

Introduction

The K40 is a single board Morse keyer with a built in IBM AT keyboard interface. It can be used as a keyer only or as a CW keyboard. All keyer configuration and control is entered through the keyboard. This is a kit product consisting of a double-sided PCB, two PIC microcontrollers, memory, board-mounted components, and keyboard connector. A 2 line by 16 character LCD display can be added as an option. Through hole components are used allowing easy assembly. This document describes how the K40 works, how to assemble one, and how to operate it.

Features

- Built-In PS/2 AT Keyboard Interface
- Iambic CW Paddle Interface
- PTT Output: Open Collector (low true)
- Key Output: Open Collector (low true)
- Adjustable lead in and tail delays
- Adjustable Speed 5-99 WPM
- Adjustable Weighting
- Adjustable Keying Compensation
- Built-In Sidetone Generator
- On Board Speaker
- Optional LCD Display
- Rotary Encoder for fast WPM change
- 12 Message memories
- Message pushbutton
- No crystals or oscillators
- Operating Voltage: 8-18 VDC
- On board regulated 5 volt supply
- Current Draw: < 5 ma less keyboard
- Embedded commands in messages
- Iambic A, B, and "Bug" keyer modes
- Built in CW practice modes
- Autospace
- First Dit/Dah adjustable correction
- HSCW/QRSS Output Capability
- Farnsworth speed mode
- Extensive RFI filtering
- Keyboard Paddles

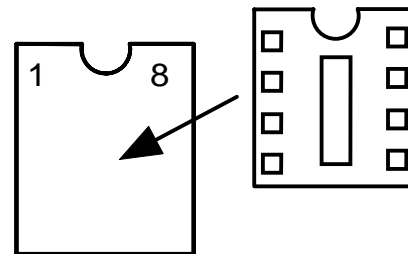
Assembly Instructions

The assembly of the K40 is very easy; all you need is a low wattage soldering iron, some solder, a few pieces of hook up wire, a decent pair of wire cutters, and small pliers. A VoltOhmMeter is handy for debug but not essential if you take your time and assemble the kit carefully. You will also need some sort of power supply that provides a voltage between 8 to 18 VDC (12VDC is optimum) at about 250 ma. These instructions will take you through a step by step process that will test portions as you go. This will make debugging much easier since if a problem arises you will be able to locate the source right away.

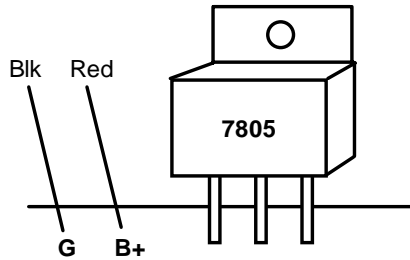
- 1) First off, inventory and identify all parts ahead of time using the Bill of Materials on Page 18. This will allow the assembly to proceed smoothly. You might want to verify resistor values with an ohmmeter if you are color impaired like I am.
- 2) After inventory, carefully inspect the PCB for any solder shorts between etches, it's easier to find one now.
- 3) First install the 1/4 watt resistors. It's easiest to start with R1 and do them in order. (skip R5, it's not installed) Observe the silk screen to make sure you are placing them correctly. Install the 6-pin R-network, the end with the

dot goes in the square hole. After soldering, trim the resistor and R network leads.

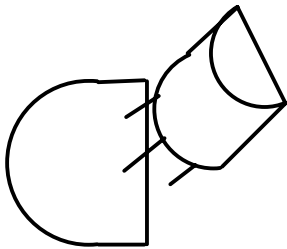
- 4) Next install the .01 uF capacitors followed by the .001uF capacitors. (skip C11, it's not installed) Then install the 47uF electrolytic cap. The long lead is the plus lead, look for the silk screen + to verify where it goes.



- 5) Next install the three DIP sockets. Orient them so the little notch in the top aligns with the notch in the silk screen. This will make it easier to correctly install the ICs later on. It's easier if you bend two legs over on the back to hold them in while you solder them in place. If you do this just make sure that the bent over lead doesn't accidentally short to an adjacent trace.
- 6) Now we will install and check out the 5-volt regulator. Orient VR1 as shown in the following diagram, heat sink facing board edge.

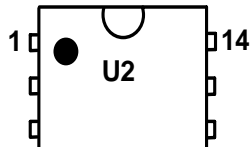


- 7) Next, strip and tin the ends of two pieces of hook up wire, one red, one black. Install the black wire as shown in the G hole and the red wire in the B+ hole. These are our power supply input leads. To test the regulator, connect the power leads to a power source that can provide something in the range of 8 to 16 volts DC. Connect the red lead to the positive power terminal and black to the negative. Turn on the power and measure the voltage between pin 1 and 14 on U2 with a voltmeter. Pin 1 should sit at +5 volts relative to pin 14, if it doesn't recheck that VR1 is in correctly and there aren't any solder shorts. Remove power after testing.
- 8) Install Q3 observing that the flat face of the transistor lines up with the silk screen.



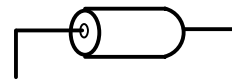
Next install the speaker, make sure you put the long speaker lead or plus side through the hole with a + sign next to it.

- 8) Next we will install all three ICs. Carefully install U2 (the 16F688 PIC with the red dot) in the socket next to the R-network. Align the



little circular notch on the IC and with the socket's notch. Now install the 16F688 Console PIC U3 (no dot) observing pin 1 alignment. Finally, install the 24LC32B EEPROM U4. *Note that all ICs on the boards are oriented the same way.*

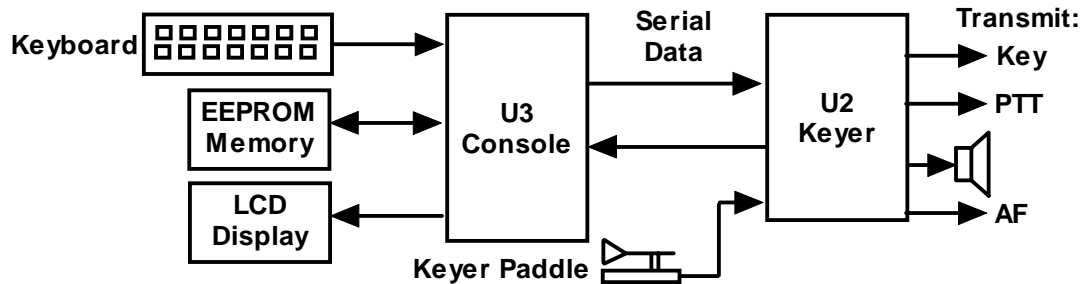
- 9) Now we will test the Keyer PIC. First of all, install two lengths of hook up wire in the PCB holes marked DAH and DIT, these will be your paddle keying leads. Connect a third wire to the G hole next to the AF hole. This will be the common return from the keyer paddles.
- 10) Turn on the power then touch the keying leads to the keying ground lead, you should get dits, dahs, and alternating dits/dahs if you hold all three together. If there is a problem here, the first place to check that Q3 & R4 are in right. Poor soldering is the most common source of assembly problems. Remove power after testing.
- 11) Now install the keying transistor Q1 and the PTT transistor Q2.
- 11) We are now at the keyboard interface. First install L1 and L2, these consist of a ferrite bead on a resistor lead:



- 12) Next, install the keyboard connector J1, the holes are a tight fit but if you take your time you'll find it will slide into place. **NOTE:** Make sure the connector body is flush against the PCB before you solder it in place.
- 13) Install potentiometer R6 with screw adjust close to the silkscreened R6 (see page 20).
- 14) Test the keyboard interface: Plug in a PS/2 style keyboard into J1. (Please don't use an old IBM-XT keyboard with an adapter as it won't work and may damage the K40, USB keyboards with a PS/2 adapter are OK). Turn on power and you'll hear the KEYER PIC send an "R". At the same time the lights on the keyboard should turn on and then go out, in any case the lights should be off after power up. Now press the NUMLOCK key and the NUMLOCK light on the keyboard should turn on. Press it again and it'll turn off. Press any letter key and it will be sent in Morse sidetone with the PTT and KEY lines activated as well.
- 15) That's it! After reading through the theory of operations it's on to the command section to learn about the K40 command set.

