General Class Study Guide

Class Course Book for July 2023 to June 2027

K4VRC

The Villages Amateur Radio Club
The Villages, Florida
www.k4vrc.com

General Class Study Guide

All Amateur Radio Operators,

Amateur radio has been around for a long time and has grown itself into a worldwide community of licensed hams on the airwaves with all sorts of communications technology. Ham radio attracts those who have never held a microphone as well as deep technical experts who grew up with a soldering iron and computers. Your United States Amateur Service license gives you the most extensive wireless communications privileges available to any private citizen anywhere in the world. In the United States, amateur radio licensing is governed by the Federal Communications Commission (FCC) under strict federal regulations. Licenses to operate amateur stations for personal use are granted to individuals of any age once they demonstrate an understanding of pertinent FCC regulations, knowledge of radio station operation and safety considerations. Over 110 years ago, December 13 1912, amateur radio operator licensing by the United States government began. Under authority of the Radio Act the Department of Commerce issued the first Amateur operator license to Irving Vermilya, call sign 1HAA. In the spring of 1921, Vermilya's station was upgraded to Special Amateur license, call sign of 1ZE and later W1ZE. Over the years, the classes have changed significantly, leading to the current system of three open classes and two grandfathered (Novice and Advanced) but closed to new applicants. Today we have Technician, General and the top US license class is Amateur Extra Class. Upgrading to a General license--which conveys extensive HF privileges only requires passing a written examination. You must pass 26 of a 35-question multiple-choice exam. Those with General licenses are granted 98% of the privileges on US amateur bands. Once you do, the entire range of operating modes and the majority of the amateur spectrum below 30 MHz become available to you.

The General Class license course is specially presented for those with amateur radio experience who want to learn and do more with amateur radio. The course will cover a vast amount of material in seven classes. It is intended to help members advance in the hobby we love and give a little boost to those on the fence.

Looking forward to congratulating you in your advancement to General Class,

George K2DM

George Briggs
President
The Villages Amateur Radio Club

PS All amateur radio operators are welcome to use and share this document. Comments about this document can be sent by means of the club website contact form; https://www.k4vrc.com/contact-us.html Please include; a detailed description of the issue with exam question ID and page number.

Table of Contents

Revisions

Original Release – 8/17/23

Chapter 1 - Introduction

Just Enough for Understanding

Studying for your HAM radio license is not easy for most people and this course is designed to help you with the difficult parts. Normally the class time is used to address the how and why questions. This is not intended to be traditional classroom experience instead you should expect a much more informal discussions about electronics as it relates to HAM radio in non-technical terms not Electrical Engineering. Just the opposite of most of the well-known ham radio license manuals that spend way too much content on electrical theory and fail to stay within the scope of the exam. This is not to say just teach the test. A good example is the radio transceiver, you need to know what it does, not make one. You do not need a basic understanding of how radio works. Simply put there is only seven classes (about 14 Hours in class room time) to gain an introductory level understanding of the technology and the Code of Federal Regulations Title 47, Telecommunication. Part 97, Amateur Radio Service. The course format is just enough information for context and essential understanding needed to pass the licensing test.

Less Math for more Comprehension

Historically most HAMs have problems passing the license exams due to the math required. It may relieve some of your concerns to know the question pool has reduced the number of questions requiring calculations in favor of comprehension questions. This course will focus on thinking through the questions and avoiding the algebra to solve problems. You still need to use a small amount of math to solve problems but just add, subtract, multiple and divide. Working the example problems in class will help you be at ease with using the math required. Thinking carefully about the wording of the question will often lead to the only correct answer without any math! This means many multiple-choice questions can be solved logically without doing the math and the discussion from this course will help you avoid selecting the wrong answer.

Seven Classes

The seven classes will meet for about two hours once a week. Each topic begins with an overview of the homework assignment for context followed by review of the questions covered. Understanding is reinforced with your questions and discussion. To prepare for each class;

- Reading of chapter prior to class
- Watch KE0OG Videos on YouTube
- Work chapter sample problems prior to class
- Review Class Study Guide to supplement your reading
- Take practice tests (online) at home between classes
- In class review of assignment, discussion and help with problems

Memory Retention

If you attend all classes, keep up with readings, and take practice tests conscientiously, preparing can be a relatively pain-free process. Pain-free does not mean work-free! Take practice tests online from multiple sites or different APPs. Many past students have found that preparing for the exam for 60 minutes per day, five or six days per week, will leave them well-prepared at exam time. Don’t cram at the end as hitting hard at the last minute simply don't work for most people and they experience declining returns on their efforts when they attempt to study for two and three hours straight.

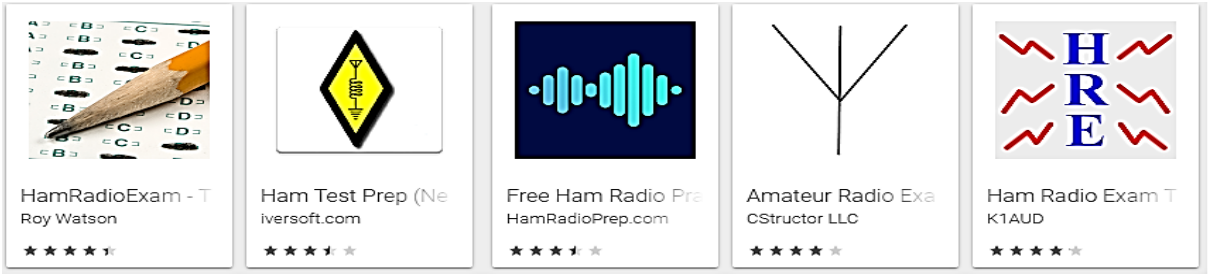
Learning Aids

You are encouraged to use every study resource that works for you. In general people retain more details from a hard copy document. Print this study guide so you can take it with you to study, write on it, underline or highlight the text for reference later. You can place a copy of this guide on an eReader. Other books are not required but if you do have questions from other sources, they will be discussed during the open review at the end of each class. The following are helpful sources of information;

HAM Radio for Dummies (free PDF Book)
KB6NU No-Nonsense Study Guide (free PDF Book)
Operating Procedures for Amateur Radio (free PDF Book)

Take online practice tests online, but not more than once a day.
http://arrlexamreview.appspot.com/
https://hamexam.org/
https://hamstudy.org/

Many people have found using a test App on their phone or tablet is a helpful tool

