An AC Plasma Display Module

Shozo Umeda,* Yasunari Shirouchi,* Hiroyuki Ishizaki* and Tadatami Mori*

Abstract

The plasma display panel, used here, has an active area of 307 mm×307 mm, with crossed grid electrodes of 512×512 lines.

A dielectric film, which covers electrodes of the panel to separate them from discharging gas, is processed to be opaque for a screen of the slide projector by dispersing Al_2O_3 into dielectric material of lead borosilicate glass.

Electrodes, less than 100μm in width, are fabricated by squeezing conducting paste containing gold into grooves pre-etched on the substrate glasses.

An optical image projected on the plasma panel through a slide film can be superimposed on a graphic or a character display written in accordance with the data from an information processing system without any parallax.

1. Introduction

This paper describes a graphic display hardware using AC plasma display. In 1971, W. E. Johnson and others presented a paper on an AC plasma display module having 512×512 lines and an effective display area of 8½ inches square in the United States.(3)

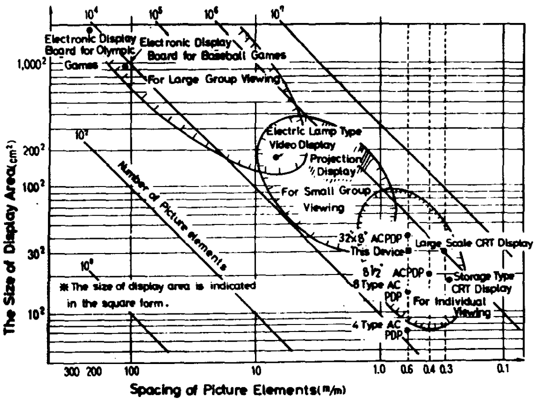

Fig. 1 Size vs. Picture Element Pitch of Various Display Devices.

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* Fujitsu Laboratories Ltd., Electron Device Laboratory

Because of its high positioning accuracy, clear and flickerless display, easy superposition of an optical image, and capability of partial writing, erasing and storing display, plasma display promises to offer an extensive use as terminals in CAD, CAI and, also in a variety of man-machine interactive display systems.
Attempted in this paper are enlarging the panel size (307 mm × 307 mm, 17 inches in diagonal dimensions), manufacturing a parallax-free projection screen in the dielectric film of the panel, and proposing an unique production method of the electrode.

Through a chart of various display devices shown in Fig. 1, one can find the role of this module.

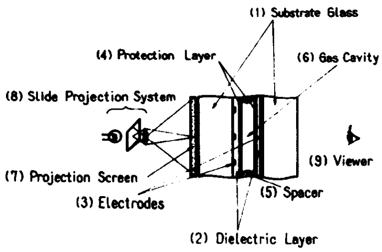

Fig. 2 (a) A cross-sectional View of a conventional AC Plasma Panel with a Slide Projection Screen on the outside of a Substrate Glass.

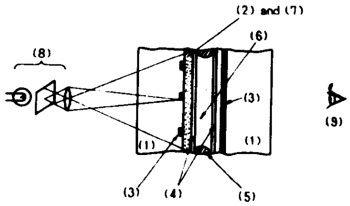

Fig. 2 (b) A cross-sectional View of the newly developed Plasma Panel which has an opaque Dielectric Layer to serve as a Slide Projection Screen without any Parallax.

2. Plasma Display Panel (PDP)

A general description of PDP has been given in other papers.[1][2] A built-in optical image projection screen is explained, and a method of making electrodes for larger panels is proposed in this chapter.
A conventional AC plasma panel has a cross-section as shown in Fig. 2 (a).

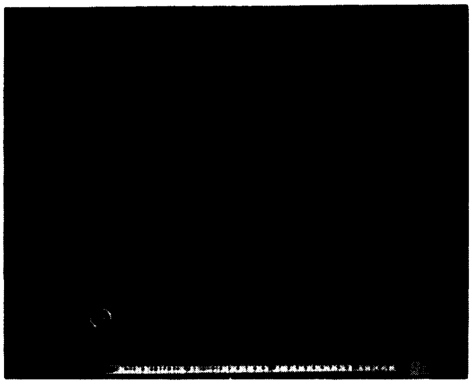

Fig. 3 An AC Plasma Panel newly developed, which has an opaque Dielectric Layer and Etch-Grooving Electrodes.

