

# Development of Driver IC on TFT-based Liquid Crystal Display

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**Abstract** ? Driver IC is one of the key components on the LCD monitor and LCD/TV. The function of the driver IC is to transfer and forward the input signals to LCD panel module. Inside driver IC, there are several operating units which process the input signals and generate the appropriate size and resolution to the LCD panel module. LCD panel module will display these input signals. However, there are some difficulties which driver IC designer, LCD monitor and LCD/TV maker will face. Thus, this article addresses the function and difficulties on driver IC.

**Keywords** ? Driver IC, LCD panel module, LCD monitor, LCD/TV,

## Introduction

LCD (Liquid Crystal Display) monitor and LCD/TV is the one of the greatest developments during this decade. This industry is growing prosperously present time and will mature continually in the future. Companies in this field are investigating a lot of capital on establishing newest manufacturing factory and developing newest technology. The reason why these companies are doing is to raise better quality (or yield rate) and save the cost. Furthermore, due to the consumer type is changing, the market of this industry becomes larger covered not only Information Technology field (LCD monitor) but also family electronic product (LCD/TV). Thus, the company which step faster than others will conduct the technology and market.

When end users purchase whether LCD monitor or LCD/TV, the unit price will be the first priority. Except the unit price, the performance will be another key point which they will look into. The performance of LCD monitor and LCD/TV not only on LCD panel module manufacturer, but also the other factors, like the driver IC, back light module, and so on. This article will address the driver IC on LCD monitor and LCD/TV.

on these abbreviations and contents.

TABLE 1 ? The description and explanation of Abbreviation

Abbreviation	Description and Explanation
MCU	Micro Controller Unit ? Using a program to instruct each step of the LCD monitor or LCD/TV
OSD	On Screen Display ? Adjust proper contrast, brightness, vertical and horizontal position, color temperature, and other setting
ADC	Analog Digital Converter ? Transfer the signal from analog to digital
DVI	Digital Visual Interface ? Connection interface by digital data
LVDS	Low Voltage Differential Signaling ? Low-power, low-noise, and high-speed differential technology to create a direct transmitting way between CPU and LCD display
TTL	Transistor- to- Transistor Logic ? A digital circuit communication interface used for the discrete digital output or build-in device
TMDS	Transition Minimized Differential Signaling ? A standard interface using on transmitting digital data to LCD display device

p.s. Referring to [3], [4]

## 1 Overview of driver IC

### 2.1 Abbreviation explanation

There are some abbreviations which are widely used. To let reader easily realize, TABLE 1 is the brief explanation

### 2.2 Basic function explanation

Basically the function of driver ICs is to change the signals from computer (VGA card) or TV/video to LCD panel module. Inside driver IC, there are several operating

units, and these operating units are to transmit the data forwardly. FIGURE 1 is the description of the LCD monitor or LCD/TV with the different input signals and the inner functional of driver IC.

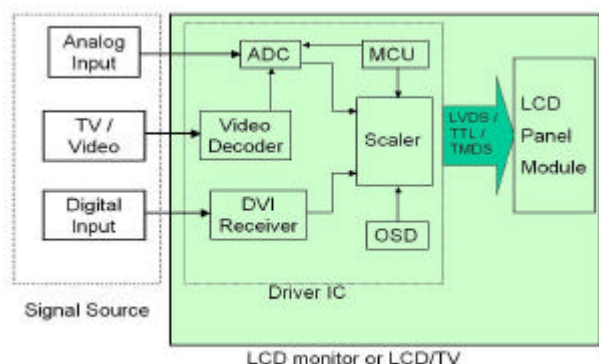


FIGURE 1 ? The function units block diagram of LCD monitor and LCD/TV [3], [4]

Generally there are 3 kinds of input signals on LCD monitor and LCD/TV, which are analog, digital, and TV/video signal. For analog and TV/video signal, these 2 signals are analog, so they need to be transferred to digital by ADC. After signal transformation, the ADC will forward the data to Scaler. For the digital signal, since driver IC internal operating signal is digital, DVI receiver is to confirm that the data is no error, and then transmit the data to Scaler. When Scaler receives the data, this IC will process the data and generate the suitable performance size and resolution.

