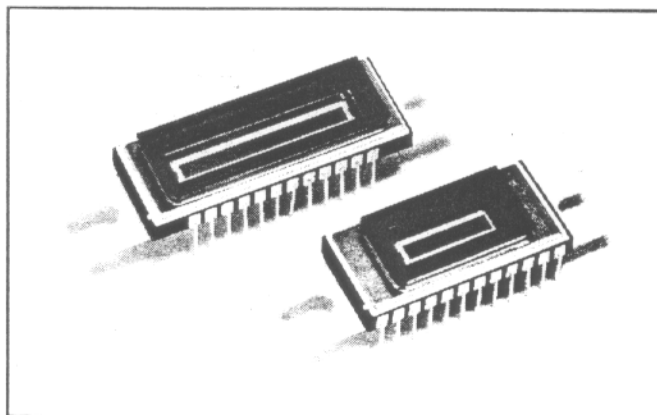


**A built-in thermoelectric cooler enables highly stable measurements even at very-low-light level**

### FEATURES

- Wide photosensitive area  
Pixel pitch: 50  $\mu\text{m}$  (S5930 Series), 25  $\mu\text{m}$  (S5931 Series)  
Pixel height: 2.5mm
- High UV sensitivity with good stability
- Excellent photometric capabilities  
Low dark current and high saturation charge  
good linearity  
Wide dynamic range
- Start pulse and clock pulses are CMOS logic compatible
- Built-in thermoelectric peltier cooler ( $T_s=0^\circ\text{C}$ )



### APPLICATIONS

- Multichannel spectrophotometry
- Image readout systems

N-MOS Linear image sensors are self-scanning photodiode arrays designed specifically for multichannel spectrophotometers. The scanning circuit consists of N-channel MOS transistors, and offers operation of low power consumption and easy handling. Each photodiode has a large active area with high UV sensitivity, yet assures exceptionally low noise. Thermoelectric cooling (air-cooled) enables a long exposure time, making it possible to obtain signals with a high S/N ratio even at low light levels. A sapphire window is welded onto the package, allowing high reliability.

### SELECTION GUIDE

Type No.	Number of Pixels	Pixel Size $\mu\text{m(H)} \times \mu\text{m(V)}$	Effective Active Area $\text{mm(H)} \times \text{mm(V)}$	Remark
S5930- 256S	256	50 $\times$ 2500	12.8 $\times$ 2.5	Standard Type
S5930- 512S	512		25.6 $\times$ 2.5	
S5931- 512S	512	25 $\times$ 2500	12.8 $\times$ 2.5	
S5931-1024S	1024		25.6 $\times$ 2.5	
S5932- 256S	256	50 $\times$ 2500	12.8 $\times$ 2.5	IR-enhanced Type
S5932- 512S	512		25.6 $\times$ 2.5	
S5933- 512S	512	25 $\times$ 2500	12.8 $\times$ 2.5	
S5933-1024S	1024		25.6 $\times$ 2.5	

\*In addition to the S5930 and S5931 series, Hamamatsu provides the S5932 and S5933 series thermoelectrically-cooled N-MOS linear image sensors optimized for high sensitivity in the near infrared range. These devices have the peak wavelength at 800nm as shown in Figure 3. Other characteristics are identical with the S5930 and S5931 series.

# THERMOELECTRICALLY-COOLED N-MOS LINEAR IMAGE SENSORS S5930, S5931 SERIES

Figure 1: Equivalent Circuit

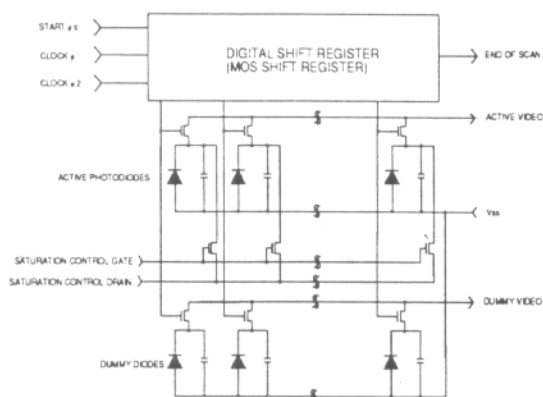
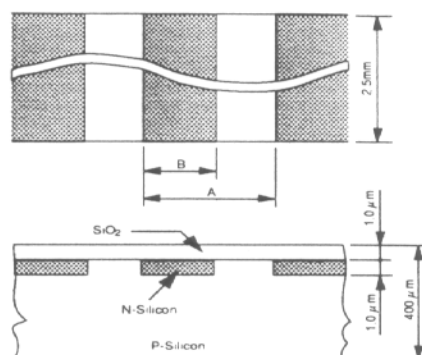