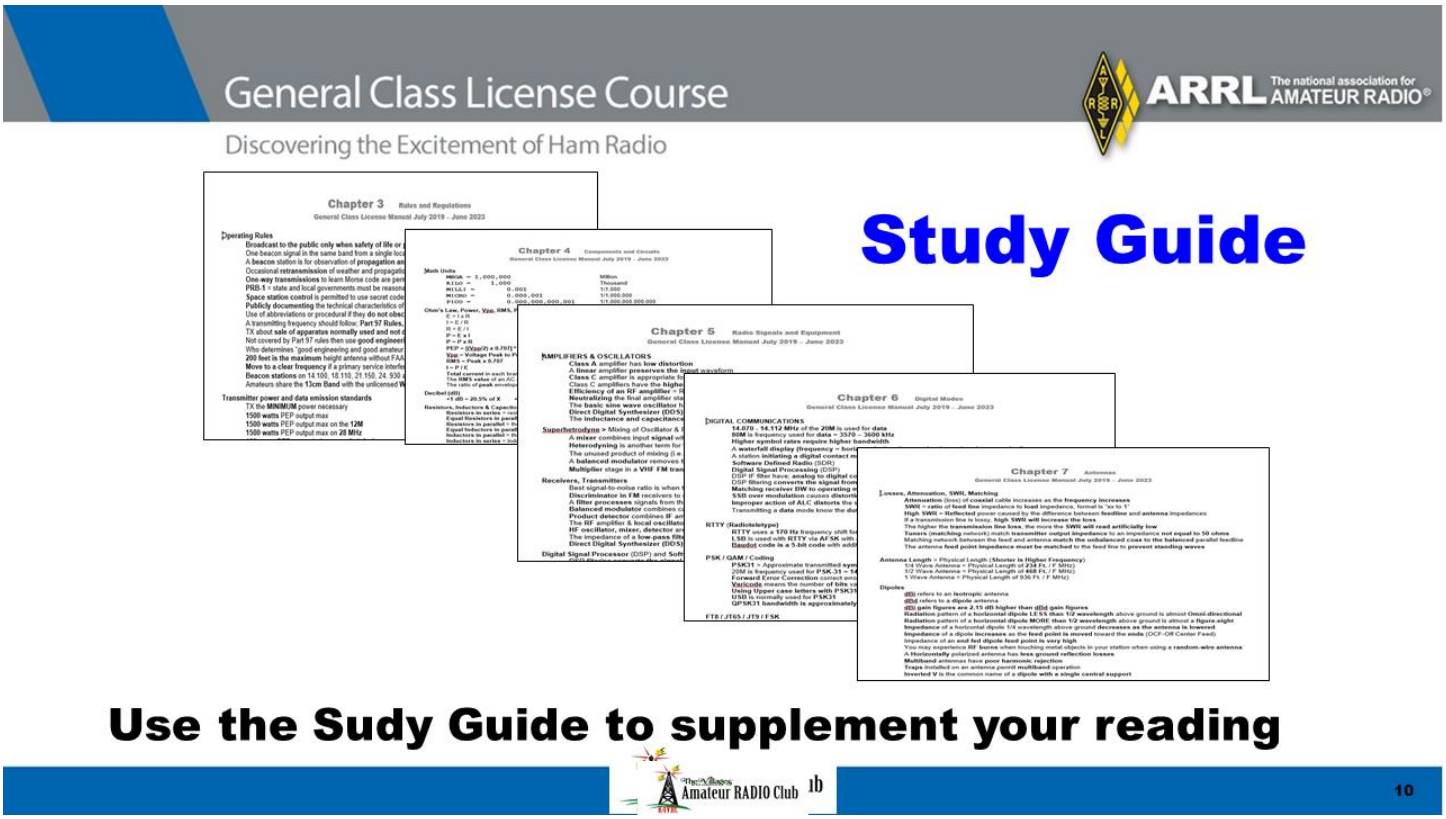


https://play.google.com/store/apps
https://www.apple.com/ios/app-store/

Dave Casler KE0OG Videos lectures are highly recommended.

learn.arrl.org/courses

How to use this Study Guide



How to use this Study Guide

Studying for your General Class license is not easy for most people and this course is designed to help you with the difficult parts. The course uses reading assignments, a staple of classrooms around the world, and the watching the KE0OG videos as a more in-depth reinforcement to get you going in the right direction. If you really want more help or to delve deeply into the details look at the free books listed under Learning Aids. Use the Study Guide to help in keeping your thoughts organized. Just treat this guide like someone had given you their class notes. All the important points from each class are neatly prepared for you. When taking practice tests, use the Question Cross Reference section in this guide to review questions you answered incorrectly. The General Class Question Pool is sorted alphanumerically with the page number where the question is discussed in the text of the ARRL General Class License Manual. This Study Guide is one more tool like the text book and videos to help you succeed. Sometimes, it's all too easy for things to get disorganized. This guide was prepared to make sure that everything's laid out in a way that makes it simple to find the notes you need.

Print the cross reference and keep it in your ARRL manual. Make a check in the Help box when you miss the question. If you miss the same question, repeatedly be sure to ask about that question during the class discussion.

Chapter 2 - Procedures and Practices

On-the-Air

Avoid harmful interference >> **Listen**, then ask if the **frequency is in use**, followed by your **call sign**
"CQ DX" is looking for any station **outside their own country** (outside the 48 US States)
"CQ CQ CQ" is looking for **ANY STATION**
Break into phone by **saying call sign once during a break** between other stations
60M other than a dipole antenna, you must **keep a record of the antenna gain**
No one has priority access to frequencies, common courtesy should be a guide
INCREASING INTERFERENCE from another station resolve in a **MUTUALLY ACCEPTABLE MANNER**
Use NATO Phonetic Alphabet = Alpha, Bravo, Charlie, Delta, Foxtrot, Golf, Hotel, India, etc
Follow the voluntary band plan for the operating mode you intend to use
50.100 to 50.125 MHz voluntary band plan is for the **48 US States**
Keep a **STATION LOG** in case the **FCC REQUESTS INFORMATION** about your station
Signal Reports typically **exchanged first** allow each station **TO OPERATE ACCORDING TO CONDITIONS**
When participating in a **CONTEST IDENTIFY YOUR STATION ACCORDING TO FCC REGULATIONS**
GOOD NET MANAGEMENT always has a **BACKUP FREQUENCY IN CASE OF INTERFERENCE**

SSB > Single Sideband is a form of Amplitude Modulated (AM) Signal

SSB uses **Less bandwidth** used and **higher power efficiency**
Only **one sideband is transmitted;** the other sideband **and carrier are suppressed**
SSB most often used for **HF Voice**
The **upper end of the voice** portion of a band is normally available to General Class licensees
USB is normally used for **17M & 12M**
USB is normally used for 30M **(10 MHz up)** including **VHF& UHF SSB**
LSB is normally used for 40M & down **(COMMONLY ACCEPTED AMATEUR PRACTICE)**
LSB is normally used for 40M & down **(7 MHz down)**
VOX operation allows **"hands free"** operation
SSB **frequency separation** to minimize interference is **2 to 3 KHz**
Dual VFO permits TX & RX different frequencies

CW > Send Continuous Wave using; a Straight Key, an Electronic Keyer and a Computer Keyboards

Avoid **HARMFUL INTERFERENCE** >> **SEND "QRL?",** followed by your **call sign**
Electronic Keyer automatic generation of dots and dashes
Reply to a CQ **at the speed the CQ was sent**
"ZERO BEAT" is matching TX frequency to the received signal
CW **frequency separation** to minimize interference is **150 to 500 Hz**
"C" added to an **RST** report means **Chirpy** or unstable signal

Abbreviations, Pro-Signs and "Q" Signals

Indicates low power operation >>> **QRP**
Can you hear me between your signals >>> **QSK (full break CW)**
I acknowledge receipt >>> **QSL**
I am ready to receive messages >>> **QRV**
Indicates send slower >>> **QRS**
IS THIS FREQUENCY IN USE? >>> QRL
RECEIVING INTERFERENCE FROM NATURE / STATIC >>> QRN
Indicates listening only for a specific station >>> **KN**
Indicates the end of a formal message >>> **AR**
VOX (Voice Activated Transmit) allows "hands free" operation

SOS > Emergency Communications

Acknowledge a station in **distress** and determine **what assistance** may be needed
RACES = Radio Amateur Civil Emergency Service
RACES control operator **MUST HAVE AN FCC LICENSE**
RACES training drills can be conducted no more than **1 Hr/Week** without special authorization

On the Air
arrl.org/ota

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*)
3.525 — 3.600 — 3.800 — 4.000

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 — 7.075 — 7.100 — 7.300
ITU 1,3 & FCC Region 2 west of 130° west or below 20° north
E
A
G
N,T
200 W
7.025 — 7.125 — 7.175 — 7.300
N,T *outside Region 2*

30 Meters (10.1 MHz) E,A,G

10.100 — 10.150
200 Watts Maximum

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
21.275
N,T (*200 W*)
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.

OTAbands **rev. 1-22-20**

Chapter 3 - Rules and Regulations

Station Rules

A transmitting frequency should follow; **Part 97 Rules, band plans** & **avoid interfering**
80M, 40M, 20M & 15M have portions where General **CANNOT** transmit (inverted layer cake)
80M, 40M, 20M & 15M have portions where **only Extra Class CAN** transmit (inverted layer cake)
The **UPPER END OF THE VOICE** portion of a band is normally available to General Class licensees
General **CANNOT** transmit **7.125 to 7.175 MHz** (inverted layer cake)
General **CAN** transmit **21.275 to 21.450 MHz** (inverted layer cake)
General **CAN** transmit **CW over the entire 10M band**
30M band is restricted to **CW & Data only**
60M USES CHANNELS rather than frequencies
Secondary users are permitted if they do not cause harmful **interference** to primary users
Within one mile of an FCC Monitoring Station take special steps to avoid harmful interference
You must avoid interference when using **spread spectrum**
10M **ABOVE 29.5 MHZ** is available for **REPEATER USE**
Occasional **retransmission** of weather and propagation information is permitted
One-way transmissions to learn Morse code are permitted
PRB-1 = state and local governments must be reasonably accommodate antenna structures
Publicly documenting the technical characteristics of a **digital protocol** required
Use of abbreviations or procedural if they **do not obscure the meaning**
Not covered by Part 97 rules then use **good engineering and good amateur practice**
Who determines "good engineering and good amateur practice" **the FCC**
200 feet is the maximum height antenna without FAA
One beacon signal in the same band from a single location
A **beacon** station is for observation of **propagation and reception**
Beacon stations on 14.100, 18.110, 21.150, 24. 930 and 28.200 MHz
Beacon stations on 28.200 to 28.300 MHz
Amateurs share the **13cm Band** with the unlicensed **Wi-Fi** on **2.4 GHz**
Amateurs **CANNOT communicate** with the unlicensed users **Wi-Fi** on **2.4 GHz**

Exams, Volunteer Monitoring, Volunteer Examiners and Coordinators

Volunteer Monitoring Program are volunteers who are formally enlisted to monitor for violations
Volunteer Monitoring Program objective is to encourage HAMs to **SELF-REGULATE**
DF skills are used to locate stations violating FCC Rules
Volunteer Examiners (VE) are accredited by **Volunteer Examiner Coordinator (VEC)**
A **Volunteer Examiner** must be **18 years old**
At **least three VEs** must be present for an exam
A VE holding a **General may administer a Technician** exam (must be higher or Extra for Extra)
A non-U.S. citizen VE must be a General Class or above (no difference than any other VE)
K4VRC / AG >> a new **General with a CSCE may operate** before FCC ULS shows upgrade
A Certificate of Successful Completion of Examination (**CSCE) is valid for 365 days**
Expired General, Advanced, or Extra **must pass element 2 (Tech)** to restore a previously-held license

