Datasheet

Ambient Light Sensor IC Series

Digital 16bit Serial Output Type Ambient Light Sensor IC

BU27030NUC

General Description

BU27030NUC is a digital Ambient Light Sensor IC with I²C bus interface. This IC is most suitable for obtaining ambient light data for adjusting LCD and backlight power of TV and mobile phone. It is capable of detecting a very wide range of illuminance.

Key Specifications

- VCC Voltage Range: 1.7 V to 3.6 V
- Illuminance Detection Range: 20 klx (Typ)
- Current Consumption: 120 µA (Typ)
- Power Down Current: 1.0 µA (Typ)
- Operating Temperature Range: -40 °C to +85 °C

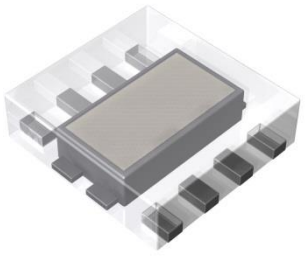
Features

- Built-in IR Cut Filter
- 2 outputs with Different Spectral Response
- Correspond to Dark Window because of High Sensitivity
- Rejecting 50 Hz / 60 Hz Light Noise
- I²C Bus Interface (f/s mode support)
- Correspond to both 1.2 V and 1.8 V Logic Interface
- Resolution 0.0007 lx/count (Typ)
  (In highest gain and longest measurement time setting)

Package

W (Typ) x D (Typ) x H (Max)

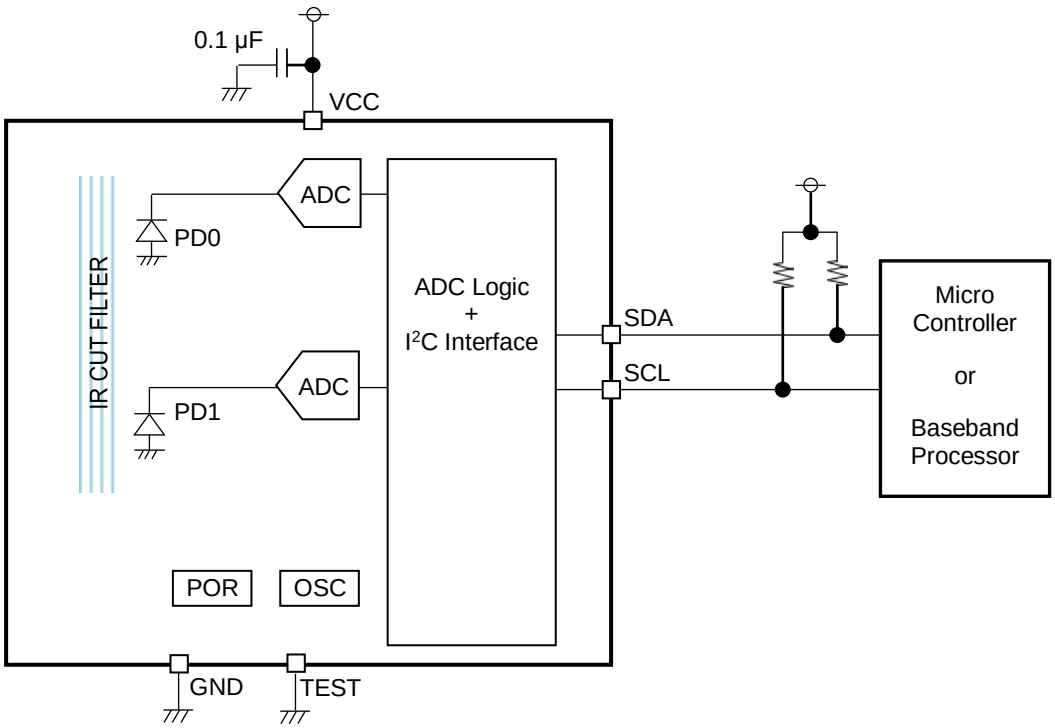
WSON008X2120 2.1 mm x 2.0 mm x 0.6 mm



Applications

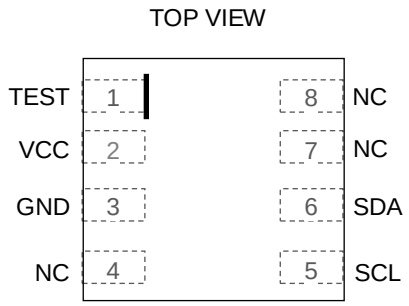
Mobile Phone, Tablet PC, Note PC, Portable Game Machine, LCD TV, Digital Camera

