

# Advanced Amateur Radio Licence: Part III

## Transmitters/Modulation and Receivers/Performance

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# Outline

## Transmitters and Modulation

- Oscillators

- RF Power Amp

- Modulation

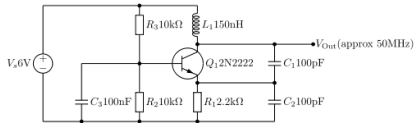
- Repeater

## Codes

## Signal Processing

- ▶ An oscillator is an amplifier with positive feedback.
- ▶ For your convenience, oscillator circuits named after the developer, rather than properties of the circuit.
- ▶ Connect an oscillator to a class C amp with a switch and you've got a (simplistic) CW transmitter.
- ▶ Silver mica capacitors used in high stability oscillator circuits.

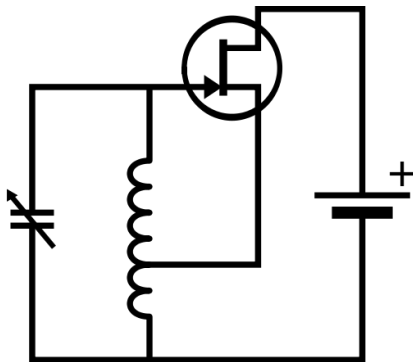
# Colpitts



[http://en.wikipedia.org/wiki/File:NPN\\_Colpitts\\_oscillator\\_collector\\_coil.svg](http://en.wikipedia.org/wiki/File:NPN_Colpitts_oscillator_collector_coil.svg)

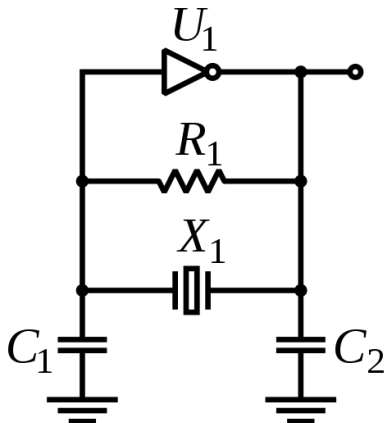
- ▶ Colpitts gets the feedback via a capacitive divider
- ▶ VFO usually based on Colpitts due to stability

# Hartley



[http://en.wikipedia.org/wiki/File:Hartley\\_osc.svg](http://en.wikipedia.org/wiki/File:Hartley_osc.svg)

- ▶ Hartley gets the feedback via a tapped coil



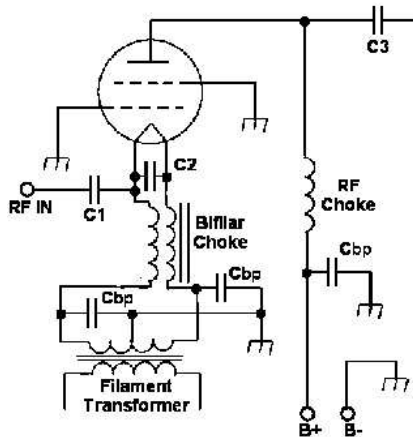
[http://en.wikipedia.org/wiki/File:Pierce\\_oscillator.svg](http://en.wikipedia.org/wiki/File:Pierce_oscillator.svg)

- ▶ Pierce gets the feedback via a capacitive coupling
- ▶ Pierce is usually used for crystals

# Phase locked loop (PLL)

- ▶ Controller that generates an output signal with phase related to phase of an input signal.
- ▶ Analog and digital implementations.
- ▶ Analog form is a phase detector and a VCO.

## Grounded Grid amplifier



Repeated from last time

taken from <http://wb0nni.dakotamade.com/ggbasic.html>. See there for discussion, also the answer to the grounded grid questions



# Modulation types

## AM/SSB

- ▶ Amplitude Modulation (AM)
  - ▶ output is carrier and two sidebands, but really, all the info is in one sideband
- ▶ Balanced modulator
  - ▶ removes the carrier
- ▶ Single Side Band (SSB)
  - ▶ effective 6db gain in the transmitter and 3dB in the receiver.

# Modulation types

## FM

- ▶ Frequency Modulation (FM)
  - ▶ Frequency varies linearly with voltage
  - ▶ Modulation Index:  $x = \frac{D}{f_m}$ ,
  - ▶ Deviation Ratio:  $dr = \frac{D}{f_{max}}$ .
  - ▶ Necessary Bandwidth:  $B = 2M + 2D$

# Modulation types

## FM

- ▶ Phase Modulation
  - ▶ Phase varies linearly with voltage
  - ▶ Of necessity, this also varies frequency, but not linearly with voltage
  - ▶ PM emphasises higher frequencies
  - ▶ Commercial standards based on PM
  - ▶ Preemphasis in the *FM transmitter* artificially boosts high frequencies
  - ▶ Deemphasis in the *FM receiver* restores the original signal

# Modulation types

## Intermodulation interference

- ▶ Occurs when nonlinear mixing takes place between two transmitted frequencies. Usually in the final amp.
- ▶ Most common frequencies are  $2A-B$ , and  $2B-A$

Spread spectrum: see notes

# Repeater

Notes taken from the Examiner comments

"The Carrier Operated Relay (COR) is the circuit which detects an incoming signal at the receiver. In a simplistic repeater, the COR would in turn activate the transmitter. In real-life, the COR signal is taken through a controller where a time-out timer (to prevent overly long transmissions), a "tail" timer (hang time, to keep the repeater on the air between exchanges), a courtesy tone (or "tail beep", to signal the reset of the time-out timer) and an identifier (to transmit the repeater's call sign) are implemented."

