

High-definition Plasma TVs

— Hitachi is a World Leader in Bringing High-definition TV Products with High Precision Screens in Convenient Sizes to the Market —

Kosuke Ozeki
Masahiko Umeda
Mitsuo Okimoto
Akira Omachi

OVERVIEW: The 20th century, which is often referred to as the video era, has come to a close. The driving force in that era was the TV broadcasting industry, which is about to change significantly in the 21st century with the emergence of digital broadcasting. The market for flat-panel displays using plasma panels and liquid crystal panels is rapidly expanding. In addition to CRTs and digital devices that have been the heart of imaging devices, plasma TVs are expected to be leading next-generation display devices: they are thin, lightweight, and have a wide viewing angle. Working towards the wide-spread availability of plasma TVs, Hitachi first introduced a 32-inch plasma TV on the market in April 2001. The 32-inch plasma display panel of this TV employs the alternate lighting of surfaces (ALIS) method to support high-definition digital broadcasting. The display has 1,024 pixels vertically and it is 82 centimeters in diagonal (which corresponds to a 34-inch CRT TV set). Hitachi has thus become a world leader in high-definition, high-resolution HDTV displays with a size that was previously difficult to obtain. In addition, in September 2001, by having introduced two new models of its digital broadcasting satellite (BS) high-definition plasma TV, with 37- and 42-inch displays, Hitachi has brought a total of five models of plasma TV onto the Japanese market.

INTRODUCTION

TVs and displays with a plasma display panel (PDP), which are thin, lightweight, high-intensity, and have a wide viewing angle, have been predominantly used in commercial applications because of their large screens of 42 and 50 inches. Recently, however, the advantages of thin plasma TVs have become obvious, and the demand for such TVs to be used in the home is gradually increasing.

Hitachi has recently taken on the task of making PDPs smaller as part of our effort to encourage the use of thin TVs as next-generation TVs in the home. With the goal of introducing plasma TVs into homes, Hitachi has put into the market the W32-PD2100 and W32-PDH2100 models of high-definition plasma TV with 32-inch high-definition PDPs, whose size is more appropriate to a standard Japanese living room.

In addition, Hitachi also provides specially designed stands for wall-mounted units, as well as movable stands, open stands, side racks, and low racks to allow flexible installation so that the TV matches the interior of the living room. This flexible installation has been made possible by the advantages of our plasma TV including its thin display and light weight.

TVs can also be used as home theater systems.

To further promote the spread of plasma TVs, Hitachi has brought the world's first 37- and 42-inch high-definition plasma TVs onto the market. Here, the development of Hitachi's TV products is described in further detail.

MARKET RESEARCH ON CONSUMER ATTITUDES TOWARD PLASMA TVS

User Surveys

To formulate a strategy for the development of plasma TVs of particular sizes for home use, we conducted two surveys to find out what consumers thought about TVs of different sizes. The surveys were based on focus group interviews.

Focus group interviews of designers, intellectuals, and large-screen TV users

Cardboard models of 28-, 32-, 36-, 42- and 50-inch plasma TVs were used in this survey to collect opinions about a plasma TV that would be ideal for home use. The results indicated that ideally, the plasma TV should be 28 to 32 inches, movable, light and simple. In a qualitative survey, the answer "it should be light" was

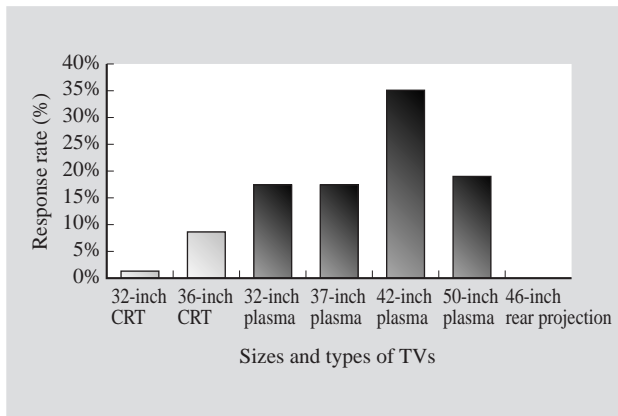


Fig. 1— What Kind of TV Would You Buy Next? (Prior to indicating prices)

The focus is particularly on the 42-inch plasma TV.

