General License Class

1

General Class

Chapter 5

Radio Signals & Equipment

2

Basic Modes and Bandwidth

Modulation

- Changing a signal in some manner to convey information is called “modulation”.
  - Can change amplitude (AM).
  - Can change frequency (FM).
  - Can change phase (PM).
  - A signal with no information is “unmodulated”.

3

Basic Modes and Bandwidth

Modulation

- A combination of the way the signal is changed, and the type of information being transmitted, is called the operating “mode”.
  - Voice mode or phone.
    - The information is analog or digitized voice.
  - Data mode or digital mode.
    - The information is data.

4

Basic Modes and Bandwidth

Continuous Wave (CW)

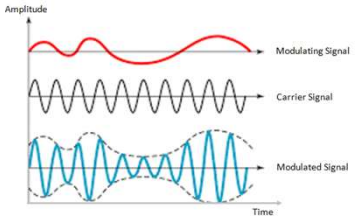
- A signal at one frequency whose amplitude never varies.
- Normally used to refer to turning the signal on & off in a specific pattern to convey information.
  - Morse Code.

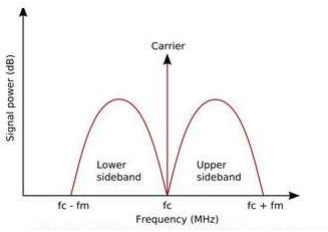
5

Basic Modes and Bandwidth

Amplitude Modulated Modes

- Amplitude Modulation (AM).
  - Carrier plus two sidebands are transmitted.
  - Higher fidelity.





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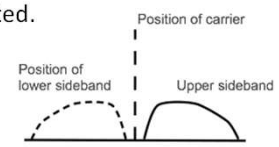
Basic Modes and Bandwidth

Amplitude Modulated Modes

- Single-Sideband (SSB).
  - Carrier & one sideband are suppressed.
    - Lower Sideband (LSB).
      - Only lower sideband is transmitted.
    - Upper sideband (USB).
      - Only upper sideband is transmitted.
  - Higher efficiency.
  - Less bandwidth.



7

Basic Modes and Bandwidth

Frequency and Phase Modulated Modes

- Frequency Modulation (FM).
  - Frequency change proportional to amplitude of modulating signal.
  - Deviation = amount of frequency change.
  - Constant power output whether modulated or not.

8

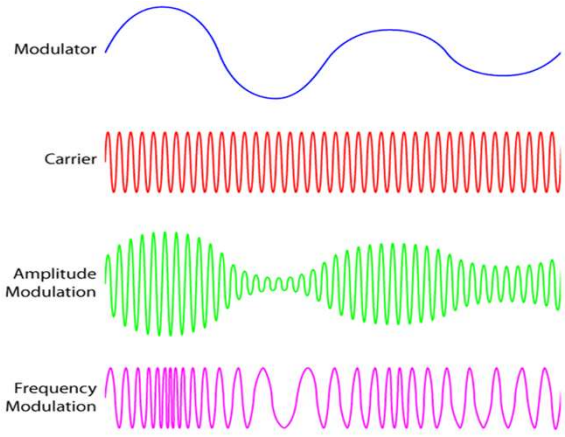
Basic Modes and Bandwidth

Frequency and Phase Modulated Modes

- Phase Modulation (PM).
  - Frequency change proportional to **both** amplitude and frequency of modulating signal.
  - Constant power whether modulated or not.

9

Basic Modes and Bandwidth



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Basic Modes and Bandwidth

Bandwidth Definition

- All modulated signals have sidebands.
- FCC defines bandwidth as:

> §97.3(a)(8) -- *Bandwidth*. The width of a frequency band outside of which the mean power of the transmitted signal is attenuated at least 26 dB below the mean power of the transmitted signal within the band.

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Basic Modes and Bandwidth

Bandwidth Definition

Type of Signal	Typical Bandwidth
AM Voice	6 kHz
Amateur Television	6 MHz
SSB Voice	2 kHz to 3 kHz
Digital using SSB	50 Hz to 3 kHz
CW	100 Hz to 300 Hz
FM Voice	10 kHz to 15 kHz

12

Basic Modes and Bandwidth

Link Budgets

- The term link budget refers to all of the signal gains and losses in a communications link.

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Basic Modes and Bandwidth

Link Budgets

- For a radio link, the link budget includes:
  - Transmitter power.
  - Transmission line loss
  - Antenna gain.
  - Propagation losses.
  - Receiver antenna gain.
  - Receive antenna transmission line losses.

14

Basic Modes and Bandwidth

Link Budgets

- The link margin is the difference between the minimum signal strength required to receive the signal and the actual signal strength received.

15

G8A02 -- What is the name of the process that changes the phase angle of an RF wave to convey information?

A. Phase convolution
B. Phase modulation
C. Phase transformation
D. Phase inversion

16

G8A03 -- What is the name of the process that changes the instantaneous frequency of an RF wave to convey information?

A. Frequency convolution
B. Frequency transformation
C. Frequency conversion
D. Frequency modulation

17

G8A05 -- What type of modulation varies the instantaneous power level of the RF signal?

A. Power modulation
B. Phase modulation
C. Frequency modulation
D. Amplitude modulation

18

G8A07 -- Which of the following phone emissions uses the narrowest bandwidth?

A. Single sideband
B. Vestigial sideband
C. Phase modulation
D. Frequency modulation

19

G8A13 -- What is a link budget?

A. The financial costs associated with operating a radio link
B. The sum of antenna gains minus system losses
C. The sum of transmit power and antenna gains minus system losses as seen at the receiver
D. The difference between transmit power and receiver sensitivity

20

G8A14 -- What is link margin?

A. The opposite of fade margin

B. The difference between received power level and minimum required signal level at the input to the receiver

C. Transmit power minus receiver sensitivity

D. Receiver sensitivity plus 3 dB

21

Radio's Building Blocks

- Radios are constructed using certain type of circuits or "building blocks".
  - Traditionally, these circuits have been constructed with physical components.
  - Modern digital signal processing (DSP) techniques allow many of the functions to be performed mathematically.
    - Radios in which nearly all functions are implemented mathematically in software are called "Software-Defined Radios" (SDR).

22

Radio's Building Blocks

Filters

- Filters are circuits that have different responses depending on the frequency of the applied signal.

23

Radio's Building Blocks

Filters

- Filters attenuate some frequencies and pass other frequencies unattenuated.
  - Pass band – The range or ranges of frequencies where the signal **is not** attenuated.
  - Stop band – The range or ranges of frequencies where the signal **is** attenuated.

24

Radio's Building Blocks

Filters

- There is always some loss within the pass band.
  - This is called the insertion loss.
- There is a maximum amount of attenuation achievable in the stop band.
  - This is called the ultimate rejection.

25

Radio's Building Blocks

Filters

- Filters are classified as to how the response varies with frequency:
  - Low-pass filters.
  - High-pass filters.
  - Band-pass filters.
  - Band-reject filters.
    - a.k.a. – Notch filters.

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Radio's Building Blocks

Filters

- Low-pass filter.
  - Passes frequencies below the cut-off frequency.
  - Attenuates frequencies above the cut-off frequency.
  - The cut-off frequency is the frequency at which the response falls to 3 dB below the maximum level.
    - a.k.a. – Half-power frequency.

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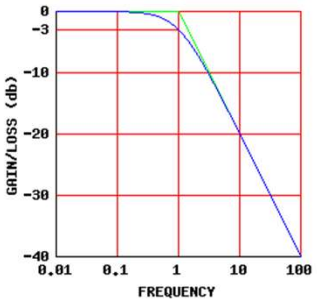
Radio's Building Blocks

Filters

- Low-pass filter.



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Radio's Building Blocks

Filters

- High-pass filter.
  - Attenuates frequencies below the cut-off frequency.
  - Passes frequencies above the cut-off frequency.
  - The cut-off frequency is the frequency at which the response rises to 3 dB below the maximum level.
    - a.k.a. – Half-power frequency.

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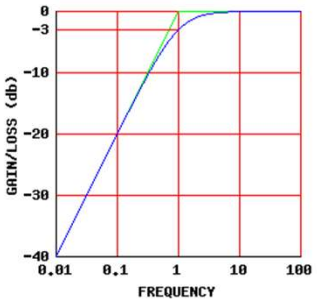
Radio's Building Blocks

Filters

- High-pass filter.



30

Radio's Building Blocks

Filters

- Band-pass filter.
  - 2 cut-off frequencies.
    - The cut-off (or half-power) frequencies are the frequencies where the response is 3dB below maximum.
  - Passes frequencies between the cut-off frequencies.
  - Attenuates frequencies outside of the cut-off frequencies.

