LV8044LP

ON Semiconductor®

http://onsemi.com

Bi-CMOS IC

For Digital Still Camera
6-channel Motor Driver IC
Application Note

Overview

The LV8044LP is a 6-channel motor driver IC for digital still camera.

Function

- Two microstep drive H-bridge driver channels.
- Two microstep drive/PWM saturated drive switchable H-bridge driver channels.
- Two constant-current drive H-bridge driver channels.
- Drive mode switchable between 2-phase, 1-2 phase full torque, 1-2 phase, and 4W1-2 phase (channels 1, 2, 3, and 4).
- Microstep drive step advance controlled by a single step signal input (channels 1, 2, 3, and 4).
- Ability to set the hold current to one of four levels (channels 1, 2, 3, and 4).
- Ability to set the constant-current reference voltage to one of 16 levels from the serial data (channels 5 and 6).
- Eight-bit 3-wire serial control.
- Three on-chip photosensor driver circuits.
- Built-in MO(stepping position detection monitor output) function.

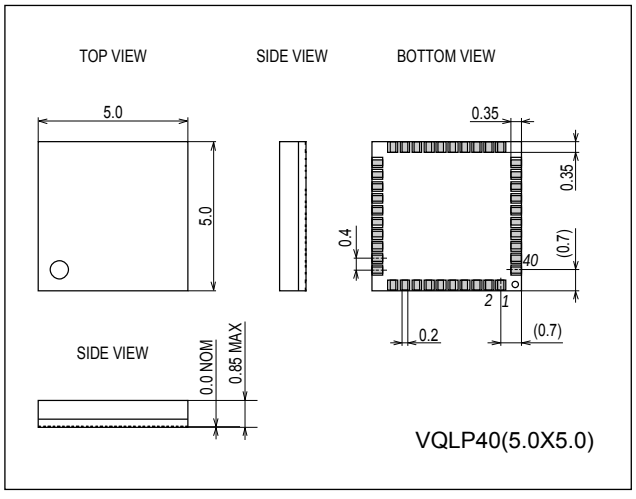
Typical Applications

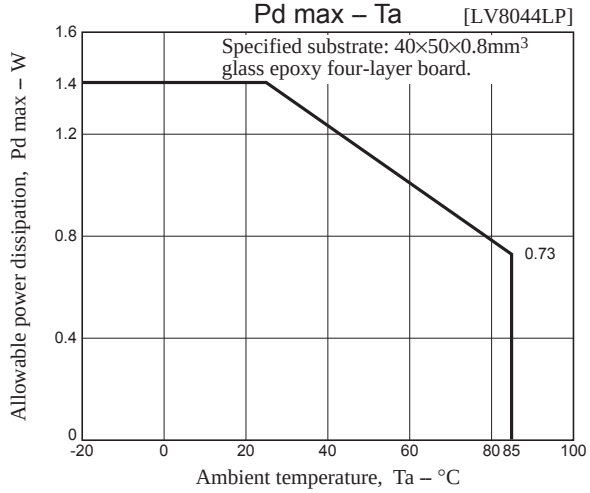
- DSC
- Security camera
- CCTV

Package Dimensions

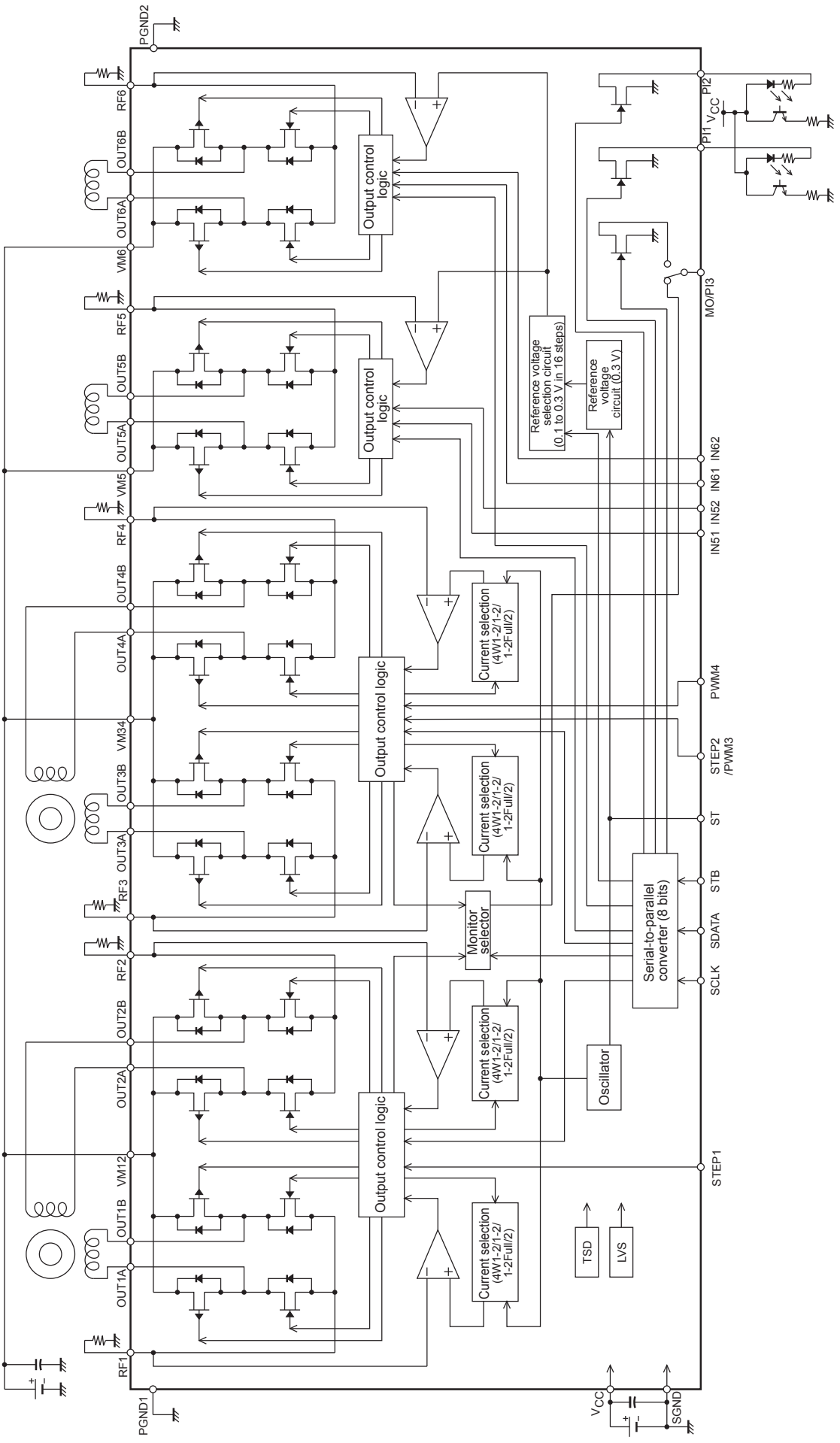
unit : mm (typ)

[LV8044LP]



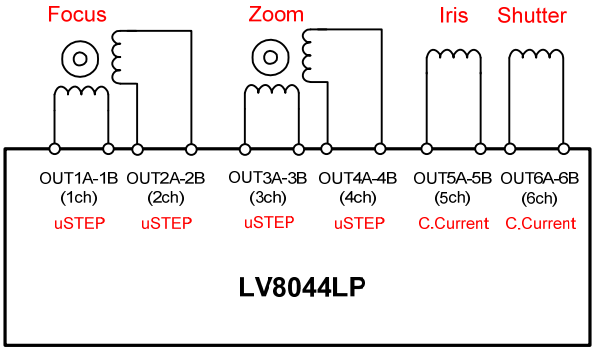


Block Diagram

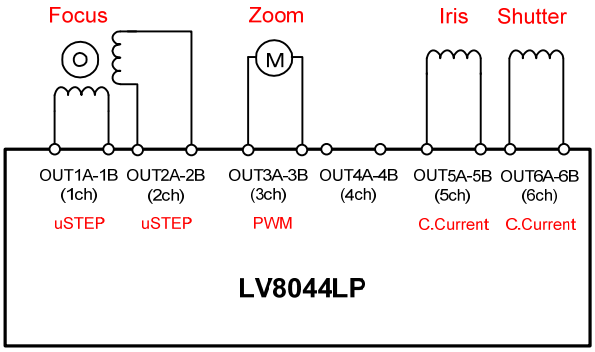


Application examples

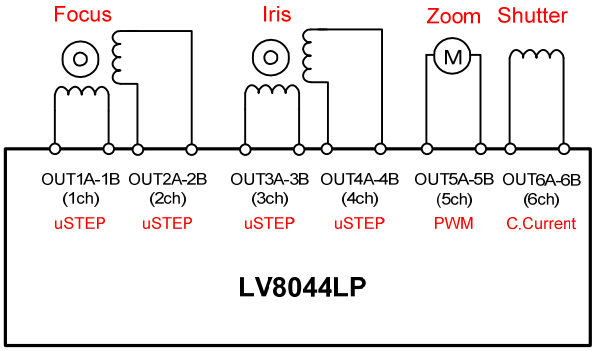
Application-1



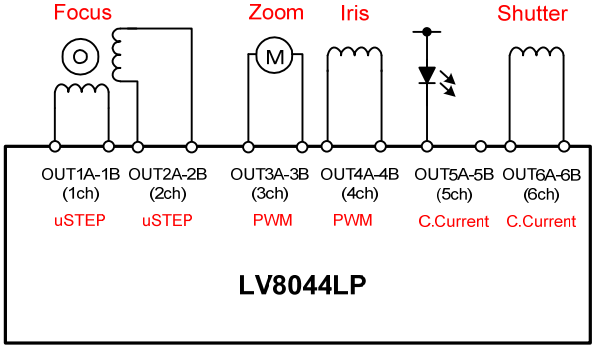
Application-2



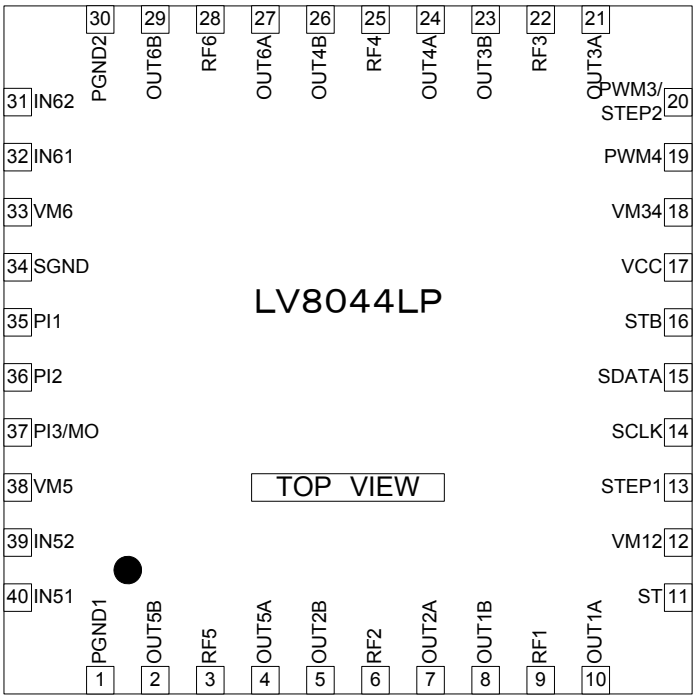
Application-3



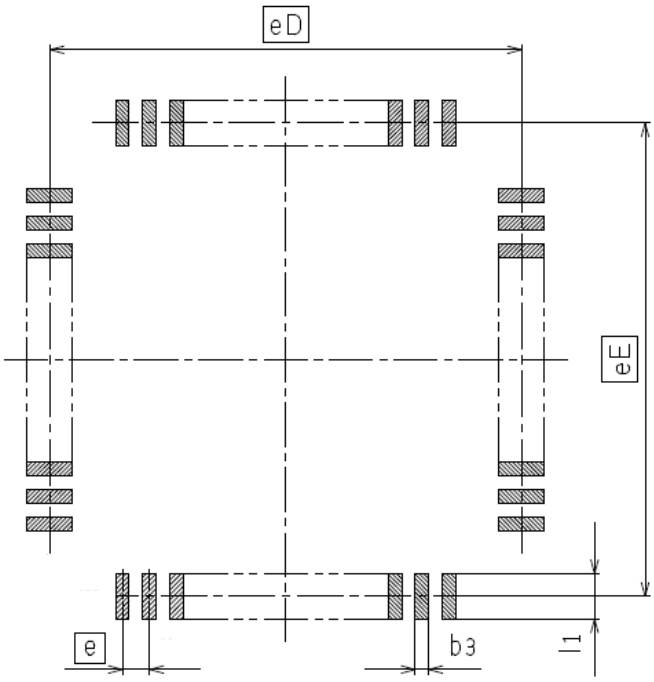
Application-4



Pin Assignment



Recommended Soldering Footprint



(Unit:mm)

Reference symbol	Packages name				
	VQLP24/J(3.5X3.5)	VQLP24(4.0X4.0)	VQLP32(4.0X4.0)	VQLP40(5.0X5.0)	
eD	3.25	3.75	3.75	4.75	
eE	3.25	3.75	3.75	4.75	
e	0.40	0.50	0.40	0.40	
b3	0.20	0.25	0.20	0.20	
l1	0.55	0.55	0.55	0.55	

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage 1	V_M max		6.0	V
Power supply voltage 2	V_{CC} max		6.0	V
Output peak current	I_O peak	Each CH tw ≤ 10ms, duty 20%	600	mA
Output continuous current	I_O max	Each CH	400	mA
Allowable power dissipation 2	Pd max	LV8044LP With substrate *	1.4	W
Operating temperature	Topg		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

*: With 40mm × 50mm × 0.8mm glass epoxy substrate (four-layer substrate).

