

Linear Constant Current VCM Driver



BU64241GWZ BU64243GWZ

●General Description

The BU64241GWZ and BU64243GWZ are designed to drive voice coil motor (VCM). The drivers include ISRC (intelligent slew rate control) to reduce mechanical ringing to optimize the camera's auto focus capabilities.

●Features

- 2.3 V min driver power supply
- Current sink output
- 10 bit resolution current control
- ISRC mechanical ringing compensation
- 2-wire serial interface
- Integrated current sense resistor

●Applications

- Autofocus in mobile camera modules
- Driving VCM actuators

●Key Specifications

- | | |
|--------------------------|---------------------|
| ■ Power supply range | 2.3 to 4.8 V |
| ■ Standby current | 0 μ A (typ.) |
| ■ Internal resistance | 1.5 Ω (typ.) |
| ■ Master clock | 400 kHz (typ.) |
| ■ Output maximum current | 130 mA (typ.) |

●Package

- | | |
|--------------|------------------------------|
| ■ BU64241GWZ | W (Typ.) xD (Typ.) xH (Max.) |
| UCSP30L1 | 1.30 mm x 0.77 mm x 0.33 mm |
| ■ BU64243GWZ | W (Typ.) xD (Typ.) xH (Max.) |
| UCSP35L1 | 0.77 mm x 1.30 mm x 0.40 mm |

●Typical Application Circuit

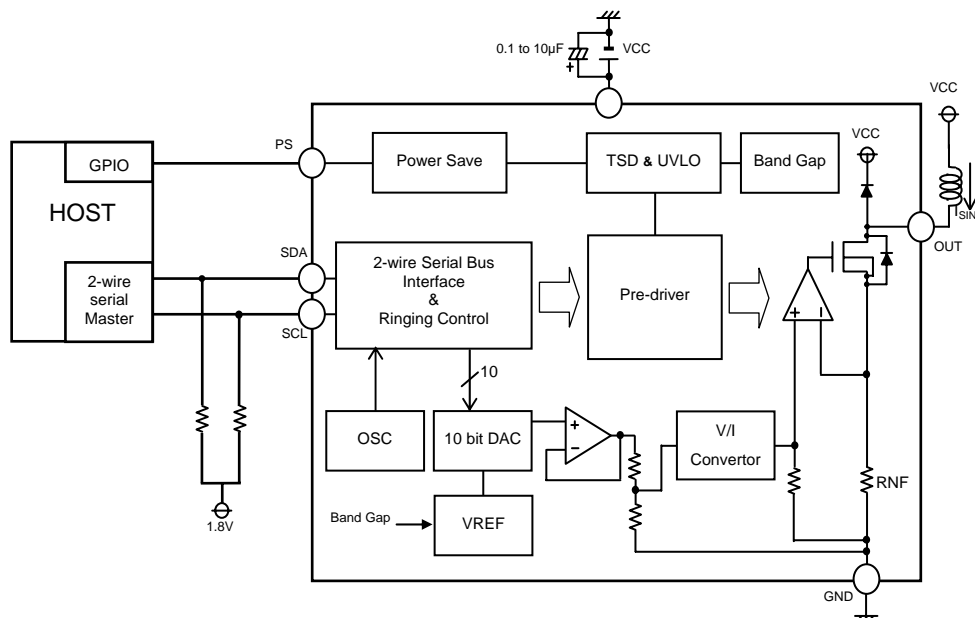


Figure 1. Typical Application Circuit

● Pin Configuration

| | | | |
|---|-----|-----|-----|
| | 1 | 2 | 3 |
| A | PS | SDA | SCL |
| B | OUT | GND | VCC |

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| | | |
|---|-----|-----|
| | 1 | 2 |
| A | OUT | PS |
| B | GND | SDA |
| C | VCC | SCL |

BU64243GWZ

Figure 2. Pin configuration (TOP VIEW)

● Pin Description

| Ball Name | Function |
|-----------|----------------------|
| PS | Power save |
| SDA | Serial data input |
| SCL | Serial clock input |
| OUT | Current output |
| GND | Ground |
| VCC | Power supply voltage |

● Block Diagram

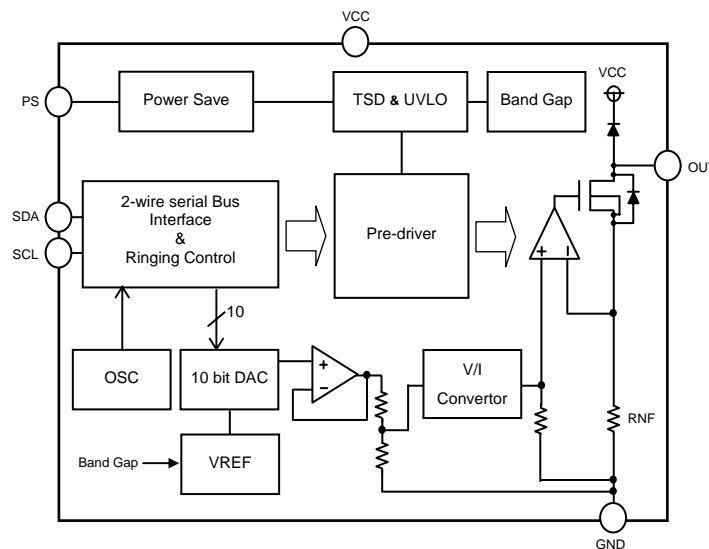


Figure 3. Block Diagram

● Absolute Maximum Ratings

| Parameter | Symbol | Limit | Unit |
|-------------------------------------|--------|---------------------------------------|------|
| Power supply voltage | VCC | - 0.5 to + 5.5 | V |
| Power save input voltage | VPS | - 0.5 to + 5.5 | V |
| Control input voltage ^{*1} | VIN | - 0.5 to + 5.5 | V |
| Power dissipation | Pd | 220 ^{*2} , 330 ^{*3} | mW |
| Operating temperature range | Topr | - 25 to + 85 | °C |
| Junction temperature | Tjmax | 125 | °C |
| Storage temperature range | Tstg | - 55 to + 125 | °C |
| Output current | IOUT | + 200 ^{*4} | mA |

^{*1} VIN is 2-wire serial interface input pins (SCL, SDA)

^{*2} UCSP30L1 package. Reduced by 2.2 mW/°C over 25 °C when mounted on a glass epoxy board (50 mm × 58 mm × 1.75 mm; 8 layers)

^{*3} UCSP35L1 package. Reduced by 3.3 mW/°C over 25 °C when mounted on a glass epoxy board (50 mm × 58 mm × 1.75 mm; 8 layers)

^{*4} Must not exceed Pd, ASO, or Tjmax of 125 °C

● Recommended Operating Ratings

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|-------------------------------------|--------|------|------|-------------------|------|
| Power supply voltage | VCC | 2.3 | 3.0 | 4.8 | V |
| Power save input voltage | VPS | 0 | - | 4.8 | V |
| Control input voltage ^{*1} | VIN | 0 | - | 4.8 | V |
| 2-wire serial interface frequency | FCLK | - | - | 400 | kHz |
| Output current | IOUT | - | - | 130 ^{*5} | mA |

^{*1} VIN is 2-wire serial interface input pins (SCL, SDA)