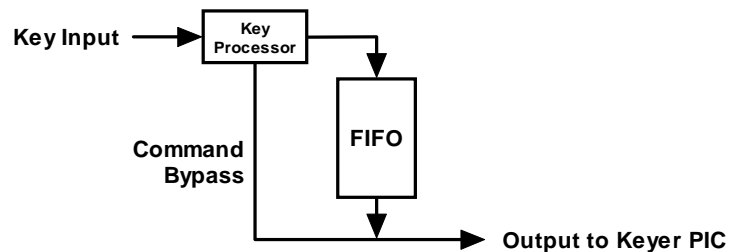
Theory of Operation

This section will help you learn how the K40 works. As shown in the block diagram two PIC processors share the task of converting keystrokes to Morse code. U3, the console PIC, is responsible for retrieving keystrokes from the keyboard and determining what to do with them. U2 is the Keyer PIC which is a slave to the console, its main task is to generate Morse code and monitor the keyer paddle inputs. It throttles the Console PIC via the flow control signal. The 4-kilobyte EEPROM memory stores up to 12 messages, system settings, and holds the keyboard type ahead and LCD display buffers.

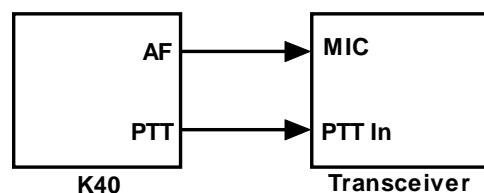


There are two types of keyboard inputs: Commands and Data. Commands modify the K40's operation in some way, for example changing operating speed, turning off sidetone, recording a message etc. Data are letters, numbers, or prosigns that are to be sent in Morse. Commands and data are processed differently by the K40. Data is put into a type ahead buffer that allows the user to type faster than the Morse that is being sent. The size of this buffer is about 200 characters and is a FIFO which is an acronym for First In First Out. This means that characters are taken out in the order they were put in. Since there can be a considerable delay from keyboard input to Morse output, commands bypass the input FIFO and are sent to the Keyer PIC immediately. This allows changes to be made immediately while sending is underway. The command bypass also allows one message to be sent while another is being entered.

Since there are times when you don't want commands to take effect immediately, the K40 allows commands to be buffered. This means that the command is placed in the typeahead buffer and won't be acted on until it comes out of the buffer. An example of the use of a buffered command would be to send two words at two different speeds, the first at 15 WPM and the second at 20 WPM. By placing a buffered speed command between the words the speed will not be changed until the first word is completely sent. Not all, but many of the immediate commands can be entered as buffered commands. Most often, buffered commands are used in messages. This will be covered in the message entry section.



The K40 provides a low-level filtered "near sinewave" sidetone audio output which can be fed into the microphone of a transmitter. By keying the transmitter with the PTT output you have AF driven CW (MCW). The PTT output is open collector and in most cases can drive the transmitter PTT input directly. Full control over PTT is provided to compensate for transmit changeover delay and hold keying between letters and words.

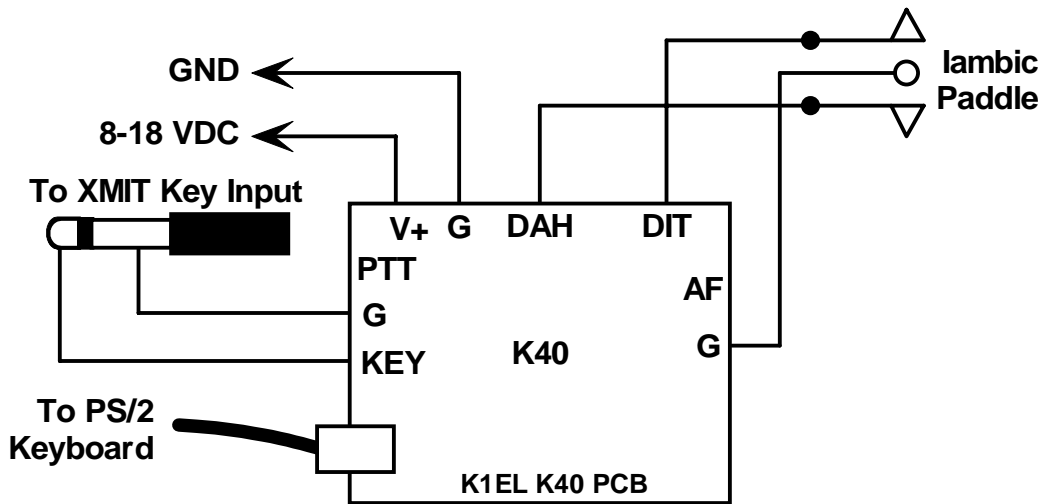


Paddle status is read directly through input pins on the console PIC. The K40 also has a built in speaker driver that can drive either an on board Piezo speaker or an external 8-ohm speaker. The volume is fixed by an on-board resistor.

The K40 provides an interface for an optional LCD display. The interface is fixed format at 16 characters by 2 lines. The interface is compatible with most, if not all, LCD displays based on the Hitachi HD44780 controller I.C. The display allows the user to see what is being typed in while sending and do basic editing. It is also possible to scroll back to view the last 14 lines typed in. The outgoing viewport can be selected by hitting the TAB key which allows the user to see outgoing Morse as it is being sent. The outgoing buffer is much larger at 125 lines. A cursor is shown when viewing the edit buffer, the cursor is not shown in the outgoing buffer.

Using the K40

The following diagram illustrates a basic K40 set up. The paddle is optional and is not a requirement. Likewise the K40 could be used without the keyboard but it would not be possible to enter commands, or play messages. The PTT output is used primarily in HSCW and AF keying modes. A PTT connection would not be required for normal CW keying of a transmitter or transceiver. The on-board keying circuit on the K40 PCB is only capable of keying positive voltages up to 60 VDC. It is not compatible with negative keying voltages and external circuitry is required.



The sidetone SP output can drive an 8-ohm speaker in a situation where you need more sidetone volume. The 100-ohm resistor R8 fixes the volume level and can be adjusted to suit. In most configurations you will use the sidetone built into your transceiver, but it's nice to have it for practice or testing purposes.

When the K40 powers up it will automatically load its settings from EEPROM and be ready to use. Messages will be preserved from your last session as well as any setting you may have saved.

!! Important Note: Some older keyboards draw a significant amount of power and can cause the 7805 regulator to overheat. A heatsink maybe required in some extreme cases !!

Office Max and Staples (as well as others) sell AT style keyboards made by Belkin and Fellowes which work great with the K40 and can be bought for \$5 with rebate. They draw a tiny amount of current and allow a couple of months of typical operation with a 9-volt battery.

Shift/ALT/CTL Keys

This is basic stuff but, the Shift, Ctrl, and Alt keys allow multiple key functions to be assigned to a single key. If you are not familiar with these keys here's how they are used:

- 1) Press and hold the CTL key then press the letter A for CTL-A.
- 2) Press and hold the ALT key then press the letter A for ALT-A.
- 3) Press and hold the SHIFT key then press the letter A for SHIFT-A.

4) Press the A key by itself for the letter A

In this User Manual: SHIFT-key refers to a key pressed with Shift: **SHIFT-F1** for example
 ALT-key refers to a key pressed with Alt: **ALT-PGUP** for example
 ^key refers to a key pressed with Ctrl: **^C, ^B** for example

General Information

The K40 accepts input from a keyboard or iambic paddle; you can switch between them whenever you want. Just remember if there is data being sent out of the circular buffer when you press the paddles, the two may collide and give you unexpected results. If you want to pause the K40 in order to use the paddles just press the Insert key.

When you press a command key that requires additional parameters, the CAPS light on the keyboard will turn on to remind you that more keystrokes are required to finish the command. When recording a message or other stored information the CAPS light will stay on until recording is ended. When the K40 is in pause state (via the INSERT KEY or by the ^P buffered wait command) the CAPS light will flash to remind you the K40 is paused and waiting for user intervention (press INSERT) to continue. The SCROLL LOCK light is used to signify when either a message buffer or the type ahead buffer is full, more on this later. Most of the information on how to use the keyer revolves around the command set so we will dive right in.

Command Description by Key

Note: SHIFT-F1 means F1 pressed while the shift key is held. For clarity a space is placed between commands and values in the following examples, in reality no spaces are used in any command. Likewise argument values shown enclosed with <> are entered without the <>. So an example like:

SHIFT-F2 <45> should really be entered as **SHIFT-F2 4 5**

F1 through F12: Send Message

Messages are assigned to the twelve function keys. Hitting one of these keys will cause a message to be queued up and sent after the current contents of the FIFO buffer have been sent, in other words they are buffered. There is no way to send a message immediately except to first clear the FIFO buffer with the ESC key and then send the message. If you hit the message key of an empty slot nothing will happen. See below for instructions on how to load a message.

