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XCTC-4X4L Touch Sense Lock Controller

Introduction

This kit contains all the electronics you will need to build a high quality Touch Sense Lock Controller circuit. Two printed circuit boards, the main controller PCB and the 4x4 keypad PCB, and all the necessary components are included.

Features

- Electronic lock controller and keypad that uses Capacitive Touch Sense technology
- Key strikes are detected through flat, solid overlay material such as glass - it does not use mechanical or membrane key switches
- Capacitive Touch Sense technology is a very reliable alternative to mechanical or membrane keypads - There are no moving parts to wear out and no metal contacts to corrode over time
- Capacitive Touch Sense works by detecting the tiny changes of capacitance introduced by finger touch. The user does not have to be grounded to operate the keypad
- Entering the correct combination on the Touch Keypad closes a relay circuit that can be used to drive an electronic lock solenoid, garage door opener, or other such device
- Combination is user programmable - there are up to 15 combo keys and combos can be up to 10 keys long - which provides 15^{10}, or over 576 Billion possible combinations
- Combo is saved in non-volatile memory - it will be retained in case of power failure - and can't be seen or read out of the processor chip in any way, providing maximum security
- Two modes of operation are supported:
  - Normal lock operation. The user programmed combination is entered to open the lock. The combination can only be re-programmed by inserting a jumper shunt on the controller PCB
  - One-time-use combo mode: User enters a new combination for each lock/unlock cycle. This mode is useful for public locker type applications
- This device is capable of sensing touch through any non-conductive material such as glass, plexiglass, lucite, tile, dry wood, plastic, drywall, etc.
- Sensitivity of the Touch Sense circuitry is adjustable to support a wide range of overlay materials and thicknesses - up to 1" thick or more
- The controller continuously self calibrates to allow for drift of system and ambient conditions
- User can either use the provided 4x4 keypad PCB or create your own custom touch sense keypad using any conductive material such as copper or foil tape, copper clad board, or even some random small metal objects. No one would even know its your security keypad!
- Optically isolated relay control circuit can drive a small DC load directly or it can be connected to a power FET or TRIAC to drive larger DC or AC loads
- Hacker deterrent feature: 60 second delays are added between combo entry cycles after 5 or more incorrect combos are entered - this discourages people from trying to guess the combo
- On-board beeper and LED provides audible and visual feedback when touch is detected
- Applications:
  - Secure garage door opener keypad
  - Replacement or extension of mechanical or membrane keypads
  - Replace old faulty rubber keypad with reliable solid state Capacitive Touch keypad
  - Secure and decorative electronic lock keypad with a tough, sealed glass exterior
  - Hide your electronic lock keypad behind any non-conductive surface like tile, wood, drywall, etc.
- This kit contains 42 components and 2 PCB's and can be built by medium skill level hobbyists
- This kit is proudly designed and packaged in the USA

Unpacking Your Kit

Carefully unpack and take stock of the components in your kit. The electronic components are packed in 1 bag labeled 'Bag A'. See Table 1 and Table 2 for a complete listing of your components.

Assembly Instructions

It is very important that you read and understand all of the following instructions before you start your assembly so that you don't make any mistakes that might be difficult to recover from. The assembly should be done in the order listed in Table 1 and Table 2 or you may have difficulty physically accessing components for soldering.

What you'll need

- Soldering iron with small or medium tip
- Damp sponge for tip cleaning
- Solder
- Solder wick or solder sucker in case of solder bridging (stranded wire could substitute)
- Small needle nose pliers.
- Small wire cutters
- Small straight screwdriver
- Magnifying glass to read the markings on the tiny components

