

# In-Cell触摸屏原理

2010.3.15

# Introduction of touch panel

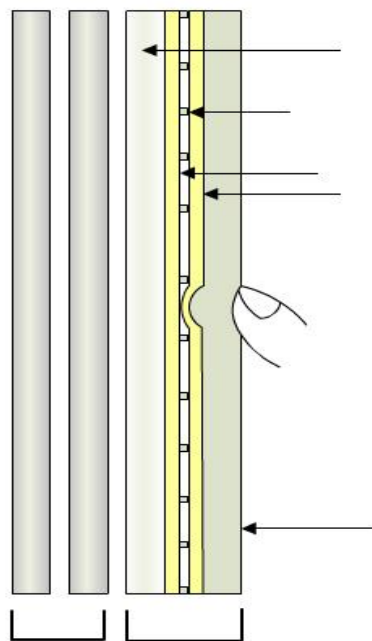
- 1. Resistive touch panel
  - 1.1 traditional resistive touch panel (directly glue on LCD module)
    - a. 4/5/6/8-wire resistive touch panel
    - b. digital resistive touch panel (touch switches, matrix)
  - 1.2 integrate resistive touch panel into LCD cell (between top and bottom glasses)
- 2. Capacitive touch panel
  - 2.1 capacitance changed by deformation of top glass
  - 2.2 capacitance changed by induced current from finger
    - 2.2.1 surface capacitive touch panel**
    - 2.2.2 projective capacitive touch panel**
      - 2.2.2.1 detect self capacitance**
      - 2.2.2.2 detect mutual capacitance**
- 3. Other touch panel (Infrared, SAW, Electromagnetic, Optical...)

## Resistive touch panel

基本原理：

触摸时，两层ITO互相接触，从而在两层ITO之间形成电阻通路

根据上下基板材料，可分为film on glass, glass on glass, film on film等结构。



## 1.1 4-wire resistive touch panel

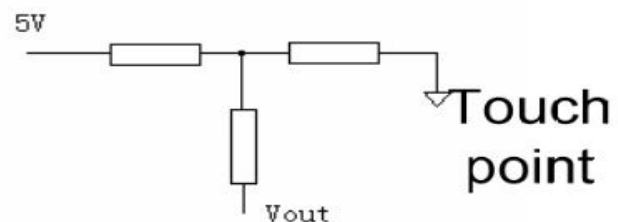
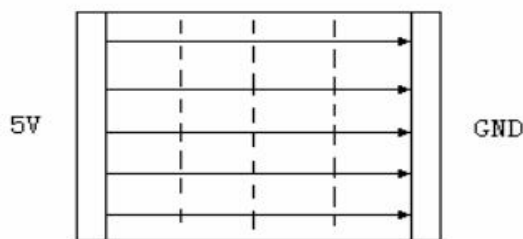
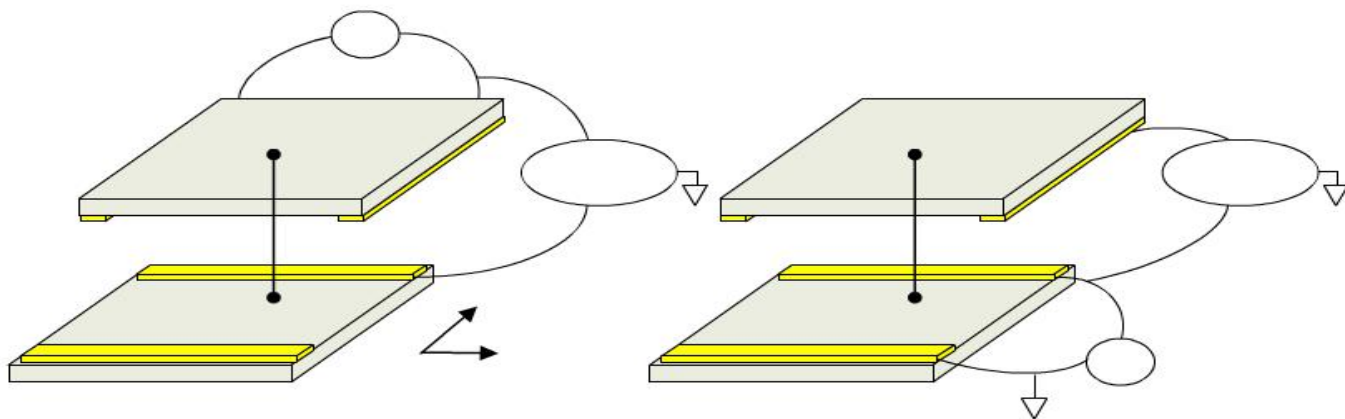
在两电极上加5V  
直流电

在ITO均匀电阻  
平面上形成均匀  
稳恒电流场

在另一面的ITO  
电极上测量电压

根据测得电压值  
(0-5V) 确定触  
摸点的位置

用同样方法测量  
Y坐标



## **1.1 4-wire resistive touch panel**

Low life time (around 1 million times)

Low transmissivity (75%-85%)