"In the context of a repeater installation, a duplexer is a specialized filter which allows operating the receiver and transmitter simultaneously on the same antenna. The duplexer is built with four or more quarter-wavelength cavity resonators. The duplexer provides isolation ( 90 dB or more on 2m ) between the receive and transmit paths at the expense of insertion loss."

Intermodulation is usually cited in the context of a repeater.

- ▶ AMTOR - Amateur Teleprinting Over Radio
- ▶ MODE A - ARQ - (automatic repeat request) retransmission of the group of characters will occur automatically if the transmission is not acknowledged.
- ▶ MODE B - FEC - (Forward error correction) redundancy, hamstudy says each character is sent twice.
- ▶ Generally replaced by PSK31, etc now.

### ASCII - American Standard Code for Information Interchange - 8 bit transmission (in the questions), but 7-bit by orig. definition

Dec	Hex	Oct	Char	Dec	Hex	Oct	HTML	Chr	Dec	Hex	Oct	HTML	Chr	Dec	Hex	Oct	HTML	Chr
0	0	000	<b>NUL</b> (null)	32	20	040	#32;	<b>Space</b>	64	40	100	#64;	<b>@</b>	96	60	140	#96;	<b>`</b>
1	1	001	<b>SOH</b> (start of heading)	33	21	041	#33;	<b>!</b>	65	41	101	#65;	<b>A</b>	97	61	141	#97;	<b>a</b>
2	2	002	<b>STX</b> (start of text)	34	22	042	#34;	<b>"</b>	66	42	102	#66;	<b>B</b>	98	62	142	#98;	<b>b</b>
3	3	003	<b>ETX</b> (end of text)	35	23	043	#35;	<b>#</b>	67	43	103	#67;	<b>C</b>	99	63	143	#99;	<b>c</b>
4	4	004	<b>EOF</b> (end of transmission)	36	24	044	#36;	<b>\$</b>	68	44	104	#68;	<b>D</b>	100	64	144	#100;	<b>d</b>
5	5	005	<b>ENQ</b> (enquiry)	37	25	045	#37;	<b>%</b>	69	45	105	#69;	<b>E</b>	101	65	145	#101;	<b>e</b>
6	6	006	<b>ACK</b> (acknowledge)	38	26	046	#38;	<b>&amp;</b>	70	46	106	#70;	<b>F</b>	102	66	146	#102;	<b>f</b>
7	7	007	<b>BEL</b> (bell)	39	27	047	#39;	<b>'</b>	71	47	107	#71;	<b>G</b>	103	67	147	#103;	<b>g</b>
8	8	010	<b>BS</b> (backspace)	40	28	050	#40;	<b>(</b>	72	48	110	#72;	<b>H</b>	104	68	150	#104;	<b>h</b>
9	9	011	<b>TAB</b> (horizontal tab)	41	29	051	#41;	<b>)</b>	73	49	111	#73;	<b>I</b>	105	69	151	#105;	<b>i</b>
10	A	012	<b>LF</b> (NL line feed, new line)	42	2A	052	#42;	<b>*</b>	74	4A	112	#74;	<b>J</b>	106	6A	152	#106;	<b>j</b>
11	B	013	<b>VT</b> (vertical tab)	43	2B	053	#43;	<b>+</b>	75	4B	113	#75;	<b>K</b>	107	6B	153	#107;	<b>k</b>
12	C	014	<b>FF</b> (NP form feed, new page)	44	2C	054	#44;	<b>,</b>	76	4C	114	#76;	<b>L</b>	108	6C	154	#108;	<b>l</b>
13	D	015	<b>CR</b> (carriage return)	45	2D	055	#45;	<b>-</b>	77	4D	115	#77;	<b>M</b>	109	6D	155	#109;	<b>m</b>
14	E	016	<b>SO</b> (shift out)	46	2E	056	#46;	<b>.</b>	78	4E	116	#78;	<b>N</b>	110	6E	156	#110;	<b>n</b>
15	F	017	<b>SI</b> (shift in)	47	2F	057	#47;	<b>/</b>	79	4F	117	#79;	<b>O</b>	111	6F	157	#111;	<b>o</b>
16	10	020	<b>DLE</b> (data link escape)	48	30	060	#48;	<b>0</b>	80	50	120	#80;	<b>P</b>	112	70	160	#112;	<b>p</b>
17	11	021	<b>DC1</b> (device control 1)	49	31	061	#49;	<b>1</b>	81	51	121	#81;	<b>Q</b>	113	71	161	#113;	<b>q</b>
18	12	022	<b>DC2</b> (device control 2)	50	32	062	#50;	<b>2</b>	82	52	122	#82;	<b>R</b>	114	72	162	#114;	<b>r</b>
19	13	023	<b>DC3</b> (device control 3)	51	33	063	#51;	<b>3</b>	83	53	123	#83;	<b>S</b>	115	73	163	#115;	<b>s</b>
20	14	024	<b>DC4</b> (device control 4)	52	34	064	#52;	<b>4</b>	84	54	124	#84;	<b>T</b>	116	74	164	#116;	<b>t</b>
21	15	025	<b>NAK</b> (negative acknowledge)	53	35	065	#53;	<b>5</b>	85	55	125	#85;	<b>U</b>	117	75	165	#117;	<b>u</b>
22	16	026	<b>SYN</b> (synchronous idle)	54	36	066	#54;	<b>6</b>	86	56	126	#86;	<b>V</b>	118	76	166	#118;	<b>v</b>
23	17	027	<b>ETB</b> (end of trans. block)	55	37	067	#55;	<b>7</b>	87	57	127	#87;	<b>W</b>	119	77	167	#119;	<b>w</b>
24	18	030	<b>CAN</b> (cancel)	56	38	070	#56;	<b>8</b>	88	58	130	#88;	<b>X</b>	120	78	170	#120;	<b>x</b>
25	19	031	<b>EN</b> (end of medium)	57	39	071	#57;	<b>9</b>	89	59	131	#89;	<b>Y</b>	121	79	171	#121;	<b>y</b>
26	1A	032	<b>SUB</b> (substitute)	58	3A	072	#58;	<b>:</b>	90	5A	132	#90;	<b>Z</b>	122	7A	172	#122;	<b>z</b>
27	1B	033	<b>ESC</b> (escape)	59	3B	073	#59;	<b>;</b>	91	5B	133	#91;	<b>[</b>	123	7B	173	#123;	<b>{</b>
28	1C	034	<b>FS</b> (file separator)	60	3C	074	#60;	<b>&lt;</b>	92	5C	134	#92;	<b>\</b>	124	7C	174	#124;	<b> </b>
29	1D	035	<b>GS</b> (group separator)	61	3D	075	#61;	<b>=</b>	93	5D	135	#93;	<b>]</b>	125	7D	175	#125;	<b>}</b>
30	1E	036	<b>RS</b> (record separator)	62	3E	076	#62;	<b>&gt;</b>	94	5E	136	#94;	<b>^</b>	126	7E	176	#126;	<b>~</b>
31	1F	037	<b>US</b> (unit separator)	63	3F	077	#63;	<b>?</b>	95	5F	137	#95;	<b>_</b>	127	7F	177	#127;	<b>DEL</b>

