Project - World of LCDs-1

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Chapter 1
The Growing World of LCDs

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1. What is a Liquid Crystal?

A liquid crystal is an intermediary substance between a liquid and solid state of matter
Liquid crystals were discovered by the Austrian botanist Rheinitzer in 1888. Liquid crystal is a term that indicates the status of a substance that is neither solid nor liquid, e.g. soapy water. In 1963, Williams, while working for RCA discovered that the way light passes through liquid crystal changes when it is stimulated by an electrical charge. Five years later, another RCA researcher named Heilmeyer and his colleagues made a display prototype that applied this concept. This prototype's success marked the beginning of modern liquid crystal display (LCD) technology. In the beginning, liquid crystals were initially too unstable to use as a material for manufacturing display units, creating several merchandising problems for LCD technology until a professor of the University of Hull in the U.K. made a scientific breakthrough when he discovered a stable liquid crystal material (biphenyl). Sharp further refined LCD technology, and in 1973 introduced the EL-8025, the world's first electronic calculator featuring an LCD display. The core technology

behind the development of the the EL-8025 still forms the basis all current LCD products.

2.The Expanding Applications of LCDs

Applications for liquid crystal displays now extend beyond calculators and digital watches to countless other products, including word processors, televisions and even video systems on trains.

Personal Information Tool (for Japanese market)

Keyboard-enhanced Personal Information Tool (for international markets)

LCDs in everyday life
LCDs are finding a growing variety of applications in televisions, word processors, personal computers, and in other electronic office equipment products. LCDs are widely used in imaging and information systems that are commonly found in Japanese railway systems and other modes of transportation.

The continuing progress of LCDs
The greatly expanded use of LCDs is the result of recent significant breakthroughs made in the following four areas of LCD technology:

1. advancing beyond alphanumeric to graphic capabilities

2. advancing beyond monochrome displays to color

3. advancing beyond only still images to moving pictures

4. advancing being small screen displays to now using large screens

3. On The Cutting Edge of Display Technology

Until very recently, most AV and data communications devices used cathode ray tube (CRTs) monitors as their main display device. CRTs, however, require high voltage for the emission and angle control of the electron beams, and it is difficult to slim-down the size of CRT units. Flat panel display technology is the perfect answer to demands for more compact displays with greater energy efficiency and diversity.

From CRTs to flat panel displays
Flat panel displays are being developed to realize 1) a thinner unit and 2) low voltage operation and low power consumption--objectives not easily achieved with CRTs. There are a number of distinct systems which differ by the types of materials and the display method they use.

LCD (liquid crystal display)
PDP (plasma display)
LED (light emitting diode)
EL (electroluminescent) panel
VFD (vacuum fluorescent display)
DMD (digital micromirror device): projection type
FED (field emission display)

LCDs--the display of choice
Of all these systems, the liquid crystal display is considered to be the most promising. In addition to being thin and lightweight, these displays run on voltages so low they can be driven directly by an LSI. And since they consume low power, they can run for long periods on batteries. Additional advantages over other types of flat panel display include:

1. adaptability to full color
2. low cost
3. large potential for technological development

Type of flat panel display

DSTN Color LCD Notebook Computer (for Japanese market)

DSTN Color LCD Notebook Computer (for international markets

4. Latest LCD Lineup

28-Inch TFT Full-Color LCD Display

28-inch TFT Full-Color LCD Unit (prototype)

The world's first large-size LCD offering images as clear and crisp as a CRT
In the past, LCD picture quality was considered inferior to that of CRTs, and creating LCDs in sizes greater than 10 inches were not though possible. This changed dramatically in 1988 when a remarkable prototype with the following features was introduced:

1. 14" screen (the largest LCD screen to date)
2. 27 mm thick (about 1/13 that of 14" CRTs)
3. 1.8 kg (about 1/4 that of 14" CRTs)
4. Picture quality comparable to a CRT

The secret to large screen, high-resolution LCD imaging "active matrix" and "TFT"
The active matrix system is one configurational method of driving an LCD. It offers quick responsiveness to moving pictures and high picture quality. This 28-inch LCD screen offers 307,200 pixel (640 x 480 resolution) and RGB compatibility enabling high-definition 921,600-dot image reproduction. A TFT (thin film transistor) is applied to each pixel, ensuring concise control to create high-contrast full-color display images.

The secret to a beautiful picture
"Normally white"
With products that employ this technology, the screen is normally white when no voltage is applied. The use of a white screen creates darker colors during operation, so better contrast is achieved than in other products in which screens are normally black when no voltage is applied. Because of a high contrast shutter function, beautiful multicolor images can be reproduced by superimposing RGB color fitters.

