Ordering number : EN*4971A

LC9947G

1/5-Inch Optical Size EIA Black-and-White Solid-State Imaging Device

Preliminary

Overview

The LC9947G is a 1/5-inch optical size frame transfer CCD (charge-coupled device) solid-state imaging device.

Features

- Effective number of pixels [total pixels]: 508 × 492 [532 × 500] (H × V)
- Number of optical blacks
  Horizontal direction: Front: 2 pixels
  Rear: 22 pixels
  Vertical direction: Front: 5 pixels
  Rear: 3 pixels
- Dummy bits - Horizontal direction: 4 pixels
- Horizontal resolution: 380 TV lines
- Miniature size supports compact application designs.
- The LC9947G is provided in a 20-pin half-pitch completely transparent DIP package.
- Horizontal shift register, 5 V operation
- Can be used with a variable-speed electronic shutter

Device Structure

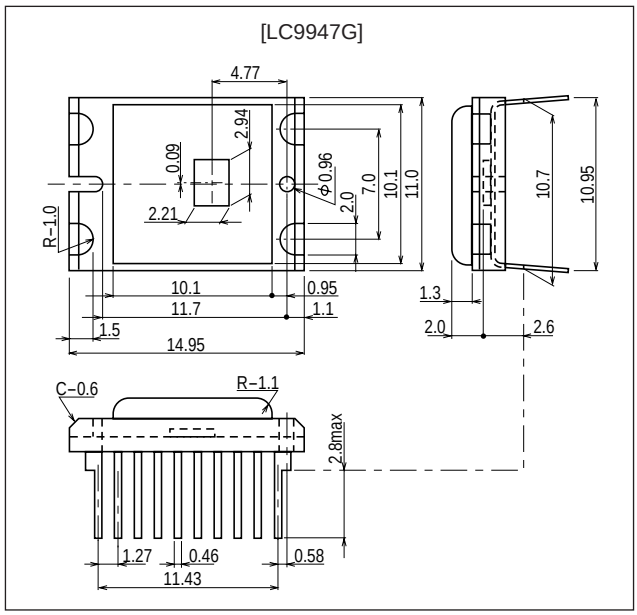
- 1/5-inch optical size frame transfer CCD image sensor
- Unit cell size: 5.8 µm (H) × 4.5 µm (V)
- Chip size: 4.180 mm (H) × 5.100 mm (V)
- Parallel gate CCD sensor
- Built-in high-sensitivity output amplifier

Note: Please contact your Sanyo sales representative in advance if you plan to design an optical system for this product.

Package Dimensions

Unit: mm

3217



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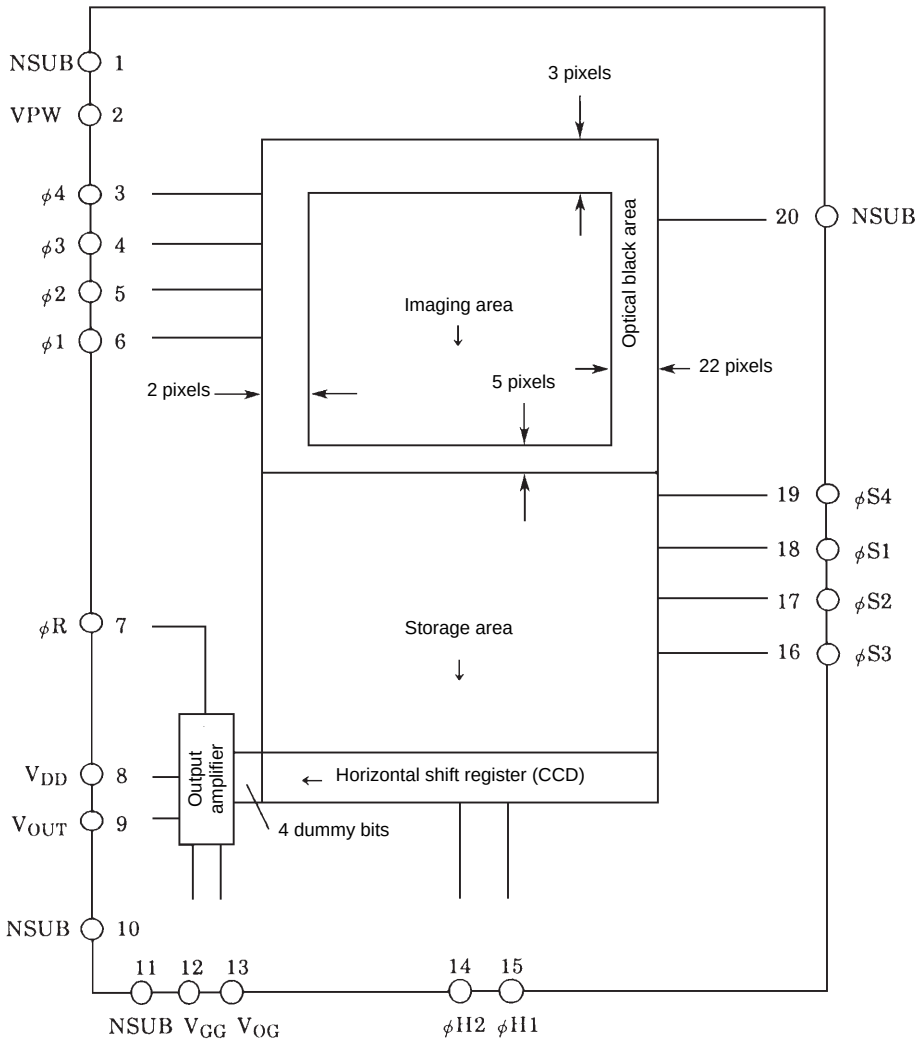
Specifications

