

# Subelement E1 - Commission's Rules

## Group E1A - Operating Standards: frequency privileges; emission standards; automatic message forwarding; frequency sharing; stations aboard ships or aircraft

E1A01 (D)

When using a transceiver that displays the carrier frequency of phone signals, which of the following displayed frequencies represents the highest frequency at which a properly adjusted USB emission will be totally within the band?

- 3 kHz below the upper band edge

E1A02 (D)

When using a transceiver that displays the carrier frequency of phone signals, which of the following displayed frequencies represents the lowest frequency at which a properly adjusted LSB emission will be totally within the band?

- 3 kHz above the lower band edge

E1A03 (C)

With your transceiver displaying the carrier frequency of phone signals, you hear a station calling CQ on 14.349 MHz USB. Is it legal to return the call using upper sideband on the same frequency?

- No, the sideband will extend beyond the band edge

E1A04 (C)

With your transceiver displaying the carrier frequency of phone signals, you hear a DX station calling CQ on 3.601 MHz LSB. Is it legal to return the call using lower sideband on the same frequency?

- No, the sideband will extend beyond the edge of the phone band segment

E1A05 (C)

What is the maximum power output permitted on the 60 meter band?

- 100 watts PEP effective radiated power relative to the gain of a half-wave dipole

E1A06 (B)

Where must the carrier frequency of a CW signal be set to comply with FCC rules for 60 meter operation?

- At the center frequency of the channel

E1A07 (D)

Which amateur band requires transmission on specific channels rather than on a range of frequencies?

- 60 meter band

E1A08 (B)

If a station in a message forwarding system inadvertently forwards a message that is in violation of FCC rules, who is primarily accountable for the rules violation?

- The control operator of the originating station

E1A09 (A)

What is the first action you should take if your digital message forwarding station inadvertently forwards a communication that violates FCC rules?

- Discontinue forwarding the communication as soon as you become aware of it

E1A10 (A)

If an amateur station is installed aboard a ship or aircraft, what condition must be met before the station is operated?

- Its operation must be approved by the master of the ship or the pilot in command of the aircraft

E1A11 (B)

Which of the following describes authorization or licensing required when operating an amateur station aboard a U.S.-registered vessel in international waters?

- Any FCC-issued amateur license

E1A12 (C)

With your transceiver displaying the carrier frequency of CW signals, you hear a DX station's CQ on 3.500 MHz. Is it legal to return the call using CW on the same frequency?

- No, one of the sidebands of the CW signal will be out of the band

E1A13 (B)

Who must be in physical control of the station apparatus of an amateur station aboard any vessel or craft that is documented or registered in the United States?

- Any person holding an FCC issued amateur license or who is authorized for alien reciprocal operation

E1A14 (D)

What is the maximum bandwidth for a data emission on 60 meters?

- 2.8 kHz

## **Group E1B - Station restrictions and special operations: restrictions on station location; general operating restrictions, spurious emissions, control operator reimbursement; antenna structure restrictions; RACES operations**

E1B01 (D)

Which of the following constitutes a spurious emission?

- An emission outside its necessary bandwidth that can be reduced or eliminated without affecting the information transmitted

E1B02 (D)

Which of the following factors might cause the physical location of an amateur station apparatus or antenna structure to be restricted?

- The location is of environmental importance or significant in American history, architecture, or culture

E1B03 (A)

Within what distance must an amateur station protect an FCC monitoring facility from harmful interference?

- 1 mile

E1B04 (C)

What must be done before placing an amateur station within an officially designated wilderness area or wildlife preserve, or an area listed in the National Register of Historical Places?

- An Environmental Assessment must be submitted to the FCC

E1B05 (C)

What is the National Radio Quiet Zone?

- An area surrounding the National Radio Astronomy Observatory

E1B06 (A)

Which of the following additional rules apply if you are installing an amateur station antenna at a site at or near a public use airport?

- You may have to notify the Federal Aviation Administration and register it with the FCC as required by Part 17 of FCC rules

E1B07 (B)

What is the highest modulation index permitted at the highest modulation frequency for angle modulation below 29.0 MHz?

- 1.0

E1B08 (D)

What limitations may the FCC place on an amateur station if its signal causes interference to domestic broadcast reception, assuming that the receivers involved are of good engineering design?

- The amateur station must avoid transmitting during certain hours on frequencies that cause the interference

E1B09 (C)

Which amateur stations may be operated under RACES rules?

- Any FCC-licensed amateur station certified by the responsible civil defense organization for the area served

E1B10 (A)

What frequencies are authorized to an amateur station operating under RACES rules?

- All amateur service frequencies authorized to the control operator

E1B11 (A)

What is the permitted mean power of any spurious emission relative to the mean power of the fundamental emission from a station transmitter or external RF amplifier installed after January 1, 2003 and transmitting on a frequency below 30 MHz?

- At least 43 dB below

## **Group E1C - Station control: definitions and restrictions pertaining to local, automatic and remote control operation; control operator responsibilities for remote and automatically controlled stations**

E1C01 (D)

What is a remotely controlled station?

- A station controlled indirectly through a control link

E1C02 (A)

What is meant by automatic control of a station?

- The use of devices and procedures for control so that the control operator does not have to be present at a control point

E1C03 (B)

How do the control operator responsibilities of a station under automatic control differ from one under local control?

- Under automatic control the control operator is not required to be present at the control point

E1C04 (A)

What is meant by IARP?

- An international amateur radio permit that allows U.S. amateurs to operate in certain countries of the Americas

E1C05 (A)

When may an automatically controlled station originate third party communications?

- Never

E1C06 (C)

Which of the following statements concerning remotely controlled amateur stations is true?

- A control operator must be present at the control point

E1C07 (C)

What is meant by local control?

- Direct manipulation of the transmitter by a control operator

E1C08 (B)

What is the maximum permissible duration of a remotely controlled station's transmissions if its control link malfunctions?

- 3 minutes

E1C09 (D)

Which of these ranges of frequencies is available for an automatically controlled repeater operating below 30 MHz?

- 29.500 MHz - 29.700 MHz

E1C10 (B)

What types of amateur stations may automatically retransmit the radio signals of other amateur stations?

- Only auxiliary, repeater or space stations

E1C11 (A)

Which of the following operating arrangements allows an FCC-licensed U.S. citizen to operate in many European countries, and alien amateurs from many European countries to operate in the U.S.?

- CEPT agreement

E1C12 (C)

What types of communications may be transmitted to amateur stations in foreign countries?

- Communications incidental to the purpose of the amateur service and remarks of a personal nature

E1C13 (C)

Which of the following is required in order to operate in accordance with CEPT rules in foreign countries where permitted?

- You must bring a copy of FCC Public Notice DA 11-221

## **Group E1D - Amateur Satellite service: definitions and purpose; license requirements for space stations; available frequencies and bands; telecommand and telemetry operations; restrictions, and special provisions; notification requirements**

E1D01 (A)

What is the definition of the term telemetry?

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

E1D02 (C)

What is the amateur satellite service?

- A radio communications service using amateur radio stations on satellites

E1D03 (B)

What is a telecommand station in the amateur satellite service?

- An amateur station that transmits communications to initiate, modify or terminate functions of a space station

E1D04 (A)

What is an Earth station in the amateur satellite service?

- An amateur station within 50 km of the Earth's surface intended for communications with amateur stations by means of objects in space

E1D05 (C)

What class of licensee is authorized to be the control operator of a space station?

- Any class with appropriate operator privileges

E1D06 (A)

Which of the following is a requirement of a space station?

- The space station must be capable of terminating transmissions by telecommand when directed by the FCC

E1D07 (A)

Which amateur service HF bands have frequencies authorized for space stations?

- Only the 40 m, 20 m, 17 m, 15 m, 12 m and 10 m bands

E1D08 (D)

Which VHF amateur service bands have frequencies available for space stations?

- 2 meters

E1D09 (B)

Which UHF amateur service bands have frequencies available for a space station?

- 70 cm and 13 cm

E1D10 (B)

Which amateur stations are eligible to be telecommand stations?

- Any amateur station so designated by the space station licensee, subject to the privileges of the class of operator license held by the control operator

E1D11 (D)



Which amateur stations are eligible to operate as Earth stations?

- Any amateur station, subject to the privileges of the class of operator license held by the control operator

## **Group E1E - Volunteer examiner program: definitions, qualifications, preparation and administration of exams; accreditation; question pools; documentation requirements**

E1E01 (D)

What is the minimum number of qualified VEs required to administer an Element 4 amateur operator license examination?

- 3

E1E02 (C)

Where are the questions for all written U.S. amateur license examinations listed?

- In a question pool maintained by all the VECs

E1E03 (C)

What is a Volunteer Examiner Coordinator?

- An organization that has entered into an agreement with the FCC to coordinate amateur operator license examinations

E1E04 (D)

Which of the following best describes the Volunteer Examiner accreditation process?

- The procedure by which a VEC confirms that the VE applicant meets FCC requirements to serve as an examiner

E1E05 (B)

What is the minimum passing score on amateur operator license examinations?

- Minimum passing score of 74%

E1E06 (C)

Who is responsible for the proper conduct and necessary supervision during an amateur operator license examination session?

- Each administering VE

E1E07 (B)

What should a VE do if a candidate fails to comply with the examiner's instructions during an amateur operator license examination?

- Immediately terminate the candidate's examination

E1E08 (C)

To which of the following examinees may a VE not administer an examination?

- Relatives of the VE as listed in the FCC rules

E1E09 (A)

What may be the penalty for a VE who fraudulently administers or certifies an examination?

- Revocation of the VE's amateur station license grant and the suspension of the VE's amateur operator license grant

E1E10 (C)

What must the administering VEs do after the administration of a successful examination for an amateur operator license?

- They must submit the application document to the coordinating VEC according to the coordinating VEC instructions

E1E11 (B)

What must the VE team do if an examinee scores a passing grade on all examination elements needed for an upgrade or new license?

- Three VEs must certify that the examinee is qualified for the license grant and that they have complied with the administering VE requirements

E1E12 (A)

What must the VE team do with the application form if the examinee does not pass the exam?

- Return the application document to the examinee

E1E13 (B)

Which of these choices is an acceptable method for monitoring the applicants if a VEC opts to conduct an exam session remotely?

- Use a real-time video link and the Internet to connect the exam session to the observing VEs

E1E14 (A)

For which types of out-of-pocket expenses do the Part 97 rules state that VEs and VECs may be reimbursed?

- Preparing, processing, administering and coordinating an examination for an amateur radio license

**Group E1F - Miscellaneous rules: external RF power amplifiers; national quiet zone; business communications; compensated communications; spread spectrum; auxiliary stations; reciprocal operating privileges; IARP and CEPT licenses; third party communications with for**

E1F01 (B)

On what frequencies are spread spectrum transmissions permitted?

- Only on amateur frequencies above 222 MHz

E1F02 (C)

What privileges are authorized in the U.S. to persons holding an amateur service license granted by the Government of Canada?

- The operating terms and conditions of the Canadian amateur service license, not to exceed U.S. Extra Class privileges

E1F03 (A)

Under what circumstances may a dealer sell an external RF power amplifier capable of operation below 144 MHz if it has not been granted FCC certification?

- It was purchased in used condition from an amateur operator and is sold to another amateur operator for use at that operator's station

E1F04 (A)

Which of the following geographic descriptions approximately describes "Line A"?

- A line roughly parallel to and south of the U.S.-Canadian border

E1F05 (D)

Amateur stations may not transmit in which of the following frequency segments if they are located in the contiguous 48 states and north of Line A?

- 420 MHz - 430 MHz

E1F06 (A)

Under what circumstances might the FCC issue a Special Temporary Authority (STA) to an amateur station?

- To provide for experimental amateur communications

E1F07 (D)

When may an amateur station send a message to a business?

- When neither the amateur nor his or her employer has a pecuniary interest in the communications

E1F08 (A)

Which of the following types of amateur station communications are prohibited?

- Communications transmitted for hire or material compensation, except as otherwise provided in the rules

E1F09 (D)

Which of the following conditions apply when transmitting spread spectrum emission?

- All of these choices are correct

E1F10 (C)

What is the maximum permitted transmitter peak envelope power for an amateur station transmitting spread spectrum communications?

- 10 W

E1F11 (D)

Which of the following best describes one of the standards that must be met by an external RF power amplifier if it is to qualify for a grant of FCC certification?

- It must satisfy the FCC's spurious emission standards when operated at the lesser of 1500 watts or its full output power

E1F12 (B)

Who may be the control operator of an auxiliary station?

- Only Technician, General, Advanced or Amateur Extra Class operators

## **Subelement E2 - Operating Procedures**

### **Group E2A - Amateur radio in space: amateur satellites; orbital mechanics; frequencies and modes; satellite hardware; satellite operations**

E2A01 (C)

What is the direction of an ascending pass for an amateur satellite?

- From south to north

E2A02 (A)

What is the direction of a descending pass for an amateur satellite?

- From north to south

E2A03 (C)

What is the orbital period of an Earth satellite?

- The time it takes for a satellite to complete one revolution around the Earth

E2A04 (B)

What is meant by the term mode as applied to an amateur radio satellite?

- The satellite's uplink and downlink frequency bands

E2A05 (D)

What do the letters in a satellite's mode designator specify?

- The uplink and downlink frequency ranges

E2A06 (A)

On what band would a satellite receive signals if it were operating in mode U/V?

- 435 MHz - 438 MHz

E2A07 (D)

Which of the following types of signals can be relayed through a linear transponder?

- All of these choices are correct

E2A08 (B)

Why should effective radiated power to a satellite which uses a linear transponder be limited?

- To avoid reducing the downlink power to all other users

E2A09 (A)

What do the terms L band and S band specify with regard to satellite communications?

- The 23 centimeter and 13 centimeter bands

E2A10 (A)

Why may the received signal from an amateur satellite exhibit a rapidly repeating fading effect?

- Because the satellite is spinning

E2A11 (B)

What type of antenna can be used to minimize the effects of spin modulation and Faraday rotation?

- A circularly polarized antenna

E2A12 (D)

What is one way to predict the location of a satellite at a given time?

- By calculations using the Keplerian elements for the specified satellite

E2A13 (B)

What type of satellite appears to stay in one position in the sky?

- Geostationary

E2A14 (C)

What technology is used to track, in real time, balloons carrying amateur radio transmitters?

- APRS

## **Group E2B - Television practices: fast scan television standards and techniques; slow scan television standards and techniques**

E2B01 (A)

How many times per second is a new frame transmitted in a fast-scan (NTSC) television system?

- 30

E2B02 (C)

How many horizontal lines make up a fast-scan (NTSC) television frame?

- 525

E2B03 (D)

How is an interlaced scanning pattern generated in a fast-scan (NTSC) television system?

- By scanning odd numbered lines in one field and even numbered lines in the next

E2B04 (B)

What is blanking in a video signal?

- Turning off the scanning beam while it is traveling from right to left or from bottom to top

E2B05 (C)

Which of the following is an advantage of using vestigial sideband for standard fast- scan TV transmissions?

- Vestigial sideband reduces bandwidth while allowing for simple video detector circuitry

E2B06 (A)

What is vestigial sideband modulation?

- Amplitude modulation in which one complete sideband and a portion of the other are transmitted

E2B07 (B)

What is the name of the signal component that carries color information in NTSC video?

- Chroma

E2B08 (D)

Which of the following is a common method of transmitting accompanying audio with amateur fast-scan television?

- All of these choices are correct

E2B09 (D)

What hardware, other than a receiver with SSB capability and a suitable computer, is needed to decode SSTV using Digital Radio Mondiale (DRM)?

- No other hardware is needed

E2B10 (A)

Which of the following is an acceptable bandwidth for Digital Radio Mondiale (DRM) based voice or SSTV digital transmissions made on the HF amateur bands?

- 3 KHz

E2B11 (B)

What is the function of the Vertical Interval Signaling (VIS) code sent as part of an SSTV transmission?

- To identify the SSTV mode being used



E2B12 (D)

How are analog SSTV images typically transmitted on the HF bands?

- Varying tone frequencies representing the video are transmitted using single sideband

E2B13 (C)

How many lines are commonly used in each frame of an amateur slow-scan color television picture?

- 128 or 256

E2B14 (A)

What aspect of an amateur slow-scan television signal encodes the brightness of the picture?

- Tone frequency

E2B15 (A)

What signals SSTV receiving equipment to begin a new picture line?

- Specific tone frequencies

E2B16 (D)

Which is a video standard used by North American Fast Scan ATV stations?

- NTSC

E2B17 (B)

What is the approximate bandwidth of a slow-scan TV signal?

- 3 kHz

E2B18 (D)

On which of the following frequencies is one likely to find FM ATV transmissions?

- 1255 MHz

E2B19 (C)

What special operating frequency restrictions are imposed on slow scan TV transmissions?

- They are restricted to phone band segments and their bandwidth can be no greater than that of a voice signal of the same modulation type

## **Group E2C - Operating methods: contest and DX operating; spread-spectrum transmissions; selecting an operating frequency**

E2C01 (A)

Which of the following is true about contest operating?

- Operators are permitted to make contacts even if they do not submit a log

E2C02 (A)

Which of the following best describes the term self-spotting in regards to HF contest operating?

- The generally prohibited practice of posting one's own call sign and frequency on a spotting network

E2C03 (A)

From which of the following bands is amateur radio contesting generally excluded?

- 30 m

E2C04 (A)

What type of transmission is most often used for a ham radio mesh network?

- Spread spectrum in the 2.4 GHz band

E2C05 (B)

What is the function of a DX QSL Manager?

