

Preliminary

Contact Image Sensor (CIS) Module

Product Name

M208-A4

Approval

Notes

CMOS Sensor Inc.

20045, Stevens Creek Blvd.,
Suite 1A
Cupertino, CA., 95014
Tel: (408) 366-2898
Fax: (408) 366-2698

Approved

Checked

Designed

Issued

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Revision no.

All specifications of this device are subject to change without notice.

Revision control sheet

Revision No.	Date	Item of change and content	Reason	Approved	Designed

CMOS Sensor Inc.

M208-A4 600 dpi, A4 size, Contact Image Sensor (CIS) module

Features:

- 5184 x 1 image sensing elements
- 600 dots per inch (dpi) resolution
- 219 mm scanning length
- 18 mm x 11.3 mm x 231 mm compact size
- No residual image
- Red, Green, Blue LED light source
- light weight
- single 5 V power supply
- Good linearity: $1 \pm 5\%$
- high integration for light source, lens and sensor
- 12 pin connector for input and output

Description:

The M208-A4 contact image sensor (CIS) module is a contact type image sensing module. That is composed of a line of LED as a light source, a long Selfoc rod lens array, and 5184 photo-detector array. Input and output electronic contact is via a 12-pin connector. The cross sectioned view of the M208-A4 CIS module is shown in figure 1. Figure 2, on the following page, is a block diagram of the module.

The module is suitable for scanning A4 size (216 mm) documents with 600-dpm resolution. Applications include 600 dpi color scanner, document scanner, and other office automation (OA) equipment.

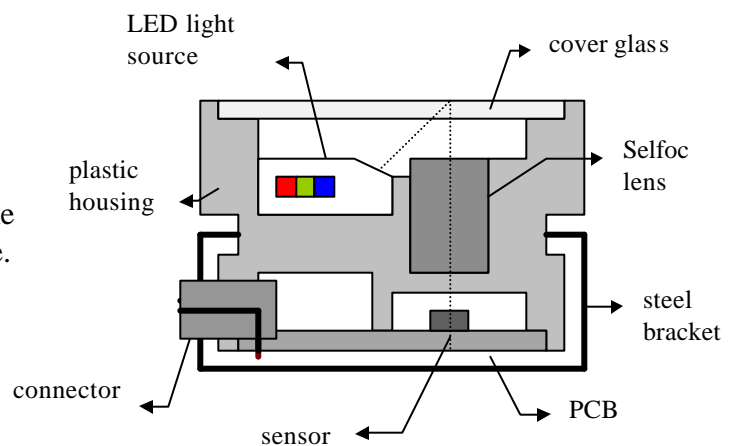


Figure 1. Cross section view of the M208-A4 CIS module.

Functional block diagram:

