Ordering number : ENA0004A

SANYO Semiconductors
DATA SHEET

LV8042LG — Bi-CMOS IC For Digital Still Cameras 7-Channel Single-Chip Motor Driver ICs

Overview

The LV8042LG is Motor driver 7ch single-chip for DSC.

Features

- Micro-step driven stepping motor driver×2
- PWM driven forward/reverse motor driver
  (changeover to the micro-step driving stepping motor driver 1ch possible) × 2
- PWM driven forward/reverse motor driver×2
- Constant-current forward/reverse motor driver × 1
- Two-phase, single-two phase full torque, single-two phase, 4W1-2, phase excitation drive changeover possible (1/2/3/4ch)
- Progress of micro-step driven excitation steps by clock signal input only (1/2/3/4ch)
- Holding electrification current changeover in four steps possible by serial data (1/2/3/4ch)
- Constant-current control chopping frequency variable with external resistor (1/2/3/4ch)
- 8-bit wire serial data control

Actuator application example

	Shutter	Iris	Focus	Zoom
Application 1	Constant current /VCM	Saturation /STM or VCM	Micro-step /STM	Micro-step /STM
Application 2	Constant current /VCM	Saturation /STM or VCM	Micro-step /STM	Saturation /STM or DCM
Application 3	Constant current /VCM	Micro-step /STM	Micro-step /STM	Saturation /STM or DCM

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Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_M max		6	V
Supply voltage 2	V_{CC} max		6	V
Output peak current	$I_O$peak	1ch/2ch/3ch/4ch/5ch/6ch/7ch Pulse width<10ms, ty≤20%	600	mA
Output continuous current	I_O max	1ch/2ch/3ch/4ch/5ch/6ch/7ch	400	mA
Allowable power dissipation 1	Pd max1	Independent IC	0.32	W
Allowable power dissipation 2	Pd max2	Mounted on a specified board *	1.4	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

Note *1: Mounted on a specified board: 40mm×50mm×0.8mm glass epoxy (four-layer substrate)

Allowable Operating Range at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range 1	VM		2 to 5.5	V
Supply voltage range 2	V_{CC}		2.7 to 5.5	V
Logic input voltage	V_{IN}		0 to V_{CC}+0.3	V
Chopping frequency	fchop	1ch, 2ch, 3ch, 4ch	50 to 200	kHz
Clock frequency	fCLK	CLK12, CLK34	to 64	kHz
PWM frequency	fPWM	PWM3, PWM4, PWM5, PWM6	to 100	kHz

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

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Standby current drain	Istn	ST="L"			1.0	μA
Operating current drain 1	IM	ST="H", PWM="H", IN72="H" no load		50	100	μA
Operating current drain 2	I_{CC}	ST="H", PWM="H", IN72="H" no load		4.0	5.0	mA
V_{CC} low-voltage cutting voltage	VthV_{CC}		2.1	2.35	2.6	V
Low-voltage hysteresis voltage	VthHIS		100	150	200	mV
VG reference voltage	VGL		4.4	4.7	5.0	V
Charge pump boost voltage	VGH		VM+3.5	VM+4	VM+4.5	V
Charge pump rise time	tONG	C (VGH)=0.1μF		0.1	0.2	ms
Charge pump oscillation frequency	Fchg	R=20kΩ	100	125	150	kHz
Thermal shutdown temperature	TSD	Design guarantee*	150	160	180	°C
Thermal hysteresis width	ΔTSD	Design guarantee*	20	30	40	°C
Stepping motor driver (1ch/2ch)						
Output ON resistance	Ronu1	I_O=400mA, upper		0.6	0.7	Ω
	Rond1	I_O=400mA, lower		0.6	0.7	Ω
Output leak current	$I_O$leak1				1.0	μA
Diode forward voltage	VD1	ID=-400mA	0.6	0.9	1.2	V
Logic pin input current	I_{IN}L1	V_{IN}=0V (ST, CLK12)			1.0	μA
	I_{IN}H1	V_{IN}=3.3V (ST, CLK12)	20	33	50	μA
Logic input "H" level voltage	V_{IN}H1	ST, CLK12	2.5			V
Logic input "L" level voltage	V_{IN}L1	ST, CLK12			1.0	V

Note: * Design target value. These items are not tested.

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Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Current selection reference voltage level	4W1-2 phases		Step 16 (1ch comparing level during initialization)	0.185	0.200	0.215	V
			Step 15 (initialization +1)	0.185	0.200	0.215	V
			Step 14 (initialization +2)	0.185	0.200	0.215	V
			Step 13 (initialization +3)	0.176	0.191	0.206	V
			Step 12 (initialization +4)	0.170	0.185	0.200	V
			Step 11 (initialization +5)	0.162	0.177	0.192	V
			Step 10 (initialization +6)	0.154	0.169	0.184	V
			Step 9 (initialization +7)	0.146	0.161	0.176	V
			Step 8 (initialization +8)	0.129	0.144	0.159	V
			Step 7 (initialization +9)	0.113	0.128	0.143	V
			Step 6 (initialization +10)	0.097	0.112	0.127	V
			Step 5 (initialization +11)	0.079	0.094	0.109	V
			Step 4 (initialization +12)	0.062	0.077	0.092	V
			Step 3 (initialization +13)	0.044	0.059	0.074	V
			Step 2 (initialization +14)	0.024	0.039	0.054	V
			Step 1 (initialization +15)	0.006	0.021	0.036	V
	1-2 phases		Step 16 (1ch comparing level during initialization)	0.185	0.200	0.215	V
			Step 8 (initialization +1)	0.129	0.144	0.159	V
	1-2 phases full torque		Step 16 (1ch comparing level during initialization)	0.185	0.200	0.215	V
			Step 8 (initialization +1)	0.185	0.200	0.215	V
	2 phase		Step 8	0.185	0.200	0.215	V
Chopping frequency		Fchop1	R=20kΩ	100	125	150	kHz
Current setting reference voltage		VSEN11	(D3, D2)=(0, 0)	0.185	0.200	0.215	V
		VSEN12	(D3, D2)=(0, 1)	0.119	0.134	0.149	V
		VSEN13	(D3, D2)=(1, 0)	0.085	0.100	0.115	V
		VSEN14	(D3, D2)=(1, 1)	0.051	0.066	0.081	V
PWM drive/stepping motor driver (3ch/4ch)							
Output ON resistance		Ronu2	I_O=400mA, upper		0.6	0.7	Ω
		Rond2	I_O=400mA, lower		0.6	0.7	Ω
Output leak current		$I_O$leak2				1.0	μA
Diode forward voltage		VD2	ID=-400mA	0.6	0.9	1.2	V
Logic input current		I_{IN}L2	VIN=0V (PWM3, PWM4)			1.0	μA
		I_{IN}H2	VIN=3.3V (PWM3, PWM4)	20	33	50	μA
Logic input “H” level voltage		V_{IN}H2	PWM3, PWM4	2.5			V
Logic input “L” level voltage		V_{IN}L2	PWM3, PWM4			1.0	V

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Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Current selection reference voltage level	4W1-2 phases		Step 16 (3ch comparing level during initialization)	0.185	0.200	0.215	V
			Step 15 (initialization +1)	0.185	0.200	0.215	V
			Step 14 (initialization +2)	0.185	0.200	0.215	V
			Step 13 (initialization +3)	0.176	0.191	0.206	V
			Step 12 (initialization +4)	0.170	0.185	0.200	V
			Step 11 (initialization +5)	0.162	0.177	0.192	V
			Step 10 (initialization +6)	0.154	0.169	0.184	V
			Step 9 (initialization +7)	0.146	0.161	0.176	V
			Step 8 (initialization +8)	0.129	0.144	0.159	V
			Step 7 (initialization +9)	0.113	0.128	0.143	V
			Step 6 (initialization +10)	0.097	0.112	0.127	V
			Step 5 (initialization +11)	0.079	0.094	0.109	V
			Step 4 (initialization +12)	0.062	0.077	0.092	V
			Step 3 (initialization +13)	0.044	0.059	0.074	V
			Step 2 (initialization +14)	0.024	0.039	0.054	V
			Step 1 (initialization +15)	0.006	0.021	0.036	V
	1-2 phases		Step 16 (3ch comparing level during initialization)	0.185	0.200	0.215	V
			Step 8 (initialization +1)	0.129	0.144	0.159	V
	1-2 phases full torque		Step 16 (3ch comparing level during initialization)	0.185	0.200	0.215	V
			Step 8 (initialization +1)	0.185	0.200	0.215	V
	2 phase		Step 8	0.185	0.200	0.215	V
Chopping frequency		Fchop2	R=20kΩ	100	125	150	kHz
Current setting reference voltage		VSEN21	(D5, D4)=(0, 0)	0.185	0.200	0.215	V
		VSEN22	(D5, D4)=(0, 1)	0.119	0.134	0.149	V
		VSEN23	(D5, D4)=(1, 0)	0.085	0.100	0.115	V
		VSEN24	(D5, D4)=(1, 1)	0.051	0.066	0.081	V
PWM driven forward/reverse motor driver (5ch/6ch)							
Output ON resistance		Ronu3	I_O=400mA, upper		0.6	0.7	Ω
		Rond3	I_O=400mA, lower		0.6	0.7	Ω
Output leak current		$I_O$leak3				1.0	μA
Diode forward voltage		VD3	ID=-400mA	0.6	0.9	1.2	V
Logic pin input current		I_{IN}L3	V_{IN}=0V (PWM5, PWM6)			1.0	μA
		I_{IN}H3	V_{IN}=3.3V (PWM5, PWM6)	20	33	50	μA
Logic input “H” level voltage		V_{IN}H3	PWM5, PWM6	2.5			V
Logic input “L” level voltage		V_{IN}L3	PWM5, PWM6			1.0	V
Constant current forward/reverse motor driver (7ch)							
Output ON resistance		Ronu4	I_O=400mA, upper		0.6	0.7	Ω
		Rond4	I_O=400mA, lower		0.6	0.7	Ω
Output leak current		$I_O$leak4				1.0	μA
Diode forward voltage		VD4	ID=-400mA	0.6	0.9	1.2	V
Logic pin input current		I_{IN}L4	V_{IN}=0V (IN71, IN72)			1.0	μA
		I_{IN}H4	V_{IN}=3.3V (IN71, IN72)	20	33	50	μA
Logic input “H” level voltage		V_{IN}H4	IN71, IN72	2.5			V
Logic input “L” level voltage		V_{IN}L4	IN71, IN72			1.0	V
Output constant current		I_{OUT}7	Rload=3Ω, SEN7=0.5Ω, LIM7=0.2V	384	400	416	mA
VREF7 output voltage		VREF7	(D7, D6)=(0, 0)	0.190	0.200	0.210	V
LIM7 input current		ILIM7	LIM7=0V			1.0	μA

