Technician and General Class Amateur Radio & Satellite Stuff

Anthony Odenthal, KE7OSN Amateur Extra

December 6, 2013

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- To introduce you to Amateur Radio
- Prepare you to take (and pass) the technician and general exams
- Introduce you to satellite communications.

A little about myeself

- Passed Tech Sept 2007
- Passed Gen Oct 2007
- Joined Benton County ARES April 2012
- Passed Extra April 2012
- Became a VE in June 2012

What is Amateur Radio?

Amateur radio are people and activities that are regulated and encouraged, in the US and abroad, that allow licensed individuals to play around with radio waves, electronics, software, techniques, practices, and equipment to do all sorts of really cool stuff. Radio Amateurs are some of the least restricted users of radio spectrum, and with that freedom they have proven time and time again their worth. The term Amateur refers to someone who does something as a pastime rather than a profession.

Some useful tools

Some things you may want to look into as useful for studying

- AA9PW practice exams `http://aa9pw.com`
- ARRL license Manuals `http://www.arrl.org/shop/Licensing-Education-and-Training/`

About the test

- 35 questions

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- 396 questions in the tech pool, 457 in the general
- Need a 75% to pass

Shal we begin?

Remember if I go too fast or you have questions, let me know.

Table of Contents

Who's In charge

International Telecommunications Union (ITU)

- Worldwide, treaty-based organization that allocates frequencies for specific uses.
- Primary Users - first "rights" to a frequency
- Secondary Users - permitted to use a frequency but must not interfere with a primary user
- World divided into 3 regions, US is in Region 2
- Creates "bands" - sections of spectrum allocated for amateur radio use.

Who's In Charge

Federal Comunications Commission (FCC)

- Promulgates rules for non-federal radio users within ITU spec
- Divides amateur bands into mode-specific sub-bands
- Rules for telecommunications are in the Code of Federal Regulations, Chapter 47
- Rules for amateur radio are in Part 97 of Chapter 47 (47 CFR 97)

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- Voluntary rules unless there is interference, then the coordinated user "wins"
- Gentleman's agreement

FCC allocations

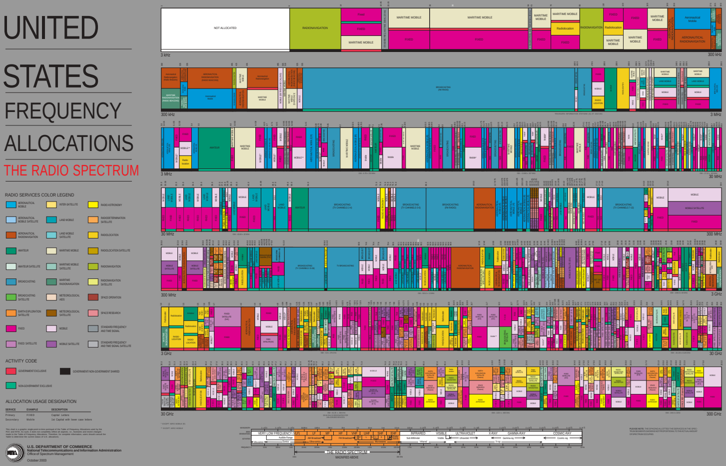

Table of Contents

47 CRF 97.1 Basic Purpose

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

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E Continuation and extension of the amateur's unique ability to enhance international goodwill.

Keyphrase

...a voluntary noncommercial communications service...

This phrase sums up almost every rule and tenant of amateur radio.

A voluntary noncommercial communications service

Noncommercial means no "pecuniary interest". It is illegal to profit from the use of amateur radio.

As with almost any rule there are exceptions"

- Teachers may use ham radio in the classroom as a teaching aid
- "Code practice" transmissions
- Disaster Drills

More basic rules

- No Music - expect transmission or re-transmission of a signal from a space station
- No Broadcasting
- No commercial traffic
- No profanity
- No codes or ciphers intended to hid content
- No international third party traffic unless treaty-approved

Table of Contents

Licenses

A license is valid for ten years, with a two year grace period. Upgrades don't count as renewals. Basic renewals are free! There are five classes.

- *Novice
- Technician
- General
- *Advanced
- Extra

Licenses

There are four kinds of licenses, Individual hams hold both a "Station" and "Operator"

- Station
- Operator
- Club - W7OSU, K7CVO, W1AW
- Special Event - A7W

Clubs can get a "club callsign", and events can get an event callsign.

Table of Contents

Callsigns

- US callsigns start with A,K,N, or W
- The format is one or two letters, a number, and one to three letters.
- New callsigns are assigned in sequential order - number indicates the region in the US
- Shorter callsigns are reserved for higher license classes
- 1X1 for special events only

Callsigns

- KE7OSN
- N8GFO

Callsigns

- KE7OSN
- N8GFO -Yep

Callsigns

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- K7HZ -That's an Extra

Callsigns

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- K7HZ -That's an Extra
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Callsigns

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- K7HZ -That's an Extra
- VE6GLW -That's Canadian

Callsigns

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- K7HZ -That's an Extra
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- KL0O

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Operator

Who "operates" an amateur station?

Operator

Who "operates" an amateur station?
The control operator, who is designated by the station licensee, and determines the privileges of operation.
e.g. if you are at a radio that can operate outside your privileges, you still can only use what you are licensed to.

Your Callsign

A station must transmit it's callsign at least every ten minutes and at the end of every communication.
Special situations have special rules

- Control operator working outside of a station licensee privileges.
- Special event station control operator
- Control operator using new privileges prior to FCC database update

The Uniform Licensing System

The ULS is an online database of FCC license information. A new licensee may use their privileges as soon as their information appears in the ULS. When you upgrade you may use your new privileges as soon as you pass the test.

Typical uses of a callsign

- W7OSU This is KE7OSN

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- Net Control This is KE7OSN

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- This is KF7FGE stroke (/) KE7OSN

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- This is W7OSU (Go Ahead)
- CQ CQ CQ this is KE7OSN
- KE7OSN monitoring
- This is KF7FGE stroke (/) KE7OSN
- Hey Bob, you around?

Hey bob, you around

Hey bob you around?
Legal?

