

Introduction

K40FILT is an accessory board for the K40 CW Keyboard Kit that allows the K40 to send and receive RTTY. Audio from a receiver is fed to the K40FILT where it is filtered and then processed by a PIC processor running at 5 MIPS. The processed data is demodulated and fed over to the K40 for Baudot to ASCII conversion and display on the LCD. Letters typed on the K40 side are converted to ASCII and then output either as FSK or AFSK through a sine wave tone generator on the K40FILT board. The K40FILT has an LED array that is used to tune RTTY stations in quickly and accurately.

Features

- Audio preamp/filter
- 4 Pole SCAF Bandpass Filter
- DSP demodulator
- AFSK Tone generator
- PIC16F684 PIC Processor
- LED tuning display on board
- PIC12F508 LED controller
- Transmit/Receive Switching
- Single +5 volt supply requirement
- Board dimension: 2.25 by 3.0 inches
- Diddle, UOS, ATC, Autostart
- Current Draw: < 10 ma

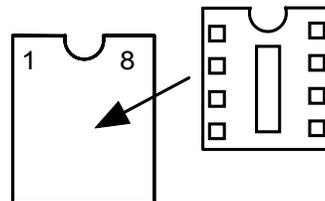
Assembly Instructions

An accurate DVM or VOM is a requirement for this project. There are a large number of precision 1% resistors that MUST be installed correctly to insure proper operation. The color codes on these resistors can be confusing and an ohmmeter is the most reliable way to insure correct resistor placement. Other than that, the assembly of the K40FILT is very easy; all you need is a low wattage soldering iron, some solder, a few pieces of hook up wire, a good pair of wire cutters, and small pliers. You will need an assembled, working K40 board to test and check out the K40FILT board. 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, inventory and identify all parts before you start. This will allow the assembly to proceed smoothly. The Bill of Materials can be found on Page 12. Use your ohmmeter to sort the resistors by value. Email us about any shortages and we'll send them to you.
- 2) After inventory, carefully inspect the PCB for any solder shorts or other obvious defects, it's easier to find them before placing parts.
- 3) Start with the six LEDs, the easiest way to do this is to install one of the center ones first. Align the LED carefully to be in the center of the silkscreen with front edge flush with the front edge of the PCB. Carefully solder in place. One by one install the remaining five LEDs insuring that each LED is spaced evenly and is flush with the front edge. I solder one lead first so I can go back and individually tweak them before soldering

the second lead. It's important to do a good job so that the LEDs fit correctly through the front panel of the enclosure.

- 4) Next install the ¼ watt resistors. Verify each value with the Bill of Materials on Page 13 and Fig 7 on page 18. Double check to make sure you get them placed correctly. I start with R1 and go all the way through to R24. Note that 10K resistor R21 is a 5% value.



- 5) Next install the DIP sockets. Align the notch in the socket with the silkscreen. Note that the socket for U1 is made up of three 8 pin sockets. Carefully line these up before soldering. It's easy to bridge adjacent socket pins when soldering so take your time.
- 6) Install and solder the capacitors. Two caps, C2 and C11 have polarity markers that must be observed. On both caps the long lead is the positive lead and should be installed closest to the + silkscreen legend. (The square pad is the positive side)
- 7) Install the ceramic resonator X1, orientation does not matter.
- 8) The last item to install is the trimpot, VR1, this part can be installed in either orientation. I install it so that the Screw Adjust is closest to U4.

- 9) Now wire the K40FILT board to the K40 board as shown in Fig. 9 on Page 19. (If you purchased the K40 enclosure, follow the detailed wiring harness instructions) Note that there are three signal connections, +5V and two grounds. After this step, but before installing any ICs, turn the K40 power on and measure the voltage on U4 pins 14 and 7. Pin14 should be +5V with respect to pin 7.
- 10) Turn power off and install U3. Power on again and measure the voltage on U3 pin 5, you should see about 2.5 volts (this is the filter clock which can be viewed with an oscilloscope if you have one, it should be a 200 KHz square wave). If you don't see 2.5 volts carefully check the soldering connections on U3 and X1.
- 11) Turn power off again and install U1, power up again and you should see 2.5 volts on pin 6. This is the analog reference. Again, if you don't see 2.5 volts check the connections on U1 particularly the power pins and bypass caps. Remove power after testing.
- 12) Now install U2 and U4. Power up and hit ALT-F1 on the K40 keyboard. You should see **RTTY ON** show on the display. Monitor the voltage on U3 pin 6 on U3 with a voltmeter. Hit the Insert key on the K40 keyboard. Pin 6 will toggle between +5V and 0V each time you press Insert. Check that Pin 7 toggles also and is the complement of pin 6 (when 6 is high 7 is low and vice versa)
- 13) Turn power off and install U5. Power up and watch the LED display, you should see a power up LED test in which each LED is turned on and off in a sequence. Make sure all LEDs light one at a time. When the test is over all LEDs will turn off. If not check the connections on the LEDs and U5.
- 14) Now it's time to check out the K40FILT filters. Connect an audio frequency generator or receiver audio output to the AF input on the K40FILT board. The level needs to be around 1V peak to peak, preferably a high impedance output (600Ω). You can use speaker audio out but you may need a higher level. If you are using a receiver, turn on calibrate or tune in a carrier signal to get a beat note. If you are using a signal generator set it to 2000 Hz. Tune up and down slowly until you see some activity on the LED display. You may have to play with the audio level some. As you tune you will first see LEDs light on one side, continue tuning and you will see the LEDs sequence across from one side to the other. The left most LED corresponds to a 2295 Hz tone while the right most is 2125 Hz. If your audio level is too low you may only see one or two LEDs light each side of center as you tune. Try increasing the gain by hitting the ALT-F2 command. If you are having problems read the section on filter verification.
- 15) Now let's try to tune in some RTTY stations. Connect AF IN to your receiver's audio output. Make sure you are still in RTTY mode (ALT-F1). Look on 20 meters around 14.080-14.090MHz that's usually a good place. When no station is tuned in, the LEDs should be out. As you approach proper tuning you will see one LED side light up and then both LED banks will alternate back and forth in cadence with the RTTY signal. A properly tuned signal will show the LEDs on each end the brightest with an occasional LED flash in between. As soon as you are tuned in, the print gate will open and letters will appear on the K40 display. If you are printing garbage, it's possible that you need to reverse the mark and space tones. This can be done in one of two ways. First is using the Rx reverse command on the K40. Hit ALT-F8 and the K40 will reverse receive mark and space. Second is by changing the receiver to the opposite sideband and retune.
- 16) Now test the FSK transmit mode, you'll need an ohmmeter for this. Press the SHIFT-F8 key to turn RTTY Tune on. The open collector PTT output will turn on and show continuity to ground. The KEY output will remain off. The rightmost tuning LED will be lit. Press the ALT-F9 key and now the left most LED will light and the KEY output will show continuity to ground. Measure, with the red meter test lead on the KEY or PTT output pad black on ground. To test AFSK, leave the K40 in tune mode and with an oscilloscope look at the FO pad on the K40FILT. Adjust VR1 CCW to increase the output level to something you can trigger on. Now press ALT-F9 and you will see the tone switch between 2125 and 2295 Hz. When the LCD display shows TX+ the tone should be 2125 Hz and 2295 on TX-. Hit Shift-F8 to leave tune mode. Hit Shift-F3 to enable diddle and then press INSERT to turn on transmit. You should see mark/space activity on both the KEY and FO outputs. If you don't have a scope you can listen to the tones at FO with HiZ cans. Hit Insert when done.
- 17) 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

The following block diagram shows the basic sections of the K40 filter board. Audio from the receiver is amplified and filtered through an initial active filter stage. This stage provides 16dB gain for low level audio input and also provides some out of band signal rejection. This stage also isolates and protects the SCAF from the input. The LMC6482 handles large input amplitudes well and clips very cleanly. The first narrow bandpass filter is made up of two sections of an LTC1068 switched capacitor filter. It provides a filter bandwidth of about 800Hz with a center frequency of 2210 Hz. The output of the bandpass filter is then fed into a pair of tone filters made up of the remaining two sections of the LTC1068. These filters are set to 2125 and 2295 Hz respectively. The filtered tones are then fed directly into the PIC processor where they are rectified, filtered and sliced to produce a digital Baudot serial output. Additionally the PIC provides a signal gate to squelch output and the LED display if no signal is tuned in. A PWM signal is sent to a second PIC to drive an LED tuning bar display. The LED bar also indicates mark/space activity on transmit.

