified the ITU that they object to such communications**. G1B08

G1C – Transmitter power regulations; data emission standards; 60-meter operation requirements

Transmitter power regulations

The maximum transmitter power an amateur station may use on 10.140 MHz is **200 watts PEP output**. G1C01

The maximum transmitter power an amateur station may use on the 12-meter band is **1500 watts PEP output**. G1C02

The limit for transmitter power on the 28 MHz band for a General Class control operator is **1500 watts PEP output**. G1C05

The limit for transmitter power on the 1.8 MHz band is **1500 watts PEP output**. G1C06

The maximum power limit on the 60-meter band is an **ERP of 100 watts PEP with respect to a dipole**. G1C09

ERP = Effective Radiated Power

The measurement specified by FCC rules that regulate maximum power is **PEP output from the transmitter**. G1C11

60-meter operation requirements

The maximum bandwidth permitted by FCC rules for amateur radio stations transmitting on USB frequencies in the 60-meter band is **2.8 kHz**. G1C03

The FCC rules require that when operating in the 60-meter band that **If you are using an antenna other than a dipole, you must keep a record of the gain of your antenna**. G1C04

Data emission standards

Before using a new digital protocol on the air, you must **Publicly document the technical characteristics of the protocol**. G1C07

The maximum symbol rate permitted for RTTY or data emission transmitted at frequencies below 28 MHz is **300 baud**. G1C08

The maximum symbol rate permitted for RTTY or data emission transmissions on the 10-meter band is **1200 baud**. G1C10

G1D – Volunteer Examiners and Volunteer Examiner Coordinators; temporary identification; element credit; remote operation

Volunteer Examiners

Any person who can demonstrate that they once held an FCC-issued General, Advanced, or Amateur Extra class license that was not revoked by the FCC may receive partial credit for the elements represented by an expired amateur radio license. G1D01

To obtain a new General class license after a previously held license has expired and the two-year grace period has passed, **The applicant must show proof of the appropriate expired license grant and pass the current Element 2 exam**. G1D11

The license examinations you may administer as an accredited Volunteer Examiner holding a General class operator license is the **Technician only**. G1D02

At least three Volunteer Examiners of General class or higher must observe the administration of a Technician class license examination. G1D04

If you are a Technician class operator and have an unexpired Certificate of Successful Completion of Examination (CSCE) for General class privileges, you may operate **On any General or Technician class band segment**. G1D03

Until an upgrade to General class is shown in the FCC database, a Technician licensee must identify with “AG” after their call sign **Whenever they operate using General class frequency privileges**. G1D06

When operating a US station by remote control from outside the country, the license required of the control operator is **A US operator/primary station license**. G1D05

When operating a station in South America by remote control over the internet, from the US, **Only those of the remote station’s country regulations apply**. G1D12

The organization that accredits Volunteer Examiners is **A Volunteer Examiner Coordinator**. G1D07

VE = Person   VEC = Organization

A non-US citizen must meet the following criteria to be an accredited Volunteer Examiner, **The person must hold an FCC granted amateur radio license of General class or above**. G1D08

The minimum age that one must be to qualify as an accredited Volunteer Examiner is **18 years**. G1D10

A Certificate of Successful Completion of Examination (CSCE) is valid for exam element credit for **365 days**. G1D09

G1E – Control categories; repeater regulations; third-party rules; ITU regions; automatically controlled digital station

Third-party rules

A third party would be disqualified from participating in sending a message via an amateur station if **The third party's amateur license has been revoked and not reinstated**. G1E01

The restrictions on messages sent to a third party in a country with which there is a Third-Party Agreement is that **They must relate to amateur radio, or remarks of a personal character, or messages relating to emergencies or disaster relief**. G1E05

Repeater regulations

A 10-meter repeater may retransmit the 2-meter signal from a station that has a Technician class control operator, **Only if the 10-meter repeater control operator holds at least a General class license**. G1E02

Control categories

All of the following conditions require a licensed amateur radio operator to take specific steps to avoid harmful interference to other users or facilities: G1E04

- When operating within one mile of an FCC Monitoring Station
- When using a band where the Amateur Service is secondary
- When a station is transmitting spread spectrum emissions

All these choices are correct

There is **No part** of the 2.4 GHz band where an amateur station may communicate with non-licensed Wi-Fi stations. G1E07

The maximum PEP output allowed for spread spectrum transmissions is **10 watts**. G1E08

An amateur operator should normally avoid transmitting on 14.100, 18.110, 21.150, 24. 930 and 28.200 MHz because **A system of propagation beacon stations operates on those frequencies**. G1E10

ITU regions

The frequency allocations of which ITU region apply to radio amateurs operating in North and South America is in **Region 2**. G1E06

Automatically controlled digital station

The requirement to conduct communications with a digital station operating under automatic control outside the automatic control band segments is **The station initiating the contact must be under local or remote control**. G1E03

Third-party messages may be transmitted via remote control only **Under any circumstances in which third party messages are permitted by FCC rules** G1E12

The bands that automatically controlled stations may transmit RTTY or data emissions communicate with other automatically controlled digital stations is **Anywhere in the 6-meter or shorter wavelength bands, and in limited segments of some of the HF bands**. G1E11

G2 - Operating Procedures (5 Exam Questions)

G2A – Phone operating procedures: USB/LSB conventions, breaking into a contact, transmitter setup for voice operation; answering DX stations

USB/LSB conventions

The mode most commonly used for voice communications on frequencies of 14 MHz or higher is the **Upper sideband**. G2A01

The mode most commonly used for SSB voice communications in the VHF and UHF bands is the **Upper sideband**. G2A03

The mode most commonly used for voice communications on the 17- and 12-meter bands is the **Upper sideband**. G2A04

The mode most commonly used for voice communications on the 160-, 75-, and 40-meter bands is the **Lower sideband**. G2A02

Most amateur stations use lower sideband on the 160-, 75-, and 40-meter bands because **It is commonly accepted amateur practice**. G2A09

Phone operating procedures

The mode of voice communication that is most commonly used on the HF amateur bands is **Single sideband**. G2A05

An advantage of using single sideband, as compared to other analog voice modes on the HF amateur bands is **Less bandwidth used and greater power efficiency**. G2A06

A statement that is true of single sideband (SSB) is **Only one sideband is transmitted; the other sideband and carrier are suppressed**. G2A07

Breaking into a contact

The recommended way to break into a phone contact is to **Say your call sign once**. G2A08

Transmitter setup for voice operation

A statement that is true of VOX operation versus PTT operation is **It allows “hands free” operation**. G2A10

VOX = Voice Operating Transmit
PPT = Push to Talk

The control that is typically adjusted for proper ALC setting on a single sideband transceiver is the **Transmit audio or microphone gain**. G2A12

ALC = Automatic Level Control

Answering DX stations

Generally, those who should respond to a station in the contiguous 48 states calling “CQ DX” are **Any stations outside the lower 48 states**. G2A11

G2B – Operating effectively; band plans; drills and emergencies; RACES operation

Operating effectively

A good amateur practice if propagation changes during a contact creating interference from other stations using the frequency is to **Attempt to resolve the interference problem with the other stations in a mutually acceptable manner**. G2B03

When selecting an SSB transmitting frequency, the minimum separation you should use to minimize interference to stations on adjacent frequencies is
2 kHz to 3 kHz. G2B05

A good amateur practice for net management is to **Have a backup frequency in case of interference or poor conditions**. G2B10

When selecting a CW transmitting frequency, the minimum separation from other stations you should use to minimize interference to stations on adjacent frequencies is **150 Hz to 500 Hz**. G2B04

You can avoid harmful interference on an apparently clear frequency before calling CQ on CW or phone by **Send “QRL?” on CW, followed by your call sign; or, if using phone, ask if the frequency is in use, followed by your call sign**. G2B06

QRL means Are you busy? Or I am busy, please do not interfere

Band plans

Follow the voluntary band plan complies with commonly accepted amateur practice when choosing a frequency on which to initiate a call. G2B07

The voluntary band plan restriction for US stations transmitting within the 48 contiguous states in the 50.1 MHz to 50.125 MHz band segment is to **Only contacts with stations not within the 48 contiguous states**. G2B08

Drills and emergencies

It is true concerning access to frequencies that **Except during emergencies, no amateur station has priority access to any frequency**. G2B01

The first thing you should do if you are communicating with another amateur station and hear a station in distress break in is to **Acknowledge the station in distress and determine what assistance may be needed**. G2B02

RACES operation

Only a person holding an FCC-issued amateur operator license may be the control operator of an amateur station transmitting in RACES to assist relief operations during a disaster. G2B09

RACES training drills and tests may be routinely conducted without special authorization **No more than 1 hour per week**. G2B11

G2C – CW operating procedures and procedural signals; Q signals; full break-in

CW operating procedures and procedural signals

When a CW operator sends "KN" at the end of a transmission it means they are **Listening only for a specific station or stations**. G2C03

The prosign that is sent to indicate the end of a formal message when using CW is **AR**. G2C08

When sending CW, the "C" added to the RST report means **Chirpy or unstable signal**. G2C07

RST = **R**eadability-Signal **S**trength-**T**one

The best speed to use when answering a CQ in Morse code is **The fastest speed at which you are comfortable copying, but no faster than the CQ**. G2C05

The term "zero beat" in CW operation means **Matching the transmit frequency to the frequency of a received signal**. G2C06

Q signals

If a CW station sends "QRS", you should **Send slower**. G2C02

The Q signal "QRL?" means **"Are you busy?" or "Is this frequency in use?"**. G2C04

The Q signal "QSL" means **I have received and understood**. G2C09

The Q signal "QRN" means **I am troubled by static**. G2C10

The Q signal "QRV" means **I am ready to receive**. G2C11

Full break-in

A description of full break-in CW operation (QSK) is **Transmitting stations can receive between code characters and elements**. G2C01

If another station wishes to interrupt, you will hear its signal between your dots and dashes

G2D – Volunteer Monitor Program; HF operations

Volunteer Monitor Program

The Volunteer Monitor Program are **Amateur volunteers who are formally enlisted to monitor the airwaves for rules violations**. G2D01

The objective of the Volunteer Monitor Program are **To encourage amateur radio operators to self-regulate and comply with the rules**. G2D02

A procedure that may be used by Volunteer Monitors to localize a station whose continuous carrier is holding a repeater on in their area is to **Compare beam headings on the repeater input from their home locations with that of other Volunteer Monitors**. G2D03

HF operations

An azimuthal projection map can be described as **A map that shows true bearings and distances from a specific location**. G2D04

Get your own map at https://ns6t.net/azimuth/azimuth.html

If you are looking for an HF contact with any station you should **Repeat "CQ" a few times, followed by "this is," then your call sign a few times, then pause to listen, repeat as necessary**. G2D05

When making a "long-path" contact with another station, a directional antenna should be pointed **180 degrees from the station's short-path heading**. G2D06

An example of the NATO Phonetic Alphabet is **Alpha, Bravo, Charlie, Delta**. G2D07

Many amateurs keep a station log **To help with a reply if the FCC requests information about your station**. G2D08

When participating in a contest on HF frequencies, it is required that you **Identify your station according to normal FCC regulations**. G2D09