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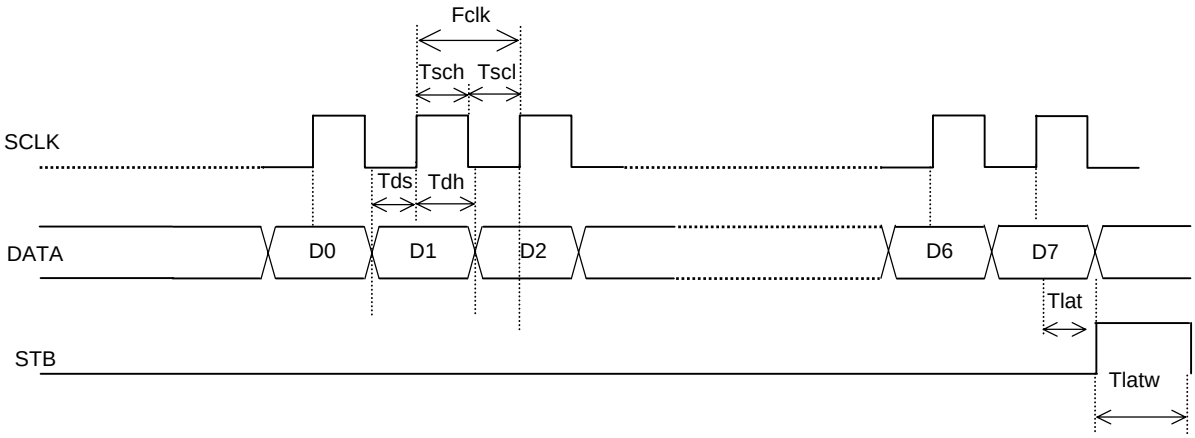
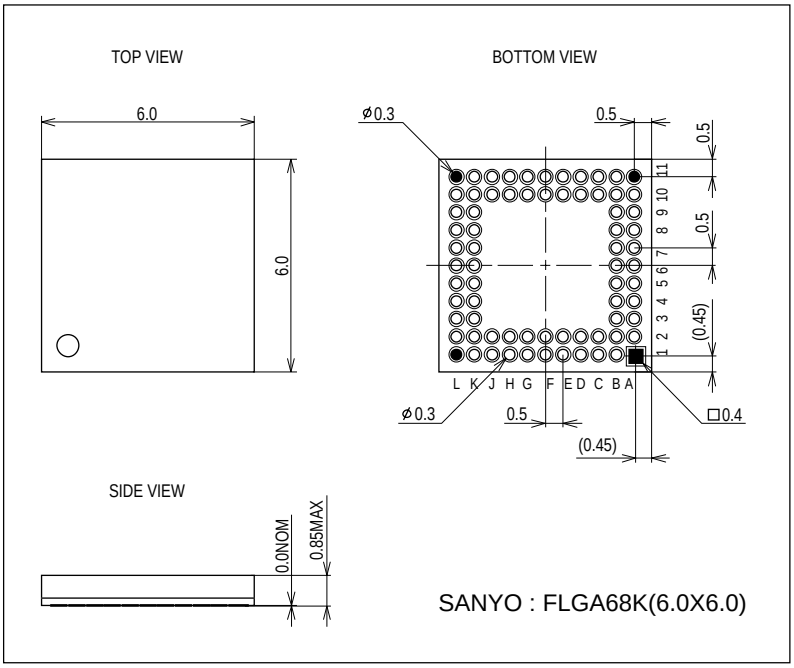
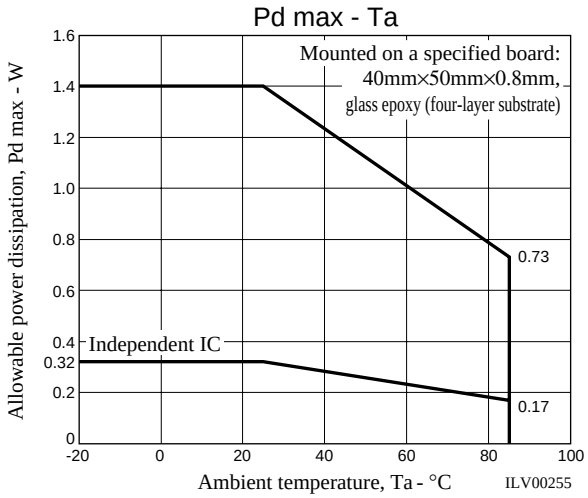
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
FC7 rapid charge current	Irafc7		300	450	600	µA
FC7 steady charge current	Ichfc7		5	10	15	µA
FC7 steady discharge current	Idisfc7		5	10	15	µA
Current setting reference voltage	VSEN41	(D7, D6)=(0, 0)	0.190	0.200	0.210	V
	VSEN42	(D7, D6)=(0, 1)	0.124	0.134	0.144	V
	VSEN43	(D7, D6)=(1, 0)	0.090	0.100	0.110	V
	VSEN44	(D7, D6)=(1, 1)	0.056	0.066	0.076	V
Serial data transmission pin						
Logic pin input current	I_{IN}L5	V_{IN}=0V (SCLK, DATA, STB)			1.0	µA
	I_{IN}H5	V_{IN}=3.3V (SCLK, DATA, STB)	20	33	50	µA
Logic input “H” level voltage	V_{IN}H5	SCLK, DATA, STB	2.5			V
Logic input “L” level voltage	V_{IN}L5	SCLK, DATA, STB			1.0	V
Minimum SCLK “H” pulse width	Tsch		0.125			µs
Minimum SCLK “L” pulse width	Tscl		0.125			µs
STB specified time	Tlat		0.125			µs
Minimum STB pulse width	Tlatw		0.125			µs
Data setup time	Tds		0.125			µs
Data hold time	Tdh		0.125			µs
Maximum SCLK frequency	Fclk				4	MHz



Package Dimensions

unit : mm (typ)
3326





Pin Functions

Pin No	Pin Name	Description
5	VM12	STP 1ch/2ch Motor power connection pin
2	OUT1A	STP 1ch OUTA Output pin
4	OUT1B	STP 1ch OUTB Output pin
3	SEN1	STP 1ch Current sensing resistor connection pin
6	OUT2A	STP 2ch OUTA Output pin
8	OUT2B	STP 2ch OUTB Output pin
7	SEN2	STP 2ch Current sensing resistor connection pin
68	PGND12	STP 1ch/2ch Power GND
67	CLK12	STP Clock signal input pin
66	MO	STP Position detection monitor pin
29	SCLK	Serial data transmission CLK input pin
27	DATA	Serial data input pin

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Pin No	Pin Name	Description
28	STB	Serial data latch pulse input pin
32	R	Oscillation frequency setting resistor connection pin
13	VM34	PWM/STP 3ch/4ch Motor power connection pin
10	OUT3A	PWM 3ch OUTA Output pin STP 3ch OUTA Output pin
12	OUT3B	PWM 3ch OUTB Output pin STP 3ch OUTB Output pin
11	SEN3	STP 3ch Current sensing resistor connection pin
14	OUT4A	PWM 4ch OUTA Output pin STP 4ch OUTA Output pin
17	OUT4B	PWM 4ch OUTB Output pin STP 4ch OUTB Output pin
15	SEN4	STP 4ch Current sensing resistor connection pin
20	PGND34	PWM/STP 3ch/4ch Power GND
21	PWM3/CLK34	PWM 3ch PWM Signal input pin STP Clock signal input pin
22	PWM4	PWM 4ch PWM Signal input pin
39	VM56	PWM 5ch/6ch Motor power connection pin
36	OUT5A	PWM 5ch OUTA Output pin
38	OUT5B	PWM 5ch OUTB Output pin
33	PWM5	PWM 5ch PWM Signal input pin
41	OUT6A	PWM 6ch OUTA Output pin
44	OUT6B	PWM 6ch OUTB Output pin
34	PWM6	PWM 6ch PWM Signal input pin
43	PGND56	PWM 5ch/6ch Power GND
49	VM7	Constant-current 7ch motor power connection pin
58	FC7	Constant-current 7ch phase compensation capacitor connection pin
47	SEN7	Constant-current 7ch current sensing resistor connection pin
46	OUT7A	Constant-current 7ch OUTA output pin
48	OUT7B	Constant-current 7ch OUTB output pin
64	IN71	Constant-current 7ch 1 logic input pin
65	IN72	Constant-current 7ch 2 logic input pin
45	PGND7	Constant-current 7ch power GND
62	VREF7	Constant-current 7ch current setting reference voltage output
60	LIM7	Constant-current 7ch constant-current setting pin
51	CPL1	Charge pump capacitor connection pin
52	CPL2	Charge pump capacitor connection pin
54	CPH1	Charge pump capacitor connection pin
56	CPH2	Charge pump capacitor connection pin
53	VGL	Lower DMOS gate voltage capacitor connection pin
57	VGH	Upper DMOS gate voltage capacitor connection pin
24	ST	Chip enable pin
30	V_{CC}	Logic power connection pin
26	GND	Signal GND

