

System Lens Drivers

μ-step System Lens Driver for Digital Still Cameras

BU24036MWV

●General Description

BU24036MWV is a system Lens Driver that uses μ-step driving to make the configuration of the sophisticated, high precision and low noise lens driver system possible. This IC has a built-in driver for both DC motor and voice coil motor and a μ-step controller that decreases CPU power. Therefore, multifunctional lens can be applied.

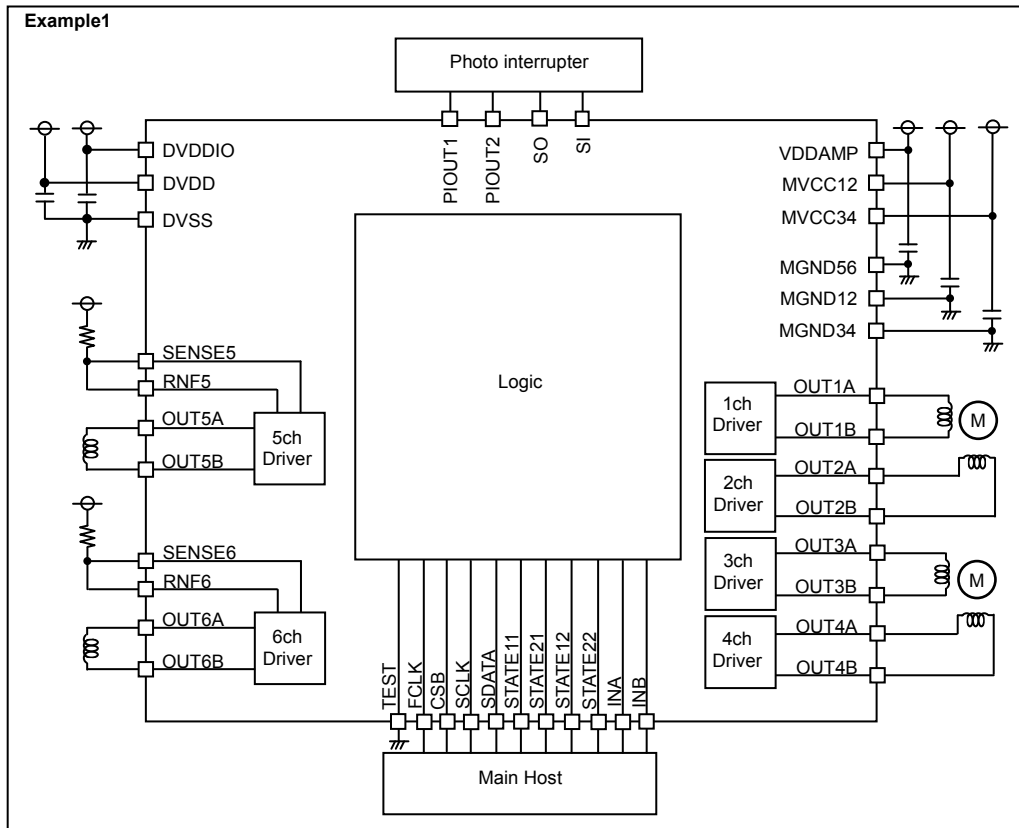
●Features

- Built-in 6 channels Driver block
1ch-4ch: Voltage control type H-bridge (Adaptable to STM 2systems)
5ch: Voltage / Current control type H-bridge
6ch: Current control type H-bridge
- Built-in 2 channels PI driving circuit
- Built-in 1 channels Waveforming circuit
- Built-in FLL digital servo circuit
- Built-in PLL circuit
- Built-in STM control circuit : Autonomous control (cache / updown mode), Clock IN control

●Applications

- Digital still cameras

●Typical Application Circuit



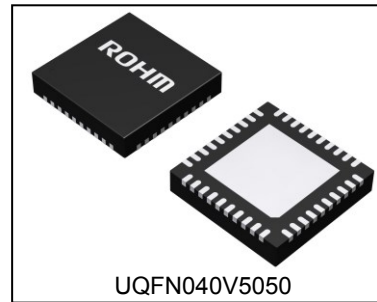
●Key Specifications

- I/O Power Supply Voltage: 1.62V to 3.6V
- Digital Power Supply Voltage: 2.7V to 3.6V
- Driver Power Supply Voltage: 2.7V to 5.5V
- Output Current (1ch,2ch,6ch): ±500mA(Max)
- Output Current (5ch): ±600mA(Max)
- Input Clock Frequency: 1MHz to 28MHz
- FET ON Resistance (1ch,2ch): 2.0Ω (Typ)
- FET ON Resistance (3ch,4ch): 1.5Ω (Typ)
- FET ON Resistance (5ch,6ch): 1.0Ω (Typ)
- Operating Temperature Range: -20°C to +85°C

●Package

UQFN040V5050

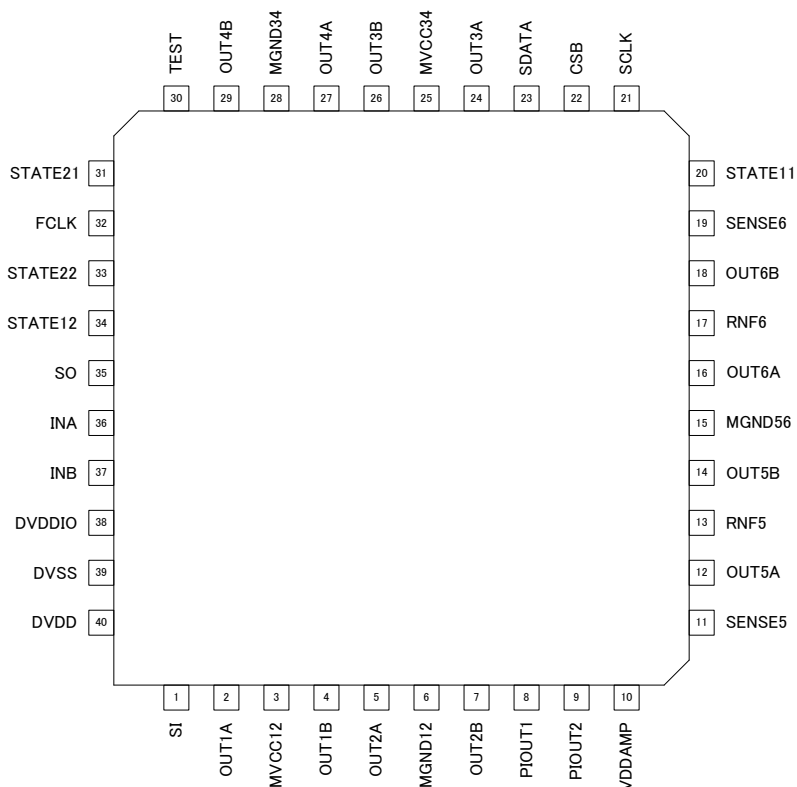
5.00mm x 5.00mm x 1.00mm



○Product structure : Silicon monolithic integrated circuit ○This product is not designed for protection against radioactive rays