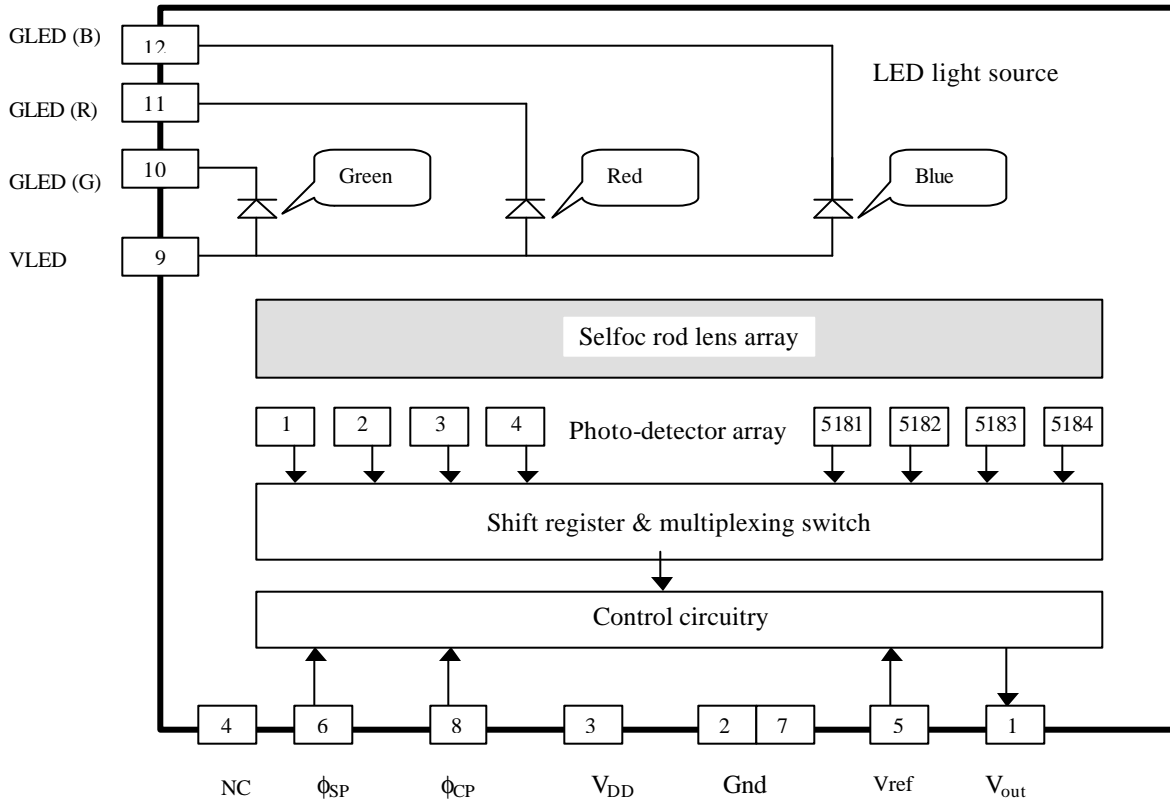


Figure 2. M208-A4 color CIS module block diagram.

Pin description:

Pin #	Symbol	Description
1	V_{out}	Analog video output signal
2	Gnd	Ground; 0 V
3	V_{DD}	power supply voltage; + 5 V
4	NC	Not connection
5	V_{ref}	External reference voltage (0.6 V ~ 1.5 V)
6	ϕ_{SP}	Start pulse
7	Gnd	Ground; 0 V
8	ϕ_{CP}	Main clock pulse
9	VLED	Common Anode of the LED light source
10	GLED (G)	Cathode of Green LED light source
11	GLED (R)	Cathode of Red LED light source
12	GLED (B)	Cathode of Blue LED light source

Table 1. The bonding pad description of the M208-A4 CIS module.

Electro-optical characteristics:

(all shipped modules are tested under the following testing conditions)

Table 2. Operating conditions and typical electro-optical characteristics of the M208-A4 CIS module in Color mode. [under testing conditions of $f = 1$ MHz, $V_{DD} = 5$ V, ILED = 45 mA (red), 45 mA (green), 45 mA (blue), $T_a^{*(1)} = 25$ °C]

Symbol	Parameter	Test conditions	min.	typ	max	unit
ϕ_{CP}	Clock frequency			1.0		MHz
$F^{*(2)}$	Pixel readout rate			2.0		MHz
$T_{int}^{*(3)}$	Line scanning rate			8		ms/line
$V_{pc}^{*(4)}$	Analog output voltage at white paper	O.D. $^{*(9)} = 0.05 \sim 0.1$	0.8			V
$U_{pc}^{*(5)}$	White paper non-uniformity	O.D. = 0.05 ~ 0.1			50	%
$V_d^{*(6)}$	Analog output voltage at dark paper	light off, O.D. = 0.8	0.03		0.4	V
$U_d^{*(7)}$	Dark signal non-uniformity	light off, O.D. = 0.8			0.3	V
MTF $^{*(8)}$	Modulation transfer function (Green)	at 5.7 lp/mm $^{*(10)}$	20			%
	(Blue)		10			%
	(Red)		15			%

Table 3. Operating conditions and typical electro-optical characteristics of the M208-A4 CIS module in B/W mode. [under testing condition of $f = 1$ MHz, $V_{DD} = 5$ V, ILED = 20 mA (red, green, blue), $T_a^{*(1)} = 25$ °C]

Symbol	Parameter	Test conditions	min.	typ	max	unit
ϕ_{CP}	Clock frequency			1.0		MHz
$F^{*(2)}$	Pixel readout rate			2.0		MHz
$T_{int}^{*(5)}$	Line scanning rate			3		ms/line
$V_{pc}^{*(4)}$	Analog output voltage at white paper	O.D. $^{*(9)} = 0.05 \sim 0.1$	0.8			V
$U_{pc}^{*(5)}$	White paper non-uniformity	O.D. = 0.05 ~ 0.1			50	%
$V_d^{*(6)}$	Analog output voltage at dark paper	light off, O.D. = 0.8	0.03		0.4	V
$U_d^{*(7)}$	Dark signal non-uniformity	light off, O.D. = 0.8			0.3	V
MTF $^{*(8)}$	Modulation transfer function (Green)	at 5.7 lp/mm $^{*(10)}$	20			%

Definition:

1. T_a is ambient temperature.
2. F is a pixel readout rate. It is double of the clock frequency.
3. T_{int} is an integration time or line scanning time. In the B/W operation mode, it is determined by the interval between two start pulses. For the color operation mode, T_{int} is at least three times that of the B/W mode.
4. $V_{pc}(n)$ is the effective output signal of each pixel. It is defined by:
 $V_{pc} = V_p(n) - V_d(n)$
 $V_p(n)$ is the output signal of nth pixel in the white paper.
 $V_d(n)$ is the output signal of nth pixel in the dark paper.