SHIFT-F1: Save Something in Memory

The K40 has the ability to store messages and other items in non-volatile memory. Non-volatile means that the memory contents are preserved even if power is turned off. Recording begins by pressing the SHIFT-F1 key; the following chart shows all available recording options:

SHIFT-F1 followed by:	F1-F12	- Record a message
	SHIFT F9-F12	- Set a Fast WPM key
	SHIFT 0-9	- Record a Custom Prosign
	M	- Map a numeric
	P	- Store current settings as the power-on default

Message Recording

Message recording is easy, let's say you want to put a new message in slot F4, first press SHIFT-F1 then press F4. The CAPS light will come on to let you know that you are in record mode and you can then enter your message. If you make a mistake you can back up using the BACKSPACE key. At any time you can abort by pressing the ESC key. Any alphanumeric key or prosign can be put into a message as well as any buffered command. The message slots are fixed in size, when you get to within 8 entries of the slot being full the SCROLL LOCK light will turn on. When you reach the end of the slot (Slot FULL) the SCROLL LOCK light will flash. When you are all finished and want to save the message, press the ENTER key and the CAPS LOCK light will go out. If you want to review your message, without actually sending it, hit the Transmit Mute key (SHIFT-F7) followed by the desired message key and your message will be played in sidetone only. (Don't forget to turn off transmit mute when you are ready to go "live" again). The following chart shows the sizes of the 12 message buffers in letters/commands:

F1 - 192	F4 - 192	F7 - 192	F10 - 112
F2 - 192	F5 - 192	F8 - 112	F11 - 32
F3 - 192	F6 - 192	F9 - 112	F12 - 32

Fast WPM Keys

Four command keys SHIFT-F9 through SHIFT-F12 are assigned as Fast WPM change keys. You can program these keys to speeds of your choice. To set these keys simply press SHIFT-F1 followed by the desired Fast WPM key and a two digit number from 5-99. For example, to set the SHIFT-F10 key to 14 WPM enter the sequence:

```
SHIFT-F1 SHIFT-F10 <14>
```

NOTE: Fast WPM settings are not automatically saved in EEPROM, to save them you need to enter the "Preserve Settings" command (SHIFT-F1 P) described in a later section.

Custom Prosigns

You can permanently assign 11 custom prosigns. A "prosign" in this context is simply any two normal characters concatenated into a single character. The 11 abbreviation keys ~!@#%&^*() are reserved for custom prosigns. Several common prosigns such as AR, SK, BT, And DN are already assigned (see page 13) so you don't have to add these. One application of this feature could be adding special European language characters or uncommon prosigns. Note that _ and + can not be remapped. To illustrate how the command works let's assign AS to the @ key, just enter the following sequence:

```
SHIFT-F1 @ A S
```

From this time on, anytime you press @ AS will be sent. Custom prosigns are automatically stored in EEPROM after they are entered.

Numeric Mapping

Numeric Mapping allows you to substitute a letter for a number when sending a serial number. T is a popular mapping for zero but you can choose what you like for 0 and any other numbers 1-9. To record a mapping press SHIFT-F1 followed by M. After the CAPS light turns on, press the number you want to map followed by what you want it to map to. So to map 0 to T you enter the sequence:

```
SHIFT-F1 M 0 T
```

NOTE: Only 0 through 9 can be mapped. Numeric mappings are not automatically saved in EEPROM, to save them you need to enter the "Preserve Settings" command (SHIFT-F1 P) described below.

Preserving Settings

The basic settings of the K40 reside in EEPROM so that they are preserved when power is shut off. When the K40 is powered on for the first time a default set of values are loaded into EEPROM. You can customize these defaults very easily. When you have the K40 setup the way you like it, just press SHIFT-F1 followed by the letter P and current settings for the following items will be saved in EEPROM memory:

Speed	Paddle Swap	Paddle Sensitivity
Weight	Sidetone disable	Fast WPM keys
Character Spacing	Sidetone Frequency	Numeric mapping
Iambic Mode	PTT delays	Pin Configuration
Autospace Setting	Serial number	

SHIFT-F2: Change Sending Speed

This immediate command will set the current WPM speed to whatever you desire. The syntax for the command is:

```
SHIFT-F2 <nn> where nn is a two digit decimal speed from 05 to 99 WPM
```

Two digits must be entered or the command will be ignored. Note that you can also change speed in increments of 1 WPM with the UP and DOWN arrow keys and the rotary encoder. See the section on buffered commands to learn how buffered speed changes are made.

SHIFT-F4: Morse Code Practice

A dual mode multi-level code practice program is built into the K40. It's accessed via the SHIFT-F4 command key. There are two styles of practice, receive only and echo (receive/respond) practice. There are four levels of practice organized by easy to difficult letter groups. The four levels are:

Level 1: E T A N I M W S G D U K O R

Level 2: C Q P J F B V Y H X Z L including level 1

Level 3: 1 2 3 4 5 6 7 8 9 0 including level 1 & 2

Level 4: ? / , . AR SK BT AS including level 1 & 2 & 3

The syntax for entering a practice mode is:

SHIFT-F4<style><level> where style is R for receive or E for echo practice

SHIFT-F4 R2 selects Level 2 receive practice

SHIFT-F4 E4 selects Level 4 echo practice

Receive Practice Description: Random characters from the selected level are sent in groups of five. Practice will continue until the ESC key is pressed.

Echo Receive/Transmit Practice Description: The K40 will send a character from the selected level and you must respond by echoing the character back on the keyboard. If you get it right the K40 will repeat the first character followed by a new character. Now you must echo back both characters. The K40 will continue to add characters until it reaches five after which it will start with a new set. If you miss a character the K40 will send 8 dits and start over with a new sequence of characters. When you want to end this practice hit the ESC key and the K40 will send an SK to let you know it's done.

Known Bug: If you hit a message key during Echo practice the K40 will send random characters for the length of the message and then go back to echo practice.

SHIFT-F5: Toggle Farnsworth Sending

Farnsworth spacing is useful for CW practice because it encourages you to learn characters by sound not individual dits and dahs. In the K40, Farnsworth is implemented by sending letters at a fixed rate of 18 WPM regardless what the WPM sending rate is. Spacing between characters is determined by the sending rate. When the WPM rate is set above 18 WPM, Farnsworth is automatically disabled. It's a "toggle" command which means if Farnsworth is on when you press SHIFT-F5 it'll be turned off, if it's off you'll turn it on

SHIFT-F6: Toggle Sidetone

This is how you turn sidetone on and off. If you would rather use the sidetone already provided by your transceiver just disable the K40 sidetone, it's not required. This command is both an immediate and a toggle command.

SHIFT-F7: Toggle Transmitter Muting

This command allows you to temporarily disable the Key and PTT outputs. Sidetone is not affected by this command. Transmit muting is useful for verifying a message "off line" or for code practice. This is both an immediate and toggle command.

SHIFT-F8: Tune Toggle

Use this command to force transmit keying to a constant key down condition. Both the KEY and PTT outputs are turned on. Press SHIFT-F8 again to cancel tune. ESC will also cancel a tune command.

SHIFT-F9 through SHIFT-F12: Fast WPM Keys

In contesting or just general QSO hunting it's handy to have several preset CW speed settings that you can select with a single key press. One key press and the operating speed is changed. You learned how to program these keys in the SHIFT-F1 section.

ALT Commands

The ALT command keys are configuration commands that setup K40 operating preferences. In most cases you'll set these once, save them to memory, and not think about them again. Remember to use the SHIFT-F1 P command to save these settings in EEPROM so that they will be loaded next time you power up.

ALT-F2: PTT Lead In Delay Time

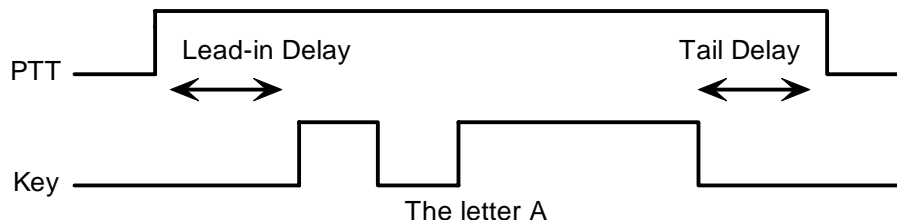
The K40 provides a transmitter PTT output that can be used to switch a transmitter over to transmit mode in advance of actual CW keying. You have control over the time delay between when PTT is asserted and when CW keying will start. The format for the command is:

ALT-F2 <nn> where nn is a two digit number calling out the delay in 10's of milliseconds.

nn= 26 selects 260 milliseconds. The maximum delay that can be set is 99 or 990 milliseconds.

ALT-F3: PTT Tail Delay Time

Time delay to PTT deassertion is programmed in units of 10 mSecs. The syntax is the same as ALT-F2.

