

Ambient light sensor ICs

# Digital 16bit Serial Output Type Color Sensor IC

## BH1745NUC

### General Description

BH1745NUC is digital color sensor IC with I<sup>2</sup>C bus interface. This IC senses Red, Green and Blue light (RGB) and converts them to digital values. The high sensitivity, wide dynamic range and excellent Ircut characteristics makes this IC the most suitable to obtain the illuminance and color temperature of ambient light for adjusting LCD backlight of TV, mobile phone and tablet PC. It is possible to detect very wide range light intensity. (0.005 – 40k lx)

### Key Specifications

- VCC Voltage Range: 2.3V to 3.6V
- Maximum Sensitivity: 0.005Lx/step
- Current Consumption: 130μA (Typ)
- Standby Mode Current: 0.8μA (Typ)
- Operating Temperature Range: -40°C to +85°C

### Package(s)

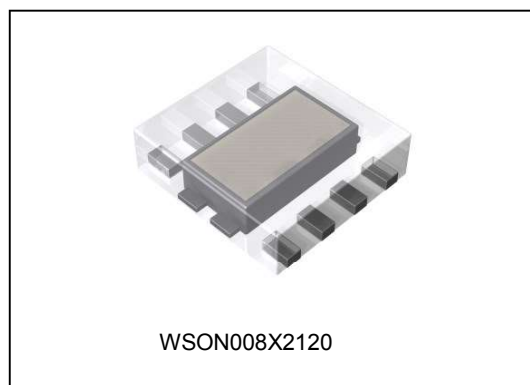
WS0N008X2120 W(Typ) x D(Typ) x H(Max)  
2.10mm x 2.00mm x 0.6mm

### Features

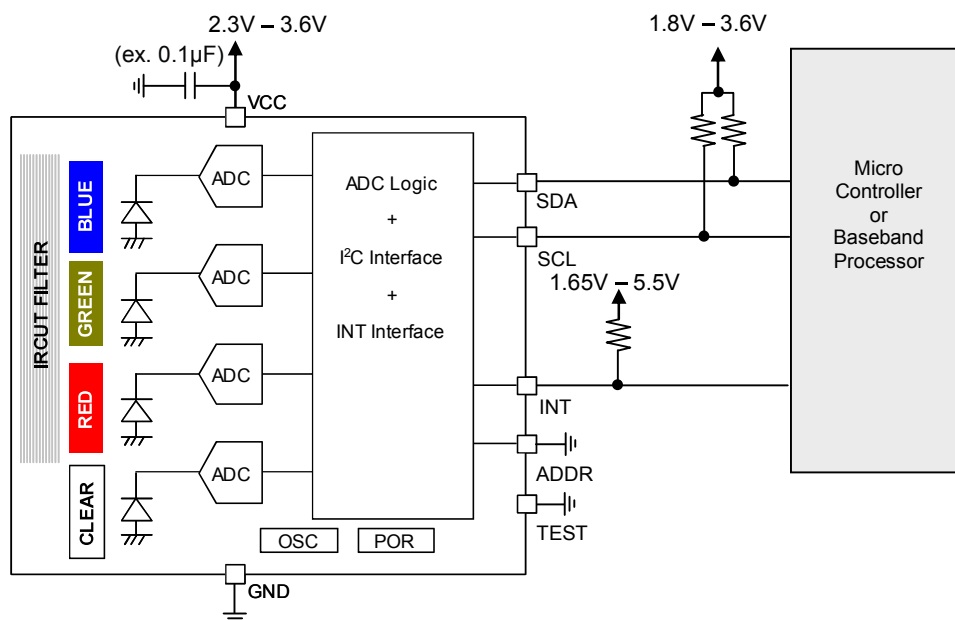
- The Excellent Ircut Characteristics with an Ircut Filter
- The High Sensitivity and Wide Dynamic Range (0.005 – 40k lx)
- Supports Low Transmittance (Dark) Window
- Correspond to I<sup>2</sup>C Bus Interface ( f/s mode support )
- Low Current by Power Down Function
- Rejecting 50Hz/60Hz Light Noise
- Correspond to 1.8V Logic Interface
- Programmable Interrupt Function
- It is possible to select 2 type of I<sup>2</sup>C bus slave address. (ADDR = 'L': "0111000", ADDR = 'H': "0111001")

### Applications

LCD TV, Mobile phone, NOTE PC, Tablet PC, Portable game machine, Digital camera, Digital video camera, PDA, LCD display



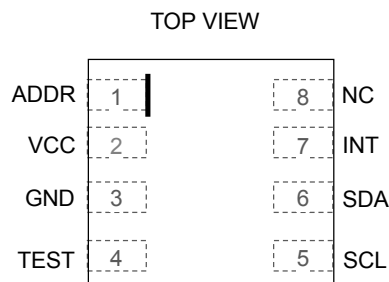
### Typical Application Circuits



○Product structure : Silicon monolithic integrated circuit.  
 ○This product does not include laser transmitter.  
 ○This product includes Photo detector, ( Photo Diode ) inside of it.

○This product is not designed protection against radioactive rays.  
 ○This product does not include optical load.

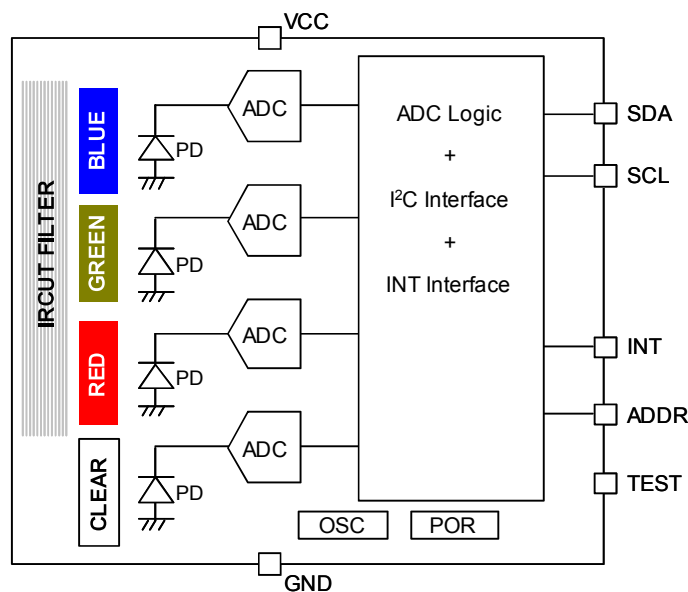
## Pin Configuration



## Pin Description

Pin No.	Pin Name	Function
1	ADDR	I <sup>2</sup> C bus slave address terminal
2	VCC	Power supply terminal
3	GND	GND terminal
4	TEST	Test terminal. Connect to GND.
5	SCL	I <sup>2</sup> C bus Interface SCL terminal.
6	SDA	I <sup>2</sup> C bus Interface SDA terminal.
7	INT	Nch open drain output. Interrupt setting is defined by internal register. Register value is possible to configure by I <sup>2</sup> C bus.
8	NC	Non connect (Open).

