Sharp Radios over the Years

From Crystal to Vacuum Tubes to Transistors

The golden age of radio in Japan spanned the 35-year period from 1925, when broadcasts began, to 1960, when television became widespread. The wartime economy of the mid-1930s and later hampered development of technology for radios. But in homes across the nation, radio continued to serve as the family's primary source of information and entertainment.

1925 *Radio's Infancy*

Crystal Radio

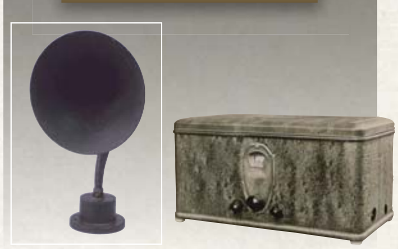
Comprising a tuned circuit for picking up broadcast signals and a crystal detector for extracting the audio signal from the radio waves, the crystal radio required a receiver in order to function properly.

1929 *Radio Age Dawns*

Battery-Powered Vacuum-Tube Radio

Although the vacuum-tube radio had a speaker to amplify sound and boasted high sensitivity, its expensive battery had to be replaced periodically, making it no more than a temporary product on the scene.

1930 *Growth Period*



AC Vacuum-Tube Radio (No. 30)

Drawing its power from a lamp line, this radio featured a separate speaker placed on top of the main unit.

1930 *Growth Period*

Radio with Built-in Speaker (No. 21)

This radio used regenerative detection to improve sensitivity, with sound being picked up directly from different frequencies. This was the most common type of radio until the end of World War II. Sharp was the first company to make a radio with built-in speakers.

1932 *A Maturing Market*

Phono Radio (No. 53)

Sharp released a combination radio and record player, designed as a luxurious piece of furniture.

1932 *A Period of Development*

Midget Radio (No. 34)

Advancements in vacuum tube performance—including four- and five-terminal designs—enabled radios to become smaller. Sharp's midget radio was a popular addition to the company's product lineup.

1938 *Growth Slows*

Wartime Austerity Radio (Aikoku No. 1)

Tightening wartime measures restricted the amount of metal that could be used for radio parts such as transformers. Soon only government-standardized models were being manufactured.

Note: The Sino-Japanese War broke out in 1937, miring the country in war.

1950 *Business Recovers*

Superheterodyne Radio (5R-50)

Shortly before the onset of private broadcasting in Japan, there was an industry-wide switch to superheterodyne models, which offered superior sensitivity and clearer channel selection. Compact, inexpensive models became popular.

