

Amateur Extra – The Right Answers

Chapter Six – Radio Circuits and Systems

E6C01. What is the function of hysteresis in a comparator?

**To prevent input noise from causing unstable output signals**

E6C02. What happens when the level of a comparator's input signal crosses the threshold?

**The comparator changes its output state**

E7B01. For what portion of a signal cycle does a Class AB amplifier operate?

**More than 180 degrees but less than 360 degrees**

E7B02. What is a Class D amplifier?

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

E7B03. Which of the following components form the output of a class D amplifier circuit?

**A low-pass filter to remove switching signal components**

E7B04. 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. What can be done to prevent unwanted oscillations in an RF power amplifier?

**Install parasitic suppressors and/or neutralize the stage**

E7B06. Which of the following amplifier types reduces or eliminates even-order harmonics?

**Push-pull**

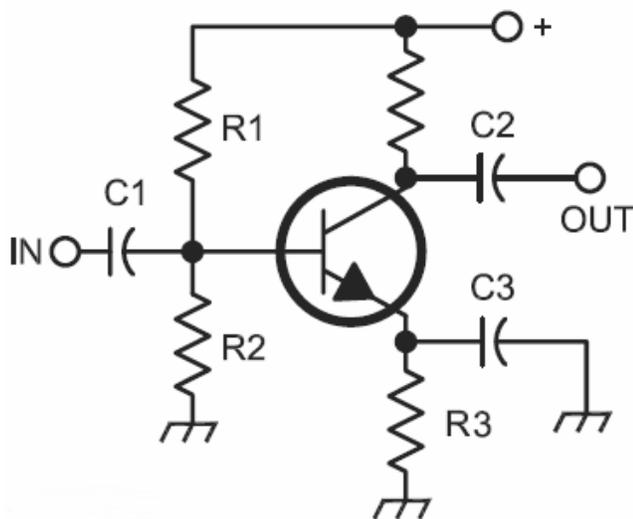
E7B07. Which of the following is a likely result when a Class C amplifier is used to amplify a single-sideband phone signal?

**Signal distortion and excessive bandwidth**

E7B08. How can an RF power amplifier be neutralized?

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

Figure E7-1



E7B10. In Figure E7-1, what is the purpose of R1 and R2?

**Fixed bias**

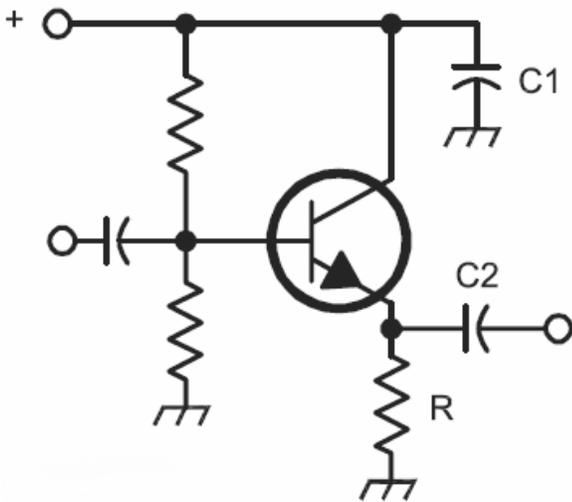
E7B11. In Figure E7-1, what is the purpose of R3?

**Self bias**

E7B12. What type of amplifier circuit is shown in Figure E7-1?

**Common emitter**

Figure E7-2



E7B13. In Figure E7-2, what is the purpose of R?

**Emitter load**

E7B14. 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. What is one way to prevent thermal runaway in a bipolar transistor amplifier?

**Use a resistor in series with the emitter**

E7B16. What is the effect of intermodulation products in a linear power amplifier?

**Transmission of spurious signals**

E7B17. 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. What is a characteristic of a grounded-grid amplifier?

**Low input impedance**

E7G01. What is the typical output impedance of an integrated circuit op-amp?

**Very low**

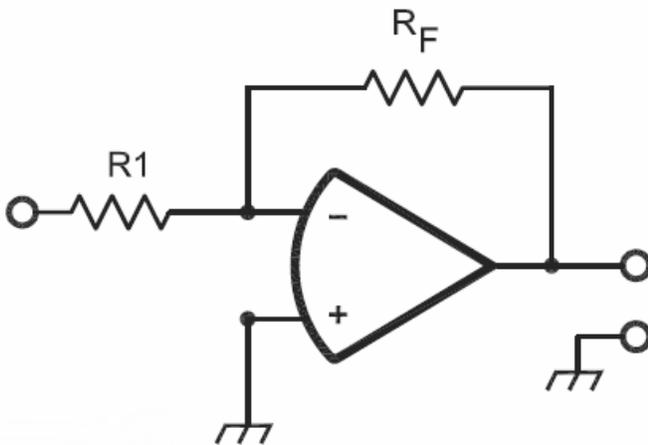
E7G03. What is the typical input impedance of an integrated circuit op-amp?

