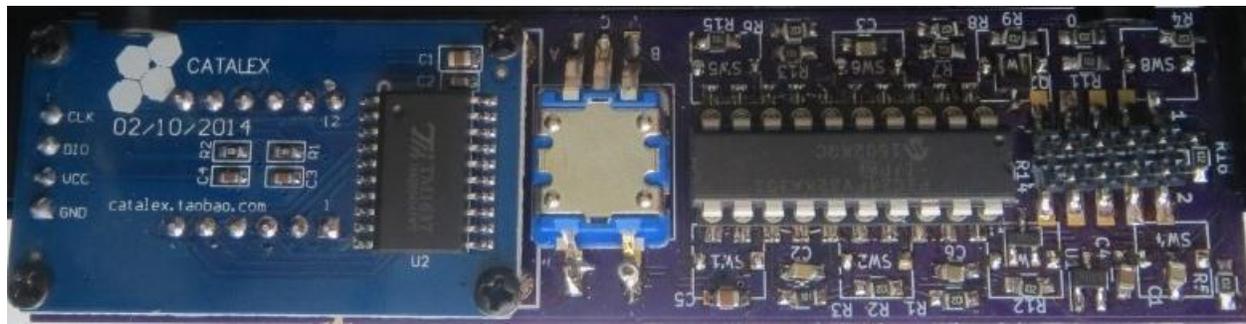


FRONT PANEL ASSEMBLY

2017-05-07



The Midnight Ultimate Keyer (MUK) consists of two functional assemblies:

- **Rear Panel** containing the interface and power connectors.
- **Front Panel** containing the basic keyer electronics, the four-character 7-segment display, all manual controls, and the miniature speaker.

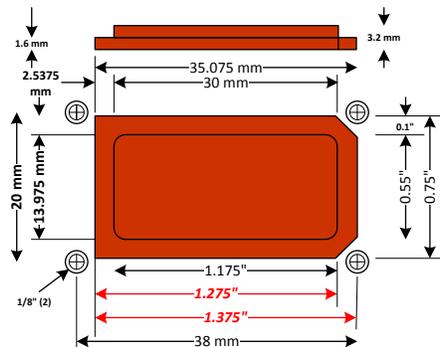
The rear panel assembly is used to supply power to the front panel during testing so it should be assembled before assembling the front panel. The rear panel assembly instructions are covered elsewhere.

This document provides step-by-step instructions for assembling and testing the MUK front panel assembly. The front panel is actually a PCB assembly designed to fit in grooves around the front opening of the MUK enclosure. The eight pushbuttons and the miniature speaker are through-hole devices that mount on the front side of the front panel. All other devices are surface-mount devices that mount on pads on the back side of the front panel. Since the solder mask and silk screen in the front of the panel are visible, care should be exercised to not damage them during the assembly process.

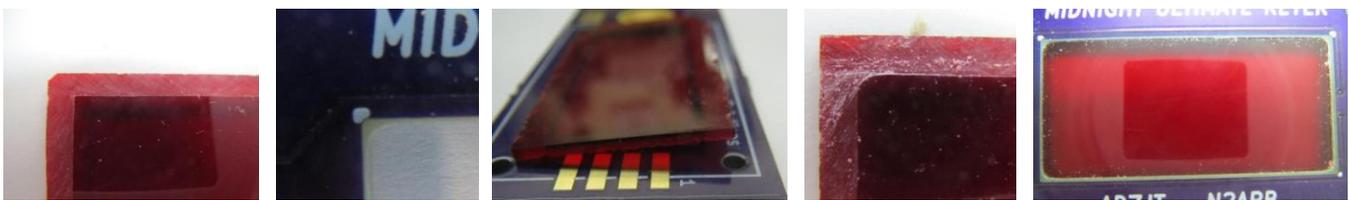
A bill of materials (BOM) and a schematic are included at the end of this document. Most components on the BOM have assigned reference numbers (U1, Q1, C1, R1, etc.) which are printed on the front panel near the pads the component is to be soldered to.

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1. LENS FITTING

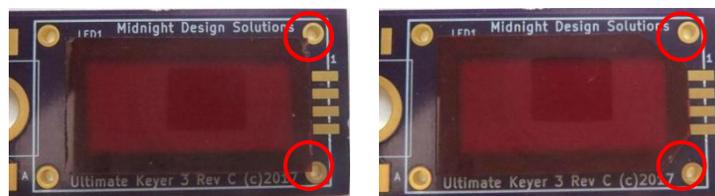


The red lens is milled to produce a raised center with square corners. This raised portion fits into the rectangular cutout in the front panel. Since this cutout is routed with a round bit, the corners are rounded and the lens will not fit properly. The solution is to round the raised corners on the lens with a file. The following picture sequence illustrates the problem and the solution.



