

A High-resolution Reflective-type LCD Projector

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OVERVIEW: The use of digital technology in such forms as personal computers in offices, schools, or homes is continually growing. At the same time, the usage of liquid crystal display (LCD) projectors is changing; for example, they are being increasingly used for meetings, training sessions, classroom education, presentations, and visual entertainment. To keep abreast of these rapid changes, it is essential to develop projectors that can provide high brightness, high resolution, and many functions in a compact, light unit. Hitachi, Ltd. has fully satisfied the above-mentioned requirements with the development of a new LCD projector—the CP-SX5500W. This projector supports the projection of real SXGA (super extended graphics array) images. It has the following main features: a 0.9-inch high-resolution (vertical: 1,365 dots; horizontal: 1,024 lines) reflective-type LCD panel based on Hitachi's own LCoS (liquid crystal on silicon) technology; an optimized optical design with a 220-W ultrahigh brightness lamp; a brightness of 1,500 ANSI (American National Standards Institute) lumens; and low weight (5.6 kg). Outstanding projection performance is provided by several advanced features: a "real" image display compatible with VGA to SXGA formats, horizontal-vertical keystone correction of image distortion, multiple input/output terminals, progressive scanning for high picture quality, a "picture-in-picture" function, a partial expansion function, a freeze function, and remote control by PC mouse or laser pointer.

INTRODUCTION

THE market for projectors can be separated into two categories: projection of video pictures for home use, and projection of images on personal computer (PC) screens for business use. In regards to video projection, as BS (broadcasting satellite) digital broadcasting becomes full scale, projectors must not only support such broadcasting but also provide high-quality pictures. At the same time, the resolution and brightness of PC images are rapidly being improved.

In response to these circumstances, Hitachi's product lineup is being strengthened in order to meet the demands for higher picture quality, higher resolution, and portability. As part of this lineup, a new projector—the CP-SX5500W—has been developed as a "universal projector" that meets all the demands mentioned above. Its detailed specifications and performance are outlined in the following sections (see Fig. 1).



Fig. 1— CP-SX5500W: A High-Resolution, Reflective-type LCD Projector.

The CP-SX5500W is based on Hitachi's own 0.9-inch reflective-type LCD panel and provides high-quality, high-resolution pictures to meet the growing demands of business and home markets in the digital era.

