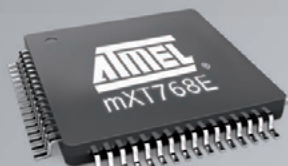
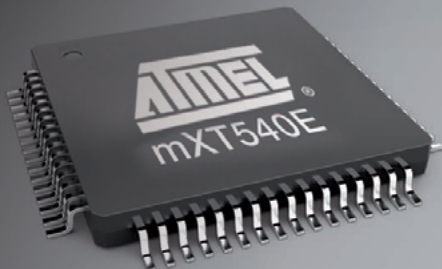


Capacitive Touch Technology Opens the Door to a New Generation of Automotive User Interfaces

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When designing a modern car, the spotlight is on the driving experience, from the external impression that the vehicle makes to the way in which the driver and passenger interact with the air-conditioning, navigation or infotainment systems. The key to this experience is the use of clearly laid out, intuitive operating elements which represent the driver-car interface.

The user interface in a modern car is very comprehensive. Most of the essential functions are just a few centimeters away

from the point where the driver holds the steering wheel, and are accessed by various combinations of touches and movements. The steering column switch is an effective way of bringing together functions which allow the driver to activate the direction indicator, control the windscreen wipers or adjust the headlights without needing to move his hands far from the steering wheel while keeping his eye on the road at the same time. For this, however, drivers have had to learn the specific press and turn combinations for the required function.

Because more and more electronic systems are being integrated into vehicles, the user interface needs to be expanded: there are too many functions for an interface that is based on mechanical keys. An interactive touch-sensitive display provides the opportunity to integrate many different functions in a concentrated space in the center of the dashboard. The different pages shown on the screen provide individual user interfaces for the various functional blocks. The touchscreen presents new challenges in menu definition so that user interfaces can be made safe, easy to use and intuitive.

Bringing Familiar Touchscreen Interface Into Vehicles

If the driver tries to look at details of his surroundings on the navigation system without a touch-sensitive display, he must do this by operating a directional button, which is awkward and takes his attention away from the road traffic for a considerable time.

A touchscreen allows the system in question to recognize wipe and zoom gestures, which means that the user can change the scale of the map or the position in just a short time. When scrolling through lists, in a telephone book for example, the wipe gesture considerably reduces the length of time for which attention is deflected.

Basically, more and more drivers are familiar with the operation of smartphones and touch pads. Therefore, they often try to intuitively push aside images on the display through touches, or influence them with other standard gestures.

Without gesture support, it may even happen that the driver and passenger are dissatisfied that the vehicle systems do not work in the same way as the smartphones and tablet PCs with which they are accustomed.

Most first-generation touch-sensitive interfaces were based on the same principle as the mechanical soft-touch keys on the dashboard: the pressing together of two conductive surfaces to change the electrical resistance. This resistive touchscreen technology uses a flexible layer over a substrate below it, separated by a small gap of air. The layers consist of transparent plastic coated with a grid of very thin electric wires and mounted over the liquid crystal display (LCD). To register a contact, the electric wires must be pressed together through holes in the spacer.

Because this type of touchscreen can only recognize the touch of an individual finger, it is not suitable for entering multi-touch gestures.

Resistive touchscreens were preferred in the past because they are easy to control and relatively cheap to manufacture. The additional plastic layers, however, cause many internal reflections, which lead to a lower light transmission. An outer elastic layer of soft plastic means that the surface is sensitive to scratching. Capacitive technology eliminates many of the problems known from resistive touchscreens, and it is continuing to develop rapidly. Users of smartphones and Internet tablet computers are familiar with the advantages of capacitive technology.

A capacitive touchscreen can be regarded as an arrangement of lots of capacitors that have a particular capacity. If a finger approaches the surface, this leads to a slight change in the capacities of one or more of these sensors (see Figure 1).

