THINKING BEYOND THE TOUCH

Dawar Capacitive Ring

By Tony Gray

Director of PCAP Touch Technology

Sustaining Quality,
Exceeding Expectations

DawarTouch®

THINKING BEYOND THE TOUCH
921 Ridge Ave., Pittsburgh, PA 15212
PH: 800-366-1904 | E-mail: sales@dawar.com
dawar.com

August 26, 2025
Rev A

Introducing Dawar Capacitive Ring

Dawar is excited to introduce an amazing new feature of our Projected Capacitive (PCAP) touch technology:

Dawar Capacitive Ring

What is Dawar Capacitive Ring (DCR)?

Dawar's Capacitive Ring (DCR) technology is an exciting new way to integrate traditional mechanical knobs directly on a display without the need for a rotary encoder. The DCR knob is essentially two rings coupled by a circular ring of ball bearings. The bearings fit into small detents between the rings, providing tactile feedback as the DCR rotates (Figure 1).

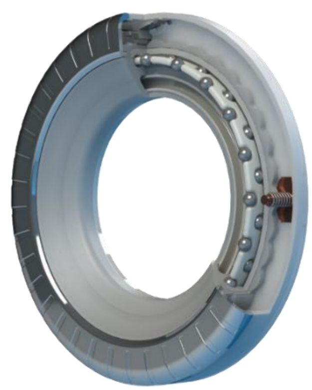


Figure 1

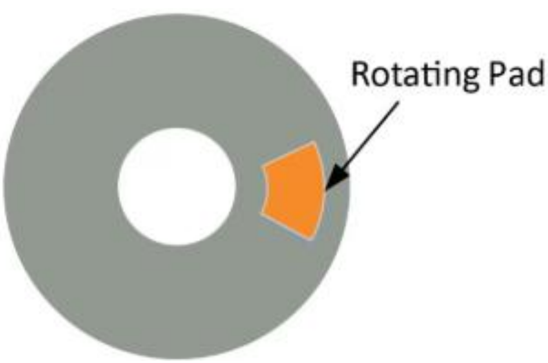


Figure 2

The bottom section of the DCR is adhered to the front cover lens of your product using standard VHB-type adhesive. Once applied to the cover lens, the lower section of the DCR remains stationary while the top section rotates. Small conductive pads on the rotating ring are sensed by Dawar's Projected Capacitive (PCAP) touch sensor (Figure 2).

921 Ridge Ave., Pittsburgh, PA 15212
PH: 800-366-1904 | E-mail: sales@dawar.com
dawar.com

As the conductive pads rotate around the ring, sophisticated software algorithms in the PCAP touch controller determine the knob's position based on the locations of the conductive pads. In addition to monitoring the rotation of the ring, the touch controller can also detect a push action if the knob is designed with a spring-loaded jog capability. For example, the user can rotate the knob to select a new mode, then push the knob to activate that mode.

Benefits of DCR

Adding a Dawar Capacitive Ring to your device enables all kinds of unique and eye-catching user interactions with your product. If you're replacing an existing mechanical knob, there are potential cost savings including:

- Replace multiple mechanical knobs with a single DCR
- No rotary encoder needed
- No analog-to-digital conversion of the rotary encoder's position
- No hole through the product's enclosure
- Eliminating the mechanical knob might even allow you to make the entire enclosure smaller
- Eliminating a hole in the enclosure also allows your device to be more easily sealed against dust and liquid contamination

The most exciting advantage of integrating a DCR with your product is the ability to closely tie your graphical user interface (GUI) with your DCR's functionality. Imagine rotating the DCR knob and seeing the adjusted value displayed right in the center of the ring. For example, the DCR might be controlling the temperature. The current temperature set point can be displayed in the center of the ring and will change while the DCR is rotating. You can even add graphical elements around the outside of the ring (Figure 3).

Figure 3

How it Works

A Projected Capacitive (PCAP) touch screen projects an electric field above the surface of the cover lens. When a finger enters that electric field, it steals some of the charge (Figure 4).