Transmitter power and data emission standards

TX the **MINIMUM** power necessary
Transmitter power is PEP output from the transmitter
1500 watts PEP output max
1500 watts PEP output max on the **12M**
1500 watts PEP output max on **28 MHz**
100 watts PEP output is the power limit for **beacon** stations
200 watts PEP output max on **10.140 MHz**
100 watts PEP ERP using a dipole limit on the **60M**
10 watts PEP output max using **Spread Spectrum**
2.8 KHz max BW on USB frequencies in the **60M**
300 baud max for RTTY or data **below 28 MHz**
1200 baud max for RTTY or data on **10M**

Control, Repeater, Third Party, ITU

OPERATING A US STATION BY REMOTE control from outside the country **REQUIRES A US LICENSE**
OPERATING A REMOTE STATION **REQUIRES A HOST COUNTRY LICENSE**
A **Tech may TX on a 2M via a 10M** repeater when the **10M control operator holds a General**
A **third-party** is prohibited by an amateur who ever **had their license revoked**
A **third-party** TX is prohibited unless a **third-party agreement in effect** with that country
A **third-party** is messages must be **personal or emergencies or disaster relief**
Amateurs may communicate with any country except those that object to the ITU
ITU 2 region apply to radio amateurs operating in **North and South America**

Chapter 4 - Components and Circuits

Math Units

MEGA =	1,000,000.	Million
KILO =	1,000.	Thousand
MILLI =	0.001	1/1,000
MICRO =	0.000,001	1/1,000,000
NANO =	0.000,000,001	1/1,000,000,000
PICO =	0.000,000,000,001	1/1,000,000,000,000

TO CONVERT ⌂ MOVE DECIAL POINT

Decibel (dB)

+1 dB = 20% of X **+3 dB = 2X** +6 dB = 4X +10dB = 10X

-1 dB = 80% of X **-3 dB = 1/2X** **-**6 dB = 1/4X **-**10dB = 1/10X

+ 3 dB is double

-3 dB is half

Electrical Terms

Impedance is the **opposition** to the flow of current in an **AC** circuit **(Z)**
Impedance is measured in **Ohms (R = E / I)**
Reactance is the **opposition** to AC caused by **capacitance or inductance (X)**
Reactance opposes the flow of **AC** in an **inductor**
Reactance opposes the flow of **AC** in a **capacitor**
Reactance is measured in **Ohms**

Electrical Properties

Inductor reactance **increases with frequency**
Capacitor reactance **decreases with frequency**
Impedance is very low when inductive and capacitive **reactance are equal** in a series
Impedance is very low at **Resonance**

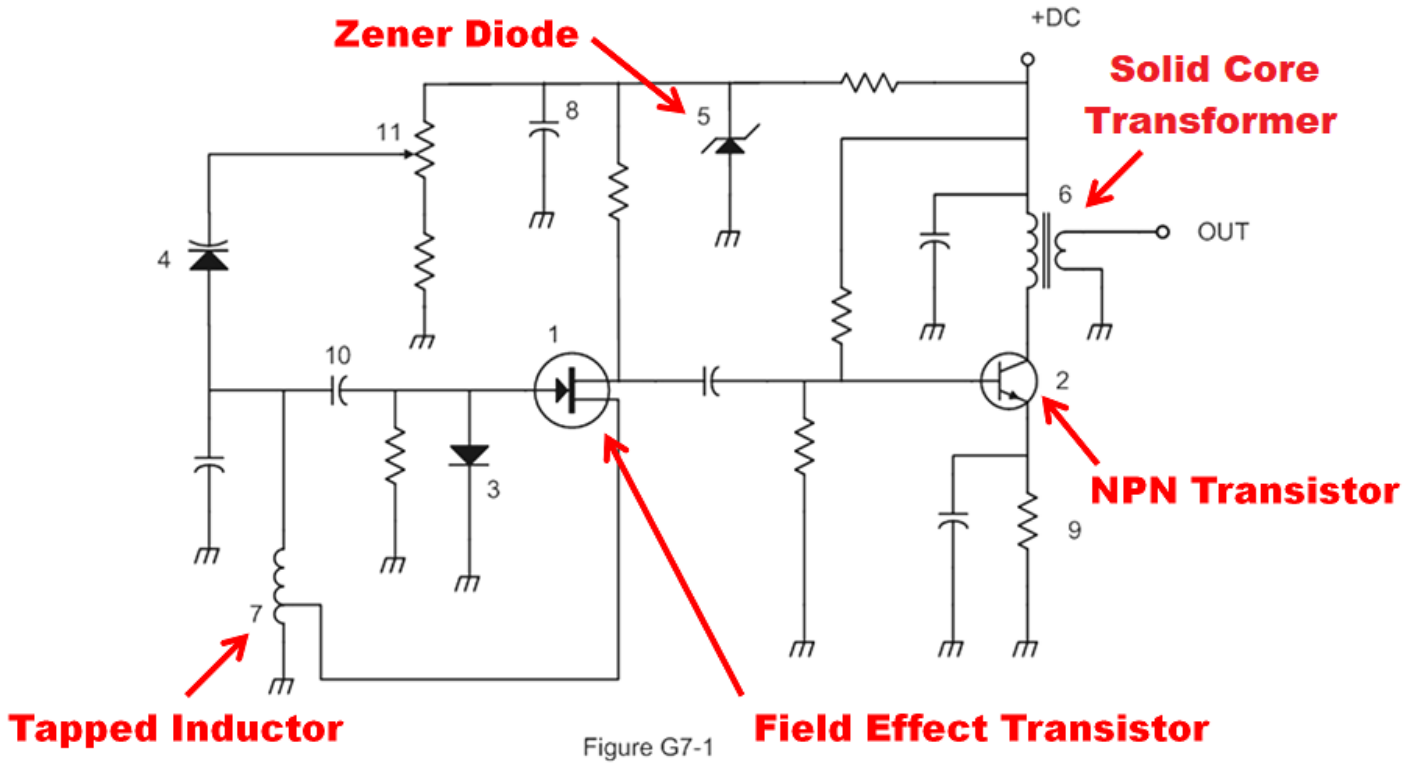


Figure G7-1

Resistors, Inductors & Capacitors

Resistors in series = resistor values added
Equal Resistors in parallel = resistor value / number of resistors
Resistors in parallel = the reciprocal of (the sum of all the reciprocal resistor values)
Equal Inductors in parallel = inductor value / number of inductors
Inductors in parallel = the reciprocal of (the sum of all the reciprocal inductor values)
Inductors in series = inductors values added
Capacitors in parallel = capacitor values added
Equal Capacitors in series = capacitor value / number of capacitors
Capacitors in series = the reciprocal of (the sum of all the reciprocal capacitor values)

Inductors or Resistors in Parallel

$$L = \frac{1}{\frac{1}{L} + \frac{1}{L} + \cdots \frac{1}{L}}$$

Inductors or Resistors in Series

$$L = L + L + \cdots L$$

Capacitors in Series

$$C = \frac{1}{\frac{1}{C} + \frac{1}{C} + \cdots \frac{1}{C}}$$

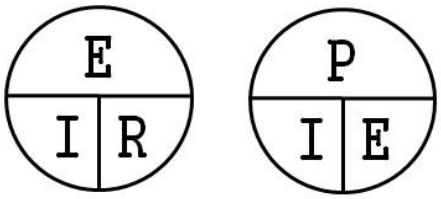
Capacitors in Parallel

$$C = C + C + \cdots C$$

The total current in **PARALLEL RESISTORS** is equal to the **SUM OF THE CURRENTS**
A **wire-wound resistor's inductance** could make circuit performance unpredictable
Low Voltage Electrolytic capacitors are low cost
High capacitance for given volume is an advantage of an electrolytic capacitor
Inductor is operated **above its self-resonant frequency** becomes capacitive
A ferrite core toroidal has; **large inductance, freq optimized properties, magnetic field stay in core**
The **"mix,"** determines the performance of a **ferrite core** at different frequencies

Ohm's Law, Power, Vpp, RMS, PEP

E = I x R
I = E / R
R = E / I
P = E x I
$P = I^2 \times R$
PEP = [(Vpp/2) x 0.707] ² / R
Vpp = Voltage Peak to Peak = 2 (1.41 x RMS)
RMS = Peak x 0.707



The **RMS value** of an AC signal is the **power dissipation** as a **DC** voltage of the **same value**

Transformers

Mutual inductance causes a voltage to appear across the **secondary winding** of a transformer
The **lower voltage winding of a** transformer requires a **larger size wire**
The transformer **VOLTAGE** output **= Input x (Np/Ns)**
The transformer output **IMPEDANCE = Input x Square Root of (Pimp/Simp)**
To **match impedance,** use an **impedance matching transformer**
A **transformer, Pi-network or transmission line** can be used for **impedance matching**

