

## 2.3 The Picture Quality of FPD TVs

*Jumpei Nakamura*

Japan Picture quality & Technology Laboratory

2-12-9 Nishishizu Sakura city Chiba Japan

### Abstract

Present status of picture quality and the future target status for FPD TV's are shown based on the evaluated result of FPD TVs and CRT TVs. FPD TV will be required to be design under ergonomics concept and to be revised some of the definition for to enrage the market.

### 1. Introduction

The technologies of FPD manufacturing has remarkably advanced for several years. Especially the advance of the large size is distinguished. According to it, large sizes FPD TVs are going to sale rapidly. Therefore the TV market, where was only CRT TVs area, is changing drastically.

Based on the result of present FPD TVs picture quality evaluation, here mentioned the 5 main qualities status, Brightness / Contrast ratio / Viewing angle / Color representation / Response time, and the future target of them.

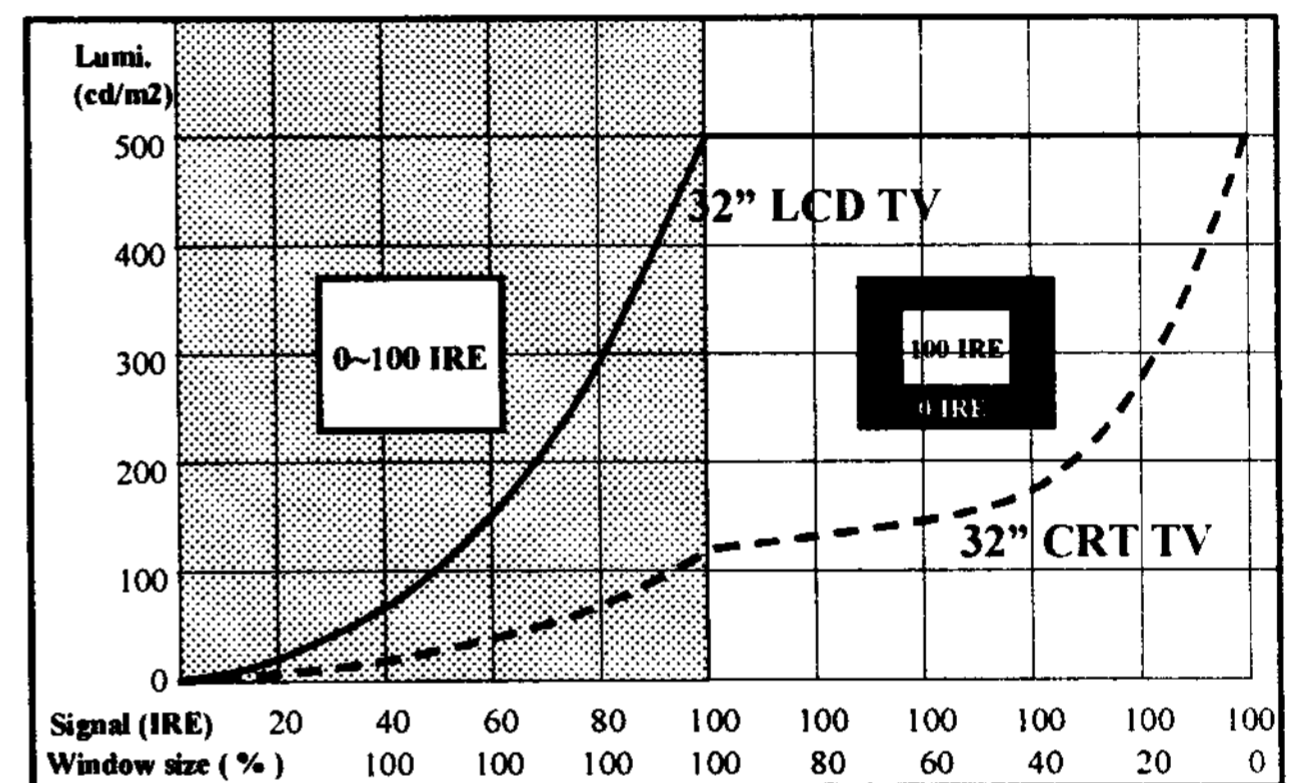
FPD TVs are using different picture quality definitions from CRT TV. Especially LCD TV is using some of original definitions such as viewing angle and response time which does not need to discuss in CRT TV. However, when the different definitions are using in a same market, users will be confused so much. Therefore it is necessary to revise the definitions as soon as possible.