QRP operation means Low-power transmit operation. G2D10

Signal reports are typically exchanged at the beginning of an HF contact **To allow each station to operate according to conditions**. G2D11

G2E – Digital mode operating procedures

Digital mode operating procedures

The mode normally used when sending RTTY signals via AFSK with an SSB transmitter is **LSB**. G2E01

RTTY = **R**adio **T**ele**TY**pe
AFSK = Audio Frequency Shift Keying

The standard sideband for JT65, JT9, FT4, or FT8 digital signal when using AFSK is **USB**. G2E05

JI9, JI65, FT4 and FT8 are all part of WSJT
Weak Signal Joe Taylor

VARA is **A digital protocol used with Winlink**. G2E02

The symptoms that may result from other signals interfering with a PACTOR or VARA transmission are: G2E03

- Frequent retries or timeouts
- Long pauses in message transmission
- Failure to establish a connection between stations

All these choices are correct

The most common frequency shift for RTTY emissions in the amateur HF bands is 170 Hz. G2E06

A good practice when choosing a transmitting frequency to answer a station calling CQ using FT8 is to **Find a clear frequency during the alternate time slot to the calling station**. G2E04

A required when using FT8 is that the **Computer time accurate to within approximately 1 second**. G2E07

A common location for FT8 is **Approximately 14.074 MHz to 14.077 MHz**. G2E15

The segment of the 20-meter band that most digital mode operations are commonly found is **Between 14.070 MHz and 14.100 MHz**. G2E08

You cannot join a contact between two stations using the PACTOR protocol because **Joining an existing contact is not possible, PACTOR connections are limited to two stations**. G2E09

Trick Question

A way to establish contact with a digital messaging system gateway station is to **Transmit a connect message on the station's published frequency**. G2E10

The primary purpose of an Amateur Radio Emergency Data Network (AREDN) mesh network is **To provide high-speed data services during an emergency or community event**. G2E11

You can describe Winlink as: G2E12

- An amateur radio wireless network to send and receive email on the internet
- A form of Packet Radio
- A wireless network capable of both VHF and HF band operation

All these choices are correct

If you cannot decode an RTTY or other FSK signal even though it is apparently tuned in properly then what could be wrong is: G2E13

- The mark and space frequencies may be reversed
- You may have selected the wrong baud rate
- You may be listening on the wrong sideband

All these choices are correct

G3 - Radio Wave Propagation (3 Exam Questions)

G3A – Sunspots and solar radiation; geomagnetic field and stability indices

Sunspots and solar radiation

A sudden ionospheric disturbance can have an effect on the daytime ionospheric propagation because **It disrupts signals on lower frequencies more than those on higher frequencies**. G3A02

A higher sunspot number can affect HF propagation because a **Higher sunspot numbers generally indicate a greater probability of good propagation at higher frequencies**. G3A01

The increased ultraviolet and X-ray radiation from a solar flare will affect radio propagation on Earth in approximately **8 minutes**. G3A03

HF propagation conditions that vary periodically in a 26- to 28-day cycle can be caused by the **Rotation of the Sun's surface layers around its axis**. G3A10

For a coronal mass ejection to affect radio propagation on Earth it can take **15 hours to several days**. G3A11

The least reliable bands for long-distance communications during periods of low solar activity are **15 meters, 12 meters, and 10 meters**. G3A04

Long distance radio communication can usually be affected by the charged particles that reach Earth from solar coronal holes because **HF communication is disturbed**. G3A14

The solar flux index is **A measure of solar radiation with a wavelength of 10.7 centimeters**. G3A05

The point in the solar cycle where the 20-meter band usually supports worldwide propagation during daylight hours is **At any point**. G3A07

Geomagnetic field and stability indices

A geomagnetic storm is **A temporary disturbance in Earth's geomagnetic field**. G3A06

High geomagnetic activity can benefit radio communications because it **Creates auroras that can reflect VHF signals**. G3A09

A geomagnetic storm can affect HF propagation because it **Degrade high-latitude HF propagation**. G3A08

The K-index measures **The short-term stability of Earth's geomagnetic field**. G3A12

The A-index measures **The long-term stability of Earth's geomagnetic field**. G3A13

G3B – Maximum Usable Frequency; Lowest Usable Frequency; short path and long path propagation; determining propagation conditions; ionospheric refraction

Maximum Usable Frequency

MUF stand for **The Maximum Usable Frequency for communications between two points**. G3B08

The frequency that will have the least attenuation for long-distance skip propagation is **Just below the MUF**. G3B03

The following factors affect the MUF: G3B02
- Path distance and location
- Time of day and season
- Solar radiation and ionospheric disturbances

All these choices are correct

Lowest Usable Frequency

LUF stand for **The Lowest Usable Frequency for communications between two specific points**. G3B07

What usually happens to radio waves with frequencies below the LUF are **They are attenuated before reaching the destination**. G3B06

The ionosphere affects radio waves with frequencies below the MUF and above the LUF, **They are refracted back to Earth**. G3B05

What happens to HF propagation when the LUF exceeds the MUF is the **Propagation via ordinary skywave communications is not possible over that path**. G3B11

Short path and long path propagation

A characteristic of skywave signals arriving at your location by both short-path and long-path propagation is **A slightly delayed echo might be heard**. G3B01

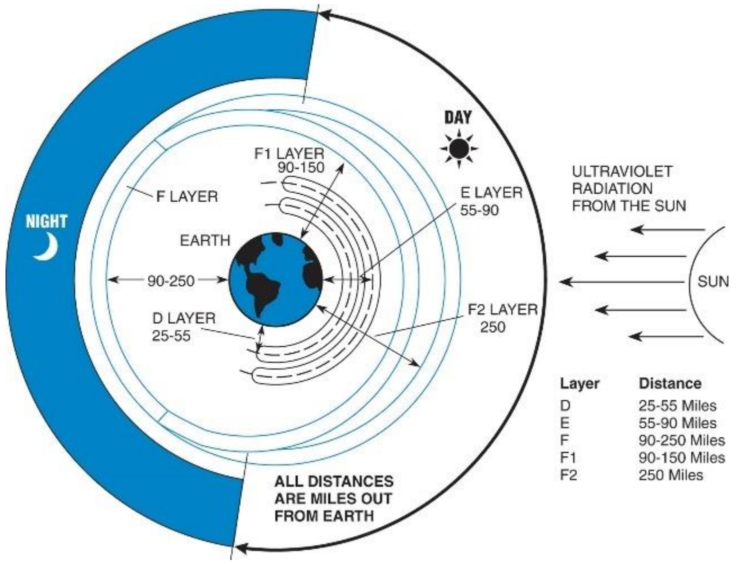
Determining propagation conditions

A way to determine the current propagation on a desired band from your station is to **Use a network of automated receiving stations on the internet to see where your transmissions are being received**. G3B04

G3C – Ionospheric regions; critical angle and frequency; HF scatter; near vertical incidence skywave (NVIS)

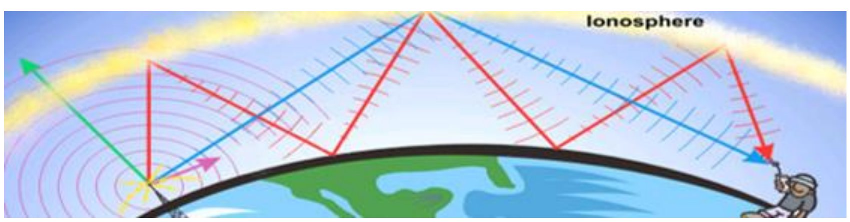
Ionospheric regions

A skip propagation via the F2 region is longer than that via the other ionospheric regions **Because it is the highest region**. G3C03



The approximate maximum distance along the Earth's surface normally covered in one hop using the F2 region is **2,500 miles**. G3B09

The approximate maximum distance along the Earth's surface normally covered in one hop using the E region is **1,200 miles**. G3B10

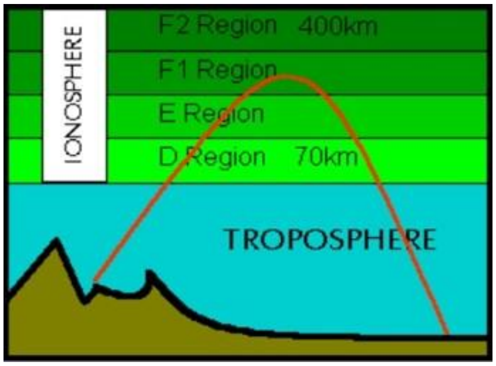


During the summer, the lower HF frequencies typically have **High levels of atmospheric noise or static**. G3B12

The ionospheric region that is closest to the surface of Earth is **The D region**. G3C01
D for DIRT

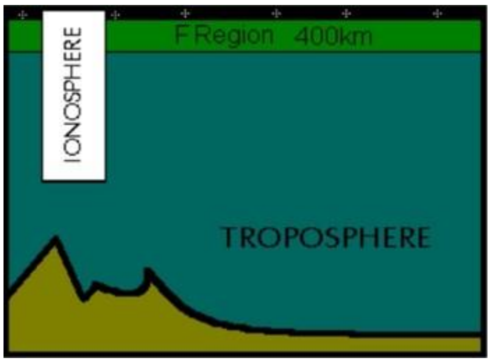
Long-distance communication on the 40-, 60-, 80-, and 160-meter bands is more difficult during the day because **The D region absorbs signals at these frequencies during daylight hours**. G3C05

The ionospheric region that is the most absorbent of signals below 10 MHz during daylight hours is **The D region**. G3C11



During the day....

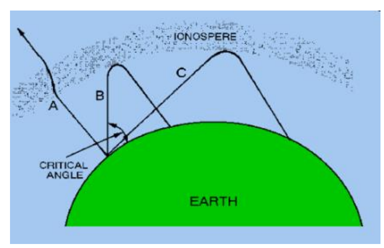
- The “D” Region is closest to Earth
- The “D” Region absorbs MF/HF radio signals
- The “F2” Region is most responsible for long distance communication



- **At night....**
- The “D” & “E” Regions disappear
- The “F1” & “F2” Regions combine into one with reduced ionization

Critical angle and frequency

The term “critical frequency” at a given incidence angle means **The highest frequency which is refracted back to Earth**. G3C02

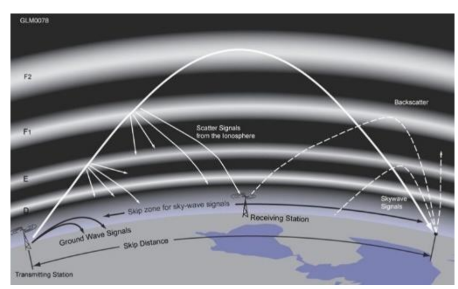


The term “critical angle”, as applied to radio wave propagation means **The highest takeoff angle that will return a radio wave to Earth under specific ionospheric conditions**. G3C04

One factor that affects how well the ionosphere will reflect a signal is the angle at which the signal impinges upon it.

If the angle is too high, it will pass right through the ionosphere and not be reflected back to earth.

