

# TFT-LCD TV LC-20V1

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## Abstract

Since the development of its first 10.4" and 8.4" "Window" model TFT-LCD televisions in 1995, Sharp has continued to create LCD TVs which have expanded this new electronics market. Sharp is now proud to announce the development of a 20" LCD TV (equivalent to a 21" CRT TV), the world's largest. With sophisticated advances such as a more efficient backlighting system, an LCD module with wide color reproduction, and thin, high quality speakers, this LCD TV offers high quality pictures and sound, a sleek, thin design, and low power consumption.

## Introduction

Requirements of a thin television in the market have risen while the enlargement of LCD TV advances.

In smaller TV than 30-inch, LCD TV using the liquid crystal module for a display device is the most excellent in low power consumption, brightness and the cost.

20-inch LCD TV developed at this time achieved 49.5 mm thickness while satisfying the high brightness, the high resolution, the multi color reproducing, the rich sound quality, and making low power consumption as results of adopting a newly developed backlight system, a 19.7 inch liquid crystal module of the high color purity color filter, a newly developed small speakers, and three dimension at YC separation circuit.

## 1. High resolution

### 1.1 Three dimensional YC separation circuit

In the NTSC signal, using the phase of the chroma signal reverses between frames, luminance signal (Y) and chroma signal (C) are separated by calculating between adjoined frames. In the static image, accurate Y/C separation is possible because the accuracy of the correlation of the pixel between frames is very high. For the noise element in which the correlation does not exist between frames, the noise can be decreased by cyclic access.

### 1.2 Gray scale correction circuit

When driving the liquid crystal module, it is necessary to correct the gray scale according to one permeability in the voltage characteristic of the liquid crystal panel. **Fig 1** shows a permeability characteristic of 20-inch liquid crystal panel. There are three gray scale correction methods; analog method, digital method and gray scale voltage correction method.

Though an analog method obtains an excellent pixel characteristic, the circuit becomes very complex if corrected by the analogue only. In case of the digital method, if numbers of bit are few, the quantum noise shall

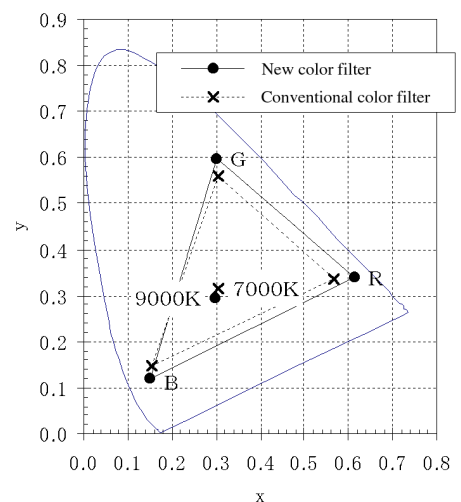


Fig. 1 Liquid crystal panel transmissivity characteristics.

become eminent, and if numbers of bit are many, calculation number circuit becomes complex. In the gray scale voltage correction method, since the correction is performed by applying the characteristic to the reference voltage in setting the reference voltage in detail which decide the gray scale, the correction curve cannot be freely set because of electron noise.

In this model, a combined analog correction and the gray scale voltage correction is implemented and attained an excellent gray scale reproduction characteristic at low cost, in considering the circuit cost and the characteristics.

### 1.3 Multi color reproduction

In this model, color reproduction range is expanded, and the color filter of the liquid crystal panel is improved in order to attain more vivid image. The color temperature of the backlight described later has been changed. **Fig 2** shows the color reproduction range of 20-inch TV.

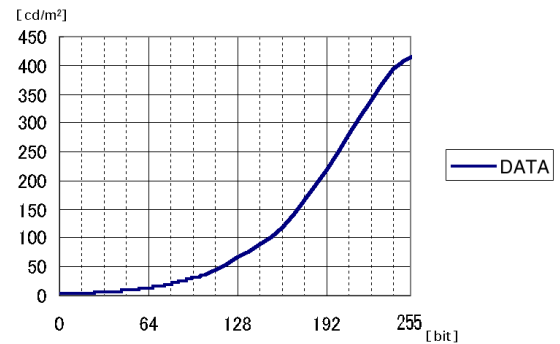


Fig. 2 Color reproduction range.