In AFSK transmit mode, the PIC generates square waves at either the mark or space frequency as determined by the FSK input from the K40. The square waves are fed through the bandpass filter which filters the harmonic content resulting in a clean sine wave output. Frequency change is made at zero crossing so that there is no phase discontinuity in the signal.

In FSK transmit mode, the K40 KEY output is fed to the transmitter FSK input. The K40 PTT is connected to the transmitter key input. In other words, KEY controls frequency shift and PTT controls transmitter keying, with Rx/Tx changeover timing controlled by settings in the K40.

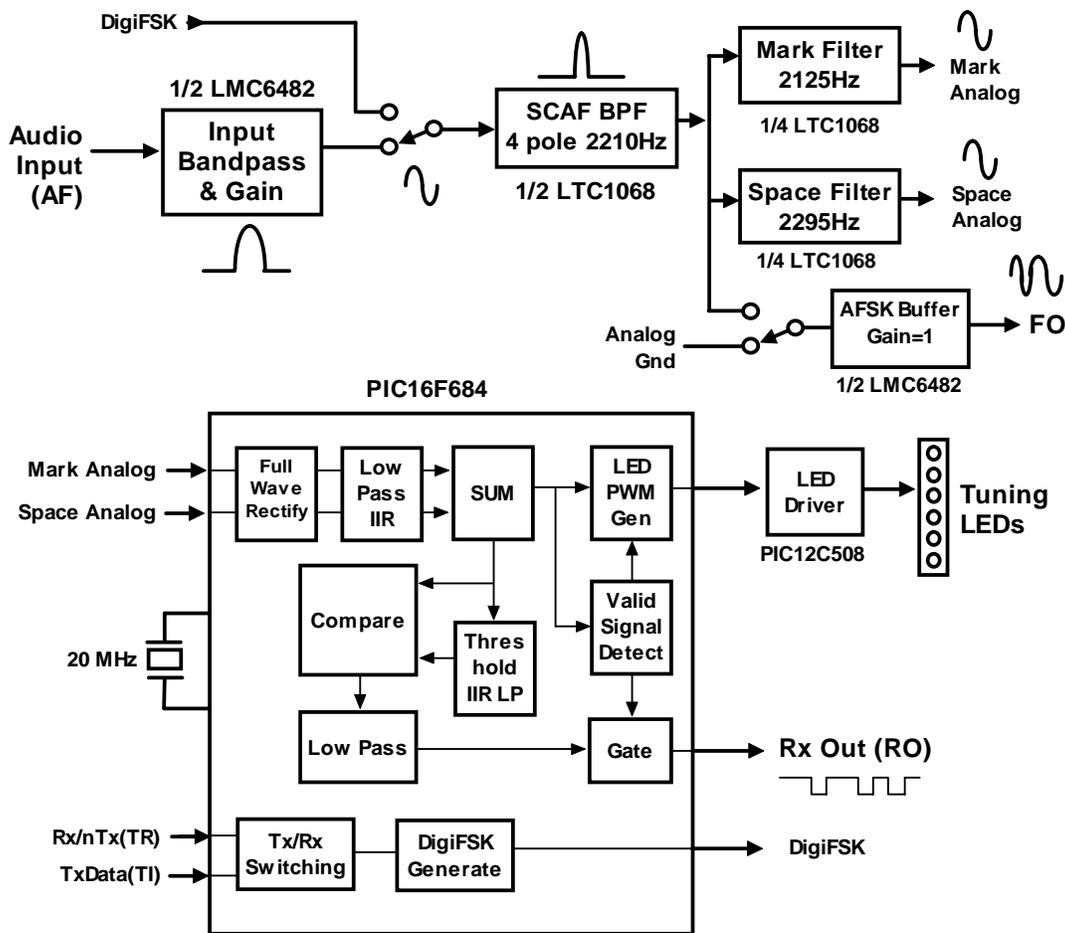


Fig 1 – K40 Filter Board Block Diagram

Using the K40 in RTTY Mode

On the amateur bands, RTTY is commonly transmitted by frequency shift keying. Information is sent by switching between two tones, most often 170 Hz apart. One tone, idle, is called mark while the other is called space. The most common tone orientation is for the space tone to be higher in frequency than the mark frequency. It is important for a station to be set up with the same mark/space relationship as other stations on the band, otherwise QSOs will be difficult if not impossible. The K40 follows this convention: In normal transmit mode (TX+) the KEY output will be off for mark and on for space. This is compatible with most transceivers that support FSK. In normal receive mode the lower frequency (2125Hz) of the tone pair is interpreted as a mark while the higher tone (2295Hz) is interpreted as a space. This is in line with most transceivers set to RTTY mode. This also corresponds to upper sideband mode (USB). AFSK Tx tones follow the same scheme as receive as shown in the table below.

AFSK	Mark Frequency	Space Frequency	FSK	Mark Key Out	Mark Key Out
Normal RX+/TX+	2125 Hz	2295 Hz	Normal TX+	Off	On
Reverse Rx-/TX-	2295 Hz	2125 Hz	Reverse Tx-	On	Off

Table 1

As mentioned previously there are two ways to generate FSK transmissions, the first is by AFSK whereby a transmitter is run in USB mode and audio tones are fed into the Mic input. The second is by direct FSK where the frequency of the transmitter's VFO is pulled up or down by switching extra capacitance across the VFO tank circuit or heterodyne crystal. In newer rigs that use digital synthesis, FSK is applied to a digital frequency synthesizer and the frequency shifting is done in the digital domain. Purists will say that AFSK or digital FSK results in less phase distortion and narrowest bandwidth but both can be used successfully.

In RTTY receive the K40 filter board simply converts the two audio tones back into a digital 1 and 0 serial data stream. Audio is taken either from the transceiver high impedance line output or across the speaker. The K40 FILT input has an impedance of about 1K ohms so an impedance transformer is helpful to match a receiver's low impedance speaker output to the K40FILT input. Once it is decoded, the serial data stream is passed over to the Keyer PIC on the K40 PCB where Baudot to ASCII conversion takes place with resulting letters and numbers displayed on the LCD.

In an effort to make K40 RTTY operation easy to use, the basic operational mode is fixed. That means 60 WPM (45.45 baud), Baudot coding (5 data bits with 2 stop bits) at 2125/2295 Hz shift. Automatic threshold correction is always enabled during receive as well as automatic unshift on space. The user has control of transmit diddle and mark/space reversal in both transmit and receive.

To enable RTTY mode simply press ALT-F1 and the K40 will change to RTTY mode and **RTTY ON** will be displayed momentarily on the LCD. To change back to CW mode just press ALT-F1 again and the LCD will display **RTTY OFF** placing the K40 back in CW mode. When switching to RTTY mode the K40 will automatically be set to receive with the receive buffer displayed.

Receiving

Find a RTTY station that is transmitting and attempt to tune it in. This takes practice and a bit of patience at first. But after a while you will learn how to watch the LEDs and tune carefully to get the widest spread in cadence with RTTY frequency shift keying heard. If you have a wide LED swing but garbage is printing, there are two possibilities, it may not be an RTTY station, or you need to reverse mark and space. Generally if you set your transceiver to USB or RTTY mode the K40 should be set to RX+. This is not a standard, for example the Drake R8 receiver set to RTTY mode runs in LSB mode requiring RX-. ALT-F8 is the command used to change between RX+ and RX-.

The spread of the LED display will change as a signal fades in and out and as selective fading causes mark and space to have different amplitudes. The K40FILT automatically compensates for both conditions and no retuning is necessary. With very deep fades, the K40 may print an erroneous character or get out of sync for a couple of characters. This is normal for HF RTTY operation. Some higher end DSP demodulators can follow weak signals and extreme noise better than the K40FILT can with its meager 5 MIPS PIC. Baudot coding uses FIGS and LTRS codes to shift between an upper and lower character set. If one of these codes is missed due to noise the K40 will print in the wrong case until the next space, carriage return, FIGS or LTRS code. If this happens you may see a string of numbers or punctuation in the middle of a sentence.