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.
Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply voltage range 1	V_M		2.7		5.5	V
Power supply voltage range 2	V_{CC}		2.7		5.5	V
Logic input voltage range	V_{IN}		0		V_{CC} +0.3	V
STEP frequency	F_{STEP}	STEP1, STEP2			64	KHz
PWM frequency	F_{PWM}	STEP3, STEP4			100	Khz

Electrical Characteristics at Ta = 25°C, V_M = 5V, V_{CC} = 3.3V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Standby supply current	I_{STN}	ST = "L"			1.0	μA
Motor supply current	I_M	ST = "H", PWM3 = PWM4 = "H", IN51 = IN61 = "H", no load		50	100	μA
Logic supply current	I_{CC}	ST = "H", PWM3 = PWM4 = "H", IN51 = IN61 = "H", no load	2	3	4	mA
V_{CC} low-voltage cut voltage	$V_{th}V_{CC}$		2.1	2.35	2.6	V
Low-voltage hysteresis voltage	V_{th}HIS		100	150	200	mV
Thermal shutdown temperature	TSD	Design guarantee	150	180	200	°C
Thermal hysteresis width	ΔTSD	Design guarantee		40		°C

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Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Microstep Driver (channels 1, 2, 3, and 4)							
Output on resistance		Ronu	I_O = 400mA, Upper ON resistance		0.7	0.8	Ω
		Rond	I_O = 400mA, Lower ON resistance		0.5	0.6	Ω
Output leak current		$I_O$leak1				1.0	μA
Diode forward voltage 1		V_D1	ID = -400mA		0.9	1.2	V
Logic pin input current		I_{in}L	V_{IN} = 0V (ST, STEP1, STEP2)			1.0	μA
		I_{in}H	V_{IN} = 3.3V (ST, STEP1, STEP2)	20	33	50	μA
Logic input “H” level voltage		V_{in}h	ST, STEP1, STEP2	2.5			V
Logic input “L” level voltage		V_{in}l	ST, STEP1, STEP2			1.0	V
Current selection reference voltage level	4W1-2 phase	Vstep16	Step 16 (Initial level: the channel 1 comparator level)	0.185	0.200	0.215	V
		Vstep15	Step 15 (Initial+1)	0.185	0.200	0.215	V
		Vstep14	Step 14 (Initial+2)	0.185	0.200	0.215	V
		Vstep13	Step 13 (Initial+3)	0.176	0.193	0.206	V
		Vstep12	Step 12 (Initial+4)	0.170	0.186	0.200	V
		Vstep11	Step 11 (Initial+5)	0.162	0.178	0.192	V
		Vstep10	Step 10 (Initial+6)	0.154	0.171	0.184	V
		Vstep9	Step 9 (Initial+7)	0.146	0.163	0.176	V
		Vstep8	Step 8 (Initial+8)	0.129	0.148	0.159	V
		Vstep7	Step 7 (Initial+9)	0.113	0.131	0.143	V
		Vstep6	Step 6 (Initial+10)	0.097	0.115	0.127	V
		Vstep5	Step 5 (Initial+11)	0.079	0.097	0.109	V
		Vstep4	Step 4 (Initial+12)	0.062	0.079	0.092	V
		Vstep3	Step 3 (Initial+13)	0.044	0.06	0.074	V
		Vstep2	Step 2 (Initial+14)	0.024	0.04	0.054	V
		Vstep1	Step 1 (Initial+15)	0.006	0.02	0.036	V
	1-2 phase	Vstep16	Step 16 (Initial level: the channel 1 comparator level)	0.185	0.200	0.215	V
		Vstep8	Step 8 (Initial+1)	0.129	0.148	0.159	V
	1-2 phase (Full torque)	Vstep16	Step 16 (Initial level: the channel 1 comparator level)	0.185	0.200	0.215	V
		Vstep8	Step 8 (Initial+1)	0.185	0.200	0.215	V
	2 phase	Vstep8	Step 8	0.185	0.200	0.215	V
Chopping frequency		fchop1		104	130	156	KHz
		fchop2		52	65	78	KHz
		fchop3		160	200	240	KHz
		fchop4		80	100	120	KHz
Current setting reference voltage		VSEN00	(D5, D6) = (0, 0)	0.185	0.200	0.215	V
		VSEN01	(D5, D6) = (0, 1)	0.119	0.134	0.149	V
		VSEN10	(D5, D6) = (1, 0)	0.085	0.100	0.115	V
		VSEN11	(D5, D6) = (1, 1)	0.051	0.066	0.081	V

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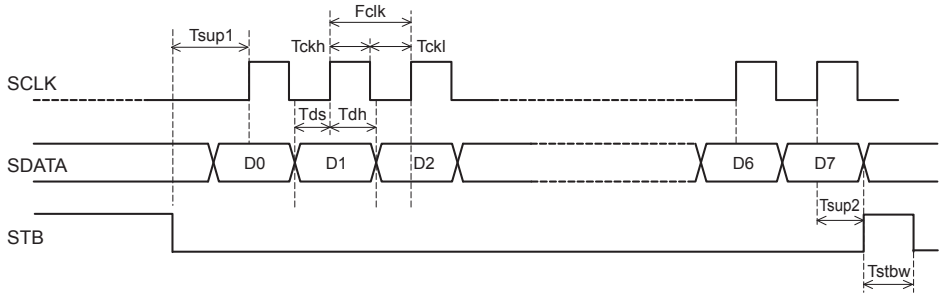
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Constant-Current Drive (channels 5 and 6)						
Output on resistance	Ronu	I_O = 400mA, Upper ON resistance		0.7	0.8	Ω
	Rond	I_O = 400mA, Lower ON resistance		0.5	0.6	Ω
Output leak current	$I_O$leak				1.0	μA
Diode forward voltage 1	V_D1	ID = -400mA		0.9	1.2	V
Logic pin input current	I_{in}L	V_{IN} = 0V, (IN51, IN52, IN61, IN62)			1.0	μA
	I_{in}H	V_{IN} = 3.3V, (IN51, IN52, IN61, IN62)	20	33	50	μA
Logic input “H” level voltage	V_{in}h	IN51, IN52, IN61, IN62	2.5			V
Logic input “L” level voltage	V_{in}l	IN51, IN52, IN61, IN62			1.0	V
Output constant current	I_{OUT}	Rload = 3Ω,RF = 0.5Ω, Internal standard = 0.2V	380	400	420	mA
Current setting reference voltage	Vref0	(D4, D5, D6, D7) = (0, 0, 0, 0)	0.285	0.30	0.315	V
	Vref1	(D4, D5, D6, D7) = (1, 0, 0, 0)	0.19	0.20	0.21	V
	Vref2	(D4, D5, D6, D7) = (0, 1, 0, 0)	0.18	0.190	0.2	V
	Vref3	(D4, D5, D6, D7) = (1, 1, 0, 0)	0.171	0.180	0.189	V
	Vref4	(D4, D5, D6, D7) = (0, 0, 1, 0)	0.161	0.170	0.179	V
	Vref5	(D4, D5, D6, D7) = (1, 0, 1, 0)	0.156	0.165	0.173	V
	Vref6	(D4, D5, D6, D7) = (0, 1, 1, 0)	0.152	0.160	0.168	V
	Vref7	(D4, D5, D6, D7) = (1, 1, 1, 0)	0.147	0.155	0.163	V
	Vref8	(D4, D5, D6, D7) = (0, 0, 0, 1)	0.143	0.150	0.158	V
	Vref9	(D4, D5, D6, D7) = (1, 0, 0, 1)	0.137	0.145	0.152	V
	VrefA	(D4, D5, D6, D7) = (0, 1, 0, 1)	0.133	0.140	0.147	V
	VrefB	(D4, D5, D6, D7) = (1, 1, 0, 1)	0.128	0.135	0.142	V
	VrefC	(D4, D5, D6, D7) = (0, 0, 1, 1)	0.123	0.130	0.137	V
	VrefD	(D4, D5, D6, D7) = (1, 0, 1, 1)	0.114	0.120	0.126	V
	VrefE	(D4, D5, D6, D7) = (0, 1, 1, 1)	0.104	0.110	0.116	V
	VrefF	(D4, D5, D6, D7) = (1, 1, 1, 1)	0.095	0.100	0.105	V
Photo-sensor Drive Circuit						
Output saturation voltage	Vsat	I_O = -20mA		0.09	0.12	V
Serial Data Transfer Pin						
Logic pin input current	I_{in}L	V_{IN} = 0V (SCLK, SDATA, STB)			1.0	μA
	I_{in}H	V_{IN} = 3.3V (SCLK, SDATA, STB)	20	33	50	μA
Logic input “H” level voltage	V_{in}h	SCLK, SDATA, STB	2.5			V
Logic input “L” level voltage	V_{in}l	SCLK, SDATA, STB			1.0	V
Minimum SLCK “H” pulse width	Tckh		0.125			μs
Minimum SLCK “L” pulse width	Tckl		0.125			μs
Minimum setup time (STB → SCLK rising edge)	Tsup1		0.125			μs
Minimum setup time (SCLK rising edge →STB)	Tsup2		0.125			μs
Minimum STB pulse width	Tstbw		0.125			μs
Data setup time	Tds		0.125			μs
Data hold time	Tdh		0.125			μs
Maximum SCLK frequency	Fclk				4	MHz

Serial Input Switching Characteristics Timing Chart



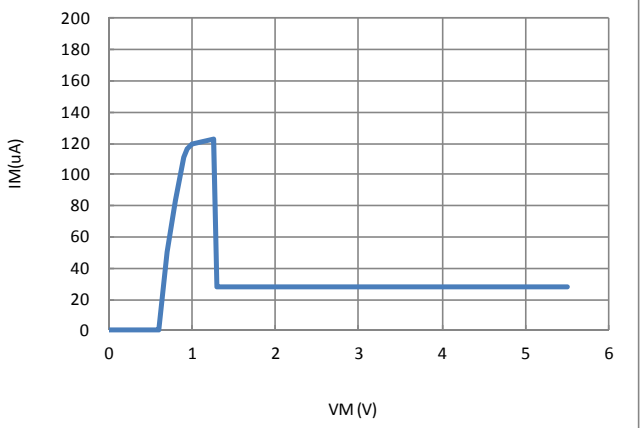


Figure 1 Motor Supply Current vs VM Voltage (VCC=3.3V,ST=PWM3=PWM4=IN51=IN61="H")

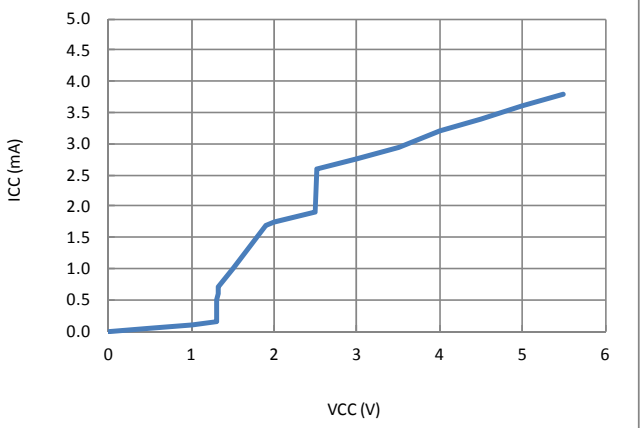


Figure 2 Logic Supply Current vs VCC Voltage (VM=5V,ST=PWM3=PWM4=IN51=IN61="H")

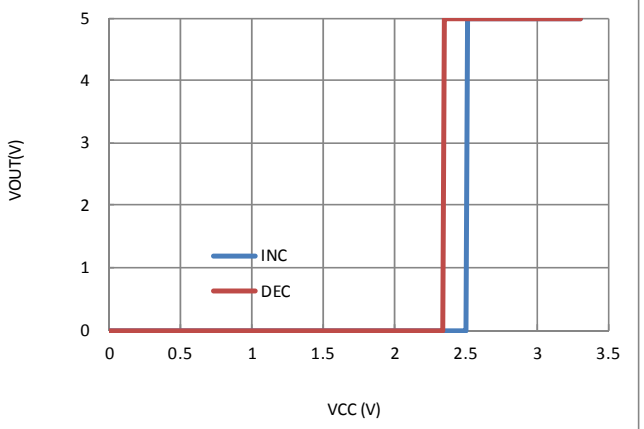


Figure 3 VCC Low-voltage Cut Voltage (VM=5V)

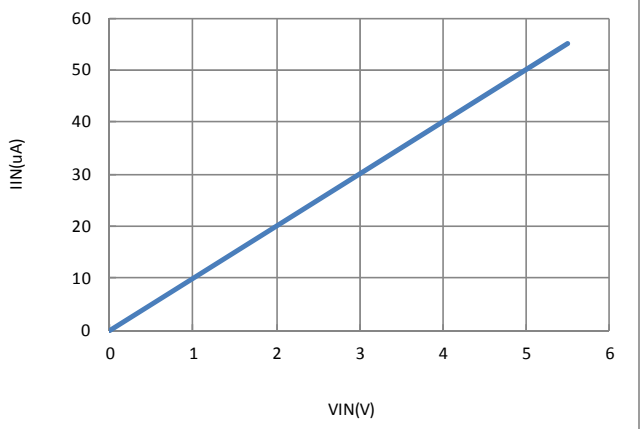


Figure 4 Logic Pin Input Current vs VIN (VCC=5.5V)

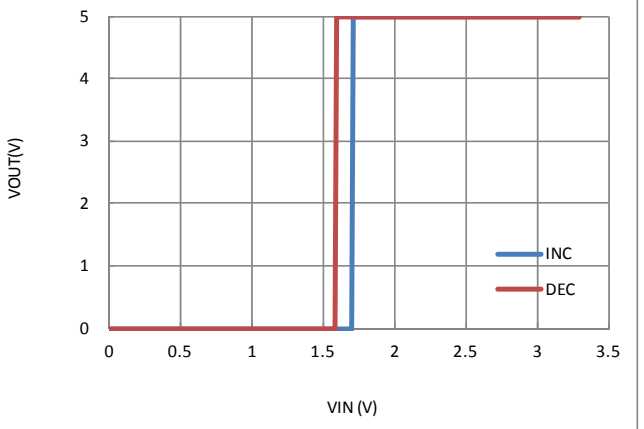


Figure 5 VOUT vs VIN (VCC=3.3V,VM=5V)

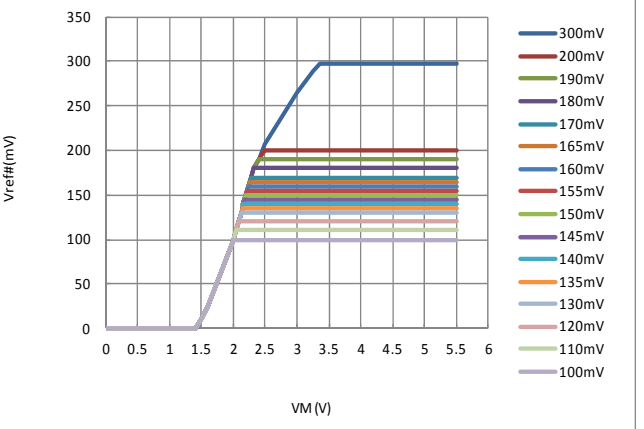


Figure 6 Current Setting Reference Voltage vs VM (VCC=5V)

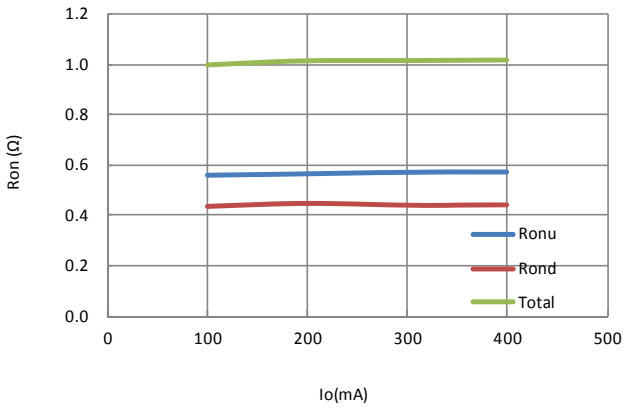


Figure 7 Output on Resistance vs Output Current (ch 1,2,3, and 4) (VCC=3.3V,VM=5V)

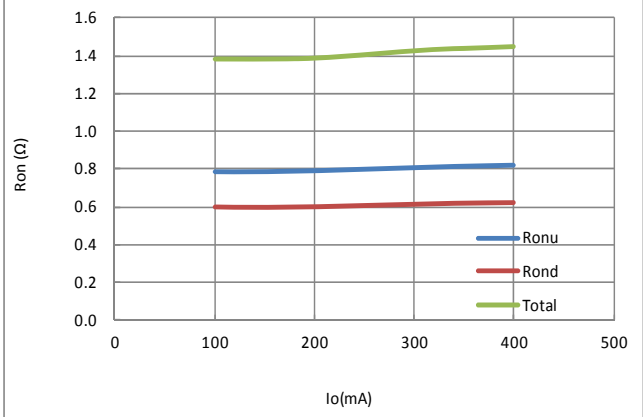


Figure 8 Output on Resistance vs Output Current (ch 1,2,3, and 4) (VCC=3.3V,VM=3V)

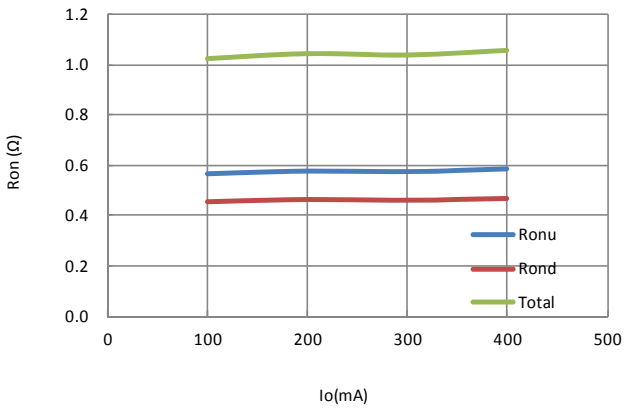


Figure 9 Output on Resistance vs Output Current (ch 5 and 6) (VCC=3.3V,VM=5V)

