Touch Switch/Motion Sensor

Model XCTS-1M

Operators Manual

Xkitz.com

Invisible Touch Switch:

The XCTS-1M allows you to install an invisible switch nearly anywhere. It detects any sudden change in the capacitance on a 'Touch Plate' that results from human touch. The Touch Plate can be hidden behind any non-conductive overlay material like glass, Plexiglas, tile, wood, plastic, drywall, granite, etc. The output circuit will be actuated when that area of the overlay is touched. When touch is detected, it sources a DC voltage on the 'Load' output.

Invisible Motion Sensor:

The XCTS-1M has a Motion Sensor mode that can clandestinely detect any human or animal passing above a conductive sensor strip that can be mounted under a floor, or under a floor mat, etc. The sensor strip and XCTS-1M box mounted under the floor are completely out of sight, forming a truly invisible motion sensor that can be installed nearly anywhere. The output voltage is pulsed whenever motion is detected. This can be used as input to a security system, or to trigger an alarm, etc.

Details:

- No moving parts to wear out or corrode over time – makes a very reliable alternative to mechanical switches
- The sensitivity of the Touch Sense circuitry is adjustable to support a wide range of applications
- Housed in a sturdy ABS plastic enclosure with mounting flanges
- Switch action modes supported:
    - Toggle switch
    - Momentary contact switch
- You can create your own custom touch plate using any conductive material such as copper tape, copper clad board, or virtually any other conductive object
- Power supply requirements:
    - 6V DC min.
    - 30V DC max.
    - Current capability sufficient to drive the output load plus 15mA
- Output Load drive characteristics:
    - DC output voltage is equal to the power supply voltage
    - 10 Amps max output current
    - Fuse protected output
- Plastic Enclosure Specifications:
    - Sturdy, Black, Flame Retardant ABS
    - Flame Rating: UL94V-0
    - 1.5" x 1.3" x 0.8" in height (excluding mounting flanges)
    - Two Mounting Flanges with .188" mounting holes
- For use in moisture free environments. Moisture on the touch sense surface will degrade touch sense performance
- Applications:
    - Install a hidden light switch almost anywhere
    - Automotive and RV Touch Switch Panels
    - Hidden electric lock trigger for liquor, medication, or gun cabinet
    - Any conductive or semi-conductive object can be turned into a touch switch - Even a house plant or a glass of water can become a light switch!
    - Invisible silent alarm trigger - just place your hand on the counter over the hidden touch plate mounted under the counter to trigger a silent alarm
    - Hidden Motion Sensor
    - Proximity switch - sensitivity can be set high enough to detect the *nearby* presence of a person, animal, or any other any conductive or semi-conductive object or material.
    - Moisture sensor switch - this circuit can remotely detect the presence of moisture nearby, without having to come in direct contact with the moisture itself.
- Sold fully assembled and ready to install
- Warranty: 1 year parts and labor
- **Warning:** May be susceptible to RFI or EMI interference. Not suitable for life critical applications

Overview:

The XCTS-1M combines a highly sensitive 'Capacitive Touch Sensor' with a high current DC switch. It constantly monitors the capacitance measured on an attached metal electrode called the 'Touch Plate' and can detect infinitesimal fluctuations that result from people or conductive objects coming into proximity of the touch plate. Touch is detected when a sudden increase in capacitance is observed. The high current DC switch is actuated in response to touch detection.

This can be used for a wide variety of applications, such as creating invisible light switches, or secretly actuating electric locks or alarms, or sensing the motion of people in a room, or remotely detecting the presence of moisture.

Direct vs. Indirect Touch Detection:

The XCTS-1M can support either direct or indirect touch detection, selectable via jumper settings. Select 'Direct Touch' mode when the users are expected to contact the metal of the touch plate directly, with no insulating overlay material between the metal of the plate and the user's skin. Select 'Indirect Touch' mode when the touch plate is mounted behind an insulating overlay material, and touch will be detected through the overlay material.