Figure 2: Sensor Geometry



S5930 Series A=50  $\mu$ m B=45  $\mu$ m  
S5931 Series A=25  $\mu$ m B=20  $\mu$ m

## MAXIMUM RATINGS

Parameter	Symbol	S5930, S5931 Series	Unit
Supply Clock Amplitude	$V_{\phi}$	15	V
Operating Temperature <sup>①</sup>	$T_{opr}$	-40 to +65	°C
Storage Temperature	$T_{stg}$	-40 to +85	°C

<sup>①</sup>No dew. When operating the device at 0°C, ambient temperature should be 35°C maximum.

## ELECTRICAL CHARACTERISTICS (Ta=25°C)

Parameter	Symbol	S5930 Series			S5931 Series			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Video Bias Voltage <sup>②</sup>	$V_b$	1.5	$V_{\phi}$ -3.0	$V_{\phi}$ -2.5	1.5	$V_{\phi}$ -3.0	$V_{\phi}$ -2.5	V
Saturation Control Gate Voltage	$V_{scg}$	-	0	-	-	0	-	V
Saturation Control Drain Voltage	$V_{scd}$	-	$V_b$	-	-	$V_b$	-	V
Start Pulse Voltage ( $\phi$ st) <sup>②</sup>	-High	4.5	$V_{\phi}$	10	4.5	$V_{\phi}$	10	V
	-Low	0	-	0.4	0	-	0.4	
Clock Pulse Voltage ( $\phi$ 1, $\phi$ 2) <sup>②</sup>	-High	4.5	5	10	4.5	5	10	V
	-Low	0	-	0.4	0	-	0.4	
Start Pulse Rise / Fall Times ( $\phi$ st)	$tr_{\phi s}, tf_{\phi s}$	-	-	500	-	-	500	ns
Start Pulsewidth ( $\phi$ st)	$tpw_{\phi s}$	200	-	-	200	-	-	ns
Clock Pulse Rise / Fall Times ( $\phi$ 1, $\phi$ 2)	$tr_{\phi 1}, tr_{\phi 2}$	-	-	500	-	-	500	ns
	$tf_{\phi 1}, tf_{\phi 2}$	-	-	500	-	-	500	
Clock Pulsewidth ( $\phi$ 1, $\phi$ 2)	$tpw_{\phi 1}, tpw_{\phi 2}$	200	-	-	200	-	-	ns
Start Pulse ( $\phi$ st) and Clock Pulse ( $\phi$ 2) Overlap	$t_{\phi ov}$	200	-	-	200	-	-	ns
Clock Pulse Space	X1, X2	0	-	-	0	-	-	ns
Data Rate <sup>③</sup>	f	0.1	-	2000	0.1	-	2000	kHz
Video Delay Time (50% of saturation) <sup>③, ④</sup>	$t_{vd}$	- 120(-256Q)	-	-	- 150(-512Q)	-	-	ns
		- 160(-512Q)	-	-	- 200(-1024Q)	-	-	
Clock Pulse Line Capacitance ( $\phi$ 1, $\phi$ 2) at 5V bias	$C_{\phi}$	- 36(-256Q)	-	-	- 50(-512Q)	-	-	pF
		- 67(-512Q)	-	-	- 100(-1024Q)	-	-	
Saturation Control Gate Line Capacitance ( $V_{scg}$ ) at 5V bias	$C_{scg}$	- 20(-256Q)	-	-	- 24(-512Q)	-	-	pF
		- 35(-512Q)	-	-	- 45(-1024Q)	-	-	
Video Line Capacitance at 2V bias	$C_v$	- 11(-256Q)	-	-	- 16(-512Q)	-	-	pF
		- 20(-512Q)	-	-	- 30(-1024Q)	-	-	

<sup>②</sup> $V_{\phi}$  is supply clock amplitude.