● Pin Configuration

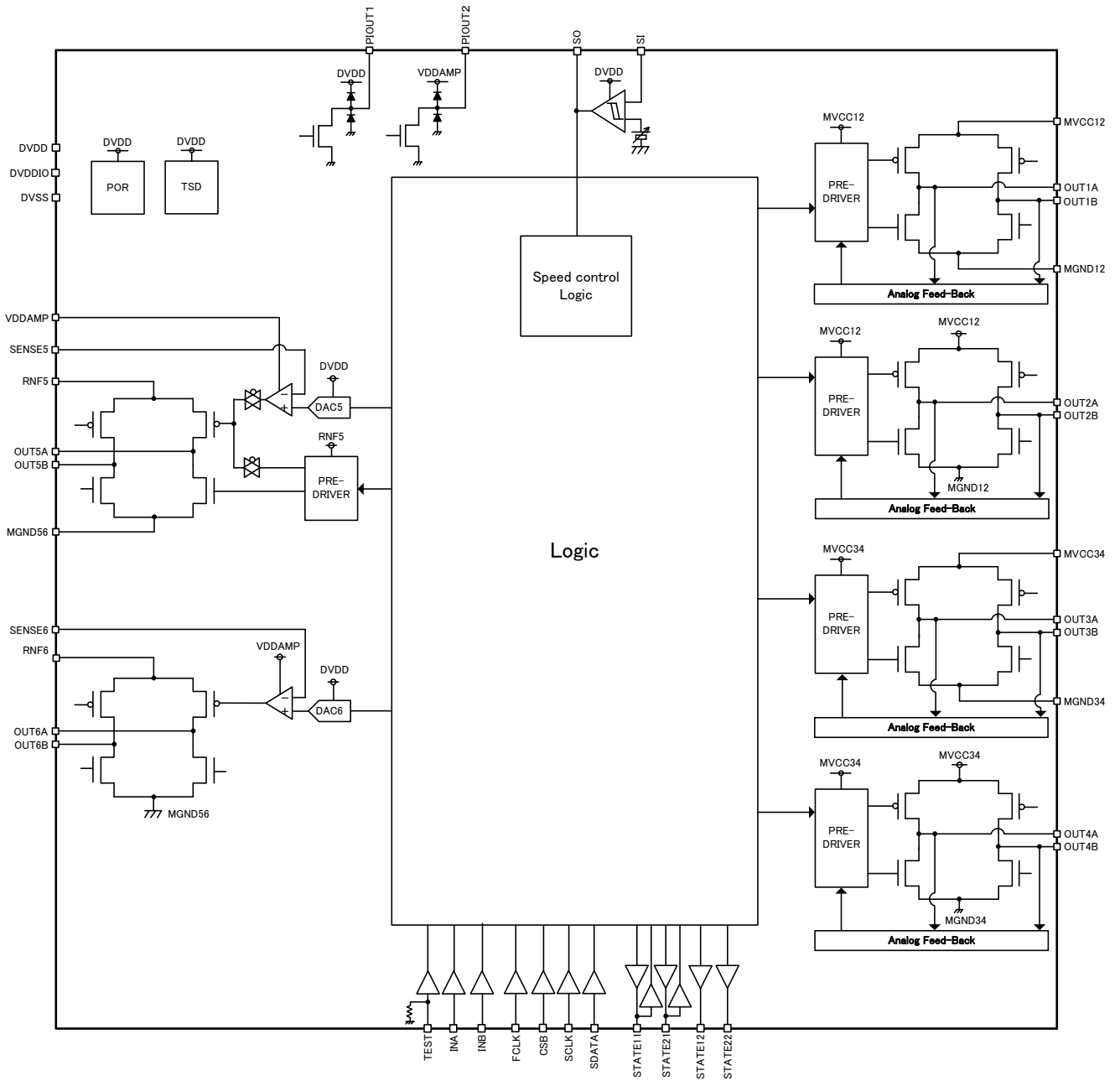
(Top view)



● Pin Description

No.	Pin Name	Power Supply	Function	No.	Pin Name	Power Supply	Function
1	SI	DVDD	Waveforming input	21	SCLK	DVDDIO	SCLK logic input
2	OUT1A	MVCC12	1ch Driver A output	22	CSB	DVDDIO	CSB logic input
3	MVCC12	-	1ch, 2ch Driver power supply	23	SDATA	DVDDIO	SDATA logic input
4	OUT1B	MVCC12	1ch Driver B output	24	OUT3A	MVCC34	3ch Driver A output
5	OUT2A	MVCC12	2ch Driver A output	25	MVCC34	-	3ch, 4ch Driver power supply
6	MGND12	-	1ch, 2ch Driver ground	26	OUT3B	MVCC34	3ch Driver B output
7	OUT2B	MVCC12	2ch Driver B output	27	OUT4A	MVCC34	4ch Driver A output
8	PIOUT1	DVDD	PI driving output 1	28	MGND34	-	3ch, 4ch Driver ground
9	PIOUT2	VDDAMP	PI driving output 2	29	OUT4B	MVCC34	4ch Driver B output
10	VDDAMP	-	5ch, 6ch Power supply of current driver control	30	TEST	DVDDIO	TEST logic input
11	SENSE5	VDDAMP	Negative input for 5ch current driver	31	STATE21	DVDDIO	STATE21 logic input/output
12	OUT5A	RNF5	5ch Driver A output	32	FCLK	DVDDIO	FCLK logic input
13	RNF5	-	5ch Driver power supply	33	STATE22	DVDDIO	STATE22 logic output
14	OUT5B	RNF5	5ch Driver B output	34	STATE12	DVDDIO	STATE12 logic output
15	MGND56	-	5ch,6ch Driver ground	35	SO	DVDDIO	Waveforming output
16	OUT6A	RNF6	6ch Driver A output	36	INA	DVDDIO	INA logic input
17	RNF6	-	6ch Driver power supply	37	INB	DVDDIO	INB logic input
18	OUT6B	RNF6	6ch Driver B output	38	DVDDIO	-	I/O power supply
19	SENSE6	VDDAMP	Negative input for 6ch current driver	39	DVSS	-	ground
20	STATE11	DVDDIO	STATE11 logic input/output	40	DVDD	-	Digital power supply

●Block Diagram



●Description of Blocks

Stepping Motor Driver (1ch-4ch Driver)

- Built-in stepping motor driver of PWM driving type.
- Maximum 2 stepping motors can be driven independently.
- Built-in voltage feedback circuit of D-class type.
- 3ch/4ch drivers can also drive independently for DC motor or voice coil motor.

(1) Control

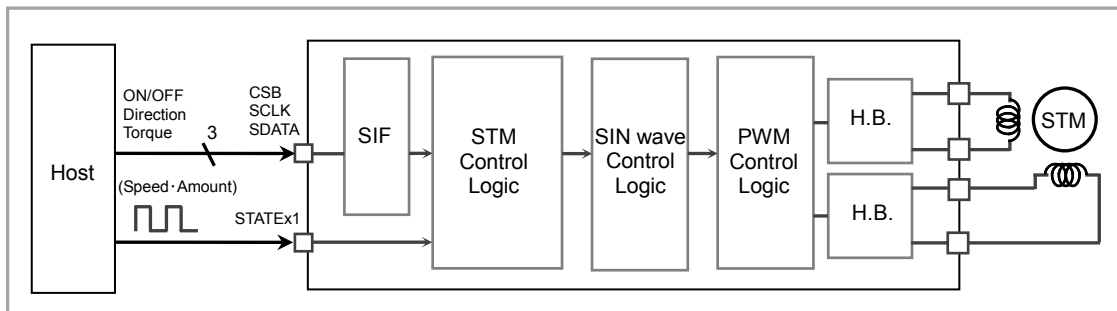
It corresponds to both the Clock IN and the Autonomous control.

(i)Clock IN Control

Set the registers for the stepping motor control.

The stepping motor is rotated and synchronized with the input clock in the STATE pin.

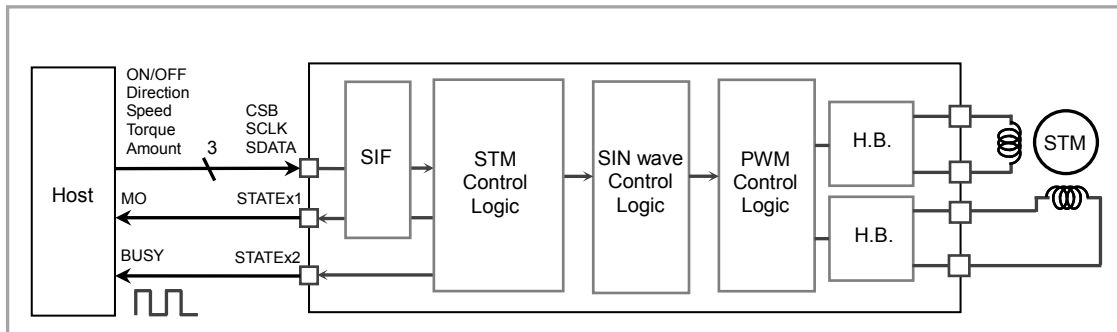
It is possible to select the mode of stepping motor control from μ -step, 1-2 phase excitation, 2 phase excitation and the number of edge for electrical angle cycle from 4, 8, 32, 64, 128, 256, 512 or 1024.



(ii)Autonomous Control

The stepping motor is rotated by setting the registers for the stepping motor control.

It is possible to select the mode of stepping motor control from μ -step (1024 portion), 1-2 phase excitation and 2 phase excitation.



Cache Method

Built-in Cache registers.

Cache registers enable the setting of subsequent process while the motor is in operation. Through these registers, operations are done continuously.

The state of rotation command (ACT), state of Cache registers (BUSY), motor operation position (MO), and state of excitation (MO&EN) are synchronized with the motor rotation and can be selected to be the output of the STATE pin.

Up Down Method

It is possible to set Up, Constant and Down operation before the motor operates.

The state of rotation command (ACT), Cache register (BUSY), motor position (MO), and excitation (MO&EN) synchronized with the motor rotation are the output of the STATE pin.

