Morse Code & CW Operation
6-April-2019
285 TechConnect Radio Club – NAØTC
Jed Baer – KDØYMG

- ◆ Morse code
- ◆ Keys, bugs, paddles, accessories
- ◆ CW Operation: Larry – KØNA

Morse Code

What is Morse code? From Wikipedia (https://en.wikipedia.org/wiki/Morse_code):

- Morse code is a character encoding scheme used in telecommunication that encodes text characters as standardized sequences of two different signal durations called dots and dashes or dits and dahs.
- Morse code is named for Samuel F. B. Morse, an inventor of the telegraph.
- The International Morse Code encodes the 26 English letters A through Z, some non-English letters, the Arabic numerals and a small set of punctuation and procedural signals (prosigns).
- There is no distinction between upper and lower case letters.
- To increase the efficiency of encoding, Morse code was designed so that the length of each symbol is approximately inverse to the frequency of occurrence in text of the English language character that it represents.
- After some minor changes, International Morse Code was standardized at the International Telegraphy Congress in 1865 in Paris and was later made the standard by the International Telecommunication Union (ITU). Morse's original code specification, largely limited to use in the United States and Canada, became known as American Morse code or railroad code.
- ITU specification: https://www.itu.int/rec/R-REC-M.1677-1-200910-I/
- Non-English: https://en.wikipedia.org/wiki/Morse_code_for_non-Latin_alphabets
- Can be transmitted many ways:
  - Radio
  - Flashing light
  - Knocking
  - Telegraph
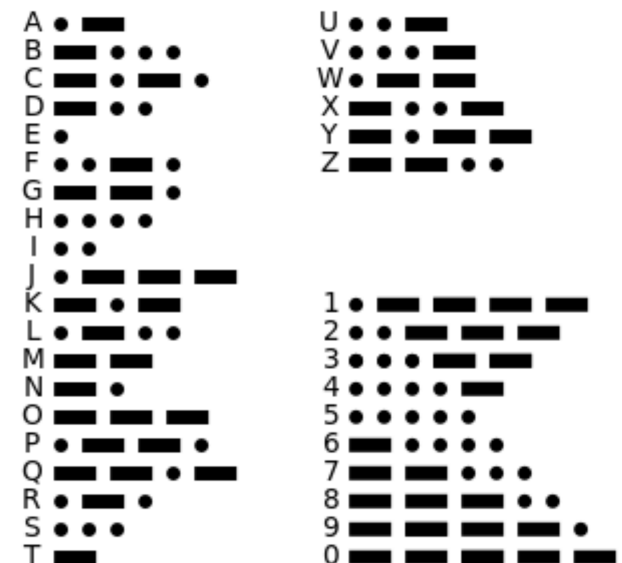 - Internet
- Morse is not CW

In the 1830s, the British team of Cooke and Wheatstone developed a telegraph system with five magnetic needles that could be pointed around a panel of letters and numbers by using an electric current
...
In 1843, Morse and Vail received funding from the U.S. Congress to set up and test their telegraph system between Washington, D.C., and Baltimore, Maryland. On May 24, 1844, Morse sent Vail the historic first message: "What hath God wrought!"

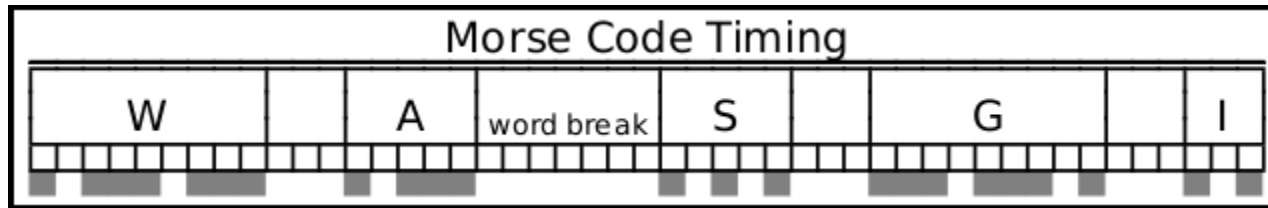https://www.history.com/topics/inventions/telegraph

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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.

A ● ▬
B ▬ ● ● ●
C ▬ ● ▬ ●
D ▬ ● ●
E ●
F ● ● ▬ ●
G ▬ ▬ ●
H ● ● ● ●
I ● ●
J ● ▬ ▬ ▬
K ▬ ● ▬
L ● ▬ ● ●
M ▬ ▬
N ▬ ●
O ▬ ▬ ▬
P ● ▬ ▬ ●
Q ▬ ▬ ● ▬
R ● ▬ ●
S ● ● ●
T ▬

U ● ● ▬
V ● ● ● ▬
W ● ▬ ▬
X ▬ ● ● ▬
Y ▬ ● ▬ ▬
Z ▬ ▬ ● ●

1 ● ▬ ▬ ▬ ▬
2 ● ● ▬ ▬ ▬
3 ● ● ● ▬ ▬
4 ● ● ● ● ▬
5 ● ● ● ● ●
6 ▬ ● ● ● ●
7 ▬ ▬ ● ● ●
8 ▬ ▬ ▬ ● ●
9 ▬ ▬ ▬ ▬ ●
0 ▬ ▬ ▬ ▬ ▬

Character and word spacing

Morse Code Timing							
W		A	word break	S		G	I

- One dit between elements
- One dah between characters
- Seven dits between words
- End of sentence:
  - Period: **.-.-.-**
  - Prosign BT: **-...-**

Proper character and word spacing make it easier for the receiving station to copy your transmission.
Fist: *the characteristic signaling rhythm of an individual telegraph or CW operator when sending Morse code* (https://www.definitions.net/definition/fist)

Words per minute: *Proficiency in Morse code is measured in how many words per minute someone can send or receive. This seems a tricky concept given that you can send more short words per minute than long ones. The work-around is to standardise on the word "PARIS" as the standard word, so if Morse is being sent at 20 words per minute (or "20 wpm") then the word "PARIS" (or, more precisely "PARIS " with a space on the end) could be sent 20 times in a minute.* (https://morsecode.scphillips.com/timing.html)

Prosigns and Q-codes

Prosigns: *Prosigns are symbols formed by running together two characters into one (without the intercharacter space) to make an abbreviation for the most common procedural signals. Usually written with a BAR over the characters.*

Prosigns originated with telegraphers. Q-codes with radio telegraphy.