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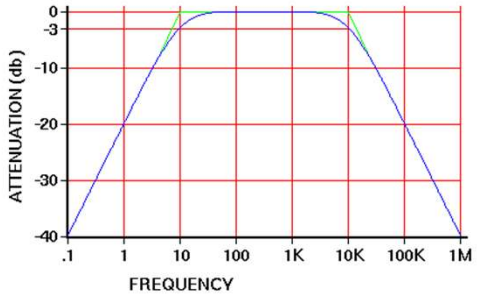
Radio's Building Blocks

Filters

- Band-pass filter.



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Radio's Building Blocks

Filters

- Band-reject filter.
  - 2 cut-off (or half-power) frequencies.
  - Attenuates frequencies between the cut-off frequencies.
  - Passes frequencies outside of the cut-off frequencies.
  - If the stop band is narrow, it may be called a notch filter.

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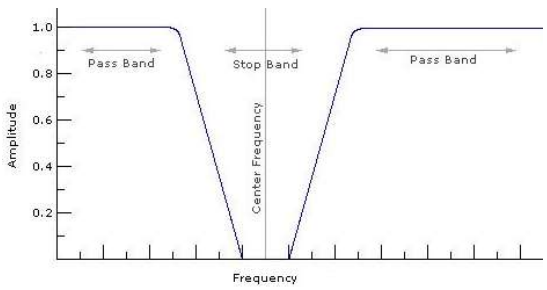
Radio's Building Blocks

Filters

- Band-reject filter.



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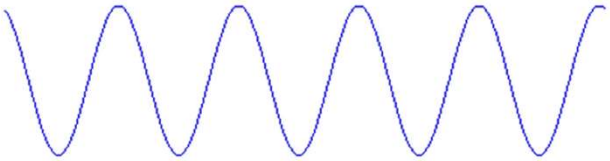
Radio's Building Blocks

Oscillators

- An oscillator generates a sine-wave signal at a specific frequency.



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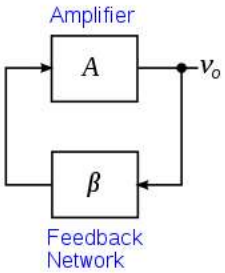
Radio's Building Blocks

Oscillators

- An oscillator is an amplifier with positive feedback.
  - A = Amplifier gain.
  - β = Feedback ratio.
  - Loop Gain = A x β
  - If the loop gain is >1 and is in phase, the circuit will oscillate.



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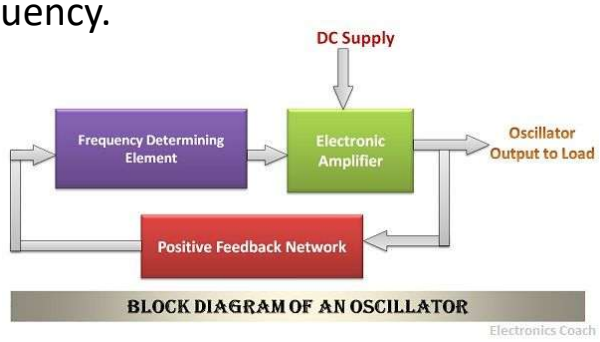
Radio's Building Blocks

Oscillators

- A filter in the feedback loop determines the frequency.



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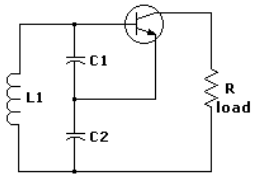
Radio's Building Blocks

Oscillators

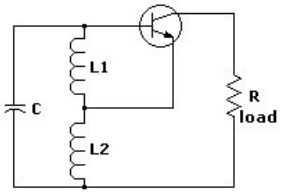
- Colpitts oscillator.

  The frequency is determined by the values of L & C.



- Hartley oscillator.

  The frequency is determined by the values of L & C.



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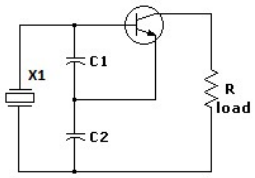
Radio's Building Blocks

Oscillators

- Pierce oscillator.

The frequency is determined by a crystal.



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Radio's Building Blocks

Oscillators

- Crystals.
  - A small wafer of piezoelectric material (usually quartz) with precise physical dimensions.
    - Piezoelectric effect.
      - The crystal deforms mechanically when a voltage applied.
      - A voltage is generated when the crystal is deformed.

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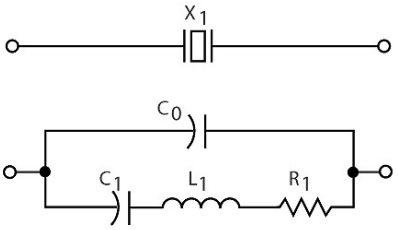
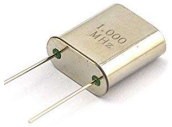
Radio's Building Blocks

Oscillators

- Crystals.





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Radio's Building Blocks

Oscillators

- Variable-frequency oscillator (VFO).
  - Make either L or C adjustable (usually C).
  - Not as stable.
  - Used to tune radio to different frequencies

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Radio's Building Blocks

Oscillators

- Variable-frequency oscillator (VFO).
  - Frequency Synthesizers.
    - Have mostly replaced L-C VFOs in modern designs.
    - "Crystal-controlled" VFOs.
      - Phase-Lock-Loop (PLL).
      - Direct Digital Synthesis (DDS)
    - Have the stability of a crystal oscillator.
    - Frequency can be changed by software.

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Radio's Building Blocks

Mixers

- Mixing is also known as heterodyning.
- Used to change the frequency of a signal.
- Mathematically multiplies 2 frequencies together, generating 4 output frequencies.
  - $f_1 \times f_2 \rightarrow f_1,\ f_2,\ f_1+f_2, f_1-f_2$
- Mixers, product detectors, & modulators are all the same basic circuit.

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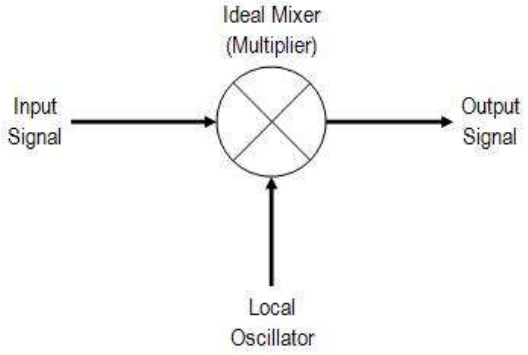
Radio's Building Blocks

Mixers



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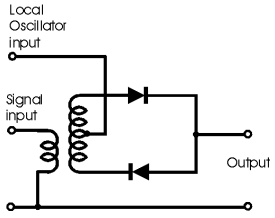
Radio's Building Blocks

Mixers

- Single-balanced mixer.
  - Local oscillator or input signal is suppressed, but not both.



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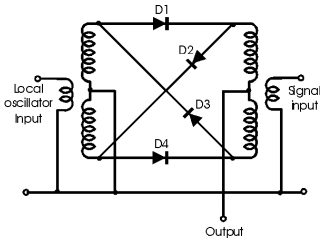
Radio's Building Blocks

Mixers

- Double-balanced mixer.
  - f_{RF} & f_{LO} are suppressed leaving only sum & difference frequencies.



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Radio's Building Blocks

Multipliers

- A multiplier stage creates a multiple of the input frequency.
  - An amplifier stage that has a lot of distortion (harmonics).
    - Class C amplifier.
  - The output circuit is tuned to the desired harmonic.

48

Radio's Building Blocks

Multipliers

- Used in VHF/UHF transmitters to generate an FM/PM modulated signal at a low frequency & then multiplied to the desired frequency.

49

Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Plate modulation.
    - Originally, AM was produced by varying the DC plate voltage to the final stage of a transmitter.
      - If a solid-state transmitter, substitute collector or drain for plate.
    - Requires a LOT of audio power.
      - A 1 kW transmitter needs 1 kW of audio!

50

Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Screen modulation.
    - a.k.a. – Controlled-carrier modulation.
    - The modulating signal varies the screen voltage of the final amplifier stage.
      - Less AF power is required, but less transmitter power output & more distortion of the modulating signal than with plate modulation.

51

Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - AM can be generated by mixing the modulating signal (f_M) with a carrier (f_C).
    - $f_C \times f_M$ ➔ f_C, f_M, f_C+f_M, f_C-f_M

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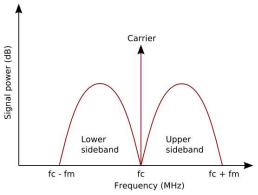
Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Using a single-balanced mixer, an AM signal is produced.
    - $f_C \times f_M$ ➔ f_C, f_M, f_C+f_M, f_C-f_M



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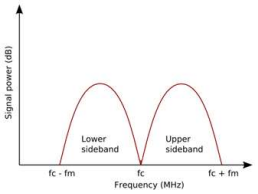
Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Using a double-balanced mixer, a double-sideband (DSB) signal is produced.
    - $f_C \times f_M$ ➔ f_C+f_M, f_C-f_M



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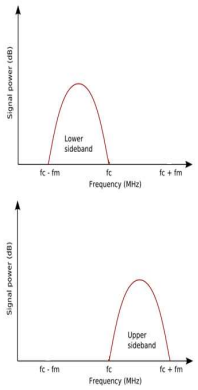
Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - The double-sideband signal is then converted to a SSB signal by filtering out the unwanted sideband.
    - Filter method of SSB generation.