Typical Application Circuit



○Product structure : Silicon integrated circuit.
○This product does not include laser transmitter.
○This product includes Photo detector, (Photo Diode) inside of it.
○This product has no designed protection against radioactive rays.
○This product does not include optical load.

Pin Configuration

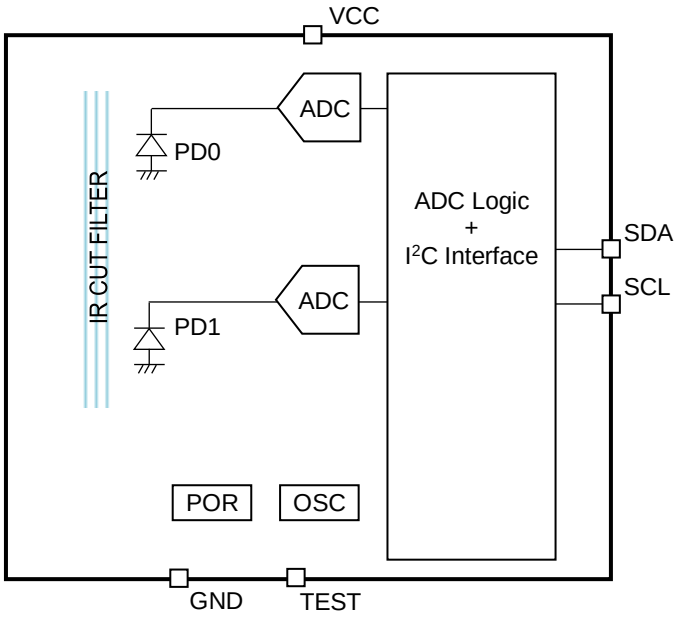


Pin Description

Pin No.	Pin Name	Function
1	TEST	Test pin (Connect to GND)
2	VCC	Power supply*(Note 1)*
3	GND	Ground
4	NC	Non connect*(Note 2)*
5	SCL	I^2C bus serial clock*(Note 3)*
6	SDA	I^2C bus serial data*(Note 3)*
7	NC	Non connect*(Note 2)*
8	NC	Non connect*(Note 2)*

(Note 1) Dispose a bypass capacitor as close as possible to the IC.
(Note 2) Please use the NC pin as open pin.
(Note 3) If there is a device falls sharply among other devices connected to the SDA and SCL pins, it might generate undershoot and the pin voltage might be the ground potential or below. When the undershoot occurs, must take a measure like adding a capacitor near to the pin of the device concerned.

Block Diagram



Description of Blocks

- PD0, PD1: Photodiode
- IR CUT FILTER: Infrared cut filter
- ADC: Analog-to-Digital Converter for obtaining digital data.
- ADC Logic and I^2C Interface: ADC control logic and I/F logic
- OSC: Clock generator 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
Supply Voltage	V_{CC_MR}	4.5	V
Input Voltage [SCL, SDA]	V_{IN_MR}	-0.3 to +4.5	V
Storage Temperature Range	Tstg	-40 to +100	°C
Maximum Junction Temperature	Tjmax	100	°C

Caution 1: *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.*

Caution 2: *Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

Thermal Resistance*(Note 1)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s*(Note 3)*	2s2p*(Note 4)*	
WSON008X2120				
Junction to Ambient	θ_{JA}	384.2	54.2	°C/W
Junction to Top Characterization Parameter*(Note 2)*	Ψ_{JT}	82	12	°C/W

(Note 1) Based on JESD51-2A (Still-Air).
(Note 2) The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
(Note 3) Using a PCB board based on JESD51-3.
(Note 4) Using a PCB board based on JESD51-5, 7.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3 mm x 76.2 mm x 1.57 mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70 µm

Layer Number of Measurement Board	Material	Board Size	Thermal Via*(Note 5)*	
			Pitch	Diameter
4 Layers	FR-4	114.3 mm x 76.2 mm x 1.6 mmt	1.20 mm	Φ0.30 mm

Top		2 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70 µm	74.2 mm x 74.2 mm	35 µm	74.2 mm x 74.2 mm	70 µm

(Note 5) This thermal via connects with the copper pattern of all layers.