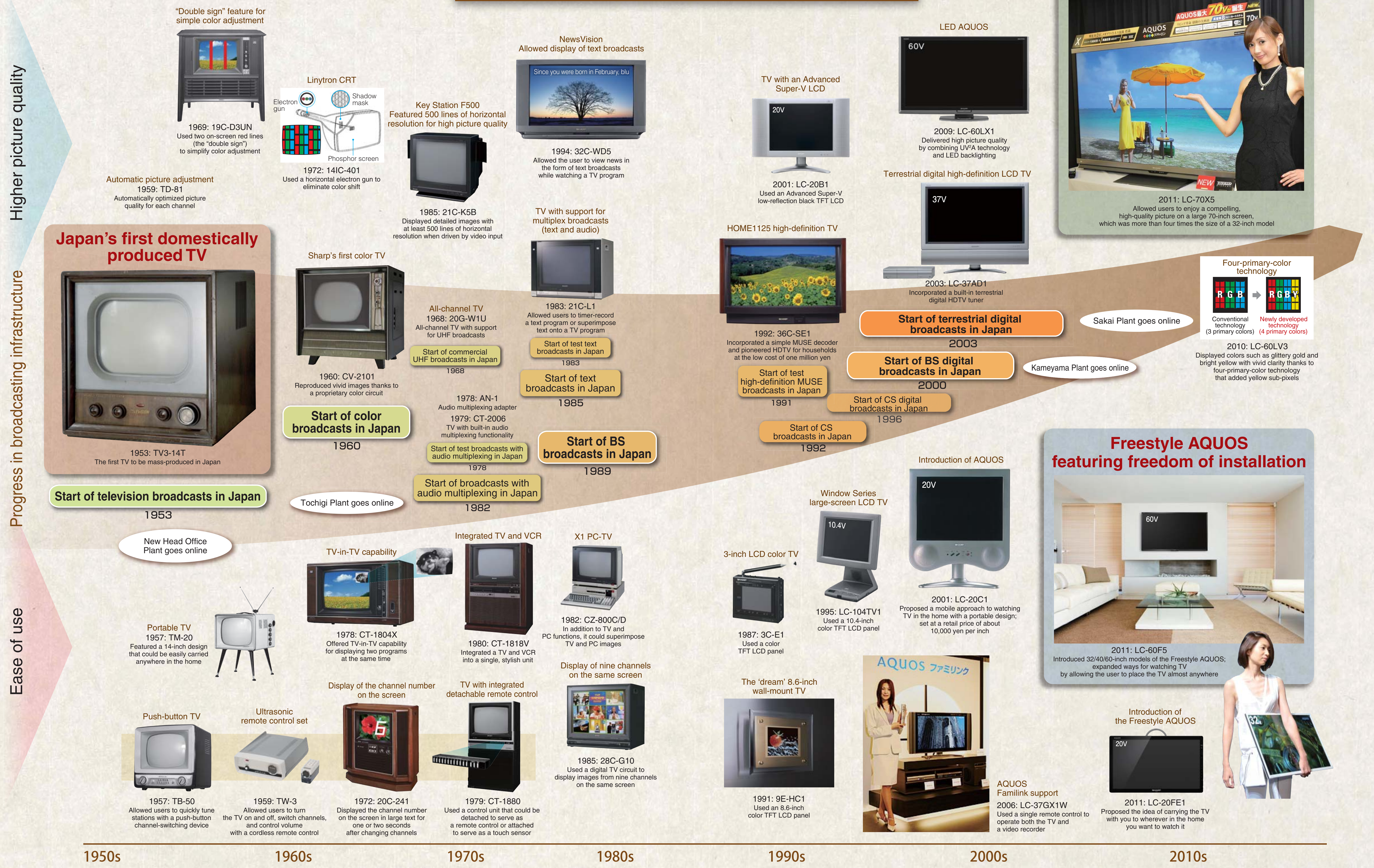
Note: Superheterodyne models were built during the war years, but these were specialized models designed to function over long distances.

1957 *The Zenith*

Transistor Radio (TR-115)

The transistor revolutionized the radio. Compact, portable radios were a hit around the world.

History of Television Development at Sharp



Device Industry and Information/Communications Products That Originated in Calculators

Device industry stemming from the calculator

Semiconductor Industry

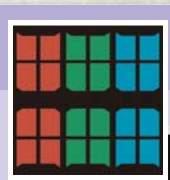

Camera module


Microwave oven


Word processor

Faced with the need for LSIs to use in its calculators, Sharp built the Advanced Development and Planning Center including a semiconductor plant in Tenri in 1970 and began mass-producing LSIs. Sharp's approach of developing distinctive products through the in-house manufacture of key devices began here.

LCD Industry



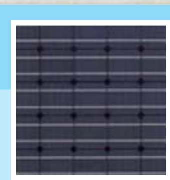

LCD TV


Media tablet


Videocamera

To differentiate its offerings from those of competitors, Sharp incorporated an LCD, which it had been researching since 1969, in a calculator, thereby creating a thinner device that used less power. LCDs went on to become key devices used in fields ranging from information/communications devices to audiovisual products, evolving into a premier electronics industry.

Solar Cell Industry




Community utilizing solar power

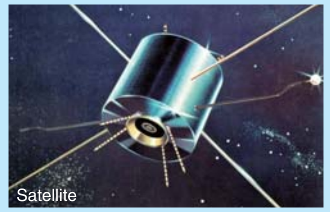

Satellite

Photo: JAXA


Mega-solar plant

Sharp began conducting research into solar cells in 1959 and initiated mass production in 1963, but it was the incorporation of solar cells into calculators that provided the key impetus to development of the component. The solar cell industry will continue to grow in the future, with products ranging from residential solar power systems to mega-solar plants.