- To handle the receiving and sending of confirmation cards for a DX station

E2C06 (C)

During a VHF/UHF contest, in which band segment would you expect to find the highest level of activity?

- In the weak signal segment of the band, with most of the activity near the calling frequency

E2C07 (A)

What is the Cabrillo format?

- A standard for submission of electronic contest logs

E2C08 (B)

Which of the following contacts may be confirmed through the U.S. QSL bureau system?

- Contacts between a U.S. station and a non-U.S. station

E2C09 (C)

What type of equipment is commonly used to implement a ham radio mesh network?

- A standard wireless router running custom software

E2C10 (D)

Why might a DX station state that they are listening on another frequency?

- All of these choices are correct

E2C11 (A)

How should you generally identify your station when attempting to contact a DX station during a contest or in a pileup?

- Send your full call sign once or twice

E2C12 (B)

What might help to restore contact when DX signals become too weak to copy across an entire HF band a few hours after sunset?

- Switch to a lower frequency HF band

E2C13 (D)

What indicator is required to be used by U.S.-licensed operators when operating a station via remote control where the transmitter is located in the U.S.?

- No additional indicator is required

## **Group E2D - Operating methods: VHF and UHF digital modes; APRS**

E2D01 (B)

Which of the following digital modes is especially designed for use for meteor scatter signals?

- FSK441

E2D02 (D)

Which of the following is a good technique for making meteor scatter contacts?

- All of these choices are correct

E2D03 (D)

Which of the following digital modes is especially useful for EME communications?

- JT65

E2D04 (C)

What is the purpose of digital store-and-forward functions on an Amateur Radio satellite?

- To store digital messages in the satellite for later download by other stations

E2D05 (B)

Which of the following techniques is normally used by low Earth orbiting digital satellites to relay messages around the world?

- Store-and-forward

E2D06 (A)

Which of the following describes a method of establishing EME contacts?

- Time synchronous transmissions alternately from each station

E2D07 (C)

What digital protocol is used by APRS?

- AX.25

E2D08 (A)

What type of packet frame is used to transmit APRS beacon data?

- Unnumbered Information

E2D09 (D)

Which of these digital modes has the fastest data throughput under clear communication conditions?

- 300 baud packet

E2D10 (C)

How can an APRS station be used to help support a public service communications activity?

- An APRS station with a GPS unit can automatically transmit information to show a mobile station's position during the event

E2D11 (D)

Which of the following data are used by the APRS network to communicate your location?

- Latitude and longitude

E2D12 (A)

How does JT65 improve EME communications?

- It can decode signals many dB below the noise floor using FEC

E2D13 (A)

What type of modulation is used for JT65 contacts?

- Multi-tone AFSK

E2D14 (B)

What is one advantage of using JT65 coding?

- The ability to decode signals which have a very low signal to noise ratio

## **Group E2E - Operating methods: operating HF digital modes; error correction**

E2E01 (B)

Which type of modulation is common for data emissions below 30 MHz?

- FSK

E2E02 (A)

What do the letters FEC mean as they relate to digital operation?

- Forward Error Correction

E2E03 (C)

How is the timing of JT65 contacts organized?

- Alternating transmissions at 1 minute intervals

E2E04 (A)

What is indicated when one of the ellipses in an FSK crossed-ellipse display suddenly disappears?

- Selective fading has occurred

E2E05 (A)

Which type of digital mode does not support keyboard-to-keyboard operation?

- Winlink

E2E06 (C)

What is the most common data rate used for HF packet?

- 300 baud

E2E07 (B)

What is the typical bandwidth of a properly modulated MFSK16 signal?

- 316 Hz

E2E08 (B)

Which of the following HF digital modes can be used to transfer binary files?

- PACTOR

E2E09 (D)

Which of the following HF digital modes uses variable-length coding for bandwidth efficiency?

- PSK31

E2E10 (C)

Which of these digital modes has the narrowest bandwidth?

- PSK31

E2E11 (A)

What is the difference between direct FSK and audio FSK?

- Direct FSK applies the data signal to the transmitter VFO

E2E12 (C)

Which type of control is used by stations using the Automatic Link Enable (ALE) protocol?

- Automatic

E2E13 (D)

Which of the following is a possible reason that attempts to initiate contact with a digital station on a clear frequency are unsuccessful?

- All of these choices are correct

## **Subelement E3 - Radio Wave Propagation**

### **Group E3A - Propagation and technique, Earth-Moon-Earth communications; meteor scatter**

E3A01 (D)

What is the approximate maximum separation measured along the surface of the Earth between two stations communicating by Moon bounce?

- 12,000 miles, if the Moon is visible by both stations

E3A02 (B)

What characterizes libration fading of an EME signal?

- A fluttery irregular fading

E3A03 (A)

When scheduling EME contacts, which of these conditions will generally result in the least path loss?

- When the Moon is at perigee

E3A04 (D)

What do Hepburn maps predict?

- Probability of tropospheric propagation

E3A05 (C)

Tropospheric propagation of microwave signals often occurs along what weather related structure?

- Warm and cold fronts

E3A06 (C)

Which of the following is required for microwave propagation via rain scatter?

- The rain must be within radio range of both stations

E3A07 (C)

Atmospheric ducts capable of propagating microwave signals often form over what geographic feature?

- Bodies of water

E3A08 (A)



When a meteor strikes the Earth's atmosphere, a cylindrical region of free electrons is formed at what layer of the ionosphere?

- The E layer

E3A09 (C)

Which of the following frequency range is most suited for meteor scatter communications?

- 28 MHz - 148 MHz

E3A10 (B)

Which type of atmospheric structure can create a path for microwave propagation?

- Temperature inversion

E3A11 (B)

What is a typical range for tropospheric propagation of microwave signals?

- 100 miles to 300 miles

E3A12 (C)

What is the cause of auroral activity?

- The interaction in the E layer of charged particles from the Sun with the Earth's magnetic field

E3A13 (A)

Which emission mode is best for aurora propagation?

- CW

E3A14 (B)

From the contiguous 48 states, in which approximate direction should an antenna be pointed to take maximum advantage of aurora propagation?

- North

E3A15 (C)

What is an electromagnetic wave?

- A wave consisting of an electric field and a magnetic field oscillating at right angles to each other

E3A16 (D)

Which of the following best describes electromagnetic waves traveling in free space?

- Changing electric and magnetic fields propagate the energy

E3A17 (B)

What is meant by circularly polarized electromagnetic waves?

- Waves with a rotating electric field

## **Group E3B - Propagation and technique, trans-equatorial; long path; gray-line; multi-path propagation**

E3B01 (A)

What is transequatorial propagation?

- Propagation between two mid-latitude points at approximately the same distance north and south of the magnetic equator

E3B02 (C)

What is the approximate maximum range for signals using transequatorial propagation?

- 5000 miles

E3B03 (C)

What is the best time of day for transequatorial propagation?

- Afternoon or early evening

E3B04 (B)

What is meant by the terms extraordinary and ordinary waves?

- Independent waves created in the ionosphere that are elliptically polarized

E3B05 (C)

Which amateur bands typically support long-path propagation?

- 160 meters to 10 meters

E3B06 (B)

Which of the following amateur bands most frequently provides long-path propagation?

- 20 meters

E3B07 (D)

Which of the following could account for hearing an echo on the received signal of a distant station?

- Receipt of a signal by more than one path

E3B08 (D)

What type of HF propagation is probably occurring if radio signals travel along the terminator between daylight and darkness?

- Gray-line

E3B09 (A)

At what time of year is Sporadic E propagation most likely to occur?

- Around the solstices, especially the summer solstice

E3B10 (B)

What is the cause of gray-line propagation?

- At twilight and sunrise, D-layer absorption is low while E-layer and F-layer propagation remains high

E3B11 (D)

At what time of day is Sporadic-E propagation most likely to occur?

- Any time

E3B12 (B)

What is the primary characteristic of chordal hop propagation?

- Successive ionospheric reflections without an intermediate reflection from the ground

E3B13 (A)

Why is chordal hop propagation desirable?

- The signal experiences less loss along the path compared to normal skip propagation

E3B14 (C)

What happens to linearly polarized radio waves that split into ordinary and extraordinary waves in the ionosphere?

- They become elliptically polarized

## **Group E3C - Propagation and technique, Aurora propagation; selective fading; radio-path horizon; take-off angle over flat or sloping terrain; effects of ground on propagation; less common propagation modes**

E3C01 (B)

What does the term ray tracing describe in regard to radio communications?

- Modeling a radio wave's path through the ionosphere

E3C02 (A)

What is indicated by a rising A or K index?

- Increasing disruption of the geomagnetic field

E3C03 (B)

Which of the following signal paths is most likely to experience high levels of absorption when the A index or K index is elevated?

- Polar paths

E3C04 (C)

What does the value of B<sub>Z</sub> (B sub Z) represent?

- Direction and strength of the interplanetary magnetic field

E3C05 (A)

What orientation of Bz (B sub z) increases the likelihood that incoming particles from the Sun will cause disturbed conditions?

- Southward

E3C06 (A)

By how much does the VHF/UHF radio horizon distance exceed the geometric horizon?

- By approximately 15 percent of the distance

E3C07 (D)

Which of the following descriptors indicates the greatest solar flare intensity?

- Class X

E3C08 (A)

What does the space weather term G5 mean?

- An extreme geomagnetic storm

E3C09 (C)

How does the intensity of an X3 flare compare to that of an X2 flare?

- Twice as great

E3C10 (B)

What does the 304A solar parameter measure?

- UV emissions at 304 angstroms, correlated to solar flux index

E3C11 (C)

What does VOACAP software model?

- HF propagation

E3C12 (C)

How does the maximum distance of ground-wave propagation change when the signal frequency is increased?

- It decreases

E3C13 (A)

What type of polarization is best for ground-wave propagation?

- Vertical

E3C14 (D)

Why does the radio-path horizon distance exceed the geometric horizon?

- Downward bending due to density variations in the atmosphere

E3C15 (B)

What might a sudden rise in radio background noise indicate?

- A solar flare has occurred

## **Subelement E4 - Amateur Practices**

### **Group E4A - Test equipment: analog and digital instruments; spectrum and network analyzers, antenna analyzers; oscilloscopes; testing transistors; RF measurements**

E4A01 (C)

Which of the following parameter determines the bandwidth of a digital or computer-based oscilloscope?

- Sampling rate

E4A02 (B)

Which of the following parameters would a spectrum analyzer display on the vertical and horizontal axes?

- RF amplitude and frequency

E4A03 (B)

Which of the following test instrument is used to display spurious signals and/or intermodulation distortion products in an SSB transmitter?

- A spectrum analyzer

E4A04 (A)

What determines the upper frequency limit for a computer soundcard-based oscilloscope program?

- Analog-to-digital conversion speed of the soundcard

E4A05 (D)

What might be an advantage of a digital vs an analog oscilloscope?

- All of these choices are correct

E4A06 (A)

What is the effect of aliasing in a digital or computer-based oscilloscope?

- False signals are displayed

E4A07 (B)

Which of the following is an advantage of using an antenna analyzer compared to an SWR bridge to measure antenna SWR?

- Antenna analyzers do not need an external RF source

E4A08 (D)

Which of the following instrument would be best for measuring the SWR of a beam antenna?

- An antenna analyzer

E4A09 (B)

When using a computer's soundcard input to digitize signals, what is the highest frequency signal that can be digitized without aliasing?

- One-half the sample rate

E4A10 (D)

Which of the following displays multiple digital signal states simultaneously?

- Logic analyzer

E4A11 (A)

Which of the following is good practice when using an oscilloscope probe?

- Keep the signal ground connection of the probe as short as possible

E4A12 (B)

Which of the following procedures is an important precaution to follow when connecting a spectrum analyzer to a transmitter output?

- Attenuate the transmitter output going to the spectrum analyzer

E4A13 (A)

How is the compensation of an oscilloscope probe typically adjusted?

- A square wave is displayed and the probe is adjusted until the horizontal portions of the displayed wave are as nearly flat as possible

E4A14 (D)

What is the purpose of the prescaler function on a frequency counter?

- It divides a higher frequency signal so a low-frequency counter can display the input frequency

E4A15 (C)

What is an advantage of a period-measuring frequency counter over a direct-count type?

- It provides improved resolution of low-frequency signals within a comparable time period

**Group E4B - Measurement technique and limitations;  
instrument accuracy and performance limitations; probes;  
techniques to minimize errors; measurement of "Q";  
instrument calibration**



E4B01 (B)

Which of the following factors most affects the accuracy of a frequency counter?

- Time base accuracy

E4B02 (C)

What is an advantage of using a bridge circuit to measure impedance?

- It is very precise in obtaining a signal null

E4B03 (C)

If a frequency counter with a specified accuracy of  $\pm 1.0$  ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?

- 146.52 Hz

E4B04 (A)

If a frequency counter with a specified accuracy of  $\pm 0.1$  ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?

- 14.652 Hz

E4B05 (D)

If a frequency counter with a specified accuracy of  $\pm 10$  ppm reads 146,520,000 Hz, what is the most the actual frequency being measured could differ from the reading?

- 1465.20 Hz

E4B06 (D)

How much power is being absorbed by the load when a directional power meter connected between a transmitter and a terminating load reads 100 watts forward power and 25 watts reflected power?

- 75 watts

E4B07 (A)

What do the subscripts of S parameters represent?

- The port or ports at which measurements are made

E4B08 (C)

Which of the following is a characteristic of a good DC voltmeter?

- High impedance input

E4B09 (D)

What is indicated if the current reading on an RF ammeter placed in series with the antenna feed line of a transmitter increases as the transmitter is tuned to resonance?

- There is more power going into the antenna

E4B10 (B)

Which of the following describes a method to measure intermodulation distortion in an SSB transmitter?

- Modulate the transmitter with two non-harmonically related audio frequencies and observe the RF output with a spectrum analyzer

E4B11 (D)

How should an antenna analyzer be connected when measuring antenna resonance and feed point impedance?

- Connect the antenna feed line directly to the analyzer's connector

E4B12 (A)

What is the significance of voltmeter sensitivity expressed in ohms per volt?

- The full scale reading of the voltmeter multiplied by its ohms per volt rating will indicate the input impedance of the voltmeter

E4B13 (C)

Which S parameter is equivalent to forward gain?

- S<sub>21</sub>

E4B14 (B)

What happens if a dip meter is too tightly coupled to a tuned circuit being checked?

- A less accurate reading results

E4B15 (C)

Which of the following can be used as a relative measurement of the Q for a series-tuned circuit?

- The bandwidth of the circuit's frequency response

E4B16 (A)

Which S parameter represents return loss or SWR?

- S11

E4B17 (B)

What three test loads are used to calibrate a standard RF vector network analyzer?

- Short circuit, open circuit, and 50 ohms

## **Group E4C - Receiver performance characteristics, phase noise, capture effect, noise floor, image rejection, MDS, signal-to-noise-ratio; selectivity**

E4C01 (D)

What is an effect of excessive phase noise in the local oscillator section of a receiver?

- It can cause strong signals on nearby frequencies to interfere with reception of weak signals

E4C02 (A)

Which of the following portions of a receiver can be effective in eliminating image signal interference?

- A front-end filter or pre-selector

E4C03 (C)

What is the term for the blocking of one FM phone signal by another, stronger FM phone signal?

- Capture effect

E4C04 (D)

How is the noise figure of a receiver defined?

- The ratio in dB of the noise generated by the receiver to the theoretical minimum noise

E4C05 (B)

What does a value of -174 dBm/Hz represent with regard to the noise floor of a receiver?

- The theoretical noise at the input of a perfect receiver at room temperature

E4C06 (D)

A CW receiver with the AGC off has an equivalent input noise power density of -174 dBm/Hz. What would be the level of an unmodulated carrier input to this receiver that would yield an audio output SNR of 0 dB in a 400 Hz noise bandwidth?

- -148 dBm

E4C07 (B)

What does the MDS of a receiver represent?

- The minimum discernible signal

E4C08 (C)

An SDR receiver is overloaded when input signals exceed what level?

- The maximum count value of the analog-to-digital converter

E4C09 (C)

Which of the following choices is a good reason for selecting a high frequency for the design of the IF in a conventional HF or VHF communications receiver?

- Easier for front-end circuitry to eliminate image responses

E4C10 (B)

Which of the following is a desirable amount of selectivity for an amateur RTTY HF receiver?

- 300 Hz

E4C11 (B)

Which of the following is a desirable amount of selectivity for an amateur SSB phone receiver?

- 2.4 kHz

E4C12 (D)

What is an undesirable effect of using too wide a filter bandwidth in the IF section of a receiver?

- Undesired signals may be heard

E4C13 (C)

How does a narrow-band roofing filter affect receiver performance?

- It improves dynamic range by attenuating strong signals near the receive frequency

E4C14 (D)

What transmit frequency might generate an image response signal in a receiver tuned to 14.300 MHz and which uses a 455 kHz IF frequency?

- 15.210 MHz

E4C15 (D)

What is usually the primary source of noise that is heard from an HF receiver with an antenna connected?

- Atmospheric noise

E4C16 (A)

Which of the following is caused by missing codes in an SDR receiver's analog-to-digital converter?

- Distortion

E4C17 (D)

Which of the following has the largest effect on an SDR receiver's linearity?

- Analog-to-digital converter sample width in bits

**Group E4D - Receiver performance characteristics, blocking dynamic range, intermodulation and cross-modulation interference; 3rd order intercept; desensitization; preselection**

E4D01 (A)

What is meant by the blocking dynamic range of a receiver?