Screen size:
28 inches (704 mm)

Number of pixels:

640 x 480 RGB dots

Pitch of pixels:
0.88 x 0.88 mm

Number of colors:
16.7 million colors

Outside dimensions:
633(W) x 510(H) x 37(D) mm

Power consumption:
Approx. 100W

Contrast:
100:1 or more

Brightness:
150 cd/cm2

Weight:
18 kg

Main product functions:
Multitask displays for PCs, information panels, presentation screens, monitor displays for conferences, wall-mount TVs, etc

LCD Display TVs

LCD Display TVs (for Japanese market)

Thin profile and lightweight designs with amazingly high picture quality
Both the 10.4-inch and 8.4-inch models project clear and crisp images in an astounding 920,000 pixel resolution. Low-reflectivity TFT LCD panels are used to reduce the reflection of external light, thereby ensuring easy-on-the-eye image viewing. Advanced LCD technology has made it possible to design the 10.4-inch LCD Display TV in an ultra-slim and lightweight body with a weight of 2.3 kg an a monitor profile of just 47 mm. The LCD Display TVs can be placed on the top of a desk or table, or the kitchen countertop, thus matching a wide range of viewing styles.
Car Navigation LCD TV

Car Navigation LCD TV

The Car Navigation LCD TV goes anywhere
The LCD Car Navigation System features a quick-release method which allows the monitor to be detached from the

GPS unit and the connector. When you arrive at a destination, you can take the monitor out of the car and use it as a portable LCD television for maximum mobility. The car navigator incorporates low-reflectivity LCD panels and a high-brightness backlight, ensuring easy-on-the-viewing excitement even in a bright car interior or outdoors in the day time. Apart from delivering clear and crisp TV broadcasts, the Car Navigation System also provides high-definition displays of automobile-navigation maps.
LCD PanelVision TV

LCD PanelVision TV (for Japanese market)

LCD Rear Projection System Configuration

LCD technology--expanding super large-screen visual excitement
The rear LCD projection system of the LCD PanelVision TV delivers bright, vivid-color and easy-on-the-eyes viewing on a large screen that captures all the excitement of television entertainment. Equipped with a super-large 43-inch screen, the TV weighs approximately 41 kg and has a space-saving width of only 38.5 cm.
LCD Video Projector

LCD Projection System Configuration

Lamp: newly developed high-brightness metal halide lamp
C1-C3: Condenser lenses

M1-M3: Full-reflection mirrors

Filter: Ultraviolet-ray filter
DM1-DM4: Dichroic mirrors

Beautifully reproduce detailed imagesÐeven in a brightly lit room
Delivering a 4,000-lux screen brightness four times as bright as that of conventional models, the LCD video projector offers unsurpassed high-contrast quality images. There are three LCD panels built in the projector, each of which lets red, green or blue light pass. These three basic colors then converge to form colorful, animated pictures.

Hi-Vision LCD Projector

The odds-on winner of the HDTV era delivers high-definition pictures with high-pixel density
This compact, lightweight Hi-Vision LCD Projector utilizes two-inch polysilicon TFT panels that reproduce Hi-Vision images with a high-definition quality of 1,125 scanning linesÑdouble the number of conventional models, and a 16:9 screen ratio compared with the 4:3 ratio of most other projectors. Images are projected onto a super large-screen in an

adjustable size ranging from 55 to 200 inches.

The main features of the compact, lightweight Hi-Vision LCD Projector include:
1. The utilization of three high-definition two-inch polysilicon TFT LCD panels (one with 1.31 million pixels) for the Hi-Vision system which reproduces the three RGB basic colors.

2. The realization of 400:1 ratio high-contrast images.

3. Enhance brightness by about 40% over most other conventional LCD video projectors by a high-transparency LCD panel.

LCD Miracle Screen System

From show window to screen in a flash
The LCD Miracle Screen combines the LCD video projector and Instant Photosensitive Glass (LCD) which becomes opaque or transparent by turning the power on and off. Instant Photosensitive Glass is ordinarily a transparent show window, but when the power is turned off, it becomes an opaque screen on which LCD images can be projected. The Miracle Screen System can be used in various ways for window displays and special events.
TFT Color LCD Notebook Computers

DSTN Color LCD Notebook Computer (for Japanese market)

DSTN Color LCD Notebook Computer (for international market)

TFT LCD configuration
In AV displays, full color is reproduced by arranging RGB pixels in a delta configuration. In office equipment displays, the sharp contrast between graphics and characters is produced using a stripe configuration of RGB pixels.