Sharp Calculators Recognized as an IEEE Milestone (2005)

Sharp calculators have been recognized as an IEEE Milestone by the IEEE, an international academic society in the area of electricity and electronics. The honor recognizes innovative initiatives undertaken by Sharp from 1964 to 1973 to miniaturize calculators and reduce their power consumption.

Semiconductor, LCD, and solar cell technologies established as part of these research processes made significant contributions to the development of the electronics industry.


IEEE Milestone commemorative plaque

All-transistor diode calculators


1964: CS-10A

IC calculators


1967: CS-31A

LSI calculators


1969: QT-8D

Used MOS LSIs to achieve a higher degree of integration than was possible with ICs

LCD calculators


1973: EL-805

Used an LCD and C-MOS LSIs; could be used for 100 hours on a single AA battery

Solar-powered calculators


1976: EL-8026

Brought solar cells, which had previously been used exclusively in lighthouses and on satellites, to the calculator

Buttonless


1977: EL-8130

0.8 mm thick


1985: EL-900

Exceptional designs


1979: EL-8152

Development of more advanced manufacturing technologies

ELSIs

Awarded the 1970 Okochi Memorial Production Prize

Development of the film carrier method


1976: EL-8020

Production line automation

First-half process


1978: EL-8140

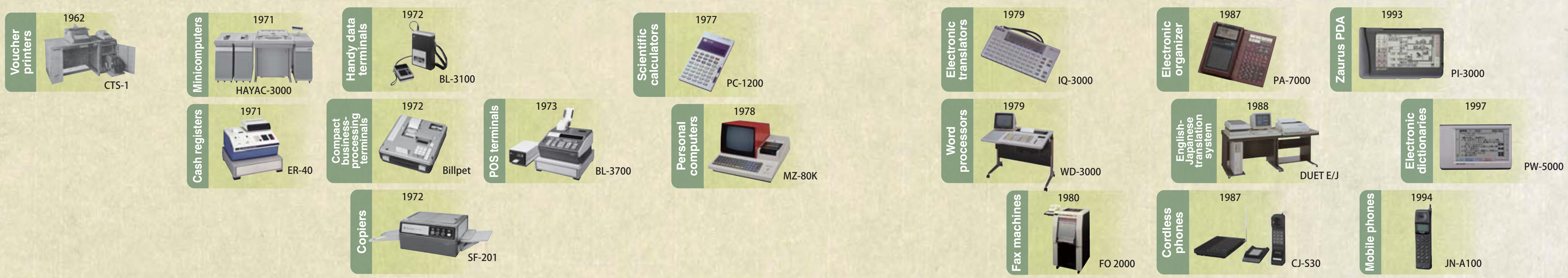
Second-half process


1980: EL-211

Awarded the 1980 Okochi Memorial Production Prize

Sharp's information communications products that are attracting attention today

Origins of information/communications products



Developing along with Application Products: Optoelectronic Devices

What are optoelectronics devices?
Optoelectronic devices—semiconductor components that combine optics and electronics—have played a major role in the development of an advanced, information-based society thanks to their ability to communicate, store, and convert large volumes of information quickly and accurately. They consist of light-emitting and light-receiving elements, and they are available in numerous variations of purpose and function. Sharp began dedicating resources to research in this field early on and established a lead in the global market thanks to technological advantages in terms of products and manufacturing techniques.

1960s 1970s 1980s 1990s 2000s 2010s

Light-based displays and lighting

Type of information that can be displayed

Inorganic ELs · Lighting and signboards · Red LEDs · LEDs for displaying numbers and symbols · Dots · Numbers · Symbols · 5key technologies (1) Liquid phase epitaxy · LED lamps · Calculators · Dot matrix LEDs · Text · LED displays · Blue LEDs · Graphics · Full-color LED displays · LCD TV backlights · LEDs for lighting · LED AQUOS · LED lighting

LED lighting LEDs can be used to implement lighting that boasts lower energy use as well as a longer service life than conventional incandescent and fluorescent bulbs. Additionally, the emitted wavelength can be controlled to obtain the desired light color.