## Block Diagram



## Description of Blocks

- Ircut Filter
  - This filter passes visible light and blocks infrared light.
- RED, GREEN, BLUE, CLEAR
  - Red, Green, Blue, and Clear color pass filter
- PD
  - Photodiodes (PD) convert light into current.
- ADC
  - AD converter for obtaining digital 16bit data.
- ADC Logic + I<sup>2</sup>C Interface + INT Interface
  - ADC control logic and I<sup>2</sup>C bus Interface and Interrupt function Interface.
- OSC
  - Internal oscillator (typ 720 kHz). It is clock for internal logic.
- POR
  - Power on reset. All registers are reset after VCC is supplied.

**Absolute Maximum Ratings** (Ta = 25°C)

Parameter	Symbol	Rating	Unit
VCC, Supply Voltage	V <sub>CCMAX</sub>	-0.3 to +4.5	V
ADDR, SDA, SCL, TEST Terminal Voltage	V <sub>ADDRMAX</sub> , V <sub>SDAMAX</sub> , V <sub>SCLMAX</sub> , V <sub>TESTMAX</sub>	-0.3 to +4.5	V
INT Terminal Voltage	V <sub>INTMAX</sub>	7	V
Operating Temperature	T <sub>OPR</sub>	-40 to +85	°C
Storage Temperature	T <sub>STG</sub>	-40 to +100	°C
INT, SDA Sink Current	I <sub>MAX</sub>	7	mA
Power Dissipation	P <sub>D</sub>	0.40 <sup>(Note 1)</sup>	W

(Note 1) Reduce by 5.33mW/°C over 25°C, when mounted on 2-layer PCB of 114.3mm × 76.2mm × 1.6mm.

PCB incorporates thermal via. Copper foil area on the reverse side of PCB : 74.2mm × 74.2mm

**Caution:** Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

**Recommended Operating Conditions** (Ta= -40°C to +85°C)

Parameter	Symbol	Min	Typ	Max	Unit
VCC Voltage	V <sub>CC</sub>	2.3	2.5	3.6	V
INT Terminal Voltage	V <sub>INT</sub>	—	—	5.5	V
SDA,SCL Terminal Voltage	V <sub>I2C</sub>	—	—	3.6	V

**Electrical Characteristics** (Unless otherwise specified, VCC=2.5V, Ta=25°C, Registers are default value)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Supply Current	I <sub>CC1</sub>	—	130	250	μA	MODE_CONTROL2(42h)=10h, Ev = 100 lx <sup>(Note 2)</sup>
Standby Mode Current	I <sub>CC2</sub>	—	0.8	1.5	μA	No Input Light
Red Data Count Value	D <sub>RED</sub>	3400	4000	4600	count	MODE_CONTROL2(42h)=12h, EV = 20μW/cm <sup>2</sup> <sup>(Note 3)</sup>
Green Data Count Value	D <sub>GREEN</sub>	2847	3350	3853	count	MODE_CONTROL2(42h)=12h, EV = 20μW/cm <sup>2</sup> <sup>(Note 4)</sup>
Blue Data Count Value	D <sub>BLUE</sub>	2014	2370	2726	count	MODE_CONTROL2(42h)=12h, EV = 20μW/cm <sup>2</sup> <sup>(Note 5)</sup>
Clear Data Count Value	D <sub>CLEAR</sub>	128	160	192	count	MODE_CONTROL2(42h)=12h, EV = 20μW/cm <sup>2</sup> <sup>(Note 4)</sup>
Dark Count Value	S <sub>0_0</sub>	0	0	3	count	MODE_CONTROL2(42h)=12h, No input light
RGB Data Update Period	T <sub>INT</sub>	-	160	225	msec	MODE_CONTROL2(42h)=10h
INT Output 'L' Voltage	V <sub>INTL</sub>	0	—	0.4	V	I <sub>INT</sub> = 3mA
SCL SDA Input 'H' Voltage	V <sub>IH</sub>	1.26	—	—	V	
SCL SDA Input 'L' Voltage	V <sub>IL</sub>	—	—	0.54	V	
SCL SDA Input 'H'/'L' Current	I <sub>IHL</sub>	-10	—	10	μA	
I <sup>2</sup> C SDA Output 'L' Voltage	V <sub>OL</sub>	0	—	0.4	V	I <sub>OL</sub> = 3mA
ADDR Input 'H' Voltage	V <sub>ADDRH</sub>	V <sub>CC</sub> *0.7	—	—	V	
ADDR Input 'L' Voltage	V <sub>ADDRL</sub>	—	—	V <sub>CC</sub> *0.3	V	

(Note 2) White LED is used as optical source.

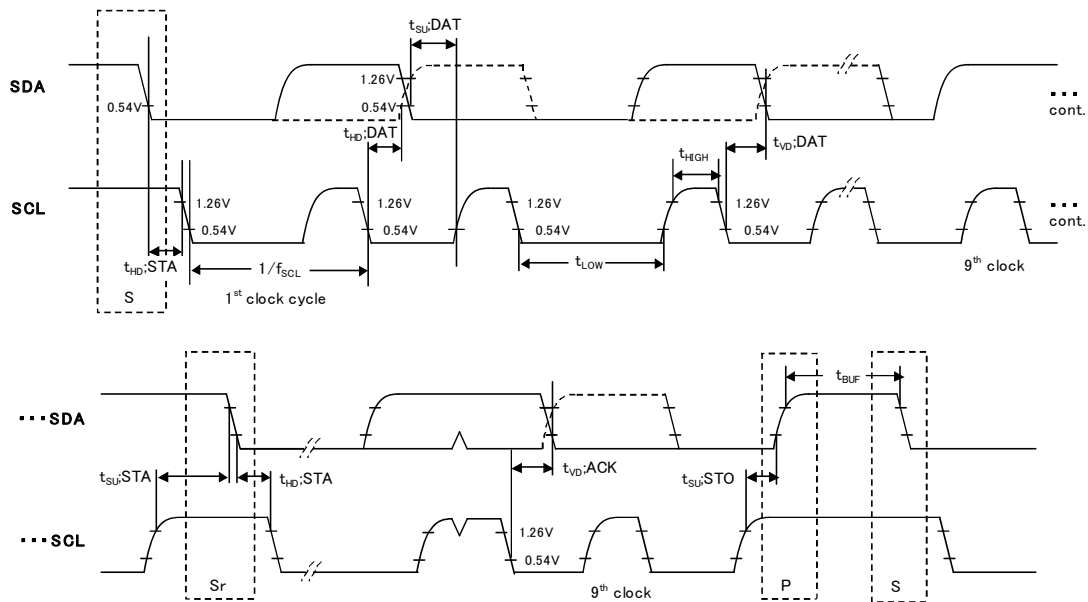
(Note 3) Red LED is used as optical source.

