Techno World

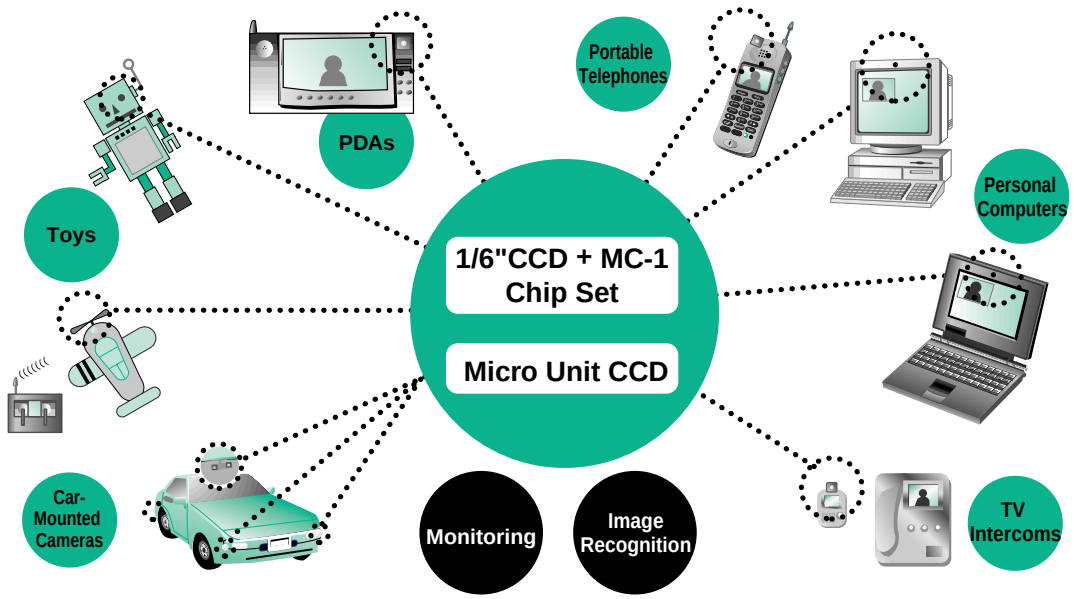
Multimedia Cameras for the Visual Society

Ultraminiature Multimedia Camera Systems

- **Multimedia camera LSI chip set and 1/6-inch CCD for ultraminiature cameras**
- **Miniature thin-form factor CCD system unit (“Micro Unit CCD”) that can be easily embedded in end products**
- **Two solutions from Sony: the CCD unit and the chip set**

As the information society advances, the electronics industry is making rapid progress in both digital imaging and networking technology. Due to these trends there are now increasing needs for ultraminiature thin-form factor cameras for easy image capture. The personal computer camera market is also expected to grow due to the use of personal computer video conferencing and video telephony, which are now becoming practical due to the widespread use of personal computers and the fact that most PCs are now equipped with a full complement of peripheral devices. Also, a trend towards incorporating cameras in miniature portable equipment is developing, and there is hope that a market for portable video telephones may emerge. Furthermore, the ultraminiature thin-form factor camera may become indispensable in many social scenes, beginning with the home where it will be used increasingly in toys and games, and in cars.

To respond to these needs, Sony has marshalled its miniaturization technology, which is one of Sony’s strong points, to develop a 1/6-inch CCD, which is the industry’s smallest 250,000-pixel device, and two system solutions in this area: the MC-1 multimedia camera LSI chip set and the “Micro Unit CCD”, which can be easily embedded in application equipment.



■ Figure 1 Sample Applications for Ultraminiature Multimedia Camera System

1/6-inch *Super* HAD CCD*™

* Super HAD CCD™ is a trademark of Sony Corporation.

The ICX096AKE (NTSC) and the ICX097AKE (PAL) are the industry's first 1/6-inch optical system CCD image sensors that provide 250,000 and 290,000 effective pixels.

1) Ultraminiature CCD needs

Ultraminiature CCD image sensors are used in a wide range of applications, from ultraminiature cameras, camcorders, PDAs (personal digital assistants), and digital still cameras to medical imaging instruments such as endoscopes. As a result, even further miniaturization and increased pixel counts are desired in these devices.

