The NorCal FCC-1 Assembly & Operating Manual

Rev. 1.1
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Contents

1. Introduction

The NorCal FCC-1 is a highly flexible frequency counter that incorporates features not found in any comparable unit. Its small size allows it to be incorporated into your favorite rig and your battery will hardly notice its modest current requirements. A high impedance input buffer provides high gain and isolates the counter to minimize loading of the signal source. The 4-bit band select input enables the counter to directly display your operating band and supports programmable parameters on a per-band basis. These parameters are stored in nonvolatile EEPROM. The 16 character by 2 line display is a high contrast, super twisted nematic LCD that's easily viewable over a wide angle in modest lighting conditions. Three menu-driven pushbuttons are provided to support user programming. Operation is as simple as connecting power and a signal source.

Adding a high frequency prescaler ahead of the FCC-1 extends the nominal 50 MHz input range into the GHz region. The FCC-1 will read the frequency directly because you can program the exact division ratio. You can also program the IF offset well into the VHF region for total flexibility. The display calculation allows for all combinations of VFO and IF frequencies.

The kit contains all of the necessary parts. There are no surface mount parts to contend with, so this is a kit suitable for builders with modest soldering experience. The board is solder-masked and has silkscreened component outlines for ease in assembly. The FCC-1 can be hardwired directly into your rig, or you can install your favorite connectors for flexibility.

With a future add-on board, the FCC-1 becomes a DDS frequency synthesizer that's capable of replacing conventional analog VFOs in many applications.

Features

- 16 character by 2 line high contrast LCD
- 10 digit frequency display
- Band annunciator
- 3 pushbuttons for user programming
- 16 nonvolatile band memories for programmable parameters
- Programmable IF offset in 1Hz increments
- Programmable display calculation: Direct, VFO+IF, VFO-IF, IF-VFO
- Prescaler compensation
- Display averaging to reduce least significant digit dither
- Expandable to include a low power DDS VFO with shaft encoder

2. Specifications

Dimensions	1.9” x 3.05” x 1.125” (HWD)
Weight	1.5 oz.
Power Supply	7.5-20VDC @ 20mA, typical, reverse polarity protected
Input Sensitivity	30mVrms typical - see Figure 1
Input Impedance	1Meg || 15pF
Input Frequency Range	500 Hz to >50 MHz
Display Frequency Range	1Hz to >2.1 GHz
Display Resolution	1Hz, 10Hz
IF Offset	0 to >268 MHz, programmable per band
Prescale Factor	1 to 255, programmable per band
Gate Period	100 mS, 1 Sec
Band Select	4-bit CMOS level input, with internal pull-ups
Band Annunciator	160m, 80m, 60m, 40m, 30m, 20m, 17m, 15m, 12m, 10m, 6m, 2m, 1.25m, 70cm, User, Direct
Controls	LCD contrast, calibration, 3 pushbuttons
Inputs	Power, Signal, Band Select, Keyline (future use)
Outputs	Expansion Connector (future use)

3. Assembly Notes

The FCC-1 can be built in an evening, depending on the builder's experience. It is important to use a good soldering iron with a fine tip. A temperature-controlled soldering station with a 1/16" or 3/32" chisel tip is ideal. A 25-40 Watt pencil type soldering iron is also suitable. Lead-based solder is being phased out, but 60/40 or 63/37 tin/lead rosin-core, .025" diameter solder is suitable for assembling this kit. Silver-bearing solder is also acceptable, but not necessary. ***Under no circumstances should you use solder with an acid-core flux***.

The assembly instructions below are organized to permit ease of component installation. Novice builders will benefit by following the steps in order. Experienced builders may install a number of parts before soldering to speed up assembly. All of the parts, except for the switches, header and LCD are installed on the component side of the board. The silkscreen component outlines indicate the component locations and orientation. Appendix B contains an enlarged board layout. Always trim the excess lead length after soldering, unless the instructions indicate otherwise.

3.1 Preassembly Mods

The counter was designed for RF service, and the input sensitivity decreases below 10Khz. If you wish to use the FCC-1 as an audio frequency counter, a user-supplied capacitor will be required. Install a 10uF, 16V electrolytic cap at C8 with the negative cap lead oriented as shown in Photo 1. On the solder side of the board, tack-solder the original 0.1uF cap across the electrolytic cap leads at C8. The extra capacitance increases the drive to Q2, which presents a low impedance.

If you are planning to use a prescaler in front of the FCC-1, it may be possible to eliminate some components to reduce current consumption. The prescaler output must be 5V CMOS compatible. If this is the case, you can eliminate C7, C8 Q1, Q2, R3, R4, R5 and R6. ***Skip the assembly steps marked with an (*)***. Install a jumper from the C7 pad closest to JP3 to Q2-C (marked 1 on the legend), as shown in Photo 1. This will provide a direct digital input to the PIC and save about 15 mA in current consumption.

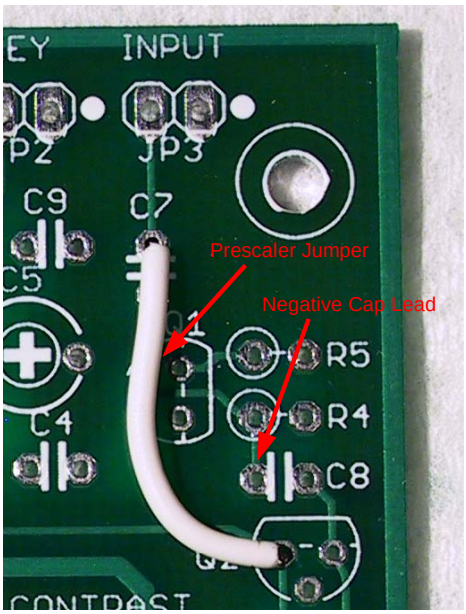


Photo 1. Preassembly Mods

3.2 Component Lead Forming

The discrete resistors and diodes in the FCC-1 are oriented vertically to save space. It's helpful to orient all the resistors in the same direction, with the least significant stripe at the top. For example, a 10K resistor has Brown, Black, Orange and Gold stripes. Bend over the lead closest to the Brown stripe so that it is parallel to the resistor body. Refer to Photo 2. Not only does it look better, but orienting the resistors the same way helps debugging the FCC-1 if it's necessary. The two diodes have a stripe at one end. Bend the striped lead so that it is parallel to the diode body, as shown in Photo 2.