Prosigns (partial listing)		
AA	.-.-	New Line
AR	.-.-.	End of message
AS	.-...	Stand by
CL	-.-..-..	Clear
BK	-...-.-	Break; Invite receiving station to transmit
BT	-...-	Pause; Break for Text; New paragraph
K	-.-	Go – invite any station to transmit
KA	-.-.-	Beginning of message
KN	-.--.	Go – invite specific station to transmit
R	.-.	All received OK; Roger
SK	...-.-	End of contact
VE	...-.	Understood
	-..-.	Shave and a haircut
	..	Two bits
https://morsecode.scphillips.com/morse2.html		
http://kent-engineers.com/prosigns.htm		

Q Codes (partial listing)	
QRM	Is my transmission being interfered with?
QRN	Are you having trouble with static?
QRO	Should I increase power?
QRP	Should I decrease power?
QRQ	Should I send faster?
QRS	Should I send slower?
QRT	Should I stop sending; I'm shutting down
QRZ	Who is calling me?
QSY	Should I go to another freqency?
QTH	What is your location?
QLF	Are you sending with your left foot?
http://kent-engineers.com/qcode.htm	

Q-codes followed by a question mark are a question to another station. The response uses the Q-code followed by more information:
- ◆ QTH?
- ◆ QTH DM79MO

https://en.wikipedia.org/wiki/Q_code

Learning Morse

"It is not the speed at which a letter is sounded that perplexes the learner, but the rapid succession in which they follow each other." – Thomas Edison (source http://www.n5kd.org/radio/morse/)

Sounds: Learning the code is (or should be) an aural pursuit.
- Infants learn to speak by listening to words and sentences
- Should (or can) learning Morse code be different for sending and receiving?
- I've heard the assertion that one should learn to receive all characters, prior to sending
- *People who develop fast code skills (30wpm+) are without a doubt processing the code in the language centers of the brain.* https://cq2k.com/do-you-use-farnsworth.html

Methods:

Code tapes:
>(play morse_mil_1.mp3)
>(play 01-TMO0.mp3 – from K6RAU)

>*In very short order, and unconsciously, you'll memorize the tape. This will lull you into false confidence in your ability. That false confidence will be quickly shattered when you hear transmitted text that you haven't memorized.* (https://www.qsl.net/n1irz/finley.morse.html)

Koch:
>*Koch's method … dictates that you should start learning <u>at the desired speed</u> - but you start with only two characters. Each session is five minutes long, and whenever you get 90% or more correct, you add another character.* (http://www.justlearnmorsecode.com/koch.html)

>However: *It ought to be illegal to teach anyone code at 5 wpm. Every minute spent toying with 5 wpm code is irrevocably wasted. In addition, as we'll see later, starting with slow code is a virtually-guaranteed path to frustration and quitting. Morse at 5 wpm and Morse at 15 or 20 wpm are completely different critters, and you don't want to waste time on the wrong one.* (https://www.qsl.net/n1irz/finley.morse.html)

>Koch teaches letters, not words, but can be used for words.

Farnsworth:
>The Farnsworth method is similar to Koch, except that it uses a fast (e.g. 20wpm character rate) but increases the spacing between characters, to allow extra time for recognition.

Simply listening:

Copying QSOs off the air -- *You don't know the speed of code you find on the bands, and much code on the air is pretty badly sent. All this makes it useless for training purposes. Formal code-practice sessions, such as those on W1AW, are OK, however.* (https://www.qsl.net/n1irz/finley.morse.html)

ARRL W1AW transmissions: http://www.arrl.org/w1aw, http://www.arrl.org/code-transmissions

Frequencies are 1.8025, 3.5815, 7.0475, 14.0475, 18.0975, 21.0675, 28.0675 and 147.555 MHz.

Slow Code = practice sent at 5, 7-1/2, 10, 13 and 15 words per minute (wpm).

Fast Code = practice sent at 35, 30, 25, 20, 15, 13 and 10 wpm.