Hey bob, you around

Hey bob you around?
Legal?
Yes, as long as you keep to the every ten minutes and the end of every communication.

Hey bob, you around

Hey bob you around?
Legal?
Yes, as long as you keep to the every ten minutes and the end of every communication.
What if Bob isn't there?

Hey bob, you around

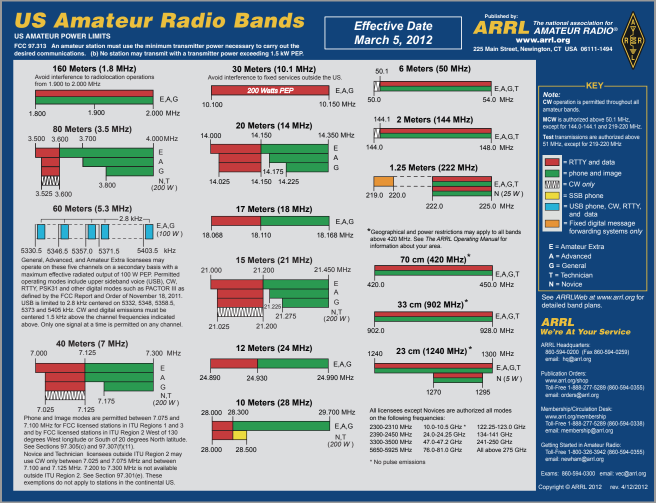
Hey bob you around?
Legal?
Yes, as long as you keep to the every ten minutes and the end of every communication.
What if Bob isn't there?
KE7OSN clear

Types of stations

- Club – at least four people, one of which accepts responsibility and is the "trustee".
- Space – at least 50km above the surface.
- Beacon – transmits a low-level signal for propagation studies
- Repeater – retransmits a signal heard on one frequency on another frequency.
- Auxillary – a secondary receiver that feeds a repeater station.

Table of Contents

Band Plan


US Amateur Radio Bands
US AMATEUR POWER LIMITS
FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications. (b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.
Effective Date March 5, 2012
Published by: ARRL The national association for AMATEUR RADIO® www.arrl.org
225 Main Street, Newington, CT USA 06111-1494
160 Meters (1.8 MHz)
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz
1.800 1.900 2.000 MHz E,A,G
80 Meters (3.5 MHz)
3.500 3.600 3.700 4.000 MHz
E A G N,T (200 W)
3.525 3.600 3.800
60 Meters (5.3 MHz)
2.8 kHz E,A,G (100 W)
5330.5 5346.5 5357.0 5371.5 5403.5 kHz
General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated output of 100 W PEP. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III as defined by the FCC Report and Order of November 18, 2011. USB is limited to 2.8 kHz centered on 5332, 5348, 5358.5, 5373 and 5405 kHz. CW and digital emissions must be centered 1.5 kHz above the channel frequencies indicated above. Only one signal at a time is permitted on any channel.
40 Meters (7 MHz)
7.000 7.125 7.300 MHz
E A G N,T (200 W)
7.025 7.125 7.175
Phone and Image modes are permitted between 7.075 and 7.100 MHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11).
Novice and Technician licensees outside ITU Region 2 may use CW only between 7.025 and 7.075 MHz and between 7.100 and 7.125 MHz. 7.200 to 7.300 MHz is not available outside ITU Region 2. See Section 97.301(e). These exemptions do not apply to stations in the continental US.
30 Meters (10.1 MHz)
Avoid interference to fixed services outside the US.
200 Watts PEP E,A,G
10.100 10.150 MHz
20 Meters (14 MHz)
14.000 14.150 14.350 MHz
E A G
14.025 14.150 14.175 14.225
17 Meters (18 MHz)
18.068 18.110 18.168 MHz E,A,G
15 Meters (21 MHz)
21.000 21.200 21.450 MHz
E A G N,T (200 W)
21.025 21.200 21.225 21.275
12 Meters (24 MHz)
24.890 24.930 24.990 MHz E,A,G
10 Meters (28 MHz)
28.000 28.300 29.700 MHz
E,A,G N,T (200 W)
28.000 28.500
6 Meters (50 MHz)
50.1 50.0 54.0 MHz E,A,G,T
2 Meters (144 MHz)
144.1 144.0 148.0 MHz E,A,G,T
1.25 Meters (222 MHz)
219.0 220.0 222.0 225.0 MHz E,A,G,T N (25 W)
*Geographical and power restrictions may apply to all bands above 420 MHz. See The ARRL Operating Manual for information about your area.
70 cm (420 MHz)*
420.0 450.0 MHz E,A,G,T
33 cm (902 MHz)*
902.0 928.0 MHz E,A,G,T
23 cm (1240 MHz)*
1240 1300 MHz E,A,G,T N (5 W)
1270 1295
All licensees except Novices are authorized all modes on the following frequencies:
2300-2310 MHz 10.0-10.5 GHz * 122.25-123.0 GHz
2390-2450 MHz 24.0-24.25 GHz 134-141 GHz
3300-3500 MHz 47.0-47.2 GHz 241-250 GHz
5650-5925 MHz 76.0-81.0 GHz All above 275 GHz
* No pulse emissions
KEY
Note:
CW operation is permitted throughout all amateur bands.
MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.
Test transmissions are authorized above 51 MHz, except for 219-220 MHz
= RTTY and data
= phone and image
= CW only
= SSB phone
= USB phone, CW, RTTY, and data
= Fixed digital message forwarding systems only
E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice
See ARRLWeb at www.arrl.org for detailed band plans.
ARRL We're At Your Service
ARRL Headquarters: 860-594-0200 (Fax 860-594-0259) email: hq@arrl.org
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Exams: 860-594-0300 email: vec@arrl.org
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ITU Band Names

- MF - Medium Frequency 300KHz to 3MHz
- HF - High Frequency 3MHz to 30 MHz
- VHF - Very High Frequency 30MHz to 300MHz
- UHF - Ultra High Frequency 300MHz to 3GHz
- SHF - Super High Frequency 3GHz to 30GHz
- EFE - Extremely High Frequency - 30GHz to 300GHz
- THF - Tremendously High Frequency - 300GHZ to 3THz

