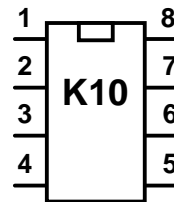


FEATURES

- Keyer speed range: 5 - 59 WPM
- HSCW: 1500, 2000, 4000 or 6000 lpm
- Message Memory: 96 letters in four slots with embedded commands.
- Keying Modes: Straight key, Iambic A or B
- Audio Frequency keying mode
- Farnsworth support
- Automatic letterspace mode
- Adjustable weighting: 3:1 or 4:1 dah:dit ratio
- Paddle swap command
- Beacon: Programmable interval: 1 to 59 seconds
- Sidetone Output: TTL Square wave, 100Ω output Z
- Adjustable Sidetone frequency
- Keying output: TTL, high true when keyed
- Optional Speed control potentiometer support
- Push-button user interface
- 24 easy to use commands
- Built in receive & transmit code practice modes
- Operating Voltage: 3-7 VDC, built in oscillator
- Power Consumption: 5 ma active, 1 μA standby

DESCRIPTION

The K10 is a single chip Morse keyer with an extended set of features that will be described in this datasheet. It employs a Microchip PIC12C672 single chip microprocessor and requires minimal components to construct a powerful iambic keyer. The K10 has a rich set of commands that are entered directly in Morse code. Besides low power and low cost the K10 also provides Beacon and High Speed CW modes.



Top View

- Pin 1: VCC
- Pin 2: Key Out
- Pin 3: Sidetone Out
- Pin 4: Command Pushbutton
- Pin 5: Dit Paddle
- Pin 6: Dah Paddle
- Pin 7: Switch Network
- Pin 8: Ground

Typical Keyer Application

Figure 1 is a schematic of a complete K10 keyer using a minimum of components. The switch resistor network, the MSG2-4 switches, and the rate pot driving pin 7 provide optional features. Tie pin 7 to pin 1 if it is not used. The command push-button provides access to command mode and message one.

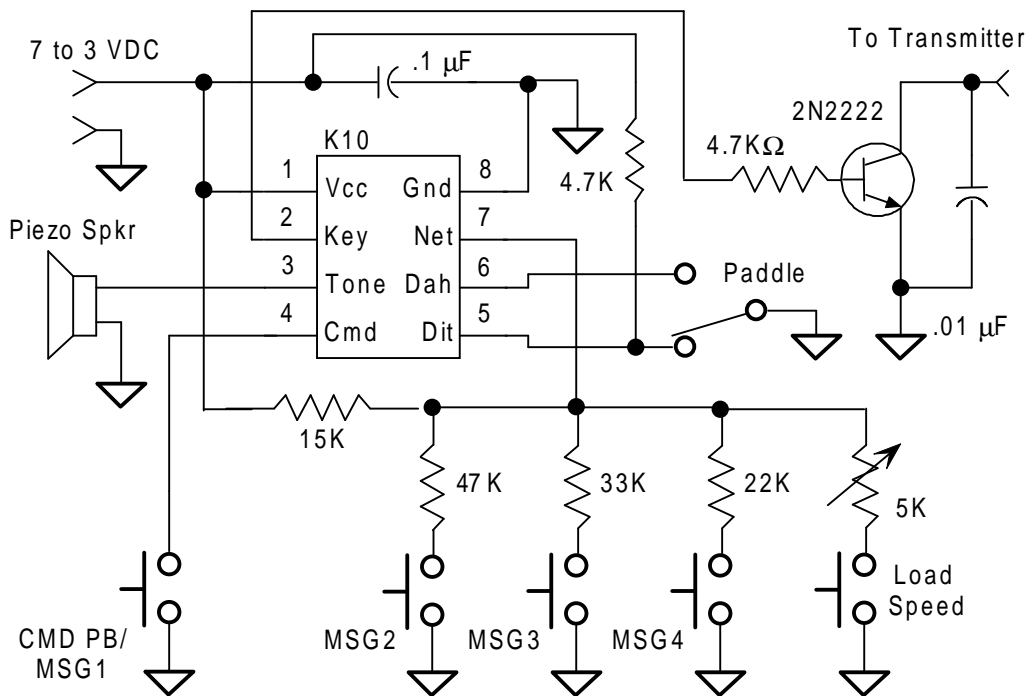


Figure 1

Keying Considerations

The K10 is not capable of directly keying a transmitter and requires a transistor buffer between the keyer chip and the transmitter. The schematic in Figure 1 uses positive keying. The diagram shown in Figure 2 would be used for negative keying. Most modern rigs utilize positive keying while older tube style rigs generally are negatively keyed.