<sup>③</sup> $V_b=2.0V$ ,  $V_{\phi}=5.0V$

<sup>④</sup>Measured with a C5964

## ELECTRICAL AND OPTICAL CHARACTERISTICS (Ta=25°C)

Parameter	Symbol	S5930 Series			S5931 Series			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Pixel Pitch		-	50	-	-	25	-	$\mu\text{m}$
Pixel Height		-	2.5	-	-	2.5	-	mm
Photodiode Dark Current (at 25°C) ⑤	$I_D$	-	0.2	0.6	-	0.1	0.3	pA
Photodiode Dark Current (at 0°C) ⑤	$I_D$	-	0.006	0.018	-	0.003	0.009	
Photodiode Capacitance ⑤	Cph	-	20	-	-	10	-	pF
Spectral Response Range (10% of peak)	$\lambda$	200~1000			200~1000			nm
Peak Sensitivity Wavelength	$\lambda_p$	-	600	-	-	600	-	nm
Saturation Exposure ⑤、⑥	Esat	-	180	-	-	180	-	$\text{mIx} \cdot \text{s}$
Saturation Charge ⑤	Qsat	-	50	-	-	25	-	pC
Sensitivity Uniformity ⑦		-	-	$\pm 3$	-	-	$\pm 3$	%

⑤  $V_b=2.0\text{V}$ ,  $V_\phi=5.0\text{V}$

⑥ 2856k, Tungsten lamp

⑦ 50% of saturation, excluding first and last elements

figure 3: Spectral Response

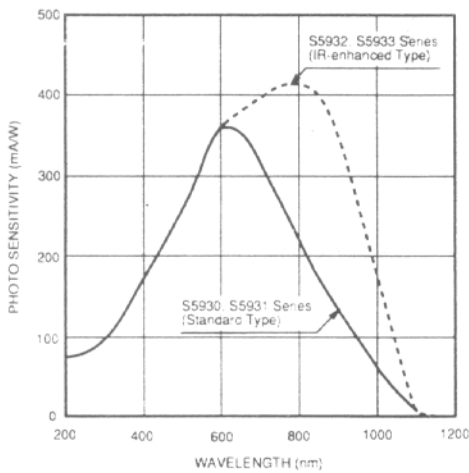


Figure 4: Output Charge vs. Exposure

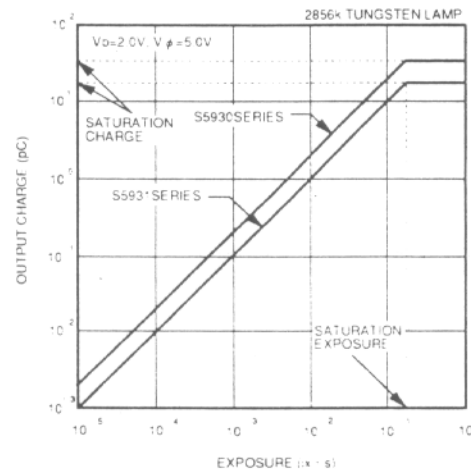
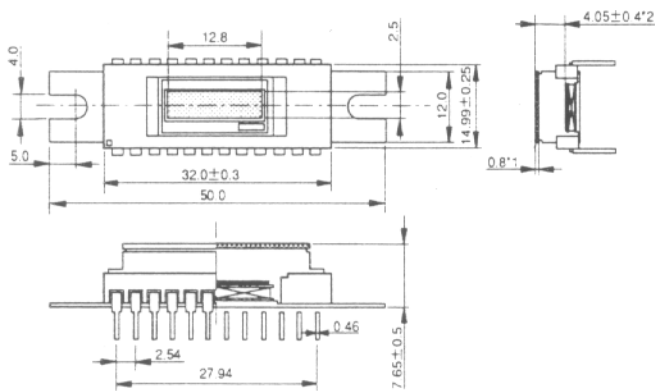
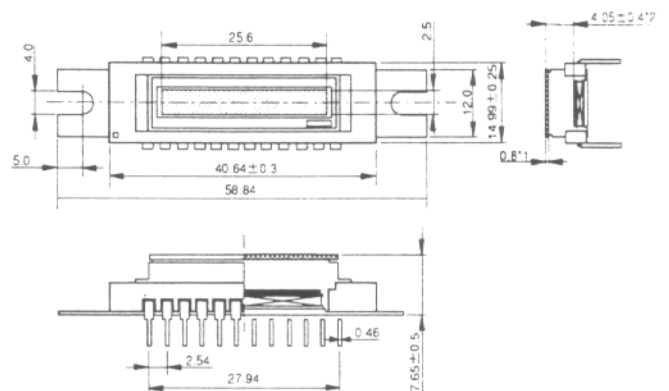