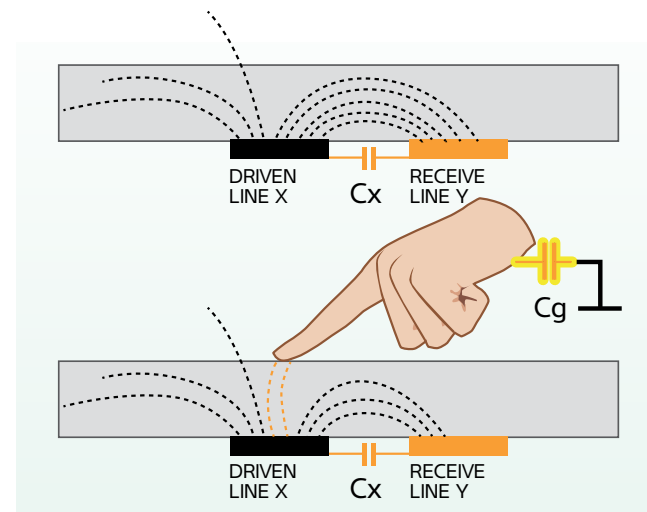


Figure 1. Mutual Capacitance Measurement

Understanding Sensor Capacities

There are two basic ways of mapping the capacity: self-capacitance and mutual capacitance. Many first-generation touchscreens were based on measurement of self-capacitance. However, they had the same kind of problem as the resistive touchscreens. Because the self-capacitance method measures the input signal of a complete row and column of electrodes, it cannot always unambiguously classify the position when operated with more than one finger. Mutual capacitance technology guarantees this by measuring every point of intersection in the orthogonal matrix. In this way, it is possible to exclude gaps in the finger classification which would be visible on the screen, depending on the application software. One

of the important differences between capacitive and resistive technology is that the user's finger does not need to exert any pressure on the surface of the screen to be recognized. Placing the finger on the surface leads to a tiny change in capacity of the corresponding capacitive sensor, which is recognized by the controller. The precise position of the fingers on the touchscreen is calculated when the measured values of all points of the intersection are evaluated. Nowadays, a sensitive touchscreen controller, such as a member of the Atmel® maXTouch® family (see Figure 2), is even able to register the approach of one or more gloved fingers.

As the capacity changes in this case are only very small, it is vitally important to be able to remove the effects of noise and interference. For this, there are various algorithms that minimize the capture of interference and that further suppress its effects by post-processing. The special interference suppression of the maXTouch controllers offers a number of advantages. It is now even possible to reduce the number of sensor layers above the LCD screen to a minimum. Many existing touchscreens need a

shield layer to protect the measurement signals from the strong display radiation that is generated by the rapidly switching transistors in the LCD screen. A reduction in the sensor layers leads to a smaller loss of brightness, which improves the image reproduction quality of the display. In addition, the manufacturing costs of the touch-sensitive sensor can also be reduced. The post-processing functions guarantee reliable operation in the specific ambient conditions in the automotive sector. Drift compensation, for example, ensures that the touchscreen interface is always calibrated to the ambient conditions, and reacts, for example, independently of changes in the relative humidity and temperature. Post-processing also ensures that touches by both fingers wearing gloves and bare fingers can be recognized at the same time without additional switchovers.

The electrode (individual capacitive sensor) spacing is another important criterion for touchscreens. A spacing of 5mm or less means that it is possible to recognize not only small zoom movements between two or more fingers, but also the

