ROHM SEMICONDUCTOR

Datasheet

Linear Constant Current VCM Driver

BU64981AGWZ

General Description

The BU64981AGWZ is designed to drive voice coil motors (VCM). The driver includes ISRC (intelligent slew rate control) to reduce mechanical ringing to optimize the camera's auto focus capabilities.

Key Specifications

■ Power Supply Range:	2.3V to 4.8V
■ Standby Current:	70µA(Typ)
■ Internal Resistance:	2.5Ω(Typ)
■ Master Clock:	2MHz(Typ)
■ Output Maximum Current:	100mA(Typ)
■ Operating Temperature Range:	-25°C to +85°C

Package

Package	W(Typ) x D(Typ) x H(Max)
UCSP30L1A	0.72mm x 1.13mm x 0.33mm

Features

- ■ 2.3V Min Driver Power Supply
- ■ Current Sink Output
- ■ 10 bit Resolution Current Control
- ■ ISRC Mechanical Ringing Compensation
  $(1/f_0)$ x 0.48/ x 0.72/ x 0.92/ x 1.2
- ■ 2-wire Serial Interface
- ■ I2C Fast-mode Plus compatible
- ■ I2C Address Select Input
  AS=H : 0x18 / AS=L : 0x1C
- ■ Integrated Current Sense Resistor

Applications

- ■ Autofocus in Mobile Camera Modules
- ■ Driving VCM Actuators

Typical Application Circuit

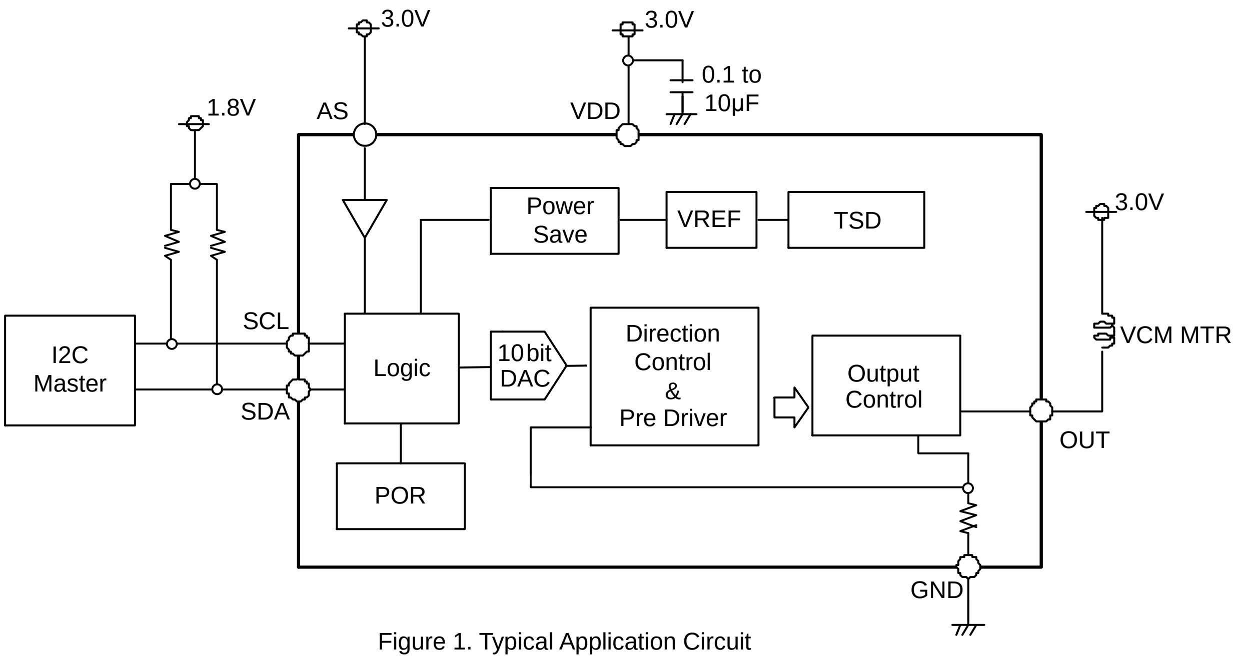


Figure 1. Typical Application Circuit

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

Pin Configuration

	1	2
A	OUT	AS
B	GND	SDA
C	VDD	SCL

Figure 2. Pin configuration (TOP VIEW)

Pin Description

Pin No.	Pin Name	Function
A1	OUT	Current output
A2	AS	I2C address select input
B1	GND	Ground
B2	SDA	Serial data input
C1	VDD	Power supply voltage
C2	SCL	Serial clock input