**Very high**

E7G04. 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**

Figure E7-4

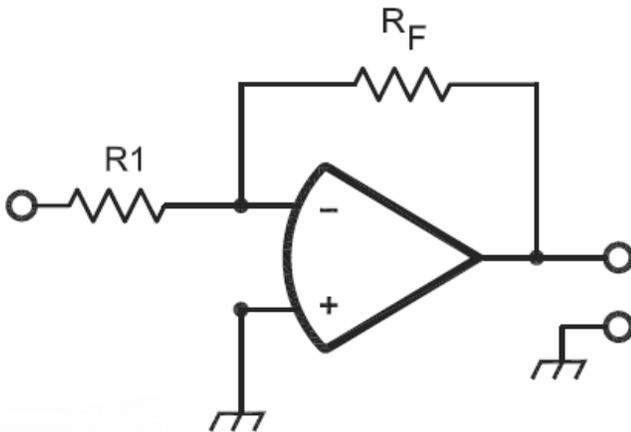


E7G07. What magnitude of voltage gain can be expected from the circuit in Figure E7-4 when R1 is 10 ohms and R<sub>F</sub> is 470 ohms?

E7G08. How does the gain of an ideal operational amplifier vary with frequency?

**It does not vary with frequency**

Figure E7-4



E7G09. 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**

E7G10. 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**

E7G11. 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. What is an integrated circuit operational amplifier?

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

E6D02. 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. Which of the following is an aspect of the piezoelectric effect?

**Mechanical deformation of material by the application of a voltage**

E7E01. Which of the following can be used to generate FM phone emissions?

**A reactance modulator on the oscillator**

E7E02. What is the function of a reactance modulator?

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

E7E03. How does an analog phase modulator function?

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

E7E04. What is one way a single-sideband phone signal can be generated?

**By using a balanced modulator followed by a filter**

E7E05. What circuit is added to an FM transmitter to boost the higher audio frequencies?

**A pre-emphasis network**

E7E06. Why is de-emphasis commonly used in FM communications receivers?

**For compatibility with transmitters using phase modulation**

E7E07. What is meant by the term baseband in radio communications?

**The frequency components present in the modulating signal**

E7E08. 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. What occurs when an excessive amount of signal energy reaches a mixer circuit?

**Spurious mixer products are generated**

E7E10. How does a diode detector function?

**By rectification and filtering of RF signals**

E7E11. Which type of detector is used for demodulating SSB signals?

**Product detector**

E7E12. What is a frequency discriminator stage in a FM receiver?

**A circuit for detecting FM signals**

E7H01. What are three oscillator circuits used in Amateur Radio equipment?

**Colpitts, Hartley and Pierce**

E7H02. Which describes a microphonic?

**Changes in oscillator frequency due to mechanical vibration**

E7H03. How is positive feedback supplied in a Hartley oscillator?

**Through a tapped coil**

E7H04. How is positive feedback supplied in a Colpitts oscillator?

**Through a capacitive divider**

E7H05. How is positive feedback supplied in a Pierce oscillator?

**Through a quartz crystal**

E7H06. Which of the following oscillator circuits are commonly used in VFOs?

**Colpitts and Hartley**

E7H07. How can an oscillator's microphonic responses be reduced?

**Mechanically isolating the oscillator circuitry from its enclosure**

E7H08. Which of the following components can be used to reduce thermal drift in crystal oscillators?

**NP0 capacitors**

E7H09. 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. What information is contained in the lookup table of a direct digital frequency synthesizer?

**The amplitude values that represent a sine-wave output**

E7H11. What are the major spectral impurity components of direct digital synthesizers?

**Spurious signals at discrete frequencies**

E7H12. Which of the following must be done to ensure that a crystal oscillator provides the frequency specified by the crystal manufacturer?

**Provide the crystal with a specified parallel capacitance**

E7H13. Which of the following is a technique for providing highly accurate and stable oscillators needed for microwave transmission and reception?

**Use a GPS signal reference**

**Use a rubidium stabilized reference oscillator**

**Use a temperature-controlled high Q dielectric resonator**

E7H14. 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. Which of these functions can be performed by a phase-locked loop?

**Frequency synthesis, FM demodulation**

E7F01. 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**

E7F03. What type of digital signal processing filter is used to generate an SSB signal?

**A Hilbert-transform filter**

E7F04. What is a common method of generating an SSB signal when using digital signal processing?

**Combine signals with a quadrature phase relationship**

E7F05. 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. 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. What functions can a Fast Fourier Transform perform?

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

E7F08. What is the function of decimation with regard to digital filters?

**Reducing the effective sample rate by removing samples**

E7F09. 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. What aspect of receiver analog-to-digital conversion determines the maximum receive bandwidth of a Direct Digital Conversion SDR?

**Sample rate**

E7F11. 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. What digital process is applied to I and Q signals to recover the baseband modulation information?

**Fast Fourier Transform**

E7F16. 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. What do the letters I and Q in I/Q Modulation represent?