- The difference in dB between the noise floor and the level of an incoming signal which will cause 1 dB of gain compression

E4D02 (A)

Which of the following describes two problems caused by poor dynamic range in a communications receiver?

- Cross-modulation of the desired signal and desensitization from strong adjacent signals

E4D03 (B)

How can intermodulation interference between two repeaters occur?

- When the repeaters are in close proximity and the signals mix in the final amplifier of one or both transmitters

E4D04 (B)

Which of the following may reduce or eliminate intermodulation interference in a repeater caused by another transmitter operating in close proximity?

- A properly terminated circulator at the output of the transmitter

E4D05 (A)

What transmitter frequencies would cause an intermodulation-product signal in a receiver tuned to 146.70 MHz when a nearby station transmits on 146.52 MHz?

- 146.34 MHz and 146.61 MHz

E4D06 (D)

What is the term for unwanted signals generated by the mixing of two or more signals?

- Intermodulation interference

E4D07 (D)

Which describes the most significant effect of an off-frequency signal when it is causing cross-modulation interference to a desired signal?

- The off-frequency unwanted signal is heard in addition to the desired signal

E4D08 (C)

What causes intermodulation in an electronic circuit?

- Nonlinear circuits or devices

E4D09 (C)

What is the purpose of the preselector in a communications receiver?

- To increase rejection of unwanted signals

E4D10 (C)

What does a third-order intercept level of 40 dBm mean with respect to receiver performance?

- A pair of 40 dBm signals will theoretically generate a third-order intermodulation product with the same level as the input signals

E4D11 (A)

Why are third-order intermodulation products created within a receiver of particular interest compared to other products?

- The third-order product of two signals which are in the band of interest is also likely to be within the band

E4D12 (A)

What is the term for the reduction in receiver sensitivity caused by a strong signal near the received frequency?

- Desensitization

E4D13 (B)

Which of the following can cause receiver desensitization?

- Strong adjacent channel signals

E4D14 (A)

Which of the following is a way to reduce the likelihood of receiver desensitization?

- Decrease the RF bandwidth of the receiver

## **Group E4E - Noise suppression: system noise; electrical appliance noise; line noise; locating noise sources; DSP noise reduction; noise blankers**

E4E01 (A)

Which of the following types of receiver noise can often be reduced by use of a receiver noise blanker?

- Ignition noise

E4E02 (D)

Which of the following types of receiver noise can often be reduced with a DSP noise filter?

- All of these choices are correct

E4E03 (B)

Which of the following signals might a receiver noise blanker be able to remove from desired signals?

- Signals which appear across a wide bandwidth

E4E04 (D)

How can conducted and radiated noise caused by an automobile alternator be suppressed?

- By connecting the radio's power leads directly to the battery and by installing coaxial capacitors in line with the alternator leads

E4E05 (B)

How can noise from an electric motor be suppressed?

- By installing a brute-force AC-line filter in series with the motor leads

E4E06 (B)

What is a major cause of atmospheric static?

- Thunderstorms



E4E07 (C)

How can you determine if line noise interference is being generated within your home?

- By turning off the AC power line main circuit breaker and listening on a battery operated radio

E4E08 (A)

What type of signal is picked up by electrical wiring near a radio antenna?

- A common-mode signal at the frequency of the radio transmitter

E4E09 (C)

What undesirable effect can occur when using an IF noise blanker?

- Nearby signals may appear to be excessively wide even if they meet emission standards

E4E10 (D)

What is a common characteristic of interference caused by a touch controlled electrical device?

- All of these choices are correct

E4E11 (B)

Which is the most likely cause if you are hearing combinations of local AM broadcast signals within one or more of the MF or HF ham bands?

- Nearby corroded metal joints are mixing and re-radiating the broadcast signals

E4E12 (A)

What is one disadvantage of using some types of automatic DSP notch-filters when attempting to copy CW signals?

- A DSP filter can remove the desired signal at the same time as it removes interfering signals

E4E13 (D)

What might be the cause of a loud roaring or buzzing AC line interference that comes and goes at intervals?

- All of these choices are correct

E4E14 (C)

What is one type of electrical interference that might be caused by the operation of a nearby personal computer?

- The appearance of unstable modulated or unmodulated signals at specific frequencies

E4E15 (B)

Which of the following can cause shielded cables to radiate or receive interference?

- Common mode currents on the shield and conductors

E4E16 (B)

What current flows equally on all conductors of an unshielded multi-conductor cable?

- Common-mode current

## **Subelement E5 - Electrical Principles**

### **Group E5A - Resonance and Q: characteristics of resonant circuits: series and parallel resonance; Q; half-power bandwidth; phase relationships in reactive circuits**

E5A01 (A)

What can cause the voltage across reactances in series to be larger than the voltage applied to them?

- Resonance

E5A02 (C)

What is resonance in an electrical circuit?

- The frequency at which the capacitive reactance equals the inductive reactance

E5A03 (D)

What is the magnitude of the impedance of a series RLC circuit at resonance?

- Approximately equal to circuit resistance

E5A04 (A)

What is the magnitude of the impedance of a circuit with a resistor, an inductor and a capacitor all in parallel, at resonance?

- Approximately equal to circuit resistance

E5A05 (B)

What is the magnitude of the current at the input of a series RLC circuit as the frequency goes through resonance?

- Maximum

E5A06 (B)

What is the magnitude of the circulating current within the components of a parallel LC circuit at resonance?

- It is at a maximum

E5A07 (A)

What is the magnitude of the current at the input of a parallel RLC circuit at resonance?

- Minimum

E5A08 (C)

What is the phase relationship between the current through and the voltage across a series resonant circuit at resonance?

- The voltage and current are in phase

E5A09 (C)

How is the Q of an RLC parallel resonant circuit calculated?

- Resistance divided by the reactance of either the inductance or capacitance

E5A10 (A)

How is the Q of an RLC series resonant circuit calculated?

- Reactance of either the inductance or capacitance divided by the resistance

E5A11 (C)

What is the half-power bandwidth of a parallel resonant circuit that has a resonant frequency of 7.1 MHz and a Q of 150?

- 47.3 kHz

E5A12 (C)

What is the half-power bandwidth of a parallel resonant circuit that has a resonant frequency of 3.7 MHz and a Q of 118?

- 31.4 kHz

E5A13 (C)

What is an effect of increasing Q in a resonant circuit?

- Internal voltages and circulating currents increase

E5A14 (C)

What is the resonant frequency of a series RLC circuit if R is 22 ohms, L is 50 microhenrys and C is 40 picofarads?

- 3.56 MHz

E5A15 (A)

Which of the following can increase Q for inductors and capacitors?

- Lower losses

E5A16 (D)

What is the resonant frequency of a parallel RLC circuit if R is 33 ohms, L is 50 microhenrys and C is 10 picofarads?

- 7.12 MHz

E5A17 (A)

What is the result of increasing the Q of an impedance-matching circuit?

- Matching bandwidth is decreased

## **Group E5B - Time constants and phase relationships: RLC time constants: definition; time constants in RL and RC circuits; phase angle between voltage and current; phase angles of series and parallel circuits**

E5B01 (B)

What is the term for the time required for the capacitor in an RC circuit to be charged to 63.2% of the applied voltage?

- One time constant

E5B02 (D)

What is the term for the time it takes for a charged capacitor in an RC circuit to discharge to 36.8% of its initial voltage?

- One time constant

E5B03 (B)

What happens to the phase angle of a reactance when it is converted to a susceptance?

- The sign is reversed

E5B04 (D)

What is the time constant of a circuit having two 220 microfarad capacitors and two 1 megohm resistors, all in parallel?

- 220 seconds

E5B05 (D)

What happens to the magnitude of a reactance when it is converted to a susceptance?

- The magnitude of the susceptance is the reciprocal of the magnitude of the reactance

E5B06 (C)

What is susceptance?

- The inverse of reactance

E5B07 (C)

What is the phase angle between the voltage across and the current through a series RLC circuit if  $X_C$  is 500 ohms,  $R$  is 1 kilohm, and  $X_L$  is 250 ohms?

- 14.0 degrees with the voltage lagging the current

E5B08 (A)

What is the phase angle between the voltage across and the current through a series RLC circuit if  $X_C$  is 100 ohms,  $R$  is 100 ohms, and  $X_L$  is 75 ohms?

- 14 degrees with the voltage lagging the current

E5B09 (D)

What is the relationship between the current through a capacitor and the voltage across a capacitor?

- Current leads voltage by 90 degrees

E5B10 (A)

What is the relationship between the current through an inductor and the voltage across an inductor?

- Voltage leads current by 90 degrees

E5B11 (B)

What is the phase angle between the voltage across and the current through a series RLC circuit if  $X_C$  is 25 ohms,  $R$  is 100 ohms, and  $X_L$  is 50 ohms?

- 14 degrees with the voltage leading the current

E5B12 (A)

What is admittance?

- The inverse of impedance

E5B13 (D)

What letter is commonly used to represent susceptance?

- B

## **Group E5C - Impedance plots and coordinate systems: plotting impedances in polar coordinates; rectangular coordinates**

E5C01 (A)

Which of the following represents a capacitive reactance in rectangular notation?

- $-jX$

E5C02 (C)

How are impedances described in polar coordinates?

- By phase angle and amplitude

E5C03 (C)

Which of the following represents an inductive reactance in polar coordinates?

- A positive phase angle

E5C04 (D)

Which of the following represents a capacitive reactance in polar coordinates?

- A negative phase angle

E5C05 (C)

What is the name of the diagram used to show the phase relationship between impedances at a given frequency?

- Phasor diagram

E5C06 (B)

What does the impedance  $50-j25$  represent?

- 50 ohms resistance in series with 25 ohms capacitive reactance

E5C07 (B)

What is a vector?

- A quantity with both magnitude and an angular component

E5C08 (D)

What coordinate system is often used to display the phase angle of a circuit containing resistance, inductive and/or capacitive reactance?

- Polar coordinates

E5C09 (A)

When using rectangular coordinates to graph the impedance of a circuit, what does the horizontal axis represent?

- Resistive component

E5C10 (B)

When using rectangular coordinates to graph the impedance of a circuit, what does the vertical axis represent?

- Reactive component

E5C11 (C)

What do the two numbers that are used to define a point on a graph using rectangular coordinates represent?

- The coordinate values along the horizontal and vertical axes

E5C12 (D)

If you plot the impedance of a circuit using the rectangular coordinate system and find the impedance point falls on the right side of the graph on the horizontal axis, what do you know about the circuit?

- It is equivalent to a pure resistance

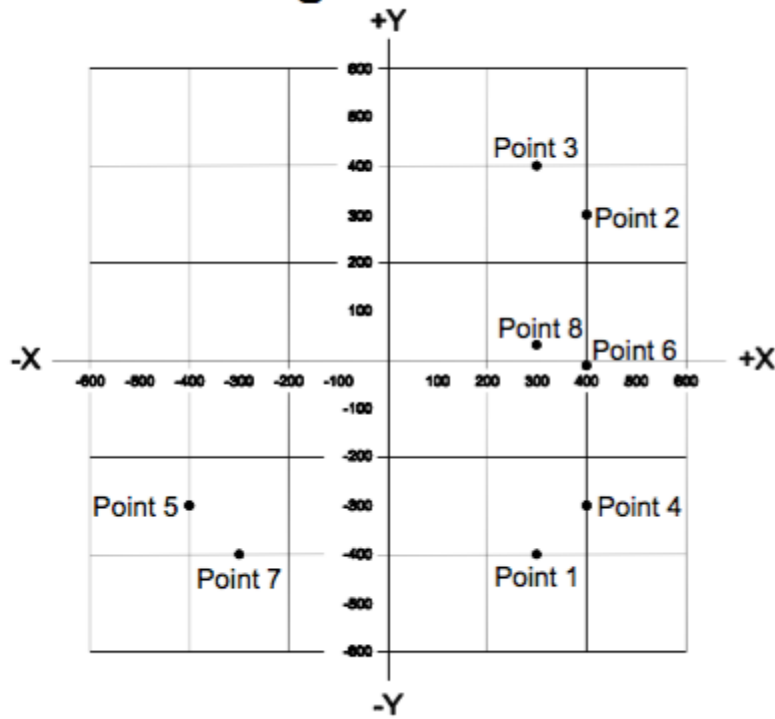
E5C13 (D)

What coordinate system is often used to display the resistive, inductive, and/or capacitive reactance components of impedance?

- Rectangular coordinates



**Figure E5-2**

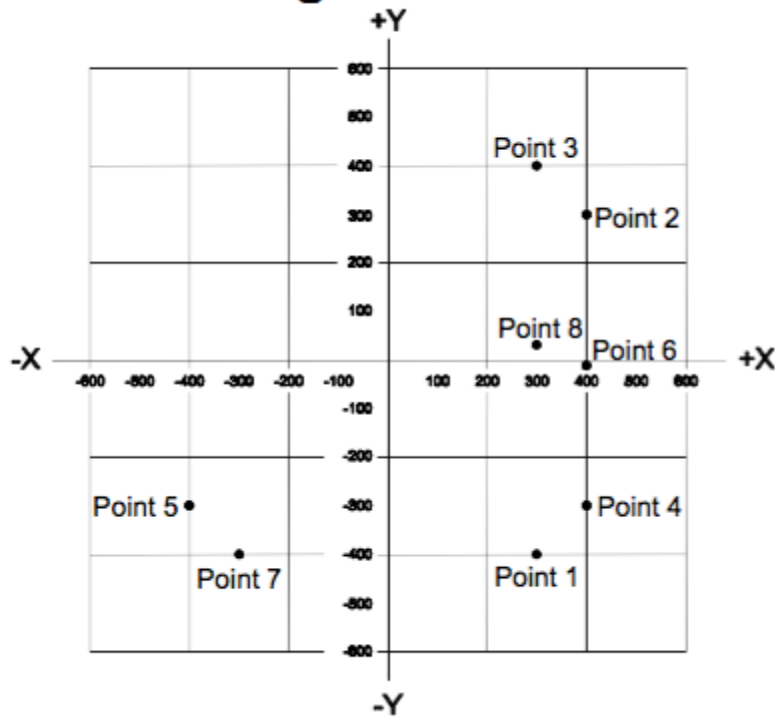


E5C14 (B)

Which point on Figure E5-2 best represents the impedance of a series circuit consisting of a 400 ohm resistor and a 38 picofarad capacitor at 14 MHz?

- Point 4

**Figure E5-2**

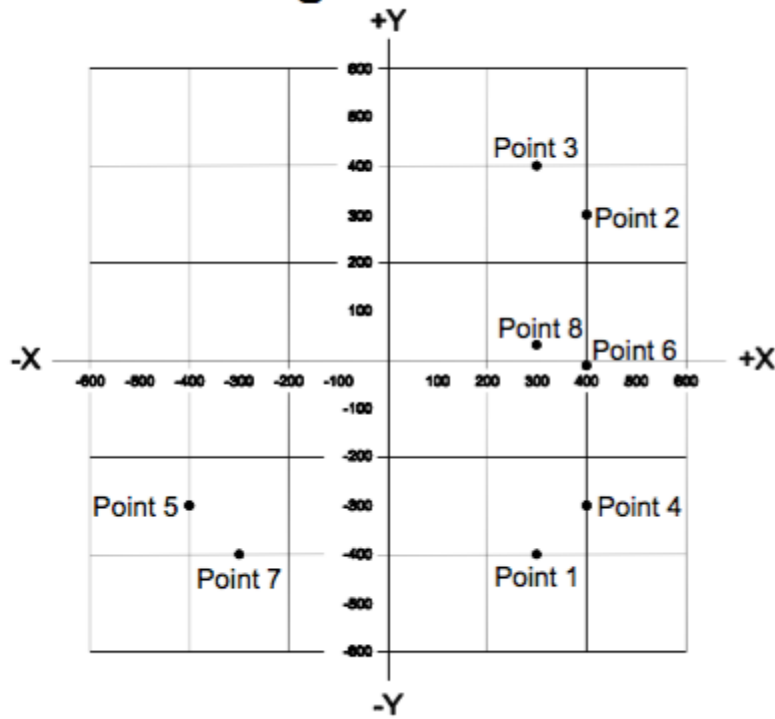


E5C15 (B)

Which point in Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor and an 18 microhenry inductor at 3.505 MHz?

- Point 3

**Figure E5-2**

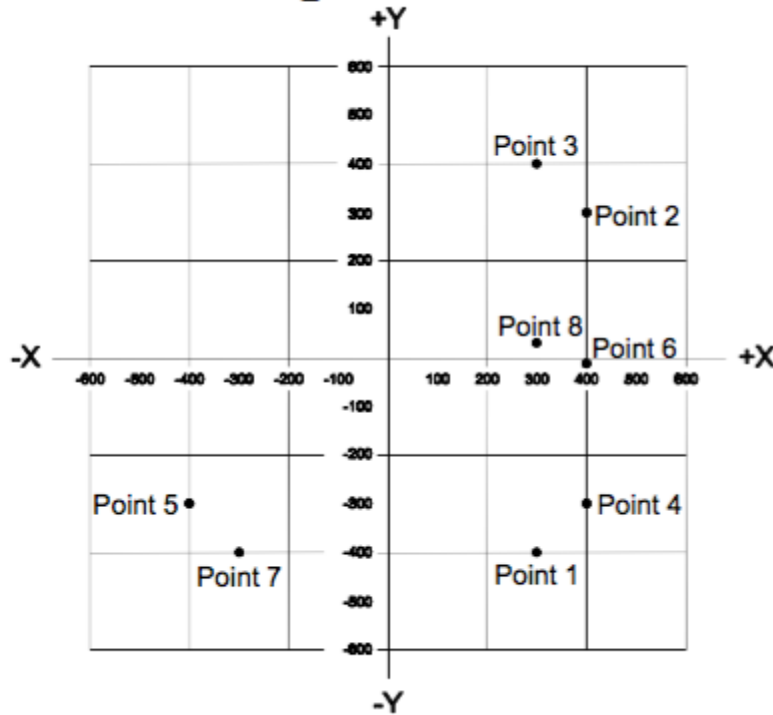


E5C16 (A)

Which point on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor and a 19 picofarad capacitor at 21.200 MHz?