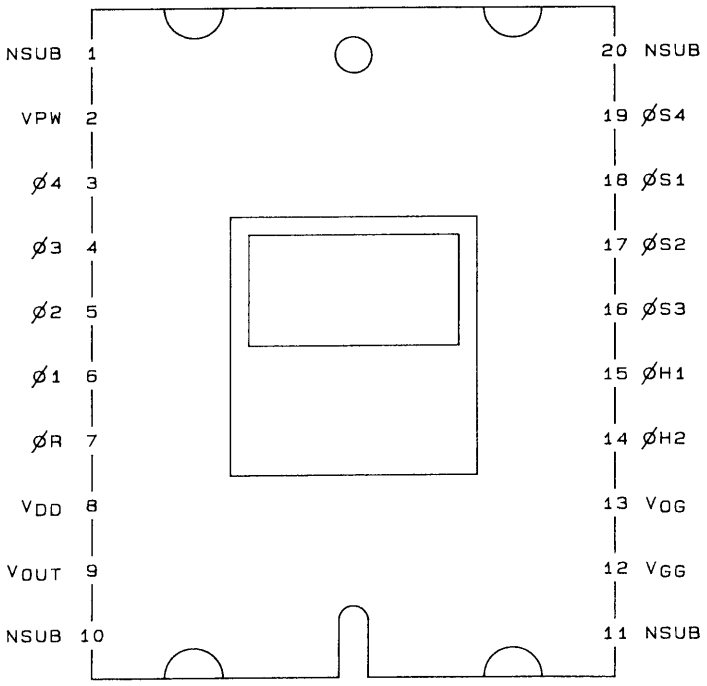
Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{DD}	V_{PW} = 0 V	–0.3 to +18	V
Load to gate voltage	V_{GG}	V_{PW} = 0 V	–0.3 to +5	V
N-substrate to P-well voltage	—	Between NSUB and VPW	–0.3 to +50	V
N-substrate to imaging and storage areas voltage	—	Between NSUB and ø1 to ø4, NSUB and øS1 to øS4	–0.3 to +55	V
Reset gate voltage	—	øR: V_{PW} = 0 V	–0.3 to +18	V
Horizontal clock voltage	—	øH1, øH2: V_{PW} = 0 V	–15 to +18	V
Pin voltage	—	Pins other than described above: V_{PW} = 0 V	–0.3 to +10	V
Operating temperature	Topr		–10 to +60	°C
Storage temperature	Tstg		–30 to +80	°C

Block Diagram



Pin Assignment



Top view A02952

Pin Functions

Pin No.	Symbol	Pin function	Pin No.	Symbol	Pin function
1	NSUB	N-substrate	20	NSUB	N-substrate
2	VPW	P-well	19	øS4	Storage area clock
3	ø4	Imaging area clock	18	øS1	Storage area clock
4	ø3	Imaging area clock	17	øS2	Storage area clock
5	ø2	Imaging area clock	16	øS3	Storage area clock
6	ø1	Imaging area clock	15	øH1	Horizontal shift register clock
7	øR	Reset gate	14	øH2	Horizontal shift register clock
8	V_{DD}	Power supply	13	V_{OG}	CCD output gate
9	V_{OUT}	CCD output	12	V_{GG}	Load gate
10	NSUB	N-substrate	11	NSUB	N-substrate

