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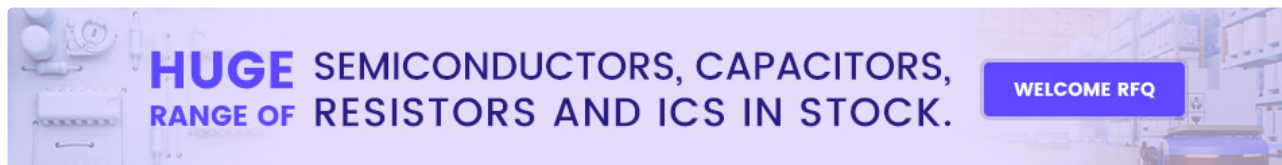
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Introduction to DDIC (Display Driver IC)

17 February 2022

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Driver IC is an integrated circuit chip that controls the switching and display method of LCD panels and AMOLED panels. With the increase of panel display resolution and data transmission speed, the requirements for driver ICs are also increasing.



What is DISPLAY DRIVER?

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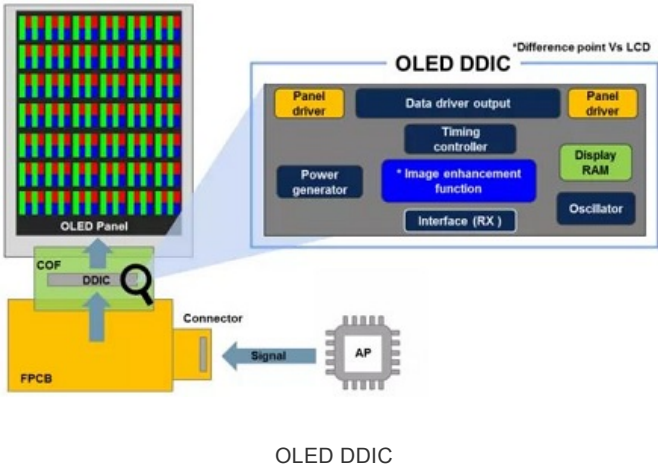
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I What is DDIC?
II Passive Matrix and Active Matrix
III DDIC package form

Display Driver IC (DDIC) is one of the main control components of the panel, also known as the "brain" of the panel. Its main function is to send drive signals and data to the **display panel** in the form of electrical signals, through the control of screen brightness and color, so that letters, pictures, and other image information can be presented on the screen.

I What is DDIC?

The main function of the **Display Driver Integrated Circuit (DDIC)** is to control the **OLED display panel**. It needs to work with **OLED displays** to be thin, flexible, and foldable, and to provide a wide color gamut and high-fidelity display signals. At the same time, OLED requires lower power consumption than LCD to achieve higher battery life.



DDIC drives the **display panel** through electrical signals and transmits video data. The location of **DDIC** is differentiated according to **PMOLED** or **AMOLED** (the distinction between PM and AM is detailed below):

In the case of **PMOLED**, **DDIC** inputs current to both the horizontal and vertical ports of the panel, and the pixel dots will light up under current excitation, and the brightness can be controlled by controlling the current level.

As for **AMOLED**, each pixel corresponds to a TFT layer (Thin Film Transistor) and a data storage capacitor, which controls the gray level of each pixel. This approach achieves low power consumption and extended lifetime, and the **DDIC** controls each pixel through the TFT. Each pixel is composed of multiple sub-pixels to represent the three primary RGB colors (R red, G green, B blue).



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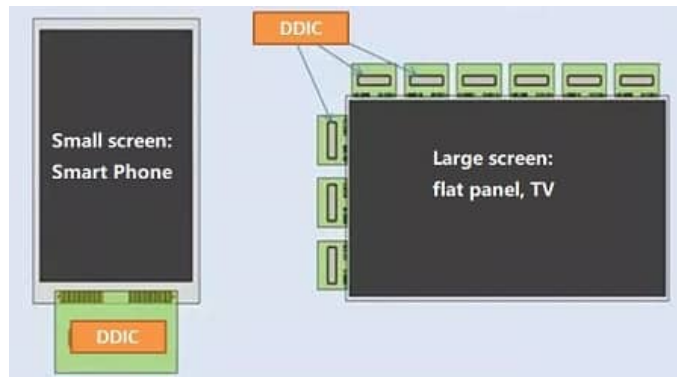
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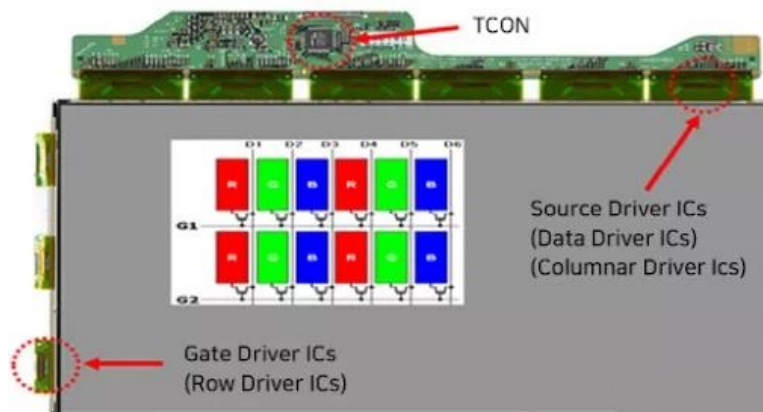