5. U_{pc} is a pixel - pixel photo response non-uniformity within whole module.

$$U_{pc} = [(V_{pcmax} - V_{pcmin}) / V_{pcmax}] \times 100\%$$

$$V_{pcmax} = \text{MAX} [V_{pc}(n)]; \text{ it is the maximum effective output signal.}$$

$$V_{pcmin} = \text{MIN} [V_{pc}(n)]; \text{ it is the minimum effective output signal.}$$
6. V_{dmin} is the minimum output signal in the dark and defined by:

$$V_{dmin} = \text{MIN} [V_d(n)];$$
 where n = 1, 2, 5184 pixels on the whole module.
7. U_d is the dark output non-uniformity and defined by:

$$U_d = V_{dmax} - V_{dmin}$$
 Where $V_{dmax} = \text{MAX} [V_d(n)];$ it is the maximum dark output signal.

$$V_{dmin} = \text{MIN} [V_d(n)];$$
 it is the minimum dark output signal.
8. MTF is a output response of the module using a MTF image target and defined by:

$$\text{MTF} = \text{MIN} \{ [(V_{max} - V_{min}) / (V_{max} + V_{min})] \} \times 100\%$$
 where V_{max} is the maximum output voltage using a MTF image target.
 V_{min} is the minimum output voltage using a MTF image target.
 MTF image target is 5.75 lp/mm
9. O.D. = optical density of the paper.
10. lp / mm = line pair per millimeter

Absolute maximum ratings:

Power supply voltage, V _{DD}	-----	6.5 V
Power supply current, I _{DD}	-----	100 mA
LED power supply current, I _{LED}	-----	80 mA
Digital input voltage range (high), V _{Ih}	-----	V _{DD} + 0.5 V
Digital input voltage range (low), V _{Il}	-----	- 0.5 V
Digital input current range, I _{Ih}	-----	-20 mA to 20 mA
Operating free-air temperature range, T _a	-----	0 °C ~ 50 °C
Storage temperature range, T _{stg}	-----	-25 °C ~ 70 °C
Storage humidity range, H _{stg}	-----	10 ~ 90 % RH

‡ Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress rating only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 4. Recommended operating conditions:

Item	Symbol	Min.	Typ.	Max.	Unit
Positive power supply voltage	V_{DD}	4.75	5	5.25	V
LED power supply current	I _{LED}		40	60	mA
High level input voltage	V_{ih}	$V_{DD} - 0.7$		V_{DD}	V
Low level input voltage	V_{iL}	0		0.7	V
Clock frequency	f	5	1		MHz
Clock pulse high duty cycle			50		%
Clock pulse high duration	t _w		0.5		Us
Sensor integration time (color) (B/W)	t _{int}		8 3		ms
Operating humidity	H _{op}	10		85	% RH
Operating free-air temperature	T _a	0		50	°C

Table 5. LED light source characteristics (I_F = 20 mA, 25 °C):

Parameter	Peak emission wavelength	Spectral line half width ($\Delta\lambda$)
Red LED	640 nm	20 nm
Green LED	525 nm	40 nm
Blue LED	470 nm	30 nm

Table 6. LED Maximum rating:

Parameter	Symbol	Red	Green	Blue	Note
DC forward current	I _F	25 mA	25 mA	25 mA	1
Pulse forward current	I _{FP}	45 mA	45 mA	45 mA	2

1. For B/W mode operation, the LED current is continuous.
2. For color mode operation, the maximum pulse width is 2 ms and 20% of duty cycle.