(Note 4) Green LED is used as optical source.

(Note 5) Blue LED is used as optical source.

I<sup>2</sup>C Bus Timing Characteristics (Unless otherwise specified VCC=2.5V Ta=25°C)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
I <sup>2</sup> C SCL Clock Frequency	f <sub>SCL</sub>	0	—	400	kHz	
I <sup>2</sup> C Hold Time ( Repeated ) START Condition	t <sub>HD;STA</sub>	0.6	—	—	μs	
I <sup>2</sup> C 'L' Period of the SCL Clock	t <sub>LOW</sub>	1.3	—	—	μs	
I <sup>2</sup> C 'H' Period of the SCL Clock	t <sub>HIGH</sub>	0.6	—	—	μs	
I <sup>2</sup> C Set up time for a Repeated START Condition	t <sub>SU;STA</sub>	0.6	—	—	μs	
I <sup>2</sup> C Data Hold Time	t <sub>HD;DAT</sub>	0	—	—	μs	
I <sup>2</sup> C Data Setup Time	t <sub>SU;DAT</sub>	100	—	—	ns	
I <sup>2</sup> C Set up Time for STOP Condition	t <sub>SU;STO</sub>	0.6	—	—	μs	
I <sup>2</sup> C Bus Free Time between a STOP and START Condition	t <sub>BUF</sub>	1.3	—	—	μs	
I <sup>2</sup> C Data Vaild Time	t <sub>VD;DAT</sub>	—	—	0.9	μs	
I <sup>2</sup> C Data Vaild Acknowledge Time	t <sub>VD;ACK</sub>	—	—	0.9	μs	



Typical Performance Curves

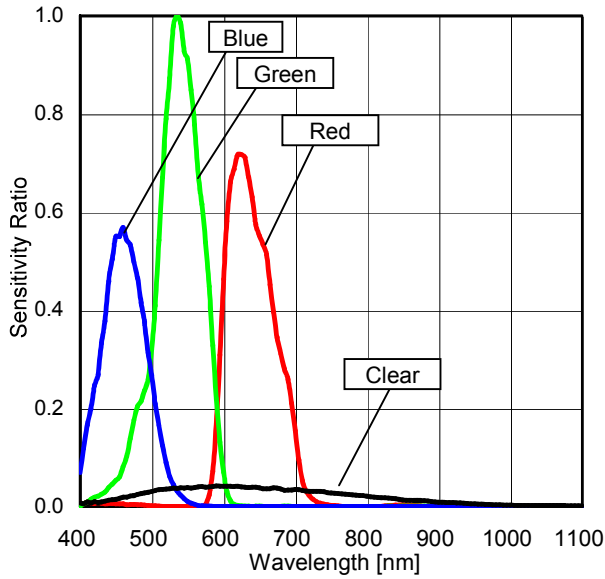


Figure 1. RGBC Spectral Response

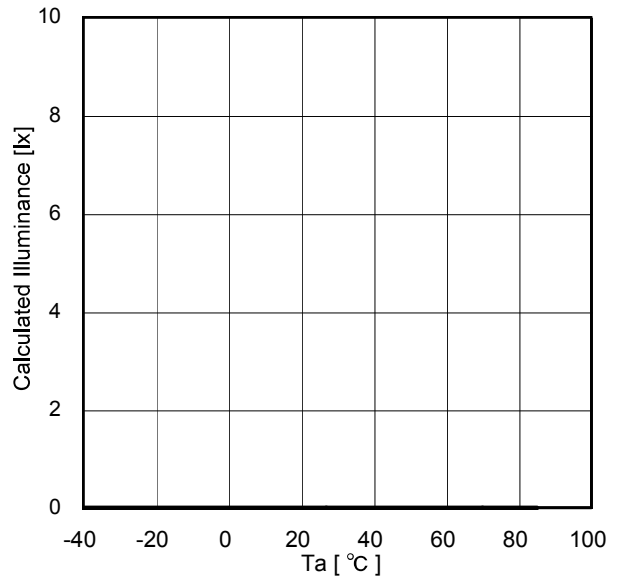


Figure 2. Temperature Dependency of Dark (0 lx) Sensor out from RGBC (MODE CONTROL2=10h)

