easyTouch General Integration and User Guide

Suitable for

Data Modul easyMaxTouch Product Series

Rev 1.1

Version January 2013

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1 Revision of History

Rev.	Date	Page	Description	by
1.0	07.12.2010	All	First Draft	YL
1.1	21.01.2013	All	Rewrite	AT

2 General Information

This guide is a general assembly and user guide for Data Moduls projective capacitive touch screen solution called easyTouch. Since easyTouch is based on ATMELs maXTouch technology some specific information may only apply to those controllers. However, most of the information in this document applies for almost any projected capacitive touch solution on the market.

To achieve an optimal touch performance it is necessary to follow most of the hints and advices although it is obvious that sometimes not all rules can be applied because of mechanical restrictions or cost reasons. Advanced noise suppression and signal processing algorithms in the maXTouch IC may be able to optimize the overall touch performance but a good mechanical and electrical integration of the touch system into the complete unit is the key factor of a good touch performance and a successful product in the market.

3 easyTouch Panel Assembly Guide

Projected capacitive touch solutions like easyTouch have the huge advantage to work through a protection material in front of the actual touch sensitive screen. Of course this is an important design factor for most products but it is also a very important aspect when it comes to touch performance and sensitivity of the touch system. Choosing the wrong cover material or the wrong thickness of the material will result in poor touch sensitivity and degraded multi touch performance.

3.1 easyTouch panel behind a PET protection film

Choosing a PET protection film as a cover of the touch screen and mounting it with an air gap between the touch and the PET film will result in a dramatic decrease in sensitivity.

In case of small size devices (e.g. 4.3”) the PET protection film will be lying rather flat over the touch screen. However at larger sizes the PET film will start bending, thereby resulting in an uneven air gap. Moreover, touching the device will bend the PET protection film even more.

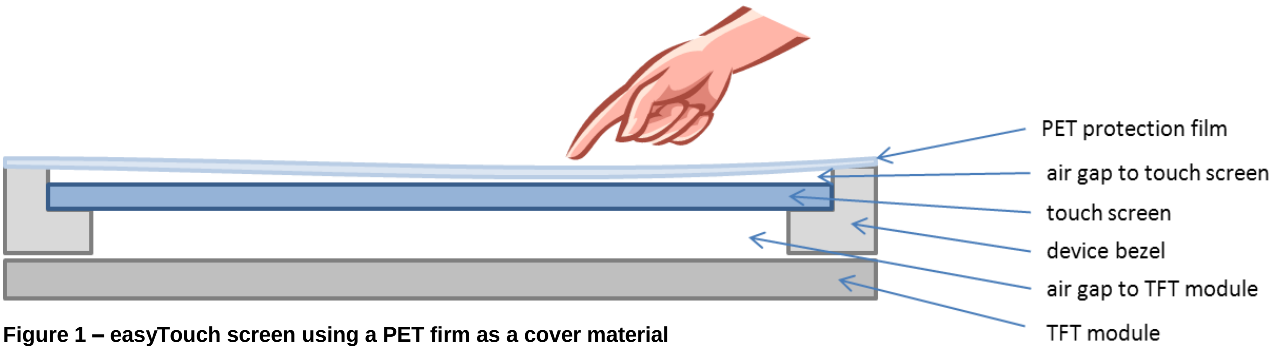

Figure 1 – easyTouch screen using a PET firm as a cover material

Since the controller IC needs to be calibrated on the electromagnetic field situation in front of the touch sensor a change in the thickness of the air gap during runtime (e.g. when someone touches the panel) will result in unstable touch detection or even false touch recognition in the bended PET film area.

The only way to overcome this situation is a direct lamination of the PET cover film to the touch screen and therefore eliminating the air gap.

In general an air gap between any kind of protection or cover material and the touch screen should be avoided as it causes many different kinds of problems that all reduce the overall touch performance or even make it impossible to configure the touch controller for stable touch recognition without false touches.