Not resist scratch

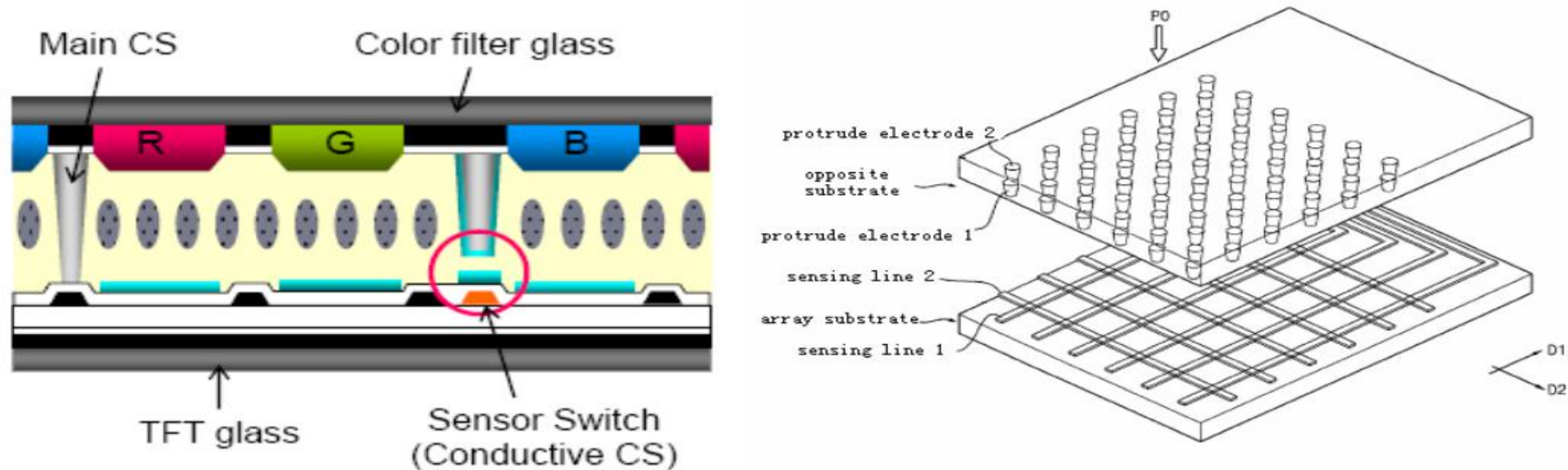
Lowest cost

Easy detect circuit

Works with any stylus

## 1.2 Incell resistive touch panel—samsung(1)

- Basic principle:  
When pressed, the sensor switch is on (conductive column spacer contact sensor electrode)  
From plan view, at touch point, common electrode contact two sensing lines perpendicular with each other respectively



