

The background of the slide features a close-up, slightly blurred image of the American flag. The stars and stripes are visible, with the red and white stripes running diagonally across the frame. The blue field with white stars is on the left side.

Technician Licensing Class

May 23 & 24, 2014

Vers. 3.2.14 M.Hayden

Welcome to the Technician Licensing Class !



Glendora Emergency Response Communications



Southern California Intermountain Repeater Association



American Radio Relay League

CLASS INFORMATION

Class Schedule:

First session - May 23, 2014, 6:30 pm to 9:00 pm

Second session – May 24, 2014, 7:30 am – 3:30 pm

Test session – May 29, 2014, 6:30 pm until last examinee is finished

Location of all sessions:

2121 E. Rte. 66, Glendora CA, multi purpose room.

Instructional Staff:

Frank Bigelow, KG6TQV

Jim Dowdle, KG6TQT

Rob Foth, KE6YGF

David Gordon, KJ6OOH

Mark Hayden, N7YLA

Dennis Swink, KI6NQG

HOW ARE THE 394 QUESTIONS ARRANGED?

They are arranged in ten chapters called "sub elements". Each sub element is further divided into exam groups. The number of exam groups varies from two to six, with an average of about 11 questions in each exam group.

Sub Element	Number of Groups	Questions in Pool	Exam Questions
T-1	6	68	6
T-2	3	31	3
T-3	3	33	3
T-4	2	22	2
T-5	4	45	4
T-6	4	47	4
T-7	4	47	4
T-8	4	44	4
T-9	4	22	2
T-0	3	35 Total Pool Ques = 394	3 Total Exam Ques = 35

Amateur Radio Technician Class

Element 2 Course Presentation

ELEMENT 2 SUB-ELEMENTS

- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- T2 - Operating Procedures
- T3 - Radio wave characteristics, radio and electromagnetic properties, propagation modes
- T4 - Amateur radio practices and station set up
- T5 - Electrical principles, math for electronics, electronic principles, Ohm's Law
- T6 - Electrical components, semiconductors, circuit diagrams, component functions
- T7 - Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing
- T8 - Modulation modes, amateur satellite operation, operating activities, non-voice communications
- T9 - Antennas, feedlines
- T0 - AC power circuits, antenna installation, RF hazards

T1A: Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules.

- **T1A1** For whom is the Amateur Radio Service intended?

The Amateur Radio Service is intended for persons who are interested in radio technique solely with a personal aim and without pecuniary interest.

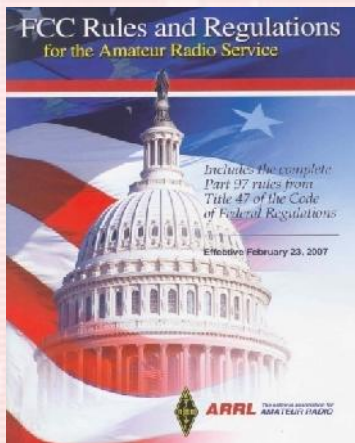


William,
KI6YBW
earned his
Technician
License at
age 10

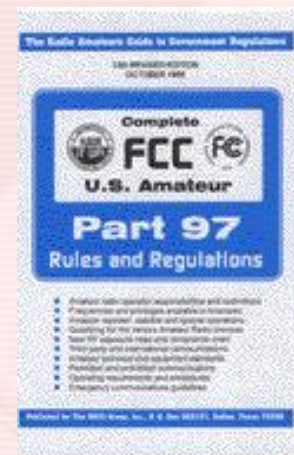
There is no minimum age requirement for holding an FCC Amateur Radio License.

T1A: Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules.

- **T1A2** What agency regulates and enforces the rules for the Amateur Radio Service in the United States?
The FCC
- **T1A3** Which Part of the FCC rules contains the rules and regulations governing the Amateur Radio Service?
Part 97 of the FCC rules.



FCC governs Amateur Radio Service



Part 97 Amateur Radio regulations are contained in Title- 7
47 Telecommunication. (3 inches thick)

T1A: Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules.

- **T1A4 Which of the following meets the FCC definition of harmful interference?**

That which seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with the Radio Regulations

- **T1A5 What is the FCC part 97 definition of a space station?**

An amateur station located more than 50 km above the Earth's surface

- **T1A6 What is the FCC Part 97 definition of telecommand?**

A one-way transmission to initiate, modify or terminate functions of a device at a distance

- **Types of Commands**

- Turning ON an amateur radio satellite
- Initiating a satellite mode change
- Turning OFF a distant propagation radio beacon
- Changing data ports on a digital repeater system

T1A: Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules.

- **T1A7 What is the FCC Part 97 definition of telemetry?**

A one-way transmission of measurements at a distance from the measuring instrument

- **Type of Information**

- Battery condition: Full
 - Outside temperature: Very cold
 - Power output: Excellent
 - Solar Panels: Bring on the sun!

- **T1A8 Which of the following entities recommends transmit/receive channels and other parameters for auxiliary and repeater stations?**

Frequency Coordinator

- **T1A9 Who selects a frequency coordinator?**

Amateur operators in a local or regional area that are eligible to be auxiliary or repeater stations

T1A: Amateur Radio services; purpose of the amateur service, amateur-satellite service, operator/primary station license grant, where FCC rules are codified, basis and purpose of FCC rules, meanings of basic terms used in FCC rules.

- **T1A10 What is the FCC Part 97 definition of an amateur station?**

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



A control operator



Make sure the FCC has issued your call sign before you go on the air for the first time. There are exceptions such as "third party" use.

- **T1A11 Which of the following stations transmits signals over the air from a remote receive site to a repeater for retransmission?**

Auxiliary station

T1B: Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges.

- **T1B1 What is the ITU?**

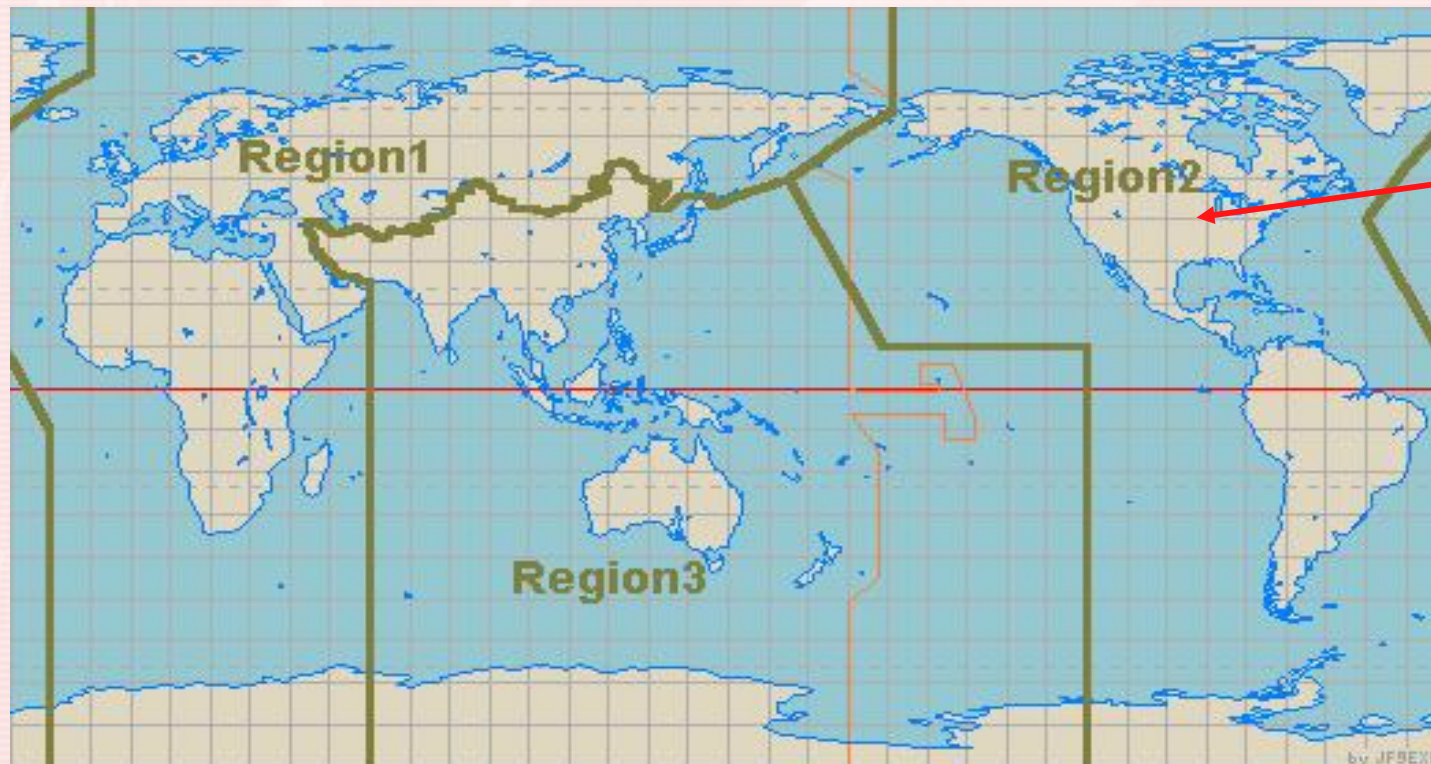
A United Nations agency for information and communication technology issues



T1B: Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges.

- **T1B2 North American amateur stations are located in which ITU region?**

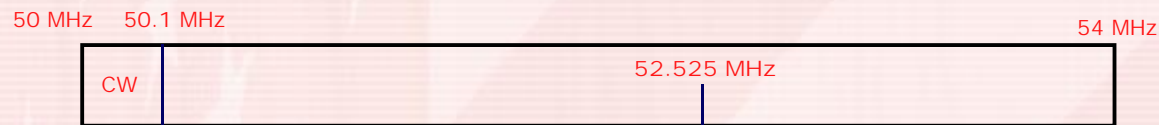
Region 2



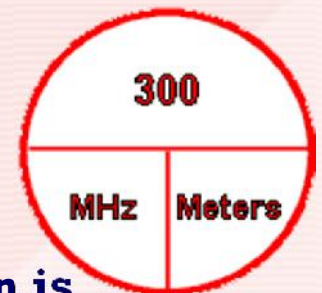
North
America
ITU
Region 2

T1B: Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges.

- **T1B3 Which frequency is within the 6 meter band? 52.525 MHz**



6-Meter Wavelength Band Privileges



- **T1B4 Which amateur band are you using when your station is transmitting on 146.52 MHz? 2 meter band**



2-Meter Wavelength Band Privileges

- **T1B5 Which 70 cm frequency is authorized to a Technician Class license holder operating in ITU Region 2? 443.350 MHz**

- 443.350 MHz is in the upper third of the 70 cm band



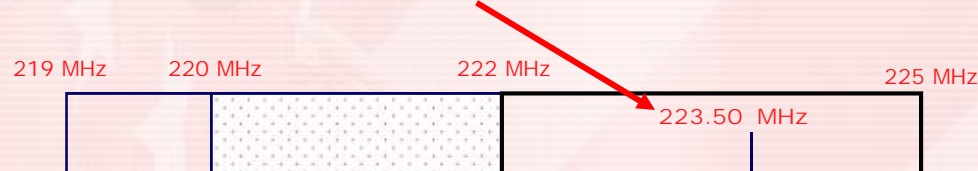
70-CM Wavelength Band Privileges

T1B: Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges.

- T1B6 Which 23 cm frequency is authorized to a Technician Class operator license? 1296 MHz**



- T1B7 What amateur band are you using if you are transmitting on 223.50 MHz? 1.25 meter band**



1.25-Meter Wavelength Band Privileges

- T1B8 What do the FCC rules mean when an amateur frequency band is said to be available on a secondary basis?**
Amateurs may not cause harmful interference to primary users

T1B: Authorized frequencies; frequency allocations, ITU regions, emission type, restricted sub-bands, spectrum sharing, transmissions near band edges.

- **T1B9 Why should you not set your transmit frequency to be exactly at the edge of an amateur band or sub-band?**
 - To allow for calibration error in the transmitter frequency display
 - So that modulation sidebands do not extend beyond the band edge
 - To allow for transmitter frequency drift
 - All of these choices are correct
- **T1B10 Which of the bands available to Technician Class operators have mode-restricted sub-bands?** The 6 meter, 2 meter, and 1.25 meter bands
 - 6 meters 50.0 – 50.1 No FM!
 - 2 meters 144.0 – 144.1 No FM!
 - 1.25 meters 222.0 – 222.34 No FM!
- **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?** CW only

T1C: Operator classes and station call signs; operator classes, sequential, special event, and vanity call sign systems, international communications, reciprocal operation, station license and licensee, places where the amateur service is regulated by the FCC, name and address on ULS, license term, renewal, grace period.

- **T1C1 Which type of call sign has a single letter in both the prefix and suffix? Special event**

Our local Boy Scout
Jamboree On The Air
special event call sign is
K6U, "Kilo Six Uniform"



- **T1C2 Which of the following is a valid US amateur radio station call sign? W3ABC**

Ham radio call signs, for the U.S, begin with A, K, N, or W. They also have a single numbers 0 through 9.

T1C: Operator classes and station call signs; operator classes, sequential, special event, and vanity call sign systems, international communications, reciprocal operation, station license and licensee, places where the amateur service is regulated by the FCC, name and address on ULS, license term, renewal, grace period.

- **T1C3 What types of international communications are permitted by an FCC-licensed amateur station?**

Communications incidental to the purposes of the amateur service and to remarks of a personal character

- **T1C4 When are you allowed to operate your amateur station in a foreign country?** When the foreign country authorizes it

- **T1C5 What must you do if you are operating on the 23 cm band and learn that you are interfering with a radiolocation station outside the United States?**

Stop operating or take steps to eliminate the harmful interference

- **T1C6 From which of the following may an FCC-licensed amateur station transmit, in addition to places where the FCC regulates communications?**

From any vessel or craft that is documented or registered in the United States

T1C: Operator classes and station call signs; operator classes, sequential, special event, and vanity call sign systems, international communications, reciprocal operation, station license and licensee, places where the amateur service is regulated by the FCC, name and address on ULS, license term, renewal, grace period.

- **T1C7** What may result when correspondence from the FCC is returned as undeliverable because the grantee failed to provide the correct mailing address?

Revocation of the station license or suspension of the operator license

- **T1C8** What is the normal term for an FCC-issued primary station/operator license grant? Ten years
- **T1C09** What is the grace period following the expiration of an amateur license within which the license may be renewed?
- Two years

Call Sign/Number	Grant Date	Expiration Date	File Number	Print Date	Effective Date
K3DIO	07-06-2006	09-24-2016	0002670444	07-06-2006	07-06-2006
Operator Privileges		Station Privileges		HERE	
Amateur Extra		PRIMARY		FOLD	
BYTHEWAY JR, ROBERT W ROBERT W. BYTHEWAY, JR. 1632 SPANISH TRAIL PLANO TX 75023					
AMATEUR RADIO LICENSE FCC Registration Number (FRN) 0003315850 FCC 660					
APRIL 2002 THIS LICENSE IS NOT TRANSFERABLE. SPECIAL CONDITIONS/ENDORSEMENTS: NONE Licensee's Signature: <i>Robert W. Bytheway Jr.</i> FEDERAL COMMUNICATIONS COMMISSION					

UNITED STATES OF AMERICA FEDERAL COMMUNICATIONS COMMISSION AMATEUR RADIO LICENSE			
K3DIO			
BYTHEWAY JR, ROBERT W ROBERT W. BYTHEWAY, JR. 1632 SPANISH TRAIL PLANO TX 75023			
FCC Registration Number: FRN 0003315850			
Special Conditions/Endorsements			
NONE			
Grant Date	Effective Date	Print Date	Expiration Date
07-06-2006	07-06-2006	07-06-2006	09-24-2016
File Number	Operator Privileges	Station Privileges	
0002670444	AMATEUR EXTRA	PRIMARY	
THIS LICENSE IS NOT TRANSFERABLE			
Licensee's Signature: <i>Robert W. Bytheway Jr.</i> APR 2002			

T1C: Operator classes and station call signs; operator classes, sequential, special event, and vanity call sign systems, international communications, reciprocal operation, station license and licensee, places where the amateur service is regulated by the FCC, name and address on ULS, license term, renewal, grace period.

- **T1C10 How soon may you operate a transmitter on an amateur service frequency after you pass the examination required for your first amateur radio license?**

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



- **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?**

No, transmitting is not allowed until the ULS database shows that the license has been renewed

T1D: Authorized and prohibited transmissions

- **T1D1 With which countries are FCC-licensed amateur stations prohibited from exchanging communications?**

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

- **T1D2 On which of the following occasions may an FCC-licensed amateur station exchange messages with a U.S. military station?**

- During an Armed Forces Day Communications Test

- **T1D3 When is the transmission of codes or ciphers allowed to hide the meaning of a message transmitted by an amateur station?**

Only when transmitting control commands to space stations or radio control craft

Space
station



Radio
control
craft



T1D: Authorized and prohibited transmissions

- **T1D4 What is the only time an amateur station is authorized to transmit music?**

When incidental to an authorized retransmission of manned spacecraft communications



Music in the background at your station is not permitted.

- **T1D5 When may amateur radio operators use their stations to notify other amateurs of the availability of equipment for sale or trade?**

When the equipment is normally used in an amateur station and such activity is not conducted on a regular basis

T1D: Authorized and prohibited transmissions

- **T1D6 Which of the following types of transmissions are prohibited?**

Transmissions that contain obscene or indecent words or language

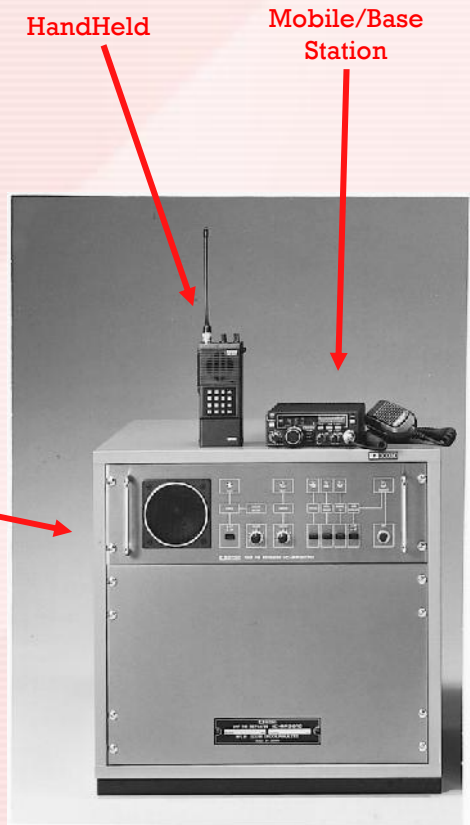
- Absolutely not allowed = indecent and obscene language

- **T1D7 When is an amateur station authorized to automatically retransmit the radio signals of other amateur stations?**

When the signals are from an auxiliary, repeater, or space station

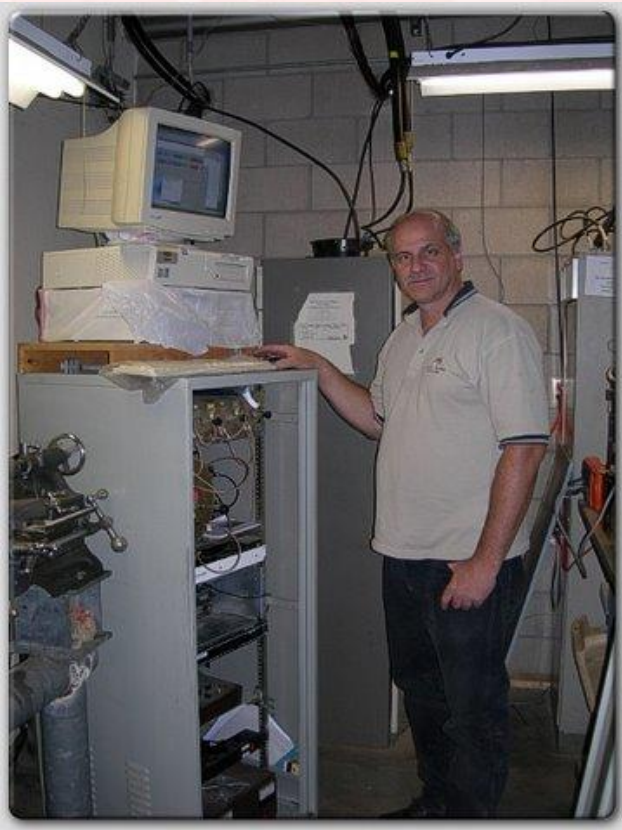
Repeater

A repeater: Nice clean, neat, and compact.



T1D: Authorized and prohibited transmissions

What repeaters really look like.

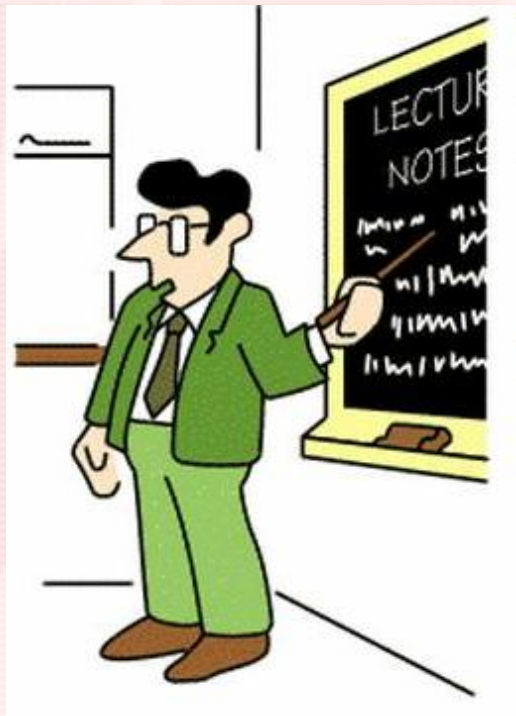


These repeaters are maintained by Joe Parrino, N6WZK

T1D: Authorized and prohibited transmissions

- **T1D8 When may the control operator of an amateur station receive compensation for operating the station?**

When the communication is incidental to classroom instruction at an educational institution



School teachers
can receive their
regular pay when
teaching about
ham radio

T1D: Authorized and prohibited transmissions

- **T1D9 Under which of the following circumstances are amateur stations authorized to transmit signals related to broadcasting, program production, or news gathering, assuming no other means is available?**

Only where such communications directly relate to the immediate safety of human life or protection of property

- **T1D10 What is the meaning of the term broadcasting in the FCC rules for the amateur services?**

Transmissions intended for reception by the general public

- **T1D11 Which of the following types of communications are permitted in the Amateur Radio Service?**

Brief transmissions to make station adjustments

T1E: Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator.

- **T1E1 When must an amateur station have a control operator?**
Only when station is transmitting



When you operate your station you are the “control operator,” and you are at the station’s “control point.”

- **T1E2 Who is eligible to be the control operator of an amateur station?**
Only a person for whom an amateur operator/primary station license grant appears in the FCC database or who is authorized for alien reciprocal operation

T1E: Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator.

- **T1E3 Who must designate the station control operator?**

The station licensee

- **T1E4 What determines the transmitting privileges of an amateur station?**

The class of operator license held by the control operator



When you operate from another ham's station, you use your license class privileges.

T1E: Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator.

- **T1E5 What is an amateur station control point?**

The location at which the control operator function is performed

The control point is the spot where you have complete capability to turn your equipment on or off.



T1E: Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator.

- **T1E6 Under which of the following types of control is it permissible for the control operator to be at a location other than the control point?** Automatic control
- **T1E7 When the control operator is not the station licensee, who is responsible for the proper operation of the station?**
The control operator and the station licensee are equally responsible
 - Both of you are responsible for the transmissions
- **T1E8 What type of control is being used for a repeater when the control operator is not present at a control point?**
Automatic control

T1E: Control operator and control types; control operator required, eligibility, designation of control operator, privileges and duties, control point, local, automatic and remote control, location of control operator.

- **T1E9 What type of control is being used when transmitting using a handheld radio?**

Local control

- **T1E10 What type of control is used when the control operator is not at the station location but can indirectly manipulate the operating adjustments of a station?**

Remote

- **T1E11 Who does the FCC presume to be the control operator of an amateur station, unless documentation to the contrary is in the station records?**

The station licensee

- Another licensee runs your gear, log who it was.

T1F: Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection.

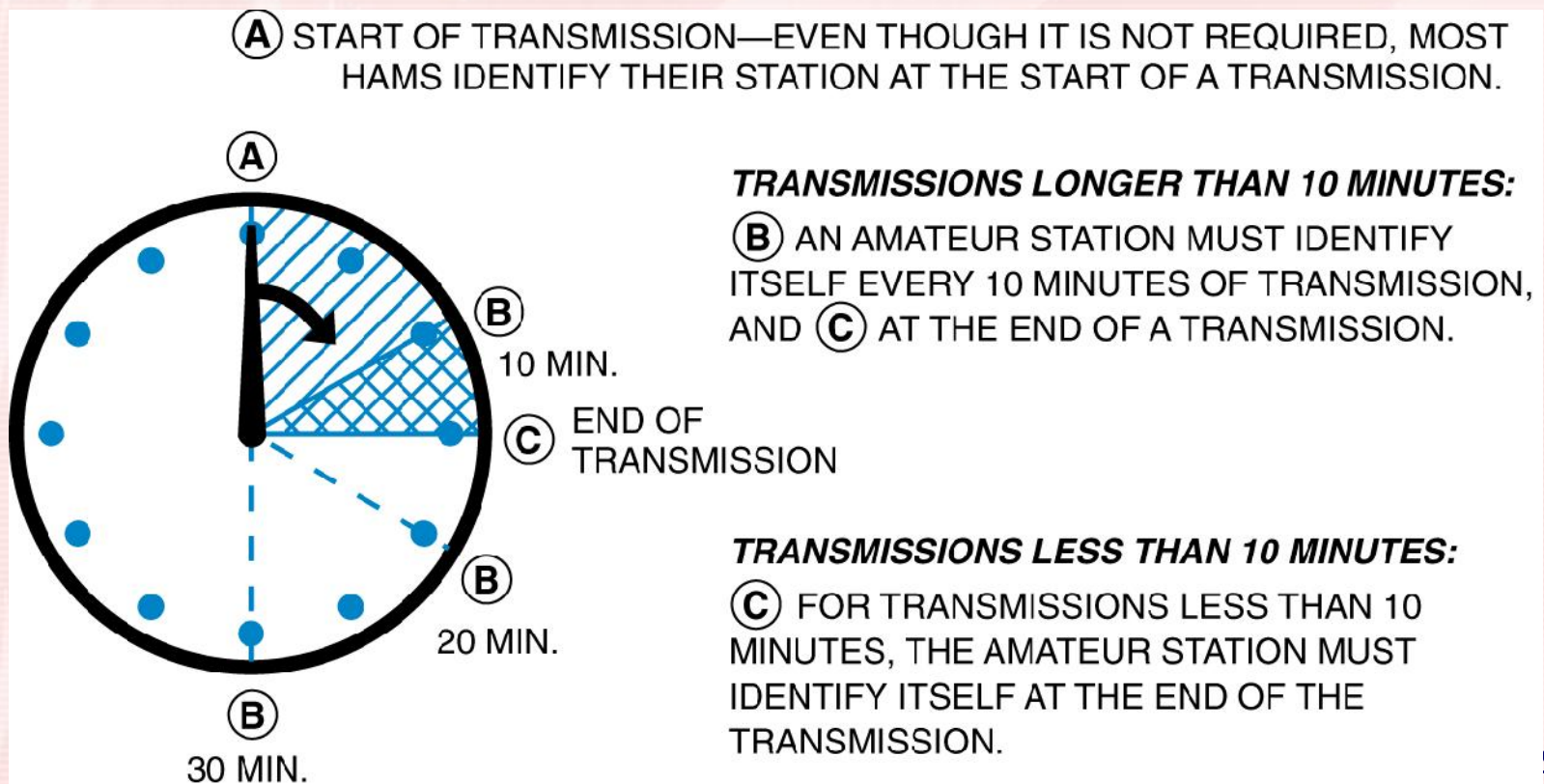
- **T1F1 What type of identification is being used when identifying a station on the air as “Race Headquarters”?** Tactical call
 - Tactical call signs **ARE** permitted as long as they don’t sound like a U.S. or foreign call sign.



- **T1F2 When using tactical identifiers, how often must your station transmit the station’s FCC-assigned call sign?** Every ten minutes

T1F: Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection.

- **T1F03 When is an amateur station required to transmit its assigned call sign?** At least every 10 minutes during and at the end of a contact



T1F: Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection.

- **T1F4 Which of the following is an acceptable language for use for station identification when operating in the phone sub-band?**

The English language

- **T1F5 What method of call sign identification is required for a station transmitting phone signals?**

Send the call sign using CW or phone emission

Repeaters can identify with a voice message announcing their call sign, or use Morse code not to exceed 20wpm to send out their station call letters



T1F: Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection.

- **T1F6 Which of the following formats of a self-assigned indicator is acceptable when identifying using a phone transmission?**

KL7CC stroke W3, KL7CC slant W3 and KL7CC slash W3 “All of these choices are correct”

- **T1F7 Which of the following restrictions apply when appending a self-assigned call sign indicator?**

It must not conflict with any other indicator specified by the FCC rules or with any call sign prefix assigned to another country

- **T1F8 When may a Technician Class licensee be the control operator of a station operating in an exclusive Extra Class operator segment of the amateur bands? Never**

- **You must stay within your Technician Class band privileges.**

- **T1F9 What type of amateur station simultaneously retransmits the signal of another amateur station on a different channel or channels?**
Repeater station

T1F: Station identification and operation standards; special operations for repeaters and auxiliary stations, third party communications, club stations, station security, FCC inspection.

- **T1F10 Who is accountable should a repeater inadvertently retransmit communications that violate the FCC rules?** The control operator of the originating station
- **T1F11 To which foreign stations do the FCC rules authorize the transmission of non-emergency third party communications?** Any station whose government permits such communications
- **T1F12 How many persons are required to be members of a club for a club station license to be issued by the FCC?** At least 4
- **T1F13 When must the station licensee make the station and its records available for FCC inspection?** Any time upon request by an FCC representative

Technician Licensing Class “T2”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

Element 2 Course Presentation

ELEMENT 2 SUB-ELEMENTS

- T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.
- **T2 – Operating Procedures**
- T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes
- T4 – Amateur radio practices and station set up
- T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law
- T6 – Electrical components, semiconductors, circuit diagrams, component functions
- T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing
- T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications
- T9 – Antennas, feedlines
- T0 – AC power circuits, antenna installation, RF hazards

T2A: Station operation; choosing an operating frequency, calling another station, test transmissions, use of minimum power, frequency use, band plans.

T2A1 What is the most common repeater frequency offset in the 2 meter band? Plus or minus 600 kHz

- **T2A2 What is the national calling frequency for FM simplex operations in the 70 cm band? 446.000 MHz**
- **T2A3 What is a common repeater frequency offset in the 70 cm band? Plus or minus 5 MHz**
- **T2A4 What is an appropriate way to call another station on a repeater if you know the other station's call sign?**
Say the station's call sign then identify with your call sign
 - **W2HLD this is K3DIO**
- **T2A5 What should you transmit when responding to a call of CQ?**
The other station's call sign followed by your call sign
 - **W5YI this is K3DIO**

T2A: Station operation; choosing an operating frequency, calling another station, test transmissions, use of minimum power, frequency use, band plans.

- **T2A6 What must an amateur operator do when making on-air transmissions to test equipment or antennas?**

Properly identify the transmitting station

- All transmissions must be identified

- **T2A7 Which of the following is true when making a test transmission?** Station identification is required at least every ten minutes during the test and at the end

Just like normal ID requirements for a QSO

- **T2A8 What is the meaning of the procedural signal "CQ"?**

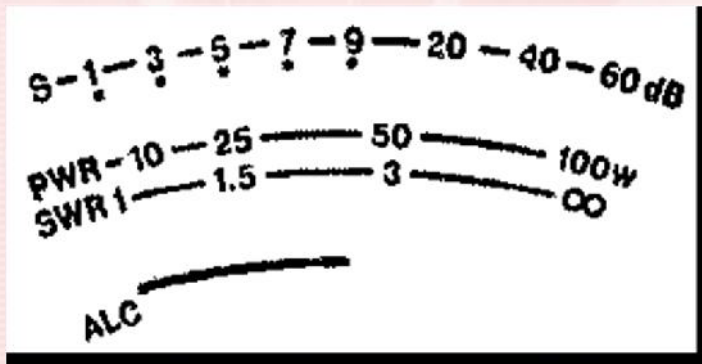
Calling any station

- **T2A9 What brief statement is often used in place of "CQ" to indicate that you are listening on a repeater?** Say your call sign

- **T2A10 What is a band plan, beyond the privileges established by the FCC?** A voluntary guideline for using different modes or activities within an amateur band

T2A: Station operation; choosing an operating frequency, calling another station, test transmissions, use of minimum power, frequency use, band plans.

- **T2A11 What are the FCC rules regarding power levels used in the amateur bands?** An amateur must use the minimum transmitter power necessary to carry out the desired communication

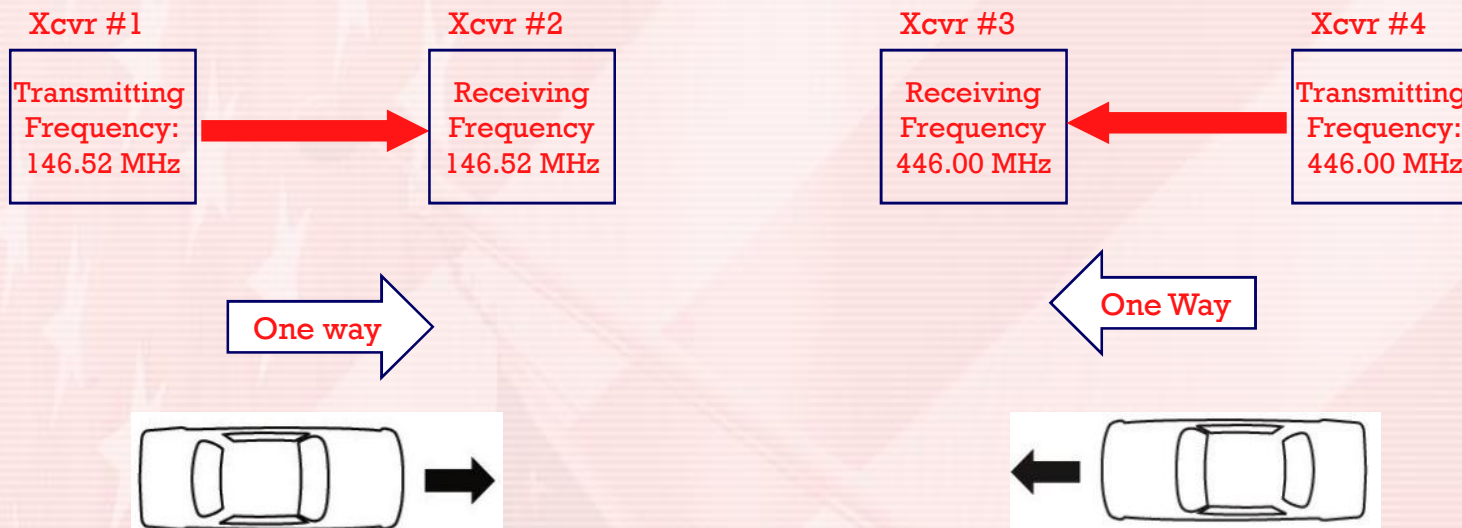


Use the minimum amount of power output to make contact with another station

T2B: VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics.

- T2B1 What is the term used to describe an amateur station that is transmitting and receiving on the same frequency?**

Simplex communication



- No offset frequency used for simplex like with a repeater

T2B: VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics.

- **T2B2 What is the term used to describe the use of a sub-audible tone transmitted with normal voice audio to open the squelch of a receiver?**
CTCSS = Continuous Tone-Coded Squelch System

- Also called a PL tone.