### 2. Brightness

The maximum luminance of LCD TV is going up to about 500 nits, which is equivalent with the peak luminance of CRT TV of the similar size [1]. On the other hand, the luminance of full screen white and peak luminance of PDP TV are 20%-30% less than those of CRT TV.

Fig 1 shows the brightness characteristics comparison graph of 32" CRT TV and 32" LCD TV. In case of the signal is displayed on full size of the screen, the luminance of CRT TV is going up depends on signal levels and when the signal level is around 100 IRE (%), the luminance is saturates around 110~120 nits. However even if the signal is 100 IRE constant, when the display area on the screen is changing to small, the luminance is going up further more and saturates around at 500 nits. This is the "Peak Brightness (or Luminance)" characteristics. On the other hand, the luminance of LCD TV saturates around the signal level is maximum. After signal became to maximum, even if the display area on the screen is changed, the luminance is keeping constant. This means LCD TV is designed having no peak brightness. There for when the maximum brightness of CRT TV and LCD TV are same, at most of the picture level area, LCD TV is much brighter than CRT TV. Especially when the high APL (Average Picture Level) signal is coming in, the luminance of LCD TV is more over 4 times higher than CRT TV. Depend on this reason the stress for user's eyes are getting strong in proportion to luminous intensity. The luminous intensity has in proportion to luminance, display area size and displayed time.

It was happened "The photosensitive convulsion" by animation TV program in Japan several years ago. If it was LCD TV, the chance of the symptom would be much higher than CRT TV. The luminance of PC monitor is recommended 100 nits for workability by ISO DVT regulation [2]. However TV has no such regulation. So brightness condition has big difference between monitor and TV. LCD TV has luminance competition without consideration of user's health. Already LCD TV brightness is higher enough compeer with same size CRT TV. It will need to reduce the luminance of high APL pictures. This means it should be designed to have peak brightness characteristics such as CRT TV.



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Fig1. Brightness of CRT TV and LCD TV

Further more LCD TV should be designed under consideration of ergonomics and low power consumption rather than high brightness competition.

### 3. Contrast Ratio

As well known, the contrast ratio of CRT TV is very high in a dark room condition. It is more over 5000:1. The other hand LCD TV has 500:1- 800:1 contrast ratio without backlight control and 1200:1- 1500:1 with backlight control by APL condition. PDP TV has 500:1- 3000:1 contrast ratio [3].

However contrast ratio has much relation with ambient luminance.

Fig.2 shows contrast ratio shift characteristics of CRT TV and LCD TV by ambient luminance. The contrast ratio of CRT TV shifts extremely. LCD TV does not shift so much. Here we can see, when the ambient luminance is over 50 lx, contrast ratio of LCD TV cross over and keep higher than CRT TV's one. The dots line on Fig.2 means if we use LCD TV in the place of more over 100 lx ambient luminance, 300:1 contrast ratio LCD TV has much higher contrast than CRT TV. There for LCD TV which used in normal living room, the contrast ratio of 300:1 is good enough. It will be one of a suggestion for LCD TV designing.

The ISO VDT also has contrast ratio recommendation for PC monitor, 6:1-10:1 under 250 lx conditions. Because the high contrast monitor will make the worker to be tired. At TV area, it should not compete for only the contrast number without discussion of ergonomics issues [4].