Figure 5: Dimensional Outlines (Unit: mm)

S5930-256S, S5931-512S



S5930-512S, S5931-1024S



\*1: Thickness of sapphire window

\*2: Optical distance from the outer surface of the sapphire window to the chip surface.

# THERMOELECTRICALLY-COOLED N-MOS LINEAR IMAGE SENSORS S5930, S5931 SERIES

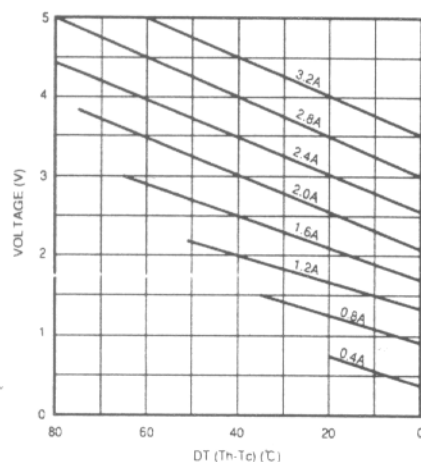
## ■ PELTIER ELEMENT TYPE 1. (T-06E 144P-RNO)

Peltier element type 1 is built into the S5930-512S, S5931-1024S for thermoelectric cooling.

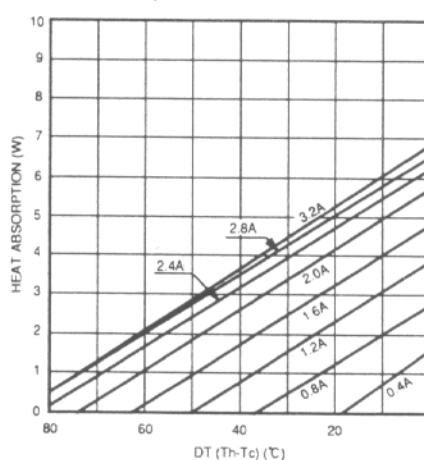
Parameter	Value
Internal Resistant (at 25°C)	1.25 $\Omega$
Max. Current (Tc-Th 20°C)	3.6A
Max. Voltage (Tc-Th 80°C)	6.2V
Max. Heat Absorption (Tc-Th 20°C)	7.5W

## PERFORMANCE DIAGRAM OF PELTIER ELEMENT TYPE 1. (Tc=0°C)

### ■ Voltage - DT

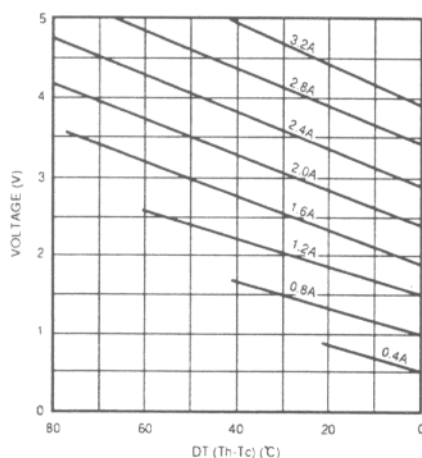


### ■ Heat Absorption - DT

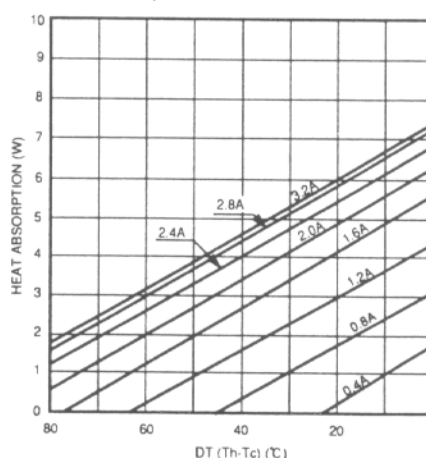


(Tc=20°C)