The value of the voltage of the pixels on the TFT (or the time duty cycle of the On state) is transmitted one by one according to a certain time rhythm in a scanning manner.

Some of the ICs responsible for scanning are DDICs, some are responsible for horizontal and some are responsible for vertical. The one responsible for horizontal work is called **Gate IC** (also called Row IC), and the one responsible for vertical work is called Source IC (also called Column IC).



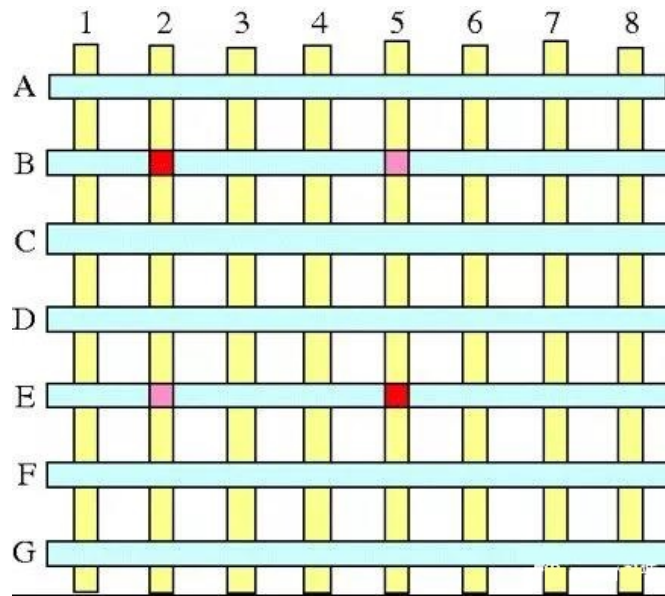
DDIC location



In addition, DDICs need to have a chip responsible for assigning tasks to them, called Timing Controller, or T-CON for short, which is generally the most complex chip in the display and can be considered as the "CPU" of the display. It is mainly responsible for analyzing the signal from the host computer, disassembling it, converting it into a signal that the Source/Gate IC can understand, and then assigning it to the Source/Gate for execution. T-CON has this function because it has the ability to control the tempo of time that the Source/Gate does not have, so it is called Timing Controller. The increasing resolution, refresh rate, and color depth are challenging the processing capability of T-CON and the information transmission capability of various interfaces before and after.

II Passive Matrix and Active Matrix

The DDI drives the display by scanning. As you can see from the above diagram, adding voltage to the corresponding rows and columns will light up the corresponding pixels. But here comes the problem, if we want to light up 2B and 5E at the same time, by adding voltage to 2 columns and 5 columns as well as row B and row E at the same time, we will find that even 5B and 2E are innocently lit up. To prevent this from happening, we must give a distinction in time between the sequential order of the lines.



display structure

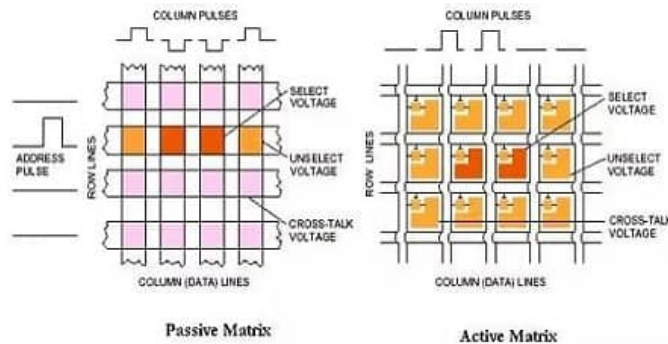
The current choice is to process one X-axis line at a time. We apply voltage to one horizontal line at a time, then scan all the values on the Y-axis, and then quickly process the next line. If we switch fast enough, it is possible to show a complete picture because of the visual residual phenomenon. This approach is called Passive Matrix.

