

# High-brightness LCD Projector

Kiichi Murayama  
Kazuhiro Kaizaki  
Masaharu Deguchi  
Nobuaki Kabuto

*OVERVIEW: Personal computers (PCs) are becoming increasingly common in companies, schools, and other work environments. In meetings, training, education, and presentations, where OHPs (overhead projectors) were once the norm, there is a shift taking place toward the use of PCs with LCD projectors. An analysis of the requirements in LCD projectors shows a demand for (1) brightness, (2) high definition, (3) compactness and light weight, and 4) multiple functions. Hitachi, Ltd. recently completed development of a new, high-brightness, high-definition, multifunction model — the CP-X960 — which is designed specifically to respond to these diversifying needs. The CP-X960, which was released in September 1999, is a “True-XGA”\* LCD projector that has achieved a brightness of 1,800 ANSI lm through the use of an optimally designed optic lens and a 190-W UHB (ultra high brightness) lamp. This model offers “Digital Keystone Correction,” “P in P,” “Digital Zoom,” “Freeze Frame,” and “Laser Pointer” functions, along with a variety of other features that assist the user in creating easy-to-run, high-impact presentations.*

## INTRODUCTION

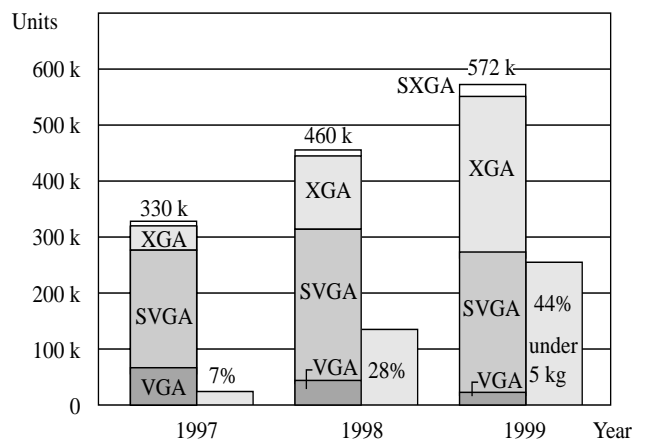
REQUIREMENTS for LCD projectors tend to center on either video recorder imaging (mainly consumer applications) or PC imaging (mainly business applications). Here, we will discuss the trends in the market for the latter of these two, as well as the high-brightness LCD projector “CP-X960” recently developed by Hitachi.

## TRENDS IN THE LCD PROJECTOR MARKET

Recent trends in the global market are illustrated in the graph shown in Fig. 1. LCD projectors are used by companies for meetings, training, and various presentations, and by schools as an educational tool and in seminars, as a tool to project images from a PC screen onto a larger display. Among the characteristics demanded of LCD projectors used to create large images in well-lit locations, the most important is brightness. Part of the reason that production volumes have been expanding steadily is that brightness has increased, which has in turn resulted in an expansion in the number of locations where the projectors can

be used. Even portable units (5 – 10 kg), which last year had a brightness of between 1,000 – 1,400 lm, now offer a brightness level of 1,600 – 2,000 lm.

Furthermore, because LCD projectors are used to display images from PC screens, trends in PCs have also affected requirements for projectors. Fig. 1 shows that along with the expanding number of production



VGA\*: video graphics array SVGA: super video graphics array  
XGA\*: extended graphics array SXGA: super extended graphics array

Fig. 1—Trends in the Global LCD Projector Market.

There has been a steady expansion in production volumes for LCD projectors intended for use with PCs in presentations.

\* VGA and XGA are registered trademarks of International Business Machines Corp. of the U.S.

models, the ratio of extended graphic array (XGA) units is also expanding. One can assume that this is related to the shift in specifications from SVGA to XGA in the screens for the notebook PCs to which the LCD projectors are connected.