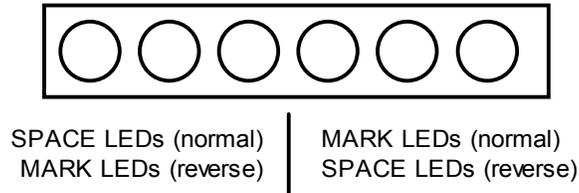


Fig. 2 – RTTY Indicator LEDs

The LED display will blank when a signal is very far out of tune or no signal is present. This is an aid for tuning, since the display will stay off until you are close to a station. At that point the display will turn on and you can tune in easily. The right mode LED corresponds to Mark while left most LED corresponds to Space. If RX is set to reverse the LED positions are reversed. You will find that you can successfully tune in very weak stations that only light one or two LEDs each side of center. Contests add an extra challenge since stations can be right next to one another. K40FILT does a good job with its built-in band pass filter but I find a narrow IF filter in the receiver set to RTTY mode will improve the K40 copy particularly with strong adjacent signals. Turning AGC off can help reduce this interference also.

Transmitting

There are three K40 outputs used for transmitting, PTT, KEY, and FO. The K40 PTT output is used to key your transceiver and switches to ground when active. This usually goes to the key input but check your transceiver's manual to be sure. The K40 KEY output is used to frequency shift key your transceiver in FSK mode. If your transceiver has a direct FSK input it's the easiest way to go. Use Table 1.1 to determine what your transmitter requires and set the K40 to either TX+ or TX- mode (ALT-F9). If your transceiver does not support FSK you will need to run in USB AFSK mode. In this case connect the K40FILT FO output (AFSK on the enclosure) to your transceiver audio input. Sometimes you can drive the microphone input directly, in other cases there may be a phone patch or line input jack that you may want to use instead, again consult your transceiver manual. When running AFSK mode you will have to set the input level appropriately to prevent over modulation. There are two adjustments that control this, the output level control on the K40FILT board and the Mic level on your transceiver. Set the K40 to RTTY mode (ALT-F1) and then hit the insert key, if everything is hooked up correctly this will key your rig. It's best to start both level controls near minimum (K40FILT pot fully clockwise) and gradually increase both together to a point where you just start to see an RF output. Monitoring ALC, advance the mic to a point where either you reach your desired power output or the ALC stops increasing with increasing Mic level. It is always a good idea to monitor your signal after the adjustments are complete to make sure it is clean.

Both FSK and AFSK are produced simultaneously by the K40FILT board, choose the one you want to use and ignore the other. Both KEY and PTT outputs are open collector and can key up to 50 V. I have found most modern transceivers present a voltage in the range of 5 to 12 volts which must be pulled low to assert. It is imperative that you check this carefully to be sure that it is within the range the K40 can control.

One problem in running RTTY on a separate transmitter and receiver is accurately tuning your receiver to the frequency you are transmitting on. When running AFSK with a transceiver this is not usually an issue since the tone pair frequencies transmitted are the same as those received.

The spot command provides a way synchronize a transmitter and receiver running FSK. Spot is enabled and disabled by SHIFT-F4. When in spot mode, the K40FILT board is held in receive during transmit. This allows you to tune your transmitted FSK on your receiver and tune using the LEDs on the K40FILT board. The filter board will demodulate the signal and pass decoded Baudot over to the K40. Since the K40 can transmit and receive simultaneously, the data stream will be displayed in the receive window. This is a valuable tool for setting up your RX-/RX+ and TX-/TX+ settings. It's not unusual in FSK setups to run receive shift differently than transmit shift (.i.e. RX+/TX- or RX-/TX+) it's mainly a function on how the transmitter FSK input works.

If you want to transmit with Diddle on, use the ALT-F3 command to turn it on (or off). When diddle is on, the K40 will continually send the LTRS characters when there are no characters queued up to send. This fills transmit with a continuous stream of frequency shift transitions which help the demodulator on the receive side stay in sync with your transmission and will reduces errors.

When you use the insert key to change from receive to transmit, the LCD display is automatically toggled to show the transmit window. The transmit buffer is identified by an underline cursor which indicates the text

entry point. When going back to receive, the LCD is toggled back to the receive window and the cursor is turned off. The user can toggle between receive and transmit windows manually by using the TAB key. Scrolling (PGUP/PGDN) is also supported and hitting the HOME key returns the buffer back to the active line. **However, don't hit END, that key is used for fast callsign entry!!** While receiving, the K40 supports type ahead so you can enter a response message while reading an incoming message. You can quickly toggle to the Tx buffer with the TAB key to check a spelling or see where you are. Hit TAB again to get back to the incoming display. The Caps Lock light on the keyboard will flash when there are characters in queue waiting to be sent.

The transmit monitor command Shift-F4 is useful in some cases. It allows you to monitor real time transmit progress in the receive window and will show messages fully expanded instead of message token letters. When TX monitor is on, the transmit stream is printed in lower case in the Rx window. The LCD window is not toggled back and forth with transmit/receive in this mode since everything can be seen in one window. You still can toggle the display manually with the TAB key. TX monitor can produce quite a cluttered display and I only use it to verify that messages are being sent the way I expect. It's useful in contests when you are using the fast callsign entry feature and want to be sure you entered callsigns correctly.

Since the 16 by 2 line LCD display does not give you an accurate view of what your output looks like, the K40 implements an automatic carriage return feature. You can just type without regard to where the line end should be. When the line reaches a length longer than 40 characters, the next space entered will automatically generate a carriage return line feed sequence. You can enter carriage return if you like and it's supported but not required. Hitting the Enter key or ^M will generate a carriage return sequence. It's displayed as a right arrow -> on the LCD. Sorry, but the line wrap point is fixed at 40 letters and cannot be changed.

Most of the message features of the K40 in CW mode are supported for RTTY mode except for CW only features like prosigns and speed changes. Only buffered commands available in RTTY mode are covered in this manual. The ^K token is redefined in RTTY mode, ^K toggles between receive and transmit. This allows you to build a message that will automatically set the K40 to transmit mode before sending the message. A ^K at the end of the message returns the K40 back to receive after the message has been sent. This is great for contests since you can build a message like:

```
^K^M^MCQ CQ CQ TEST DE K1EL K1EL PSE K^K
```

You can then fire it off just by pressing a single message key. Note that the message starts with two CRLF sequences, that's what the two ^M do. In other words use ^M to insert a CR/LF. Unfortunately you can't use the enter key since that will end message entry mode.

There are two rules to follow when using ^K:

- 1) Always put a ^K at the beginning and end of the message.
 - 2) Don't use the Insert key while transmitting a message with a ^K in it, the transmit state of the console PIC can get out of sync with the keyer PIC. If you want to stop a message please use ESC.
- If you do send a ^K message without the trailing ^K it's not a big deal, but you will have to hit Insert twice to get back in sync again.

A nice K40 feature is fast callsign entry. Pressing the END key will open up a small window in the upper left corner of the display where you can enter a callsign. When you hit return, the callsign will be copied into the F12 message slot. This is great for contest exchanges. Try entering a message formatted like this:

```
^K^M ^C<F12> DE K1EL 5NN 5NN NH NH QSL ^C<F12> DE K1EL QSL? ^M^K
```

Now you can quickly enter different callsigns into the F12 slot using the END key and reuse the above message over and over again. Note that the CALL token ^C is used to call the message in F12 and then return. If you did not include the ^C, the message would jump to the F12 slot and stop when that message finished.

A note about lead in and tail: you will notice when working other RTTY stations that it is common practice to key the transmitter without modulation for a second or two before starting to send data. Again there may also be a similar delay at the end of the transmission. This can be duplicated on the K40 through the use of the lead in and tail delay settings. They specify the amount of time after PTT is asserted before FSK starts and how long to hold PTT after FSK is finished.