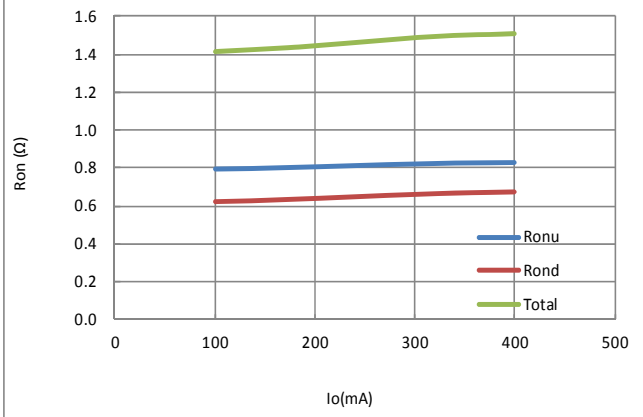


Figure 10 Output on Resistance vs Output Current (ch 5 and 6) (VCC=3.3V,VM=3V)

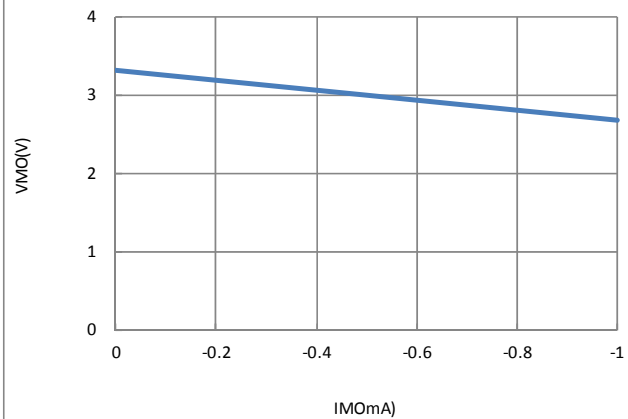


Figure 11 MO Output Voltage vs IMO(Sink) (VCC=3.3V)

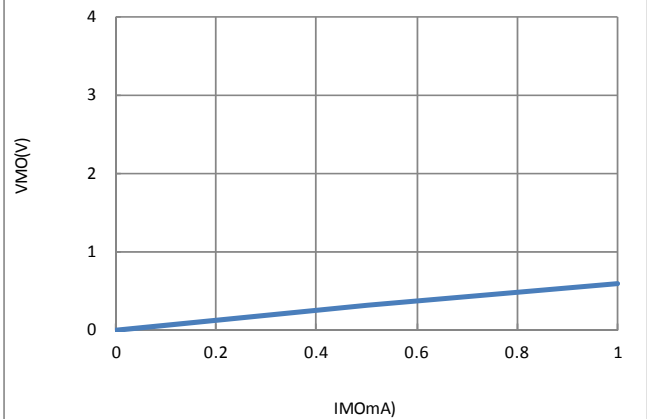


Figure 12 MO Output Voltage vs IMO (Source) (VCC=3.3V)

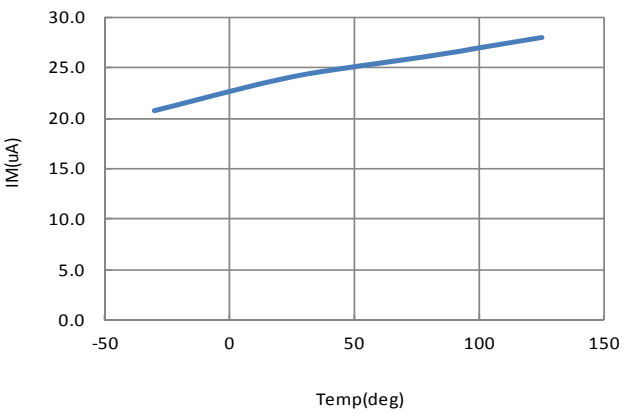


Figure 13 Motor Supply Current vs Temperature (VCC=3.3V,VM=5V,ST=PWM3=PWM4=IN51=IN61="H")

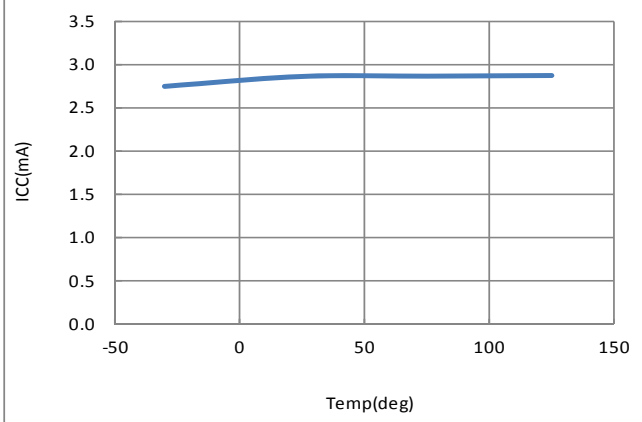


Figure 14 Logic Supply Current vs Temperature (VCC=3.3V,VM=5V,ST=PWM3=PWM4=IN51=IN61="H")

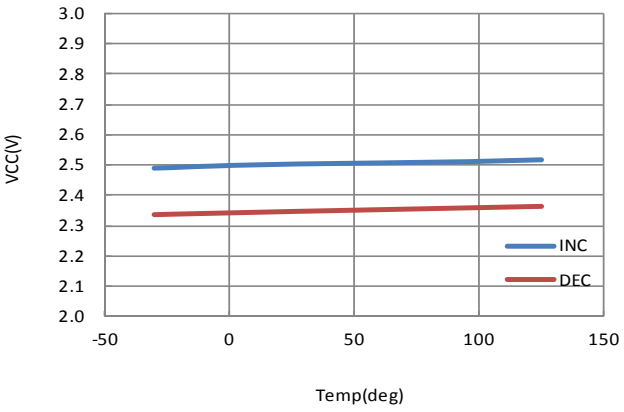


Figure 15 VCC Low-voltage Cut Voltage vs Temperature (VM=5V)

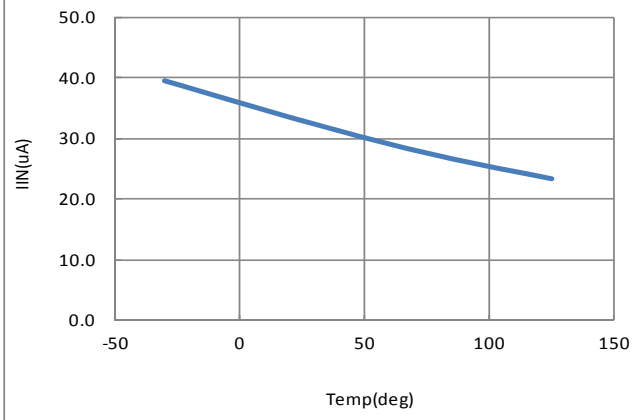


Figure 16 Logic Pin Input Current vs Temperature (VCC=VIN=3.3V)

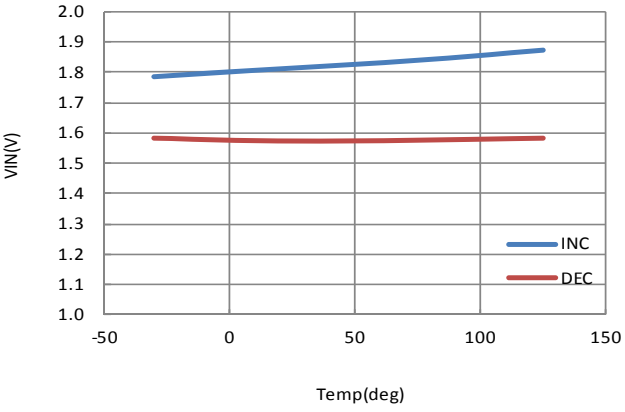


Figure 17 Logic Input Level Voltage vs Temperature (VCC=3.3V,VM=5V)

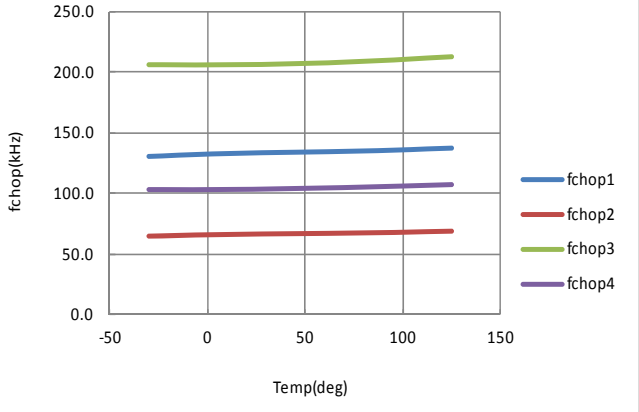


Figure 18 Chopping Frequency vs Temperature (VCC=3.3V,VM=5V)

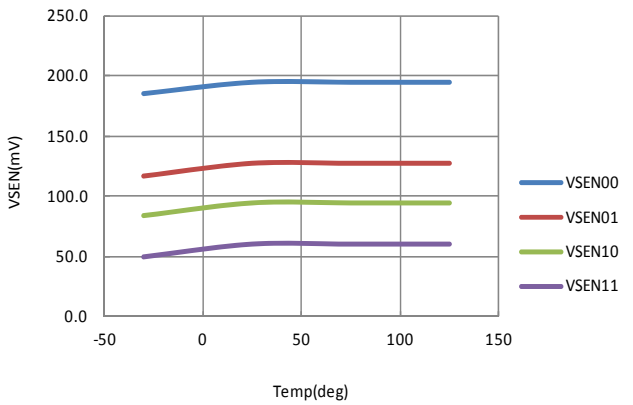


Figure 19 Current Setting Reference Voltage vs Temperature (VCC=3.3V,VM=5V)

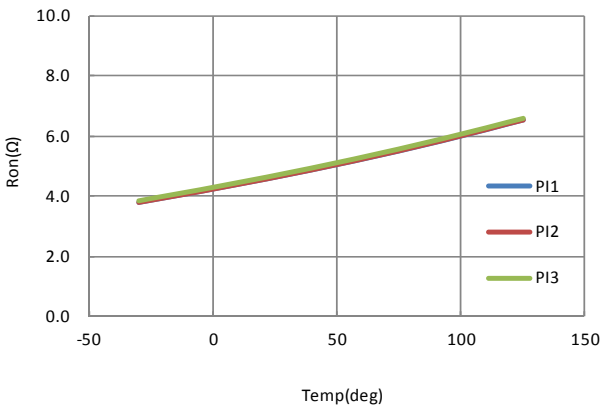


Figure 20 PI Output on Resistance vs Temperature (VCC=3.3V,VM=5V,IOUT=20mA)

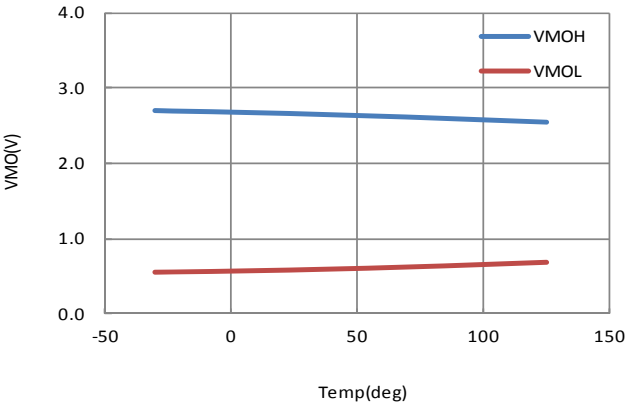


Figure 21 MO Output Voltage vs Temperature (VCC=3.3V, IMOH=-1mA,IMOL=1mA)

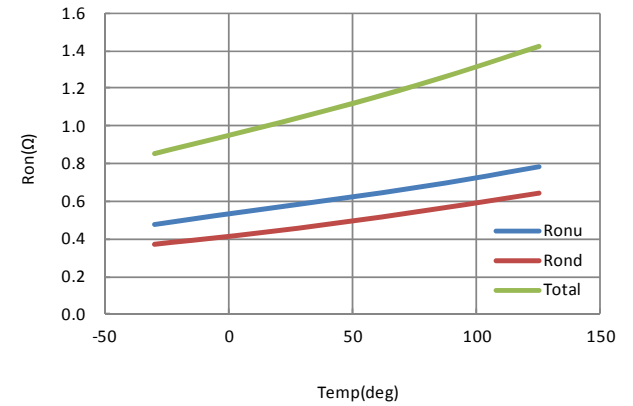


Figure 22 Output on Resistance vs Temperature (ch 1,2,3, and 4) (VCC=3.3V,VM=5V,IOUT=400mA)

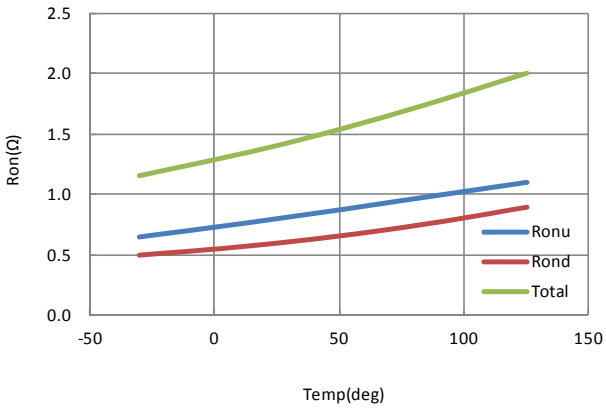


Figure 23 Output on Resistance vs Temperature (ch 1,2,3, and 4) (VCC=3.3V,VM=3V,IOUT=400mA)

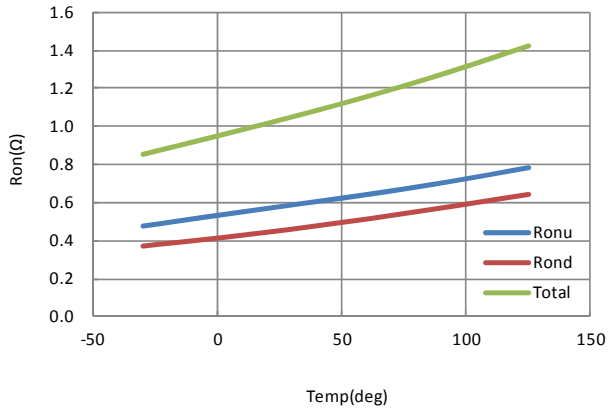


Figure 24 Output on Resistance vs Temperature (ch 5 and 6)
(VCC=3.3V,VM=5V,IOUT=400mA)

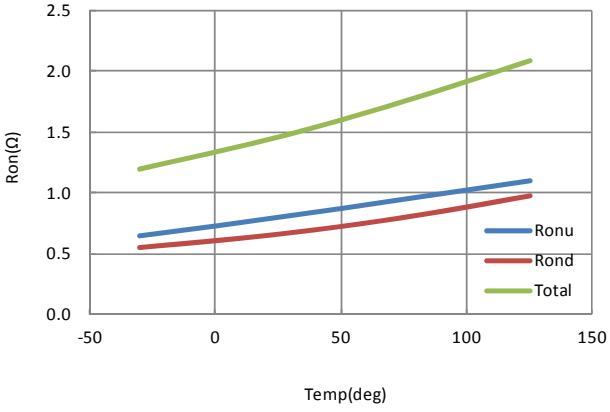


Figure 25 Output on Resistance vs Temperature (ch 5 and 6)
(VCC=3.3V,VM=3V,IOUT=400mA)