2) The industry's smallest unit pixel

In developing the ICX096AKE and the ICX097AKE, Sony optimized the pattern used for the pixel sections of the device as well as the fabrication process to achieve the industry's smallest unit pixel. Also, by adopting Sony's unique "Super HAD CCD" technology, which optimizes the formation of on-chip microlenses, we increased the effective light receiving area by 20% over previous Sony products. This results in a 32% increase in the sensitivity per unit area as compared to Sony 1/4-inch CCD products. As a result, the ICX096AKE achieves a high sensitivity of 330 mV despite its extremely small 1/6-inch size. (See tables 1 and 2.)

3) The miniature SON (LCC) package

The ICX096AKE and the ICX097AKE are provided in the miniature SON (LCC) package. This package achieves a thickness of 2.3 mm, which corresponds to a 66% reduction from that of Sony 1/4-inch CCD image sensors. (See figure 2.) This allows the optical system lens block to be miniaturized even further.

4) Compatibility with current systems

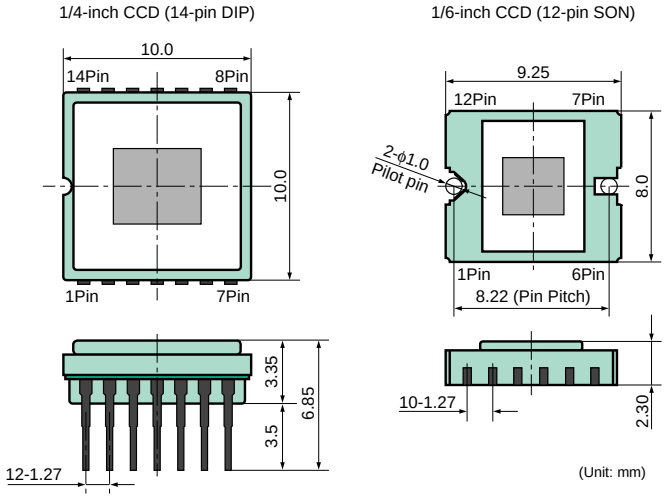
Since the ICX096AKE and the ICX097AKE have pixel count and drive signal specifications that are identical to those of Sony's 1/4-inch 250,000-pixel CCD products (the ICX086AK and ICX087AK), they can be used in current systems without significant changes to the system. (See figure 3.)

■ Table 1 1/6-inch CCD Image Sensor Structure

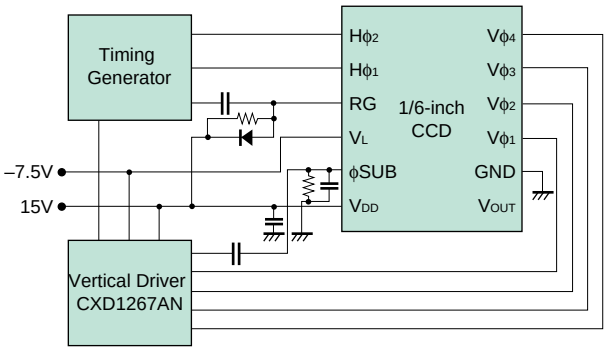
Item	ICX096AKE	ICX097AKE
Effective optical diameter (mm)	3.0	
Number of effective pixels (pixels)	510 (H) × 492 (V)	500 (H) × 582 (V)
Pixel size (µm)	4.80 (H) × 3.75 (V)	4.90 (H) × 3.15 (V)

■ Table 2 1/6-inch CCD Imaging Characteristics

Item	ICX096AKE	ICX097AKE
Sensitivity (F 5.6) (mV)	330	300
Saturation signal (mV)	600	500
Smear (V/10) (dB)	–86	



■ Figure 2 Comparison of 14-pin DIP and 12-pin SON(LCC) Package Dimensions



■ Figure 3 Example 1/6-inch CCD Drive Circuit

MC-1
Multimedia Camera LSI Chip Set

The MC-1 is a chip set for ultraminiature single-CCD Ye/Cy/Mg/G color cameras, and is centered around the CXD3123R. The CXD3123R is not just a camera signal-processing function, but also integrates a control microcomputer, an A/D converter, D/A converters, and other functions required by CCD cameras on a single chip. This high level of integration allows ultraminiature low-power CCD cameras to be implemented easily.