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operating Temperature	Topr	-40	+25	+85	°C
Supply Voltage	V_{CC}	1.7	1.8	3.6	V
Input Voltage [SCL, SDA]	V_{IN}	0	-	3.6	V

Electrical Characteristics

(Unless otherwise specified, V_{CC} = 1.8 V, Ta = 25 °C, MEAS_EN = 1, WAIT_EN = 1, MEAS_MODE = 55 ms mode, x1 gain mode)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Current Consumption	I_{CC1}	-	120	200	µA	Ev = 100 lx *(Note 1)*
Power Down Current *(Note 2)*	I_{CC2}	-	1	4	µA	No input light MEAS_EN = 0 SCL = SDA = 1.8 V
DATA0 Data Count Value	D_{CH0}	5000	5900	6800	count	Ev = 1000 lx *(Note 1)* MEAS_MODE = 100 ms mode WAIT_EN = 0
DATA1 Data Count Value	D_{CH1}	1200	1450	1700	count	Ev = 1000 lx *(Note 1)* MEAS_MODE = 100 ms mode WAIT_EN = 0
Dark Count Value	S_{0_0}	0	-	2	count	No input light
Measurement Time	t_{MT1}	82	91	100	ms	
SCL SDA Input 'H' Voltage	V_{IH}	0.84	-	-	V	
SCL SDA Input 'L' Voltage	V_{IL}	-	-	0.45	V	
SDA Output 'L' Voltage	V_{OL}	0	-	0.4	V	I_{OL} = 3 mA

(Note 1) White LED is used.

(Note 2) Current value depends on voltage difference between VCC and the SCL or SDA pins.

Typical Performance Curves

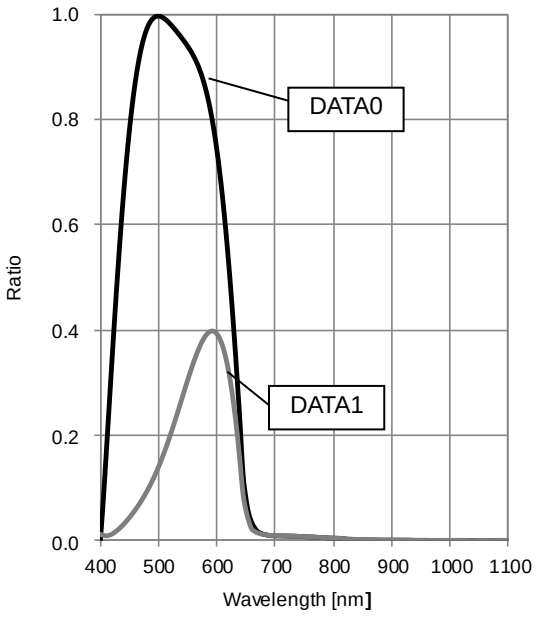
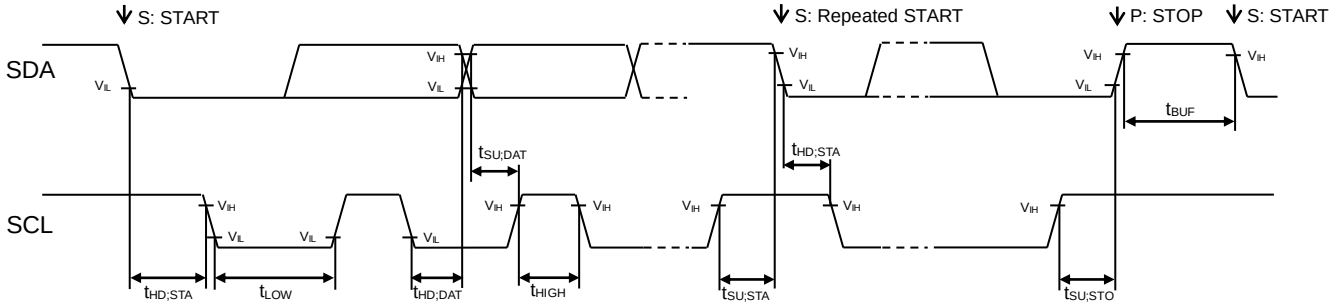