Transistors, Diodes, Vacuum Tubes

Saturation and cut-off regions are stable operating points for a bipolar transistor used as a switch
A **MOSFET gate is separated from the channel** with a thin insulating layer
Control grid of a triode tube regulates the flow of electrons between cathode and plate
A **screen grid** in a vacuum tube **reduces grid-to-plate capacitance**
0.3 volts junction threshold voltage of a **germanium diode**
0.7 volts junction threshold voltage of a **conventional silicon diode**
An LED is **Forward Biased** when emitting light (conducts)
A liquid crystal display has higher contrast compare to an LED

Digital Circuits, Integrated Circuits

Integrated circuit **operational amplifier** is an **analog** device
MMIC >> **Monolithic Microwave Integrated Circuit**
CMOS integrated circuits have **lower power consumption** compared to TTL
Eight states in a **3-bit binary** counter
A **shift register** is a clocked array that **passes data in steps** along the array

Power Supplies

360 degrees of the AC cycle is converted to DC by a **full-wave rectifier**
180 degrees of the AC cycle is converted to DC by a **half-wave rectifier**
The output waveform of a **full-wave rectifier** = Series of DC **pulses 2X freq** of the AC input
A **half-wave rectifier** circuit uses **one diode**
One type of **Full-wave rectifier** circuit uses **two diodes and a center-tapped transformer**
Capacitors and inductors are used in a **power-supply filter network**
A power-supply **bleeder resistor** discharges the filter capacitors
A **switch-mode PS high frequency operation** allows the use of smaller components

Solar, Wind, Batteries

LOW INTERNAL RESISTANCE batteries provide **HIGH DISCHARGE CURRENTS**
10.5 volts is the **minimum discharge voltage** of a standard **12 volt lead acid** battery
A solar panel with a **lithium iron phosphate battery** needs a **charge controller**
The individual **cells in a solar panel are connected in a series-parallel** configuration
The open-circuit voltage from a fully illuminated silicon **photovoltaic cell is 0.5 VDC**
A **series diode** between a solar panel and a storage battery **prevents self-discharge**

Connectors

RCA Phono used for low frequency or dc signal connections
BNC connectors are commonly used for RF service at **frequencies up to 4 GHz**
SMA connector is a small threaded connector suitable for signals up to several GHz
N connector is a moisture-resistant RF connector useful to 10 GHz

Test and Measurement Equipment

An **oscilloscope** contains **horizontal and vertical channel** amplifiers
An oscilloscope can **measure complex waveforms**
An oscilloscope can **check the keying waveform of a CW transmitter**
The attenuated TX RF is connected to **the vertical of an oscilloscope to check RF envelope**
A **high input impedance voltmeter** decreases the **loading on circuits** being measured
A digital voltmeter has better precision than an analog meter
An **antenna analyzer** is used for **antenna and feed line SWR measurements**
An **antenna analyzer** is used to **determine the impedance of a coaxial cable**
Strong signals can affect the **accuracy of antenna analyzer** measurements
An **analog** readout may be **preferred** when **adjusting tuned circuits**
Standing wave ratio (SWR) can be determined with a **directional wattmeter**

Chapter 5 - Amateur Radio Equipment

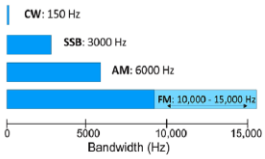
AM > Sends information by **varying the power** of the transmitted **RF Envelope** proportional to the microphone input
Modulator > Combines speech and RF
AM has a 6 KHz bandwidth

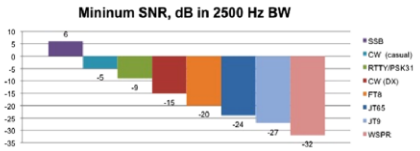
SSB > Single Sideband is a form of Amplitude Modulated (AM) Signal
Transmitter power can be used more effectively More transmitter power in one sideband
A filter removes the unwanted sideband from the balanced modulator in a SSB phone TX
SSB has a **narrower (3 KHz)** bandwidth

FM > Frequency Modulation changes the **frequency** of an RF wave to convey information
RF carrier **frequency** changes proportionally to the **instantaneous amplitude of the modulating** signal
FM phone transmission with **5 kHz deviation** and a **3 kHz modulating** signal has a **16 kHz bandwidth**
(5 KHz + 3KHz) X 2 = (8 KHz) X 2 = 16 KHz.
FM 146.52 MHz with **5 kHz deviation** using a **Reactance Modulator 12.21 MHz Osc** has a **416.7 Hz Dev**
5 KHz / (146.52 MHz / 12.21 MHz) = 5 KHz / 12 = 416.66 Hz

PM > Phase Modulation changes the **phase angle** of an RF wave to convey information
PM is produced by a **reactance modulator** connected to an RF power amplifier

Type of Signal	Typical Bandwidth
AM Voice	6 kHz
AM Broadcast	10 kHz
Analog TV	6 MHz
SSB Voice	2 kHz to 3 kHz
SSB Digital	<100 Hz to 3 kHz
CW	150 Hz
FM Voice	10 kHz to 15 kHz
FM Broadcast	180 kHz





Transceiver Functions
Noise blanker reduce receiver gain during a **noise pulse**
Too much Noise blanker may cause **distorted received** signals

"NOTCH FILTER" reduces interference from carriers in the receiver passband
Low-pass filter cutoff frequency is the frequency above which a filter's output is **half the input**
Ultimate rejection specifies a filter's reject signals outside its passband
Upper and lower **half-power points** is the **bandwidth of a band-pass filter**
Insertion loss specifies a filter's attenuation inside its passband

Reverse may be possible to reduce or eliminate interference from other signals
Attenuator reduces signal overload due to strong incoming signals
Automatic Level Control (ALC) reduces over drive distortion in an RF power amp

Transmitter Linearity performance is determined by a **two-tone test**
Two **non-harmonically related audio signals** are used to conduct a **two-tone test**
TRANSMIT ALC can be adjusted by the audio or **MICROPHONE GAIN**
TIME DELAY keying allows RX / TX changeover to complete properly before RF output is allowed

AMPLIFIERS & OSCILLATORS
Class A amplifier the amplifying device conducts **100%** of the time
A **linear** amplifier **preserves the input** waveform
Class C amplifier is appropriate for amplifying **CW or FM signals**
Class C amplifiers have the **highest efficiency**
Efficiency of an RF amplifier = RF output power / DC input power
Neutralizing the final amplifier stage of a transmitter **eliminates self-oscillations**
The **basic sine wave oscillator** has a filter & amplifier operating in a feedback loop
Direct Digital Synthesizer (DDS) is a high-stability **variable frequency oscillator** (VFO)
The **inductance and capacitance** in the **tank circuit** determines the **frequency** of an LC oscillator
Max power out without exceeding max plate current for control of a tube RF amp
Plate current DIP indicates correct adjustment of a tube amp plate tuning control

Receivers, Transmitters

A **LINK BUDGET** is the sum of Tx Power + antenna gains minus losses as seen at the Receiver
LINK MARGIN is the difference between signal at the RX vs minimum required signal level at the RX
Best signal-to-noise ratio is when the receiver bandwidth equals the signal bandwidth
Product detector combines **IF** amplifier & **BFO** and send the result to the AF amplifier in SSB RX
Amplifier gain, demodulator bandwidth & noise figure affects **RECEIVER SENSITIVITY**

Superheterodyne > Mixing of Oscillator & RF SHIFTS to Intermediate Frequency (IF) STAGE

A **mixer** combines input **signal** with **oscillator** signal to produce **intermediate frequency (IF)** = **455 KHz**
Heterodyning is another term for the **mixing of two RF signals**. (sum and difference)
Image Response interference is from a signal at **twice the IF frequency**
A **balanced modulator** removes the carrier and leaves the **upper and lower sidebands**
Multiplier stage in a **VHF FM transmitter** uses a **HF harmonic to reach RF** frequency

Digital Signal Processor (DSP) and **Software Defined Radio** (SDR)

SDR can create any **MODULATION, FILTER OR DETECTOR**
DSP filter can produce a **wide range of bandwidths and shapes** compared to analog filters
A **DSP filter** has a wide **range of filter bandwidths and shapes**
90-degree phase difference between the **I and Q signals** for SDR Mod/Demod
SDR or I/Q can create any modulation the with appropriate processing (Software)
AND gate output is high only when **both** inputs are high

Speech processors; S meters; SSB

A **speech processor increases average power** of a SSB phone TX
A **SPEECH PROCESSOR INCREASES THE LOUDNESS** of a SSB phone TX
An **incorrectly adjusted** speech processor; **Distorted speech, Intermodulation, background noise**
Overmodulation creates excessive bandwidth
Signal distortion caused by **excessive SSB drive produces "flat-topping"** distortion
ODD-ORDER intermodulation products are closest to the **original signal frequencies**
An **S Meter** measures **received signal strength**
Receivers have S meters (signal strength meters)
S Meter reading of **S9 = S8 times 4** (S Unit = ~6dB = 4X)
S meter **20 dB over S-9** = S-9 signal **X 100**