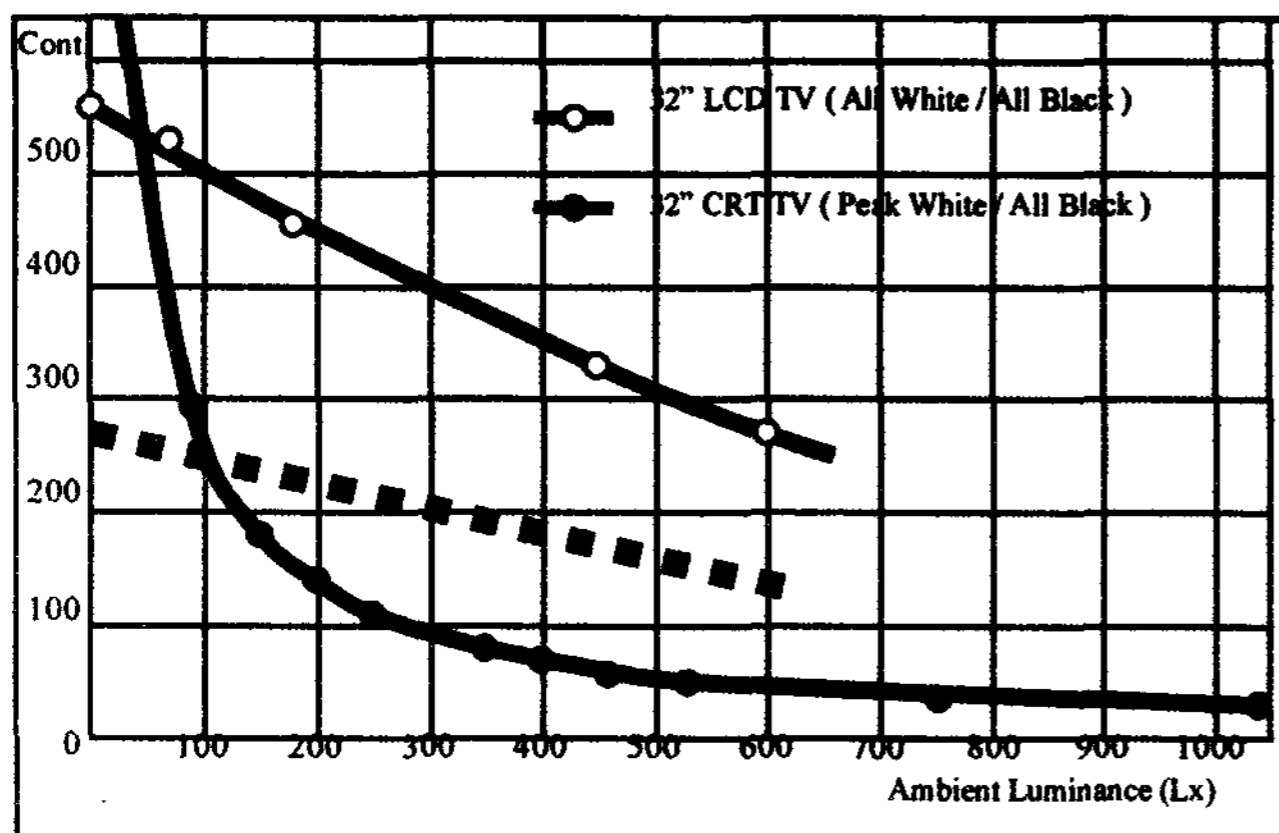


Fig.2 Contrast Shift by Ambient Luminance

#### 4. Color Representation

In the beginning stage of FPD TVs development, color representation was a one of big issue to be improved. At that time for to get high brightness, there was some method such as Green specter up and also use thinner color filters. Therefore the color representation was very poor. There are color standards in TV broadcasting for color management. Until now most of the TVs, even if CRT TV, are following EBU 100% (NTSC 72%) color gamut. However, recently there are some samples such as NTSC 100% color gamut type for to appeal "Some thing difference".

In nowadays even if NTSC TV broadcasting area, the camera which has EBU 100% color gamut filter are using for take pictures. If the NTSC 100% TV set is used under this situation, it has about 30% color extension compare with actual colors. At that case it will make some trouble at TV shopping.

It is welcome to show the possibility of technology but need to be careful to mass production TV set only. It should be change at a same time with TV camera for color management. Other wise it has miss matching of color representation.

As the user's glance, it is expected to manufacture FPD TV sets under the lure of TV broadcasting.

