Preliminary

Contact Image Sensor (CIS) Module	
Product Name	**M206-A4C**

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	November 14. 2005	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.

M206-A4C
600 dpi, A4 size, Contact Image Sensor (CIS) module

Features:

- 5184 x 1 image sensing elements
- 600 dots per inch (dpi) resolution
- 218.25 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 ± 5%
- high integration for light source, lens and sensor
- 12 pin connector for input and output

Description:

The M206-A4C contact image sensor (CIS) module is a contact type image sensing module that is composed of a line of LED's as a light source, a long Selfoc rod lens array, and 5160 photo-detector array. Input and output electronic contact is via a 12-pin connector. The cross sectional view of the M206-A4C 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.

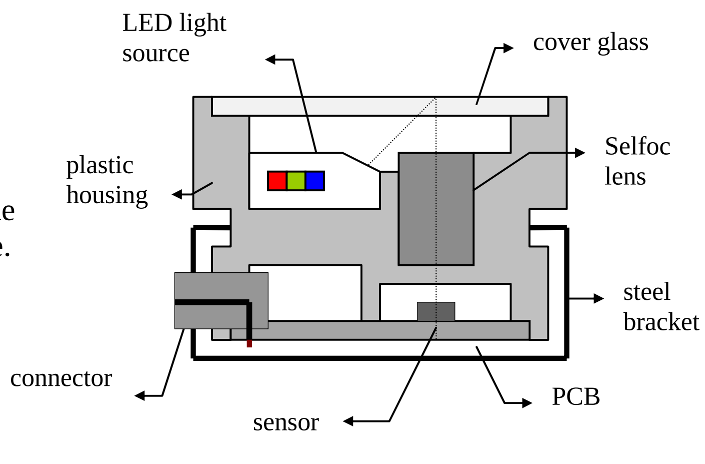

Figure 1. Cross section view of the M206-A4C CIS module.

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Functional block diagram:

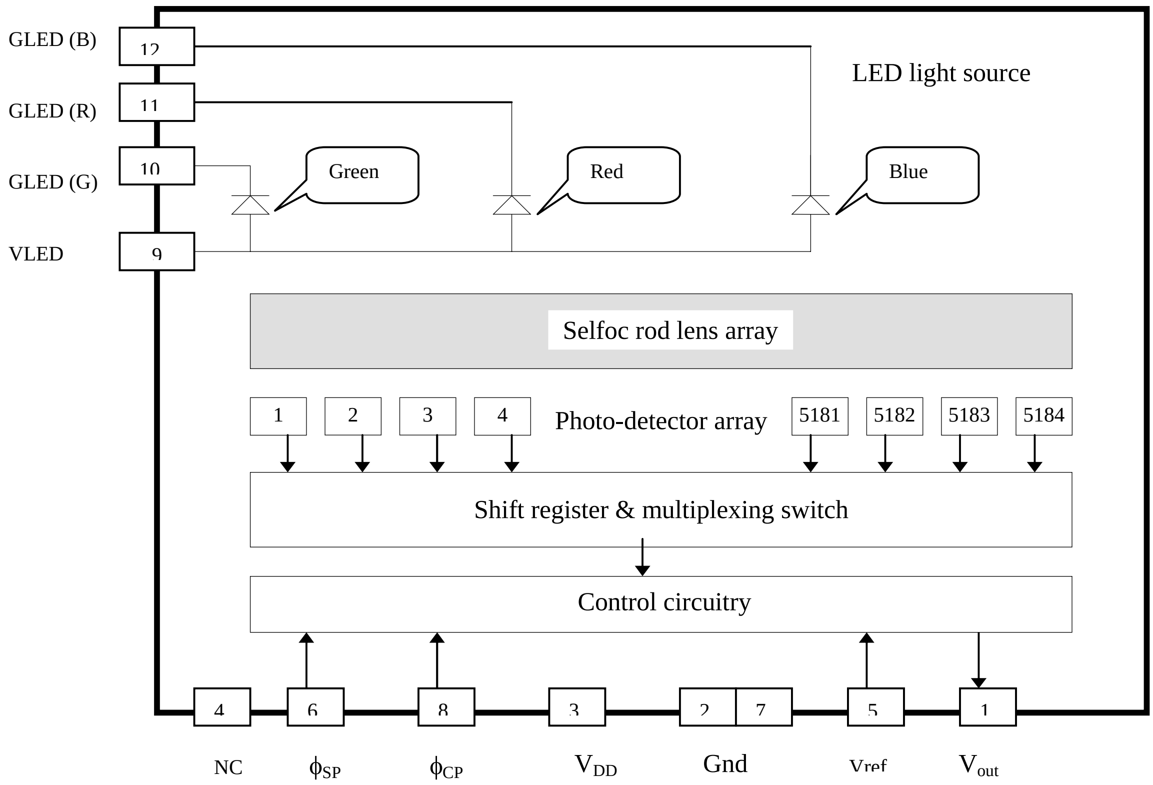


Figure 2. M206-A4C color CIS module block diagram.

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	Vref	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 M206-A4C 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 M206-A4C 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), $Ta^{*(1)}$ = 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 ~ 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) (Blue) (Red)	at 5.7 lp/mm$^{*(10)}$	20 10 15			% % %

Table 3. Operating conditions and typical electro-optical characteristics of the M206-A4C CIS module in B/W mode. [under testing condition of f = 1 MHz, V_{DD} = 5 V, ILED = 20 mA (red, green, blue), $Ta^{*(1)}$ = 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			3		ms/line
$V_{pc}^{*(4)}$	Analog output voltage at white paper	O.D. $^{*(9)}$ = 0.05 ~ 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. Ta 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. Vpc(n) is the effective output signal of each pixel. It is defined by:
   Vpc = Vp(n) – Vd(n)
   Vp (n) is the output signal of nth pixel in the white paper.
   Vd (n) is the output signal of nth pixel in the dark paper.

5. Upc is a pixel - pixel photo response non-uniformity within whole module.

   Upc = [(Vpcmax - Vpcmin) / Vpcmax] x 100%

   Vpcmax = MAX [Vpc(n)]; it is the maximum effective output signal.

   Vpcmin = MIN [Vpc(n)]; it is the minimum effective output signal.

6. Vdmin is the minimum output signal in the dark and defined by:

   Vdmin = MIN [Vd(n)];

   where n = 1, 2, 5184 pixels on the whole module.

7. Ud is the dark output non-uniformity and defined by:

   Ud = Vdmax – Vdmin

   Where Vdmax = MAX[Vd(n)]; it is the maximum dark output signal.

   Vdmin = MIN [Vd(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:

   MTF = MIN {[(Vmax - Vmin) / (Vmax + Vmin)]} x 100%

   where Vmax is the maximum output voltage using a MTF image target.

   Vmin 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, ILED	80 mA
Digital input voltage range (high), Vih	V_{DD} + 0.5 V
Digital input voltage range (low), Vil	- 0.5 V
Digital input current range, Iih	-20 mA to 20 mA
Operating free-air temperature range, Ta	0 °C ~ 50 °C
Storage temperature range, Tstg	-25 °C ~ 70 °C
Storage humidity range, Hstg	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	ILED		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	tw		0.5		Us
Sensor integration time (color) (B/W)	t_{int}		8 3		ms
Operating humidity	Hop	10		85	% RH
Operating free-air temperature	Ta	0		50	°C

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

Parameter	Peak emission wavelength	Spectral line half width (Δλ)
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	IF	25 mA	25 mA	25 mA	1
Pulse forward current	IFP	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:

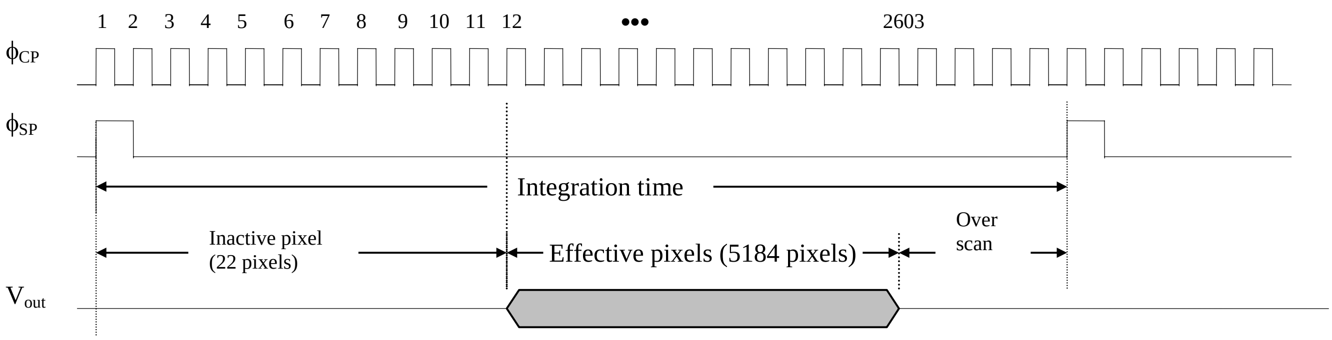
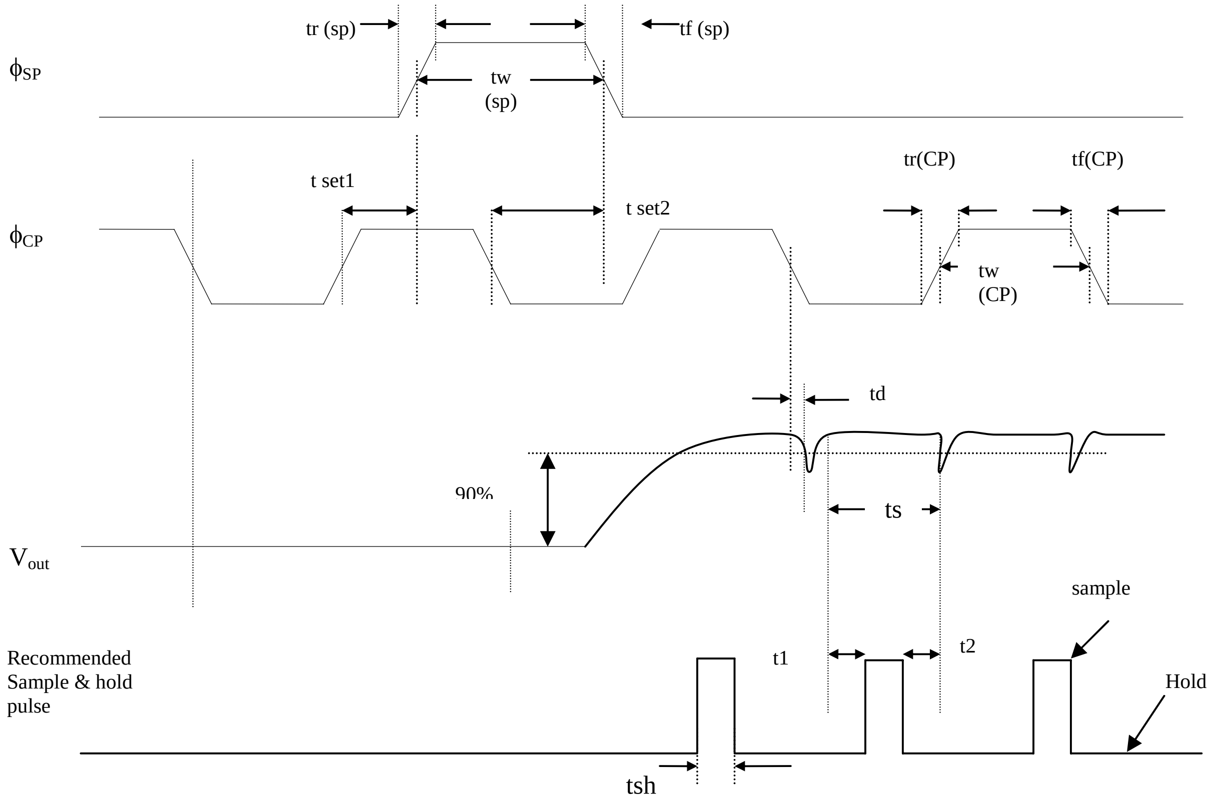


Table 7. Switching characteristics:

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		(¼)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.