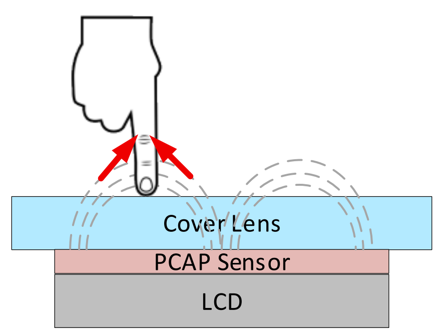


Figure 4

DAWAR
THINKING BEYOND THE TOUCH
921 Ridge Ave., Pittsburgh, PA 15212
PH: 800-366-1904 | E-mail: sales@dawar.com
dawar.com

A touch controller attached to the PCAP sensor detects this transfer of charge and its location on the sensor and reports a touch event to the host. Typically, a finger produces a strong signal to the touch controller because the human body can absorb a lot of the projected electric field (Figure 5).

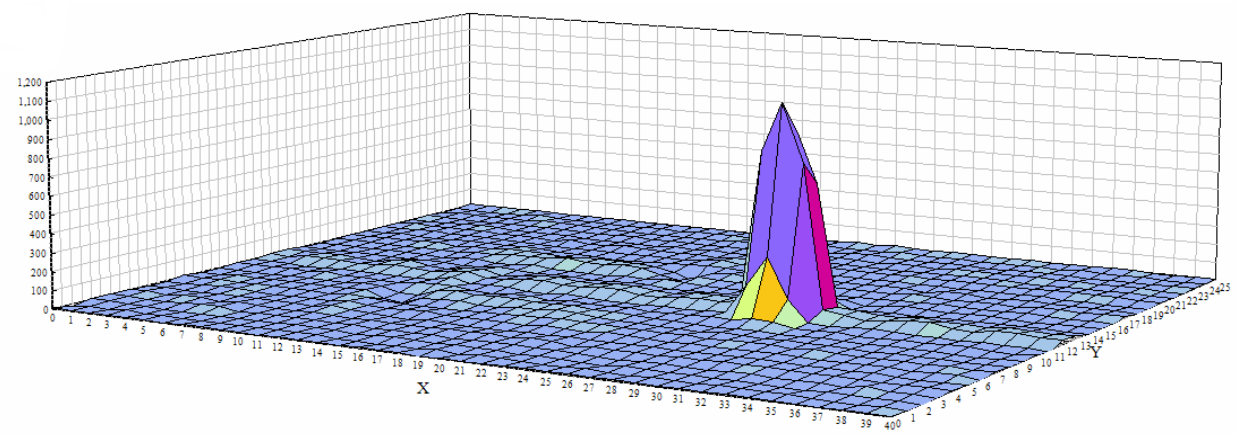


Figure 5

The conductive pads on the bottom of the Dawar Capacitive Ring are very small, which results in much smaller signals than a human finger. When the user is touching the DCR, the conductive pads are capacitively coupled to the user's body. This generates signals that are about 20% of a finger signal (Figure 6).

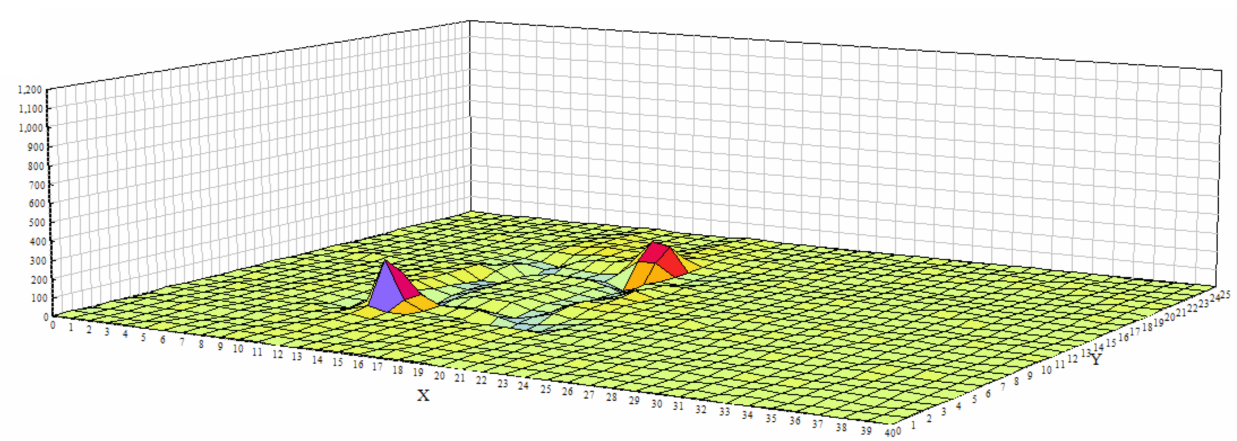


Figure 6

THINKING BEYOND THE TOUCH
921 Ridge Ave., Pittsburgh, PA 15212
PH: 800-366-1904 | E-mail: sales@dawar.com
dawar.com

When the user lets go of the DCR, the signals generated by the pads drop to about 10% of the finger signal (Figure 7).