^{*5} Must not exceed Pd, ASO

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

| Parameter | Symbol | Limit | | | Unit | Conditions |
|--|--------|-------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Power Consumption | | | | | | |
| Standby current | ICCST | - | 0 | 5 | μA | Power save pin = L = VPSL |
| Circuit current | ICC | - | 0.6 | 1.0 | mA | Power save pin = H = VPSH 2-wire serial PS bit = 1, SCL = 400 kHz |
| Power Save Input (VPS = PS) | | | | | | |
| High level input voltage | VPSH | 1.26 | - | VCC | V | |
| Low level input voltage | VPSL | 0 | - | 0.5 | V | |
| High level input current | IPSH | - 10 | - | 10 | μA | VPS = 3 V |
| Low level input current | IPSL | - 10 | - | 10 | μA | VPS = 0 V |
| Control Input (VIN = SCL, SDA) | | | | | | |
| High level input voltage | VINH | 1.26 | - | VCC | V | |
| Low level input voltage | VINL | 0 | - | 0.5 | V | |
| Low level output voltage | VINOL | - | - | 0.4 | V | IIN = + 3.0 mA (SDA) |
| High level input current | IINH | - 10 | - | 10 | μA | Input voltage = 0.9 x VIN |
| Low level input current | IINL | - 10 | - | 10 | μA | Input voltage = 0.1 x VIN |
| Under Voltage Lock Out | | | | | | |
| UVLO voltage | VUVLO | 1.6 | - | 2.2 | V | |
| Master Clock | | | | | | |
| MCLK frequency | MCLK | - 5 | - | 5 | % | MCLK = 400 kHz |
| 10 Bit D/A Converter (for Controlling Output Current) | | | | | | |
| Resolution | DRES | - | 10 | - | bits | |
| Differential nonlinearity | DNL | - 1 | - | 1 | LSB | |
| Integral nonlinearity | INL | - 4 | - | 4 | LSB | |
| Output Current Performance | | | | | | |
| Output current resolution | IORES | - | 126 | - | μA | Per 1 DAC code step |
| Output maximum current | IOMAX | 117 | 130 | 143 | mA | DAC_code = 0x3FF |
| Zero code offset current | IOOFS | 0 | 1 | 5 | mA | DAC_code = 0x000 |
| Output voltage | VOUT | - | 150 | 200 | mV | Output current = 100 mA |
| Maximum applied voltage | VOMAX | - | - | VCC | V | |
| Output resistance | ROUT | - | 1.5 | 2.0 | Ω | |

● Typical Performance Curves

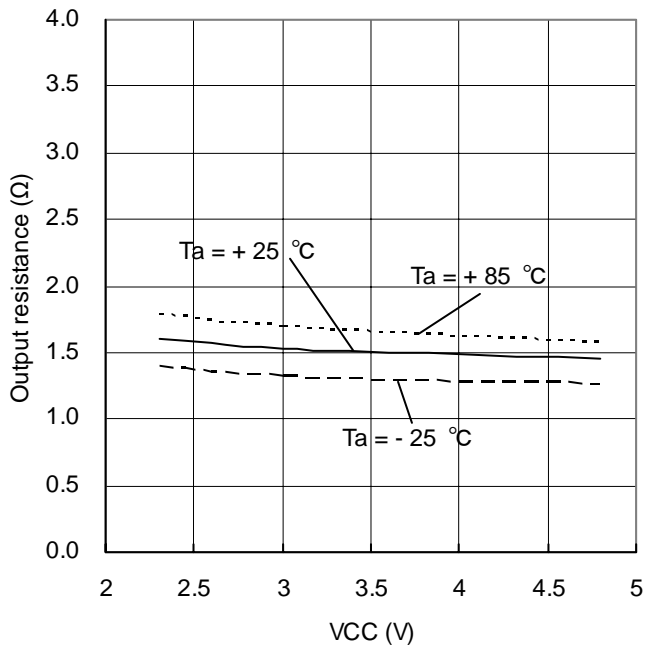


Figure 4. Output resistance

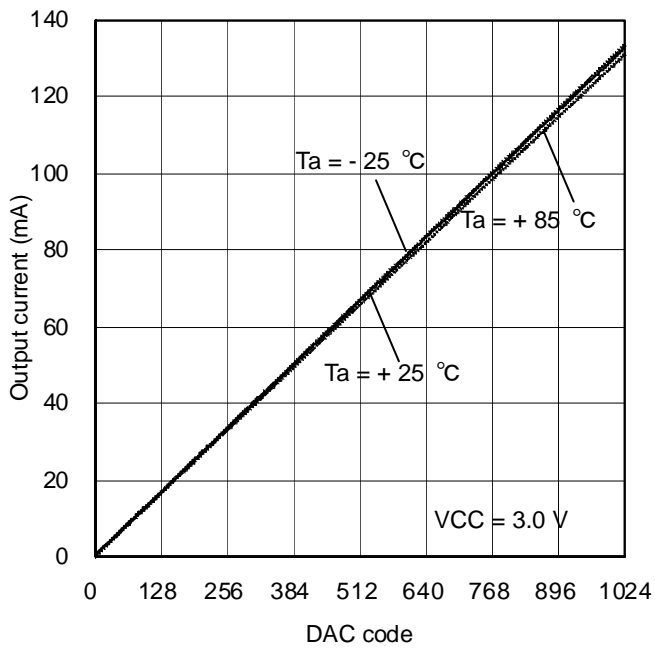


Figure 5. Output current vs. DAC code

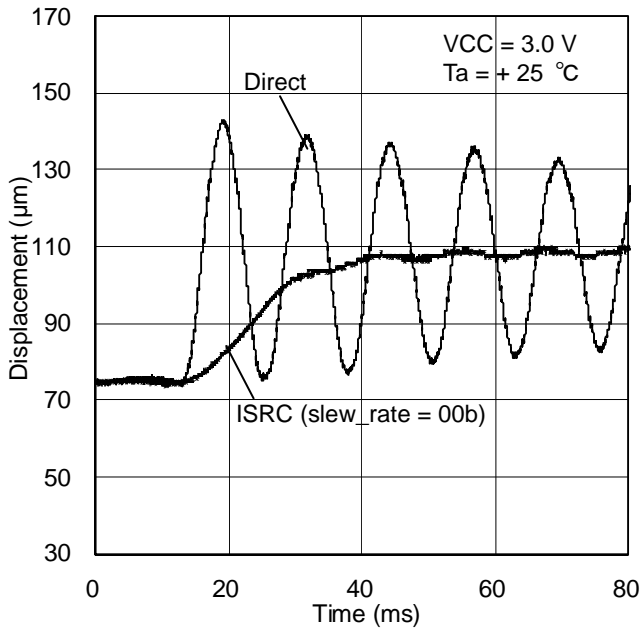


Figure 6. Displacement vs. settling time (slew_rate = 00b)

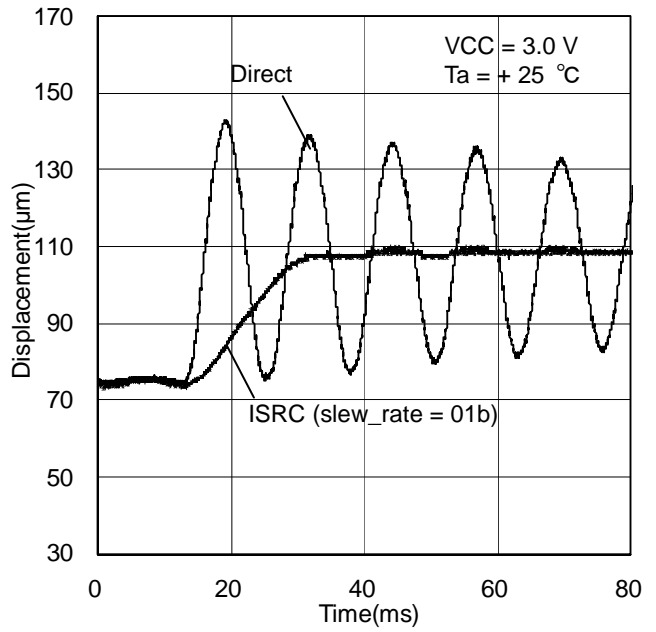


Figure 7. Displacement vs. settling time (slew_rate = 01b)

