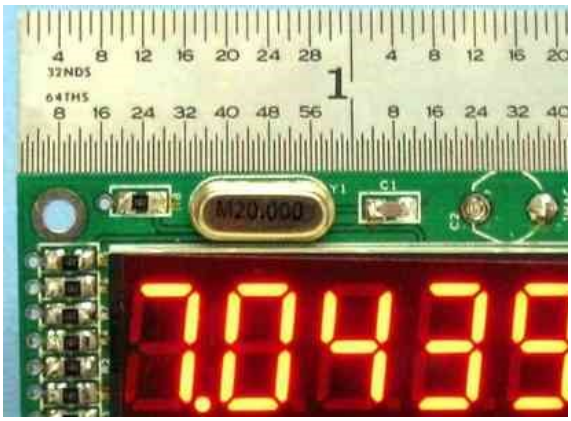
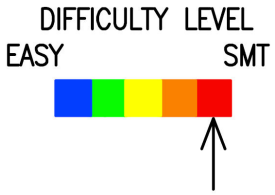
QRPGuys SMT Digital Dial/Frequency Counter





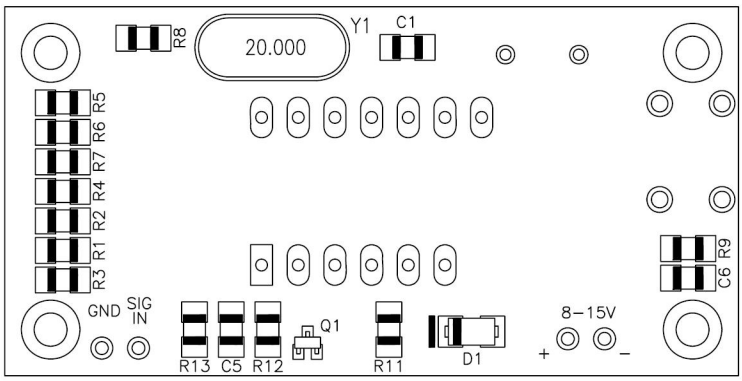
First, familiarize yourself with the parts and check for all the components. If a part is missing, please contact us and we will send one. You must use ***qrpguys.parts@gmail.com*** to request a part.

Parts List

1 – QRPGuys SMT Digital Dial/Counter PCB
1 – U1, 78L05, 5V regulator, SOT-89 case, 3 legs and a tab opposite
1 – U2, PIC 16F628A MPU, 18SOIC
1 – 5 digit common cathode display
2 – Q1, Q2, 2N3904, SOT-23 case
1 – D1, SS12 diode, DO-214AC case, w/ band on one end, marked “2FP”
4 – D2, D3, D4, D5, 1N4148 diode, SOD-123 case, w/ band on one end, marked “T4”
1 – Y1, 20.000 MHz crystal
1 – S1, Pushbutton switch, PCB mount
1 – C1, 47pF capacitor, SMD 0805, marked w/blue marker
1 – C2, 30pF trimmer capacitor, (green)
2 – C3, C4, 10uF electrolytic capacitor SMD 1210, marked 106C, yellow w/tan band
1 – C5, .022uF capacitor, SMD 0805, marked w/violet marker
1 – C6, .01uF capacitor, SMD 0805, marked w/yellow marker
8 – R1, R2, R3, R4, R5, R6, R7, R8, 1K ohm resistor, SMD, marked 102 or 1001
1 – R9, 22K ohm resistor, SMD 0805, marked 223 or 2202
2 – R10, R11, 470 ohm resistor, SMD 0805, marked 471 or 4703
1 – R12, 47K ohm resistor, SMD 0805, marked 473 or 4702
1 – R13, 100 ohm resistor, SMD 0805, marked 101 or 1000
1 – R14, 10K ohm resistor, SMD 0805, marked 103 or 1002
2 – 90º 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

Assemble the SMD components first. Start with the components on the front side of the board. Use the figure below for the parts location. It is best to use a cookie sheet under your board to catch any wayward components.

Start with installing the 0805 size resistors and capacitors.