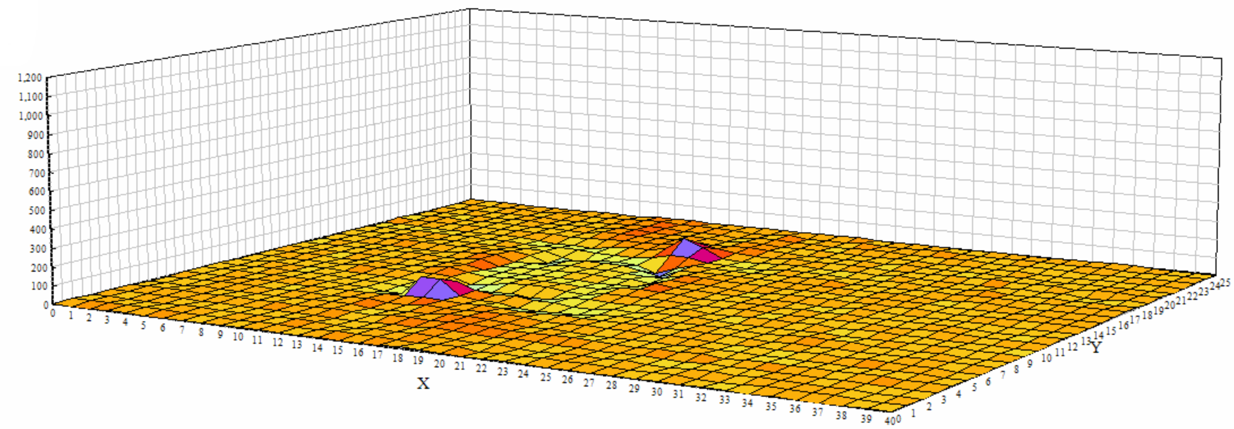


Figure 7

This makes it very difficult for the touch controller to detect and locate the conductive pads, especially when the DCR is not being touched. Fortunately, the touch controller includes very sophisticated algorithms designed to detect and locate these small signals. As the user rotates the DCR, the signals from the conductive pads rotate around the center of the ring. The touch controller detects this movement and sends rotation events to the host notifying it that the DCR is rotating.

When the user pushes down on a jog-enabled DCR, the pads get closer to the sensor and generate slightly larger signals. The touch controller detects these increases in the signals and reports a push event to the host. Detecting the signals from the DCR is even more difficult in the presence of electrical noise. Often the electrical noise from the LCD generates signals that are larger than the signals from the conductive pads. However, signals generated by electrical noise, particularly by LCDs, tend to move across the sensor almost like waves. The touch controller can differentiate between the small DCR signals and the larger noise signals by monitoring the signals for several measurement frames. If the signal moves in a non-circular manor or moves outside the area where the DCR is mounted, then it can't be from the DCR. Through a process of elimination, the touch controller can separate the small DCR signals from the noise.

DCR Design Constraints

The difficulty involved in detecting the relatively small DCR signals places several constraints on the design of the DCR. The first constraint is the size of the knob. The knob can't be too large because the pads would be too far away from each other to be easily associated with each other. The knob also can't be too small because then the pads would also be smaller and generate even lower signal levels. The ideal size for a DCR is about 2.5 inches in diameter. The smallest supported size is currently around 1.5 inches, but for reliable operation of a knob that size, there must be very little electrical noise present on the touch sensor. Smaller DCR sizes may be possible depending on the application.

Another constraint is the number of detectable positions. The ball bearing ring that connects the static inner ring of the DCR with the rotatable outer ring has a defined number of detent positions that the ring can be rotated to. The number of detents defines the minimum detectable rotation angle. A 2.5in knob typically has 22 detents giving a minimum detectable rotation angle of 16°. In other words, as the DCR rotates through a full 360° of rotation, the host receives 22 rotation events, one for every 16° of rotation. Smaller knobs have fewer detents so that the pads can still be reliably located. A 1.5in knob might only have 18 detents giving a minimum detectable rotation angle of 20°.

