



2

General Class Unit 7 Question Pool §7

Practical Circuits

3 Questions

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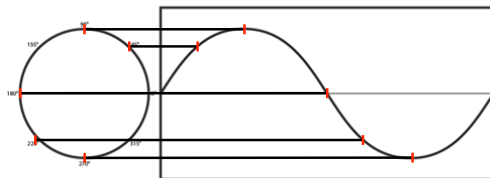
4

Phase Angle

The phase angle of a wave is the portion which has elapsed relative to a starting point.

0° – none, 180° – $\frac{1}{2}$, 360° all

90° – $\frac{1}{4}$, 270° – $\frac{3}{4}$



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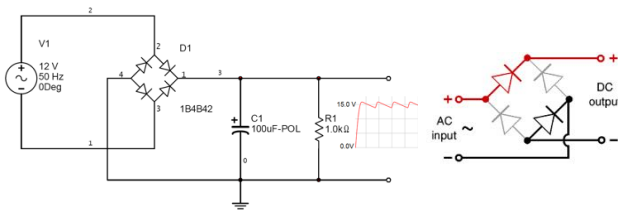


5

Rectifiers

A rectifier converts AC current into DC current.

One or more diodes can be used to create a rectifier.



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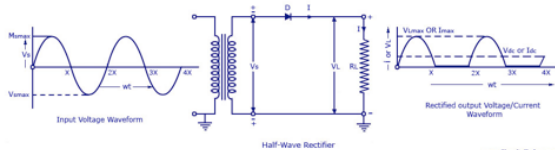


6

Rectifiers

A half-wave rectifier converts *180 degrees* of the AC wave form.

An advantage of a half-wave rectifier in a power supply is that *only one diode is required*.



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G7A05 G7A04

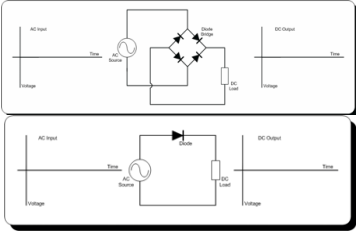


Rectifiers



A full-wave rectifier converts *360 degrees* of the AC wave form.

The output waveform of an unfiltered full-wave rectifier is a *series of DC pulses at twice the frequency of the AC input.*



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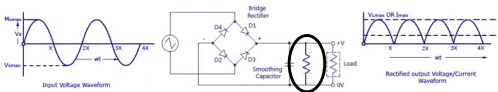
G7A06 G7A07 G7A01



Rectifiers



A bleeder resistor is often added which *ensures that the filter capacitors are discharged when power is removed* so they cannot cause a shock or spark.



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8

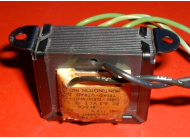
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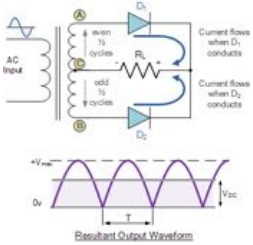


Rectifiers



One type of *full-wave* rectifier circuit uses two diodes and a center-tapped transformer.





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9

G7A03



Power Supplies





High-frequency operation allows the use of smaller components in a switch-mode power supply, which is an advantage over a linear power supply.

Capacitors and inductors are used in a power supply's filter network.

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10

G7A08 G7A02



Schematic Symbols

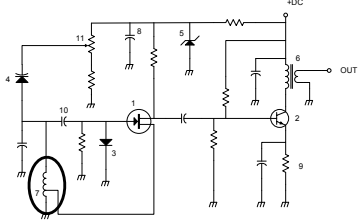


Figure G7-1

Find a Tapped Inductor



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11

G7A13



Schematic Symbols

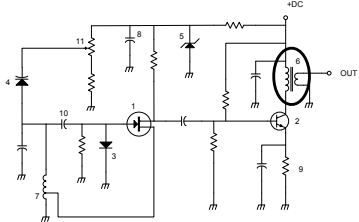


Figure G7-1

Find a Solid Core Transformer



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G7A12



Schematic Symbols

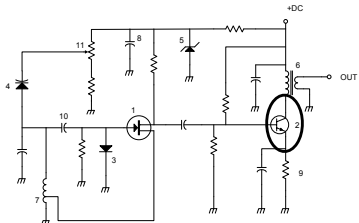


Figure G7-1

Find an NPN Junction Transistor



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G7A11



Schematic Symbols

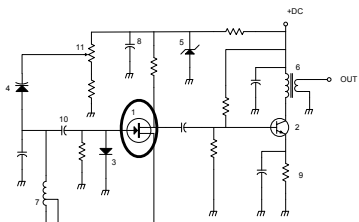


Figure G7-1

Find a Field Effect Transistor



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14

G7A09




Schematic Symbols

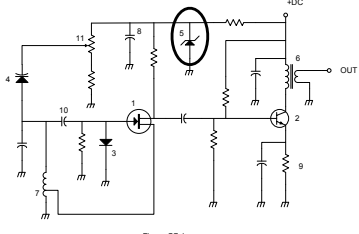


Figure G7-1

Find a Zener Diode

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15

G7A10




Basic Digital Circuitry

$2^6 = 64$	$2^5 = 32$	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
1	0	1	0	0	1	0

Digital circuits count using binary or base 2 which uses only 0's and 1's, or off and on.