FRONT

Parts placement figure

[ ] Install R1- R8, 1K ohm resistor, SMD 0805, marked 102 or 1001

[ ] Install R9, 22K ohm resistor, SMD 0805, marked 223 or 2202

[ ] Install R11, 470 ohm resistor, SMD 0805, marked 471 or 4703

[ ] Install R12, 47K ohm resistor, SMD 0805, marked 473 or 4702

[ ] Install R13, 100 ohm resistor, SMD 0805, marked 101 or 1000

[ ] Install C1, 47pF capacitor, SMD 0805, marked w/blue marker

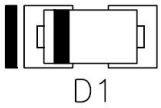
[ ] Install C5, .022uF capacitor, SMD 0805, marked w/violet marker

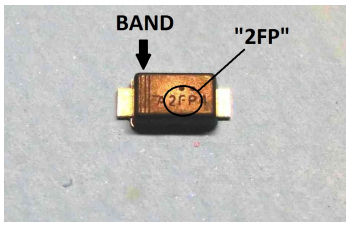
[ ] Install C6, .01uF capacitor, SMD 0805, marked w/yellow marker

[ ] Install Q1, one of the 2N3904 transistors, marked “1A”

The SS12 diode is a polarized device and must be mounted in the correct orientation. It has a band on one end that must match the small bar printed on the PCB as shown in the figure below.

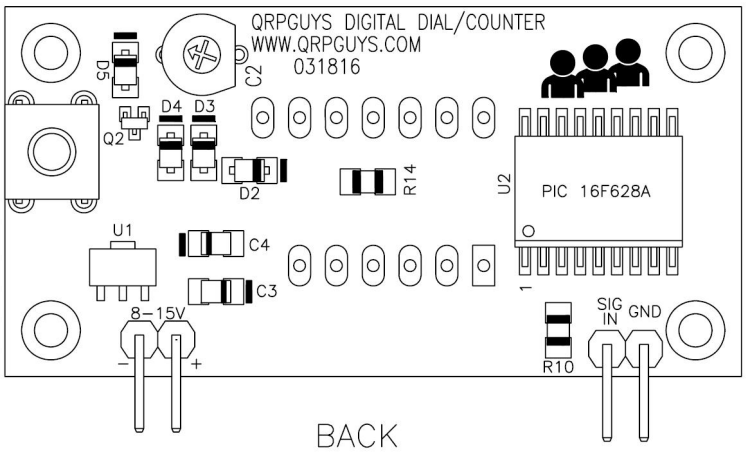
[ ] Install D1 the SS12 diode with the cathode band positioned as shown on the side of the bar marked on the PCB. It is marked “2FP” within the part number on the top.





[ ] Install Y1, the 20.000 MHz crystal. It is shown mounted on the front of the PCB, however if there are any clearance concerns there, mount it on the back.

This completes the small components on the front side. Continue with the SMD components on the back as shown below



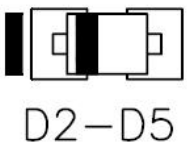
[ ] Install Q2, one of the 2N3904 transistors, marked “1A”

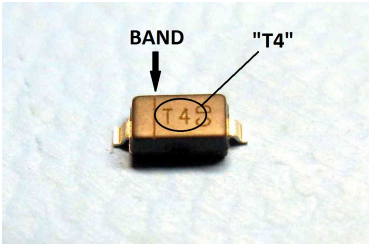
[ ] Install R10, 470 ohm resistor, SMD 0805, marked 471 or 4703

[ ] Install R14, 10K ohm resistor, SMD 0805, marked 103 or 1002

[ ] Install D2, D3, D4, D5, 1N4148 diodes, marked “T4” with bar on one end.

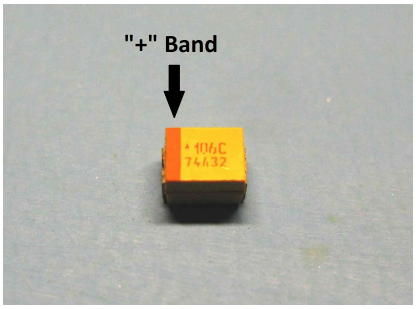
The diodes are polarized devices and must be mounted in the correct orientation. It has a band on one end that must match the small bar printed on the PCB as shown in the figure below.