- **2. Capacitive touch panel**

- 2.1 capacitance changed by deformation of top glass

- 2.2 capacitance changed by induced current from finger

- 2.2.1 surface capacitive touch panel**

- 2.2.2 projective capacitive touch panel**

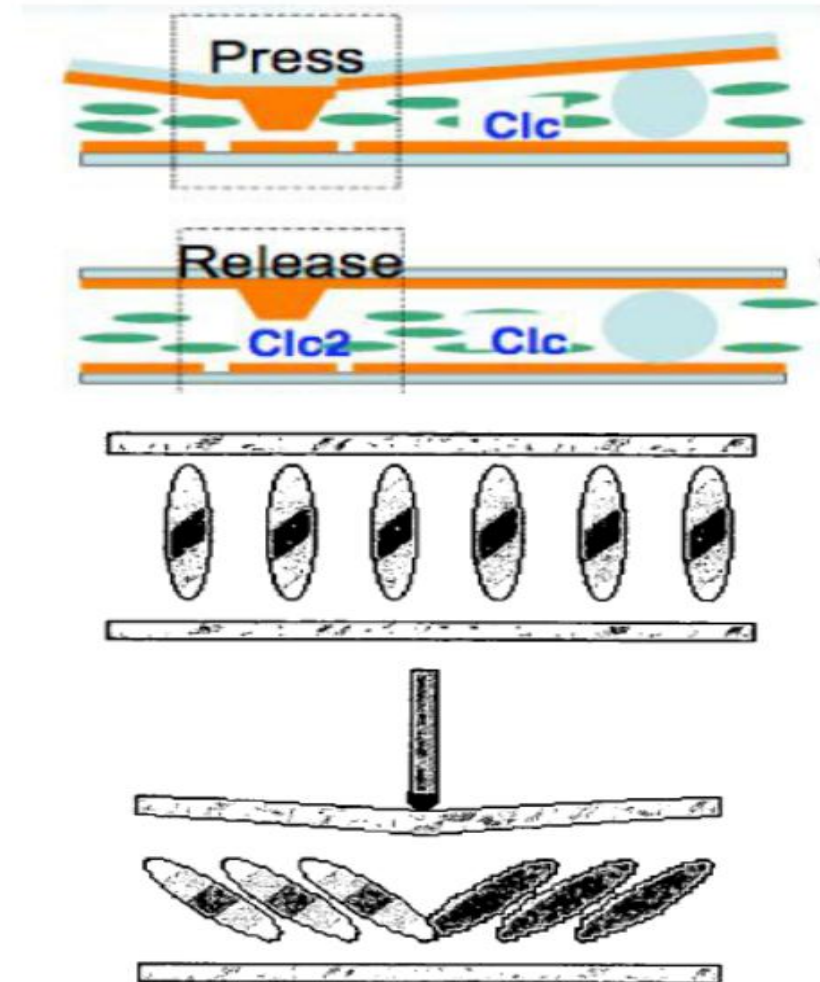
- 2.2.2.1 detect self capacitance**

- 2.2.2.2 detect mutual capacitance**



## 2.1 Capacitive touch panel (压力式)

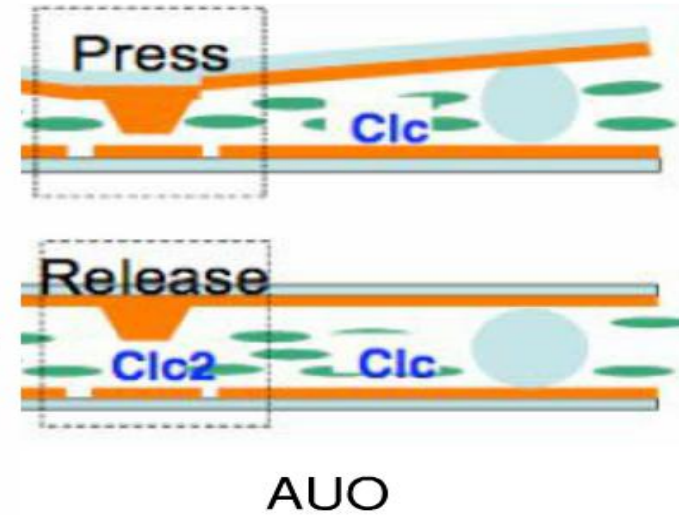
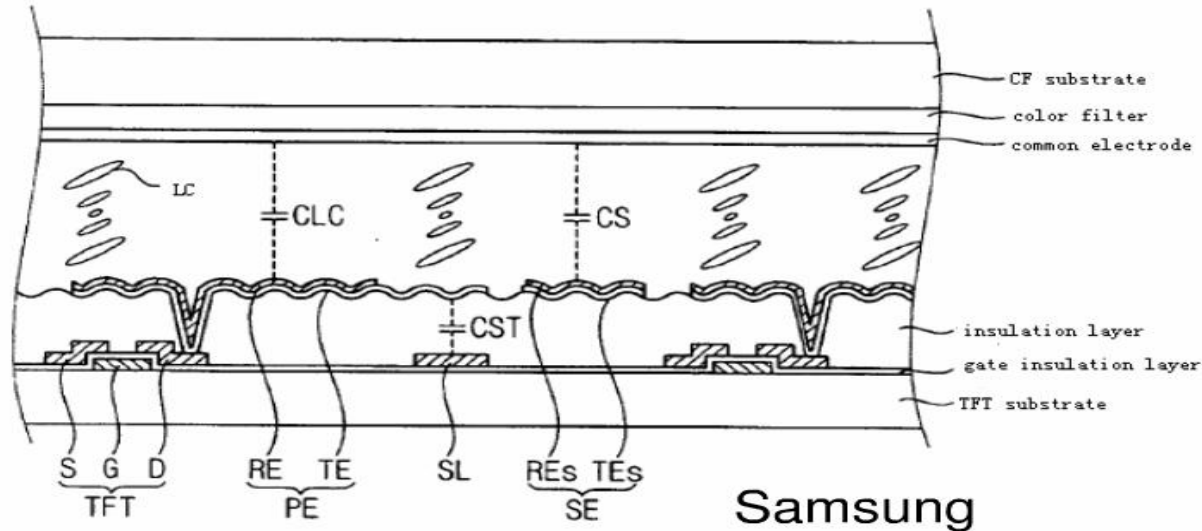
- This integrate type has some different structures, includes:
  - Cell gap change type  
Samsung filed a patent (US20080048994). AUO has made a demo.
  - LC alignment change type  
Samsung filed patent (US20050094038) very early, but Samsung's demo applied another detect circuit (SID07 24.3), and Epson made a demo (SID08 55.2) based on Samsung's structure by using LTPS, IPS and active matrix sensor so that improved the performance.





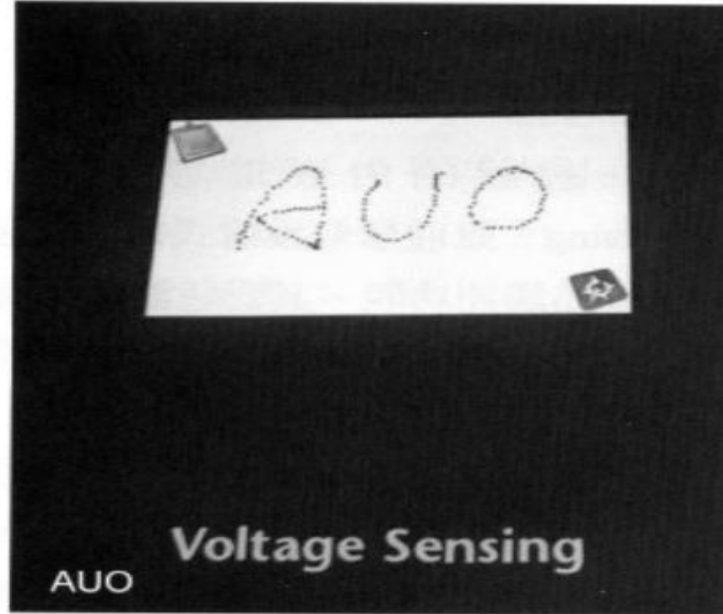
## Cell gap change type(1)

- Samsung's patent (US20080048994) only posed a basic principle, its layer structure and detailed detect method is not shown in the patent.
- Though AUO has made a demo, there are very few open materials of its detect principle.
- They use the same principle: detect the capacitance change between common electrode and sense electrode by cell gap deformation.
- There are many ways to detect capacitance change, which way Samsung and AUO used is unknown.



## Cell gap change type(2)

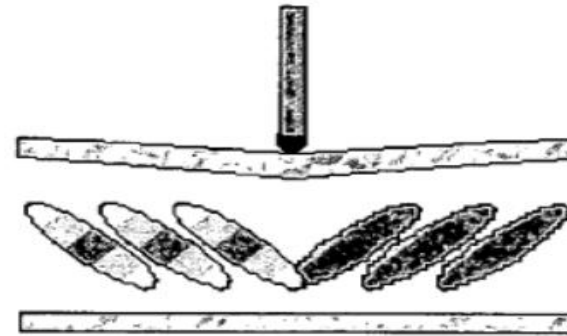
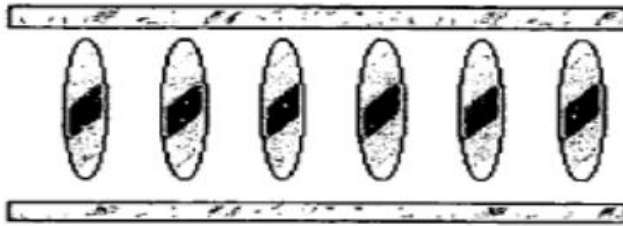
- AUO和LG的压力式内嵌触摸屏样品



## LC alignment change type—Samsung(1)

- Samsung's patent (US20050094038) first proposed this method:

Because different LC alignment has different dielectric constant, and when pressed, the LC alignment is changed, so that the LC capacitance changed.