●Description of Blocks

Voltage / Current Driver (5ch Driver)

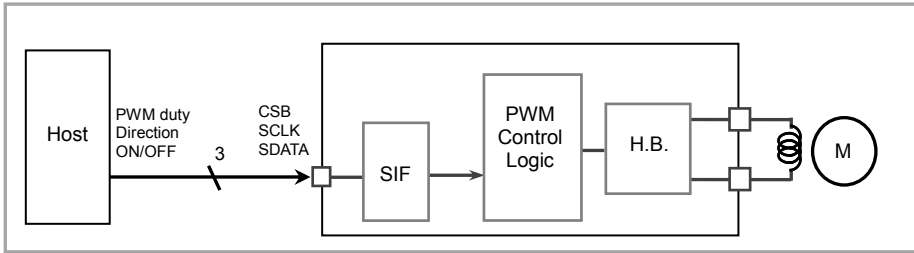
Built-in voltage driver of PWM driving type / constant current driver.
 Built-in digital FLL speed control logic for voltage driver.

(1) Control

(i)Register Control

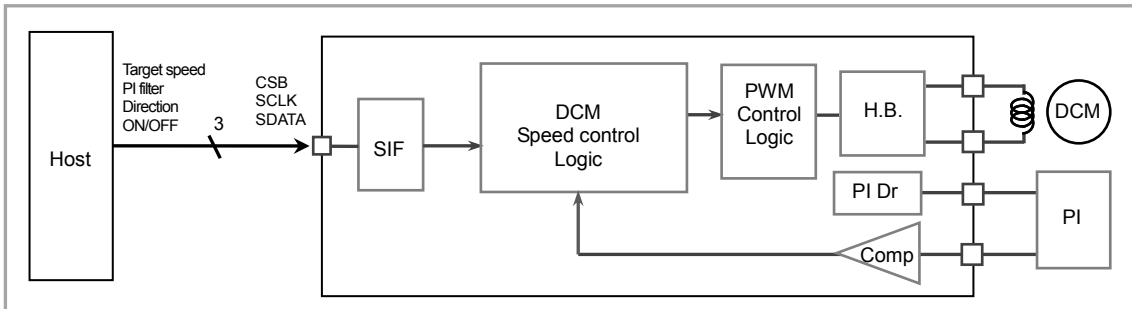
■Voltage Driver (at speed control = OFF)

The PWM drive is executed by the PWM duty ratio, the PWM direction and the PWM ON/OFF which are controlled by the register settings.



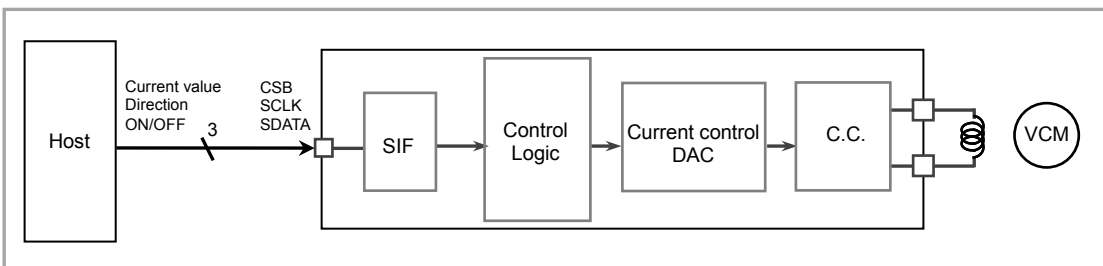
■Voltage Driver (at speed control = ON)

The speed control drive is executed by the target speed value, the direction, the coefficient value of PI filter and the turning ON/OFF which are controlled by the register settings.
 The motor speed is adjusted by comparing the target speed with the motor speed detected at the signal of photo-interrupter.



■Current Driver

The constant current drive is executed by the output current value, the current direction and the current ON/OFF which are controlled by the register settings.

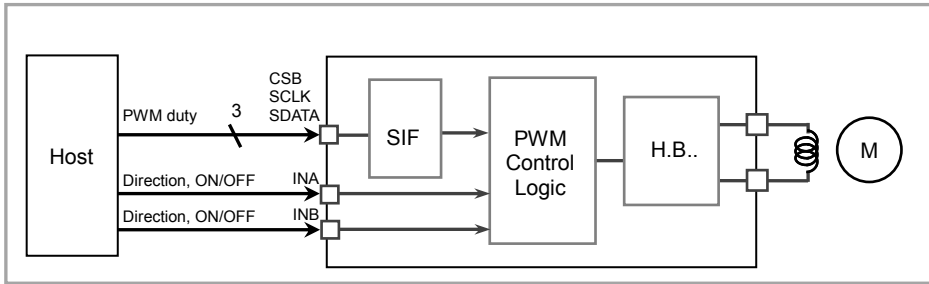


●Description of Blocks

(ii)External Pin Control

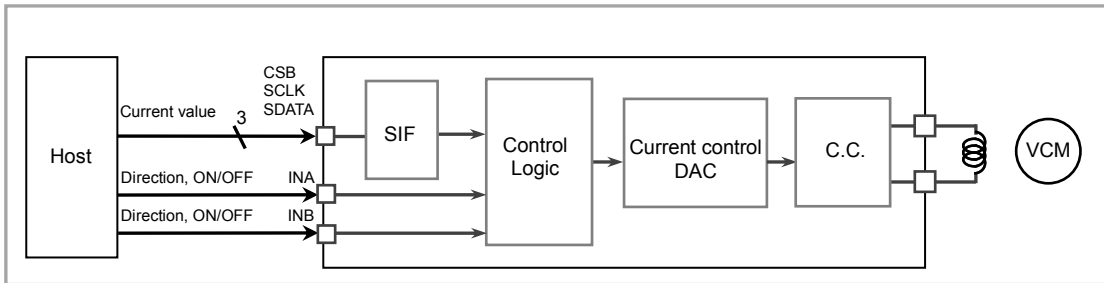
■Voltage Driver (only at speed control = OFF)

The PWM drive is executed by the PWM duty ratio which is controlled by the register setting. The PWM direction and PWM ON/OFF are controlled by INA/INB pin.



■Current Driver

The constant current drive is executed by the output current value which is controlled by the register setting. Constant current driving direction and turning ON/OFF are controlled by INA/INB pin.



●Description of Blocks

Current Driver (6ch Driver)

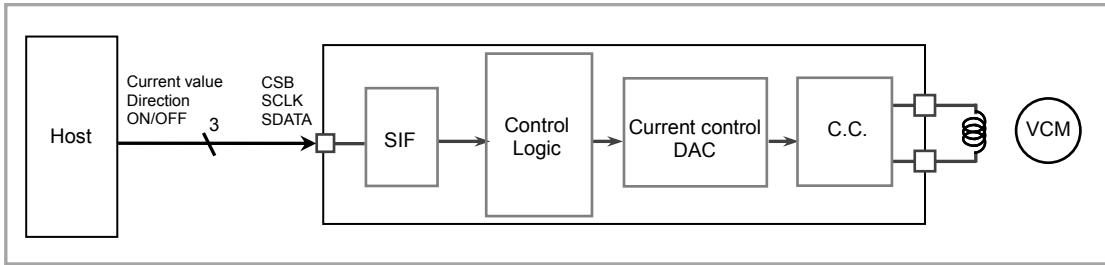
Built-in constant current driver.

The voltage of RNF pin and the external resistor (RRNF) determine the amount of output current. The internal high-precision amplifier (CMOS gate input) is used for the constant current control. If any resistance component exists in the wirings of RNF pin and the external resistor (RRNF), the precision can be reduced. To avoid this, pay utmost attention to the wirings.

(1) Control

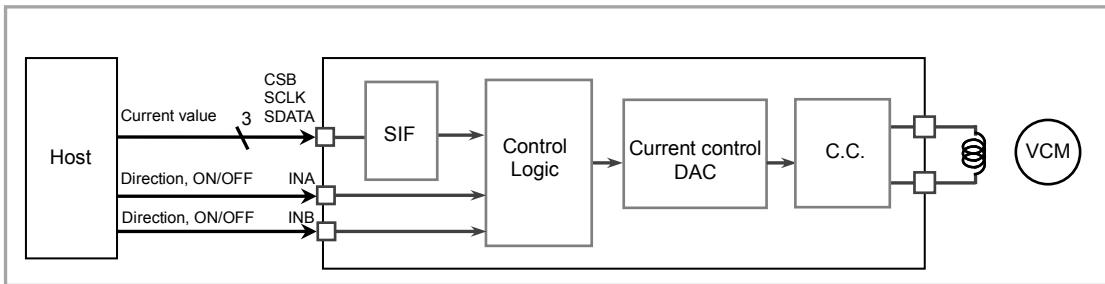
(i)Register Control

The constant current drive is executed by the output current value, the current direction and the current ON/OFF which are controlled by the register settings.



(ii)External Pin Control

The constant current drive is executed by the output current value which is controlled by the register setting. Constant current driving direction and turning ON/OFF are controlled by INA/INB pin.



● Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Limit	Unit	Remark
Power Supply Voltage	DVDDIO DVDD	-0.3 to +4.5	V	
	MVCC	-0.3 to +7.0	V	MVCC12, MVCC34, VDDAMP
Input Voltage	VIN	-0.3 to supply voltage+0.3	V	
Input / Output Current *1	IIN	±500	mA	MVCC12, MVCC34, RNF6
		±600	mA	RNF5
		+50	mA	PIOUT1
		+150	mA	PIOUT2
Storage Temperature Range	TSTG	-55 to +125	°C	
Operating Temperature Range	TOPE	-20 to +85	°C	
Permissible Dissipation *2	PD	2600	mW	

*1 Must not exceed PD.

*2 To use at a temperature higher than Ta=25 °C, derate 26mW per 1 °C
(At mounting 74.2mm x 74.2mm x 1.6mm / 4 layer Board)

● Recommended Operating Rating (Ta=25°C)

Parameter	Symbol	Limit	Unit	Remark
I/O Power Supply	DVDDIO	1.62 to 3.6	V	
Digital Power Supply Voltage	DVDD	2.7 to 3.6	V	DVDD ≤ MVCC
Driver Power Supply Voltage	MVCC	2.7 to 5.5	V	MVCC12, MVCC34, RNF5 RNF6, VDDAMP
Clock Operating Frequency	FCLK	1 to 28	MHz	Reference clock

●Electrical Characteristics

(Unless otherwise specified, Ta=25°C, DVDDIO=DVDD=3.0V, MVCC=5.0V, DVSS=MGND=0.0V)

Parameter	Symbol	Limit			Unit	Conditions	
		MIN	TYP	MAX			
<Current Consumption>							
Quiescence	(DVDDIO)	ISSDO	-	0	10	μ A	CMD_RS=0
	(DVDD)	ISSD	-	50	95	μ A	
	(MVCC)	ISSM	-	0	10	μ A	
Operation	(DVDDIO)	IDDDO	-	0.1	1	mA	CMD_RS=STB=CLK_EN=1 FCLK=24MHz CLK_DIV setting : 0h No load
	(DVDD)	IDDD	-	6	10	mA	
<Logic Block>							
Low-level Input Voltage	VIL	DVSS	-	0.3DVDDIO		V	
High-level Input Voltage	VIH	0.7DVDDIO	-	DVDDIO		V	
Low-level Input Current	IIL	0	-	10		μ A	VIL=DVSS
High-level Input Current	IIH	0	-	10		μ A	VIH=DVDDIO
Low-level Output Voltage	VOL	DVSS	-	0.2DVDDIO		V	IOL=1.0mA
High-level Output Voltage	VOH	0.8DVDDIO	-	DVDDIO		V	IOH=1.0mA
<PI Driving Circuit>							
Output Voltage	PIVO	-	0.15	0.5		V	IIH=30mA
<Waveforming Circuit>							
Detective Voltage Error	Vth	1.4	1.5	1.6		V	Vth setting : 20h
<Voltage Driver Block 1ch-4ch>							
ON-resistance	Ron	-	2.0	2.5		Ω	IO=±100mA (the sum of high and low sides, 1ch, 2ch driver)
		-	1.5	2.0		Ω	IO=±100mA (the sum of high and low sides, 3ch, 4ch driver)
OFF-leak Current	IOZ	-10	0	+10		μ A	Output HiZ setting
Average Voltage Accuracy between different Output Pins	Vdiff	-5	-	+5		%	Vdiff setting : 2Bh
<Voltage/Current Driver Block 5ch>							
ON-resistance	Ron	-	1.0	1.5		Ω	IO=±100mA (the sum of high and low sides)
OFF-leak Current	IOZ	-10	0	+10		μ A	Output HiZ setting
Output Current	IO	190	200	210		mA	At current driver mode DAC setting : 80h RRNF=1 Ω
<Current Driver Block 6ch>							
ON-resistance	Ron	-	1.0	1.5		Ω	IO=±100mA (the sum of high and low sides)
OFF-leak Current	IOZ	-10	0	+10		μ A	Output HiZ setting
Output Current	IO	190	200	210		mA	DAC setting : 80h RRNF=1 Ω

● Typical Performance Curves

(Unless otherwise specified, $T_a=25^\circ\text{C}$, $DVDDIO=DVDD=3.0\text{V}$, $MVCC=5.0\text{V}$, $DVSS=MGND=0.0\text{V}$)