For AV equipment:
Delta configuration--full color
For office equipment:
Stripe configuration--multicolor

Thin and lightweight with low power consumption
Sharp TFT LCD Modules feature thin profiles, light weight and low power consumption. Now setting new standards in notebook-size PCs, they deliver bright, clear images of the highest quality, making them ideal displays for the multimedia notebook PCs of the future. Through the development of original technology, Sharp has successfully designed TFT color LCDs with a super high-aperture ratio of 81% compared to the 47% ratio of conventional 10.4-inch SVGA models, thereby offering substantially reduced power consumption and enhanced picture quality. This advanced proprietary technology is applied to the production of Sharp's TFT LCD modules (the 10.4-inch S-VGA, 11.3-inch SVGA, 12.1-inch XGA displays) for use in multimedia-compatible notebook PCs.
1. VGA: Offered in standard PCs with 640 x 480 RGB pixel resolution for displaying PC-generated images. 2. SVGA: With 800 x 600 RGB pixel resolution, PC-generated images are displayed with a display capacity 1.6 times larger than VGA specifications. 3. XGA: 1024 x 768 RGB pixel resolution for displaying images with a display capacity 2.6 times

larger than VGA specifications.
STN Color LCD Displays

Japanese Color Word Processor
(for Japanese market)

Convenient, fun, and user-friendly
vivid-color reproduction
Sharp's Color Japanese Word Processor is equipped with an OCR (optical character reader) feature that allows typed characters from newspapers and magazines to be inputted as text data. It also allows video images and photographs to be read in and processed for graphic layout use, as well as pen-based input and editing supported by enhanced handwritten character and graphic recognition functions. Japanese Color Word Processor is also equipped with a color LCD monitor which allows users to craft documents in stunning color, improving visibility, fun, and ease of use.
STN LCD Displays

Keyboard-enhanced Personal Information Tool (for international market)

Personal Information Tool
(for Japanese market)

LCD Pad Wiz
(for Japanese market)

Personal Information Tools progress in portability and operability
LCD Pad Wiz, one of Sharp's cutting-edge personal information tools, has a compact and lightweight body designed to neatly fit into a shirt pocket. With an intelligent handwritten character recognition function, users can quickly input and interactively share data via telephone lines. Wiz allows users to make full use of the data as if they had written the information down in a pocketbook. The Personal Information Tool enables data to be collected and transmitted by a PC data link, electronic mail, facsimiles, or from pay phones and portable phones. These and other personal information tools will soon be equipped with color LCD monitors to substantially expand and upgrade information handling and management.
Large-Screen Color STN LCDs

17.7-inch XGA Color LCDs

High picture quality with a simple matrix system
An LCD has been introduced that uses the simple matrix system, which is ideal for still images, to provide picture quality that is sufficiently high for office and image data processing equipment. Its features include:

1. Low cost
2. Multicolor (16.7 million colors)

3. Adaptable to large screens
4. Applicable to a wide range of products including personal information devices

New STN LCD Driver
Sharp Addressing

New color LCD reduces on-screen shadow and increases picture quality
Thanks to a new driver technique, Sharp has been able to create a new level of LCD excitement by substantially reducing the on-screen shadow. Sharp is currently working on advancing this breakthrough to improve the LCD response rate in order to better process high-speed moving images. Some of the new driver's features include:
1. A higher-quality LCD picture, which is achieved by reducing the display shadow through the development of a new LCD driver and peripheral circuitry that corrects and regulates changes in the electrical voltage feeding the liquid crystal matrix.

2. Wide-angle viewing, which is achieved by adding new optical film as well as the conventional phase difference plate.

3. A process for giving all the cells a uniform thickness.

4. A process for making the unit thinner and lighter.

DMGH-Method Reflective Color LCDs

DMGH-Method Reflective Color LCDs

A four-color, easy-on-the-eyes LCD with low power-consumption that achieves an amazing level of brightness without a backlight
DMGH (Double Metal Guest Host)ÑMethod Reflective Color LCDs are one of the types of the active-matrix systems that use diodes for switching. The following major features are offered by DMGH reflective LCDs:
1. Bright, easy-on-the-eyes screen without a backlight:
Guest Host LCDs eliminate the need for deflecting plates.

2. Four-color display including easy-to-read "paper white" background color:
Cyan and red complementary-color micro-filters enable four-color display in green, red, white, and black.

3. Low power consumption:
The unit consumes only 60 mW, approximately one-third the amount of power needed by conventional LCDs equipped with a backlight system (on a 6-inch office equipment unit with 1.8 W).

4. Wide viewing angle:
The unit offers a wide viewing angle of 100 degrees, both vertically and horizontally.

5. Vivid-color display without double images:
The pixel electrode also serves as a reflector to eliminate double reflections.