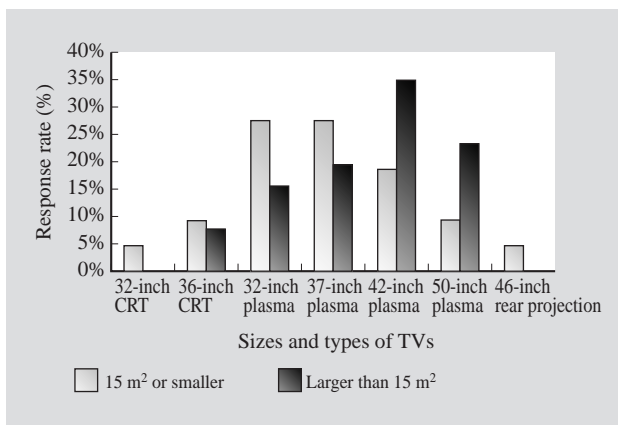


Fig. 2— What Kind of TV Would You Buy for Your Living Room? (Prior to indicating prices)

In Japanese cities, the 32- and 37-inch models were well received.

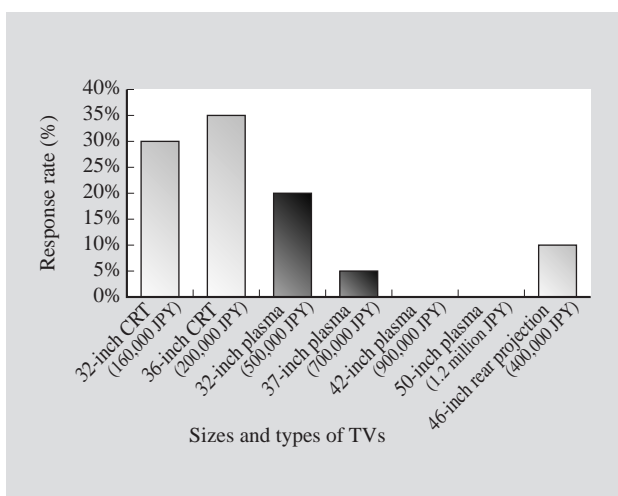


Fig. 3— What Kind of TV Would You Buy Next? (After indicating prices)

CRT TVs were frequently selected, though 25% of users also selected 32-inch plasma TVs because they are thin.

elicited. The results also indicated the need to “provide movable attachments” such as stands of various types, and the favored TV size in this survey was 32 to 36 inches.

Consumer opinion survey

Design models of 32- and 37-inch plasma TVs, actual 42- and 50-inch plasma TVs, 32- and 36-inch CRT TVs, and 46-inch rear-projection TVs were used in the evaluation.

The interviewees were asked to identify criteria other than the price for selecting a new TV. The results are shown in Fig. 1, where the focus is on plasma TVs. The number of people saying they will buy a TV with a 42-inch screen was particularly high. The results indicate that people prefer next-generation TVs with a large screen and a thin display.

On the basis of user profiles obtained from the survey, the users were divided based on the size of their living room where the TV would be located. Those who had a large living room (larger than 15 m²) preferred the 42-inch model, while those whose living room was 15 m² or smaller opted for the 32- and 37-inch models. Based on these results we estimated that the 32- and 37-inch models will be more appropriate for the relatively small houses in urban residential areas (see Fig. 2).

Many respondents also had very positive opinions about plasma TVs as the TVs that would create a new lifestyle and make their life more comfortable by: (1) allowing for more space in the room, (2) fitting better with the room interior, (3) creating a feeling of spaciousness, and (4) allowing for flexibility in furniture arrangement.

We then showed the respondents the estimated selling price of plasma TVs.