CTCSS Tones In Use

67.0 Hz	94.8 Hz	131.8 Hz	171.3 Hz	203.5 Hz
69.3 Hz	97.4 Hz	136.5 Hz	173.8 Hz	206.5 Hz
71.9 Hz	100.0 Hz	141.3 Hz	177.3 Hz	210.7 Hz
74.4 Hz	103.5 Hz	146.2 Hz	179.9 Hz	218.1 Hz
77.0 Hz	107.2 Hz	151.4 Hz	183.5 Hz	225.7 Hz
79.7 Hz	110.9 Hz	156.7 Hz	186.2 Hz	229.1 Hz
82.5 Hz	114.8 Hz	159.8 Hz	189.9 Hz	233.6 Hz
85.4 Hz	118.8 Hz	162.2 Hz	192.8 Hz	241.8 Hz
88.5 Hz	123.0 Hz	165.5 Hz	196.6 Hz	250.3 Hz
91.5 Hz	127.3 Hz	167.9 Hz	199.5 Hz	254.1 Hz

T2B: VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics.

- **T2B3 Which of the following describes the muting of receiver audio controlled solely by the presence or absence of an RF signal?**

Carrier squelch

- **T2B4 Which of the following common problems might cause you to be able to hear but not access a repeater even when transmitting with the proper offset?**
- The repeater receiver requires audio tone burst for access
- The repeater receiver requires a CTCSS tone for access
- The repeater receiver may require a DCS tone sequence for access
- **All of these choices are correct**

T2B: VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics.

- **T2B5 What determines the amount of deviation of an FM signal?**

The amplitude of the modulating signal

- **T2B6 What happens when the deviation of an FM transmitter is increased?** Its signal occupies more bandwidth

- **T2B7 What should you do if you receive a report that your station's transmissions are causing splatter or interference on nearby frequencies?**

Check your transmitter for off-frequency operation or spurious emissions

- **T2B8 What is the proper course of action if your station's transmission unintentionally interferes with another station?**

Properly identify your transmission and move to a different frequency

T2B: VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics.

- **T2B9 Which of the following methods is encouraged by the FCC when identifying your station when using phone? Use of a phonetic alphabet**

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

- **T2B10 What is the "Q" signal used to indicate that you are receiving interference from other stations? QRM**
- **T2B11 What is the "Q" signal used to indicate that you are changing frequency? QSY**

T2B: VHF/UHF operating practices; SSB phone, FM repeater, simplex, frequency offsets, splits and shifts, CTCSS, DTMF, tone squelch, carrier squelch, phonetics.

QRM	Something is causing interference
QRN	I am troubled by static/noise.
QRP	I am running low power.
QRT	I am going off the air.
QRZ	Who is calling me?
QSB	Your signal is fading.
QSL	I received the message.
QSO	I will communicate with _____ directly.
QSY	I am changing frequency to _____.
QTH	My location is _____.

T2C: Public service; emergency and non-emergency operations, message traffic handling (T2C2, T2C3 removed by FCC)

- **T2C1 What set of rules applies to proper operation of your station when using amateur radio at the request of public service officials?**

FCC Rules

- Amateur radio operators are not relieved from FCC rules at request from FBI, FEMA, or any other Federal agency.

- **T2C4 What do RACES and ARES have in common?**

Both organizations may provide communications during emergencies



- **T2C5 What is the Radio Amateur Civil Emergency Service?**

A radio service using amateur stations for emergency management or civil defense communications

T2C: Public service; emergency and non-emergency operations, message traffic handling

- **T2C6 Which of the following is common practice during net operations to get the immediate attention of the net control station when reporting an emergency?**

Begin your transmission with “Priority” or “Emergency” followed by your call sign



Another way to interrupt a conversation to signal a distress call is to say the word “BREAK” several times to indicate a priority or emergency distress call.

T2C: Public service; emergency and non-emergency operations, message traffic handling

- T2C7 What should you do to minimize disruptions to an emergency traffic net once you have checked in?**

Do not transmit on the net frequency until asked to do so by the net control station

- T2C8 What is usually considered to be the most important job of an amateur operator when handling emergency traffic messages?**

Passing messages exactly as written, spoken or as received

- Write in block letters, word for word.

THE AMERICAN RADIO RELAY LEAGUE RADIOGRAM VIA AMATEUR RADIO							
NUMBER	PRIORITY	FX	STATION OF ORIGIN	CHECK	PLACE OF ORIGIN	TIME FILED	DATE
TO					THIS RADIO MESSAGE WAS RECEIVED AT		
TELEPHONE NUMBER					ADDRESS: _____		
					NAME: _____		
					STREET ADDRESS: _____		
					CITY, STATE, ZIP: _____		
FROM		DATE		TIME		SENT TO	
REC'D		DATE		TIME		SENT TO	
<small>THE AMERICAN RADIO RELAY LEAGUE, INC. IS THE NATIONAL MEMBERSHIP SOCIETY OF LICENSED RADIO AMATEURS AND THE PUBLISHER OF QST. AS SUCH, ONE OF ITS FUNCTIONS IS PROMOTION OF PUBLIC SERVICE COMMUNICATIONS AMONG AMATEUR OPERATORS. TO THAT END, THE LEAGUE HAS ORGANIZED THE NATIONAL TRAFFIC SYSTEM FOR ONLY EMERGENCY MESSAGE HANDLING.</small>							

T2C: Public service; emergency and non-emergency operations, message traffic handling

- **T2C9 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?**

When normal communications systems are not available

- *in an emergency, anything goes!*



T2C: Public service; emergency and non-emergency operations, message traffic handling

- **T2C10 What is the preamble in a formal traffic message?**

The information needed to track the message as it passes through the amateur radio traffic handling system

- Keep track of emergency messages as they pass through the well structured amateur radio traffic-handling system.

- **T2C11 What is meant by the term "check" in reference to a formal traffic message?**

The check is a count of the number of words in the message

- include a 'check' to make sure **all words in a message** indeed were received in their entirety.

Technician Licensing Class “T3”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

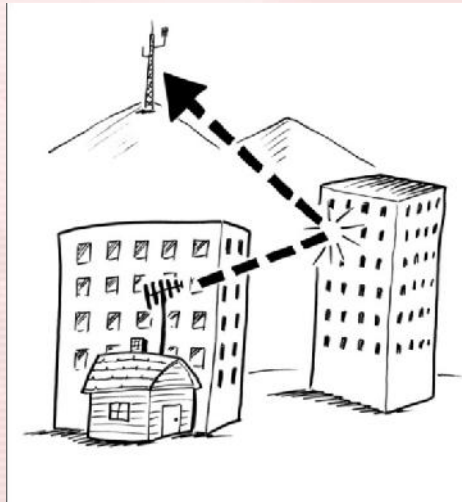
T3A: Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF, and UHF; fading, multipath; wavelengths vs. penetration; antenna orientation.

- **T3A1 What should you do if another operator reports that your station's 2 meter signals were strong just a moment ago, but now they are weak or distorted?**

Try moving a few feet, as random reflections may be causing multi-path distortion

- **T3A2 Why are UHF signals often more effective from inside buildings than VHF signals?**

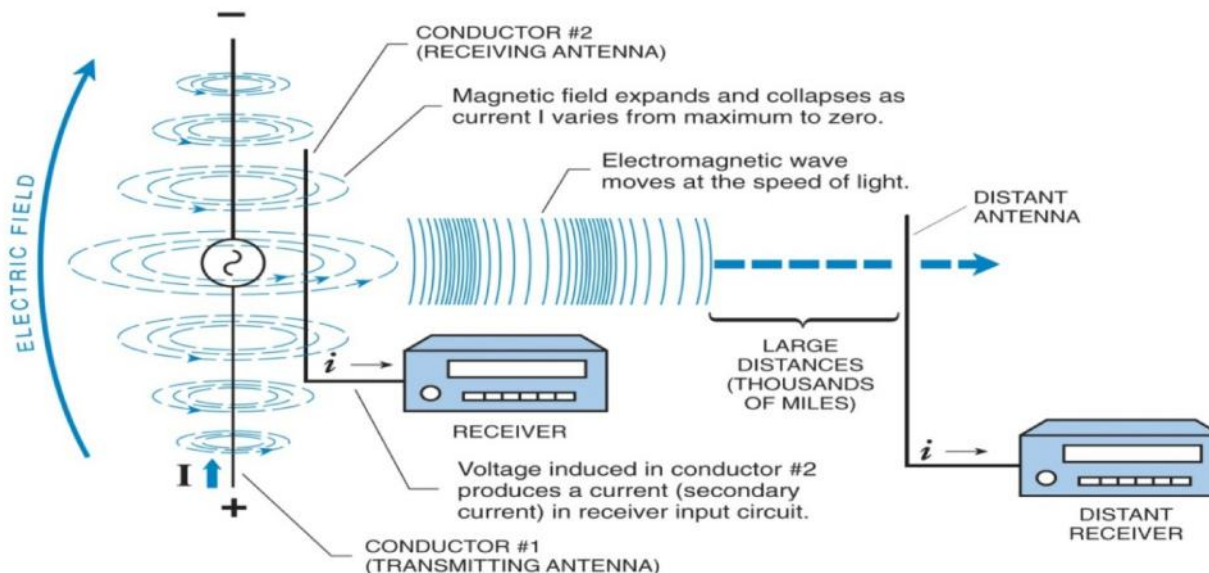
The shorter wavelength allows them to more easily penetrate the structure of buildings



UHF signals are short enough in wavelength to permit bouncing around inside buildings and penetrating of walls.

T3A: Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF, and UHF; fading, multipath; wavelengths vs. penetration; antenna orientation.

- T3A3 What antenna polarization is normally used for long-distance weak-signal CW and SSB contacts using the VHF and UHF bands? Horizontal
- **T3A4 What can happen if the antennas at opposite ends of a VHF or UHF line of sight radio link are not using the same polarization?**
Signals could be significantly weaker



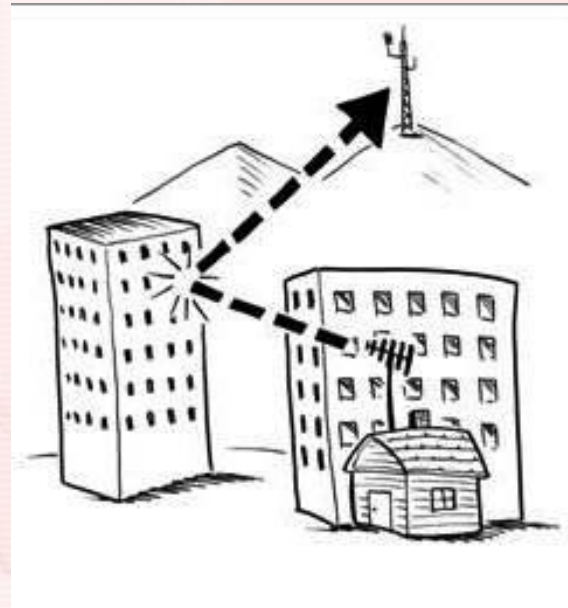
Transmitter to Receiver – Radio waves from transmitting antennas induce signals in receiving antennas as they pass by

T3A: Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF, and UHF; fading, multipath; wavelengths vs. penetration; antenna orientation.

- **T3A5 When using a directional antenna, how might your station be able to access a distant repeater if buildings or obstructions are blocking the direct line of sight path?**

Try to find a path that reflects signals to the repeater

Directional
Antenna can be
used to bounce
signal to reach
repeater blocked
by building



T3A: Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF, and UHF; fading, multipath; wavelengths vs. penetration; antenna orientation.

- **T3A6 What term is commonly used to describe the rapid fluttering sound sometimes heard from mobile stations that are moving while transmitting?**
Picket fencing
- **T3A7 What type of wave carries radio signals between transmitting and receiving stations?**
Electromagnetic
- **T3A8 What is the cause of irregular fading of signals from distant stations during times of generally good reception?**
Random combining of signals arriving via different path lengths

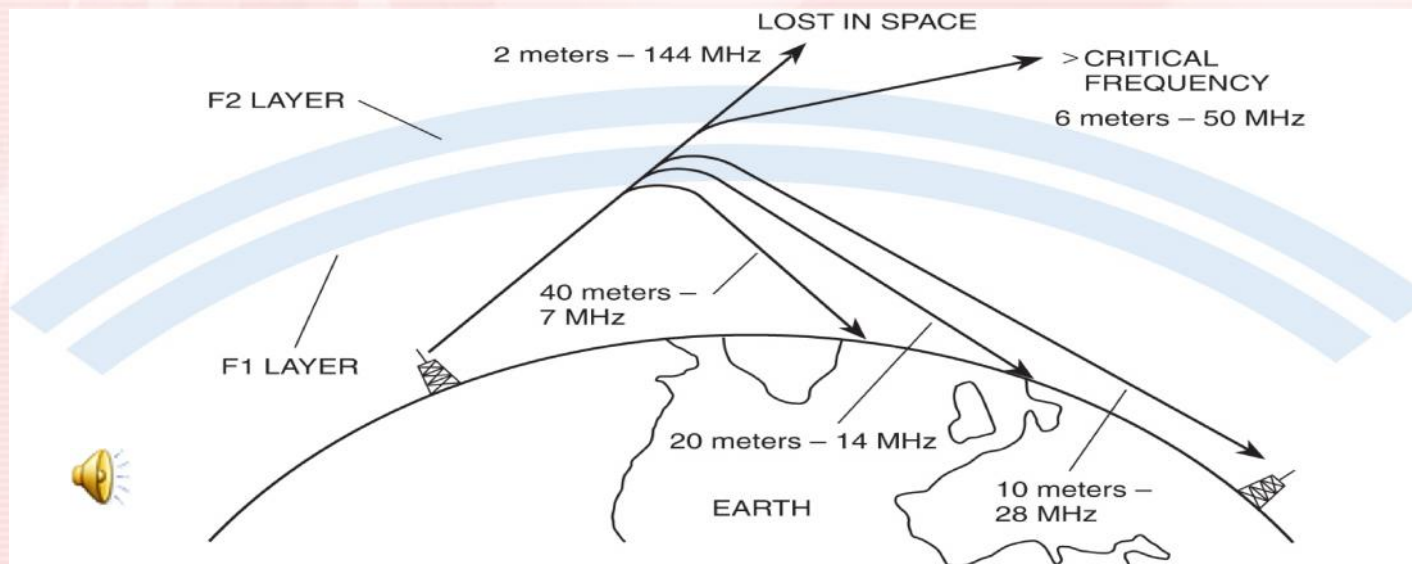


T3A: Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF, and UHF; fading, multipath; wavelengths vs. penetration; antenna orientation.

- **T3A9 Which of the following is a common effect of "skip" reflections between the Earth and the ionosphere?**

The polarization of the original signal is randomized

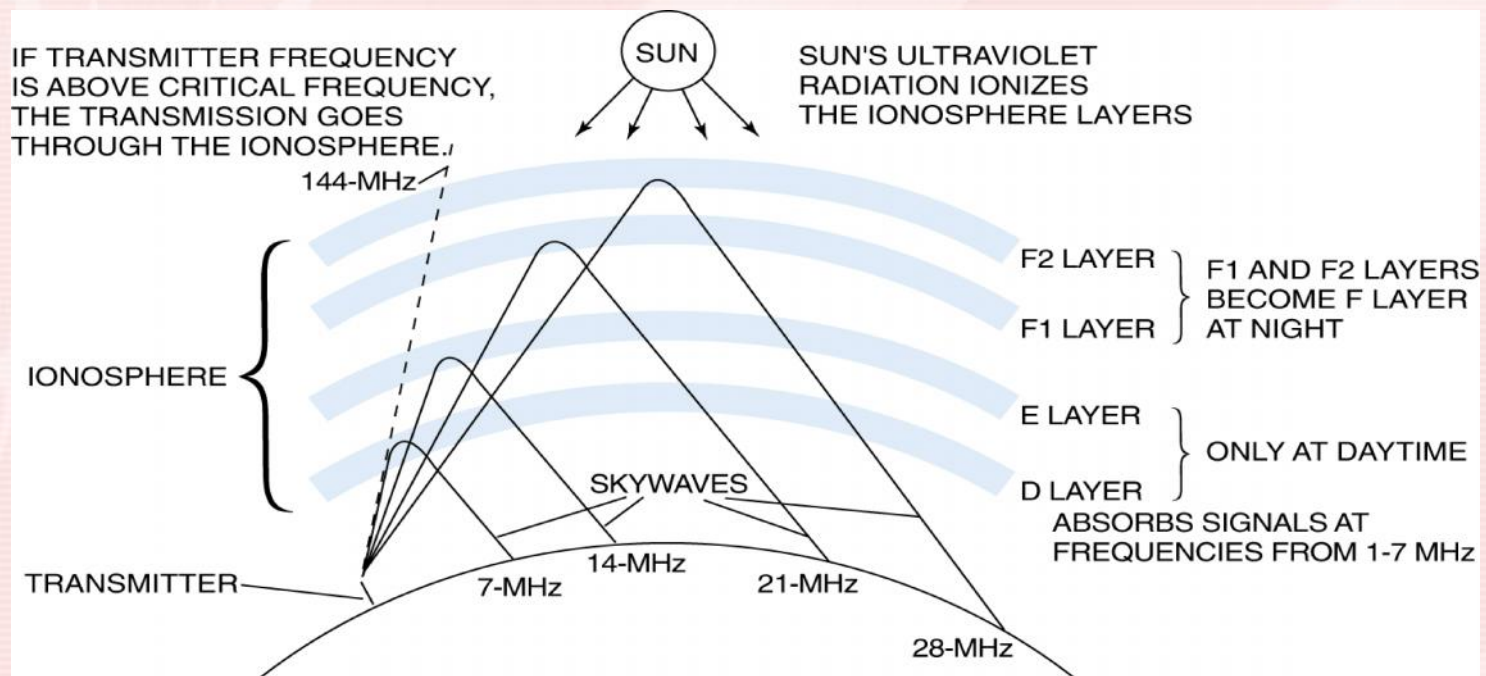
- Skip happens when signals refract and reflect off the ionosphere.
 - DX stations 1000 miles away come booming in.
- Every 30 seconds signal goes from strong to weak and back.
 - Caused by random, ever changing polarization of the original signal.



Critical Frequency

T3A: Radio wave characteristics; how a radio signal travels; distinctions of HF, VHF, and UHF; fading, multipath; wavelengths vs. penetration; antenna orientation.

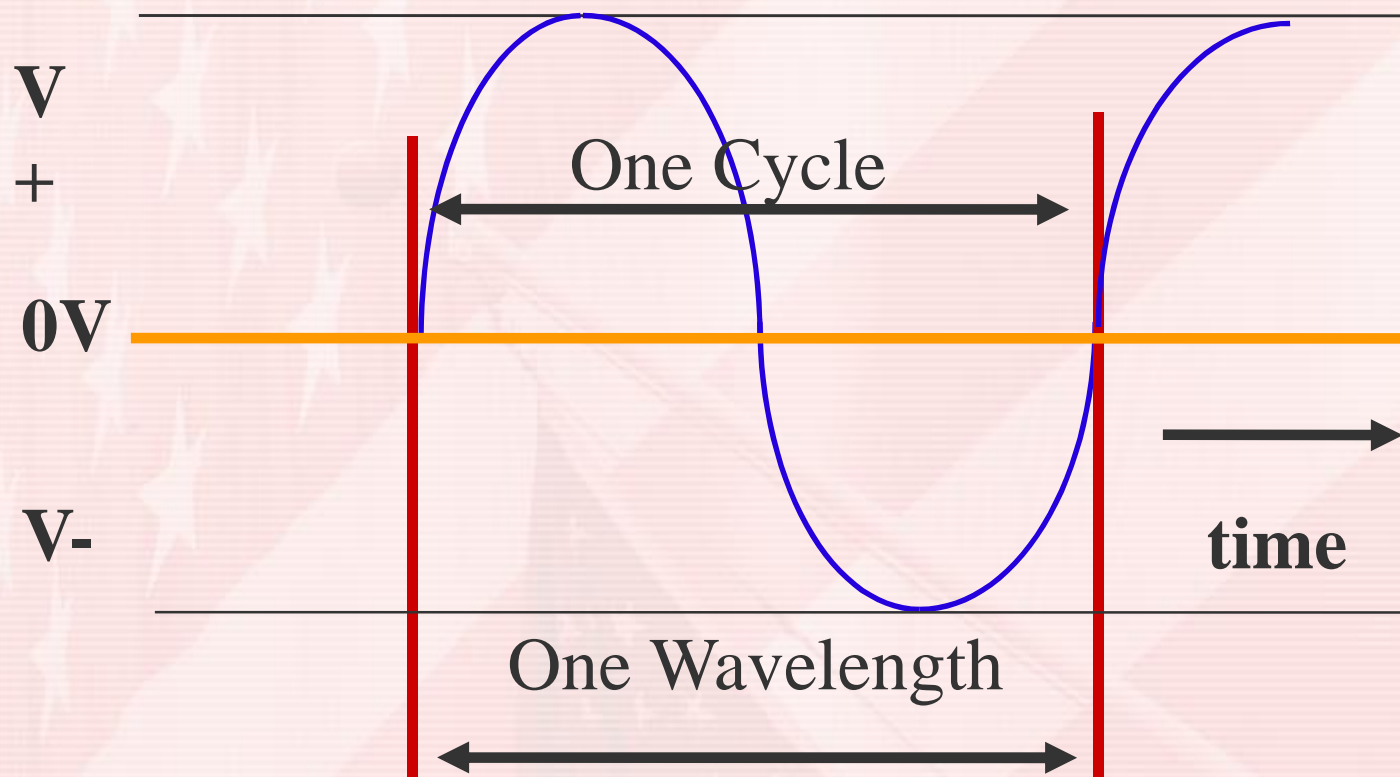
- **T3A10 What may occur if VHF or UHF data signals propagate over multiple paths?** Error rates are likely to increase
- **T3A11 Which part of the atmosphere enables the propagation of radio signals around the world?** The ionosphere



Ionosphere and its layers

T3B: Radio and electromagnetic wave properties; the electromagnetic spectrum, wavelength vs. frequency, velocity of electromagnetic waves.

- **T3B1 What is the name for the distance a radio wave travels during one complete cycle? Wavelength**
- **T3B2 What term describes the number of times per second that an alternating current reverses direction? Frequency**



T3B: Radio and electromagnetic wave properties; the electromagnetic spectrum, wavelength vs. frequency, velocity of electromagnetic waves.

- **T3B3 What are the two components of a radio wave?**

Electric and magnetic fields

They are at right angles to each other and together are called "electromagnetic" radio waves

- **T3B4 How fast does a radio wave travel through free space?**

At the speed of light

- **T3B5 How does the wavelength of a radio wave relate to its frequency?**

The wavelength gets shorter as the frequency increases

- Higher in frequency the shorter the distance between each wave.

T3B: Radio and electromagnetic wave properties; the electromagnetic spectrum, wavelength vs. frequency, velocity of electromagnetic waves.

- T3B6 What is the formula for converting frequency to wavelength in meters?**

Wavelength in meters equals 300 divided by frequency in megahertz (**One answer ends with word Megahertz**)

Conversions Between Wavelength and Frequency

Converting Frequency
to Wavelength

To find wavelength (λ) in
meters, if you know frequency
(f) in megahertz (MHz) Solve:

$$\lambda(\text{meters}) = \frac{300}{f(\text{MHz})}$$

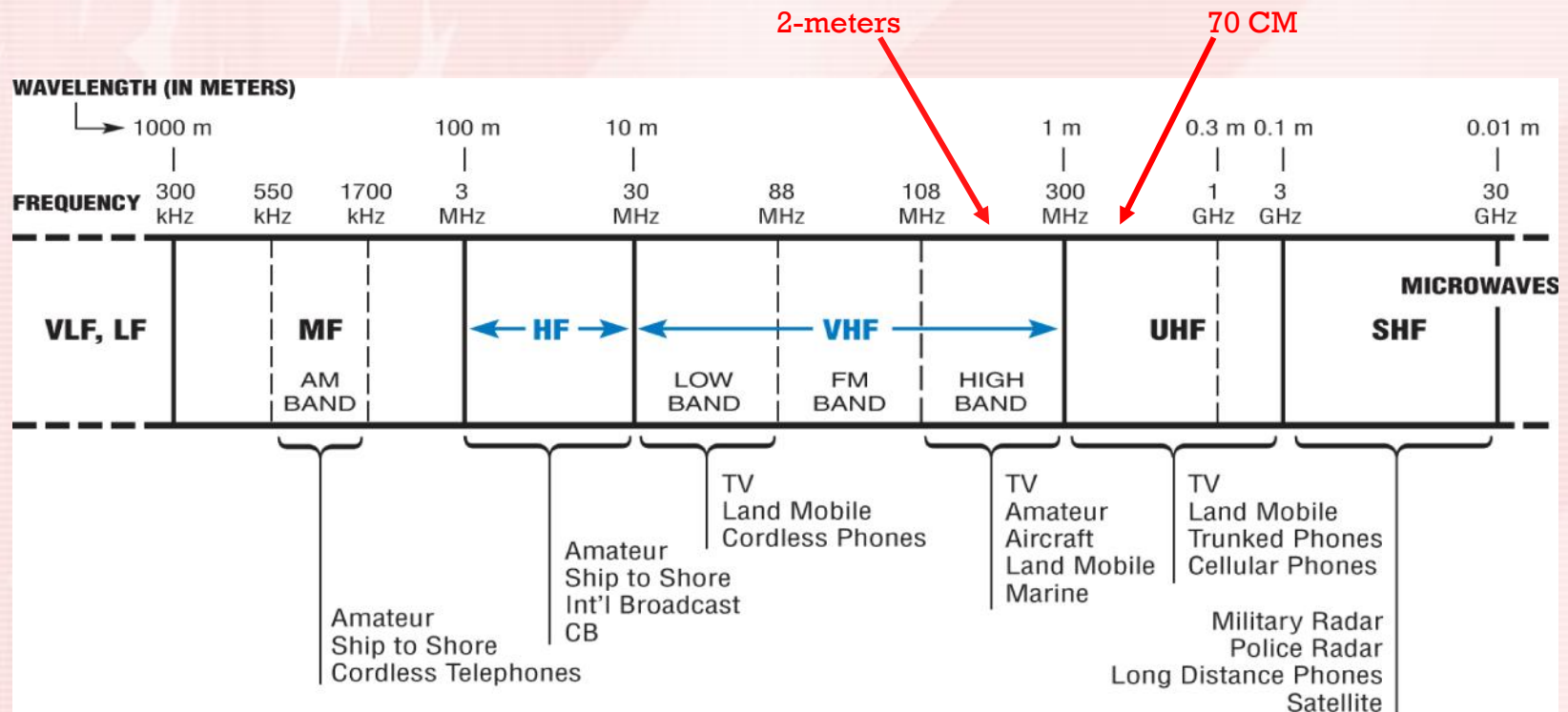
Converting Wavelength
to Frequency

To find frequency (f) in
megahertz (MHz), if you know
wavelength (λ) in meters,
Solve:

$$f(\text{MHz}) = \frac{300}{\lambda(\text{meters})}$$

T3B: Radio and electromagnetic wave properties; the electromagnetic spectrum, vs. frequency, velocity of electromagnetic waves.

- **T3B7 What property of radio waves is often used to identify the different frequency bands?** The approximate wavelength
 - Wavelength of the band: 2 meters; 20 meters; 40 meters, etc
- **T3B8 What are the frequency limits of the VHF spectrum?**
30 to 300 MHz



T3B: Radio and electromagnetic wave properties; the electromagnetic spectrum, vs. frequency, velocity of electromagnetic waves.

- **T3B9 What are the frequency limits of the UHF spectrum?**
300 to 3000 MHz
 - UHF is 300 MHz to 3000 MHz
- **T3B10 What frequency range is referred to as HF?**
3 to 30 MHz
- **T3B11 What is the approximate velocity of a radio wave as it travels through free space?**
300,000,000 meters per second

T3C: Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizons

- **T3C1 Why are "direct" (not via a repeater) UHF signals rarely heard from stations outside your local coverage area?**

UHF signals are usually not reflected by the ionosphere

- **REFRACTION IN THE IONOSPHERE:**

- When a radio wave is transmitted into an ionized layer, refraction, or bending of the wave, occurs.
- Refraction is caused by an abrupt change in the velocity of the upper part of a radio wave as it strikes or enters a new medium.
- The amount of refraction that occurs depends on three main factors:
 - (1) the density of ionization of the layer,
 - (2) the frequency of the radio wave,
 - (3) the angle at which the wave enters the layer

- **REFLECTION IN THE IONOSPHERE:**

- When a radio wave hits an obstacle, some or all of the wave is reflected, with a loss of intensity.
- Reflection is such that the angle of incidence is equal to the angle of reflection.

T3C: Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizons

- **T3C2 Which of the following might be happening when VHF signals are being received from long distances?** Signals are being refracted from a sporadic E layer 📢
 - Sporadic-E refractions off ionized patches of the ionospheric E-layer are common in summer on 6-meters.
- **T3C3 What is a characteristic of VHF signals received via auroral reflection?** The signals exhibit rapid fluctuations of strength and often sound distorted 📢



Incoming signals from a distant station heard hundreds of miles away will sound fluttery and distorted by auroral bounce

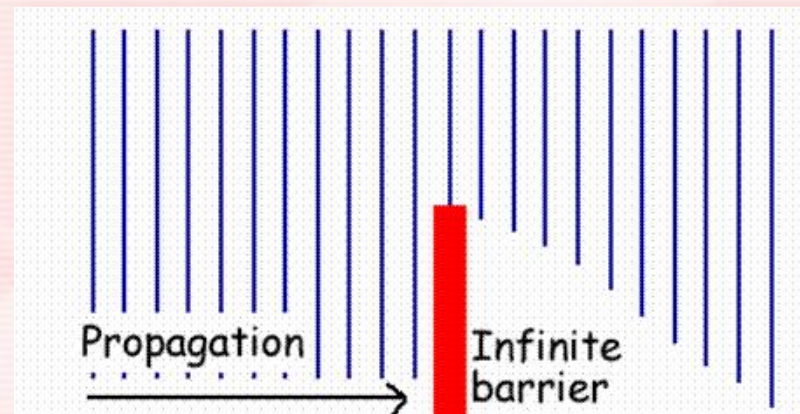
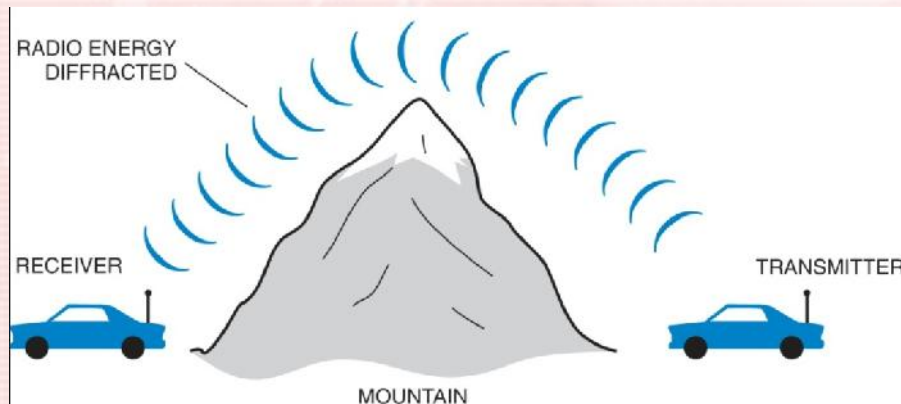
T3C: Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizons

- **T3C4 Which of the following propagation types is most commonly associated with occasional strong over-the-horizon signals on the 10, 6, and 2 meter bands?**

Sporadic E

- **T3C5 What is meant by the term "knife-edge" propagation?**

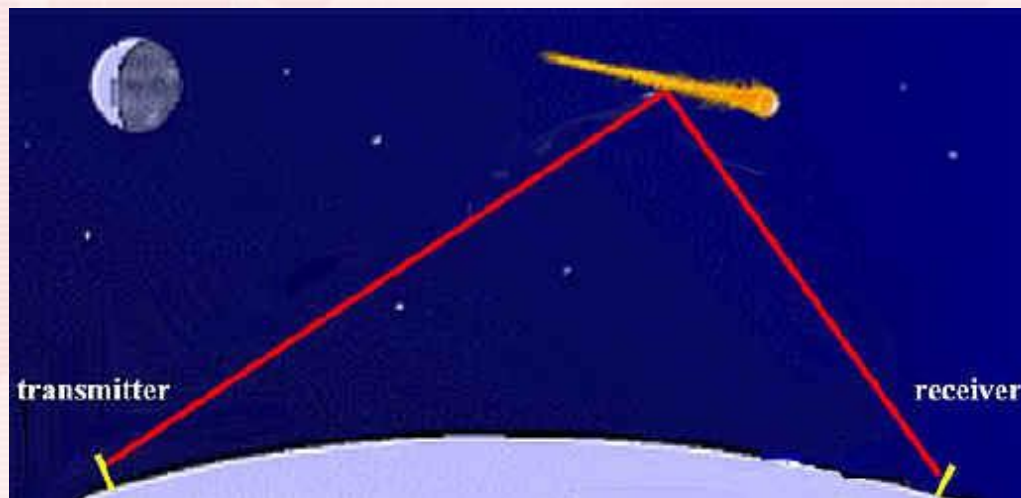
Signals are partially refracted around solid objects exhibiting sharp edges



Knife-Edge Diffraction

T3C: Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizons

- **T3C6 What mode is responsible for allowing over-the-horizon VHF and UHF communications to ranges of approximately 300 miles on a regular basis? Tropospheric scatter** 📢
- **T3C7 What band is best suited to communicating via meteor scatter?**
6 meters
 - Leonids and Geminids meteor showers provide these conditions
 - Bounce signals off meteor tail 📢

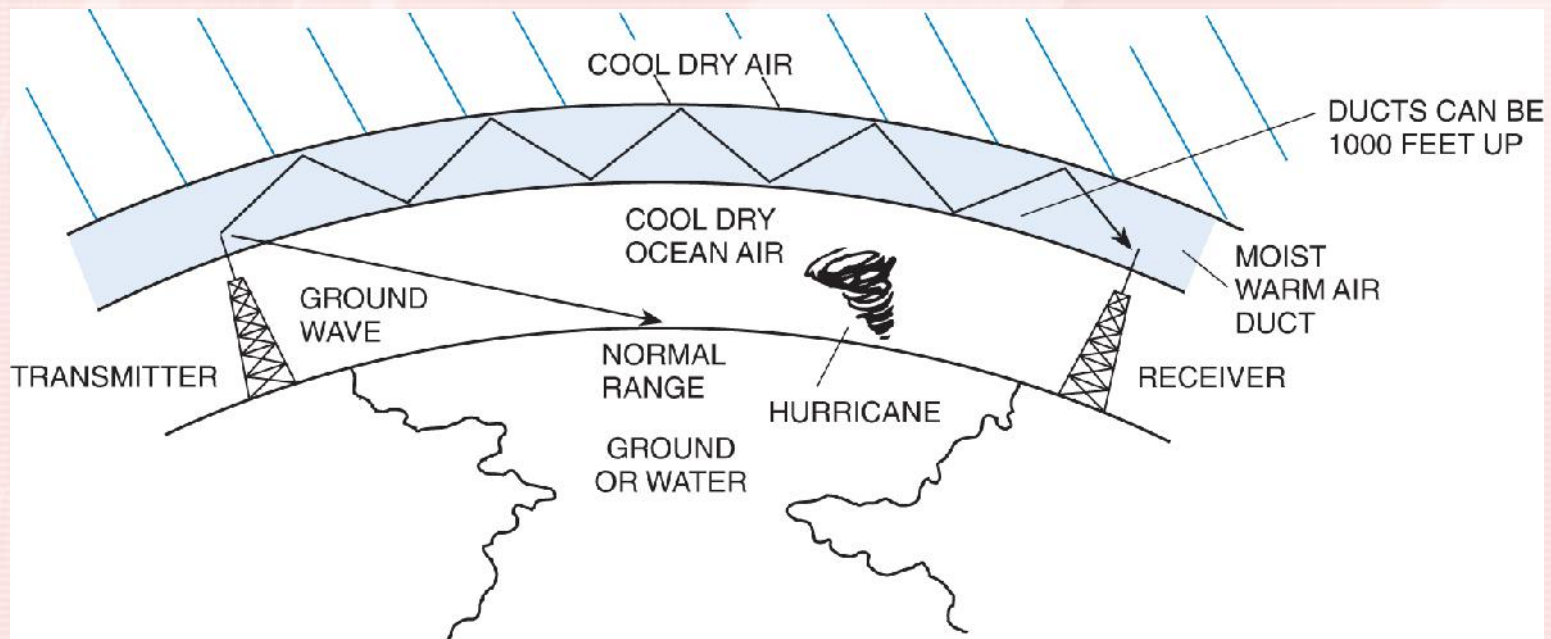


T3C: Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizons

- **T3C8 What causes "tropospheric ducting"?**

Temperature inversions in the atmosphere

Tropoducting on 2 meters 📡 and 10 GHz 📡



Tropospheric Ducting

T3C: Propagation modes; line of sight, sporadic E, meteor, aurora scatter, tropospheric ducting, F layer skip, radio horizons

- **T3C9 What is generally the best time for long-distance 10 meter band propagation?** During daylight hours
- **T3C10 What is the radio horizon?**
The distance at which radio signals between two points are effectively blocked by the curvature of the Earth
 - VHF & UHF radio signals will generally travel “line of sight.”
 - VHF & UHF radio signals are blocked by the curvature of the Earth.



