The Road to CW

Second Edition

April 26, 2016

de W4ALF – Christian Bravo

Foreward:

The purpose of this handbook was to compile the most common topics, questions and thoughts on the process of learning CW for the "NEW" student or aspiring student.

I want to clarify up front that a good portion of the content in this handbook is not original and was provided from sources I have found on the internet. Most of the content is freely distributable, several sources I requested permission to use. This PDF handbook is not intended for sale and its only intent it to help others learn CW and promote this mode of operation on the Ham bands. I have made an effort to reference my major sources. If you have found content from a specific source and it is not referenced in my handbook. Please feel free to contact me at w4alf@arrl.net and I can add it to the handbook. I hope you enjoy the read and that my efforts have offered you the motivation to start on your own "Road to CW"!

About Me:

I began this hobby in February of 2014 and became licensed that same month. I hold an US Extra license that was awarded in March of 2014. At the time of this writing I would have been a ham for just about two years. I spent a lot of time "paper chasing". I currently have the following awards CQ WPX, CQ WAZ, WAS 40M, DXCC 150, WAS CW, DXCC CW, WAC [4 Bands].

I began my journey with CW somewhere in August of 2015 and have never looked back. Of the 3,000 Qso's I have logged more than half are now in CW mode. CW is my main mode of operation.

I am currently a resident of the bluegrass state of Kentucky. I have a wife (Terri) and wonderful baby boy (Alex). At the age of 43, I am a late comer to both ham radio and fatherhood! I find both challenging and rewarding.

My normal operating equipment at the home shack is: k3 rig, 500w amp when needed, kent dual paddle key, Lionel j38 straight key, Cushcraft MA5B yagi @ 35ft, Ground mounted Hustler 8BTV Vertical antenna with 32 - 20ft. radials.

My next challenge will be the world of QRP, which I am just now dipping my toes in!

So look for "The Road to QRP" sometime next year!

Contents

What is CW?

According to Wikipedia:

A **continuous wave or continuous waveform (CW)** is an electromagnetic wave of constant amplitude and frequency; and in mathematical analysis, of infinite duration. Continuous wave is also the name given to an early method of radio transmission, in which a carrier wave is switched on and off. Information is carried in the varying duration of the on and off periods of the signal, for example by Morse code in early radio. In early wireless telegraphy radio transmission, CW waves were also known as "undamped waves", to distinguish this method from damped wave transmission.
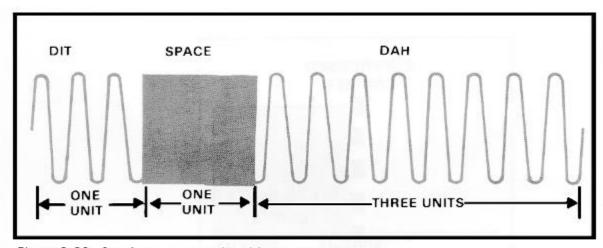

Figure 2-20. Continuous wave signal for the letter A.

[Image from www.globalsecurity.org]
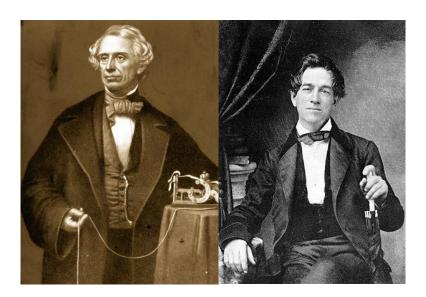
Brief History Morse/Vail/Marconi:

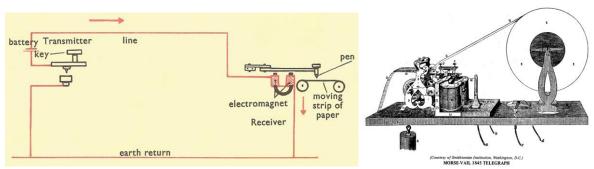**Samuel Morse and Alfred Vail:** *[also from Wikipedia]*

Beginning in 1836, the American artist Samuel F. B. Morse, the American physicist Joseph Henry, and Alfred Vail developed an electrical telegraph system. This system sent pulses of electric current along wires which controlled an electromagnet that was located at the receiving end of the telegraph system. A code was needed to transmit natural language using only these pulses, and the silence between them. Morse therefore developed the forerunner to modern International Morse code.

The Morse code was developed so that operators could translate the indentations marked on the paper tape into text messages. In his earliest code, Morse had planned to transmit only numerals, and to use a codebook to look up each word according to the number which had been sent. However, the code was soon expanded by Alfred Vail to include letters and special characters, so it could be used more generally. Vail estimated the frequency of use of letters in the English language by counting the movable type he found in the type-cases of a local newspaper in Morristown. The shorter marks were called "dots", and the longer ones "dashes", and the letters most commonly used were assigned the shorter sequences of dots and dashes.

In the original Morse telegraphs, the receiver's armature made a clicking noise as it moved in and out of position to mark the paper tape. The telegraph operators soon learned that they could translate the clicks directly into dots and dashes, and write these down by hand, thus making the paper tape unnecessary. When Morse code was adapted to radio communication, the dots and dashes were sent as short and long pulses. It was later found that people become more proficient at receiving Morse code when it is taught as a language that is heard, instead of one read from a page.

To reflect the sounds of Morse code receivers, the operators began to vocalize a dot as "dit", and a dash as "dah". Dots which are not the final element of a character became vocalized as "di". For example, the letter "c" was then vocalized as "dah-di-dah-dit".

Above Images - Top to Bottom/Left to Right: Samuel Morse/Alfred Vail/Morse Telegraph

Images courtesy of Wikipedia, The Smithsonian Institute Website and www.daviddarling.info

Guglielmo Marconi - "Father of Wireless Telegraphy": *[text and image from Wikipedia]*

Wireless telegraphy is the transmission of electric telegraphy signals without wires (wirelessly). It is now used as a historical term for early radio telegraphy systems which communicated with radio waves, although when the term originated in the late 19th century it was also used for a variety of other experimental techniques for communicating telegraphically without wires, such as photoelectric and induction telegraphy.
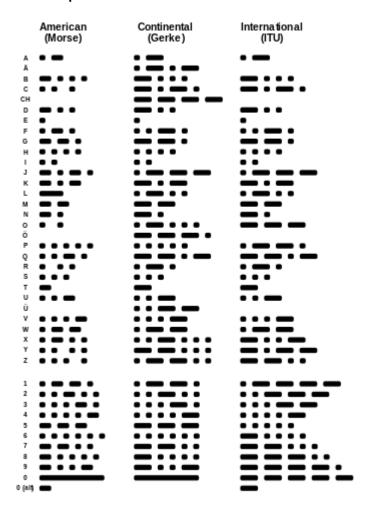

Wireless telegraphy came to mean Morse code transmitted by radio waves (electromagnetic waves), initially called "Hertzian waves", discovered by Heinrich Hertz in 1886. The first practical wireless telegraphy transmitters and receivers were developed by Guglielmo Marconi beginning in 1895. By 1910 communication by Hertzian waves was universally referred to as "radio",[3] and the term wireless telegraphy has been largely replaced by the more modern term "radiotelegraphy". The transmission of speech (radiotelephony) began to displace wireless telegraphy by the 1920s for many applications, making possible radio broadcasting. Wireless telegraphy continued to be used for private point-to-point business, governmental, and military communication, such as telegrams and diplomatic communications, and evolved into radioteletype networks. Continuous wave (CW) radiotelegraphy is regulated by the International Telecommunication Union (ITU) as emission type A1A.

The Code [Dits and Dahs]

International Morse Code: *[Image and text from Wikipedia]*

Each Morse code symbol represents either a text character (letter or numeral) or a prosign and is represented by a unique sequence of dots and dashes. The duration of a dash is three times the duration of a dot. Each dot or dash is followed by a short silence, equal to the dot duration. The letters of a word are separated by a space equal to three dots (one dash), and the words are separated by a space equal to seven dots. The dot duration is the basic unit of time measurement in code transmission. To increase the speed of the communication, the code was designed so that the length of each character in Morse varies approximately inversely to its frequency of occurrence in English. Thus the most common letter in English, the letter "E", has the shortest code, a single dot. American Morse was used early on in the States but soon was replaced by the ITU international version of the code we use today.

Visual Representation of Morse Code - Dots and Dashes

Prosigns/Procedural Signals and Abbreviations:

[portions of this section are from the SKCC group website]

CW operators use prosigns, procedural signals, and abbreviations -- more so than operators using phone and digital modes. And that's a good thing. Using these elements alone, you can conduct a basic exchange with a ham in another part of the world without having to know his or her language because precisely because you both are using internationally accepted abbreviations. There are literally hundreds of these in use today, but only a very small number are considered "common" or "must know." We review these fundamental ones in the following subsections.

What's a prosign? It's a special character made by running two characters together **without** any spacing between them. For example, the characters B (dah-di-di-dit) and T (dah) can be run together as BT (dah-di-di-di-dah) to form a new character. When written out in guides such as this one, prosigns are designated with an overscore such as $\overline{BT}$. From here forward we will designate prosigns with brackets [BT].

Common Prosigns

[AR] = Means end of a transmission. It is not necessarily an invitation to transmit. **AR** is used after calling a station with which contact has not already been established.
[AS] = Wait, stand by for a short time
[BT] = Separation, or break, between address and text; between text and signature in a radiogram. Also used between topics in a QSO or "Pause/Moment of thought".
[IMI] = "di-di-dah-dah-di-dit" Yes, this is a standard CW question mark. But it also can be used to ask for a repeat of difficult words as well as to indicate a query (?).
[SK] = The communications is concluded or clear. End of Work

Common Procedural Signals

DE = Used as "FROM" after the other station(s) and before your call
ES = & or and
K = Indicates you are turning the conversation over to another station or stations.
KN = Indicates you are turning the conversation over to a specific station and no one else is to call or answer. Use this only when you wish a specific station to answer.
R = All received and understood, the telegrapher's version of "roger."

Common Abbreviations used in CW QSOs

Long before today's teenagers were texting and using bizarre abbreviations (LOL and BFF), amateur radio operators were using their own set of abbreviations -- just to save time. The easiest rule for making just about any abbreviation is simply to remove the vowels from the word. That means a complete list of abbreviations would fill a dictionary. But, there are several that you'll run across in a normal CW QSO. I have listed some of the most common below.

ABT = About AGN = Again ANT = Antenna BK = Break, Break in, more commonly [Back to you] BTU = Back to you BURO = Bureau B4 = Before C = Yes, Correct CL = I am closing my station; Call CONDX = Conditions CPY = Copy CUAGN = See you Again CUL = See You Later CUD = Could DEG = Degrees	DR = Dear FB = Fine Business FER = For GG = Going GL = Good Luck GM/GA/GE = Good Morning / Good Afternoon/Good Evening HIHI = denotes laughter HPE = Hope HR = Here HW = How OM = Old Man OP = Operator NR = Number NW = Now PSE = Please	PWR = Power RST= signal report SIG = Signal SRI = Sorry TEMP = Temperature TNX = Thanks TU = Thank you UR = Your VY = Very WID = With WUD = Would WX = Weather YR(S) = Year(s)

Common Q-Signals Used in CW QSOs

CW operators also use the same set of Q-Signals as phone and digital-mode operators. With CW, however, some of these appear more frequently during a contact. If the Q signal stands alone, it typically represents a statement. If it's followed by a question mark, it's a query.