HF scatter



The type of propagation that allows signals to be heard in the transmitting station’s skip zone is **Scatter**. G3C09

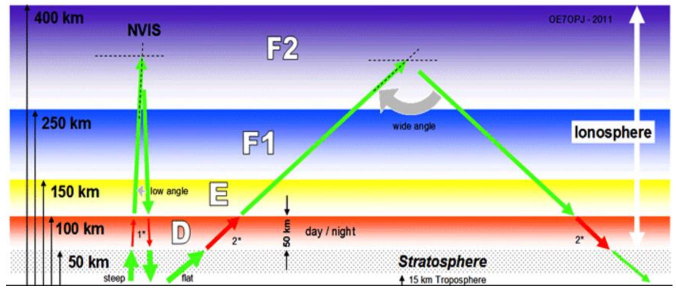
HF scatter signals in the skip zone are usually weak because **Only a small part of the signal energy is scattered into the skip zone**. G3C08

A characteristic of HF scatter is **Signals have a fluttering sound**. G3C06

HF scatter signals often sound distorted because the **Energy is scattered into the skip zone through several different paths**. G3C07

Near vertical incidence skywave (NVIS)

Near vertical incidence skywave (NVIS) propagation is a **Short distance MF or HF propagation at high elevation angles**. G3C10



G4 - Amateur Radio Practices (5 Exam Questions)

G4A – Station configuration and operation

Station configuration and operation

The purpose of the notch filter found on many HF transceivers is **To reduce interference from carriers in the receiver passband**. G4A01

The benefit of using the opposite or "reverse" sideband when receiving CW is **It may be possible to reduce or eliminate interference from other signals**. G4A02

A noise blanker works **By reducing receiver gain during a noise pulse**. G4A03

The effect on the plate current of the correct setting of a vacuum-tube RF power amplifier's TUNE control is **A pronounced dip**. G4A04

The automatic level control (ALC) is used with an RF power amplifier **To prevent excessive drive**. G4A05

The purpose of an antenna tuner is to **Increase power transfer from the transmitter to the feed line**. G4A06

When a receiver's noise reduction control level is increased the **Received signals may become distorted**. G4A07

The correct adjustment for the LOAD or COUPLING control of a vacuum tube RF power amplifier is the **Desired power output without exceeding maximum allowable plate current**. G4A08

The purpose of delaying RF output after activating a transmitter's keying line to an external amplifier is **To allow time for the amplifier to switch the antenna between the transceiver and the amplifier output**. G4A09

The function of an electronic keyer is the **Automatic generation of dots and dashes for CW operation**. G4A10

The ALC system should be inactive when transmitting AFSK data signals because **The ALC action distorts the signal**. G4A11

ALC = Automatic Level Control
AFSK = Audio Frequency Shift Keying

A common use of the dual-VFO feature on a transceiver is **To transmit on one frequency and listen on another**. G4A12

A Variable Frequency Oscillator (VFO) is used to tune a radio to different frequency.

The purpose of using a receive attenuator is **To prevent receiver overload from strong incoming signals**. G4A13

G4B – Tests and test equipment

Tests and test equipment

The test equipment that contains horizontal and vertical channel amplifiers is **An oscilloscope**. G4B01

The best instrument to use for checking the keying waveform of a CW transmitter is **An oscilloscope**. G4B03

An advantage of an oscilloscope versus a digital voltmeter is that **Complex waveforms can be measured**. G4B02

The signal source that is connected to the vertical input of an oscilloscope when checking the RF envelope pattern of a transmitted signal is **The attenuated RF output of the transmitter**. G4B04

Too much power applied to the oscilloscope vertical input will cause permanent damage to the oscilloscope. Power should be limited to a few milliwatts.

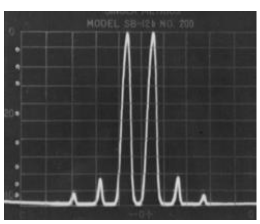
Voltmeters have a high input impedance because **It decreases the loading on circuits being measured**. G4B05

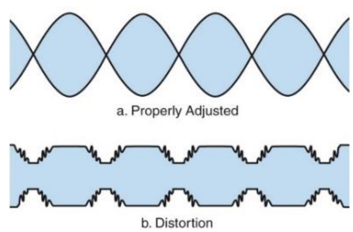
An advantage of a digital multimeter as compared to an analog multimeter is its **Higher precision**. G4B06

An analog multimeter is preferred to a digital multimeter **When adjusting circuits for maximum or minimum values**. G4B09

The signals that are used to conduct a two-tone test is **Two non-harmonically related audio signals**. G4B07

A two-tone test analyzes the transmitter performance parameter of **Linearity**. G4B08





A directional wattmeter can determine the **Standing wave ratio** (SWR). G4B10

When an antenna analyzer is being used for SWR measurements it must be connected to the **Antenna and feed line**. G4B11

The effect that strong signals from nearby transmitters can have on an antenna analyzer is the **Received power that interferes with SWR readings**. G4B12

With an antenna analyzer you can measure the **Impedance of coaxial cable**. G4B13

G4C – Interference to consumer electronics; grounding and bonding

Interference to consumer electronics

You can reduce RF interference to audio frequency circuits by using a **Bypass capacitor**. G4C01

A cause of interference covering a wide range of frequencies can come from the **Arcing at a poor electrical connection**. G4C02

The sound that is heard from an audio device experiencing RF interference from a single sideband phone transmitter is **Distorted speech**. G4C03

The sound that is heard from an audio device experiencing RF interference from a CW transmitter is **On-and-off humming or clicking**. G4C04

To reduce RF interference caused by common-mode current on an audio cable you should **Place a ferrite choke on the cable**. G4C08

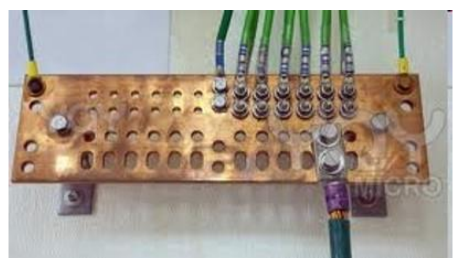
Grounding and bonding

A possible cause of high voltages that produce RF burns is **The ground wire has high impedance on that frequency**. G4C05

A possible effect of a resonant ground connection is **High RF voltages on the enclosures of station equipment**. G4C06

Soldered joints should not be used in lightning protection ground connections because **A soldered joint will likely be destroyed by the heat of a lightning strike**. G4C07

The effects of ground loops can be minimized when you **Bond equipment enclosures together**. G4C09



Ground loop is a current path that connects two or more pieces of equipment in a loop in which voltage can be induced by RF or magnetic fields.

A symptom caused by a ground loop in your station's audio connections is when **You receive reports of "hum" on your station's transmitted signal**. G4C10

A technique that helps to minimize RF "hot spots" in an amateur station is **Bonding all equipment enclosures together**. G4C11

All metal enclosures of station equipment must be grounded because **It ensures that hazardous voltages cannot appear on the chassis**. G4C12

G4D – Speech processors; S meters; sideband operation near band edges

Speech processors

The purpose of a speech processor in a transceiver is to **Increase the apparent loudness of transmitted voice signals**. G4D01

A speech processor affects a single sideband phone signal when **It increases average power**. G4D02

The effects of an incorrectly adjusted speech processor are: G4D03

- Distorted speech
- Excess intermodulation products
- Excessive background noise

All these choices are correct

Decibels

dB	Power Change
3 dB	2x
6 dB	4x
9 dB	8x
10 dB	10x
20 dB	100x
30 dB	1000x
40 dB	10,000x

The decibel (dB) is the unit used to measure the intensity of a sound. The deci is the metric prefix that means one tenth so therefore a decibel is 1/10 of a bel. The bel was named for Alexander Graham Bell.

We use the decibel as a comparison of power levels.

S meters

An S meter measures the **Received signal strength**. G4D04

A signal that reads 20 dB over S9 as compared to one that reads S9 on a receiver, assuming a properly calibrated S meter is **It is 100 times more powerful**. G4D05

10 dB would be 10 times more powerful
therefore 20 dB would be 10 times the 10 dB or 10 x 10 or 100.

The change in signal strength that is typically represented by one S unit is **6 dB**. G4D06

The power output of a transmitter must be raised **Approximately 4 times** to change the S meter reading on a distant receiver from S8 to S9. G4D07

Readings from S1 to S9 are not in dB. The readings above S9 are given in dB above S9. Each S unit represents approximately a 6 dB change (4 times power change).

Sideband operation near band edges

The frequency range that is occupied by a 3 kHz LSB signal when the displayed carrier frequency is set to **7.178 MHz is 7.175 MHz to 7.178 MHz**. G4D08

7.178 – 3 = 7.175

The frequency range that is occupied by a 3 kHz USB signal with the displayed carrier frequency set to **14.347 MHz is 14.347 MHz to 14.350 MHz**. G4D09

14.347 + 3 = 14.350

The closest to the lower edge of a band's phone segment that your displayed carrier frequency should be when using 3 kHz wide LSB is **At least 3 kHz above the edge of the segment**. G4D10

The closest to the upper edge of a band's phone segment that your displayed carrier frequency should be when using 3 kHz wide USB **At least 3 kHz below the edge of the band**. G4D11

G4E – Mobile and portable HF stations; alternative energy source operation

Mobile and portable HF stations

The purpose of a capacitance hat on a mobile antenna is **To electrically lengthen a physically short antenna**. G4E01

The purpose of a corona ball on an HF mobile antenna is **To reduce RF voltage discharge from the tip of the antenna while transmitting**. G4E02

They dissipate static build up from movement through the air caused by vehicle movement

The direct, fused power connections that would be the best for a 100-watt HF mobile installation is **To the battery using heavy-gauge wire**. G4E03

You should not use DC power for a 100-watt HF transceiver supplied by a vehicle's auxiliary power socket because **The socket's wiring may be inadequate for the current drawn by the transceiver**. G4E04

The most limiting of an HF mobile installation is the **Efficiency of the electrically short antenna**. G4E05

A disadvantage of using a shortened mobile antenna as opposed to a full-size antenna is the **Operating bandwidth may be very limited**. G4E06

The following may cause receive interference to an HF transceiver installed in a vehicle: G4E07

- The battery charging system
- The fuel delivery system
- The control computers

All these choices are correct

Alternative energy source operation

The configuration of individual cells in a solar panel when connected together are S**eries-parallel**. G4E08

The approximate open-circuit voltage from a fully illuminated silicon photovoltaic cell is **0.5 VDC**. G4E09

A series diode should be connected between a solar panel and a storage battery that is being charged by the panel **To prevent discharge of the battery through the panel during times of low or no illumination**. G4E10

The precaution that should be taken when connecting a solar panel to a lithium iron phosphate battery is **The solar panel must have a charge controller**. G4E11

G5 - Electrical Principles (3 Exam Questions)

G5A – Reactance; inductance; capacitance; impedance; impedance transformation; resonance

Reactance

The unit that is used to measure reactance is the **Ohm**. G5A09

The letter that is used to represent reactance is the **X**. G5A11

Reactance is the **Opposition to the flow of alternating current caused by capacitance or inductance**. G5A02