Next, we see that small, lightweight machines have come to account for 44% of these production models. This is most likely related to the desire of users to offer presentations easily while on business trips or while visiting customers, along with the fact that these machines can now offer an effective brightness level of 800 – 1,000 lm.

High-level functions have also developed substantially, as a result of the progress in circuit technology and PC software. The newest LCD projectors offer such features as “Digital Keystone Correction,” “P in P,” and digital zoom functions, all of which are intended to create effective, easy-to-run, high-impact presentations, and to improve convenience for users.

The main points regarding the user requirements discussed above can be summarized as follows.

- (1) Brightness levels have increased to 1,600 – 2,000 lm, even in portable machines.
- (2) The ratio of high-resolution XGA models has increased rapidly, to around 50%.
- (3) The ratio of mobile units has also increased; these units now comprise 44% of production models.
- (4) Progress has been made in the development of convenient multiple functions for presentations.

Hitachi has thus developed the CP-X960, a True-XGA LCD projector that meets user needs for both brightness and multiple functions.

## SPECIFICATIONS AND CHARACTERISTICS OF THE CP-X960

Fig. 2 shows a product photo of the CP-X960 XGA LCD projector with three 1.3-inch microlenses. The main specifications are shown in Table 1. The following are the most notable characteristics of this model.

### (1) High brightness (1,800 ANSI lm)

With the CP-X960, Hitachi has achieved a brightness level of 1,800 ANSI lm, an increase of 64% compared to previous models (Hitachi survey). This was accomplished by adopting an LCD panel with microlens; an optical integrator; a low F-value (1.7 F) projection lens; a high-output (190 W), short-arc (1.3 mm), UHB lamp; and a luminous optical system that makes highly efficient use of light through polarized light transformation.



Fig. 2—High-brightness LCD Projector “CP-960.” High-brightness LCD projectors offer clear imaging even in bright rooms, increasing the effectiveness of presentations.

TABLE 1. Main Specifications of the CP-X960 Achieves a brightness level of 1,800 ANSI lm by adopting a high-efficiency luminous optical system and an F1.7 projection lens.

Item	Specifications
Liquid crystal panel structure	1.3" polysilicon active matrix TFT × 3 (with micro-lens)
Number of pixels	786,432 pixels (v 768 × h 1,024)
Resolution	1,024 × 768 pixels
Lens	Power zoom (F=1.7–2.3) 1:1.3 Power focus
Lamp	190-W UHB
Brightness	1,800 ANSI lm
Speakers	1.2 W + 1.2 W (stereo)
Power supply	AC 90 – 132 V/ AC 198 – 264 V
Power consumption	300 W
Operating temp.	0 – 35°C (32 – 95°F)
Dimensions (W × H × D)	289 × 119 × 345 mm (11.4" × 4.7" × 13.6")
Weight	5.9 kg (13 lbs)

ANSI: American National Standards Institute

UHB: ultra-high brightness

### (2) Light weight (5.9 kg)

The CP-X960 is easy to carry, and has a smooth, simple design. Hitachi has reduced the total volume (width × depth × height; not including protrusions) by 64% compared to previous models, and has succeeded in reducing the weight by 25%, to 5.9 kg.

### (3) Addition of Multiple Functions Convenient for Presentations

A number of features have been included to allow more varied and more effective presentations. These include:

- (a) Digital Keystone Correction function
- (b) P in P (Picture in Picture) function
- (c) Digital Zoom function

- (d) Freeze Frame function
- (e) Remote control with laser pointer
- (f) USB connector
- (g) Plug and Play function

A high brightness level of 1,800 ANSI lm has been achieved through the use of an LCD panel with microlens, an F1.7 projection lens, and a high-efficiency luminous optical system.