**ALT-F4: Set Serial Number**

For contesting, the ability to send and keep track of a serial number is indispensable. This command allows you to preset the serial number to any 4 digit number from 0000 to 9999. Just hit ALT-F4, wait for the CAPS LOCK to light and enter 4 numbers. If you make a mistake hit ESC to cancel and re-enter the number (in other words backspace won't work on this guy). Any non-numeric entered will cause the K40 to simply ignore the command and not change the serial number. Once the serial number is set you can increment, decrement, and send the serial number using buffered commands CTL-I, CTL-D, and CTL-N respectively.

ALT-F5: Toggle Contest Spacing

By default, the spacing between words is 7 dit times, this will toggle to 6 dit times.

ALT-F6: Select Paddle Mode (applies to paddle input only)

The K40 supports four keying modes: Iambic A, B, Ultimatic and Bug manual keying modes. In Iambic mode the K40 makes both dits and dahs automatically based on which paddle you press but in bug mode the K40 makes the dits and you make the dahs. You also can use bug mode to operate in straight key mode or if you want to key through the K40 with a different keyer, simply set bug mode and use the dah input to key the K40. 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. In Ultimatic mode when both paddles are pressed the keyer will send a continuous stream of whichever paddle was last pressed. Everytime you hit ALT-F6 the K40 will cycle to the next keying mode, IambicA->IambicB->Bug->Ultimatic->IambicA.

ALT-F7: Toggle Autospace (applies to paddle input only)

Here is how autospace works: If you pause for more than one dit time between a dit or dah the K40 will interpret this as a letter-space and will not send the next dit or dah until a full letter-space time has been met. The normal letter-space is 3 dit spaces but by using the ALT-LEFT and ALT-RIGHT commands you can modify this. The K40 has a paddle event memory so that you can enter dits or dahs during the inter-letter space and the K40 will send them as they were entered. With a little practice, autospace will help you to send perfectly spaced Morse.

ALT-F8: Modify Output port

You can operate the K40 to run in a SO2R mode. This command will toggle between three modes:

Mode 1: Key Output = Key, PTT Output=PTT (normal default)	LCD Displays: K1P2
Mode 2: Key Output=Key, PTT always deasserted	LCD Displays: K1
Mode 3: Key always deasserted, PTT Output=Key	LCD Displays: K2

ALT-F9: Swap Paddles (applies to paddle input only)

You can swap paddles with the command. This is a nice feature to have when right and left handed ops want to share the same keyer.

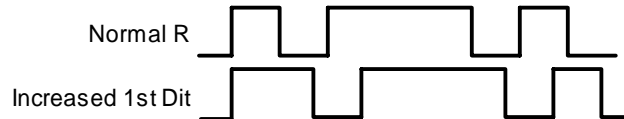
ALT-F10: Set 1st Extension

The K40 addresses problems often encountered when keying older transceivers with slow break in response. Due to a slow receive to transmit changeover time, the first dit or dah of a letter sequence can be

chopped and reduced in length. Adding a fixed amount to the first element of a sequence can compensate this for. In other words if an R is sent the first dit will be elongated but the subsequent dah-dit is sent normally. The compensation amount is transceiver dependent and is generally independent of sending speed. Note though that this is usually only a noticeable problem at higher CW speeds >25 WPM.

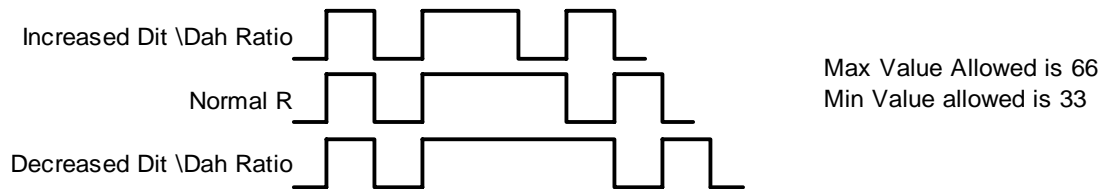
ALT-F10 <nn> where nn is a two digit number (0-99) calling out the delay in milliseconds.

A challenge in this scheme is to determine when sending has stopped long enough to cause the transceiver to switch back to receive. If it has it'll require a new first element correction on the next sequence. The K40 uses the PTT tail timer to determine this, set the tail timer to roughly match the transmit to receive changeover time of the transceiver and things will work fine. It takes some trial and error to get it set up right so make sure you save the values in EEPROM when you're done using the **SHIFT-F1 P** command.



ALT-F11 <nn> Set Dit/Dah Ratio

Default is 50 for standard 1:3. Smaller values decrease ratio larger values increase ratio. This causes an intentional distortion of the Morse waveform. Some ops use this option to make their CW sound less "machine like". Purists (myself included) recommend that you should always leave the ratio set at 1:3 which is the universal standard.



ALT-F12: Start Persistent Beacon

When this command is issued, the K40 will send the message in slot 1 (F1) repetitively. A jump to message F1 command is not required at the end of the message. The message can contain any valid command, and calls or jumps to other messages will be honored. It is called persistent because if power is lost and then restored the beacon will continue to cycle. The beacon is ended by hitting the ESC (escape key).

ALT-PGDN: Decrease Paddle Sensitivity (applies to paddle input only)

ALT-PGUP: Increase Paddle Sensitivity

This controls when the K40 will start looking for a new paddle press after sensing the current one. The K40 doesn't wait for a dit or dah to finish before looking for the next paddle action. This means there needs to be a delay to allow you to get off a paddle before it's latched again. If there were no delay the keyer would send dits or dahs continually, if there is too much delay it bogs you down because you can't get ahead of the keyer. The default value is one dit time and is adjustable in units of 1/10th of a dit time. Faster operators report a setting somewhat less than default is more pleasing. Use the ALT-HOME command to check the setting. The delay is calculated with this formula:

$DELAY_TIME = (SENSITIVITY * DIT_TIME) / 10$ where Sensitivity is a value between 5 and 33, 10 is default

ALT-HOME: Status

Hitting this key will cause several status values to be sent in Morse. **Hit ESC to cancel, revision E only.

The following values are sent:

Console Software Revision	(single letter)
Keyer Software Revision	(single letter)
WPM Setting	S+(one or two digits 5 – 99)
Sidetone Freq	Q+(one or two digits 0 – 10)
Weighting	W+(two digits 10 – 89)
PTT Lead In Delay	L+(one or two digits 0 – 99)
PTT Tail Delay	T+(one or two digits 0 – 99)
1 st bit Adjust	X+(one or two digits 0 – 99)

Key Compensation	K+(one or two digits 0 – 99)
Farnsworth	F+("0" if off, "18" if on)
Paddle Sensitivity	J+(two digits 10-90)
Dit/Dah Ratio	R+(two digits 10-90)

CTL-ALT-DEL: Clear EEPROM and Restart

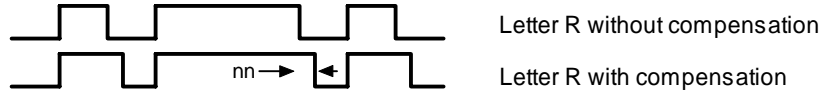
This causes the K40 to clear all of EEPROM and reload the factory settings. Be careful when using this because it will erase all of your messages, prosigns, and numeric mappings. The factory settings are:

Speed = 15 WPM	Extra Space = 0	Shift-F9 = 13 WPM
Autospace off	1 st Extension = 0	Shift-F10 = 15 WPM
Iambic B	KeyComp/Weighting normal	Shift-F11 = 18 WPM
PTT Delays = 0	Ratio normal	Shift-F12 = 20 WPM

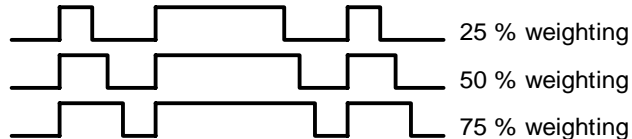
Known bug: only one of the two delete keys on the keyboard will work for CTL-ALT-DEL

UP ARROW: Increase Speed by 1 WPM**DOWN ARROW: Decrease Speed by 1 WPM****ALT-RIGHT<nn> : Set Key Compensation**

Keying Compensation allows a fixed amount of time to be added to the length of all dits and dahs. QSK keying on modern transceivers can cause shortening of these elements which is especially noticeable at high speeds. The K12 allows the length of the elements to be increased uniformly to compensate for this. The adjustments can be made in one-millisecond steps. The maximum adjustment is 31 mSecs. Key compensation is very similar to Weighting in that any adjustment added to the dits and dahs is subtracted from the spacing so the resulting speed is not changed. The difference between weighting and keying compensation is that compensation is independent of speed, so if 10 mSec of key compensation is selected, 10 mSec will be always be added regardless of speed. So be careful at high speeds with large values of keying compensation, dits and dahs may run together with no spacing at all.

