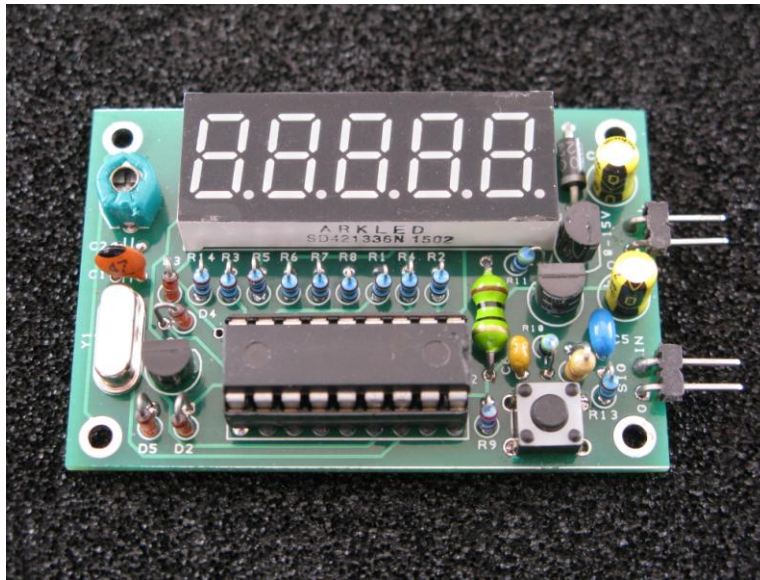




QRPGuys Digital Dial/Frequency Counter



First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us and we will send one. You must use qrpguys.parts@gmail.com to request a part.