HF 3-30MHz

- 80 Meters
  - 3.525-3.600MHz: CW Only
- 40 Meters
  - 7.025-7.125MHz: CW Only
- 15 Meters
  - 21.025-21.200MHz: CW Only
- 10 Meters
  - 28.000-28.300MHz: CW, RTTY/Data 200 watts PEP max
  - 28.300-28.500MHz: CW, Phone 200 watts PEP max

VHF 30-300MHz

- 6 Meters
  - 50.0-50.1MHz CW Only
  - 50.1-54.0MHz All modes
- 2 Meters
  - 144.0-144.1MHz CW Only
  - 144.1-148.0MHz All modes
- 1.25 Meters
  - 222.00-225.00MHz All modes

UHF 300-3000MHz (3GHz)

- 70 Centimeters
  - 420.0-450.0MHz All Modes
- 33 Centimeters
  - 902.0-928.0MHz All Modes
- 23 Centimeters
  - 1240-1300MHz All Modes
- 2.4GHz
  - 2.3-2.31GHz
  - 2.39-2.45GHz *

2.4GHz

We share the 2390-2450MHz band with: 802.11 networks, cordless phones, video cameras, zigbee, etc.
We are PRIMARY users. We have first "rights". Secondary users must not cause us interference and must accept interference from our operations.

SHF 3GHz-30GHz and up

- 3.3-3.5GHz
- 5.65-5.925GHz
- 10.0-10.5GHz
- 24.0-24.25GHz
- 47.0-47.2GHz
- 76.0-81.9GHz
- 119.98-120.02GHz
- 142-149GHz
- 241-250GHz
- Everything above 300GHz

Table of Contents

T1A 6 Questions from T1

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  D. Persons who are interested in radio technique solely with a personal aim and without pecuniary interest

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  A. A station in an Amateur Radio Service consisting of the apparatus necessary for carrying on radio communications

T1A 6 Questions from T1

- **T1A01 For whom is the Amateur Radio Service intended?**
  D. Persons who are interested in radio technique solely with a personal aim and without pecuniary interest
- **T1A02 What agency regulates and enforces the rules for the Amateur Radio Service in the United States?**
  C. The FCC
- **T1A03 Which part of the FCC rules contains the rules and regulations governing the Amateur Radio Service?**
  D. Part 97
- **T1A04 Which of the following meets the FCC definition of harmful interference?**
  C. That which seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with the Radio Regulations
- **T1A05 What is the FCC Part 97 definition of a space station?**
  D. An amateur station located more than 50 km above the Earth's surface
- **T1A06 What is the FCC Part 97 definition of telecommand?**
  C. A one-way transmission to initiate, modify or terminate functions of a device at a distance
- **T1A07 What is the FCC Part 97 definition of telemetry?**
  C. A one-way transmission of measurements at a distance from the measuring instrument
- **T1A08 Which of the following entities recommends transmit/receive channels and other parameters for auxiliary and repeater stations?**
  B. Frequency Coordinator
- **T1A09 Who selects a Frequency Coordinator?**
  C. Amateur operators in a local or regional area whose stations are eligible to be auxiliary or repeater stations
- **T1A10 What is the FCC Part 97 definition of an amateur station?**
  A. A station in an Amateur Radio Service consisting of the apparatus necessary for carrying on radio communications
- **T1A11 Which of the following stations transmits signals over the air from a remotereceive site to a repeater for retransmission?**
  C. Auxiliary station

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T1B 6 Questions from T1

- **T1B01 What is the ITU?**
  B. A United Nations agency for information and communication technology issues

T1B 6 Questions from T1

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- **T1B03 Which frequency is within the 6 meter band?**
  B. 52.525 MHz

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  D. 1.25 meter band

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  A. To allow for calibration error in the transmitter frequency display
  B. So that modulation sidebands do not extend beyond the band edge
  C. To allow for transmitter frequency drift
  D. All of these choices are correct

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- **T1B11 What emission modes are permitted in the mode-restricted sub-bands at 50.0 to 50.1 MHz and 144.0 to 144.1 MHz?**
  A. CW only

T1C 6 Questions from T1

- **T1C01 Which type of call sign has a single letter in both the prefix and suffix?**
  C. Special event

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- **T1C08 What is the normal term for an FCC-issued primary station/operator license grant?**
  C. Ten years

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  C. As soon as your name and call sign appear in the FCC s ULS database

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- **T1C11 If your license has expired and is still within the allowable grace period, may you continue to operate a transmitter on amateur service frequencies?**
  A. No, transmitting is not allowed until the ULS database shows that the license has been renewed

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  A. Any country whose administration has notified the ITU that it objects to such communications

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  D. Transmissions intended for reception by the general public

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- **T1D10 What is the meaning of the term broadcasting in the FCC rules for the amateur services?**
  D. Transmissions intended for reception by the general public
- **T1D11 Which of the following types of communications are permitted in the Amateur Radio Service?**
  A. Brief transmissions to make station adjustments

T1E 6 Questions from T1

- **T1E01 When must an amateur station have a control operator?**
  A. Only when the station is transmitting

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Anthony Odenthal, KE7OSN Amateur Extra

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Table of Contents

97.403 Safety of life and protection of property

No provision of these rules prevents the use by an amateur station of any means of radio communication at its disposal to provide essential communication needs in connection with the immediate safety of human life and immediate protection of property when normal communication systems are not available.

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ARES

ARES – **A**mateur **R**adio **E**mergency **S**ervice

- Organized and run by ARRL
- Supports governmental and NGO groups.
- Most groups are organized at the county level
- “EC” – Emergency Coordinator

RACES

RACES – **R**adio **A**mateur **C**ivil **E**mergency **S**ervice

- Defined by the FCC
- Supports governmental agencies ONLY.
- Operators are registered with the controlling agency.
- RACES Officer
- Activated by federal declaration of emergency.
- In Oregon, ARES members are also registered in RACES

Table of Contents

Disaster == Organized Chaos

To keep some organization to the use of frequencies and communications, groups are organized into “nets”.
A “net” is a group of stations that are cooperating in the use of a frequency. The “net control” is responsible for deciding who gets to talk.

Disaster == Organized Chaos

There are two kinds of nets:

Directed - the net control is strict in controlling who talks to whom. Stations tell net control they have a message for another station, and the net control directs them to call that station and pass the message.