About 65% of respondents chose the CRT TVs as the TV they would buy. However, 25% of respondents said that they would consider buying a plasma TV even if it were 500,000 JPY or more. Many respondents chose the 32- and 37-inch models, indicating their preference for a thin plasma TV over one with a large screen (see Fig. 3).

Based on these results, we tried to determine the screen size and the selling price of plasma TVs that would be affordable to buyers in order to encourage the spread of plasma TVs. Thus, Hitachi developed its debut strategy.

Concept

A concept was developed for the promotion of high-

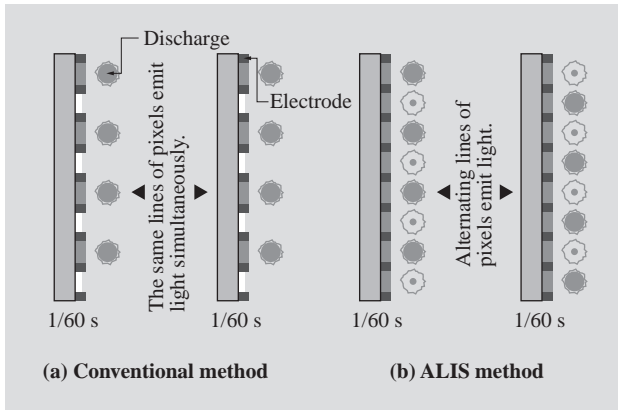


Fig. 4— Comparing Conventional and ALIS Methods. The ALIS method provides twice the number of pixels vertical resolution with the same electrode pitches as the conventional method. This method is effective in achieving higher definition and resolution with a smaller size.

definition plasma TVs and the development of plasma TVs began.

The slogan “The days of adjusting your lifestyle to a TV are over. A new form of TV watching has emerged as part of your life” was adopted. Thanks to high-quality imaging, “a TV can now adjust itself to your lifestyle,” while being close to the size that suits your lifestyle.

The new TV features (1) advanced design, (2) flexible installation, and (3) high-definition image quality.

HIGH-DEFINITION PDPs

ALIS Panels for 32-, 37-, and 40-inch Digital HDTVs

To improve the resolution of PDPs, the size of each pixel pitch (cell) must be reduced and the number of electrodes increased. However, with smaller cells, there are trade-offs between the aperture ratio, intensity, and yield in cell microfabrication, making small high-definition PDPs has thus been difficult. Although the number of electrodes in our PDP is almost the same as that in video-graphics-array (VGA) PDPs, by using the alternate lighting of surfaces (ALIS) method that enables alternating even and odd lines of electrodes to make pixels emit light, the definition is improved with 1,024 pixels vertical resolution which is twice the resolution of a conventional TV (see Fig. 4). The graininess of low bright images has been reduced by using a newly developed multi-tone LSI in the panel actuator. In addition, the image blackness has been intensified and the color reproducibility enhanced by

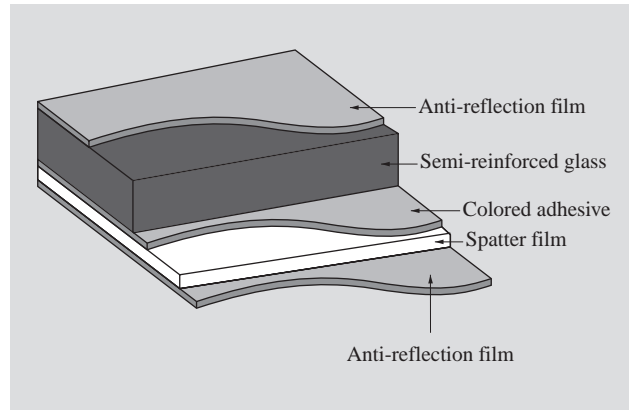


Fig. 5— Structure of Newly Developed MBP Colored Film. Mounting the MBP colored filter panel on the front of a plasma TV improves the color purity and contrast. This panel also serves as an electromagnetic-wave shield.

means of a newly developed multi-band pass (MBP) color filter that enables the reproduction of images with better color purity than that in CRT TVs (see Fig. 5).