- Point 1

**Figure E5-2**



E5C17 (D)

Which point on Figure E5-2 best represents the impedance of a series circuit consisting of a 300 ohm resistor, a 0.64-microhenry inductor and an 85-picofarad capacitor at 24.900 MHz?

- Point 8

**Group E5D - AC and RF energy in real circuits: skin effect; electrostatic and electromagnetic fields; reactive power; power factor; coordinate systems**

E5D01 (A)

What is the result of skin effect?

- As frequency increases, RF current flows in a thinner layer of the conductor, closer to the surface

E5D02 (B)

Why is it important to keep lead lengths short for components used in circuits for VHF and above?

- To avoid unwanted inductive reactance

E5D03 (D)

What is microstrip?

- Precision printed circuit conductors above a ground plane that provide constant impedance interconnects at microwave frequencies

E5D04 (B)

Why are short connections necessary at microwave frequencies?

- To reduce phase shift along the connection

E5D05 (A)

Which parasitic characteristic increases with conductor length?

- Inductance

E5D06 (D)

In what direction is the magnetic field oriented about a conductor in relation to the direction of electron flow?

- In a direction determined by the left-hand rule

E5D07 (D)

What determines the strength of the magnetic field around a conductor?

- The amount of current flowing through the conductor

E5D08 (B)

What type of energy is stored in an electromagnetic or electrostatic field?

- Potential energy

E5D09 (B)

What happens to reactive power in an AC circuit that has both ideal inductors and ideal capacitors?

- It is repeatedly exchanged between the associated magnetic and electric fields, but is not dissipated

E5D10 (A)

How can the true power be determined in an AC circuit where the voltage and current are out of phase?

- By multiplying the apparent power times the power factor

E5D11 (C)

What is the power factor of an R-L circuit having a 60 degree phase angle between the voltage and the current?

- 0.5

E5D12 (B)

How many watts are consumed in a circuit having a power factor of 0.2 if the input is 100-VAC at 4 amperes?

- 80 watts

E5D13 (B)

How much power is consumed in a circuit consisting of a 100 ohm resistor in series with a 100 ohm inductive reactance drawing 1 ampere?

- 100 Watts

E5D14 (A)

What is reactive power?

- Wattless, nonproductive power

E5D15 (D)

What is the power factor of an R-L circuit having a 45 degree phase angle between the voltage and the current?

- 0.707

E5D16 (C)

What is the power factor of an R-L circuit having a 30 degree phase angle between the voltage and the current?

- 0.866

E5D17 (D)

How many watts are consumed in a circuit having a power factor of 0.6 if the input is 200VAC at 5 amperes?

- 600 watts

E5D18 (B)

How many watts are consumed in a circuit having a power factor of 0.71 if the apparent power is 500VA?

- 355 W

## **Subelement E6 - Circuit Components**

**Group E6A - Semiconductor materials and devices:  
semiconductor materials germanium, silicon, P-type, N-type;  
transistor types: NPN, PNP, junction, field-effect transistors:  
enhancement mode; depletion mode; MOS; CMOS; N-  
channel; P-channel**

E6A01 (C)

In what application is gallium arsenide used as a semiconductor material in preference to germanium or silicon?

- In microwave circuits

E6A02 (A)

Which of the following semiconductor materials contains excess free electrons?

- N-type

E6A03 (C)

Why does a PN-junction diode not conduct current when reverse biased?

- Holes in P-type material and electrons in the N-type material are separated by the applied voltage, widening the depletion region

E6A04 (C)

What is the name given to an impurity atom that adds holes to a semiconductor crystal structure?

- Acceptor impurity

E6A05 (C)

What is the alpha of a bipolar junction transistor?

- The change of collector current with respect to emitter current

E6A06 (B)

What is the beta of a bipolar junction transistor?

- The change in collector current with respect to base current

E6A07 (D)

Which of the following indicates that a silicon NPN junction transistor is biased on?

- Base-to-emitter voltage of approximately 0.6 to 0.7 volts

E6A08 (D)

What term indicates the frequency at which the grounded-base current gain of a transistor has decreased to 0.7 of the gain obtainable at 1 kHz?

- Alpha cutoff frequency

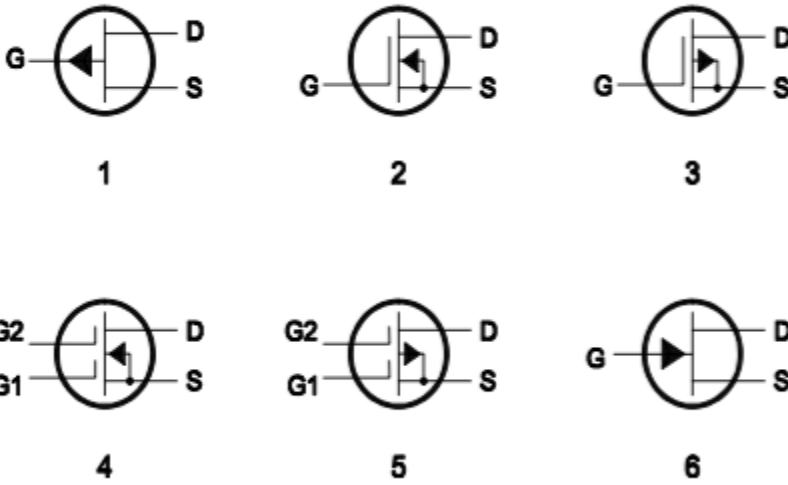
E6A09 (A)

What is a depletion-mode FET?

- An FET that exhibits a current flow between source and drain when no gate voltage is applied



**Figure E6-2**

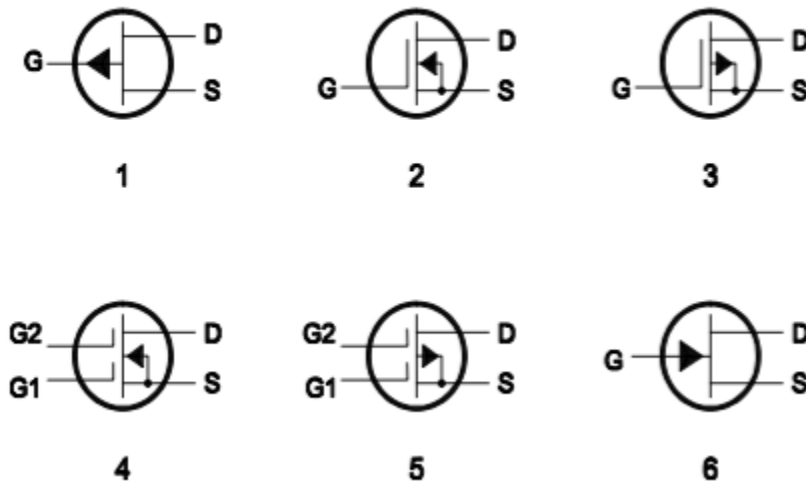


E6A10 (B)

In Figure E6-2, what is the schematic symbol for an N-channel dual-gate MOSFET?

- 4

**Figure E6-2**



E6A11 (A)

In Figure E6-2, what is the schematic symbol for a P-channel junction FET?

- 1

E6A12 (D)

Why do many MOSFET devices have internally connected Zener diodes on the gates?

- To reduce the chance of the gate insulation being punctured by static discharges or excessive voltages

E6A13 (C)

What do the initials CMOS stand for?

- Complementary Metal-Oxide Semiconductor

E6A14 (C)

How does DC input impedance at the gate of a field-effect transistor compare with the DC input impedance of a bipolar transistor?

- An FET has high input impedance; a bipolar transistor has low input impedance

E6A15 (B)

Which semiconductor material contains excess holes in the outer shell of electrons?

- P-type

E6A16 (B)

What are the majority charge carriers in N-type semiconductor material?

- Free electrons

E6A17 (D)

What are the names of the three terminals of a field-effect transistor?

- Gate, drain, source

## **Group E6B - Semiconductor diodes**

E6B01 (B)

What is the most useful characteristic of a Zener diode?

- A constant voltage drop under conditions of varying current

E6B02 (D)

What is an important characteristic of a Schottky diode as compared to an ordinary silicon diode when used as a power supply rectifier?

- Less forward voltage drop

E6B03 (C)

What special type of diode is capable of both amplification and oscillation?

- Tunnel

E6B04 (A)

What type of semiconductor device is designed for use as a voltage-controlled capacitor?

- Varactor diode

E6B05 (D)

What characteristic of a PIN diode makes it useful as an RF switch or attenuator?

- A large region of intrinsic material

E6B06 (D)

Which of the following is a common use of a hot-carrier diode?

- As a VHF/UHF mixer or detector

E6B07 (B)

What is the failure mechanism when a junction diode fails due to excessive current?

- Excessive junction temperature

E6B08 (A)

Which of the following describes a type of semiconductor diode?

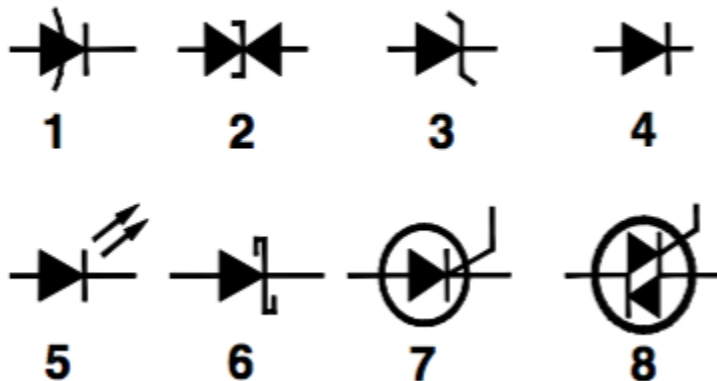
- Metal-semiconductor junction

E6B09 (C)

What is a common use for point contact diodes?

- As an RF detector

**Figure E6-3**



E6B10 (B)

In Figure E6-3, what is the schematic symbol for a light-emitting diode?

- 5

E6B11 (A)

What is used to control the attenuation of RF signals by a PIN diode?

- Forward DC bias current

E6B12 (C)

What is one common use for PIN diodes?

- As an RF switch

E6B13 (B)

What type of bias is required for an LED to emit light?

- Forward bias

## **Group E6C - Integrated circuits: TTL digital integrated circuits; CMOS digital integrated circuits; gates**

E6C01 (A)

What is the function of hysteresis in a comparator?

- To prevent input noise from causing unstable output signals

E6C02 (B)

What happens when the level of a comparator's input signal crosses the threshold?

- The comparator changes its output state

E6C03 (A)

What is tri-state logic?

- Logic devices with 0, 1, and high impedance output states

E6C04 (B)

What is the primary advantage of tri-state logic?

- Ability to connect many device outputs to a common bus

E6C05 (D)

What is an advantage of CMOS logic devices over TTL devices?

- Lower power consumption

E6C06 (C)

Why do CMOS digital integrated circuits have high immunity to noise on the input signal or power supply?

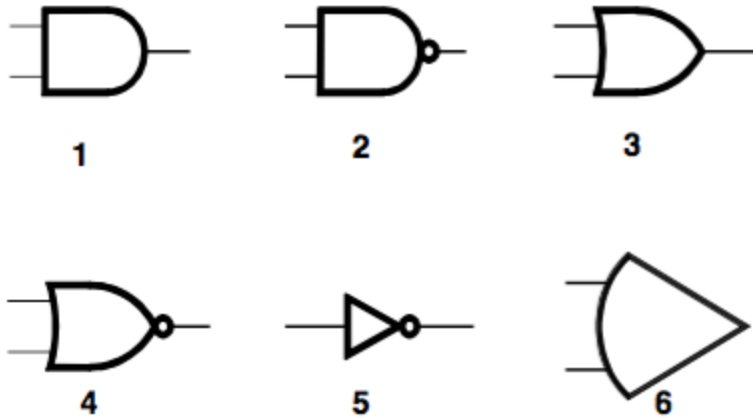
- The input switching threshold is about one-half the power supply voltage

E6C07 (B)

What best describes a pull-up or pull-down resistor?

- A resistor connected to the positive or negative supply line used to establish a voltage when an input or output is an open circuit

**Figure E6-5**



E6C08 (B)

In Figure E6-5, what is the schematic symbol for a NAND gate?

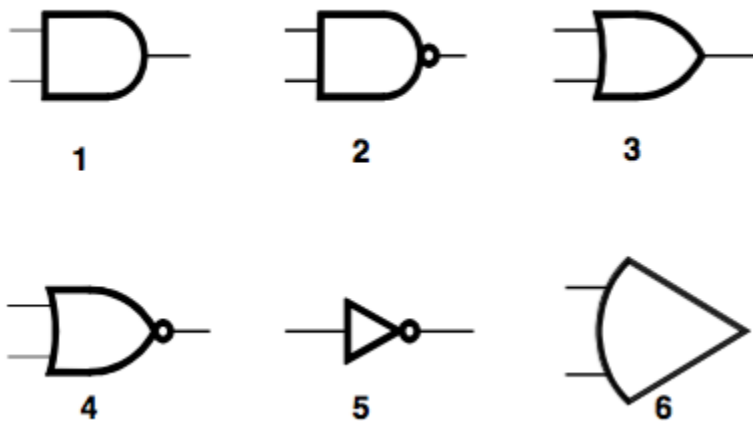
- 2

E6C09 (B)

What is a Programmable Logic Device (PLD)?

- A programmable collection of logic gates and circuits in a single integrated circuit

**Figure E6-5**

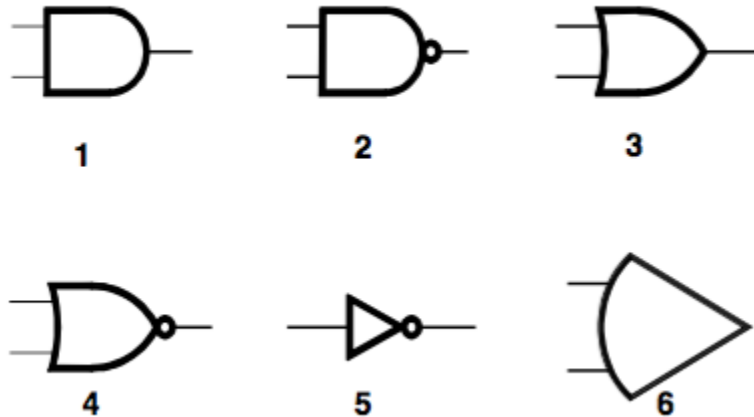


E6C10 (D)

In Figure E6-5, what is the schematic symbol for a NOR gate?

- 4

**Figure E6-5**



E6C11 (C)

In Figure E6-5, what is the schematic symbol for the NOT operation (inverter)?

- 5

E6C12 (D)

What is BiCMOS logic?

- An integrated circuit logic family using both bipolar and CMOS transistors

E6C13 (C)

Which of the following is an advantage of BiCMOS logic?

- It has the high input impedance of CMOS and the low output impedance of bipolar transistors

E6C14 (B)

What is the primary advantage of using a Programmable Gate Array (PGA) in a logic circuit?

- Complex logic functions can be created in a single integrated circuit

## **Group E6D - Optical devices and toroids: cathode-ray tube devices; charge-coupled devices (CCDs); liquid crystal displays (LCDs); toroids: permeability, core material, selecting, winding**

E6D01 (A)

How many turns will be required to produce a 5-microhenry inductor using a powdered-iron toroidal core that has an inductance index (A L) value of 40 microhenrys/100 turns?

- 35 turns

E6D02 (A)

What is the equivalent circuit of a quartz crystal?

- Motional capacitance, motional inductance, and loss resistance in series, all in parallel with a shunt capacitor representing electrode and stray capacitance

E6D03 (A)

Which of the following is an aspect of the piezoelectric effect?

- Mechanical deformation of material by the application of a voltage

E6D04 (B)

Which materials are commonly used as a slug core in a variable inductor?

- Ferrite and brass

E6D05 (C)

What is one reason for using ferrite cores rather than powdered-iron in an inductor?

- Ferrite toroids generally require fewer turns to produce a given inductance value

E6D06 (D)

What core material property determines the inductance of a toroidal inductor?

- Permeability

E6D07 (B)



What is the usable frequency range of inductors that use toroidal cores, assuming a correct selection of core material for the frequency being used?

- From less than 20 Hz to approximately 300 MHz

E6D08 (B)

What is one reason for using powdered-iron cores rather than ferrite cores in an inductor?

- Powdered-iron cores generally maintain their characteristics at higher currents

E6D09 (C)

What devices are commonly used as VHF and UHF parasitic suppressors at the input and output terminals of a transistor HF amplifier?

- Ferrite beads

E6D10 (A)

What is a primary advantage of using a toroidal core instead of a solenoidal core in an inductor?

- Toroidal cores confine most of the magnetic field within the core material

E6D11 (C)

How many turns will be required to produce a 1-mH inductor using a core that has an inductance index (A L) value of 523 millihenrys/1000 turns?

- 43 turns

E6D12 (C)

What is the definition of saturation in a ferrite core inductor?

- The ability of the inductor's core to store magnetic energy has been exceeded

E6D13 (A)

What is the primary cause of inductor self-resonance?