The negative keying circuit in Figure 2 has a maximum rating of -30 volts at 20 ma. Some transmitters may exceed this rating and will require a more robust circuit

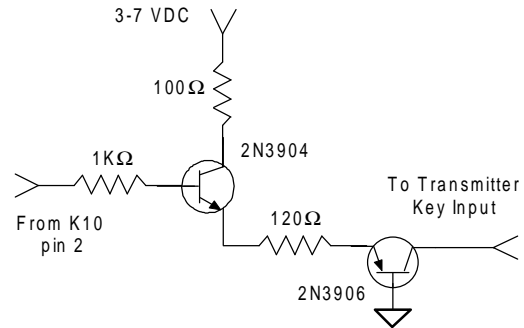


Figure 2

Construction

A K10 keyer can be constructed on a small piece of perf-board. The layout is not critical, be sure to include a .1 μ F power supply bypass capacitor and place it as close as possible to K10 pins 1 and 8. If using a supply greater than 5 volts, use a 78L05 regulator to provide 5 volts for the K10. A socket for the K10 is recommended to avoid damage during assembly and to allow future upgrades. Be sure to use normally open switches for the push-buttons. All parts can be purchased at a local Radio Shack store. The RS 273-073 piezo element works well as a sidetone output speaker. Use the interface shown in Figure 3 if you wish to drive a small speaker. If installing the K10 directly in a transceiver, the sidetone audio should be fed into the receiver's audio chain, it may be necessary to reduce the output level by using an attenuator network such as shown in Figure 4. Select R1 and R2 to give you the desired attenuation: $V_{OUT} = (V_{IN} \times R2) / (R1 + R2)$

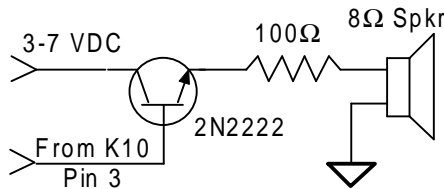


Figure 3

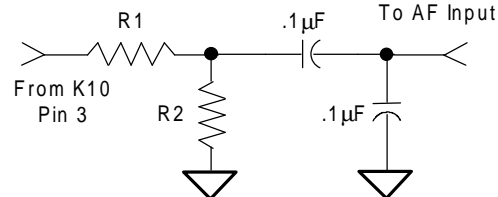


Figure 4

Input Considerations

A paddle or command push-button input is activated by switching it to ground. Pull-ups for pins 4 and 6 are built into the K10 so no external pull-up resistors are required. Pin 5 however **does** require an external pullup resistor (4.7 to 10K Ω). A shunt .001 μ F capacitor is recommended on each input to prevent RF from getting into the K10.

Push-button Functionality

The K10 requires at least one push-button control. This switch is referred to as the command push-button and it connects to pin 4. It serves two functions, command control and message record/playback control. Up to three additional message push-buttons can be added to provide a total of four message slots. Pin 7 is an analog input which senses the switch network shown in Figure 1. Message push-buttons 2 through 4 as well as an optional analog speed control all connect to Pin 7 as shown.

Command Mode

If the command push-button is pressed and held, the K10 will respond after about two seconds with the letter **R** in sidetone only. This means the K10 is ready to accept a command, you simply enter the command letter in Morse on the paddles and the command will be executed. Some commands require additional information which the K10 will prompt you for by outputting the letter **E** (for enter). All commands provide some sort of

feedback to tell you if the command was understood and executed properly. If an illegal command is entered the K10 will respond with a question mark.