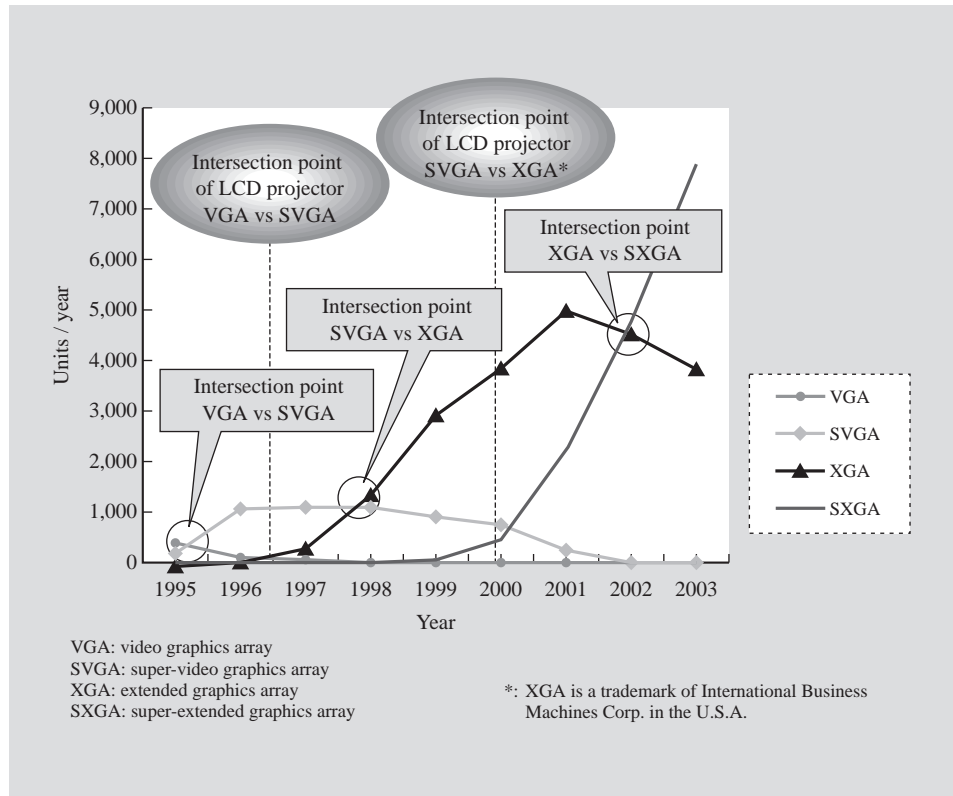


Fig. 2— Trends in the Market for LCD Projectors. The trend lines describing the demand for VGA, SVGA, XGA, and SXGA resolution in PC and projectors are indicated.

TRENDS IN THE LCD PROJECTOR MARKET

Recent trends in display resolution for personal computers and projectors and their crossover points are shown in Fig. 2. The biggest use of projectors is for projecting PC images onto a large screen in business meetings, training sessions, various kinds of presentations, school lessons, and lectures. Trends in the PC market therefore have a big influence on the projector market. It is clear from the figure that the demand for PCs with resolution beyond that attained by SXGA will continue to increase; thus, it is anticipated that the demand for projectors that can match this increasing PC performance will also increase.

It is considered that the “volume zone” regarding projector brightness (i.e., the most practical brightness for the mass market) will be in the range of 1,500-2,000 ANSI lumens. In addition, as well as progress in circuit and microprocessor technologies, products with many functions are being developed. To keep up with these developments, functions such as horizontal-vertical keystone correction and video-picture-quality improvement are being increasingly demanded. Accordingly, with the aim of meeting these demands, Hitachi has developed a new high-resolution reflective LCD projector, the CP-SX5500W.

SPECIFICATIONS AND CHARACTERISTICS OF THE CP-SX5500W

Main Specifications

The main specifications of the CP-SX5500W projector are listed in Table 1. The main features of the specifications are summarized as follows:

TABLE 1. Main Specifications of the CP-SX5500W
 The application of a 0.9-inch reflective-type LCoS (liquid crystal on silicon) panel produces high-resolution, high-quality pictures.

Feature	Specification
LCD panel	0.9-inch reflective-type LCoS panel
Panel pixel density	Vertical: 1,365 dots; horizontal: 1,024 lines
Projection lens	F2.7-F3.1; f = 37.6-48.8 mm
Light source	220-W UHB lamp
Brightness	1,500/1,200 (Whisper mode) ANSI lumens
Zoom	Manual (1:1.3)
Focus	Manual
Sound output	1.0 W (mono)
Power supply	AC 120-240 V (50/60 Hz)
Power consumption	360 W
Dimensions	Width: 350; depth: 335; height: 103 (mm) [not including protruding parts]
Weight	5.6 kg

UHB: ultra-high brightness

(1) High resolution and high picture quality

The CP-SX5500W uses Hitachi's originally developed LCoS 0.9-inch reflective-type liquid-crystal panel, which has a high aperture ratio resulting in fine pixel lines and a seamless projected image. Moreover, by means of the most suitable optical design, high picture contrast (600:1) is achieved.

(2) Design for ease of use

A simple, lightweight design (5.6 kg) means that the projector is easy to carry, and noticeable fan noise has been reduced to 32 dB with Whisper mode.

(3) Various convenient features

Several features are incorporated to enable convenient use: keystone image correction; native resolution mode display compatible with VGA to SXGA image projection; "progressive" projection technology for high-quality picture display; black expansion; "picture in picture" function; partial expansion function; freeze function; and remote control by PC mouse and laser pointer.