Pin Assignment

	L	K	J	H	G	F	E	D	C	B	A	
		17 OUT4B	15 SEN4	13 VM34	11 SEN3	9 (NC)	7 SEN2	5 VM12	3 SEN1	1 (NC)		1
	18 (NC)	16 (NC)	14 OUT4A	12 OUT3B	10 OUT3A	8 OUT2B	6 OUT2A	4 OUT1B	2 OUT1A	67 CLK12	68 PGND12	2
	20 PGND34	19 (NC)								65 IN72	66 MO	3
	22 PWM4	21 PWM3/ CLK34								63 (NC)	64 IN71	4
	24 ST	23 (NC)								61 (NC)	62 VREF	5
	26 GND	25 (NC)				LV8042LG				59 (NC)	60 LIM7	6
	28 STB	27 DATA								57 VGH	58 FC7	7
	30 V_{CC}	29 SCLK								55 (NC)	56 CPH2	8
	32 R	31 (NC)								53 VGL	54 CPH1	9
	34 PWM6	33 PWM5	36 OUT5A	38 OUT5B	40 (NC)	42 (NC)	44 OUT6B	46 OUT7A	48 OUT7B	50 (NC)	52 CPL2	10
		35 (NC)	37 (NC)	39 VM56	41 OUT6A	43 PGND	45 PGND	47 SEN7	49 VM7	51 CPL1		11

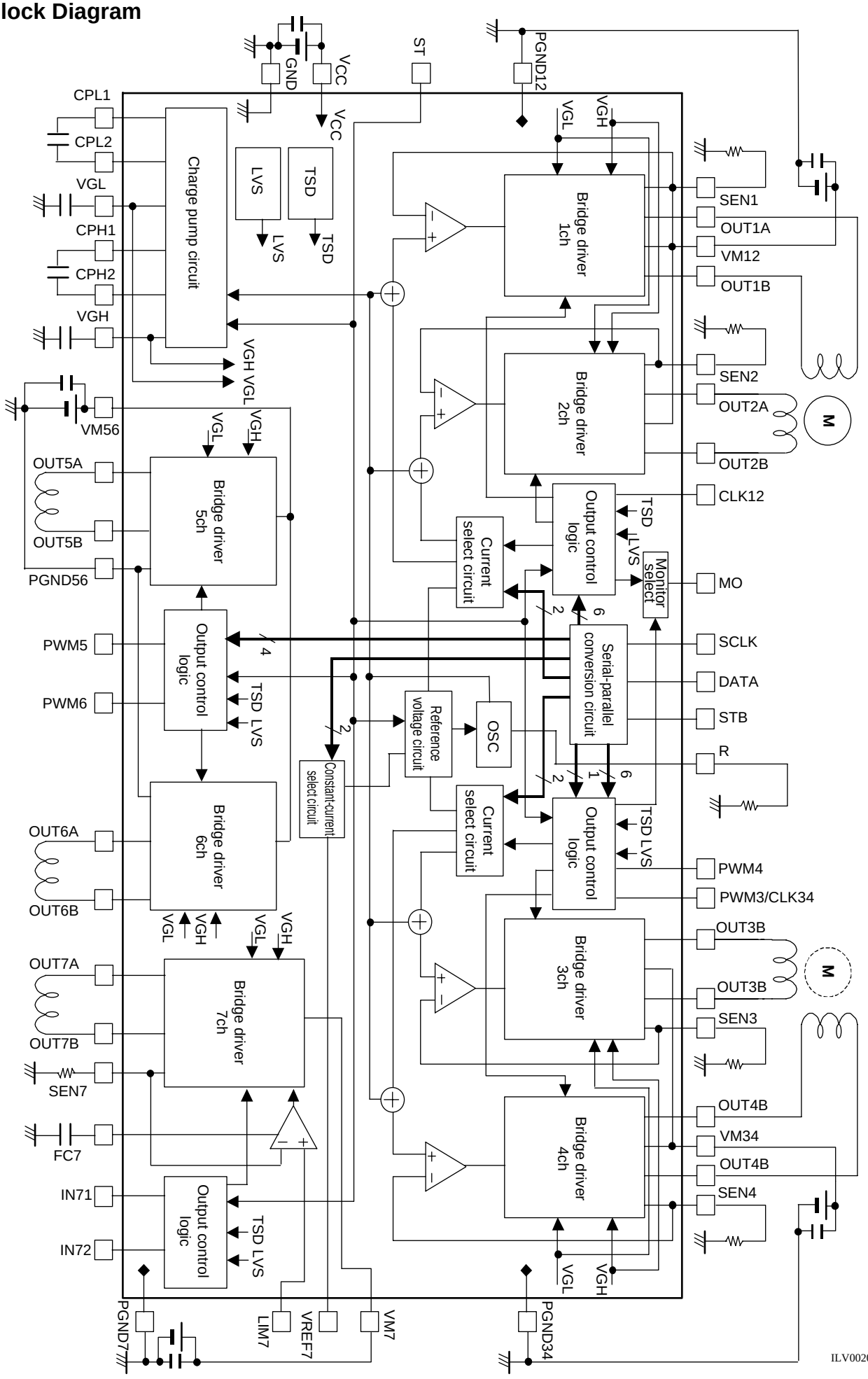
Top View

	A	B	C	D	E	F	G	H	J	K	L
1		1 (NC)	3 SEN1	5 VM12	7 SEN2	9 (NC)	11 SEN3	13 VM34	15 SEN4	17 OUT4B	
2	68 PGND12	67 CLK12	2 OUT1A	4 OUT1B	6 OUT2A	8 OUT2B	10 OUT3A	12 OUT3B	14 OUT4A	16 (NC)	18 (NC)
3	66 MO	65 IN72								19 (NC)	20 PGND34
4	64 IN71	63 (NC)								21 PWM3/ CLK34	22 PWM4
5	62 VREF7	61 (NC)								23 (NC)	24 ST
6	60 LIM7	59 (NC)				LV8042LG				25 (NC)	26 GND
7	58 FC7	57 VGH								27 DATA	28 STB
8	56 CPH2	55 (NC)								29 SCLK	30 V_{CC}
9	54 CPH1	53 VGL								31 (NC)	32 R
10	52 CPL2	50 (NC)	48 OUT7B	46 OUT7A	44 OUT6B	42 (NC)	40 (NC)	38 OUT5B	36 OUT5A	33 PWM5	34 PWM6
11		51 CPL1	49 VM7	47 SEN7	45 PGND7	43 PGND56	41 OUT6A	39 VM56	37 (NC)	35 (NC)	

(NC): No Connect

Bottom view

Block Diagram



Serial Data Input Specification

Register (D1, D0): Selection of Data Transmission Destination

D1	D0	Mode
0	0	STP reference voltage setting/Monitor output setting/3ch · 4ch drive mode setting
0	1	1ch · 2ch (STP) setting
1	0	3ch · 4ch (PWM/STP) setting
1	1	5ch · 6ch(PWM) setting /7ch (constant current) reference voltage setting

Setting (D1, D0) of serial data as shown in the table above enables selection of the register for status setting of each motor driver.

STP Reference Voltage Setting/Monitor Output Setting/3ch · 4ch Drive Mode Setting

Register No.	Data	Nomenclature	Functions
D0	0	RG_SELECT 1	Register select 1
D1	0	RG_SELECT 2	Register select 2
D2	0 or1	VSEN1_SELECT 1	1ch · 2ch reference voltage select 1
D3	0 or 1	VSEN1_SELECT 2	1ch · 2ch reference voltage select 2
D4	0 or 1	VSEN2_SELECT 1	3ch · 4ch reference voltage select 1
D5	0 or 1	VSEN2_SELECT 2	3ch · 4ch reference voltage select 2
D6	0 or 1	MO_SELECT	Monitor output channel select
D7	0 or 1	PWM/MICRO	3ch · 4ch drive mode setting

1ch · 2ch (STP) Setting

Register No.	Data	Nomenclature	Functions	Channel
D0	1	RG_SELECT 1	Register select 1	
D1	0	RG_SELECT 2	Register select 2	
D2	0 or 1	F/R 1	Forward/reverse setting	1ch/2ch (STP)
D3	0 or 1	MS 11	Micro-step select 1	
D4	0 or 1	MS 12	Micro-step select 2	
D5	0 or 1	HOLD 1	Step hold setting	
D6	0 or 1	RESET 1	Logic reset	
D7	0 or 1	OUT ENABLE 1	Output enable	

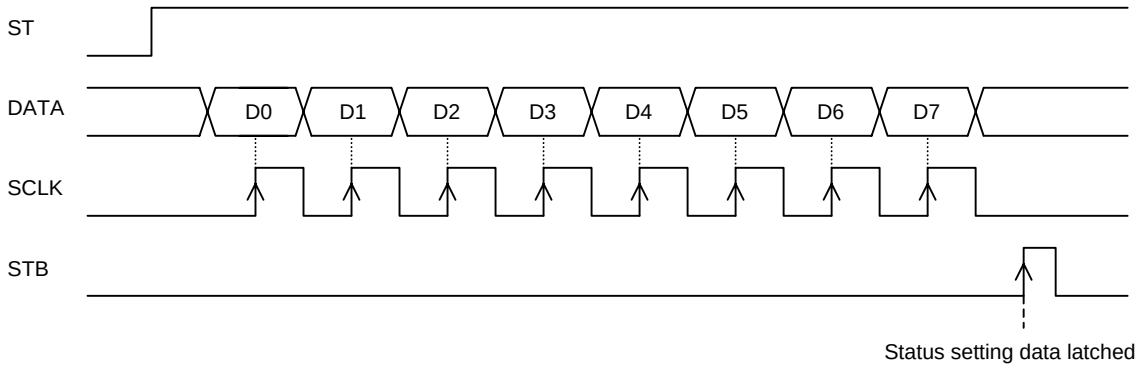
3ch · 4ch (PWM/STP) Setting

Register No	Data	Nomenclature		Functions		Channel	
		3ch · 4ch drive setting (D7)		PWM mode	STP mode		
		"0"	"1"				
D0	0	RG_SELECT 1		Register select 1			
D1	1	RG_SELECT 2		Register select 2			
D2	0 or 1	F/R 3	F/R 2	Forward/reverse setting	Forward/reverse setting	3ch PWM	3ch/4ch (STP)
D3	0 or 1	DECAY 3	MS 21	Current attenuation mode setting	Micro-step select 1		
D4	0 or 1	F/R 4	MS 22	Forward/reverse setting	Micro-step select 2	4ch PWM	
D5	0 or 1	DECAY 4	HOLD 2	Current attenuation mode setting	Step hold setting		
D6	0 or 1	(DUMMY)	RESET 2	(Dummy data)	Logic reset		
D7	0 or 1	(DUMMY)	OUT ENABLE 2	(Dummy data)	Output enable		