QRG(?) -- My exact frequency is _____. What is your exact frequency? **QRL(?)** -- Frequency is busy. **QRM(?)** -- Interference from another station **QRN(?)** -- Interference from static **QRO(?)** -- Increase power **QRP(?)** -- Decrease power/ Using low power 5W or less **QRQ(?)** -- Send faster **QRS(?)** -- Send slower **QRT(?)** -- Stop sending **QRU(?)** -- All done - nothing more	**QRV(?)** -- I am ready **QRX(?)** -- Please Wait a minute or more **QRZ(?)** -- Who is calling me or CQ call after previous QSO **QSB(?)** – Fading Signal **QSK(?)** -- I can hear you while I am sending **QSL(?)** -- I acknowledge receipt **QSX(?)** -- I am listening on ... **QSY(?)** -- Change frequency to ... **QTH(?)** -- My location is ...

Cut Numbers:

Another common abbreviation scheme is *cut numbers*. The Morse numbers are the longest symbols, so naturally we hams have figured a way to make them shorter (it was probably the telegraphers, but who knows?). Common ones are

       N = 9
       T = 0
       A = 1
       U = 2
and the rest are
       V = 3
       E = 5
       B = 7
       D = 8

"599" can be "5NN" which is much more common with dxing. There are others - 100W (100 Watts) could be ATT W or 1TT W

The RST Reporting System [portions of this section are from the SKCC group website]

If you have used phone or digital modes, you are probably already familiar with the RS signal-reporting system, as in "you're five by eight here in South Snowshoe, MA."

CW operators add another component to the signal report: the "T," for signal tone. For all practical purposes, with today's solid-state radios with well-regulated and fully filtered power supplies, a "9" tone report is most common. But some hams still run tube equipment, or radios with wiggy power supplies. Give them an honest report so they can troubleshoot their radios if needed.

R: Readability
1 -- Unreadable
2 -- Barely readable, occasional words distinguishable
3 -- Readable with considerable difficulty
4 -- Readable with practically no difficulty
5 -- Perfectly readable

S: Signal Strength
1 -- Faint signals, barely perceptible
2 -- Very weak signals
3 -- Weak signals
4 -- Fair signals
5 -- Fairly good signals
6 -- Good signals
7 -- Moderately strong signals
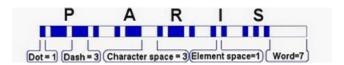8 -- Strong signals
9 -- Extremely strong signals

T: Tone

1 -- Sixty cycle A.C. or less, very rough and broad

2 -- Very rough A.C., very harsh and broad

3 -- Rough A.C. tone, rectified but not filtered

4 -- Rough note, some trace of filtering

5 -- Filtered rectified a.c. but strongly ripple-modulated

6 -- Filtered tone, definite trace of ripple modulation

7 -- Near pure tone, trace of ripple modulation

8 -- Near perfect tone, slight trace of modulation

9 -- Perfect tone, no trace of ripple or modulation of any kind

Words Per Minute (WPM) or Characters Per Minute:

So how exactly do we measure the speed of Code that is transmitted?? [*de SV8GXC website*]

The basic element of Morse code is the dot and all other elements can be defined in terms of multiples of the dot length. The other elements are dash (= dot length x 3), pause between elements (= dot length), pause between characters (= dot length x 3) and pause between words (= dot length x 7). An example is the word PARIS that has length of 50 dot lengths:

The base unit of measurement is the word **PARIS** (or CODEX).

Let's do a quick calculation of the number of dots in the word PARIS, our elementary timing unit:

Letter P: 11 dots + 3 of letter spacing.

Letter A: 5 dots + 3 of letter spacing.

Letter R: 7 dots + 3 of letter spacing.

Letter I: 3 dots + 3 of letter spacing.

Letter S: 5 dots.

Word spacing: 7 dots.

By summing all, we get a grand total of 50 dots, including the word space at the end.

One word per minute (WPM), therefore, corresponds to 50 dots per minute, 2 WPM to 100 and so on. It has been agreed, as a convention, that the speed in CPM is evaluated by multiplying the WPM speed by 5. One WPM corresponds, then, to 5 characters per minute.
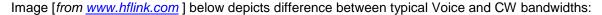
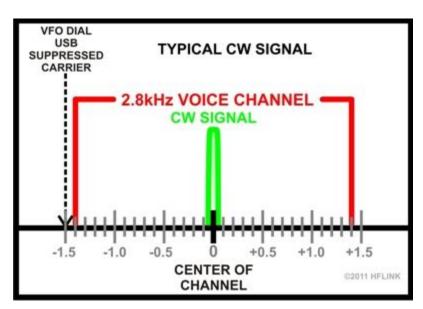**Determining Bandwidth of a CW Signal:** *[de K3WWP's CW Website]*

CW is the most efficient of all ham radio modes in several ways including making the most efficient use of the limited spectrum space available to ham radio. The next three paragraphs explain why that is so, and are quite technical in nature. If you hate math, you may want to skip them.

The bandwidth of a CW signal depends on two factors: 1 - The speed at which it is sent, and 2 - The shape of the keying waveform. Basically the bandwidth increases with increasing speed, and also increases the closer the keying waveform approaches a perfect square wave. A perfect square wave is an undesirable keying waveform for a few different reasons including being hard to obtain and causing key clicks. There should be a small rise and fall time to the waveform to produce the best sounding CW. Without delving into the complex math, I'll just say that a normal CW signal has a shape that boils down to a so called shape factor or 'K' of 4.8. The formula for CW bandwidth is BW = BPS X K where BW is bandwidth in Hz., BPS is baud rate per second, and K is the shape factor. Baud rate is determined by the number of dit sized elements (bauds) sent in a minute. The word 'PARIS' is used as a normal word when computing CW speed. PARIS contains 50 (dit sized) elements or bauds, so a speed of 1 word per minute is defined as 50 bauds per minute making a baud rate of 50/60 or approximately 0.83 BPS.

Taking all the info in the above paragraph into account, a CW signal at 1 WPM occupies 0.83 (BPS) X 4.8 (K) = 3.984 Hz. or rounding off, 4 Hz. A 10 WPM signal would occupy 10 X 4 or 40 Hz. A 25 WPM signal 100 Hz., and so on. So allowing for 100 Hz. spacing between signals, about 10-12 25 WPM CW signals can fit in the same space as one SSB signal.

Going a little bit further, assuming a SSB signal takes up 2000 Hz., and comparing a 100 watt 25 WPM CW signal with a 100 watt SSB signal, we have the following. The average power density for CW is 100W / 100 Hz. or 1 w/Hz. For SSB it's 100W / 2000 Hz. or .05 w/Hz. Follow closely now, it gets interesting although a little more technical. We could say that the gain in using CW over SSB is Gain(db) = 10*log(1/.05) which is about 13db. That means that a 5 watt CW signal packs an equivalent punch to a SSB signal at 100 watts.

Image [*from www.hflink.com*] below depicts difference between typical Voice and CW bandwidths:

Why Learn CW?

Why should I learn morse code? It is no longer required for any radio amateur licensing exam. So why learn it?

Here are some of my reasons why I think you should learn the CODE!

1. It is challenging and fun!

2. One the most efficient modes to communicate with, especially for QRP and Portable Operation: unlike other digital modes, CW can be decoded in your head.

Small bandwidth required makes CW very efficient and great for QRP/PORTABLE/DX!

Mode	*Bandwidth*
FM Voice	15.0 KHZ
AM Voice	4-6.6 KHZ
SSB Voice	1.8-3 KHZ
RTTY	.300-1
CW	.100-.500
BPSK	.031-.100

3. You can open up more DX entity opportunities operating in the CW sub band!

A note for General Class operators in the USA: Because of your frequency limitations you will have an uphill fight in DXing. Some DX stations operate higher in the bands, but many do not. Let's face it. Most DX stations really don't care about working as many W's as they can. They have already worked thousands of them.   Some DXpeditions are nice guys and try to work everybody, giving special attention to American General Class operators. This is especially true if there are American operators on the expedition team. Many others just don't care about the quirks of the American licensing system. It is really worth the effort to upgrade if you are serious about DXing.

Lot of CW DX lives in lower part of the 20M CW sub band 14.000 to 14.025. Time to get your EXTRA!

20 Meters
General class:
14.025 -14.150 MHz CW, RTTY/Data
14.225 -14.350 MHz: CW, Phone, Image
Advanced class:
14.025 -14.150 MHz CW, RTTY/Data
14.175 -14.350 MHz: CW, Phone, Image
Amateur Extra class:
14.000 - 14.150 MHz CW, RTTY/Data
14.150 -14.350 MHz: CW, Phone, Image

4. Lastly and probably most important: morse code communication is part technique and art form. Many who operate CW enjoy operating in this mode almost exclusively and derive a sense of satisfaction at the end of each QSO!

My Initial Motivation for Learning the Code:

I initially began investigating ways to learn morse code because I was actively pursuing my DXCC award at the time and always noticed many "spotted" DX entities that were in the CW sub band, many times these entities I never or rarely saw on SSB or digital modes. This frustrated me and pushed me to figure out how to "tap into" this mode and be able to chase those new DX entities.

As I began to learn CW, (I initially read Zen and Art of Radiotelegraphy by Carlos Consoli IK0YGJ) I began to appreciate the code as an art form and a mode that produced a level of enjoyment and reward every time I completed a QSO [Q code for "conversation"].

CW, to me, is like a mixture of learning a new language and learning how to play musical instrument. The timing and auditory structure of the code reminded me of learning Drums or Piano. The building of words sentences in transmit and "head Decoding" on copy was very much the same as when I learned the Spanish language, as a teenager, while I was living abroad.

How long did it take me?

Well…I realized I am a very slow learner…I spent about 6 months [I understand many have learned in just a couple months?] just learning the code off air before I even attempted to get on the air for a QSO for the first time. I practiced 4 or 5 times a week for about 30 to 45 minutes each practice session. The sessions involved first transmit practice and then copy. Most of the copy and transmit was initially random 5 character groups of random letters. I then moved to practicing sample Qso's, English word lists, and callsign lists I built from my log file [dumped in .txt files]. I also listened to slow Qso's on air and the ARRL Practice CW transmissions they transmit daily. My first QSO's were with CW buddies that were able to transmit and repeat at a speed I was comfortable with, at about 10 WPM. My first QSO's were a disaster, but after about 4 or 5 scheduled sessions on air with my CW buddies, I was starting to slowly get better! It was probably another 3 to 6 months before I started to feel comfortable with CW and, for the most part, not even think about how green I was at morse code. I looked back at the copy I took down for practice and it filled several ring bound notebooks. The level of effort expended to learn CW was not insignificant.

CW takes practice there is no way around that.

I still have my good days and bad days. It is like when I play guitar, some days I can play that piece great, some other days it feels like I'm hitting the wrong "note" too often. Don't let my timeline discourage you! I am a very slow learner, some folks I know learned in much less time than it took me to learn! BUT more importantly, there was an AHA! moment that marked the beginning of my high level of enjoyment for the practice sessions and I began looking at CW as an art form akin to picking up a guitar and practicing so one can learn to play their favorite piece someday!

Be persistent! Don't give up, it will come to you and you will forever be rewarded by operating this mode, this is one thing that I can guarantee you!

The Key to Keys and Keyers

Keys versus Keyers:

First, some Clarification:

A "Key" or "Paddles" is the thing you actually touch to send with.

A "Keyer" is a device used to generate dits and dahs electronically. This can be external to the radio and Key itself, or more commonly it is built inside most modern transceivers.

Ok, now that the two have been defined…

Types of Keys

I will categorize keys into 2 groups mechanical keys and paddle keys requiring an electronic keyer.

Mechanical Keys

Straight Keys:

Straight key - Basic single-lever key going back to the days of Morse and Vail themselves. A simple Lever that is spring-loaded, normally-open switch with a knob that moves up and down. Dits, dahs and spaces made manually. Shown below is a WWII era Lionel J-38 straight key. Some Straight keys also have a navy knob or skirted knob. Most ops cannot send good code faster than 20-25 wpm with a straight key. Up and down motion can be a source of carpal-tunnel problems, called "glass arm" and "telegrapher's arm" back-when. No electronics, will key anything.