K10 Command List

A - Select sidetone on or off	P - Start receive practice session
B - Start CW Beacon	Q - Query current WPM speeds
C - Set command speed in WPM	R - Review message without transmitting
D - Set Fast/Slow AFK tail delay	S - Set CW transmit speed in WPM
F - Set Farnsworth speed in WPM	T - Key transmitter for tuning
G - Select AF/normal keying	U - Select Autospacing on/off
H - HSCW mode enable	V - Start transmit practice session
I - Select Iambic mode A or B	W - Select 3:1 or 4:1 Dah:Dit ratio
K - Select straight or iambic key mode	X - Exchange Paddles
L - Load message memory slot on line	Y - Analog input diagnostic
M - Load message memory slot off line	Z - Select sidetone frequency
O - Select Tone or Keyed HSCW oscillator	

In the command descriptions below, the [n] or [nn] notation means that additional parameters must be entered on the paddles after the command. [pb] means that a message push-button response is required.

A - Sidetone enable is toggled when this command is entered. Toggle means if the sidetone was on when this command was issued it will be turned off and vice versa. The K10 will acknowledge this command by responding with an **R**.

B [nn]- This command starts a beacon transmit. After the command, the number of seconds **between** beacons must be entered. The minimum time is 1 second the maximum time is 59 seconds. Beacons will start just after the **B** command is issued and the contents of message slot 1 will be sent at the specified interval. Beacons are turned off by pressing the command push-button. As a signal that the beacon has been canceled the K10 will respond with **I**. Sophisticated beacon formats can be created by embedding commands in the message. See the *Message Functionality* section. HSCW Beacons are described in the HSCW section.

Note that the K10 can only beacon the message loaded in slot one, but through the use of the /A embedded command you can alternate between message slot one and two. Just include a single /A command at the end of each buffer and the K10 will switch buffers after every beacon. The K10 will not accept the **B** command if a message has not been loaded in slot one, it will respond with the empty warning: **MT**. Since the K10 goes into power down mode between beacons it will not respond to paddle or speed control change during beacons.

C [nn]- This command is used to set the command WPM speed of the K10. The K10 allows you to run the command WPM at a different rate than the transmit WPM. After the **C** command is issued enter the speed in WPM. See the **S** command for details on entering WPM speeds.

D - Sets the transmit turn off delay time in AFK and HSCW mode. You can toggle between two delays a fast delay which is 1.5 word space times and a slow delay which is 3 word space times. An **F** or **S** is the K10's response to this command (F=fast, S=slow).

F [nn]- This command is used to set a Farnsworth sending speed in WPM. After **F** the command is issued enter the speed in WPM, see the **S** command for details on entering WPM speeds. If you want to cancel Farnsworth simply enter a zero for the speed.

It is common at low speeds to use faster timing for the Morse letters than the time between letters, this is known as Farnsworth spacing. By default the letter and spacing are equal, the **F** command can be used to specify the letter speed while the spacing speed is determined by the **S** command. It is not possible to set a sending speed faster than the Farnsworth speed. You will find that the effect of Farnsworth spacing is only noticeable when sending a message or with autospacing mode enabled.

G - The K10 supports two types of transmitter keying. In normal CW mode, K10 pin 2 keys the transmitter and pin 3 provides a sidetone. In AF keying mode the transmitter is operated in phone mode, pin 2 keys the PTT line and sidetone from pin 3 is connected to the microphone input through a suitable attenuation and filtering circuit. The PTT keying has a built in release delay which keeps the transmitter keyed between CW letters

being sent. This delay is proportional to sending speed and can be changed using the **D** command. Each time the **G** command is issued the K10 will toggle between the two keying modes responding with an **A** for AFK or an **N** for normal mode.

H [n] - This command enables or disables HSCW mode. After receiving the H command, the K10 will prompt for the desired HSCW speed. Which you enter as a single number from the table below:

0 - Disable HSCW mode	4 - Enable 4000 lpm HSCW
1 - Enable 1500 lpm HSCW	6 - Enable 6000 lpm HSCW
2 - Enable 2000 lpm HSCW	

The section *High Speed CW Operation* describes how to use the K10 in HSCW mode.

I - Toggle between Iambic mode A and B. In either iambic mode, alternating dits and dahs are sent while both paddles are held closed. In mode B an extra alternate dit or dah is sent after both paddles are released. An **A** or **B** is the K10's response to this command.

K - The K10 can be placed in straight key mode with this command. A dah paddle press will key the transmitter for as long as the paddle is pressed. Use the swap command: **X** to choose either the left or right paddle. To get back to normal keyer mode, just press and hold the push-button, wait for the **R**, and enter the **K** command again. The K10 will leave straight key mode for command entry but will return after the command is complete. Run transmit practice in straight key mode to work on your straight keying skill..

