**K3MT**
**presents . . .**

# CW SKILL
# and how to acquire it

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**May, 1997**

If you can turn something on and off (a carrier, a light, a car horn, a bell), or interrupt something (light from a distant lamp, the sun, a star, smoke from a fire, the power to a city block) - or wave something (a flag, your arms, your ears or eyelids) - then you can communicate IF YOU KNOW MORSE! For manual Morse IS THE LEAST TECHNOLOGICALLY COMPLEX WAY OF MODULATING A SIGNAL SOURCE!

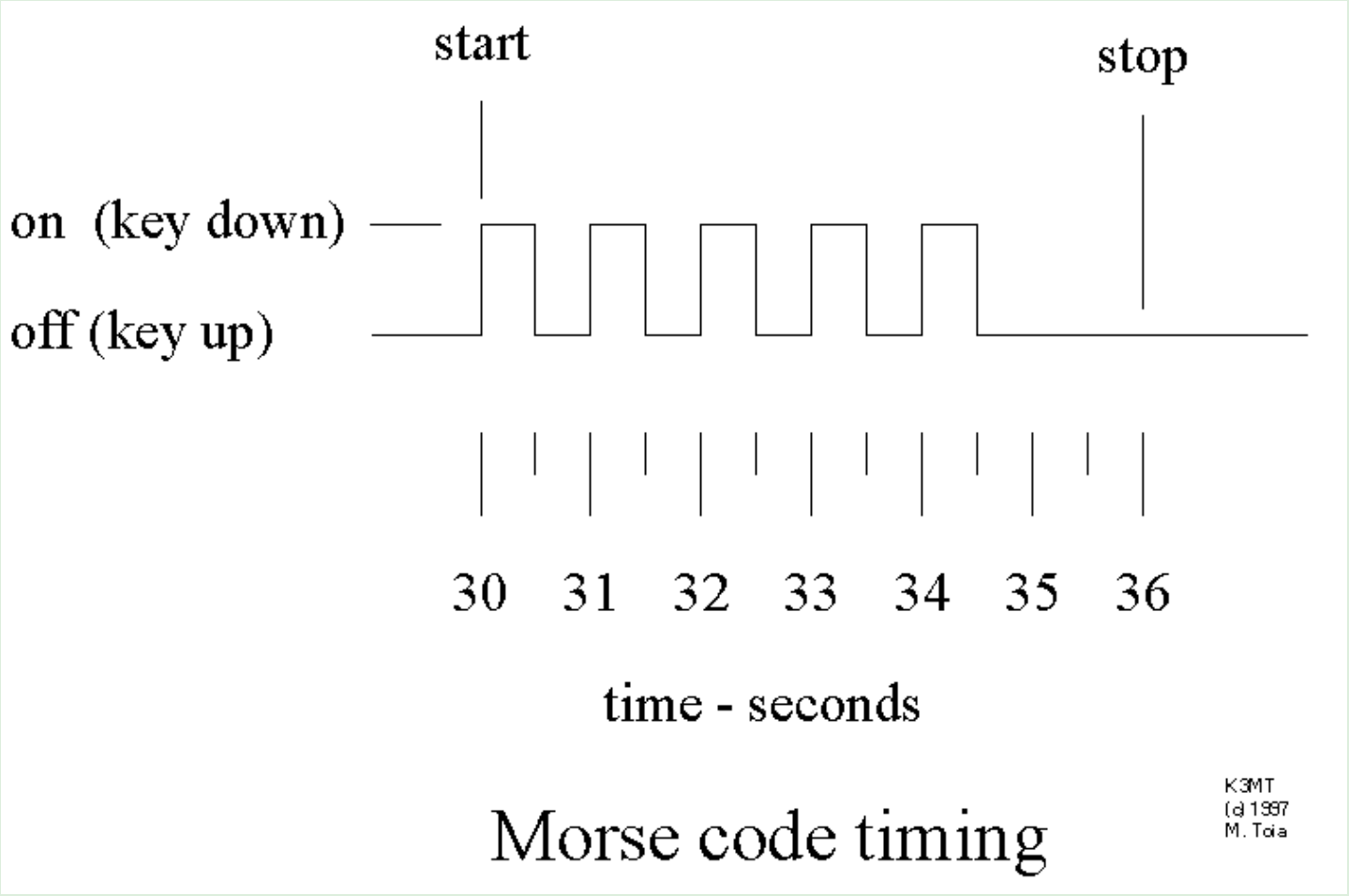
A radio transmitter has various sections inside it. The first, without which the transmitter would be useless, is the carrier oscillator. This circuit generates a radio frequency voltage - a sine wave of constant frequency and amplitude, called a *continuous wave*. Everything else the transmitter does uses this carrier. It amplifies it, modulates it, shifts its frequency, and then puts the result on the transmitter's antenna jack.