Toggle Switch vs. Momentary Contact Mode:

The switch action mode can be selected via jumper setting:

In Toggle Switch mode, the output is alternately activated and deactivated for each touch detection cycle.

In Momentary Contact mode, the output is activated only while touch is detected.

Motion Sensor Mode:

Motion Sensor Mode can be selected via jumper setting. In this mode the XCTS-1M is reconfigured to detect tiny fluctuations in capacitance that occur when a person or animal passes over a conductive sensor strip that can be mounted under a floor, or under a floor mat, or under stairs, etc. A brief voltage pulse is emitted on the Load output when motion is detected.

Sensitivity Adjustment:

The small trim-pot on the XCTS-1M controls the touch detection sensitivity. Turning clockwise increases the sensitivity. The Status LED blinks red while you're turning the pot, then blinks green twice when you stop turning to indicate the system has been recalibrated based on the new trim-pot setting.

Status LED:

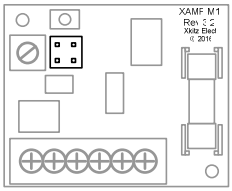
There is an LED on the XCTS-1M that indicates the current system status. It can illuminate either in red or green, solid or blinking:

LED Status	Description
Off	System is stable, Output is deactivated
Solid GREEN	System is stable, Output is activated
Solid RED	System is stable, Touch is currently detected
Blinking GREEN	System calibration is in progress, occurs after power up, after trim-pot adjustment, and after a change of jumper setting
Blinking RED	Trim-pot movement is detected

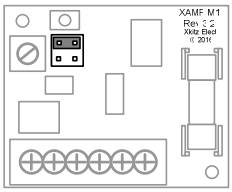
Option Jumpers:

The operating mode is selected by the configuration of two jumper shunts, shown in the figures below.

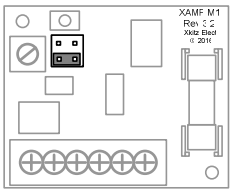
Toggle Switch, Indirect Touch Detect Mode – Both shunts removed



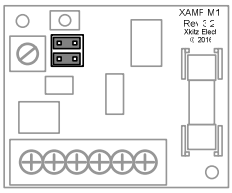
Momentary Contact, Indirect Touch Detect Mode – Top shunt installed



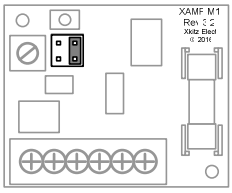
Toggle Switch, Direct Touch Detect Mode – Bottom shunt installed



Momentary Contact, Direct Touch Detect Mode – Both shunts installed



Motion Sensor Mode – Single shunt installed vertically on the right



Wiring and Installation:

Connection to Power Supply:

The XCTS-1M requires an input voltage in the range of 6V-30V DC, with current capability sufficient to drive the output load plus 15mA. It is recommended to use a clean, good quality power supply. Linear supplies are preferred because they generally produce the cleanest DC voltage. Switching supplies can sometimes produce high frequency noise on the DC voltage, which can in some cases interfere with the operation of the XCTS-1M.

See Fig. 2 System Level Wiring diagram below for power supply connection info.

Earth Grounding:

Some applications will benefit from earth grounding the system. Generally speaking, any application that is powered from a DC power supply sourced from AC mains should be earth grounded. Battery powered applications generally don't need earth grounding, or can be supported by adding a ground plane around the touch plate.

Earth grounding significantly increases the signal-to-noise ratio of the detection circuits. See Fig. 2 System Level Wiring diagram below for info on how to connect the earth ground.

Connection to DC Output Load:

Connect the DC Load as shown in Fig. 2 System Level Wiring diagram below.