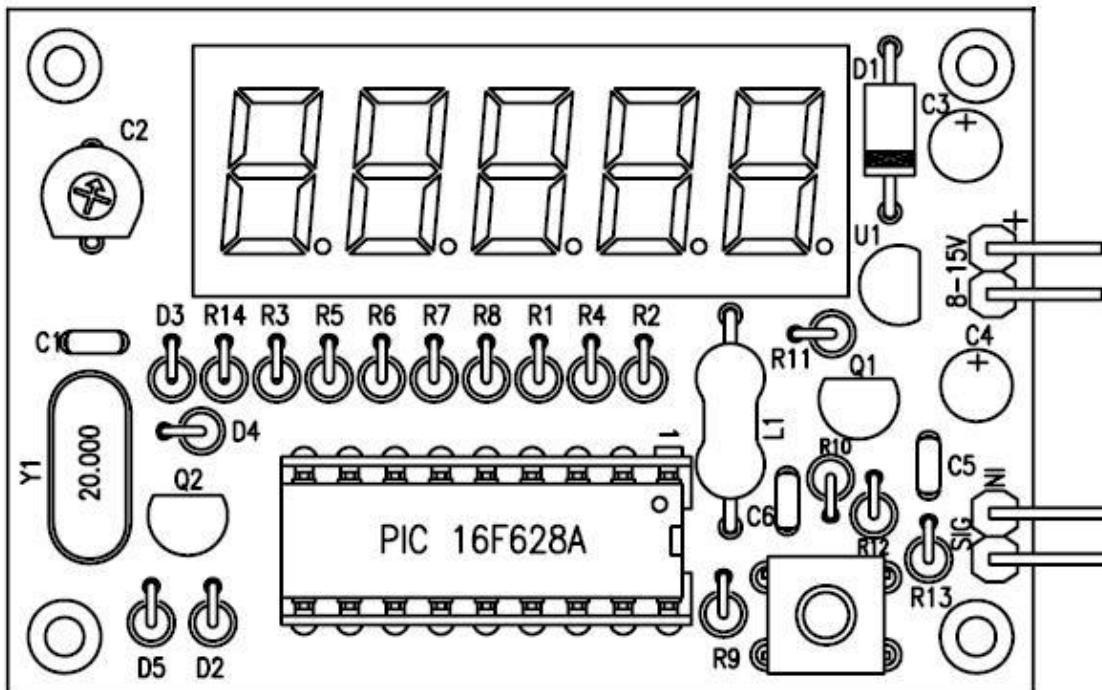
Parts List

- 1 – QRPGuys Digital Dial/Counter PCB
- 1 – U1, 78L05, TO-92 case
- 1 – U2, PIC 16F628A MPU, 18pin DIP
- 1 – U3, 5 digit common cathode display
- 2 – Q1, Q2, 2N3904, TO-92 case
- 1 – D1, 1N4001,2,3,4 diode, black, w/silver band
- 4 – D2, D3, D4, D5, 1N4148 diode, small glass, with black band on one end
- 1 – Y1, 20.000 MHz crystal
- 1 – L1, 10uH fixed inductor, (brown-black-black-silver), **do not confuse this with a resistor**
- 1 – S1, Pushbutton switch, PCB mount
- 1 – C1, 47pF capacitor, marked 47
- 1 – C2, 30pF trimmer capacitor, (green)
- 2 – C3, C4, 10uF electrolytic capacitor
- 1 – C5, .022uF capacitor, marked 223
- 1 – C6, .01uF capacitor, marked 103
- 8 – R1, R2, R3, R4, R5, R6, R7, R8, 1K ohm resistor, 1/8W, (brown-black-red-gold)
- 1 – R9, 22K ohm resistor, 1/8W, (red-red-orange-gold)
- 2 – R10, R11, 470 ohm resistor, 1/8W, (yellow-violet-brown-gold)
- 1 – R12, 47K ohm resistor, 1/8W, (yellow-violet-orange-gold)
- 1 – R13, 100 ohm resistor, 1/8W, (brown-black-brown-gold)
- 1 – R14, 10K ohm resistor, 1/8W, (brown-black-orange-gold)
- 1 – IC socket, 18 pin
- 2 – 90° 2 pin header
- 1 – red acetate filter
- 4 – 2-56 SS flat head screw
- 4 – 2-56 SS nut
- 4 - #2 x 5/16"L nylon spacer

We will assemble the smallest components first. All the components mount on the front of the board. This is the side of the board with part outlines printed on the board. All the components must mount shorter than the height of the display when it is installed. During the assembly keep the 5 digit display handy for comparison. The highest components to be concerned about are U1, Q1, Q2.

Start with installing the diodes and 1/8 watt resistors. It is best to verify the resistor values with a DMM first before soldering them onto the board. The 1/8W resistors are extremely small and difficult to read the color bands.

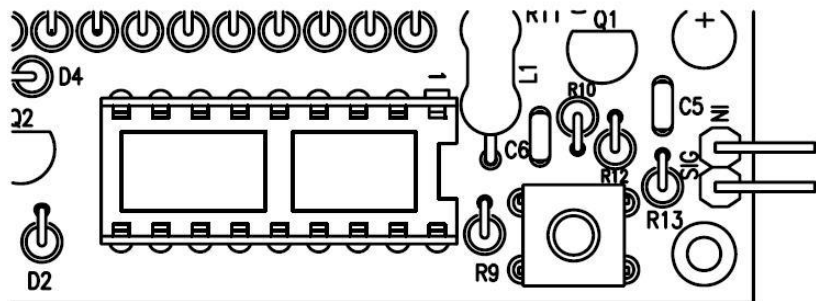
All resistors and 1N4148 diodes are mounted vertically. The small figure shows how to bend the leads, the parts placement figure below illustrates where all the components go. The 1N4148 diodes are polarized devices and must mount with the band at the top of the device and, matching the outline on the board to be correct.



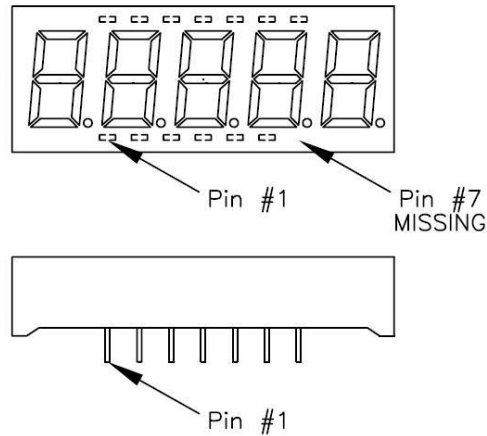
Parts placement figure

- [] Install D2 thru D5 the small glass 1N4148 diodes vertically with the black cathode band **“UP”** as shown in the earlier graphic. The circle diagram on the board must match the body of the diode to get the polarity correct.
- [] Install D1, the black 1N4001 diode horizontally with the silver cathode banded end closest to U1. This can be a 1N4001 through 1N4004.
- [] Install R9, 22K ohm (red-red-orange-gold)
- [] Install R10, R11, 470 ohm (yellow-violet-brown-gold)