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Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Phasing method of SSB generation.
    - 2 double-balanced mixers.
    - 2 carrier signals 90° out-of-phase
    - 2 modulating signals 90° out-of-phase
      - **REALLY** difficult to create in hardware.
      - Relatively easy to create in software.
        - Method used by software-defined radios.

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Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Advantages of SSB.
    - Transmitter power is used more effectively.
      - In AM, only 25% of the available power is used to transmit the information.
      - In SSB, 100% of the transmitter power is used.
    - 1/2 the bandwidth of AM.

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Radio's Building Blocks

Modulators

- Amplitude Modulators.
  - Disadvantages of SSB.
    - Lower fidelity than AM.
      - Voice does not sound normal if not tuned in properly.
    - More difficult to tune in than an AM signal.

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Radio's Building Blocks

Modulators

- Frequency & Phase Modulators.
  - Frequency modulation (FM).
    - Carrier frequency deviates in proportion to amplitude of the modulating signal.
  - Phase modulation (PM).
    - Carrier frequency deviates in proportion to both the amplitude and the frequency of the modulating signal.

59

Radio's Building Blocks

Modulators

- Frequency & Phase Modulators.
  - By changing the audio frequency response of the modulator, an FM modulator can be used to generate PM and vice versa.

60

Radio's Building Blocks

Modulators

- Frequency & Phase Modulators.
  - Both FM & PM sound the same on the air (almost).
    - The only difference is in the frequency response of the audio.
  - Both FM & PM can be demodulated with the same circuitry.

61

Radio's Building Blocks

Modulators

- Frequency & Phase Modulators.
  - The location of the modulator circuit determines whether FM or PM is produced.
    - Modulation applied to the oscillator circuit → FM.
    - Modulation applied to an amplifier stage after the oscillator → PM.

62

Radio's Building Blocks

Modulators

- Quadrature Modulation.
  - a.k.a.– I-Q modulation.
    - **I** = In-phase signal.
    - **Q** = Quadrature signal (phase shifted by 90°).
    - By mathematically combining the I & Q signals, any type of modulation can be produced:
      - AM, DSB, USB, LSB, FM, PM.
    - Used in software-defined radios.

63

G7B07 -- Which of the following are basic components of a sine wave oscillator?

A. An amplifier and a divider
B. A frequency multiplier and a mixer
C. A circulator and a filter operating in a feed-forward loop
D. A filter and an amplifier operating in a feedback loop

64

G7B09 -- What determines the frequency of an LC oscillator?

A. The number of stages in the counter
B. The number of stages in the divider
C. The inductance and capacitance in the tank circuit
D. The time delay of the lag circuit

65

G7C05 -- Which of the following is characteristic of a direct digital synthesizer (DDS)?

A. Extremely narrow tuning range
B. Relatively high-power output
C. Pure sine wave output
D. Variable output frequency with the stability of a crystal oscillator

66

G7C07- What term specifies a filter's attenuation inside its passband?

A. Insertion loss
B. Return loss
C. Q
D. Ultimate rejection

67

G7C09 - What is the phase difference between the I and Q RF signals that software-defined radio (SDR) equipment uses for modulation and demodulation?

A. Zero
B. 90 degrees
C. 180 degrees
D. 45 degrees

68

G7C10 - What is an advantage of using I-Q modulation with software-defined radios (SDRs)?

A. The need for high resolution analog-to-digital converters is eliminated

B. All types of modulation can be created with appropriate processing

C. Minimum detectible signal level is reduced

D. Automatic conversion of the signal from digital to analog

69

G7C11 - Which of these functions is performed by software in a software-defined radio (SDR)?

A. Filtering

B. Detection

C. Modulation

D. All these choices are correct

70

G7C12 - What is the frequency above which a low-pass filter's output power is less than half the input power?

A. Notch frequency
B. Neper frequency
C. Cutoff frequency
D. Rolloff frequency

71

G7C13 - What term specifies a filter's maximum ability to reject signals outside its passband?

A. Notch depth
B. Rolloff
C. Insertion loss
D. Ultimate rejection

72

G7C14 - The bandwidth of a band-pass filter is measured between what two frequencies?

A. Upper and lower half-power
B. Cutoff and rolloff
C. Pole and zero
D. Image and harmonic

73

G8A04 -- What emission is produced by a reactance modulator connected to an RF power amplifier?

A. Multiplex modulation
B. Phase modulation
C. Amplitude modulation
D. Pulse modulation

74

G8B03 -- What is another term for the mixing of two RF signals?

A. Heterodyning
B. Synthesizing
C. Frequency inversion
D. Phase inversion

75

G8B04 -- What is the stage in a VHF FM transmitter that generates a harmonic of a lower frequency signal to reach the desired operating frequency?

A. Mixer
B. Reactance modulator
C. Balanced converter
D. Multiplier

76

G8B11 -- What combination of a mixer's Local Oscillator (LO) and RF input frequencies is found in the output?

A. The ratio
B. The average
C. The sum and difference
D. The arithmetic product

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Transmitters

CW Transmitters

- Oscillator.
  - Crystal controlled.
  - VFO
    - Add mixer for multi-band.
- Buffer (optional).
  - Reduces "chirp".
- Power amplifier.
  - Non-linear okay.

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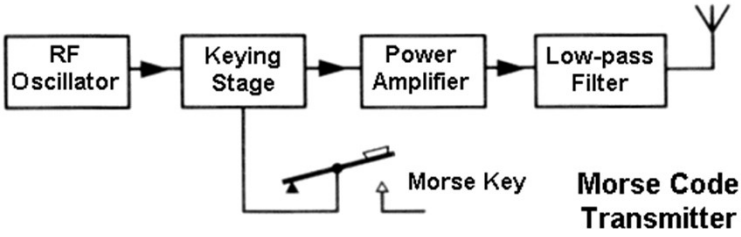
Transmitters

CW Transmitters



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Transmitters

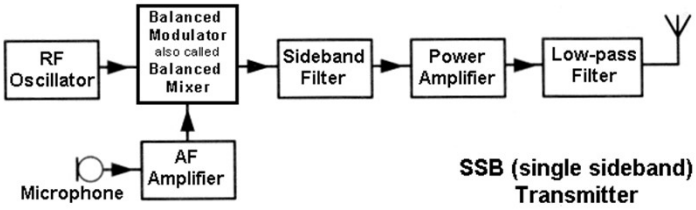
SSB Phone Transmitters

- Add a modulator after the oscillator.
  - A balanced mixer is used to produce a double-sideband (DSB) signal.
  - A filter is used to remove one of the sidebands.
- All amplifier stages following the modulator **MUST BE LINEAR!**

80

Transmitters

SSB Phone Transmitters



SSB (single sideband) Transmitter

81

Transmitters

FM Transmitters

- Normally, FM modulation is accomplished at a low frequency & multiplied to operating frequency.

82

Transmitters

FM Transmitters

- Deviation is multiplied along with the frequency.
  - e.g. – A 12 MHz FM signal with a deviation of 1 kHz would have a deviation of 12 kHz when multiplied 12 times to 144 MHz.
  - Low distortion of the modulating signal is easier to accomplish with a smaller deviation.

83

Transmitters

FM Transmitters

- Amplifier stages do NOT have to be linear.
  - Multiplier stages by their very nature are not linear.