Code practice text is from the pages of QST magazine, the League's membership journal. The source is given at the beginning of each practice session and alternate speeds within each session. For example, "Text is from November 2010 QST, pages 9 and 81," indicates that the practice session's plain text is from the article on page 9 and its mixed number/letter groups are from page 81

http://www.arrl.org/code-practice-files
◆ 15WPM (play 190313_15WPM.mp3)
◆ 40WPM (play 190129_40WPM.mp3)
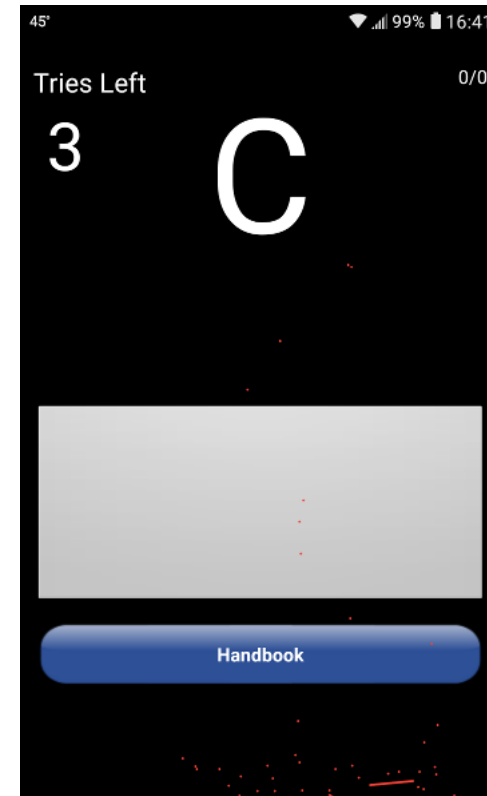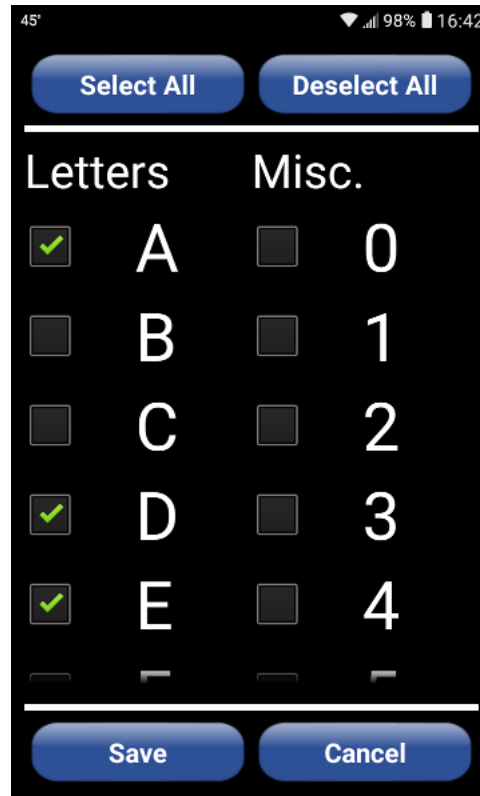
http://www.morseresource.com/podcasts.php

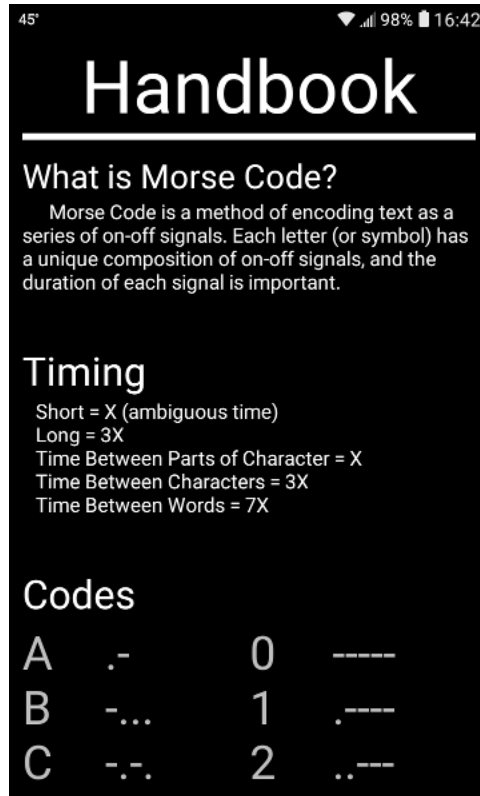Built-in code-practice function in your radio, e.g. the Yaesu FT-2900R has a "CW Training" feature.

Programs:

Android:

MorseCT

Handbook

What is Morse Code?

Morse Code is a method of encoding text as a series of on-off signals. Each letter (or symbol) has a unique composition of on-off signals, and the duration of each signal is important.

Timing

Short = X (ambiguous time)
Long = 3X
Time Between Parts of Character = X
Time Between Characters = 3X
Time Between Words = 7X

Codes

A	.-	0	-----
B	-...	1	.----
C	-.-.	2	..---

Select All   Deselect All

Letters   Misc.

☑ A   ☐ 0

☐ B   ☐ 1

☐ C   ☐ 2

☑ D   ☐ 3

☑ E   ☐ 4

Save   Cancel

Tries Left   0/0

3   C

Handbook

Choose your exercise

Koch training
Learn CW from scratch with the Koch method

Read text
Play a text file in CW

Train words or sentences
Random words or sentences from a file

Callsigns [PRO]
Sequence of worldwide callsigns

Standard QSO [PRO]
Train on standard QSO sentences

User defined 1
— empty —

User defined 2 [PRO]
On PRO version only

User defined 3 [PRO]
On PRO version only

User defined 4 [PRO]
On PRO version only

User defined 5 [PRO]
On PRO version only

User defined 6 [PRO]