MCU starts to operate while signal arrived ADC, and will command and instruct for the following operating steps. Since Scaler is to perform the display size and resolution and all these setups were saved at OSD, OSD will transmit these setups to Scaler. Hence, Scaler can follow these setups and display suitable size and resolution. Once when the input signal has been processed and finalized by Scaler, the data will transmit to LCD panel module through appropriate interface, like LVDS, TTL, or TMDS.

FIGURE 1 indicates that input signals are translated by driver IC, and then forward to LCD panel module. During signal translation, the input signals shall be processed to transmitted data, so that all units can recognize the input signals. After receiving the accessible data, LCD panel module will perform the input signals, no matter analog, digital, or TV/video signal. Thus, driver IC is similar like an interpreter changing different kinds of signal interface.

## 2 Application and comparison

### 3.1 IC design

Generally driver IC can be classified to 2 types, integrated and separated. Referring to FIGURE 1, if the operating units of driver IC are combined inside an IC, it is integrated driver IC; if the operating units of driver IC are divided to several ICs, it is separated driver IC. LCD monitor or LCD/TV manufacturers can decide which kind of driver IC they would like to apply on the product according to their consideration.

TABLE 2 ? Driver IC comparison

Company	IC type	Containing Operating Unit
Company A	Type I	ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler <input checked="" type="checkbox"/> Video Decoder LVDS/TTL/TMDS DVI receiver <input checked="" type="checkbox"/> Others: <u>Frame buffer</u>
	Type II	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS <input checked="" type="checkbox"/> DVI receiver Others: _____
Company B	Type I	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler ? Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS <input checked="" type="checkbox"/> DVI receiver Others: _____
	Type II	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS DVI receiver Others: _____
Company C	Type I	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS DVI receiver Others: _____
	Type II	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS <input checked="" type="checkbox"/> DVI receiver ? Others: _____
Company D	Type I	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS <input checked="" type="checkbox"/> DVI receiver Others: _____
Company E	Type I	<input checked="" type="checkbox"/> ADC <input checked="" type="checkbox"/> OSD <input checked="" type="checkbox"/> MCU <input checked="" type="checkbox"/> Scaler Video Decoder <input checked="" type="checkbox"/> LVDS/TTL/TMDS DVI receiver Others: _____

p.s. Referring to [3], [4]

TABLE 2 addresses several driver ICs containing with different kinds of operating units. It indicated that most of the driver ICs include the operating unit of ADC, OSD, MCU, Scaler, and LVDS/TTL/TMDS. Due to each company has its own know-how and technology on different areas, some types of driver IC contain different operating units which are the predominance of the driver IC design company. TABLE 2 also shows that several driver IC design companies launch more than 1 kind of products, which is to satisfy with LCD monitor and LCD/TV maker's request. This action will help these driver IC design companies to raise their market share and increase the rivaled ability.

About 2 to 3 years ago, LCD monitor and LCD/TV makers only could choose separated driver IC. That is

because IC design and manufacturing technology was not matured enough. Each operating unit was an individual IC, so there are several ICs on control board of LCD monitor and LCD/TV. Chronologically, the IC design and manufacturing technology have progressed. Driver IC designer can considerate about the market request, and provide the appropriate products. Therefore, LCD monitor and LCD/TV makers have more chances to select appropriate driver IC based on cost, technology, quality, or compatibility.

### 3 Difficulty on driver IC

The technology of driver IC is still growing up. When LCD monitor or LCD/TV manufacturers select the driver IC, they will also consider about the difficulty which will be the obstructer or will be the problem. This article addresses 2 factors that driver IC designer and LCD monitor and LCD/TV manufacturer need to considerate about before selecting driver IC, and they are compatibility and operating temperature.