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

Technician Licensing Class “T4”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

- T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A1 Which of the following is true concerning the microphone connectors on amateur transceivers?**

Some connectors include push-to-talk and voltages for powering the microphone

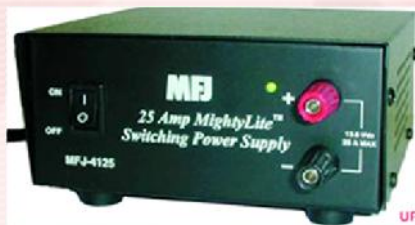


T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A2 What could be used in place of a regular speaker to help you copy signals in a noisy area? A set of headphones**



- **T4A3 Which is a good reason to use a regulated power supply for communications equipment? It prevents voltage fluctuations from reaching sensitive circuits**



MFJ-4125 13.8VDC@22Amp



Jetstream JTPS30M Regulated Power Supply

T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A4 Where must a filter be installed to reduce harmonic emissions?** Between the transmitter and the antenna

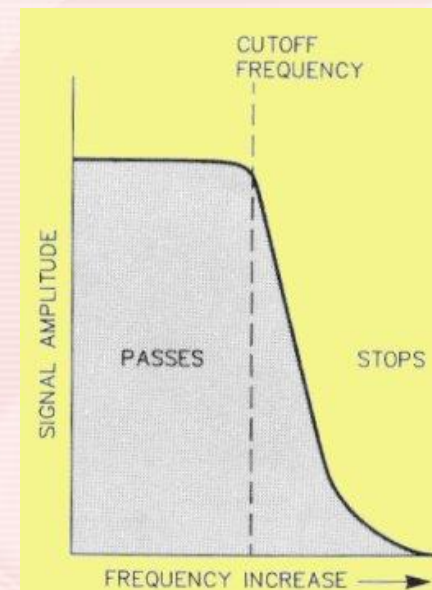
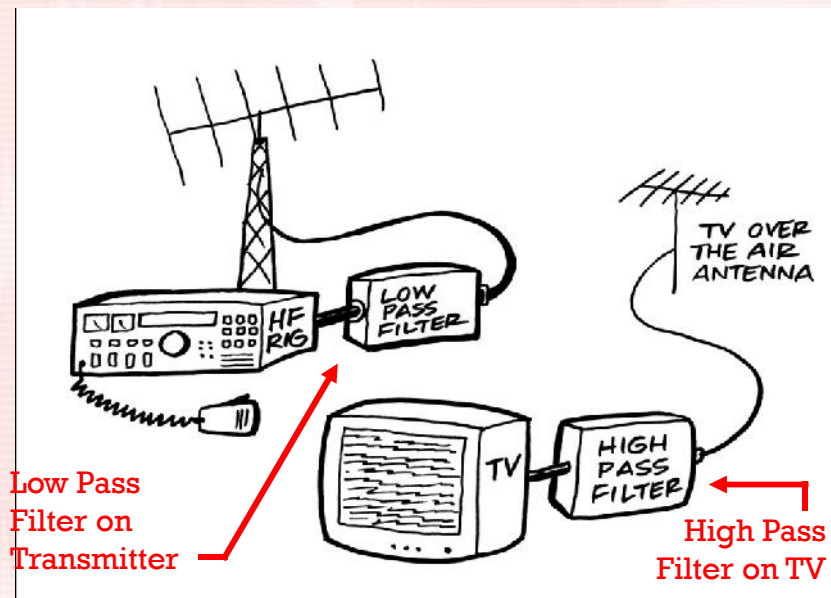


Drake TV-3300-LP Low Pass Filter.
80 db attenuation above 41 MHz.
1000 Watts below 30 MHz.

There are low-pass filters like this one, band-pass filters, and high-pass filters that can be used to solve interference problems.

T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A5 What type of filter should be connected to a TV receiver as the first step in trying to prevent RF overload from a nearby 2 meter transmitter? Band-reject filter**



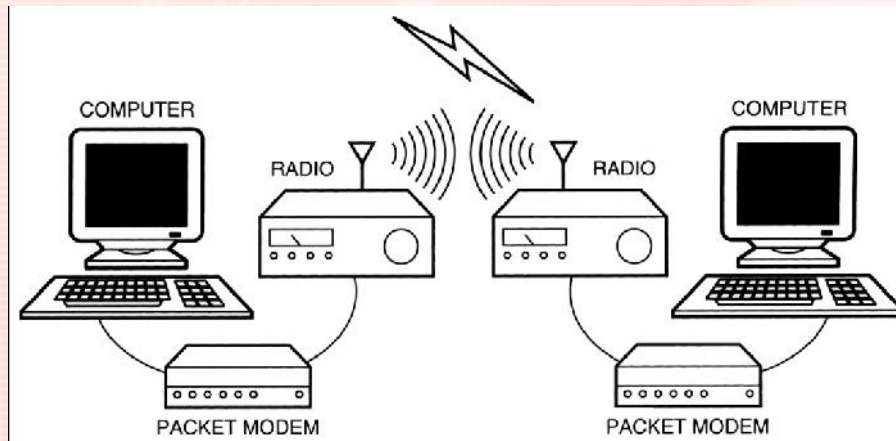
Low Pass Filter

Passes low frequencies and cuts high frequencies

T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A6 Which of the following would be connected between a transceiver and computer in a packet radio station?**

Terminal node controller



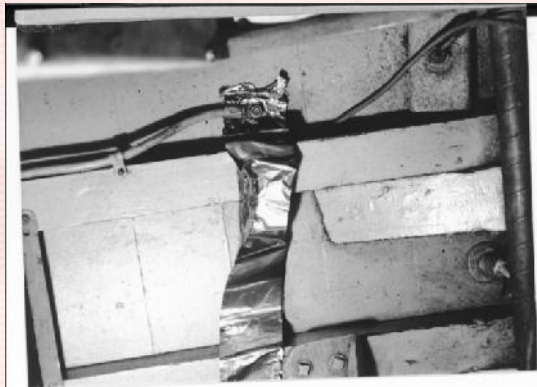
A Packet Radio System.



Some Packet equipment

T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A7 How is the computer's sound card used when conducting digital communications using a computer?** The sound card provides audio to the microphone input and converts received audio to digital form
- **T4A8 Which type of conductor is best to use for RF grounding?**
- Flat strap
 - Offers best surface area
 - Bleed off static and minimize ground currents
 - Straps usually are 3 inches wide
 - Folding okay to snake down to a healthy ground rod



Copper Foil Ground Strap Provides Good Surface Area Ground

T4A: Station setup; microphone, speaker, headphones, filters, power source, connecting a computer, RF grounding

- **T4A9 Which would you use to reduce RF current flowing on the shield of an audio cable? Ferrite choke**

Clam shell iron
devices just snap
on over wiring



- **T4A10 What is the source of a high-pitched whine that varies with engine speed in a mobile transceiver's receive audio? The alternator**
- **T4A11 Where should a mobile transceiver's power negative connection be made? At the battery or engine block ground strap**
 - Ham radio power leads need to be connected directly at the battery source.

T4B: Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

- **T4B1 What may happen if a transmitter is operated with the microphone gain set too high?** The output signal might become distorted
- **T4B2 Which of the following can be used to enter the operating frequency on a modern transceiver?**

The keypad or VFO knob

- **VFO – Variable Frequency Oscillator**



VFO knob



Mic Keypad

T4B: Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

- **T4B3 What is the purpose of the squelch control on a transceiver?**

To mute receiver output noise when no signal is being received

- Squelch control silences the background noise

squelch control



squelch control

- **T4B4 What is a way to enable quick access to a favorite frequency on your transceiver?** Store the frequency in a memory channel



With a transceiver (HT) like one of these, you can hold your ham station in the palm of your hand.

T4B: Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

- **T4B5 Which of the following would reduce ignition interference to a receiver?** Turn on the noise blanker
 - Not on common FM handheld or mobile FM radios
 - On bigger high-frequency, multi-mode transceiver



Even this older Icom 730 has the NB function

PreAmp built in

NB – Noise Blanker

T4B: Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

- **T4B6 Which of the following controls could be used if the voice pitch of a single-sideband signal seems too high or low?**
The receiver RIT or clarifier
- **T4B7 What does the term "RIT" mean?**
Receiver Incremental Tuning



Set knob to neutral, press RIT button to turn on function, and then adjust slightly for proper SSB voice reception

RIT adjusts voice pitch, not the frequency of received station.

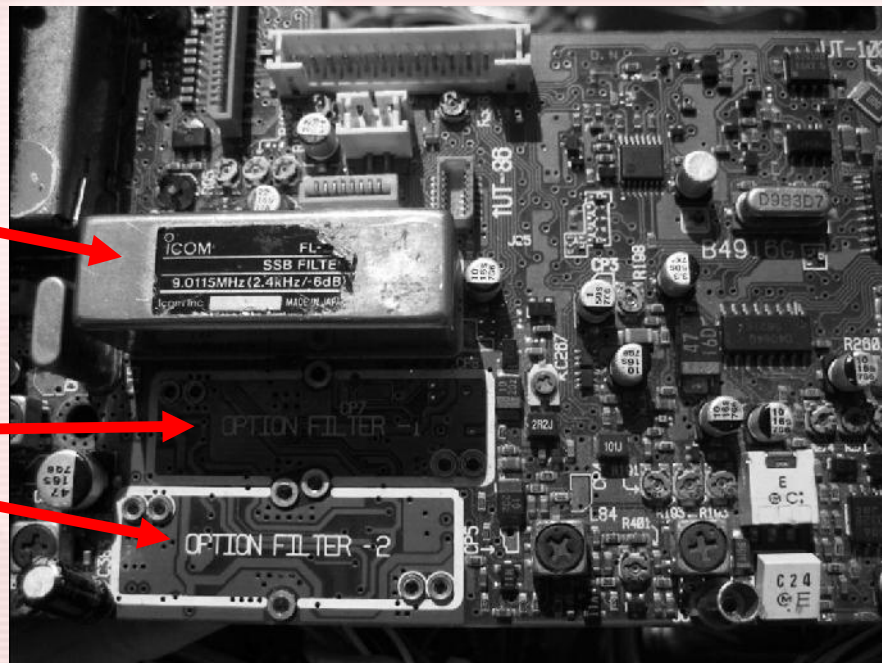
T4B: Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

- **T4B8 What is the advantage of having multiple receive bandwidth choices on a multimode transceiver?** Permits noise or interference reduction by selecting a bandwidth matching the mode
- **T4B9 Which of the following is an appropriate receive filter to select in order to minimize noise and interference for SSB reception?**

2400 Hz

SSB Filter

Slots for
optional filters



Receiver section in a communications transceiver

T4B: Operating controls; tuning, use of filters, squelch, AGC, repeater offset, memory channels

- **T4B10 Which of the following is an appropriate receive filter to select in order to minimize noise and interference for CW reception?**

500 Hz

- Bandwidth filters vary for the mode being received.

- **T4B11 Which of the following describes the common meaning of the term “repeater offset”?**

The difference between the repeater’s transmit and receive frequencies

Technician Licensing Class “T5”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T5A: Electrical principles; current and voltage, conductors and insulators, alternating and direct current

- **T5A1 Electrical current is measured in which of the following units?**
Amperes
- **T5A2 Electrical power is measured in which of the following units?**
Watts The power meter outside is called 'watt meter'
- **T5A3 What is the name for the flow of electrons in an electric circuit?** Current Think of the flow of water in a pipe (not the force)
- **T5A4 What is the name for a current that flows only in one direction?**
Direct current



9 Volt
battery

AAA
battery

Motor cycle
battery

Hand held
battery

T5A: Electrical principles; current and voltage, conductors and insulators, alternating and direct current

- **T5A5 What is the electrical term for the electromotive force (EMF) that causes electron flow? Voltage**
 - Think of voltage as water pressure in the pipes (not the flow)
- **T5A6 How much voltage does a mobile transceiver usually require?**
About 12 volts
- **T5A7 Which of the following is a good electrical conductor?**
Copper
- **T5A8 Which of the following is a good electrical insulator? Glass**



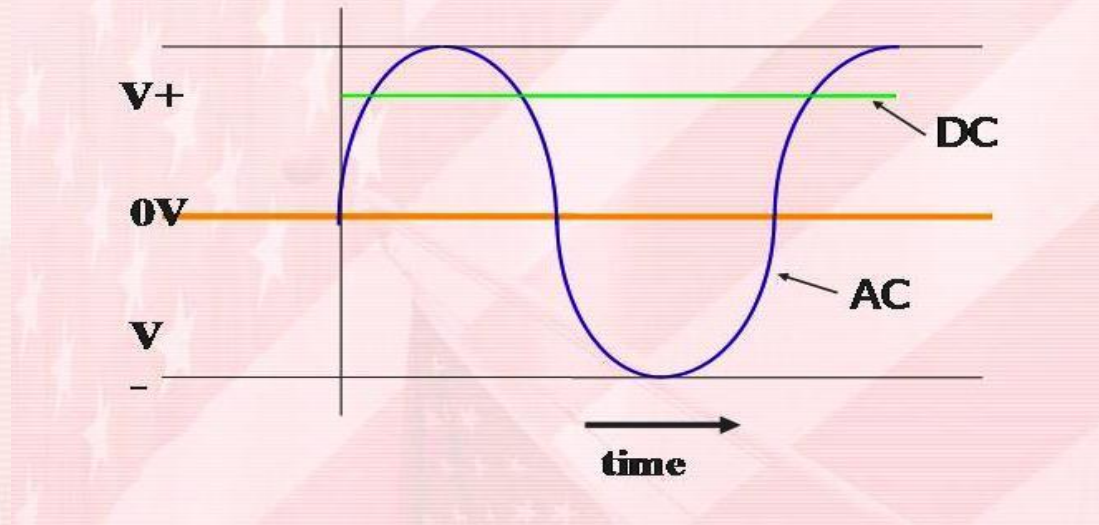
Copper is
a good
conductor



Glass is a
good
insulator

T5A: Electrical principles; current and voltage, conductors and insulators, alternating and direct current

- **T5A9 What is the name for a current that reverses direction on a regular basis?** Alternating current



- **T5A10 Which term describes the rate at which electrical energy is used?** Power
- **T5A11 What is the basic unit of electromotive force?** The volt

T5B: Math for electronics; decibels, electrical units and the metric system

- **T5B1 How many milliamperes is 1.5 amperes?** 1,500 milliamperes
- **T5B2 What is another way to specify a radio signal frequency of 1,500,000 hertz?** 1500 kHz
- **T5B3 How many volts are equal to one kilovolt?** One thousand volts
- **T5B4 How many volts are equal to one microvolt?**
One one-millionth of a volt
- **T5B5 Which of the following is equivalent to 500 milliwatts?** 0.5 watts
- **T5B6 If an ammeter calibrated in amperes is used to measure a 3000-milliamperere current, what reading would it show?** 3 amperes

T5B: Math for electronics; decibels, electrical units and the metric system

Metric	Exponent	English
Tera	10^{12}	Trillion
Giga	10^9	Billion
Mega	10^6	Million
Kilo	10^3	Thousand
Centi	10^{-2}	Hundredth
Milli	10^{-3}	Thousandth
Micro	10^{-6}	Millionth
Nano	10^{-9}	Billionth
Pico	10^{-12}	Trillionth

Scientific Notation

Prefix		Multiplication Factor	Prefix		Multiplication Factor
tera	10^{12}	1,000,000,000,000	deci	10^{-1}	0.1
giga	10^9	1,000,000,000	centi	10^{-2}	0.01
mega	10^6	1,000,000	milli	10^{-3}	0.001
kilo	10^3	1,000	micro	10^{-6}	0.000001
hecto	10^2	100	nano	10^{-9}	0.000000001
deca	10^1	10	pico	10^{-12}	0.000000000001
unit	10^0	1	femto	10^{-15}	0.000000000000001

METRIC PREFIX SCALE

Units used in electronics:

Volt, Amp, Ohm, Watt, Farad, Henry, Hertz



T	G	M	k	UNITS	m	μ	n	p
tera	giga	mega	kilo	-	milli	micro	nano	pico
10¹²	10⁹	10⁶	10³	10⁰	10⁻³	10⁻⁶	10⁻⁹	10⁻¹²



Larger Units
(decimal moves to left)

Smaller Units
(decimal moves to right)

T5B: Math for electronics; decibels, electrical units and the metric system

- **T5B7 If a frequency readout calibrated in megahertz shows a reading of 3.525 MHz, what would it show if it were calibrated in kilohertz?**
- 3525 kHz
- **T5B8 How many microfarads are 1,000,000 picofarads? 1 microfarad**
- **T5B9 What is the approximate amount of change, measured in decibels (dB), of a power increase from 5 watts to 10 watts? 3 dB**

3 dB gain is a double of power

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

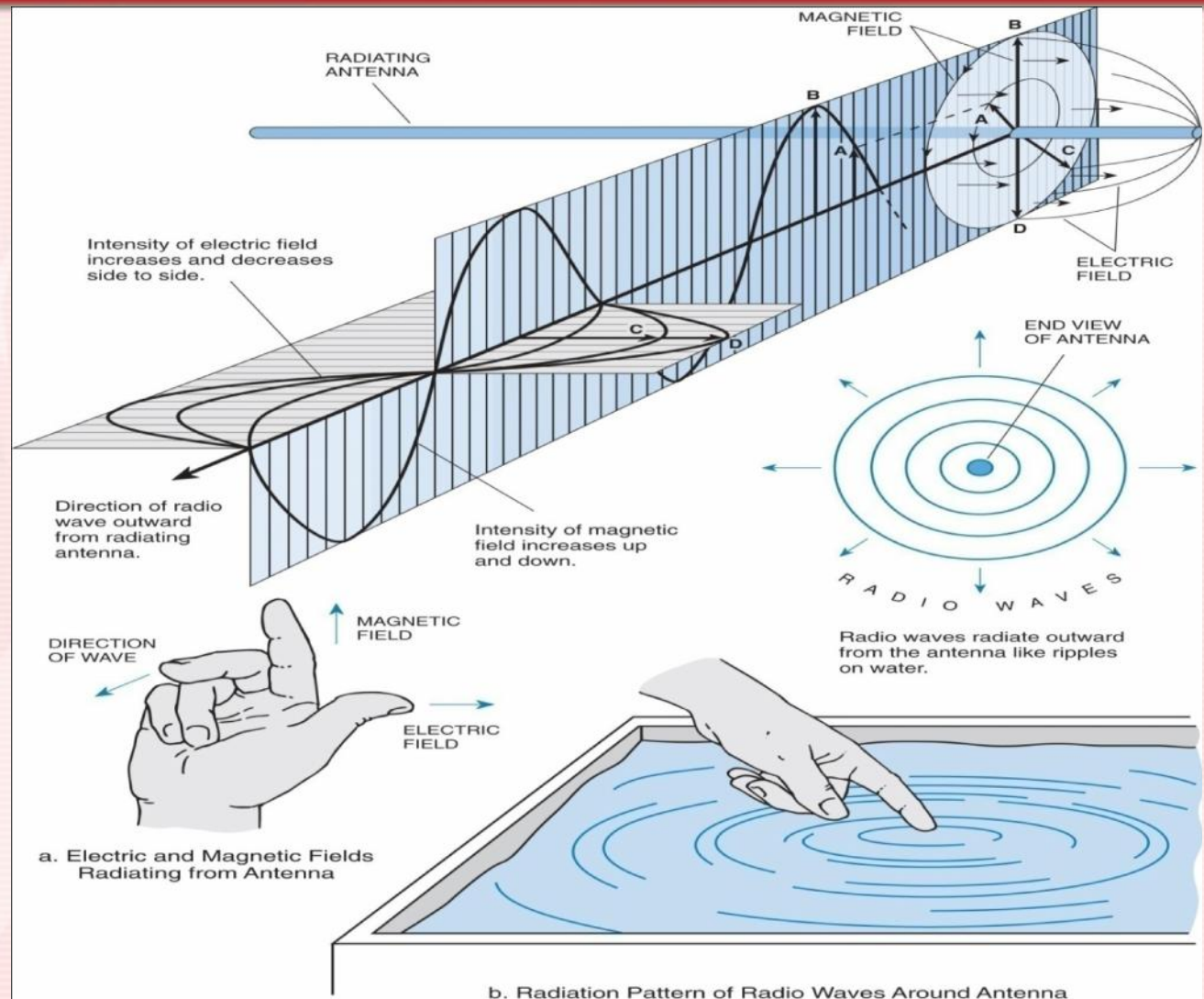
- **T5B10 What is the approximate amount of change, measured in decibels (dB), of a power decrease from 12 watts to 3 watts? 6 dB**
- **T5B11 What is the approximate amount of change, measured in decibels (dB), of a power increase from 20 watts to 200 watts? 10 dB**

T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

- **T5C1 What is the ability to store energy in an electric field called?**
Capacitance
- **T5C2 What is the basic unit of capacitance?** The farad
- **T5C3 What is the ability to store energy in a magnetic field called?**
Inductance
- **T5C4 What is the basic unit of inductance?** The henry
- **T5C5 What is the unit of frequency?** Hertz

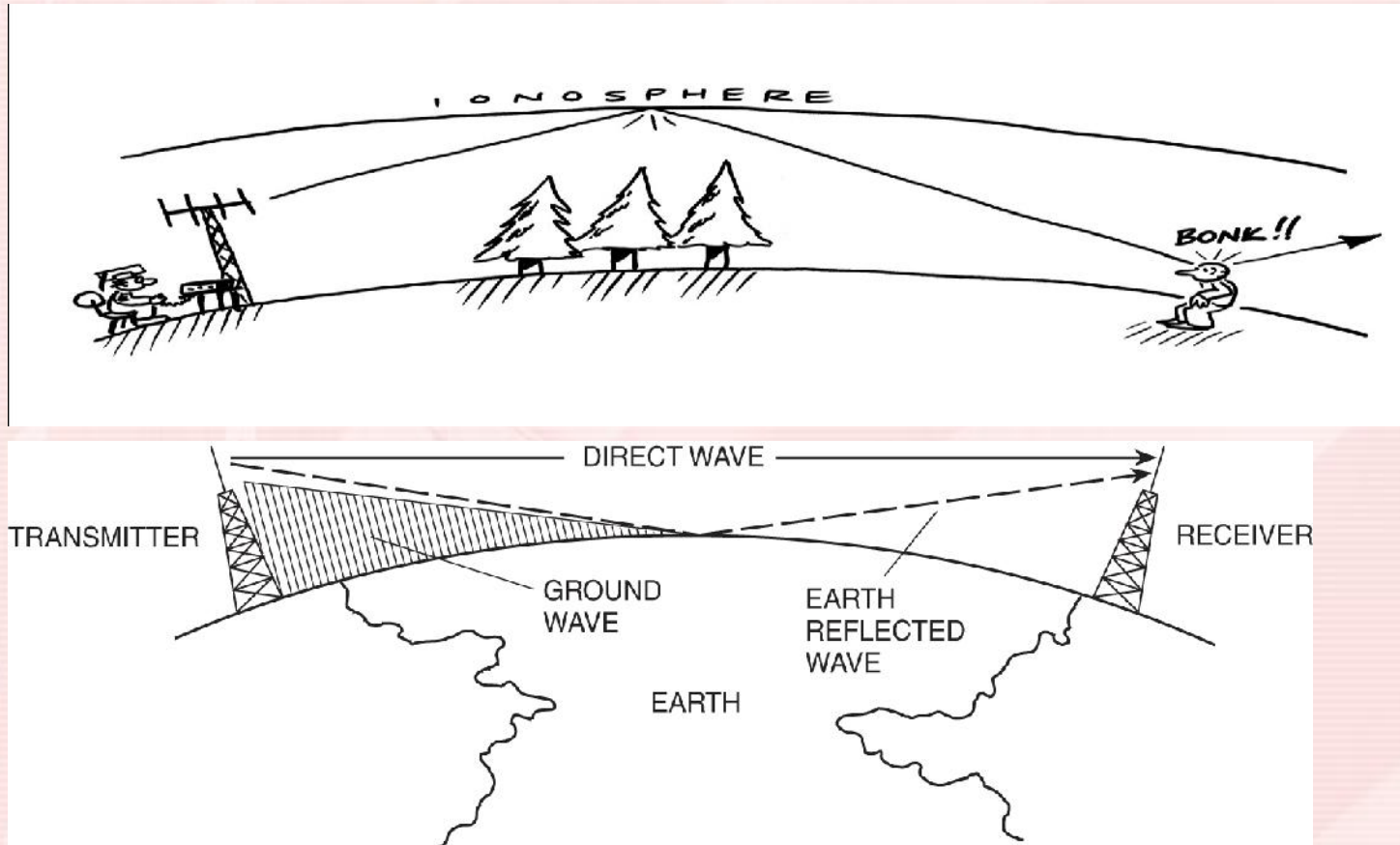
T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

- **T5C6 What is the abbreviation that refers to radio frequency signals of all types? RF**
 - Term “RF” refers to radio frequency



T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

- **T5C7 What is a usual name for electromagnetic waves that travel through space? Radio waves**



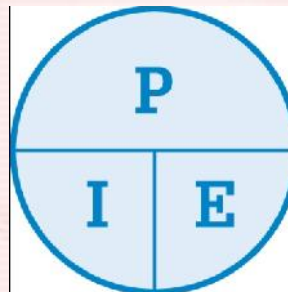
T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

T5C8 What is the formula used to calculate electrical power in a DC circuit?

Power (P) equals voltage (E) multiplied by current (I)

The math is easy

Two known numbers are given, solve for the unknown



Cover up the unknown and plug the numbers in the other two

$$P = I \times E$$

Finding Power

$$I = P / E$$

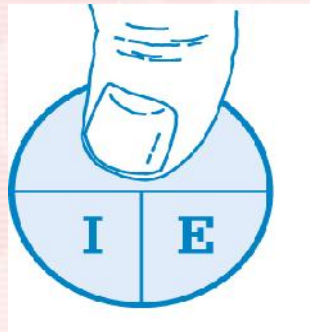
Finding Amperes

$$E = P / I$$

Finding Voltage

T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

- **T5C9 How much power is being used in a circuit when the applied voltage is 13.8 volts DC and the current is 10 amperes? 138 watts**
 - Solving for “P” so cover up the P and plug in the other two numbers
 - **E** is given as 13.8 volts and **I** is given as 10 amperes



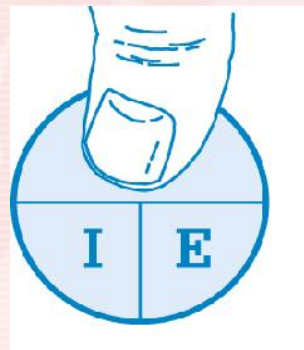
$$P = I \times E$$

$$P = 10 \times 13.8$$

$$P = 138 \text{ watts}$$

T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

- **T5C10 How much power is being used in a circuit when the applied voltage is 12 volts DC and the current is 2.5 amperes? 30 watts**
 - Solving for “P” so cover up the “P” and plug in the other two numbers
 - **E** is given as 12 volts and **I** is given as 2.5 amperes



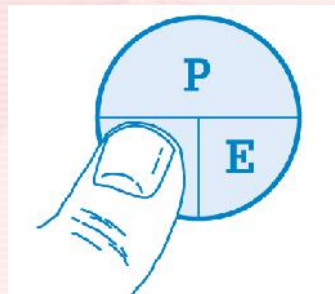
$$P = I \times E$$

$$P = 2.5 \times 12$$

$$P = 30 \text{ watts}$$

T5C: Electronic principles; capacitance, inductance, current flow in circuits, alternating current, definition of RF, power calculations

- **T5C11 How many amperes are flowing in a circuit when the applied voltage is 12 volts DC and the load is 120 watts? 10 amperes**
 - Solving for “I” so cover up the “I” and plug in the other two numbers
 - **P** is given as 120 watts and **E** is given as 12 volts and



$$I = P / E$$

$$I = 120 / 12$$

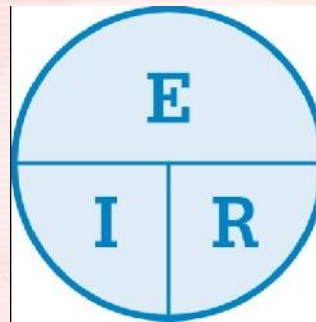
$$I = 10 \text{ Amperes}$$

T5D Ohm's Law

- **T5D1 What formula is used to calculate current in a circuit?**
Current (I) equals voltage (E) divided by resistance (R)
 - **E** is for Voltage, **I** is for current, and **R** is for resistance

The math is easy

Two known
numbers are
given, solve for
the unknown



Cover up the unknown and plug
the numbers in the other two

$$I = E / R$$

Finding Amperes

$$E = I \times R$$

Finding Voltage

$$R = E / I$$

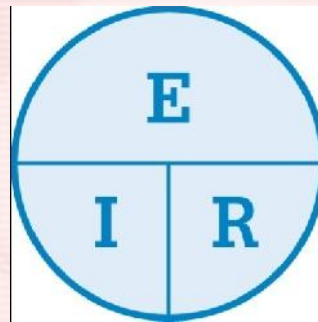
Finding Resistance ¹⁰²

T5D Ohm's Law

- **T5D2 What formula is used to calculate voltage in a circuit?**
Voltage (E) equals current (I) multiplied by resistance (R)
 - **E** is for Voltage, **I** is for current, and **R** is for resistance

The math is easy

Two known
numbers are
given, solve for
the unknown



Cover up the unknown and plug
the numbers in the other two

$$E = I \times R$$

Finding Voltage

$$I = E / R$$

Finding Amperes

$$R = E / I$$

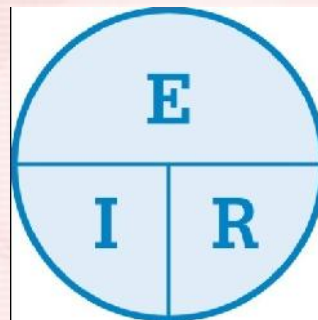
Finding Resistance

T5D Ohm's Law

- **T5D3 What formula is used to calculate resistance in a circuit?**
Resistance (R) equals voltage (E) divided by current (I)
 - **E** is for Voltage, **I** is for current, and **R** is for resistance

The math is easy

Two known
numbers are
given, solve for
the unknown



Cover up the unknown and plug
the numbers in the other two

$$R = E / I$$

Finding Resistance

$$I = E / R$$

Finding Amperes

$$E = I \times R$$

Finding Voltage

T5D Ohm's Law

- **T5D4 What is the resistance of a circuit in which a current of 3 amperes flows through a resistor connected to 90 volts? 30 ohms**
 - Solving for “R” so cover up the “R” and plug in the other two numbers
 - **E** is given as 90 volts and **I** is given as 3 amperes



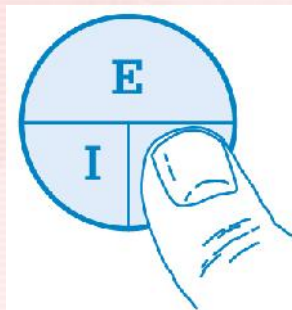
$$R = E / I$$

$$R = 90 / 3$$

$$R = 30 \text{ ohms}$$

T5D Ohm's Law

- **T5D5 What is the resistance in a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes? 8 ohms**
 - Solving for “R” so cover up the “R” and plug in the other two numbers
 - **E** is given as 12 volts and **I** is given as 1.5 amperes



$$R = E / I$$

$$R = 12 / 1.5$$

$$R = 8 \text{ ohms}$$

T5D Ohm's Law

- **T5D6 What is the resistance of a circuit that draws 4 amperes from a 12-volt source? 3 ohms**
 - Solving for “R” so cover up the “R” and plug in the other two numbers
 - **E** is given as 12 volts and **I** is given as 4 amperes



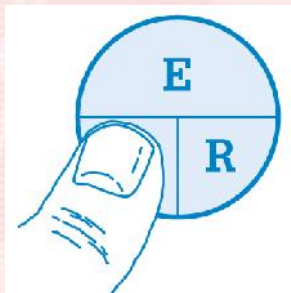
$$R = E / I$$

$$R = 12 / 4$$

$$R = 3 \text{ ohms}$$

T5D Ohm's Law

- **T5D7 What is the current flow in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms? 1.5 amperes**
 - Solving for “I” so cover up the “I” and plug in the other two numbers
 - **E** is given as 120 volts and **R** is given as 80 ohms



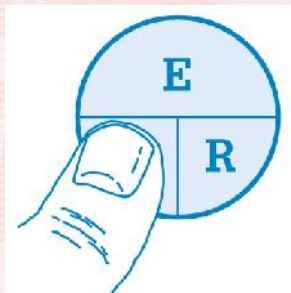
$$I = E / R$$

$$I = 120 / 80$$

$$I = 1.5 \text{ amperes}$$

T5D Ohm's Law

- **T5D8 What is the current flowing through a 100-ohm resistor connected across 200 volts? 2 amperes**
 - Solving for "I" so cover up the "I" and plug in the other two numbers
 - **E** is given as 200 volts and **R** is given as 100 ohms



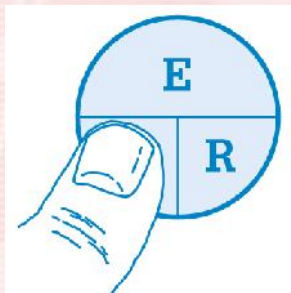
$$I = E / R$$

$$I = 200 / 100$$

$$I = 2 \text{ amperes}$$

T5D Ohm's Law

- **T5D9 What is the current flowing through a 24-ohm resistor connected across 240 volts? 10 amperes**
 - Solving for "I" so cover up the "I" and plug in the other two numbers
 - **E** is given as 240 volts and **R** is given as 24 ohms



$$I = E / R$$

$$I = 240 / 24$$

$$I = 10 \text{ amperes}$$

T5D Ohm's Law

- **T5D10 What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it? 1 volt**
 - Solving for “E” so cover up the “E” and plug in the other two numbers
 - **I** is given as 0.5 amperes and **R** is given as 2 ohms



$$E = I \times R$$

$$E = 0.5 \times 2$$

$$E = 1 \text{ volt}$$

T5D Ohm's Law

- **T5D11 What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it? 10 volts**
 - Solving for “E” so cover up the “E” and plug in the other two numbers
 - **I** is given as 1 ampere and **R** is given as 10 ohms



$$E = I \times R$$

$$E = 1 \times 10$$

$$E = 10 \text{ volts}$$

T5D Ohm's Law

- **T5D12 What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it? 20 volts**
 - Solving for “E” so cover up the “E” and plug in the other two numbers
 - **I** is given as 1 ampere and **R** is given as 10 ohms



$$E = I \times R$$

$$E = 2 \times 10$$

$$E = 20 \text{ volts}$$

Technician Licensing Class “T6”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

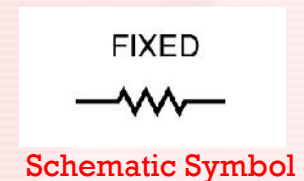
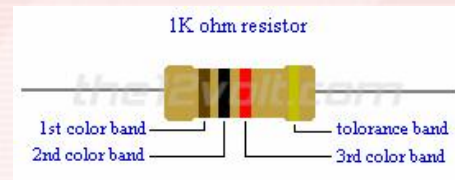
Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

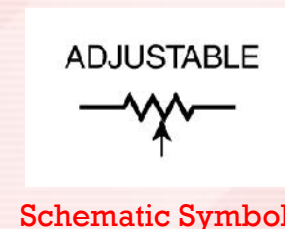
- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T6A: Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

- T6A1 What electrical component is used to oppose the flow of current in a DC circuit? Resistor**



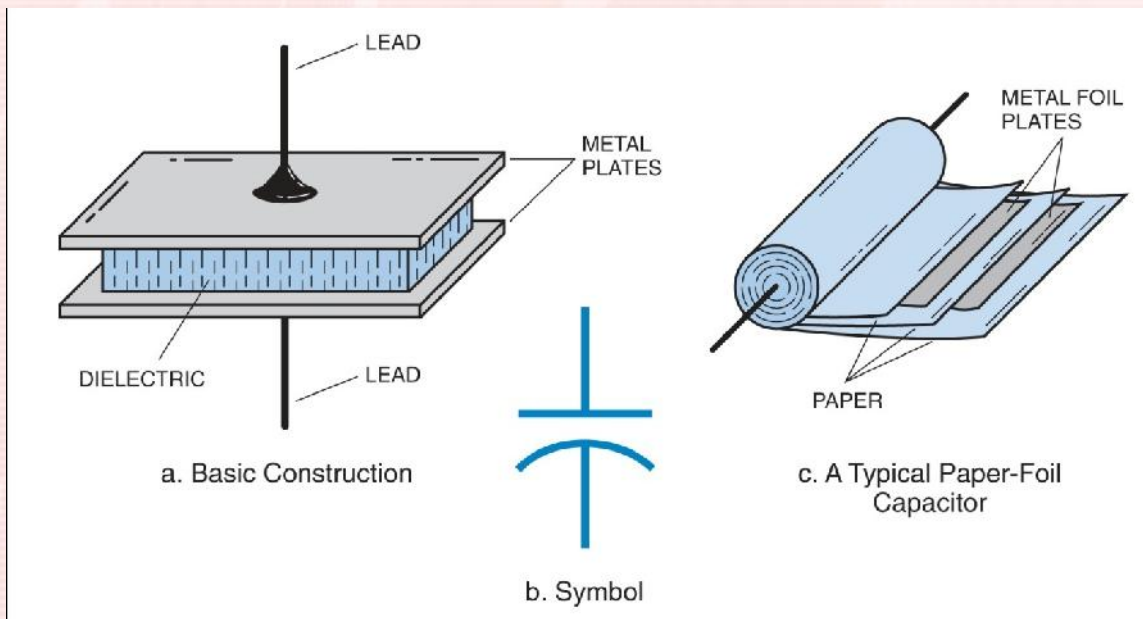
- T6A2 What type of component is often used as an adjustable volume control? Potentiometer**



- T6A3 What electrical parameter is controlled by a potentiometer? Resistance**

T6A: Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

T6A4 What electrical component stores energy in an electric field? Capacitor

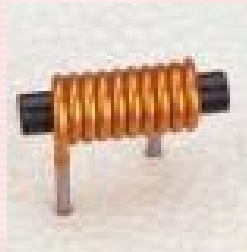


Various fixed capacitors

Typical construction and schematic symbol for capacitors.