Free - the net control allows stations to contact each other as they need to.

Disaster == Organized Chaos

There are three types of messages

Formal - written messages.

Informal - unwritten messages.

Administrative - station to station housekeeping.

Written Messages – Formal Traffic

ARES and RACES have adopted the NIMS/ICS system for written traffic. I.e., ICS-213 message forms, in either digital or transcribed versions.

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The TEST doesn't ask you about that. The TEST deals with the National Traffic System message form.

Written Messages – Formal Traffic

The National Traffic System (NTS) is a system organized by ARRL to transmit messages in a standard format, usually concerning "Health and Welfare". For example: "Aunt Martha arrived home safely. Have a happy birthday." Or "welcome to Ham radio". These messages use the NTS RadioGram form. The process is described in depth in the Message Processing Guidelines (MPG).

NTS RadioGram Form

The American Radio Relay League
RADIOGRAM
Via Amateur Radio

Number	Precedence	HX	Station of Origin	Check	Place of Origin	Time Filed	Date

To:

This Radio Message was received at:

Amateur Station____________ Date_____
Name____________________________
Street Address__________________
City, State, Zip________________

Telephone Number:

From	Date	Time	To	Date	Time
REC'D			SENT		

A licensed Amateur Radio Operator, whose address is shown above, handled this message free of charge. As such messages are handled solely for the pleasure of operating, a "Ham" Operator can accept no compensation. A return message may be filed with the "Ham" delivering this message to you. Further information on Amateur Radio may be obtained from ARRL Headquarters, 225, Main Street, Newington, CT 06111.

The American Radio Relay League, Inc. is the National Membership Society of licensed radio amateurs and the publisher of *QST* Magazine. One of its functions is promotion of public service communication among Amateur Operators. To that end, The League has organized the National Traffic System for daily nationwide message handling.

Table of Contents

Types of radio short-hand

Amateur radio has its own codes, and slang. Much like 1337 or txt, this "shared language" makes it easier to communicate quickly, and efficently. Much of it comes from the days of telegraph and Morse Code.

Q Codes - Three letter codes beginning with Q

Number codes - Codes sent as numbers, we really only us 73

Pro-words - Standardized ways of saying things in a clear and concise fashion

Phonetics - Words for letters, try saying BCDEZGT five times fast.

Q-Codes

Q codes are three letter codes that begin with Q and not QU and can be sent as either a question or a response. Really useful when using Morse Code as the codes are much shorter than what they represent. Some common Q codes are listed below.

QSY	Change frequency
QRT	Stop transmitting
QRZ	I'm calling
QRM	Man made interference
QRN	Natural interference or Noise
QSL	Acknowledge
QST	Message to all amateurs

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Pro-words

Pro or Professional words are used as shorthand, and because they prevent confusion. Yea and Nah kinda sound the same.

Roger	Received
WilCO	Will Comply
Over	I'm done talking for now
Out	I'm done talking to you
This Is	I'm going to say my callsign now
Wait	Hold on for a while
Affirmative	Yes
Negative	No

Phonetics

In amateur radio we use ITU phonetics, this helps us reduce the potential of confusion over letters that sound the same

A - Alfa "AL-FAH"	N - November "NO-VEM-BER"	0 "ZEE-RO"
B - Bravo "BRAH-VOH"	O - Oscar "OSS-CAH"	1 "WUN"
C - Charlie "CHAR-LEE"	P - Papa "PAH-PAH"	2 "TOO"
D - Delta "DELL-TAH"	Q - Quebec "KEH-BECK"	3 "TH-UH-REE"
E - Echo "ECK-OH"	R - Romeo "ROW-ME-OH	4 "FOW-ER"
F - Foxtrot "FOKS-TROT"	S - Sierra "SEE-AIR-RAH"	5 "FI-IV" OR "FIFE"
G - Golf "GOLF"	T - Tango "TANG-GO"	6 "SIX"
H - Hotel "HOH-TELL"	U - Uniform "YOU-NEE-FORM"	7 "SEV-EN"
I - India "IN-DEE-AH"	V - Victor "VIK-TAH"	8 "ATE"
J - Juliett "JEW-LEE-ETT	W - Whiskey "WISS-KEY"	9 "NIN-ER"
K - Kilo "KEE-LOH"	X - X-Ray "ECKS-RAY"	
L - Lima "LEE-MAH	Y - Yankee "YANG-KEY"	
M - Mike "MIKE"	Z - Zulu "ZOO-LOO"	

W7QH becomes "Whiskey 7 Quebec Hotel"

CQ and 73

There are two other special cases.

- CQ is the standard calling call. Think of it as Seek You, though no one really knows where it comes from. It is common to add extra stuff depending on the situation. You might hear CQ JOTA, CQ Field Day, CQ Contest, CQ DX, CQ Oregon. This lets people pick who they are looking for. A common general CQ would sound like "CQ CQ CQ this is KE7OSN calling CQ CQ CQ"
- The other thing that comes up is the number 73, this goes back to the old Western Union Telegraph 92 codes, these were numbers that could be used in place of certain phrases, most of them dealing with packages or trains. 73 means "Beast Regards" and is generally used as "goodbye"

Table of Contents

Power

In most amateur bands the maximum legal limit for power output is 1500 Watts, PEP. PEP - Peak Envelope Power is the largest amplitude of a signal. On some bands the limit is lower, for each band there is also a point at which you have to do a safety evaluation of your station to avoid unsafe exposure. You should always use the minimal power required to do what you need to do.