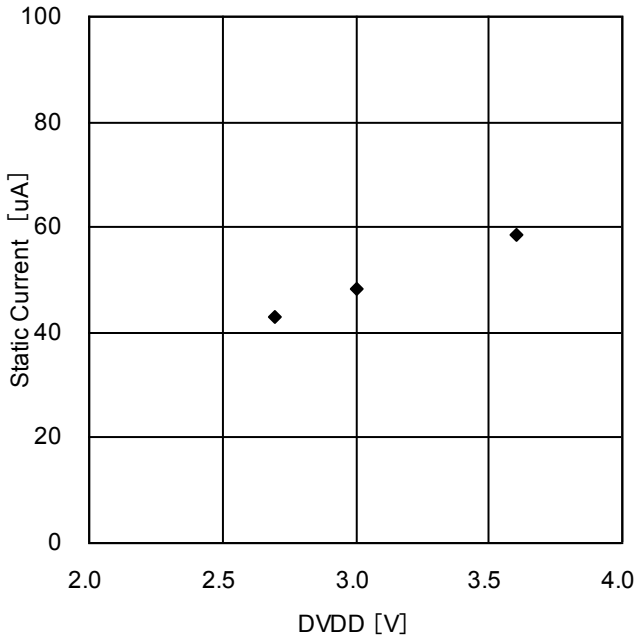


Figure 1. DVDD Static Current Voltage Dependency

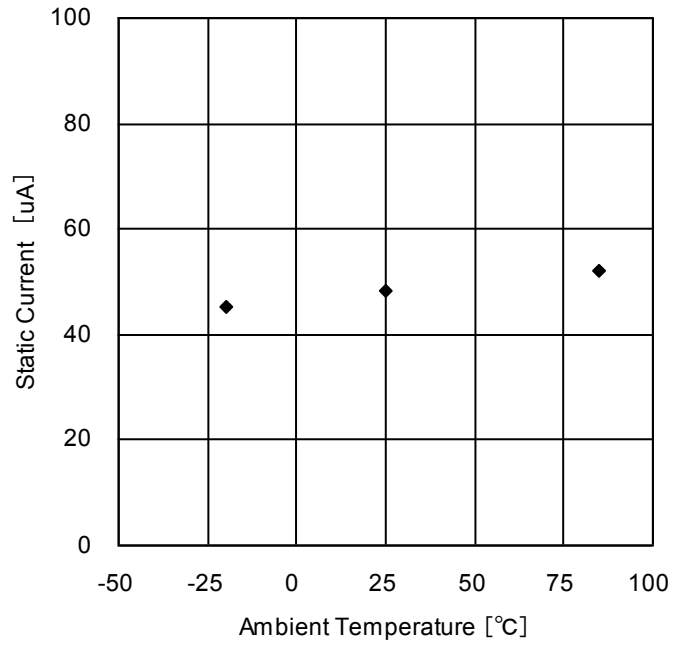


Figure 2. DVDD Static Current Temperature Dependency

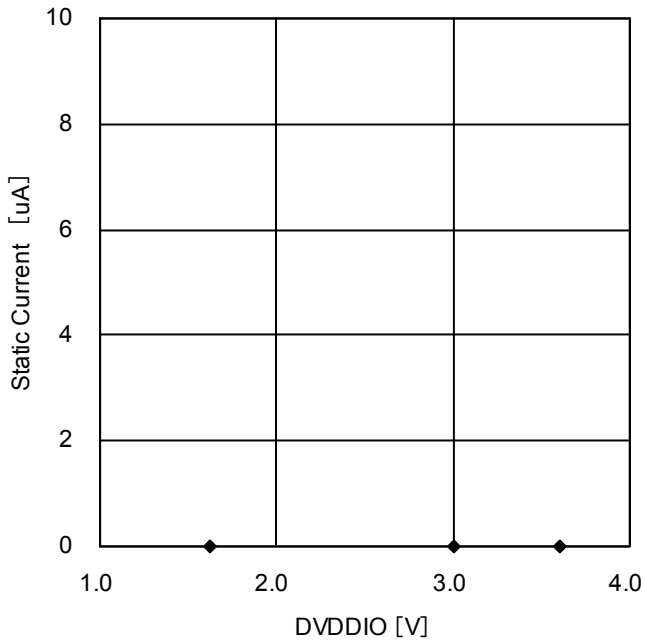


Figure 3. DVDDIO Static Current Voltage Dependency

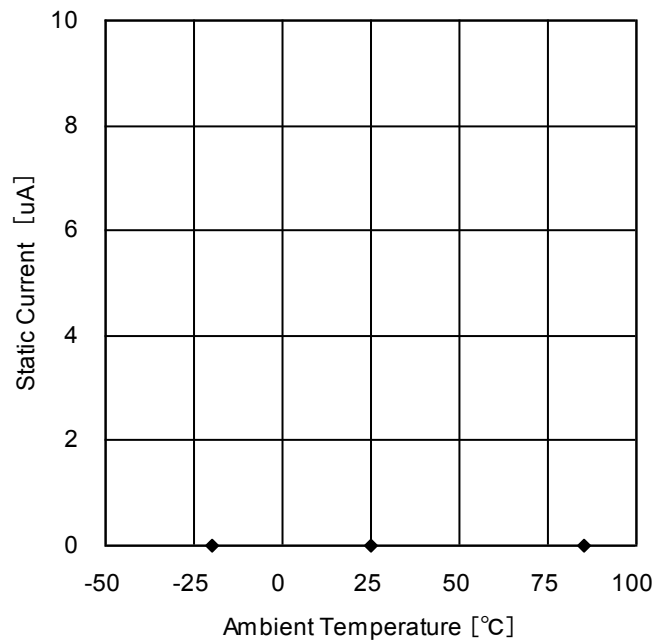


Figure 4. DVDDIO Static Current Temperature Dependency

● Typical Performance Curves

(Unless otherwise specified, $T_a=25^{\circ}\text{C}$, $\text{DVDDIO}=\text{DVDD}=3.0\text{V}$, $\text{MVCC}=5.0\text{V}$, $\text{DVSS}=\text{MGND}=0.0\text{V}$)

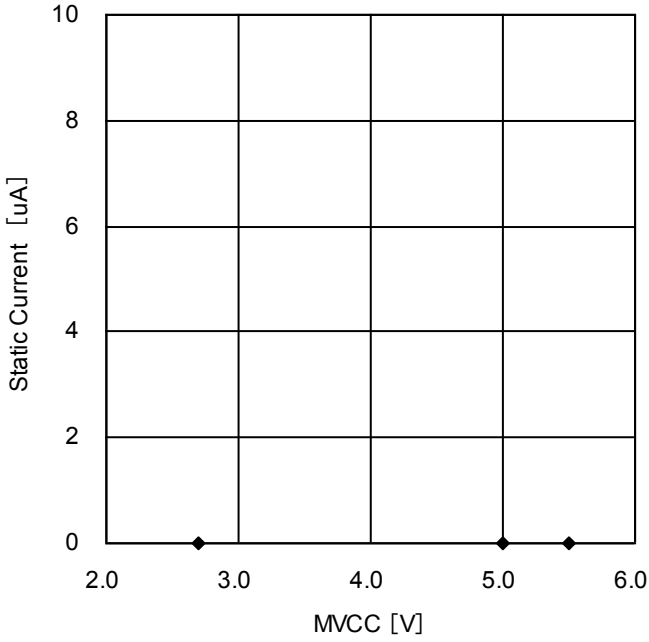


Figure 5. MVCC Static Current Voltage Dependency

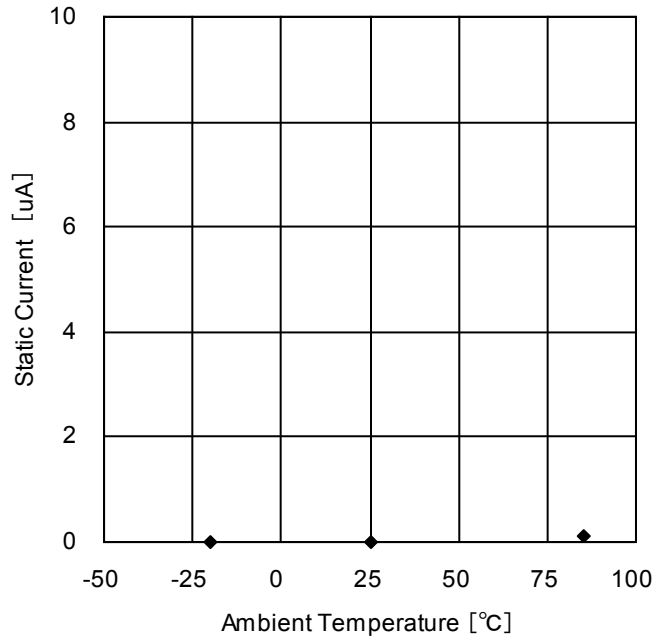


Figure 6. MVCC Static Current Temperature Dependency

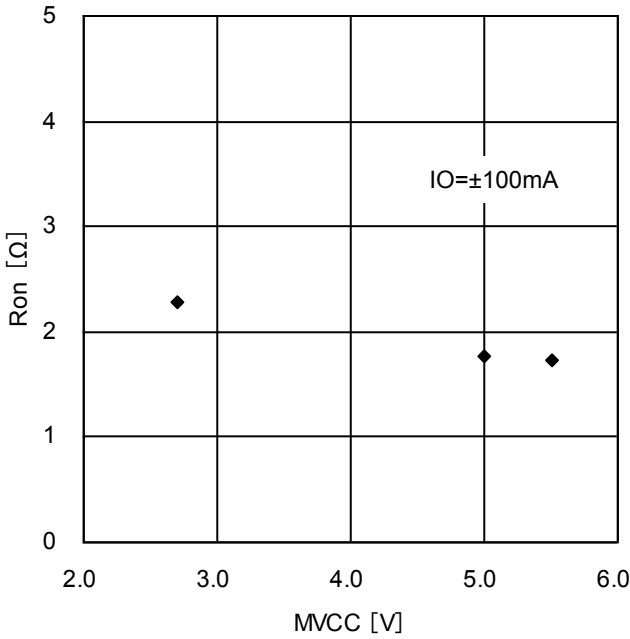


Figure 7. Output ON-Resistance MVCC Dependency (Voltage driver block)

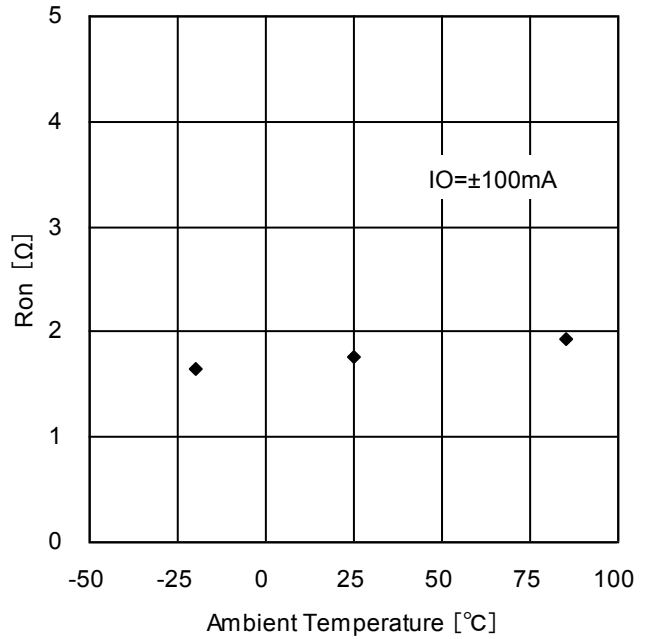


Figure 8. Output ON-Resistance Temperature Dependency (Voltage driver block)

● Typical Performance Curves

(Unless otherwise specified, $T_a=25^\circ\text{C}$, $DVDDIO=DVDD=3.0\text{V}$, $MVCC=5.0\text{V}$, $DVSS=MGND=0.0\text{V}$)

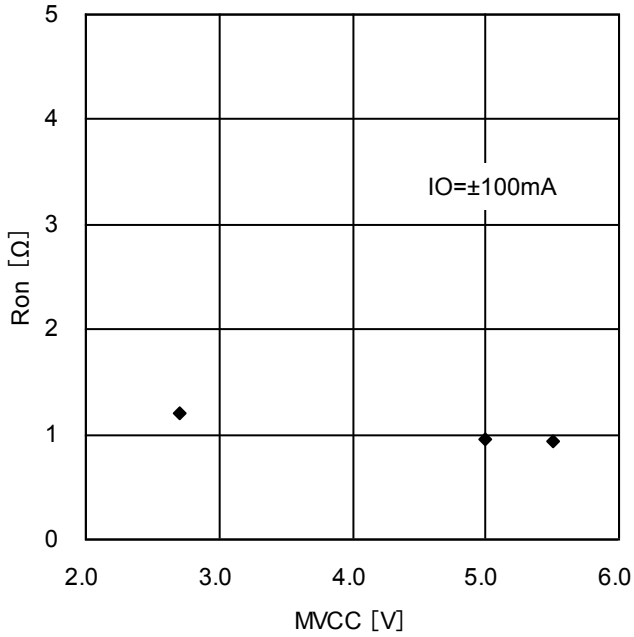


Figure 9. Output ON-Resistance
MVCC Dependency
(Current driver block)