5ch · 6ch (PWM) Setting/7ch (constant-current) Reference Voltage Setting

Register No.	Data	Nomenclature	Functions	Channel
D0	1	RG_SELECT 1	Register select 1	
D1	1	RG_SELECT 2	Register select 1	
D2	0 or 1	F/R5	Forward/reverse setting	5ch PWM
D3	0 or 1	DECAY5	Current attenuation mode setting	
D4	0 or 1	F/R6	Forward/reverse setting	6ch PWM
D5	0 or 1	DECAY6	Current attenuation mode setting	
D6	0 or 1	VSEN7_SELECT 1	7ch constant-current reference voltage select 1	7ch Constant current
D7	0 or 1	VSEN7_SELECT 1	7ch constant-current reference voltage select 2	

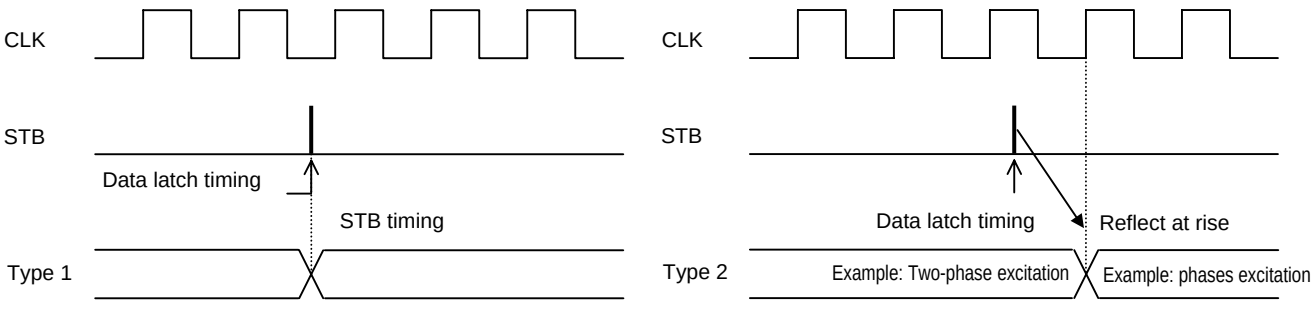
Serial Data Input Setting



Input DATA and SCLK after setting of STB = "L". SCLK is not accepted in the state with STB = "H".
Input DATA from D0 to D7 in this order. CLK performs data transmission at the rise edge and latches all data at rise of STB after transmission of all data.
All of serial data is reset to "0" with ST = "L". and at the voltage to cut V_{CC} low voltage.

Timing to Reflect Serial Data to the Output

- PWM mode (Applicable to 3, 4, 5, and 6ch)
  Type 1: FR and DECAY settings during PWM drive are reflected simultaneously with the STB signal of data latching.
- STP mode (Applicable to 1, 2, 3, and 4ch)
  Type 1: HOLD, RESET, CUT ENABLE settings and reference voltage setting are reflected simultaneously with the STB signal of data latching.
  Type 2: Forward/reverse (F/R) and excitation mode (MS) settings made during STEP setting are reflected at rise of the next clock of data latching.



Stepping Motor Driver (1ch/2ch)

CLK Function

Input		Operation mode	Charge pump circuit
ST	CLK12		
L	*	Standby mode	Stop
H		Excitation step feed	Operating
H		Excitation step hold	

1ch · 2ch (STP) Status Setting Serial Data: (D1, D0=0, 1)

D7 (OE)	D6 (RST)	D5 (HOLD)	D4 (MS2)	D3 (MS1)	D2 (F/R)	Operation mode
*	*	*	*	*	0	CW (forward)
*	*	*	*	*	1	CCW (reverse)
*	*	*	0	0	*	2 phase excitation drive
*	*	*	0	1	*	1-2 phases full torque excitation drive
*	*	*	1	0	*	1-2 phases excitation drive
*	*	*	1	1	*	4W1-2 phases excitation drive
*	*	0	*	*	*	Step hold cancel
*	*	1	*	*	*	Step hold
*	0	*	*	*	*	Counter reset (Excitation at initial position)
*	1	*	*	*	*	Counter reset cancel
0	*	*	*	*	*	Output high impedance
1	*	*	*	*	*	Output operation state

*: Don't Care

1ch · 2ch Reference Voltage Setting Serial Data: (D1, D0=0, 0)

D3 (VSEN1_SELECT2)	D2 (VSEN1_SELECT1)	Current setting reference voltage (at 100%)
0	0	0.2V
0	1	0.134V
1	0	0.1V
1	1	0.066V

The reference voltage to set the output current can be changed over in four stages by the serial data.
This is effective for power saving during hold power application of the motor.

Set Current Calculation Method

I_{OUT} = (reference voltage × set current ratio) /SEN resistance

As the reference voltage is variable (0.2V, 0.134V, 0.1V, 0.066V) by the serial data, the output current can be set from the reference voltage and SEN resistance.

(Example) The output current as shown below flows when the reference voltage is 0.2V, the set current ratio is 100%, and the SEN resistance is 1Ω.

I_{OUT} = 0.2V × 100%/1Ω = 200mA

Monitor Output Channel Setting Serial Data: (D1, D0=0, 0)

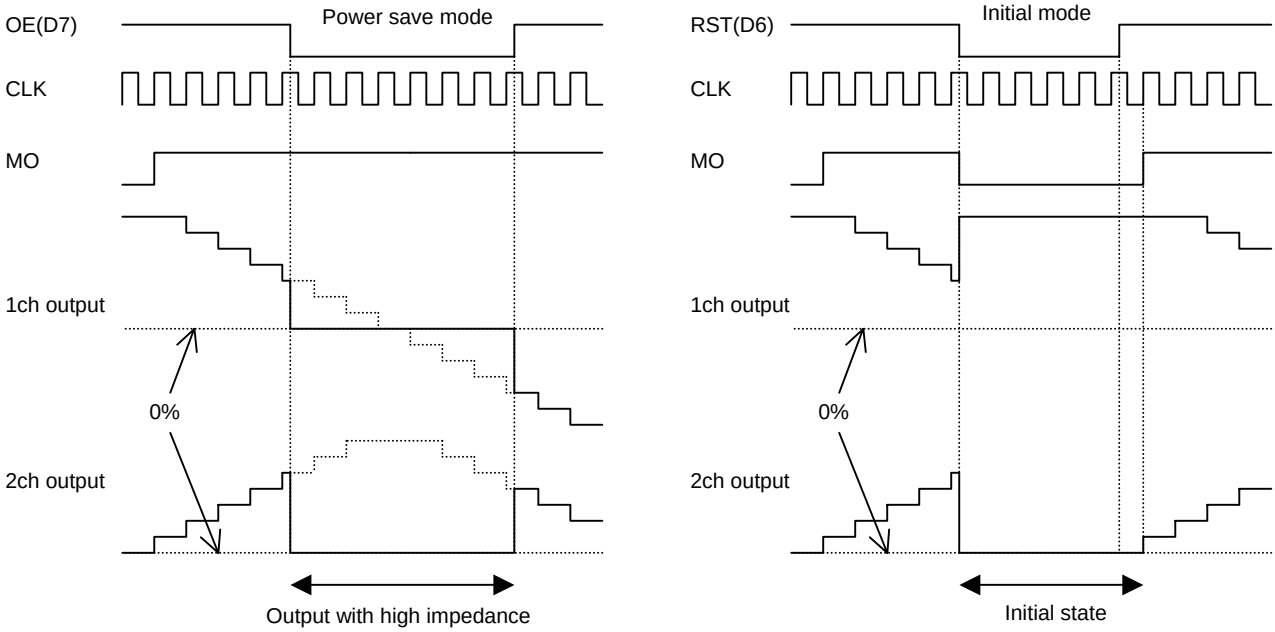
MO Pin (Pin 66)

D6 (MO_SELECT)	Monitor output channel	Monitor output state
0	1ch · 2ch STP	"L" output at the initialization position of STP
1	3ch · 4ch STP	

Initial Excitation Position (Monitor output position)

Excitation mode	1ch	2ch
2 phase	100%	-100%
1-2 phases full torque	100%	0%
1-2 phases	100%	0%
4W1-2 phases	100%	0%

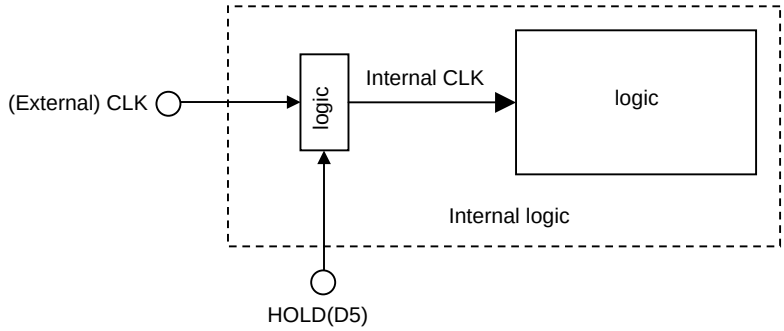
OUTPUT ENABLE (D7), RESET (D6) Operation Description