#### 5. Viewing Angle

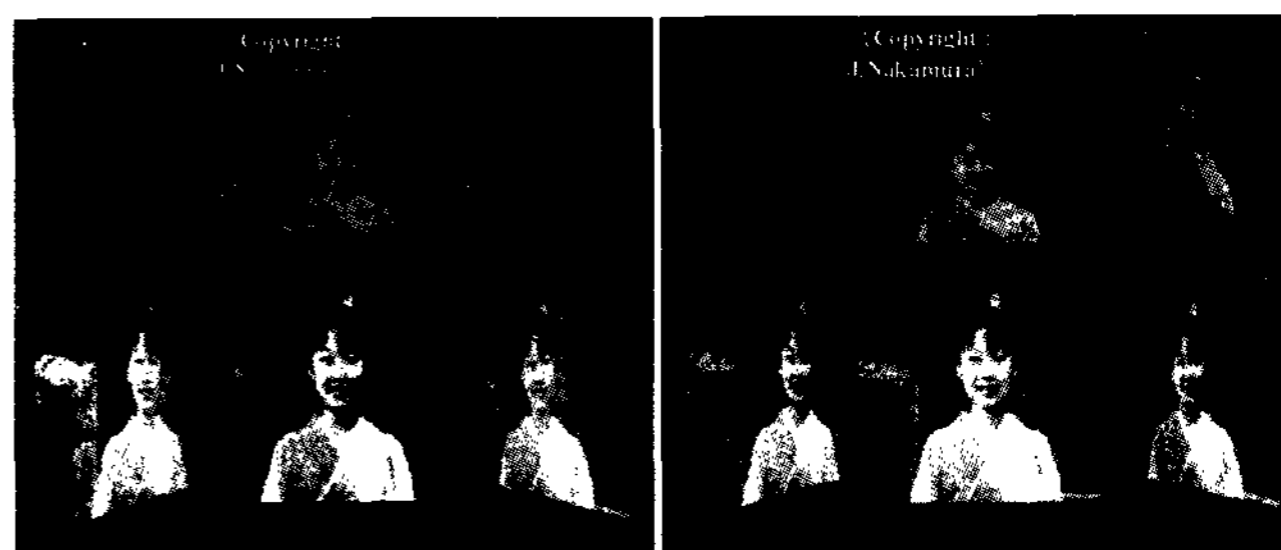
As well known, LCD has "Viewing Angle" which is one of the most important items should be improved. Compare with ordinal TN mode LCD, it has been much improved by VA mode and IPS mode LCDs. However still it is required much more improve. The previous definition of LCD viewing angle is defined the area of more over 10:1 contrast ratio. However the theory of more over 10:1 is unclear for users. It has much difference compare with actual user's feeling. For example, according to previous definition, both of VA mode LCD and IPS mode LCD having almost same viewing angle value such as 170 degrees. However it has big difference when we see in actually. There for end users are having some of wonders for LCD specifications and definitions.

Fig.3 shows the pictures of center view and 45 degrees view of VA mode LCD and IPS mode LCD [5]. In VA mode, each 45 degree pictures are changed brightness and colors. The other hand

IPS mode LCD is keeping good picture. This is because of viewing angle has depends on not only contrast but also Gamma characteristics and color shift.

For to solve this difference problem the new definition of LCD viewing angle which fit users feeling is required as soon as possible.

Fig. 4 is the results of color shift check of previous VA mode LCD TV and IPS mode LCD TV by 45 degrees. VA mode LCD has much shifts of color value ( $u'v'$ ) compare with IPS mode LCD.



(a). VA Mode LCD

(b). New IPS Mode LCD

Fig.3 Viewing Angle

Especially such as the clothes (Vermilion color) and the wall color are shifting very much. [6]. In ISO regulation the color difference, in same screen, for PC monitor is recommending as the color uniformity ( $\Delta u', v'$ ), which should be less than 0.02. Even if viewing angle changed, the color shift should be considered as same as the color uniformity.

As far as home use TV, for to keep original picture, the target of color shift by viewing angle should be follow to equation 1) at 45 degrees light hand and left hand.

$$u'v' (45 \text{ degrees}) \leq 0.02 \dots 1)$$

The ISO regulation is not specified measurement colors. It is allowed to use a convenient color of TV set manufacturers for declaration. However depends on the color, color shift value has much difference.

