

Environmental Data Memory and Display Status Monitoring Technology of Outdoor Display

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Abstract

This paper presents environment data memory technology and display status monitoring technology developed by BOE in TFT-LCD outdoor display LCM. Add a metal ring designed in panel BM used as resistance temperature sensor, MCU calculates the temperature data as panel environment data and stores it in a flash memory. According to the temperature value, if it is too high than the specification, MCU controls to decrease BLU brightness or turn off the panel and BLU in order to protect LCM from higher temperatures. Using MCU or TCON IC to detect the panel driving electric signal and identify if the signal is normal or abnormal, based on this, different hexadecimal codes are output to SoC to realize display status remote monitoring function.

Author Keywords

TFT-LCD; Outdoor Display; Environment Data Memory (EDM); LCM Self Protect; Display Status Monitoring;

1. Background

TFT-LCD has been used in the outdoor environment for many years. Outdoor display LCM brightness is being improved from 2000nit to 4500nit or higher. However, higher BLU brightness will not only result in a higher increase in the temperature of the panel surface, the TFT characteristics will also get deterioration because of a-si photosensitive properties, which could cause panel display issues and a shorter lifetime. In the outdoor environment, when LCM is directly irradiated by strong sunlight, panel temperature will rise sharply, which may cause panel damage. Although outdoor display terminals have a cooling fan design to reduce the temperature, but it maybe still not enough or not timely to lower the temperature. It is still necessary to design other protection measures to protect LCM from high brightness and temperature.

At the same time, when outdoor LCM happened display issues, the maintenance provider of the display terminals usually could not know the issues in the first time, so it is urgently needed to develop the display status monitoring function.

2. Environment Data Memory (EDM) Technology

2.1 Function of EDM Technology

EDM technology aims to realize three functions:

1. Panel temperature sensing and storing the temperature data to flash memory as panel environment data.
2. Panel self-protection function: if the panel temperature is too high over the predetermined specific temperature, lower BLU brightness through PWM adjustment or turn off the BLU and panel until the panel temperature is lower than the predetermined specific temperature.
3. The panel temperature data stored in flash memory can be read by the SoC through the I2C interface to control the cooling fan of display terminals or perform other actions.

2.2 Design and Realization of EDM Technology

As shown in Figure 1, add a metal ring design in the panel BM area, and this metal ring can be used as a resistance temperature sensor; MCU processes the sensor data to get the temperature data and stores the temperature data to flash memory as data log for reference when there is temperature relative problems; at the same time, if the panel temperature is higher than one threshold value, MCU control to reduce PWM duty of BLU converter to reduce the BLU brightness or turn off the panel and BLU in order to protect LCM from higher temperature.

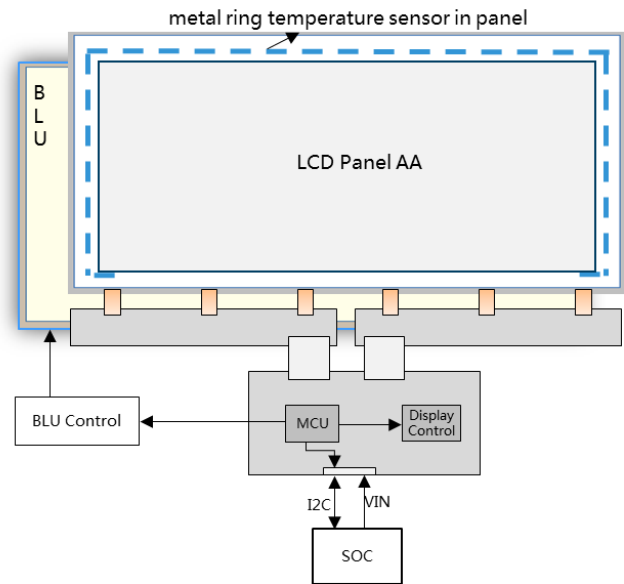


Figure 1. EDM System Architecture

Figure 2 shows the hardware design block of EDM technology. The metal ring resistance temperature sensor is driven by a 3.3V voltage, the MCU ADC pin acquires the output voltage of the metal ring and calculates out the temperature data in MCU software, the MCU stores the temperature data to flash memory continuously through the SPI interface. The SoC can do communicate with flash memory through the I2C interface to read the temperature data.

Regarding the panel self-protection function, if the MCU acquired panel temperature higher than the specific temperature continuously, a higher temperature lasts for ten minutes for example, MCU controls the PWM duty from 100% to 10% by 10% step until the temperature is lower than the specific temperature; if 10% duty is not enough to lower the temperature, then MCU controls the PMIC EN and BLU_ON/OFF to turn off panel and BLU. MCU controls to turn on the panel and BLU after MCU tested the temperature is lower enough than the specific temperature. We also design a self-protection on/off select pin that SoC can control to meet different requirements.

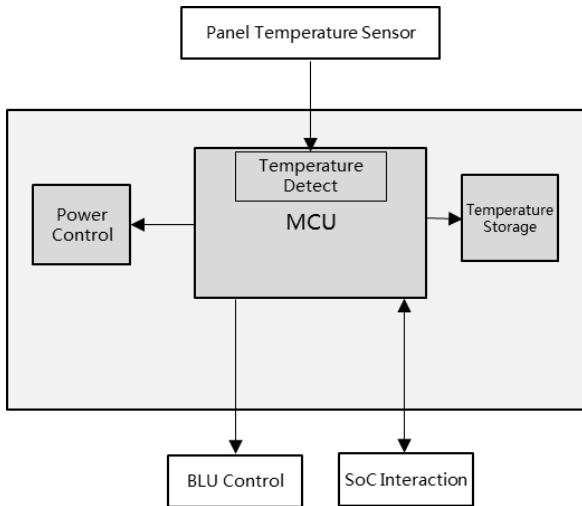


Figure 2. EDM Hardware Design Block Diagram

3. Display Status Monitoring Technology

3.1 Function Introduction

Using MCU IC or TCON IC to detect panel and BLU driving signals on panel driving PCB boards, if some signals are detected out of spec, then MCU or TCON IC output different codes as shown in table 1 through I2C or UART interface, these different code means that there is abnormal display and can locate which part is abnormal for reference, SoC can receive this code immediately before end users find this abnormal display, SoC can also use this alarm code to instruct the after-sales maintenance with high efficiency.