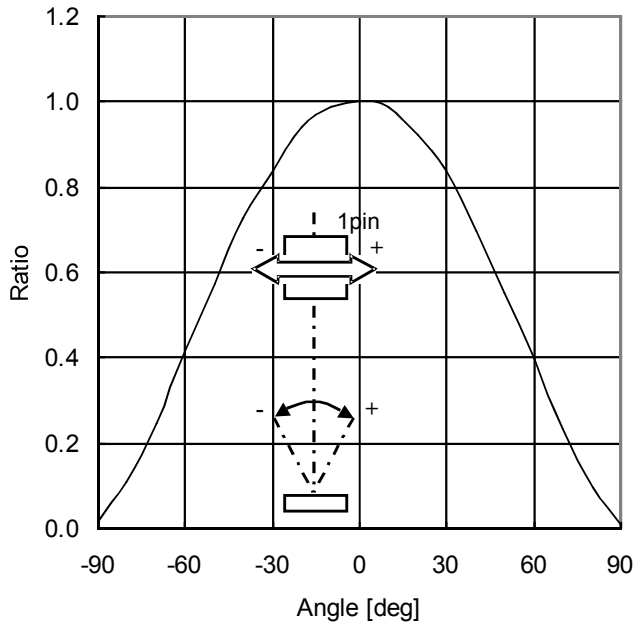


Figure 3. Directional Characteristics 1

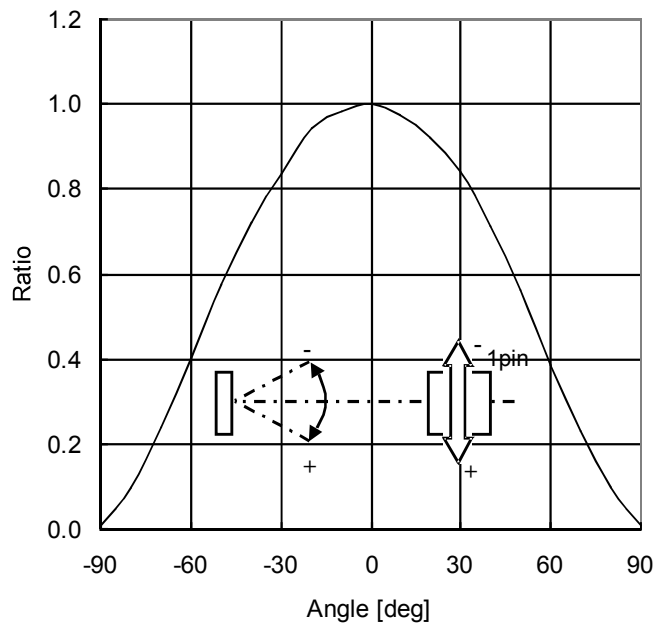


Figure 4. Directional Characteristics 2

Typical Performance Curves - continued

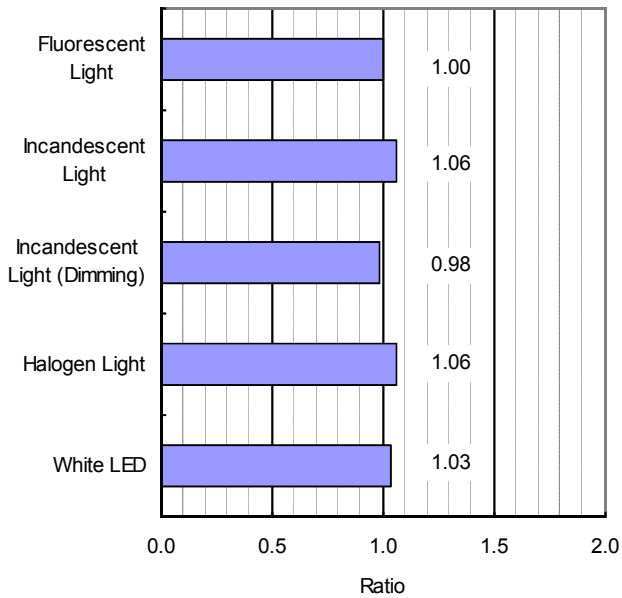


Figure 5. Light Source Dependency of lx calculation from RGBC (Fluorescent Light is set to "1")

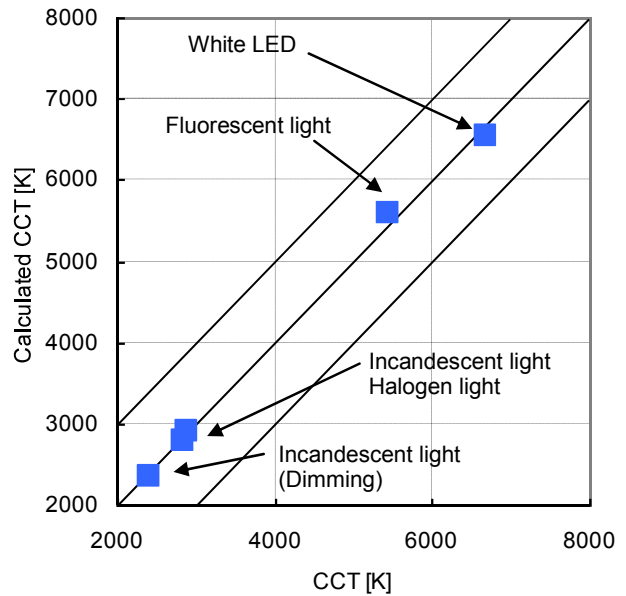


Figure 6. Light Source Dependency of CCT calculation from RGBC

## Command Set

Address	TYPE	Default	Register Name	Register Function
40h	RW	0Bh	SYSTEM_CONTROL	System control
41h	RW	00h	MODE_CONTROL1	Function setting
42h	RW	00h	MODE_CONTROL2	Function setting
44h	RW	00h	MODE_CONTROL3	Function setting
50h	R	00h	RED_DATA_LSBs	Low byte of RED
51h	R	00h	RED_DATA_MSBs	High byte of RED
52h	R	00h	GREEN_DATA_LSBs	Low byte of GREEN
53h	R	00h	GREEN_DATA_MSBs	High byte of GREEN
54h	R	00h	BLUE_DATA_LSBs	Low byte of BLUE
55h	R	00h	BLUE_DATA_MSBs	High byte of BLUE
56h	R	00h	CLEAR_DATA_LSBs	Low byte of CLEAR
57h	R	00h	CLEAR_DATA_MSBs	High byte of CLEAR
58h	R	00h	DINT_DATA_LSBs	Low byte of Internal Data
59h	R	00h	DINT_DATA_MSBs	High byte of Internal Data
60h	RW	00h	INTERRUPT	Interrupt setting
61h	RW	01h	PERSISTENCE	Persistence setting
62h	RW	FFh	TH_LSBs	Higher threshold low byte
63h	RW	FFh	TH_MSBs	Higher threshold high byte
64h	RW	00h	TL_LSBs	Lower threshold low byte
65h	RW	00h	TL_MSBs	Lower threshold high byte
92h	R	E0h	MANUFACTURER ID	Manufacturer ID

## ○ SYSTEM\_CONTROL ( 40h )

Field	Bit	TYPE	Description
SW reset	7	RW	0 : initial reset is not started 1 : initial reset is started
INT reset	6	RW	0 : INT pin status is not initialized. 1 : INT pin become inactive ( high impedance )
Part ID	5 : 0	R	001011

Default value 0Bh

## ○ MODE\_CONTROL1 ( 41h )

Field	Bit	TYPE	Description
Reserved	7 : 3	RW	Write 000000
Measurement time	2 : 0	RW	RGBC Measurement time. RGBC each data are updated by the following time. 000 : 160msec 001 : 320msec 010 : 640msec 011 : 1280msec 100 : 2560msec 101 : 5120msec 110 : Forbidden to use 111 : Forbidden to use