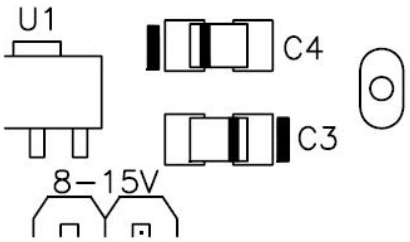




[ ] Install C3, C4, 10uF electrolytic capacitor SMD 0805, marked 106C

These capacitors are polarized devices and must be mounted in the correct orientation. It has a band on the positive end that must match the small bar printed on the PCB as shown in the figure below.





[ ] Install U1, 78L05, 5V regulator, SOT-89 case, solder all three small pads and the heatsink pad.

[ ] Install U2, PIC16F628A IC with the orientation of pin #1 matching the figure. Tack two opposite corners to check for centering on the pads before soldering all the pins.

The next two components can be mounted on either side. If they are mounted on the rear (recommended for accessibility) the overall thickness is ~.55". If you are pressed for minimum thickness, you can mount them on the front with an overall thickness of ~.42" (with less accessibility to the pushbutton and calibration variable capacitor when mounted).

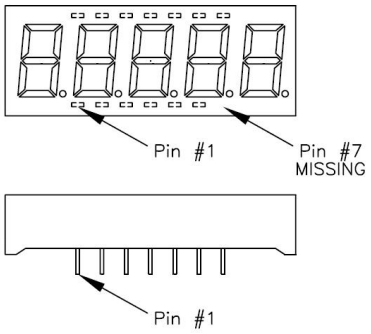
[ ] Install the push button switch at S1.

[ ] Install C2, 30pF, trimmer capacitor. Match the flat with the outline on the board.

[ ] Install the two pin headers, but first decide how you may want to use the counter before installing these headers. You may choose not to use them at all, and wire directly to the PCB to connect to a receiver or transceiver for use in an enclosure.

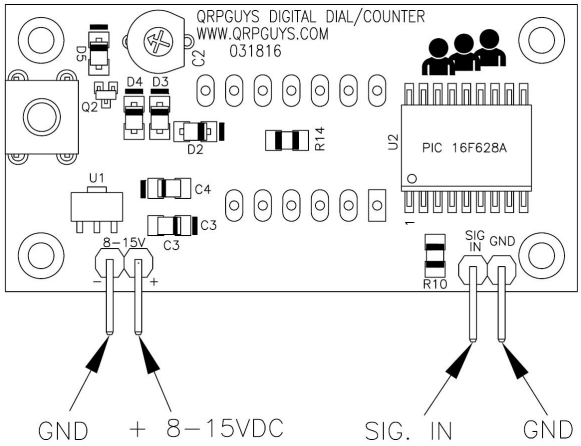
Return to the front side of the board.

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



This completes the assembly.

Connecting the counter



Usage

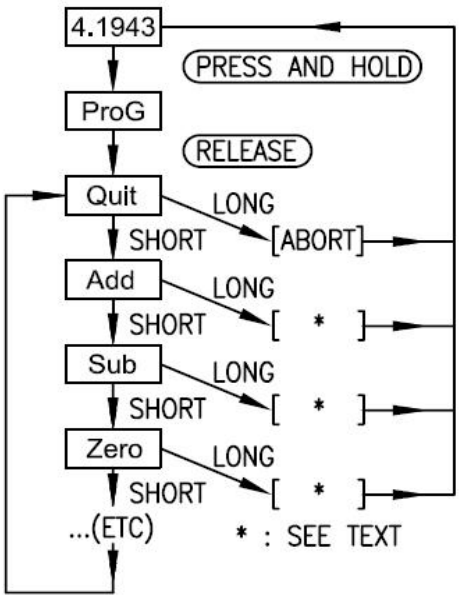
The circuit used is basically a DL4YHF counter V2 with the extra digit and 2N3904 preamp, packaged to fit neatly within your project case. A Google search will reveal numerous display variants and modifications for experimenters for over a 10 year evolution by Wolf. There have been many diverse mods., 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/dl4yhf/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 looks 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.