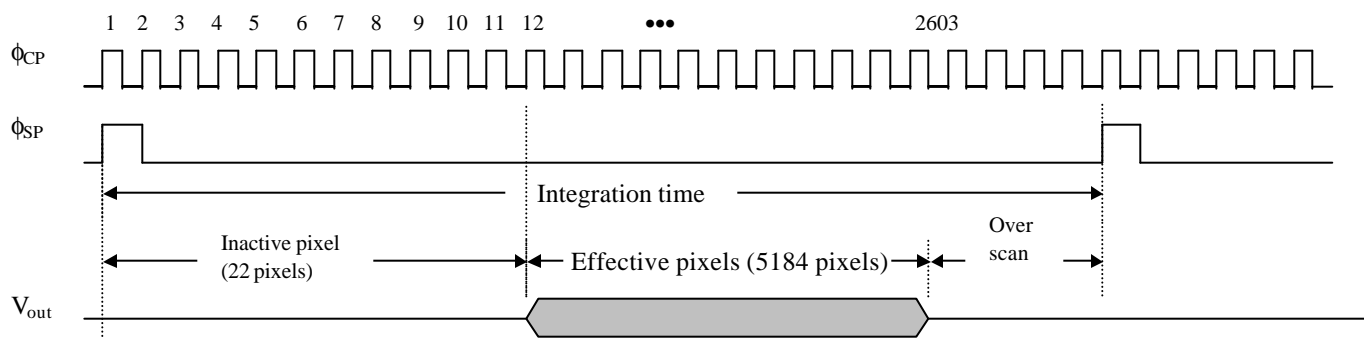
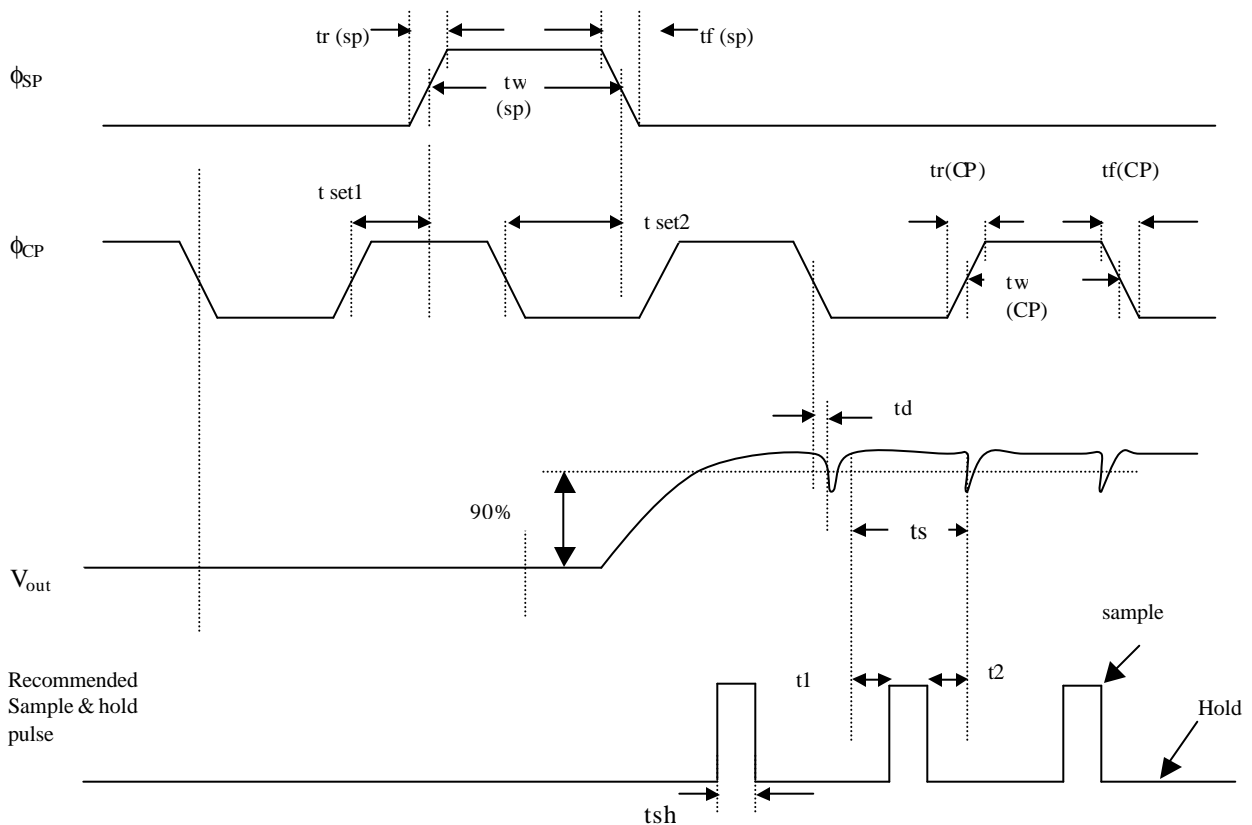
Figure 3. Timing Diagram:

Table 7. Switching characteristics:

item	Description	symbol	min.	Typ.	Max.	unit
1	Clock frequency	f (CP)		1	1.5	MHz
2	Clock pulse width	tw (CP)	475	500	525	ns
3	Clock pulse duty cycle		45	50	55	%
4	Clock pulse rise time	tr (CP)	0		1/(20*f(CP))	ns
5	Clock pulse fall time	tf (CP)	0		1/(20*f(CP))	ns
6	Start pulse width	tw (SP)	1020			ns
7	Start pulse rise time	tr (SP)	0		1/(20*f(CP))	ns
8	Start pulse fall time	tf (SP)	0		1/(20*f(CP))	ns
9	ϕ_{SP} setup time	tset1	-150		50	ns
10	ϕ_{SP} hold time	tset2	20			ns
11	Video signal delay time	td		50		ns
12	Video signal stable time	ts	100			ns
13	Sample & hold pulse	tsh		(1/4)tw(CP)		ns
14	Rise time to S/H	t1	0	50		ns
15	Fall time to S/H	T2	0	50		ns

Figure 4. Switching waveforms:



Application:

1. LED control circuitry:

The Red, Green and Blue color of LED must be driven by the current. The following circuitry is a simplified circuit to drive the LED array.