Block Diagram

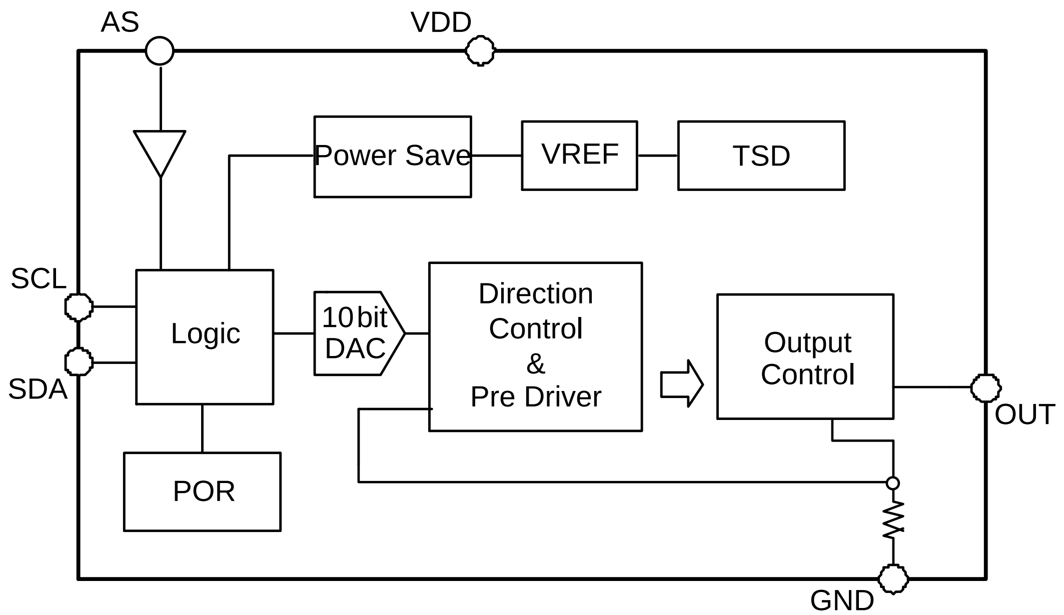


Figure 3. Block Diagram

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Power supply voltage	V_{DD}	-0.5 to +5.5	V
Address select input voltage	V_{AS}	-0.5 to +5.5	V
Control input voltage(Note 1)	V_{IN}	-0.5 to +5.5	V
Power dissipation	Pd	0.29(Note 2)	W
Junction temperature	Tjmax	125	°C
Storage temperature range	Tstg	-55 to +125	°C
Output current	I_{OUT}	200(Note 3)	mA

(Note 1) VIN is 2-wire serial interface input pins (SCL, SDA)
(Note 2) UCSP30L1A package. Reduced by 2.9mW/°C over 25°C when mounted on a glass epoxy board (50mm × 58mm × 1.75mm; 8layers)
(Note 3) Must not exceed Pd or Tjmax of 125°C

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage	V_{DD}	2.3	3.0	4.8	V
Address select input voltage	V_{AS}	0	-	4.8	V
Control input voltage(Note 4)	V_{IN}	0	-	4.8	V
Operating temperature range	Topr	-25	-	+85	°C
2-wire serial interface frequency	f_{CLK}	-	-	1.0	MHz
Output current	I_{OUT}	-	-	100(Note 5)	mA

(Note 4) V_{IN} is 2-wire serial interface input pins (SCL, SDA)
(Note 5) Must not exceed Pd or Tjmax of 125°C

Electrical Characteristics (Unless otherwise specified Ta = 25°C, VDD = 3.0V)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Power Consumption						
Standby current	I_{DDST}	-	70	120	µA	PS bit = 0
Circuit current	I_{DD}	-	1.0	1.5	mA	PS bit = 1,EN bit = 0
Address Select Input (V_{AS} = AS)						
High level input voltage	V_{ASH}	1.26	-	VDD	V	
Low level input voltage	V_{ASL}	0	-	0.5	V	
High level input current	I_{ASH}	-5	-	+5	µA	V_{AS} = 3V
Low level input current	I_{ASL}	-5	-	+5	µA	V_{AS} = 0V
Control Input (V_{IN} = SCL, SDA)						
High level input voltage	V_{INH}	1.26	-	VDD	V	
Low level input voltage	V_{INL}	0	-	0.5	V	
Low level output voltage	V_{INOL}	-	-	0.4	V	I_{IN} = +3.0mA (SDA)
High level input current	I_{INH}	-5	-	+5	µA	Input voltage = 0.9 x V_{IN}
Low level input current	I_{INL}	-5	-	+5	µA	Input voltage = 0.1 x V_{IN}
Master Clock						
MCLK frequency	M_{CLK}	-3	-	+3	%	2MHz (Typ)
10 Bit D/A Converter (for Controlling Output Current)						
Resolution	D_{RES}	-	10	-	bits	
Differential nonlinearity	D_{DNL}	-1	-	+1	LSB	
Integral nonlinearity	D_{INL}	-4	-	+4	LSB	
Output Current Performance						
Output current resolution	I_{ORES}	-	98	-	µA	Per 1 DAC code step
Output maximum current	I_{OMAX}	95	100	105	mA	Target position DAC Code = 0x3FF
Zero code offset current	I_{OOFS}	0	1	5	mA	Target position DAC Code = 0x000
Maximum applied voltage	V_{OMAX}	-	-	VDD	V	
Output resistance	R_{OUT}	-	2.5	3.3	Ω	

Timing Chart (Ta = 25°C, VDD = 3.0V)