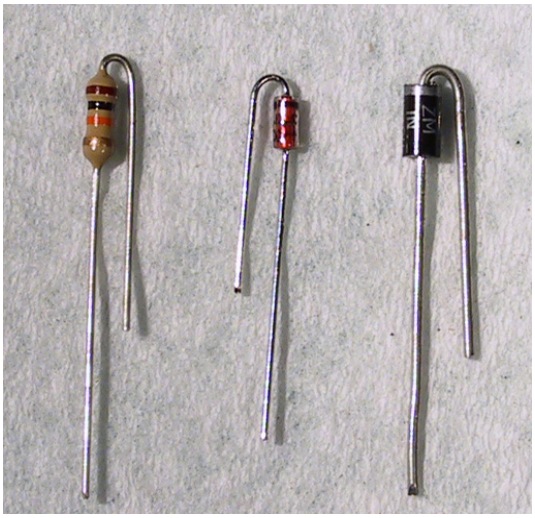


Photo 2. Formed Component Leads

4. Assembly

- ❑ Inventory all of the parts against the Bill of Materials in Appendix A. Every care was taken in kitting the parts to insure completeness. Note any discrepancies and NorCal will gladly supply the missing parts.

- ❑ Locate the red 20pF trimmer cap and examine it carefully. Install it with the flat side facing Y1 as shown in Photo 3. Solder both leads, being careful to use minimal heat because this part is easily damaged. There's no need to trim the leads.

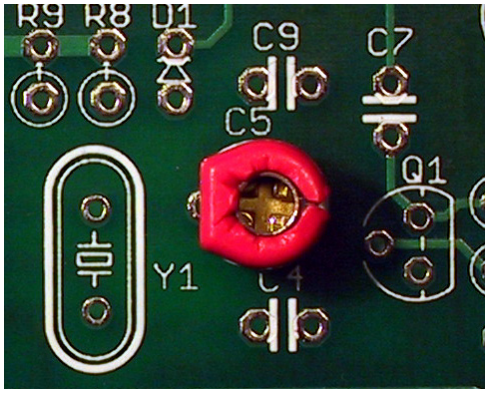


Photo 3. C5 Orientation

- ❑ Install the three 0.1uF caps, which are marked "104", at C1, C3 and *C8 and solder. **NOTE:** To extend the range of the FCC-1 into the lower audio frequencies, install a 10uF, 16V electrolytic cap for C8. See Photo 1 for orientation. Install the 0.1uF cap across the electrolytic cap leads on the solder side of the board. Remember to trim the excess lead length as close to the board as possible.

  *Skip the installation of C8 if using direct prescaler input.

- ❑ *Locate the two 0.01uF caps, which are marked "103". Straighten the leads with needle nose pliers and install at C6 and C7. Solder using minimal heat.

- ❑ Locate the 33pF C0G cap, which is marked "330J". Install it at C4 and solder using minimal heat.

- ❑ Locate the 22pF C0G cap, which is marked "220J". Install it at C9 and solder using minimal heat.

- ❑ Locate the 1N4148 diode. Bend the cathode lead (striped end) of the diode to form a U-shape, as shown in Photo 2. Install D1 with the body of the diode in the circled hole, as shown in Photo 4. Solder both leads, using the minimal heat required to form a good joint.

Photo 4. D1 Installation.

- ❑ Install the 4 10K resistors (Brown-Black-Orange-Gold) at *R3, R7, R8 and R9, observing the outlined patterns. The body of the resistors is inserted into the circled holes. Solder all the leads. Photo 5 shows a typical installation.

  * Don't install R3 if using direct prescaler input.

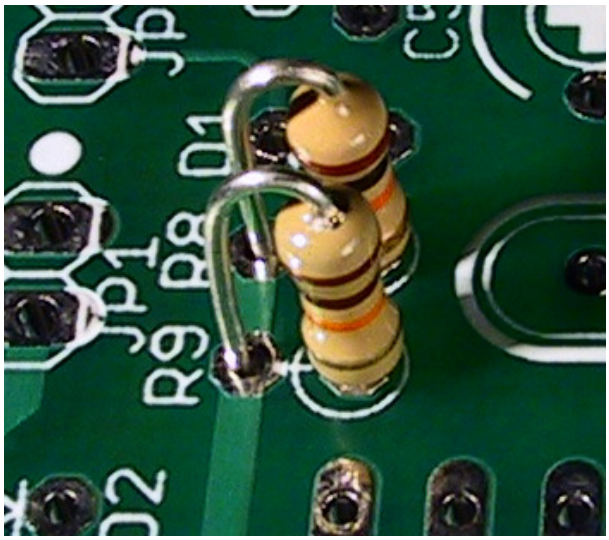


Photo 5. Resistor Orientation.

- ❑ Locate C2, the 10uF electrolytic cap. Install it with the negative striped end facing the edge of the board. Solder both leads.

- ❑ Locate the 78L05 regulator. Bend the center lead slightly away from the flat side and install it at the U3 location. The outline shows the proper orientation; refer to Photo 6. Position the regulator 1/8” above the board and solder the 3 leads.

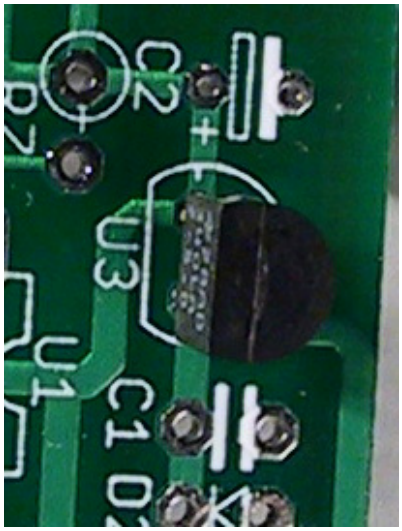


Photo 6. U3 Installation.

- ❑ *Locate the J310 FET. Bend the center lead slightly away from the flat side and install it at the Q1 location. The outline shows the proper orientation. Position the part 1/8” above the board and solder the 3 leads.

- ❑ *Locate the MPSH10 transistor. Bend the center lead slightly away from the flat side. Using needle nose pliers, straighten the end pins. Install the transistor at the Q2 location, observing the outline orientation. Position it 1/8” above the board and solder the 3 leads.

- ❑ Locate the 1N4004 diode. Bend the cathode lead (striped end) of the diode to form a U-shape, as shown in Photo 2. Install it at D2 with the body of the diode in the circled hole, as shown in Photo 7. Solder both leads.