### ■ Voltage - DT



### ■ Heat Absorption - DT



## ■ CHIP THERMISTOR

Parameter	Value
Resistance (at 25°C)	10k $\Omega$
B-constant (at 25°C)	3450k
Operating Temperature	-40 ~ +100°C

## RESISTANCE vs. TEMPERATURE CHARACTERISTIC

Temperature (°C)	Resistance (k $\Omega$ )
-20	78.4
-10	46.7
0	28.1
10	18.2
20	12.2
25	10.0
30	8.3
40	5.7

## ■ PELTIER ELEMENT TYPE 2. (T-06E 108P-RNO)

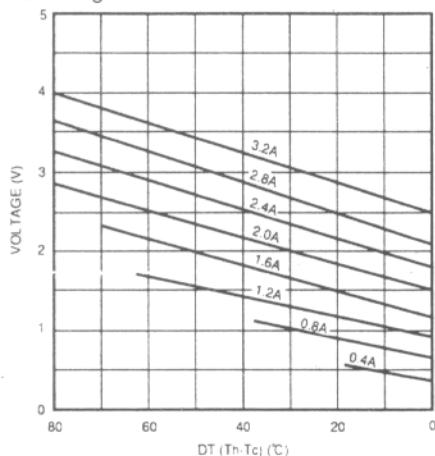
Peltier element type 2 is built into the "S5930-256S", "S3931-512S" for thermoelectric cooling.

Parameter	Value
Internal Resistant (at 25°C)	0.983 $\Omega$
Max. Current (Tc-Th 20°C)	3.6A
Max. Voltage (Tc-Th 80°C)	4.7V
Max. Heat Absorption (Tc-Th 20°C)	5.7W

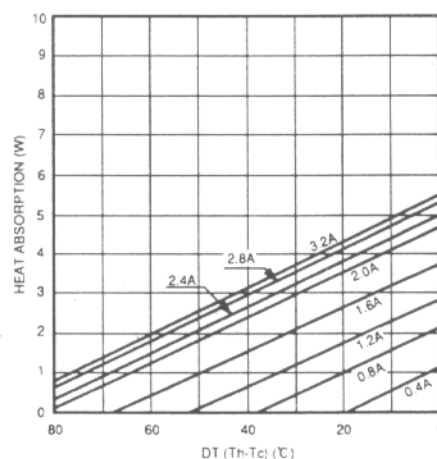
### PERFORMANCE DIAGRAM OF PELTIER ELEMENT TYPE 2.

(Tc=0°C)

#### ■ Voltage - DT

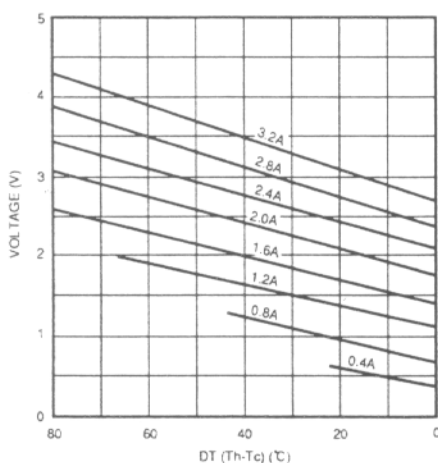


#### ■ Heat Absorption - DT

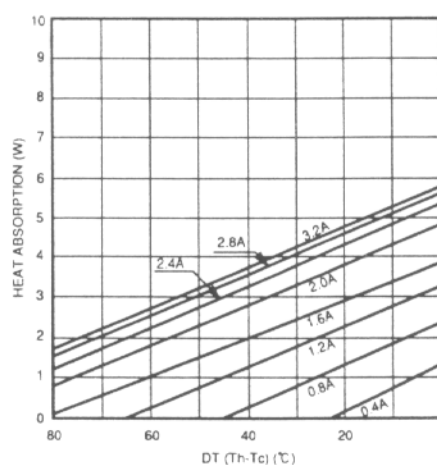


(Tc=20°C)

