Chapter 5 Radio Signals and Equipment

[12 exam questions – 3 groups] G4, G7, G8

AM > Send information by **varying the instantaneous power** of the transmitted **RF Envelope** proportional to the microphone input

Modulator > Combines speech and RF

AM has a 6 KHz bandwidth

SSB > Single Sideband is a form of Amplitude Modulated (AM) Signal

Transmitter power can be used more effectively More transmitter power in one sideband

SSB has a **narrower (3 KHz)** bandwidth

FM > Frequency Modulation changes the **frequency** of an RF wave to convey information

RF carrier **frequency** changes proportionally to the **instantaneous amplitude of the modulating** signal

FM has a 5 to 15 KHz bandwidth (Deviation)

FM phone transmission with **5 kHz deviation** and a **3 kHz modulating** signal has a **16 kHz bandwidth**

(5 KHz + 3KHz) X 2 = (8 KHz) X 2 = 16 KHz.

FM 146.52 MHz with **5 kHz deviation** using a **Reactance Modulator 12.21 MHz Osc** has a **416.7 Hz Dev**

5 KHz / (146.52 MHz / 12.21 MHz) = 5 KHz / 12 = 416.66 Hz

FM phone is **NOT used below 29.5 MHz** because it exceeds the bandwidth for HF

PM > Phase Modulation changes the **phase angle** of an RF wave to convey information

PM is produced by a **reactance modulator** connected to an RF power amplifier

Digital Communications > **RTTY, Morse code, PSK31 and packet** are digital communications

Higher symbol rates require higher bandwidth

Transmitting a **data** mode know the **duty cycle** to prevent **damage to your transmitter's** final stage.

PSK31 > Approximate transmitted **symbol rate is 31**

Matching receiver BW to operating mode BW results in the **best signal to noise ratio**

Forward Error Correction correct errors in received data by **TX redundant info with the data**

AMPLIFIERS & OSCILLATORS

Class A amplifier has **low distortion**

A **linear** amplifier **preserves the input** waveform

Class C amplifier is appropriate for amplifying **CW signal**

Class C amplifiers have the **highest efficiency**

Efficiency of an RF amplifier = RF output power / DC input power

Neutralizing the final amplifier stage of a transmitter **eliminates self-oscillations**

The **basic sine wave oscillator** has a filter & amplifier operating in a feedback loop

The **inductance and capacitance** in the **tank circuit** determines the **frequency** of an LC oscillator

Receivers, Transmitters

Discriminator in FM receivers to convert signals coming from the **IF amplifier to audio**

A **filter processes** signals from the **balanced modulator before the mixer** in a SSB phone TX

Balanced modulator combines carrier **oscillator & audio** and the result to a **filter** in a SSB phone TX

Product detector combines **IF** amplifier & **BFO** and send the result to the AF amplifier in SSB RX

The **RF** amplifier & **local oscillator** are **mixed** and the result to the **IF filter** in a superheterodyne RX

HF oscillator, mixer, detector are basic stages of a superheterodyne RX

The impedance of a **low-pass filter should equal** the Impedance of the **transmission line**

Direct Digital Synthesizer (DDS) provides variable frequency with the stability of a crystal oscillator

Digital Signal Processor (DSP)

DSP IF filter have; **analog to digital converter, digital processor, digital to analog converter**

DSP filtering **converts the signal from analog to digital and using digital processing**

Software Defined Radio (SDR)

SDR performs most major **signal processing functions are performed by software**

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Superhetrodyne > Mixing of Oscillator & RF SHIFTS to Intermediate Frequency (IF) STAGE

A **mixer** combines input **signal** with **oscillator** signal to produce **intermediate frequency (IF)** = **455 KHz**
Heterodyning is another term for the **mixing of two RF signals**.
The unused product of mixing (i.e. **-** 455 KHz) **Image Response causing interference in the receiver.**
A **balanced modulator** removes the carrier and leaves the **upper and lower sidebands**
Multiplier stage in a **VHF FM transmitter** uses a **HF harmonic to reach RF** frequency