Figure 1. Ratio vs Wavelength
(Spectral Response)

I²C Bus Timing Characteristics (Unless otherwise specified V_{CC} = 1.8 V, Ta = 25 °C)



Parameter	Symbol	Min	Typ	Max	Unit	Conditions
SCL Clock Frequency	f_{SCL}	0	-	400	kHz	
'L' Period of the SCL Clock	t_{LOW}	1.3	-	-	µs	
'H' Period of the SCL Clock	t_{HIGH}	0.6	-	-	µs	
Setup Time for Repeated START	$t_{SU;STA}$	0.6	-	-	µs	
Hold Time for START	$t_{HD;STA}$	0.6	-	-	µs	
Data Setup Time	$t_{SU;DAT}$	100	-	-	ns	
Data Hold Time	$t_{HD;DAT}$	0	-	-	µs	
Set Up Time for STOP	$t_{SU;STO}$	0.6	-	-	µs	
Bus Free Time between STOP and START	t_{BUF}	1.3	-	-	µs	

I²C Bus Communication

1. Write Format

(1) Indicate register address

S	Slave Address	W 0	ACK	Register Address	ACK	P

(2) Write data after indicating register address

S	Slave Address	W 0	ACK	Register Address	ACK

Data specified at register address field	ACK	…	ACK	Data specified at register address field + N	ACK	P

2. Read Format

(1) Read data after indicating register address

S	Slave Address	W 0	ACK	Register Address	ACK

S	Slave Address	R 1	ACK	Data specified at register address field	ACK

Data specified at register address field + 1	ACK	…	ACK	Data specified at register address field + N	NACK	P

(2) Read data from the specified register

S	Slave Address	R 1	ACK	Data specified at register address field	ACK

Data specified at register address field + 1	ACK	…	ACK	Data specified at register address field + N	NACK	P

: from master to slave : from slave to master

I²C Bus Slave Address

Slave address is 0111000.

Register Map*(Note 1)*

Register Address	Register Name	R/W	D7	D6	D5	D4	D3	D2	D1	D0
0x40	SYSTEM_CONTROL	RW	SW_RESET	0	PART_ID [5:0]					
0x41	MODE_CONTROL1	RW	0	0	0	0	0	WAIT_EN	0	MEAS_MODE
0x42	MODE_CONTROL2	RW	DATA0_GAIN [3:0]				DATA1_GAIN [3:0]			
0x43	MODE_CONTROL3	RW	VALID	0	0	0	0	0	0	MEAS_EN
0x50	DATA0	R	DATA0_data [7:0]							
0x51		R	DATA0_data [15:8]							
0x52	DATA1	R	DATA1_data [7:0]							
0x53		R	DATA1_data [15:8]							
0x92	MANUFACTURER_ID	R	MANUFACTURER_ID [7:0]							

(Note 1) Do not write any commands to other addresses except above. Do not write '1' to the fields in which value is '0' in above table.

(0x40) SYSTEM_CONTROL

Fields	Function
SW_RESET	When software reset is performed, all registers are reset. 0: - (No action) 1: Perform software reset
PART_ID	PART ID 0x12 (Read only register)

default value 0x12

(0x41) MODE_CONTROL1

Fields	Function
WAIT_EN	0: There is no interval 1: There is interval after each measurement. (Low current consumption mode) Only in 55 ms mode this function is available. When this mode is active, measurement time is same at 100 ms mode
MEAS_MODE	Measurement mode for DATA0 and DATA1 0: 100 ms mode 1: 55 ms mode

default value 0x00

(0x42) MODE_CONTROL2

Fields	Function
DATA0_GAIN	Gain setting of ADC DATA0 0010: x1 gain mode 1010: x32 gain mode 1100: x256 gain mode Other setting is prohibited.
DATA1_GAIN	Gain setting of ADC DATA1 0010: x1 gain mode 1010: x32 gain mode 1100: x256 gain mode Other setting is prohibited.