Simple system structure

The MC-1 chip set consists of the following three chips. (See table 3 and figure 4.)

- Camera signal processing LSI (CXD3123R)
- CDS/AGC IC (either the CXA2006Q or the CXA2096N)
- Vertical driver (CXD1267AN)

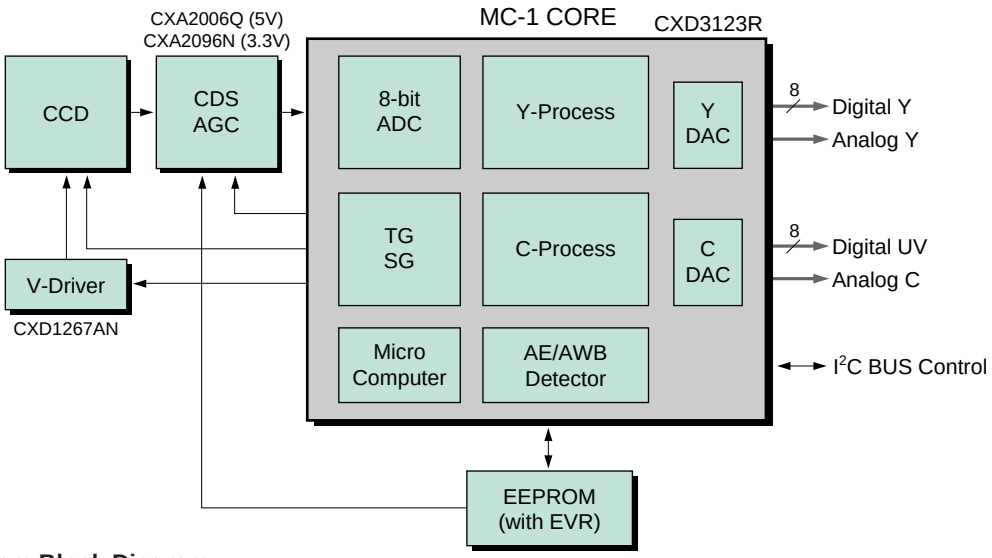
This chip set supports the ICX076AK 180,000-pixel CCD image sensor and the ICX086AK, ICX096AKE, ICX206AK (NTSC) 250,000-pixel CCD image sensors. (See table 4.)

■ **Table 3 MC-1 System LSI Configuration**

Function	Product name	Supply voltage	Package
CORE	CXD3123R	3.3V/5.0V	100pin LQFP
CDS/AGC	CXA2006Q CXA2096N	5.0V 3.3V	32pin QFP 20pin SSOP
V-Driver	CXD1267AN	–7.5V/15V	20pin SSOP

■ **Table 4 CCD Products Supported by MC-1**

Product name	Optical system	Number of effective pixels
ICX076AK	1/5 inch	362 (H) × 492 (V)
ICX086AK	1/4 inch	510 (H) × 492 (V)
ICX096AKE	1/6 inch	
ICX206AK	1/4 inch	



■ **Figure 4 MC-1 System Block Diagram**

CXD3123R Camera Signal Processing LSI

1) AE and AWB functions implemented by an on-chip microcomputer

The CXD3123R includes a microcomputer functionally identical to the Sony 8-bit SPC700 microcomputer. This allows the CXD3123R to provide the following features.

- The implementation on chip of both an automatic following type AWB algorithm and an AE function based on electronic shutter and AGC functions.
- Applications can adjust the substrate voltage and other DC voltages and they can read and write the system settings data and the image data stored in the external on-chip EVR EEPROM using the serial control pins.

2) Camera total power consumption held to about 500 mV by 3.3-V low-voltage drive

While it goes without saying that the CXD3123R internal logic circuits can be operated at 3.3 V, the CXD3123R also supports 3.3-V system drive CCD image sensors and CDS/AGC ICs. When the combination of the CXA2096N 3.3-V system CDS/AGC IC and the ICX206AK, which support 3.3-V horizontal drive, is used, total camera power consumption can be held to about 500 mW by driving the internal A/D converter at 3.3 V. This is about 1/2 the power consumption of earlier camera systems.