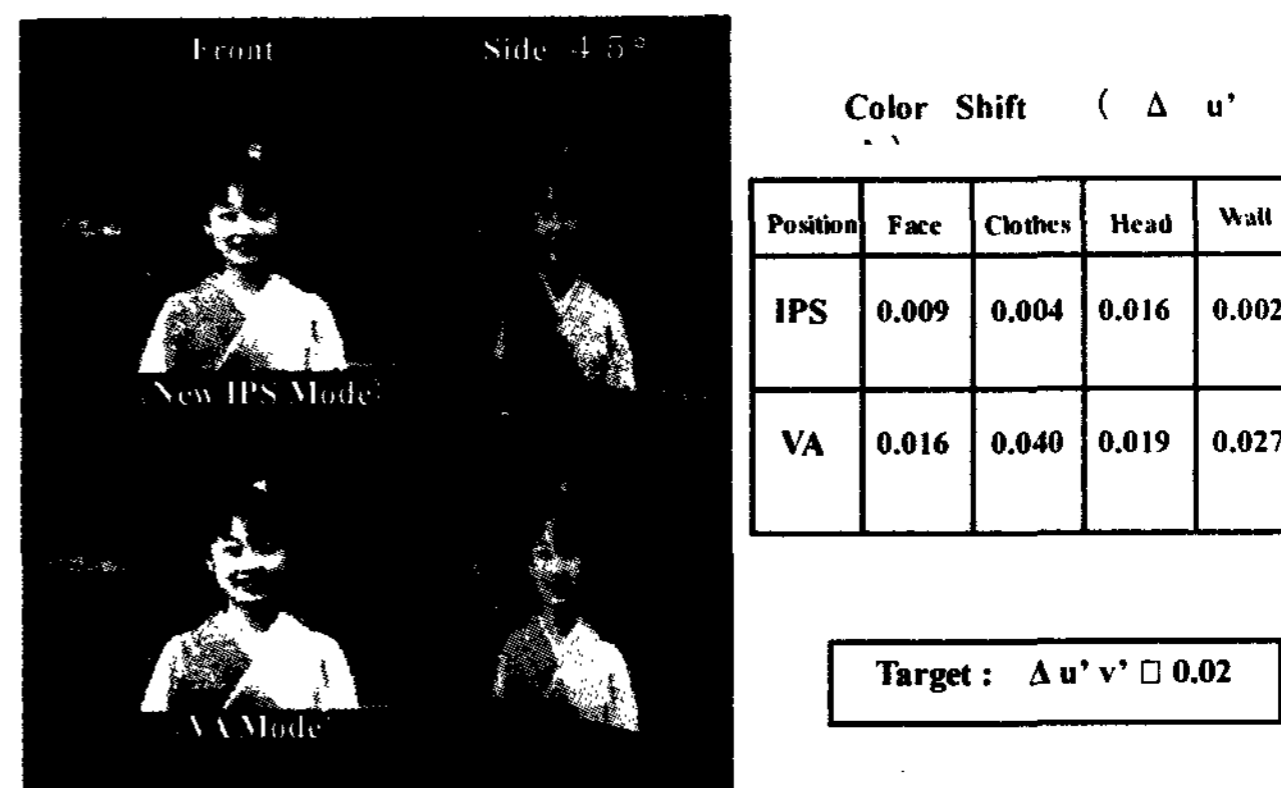


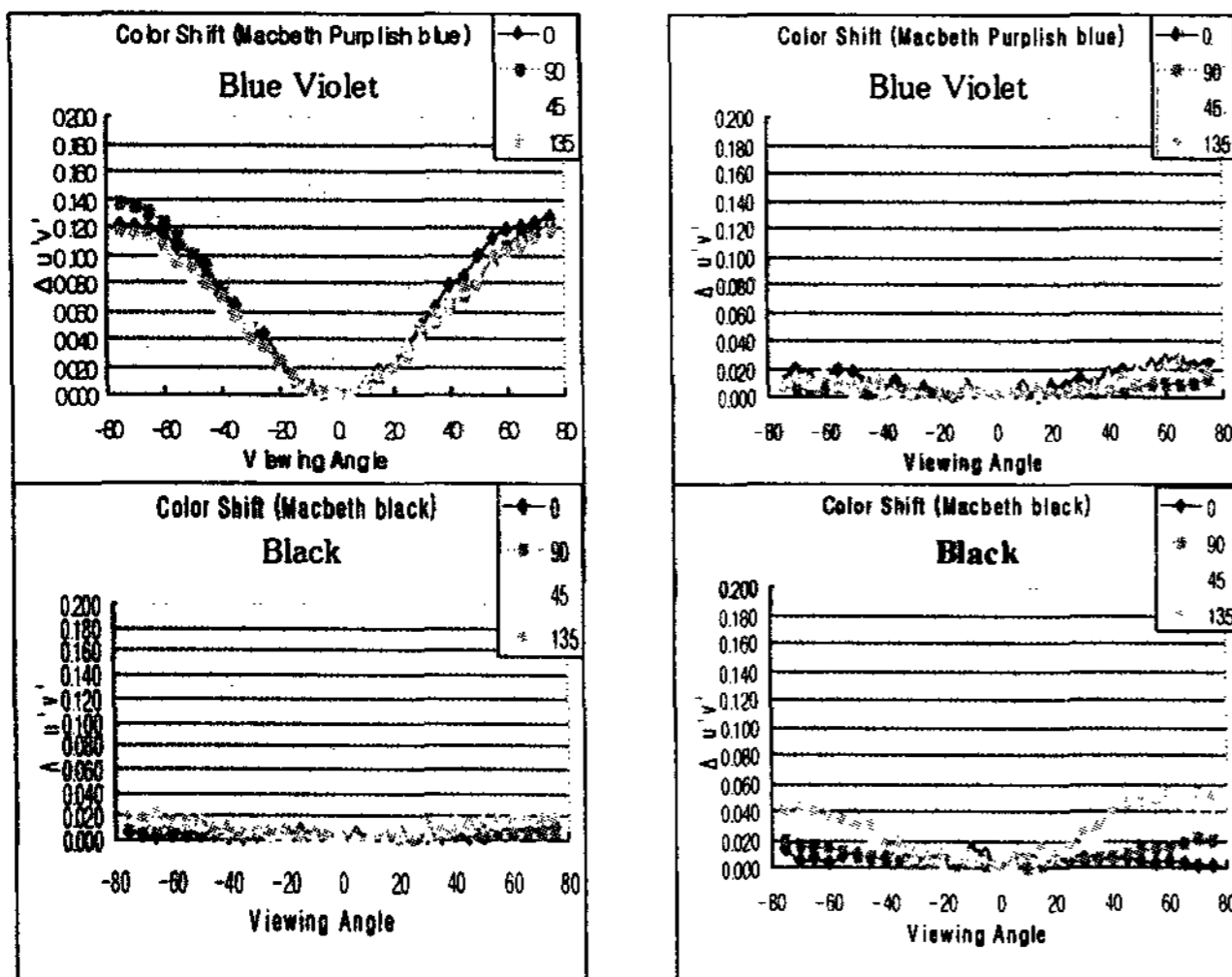
Fig.4 Actual Color Shift by Viewing Angle