The *simplest* thing a transmitter can do to this carrier is to turn it on and off. By providing another jack where you, the operator, can connect a switch, the transmitter lets you turn the carrier on and off conveniently. The switch is known as a *telegraph key*, and the operating mode where you turn the transmitter on and off to communcate is called **CW**, an abbreviation for continuous wave, even though the output is *not* continuous!

## THE STRUCTURE OF MORSE CODE - FROM AN ENGINEER'S VIEWPOINT.

### *Timing of "dits" and the letter space*

Morse sends information by turning a transmitter on and off in a well-defined pattern. Suppose you connect a key to your transmitter, and sit by it with a watch on your left wrist. The watch has a "seconds" display. You start at 15 seconds past the minute and wait . . wait . . until exactly 30 seconds past. At that time you press the key down for 1/2 second, let it up for 1/2 second, and do this four more times. We engineers describe this action like this:




The *graph* we draw depicts time in seconds passing away along the horizontal axis, from left to right - our time axis always goes from left (the past) to right (the future). The vertical axis shows whether the transmitter is "on" - key "down" - or "off" - key "up".

Notice that this string of five **dits**, which ordinary people call "dots," consist of alternating one-half second intervals when the key is down with intervals when it is up. This pattern, in morse, is brought to you by the number **five**. It is the number five, when properly sent by a cw (aka Morse) operator.

There's a very important part of the number five, and all other letters, numbers, or symbols you can send by CW. *At the end, the key must be "up" for two more time intervals!* This is called the "letter space" and is used to separate one letter, number, or symbol from another. Thus **5** starts at the first dit, and lasts until the "stop" mark shown on the graph.

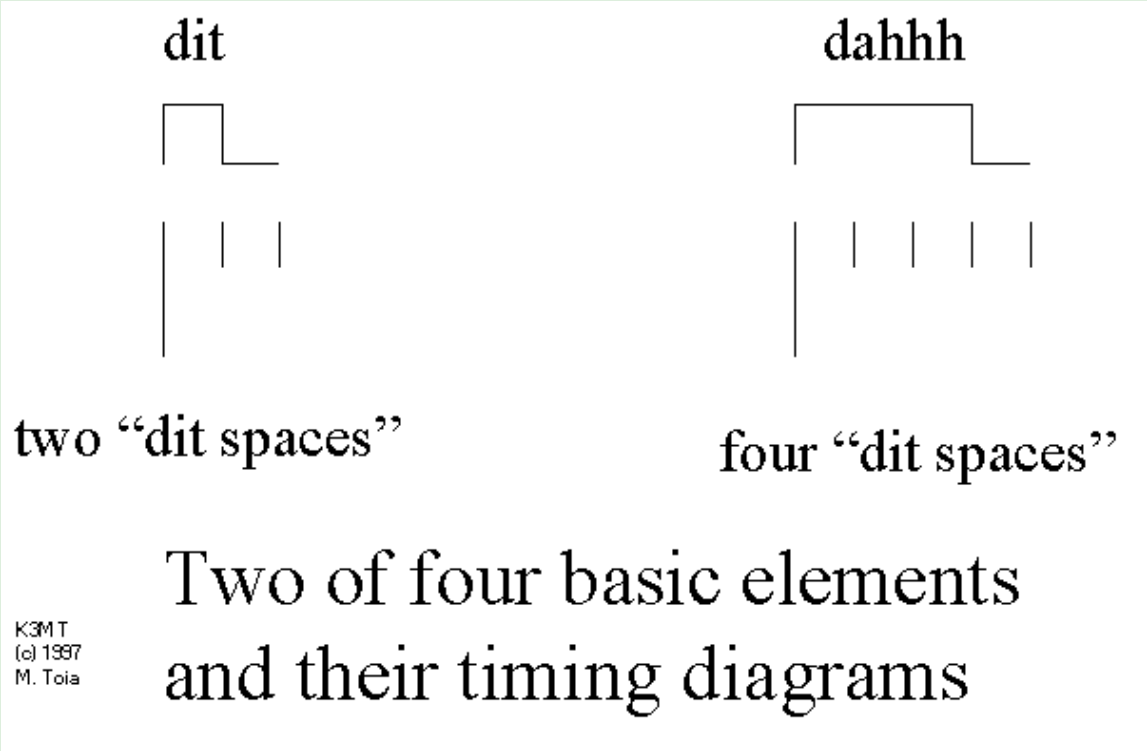
***Basic Morse elements - dit, dah, letter space, and the word space***