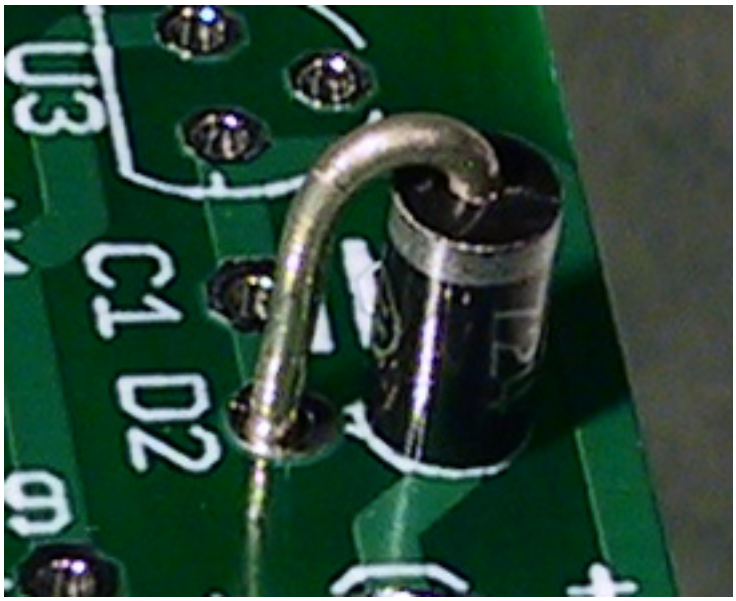


Photo 7. D2 Installation.

- ❑ *Install the 1Meg resistor (Brown-Black-Green-Gold) at R5 and solder both leads.

- ❑ *Install the 220 Ohm resistor (Red-Red-Brown-Gold) at R4. Solder both leads.

- ❑ *Install the 470 Ohm resistor (Yellow-Violet-Brown-Gold) at R6 and solder both leads.

- ❑ Examine the 10K SIP resistor network and locate the round dot which indicates pin 1. Line it up with the dot on the board and install it at R2 and solder all the pins. Photo 8 shows the correct orientation. The component outline shows an “X” at pin 1.

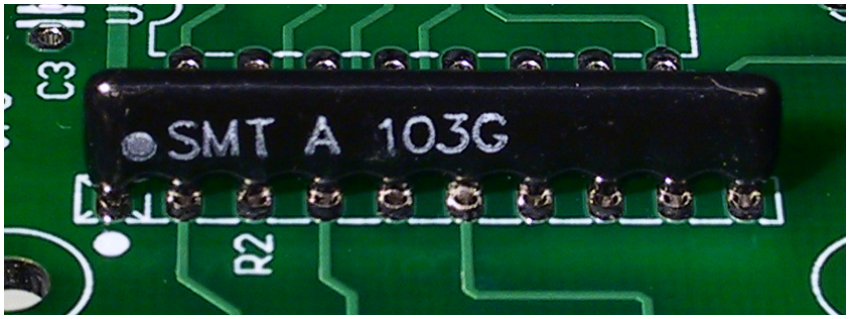


Photo 8. SIP Resistor Network Orientation.

- ❑ Install the 5K trimpot at R1 and solder.

- ❑ Install the 4 MHz crystal at Y1 and solder. Be careful to use the minimal amount of heat necessary to permit a good solder joint.

- ❑ Install the 18-pin IC socket at U1. Make sure the socket is aligned with the component outline. Solder all of the pins.

- ❑ Remove the 74HC165 from its protective foam and lay one side against a flat surface. Gently bend the pins so they are at right angles to the chip body. Repeat for the other side. Install the IC at U2 according to the component outline. Pin 1 should be pointing toward C3, as shown in Photo 11, Solder all of the pins.

- ❑ Switches SW1-3 must be prepared before installation. Straighten the bends in the leads using needle nose pliers, as shown in Photo 9. Install the switches on the ***solder side*** of the board, as indicated by the component outline. Make sure they are seated flush against the board and solder the all pins on the component side. Don't trim the leads.

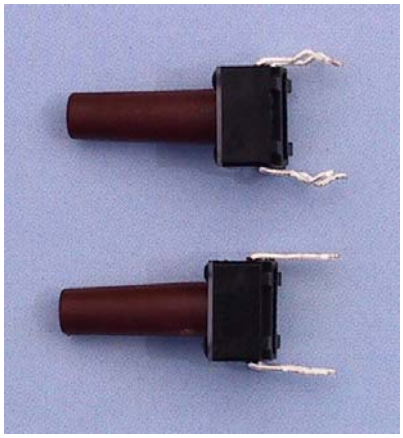


Photo 9. Original and Modified Switch Pins.

- ❑ Connectors JP1, 3 and 6 are user-supplied. These are headers with 0.1" pin spacing. Suggested 2-pin connectors are the Molex 22-23-2021 (Digikey catalog number WM4200-ND). The suggested 5-pin connector is the Molex 22-23-2051 (Digikey catalog number WM4203-ND). These are preferred since they have polarized retaining clips that prevent the mating connectors from being installed backwards or becoming loose. Conventional headers will also work fine. Direct wiring is also possible and you can install wires at this time or wait until the board is assembled. JP2 and JP5 are reserved for future expansion.

- ❑ Although the FCC-1 board is solder-masked, there are still opportunities for solder bridges to develop. Carefully inspect your work, checking for solder bridges and cold joints before proceeding. Diagnosing problems once the LCD is installed will be difficult.

- ❑ Measure the power input resistance by connecting the negative lead of an Ohmmeter to JP1 pin 1 (the pin with the white dot) and the positive lead to JP1 pin 2. The DC resistance should be greater than 1Meg Ohm. Correct any problems before proceeding.

- ❑ Connect a 7.5-15V DC power supply to JP1. Pin 1 is the negative input. Insert a milliammeter in series with the positive lead and measure the supply current. It should be less than 20mA. Correct any problems before proceeding.

- ❑ With power applied to JP1, connect the negative probe of a voltmeter to pin 8 of U2. Connect the positive lead to U2 pin 16. The voltage should be 5.0 Volts +/- 5%. Correct any problems before proceeding

- ❑ Locate the 17-pin header and clip off an end pin. The header has long pins on one end and shorter pins on the other. Insert the long pins into the JP4 position of the on the s***older side*** FCC-1 board, but don't solder yet. Photo 10 shows the correct orientation with the short pins pointing up from the board.

Photo 10. Header Installation.

- ❑ Locate the 4 nylon spacers and place them over the LCD mounting holes on solder side of the FCC-1 board. It's helpful to support the board on the component side to keep it level. You can put a small dab of contact cement on the board to keep the spacers in place.

- ❑ Remove the LCD from its antistatic bag and gently install it over the short header pins. Make sure the nylon spacers are still in place.

- ❑ Insert four 4-40 screws at the front of the LCD through the spacers and FCC-1 board. Thread 4-40 nuts on the component side of the board. Make sure the LCD display is square with the FCC-1 board and finger tighten the nuts.