3.2 easyTouch panel behind a plastic protection window

Non-glass based protection materials are very popular due to its robustness and mechanical strength. Also even thicker materials still provide a good transparency and may also be printed from the back side. Popular materials are polycarbonate, plexi glass (PMMA) or acrylic glass. As mentioned before, direct lamination of the touch screen to those cover materials is absolutely necessary for a stable touch performance.

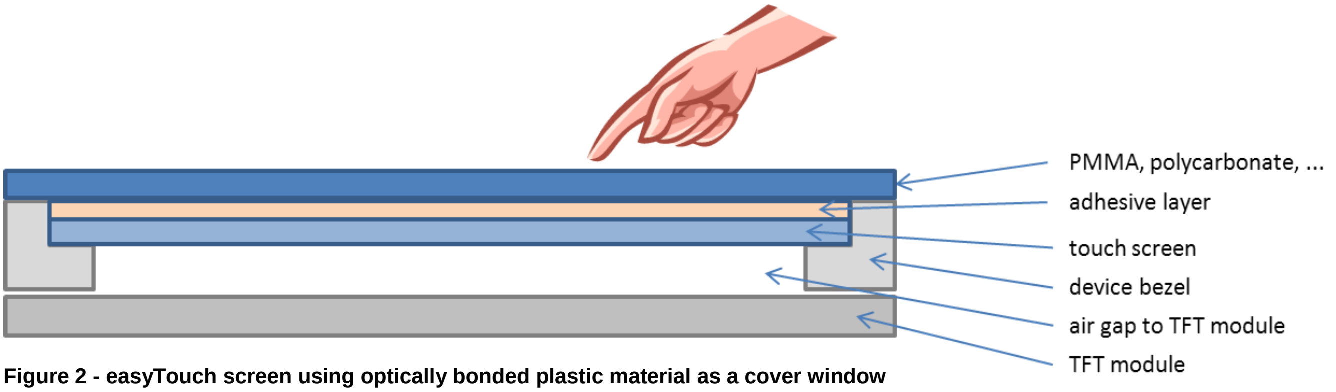

Figure 2 - easyTouch screen using optically bonded plastic material as a cover window

The adhesive layer eliminates the air gap and connects the protection or cover material directly to the touch sensor. The choice of the lamination technology and material for the adhesive layer plays an extremely important role when it comes to long term durability.

The most reliable technology and process is optical bonding using liquid OCA and UV curing. This technology offers the best optical performance and a high production yield rate especially when using large size screens. Temperature and humidity tests as well as accelerated aging tests have shown that other lamination technologies, like film based OCA lamination, are critical in terms of air bubbles and inclusions especially under rough environmental conditions like humidity and heat. Even if directly after the lamination no air bubbles are visible, tests have shown that after several months air bubbles may appear in the adhesive layer between touch screen and cover material.

From the beginning of 2013 DATA MODUL offers fully automated liquid OCA optical bonding of touch screens to cover materials as PMMA, polycarbonate or normal and strengthened float glass. As a special service our optical bonding team and glass experts will provide full support to find the optimal cover protection material for every application to provide optimal touch performance and best protection for the product.

3.3 easyTouch panel behind a glass protection window

In general, glass should be the first choice when it comes to selecting the material of the cover lens for an easyTouch based product. One of the major advantages of glass is its fairly high relative dielectric constant or relative permittivity. This physical constant characterizes the ability of a substance to store electrical energy in an electric field. The higher this constant is the better the easyTouch works through a thicker layer of this material. Compared to other materials the relative permittivity of glass is about as twice as high as of polycarbonate. Please see the Table 1 as a reference for some relative permittivity values.

Material	Relative permittivity ε_r
Glass	~6
Polycarbonate	~3.0
PMMA	2.8 – 3.7
CORNING® Gorilla® Glass	7.18 – 7.52[1]
SCHOTT Xensation™ Glass	7.3 – 7.7[2]
Air	1.006

Table 1 – relative permittivity values

Some special glass materials like the *Schott Xensation™* or *CORNING® Gorilla®* glass offer an even higher relative permittivity than standard common float or chemically strengthened glass and therefore are better materials to be used as a cover or protection layer in easyTouch applications. Furthermore those glasses have excellent properties when it comes to scratch resistance, impact and bending strength.