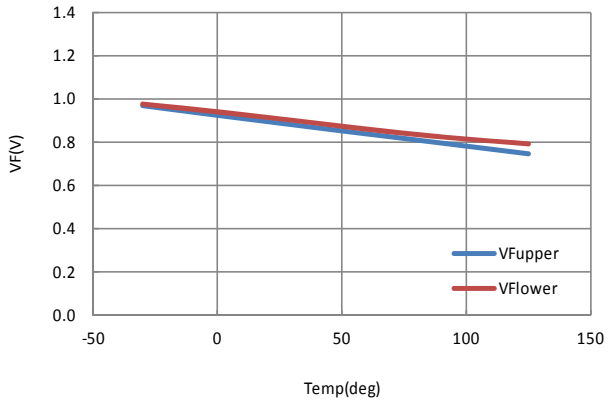


Figure 26 Output Diode Forward Voltage vs Temperature (ch 1,2,3, and 4)
(IF=400mA)

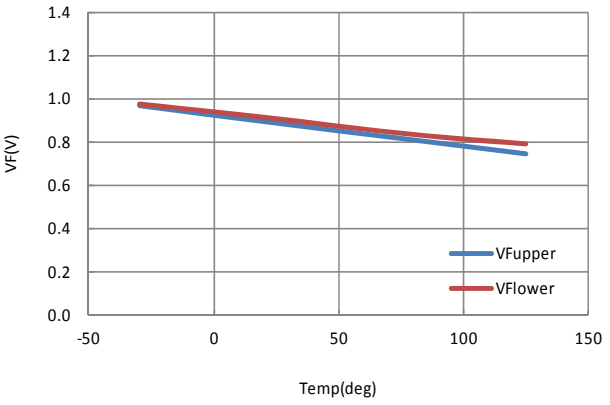
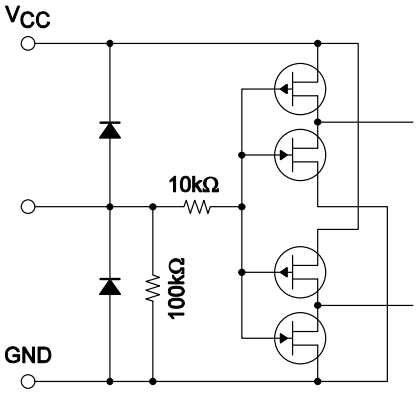
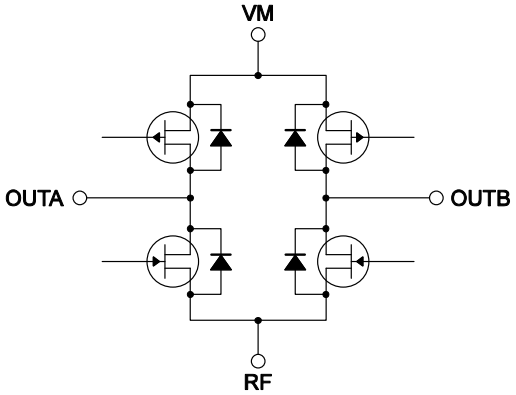
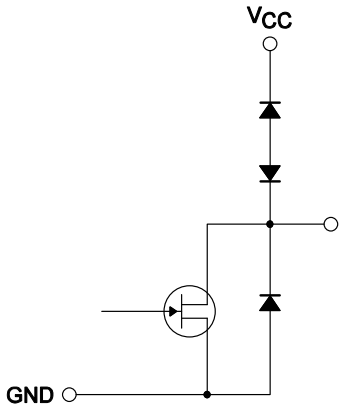


Figure 27 Output Diode Forward Voltage vs Temperature (ch 5 and 6)
(IF=400mA)

Pin Function

Pin No.	Pin name	Function	Equivalent circuit
13	STEP1	Channels 1/2 - STEP signal input	
20	PWM3/STEP2	3ch PWM signal input / Channels 3/4 - STEP signal input	
19	PWM4	4ch PWM signal input	
40	IN51	Channel 5 - Logic input 1	
39	IN52		
32	IN61	Channel 6- Logic input 1	
31	IN62		
14	SCLK	Serial data transfer clock input	
15	SDATA	Serial data input	
16	STB	Serial data latch pulse input	
11	ST	Chip enable	
10	OUT1A	1ch OUTA output	
7	OUT2A	2ch	
21	OUT3A	3ch	
24	OUT4A	4ch	
4	OUT5A	5ch	
27	OUT6A	6ch	
8	OUT1B	1ch OUTB output	
5	OUT2B	2ch	
23	OUT3B	3ch	
26	OUT4B	4ch	
2	OUT5B	5ch	
29	OUT6B	6ch	
9	RF1	1ch Current sensing resistor connection	
6	RF2	2ch	
22	RF3	3ch	
25	RF4	4ch	
3	RF5	5ch	
28	RF6	6ch	
12	VM12	Channels 1/2 - Motor power supply	
18	VM34	Channels 3/4 - Motor power supply	
38	VM5	Channels 5 - Motor power supply	
33	VM6	Channels 6 - Motor power supply	
35 36	PI1 PI2	Photosensor drive output	

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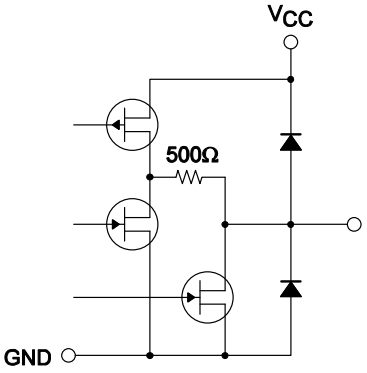
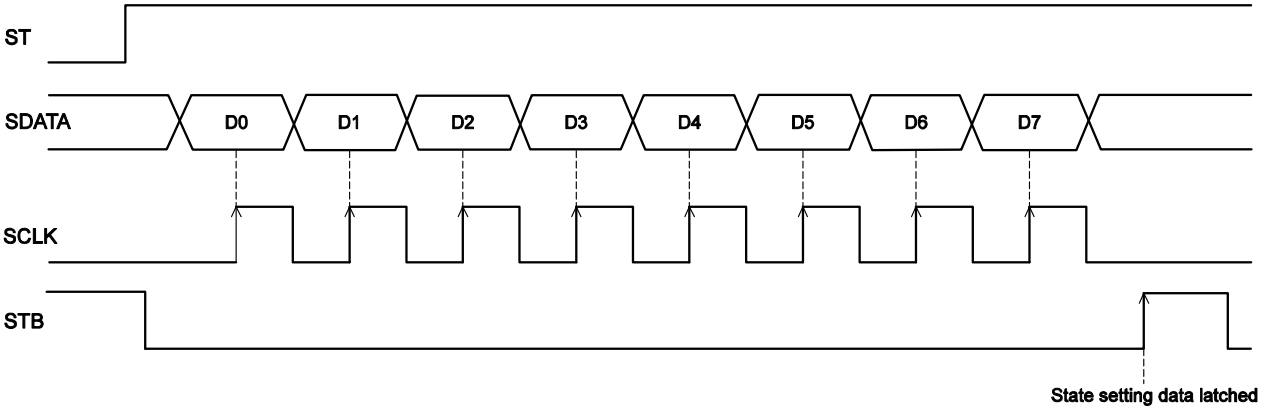
Pin No.	Pin name	Function	Equivalent circuit
37	PI3/MO	Photosensor drive output 3/position detection monitor	
17	V_{CC}	Logic system power supply	
1	PGND1	Channels 1/2/5 - Power system ground	
30	PGND2	Channels 3/4/6 - Power system ground	
34	SGND	Signal system ground	

Unused Pin Transaction Method

Pin No.	Pin name	Unused transaction method
1	PGND1	Connect to GND
2	OUT5B	Open
3	RF5	Connect to GND
4	OUT5A	Open
5	OUT2B	Open
6	RF2	Connect to GND
7	OUT2A	Open
8	OUT1B	Open
9	RF1	Connect to GND
10	OUT1A	Open
11	ST	Open or connect to GND
12	VM12	Connect to motor power supply terminal
13	STEP1	Open or connect to GND
14	SCLK	Open or connect to GND
15	SDATA	Open or connect to GND
16	STB	Open or connect to GND
17	VCC	Connect to control power supply terminal
18	VM34	Connect to motor power supply terminal
19	PWM4	Open or connect to GND
20	PWM3/STEP2	Open or connect to GND
21	OUT3A	Open
22	RF3	Connect to GND
23	OUT3B	Open
24	OUT4A	Open
25	RF4	Connect to GND
26	OUT4B	Open
27	OUT6A	Open
28	RF6	Connect to GND
29	OUT6B	Open
30	PGND2	Connect to GND
31	IN62	Open or connect to GND
32	IN61	Open or connect to GND
33	VM6	Connect to motor power supply terminal
34	SGND	Connect to GND
35	PI1	Open
36	PI2	Open
37	PI3/MO	Open
38	VM5	Connect to motor power supply terminal
39	IN52	Open or connect to GND
40	IN51	Open or connect to GND

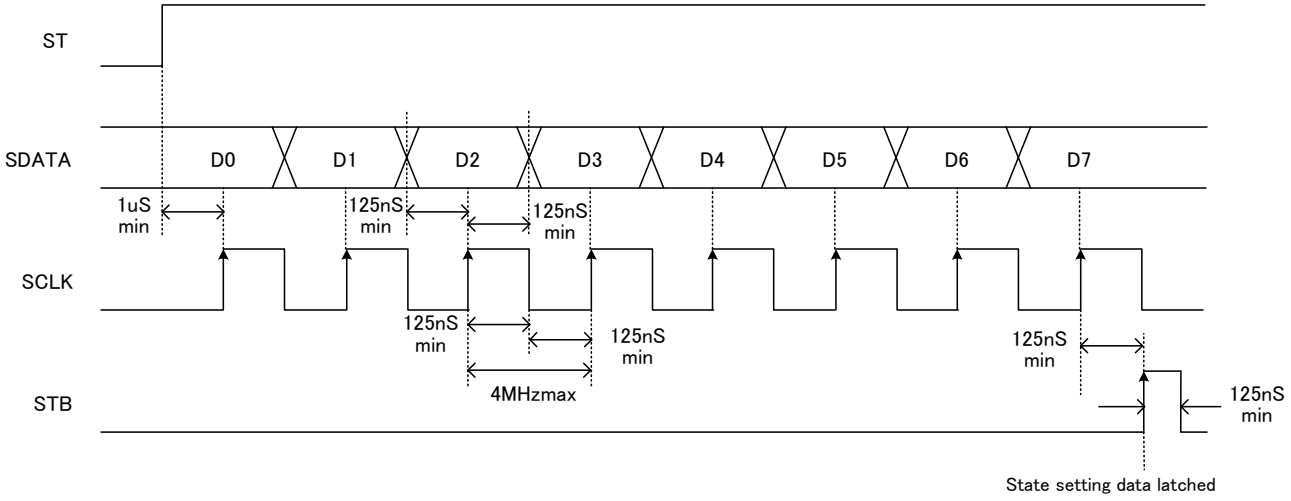
Serial Data Input Specifications

1. Serial Data Input Setup



First set STB low and then input the SDATA and SCLK signals. The SCLK signal is not accepted when STB is high.
SDATA inputs the data in the order D0, D1, … D6, D7.
Data is transferred on the rising edge of SCLK and after all data has been transferred, all the data is latched at the rising edge of STB.

(*) Detailed description of each serial data input



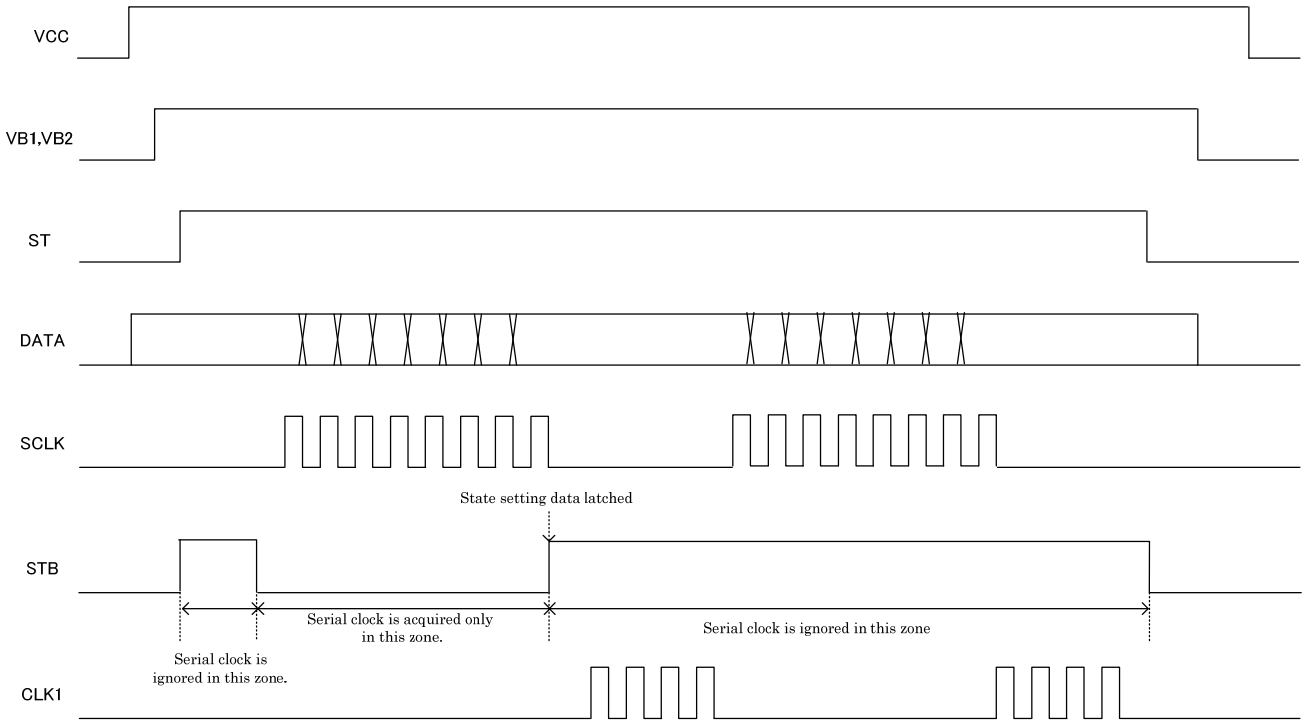
- Input timing of serial data
  - The timing of each serial data input is given above.

  (See the section of **Serial Data Transfer Pin** in **Electrical Characteristics** for the specification.)
- ST input
  - When ST = “L”, the IC is OFF and when ST=”H”, the IC is ON.
  - Make sure to input serial data after switching ST input to ”H”.
  - When ST = “L”, internal register is reset and when ST = ”H”, the reset is cancelled. Hence, ST input should be kept “H” to retain the setup of internal register.

  (Also when VCC voltage drops below V_{CC} low-voltage cut voltage (VthVcc), internal register is reset.)
- DATA signal
  - Data signal should be input in the order of D0 through D7.
- STB signal
  - At the rising edge of STB signal, all the data of D0 to D7 are latched.

  (8 bits of input data immediately before the rise of STB signal are latched.)
  - While STB signal is “H”, the internal circuit does not accept SCLK signal. To input next serial data, make sure to switch STB signal to “L” (See the following diagram).