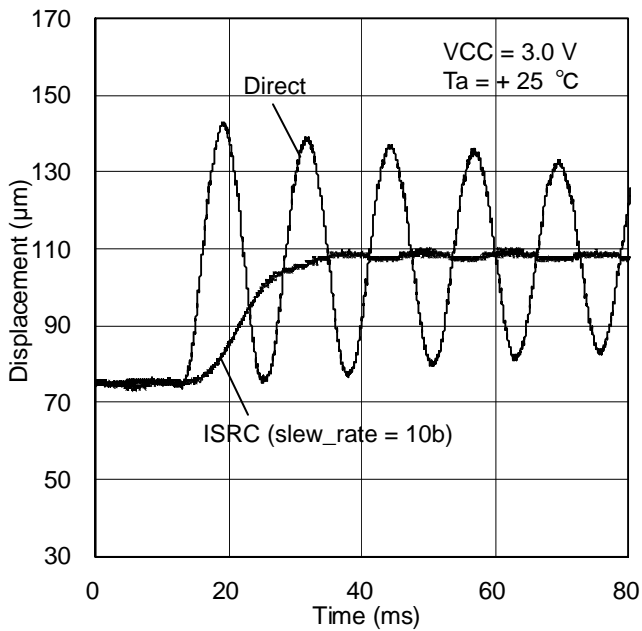


Figure 8. Displacement vs. settling time (slew_rate = 10b)

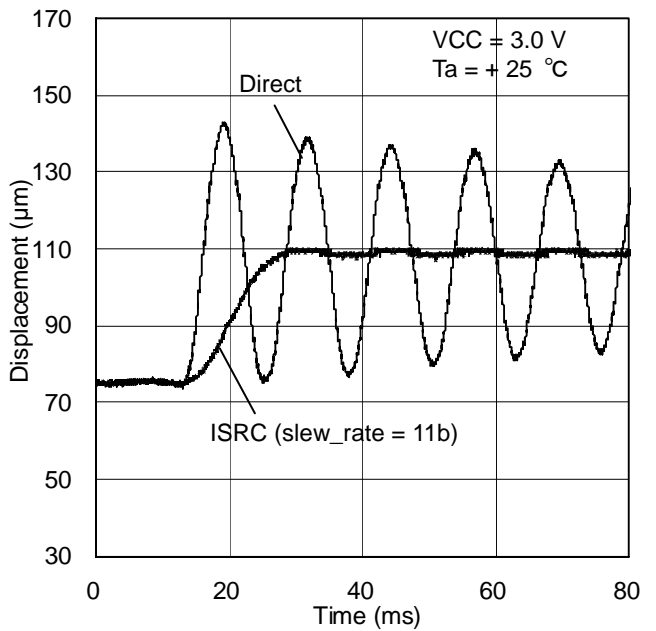


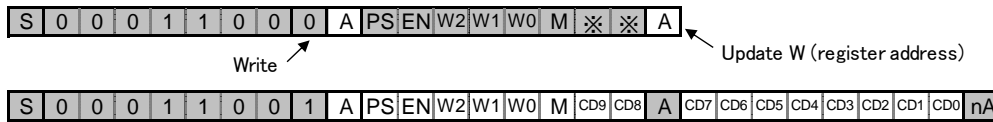
Figure 9. Displacement vs. settling time (slew_rate = 11b)

●2-wire serial BUS Format (Fast mode SCL = 400 kHz)

Write mode (R/W = 0) Output from Master Output from Slave



Read mode



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/sequence start |
| M | Mode select | M=0=ISRC mode disabled M=1=ISRC mode enabled |
| W2W1W0 | Register address | 000b = Output current setting |
| | | 001b = Parameter setting 1 |
| | | 010b = Parameter setting 2 |
| | | 011b = Parameter setting 3 |
| | | 100b = Parameter setting 4 |
| 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

Note: Setting the external power save pin = VPSL (typically 0 V) will reset all 2-wire serial registers to 0

●Register Map

| Address | Bit | Bit Name | Function |
|---------|--------|----------------|---------------------------------|
| 000b | D[9:0] | C_DAC[9:0] | Point C DAC code setting[9:0] |
| 001b | D[9:8] | | |
| | D[7:3] | rf[4:0] | Resonant frequency setting[4:0] |
| | D2 | | |
| | D[1:0] | slew_rate[1:0] | Slew rate speed setting[1:0] |
| 010b | D[9:0] | A_DAC[9:0] | Point A DAC code setting[9:0] |
| 011b | D[9:0] | B_DAC[9:0] | Point B DAC code setting[9:0] |
| 100b | D[9:8] | | |
| | D[7:5] | str[2:0] | Step resolution setting[2:0] |
| | D[4:0] | stt[4:0] | Step time setting[4:0] |

● Characteristics of the SDA and SCL Bus Lines for 2-wire Serial Interface (Ta = - 25 to +85 °C, VCC = 2.3 to 4.8 V)

| Parameter | Symbol | STANDARD-MODE ⁶ | | FAST-MODE ⁶ | | Unit |
|---|---------|----------------------------|------|------------------------|------|------|
| | | Min. | Max. | Min. | Max. | |
| Pulse width of spikes which must be suppressed by the input filter | tSP | 0 | 50 | 0 | 50 | ns |
| Hold time (repeated) start condition. The first clock pulse is generated after this period. | tHD;STA | 4.0 | - | 0.6 | - | μs |
| Low period of the SCL clock | tLOW | 4.7 | - | 1.3 | - | μs |
| High period of the SCL clock | tHIGH | 4.0 | - | 0.6 | - | μs |
| Set-up time for repeated START condition | tSU;STA | 4.7 | - | 0.6 | - | μs |
| Data hold time | tHD;DAT | 0 | 3.45 | 0 | 0.9 | μs |
| Data set-up time | tSU;DAT | 250 | - | 100 | - | ns |
| Set-up time for stop condition | tSU;STO | 4.0 | - | 0.6 | - | μs |
| Bus free time between a stop and start condition | tBUF | 4.7 | - | 1.3 | - | μs |

⁶ STANDARD-MODE and FAST-MODE 2-wire serial interface devices must be able to transmit or receive at the designated speed. The maximum bit transfer rates are 100 kbit/s for STANDARD-MODE devices and 400 kbit/s for FAST-MODE devices. This transfer rates is based on the maximum transfer rate. For example the bus is able to drive 100 kbit/s clocks with FAST-MODE.