## LC alignment change type—Samsung(2)

- Samsung和Epson的in-cell LC alignment change type TP



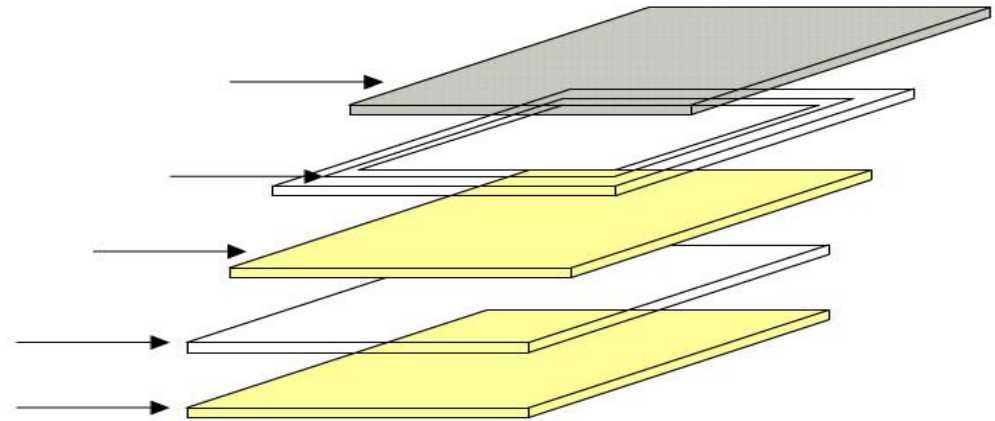
Samsung



Epson

## 2.2.1 Surface capacitive touch panel

- Have 2 conductive coatings. Upper conductive coating is the working plane.
- Lower coating is shielding plane.



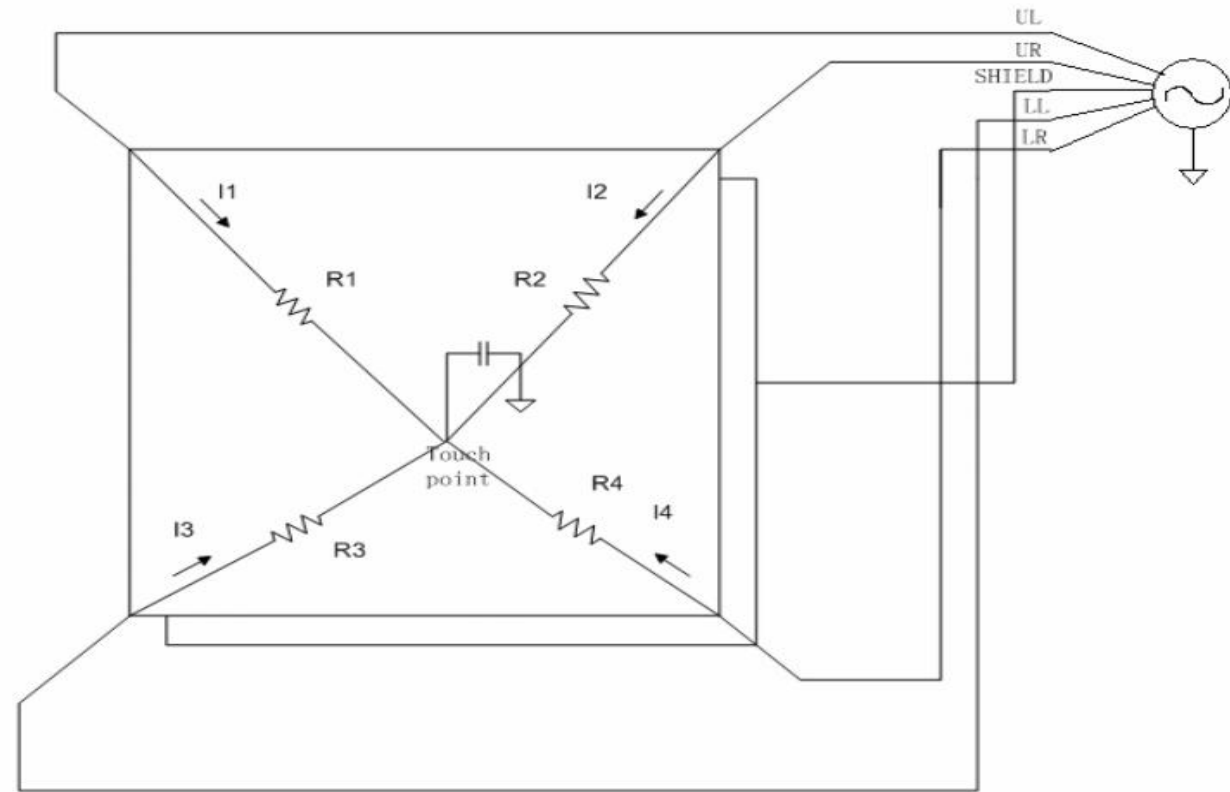


# Surface capacitive touch panel

**Surface capacitive touch panel principle:**

**Touch point is treated as connecting to ground by a capacitor. The resistor from touch point to 4 corners R1-4 is related to the distance from touch point to 4 corners. The more the distance is, the more the resistor is.**

**When add sine signal on 4 corners, the current at 4 corners I1-4 is inverse proportion to related R1-4. By measuring I1-4, the touch point can be detected.**





## Surface capacitive touch panel

Long life time (around 100 million times)

Higher transmissivity (Can reach 90%)