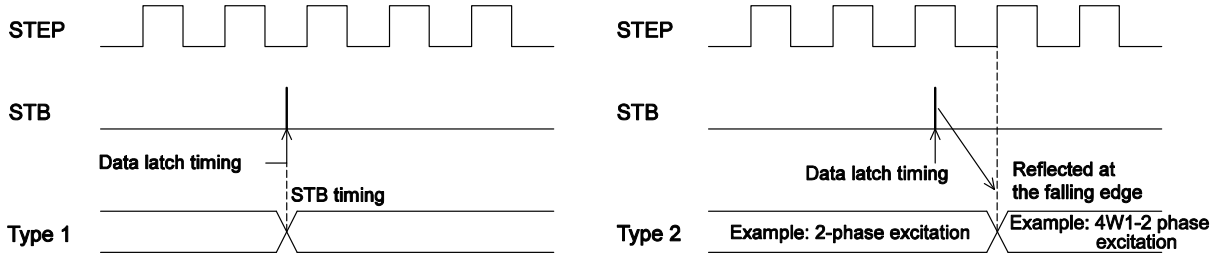
- Timing when serial data is reflected to output
  - While serial data is latched at the rising edge of STB signal, there are 2 types of timing when the data is reflected to output. See **2. Timing with which the Serial Data Settings are Reflected in the Output** for further details.
- The order of power supply for “VCC”, “VM12, VM34, VM5, VM6” and “ST” is as follows.
  (power supply) “VCC” → “VM12, VM34, VM5, VM6” → “ST”
  (OFF) “ST” → “VM12, VM34, VM5, VM6” → “VCC”



2. Timing with which the Serial Data Settings are Reflected in the Output

- STP timing mode (applies to microstep driver settings)
  Type 1: The hold, reset, and enable settings, as well as the reference voltage setting are reflected at the same time as the STB signal data latch operation.
  Type 2: The forward/reverse (FR) and the excitation setting mode (MS) settings that are set at STP setup are reflected in the output at the next clock rising edge after data latch.
- STB timing (applies to settings other than the above)

Type 1: The PWM driver, constant-current driver, PI, and other settings are reflected at the same time as the STB signal data latch operation.



Serial Data Truth Table

Serial Logic Table (1)

Input								Setting mode	Description	Remarks	Set channel						PI	Serial data reflection timing		
D0	D1	D2	D3	D4	D5	D6	D7				1ch	2ch	3ch	4ch	5ch	6ch		STEP1	STEP2	STB
0	0	0	0	0	*	*	*	Channels 1 and 2 excitation mode selection	2 phase		○	○						○		
			1	0	*	*	*		1-2 phase (full torque)											
			0	1	*	*	*		1-2 phase											
			1	1	*	*	*		4W1-2 phase											
			*	*	0	0	*	Channels 1 and 2 current reference voltage selection	100% (0.2V)											○
			*	*	1	0	*		67% (0.134V)											
			*	*	0	1	*		50% (0.1V)											
			*	*	1	1	*		33% (0.066V)											
			*	*	*	*	0	(Dummy data)												
			*	*	*	*	1													
1	0	0	0	*	*	*	*	1/2ch energization direction	CW (Forward)		○	○						○		
			1	*	*	*	*		CCW (Reverse)											
			*	0	*	*	*	1/2ch step hold	Cancel											○
			*	1	*	*	*		Hold											
			*	*	0	*	*	1/2ch counter reset	Reset											
			*	*	1	*	*		Cancel											
			*	*	*	0	*	1/2ch output enable	Output OFF											
			*	*	*	1	*		Output ON											
			*	*	*	*	0	(Dummy data)												
			*	*	*	*	1													

Serial Logic Table (2)

Input								Setting mode	Description	Remarks	Set channel						PI	Serial data reflection timing		
D0	D1	D2	D3	D4	D5	D6	D7				1ch	2ch	3ch	4ch	5ch	6ch		STEP1	STEP2	STB
0	1	0	0	0	*	*	*	3/4ch excitation mode selection	2 phase				○	○					○	
			1	0	*	*	*		1-2 phase (full torque)											
			0	1	*	*	*		1-2 phase											
			1	1	*	*	*		4W1-2 phase											
			*	*	0	0	*	3/4ch current reference voltage selection	100% (0.2V)											○
			*	*	1	0	*		67% (0.134V)											
			*	*	0	1	*		50% (0.1V)											
			*	*	1	1	*		33% (0.066V)											
			*	*	*	*	0	3/4ch Channels 3 and 4 saturation/microstep selection	PWM											
			*	*	*	*	1		Microstep											
1	1	0	0	0	*	*	*	3ch energization direction (Saturated mode)	OFF				○							○
			1	0	*	*	*		OUT3A → OUT3B											
			0	1	*	*	*		OUT3B → OUT3A											
			1	1	*	*	*		Brake											
			*	*	0	0	*	4ch energization direction (Saturated mode)	OFF					○						
			*	*	1	0	*		OUT4A → OUT4B											
			*	*	0	1	*		OUT4B → OUT4A											
			*	*	1	1	*		Brake											
			*	*	*	*	0	3/4ch PWM DECAY (Saturated mode)	Brake				○	○						
			*	*	*	*	1		Standby mode											
			0	*	*	*	*	3/4ch energization direction (Microstep mode)	CW (Forward)										○	
			1	*	*	*	*		CCW (Reverse)											
			*	0	*	*	*	3/4ch step hold (Microstep mode)	Cancel											○
			*	1	*	*	*		Hold				○	○						
			*	*	0	*	*	3/4ch counter reset (Microstep mode)	Reset											
			*	*	1	*	*		Cancel											
			*	*	*	0	*	3/4ch output enable (Microstep mode)	Output OFF											
			*	*	*	1	*		Output ON											
			*	*	*	*	0	(Dummy data)												
			*	*	*	*	1													

Serial Logic Table (3)

Input								Setting mode	Description	Remarks	Set channel						PI	Serial data reflection timing		
D0	D1	D2	D3	D4	D5	D6	D7				1ch	2ch	3ch	4ch	5ch	6ch		STEP1	STEP2	STB
0	0	1	0	0	*	*	*	5ch energization direction	OFF	*1					○					○
			1	0	*	*	*		OUT5A □ OUT5B											
			0	1	*	*	*		OUT5B □ OUT5A											
			1	1	*	*	*		Brake											
			*	*	0	0	*	6ch energization direction	OFF	*2						○				
			*	*	1	0	*		OUT6A □ OUT6B											
			*	*	0	1	*		OUT6B □ OUT6A											
			*	*	1	1	*		Brake											
			*	*	*	*	0	(Dummy data)												
			*	*	*	*	1													
1	0	1	0	*	*	*	*	Reference setting channel selection	5ch setting							○	○			○
			1	*	*	*	*		6ch setting											
			*	0	0	0	0	Constant-current reference voltage	0.300V											
			*	1	0	0	0		0.200V											
			*	0	1	0	0		0.190V											
			*	1	1	0	0		0.180V											
			*	0	0	1	0		0.170V											
			*	1	0	1	0		0.165V											
			*	0	1	1	0		0.160V											
			*	1	1	1	0		0.155V											
			*	0	0	0	1		0.150V											
			*	1	0	0	1		0.145V											
			*	0	1	0	1		0.140V											
			*	1	1	0	1		0.135V											
			*	0	0	1	1		0.130V											
			*	1	0	1	1		0.120V											
			*	0	1	1	1		0.110V											
			*	1	1	1	1		0.100V											

Serial Logic Table (4)

Input								Setting mode	Description	Remarks	Set channel						PI	Serial data reflection timing		
D0	D1	D2	D3	D4	D5	D6	D7				1ch	2ch	3ch	4ch	5ch	6ch		STEP1	STEP2	STB
0	1	1	0	*	*	*	*	Photo-sensor drive 1	OFF								○			○
			1	*	*	*	*		ON											
			*	0	*	*	*	Photo-sensor drive 2	OFF											
			*	1	*	*	*		ON											
			*	*	0	*	*	Photo-sensor drive 3 (When PI3 output selected)	OFF											
			*	*	1	*	*		ON											
			*	*	*	0	*	(Dummy data)												
			*	*	*	1	*													
			*	*	*	*	0	(Dummy data)												
			*	*	*	*	1													
1	1	1	0	*	*	*	*	PI3/MO select	PI3 Output								○			○
			1	*	*	*	*		MO output											
			*	0	*	*	*	MO output channel selection (When MO output selected)	1/2ch	*3										
			*	1	*	*	*		3/4ch											
			*	*	0	*	*	MO output position	Initial position	*4										
			*	*	1	*	*		1-2 phase											
			*	*	*	0	0	Chopping frequency setting	130KHz											
			*	*	*	1	0		65KHz											
			*	*	*	0	1		200KHz											
			*	*	*	1	1		100KHz											

Notes

*1: This serial data is only accepted when the IN51/IN52 pulse inputs are in the Low/Low states, respectively. It is ignored at all other times.

*2: This serial data is only accepted when the IN61/IN62 pulse inputs are in the Low/Low states, respectively. It is ignored at all other times.

*3: When D4 = 1, MO is only output if microstep mode is selected for channels 3 and 4. In PWM mode, this output is held fixed at the high level.

*4: The MO output can be specified to be the 1-2 phase position only in 4W1-2 phase excitation mode. In all other excitation modes, the MO output position becomes the initial position regardless of the serial data values.

Channels 1 and 2 Driver Circuit (Microstep drive stepping mode driver)

STEP1 Pin Function

Input		Operating mode
ST	STEP1	
Low	*	Standby mode
High		Excitation step feed
High		Excitation step hold

Excitation Mode Setting (D0 = 0, D1 = 0, D2 = 0)

D3	D4	Excitation mode	Initial position	
			1ch	2ch
0	0	2 phase excitation	100%	-100%
1	0	1-2 phase excitation (full torque)	100%	0%
0	1	1-2 phase excitation	100%	0%
1	1	4W1-2 phase excitation	100%	0%

The initial state at power on is the initial position for each excitation mode when the counter is reset.

Reference Voltage Setting Serial Data: (D0 = 0, D1 = 0, D2 = 0)

D5	D6	Current setting reference voltage (When microstep is 100%)
0	0	0.2V
1	0	0.134V
0	1	0.1V
1	1	0.066V

The output current setting reference voltage can be switched between four levels with the serial data. This setting is useful for saving power in the motor powered hold state.

Calculating the Set Current

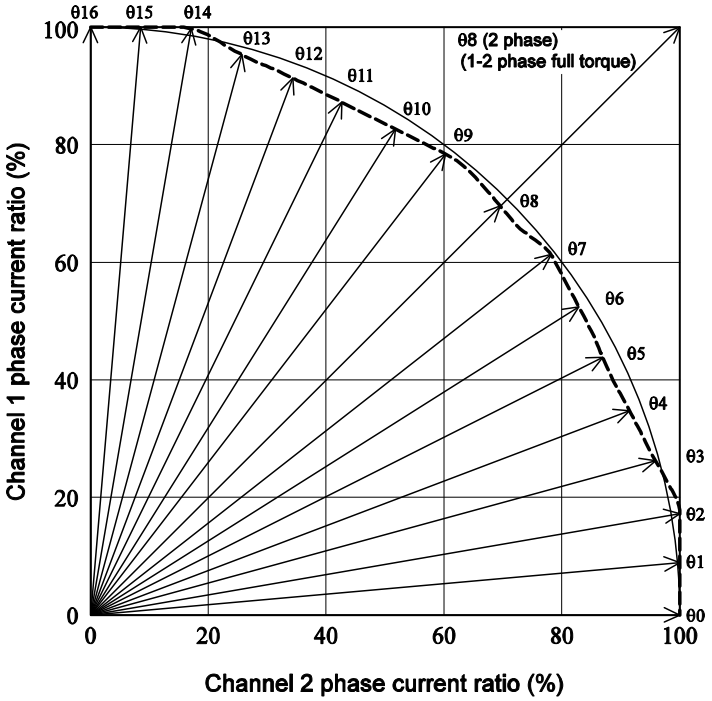
Since the reference voltage can be modified (0.2, 0.134, 0.1, and 0.66V) with the serial data, the output current can be set with the reference voltage and the resistor RF connected between the RF pin and ground.

I_{OUT} = (<reference voltage> × <set current ratio>)/<RF resistor value>

Example: If the reference voltage is 0.2 V, the set current ratio is 100%, and the RF resistor value is 1Ω, then the output current will be that shown below.

I_{OUT} = 0.2V × 100%/1Ω = 200mA

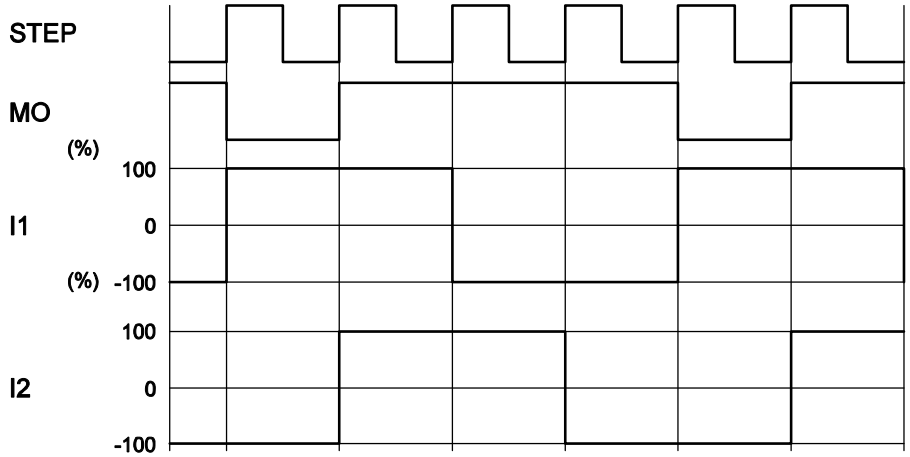
Output Current Vector Locus (With one step normalized to 90 degrees)



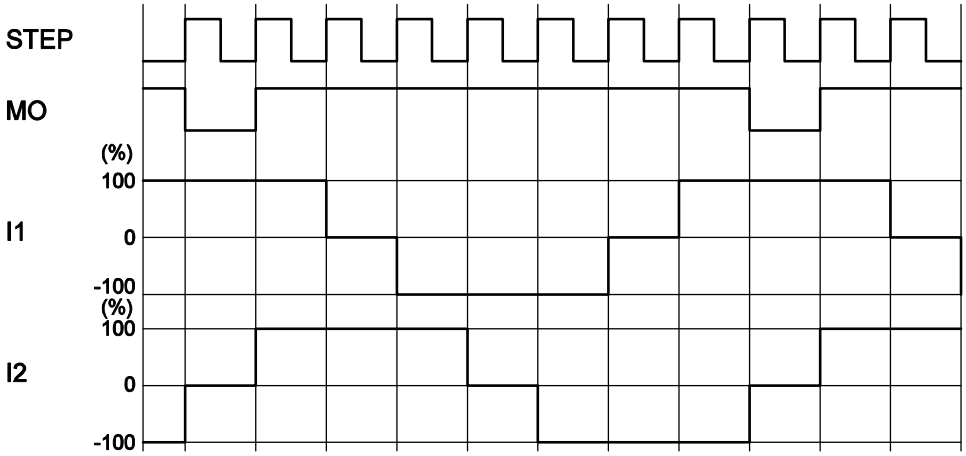
Set Current Ratios in the Different Excitation Modes

STEP	4W1-2 phase (%)		1-2 phase (%)		1-2 phase full torque (%)		2 phase (%)	
	1ch	2ch	1ch	2ch	1ch	2ch	1ch	2ch
θ0	0	100	0	100	0	100		
θ1	10	100						
θ2	20	100						
θ3	30	96.5						
θ4	39.5	93.0						
θ5	48.5	89						
θ6	57.5	85.5						
θ7	65.5	81.5						
θ8	74.0	74.0	74.0	74.0	100	100	100	100
θ9	81.5	65.5						
θ10	85.5	57.5						
θ11	89	48.5						
θ12	93.0	39.5						
θ13	96.5	30						
θ14	100	20						
θ15	100	10						
θ16	100	0	100	0	100	0		