Then the biggest disadvantage of this way is that, unless we switch each line at a super blockless speed, the time that each line can actually be divided into voltages is very short.

Once the voltage is moved to the next line, the pixels on the original line will all be darkened. The overall picture gives a very dark and not bright feeling.

Another problem is that if a pixel should not be lit, but because the pixel next to it should be lit, a voltage is added to the corresponding X-axis. This pixel is also affected by the pixel next to it and is lit up a little. The result is that the image is poorly defined and the edges of the image will be blurred.

How to solve these two problems?



Active matrix and passive matrix

A switch and a transistor **capacitor** are added to each pixel like the one on the right side of the picture above.

Once a voltage is added, this capacitor is able to conserve energy. The capacitor will release its own saved voltage to keep the pixel bright until the voltage returns to the pixel in this line again. This results in a significant increase in overall brightness. Second, the switching of each pixel acts as a threshold so that if one pixel is lit by the addition of voltage, it gives an effect to the neighboring pixels. Because of the threshold, this effect is not able to light up the neighboring pixels.

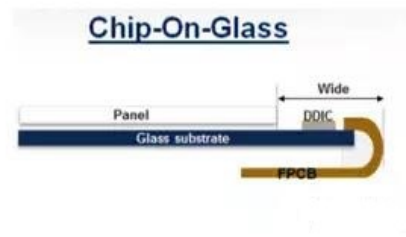
This approach is done as **Active Matrix** (AMOLED's AM is the abbreviation of **Active Matrix**). AM is very advantageous, but the cost of such is that the structure of TFT becomes more complex.

III DDIC package form

Since Samsung first introduced curved screens in 2013, flexible display technology has rapidly evolved. Broadly speaking, there are two types of displays, namely rigid displays and flexible displays. Rigid displays use rigid glass as the substrate, while flexible screens use a plastic (polyimide, or PI, organic polymer) as the substrate, with bendable, foldable, and curvable properties. Some high-end smartphones use this material when the edges of the screen are bent and the texture is enhanced.

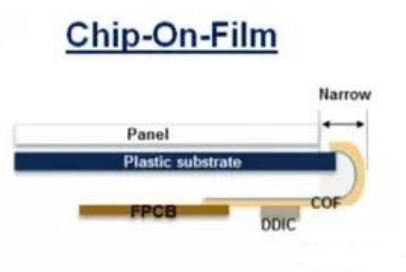
Objectively speaking, COG, COF, and COP are three different packaging technologies for screen display driver ICs, which are also called "screen packaging" under the general media conduction. The main application of the three is to realize the cell phone or TV system to its screen (LCD, OLED) drive control, and with other systems such as the motherboard FPCB, components, and other signal links.

COG (Chip On Glass) is the cell phone screen display driver IC directly bonded to the glass-based rigid glass substrate (Glass Substrate), and then linked by the FPCB to the rest of the phone PCB or components. This package is usually used for rigid displays, such as LCDs.



COG cross-section schematic

COF (Chip On Film) is the indirect bonding of [DDIC](#) to a flexible plastic substrate through Adhesive Thin Film to achieve a flexible display, such as OLED.



Schematic diagram of COF section

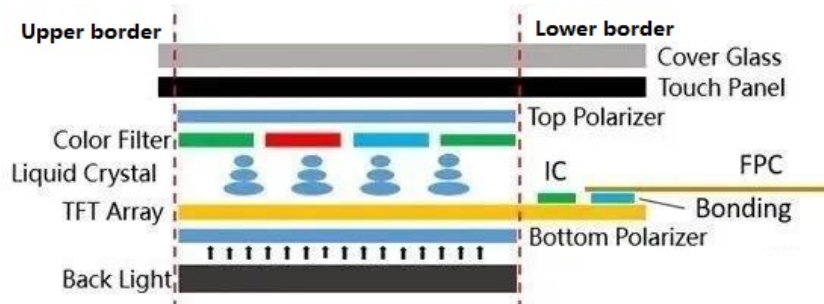
COP (Chip On Plastic) is to fix the [DDIC](#) directly on the flexible plastic substrate.



Schematic diagram of COP section

With the development of a flexible screen, the COF (chip on film) packaging technology of DDIC came into being in order to improve the screen to body ratio (screen to body ratio).

The structure diagram of the conventional LCD module is shown in the following figure.