T6A: Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

- **T6A05 What type of electrical component consists of two or more conductive surfaces separated by an insulator? Capacitor**
- **T6A6 What type of electrical component stores energy in a magnetic field? Inductor**
- **T6A07 What electrical component is usually composed of a coil of wire? Inductor**



FIXED

VARIABLE

Schematic Symbol

T6A: Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

- **T6A8 What electrical component is used to connect or disconnect electrical circuits? Switch**



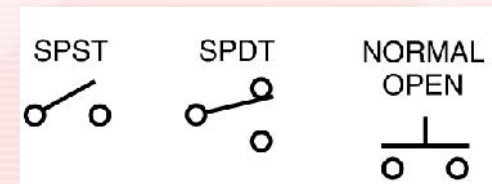
Toggle Switch



Slide Switch



Rocker Switch



Schematic Symbol

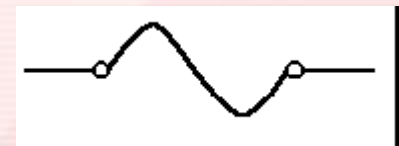
- **T6A9 What electrical component is used to protect other circuit components from current overloads? Fuse**



Slow Blow Fuse



Automobile Fuse



Schematic Symbol

T6A: Electrical components; fixed and variable resistors, capacitors, and inductors; fuses, switches, batteries

- **T6A10 What is the nominal voltage of a fully charged nickel-cadmium cell? 1.2 volts**

Ni-Cad rechargeable
1.25 volt batteries in a
marine hand held.



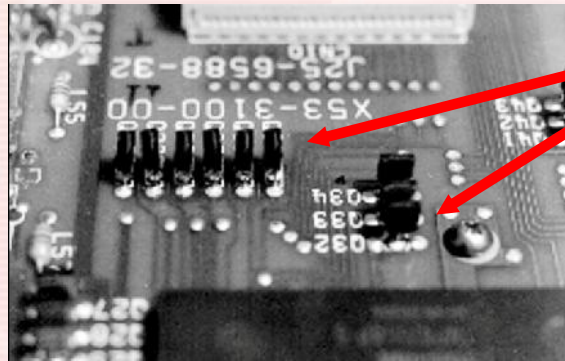
Small and compact
just like Ham Radio
hand helds.

Rubber duck antenna

- **T6A11 Which battery type is not rechargeable? Carbon-zinc**

T6B: Semiconductors; basic principles of diodes and transistors

- **T6B1 What class of electronic components is capable of using a voltage or current signal to control current flow? Transistors**



Rows of Transistors

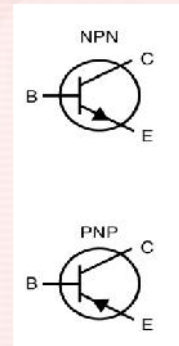
- **T6B2 What electronic component allows current to flow in only one direction? Diode**
 - Rectification is process of changing AC to pulsating DC
 - Diode stops current flow when it tries to go in the reverse direction

T6B: Semiconductors; basic principles of diodes and transistors

- T6B3 Which of these components can be used as an electronic switch or amplifier? Transistor**

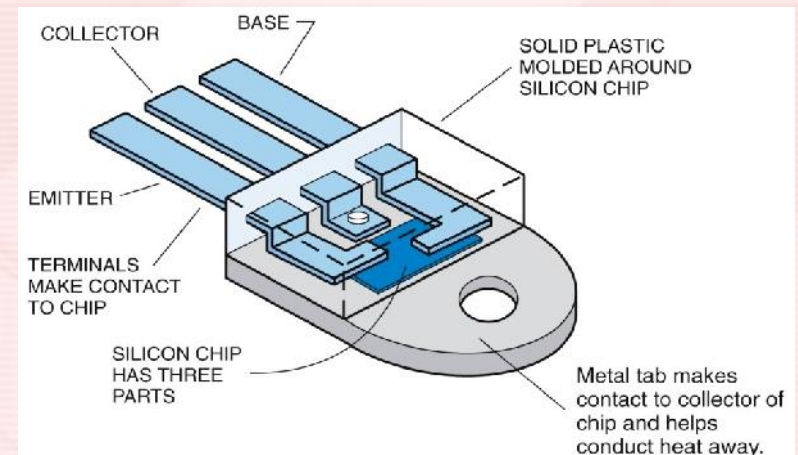
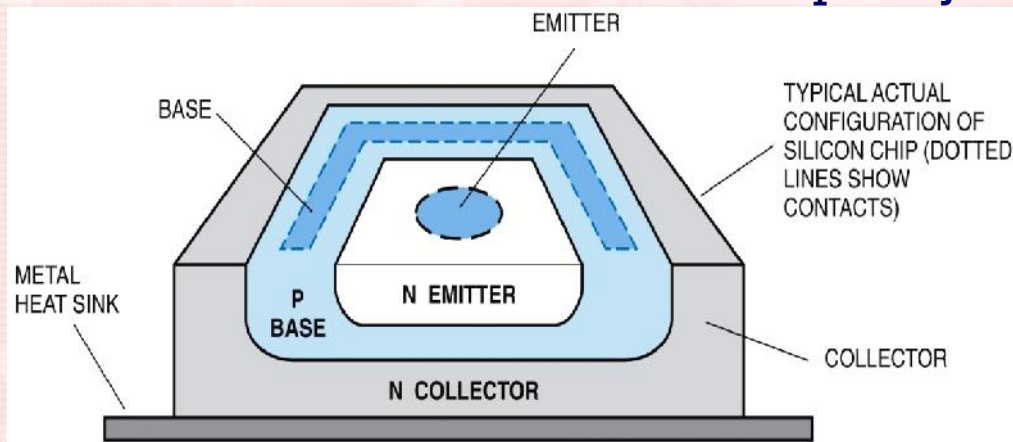


Small Signal Transistors



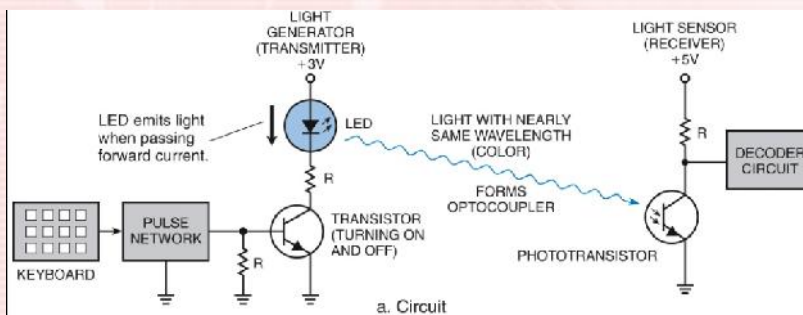
Schematic Symbol

- T6B4 Which of these components is made of three layers of semiconductor material? Bipolar junction transistor**

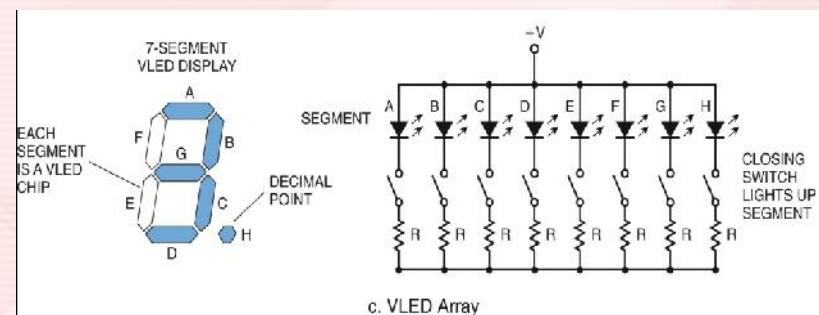


T6B: Semiconductors; basic principles of diodes and transistors

- **T6B5 Which of the following electronic components can amplify signals?**
Transistor
- **T6B6 How is a semiconductor diode's cathode lead usually identified?**
With a stripe
- **T6B7 What does the abbreviation "LED" stand for?** Light Emitting Diode



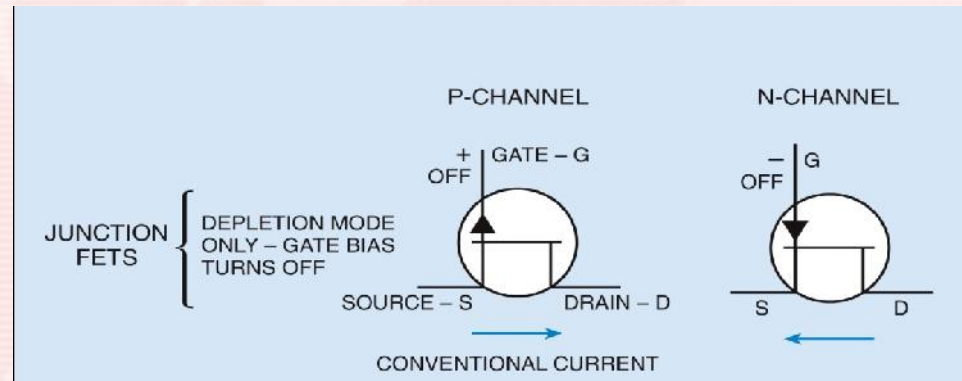
a. Circuit



c. VLED Array

T6B: Semiconductors; basic principles of diodes and transistors

- **T6B8 What does the abbreviation "FET" stand for?** Field Effect Transistor

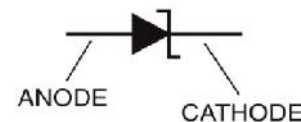


- **T6B9 What are the names of the two electrodes of a diode?** Anode and cathode



Here is the schematic symbol of a diode. Current will only flow ONE WAY in a diode. You can remember this diode diagram as a one-way arrow (key words).

Semiconductor Diode

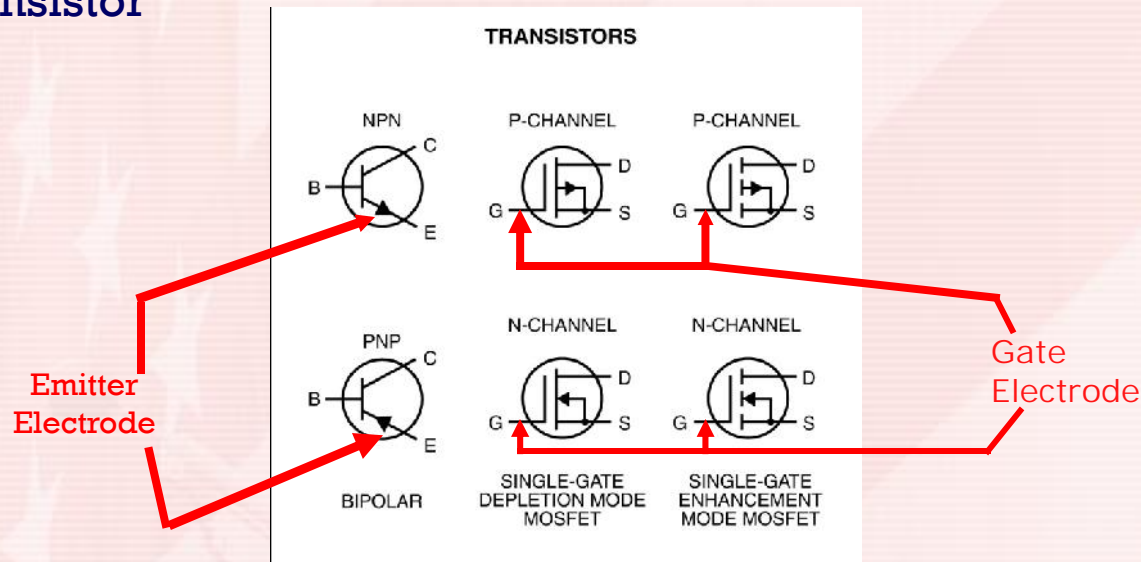


Here is the schematic symbol of a Zener diode. Since a diode only passes energy in one direction, look for that one-way arrow, plus a "Z" indicating it is a Zener diode. Doesn't that vertical line look like a tiny "Z"?

Zener Diode

T6B: Semiconductors; basic principles of diodes and transistors

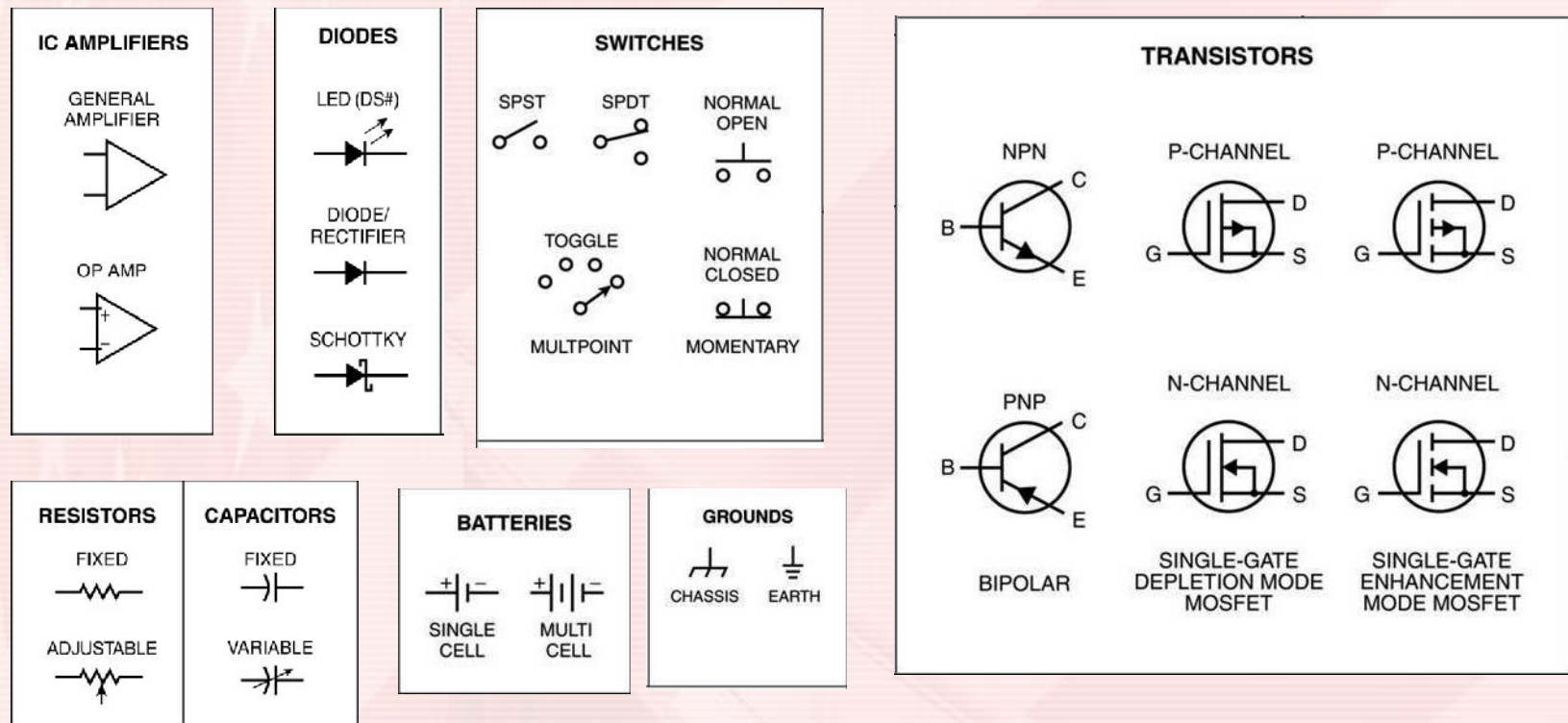
- **T6B10 Which semiconductor component has an emitter electrode?**
Bipolar transistor



- **T6B11 Which semiconductor component has a gate electrode?**
Field effect transistor
- **T6B12 What is the term that describes a transistor's ability to amplify a signal?** Gain

T6C: Circuit diagrams; schematic symbols

- T6C1 What is the name for standardized representations of components in an electrical wiring diagram? Schematic symbols**



T6C: Circuit diagrams; schematic symbols

T6C2 What is component 1 in figure T1? Resistor

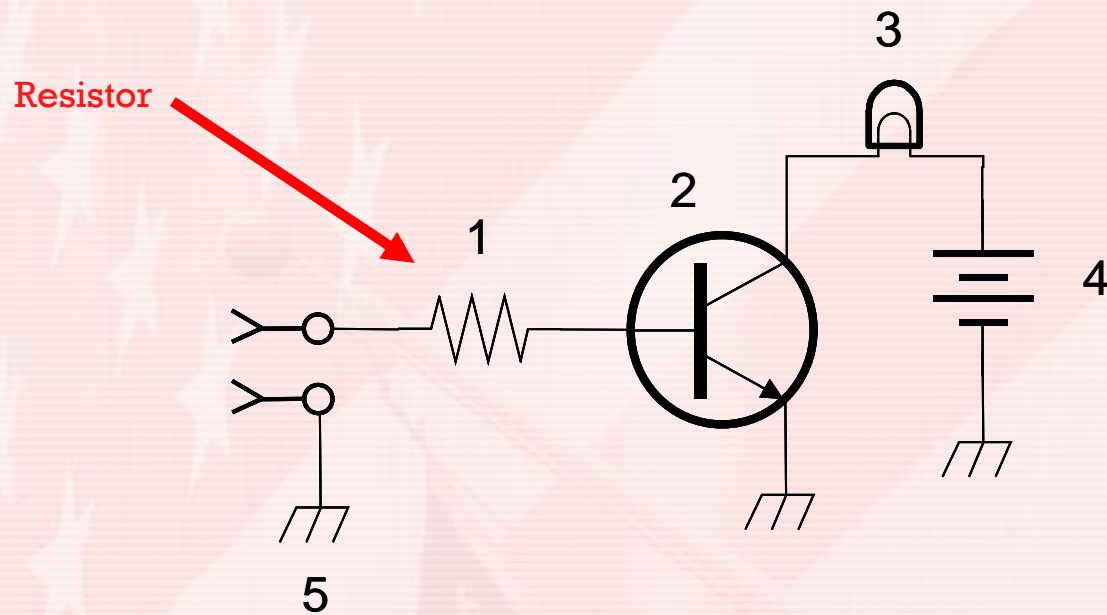


Figure T1

T6C: Circuit diagrams; schematic symbols

- **T6C3 What is component 2 in figure T1? Transistor**

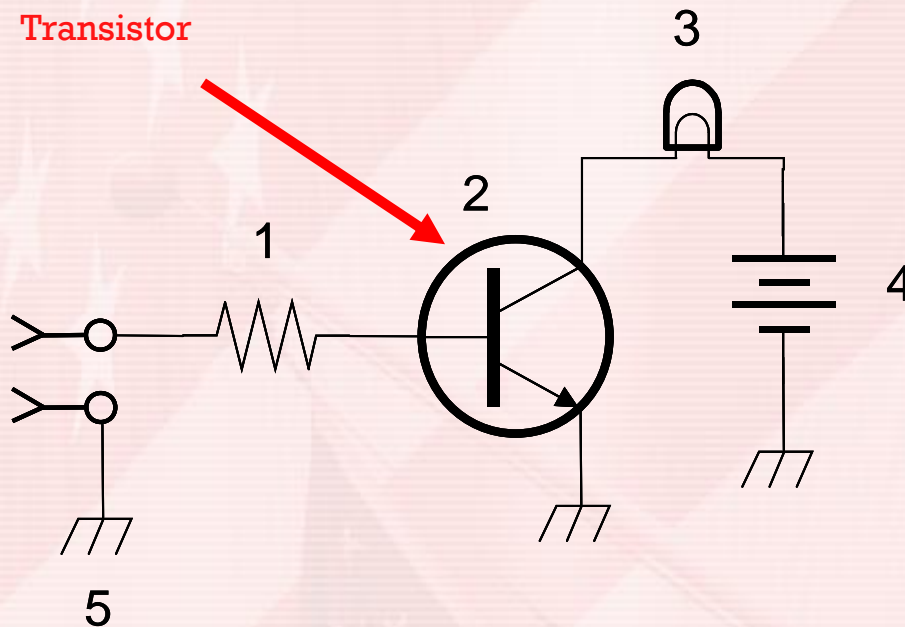
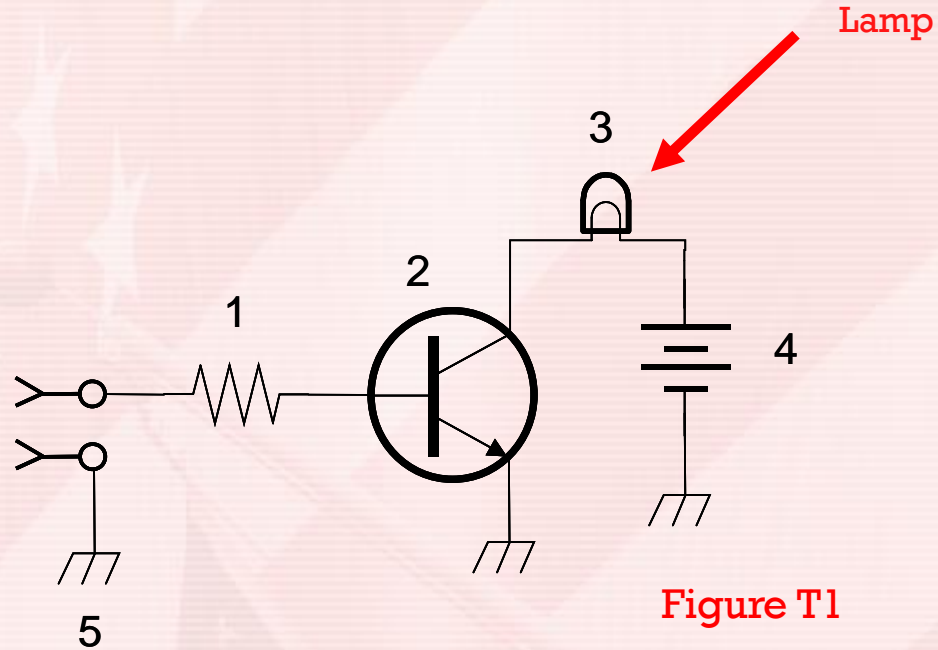


Figure T1

T6C: Circuit diagrams; schematic symbols

- **T6C4 What is component 3 in figure T1? Lamp**



T6C: Circuit diagrams; schematic symbols

- **T6C5 What is component 4 in figure T1? Battery**

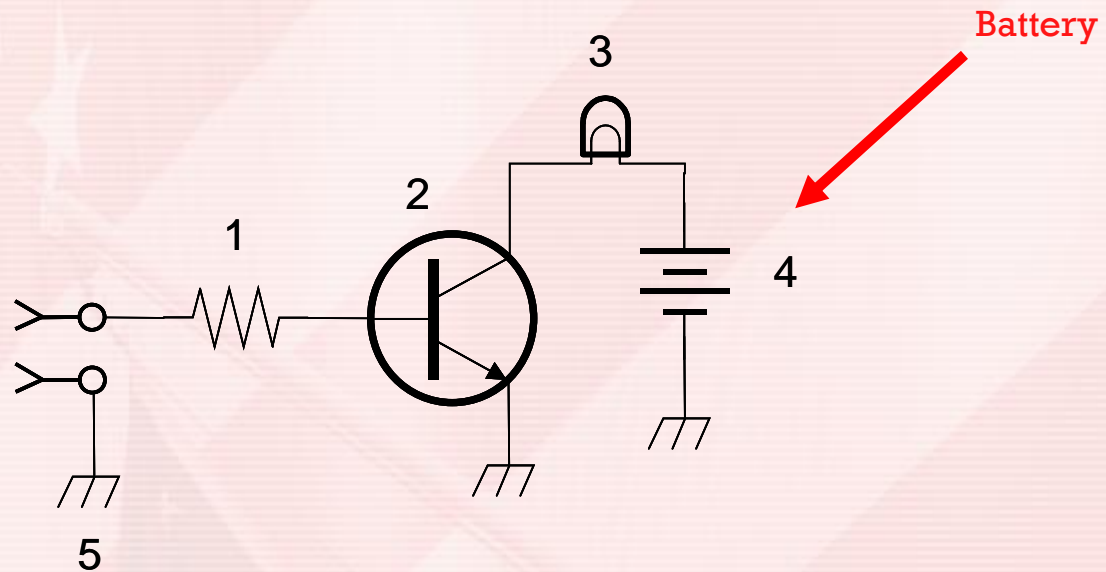


Figure T1

T6C: Circuit diagrams; schematic symbols

- **T6C6 What is component 6 in figure T2? Capacitor**

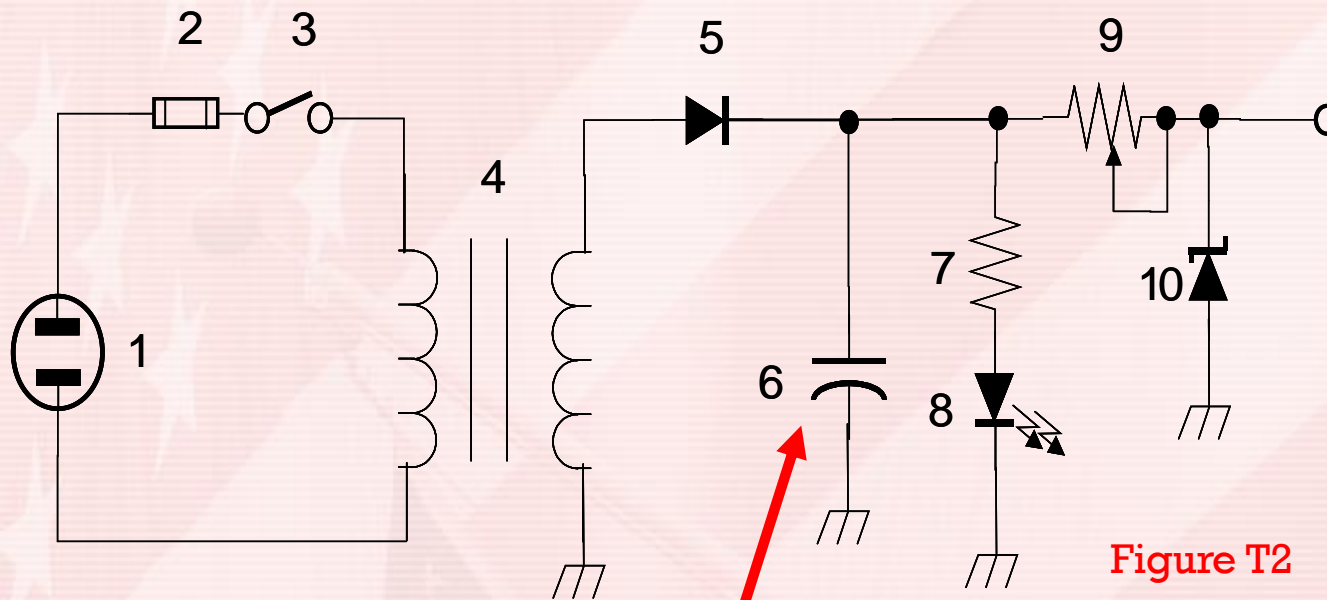


Figure T2

T6C: Circuit diagrams; schematic symbols

- **T6C7 What is component 8 in figure T2?** Light emitting diode

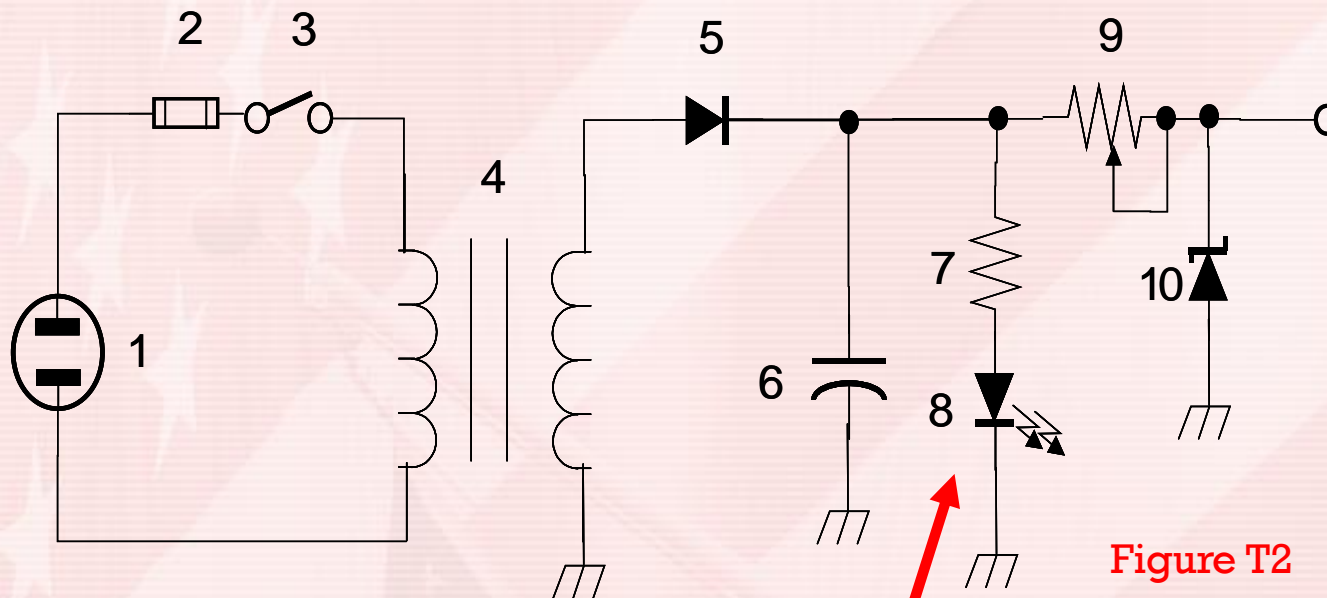
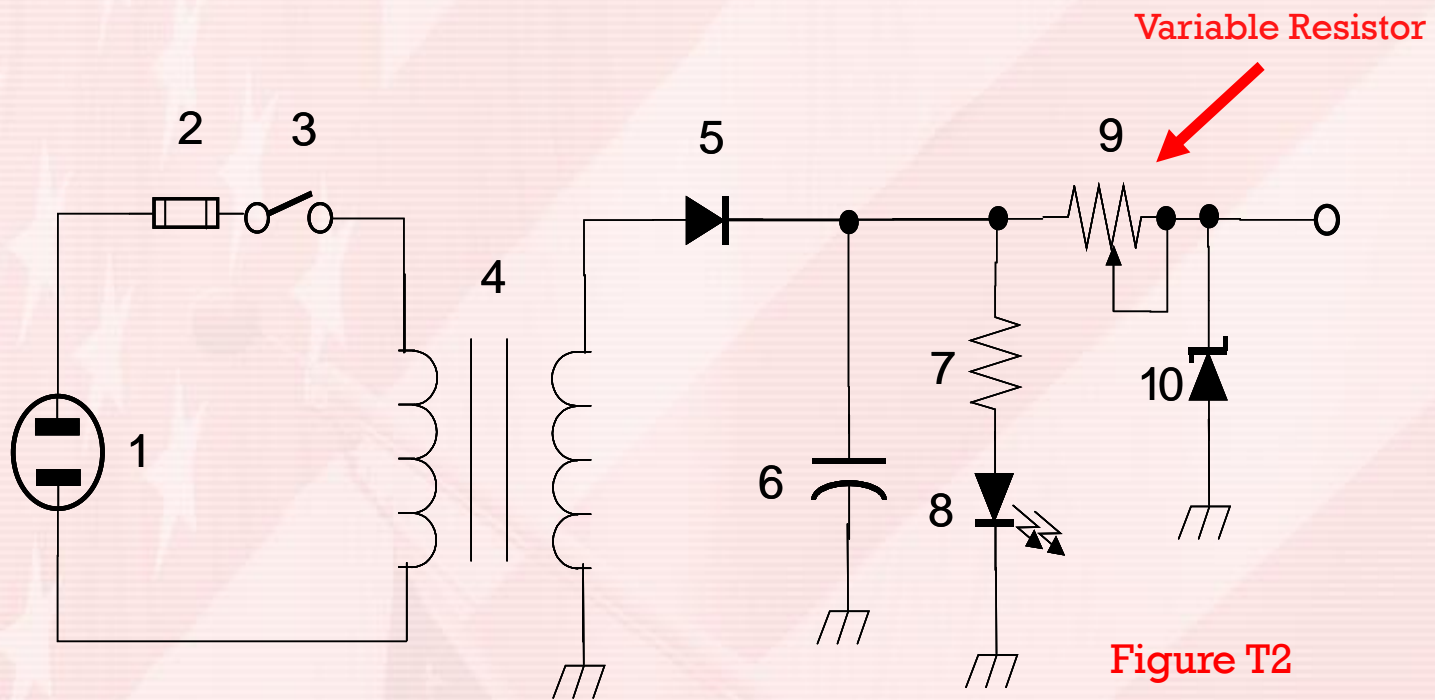