Morse uses patterns of on/off based on a single time unit - the dit space. A *dit* - **please, not a dot!** - takes two dit space intervals, and a dahhhhh (I drag it out to show that it lasts longer than a dit) takes four dit spaces. The dit has a key down time of one dit space, and the dah has a key down time of three dit spaces - three times as long as a dit.

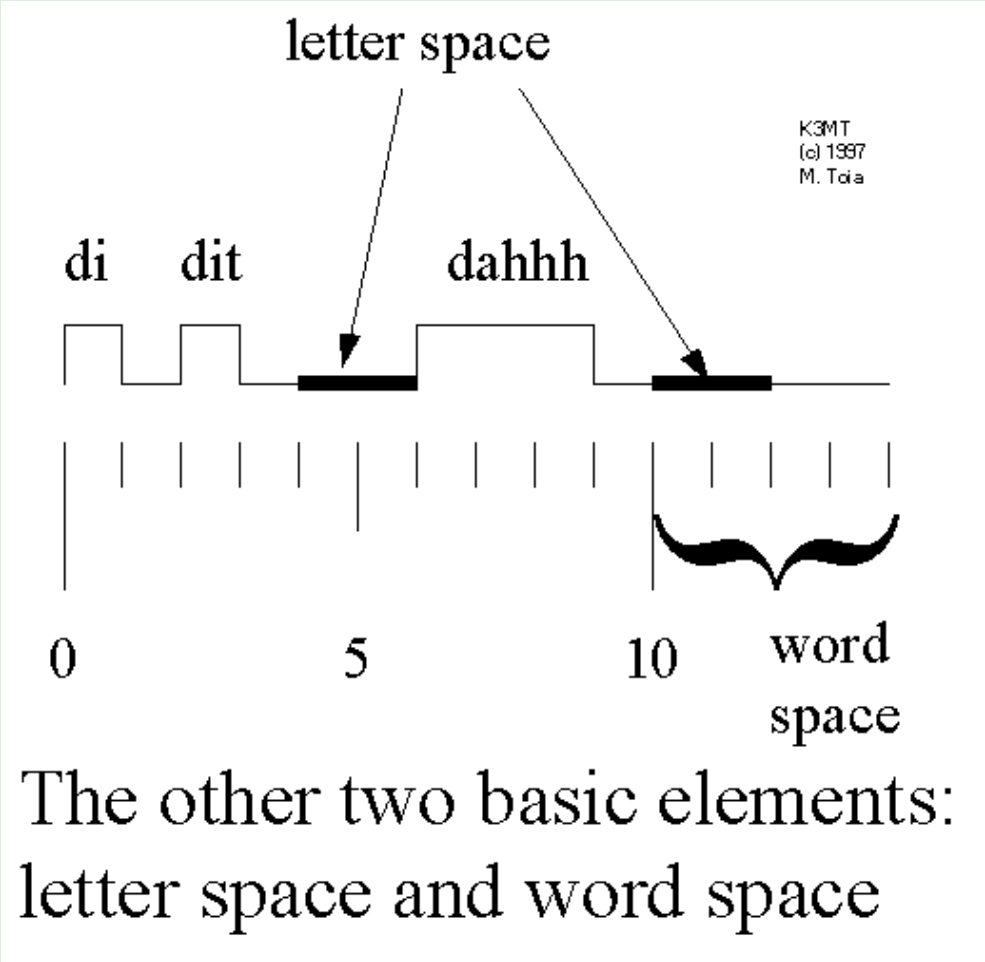
When you add the single dit space of key up at the end of a dit and a dah, you find that **a dit takes *two* dit spaces, and the dah takes four.**