The opposition to the flow of alternating current in an inductor is called **Reactance**. G5A03

The opposition to the flow of alternating current in a capacitor is called **Reactance**. G5A04

An inductor reacts to AC in that **As the frequency of the applied AC increases, the reactance increases**. G5A05

A capacitor reacts to AC in that **As the frequency of the applied AC increases, the reactance decreases**. G5A06

Impedance

The term for the inverse of impedance is **Admittance**. G5A07

Impedance is **The ratio of voltage to current**. G5A08

Impedance transformation

The following devices can be used for impedance matching at radio frequencies: G5A10

- A transformer
- A Pi-network
- A length of transmission line

All these choices are correct

When inductive and capacitive reactance are equal in a series LC circuit the **Resonance causes impedance to be very low**. G5A01

Resonance

In an LC circuit at resonance the **Inductive reactance and capacitive reactance cancel**. G5A12

G5B – The decibel; current and voltage dividers; electrical power calculations; sine wave root-mean-square (RMS) values; PEP calculations

The decibel

The dB change that is represented in a factor of two increase or decrease in power is **Approximately 3 dB**. G5B01

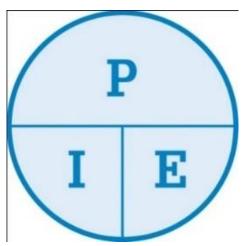
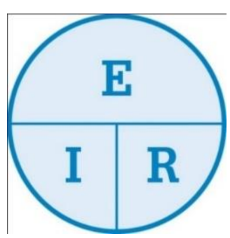
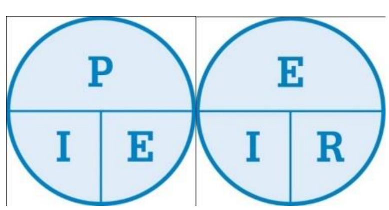
The percentage of power loss that is equivalent to a loss of 1 dB is **20.6 percent**. G5B10

Current and voltage dividers

The total current relates to the individual currents in a circuit of parallel resistors in that **It equals the sum of the currents through each branch**. G5B02

Kirchhoff's current law states that the sum of the currents flowing into a circuit node must equal the sum of the currents flowing out of the current node

Electrical Power Calculations

<table>
<tr><td>POWER EQUATION

</td><td>P = Power (watts)
I = Current Intensity (amps)
E = Electromotive Force (volts)
P = I x E
I = P / E
E = P / I</td></tr>
<tr><td>OHMS LAW EQUATION

</td><td>E = Electromotive Force (volts)
I = Current Intensity (amps)
R = Resistance (ohms)
E = I x R
I = E / R
R = E / I</td></tr>
<tr><td>
</td><td>P = I x E
P = (E / R) x E
P = E² / R
P = I x E
P = I x (I x R)
P = I² x R</td></tr>
</table>

If 400 VDC is supplied to an 800-ohm load, the watts of electrical power that are consumed is **200 watts**. G5B03

Resistor's power consumption (P), in watts, is equal to the squared value of the resistor's voltage (E), in volts, divided by the resistor's resistance (R), in ohms.

$$P = E^2 / R$$

$$P = (400)^2 / 800$$

$$P = 160{,}000 / 800$$

$$P = 200 \text{ Watts}$$

If a 12 VDC light bulb draws 0.2 amperes, then the watts of electrical power that are consumed is **2.4 watts**. G5B04

$$P = I \times E$$

$$P = 0.2 \times 12$$

$$P = 2.4 \text{ Watts}$$

If a current of 7.0 milliamperes flows through a 1,250-ohm resistance , then the watts that are consumed is **Approximately 61 milliwatts**. G5B05

Resistor's power consumption (P), in watts, is equal to the squared value of the resistor's current (I), in amps, divided by the resistor's resistance (R), in ohms.

$$P = I^2 \times R$$

$$P = (0.007)^2 \times 1250$$

$$P = 0.000049 \times 1250$$

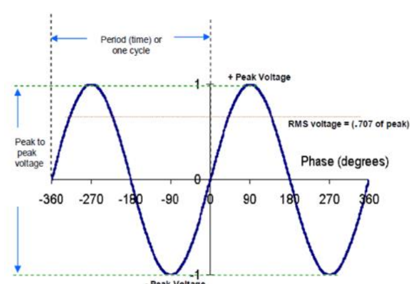
$$P = 0.0613 \text{ watts}$$

$$0.061 \text{ Watts} = 61.3 \text{ Milliwatts}$$

Root-Mean-Square (RMS)

RMS= Root Mean Square

The RMS value for a sine wave is the value of an equivalent DC voltage required to generate the same amount of power or heat in a resistance load



RMS voltage = .707 of peak

Peak Voltage = 1.414 times the RMS Value

Peak to Peak Voltage = 2x (RMS x 1.414)

Sine wave root-mean-square (RMS) values

The value of an AC signal that produces the same power dissipation in a resistor as a DC voltage of the same value is **The RMS value**. G5B07

The peak-to-peak voltage of a sine wave with an RMS voltage of 120 volts is **339.4 volts**. G5B08

Peak to Peak = 1.414 (2 (RMS))

1.414 (2 (120))

1,414 (240) = 339.4 Volts

The RMS voltage of a sine wave with a value of 17 volts peak is **12 volts**. G5B09

RMS = Peak x 0.707

RMS = 17 x 0.707

RMS = 12 Volts

The RMS voltage across a 50-ohm dummy load dissipating 1200 watts is **245 volts.** G5B12

E = √ (P x R)

E = √ (1200 x 50)

E = √ 60,000

E = 244.9 Volts RMS

PEP calculations

The ratio of PEP to average power for an unmodulated carrier is **1.00**. G5B11

The output PEP of an unmodulated carrier if the average power is 1060 watts is **1060 watts**. G5B13

The PEP produced by 200 volts peak-to-peak across a 50-ohm dummy load is **100 watts**. G5B06

PEP =[(200 / 2) x .707] ² / R

PEP= [70.7] ² / 50

PEP= 4,998 / 50

PEP= 99.97 Watts

The output PEP of 500 volts peak-to-peak across a 50-ohm load is **625 watts.** G5B14

PEP =[(500 / 2) x .707] ² / R

PEP= [250 x .707] ² / 50

PEP= [176.75] ² / 50

PEP= 31,240. 56 / 50

PEP = 624.81 Watts

G5C – Resistors, capacitors, and inductors in series and parallel; transformers

Calculating Series and Parallel Values

Component	In Series
Resistor	*Add values, R1 + R2 + R3 + …*
Inductor	*Add values, L1 + L2 + L3 + …*
Capacitor	*1/(1/C1 + 1/C2 + 1/C3 + …)*

Component	In Parallel
Resistor	*1/(1/R1 + 1/R2 + 1/R3 + …)*
Inductor	*1/(1/L1 + 1/L2 + 1/L3 + …)*
Capacitor	*Add values, C1 + C2 + C3 + …*

Resistors, capacitors, and inductors in series and parallel

The component that should be added to a capacitor to increase the capacitance is **A capacitor in parallel**. G5C13

Capacitors in parallel: C(total) = C1 + C2 + C3 + …

The component that should be added to an inductor to increase the inductance is **An inductor in series**. G5C14

Inductors in series: L(total) = L1 + L2 + L3 + …

The total resistance of a 10-, a 20-, and a 50-ohm resistor connected in parallel is **5.9 ohms**. G5C03

$$R_T = 1/\left[(1/R_1) + (1/R_2) + (1/R_3)\right]$$

$$R_T = 1/\left[(1/10) + (1/20) + (1/50)\right]$$

$$R_T = 1/\left[(0.1) + (0.05) + (0.02)\right]$$

$$R_T = 1/.17$$

$$R_T = 5.88 = 5.9$$

<u>Remember that the total resistance in a parallel circuit will always be less than the smallest resistor in the parallel network.</u>

The approximate total resistance of a 100- and a 200-ohm resistor in parallel is **67 ohms**. G5C04

$$R_T = 1/\left[(1/R_1) + (1/R_2)\right]$$

$$R_T = 1/\left[(1/100) + (1/200)\right]$$

$$R_T = 1/\left[(0.01) + (0.005)\right]$$

$$R_T = 1/.01505$$

$$R_T = 66.445 = 67$$

The equivalent capacitance of two 5.0-nanofarad capacitors and one 750-picofarad capacitor connected in parallel is **10.750 nanofarads**. G5C08

One nanofarad is equal to 1000 picofarads

When capacitors are in parallel, simply add them together

5 nF + 5 nF + .750 nF = 10.750 nF

The capacitance of three 100-microfarad capacitors connected in series is **33.3 microfarads**. G5C09

For identical capacitors in series simply divide

$C = 100 / 3$

$C = 33.333$

The capacitance of a 20-microfarad capacitor connected in series with a 50-microfarad capacitor is **14.3 microfarads**. G5C12

$C_T = 1/ [(1/C_1) + (1/C_2)]$

$C_T = 1/ [(1/20) + (1/50)]$

$C_T = 1/ [(.05)+(1/.02)]$

$C_T = (1/.07)$

$C_T = 14.285 = 14.3$

The inductance of three 10-millihenry inductors connected in parallel is **3.3 millihenries**. G5C10

For identical inductors in parallel simply divide the inductance of one inductor by the number of inductors.

$L = 10 / 3$

$L = 3.333$

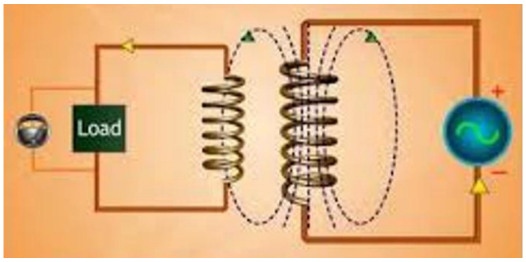
The inductance of a circuit with a 20-millihenry inductor connected in series with a 50-millihenry inductor is **70 millihenries**. G5C11

For inductors in series, simply add.

$L = 20 + 50$

$L = 70$

Transformers



The name of the cause of a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding is **Mutual inductance**. G5C01

The output voltage of an input signal as is applied to the secondary winding of a 4:1 voltage step-down transformer instead of the primary winding is **The input voltage is multiplied by 4**. G5C02

The ratio of the output turns to the input turns determines the output voltage to the input voltage ratio.
A 100-turn primary with 100-volt AC input will give a 25-turn secondary with a 25-volt AC output.
Reversing and putting 100-volts AC on the 25-turn side you get 400-volt output on the 100-turn side.

The primary winding wire of a voltage step-up transformer is usually a larger size than that of the secondary winding **To accommodate the higher current of the primary**. G5C05

The voltage output of a transformer with a 500-turn primary and a 1500-turn secondary when 120 VAC is applied to the primary is **360 volts**. G5C06

The secondary voltage is the ratio between the secondary and primary windings multiplied by the input voltage:

$$V = (1{,}500 \div 500)(120) \text{ or } (3)(120) \text{ or } 360 \text{ Volts}$$

The transformer turns ratio that matches an antenna's 600-ohm feed point impedance to a 50-ohm coaxial cable is **3.5 to 1**. G5C07

Turns ratio is the square root of the impedance ratio.