Note that the CW paddles and speed control are inoperative in RTTY mode. Also CW specific command keys are disabled in RTTY mode.

Command Description by Key

Several K40 commands operate differently in RTTY mode and some commands are not supported at all. In the command descriptions below, a double star ** indicates an RTTY mode command.

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

A message key press is denoted by <Fx> where x is the message key number, <F1> <F2> <F10>

The Shift command keys setup K40 RTTY operating modes. Remember to use the SHIFT-F1 P command to save these settings in EEPROM if you want them to be held so that they will be loaded next time you power up.

F1 through F12: Send Message

To make message access easy, they 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 commands. There is no way to send a message immediately except to 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. (Copied from the K40 manual)

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
 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

Preserving Settings

The basic settings of the K40 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: (Only the RTTY related items are shown below)

Lead In Delay Tail Delay Tx Reverse Rx Reverse RTTY On/Off Serial Number Diddle Gain

SHIFT-F2: Gain 2x Multiplier Toggle **

Use this command to enable or disable additional gain in the receive channel. Turn 2X gain off for receive input levels in the range of 500mV to 2V of peak to peak audio. Turn 2X gain for receive levels from 100 to 500 mV.

SHIFT-F3: Diddle Toggle **

Use this command to enable or disable diddle on transmit.

SHIFT-F4: Spot Toggle **

When operating the K40 RTTY in FSK with a separate transmitter and receiver, this command provides a means to exactly tune your receiver to your transmitter frequency. When spot is enabled, the K40 board is set to transmit while the K40 filter board is left in receive mode. This allows the receiver to be tuned into the transmitted RTTY stream using the K40 filter boards tuning LEDs. In addition since the K40 can transmit and receive simultaneously, the transmitted data, once tuned in on the filter board will be displayed in the K40's LCD receive window.

SHIFT-F6: Tx Monitor Toggle **

Use this command to control the Tx monitor mode. When enabled (on) transmitted characters will be printed in the Receive window in lower case.

SHIFT-F8: Tune Toggle/Test FSK **

The PTT output is turned on. The sense of the FSK output can be toggled by using the ALT-F9 command. This allows either mark or space to be sent continuously to tune filters or test keying. Be sure to leave transmit sense in the state you started with.

ALT Commands

The ALT command keys setup K40 RTTY 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-F1: Set RTTY/CW Mode

This is the way you put the K40 into RTTY mode. The mode will toggle each time this command is pressed. A message on the display will tell you what mode it is changing to.

ALT-F2: PTT Lead In Delay Time

The K40 provides a transmitter PTT output that is used to switch a transmitter over to transmit mode in advance of actual FSK transmit. A default time of 800 milliseconds is built in but you can extend it using this command. The time delay specifies the time between when PTT is asserted and when FSK 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+800 milliseconds. The maximum delay that can be set is 99 or 990+800 = 1.8 seconds.

Note that a default delay of 600 mSec is used if Lead In is left at zero. It is essential to have a period of unmodulated signal before FSK starts to insure the receiving station locks to your signal in advance.

ALT-F3: PTT Tail Delay Time

Like Lead In delay the time between the end of FSK modulation and PTT deassertion is programmed in units of 10 mSecs. A default time of 800 ms is built in. The syntax is the same as ALT-F2. A tail delay helps transmissions to end cleanly and can help prevent stray characters at transmission end.

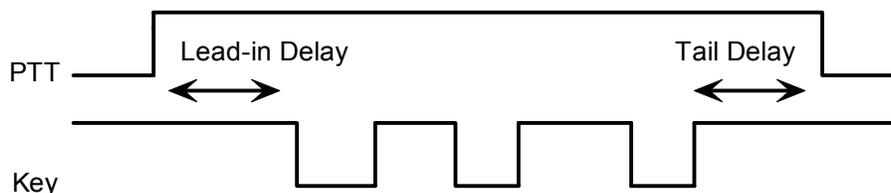


Fig. 3 – Lead and Tail Illustration

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 and enter four 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. The right and left arrow keys can also be used to increment the serial number.

ALT-F8: Set Rx Reverse Mode **

This sets the sense of the serial receive data. When pressed a display will shows the mode it is changing to. For example if the display shows RX- receive is reversed, mark lo/space hi. RX+ signifies normal receive sense, mark hi/space lo.

ALT-F9: Set Tx Reverse Mode **

This sets the sense of the serial transmit data. When pressed a display will shows the mode it is changing to. For example if the display shows TX- transmit is reversed, mark lo/space hi. TX+ signifies normal transmit sense, mark hi/space lo.

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. 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).

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. Since the factory default is CW mode, RTTY mode will be cancelled. See the K40 manual for the default settings.

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

HOME: Return Display to Home Position

The current display line is set to the current active position. In receive this means the current line new data is being added to. In transmit this means the line the input cursor is on.

END: Quick Message Load

This command allows message F12 to be loaded very quickly. It is intended to be used to load a callsign that would be called from other messages. This is very useful during contests.

For example let's say that the following message was loaded in F1:

```
^K^C<F12> DE K1EL K1EL K^K
```

When a station is heard that you want to call hit **END** and then quickly type in the callsign followed by **ENTER**. Then when you hit F1 the callsign is inserted and sent:

```
W1XYZ DE K1EL K1EL K
```

Another message can be loaded into F2:

```
^K^C<F12> 599 NH QSL? BK^K
```

Which plays as:

```
W1XYZ 599 NH QSL ?
```

TAB: Toggle Receive/Transmit Display Window

Either incoming or outgoing streams can be displayed. The TAB key selects which. A blinking cursor is shown in the transmit (outgoing) window.

SHIFT-TAB: Clear Displays

Clears both receive and transmit display windows.

ESC: Abort/Clear Buffer

ESC can be pressed at any time to abort a message, abort a command, or to clear the type ahead buffer. If you press ESC while entering a message 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: Receive/Transmit Control **

This will toggle the K40 receive and transmit mode. When first starting out, the K40 is set to receive mode. The receive display is shown and the K40 Filter board is set to receive mode. Pressing the insert key will toggle to transmit mode, the PTT line is asserted and the K40 Filter board is placed in transmit mode. A fast way to tell if transmit is in force is to look for the blinking cursor on the display. If the display is in home position then the blinking cursor is visible. In receive mode no cursor is displayed.

This is a toggle command, each press will advance from transmit->receive or receive->transmit.

+ (plus): Increment Serial Number**- (minus): Decrement Serial Number****Buffered Commands**

The K40 supports the following buffered commands. See the K40 manual for a discussion of buffered commands.

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's 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>- Toggle RTTY Receive/Transmit **

This is used to build a message that will automatically change to transmit mode when the message key is pressed. This allows the user to send a message with one keystroke. Normally the insert key would have to be pressed followed by the message key. A CTL-K command should be placed at the end of a message to return the K40 to receive mode after the message is sent.

```
^KCQ CQ CQ DE K1EL K1EL K^K
```

The above message, sent with the K40 in Rx mode, will change to transmit, send the message and then change back to receive mode. If the message were sent while the K40 was already in transmit, the ^K commands are ignored.

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 Insert a CRLF Sequence **

This inserts a Carriage Return/Line Feed sequence into a message.

```
^M^MCQ CQ CQ DE K1EL K1EL K^M
```

The above message will send two CR/LFs followed by the message and then send another CR/LF

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.

CTL-S – NULL Command **

In RTTY mode the ^S command has no effect and is ignored. It will be displayed on the LCD input window but will not be acted upon.

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: BCON DE K1EL ^W60 <F1>

When you press F1, BCON DE K1EL will be sent followed by a pause 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 ^Z<F1> SK

Results when F1 is pressed: CQ CQ DE K1EL CQ CQ DE K1EL SK

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 however 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.

Additional Key Assignments

These are the key assignments that are treated just like letters and are buffered.