L [pb], **M [pb]**- Both the **L** and **M** commands are used to load the message memory slots. There is a detailed description of message loading in the *Message Functionality* section. The two commands differ only in the fact that the **L** command loads the memory "on line" while keying the transmitter. **L** saves time by recording something that you will repeat later. The following fragments are good examples:

K1EL DE WA1QMO or CQ CQ CQ DE K1EL K

O - In HSCW mode the K10 can provide either a direct 2000 Hz tone output or a tone key which would be used to key an external oscillator. The **O** command will toggle between the two modes responding with an **T** for tone mode or a **K** for keyed mode. Note that the **O** command only applies to HSCW mode.

P [n]- The K10 has a built in CW receive practice mode. After the **P** command is issued the K10 will request a difficulty level. You then enter a letter from A to D which specifies the level of difficulty. Level A is the easiest and level D the hardest. After the level is entered, random letters are sent in groups of five with a space between each group. To end practice mode simply press the command push-button. Here is a description of the each practice level:

- Level A:** A,D,E,G,I,K,M,N,O,R,S,T,U,W
- Level B:** Level A plus B,C,F,H,J,L,P,Q,V,X,Y,Z
- Level C:** All letter and numbers
- Level D:** All letters, numbers, and punctuation including: SK, AS, BT, DN, AR

Q - This command is used to question the K10 about its current speed settings. After the command is issued the K10 will respond with three Morse speeds in the following format:

15 F25 C18

This example reports a sending speed of 15 WPM, a Farnsworth speed of 25 WPM, and a command speed of 18 WPM. Again, Farnsworth is the speed the letters are sent at while the sending speed is the effective speed, or speed between letters. You can stop the response message any time after the first speed is sent by pressing the command pushbutton.

R [pb] - You can review a message without transmitting using this command. After the **R** command is entered the K10 will respond with an **M**. You then press the message button of the message you wish to play. The message will be sent in sidetone only. If you try to play an empty slot the K10 will respond with **MT**.

S [nn]- The CW sending speed is set with this command. The new value is entered directly in WPM in the following manner. After the **S** command is issued the K10 will respond with a single **E**, you then directly enter the speed. As a short cut, a **T** can be entered for zero. If the desired speed is a single digit, either enter the single number, or send a zero or T first. i.e. **7** or **07** or **T7** for 7 WPM. Likewise **2T** can be entered for 20 WPM. If an illegal value is entered, the K10 will respond with a question mark, if the value is good the K10 will respond with an **R**.

T - After a brief pause, this command will key the transmitter for tuning. The K10 will stay in tune mode until the command push-button is pressed.

U - This command toggles autospace mode. When autospace is enabled the K10 will automatically insert proper inter-letter space between letters. Each time the **U** command is issued the K10 will toggle between modes responding with an **A** for autospace enabled an **N** for autospace disabled.

Here is how autospace works: If you pause for more than one dit time between a dit or dah the K10 will interpret this as a letter-space and will not send the next dit or dah until the letter-space time has been met. The normal letter-space is 3 dit spaces but this can be increased by using the **F** command. The K10 has a paddle event memory so that you can enter dits or dahs during the inter-letter space and the K10 will send them as they were entered. With a little practice, autospace will force you to send near perfect Morse.

V [n]- This command starts a transmit practice session. After the command enter a practice level from the table shown in the transmit practice command description above. After accepting the level the K10 will start by outputting a single Morse letter, you respond by echoing the letter back. If it was entered correctly the K10 will respond by resending the first letter followed by a second letter. Both of these must be echoed correctly. Finally three letters will be sent which must be echoed back. After the correct response the cycle starts over again with a new set. In addition to improving keying skills, this practice builds head copy and letter recognition skills.

If the K10 is not recognizing what you are sending make sure you are leaving proper space between letters and not sending too much faster or slower than the currently set sending speed (**S** command). As a real skill builder, try running receive practice in straight key mode.

W - This command is used to change the dit/dah ratio which is also referred to as weighting. The default ratio is three dits per one dah. As an alternative a four to one ratio can be selected. Every time this command is entered the ratio will toggle between 3:1 and 4:1. The K10 will always respond with a letter **R** to signify that this command was accepted.