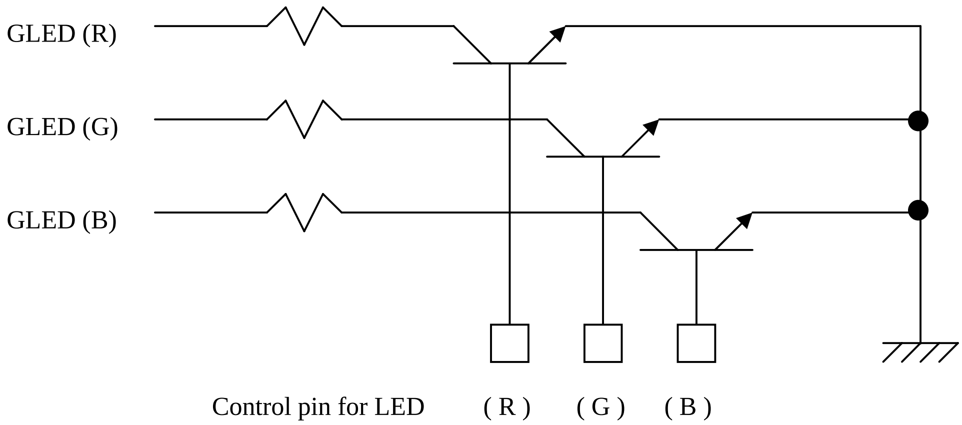
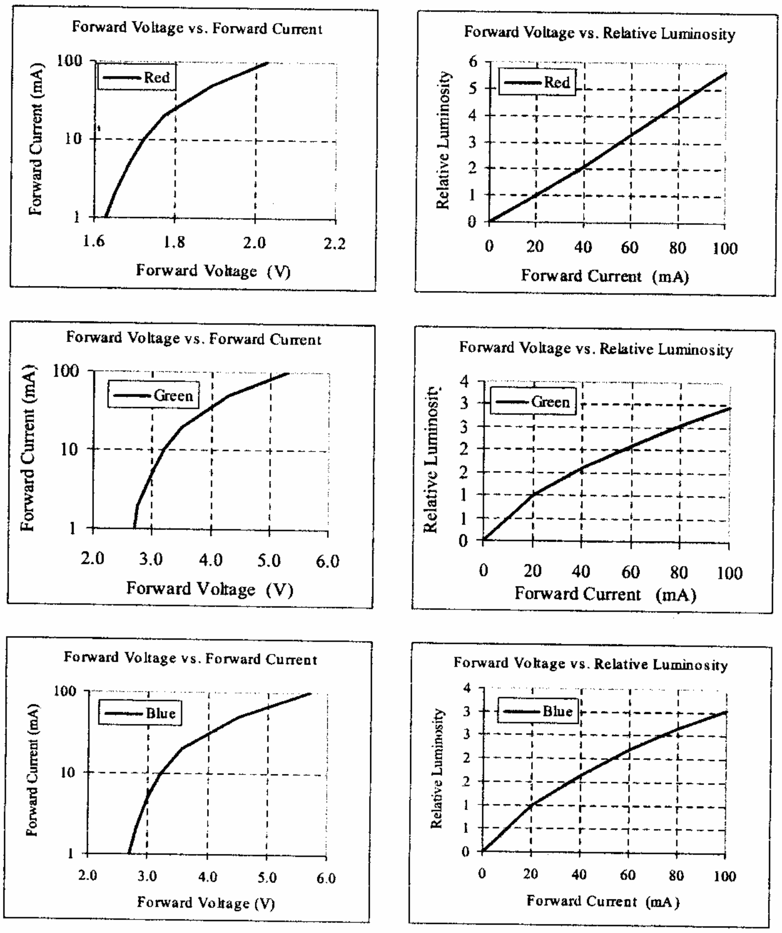
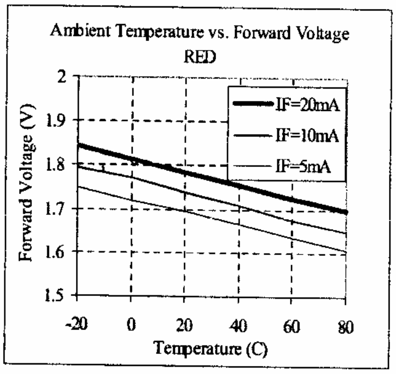
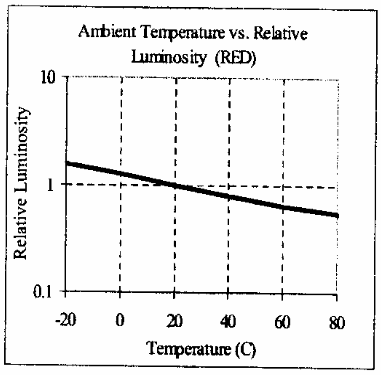