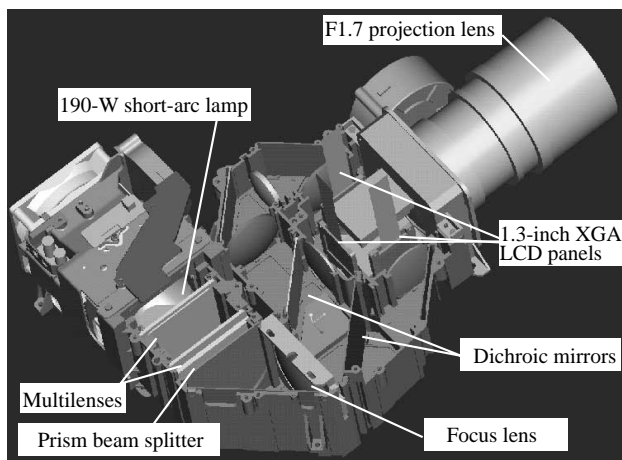
### Make-up and Characteristics of the Optical System

The CP-X960 has achieved a brightness level of 1,800 lm, a 64% increase compared to that of previous models (1100 lm). In order to attain this high level of brightness, Hitachi improved the effective aperture ratio by adopting a microlens for the XGA-compatible LCD panel, and in addition has increased the efficiency of the optical system, including the lamp. Here, we will discuss the make-up and the characteristics of the recently developed optical system.

Fig. 3 is a construction diagram of the optical system developed by Hitachi.

The system is comprised of the following elements: a lamp (the light source); an illumination system that lights up the LCD panel using the lamp's luminous flux; a color separation system that separates the light into three colors: Red, Green, and Blue; an LCD panel with three microlenses; a color synthesis system that creates images on a three-color LCD panel; and a projection lens that projects the image from the LCD panel onto the screen.

The following is a description of the characteristics



*Fig. 3—Newly Developed Optical System.*

*A high brightness level of 1,800 ANSI lm has been achieved through the use of an LCD panel with microlens, an F1.7 projection lens, and a high-efficiency luminous optical system.*

of this newly developed optical system.

#### (1) Adoption of an LCD panel with microlenses

By adopting an LCD panel with 1.3-inch XGA-level image dissection microlenses, Hitachi increased the effective aperture ratio of the LCD panel to approximately 73% from the previous 57%. This, in turn, increased the penetration efficiency of the LCD panel.

#### (2) Development of a projection lens with a large aperture (low F value)

In order to take full advantage of the effects of the improved effective aperture ratio described above, Hitachi developed a multicoating projection lens with a large F1.7 aperture diameter (for a low F value), thus ensuring the best brightness level available for a portable model.

#### (3) Adoption of a short-arc, 190-W UHB lamp

In the case of a luminous optical system comprised of a multi-lens optical integrator and polarized light transformation, in order to obtain more efficient use of light, it is necessary to ensure excellent parallelism from the light source; that is to say, a short arc-length lamp is required. In the past, lamps in the 1.3 mm arc-length class were only available with an output power of roughly 100 – 150 W; for the CP-X960, Hitachi has adopted a bright 190-W lamp. A highly effective coolant is also essential for such a high output lamp. In this model, the light source segment is housed within a half-sealed area formed by the reflector and the front glass. This area is designed with a highly effective forced-air cooling system, allowing a lamp that offers both a short arc length and high output power.

### Multiple Functions Through Improved Circuit Technology and PC Software

Here, we will explain two of the features of the CP-X960 XGA LCD projector: the Digital Keystone Correction function, which corrects imaging distortions that arise as a result of “Gate projections”; and the P in P function, which inserts video images into a PC display.

#### (1) Digital Keystone Correction function

Because of space restrictions in the environment where equipment is used, the screen and the projector are at times set up at an angle relative to one another (“Gate” projection). The frequent result is that the

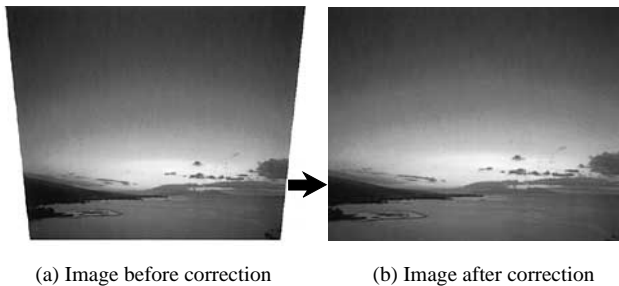


Fig. 4—Effects of the Trapezoidal Distortion Correction Function.