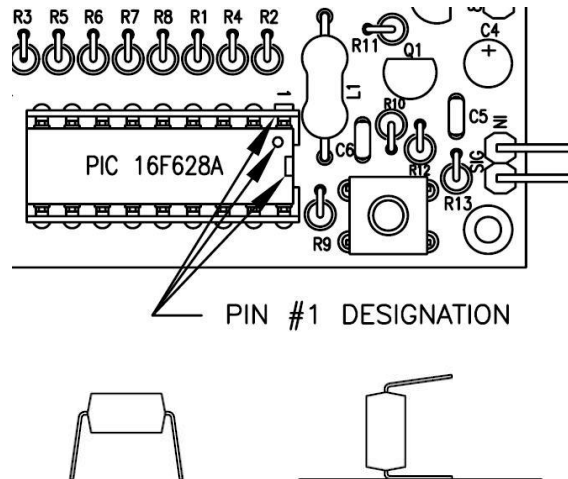
- [] Install R12, 47K ohm (yellow-violet-orange-gold)
- [] Install R13, 100 ohm (brown-black-brown-gold)
- [] Install R14, 10K ohm (brown-black-orange-gold)
- [] Install R1 thru R8, 1K ohm (brown-black-red-gold)
- [] Install C1, 47pF, marked 47. If a .2" spaced capacitor is supplied, carefully bend the leads to fit the board.
- [] Install C5, .022uF, marked 223. If a .2" spaced capacitor is supplied, carefully bend the leads to fit the board.
- [] Install C6, .01uF, marked 103. If a .2" spaced capacitor is supplied, carefully bend the leads to fit the board.
- [] Install C2, 30pF, trimmer capacitor. Match the flat with the outline on the board. This capacitor may be mounted on the back side of the board for installations where you may want to make calibration adjustments when the display is mounted in an enclosure. The will increase the overall thickness of the package by the height of the capacitor.
- [] Install Y1, the 20.000 MHz crystal
- [] Install L1, the 10uH choke horizontally. It looks like a fatter resistor, color coded (brown-black-black-silver)
- [] Install U1, the 78L05 regulator. Observe the outline shown on the board and placement graphic. **Install close to the board so that it is not taller than the display.**
- [] Install Q1 and Q2, the 2N3904 transistors. Observe the outline shown on the board and placement graphic. **Install close to the board so that it is not taller than the display.**
- [] Install C3 C4, the 10uF electrolytic capacitors. Observe the polarity. The long lead is **"Positive"**, and must match the silk screened **"+"** on the board and placement graphic. Do not confuse the power input polarity for C3 and C4 orientation.
- [] Install the push button switch at S1. This part may also be installed on the back side of the PCB to gain easy access to when the counter/display is installed in an enclosure.
- [] Install the 18 pin IC socket with the notched end of the socket at the pin 1 end.



- [] Mount the 5 digit display, at U3. There is no pin at position #7, and matches the pcb, so it cannot be installed incorrectly. Clip the pins flush after soldering.



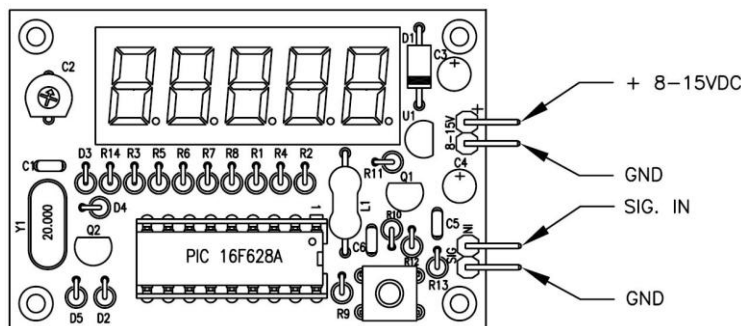
- [] Install the two pin headers, but first decide how you may want to use the counter before installing these headers. You may not use them at all, and wire directly to the PCB to connect to a receiver or transceiver for use in an enclosure.
- [] Install the PIC16F628A IC into the socket with pin 1 at the correct end of the socket.



When inserting IC's the pins are flared so that they can be retained by auto insertion tools. Gently rock them on a flat surface so the pins are parallel and they will insert into the sockets more easily.

This completes the assembly.