Basic timing, then, puts two dits in the space on one dah - when the dah is three times as long as the dit. The ratio of dah length to dit length is called *weighting*. For now, keep your practice on this standard 3:1 weighting. Remember this - it will be important in the exercise section later.

This graph depicts the timing of the dit and dahh.




Now consider **IT** - the word, that is. This graph shows how IT appears with key up/key down patterns.




The other two basic elements: letter space and word space

The "I" is "di dit" - two fast dits that, when you speak them, slur together, losing the "t" on all but the last dit. The "T" of "IT" is a single dah. Notice the letter space between the I and T in the graph. Without it, the dits and dah will run together, making something not intelligible as "IT." The letter spaces are shown in bolder line width here only to emphasize that they are necessary parts of good Morse!

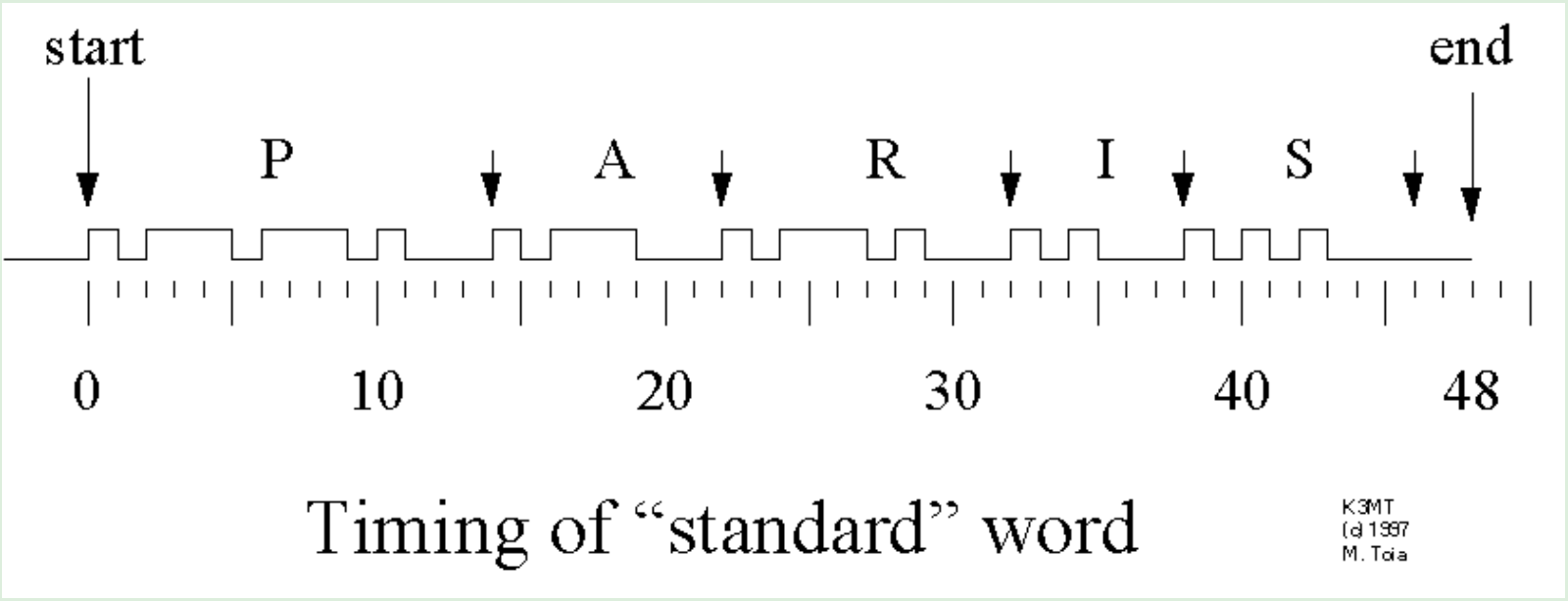
Also notice that the end of a word has *two* letter spaces, which separate the word from the next word. This is called a *word space.* Thus Morse has four basic elements:

- the dit - two dit spaces long
- the dah - four dit spaces long
- the letter space - two dit spaces long
- the word space - four dit spaces long.

***The standard word***

You have heard, or will shortly hear, about CW operator's "code speed." This is stated in *words per minute,* or WPM. Before the FCC changed the rules in April of 2000, getting a Novice license required your code speed to be 5 WPM; a general, 13 WPM; and an extra, 20 WPM. So what is a word? U.S. Army Signal Corps standards in the fifties used "PARIS" as the length of a standard word. My code training equipment back then used paper tape keying machines, and each tape had a long leader of repeating "PARIS" so I

could count the repetitions to set machine code speed. Here is a graph of PARIS:




It starts at the "Start" mark. P has the pattern di dah dah dit. Look closely at the graph. Notice the structure of the dits and dahs, *and the letter space after the last dit.* A small arrow marks the end of P and the start of A. Follow the graph to see the structure of

- P - di dah dah dit
- A - di dah
- R - di dah dit
- I - di dit
- S - di di dit
- - the letter spaces
- - the final two letter spaces, or word space

PARIS - the standard word - takes 48 dit spaces of time.

***Measuring code speed***

Since a "word" takes 48 dit spaces, a speed of 5 WPM will have 240 dit spaces per minute. A single dit takes two dit spaces, so a continuous string of dits, at 120 per minute, is code being sent at 5 WPM. My very first graph above shows five dits at one-second intervals - this is a code speed of 2 1/2 WPM.

Code speed then has:

- 120 dits/minute, 60 dahs/minute - 5 WPM
- 312 dits/minute, 156 dahs/minute - 13 WPM
- 480 dits/minute, 240 dahs/minute - 20 WPM

***HOW TO BECOME A GREAT FIST***

CW operators each have individual "sounds" to their rhythmic tapping of the key - or, as we say, *pounding the brass*. Some are beautiful to hear. Others need some practice. Still others are almost intelligible.

To be complimented on one's *fist* - the beautiful, rhythmic pattern produced at brass pounding - is indeed a lofty goal. To be found out as a *lid* - a poor operator - is cause for concern and need of improvement. Ham radio, unlike the internet, does not engage in flame wars. Instead, we hams try our best to help one another, and take pride in doing so. That's one reason I have written this.

### *Step 1 - position*

Establish a comfortable position. Sit in a chair facing your operating table. Place the key on the table about even with your left shoulder. It should be fastened to a thin base, or to the table itself.

Put your right elbow on the table. Bend your right arm so your right hand touches the key. Move the key to do this: your thumb, index finger, and middle finger should all be able to touch the key's knob.

Put your index finger on top of the knob, and use your thumb and middle finger to *very lightly* squeeze the opposite sides of the knob. Don't overdo the squeezing - you should just be able to lift the key up with the right finger positions. Let your ring and little finger curl up lightly under your hand. You've now made a very loose fist.

Put the fingers of your left hand under your right wrist. Relax.

Now lift your right wrist just a bit and let your hand fall limp: your index finger should then fall heavily enough on the knob to just about close the key. A very slight downward pressure with your hand will complete key closure. *Do not "push forward" with your arm to close the key:* get the feel of hinging your hand at the wrist, with the forearm not moving.

### *Step 2 - adjusting the key*

Adjust the gap under the key contact. Open the gap with the rear screw on the key. Adjust the side screws so the armature - the part that rocks up and down - doesn't wobble from side to side. Also adjust them so the armature contact is centered over the base contact - these are usually just ahead of the front screw, on the bottom side of the armature. Don't overtighten the side screws.