Clock Voltage at frame shift frequency = 3.58 MHz

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Imaging block pulses: ø1, ø2, ø3, ø4						
Pulse amplitude	V_{PIF}	*	14.0	14.5	15.0	V
Low level	V_{LIF}	*	–10.0	–9.5	–9.0	V
Storage block pulses: øS1, øS2						
Pulse amplitude	V_{PSL}		14.0	14.5	15.0	V
Low level	V_{LSL}		–7.0	–6.5	–6.0	V
Storage block pulses: øS3, øS4						
Pulse amplitude	V_{PSL}		14.0	14.5	15.0	V
Low level	V_{LSL}		–8.0	–7.5	–7.0	V
Horizontal transfer pulses: øH1, øH2						
Pulse amplitude	V_{PH}		4.5	5.0	5.5	V
Low level	V_{LH}		0	0	0.5	V
Reset gate: øR						
Pulse amplitude	V_{PR}		4.5	5.0	5.5	V
Low level	V_{LR}		3.6	4.0	4.4	V
Substrate pulse: øNSUB						
High level	V_{HSUB}**	See Figure 1	30.0		40.0	V
Low level	V_{LSUB}	See Figure 1	17.5	18.0	18.5	V

Note: * A 47 pF capacitor must be inserted as shown in figure 2.
** Adjust the V_{HNS} saturation output to its maximum value without causing picture degradation.

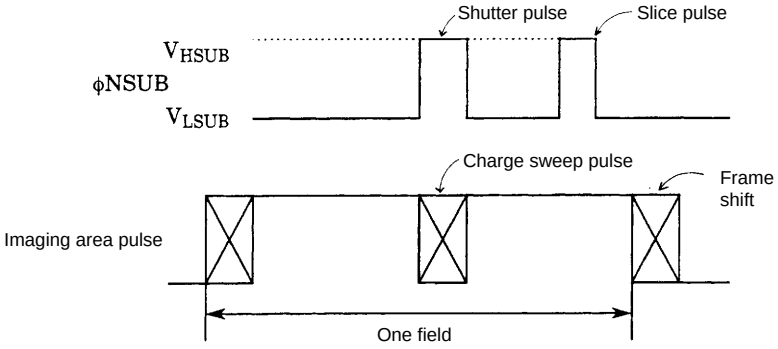


Fig. 1

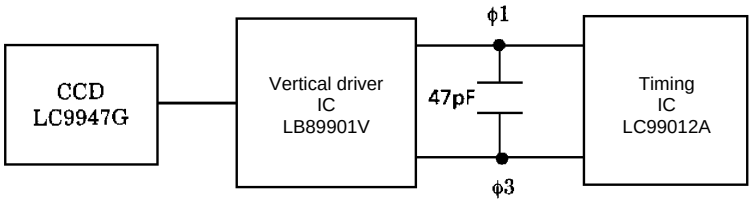


Fig. 2

Bias Conditions

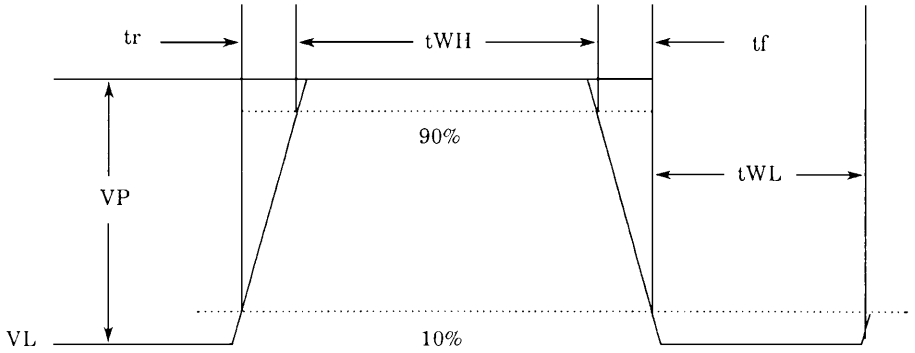
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
P-well	VPW			0		V
Output circuit voltage	V_{DD}	*1	14.5	15.0	15.5	V
	V_{GG}	*2	0.5	0.8	1.1	V
OG bias	V_{OG}	*2	4.5	5.0	5.5	V

Note: 1. This level must not become higher than the substrate pulse low level V_{LSUB}.
2. These input pins are in high impedance state.