Figure T2

Light Emitting Diode

T6C: Circuit diagrams; schematic symbols

- **T6C8 What is component 9 in figure T2?** Variable resistor



T6C: Circuit diagrams; schematic symbols

- **T6C9 What is component 4 in figure T2?** Transformer

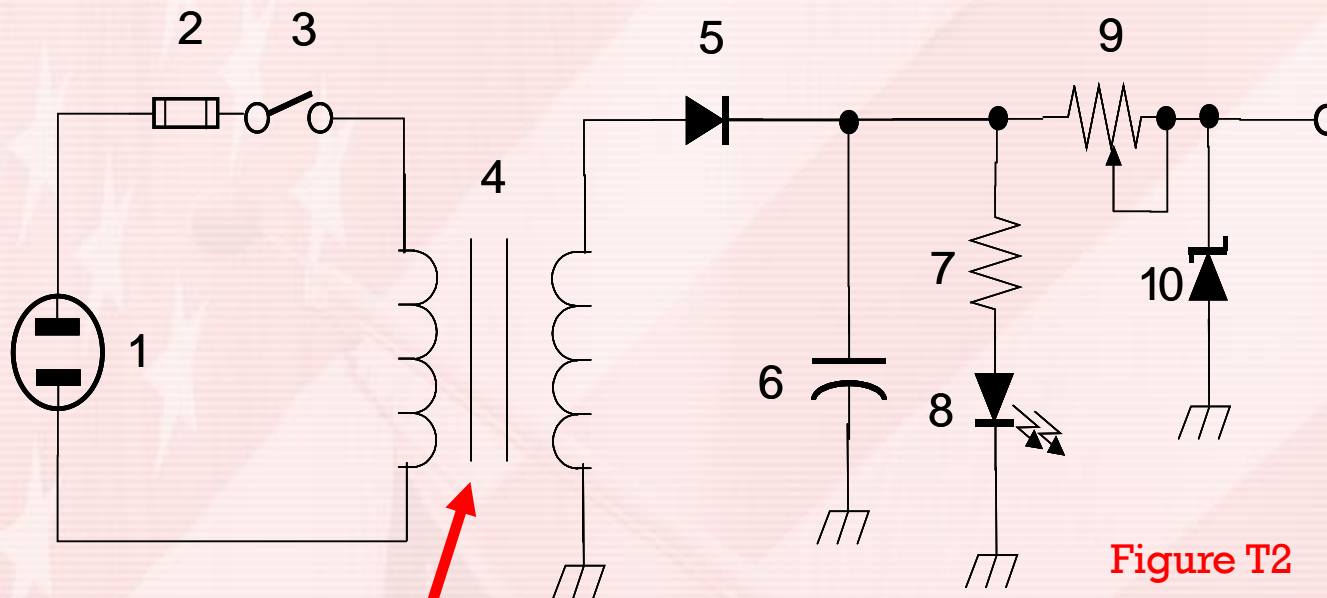
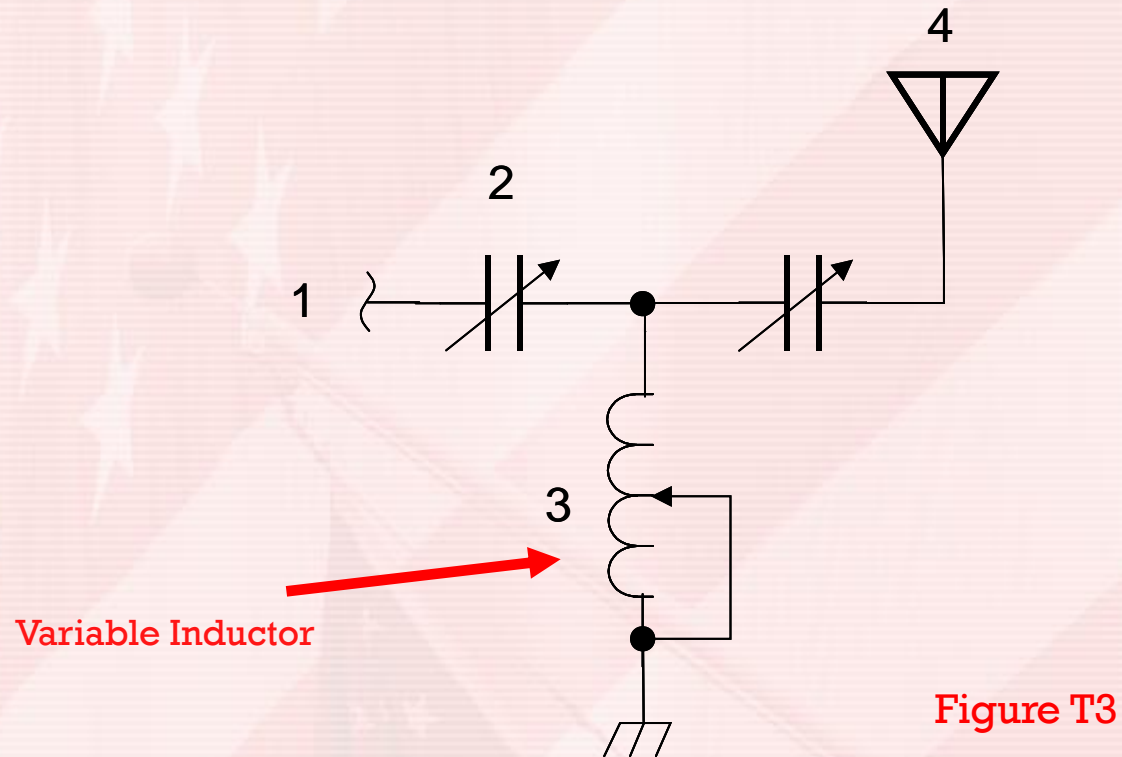


Figure T2

Transformer

T6C: Circuit diagrams; schematic symbols

- **T6C10 What is component 3 in figure T3?** Variable inductor



T6C: Circuit diagrams; schematic symbols

- **T6C11 What is component 4 in figure T3? Antenna**

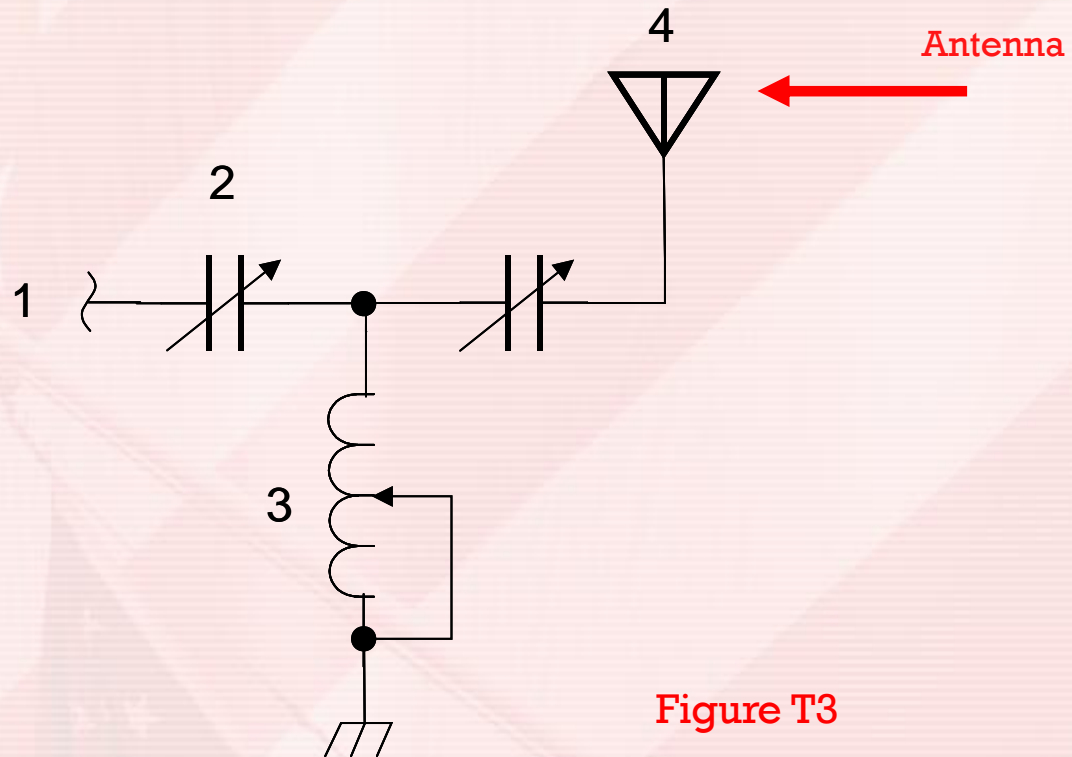
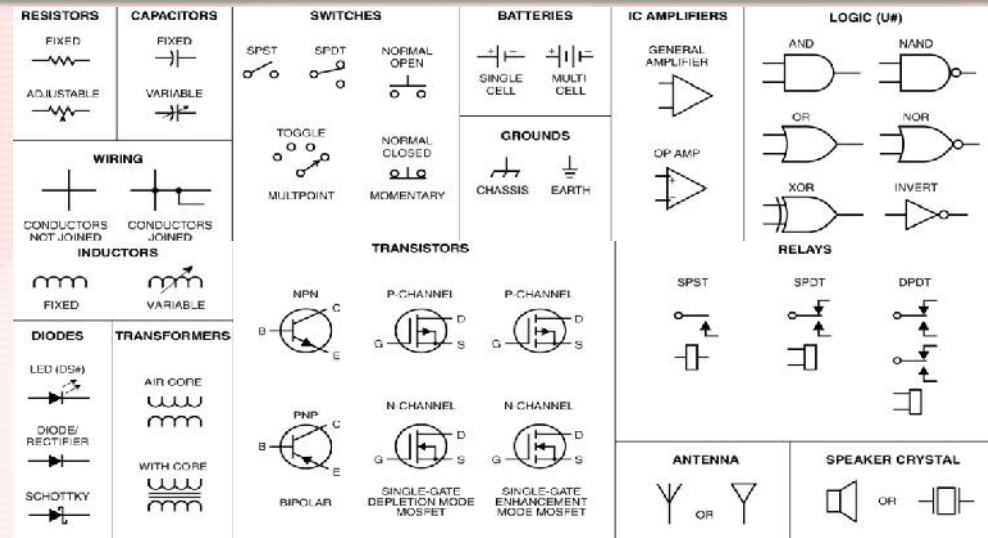


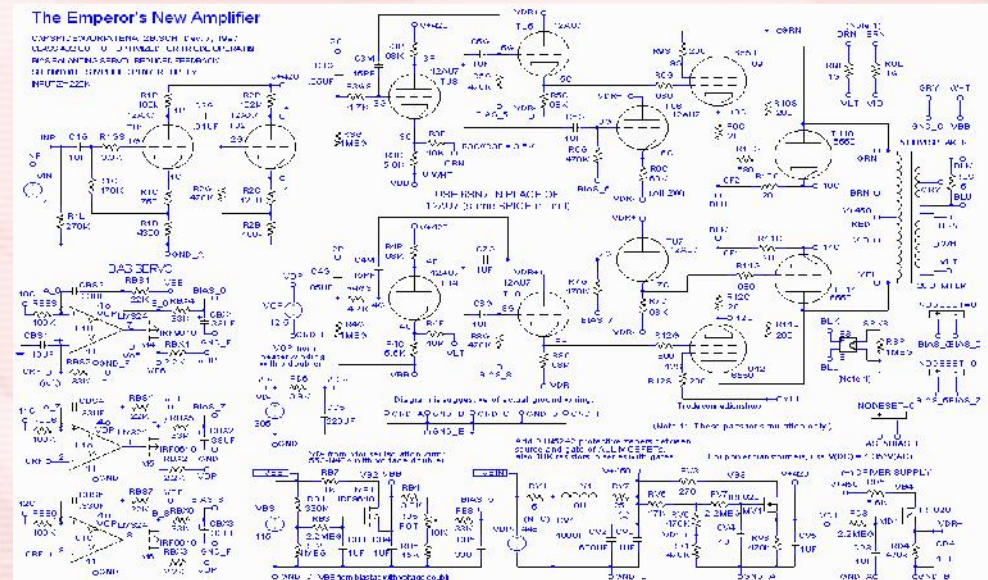
Figure T3

T6C: Circuit diagrams; schematic symbols

- **T6C12 What do the symbols on an electrical circuit schematic diagram represent?**
Electrical components

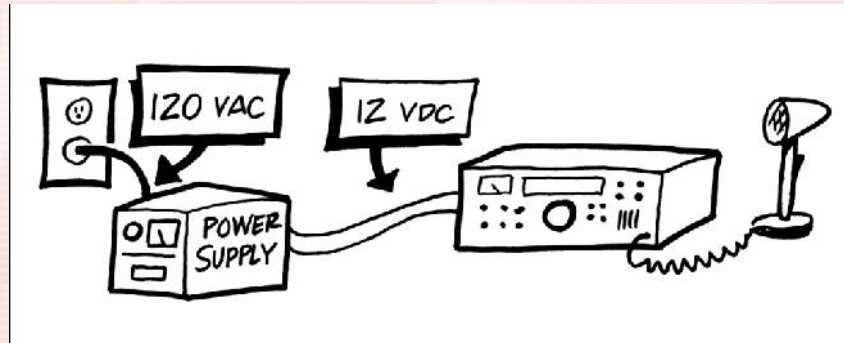


- **T6C13 Which of the following is accurately represented in electrical circuit schematic diagrams?**
- The way components are interconnected



T6D: Component functions

- **T6D1 Which of the following devices or circuits changes an alternating current into a varying direct current signal? Rectifier**



Power supply contains: Transformer, rectifier (diodes), filter choke, capacitors, and regulators.

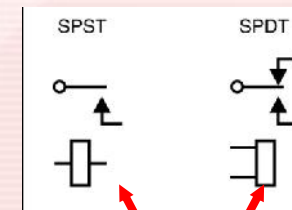
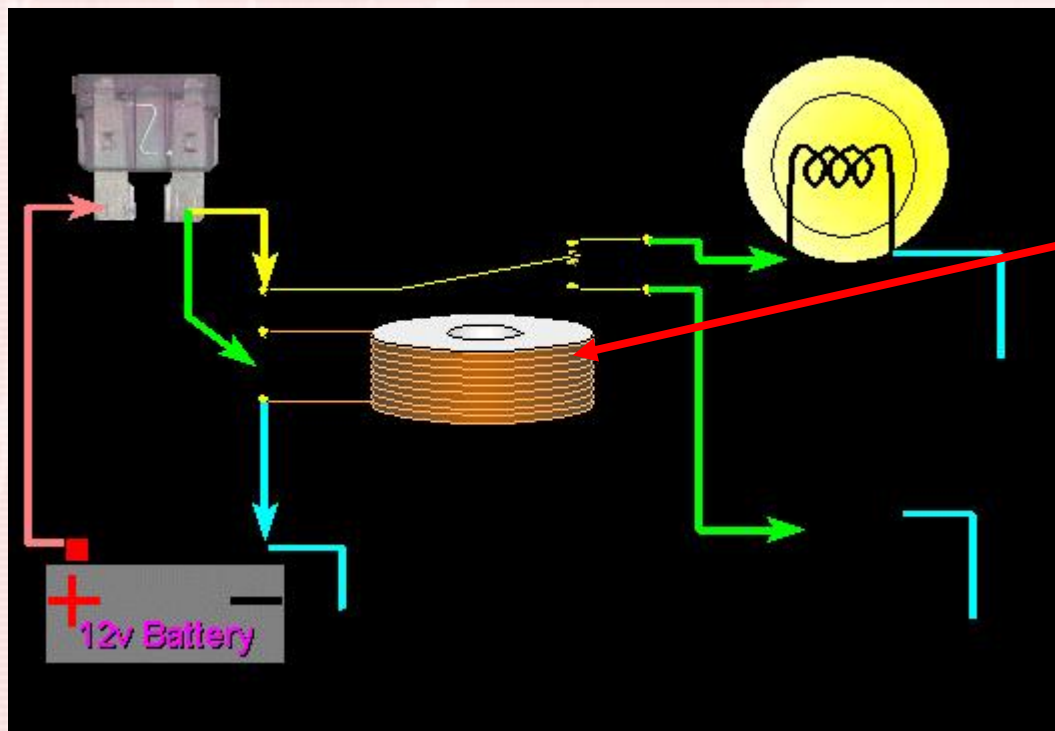
This circuitry converts the house 120 VAC to varying DC and that is filtered and smoothed out to produce DC current that we need for our ham radio equipment.

T6D: Component functions

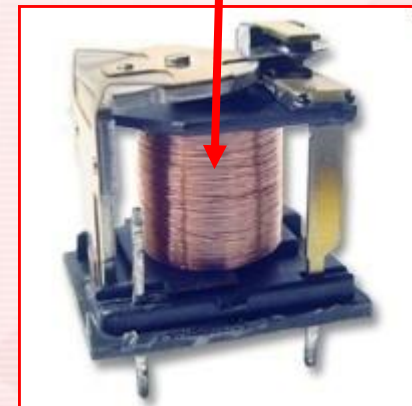
T6D2 What best describes a relay?

A switch controlled by an electromagnet

Relays

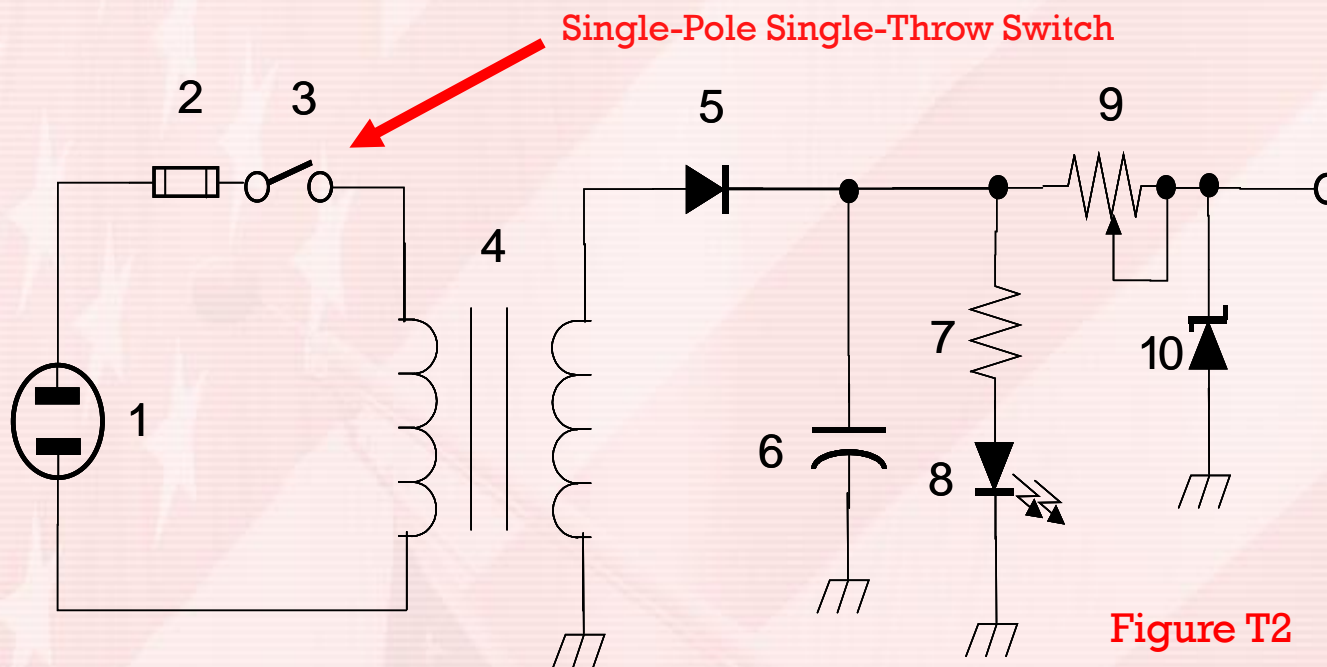


Electromagnets



T6D: Component functions

- T6D3 What type of switch is represented by item 3 in figure T2?**
Single-pole single-throw



T6D: Component functions

- **T6D4 Which of the following can be used to display signal strength on a numeric scale? Meter**



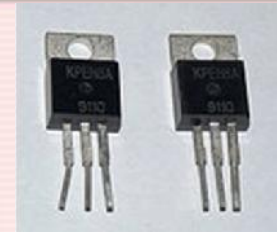
S-Meter



Icom 7700

T6D: Component functions

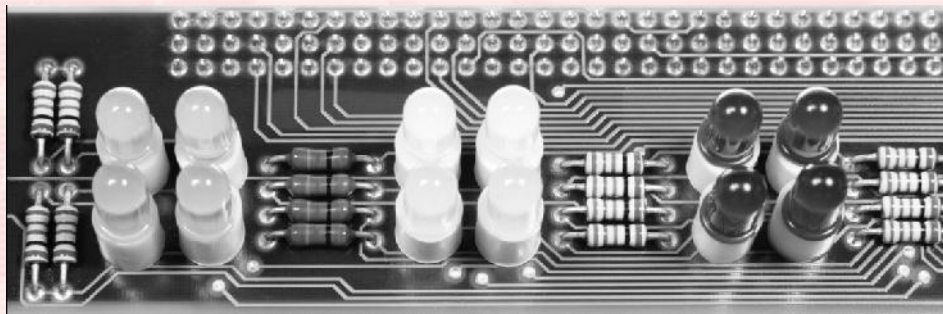
- **T6D5 What type of circuit controls the amount of voltage from a power supply? Regulator**
- **T6D6 What component is commonly used to change 120V AC house current to a lower AC voltage for other uses? Transformer**
- **T6D7 Which of the following is commonly used as a visual indicator? LED**



Voltage Regulators



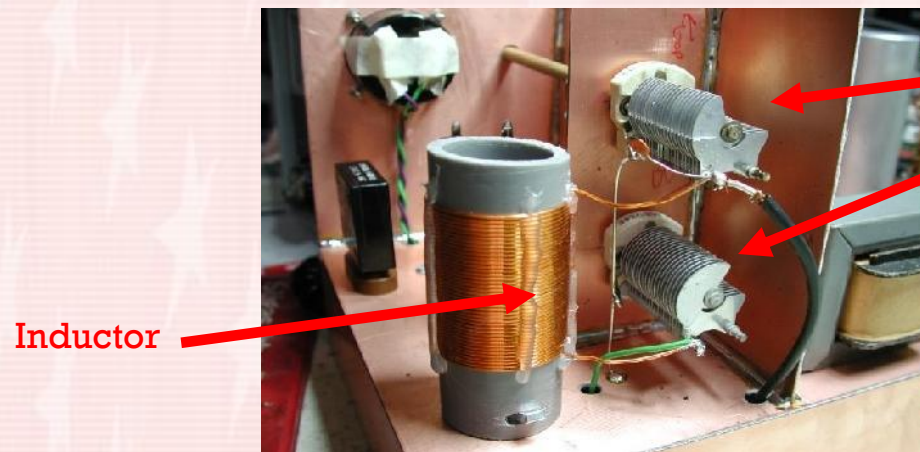
Voltage Transformer



An array of LEDs and resistors mounted on a printed circuit board

T6D: Component functions

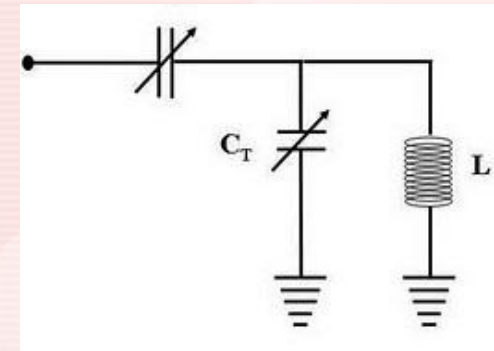
- **T6D8 Which of the following is used together with an inductor to make a tuned circuit? Capacitor**



Inductor

Capacitor (variable)

Tank Circuit or Tuned Circuit

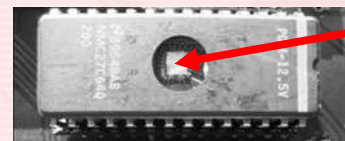


Tank Circuit Schematic

T6D09 What is the name of a device that combines several semiconductors and other components into one package?

Integrated circuit

Large-scale integrated circuit chip



T6D: Component functions

- **T6D10 What is the function of component 2 in Figure T1?**
- Control the flow of current

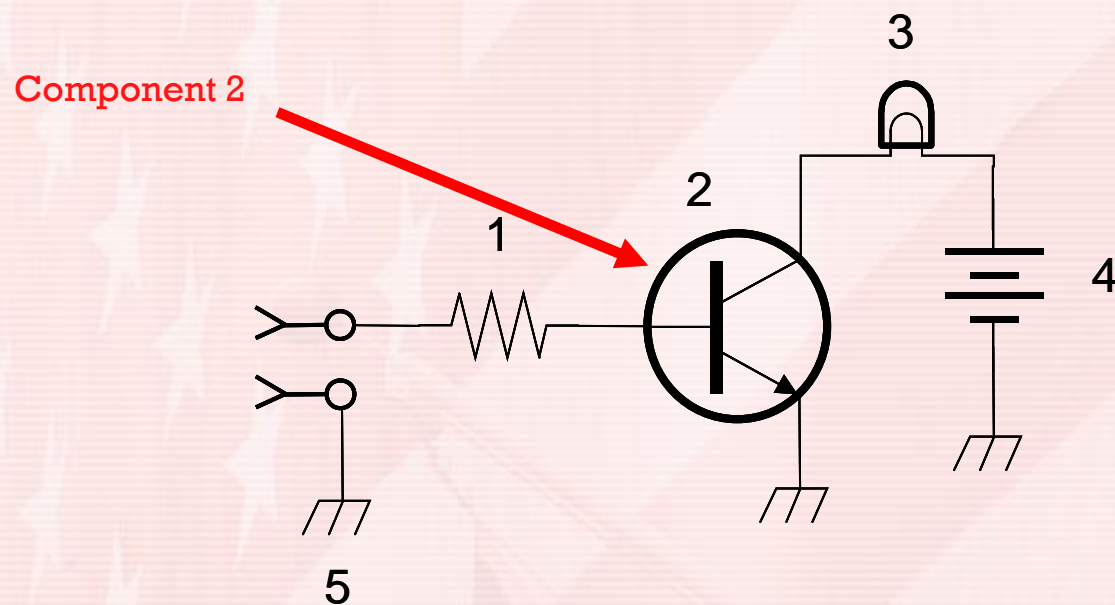


Figure T1

- **T6D11 Which of the following is a common use of coaxial cable?**
Carry RF signals between a radio and antenna

Technician Licensing Class “T7”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A1 What is the function of a product detector?** Detect CW and SSB signals
 - Block 1 as a product detector will detect CW and SSB

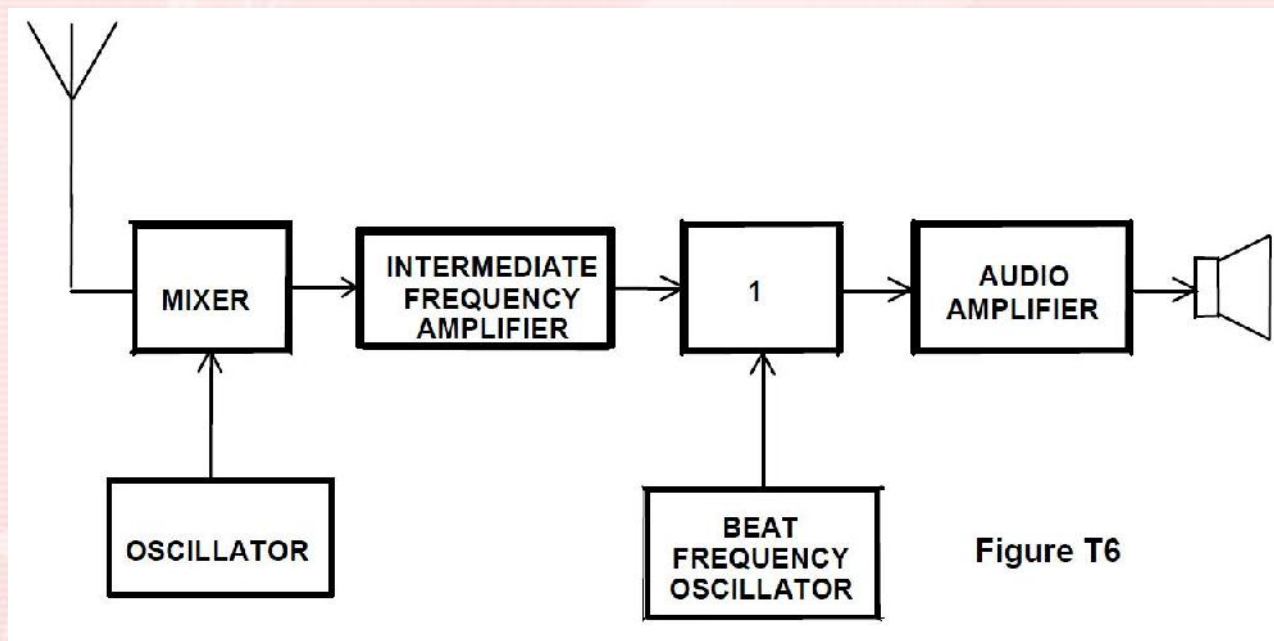


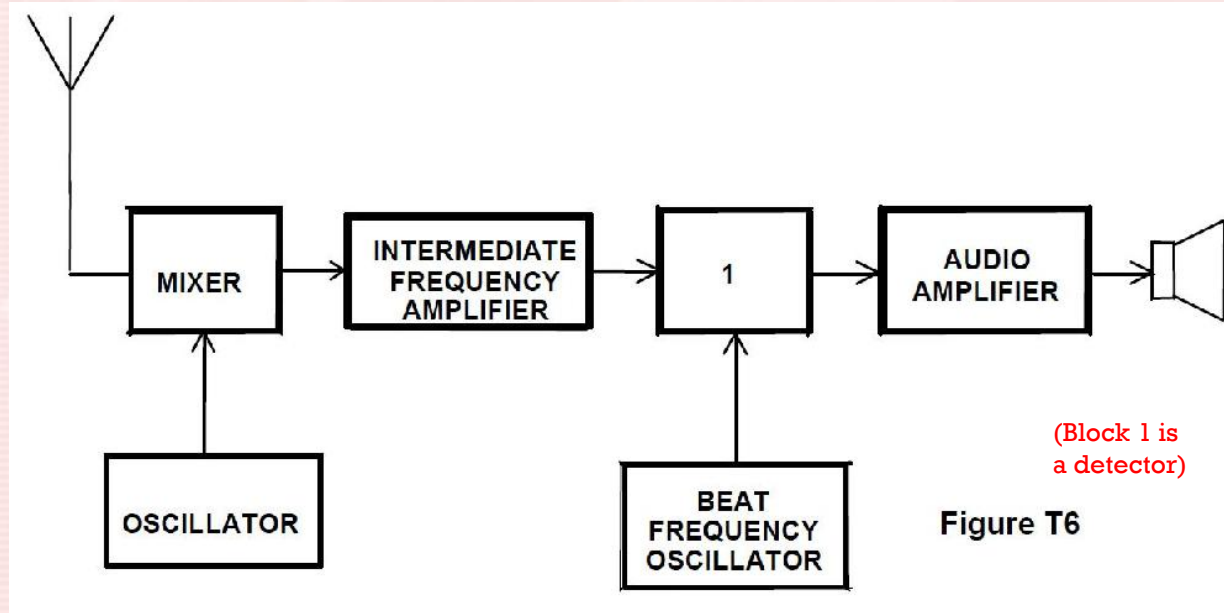
Figure T6

- A Product detector is necessary in a simple Morse code (CW) and single-sideband (SSB) receiver.

T7A: Station radios; receivers, transmitters, transceivers.

T7A2 What type of receiver is shown in Figure T6?

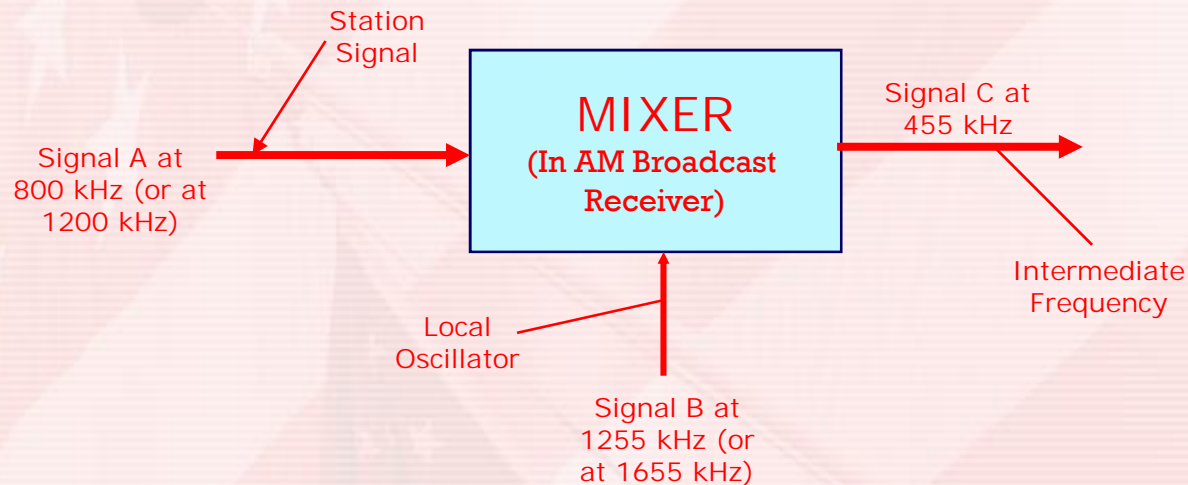
Single-conversion superheterodyne



- Single-conversion superhet has only one IF amplifier.