Trapezoidal distortion of images resulting from projection angle (a) is corrected by the trapezoidal distortion correction function (b).

projected image is distorted into a trapezoidal form. The CP-X960 is able to create a clean, undistorted image, through highly precise application of a “Hi-resizing” circuit. In this way, the distorted image signal that has been input is “reverse-corrected” before being brought up on the LCD panel (see Fig. 4).

This function corrects the trapezoidal distortion of images resulting from the projection angle.

#### (2) P in P function

This function makes it possible to insert a video-input screen into a PC-generated image in the form of a “mini-window.”

The user can choose from two sizes for the mini-window;  $320 \times 240$  pixels, or  $213 \times 160$  pixels. The mini-window can be placed in any of the four corners of the main screen.

This function can be used in many ways, to create effective presentations by adding elements that would have been impossible using still displays. Aside from applications in video conferencing, the mini-window can be used to show the presenter’s face or to show supplementary materials through video images.

In addition, the CP-X960 offers remote control mouse operation using USB connections (a feature that has gained popularity as a terminal connection for notebook PC accessories) and additional Japanese menus, along with a range of other features intended to improve ease of use.

## CONCLUSIONS

Here, we have provided an outline of the main features of the CP-X960, an XGA-compatible, high-brightness, portable LCD projector. The CP-X960 offers an excellent brightness level of 1,800 ANSI lm, the light weight of 5.9 kg, Digital Keystone Correction

function, P in P function, and a variety of other features to improve usability and ensure more effective presentations.

In the future, as user requirements for brighter, smaller, and higher resolution LCD projectors increase, Hitachi will continue its efforts to develop the technologies required to offer newer and better models that meet these needs.

## REFERENCE

- (1) S. Obuchi, et al, “Ultra Portable LC Projector with High-Brightness Optical System”; ICCE, Digest of Technical Papers, pp. 132-133 (June 1999).

## ABOUT THE AUTHORS



### Kiichi Murayama

Joined Hitachi, Ltd. in 1972, and now works at the Digital Media Systems Division of the Digital Media. He is currently engaged in planning for the CP-X960 projector. Mr. Murayama can be reached by e-mail at [kmurayam@cm.yokohama.hitachi.co.jp](mailto:kmurayam@cm.yokohama.hitachi.co.jp).



### Kazuhiro Kaizaki

Joined Hitachi, Ltd. in 1983, and now works at the Digital Media Systems Division of the Digital Media. He is currently engaged in circuit design for the CP-X960 projector. Mr. Kaizaki can be reached by e-mail at [k\\_kai@cm.yokohama.hitachi.co.jp](mailto:k_kai@cm.yokohama.hitachi.co.jp).



### Masaharu Deguchi

Joined Hitachi, Ltd. in 1985, and now works at the Digital Media Systems Division of the Digital Media. He is currently engaged in optical systems design for the CP-X960 projector. Mr. Deguchi is a member of the Institute of Image Information and Television Engineers, and can be reached by e-mail at [deguchi@cm.yokohama.hitachi.co.jp](mailto:deguchi@cm.yokohama.hitachi.co.jp).



### Nobuaki Kabuto

Joined Hitachi, Ltd. in 1980, and now works at the Digital Media Systems R&D Division of the Digital Media. He is currently engaged in display systems development. Mr. Kabuto is a member of the Institute of Image Information and Television Engineers, and can be reached by e-mail at [kabuto@msrd.hitachi.co.jp](mailto:kabuto@msrd.hitachi.co.jp).