DC Characteristics

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
DC operating current	I_{DD}		2.5	4.5	6.5	mA

Drive Pulse Waveform Standards



Note: VP: Pulse amplitude
VL: Low level

Symbol	tWH	tWL	tr	tf	Unit	Notes
	typ	typ	typ	typ		
ø1	166	100	6.5	6.5	ns	During frame transfer When the frame shift frequency is 3.58 MHz
ø2	141	116	11	11		
ø3	166	100	6.5	6.5		
ø4	141	116	11	11		
øS1	141	116	11	11	ns	During frame transfer When the frame shift frequency is 3.58 MHz
øS2	141	116	11	11		
øS3	141	116	11	11		
øS4	141	116	11	11		
øS1	1.36	62.1	30	30	ns	During 1H line vertical transfer The figures enclosed in dark lines are in µs units.
øS2	1.36	62.1	30	30		
øS3	62.1	1.36	30	30		
øS4	62.1	1.36	30	30		
øR	11	86	4	4	ns	Reset pulse
øH1	50	49	3	3		During horizontal transfer
øH2	50	49	3	3		
øNSUB	9.9	16.59*	0.07	1	µs	Slice pulse * The units are ms
øNSUB	4.2	16.59*	0.07	1	µs	Shutter pulse * The units are ms

Imaging Characteristics at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Sensitivity	S	Test method 1	110			mV
Video signal non-uniformity	VF	Test method 2			15	%
Saturated signal level	Vsat	Test method 3*	600			mV
Smear	SM	Test method 4**		0.04		%
Dark signal	Vdrk	Test method 5, Ta = 55°C			7	mV
γ characteristics	γ			1		—

Note: * When used with the substrate pulse be set to V_{HSUB} = 40 ±2 V, set the minimum saturated output voltage to 450 mV.
** For a frame shift frequency of 3.58 MHz and a storage time of 1/60 s.

Test Methods

The following tests are performed with the CCD device to be measured mounted on the Sanyo evaluation board.

1. Sensitivity
   Set up a CCV31F pattern box (Dai Nippon Printing Co., Ltd., intensity: 1320 NT, color temperature: 3100°K) with no pattern, and take an image with C-500 a 1 mm thickness infrared blocking filter mounted in front of a Fujinon HF16A lens. Set the lens aperture to f11, and set the separation between the lens and the pattern box to be 50 cm. Measure the CCD output signal from the center of the image in this state.

2. Video signal non-uniformity
   Test this item under the following conditions.
   - Standard drive state (See the specifications document.)
   - Use a halogen lamp with a color temperature of 3200°K as the light source.
   - Use an infrared blocking filter (C-500, 1 mm thickness).

   Set the CCD surface illumination level to be 7 lux, and divide the screen into 45 blocks as shown in Figure 3. Measure the average value in each block and determine the maximum, minimum, and mean of those values. Determine the ratio of the difference between the maximum and minimum of the block averages to the mean of the block averages.

$$VF = \frac{\text{(block average maximum)} - \text{(block average minimum)}}{\text{(block average mean)}}$$

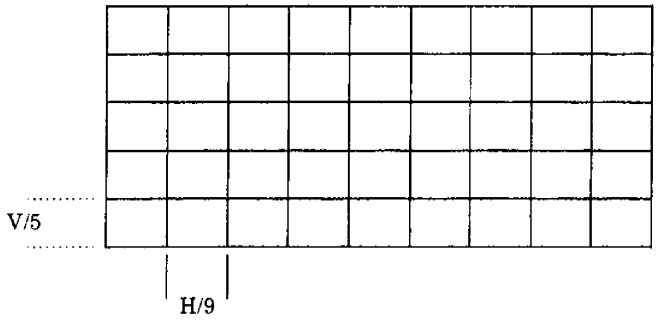


Fig. 3

3. Saturated signal level
   In the test method 1 setup state, remove the lens to saturate the output signal. Measure the CCD output signal from the center of the image at this time.

4. Smear
   - Place a 1/10 V chart in front of a halogen light source as described below and take the image.
   - Adjust the image (input) light intensity using ND filters so that the output signal at point A, i.e., the CCD output, becomes 250 mV.
   - Remove the ND filter and measure the output value for the first line (at point B) in the CCD output signal.