**ALT-LEFT<nn>: Set Key Weighting**

The keying weight can be adjusted in percentage from 25% to 75%. When set to 50 % the dit time is equal to the inter-element time, which is normal. Values less than 50 reduce weighting while values greater than 50 increase weighting. Note that weighting does not affect sending speed because any increase in keyed time is subtracted from spacing time. Reduction in weighting results in a thinner sound while increased weighting results in a heavier sound. Since weighting will track speed, one weighting setting will sound the same at all speeds.

**ALT-UP: Increase Sidetone Frequency****ALT-DOWN: Decrease Sidetone Frequency**

Sidetone frequency can be adjusted in fixed steps. The steps are specified in the following chart:

400 Hz	571 Hz	1000 Hz
444 Hz	666 Hz	1333 Hz
500 Hz	800 Hz	2000 Hz

HOME: Return Display to Home Position**END: Fast Callsign Entry (revision E only)**

You can quickly and easily enter a message in slot F12 by pressing END. It's intended to be used to enter a callsign on the fly. When you have entered your text hit return to save. Pressing the END key will bring up a small text entry window in the upper left hand corner of the LCD display. This allow you to see what you are entering while referencing the rest of the display, handy for picking out a callsign.

SHIFT-TAB: Clear Keyboard Display

Clears the keyboard display, the transmit display is not cleared. **In revision E both displays are cleared

ESC: Abort/Clear Buffer

This can be pressed at any time to abort a message, abort a command, or to clear the typeahead buffer. If this is pressed during message entry the message buffer will be cleared and you effectively can start over at the beginning. (Note: You need to press enter to exit message entry mode, ESC just clears what you have entered and starts you over)

INSERT: Pause

You can put the K40 into pause with either of these keys. Sending will stop immediately and will not resume until Insert or Tab is pressed again. While the K40 is paused the CAPS Lock light on the keyboard will flash.

DEL: Send Error Dits

Eight dits will be sent to signify a CW error.

Right Arrow: Increment Serial Number**Left Arrow: Decrement Serial Number****Buffered Command Language**

A simple yet powerful command set is provided that allows you to assemble complex CW messages. The language revolves around 13 basic commands. These commands can be inserted into a message to perform various functions. They occupy space in the message slot so be careful in using them when the slot is close to being full. Review the SHIFT-F1 command to learn how to record a message. When F1 or some other message key is referred to in the examples this just means you press the F1 (or whatever) key. Following is a list of the commands including descriptions:

F1-F12 - Jump to message

As mentioned previously, message keys are buffered commands which are sent as they are taken out of the FIFO buffer. The ability to jump from one message to another is very useful. Here's a simple example:

Load Slot F1 with: CQ CQ F3
 Load Slot F2 with: QRZ QRZ F3
 Load Slot F3 with: DE K1EL K

Message F1 will be sent as: CQ CQ DE K1EL K
 Message F2 will be sent as: QRZ QRZ DE K1EL K

Jump can be used to make a message loop, here how:

Load Slot F1 with: CQ CQ CQ CQ DE K1EL K1EL K1EL F1

After sending CQ CQ CQ CQ DE K1EL K1EL K1EL we loop back to the beginning and send it again. This will repeat forever until the ESC key is pressed.

CTL-C <F1-F12> - Call a message

The call command will jump to the specified message, send that message, and after the message completes the stream will return to where it was called. It is more flexible than a jump to message. An example of this command is:

Load slot F1 with: ^C F2 ^C F2 de ^C F3 ^C F3 BTU OM KN
 Load slot F2 with: WA1ABC
 Load Slot F3 with: K1EL

Message F1 will play as: WA1ABC WA1ABC DE K1EL K1EL BTU OM KN

This illustrates a powerful feature; you can build up complicated messages that can be reused by substituting different callsigns in a called slot. In this example the complicated message is in slot F1 and the called slots are F2 and F3. Even though F2 and F3 are called by F1 they can still be sent individually.

CTL-D - Decrement Serial Number

The four digit serial number is decremented by one. If equal to zero the serial number is not decremented.

CTL-I - Increment Serial Number

The four digit serial number is incremented. If equal to 9999 it is not incremented.

CTL-K <nn>- Key down for nn seconds

The transmitter will be held in key down state until the timer expires.

CTL-L <nn> - Load Loop Count (nn = 01 → 99)

This command works in conjunction with the CTL-Z command. A loop count is entered with this command. The CTL-Z command will decrement this loop count and will repeat a message until the loop count reaches zero. See the CTL-Z description for more info.

CTL-M <C1><C2> - Merge Next Two Letters into a Prosign

You can build "on the fly" prosigns with this command. Just press CTL-M followed by two letters or numbers and they will be merged together: ^MAR is sent as AR. Note that nothing will be sent until both letters have been entered.

CTL-N - Send Serial Number

The four digit serial number is sent in Morse. A leading zero is suppressed so 0047 is sent as 047. If a number has been mapped using the SHIFT-F1 M command, the mapped value will be substituted.

CTL-P - Pause Output Until Insert Key Pressed

K40 output keying will be paused indefinitely until the INSERT key is pressed. While paused, the CAPS LOCK light on the keyboard will flash to let you know that pause is in effect. This command is used to insert a pause into a message to allow you to insert something manually. For example you might make a message up that looks like this:

```
UR RST IS ^P NAME HR IS STEVE
```

After playing UR RST IS, the K40 will pause to allow you to enter an RST after which you hit the INSERT key which releases the K40 to continue with the rest of the message. Note that the ESC key also cancels a pause, but will kill the remainder of a message in progress.

CTL-S <nn> Change Speed to NN WPM (nn = 05 → 99) HSCW/QRSS Speed Set

You can build a message that has a speed change in it with this command. This command is also used to run HSCW or QRSS speeds.

Load Message Slot F1 with: ^S 10 CQ CQ DE K1EL K1EL ^S 22 CQ CQ DE K1EL F1
F1 will repeat until ESC: CQ CQ DE K1EL (at 10 wpm) CQ CQ DE K1EL (at 22 wpm)

The K40 supports both HSCW (High Speed CW) and QRSS (Extremely Slow) transmit rates through the use of this buffered command. The syntax for the HSCW command is:

^S<Hn> where n is a single digit number representing the lpm rate divided by 1000.

For example ^SH2 selects 2000 lpm and ^SH4 selects 4000 lpm. Any rate from 1000 to 8000 can be picked although only a handful of them are actually used by radio amateurs. In the US, common rates are 1000, 2000, 4000 and 6000 lpm while in Europe 1000, 3000, 4000 lpm are common.

The syntax for the QRSS command is:

^S<Qn> where n is a single digit number 1-4 representing the QRSS rate.

1=QRSS3: 3 second dits	2=QRSS6: 6second dits
3=QRSS30: 30 second dits	4=QRSS60: 60 second dits

For example ^SQ1 selects QRSS3 or 3 second dits and ^SQ4 selects 60 second dits.

NOTE!!: Remember to put a buffered speed command at the end of a message that contains either a QRSS or HSCW command to restore normal CW operation when the message is completed.

HSCW Operation Hints: In running HSCW mode, a common practice is to key the transmitter when sending and feed keyed audio tones into the microphone input. You can use the K40 sidetone output directly as a tone source as this is a keyed 2000 Hz tone in HSCW mode. Alternatively, you can use the K40 key output to key an external tone generator. In either case, the PTT output of the K40 should be connected to the PTT input of the transmitter.

You have a choice of either inserting an HSCW/QRSS command into a message or use it on the fly while you are typing. It is not very useful "on the fly" though and is intended to be used in a message. Use ESC to leave HSCW/QRSS mode.

CTL-W <NN> Wait for NN Seconds (NN = 01 → 99)

This command is used to insert a fixed pause into a message, it's well suited for building a beacon message:

Load Message Slot F1 with: `VVV ^K05 BCON DE K1EL ^W60 F1`

When you press F1 three V's will be followed by a keydown for 5 seconds, then `BCON DE K1EL` will be sent followed by a wait of 60 seconds after which the whole thing will be repeated. This beacon will repeat until you hit the ESC key.

Longer delays than 99 seconds can be derived by looping a wait command in a DECSZ loop. (an example is given in the CTL-Z command description).