Turns ratio = $\sqrt{(600/50)}$ or $\sqrt{(12)}$ or 3.46 to 1

G6 - Circuit Components (2 Exam Questions)

G6A – Resistors; capacitors; inductors; rectifiers; solid-state diodes and transistors; vacuum tubes; batteries

Resistors

Wire-wound resistors should not be used in RF circuits because **The resistor's inductance could make circuit performance unpredictable**. G6A06

Wire wound resistors can act like an inductor at certain frequencies.

Capacitors

A characteristic of an electrolytic capacitor is its **High capacitance for a given volume**. G6A04

A characteristic of a low voltage ceramic capacitor is its **Comparatively low cost**. G6A08

Inductors

When an inductor is operated above its self-resonant frequency, **It becomes capacitive**. G6A11

Above the self-resonant frequency, the component's reactance switches type, making an inductor capacitive and a capacitor inductive.

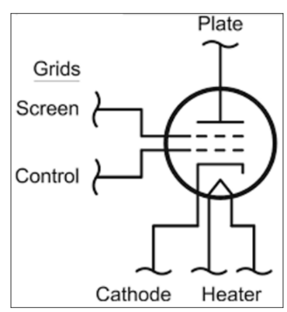
Solid-state diodes and transistors

The approximate forward threshold voltage of a germanium diode is **0.3 volts**. G6A03

The approximate forward threshold voltage of a silicon junction diode is **0.7 volts**. G6A05

The operating points for a bipolar transistor that are used as a switch are the **Saturation and cutoff**. G6A07

MOSFET construction is described as **The gate is separated from the channel by a thin insulating layer**. G6A09



The element of a vacuum tube that regulates the flow of electrons between cathode and plate is the **Control grid**. G6A10

The primary purpose of a screen grid in a vacuum tube is **To reduce grid-to-plate capacitance**. G6A12

Batteries

The minimum allowable discharge voltage for the maximum life of a standard 12-volt lead-acid battery is **10.5 volts**. G6A01

An advantage of batteries with a low internal resistance is a **High discharge current**. G6A02

G6B – Analog and digital integrated circuits (ICs); microwave ICs (MMICs); display devices; RF connectors; ferrite cores

Analog and digital integrated circuits (ICs)

An advantage of CMOS integrated circuits as compared to TTL integrated circuits is a **Low power consumption**. G6B03

CMOS = Complementary Metal-Oxide Semiconductor
TTL = Transistor-Transistor Logic

An integrated circuit operational amplifier is an **Analog device**. G6B06

Microwave ICs (MMICs)

The term MMIC means a **Monolithic Microwave Integrated Circuit**. G6B02

Display devices

An LED when emitting light is **Forward biased**. G6B08

A liquid crystal display as compared to an LED display has a **Higher contrast in high ambient lighting**. G6B09

RF connectors

The typical upper frequency limit for low SWR operation of 50-ohm BNC connectors is **4 GHz**. G6B04

A type N connector is described as **A moisture-resistant RF connector useful to 10 GHz**. G6B07

An SMA connector is **A small threaded connector suitable for signals up to several GHz**. G6B11

A connector type that is commonly used for low frequency or DC signal connections to a transceiver are the **RCA Phono**. G6B12

Ferrite cores

The performance of a ferrite core at different frequencies is determined by **The composition, or "mix," of materials used**. G6B01

Ferrite may contain iron, zinc, or manganese, or a mix of.

A ferrite bead or core can reduce common-mode RF current on the shield of a coaxial cable **By creating an impedance in the current's path**. G6B10

An advantage of using a ferrite core toroidal inductor is: G6B05

- Large values of inductance may be obtained
- The magnetic properties of the core may be optimized for a specific range of frequencies
- Most of the magnetic field is contained in the core

All these choices are correct

G7 - Practical Circuits (3 Exam Questions)

G7A – Power supplies; schematic symbols

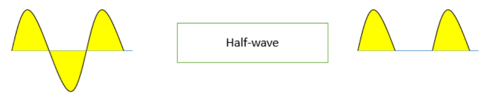
Power supplies

The function of a power supply bleeder resistor is **It discharges the filter capacitors when power is removed**. G7A01

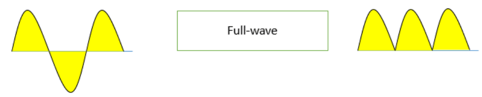
The components that are used in a power supply filter network are **Capacitors and inductors**. G7A02

A characteristic of a switchmode power supply as compared to a linear power supply is the **High-frequency operation allows the use of smaller components**. G7A08

The portion of the AC cycle that is converted to DC by a half-wave rectifier is **180 degrees**. G7A05



The portion of the AC cycle that is converted to DC by a full-wave rectifier is **360 degrees**. G7A06



The output waveform of an unfiltered full-wave rectifier connected to a resistive load is **A series of DC pulses at twice the frequency of the AC input**. G7A07

A characteristic of a half-wave rectifier in a power supply is **Only one diode is required**. G7A04

The type of rectifier circuit that uses two diodes and a center-tapped transformer are a **Full-wave**. G7A03

Schematic symbols

A field effect transistor is **Symbol 1**. G7A09

An NPN junction transistor is **Symbol 2**. G7A11

A Zener diode is **Symbol 5**. G7A10

A solid core transformer is **Symbol 6**. G7A12

A tapped inductor is **Symbol 7**. G7A13

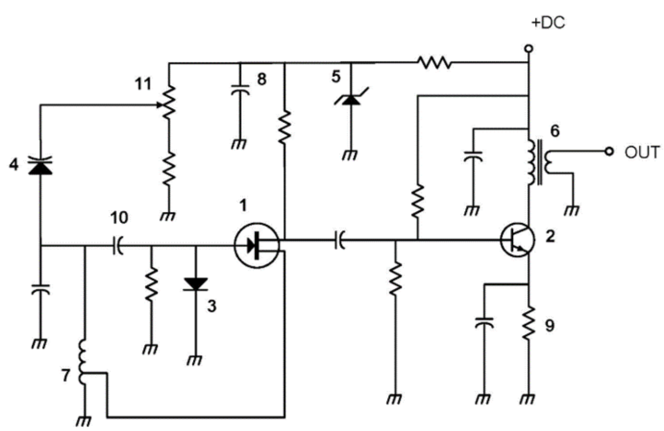
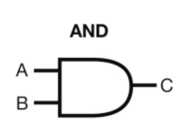


Figure G7-1

G7B – Digital circuits; amplifiers and oscillators

Digital circuits

The function of a two-input AND gate can be described as the **Output is high only when both inputs are high**. G7B03



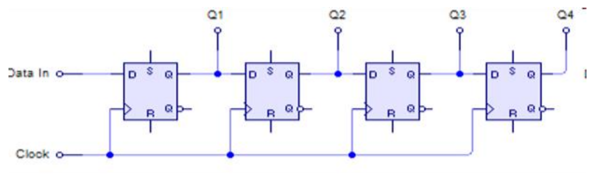
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

A 3-bit binary counter has **8 States**. G7B05

There are 8 states in a 3-bit binary counter.

000	001	010	011
100	101	110	111

A shift register is **A clocked array of circuits that passes data in steps along the array**. G7B06



Amplifiers and oscillators

The purpose of neutralizing an amplifier is **To eliminate self-oscillations**. G7B01

In a Class A amplifier, the percentage of the time that the amplifying device conducts is **100%**. G7B04

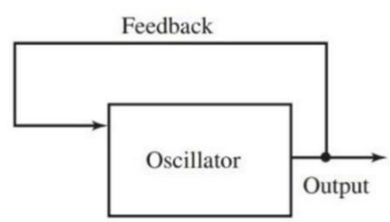
The efficiency of an RF power amplifier can be determined when you **Divide the RF output power by the DC input power**. G7B08

A linear amplifier can be described as **An amplifier in which the output preserves the input waveform**. G7B10

The class of amplifier that has the highest efficiency is **Class C**. G7B02

The mode of a Class C power stage that is appropriate for amplifying a modulated signal is **FM**. G7B11

The basic components of a sine wave oscillator are **A filter and an amplifier operating in a feedback loop**. G7B07



The frequency of an LC oscillator can be determined by **The inductance and capacitance in the tank circuit**. G7B09

L = Inductance; C = Capacitance

G7C – Transceiver design; filters; oscillators; digital signal processing (DSP)

Transceiver design

The output that is produced by a balanced modulator is a **Double-sideband modulated RF**. G7C02

A product detector is **Used in a single sideband receiver to extract the modulated signal**. G7C04

One reason to use an impedance matching transformer at a transmitter output is **To present the desired impedance to the transmitter and feed line**. G7C03

The parameters that affects receiver sensitivity are: G7C08

- Input amplifier gain
- Demodulator stage bandwidth
- Input amplifier noise figure

All these choices are correct

Filters

The circuit that is used to select one of the sidebands from a balanced modulator is a **Filter**. G7C01

The term that specifies a filter's attenuation inside its passband is its **Insertion loss**. G7C07

The bandwidth of a band-pass filter is measured between the **Upper and lower half-power frequencies**. G7C14

The frequency above which a low-pass filter's output power is less than half the input power is the **Cutoff frequency**. G7C12

The term that specifies a filter's maximum ability to reject signals outside its passband is its **Ultimate rejection**. G7C13

Oscillators

A characteristic of a direct digital synthesizer (DDS) is a **Variable output frequency with the stability of a crystal oscillator**. G7C05

Digital signal processing (DSP)

An advantage of a digital signal processing (DSP) filter as compared to an analog filter is **A wide range of filter bandwidths and shapes can be created**. G7C06

The phase difference between the I and Q RF signals that software-defined radio (SDR) equipment uses for modulation and demodulation is **90 degrees**. G7C09

"I" refers to "in-phase" and "Q" to quadrature

Quadrature modulation is also called I/Q modulation because of the I And Q signals that create the modulated output signal refers to two sinewaves that have the same frequency and are 90° out of phase.

An advantage of using I-Q modulation with software-defined radios (SDRs) is that **All types of modulation can be created with appropriate processing**. G7C10

These functions are performed by software in a software-defined radio (SDR): G7C11

- Filtering
- Detection
- Modulation

All these choices are correct

G8 - Signals and Emissions (3 Exam Questions)

G8A – Carriers and modulation: AM, FM, and single sideband; modulation envelope; digital modulation; overmodulation; link budgets and link margins

Carriers and modulation

The name of the process that changes the phase angle of an RF signal to convey information is **Phase modulation**. G8A02

The emission that is produced by a reactance modulator connected to a transmitter RF amplifier stage is **Phase modulation**. G8A04

The name of the process that changes the instantaneous frequency of an RF wave to convey information is **Frequency modulation**. G8A03

The type of modulation that varies the instantaneous power level of the RF signal is **Amplitude modulation**. G8A05

The phone emission that uses the narrowest bandwidth is **Single sideband**. G8A07

The modulation envelope of an AM signal is **The waveform created by connecting the peak values of the modulated signal**. G8A11

Direct binary FSK modulation is generated **By changing an oscillator's frequency directly with a digital control signal**. G8A01

FSK = Frequency Shift Keying

QPSK modulation is the **Modulation in which digital data is transmitted using 0-, 90-, 180- and 270-degrees phase shift to represent pairs of bits**. G8A12

QPSK = Quadrature Phase Shift Keying

Quadrature Phase Shift Keying is a form of phase **modulation** technique, in which two information bits (combined as one symbol) are modulated at once, selecting one of the four possible carrier phase shift states.