Source: [www.LookupTables.com](http://www.LookupTables.com)



- ▶ AX.25 - packet radio protocol.
- ▶ Occupies first, second and third layers of OSI networking model (physical, data and network)

# Codes

## BAUDOT

BAUDOT - 5 bit transmission - One case for text, shift between

International telegraphy alphabet No. 2 (Baudot-Murray code)<sup>[15]</sup>

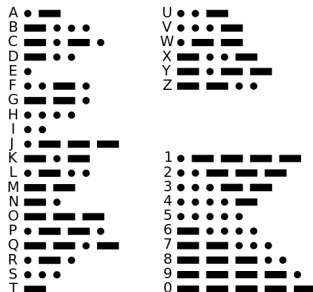
Pattern of impulses 1=mark 0=space		Letter shift	Figure shift
msb on left	msb on right		
00000	00000	Null	Null
00100	00100	Space	Space
10111	11101	Q	1
10011	11001	W	2
00001	10000	E	3
01010	01010	R	4
10000	00001	T	5
10101	10101	Y	6
00111	11100	U	7
00110	01100	I	8
11000	00011	O	9
10110	01101	P	0
00011	11000	A	-
00101	10100	S	Bell
01001	10010	D	\$
01101	10110	F	!
11010	01011	G	&
10100	00101	H	#
01011	11010	J	'
01111	11110	K	(
10010	01001	L	)
10001	10001	Z	*
11101	10111	X	/
01110	01110	C	:
11110	01111	V	;
11001	10011	B	?
01100	00110	N	.
11100	00111	M	
01000	00010	Carriage return	Carriage return
00010	01000	Line feed	Line feed
11011	11011	Shift to figures	
11111	11111	Shift to letters	

figure and text mode.

CW - Morse code. Note variable length per character - more

### International Morse Code

1. The length of a dot is one unit.
2. A dash is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.



frequently used characters are shorter.

[http://en.wikipedia.org/wiki/File:  
International\\_Morse\\_Code.svg](http://en.wikipedia.org/wiki/File:International_Morse_Code.svg)

# Signal Processing

(See the HamStudy notes)