Another solution would be to square the corners of the cutout with a file but I find filing the lens generally gives better looking results.

After the lens is fitted to the cutout, note that the two corners of the lens closest to the end of the frontpanel overlap the two mounting holes. The corners of the lens must be trimmed to give clearance for the stand-offs used to mount the display module. Cut off the corners with a flush cutter or a diagonal pliers or file them at a 45-degree angle.



After the lens has been fitted, set it aside until the rest of the board is assembled.

2. IC SOCKET GULL WINGS

The 20-pin IC socket must be modified so it can be surface mounted. This involves converting the straight solder pins to gull wings. With the IC socket sitting upside down on a flat surface, use a straight edge to bend each group of 10 pins outwards to about a 45 degree angle. Use a long nose or duckbill pliers to bend the legs in the middle about 90 degrees

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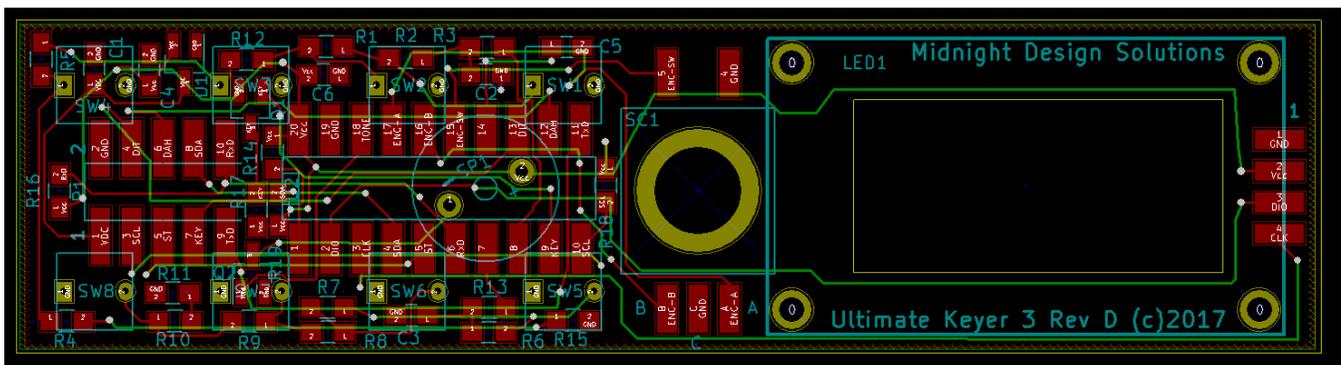
up (with the IC socket sitting upright). It will be easier to just do a few legs at a time depending on how wide your pliers are. After all 20 pins have been converted to gull wings, place the IC socket upright on a flat surface. If necessary, adjust individual legs so that all legs touch the flat surface or are close to touching the flat surface. The following picture sequence illustrates the conversion of straight to gull wing solder pins.



After the gull wing conversion, set the IC socket aside until all the small SMD parts have been soldered. The socket should not be installed now as it will be in the way of soldering the other parts and it may be damaged should you touch the plastic socket body with a hot soldering iron. Set it aside until all SMD parts have been soldered on.

3. SOLDER ALL SMALL SMD PARTS (BOM items 1 - 9)

Here is a drawing of the component side of the MUK PCB for your reference. Note that this PCB view is actually upside down from the way it mounts in the enclosure.



The PCB layout is fairly dense so take your time. I recommend you install the components in the order listed in the BOM. You will probably need a magnifier/light and something to hold the PCB steady AND LEVEL (so the SMD parts won't slide off). I use a cheap, aluminum foil cookie sheet under my work. This provides a safety net if I happen to drop any very tiny parts. I also ground the cookie sheet as a guard against ESD. You will also need a low-wattage, temperature-controlled soldering iron. Here's a picture of my assembly station:

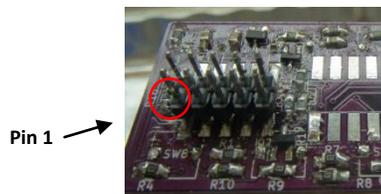
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I have a very small, conical tip on my soldering iron. I use a vice to bend the end of the tip into a small hook. When soldering SMD devices, I usually put solder on one pad, position the component, and just touch the pad with the very end of the soldering iron tip until the solder flows and the device is attached to the board by that single pin. The hook on the tip avoids having to stand the iron on end to get the tip in among surrounding SMD parts. I use a small, piece of a bamboo skewer to help position the component and (if required) to hold it down while soldering and/or nudge it back into position if it moves while the solder flows. After the first pin is soldered and the component is in proper position, I solder the rest of the pins then go back and touchup the first pin. It takes very little heat to do flow solder on SMD pads. When soldering to a solder tab (e.g., on a phone jack), I get better heat transfer when I wrap the hook around the pin thus providing more contact area for heat transfer from an otherwise too-small tip.

4. INSTALL P1 (BOM Item 10)

After the small SMD components are soldered, install P1. Put a small amount of solder on one of the J1 corner pads. Position the header so it is centered on the 10 pads. The pads are oversized to make it easier to hand solder them. Touch the soldering iron tip to the pad with the solder until the solder flows. This will take a little longer than with the 0805 components due to the mass of the pin. Once solder flows, make sure the header is still centered on the pad array and let the solder cool. If the header is not 100% properly aligned, don't worry about it. There should be enough play in the pin that is soldered to allow you to slightly rotate the header into position. Once properly positioned, solder the pin diagonally opposite the first pin you soldered. Carefully check that all leads are located on and can be soldered to their pads before soldering the rest of the leads. Since J1 accepts a cable, there is no need to precision align it.



5. PUSHBUTTON SWITCHES SW1 - SW8 (BOM Item 11)

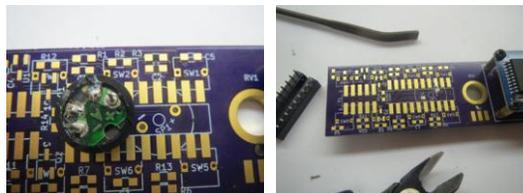
Now it is time to solder the eight pushbutton switches on **the ON THE OTHER SIDE OF THE BOARD**. Note that the switch bases are not totally symmetrical. They can be installed in either of two orientations. The finished product will look a little better if all switches are oriented the same way. Install and solder one switch at a time.

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Install the switches starting at the center of the board (switches 1 and 5) and ending at the end of the PCB (switches MC and 4). Install one switch at a time by soldering one lead then, while holding the iron on the joint, hold the switch to the PCB with enough force to activate the switch while soldering. This will assure the switch is mounted flat on the PCB. Then repeat the process for the second lead. Trim the leads near-flush to the PCB.

6. PIEZO SPEAKER SP1 (BOM Item 12)

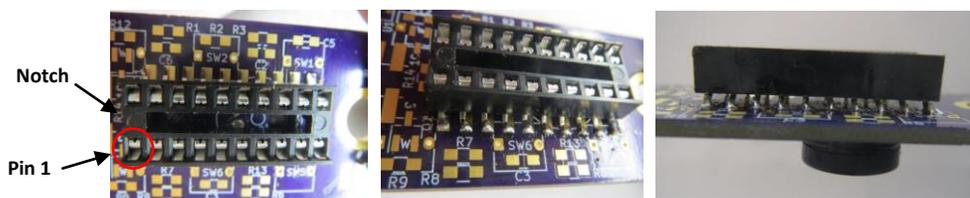
The speaker also mounts on the front of the PCB. Note the polarity marking on the speaker and the PCB silk screen ("+" and "-"). Install the speaker in a manner similar to the pushbutton switches. Solder one lead then, while the solder is still flowing, press the speaker firmly against the PCB while the solder cools. Repeat the process for the second speaker lead. Once soldered in, Trim the leads as close as possible to the back surface of the PCB to avoid interference with the 20-pin IC socket (J1) which mounts directly behind the speaker.



7. 20-PIN IC SOCKET J1 (BOM Item 13)

Now it's time to mount the IC socket you modified in Step 2. Mount it about the same way you mounted P1. Be careful to not touch the plastic body with your soldering iron. Put a small amount of solder on the pad for pin 1 (lower left corner, next to P1). Position the IC socket with pin 1 (at end with notch) over the pad with the solder and center it in the pad pattern. These pads are also oversized to simplify hand soldering. Once the socket is properly positioned, touch the soldering iron tip to the pin 1 pad until the solder flows. To make sure all pins will make contact with their respective pads, gently press down on the socket while the solder is cooling. Double check the alignment and solder pin11 to its pad while gently pressing down on the socket. Solder the remaining pins and carefully inspect each solder joint to make sure the solder has flowed on both the pad and the gull wing.