General Assembly Guidelines

- **Take your time!!** Most mistakes are made when rushing through the assembly. Taking the time to double check every step will pay off with a first-time functional device.
- In cases where it is necessary to re-form the leads on components (such as resistors and diodes), be very careful not to put stress where the lead enters the component itself. The physical attachment of the lead to the component can sometimes be very fragile and the lead may break off if too much force is applied. Reforming the leads can be done by gripping the lead with small needle-nose pliers at the base of the component while bending the lead on the other side of the pliers.
- Use as little heat and solder as necessary to affix the components to the PCB (printed circuit board). Many of the parts in this kit are temperature sensitive. Overheating may damage them.
- Always clean the soldering iron tip on the damp sponge prior to every solder joint. Re-tin whenever the tip gets a little dull. (tinning is the application of fresh solder to the tip of the iron until its shiny, wipe excess on a damp sponge).
- Inspect the solder joints. They should be shiny and smoothly connect the pad to the lead. A dull looking joint may indicate it is 'cold', meaning that either the pad or the lead weren't heated enough to allow reliable connection. This could lead to erratic operation of the device. Re-flow the joint again with the soldering iron, apply equal heat to both the pad and the lead, apply a little more solder if needed to get a good shiny connection.
- When clipping the excess leads of the through-hole parts, don't try to clip too close to the PCB. Clip just above the solder joint to avoid fracturing the solder joint, which could lead to device failure sometime in the future.
- Carefully inspect each solder joint to make sure you didn't accidentally form a 'solder bridge', or connect two adjacent pads together. Remove solder bridges by using solder wick or a solder sucker. If the bridge is small you may be able to remove it by just reheating the joint and sliding the soldering iron across the bridge. If not, see the next step.
- If you need to remove solder from a hole (or a solder bridge) and you don't have solder wick or a solder sucker, you can use stripped stranded wire in place of solder wick. Place the stranded wire across the hole and touch the soldering iron to the wire, above the hole. As the wire heats it will melt the solder in the hole, and the melted solder will tend to wick up into the stranded wire. When the wire fills up with solder, move a clean part of the wire over the hole and repeat until the hole is clear of solder.

Main Controller Circuit Board Assembly

You're ready to begin assembling your Touch Sense Lock Controller circuit board. Assemble the board in the order listed in Table 1. Use the install check boxes on the right side to track your progress. The 'Install Notes' column will alert you to any special instructions (listed below) for each of the components.

Table 1. Main Circuit Board Parts List

Pack √	Device	Value	Marking	Qty	Reference Designators	Install Notes	Install √
	CIRCUIT BOARD (PCB)	REV 1.2	CTC16	1			
	RESISTOR	3.3M	ORA-ORA-GRN	16	R1,R2,R3,R4,R5,R6,R7, R8,R9,R10,R11,R12,R13, R14,R15,R16		
	RESISTOR	330	ORA-ORA-BRN	2	R17,R19		
	RESISTOR	100K	BRN-BLK-YEL	2	R20,R21		
	RESISTOR	47	YEL-VIO-BLK	1	R22		
	CAPACITOR	.1uF	104	1	C1		
	CAPACITOR	22pF	22J	2	C2,C3		
	CAPACITOR	100uF	100uF	2	C4,C5	1	
	LED (OPTIONAL)			1	D1	2	
	CRYSTAL	20 Mhz	FS20.00P **	1	Y1		
	TRIMPOT	100K		1	R18		
	MICRO-PROCESSOR	PIC16LF872		1	U1	3	
	OPTO-ISOLATOR	4N38A *	4N38A	1	ISO1	4	
	VOLTAGE REGULATOR	78L05	78L05	1	U2	5	
	BEEPER			1	LS1	6	
	2.1MM CONNECTOR			1	J7		
	JUMPER, 2 PIN			1	J5		
	JUMPER SHUNT			1		7	
	CONNECTOR, 2 PIN			1	J3		
	MATING 2-PIN CONN			1		8	
	CONNECTOR, 10-PIN	FEMALE		2	J1,J2	9	
	9 VDC WALL ADAPTER					10	
	NO PARTS GO HERE				J4,J6,J8,J9		

* May also be 4N35
** May also be marked FS20.000

Main Controller Circuit Board Component Installation Notes:

1. Electrolytic capacitors are polarized devices, be sure to install them the right way around. The positive lead is longer than the negative lead. The positive lead goes in the square pad hole on the PCB. Note that the polarity is also marked on the outer casing of the cap.
2. **Do not install this LED if you intend to install the other LED on the keypad circuit board (preferred)**. The LED is polarized, it won't light if its installed the wrong way around. It has one lead longer than the other. Install the long lead (anode) in the square pad hole.
3. The PIC16LF872 processor chip is polarized, it must be installed the right way around or it will be permanently damaged; align the notch on one end of the device with the notch on the silk screen. You may need to bend the rows of pins inward slightly in order to fit the device into the hole pattern on the circuit board. Do this by gently pressing the entire row of pins on one side of the device against a table top until the pins are sufficiently bent. Do this for the other row of pins also. When inserting the device into the board, be careful not to bend any pins under the device. Verify you can see all 28 pins sticking through the bottom of the board before soldering.
4. The opto-isolator, ISO1, is polarized. The dot or notch on the device should be aligned with the notch on the PCB silk screen.
5. The voltage regulator is polarized. It has a flat side and a rounded side. Install this component in such a way that the shape matches the shape on the PCB silk screen.
6. The Beeper is polarized also. The long lead should go in the square pad hole.
7. The shunt is placed on the pins of jumper J5, not soldered to the PCB
8. This connector mates with J3 and can be used to connect to your lock solenoid

9. These single in-line connectors **must be inserted on the solder side** of the PCB and soldered from the top side of the board. Be careful that these are installed straight (perpendicular to the PCB) or the connection to the keypad may not fit properly.

10. This is the main power supply for the lock controller. It plugs into connector J7.

4X4 Keypad Circuit Board Assembly

Now assemble the keypad circuit board. Again, assemble the board in the order listed in Table 2.

Table 2. 4X4 Keypad Circuit Board Parts List

Pack √	Device	Value	Marking	Qty	Reference Designators	Install Notes	Install √
	CIRCUIT BOARD (PCB)	REV 1.1	KP4X4	1			
	LED (SURFACE MOUNT)			1	D1	1	
	CONNECTOR, 10-PIN	MALE		2	J1,J2	2	

4x4 Keypad Circuit Board Component Installation Notes:

1. **Install this LED only if you did not install the LED on the main controller**. This is a surface mount LED which shines downward through the hole in the PCB so that it is visible from the front of the keypad PCB. This is a polarized device. Align the notch on the device with the crossed corner on the PCB silkscreen (the side nearest the 'D1' on the silkscreen). Be careful to center the device in the square pattern so that the LED light is centered in the hole. To install this device, first melt some solder onto one of the square pads. Using tweezers or small needle-nose pliers, place the LED into position and re-flow the soldered pad to attach the pin. If the LED is aligned properly, solder the other pin.

2. These right angle connectors attach the keypad to the main controller board. To ensure that the connectors are aligned properly, first insert the connectors into the female connectors on the controller PCB with the right angle pins pointed outward. With the keypad PCB flat on the table, place the controller, connector side down (component side up), on the keypad PCB. Align J1 of the controller to J1 of the keypad board, and J2 to J2. The right angle pins of both connectors should be centered in the 2 groups of rectangular pads on the keypad board. Tack solder one of the pins on each connector. Double check the alignment then solder the rest of the pins.

Calibration and Testing

Now you're ready to test and calibrate your lock controller. Turn the trim-pot R18 all the way counter clockwise. This sets the sensitivity to the LOWEST possible setting. Remove the shunt from J5. Power up the controller by plugging the power adapter into J7, you should hear two beeps and see the LED flash 2 times. This means your microprocessor is functional. Without any overlay material in place over the keypad, touch each one the 16 keys on the keypad. You should hear a beep and see the LED light each time you touch a key. If you get a beep/flash for each key then your lock controller is working. Congratulations!

Now place your selected overlay material (plexi-glass, glass, plastic, etc) on your keypad. There are mounting holes on the keypad you can use or you can affix the overlay material with a NON-WATER BASED adhesive such as silicone. Water based adhesives will conduct electricity and may cause your keypad to malfunction while the adhesive is drying. You can also just tape your overlay material in place to start with for temporary testing purposes. Try to attach the overlay tightly enough to the keypad so that it doesn't move when you touch it because this could cause erratic behavior of the keypad.