Touch Plate Connection:

In order to detect touch, the XCTS-1M must be connected to some form of 'Touch Plate'. This can be nearly any conductive metal object, but will normally take the form of a flat piece of copper affixed behind an insulating overlay material. Connect the touch plate to the XCTS-1M by soldering one end of a thin gauge insulated wire to the touch plate, and connecting the other end to the 'Touch Plate' input of the green terminal block (see Fig 2 System Wiring Diagram below).

Many applications will benefit from adding a second, adjacent ground plane near, or preferably completely surrounding the touch plate. This greatly increases the signal-to-noise ratio of the capacitance measurements. Connect the ground plane to the 'Ground Plane' input of the green terminal block (again, see Fig 2 System Wiring Diagram below).

You should use the thinnest wire possible for connecting the touch plate and ground plane, preferably 28ga or smaller, to connect the plate to the controller. Small gauge wire minimizes the chance of electrical interference and will increase the signal-to-noise ratio.

Note that you may get false activations when you touch the connecting wire. This is expected, so you should route and tack down the wire where it will be least susceptible to false activation. This can also be minimized by using two conductor cable (ribbon cable or similar), one to connect the touch plate and the other connected to the ground plane. Even if you're not using a ground plane, it helps to run a ground wire parallel the touch plate wire (and left unconnected on the touch plate end).

For best results, the length of the touch plate connecting wire should be minimized. Longer wires become increasingly susceptible to ambient electrical noise and decrease the detection signal-to-noise ratio. In practice, installations with wires up to 2-3' long should be able to be made reliable.

Integrated Touch Plate:

The XCTS-1M comes with a standard Touch Plate board that forms the cap of the plastic enclosure box. This allows you to mount the enclosure with the integrated touch plate directly behind your overlay material and saves you the trouble of mounting and wiring a separate touch plate.

Create Your Own Touch Plate:

You can make your custom touch sense plate in almost any size, shape and configuration. Nearly any conductive material such as copper foil tape, which is available in any hardware store, can be used. Or any conductive material or small metal objects will work as well. The plate or object just needs to be wired to the controller using the guidelines below.

Figure 2 System Wiring Diagram below shows how the touch sense plate and the optional ground plane are wired. Simply connect the touch plate to the controller using a thin gauge insulated connecting wire. Here are some guidelines:

- The touch plate must be electrically isolated from ground, or any other metal object.
- The overlay material must be non-conductive.
- The minimum size of the plate is dependent on the thickness of the overlay material: the thicker the overlay, the larger the plate needs to be. As a rule of thumb, the plate diameter should be at least 2 to 3 times wider than the thickness of the overlay material for reliable operation. This is an area you can experiment with.
- The plate size is also limited by the length of the wiring to the controller. The longer the wire the larger the plate will need to be to overcome noise picked up by the longer connecting wires. Connecting wire length up to about 12" works very reliably with .625" diameter touch plate. Connecting wire lengths up to 3' have been tested and work well with a plate that is 1.25" in diameter. (1/8" overlay thickness)
- The maximum size of the plates is something you can experiment with. Xkitz has tested plates larger than 20" square with no degradation of performance. Larger plates will generally give you a higher level of sensitivity and a longer range of detection, which can sometimes lead to false activations. In other words, you may see that the circuit detects the presence of hands *nearby* the touch plate, as opposed to actually touching the overlay material. If you experience this behavior, you can fix it by turning the sensitivity lower until the circuit detects only physical touch of the overlay material.

Initial Power Up and Testing:

Prior to initial power up, turn the trim-pot fully counter clock-wise to select the lowest sensitivity setting. It's generally a good idea to double check all your connections. Use a multi-meter to verify you have no short circuit across the DC input voltage or the output Load.

Apply power to your system. You should see the green LED blink a few times while the XCTS-1M is calibrating itself. Once the LED stops blinking (which should be within 1-2 seconds), you can test the touch sensor by touching the 'Touch Plate' terminal screw on the green terminal block with a small non-insulated metal screwdriver. You should see the output Load is actuated by this touch. The LED should illuminate red, and the output Load should be activated.