## 2. Highly improved sound quality

Thin profile of 4.95 cm is one of features of LC-20V1 20-inch LCD TV. Since the inside space is largely filled with the liquid crystal panel, the backlight, and the circuit chassis, how speaker system is created in this narrow space was the biggest problem to solve in order to reproduce the rich "Sound".

In consideration of producing the sound quality of LCD TV that is easy to listen, not tiring, a capability to reproduce a certain frequency range is required. Then, the reproduction capability on the bass side range became a problem. The space allocated to the speaker system was a part of 3 - 4 cm high. We judged it was apart from a reality to use this limited space since putting the speaker systems in this small area to reproduce the sound of bass range in maintaining rear space of TV. It would make the unit larger and the capacity of rear unit could not be maintained. Then, we thought about reproducing the sound by dividing the frequency range. A pair of speakers for high and middle range (3 x 4 cm oval) were mounted in the space underneath of the screen and a speaker for low range bass speaker (8 cm round) was mounted in rear facing backward. Since independent speakers for right channel and left channel of bass side range was impossible spacewise, right and left signal are synthesized in making base side range speaker one forming 3D speaker system (2 ways, 3 speakers). Multi-amplifier (3 amplifiers) system was adopted enabling to drive each speaker with the amplifiers exclusively prepared for the frequency range.

Foregoing is assumed to be a basic design and the problem solution is discussed as follows.

### 2.1 Development of thin type bass range speakers

The development of the speaker for a thin bass region is indispensable to achieve 4.95 cm of the TV thickness. It must be as thin as possible while satisfying the performance and reliability. As a technique, firstly, the cancellation magnet was eliminated since liquid crystal is not influenced by magnetism unlike CRT. Secondly, the down roll edge was adopted (dashing out 0 mm at the maximum amplitude) to evade cone paper dashing out in front when the vibration board edge part vibrates. As a result, though it was a 8 cm bass range speaker the thinness of 24 mm was attained.

### 2.2 Structure design of sounds

The high and middle range speakers, mounted underneath of the screen were sealing box structure of about 140 cc each both left and right in order to keep sound quality clear. The bass range speaker could not be put in a space requiring box because of the limited space and radiation. Then, without having an independent special box internally, the entire TV internal space was made as if a speaker box. Capacity is secured, the sound leakage is decreased and the interfere of the prevention sound has been decreased by improving an internal sealing up degree

as much as possible in relation to devising the radiation holes.

### **2.3 Electric frequency range design**

Since 3D system aims to attain utmost separation of left and right, the woofer, prepared for synthesized right and left sound reproduction, cannot produce the frequency that is higher than bass range. However, in the system at this time, if the base range is completely divided electrically, some acoustically inconvenient frequency range would be generated. In order to overcome the inconvenience, the speakers for high and middle range, mounted in the space underneath of the screen, are made to reproduce the entire frequency range making the woofer to supplement the lack part in the base range sound. The belt region on the bass range side has been decided electrically in a manner that a right and left separation degree shall be maintained as much as possible.

In order to attain "thin structure" which is the feature of the LCD TV, the aforesaid solutions were implemented enabling to design better sound system. As a result, we could develop a sound system of easy to listen not tiring in maintaining clear middle and high range sound while obtaining volume feeling of bass range sound.

## **3. Backlight**

In the LCD TV, the improvement of the picture quality, for instance, often leads to the decrease in the screen luminance of the decrease such as the permeability of the liquid crystal panel etc. In 20-inch LCD TV of this time, as the better picture quality that was not possible to produce in the conventional LCD TV, a backlight of luminance about 1.5 times better than the conventional system was required.

Generally, the technique of adopting the backlight of the right under formula and increasing the number of the lamp is used in order to obtain a high luminance on a large screen. However, because there was a requirement to minimize the thickness of the entire TV, a light introducing board method backlight of a new lamp layout was developed. Luminance 400 cd/m<sup>2</sup> on the screen was able to obtain by devising the composition of optical seat, installation structure, etc.