Structure diagram of LCD display module

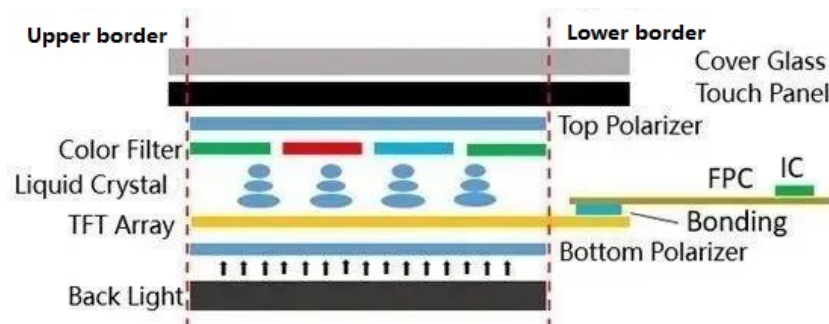
In the figure, the area between the red dotted lines is what we call the display area, that is, the area where the screen shines. The part outside the red dotted line is what we often call the upper border (forehead) and lower border (chin), as well as the left and right bezels (not shown in the figure).

Among them, the upper border and the left and right bezels are mainly reserved for the entire LCD module and the front of the phone to fit the part of the glue. This width is about 2-3mm. However, the lower border part in addition to the width reserved for dispensing, there is our **screen driver IC** and FPC line (FPC line through bonding and TFT Array connection).

The driver IC is mainly used to control the voltage of the LCD layer, thus controlling the brightness of each pixel of the screen, while the FPC is mainly to connect the LCD module to the phone's motherboard. This part determines how thick the phone's chin.

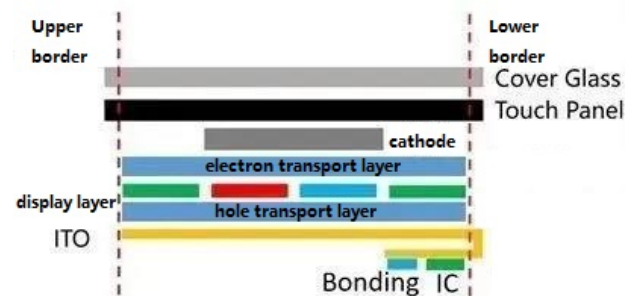
The packaging technology used in the LCD module shown above is what we call the COG package. TFT thin-film **crystal circuits** have a TFT substrate as the base material. In COG package, this substrate is usually glass material, which is not bendable. This is the reason why the chin of the LCM module in COG package is thick.

Then in COF package, the substrate of the TFT thin film crystal circuit is also glass. But unlike COG, the driver circuit is integrated into the FPC flexible board. Therefore, the lower border part only needs to set aside a bonding area for the FPC and TFT connection, which can reduce the thickness of the lower border by about 1.5mm, as shown in the figure below. At present, the major manufacturers of non-flagship [Android](#) machines are basically using COF package form.



Structure diagram of LCD display module in COF package form

The COP package can only be used for OLED screens. Because in the OLED screen, the substrate of ITO can be glass or bendable plastic. If the substrate is plastic, the part of the substrate connecting the FPC and driver IC can be bent, so that only the width of the dispensing area needs to be reserved. In this case, the lower border can be thinner, which is why the iPhone X's chin can be so narrow. The principle of COP package in OLED screen is shown in the figure below.



Principle of COP packaging implemented in OLED screens



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// . Frequently Asked Questions

1.What does display driver IC do?

A display driver is a type of semiconductor with an integrated circuit that acts as an interface between microprocessors and LCDs. The device controls display systems in PCs and cell phones. The display driver IC market is divided into two broad segments, namely the LED DDIC and touches controller IC (TCIC).

2.What is one of the main control components of the panel?

Display Driver IC

3.What is the source IC also called?

Column IC

4.What drives the display by scanning?

The DDIC

5.What type of material does flexible screens use as the substrate?

Plastic

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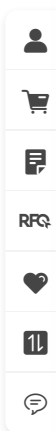


What are the Commonly Used Circuit Protection Components?

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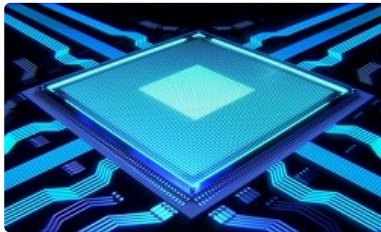


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The ISP (Image Signal Processor) is mainly responsible for the photographing part in the system-on-chip (SOC) of the mobile phone.

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What is an Integrated Circuit (ICs) and Why Integrated Circuit is shortage?

UTMEL 23 September 2021 3962

An Integrated Circuit(IC), or we can call it IC, chip, or microchip is a small semiconductor-based electronic device minuscule chip consisting of fabricated transistors, resistors, and capacitors, and other metallic connections required for a complete electrical circuit. In this article, we will discuss it in five aspects.

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