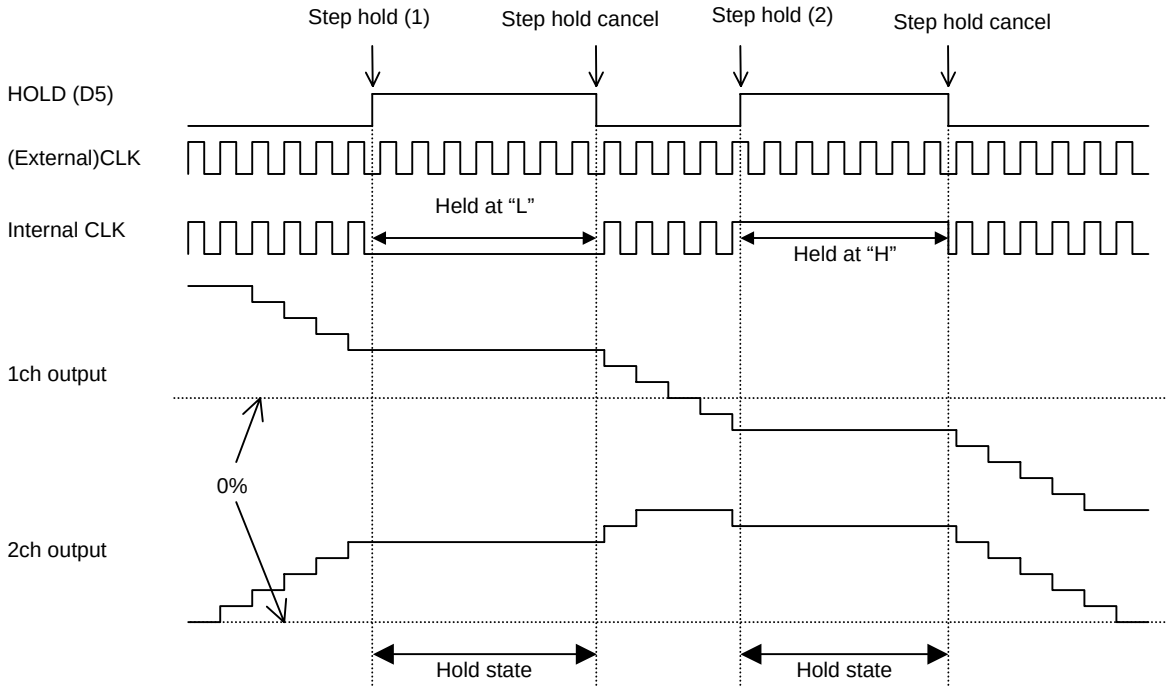


With OE (D7) data = "0", the output is turned OFF and becomes high impedance at rise of STB.
As the internal logic circuit is operating, however, the position number proceeds while CLK is input.
Therefore, with OE (D7) data returned to "1", the level along the position number proceeding with the CLK input is output.

With RST (D6)= "0", the output is initialized at rise of STB and the MO output becomes Low.
With RST (D6)= "1" subsequently, the position number proceeds at the next CLK input.

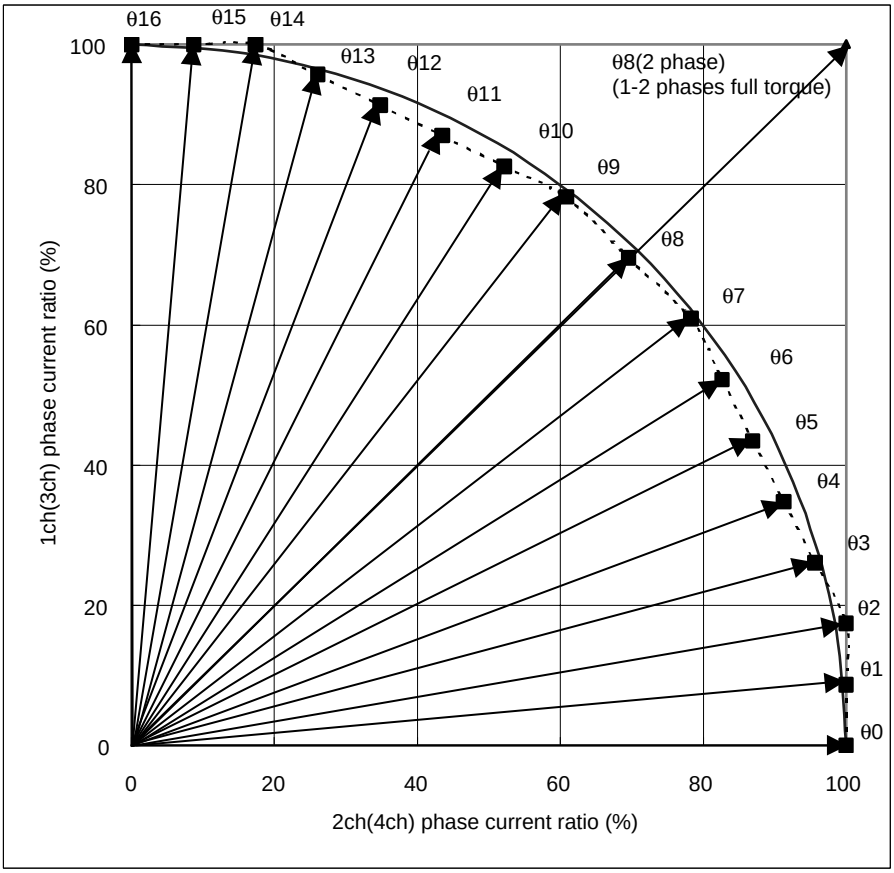
HOLD (D5) Operation Description





With HOLD (D5) data = "1", the external CLK data is held as it is in the internal CLK.
In the step hold (1) timing as shown above, the (external) CLK is at "L", so that the internal CLK is held at "L."
In the step hold (2) timing, the (external) CLK is at "H", so that the internal CLK is held at "H."
With HOLD (D5) data = "0", the internal CLK is synchronized with the normal (external) CLK.
The output holds the status in the timing of input of step hold. After canceling of step hold, the position No. proceeds in the timing of CLK (rise).
As long as the hold status continues, the position No. does not proceed even when (external) CLK is input.

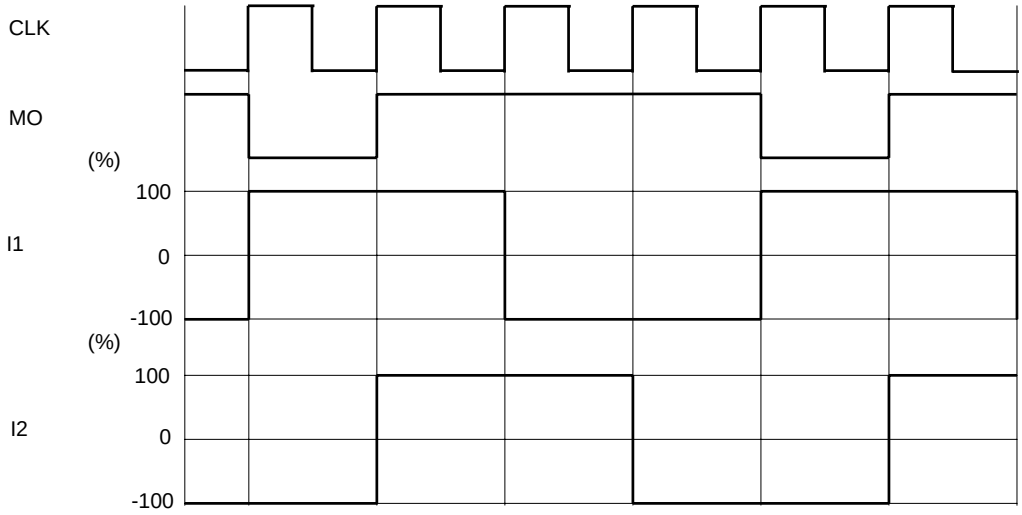
Output Current Vector Locus (one step is normalized to 90 degree)



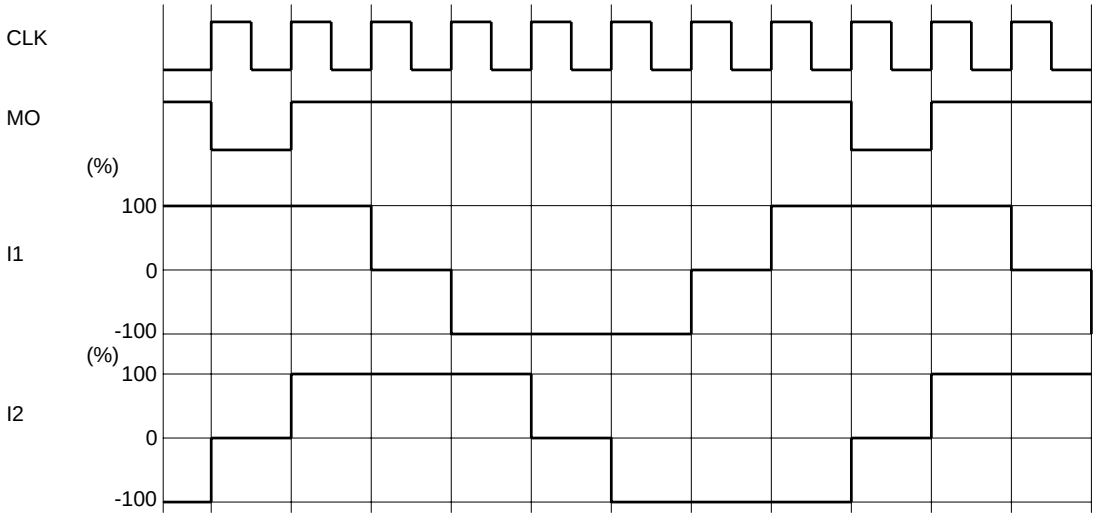
Set Current Ratio in Each Excitation Mode

STEP	4W1-2 phase (%)		1-2 phases (%)		1-2 phases full torque (%)		2 phase (%)	
	1ch (3ch)	2ch (4ch)	1ch (3ch)	2ch (4ch)	1ch (3ch)	2ch (4ch)	1ch (3ch)	2ch (4ch)
θ0	0	100	0	100	0	100		
θ1	8.69	100						
θ2	17.39	100						
θ3	26.08	95.65						
θ4	34.78	91.3						
θ5	43.48	86.95						
θ6	52.17	82.61						
θ7	60.87	78.26						
θ8	69.56	69.56	69.56	69.56	100	100	100	100
θ9	78.26	60.87						
θ10	82.61	52.17						
θ11	86.95	43.48						
θ12	91.3	34.78						
θ13	95.65	26.08						
θ14	100	17.39						
θ15	100	8.69						
θ16	100	0	100	0	100	0		