Images sourced from: www.History.com and www.qsl.net

Images above left to right: Lionel J38 Straight key/Vail Correspondent/Navy Flame Proof Straight Key
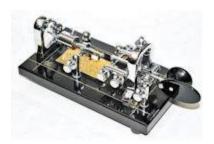
Sideswiper, "cootie key": [W1SFR torsion bar side swiper depicted below]

Simplest form of speed key. Key lever moves horizontally right and left, spring-loaded to return to center (open) position. Dits, dahs and spaces made manually. Side to side motion avoids carpal-tunnel problems and can permit higher speeds. No electronics, will key anything.

Semi-automatic key or "Bug":
Bug, semiautomatic key, "vibroplex" (actually a brand name) - Most common form of speed key before electronic keyers. Key lever moves horizontally right and left, spring-loaded to return to center (open) position. Dits made automatically by mechanical means, dahs and spaces made manually. Side to side motion avoids carpal-tunnel problems and, with automatic dits, permits higher speeds. For a right-handed op, thumb makes dits, first finger makes dahs. Left-hand op needs left-handed key. No electronics, will key anything. Speed adjustment is mechanical.

<center>*PADDLES used with electronic Keyers*</center>

Single-lever paddles:
Single key lever moves horizontally right and left, spring-loaded to return to center (open) position. Both sides cannot be closed at the same time. Dits, dahs and intra-letter spaces made automatically by electronic keyer. Electronics may be stand-alone or built into rig. Side to side motion avoids carpal-tunnel problems and, with automatic dits and dahs, permits higher speeds. For a right-handed op, contacts are usually wired so that thumb makes dits, first finger makes dahs, but some ops prefer reverse. Left-hand op can use same key. Interface relay or other system may be needed when external electronic keyer is used to key certain rigs. Speed adjustment is electronic. "Paddles" name comes from shape of key knobs.

Double-lever paddles, sometimes referred to as "iambic" paddles or Dual Paddles:
Shown Below..Two key levers move horizontally right and left, spring-loaded to return to (open) position. Both sides can be closed at the same time for "iambic" or "squeeze key" operation. Dits, dahs and intra-letter spaces made automatically by electronic keyer. Electronics may be stand-alone or built into rig. Side to side motion avoids carpal-tunnel problems and, with automatic dits and dahs, permits higher speeds. For a right-handed op, thumb usually makes dits, first finger makes dahs, but some ops prefer reverse. Left-hand op can use same key. Interface relay or other system may be needed when external electronic keyer is used to key certain rigs. Speed adjustment is electronic. "Paddles" name comes from shape of key knobs.

"Iambic" or "squeeze" operation is a feature of the keyer, not the key. With double-lever paddles, both sides can be closed simultaneously by squeezing, hence the name. An electronic keyer set up for iambic or squeeze operation will generate an alternating series of dits and dahs when both paddles are closed at the same time; the series starts with whichever side is closed first. This permits many letters with both dits and dahs to be sent with a single squeeze of the paddles.

Iambic Mode A and B:

(I will keep this topic simple.)

There are two common iambic modes: Mode A and Mode B. They differ only in what happens when the key levers both are released after both being closed.

In Mode A, the keyer finishes the dit or dah being sent and stops.

In Mode B, the keyer finishes the dit or dah being sent and then sends the opposite (dah or dit) once.

Mode A is far more popular. Let's move on…

Which Type of Key should I start with?

The common choices are a Straight Key or Dual Paddle.

Straight Key :

Pros: Easy to operate, Manually created dits and dahs

Cons: Less efficient to operate, higher speeds more difficult, user fatigue sets in quicker

Dual Paddle with Iambic Keyer:

Pros: More efficient than straight key, higher speed easier to achieve, electronic keyer creates perfect dits and dahs spacing

Cons: Depends on an electronic keyer, some believe as you strive for higher speeds "squeezing" becomes detrimental to accurate keying.

My Recommendation:

To be honest, you can start with either it is your preference. I chose to learn with a dual paddle because I knew this would be the style key I was going to use as my main key. Dual Paddles are more efficient when it comes to the number of hand movements.

Why?

Fewer movements of the hand are required in order to generate any given piece of Morse code text. Fewer hand movements result in reduced strain on the muscles of the hand and hence easier, more comfortable operation of the keying system.

How exactly is it easier?

As I mentioned in the previous section on types of keys, using a dual paddle with an iambic keyer you are able to send a continuous string of dits or dahs with each paddle. Both paddles are able to be triggered simultaneously which also for you to "insert" dits or dahs to a string of dahs or dits.

For Example [*assume right paddle set for dahs, left paddle for dits*]:

To generate the letter Q with an Iambic keyer and dual paddle you would press the right paddle for a string of 2 dahs and after the second dah press the left paddle to "insert" one dit. You would then immediately release the left paddle and allow another dah to occur from the still depressed right paddle or dah paddle

Note: Movement defined as pressing a paddle

LETTER	Straight Key Movements Required	Dual paddle Iambic keyer Movements Required
Q	4	2
5	5	1
C	4	2

Broken down further for Q [dual paddle RP= Right Paddle LP=Left Paddle]

RP Press [Dah Dah] LP Press [Dit], LP Release, [Dah] – *this Dah is from RP still being Pressed*, RP Release.

Iambic Keyer/Dual Paddle efficiency: [text below from: Marshall G. Emm, N1FN Iambic keying Debunking the myth]

Chuck Adams, K7QO, has done an exhaustive analysis of the keystrokes (hand motions) required to generate code using each of the common devices. You can read his complete tutorial on sending code at http://www.qsl.net/k7qo/sending.html . Chuck counted the keystrokes needed to generate the 26 letters of the alphabet and the ten numbers from zero through nine. In the table of his results below please note that Non-iambic Electronic Keyer includes an iambic keyer used with a single lever paddle or otherwise without using the iambic features, and Iambic Electronic Keyer is used with dual lever paddles.

Device	Keystrokes
Straight Key	132
Semi – automatic bug	87
Non – Iambic Electronic Keyer	73
Iambic Electronic Keyer	65

There is a HUGE improvement in going from a straight key to a bug-- and in addition to the reduction of keystrokes the change from vertical to horizontal keying motion went a long way toward relieving "glass fist" as carpal tunnel syndrome was known in the trade. The keystroke count has been reduced by an amazing **34.1%. And from Iambic Keyer to Straight key a reduction of 49%.**

Final Thoughts on SK vs DP:

I found it with a little practice I was able to operate a straight key after learning CW with a dual paddle. Learning the squeezing technique required for iambic keying would have to be learned if I would have started with a straight key.

I use a straight key for SKCC events or if someone else is calling with a straight Key. My current speed with a straight key is around 18wpm max. Dual Paddle I can transmit around 23 WPM. But after only one long rag chew or several short qso's on straight key I have to take a small break due to the amount of effort required.

Some people struggle with the specific motor skill of "Squeezing" or interlacing dits and dahs with a dual paddle. This tends to occur with the generation who learned with a straight key [but not always] and later try to learn using a dual paddle with iambic keying. Being a first timer learning Code I had no previous "burnt in" motor skill memory to get in the way. But it is a different and perhaps a little more complex "timing" than the straight key hand movement up and down…I think the little extra effort will pay off in efficiency during keying and the reduction in fatigue. At the end of the day it boils down to practice and more practice, it will come to those who practice! Did I mention you need to practice?

Also, there is also the thought that it is beneficial to learn with a keyer that forms perfectly timed dits and dahs when first learning Morse Code.

Just like the split KOCH vs FARNSWORTH, so is the camp divided on Straight key vs Dual Paddle!

Again, pick what you are comfortable with and go with it! Just because to start with straight key doesn't mean you will not be able to pick up using a dual paddle and Iambic Keyer down the road.

Tools, Websites, Gizmos and also Gimmicks to help you learn CW:

I want to touch on this topic a bit since CW does require effort. There are many products out there that claim they will help you learn CW in unrealistic timeframes or at unrealistic keying speeds, if it sounds too good to be true then stay away. I've seen banners on the www.qrz.com site for some vendor claiming to take you from "no code to know code" in 12 days…This is not likely or realistic.

Let me mention a few items that I have used and have worked for me.

I would start with some sort of computer software that can randomly generate characters, callsign, words, etc. The software must also have a way for you adjust the speed and spacing between words so you are able to slow down the actual transmitted speed for copying the code on paper. Hopefully the software gives you a choice of Farnsworth or Koch [or both] style training. Once you have learned the code I would then try finding a CW Buddy with whom you can practice with on air with scheduled QSO's.

G4FON is a free software app that uses the KOCH method:
http://www.g4fon.net/

RufzXP – is a PC based software to help you with copy of callsigns, it will adjust the speed based on how well you are copying callsigns. If you miss, it slows down and speeds up when you begin to correctly type in the transmitted callsigns.
http://www.rufzxp.net/

Morse Runner – is a great PC app that will help you simulate a contest style exchange and does a great job at simulating the "on air" environment with features like: QRM,QSB,QRN, pileups, lids, etc.
http://www.dxatlas.com/morserunner/ – *W4ALF recommends*

Android App – Morse Trainer by WOLPHI – *W4ALF recommends*
Search the Google app store for "Morse Trainer" make sure it is the one by WOLPHI
http://www.wolphi.com/ham-radio-apps/morse-trainer/

The CW Machine and CW Trainer are excellent learning tools (warning : this is not a cheap solution)
http://www.i2rtf.com/html/cw_machine.html - this can help you greatly with timing and spacing.

The ARRL has various on air transmissions to help you learn Morse Code:
        Daily Morse Code Practice
        Bulletins
        Qualifying Runs
http://www.arrl.org/w1aw-operating-schedule

CW online Training:

CWops Online Training ACADEMY, CWops offers free Classes – *W4ALF recommends*
http://www.cwops.org/cwacademy2.html
The classes are offered several times a year and book quickly. They are structured in three levels:
Level I for beginners, level 2 for those circa 10-15wpm and level 3 is for those wanting to achieve code at 20 wpm +

CW ELMERS:

One of the best ways you can practice on air is with a real person. There are several CW associations that have programs that have volunteers that will help you on air. "CW buddies" or "CW elmers":

SKCC – Straight Key Century Club – *W4ALF recommends portions of this ebook are derived from their content!*
http://www.skccgroup.com/member_services/beginners_corner/

NAQCC – North American QRP CW Club also has CW buddies!
http://www.naqcc.info/

Audio CD's are a good way to practice while on the go or driving to work!

Gordon West WB6NOA has a set of audio CDs that are excellent! I use them in the car all the time.
http://www.w5yi.org/catalog_details.php?pid=30&sort=4

ARRL has a morse training CD as well, good first CD, you will quickly outgrow 5WPM:
http://www.arrl.org/shop/Your-Introduction-to-Morse-Code-audio-CDs

CW LEARNING ROADMAP

Before I get into "how I did it". I want to clarify what should already be obvious. This is the road I followed to learn CW, everyone will have their path, preferences, favorite learning styles and methods. Use my roadmap as a guide or way to see what perhaps may or may not work for you. Ask other CW elmers, google or refer to some of my learning reference links and design your own *Path* to learn CW. Who knows maybe we will QSO someday on air and you can tell me how you did it!

The below bullets are the general progress milestones one tends to follow:

- Learn the characters, letters and numbers
- Learn the prosigns, procedurals, punctuation
- Practice Words, Callsigns, sample QSO's and CW QSO lingo
- Getting on the air making QSO's

Once your transmit is solid to at least 10/15 wpm, your next step would be head copy versus copy by pencil and paper and increasing your current speed, both sending and copying.

NOTE: It is a generally accepted rule to not send or transmit faster than you can copy. This keeps you from being forced to copy or transmit beyond a speed you are comfortable with and reduce errors and increase intelligibility. Most Ops will adjust to the speed you are transmitting at.