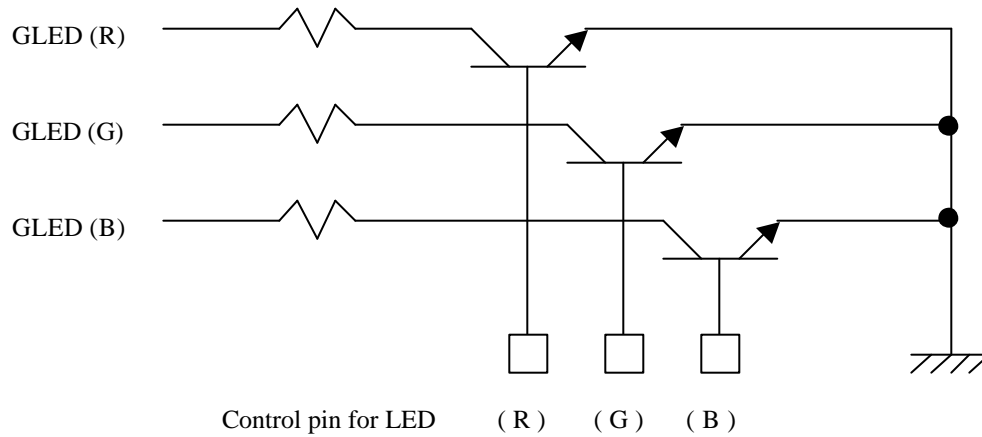
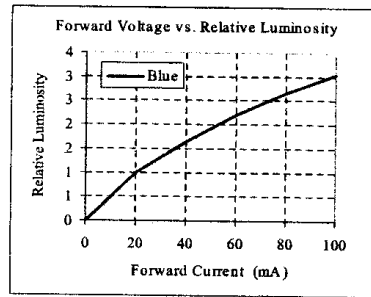
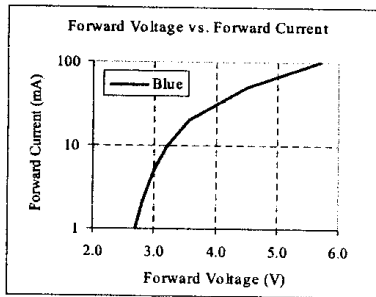
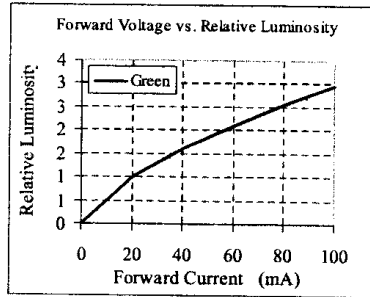
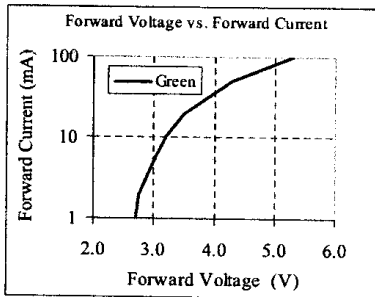
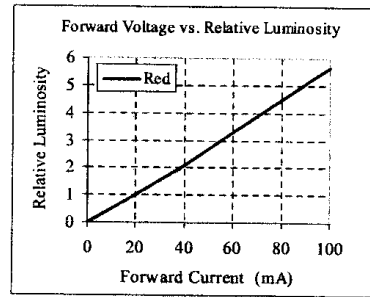
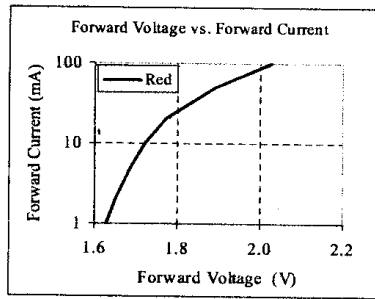
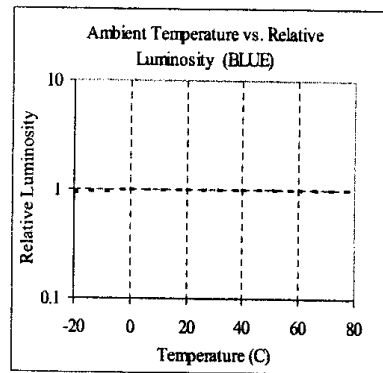
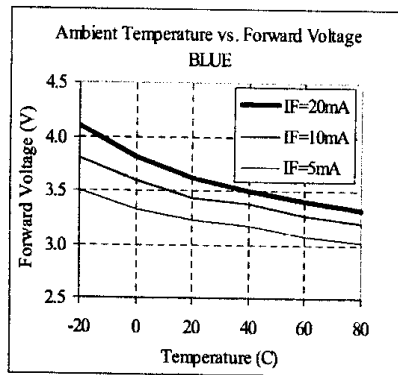
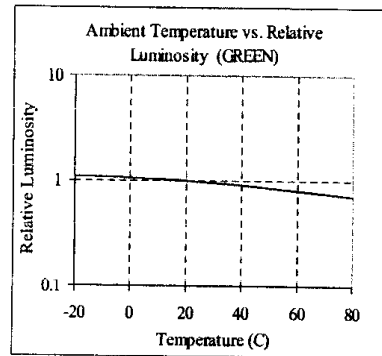
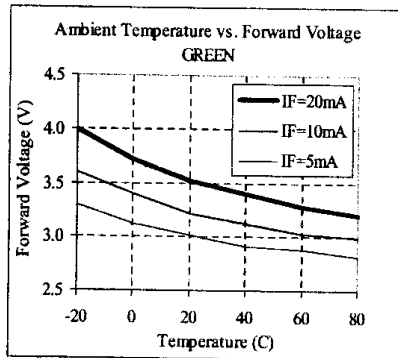
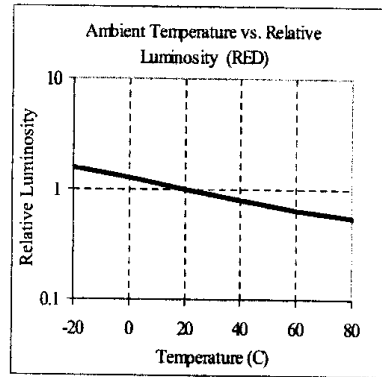
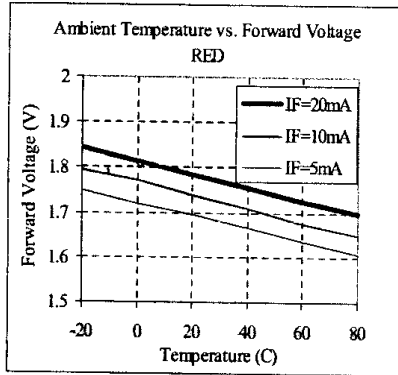