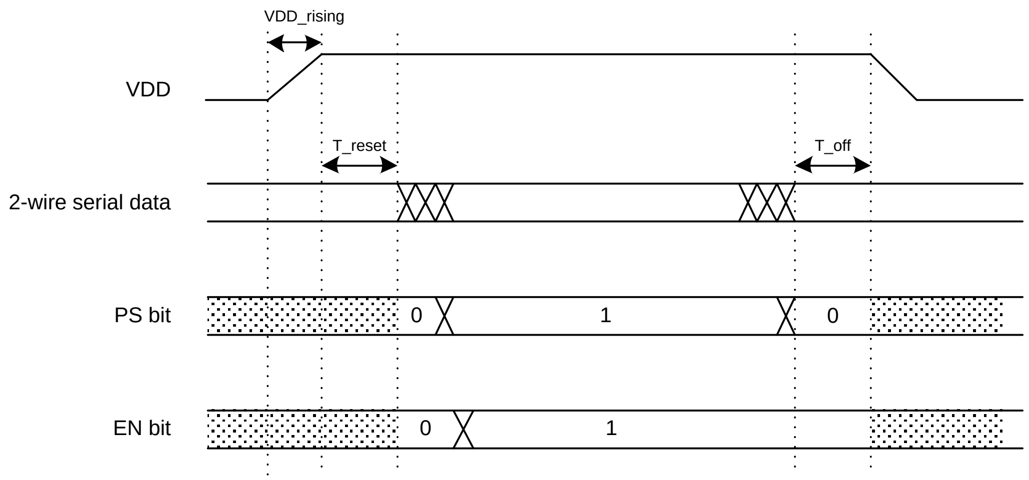
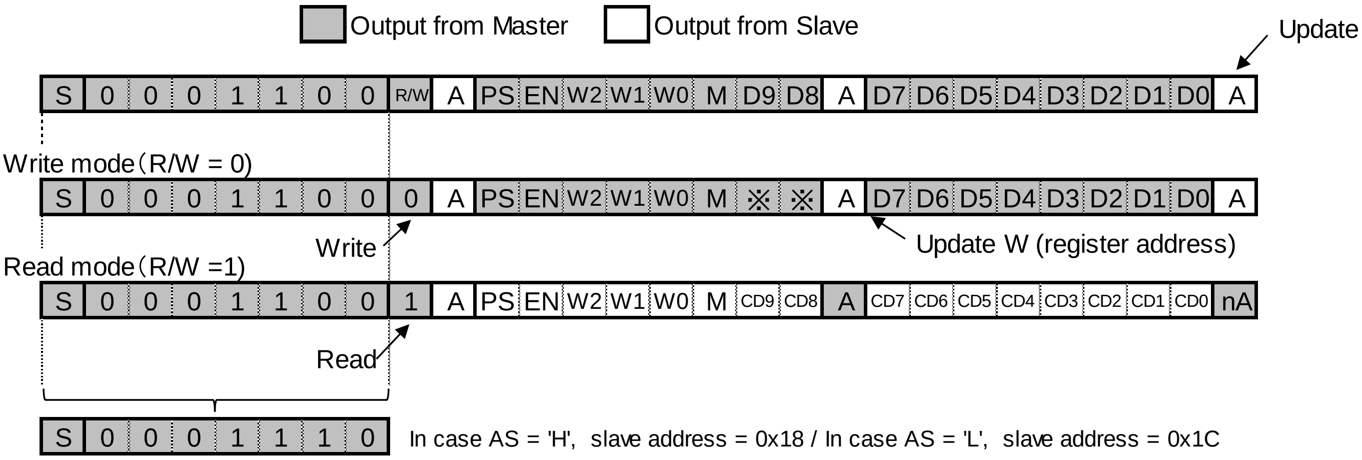


Figure 4. Timing Chart

Parameter	Symbol	Min	Typ	Max	Unit
VDD rising time	VDD_rising	0	-	-	µs
Time from VDD going high until first serial command	T_reset	20	-	-	µs
Time delay of last serial command until VDD going low	T_off	1.3	-	-	µs

2-wire serial BUS Format (Fast-mode SCL = 400kHz / Fast-mode Plus SCL = 1MHz)



S : start signal P : stop signal

A : acknowledge nA : non acknowledge ※ : Don't care

Register Name	Setting Item	Description
R/W	Read/Write mode	0 = Write mode (0x18 address), 1 = Read mode (0x19 address)
PS	Serial power save	0 = Driver in standby mode, 1 = Driver in operating mode
EN	Driver output status	0 = Output is Hi-Z 1 = Constant current sink
W2W1W0	Register address	000b = Output current setting
		001b = Parameter setting 1
M	Mode select	M=0=ISRC mode disabled M=1=ISRC mode enabled
D9 to D0	Data bits	Register data

Register Update Timing

PS – Register is updated during the 2nd ACK response during a 3-byte 2-wire serial command
EN – Register is updated during the 3rd ACK response during a 3-byte 2-wire serial command
Wx – Register is updated during the 2nd ACK response during a 3-byte 2-wire serial command
M – Register is updated during the 3rd ACK response during a 3-byte 2-wire serial command
Dx – Register is updated during the 3rd ACK response during a 3-byte 2-wire serial command

Resister Map

Address W2W1W0	Bit	Bit Name	Function
000b	D[9:0]	C_DAC[9:0]	Target position DAC Code[9:0]
001b	D[9:2]	rf[7:0]	Resonant frequency setting[7:0] [D7:D0] = 0x00: 50Hz [D7:D0] = 0xFF: 152Hz
	D[1:0]	slew_rate[1:0]	Slew rate speed setting[1:0] [D1:D0] = 0x00: ISRC mode ((1/f_0) x 0.48) [D1:D0] = 0x01: ISRC mode ((1/f_0) x 0.72) [D1:D0] = 0x02: ISRC mode ((1/f_0) x 0.92) [D1:D0] = 0x03: ISRC mode ((1/f_0) x 1.2)