The following picture sequence illustrates the process. Note the pictures were done using an otherwise empty PCB to make it easier to see what was going on.



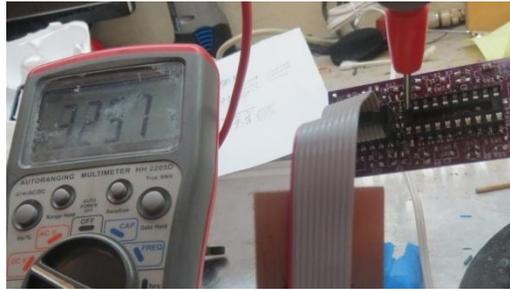
8. TEST 1: SMOKE TEST

This is a good time to test the basic power regulation and distribution, before installing any more active components. To do this, use the rear panel assembly. Plug the cable connector into the front panel's, 10-pin interface connector (P1).

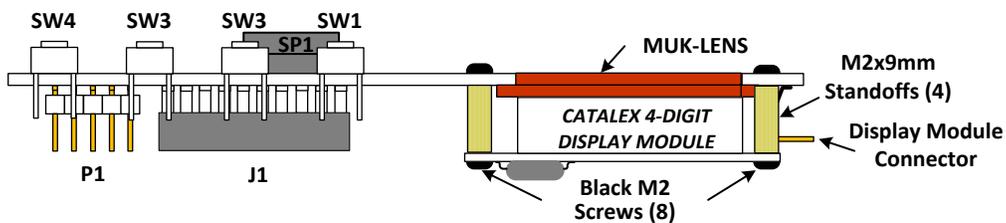
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Be careful to orient the connectors pin 1 to pin 1. Pin 1 of P1 is at the end nearest the edge front panel. Apply power (+9 to +16 VDC to center pin of DC power connector). Measure the following voltages:

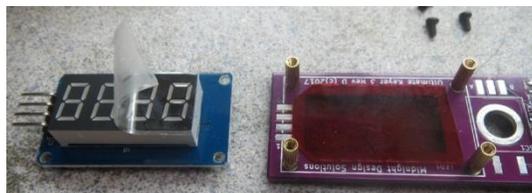
P1	Pin 1	Input power (+9 to 16V)
LED1	Pin 2	Vcc (approx. 3.3V)
U2	Pin 20	Vcc (approx 3.3V)



9. MOUNT THE DISPLAY MODLE LED1 (BOM Items 14 - 17)

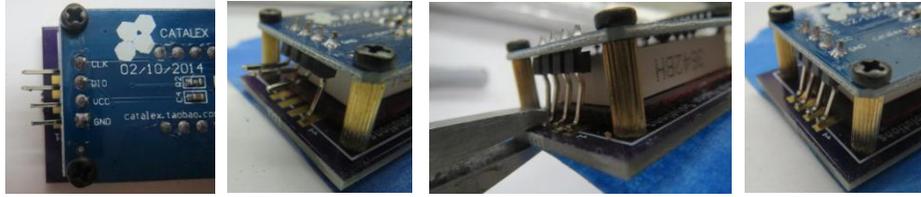


Install the four M2 x 9mm stand offs on the back side of the front panel using four of the black M2 screws. Tighten them fairly tight but try to avoid damaging the screw heads as they are visible on the front panel of the MUK. Make sure all the protective paper guard has been removed from both sides of the lens and install it so the raised middle section is in the cutout in the PCB. Remove the protective plastic cover from the front of the LED module. Use the remaining four black M2 screws to attach the display module to the four standoffs. Orient the display module so the four-pin interface connector is extending over the end of the front panel.



The connector pins must be bent down so they can be soldered to the four pads below them. To make sure the ends of the pins don't extend into the border of the PCB that must be inserted in a 1/16 inch channel in the enclosure, all four pins should be shortened about 1/16 to 1/8 inch (see picture below). Place a piece of masking tape on the front panel below the pads to protect the front surface. Use a pliers to bend one pin at a time by having one jaw on the masking tape and the other on the pin. Close the pliers to bend the pin down and, when the pin makes contact with the pad, bend the tip of the pin so it is parallel with the pad. Repeat the process on the remaining three pins, one at a time.