17/0:13

»»» KKKKKK MMMMMK KM

20 wpm

Linux:

```
$ man -k morse
aldo (1)            - A fully console morse code trainer written in ISO C++.
bcd (6)             - "reformat input as punch cards, paper tape or morse code"
cw (1)              - sound characters as Morse code on the soundcard or console speaker
cw (7)              - the international Morse code
cwcp (1)            - curses-based Morse tutor program
cwgen (1)           - generate groups of random characters for Morse code practice
morse (1)           - Morse-code trainer and QSO generator for aspiring radio hams
morse (6)           - "reformat input as punch cards, paper tape or morse code"
morse-x (1)         - morse practicing tool
morseALSA (1)       - Morse-code trainer and QSO generator for aspiring radio hams
morseLinux (1)      - Morse-code trainer and QSO generator for aspiring radio hams
morseOSS (1)        - Morse-code trainer and QSO generator for aspiring radio hams
morseX11 (1)        - Morse-code trainer and QSO generator for aspiring radio hams
ppt (6)             - "reformat input as punch cards, paper tape or morse code"
qrq (1)             - High speed Morse telegraphy trainer
qrqscore (1)        - High speed Morse telegraphy trainer
QSO (1)             - Morse-code trainer and QSO generator for aspiring radio hams
xcwcp (1)           - X Window-based Morse tutor program
```

Live demo of "cw" program:

```
$ cwt 12 25 Y
K R P R I I U U I P R T U A T I W I O L S L U U P
[SK]
$ cw -s a -w 20 -t 666 -v 20 -g 7 -f mwords
RAM
TRAP
PAM
TUSK
MAP
SOOT
...
```

CWirc – send/receive Morse via IRC
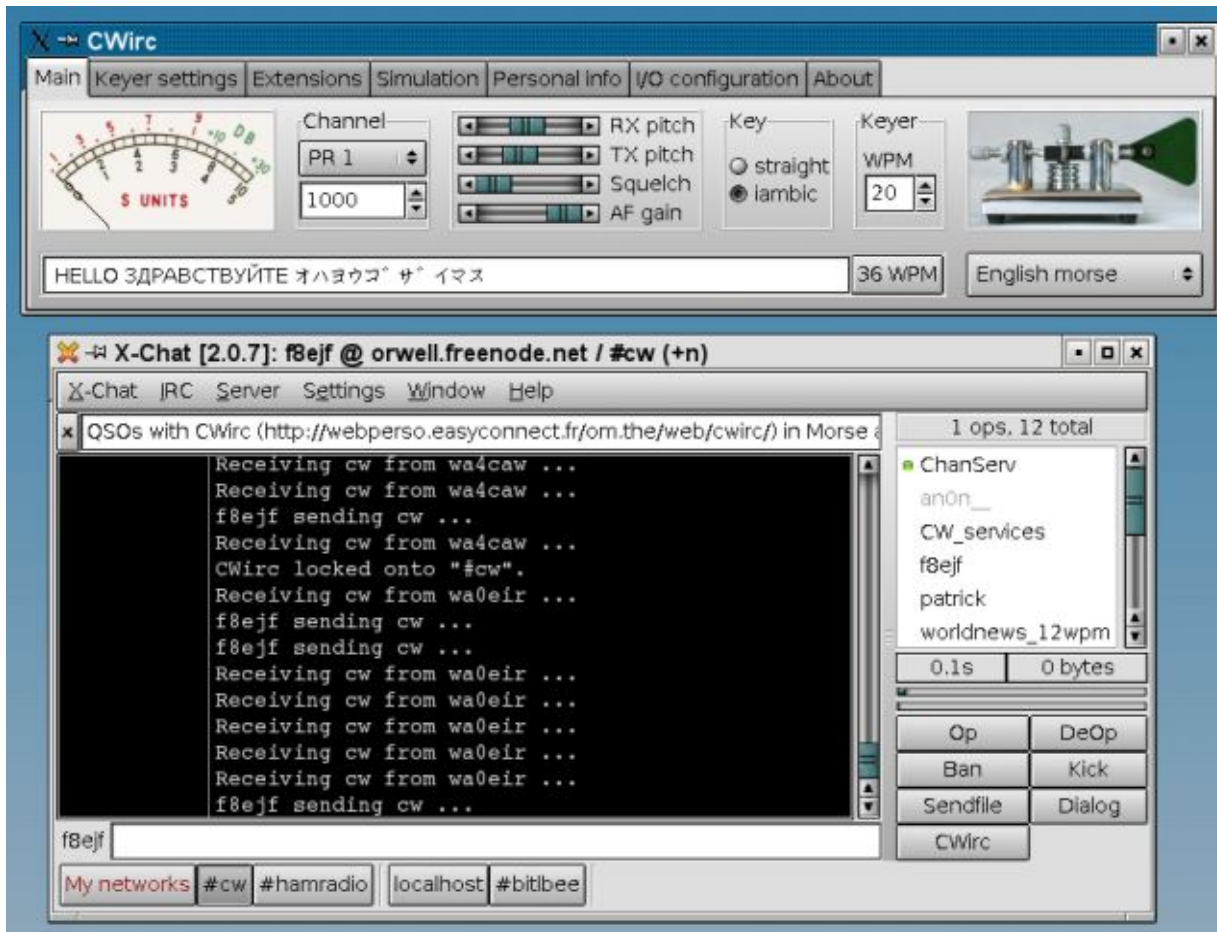
Code Practice Oscillators:

Practice oscillators generate a tone in response to operation of a Morse code key.
- ◆ "Side-tone" generator as part of an electronic keyer
- ◆ "Side-tone" of your transceiver, using dummy load, or transmitter turned off
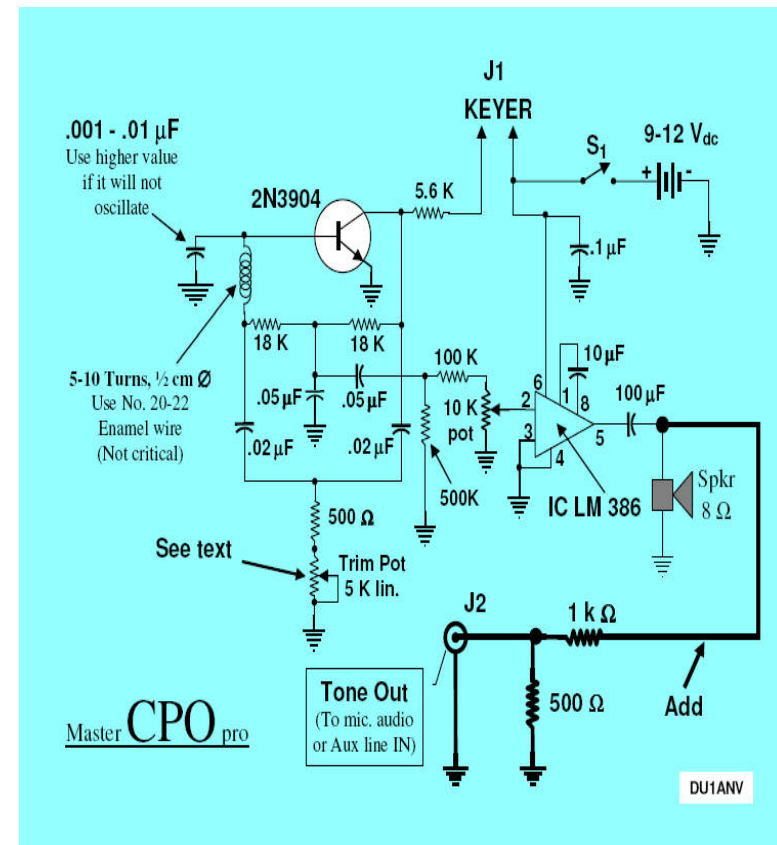- ◆ Purpose-built device

The Twin-T Oscillator:

Fig. 1. The master CPO pro circuit for MORSE CODE practice. This audio oscillator will produce a pure sine-wave signal within the range of 500 – 2000 Hz. Part of the output can be tapped from the speaker line (shown in BOLD lines) to modulate an FM Rig or feed an audio amplifier for mass training practice via J2 (See text description).

From an article by DU1ANV, Philippine Amateur Radio Association
https://www.para.org.ph/para-Code-Practise-Oscillator.html

I sort-of successfully built this:
- ◆ Oscillator worked
- ◆ Destabilized when connected to LM386
- ◆ Really destabilized when speaker connected
- ◆ Many variations exist on the web

Other oscillators:
- ◆ 555 or other timer IC – square wave output
- ◆ Pick or Atmel direct-digital synthesis

Commercial products:
- ◆ http://www.mtechnologies.com/misc/ttone.htm
- ◆ MFJ 557
- ◆ Heathkit HD-16, HD-1416

Morserino:

https://forums.qrz.com/index.php?threads/introducing-the-morserino-32-a-new-way-to-learn-morse-code.647677/#post-4978373

http://www.morserino.info/morserino-32.html

Notable feature is the "echo trainer" mode. The student does not write anything down, but instead repeats the "transmitted" code sequence, and the device provides an indication of correct/incorrect. Still uses characters. (Possibly, word mode is available?)
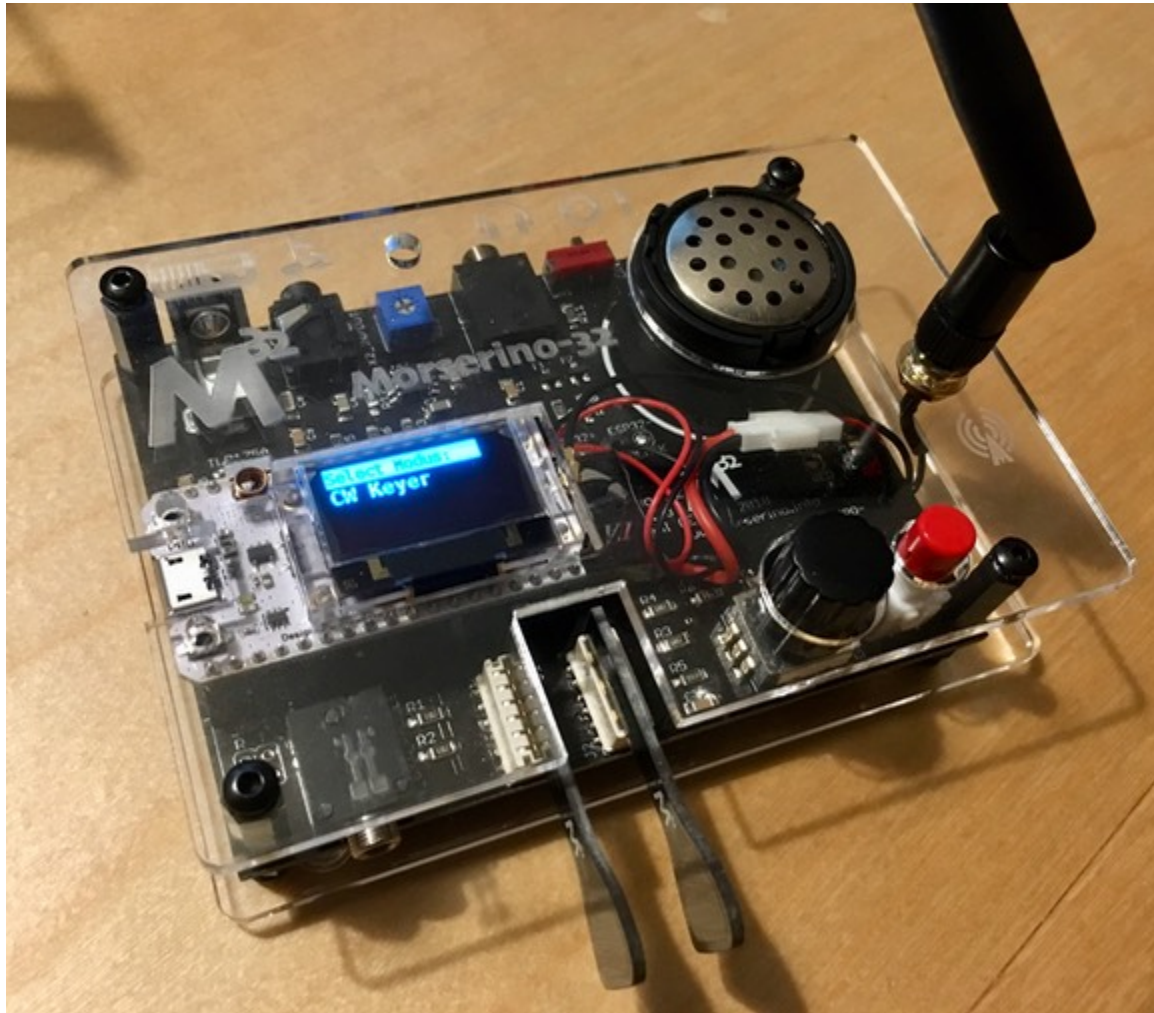
Other tips:
- Use paddles and keyer to emphasize proper timing.