Exchange of data

Type of data that can be communicated

Infrared diodes · Photocouplers/photo-interrupters · 5key technologies (2) OPIC · Signal transmission circuits · Operation of consumer electronics · Air conditioners · Remote-controlled TVs · Infrared communications devices · Text, still images · Electronic organizers · IrSimple high-speed infrared communications devices · High-definition images · Mobile phones

Photocouplers and photo-interrupters Photocouplers and photo-interrupters, which consist of light-emitting and light-receiving elements, convert electrical signals and transmit them as light. They are used to detect the presence of objects and their position.

Infrared communications Infrared communications allow information to be sent and received wirelessly using infrared light. TV remote controls are a typical example of this technology, but it is also used to send and receive image and text data between devices such as mobile phones and computers. Standardization bodies have established standards governing various aspects of the technology's implementation, including communication ranges and formats. Compared to radio waves, infrared communications offer a high level of security.

Storage of data

Type of data that can be handled

Lasers Whereas sunlight and fluorescent light contain various wavelengths, laser light consists of a single wavelength. Due to the high level of linearity of the light they produce, lasers are used in laser pointers, and they are essential for optical disc media such as BDs and DVDs.

Infrared laser diodes · 5key technologies (3) VSIS structure · 5key technologies (4) Hologram laser unit · Hologram lasers · Music · CD players · MD recorders · 5key technologies (5) Vapor phase epitaxy · Red laser diodes · Computer data · Computers · TV images · DVD recorders · Blue-violet laser diodes · High-definition images · BD recorders

Laser wavelength (color) Lasers with shorter wavelengths are needed in order to read and store higher densities of information using optical disc media. For example, CDs use infrared lasers, while DVDs use red, and BDs blue-violet, lasers. Of these, BDs have the highest storage capacity. Additionally, lasers with higher output are required in order to improve write speeds.

Image capture

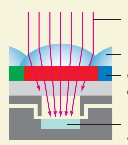
Type of data that can be captured

Blue cells for cameras · Light and dark areas · Cameras · Mark sensors · White and black areas · Large electronic calculators Paper tape readers · One-dimensional CCD line sensors · Image and text on paper · Fax machines · CCD area sensors · Video recording · Videocameras · C-MOS camera modules · Mobile phones

Camera modules Sharp developed compact, thin-profile camera modules that integrated image sensors and lenses in order to shrink the size of mobile devices.

Sharp's one-of-a-kind technologies

On-chip color filter
On-chip micro-lens



Sharp developed a proprietary manufacturing method for creating a color filter and super-small, light-collecting lens directly on the surface of CCD and C-MOS chips. These innovations delivered improved image quality and sensitivity, helping maintain Sharp's lead in the industry.

Sharp's One-of-a-Kind Technologies That Bolster Its Lead in Optoelectronics

5key technologies

Manufacturing technology

1 Liquid phase epitaxy

This method for forming light emitter p-n junctions at the same time as crystal is grown allows growth of extremely high-quality crystal. Sharp's patents in the area of crystal growth propelled the company to a leading position in the industry.

Product technology

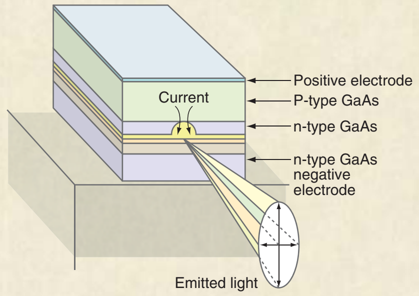
2 OPIC (optical IC)

OPICs integrate a light-receiving element and signal processing circuit onto a single chip. Integration with an IC reduces the effects of external interference and allows output signals to be directly linked to a microcontroller. The design was instrumental in the development of more compact, more reliable, and more inexpensive devices.

Manufacturing technology

3 VSIS structure
(V-channeled substrate inner stripe)

The creation of a V-shaped groove on a P-type gallium arsenide substrate allows the formation of a series of thin layers, providing stable laser light with a long service life.