Default value 00h

## ○ MODE\_CONTROL2 ( 42h )

Field	Bit	TYPE	Description
VALID	7	R	0 : RGBC data is not updated after last writing MODE_CONTROL1,2,3 register or last reading MODE_CONTROL2 register. 1 : RGBC data is updated after last writing MODE_CONTROL1,2,3 register or last reading MODE_CONTROL2 register.
Reserved	6 : 5	RW	Write 00
RGBC_EN	4	RW	0 : RGBC measurement is inactive and becomes power down. 1 : RGBC measurement is active.
Reserved	3 : 2	RW	Write 00
ADC GAIN	1 : 0	RW	GAIN setting for RGBC measurement. 00 : 1X 01 : 2X 10 : 16X 11 : Forbidden to use

Default value 00h

## ○ MODE\_CONTROL3 ( 44h )

Field	Bit	TYPE	Description
MODE_CONTROL3	7 : 0	RW	Write 02h.

Default value 00h

## ○ RED\_DATA\_LSBs ( 50h )

Register	TYPE	7	6	5	4	3	2	1	0
RED_DATA_LSBs	R	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>

Default value 00h

## ○ RED\_DATA\_MSBs ( 51h )

Register	TYPE	7	6	5	4	3	2	1	0
RED_DATA_MSBs	R	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>

Default value 00h

## ○ GREEN\_DATA\_LSBs( 52h )

Register	TYPE	7	6	5	4	3	2	1	0
GREEN_DATA_LSBs	R	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>

Default value 00h

## ○ GREEN\_DATA\_MSBs( 53h )

Register	TYPE	7	6	5	4	3	2	1	0
GREEN_DATA_MSBs	R	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>

Default value 00h

## ○ BLUE\_DATA\_LSBs ( 54h )

Register	TYPE	7	6	5	4	3	2	1	0
BLUE_DATA_LSBs	R	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>

Default value 00h

## ○ BLUE\_DATA\_MSBs ( 55h )

Register	TYPE	7	6	5	4	3	2	1	0
BLUE_DATA_MSBs	R	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>

Default value 00h



## ○ CLEAR\_DATA\_LSBs( 56h )

Register	TYPE	7	6	5	4	3	2	1	0
CLEAR_DATA_LSBs	R	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>

Default value 00h

## ○ CLEAR\_DATA\_MSBs( 57h )

Register	TYPE	7	6	5	4	3	2	1	0
CLEAR_DATA_MSBs	R	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>

Default value 00h

## ○ DINT\_DATA\_LSBs( 58h )

Register	TYPE	7	6	5	4	3	2	1	0
Reserved	R	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>

Default value 00h

## ○ DINT\_DATA\_MSBs( 59h )

Register	TYPE	7	6	5	4	3	2	1	0
Reserved	R	2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>

Default value 00h

DINT registers output data for internal calculation of BH1745NUC. This register is unnecessary to read. It is used for IC Test only.

## ○ INTERRUPT ( 60h )

Field	Bit	TYPE	Description
INT STATUS	7	R	INT STATUS of RGBC 0 : Interrupt signal is inactive 1 : Interrupt signal is active
Reserved	6 : 5	R	Reserved
INT LATCH	4	RW	0 : INT pin is latched until INTERRUPT register is read or initialized. 1 : INT pin is updated after each measurement.
INT SOURCE	3 : 2	RW	INT source select 00 : Red channel 01 : Green channel 10 : Blue channel 11 : Clear channel
Reserved	1	RW	Write 0
INT ENABLE	0	RW	0 : INT pin disable. 1 : INT pin enable.

Default value 00h

## ○ PERSISTENCE ( 61h )

Field	Bit	TYPE	Description
Reserved	7 : 2	R	Reserved
PERSISTENCE	1 : 0	RW	Interrupt persistence function. 00 : Interrupt status is toggled at each measurement end. 01 : Interrupt status is updated at each measurement end. 10 : Interrupt status is updated if 4 consecutive threshold judgments are the same. 11 : Interrupt status is updated if 8 consecutive threshold judgments are the same.

Default value 01h

## ○ TH\_LSBs ( 62h )

Register	TYPE	7	6	5	4	3	2	1	0
TH_LSBs	RW	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$

Default value FFh

## ○ TH\_MSBs ( 63h )

Register	TYPE	7	6	5	4	3	2	1	0
TH_MSBs	RW	$2^{15}$	$2^{14}$	$2^{13}$	$2^{12}$	$2^{11}$	$2^{10}$	$2^9$	$2^8$

Default value FFh

## ○ TL\_LSBs ( 64h )

Register	TYPE	7	6	5	4	3	2	1	0
TL_LSBs	RW	$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$

Default value 00h

## ○ TL\_MSBs ( 65h )

Register	TYPE	7	6	5	4	3	2	1	0
TL_MSBs	RW	$2^{15}$	$2^{14}$	$2^{13}$	$2^{12}$	$2^{11}$	$2^{10}$	$2^9$	$2^8$

Default value 00h

## ○ MANUFACTURER ID ( 92h )

Register	TYPE	7	6	5	4	3	2	1	0
Manufacturer ID	R	1	1	1	0	0	0	0	0

Default value E0h

### Explanation of Software Reset Command

All registers are reset and BH1745NUC becomes power down by Software reset command.

### Explanation of Accessing MODE\_CONTROL

If master Writes to MODE\_CONTROL1(41h), MODE\_CONTROL2(42h) and MODE\_CONTROL3(44h) register, RGBC measurement currently in progress is interrupted immediately and re-started from the beginning, and VALID register returns to 'L'. When the re-started measurement is finished, VALID register turns to 'H'.

### Power on Sequence

Please note the below behavior when application design.

1) Power on time:  $t_1$

" $t_1$ " should be more than 2ms. The IC becomes active state after 2ms by which VCC voltage goes beyond 2.0V from less than 0.4V.