The lamp life was also improved. A 40,000 hours life which drastically exceeded 28,000 hours of a former model (15 inch) was achieved by using external mercury introduction method lamp, etc.

### **3.1 Problem on backlight designing**

In a conventional LCD TV, a white color temperature has been designed in the vicinity of 7000K near the luminescence color of the sun. However, in this 20-inch LCD TV, design began to reproduce white in the vicinity of 9000K by increasing blue of the phosphor of the lamp and reducing red and green in order to produce more vivid white.

As results of decreasing a fluorescent body green which contribution rate to the luminance high, because blue sensitivity is low in human eyes characteristics, the efficiency of the backlight has decreased by about 10% by raising the color temperature from 7000K to 9000K.

Additionally, a color filter of the liquid crystal panel of about 15% lower permeability from the conventional color filter was adopted in order to expand the range of color reproduction.

Moreover, the light introducing sheet which is called prism sheet is often used to improve the luminance in the direction of the front to the backlight of the liquid crystal panel. However, when light introducing sheets are used, the luminance of upper and lower (or, upper and lower and right and left) direction lowers although luminance in the front goes up to 1.2 times to 1.6 times. Contrary to the monitor for PC, it has been forecasted that the users will watch the TV screen from various directions of large screen LCD TV. Light introducing sheet was not adopted enabling to obtain an excellent view from various viewing angle.

As a backlight for three picture quality improvements, color temperature, reproduction range, and view corner - luminance characteristic, about 1.5 times faster speed were needed comparing with the conventional LCD TV design.

### 3.2 Technique for luminance improvement

#### 3.2.1 Method of backlight

There are two types of backlight for the liquid crystal panel; the right under type which the lamp is arranged under the panel, and the light introducing board type to lead light under screen with transparent acrylic board by arranging lamp in edge part of screen.

In the right under type, it is possible to obtain the required luminance by increasing the number of the lamp, uneven luminance shall be created where the part with the lamps below and the parts which are not. To soften this irregular luminance, the distance from the panel to the lamp is needed and the thickness of the backlight becomes in the vicinity of 30 mm to eliminate such irregular luminance. We are compelled to give up the adoption of the backlight of the right under type in order to materialize "50 mm or less in the TV thickness" which is the target of 20-inch LCD TV at this time.

The light introducing board type backlight is generally used for note PC etc. Most of them use one lamp in lengthy side or one lamp each in upper lengthy side and lower lengthy side - two-lamp system. In the PC monitor for which a high luminance is required, some examples of four lamps in total each of two lamps at the top and bottom are noticed. Since a high luminance was required in this 20-inch TV, the light introducing board type backlight of the fluorescent tube composition with six lamps in total, three each upper and lower, was adopted. **Fig 3** and **4** show the backlight system and the lamp layout of 20-inch LCD TV.

In the light introducing board type backlight, it is the most important point how efficient to put the light of the lamp in the light introducing board. The method of displaying the lamp concurrently to the light introducing board is adopted as an efficient method usually. When three lamps are used, usually the thickness of the light introducing board becomes 10 - 12 mm in the lamp layout arranged.

Then, in order to make the unit in thin structure and light in weight, the lamps were arranged to become reverse triangular toward the light introducing board in order to increase the incidence efficiency. As a result, the incidence efficiency equal to the light introducing board thicker than 10 mm was obtained with the light introducing board of 8 mm thick.

#### 3.2.2 Reflective polarizer installation structure

The polarizer of the liquid crystal panel shall lose the light about 50% theoretically because it absorbs the light other than the polarized light axis. To decrease this light loss, the polarizer of an opposite type is put in the backlight side. Although the polarizer of a reflective type cannot be eliminated from the liquid crystal panel since the polarized light degree is not enough, it is possible to improve the luminance about 30% in reusing the light absorbed by the panel polarizer by returning it to backlight. However, since the difference of heat expansion rate of the reflective type polarizer between the reflective axis and the penetration axis of light is five times or more, wrinkle is generated in the sheet by the rise of the ambient temperature.