- ❑ Inspect the gap between the LCD and the FCC-1 board. The LCD tabs will be close to the board, but the tab above C9 should clear both solder pads. If it touches either pad, remove the LCD and gently bend the tab to eliminate contact. Reassemble following the previous step.

- ❑ After the LCD is aligned with the FCC-1 board, tighten the nuts for a snug, but not overly tight fit. You can apply a small dab of contact cement

- ❑ Solder the 16 header pins on the top of the LCD. Use minimal heat here. It's a good idea to solder the end pins first and then work toward the center to evenly distribute the heat and minimize hot spots. Inspect your work for solder bridges. Don't trim the header pins.

- ❑ Flip the FCC-1 board over and solder the 16 header pins on the component side of the board. Solder the end pins first and work toward the center to minimize hot spots on the board. Inspect your work for solder bridges. Don't trim the excess header pin length.

- ❑ Remove the PIC16F628A from its protective foam and lay one side against a flat surface. Gently bend the pins so they are at right angles to the chip body. Repeat for the other side. Install the PIC in the U1 socket with pin 1 pointing toward U3, as shown in Photo 11.

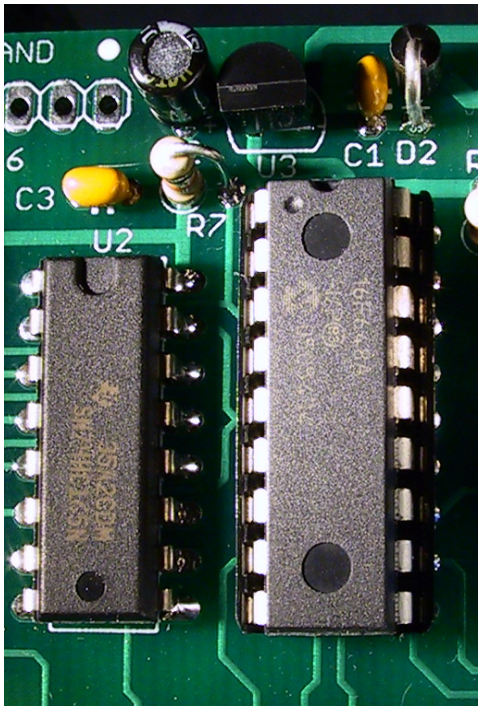


Photo 11. U1 and U2 Installation.

5. Initial Test

- ❑ Using a fine blade screwdriver, rotate the shaft of R1 fully counter-clockwise.

- ❑ Apply a 7.5-20 volt DC supply to JP1. Pin 1 is negative. The display should indicate **FCC-1 Ver 1.0** on the top line. This will be displayed for about a second. The top line should then display **0.00 KHz** at the right side and the second line should read **Dir** at the left side, as shown in Photo 12.

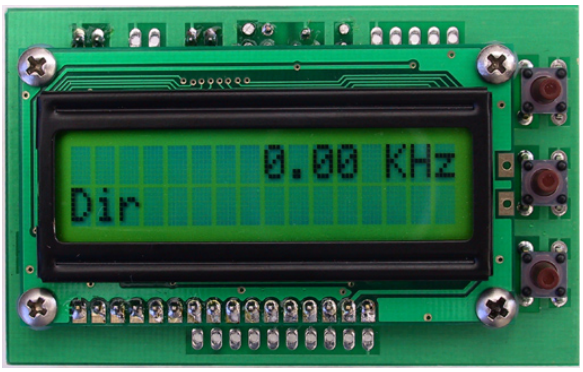


Photo 12. FCC-1 Operational Display.

- ❑ The display will likely show dark rectangles at each character position, as shown in Photo 12. Rotate R1's shaft clockwise until the rectangles just disappear. This is the highest contrast position. Rotating the shaft further will reduce the contrast of the displayed characters.

6. Calibration

There are several ways to calibrate the FCC-1. For users in the Americas, calibration can be performed by heterodyning the calibration frequency with WWV. Users in other parts of the world have other options, as explained below. The PIC uses the 4 MHz crystal as a timing reference which is fine tuned by C5. Measuring the PIC clock frequency isn't practical because probe capacitance will load the crystal and alter its frequency.

If the WWV signal is available in your area, the following procedure applies. Hold down the Menu button (SW3) and apply power to the FCC-1. The LCD will display **Cal**. Allow it to stabilize for 15 minutes before proceeding. The PIC will be generating a 250 KHz rectangular waveform which is available on JP4 pin 14. Clip a lead to the header pin on the component side of the FCC-1 board and wrap a few turns around the antenna of a shortwave receiver tuned to WWV. The 10 MHz frequency is best. Adjust C5 until the beat note is minimized. The trimcap rotor is grounded, so a metal screwdriver can be used. With a little care, it is possible to get the beating down to less than 1 Hz. Congratulations, you're done. Cycle the power to exit the calibration mode.

For builders in areas where WWV is unavailable, the FCC-1 can be calibrated using an accurate frequency counter. Couple JP4 pin 14 to the counter and adjust C5 until the counter displays 250.000KHz. Another way to calibrate the FCC-1 is to use a frequency generator of known accuracy. Couple a 10MHz – 30 MHz signal source to the FCC-1 and adjust C5 until the displayed count agrees with the generator setting.

7. Connecting the FCC-1

Tables 1-3 illustrate the connections for the FCC-1. The power supply can be any DC voltage between 7.5 and 20 Volts and is reverse polarity protected. The dot at the JP1 connector pin indicates ground.

The signal input is connected to JP3. The ground connection is attached to pin 1, as indicated by the dot on the component outline. The minimum input signal amplitude depends on frequency. Figure 1 illustrates the signal requirements vs. frequency using the stock components.

The frequency input at JP3 is not protected against high voltages. The input capacitor has a 50V rating, so you must isolate any high voltage DC before applying the signal to the FCC-1. The FET input buffer can tolerate about 4Vpp before the gate becomes forward biased. Limit the AC input voltage to less than 2Vpp to provide a safety margin.

Adding bandswitch inputs allows the FCC-1 to indicate the operating band and permits the use of different operating parameters for each band. Table 4 shows the band inputs vs. displayed annunciator. A 0 level indicates ground while a 1 level indicates an open circuit. Note: the User* indicates that this band name is modifiable by the user. The band inputs can be connected to a switch that grounds the input signals since the FCC-1 contains internal pull-ups. These signals should not be shared with other circuitry to prevent unwanted interactions. If the FCC-1 will be used on a monoband rig, the band inputs can be hardwired for that band.