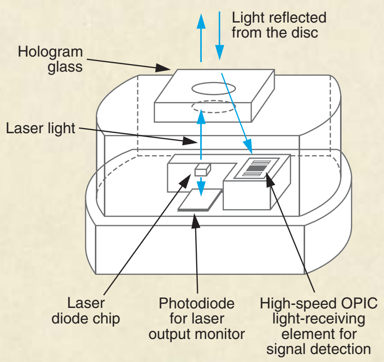


Product technology

4 Hologram laser unit

A hologram laser unit incorporates a light-emitting laser element and a light-receiving signal-reading element into a single package. In addition to allowing more compact pickups, the design is distinguished by its reduction of the need to perform optical adjustment during the assembly process.

Inside structure of a hologram laser



Manufacturing technology

3 Vapor phase epitaxy

Vapor phase epitaxy technology is used to form thin films by growing crystals of the vaporized material on a substrate. Sharp has drawn on its expertise in the area of crystal growth technologies to establish a lead over competitors and seize high market share.

Evolution of LCD Technology and Application Products

1970s | 1980s | 1990s | LCD technology today (2000 and beyond)

Representative application products


LCD calculators


Thin-profile calculator


Electronic translator


Japanese word processor


Electronic organizer


Portable TVs


LCD projectors


LCD videocameras


Car navigation systems


Laptop and notebook computers

Mobile


Tablets


Mobile phones


PDA

IGZO*1

CG-Silicon*2

Large LCDs

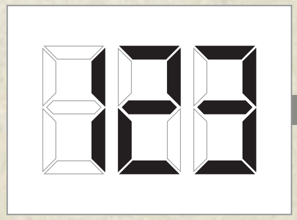

Large-screen LCD TVs

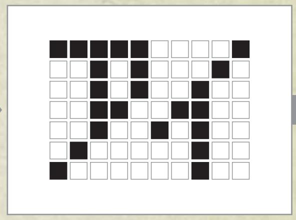
Full-HD*3 panels

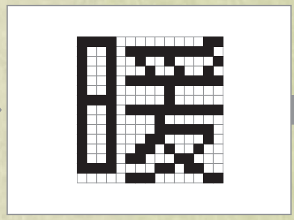
Double-speed Advanced Super-V LCDs*4


Touchscreen displays

Type of information displayed







Major LCD technologies

DSM LCD

DSM (dynamic scattering mode) displays use the fact that light is scattered when a voltage is applied to liquid crystal.

The advantage of a simple design was offset by high operating voltages and sluggish response in cold environments.

TN LCD

Passive matrix type

TN (twisted nematic) displays use the fact that previously aligned liquid crystal molecules change their alignment when a voltage is applied.

TN LCDs solved the problems with DSM designs but suffered from deteriorating contrast as the number of pixels was increased.

STN LCDs / Color STN LCDs

STN (super twisted nematic) displays use liquid crystal molecules that twisted to a much higher degree than those in a TN LCD, yielding superior contrast.

STN displays were characterized by a yellow-green or blue tint. Later designs eliminated the tint and introduced color capability.

Color TFT LCDs

Active matrix type

TFT displays use thin-film transistors (TFTs) to switch pixels on and off.

TFT displays provide dramatically improved contrast and response compared to TN LCDs, even when the number of pixels is increased.

Mobile Advanced Super-V LCDs / Advanced TFT LCDs

Reflective/transflective type

A reflector inside the LCD's pixels reflects incident light from the surface of the display to increase ease of viewing.

This technology makes possible displays that can be viewed in bright light.

Note: Some mobile products use transmissive LCDs.

Advanced Super-V LCDs

Advanced Super-V

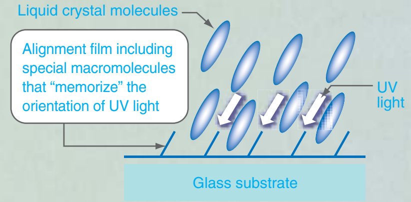
This new display technology incorporates innovations in liquid crystal molecule alignment and pixel structure.

Advanced Super-V LCDs provide excellent viewing angles in all directions, fast response, and no image persistence, even when displaying fast-motion video. Moreover, they can display high-contrast images.

Advanced technology for large LCDs

UV^{2}A* technology

This photo-alignment technology allows liquid crystal molecules to be aligned with a high degree of precision. It also allows high contrast of 5,000:1 (1.6 times better than previous technologies), fast response (2 times better than previous technologies), and high light utilization efficiency (with an aperture ratio that is at least 20% higher than previous technologies) for vivid colors and reduced energy use. Moreover, the simple design affords a high level of production efficiency.