#### ■ Voltage - DT

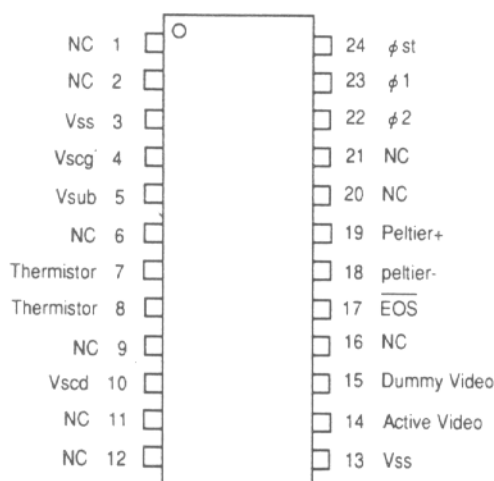


#### ■ Heat Absorption - DT



# THERMOELECTRICALLY-COOLED N-MOS LINEAR IMAGE SENSORS S5930, S5931 SERIES

## PINOUT AND RECOMMENDED OPERATING CONDITIONS



\*Vss, Vsub and NC should be grounded.

\*Pin 20 is electrically connected to the package metal.

Terminal	Input or Output	Description
$\phi 1$ , $\phi 2$	Input (C-MOS logic compatible)	Pulses for operating the MOS shift register. As the video output signal is obtained synchronized with the rise of $\phi 2$ , the video data rate is equal to the clock pulse frequency.
$\phi st$	Input (C-MOS logic compatible)	Pulse to start operation of the MOS shift register. The time interval between start pulses is equal to the signal accumulation time.
Vss	—	Connected to the anode of each photodiode. This should be grounded.
Vscg	Input	Used for restricting blooming. This should be set at the base line of each input pulse and is normally the ground level.
Vscd	Input	Used for restricting blooming. This should be biased at a voltage equal to the video bias at all times.
ACTIVE VIDEO	Output	Video output signal. A positive voltage should be applied to the video line which connects the photodiode cathodes so that each photodiode is reverse-biased. It is recommended that the video bias be 2V when the amplitude of $\phi 1$ , $\phi 2$ and $\phi st$ is at 5V.
DUMMY VIDEO	Output	This has the same structure as the active video, but is not connected to the photodiodes, so only spike noise is output. It should be biased at a voltage equal to the active video line. When in use otherwise, it should be open circuited.
Vsub	—	Connected to the silicon substrate. This should be grounded.
$\overline{EOS}$	Output (C-MOS logic compatible)	This should be pulled up to 5V using a 10k $\Omega$ resistor. Negative polarity. The end of scan signal is obtained synchronized with $\phi 2$ right after the last photodiode is addressed.
NC	—	No connection. These should be grounded.
PELTIER	Input	For cooling of the sensor chip.
THERMISTOR	Input	For temperature control.

# HAMAMATSU

HAMAMATSU PHOTONICS K.K., Solid State Division

1126-1 Ichino-cho, Hamamatsu City, 435 Japan, Telephone:053-434-3311, Fax:053-434-5184, Telex:4225-185

U.S.A.: Hamamatsu Corporation, 360 Foothill Road, P.O. Box 6910, Bridgewater, N.J. 08807-0910, Telephone 908-231-0960, Fax 908-231-1218

Germany: Hamamatsu Photonics Deutschland GmbH, Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Telephone 49-8152-375-0, Fax 49-8152-2658

France: Hamamatsu Photonics France, Zone Orlytech-BT, 523 3, Allée du Cdt. Mouchotte, Paray Vieille Poste 91781 Wissous Cedex, France Telephone 33-(1)49 75 56 80, Fax 33-(1)49 75 56 87

United Kingdom: Hamamatsu Photonics UK Limited, Lough Point, 2 Gladbeck Way, Windmill Hill, Middlesex EN2 7JA, England, Telephone 44-1-367-3560, Fax 44-1-367-6384

North Europe: Hamamatsu Photonics Norden AB, Farögatan 7, 164 40 Kista, Sweden, Telephone 46-8-703-29-50, Fax 46-8-750-58-95

Oct 94