● 2-wire Serial Interface Timing

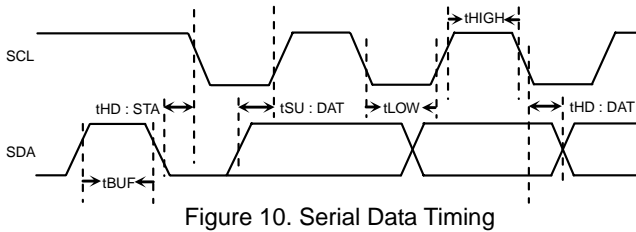


Figure 10. Serial Data Timing

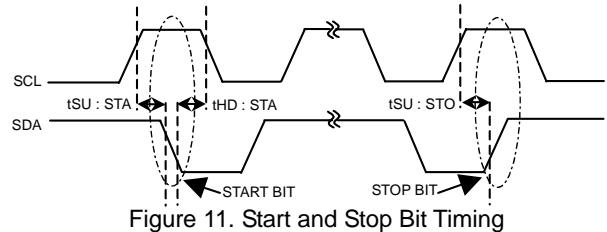


Figure 11. Start and Stop Bit Timing

● Initialization Sequence

| Item | Symbol | Min. | Typ. | Max. | Unit |
|--|--------|------|------|------|------|
| Setup time for external power save pin | tPS;r | 0 | - | - | μs |
| Hold time for external power save pin | tPS;f | 0 | - | - | μs |
| 2-wire serial data start time | ti2c;s | 15 | - | - | μs |
| 2-wire serial data stop time | ti2c;p | 1.3 | - | - | μs |

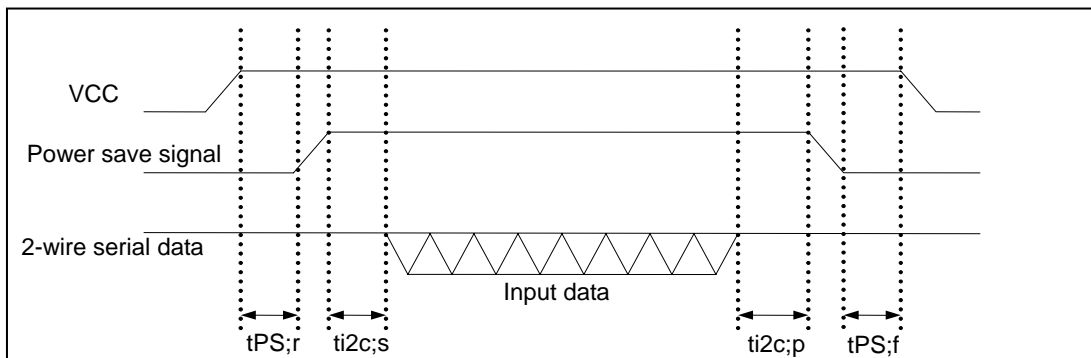


Figure 12. Timing Between Applying Power (VCC) Until Input of Serial Data

● Power Dissipation

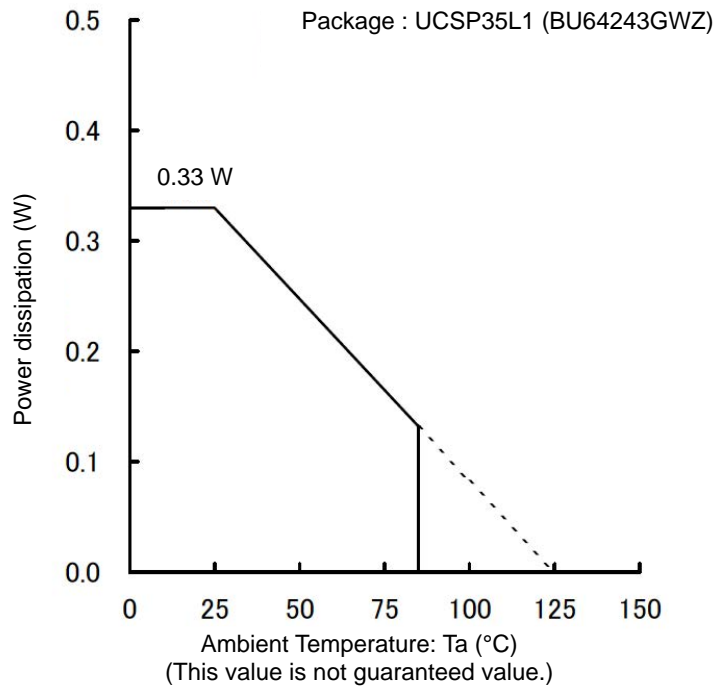
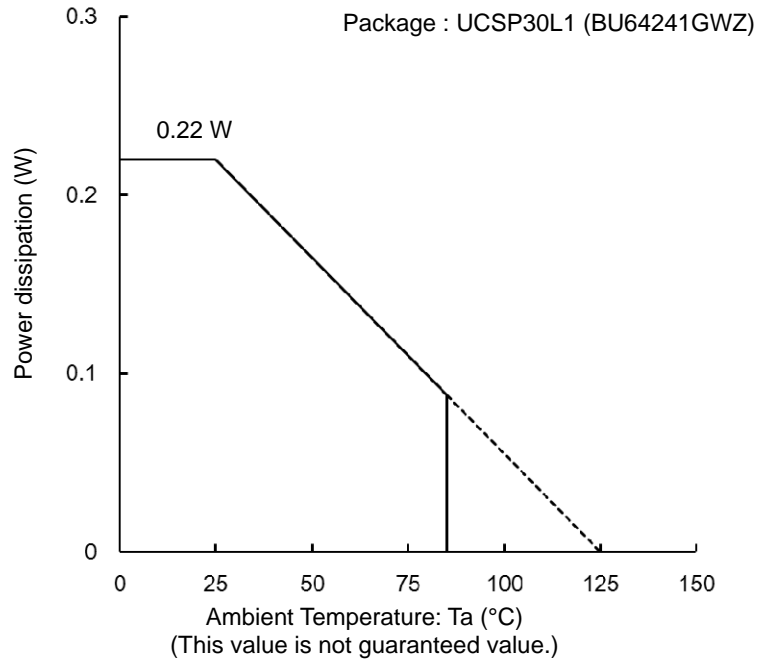
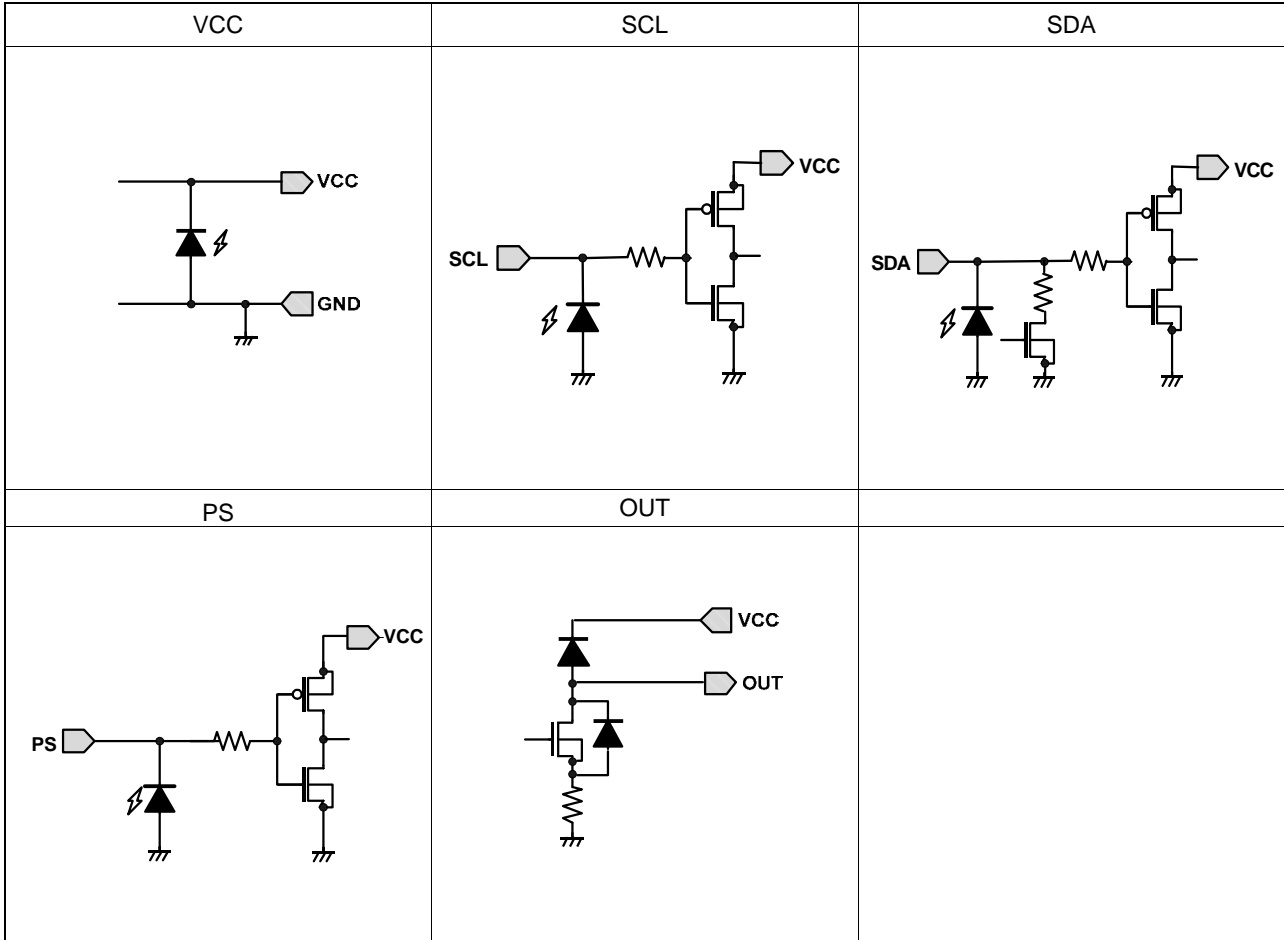