The data in Table 1 helps also understanding why air gaps between the cover material and the touch screen result in extremely degraded touch performance. This is because air, having a relative permittivity of 1.006, is a very poor material when it comes to storing electrical energy in an electrical field. Thus also when using glass as a cover material it is strongly recommended to directly optically bond the cover glass to the touch screen using liquid UV-curing OCA for best optical and touch performance.

However, as shown in Figure 2 an air gap is used between the touch screen and the TFT module. It is used to reduce the influence of noise emitted by the TFT module entering the touch screen and maybe triggering false touch events. In this special case this air gap acts as some kind of insulator for any kind of radiated emissions coming from the TFT module or other electronic devices that are mounted behind the easyTouch screen. A thickness of 0.8mm to 1.1mm of an air gap may be considered as a good compromise between parallax distortion and noise reduction and it is strongly recommended.

[1] CORNING Gorilla Glass Product Information Sheet - http://www.corninggorillaglass.com/characteristics

[2] SCHOTT Xensation™ Product Specification - http://www.schott.com/xensation/english/index.html

3.4 Thickness of the cover material

As different materials have different relative permittivity values the maximum possible thickness of the cover lens depends also on the used material. As a standard for industrial use 3mm of strengthened glass has shown to be a good compromise between hardness, scratch resistance, protection and good multi touch performance. For any type of polycarbonate or PMMA the thickness has to be reduced since the relative permittivity of those materials is about half of glass. A thickness of 1.1 to 1.6mm provides about the same touch performance as 3mm of glass would do. Especially for polymer materials the relative permittivity depends very much on the exact composition of the polymer, therefore very often the maximum thickness of a non-glass material has to be defined by a series of tests.

Of course thicker cover materials are possible but always with degradation in touch performance. For example 6mm thick glass may still provide solid single touch performance but only when the device is used in an electrically quiet environment, when the touch controller is properly configured for the used screen size and some signal processing algorithms are used to reduce the background noise to a minimum. Adding thickness to the cover material always reduces the signal to noise ratio of the data the touch controller uses to detect a touch event. Having a thick cover lens and using the device in an electrically noisy area may result in false touches being triggered because the influence of the finger touching the coverless on the electrical field is so small that the touch controller may not be able to differentiate between background noise and the actual touch.

So choosing the thickness of the cover lens should always be a compromise of choosing the material as thick as necessary but, at the same time, as thin as possible.

3.5 Touch sensitivity and signal to noise ratio

The touch sensitivity and the signal to noise ratio (SNR) depend on a number of different factors. As discussed in the previous chapters of this document the thickness of the cover lens, the material of the cover lens and the configuration of the touch controller have a major influence on the overall system touch performance. But also some additional and not so commonly known electrical factors have a large influence on the overall system touch sensitivity. One of those factors is the *current return path* of the system. For a high SNR a good current return path is very important and necessary. For better understanding of why a good current return path is needed it is necessary to understand the basic working principle of the easyTouch and therefore the mutual capacitive sensing method.

The easyTouch controller measures the change in capacitance in an indirect way by measuring the current coming out of charged mutual capacitor between the X- and Y-electrodes in the touch screen sensor. The current is integrated over time and therefore the charge in the mutual capacitor is calculated as $Q = \int i dt$. This measured charge is proportional to the mutual capacitance between the X- and Y-electrodes.

A touching finger on the screen has an influence on the mutual capacitance and draws a current away from the screen, discharging the capacitor via the touching finger, hand, arm, body and so on. This current (or charge) has to be returned to the touch controller because of Kirchhoff's Current Law[3].

Now it needs to be understood that there are two general types of devices which are different in the way this current loop is closed. The first class of devices is called *floating* devices -

[3] The sum of all currents flowing into a node or junction is equal to the sum of currents that are flowing out.

meaning that those devices do not have a fixed earth potential reference because they are powered by batteries. Devices like cell phones, tablet PCs and PDAs belong to this class of devices.[4] The second class of devices is called *tethered* devices – meaning that those devices have a more or less fixed earth potential reference via their main power supply.