Only work with fingers

Higher cost

Patent issue

Complex detect circuit

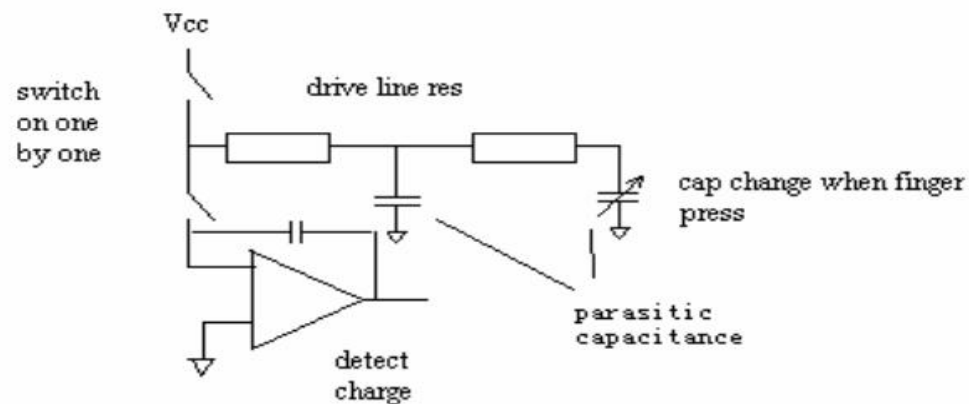
Fast response speed

## 2.2.2 投射电容触摸屏(PCT)

- 投射电容触摸屏（projective capacitive touch panel）可分为两种不同的结构：自电容(self capacitive)与互电容(mutual capacitive)
- 自电容为较早的技术，来源于touch key, touchpad
- 互电容技术由iphone发扬光大，发展迅猛，将逐渐取代自电容类型

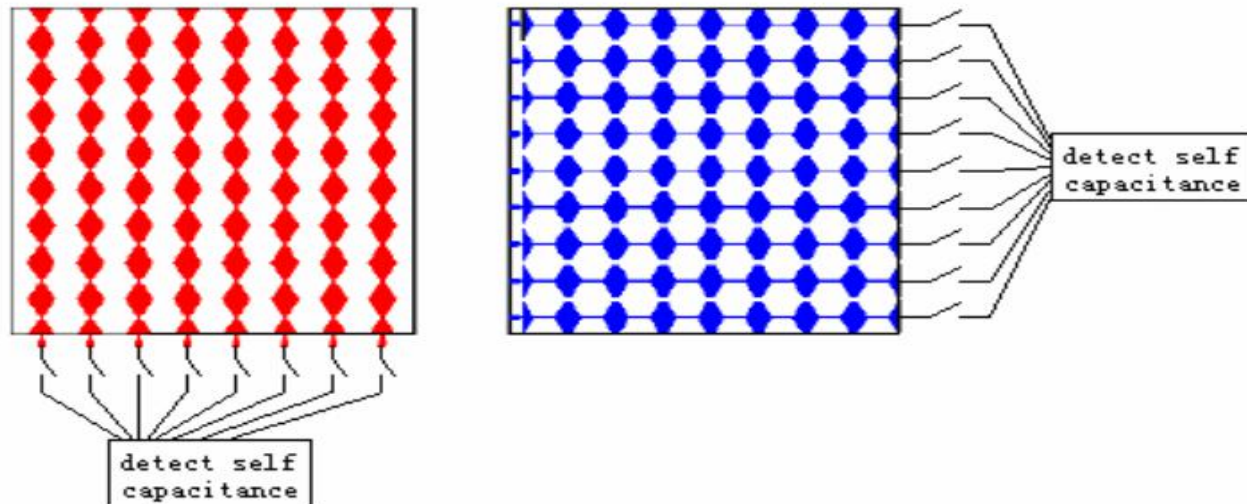
# Self capacitance

- 自电容原理为当手接触时，等效为parasitic capacitance增加，而且自电容检测都是在前端（提供电源端）。检测原理有很多，可检测电压、电流、电荷，下图为charge transfer检测原理。
- 通过开关依次开合不断对parasitic capacitance进行充电放电，检测放电时通过的电荷，当有手指接触时，流出电荷增加。



## Detect self capacitance

- Panel layout: generally using 'diamond' pattern, so the capacitor from finger to both ITO layers will be big enough. The detect sequence is, first detect self capacitance at one layer (red), one line by one line, to get X position, then detect another layer (blue), to get Y position. So this is fake multi-touch.