Figure 5. A reference circuitry of LED light source.

2. LED characteristics:





3. Driver timing diagram:

3.1 Color mode operation:

The CIS module used for the color mode of operation is shown in figure 6. In this mode of operation, three different color light sources are pulsed. The following instruction is used to set the output signal level for three different color light source.

- 3.1.1 The currents of three LED are set within the spec as described in Table 6.
- 3.1.2 The pulse width of three color LED is set to Maximum ($T_{red} = T_{green} = T_{blue} = T_{max}$).
- 3.1.3 Measure the output voltage for three different color LED's.
- 3.1.4 Keep the smallest signal and pulse width on that color of LED as a reference. For example, the output signal is 1 V, 0.8 V and 1.2 V for R, G, and B color of LED, respectively. Then choose Green LED as a reference LED and 0.8 V as a reference voltage.
- 3.1.5 Reduce the pulse width of the other two LED's until the output signal is the same as the reference voltage. For example, the green LED pulse is set to T_{max} and the red and blue LED pulses are reduced, as shown in figure 6.

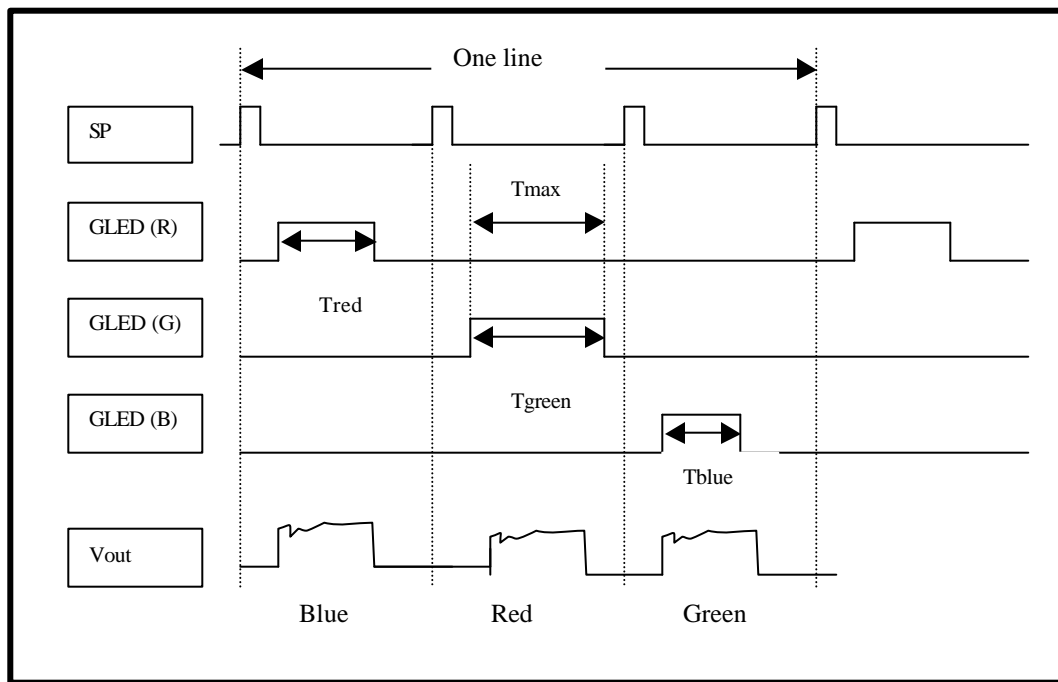


Figure 6. Timing diagram of the CIS module for color mode of operation.