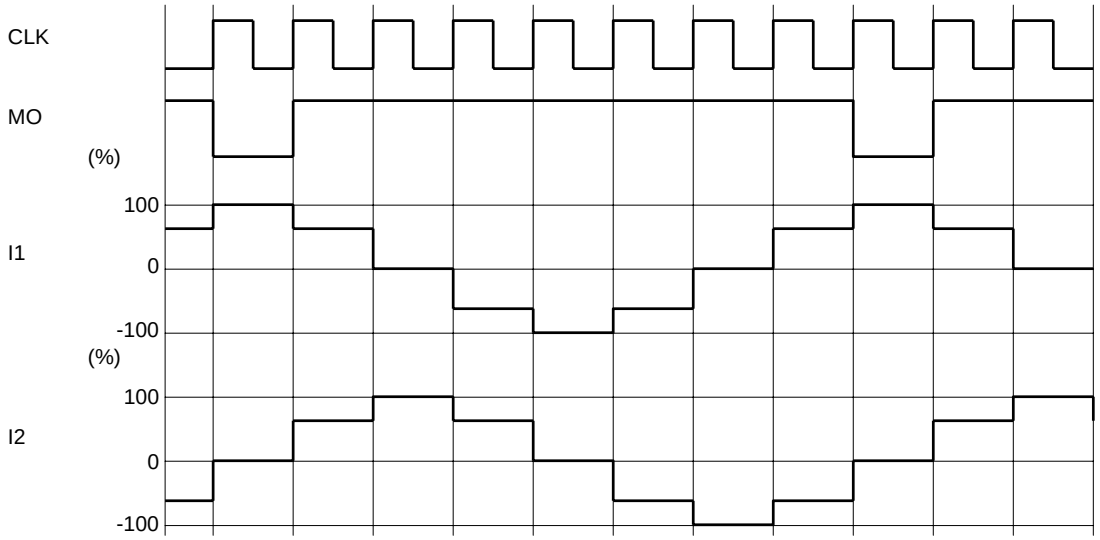
2 Phase Excitation (D4="0", D3="0", D2="0": CW mode)



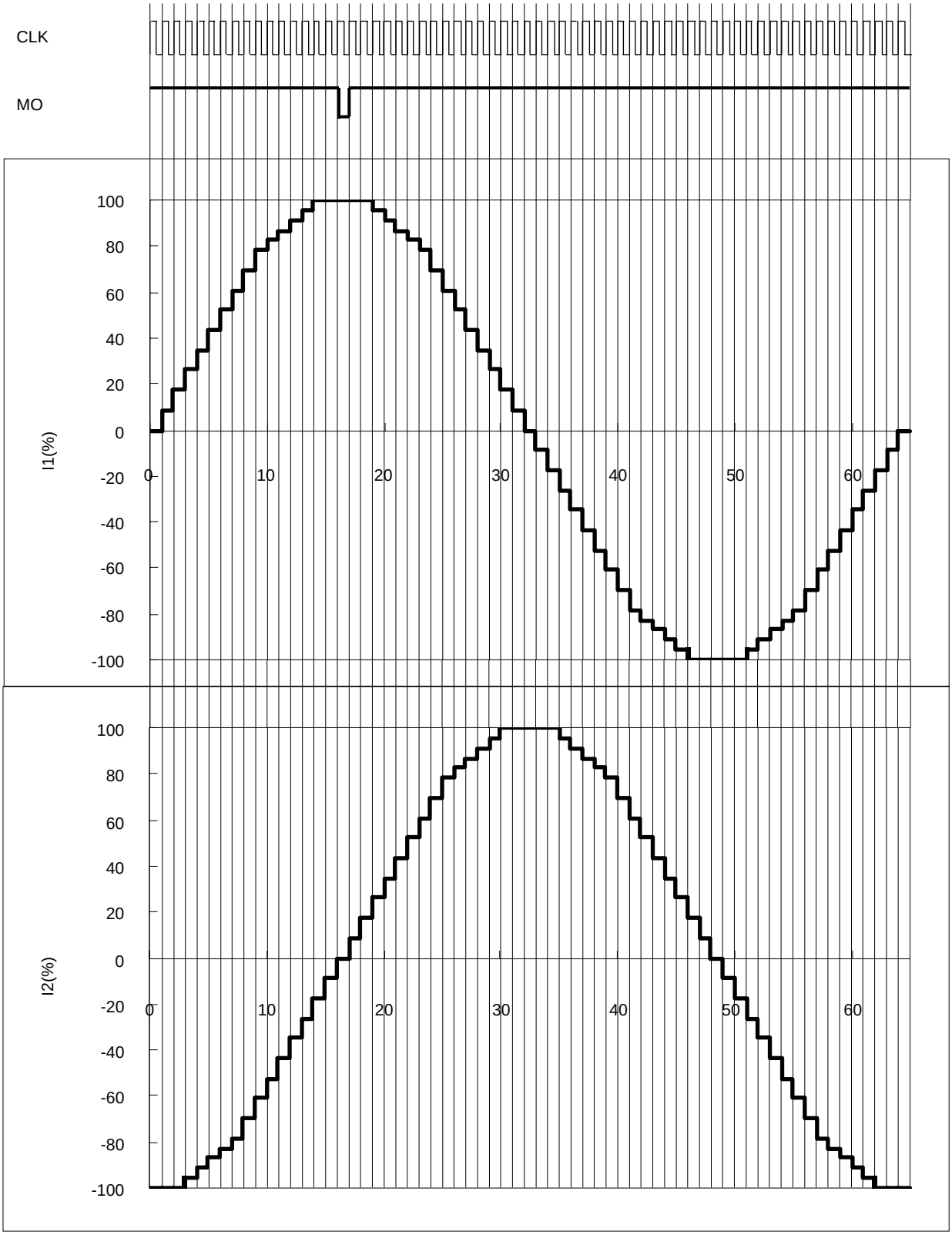
1-2 Phases Full Torque (D4="0", D3="1", D2="0": CW mode)



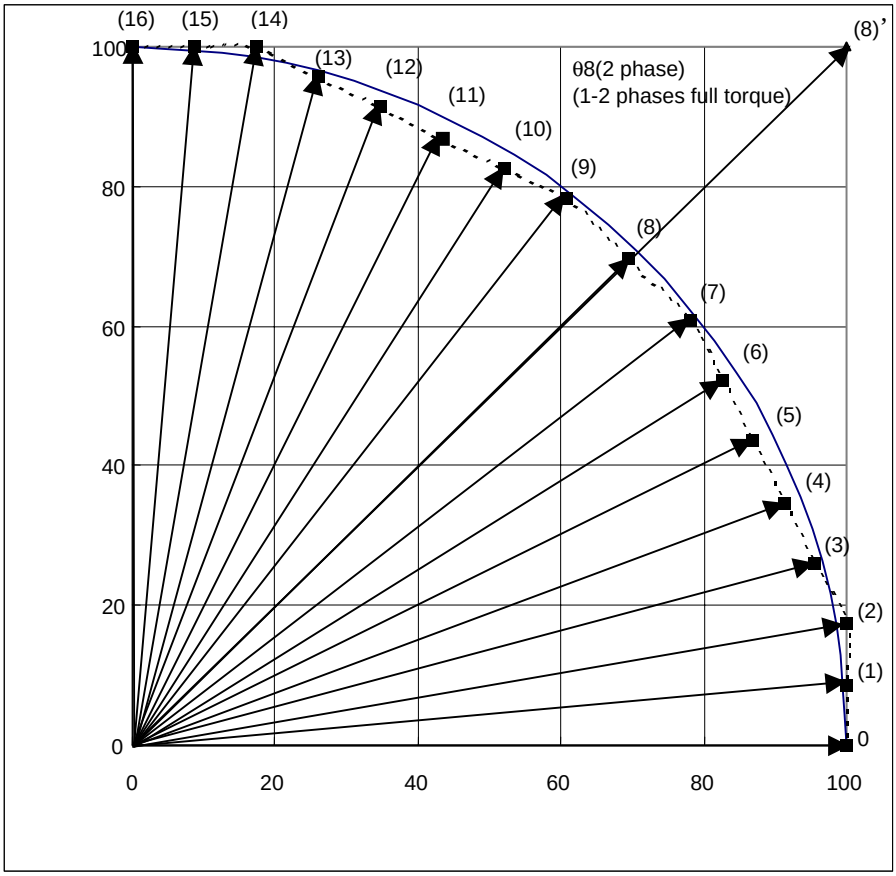
1-2 Phases Excitation (D4="1", D3="0", D2="0": CW mode)

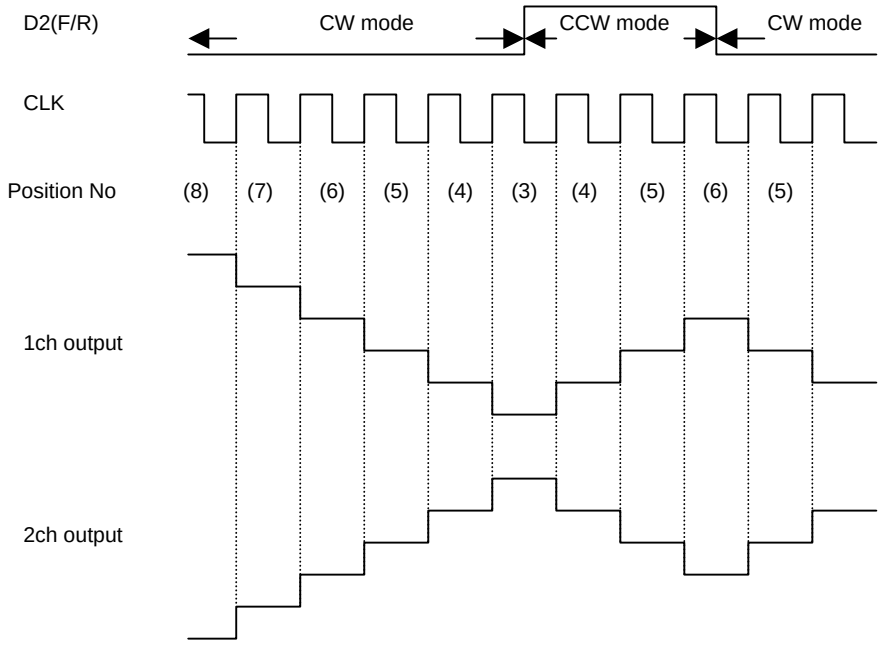


4W1-2 Phases Excitation (D4="1", D3="1", D2="0": CW mode)