default value 0x22

Register Map - continued

(0x43) MODE_CONTROL3

Fields	Function
VALID	Measurement data update status after changing settings of the below registers or reading MODE_CONTROL3 register. (Read only register) 0: Measurement data is not updated. 1: Measurement data is updated. Object registers: 0x41, 0x42, 0x43
MEAS_EN	0: Disable measurement 1: Enable measurement

default value 0x00

(0x50 / 0x51) DATA0

Fields	Function
DATA0_data [15:0]	DATA0 measurement data

default value 0x0000

(0x52 / 0x53) DATA1

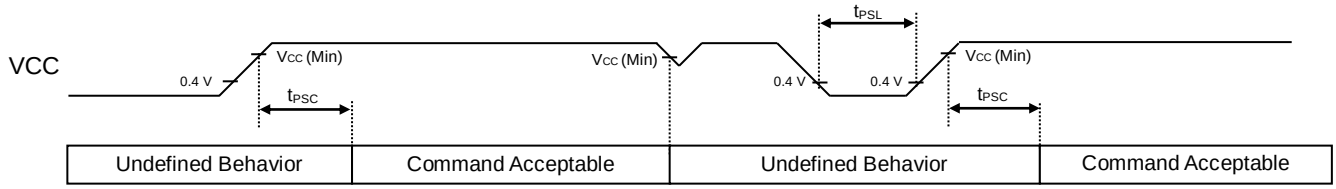
Fields	Function
DATA1_data [15:0]	DATA1 measurement data

default value 0x0000

(0x92) MANUFACTURER_ID

Fields	Function
MANUFACTURER_ID	MANUFACTURER_ID: 0xE0

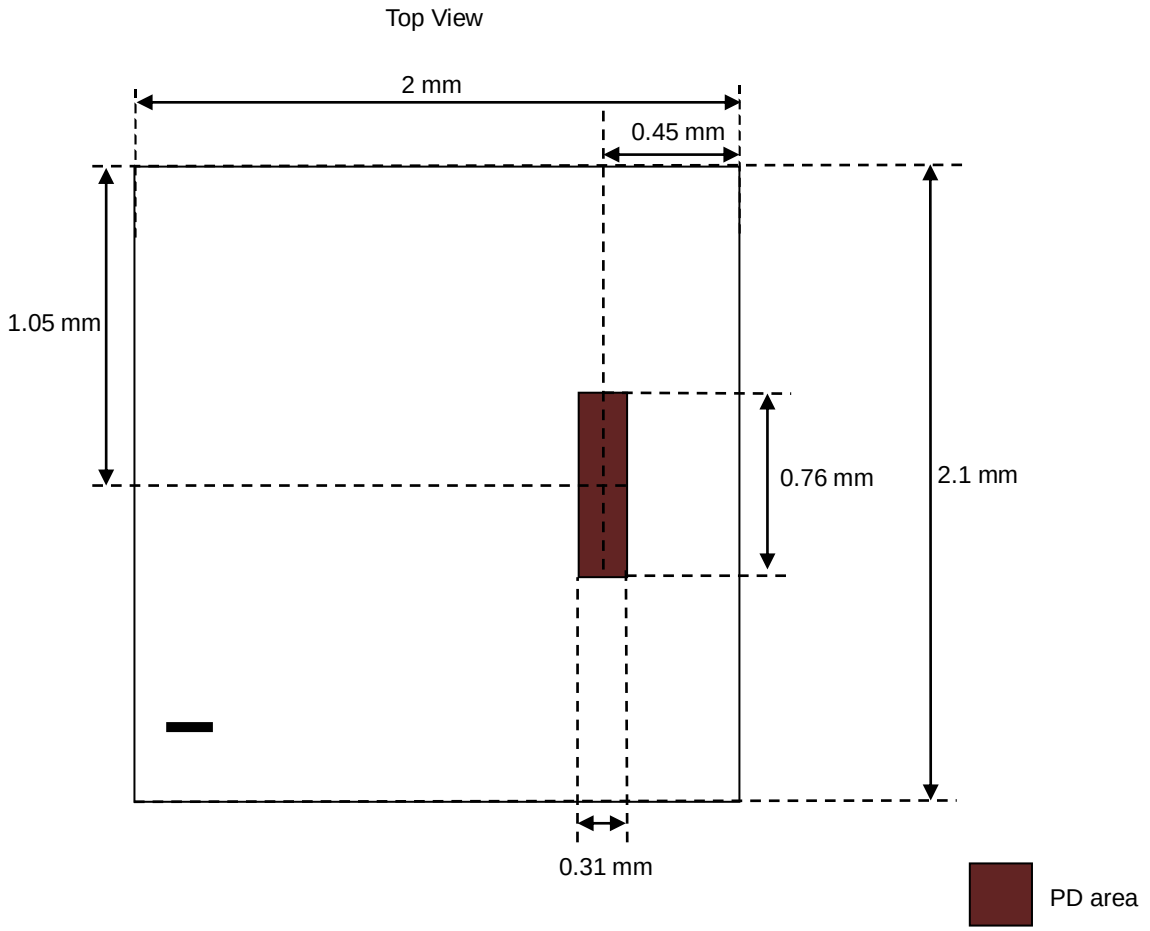
Power Supply Sequence (Unless otherwise specified V_{CC} = 1.8 V, Ta = 25 °C)