Multiple bits, or digits, are used to represent larger numbers.

For example, 3-bits can have 2^3 or 8 states.

The state of a digital circuit is either true or false.

True is generally represented by a 1 or a high voltage.

False is generally represented by a 0 or a low voltage.

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31

G7B05




Basic Digital Circuitry

A two-input AND gate has an *output that is high only when both inputs are high.*

INPUT		OUTPUT
A	B	A • B
0	0	0
0	1	0
1	0	0
1	1	1

A two-input OR gate has an output that is high only when either or both inputs are high.

INPUT		OUTPUT
A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

A two-input NOR gate has an *output that is low when either or both inputs are high.*

INPUT		OUTPUT
A	B	$\overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

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32

G7B03 G7B04




Basic Digital Circuitry

A shift register is a *clocked array of circuits that passes data in steps along the array.*

Shift Register							
7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0

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33

G7B06



Analog Circuitry

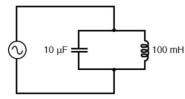


34

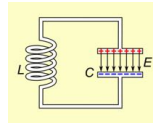
G7B09 G7B07

The frequency of an LC oscillator is determined by *the inductance and capacitance in the tank circuit*.

Resonance will be experienced in a tank circuit when the reactance of the capacitor and inductor are equal to each other. Because inductive reactance increases with increasing frequency and capacitive reactance decreases with increasing frequency, there will only be one frequency where these two reactances will be equal.



Simple parallel resonant circuit (tank circuit).



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Analog Circuitry

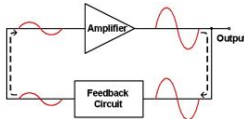


35

G7B09 G7B07

The basic components of a sine wave oscillator are *a filter and an amplifier operating in a feedback loop*.

In a feedback loop a fraction of the amplifier's output signal is fed back to be in phase with the input, and by adding together the feedback and input signals, the amplitude of the input signal is increased.



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Power Amplifiers



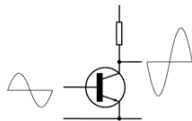
36

G7B10



A linear amplifier is *an amplifier in which the output preserves the input waveform*.

Power amplifiers come in different classes. Common classes are A, B, AB, and C.



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Power Amplifiers



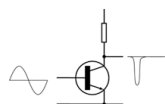
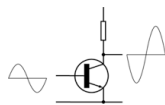
37

G7B02 G7B11

A class A amplifier has low distortion.

A *class C* amplifier has the highest efficiency but a high amount of distortion.

FM is the appropriate mode for amplifying a modulated signal using a class C power stage.



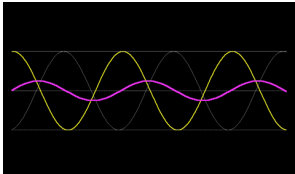
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Power Amplifiers





$$\eta = \frac{P_{RF}}{P_{DC}}$$

The efficiency of an RF power amplifier is determined by dividing the RF output power by the DC input power.

To eliminate self-oscillations an amplifier neutralizes the final amplifier stage of a transmitter.

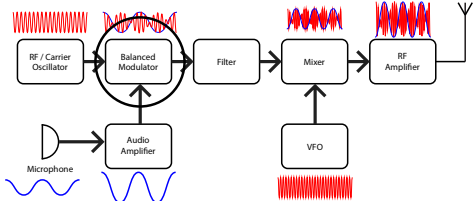
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38

G7B08 G7B01



Single Sideband Transmitter





The *balanced modulator* combines the signals from carrier oscillator and the speech/audio amplifier.

The balanced modulator creates the amplitude modulated radio signal.

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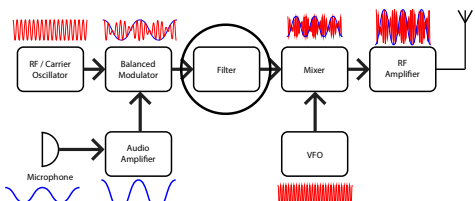
53

G7C02

The balanced modulator also generally removes the carrier, and leaves a double sideband carrier suppressed AM signal.



Single Sideband Transmitter





The *filter* processes the output of the balanced modulator and sends it to the mixer.

The filter removes the unwanted sideband.

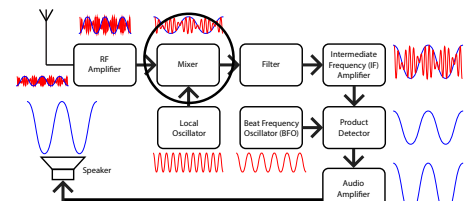
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54

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Superheterodyne Receiver





The *mixer* takes the output of the RF amplifier and the local oscillator then sends it to the IF amplifier.