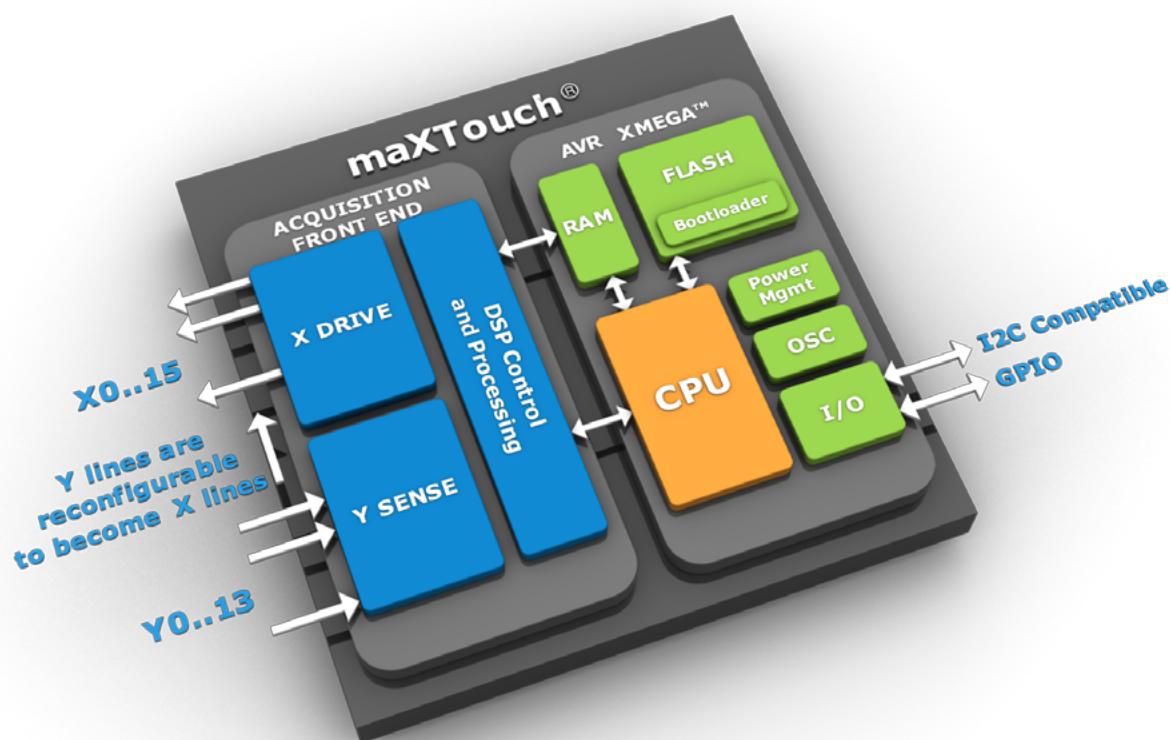


Figure 2. Block Diagram Atmel maXTouch Controller

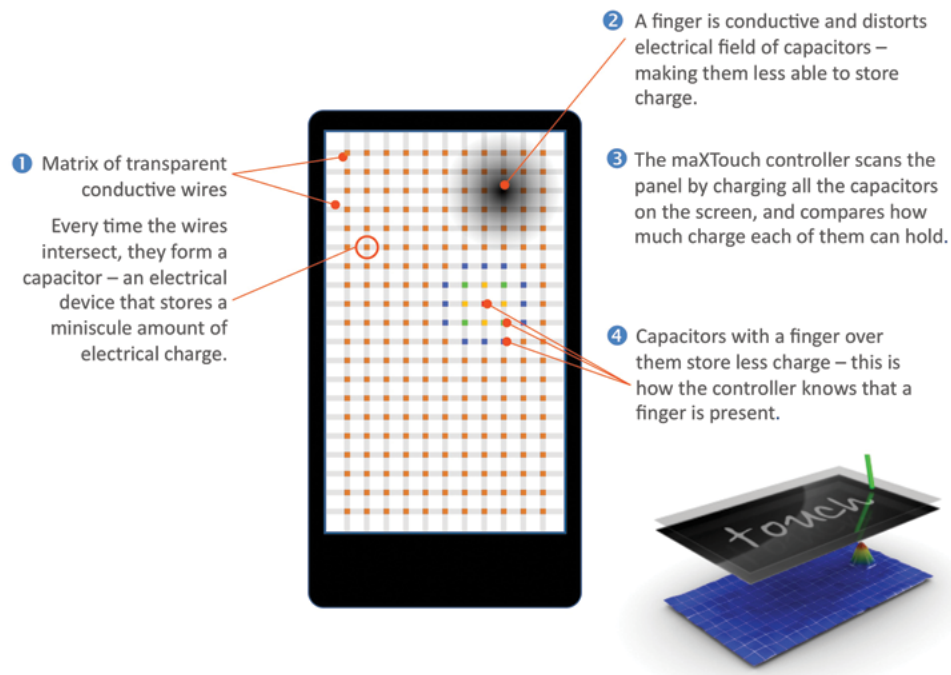


Figure 3. How Capacitive Sensing Works

difference between a weak and a strong touch (see Figure 3). Post-processing as applied by Atmel's maXTouch family also helps the system to recognize that large areas of the screen are covered, for example, if a user places the palm of his hand on the screen. This action is rejected as an accidental contact, thus preventing the incorrect triggering of unwanted functions.

All these functions make it possible to design intuitive, highly reactive user interfaces that mimic the application experience of tablet computers in automobiles.

The touchscreen can also be combined with capacitive proximity sensors. In this way, it is possible to identify whether a hand is approaching from the left or right, in order to allow just the passenger to use certain functions. This makes it easier for car manufacturers to comply with local laws which state, for example, that a driver is not allowed to change navigational settings when driving, while a passenger could continue to do this at any time, because his hand is approaching from a different angle.

Because the displays in the center panel of the dashboard are becoming larger all the time, it is a good idea to offer

divided interfaces so that a passenger can "push aside" part of the screen to display the interface for audio settings while the driver can continue to interact with the main operating elements. Because it recognizes from which side the hand approaches the screen, the host microcontroller can provide access to the correct set of operating elements for the user.

Delivering Intuitive Automotive Interfaces

By using intelligent, capacitive touch technology, such as the Atmel maXTouch family, vehicle manufacturers can integrate a new generation of user interfaces into their designs, thus continuing the tradition of intuitive, achievable and reactive operating elements. The intelligence inherent in the controllers ensures that the latest characteristics of modern consumer interfaces can also be used quickly in the world of automobiles.



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