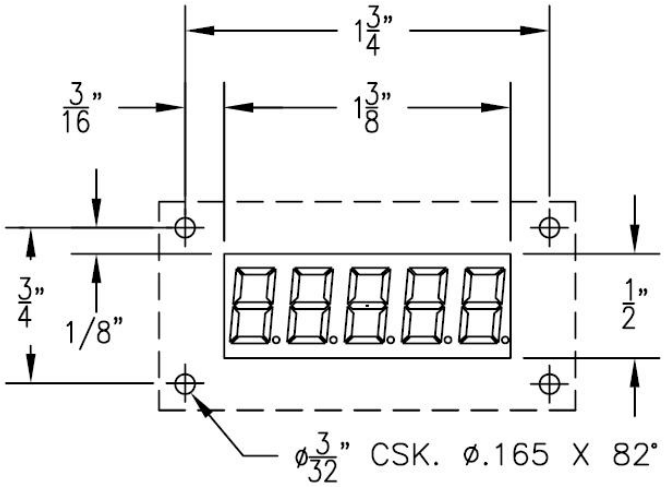
So, what we do is, from the 8.059 MHz, we SUBTRACT 4.000MHz!!
This will allow the digital display to shift the decimal point in the display one to the left and give us the last digit for the 100Hz value.

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).

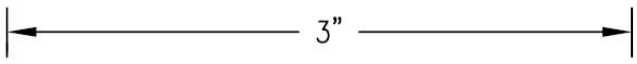
Now the display will show 4.0593 MHz for operation at 14.0593 MHz with the least significant digit being dropped. Some people have to record on their QSL cards the frequency down to the 100Hz reading. I am not one of those, but to each his own. The capability to get more precision in the display is needed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

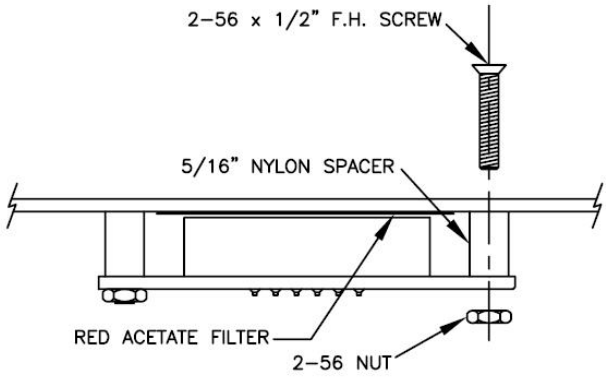
Mounting your digital dial

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.