A Keyline input is provided at JP2, but it is not used with the FCC-1 operating in frequency counter mode.

JP1 Pin	Signal
1	GND
2	+Supply

Table 1. JP1 Power Connections

JP3 Pin	Signal
1	GND
2	Signal Input

Table 2. JP3 Signal Connections

JP6 Pin	Signal
1	GND
2	B1
3	B2
4	B3
5	B4

Table 3. JP6 Band Select Connections

B4	B3	B2	B1	Display
0	0	0	0	160m
0	0	0	1	80m
0	0	1	0	60m
0	0	1	1	40m
0	1	0	0	30m
0	1	0	1	20m
0	1	1	0	17m
1	1	1	1	15m
1	0	0	0	12m
1	0	0	1	10m
1	0	1	0	6m
1	0	1	1	2m
1	1	0	0	1.25m
1	1	0	1	70cm
1	1	1	0	User*
1	1	1	1	Dir

Table 4. Band Select Inputs vs. Band Display

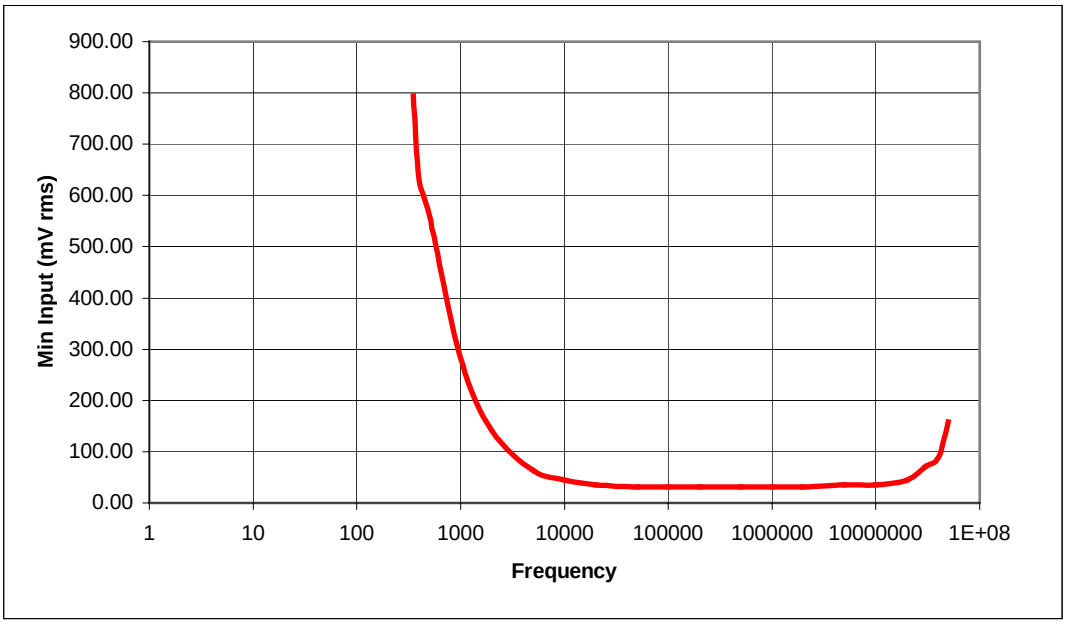


Figure 1. Typical Stock FCC-1 Input Sensitivity vs. Frequency

8. FCC-1 Programming Introduction

The FCC-1 stores 4 unique parameters per band: Gate Period, IF offset frequency, Display calculation and Prescale value. All of the parameters are stored in the PIC internal EEPROM so they are retained after power is removed. Each band is programmed independently. Three pushbuttons are used to program the parameters, and their operation is straightforward and intuitive. There are two operating modes: Normal and Menu. The FCC-1 always powers up in the Normal mode. Table 5 illustrates the general pushbutton operation as a function of operating mode.

Button	Normal Mode	Menu Mode
SW1	Change Resolution	Change value
SW2	None	Menu Functions
SW3	Enter Menu Mode	Menu functions

Table 5. Pushbutton Operation vs. Mode

In normal mode, SW1 is used to selectively disable least significant digits. In Menu Mode, it is used to change parameter values.

SW2 has no function in the Normal Mode. In Menu Mode, it is used to select digit or character positions or decrement character values

SW3 is used to enter and exit the Menu Mode, and also has other functions within the Menu Mode.

8.1 SW1 Normal Mode Operation

SW1 changes the display resolution in the Normal Mode. The lowest displayed digit depends on the gate period. With a 1 second gate period, the minimum resolution is 1 Hz, so the least significant digit is displayable. With a 100ms gate, the minimum displayed resolution is 10 Hz and the 1Hz position is blank. Pressing and releasing SW1 decreases the display resolution up to 1KHz, one digit at a time. The digits not being displayed are blank. Pressing the button with a 1Khz display resolution returns the display to the highest permitted by the gate period.

For example, assume the gate period is 1 second. The FCC-1 powers up displaying the 1 Hz digit. Pressing and releasing SW1 decreases the resolution to 10Hz. Pressing again reduces it to 100Hz and so on. Figure 2 illustrates the sequence. It's important to note that SW1 is sampled after a gate period has elapsed. If you're using a 1 second gate period, hold down SW1 for at least a second. It may take up to a second for the display to reflect the new resolution. There's no problem holding down the button for longer than the gate period. When using the 100mS gate, the 1Hz step is skipped.

The FCC-1 is shipped with a 100mS gate period programmed for all bands. Try stepping through the variable display resolution to become familiar with its operation. The display resolution is not stored in EEPROM and the FCC-1 will revert to the highest resolution display when power is cycled.

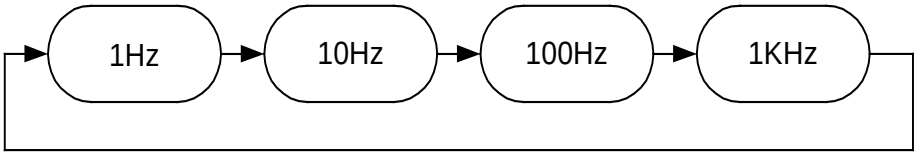


Figure 2. SW1 Display Resolution Sequence

8.2 SW3 Operation

Pressing and holding SW3 for at least a second will put the FCC-1 into Menu Mode. You will know you're entering this mode because the LCD will display "Menu" and will continue to do so until SW3 is released. There are 5 parameters available for editing. The first menu item to appear is the Band parameter. Tapping SW3 advances the next menu item. Figure 3 illustrates the sequence. Pressing and holding SW3 for at least 1 second will return to the Normal Mode, provided no changes were made. The display will indicate "Exit" as long as SW3 is held down. Normal Mode operation resumes when the button is released.