Table of Contents

T2A 3 quesions from T2

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79 of 396 19.9%

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79 of 396 19.9%

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79 of 396 19.9%

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- **T2A05 What should you transmit when responding to a call of CQ?**
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79 of 396 19.9%

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79 of 396 19.9%

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- **T2A11 What are the FCC rules regarding power levels used in the amateur bands?**
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101 of 396 25.5%

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101 of 396 25.5%

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101 of 396 25.5%

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101 of 396 25.5%

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101 of 396 25.5%

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101 of 396 25.5%

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- **T2C06 Which of the following is common practice during net operations to get the immediate attention of the net control station when reporting an emergency?**
  C. Begin your transmission with Priority or Emergency followed by your call sign
- **T2C07 What should you do to minimize disruptions to an emergency traffic net once you have checked in?**
  C. Do not transmit on the net frequency until asked to do so by the net control station
- **T2C08 What is usually considered to be the most important job of an amateur operator when handling emergency traffic messages?**
  A. Passing messages exactly as written, spoken or as received
- **T2C09 When may an amateur station use any means of radio communications at its disposal for essential communications in connection with immediate safety of human life and protection of property?**
  B. When normal communications systems are not available
- **T2C10 What is the preamble in a formal traffic message?**
  D. The information needed to track the message as it passes through the amateur radio traffic handling system
- **T2C11 What is meant by the term "check" in reference to a formal traffic message?**
  A. The check is a count of the number of words or word equivalents in the text portion of the message

101 of 396 25.5%

Table of Contents

Electromagnetic Waves

Electromagnetic waves are energy waves that move through space, similar to the way waves move in water or sound through air.
In a vacuum these waves move at the speed of light 299,792,458m/s or 186,282.397$miles/second$. This is good as these waves are light.

Speed of light

We can round up to 300,000,000m/s. Some distance measured in terms of light-time

Average distance between the Sun and Earth - 8 minutes

GEO Satellite to Earth's Surface - about a half second

Nearest other star to our Sun 4.25 Years

Voyager Space probe to the Sun at 18,884,401,200 Km from the sun?

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Frequency - not just an ok movie

We often refer to a wave by it's frequency. Frequency is the number of times a wave cycles in a given time. We use Hertz (Hz) which has the unites of $\frac{1}{Seconds}$.
Middle C is 440Hz, or 440 cycles per second.
KLOO-AM is 1.340MHz, or 1,340,000 cycles per second.

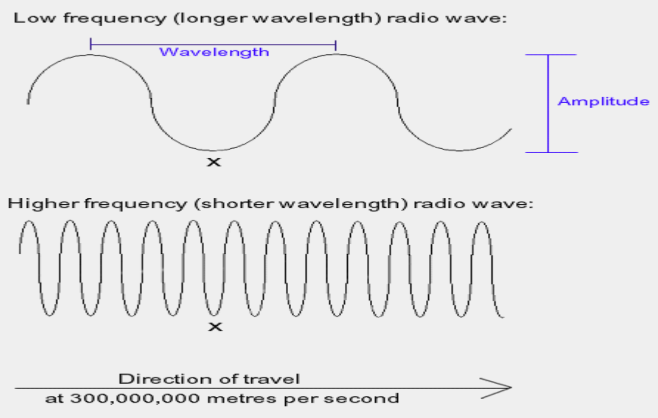
SI Prefixs

Sometimes it is a lot easier to shorten things up a bit.

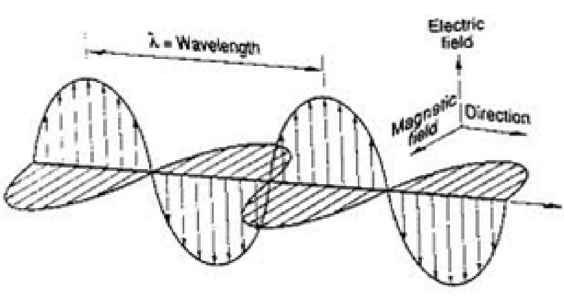
Tera	T	10^{12}	1,000,000,000,000
Giga	G	10^{9}	1,000,000,000
Mega	M	10^{6}	1,000,000
Kilo	K	10^{3}	1,000
Deci	d	10^{-1}	0.1
Ceni	c	10^{-2}	0.01
Milli	m	10^{-3}	0.001
Micro	μ	10^{-6}	0.000001
Nano	n	10^{-9}	0.000000001
Pico	p	10^{-12}	0.000000000001

Wavelength

We also use wavelength to describe waves. The wavelength is the distance between two like points on the wave exactly one cycle apart, e.g. the distance between peaks.



ElectoMagnetic



Electromagnetic waves have two parts, one electric part, and one magnetic part. The magnetic part is rotated and phase shifted by 90°

Wavelength to frequency and back

It is easy to convert between wavelength and frequency just use the equation below.

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$$Wavelength(meters) = \frac{300}{Freq.(MHz)}$$

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We'll practice on the next slide

MATH!!!

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  That fits nicely in the 40meter band

MATH!!!

- Lets try to convert 7.025MHz into a wavelength to figure out which band it belongs to.
  $Wavelength(\lambda) = \frac{300}{7.025}$ that comes out to 42.7meters
  That fits nicely in the 40meter band
- Now lets try 223.50MHz
  $\frac{300}{223.50} = ?$

MATH!!!

- Lets try to convert 7.025MHz into a wavelength to figure out which band it belongs to.
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  That fits nicely in the 40meter band
- Now lets try 223.50MHz
  $\frac{300}{223.50}$ =? 1.35, for the 1.25meter band.

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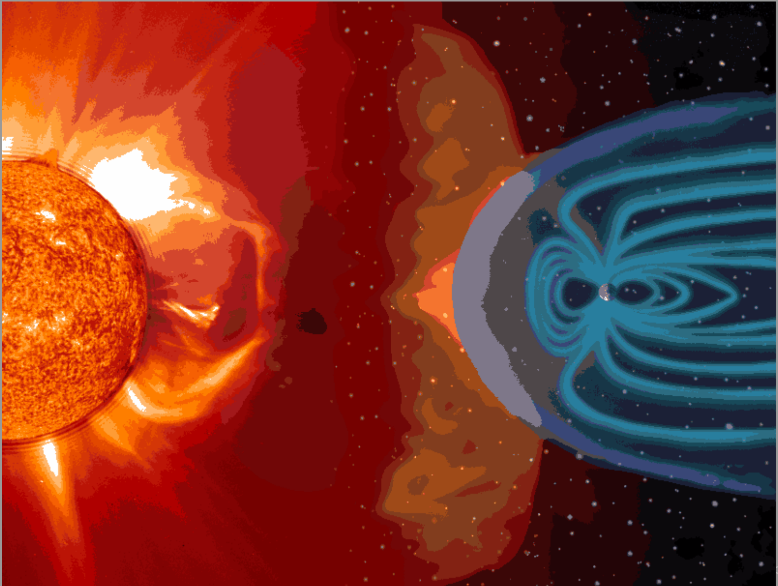
Reflections can be really useful when you don't have a direct line of sight.
Radio waves will also refract.