In a conventional backlight, the generation of wrinkle was reduced by arranging the diffusion sheet having a soft spot of polycarbonate without birefringence (not to polarize) on the reflective type polarizer (panel side). The less diffusion sheet of polycarbonate is more expensive than the diffusion sheet of usual PET and makes screen luminance decreased by about 10%.

Then, in this 20-inch TV, the examination of the maintenance structure of an opposite polarizer is repeated from

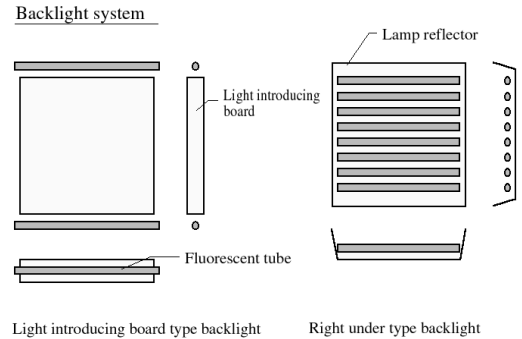


Fig. 3 Backlight system.

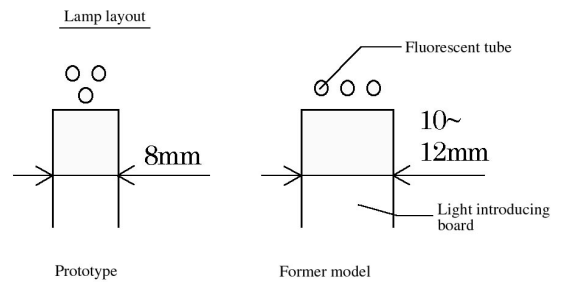


Fig. 4 Lamp layouts.

the earlier stage of the design, and the development of an easy to manufacture steady sheet maintenance structure which was not wrinkle without using less diffusion sheet has been developed.

### 3.2.3 Others

As to the opposite sheet arranged on the back of the light introducing board, the backlight efficiency of a conventional 7% improvement was able to obtain by optimizing the composition.

The number of sheets of the optical sheet also was reduced from five of previous model (15 inch) to three and the productivity was improved by making the structure easy to assemble.

### 3.3 Lamp life

Lamp (fluorescent tube) life is an important element as well as the luminance for the characteristics of the backlight. **Fig. 5** shows the structure of the lamp.

The life of a fluorescent tube is greatly effected by the amount of the mercury enclosed internally and the amount of mercury enclosed was limited from the size of the electrode because the electrode also serves as the dispenser of mercury in a conventional fluorescent tube. The external mercury enclosed method that the amount of mercury was able to be set freely was used though some manufacturing processes became complex in the lamp adopted at this time. As a result, the life of fluorescence tube of the 20-inch TV was improved to 40,000 hours which greatly exceeded 28,000 hours of the previous model (15 inch).

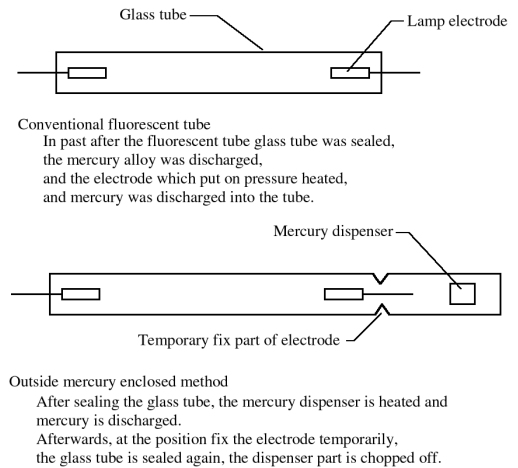


Fig. 5 The lamp structure.

### Conclusion

The 20-inch LCD TV reaches a level to be replaceable to CRT TV in performance. This offers low power consumption and provides variety of installation methods such as wall hung, having features such as flicker free, gentle to eyes, etc. In order to popularize LCD TV in home as main TV, we must make every effort for the development in the areas; further expansion of screen size, improvement of contrast, improvement of response speed, and reducing cost competitive to CRT TV.

### Acknowledgment

Finally, the author wishes to express his deep gratitude to those concerned of the TFT Liquid Crystal Display Group and Electronic Components Group for their cooperation in developing this machine.

(received June 15, 1999)