Characteristics of the SDA and SCL Bus Lines for 2-wire Serial Interface (Ta = 25°C, VDD = 3.0V)

Parameter	Symbol	FAST-MODE			FAST-MODE PLUS			Unit
		Min	Typ	Max	Min	Typ	Max	
SCL clock frequency	fSCL	-	-	400	-	-	1000	kHz
High period of the SCL clock	tHIGH	0.6	-	-	0.26	-	-	μs
Low period of the SCL clock	tLOW	1.3	-	-	0.5	-	-	μs
Hold time (repeated) START condition	tHD:STA	0.6	-	-	0.26	-	-	μs
Setup time (repeated) START condition	tSU:STA	0.6	-	-	0.26	-	-	μs
Data hold time	tHD:DAT	0	-	0.9	0	-	0.46	μs
Data set-up time	tSU:DAT	100	-	-	50	-	-	ns
Set-up time for stop condition	tSU:STO	0.6	-	-	0.26	-	-	μs
Bus free time between a stop and start condition	tBUF	1.3	-	-	0.5	-	-	μs

FAST-MODE, and FAST-MODE PLUS (Fm+) 2-wire Serial Interface devices must be able to transmit or receive at the designated speed. The maximum bit transfer rates are 400kbit/s for FAST-MODE devices, and 1Mbit/s for Fm+ devices. This transfer rates is based on the maximum transfer rate. For example the bus is able to drive 100kbit/s clocks with Fm+.

2-wire Serial Interface Timing

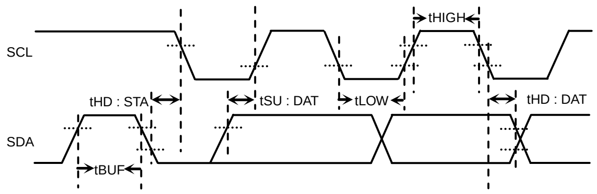


Figure 5. Serial Data Timing

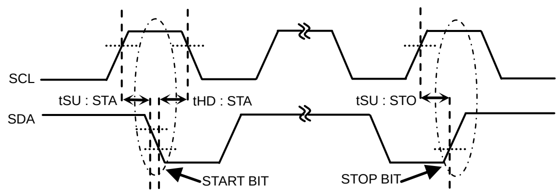


Figure 6. Start and Stop Bit Timing

Controlling Mechanical Ringing

A voice coil motor (VCM) is an actuator technology that is intrinsically noisy due to the properties of the mechanical spring behavior. As current passes through the VCM, the lens moves and oscillates until the system reaches a steady state. The BU64981AGWZ lens driver is able to control mechanical oscillations by using the integrated ISRC (intelligent slew rate control) function. ISRC is operated by setting multiple control parameters that are determined by the intrinsic characteristics of the VCM. The following steps illustrate how to best utilize ISRC to minimize mechanical oscillations.

・Step A – f_0 setting

Each VCM has a resonant frequency that can either be provided by the manufacturer or measured. The resonant frequency of an actuator determines the amount of ringing (mechanical oscillation) experienced after the lens as been moved to a target position and the driver output current held constant. To determine the resonant frequency, f_0, input a target DAC code by modifying the 10bit C_DAC[9:0] value in register W2W1W0 = 000b that will target a final lens position approximately half of the actuator’s full stroke. Take care to not apply too much current so that the lens does not hit the mechanical end of the actuator as this will show an incorrect resonant period. In order to start movement of the lens to the DAC code that was set in C_DAC[9:0], the EN bit must be set to 1.

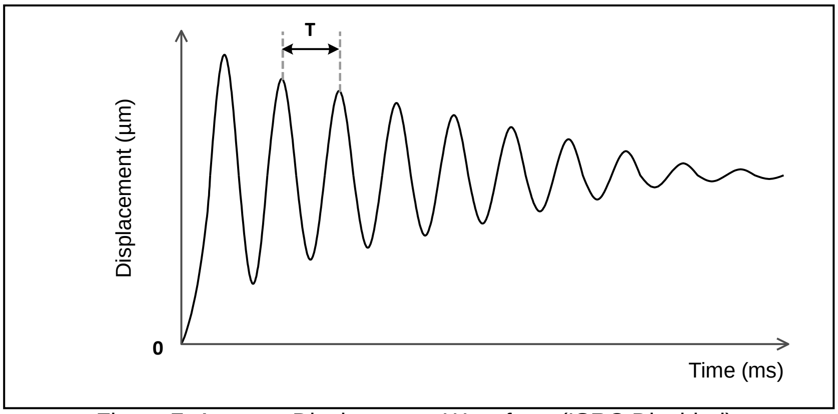


Figure 7. Actuator Displacement Waveform (ISRC Disabled)

The resonant frequency (Hz) of the actuator can be calculated with Equation 1 using the resonant period observed in Figure 7.

$$f_0 = (T)^{-1}$$

Equation 1. Resonant Frequency vs. Time Period Relationship

After calculating the correct resonant frequency, program the closest value in the W2W1W0 = 001b register using the 8 bit rf[7:0] values from Table 1. When calculating the resonant frequency take care that different actuator samples’ resonant frequencies might vary slightly and that the frequency tolerance should be taken into consideration when selecting the correct driver resonant frequency value.