Connecting the counter



Usage

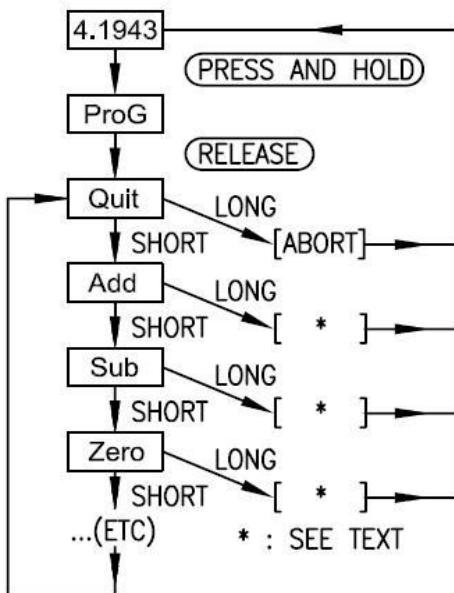
The circuit used is basically a DL4YHF counter V2 with the extra digit and 2n3904 preamp, packaged to fit neatly within your project case. A Google search will reveal numerous display variants and modifications for experimenters for over a 10 year evolution by Wolf. There have been many diverse mods., prescaler, extra digits, RS232 port communication, etc. by others worldwide around this clever code. Use this as a platform for your experiments, improvements and share with others. For a full history of modifications and product evolution, visit Wolf's site:

http://www.qsl.net/dl4yh/freq_counter/freq_counter.html

Powering up the completed board. All the digits should display "8" for about 1 sec. and then a "0" in the fourth digit when no signal is present. If you do not see this response, remove the power immediately. Check for errors. The most common errors are faulty solder joints. Inspect carefully for bridged solder joints and missed solder connections. Verify that the PIC chip is installed with pin 1 in the correct position. The next most common mistake is the polarity reversed on a diode or an electrolytic capacitor. It is helpful to have someone else look for errors. You can easily miss your own mistakes.

The counter can be used as a stand alone frequency counter, or frequency readout for an analog receiver, reading directly from 100Hz to 50MHz. C2 is the adjustment for calibrating the counter connected to a known frequency standard. *If the counter is to be used as frequency display on a radio, consult the radio designer for the correct connection point and coupling capacitor suggestions.*

If the counter is used as a frequency display in a non direct conversion receiver or transceiver, you may want to add or subtract an offset value from the measured frequency. The offset frequency is the same as the intermediate frequency in many cases, because the counter is usually connected to the receivers VFO (variable frequency oscillator). *Consult the radio designer for the correct connection point and coupling capacitor suggestions for reading the local vfo frequency.* For this purpose, a programming mode (aka "setup mode") has been implemented in the firmware so you can enter the offset frequency.



The signal RA5 (pin 4 of the PIC 16F628A) is used to switch from normal counter mode to programming mode by using the pushbutton switch. If you do not need to add or subtract a frequency offset, use it as it is. However, by pushing the switch, the firmware will be instructed to use the currently measured frequency as the new offset value. In other words, you must *apply the offset frequency to the counter's input*. Wait until the value is displayed correctly and then enter the programming mode as explained below to store the value and to set it as added or subtracted to the VFO frequency. The pushbutton also allows you to program the 15 second power-saving mode to on or off.

The program flow chart on the left shows how to enter programming mode, how to select a menu, and to execute the associated function. To enter programming mode, press and hold the programming pushbutton until the PIC shows "ProG" on the LED display. Then release the "button". You are now in the first menu of the programming mode.

To select the next menu, press the button for less than a second. To execute the selected function, press the button for a longer time.

The menu functions are :

- "Quit" : Aborts programming mode without changing anything.
- "Add" : Saves the previously measured frequency permanently, so it will be added in future.
- "Sub" : Saves the previously measured frequency permanently, so it will be subtracted in future.
- "Zero" : Sets the frequency offset to zero, so the display will show the measured frequency without offset. The previously programmed offset will be lost.
- "Table": Allows you to select a predefined offset value from a table. The table itself is also located in the PIC's data EEPROM, so you may find different values in it. When skipping through the table, the frequencies are shown in numeric form, like 455.0 (kHz), 4.1943 (MHz), 4.4336 (MHz), 10.700 (MHz). After selecting an entry (long keypress), you will be taken back to the main menu to select "Add" or "Subtract".
- "PSave" / "NoPSV": turns the power-saving on/off. In power-saving mode, the display is turned off after 15 seconds of no "significant" change in frequency, and on again as soon as the frequency changes by more than a few dozen Hertz.