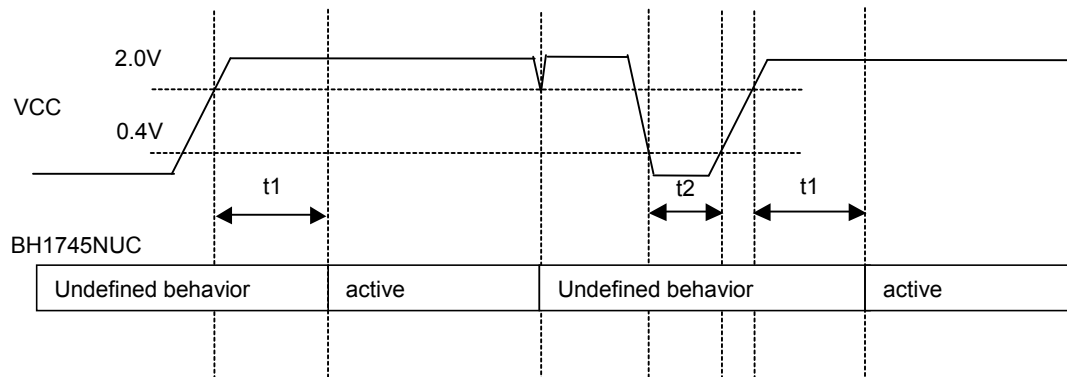
2) Power off time:  $t_2$

" $t_2$ " should be more than 1ms. The period that VCC is less than 0.4V should be more than 1ms before power supply.

\* "active state" means the state that the IC operates correctly.

When power supply, INT terminal is hi-impedance state.

Once VCC goes below 2.0V, power supply sequence should follow below sequence.



**I<sup>2</sup>C Bus Communication**

- 1) Slave address "0111000" (ADDR = 'L') or "0111001" (ADDR = 'H')
- 2) Main write format
  1. Case of Indicate register address



2. Case of write to data register after indicating register address



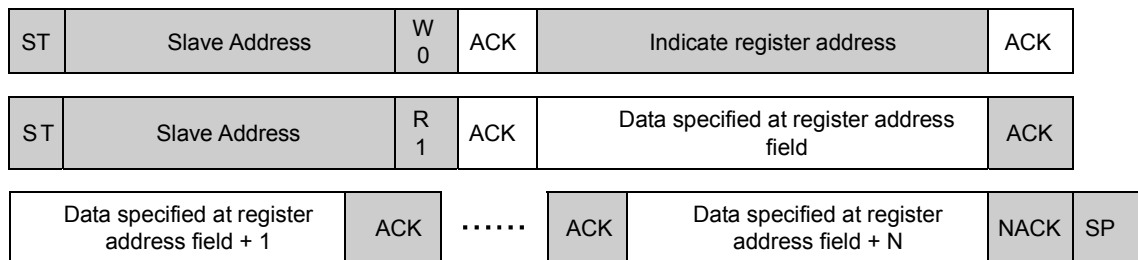
BH1745NUC continues to receive data with address increments until master issues stop condition.  
 Write cycle is 40h - 41h - 42h - 43h ... 57h - 58h - 59h ... FFh - 00h - 01h ... 3Fh - 40h.....  
 All registers are included in write-chain.

Ex) If register address field is 42h, then BH1745NUC writes data like seeing in below.  
 42h - 43h - 44h - 45h - 46h ..... 3Eh - 3Fh - 40h..... It is continued until master issues stop condition.

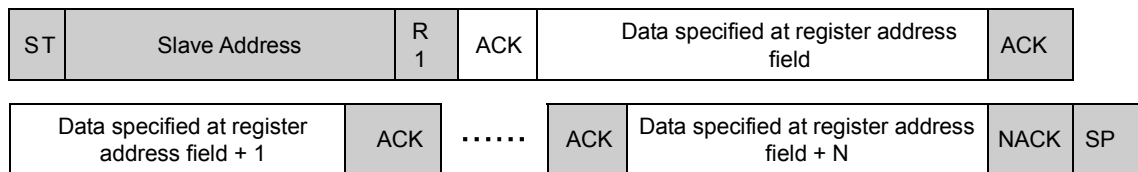
\*There is no registers in address 00h-3Fh, 43h, 45h - 4Fh, 5Ah - 5Fh and 66h - 91h, 93h-FFh, but it is necessary to access these registers when writing some data with address increments. It is recommended to access 40h - 42h, 50h - 50h - 57h and 60h - 65h individually.

- 3) Main read format

1. Case of read data after indicate register address (Master issues restart condition)



2. Case of read data



BH1745NUC outputs data from specified address field until master issues stop condition.  
 Read cycle is 40h - 41h - 42h - 43h ... 57h - 58h - 59h ... FFh - 00h - 01h ... 3Fh - 40h.....  
 All registers are included in read-chain.

Ex) If register address field is 50h, then BH1745NUC outputs data like seeing in below.  
 50h - 51h - 52h ..... FFh - 00h - 01h... 3Fh - 40h... It is continued until master issues stop condition.

\*There is no registers in address 00h-3Fh, 43h, 45h - 4Fh, 5Ah - 5Fh and 66h - 91h, 93h-FFh, but it is necessary to access these registers when reading data with address increments. It is recommended to access 40h - 44h, 50h - 50h - 57h, 60h - 65h and 92h individually. When master access to register address that does not exists, FFh is read.



\*BH1745NUC operates as I<sup>2</sup>C bus slave device.  
 \*Please refer formality I<sup>2</sup>C bus specification of NXP semiconductor

**Interrupt Function**

Interrupt function compares the measurement result selected from RGBC data by INT SOURCE register (60h<3:2>) to preset interrupt threshold level. Interrupt status is monitored by INT pin. Interrupt function is able to be controlled by INTERRUPT register (60h).

Interrupt persistence is defined at PERSIST register (61h).

INT pin is Nch open drain terminal so this terminal should be pull-up to some kind of voltage source by an external resistor.

There are two output modes about interrupt function (latched mode and unlatched mode).

INT terminal is high impedance when VCC is supplied.