Transceiver Operation

"NOTCH FILTER" reduces interference from carriers in the receiver passband
Digital Signal Processing (DSP) removes noise from received signals
A **DSP IF filter** has a **range of filter bandwidths and shapes**
A **DSP filter** can perform **automatic notching** of interfering carriers

Reverse SSB may be possible to reduce or eliminate interference from other signals
IF shift control avoids interference from stations very close to the receive frequency
Dual VFO permits monitoring the TX / RX freq when they are not the same
In **Split Mode** the transceiver is set to different transmit and receive frequencies
Attenuator reduces signal overload due to strong incoming signals
Automatic Level Control (ALC) reduces over drive distortion in an RF power amp
ALC system should **NOT** be activate when **transmitting PSK31** data signals

Excessive drive power may damage a solid-state RF power amplifier
Max power out without exceeding max plate current for control of a tube RF amp
Plate current DIP indicates correct adjustment of a tubeamp plate tuning control

ELECTRONIC KEYER provides auto generation of strings of dots and dashes for CW
TIME DELAY keying allows RX / TX changeover to complete properly before RF output is allowed
Antenna coupler matches the transmitter output to an impedance other than 50 ohms

Speech processors; S meters; sideband operation near band edges

A **speech processor increases the intelligibility** of phone signals
A **speech processor increases average power** of a SSB phone TX
An **incorrectly adjusted** speech processor; **Distorted speech, Splatter, Excessive background**

3 kHz LSB with a carrier frequency 7.178 MHz occupies 7.175 to 7.178 MHz (3 KHz below)
3 kHz USB with a carrier frequency 14.347 MHz occupies 14.347 to 14.350 MHz (3 KHz above)

An **S Meter** measures **received signal strength**
Receivers have S meters (signal strength meters)
S Meter reading of **S9 = S8 times 4** (S Unit = ~6dB = 4X)
S meter **20 dB over S-9** = S-9 signal **X 100**

Over Modulation > Distortion causing splatter or interference

SSB over modulation causes **distortion** and occupies **more bandwidth**
SSB Mic gain is typically adjusted for **proper ALC** setting on an amateur single sideband transceiver
SSB Flat-Topping signal distortion caused by **excessive drive**

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Transmitter Interference

Distorted speech can be heard on telephone if there is interference from a **SSB TX** (Donald Duck)
On-and-off humming or clicking on telephone if there is interference from a **CW TX**

Connect all grounds to a single point to avoid a **ground loop**
HUM could be a symptom of a **ground loop** somewhere in your station

A **ferrite bead** on cables reduces RF interference (**common-mode current on an audio cable**)
A **bypass capacitor reduces RF interference** to audio-frequency devices
Connect all equipment grounds together to avoid unwanted effects of stray RF

High RF voltages on station equipment can be caused by a **resonant ground**
A **high impedance ground** on a frequency can cause an **RF burns** when HF TX
Arcing can cause of interference covering a wide range of frequencies

HF Mobile Radio Installations and Emergency Power

The **antenna limits an HF mobile** transceiver operating in the 75M
A **shortened mobile** antenna has **limited BW** compared to a full size
"CAPACITANCE HAT" electrically lengthens a physically short antenna
"CORONA BALL" reduces high voltage discharge from the tip of the antenna

The **vehicle control computer** may cause **interfering signals** in the receiver of an HF mobile
Wire a 100W HF mobile **directly to a fused battery connections** using heavy gauge wire
Do NOT wire a 100W HF mobile to an **automobile's auxiliary power socket**

Photovoltaic conversion process changes sunlight into electricity
0.5 VDC is the open-circuit voltage from a photovoltaic cell
A **diode prevents self discharge** of the battery though the solar panel at night
A **large storage system** is needed to supply power when the **wind is not blowing**