Figure 13. Power dissipation Pd (W)

● I/O equivalence circuit



●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 BU64241GWZ and BU64243GWZ lens drivers are 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 A1 – Determining the Resonant Frequency of the VCM

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 has 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 10 bit 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.

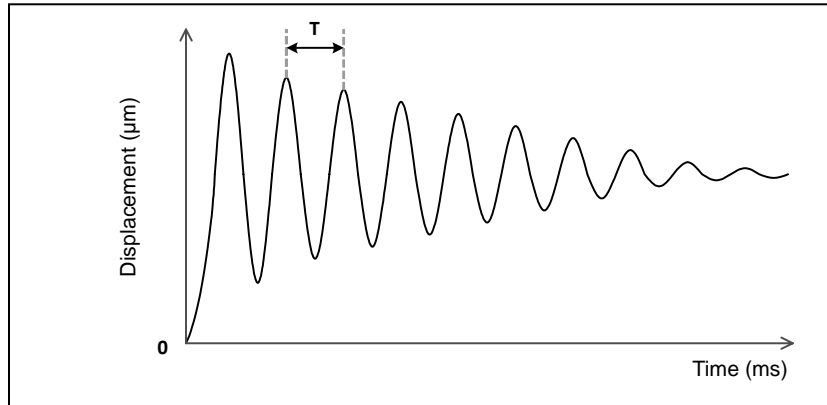


Figure 14. Actuator Displacement Waveform (ISRC Disabled)

The resonant frequency (Hz) of the actuator can be calculated with Equation 1 using the resonant period observed in Figure 14.

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

Equation1. Resonant Frequency vs. Time Period Relationship

After calculating the correct resonant frequency, program the closest value in the W2W1W0 = 001b register using the 5 bit rf[4:0] 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[4:0])

| rf[4:0] | f_0 | rf[4:0] | f_0 | rf[4:0] | f_0 | rf[4:0] | f_0 |
|---------|-------|---------|--------|---------|--------|---------|-------|
| 00000 | - | 01000 | 85 Hz | 10000 | 125 Hz | 11000 | - |
| 00001 | 50 Hz | 01001 | 90 Hz | 10001 | 130 Hz | 11001 | - |
| 00010 | 55 Hz | 01010 | 95 Hz | 10010 | 135 Hz | 11010 | - |
| 00011 | 60 Hz | 01011 | 100 Hz | 10011 | 140 Hz | 11011 | - |
| 00100 | 65 Hz | 01100 | 105 Hz | 10100 | 145 Hz | 11100 | - |
| 00101 | 70 Hz | 01101 | 110 Hz | 10101 | 150 Hz | 11101 | - |
| 00110 | 75 Hz | 01110 | 115 Hz | 10110 | - | 11110 | - |
| 00111 | 80 Hz | 01111 | 120 Hz | 10111 | - | 11111 | - |

• Step A2 – Selecting the Autofocus Algorithm's Target DAC Codes

The ISRC algorithm is a proprietary technology developed to limit the ringing of an actuator by predicting the magnitude of ringing created by an actuator and intelligently controlling the output signal of the driver to minimize the ringing effect. Due to the ringing control behavior of ISRC, it is unable to operate properly unless the lens is floating (lens lifted off of the mechanical end of the actuator). As such the ringing control behavior is broken into three separate operational areas in order to provide the most optimally controlled autofocus algorithm.

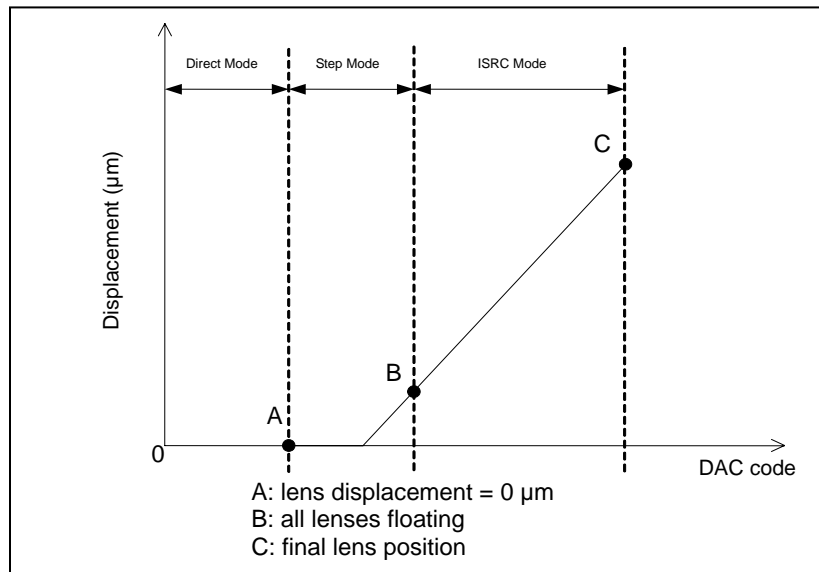


Figure 15. Lens Displacement vs. DAC Code

Figure 15 illustrates the different operational modes that control the autofocus algorithm. Due to ISRC requiring a floating lens, points A and B need to be set in order to create a floating condition. Point A corresponds to the maximum amount of current that can be applied to all VCM units without floating the lens. Point B corresponds to the minimum amount of current that can be applied to the VCM so that all actuator units are floating. It should be noted that the target DAC codes could vary between different actuator units and that sufficient evaluation should be performed before selecting the point A and B target DAC codes. Point C is the final lens target position determined by the level of focus required for the image capture.

The actuator manufacturer should be able to provide the required current for points A and B, however it is possible to test these points by slowly increasing the 10 bit value of C_DAC[9:0] and measuring the lens movement using a laser displacement meter or some other device to measure lens displacement.

●Controlling the Driver

After following steps A1 and A2 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 – Setting Point A, B, and C DAC Codes

Points A, B, and C are defined by 10 bit DAC codes set with the following registers:

| Location | W2W1W0 Register | DAC Code Location | Description |
|----------|-----------------|-------------------|---|
| Point C | 000b | C_DAC[9:0] | Final lens position before image capture |
| Point A | 010b | A_DAC[9:0] | Maximum output current without floating the lens |
| Point B | 011b | B_DAC[9:0] | Minimum output current required to float the lens |

• 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 10 bit 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 point C with direct mode, ringing and settling time will be at a maximum.