Fig.5 shows the biggest color shift data of Macbeth Chart colors by viewing angle, which are "Purple Blue" for VA mode and IPS mode, also "Black" for IPS mode. When the "Purple Blue", VA mode LCD has big color shift H/V and diagonal angle. The other hand color shift of New IPS mode LCD is very small in

every angle. It is very good. Then how is "Black"? VA mode LCD is very stable and IPS mode LCD has small shift.

Like this, when we use the color shift data of Macbeth chart for viewing angle check, we can get suitable data such as good matching as actual viewing.

As I mentioned, the present viewing angle definition is only defined by 10:1 contrast ratio area even if the actual maximum contrast ratio is more over 500:1. There for it has big different feeling compare with actual viewing. Here I advocate "New definition" of LCD viewing angle, which is including Contrast ratio shift, Gamma shift and Color shift.



(a) . VA mode LCD

(b) . New-IPS mode LCD

Fig.5 Color Shift by viewing Angle

## 6. Response Time

As well known, PDP and LCD have a problem of moving picture response. PDP is drove by use of sub fields for to display gray scales. Therefore when the moving pictures displayed on the screen, PDP has "Pseudo Outline". It is one of major problem of PDP TV. The other hand, LCD has "Motion Artifact" by LC material response time and driving method of LCD. Especially when the LCD is getting bigger size, the response time problem will be more major issue. The response time of LCD has been improved by the technologies of "Over Drive" [7] and "Black insertion" [8]. However still it has big gap between LCD and CRT. Fundamentally, as far as LCD is drove by hold mode, it can not solve motion artifact problem [9]. "Impulse Drive", such as back light blinking method and Black insertion method, or high scan drive will be required to solve this problem. It will be required more over 4 msec impulse drive for equivalent to CRT response time. The measurement method and specification of LCD response time is going to change to MPRT (Moving Picture Response Time) [10]. In Japan Most of LCD venders and TV set manufacturers were discussed and got agreement. Now it is proposing to VESA as a standard for LCD. Also measurement tool is going to on sale [11].

This MPRT is aiming to measure and note response time more fit for user's actual feeling. It is expected to be international standard as soon as possible.

## 7. Summery

Here mentioned the 5 Key Point of picture quality for FPD

TVs. Some of the characteristics and definitions have much difference between CRT characteristics. There for if we compare only partial value of the data it has much difference in actual viewing. We need to discuss and compare the values carefully.

PDP TV will be required to increase the luminance more 20%~30%, to reduce reflection by ambient luminance and to reduce pseudo outlines.

In case of LCD TV, the contrast ratio of 300:1~500:1 is good enough for living room use. However it will be required to reduce the brightness of high APL pictures, to improve response time less than 4 msec for to approach CRT TV's response time. As long as LCD TV's viewing angle, ordinal definition which is "The area of more over than 10:1 contrast ratio" has no meaning in actually. I advocate the new definition which include not only contrast but also gamma shift and color shift.

For to improve FPD TV's picture quality, it is required not only compete for the data value but also to make the target under point of view for ergonomics and power consumption saving.

## 8. References

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