X - This command will cause the K10 to exchange paddle Inputs (dit and dah). The K10 will always respond with a letter **R** to signify that this command was accepted.

Y - Analog input diagnostic. This command is used to verify the correct operation of the switch network connected to the analog input pin 7. This network allows three switches and a potentiometer to share a single pin on the K10. The K10 contains an analog to digital converter which can accurately measure the voltage on Pin 7 and determine which switch is activated.

After the **Y** command is issued, the analog input value on pin 7 will be sent in Morse in sidetone. Simply press a push-button or enable the speed potentiometer to obtain a reading. For proper operation the input values must fall within the following ranges:

No switch	255 to 200	PB 4	162 to 135
PB 2	200 to 184	Speed Pot	100* to 0
PB 3	183 to 163		

Z - This command allows the sidetone frequency to be modified. After this command is entered the sidetone oscillator will be turned on. Pressing the paddles will raise or lower the frequency. There are 8 possible choices: 1333, 1000, 800, 666, 570, 500, 440, and 400 Hz. Pressing the command push-button will end this command and store the new sidetone frequency.

Important Note ! When in command mode, transmitter keying is disabled and replies are sent in sidetone only. Thus in order to use command mode you must have some sort of sidetone connected. If sidetone had been disabled with the **A** command it will be re-enabled automatically when entering command mode.

Speed Potentiometer Functionality

The K10 supports the use of a potentiometer to set the sending speed. The “speed pot” is read using the K10’s analog input pin 7 which is shared with the message push-buttons. Due to this only one device, namely a push-button or pot, can be enabled at one time. This is why the pot must be switched in and out of the circuit. Another important reason is to reduce the power consumption in power down mode. Note that the pot is optional, speed can also be set by either the **S** command or by the *Fast Speed Set* feature described in the next section. To use the speed pot simply press the pot enable button and the K10 will output dits at the current speed in sidetone, just turn the knob to get the desired speed. The speed pot range is a subset of the entire speed range of the K10, 10 to 40 WPM. You can change speed while sending a message, dits won’t be sent and the speed will be updated after the current character is completed. You can calibrate the pot by pressing the pot enable push-button after issuing the Y command. Divide the number sent by the K10 by two and add ten to arrive at the speed value. Make tick marks around the pot’s knob to make up a dial. The speed pot’s range can be tailored by adjusting the value of the pot and/or adding series resistance (see appendix A). Note that the absolute maximum speed pot setting is 50 WPM.

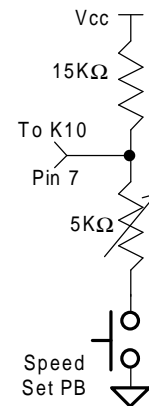


Figure 5

Fast Speed Set Feature

The sending speed can be quickly changed by holding the command push-button and then pressing the dit paddle to decrease the speed by 2 wpm or pressing the dah paddle to increase by 2 wpm. You must press the paddle before the normal command mode time-out occurs, but once in fast change mode it will stay there until the command push-button is released. A dit is sent each time the speed is incremented or decremented.

Message Functionality

Messages are loaded using the **L** or **M** commands. After the command is issued the K10 will respond with an **M** after which the desired message button must be pressed. When the K10 is ready to accept a new message it will respond with an **I**. The message is entered directly on the paddles at a steady rate, making sure to leave correct space between letters. To insert a word space simply pause for longer than a letter space and the K10 will respond with an **E** to signify a word space insertion. When the message has been completely entered press the command push-button and the K10 will respond with an **R** to signify that the message was accepted and stored. If an error is made while entering a message, press and hold the command push-button until the K10 responds with an **I**, this signifies that the last message was erased and a new one can be re-entered. If the message memory becomes full while entering a message the K10 will interrupt the load and respond with a **F**. This will automatically end the load and return the K10 back to non-command mode. There are 96 letters in message memory that can be distributed in any way between four message slots. The length of the messages is not fixed. This means, for example, you could have one message of 85 characters, one message with 5 characters, and a third with 10 characters. The fourth message would then be unavailable. Remember that each word space occupies one memory location.