84

Transmitters

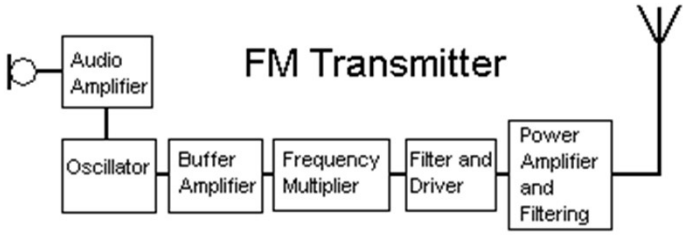
FM Transmitters

- Bandwidth.
  - FM & PM signals have an infinite number of sidebands.
    - The sidebands decrease in amplitude as the distance from the carrier frequency increases.
    - The bandwidth of an FM or PM signal is:
      - BW = 2 x (f_D + f_m)

85

Transmitters

FM Transmitters



86

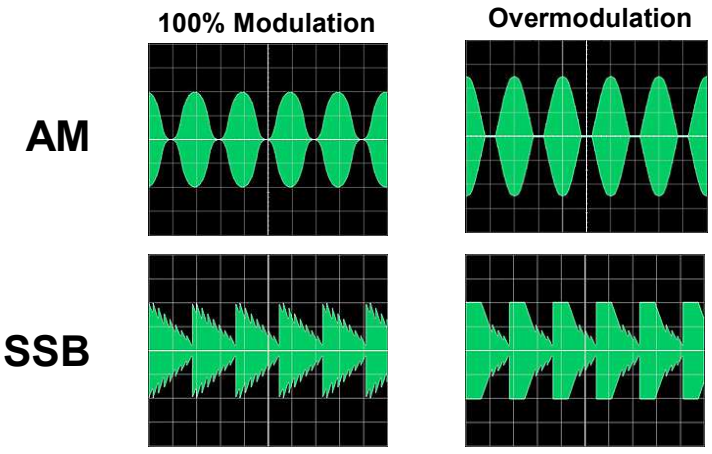
Transmitters

Signal Quality

- Overmodulation – AM modes.
  - Distorts audio.
    - Drives amplifier into cutoff, causing flat-topping.
    - Distortion results in excessive bandwidth.
      - Interference to nearby frequencies.
      - Splatter.

87

Transmitters



88

Transmitters

Signal Quality

- Overmodulation – AM modes.
  - Caused by:
    - Talking too loudly.
      - Speak normally.
    - Transmitter not adjusted properly.
      - Adjust microphone gain so that ALC peaks at but does not exceed “0”.

89

Transmitters

Signal Quality

- Overmodulation – AM modes.
  - A “two-tone” test can be used to measure the linearity of an AM or SSB transmitter.
    - Modulate the transmitter with 2 audio tones.
      - The 2 tones **MUST NOT** be harmonically related.
      - The ARRL lab uses 700 Hz & 1900 Hz.
    - Use a spectrum analyzer to look for spurious signals.

90

Transmitters

Signal Quality

- Controlling sideband frequency.
  - It is important to know exactly what range of frequencies your signal occupies.
    - Your **ENTIRE** signal must be within the band or band segment authorized to your class of license.

91

Transmitters

Signal Quality

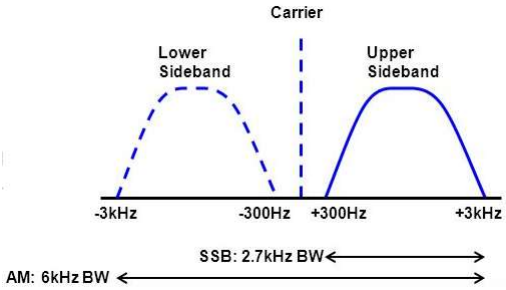
- Controlling sideband frequency.
  - Transceiver VFOs display the carrier frequency.
  - SSB signals occupy a range of frequencies above (USB) or below (LSB) the carrier frequency.
    - This is called the “bandwidth” of the signal.
    - The bandwidth of the signal is equal to the highest audio frequency being transmitted.

92

Transmitters

Signal Quality

- Controlling sideband frequency.



93

Transmitters

Signal Quality

- Controlling sideband frequency.
  - If operating USB, keep the VFO frequency at least 3 kHz below the upper limit of the band.
  - If operating LSB, keep the VFO frequency at least 3 kHz above the lower limit of the band segment authorized to your class of license.

94

Transmitters

Signal Quality

- Speech processing.
  - a.k.a. – Speech compression.
  - Increases the average power of the transmitted signal.
  - Used to improve readability of SSB signals under poor conditions.

95

Transmitters

Signal Quality

- Speech processing.
  - The improper adjustment of a speech processor can result in:
    - Distorted speech.
    - Splatter.
    - Excessive background pickup.

96

Transmitters

Signal Quality

- Overdeviation.
  - The overmodulation of FM or PM signals is called “overdeviation” & causes:
    - Excessive bandwidth.
    - Audio distortion.
    - “Chopping” of received signal.
  - Most transmitters have circuits to limit deviation.

97

Transmitters

Signal Quality

- Key clicks.
  - CW is actually an AM signal that is 100% modulated by a series of pulses.
  - A pulse consists of a fundamental frequency and an infinite number of harmonics.
  - Therefore, a CW signal with a square keying envelope is infinitely wide!

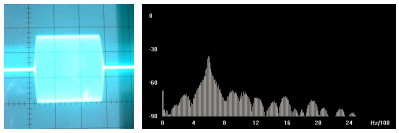
98

Transmitters

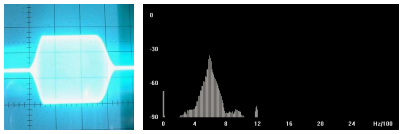
Signal Quality

- Key clicks.
  - To reduce key clicks, add a gradual rise & fall to the keying signal.

2ms – Key Clicks



8ms – No Key Clicks



99

G2A12 -- What control is typically adjusted for proper ALC setting on a single sideband transceiver?

A. RF clipping level
B. Transmit audio or microphone gain
C. Antenna inductance or capacitance
D. Attenuator level

100

G4B07 -- What signals are used to conduct a two-tone test?

A. Two audio signals of the same frequency shifted 90 degrees

B. Two non-harmonically related audio signals

C. Two swept frequency tones

D. Two audio frequency range square wave signals of equal amplitude

101

G4B08 -- What transmitter performance parameter does a two-tone test analyze?

A. Linearity

B. Percentage of suppression of the carrier and undesired sideband for SSB

C. Percentage of frequency modulation

D. Percentage of carrier phase shift

102

G4D01 -- What is the purpose of a speech processor in a transceiver?

A. Increase the apparent loudness of transmitted voice signals
B. Increase transmitter bass response for more natural-sounding SSB signals
C. Prevent distortion of voice signals
D. Decrease high-frequency voice output to prevent out-of-band operation

103

G4D02 -- How does a speech processor affect a single sideband phone signal?

A. It increases peak power
B. It increases average power
C. It reduces harmonic distortion
D. It reduces intermodulation distortion

104

G4D03 -- What is the effect of an incorrectly adjusted speech processor?

A. Distorted speech
B. Excess intermodulation products
C. Excessive background noise
D. All these choices are correct

105

G4D08 -- What frequency range is occupied by a 3 kHz LSB signal when the displayed carrier frequency is set to 7.178 MHz?

A. 7.178 to 7.181 MHz
B. 7.178 to 7.184 MHz
C. 7.175 to 7.178 MHz
D. 7.1765 to 7.1795 MHz

106

G4D09 -- What frequency range is occupied by a 3 kHz USB signal with the displayed carrier frequency set to 14.347 MHz?

A. 14.347 to 14.647 MHz
B. 14.347 to 14.350 MHz
C. 14.344 to 14.347 MHz
D. 14.3455 to 14.3485 MHz

107

G4D10 -- How close to the lower edge of a band's phone segment should your displayed carrier frequency be when using 3 kHz wide LSB?

A. At least 3 kHz above the edge of the segment
B. At least 3 kHz below the edge of the segment
C. At least 1 kHz below the edge of the segment
D. At least 1 kHz above the edge of the segment

108

G4D11 -- How close to the upper edge of a band's phone segment should your displayed carrier frequency be when using 3 kHz wide USB?

A. At least 3 kHz above the edge of the band
B. At least 3 kHz below the edge of the band
C. At least 1 kHz above the edge of the segment
D. At least 1 kHz below the edge of the segment

109

G7C01 -- What circuit is used to select one of the sidebands from a balanced modulator?

A. Carrier oscillator
B. Filter
C. IF amplifier
D. RF amplifier

110

G7C02 -- What output is produced by a balanced modulator?

A. Frequency modulated RF
B. Audio with equalized frequency response
C. Audio extracted from the modulation signal
D. Double-sideband modulated RF

111

G8A08 -- Which of the following is an effect of overmodulation?

A. Insufficient audio
B. Insufficient bandwidth
C. Frequency drift
D. Excessive bandwidth

112

G8A10 -- What is meant by the term "flat-topping," when referring to an amplitude-modulated phone signal?

A. Signal distortion caused by insufficient collector current
B. The transmitter's automatic level control (ALC) is properly adjusted
C. Signal distortion caused by excessive drive or speech levels
D. The transmitter's carrier is properly suppressed

113

G8A11 -- What is the modulation envelope of an AM signal?

A. The waveform created by connecting the peak values of the modulated signal
B. The carrier frequency that contains the signal
C. Spurious signals that envelop nearby frequencies
D. The bandwidth of the modulated signal

114

G8B06 -- What is the total bandwidth of an FM phone transmission having 5 kHz deviation and 3 kHz modulating frequency?

A. 3 kHz
B. 5 kHz
C. 8 kHz
D. 16 kHz

115

G8B07 -- What is the frequency deviation for a 12.21 MHz reactance modulated oscillator in a 5 kHz deviation, 146.52 MHz FM phone transmitter?

A. 101.75 Hz
B. 416.7 Hz
C. 5 kHz
D. 60 kHz

116

Transmitters

Amplifiers

- Linear & non-linear amplifiers.
  - Linear amplifiers:
    - Preserve the shape of the input waveform.
      - Low distortion.
    - Can be used for all modes.
    - Are required for amplifying AM or SSB signals.

117

Transmitters

Amplifiers

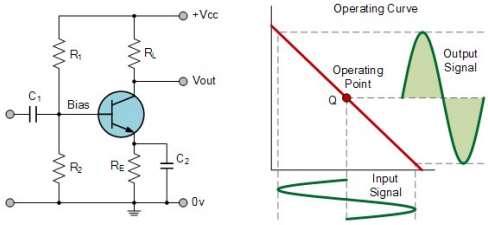
- Linear & non-linear amplifiers.
  - Non-linear amplifiers.
    - Do **NOT** preserve the shape of the input waveform.
      - High distortion.
    - Are suitable only for CW or FM/PM signals.

118

Transmitters

Amplifiers

- Class A amplifier
  - Device conducts for entire 360° of cycle.
  - Best linearity (lowest distortion).
  - Least efficient.

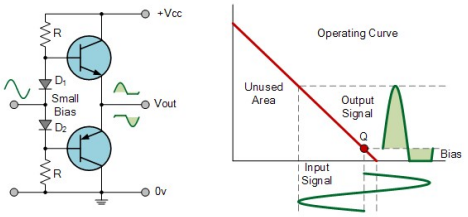


119

Transmitters

Amplifiers

- Class AB amplifier
  - Each device conducts for >180° but <360° of cycle.
  - Good linearity.
  - More efficient than Class A.

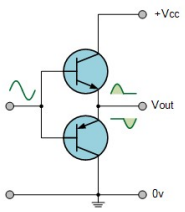


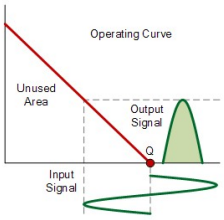
120

Transmitters

Amplifiers

- Class B amplifier
  - Each device conducts for only 180° of cycle.
  - Fairly good linearity.
  - More efficient than Class AB.



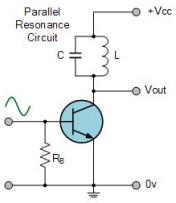


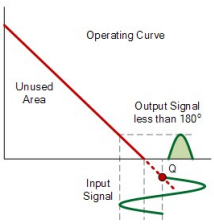
121

Transmitters

Amplifiers

- Class C amplifier
  - Device conducts for <180° of cycle.
  - Most efficient.
  - **Non-linear.**





122

Transmitters

Amplifiers

- Keying circuit.
  - Switches the amplifier from receive (bypass) mode to transmit mode.
- Keying delay.
  - A small delay added to the transmitter circuit.
  - Ensures that the amplifier has completely changed over to transmit mode before any RF power is applied.

123

Transmitters

Amplifiers

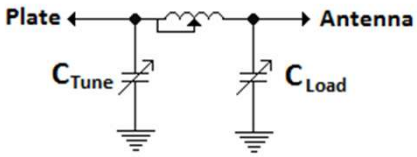
- Tuning & driving a vacuum-tube amplifier.
  - Solid-state amplifiers are usually designed so that no adjustments are required other than selecting the band.
  - Vacuum-tube amplifiers must be adjusted for the specific frequency of operation within the band.

124

Transmitters

Amplifiers

- Tuning & driving a vacuum-tube amplifier.
  - Three main controls:
    - Band
    - Tune (or Plate).
    - Load (or Coupling).



125

Transmitters

Amplifiers

- Tuning & driving a vacuum-tube amplifier.
  - Tuning procedure:
    1. Set amplifier meter to monitor plate current.
    2. Set amplifier to desired band.
    3. Apply a small amount of drive power.
    4. Adjust *Tune* for a dip (minimum) in plate current.
    5. Adjust *Load* for maximum output power.
    6. Repeat steps 4 & 5 until maximum power output is achieved.

126

Transmitters

Amplifiers

- Tuning & driving a vacuum-tube amplifier.
  - When tuning or operating a vacuum-tube amplifier:
    - **Be careful to NEVER exceed the maximum grid current!**
    - **Do not exceed the maximum plate current!**

127

Transmitters

Amplifiers

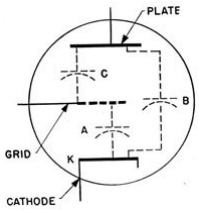
- Tuning & driving a vacuum-tube amplifier.
  - ALC.
    - Some amplifiers have an ALC output which can be used to automatically reduce the drive from the transceiver to prevent exceeding maximum drive level.

128

Transmitters

Amplifiers

- Tuning & driving a vacuum-tube amplifier.
  - Neutralization.
    - Triode tubes and semiconductors are susceptible to self-oscillation due to stray internal capacitances.
    - External components are added to cancel the effect of the stray capacitances.



129

G4A04 -- What is the effect on plate current of the correct setting of a vacuum-tube RF power amplifier's TUNE control?

A. A pronounced peak
B. A pronounced dip
C. No change will be observed
D. A slow, rhythmic oscillation

130

G4A05 -- Why is automatic level control (ALC) used with an RF power amplifier?

A. To balance the transmitter audio frequency response
B. To reduce harmonic radiation
C. To prevent excessive drive
D. To increase overall efficiency

131

G4A08 -- What is the correct adjustment for the LOAD or COUPLING control of a vacuum tube RF power amplifier?

A. Minimum SWR on the antenna
B. Minimum plate current without exceeding maximum allowable grid current
C. Highest plate voltage while minimizing grid current
D. Desired power output without exceeding maximum allowable plate current

132

G4A09 -- What is the purpose of delaying RF output after activating a transmitter's keying line to an external amplifier?

A. To prevent key clicks on CW
B. To prevent transient overmodulation
C. To allow time for the amplifier to switch the antenna between the transceiver and the amplifier output
D. To allow time for the amplifier power supply to reach operating level

133

G7B01 -- What is the purpose of neutralizing an amplifier?

A. To limit the modulation index
B. To eliminate self-oscillations
C. To cut off the final amplifier during standby periods
D. To keep the carrier on frequency

134

G7B02 -- Which of these classes of amplifiers has the highest efficiency?

A. Class A
B. Class B
C. Class AB
D. Class C

135

G7B04 -- In a Class A amplifier, what percentage of the time does the amplifying device conduct?

A. 100%
B. More than 50% but less than 100%
C. 50%
D. Less than 50%

136

G7B08 -- How is the efficiency of an RF power amplifier determined?

A. Divide the DC input power by the DC output power
B. Divide the RF output power by the DC input power
C. Multiply the RF input power by the reciprocal of the RF output power
D. Add the RF input power to the DC output power

137

G7B10 -- Which of the following describes a linear amplifier?

A. Any RF power amplifier used in conjunction with an amateur transceiver
B. An amplifier in which the output preserves the input waveform
C. A Class C high efficiency amplifier
D. An amplifier used as a frequency multiplier

138

G7B11 -- For which of the following modes is a Class C power stage appropriate for amplifying a modulated signal?

A. SSB
B. FM
C. AM
D. All these choices are correct

139

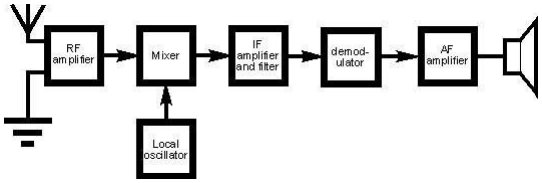
Break

140

Receivers

Basic Superheterodyne Receivers

- Invented in 1918 by Edwin Armstrong.
- By far the most popular receiver architecture in use today.



141

Receivers

Basic Superheterodyne Receivers

- The incoming radio frequency (RF) signal is mixed (or heterodyned) with a local oscillator signal to produce an intermediate frequency (IF) signal
  - *Super*heterodyne means the local oscillator frequency is higher than the input frequency.
    - Easier image rejection.

142

Receivers

Basic Superheterodyne Receivers

- The IF signal is amplified & filtered.
  - Sharp, narrow filters reject signals close to the desired frequency.

143

Receivers

Basic Superheterodyne Receivers

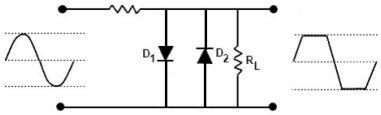
- IF filtering.
  - Use a filter with a bandwidth that matches the mode being used.
    - Best signal-to-noise ratio (S/N).