Characteristic of QPSK31 are: G8A06

- It is sideband sensitive
- Its encoding provides error correction
- Its bandwidth is approximately the same as BPSK31

All these choices are correct

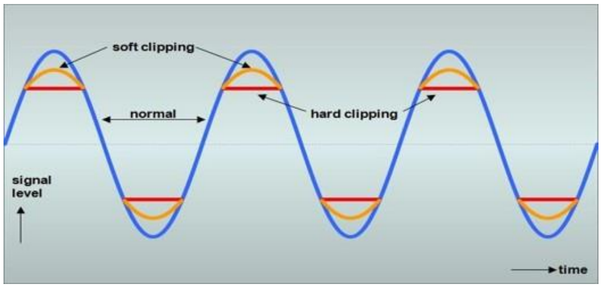
QPSK31 = Quadrature phase shift keying

BPSK31 = Binary phase shift keying

The type of modulation that is used by FT8 is **8-tone frequency shift keying**. G8A09

An effect of overmodulation is **Excessive bandwidth**. G8A08

The term "flat-topping," when referring to an amplitude-modulated phone signal, means **Signal distortion caused by excessive drive or speech levels**. G8A10



A link budget is **The sum of transmit power and antenna gains minus system losses as seen at the receiver**. G8A13

A link margin is **The difference between received power level and minimum required signal level at the input to the receiver**. G8A14

G8B – Frequency changing; bandwidths of various modes; deviation; intermodulation

Frequency changing

The mixer input that is varied or tuned to convert signals of different frequencies to an intermediate frequency (IF) is the **Local oscillator**. G8B01

The term for interference from a signal at twice the IF frequency from the desired signal is an **Image response**. G8B02

The stage in a VHF FM transmitter that generates a harmonic of a lower frequency signal to reach the desired operating frequency is the **Multiplier**. G8B04

The intermodulation product that is closest to the original signal frequencies is the **Odd-order**. G8B05

An odd-order intermodulation product of frequencies F1 and F2 is **2F1-F2**. G8B13

Bandwidths of various modes

The total bandwidth of an FM phone transmission having 5 kHz deviation and 3 kHz modulating frequency is **16 kHz**. G8B06

Bandwidth = 2 x (5 + 3) = 16

It is good to match receiver bandwidth to the bandwidth of the operating mode because **It results in the best signal-to-noise ratio**. G8B09

The relationship between transmitted symbol rate and bandwidth is a **Higher symbol rates require wider bandwidth**. G8B10

Deviation

The frequency deviation for a 12.21 MHz reactance modulated oscillator in a 5 kHz deviation, 146.52 MHz FM phone transmitter is **416.7 Hz**. G8B07

5 / 12 = 0.4166 = 416.7 Hz

It is important to know the duty cycle of the mode you are using when transmitting because **Some modes have high duty cycles that could exceed the transmitter's average power rating**. G8B08

The combination of a mixer's Local Oscillator (LO) and RF input frequencies is found in the output's **The sum and difference**. G8B11

Intermodulation

The process that combines two signals in a non-linear circuit to produce unwanted spurious outputs is **Intermodulation**. G8B12

Combination of two or more signals will create another signal which may fall into another frequency band of the system and cause interference to the system.

G8C – Digital emission modes

Digital emission modes

The band where amateurs share channels with the unlicensed Wi-Fi service is **2.4 GHz**. G8C01

2.4 GHz is in the 13-centimeter band

The digital mode that is used as a low-power beacon for assessing HF propagation is **WSPR**. G8C02

WSPR (whisper) stands for the Weak Signal Propagation Reporter

The part of a packet radio frame that contains the routing and handling information is the **Header**. G8C03

The Baudot code can be described as **A 5-bit code with additional start and stop bits**. G8C04

In an ARQ mode, a NAK response to a transmitted packet is a **Request retransmission of the packet**. G8C05

ARQ = **A**utomatic **R**epeat Re**q**uest
NAK = **N**ot **A**c**k**nowledged

Receiving station will quickly transmit NAK for perfect copy.

The result to a failure to exchange information due to excessive transmission attempts when using an ARQ mode is **The connection is dropped**. G8C06

Forward error correction (FEC) allows the receiver to correct data errors **By transmitting redundant information with the data**. G8C10

The narrow-band digital mode that can receive signals with very low signal-to-noise ratios is **FT8**. G8C07

An FT8 signal report of +3 means **The signal-to-noise ratio is equivalent to +3dB in a 2.5 kHz bandwidth**. G8C15

The type of code that is used for sending characters in a PSK31 signal is **Varicode**. G8C12

PSK = Phase Shift Keying

The following statement is true about PSK31, the **Upper case letters use longer Varicode bit sequences and thus slow down transmission**. G8C08

It is true of mesh network microwave nodes that **If one node fails, a packet may still reach its target station via an alternate node**. G8C09

The two separate frequencies of a Frequency Shift Keyed (FSK) signal are identified as **Mark and space**. G8C11

A waterfall display can be described as the **Frequency is horizontal, signal strength is intensity, time is vertical**. G8C14

What is indicated on a waterfall display by one or more vertical lines on either side of a data mode or RTTY signal **Overmodulation**. G8C13

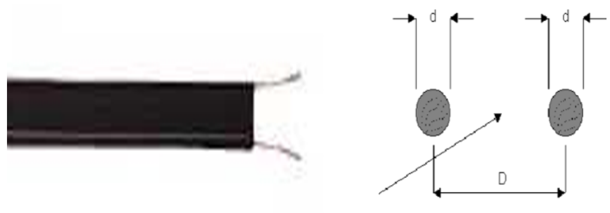
The following provide digital voice modes, **DMR, D-STAR, and SystemFusion**. G8C16

G9 - Antennas and Feed Lines (4 Exam Questions)

G9A – Feed lines: characteristic impedance and attenuation; standing wave ratio (SWR) calculation, measurement, and effects; antenna feed point matching

Feed lines

A factor that determines the characteristic impedance of a parallel conductor feed line is **The distance between the centers of the conductors and the radius of the conductors**. G9A01



The nominal characteristic impedance of “window line” transmission line is **450 ohms**. G9A03

The relationship between high standing wave ratio (SWR) and transmission line loss is that **High SWR increases loss in a lossy transmission line**. G9A02

The attenuation of coaxial cable will change with increasing frequency causing **Attenuation increases**. G9A05

Units of RF feed line loss is usually expressed in **Decibels per 100 feet**. G9A06

If the SWR on an antenna feed line is 5:1, and a matching network at the transmitter end of the feed line is adjusted to present a 1:1 SWR to the transmitter, then the resulting SWR on the feed line would be **5:1**. G9A08
The matching network allows the transmitter to see a matched load; it does not change the characteristic impedance of the feedline or antenna it is matching to.

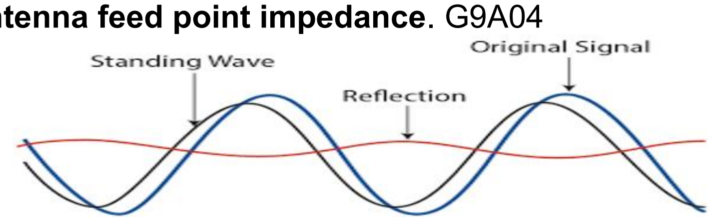
When connecting a 50-ohm feed line to a 200-ohm resistive load, the standing wave ratio result would be **4:1**. G9A09

When connecting a 50-ohm feed line to a 10-ohm resistive load, the standing wave ratio result would be **5:1**. G9A10

The effect of transmission line loss on SWR measured at the input to the line would be **Higher loss reduces SWR measured at the input to the line**. G9A11

Antenna feed point matching

A cause of reflected power at an antenna’s feed point is **A difference between feed line impedance and antenna feed point impedance**. G9A04



To prevent standing waves on a feed line connected to an antenna, **The antenna feed point impedance must be matched to the characteristic impedance of the feed line**. G9A07

G9B – Basic dipole and monopole antennas

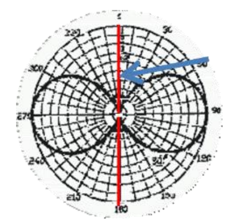
Basic dipole and monopole antennas

A characteristic of a random-wire HF antenna connected directly to the transmitter is the **Station equipment may carry significant RF current**. G9B01

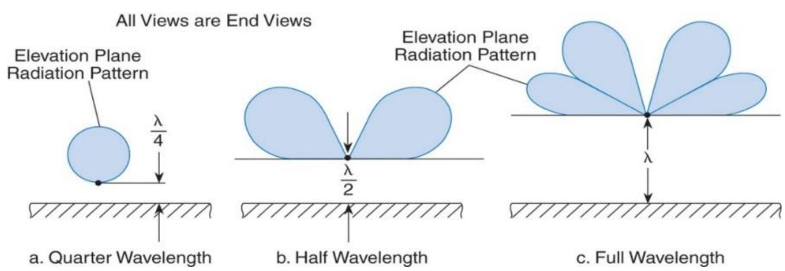
A common way to adjust the feed point impedance of an elevated quarter-wave ground-plane vertical antenna to be approximately 50 ohms is to **Slope the radials downward**. G9B02

The best description of the radiation pattern of a quarter-wave ground-plane vertical antenna is **Omnidirectional in azimuth**. G9B03

The radiation pattern of a dipole antenna in free space in a plane containing the conductor is **It is a figure-eight at right angles to the antenna**. G9B04



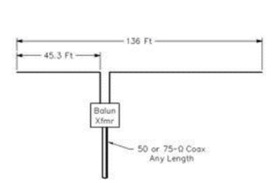
Antenna height affects the azimuthal radiation pattern of a horizontal dipole HF antenna at elevation angles higher than 45 degrees in that **If the antenna is less than 1/2 wavelength high, the azimuthal pattern is almost omnidirectional**. G9B05



The radial wires of a ground-mounted vertical antenna system should be placed **On the surface or buried a few inches below the ground**. G9B06

The feed point impedance of a horizontal 1/2 wave dipole antenna will change as the antenna height is reduced to 1/10 wavelength above ground, **It steadily decreases**. G9B07

The feed point impedance of a 1/2 wave dipole will change as the feed point is moved from the center toward the ends, **It steadily increases**. G9B08



An advantage of using a horizontally polarized as compared to a vertically polarized HF antenna is **Lower ground losses**. G9B09

The approximate length for a 1/2 wave dipole antenna cut for 14.250 MHz is **33 feet**. G9B10

$$468 / 14.250 = 32.8$$

The approximate length for a 1/2 wave dipole antenna cut for 3.550 MHz is **132 feet**. G9B11

468 / 3.550 = 131.8

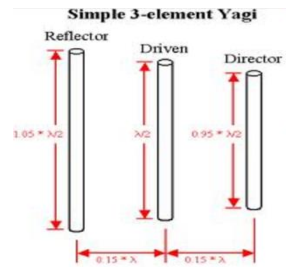
The approximate length for a 1/4 wave monopole antenna cut for 28.5 MHz **8 feet**. G9B12

468 / 28.5 = 16.4   16.4 / 2 = 8.2

G9C – Directional antennas

Directional antennas

When you compare the lengths of a three-element Yagi reflector and director to that of the driven element, **The reflector is longer, and the director is shorter**. G9C03

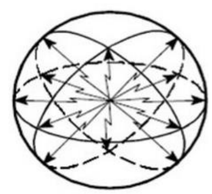


The approximate length of the driven element of a Yagi antenna is **1/2 wavelength**. G9C02

To increase the bandwidth of a Yagi antenna, use **Larger-diameter elements**. G9C01

The primary effect of increasing boom length and adding directors to a Yagi antenna is the **Gain increases**. G9C05

If you compare the antenna gain in dBi to the gain stated in dBd for the same antenna you will find the **Gain in dBi is 2.15 dB higher**. G9C04

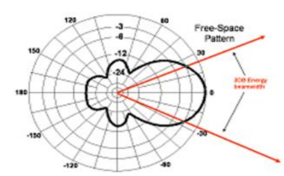


dBi is dB intrinsic (gain relative to a theoretical spherical antenna). dBd is gain relative to a dipole.