Table 1. f_0 Settings (rf[7:0])

rf[7:0]	f_0	rf[7:0]	f_0	rf[7:0]	f_0	rf[7:0]	f_0
00000000	50 Hz	00001000	53.2 Hz	00010000	56.4 Hz	00011000	59.6 Hz
00000001	50.4 Hz	00001001	53.6 Hz	00010001	56.8 Hz	00011001	60 Hz
00000010	50.8 Hz	00001010	54 Hz	00010010	57.2 Hz	00011010	60.4 Hz
00000011	51.2 Hz	00001011	54.4 Hz	00010011	57.6 Hz	00011011	60.8 Hz
00000100	51.6 Hz	00001100	54.8 Hz	00010100	58 Hz	00011100	61.2 Hz
00000101	52 Hz	00001101	55.2 Hz	00010101	58.4 Hz	00011101	61.6 Hz
00000110	52.4 Hz	00001110	55.6 Hz	00010110	58.8 Hz	00011110	62 Hz
00000111	52.8 Hz	00001111	56 Hz	00010111	59.2 Hz	00011111	62.4 Hz

Controlling Mechanical Ringing – continued

Table 1 f_0 Settings (rf[7:0])

rf[7:0]	f_0	rf[7:0]	f_0	rf[7:0]	f_0	rf[7:0]	f_0
00100000	62.8 Hz	01000000	75.6 Hz	01100000	88.4 Hz	10000000	101.2 Hz
00100001	63.2 Hz	01000001	76 Hz	01100001	88.8 Hz	10000001	101.6 Hz
00100010	63.6 Hz	01000010	76.4 Hz	01100010	89.2 Hz	10000010	102 Hz
00100011	64 Hz	01000011	76.8 Hz	01100011	89.6 Hz	10000011	102.4 Hz
00100100	64.4 Hz	01000100	77.2 Hz	01100100	90 Hz	10000100	102.8 Hz
00100101	64.8 Hz	01000101	77.6 Hz	01100101	90.4 Hz	10000101	103.2 Hz
00100110	65.2 Hz	01000110	78 Hz	01100110	90.8 Hz	10000110	103.6 Hz
00100111	65.6 Hz	01000111	78.4 Hz	01100111	91.2 Hz	10000111	104 Hz
00101000	66 Hz	01001000	78.8 Hz	01101000	91.6 Hz	10001000	104.4 Hz
00101001	66.4 Hz	01001001	79.2 Hz	01101001	92 Hz	10001001	104.8 Hz
00101010	66.8 Hz	01001010	79.6 Hz	01101010	92.4 Hz	10001010	105.2 Hz
00101011	67.2 Hz	01001011	80 Hz	01101011	92.8 Hz	10001011	105.6 Hz
00101100	67.6 Hz	01001100	80.4 Hz	01101100	93.2 Hz	10001100	106 Hz
00101101	68 Hz	01001101	80.8 Hz	01101101	93.6 Hz	10001101	106.4 Hz
00101110	68.4 Hz	01001110	81.2 Hz	01101110	94 Hz	10001110	106.8 Hz
00101111	68.8 Hz	01001111	81.6 Hz	01101111	94.4 Hz	10001111	107.2 Hz
00110000	69.2 Hz	01010000	82 Hz	01110000	94.8 Hz	10010000	107.6 Hz
00110001	69.6 Hz	01010001	82.4 Hz	01110001	95.2 Hz	10010001	108 Hz
00110010	70 Hz	01010010	82.8 Hz	01110010	95.6 Hz	10010010	108.4 Hz
00110011	70.4 Hz	01010011	83.2 Hz	01110011	96 Hz	10010011	108.8 Hz
00110100	70.8 Hz	01010100	83.6 Hz	01110100	96.4 Hz	10010100	109.2 Hz
00110101	71.2 Hz	01010101	84 Hz	01110101	96.8 Hz	10010101	109.6 Hz
00110110	71.6 Hz	01010110	84.4 Hz	01110110	97.2 Hz	10010110	110 Hz
00110111	72 Hz	01010111	84.8 Hz	01110111	97.6 Hz	10010111	110.4 Hz
00111000	72.4 Hz	01011000	85.2 Hz	01111000	98 Hz	10011000	110.8 Hz
00111001	72.8 Hz	01011001	85.6 Hz	01111001	98.4 Hz	10011001	111.2 Hz
00111010	73.2 Hz	01011010	86 Hz	01111010	98.8 Hz	10011010	111.6 Hz
00111011	73.6 Hz	01011011	86.4 Hz	01111011	99.2 Hz	10011011	112 Hz
00111100	74 Hz	01011100	86.8 Hz	01111100	99.6 Hz	10011100	112.4 Hz
00111101	74.4 Hz	01011101	87.2 Hz	01111101	100 Hz	10011101	112.8 Hz
00111110	74.8 Hz	01011110	87.6 Hz	01111110	100.4 Hz	10011110	113.2 Hz
00111111	75.2 Hz	01011111	88 Hz	01111111	100.8 Hz	10011111	113.6 Hz