Transmitter QRM

Intermodulation is two signals mixed in a non-linear circuit producing unwanted spurious outputs
Distorted speech can be heard on telephone if there is interference from a **SSB TX** (Donald Duck)
On-and-off humming or clicking on telephone if there is interference from a **CW TX**
Connect all grounds to a single point to avoid a **ground loop**
Bond all equipment together to **avoid Ground Loops**
Connect all equipment grounds together to avoid unwanted effects of stray RF **(HOT SPOTS)**
Grounding Metal Enclosures ensures that **hazardous voltages** cannot appear on the chassis
High RF voltages on station equipment can be caused by a **resonant ground**
A **high impedance ground** on a frequency can cause an **RF burns** when HF TX
HUM could be a symptom of a **ground loop** somewhere in your station
A **ferrite bead** on cables reduces RF interference (**common-mode current on an audio cable**)
A **bypass capacitor reduces RF interference** to audio-frequency devices
Arcing can cause of interference covering a wide range of frequencies
ODD-ORDER INTERMODULATION PRODUCT of frequencies F1 and F2 = 2F1-F2

HF Mobile Radio Installations and Emergency Power

Efficiency of the electrically **short antenna limits an HF mobile** operation
Vehicle **computer, charging & fuel system** may cause **interfering signals** in the receiver of an HF mobile
Wire a 100W HF mobile **directly to a fused battery connections** using **heavy gauge wire**
Do NOT wire a 100W HF mobile to an **automobile's auxiliary power socket (too much current)**

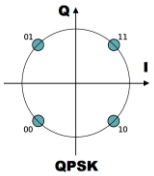
Chapter 6 - Digital Modes

RTTY (**Radioteletype)**

RTTY uses a **170 Hz** frequency shift for **Mark and Space**
LSB is used with **RTTY** via **AFSK** with an SSB transmitter
Baudot code is a 5-bit code with additional start and stop bits
Direct FSK is Data signal changing an oscillator's frequency
AFSK is Data signal changing audio frequency (microphone input)
RTTY failure causes; reversed **Mark/Space**, wrong **BAUD** rate & wrong **LSB vs USB**

PSK / QAM / Coding

Forward Error Correction correct errors by **TX redundant info with the data**
Varicode means the number **of bits** varies data bits in a **PSK31 character**
Using Upper case letters with PSK31 slows down transmission due to VARICODE
QPSK31 bandwidth is approximately **equal PSK31,** requires **USB** & has **error correction**
QPSK data is transmitted at **0, 90, 180 & 270 degrees phase** shift



FT8 / JT65 / JT9 / FSK

USB is used to generate **JT65, JT9, or FT8**
FT8 is an 8-tone frequency shift keying
FT8 is a **narrow-band** digital mode that can receive with **very low signal-to-noise ratios**
FT8 digital mode requires a **computer time accurate** within approximately **1 second**
FT8 RST of +3 means the **SNR of +3dB** in a 2.5 kHz bandwidth
20M is frequency used for **FT8 = 14.074 to 14.077 MHz**
FT8 call on a clear frequency during the alternate time slot to the calling station

DIGITAL COMMUNICATIONS

Software Defined Radio (SDR) & **Digital Signal Processing** (DSP)
Higher symbol rates require higher bandwidth
DMR, D-STAR, & SYSTEMFUSION provide digital voice modes
14.070 - 14.100 MHz of the **20M** is used for **data**
A **waterfall display (frequency = horizontal, signal strength = intensity, time = vertical)**
A station **initiating a digital contact must be under local or remote control** outside the auto control segments
Automatically controlled digital stations are permitted **above 50 MHz** & segments of some of the HF bands
Overmodulation is indicated on a waterfall display by **vertical lines on either side** of a data mode or RTTY
ALC distorts digital signals and can cause spurious emissions
Transmitting a **data** mode know the **duty cycle** to prevent **damage to your transmitter's** final stage
WSPR is a digital mode low-power **BEACON** for assessing HF propagation

PACTOR / WINLINK / WINMOR / MESH / ARDEN

DIGITAL MODES ARE NEVER EXEMPT from Part 97 third-party rules
The **Header** of a data packet contains the **routing and handling information**
Request the packet be **retransmitted** is meant by an **NAK response** to a transmitted packet
Transmit a connect message to establish contact with a digital messaging system gateway
PACTOR connections are limited to two stations (**Joining an existing contact is not possible)**
Failure to exchange information due to ARQ; retries, timeouts will **DROP CONNECTION**
Signals interfering with PACTOR or VARA cause; **retries, timeouts and connection failures**
WINLINK uses the internet to transfer messages
VARA is a digital protocol used with **WINLINK**
GATEWAY is another name for a **WINLINK Remote Message Server**
WINLINK is a form of PACKET using VHF AND HF bands & can send and receive **EMAIL**
MESH network, if one node fails, a packet may still reach its target station via an alternate node
Amateur Radio Emergency Data Network (AREDN)
AREDN mesh network provides high-speed data services during an emergency

Chapter 7 - Antennas

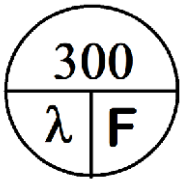
Dipoles

dBi refers to an **isotropic** antenna
dBd refers to a **dipole** antenna
dBi gain figures are 2.15 dB higher than dBd gain figures
Radiation pattern of a **horizontal dipole LESS than 1/2 wavelength** above ground is almost **Omni-directional**
Radiation pattern of a **horizontal dipole MORE than 1/2 wavelength** above ground is almost a **figure-eight**
Impedance of a horizontal dipole 1/4 wavelength above ground **decreases as the antenna is lowered**
Impedance of a dipole **increases** as the **feed point is moved** toward the **ends** (OCF-Off Center Feed)
Impedance of an **end fed dipole feed point is very high**
RF burns when touching metal objects in your station **(High RF Currents)** using a **random-wire antenna**
A **Horizontally** polarized antenna has **lower ground reflection losses**
Multiband antennas have **poor harmonic rejection**
Traps installed on an antenna permit **multiband** operation
Inverted V is the common name of a **dipole with a single central support**

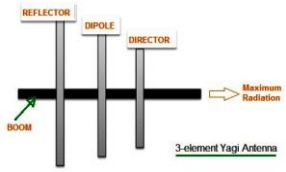
Monopole Antennas

Place **radial wires** of a vertical antenna on the surface or buried a **few inches below the ground**
Downward sloping radials (~ 45 Deg) ref ground-plane brings the feed-point impedance to **50 ohms**
The radiation pattern of a **quarter-wave, vertical antenna is Omnidirectional** in azimuth
A **shortened mobile** antenna has **limited BW** compared to a full size
A **"screwdriver"** mobile antenna adjusts its feed-point impedance by **varying the base inductance**
"CAPACITANCE HAT" electrically lengthens a physically short antenna
"CORONA BALL" reduces high voltage discharge from the tip of the antenna

Antenna Length > Physical Length (**Shorter is Higher Frequency**)
1/4 Wave Antenna = Physical Length of 234 Ft. / F MHz)
1/2 Wave Antenna = Physical Length of 468 Ft. / F MHz)
1 Wave Antenna = Physical Length of 300M. / F MHz)



YAGI Antenna consists of a driven element, reflector and director element(s)



The Yagi **driven** element is **1/2 wavelength**
The Yagi **director** is the **shortest element**
The Yagi **reflector** is the **longest element**
Using **larger diameter** elements will **increase** the **SWR bandwidth** of a Yagi
The **"main lobe"** is direction of **maximum radiated field** from the antenna
Front-to-back ratio" (FB) means the **"main lobe"** compared to the back
Increasing the **boom length and adding directors** to a Yagi antenna **increases the gain**
The **boom length**, **number** of elements and element **spacing** determine gain, FB ratio, SWR BW
A "**gamma** match" **driven element is NOT insulated from the YAGI boom**
A beta or **hairpin match is a stub placed** at the feed point of a Yagi to provide impedance matching
Stacked Yagi antennas spaced 1/2 wave have **3dB gain** more than a single Yagi
Stacking Horz Yagi antennas **narrows main lobe in elevation**

Loop Antennas

Radiation pattern of a **HALO** is almost **Omni-directional**
MAG LOOP (1/10 WL) has pattern nulls broadside to the loop

"**NVIS**" Near Vertical Incidence Skywave

The advantage of an **NVIS** is the **high vertical angle radiation for short skip** during the day
An **NVIS** antenna typically installed between **1/10 and 1/4 wavelength above ground**

Log Periodic Antenna

A **log periodic** antenna **spacing of elements** increases **logarithmically** along the boom
A **log periodic** antenna has **wide bandwidth**