G9C06 **DELETED**

In reference to a Yagi antenna, “front-to-back ratio” means **The power radiated in the major lobe compared to that in the opposite direction**. G9C07

The “main lobe” of a directive antenna means **The direction of maximum radiated field strength from the antenna**. G9C08



In free space, the gain of two three-element, horizontally polarized Yagi antennas spaced vertically 1/2 wavelength apart typically as compared to the gain of a single three-element Yagi, the gain is **Approximately 3 dB higher**. G9C09

The following can be adjusted to optimize forward gain, front-to-back ratio, or SWR bandwidth of a Yagi antenna: G9C10

- The physical length of the boom
- The number of elements on the boom
- The spacing of each element along the boom

All these choices are correct

A beta or hairpin match is **A shorted transmission line stub placed at the feed point of a Yagi antenna to provide impedance matching**. G9C11

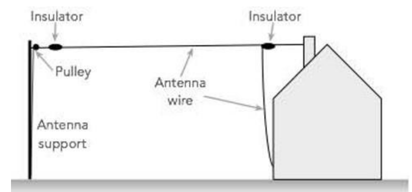
A characteristic of using a gamma match with a Yagi antenna is **It does not require the driven element to be insulated from the boom**. G9C12

G9D – Specialized antenna types and applications

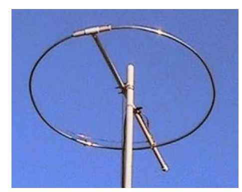
Specialized antenna types and applications

An antenna type that will be most effective as a near vertical incidence skywave (NVIS) antenna for short-skip communications on 40 meters during the day is **A horizontal dipole placed between 1/10 and 1/4 wavelength above the ground**. G9D01

The feed point impedance of an end-fed half-wave antenna is **Very high**. G9D02



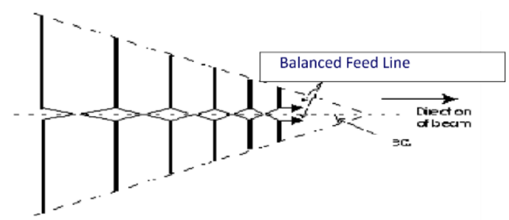
The direction of the maximum radiation from a VHF/UHF "halo" antenna is **Omnidirectional in the plane of the halo**. G9D03



An advantage of vertically stacking horizontally polarized Yagi antennas is **It narrows the main lobe in elevation**. G9D05

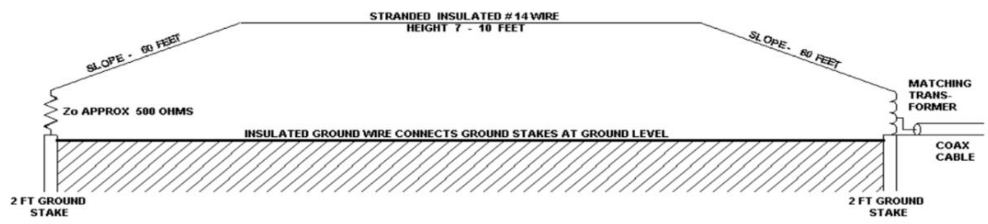
An advantage of a log-periodic antenna **Wide bandwidth**. G9D06

A log-periodic antenna can be described as the **Element length and spacing vary logarithmically along the boom**. G9D07



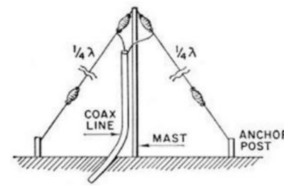
A "screwdriver" mobile antenna adjusts its feed point impedance **By varying the base loading inductance**. G9D08

The primary use of a Beverage antenna is as a **Directional receiving for MF and low HF bands**. G9D09



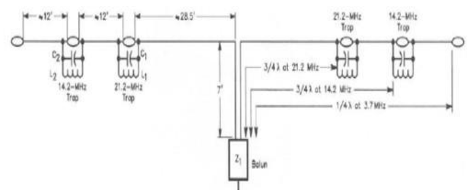
The direction that an electrically small loop (less than 1/10 wavelength in circumference) having nulls in its radiation pattern is **Broadside to the loop**. G9D10

The common name of a dipole with a single central support is the **Inverted V**. G9D12



The primary function of antenna traps is **To enable multiband operation**. G9D04

A disadvantage of multiband antennas is that **They have poor harmonic rejection**. G9D11



G9D13 **DELETED**

G0 - Electrical and RF Safety (2 Exam Questions)

G0A – RF safety principles, rules, and guidelines; routine station evaluation

RF safety principles, rules, and guidelines

One way that RF energy can affect human body tissue is **It heats body tissue**. G0A01

The following can be used to determine RF exposure from a transmitted signal: G0A02
- Its duty cycle
- Its frequency
- Its power density

All these choices are correct

The effect of modulation duty cycle on RF exposure is **A lower duty cycle permits greater power levels to be transmitted**. G0A07

The type of instrument that can be used to accurately measure an RF field strength is **A calibrated field strength meter with a calibrated antenna**. G0A09

A precaution that you should take if you install an indoor transmitting antenna is to **Make sure that MPE limits are not exceeded in occupied areas**. G0A11
MPE = Maximum Permissible Exposure

The stations that are subject to the FCC rules on RF exposure are **All stations with a time-averaged transmission of more than one milliwatt**. G0A12

Routine station evaluation

You can determine that your station complies with FCC RF exposure regulations: G0A03
- By calculation based on FCC OET Bulletin 65
- By calculation based on computer modeling
- By measurement of field strength using calibrated equipment

All these choices are correct

When evaluating RF radiation exposure “time averaging” means **The total RF exposure averaged over a certain period**. G0A04

If an evaluation of your station shows that the RF energy radiated by your station exceeds permissible limits for possible human absorption you must **Take action to prevent human exposure to the excessive RF fields**. G0A05

If your station fails to meet the FCC RF exposure exemption criteria you must **Perform an RF Exposure Evaluation in accordance with FCC OET Bulletin 65**. G0A06

Steps that an amateur operator must take to ensure compliance with RF safety regulations is to **Perform a routine RF exposure evaluation and prevent access to any identified high exposure areas**. G0A08

If an evaluation shows that a neighbor might experience more than the allowable limit of RF exposure from the main lobe of a directional antenna you must **Take precautions to ensure that the antenna cannot be pointed in their direction when they are present**. G0A10

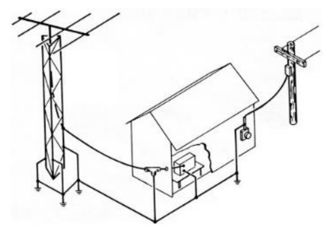
G0B – Station safety: electrical shock, grounding, fusing, interlocks, and wiring; antenna and tower safety

Station safety: electrical shock, grounding, fusing, interlocks, and wiring

In a four-conductor 240 VAC circuit you should attach fuses or circuit breakers to **Only the hot wires**. G0B01

According to the National Electrical Code, the minimum wire size that may be used safely for wiring with a 20-ampere circuit breaker is **AWG number 12**. G0B02

The size of fuse or circuit breaker that would be appropriate to use with a circuit that uses AWG number 14 wiring is **15 amperes**. G0B03



The station's lightning protection ground system should be located **Outside the building**. G0B04

Lightning arrestors should be located **Where the feed lines enter the building**. G0B13

The National Electrical Code covers the **Electrical safety of the station**. G0B06

A conditions that will cause a ground fault circuit interrupter (GFCI) to disconnect AC power is when **Current flowing from one or more of the hot wires directly to ground**. G0B05

When installing an emergency generator, **The generator should be operated in a well-ventilated area**. G0B09

The purpose of a power supply interlock is **To ensure that dangerous voltages are removed if the cabinet is opened**. G0B12

A requirement for lightning protection ground rods is that **They must be bonded together with all other grounds**. G0B11

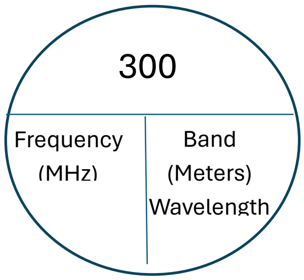
A danger from lead-tin solder is that **Lead can contaminate food if hands are not washed carefully after handling the solder**. G0B10

Antenna and tower safety

When climbing a tower using a safety harness you should **Confirm that the harness is rated for the weight of the climber and that it is within its allowable service life**. G0B07

Before climbing a tower that supports electrically powered devices you must **Make sure all circuits that supply power to the tower are locked out and tagged**. G0B08

General License Class Formulas

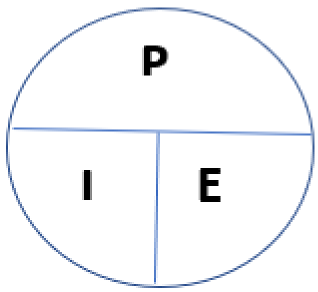


Band / Frequency Conversion

Band = 300 / Frequency

Frequency = 300 / Band

Approximately

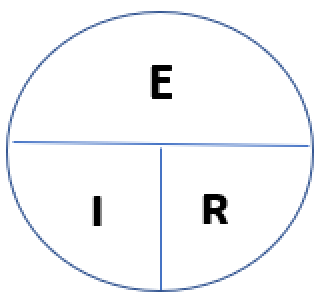


Power Equation

P = Power – Watts

I = Current – Amps

E = Volts – Voltage



OHMs Law

E = Volts – Voltage

I = Current – Amps

R = Resistance - Ohms

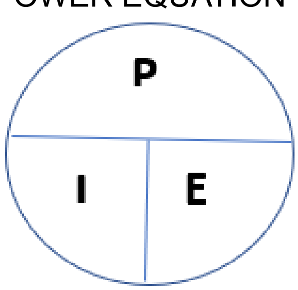
HINT To get the Power Equation, remember Pie, P-I-E,

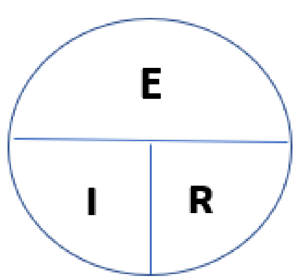
To get OHM's Law, reverse the P & E and put a leg on the P to create an R, E-I-R

When the Power Equation or the OHM's Law formulas don't work because of missing information, combine them to find a solution.