Typically, a DCR has two conductive pads located 180° from each other. This is good design practice to ensure reliable detection in the presence of electrical noise. Because the pads are symmetrical, it is impossible to provide an absolute position of the knob. Only relative position reports are possible. Also for this reason, a DCR is typically designed for free 360° rotation with no stops. While it is possible to design and tune a DCR with asymmetrical pads for absolute positioning, the position reporting may not be reliable. Applications requiring absolute position readings have additional design constraints and require research and development.

Larger DCR knobs can have a donut design, allowing the LCD to be visible in the center of the ring. As the knob gets smaller, the sizes of the conductive pads must stay the same. Therefore, the center cutout must get smaller. For this reason, DCR knobs smaller than 2in typically don't have a center cutout.

Finally, the location of the DCR is also critical for proper operation. The main constraint is that the entire DCR must be several millimeters from the edge of the sensor's active area. This is important because the edges of a PCAP sensor are typically less sensitive and report lower signal levels. Once the general location of the DCR has been selected, it may be helpful to move the knob slightly to achieve better alignment with the touch sensor's electrodes resulting in better signal levels. Dawar's engineering team can help guide the optimum DCR placement.

Dial Design

At first glance the design of the physical DCR knob doesn't seem very complicated. It consists of two rings coupled by third ball-bearing ring with one or more embedded conductive pads. For a jog dial, add some form of spring-loaded vertical movement between the two rings. However, extensive testing has shown that the DCR design is much more complicated than it appears. Getting the right amount of conductive coupling to the electric field when the DCR is not being touched is very difficult, especially given that the amount of coupling changes depending on what rotation position the DCR is in. As the pads rotate over the touch sensor, some rotation positions will have greater coupling than others.

Adding a jog feature increases the complexity exponentially. As the DCR is pressed, it is critical that the spacing between the conductive pads and the touch sensor be the same around the entire diameter of the knob. If the user is only pushing on one side of the knob, that side will tend to be closer to the cover lens than the opposite side. The DCR must be designed so that the force of the push is equally distributed around the entire knob. This is made even more complicated by the donut shape of larger knobs where the user can't push directly on the center of the knob.

For these reasons, Dawar strongly suggests using one of our proven knob designs. Dawar has knob designs in several sizes that have undergone rigorous testing and have been proven reliable. While it is possible to design a custom knob, an extensive amount of research and development may be needed to ensure reliable operation.