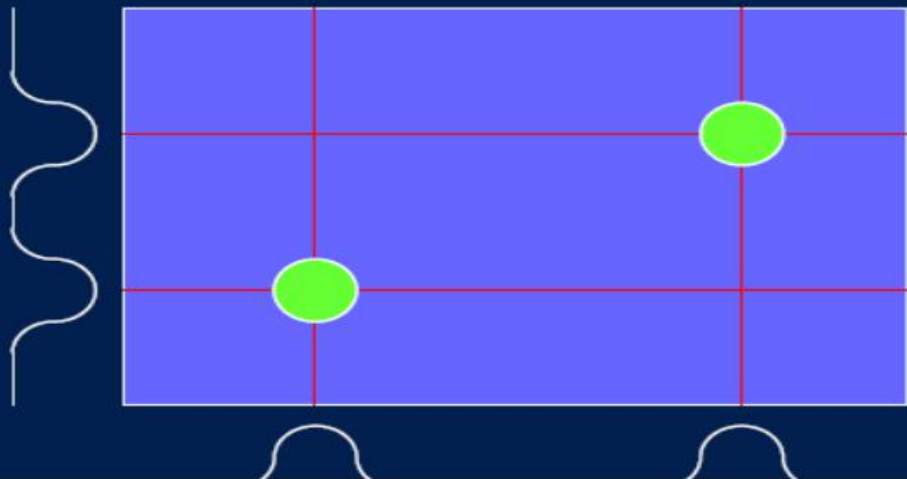




## Projective capacitive touch panel

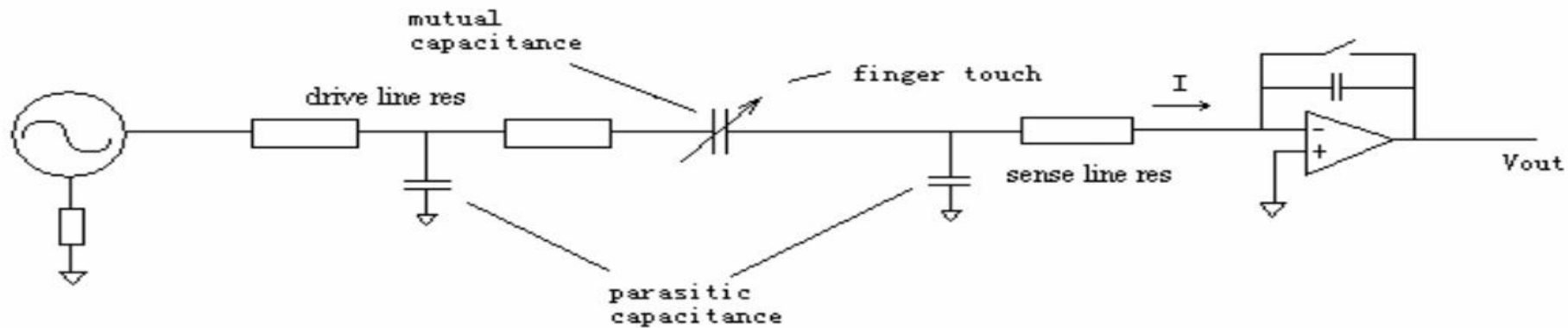
自电容的多点触摸定位问题:

- 2 个触摸 = 4 个交叉点
- 轴坐标式XY矩阵可以检测出两个（或以上）触摸的存在
- 只能确定单点触摸的位置
- 当有第二个触摸存在时就增加了两个“鬼点”
  - 不能确定真正的触摸点是哪一组



# Mutual capacitance

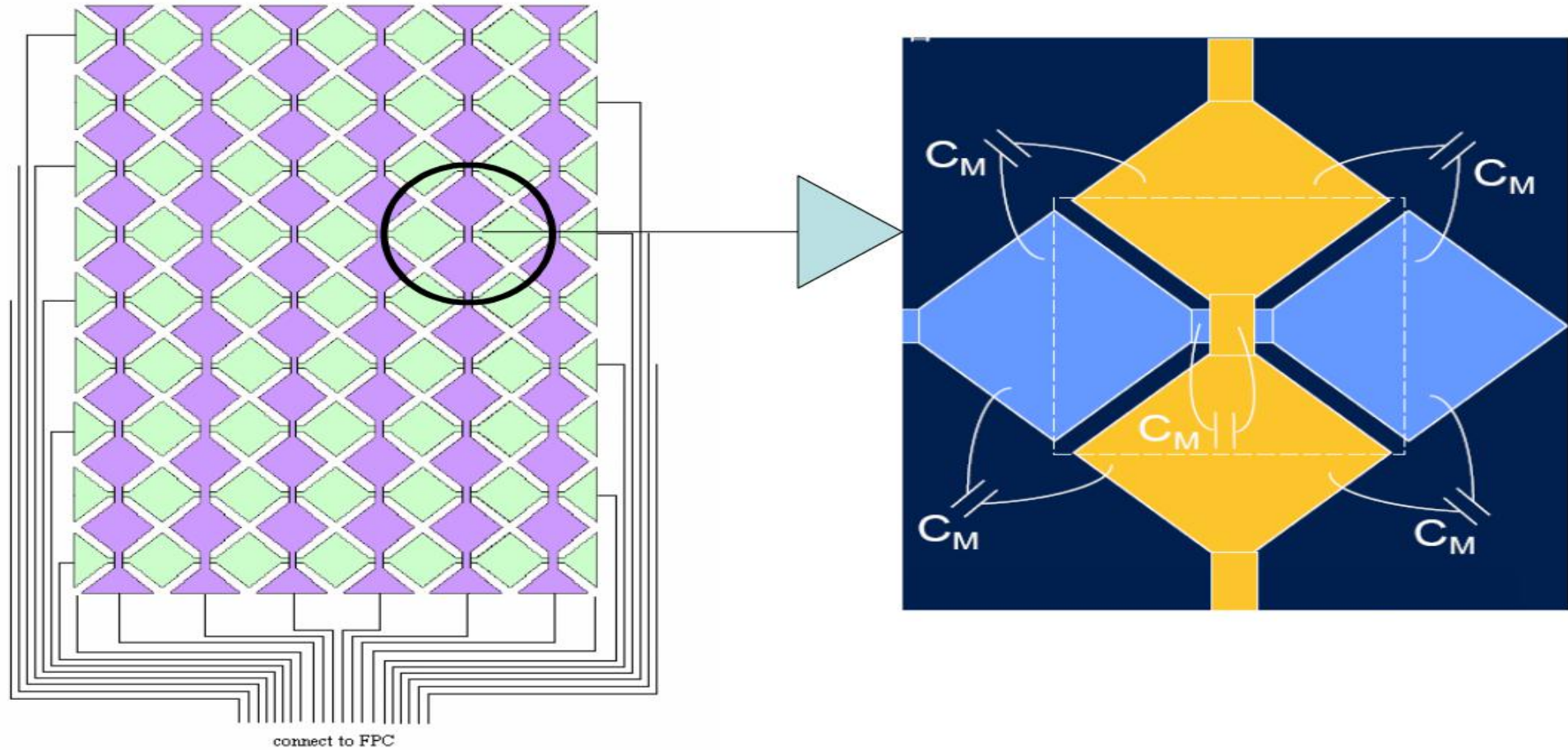
- 互电容原理为：当手指接触时，等效为互电容改变，互电容检测一般是在后端（sense端）。
- 可以检测电压或者电荷。下图为电荷检测等效电路。手指接触后等效为互电容减小，此时读出电荷减小。