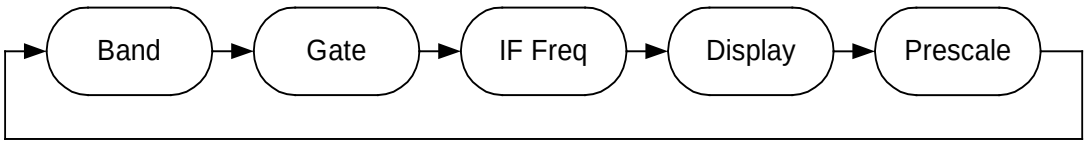


Figure 3. Menu Item Select Sequence

Familiarize yourself with SW3's operation, but resist the temptation to change any parameters at this time.

9. FCC-1 Menu Mode Operations

Table 6 lists the Menu items available for editing and their function.

Parameter	Function
Band	Select band settings to examine/modify
Gate	Select counting interval: 1Second or 100mS
IF Freq	Enter the IF offset frequency
Display	Select display calculation
Prescale	Enter the upstream division ratio

Table 6. Menu Mode Parameters

When the Menu Mode is entered, the first selection that appears is **Band**. The band annunciator on the LCD displays the band selected by the band inputs at JP6. The Gate, IF Freq, Display and Prescale values that follow are all associated with this band. As a reminder, the LCD will display the band at the right of the top line. Since the frequency counter software is not active in this mode, pushbutton latency will be noticeably shorter.

9.1 Changing Bands

You can select the band to examine/modify in this menu. Tap SW1 to increment the band whose parameters you wish to adjust. The sequence is 160m, 80m, 60m, 40m, 30m, 20m, 17m, 15m, 12m, 10m, 6m, 2m, 1.25m, 70cm, User and Direct. The sequence then repeats, as illustrated in Figure 4.

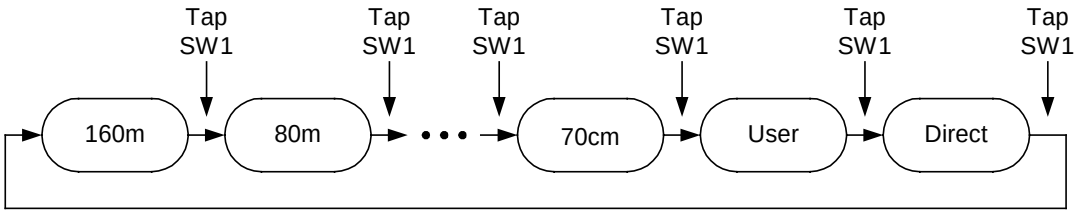


Figure 4. Band Select Sequence

9.2 Editing User Band Name

In the Band menu, you can edit the User band name. You can customize this band name with up to 8 characters. Simply tap SW1 until the display is past the 70cm band and the band annunciator will display the contents of the user band name stored in EEPROM. The FCC-1 is shipped with the default name set to **User**.

To edit the User band name, tap SW2. An underline cursor will appear under the leftmost character. SW1 and SW2 are now used to change this character. SW1 increments the character while SW2 decrements it. The full ASCII character set is supported, from the space character through the -> character. Tap SW3 to advance to the next character position. Repeated tapping will sequence through all 8 character positions and then return to the first. When you are satisfied with the band name, press and hold SW3 for at least 1 second. This exits the user band edit sub-menu and advances the menu selection to the Gate item. Figure 5 illustrates how the band name is edited.

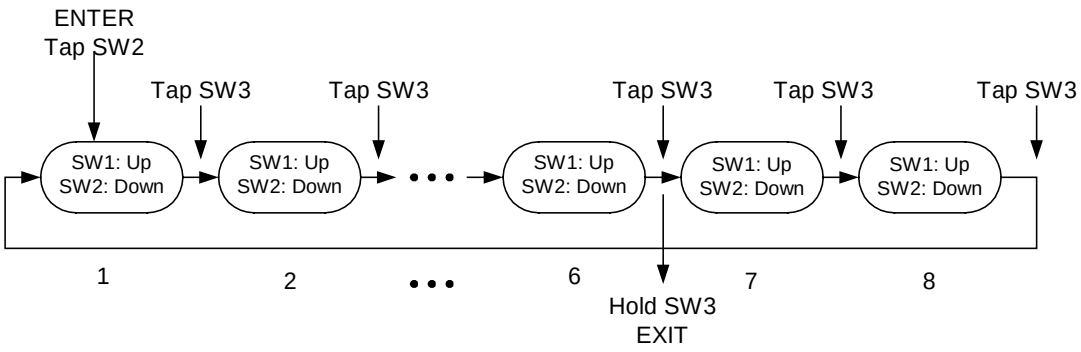


Figure 5. User Band Name Editing

9.3 Editing Gate Period

When you are satisfied with the band selection, tap SW3 to edit the Gate period. The display will indicate **Gate** at the left of the top line and the band on the right. The second line displays the current gate period. Tap SW1 to toggle between 1 sec and 100ms. The 1 sec gate period permits counting to 1Hz resolution. The 100ms gate period allows 10Hz resolution. When you are satisfied with the gate period, tap SW3 to enter the IF Offset item.

9.4 Editing IF Offset Frequency

The IF Offset parameter is used to modify the frequency count to compensate for receiver IF frequency, or transmit premix oscillator frequency. You can program IF offsets ranging from 0 Hz to 268,435.456 KHz. If you attempt to exceed the maximum limit, the offset will rollover to 0 Hz. Use SW3 to enter the IF Freq menu selection. The LCD will display **IF Freq** at the left of the top line and the current band will appear at the right. The bottom line displays the current IF offset frequency with an underline cursor at the 1Hz position. The FCC-1 is shipped with 0 offset frequency, so the display will indicate **0.000KHz**. Tap SW1 repeatedly to increment the current decade. Note that the digit rolls over from 9 to 0 without incrementing the next decade. This is handy if you increment past the desired digit. Press SW2 to advance to the next decade. To make the display easy to read, leading 0 digits are suppressed beyond 1Khz. Tap SW2 past 1Khz and the leading 0 digits will appear, one by one, at the current decade. Figure 6 illustrates the IF Offset editing process. When you have entered the IF offset frequency, tap SW3 to advance to the next menu item.