Now if you touch the keys (from the outside of your overlay) you'll probably notice that the keys are no longer detected. This is because the sensitivity is set to the lowest setting. Gradually turn R18 clockwise to increase the sensitivity until you get reliable operation of the keypad. Keep your hands and other objects away from the front of the keypad while you're adjusting the device to avoid confusing the calibration algorithms. As you turn the trim-pot you should hear beeps and see LED flashes. Once you stop turning the trim-pot you'll hear two final beeps indicating that the device has recalibrated itself with the new trim-pot setting. Your final adjustments should be done in very small increments; turn the pot until you hear just one beep then stop turning. You'll hear two more beeps to indicate your new setting was taken. Test the keypad for reliable operation, repeat if necessary.

As you increase the sensitivity, you may reach a point where the LED stays on solid and no keys are detected. This means you've set the sensitivity too high. Turn the trim-pot back counter clockwise in very small increments (one beep at a time) until you get good reliable operation.

Operation - General

The XCTC-4X4L lock controller can support up to 16 touch sensitive keys. The keypad PCB included in this kit has these 16 keys arranged in a 4x4 grid pattern, with the keys labeled C1-C16. The keys labeled C1-C15 can be used as normal combination keys. C16 in the lower right hand corner has a special function; its called the <Enter> key. The <Enter> key acts kind of like a bookend: it is entered first before starting to enter the combination, then again after to indicate the combo is entered. Action is taken by the controller only after the second time the <Enter> key is touched: for instance the lock is opened or the combo is save in memory.

The LED and the beeper give visual and audible feedback to help you interface with the device. When a key touch is detected you will hear a short beep and see the LED flash briefly (referred to below as beep/flash). If the controller detects some error with the keys entered (such as incorrect combo sequence or multiple keys touched), it will emit a louder, longer beep to indicate this. The beeper/LED are also used to indicate to you the state that the device is currently in, for example when keypad is frozen due to too many bad combos entered, the LED will just flash at a 1 Hz rate until the freeze period is up. See Table 3 for the list of LED indications.

The Lock Controller can operate in one of two modes: Normal Lock mode or One-Time-Use Combo mode. The next two sections talk about these modes.

Normal Lock Mode

This mode operates just like a normal combination lock: you set the combination once then enter that combination whenever you want to open the lock.

Setting the combo:
The procedure below lets you set the combination and store it in non-volatile memory (meaning it will be remembered even if the power is turned off). The combination can be composed of any key other than the <Enter> key and the sequence can be from 1 to 10 keys longs, whatever the user prefers. If at any point in the process you get lost or confused, just cycle the power and start over.

1. Remove power from the controller
2. Insert the jumper shunt at J5
3. Apply power to the controller
   - Note that the LED is now normally on and will blink off briefly when a key is touched.
4. To set the combination, enter:

   <Enter> <Combination (1-10 numbers)> <Enter>

   - 2 beeps/flashes indicate the combination has been accepted and saved properly. The LED will switch to normally off after the 2 beep/flashes.
   - 1 long, loud beep indicates there was a problem with the combination as entered, such as it was longer than 10 keys or multiple keys were entered at the same time. Repeat step 4.
5. When the combination is accepted, remove power from the controller
6. Remove the jumper shunt from J5 (leave it attached to one prong of the jumper if you like)
7. Apply power to the controller

Now the combination is saved and will remain in memory even if the power to the controller fails. The combo you entered cannot be seen or read out of the PIC processor chip in any way, so it is completely secure. You can re-set the combination any time by following this procedure again.

Normal Operation:
Now you can open the lock at any time by entering:

<Enter> <Combo> <Enter>

- If the correct combination is entered the lock circuit will be energized for 5 seconds to open the lock. During the 5 second period that the lock circuit is energized the LED will flash at a rate of 5Hz (5 blinks per second).
- If the combo entered is not correct, you'll hear a single longer beep and, of course, the lock won't open
- If the combo is entered wrong five or more times the controller will freeze the keypad for 60 seconds. During this time the LED will flash at 1Hz rate and no entry to the keypad will be accepted. This is to discourage people from trying to guess the combination. After the 60 second period is up, the keypad is re-enabled and you can again enter the combo.

If power to the controller is interrupted, it will go to the locked position. When power is restored it will stay in the locked position until the correct combo is entered.