[is mapped to	QRZ
]	is mapped to	QSL
@	is mapped to	BELL

K40FILT Specifications

RTTY Receive

Tone Pairs Mark/Space	2125/2295Hz (2295/2125Hz reverse)
Input Level	1V nominal 5V max peak to peak.
Data Rate	45.45 Baud (60 WPM fixed) 5% accuracy
Data Format	Five level Baudot 1 start, 2 stop bits
Unshift on Space	Standard, always on
Threshold Control	Automatic, always on
Autostart	Standard, fixed level
Tuning Indication	Six LEDs frequency bar graph, auto squelch
Gain Boost	User selectable 2X gain

RTTY Transmit

Output Modes	Audio Frequency Keying / Frequency Shift by level
Data Rate	45.45 Baud (60 WPM) fixed 5% accuracy
Data Format	Five level Baudot 1 start, 2 stop bits
Tone Pairs Mark/Space	2125/2295Hz (2295/2125Hz reverse) AFSK only
FSK Level	Mark high/Space Low (Mark Low/Space High reverse)
AFSK Tone Format	Sine wave, 1% accuracy, spurious response at least -50 db below fundamental
AFSK Tone Level	100 mV to 2.5V peak to peak (on board pot adjust)
Figures Control	Automatic fig/space generation
Diddle	User selectable
FSK Spot	User selectable
Automatic CR/LF	
Line Length	40 characters nominal with automatic word wrap

Filter Verification Procedure

The on-board ASFK tone generator can be used to verify the operation of the front end filter. You can use either an oscilloscope or an AC voltmeter to do the checks. It is assumed that you have the K40 wired correctly to the K40 FILT and that you have a keyboard attached to the K40. Values given are ballpark values and may vary plus or minus 10%. The key thing to look for is that there is a difference in voltages on U1 pin 15 and pin 22 when changing from mark tone to space tone. Pin 22 should be higher than pin 15 during mark and vice versa during space. The high and low voltage levels on each should match closely.

- 1) With power applied, enter CTL-ALT-DEL to reset the K40 and K40FILT.
- 2) Measure pin 9 of U3 to ground, you should see 0 volts.
- 3) Pins 3, 10, 15, and 22 of U1 and pin 7 of U2 should be at 2.5V DC.
- 4) Press SHIFT-F8 to enter tune mode, a 2125Hz mark tone will be generated.
- 5) You should now see approximately:
 - .2 VAC between pin 9 of U3 and AGND (Pin 6 of U1)
 - 1.0 VAC between pin 10 of U4 and AGND
 - .7 VAC between pin 10 of U1 and AGND
 - 1.0 VAC between pin 3 of U1 and AGND
 - 1.0 VAC on pin 22 of U1 and pin 13 of U3 (2125Hz) to AGND
 - .3 VAC on pin 15 of U1 and pin 12 of U3 (2295Hz) to AGND
 Press ALT-F9 to generate a 2295 Hz space tone.
- 6) You should now see approximately:
 - .2 VAC between pin 9 of U3 and AGND
 - .7 VAC between pin 10 of U1 and AGND
 - 1.0 VAC between pin 3 of U1 and AGND
 - .3 VAC on pin 22 of U1 and pin 13 of U3 (2125Hz) to AGND
 - 1.0 VAC on pin 15 of U1 and pin 12 of U3 (2295Hz) to AGND
- 7) That completes the tests, if you encounter differences look in the related circuitry for shorts, unsoldered connections, incorrect resistor placement or missing components.

Oscilloscope Measurements

An oscilloscope will provide a more accurate way of measuring the filter levels, The table below shows peak to peak values for various filter settings. They taken in tune mode (SHIFT-F8) in TX+ and TX- mode.

ALT-F9	U1 Pin 10	U1 Pin 3	U1 Pin 15	U1 Pin21
TX+	2.8V PtP	3.0V PtP	1.4V PtP	3.2V PtP
TX-	1.7V PtP	3.0V PtP	3.2V PtP	1.4V PtP

Table 2

Immediate Commands

Key	Normal	Shift	ALT
F1	Play Message 1	Record	Toggle RTTY Mode
F2	Play Message 2	2X Rx Gain	Set Lead-in Delay
F3	Play Message 3	Toggle Diddle	Set Tail Delay
F4	Play Message 4	Toggle Spot	Set Serial Number
F5	Play Message 5	N/A	N/A
F6	Play Message 6	Toggle Tx Monitor	N/A
F7	Play Message 7	N/A	N/A
F8	Play Message 8	Toggle Tune	Rx Reverse
F9	Play Message 9	N/A	Tx Reverse
F10	Play Message 10	N/A	N/A
F11	Play Message 11	N/A	N/A
F12	Play Message 12	N/A	Beacon Message
↑ UP	N/A	N/A	N/A
↓ DOWN	N/A	N/A	N/A
END	Fast F12 Msg Load	N/A	N/A
PGUP	Scroll Display Up	N/A	N/A
PGDN	Scroll Display Down	N/A	N/A
HOME	Return display to home	N/A	N/A
TAB	Toggle Display view	Clear LCD Displays	N/A
ESC	Abort/Cancel	N/A	N/A
INSERT	Tx/Rx Control	N/A	N/A

Table 3

Buffered Commands

CTL	Command	Syntax
C	Call Message	^C<msg>
D	Serial # -1	^D
I	Serial #+1	^I
K	Toggle Tx	^K
L	Load Loop Count	^L<nn> nn=count
M	Insert CR	^M
N	Play Serial#	^N
W	Wait	^W<nn> nn=seconds
Z	DECSZ Loop	^Z

Table 4

Bill of Materials

Reference	Description	Package	Check
K40FILT PCB	K40 Filter Printed Circuit Card	PC Board	
U1	LTC 1068 Switch Cap Filter IC	24 pin SDIP	
U2	LMC6482 Dual Op Amp	8 Pin DIP	
U3	PIC16F684 RTTY Controller	14 Pin DIP	
U4	CD4066 CMOS Switch	14 Pin DIP	
U5	PIC12F508 Display Controller	6 Pin DIN	
D1-D8	LED Display	2 Pin	
R22,R23	270 Ω 5% Resistor	1/4 W	
R1,R6,R9,R14, R21	10K 1% Resistor	1/4 W Blue	
R2	49.9K 1% Resistor	1/4 W Blue	
R3	24.3K 1% Resistor	1/4 W Blue	
R4	78.7K 1% Resistor	1/4 W Blue	
R5	113K 1% Resistor	1/4 W Blue	
R7,R15	118K 1% Resistor	1/4 W Blue	
R8,R20	26.7K 1% Resistor	1/4 W Blue	
R10,R17	61.9K 1% Resistor	1/4 W Blue	
R11	392K 1% Resistor	1/4 W Blue	
R12	31.6K 1% Resistor	1/4 W Blue	
R13	105K 1% Resistor	1/4 W Blue	
R16, R24	4.7K 5% Resistor	1/4 W	
R18	4.64K 1% Resistor	1/4 W Blue	
R19	2.26K 1% Resistor	1/4 W Blue	
C11	100 μ f capacitor	electrolytic	
C2	2.2 μ f capacitor	tantalum	
C7, C8, C9, C10	.01 μ f 100 VDC capacitor	ceramic disc	
C1, C3, C6	.1 μ f ceramic capacitor	.1" lead space	
C5	.0047 μ F mylar capacitor	Dipped radial	
C4	.027 μ F mylar capacitor	Dipped radial	
X1	20 MHz Ceramic Resonator	3 lead	
VR1	10 K Potentiometer	Vertical mount	
N/A	2-8Pin, 1-24pin	8P DIP socket	
N/A	2-14pin	14P DIP socket	