Learning methods KOCH Or FARNSWORTH, maybe both: KOCHWORTH?

KOCH METHOD:

The "Koch Method" consist of learning each individual Letter at a fairly high speed, then adding 1 or 2 more letters, then alternating the sending and mixing the letters up. When you have achieved a copying success rate of say 90% or so then add 1 or 2 more letters, or perhaps a number or two. And keep doing that, until you have the Alphabet the numbers and the most often used punctuation marks mastered. Once you get this far you can then switch to listen to words to get used to the sound of a word rather than the sound of letters, which I believe is the only way to high Speed copying, coupled with reading without the assistance of a pencil and paper (in your head like regular speech).

FARNSWORTH METHOD:

Farnsworth "timing" is defined as sending the characters at a faster speed than the words. For example, one would send the characters at 20 WPM but adding enough time between them to slow down the overall rate of transmission to 10 WPM. At low speeds the person just learning morse code starts at very low speeds, where counting dots and dashes is easier than recognizing the rhythm of the characters. The idea behind the Farnsworth method is to eliminate the counting phase by sending the characters at a speed at which rhythm recognition is easy and counting is not. This forces the individual to learn the rhythms or "sound" of characters and words versus counting dots and dashes. Initially the rate of transmission is slowed (by the addition of time between characters) to allow the student to gradually build the skill of recognizing and writing the received text. The process by which the student processes the characters is never changed; He/she just gets better (faster) at doing so by decreasing time between characters and words.

The ARRL has now converted all of its Morse materials to Farnsworth timing. ARRL is using a standard of 18 WPM as the character rate. At 18WPM and faster speeds, ARRL reverts to standard timing.

Which one should you use?

It doesn't really matter. Try both initially and see which one works for you.

I was not successful at a true or "Koch" style of learning but many hams I know have used this method over the Farnsworth method. The risk generally associated with the Farnsworth method is that it may make increasing your speed a more difficult task later on versus the KOCH method. My issue with the KOCH method was I just couldn't copy letter groups at say 15wpm/20wpm and have time to process what I just heard.

I chose Farnsworth at 15wpm/18WPM with spacing making effective speed down to 10wpm. I learned the characters by groups adding a new character every time I achieved 90% accuracy in copy. The spacing was not reduced until after I had learned all the characters and prosigns. So some elements were "Koch-ish" in my learning.

I did not choose Farnsworth over Koch because I knew much about either method but purely as a result of not being able to copy properly code groups or "words" with the Koch method at such initial high speeds.

Now that I am trying to increase my copying past 15wpm, it is possible that my choice could make my path to increasing my copy speed a bit longer.

Again, choose what works for you. I heard and read the pros/cons of both from many sources and half use KOCH the other half Farnsworth.

It's Time To Start The Learning Process

Learning the Letters and Numbers:

You will first need to learn the characters required to hold communications via CW:

I learned the letters by groups:

These Letters are grouped together in increasing length. The training will be focused on receiving letters and numbers, and copying them down on paper.

1 element character group	E, T
2 element character group	A,N,I,M
3 element character group	S,O,R,K,D,U,G,W
4 element character group	C,Q,J,Y,F,L,B,V,P,X,H,Z
Numbers 5 element group	1,2,3,4,5,6,7,8,9,0

I learned using a slightly modified grouping of characters in the following order left to right: ETANIM / DSOURC / KPBGWL / QHFY / ZVXJ / 12345 / 67890.

Numbers all have 5 elements required to key each, these were learned at the end.

This is the grouping suggested by Carlos Consoli - IK0YGJ in "Zen and Art of Radiotelegraphy".

Then you will also be transmitting the same groups of letters back using your key and some sort of method for decoding what you are transmitting. I will discuss this further in the next section.

Focus on one group of letters a week and you can further break down the group by learning a couple letters at a time.

It actually took me more than a week for each group of characters.

Go at your own pace, your goal is to learn CW not win a race with someone else to your goal!

Digraphs and Trigraphs:
In the world of phonetics Digraphs [two letter combinations] and Trigraphs [three letter combinations] are defined as letter combinations that are commonly found in words so the direct application for our purposes directly relate to being able to practice letter combinations that are more likely to occur in our QSO's. I would not spend tons of time on these but I would practice these as a transition between learning single letters or random letter groups and full blown English words. Below are a couple of examples and in Appendix B is a list of Digraphs and Trigraphs for you to practice.

Digraph Example: ED for BED RED FED MEDICAL

Trigraph Example: OLD for BOLD TOLD FOLD COLD MOLD HOLD GOLDEN

Learning some of that "other stuff"

Once you have learned the above you will have to learn the punctuation and prosigns. There are more but these are the essential ones. Use the same method of adding a couple at a time to learn.

Punctuation	**Period [.]**	.	.—.—.—
Punctuation	**Comma [,]**	,	——..——
Punctuation	**Question Mark [?]**	?	..——..
Punctuation	**SlashFraction Bar [/]**	/	—..—.
Prosigns	Wait, stand by for a short time **[=]**	BT	—...—
Prosigns	**End of Work - Communication has concluded**	SK	...—.—
Prosigns	**End of Transmission**	AR	.—.—.
Procedural	**Invitation to Transmit**	K	—.—
Procedural	**Starting Signal**	KN	—.—.—

CW Learning Roadmap Summary with Timeline

I want to conclude this section by laying out a possible timeline of learning. **NOTE**: the length of time associated will vary greatly based on each person. Some will take less time others much longer [For example me]. We will assume that at this point you probably have already decided on the type of key, Koch or Farnsworth learning method and have acquired any software, keyers and practice CD's.
[This Timeline is suggested by Carlos Consoli- IK0GJ in "The Zen and Art of Radiotelegraphy]

Phase I – Learning the Code

Learning Letters and Numbers:
Week 1:   ETANIM
Week 2:   DSOURC
Week 3:   KPBGWL
Week 4:   QHFY
Week 5:   ZVXJ
Week 6:   12345
Week 7:   67890

Learn Additional characters and procedurals
Week 8:   **. , ? / = AR SK**

Groups are organized by increasing character duration. First part of week can be used to learn the new characters, transmit and receive. The latter part of the week they can be mixed with the already learned characters from the previous weeks. Each week you goal will be to learn new characters learning to copy using pen and paper and also transmit with the proper cadence.

Phase II – Qso's and consolidating speed up to 20WPM
2 months

Depending on the WPM speed you have been able to learn at, this phase aims to increase that speed up to 20WPM for both reception and transmission. Try to set a goal of proper copy and transmit of 90% before increasing WPM by 1or 2 WPM. Target about 2WPM each week.

It is also in this phase where you will practice standard QSO's and associated abbreviations Q codes and prosigns. You can also practice Digraphs and Trigraphs as a transition from learning the single characters and full blown words and QSO's *[See Appendix B for practice files and content].*

Near the beginning of this phase you should have your first official on air QSO under your belt. Hopefully, you have been able to source a CW buddy [NAQCC/SKCC] and have had the chance to practice QSO's on air as well.

Towards the end of this phase, on air QSO's should now happen frequently to help gain confidence and get you on air. I followed the axiom of 1 cw on air qso a day for 30 consecutive days. This really helped me with confidence on air.

Phase III – Head copy
Variable timeline - Open

This phase focuses on the transition from pen and paper to "head copy".

Timing of the Code and why it is important:

When I first started researching and reading about how to learn morse code, most of what I read focused almost solely on copy, or receive. Why? Before the Morse Code requirement was dropped from USA licensure requirements that is all that was necessary. I did not find much on how to "check" your timing or proper spacing of practiced CW or effective/Accurate ways of doing so.

FOR EXAMPLE:

W4ALF DE RT0L HELLO KEN, THANKS FOR UR CALL, I ASSUME UR KENWOOD IS NOW FIXED? BK

NOT THE SAME AS:

W4AL F D ERT0L HELL OKEN, T HANKS FORUR C ALL, I ASS U ME UR KEN WOOD IS NO WFIX ED? BK

Never "ASSUME" your timing is correct when learning and practicing CW, or you could make an

<div align="center">

ASS out of **U** and **ME**

</div>

How do you check your transmitted CW code for proper Timing/Spacing?

My first year at Dayton Hamvention [2014], I ran across the Begali CW key booth. A German looking/sounding gentlemen was demonstrating to someone the "art of CW". He was using a Begali key plugged into a little box that then plugged into a Laptop via USB. As he keyed, his code was displayed on the screen of the laptop using software called CW Trainer.

As I watched the potential customer key away during this "Demo", I noticed sometimes his words seemed spaced correctly, but some words were NOT.

This was all before my journey into learning CW. But my curiosity was piqued by this DEMO.

It wasn't until later that year when I began learning CW that I realized how important timing was to proper CW transmission.

The gentlemen behind the Begali booth was Ulrich H. Steinberg, N2DE, the designer of the "CW Machine". This electronic keyer and associated software "CW Trainer" is an excellent way to learn the code and also visually verify and accurately practice your CW timing.

I purchased this keyer and associated Software. As pricey as the keyer was, I believe it was essential in my quick learning of proper Timing and Spacing of my CW code.

Site for CW Machine – electronic Keyer and associated CW Trainer software:
http://www.i2rtf.com/html/cw_machine.html

Other Options for checking Timing/Spacing of your Transmitted Code During Practice

Not every can afford or is willing to pay upwards of $300 dollars for the CW Machine electronic keyer.

Luckily there are some other options for checking your code spacing and timing.
I want to emphasize again the importance of learning proper timing/spacing of your code both inter element, between characters and between words.

Without proper timing and spacing you code will sound sloppy and be difficult to copy.

MFJ sells a small pocket code reader that can decode the audio from your transceiver. Either with its internal mic or with your transceiver audio output plugged directly into it. IT will also let you replay the last 140 characters of code input into the device.

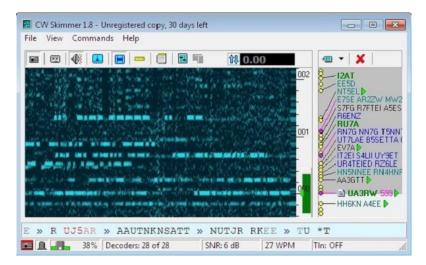Here is the link to the MFJ 461:

http://www.mfjenterprises.com/Product.php?productid=mfj-461

Another option is to use the CW skimmer software. If you are able to input the audio from your transceiver into your computer where the software resides, the cw skimmer software should be able to decode your CW.

Link to CW Skimmer:
http://www.dxatlas.com/cwskimmer/

If you are lucky enough to own a K3, then you already have a built in CW decoder and will require nothing more to check your spacing and timing.

You might also want to check with your local amateur radio club. You may be able to source a CW elmer who can assist with verifying your timing of on air code or your recorded code.

Lastly, some folks will record themselves and play back their transmitted code to check timing. This works much better once you learn the code and have proper timing somewhat "burned" into your memory. For the very new student, I don't recommend this method because in the beginning you won't really know whether your timing/spacing is off. Luckily, there will be a moment in time where you will begin to recognize all on your own that you have made a mistake in transmitting.

There are other methods or gadgets to accomplish this. Above are the ones I am aware or have used.

CW Procedure and your First QSO

[The following section has portions that are partly or entirely from:
http://www.skccgroup.com/member_services/beginners_corner/]

Checking to see if the frequency is clear:

In this example, W4ALF will check to see if the frequency is clear - this is a good, courteous practice, try to make this a habit in all your radio fun.

The first step is to listen for several seconds or even a few minutes. A frequency may sound quiet when you first tune to it. But a QSO may be underway, but propagation allows you to hear only one of the two stations. Listening for a decent interval gives the station you **can** hear enough time to make itself known, saving you the need to ask if the frequency is clear.

If you hear nothing, it's still useful to check with a query on the air, using QRL?. A good basic rule is to keep your inquiry as short as possible to minimize disruption to an existing QSO.