The mixer converts a higher RF frequency to a lower intermediate frequency (IF).

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55

G7C03



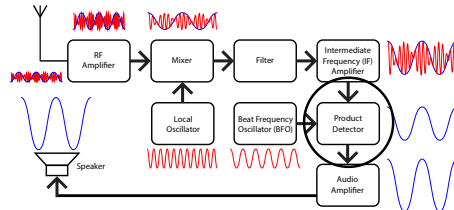
Superheterodyne Receiver



56

G7C04

The *product detector* combines signals from the IF amplifier and BFO and sends them to the AF amplifier. The product detector recovers the audio signal from the modulated radio wave.



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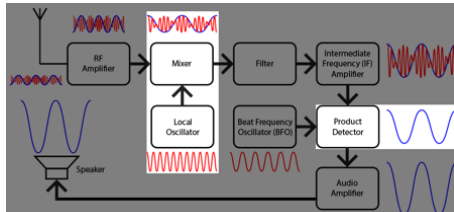
Superheterodyne Receiver



57

G7C07

The simplest combination of stages that implement a superheterodyne receiver are an *HF oscillator*, *mixer*, and *detector*.



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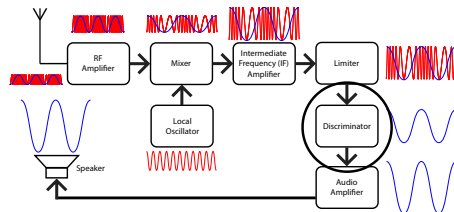
FM Receiver



58

G7C08

The *discriminator* takes the IF output signals and passes them into the audio amplifier. The discriminator is like a detector, however it demodulates FM instead of AM.



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Digital Signal Processing (DSP)

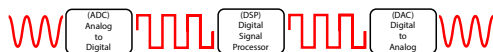


59

Was a question before 2019. Keep for prelude to SDR radios.

Digital signal processing is accomplished by converting the signal from analog to digital and using digital processing.

A digital signal processor IF filter consists of:
an analog to digital converter
a digital processor chip
a digital to analog converter



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Software Defined Radio



60

G7C11

A “software-defined radio” (SDR) is a radio in which most major signal processing functions are performed by software.



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Software Defined Radio



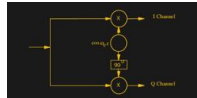
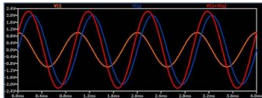
61

G7C09 G7C10 Quadrature refers to anything mathematical that involves a quarter circle, in this case the 90 degree phase shift between the two local oscillators.

The I and Q signals that software-defined radio (SDR) equipment uses for modulation and demodulation has a phase difference of 90 degrees.

An advantage of using I and Q signals in software-defined radios (SDRs) is that *all types of modulation can be created with appropriate processing.*

Quadrature refers to a 90 degree phase shift between two local oscillators, revealing not only the frequency and amplitude information in the signal like from a single mixer in a traditional radio, but also the phase information: the I (In phase) and Q (Quadrature) component signals.



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Direct Digital Synthesis

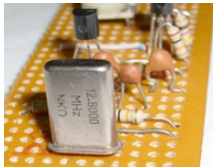


62

G7C05 G7G16

A transceiver controlled by a direct digital synthesizer (DDS) has the advantage of *variable frequency with the stability of a crystal oscillator.*

A typical application for a Direct Digital Synthesizer is a *high-stability variable frequency oscillator in a transceiver.*



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Filters



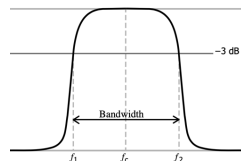
63

G7C14 G7C13 G7C15

The bandwidth of a band-pass filter is measured between the *upper and lower half-power* frequencies.

A filter’s maximum ability to reject signals outside its passband is specified as its *ultimate rejection*.

A filter’s attenuation (loss) inside its passband is its *insertion loss*.



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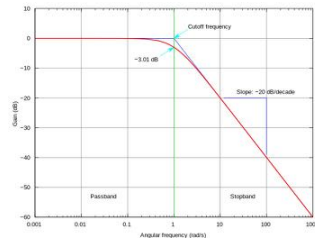
Filters



64

G7C12

The frequency above which a low-pass filter's output power is less than half the input power is the *cutoff frequency*.



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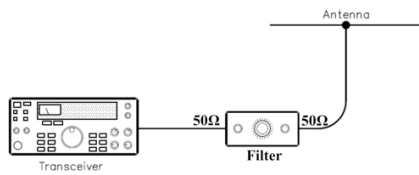
Impedance Matching



65

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The impedance of a low pass filter should be *about the same* as the impedance of the transmission line it is inserted into.



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