Beverage Antenna

A **Beverage** antenna has high **transmit losses** compared to other types of antennas
A **Beverage** antenna is used for **directional receiving** for low HF bands
A **Beverage** antenna is a very **long and low receiving** antenna that is highly directional

Parallel & Coaxial Feedline Impedance

Typical characteristic **impedance** of **coaxial** cables is **50 and 75 ohms**
Impedance of a parallel conductor feedline is determined by the **distance between the conductors**
Characteristic **Impedance of "window line"** parallel transmission line is. **450 ohms**
RF feed line **losses** is expressed in **dB per 100 ft**
RF feed line losses increase with frequency

Losses, Attenuation, SWR, Matching

If a transmission line is lossy, **high SWR will increase the loss**
High SWR = Reflected power caused by the difference between **feedline** and **antenna** impedances
SWR = **ratio** of **feed line** impedance to **load** impedance, format is "xx to 1" (Always > 1)
SWR = Z1 / Z2 or Z2 / Z1 whichever is > 1
SWR = Z1 / Z2 = 200 / 50 = 4:1 SWR **SWR = Z1 / Z2 = 50 / 10 = 5:1 SWR**
A **5:1 SWR feed line matched** 1:1 SWR TX **still has a 5:1 SWR on the feed line**
The higher the **transmission line loss**, the more the **SWR will read artificially low**
Tuners (**matching** network) match **transmitter output impedance** to an impedance **not equal to 50 ohms**
Tuners (**matching** network) match **increase power transfer between the TX & Feedline**
The antenna **feed point impedance must be matched** to the feed line to **prevent standing waves**
Attenuation (loss) of **coaxial** cable increases as the **frequency increases**

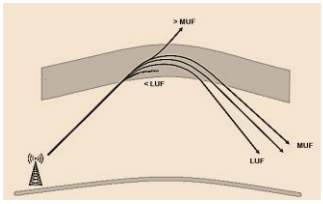
Chapter 8 - Propagation

Ionospheric Layers

The **D layer is closest** to the surface of the Earth **absorbing** most long **skip signals**
The D layer absorbs lower HF frequencies during daylight hours (< 10 MHz)
F2 region is the **highest ionospheric** region and provides the **longest distance propagation**

"Critical Angle" is the highest takeoff angle that **bends RF back to Earth**
"Critical Frequency" for takeoff angle is the highest frequency that **bends back to Earth**
Combining of **several paths** makes HF scatter signals **sound distorted**
HF scatter signals are weak as a small part of the signal get to the skip zone
A **fluttering sound** is a characteristic of **HF scatter** signals
Scatter allows a signal to be detected **too far for ground wave but too near for sky** wave

Maximum Usable Frequency; Lowest Usable Frequency; propagation "hops"



"MUF" the maximum usable freq for communications between two points
The **best propagation is** a frequency just **below the MUF**
Check Spotting to determine if the **MUF is high enough** to support skip
"LUF" the Lowest Usable Frequency for communications between two points
Frequencies **below the LUF are completely absorbed** by the ionosphere
LUF < Freq < MUF = **best propagation is** frequency is **bent back to the Earth**
LUF > MUF = No HF radio frequency will support skywave communications
2,500 miles is the maximum distance covered in **one hop using the F2 region**
1,200 miles is the maximum distance covered in **one hop using the E region**

Propagation

A **Sudden Ionospheric Disturbance (SID) disrupts on lower frequencies** more than higher frequencies
Near Vertical Incidence Skywave **(NVIS) is Short distance MF or HF propagation**
The **sun's rotation** causes **HF propagation** to vary on a **28-day cycle**
20M DX is reliable during any point in the solar cycle
20 meters supports worldwide propagation during **daylight at any point in the solar cycle**
DX Frequencies **above 20 MHz** are **least reliable** during periods of **low solar activity**
"LONG-PATH" is opposite direction **180 degrees from its short-path heading**
An **ECHO** can be heard when **both short and long path propagation are received**
A world map projection centered on a particular location is an **Azimuthal Projection map**
High atmospheric **noise is typical of the lower HF during the summer**

Solar Disturbances

The typical **sunspot cycle is 11 years**
The **radio energy emitted by the sun** is measured by the **solar flux index**
The **sunspot number** is based on **counting sunspots** and sunspot groups
The **solar-flux index** is a measure of solar activity at **10.7 cm** wavelength
Charged particles from **Coronal Mass Ejections to disrupt HF**
It takes **15 Hrs to days** for charged particles from **Coronal Mass Ejections to affect Earth**
The ultraviolet and X-ray **radiation** from solar **flares** take **8 Minutes** to affect Earth
Higher sunspot indicates better propagation at higher frequencies

Magnetic Disturbances

The **K-index** is the **short term** stability of the Earth's **magnetic field**
The **A-index** is the **long term** stability of the Earth's **magnetic field**
Geomagnetic storm is a temporary disturbance in Earth's **magnetosphere**
A **sudden change** in the **Earth's magnetic field is a geomagnetic disturbance**
North or South Latitudes **above 45 degrees** are **more sensitive to geomagnetic disturbances**
Degraded high-latitude HF is caused by **geomagnetic storm** on radio-wave propagation
Aurora from periods of **high geomagnetic reflect VHF signals** (good DX on VHF)

Chapter 9 – Safety / RF Exposure Hazard

Electrical Hazards

ONLY Hot wires in a four-conductor line cord **should be fused** from a 240-VAC single-phase source
Ground Fault Circuit Interrupter (GFCI) disconnects when current is flowing directly to ground
#14 AWG Wire >> **15 amperes** of continuous current (15A Circuit Breaker)
#12 AWG Wire >> **20 amperes** of continuous current

An emergency generator should be **located in a well-ventilated area**

Power supply interlock ensures that **dangerous voltages are removed if the cabinet is opened**
Lead (lead-tin solder) can **contaminate food if hands are not washed carefully after handling**
Electrical safety of your station is covered by the **National Electrical Code**
The station's lightning protection **ground system be located outside the building**
Lightning protection **ground rods must be bonded together** with all other grounds
Lightning arrestors be located where the feed lines **enter the building**
A **soldered joint** will likely be **destroyed by the heat of a lightning strike** (do not solder ground rods)

Radio Frequency Exposure Hazard

RF energy can **heat human body tissue**
All stations with a **time-averaged TX > 1 mW are subject to the FCC** rules on RF exposure
RF **MAXIMUM PERMISSIBLE EXPOSURE (MPE)** is determined by **power density, freq & duty cycle**
You must **take action to prevent human exposure to the excessive RF fields**
A **lower TX duty cycle permits** greater short-term RF exposure levels
The total RF exposure averaged over a certain period is **"TIME AVERAGING"**
Perform a routine RF exposure evaluation to ensure compliance with RF safety regulations
A **calibrated field-strength meter** can be used to accurately measure an RF field
Take action to prevent human exposure if an evaluation shows TX exceeds MPE
Take steps to **prevent directional antenna exceeding MPE** from point at neighbor
Ensure **MPE limits are not exceeded** in occupied areas **with indoor transmitting antenna**
FCC OET Bul 65, computer model or field strength meter determine complies with RF

Outdoor Safety

Confirm that the safety **harness is rated weight** of climber and within **service life**
Make sure all **circuits that supply power to the tower are locked out and tagged** prior to climb

Glossary

AC	**Alternating Current - Electric current flowing in alternating directions. In the US the frequency is 60 Hz.**
AGC	Automatic Gain - This flattens the sound
AM	Amplitude - Amplitude is changed to add the modulation known as voice.
Ammeter	Measure's amps or electric current and is connected in series with the circuit.
Amperes	A measurement of the current. Current is measured in Amperes (or commonly referred to as amps).
Antenna	The apparatus used to send and receive radio signals.
Antenna	omnidirectional antenna. Many houses have a satellite TV dish installed which is a directional antenna.
Antenna Analyzer	Tests the antenna to show what frequency it works best at and many other features.
APRS	Automatic Packet - Real-time tactical digital communications using a map to show the locations of stations
AR	Automatic Repeat - A digital scheme whereby the receiving station detects errors and sends a request to send again
ARES	Amateur Radio Emergency Services
ARRL	The Amateur Radio Relay League. Originally messages were routinely passed from one operator to the next (relayed) to get information sent great distances.
ATV	Amateur Television - Hams using video cameras and TV's with their transceivers to have two-way video
Auxiliary Station	A special repeater generally devoted to extending coverage for an individual station.
Band	A segment of the radio wave spectrum, identified by the approximate wavelength. For example, a2 Meter Band signal is approximately 2 Meters long for one wavelength.
Band Plan	A description or illustration of how parts of each band or wavelength segment is appropriately used.
Beacon	An amateur radio propagation beacon is a radio beacon, whose purpose is the investigation of the propagation of radio signals. They continuously transmit signals to demonstrate how well the signals are traveling.
Beam Antenna	See Directional Antenna.
CQ	Calling Any Station
Call Sign	The letters and number assigned by the FCC to a given license holder. All call signs are unique, meaning only one person or entity may hold a valid call sign. If a license has expired and the grace period has passed, that call sign may be issued to someone
Capacitor	A component that can store energy in an electrical field.