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A3 What is the function of a mixer in a superheterodyne receiver?**
To shift the incoming signal to an intermediate frequency
 - Usually referred to as “ I F “



Block Diagram of an AM Broadcast Receiver Mixer

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A4 What circuit is pictured in Figure T7, if block 1 is a frequency discriminator?** An FM receiver
 - Recovers information contained in the incoming signal
 - Also referred to as a demodulator

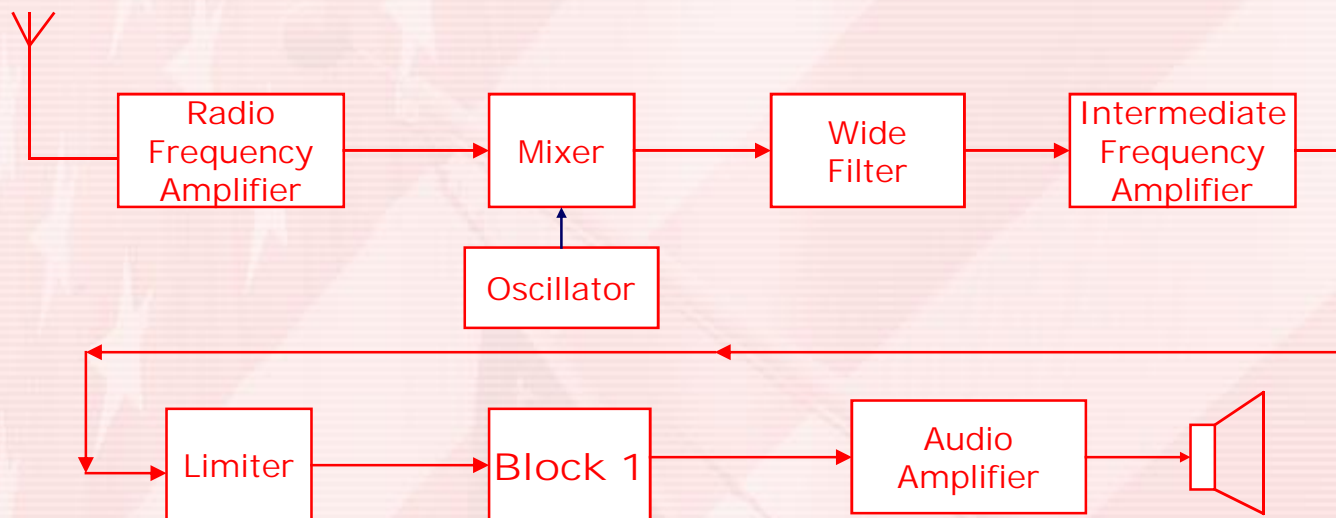


Figure T7

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A5 What is the function of block 1 if figure T4 is a simple CW transmitter? Oscillator**

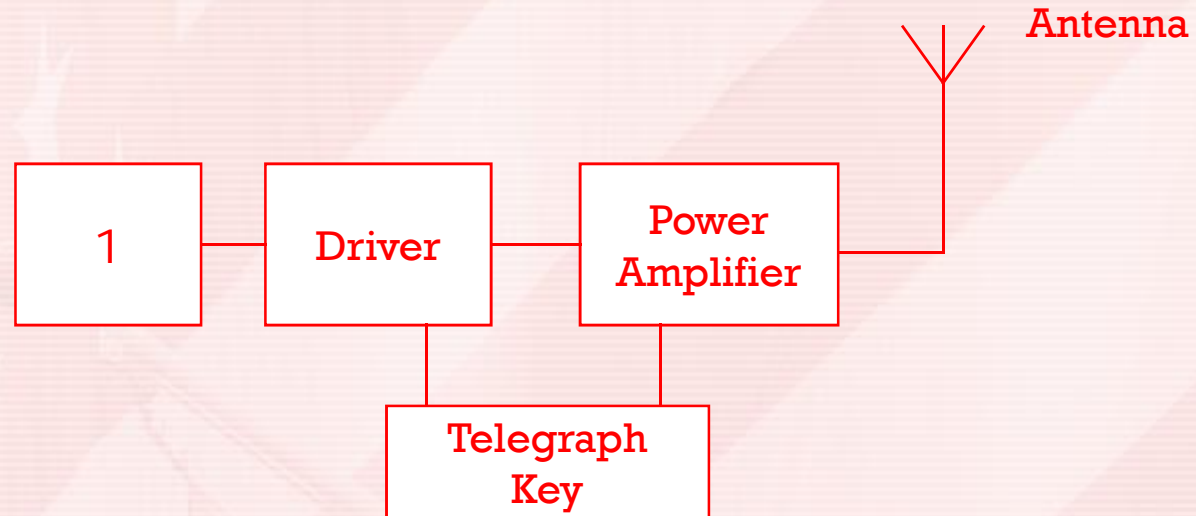
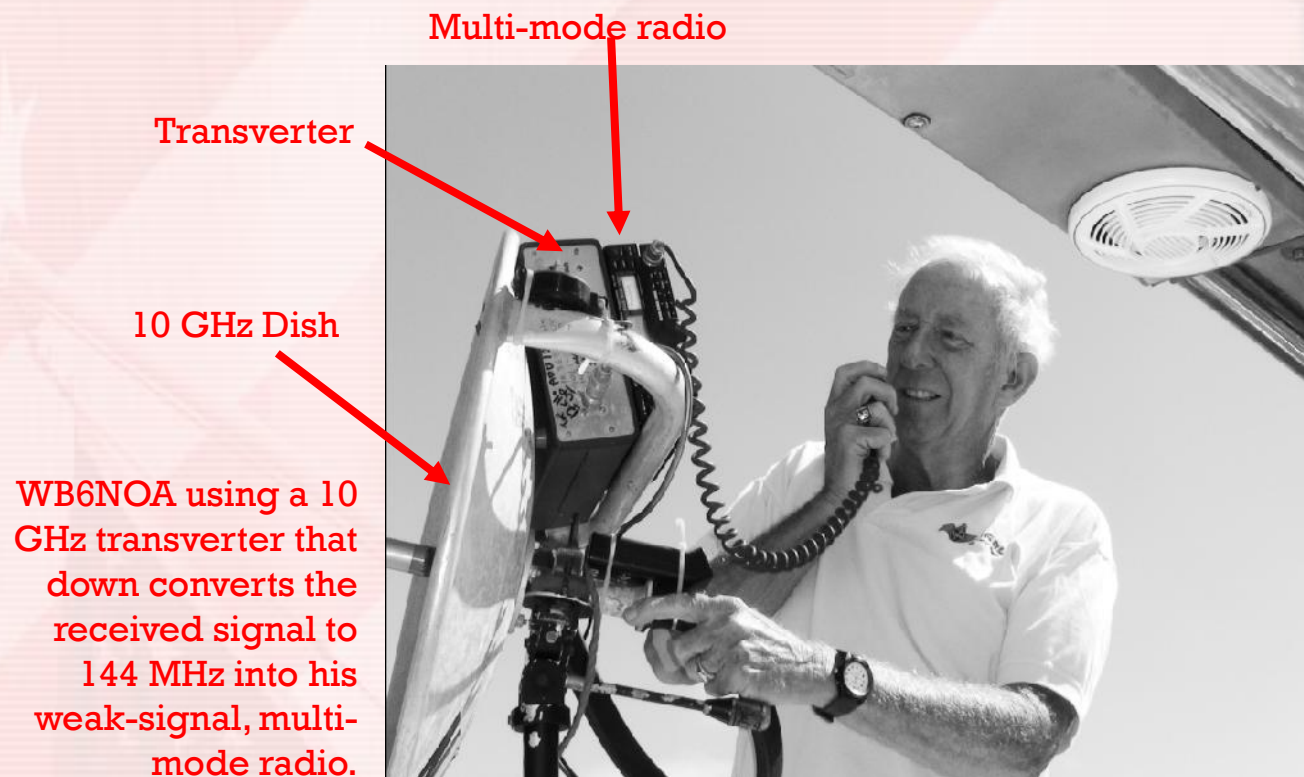


Figure T4

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A6** What device takes the output of a low-powered 28 MHz SSB exciter and produces a 222 MHz output signal? Transverter



T7A: Station radios; receivers, transmitters, transceivers.

- T7A7 If figure T5 represents a transceiver in which block 1 is the transmitter portion and block 3 is the receiver portion, what is the function of block 2?
A transmit-receive switch

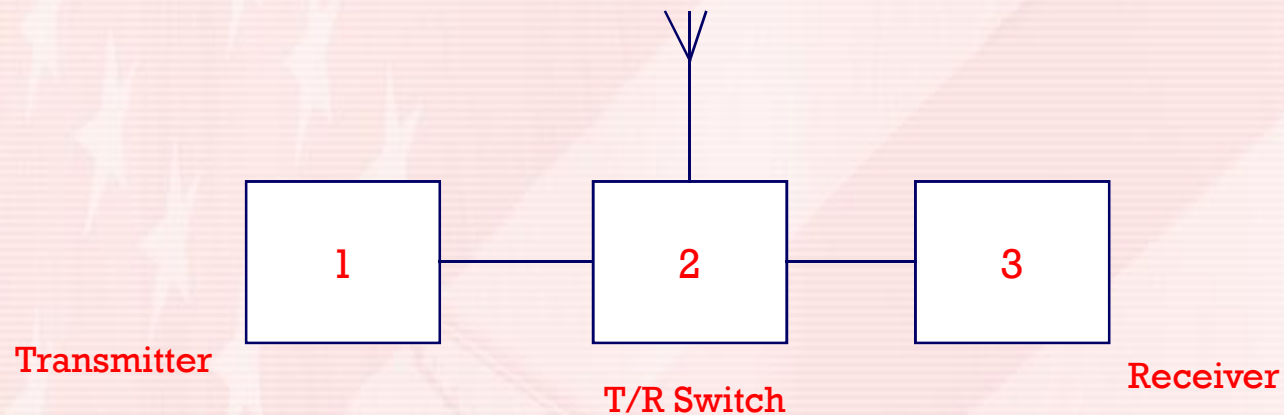
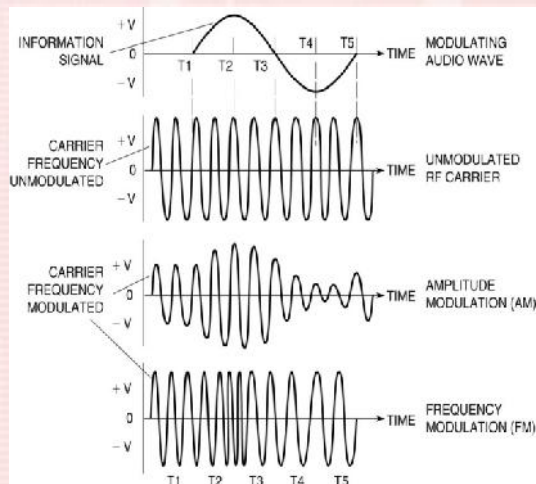


Figure T5

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A8 Which of the following circuits combines a speech signal and an RF carrier? Modulator**
- **T7A9 Which of the following devices is most useful for VHF weak-signal communication? A multi-mode VHF transceiver**



**Multi-mode
VHF/UHF
transceiver**

T7A: Station radios; receivers, transmitters, transceivers.

- **T7A10 What device increases the low-power output from a handheld transceiver?**

An RF power amplifier



- **T7A11 Which of the following circuits demodulates FM signals?**
Discriminator
 - Also a detector or demodulator
 - Recovers information
- **T7A12 Which term describes the ability of a receiver to discriminate between multiple signals?** Selectivity
- **T7A13 Where is an RF preamplifier installed?**
- Between the antenna and receiver

T7B: Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces

- **T7B1 What can you do if you are told your FM handheld or mobile transceiver is over deviating?** Talk farther away from the microphone
- **T7B2 What is meant by fundamental overload in reference to a receiver?** Interference caused by very strong signals



Good TV reception.



Front end overloaded TV reception

T7B: Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces

- **T7B3 Which of the following may be a cause of radio frequency interference?** Fundamental overload, Harmonics, Spurious emissions."All of these choices are correct"
- **T7B4 What is the most likely cause of interference to a non-cordless telephone from a nearby transmitter?**
The telephone is inadvertently acting as a radio receiver
 - Be aware of inexpensive corded telephones
- **T7B5 What is a logical first step when attempting to cure a radio frequency interference problem in a nearby telephone?**
Install an RF filter at the telephone
 - Snap filters over telephone power cord
 - Snap filters over curly cord
 - Snap filters on the actual incoming telephone line cord
 - The more you add, the less likely you'll have interference

T7B: Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces

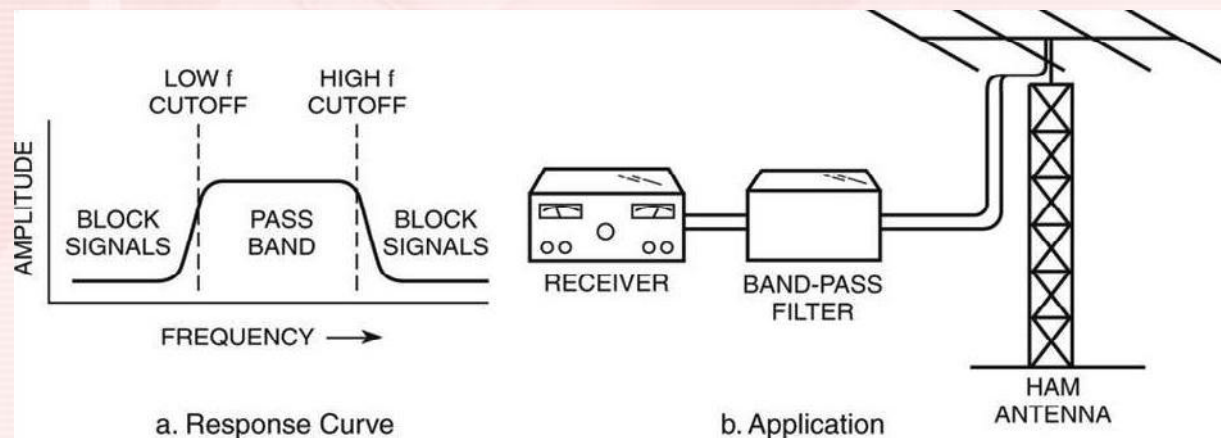
- **T7B6 What should you do first if someone tells you that your station's transmissions are interfering with their radio or TV reception?**

Make sure that your station is operating properly and that it does not cause interference to your own television

- Double check that your TV is working okay when transmitting

- **T7B7 Which of the following may be useful in correcting a radio frequency interference problem?**

Snap-on ferrite chokes, Low-pass and high-pass filters, Band-reject and band-pass filters “All of these choices are correct”

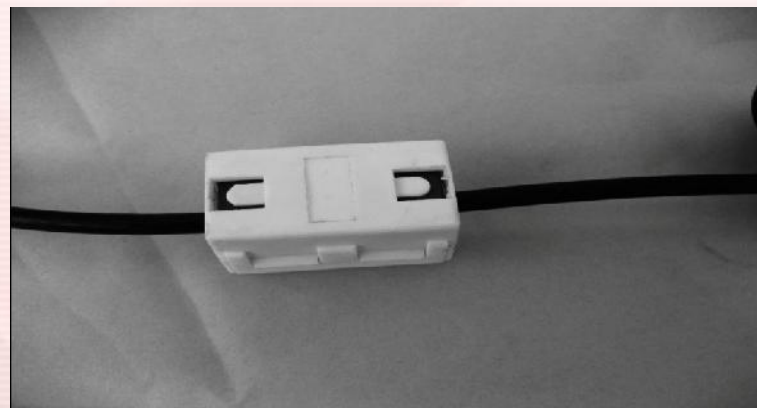


T7B: Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces

- **T7B8 What should you do if a "Part 15" device in your neighbor's home is causing harmful interference to your amateur station?**

Work with your neighbor to identify the offending device, Politely inform your neighbor about the rules that require him to stop using the device if it causes interference, Check your station and make sure it meets the standards of good amateur practice "All of these choices are correct"

A simple snap-on choke filter like this one can help resolve harmful interference problems on Part 15 devices.

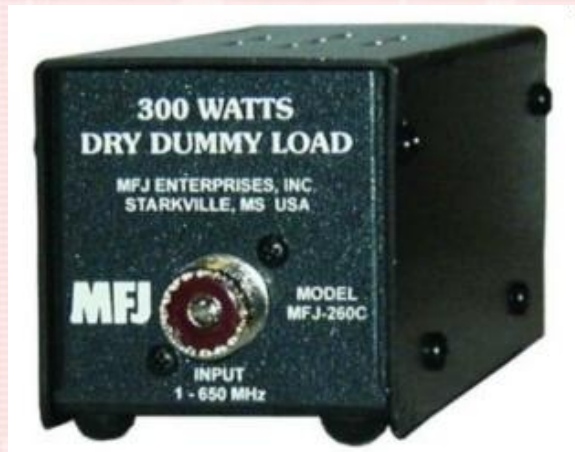


T7B: Common transmitter and receiver problems; symptoms of overload and overdrive, distortion, interference, over and under modulation, RF feedback, off frequency signals; fading and noise; problems with digital communications interfaces

- **T7B9 What could be happening if another operator reports a variable high-pitched whine on the audio from your mobile transmitter?**
Noise on the vehicle's electrical system is being transmitted along with your speech audio
 - Automobile alternator without filters on leads
- **T7B10 What might be the problem if you receive a report that your audio signal through the repeater is distorted or unintelligible?**
Your transmitter may be slightly off frequency, Your batteries may be running low, You could be in a bad location, "All of these choices are correct"
- **T7B11 What is a symptom of RF feedback in a transmitter or transceiver?** Reports of garbled, distorted, or unintelligible transmissions
 - Most likely cause is RF feedback between your antenna and mic
- **T7B12 What does the acronym "BER" mean when applied to digital communications systems?** Bit Error Rate

T7C: Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes.

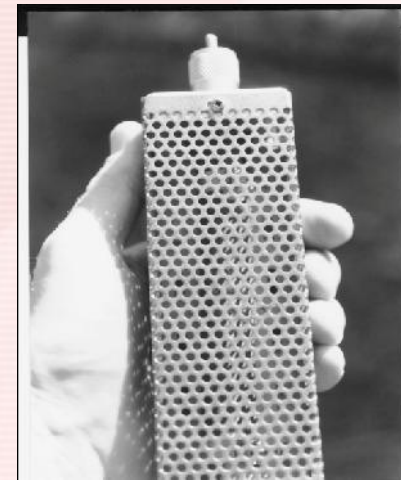
- **T7C1 What is the primary purpose of a dummy load?** To prevent the radiation of signals when making tests
 - Prevents signals from being sent out over the air
 - Allows observation of signal on Spectrum Analyzer



300 Watt Dry
Dummy Load



Dummy Load-Can
1kw with oil



Dry Dummy Load

T7C: Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes.

- **T7C2 Which of the following instruments can be used to determine if an antenna is resonant at the desired operating frequency? An antenna analyzer**

- **T7C3 What, in general terms, is standing wave ratio (SWR)?**
A measure of how well a load is matched to a transmission line



MFJ-269 SWR Analyzer

T7C: Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes.

- T7C04 What reading on an SWR meter indicates a perfect impedance match between the antenna and the feedline?**
1 to 1

<u>SWR Reading</u>	<u>Antenna Condition</u>
1:1	Perfectly Matched
1.5:1	Good Match
2:1	Fair Match
3:1	Poor Match
4:1	Something definitely Wrong

Note: impedance measures how easily a circuit conducts current when a voltage runs through it. Measured in **ohms**, impedance is a way of telling you how much of the voltage introduced at one end will really make it to the other end.

A battery operated SWR analyzer for tower antenna work

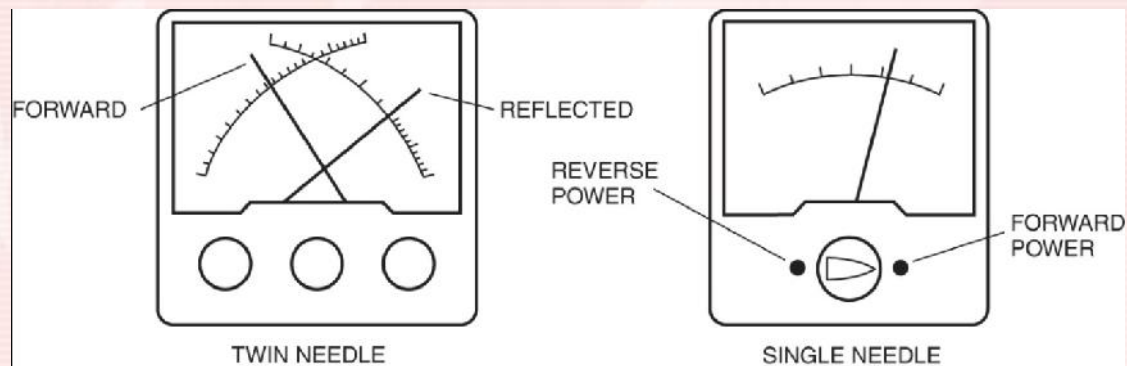


T7C: Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes.

- **T7C5 What is the approximate SWR value above which the protection circuits in most solid-state transmitters begin to reduce transmitter power?** 2 to 1
- **T7C6 What does an SWR reading of 4:1 mean?**
An impedance mismatch
- **T7C7 What happens to power lost in a feedline?**
It is converted into heat

T7C: Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes.

- T7C8 What instrument other than an SWR meter could you use to determine if a feedline and antenna are properly matched?**
Directional wattmeter



Dual/Twin Needle



Single Needle

T7C: Antenna measurements and troubleshooting; measuring SWR, dummy loads, feedline failure modes.

- **T7C9 Which of the following is the most common cause for failure of coaxial cables?** Moisture contamination
 - Regular BNC, Type N, and PL259 connectors are not water-tight.
- **T7C10 Why should the outer jacket of coaxial cable be resistant to ultraviolet light?** Ultraviolet light can damage the jacket and allow water to enter the cable
- **T7C11 What is a disadvantage of "air core" coaxial cable when compared to foam or solid dielectric types?**

It requires special techniques to prevent water absorption

Smaller
Heliax

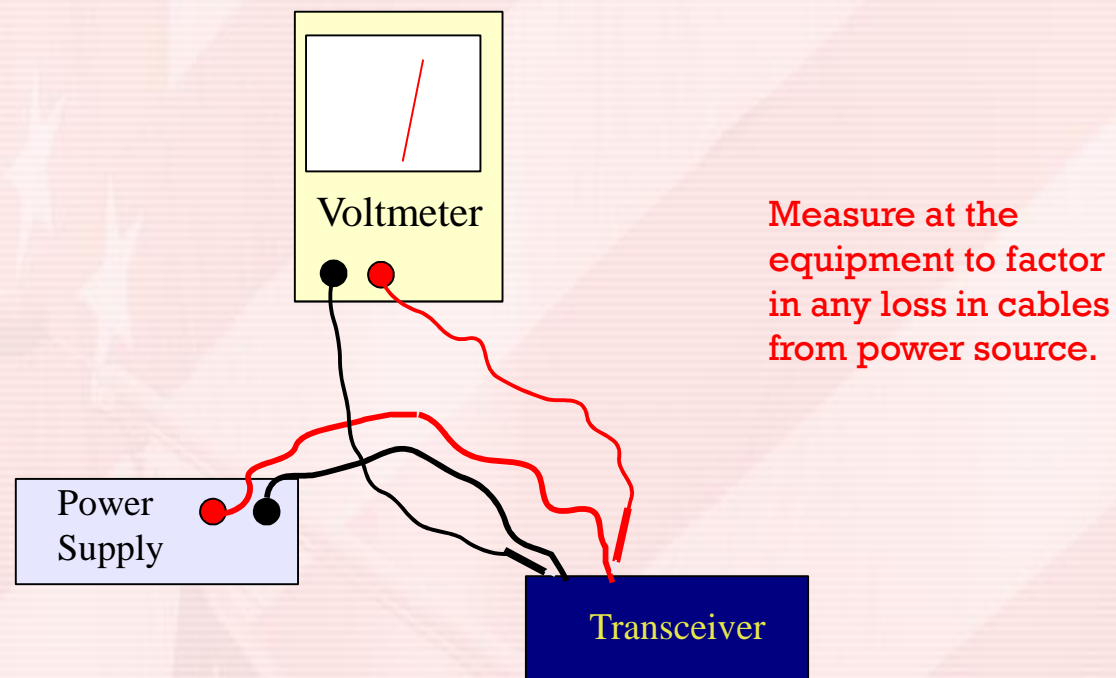


Large coax, with
hollow center
conductor, low loss

T7D: Basic repair and testing; soldering, use of a voltmeter, ammeter and ohmmeter

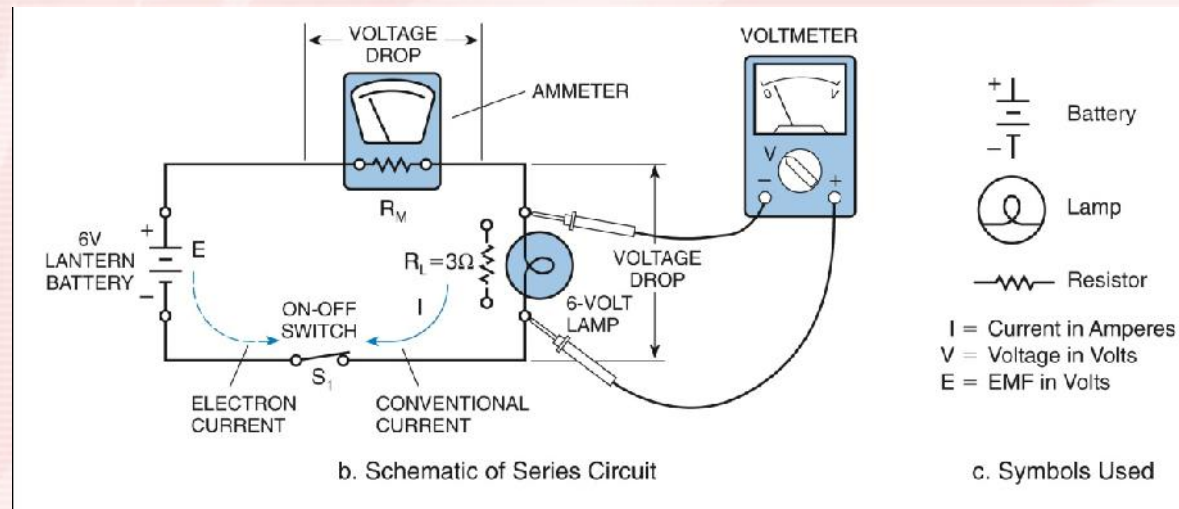
- **T7D1 Which instrument would you use to measure electric potential or electromotive force? A voltmeter**
- **T7D2 What is the correct way to connect a voltmeter to a circuit?**
In parallel with the circuit
 - Car battery is measured in parallel
 - House wall sockets are measured in parallel

T7D: Basic repair and testing; soldering, use of a voltmeter, ammeter and ohmmeter



T7D: Basic repair and testing; soldering, use of a voltmeter, ammeter and ohmmeter

- **T7D3 How is an ammeter usually connected to a circuit?**
In series with the circuit
- **T7D4 Which instrument is used to measure electric current?**
An ammeter



T7D: Basic repair and testing; soldering, use of a voltmeter, ammeter and ohmmeter

- **T7D5 What instrument is used to measure resistance? An ohmmeter**



A D'Arsonval-type meter uses a mechanical needle to indicate the test results.



Digital meter

Both use internal batteries.

Caution:
NEVER
measure
voltage or
current in the
Ohm position

T7D: Basic repair and testing; soldering, use of a voltmeter, ammeter and ohmmeter

- **T7D6 Which of the following might damage a multimeter?**
Attempting to measure voltage when using the resistance setting
- **T7D7 Which of the following measurements are commonly made using a multimeter?** Voltage and resistance



Volt Ohm Meter VOM

<u>Parameter</u>	<u>Basic Unit</u>	<u>Measuring Instrument</u>
Voltage (E)	Volts	Voltmeter
Current (I)	Amperes	Ammeter
Resistance	Ohms 10^3	Ohmmeter
Power (P)	Watts	Wattmeter



Digital Volt Ohm Meter
Much more accurate

T7D: Basic repair and testing; soldering, use of a voltmeter, ammeter and ohmmeter

- **T7D8 Which of the following types of solder is best for radio and electronic use?** Rosin-core solder
- **T7D9 What is the characteristic appearance of a "cold" solder joint?**
 - A grainy or dull surface
- **T7D10 What is probably happening when an ohmmeter, connected across a circuit, initially indicates a low resistance and then shows increasing resistance with time?** The circuit contains a large capacitor
- **T7D11 Which of the following precautions should be taken when measuring circuit resistance with an ohmmeter?** Ensure that the circuit is not powered

Learning how to use a multimeter is an essential skill in testing and repairing radio gear



Technician Licensing Class “T8”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

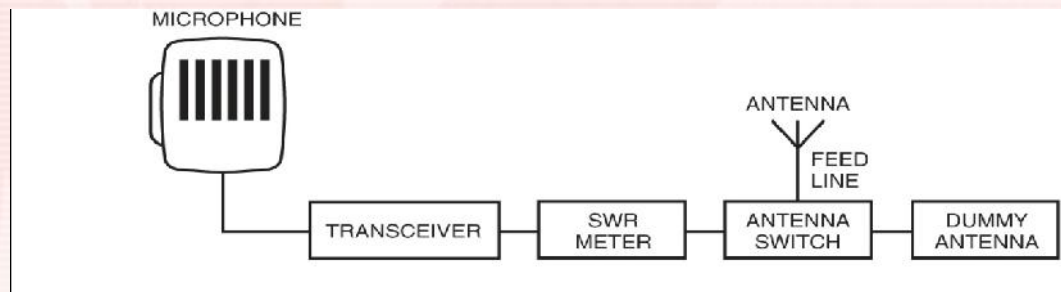
Element 2 Course Presentation

➤ ELEMENT 2 SUB-ELEMENTS

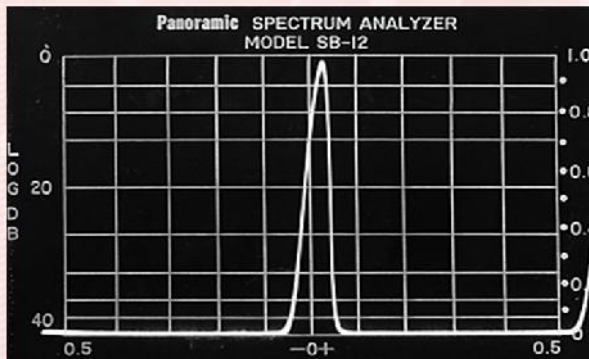
- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T8A: Modulation modes; bandwidth of various signals

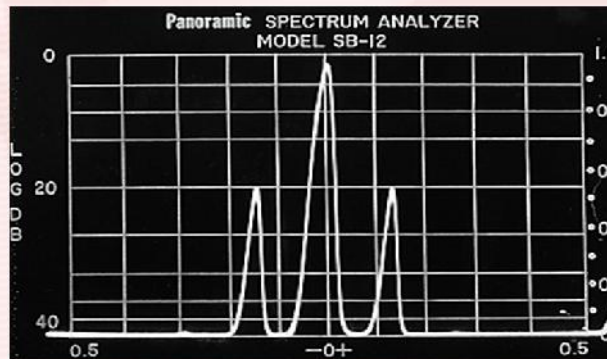
- T8A1 Which of the following is a form of amplitude modulation?**
Single sideband



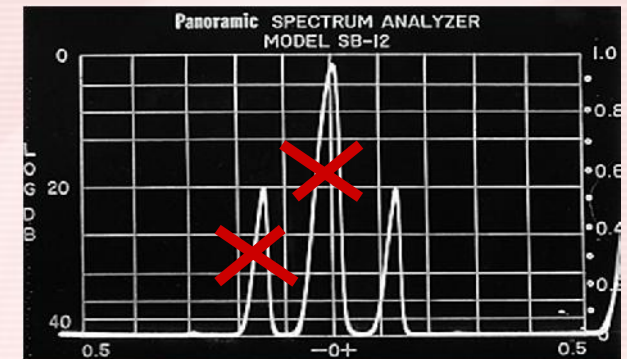
Voice or Phone Station



Carrier only CW



Tones produce both side bands or AM



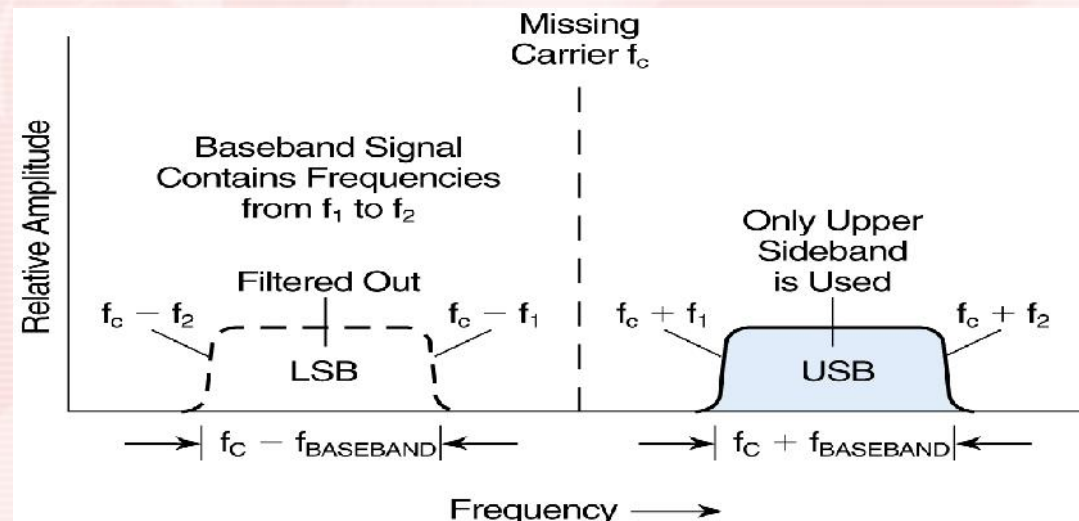
Remove one sideband and suppress carrier becomes SSB

T8A: Modulation modes; bandwidth of various signals

- **T8A2 What type of modulation is most commonly used for VHF packet radio transmissions? FM**
- **T8A3 Which type of voice modulation is most often used for long-distance or weak signal contacts on the VHF and UHF bands? SSB**
- **T8A4 Which type of modulation is most commonly used for VHF and UHF voice repeaters? FM**
- **T8A5 Which of the following types of emission has the narrowest bandwidth? CW**
- **T8A6 Which sideband is normally used for 10 meter HF, VHF and UHF single-sideband communications? Upper sideband**
 - Upper sideband is always used on VHF & UHF

T8A: Modulation modes; bandwidth of various signals

- **T8A7 What is the primary advantage of single sideband over FM for voice transmissions?** SSB signals have narrower bandwidth
 - SSB uses less bandwidth than FM signals.
- **T8A8 What is the approximate bandwidth of a single sideband voice signal?** 3 kHz



SSB signals are Amplitude Modulated (AM) with the carrier and one sideband suppressed.

T8A: Modulation modes; bandwidth of various signals

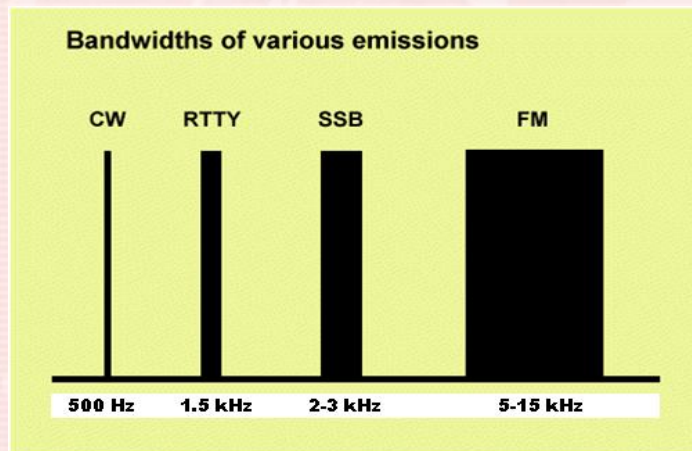
- **T8A9 What is the approximate bandwidth of a VHF repeater FM phone signal?** Between 5 and 15 kHz
- **T8A10 What is the typical bandwidth of analog fast-scan TV transmissions on the 70 cm band?** About 6 MHz



Amateur TV signals can be received on a variety of equipment – even a small hand-held monitor.

T8A: Modulation modes; bandwidth of various signals

- **T8A11 What is the approximate maximum bandwidth required to transmit a CW signal? 150 Hz**



CW Signal	500 Hz wide
SSB Signal	2 - 3 kHz wide
FM Signal	5 - 15 kHz wide
UHF Fast-Scan TV	~ 6 MHz

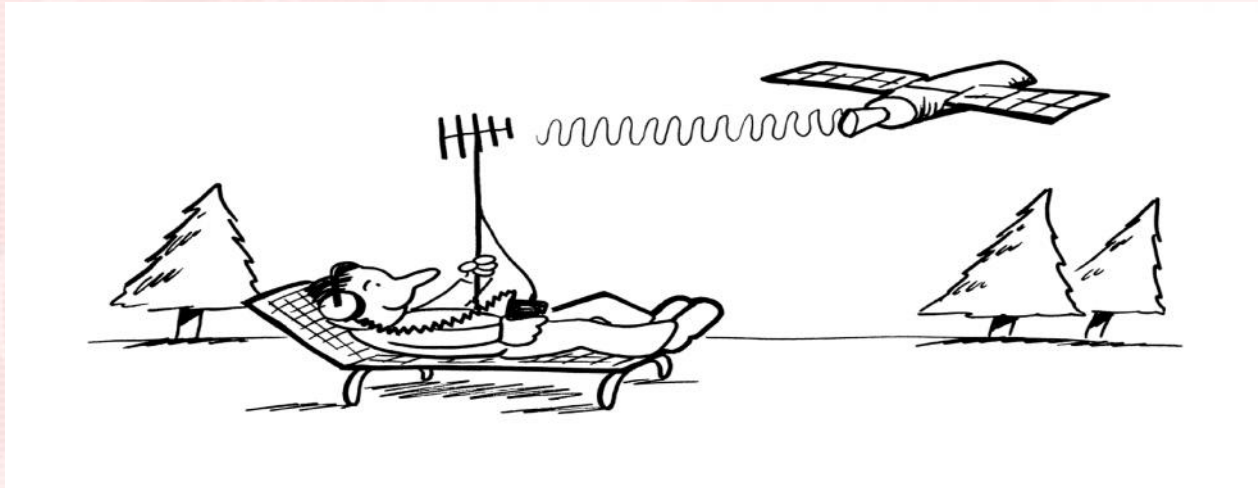
T8B: Amateur satellite operation; Doppler shift, basic orbits, operating protocols.

- **T8B1 Who may be the control operator of a station communicating through an amateur satellite or space station?** Any amateur whose license privileges allow them to transmit on the satellite uplink frequency

T8B2 How much transmitter power should be used on the uplink frequency of an amateur satellite or space station?