One-Time-Use Combo Lock Mode

In this mode you program a different combination for each lock/unlock cycle. The controller starts in the OPEN/PROGRAM state. You can tell when it's in the OPEN/PROGRAM state when the sense of the LED is inverted: it's normally ON and blinks OFF when you touch a key. In the OPEN/PROGRAM state you can open the lock any time without entering a combination (by hitting <Enter> twice), or you can go to LOCKED state by entering a valid combo that will be used just one time. Once in the LOCKED state, you can only open the lock by entering the same combination again (or a security combo, described below). The one-time-use combo mode is good for multi-user type applications such as public lockers, where each user will need his or her own private combination.

If power to the controller is interrupted while in One-Time-Use Combo mode, it will go to the locked position. When power is restored , the controller will return to the state it was in prior to the power fail; either OPEN/PROGRAM state or LOCKED state.

For one-time-use mode you must insert the jumper shunt at J5 and leave it inserted at all times.

When in OPEN/PROGRAM State (LED is normally ON), you can:

Open the lock without entering a combo:

<Enter> <Enter>

This energizes the lock circuit for 5 seconds

Set a new combo and go to LOCKED state:

<Enter> <New Combination (1-10 numbers)> <Enter>

The combination is saved as the new one-time-use combo, and the controller goes to LOCKED state

When in LOCKED State (LED is normally OFF), you can:

Open the lock by entering the same one-time-use combo:

<Enter> <Combination> <Enter>

This energizes the lock circuit for 5 second, and the controller goes back to OPEN/PROGRAM state

Security Combo

If the user forgets the combination, you can open the lock and return it to the OPEN/PROGRAM state by entering the security combination. First you must program the security combination as follows:

1. Remove power from the controller
2. Remove the jumper shunt at J5
3. Apply power to the controller
4. To set the security combination:
5. Press and hold the <Enter> key for 10 seconds. After 10 seconds you'll hear a multi-tone beep and see the LED blink twice, leaving the LED in normally ON mode.
6. Enter:

   <Enter> <Combination (must be exactly 10 numbers long, no less, no more)> <Enter>

   - 2 beeps/flashes indicate the security combination has been accepted and saved properly. The LED will switch back to normally off after the 2 beep/flashes.
   - If the combination is not exactly 10 numbers long you'll hear the multi-tone beep again. If this happens, repeat step 6.
7. When the combination is accepted, remove power from the controller
8. Replace the jumper shunt at J5
9. Apply power to the controller

Now, if the user has forgotten the one-time-use combo, you can override the it; open the lock and put the controller back in OPEN/PROGRAM mode by entering:

<Enter> <Security Combo> <Enter>

This security combo feature is valid in the One-Time-Use combo mode only, not in Normal Lock mode.

Table 3. LED Mode Indications

LED is Solid OFF	Device is in LOCKED state - ready to accept combination entry to open the lock
LED is Solid ON	Device is in OPEN/PROGRAM state - ready to be programmed with a new combination
LED is blinking slowly (1 Hz rate)	Keypad is frozen due to too many wrong combos entered. This goes on for 60 seconds after 5 or more bad combo's entered
LED is blinking fast (5 Hz rate)	Lock circuit is energized (unlocked). This goes on for 5 seconds after correct combo is entered, then the lock circuit is turned off

Keypad Mounting Considerations

The controller must be mounted in a secure location for obvious reasons: you don't want an intruder to be able to just short the lock circuit and open the lock, or be able to re-program the combination (by inserting J5 shunt). Mounting the controller on the secure side of the lock will solve these problems.

The 4x4 keypad included in this kit is suitable for use with overlay material up to about1/8" thick. It works well with window glass, plexi-glass and plastic. For use with thicker materials, you can make your own custom keypad as described below.

For the keypad graphic design, you can create a paper insert with Word, Photoshop, etc. to place between the keypad PCB and the transparent overlay surface. Capacitive touch works through paper as well as glass and plastic. Photo paper works great for keypad graphics.

Capacitive Touch Sense technology works best in dry conditions. Since water is a pretty good conductor, the keypad won't work very well if it gets wet. The keypad should be mounted in a location that is sheltered from rain or other sources of moisture.

Connect Your Lock Controller to Your Solenoid, Garage Door Opener, etc.