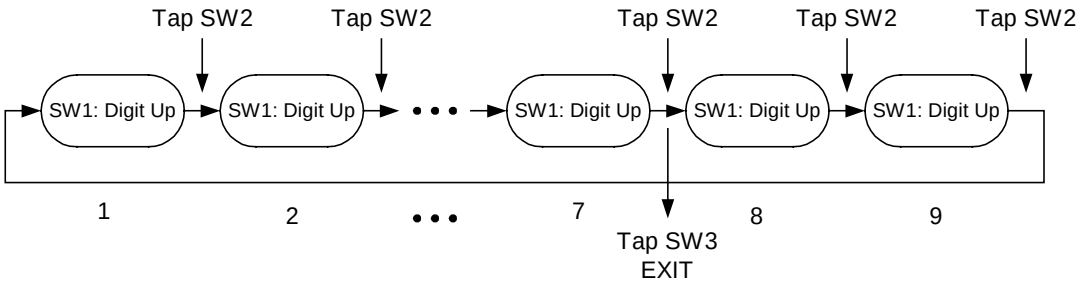


Figure 6. IF Offset Frequency Editing

9.5 Editing Display Calculations

The FCC-1 calculates the displayed frequency using one of four methods:

1. $F_{display}$ = (Prescale * F_{in})
2. $F_{display}$ = (Prescale * F_{in}) + IF Offset
3. $F_{display}$ = (Prescale * F_{in}) – IF Offset
4. $F_{display}$ = IF Offset – (Prescale * F_{in})

Where: $F_{display}$ = Frequency displayed on the LCD
F_{in} = Counted input frequency
Prescale = Programmed prescale value
IF Offset = Programmed IF offset frequency

After the calculations are applied in methods 1 and 2, the displayed frequency can be as high as 2,146,483.648 KHz (2.146…GHz). If this value is exceeded, the LCD will display **Neg Frequency**. This will also be displayed when the scaled input frequency is less than the IF offset in method 3, or when the scaled input frequency is greater than the IF offset in method 4.

You can program the display calculation method for each band in the **Display** menu. The choices are: **Direct**, **VFO+IF**, **VFO-IF** and **IF-VFO**. Tap SW1 to select the desired offset calculation, then tap SW3 to advance to the next menu.

9.6 Editing Prescale Value

All of the display calculations use the prescale factor. When the FCC-1 is used with a conventional HF rig, this parameter is generally set to 1. If the frequency you're measuring was divided down from some higher frequency, or it is involved in a downstream multiplication, the Prescale value must be modified. Older transmitters typically use frequency multiplication to arrive at the final output frequency. If the FCC-1 is connected to the VFO output, the Prescale value can be programmed to reflect the downstream multiplication factor.

The prescale adjustment also becomes important when the FCC-1 is used in a VHF, UHF or microwave rig. For example, many older VHF rigs use an HF oscillator which is multiplied up the desired output frequency. The output is likely beyond the upper frequency limit of the FCC-1 of approx. 55 MHz, but this limitation is overcome by counting the HF oscillator output. The Prescale value is then set to the multiplication factor.

In the case where the frequency of a VHF/UHF/Microwave oscillator must be measured, a prescaler is necessary to divide the frequency by a large factor. Typical prescaler ICs divide the input frequency by 64 or 128 and the output frequency is well within the range of the FCC-1. Set the Prescaler value to the division factor and FCC-1 will display the oscillator frequency.

Programming the Prescale value is similar to setting up the IF Offset frequency, except that only three digits are used. If no Prescale value is required, you can set the value to 000 or 001, they are treated identically. Otherwise, use SW1 and SW2 to enter the proper value, remembering that the maximum limit is 255. If you attempt to exceed this, the value will wrap around to 000.

9.7 Saving The Changes

There are two ways to save the modified parameters. The first way is to exit the Menu Mode by holding down SW3 for at least 1 second. The display will indicate **Save?** followed by the current band. Tapping SW1 will store the new parameters in EEPROM and the display will indicate **Saved!** on the second line. Tapping SW2 skips the EEPROM update, but the FCC-1 uses the new parameters as long it's powered up. Line 2 of the display will indicate **Not Saved!** The display will then briefly indicate **Exit** and operation will return to the Normal Mode.

The second way to save parameter changes is to change bands in Menu Mode. The software recognizes that the current band's parameters have been modified and it won't let you advance to the next band before offering the chance to save the parameters. The parameter save dialog is the same as before. After you tap either SW1 or SW2, the display will indicate the save status and the band will be advanced.