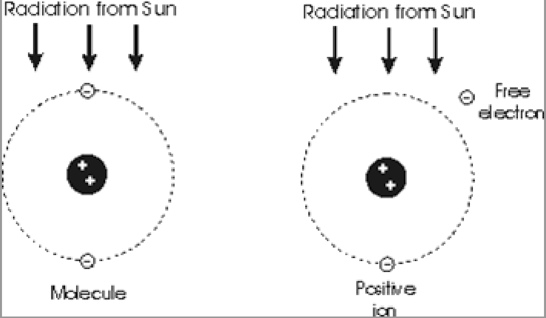
Solar Wind



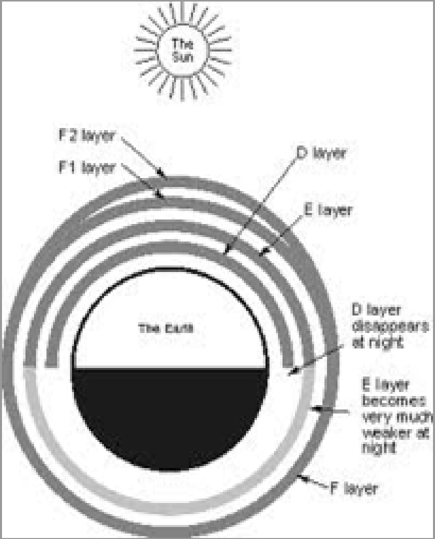
Solar Radiation

Solar radiation charges atoms in the atmosphere, breaking loose electrons, to create ions, which can interact with radio waves.

At night the electrons recombined with their atoms. This means things change from day to night.



Ionosphere



The parts of the atmosphere most affected by ionization are collectively called the Ionosphere!
It has multiple layers, each interact differently with radio waves. The D layers mostly absorbs RF, while the E and F layers reflect.
HF is is ruled by the ionosphere
VHF and up . . . not so much.

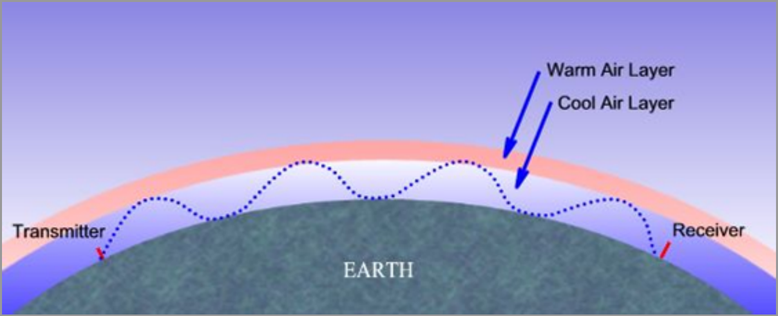
Ionosphere

During the day the D layers absorbs a large chunk of HF, at night it goes away and signals bounce (refract) off the E and F layers.
VHF and above mostly just goes through the ionosphere. . .
But sometimes at night there is just enough E layer to refract VHF signals. We call this "Sporadic E"

Auroras and Meteor Showers

The auroras are a visible sign of ionization, as they move they can cause received signals to sound fluttery.
Meteor showers leave short lived trails of ionized gases, that can refract signals, these effects are impossible to predict and last seconds.
You can even bounce radio signals off the moon!

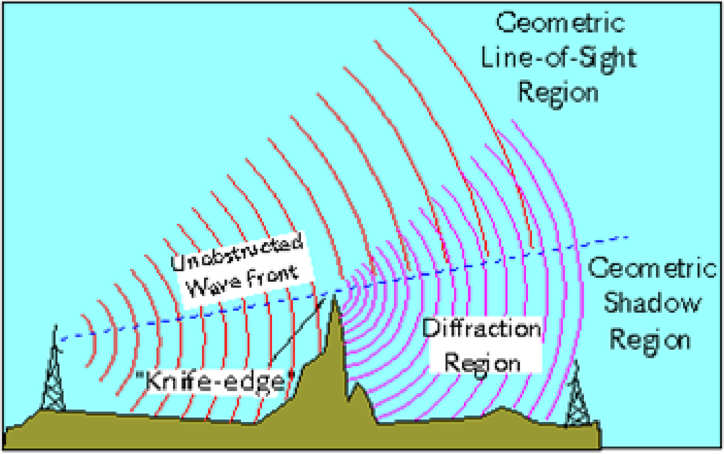
Tropospheric Ducting



Air can refract electromagnetic radiation. A temperature inversion (warm air above cold) can cause VHF signals to refract and travel long distances.

This is called "Tropospheric Ducting" and often happens between here and Hawaii, it mostly affects VHF.

Knife Edge



knife-edge effect

Polarization

Antennas tend to radiate and receive waves polarized along the direction of the antenna. An antenna pointing vertically produces vertically polarized waves, and the equivalent is true for a horizontal antenna.

If the polarization of the receiving antenna does not match the wave it is receiving then the signal strength is reduced by a significant degree. In an ideal world without the magnetic portion of a wave two antennas rotated $\pm 90^\circ$ would not be able to "see" each other.