Sensitivity Adjustment:

Once you have your touch sense plate in place and wired to the controller, you need to adjust the touch detection sensitivity. Do this by slowly turning the sensitivity adjustment trim-pot clockwise, which increases the detection sensitivity, until you reach the point where touch is detected reliably for your sense plate/overlay material. Keep hands and other objects away from the touch sense plate and connecting wire while adjusting the sensitivity to prevent calibration errors. The LED will flash red while you're turning the trim-pot. When you stop turning the pot, the LED will give 2 final green flashes to indicate the new setting has been accepted and the system has calibrated to this new value.

It's generally best to set the sensitivity to the lowest level that will still allow proper activation. This reduces the likelihood of false activations from ambient electrical noise.

Application Info:

Conductive or Semi-Conductive Objects Used to Extend the Touch Sense Field in 3D:

The XCTS-1M is sensitive enough to allow you to extend the touch sensor's field up into three dimensional objects placed on a horizontally aligned touch plate. Conductive or semi-conductive objects such as a metal statue, a glass of water, or even a house plant can become part of the touch sensor's detection field. Touching anywhere on this object will actuate the circuit.

The touch plate, in this application, should be a flat copper plate, large enough to allow the 3D object to be placed within its perimeter.

'Direct Touch' mode should be selected in this application.

Moisture vs. Touch Sense:

The Capacitive Touch Sense mode works best in dry conditions. Since water is a pretty good conductor, the circuit may not work very well if the touch sense plate or overlay material is wet. The touch plate should be mounted in a location that is sheltered from rain or other sources of moisture.

Moisture Detection:

The XCTS-1M can be used as a moisture detector. Again, since water is a good conductor, its presence can be remotely sensed by the touch sensor circuitry. In this application you must use a ground plane adjacent to the touch plate. The presence of moisture in near proximity to the gap between the touch plate and the ground plane will actuate the circuit.

For example, if you affix two horizontal strips of copper tape to a bottle, and connect them as the touch plate and ground plane, the circuit will actuate when water is added to the bottle up to the gap between the plates.

Troubleshooting Guide:

Problem	Possible Cause	Solution
No activity – The LED doesn't blink on power up	Power supply may not be working	Verify your input voltage is applied and connected properly. Use a multi-meter to confirm your input voltage is present on the green terminal block.
Erratic Operation, or random activation, or touch not detected	Bad connection to sense plate	The signal to detect touch is extremely sensitive. Poor contact between the XCTS-1M and the touch sense plate and/or the ground plane can cause erratic operation.
	Sensitivity may be too high	Turn the trim-pot counterclockwise just a bit. Wait a few seconds then check for proper operation, repeat if necessary.
	Ambient electrical noise	Heavy machinery on the AC mains, or cell phones, etc. can emit electrical noise that can interfere with the proper operation of the touch detection circuitry. Try moving the XCTS-1M further away from any possible noise sources.
	Noisy power supply	High frequency noise on the power supply (as can be caused by a switching power supply) can occasionally interfere with the proper operation of the touch detection circuitry. Try a different power supply, or a battery, and see if performance improves.
	Touch Plate connecting wire too long	Try a shorter connecting wire and see if performance improves
	Needs ground plane to be added	Erratic behavior generally arises from low signal-to-noise ratio. You can greatly increase you SNR by adding a ground plane near or surrounding your Touch Plate
	Needs to be earth grounded	Earth grounding your power supply will also greatly increase your SNR. See Fig 2 below for earth grounding info.
Touch detection works but not always, sometimes touch is missed	The sensitivity may be set too low	Turn the trim-pot clockwise just a bit. Wait a few seconds then check for proper operation, repeat if necessary.
	Overlay material too thick or Touch Plate too small	The Touch Plate diameter should be at least 2-3 times the thickness of your overlay material for reliable operation. Try increasing the diameter of the Touch Plate
	Signal-to-Noise Ratio too low	Increasing your SNR will allow you to turn the sensitivity higher without leading to erratic behavior. Either add a ground plane near your touch plate, and/or earth ground your power supply to increase your SNR
Red LED stuck ON, regardless of touch being detected	The sensitivity may be set too high.	Turn the trim-pot counterclockwise just a bit. Wait a few seconds then check for proper operation, repeat if not.
		See 'Erratic Operation' above for other possible solutions
Switch circuit 'bounces', or exhibits multiple switch closures per touch	The sensitivity may be set too high.	The sensitivity should be set just high enough to detect touch. When the sensitivity is set too high, the circuit will detect when something is *approaching* the touch plate, and may bounce during this time. Turn the trim-pot counterclockwise just a bit. Wait a few seconds and check for proper operation, repeat if necessary.
		See 'Erratic Operation' above for other possible solutions
Touch sense and LED operate correctly, but output Load won't activate	The fuse may be blown	Check the fuse, replace if necessary. Use a maximum 10 Amp fuse, size 2AG