The minimum amount of power needed to complete the contact

- Just a repeat of previous mention about amount of power output



To work satellites with your handheld, buy a small directional antenna for your satellite radio. You probably won't hear much with your rubber duck antenna.

T8B: Amateur satellite operation; Doppler shift, basic orbits, operating protocols.

- **T8B3 Which of the following can be done using an amateur radio satellite?** Talk to amateur radio operators in other countries
- **T8B4 Which amateur stations may make contact with an amateur station on the International Space Station using 2 meter and 70 cm band amateur radio frequencies?**

Any amateur holding a Technician or higher class license



Many Astronauts are licensed radio amateurs.

The International Space Station downlink, FM is 145.800 MHz. Use an HT to listen when it's passing over you.

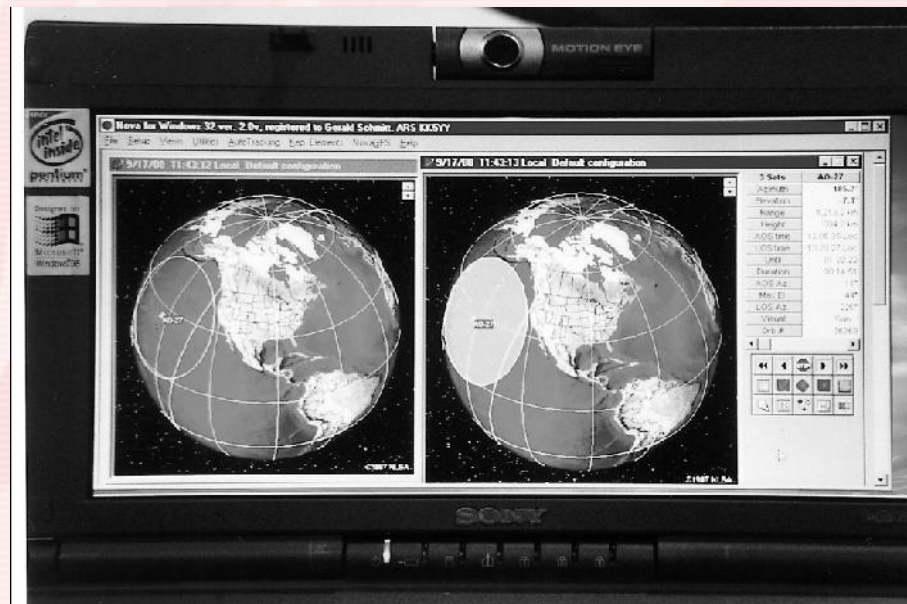


International Space Station has a big ham station on board.

T8B: Amateur satellite operation; Doppler shift, basic orbits, operating protocols.

- **T8B5 What is a satellite beacon?** A transmission from a space station that contains information about a satellite
- **T8B6 What can be used to determine the time period during which an amateur satellite or space station can be accessed?**

A satellite tracking program

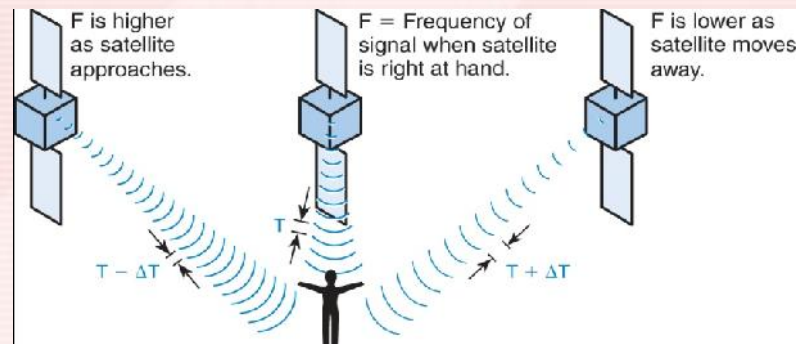


Computer programs and websites can show you where and when an amateur satellite or the Space Station will be in range of your ham station.

T8B: Amateur satellite operation; Doppler shift, basic orbits, operating protocols.

- T8B7 With regard to satellite communications, what is Doppler shift?** A change in signal frequency caused by motion of the transmitting station

Doppler Effect



- T8B8 What is meant by the statement that a satellite is operating in "mode U/V"?** The satellite uplink is in the 70 cm band and the downlink is in the 2 meter band

Frequency Bands

High Frequency

VHF

UHF

L band

S band

C band

X band

K band

Frequency Range

21 - 30 MHz

144 - 146 MHz

435 - 438 MHz

1.26 - 1.27 GHz

2.4 - 2.45 GHz

5.8 GHz

10.4 GHz

24 GHz

Modes

Mode H

Mode V

Mode U

Mode L

Mode S

Mode C

Mode X

Mode K

T8B: Amateur satellite operation; Doppler shift, basic orbits, operating protocols.

- **T8B9 What causes "spin fading" when referring to satellite signals?**
Rotation of the satellite and its antennas
 - Rotation in space makes the signals fade in and out.
 - This rotation keeps solar panels from overheating.

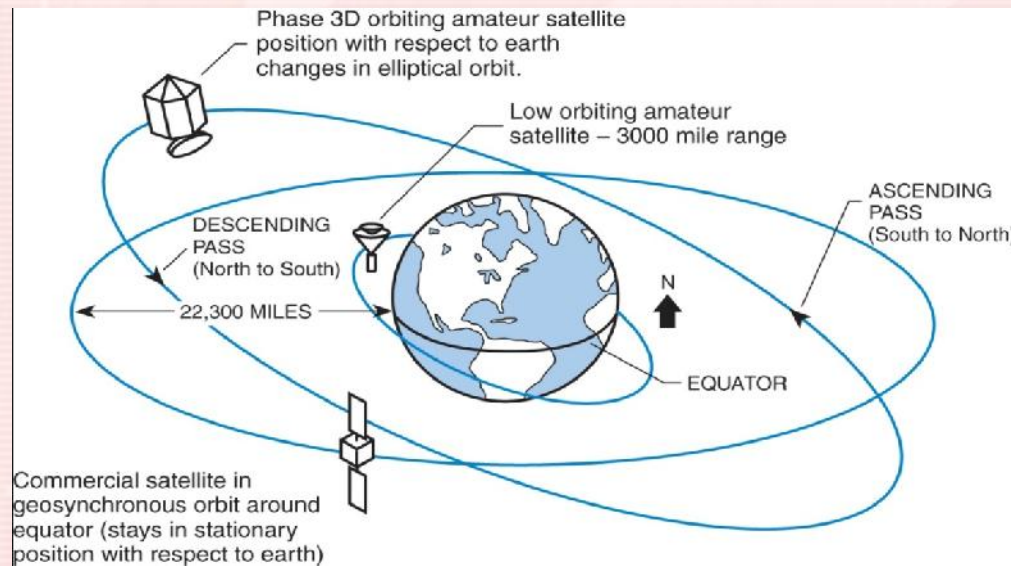
Tracking and communicating through amateur satellites can be done with a cross-polarized satellite antenna



T8B: Amateur satellite operation; Doppler shift, basic orbits, operating protocols.

- **T8B10 What causes "spin fading" when referring to satellite signals?**
Rotation of the satellite and its antennas

Orbiting Satellites



- **T8B11 What is a commonly used method of sending signals to and from a digital satellite?** FM Packet
 - FM packet a very popular digital communications system
 - Packets usually stored and forwarded, via satellite or space station

T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

- **T8C1 Which of the following methods is used to locate sources of noise interference or jamming? Radio direction finding**



3-element homebrew Yagi
DF Antenna



3-element Quad DF Antenna

T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

- **T8C2 Which of these items would be useful for a hidden transmitter hunt?** A directional antenna



Hidden Transmitter Hunts are called Fox Hunting



All ages participate in a Fox Hunt

T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

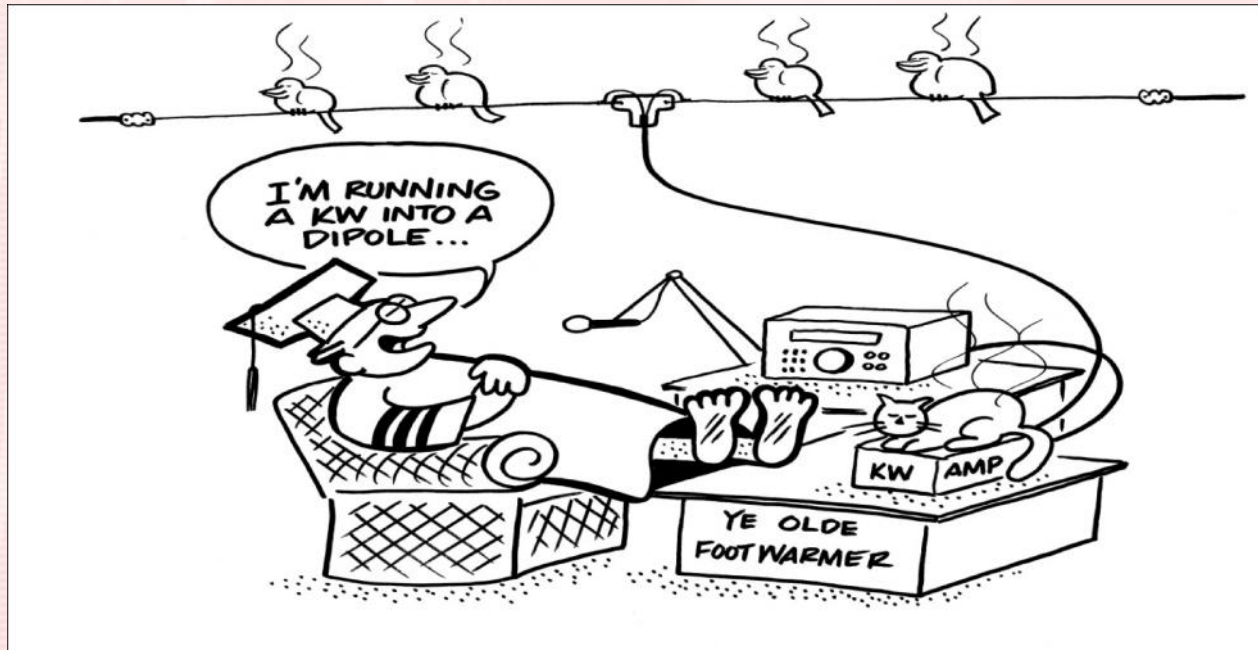
- **T8C3 What popular operating activity involves contacting as many stations as possible during a specified period of time? Contesting**



Field Day Every June Enjoyed by Hams the World Over

T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

T8C4 Which of the following is good procedure when contacting another station in a radio contest? Send only the minimum information needed for proper identification and the contest exchange

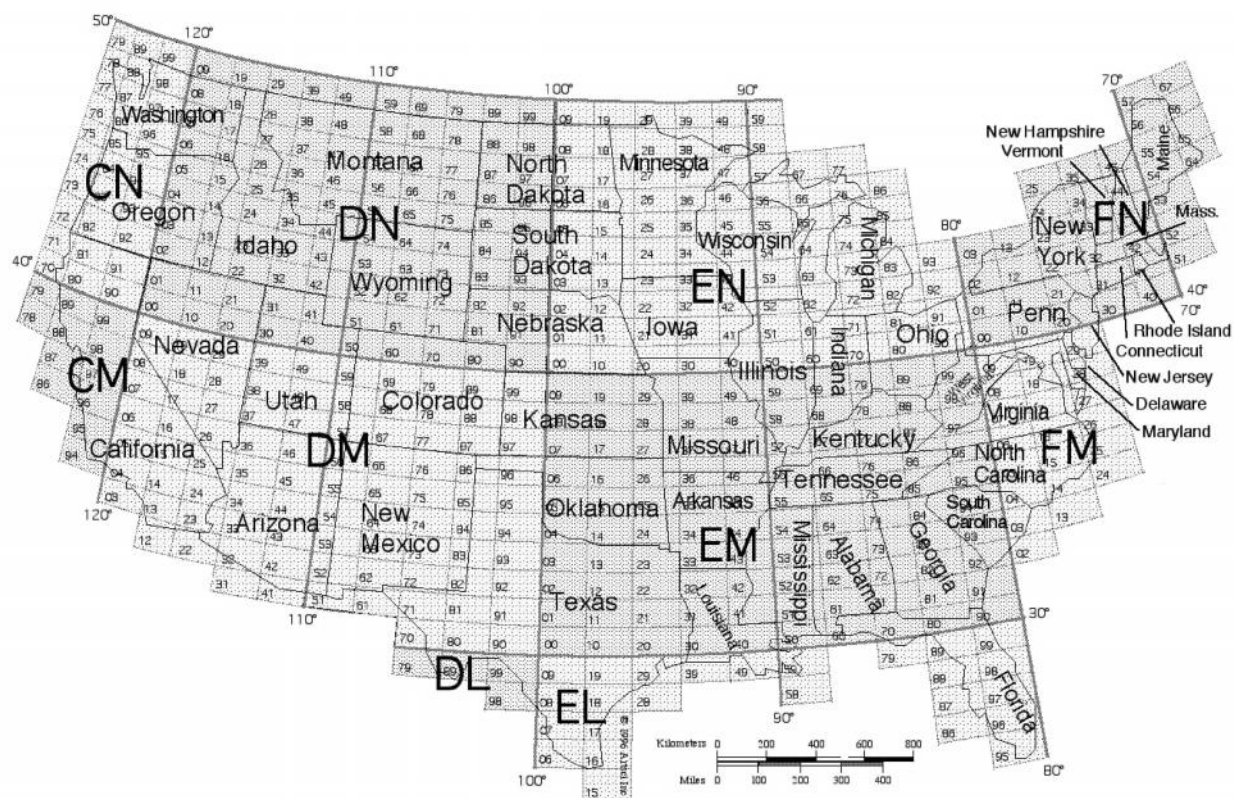


Chit chat is great for normal QSO's, but not for contests.

Contesting needs your call sign and info for contest only.

T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

- **T8C5 What is a grid locator?** A letter-number designator assigned to a geographic location



T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

- **T8C6 For what purpose is a temporary "1 by 1" format (letter-number-letter) call sign assigned?** For operations in conjunction with an activity of special significance to the amateur community
 - W6C = "Whiskey Six Covina" Christmas Parade Net
 - K6U = "Kilo Six Uniform" Boy Scout Jamboree On The Air
- **T8C7 What is the maximum power allowed when transmitting telecommand signals to radio controlled models?** 1 watt
 - Telecommand signals are unidentified commands permitted by rule.

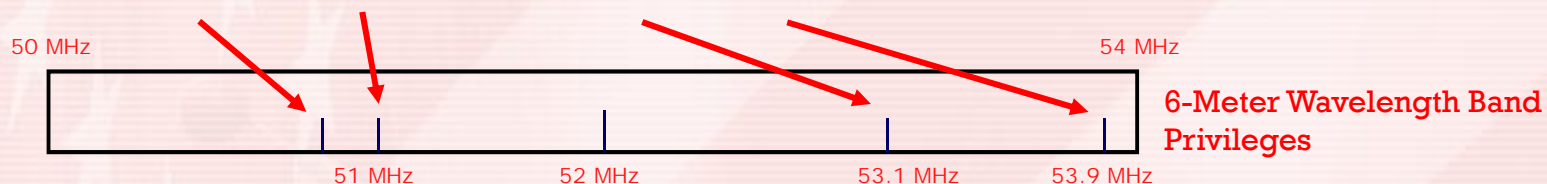


Hams can use frequencies on the 6-Meter Band to radio control a model aircraft.

T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

T8C8 What is required in place of on-air station identification when sending signals to a radio control model using amateur frequencies? A label indicating the licensee's call sign and address must be affixed to the transmitter

- Strange radio control signals can be heard using RC:
 - 50.800 to 51.0 MHz and 53.1 to 53.9 MHz.



T8C: Operating activities; radio directing finding, radio control, contests, special event stations, basic linking over Internet

- **T8C9 How might you obtain a list of active nodes that use VoIP?** From a repeater directory
- **T8C10 How do you select a specific IRLP node when using a portable transceiver?** Use the keypad to transmit the IRLP node ID

Keypad on this rig's top corner and on back of microphone. (Not necessarily this way on all rigs.)



- **T8C11 What name is given to an amateur radio station that is used to connect other amateur stations to the Internet?** A gateway
 - Similar to a Gateway in connection to a computer network

T8D: Non-voice communications; image data, digital modes CW, packet, PSK31

- **T8D1 Which of the following is an example of a digital communications method?**

Packet, PSK31, MFSK - All of these choices are correct

- **T8D2 What does the term APRS mean?**
Automatic Position Reporting System

- **T8D3 Which of the following is normally used when sending automatic location reports via amateur radio?**

A Global Positioning System receiver



Kenwood dual bander
plugged into the Avmap
G5 GPS position plotter.

T8D: Non-voice communications; image data, digital modes CW, packet, PSK31

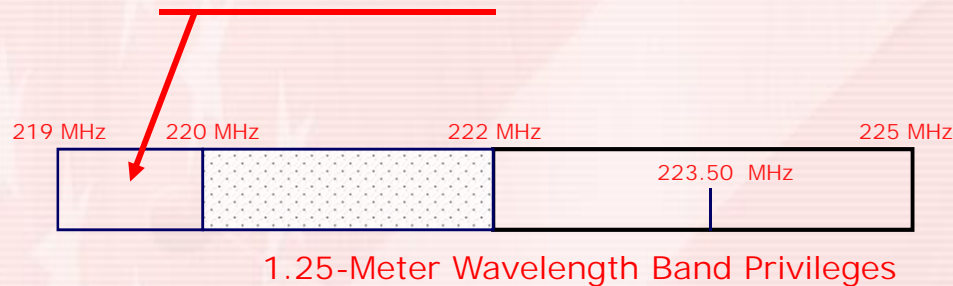
- **T8D4 What type of transmission is indicated by the term NTSC?**
An analog fast scan color TV signal



When you're ready, you can add the fun of ATV to your ham shack.

T8D: Non-voice communications; image data, digital modes CW, packet, PSK31

- **T8D5 Which of the following emission modes may be used by a Technician Class operator between 219 and 220 MHz? Data**
 - 219 to 220 MHz for point-to-point digital message forwarding

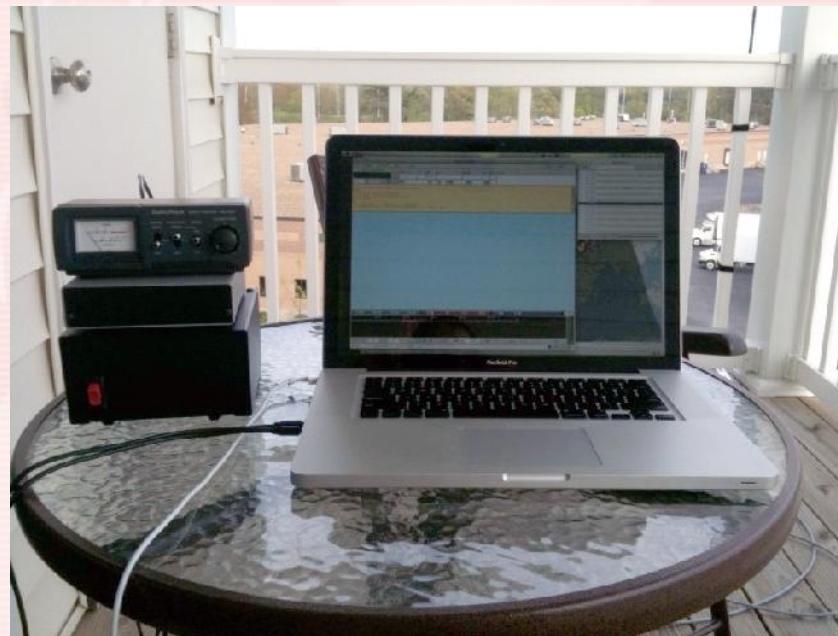


- **T8D6 What does the abbreviation PSK mean? Phase Shift Keying**

T8D: Non-voice communications; image data, digital modes CW, packet, PSK31

- **T8D7 What is PSK31?** A low-rate data transmission mode

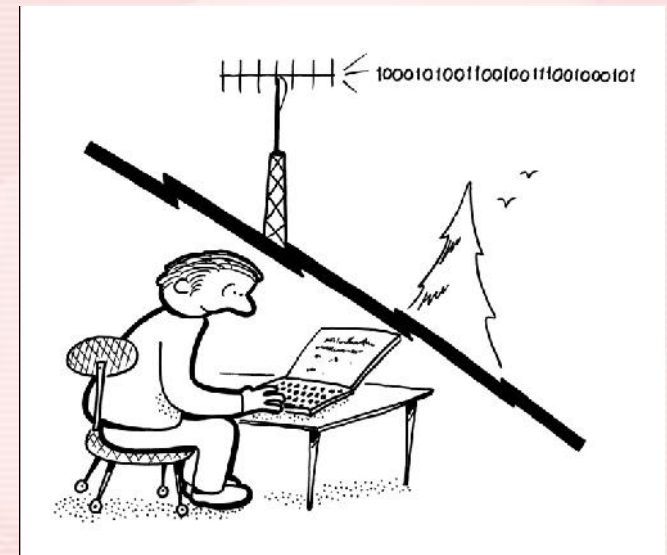
PSK31 allows worldwide “text messaging” communication with high frequency (HF) radio with low power (~5 watts) and narrow bandwidth. It combines amateur radio with digital signal processing on a laptop computer.



T8D: Non-voice communications; image data, digital modes CW, packet, PSK31

- **T8D8 Which of the following may be included in packet transmissions?**
- A check sum which permits error detection
- A header which contains the call sign of the station to which the information is being sent
- Automatic repeat request in case of error
- All of these choices are correct

Laptop,
TNC, and
Handheld
comprise
Packet
Station.



T8D: Non-voice communications; image data, digital modes CW, packet, PSK31

- **T8D9 What code is used when sending CW in the amateur bands?**
Morse
- **T8D10 Which of the following can be used to transmit CW in the amateur bands?**
 - Straight Key
 - Electronic Keyer
 - Computer Keyboard
 - All of these choices are correct
- **T8D11 What is a "parity" bit?**
An extra code element used to detect errors in received data

Technician Licensing Class “T9”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

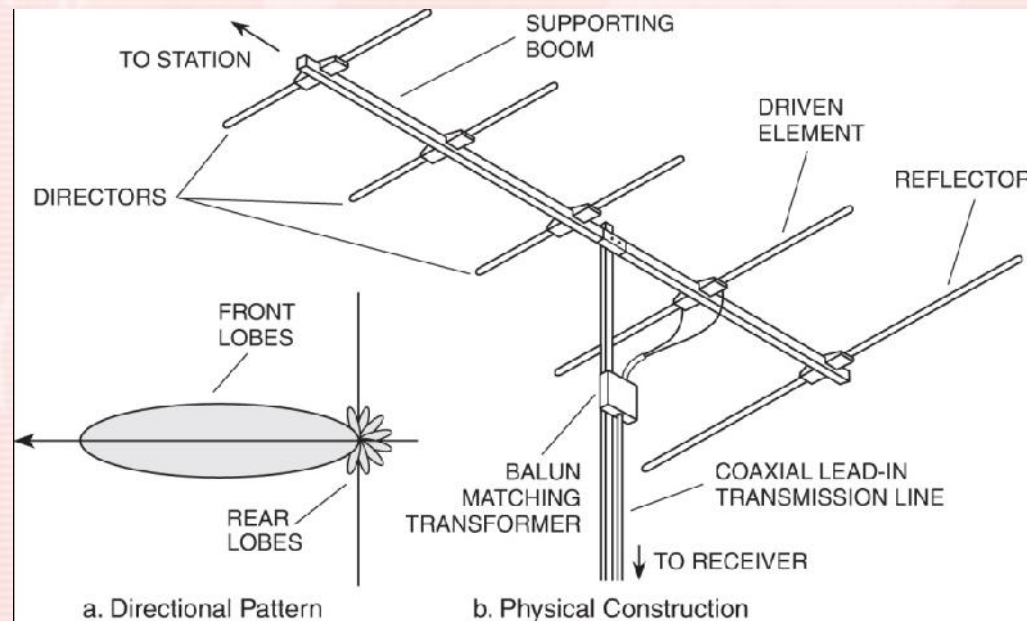
Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

- T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

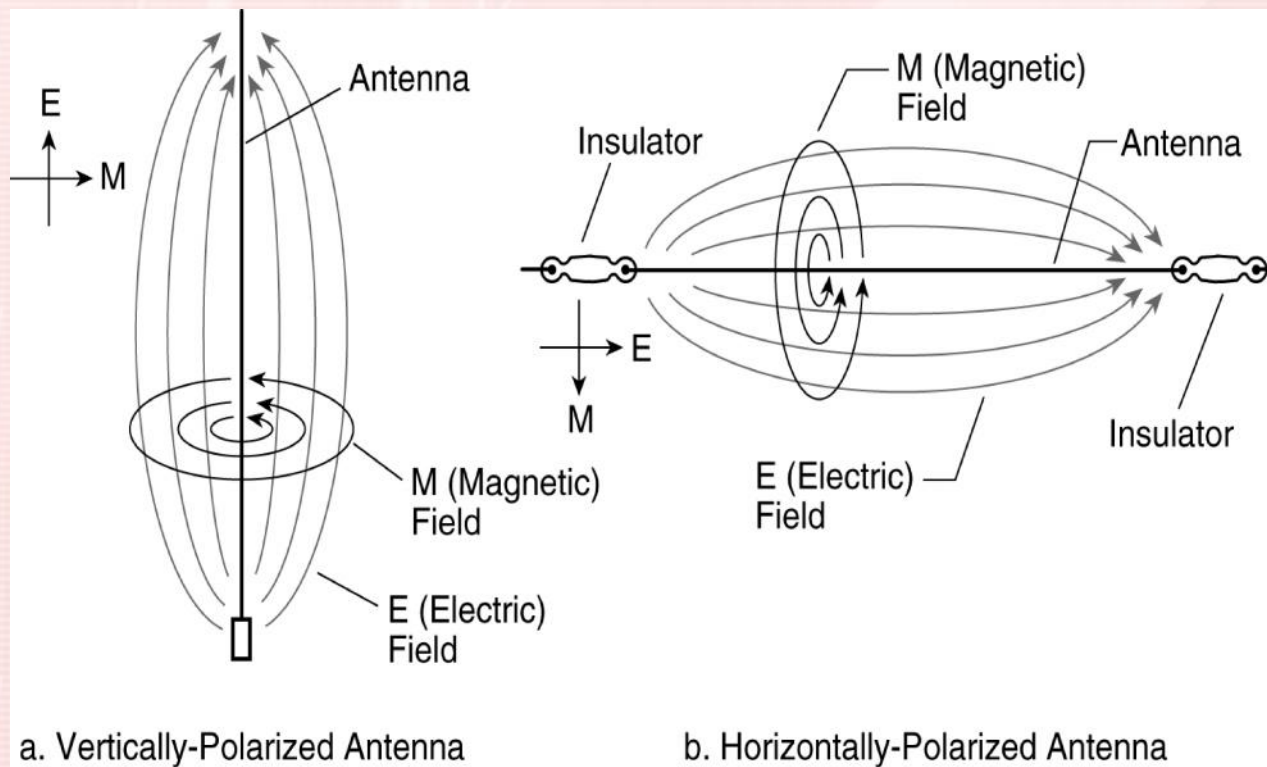
- **T9A1 What is a beam antenna?** An antenna that concentrates signals in one direction



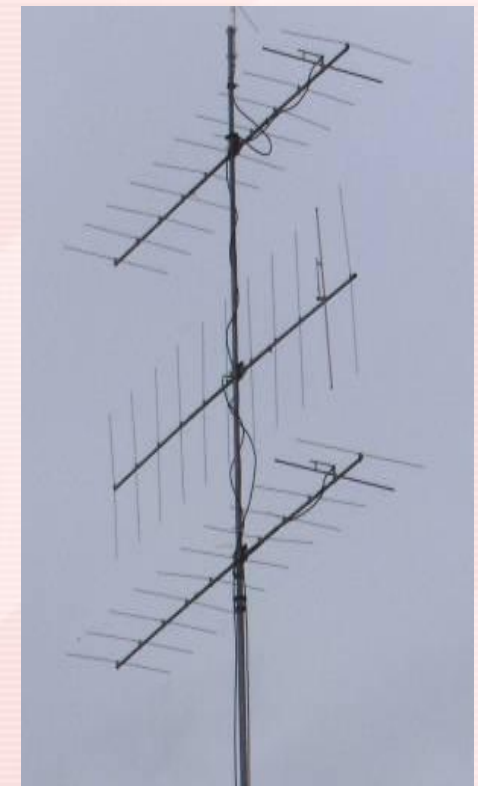
A Beam Antenna – The Yagi Antenna

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- **T9A2 Which of the following is true regarding vertical antennas?**
- The electric field is perpendicular to the Earth



Vertical and Horizontal Polarization

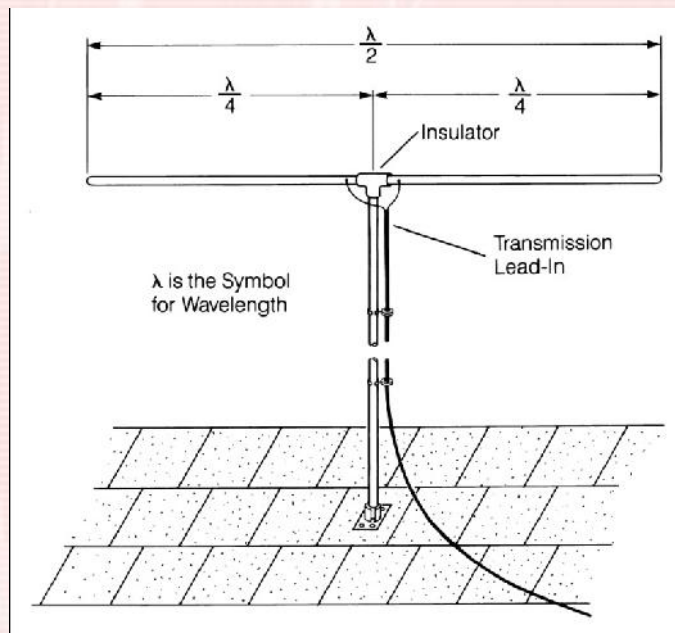


H & V Polarized Antennas

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- T9A3 Which of the following describes a simple dipole mounted so the conductor is parallel to the Earth's surface?**

A horizontally polarized antenna



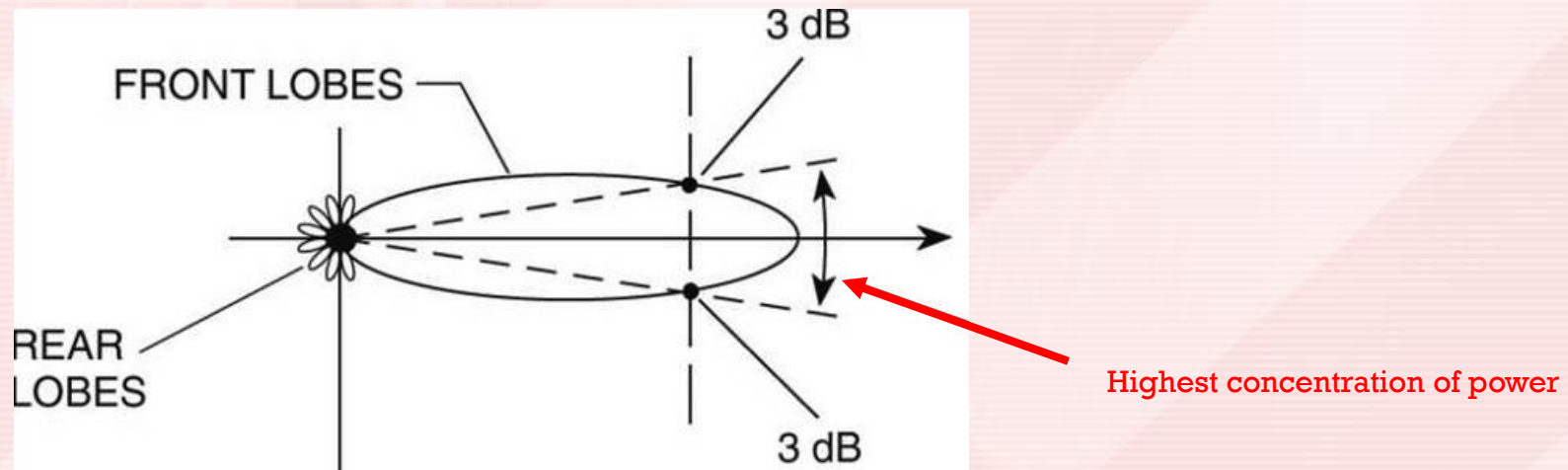
Simple Dipole



Three element beam

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- **T9A4 What is a disadvantage of the "rubber duck" antenna supplied with most handheld radio transceivers?**
It does not transmit or receive as effectively as a full-sized antenna
- **T9A5 How would you change a dipole antenna to make it resonant on a higher frequency?** Shorten it
- **T9A6 What type of antennas are the quad, Yagi, and dish?**
Directional antennas



Directional Radiation Pattern of a Yagi Beam

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- **T9A7 What is a good reason not to use a "rubber duck" antenna inside your car?** Signals can be significantly weaker than when it is outside of the vehicle



Modern dual- and tri-band handheld transceivers like these have amazing built-in capabilities that make ham radio easy, fun, and portable.