NOTE: Prosigns will be indicated with a bracket. e.g. **[BT]**

Example 1: **QRL?**
Example 2: **QRL? DE W4ALF K**

Please note: If the frequency is busy, you may hear a C (correct), R or QRL in response. Do not respond. Simply move on and select another frequency.

Calling CQ:

If there is no response to your QRL? you may proceed to calling CQ.

CQ CQ CQ DE W4ALF W4ALF K

Please note: A 3x3 or 3x2 format is recommended. In other words, send CQ three times, followed by the DE (from/this is), followed by your call sign two/three times. That's enough -- take a break and see if anyone hears you and wants to call you. The K at the end means that you are done transmitting and invites anyone to respond.

Also you may want to open up your filter bandwidth while calling cq so that you don't miss any response outside a narrow bandwidth filter you might have in place. Once in QSO you can then narrow your filter down.

Receiving the Response:

In this example, AI4BJ will respond to your CQ.

W4ALF DE AI4BJ AI4BJ [AR]   *Note: [Also common could be the reply: **AI4BJ AI4BJ**]*

Please Note: Although the use of AR at the end of the call is strictly correct procedure, many operators will end the call with a simple K. The argument for the use of AR is twofold:

-- K should be used only after communication has been established and that, at this point in a QSO, full two-way communications has not yet been established.
-- Many calls end with a K and depending on conditions it can be unclear if the sender has finished. [AR] removes any ambiguity.

In actual practice, be prepared for either K or [AR].

The QSO is now in progress:

W4ALF begins the QSO by responding as follows:

AI4BJ DE W4ALF GM DR OM ES TNX FER CALL [BT] UR RST 599 5NN HR QTH KY KY [BT] NAME CHRIS CHRIS ES SKCC 14105 14105 SO HW CPY? AI4BJ DE W4ALF [KN]

Some notes:

-- Note the use of cut numbers: 5NN = 599

-- Note the use of the [BT] prosign to serve as a break between sections or sentences of the QSO. CW operators seldom use a period in their QSOs.

-- Many operators will use longer pauses between thoughts and seldom use the [BT]. Some operators will use more [BT]'s. Each operator will have a different style.

-- The prosign [KN] denotes that only AI4BJ should answer. This is an alternate procedure, so a simple K can be expected.

-- The prosign [AR] can also be included after the message content but before the call signs based on suggested ARRL procedure. However, the use of [AR] is optional and not necessary in day to day communications. Note: It is not uncommon to hear someone end their comeback with [AR] K

Continuing the QSO:
AI4BJ now transmits and returns the basic information to W4ALF:

W4ALF DE AI4BJ TNX FER RPT [BT] SLD CPY UR 589 589 [BT] OP HR MARK IN BURLINGTON, KY [BT] HW NW? W4ALF DE AI4BJ [KN]

Additional Information:

Both stations may continue to play catch by conversing back and forth as long as desired. For example, here is an additional exchange containing yet more typical information:

FB MARK [BT] WX HR WARM ES DRY TEMP 75F [BT] RIG K3 K3 ES ANT YAGI UP 35 FT [BT] HW NW? BK

BK: is sometimes used to quickly turn over the conversation to the operator without sending the full callsigns at the end of the message.

AI4BJ can now send the same type of info. This is the point that the QSO becomes fairly free form with suggested topics such as age, other hobbies, discussion of further topics in ham radio etc.

OK CHRIS K3 DOING VFB [BT] RIG HR IS KX3 ES PWR 1TT W HW? BTU DE AI4BJ K

-- Note: the free form response has cut numbers 1TT W for 100 watts and a short BTU or "back to you" with only "de AI4BJ K" to end the message. Proper? No. But this is very common.

BUT PLEASE NOTE: For US operators, the FCC requires that you send your call at the end of a QSO and once every 10 minutes during a QSO. It is not necessary to exchange call signs every time you hand the QSO over to the other station or as you pick up the other station's hand-off. When you take advantage of the 10-minute rule, your conversations can flow more smoothly.

Completing the QSO:

And soon it is time to sign off.

AI4BJ DE W4ALF TNX FER FB QSO MARK [BT] HPE CUAGN [BT] VY 73 TO U ES URS AI4BJ DE W4ALF [AR] [SK]

AI4BJ would now reply.

W4ALF DE AI4BJ OK CHRIS 73 ES CUL AI4BJ DE W4ALF [AR] [SK] dit dit

W4ALF would send back a final.

 dit dit

- This concludes the whole QSO -

Over time, it has become somewhat traditional for one station to send shave-and-a-hair-cut (dit di-di-dit dit) to which the other station can respond with two bits (**dit dit**). Often, both stations will simply send a dit dit as a final goodbye.

Goodbyes are best done quickly. Like everything else in Morse operation, brevity is best. Using proper procedure will make you sound like a seasoned pro to those who listen in.

Below is the full QSO [I also have practice QSO's and text in APPENDIX B]

CQ CQ CQ DE W4ALF W4ALF K

W4ALF DE AI4BJ AI4BJ AR

AI4BJ DE W4ALF GM DR OM ES TNX FER CALL [BT] UR RST 599 5NN HR QTH KY KY [BT] NAME CHRIS CHRIS ES SKCC 14105 14105 SO HW CPY? AI4BJ DE W4ALF KN

W4ALF DE AI4BJ TNX FER RPT [BT] SLD CPY UR 589 589 [BT] OP HR MARK IN BURLINGTON, KY [BT] HW NW? W4ALF DE AI4BJ KN

FB MARK [BT] WX HR WARM ES DRY TEMP 75F [BT] RIG K3 K3 ES ANT YAGI UP 35 FT [BT] HW NW? BK

OK CHRIS K3 DOING VFB [BT] RIG HR IS KX3 ES PWR 1TT W HW? BTU DE AI4BJ K

AI4BJ DE W4ALF TNX FER FB QSO MARK [BT] HP CUAGN [BT] VY 73 TO U ES URS AI4BJ DE W4ALF AR SK

W4ALF DE AI4BJ OK CHRIS 73 ES CUL W4ALF DE AI4BJ AR SK dit dit

Dit dit

Now a sample of a Contest QSO:

You will find contest QSO's and DX QSO's will normally be very brief and transmit as little as each callsign and a standard 5NN RST Report.

NOTE: How do you know what the exchange is for a particular contest? You can refer to the following website by WA7BNM tracks all major contests and what the exchanges are. You find out rules, website contest links, and filter by type of contests. I bring this up on my computer every time I jump on the radio.

Contest Calendar website: http://www.hornucopia.com/contestcal/

CQ CQ CQ DE KL7ICE TEST UP

--Note this caller used "TEST" which indicates he/she is participating in a contest and "UP" which means they are working split and listening at least 1khz higher than their transmit frequency. So, this means you need set your VFO B and transceiver to "split" to allow the caller to hear your reply.

I set my radio for split operation and I now reply with my callsign

W4ALF

Because there is a pileup they only catch part of my callsign and request my call again using what info they have heard.

W4? AGN

I reply again and they now copy my whole callsign

W4ALF W4ALF

Note: in this situation I send my call at least a couple of times to give them more of a chance to copy my call

They now reply with a signal report and a sequential number used for the contest

W4ALF 599 NR 234

I now reply with my RST and NR

599 009 TU

They now continue on

W4ALF TU QRZ?

Note: TU is Thank you and the QRZ? Indicates the caller is now ready to receive a new QSO.

Super Summary Bullet Points

- Learn at your pace, it is not a race. Learning CW is a personal goal. 2 months or 2 years

- Learn the code by recognizing sound patterns or "rhythms" of the characters. DO NOT count dits and dahs.

- Learning morse code takes practice and patience. If possible, practice every day. Learning the code is akin to learning to play an instrument, you will sometimes take one step backwards before you take 2 steps forward. Don't give up you will be rewarded many times over when you start getting on air making QSO's!

- Sending will be easier than copying. Don't get frustrated, keep practicing your copy!

- Learn a couple characters at a time, next, move to learning character patterns [i.e. de, 73 SK, CQ, 599, FB], move briefly to Digraphs and Trigraphs and then to full words and practice QSO's.

- Proper timing/spacing while sending is the key to anyone understanding your message, focus on on accurate sending over speed! Axiom: Accuracy over Speed – Always.

- When learning to copy, if you miss something just continue writing down the copied code and come back to the missed characters or words later. You would be surprised how much you can copy and then "fill in the holes" later!

- Learn to copy by writing down the code but once you comfortable with copy, try to learn to "head copy" by just putting down the pencil and paper.

- Use technology that is available now! Android apps, PC training software but also include practice that is on air (ARRL practice transmissions).

- Find a CW elmer or Code Buddy – Try NAQCC, SKCC, FISTS, CWops. On air practice with a real person will bridge you from off air learning to on air experience. The elmer can also help you with CW QSO etiquette and general advice with QSO's, Key adjustments, good events to participate in to gain good CW on air time and practice. [SKCC sprintathon monthly sprints are great contests to make slow code QSO's.]

This concludes the main text of the ebooklet. After the main text you will find the Appendices containing many links to useful sites for CW related topics that are packed with information. I hope you found this information helpful and a resource to build your own "Road to CW"!

73 es GL de W4ALF AR SK dit dit

[END MAIN TEXT]

APPENDIX A:

Website Links

ARRL links for on air CW Practice:

Daily Morse Code Practice
Bulletins
Qualifying Runs
http://www.arrl.org/w1aw-operating-schedule

ARRL Practice Audio Files:
http://www.arrl.org/code-practice-files

Links to Groups with CW buddy programs:

SKCC [Straight Key Century Club] Group "Morse Elmers" *– W4ALF recommends*
http://www.skccgroup.com/member_services/morse_elmers/

NAQCC [North American QRP CW Club] CW Buddies: *– W4ALF recommends*
http://www.naqcc.info/cw_buddies.html

CW online Training:

CWops Online Training ACADEMY [Free Instructor led Web based classes over 8 weeks – Levels 1,2,3]
– W4ALF recommends
http://www.cwops.org/cwacademy2.html

CW Software:

Android App – Morse Trainer by WOLPHI *– W4ALF recommends*
Search the Google app store for "Morse Trainer" make sure it is the one by WOLPHI. This app contains many modes such as callsign mode, qso text mode, English words, random 5 character groups, your own text files can also be loaded! This allows you to practice CW copy on your phone or tablet, on the go!

http://www.wolphi.com/ham-radio-apps/morse-trainer/

CW Skimmer – This PC based software can decode a CW signal.
http://www.dxatlas.com/cwskimmer/

G4FON – PC based software training using the KOCH method and that can be speed adjusted.
http://www.g4fon.net/

DM780 – Ham Radio Deluxe's digital mode portion of the software can decode CW.
http://ham-radio-deluxe.com/

RufzXP – This PC based CW training software will adjust it's transmitting speed of callsigns based on your typed in responses.
http://www.rufzxp.net/

Morse Runner – is a PC based software that simulates working in a contest with features such as: QRM, QRN, pile ups. *– W4ALF recommends*
http://www.dxatlas.com/morserunner/

ebook2cw – This free PC based utility app will allow you to convert text to morse code by creating .mp3 files
https://fkurz.net/ham/ebook2cw.html

Audio CD's:
Gordon West WB6NOA has a set of audio CDs that are excellent! I use them in the car all the time.
http://www.w5yi.org/catalog_details.php?pid=30&sort=4

ARRL has a morse training CD as well, good first CD, you will quickly outgrow 5WPM:
http://www.arrl.org/shop/Your-Introduction-to-Morse-Code-audio-CDs

Keys:
MFJ
http://www.mfjenterprises.com/Categories.php?sub=0&ref=31

BENCHER
http://www.mfjenterprises.com/Product.php?productid=BY-I

KENT *– W4ALF recommends*
http://www.kent-engineers.com/

VIBROPLEX
http://www.vibroplex.com/

BEGALI
http://www.i2rtf.com/

AMERICAN MORSE
http://www.americanmorse.com/

N3ZN
http://www.n3znkeys.com/

About Keys and Keyers:
By N2EY [simple explanation]
http://www.hamuniverse.com/n2eycodekeys.html

Practice Keyers and Electronic Memory Keyers:

CW MACHINE – Keyer and CW Trainer software *– W4ALF recommends*
http://www.i2rtf.com/html/cw_machine.html

MFJ 461 Morse Reader and Tutor
http://www.mfjenterprises.com/Product.php?productid=MFJ-461

K1EL – winkeyer USB – electronic Memory keyer
http://k1el.tripod.com/wkusb_smt.html

Website with Contest Calendar:
How do you know what the exchange is for a particular contest? You can refer to the following website by WA7BNM which tracks all major contests and what the exchanges are. You can find out when the contest is running, rules, website contest links and you can filter by type of contests. I bring this up on my computer every time I jump on the radio.