Table 1. Definition of Display Status Monitoring Code

Code	Code Meaning	
0xFF	Normal Display	
0x01	No Display	PMIC damage
0x02	Abnormal Display	GOA Signal abnormal
0x03	Bist abnormal display	Input signal abnormal
0x04	BLU abnormal display	Light Bar driving abnormal

3.2 Design and Realization

Figure 3 shows one hardware design schematic block diagram. An MCU was added to the normal TCON board design to acquire and detect electric signals including the power voltage of the PMIC for the panel display power supply, the GOA driving signal output from the level shift IC, and the Light Bar driving voltage.

At the same time, if the key part IC on the TCON board has a status indication signal whose high or low voltage means the IC is working in normal or abnormal status, we can also detect this kind of signal to perform a monitoring function as shown in Figure 4, TCON is used to detect the status indication signal of PMIC, L/S IC, and LED Driver IC.

MCU or TCON should use an independent power supply system from TCON display power system to ensure that display power supply does not affect the monitoring function.

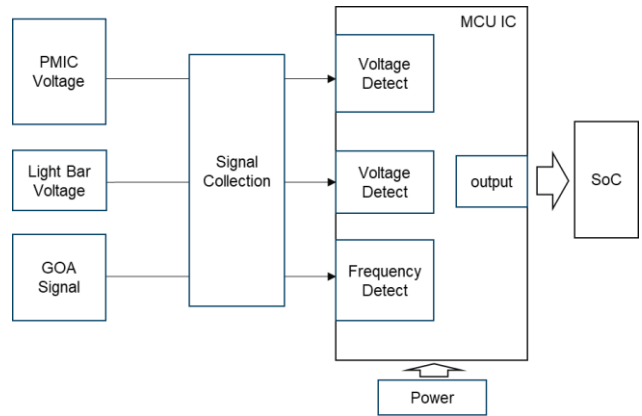


Figure 3. Monitoring by MCU Schematic Block Diagram

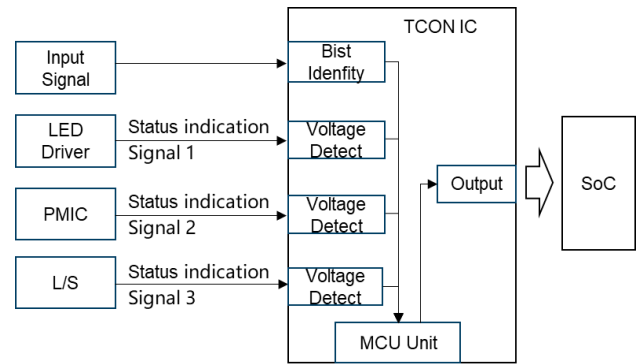


Figure 4. Monitoring by TCON Schematic Block Diagram

In the software flow as shown in Figure 5 and 6, the detected signals were set to a predetermined specific value as specification, If the voltage value of the DC voltage signal and frequency of the frequency signal are out of the specification range, then MCU or TCON IC outputs a relative alarm code to SoC.

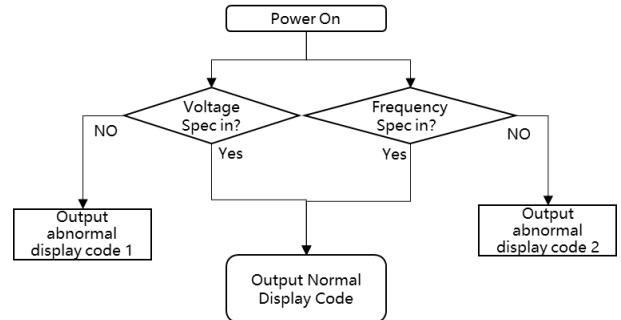


Figure 5. Software Flow Diagram of MCU Detect

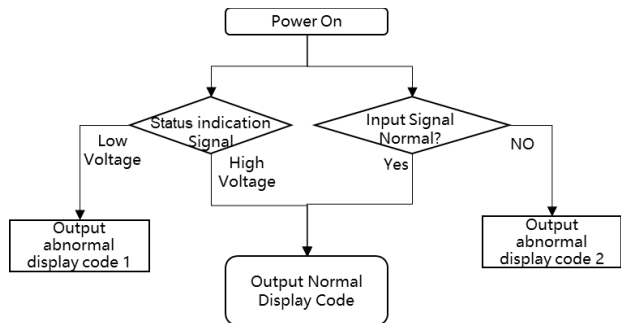


Figure 6. Software Flow Diagram of TCON Detect

4. Summary

This paper presents two new technologies used in outdoor wide-temperature and high-brightness display LCM. Environment Data Memory technology can detect panel temperature and perform self-protection actions to give display terminals longer lifetimes. Display Status Monitoring technology can make display terminals more intelligent. With these two technologies, outdoor display products will develop in a more reliable and intelligent direction.

5. References

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