Screen size:
5.8 inches

Number of dots:

480 x cyan/red x 320

Viewing angle:
100 degrees, both horizontally and vertically

Colors on display:
Cyan, red, white, black

Power consumption:
60 mW

ECB-Method Reflective STN Color LCDs

Reflective STN Color LCD

High-definition clear color images without a backlight and color filter

This Reflective STN Color LCD is based on a newly developed electrically controlled birefringence (ECB*) technology that delivers a high-brightness, high- definition display with low power consumption while eliminating the need for a backlight and color filter. It is capable of delivering a true black display more sharply defined than previously possible, and this new color LCD display achieves crisp, clear reproduction of both text and images.

1. A single pixel allows a continuous color display of white, black, blue, green and red:
The unit offers a true black display that makes it possible to deliver crisp and clear presentations of both text and images.

2. Bright background colors:
Sharp's new phase differential plate, a new liquid crystal material system, as well as reflector with high reflectivity, make it possible to attain bright, vivid background colors.

3. Low power consumption:
Like the standard-type STN LCD unit, the ECB-method STN color LCD unit eliminates the need for a backlight and thus reduces the power consumption level.

* Electrically Controlled Birefringence (ECB) Changing the voltage applied to the liquid crystal layer modifies the tilt of the liquid crystal molecules. The resulting change in birefringence of the liquid crystal layer is detected by the two polarizers. This system is used for color displays.

Screen size:
3.4 inches

Resolution:
160 x 240 dots

Colors on display:
Five colors: green, red, white, black, blue

Display contrast:
7:1

Response speed:
500 ms

LCD Input/Output Panel

Comparing Tablet Panel Units

Sensitive Method Electrostatic Induction Method Electromagnetic Induction Method Unified LCD input and detection plate structure

Features/Subjects
Low cost
Cordless stylus
Power consumption
High reliability, durability
No keyboard function
Power consumption
Cordless stylus
High reliability, durability
No keyboard function
Visual recognition (the detection panel is provided below the display screen)
High reliability, durability
No undesired fingertip input
Low cost
Visual recognition (LCD panel is a detection panel itself)

No keyboard function
Needs a wired stylus
Cost
Needs a wired stylus

Applications
Personal information tool (Sharp)
Electronic organizer (Sharp)
Prostation (Sharp), others
Palmtop PTC-500 (Sony)
PENTOP (Wacom)
NCR3125 (NCR)
Japanese color word processor (Sharp)
Prostation (Sharp)

Configuration

Making display and pen-based input technologies available by combining LCD input and detection panels
Low cost, lightweight, high-definition LCDs with low power consumption are in great demanded for use with pen-input panels, and there are more than three methods currently in practical use for designing such applications. These include a pressure-sensitive method (used in Personal Information Tool and others), an electrostatic induction method and an electromagnetic induction method. The most conventional system coordinates detecting sensor plates that are piled on top of an LCD panel's structure, thus allowing pen-based input. The combination of LCD input and detection plates in one body have eliminated the need for other sensory tablets, and offer the ability to streamline recognition functions. This pen-based input is now widely used in PCs, word processors, and various other products.

Sharp LCD Office Information Management System
nicknamed "Prostation"-LW Series
(for Japanese market)

Meeting all the needs of modern office communications
Prostation is a new pen-operated computer equipped with a large 10.4-inch color LCD display that allows easy and quick operation with just one touch of a stylus or fingertip. Simply use Prostation, and group communications become incredibly convenient with a "Screen-Shared Interactive Dialog Function." With this feature, users can communicate with another by writing a message on the pad with a stylus, simultaneously transmitting the contents to the receiving user's Prostation. A "Voice-Assisted Handwritten Memo Function" enables users to communicate through both written and voice-assisted means. "Electronic Mail Software" allows users to efficiently transmit information via digitally handwritten memos.
5.Giant Microelectronics

Enlarged view of TFT LCD

Expanding LCD horizons with "giant microelectronics"
In addition to utilizing "microelectronics" technology to create high picture quality LCDs, R&D is being focused on "giant microelectronics" technology which makes it possible to successfully create large screen LCDs with incredibly high picture quality. Sharp is currently working on developing:

1. Advanced miniaturization technology

2. Highly reliable production technology

3. Development of new production structures

Pursuing high picture quality through advanced micro-technology
There are two essential technologies required to develop LCD high picture quality:

1. Increase the number of pixels

2. Make conductors and thin-film transistors (TFTs) as small and as narrow as possible to increase the pixel surface

area
6.The Ever-Expanding LCD Market

Changes in Semiconductor/LCD Market Output

Like semiconductors, the LCD market is expected to grow rapidly
Based on the interrelationship between the semiconductor and LCD markets, it is clear that the LCD market is currently 15 years behind the semiconductor market in terms of growth. It is estimated that, like semiconductors, which experienced tremendous market growth during the 1980s, the LCD market will begin to expand rapidly in the late 1990s and grow to be worth 2 trillion yen by the year 2000.