144

Receivers

Basic Superheterodyne Receivers

- In an FM receiver, the IF amplifier includes a "limiter" stage.
  - Eliminates amplitude variations.
    - Amplifier stage with high gain so that signal "flat-tops".
    - Diode "clipper" circuit.



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Receivers

Basic Superheterodyne Receivers

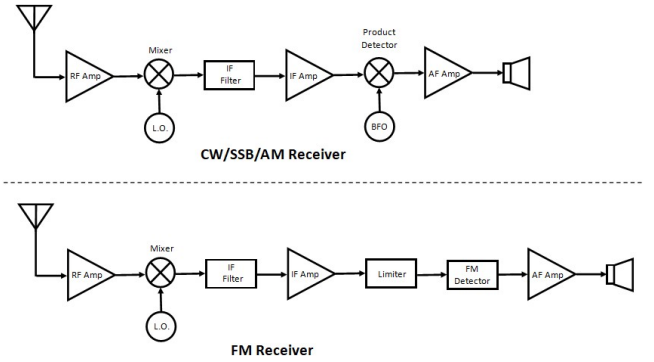
- The output from the IF amplifier is sent to a demodulator circuit.
- The type of demodulator varies by mode.

Mode	Demodulator Type
AM	Product Detector or Envelope Detector
CW/SSB	Product Detector
FM/PM	Frequency Discriminator or Quadrature Detector

146

Receivers

Basic Superheterodyne Receivers



147

Receivers

Basic Superheterodyne Receivers

- Product Detector.
  - A mixer combining the output of the IF amplifier with a signal from a beat frequency oscillator (BFO).
    - The BFO frequency is at or near the IF frequency.
    - $f_{IF} \times f_{BFO} \rightarrow f_{AF}$
  - For SSB & AM, the BFO frequency is set to the carrier frequency.

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Receivers

Basic Superheterodyne Receivers

- Product Detector.
  - For CW, the BFO frequency is set a few hundred Hertz above or below the carrier frequency.
    - CWL – BFO frequency above carrier frequency.
    - CWU– BFO frequency below carrier frequency.
    - Switching between CWL or CWU can avoid interference from a signal close to the receive frequency.

149

Receivers

Basic Superheterodyne Receivers

- Design challenges.
  - Images.
    - Two different frequencies when mixed with the local oscillator frequency will produce a signal at the IF frequency.
      - $f_{RF1} = f_{LO} + f_{IF}$
      - $f_{RF2} = f_{LO} - f_{IF}$
    - The unwanted frequency is called the “image”.

150

Receivers

Basic Superheterodyne Receivers

- Design challenges.
  - Images.
    - The image frequency must be filtered out by the receiver “front-end”.
    - The farther the image frequency is from the desired frequency, the easier to filter out the image.
      - This is why a local oscillator frequency higher than the RF frequency is preferred.

151

Receivers

Basic Superheterodyne Receivers

- Design challenges.
  - Birdies.
    - The local oscillator & other oscillators in the circuit can mix & produce signals at various frequencies. These “spurs” can cause interference to the desired signal.
  - Unwanted radiation.
    - The local oscillator signal can leak out through receiver front end to the antenna & be radiated.

152

Receivers

Basic Superheterodyne Receivers

- Double-conversion & triple-conversion superheterodyne receivers.
  - 2 or 3 local oscillators with 2 or 3 different sets of IF amplifiers & filters.
    - Better filtering can be achieved at lower frequencies.
    - Increases susceptibility to images & birdies.

153

Receivers

Digital Signal Processing (DSP)

- Part of practically all modern transceivers.
  - Replacing some of the analog circuitry.
- Procedure:
  1. Convert analog signal to series of numbers.
  2. Process series of numbers mathematically.
  3. Convert resulting series of numbers back to analog signal.

154

Receivers

Digital Signal Processing (DSP)

- Advantages.
  - Performance.
    - Allows signal processing difficult or impossible to obtain by analog methods.
  - Flexibility.
    - Functions, options, & adjustments limited only by processor speed & memory.

155

Receivers

Digital Signal Processing (DSP)

- Main uses.
  - Signal filtering.
    - A wide variety of filter widths & shapes can be defined.
    - Users can create their own custom filters.
  - Noise reduction.
    - Many types of noise can be detected & removed.

156

Receivers

Digital Signal Processing (DSP)

- Main uses (cont'd).
  - Notch filtering.
    - Automatically detect & notch out an interfering signal.
      - Most effective against carriers or CW signals.
  - Audio frequency equalization.

157

Receivers

Digital Signal Processing (DSP)

- Software-Defined Radio (SDR).
  - A software-defined radio (SDR) system is a radio communication system where components that have been typically implemented in hardware (e.g. mixers, filters, modulators/demodulators, detectors, etc.) are instead implemented by means of software on a computer or embedded computing devices.

158

Receivers

Digital Signal Processing (DSP)

- Software-Defined Radio (SDR).
  - The ideal SDR receiver would be to attach an antenna to an analog-to-digital converter (ADC).
  - Similarly, the ideal SDR transmitter would be to attach a digital-to-analog converter (DAC) to an antenna.
  - Not feasible with current technology, so some compromise is necessary.

159

Receivers

Digital Signal Processing (DSP)

- Software-Defined Radio (SDR).
  - Some analog processing still required.
  - Future is an all-digital radio.
  - Commercial SDRs now available for amateur use.

160

Receivers

Managing Receiver Gain

- RF Gain & Automatic Gain Control (AGC).
  - RF Gain.
    - Start with RF gain set to maximum (highest sensitivity).
    - Adjust down for comfortable listening (lower noise).

161

Receivers

Managing Receiver Gain

- RF Gain & Automatic Gain Control (AGC).
  - AGC.
    - A circuit to automatically adjust receiver gain to compensate for changes in received signal strength.
    - A voltage proportional to the received signal strength is used to adjust the gain of the RF & IF amplifiers.

162

Receivers

Managing Receiver Gain

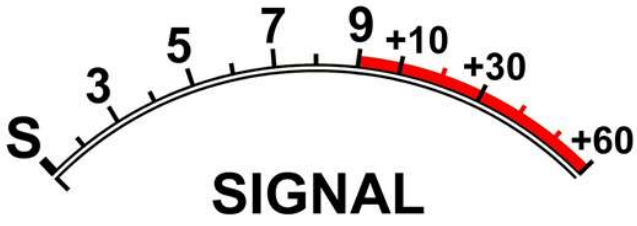
- RF Gain & Automatic Gain Control (AGC).
  - The AGC voltage is measured by the S-meter.
    - "S" stands for signal strength.
    - The S-meter is calibrated in "S" units.
      - S1 (Faint, barely perceptible) to S9 (Extremely strong).
      - Signals stronger than S9 are measured in dB over S9.
    - 1 "S" unit = 6 dB difference in input power.
      - 3 dB difference in power.
    - S9 = 50µV at antenna input.

163

Receivers

Managing Receiver Gain

- RF Gain & Automatic Gain Control (AGC).
  - S-Meter.



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Receivers

Receiver Linearity

- Just like a transmitter, non-linearity in a receiver results in spurious signals.
- Overload.
  - Extremely strong signals can drive RF pre-amp into non-linear operation.
    - Distorted received audio for all signals.
  - RF attenuator control.
    - Helps avoid overload.
    - Use in combination with RF Gain control.

165

Receivers

Rejecting Interference and Noise

- IF filters narrow the receiver's passband.
  - Rejects nearby signals.
  - Reduces noise power.
  - Select the narrowest filter which is greater than or equal to the bandwidth of the signal being received.

166

Receivers

Rejecting Interference and Noise

- IF filters will not reject interfering signals that are within the filter passband.
  - Some receivers include notch filters.
    - Reject a very narrow range of frequencies in the passband.
  - Some receivers provide an IF Shift control.
    - Shifts IF filter passband so that the desired signal is no longer centered in passband.
      - Can help reduce a signal that is just above or below the desired signal.

167

Receivers

Rejecting Interference and Noise

- Receivers usually provide features for reducing noise in the passband.
- The oldest type of noise reduction is the "Noise Blanker".
  - Detects a noise pulse and reduces receiver audio gain during the pulse.
    - Most effective against impulse-type noise such as ignition noise.

168

Receivers

Rejecting Interference and Noise

- DSP can provide other types of noise suppression.
  - Some work by looking for signals that are not part of the desired signal & reducing them.
  - Too much noise suppression can cause distortion of the received signal.
    - Especially detrimental to digital signals.

169

G4A01 -- What is the purpose of the notch filter found on many HF transceivers?