Controlling Mechanical Ringing – continued

Table 1. f_0 Settings (rf[7:0])

rf[7:0]	f_0	rf[7:0]	f_0	rf[7:0]	f_0	rf[7:0]	f_0
10100000	114 Hz	11000000	126.8 Hz	11100000	139.6 Hz	-	-
10100001	114.4 Hz	11000001	127.2 Hz	11100001	140 Hz	-	-
10100010	114.8 Hz	11000010	127.6 Hz	11100010	140.4 Hz	-	-
10100011	115.2 Hz	11000011	128 Hz	11100011	140.8 Hz	-	-
10100100	115.6 Hz	11000100	128.4 Hz	11100100	141.2 Hz	-	-
10100101	116 Hz	11000101	128.8 Hz	11100101	141.6 Hz	-	-
10100110	116.4 Hz	11000110	129.2 Hz	11100110	142 Hz	-	-
10100111	116.8 Hz	11000111	129.6 Hz	11100111	142.4 Hz	-	-
10101000	117.2 Hz	11001000	130 Hz	11101000	142.8 Hz	-	-
10101001	117.6 Hz	11001001	130.4 Hz	11101001	143.2 Hz	-	-
10101010	118 Hz	11001010	130.8 Hz	11101010	143.6 Hz	-	-
10101011	118.4 Hz	11001011	131.2 Hz	11101011	144 Hz	-	-
10101100	118.8 Hz	11001100	131.6 Hz	11101100	144.4 Hz	-	-
10101101	119.2 Hz	11001101	132 Hz	11101101	144.8 Hz	-	-
10101110	119.6 Hz	11001110	132.4 Hz	11101110	145.2 Hz	-	-
10101111	120 Hz	11001111	132.8 Hz	11101111	145.6 Hz	-	-
10110000	120.4 Hz	11010000	133.2 Hz	11110000	146 Hz	-	-
10110001	120.8 Hz	11010001	133.6 Hz	11110001	146.4 Hz	-	-
10110010	121.2 Hz	11010010	134 Hz	11110010	146.8 Hz	-	-
10110011	121.6 Hz	11010011	134.4 Hz	11110011	147.2 Hz	-	-
10110100	122 Hz	11010100	134.8 Hz	11110100	147.6 Hz	-	-
10110101	122.4 Hz	11010101	135.2 Hz	11110101	148 Hz	-	-
10110110	122.8 Hz	11010110	135.6 Hz	11110110	148.4 Hz	-	-
10110111	123.2 Hz	11010111	136 Hz	11110111	148.8 Hz	-	-
10111000	123.6 Hz	11011000	136.4 Hz	11111000	149.2 Hz	-	-
10111001	124 Hz	11011001	136.8 Hz	11111001	149.6 Hz	-	-
10111010	124.4 Hz	11011010	137.2 Hz	11111010	150 Hz	-	-
10111011	124.8 Hz	11011011	137.6 Hz	11111011	150.4 Hz	-	-
10111100	125.2 Hz	11011100	138 Hz	11111100	150.8 Hz	-	-
10111101	125.6 Hz	11011101	138.4 Hz	11111101	151.2 Hz	-	-
10111110	126 Hz	11011110	138.8 Hz	11111110	151.6 Hz	-	-
10111111	126.4 Hz	11011111	139.2 Hz	11111111	152 Hz	-	-

Controlling the Driver

After following steps A to characterize the VCM performance, the following steps should be followed in order to properly control the driver settings for optimized autofocus performance.

・Step B1 Final lens position before image capture

10bit DAC codes set with the following registers:

W2W1W0	DAC Code	Description
000b	C_DAC[9:0]	Final lens position before image capture

・Step B2 – Controlling Direct Mode

Direct mode is when the driver outputs the desired amount of output current with no output current control. The time in which the lens reaches the position that corresponds to the amount of output current set by the 10bit DAC code is ideally instant, ignoring the ringing effects. If the driver is set so that the lens is moved from a resting position to Target position with direct mode, ringing and settling time will be at a maximum.

Direct mode is used when M = 0.

M = 0 = ISRC mode disabled

When ISRC mode is disabled by setting the M bit equal to 0, the lens will traverse to the DAC code set for Target position when the EN bit is set equal to 1.

・Step B3 – Controlling ISRC Mode

ISRC operation keeps ringing at a Minimum while achieving the fastest possible settling time based on the ISRC operational conditions.

ISRC mode is used when M = 1.

・Step B4 – Controlling the ISRC Settling Time

The settling time of an actuator is the time it takes for ringing to cease. The BU64981AGWZ is able to control the settling time by modifying the slew rate speed parameter, however care must be taken to balance settling time vs. acceptable ringing levels. By increasing the slew rate speed there is the possibility to decrease the settling time but the ability to control ringing is also decreased. Likewise if less ringing is desired then there is a possibility to reduce the ringing level by using a slower slew rate speed setting at the cost of a longer settling time. The slew rate speed can be set by modifying the 2bit slew_rate[1:0] value in register W2W1W0 = 01b. Figure 8 shows the relationship of displacement vs. settling time.