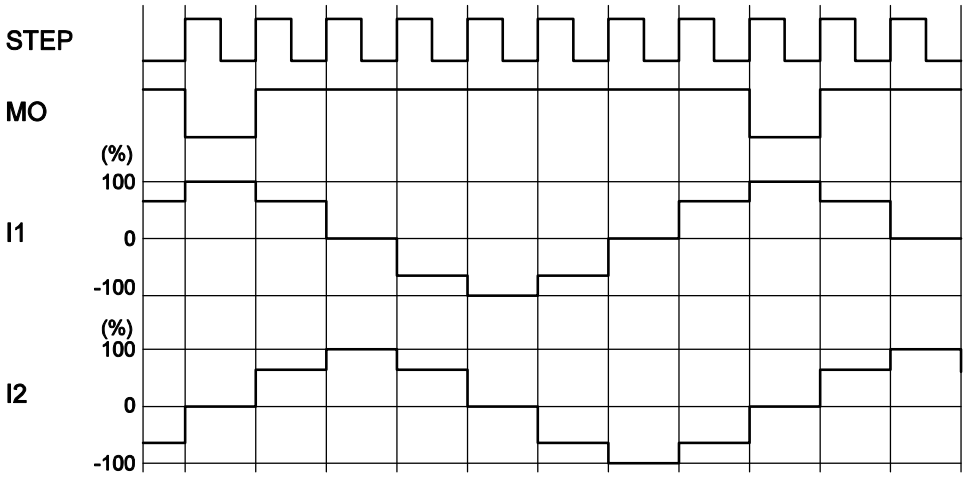
2 Phase Excitation (CW mode)



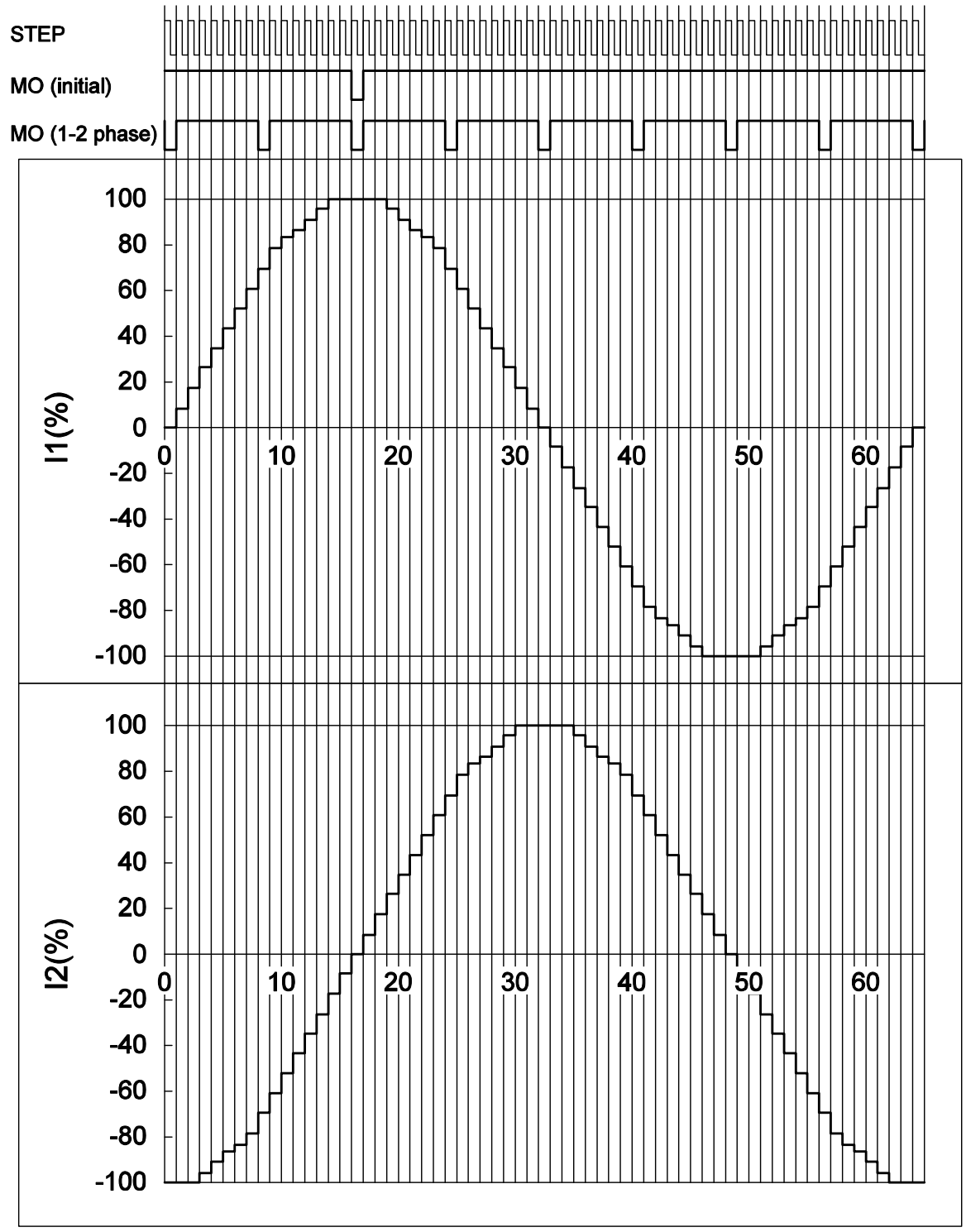
1-2 Phase Excitation full torque (CW mode)



1-2 Phase Excitation (CW mode)

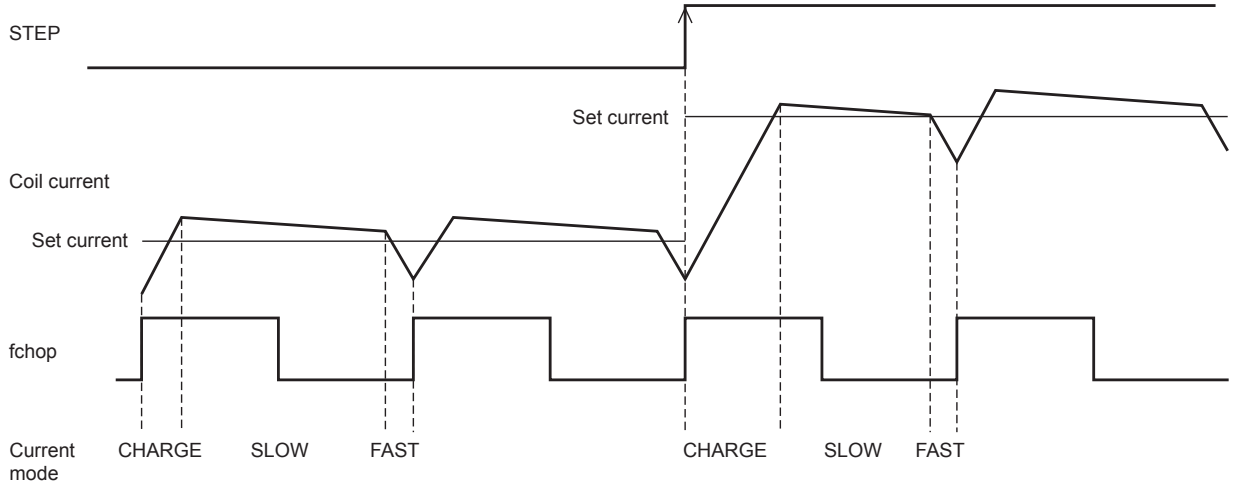


4W1-2 Phase Excitation (CW mode)

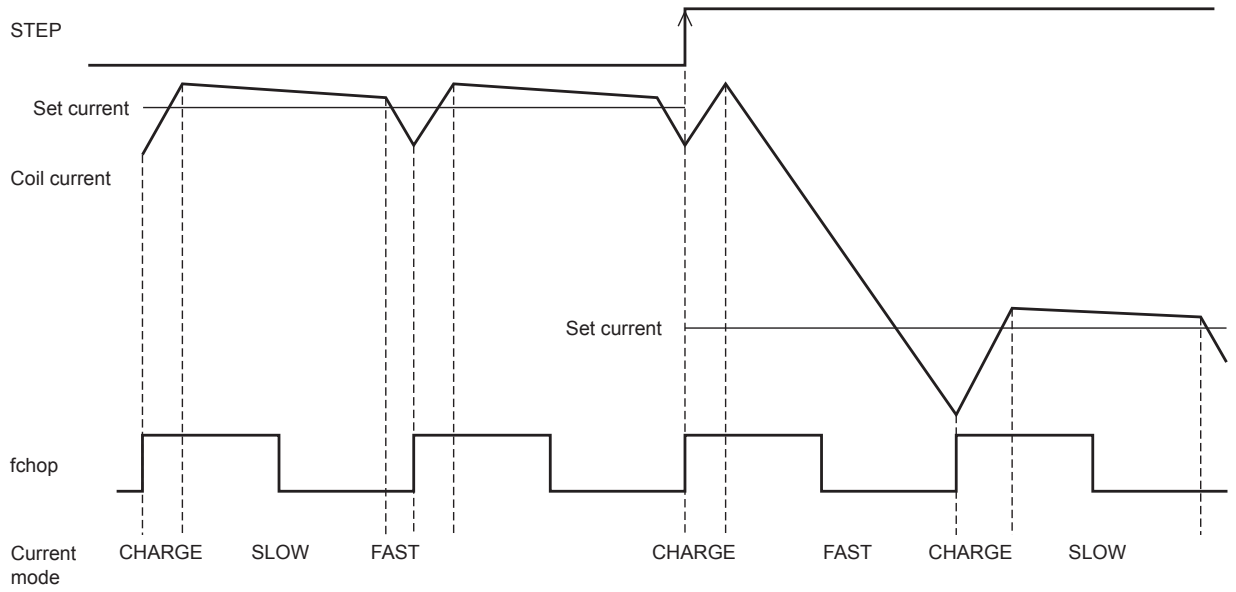


Current Control Operation Specifications

- Sine wave increasing direction



- Sine wave decreasing direction



Each of the current modes operates with the follow sequence.

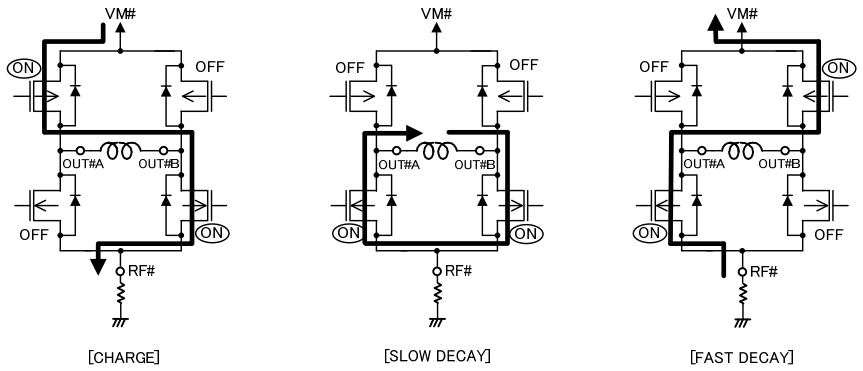
- The IC enters CHARGE mode when the chopping oscillation starts. (A period of CHARGE mode is forcibly present in 1/8 of the period, regardless of which of the coil current (ICOIL) and the set current (IREF) is larger.)
- In CHARGE mode, the coil current (ICOIL) and the set current (IREF) are compared.

If an ICOIL < IREF state exists during the CHARGE period:
The IC operates in CHARGE mode until ICOIL ≥ IREF. After that, it switches to SLOW DECAY mode and then switches to FAST DECAY mode in the last 1/8 of the period.

If no ICOIL < IREF state exists during the CHARGE period:
The IC switches to FAST DECAY mode and the coil current is attenuated with the FAST DECAY operation until the end of the chopping period.

The above operation is repeated. Normally, in the sine wave increasing direction the IC operates in SLOW (+FAST) DECAY mode, and in the sine wave decreasing direction the IC operates in FAST DECAY mode until the current is attenuated and reaches the set value and the IC operates in SLOW DECAY mode.

•Current mode diagram



Chopping Frequency Setting (D6 and D7 in the serial data)

This IC integrates an internal oscillator circuit and allows the chopping frequency used in constant-current control to be switched with the serial data (111***, D6, D7) setting.

Data D6	Data D7	Chopping frequency
0	0	130KHz
1	0	65KHz
0	1	200KHz
1	1	100KHz

Monitor Output Setting (Serial data bits D3, D4, and D5)

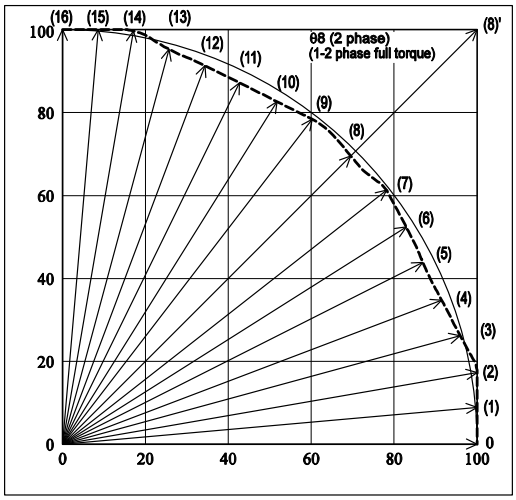
The signal output from the PI3/MO pin can be switched with the serial data (111, D3, ****) setting.

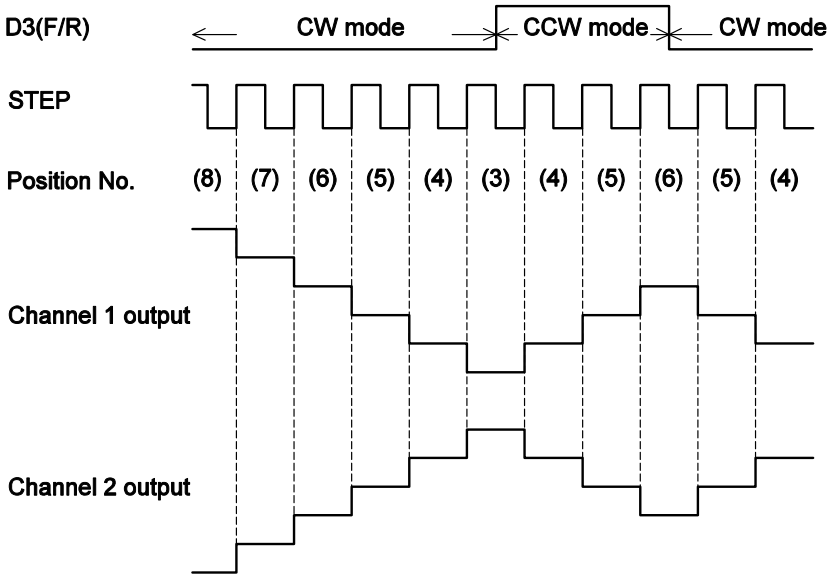
Data D3	PI3/MO pin output
0	Photosensor drive output 3
1	Stepping position detection monitor output

It is also possible to select which of channels 1 and 2 or channels 3 and 4 are output from the monitor pin with the serial data (111*, D4, D5, **) setting. The MO output position used to detect the driver excitation position in microstepping drive mode can also be switched. The state MO = Low is output at the output position.