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Technician and General Class Amateur Radio & Satellite Stuff

Anthony Odenthal, KE7OSN Amateur Extra

Electromagnetic Waves

Propagation

T3 Questions

T3A

T3B

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- **T3B09 What are the frequency limits of the UHF spectrum?**
  D. 300 to 3000 MHz
- **T3B10 What frequency range is referred to as HF?**
  C. 3 to 30 MHz
- **T3B11 What is the approximate velocity of a radio wave as it travels through free space?**
  B. 300,000,000 meters per second

123 of 396 31.0%

Title

- **T3C01 Why are "direct" (not via a repeater) UHF signals rarely heard from stations outside your local coverage area?**
  C. UHF signals are usually not reflected by the ionosphere

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- **T3C11 Why do VHF and UHF radio signals usually travel somewhat farther than the visual line of sight distance between two stations?**
  C. The Earth seems less curved to radio waves than to light

This section is going to be really short as much of the details fit in better elsewhere

Table of Contents

Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

Some microphones include push-to-talk and voltage connections. Headphones can be useful in a noisy area instead of a speaker. A regulated power supply reduces voltage fluctuations. Filters between the transmitter and antenna can reduce harmonic emissions. A band-reject filter is a good first step if your 2 meter radio is causing problems with a TV. A terminal node controller is a modem for your radio, your soundcard can be a modem too. Flat straps are good grounding cables. Ferrite chokes can reduce RF current in cables. If your radio whines in your car and it goes along with the engine its probably the alternator. A radio installed in a car should be connected to a good "ground"

Table of Contents

Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

If your mic is turned up to loud your signal may distort. You can set the frequency of a radio with the keypad or VFO knob. Squelch lets you mute the receiver when no signal is coming in. You can program favorite frequencies in memory. The noise blanker option can reduce noise. The RIT or Receiver Incremental Tuning control can change the pitch of the received audio. A good filter setting for SSB is 2400Hz, and 500Hz for CW. A repeater offset is the difference in its receive and transmit frequencies.

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  A. At the battery or engine block ground strap

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- **T4B01 (B) What may happen if a transmitter is operated with the microphone gain set too high?**
  B. The output signal might become distorted
- **T4B02 (A) Which of the following can be used to enter the operating frequency on a modern transceiver?**
  A. The keypad or VFO knob
- **T4B03 (D) What is the purpose of the squelch control on a transceiver?**
  D. To mute receiver output noise when no signal is being received
- **T4B04 (B) What is a way to enable quick access to a favorite frequency on your transceiver?**
  B. Store the frequency in a memory channel
- **T4B05 (C) Which of the following would reduce ignition interference to a receiver?**
  C. Turn on the noise blanker
- **T4B06 (D) Which of the following controls could be used if the voice pitch of a single-sideband signal seems too high or low?**
  D. The receiver RIT or clarifier
- **T4B07 (B) What does the term "RIT" mean?**
  B. Receiver Incremental Tuning
- **T4B08 (B) What is the advantage of having multiple receive bandwidth choices on a multimode transceiver?**
  B. Permits noise or interference reduction by selecting a bandwidth matching the mode
- **T4B09 (C) Which of the following is an appropriate receive filter to select in order to minimize noise and interference for SSB reception?**
  C. 2400 Hz
- **T4B10 (A) Which of the following is an appropriate receive filter to select in order to minimize noise and interference for CW reception?**
  A. 500 Hz
- **T4B11 (C) Which of the following describes the common meaning of the term repeater offset ?**
  C. The difference between the repeater s transmit and receive frequencies

Table of Contents

Ohm, Ohm on the range

Most metals are good at conducting electricity, this means they allow electrons to move around. We make wires that allow us to move electrons from one specific place to another.

Current

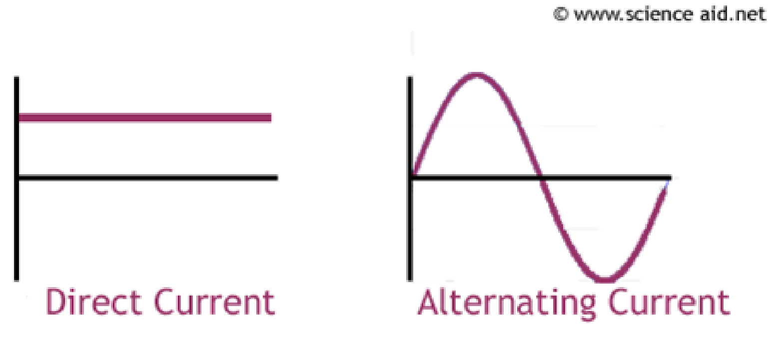
The movement of electrons is called **Current**. We measure current in the Ampere, aka the Amp, aka A (or I).

Current that moves in only one direction is called **Direct Current (DC)**. Current that changes direction regularly is called **Alternating Current (AC)**.

A device that measures current is an ammeter.

Ideas of current

Ideas of current



The Electromotive Force

The force that causes electrons to flow is called . . .

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Voltage is measured with a . . .

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We measure this force as **Voltage**, or **V**.
Voltage is measured with a **Voltmeter**

Voltage

Electrons like to spread out. It's their "natural desire" to not get bunched up that causes voltage. There can be voltage without current, but not current without voltage.

An unconnected battery has a voltage, but until it is hooked up to a complete circuit the electrons can't go anywhere.

Voltage is the difference in electrical potential between two points.

Think of something falling down stairs.

The Resistor

Resistance, impedes the flow of electrons.
The unit of resistance is the Ohm, or Ω.

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Resistance, impedes the flow of electrons.
The unit of resistance is the Ohm, or Ω. If that looks Greek, that's because it is, that Omega, a letter from the Greek alphabet
Now sing along ...
Alpha A, Beta B, Gamma Γ, Delta Δ, Epsilon E, Zeta Z, Eta H, Theta Θ, Iota I.
Anyone?

The Resistor

Resistance, impedes the flow of electrons.
The unit of resistance is the Ohm, or Ω. If that looks Greek, that's because it is, that Omega, a letter from the Greek alphabet
Resistance is measured with an ohmmeter.
Never use an ohmmeter on a live circuit

Ohms Law

The voltage across a resistor is equal to the resistance times the current. $V = IR$.
If we take a 9volt battery and connect it to a 90Ω resistor, what is the current through it?

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If we take a 9volt battery and connect it to a 90Ω resistor, what is the current through it?
$V = IR \rightarrow I = \frac{V}{R} \rightarrow I = \frac{9}{90} \rightarrow 0.1 = \frac{9}{90}$ 0.1 Amps, or 100 milliamps.