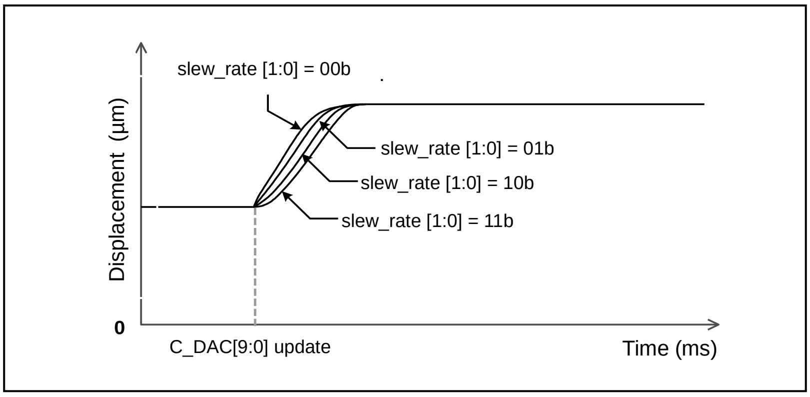


Figure 8. Displacement vs. Settling Time

Table 2. Slew Rate Speed Settings (slew_rate[1:0])

slew_rate[1:0]	Slew Rate Speed	slew_rate[1:0]	Slew Rate Speed	slew_rate[1:0]	Slew Rate Speed	slew_rate[1:0]	Slew Rate Speed
00	Fastest	01	Fast	10	Slow	11	Slowest

Controlling The Driver – continued

・Step B5 – DAC Code Update Timing Considerations

By ISRC function to control Drive patterns and DAC code change time, it's possible to control mechanical ringing of VCM. Drive patterns and DAC code change time is decided by the resonant frequency of the actuator and the driver's slew rate speed setting.
It's not possible to control ringing without outputting a drive pattern based on decided DAC code till the last.
Utilize the slew rate speed parameter to prevent update from happening to the next aim position DAC cord before DAC code output change is completed.

Please review the following example based on an actuator with a resonant frequency of 100Hz:

Table 3. Relationship between Slew Rate Speed and DAC code Change Time Based on a 100Hz Actuator

f_0	slew_rate[1:0]	DAC code Change Time
100 Hz	00	7 ms
	01	8.7 ms
	10	12 ms
	11	18 ms

In this example the settling time of the actuator can vary by up to ±3% due to the internal oscillator (MCLK) having a variance of ±3%. The settling time has a proportionally inverse relationship to the resonant frequency and therefore the settling time can be estimated as:

Table 4. Relationship between Slew Rate Speed and DAC code Change Time Based on a General Resonant Frequency f_0'

f_0'	slew_rate[1:0]	DAC code Change Time
f_0' Hz	00	7 * (100 / f_0') ms
	01	8.7 * (100 / f_0') ms
	10	12 * (100 / f_0') ms
	11	18 * (100 / f_0') ms

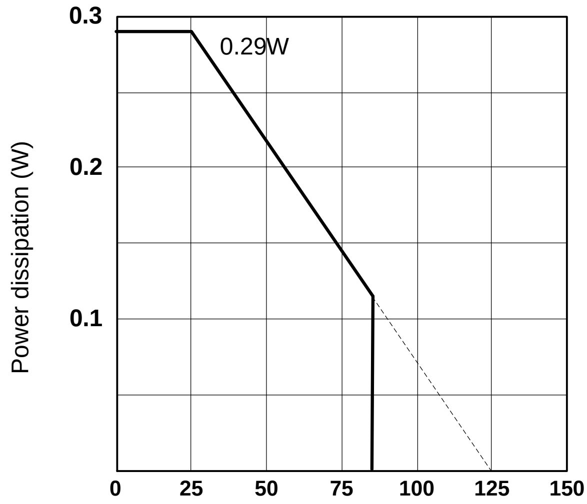
Note that the orientation of the camera module can affect the settling time due to the influence of gravity on the lens.

・Step C1 – Power Save Operation

The BU64981AGWZ can be set to enter power save mode either by setting the 2-wire serial PS bit = 0.

Power Dissipation

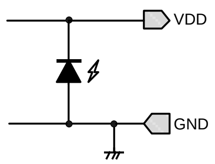
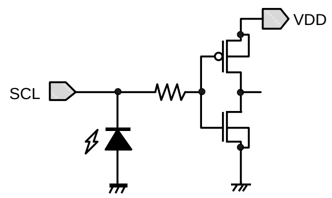
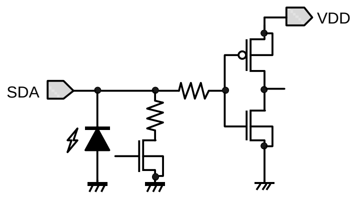
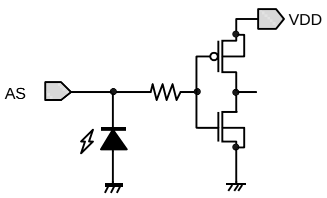
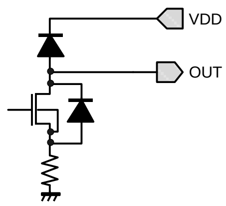
Package : UCSP30L1A (BU64981AGWZ)



Ambient Temperature: Ta (°C)
(This value is not guaranteed value.)

Figure 9. Power dissipation Pd (W)

I/O Equivalence Circuit

VDD	SCL	SDA
		
AS	OUT	
		

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. **Thermal Consideration**
   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, increase the board size and copper area to prevent exceeding the maximum junction temperature 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. **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.

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.

11. **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.