Then adjust the rear screw for clearance, using a sheet of paper, or sometimes an ace of spades. Tighten the gap until the card or paper can just be pulled out easily. Do not overtighten.

When this is right, raising your wrist should let your fingers fall on the key knob and close the contact. Adjust the key spring tension - the front screw - to get the right tension. Too heavy a spring will demand that you move your forearm, and this will cramp your "wrist" in a short time.

### *Step 3 - getting the beat*

Find a metronome or get some other way to produce 120 audible beats per minute. I coudn't afford a metronome, so I practiced in our kitchen. I let the faucet drip onto the back of a pan, and adjusted it for the beat

rate I needed.

Listen to the beat. Practice pressing the key down on one beat, and releasing it on the next. Keep this up for at least one minute. If your arm or wrist begins feeling cramped, *you are not relaxing enough.* This is not physical exercise - it is an exercise in relaxing and getting the feel of an even  on - off  action of the key.

*Step 4 - dits and dahs*

With the metronome going at 120 beats per minute, press the key for one beat. Release it on the 2nd beat. Press it on the third beat. Release it on the fourth beat. Press *and hold* it on beats 5, 6, and 7.  Release it on beat 8. Keep repeating this pattern seven more times.  Notice that this exercise demonstrates the 2:1 ratio between dit timing (2 dit spaces) and dah timing (4 dit spaces.)  2 dits = 1 dah.

You have now practiced the proper timing of sending " di di dah" eight times. After you feel comfortable with this, increase the metronome speed to 160 beats per minute, and repeat this pattern. Increase metronome speed to 200 beats per minute, and repeat the pattern again.

*Step 5 - rhythm practice patterns*

After you get the hang of step 3, try all other patterns:

- di di dah - - 8 times
- di di di di dah dah - - 8 times
- di di dah di di dah di di di di dah dah - - 6 times
- dah dah di di - - 8 times

Do these at speeds up to 200 beats per minute. Practice often.

*Step 6 - double time*

Set your metronome to 120 beats per minute. Do the same patterns as above, but key one dit and its following dit space *per beat*: you will be keying at twice the rate as before: a "di di dah" pattern will be completed in *four* metronome beats, not eight.

**Here is a common pitfall.** Pay close attention to your dahs. It is a common mistake to make them *two* dit spaces long, followed by a gap of two dit spaces.  This will mark you as a lid!  Your dahs must be *syncopated* - that is, you must count the metronome beats as musicians do: "one *and* two *and* three *and* four *and* one *and* two, etc." The dah of "di di dah" starts on "three" and lasts throughout  "three *and* four," you *release* pressure on the "and" following "four."

These rhythm drills, if practiced regularly for a few months, will improve your "fist" as heard by other amateurs. The result will be worth the toil.

**BUGS AND KEYERS**

The beginner should not know what these devices are.  If he does, he should *not* try to use these devices for at least 18 months after starting on a straight key.  I was told by my mentors that trying to adapt to a "bug"

too soon would ruin your fist!

A *keyer* is an electronic device connected to two vertical paddles. Your thumb operates the left paddle, and your index finger the right paddle. The thumb presses its paddle, and the electronics begins sending "dits" one after another. The finger presses its paddle, and the electronics sends "dahs" one after another. Pressing both paddles can cause alternating "dits" and "dahs" - called iambic mode.

A "bug" is a similar, mechanical device that sends "dits" when the thumb paddle is pressed, and sends "dahhs" *manually* by alternating pressing and releasing the finger paddle. Experienced CW operators will often send manual morse with the dah paddle alone, using it as a hand pump on its side!

There are variations on keyers and bugs. I have seen a bug with *two* actions - one sends dits as usual, and the other sends dahs. It takes a bit of care to get the two weighted actions adjusted correctly for this!

Again - **you are cautioned against trying these devices too soon!** Spend at least a year and a half on a straight key, and get your code speed up to about 15 wpm or better, before trying keyers or bugs.

73

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