2.1 Optical Image Projection Screen

An AC Plasma display module with a built-in screen for slide projection saves large-capacity local memories for video information in such systems as CAI, CAD and so forth.

The projection screen of PDP currently used is prepared generally by attaching a dispersion screen to the outside of a rear substrate glass. This is a simple method, but parallax occurs between gas discharge display images and optical projection images due to the thickness of the substrate glass, which often leads to the poor positioning of the two images in the man-machine interactive display system in which images are observed at a comparatively short distance. To solve this problem, a structure was adopted so that the dielectric layer adjacent to the discharge gas space also served as an optical dispersion screen.

The following glasses as dielectric layer material have been studied.

i) Crystallized glass (devitrified glass)

ii) Opaque glass

iii) Glass with bubbles

iv) Glass with inorganic powder dispersed

Glass with inorganic powder is adopted for the dielectric material of a panel, because of most preferable dynamic characteristics of firing voltage Vf, memory factor α and spread factor.

Only a little degradation in the operating characteristics was observed and a better workability in production processing was established. Inorganic powders to be used as a dispersion material may be Al_2O_3, TiO_2 and so on. Here, Al_2O_3, whose grain size is easily controlled, is added 10-20% by weight of the dielectric material of lead borosilicate glass. Although the dielectric constant decreases and the dielectric layer tends to become thicker due to the addition of Al_2O_3, the firing voltage has an increase of only 15% compared to that of a conventional panel. The surface of the dielectric layer is coated with an MgO to protect from ion-bombardment, and to operate the panel at a low voltage. Thus, for the central value of spread firing voltage Vf of panels obtained are 114-116 V, with maximum deviations of $\pm$4.0-5.2%, and the average memory factors of the panels are 0.37~0.41.

The memory factor α is defined as follows,

$$\alpha = (Vf - Vsm) / \tfrac{1}{2} Vf$$

where Vf is a firing voltage and Vsm is a minimum sustaining voltage.

2.2 Electrodes

In order that the discharging cells, formed in high density only by the effect of the electric field in an unpartitioned gaseous space in the panel, do not interfere with each other in those operation, the electrodes of PDP must be made narrow in width. For manufacturing the electrodes, screen printing method or photoetching method is employed. The former method is better in workability and economy, but it can hardly be a satisfactory method for producing long and narrow electrodes having a width of below 100μm. The latter method provides satisfactory electrodes. It is not economical, however, when expensive metallic materials are used at a low utility rate and require additional processes.

Therefore, for the production of the panel of this module, an EG method ("Etch-Grooving" method) has been adopted wherein grooves are made in the substrate glass by photo-etching and conductive paste is put into the grooves. By taking care of improving the adhesion of the photo-resist layer to the glass and removing the insoluble materials produced during etching, the same-quality electrodes as those obtained by photo-etching have been obtained. This method is highly economical and mass-productive since almost 100% of the conductive paste is effectively used.

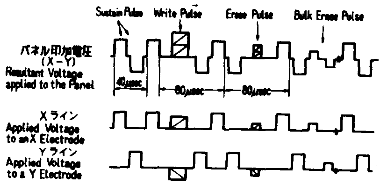

Fig. 4 Waveforms applied to the Panel.

3. Display Module

3.1 Configuration

This module is designed for a storage-type graphic display capable of random access writing, erasing and bulk erasing.

Two sustainers are used to share the gas discharge current of the whole panel. The frequency of waveform is 25kHz. In an addressing mode, a couple of addressing pulses of the same magnitude are algebraically added in a zero voltage period of 40μs logically created suspending a sustaining pulse, as illustrated in Fig. 4. Fig. 5 shows the appearance of this module.

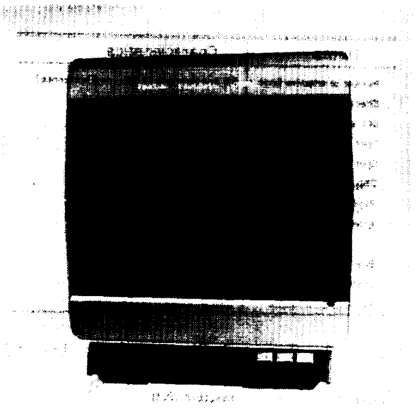

Fig. 5 External View of the Module with a superimposed Image.