模型一



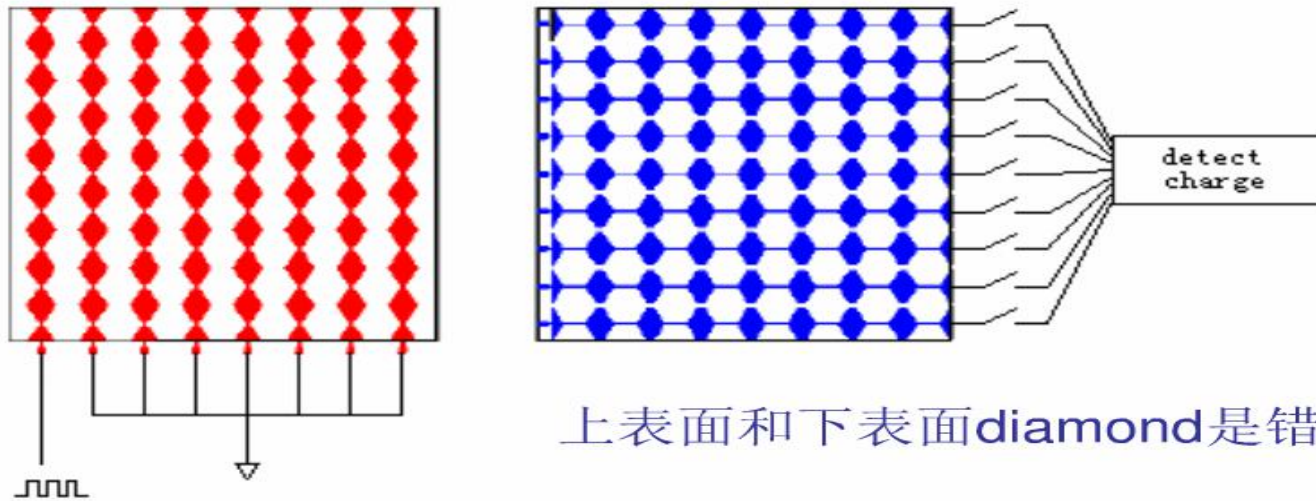
# Mutual capacitance



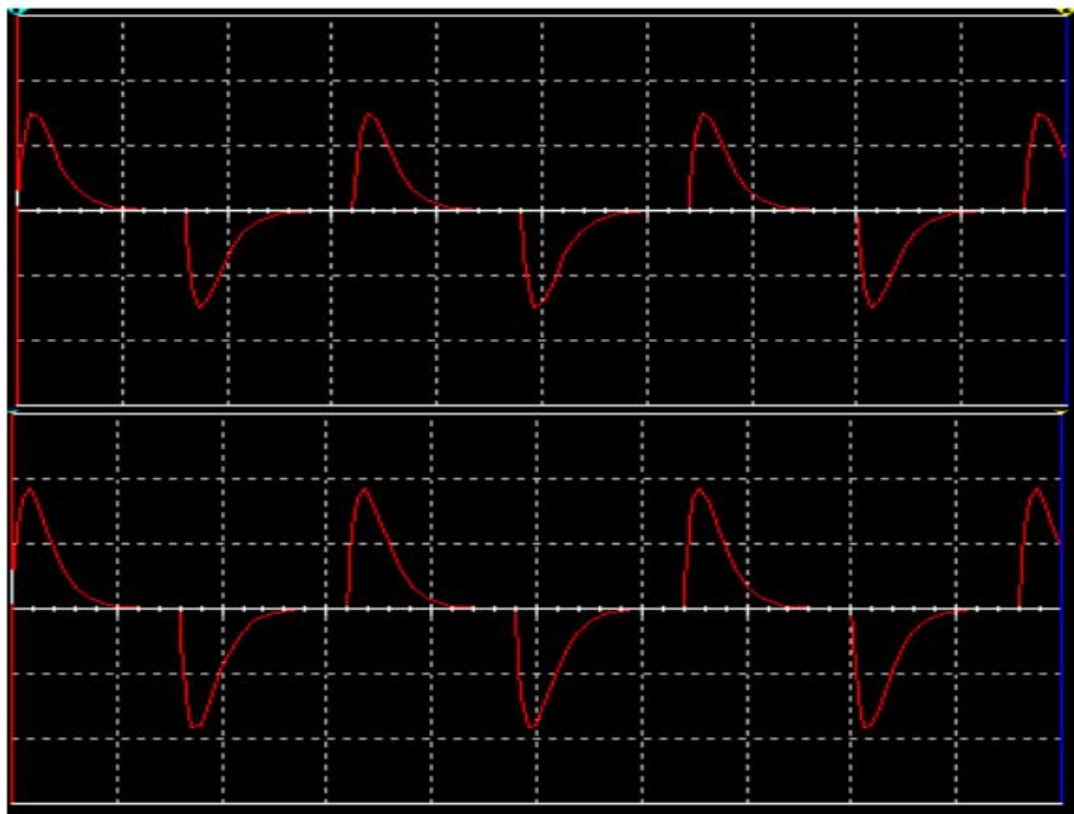
Panel 图案

# Mutual capacitance

- Driving method: At drive layer (red), add pulse signal one line by one line, and other lines connect to ground. At sense layer (blue), detect charge one by one. When all intersection is detected, the most charge decreased intersection is the touch point.
- This method is true multi-touch. So apple claimed that iphone is the first 'image sensing' touch panel in the world.



# 模型仿真结果



**No touch**

**Touch**

## 互电容的优点

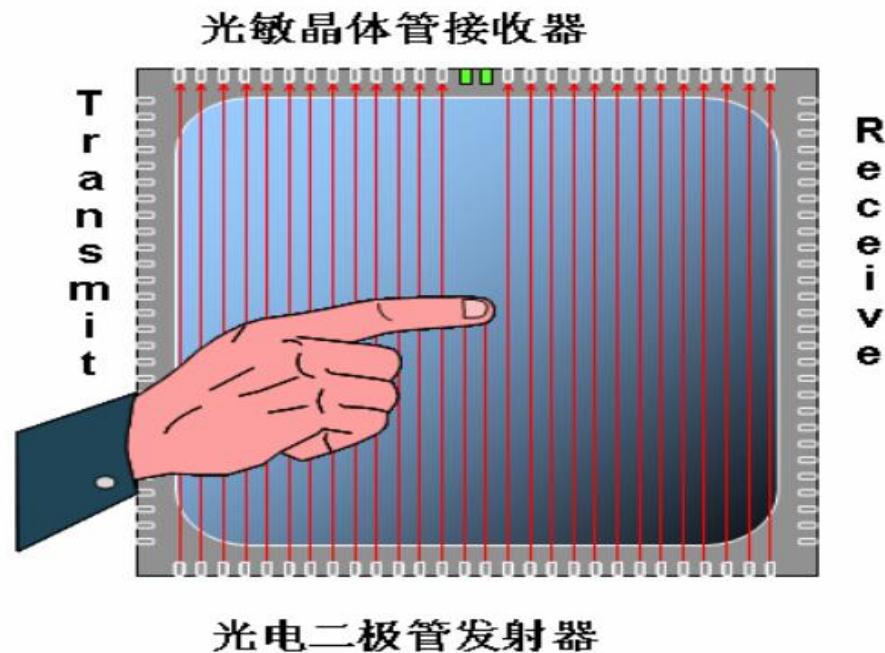
- 互电容相对自电容的显著优点：
  1. 对地寄生电容对触控检测影响很小，更适合在集成触摸屏结构
  2. 具有更强的抵抗LCD噪声能力
  3. 可以实现真正的多点触摸（不会有鬼点）
- 但互电容是一个更加新的技术，目前几乎所有触控IC厂商采用的感应技术都不一样，各自研发自己的触控技术。



