The Factors of Image Sticking in Wide Dynamic Frame Rate Technology

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ABSTRACT

With the wide use of high-refresh mobile phones, the battery handling capacity is getting worse. We have exploited a kind of Liquid crystal display, which perfectly matches the demand of high-refresh and low-power-consumption without increase in process cost. We also focus on the factors of image sticking in wide-dynamic-frame-rate technology.

1 Introduction

5G had been mentioned and expected since 2018. After 2019, 5G was becoming more and more popular. The world has entered the 5G era, and 5G mobile phones have begun to enter people's lives [1]. As a main direction of the new generation of mobile communication technology, 5G will open a new stage that can interconnect everything by network. When 5G comes, the speed of information transmission has made a qualitative leap. As the first port of human-computer interface, the display screen must make the first rapid change for 5G age.

Because of the 5G, there are many challenges to the display screen:①Ultra-high refresh frequency, the most contribution of 5G is improving the transmission rate high, so the display have the fastest refresh frequency is inevitable requirement [2]; ② Because of high refresh, the mobile phone with 5G has a poor power consumption. There is contribution that display can realize the low-frequency transmission of static picture. All in all, the display screen is required to have Ultra-high refresh frequency and low power consumption as the figure1 shows, when 5G age coming.

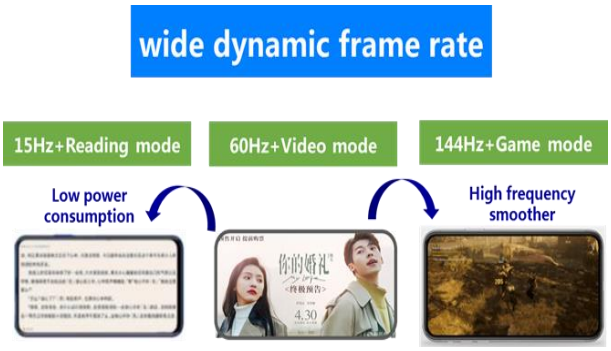

Fig. 1 Application of the wide dynamic frame rate

From 2020，the project team is committed to research the technology which can realize the wide dynamic frame rate and focus on the factors of image sticking at the high-low-frame-frequency technology. Finally we exploited a panel which perfectly matches the demand for 5G era.

2 Technology

2.1 The wide dynamic frame rate

In order to ensure the charging performance of the high refresh frequency of 144Hz, we propose a new driving mode which is mainly to adjust the relationship between gate and demux CLK, and also through TFT device performance process optimization. On the other hand, LCD with low frequency driving faces to flicker challenge. First, human being is sensitive to brightness fluctuation below 40Hz; Second, lower driving frequency means longer holding time, which requires pixel has better holding ability to suppress flicker [3]. We propose a new driving mode which is mainly to suppress the holding leakage, and also through TFT device performance process optimization. Figure2 shows the excellent flicker after the improvement.

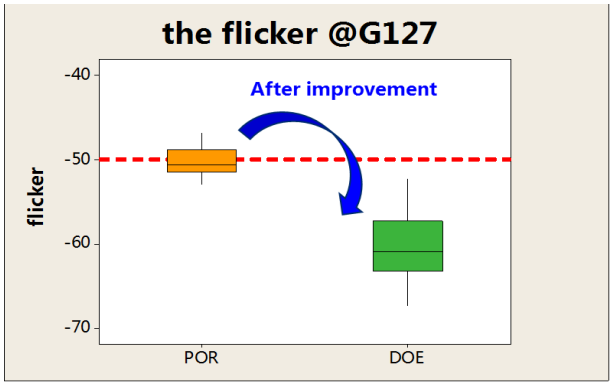

Fig. 2 Excellent flicker after improvement

2.2 The image sticking of 144Hz

The pixel charging process is different between positive and negative frame at high gray scale [4]. As the figure3 and table1 shows, the Vgs of positive frame is smaller than negative frame, then has weaker charging capacity, especially at the high refresh frequency. It causes VCOM shift, but there is no difference at low gray scale. The image sticking test is 8 * 8 checkerboard black-and-white picture, the different VCOM shift at Black and white position cause the G127 Visual to worse. Figure4 shows the VCOM shift mechanism.

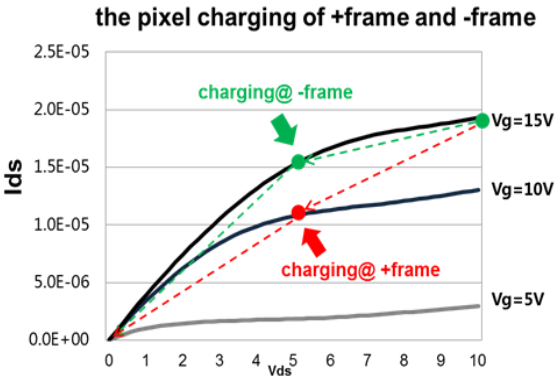

Fig. 3 Pixel charging of +frame and -frame

Table 1 Pixel node voltage of charging process

charging	S_data	D_pixel	G	Vds	Vgs
-frame	-5	5	10	10	15
	-5	0	10	5	15
	-5	-5	10	0	15
+frame	5	-5	10	10	15
	5	0	10	5	10
	5	5	10	0	5