If you are having problems entering messages into the K10, make sure you are leaving space between letters and not sending much faster or slower than the currently set command speed. If, for example, you enter an **A** followed by a **T** and end up with an **W**, you are not allowing enough space between letters. It’s a fine line though because if you allow too much space the K10 will interpret that as a word space. A good way to get the feel for “talking” to the K10 is to use the transmit practice command **V**. It will help you to improve your sending skill at the same time.

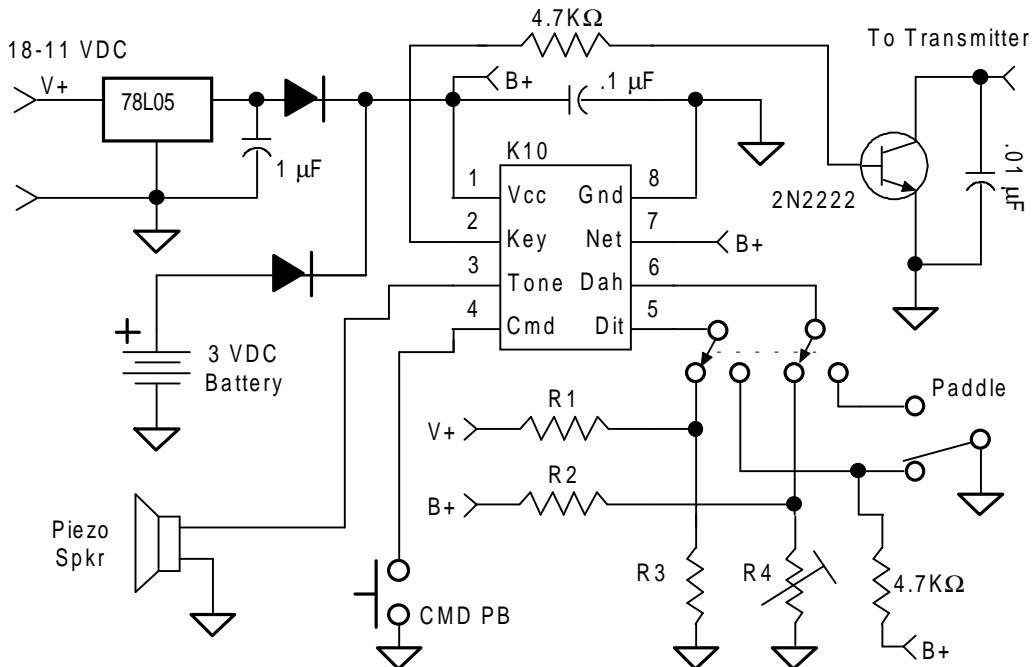
To play a message back simply press the desired message button and the message will be sent. If you want to review the message without keying the transmitter, use the **R** command. To abort a message being sent, press the command push-button and the transmission will stop after the current letter is complete.

There is a short cut for off line message loading. After initially pressing the command button, wait for the K10 to send an **R**, then press the desired message button. You can now directly enter a message without entering the **M** command. This is especially helpful in HSCW mode where new messages are frequently loaded.

Commands can be embedded in a message to allow message strings or control functions to be put in the buffer. The command format is the *slash* character **DN** (D and N sent together as one letter) followed by the command letter. If you want to insert a DN followed by a command letter into the buffer but don't want it to be interpreted as a command simply enter DN twice.

Embedded command table:

- /A Toggle beaconing between message buffer 1 and 2**
- /C Send "CQ CQ CQ" String**
- /K Key transmitter for 3 seconds, can concatenate for a longer duration**
- /N Send "NAME IS" string**
- /P Pause two word space times to allow text to be inserted**
- /Q Send "QTH IS" string**
- /R Send "UR RST IS" string**
- /1 Send Analog value on Pin 6 in decimal Morse**
- /2 Send Analog value on Pin 5 in decimal Morse**
- //1 Send /1 .i.e. don't treat it as a command**



Telemetry Beacon Application - Figure 6

The analog commands **/1** and **/2** are useful for telemetry beacons. After a beacon using these commands is started, analog sensors can be connected to the K10's paddle inputs pin 5 (GP2) and pin 6 (GP1). The voltage on the pin is sent in Morse as a number between 0 and 255 using the K10's Vcc voltage as a reference. For example, 255 is sent if the value equals Vcc and zero is sent if the value equals 0. Figure 6 above shows an example of a telemetry beacon that transmits temperature (R2,R4) and supply voltage (R1,R3). Also included is a voltage regulator and battery backup circuit. Be sure to **not** allow input pin values greater than the VCC or less than zero. Always use the K10's VCC as a reference. Microchip recommends a driving impedance of 10 KΩ to obtain accuracy better than +/- 1 LSB. Note that a DPDT switch is used to change over the inputs from paddle to sensors.