#### 4.1 Compatibility

Compatibility exists in many fields, especially on the connection between different IC makers and types. LCD monitor and LCD/TV are assembled by several components, including ICs, LCD panel module, and other components. However, LCD panel module and VGA card also contain several ICs. Thus, LCD monitor and LCD/TV makers will face to the compatible problem on the IC connections between the VGA card and LCD panel module.

There are 2 compatible issues on driver IC. The first compatibility is on the input digital signal transmitted from VGA card. The other compatibility may happen while the signal is transmitted to LCD panel module.

##### (1) Input digital signal from VGA card

VGA card makers use different kinds of processors, so some of the parameters, like impedance, will be different. Although most of the processor designers follow a standard to setup the required parameters, there are still some differences on each processor. These differences may occur the data is unable to be well transmitted or data transmittance is unstable. The reason to cause this situation is because the impedance is not matching. Therefore, before launch a new driver IC, driver IC designers are better to survey and test the impedance on all processors from the popular VGA cards, and find out the best matching of impedance.

If the impedance matching problem happened, the failure symptom will be interference, like color, dot, or line interference. The solution is driver IC designer can release

some lead pins, and these lead pins are to let LCD monitor and LCD/TV adjust and control some required parameters.

##### (2) Signal between driver IC and LCD panel module

The designer and manufacturer of driver IC (transmitter) and the ICs using on LCD panel module (receiver) may be different, so compatibility also exist when signal output from driver IC to LCD panel module. The same as impedance matching between VGA card and driver IC, some parameter setup will be different while in IC design and manufacturing procedures. Although the transmit interface is already fixed, by LVDS, TTL, or TMDS, transmitter and receiver may not match well which will cause the compatible problem.

According to the experience, there are many kinds of failure symptom, which are “no video while power on/off at specified resolution”, “display interference”, and many kind of defect symptom.

To reduce or eliminate this compatible issue, there are 2 kinds of solution. The first solution is to use the same IC designer and manufacturer on driver IC and receiver IC on the LCD panel module. The second solution is driver IC designer would survey all of the transmit interface receivers using on LCD panel module, and design a circuit which can widely match with the receiver IC.

#### 4.2 Operating temperature

Operating Temperature is the always key factor affecting on most of the electronic products. All electronic product designers are trying to figure out the best solution to reduce the operating temperature. That is because high temperature will decrease the lifetime, which means the reliability on high temperature component will be unstable after a period usage.

Inside driver IC, the unit which cause the temperature raised is ADC. That is because working frequency of ADC is higher than other units. It means the data process ability of ADC is more than other units. Thus, the work loading of IC is more, the surface temperature is higher.

There is one clock generator on ADC, and this clock is to provide the timing while ADC is operating. Since the working frequency of ADC clock generator will cause the high temperature, if driver IC designer combines ADC with other units, the temperature of whole driver IC will be raised. When the temperature of whole driver IC is raised, the frequency of whole driver IC will be unstable, directly affected the stability on other operating units. For instance, if the clock of MCU becomes unstable, MCU cannot instruct the following command synchronously. Finally, the whole circuit on LCD monitor and LCD/TV will become unstable. Thus, the way to let ADC stabilize is the way to let the

working temperature of driver IC remain low.

If the working temperature on driver IC cannot be well controlled, many failure symptoms will appear, like “no video”, “interference on OSD”, and so on.

There are many reasons which will cause the driver IC cannot suffer higher temperature. IC Packing method/technology, test pattern cannot screen out the failure, and other suspect factors that cause the working temperature remained high. Therefore, the temperature control is a technique not only driver IC designer but also driver IC manufacturer need to pay more attention.

## 5 Conclusion

Driver IC is one of the components inside LCD monitor and LCD/TV, and the main function is to transfer the input signal and perform the appropriate display. Although driver IC is not the most important component on LCD monitor and LCD/TV, it is the key item which will let the display quality become better and the lifetime become longer. Therefore, LCD monitor and LCD/TV manufacturers need to carefully choose and apply the driver IC, so that the end user can have more choices to select better quality of LCD monitor and LCD/TV.

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