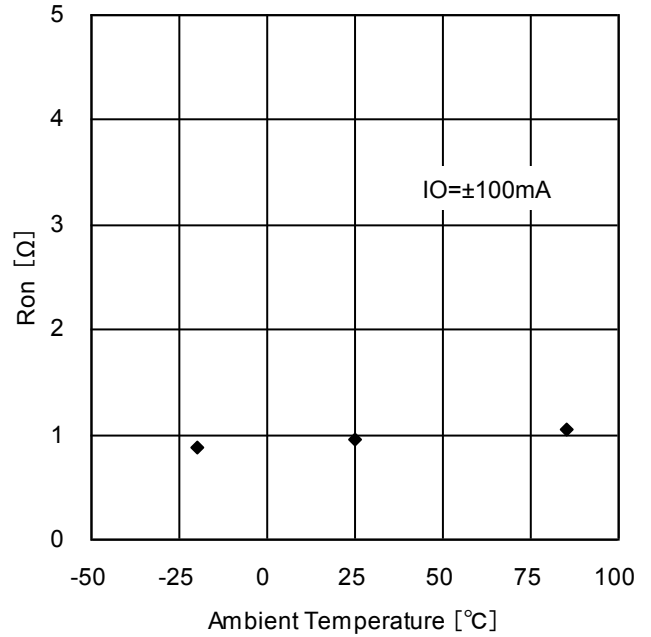


Figure 10. Output ON-Resistance
Temperature Dependency
(Current driver block)

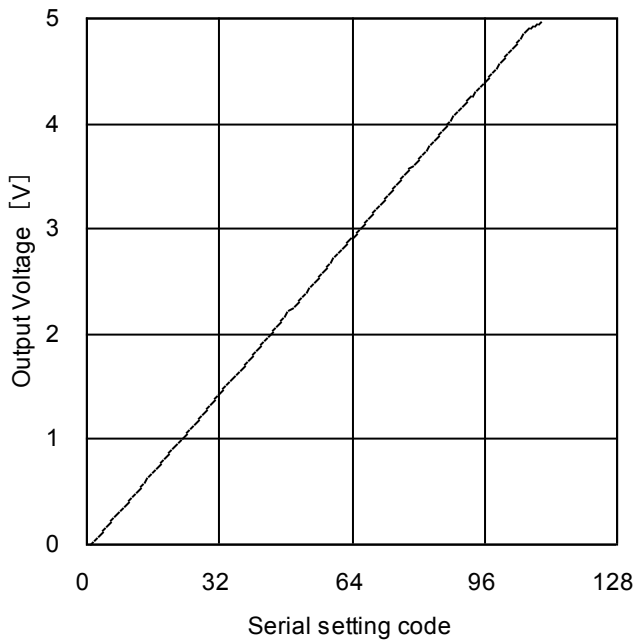


Figure 11. Average Voltage Accuracy
between different output pins
(Voltage driver block)

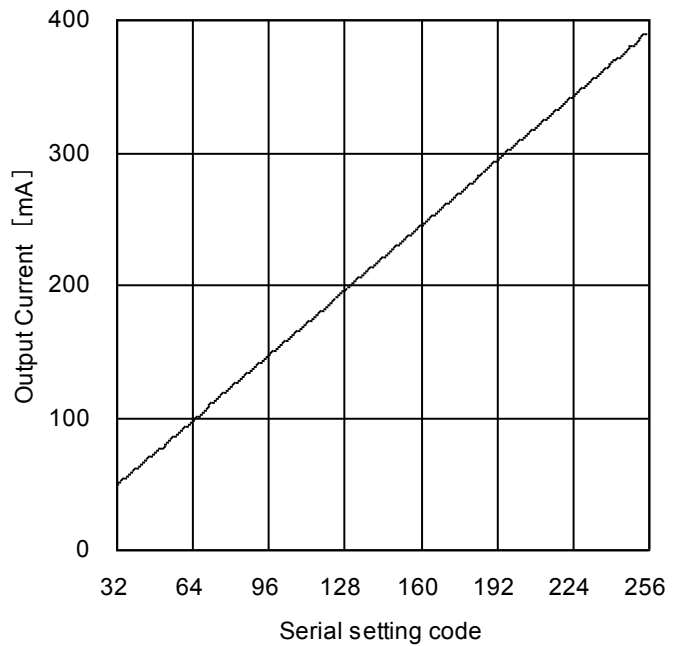


Figure 12. Output Current
(Current driver block, $R_{RNFB} = 1.0\ \Omega$, $R_L = 5.0\ \Omega$)

● Typical Performance Curves

(Unless otherwise specified, $T_a=25^\circ\text{C}$, $DVDDIO=DVDD=3.0\text{V}$, $MVCC=5.0\text{V}$, $DVSS=MGND=0.0\text{V}$)

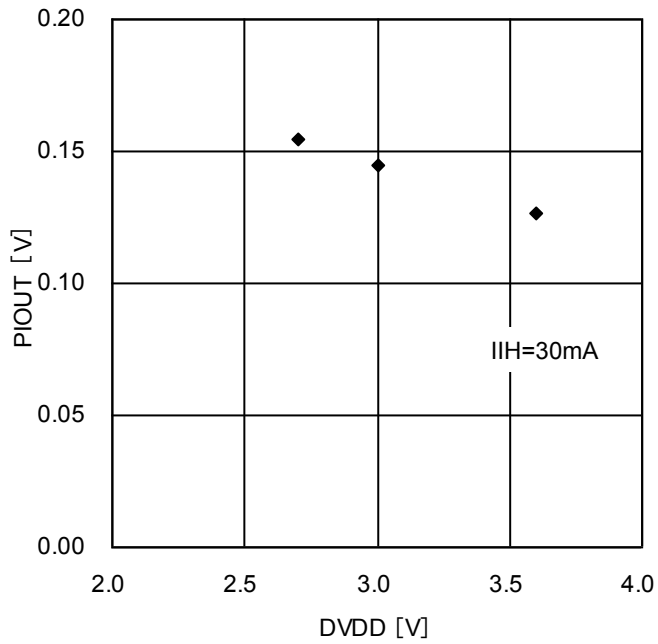


Figure 13. Output Voltage DVDD Dependency (PI driving circuit)

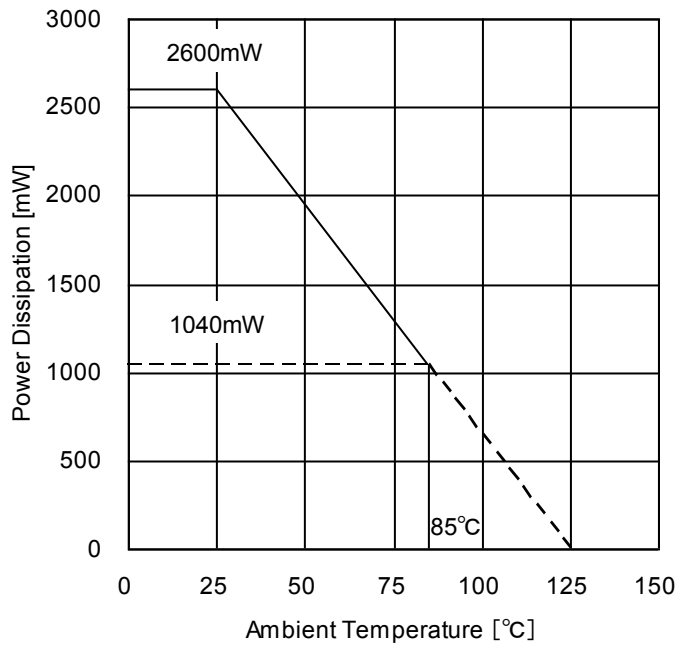
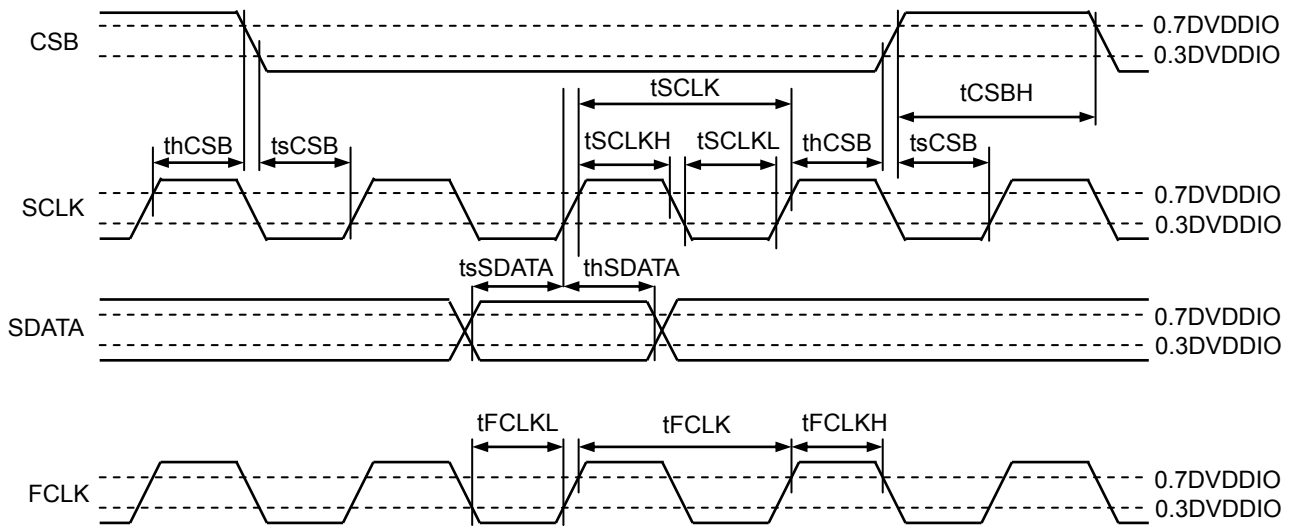