- *When looking for Watts and you only have Amps and Ohms, follow example 1*
- *When looking for Watts and you only have Volts and Ohms, follow example 2*

POWER EQUATION OHMS LAW





example 1

$P = I \times E$

$P = (E / R) \times E$

$P = E^2 / R$

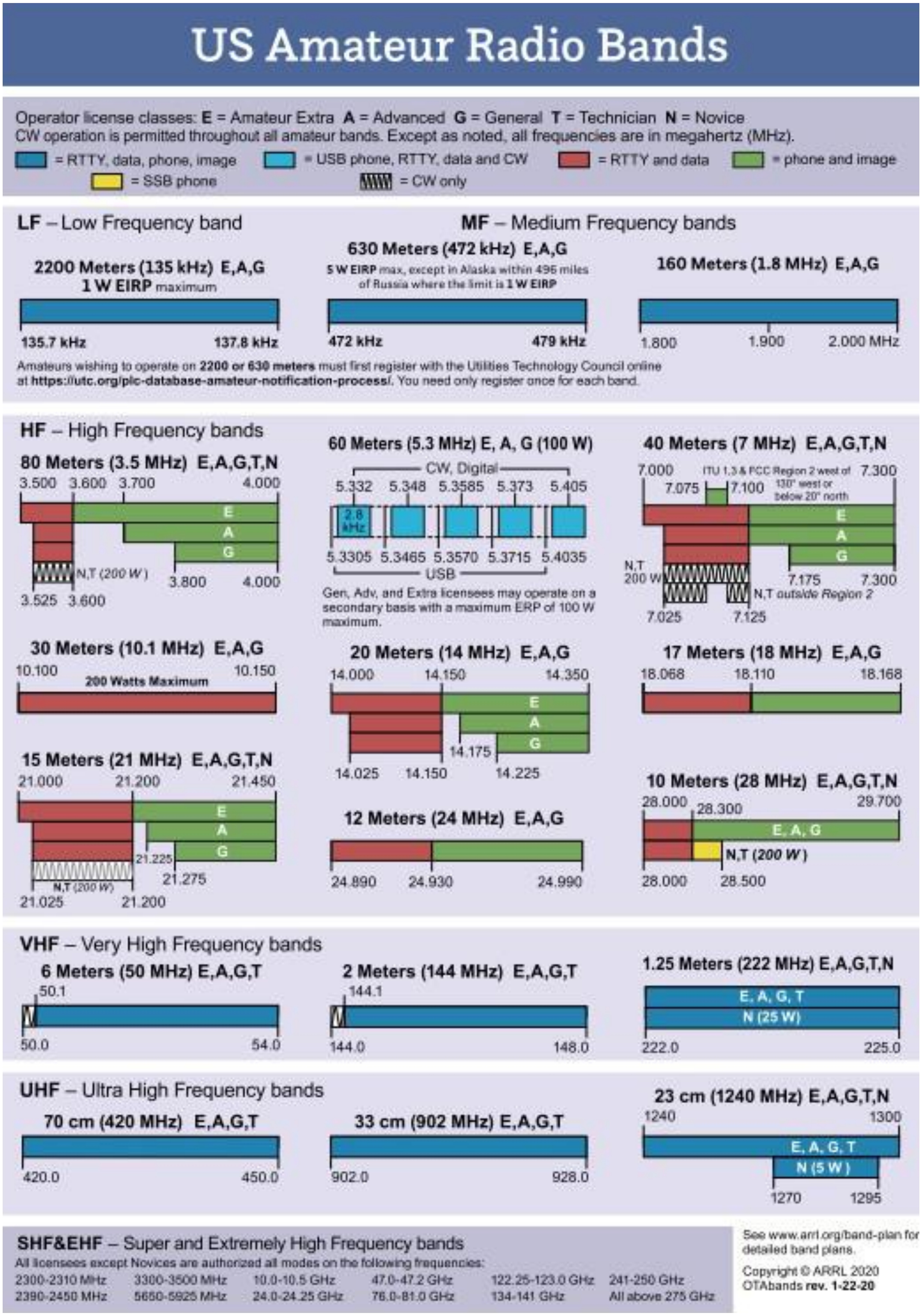
example 2

$P = I \times E$

$P = I \times (1 \times R)$

$P = I^2 \times R$

Band Plan


US Amateur Radio Bands
Operator license classes: E = Amateur Extra A = Advanced G = General T = Technician N = Novice
CW operation is permitted throughout all amateur bands. Except as noted, all frequencies are in megahertz (MHz).
= RTTY, data, phone, image
= USB phone, RTTY, data and CW
= RTTY and data
= phone and image
= SSB phone
= CW only
LF – Low Frequency band
2200 Meters (135 kHz) E,A,G
1 W EIRP maximum
135.7 kHz
137.8 kHz
MF – Medium Frequency bands
630 Meters (472 kHz) E,A,G
5 W EIRP max, except in Alaska within 496 miles of Russia where the limit is 1 W EIRP
472 kHz
479 kHz
160 Meters (1.8 MHz) E,A,G
1.800
1.900
2.000 MHz
Amateurs wishing to operate on 2200 or 630 meters must first register with the Utilities Technology Council online at https://utc.org/plc-database-amateur-notification-process/. You need only register once for each band.
HF – High Frequency bands
80 Meters (3.5 MHz) E,A,G,T,N
3.500 3.600 3.700 4.000
E
A
G
N,T (200 W)
3.800 4.000
3.525 3.600
60 Meters (5.3 MHz) E, A, G (100 W)
CW, Digital
5.332 5.348 5.3585 5.373 5.405
2.8 kHz
5.3305 5.3465 5.3570 5.3715 5.4035
USB
Gen, Adv, and Extra licensees may operate on a secondary basis with a maximum ERP of 100 W maximum.
40 Meters (7 MHz) E,A,G,T,N
7.000
ITU 1,3 & FCC Region 2 west of 130° west or below 20° north
7.300
7.075
7.100
E
A
G
N,T 200 W
7.175
7.300
N,T outside Region 2
7.025
7.125
30 Meters (10.1 MHz) E,A,G
10.100
200 Watts Maximum
10.150
20 Meters (14 MHz) E,A,G
14.000 14.150 14.350
E
A
G
14.175
14.025 14.150 14.225
17 Meters (18 MHz) E,A,G
18.068 18.110 18.168
15 Meters (21 MHz) E,A,G,T,N
21.000 21.200 21.450
E
A
G
21.225
N,T (200 W)
21.275
21.025 21.200
12 Meters (24 MHz) E,A,G
24.890 24.930 24.990
10 Meters (28 MHz) E,A,G,T,N
28.000 28.300 29.700
E, A, G
N,T (200 W)
28.000 28.500
VHF – Very High Frequency bands
6 Meters (50 MHz) E,A,G,T
50.1
50.0 54.0
2 Meters (144 MHz) E,A,G,T
144.1
144.0 148.0
1.25 Meters (222 MHz) E,A,G,T,N
E, A, G, T
N (25 W)
222.0 225.0
UHF – Ultra High Frequency bands
70 cm (420 MHz) E,A,G,T
420.0 450.0
33 cm (902 MHz) E,A,G,T
902.0 928.0
23 cm (1240 MHz) E,A,G,T,N
1240 1300
E, A, G, T
N (5 W)
1270 1295
SHF&EHF – Super and Extremely High Frequency bands
All licensees except Novices are authorized all modes on the following frequencies:
2300-2310 MHz 3300-3500 MHz 10.0-10.5 GHz 47.0-47.2 GHz 122.25-123.0 GHz 241-250 GHz
2390-2450 MHz 5650-5925 MHz 24.0-24.25 GHz 76.0-81.0 GHz 134-141 GHz All above 275 GHz
See www.arrl.org/band-plan for detailed band plans.
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General License Class Abbreviations

AC – Alternating Current
AFSK - Audio Frequency Shift Keying
ALC- -Automatic Level Control
AM – Amplitude Modulation
AR – Indicates the end of a formal message in CW
AREDN - Amateur Radio Emergency Data Network
ARQ - Automatic Repeat Request
AWR – American Wire Research
BPSK - Binary Phase Shift Keying
C - Chirpy or unstable signal
CMOS - Complementary Metal-Oxide Semiconductor
CQ DX - Any stations outside the lower 48 states
CSCE - Certificate of Successful Completion of Examination
CW – Continuous Wave (Morse Code)
dB – Decibel
DC – Direct Current
DDS - Direct Digital Synthesizer
DSP - Digital Signal Processing
E - Electromotive Force (volts)
ERP – Effective Radiated Power
FAA – Federal Aviation Administration
FCC – Federal Communications Commission
FEC - Forward Error Correction
FM – Frequency Modulations
FSK – Frequency Shift Keying
GFCI - Ground Fault Circuit Interrupter
HF – High Frequency
I – Current Intensity (Amps)
IF - Intermediate Frequency
IQ - I - In-phase; Q – Quadrature
ITU – International Telecommunications Union
KN – Listening only for a specific station or stations
LC - Inductance Capacitance
LED – Light Emitting Diode
LO - Local Oscillator
LSB – Lower Sideband
LUF - The Lowest Usable Frequency
MF – Middle Frequency
MMIC - Monolithic Microwave Integrated Circuit
MPE - Maximum Permissible Exposure
MUF – Maximum Usable Frequency
NAK - Not Acknowledged
NATO – North Atlantic Treaty Organization
NVIS - Near Vertical Incidence Skywave
OET - Office of Engineering and Technology
P – Power (Watts)
PEP - Permissible Envelope Power
PPT - Push to Talk
PSK - Phase Shift Keying
Q – Quadrature
QPSK - Quadrature Phase Shift Keying
QRL – “Are you busy?” or “I am busy, please do not interfere”
QRN - I am troubled by static
QRP - Low-power transmit operation
QRS - Send slower
QRV - I am ready to receive
QSK – Full break-in Operation
QSL - I have received and understood
R - Resistance (ohms)
RF – Radio Frequency
RMS- Root Mean Square
RST - Readability-Strength-Tone
RTTY – Radio Teletype
SDR - Software-Defined Radio
SSB – Single Sideband
SWR - Standing Wave Ratio
TTL - Transistor-Transistor Logic
UHF – Ultra High Frequency
USB – Upper Sideband
VDC – Volts Direct Current
VE – Volunteer Examiner (Person)
VEC -Volunteer Examiner Coordinator (Organization)
VFO - Variable Frequency Oscillator
VHF – Very High Frequency
VOX - Voice Operating Transmit
WSJT - Weak Signal Joe Taylor
WSPR - (whisper) Weak Signal Propagation Reporter
X – Reactance