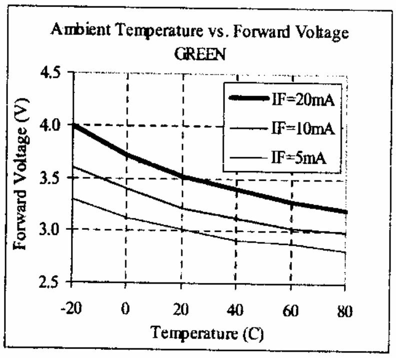
Figure 5. A reference circuitry of LED light source.

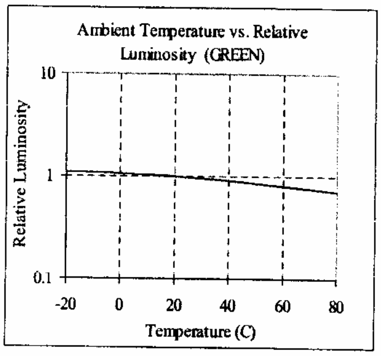
2. LED characteristics:

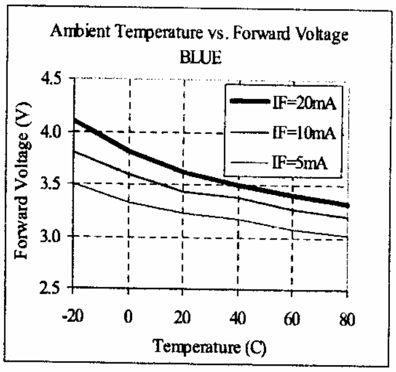


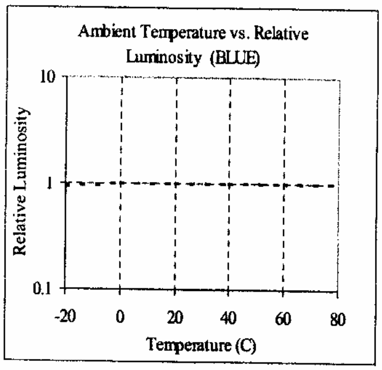

Ambient Temperature vs. Forward Voltage
RED
Forward Voltage (V)
Temperature (C)
IF=20mA
IF=10mA
IF=5mA
2
1.9
1.8
1.7
1.6
1.5
-20
0
20
40
60
80


Ambient Temperature vs. Relative Luminosity (RED)
Relative Luminosity
Temperature (C)
10
1
0.1
-20
0
20
40
60
80


Ambient Temperature vs. Forward Voltage
GREEN
Forward Voltage (V)
Temperature (C)
IF=20mA
IF=10mA
IF=5mA
4.5
4.0
3.5
3.0
2.5
-20
0
20
40
60
80


Ambient Temperature vs. Relative Luminosity (GREEN)
Relative Luminosity
Temperature (C)
10
1
0.1
-20
0
20
40
60
80


Ambient Temperature vs. Forward Voltage
BLUE
Forward Voltage (V)
Temperature (C)
IF=20mA
IF=10mA
IF=5mA
4.5
4.0
3.5
3.0
2.5
-20
0
20
40
60
80


Ambient Temperature vs. Relative Luminosity (BLUE)
Relative Luminosity
Temperature (C)
10
1
0.1
-20
0
20
40
60
80

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 sources.

- 3.1.1 The currents of three LED's are set within the spec as described in Table 6.
- 3.1.2 The pulse width of three color LED is set to Maximum (Tred= Tgreen = Tblue = Tmax).
- 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 LED, respectively. Choose a reference voltage of 0.8 V and use the corresponding Green LED as a reference LED.
- 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 Tmax and the red and blue LED pulses are reduced, as shown in figure 6.