## Other touch technology

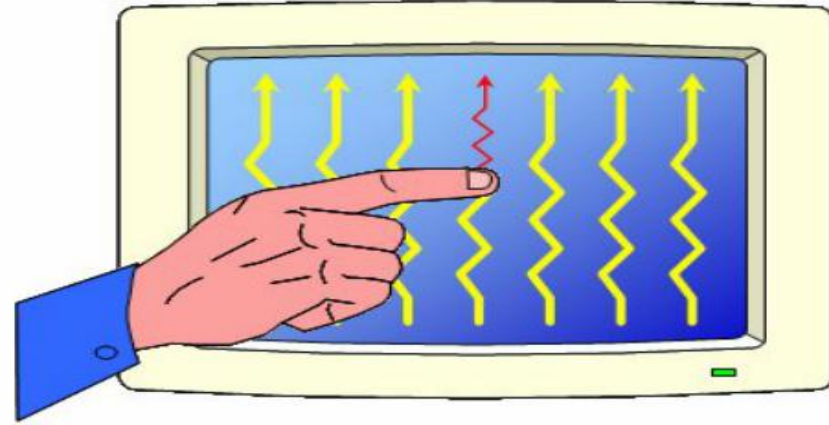
- 红外：透光度好，价格低，适应恶劣环境
- 缺点：分辨率较低，易损坏

在屏幕四边排布红外发射管和红外接收管，一一对应形成横竖交叉的红外线矩阵。用户在触摸屏幕时，手指就会挡住经过该位置的横竖两条红外线，因而可以判断出触摸点在屏幕的位置。



## Other touch technology

- 声表面波：透光好，寿命长
- 缺点：易被油污，灰尘等影响，需经常维护



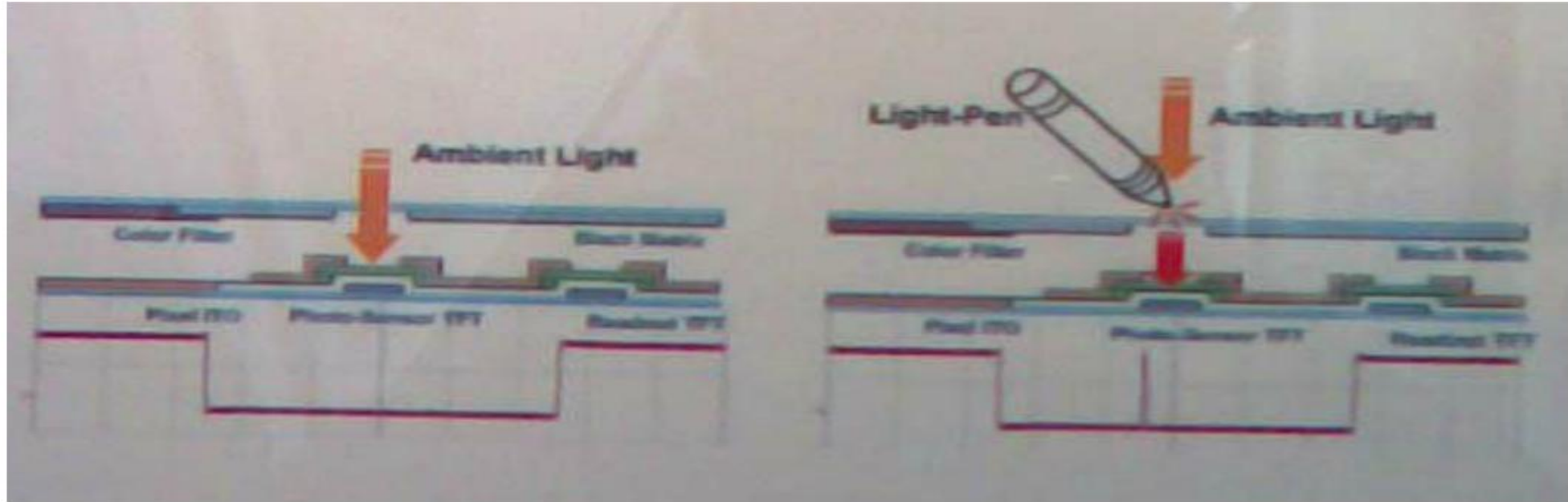
当手指或其它能够吸收或阻挡声波能量的物体触摸屏幕时，X轴途经手指部位向上走的声波能量被部分吸收，反应在接收波形上即某时刻位置上波形有一个衰减缺口。接收波形对应手指挡住部位信号衰减了一个缺口，计算缺口位置即得触摸坐标





## Optical type in-cell TP

- 光学in-cell触摸屏是在LCD TFT array基板上集成进一些光敏器件。有两种工作方式，一种如下图：靠激光笔的光被光敏器件感应以确定位置。另一种是用手指遮挡环境光从而使光敏器件感应。



## Optical type in-cell TP

- TMD, AUO, LGD, Sharp均有光学内嵌触摸屏样品面世。