**In-phase and Quadrature**

E8A01. 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**

E8A04. 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**

E8A08. 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. How many levels can an analog-to-digital converter with 8 bit resolution encode?

**256**

E8A10. 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. What type of information can be conveyed using digital waveforms?

**Human speech**

**Video signals**

**Data**

E8A12. 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. Which of these methods is commonly used to convert analog signals to digital signals?

**Sequential sampling**

E7B09. 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, while the loading capacitor is adjusted for maximum permissible plate current**

E7C01. 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. 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. What advantage does a Pi-L-network have over a Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna?

**Greater harmonic suppression**

E7C04. 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. Which filter type is described as having ripple in the passband and a sharp cutoff?

**A Chebyshev filter**

E7C06. What are the distinguishing features of an elliptical filter?

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

E7C07. What kind of filter would you use to attenuate an interfering carrier signal while receiving an SSB transmission?

**A notch filter**

E7C08. 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. What is a Jones filter as used as part of an HF receiver IF stage?

**A variable bandwidth crystal lattice filter**

E7C10. Which of the following filters would be the best choice for use in a 2 meter repeater duplexer?

**A cavity filter**

E7C11. 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 inductors in series and the capacitors in shunt at the input and output?

**Pi**

E7C12. 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. 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. Which mode is most affected by non-linear phase response in a receiver IF filter?

**Digital**

E7C15. What is a crystal lattice filter?

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

E7F02. What kind of digital signal processing audio filter is used to remove unwanted noise from a received SSB signal?

**An adaptive filter**

E7F13. What is the function of taps in a digital signal processing filter?

**Provide incremental signal delays for filter algorithms**

E7F14. Which of the following would allow a digital signal processing filter to create a sharper filter response?

**More taps**

E7F15. 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**

E7G02. What is the effect of ringing in a filter?

**Undesired oscillations added to the desired signal**

E7G05. 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. Which of the following is the most appropriate use of an op-amp active filter?

**As an audio filter in a receiver**

E7D01. 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. What is one characteristic of a switching electronic voltage regulator?

**The control device's duty cycle is controlled to produce a constant average output voltage**

E7D03. What device is typically used as a stable reference voltage in a linear voltage regulator?

**A Zener diode**

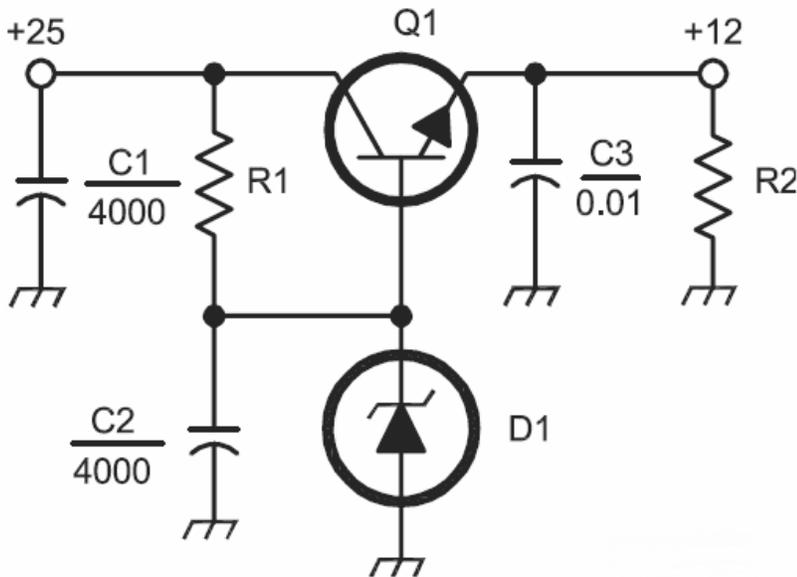
E7D04. Which of the following types of linear voltage regulator usually make the most efficient use of the primary power source?

**A series regulator**

E7D05. 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. What is the purpose of Q1 in the circuit shown in Figure E7-3?

**It increases the current-handling capability of the regulator**

E7D07. What is the purpose of C2 in the circuit shown in Figure E7-3?

**It bypasses hum around D1**

E7D08. What type of circuit is shown in Figure E7-3?

**Linear voltage regulator**

E7D09. What is the main reason to use a charge controller with a solar power system?

**Prevention of battery damage due to overcharge**

E7D10. 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. What circuit element is controlled by a series analog voltage regulator to maintain a constant output voltage?

**Pass transistor**

E7D12. What is the drop-out voltage of an analog voltage regulator?

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

E7D13. 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. What is one purpose of a 'bleeder' resistor in a conventional unregulated power supply?

**To improve output voltage regulation**

E7D15. What is the purpose of a 'step-start' circuit in a high-voltage power supply?

**To allow the filter capacitors to charge gradually**

E7D16. 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?

**To equalize, as much as possible, the voltage drop across each capacitor**

**To provide a safety bleeder to discharge the capacitors when the supply is off**

**To provide a minimum load current to reduce voltage excursions at light loads**