CTL-Z <F1-F12> Decrement Loop Count and Skip Message if Zero

This command allows you to control looping in a message. The structure of the command consists of the CTL-Z command followed by a message key (F1-F12). There must be a load loop command in the message stream somewhere ahead of the CTL-Z command. When the CTL-Z command is encountered the loop count is decremented by one and if the result is not zero the message is jumped to. If it is zero the message is skipped. The first time the ^L command is encountered the count is loaded and subsequent CTL-L commands are ignored until the loop count expires, this allows a loop count load and loop count test to reside in one message. The best way to describe the command further is with a couple of examples:

Load Message Slot F1 with: `^L02 CQ CQ DE K1EL ^ZF1 K`
Results when F1 is pressed: `CQ CQ DE K1EL CQ CQ DE K1EL K`

What happens is this: When CTL-L is processed the K40 loads the count and stores it, then it outputs the message. The CTL-Z command tells the K40 to decrement the loop count and test to see if it is zero, if it isn't zero the K40 jumps back to the beginning of F1, If the count is zero the K40 skips over the jump and just outputs the SK. Remember that the CTL-L command is ignored after the initial load.

Longer delay example:

Load Message Slot F1 with: `BCON DE K1EL F3`
Load Message Slot F3 with: `^L10 ^W60 ^Z F3 F1`
Results when F1 is pressed: `BCON DE K1EL` will be repeated every 10 minutes

In this example the message is sent followed by a jump to F3 which waits for 60 seconds 10 times (which gives us 10 minutes). After the 10 minute wait we will jump back to F1 and do it all over again.

More Message Examples:

Load F5 with: `Count is ^N. ^D ^W05 F5`
Assuming the serial number has been preset to 100 the F5 message will be sent in sequence with a delay of 5 seconds in between as:

```
Count is 100.
Count is 99.
...
Count is 0.
```

Here's an example of a message that runs at two different speeds.

Load F1 with: `^S10SLOW SPEED ^S20FAST SPEED`

Here's an example of a QRSS beacon message:

Load F3 with: `^SQ2^K05^ EL FN43 F5`

Additional Key Assignments

There are several other key assignments that are treated just like letters and are buffered.

=	is mapped to	BT	]	is mapped to	QSL
<	is mapped to	AR	/	is mapped to	DN
>	is mapped to	SK	;	is mapped to	KR
[	is mapped to	QRZ	@	is mapped to	AC
!	is mapped to	MN	\$	is mapped to	VU
(	is mapped to	KN	)	is mapped to	KK
"	is mapped to	RR	`	is mapped to	WG
-	is mapped to	DU	_	is mapped to	UK
:	is mapped to	OS	+	is mapped to	AR

Keyboard Paddle

Two keys on the keyboard are mapped as the dit and dah paddle. These keys are only found on newer WindowsXP keyboards. They are located on the lower right of the layout in the same row as the space bar between the Alt and Ctl keys. The left key is the Windows key, the right key is the listbox select key. Due to slow keyboard response these only work well below 18 WPM or so, but are useful in a pinch.

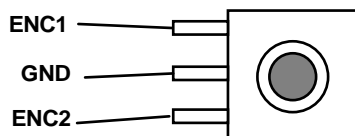
High Speed CW Operation

The K40 supports HSCW operation by being able to send character strings at 200 WPM speeds and higher. HSCW is primarily used to work other stations 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.

Rotary Encoder

The K40 provides an interface to a rotary encoder speed control. It will change the speed by 1 WPM for every click of the encoder. The connection to the encoder supplied with the K40 kit is as shown:



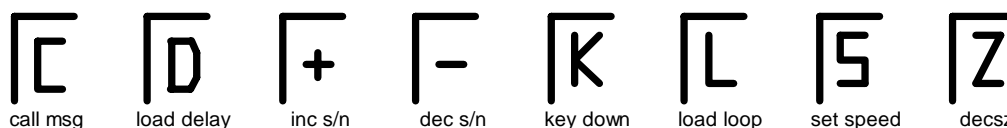
LCD Display Interface

The K40 provides an interface to an optional 16 by 2 line LCD. It is not a requirement and all built-in functions of the K40 can be accessed without a display. The display allows the user to see what he is typing when preparing out going text and also monitor transmitting progress. It does this by providing two display windows that can be selected by the TAB key. The default view is the keyboard entry window, hitting the TAB key will toggle the view over to the outgoing window. The user can type well ahead of outgoing Morse in the entry window, toggle over to monitor outgoing progress and then toggle back. You can tell which buffer is which by the presence of a underline cursor, the cursor is only displayed in the keyboard window. Use the **PGUP** and **PGDN** keys to scroll back and look at previous lines. **Home** returns you to the entry line. Messages appear in the keyboard window as a single token character while the expanded message will be displayed as it is sent in the outgoing window.

Messages are mapped to lower case letters as follows:

`F1:a F2:b F3:c F4:d F5:e F6:f F7:g F8:h F9:i F10:j F11:k F12:m.`

Buffered commands are represented by several tokens are shown below:



Other tokens are : → for merge, Ω for pause, and Σ for serial number . These tokens also show up when you enter them in a message. They act just like single characters in that you can backspace over them but they represent more content than single characters.

Command transactions will be displayed as entered, parameters can be entered but backspace is not supported, hit ESC to cancel the command leaving the parameter unchanged. To record messages follow the normal procedure, after selecting the message the first line of the current contents of the slot are displayed. If you want to leave it alone simply press the esc key. Turning the speed pot or using the arrow keys to change the serial number will be noted on the display in a temporary message in the upper right hand corner.

LCD Hook Up

The K40 provides a parallel interface to drive a standard 16 character by 2 line LCD character display based on the Hitachi HD44780 controller IC. The interface is run in a 4-bit write only mode. The following table calls out the pin connections:

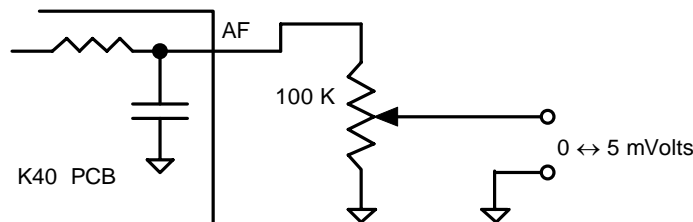
K40 Pad Name	LCD Pin	K40 Pad Name	LCD Pin
7	Data 7	E	Enable
6	Data 6	W	Write
5	Data 5	R	Register Select
4	Data 4	B	Display Bias (VB)
V	Vcc	G	Ground

The display bias level is controlled by a potentiometer on the K40 PCB, this controls the display contrast. Use a voltmeter to set the B pad to zero and then turn the pot to move towards 5 volts. At some point the display will come into view, then adjust for best contrast. K1EL has tested LCD displays from several different manufacturers with success. Make sure you use a display you know is working and one that supports the HD44780 standard interface. Beware of used or low quality surplus displays. Following are tested manufacturers: Optrex, Sharp, Hitachi, Datamedia, Samsung (LOOK FOR HD44780 CONTROLLER)

Also make sure you obtain the correct LCD pinout and pin numbering for the exact display you are using. For the most part all manufacturers use the same signal ordering: GND, +5, VB, GND, RS, W, E, D0, D1,D2,D3,D4,D5,D6,D7 but some start with Pin 1, others start with pin 14. To be safe Get A Datasheet !

AF Keying Interface

The K40 PCB has an onboard audio filter/attenuator used to convert the square wave sidetone into a low level smoothed output that is suitable to feed into a transmitter's mic input. The values listed in the bill of materials for R3, R7, C6, C10, produce a level of approximately 5 millivolts depending on load impedance. Other values can be chosen to either increase or decrease the level or a potentiometer can be used to allow an exact level control.



RF Immunity

There are several RF filters included in the K40 circuit design. Caps C1 and C3 on the keying and PTT lines prevent RF from coming back through the keying lines, C6 and C7 shunt any RF arriving over the paddle leads, and C8 and C9 filter the rotary encoder leads. L1 and L2 attenuate RF from coming in on the keyboard data and clock lines to the Console PIC.

These components also reduce RF radiation from the K40. Some keyboards can produce RF emissions on their own that can cause interference on your radio receiver. Additional filtering may be required on the keyboard itself usually a large ferrite bead on the keyboard cable. *(post note: most keyboards manufactured within the last 5 or 6 years must meet stringent RF radiation requirements and are seldom a problem).*

Revision E & F Changes

In February 2006 the revision E K40 chipset was released. Revision F was released shortly after. The primary difference between older revisions and F is the addition of the RTTY module. You need to have revision E or F to run the K40 PCB with the K40 RTTY Filter board. The start up display will tell you which revision you have. The revision F display looks like this:

```
K40 vF
WK40 vF
```

Other changes found in revision F are:

- 1) Addition of Fast Call entry mapped to **END**
- 2) Shift TAB clears both LCD display windows
- 3) ESC can be used to exit Morse status readout
- 4) Core clock frequency of both PICs changed to 8 MHz
- 5) Improved practice operation
- 6) Fixed PTT dropout on TUNE bug
- 7) Allow speed change up to 149 WPM using UP arrow or Speed encoder
- 8) Fragmented messages fixed
- 9) Persistent Beacon bug fixed
- 10) Allow ESC abort on Morse status dump

K40 RTTY operation is described in the K40 FILT Manual

Support and Warranty

The K-40 is fully guaranteed and if you are not satisfied, please return the kit 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@k1el.com

Watch the K1EL Website for latest updates and new products: <http://www.k1el.com>

While best efforts have been made to insure the K40 design is as complete and reliable as possible it is still possible to cause equipment damage or incur personal injury if the K40 kit is not used as intended, is connected incorrectly, or modified in any way. K1EL can not be held responsible in these events.