Figure 1. Connection and Jumper Quick Reference

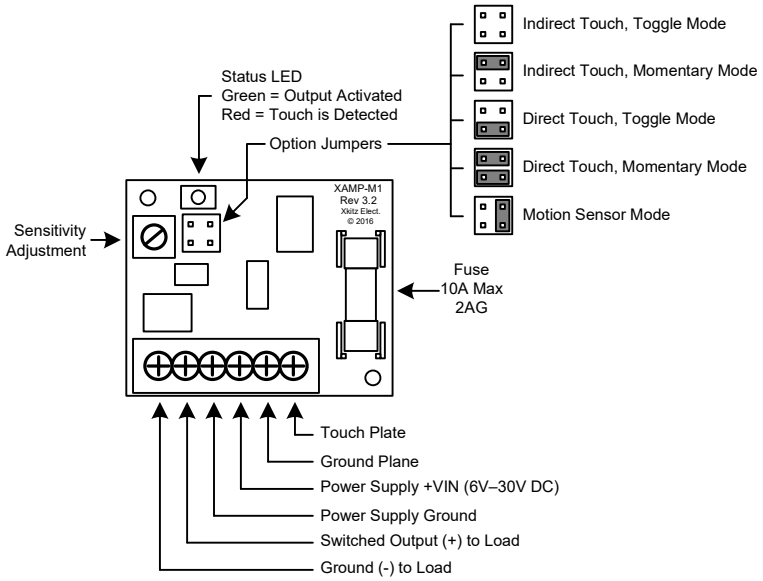


Figure 2. System Wiring Diagram

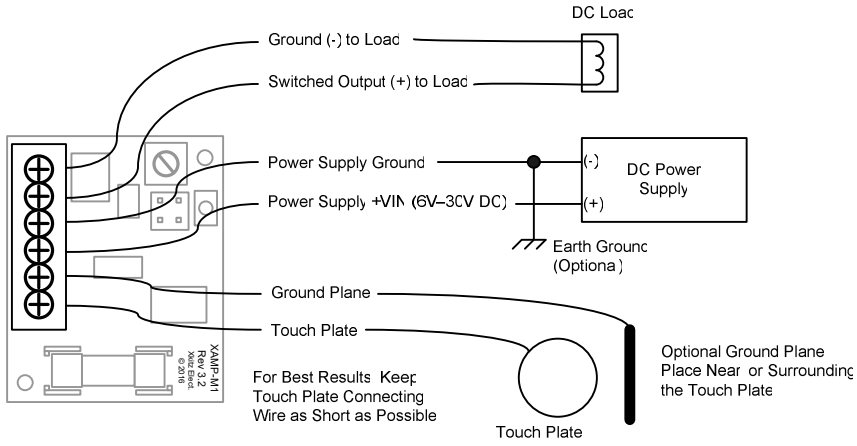


Figure 3. Enclosure Dimensions