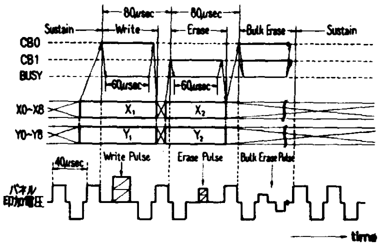

Fig. 6 Timing Chart of Interface Signals.

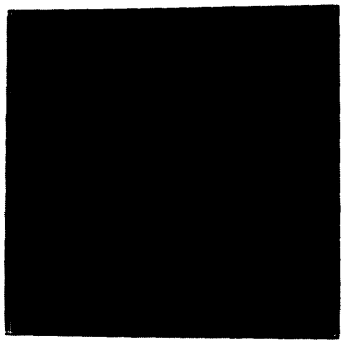

Fig. 7 Handwriting Image on this Display Module.

3.2 Input Data

The signals received are coordinate data (X0~X8, Y0~Y8) of nine bits in parallel for the selection of 512 line electrodes X, Y, and two-bit command (CB 0, CB 1) in parallel that designates the module operation (writing, erasing and sustaining). The signal which returns from this module to the outside control system is one bit (BUSY) which shows status of this module. The operation in the interface is shown in Fig. 6.

On the occasion of writing operation at (X1, Y1) the display control system switches CB 0 to logical "1" when change of the coordinate data (X1, Y1) is completed and the BUSY is at logical "0".

The moment CB 0 goes up to logical "1", display module controller set BUSY to logical "1" and returns it to the display control system, and simultaneously applies a write pulse to the designated coordinate. Upon completion, display module drops the BUSY to logical "0". The outside control system which detects this change, and drops the CB 0 to logical "0", and changes over the coordinate data.

For erasing or bulk erasing, only the combination of command CB 0 and CB 1 differs and erasing takes place according to similar sequences.

Shown in Table 1 is a main specification of this module. Fig. 7 shows an example of hand-written image on the display module via a graphic data tablet.

Items	Characteristics
Number of effective lines	512 lines(vertical) X 512 lines(horizontal)
Effect display area	307 X 307mm (Approx.)
Dot space	0.6mm
Spot size	0.4mm(approx.)
Spot intensity	50FL(approx.)
Display color	Neon orange
Panel size	440(W)X440(H)X20(T)mm
Access time for write or erase	50μ sec
Bulk erase	Possible
Sustaining power source	110 V, 400mA
External dimensions	550(W)X600(H)X195(D)mm

Table 1 General Characteristics of the Plasma Display Module.

4. Discussion

A panel which has an active area of 340 mm square, 512 × 512 EG electrodes, an opaque dielectric film holding inherent memory has been developed. In order to avoid a technical problem, to keep a gap narrow between two substrate glasses precisely, R. A. storm(6) reported on a large (about 80cm wide) plasma display in which narrow glass pipes having the width of the picture element are arranged in parallel, while D. W. Dick(7) reported a single substrate plasma display in which X, Y electrodes are grade separated on the glass substrate on one side and a cover is put on to allow it to serve as gas container. Because of its complicated construction, the former is considered to have difficulty in discharge due to the decrease in probability of existence of charged particles, plus the cost problem of the panel. It is worthy of note, however, it might be a way for development of larger panels. The latter, is attractive for its low cost potential, inspite of such disadvantages as it tends to increase the capacitance among electrodes and decrease the resolution because of its two dimensional construction. Under such circumstance, it seems likely that the "Sandwich construction" using two glass substrates remains yet, at least in the near future, in the dominant trend of AC plasma display panel.

Al_2O_3 was dispersed in one dielectric layer for an optical image projection screen, and also to serve as a dielectric layer without losing the characteristics of inherent memory. In this way, it has become possible to obtain superimposing display free from any parallex between the slide projection image and discharge display. The process of obtaining a dispersion screen in this dielectric layer led to the increase in total manufacturing processes and probably a small rise in the operating voltage, but its practical use will be decided by the demand for non-parallax display and further development of the processing technique in the years.

Realization of color conversion in AC plasma display into a more desirable color depends on its economy and stable low-voltage performance. For a technical reason we still remain with the Neon's red display. It is expected, however, that green or some other desirable intermediate color display will be practical in AC plasma display by ultraviolet light excitation of phosphor or other means.

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Literature

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