Structure and Characteristics of the Optics

The CP-SX5500W is the first model at Hitachi to use a reflective-type LCD panel. The optics of conventional projectors employ a transmissive-type LCD panel. The optical structure of the CP-SX5500W is significantly different from that of conventional projectors in terms of light separation and recombination. The optical characteristics and structure of the reflective-type LCD panel are explained in detail below.

Optical structure

The structure of the optics of the CP-SX5500W is shown in Fig. 3. Its main features are a light-source lamp; illumination of the LCD panel by collecting beams of light from the lamp; separation of polarized white light into three primary colors (red, green, and blue); recombination of the separated colors by the LCD panel (consisting of three layers, one for each color); and projection of the recombined image on the LCD panel onto a broad screen by means of a projection lens.

Optical characteristics

(1) LCoS panel

The use of 0.9-inch LCoS panel increases the aperture ratio to 92% (for SXGA-resolution images), resulting in high brightness as well as a silky smooth picture without noticeable black-matrix lines.

(2) Recombination of separate colors by LCoS panel

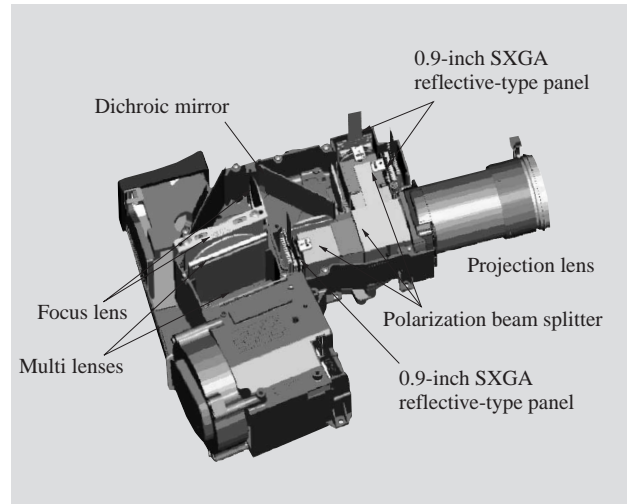


Fig. 3— Structure of the CP-SX5500W Projector Optics. High-efficiency illumination and newly developed color separation-recombination technologies produce high-luminance (1,500 lumens), high-contrast (600:1) image projection.

In the case of a system that uses a transmissive-type LCD panel, the light input is in the form of separate colors that are recombined one by one in the panel. Then the contrast of the output image is adjusted by means of deflection plates arranged in front of and behind the panel. In contrast, in the conventional reflective-type LCD system, the input and output lights to the LCD panel must follow the same path. As a result of this setup, the optics become large and, as a consequence, the contrast suffers. However, the optics of the CP-SX5500W projector solve this problem by means of a compact, unique system that provides high brightness and high contrast at the same time.

(3) Optimum optical design

The illumination system consists of a multi-lens made up of an array of cells whose light axis is eccentric, and the multi-lens is attached to a polarizing beam splitter (which ensures optimum use of polarized light). This design results in highly efficient use of input light. In addition, the f-number (focal length) of the illumination system has been optimally designed to achieve both brightness and contrast considering the angle characteristics of optical comments like a polarizing beam splitter used in color separation/combination systems.

Moreover, in the case of the conventional reflective-type system, because the back-focus distance of the projector lens has become longer, the lens has tended to become bigger. Use of the reflective-type panel in combination with an aspheric lens in the new design,

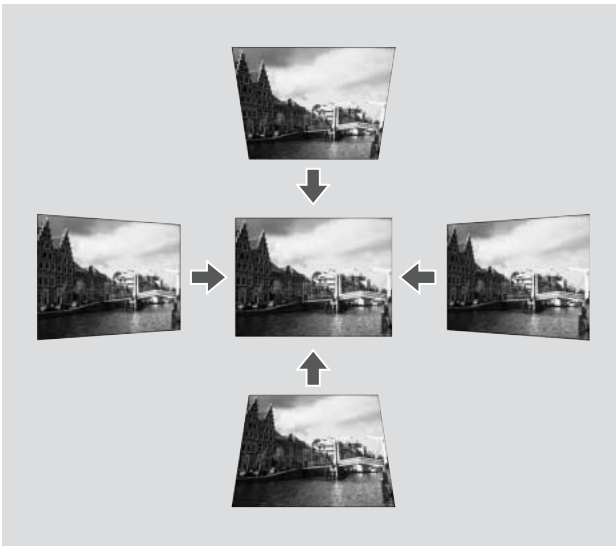


Fig. 4— Horizontal-vertical Keystone Correction.
This technique ensures that sharp images are displayed regardless of the positioning of the projector.

on the other hand, enables 1.3-times zoom and supports high-resolution SXGA images.

