

A Novel Design to Realize 6.9mm Thickness Slim Border Wallpaper TV

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ABSTRACT

In this paper we reported a new design of split TV which is thinner than former disclosed. In the new design, bonding leads were placed in distal portion of PCB while traditional design was in proximal portion, middle frame was canceled, so that we can presented a 3.5mm BM border wall paper TV which thickest point was only 6.9mm.

1 INTRODUCTION

With the development of LCD industry and the regeneration of manufacturing process, higher requirement of display quality, appearance and thickness was proposed and gradually become the main trend in display fields. Compared with wallpaper TV, normal TV may take more space for its' heavy weight, thick module and thick BM border, and as a result, the market share of normal TV will predictively gradually shrinking. Fig.1 and Fig.2 shows the appearance comparison between normal TV and wallpaper TV reported in this paper. The comparison recommend that it's very potential to research and design a TV which possess the characteristics like slim border, thin, seamless between wall and TV.

Fig.2 shows the cross section of normal TV and wallpaper TV. It's obvious that the special design ensure wall-paper TV a great advantage in TV thickness. The thinness of wallpaper TV mostly attribute to the following three aspects, remove middle frame, reduce the width of drive plate units and gathering IC(integrated circuit) in a slot located on PCB.

Wallpaper TV aimed at immersing deeper into customer's daily life, so more attention should be paid to not just the TV size and display quality. Based on the target, we proposed a split TV which separated the host system from screen so that TV can completely fits

wall. This designation greatly improve the appearance and meanwhile rise up the additional potential value of TV.

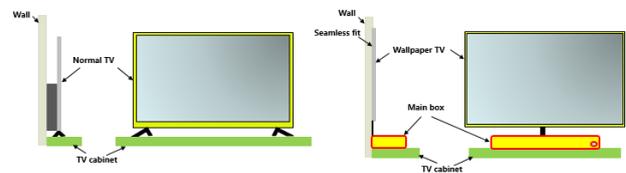


Fig.1. Schematic diagram of normal TV and wallpaper TV

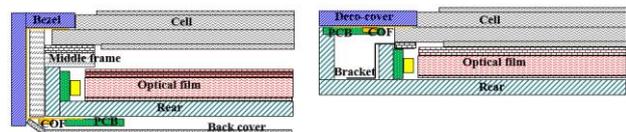


Fig.2. Cross section of normal TV and wallpaper TV

2 DESIGN OF PCB

Shorten the distance between PCB and glass edge was one of the crucial precondition to realize a thin wallpaper TV. Aimed at this target, firstly, bonding area was designed in lower portion of PCB which is away from glass, so that the distance between the PCB edge and glass was shortened to 19.475mm, this is the shortest distance among the same size TV. Secondly, a slot was made in PCB to gathering COF IC so can avoid interference between IC and PCB. It is proved that the measure was useful to reducing the width of the bezel for that by designing the PCB as a flat type (as shown in Fig.3), the PCB does not need to be folded to the back of the rear, thereby reducing the thickness of the LCM.

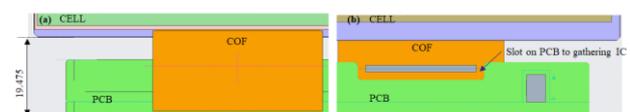


Fig.3. The flat design PCB: (a) front; (b) back

3 DESIGN OF MODULE

Fig.4 shows the cross-sectional view of wallpaper TV module. The main structure of the module was composed of rear, films, light source, glass, bracket and deco-cover. The backlight is side-lit. The deco-cover is made of aluminum alloy, which has been treated with high-gloss anodic oxidation. The light source is blue LED, it can effectively improve color gamut into 105% if additionally applied the use of QD film. In order to reduce the thickness of the LCM, middle frame was cancelled. The source side of the glass is fixed on the surface of the bracket with buffer double-sided tape, making 6.9mm be the thickest point of LCM. Except for source side, other three sides of wallpaper TV were floating designed which means glass was fixed on the rear with cushion tape, thus, a completely borderless design was presented.

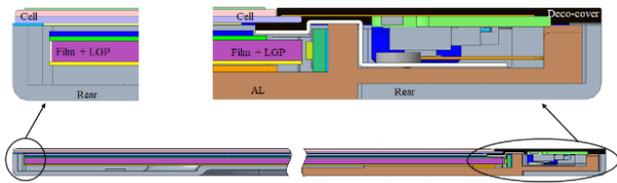


Fig.4. Cross-sectional view of wallpaper TV module

Fig.5 is a diagram of module Border. For that GDL (Gate Driver Less) design was adopted, the border of display screen is only 3.5mm. The source side of module was encapsulated by high-gloss anodic oxidation treated aluminum alloy bezel in which can laser customized logo.



Fig.5. The border of the module

The rear of wallpaper TV module as shown in Fig.6 is composed of aluminum and SECC with a reinforced structure to meet the required heat dissipation performance and support strength of the product. There is a blank rectangle on lower side of the rear to facilitate the removal and replacement of components such as FPC and connecting wires on PCB. In order to makes full use of the high support strength of the wall and achieve seamless fixation between module and wall, a simple nail-hanging structure is set on the rear.