Direct mode is used either when M = 0 or when M = 1 and the present DAC code is less than the DAC code of point A.

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 point C when the EN bit is set equal to 1.

M = 1 = ISRC mode enabled

The driver automatically uses direct mode if the present DAC code is less than the target DAC code corresponding to point A. Therefore during ISRC operation when the autofocus sequence has been started by setting the EN bit equal to 1, the driver will automatically decide to use direct mode to output current up to point A and then switch to step mode before continuing the autofocus sequence.

• Step B3 – Controlling Step Mode

Step mode is the control period in which the lens is moved by small output current steps. During step mode it is possible to control the step resolution and step time in order to generate just enough output current to float the lens with minimal ringing effects. Ringing can be better controlled by choosing a large value for the step time and a small value for the step resolution with the trade off of a greater settling time. The step time and step resolution should be chosen depending on the acceptable system limits of ringing vs. settling time.

Step mode is used when $M = 1$ and the present DAC code is in between point A and point B. Typically this mode is only used during ISRC operation between point A and B, however it is possible to move the lens to point C using only step mode if point C is set such that point C is only 1 DAC code greater than point B.

Step mode is controlled by the 5 bit step time, $stt[4:0]$, and 3 bit step resolution, $str[2:0]$, values stored in register $W2W1W0 = 100b$.

Table 2. Step Time Settings

| $stt[4:0]$ | Step Time | $stt[4:0]$ | Step Time | $stt[4:0]$ | Step Time | $stt[4:0]$ | Step Time |
|------------|-------------|------------|-------------|------------|--------------|------------|--------------|
| 00000 | - | 01000 | 400 μs | 10000 | 800 μs | 11000 | 1200 μs |
| 00001 | 50 μs | 01001 | 450 μs | 10001 | 850 μs | 11001 | 1250 μs |
| 00010 | 100 μs | 01010 | 500 μs | 10010 | 900 μs | 11010 | 1300 μs |
| 00011 | 150 μs | 01011 | 550 μs | 10011 | 950 μs | 11011 | 1350 μs |
| 00100 | 200 μs | 01100 | 600 μs | 10100 | 1000 μs | 11100 | 1400 μs |
| 00101 | 250 μs | 01101 | 650 μs | 10101 | 1050 μs | 11101 | 1450 μs |
| 00110 | 300 μs | 01110 | 700 μs | 10110 | 1100 μs | 11110 | 1500 μs |
| 00111 | 350 μs | 01111 | 750 μs | 10111 | 1150 μs | 11111 | 1550 μs |

Table 3. Step Resolution Settings

| $str[2:0]$ | Step Resolution | $str[2:0]$ | Step Resolution | $str[2:0]$ | Step Resolution | $str[2:0]$ | Step Resolution |
|------------|-----------------|------------|-----------------|------------|-----------------|------------|-----------------|
| 000 | - | 010 | 2 LSB | 100 | 4 LSB | 110 | 6 LSB |
| 001 | 1 LSB | 011 | 3 LSB | 101 | 5 LSB | 111 | 7 LSB |

• Step B4 – Controlling ISRC Mode

ISRC mode is the control period in which the lens is already floating and the driver smoothly moves the lens based on the proprietary behavior of the ISRC algorithm. 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 $M = 1$ and the present DAC code is greater than the DAC code for point B. If the target DAC code for point C is set so that the value is too large and will cause excess ringing, the point C DAC code is automatically updated with a driver pre-determined value to minimize the ringing effect. When $M = 1$, the driver will automatically switch between direct mode, step mode, and ISRC mode when the point A, B, and C DAC code conditions are met. The condition for this automatic transitioning to occur is when the register values for point A, point B, point C, step time, and step resolution are all set to values other than 0 and then the sequence will start when the EN bit is set equal to 1.

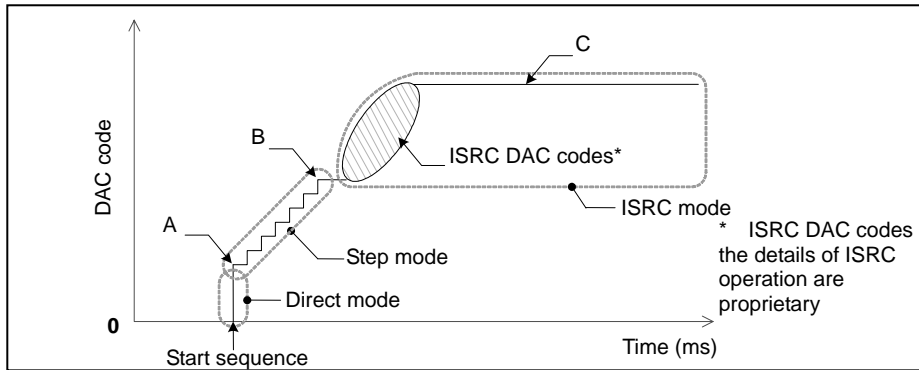


Figure 16. Three Modes Sequential Operation (Shown as DAC Codes)

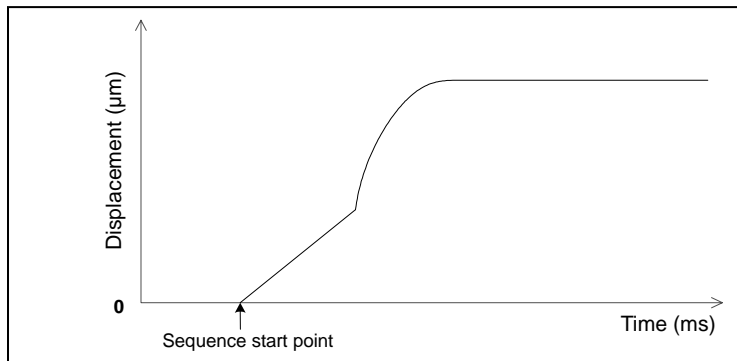


Figure 17. Three Modes Sequential Operation (Shown as Lens Displacement)

• Step B5 – Controlling the ISRC Settling Time

The settling time of an actuator is the time it takes for ringing to cease. The BU64241GWZ and BU64243GWZ are 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 2 bit `slew_rate[1:0]` value in register `W2W1W0 = 001b`. Figure 18 shows the relationship of displacement vs. settling time.

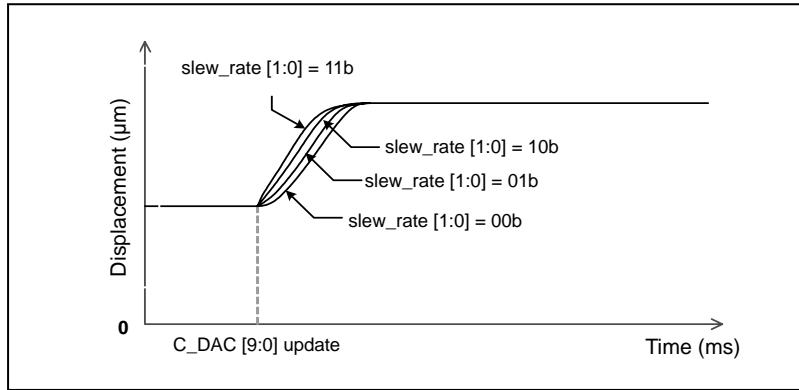


Figure 18. Displacement vs. Settling Time

Table 4. Slew Rate Speed Settings

| <code>slew_rate[1:0]</code> | Slew Rate Speed | <code>slew_rate[1:0]</code> | Slew Rate Speed | <code>slew_rate[1:0]</code> | Slew Rate Speed | <code>slew_rate[1:0]</code> | Slew Rate Speed |
|-----------------------------|-----------------|-----------------------------|-----------------|-----------------------------|-----------------|-----------------------------|-----------------|
| 00 | Slowest | 01 | Slow | 10 | Fast | 11 | Fastest |

• Step B6 – DAC Code Update Timing Considerations

Settling time is controlled by the resonant frequency of the actuator and the driver's slew rate speed setting. Depending on the combination of these parameters, the settling time can be such that updating point C with a new DAC code before the lens has settled at the original point C DAC code can adversely affect the settling time due to increased ringing effects. Utilize the slew rate speed parameter in order to modify the settling time so that any updates to the point C DAC code do not occur before the lens has settled.