Basic Operation of Set Current Step Changeover and Forward/Reverse Changeover (D2 (F/R))

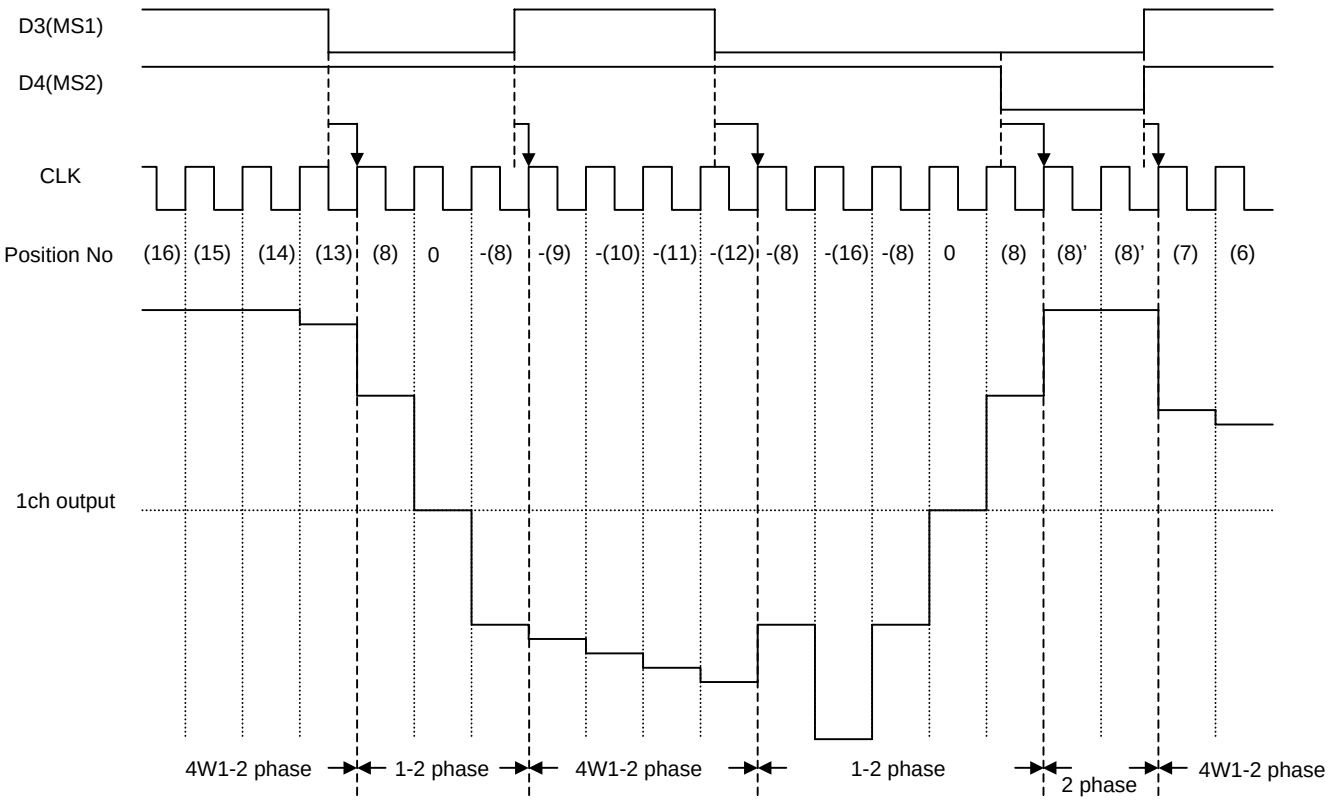




DA converter in IC proceeds by one bit at rise of input clock pulse.
D2 (F/R) data causes changeover of CW and CCW modes; the position No. decreases in the CW mode and increases in the CCW mode.
When viewed from the 1ch current, the 2ch current is delayed by 90 degree in phase in the CW mode.
When viewed from the 1ch current, the 2ch current is delayed by 90 degree in the CCW mode.

Basic Operation of Excitation Mode Changeover (D3, D4 (MS1, MS2))

CW Mode



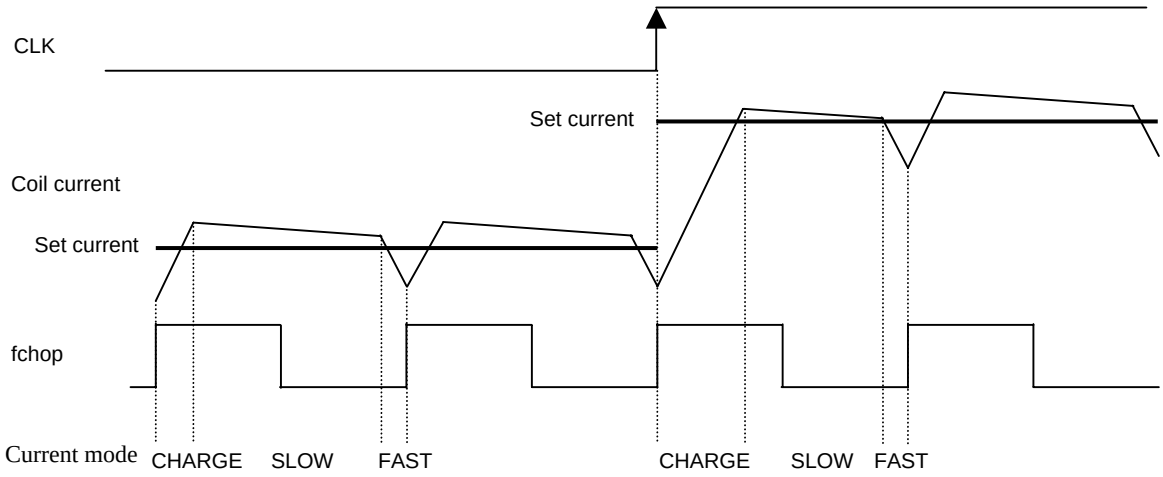
When the excitation mode is changed over during power application to the motor, the motor operates in the following sequence. (CW mode)

Before excitation mode changeover		Step position after excitation mode changeover			
Excitation mode	Position No.	4W1-2 phase	1-2 phases	1-2 phases 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 phases	(16)	(15)		(8)'	(8)'
	(8)	(7)		0	(8)'
	0	-(1)		-(8)'	-(8)'
1-2 phases full torque	(16)	(15)	(8)		(8)'
	(8)'	(7)	0		(8)'
	0	-(1)	-(8)		-(8)'
2 phase	(8)'	(7)	0	0	

* The symbol "-" such as -(8) in the table indicates that the phase has been reversed.

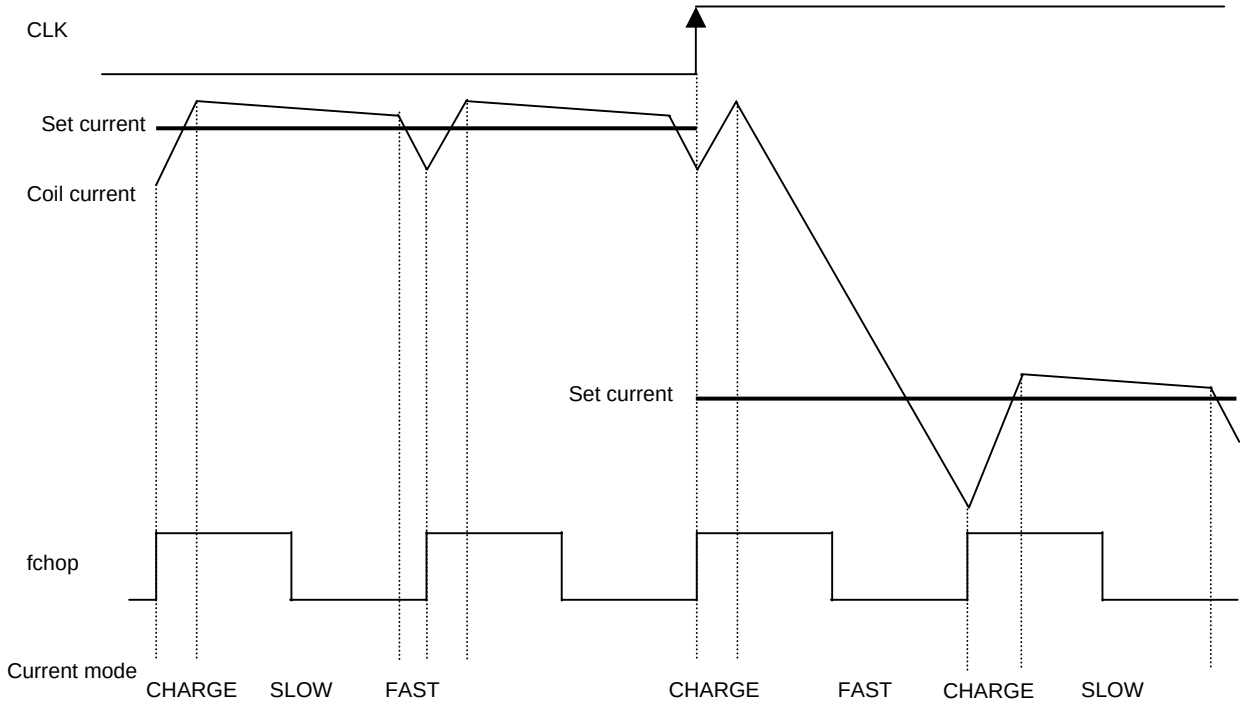
Current Control Operation Specification

Sine wave increasing direction



Sine wave decreasing direction

In each current mode, the motor operates in the following sequence.