To understand how to provide a good current return path it is necessary to have a look at an idealized “free space” model of a floating device.[5]

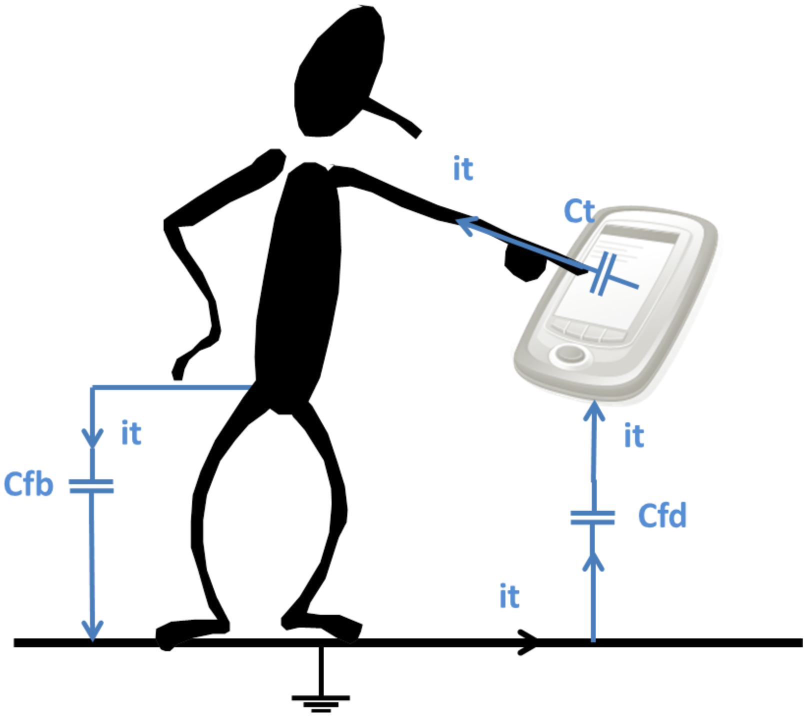

Figure 3 - idealized free space model

Ct	touch capacitance
Cfb	free space body capacitance
Cfd	free space device capacitance
it	touch current

Having a look at Figure 3 it becomes quite clear that this system is described as typically AC-coupled and therefore a good capacitive coupling of all involved device or persons is absolutely necessary for a low resistance and low noise current loop. However Figure 3 does not show the reality as it is a simplified model to describe the general situation. Furthermore Figure 3 does not show a typical application of the two device classes because it shows a free floating device which is only touched by one finger of one hand. Floating devices like cell phones are normally held by one hand and operated by a finger of the other hand.

Tethered devices are physically connected to the mains power supply which provides a fixed earth reference potential via this physical power connection. Since most of the industrial

[4] This is only the case when those devices are not connected to any type of battery charger or external power supply or being connected to a computer via USB or any other type of physical data connection that provides an external earth reference.

[5] Model is based on the contents of ATMEL document QTAN0061

applications are tethered devices only this devices will be explained in more detail in this document.