High Speed CW Operation

The K10 supports HSCW operation by being able to send character strings at 200 WPM speeds and higher. HSCW is used primarily to work stations by using Meteor Scatter propagation. The method of operation calls for short bursts of characters to be sent repetitively at high speeds for a predetermined period of time. The

receiving station listens and records the sporadically received bursts and plays them back at a slow speed to decipher the Morse message. See http://www.nitehawk.com/rasmit/ws1_15.html for more information.

When the K10 is in HSCW mode it operates normally and allows messages to be loaded into the message slots. When the message playback buttons are pressed however, the message will be sent at the rate specified when the **H** command was entered. The data can be sent either as a keyed tone or as pulses used to key an external oscillator (see **O** command). In either case a tone is fed to the transmitter's microphone input. The K10's key output is used to key the PTT input on the transmitter and incorporates a receive/transmit delay between keying and data output. Figure 7 below shows a basic HSCW setup, with a low true PTT output. The circuit within the LPF and attenuation block are application dependent and will be described in appendix B. It is important to remember to provide a sidetone output to allow feedback when commands are issued. In this circuit a buffer is placed between the K10 and the speaker to prevent excessive distortion to the HSCW audio output. This too is application dependent and some experimentation will be required.

When entering HSCW mode the K10 automatically switches to AF keying mode for normal paddle keying, this allows identification to be sent at low speed Morse using the paddles with the same transmitter connection. The K10 will stay in AF keying mode if you leave HSCW mode. Note that the sidetone enable/disable command **A** is inoperative in HSCW mode.

You can enable HSCW transmit looping by issuing a **B** command after entering HSCW mode. The K10 will respond with a **Y**. Now when you press a message button the K10 goes into a loop; transmitting for one minute and pausing for one minute over and over (timing accuracy is +/- 1 sec). This loop will continue until the command pushbutton is pressed. The K10 will send an **I** in sidetone to acknowledge the cancel. You can start another loop by pressing any message button. To cancel loop transmit mode simply enter the **B** command again and the K10 will answer with an **N** to acknowledge the cancel.