Data D4	Data D5	Channels 1 and 2 excitation mode	Channels 3 and 4 excitation mode	MO output
0	0	2 phase excitation		Channels 1 and 2 monitor/initial position
	1			
	0	1-2 phase excitation (full torque)		
	1			
	0	1-2 phase excitation		
	1			
	0	4W1-2 phase excitation		Channels 1 and 2 monitor/initial position
	1			Channels 1 and 2 monitor/1-2 phase position
1	0		2 phase excitation	Channels 3 and 4 monitor/initial position
	1			
	0		1-2 phase excitation (full torque)	
	1			
	0		1-2 phase excitation	
	1			
	0		4W1-2 phase excitation	Channels 3 and 4 monitor/initial position
	1			Channels 3 and 4 monitor/1-2 phase position
1	0		PWM drive mode	Output held fixed at the high level
	1			

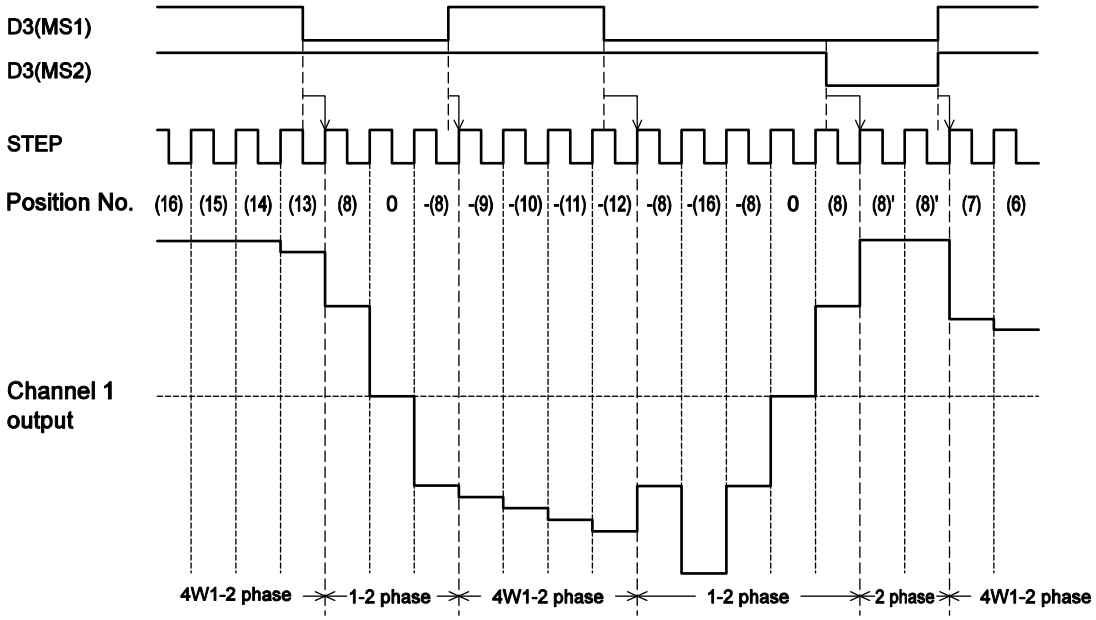
Basic Set Current Step Switching (STEP pin) and Forward/Reverse Switching (D3 in the serial data) Operations





The IC internal D/A converter advances by 1 bits on the rising edge of the input step pulse.
The CW/CCW mode can be switched with the serial data (100, D3, ****) setting. The operation progresses with the position number decreasing in CW mode and increasing in CCW mode.
In CW mode, the channel 2 current phase is delayed by 90 degrees relative to the channel 1 current.
In CCW mode, the channel 2 current phase is advanced by 90 degrees relative to the channel 1 current.

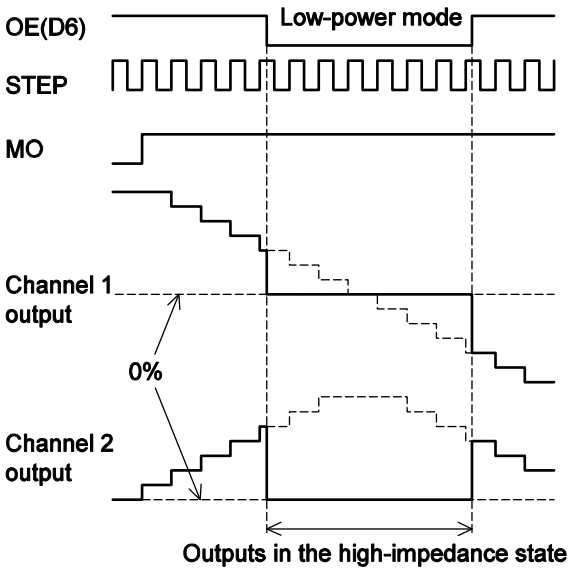
Excitation Mode Switching During Operation (D3 and D4 in the serial data)



If the excitation mode is switched when power is applied to the motor, the operation follows the sequence shown below. (CW mode)

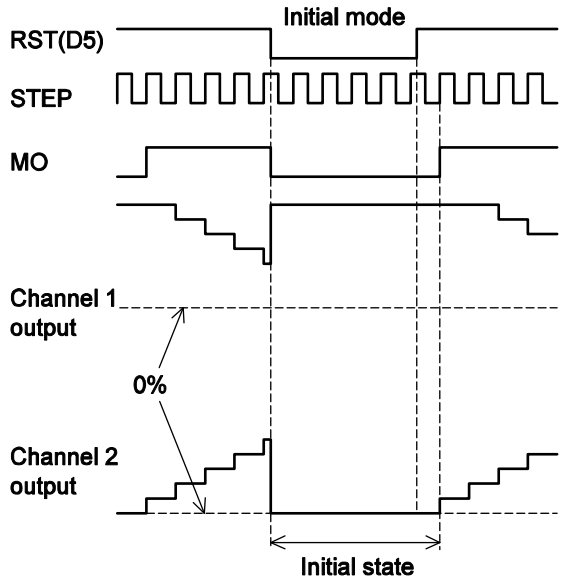
Before excitation mode switching		Step position after excitation mode switching			
Excitation mode	Position	4W1-2 phase	1-2 phase	1-2 phase full torque	2 phase
4W1-2 phase	(16)		(8)	(8)’	(8)’
	(15) to (9)		(8)	(8)’	(8)’
	(8)		0	0	(8)’
	(7) to (1)		(8)	(8)’	(8)’
	0		-(8)	-(8)’	-(8)’
1-2 phase	(16)	(15)		(8)’	(8)’
	(8)	(7)		0	(8)’
	0	-(1)		-(8)’	-(8)’
1-2 phase full torque	(16)	(15)	(8)		(8)’
	(8)’	(7)	0		(8)’
	0	-(1)	-(8)		-(8)’
2 phase	(8)’	(7)	0	0	

Output Enable Function (D6 in the serial data)



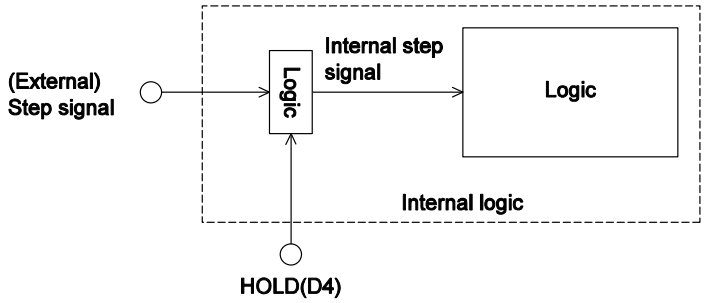
When the OE bit in the serial data, D6 (100, ***, D6, *), is set to 0, the output is turned off and set to the high-impedance state at the rise of STB.
Since, however, the internal logic circuits operate in this state, the position number will be advanced if a step input is applied. Therefore, when the OE bit (D6) is returned to 1, a level according to the position number advanced by the step input will be output.

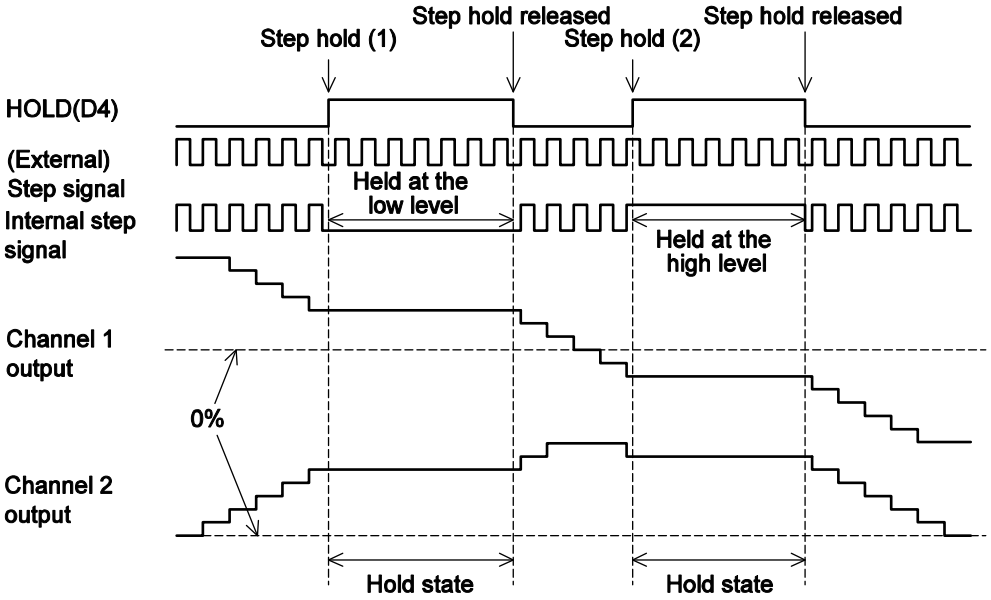
Counter Reset Function (D5 in the serial data)



When the reset bit in the serial data, D5 (100, **, D5, **), is set to 0, the output goes to the initial state at the rise of STB and the MO output goes low.
Then, when the reset bit (D5) is next set to 1, the position number will advance at the next step input.

Step Hold Function (D4 in the serial data)





When the hold bit in the serial data, D4 (100, *, D4, ***), is set to 1, the external step state at that time is held without change as the internal step state.
Since the (external) step state is low at the timing of the step hold operation (1) in the figure, the internal step state is held at the low level, and since the (external) step state is high at the timing of the step hold operation (1), the internal step state is held at the high level.
When the hold data (D) is set to 0, the internal state is synchronized with the external step signal.
The output is held at the state at the point where the step hold was applied and after the step hold is released, it advances with the timing of the next step input (rising edge).
As long as the IC is in the hold state, the position number does not advance even if external step pulses are applied.

Channels 3 and 4 Driver Circuit (Saturated drive/microstep drive)

Driver Mode Setting (D0 = 0, D1 = 1, D2 = 0)

D7 data value	Drive mode	Pin functions	Notes
0	Saturated drive	PWM3	Used as the channel 3 PWM input pin
1	Microstep drive	STEP2	Used as the channels 3 and 4 excitation step input pin

The channels 3 and 4 driver circuit can be switched between the following operating modes by bit D7 in the serial data (010, ****, D7).

(1) Two saturated mode driver channels
(2) One microstep drive stepping motor driver channel

Microstep Drive Stepping Motor Driver

The basic functionality provided is identical to that of the channels 1 and 2 stepping motor driver. See section 10-2 for details on the serial data settings.

PWM Saturated Mode Driver

Channel 3 Truth Table (PWM mode: D0 = 1, D1 = 1, D2 = 0)

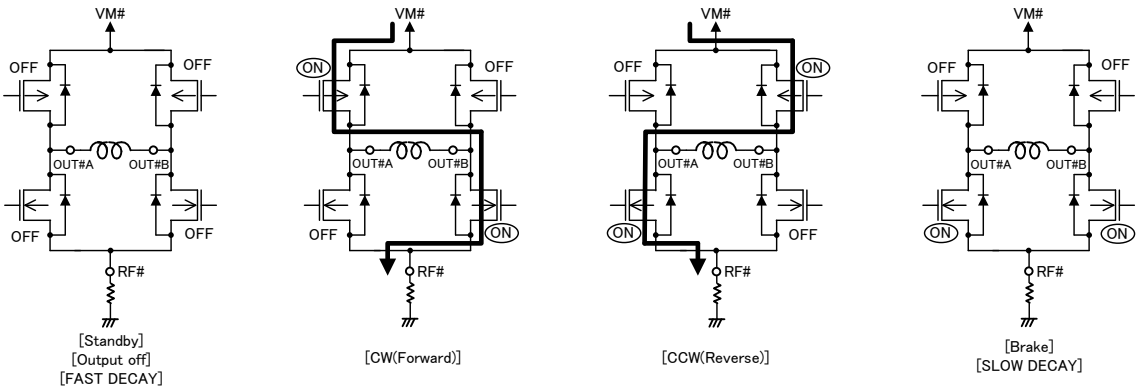
Input					Output		Operating mode
ST	PWM3	D3	D4	D7	OUT3A	OUT3B	
Low	*	*	*	*	OFF	OFF	Standby mode
High	Low	0	0	*	OFF	OFF	Output off
		1	0		High	Low	CW (forward)
		0	1		Low	High	CCW (reverse)
		1	1		Low	Low	Brake
	High	*	*	0	Low	Low	SLOW DECAY (brake)
				1	OFF	OFF	FAST DECAY (output off)

Channel 4 Truth Table (PWM mode: D0 = 1, D1 = 1, D2 = 0)

Input					Output		Operating mode
ST	PWM4	D5	D6	D7	OUT4A	OUT4B	
Low	*	*	*	*	OFF	OFF	Standby mode
High	Low	0	0	*	OFF	OFF	Output off
		1	0		High	Low	CW (forward)
		0	1		Low	High	CCW (reverse)
		1	1		Low	Low	Brake
	High	*	*	0	Low	Low	SLOW DECAY (brake)
				1	OFF	OFF	FAST DECAY (output off)

*: Don't care

Operating mode diagram



Channels 5 and 6 Driver Circuit (Constant-current drive)

Output Function

When the channels 5 and 6 driver circuit is used to drive an actuator, it can be controlled either from the serial data or from the IN51, IN52, IN61, and IN62 parallel signals.
When the parallel input signals IN51 (IN61)/IN52 (IN62) are in the low/low state (note that since these inputs are pulled down internally in the IC, the open/open state can also be used), the output mode will be determined by the serial data.
If the parallel input signals are in any state other than the above, the serial data will be ignored and the output mode will be determined by the parallel inputs.