3.2 B/W mode operation:

The CIS module used for the B/W mode of operation is shown in figure 7. In this mode of operation, three different color light sources need to apply a continuous current. The following instruction is used to set the output signal level for three different color light source.

- 3.2.1 The currents of the Green LED are set within the spec as described in Table 6.
- 3.2.2 Measure the output voltage for the green color of LED as a reference voltage.
- 3.2.3 Adjust the current for the red LED and blue LED until the output signal is the same as the reference voltage.

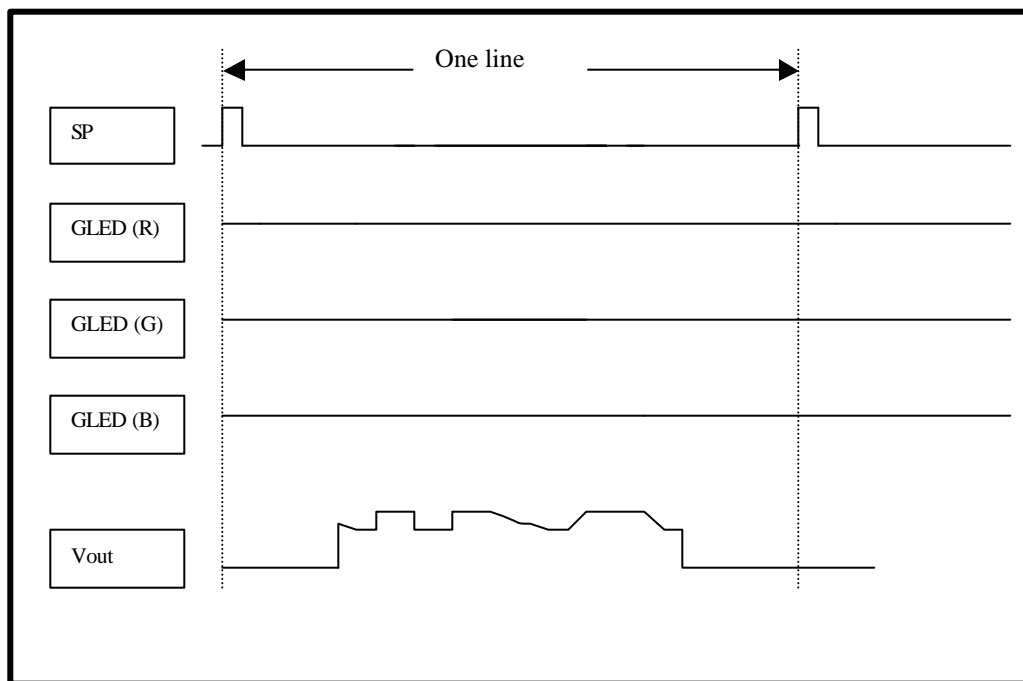


Figure 7. Timing diagram of the CIS module for B/W mode of operation.

4. A/D interface circuitry:

There are several different methods for the output signal to interface with an A/D converter. Figure 8 shows a reference circuit. Method A is very simple. Method C is more complicated and has a better performance.