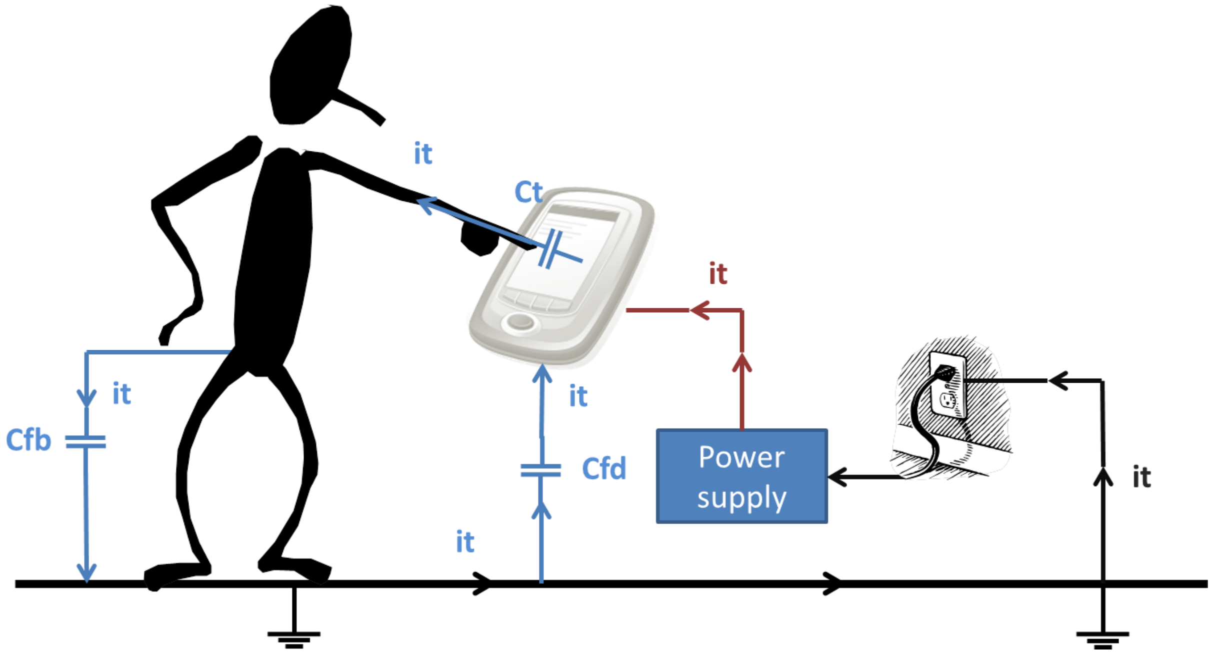

Figure 4 - idealized model of a tethered device

Tethered devices as shown in Figure 4 provide an additional current path back to the touch controller via the power supply which normally is a very good and low resistance kind of path and therefore is important to get a good touch signal. Since the current path via the power supply normally is very good it should also be taken care of not adding any kind of noise to this connection, which normally is done by noisy switching power supplies.

In comparison to Figure 3, Figure 4 clearly shows that the situation on a tethered device is far more complex. The situation shown in Figure 4 does not even show all the possible current paths to the touch controller and even is raising more questions like:

- How is the earth potential handled inside of the power supply?
- Is the low voltage connection (red path) after the power supply to the device isolated from earth?
- How is the low voltage handled inside of the device? Are there any more switching power supplies inside of the device?
- Has the device a metal housing that maybe is directly (or via capacitors) connected to the earth potential?
- Are there additional current paths maybe via other data connections like USB, Ethernet, RS232 or RS485?

Since all of the easyTouch controllers are based on ATMEL maXTouch E-series and S-series technology devices they take advantage of the maXTouchs enhanced noise filtering algorithms and robust analog frontends and therefore are able to handle a broad variety of different grounding situations. As a maXTouch Module Partner Data Modul provides full support to the customer that includes device analysis and full maXTouch parameter tuning to provide the best touch experience.

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3.6 Grounding of the touch controller board

A low noise and low impedance connection of the touch controller card to the GND potential in a device is very important to reduce noise coming into the touch controller IC. Based on Data Modul's experience it is known that the GND connection made by an USB cable is not low noise and also not low impedance. All Data Modul easyTouch USB controller cards are equipped with 4 fastening holes that provide direct access to the controller boards GND plane. Those fastening holes should be used to provide a low impedance and low noise connection to the systems GND reference.

4 Summary

Projected capacitive touch systems are far more complex than resistive touch systems. Therefore a simple “design-out resistive – design-in capacitive” approach will not lead to a successful product offering good multi-touch performance. Too many factors of those two touch technologies are different and are not comparable.

So thinking ahead and planning the product starting from the beginning of the design phase as a projected capacitive touch system and taking at least all the above mentioned facts into account is the first step to create a good performing multi-touch product.

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