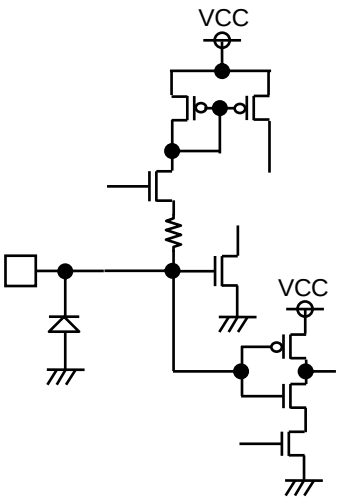
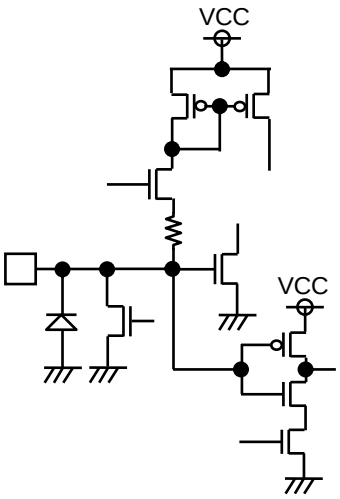
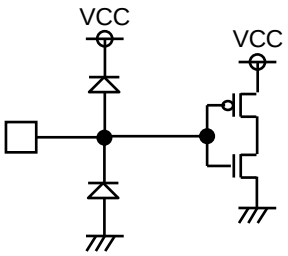
Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Command Input Wait Time after Power-up	t_{PSC}	100	-	-	µs	
Power Down Time	t_{PSL}	1	-	-	ms	

Command input is available after "t_{PSC}" from V_{CC} is supplied. If VCC voltage is below the recommended operating voltage range, internal state is "Undefined Behavior". In this case, once power down and power up again. Keep V_{CC} < 0.4 V for "t_{PSL}" or more before V_{CC} is supplied again.

Optical Design for the Device



I/O Equivalence Circuits

Pin Name	Equivalence Circuit	Pin Name	Equivalence Circuit
SCL		SDA	
TEST		-	-

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 pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. 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. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **Inrush 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.

7. **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.

8. **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.

9. **Unused Input Pins**
   Input pins 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 pins should be connected to the power supply or ground line.

10. **Regarding the Input Pin of the IC**
    In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input pins have voltages within the values specified in the electrical characteristics of this IC.