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

Table 5. Relationship Between Slew Rate Speed and Settling Time Based on a 100 Hz Actuator

| f_0 | slew_rate[1:0] | Settling Time |
|--------|----------------|---------------|
| 100 Hz | 00 | 52 ms |
| | 01 | 42 ms |
| | 10 | 26 ms |
| | 11 | 18 ms |

In this example the settling time of the actuator can vary by up to $\pm 5\%$ due to the internal oscillator (MCLK) having a variance of $\pm 5\%$. The settling time has a proportionally inverse relationship to the resonant frequency and therefore the settling time can be estimated as:

Table 6. Relationship Between Slew Rate Speed and Settling Time Based on a General Resonant Frequency f_0'

| f_0' | slew_rate[1:0] | Settling Time |
|-----------|----------------|------------------------|
| f_0' Hz | 00 | $52 * (100 / f_0')$ ms |
| | 01 | $42 * (100 / f_0')$ ms |
| | 10 | $26 * (100 / f_0')$ 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 BU64241GWZ and BU64243GWZ can be set to enter power save mode either by setting the external power save pin = VPSL (typically 0 V) or by setting the 2-wire serial PS bit = 0. It is recommended to use the external power save pin method since this will disable the internal MCLK to achieve lower power consumption while in standby mode. Please note that setting the external power save pin = VPSL will reset all 2-wire serial registers to 0.

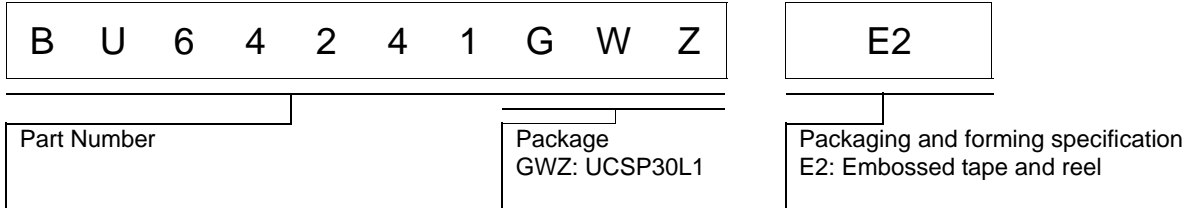
●Operational Notes

- (1) Absolute maximum ratings
Use of the IC in excess of absolute maximum ratings such as the applied voltage or operating temperature range (Topr) may result in IC damage. Assumptions should not be made regarding the state of the IC (short mode or open mode) when such damage is incurred. The implementation of a physical safety measure such as a fuse should be considered when there is use of the IC in a special mode where it's anticipated that the absolute maximum ratings may be exceeded.
- (2) Power supply lines
Regenerated current may flow as a result of the motor's back electromotive force. Insert capacitors between the power supply and ground pins to serve as a route for regenerated current. Determine the capacitance based on of all the characteristics of an electrolytic capacitor due to the electrolytic capacitor possibly losing some capacitance at low temperatures. If the connected power supply does not have sufficient current absorption capacity, regenerative current will cause the voltage on the power supply line to rise, which combined with the product and its peripheral circuitry may exceed the absolute maximum ratings. It is recommended to implement a physical safety measure such as the insertion of a voltage clamp diode between the power supply and GND pins.
- (3) Ground potential
Ensure a minimum GND pin potential in all operating conditions.
- (4) Heat dissipation
Use a thermal design that allows for a sufficient margin regarding the power dissipation (Pd) during actual operating conditions.
- (5) Use in strong magnetic fields
Use caution when using the IC in the presence of a strong magnetic field as doing so may cause the IC to malfunction.
- (6) ASO
When using the IC, set the output transistor for the motor so that it does not exceed absolute maximum ratings or ASO.
- (7) Thermal shutdown circuit
This IC incorporates a TSD (thermal shutdown) circuit. If the temperature of the chip reaches the below temperature, the motor coil output will be opened. The thermal shutdown circuit (TSD circuit) is designed only to shut off the IC to prevent runaway thermal operation. It is not designed to protect the IC or to guarantee its operation. Do not continue to use the IC after use of the TSD feature or use the IC in an environment where the its assumed that the TSD feature will be used.

| TSD ON temperature [°C] (Typ.) | Hysteresis temperature [°C] (Typ.) |
|-----------------------------------|---------------------------------------|
| 150 | 20 |

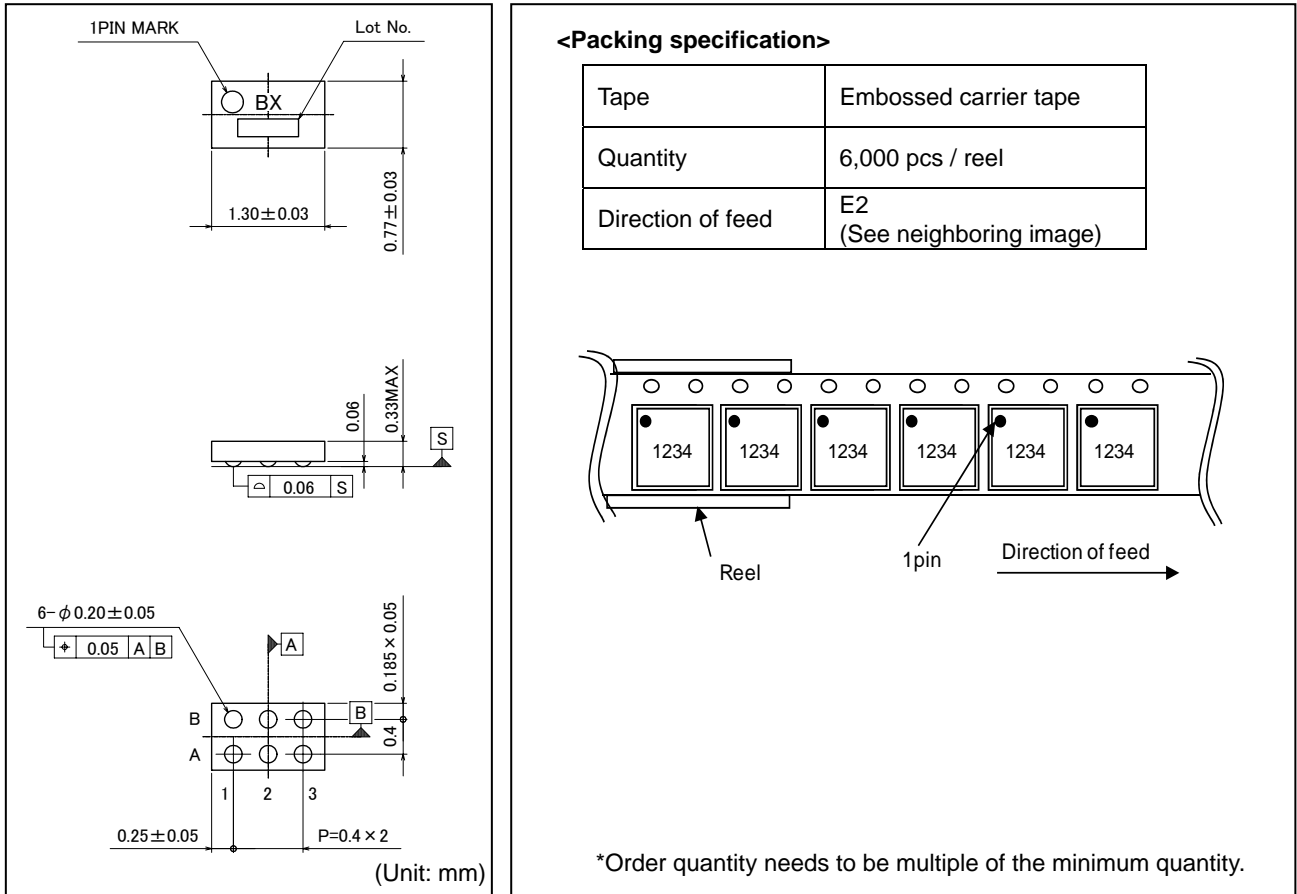
- (8) Ground Wiring Pattern
When using GND patterns for both small signal and large currents, it is recommended to isolate the two ground patterns by placing a single ground point at the application's reference point. This will help to alleviate noise in the small signal ground voltage due to noise created by the ground pattern wiring resistance for large current blocks. Be careful not to change the GND wiring pattern of any external components.
- (9) Power Save (PS) terminal
PS holds the reset function on logic concurrently. Please release PS after the start-up of VCC. Reset is not normally done when VCC is short-circuited to PS and it uses it, and there is a possibility of malfunctions.