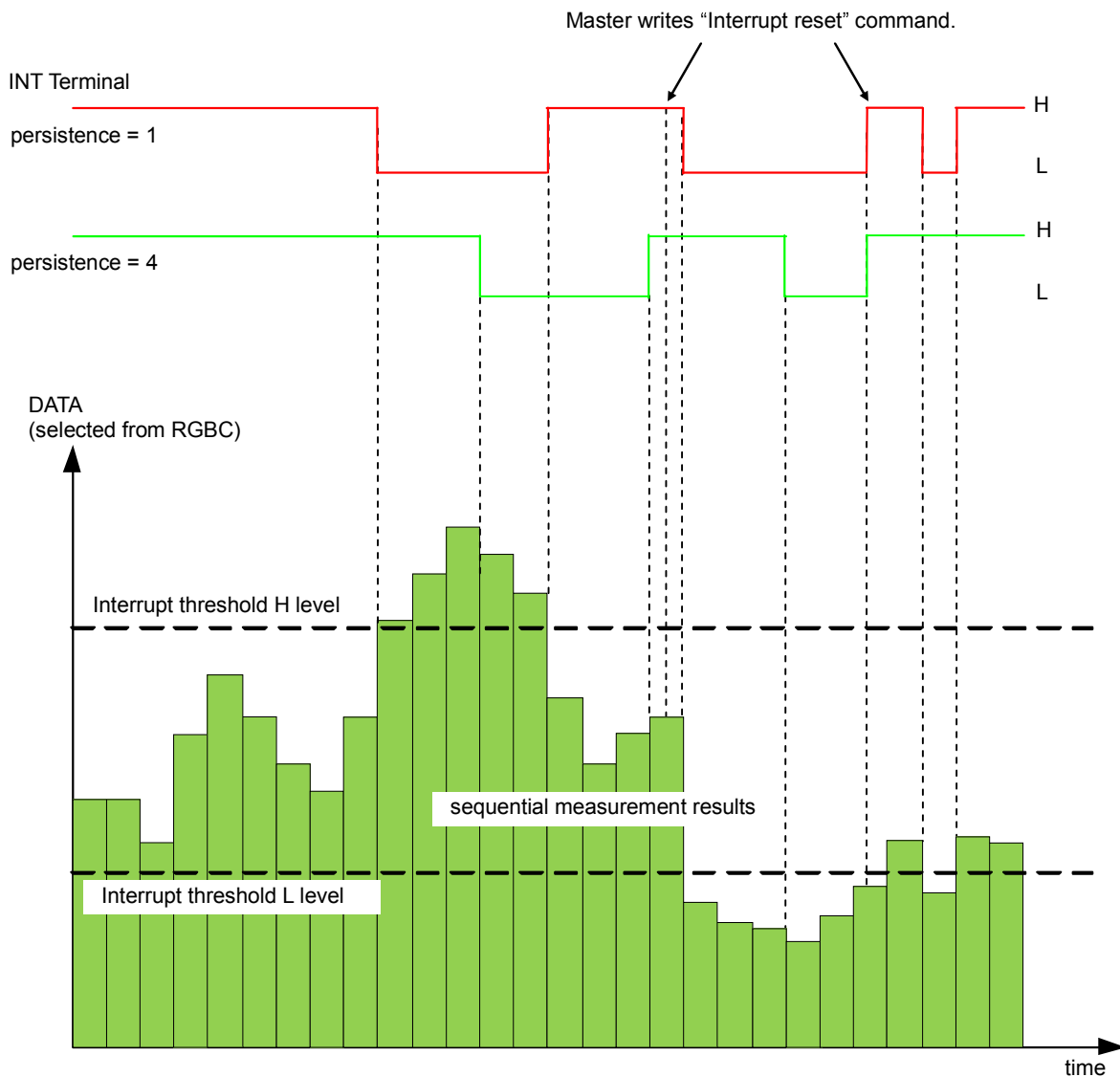
INT terminal becomes inactive by writing INT reset command, reading INTERRUPT register, writing 0 to INT ENABLE bit of INTERRUPT register or software reset.

INT terminal keeps just previous state when power down command is sent. So to set INT terminal to high impedance before power down command is sent is recommended. VCC current (approximately 25µA at VCC=2.5V) is consumed during INT terminal is 'L'.

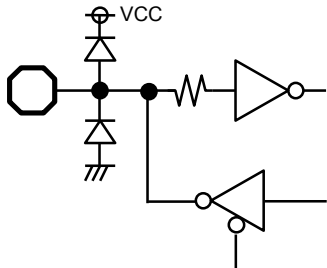
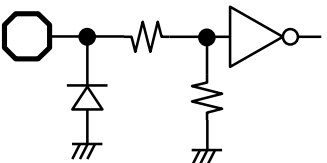
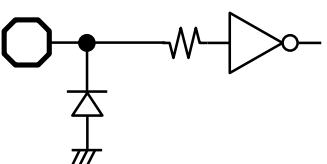
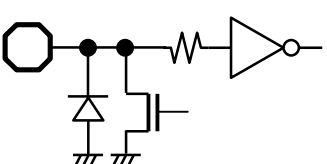
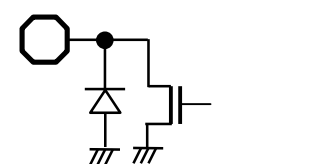
Ex1 )

In case of unlatch mode if the Data measurement value is within the range set by interrupt threshold 'H' and 'L' value, the interrupt becomes inactive. And if the measurement value is out of the range set by threshold 'H' and 'L' value, the interrupt becomes active.

In case of latch mode once the interrupt becomes active, it keeps the status until INT reset command is done or INTERRUPT register is read.



I/O Equivalent Circuit

PIN No.	Pin Name	Equivalent Circuit
1	ADDR	
2	VCC	
3	GND	
4	TEST	
5	SCL	
6	SDA	
7	INT	
8	NC	

**Operational Notes****1. Reverse Connection of Power Supply**

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply terminals.

**2. Power Supply Lines**

Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

**3. Ground Voltage**

Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

**4. Ground Wiring Pattern**

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

**5. Thermal Consideration**

Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

**6. Recommended Operating Conditions**

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

**7. Rush Current**

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

**8. Operation Under Strong Electromagnetic Field**

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

**9. Testing on Application Boards**

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

**10. Inter-pin Short and Mounting Errors**

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

## Operational Notes – continued

**11. Unused Input Terminals**

Input terminals of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input terminals should be connected to the power supply or ground line.

**12. Regarding the Input Pin of the IC**

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When  $GND > Pin A$  and  $GND > Pin B$ , the P-N junction operates as a parasitic diode.