The Lock Controller opens your physical lock by activating an opto-coupler, which connects the two contacts of J3 like a switch. You can use this in many different ways:

- Wire J3 in parallel to your garage door opener push-button. When you enter your combo it will act just like the button and open/close your garage door.
- Wire your controller to a solenoid that is used to lock a door or cabinet. When you enter the correct combo, the solenoid will actuate and unlock the door. If your solenoid draws more than 0.5 amps you can use the controller to drive a FET that in turn drives the solenoid. See Figure 1 system level wiring diagram.
- You might even want to wire the Lock Controller into your security system. Since the controller acts just like a switch, you can use it just like it were a switch.

Note that the opto-isolator used to control the lock circuit actually operates more like a transistor than a switch. This means that the current can only flow one direction through your lock circuit. Pin 2 of J3 (nearest the mounting hole) is the positive terminal of the opto-isolator. So if the lock won't open, try just flipping the connector on J3 around. See the controller schematic Figure 3.

Make Your Own Custom Keypad

You can make your own custom keypad in almost any shape and configuration you like. Your custom keypad would be used in place of the included 4x4 keypad. You can use any conductive materials to form your keypad such as copper or aluminum foil tape, which is available in any hardware store. Any conductive material or small metal objects will work, just use your imagination! The conductive objects just need to be wired to the controller using the guidelines below.

Figure 2 shows how the keypad is wired. It's not too complicated; just connect the touch pads to the controller using some sort of thin insulated connecting wire. Here are some additional guidelines:

- The touch pads (keys) must be electrically isolated from each other. These could be metallic tape applied to a non-conductive material like glass, plexi-glass, plastic, dry wood, ceramic, etc.
- The minimum size of the pads is dependent on the thickness of the overlay material: the thicker the overlay, the larger the pads need to be. As a rule of thumb, the pad should be at least about 5 times wider than the thickness of the overlay material. This is an area you can experiment with.
- The pads should be roughly similar in size (due to just the single sensitivity adjustment). You wouldn't want to make the biggest pad 10x the size of the smallest because it might be hard to adjust it to be reliable for both pads. 2-3x the size between the smallest to the largest pad should work well.
- Yours keys should be spaced apart far enough to prevent multiple keys for being activated.

- You don't need to wire all 16 touch pad circuits. The only requirement is that you wire the <Enter> key pad (C16 on the keypad schematic Figure 2, it's J2 pin 8) so that you can operate the lock functions properly. Wiring less than the 15 combo pads will effect your total number of possible combos. For example if you choose to wire 5 pads (<Enter> + 4 combo keys), you'll have about 105 million possible combos. This can be calculated as: **# of combos = n^{10}** , where n is your number of combo keys, which is raised to the power of 10 because combo's can be up to 10 numbers long. All the touch pad circuits besides the <Enter> are identical in the way they function, it doesn't matter which ones you connect to the controller in addition to the <Enter> key.
- The connecting wire length up to about 12" works very reliably, but this depends on the size of your touch pads: the smaller the pads, the shorter your wires will likely need to be. Very much longer than 12" may be more difficult to get reliable operation. Here, again, you can experiment.
- You should use the thinnest wire possible, preferably 30ga or smaller, to connect the pads to the controller. The controller detects touch by sensing small changes in capacitance. Minimizing the surface area of the connecting wire increases the signal-to-noise ratio of the detection circuitry.
- Note that you may get false key-clicks when you touch the connecting wires. This is expected.
- Its not strictly necessary to provide a ground plane surrounding the keys, but it may help increase the key-touch sense reliability. Look at how the 4x4 keypad is laid out to see how you can do this.
- You can increase the signal-to-noise ratio (sensitivity) of your keypad by grounding the controller to earth ground. Connection point J8 on the main controller can be used for this. Just connect it to any earth ground point.
- Wire your LED indicator circuit: Anode connects to J2 pin 9, Cathode to J1 pin 9.

Check **www.xkitz.com** for more application ideas, photos, and demonstration videos.