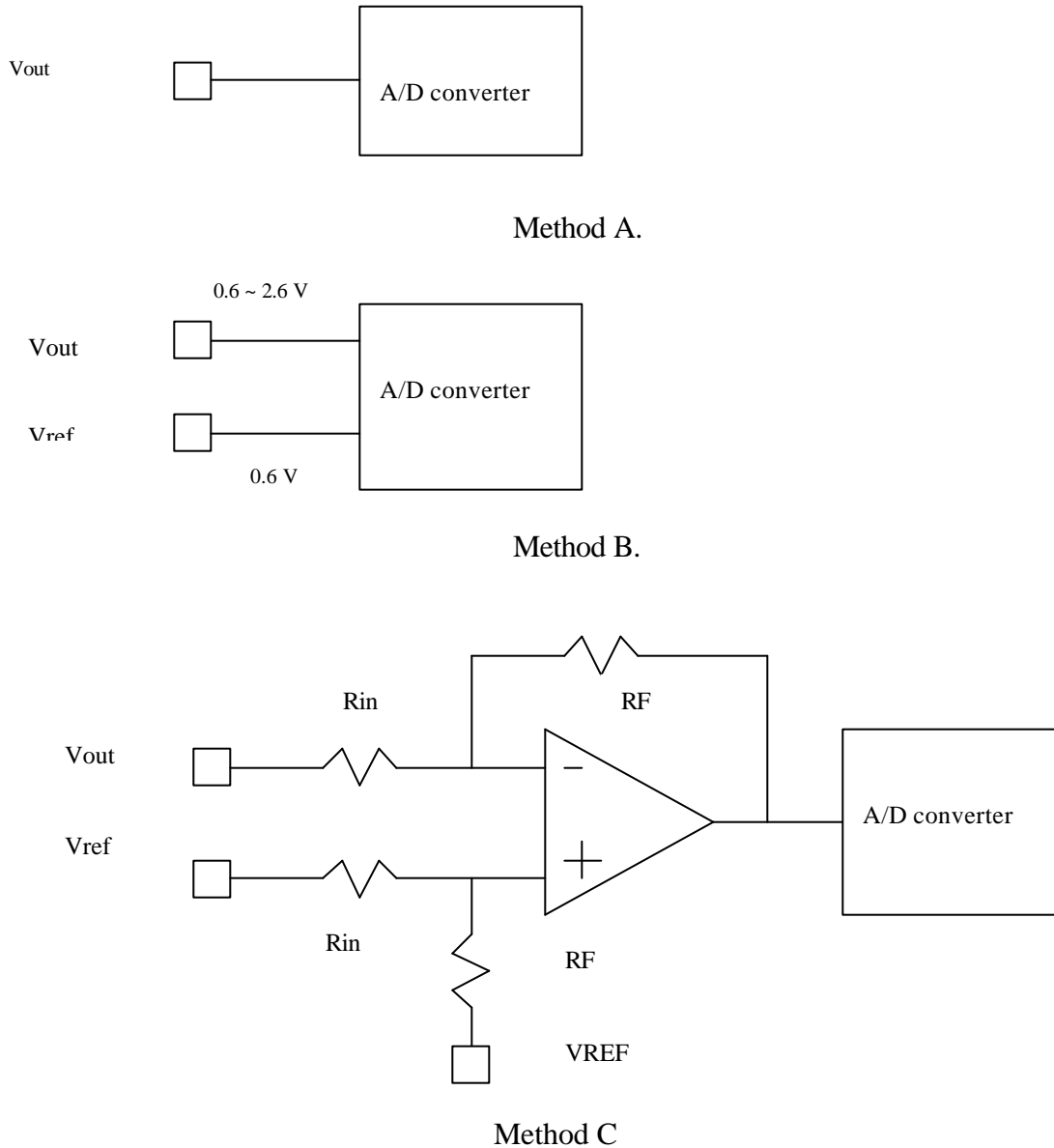


Figure 8. A reference circuitry for A/D interface.

Reliability tests:

Item	Test condition	Time	Criterion
High temp / high humidity operation	T = 45 °C, 90% RH	500 H	$\Delta V_p = -30 \sim 10 (\%)$ $\Delta V_d = -25 \sim 15 (mV)$ No physical Distortion and damage
High temp. operation	T = 50 °C	500 H	
Low temp. operation	T = 0 °C	500 H	
High temp. storage	T = 60 °C	1000 H	
High temp. / high humidity storage	T = 50 °C, 90% RH	1000 H	
Low temp. storage	T = -30 °C	1000 H	
Temp. cycle at high humidity	-10 ~ 50 °C / 90% RH	10 cycle	
Temp. cycle	-30 °C ~ RT ~ 50 °C 1 H 1 H	20 cycle	
Vibration test	3G, 10 ~ 100 Hz, 5 min. RT, X, Y, Z	60 min each	
Drop test	60 G, 5 ~ 10 msec $\pm X, \pm Y, \pm Z$	2 times	
ESD	R = 0 Ω , 200 pF, $\pm 200 V$	Once every pin	

Precautions before use:

1. Dirty Glass Surface:

The glass surface should be kept clean.

Do not wipe the sensor by hand or use in a dust polluted environment. Should the glass surface become dirty, moisten a cloth with alcohol and wipe the surface gently.

Care should be taken so as not to scratch the surface while wiping it. Any loose dust lying on the sensor surface can be cleaned using an air gun.

2. Dust and the CIS unit

The unit is housed in an air tight structure to protect it from dust. The side plates should not be removed or dust may enter the unit. When using the side holes to adjust the sensor, turn the screws slowly until tight, so as not to damage the screw hole thread.

3. Extracting / Inserting the connector

The maximum number of times that the connector should be extracted and connected is ten. If the connector is inserted / extracted more than ten times, the connector “burrs” will be eroded, thereby making the connector ineffective.

4. Stable operation

4.1 The connector pins should not be touched by bare hand or Electro-statically charged material.

4.2 Noise:

a. Insert a low frequency noise suppressing capacitor (100 μ F) between V_{DD} (+5 V) and Gnd. A high frequency noise suppressing capacitor is already integrated into the circuit.

b. Ensure that the sensor connecting cables are 30 cm or less in length. The ϕ_{CP} and Gnd, ϕ_{SP} and Gnd respectively from twisted cable pairs.

4.3 Latch Up

When the voltage is higher than the absolute maximum, “latch up” will cause the sensor to break, even if the voltage is caused by a surge. If the current varies rapidly in the external circuit, or if the power is turned off and then on again, ensure that the voltage on each terminal does not exceed the values indicated in “absolute maximum rating”.

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Attachment: the configuration and the physical dimensions (unit: mm)

M208-A4 configuration and physical dimensions.