When  $GND > Pin B$ , the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

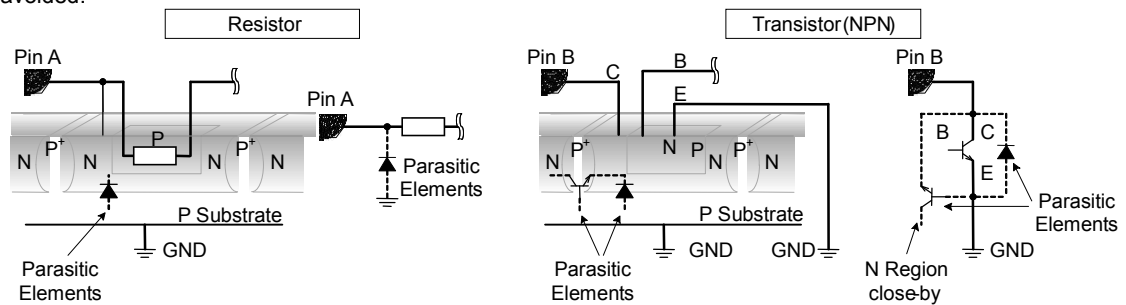


Figure xx. Example of monolithic IC structure

**13. Ceramic Capacitor**

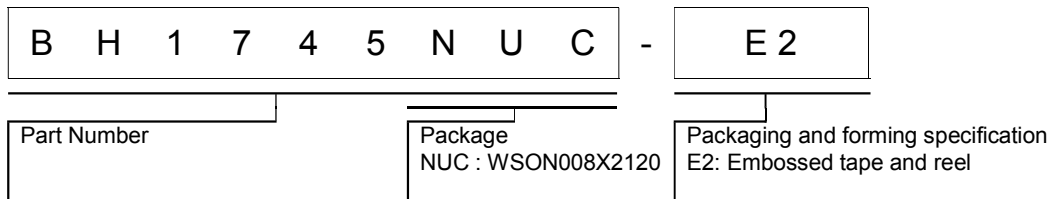
When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

**14. Area of Safe Operation (ASO)**

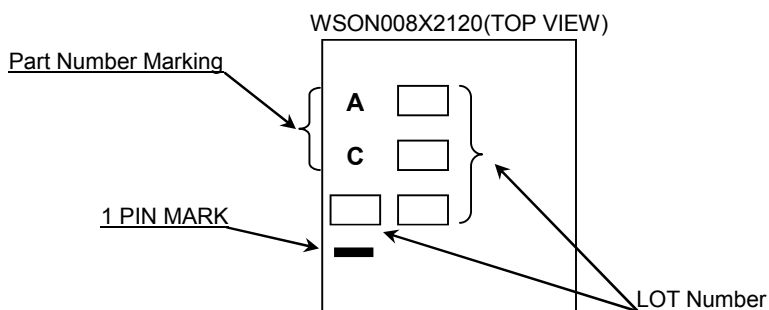
Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).



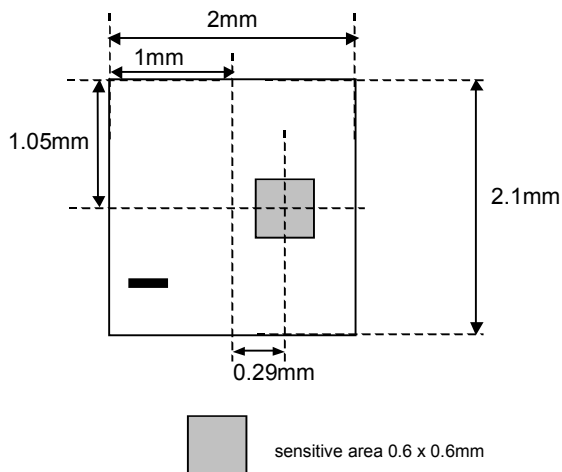
Ordering Information



Marking Diagram

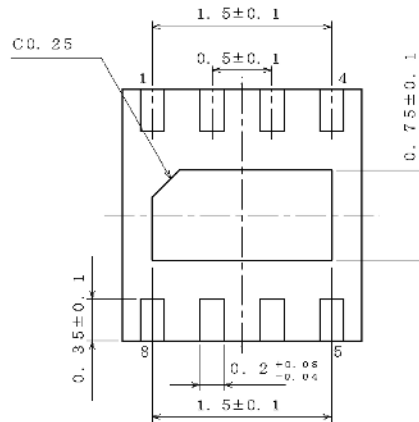
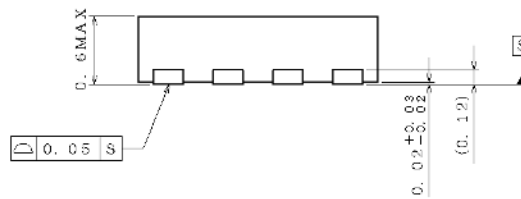
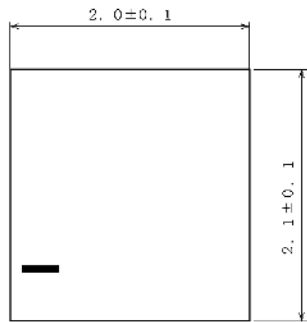


Optical design for the device



Physical Dimension, Tape and Reel Information

Package Name	WSON008X2120
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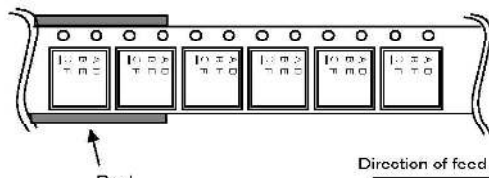
(UNIT : mm)

< Tape and Reel information >

Tape	Embossed carrier tape(with dry pack)
Quantity	4000pcs
Direction of feed	E2 (The direction is 1 pin product is at the upper left when you hold reel on the hand and you pull out the tape on the right hand)

PKG:WSON008X2120

Drawing No. EX071-5001



\*Order quantity needs to be multiple of the minimum quantity.

**Revision History**

Date	Revision	Changes
30.Jun.2014	001	New Release
23.May.2016	002	Correct description of VALID register. Correct register name. Correct "Operational Notes".

# Notice

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1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment <sup>(Note 1)</sup>, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

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  - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - [f] Sealing or coating our Products with resin or other coating materials
  - [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - [h] Use of the Products in places subject to dew condensation
4. The Products are not subject to radiation-proof design.
5. Please verify and confirm characteristics of the final or mounted products in using the Products.
6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
8. Confirm that operation temperature is within the specified range described in the product specification.
9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

**Precautions Regarding Application Examples and External Circuits**

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

**Precaution for Electrostatic**

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

**Precaution for Storage / Transportation**

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

**Precaution for Product Label**

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

**Precaution for Disposition**

When disposing Products please dispose them properly using an authorized industry waste company.

**Precaution for Foreign Exchange and Foreign Trade act**

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

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