A. To restrict the transmitter voice bandwidth
B. To reduce interference from carriers in the receiver passband
C. To eliminate receiver interference from impulse noise sources
D. To remove interfering splatter generated by signals on adjacent frequencies

170

G4A02 -- What is the benefit of using the opposite or “reverse” sideband when receiving CW?

A. Interference from impulse noise will be eliminated
B. More stations can be accommodated within a given signal passband
C. It may be possible to reduce or eliminate interference from other signals
D. Accidental out-of-band operation can be prevented

171

G4A03 -- How does a noise blanker work?

A. By temporarily increasing received bandwidth
B. By redirecting noise pulses into a filter capacitor
C. By reducing receiver gain during a noise pulse
D. By clipping noise peaks

172

G4A07 -- What happens as a receiver's noise reduction control level is increased?

A. Received signals may become distorted
B. Received frequency may become unstable
C. CW signals may become severely attenuated
D. Received frequency may shift several kHz

173

G4A13 -- What is the purpose of using a receive attenuator?

A. To prevent receiver overload from strong incoming signals
B. To reduce the transmitter power when driving a linear amplifier
C. To reduce power consumption when operating from batteries
D. To reduce excessive audio level on strong signals

174

G4D04 -- What does an S meter measure?

A. Carrier suppression
B. Impedance
C. Received signal strength
D. Transmitter power output

175

G4D05 -- How does a signal that reads 20 dB over S9 compare to one that reads S9 on a receiver, assuming a properly calibrated S meter

A. It is 10 times less powerful
B. It is 20 times less powerful
C. It is 20 times more powerful
D. It is 100 times more powerful

176

G4D06 -- How much change in signal strength is typically represented by one S unit?

A. 6 dB
B. 12 dB
C. 15 dB
D. 18 dB

177

G4D07-- How much must the power output of a transmitter be raised to change the S meter reading on a distant receiver from S8 to S9?

A. Approximately 1.5 times
B. Approximately 2 times
C. Approximately 4 times
D. Approximately 8 times

178

G7C04 -- How is a product detector used?

A. Used in test gear to detect spurious mixing products
B. Used in transmitter to perform frequency multiplication
C. Used in an FM receiver to filter out unwanted sidebands
D. Used in a single sideband receiver to extract the modulated signal

179

G7C06 -- Which of the following is an advantage of a digital signal processing (DSP) filter compared to an analog filter?

A. A wide range of filter bandwidths and shapes can be created
B. Fewer digital components are required
C. Mixing products are greatly reduced
D. The DSP filter is much more effective at VHF frequencies

180

G7C08 -- Which parameter affects receiver sensitivity?

A. Input amplifier gain
B. Demodulator stage bandwidth
C. Input amplifier noise figure
D. All these choices are correct

181

G8B01 -- Which mixer input is varied or tuned to convert signals of different frequencies to an intermediate frequency (IF)?

A. Image frequency
B. Local oscillator
C. RF input
D. Beat frequency oscillator

182

G8B02 -- What is the term for interference from a signal at twice the IF frequency from the desired signal?

A. Quadrature response
B. Image response
C. Mixer interference
D. Intermediate interference

183

G8B09 -- Why is it good to match receiver bandwidth to the bandwidth of the operating mode?

A. It is required by FCC rules
B. It minimizes power consumption in the receiver
C. It improves impedance matching of the antenna
D. It results in the best signal to noise ratio

184

HF Station Installation

Mobile Installations

- Power Connections.
  - 100W HF rig requires 20A or more.
  - Connect both power leads directly to the battery with heavy gauge (#10 or larger) wire.
    - Fuse **BOTH** leads at battery.
  - **DO NOT** use a cigarette lighter socket.
  - **DO NOT** assume that the vehicle frame is a good ground connection.

185

HF Station Installation

Mobile Installations

- Antenna Connections.
  - A mobile HF antenna is significantly shorter than 1/4λ long, especially on the lower bands.
  - The entire vehicle becomes part of the antenna system.
    - Pay attention to every detail.

186

HF Station Installation

Mobile Installations

- Antenna Connections.
  - Use the most efficient antenna possible.
  - Make solid RF ground connections to the vehicle body.
    - Install bonding straps between body panels.
  - Mount the antenna as clear of body parts as possible.

187

HF Station Installation

Mobile Installations

- Mobile interference.
  - Ignition noise.
    - The noise blankers on modern tranceivers are usually effective.
    - Diesel engines do not produce ignition noise.
  - Alternator whine.
    - Direct battery connections help.

188

HF Station Installation

Mobile Installations

- Mobile interference.
  - Vehicle computer.
  - Motor-driven devices.
    - Windshield wipers, fans, etc.

189

HF Station Installation

Grounding & Bonding

- An AC safety ground is required but is not usually adequate for RF.
- An additional RF ground is required.

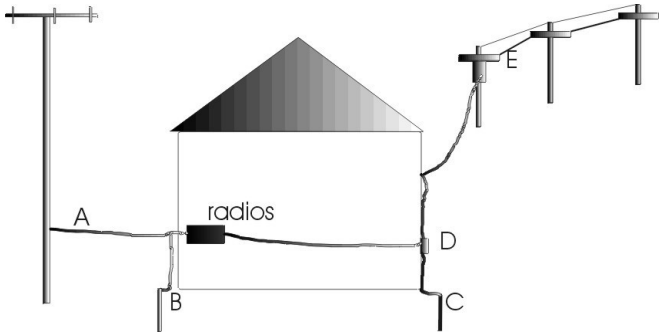
For lightning safety, AC safety ground & RF ground system must be bonded together!

190

HF Station Installation

Grounding & Bonding

- Typical station installation.



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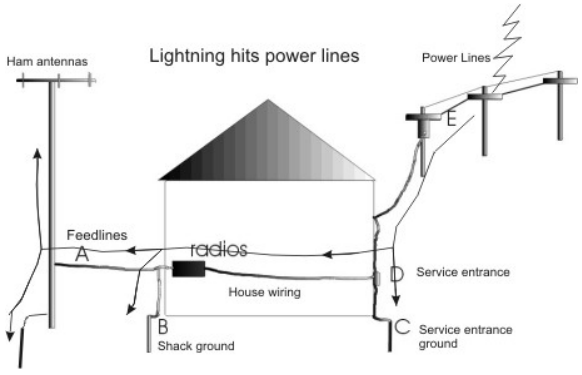
HF Station Installation

Grounding & Bonding

- Typical station installation.



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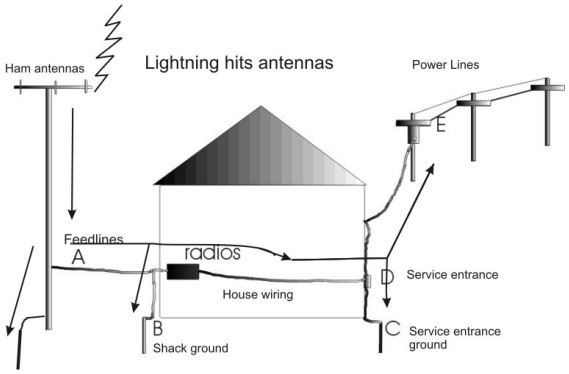
HF Station Installation

Grounding & Bonding

- Typical station installation.



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HF Station Installation

Grounding & Bonding

- RF Grounding.
  - Poor RF grounding can cause shocks or RF burns when touching equipment.

194

HF Station Installation

Grounding & Bonding

- RF Grounding.
  - Poor RF grounding can cause RF feedback.
    - RF feedback can cause hum or buzz on the transmitted signal.
    - RF feedback can cause distortion of the transmitted signal.
    - RF feedback can cause VOX circuits to “hang” & not un-key the transmitter.
    - RF feedback can cause erratic behavior of computer interfaces.

195

HF Station Installation

Grounding & Bonding

- RF Grounding.
  - **ALWAYS** connect all equipment to a single ground point in the shack.
    - A short piece of copper bar or pipe.
    - Use separate conductors for **EACH** piece of equipment.
    - Keep all ground wires as short as possible.
  - **NEVER** “daisy-chain” equipment grounds.

196

HF Station Installation

Grounding & Bonding

- RF Grounding.
  - Connect the shack ground point to a ground rod or a grounded pipe.
    - Use a flat, wide conductor.
      - Copper strap.
      - Braid.
    - Keep the ground wire as short as possible.
      - High impedance if length approaches 1/4λ.
      - No sharp (90°) bends.

197

HF Station Installation

Grounding & Bonding

- RF Grounding.
  - **NEVER** use a soldered connection to attach a ground wire to a ground rod.
    - The high currents resulting from a lightning strike would vaporize the solder.

198

HF Station Installation

Grounding & Bonding

- Ground loops.
  - Incorrect grounding can create ground loops.
  - Ground loops can cause hum or buzz on transmitted signal.
  - **ALWAYS** connect equipment to a single ground point with separate conductors for **EACH** piece of equipment.
  - **NEVER** "daisy-chain" equipment grounds.