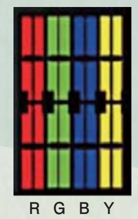


Once the orientation of the alignment film is determined by irradiating the substrate with ultraviolet (UV) light during the manufacturing process, the liquid crystal molecules are aligned in the same direction.

* UV^{2}A: Ultraviolet induced multi-domain vertical alignment

Four-primary-color technology

This technology adds yellow to the conventional three primary colors of red, green, and blue to implement four-primary-color pixels. This enhancement allows displays to vividly reproduce colors such as glittery gold and emerald-green, which are difficult to create with the conventional three primary colors.



Note: Sharp's four-primary-color concept was designed for use with LCDs; it differs from the conventional three-primary-color concept of light and color.

Ultra-high-resolution LCD technology

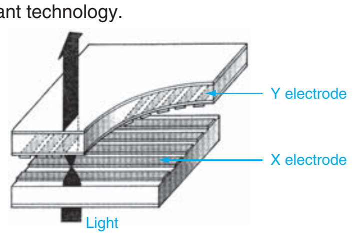
Ultra-high-resolution LCDs can display extremely realistic images with smooth edges at resolutions far in excess of standard high-definition broadcasts.

ICC 4K LCD TV (3,840 × 2,160 pixels)
Combining Sharp's large-screen, high-resolution LCD control technology with signal processing technology from I-cubed Research Center Inc., the ICC 4K LCD TV reproduces depth and texture at a level of detail that approaches the natural world.

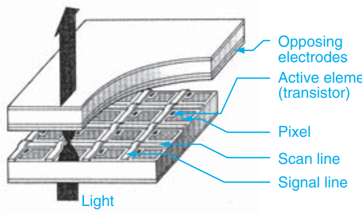
85-inch direct-view LCD compatible with Super Hi-Vision (ultra high definition)
(7,680 × 4,320 pixels)
The first display of its kind in the world, this UHDTV was developed jointly by Sharp and NHK in 2011. The device reproduces video with overwhelming presence and intensity.

■ From passive matrix to active matrix

As the size and resolution of displays increased, manufacturers were unable to resolve contrast and response speed inadequacies with passive matrix designs, and active matrix LCDs became the dominant technology.

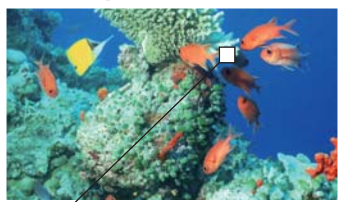


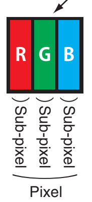
Passive matrix drive design
When a voltage is applied to X and Y electrodes forming a matrix along the display's X- and Y-axes, the potential difference created in the point (pixel) at their intersection causes the orientation of the LCD molecules there to change.



Active matrix drive (TFT) design
Transistors attached to individual pixels serve as switches, turning elements on and off.

■ Principle of color LCDs





Pixels are divided into three sub-pixels, and color filters are used to create the three primary colors of red, green, and blue. A range of colors can then be reproduced by varying the lightness and darkness of the three primary colors.

*1 IGZO

In IGZO displays, the silicon in the TFT material is replaced with an oxide of indium (In), gallium (Ga), and zinc (Zn) to more readily facilitate the flow of electrons. This technology allows smaller TFTs while increasing screen brightness and lowering energy use.

*2 CG-Silicon

CG-Silicon (continuous grain silicon) incorporates innovations in the crystalline structure of TFT silicon to more readily facilitate the flow of electrons. It can be used to create high-definition LCD panels into which peripheral functionality has been integrated.

*3 Full-HD panels

Full-HD panels with a resolution of 1,920 (horizontal) × 1,080 (vertical) pixels can reproduce the high-definition signal format (1080i) used for digital broadcasts at their native resolution.

*4 Double-speed Advanced Super-V LCDs

Double-speed Advanced Super-V LCDs create an intermediate frame between each frame sent in TV broadcasts to display 120 frames per second, enabling them to reproduce motion more smoothly.