Carrier Signal	This is like the foundation of a radio signal. This is the basis which is altered by the mixer to be the desired frequency and has modulation added upon it so communication works.
Check sum	A method of error checking. The "check" is the number of words in the message.
Coax	A feed line composed of a center wire which carries the RF signal surrounded by an insulating layer which is then surrounded by a braided wire mesh which is covered by a sturdy insulated covering. This is always round. Most Ham coax is 50 Ohm.
Code	Generally, this refers to Morse Code. Someone "talking code" is using Morse Code to communicate. This could also be part of a telecommand. Passing coded messages to hide their meaning is prohibited.
Contesting	A timed event where amateur radio operators try to contact as many other operators as they can within the time allotted.
Control Operator	The FCC licensed Amateur Radio Operator that has control of the transceiver.
Control Point	The point at which you control the transmitting on the radio. Usually the "PTT" or Push To Talk button.
CTCSS	Continuous Tone - Repeater stations generally require sending a CTCSS as part of the transmission. This
Current	A measurement of the flow of electrons in an electric circuit. A measurement of Amps shows the level of current.
CW	Continuous Wave, meaning Morse Code
dB	Decibel - A unit of measurement used to express the ratio of one value of a physical property to
DC	Direct Current - Electric current flowing in one direction. All batteries use DC. If there is a + and a -
DCS	Digital-Coded - Similar to CTCSS but this is digital where CTCSS is analog.
Diode	An electrical component like a one-way gate. Current can only flow in one direction through diode.
Directional	An antenna that focuses the signals in one direction.
DMR	Digital Mobile Radio - A digital radio standard originally designed for commercial users
DMR Talk Group	DMR is a digital method to communicate through a repeater which allows two conversations simultaneously occur. A talk group is similar to a chat room where multiple people take turns talking.
Doppler Shift	An observed change in frequency. The frequency of sound changes as the fast moving by. The radio frequency changes as the satellite rushes by.
Double or Doubling	When two stations transmit at the same time neither transmission works well. You know you were "doubled" when you stop talking only to hear someone else finishing their transmission.
DTMF	Dual-Tone Multi- - This is the audible tones used to dial a telephone number and is call "Touch Tone."
Ducting	VHF long distance path caused by temperature and humidity than the layers above and below it. This is similar to an "inversion" layer.
Dummy Load	A non-inductive resistor and a heat sink to be used in place of an antenna. This is used when testing transmitters so no actual signal is transmitted out.
Duplex	Receiving on one frequency and transmitting on a different one. This dual frequency use is called duplex, or duplexing. Repeaters use duplex.

Duty Cycle	The percentage of time that a transmitter is transmitting vs receiving.
EchoLink	A service where repeaters can be accessed through the Internet most anywhere in the world.
Emergency, May Day, SOS	The terms Emergency, Priority, May Day, SOS, and usually Break are serious words. Anyone hearing these should immediately help anyone that used the term. Those using these terms need to have an actual emergency such as a life-threatening problem.
Farad	A measurement of stored electrical energy.
FCC	Federal Communications Commission - The US agency regulates and enforces the rules for Amateur Radio Service.
FCC Rules	Always follow the FCC rules when transmitting. One rule is that all other rules can be ignored if violating those other rules will save human lives.
Feed Line	The wire that connects a transceiver to the antenna. Hand-held transceivers have no visible feedline.
Ferrite Choke	A passive electric component that suppresses high frequency noise in electronic circuits. These are often seen a cylindrical lump near the end of an electrical or signal cord.
FET	Field Effect Transistor - A special transistor. The leads are the source, gate and drain
FM	Frequency Modulation - Frequency is changed to add the modulation known as voice.
Frequency	How often something occurs. In radio, it is how often a radio wave completes one cycle. This is measured in Hertz (Hz). Higher frequencies are Kilohertz (kHz), Megahertz (MHz), Gigahertz (GHz), Terahertz (THz), etc.
Frequency Coordinator	A volunteer group that recommends frequency use for local repeaters.
Fuse	A device designed to stop the flow of energy if the flow exceeds the capacity of the fuse. Without a fuse, an electrical device could malfunction and burn or explode.
Gain	The change in performance. A transistor has gain which means it can amplify the current. An antenna can have gain which means it can amplify or improve the transmission.
Gateway	An amateur station allowing other stations to access the Internet through their station.
Gin pole	An attachment used to erect tall antenna supports called towers. This is a tall movable brace with a pulley at the top allowing heavy sections to be lifted into place at the top of the tower.
Grid Locator	A letter-number designator assigned to a geographic location. Class location is: EL88xu
Ground	A connection from an electric item to a ground rod driven into the earth.
HAM	Amateur Radio Operator - No one really knows where the term Ham came from or what it really means
Henry	A measurement of stored magnetic energy.
Hertz	The measurement of frequency and is defined as one cycle per second. Common household electricity operates at 60 Hz, or 60 cycles per second.
HF	High Frequency - This is from 3 MHz to 30 MHz. This is generally from the 10 Meter band to the 160
Identify	You identify yourself during transmissions by stating your FCC designation which is your call sign. The rules state it is done at the end of every ten minutes and at the end of the transmission.

Impendence	An opposition to the flow of AC current. Impendence is measured in ohms.
Inductor	A component that can store energy in a magnetic field.
Ionosphere	A layer of the atmosphere that can reflect HF signals back down to the earth. There are multiple layers within the Ionosphere.
IRLP	Internet Radio - This uses Voice-Over-IP (VoIP) custom software and hardware. Coupled with the
ITU	International - This the United Nations specialized agency for information and communication
Keplerian elements	Data inputs for satellite tracking.
Ladder Line	A special feed line composed of two wires separated by an insulator. This feed line looks like a rope ladder for an action figure toy.
LED	Light Emitting Diode - A diode which emits light. See Diode.
LEO	Low Earth Orbit - Most amateur radio satellites use low earth orbits.
Linked Repeaters	Connecting two or more repeaters is linking them. This link may be with a radio connection or by using an Internet connection. The radio linking is limited by the range of the signal while the Internet linking is only limited by the connection to the Internet
Log Book	This is your record of Amateur Radio communications. This should include the date, time, and frequency of the transmission, and the call sign of who you communicated with.
LSB	Lower Side Band - See SSB
Memory	Saving a frequency and other option within a transceiver.
Meter	A display. This could be a needle flexing or a series of lights. Either version offers a visual indication of the item being measured. These include a speedometer, a voltmeter, an ohmmeter.
Mixer	A component that changes the frequency generated by the oscillator. This allows one transceiver to access several frequencies.
Modulation	The addition of the sound inputs changed into RF. This get added to the carrier signal and transmitted. This is your voice spoken into the microphone and changed into electrical impulses.
Morse Code	A communications system where letters (or other characters) are represented by long sounds(dah) and short sounds (dit) transmitted over the air. For example, dah, dit dit, dah dah, dit would be the word "time."
MPE	Maximum Permissible Exposure - The MPE limits are based on whole-body specific RF absorption rates.
MR	Memory Recall - A setting to use the memorized frequencies.
NB	Noise Blanker - Reduces certain noises
NCS	Net Control Station - The station or operator directing the Ham radio net.
Net	An organized communication involving a group of Hams. This would either be a directed net which includes the NCS or an informal net which would be like a chat room.
Noise Blanker	A setting in the receiver to cut or reduce certain noise sources.
NPN or PNP	Negative and Positive - This transistor has three leads; emitter, base and collector

NTSC	National Television - The pre-1990 analog TV signal standard in the US.
Ohm	A measurement of the opposition to the flow of electrical current. The measurement of ohm is in both AC (measured as impedance) and DC (measured as resistance) circuits.
Ohmmeter	Measure's ohms or resistance. This is a powered setting on the meter so be sure there is no power in the circuit.
Omnidirectional	A normal antenna which sends the radio signal out equally in all directions
Operator	The person allowed to operate the radio.
Oscillator	A component that generates a signal or sound. The oscillator makes the carrier signal which is the transmission.
Over-deviation	An excessive level of modulation or voice input. A microphone should be held sideways to your mouth to avoid over-deviation. Think of a young child with a microphone; they often over-deviate by talking too close to the mic.
Parallel	An electrical connection where the current flows through multiple paths. Some components may not have the current flow through since an alternate path is available. Usually, the components share the current flow.
PEP	Peak Envelope Power - Peak envelope power is the maximum power at a given point in time
Phone	Speaking, as in Phonetic, using your voice.
Phonetic	Using words to represent letters. Like Alpha for A, Bravo for B, etc.
PNP or NPN	Transistor - either one negative and two positive or vice versa.
Potentiometer	A variable resistor. This has the ability to change the potential energy passing through.
Power Supply	A device to convert AC 110 V power to the DC 13.8 V (12 V) power the transceiver requires.
Propagation	The travel of a radio signal. Poor propagation means the signals are not traveling far. Good propagation means distant signals can be heard. Great propagation may include worldwide communication.
PS	heavier and more expensive than a switching PS, but it is also more accurate and dependable.
PSK	Phase Shift Keying - A popular computer-sound card-generated radioteletype mode.
QRM	Manmade noise - This means "I am receiving noise" which is not from nature
QSY	Switching to another frequency - This means "Follow me as I change to _____ frequency."
RACES	Radio Amateur Civil Emergency Service - Government activated only during the emergency and during the immediate aftermath
Radio Horizon	The point where a radio signal ends. Radio waves travel along the earth better than light waves, so radio signals can go slightly beyond the visible horizon.
Radio Wave	An energy wave consisting of Electrical energy and Magnetic energy; therefore, it is Electromagnetic energy. This travels at the speed of light which is stated as 300,000,000 Meters per second.
Receiver	Slightly adjusts the receive frequency up or down. This does not change the transmit frequency. Incremental Tuner