Table 5

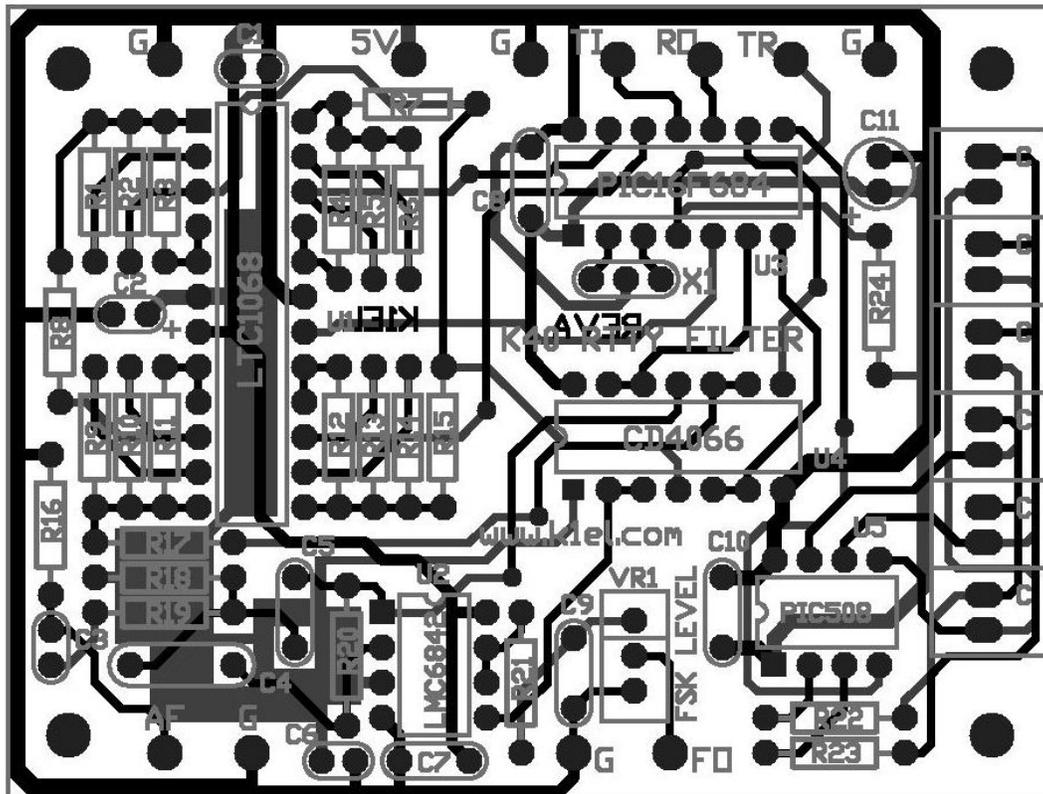


Fig 4 - K40FILT PCB Checkplot

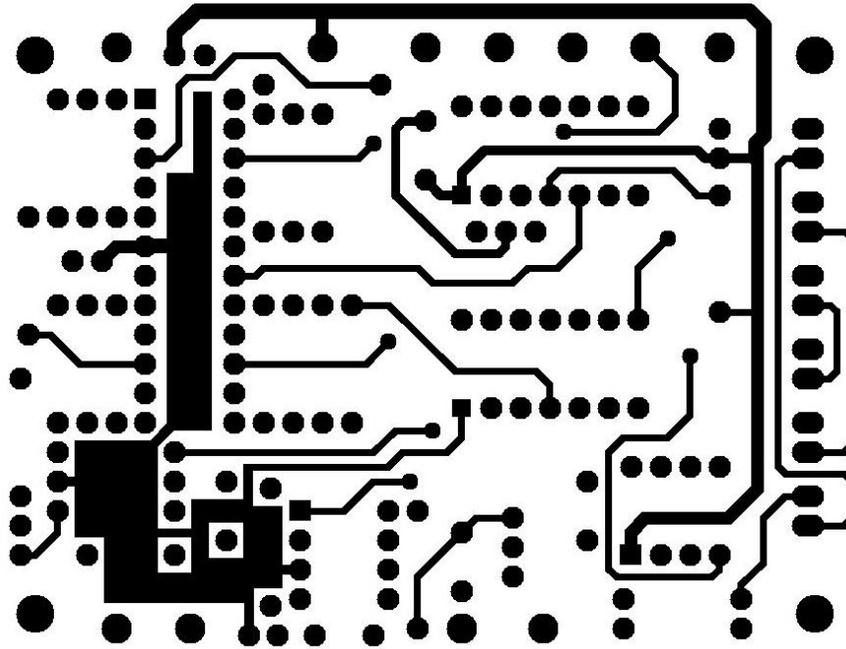


Fig 5 - K40FILT PCB Top Solder Layer

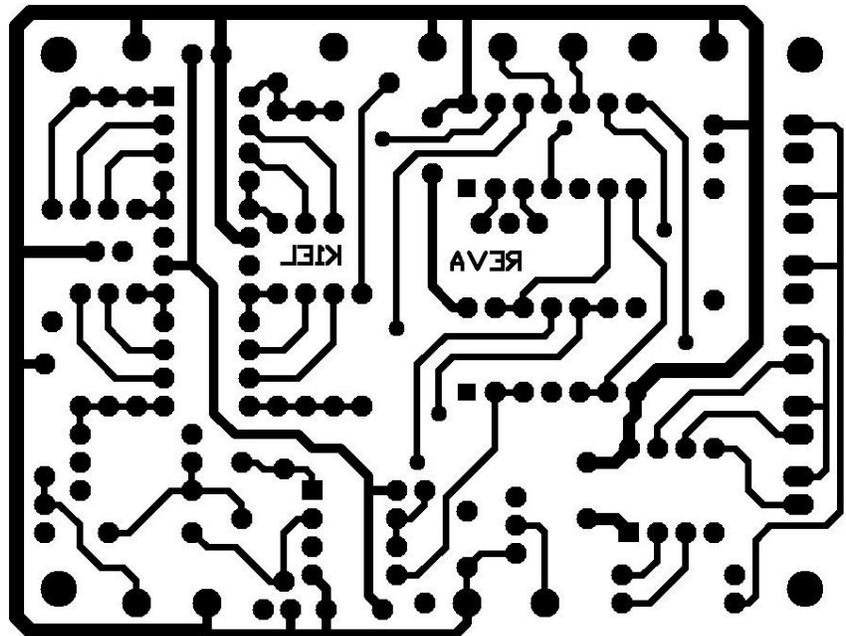


Fig 6 - K40FILT PCB Bottom Solder Layer