Immediate Commands

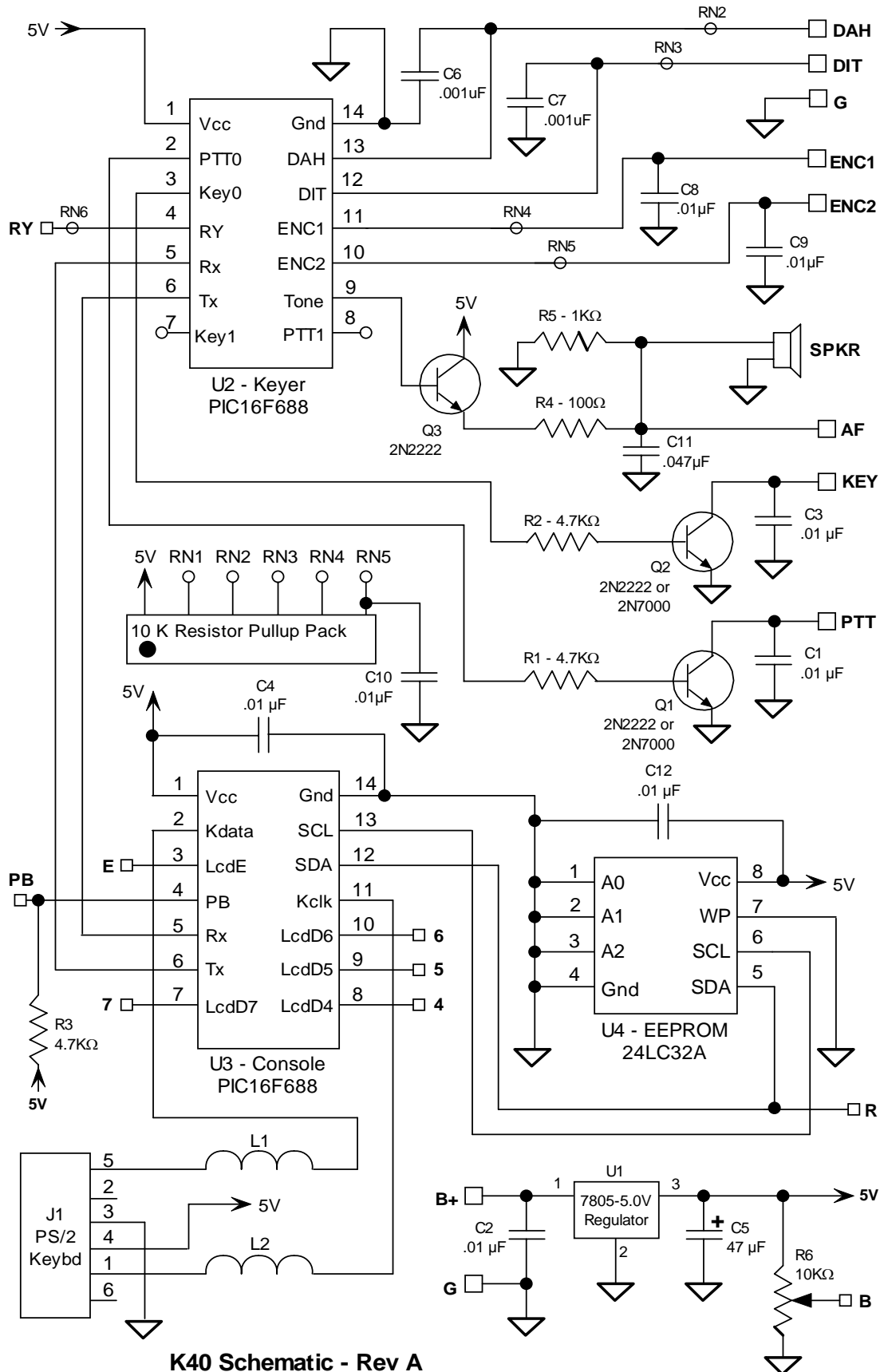
Key	Normal	Shift	ALT
F1	Play Message 1	Record	N/A (not assigned)
F2	Play Message 2	Set WPM Speed	Set Lead-in Delay
F3	Play Message 3	spare	Set Tail Delay
F4	Play Message 4	CW Practice	Set Serial Number
F5	Play Message 5	Toggle Farnsworth	Toggle Contest Spacing
F6	Play Message 6	Toggle Sidetone	Modify keyer mode
F7	Play Message 7	Toggle XMIT Mute	Toggle Autospace
F8	Play Message 8	Toggle Tune	Modify output port
F9	Play Message 9	Quick Speed 1	Swap Paddles
F10	Play Message 10	Quick Speed 2	Adjust 1 st Bit Length
F11	Play Message 11	Quick Speed 3	Adjust Ratio
F12	Play Message 12	Quick Speed 4	Persistent Message
↑ UP	Speed +1 WPM	N/A	Freq Up
↓ DOWN	Speed -1 WPM	N/A	Freq Down
← LEFT	Decrement Serial #	N/A	Set Weighting
→ RIGHT	Increment Serial #	N/A	Set Key Comp
PGUP	Scroll Display Up	N/A	Increase Sensitivity
PGDN	Scroll Display Down	N/A	Reduce Sensitivity
HOME	Return display to home	N/A	Status
TAB	Toggle Display view	Clear LCD Display	N/A
ESC	Abort	N/A	N/A
INSERT	Pause Transmit	N/A	N/A
END	Fast F12 Msg Entry	N/A	N/A