11. **Ceramic Capacitor**
    When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

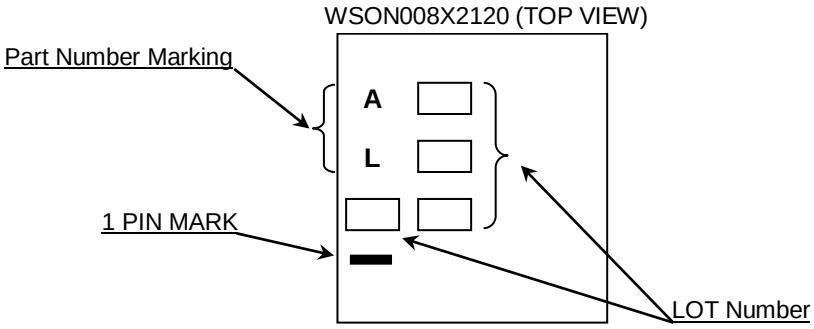
Ordering Information

B U 2 7 0 3 0 N U C	-	E 2

Package
NUC: WSON008X2120

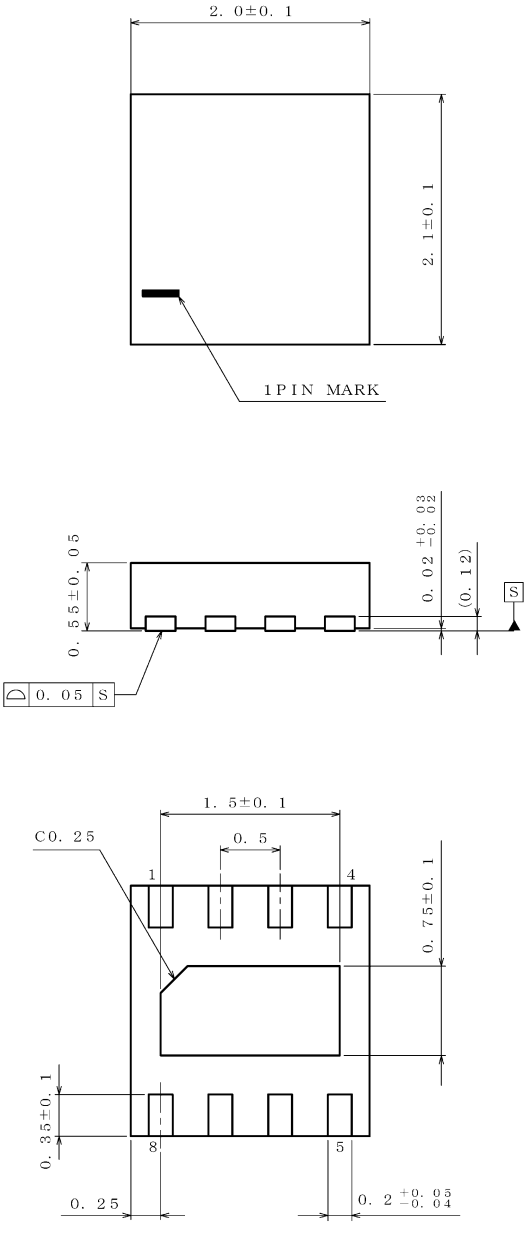
Packaging and forming specification
E2: Embossed tape and reel

Marking Diagram



Physical Dimension and Packing Information

Package Name	WSON008X2120



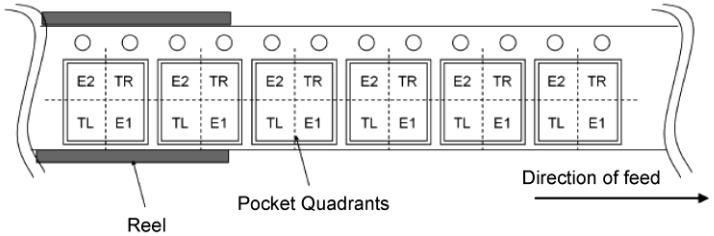
(UNIT:mm)

PKG:WSON008X2120

Drawing No. EX071-5001-2

< Tape and Reel Information >

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



Revision History

Date	Revision	Changes
19.Sep.2019	001	New Release
06.Dec.2019	002	Revise Physical Dimension and Packing Information

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipment (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 (Note 1), 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
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [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_2, H_2S, NH_3, SO_2, and NO_2
   [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 (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; 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_2, H_2S, NH_3, SO_2, and NO_2
   [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.

Precaution Regarding Intellectual Property Rights

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