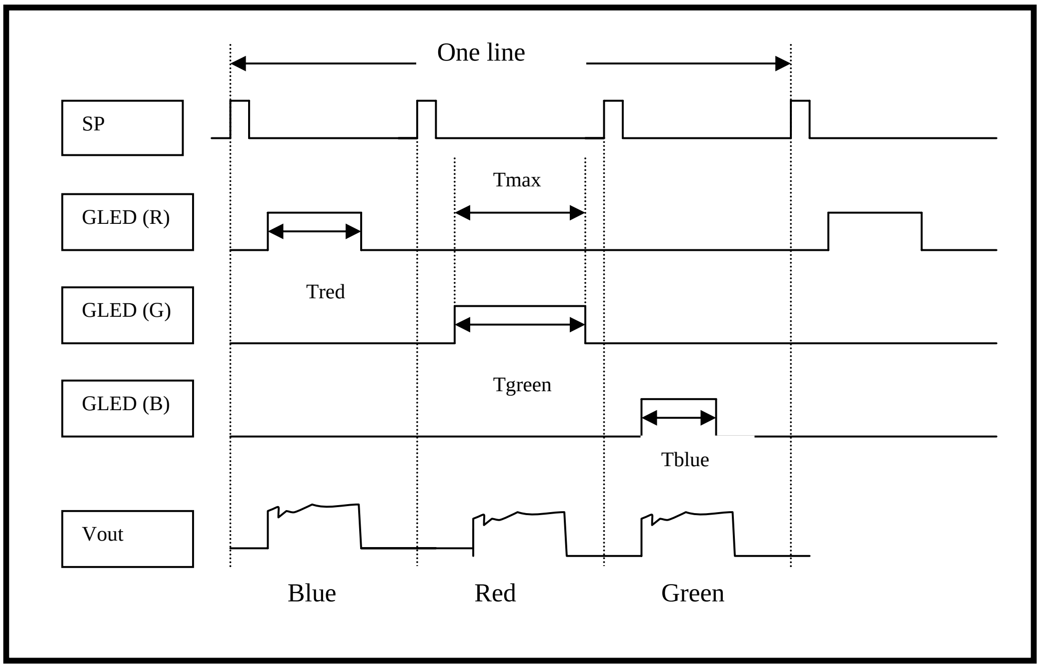


Figure 6. Timing diagram of the CIS module for color mode of operation.

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.

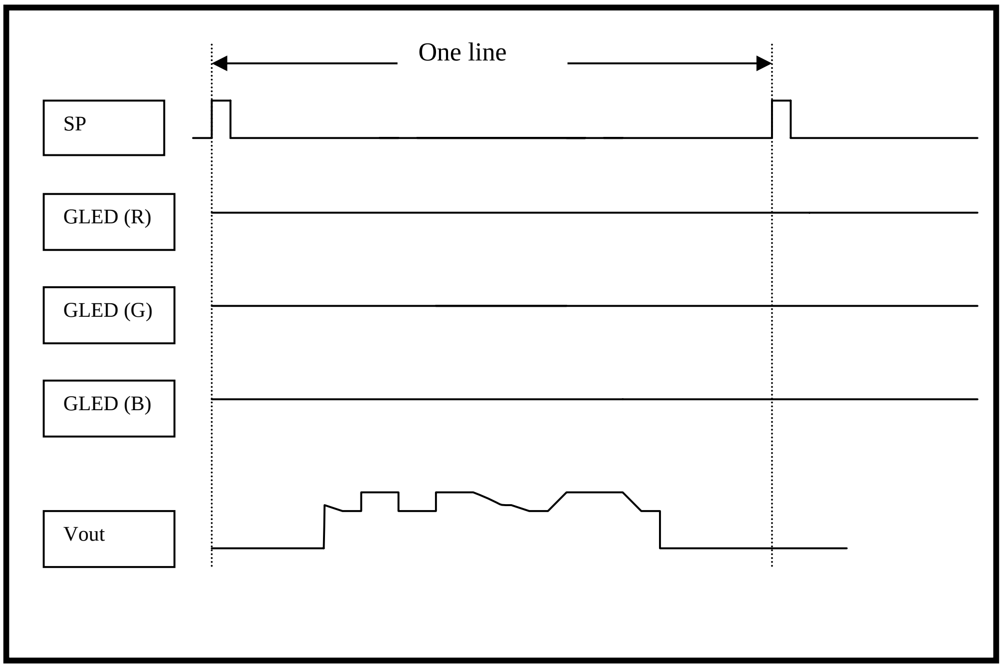
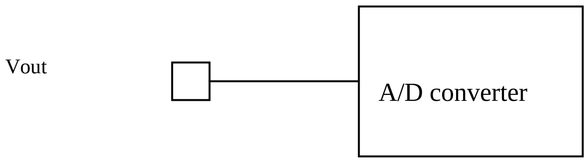