Operational Notes – continued

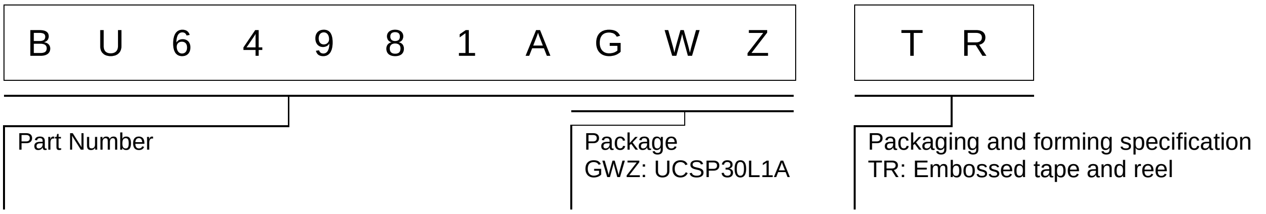
12. **Regarding the Input Pin of the IC**
In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions 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.

13. **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.

14. **Thermal Shutdown Circuit(TSD)**
This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's maximum junction temperature rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

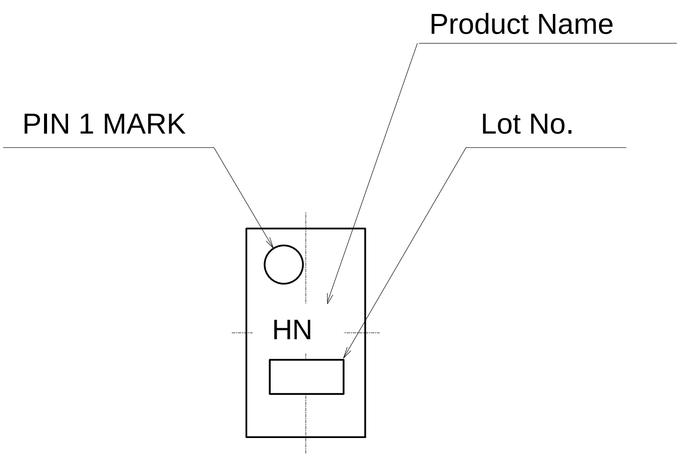
15. **Disturbance light**
In a device where a portion of silicon is exposed to light such as in a WL-CSP, IC characteristics may be affected due to photoelectric effect. For this reason, it is recommended to come up with countermeasures that will prevent the chip from being exposed to light.

Ordering Information



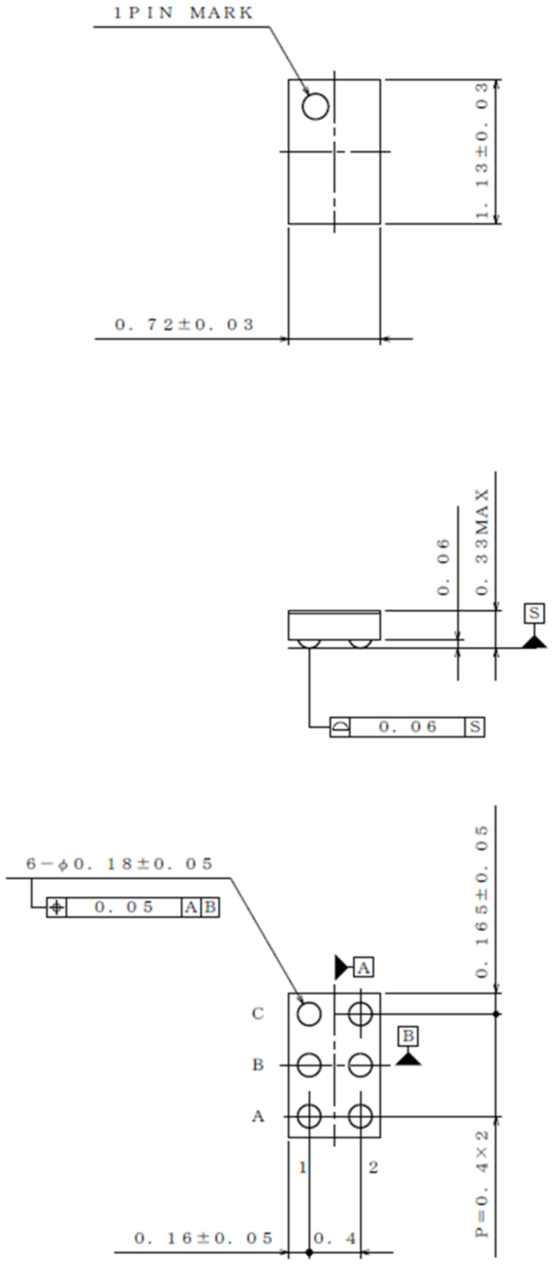
Marking Diagram (TOP VIEW)

UCSP30L1A (BU64981AGWZ)



Physical Dimension and Packing Information

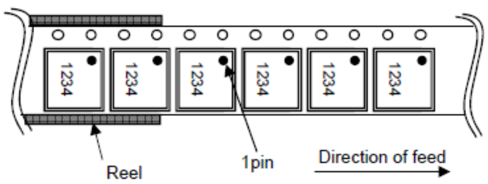
Package Name	UCSP30L1A(BU64981AGWZ)



(Unit: mm)

< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	6,000pcs
Direction of feed	TR The direction is the pin 1 of product is at the upper right when you hold reel on the left hand and ou pull out the tape on the right hand.



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

Revision History

Date	Revision	Changes
3.Aug.2017	001	New Release

Notice

Precaution on using ROHM Products

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 (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

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   [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 (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 Cl2, H2S, NH3, SO2, and NO2
   [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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