- Inter-turn capacitance

E6D14 (B)

Which type of slug material decreases inductance when inserted into a coil?

- Brass

E6D15 (A)

What is current in the primary winding of a transformer called if no load is attached to the secondary?

- Magnetizing current

E6D16 (D)

What is the common name for a capacitor connected across a transformer secondary that is used to absorb transient voltage spikes?

- Snubber capacitor

E6D17 (A)

Why should core saturation of a conventional impedance matching transformer be avoided?

- Harmonics and distortion could result

## **Group E6E - Piezoelectric crystals and MMICs: quartz crystals; crystal oscillators and filters; monolithic amplifiers**

E6E01 (C)

Which of the following is true of a charge-coupled device (CCD)?

- It samples an analog signal and passes it in stages from the input to the output

E6E02 (A)

Which of the following device packages is a through-hole type?

- DIP

E6E03 (D)

Which of the following materials is likely to provide the highest frequency of operation when used in MMICs?

- Gallium nitride

E6E04 (A)

Which is the most common input and output impedance of circuits that use MMICs?

- 50 ohms

E6E05 (A)

Which of the following noise figure values is typical of a low-noise UHF preamplifier?

- 2 dB

E6E06 (D)

What characteristics of the MMIC make it a popular choice for VHF through microwave circuits?

- Controlled gain, low noise figure, and constant input and output impedance over the specified frequency range

E6E07 (B)

Which of the following is typically used to construct a MMIC-based microwave amplifier?

- Microstrip construction

E6E08 (A)

How is voltage from a power supply normally furnished to the most common type of monolithic microwave integrated circuit (MMIC)?

- Through a resistor and/or RF choke connected to the amplifier output lead

E6E09 (D)

Which of the following component package types would be most suitable for use at frequencies above the HF range?

- Surface mount

E6E10 (D)

What is the packaging technique in which leadless components are soldered directly to circuit boards?

- Surface mount

E6E11 (D)

What is a characteristic of DIP packaging used for integrated circuits?

- A total of two rows of connecting pins placed on opposite sides of the package (Dual In-line Package)

E6E12 (B)

Why are high-power RF amplifier ICs and transistors sometimes mounted in ceramic packages?

- Better dissipation of heat

## **Group E6F - Optical components and power systems: photoconductive principles and effects, photovoltaic systems, optical couplers, optical sensors, and optoisolators**

E6F01 (B)

What is photoconductivity?

- The increased conductivity of an illuminated semiconductor

E6F02 (A)

What happens to the conductivity of a photoconductive material when light shines on it?

- It increases

E6F03 (D)

What is the most common configuration of an optoisolator or optocoupler?

- An LED and a phototransistor

E6F04 (B)

What is the photovoltaic effect?

- The conversion of light to electrical energy

E6F05 (A)

Which describes an optical shaft encoder?

- A device which detects rotation of a control by interrupting a light source with a patterned wheel

E6F06 (A)

Which of these materials is affected the most by photoconductivity?

- A crystalline semiconductor

E6F07 (B)

What is a solid state relay?

- A device that uses semiconductors to implement the functions of an electromechanical relay

E6F08 (C)

Why are optoisolators often used in conjunction with solid state circuits when switching 120VAC?

- Optoisolators provide a very high degree of electrical isolation between a control circuit and the circuit being switched

E6F09 (D)

What is the efficiency of a photovoltaic cell?

- The relative fraction of light that is converted to current

E6F10 (B)

What is the most common type of photovoltaic cell used for electrical power generation?

- Silicon

E6F11 (B)

What is the approximate open-circuit voltage produced by a fully-illuminated silicon photovoltaic cell?

- 0.5 V

E6F12 (C)

What absorbs the energy from light falling on a photovoltaic cell?

- Electrons

E6F13 (B)

What is a liquid crystal display (LCD)?

- A display utilizing a crystalline liquid and polarizing filters which becomes opaque when voltage is applied

E6F14 (B)

Which of the following is true of LCD displays?

- They may be hard view through polarized lenses

## **Subelement E7 - Practical Circuits**

### **Group E7A - Digital circuits: digital circuit principles and logic circuits: classes of logic elements; positive and negative logic; frequency dividers; truth tables**

E7A01 (C)

Which is a bi-stable circuit?

- A flip-flop

E7A02 (A)

What is the function of a decade counter digital IC?

- It produces one output pulse for every ten input pulses

E7A03 (B)

Which of the following can divide the frequency of a pulse train by 2?

- A flip-flop

E7A04 (B)

How many flip-flops are required to divide a signal frequency by 4?

- 2

E7A05 (D)

Which of the following is a circuit that continuously alternates between two states without an external clock?

- Astable multivibrator

E7A06 (A)

What is a characteristic of a monostable multivibrator?

- It switches momentarily to the opposite binary state and then returns to its original state after a set time

E7A07 (D)

What logical operation does a NAND gate perform?

- It produces logic "0" at its output only when all inputs are logic "1"

E7A08 (A)

What logical operation does an OR gate perform?

- It produces logic "1" at its output if any or all inputs are logic "1"

E7A09 (C)

What logical operation is performed by an exclusive NOR gate?

- It produces logic "0" at its output if any single input is logic "1"

E7A10 (C)

What is a truth table?

- A list of inputs and corresponding outputs for a digital device

E7A11 (D)

What type of logic defines "1" as a high voltage?

- Positive Logic

E7A12 (C)

What type of logic defines "0" as a high voltage?

- Negative logic

## **Group E7B - Amplifiers: Class of operation; vacuum tube and solid-state circuits; distortion and intermodulation; spurious and parasitic suppression; microwave amplifiers**

E7B01 (A)

For what portion of a signal cycle does a Class AB amplifier operate?

- More than 180 degrees but less than 360 degrees

E7B02 (A)

What is a Class D amplifier?

- A type of amplifier that uses switching technology to achieve high efficiency

E7B03 (A)

Which of the following components form the output of a class D amplifier circuit?

- A low-pass filter to remove switching signal components

E7B04 (A)

Where on the load line of a Class A common emitter amplifier would bias normally be set?

- Approximately half-way between saturation and cutoff

E7B05 (C)

What can be done to prevent unwanted oscillations in an RF power amplifier?

- Install parasitic suppressors and/or neutralize the stage

E7B06 (B)

Which of the following amplifier types reduces or eliminates even order harmonics?

- Push-pull

E7B07 (D)



Which of the following is a likely result when a Class C amplifier is used to amplify a single-sideband phone signal?

- Signal distortion and excessive bandwidth

E7B08 (C)

How can an RF power amplifier be neutralized?

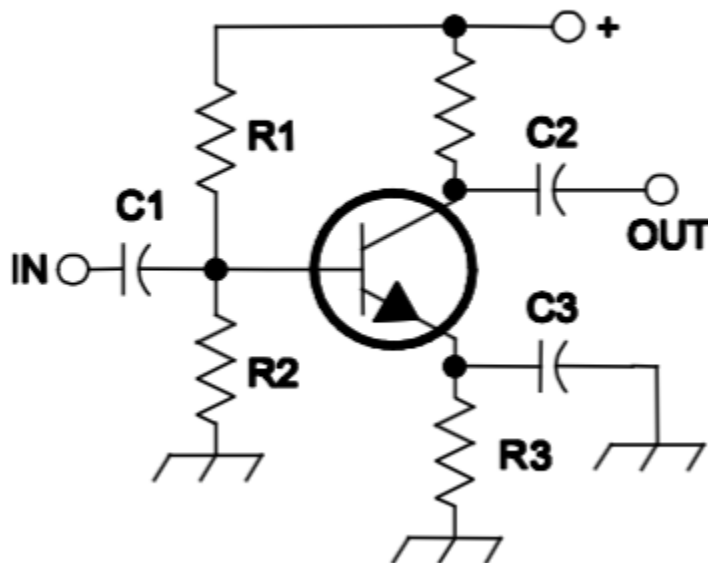
- By feeding a 180-degree out-of-phase portion of the output back to the input

E7B09 (D)

Which of the following describes how the loading and tuning capacitors are to be adjusted when tuning a vacuum tube RF power amplifier that employs a Pi-network output circuit?

- The tuning capacitor is adjusted for minimum plate current, and the loading capacitor is adjusted for maximum permissible plate current

**Figure E7-1**

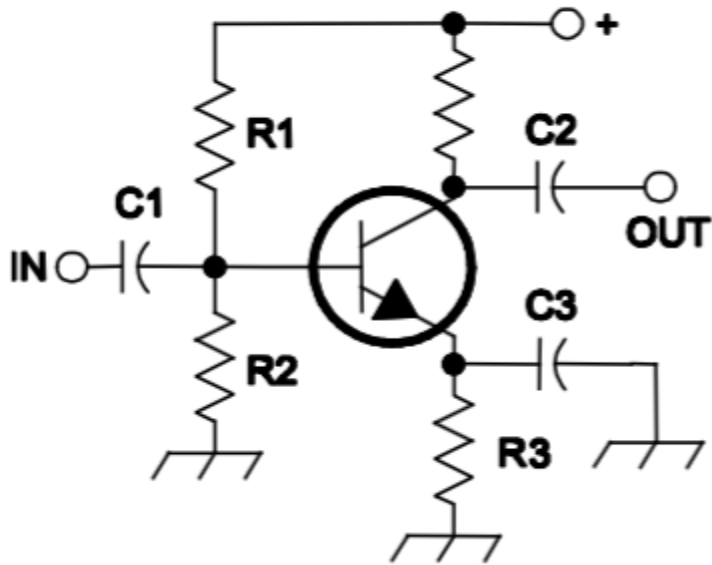


E7B10 (B)

In Figure E7-1, what is the purpose of R1 and R2?

- Fixed bias

**Figure E7-1**

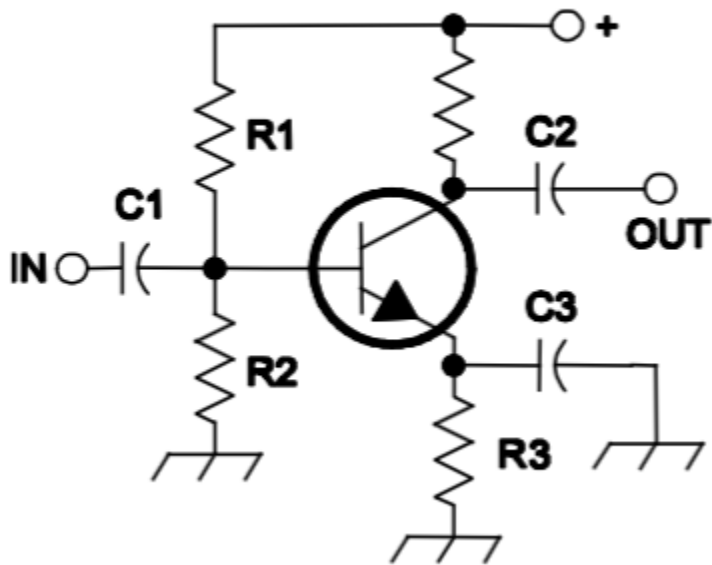


E7B11 (D)

In Figure E7-1, what is the purpose of R3?

- Self bias

**Figure E7-1**

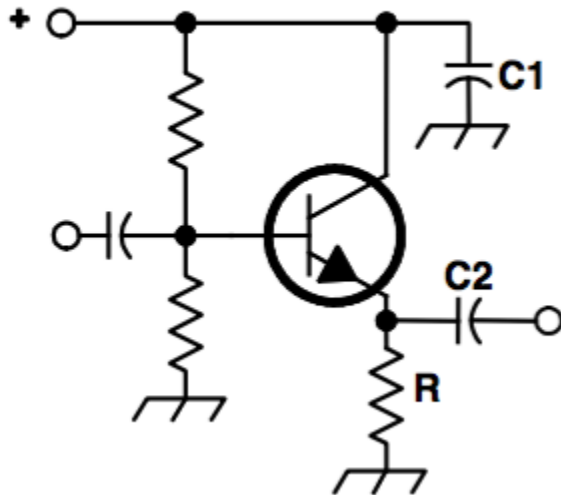


E7B12 (C)

What type of amplifier circuit is shown in Figure E7-1?

- Common emitter

**Figure E7-2**



E7B13 (A)

In Figure E7-2, what is the purpose of R?

- Emitter load

E7B14 (B)

Why are switching amplifiers more efficient than linear amplifiers?

- The power transistor is at saturation or cut off most of the time, resulting in low power dissipation

E7B15 (C)

What is one way to prevent thermal runaway in a bipolar transistor amplifier?

- Use a resistor in series with the emitter

E7B16 (A)

What is the effect of intermodulation products in a linear power amplifier?

- Transmission of spurious signals

E7B17 (A)

Why are odd-order rather than even-order intermodulation distortion products of concern in linear power amplifiers?

- Because they are relatively close in frequency to the desired signal

E7B18 (C)

What is a characteristic of a grounded-grid amplifier?

- Low input impedance

## **Group E7C - Filters and matching networks: filters and impedance matching networks: types of networks; types of filters; filter applications; filter characteristics; impedance matching; DSP filtering**

E7C01 (D)

How are the capacitors and inductors of a low-pass filter Pi-network arranged between the network's input and output?

- A capacitor is connected between the input and ground, another capacitor is connected between the output and ground, and an inductor is connected between input and output

E7C02 (C)

Which of the following is a property of a T-network with series capacitors and a parallel shunt inductor?

- It is a high-pass filter

E7C03 (A)

What advantage does a Pi-L-network have over a regular Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna?

- Greater harmonic suppression

E7C04 (C)

How does an impedance-matching circuit transform a complex impedance to a resistive impedance?

- It cancels the reactive part of the impedance and changes the resistive part to a desired value

E7C05 (D)

Which filter type is described as having ripple in the passband and a sharp cutoff?

- A Chebyshev filter

E7C06 (C)

What are the distinguishing features of an elliptical filter?

- Extremely sharp cutoff with one or more notches in the stop band

E7C07 (B)

What kind of filter would you use to attenuate an interfering carrier signal while receiving an SSB transmission?

- A notch filter

E7C08 (A)

Which of the following factors has the greatest effect in helping determine the bandwidth and response shape of a crystal ladder filter?

- The relative frequencies of the individual crystals

E7C09 (B)

What is a Jones filter as used as part of an HF receiver IF stage?

- A variable bandwidth crystal lattice filter

E7C10 (B)

Which of the following filters would be the best choice for use in a 2 meter repeater duplexer?

- A cavity filter

E7C11 (D)

Which of the following is the common name for a filter network which is equivalent to two L-networks connected back-to-back with the two inductors in series and the capacitors in shunt at the input and output?

- Pi

E7C12 (B)

Which describes a Pi-L-network used for matching a vacuum tube final amplifier to a 50 ohm unbalanced output?

- A Pi-network with an additional series inductor on the output

E7C13 (A)

What is one advantage of a Pi-matching network over an L-matching network consisting of a single inductor and a single capacitor?

- The Q of Pi-networks can be varied depending on the component values chosen

E7C14 (C)

Which mode is most affected by non-linear phase response in a receiver IF filter?

- Digital

E7C15 (D)

What is a crystal lattice filter?

- A filter with narrow bandwidth and steep skirts made using quartz crystals

## **Group E7D - Power supplies and voltage regulators**

E7D01 (D)

What is one characteristic of a linear electronic voltage regulator?

- The conduction of a control element is varied to maintain a constant output voltage

E7D02 (C)

What is one characteristic of a switching electronic voltage regulator?

- The controlled device's duty cycle is changed to produce a constant average output voltage

E7D03 (A)

What device is typically used as a stable reference voltage in a linear voltage regulator?

- A Zener diode

E7D04 (B)

Which of the following types of linear voltage regulator usually make the most efficient use of the primary power source?

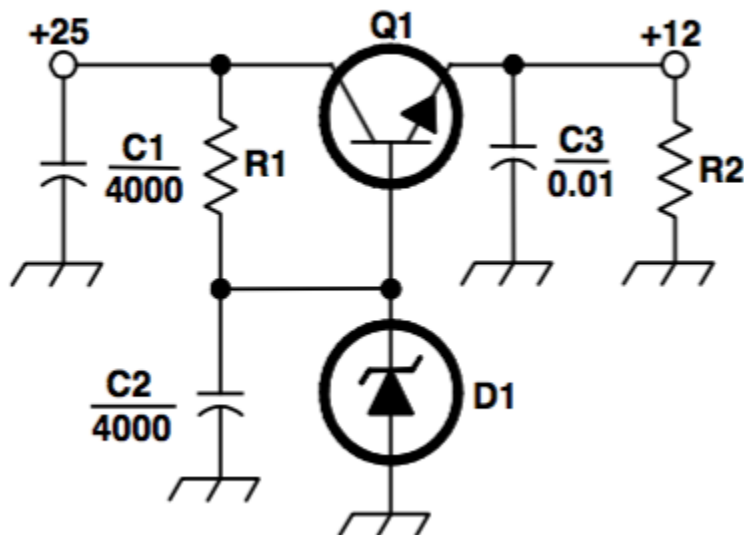
- A series regulator

E7D05 (D)

Which of the following types of linear voltage regulator places a constant load on the unregulated voltage source?