Resources:
- http://www.justlearnmorsecode.com/
- http://aa9pw.com/morsecode/ – Uses Farnsworth timing, additive letter method, but will generate code samples from text sources.
- CWops Morse Code Trainer – https://morsecode.scphillips.com/trainer.html
- ARRL – http://www.arrl.org/learning-morse-code

Keys, bugs, paddles, accessories

Photo: Richard -- AA4OO

Keys: Straight keys, sideswipers (cootie keys), semi-automatic (bugs), paddles

Straight keys:

J38:
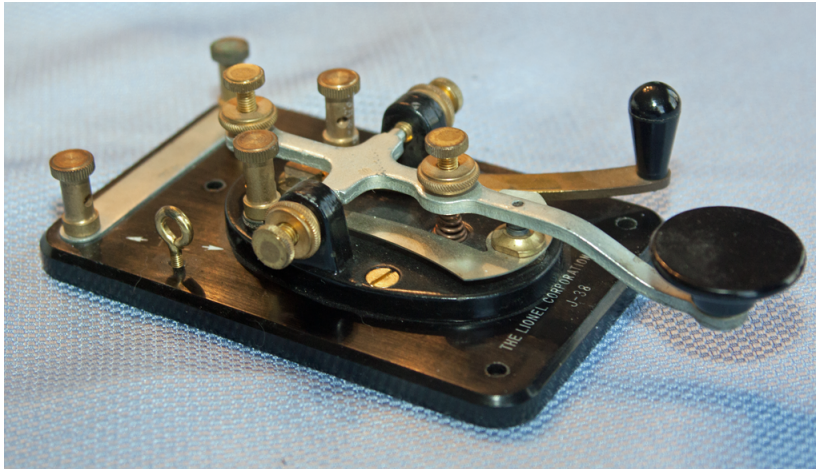
Navy J38, Lionel Corporation (Image www.kd2uj.com)

The straight keys used in wire telegraphy also had a shorting bar that closed the electrical circuit when the operator was not actively sending messages. This was to complete the electrical path to the next station

https://en.wikipedia.org/wiki/Telegraph_key

Morse-Vail Key, 1844:

Photo: Smithsonian Institution

Navy flame-proof, 1918:

Photo: Smithsonian Institution

Telegraph keys are electrical on-off switches used to send messages in Morse code and can spark when the circuit opens. Flame-proof telegraph keys, like this one made by International Radio Telegraph Company, were designed to contain the spark within a sealed chamber. These keys were necessary on early aircraft and in confined spaces such as aboard ships and submarines where the spark might ignite flammable gasses.

Key arcing? Grid-block keying!

How did we get from the Morse-Vail key to the J38?

The Bunnell Triumph:

> *As early as 1868 inventors and makers were experimenting with various lever designs attempting to solve the problem of a brass lever becoming loose on its steel axis when subject to consistent lateral pressures. This lateral movement produced a secondary problem called "sticking" that occurred when the lever was released. The key contacts would slide back across themselves instead of breaking clean especially when closely gapped. The heavier brass lever designs of the 1870's were actually an attempt to minimize this problem, but the trade off was a heavy, less responsive lever. During the 1870-1880's makers, including J.H. Bunnell & Co., promoted the cure of "sticking" with their new designs.* (http://www.telegraph-history.org/bunnell/)

Sideswiper or "cootie" key:

◆ Uses side-to-side motion, instead of up/down
◆ Has two physical contacts, which are electrically connected
◆ Dits and dahs using either contact
◆ A paddle key can be a "cootie" if left-right contacts are connected
◆ With some radios, turning the keyer off makes paddles function as a "cootie"
◆ http://www.sideswipernet.org/keys/w5peh-keys.php

Semi-automatic keys, or bugs:

> [The first bug] *was invented by Horace Greeley Martin and was called the Autoplex. It employed the same circuit as a bell or buzzer. An electromagnet pulled in a spring-loaded clapper. The clapper pulling in would interrupted the circuit, permitting a spring to return the clapper to its original position, re-establishing the circuit and the cycle would repeat.*
> *…*
> *The Autoplex patents were published and it became apparent to those interested in commercial keys that if one could be developed that was totally mechanical and reasonably priced, telegraphers would rush to buy it. Martin developed such a key but was beaten to the punch by W. O. Coffe who worked for a competitor, the Mecograph Company. Coffe's patent was issued first*
> *…*
> *Albright, who owned Vibroplex, and Bellows entered into a patent infringement lawsuit that didn't prevent either from continuing to manufacture or market their bugs. So now, Vibroplex and Mecograph duked it out in the marketplace. Vibroplex proved the more successful marketer and won this contest. Bellows died suddenly and Albright, apparently a very smart businessman, bought Mecograph from Bellows' widow. Vibroplex absorbed Mecograph and the Mecograph keys went extinct.* (http://www.arrl.org/the-first-bugs)

http://telegraphkeys.com/images/bugs/autoplex patent.jpg – Autoplex patent
http://w1tp.com/im8000a.htm – photos of the Martin Autoplex
http://telegraphkeys.com/pages/bugs/mecograph.html – The Mechograph bug
http://www.vibroplexcollector.net/ – The Vibroplex bug

https://www.youtube.com/watch?v=i77urMwJ9NM (3:52) – The Vibroplex CW Key – How does it work?

Paddles:

- Used with an electronic keyer
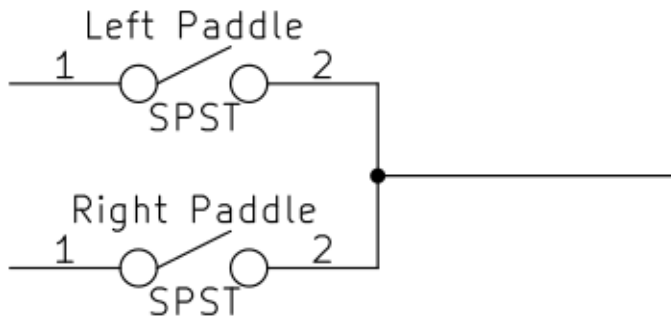- Auto-generate both dots and dashes, repeating while key is held

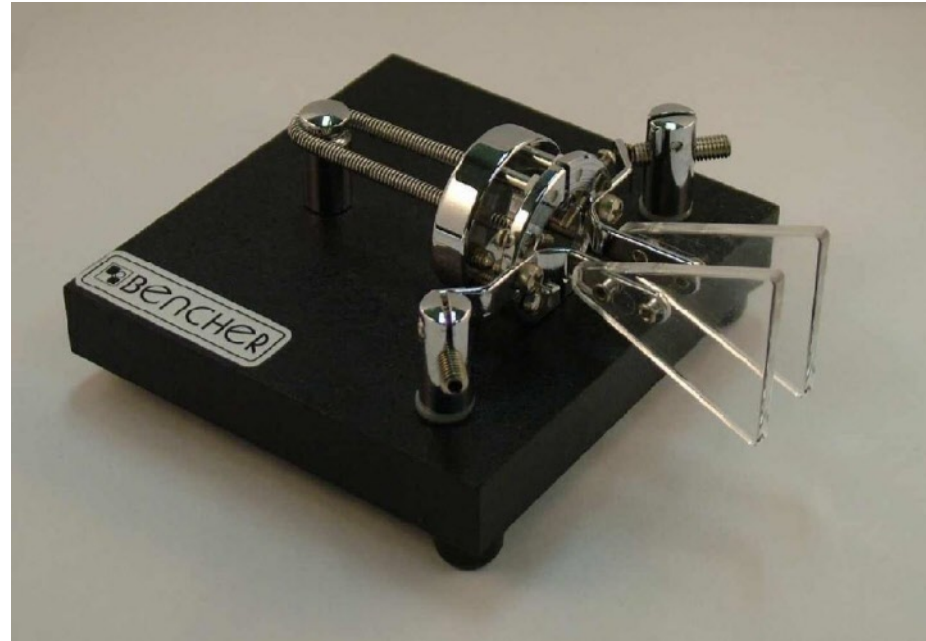**Single paddle:** operates like a SPDT switch
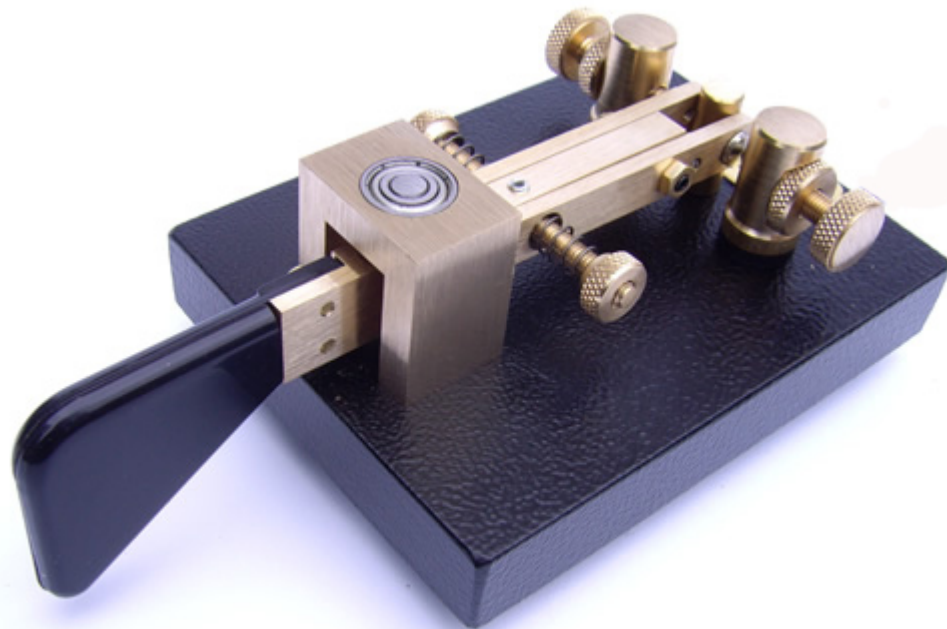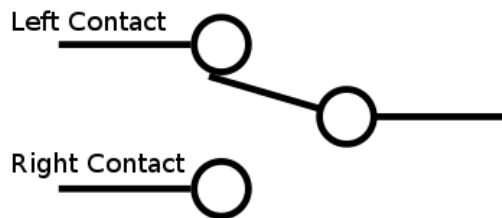
Kent Single Paddle Key