199

HF Station Installation

RF Interference (RFI).

- Any amateur radio transmitter can cause interference to other nearby devices.
- If the amateur equipment is operating properly, the responsibility to fix the problem rests with the owner of the equipment being interfered with.
  - Try convincing your neighbor of that!

200

HF Station Installation

RF Interference (RFI).

- Symptoms of RFI:

Operating Mode	Symptoms
CW, FM, or Data	On/off buzzes, humming, clicks, or thumps.
AM Phone	Undistorted speech.
SSB Phone	Distorted or garbled speech.

201

HF Station Installation

RF Interference (RFI).

- RFI can be caused by:
  - Fundamental overload.
  - Common-mode & direct pick-up.
  - Harmonics.
  - Rectification.
  - Arcing.
  - Intermodulation.

202

HF Station Installation

RF Interference (RFI).

- RFI can be interference to other nearby electronic equipment.
- RFI can be interference to your own station operation.
- Even a “clean” transmitter can cause RFI.
  - A “dirty” transmitter almost certainly will.

203

HF Station Installation

RF Interference (RFI).

- Fundamental overload.
  - A strong signal from amateur transmitter overwhelms the front-end of a receiver.
  - Usually occurs in nearby TV or radio receivers.
  - The solution is to reduce the strength of the signal entering the receiver.
    - Add high-pass filters to TV or FM receivers.
    - Add low-pass filters to AM receivers.
      - Usually very difficult to do since the antenna is internal.

204

HF Station Installation

RF Interference (RFI).

- Common-mode & direct pick-up.
  - Common-mode.
    - RF is picked up by external wiring & conducted into the interior of the device.
    - Solution is to prevent RF from entering the device.
      - The ferrite choke is your best friend!
      - Also, by-pass capacitors.

205

HF Station Installation

RF Interference (RFI).

- Common-mode & direct pick-up.
  - Direct pick-up.
    - RF is radiated directly into the interior of the device.
    - Difficult to resolve.

206

HF Station Installation

RF Interference (RFI).

- Harmonics.
  - Harmonics can fall on the frequency of another receiver.
    - The 2nd harmonic of 6m band falls into the FM broadcast band.
  - The solution is to reduce the strength of any harmonics being radiated.
    - Add a low-pass filter to the transmitter.

207

HF Station Installation

RF Interference (RFI).

- Intermodulation.
  - Any non-linear device can cause the mixing of 2 signals & create intermodulation products.
    - The intermodulation products may fall within the passband of a receiver.
    - A poor connection between 2 conductors can act like a diode & cause mixing.

208

HF Station Installation

RF Interference (RFI).

- Intermodulation.
  - The signals produced by intermodulation, called “intermodulation products”, can be either even-order or odd-order.
    - $f_{IM} = (a \times f_1) \pm (b \times f_2)$
      - If a+b is even → even-order product.
      - If a+b is odd → odd-order product.
      - Odd-order products can be close to one of the original signals.

209

HF Station Installation

RF Interference (RFI).

- Arcing.
  - Any spark or sustained arc generates noise across a **WIDE** range of frequencies.
  - Can interfere with both amateur radio & consumer devices.

210

HF Station Installation

RF Interference (RFI).

- Arcing.
  - AC power line noise.
    - A nearly continuous crackling buzz.
      - Can come & go depending on temperature or humidity.
    - Defective power line insulators
  - Motors or welders.
    - The noise is only present when the offending equipment is operated.

211

HF Station Installation

RF Interference Suppression

- Install filters.
- Add series resistance or inductance.
- Add parallel (by-pass) capacitors.
  - A small capacitor across the wiring terminals

212

HF Station Installation

RF Interference Suppression

- Form wires & cables into a coil.
- Add snap-on ferrite chokes.
  - Prevents common-mode RF signals from entering the device.
  - Prevents interference generated by the device from being radiated.

213

G4C01 -- Which of the following might be useful in reducing RF interference to audio frequency devices?

A. Bypass inductor
B. Bypass capacitor
C. Forward-biased diode
D. Reverse-biased diode

214

G4C02 -- Which of the following could be a cause of interference covering a wide range of frequencies?

A. Not using a balun or line isolator to feed balanced antennas
B. Lack of rectification of the transmitter's signal in power conductors
C. Arcing at a poor electrical connection
D. Using a balun to feed an unbalanced antenna

215

G4C03 -- What sound is heard from an audio device experiencing RF interference from a single sideband phone transmitter?

A. A steady hum whenever the transmitter is on the air
B. On-and-off humming or clicking
C. Distorted speech
D. Clearly audible speech

216

G4C04 -- What sound is heard from an audio device experiencing RF interference from a CW transmitter?

A. On-and-off humming or clicking
B. A CW signal at a nearly pure audio frequency
C. A chirpy CW signal
D. Severely distorted audio

217

G4C05 -- What is a possible cause of high voltages that produce RF burns?

A. Flat braid rather than round wire has been used for the ground wire
B. Insulated wire has been used for the ground wire
C. The ground rod is resonant
D. The ground wire has high impedance on that frequency

218

G4C06 -- What is a possible effect of a resonant ground connection?

A. Overheating of ground straps
B. Corrosion of the ground rod
C. High RF voltages on the enclosures of station equipment
D. A ground loop

219

G4C08 -- Which of the following would reduce RF interference caused by common-mode current on an audio cable?

A. Place a ferrite choke on the cable
B. Connect the center conductor to the shield of all cables to short circuit the RFI signal
C. Ground the center conductor of the audio cable causing the interference
D. Add an additional insulating jacket to the cable

220

G4C09 -- How can the effects of ground loops be minimized?

A. Connect all ground conductors in series
B. Connect the AC neutral conductor to the ground wire
C. Avoid using lock washers and star washers when making ground connections
D. Bond equipment enclosures together

221

G4C10 -- What could be a symptom caused by a ground loop in your station's audio connections?

A. You receive reports of "hum" on your station's transmitted signal
B. The SWR reading for one or more antennas is suddenly very high
C. An item of station equipment starts to draw excessive amounts of current
D. You receive reports of harmonic interference from your station

222

G4C11 -- What technique helps to minimize RF "hot spots" in an amateur station?

A. Building all equipment in a metal enclosure
B. Using surge suppressor power outlets
C. Bonding all equipment enclosures together
D. Low-pass filters on all feed lines

223

G4C12 -- Why must all metal enclosures of station equipment be grounded?

A. It prevents a blown fuse in the event of an internal short circuit
B. It prevents signal overload
C. It ensures that the neutral wire is grounded
D. It ensures that hazardous voltages cannot appear on the chassis

224

G4E03 -- Which of the following direct, fused power connections would be the best for a 100-watt HF mobile installation?

A. To the battery using heavy-gauge wire
B. To the alternator or generator using heavy-gauge wire
C. To the battery using insulated heavy duty balanced transmission line
D. To the alternator or generator using insulated heavy duty balanced transmission line

225

G4E04 -- Why should DC power for a 100-watt HF transceiver not be supplied by a vehicle's auxiliary power socket?

A. The socket is not wired with an RF-shielded power cable
B. The socket's wiring may be inadequate for the current drawn by the transceiver
C. The DC polarity of the socket is reversed from the polarity of modern HF transceivers
D. Drawing more than 50 watts from this socket could cause the engine to overheat

226

G4E05 -- Which of the following most limits an HF mobile installation?

A. "Picket Fencing"
B. The wire gauge of the DC power line to the transceiver
C. Efficiency of the electrically short antenna
D. FCC rules limiting mobile output power on the 75- meter band

227

G4E07 -- Which of the following may cause receive interference to an HF transceiver installed in a vehicle?

A. The battery charging system
B. The fuel delivery system
C. The control computers
D. All these choices are correct

228

G6B10 -- How does a ferrite bead or core reduce common-mode RF current on the shield of a coaxial cable?

A. By creating an impedance in the current's path
B. It converts common-mode current to differential mode current
C. By creating an out-of-phase current to cancel the common-mode current
D. Ferrites expel magnetic field

229

G8B05 -- Which intermodulation products are closest to the original signal frequencies?

A. Second harmonics
B. Even-order
C. Odd-order
D. Intercept point

230

G8B12 -- What process combines two signals in a non-linear circuit or connection to produce unwanted spurious outputs?

A. Intermodulation
B. Heterodyning
C. Detection
D. Rolloff

231

G8B13 -- Which of the following is an odd-order intermodulation product of frequencies F1 and F2?

A. 5F1-3F2
B. 3F1-F2
C. 2F1-F2
D. All these choices are correct

232

Questions?

233

General License Class

Next Week

Chapter 7

Antennas

234