The display range is automatically switched to give the maximum readout accuracy. The gate time is also selected automatically as listed in the following table:

Frequency range	Display	Gate time	Decimal point
0 ... 9.999 kHz	X.XXX	1 second	flashing (which means "kHz")
10 ... 99.99 kHz	XX.XXX	1/2 second	flashing
100 ... 999.9 kHz	XXX.XX	1/4 second	flashing
1 ... 9.999 MHz	X.XXXX	1/4 second	steady (which means "MHz")
10 ... 50.00 MHz	XX.XXX	1/4 second	steady

Thanks to Chuck Adams (K7QO) who figured out a way to display 100Hz resolution over 10MHz. Below is an excerpt from his write-up "Digital Display Guide for Transceivers". The whole guide is posted on the menu bar for the Digital Dial.

Some theory required here. Using the 1W on 20m, as an example, the VXO is generating 8.059MHz to get to 14.059MHz after the mixing in the mixer U2 in the transmitter section. Again, because of the 6.000MHz IF frequency used at X6 and here at X2. We want the digital display to show only the 4 in the 14. This will give us 4 additional digits available in the display for the remainder of the frequency and thus giving us the 100 Hz value for display.

So, what we do is, from the 8.059 MHz, we SUBTRACT 4.000MHz!!

This will allow the digital display to shift the decimal point in the display one to the left and give us the last digit for the 100Hz value.

In order to do this, we power up the display and feed it a 4.000MHz signal from a stable signal generator and go through the programming stage again, but this time use the SUB function to subtract the input frequency for storage (4.000MHz).

Now the display will show 4.0593 MHz for operation at 14.0593 MHz with the least significant digit being dropped. Some people have to record on their QSL cards the frequency down to the 100Hz reading. I am not one of those, but to each his own. The capability to get more precision in the display is needed for operation near band edges.

Chuck's (K7QO) measurements:

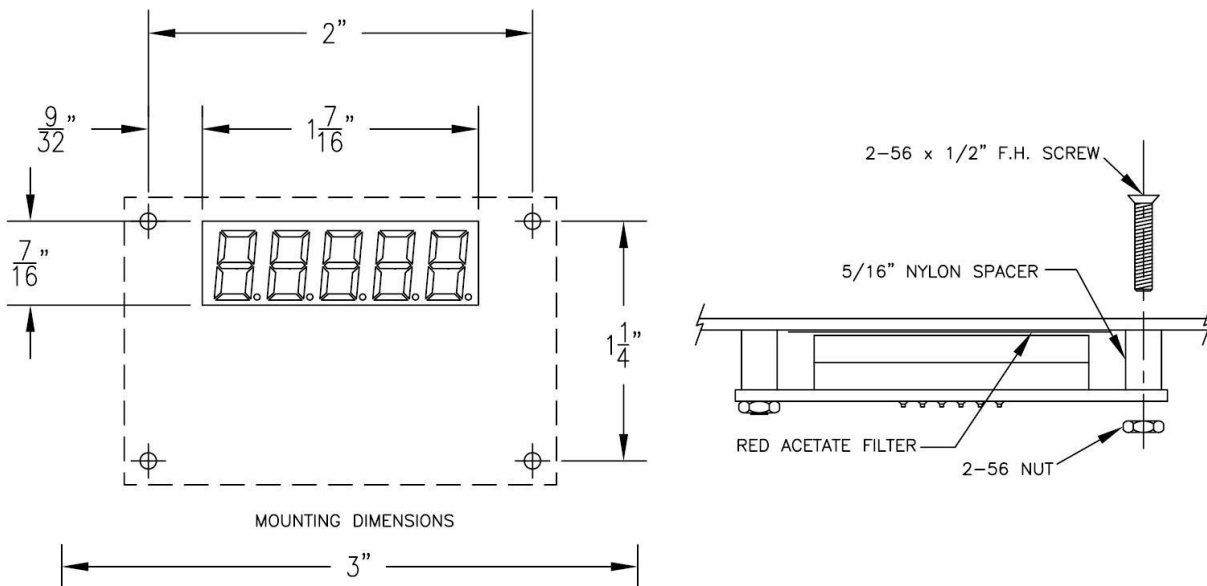
Sensitivity measured in (RMS) at 50Ω impedance :

1.00MHz – 10mV
5.00MHz – 11mV
10.0MHz – 18mV
15.0MHz – 26mV
20.0MHz – 38mV
25.0MHz – 50mV
30.0MHz – 64mV
40.0MHz – 100mV
50.0 MHz – 150mV