3) System control over an I²C bus

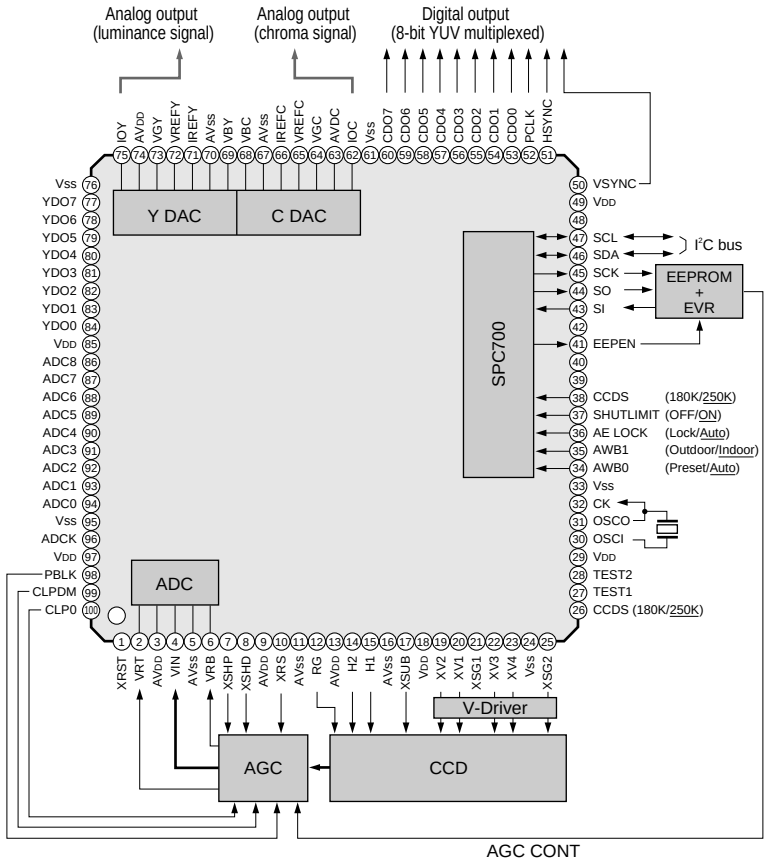
An I²C bus*1 is used for system production line adjustments and image settings. Since the data required for adjustment can be input and output, end products can be adjusted automatically on the production line. It is also possible for users to adjust the image settings in cameras embedded in personal computers over the I²C bus.

*1 For I²C bus
Purchase of Sony's I²C components conveys a license under Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specifications as defined by Philips.

4) Digital and analog output functions

The CXD3123R outputs analog luminance and chroma signals using on-chip 8-bit D/A converters. It also provides two types of digital outputs: a 16-bit YUV output that conforms to the ITU 601 recommendations and an 8-bit YUV multiplexed output. (However, note that the output frequency is the same as the CCD drive frequency.)

As can be seen from the above, the MC-1 is an LSI chip set that is optimal for multimedia cameras and that provides all the functionality required for image capture in personal computer video conferencing, PDAs, and entertainment products. When combined with the ICX096AKE 1/6-inch CCD image sensor described earlier, the CXD3123R can be used to easily construct an ultraminiature low-power CCD camera.



■ **Figure 5 CXD3123R Block Diagram and Pin Configuration**

Micro Unit CCD Miniature Thin-Form Factor CCD System Unit

micro unit CCD

The Micro Unit CCD is based on the concept of a form that can be easily embedded in applications as the image capture unit in diverse contemporary multimedia, monitoring, and image processing applications. As such, it was developed to be a miniature, thin-form factor, light-weight CCD unit. (See photograph 1.)

1) Towards a CCD multi-chip module

The multi-chip module consists of a QFN *2 ceramic package in which a CCD, a cover glass, chip components, the optical system plastic lens and a diaphragm cover are mounted on the front surface, and the driver IC, sample-and-hold IC, and camera signal processing LSI are mounted on the back surface. (See figures 6 and 7.)

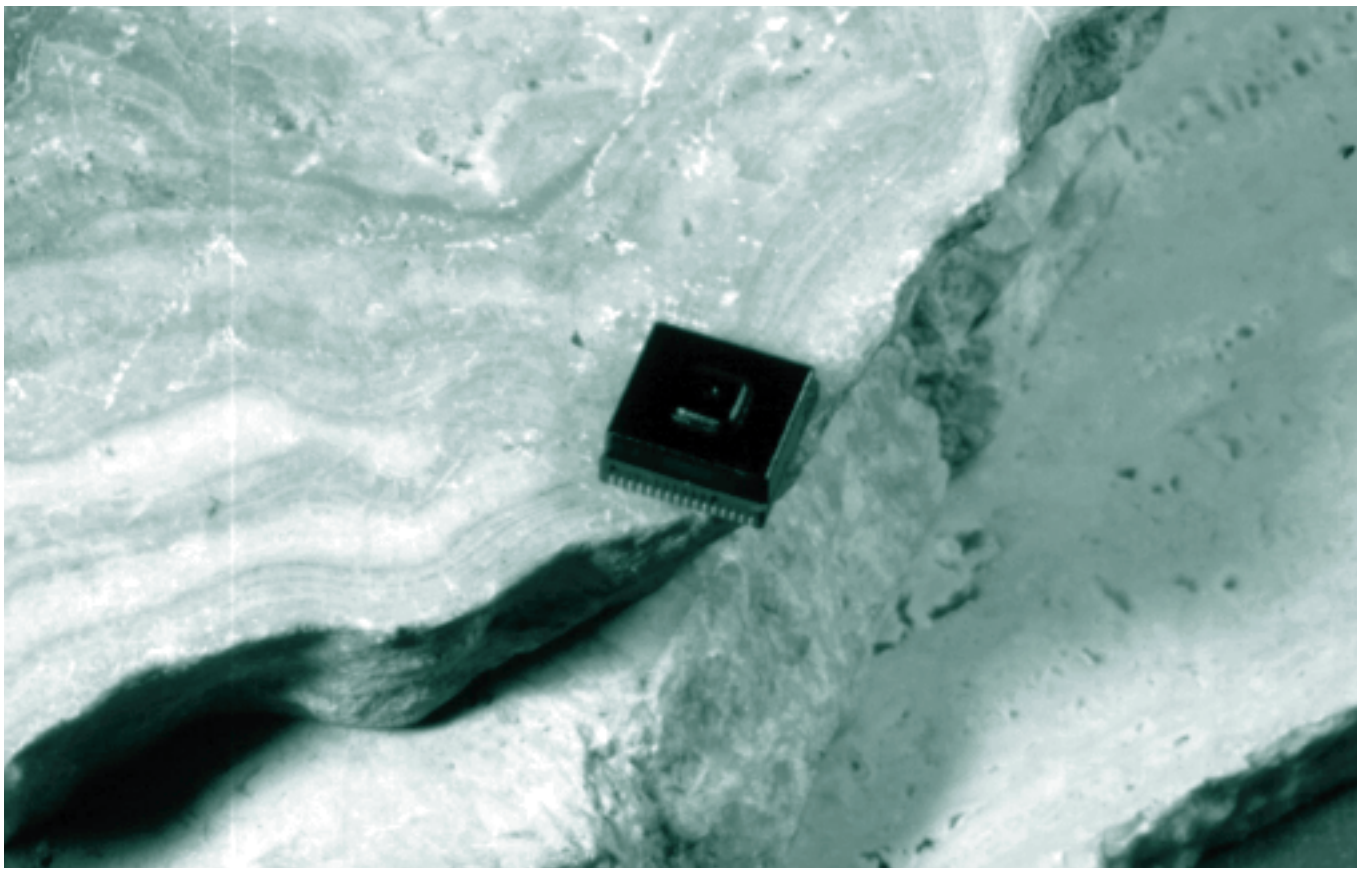
*2 QFN: Quad Flat Non-Leaded Package

2) Rich set of functions

The camera signal processing LSI incorporated in this system provides auto-white balance, automatic exposure control, backlight correction, and other functions.