HITACHI'S PROPRIETARY IMAGE PROCESSING TECHNOLOGY

The plasma TV we developed has a TV monitor and a separate audio-video control (AVC) station, which serves as a tuner, and the monitor and the AVC station are connected by a single cable. Peripherals, such as VCR and DVD players are connected to the AVC station, which allows to arrange the station separately from the monitor (see Fig. 6).

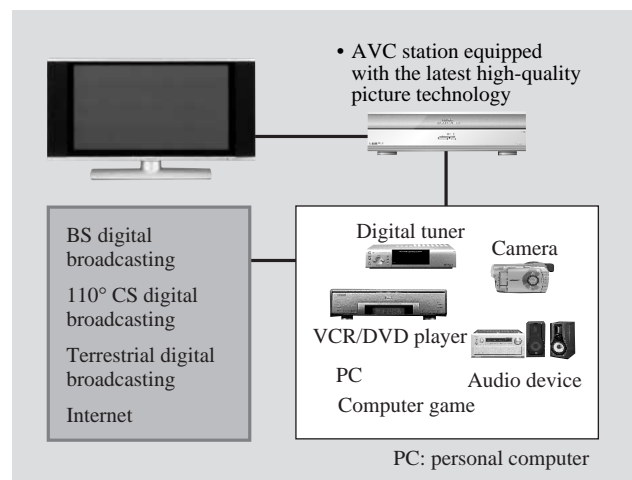


Fig. 6— System Separating the AVC Station and the Monitor. Peripherals are connected to the AVC station and can be placed some distance away from the monitor. The compactness of a plasma TV allows for a simplified layout.

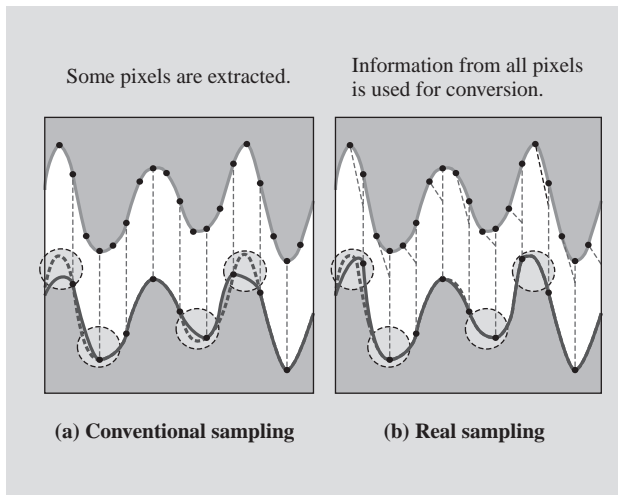


Fig. 7— Comparing Conventional Sampling and Real Sampling. The upper waveform represents the signal wave of input data. As shown in (a), by conventional sampling, the sharpness of data represented by the waveform is lost, and the waveform is smoothed out. With real sampling, as shown in (b), the sharpness of data is maintained and realistic images are reproduced.

Through the use of Hitachi's proprietary high-quality picture technology known as advanced progressive LSI and a new multi-scan converter LSI, the AVC station converts all input image formats into high-quality formats suitable for high-definition PDPs.

Advanced Progressive LSI

High-definition reproduction of input images is supported by the use of the following LSI technologies: (1) Three-field vertical & temporal (VT) interpolation that enables highly precise interpolation of moving images

With the LSI technology, the interpolation of a scanning line is performed by using vertical-image information obtained from a total of three fields: the current field, the preceding field, and the following field. This technology helps alleviate the sense of discontinuity when watching some moving pictures, and enables producing more realistic images.

(2) A "film theater" function, which enables clear reproduction of digital movies

When digital movie data are input, the function automatically determines whether the data are in the form of film images. With film images only, all 30 frames are processed as still pictures and are then displayed. As a result, images are seen as in a movie theater, which means that the users can enjoy high-quality image reproduction. High-precision interpolation of moving pictures can also be performed.