The developed optical system uses a 220-W ultra-high-brightness (UHB) lamp that produces a brightness of 1,500 ANSI lumens at a contrast of 600:1. For such a compact “real SXGA” projector, this represents top-class performance.

Circuit Technology and Features

The circuit technology of CP-SX5500W has two additional features; namely, the previously mentioned horizontal-vertical keystone correction and native resolution mode that enables images (from VGA up to SXGA) to be displayed at a 1:1 resolution.

In the case of conventional keystone correction, when the screen and the projector cannot be placed at the same height (i.e., vertically angled projection), the distorted image can be corrected by a “Hi-resizing” circuit so that a non-distorted picture can be displayed. The CP-SX5500W, moreover, has an additional correction function that can handle situations in which the projector is placed to one side of the center of the screen. This means that, as shown in Fig. 4, undistorted, sharp images can be projected regardless of the setting environment of the CP-SX5500W.

The CP-SX5500W is also equipped with a frame-rate conversion circuit to reduce picture flicker, a progressive image-projection circuit for displaying high-quality video images, and two modes for projection of VGA up to SXGA images: full mode for

displaying the whole image for each resolution, and native resolution mode for displaying the image at a 1:1 resolution. These features make the CP-SX5500W easy to use.

Characteristics of the Projector’s Structure

The structure of the whole projector utilizes the conventional characteristics, that is, high resolution and high contrast, of the reflective type LCD.

To ensure high-precision projection, the supporting parts for the glass prism used in the reflective-type optics are made of a special plastic material with almost the same linear expansivity as the glass prism. The resulting structure can maintain stable, high image quality over a long period of time.

Moreover, from the viewpoint of high-precision projection, it is assumed that the projector will be used for education (e.g., CAD: computer-aided design) and entertainment (e.g., HDTV). We therefore focused on a structure that could achieve low noise and high contrast in such circumstances.

Regarding the cooling of the whole projector structure, the air intake and exhaust fans are set away from the vents, i.e., in the central part of the unit; consequently, fan noise is not directly output from the structure. Moreover, the fan and the vents are connected by a duct for which a sound-absorbing mechanism has been designed to reduce noise output. The result of these features is outstanding, low noise performance; namely, 36 dB in normal mode and 32 dB in whisper mode.

In addition, since the lamp and the exhaust vent are separated by the exhaust duct, light leakage from the light-source lamp is completely shut out. This structure thus ensures that high contrast is maintained.

To make the whole structure more compact, the set up around the lamp is positioned diagonally to the optical axis. This unconventional set up removes the “dead space” found in other models, so the size of the CP-SX5500W projector is reduced by 20% and its weight by 18% with respect to conventional comparable Hitachi products.

Since the CP-SX5500W is portable, the circumstances in which it will be moved around will be frequent, so the handle on the body is carefully designed to prevent discomfort when the projector is being carried. Furthermore, since the handle can be folded into the body, the shape of the whole set is unobtrusive.

Including projector design, all of its parts (optical engine, optics, and overall structure) were designed

by three-dimensional CAD; consequently, wasted space was eliminated, and the final design of the CP-SX5500W is as compact as possible.

CONCLUSIONS

Hitachi, Ltd. has developed of a new projector—

the CP-SX5500W—based on a novel application of a reflective-type LCD panel. This universal projector provides high-resolution and high-quality images, has many convenient functions, and is light and easily portable. In the future, we are planning to extend this novel technology into new fields.

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