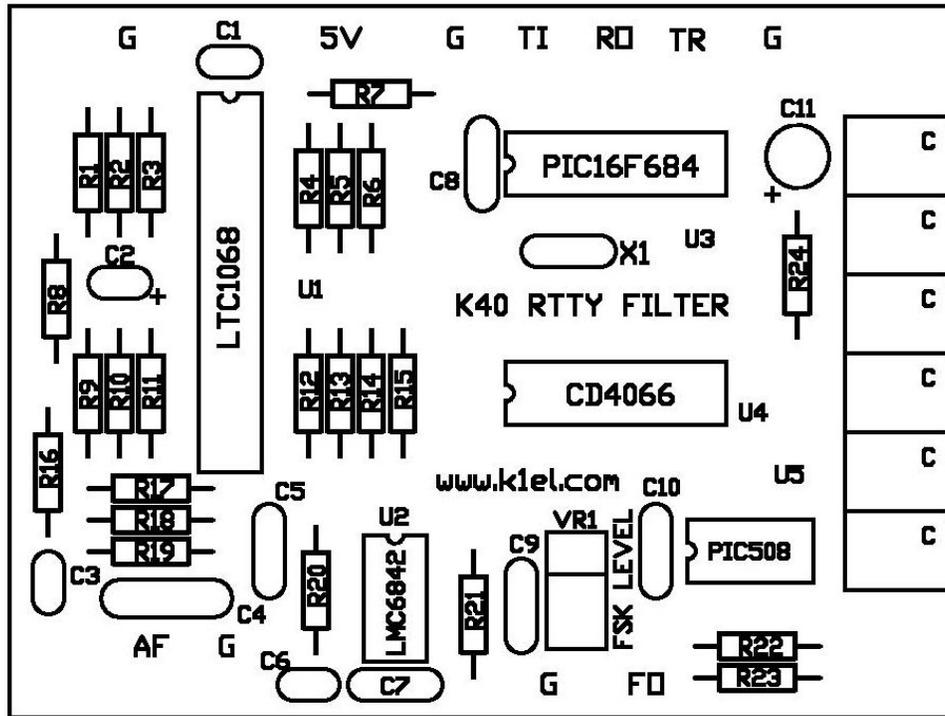


Fig 7 - K40FILT PCB Reference Designators

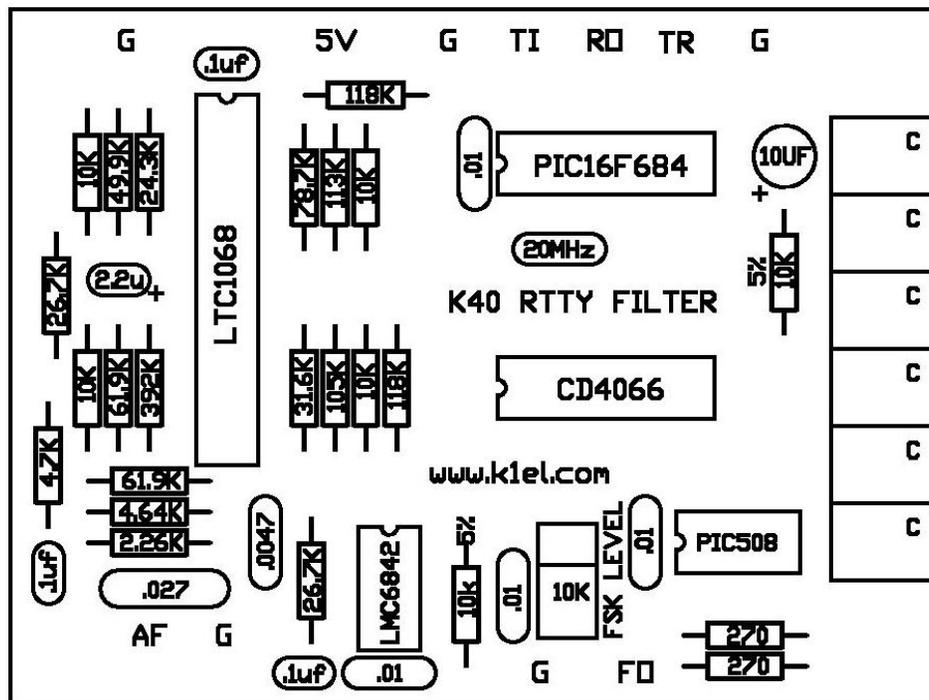
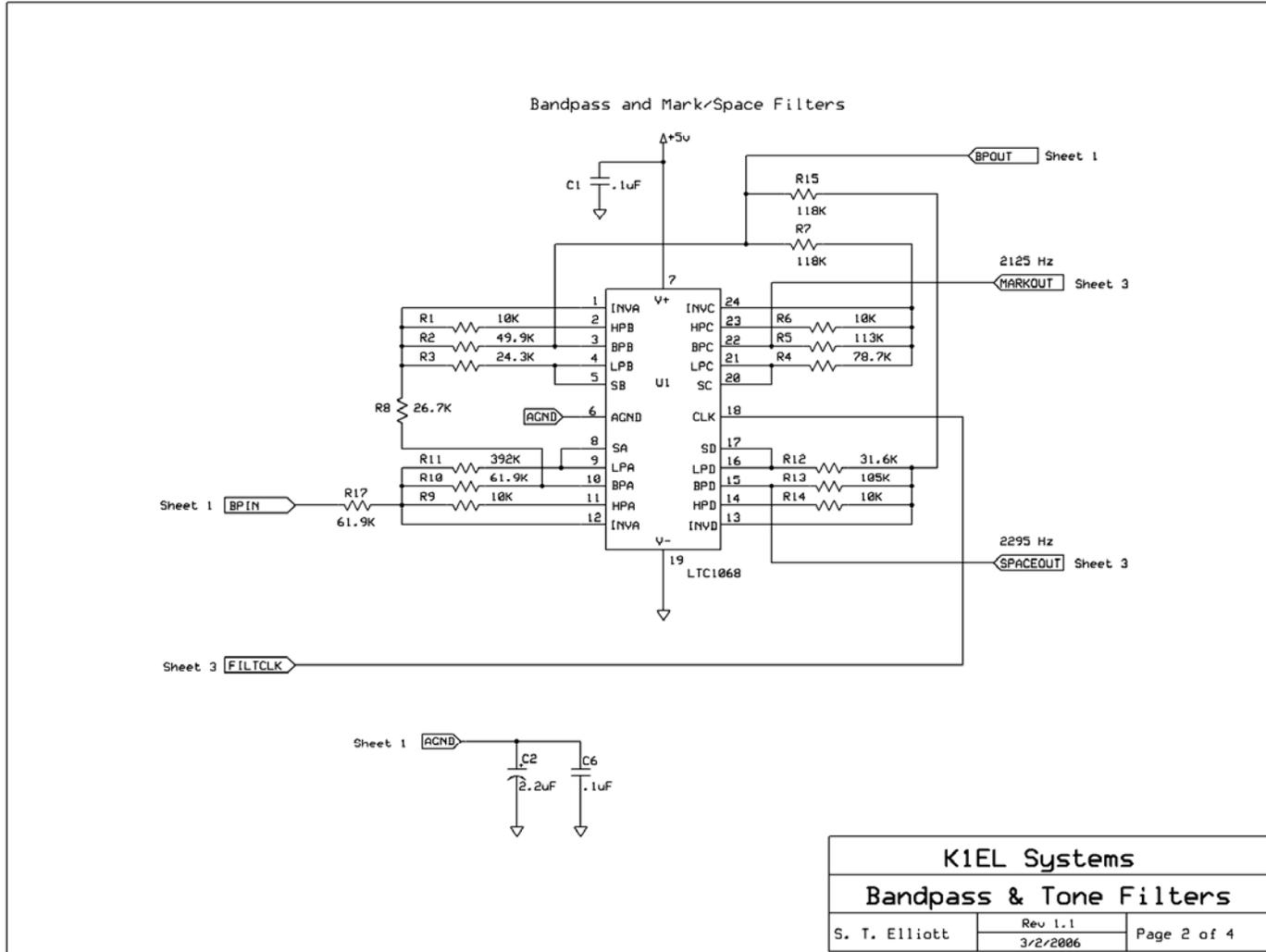
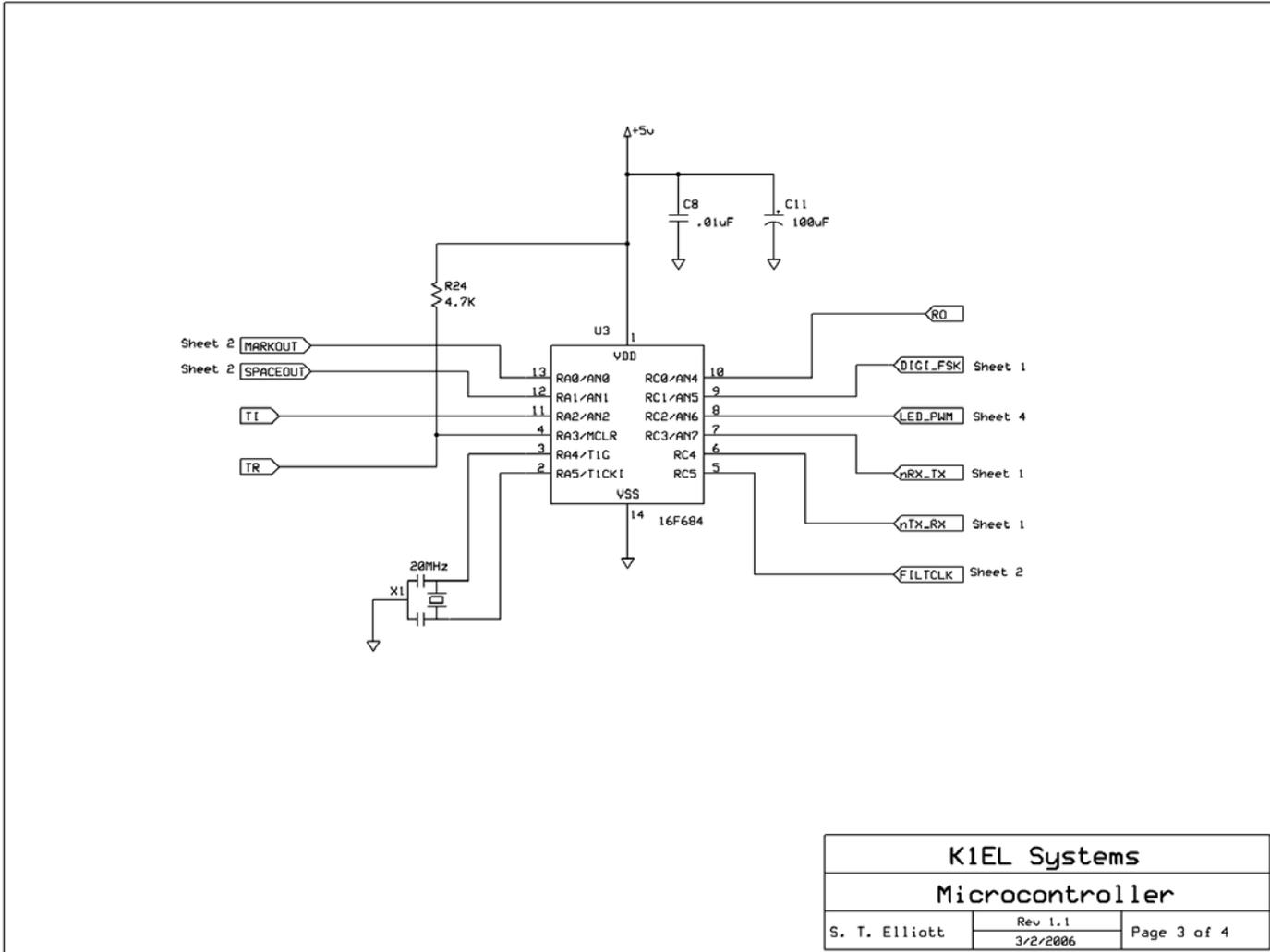
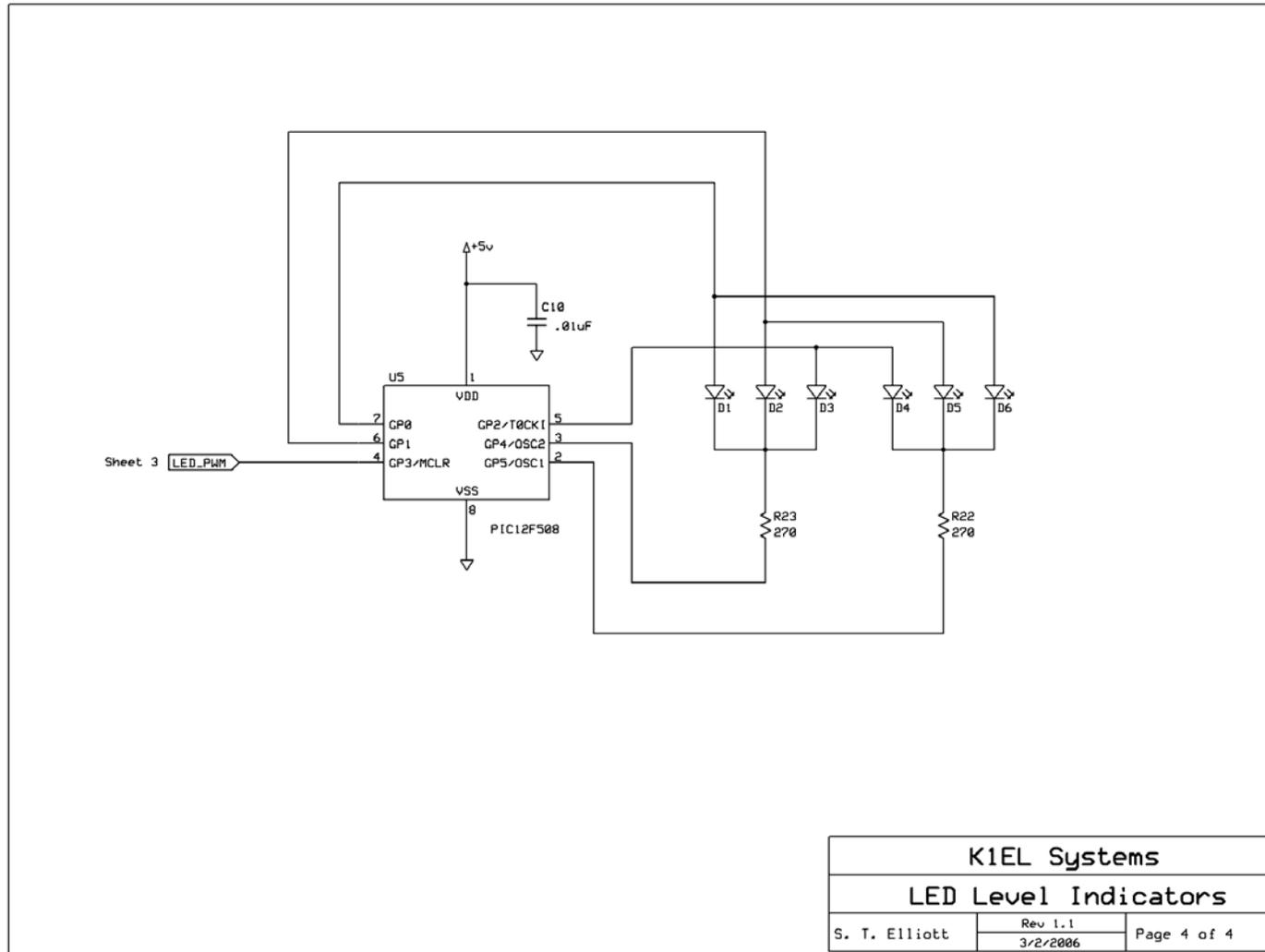