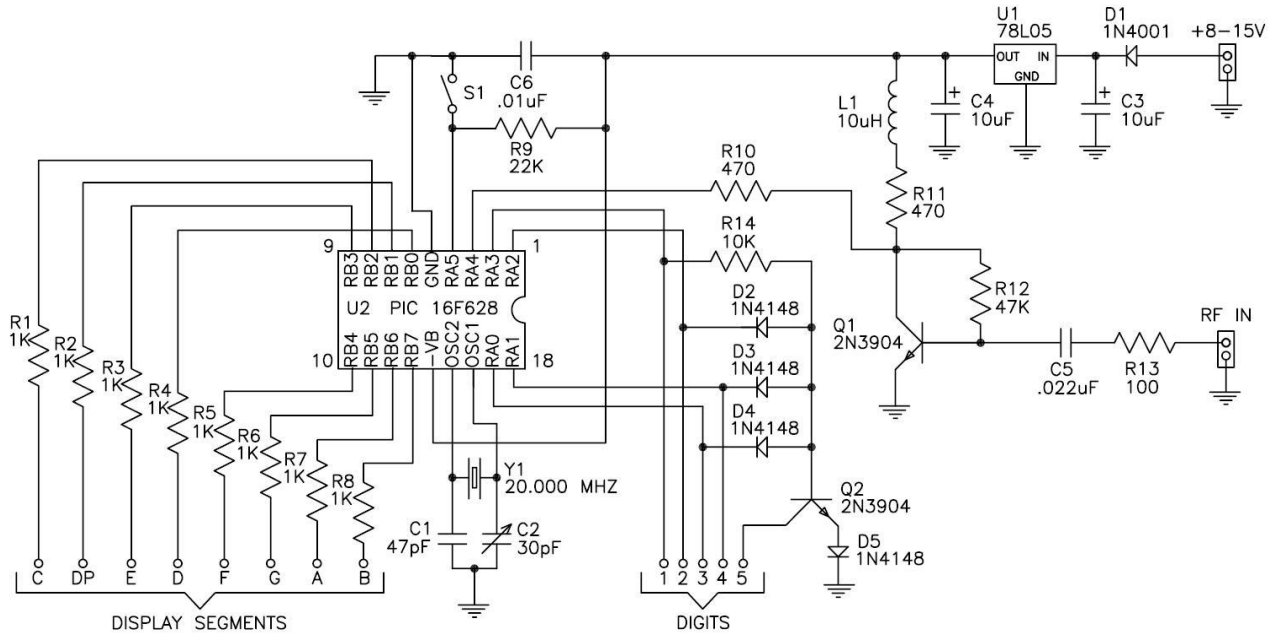
Limit the input voltage to 2.0V

Mounting your digital dial

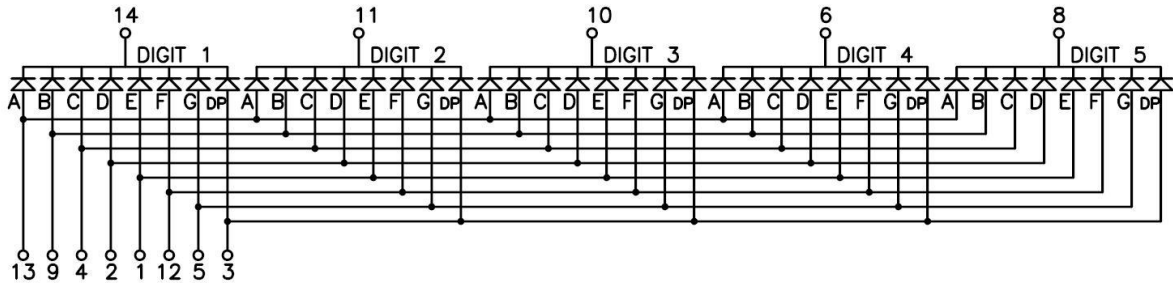
The figure below will enable you to mount the completed counter in your chassis. All the hardware is in the kit: flat head screws, spacers, and nuts, including a red acetate filter. The hardware will permit you to mount the display just below the inside surface of your chassis. You will need to drill the four small corner holes, countersink for the flat head screws, and cut out the rectangular window for the display. Use the dimensions shown below. If you scale your printer to accurately print the 3" dimension shown, you can use the graphic below and directly tape it to your case and transfer the hole locations or lay out the dimensions. Make your acetate filter larger than the cutout and carefully tape the edges to the inside of your chassis.



Schematics:



U3 - 3651A COMMON CATHODE DISPLAY



Notes:
