



Enhancing Control and User Experience with UltraTouch Technology for Raspberry Pi 5: a New Era of Capacitive and Force-Sensitive Touch Displays

CTT's UltraTouch and Raspberry Pi 5 deliver a new dimension of control and user experience

How UltraTouch's groundbreaking capacitive-force-touch sensor technology provides superior control and user experience for the Raspberry Pi 5.



The Challenges of Touch Display Modules

Touch Display Modules (TDMs) provide a convenient and versatile means of interacting with a Raspberry Pi 5. TDMs can display information or content for consumption, like a movie, and detect the location and lateral movement of multiple fingers.

Finger location and tracking on a TDM can be achieved using several technologies. The most prevalent is projected capacitance (PCAP). Most of the time, it works extremely well, being fast, accurate, and able to report finger location with sub-millimeter precision, which is why it enjoys almost universal dominance in consumer TDMs.

However, traditional TDMs often fall short in more demanding, rugged, and industrial environments. For context, PCAP works by detecting the presence of any moderately conductive object on the display.

So, where there is a requirement for the control gesture to be deliberate, such as in mission-critical applications in industrial settings, a better, more tailored solution is needed.



Enter: UltraTouch for the Raspberry Pi 5

The UltraTouch sensor is transparent, flexible, solid-state, and thinner than a human hair. As a passive layer, it consumes very little power. UltraTouch sensors detect both the location and force of finger touches and can also provide a trigger for haptic feedback.

This all-in-one capacitive and force-sensitive technology ensures precise and accurate detection of touch, with error-free dependability that elevates both user interface and experience while delivering superior control over any device, critical system, or asset.





How It Works

Whereas a PCAP-only TDM reports finger location (XY coordinates), an UltraTouch TDM provides finger location and force (XYZ) to the Raspberry Pi 5.

In terms of how this works, the UltraTouch force sensor does not act as a 'weighing scale'; instead, it is a rugged, whole area, solid-state sensor built into the display glass itself that is coupled to the PCAP system.

To simplify use, the UltraTouch system contains a register for a force threshold (adjustable roughly 100gf – 600gf), and the HID pressure container is either empty (null) if the force is below the threshold or populated if the force exceeds the threshold.

If multiple fingers are pushing on the TDM, the detected pressure is not the aggregated total (as would be the case for a weight scale sensor) but a pseudo-average of the force applied by each finger.

The availability of force as an input parameter opens the way to a plethora of new and exciting user interfaces. Virtual buttons, sliders, switches, etc., can now have force-enabled functions in addition to, and in combination with, all the usual PCAP control functions.

Some of the new input possibilities include:

- Push select (force above threshold launches action)
- Push hold (something happens continuously while force is above threshold)
- Drag push (drag then push to confirm the new setting)
- Push drag (drag only possible when force threshold exceeded)
- Staircase push* (different actions initiated by different forces, typically a maximum of three)
- Ramp push* (system response is proportional to the force)

** not currently enabled*



'Push-to-Zoom' UI Example using UltraTouch TDM

Zoom-In: one finger push

Zoom-Out: two finger push

(Rate of zoom depends on force level).

Some user interfaces made possible by UltraTouch are quite intriguing, as they offer marked improvements over traditional touch displays. Everyone is familiar with using ‘pinch to zoom’ to alter the scale of a map. However, trying to use this gesture on a touch screen in a car is not easy. The attention of the driver should be on the road ahead, while the motion and vibration of the vehicle make the gesture difficult to control, especially if the interface additionally provides map rotation. A user interface that is far simpler, easier, and reliable to use is ‘push-zoom.’ Push anywhere with one finger, and the map zooms in; push anywhere with two fingers, and the map zooms out. The rate of zoom can even be made proportional to the force applied. Once experienced, the natural and intuitive nature of this interface makes it difficult to accept anything less.

UltraTouch’s Superior User Experience (UX)

Humans are naturally wired to impart information using force as a vector. Holding hands conveys happiness, tightly gripped equates with anger and fear. We unconsciously use force when interacting with machines as well. If the button on an app is unresponsive, the natural action is to push it again, but harder. On a PCAP-only TDM, pushing serves no purpose. However, on an UltraTouch TDM, detection of a high force could be used to trigger a system reset or other intervention.

Consider three process control buttons marked Start, Pause, and Stop. The natural way to engage with these buttons is different for each:

- **Start** is associated with a push-hold gesture. Depending on the person in control, the push will often be sustained until there is confirmation by sight, sound, or another sense that the process has started.
- **Pause** is a light tap because pausing is an optional event, so the investment in the decision is small.
- **Stop** is a command, so it will be enacted by a firm push. The more urgent it is to stop the process, the harder the push will be.



Simple control interface. Desirably, the three virtual buttons have different force-touch characteristics to meet the expectation of how they need to be operated

Using an UltraTouch TDM, force sensitivity can be exploited to make the button actions mirror expectations. Doing so results in a more intuitive and pleasant-to-use interface and, in turn, makes the user experience emotionally more satisfying and gratifying – all while ensuring precise and accurate detection of touch.



UltraTouch System Control

- **Human control of a single-board computer (SBC) system**, such as the Raspberry Pi 5, or indeed any system controlled via a computer, carries risk. The purpose of the SBC is to provide control options to human overseers. Where the human-machine interface is a PCAP TDM, the Raspberry Pi 5 has no way of knowing whether a command it receives is deliberate or, indeed, human at all. UltraTouch can address both concerns, making it ideal for mission-critical applications and other system control applications where safety is important.
- **PCAP responds to any moderately conductive object applied to the display.** This propensity is increased if the gain is boosted to permit function with gloved fingers. UltraTouch requires the applied force to exceed the set threshold (which can be changed) before it is recognized as an event. This, coupled with PCAP to

define the event location on the TDM, greatly improves the security against accidental or unintended triggers.

- **UltraTouch provides one further security enhancement.** Human force touch has a very distinct and complex temporal profile. Using advanced algorithms embedded within UltraTouch, it is possible to detect the signature of human finger touch and reject other touch events even in instances where the force threshold is exceeded. Despite the complexity of the signature analysis required, it is completed in tens of milliseconds.
- **UltraTouch provides two gates that a force touch event must pass before it is reported to the Raspberry Pi 5.** Combined, they greatly improve the security of system control when using a TDM as the human-machine interface.



Raspberry Pi 5 to UltraTouch TDM

Connecting a Raspberry Pi 5 to an UltraTouch TDM is simple, as both the display and human-machine interfaces are 'plug and play'. The display requires HDMI video-in while the PCAP and force communication with Raspberry Pi OS is via USB. Raspberry Pi OS (Debian 12, kernel 6.6, released 24 July 2024, the current version at the time of writing) natively handles the relevant part of the Microsoft HID protocol to report the 'pressure' associated with touch events. This makes it straightforward to develop GUIs that exploit the new features of force-touch sensitivity.



Example of a GUI written to demonstrate the difference between PCAP-only touch and force-touch on the same UltraTouch screen. For the PCAP switch, the application ignores any force values, so the switch can be operated with the lightest touch. The switch on the right requires a push of around 300g to actuate, similar to the mechanical switch depicted.



The 7” UltraTouch RX-TM-070845A-1.0 TDM

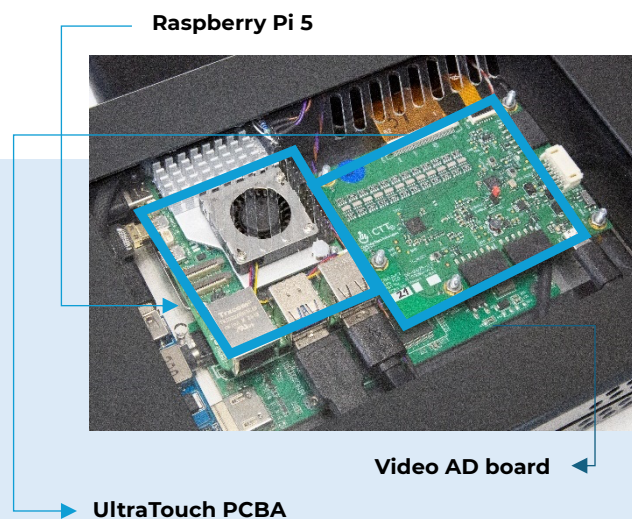
The 7” UltraTouch RX-TM-070845A-1.0 touch display module stands apart from current market offerings due to its reliability and versatility, with control and safety enhancement features to safeguard against costly downtime and protect personnel and asset wellbeing.

Key Features and Specifications:

- The device combines a premium, full-color IPS LCD (1280x720) with a rugged, whole-area, solid-state touch-and-force sensor. The PCAP system is tuned by default for thin gloves and light surface contamination, while the force threshold is adjustable between 100gf and 600gf.
- The display incorporates a high-brightness backlight (1,000cd/m2), making it sunlight readable in many environments.
- The black print is fully symmetric, and the absence of moving parts means the display can be mounted and used in any orientation with no change in force-touch sensitivity.
- A chemically strengthened cover glass, together with industrial reliability, lifetime and temperature range, plus the ability to meet IP and IK ratings with suitable mounting and enclosure ensures it can be used in a wide range of environments.
- It is designed to be 'plug-and-play' with Windows 10 and above, and

most Linux kernels. This includes Raspberry Pi OS, used with Raspberry Pi 5.

- RX-TM-070854A-1.0 delivers fast and reliable human finger force-detection for applications where value is placed on improved user interfaces, better user experience and where system control demands a high level of confidence in the user intent.





The 7" UltraTouch TDM for Raspberry Pi 5 is designed to meet the needs of industries for which dependable HMIs for critical, high-risk operations are non-negotiable. It can be implemented across applications in manufacturing, medical, agriculture, oil and gas, automotive, and much more.



Find out more

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