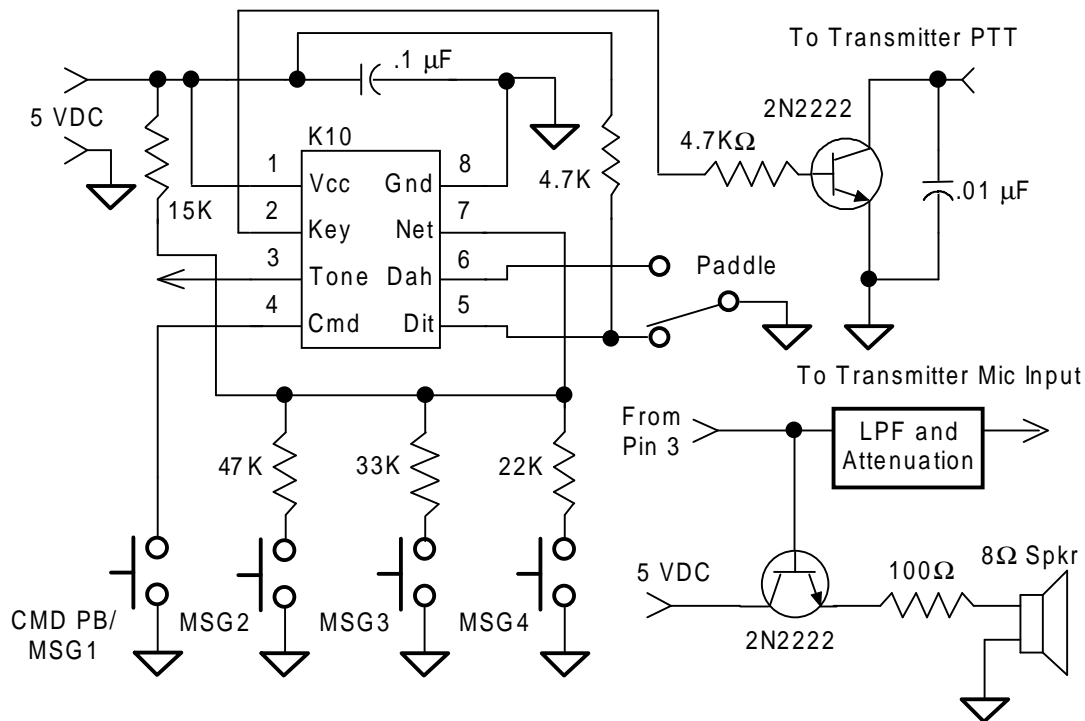


Figure 7 Typical HSCW Application

Restore Defaults (Cold Reset)

In the event the K10 accidentally gets into an undesired mode, or the command speed is accidentally set to some inoperable rate, default settings for speed and mode can be restored by pressing and holding the command button, past the **R** for about 4 seconds until the K10 sends a series of dits. At that point the power up defaults are restored. Note that the message contents are left untouched.

Sleep Mode

The K10 utilizes the automatic sleep mode of the PIC CPU. The K10 normally rests in sleep mode and draws about 1 μ A of DC current. When either the paddles or push-button(s) is pressed, the chip wakes up and goes into active mode drawing about 5 ma. After the paddle or push-button is serviced the K10 goes back to sleep.

The K10 keyer is fully guaranteed and if you are not satisfied please return the K10 IC and manual for a full refund. Any questions will be handled by snail-mail or e-mail via these addresses:

Steven T. Elliott K1EL
43 Meadowcrest Drive
Bedford, NH 03110 USA

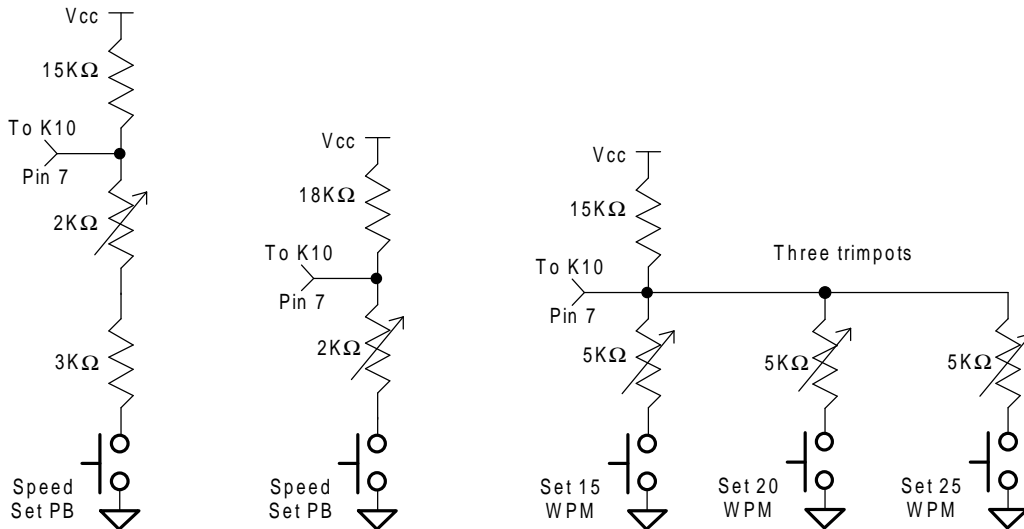
or e-mail: K1EL@aol.com

Watch the K1EL Website for latest updates and new product offerings:

<http://www.k1el.com>

Appendix A: Alternate Speed Pot Configurations

There are other ways of configuring the speed pot to provide a narrower range or use fixed values for fast speed changes. Below are three different options:



Appendix B: HSCW Audio LPF and Attenuator

This section describes the attenuation and low pass filter used for HSCW audio. Ideally the audio fed to a transmitter mic input should be as close to a sine wave as possible. The K10 provides a square wave output and it is not suitable to use without some sort of low pass filter to filter out the high frequency components of the signal. This can be a complex as an active audio filter set to a cutoff frequency of 2khz, or a simple PI RC network as described in figure 4.