Contest Calendar website: http://www.hornucopia.com/contestcal/ *– W4ALF recommends*

To Read about CW and the Learning Process:

Wikipedia has a good overview of CW in general
https://en.wikipedia.org/wiki/Morse_code

All about morse code and how to learn
http://www.9h1mrl.org/ukrae/arc_cd/extra/morse/index.htm

A MUST READ – W4ALF recommends
The Zen and Art of Radio Telegraphy by Carlos Consoli - IK0YGJ
http://www.qsl.net/ik0ygj/enu/ZART_r20101008m.pdf

A MUST READ – W4ALF recommends
Conrad Pfeifer WB4RFQ "How I learned Morse Code"
http://fine.business/ham-radio/2015/12/20/learning-morse-code

The Art and Skill of Radiotelegraphy by William Pierpont N0HFF
http://www.n9bor.us/index.php/morse-code/the-art-skill-of-radio-telegraphy

CW QSO examples and procedures:
SKCC – Straight Key Century Club
http://www.skccgroup.com/member_services/beginners_corner/

NAQCC – North American QRP CW Club
http://www.naqcc.info/

FISTS qso tips:
http://www.fistsna.org/pdfdocs/A%20BASIC%20CW%20OPERATING%20MANUAL.pdf

APPENDIX B:

Sample Text for building practice Files

Callsigns:

W1AW/KL7 V26B LR1E P43E ZD8X RA9YN VK4KW OE6MDF CU3AC EE6E 8P5A EW8QQ ON8DM
V31MA TY1AA KU9C/VP9 PJ4X E79D PY2XAT VP2VGG LZ9W VE4EAR EA8MTZF1A CE2MVF   HK1T
TK5KP SX9C 9A1A CO8DM PJ2T P33W OK1C   F5Q5R SV5AZKJ79FC HI8CR XR0YJ YS1/NP3J
G0DBE RU3FM DL2CC TM6M FY5KESV3AQR FG5LA KH2L TG9ANF MU0GSY KH6LC Z36W 5R8IC
CT3FQ TO5A XE3/K5ENS 4O7ML CN3A V55V PI4DX YN5Z GI4SJQSP1DSZ CR6K WP3C ZR9C
FR5FC YP0C 5K0A IS0BOY GA14CG OM2VL S51DX E51RAT EG4GET SK6AW 3V8SS TA4CS
K9HZ/P UW5ZM KK7YC CW5W W1AW/KP2 HV0A YV5EPM GW4BLE

Country Names:

FRANCE GERMANY BELGIUM SPAIN AFRICA ENGLAND IRELAND ITALY SLOVENIA POLAND
RUSSIA FINLAND NORWAY MOROCCO GIBRALTAR TUNISIA CZECH REPUBLIC SCOTLAND
NETHERLANDS GREECE ISRAEL SAN MARINO ALGERIA EGYPT ROMANIA AUSTRIA DENMARK
SWITZERLAND BELARUS UKRAINE DENMARK SAUDI ARABIA AZERBAIJAN UZBEKISTAN
TAJIKSTAN KYRGYZSTAN MAURITANIA GUINEA-BISSAU MAURITIUS IS. ASIATIC RUSSIA
EQUATORIAL GUINEA GUERNSEY ANDORRA NEW ZEALAND AUSTRALIA CANADA USA

Random Word Lists:

SEND NUMBER TEST DIPOLE CQ CQ CQ 73 FAMILY YOUR BEST WISHES, HV0f/P0 AI4?? LONG
QSB QSB QRM QRM 10M 12M 15M 17M 20M 40M 80M 160M 73 1KW 100W 90W 500W RTTY USB
LSB CW PSK31 W4ALF BAND FER CHRIS IN KY USA SHORT PWR QRP TEST YAESU ENTITY
DXCC WAS MY WORKED ALL STATES OPEN LOSING SIGNAL FADING FILTER 200HZ 400HZ
DIGITAL MODE TUNER RADIO SET UP HRD HAM RADIO DELUXE ROTATOR COMPUTER ES
EQUIPMENT HEATHKIT DRAKE GOOD HI HI HR GUD PLS PSE FM HV/HAVE RCVR RPT RIG RX TX
SRI SIG VY VERT ICOM YAGI QUAD 2M 80M OCF BEAM EFHW END FED ZEPP DOUBLET NET

QSL OK DIRECT LOTW RX TX K3 QSB QRM CQ CQ CQ DE W4ALF K, GM OM TNX FER CALL. RST
RIG R UR RST 599 599 5NN 5NN AGN AGN? K4CFG/2 HW? SASE LOTW TNX TU TEMP 70F CUAGN
XYL CALLING FOR DINNER 73 SRI CALLSIGN AGN? QRS PLS OK NO PROB 15WPM 20WPM
25WPM SSB VY 90W 100W 10W 50W QRP QRO NAME CHRIS CHRIS FLAG QTH KY USA
BEVERAGE ANT. LOOP FK5DY/H5 QRZ? QSL? QSO R STRONG SIG 100PCT 529 589 579 549 559
FADING 73 NEW BAND LOTW HW? PSE CONFIRM CALLSIGN PX AGN? PY5?? KENWOOD YAESU
LOG TF2MSN/P0. KY IN USA OK KEY BUG NY COUNTERPOISE BALUN FEED COAX QRS PSE
LADDER LINE ARRL MOBILE 5W AMP 12V SOLAR CONDX ELECRAFT HOME BREW HAM AGE

100 most frequent English Words:

A AN THE THIS THESE THAT SOME ALL ANY EVERY WHO WHICH WHAT SUCH OTHER I ME MY
WE US OUR YOU YOUR HE HIM HIS SHE HER IT ITS THEY THEM THEIR MAN MEN PEOPLE TIME
WORK WELL MAY WILL CAN ONE TWO GREAT LITTLE FIRST AT BY ON UPON OVER BEFORE TO
FROM WITH IN INTO OUT FOR OF ABOUT UP WHEN THEN NOW HOW SO LIKE AS WELL VERY
ONLY NO NOT MORE THERE THAN AND OR IF BUT BE AM IS ARE WAS WERE BEEN HAS HAVE
HAD MAY CAN COULD WILL WOULD SHALL SHOULD MUST SAY SAID LIKE GO COME DO MADE
WORK

More common words used in QSO's:

599 5NN 73 88 100W AR AS BK KN SK A ABT AGN ALL AND ANT ARE AS AT BEST BK BTU CAN CONDX COPY CPY CQ DE DEG DO DONT DX ES FB FER FOR FROM FT GA GE GL GM HAD HAVE HE HERE HI HIS HOW HR HW I IF IN IS IT ITS JUST KNOW LIKE MEAN MY NAME NOT NR OF OK OP OM ON ONE OR OTHER OUT PSE PWR QRL QRM QRN QRP QRQ QRS QRZ QSB QSL QSO QSY QTH R REALLY RIGHT RST SIG SIGNAL SO SOLID SOME THATS THAT THE THEM THERE THEY THINK TNX TO TU UR UP WAS WE WELL WERE WHAT WHEN WHERE WITH WX YES YOU YOUR

State Abbreviations:

AL AK AZ AR CA CO CT DE FL GA HI ID IL IN IA KS KY LA ME MD MA MI MN MS MO MT NE NV NH NJ NM NY NC ND OH OK OR PA RI SC SD TN TX UT VT VA WA WV WI WY

Digraphs and Trigraphs: [see the section where these are defined on page 23]

ES AN IT ON EN SH OT ED ST AT AR UR IN CK LL OO NG TH SS CH OA OR ZZ OW EE OI QU KN BL IGH AIR EAR THE AND URE ING TIO OLD TCH ATI FOR ELL ILL THA TER OLL RES ACK ERE CON INE TED EED COM HAT OON ILE IDE ENT ION NDE HAS ING OCK UCK

Another QSO:

CQ CQ CQ DE W4ALF W4ALF W4ALF K

W4ALF DE N3AQC N3AQC AR

N3AQC DE W4ALF GM TNX CALL UR 599 599 QTH INDEPENDENCE KY INDEPENDENCE KY NAME CHRIS CHRIS HW? [AR] N3AQC DE W4ALF [KN]

 W4ALF DE N3AQC GM CHRIS UR 589 589 IN ALBANY NY ALBANY NY NAME IS PETE PETE HW? AR W4ALF DE N3AQC [KN]

N3AQC DE W4ALF R FB PETE NICE TO MEET YOU [BT] THE RIG HR IS A K3 AT 90W TO MA5B BEAM ON ROOF UP 30FT [BT] THE WX SUNNY ES 66 DEGREES HW? [AR] N3AQC DE W4ALF [KN]

W4ALF DE N3AQC FB CHRIS [BT] WX HR WARM ES DRY TEMP 75F [BT] RIG KNWD TS520S ES ANT DIPOLE UP 50 FT BT HW CPY? W4ALF DE N3AQC [KN]

N3AQC DE W4ALF OK PETE FB TNX QSO HPE CUAGN VY 73 [SK] N3AQC DE W4ALF (EE)

And Another QSO with very loose format and abbreviations: [= is BT]

CQ de ZS6EZ CQ de ZS6EZ K
ZS6EZ de ZS4TX ZS4TX [KN]
ZS4TX de ZS6EZ GM = TU fer call = Name Chris QTH Pretoria = RST 599 = Hw cpi? ZS4TX de ZS6EZ [KN]
ZS6EZ de ZS4TX TU Chris = RST 599 plus = Name Bernie QTH Bloemfontein = Nice meet u fer 1st time = Ant 3 el Yagi up 30 m = Pwr 100 W = Wx hr fb temp 30 C = ZS6EZ de ZS4TX [KN]

ZS4TX de ZS6EZ Name agn? BK

BK Bernie Bernie BK BK

Thanks Bernie = Sri had QRM = Hr 2 el up 22 m es 1TT W = Wish I had ur 3 el = hr no space fer big ants = Wx hr also fine temp 26 C = hv bn ham 1 yr, still getting used to cw = condx rotten past few days = hv hrd vy few stns on 40 m = only sum W6 on LP b4 sunset = hvnt had much luck wrking them tho = ok must run hr to do sum chores arnd house = 73 cul bernie [AR] ZS4TX de ZS6EZ [SK] CL

 ZS6EZ de ZS4TX OK Chris = Yes 3 el lot of fun = Wrk W6 on LP all the time = Condx rotten hr too but wrked FO stn on SP at SS = OK 73 tnx QSO es QSL via buro es LotW= ZS6EZ de ZS4TX [SK]

Yet Another QSO:

CQ CQ CQ DE W6CAL W6CAL W6CAL K

W6? QRS PSE

W6CAL DE KL7ICE KL7ICE AR

KL7ICE DE W6CAL GM TNX FER QRS ES CALL UR 579 579 QTH HERMOSA, CA [BT] NAME RAMON RAMON HW? [AR] KL7ICE DE W6CAL [KN]

 W6CAL DE KL7ICE GM RAMON UR 549 549 WID QSB IN KENAI AK KENAI AK NAME IS JOHN JOHN HW? W6CAL DE KL7ICE AR K

KL7ICE DE W6CAL R FB JOHN NICE TO MEET U [BT] THE RIG HR IS A YAESU 817ND AT 5W TO A 58 FT RANDOM WIRE UP 25FT [BT] THE WX HOT ES MUGGY ES 88 DEGREES HW? BK DE W6CAL K

W6CAL DE KL7ICE FB RAMON [BT] WX HR COOL ES DRY TEMP 45F [BT] RIG ICOM 7000 ES ANT VERT GRND MOUNTED [BT] HOW CPY? BK

KL7ICE DE W6CAL OK JOHN FB TNX QSO CUL ES BEST TO U ES URS 73 [SK] KL7ICE DE W6CAL (EE)

OK RAMON FB ES GL 73 73 DE KL7ICE (EE)

Warm up phrases good for CW: [mostly panagrams]

The quick brown fox jumps over the lazy dogs back

Dells little feet looked different during summer session classes especially after he fell off the roof in Mississippi and shattered his goofy little glasses.