- A shunt regulator

**Figure E7- 3**

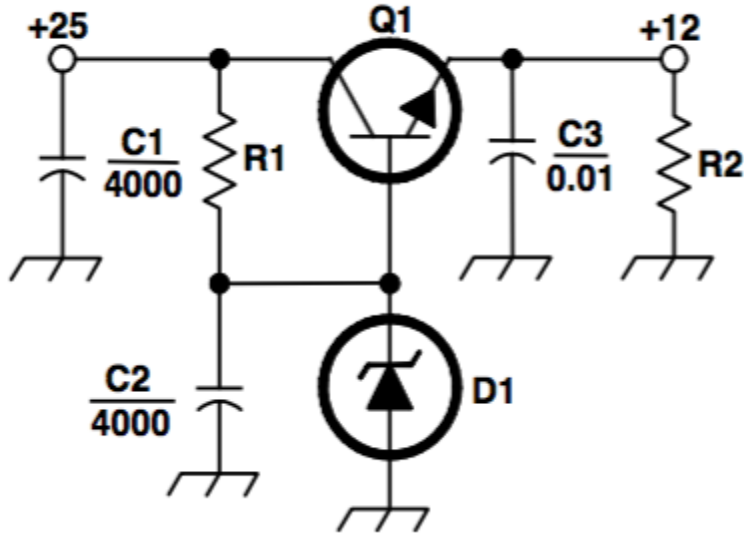


E7D06 (C)

What is the purpose of Q1 in the circuit shown in Figure E7-3?

- It increases the current-handling capability of the regulator

**Figure E7- 3**

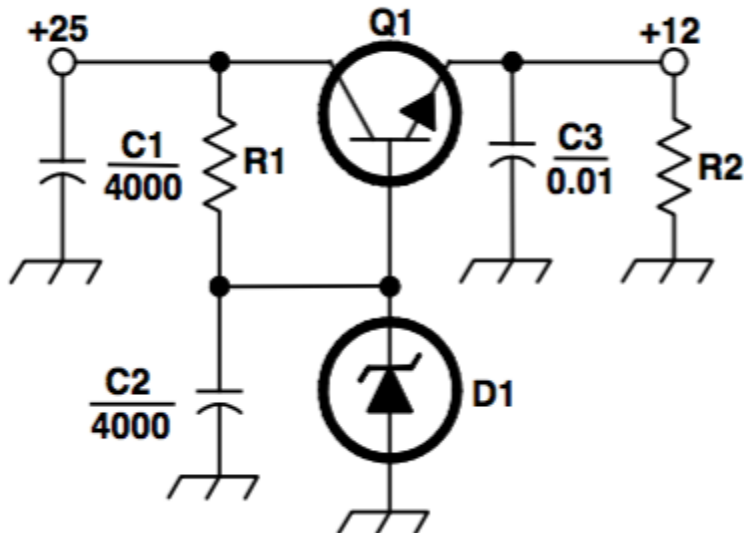


E7D07 (A)

What is the purpose of C2 in the circuit shown in Figure E7-3?

- It bypasses hum around D1

**Figure E7- 3**



E7D08 (C)

What type of circuit is shown in Figure E7-3?



- Linear voltage regulator

E7D09 (C)

What is the main reason to use a charge controller with a solar power system?

- Prevention of battery damage due to overcharge

E7D10 (C)

What is the primary reason that a high-frequency switching type high voltage power supply can be both less expensive and lighter in weight than a conventional power supply?

- The high frequency inverter design uses much smaller transformers and filter components for an equivalent power output

E7D11 (D)

What circuit element is controlled by a series analog voltage regulator to maintain a constant output voltage?

- Pass transistor

E7D12 (C)

What is the drop-out voltage of an analog voltage regulator?

- Minimum input-to-output voltage required to maintain regulation

E7D13 (C)

What is the equation for calculating power dissipation by a series connected linear voltage regulator?

- Voltage difference from input to output multiplied by output current

E7D14 (C)

What is one purpose of a "bleeder" resistor in a conventional unregulated power supply?

- To improve output voltage regulation

E7D15 (D)

What is the purpose of a "step-start" circuit in a high voltage power supply?

- To allow the filter capacitors to charge gradually

E7D16 (D)

When several electrolytic filter capacitors are connected in series to increase the operating voltage of a power supply filter circuit, why should resistors be connected across each capacitor?

- All of these choices are correct

## **Group E7E - Modulation and demodulation: reactance, phase and balanced modulators; detectors; mixer stages; DSP modulation and demodulation; software defined radio systems**

E7E01 (B)

Which of the following can be used to generate FM phone emissions?

- A reactance modulator on the oscillator

E7E02 (D)

What is the function of a reactance modulator?

- To produce PM signals by using an electrically variable inductance or capacitance

E7E03 (C)

How does an analog phase modulator function?

- By varying the tuning of an amplifier tank circuit to produce PM signals

E7E04 (A)

What is one way a single-sideband phone signal can be generated?

- By using a balanced modulator followed by a filter

E7E05 (D)

What circuit is added to an FM transmitter to boost the higher audio frequencies?

- A pre-emphasis network

E7E06 (A)

Why is de-emphasis commonly used in FM communications receivers?

- For compatibility with transmitters using phase modulation

E7E07 (B)

What is meant by the term baseband in radio communications?

- The frequency components present in the modulating signal

E7E08 (C)

What are the principal frequencies that appear at the output of a mixer circuit?

- The two input frequencies along with their sum and difference frequencies

E7E09 (A)

What occurs when an excessive amount of signal energy reaches a mixer circuit?

- Spurious mixer products are generated

E7E10 (A)

How does a diode detector function?

- By rectification and filtering of RF signals

E7E11 (C)

Which type of detector is used for demodulating SSB signals?

- Product detector

E7E12 (D)

What is a frequency discriminator stage in a FM receiver?

- A circuit for detecting FM signals

**Group E7F - Frequency markers and counters: frequency divider circuits; frequency marker generators; frequency counters**

E7F01 (C)

What is meant by direct digital conversion as applied to software defined radios?

- Incoming RF is digitized by an analog-to-digital converter without being mixed with a local oscillator signal

E7F02 (A)

What kind of digital signal processing audio filter is used to remove unwanted noise from a received SSB signal?

- An adaptive filter

E7F03 (C)

What type of digital signal processing filter is used to generate an SSB signal?

- A Hilbert-transform filter

E7F04 (D)

What is a common method of generating an SSB signal using digital signal processing?

- Combine signals with a quadrature phase relationship

E7F05 (B)

How frequently must an analog signal be sampled by an analog-to-digital converter so that the signal can be accurately reproduced?

- At twice the rate of the highest frequency component of the signal

E7F06 (D)

What is the minimum number of bits required for an analog-to-digital converter to sample a signal with a range of 1 volt at a resolution of 1 millivolt?

- 10 bits

E7F07 (C)

What function can a Fast Fourier Transform perform?

- Converting digital signals from the time domain to the frequency domain

E7F08 (B)

What is the function of decimation with regard to digital filters?

- Reducing the effective sample rate by removing samples

E7F09 (A)

Why is an anti-aliasing digital filter required in a digital decimator?

- It removes high-frequency signal components which would otherwise be reproduced as lower frequency components

E7F10 (A)

What aspect of receiver analog-to-digital conversion determines the maximum receive bandwidth of a Direct Digital Conversion SDR?

- Sample rate

E7F11 (B)

What sets the minimum detectable signal level for an SDR in the absence of atmospheric or thermal noise?

- Reference voltage level and sample width in bits

E7F12 (A)

What digital process is applied to I and Q signals in order to recover the baseband modulation information?

- Fast Fourier Transform

E7F13 (D)

What is the function of taps in a digital signal processing filter?

- Provide incremental signal delays for filter algorithms

E7F14 (B)

Which of the following would allow a digital signal processing filter to create a sharper filter response?

- More taps

E7F15 (A)

Which of the following is an advantage of a Finite Impulse Response (FIR) filter vs an Infinite Impulse Response (IIR) digital filter?

- FIR filters delay all frequency components of the signal by the same amount

E7F16 (D)

How might the sampling rate of an existing digital signal be adjusted by a factor of 3/4?

- Interpolate by a factor of three, then decimate by a factor of four

E7F17 (D)

What do the letters I and Q in I/Q Modulation represent?

- In-phase and Quadrature

## **Group E7G - Active filters and op-amps: active audio filters; characteristics; basic circuit design; operational amplifiers**

E7G01 (A)

What is the typical output impedance of an integrated circuit op-amp?

- Very low

E7G02 (D)

What is the effect of ringing in a filter?

- Undesired oscillations added to the desired signal

E7G03 (D)

What is the typical input impedance of an integrated circuit op-amp?

- Very high

E7G04 (C)

What is meant by the term op-amp input offset voltage?

- The differential input voltage needed to bring the open loop output voltage to zero

E7G05 (A)

How can unwanted ringing and audio instability be prevented in a multi-section op-amp RC audio filter circuit?

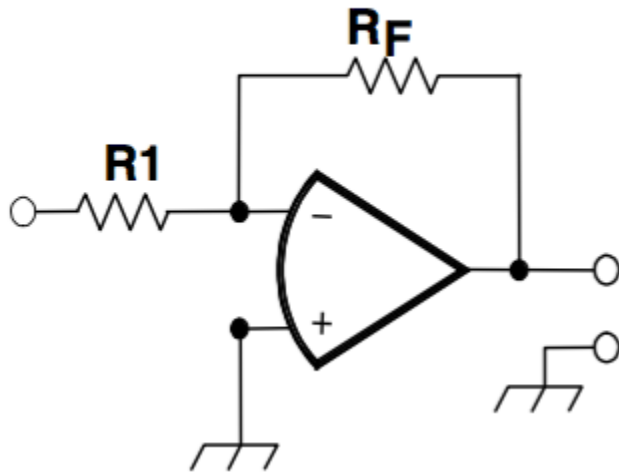
- Restrict both gain and Q

E7G06 (D)

Which of the following is the most appropriate use of an op-amp active filter?

- As an audio filter in a receiver

**Figure E7-4**



E7G07 (C)

What magnitude of voltage gain can be expected from the circuit in Figure E7-4 when R1 is 10 ohms and RF is 470 ohms?

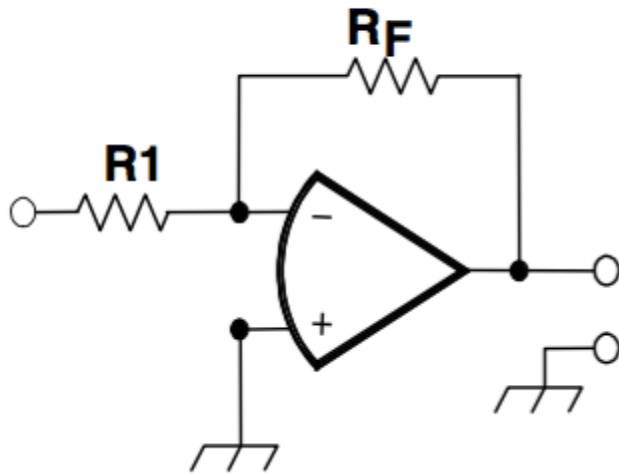
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E7G08 (D)

How does the gain of an ideal operational amplifier vary with frequency?

- It does not vary with frequency

**Figure E7-4**

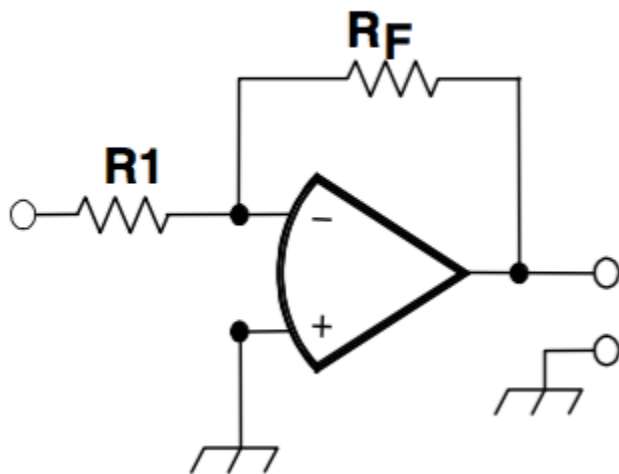


E7G09 (D)

What will be the output voltage of the circuit shown in Figure E7-4 if  $R_1$  is 1000 ohms,  $R_F$  is 10,000 ohms, and 0.23 volts DC is applied to the input?

- -2.3 volts

**Figure E7-4**



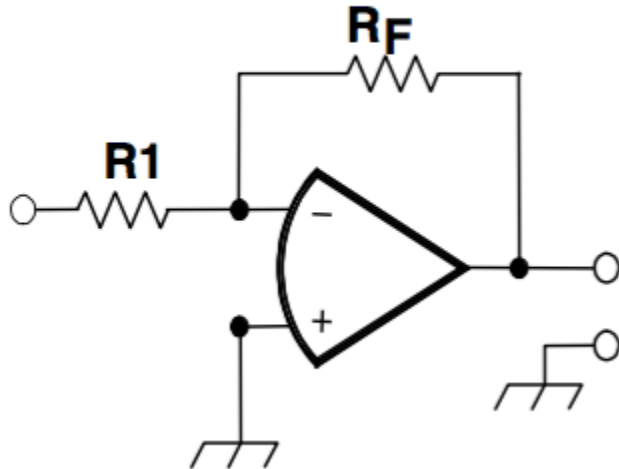
E7G10 (C)

What absolute voltage gain can be expected from the circuit in Figure E7-4 when  $R_1$  is 1800 ohms and  $R_F$  is 68 kilohms?



- 38

**Figure E7-4**



E7G11 (B)

What absolute voltage gain can be expected from the circuit in Figure E7-4 when  $R_1$  is 3300 ohms and  $R_F$  is 47 kilohms?

- 14

E7G12 (A)

What is an integrated circuit operational amplifier?

- A high-gain, direct-coupled differential amplifier with very high input impedance and very low output impedance

## **Group E7H - Oscillators and signal sources: types of oscillators; synthesizers and phase-locked loops; direct digital synthesizers**

E7H01 (D)

What are three oscillator circuits used in Amateur Radio equipment?

- Colpitts, Hartley and Pierce

E7H02 (C)

Which describes a microphonic?

- Changes in oscillator frequency due to mechanical vibration

E7H03 (A)

How is positive feedback supplied in a Hartley oscillator?

- Through a tapped coil

E7H04 (C)

How is positive feedback supplied in a Colpitts oscillator?

- Through a capacitive divider

E7H05 (D)

How is positive feedback supplied in a Pierce oscillator?

- Through a quartz crystal

E7H06 (B)

Which of the following oscillator circuits are commonly used in VFOs?

- Colpitts and Hartley

E7H07 (D)

How can an oscillator's microphonic responses be reduced?

- Mechanically isolating the oscillator circuitry from its enclosure

E7H08 (A)

Which of the following components can be used to reduce thermal drift in crystal oscillators?

- NP0 capacitors

E7H09 (A)

What type of frequency synthesizer circuit uses a phase accumulator, lookup table, digital to analog converter, and a low-pass anti-alias filter?

- A direct digital synthesizer

E7H10 (B)

What information is contained in the lookup table of a direct digital frequency synthesizer?

- The amplitude values that represent a sine-wave output

E7H11 (C)

What are the major spectral impurity components of direct digital synthesizers?

- Spurious signals at discrete frequencies

E7H12 (B)

Which of the following must be done to insure that a crystal oscillator provides the frequency specified by the crystal manufacturer?

- Provide the crystal with a specified parallel capacitance

E7H13 (D)

Which of the following is a technique for providing highly accurate and stable oscillators needed for microwave transmission and reception?

- All of these choices are correct

E7H14 (C)

What is a phase-locked loop circuit?

- An electronic servo loop consisting of a phase detector, a low-pass filter, a voltage-controlled oscillator, and a stable reference oscillator

E7H15 (D)

Which of these functions can be performed by a phase-locked loop?

- Frequency synthesis, FM demodulation

## **Subelement E8 - Signals And Emissions**

**Group E8A - AC waveforms: sine, square, sawtooth and irregular waveforms; AC measurements; average and PEP of RF signals; pulse and digital signal waveforms**

E8A01 (A)

What is the name of the process that shows that a square wave is made up of a sine wave plus all of its odd harmonics?

- Fourier analysis

E8A02 (C)

What type of wave has a rise time significantly faster than its fall time (or vice versa)?

- A sawtooth wave

E8A03 (A)

What type of wave does a Fourier analysis show to be made up of sine waves of a given fundamental frequency plus all of its harmonics?

- A sawtooth wave

E8A04 (B)

What is "dither" with respect to analog to digital converters?

- A small amount of noise added to the input signal to allow more precise representation of a signal over time

E8A05 (D)

What would be the most accurate way of measuring the RMS voltage of a complex waveform?

- By measuring the heating effect in a known resistor

E8A06 (A)

What is the approximate ratio of PEP-to-average power in a typical single-sideband phone signal?

- 2.5 to 1

E8A07 (B)

What determines the PEP-to-average power ratio of a single-sideband phone signal?

- The characteristics of the modulating signal

E8A08 (C)

Why would a direct or flash conversion analog-to-digital converter be useful for a software defined radio?

- Very high speed allows digitizing high frequencies

E8A09 (D)

How many levels can an analog-to-digital converter with 8 bit resolution encode?

- 256

E8A10 (C)

What is the purpose of a low pass filter used in conjunction with a digital-to-analog converter?

- Remove harmonics from the output caused by the discrete analog levels generated

E8A11 (D)

What type of information can be conveyed using digital waveforms?

- All of these choices are correct

E8A12 (C)

What is an advantage of using digital signals instead of analog signals to convey the same information?

- Digital signals can be regenerated multiple times without error

E8A13 (A)

Which of these methods is commonly used to convert analog signals to digital signals?