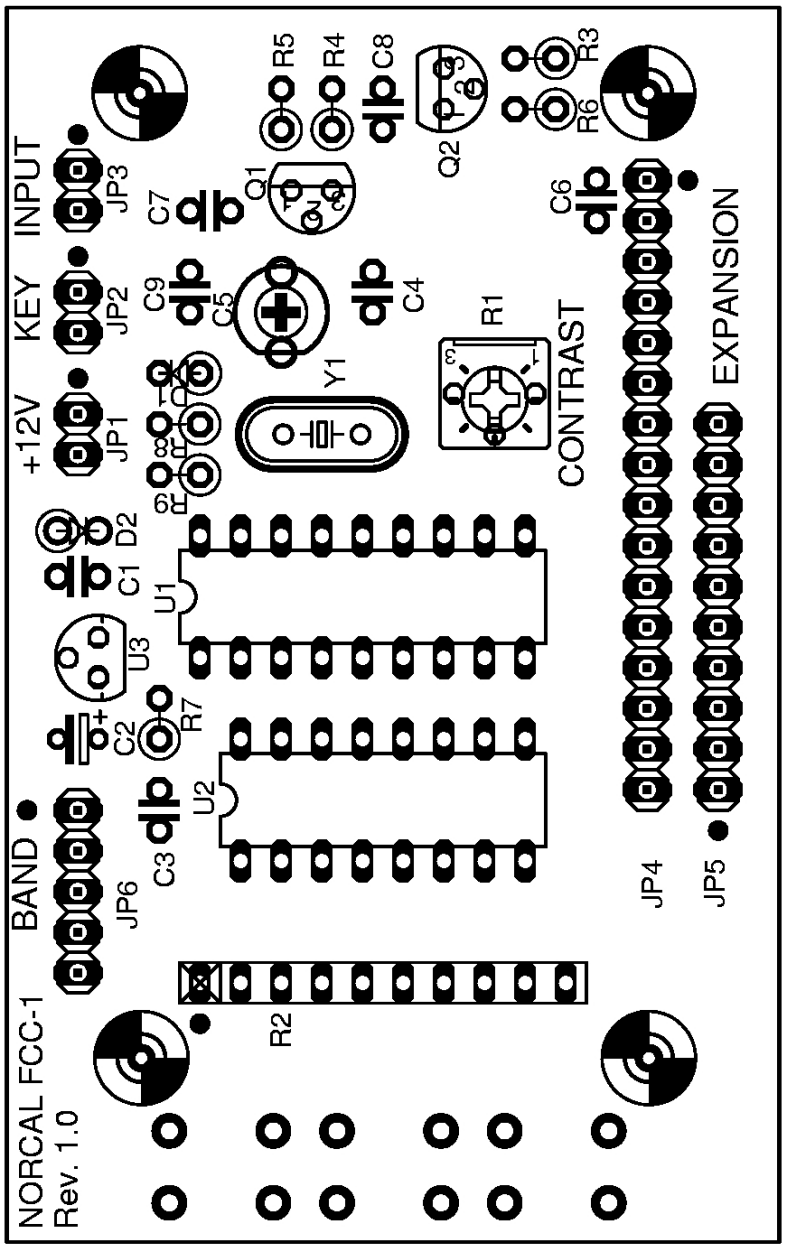
10. Installation

The FCC-1 may be attached to a front panel using the holes that fasten the LCD to the main board. You will need four 4-40 screws that are at least 5/16" long and four 1/8" long #4 nylon spacers (not supplied). You can use the drilling and cutout pattern in Appendix D as a reference. The rectangular cutout permits the LCD frame to be more or less flush with front panel.

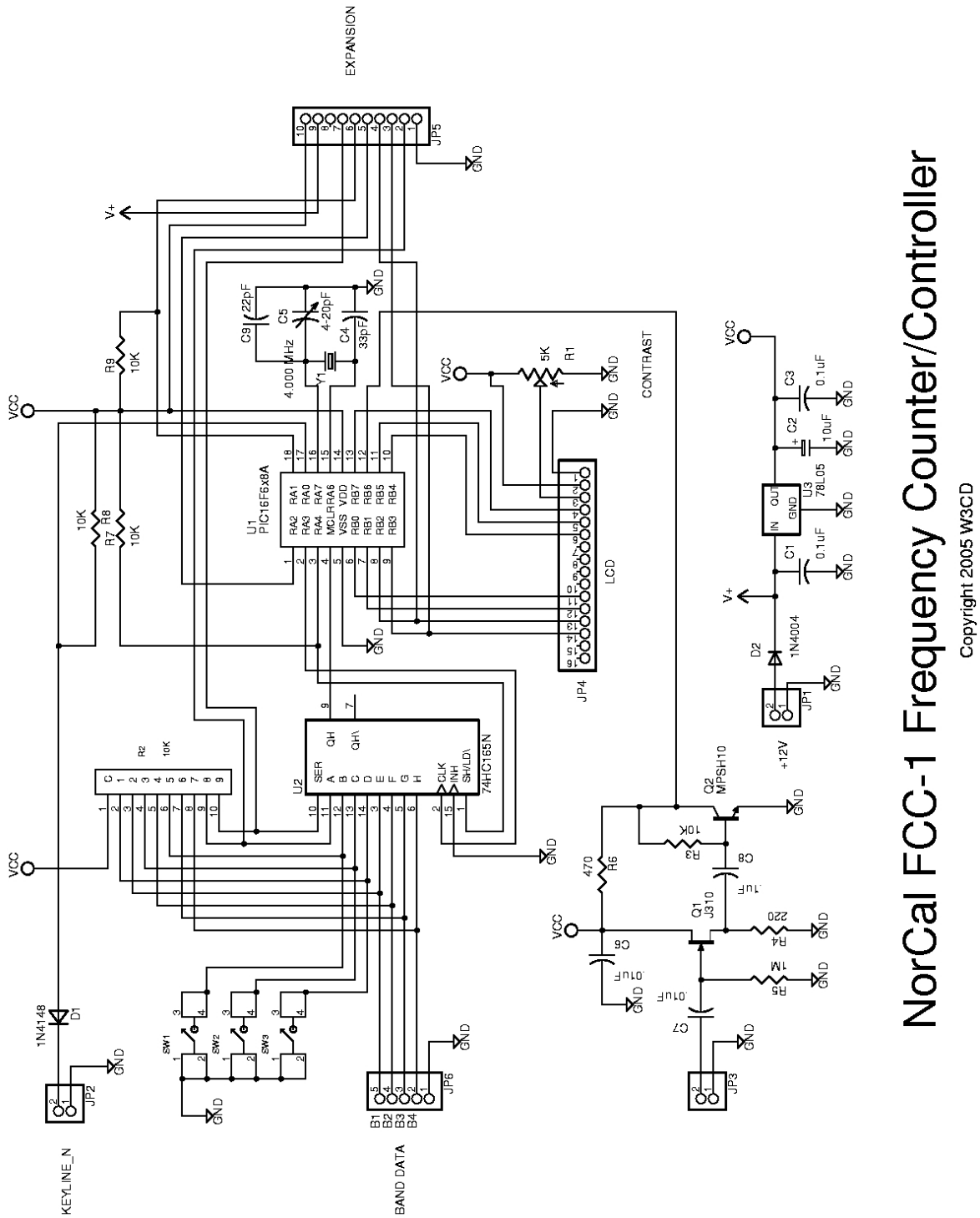
APPENDIX A. Bill of Materials

Item	Qty	Ref. Des.	Value	Description
1	3	C1, C3, C8	0.1uF	Ceramic Cap
2	1	C2	10uF	Electrolytic Cap
3	1	C4	33pF	C0G Ceramic Cap
4	1	C5	20pF	Trimcap
5	2	C6, C7	0.01uF	Ceramic Cap
6	1	C9	22pF	C0G Ceramic Cap
7	1	D1	1N4148	Diode
8	1	D2	1N4004	Diode
9	1	Q1	J310	NFET
10	1	Q2	MPSH10	NPN
11	1	R1	5K	Trimpot
12	1	R2	10K	10 pin resistor network
13	4	R3, R7, R8, R9	10K	1/4W 5% resistor
14	1	R4	220 Ohms	1/4W 5% resistor
15	1	R5	1MegOhm	1/4W 5% resistor
16	1	R6	470 Ohms	1/4W 5% resistor
17	3	SW1, SW2, SW3	SPST	Pushbutton switch
18	1	U1	PIC16F628A	Programmed PIC
19	1	U2	74HC165N	Shift register
20	1	U3	78L05	Voltage regulator
21	1	Y1	4.000MHz	Crystal
22	1	N/A		18 pin dip socket
23	1	N/A		17 pin header
24	4	N/A		1/8” nylon spacers
25	4	N/A		4-40 3/8” screw
26	4	N/A		4-40 small nut

APPENDIX B. FCC-1 Component Layout



APPENDIX C. FCC-1 Schematic



APPENDIX D. FCC-1 Panel Cutout