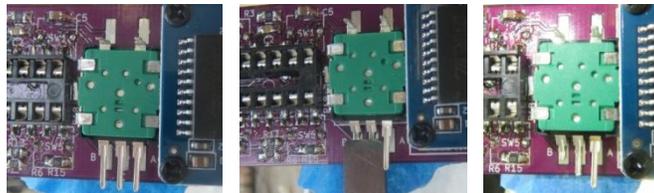
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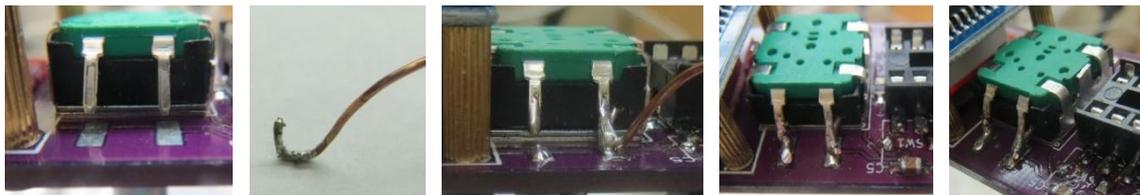
After all pins are in position, solder them to the pads. Carefully inspect the solder joints to make sure solder flowed on both the pads and the pins. Also make sure the ends of the pins do not extend beyond the ends of the pads.

10. INSTALL THE ROTARY ENCODER SC1 (BOM Item 18)

Use the hardware provided to install the rotary encoder (SC1) in the large hole in the front panel. Align the three-pin (encoder) side with the three pads marked "B", "C", and "A" and tighten the nut. Bend the three pins, out straight from the encoder body. Put a piece of masking tape on the front of the panel just below the three pins to protect the finish. Using a pliers, bend each pin down so it forms a foot resting on the pad directly below it. Note if the end of the pins extend beyond the end of the pad, trim the pins to stay within the pads. Solder the pins to the pads. If a pin is not sitting directly on the pad, it may be necessary to hold the pin down with your skewer until the solder cools.



Now, turn the board around and do the same with the two switch contact pins. You will probably find that these pins are too short to reach the pads and the gap must be bridged with a small piece of wire. Bend the wire to form a small hook at the end and apply solder to it, the pad and the pin. Hold the wire in contact with both the pad and the pin and apply heat with your soldering iron to the wire until all the solder flows. Remove the soldering iron but hold the wire in place until the solder cools. Trim the wires so they do not extend beyond the edges of the pads.



11. INSTALL THE MICROCONTROLLER U2 (BOM Item 19)

It may be necessary to bend the microcontroller (MCU) pins in slightly to properly align with the contacts in the socket (J1). Align the MCU with the contacts making sure pin one of the MCU is aligned with pin one of the socket. Pin one of the socket is located at the end closest to P1. Pin one of the MCU is identified by a dot on the top surface of the MCU. Once the MCU is properly positioned, **GENTLY** press it into the socket. If you feel any resistance, stop and find out why. If a pin is not properly aligned with a socket contact, the pin will probably bend and roll under the MCU body. After the MCU has been pressed into the socket, inspect the pins by looking under the MCU from the pin 1 end to make sure none

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of the pins have rolled under the MCU body. If one or more pins has bent and/or rolled under, remove the MCU, straighten the pins, and try again.

12. TEST 2: UNIT TEST

The basic MUK components are now assembled and I recommend you give it a unit test before installing it in the enclosure. As was done with the SMOKE TEST, use the back panel assembly to apply power. Plug the rear panel cable into P1 making sure the connector is properly aligned. Pin 1 of P1 is at the end closest to the PCB edge (away from the MCU). Apply power and you should see the front panel display " go " while "GO" is sounded ("beeped") on the speaker. The display will then change to "_go_" and dim slightly. Rotate the control knob and observe the display changing to indicate the current function. It will beep at either end of the list. Disconnect power (leave the rear panel connector plugged in) and install the MUK in its controller.