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- T9A8 What is the approximate length, in inches, of a quarter-wavelength vertical antenna for 146 MHz? 19**

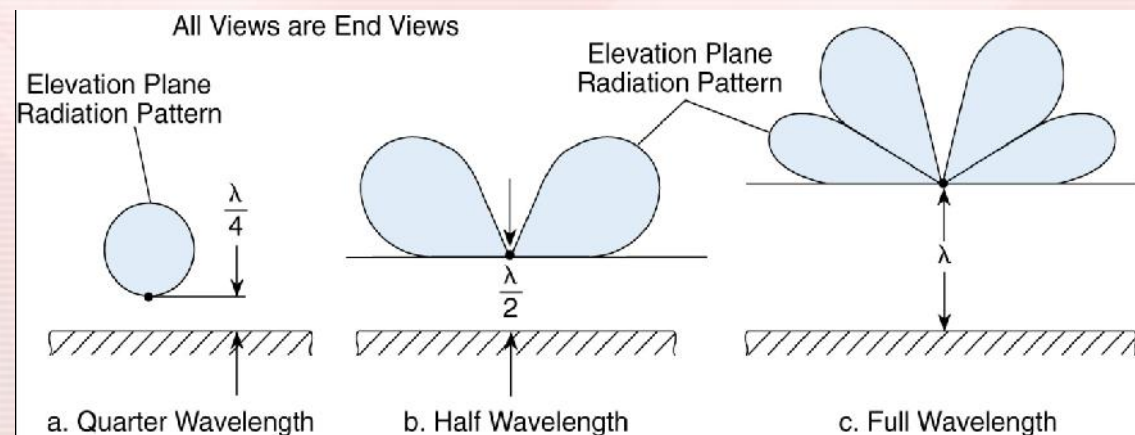
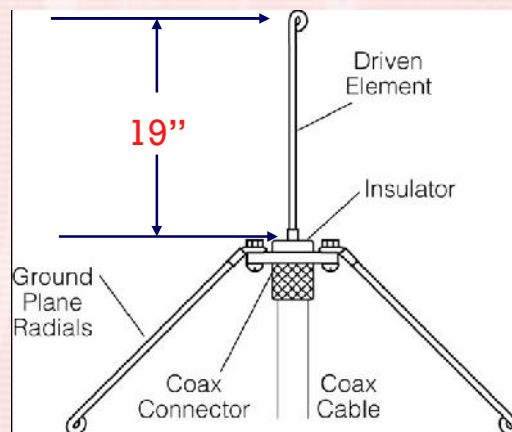
$$\text{Length of vertical in feet} = \frac{234}{f \text{ (MHz)}}$$

(for quarter-wave dipole)

(2-meters is 144-148 MHz)

$$\text{Feet} = 234/146 = 1.6$$

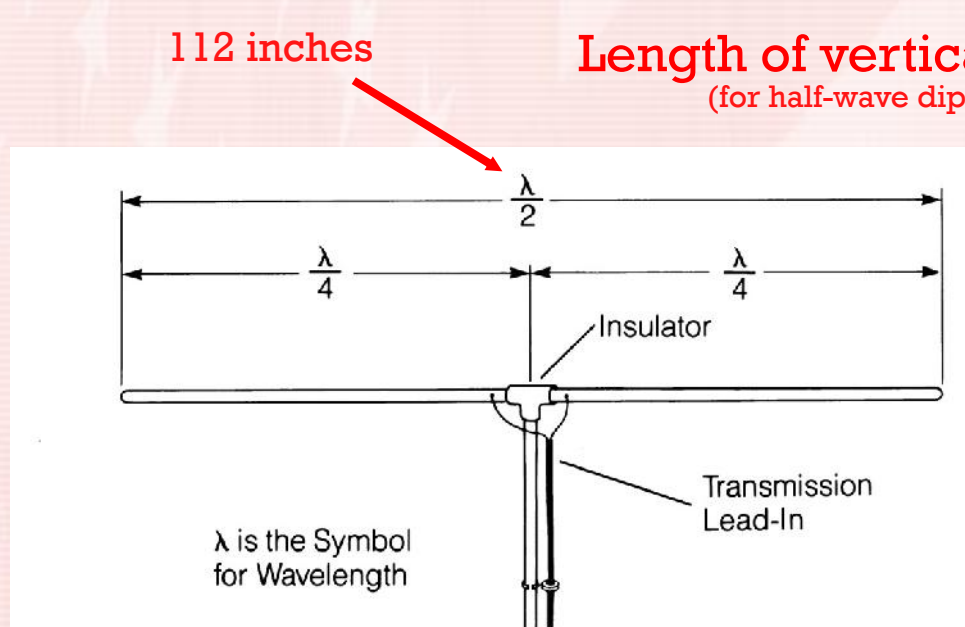
$$1.6 \times 12 = 19 \text{ inches}$$



Radiation Pattern of an Antenna Changes as Height Above Ground is Varied

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- T9A9 What is the approximate length, in inches, of a 6 meter 1/2-wavelength wire dipole antenna? 112**



Six Meter 1/2 Wavelength Dipole

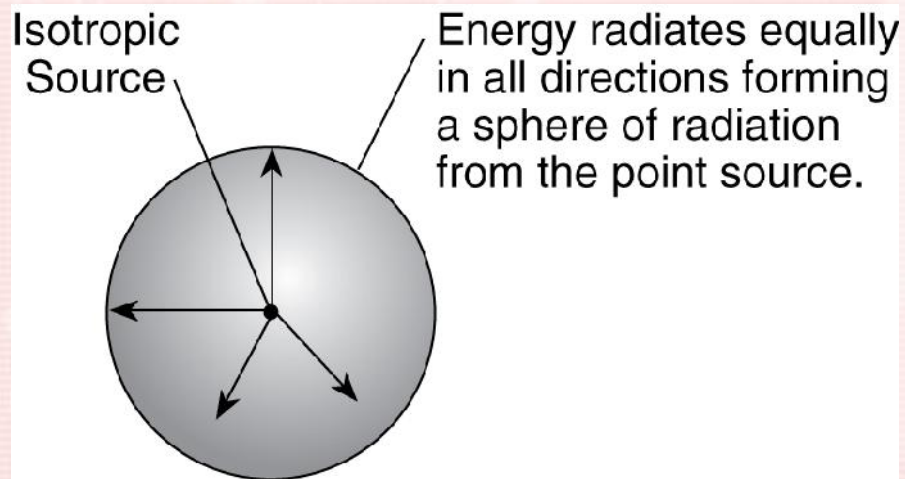
$$\text{Feet} = 468/50 = 9.36$$

$$9.36 \times 12 = 112.3 \text{ inches}$$

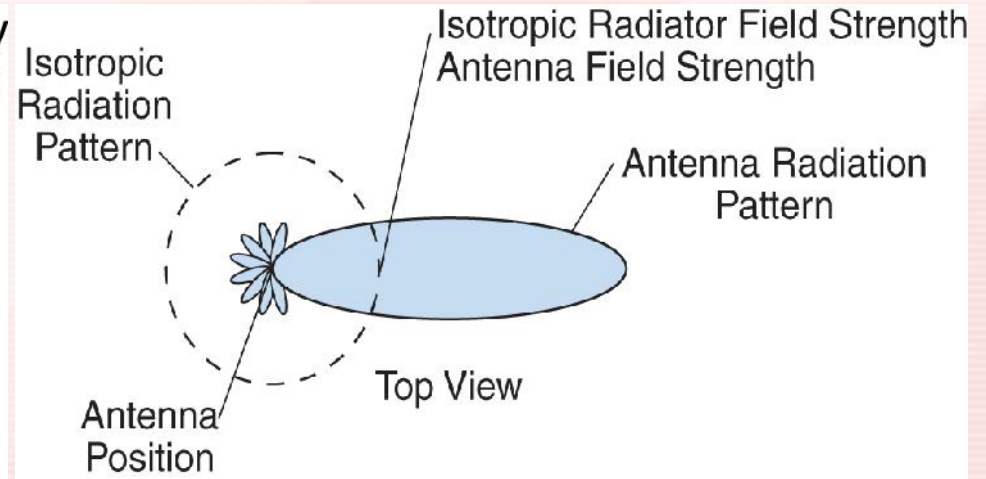
T9A10 In which direction is the radiation strongest from a half-wave dipole antenna in free space? Broadside to the antenna

T9A: Antennas; vertical and horizontal, concept of gain, common portable and mobile antennas, relationships between antenna length and frequency

- **T9A11 What is meant by the gain of an antenna?** The increase in signal strength in a specified direction when compared to a reference antenna



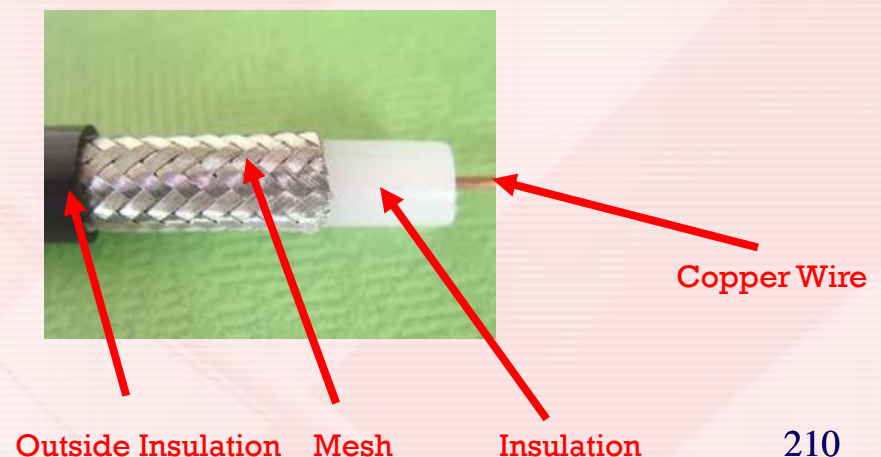
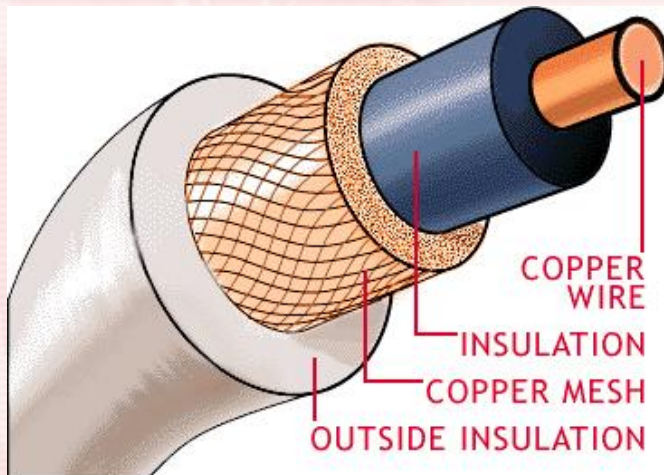
Isotropic Radiator Pattern



“Gain” of an antenna

T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.

- **T9B1 Why is it important to have a low SWR in an antenna system that uses coaxial cable feedline?** To allow the efficient transfer of power and reduce losses
- **T9B2 What is the impedance of the most commonly used coaxial cable in typical amateur radio installations?** 50 ohms
- **T9B3 Why is coaxial cable used more often than any other feedline for amateur radio antenna systems?**
It is easy to use and requires few special installation considerations



T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.

- **T9B4 What does an antenna tuner do?** It matches the antenna system impedance to the transceiver's output impedance



MFJ-971 Portable
QRP 200 Watt Tuner



Icom 7000 with LDG
7000 Auto-Tuner



Miracle QPak 50 Watt
Manual Tuner



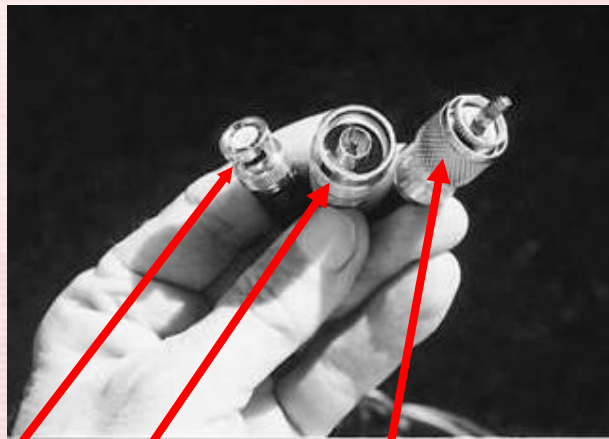
Palstar 1500 Watt Auto-Tuner



MFJ-994B 1500 Watt Auto-Tuner 211

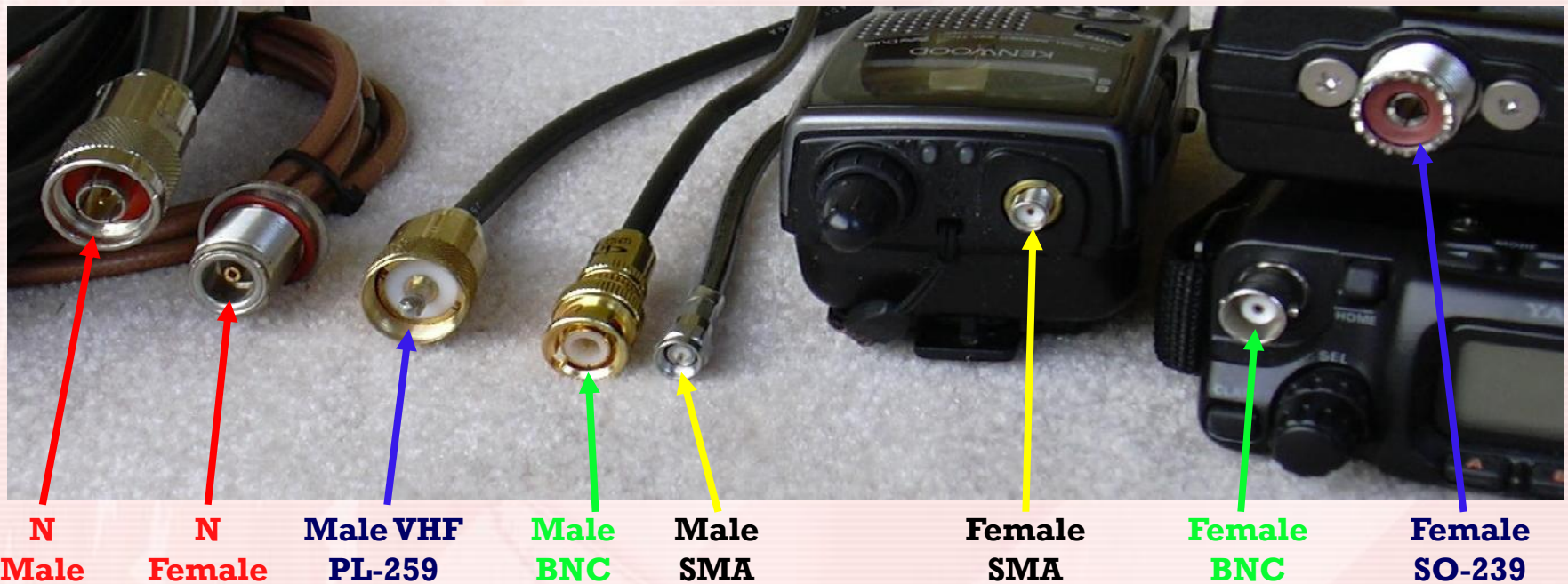
T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.

- **T9B5 What generally happens as the frequency of a signal passing through coaxial cable is increased?** The loss increases
 - The Higher the frequency the more the loss
- **T9B6 Which of the following connectors is most suitable for frequencies above 400 MHz?** A Type N connector
- **T9B7 Which of the following is true of PL-259 type coax connectors?**
The are commonly used at HF frequencies



BNC, Type N, and PL 259 Connectors

T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.



Understand the type of connector on your radio
You may need an adapter from your coax connector to your radio

Never buy cheap coax, connectors, or adapters

T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.

- **T9B8 Why should coax connectors exposed to the weather be sealed against water intrusion?** To prevent an increase in feedline loss
- **T9B9 What might cause erratic changes in SWR readings?** A loose connection in an antenna or a feedline

Make sure all coax connections are tight to help minimize interference



T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.

- **T9B10 What electrical difference exists between the smaller RG-58 and larger RG-8 coaxial cables?** RG-8 cable has less loss at a given frequency

Coax Cable Type, Size, and Loss per 100 feet

Coax Type	Size	@ 100 MHz	@ 400 MHz
RG-58U	Small	4.3 dB	9.4 dB
RG-8X	Medium	3.7 dB	8.0 dB
RG-8U	Large	1.9 dB	4.1 dB
RG-213	Large	1.9 dB	4.5 dB
Hardline	Large, Rigid	0.5 dB	1.5 dB

- **T9B11 Which of the following types of feedline has the lowest loss at VHF and UHF?** Air-insulated hard line

T9B: Feedlines; types, losses vs. frequency, SWR concepts, matching weather protection, connectors.

Coax Cable Signal Loss (Attenuation) in dB per 100ft

Loss	RG-174	RG-58	RG-8X	RG-213	RG-6	RG-11	9913	LMR-400
1MHz	1.9dB	0.4dB	0.5dB	0.2dB	0.2dB	0.2dB	0.2dB	0.3dB
10MHz	3.3dB	1.4dB	1.0dB	0.6dB	0.6dB	0.4dB	0.4dB	0.5dB
50MHz	6.6dB	3.3dB	2.5dB	1.6dB	1.4dB	1.0dB	0.9dB	0.9dB
100MHz	8.9dB	4.9dB	3.6dB	2.2dB	2.0dB	1.6dB	1.4dB	1.4dB
200MHz	11.9dB	7.3dB	5.4dB	3.3dB	2.8dB	2.3dB	1.8dB	1.8dB
400MHz	17.3dB	11.2dB	7.9dB	4.8dB	4.3dB	3.5dB	2.6dB	2.6dB
700MHz	26.0dB	16.9dB	11.0dB	6.6dB	5.6dB	4.7dB	3.6dB	3.5dB
900MHz	27.9dB	20.1dB	12.6dB	7.7dB	6.0dB	5.4dB	4.2dB	3.9dB
1GHz	32.0dB	21.5dB	13.5dB	8.3dB	6.1dB	5.6dB	4.5dB	4.1dB
Imped	50ohm	50ohm	50ohm	50ohm	75ohm	75ohm	50ohm	50ohm

Technician Licensing Class “T0”



Valid dates:

July 1, 2010 – June 30, 2014

Amateur Radio Technician Class

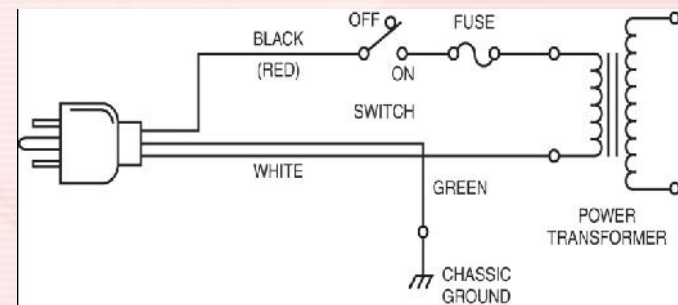
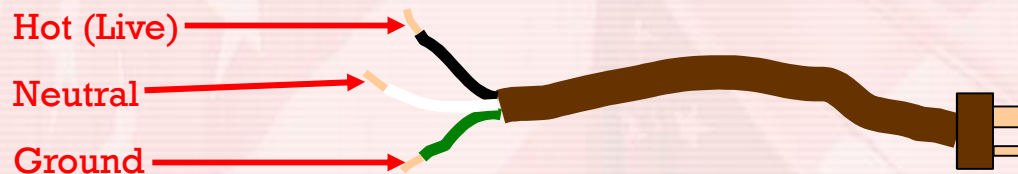
Element 2 Course Presentation

➤ **ELEMENT 2 SUB-ELEMENTS**

- **T1 - FCC Rules, descriptions and definitions for the amateur radio service, operator and station license responsibilities.**
- **T2 – Operating Procedures**
- **T3 – Radio wave characteristics, radio and electromagnetic properties, propagation modes**
- **T4 – Amateur radio practices and station set up**
- **T5 – Electrical principles, math for electronics, electronic principles, Ohm's Law**
- **T6 – Electrical components, semiconductors, circuit diagrams, component functions**
- **T7 – Station equipment, common transmitter and receiver problems, antenna measurements and troubleshooting, basic repair and testing**
- **T8 – Modulation modes, amateur satellite operation, operating activities, non-voice communications**
- **T9 – Antennas, feedlines**
- **T0 – AC power circuits, antenna installation, RF hazards**

T0A: AC power circuits; hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance.

- **T0A1 Which is a commonly accepted value for the lowest voltage that can cause a dangerous electric shock? 30 volts**
- **T0A2 How does current flowing through the body cause a health hazard?**
 - By heating tissue
 - It disrupts the electrical functions of cells
 - It causes involuntary muscle contractions
- **T0A3 What is connected to the green wire in a three-wire electrical AC plug? Safety ground**



AC Line Connections

T0A: AC power circuits; hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance.

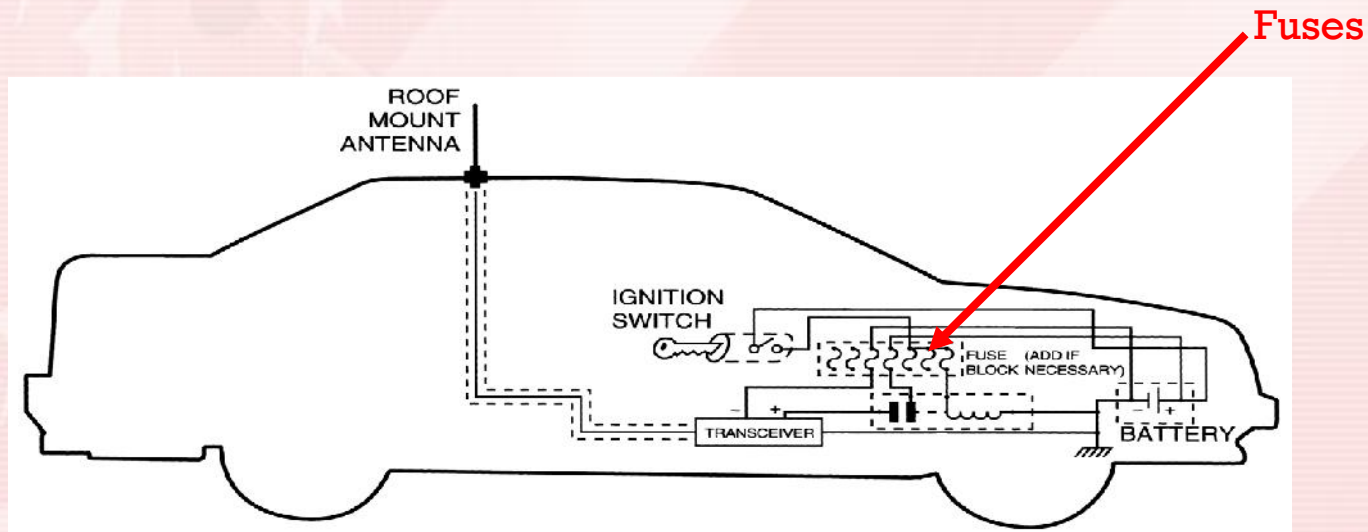
- **T0A4 What is the purpose of a fuse in an electrical circuit?** To interrupt power in case of overload



Slow-Blow fuse



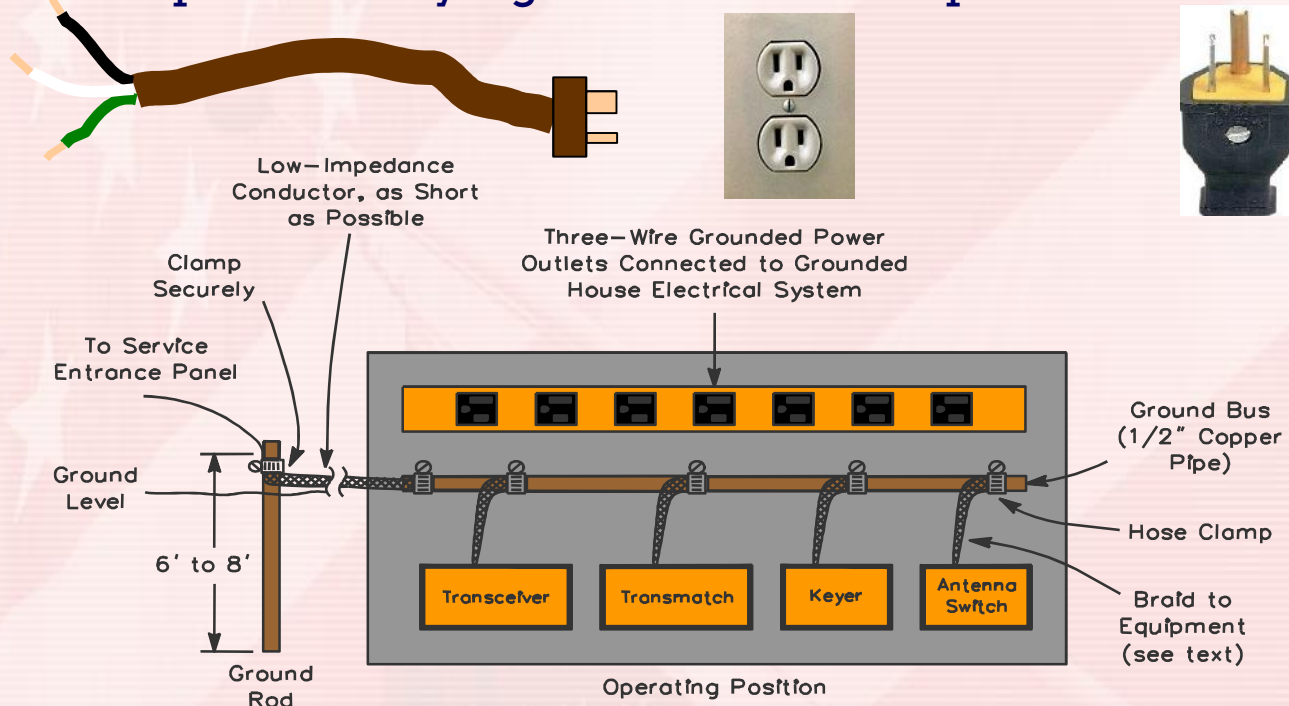
Automobile fuse



Place the fuses as close to the battery as possible

T0A: AC power circuits; hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance.

- **T0A5 Why is it unwise to install a 20-ampere fuse in the place of a 5-ampere fuse?** Excessive current could cause a fire
- **T0A6 What is a good way to guard against electrical shock at your station?** Use three-wire cords and plugs for all AC powered equipment, Connect all AC powered station equipment to a common safety ground, Use a circuit protected by a ground-fault interrupter



T0A: AC power circuits; hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance.

- **T0A7 Which of these precautions should be taken when installing devices for lightning protection in a coaxial cable feedline?**

Ground all of the protectors to a common plate which is in turn connected to an external ground

- Good for nearby lightning strikes
 - Direct hits, forget it, kiss everything goodbye for good
- **T0A8 What is one way to recharge a 12-volt lead-acid station battery if the commercial power is out?** Connect the battery to a car's battery and run the engine
- **T0A9 What kind of hazard is presented by a conventional 12-volt storage battery?** Explosive gas can collect if not properly vented
Dangerous acid could spill - Enough power to cause a fire

T0A: AC power circuits; hazardous voltages, fuses and circuit breakers, grounding, lightning protection, battery safety, electrical code compliance.

- **T0A10 What can happen if a lead-acid storage battery is charged or discharged too quickly?**

The battery could overheat and give off flammable gas or explode

T0A11 Which of the following is good practice when installing ground wires on a tower for lightning protection? Ensure that connections are short and direct

T0A12 What kind of hazard might exist in a power supply when it is turned off and disconnected? You might receive an electric shock from stored charge in large capacitors

T0A13 What safety equipment should always be included in home-built equipment that is powered from 120V AC power circuits? A fuse or circuit breaker in series with the AC "hot" conductor

T0B: Antenna installation; tower safety, overhead power lines.

- **T0B1 When should members of a tower work team wear a hard hat and safety glasses?** At all times when any work is being done on the tower
 - On ground or up the tower
 - Wear hard hat and safety glasses
- **T0B2 What is a good precaution to observe before climbing an antenna tower?** Put on a climbing harness and safety glasses



Climbing
Harness

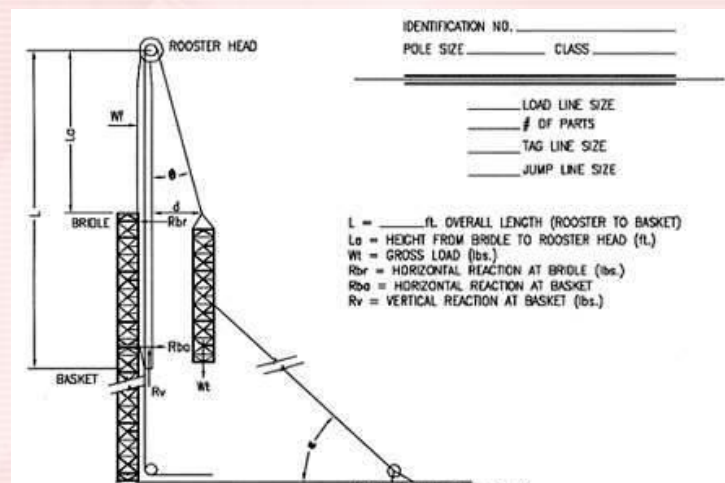
Safety
Glasses

And
Hard Hat



T0B: Antenna installation; tower safety, overhead power lines.

- **T0B3 Under what circumstances is it safe to climb a tower without a helper or observer?** Never
 - Never work on a tower without a helper
- **T0B4 Which of the following is an important safety precaution to observe when putting up an antenna tower?** Look for and stay clear of any overhead electrical wires
 - Overhead electrical wires carry more than 120 VAC
 - Use common sense and think safety first
- **T0B5 What is the purpose of a gin pole?** To lift tower sections or antennas



T0B: Antenna installation; tower safety, overhead power lines.

- **T0B6 What is the minimum safe distance from a power line to allow when installing an antenna?** So that if the antenna falls unexpectedly, no part of it can come closer than 10 feet to the power wires

- This is a 'minimum' distance

- **T0B7 Which of the following is an important safety rule to remember when using a crank-up tower?**

This type of tower must never be climbed unless it is in the fully retracted position

- Think weight overload and **never** climb a cranked up tower

- **T0B8 What is considered to be a proper grounding method for a tower?**

Separate eight-foot long ground rods for each tower leg, bonded to the tower and each other

T0B: Antenna installation; tower safety, overhead power lines.

- **T0B9 Why should you avoid attaching an antenna to a utility pole?**
The antenna could contact high-voltage power wires
 - And it may be illegal to do
- **T0B10 Which of the following is true concerning grounding conductors used for lightning protection?**
Sharp bends must be avoided
- **T0B11 Which of the following establishes grounding requirements for an amateur radio tower or antenna?** Local electrical codes
 - Always wear hard hat and safety glasses
 - Check local codes before putting up an antenna

T0C: RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others.

- **T0C1 What type of radiation are VHF and UHF radio signals?**

Non-ionizing radiation

- Quite different from X-ray, gamma ray, and ultra violet radiation

- **T0C2 Which of the following frequencies has the lowest Maximum Permissible Exposure limit?** 50 MHz

- **T0C3 What is the maximum power level that an amateur radio station may use at VHF frequencies before an RF exposure evaluation is required?** 50 watts PEP at the antenna

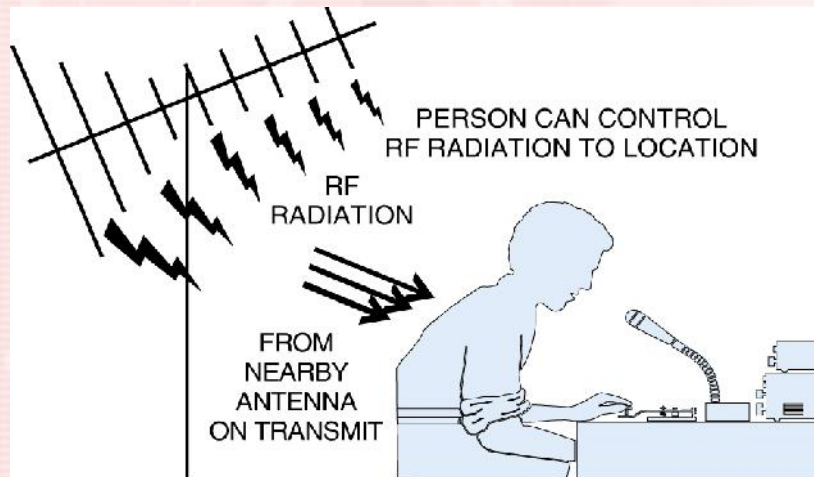


Never stand in front of a microwave feedhorn antenna.

On transmit, it radiates a concentrated beam of RF energy.

T0C: RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others.

- **T0C4 What factors affect the RF exposure of people near an amateur station antenna?**
- Frequency and power level of the RF field
- Distance from the antenna to a person
- Radiation pattern of the antenna
- All of these choices are correct



Controlled



Uncontrolled

T0C: RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others.

- **T0C5 Why do exposure limits vary with frequency?**

The human body absorbs more RF energy at some frequencies than at others

T0C6 Which of the following is an acceptable method to determine that your station complies with FCC RF exposure regulations?

By calculation based on FCC OET Bulletin 65

By calculation based on computer modeling

By measurement of field strength using calibrated equipment

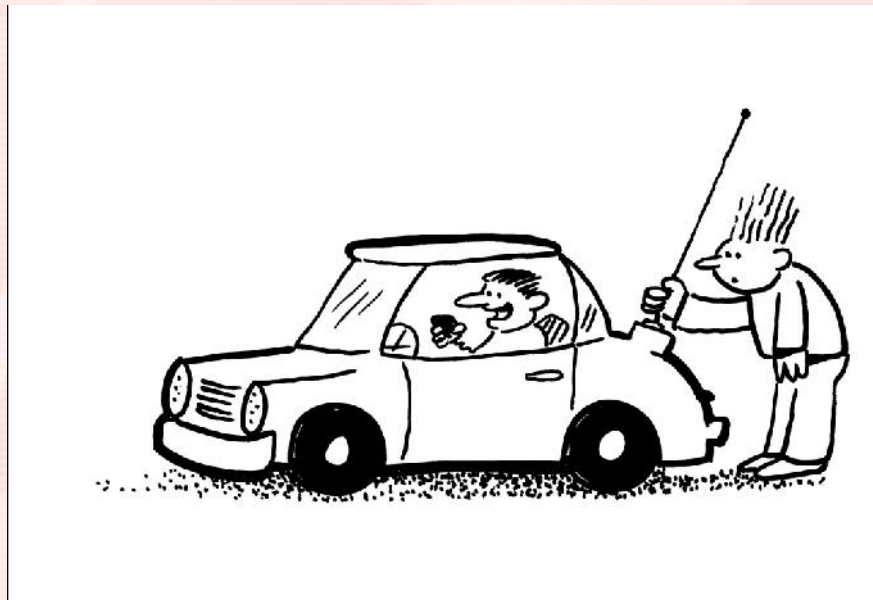
All of these choices are correct

T0C: RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others.

- **T0C7 What could happen if a person accidentally touched your antenna while you were transmitting?**

They might receive a painful RF burn

- Accidentally or on purpose, depending on the power too.



Be sure to place your antennas where no one can touch them. All antennas, not just the mobile ones.

T0C: RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others.

- **T0C8 Which of the following actions might amateur operators take to prevent exposure to RF radiation in excess of FCC-supplied limits?**
Relocate antennas



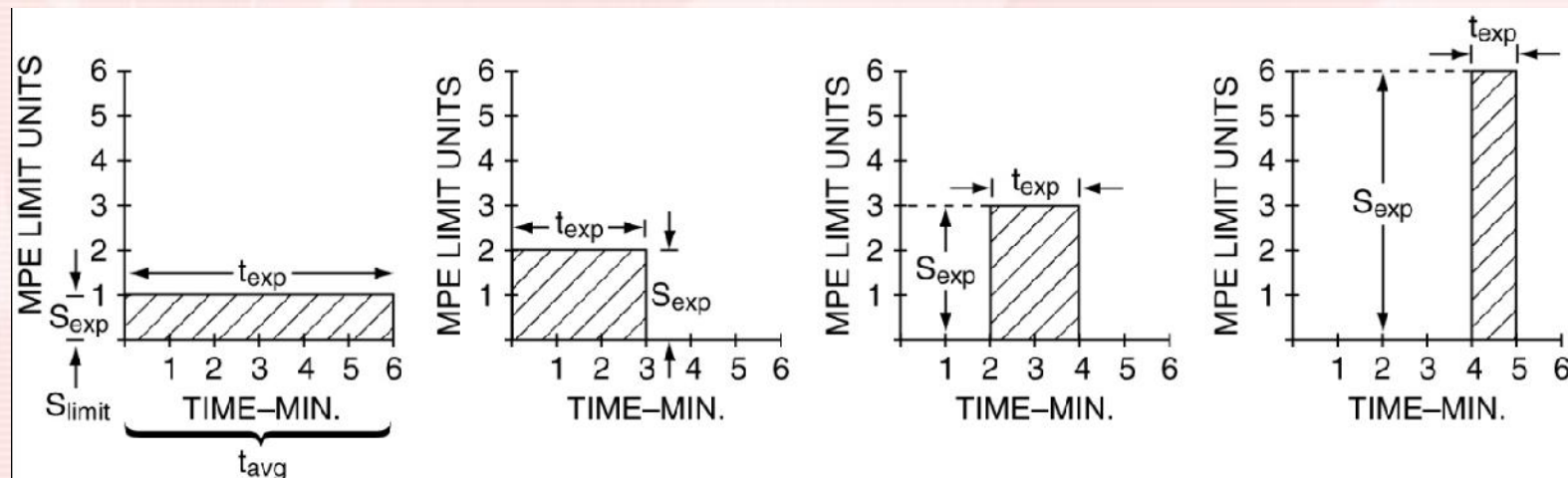
The safest place to mount the mobile antenna for minimum RF exposure is on the metal roof as shown.

- **T0C9 How can you make sure your station stays in compliance with RF safety regulations?** By re-evaluating the station whenever an item of equipment is changed

T0C: RF hazards; radiation exposure, proximity to antennas, recognized safe power levels, exposure to others.

- **T0C10 Why is duty cycle one of the factors used to determine safe RF radiation exposure levels?**

It affects the average exposure of people to radiation



- **T0C11 What is meant by "duty cycle" when referring to RF exposure?** The ratio of on-air time to total operating time of a transmitted signal

That's All Folks!

THANK YOU FOR PARTICIPATING IN
THIS TECHNICIAN CLASS!

SEE YOU HERE ON THURSDAY, MAY
29, 2014.

Reminder: Please bring your SS# and
a calculator.