Truth Table (Channel 5: D0 = 0, D1 = 0, D2 = 1)

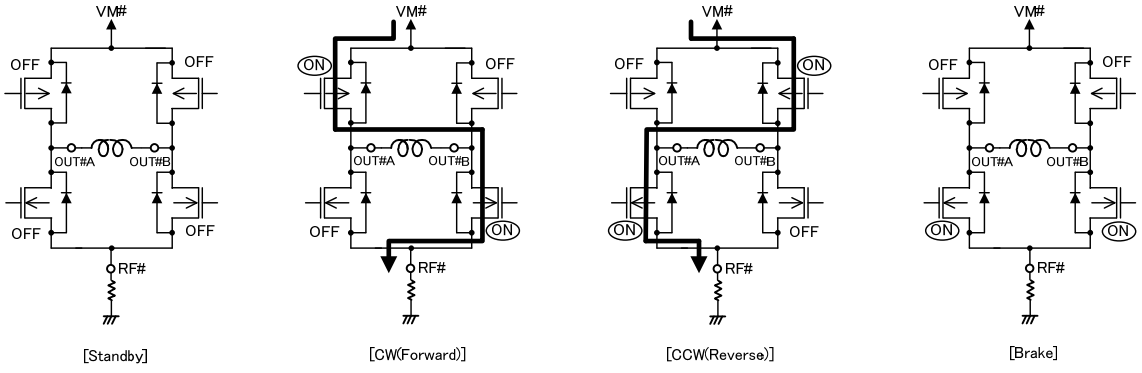
Parallel input		Serial data		Outputs		Operating mode
IN51	IN52	D3	D4	OUT5A	OUT5B	
Low	Low	0	0	OFF	OFF	Standby mode
		1	0	High	Low	CW (forward)
		0	1	Low	High	CCW (reverse)
		1	1	Low	Low	Brake
High	Low	*	*	High	Low	CW (forward)
Low	High			Low	High	CCW (reverse)
High	High			Low	Low	Brake

Truth Table (Channel 6: D0 = 0, D1 = 0, D2 = 1)

Parallel input		Serial data		Outputs		Operating mode
IN61	IN62	D5	D6	OUT6A	OUT6B	
Low	Low	0	0	OFF	OFF	Standby mode
		1	0	High	Low	CW (forward)
		0	1	Low	High	CCW (reverse)
		1	1	Low	Low	Brake
High	Low	*	*	High	Low	CW (forward)
Low	High			Low	High	CCW (reverse)
High	High			Low	Low	Brake

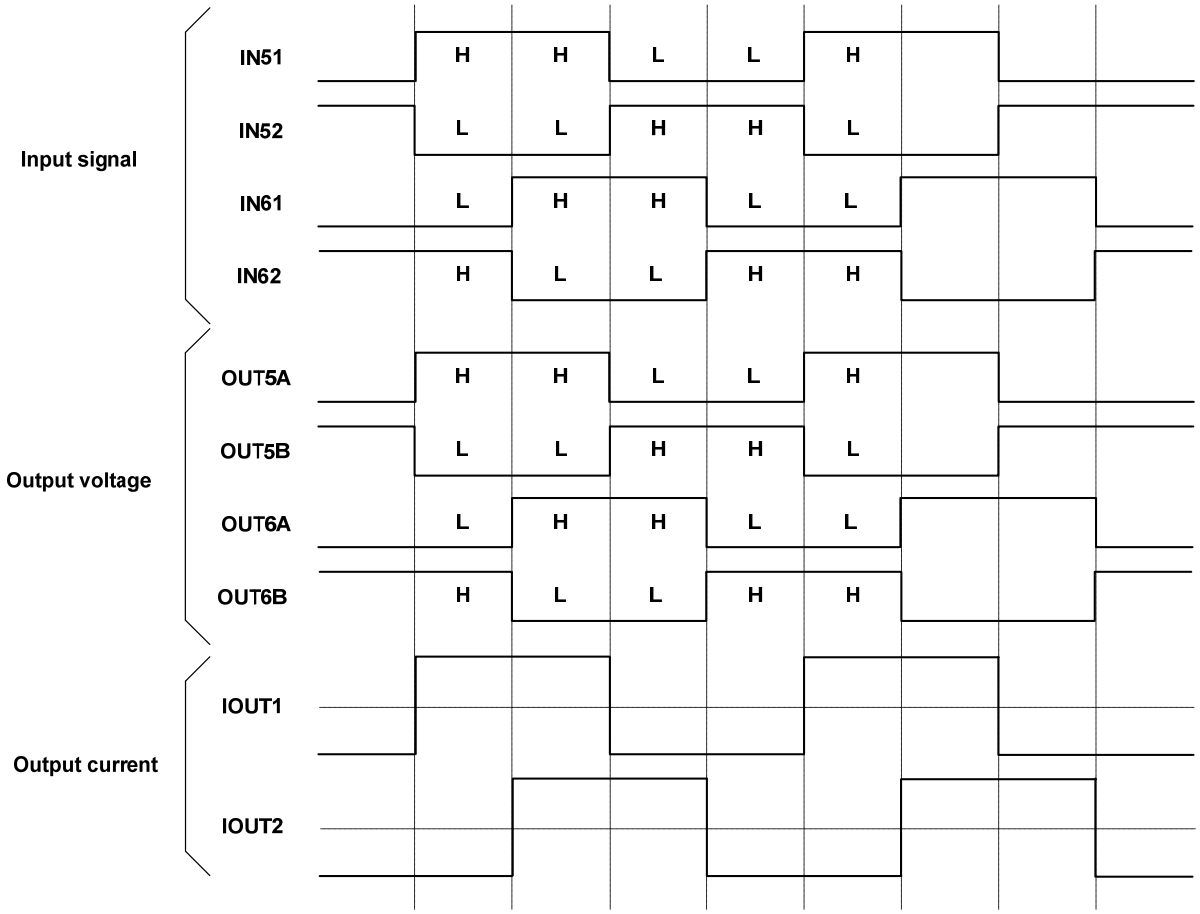
*: Don’t care

Operating mode diagram

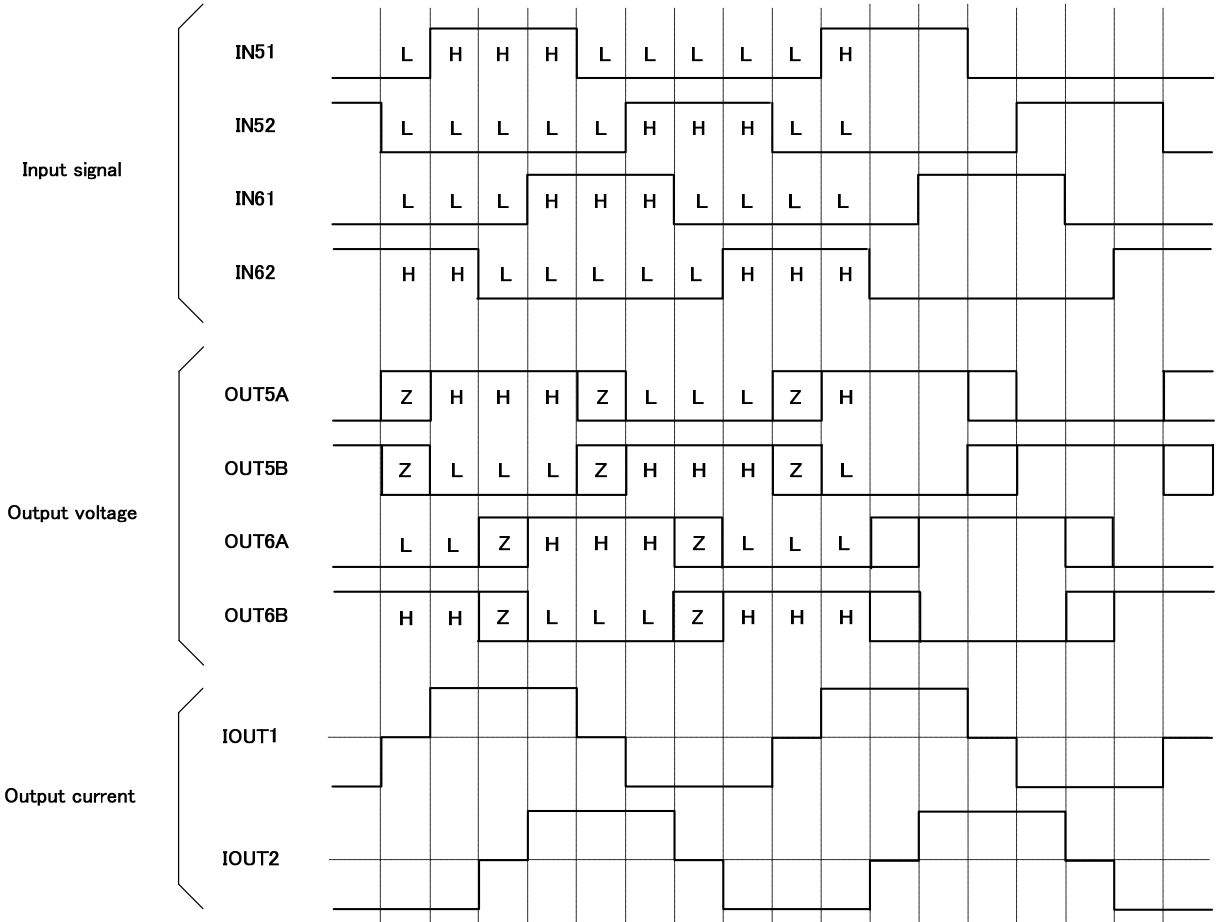


Stepping motor driving methods using parallel input

[Timing chart of 2phase excitation]



[Timing chart of 1−2phase excitation]



Constant-Current Control

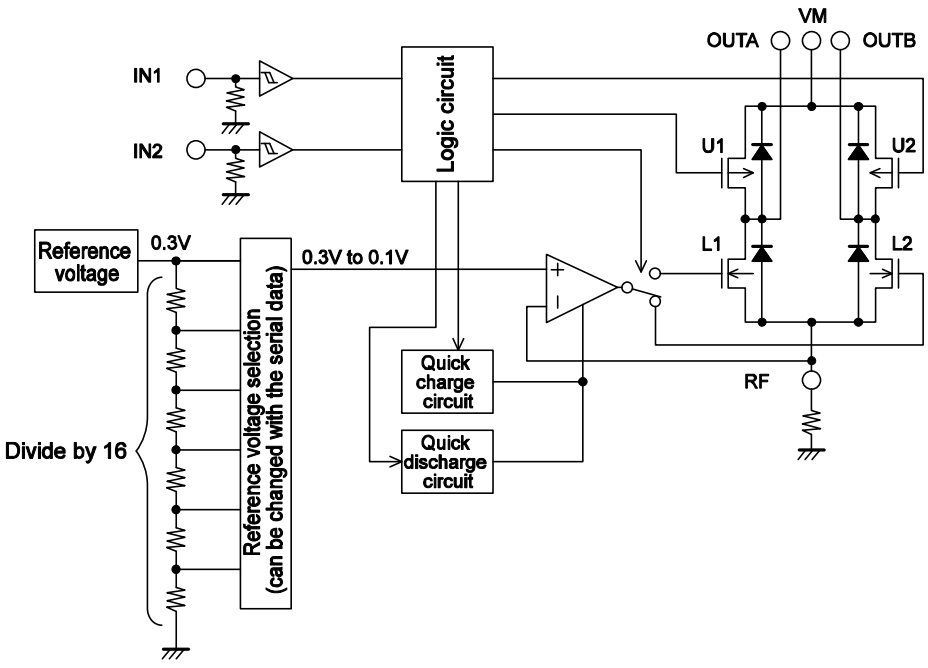
Reference Voltage Setting (D0 = 1, D1 = 0, D2 = 1, D3 = 0 (channel 5) or D3 = 1 (channel 6))

D4	D5	D6	D7	Current setting reference voltage
0	0	0	0	0.300V
1	0	0	0	0.200V
0	1	0	0	0.190V
1	1	0	0	0.180V
0	0	1	0	0.170V
1	0	1	0	0.165V
0	1	1	0	0.160V
1	1	1	0	0.155V
0	0	0	1	0.150V
1	0	0	1	0.145V
0	1	0	1	0.140V
1	1	0	1	0.135V
0	0	1	1	0.130V
1	0	1	1	0.120V
0	1	1	1	0.110V
1	1	1	1	0.100V

The constant-current setting for channels 5 and 6 can be set individually for each channel.
(When D3 is 0, channel 5 is set, and when D3 is 1, channel 6 is set.)

The constant-current output value is set by the constant-current reference voltage set with the serial data and the value of the resistor (referred to as "RF" here) connected to the RF5 or RF6 pin.
The formula below is used to calculate the constant-current output value.

<Constant-current output level> = <current setting reference voltage>/<RF resistor>



Photosensor Drive Circuit (PI1, PI2, and PI3)

The photosensor drive circuit has open-drain outputs. The output is controlled (set to on or off) by a bit in the serial data (0 or 1).

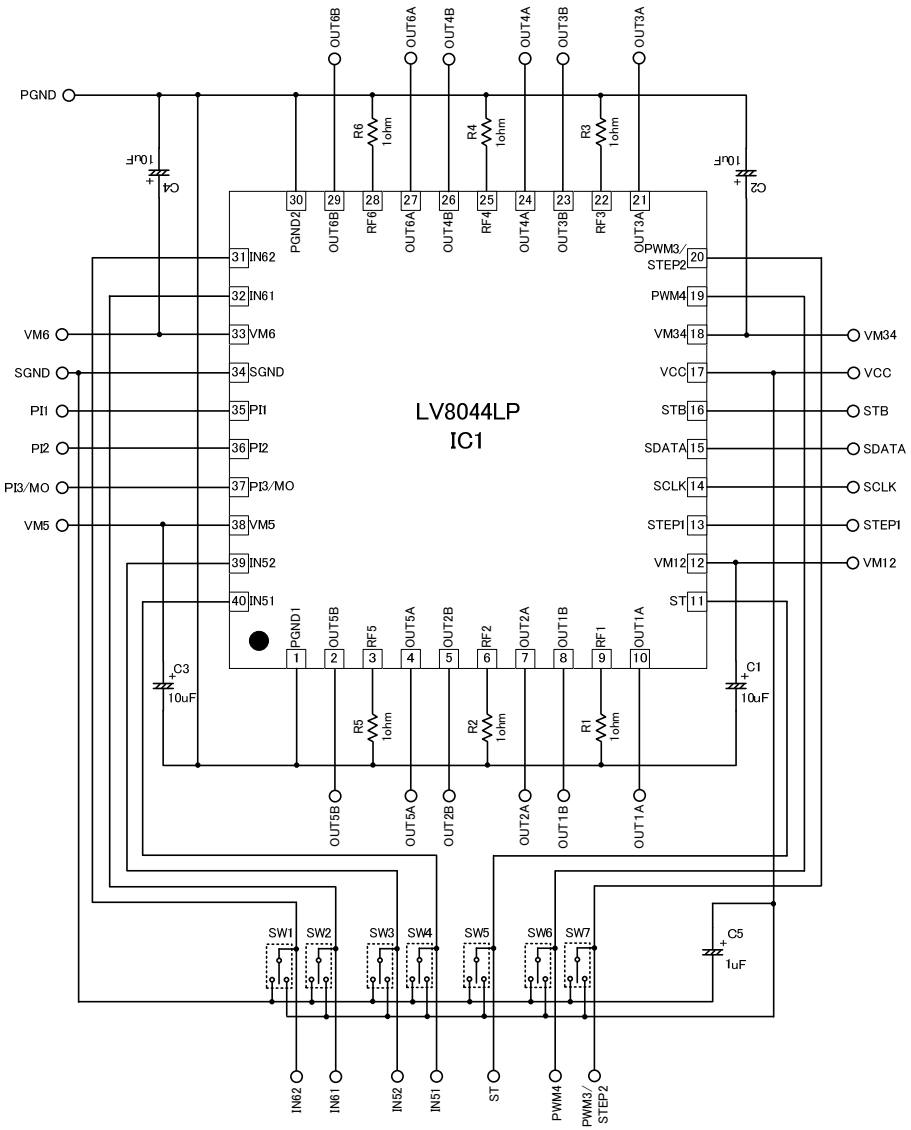
Truth Table

Input				Output			Drive circuit
ST	D3	D4	D5	PI1	PI2	PI3	
Low	*	*	*	OFF	OFF	OFF	Standby mode
High	0	*	*	OFF	*	*	Off
	1	*	*	Low	*	*	On
	*	0	*	*	OFF	*	Off
	*	1	*	*	Low	*	On
	*	*	0	*	*	OFF	Off
	*	*	1	*	*	Low	On

Evaluation board manual

•Overview

•Circuit diagram



Bill of Materials for LV8044LP Evaluation Board

Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			VQLP40 (5.0X5.0)	ON Semiconductor	LV8044LP	No	Yes
C1-C4	4	VM Bypass capacitor	10μF 50V			SUN Electronic Industries	50ME10HC	Yes	Yes
C5	1	VCC Bypass Capacitor	1μF 25V			Murata	GRM188F11E105Z	Yes	Yes
R1-R6	6	Output current detective resistor	1.0Ω, 1/4W	±1%		Rohm	MCR10EZHFL1R00	Yes	Yes
SW1-SW7	7	Switch				MIYAMA Electric	MS-621C-A01	Yes	Yes
TP1-TP35	35	Test points				MAC8	ST-1-3	Yes	Yes
CN1	1	Connector				HIROSE ELECTRIC	HIF3F-20PA-2.54DSA	Yes	Yes