13. FINAL ASSEMBLY (BOM item 20)

The MUK enclosure has two halves, top and bottom, each with grooves to hold the front and rear panels. You may start with either half but it will probably be easier if you start with the top half since it is deeper than the bottom half which will better hold the panels in alignment when they are slid into the other half. Install the front and rear panels in the grooves nearest the outer edges of the enclosure. If you are starting with the top half, make sure you install the two panels upside down. Align the other half of the enclosure so that the panels will slide into the grooves and slide it down until it closes the gap between the two enclosure halves. The fit is tight so it will be necessary for the two halves to be very parallel to avoid binding. It should not take much force to close the gap don't force it. If the gap won't close easily, check that the front and rear panels are properly seated in their grooves and make sure the cable is clear of the boss near the side of the enclosure. After the gap is closed, turn the enclosure over and use the two supplied screws to fasten them together and then add the four rubber feet.



14. TEST 3: SYSTEM TEST

Apply power and observe the same as was observed during the unit test. Now, get out a copy of the Midnight Ultimate Keyer Quick Reference and go through it following the instructions and observing the same results as are illustrated in the QR. Use a cable with an RCA phono plug on one end to plug the MUK KEY OUT line into your transmitter key jack. Navigate to the operating position ("_go_" displayed) and verify that the MUK keys your rig.

Install the control knob (BOM item21).

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15. TROUBLESHOOTING

If your newly assembled MUK fails to perform properly here are some things to look for:

- Recheck the voltages at the points listed for the SMOKE TEST.
- Carefully inspect all solder joints using a magnifier (10x recommended). If there is any doubt about any joint, reflow the solder and make sure there is a solid solder bond between the pads and the device pins.
- Carefully inspect for solder bridges between solder pads. Gently scrape the area between pads with a XACTO knife or dental pick to make sure there are no bridges too small to see.

If you are unable to solve the problem, contact us at support@midnightdesignsolutions.com with a description of the problem and we will help you solve the problem.

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BOM 1. MIDNIGHT ULTIMATE KEYER - FRONT PANEL ASSEMBLY

Order	Reference	Quantity	Value	Supplier	Part Number	Footprint
		1	PCB, 2-sided	MDS	MUK-PCB	1.062x4.173x0.062 in
1	U1	1	LDO Volt. Reg. 3.3V, 250ma	Mouser	579-MCP1703T-3302ECB	SOT-23-3
2	Q1, Q2	2	Transistor 2N7002	Mouser	863-2N7002ET1G	SOT-23-3
3	C1	1	1uF, Ceramic,16V	Mouser	80-C0805C105Z4V	805
4	C2, C3	2	.01uF, Ceramic, 50V	Mouser	710-885012207092	805
5	C4, C5	2	10uF, Ceramic, 10VDC	Mouser	77-VJ0805G106KXQTBC	805
6	C6	1	0.1uF, Ceramic,	Mouser	710-885012207072	805
7	R01,R02,R04-R10,R12,R16,R18	12	1k, 330 mw, 5%	Mouser	588-AS08J1001ET	805
8	R03, R13	2	100, 330 mw, 5%	Mouser	588-AS08J1000ET	805
9	R11,R14,R15,R17,R19	5	10K, 330 mw, 5%	Mouser	588-AS08J1002ET	805
10	P1	1	2x5 male, 0.1" SMD	Mouser	855-M20-8760546	2x5-SMD, 0.1" sp.
11	SW1 - SW8	8	Pushbutton SPST, 2-lead	Mouser	612-TL59F160Q	6.2mm square, 5mm lead sp.
12	SP1	1	PIEZO_SPEAKER	Mouser	665-AT-1220TT2R	12mm dia., 6.5mm lead sp.
13	J1	1	20-pin IC socket, gull-wing	Mouser	575-11093320411050	DIP-20, modified
14		4	M2 x 9mm Brass Standoff, F/F	Amazon	B00R1IW2XM	3.12mm dia., knurled
15		8	M2 x 5mm Phillips Pan Head, Black	eBay	272632864784	
16		1	Red Lense 1.375 x 0.75 x 0.110	MDS	MUK-LENS	
17	LED1	1	4-digit, 7-seg, LED w/TM1637			
18	SC1	1	Rot Enc, 24 PPR, Detents, w/SW	Mouser	652-PEC11R-4220F-S24	12.5x13.4mm, 5-pin
19	U2	1	pic24fv32ka301-I/P	Mouser	579-PIC24FV32KA301IP	DIP-20
20		1	Enclosure, Black	Mouser	75054-510-000 LH43-100 Black Kit	3.1d x 4.5w x 1.2h in.
21		1	Knob, 6mm D clip			

NOTE: The part suppliers and numbers listed here may differ from the parts received in your kit due to parts availability at the time your MUK is kitted.