Rectifier	A component composed of diodes aligned to alter the flow of current from alternating current to direct current.
Relay	Retransmitting from one station to another. Generally, when distance prevents one station from hearing the other, a station within range of both can relay the messages back and forth.
Repeater Offset	This is the difference between the frequency a repeater receives on vs. what it transmits on. For 2M it is generally plus or minus 600 kHz and for 70 CM is plus or minus 5 MHz
Repeater Station	A transceiver that receives a signal and immediately retransmits that signal. These are generally on mountain tops so they can transmit greater distances. Often just called a repeater.
Resistance	An opposition to the flow of DC current. Resistance is measured in ohms.
RF	Radio Frequency - The frequency of the Electromagnetic energy emission commonly called a radio wave.
RIT	Receiver Incremental - Slightly adjusts the receive frequency up or down. This does not change the transmit
Schematic	A drawing of symbols representing how electrical components are connected.
Secondary User	There is a primary user (often the government) who has priority. As long as they are not using the frequency, a secondary user can transmit. But the secondary user cannot interfere with the primary user.
Selectivity	The ability to choose. In a transceiver this chooses one signal over another.
Sensitivity	The ability to detect. In a transceiver this pulls in the weak signal.
Series	An electrical connection where the current flows through all components in order.
Simplex	Receiving and transmitting on the same frequency. This is simple.
Space Station	A repeater or Amateur Radio Station over 50 km above the earth, generally in orbit.
Spin Fading	An observed change in signal strength as a satellite rotates during its orbit.
Squelch	A setting where the receiver silences unwanted levels of sound. If the squelch is set too high, distant signals will not be heard. If it is not set high enough, steady static is heard.
SSB	Single Side Band - An amplitude modulation that uses one sideband with a carrier
Stroke, Slant, Slash	The separation between your call sign and a special designator like the slash in a date ("/").
Switch	A device to connect or open an electrical circuit, often used to turn on a light or other electrical device.
Switching PS	A small power supply that uses a rectifier to convert house current to DC.
SWR	Standing Wave Ratio - A measurement of how much radio wave energy is reflected from the antenna back to the transmitter
Tactical Call Sign	This is a term used to temporarily identify your station. You must still use your FCC call sign (see Identify) according to the rules.
Telecommand	A radio signal transmitted with the intent to control a device. Such as initiating, modifying, or terminating the functions of a device. This could be a repeater, a space station, or your RC vehicle.
Traffic	A specific organized message that is passed from one operator to the next intending to deliver the

Transceiver	A radio that both transmits and receives.
Transformer	This component changes or transforms AC power, usually from 120 V to a smaller value. These exchange the extra volts into heat which is why some transformers are hot when in use. The greater the energy difference, the hotter the transformer will be.
Transistor	A component consisting of three layers of semiconductor material. Transistors can amplify a signal and they can direct the flow of current.
Transmit	To send a radio signal.
Tropospheric	A phenomenon where a radio signal bounces up and down within a layer of the atmosphere
UHF	Ultra High Frequency - This is from 300 MHz to 3000 MHz
Uplink or Downlink	The radio transmission to or from a space station.
USB	Upper Side Band - An amplitude modulation that uses one sideband with a carrier
Variable	Some electrical components can be adjusted and have "variable" before their name. These include a variable resister (potentiometer) and a variable inductor.
VFO	Variable Frequency - The ability to change to any frequency within the radio's capability. Radios used to use
VHF	Very High Frequency - This is from 30 MHz to 300 MHz. This is generally from the 2 M to the 6 M band
VoIP	Voice over Internet Protocol - A methodology for the delivery of voice communications
Voltmeter	Measure's volts or electromotive force and is connected in parallel with the circuit.
Volts	A measurement of the electromotive force.
Watts	A measurement of electrical power. Power is measured in watts.
Wavelength	The distance traveled by a radio wave during one cycle. This can be measured from the top (peak to peak), the bottom (trough to trough), or any other single point of the radio wave.
Window Line	A special feed line composed of two insulated wires running parallel separated by 1" of flat insulation which has squares cut out looking like windows.

Question Cross Reference

This cross reference will take you directly to the page in your ARRL General Class License Manual where the question is explained. Print this cross reference and keep it in your ARRL manual. Make a check in the Help box when you miss the question. If you miss the same question, repeatedly be sure to ask about that question during the class discussion.

ID	Ch	Pg	Help
G0			
G0A01	9	9	
G0A02	9	9	
G0A03	9	13	
G0A04	9	11	
G0A05	9	13	
G0A06	9	9	
G0A07	9	11	
G0A08	9	12	
G0A09	9	13	
G0A10	9	13	
G0A11	9	14	
G0A12	9	9	
G0B01	9	6	
G0B02	9	5	
G0B03	9	5	
G0B04	9	8	
G0B05	9	6	
G0B06	9	4	
G0B07	9	16	
G0B08	9	16	
G0B09	9	7	
G0B10	9	3	
G0B11	9	8	
G0B12	9	6	
G0B13	9	8	
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G1A02	3	10	
G1A03	3	10	
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G1A06	3	10	
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G1A10	3	10	
G1A11	3	10	
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G1B02	3	11	
G1B03	3	11	
G1B04	3	14	
G1B05	3	14	
G1B06	3	3	
G1B07	3	14	
G1B08	3	14	
G1B09	3	11	
G1B10	3	11	
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G1C03	3	16	
G1C04	2	7	
G1C05	3	16	
G1C06	3	16	
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G1C08	3	17	
G1C09	3	17	
G1C10	3	17	
G1C11	3	16	
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G1D02	3	5	
G1D03	3	7	
G1D04	3	5	
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G1D06	3	7	
G1D07	3	4	
G1D08	3	4	
G1D09	3	7	
G1D10	3	16	
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G1E05	3	13	
G1E06	3	2	
G1E07	3	10	
G1E08	3	16	
G1E09	6	16	
G1E10	3	11	
G1E11	6	15	
G1E12	3	13	
G2			
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G2A03	2	10	
G2A04	2	10	
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G2A06	2	9	
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G2D02	3	3	
G2D03	3	3	
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G2D06	8	6	
G2D07	2	2	

ID	Ch	Pg	Help
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G2D09	2	6	
G2D10	3	16	
G2D11	2	11	
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G2E04	6	9	
G2E05	6	12	
G2E06	6	5	
G2E07	6	7	
G2E08	6	2	
G2E09	6	8	
G2E10	6	15	
G2E11	6	10	
G2E12	6	8	
G2E13	6	8	
G2E14	6	12	
G2E15	6	9	
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G3A02	8	12	
G3A03	8	11	
G3A04	8	8	
G3A05	8	9	
G3A06	8	12	
G3A07	8	8	
G3A08	8	12	
G3A09	8	12	
G3A10	8	8	
G3A11	8	12	
G3A12	8	9	
G3A13	8	9	
G3A14	8	12	
G3B01	8	6	
G3B02	8	10	
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ID	Ch	Pg	Help
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G3C08	8	14	
G3C09	8	14	
G3C10	8	14	
G3C11	8	5	
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G4A03	5	21	
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G4A06	7	22	
G4A07	5	21	
G4A08	5	15	
G4A09	5	15	
G4A10	2	14	
G4A11	6	13	
G4A12	2	4	
G4A13	5	20	
G4B01	4	44	
G4B02	4	44	
G4B03	4	45	
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G4B05	4	43	
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G4C05	5	24	
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G4C09	5	24	
G4C10	5	24	

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G4E11	4	39	
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G5C11	4	18	
G5C12	4	19	
G5C13	4	17	
G5C14	4	17	
G6			
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G6A06	4	22	
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G6A11	4	24	
G6A12	4	28	
G6B01	4	12	
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G6B08	4	33	
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G6B12	4	41	
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G7A12	4	8	
G7A13	4	8	
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G7B04	5	15	
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G8A06	6	5	
G8A07	5	2	
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G8A10	5	11	
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G9B03	7	5	

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G9D13	Question Deleted		