Newly Developed Multi-scan Converter LSI for Use with Flat Panel Displays

Hitachi's plasma TV includes a newly developed multi-scan converter LSI, which displays PC signals (RGB: red, green, and blue signals) from the AVC station, digital high-definition images from D4 terminals, and broadcast image signals (in the NTSC format) on a high-definition PDP. This LSI enables producing different images with high resolution as well as performing high-precision pixel conversion.

Real Sampling

With conventional direct sampling, the number of effective horizontal pixels in the 1125i and 750p formats for digital high-definition images has to be converted from 1,920 and 1,280 pixels to 852 horizontal PDP pixels in the 32-inch model and 1,024 pixels in the 37- and 42-inch models. The pixel data are then culled, and sampling is performed [see Fig. 7 (a)]. As a result, however, data for image outlines get lost and low-resolution images are produced.

To solve this problem, we introduced a new method of real sampling that samples high-definition image data in the 1125i and 750p formats with 1,920 and 1,280 effective horizontal pixels. By using horizontal-pixel information, high-precision interpolation is performed and the data are converted into a display format that best suits high-definition PDPs [see Fig. 7 (b)]. Thus, beautiful high-definition images can be reproduced.

DESIGN FEATURES

Concept for the External Design

With imaging devices like plasma TVs, the focus is on the viewer rather than on the TV itself; the design of such devices is based on considerations about the movement, rotation, and the position of the TV at the right height for the line-of-sight. The external appearance of our TV was an important consideration particularly in the design of 32- and 37-inch plasma TVs, which are intended to be living-room-size models, designed to expand the selection of available plasma TVs.

The tabletop stand for 32- and 37-inch plasma TVs has a swivel (rotation) mechanism that allows the screen to be rotated 20° to the right or left (see Fig. 8). Thus, the viewing angle of the screen can be easily changed to bring the screen in the line-of-sight of the user watching the TV, an advantage that only plasma TVs have. In addition, this model is the industry's first 37-inch plasma TV model.

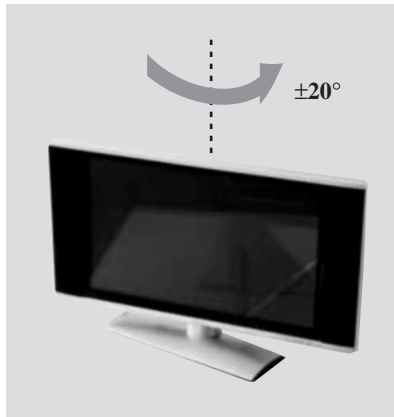


Fig. 8— Swivel (Rotation) Mechanism. The mechanism allows a 32- or 37-inch plasma TV to be rotated 20° to the right or left so that the viewing angle could be adjusted.

A Variety of Stands for Living Rooms that Match the Interior

The lineup of stands is based on the advantages of plasma TVs: their thin screen and light weight. Stands can be selected to match the interior of the living room from the list shown in Fig. 9.

(1) Movable stand

This stand is based on a major feature of plasma TVs, that is, that they are not affected by geomagnetism. Equipped with castors and a push handle, the TV can be moved anywhere and the direction it faces can be easily changed. The stand was co-developed by Asahi Industries Co., Ltd. and Wilkhahn Wilkening + Hahne GmbH of Germany.

(2) Open stand

This stand has open racks and it is best used for two or three peripheral imaging devices in a combination with the included tabletop stand. In addition, the stand has a swivel mechanism.

(3) Wide open box rack

This rack provides an attachment storage for a true home theater. By using metal brackets for the wall stand, the TV can be mounted on the wall. A center speaker can be placed in the center of the box rack, which can be used together with woodgrain side racks.

(4) Wall-mounted units

The TV can be installed as a fixed unit or as a movable unit that allows for the up and down adjustment of the viewing angle.

DIGITAL HIGH-QUALITY SOUND

(1) A digital amplifier with 1-bit $\Delta\Sigma$ modulation for the reproduction of high quality sound equivalent to that from high-end audio amplifiers

A digital amplifier is used as the power amplifier, which eliminates sound distortion. The circuit can



Fig. 9— Installation with Different Types of Stands. Stands can be selected to match the interior.

reproduce sound from high-quality digital sound sources. At the same time, the amplifier is effectively actuated at a sound conversion rate of 80%, so that the amount of produced heat can be reduced to obtain a small and lightweight circuit.