Four self-tapping nails with a size of M4*L30mm were selected as hanging nails, the amount of hanging nails is defined by the flowing calculation:

$$F=mg \quad (\text{Eq 1})$$

$$M=F*L/2 \quad (\text{Eq 2})$$

$$M_{\max}=\sigma*W \quad (\text{Eq 3})$$

$$\sigma=\sigma_s/2.5 \quad (\text{Eq 4})$$

$$W=\pi d^3/32 \quad (\text{Eq 5})$$

Where g is 9.8m/s^2 , L is 1.5mm , m is 13Kg , σ is the maximum stress of nail, σ_s is the yield strength, and W is the bending section coefficient of screw. Based on this, it can be concluded that the force F of each nail is 31.85 N , and the bending moment M of each nail is 47.78 N.mm . The yield strength of a single 5.6-grade nail is about 300 Mpa , so the σ is 120 Mpa . From this, it can be concluded that the maximum bending moment M that a single nail can withstand are 753.6 N.mm , greater than 47.78 N.mm , that means four hanging nails usage can ensure wallpaper hang on wall stably. In addition, this action simplifies the design of rear by cancelling the use of special wall mount, ensure that TV and wall can be seamlessly attached and additionally be greener. Wallpaper TV with the special rear design is completely attached to the high-support wall, so that the TV will not behave light leakage and unevenness caused by stress concentration on glass.

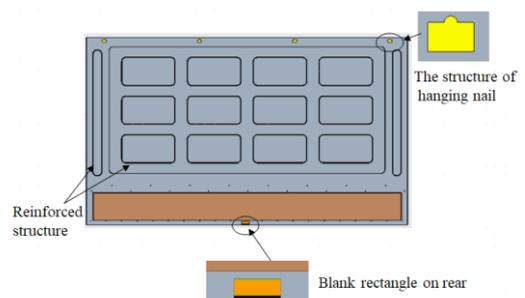


Fig.6. The schematic diagram of rear

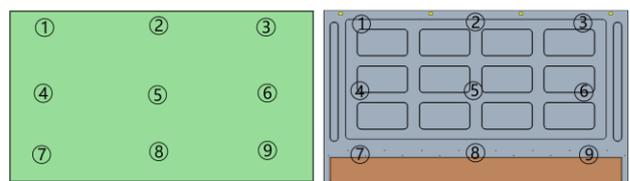


Fig.7. Distribution of temperature test point

Table1. Wallpaper TV room temperature lighting 24H

different point temperature statistics

	1	2	3	4	5	6	7	8	9
front	28.2	28.1	28.3	28.8	28.9	29.0	36.2	36.1	37.3
back	27.8	27.8	28.0	28.2	28.1	28.3	28.8	28.7	28.9

Focused on heat dissipation performance improvement, an aluminum heat-sink was designed to be placed in corresponding area of light bar. We measured the temperature in both front side and back side 9 points shown in Fig.7 after TV worked 24 hours at room temperature and the data is listed in Table 1. The table recommend that the maximum temperature of front side was 36°C (located near the light bar) while other point were less than 30°C, the back side were all less than 30°C. The temperature test illustrate that the heat dissipation performance of wallpaper TV is similar to that of mass-produced TVs on the market, and there will not exist deformation caused by exorbitant partial temperature.

4 WALLPAPER TV APPLYING

As is shown in Fig.8, SOC (system of chip) units and the power units were integrated as an independent module and further link this module with TV by only one transmission line. Further, in order to achieve a more stable transmission performance, greater transmission power of the cable and more function applying, USB3.0 and microphone signal input functions were adopted. Wallpaper TV also supports HDR technology, which means that it can achieve higher contrast and wider dynamic range images whether it is playing online or offline.

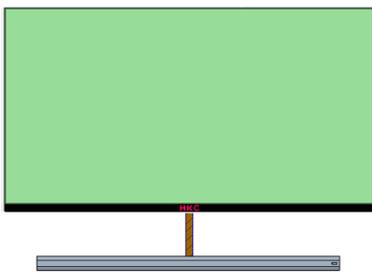


Fig.8. Schematic diagram of split design of wallpaper TV

Wallpaper TV we proposed in this paper has been successfully exhibited in the 2020 CES, 2019 Shanghai International New Display

Exhibition and Shenzhen 2019 High-tech Exhibition, and received the visitors appreciation in design concept, display performance and appearance. Fig. 9 shows 55-inch wallpaper TV in exhibition. The figures disclosed that wallpaper TV can just like a decorative painting hanging on the wall and only takes up a small space whether be placed in living room or bedroom. Also, a more detail 55-inch Wallpaper TV product specification is shown in Table 2.



Fig.9. Wallpaper TV in exhibition

Table 2. 55-inch Wallpaper TV product spec.

Subject		WPTV LCM Spec
General	Panel size	55-inch
	Resolution	3840*2160
	Border (AA-LCM): (U/L/R/D)	3.5/3.5/3.5/29.425 mm
Mechanical	Thickness(max)	6.9 mm
	Weight(max)	13 kg
Optical	Contrast Ratio(typ.)	5000:1
	Brightness(typ.)	400 nits
	Color Gamut (NTSC %) (typ.)	105%

5 CONCLUSIONS

The large improvement of thickness reduction mainly attribute to PCB face down designation and the dislocation of corresponding COF IC for that base on it, it's unnecessary to reverse PCB to the back of TV. PCB flat designation and middle frame reduction we proposed in this paper make fabricating a 6.9mm thickness TV which is the thickest in TFT-LCD field available.

Wall paper TV firstly integrated power units and SOC(system of chip)units as an independent module and further link this module with TV by only one

transmission line; secondly hang it on wall without special assisted parts; thirdly ensure a good heat-sink and anti-deformation ability by the use of extrusion formed aluminum backplane and SECC. Owing to the three reasons referred above, wall paper TV can realized TV-wall seamless, and as a result, became popular among customers.

6 ACKNOWLEDGEMENTS

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