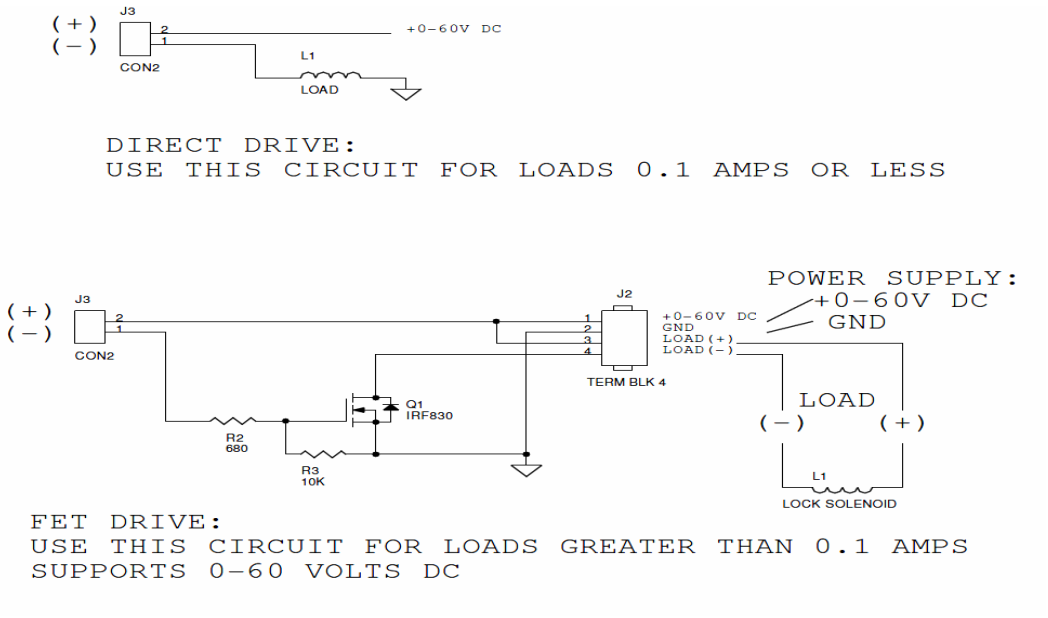
Troubleshooting

If you're having trouble with your device, check Table 4 for possible cause and solution.

Table 4. Troubleshooting Guide

Problem	Possible Cause	Solution
Does not beep twice when power applied	Microprocessor is not working	Recheck all solder joints, verify all components are installed in their proper locations. If you have a volt meter, check that you have 5V from the voltage regulator.
Some keys work but not all	Open circuit to the bad key	Re-check all your solder joints. Use an ohmmeter to check continuity from the processor to the pad at the center of the key
Erratic operation, random beeping, sometimes appears to shut down	Bad connection to one or more keypad keys	The signals to detect key touch are extremely sensitive. Poor contacts anywhere in the connections between the processor, the 3.3M resistors, and the keypad touch plates can cause this. Check all solder joints , re-flow the joints if necessary.
Keys work but not always, sometimes keys missed, or don't work with small fingers	The sensitivity is probably set too low.	Using a small straight screwdriver, turn the trim-pot R18 **clockwise** just a **tiny** bit until you hear one beep, then stop turning. You'll hear two more beeps to indicate the controller has re-calibrated itself. Check for proper operation, repeat if not.
LED stuck ON and no key touches are detected	The sensitivity is probably set too high.	Using a small straight screwdriver, turn the trim-pot R18 **counterclockwise** just a **tiny** bit until you hear one beep, then stop turning. You'll hear two more beeps to indicate the controller has re-calibrated itself. Check for proper operation, repeat if not.
The controller enters unlocked state (LED blinking fast) when combo entered, but lock doesn't open.	Opto-isolator circuit may be wired in reverse, or bad connection	Try turning the connector plugged into J3 around. The opto-isolator acts like a transistor, when energized, it will conduct electricity, but only in one direction. If turning J3 around doesn't work, check circuit continuity of your connections.
LED on the main controller board works, but the one on the keypad doesn't (or vice-versa)	These LEDs are wired in parallel. They aren't intended to both be installed.	Remove one or the other of the LEDs (regardless of which one is working). If you want the LED on the keypad, then remove the one from the main controller board.