Double paddle:
- ◆ Operates as 2 independent SPST switches
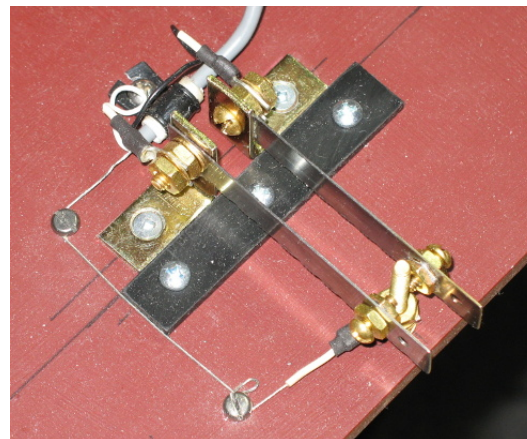- ◆ Closing both switches simultaneously enables iambic operation

Bencher BY-1

https://www.americanmorse.com/portapaddle.htm

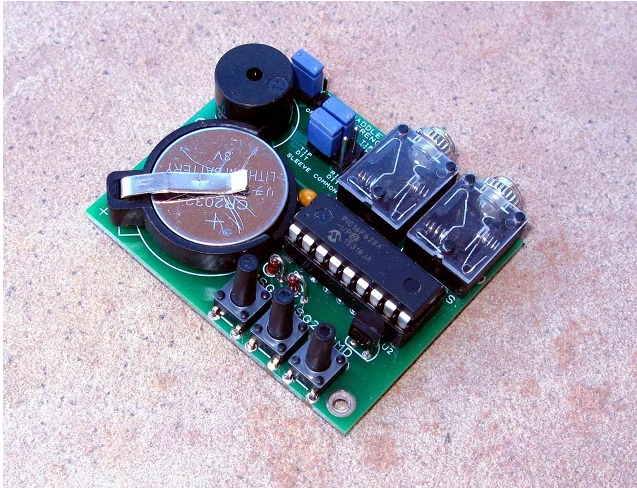*American Morse Porta Paddle-II*

Homebrew double paddle, made with hacksaw blades

– Some keys at N1FN – Marshall's web site

Keyers:

Electronic devices used to generate dits and dahs, typically using paddles as input. Many radios have built-in keyers.

QRP Guys mini-keyer V2.
 ◆ https://qrpguys.com/keyer-v2
 ◆ variable speed
 ◆ 2 memory locations
 ◆ piezo speaker – square wave
 ◆ configurable for left/right dit/dah

GHD GK509A Super Autobug Keyer
http://morseexpress.com/ghd/index.htm#keyer

Training videos:

- https://www.youtube.com/watch?v=x6ggckXtZjs – "Straight Key hand sending technique as approved by professionals. using Junker cw key"; by zoolkhan
- https://www.youtube.com/watch?v=3mkXTxnaiaM – "USA straight key setup and sending method by N1EA"; *David J. Ring, Jr.,N1EA former commercial radiotelegraphist USA merchant marine shows how he adjusts and sends with USA type straight key.*
- https://www.youtube.com/watch?v=ncOcgarGJHI – "How to operate a straight key"; GHD Key
- Other topics: Iambic A vs. Iambic B, how to adjust Vibroplex bug, etc.

More Resources

Straight Key Century Club – https://www.skccgroup.com/
KØDIT – Ft. Collins CW Group – https://fococw.com/

I've been told there are known frequencies where slow-speed code is welcome – wrote them down, now can't find them.

CW Operation

Selecting a weaker CW signal on the Icom 7300: https://www.youtube.com/watch?v=lEtu9gTHrf8 (15 min mark)

And now ... heeeeeeeeeeeeeeeeeeeeere's Larry!

Typical CW QSO

https://www.skccgroup.com/member_services/beginners_corner/

CQ CQ CQ DE W3ABC W3ABC W3ABC K

W3ABC DE W2XYZ W2XYZ AR

W2XYZ DE W3ABC TNX FER CALL BT UR RST 599 599 HR QTH READING PA READING PA BT NAME DAVE DAVE ES SKCC 1234 1234 SO HW CPY? W2XYZ DE W3ABC KN

W3ABC DE W2XYZ TNX FER RPT BT SLD CPY UR RST 589 589 BT NAME BOB BOB BT QTH PULASKI NY PULASKI NY BT SKCC 2345 2345 BT HW CPY? W3ABC DE W2XYZ KN

W2XYZ DE W3ABC FB BOB BT WX HR WARM ES DRY TEMP 75F BT RIG KNWD TS520S ES ANT DIPOLE UP 50 FT BT HW CPI? W2XYZ DE W3ABC KN

[Other conversation here]

W2XYZ DE W3ABC TNX FER FB QSO BOB BT HP CU AGN BT VY 73 TO U ES URS SK W2XYZ DE W3ABC

W2XYZ would now also sign.