Buffered Commands

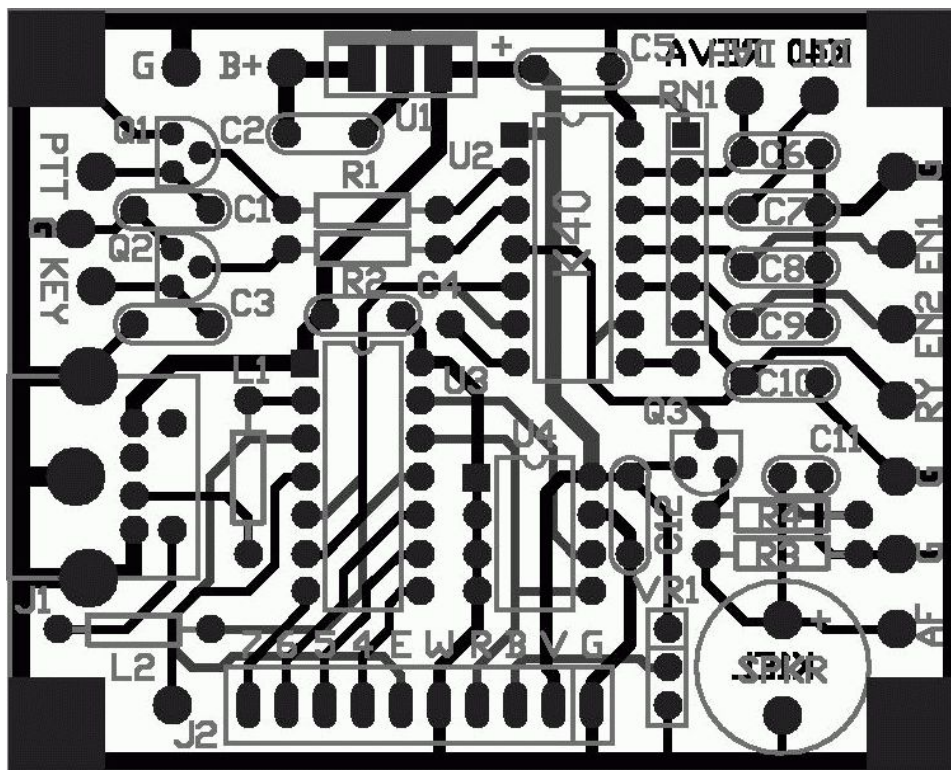
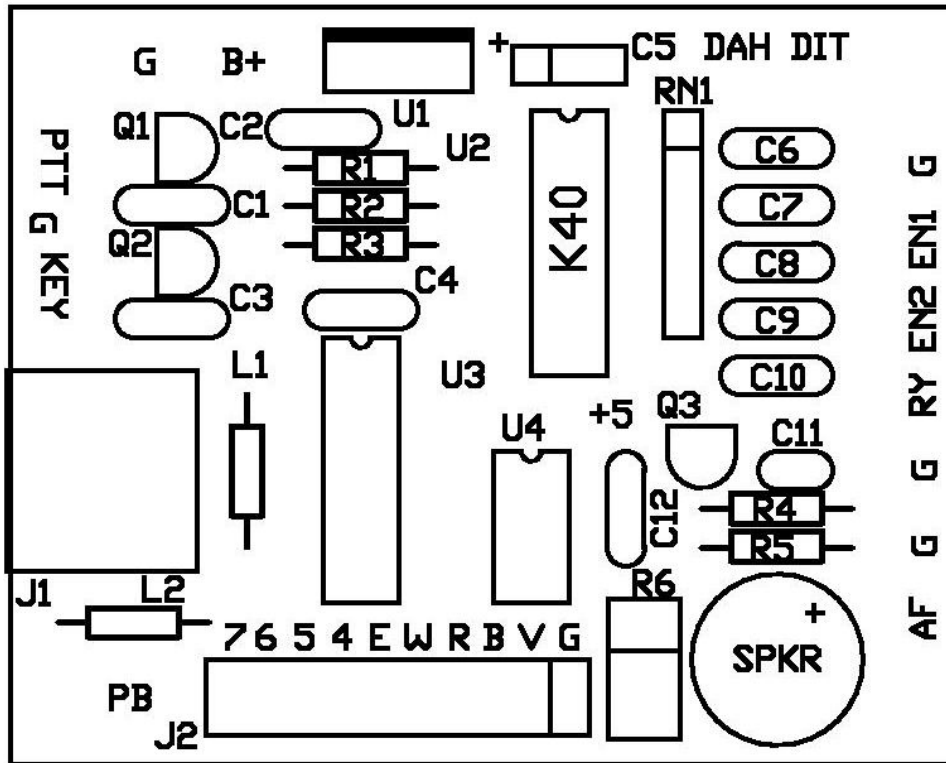
CTL	Command	Syntax
C	Call Message	^CF1
D	Serial # -1	^D
H	Set HSCW	^Hnn nn=lpm/100
I	Serial #+1	^I
K	Key Down	^Knn nn=seconds
L	Load Loop Count	^Lnn nn=count
M	Merge Letters	^Mcc
N	Play Serial#	^N
P	Pause	^P
S	Set Speed	^Snn nn=wpm
W	Wait	^Wnn nn=seconds
Z	DECSZ Loop	^Z

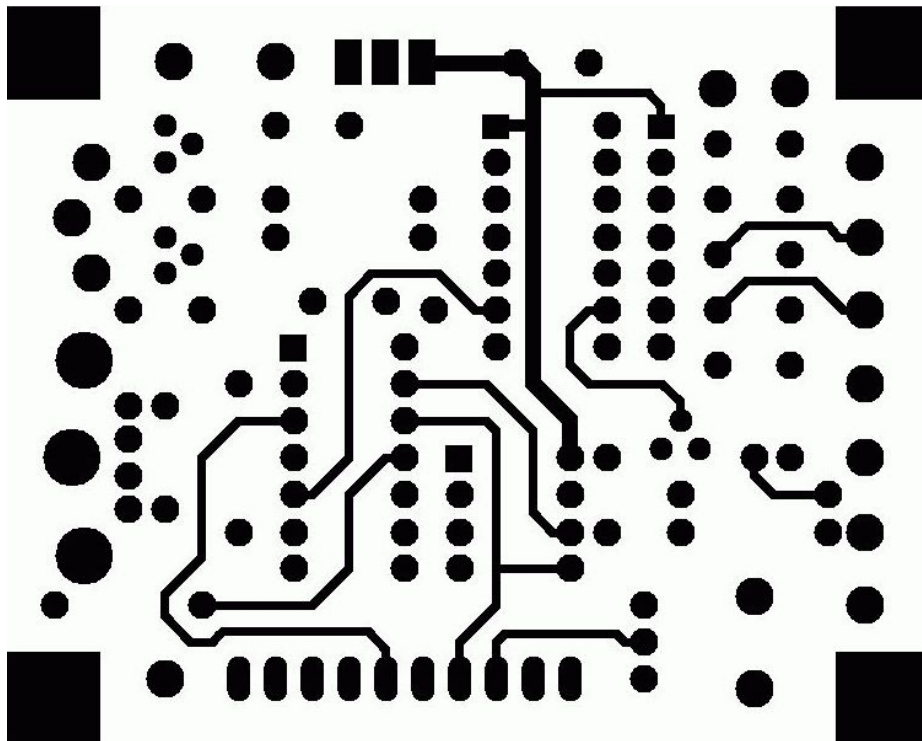
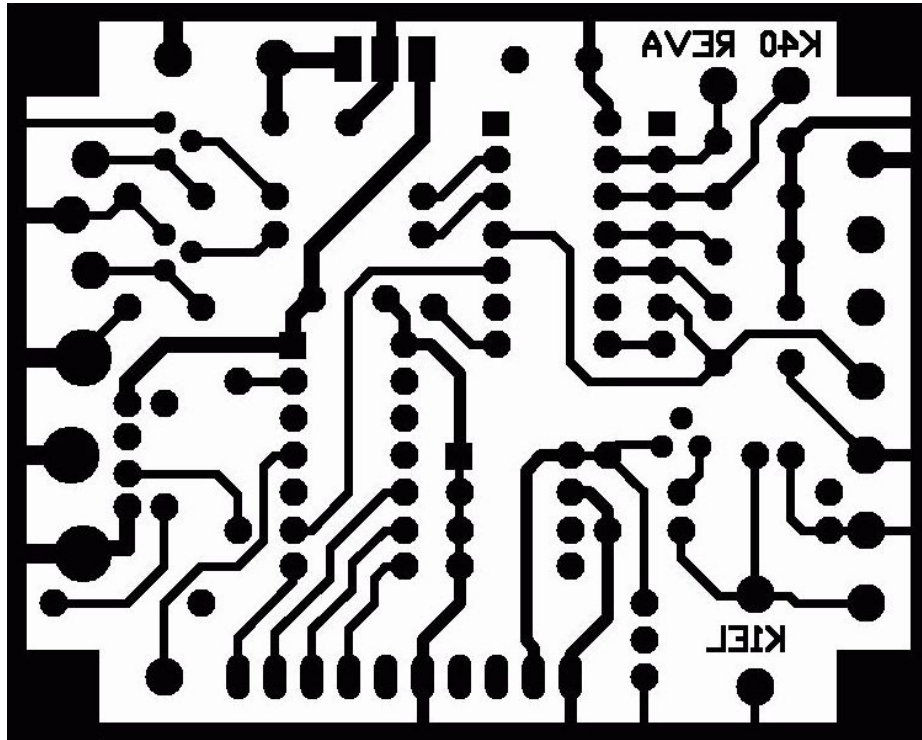
Bill of Materials

Reference	Description	Package	Check
K40PCB	K40 Printed Circuit Card	PC Board	
U1	LM7805 5 volt Regulator	TO220	
U2	PIC16F688 Keyer(Red Dot)	14 Pin DIP	
U3	PIC16F688 Console(No Dot)	14 Pin DIP	
U4	24LC32A EEPROM	8 Pin DIP	
J1	PS/2 Keyboard connector	6 Pin DIN	
RN1	10K resistor network	6 Pin SIP	
Q1, Q2	2N2222 or 2N7000 transistor	TO92	
Q3	2N2222 transistor	TO92	
R1, R2, R3	4.7 K Ω Resistor	1/4 W	
R5	1 K Ω Resistor (not installed)	1/4 W	
R4	100 Ω Resistor	1/4 W	
C5	47 μ f capacitor	electrolytic	
C1, C2, C3, C4, C8, C9, C10, C12	.01 μ f 100 VDC capacitor	ceramic disc	
C6,7	.001 μ F capacitor	ceramic disc	
C11	.05 μ F capacitor (not installed)	ceramic disc	
L1, L2	Ferrite bead	axial lead	
SPKR	Piezo Speaker		
EN1	Rotary Encoder	Panel Mount	
R6	10K Pot for LCD Bias	Vertical mount	
U4	Socket	8P DIP socket	
U2, U3	Sockets	14P DIP socket	



K40 PCB Silkscreen, Checkplot, and top bottom layers





Manual Revision F : Removed R6 Potentiometer, replaced with Jumper.