Power

When current flows through an impedance it dissipates energy as "POWER". Power is measured Watts (W).
The equation for power is $P = IV$

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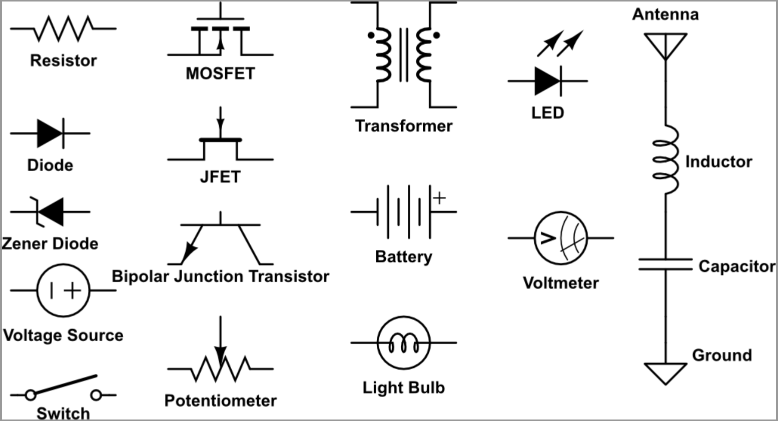
Table of Contents

Electrical Components



The Resistor

Resistors are the electrical component that provides resistance. On paper they are squiggly lines, in real life they look like.

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The Capacitor

Capacitors store energy in an electrostatic field. They are made of two conducting plates separated by an insulated material. electrons build up on one plate when charged. They pass AC fairly well, but can block DC. They are represented as two parallel lines, one may be curved. There are three types, a normal type that can be reversed, an electrolytic type that is polarized (they have a + or a - to note which way the go), and variable ones with an arrow through them.

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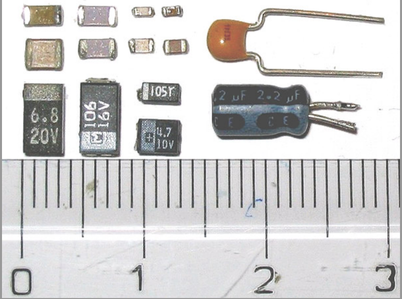


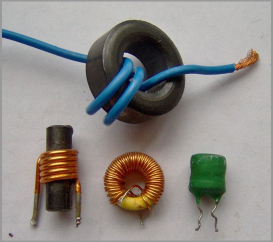
Warning

Capacitors can store a charge for some time. They can shock with ease, at best it will hurt, at worst it can cause burns and even stop your heart.

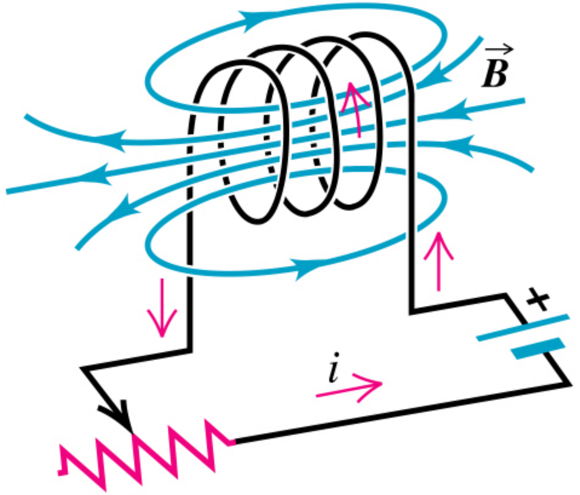
The Inductor

Inductors pass current in DC circuits, and impedes AC. They store energy in a magnetic field, magnetic fields require energy to change. This means that **any** change in current. The unit of inductance is the Henry.

They are made by winding wire in a coil. The more winds the more inductance. Sometimes iron is inserted in the middle to increase the inductance.



More Inductance

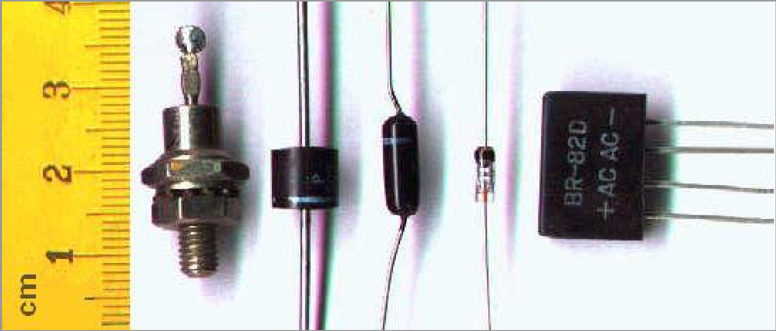


Relays

An inductor next to a magnetic switch creates a relay. They can be used to separate high current, or voltage circuits from low ones.

Diodes

Diodes prevent current from moving in one direction, while doing not much to current in the other. Some of them give off light. Others known as Zener diodes will let current flow against them if the voltage is high enough.

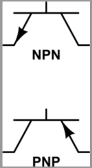


Transistors

Transistors allow a small current to control a much larger one. This gives transistors "gain". Two types we care about are Bi-polar Junction (BJT), and Field Effect (FET).

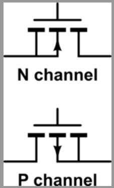
BJT's

Bipolar Junction Transistors come in two types, NPN and PNP. Both have three connections, an emitter, a collector, and a base. In diagrams the emitter is the wire with an arrow, the collector is on the same "side" as the emitter, and the base goes out the other way, if you turn it so it would stand on the two legs the base is the top.
With an NPN current is allowed to flow from the collector to the emitter when there is enough voltage between the emitter and the base. in NPN's the arrow **N**ever **P**oints i**N**.
PNP's allow current to flow from the emitter to the collector when there is enough voltage between the emitter and the base. For PNP's the arrow **P**oints i**N** **P**ermanently



MOSFET's

Metal Oxide Semiconductor Field Effect Transistors work much like BJT's but they are a little different. In the diagrams if the arrow points out they are P-channel, and if it points i**N** its an N-channel. The three wires are a Gate, a Drain, and a Source. The wire with the arrow is the source, the drain is on the same side as the source, and the other one is the gate. In either case if there is a large enough voltage between the source and the gate current can flow in the direction of the arrow between the source and the drain.



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Technician and General Class Amateur Radio & Satellite Stuff

Anthony Odenthal, KE7OSN Amateur Extra

Ohm's Law
Current
Voltage
Resistance
Ohms Law

Components
The Resistor
The Capacitor
The Inductor
Relay
Diode
Transistors

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