- Sequential sampling

## **Group E8B - Modulation and demodulation: modulation methods; modulation index and deviation ratio; pulse modulation; frequency and time division multiplexing**

E8B01 (D)

What is the term for the ratio between the frequency deviation of an RF carrier wave and the modulating frequency of its corresponding FM-phone signal?

- Modulation index

E8B02 (D)

How does the modulation index of a phase-modulated emission vary with RF carrier frequency (the modulated frequency)?

- It does not depend on the RF carrier frequency

E8B03 (A)

What is the modulation index of an FM-phone signal having a maximum frequency deviation of 3000 Hz either side of the carrier frequency when the modulating frequency is 1000 Hz?

- 3

E8B04 (B)

What is the modulation index of an FM-phone signal having a maximum carrier deviation of plus or minus 6 kHz when modulated with a 2 kHz modulating frequency?

- 3

E8B05 (D)

What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus-or-minus 5 kHz when the maximum modulation frequency is 3 kHz?

- 1.67

E8B06 (A)

What is the deviation ratio of an FM-phone signal having a maximum frequency swing of plus or minus 7.5 kHz when the maximum modulation frequency is 3.5 kHz?

- 2.14

E8B07 (A)

Orthogonal Frequency Division Multiplexing is a technique used for which type of amateur communication?

- High speed digital modes

E8B08 (D)

What describes Orthogonal Frequency Division Multiplexing?

- A digital modulation technique using subcarriers at frequencies chosen to avoid intersymbol interference

E8B09 (B)

What is meant by deviation ratio?

- The ratio of the maximum carrier frequency deviation to the highest audio modulating frequency

E8B10 (B)

What describes frequency division multiplexing?

- Two or more information streams are merged into a baseband, which then modulates the transmitter

E8B11 (B)

What is digital time division multiplexing?

- Two or more signals are arranged to share discrete time slots of a data transmission

## **Group E8C - Digital signals: digital communications modes; CW; information rate vs. bandwidth; spread-spectrum communications; modulation methods**

E8C01 (C)

How is Forward Error Correction implemented?

- By transmitting extra data that may be used to detect and correct transmission errors

E8C02 (C)

What is the definition of symbol rate in a digital transmission?

- The rate at which the waveform of a transmitted signal changes to convey information

E8C03 (A)

When performing phase shift keying, why is it advantageous to shift phase precisely at the zero crossing of the RF carrier?

- This results in the least possible transmitted bandwidth for the particular mode

E8C04 (C)

What technique is used to minimize the bandwidth requirements of a PSK31 signal?

- Use of sinusoidal data pulses

E8C05 (C)

What is the necessary bandwidth of a 13-WPM international Morse code transmission?

- Approximately 52 Hz

E8C06 (C)

What is the necessary bandwidth of a 170-hertz shift, 300-baud ASCII transmission?

- 0.5 kHz

E8C07 (A)

What is the necessary bandwidth of a 4800-Hz frequency shift, 9600-baud ASCII FM transmission?

- 15.36 kHz

E8C08 (D)

How does ARQ accomplish error correction?

- If errors are detected, a retransmission is requested

E8C09 (D)

Which is the name of a digital code where each preceding or following character changes by only one bit?

- Gray code

E8C10 (D)



What is an advantage of Gray code in digital communications where symbols are transmitted as multiple bits?

- It facilitates error detection

E8C11 (A)

What is the relationship between symbol rate and baud?

- They are the same

## **Group E8D - Waves, measurements, and RF grounding: peak-to-peak values, polarization; RF grounding**

E8D01 (A)

Why are received spread spectrum signals resistant to interference?

- Signals not using the spread spectrum algorithm are suppressed in the receiver

E8D02 (B)

What spread spectrum communications technique uses a high speed binary bit stream to shift the phase of an RF carrier?

- Direct sequence

E8D03 (D)

How does the spread spectrum technique of frequency hopping work?

- The frequency of the transmitted signal is changed very rapidly according to a particular sequence also used by the receiving station

E8D04 (C)

What is the primary effect of extremely short rise or fall time on a CW signal?

- The generation of key clicks

E8D05 (A)

What is the most common method of reducing key clicks?

- Increase keying waveform rise and fall times

E8D06 (B)

Which of the following indicates likely overmodulation of an AFSK signal such as PSK or MFSK?

- Strong ALC action

E8D07 (D)

What is a common cause of overmodulation of AFSK signals?

- Excessive transmit audio levels

E8D08 (D)

What parameter might indicate that excessively high input levels are causing distortion in an AFSK signal?

- Intermodulation Distortion (IMD)

E8D09 (D)

What is considered a good minimum IMD level for an idling PSK signal?

- -30 dB

E8D10 (B)

What are some of the differences between the Baudot digital code and ASCII?

- Baudot uses 5 data bits per character, ASCII uses 7 or 8; Baudot uses 2 characters as letters/figures shift codes, ASCII has no letters/figures shift code

E8D11 (C)

What is one advantage of using ASCII code for data communications?

- It is possible to transmit both upper and lower case text

E8D12 (D)

What is the advantage of including a parity bit with an ASCII character stream?

- Some types of errors can be detected

# Subelement E9 - Antennas And Transmission Lines

**Group E9A - Isotropic and gain antennas: definition; used as a standard for comparison; radiation pattern; basic antenna parameters: radiation resistance and reactance, gain, beamwidth, efficiency**

E9A01 (C)

What describes an isotropic antenna?

- A theoretical antenna used as a reference for antenna gain

E9A02 (D)

What antenna has no gain in any direction?

- Isotropic antenna

E9A03 (A)

Why would one need to know the feed point impedance of an antenna?

- To match impedances in order to minimize standing wave ratio on the transmission line

E9A04 (B)

Which of the following factors may affect the feed point impedance of an antenna?

- Antenna height, conductor length/diameter ratio and location of nearby conductive objects

E9A05 (D)

What is included in the total resistance of an antenna system?

- Radiation resistance plus ohmic resistance

E9A06 (D)

How does the beamwidth of an antenna vary as the gain is increased?

- It decreases

E9A07 (A)

What is meant by antenna gain?

- The ratio of the radiated signal strength of an antenna in the direction of maximum radiation to that of a reference antenna

E9A08 (B)

What is meant by antenna bandwidth?

- The frequency range over which an antenna satisfies a performance requirement

E9A09 (B)

How is antenna efficiency calculated?

- $(\text{radiation resistance} / \text{total resistance}) \times 100$  per cent

E9A10 (A)

Which of the following choices is a way to improve the efficiency of a ground-mounted quarter-wave vertical antenna?

- Install a good radial system

E9A11 (C)

Which of the following factors determines ground losses for a ground-mounted vertical antenna operating in the 3 MHz to 30 MHz range?

- Soil conductivity

E9A12 (A)

How much gain does an antenna have compared to a 1/2-wavelength dipole when it has 6 dB gain over an isotropic antenna?

- 3.85 dB

E9A13 (B)

How much gain does an antenna have compared to a 1/2-wavelength dipole when it has 12 dB gain over an isotropic antenna?

- 9.85 dB

E9A14 (C)

What is meant by the radiation resistance of an antenna?

- The value of a resistance that would dissipate the same amount of power as that radiated from an antenna

E9A15 (D)

What is the effective radiated power relative to a dipole of a repeater station with 150 watts transmitter power output, 2 dB feed line loss, 2.2 dB duplexer loss, and 7 dBd antenna gain?

- 286 watts

E9A16 (A)

What is the effective radiated power relative to a dipole of a repeater station with 200 watts transmitter power output, 4 dB feed line loss, 3.2 dB duplexer loss, 0.8 dB circulator loss, and 10 dBd antenna gain?

- 317 watts

E9A17 (B)

What is the effective radiated power of a repeater station with 200 watts transmitter power output, 2 dB feed line loss, 2.8 dB duplexer loss, 1.2 dB circulator loss, and 7 dBi antenna gain?

- 252 watts

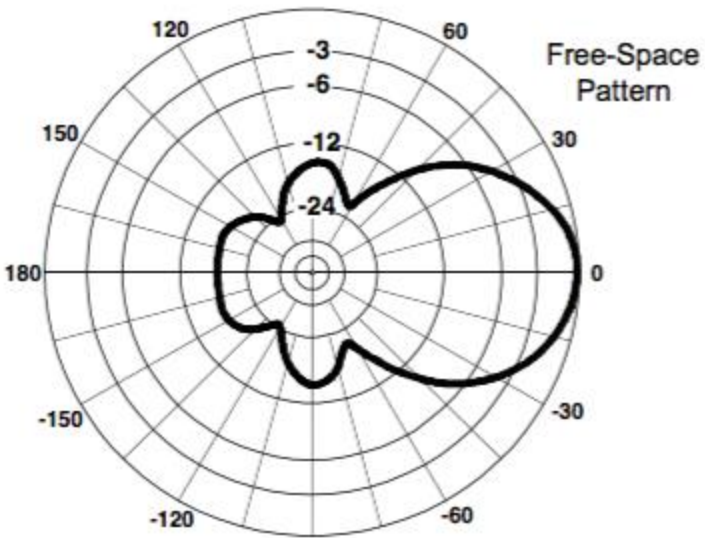
E9A18 (C)

What term describes station output, taking into account all gains and losses?

- Effective radiated power

**Group E9B - Antenna patterns: E and H plane patterns; gain as a function of pattern; antenna design; Yagi antennas**

**Figure E9-1**

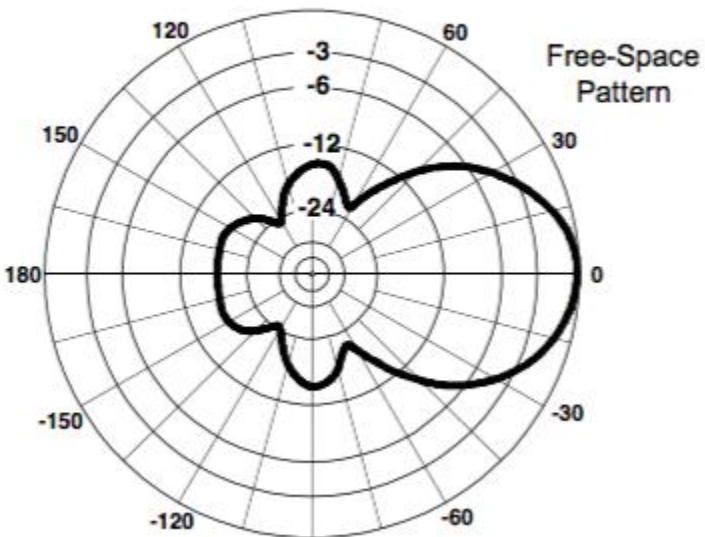


E9B01 (B)

In the antenna radiation pattern shown in Figure E9-1, what is the 3 dB beam-width?

- 50 degrees

**Figure E9-1**

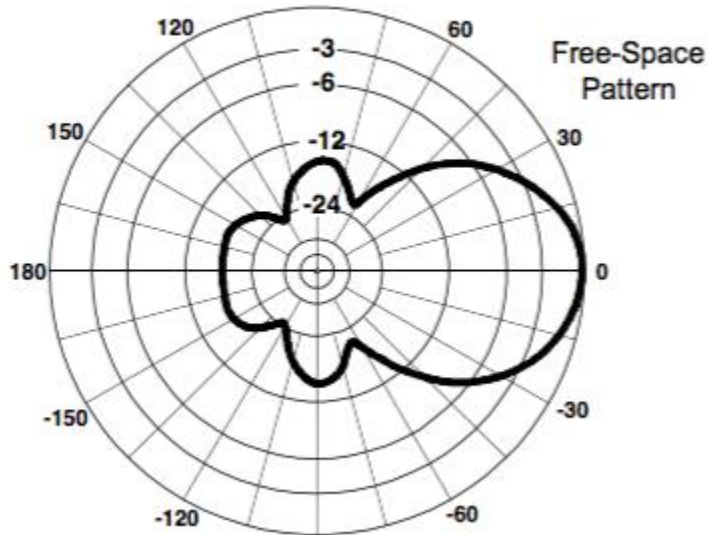


E9B02 (B)

In the antenna radiation pattern shown in Figure E9-1, what is the front-to-back ratio?

- 18 dB

**Figure E9-1**



E9B03 (B)

In the antenna radiation pattern shown in Figure E9-1, what is the front-to-side ratio?

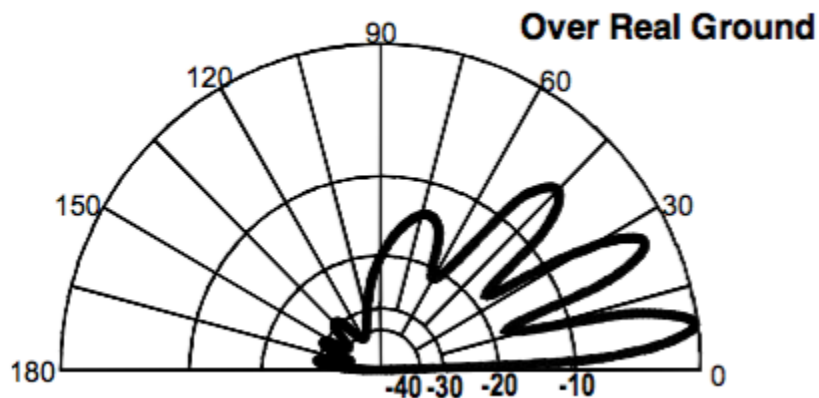
- 14 dB

E9B04 (D)

What may occur when a directional antenna is operated at different frequencies within the band for which it was designed?

- The gain may change depending on frequency

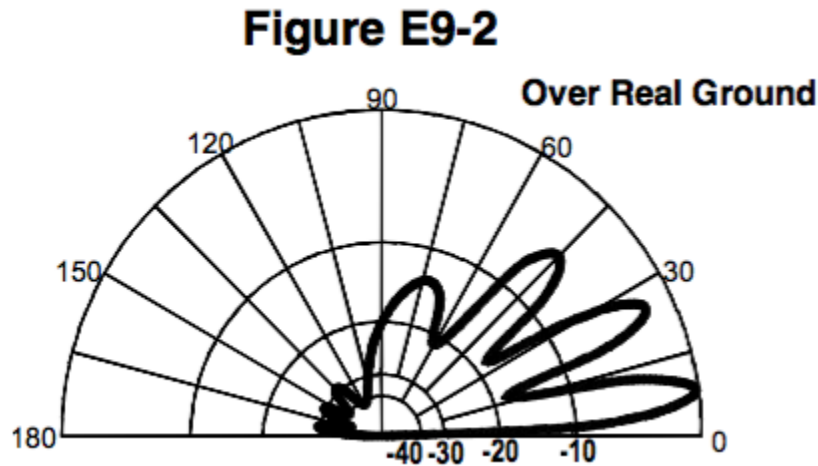
**Figure E9-2**



E9B05 (A)

What type of antenna pattern over real ground is shown in Figure E9-2?

- Elevation



E9B06 (C)

What is the elevation angle of peak response in the antenna radiation pattern shown in Figure E9-2?

- 7.5 degrees

E9B07 (C)

How does the total amount of radiation emitted by a directional gain antenna compare with the total amount of radiation emitted from an isotropic antenna, assuming each is driven by the same amount of power?

- They are the same

E9B08 (A)

How can the approximate beam-width in a given plane of a directional antenna be determined?

- Note the two points where the signal strength of the antenna is 3 dB less than maximum and compute the angular difference

E9B09 (B)

What type of computer program technique is commonly used for modeling antennas?



- Method of Moments

E9B10 (A)

What is the principle of a Method of Moments analysis?

- A wire is modeled as a series of segments, each having a uniform value of current

E9B11 (C)

What is a disadvantage of decreasing the number of wire segments in an antenna model below the guideline of 10 segments per half-wavelength?

- The computed feed point impedance may be incorrect

E9B12 (D)

What is the far field of an antenna?

- The region where the shape of the antenna pattern is independent of distance

E9B13 (B)

What does the abbreviation NEC stand for when applied to antenna modeling programs?

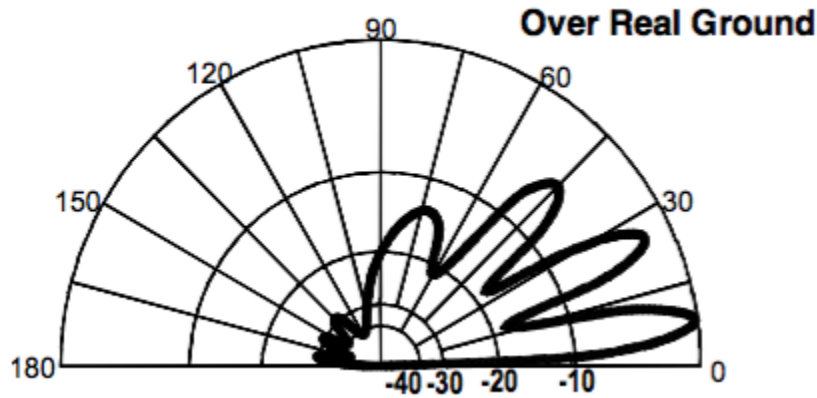
- Numerical Electromagnetic Code

E9B14 (D)

What type of information can be obtained by submitting the details of a proposed new antenna to a modeling program?

