











































E7F06 -- What is the minimum number of bits required to sample a signal with a range of 1 volt at a resolution of 1 millivolt?



- B. 6 bits
- C. 8 bits
- ➡ D. 10 bits



















































E7F10 -- What aspect of receiver analog-todigital conversion determines the maximum receive bandwidth of a direct-sampling software defined radio (SDR)?

- A. Sample rate
 - B. Sample width in bits
 - C. Integral non-linearity
 - D. Differential non-linearity







- A. Very low power consumption decreases frequency drift
- B. Immunity to out-of-sequence coding reduces spurious responses
- C. Very high speed allows digitizing high frequencies
 - D. All these choices are correct

















Passive and Active Filters

- Passive filters are constructed using only passive components.
 - Capacitors.
 - Inductors.
 - Resistors.
 - Crystals.
- Passive filters always have some insertion loss.





Filter Families and Response Types

- Helical filters are a type of passive filter that have a coil of wire inside a conductive enclosure.
 - Like cavity filters, capable of very high Qs.
 - >1000.
 - Commonly used in VHF/UHF receivers.





Passive and Active Filters

- Active filters include some type of amplification.
 - Because of the amplification, active filters can be constructed to have no insertion loss or even have gain.
 - Some types of filters can **ONLY** be built using active components.











Passive and Active Filters

- Filter Classification.
 - The stopband is the range of frequencies where the response is more than 3 dB below the maximum.
 - A filter can have either one or two stopbands.











Passive and Active Filters

- Filter Classification.
 - A band-pass filter.
 - Has 2 cut-off frequencies.
 - Passes all frequencies between the cut-off frequencies.
 - Attenuates all frequencies outside of the cut-off frequencies.
 - Has one passband and two stopbands.










- A. A crystal filter
- ➡ B. A cavity filter
 - C. A DSP filter
 - D. An L-C filter





Filter Design

- Definitions.
 - Phase response.
 - The shift of the signal phase vs. frequency.
 - Higher attenuation \rightarrow more phase shift.
 - A linear phase shift means the phase shift is smooth with no ripple as the frequency changes.
 - A non-linear phase response can distort digital signals.
 - Ringing.
 - Oscillations that continue after the signal is removed.





Filter Design

- A Chebyshev filter has:
 - Ripple in the passband.
 - A sharper cutoff transition.
 - Significant phase shift in the passband.







Filter Design

- Shape factor is:
 - Measurement of the "sharpness" of a filter.
 - The ratio of the -60dB bandwidth to the -6dB bandwidth.
 - SF = BW_{60dB} / BW_{6dB}
 - The closer the ratio is to 1.0, the sharper the filter.
 - An ideal filter would have a shape factor of 1.0.













Crystal Filters

- The IF stages of a superheterodyne receiver require very narrow bandwidth (high Q) filters with sharp transitions to filter out adjacent signals.
 - The required Q & sharpness cannot be achieved with L-C filters.













Active Filters

- Active filters:
 - Use an amplifying device.
 - Are often built using op-amps.
 - The filter characteristics are determined solely by the external components.
 - Can be built without inductors.
 - Smaller & lighter.
 - Are best suited for audio filtering in receivers.
 - Can be designed either to have no insertion loss or to have gain.





Active Filters

- Designing an active audio filter:
 - Pick standard value capacitors.
 - Low-loss.
 - Temperature stable.
 - Polystyrene (?).
 - Calculate the resistors.



E7G05 -- How can unwanted ringing and audio instability be prevented in an op-amp audio filter?

- A. Restrict both gain and Q
 - B. Restrict gain but increase Q
 - C. Restrict Q but increase gain
 - D. Increase both gain and Q

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Digital Signal Processing (DSP) Filters

- Some disadvantages of DSP filters are:
 - DSP filtering requires computing hardware.
 - The filter performance is limited by the sampling rate and the resolution of the A-to-D and D-to-A converters used.

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Digital Signal Processing (DSP) Filters

- DSP filters are categorized by their response to a very narrow pulse input called an *impulse*.
 - Extremely narrow pulses occupy a very wide range of frequencies.
 - The energy distribution across that range of frequencies is nearly flat.















E7F02 -- What kind of digital signal processing audio filter might be used to remove unwanted noise from a received SSB signal?

- ➡ A. An adaptive filter
 - B. A crystal-lattice filter
 - C. A Hilbert-transform filter
 - D. A phase-inverting filter



























Impedance Matching

- T Networks.
 - T networks can match a wide range of impedances.
 - T networks have lower loss than a pi-network.
 - T networks are used in most antenna tuners.
 - A T network is a high-pass filter and does **not** provide any harmonic suppression.

Ant Ant



E7C02 -- What is the frequency response of a Tnetwork with series capacitors and a shunt inductor?



- ➡ B. High-pass
 - C. Band-pass
 - D. Notch







- A. It introduces negative resistance to cancel the resistive part of impedance
- B. It introduces transconductance to cancel the reactive part of impedance
- C. It cancels the reactive part of the impedance and changes the resistive part to a desired value
 - D. Reactive currents are dissipated in matched resistances





Power Supplies

Unregulated Power Supplies

- The most basic type of power supply simply rectifies & filters an AC signal.
 - The output voltage will contain *ripple* because the filtering is not 100% effective.
 - The output voltage will change as the load current changes.
 - As the current increases, the voltage will drop.












































Battery Charging Regulators

- Special types of regulators called *charge controllers* are used to charge re-chargeable batteries.
 - Required to prevent over-charging or damaging the battery being charged.
 - The type of regulator used depends on the chemistry of the battery being charged.
 - Voltage regulator Lead-Acid.
 - Current regulator Ni-Cd, NiMh.









Switching Regulators







Switching Regulators

- Harmonics of the switching frequency can result in spurious signals extending well into HF frequencies, thereby causing interference.
 - Signals at regular intervals.
- Some switching power supplies provide a control to shift the switching frequency so that interference can be minimized on frequencies of interest.









High Voltage Techniques

- Bleeder resistors.
 - The output filter capacitor of a high-voltage power supply can hold a lethal charge long after the power supply power is turned off.
 - A relatively high value resistor is placed from the power supply output to ground to discharge the filter capacitors after power is removed.
 - The bleeder resistor also improves voltage regulation by providing a minimum load current to the power supply.









High Voltage Techniques

- Step-start.
 - A resistor is placed in series with the transformer primary winding.
 - After a short delay, a relay shorts the resistor.
 - This allows the capacitors to charge more slowly and limits the inrush current.









Amateur Extra Class

Next Week Chapter 7 Radio Signals and Measurements