Figure 14. Power Dissipation Curve

●Timing Chart

(Unless otherwise specified, Ta=25°C, DVDDIO=DVDD=3.0V)

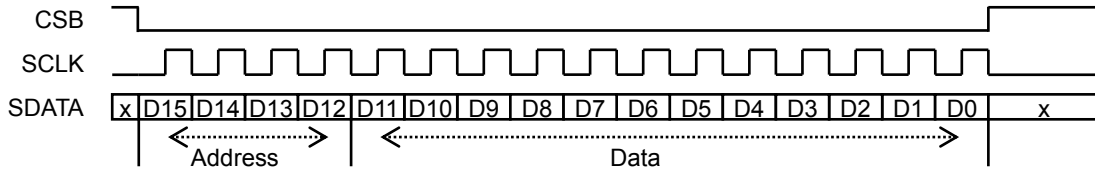
Parameter	Symbol	Specification
SCLK input cycle	tSCLK	More than 100 nsec
SCLK L-level input time	tSCLKL	More than 50 nsec
SCLK H-level input time	tSCLKH	More than 50 nsec
SDATA setup time	tsSDATA	More than 50 nsec
SDATA hold time	thSDATA	More than 50 nsec
CSB H-level input time	tCSBH	More than 380 nsec
CSB setup time	tsCSB	More than 50 nsec
CSB hold time	thCSB	More than 50 nsec
FCLK input cycle	tFCLK	More than 36 nsec
FCLK L-level input time	tFCLKL	More than 18 nsec
FCLK H-level input time	tFCLKH	More than 18 nsec



(note1) FCLK is asynchronous with SCLK.
 (note2) Duty of FCLK, SCLK are free.

●Serial interface

Control commands are framed by a 16-bit serial input (MSB first) and are sent through the CSB, SCLK, and SDATA pins. The 4 higher-order bits specify addresses, while the remaining 12 bits specify data. Data of every bit is sent through SDATA pin, which is retrieved during the rising edge of SCLK. Data becomes valid when CSB is Low and is registered during the rising edge of CSB.

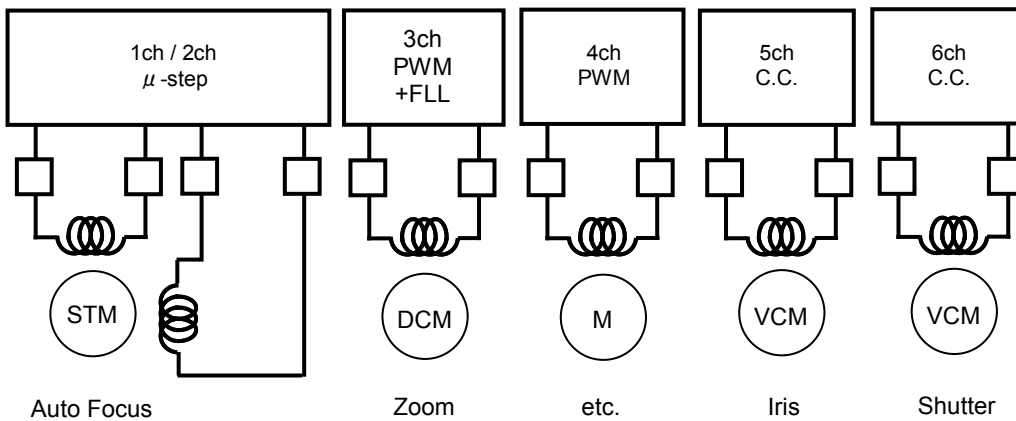
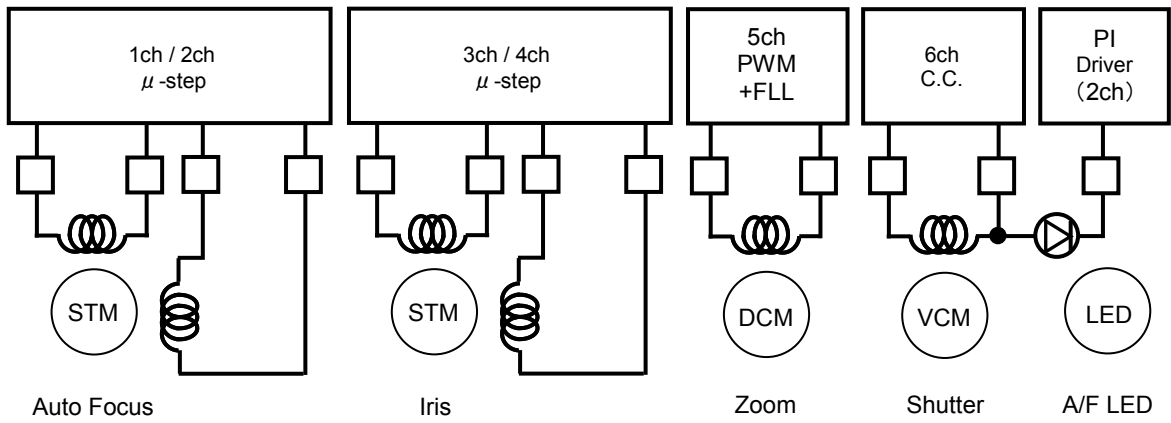
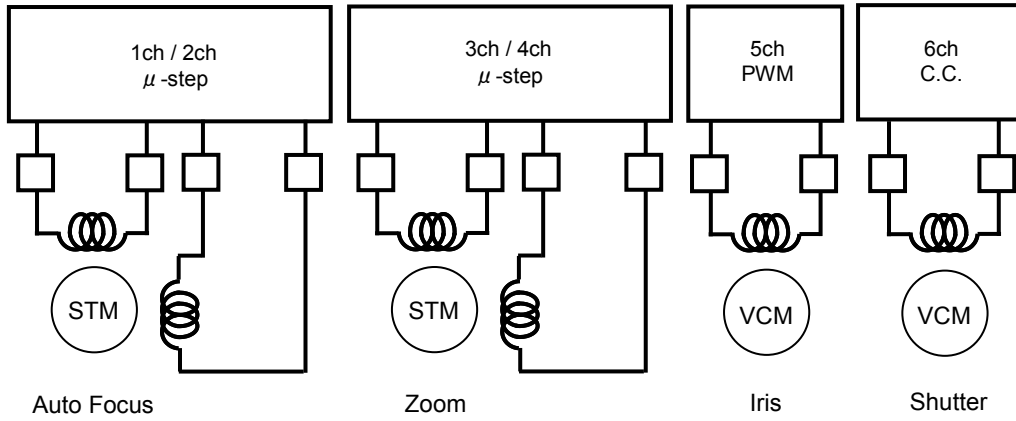