- All of these choices are correct

**Figure E9-2**

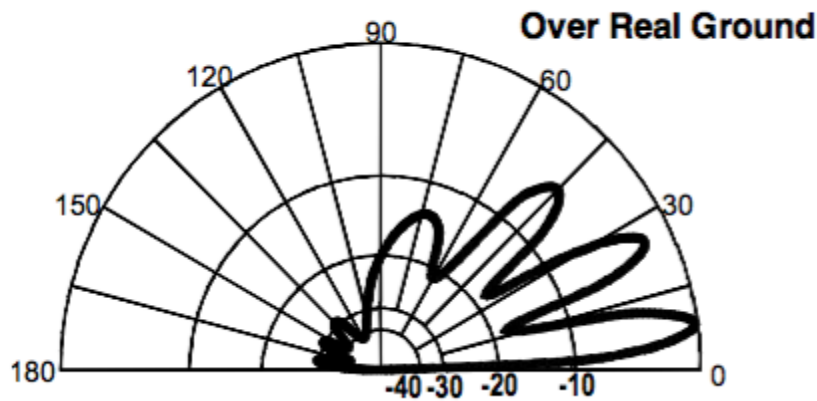


E9B15 (B)

What is the front-to-back ratio of the radiation pattern shown in Figure E9-2?

- 28 dB

**Figure E9-2**



E9B16 (A)

How many elevation lobes appear in the forward direction of the antenna radiation pattern shown in Figure E9-2?

- 4

**Group E9C - Wire and phased vertical antennas: beverage antennas; terminated and resonant rhombic antennas;**

## **elevation above real ground; ground effects as related to polarization; take-off angles**

E9C01 (D)

What is the radiation pattern of two  $1/4$ -wavelength vertical antennas spaced  $1/2$ -wavelength apart and fed  $180$  degrees out of phase?

- A figure-8 oriented along the axis of the array

E9C02 (A)

What is the radiation pattern of two  $1/4$  wavelength vertical antennas spaced  $1/4$  wavelength apart and fed  $90$  degrees out of phase?

- Cardioid

E9C03 (C)

What is the radiation pattern of two  $1/4$  wavelength vertical antennas spaced a  $1/2$  wavelength apart and fed in phase?

- A Figure-8 broadside to the axis of the array

E9C04 (B)

What happens to the radiation pattern of an unterminated long wire antenna as the wire length is increased?

- The lobes align more in the direction of the wire

E9C05 (A)

What is an OCFD antenna?

- A dipole feed approximately  $1/3$  the way from one end with a  $4:1$  balun to provide multiband operation

E9C06 (B)

What is the effect of a terminating resistor on a rhombic antenna?

- It changes the radiation pattern from bidirectional to unidirectional

E9C07 (A)

What is the approximate feed point impedance at the center of a two-wire folded dipole antenna?

- 300 ohms

E9C08 (C)

What is a folded dipole antenna?

- A dipole consisting of one wavelength of wire forming a very thin loop

E9C09 (A)

What is a G5RV antenna?

- A multi-band dipole antenna fed with coax and a balun through a selected length of open wire transmission line

E9C10 (B)

Which of the following describes a Zepp antenna?

- An end fed dipole antenna

E9C11 (D)

How is the far-field elevation pattern of a vertically polarized antenna affected by being mounted over seawater versus rocky ground?

- The low-angle radiation increases

E9C12 (C)

Which of the following describes an extended double Zepp antenna?

- A center fed 1.25 wavelength antenna (two 5/8 wave elements in phase)

E9C13 (C)

What is the main effect of placing a vertical antenna over an imperfect ground?

- It reduces low-angle radiation

E9C14 (B)

How does the performance of a horizontally polarized antenna mounted on the side of a hill compare with the same antenna mounted on flat ground?

- The main lobe takeoff angle decreases in the downhill direction

E9C15 (B)

How does the radiation pattern of a horizontally polarized 3-element beam antenna vary with its height above ground?

- The main lobe takeoff angle decreases with increasing height

## **Group E9D - Directional antennas: gain; satellite antennas; antenna beamwidth; losses; SWR bandwidth; antenna efficiency; shortened and mobile antennas; grounding**

E9D01 (C)

How does the gain of an ideal parabolic dish antenna change when the operating frequency is doubled?

- Gain increases by 6 dB

E9D02 (C)

How can linearly polarized Yagi antennas be used to produce circular polarization?

- Arrange two Yagis perpendicular to each other with the driven elements at the same point on the boom fed 90 degrees out of phase

E9D03 (A)

Where should a high Q loading coil be placed to minimize losses in a shortened vertical antenna?

- Near the center of the vertical radiator

E9D04 (C)

Why should an HF mobile antenna loading coil have a high ratio of reactance to resistance?

- To minimize losses

E9D05 (A)

What is a disadvantage of using a multiband trapped antenna?

- It might radiate harmonics

E9D06 (B)

What happens to the bandwidth of an antenna as it is shortened through the use of loading coils?

- It is decreased

E9D07 (D)

What is an advantage of using top loading in a shortened HF vertical antenna?

- Improved radiation efficiency

E9D08 (B)

What happens as the Q of an antenna increases?

- SWR bandwidth decreases

E9D09 (D)

What is the function of a loading coil used as part of an HF mobile antenna?

- To cancel capacitive reactance

E9D10 (B)

What happens to feed point impedance at the base of a fixed length HF mobile antenna as the frequency of operation is lowered?

- The radiation resistance decreases and the capacitive reactance increases

E9D11 (B)

Which of the following types of conductors would be best for minimizing losses in a station's RF ground system?

- A wide flat copper strap

E9D12 (C)

Which of the following would provide the best RF ground for your station?

- An electrically short connection to 3 or 4 interconnected ground rods driven into the Earth

E9D13 (B)

What usually occurs if a Yagi antenna is designed solely for maximum forward gain?

- The front-to-back ratio decreases

## **Group E9E - Matching: matching antennas to feed lines; power dividers**

E9E01 (B)

What system matches a higher impedance transmission line to a lower impedance antenna by connecting the line to the driven element in two places spaced a fraction of a wavelength each side of element center?

- The delta matching system

E9E02 (A)

What is the name of an antenna matching system that matches an unbalanced feed line to an antenna by feeding the driven element both at the center of the element and at a fraction of a wavelength to one side of center?

- The gamma match

E9E03 (D)

What is the name of the matching system that uses a section of transmission line connected in parallel with the feed line at or near the feed point?

- The stub match

E9E04 (B)

What is the purpose of the series capacitor in a gamma-type antenna matching network?

- To cancel the inductive reactance of the matching network

E9E05 (A)

How must the driven element in a 3-element Yagi be tuned to use a hairpin matching system?

- The driven element reactance must be capacitive

E9E06 (C)

What is the equivalent lumped-constant network for a hairpin matching system of a 3-element Yagi?

- A shunt inductor

E9E07 (B)

What term best describes the interactions at the load end of a mismatched transmission line?

- Reflection coefficient

E9E08 (D)

Which of the following measurements is characteristic of a mismatched transmission line?

- An SWR greater than 1:1

E9E09 (C)

Which of these matching systems is an effective method of connecting a 50 ohm coaxial cable feed line to a grounded tower so it can be used as a vertical antenna?

- Gamma match

E9E10 (C)

Which of these choices is an effective way to match an antenna with a 100 ohm feed point impedance to a 50 ohm coaxial cable feed line?

- Insert a 1/4-wavelength piece of 75 ohm coaxial cable transmission line in series between the antenna terminals and the 50 ohm feed cable

E9E11 (B)

What is an effective way of matching a feed line to a VHF or UHF antenna when the impedances of both the antenna and feed line are unknown?

- Use the universal stub matching technique

E9E12 (A)

What is the primary purpose of a phasing line when used with an antenna having multiple driven elements?

- It ensures that each driven element operates in concert with the others to create the desired antenna pattern



E9E13 (C)

What is a use for a Wilkinson divider?

- It is used to divide power equally between two 50 ohm loads while maintaining 50 ohm input impedance

**Group E9F - Transmission lines: characteristics of open and shorted feed lines: 1/8 wavelength; 1/4 wavelength; 1/2 wavelength; feed lines: coax versus open-wire; velocity factor; electrical length; transformation characteristics of line terminated in impedance not**

E9F01 (D)

What is the velocity factor of a transmission line?

- The velocity of the wave in the transmission line divided by the velocity of light in a vacuum

E9F02 (C)

Which of the following determines the velocity factor of a transmission line?

- Dielectric materials used in the line

E9F03 (D)

Why is the physical length of a coaxial cable transmission line shorter than its electrical length?

- Electrical signals move more slowly in a coaxial cable than in air

E9F04 (B)

What is the typical velocity factor for a coaxial cable with solid polyethylene dielectric?

- 0.66

E9F05 (C)

What is the approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 14.1 MHz?

- 3.5 meters

E9F06 (C)

What is the approximate physical length of an air-insulated, parallel conductor transmission line that is electrically one-half wavelength long at 14.10 MHz?

- 10 meters

E9F07 (A)

How does ladder line compare to small-diameter coaxial cable such as RG-58 at 50 MHz?

- Lower loss

E9F08 (A)

What is the term for the ratio of the actual speed at which a signal travels through a transmission line to the speed of light in a vacuum?

- Velocity factor

E9F09 (B)

What is the approximate physical length of a solid polyethylene dielectric coaxial transmission line that is electrically one-quarter wavelength long at 7.2 MHz?

- 6.9 meters

E9F10 (C)

What impedance does a  $1/8$  wavelength transmission line present to a generator when the line is shorted at the far end?

- An inductive reactance

E9F11 (C)

What impedance does a  $1/8$  wavelength transmission line present to a generator when the line is open at the far end?

- A capacitive reactance

E9F12 (D)

What impedance does a  $1/4$  wavelength transmission line present to a generator when the line is open at the far end?

- Very low impedance

E9F13 (A)

What impedance does a  $1/4$  wavelength transmission line present to a generator when the line is shorted at the far end?

- Very high impedance

E9F14 (B)

What impedance does a  $1/2$  wavelength transmission line present to a generator when the line is shorted at the far end?

- Very low impedance

E9F15 (A)

What impedance does a  $1/2$  wavelength transmission line present to a generator when the line is open at the far end?

- Very high impedance

E9F16 (D)

Which of the following is a significant difference between foam dielectric coaxial cable and solid dielectric cable, assuming all other parameters are the same?

- All of these choices are correct

## **Group E9G - The Smith chart**

E9G01 (A)

Which of the following can be calculated using a Smith chart?

- Impedance along transmission lines

E9G02 (B)

What type of coordinate system is used in a Smith chart?

- Resistance circles and reactance arcs

E9G03 (C)

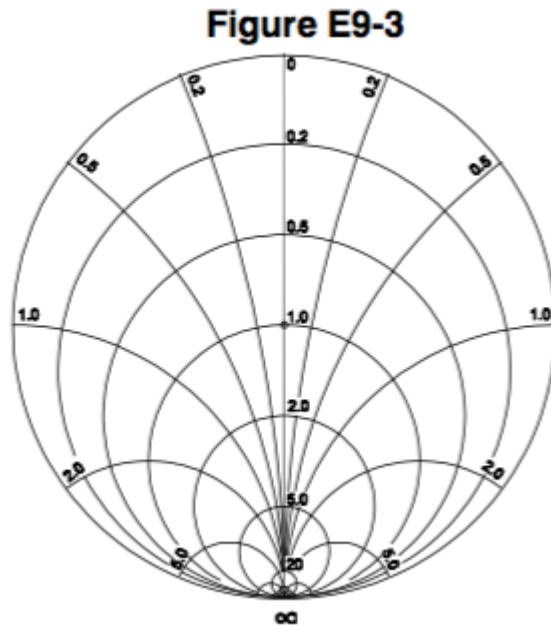
Which of the following is often determined using a Smith chart?

- Impedance and SWR values in transmission lines

E9G04 (C)

What are the two families of circles and arcs that make up a Smith chart?

- Resistance and reactance

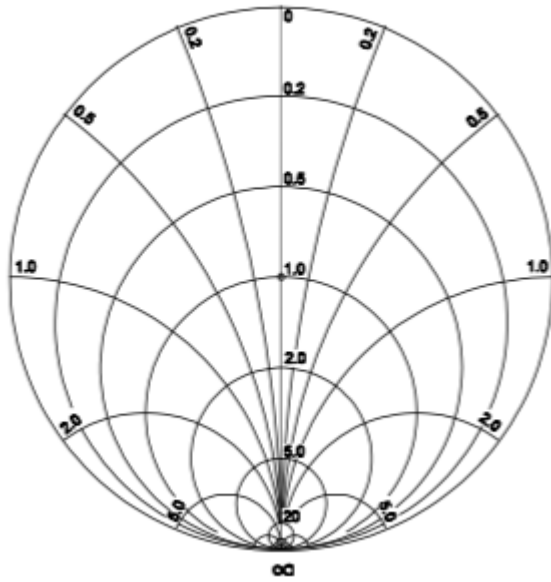


E9G05 (A)

What type of chart is shown in Figure E9-3?

- Smith chart

**Figure E9-3**

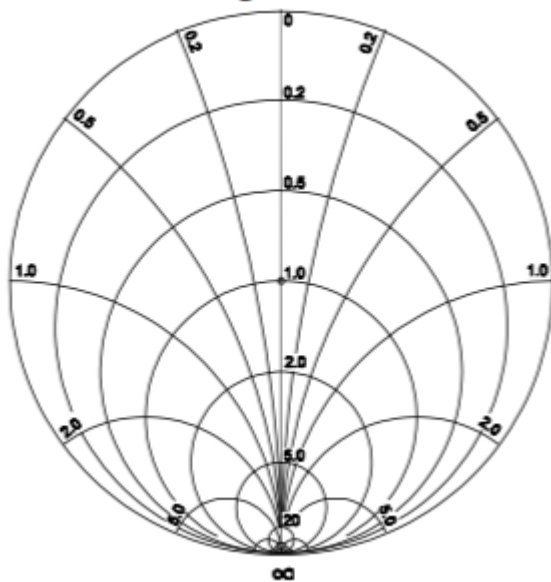


E9G06 (B)

On the Smith chart shown in Figure E9-3, what is the name for the large outer circle on which the reactance arcs terminate?

- Reactance axis

**Figure E9-3**



E9G07 (D)

On the Smith chart shown in Figure E9-3, what is the only straight line shown?

- The resistance axis

E9G08 (C)

What is the process of normalization with regard to a Smith chart?

- Reassigning impedance values with regard to the prime center

E9G09 (A)

What third family of circles is often added to a Smith chart during the process of solving problems?

- Standing wave ratio circles

E9G10 (D)

What do the arcs on a Smith chart represent?

- Points with constant reactance

E9G11 (B)

How are the wavelength scales on a Smith chart calibrated?

- In fractions of transmission line electrical wavelength

## **Group E9H - Effective radiated power; system gains and losses; radio direction finding antennas**

E9H01 (D)

When constructing a Beverage antenna, which of the following factors should be included in the design to achieve good performance at the desired frequency?

- It should be one or more wavelengths long

E9H02 (A)

Which is generally true for low band (160 meter and 80 meter) receiving antennas?

- Atmospheric noise is so high that gain over a dipole is not important

E9H04 (B)

What is an advantage of using a shielded loop antenna for direction finding?

- It is electro statically balanced against ground, giving better nulls

E9H05 (A)

What is the main drawback of a wire-loop antenna for direction finding?

- It has a bidirectional pattern

E9H06 (C)

What is the triangulation method of direction finding?

- Antenna headings from several different receiving locations are used to locate the signal source

E9H07 (D)

Why is it advisable to use an RF attenuator on a receiver being used for direction finding?

- It prevents receiver overload which could make it difficult to determine peaks or nulls

E9H08 (A)

What is the function of a sense antenna?

- It modifies the pattern of a DF antenna array to provide a null in one direction

E9H09 (C)

Which of the following describes the construction of a receiving loop antenna?

- One or more turns of wire wound in the shape of a large open coil

E9H10 (D)

How can the output voltage of a multiple turn receiving loop antenna be increased?

- By increasing either the number of wire turns in the loop or the area of the loop structure or both

E9H11 (B)

What characteristic of a cardioid pattern antenna is useful for direction finding?

- A very sharp single null

## **Subelement E0 - Safety**

### **Group E0A - Safety: amateur radio safety practices; RF radiation hazards; hazardous materials**

E0A01 (B)

What is the primary function of an external earth connection or ground rod?

- Lightning protection

E0A02 (B)

When evaluating RF exposure levels from your station at a neighbor's home, what must you do?

- Make sure signals from your station are less than the uncontrolled MPE limits

E0A03 (C)

Which of the following would be a practical way to estimate whether the RF fields produced by an amateur radio station are within permissible MPE limits?

- Use an antenna modeling program to calculate field strength at accessible locations

E0A04 (C)

When evaluating a site with multiple transmitters operating at the same time, the operators and licensees of which transmitters are responsible for mitigating over-exposure situations?

- Each transmitter that produces 5 percent or more of its MPE limit at accessible locations

E0A05 (B)

What is one of the potential hazards of using microwaves in the amateur radio bands?

- The high gain antennas commonly used can result in high exposure levels

E0A06 (D)

Why are there separate electric (E) and magnetic (H) field MPE limits?

- All of these choices are correct



E0A07 (B)

How many dangerous levels of carbon monoxide from an emergency generator be detected?

- Only with a carbon monoxide detector

E0A08 (C)

What does SAR measure?

- The rate at which RF energy is absorbed by the body

E0A09 (C)

Which insulating material commonly used as a thermal conductor for some types of electronic devices is extremely toxic if broken or crushed and the particles are accidentally inhaled?

- Beryllium Oxide

E0A10 (A)

What toxic material may be present in some electronic components such as high voltage capacitors and transformers?

- Polychlorinated Biphenyls

E0A11 (C)

Which of the following injuries can result from using high-power UHF or microwave transmitters?

- Localized heating of the body from RF exposure in excess of the MPE limits