Pack my box with five dozen liquor jugs

Six javelins thrown by the quick savages whizzed forty paces beyond the mark

Forsaking their monastic tradition/zen, twelve jovial friars gave up their vocation for a questionable existence on the flying trapeze.

APPENDIX C:
Zero beating a CW Signal
[portions of this text from: http://www.qsl.net/v73ns/zerobeat.html]

What is ZERO BEAT and CW sidetone?

CW stations should always try to zero beat each other. That means to adjust your rig's transmit frequency to exactly match the transmit frequency of the other ham you would like to talk to. Hearing two CW stations conduct a conversation a few hundred cycles apart is a waste of frequency space, and is inviting QRM. How does one zero beat another station? This is easy to do on phone or SSB, just tune so that the other fellow's voice sounds normal. But trickier on CW because when you put your receiver exactly on a CW station's transmit frequency, you hear nothing, zero. In modern transceivers, in the CW mode, the receiver's BFO is offset from the one displayed, transmit frequency in order to produce an audible tone. In other words, the transmit and receive frequencies are far enough apart for you to hear a pleasantly pitched tone when your transmitter frequency is tuned to exactly that of the ham you are listening to. This frequency offset is frequently about 600 Hz or Hertz

How does one zero beat another station?

Modern radios have a means to adjust the CW sidetone. Locate that control and learn how to use it. The tone you hear when you TX is the same tone you should tune for on RX.

It's that simple, but many do not do it properly because they like hearing their tone at a different pitch than the station they are attempting to work or may not understand that it is important to zero beat.

If you fail to zero beat and the other station is using a CW filter your signal is not going to be heard. Depending on how far off their frequency you are it could be assumed you are working someone else below them, and ignored.

* Turn off the live keying of your radio (so you do not radiate and cause QRM) and send a few dits. Hear that tone? Now, tune the station you wish to work until the two tones match.

* Another way to zero beat it turn on your wide CW filter and tune until you hear the other station. If you have dual filters, turn on the narrow one and tune until the station is heard. Bingo, you are now on the same freq as the other station.

*Many modern transceivers have an auto spot or automatic zero beat function as well. Refer to your radio manual on the "how to" for your specific radio.
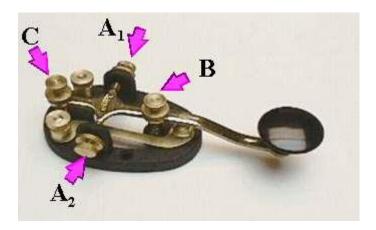
Always zero beat!

Appendix D:

Adjusting Straight Keys, Paddles, & Bugs

A "How-To" Article by N1FN

[This section, in its entirety, is directly from: http://www.morsex.com/misc/keyadj.htm]

These instructions use simple, generally familiar examples of equipment types and are designed to help you find the adjustment that suits you best. What you are looking for ultimately is a particular feel, and that will vary from person to person. Not all keys and paddles offer the same adjustments, or even use the same terminology, but hopefully this will be enough to get you started and to illustrate the general principles.

Straight Keys

The example shown is a Nye Speed-X Model 312, which is typical of a great number of straight keys.

The available adjustments are:

Arm Tension, the force needed to move the lever up and down. It's usually exerted by a coil spring between the arm and the base, and is adjusted at **B** in the drawing.

Bearing Tension, the setting of the pivot bearings on which the arm rotates. It is controlled by the pressure on the bearing surfaces, and there is one bearing (and one adjustment) on each side of the pivot arm, shown at **A₁ and A₂** in the drawing.

Contact Spacing, the space between the two electrical contacts when the key arm is not depressed (unkeyed). The contacts are located beneath the arm, toward the front of the key. The adjustment for the 312 and similar keys is at the back end of the arm, shown as **C** in the drawing.
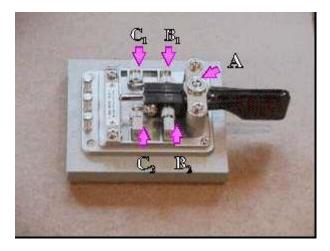
The two unmarked screws at the back of the key, on either side of C, are the binding posts for connecting the key to the transmitter.

Here are the four steps you will need to "set up" your key:

1. <u>**UN**</u>**-adjust the key**. That's right- we need to loosen everything up and get to a common starting point, because each of the adjustments has some impact on the others. Loosen the spring tension on the arm (B) until no resistance is felt when you depress the knob. Open the contact spacing (C) as far as you can without removing the adjustment screw from the arm. Loosen the bearing tension screws (A) until the arm wobbles loosely.

2. **Adjust the bearing tension**. Choose one of the two bearings and tighten its adjustment screw (A) until you can just barely feel a bit of friction as you move the arm up and down. Now back the screw off until *just* the point at which the arm moves freely again- usually it's just a fraction of a degree of screw rotation, or about as fine an adjustment as you can make. Repeat with the other bearing tension adjustment screw. Setting the second bearing is likely to have had some effect on the first, so readjust the first bearing and then finally the second bearing. At this point the arm should move up and down perfectly freely, with no sideways play or "slop."

3. **Adjust the contact spacing**. The contact spacing determines the amount of vertical movement when you depress the arm. It's entirely a matter of taste, but if you haven't used a key before and haven't developed your own preferences, start with a sixteenth of an inch or about the thickness of a penny. Adjust screw (C) until you have the desired spacing between the contacts.

4. **Adjust the arm tension**. Tighten the arm tension adjustment screw (B) to a comfortable level of tension on the arm. Again, this is a matter of preference, but it is possible to suggest a good rule of thumb if you haven't developed preferences- set it for the minimum amount of tension that will allow you to feel that you are in control of the key.

Paddles

A dual paddle is a little more complex than a straight key, but it can be thought of as two straight keys side by side and operating horizontally rather than vertically. There are also single paddles, but there is very little difference in the way they are adjusted.

The example shown is a Hi-Mound Model MK-706, which is typical of a great number of dual paddles. The available adjustments are:

Lever Tension, the force needed to move either of the two levers from side to side. It's usually exerted by a coil spring between the paddle lever and the adjusting screw, and is adjusted at **B** in the

drawing. Some paddles will have separate adjustments for each lever. Note that paddles like the "Bencher" have the tension controlled by a single long spring running around a post at the back of the unit. The two screws to which the spring is attached control the tension by changing the angle at which the spring pulls.
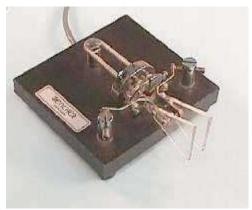
Bearing Tension, the setting of the pivot bearings on which the paddles rotate. It is controlled by the pressure on the bearing surfaces. In the paddle shown, there is a single adjustment at the center of the bearing frame, shown at **A** in the drawing. Some paddles will have separate adjustments for the two arm pivot bearings, and some paddles will even have separate adjustments for the upper and lower bearing surfaces.

Contact Spacing, the space between the two pairs of electrical contacts when the levers are at rest (unkeyed). The contacts on the 706 are located at the rear end of the lever. The adjustments for the two arms are shown as **C** in the drawing.

Here are the steps you will need to "set up" your paddle

1. <u>**Un-adjust the paddle**</u>. That's right- we need to loosen everything up and get to a common starting point, because each of the adjustments has some impact on the others. Loosen the spring tension on the paddle levers (B) until no resistance is felt when move the levers. Open the contact spacing on each side (C) as far as you can without removing the adjustment screw from the arm. Loosen the bearing tension screw (A) until the arms wobble loosely.

2. **Adjust the bearing tension**. Tighten the bearing tension adjustment screw (A) until you can just barely feel a bit of friction as you move the levers back and forth. Now back the screw off until *just* the point at which the arms move freely again- usually it's just a fraction of a degree of screw rotation, or about as fine an adjustment as you can make. If the arms have separate bearing adjustments, perform this adjustment for each arm individually. At this point the two levers should move from side to side freely, with no vertical play or "slop"

3. **Adjust the contact spacing**. The contact spacing determines the amount of horizontal movement when you depress the arm. It's entirely a matter of taste, but if you haven't used a paddle before and haven't developed your own preferences, start with about the thickness of a a dime or a bit less. Adjust screws (C) until you have the desired spacing between the contacts on each side. The spacing does not have to be identical, and in fact many "bug" operators prefer a greater gap on the dash paddle.

4. **Adjust the arm tension**. Tighten the arm tension adjustment screws (B) to a comfortable level of tension on the arm. Again, this is a matter of preference, but the general rule is to set it for the minimum amount of tension that will allow you to feel that you are in control of the paddle. There is no reason the tension should be the same if you don't want it that way. For example, if you have never used a paddle before you may find it easier to learn if tension is set slightly greater on one side or the other.

Bencher Paddles

Bencher BY-1 Paddle
Links for larger, labelled images will be found below.

The popular Bencher line of paddles poses some interesting problems in adjustment, because the design is so different from more traditional straight-lever paddles. The Bencher uses a "cantilever" arm design, so that the contacts are at the front of the paddle and the movement of the contacts is essentially from back to front rather than from side to side. This design, coupled
with the distinctive shape of the finger-pieces, is why the term "Iambic" is so often associated with the design of the paddle. But in fact, the Bencher is a simply a variation on the theme of *dual paddles*, and *Iambic refers only to the keyer* with which the paddle is used. Click here for a discussion of iambic paddles and keyers.

Adjustment of a Bencher or other cantilever style paddle is not as difficult as it looks. While the appearance is technically daunting, the Bencher is actually quite robust, and capable of adjustment in the usual ways to suit any operating style.

Naming of Parts

The parts of the Bencher need to be understood before an attempt is made to adjust the paddle. Critical parts or adjustment screws are indicated in the illustrations.

The two paddle arms are the S shaped pieces of metal which have the plastic finger-piece at the front and a contact at the other end, adjacent to the two contact post*s*. The paddle arm is attached to the semi-circular pivot plates with a single screw which goes through the arm, and extends beyond the pivot plate to rest against the stop screw.

The pivot plate rocks back and forth as the paddle is used, and adjustment consists of locating the pivot plate properly and controlling the extent of its movement. As stated, the paddle arm is attached to the front of the pivot plate with a screw that goes through the plate and controls the resting position of the plate when it is under tension from the spring. The spring attaches to a long screw that goes through the pivot plate from the upper quadrant. There is a flat spot in the threading of the screw (on the inner side of the pivot plate), where the end of the spring is attached. As the screw is moved in or out, the amount of tension is changed as the angle between the spring and the pivot plate changes.   The plate moves against two needle bearings (upper and lower on each side) with the needle bearings themselves extending forward from the bearing block and the nylon bearing seat fixed in the back side of the pivot plate.