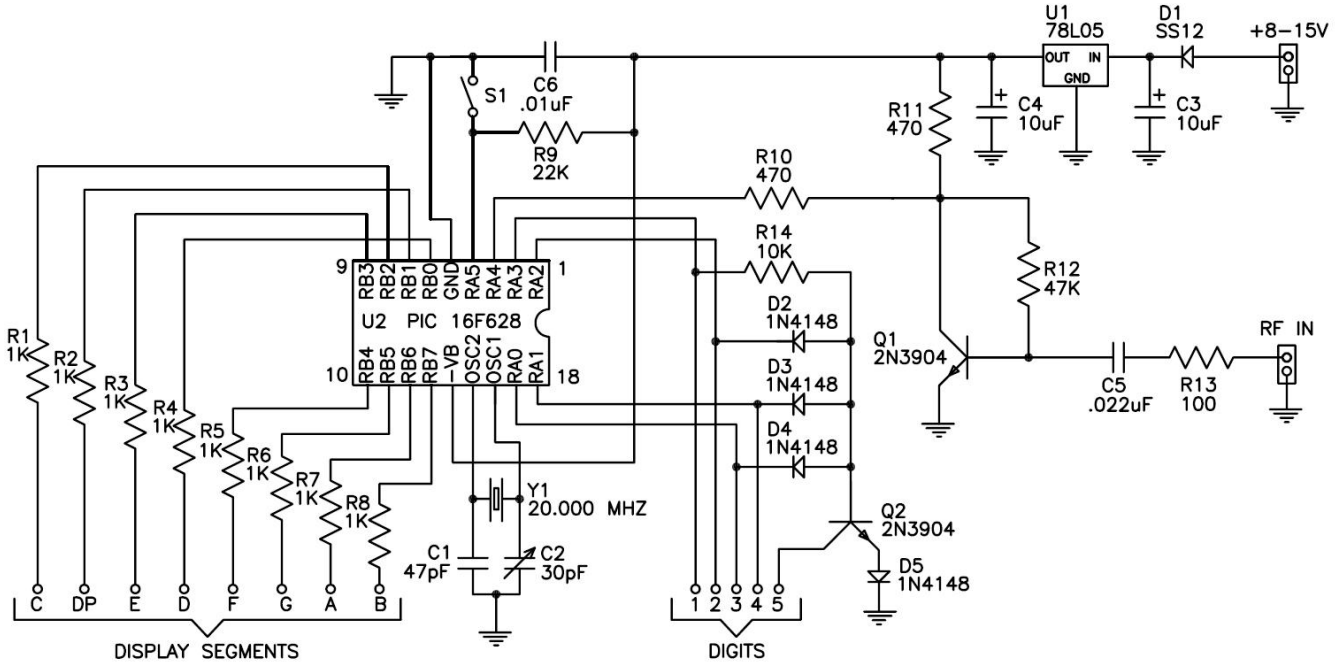


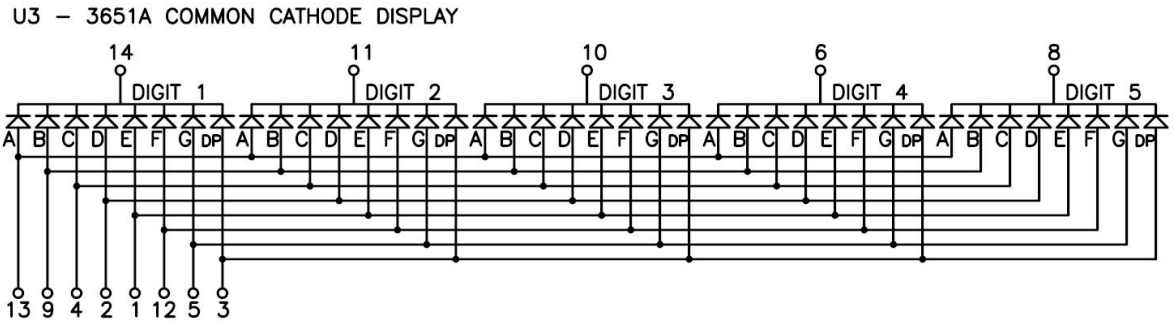
MOUNTING DIMENSIONS





Schematics:





Notes:

BOM:

U1	78L05 REGULATOR, SOT-89
U2	16F628A PIC MPU, 18SOIC
U3	5 DIGIT DISPLAY, COMMON CATHODE
Q1,Q2	2N3904, SOT-23
D1	SS12 DIODE, DO-214AC
D2-D5	1N4148 SIGNAL DIODE, SOD-123
Y1	20.000 MHZ XTAL-THRU HOLE
S1	PUSH BUTTON, PCB MOUNT, SHORT, THRU HOLE
C1	47pF CAPACITOR SMD 0805
C2	30pF TRIMMER-GREEN
C3,C4	10uF ELECTROLYTIC CAPACITOR SMD 0805
C5	.022uF CAPACITOR SMD 0805
C6	.01uF CAPACITOR SMD 0805
R1-R8	IK OHM, 1/8W SMD RESISTOR 0805
R9	22K OHM, 1/8W SMD RESISTOR 0805
R10-R11	470 OHM, 1/8W SMD RESISTOR 0805
R12	47K OHM, 1/8w SMD RESISTOR 0805
R13	100 OHM, 1/8W SMD RESISTOR 0805
R14	10K OHM, 1/8W SMD RESISTOR 0805