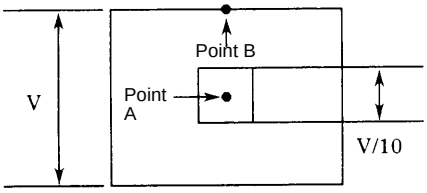


Fig. 4

$$SM = \frac{VB \times TND}{250} \times 100\ (\%)$$

VB: The amount of smear (mV) at point B
TND: Transmittance of the ND filter

5. Dark signal
   Block all light falling on the imaging element surface and measure the CCD output signal from the center of the image. At this time, do not take the difference between the signal level and the optical black segment level, but rather take the difference with the no signal level that has no pixel information. See Figure 5.

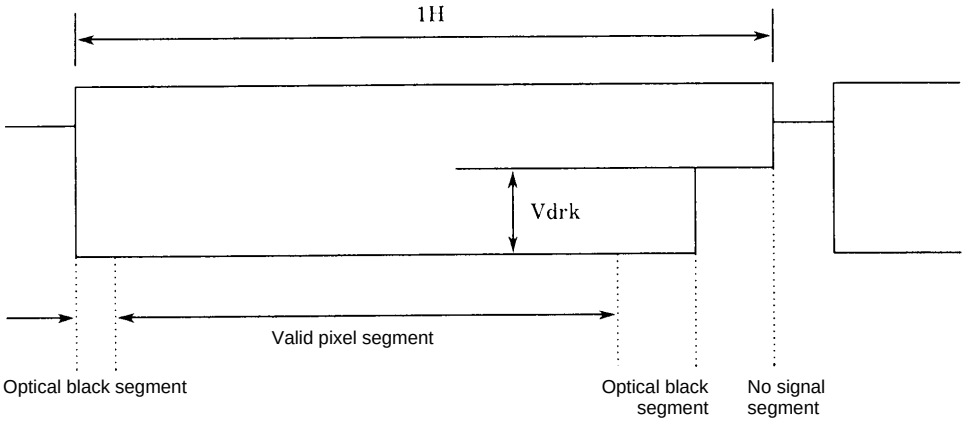


Fig. 5 Structure of the 1H Period

CCD B&W Camera Block Diagram

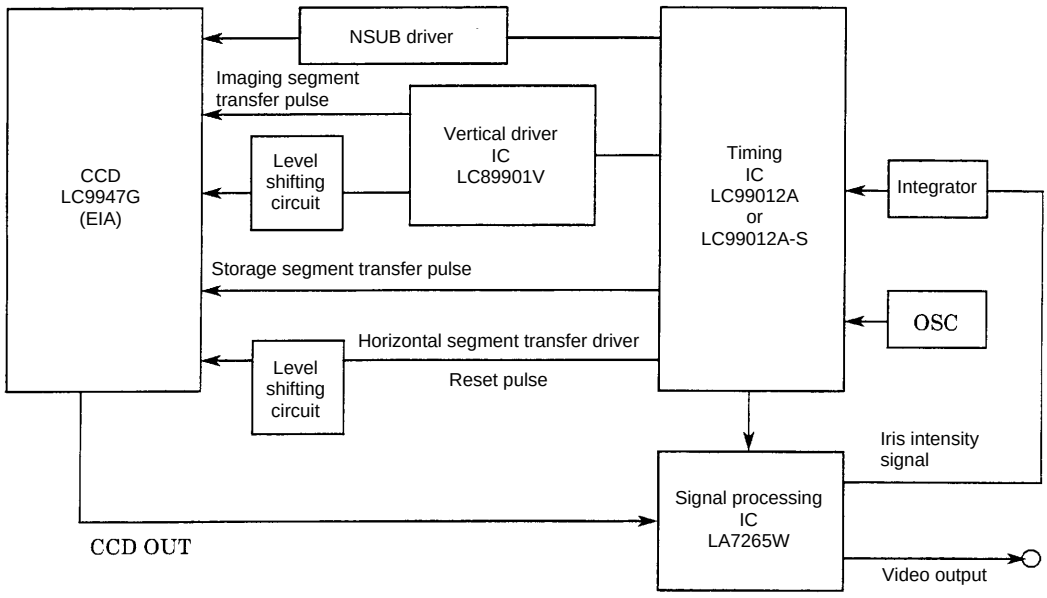


Fig. 6 CCD B&W Camera Block Diagram

Block Descriptions

OSC	Generates the basic frequency (28.636 MHz) for synchronization signals and timing pulses
Timing pulse generator IC	Generates the pulses required for the video signal (SYNC, blanking, etc.) and the pulses required for driving the CCD. This IC includes a built-in CCD horizontal driver and provides an electronic iris function.
Driver IC	Amplifies the pulses described above to their prescribed levels and drives the CCD device.
Level shifting circuit	Drive pulse level shifter
Signal processing IC	Video signal processing, including sample and hold, clamping, AGC, gamma correction, white clipping, and pedestal addition.