●Ordering Part Number (BU64241GWZ)



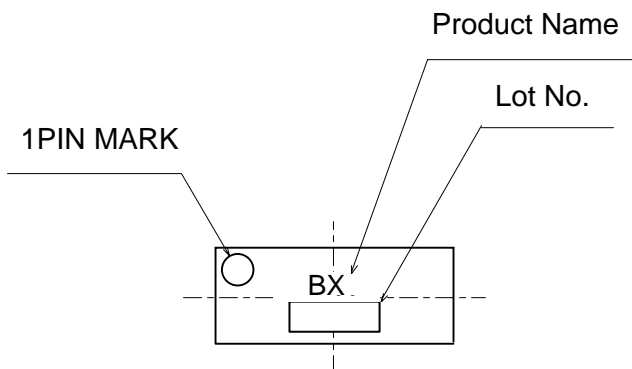
●Physical Dimension Tape and Reel Information (BU64241GWZ)

UCSP30L1 (BU64241GWZ)

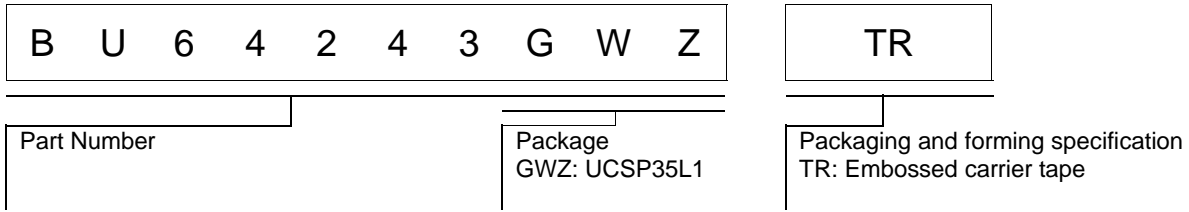


●Marking Diagram(TOP VIEW) (BU64241GWZ)

UCSP30L1 (BU64241GWZ)

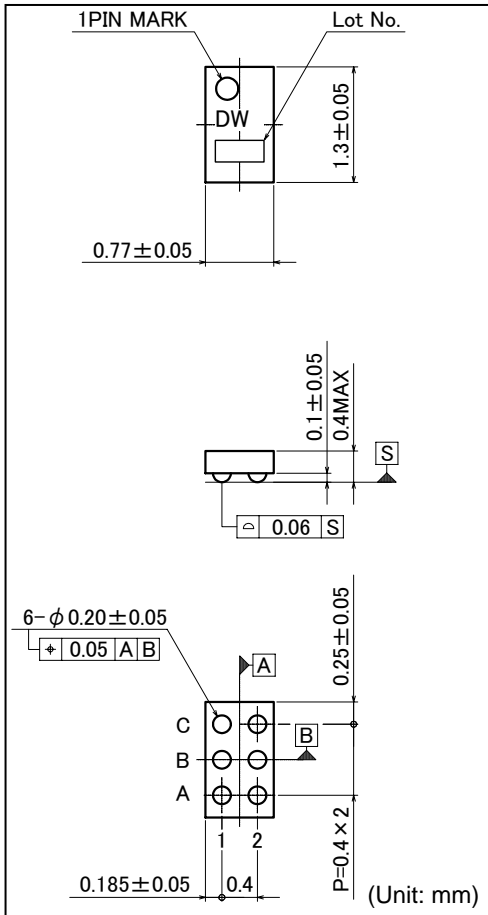


●Ordering Part Number (BU64243GWZ)



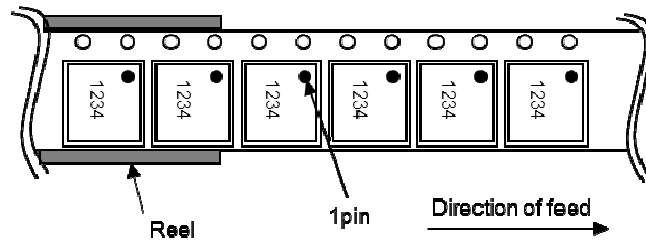
●Physical Dimension Tape and Reel Information (BU64243GWZ)

UCSP35L1 (BU64243GWZ)



<Packing specification>

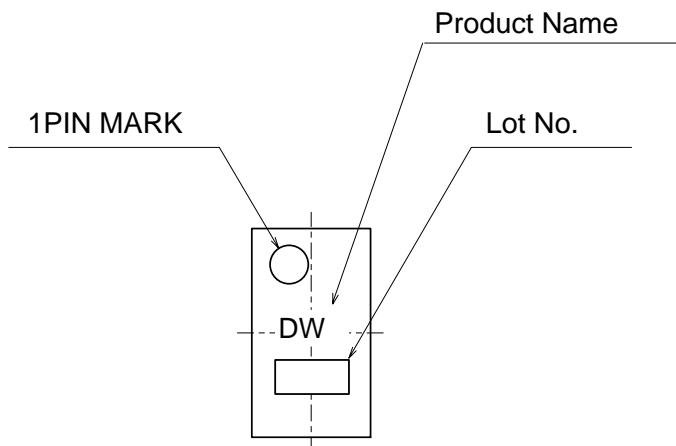
| | |
|-------------------|--|
| Tape | Embossed carrier tape |
| Quantity | 6,000 pcs / reel |
| Direction of feed | TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the right hand) |



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

●Marking Diagram(TOP VIEW) (BU64243GWZ)

UCSP35L1 (BU64243GWZ)



●Revision History

| Date | Revision | Changes |
|-------------|----------|--|
| 15.Oct.2012 | 001 | New Release |
| 11.Apr.2013 | 002 | Add information about "BU64243GWZ". |
| 31.May.2013 | 003 | Delete information about "BU64240GWZ". |

Notice

●General Precaution

- 1) Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.
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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 Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [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 (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient 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; if flow soldering method is preferred, 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**

QR code 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 our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

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