Fig 8 - K40FILT PCB Component Values





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K40 to IC703 Interface

It is a simple procedure to connect the K40 to an IC-703 for RTTY operation.
 Reference IC-703 Manual page 38
 Connect as follows:

IC-703 Connector	K40 Connection
MSEND – Pin 3	PTT (K40 PCB)
FSK – Pin 10	KEY (K40 PCB)
AF OUT – Pin 12	AF IN (Filter PCB)
GND – Pin 2	Ground (G K40 PCB)

Table 6

On K40: Enable GAINX2 (SHIFT-F2)
 Set RX and TX sense to +

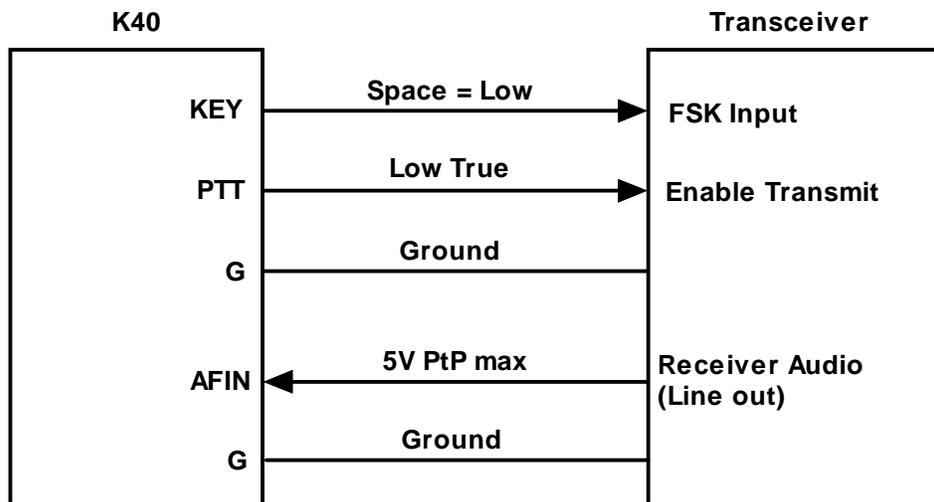


Figure 11 – Typical FSK Interconnect

Product Information

The K-40FILT 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 K40FILT design is as complete and reliable as possible it is still possible to cause equipment damage or incur personal injury if the K40FILT kit is not used as intended, is connected incorrectly, or modified in any way. K1EL can not be held responsible in these events.