Integrating DCR with Your GUI

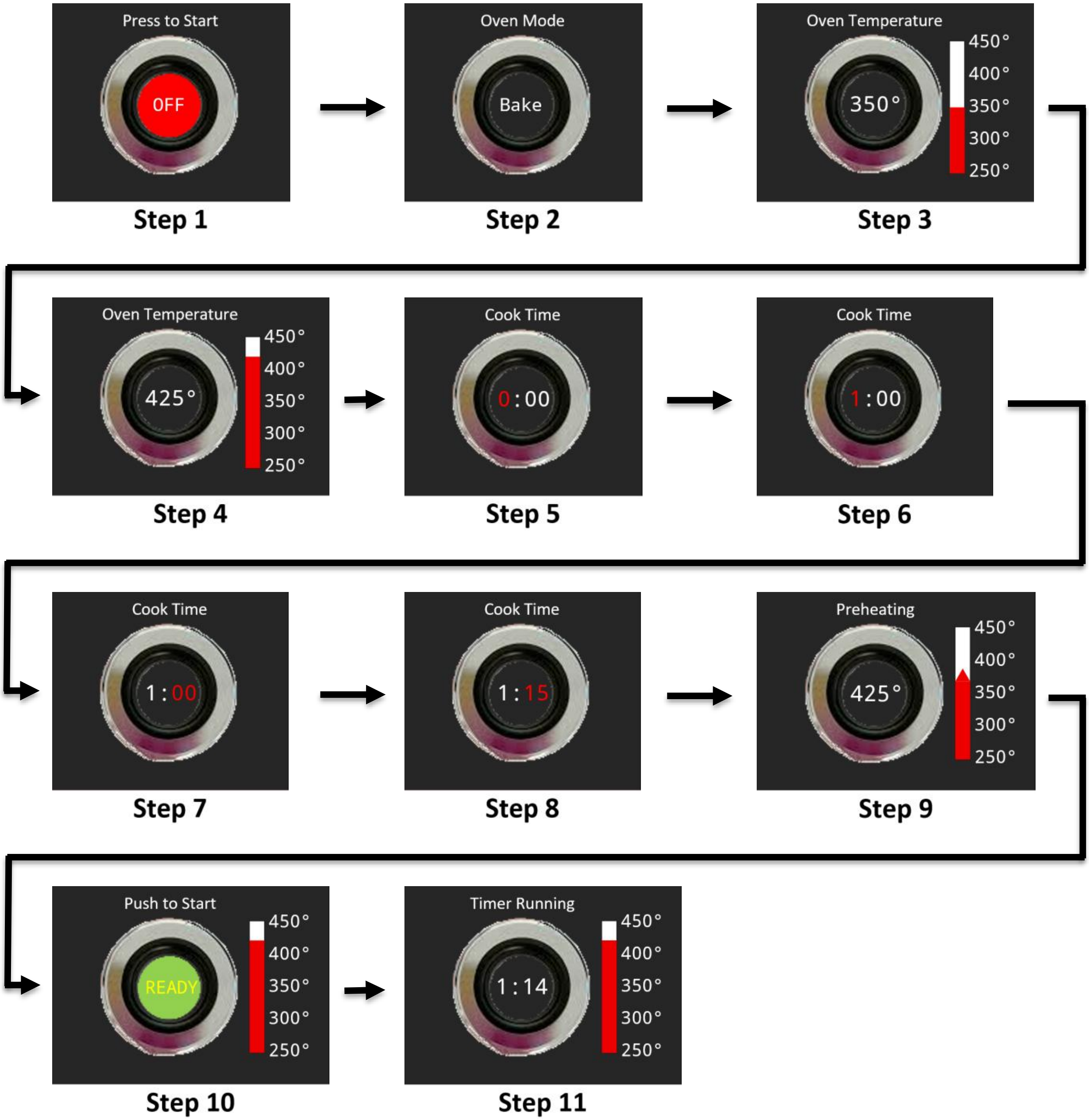
If your product already has one or more rotary encoder knobs, then replacing them with a DCR is relatively straight forward. The key difference is the integration of the display with the knob's functionality. Once the knob is placed on top of the LCD, there are a variety of ways to add graphical cues around the knob and enhance its functionality, starting with placing the value being modified in the center of the knob. If you're replacing multiple knobs, graphics can be used to indicate which value the knob is currently modifying. If the DCR is jog-enabled, then the jog feature can be used to switch modes or move to a different setting.

For example, imagine using a jog-enabled DCR to control a home oven. Cooking with an oven involves setting several parameters, always in the same order:

1) Oven mode (bake, broil, or clean)
2) Oven temperature (250° to 450°)
3) Cook time (hours and minutes)

To set an oven using a DCR, you might design the user interface like this:

1) Press the DCR knob to begin the cook setup process
2) Rotate the DCR to the desired mode (bake, broil, or clean)
3) Press the DCR to select the mode and switch to setting the temperature
4) Rotate the DCR to the desired temperature
5) Press the DCR to select the temperature and switch to setting the hours of cook time
6) Rotate the DCR to the desired number of cook hours
7) Press the DCR to select the number of cook hours and switch to setting the minutes of cook time
8) Rotate the DCR to the desired number of minutes
9) Press the DCR to begin preheating
10) Once preheating is done and the food has been placed in the oven, press the DCR to start the timer
11) During cooking, the timer countdown is shown and can be adjusted by rotating the DCR


Press to Start
OFF
Step 1
Oven Mode
Bake
Step 2
Oven Temperature
350°
450°
400°
350°
300°
250°
Step 3
Oven Temperature
425°
450°
400°
350°
300°
250°
Step 4
Cook Time
0:00
Step 5
Cook Time
1:00
Step 6
Cook Time
1:00
Step 7
Cook Time
1:15
Step 8
Preheating
425°
450°
400°
350°
300°
250°
Step 9
Push to Start
READY
450°
400°
350°
300°
250°
Step 10
Timer Running
1:14
450°
400°
350°
300°
250°
Step 11

Conclusion

Dawar's Capacitive Ring technology provides exciting new ways to upgrade your product's look and feel, delivering market differentiation and potential cost savings. Contact Dawar Technologies today to learn more about how Dawar Capacitive Ring can enhance your product!

Dawar Technologies

921 Ridge Ave.

Pittsburgh, PA 15212

1-800-366-1904

sales@dawar.com