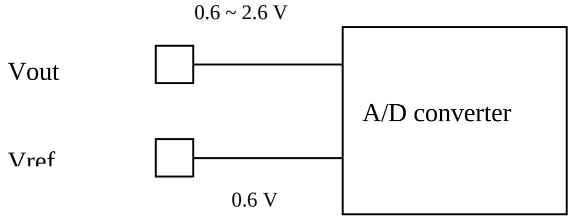
Figure 7. Timing diagram of the CIS module for B/W mode of operation.

4. A/D interface circuitry:

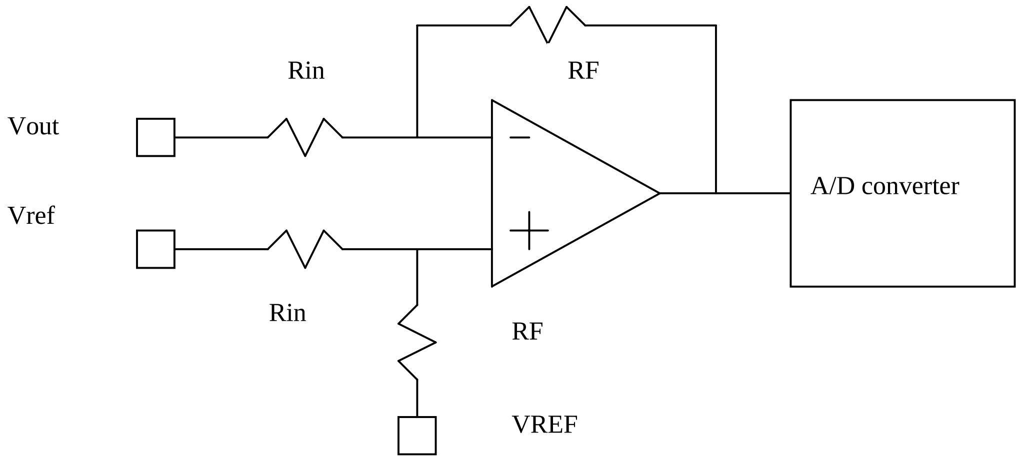
There are several different methods for the output signal to interface with an A/D converter. Figure 8 shows a reference circuit. Method A is very simple. Method C is more complicated and has a better performance.



Method A.



Method B.



Method C

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

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Reliability tests:

Item	Test condition	Time	Criterion
High temp / high humidity operation	T = 45 °C, 90% RH	500 H	
High temp. operation	T = 50 °C	500 H	
Low temp. operation	T = 0 °C	500 H	ΔVp = -30 ~ 10 (%)
High temp. storage	T = 60 °C	1000 H	
High temp. / high humidity storage	T = 50 °C, 90% RH	1000 H	ΔVd = - 25 ~ 15 (mV)
Low temp. storage	T = - 30 °C	1000 H	
Temp. cycle at high humidity	-10 ~ 50 °C / 90% RH	10 cycle	No physical
Temp. cycle	-30 °C ~ RT ~ 50 °C 1 H 1 H	20 cycle	Distoration and damage
Vibration test	3G, 10 ~ 100 Hz, 5 min. RT, X, Y, Z	60 min each	
Drop test	60 G, 5 ~ 10 msec ±X, ±Y, ±Z	2 times	
ESD	R = 0 Ω, 200 pF, ±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 μF) 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".

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

M206-A4C configuration and physical dimensions.