<Register map>

Address[3:0]				Data[11:0]													
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
0	0	0	0	A_Mode[1:0]		A_SEL[2:0]		A_different_output_voltage[6:0]						0	0		
0	0	0	1	0	0	0	0	A_Cycle[5:0]						0	0		
				0	0	1	0	A_Cycle[13:6]									
				0	1	0	0	0	0	0	A_Start_POS[3:0]						
				0	1	1	0	A_BEXC	0	0	A_BSL	A_AEXC	0	0	A_AS_L		
				1	1	1	0	0	0	A_POS[1:0]		0	A_UPDW_Stop	A_PS	A_Stop		
0	0	1	0	A_EN	A_RT	A_Pulse[9:0] / A_UPDW_Cycle[9:0]											
0	1	0	0	B_Mode[1:0]		B_SEL[2:0]		B_different_output_voltage[6:0]									
0	1	0	1	0	0	0	0	B_Cycle[5:0]						0	0		
				0	0	1	0	B_Cycle[13:6]									
				0	1	0	0	0	0	0	B_Start_POS[3:0]						
				0	1	1	0	B_BEXC	0	0	B_BSL	B_AEXC	0	0	B_AS_L		
				1	0	0	0	0	0	3_CHOP[1:0]		0	0	4_CHOP[1:0]			
				1	0	1	3_State_CTL[1:0]		3_PWM_Duty[6:0]								
				1	1	0	4_State_CTL[1:0]		4_PWM_Duty[6:0]								
				1	1	1	0	0	0	B_POS[1:0]		0	B_UPDW_Stop	B_PS	B_Stop		
0	1	1	0	B_EN	B_RT	B_Pulse[9:0] / B_UPDW_Cycle[9:0]											
1	0	1	1	0	0	0	0	B_ANSEL	A_ANSEL	Edge	0	0	0	B_CTL	A_CTL		
				0	0	1	0	0	0	0	0	0	EXT_CTL[1:0]				
1	1	0	0	0	0	Chopping[1:0]		CacheM	0	5_Mode	CLK_EN	CLK_DIV[3:0]					
1	1	0	1	0	0	0	0	0	0	0	0	0	0	PI_CTL2	PI_CTL1		
				0	0	1	0	DET_SEL	0	SPEN[1:0]		0	0	0			
				0	1	1	0	TARSP[7:0]									
				0	1	1	1	0	PSP[2:0]		0	ISP[2:0]					
				1	0	0	0	SPC_Limit_Out	0	0	0	SPC_Limit[3:0]					
1	1	1	0	0	0	0	0	5_IOUT[7:0]									
				0	0	1	0	0	5_PWM_Duty[6:0]								
				0	1	0	0	0	0	5_CHOP[1:0]		0	0	5_State_CTL[1:0]			
				0	1	1	0	0	0	0	0	6_State_CTL[2:0]					
				1	0	0	0	6_IOUT[7:0]									
				1	0	1	0	0	0	Waveform_Vth[5:0]							
				1	0	1	1	0	0	Waveform_Vth[5:0]							
				1	1	0	0	0	0	0	STB	0	0	STM_RS	CMD_RS		
Addresses other than those above				Setting prohibited													

(Note 1) The notations A and B in the register map correspond to Ach and Bch respectively. Ach is defined as 1ch and 2ch driver, Bch as 3ch and 4ch driver.
 (Note 2) After reset (Power ON reset), the initial condition is saved in all registers.
 (Note 3) For Mode, different output voltage, Cycle, EN, and RT registers, data that are written before the access to the Pulse register becomes valid and determines the rising edge of CSB after the access to the Pulse register.
 (The Mode, different output voltage, Cycle, EN, RT, and Pulse registers contain Cache registers. Any registers other than those do not contain Cache registers.)

●Application Example



● I/O Equivalence Circuit

Pin	Equivalent Circuit Diagram	Pin	Equivalent Circuit Diagram
FCLK CSB SCLK SDATA INA INB		SI	
STATE11 STATE21		STATE12 STATE22 SO	
PIOUT1		PIOUT2	
OUT1A OUT1B OUT2A OUT2B		OUT3A OUT3B OUT4A OUT4B	
OUT5A OUT5B		OUT6A OUT6B	

● I/O Equivalence Circuit

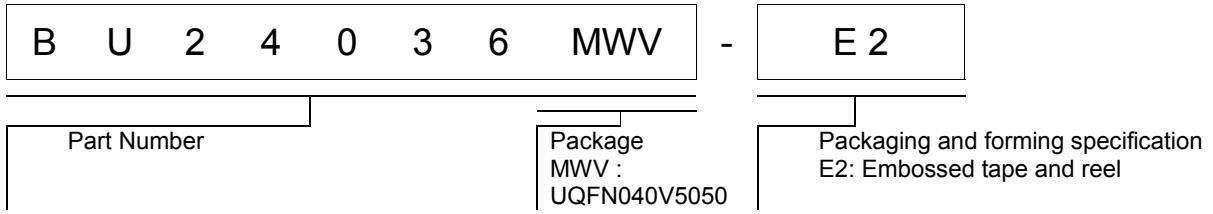
Pin	Equivalent Circuit Diagram	Pin	Equivalent Circuit Diagram
SENSE5		SENSE6	
TEST (note1)			

(note1) Short TEST pin to DVSS.

●Operational Notes

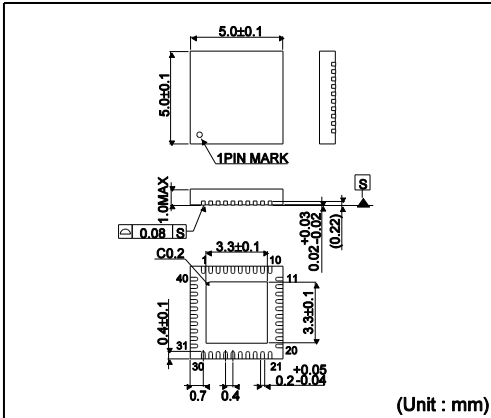
- 1) Absolute maximum ratings
If applied voltage, operating temperature range, or other absolute maximum ratings are exceeded, the LSI may be damaged. Do not apply voltages or temperatures that exceed the absolute maximum ratings. If you expect that any voltage or temperature could be exceeding the absolute maximum ratings, take physical safety measures such as fuses to prevent any conditions exceeding the absolute maximum ratings from being applied to the LSI.
- 2) GND potential
The voltage of the ground pin must be the lowest voltage of all pins of the IC at all operating conditions. Ensure that no pins are at a voltage below the ground pin at any time, even during transient condition.
- 3) Thermal design
Use a thermal design that allows for a sufficient margin by taking into account the permissible power dissipation (PD) in actual operating conditions.
- 4) Short circuit between pins and malfunctions
Ensure that when mounting the IC on the PCB the direction and position are correct. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground. 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.
- 5) Operation in strong magnetic field
Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.
- 6) Power ON sequence
Set DVDD after the setting of DVDDIO or set it simultaneously. There is no restriction on the setting of MVCC.
To turn ON the DVDD, be sure to reset at CMD_RS register.
- 7) Thermal shutdown
The IC incorporates a built-in thermal shutdown circuit, which is designed to turn off the IC when the internal temperature of the IC reaches a specified value. It is not designed to protect the IC from damage or guarantee its operation. Do not continue to operate the IC after this function is activated. Do not use the IC in conditions where this function will always be activated.
- 8) PI drive circuit
The output voltage of PIOUT1 should not exceed the voltage of the power supply voltage DVDD.
The output voltage of PIOUT2 should not exceed the voltage of the power supply voltage VDDAMP.

●Ordering Information



●Physical Dimension Tape and Reel Information

UQFN040V5050

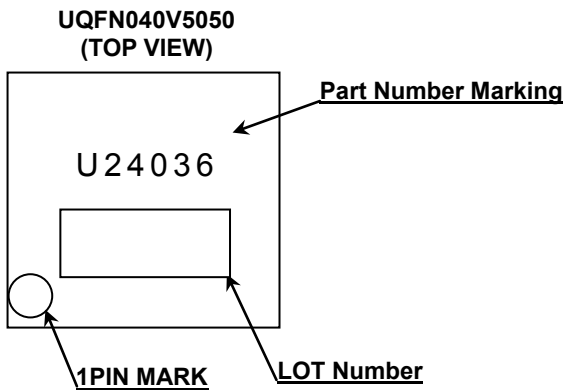


<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin 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)

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

●Marking Diagram



●Revision History

Date	Revision	Changes
10.Oct.2012	001	New Release
2.May.2013	002	Update some English words, sentences, descriptions, grammar and formatting.
20.May.2016	003	Correct Pin Description.

Notice

Precaution on using ROHM Products

- 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
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

- 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:
 - Installation of protection circuits or other protective devices to improve system safety
 - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- 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:
 - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
 - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
 - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
 - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
 - Sealing or coating our Products with resin or other coating materials
 - 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
 - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- 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.
- 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.
- Confirm that operation temperature is within the specified range described in the product specification.
- 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

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- 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.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.
2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).
3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.
2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.
3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.
4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

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.
2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.
3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.