Figure 1. System Level Wiring Suggestions (Connect to J3 on Controller PCB)



Note: Figure 1 shows some suggestions for wiring of the lock control circuit. Components shown are not included in this kit.

Figure 2. Touch Sense Lock Keypad Schematic Diagram

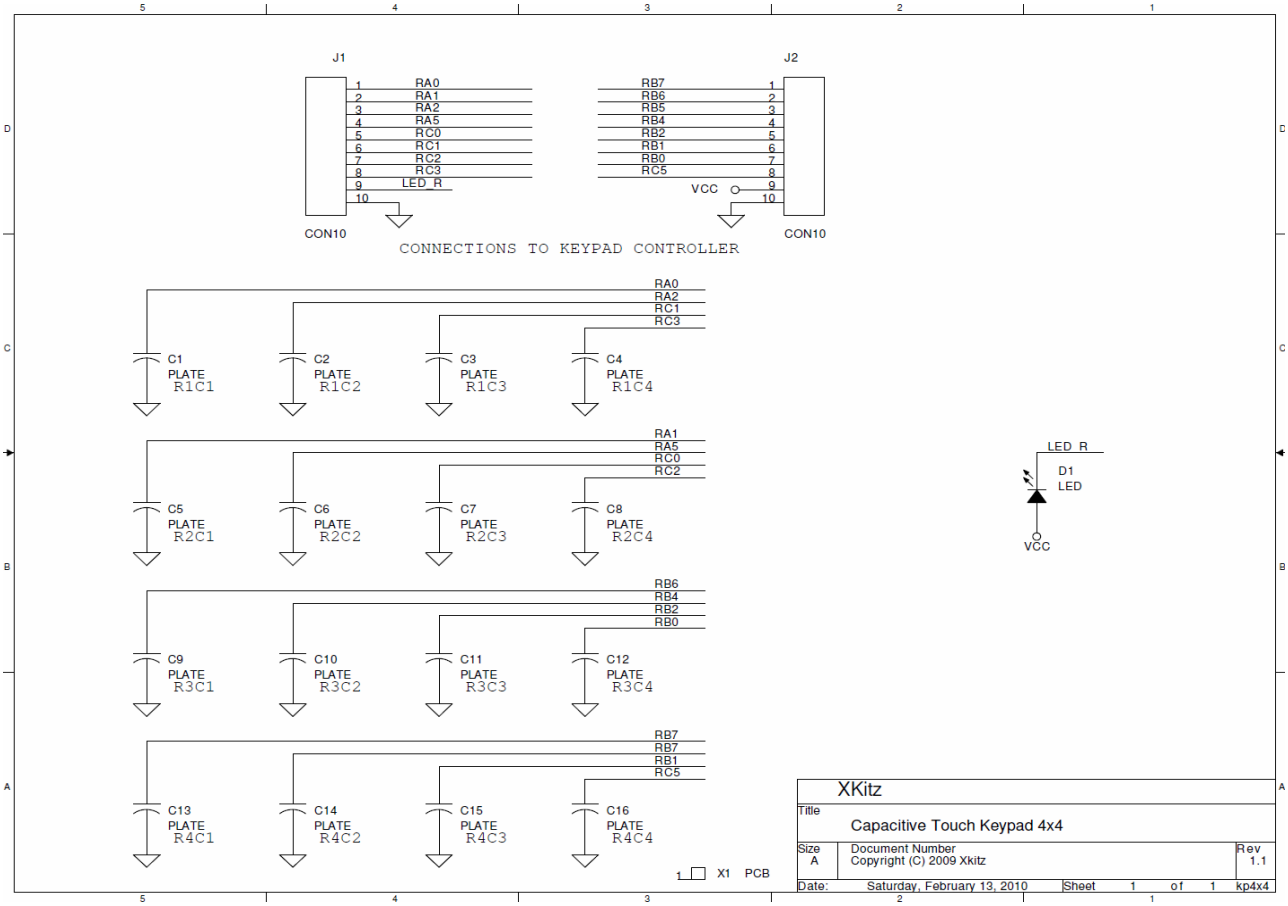


Figure 3. Touch Sense Lock Controller Schematic Diagram