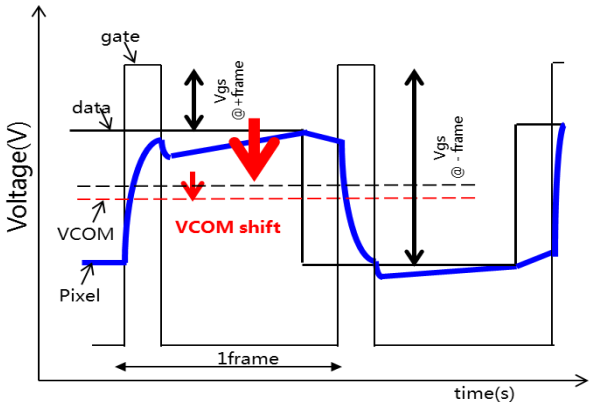

Fig. 4 VCOM shift mechanism

2.3 The image sticking of 15Hz

The test data shows that the stability deviation of low-frequency 15Hz 1-2 levels higher than that of normal 60Hz as the figure5 shows. We research the main influencing factors: VCOM shift, charging capacity and abnormal static electricity have been eliminated, focusing on the impact of long holding leakage at low-frequency. We propose two innovative methods to clarify.

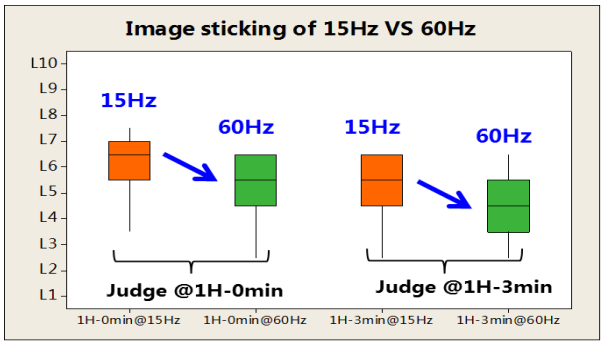

Fig. 5 The stability deviation of 15Hz and 60Hz

Firstly, innovative procedure mode : real 15Hz+VSR gate all on VS real 60Hz+VSR gate all on, as the figure6 shows. It means the picture in the charging state all the time and the leakage factor can be eliminated. According to the experimental results, 15Hz is still 1-2 levels higher than that of normal 60Hz.

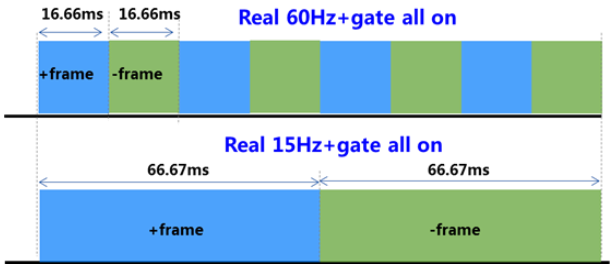

Fig. 6 Innovative procedure mode

Secondly, innovative testing method: during the test, a shading layer is added between the panel and backlight, and ensure that there is no light in the environment at the same time, as the figure7 shows. It can realize the light free state of TFT devices and almost eliminate the leakage factor. According to the experimental results, 15Hz is still 1-2 levels higher than that of normal 60Hz.

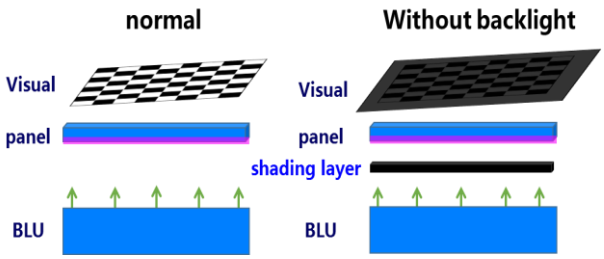

Fig. 7 Innovative testing methods

In conclusion as above, we successfully clarify that the long holding leakage is not the main influencing factor of image sticking at low-frequency. Finally, we have explored good image sticking performance with new liquid crystal and PI materials.

3 Results and Discussion

We successfully exploited a kind of Liquid crystal display, which perfectly matches the demand of the 5G era, the panel not only supports high refresh frequency of 144Hz, but also supports low refresh frequency of 15Hz. What's more, without increase in process cost. And the specifications of the LCD device were summarized and fixed in Table 2.

Table 2 Main parameters of the display

Item	Specification
Display mode	LCD
Driving mode	FFS
Driving circuit	LTPS NMOS
Screen size	6.497inch
Resolution	2400:1080
Border	0.7/0.7/0.85/3.0
Frame rate	15~144Hz

4 Conclusions

We researched a new driving mode which is mainly to suppress the holding leakage can fit flicker challenge at low-frequency, and clarified the factors of the image sticking at high-low-frame-frequency. What's more, proposed two innovative methods to clarify the impact of long holding leakage at low-frame-frequency.

References

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