There is also a "locator" screw which goes through a large, unthreaded hole in the pivot plate and screws into the bearing block. The locator screw is not actually attached to the pivot plate. The head of this screw limits the distance that the plate can move outwards if the paddle arm is moved the "wrong way." In normal use it serves no purpose, but when the arms are moved backwards (e.g. to clean the contacts) it does serve to keep the pivot plate from coming off the bearings.

The available adjustments are:

Paddle Arm Tension, the force needed to move either of the two levers from side to side. It's exerted by a long coil spring which attaches to one adjustment screw, goes to the back of the paddle and around a post, and then back up to the other adjustment screw. The two screws to which the spring is attached control the tension by changing the angle at which the spring pulls against the pivot plate.
.
Bearing Tension, adjustable only as a side-effect of varying the spring tension on the pivot plate. With needle bearings and nylon seats, it is essentially ignorable.

Contact Spacing, the space between the two pairs of electrical contacts when the levers are at rest (unkeyed). The contacts on the Bencher are an adjustable contact on the end of a screw going through the contact post, and a fixed contact on the end of the paddle arm. The contact spacing determines the distance the paddle arm will move when keyed.

Pivot Plate Position, the location of the pivot plate. There is really only one adjustment, namely the resting position (paddle unkeyed) controlled by the stop screw. The locator screw limits outward movement of the pivot plate when the paddle arm is moved "backwards."

Here are the steps you will need to "set up" your Bencher paddle

1. **Open up the contacts**. Loosen the transverse locking screw (the smaller, upper one) on each contact post and then back out the contact screw until the contact itself is up against the inner surface of the post.

2. **Inspect and adjust the position of the pivot plates**. They should be perfectly parallel with the front surface of the bearing block. Looking from the side of the paddle, you should see that the tops of the pivot plates form a straight line, parallel with the bearing block. If they don't, adjust the stop screws (accessible from the back of the bearing block) until the plates line up. When the above adjustment has been made, check the locator screw to see that the head is approximately 1/8" out from the front of the pivot plate.

3. **Adjust the contact spacing**. The contact spacing determines the amount of horizontal movement when you move the finger-piece or "key" the paddle. It's entirely a matter of taste, but if you haven't used a paddle before and haven't developed your own preferences, start with about the thickness of a dime or a bit less. Adjust the contact screws until you have the desired spacing between the contacts on each side, then tighten the locking screws above the contact adjustment screws. The spacing does not have to be identical, and in fact many former "bug" operators prefer a greater gap on the dash paddle.

4. **Inspect contact alignment**. When keyed, the contacts should meet flush and not at an angle. If they do not meet flush, you can usually fix the problem by loosening the nut that holds the contact post (on the base of the paddle) and rotating the post slightly. If you cannot achieve a flush meeting of the contacts after performing ALL of the preceding adjustments, then it is probably that the paddle arm has been bent. If you find it necessary to straighten the paddle arm,

remove it from the pivot plate and hold it firmly with a pair of pliers (or in a vice) and bend as necessary. You can also bend other (front) end of the paddle arm if you want to make a slight adjustment in how close together the finger-pieces are.

5. **Adjust the arm tension**. Adjust the tension adjustment screws to a comfortable level of tension on the arm. Again, this is a matter of preference, but the general rule is to set it for the minimum amount of tension that will allow you to feel that you are in control of the paddle. There is no reason the tension should be the same if you don't want it that way. For example, if you have never used a paddle before you may find it easier to learn if tension is set slightly greater on one side or the other. It will be pretty obvious, but tension is increased by turning the adjustment screw out (counterclockwise), and decreased by turning it in (clockwise).

Bencher Paddle Illustrations:

Figure 1. Front of mechanism.
Figure 2. Back of mechanism.

Figure 3. View from the top of the mechanism.

Bugs

Hi-Mound BK-100. Click the image to view in full size.

"Bug" is a term used to describe an automatic or semi-automatic Morse key, that is, a mechanical device which will automatically generate a series of dots and/or dashes. The most common varieties, like the Hi-Mound BK-100 shown above and the most familiar of the many GHD and Vibroplex models, are semi-automatic. This means the dots are formed automatically, while the dashes are formed manually. There have been many bugs with fully automatic dashes as well as dots, and the author owns an early THREE-paddle bug which had automatic dots and dashes, and a separate manual dash paddle for "long dashes" used in landline telegraphy.

Virtually all of the bugs which you are likely to encounter work the same way. When the lever is moved to one side, a pendulum is allowed to swing back and forth, making repeated closure of a pair of contacts to generate dots. The oscillation (and generation of dots) stops when the lever is released. The speed of the osciallation is controlled by the position of the weight on the pendulum arm. The closer the weight is to the pivot, the faster the pendulum will move.

When the lever is moved to the other side, it closes the dash contacts, acting very much like a straight key turned on its side.

Naming of Parts

Over the years the critical parts of a bug have had a lot of names, but I've tried to use the most commonly understood ones as shown in the diagram. You won't find exactly the same parts on every instrument, but usually you can figure out what does what if you understand the basics. And at this point I'd like to thank Bill, W1HIJ, for kindly providing a lot of background information for this article, along with some judicious quotes from an Army Tech Manual (TM11-459, 1945). I'll be paraphrasing those instructions, along with a simple method for testing adjustment using a VOM which Bill also described. In describing the parts there are a couple places where I'll show the name used in the Army Tech Manual in parentheses.

The Lever. The lever on a bug is usually split, that is, what appears to be a single control at the front of the bug actually drives two separate levers at the back of the device. The dash part of the lever is short and simple, while the dot part is more complex, being attached to the pendulum.

Bearing Tension Adjustment Screw. The lever his held in place on a pivot bearing, and there is usually a screw to adjust the tension so that the lever swings freely in both directions, without any sloppiness.

Arm Tension Adjustment Screws. These adjust the tension of springs which press against the lever to return it to the center or resting position.

Dash contacts. The adjustment screw adjusts the spacing between the contacts, which determines how far the lever must move when making dashes.

Dot Contacts. The screw adjusts the spacing between the contacts, which is quite different from the spacing on the dash contacts. The spacing here, in conjunction with the dwell screw, determines the "shaping" or weight of the dots.

Dot Stop Screw (back stop screw). This screw adjusts the resting position of the lever, so that oscillation is stopped by the damper.

Damper (deadener). The damper is a flexible device for instantaneously absorbing the momentum of the pendulum so as to stop (damp) the oscillation. In the case of the BK-100 (illustrated) it is a loose metal sleeve on a shaft. Other bugs use rubber "bumpers."

Pendulum (reed). The pendulum consists of an arm along which a weight can be moved. The position of the weight determines the "moment" of the pendulum, or the speed at which is oscillates.

Dwell Adjustment Screw (front stop screw). This screw adjusts the width of the pendulum's arc, and to the extent that the pendulum moves farther than is necessary for an instantaneous meeting of the dot contacts, the contacts stay closed (or dwell) until the pendulum swings back.

Procedure For Adjusting the Bug

1. Back out the two lever tension adjustment screws so that the lever moves freely to left and right.

2. Check and adjust the pivot bearing tension. The lever should move freely left and right, with no up and down sloppiness. If it requires adjustment, loosen the locknut and the screw until the lever feels sloppy. Tighten the bearing screw until the slightest amount of friction is felt as you move the arm, then back the bearing screw off until the friction just disappears. Tighten the lock nut.

3. Adjust the dash contacts as desired for comfortable movement of the dash lever. If you aren't used to a bug and don't know exactly what you are looking for, start with about 1/16 of an inch. Adjust the dash tension screw to a comfortable level of tension.

4. Adjust the resting position of the pendulum. Do this by adjusting the dot stop screw until the end of the pendulum just lightly makes contact with the damper.

5. Adjust the pendulum weight to a position appropriate for the speed you want to set the bug up for. If you have not used a bug before you will probably want to set the weight near the end of the pendulum arm, for relatively slow speed.

6. Adjust the dwell screw so that there is a small gap between the end of the screw and the side of the arm when you swing the lever to the dot side and hold it. This gap will vary significantly depending on the position of the screw along the length of the arm or pendulum. On the BK-100 it will be about 3/16", but the Army Tech Manual (for use with a particular Vibroplex) specifies .015"

7. Swing the lever over to the dot side and stop the oscillation with a fingertip, but still holding the paddle over. Adjust the dot contact screw so that the contacts *just* meet.

8. Adjust the dot lever tension to suit.

At this point, normal activation of the dot lever should result in a string of 20 or more dots being generated before oscillation slows down. If not, try some different adjustments of the dwell screw (and then readjust the dot contacts)-- you should be able to see easily whether a wider or narrower gap on the dwell screw is necessary, and find an appropriate adjustment. Most bugs can be adjusted to provide 20 or more dots from a single closure, but if yours can't, don't worry about it-- just set it for the most you can get out of it.

Note that when you change the bug's speed by moving the pendulum weight, you may need to repeat steps six and seven, particularly if you are changing speed by more than a few wpm.

Verifying Proper Dot Formation.

As mentioned above, Bill W1HIJ describes a simple way to use a VOM to determine that your dots are being generated correctly. Keeping in mind that in a string of dots, the signal should be on and off for exactly the same amount of time (space between dots equals length of dot), just hook up an analog VOM (set for resistance) to the bug's output connections. Key the bug, and you should observe the meter vibrating at about the mid point of the range. While observing the meter, fine-tune the dot contact spacing until the needle hovers at midrange, indicating a "50% dwell" or perfect weighting.

> **Finally, the last word from the Army Technical Manual:**
> *"The bug is designed to make sending easy rather than fast, and perfect control of the key is far more important than speed. Be especially careful to send dits accurately. Not all radio operators have equally sensitivie hearing, and careless sending on the semautomatic key will not be understood."*

On Iambic Paddles and Keyers

To begin at the beginning, *there is no such thing as an iambic paddle*! The confusion came about in large part because the Bencher "Iambic Keyer Paddle," as it was labeled in magazine ads, was introduced shortly after the iambic keyer itself was developed, and similar names have been used by other paddle manufacturers. Many people tend to read "Iambic Keyer" as a description of the paddle rather than the device for which it was designed to be used, the "iambic" electronic keyer. The proper terminology is "dual paddle" as opposed to "single lever paddle."

Early electrical and electronic keyers were an emulation of mechanical keying devices such as bugs, where you would press a lever in one direction to get a series of dots, and the other direction to get a series of dashes (or make them manually in the case of a *semi*-automatic key, or bug). The first keying devices, or paddles, had a single lever and were known variously as sideswipers, slap-keys, and paddles. All electronic keyers work this way, but a more recent development (mid 1950's) is the iambic or "squeeze keyer" which adds a level of functionality to the basic "dit OR dah" scenario.

With an iambic keyer, you get an *alternating series of dots and dashes* when both levers are activated at same time, or squeezed.

The term "Iambic" comes from poetry, where it is used to describe a rhythm consisting of alternating unstressed and stressed syllables, as for example "Come *live*with *me* and *be* my *love*!" When you say that out loud you will easily hear the "di-dah-di-dah-di-dah-di-dah" rhythm, or in other words the rhythm you get when you "squeeze" the paddles connected to an iambic keyer. The series can start with either a dit or a dah, depending on which lever makes contact first. If the electronics in the keyer cannot determine which contact hit first (logically simultaneous), it will default to starting with either a dit or a dah and then begin alternating. Just for the sake of being complete here, if you squeeze the paddles so as to get "dah-di-dah-di-dah-dit" the rhythm is technically "trochaic" rather than "iambic," but that's trivia you probably don't need to know.

Dual paddles like the Bencher can be used with "non-iambic" keyers, and single lever paddles can be used with iambic keyers (although the true iambic or squeeze-key features of course are unavailable with a single lever paddle).