Notes on Handling and Mounting

1. Static discharge prevention
   The following measure for static discharge prevention must be taken, since the sensor is easily destroyed by static discharges.
   - Personnel and all equipment must be grounded when handling the sensor. For safety, personnel should be grounded through a resistor of about 1 MΩ. (The use of wrist straps is recommended.)
   - Work should be performed either with bare hands or antistatic gloves. Antistatic work uniforms should be used. Also, conductive shoes should be worn.
   - Spread conductive mats on the work place floors and on workbenches so that static charges do not arise.
   - We recommend using an ionized air blower to remove static charges when handling CCD sensors.
   - Use antistatic processed boxes to transport printed circuit boards with mounted CCD devices.
   - Packing materials, parts, or other objects made from styrofoam or other material that easily accumulate static electricity must not be placed on or near workbenches.
   - All test equipment, conveyors, soldering irons, and other tools used in this work must be grounded. Also, this grounding must be a perfect ground and must be checked periodically.
   - Do not handle this IC in the vicinity of TV monitors or other equipment that generates high static voltages. If operations in the vicinity of such equipment is unavoidable, anti-static measures must be taken. For example, for TV monitors, the whole screen must be covered by an antistatic filter.
   - The relative humidity in the workplace where this IC is handled must be maintained at 50%. This is because static electricity is more easily accumulated in low humidity.

2. Soldering
   - The package temperature must never exceed 80°C.
   - In addition to static discharges, CCD sensors are also easily destroyed by thermal stress. The soldering iron tip temperature should be under 300°C when mounting on a printed circuit board, and 2 seconds per pin should be set as the target soldering time.
   - Only use soldering irons that have a temperature controller that holds the soldering iron tip at a fixed temperature.
   - Use extra care to avoid heating the element to over 80°C when re-soldering or removing a CCD element.

3. Dirt and contamination
   - Work should be performed in a clean environment.
   - Do not touch the package surface or allow any objects to contact the surface. If dirt or other contamination gets on the package surface remove it with an air blower. (We recommend the use of an ionized air blower if possible.)
   - Oily or greasy contamination can be removed with a cotton swab dipped in ethyl alcohol. Be extremely careful not to scratch the package surface.
   - Store CCD devices in their special-purpose cases to avoid dirt and other contamination and to prevent condensation when transporting into a room with a radically differing temperature, warm or cool the device in advance.

4. Storage methods
   - Do not subject CCD products to intense light for extended periods.
   - Since severe high temperature/high humidity conditions can adversely influence device characteristics, avoid storing CCD products in such environments. The temperature and humidity in locations where samples are stored must be within normal ranges, namely 5 to35 °C and 45 to 75%RH.
   - Since CCD sensors are high precision optical components, they must be protected from mechanical shocks.
   - Avoid locations where corrosive gases may be released and avoid locations with high levels of dust and dirt.
   - Avoid locations subject to rapid temperature changes.
   - Do not allow heavy objects to be stacked on top of the device storage containers during storage.
   - Use materials that do not accumulate static charges for the containers used to hold samples.
   - Since pin bending and other problems that can adversely influence reliability during mounting may occur if mechanical shocks are applied to magazines, use care when handling magazines.

5. Notes on mounting
   - The use of a lens with an optical size of over 1/5 inch can result in flare. Consult your Sanyo sales representative before selecting a lens.
   - This product is mounted in a fully clear plastic package, and is susceptible to light entering from the back of the printed circuit board that it is mounted on. Therefore end products must provide adequate protection from stray light.

6. Notes on delivering
   - Do not throw or drop packages containing this device.
   - Do not allow these devices to be exposed to moisture in inclement weather such as rain or snow.
   - Keep mechanical vibrations and shocks applied to the device packing to a minimum during transport.