3) For even thinner optical system

The MTF characteristics of the plastic lens were optimized for a 1/5-inch 180,000-pixel CCD, and as a result, an optical low-pass filter is not required. The lens is a single short-focal length aspherical plastic lens, and the CCD on-chip lenses were optimized for this short-focal length lens. The shading characteristics were improved by using a front diaphragm for the diaphragm, and it was possible to unify the diaphragm with an optical system cover that includes an infrared cut filter (IRCF). This results in a unit overall thickness of 8.4 mm, making it the thinnest unit in the industry. (See figure 7.)



■ **Photograph 1 Micro Unit CCD**

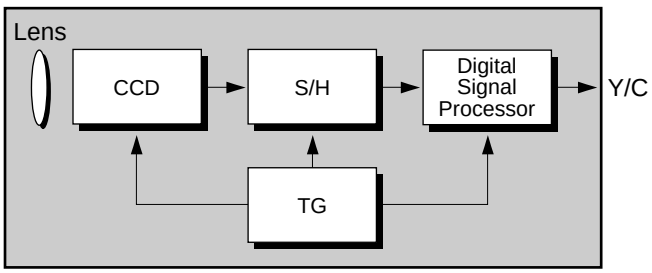
4) Adjustment-free optical system

While the optical system focus normally must be adjusted using a threaded structure, the Micro Unit CCD achieves an adjustment-free optical system by mounting a single-focus plastic lens with high-precision in the focus direction referenced to the upper surface of the CCD.

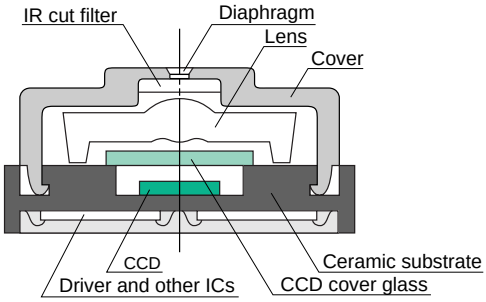
Although plastic lenses have the problem that the focal length becomes longer or shorter due to changes in the lens refractive index due to thermal characteristics, the Micro Unit CCD compensates for this by positioning the lens with legs formed in a single unit with the lens itself. Thermal expansion and contraction of the leg sections offset changes in the focal length due to temperature changes. Also, the lens is made from a material that is strongly resistant to heat, and thus the Micro Unit CCD can be used under most practical temperatures despite the lens unit being made of plastic.

Future Developments

Now, at the critical societal transition point defined by the arrival of the information network age, Sony Corporation is committed to creating the everyday life that will be experienced by mankind in the 21st century, an everyday life that is coming into view with the unification of audio/video and information technologies. The most salient aspect of society in the 21st century will be that computers and information terminals with even higher performance and functionality will merge naturally into our daily lives and form information networks that will enable the formation of a society that transcends space and time. The development of technology and the creation of infrastructures will allow video information to be freely and easily captured, transmitted, and corroborated. Sony will continue to develop key devices for image capture to respond to society's needs and desires.



■ **Figure 6 Micro Unit CCD Block Diagram**



■ **Figure 7 Micro Unit CCD Cross Section**

■ **Table 5 Micro Unit CCD Specifications**

Item	MCX18N00A	MCX18N00B
CCD	180,000 color pixels <362 (H) × 492 (V) pixels>	
Video output	Y/C analog outputs	
Lens	Fixed focus, F 2.8/f = 2.9 mm	Fixed focus, F 2.8/f = 4.0 mm
Angle of view	Horizontal: 53°, Vertical: 41°	Horizontal: 41°, Vertical: 31.2°
Focus range	20cm to infinity	
Resolution	220 TV lines	
Supply voltage	15V/5V/3.3V/–8V	
Power consumption	950mW	
Operating temperature	0 to +40˚C	
Package	64-pin QFN (Ceramic)	
Package dimensions	18.3 mm (W) × 18.3 mm (H) × 8.4 mm/7.3 mm (D:Center section/edges)	18.3 mm (W) × 18.3 mm (H) × 9.6 mm/8.5 mm (D:Center section/edges)