50-MHz sampling with 1-bit $\Delta\Sigma$ modulation is performed for all input sounds, to cover both loud and subtle ones. This method provides excellent noise shaping (background noise elimination) and improves the signal-to-noise (SN) ratio, allowing for the reproduction of a wide variety of sounds in a dynamic range. As a result, rich sounds can be reproduced that are faithful to the original sounds.

(2) New TruBass* technology to reproduce bass by using a bass reproduction method for pipe organs

In pipe organs, extremely long pipes are normally required to reproduce rich bass sounds. Normally, two pipes are used to produce sounds with different frequencies at the same time. The acoustic characteristics of the human hearing enable us to hear sounds of both frequencies at the same time while natural bass is heard as a different component of these tones. The new TruBass technology used in plasma TVs uses this sound effect to reproduce bass with compact speakers. This technology is based on using

*: TruBass is a registered trademark of SRS Labs, Inc.

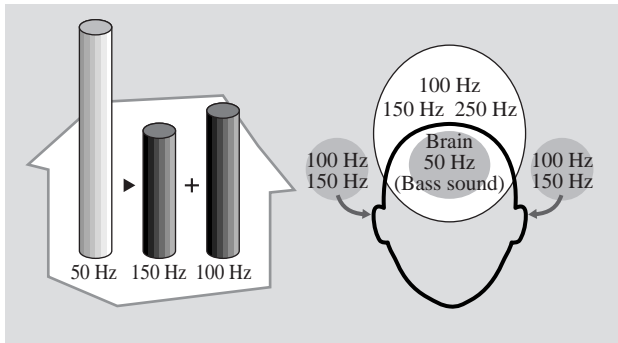


Fig. 10— Principle for “TruBass” Reproduction of Bass Sounds. To reproduce bass sounds of 50 Hz, 100 Hz and 150 Hz, which are higher harmonics of a 50-Hz bass sound, are emphasized and the difference is sensed.

sounds with two frequencies in a range that the speakers can reproduce. The difference in frequency between the sounds is interpreted as bass (see Fig. 10). This technology enables bass-sound playback and gives priority to compactness.

CONCLUSIONS

This paper described the development of Hitachi’s high-definition plasma TVs.

In 2001, Hitachi developed three models of high-definition plasma TVs with 32-, 37-, and 42-inch screens with internally mounted BS digital tuners. At the same time we developed 32- and 37-inch high-definition plasma TVs, which brought the total number of plasma TV models to five.

Plasma TVs with 32-, 37-, and 42-inch PDPs with high-definition panels will soon be introduced in Europe, and their promotion will begin in Asia and North America.

ABOUT THE AUTHORS



Kosuke Ozeki

Joined Hitachi, Ltd. in 1983, and now works at the Marketing and Products Planning Department of the Digital Media Division. He is currently engaged in domestic TV product planning. Mr. Ozeki can be reached by e-mail at ozeki@dm.kaden.hitachi.co.jp.



Masahiko Umeda

Joined Hitachi, Ltd. in 1985, and now works at the PDP Engineering Department of the Digital Media Division. He is currently engaged in domestic plasma TV design. Mr. Umeda can be reached by e-mail at umeda@cm.yokohama.hitachi.co.jp.



Mitsuo Okimoto

Joined Hitachi, Ltd. in 1985, and now works at the Display Mechanical Engineering Department of the Digital Media Division. He is currently engaged in domestic plasma TV design. Mr. Okimoto is reached by e-mail at m_oki@cm.yokohama.hitachi.co.jp.



Akira Omachi

Joined Hitachi, Ltd. in 1981, and now works at the Second Product Design Department at Design Division. He is currently engaged in design of plasma TVs and liquid crystal projectors. Mr. Omachi can be reached by e-mail at a_omachi@design.hitachi.co.jp.