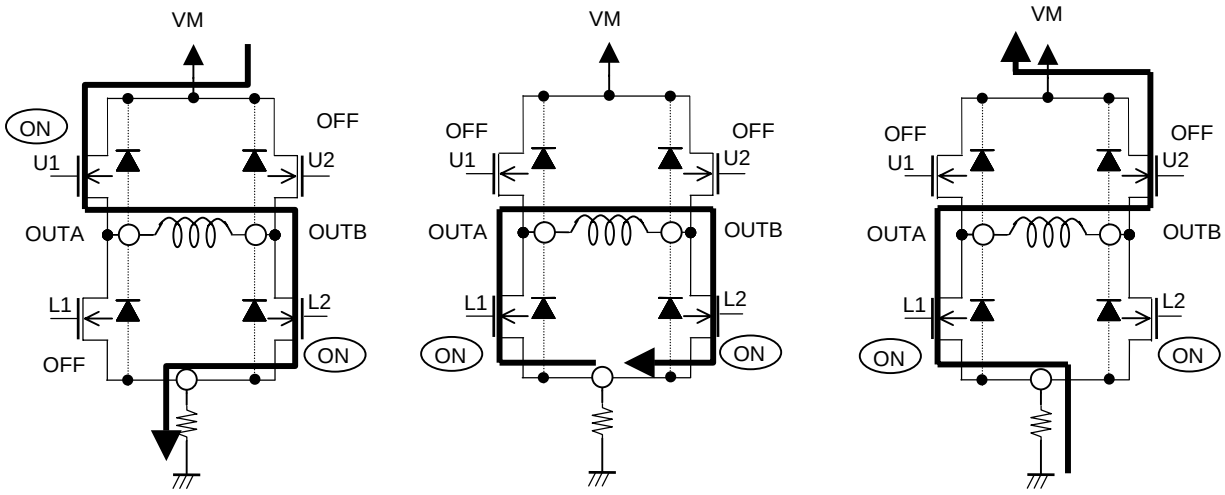


- The motor enters the CHARGE mode at rise of chopping oscillation. (Regardless of the magnitude of the coil current (ICOIL) and set current (IREF), the section in which the CHARGE mode is forced (hereinafter called the "forced CHARGE" mode) exists for 1/8 of one chopping cycle.)
- The coil current (ICOIL) is compared with the set current (IREF) in the CHARGE mode.
  In the case of ICOIL<IREF in the forced CHARGE section
  The CHARGE mode continues up to the point where ICOIL≥IREF. Subsequently, the mode is changed to the SLOW DECAY mode and finally to the FAST DECAY mode within the 1/8 portion of one chopping cycle.
  In case when ICOIL<IREF does not exists in the forced CHARGE section
  The mode changes to the FAST DECAY mode. The coil current is attenuated in the FAST DECAY mode till one chopping cycle is over.

Above steps are repeated. Normally, the SLOW (+FAST) DECAY mode is effective in the sine wave increasing direction, the FAST DECAY mode continues till the current is attenuated to the set level, then the SLOW (+FAST) DECAY mode becomes effective subsequently.

Output stage transistor function

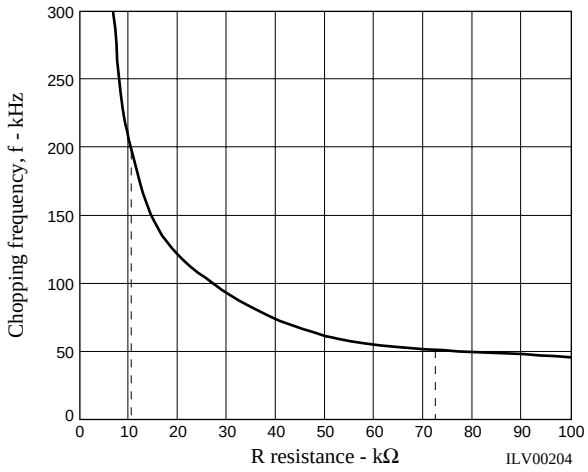
The OUTA → OUTB direction is assumed to be for charge (current increasing direction).



(CHARGE) (SLOW) (FAST)

Chopping frequency (fchop) setting method

This is the frequency for chopping, which is determined by the external resistor for constant-current control.
The chopping frequency set by the resistance connected to R pin (pin 32) is shown below.



The recommended chopping frequency ranges from 50 to 200kHz.

PWM Drive/Stepping Motor Driver (3ch/4ch)

3ch · 4ch drive motor setting serial data: (D1, D0=0, 0)

D7 (PWM/MICRO)	Operation mode	Pin function	
		Pin 21	Pin 22
0	PWM2 system	PWM3	PWM4
1	Micro-step driven STP1 system	CLK34	Not used

By setting D7 (PWM/MICRO) data as shown in the table above, changeover to two systems of direct PWM drive H-bridge driver and single system of micro-step driven stepping motor driver can be made.

PWM Drive Mode (3ch · 4ch drive mode setting D7="0")

3ch (PWM) truth table: (D1, D0=1, 0)

Input				Output		Operation mode	Charge pump circuit
ST	PWM3	D2	D3	OUT3A	OUT3B		
L	*	*	*	OFF	OFF	Standby	Stop
H	H	0	*	H[Note]	L	CW(Forward)	Operating
H	H	1	*	L	H[Note]	CCW(Reverse)	
H	L	*	0	OFF	OFF	FAST DECAY(output OFF)	
H	L	*	1	L	L	SLOW DECAY(brake)	

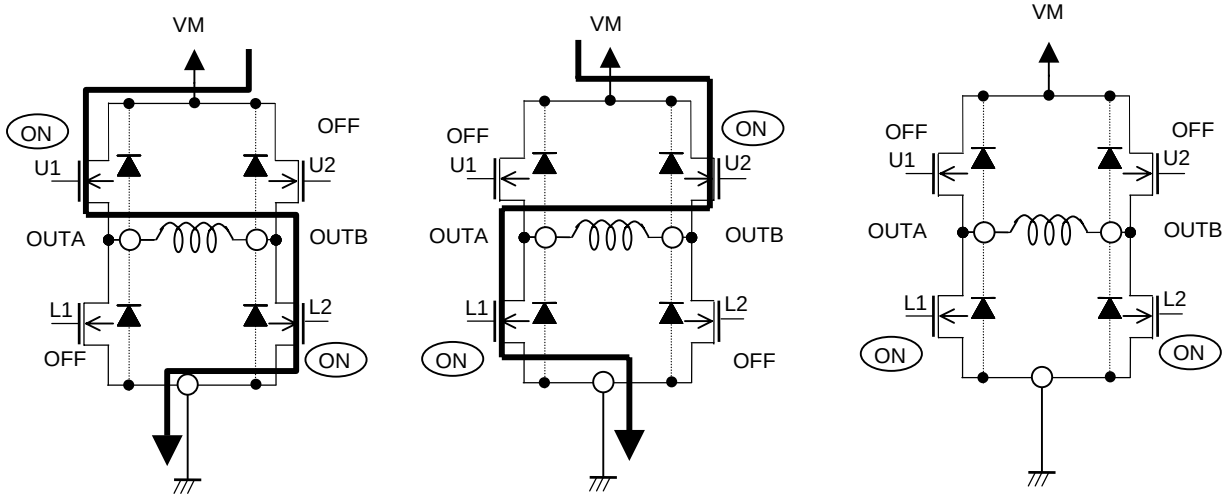
4ch (PWM) truth table: (D1, D0=1, 0)

Input				Output		Operation mode	Charge pump circuit
ST	PWM4	D4	D5	OUT4A	OUT4B		
L	*	*	*	OFF	OFF	Standby	Stop
H	H	0	*	H[Note]	L	CW(Forward)	Operating
H	H	1	*	L	H[Note]	CCW(Reverse)	
H	L	*	0	OFF	OFF	FAST DECAY(output OFF)	
H	L	*	1	L	L	SLOW DECAY(brake)	

*: Don’t care

Note: When the sensing resistor is connected to SEN 3 and 4 pins, the constant-current drive through chopping is made for the set current. Connection of SEN3 and 4 pins to GND allows saturation drive.

Output Stage Transistor Function



(Forward) (Reverse) (Brake)

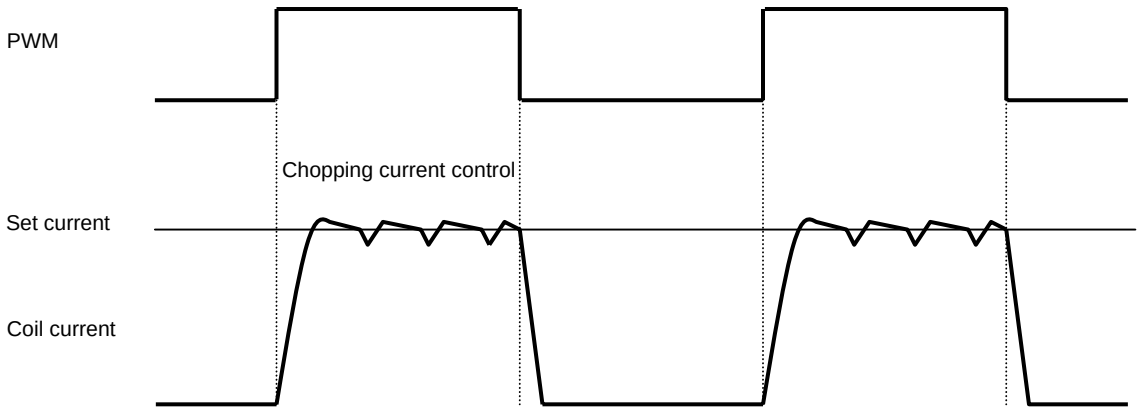
3ch · 4ch Reference Voltage Setting Serial Data: (D1, D0=0, 0)

D5 (VSEN2_SELECT2)	D4 (VSEN2_SELECT1)	Current setting reference voltage
0	0	0.2V
0	1	0.134V
1	0	0.1V
1	1	0.066V

Since the reference voltage is changed over for 3ch and 4ch simultaneously, individual setting cannot be made.

Constant-Current Chopping Drive

When the sensing resistor is connected to SEN 3 and 4 pins, the constant-current drive through chopping is made for the set current calculated from the reference voltage and SEN resistor.



Set Current Value (constant current) Calculation Method

I_{OUT} = Reference voltage/SEN resistor

Since the reference voltage can be made variable (0.2V, 0.134V, 0.1V, 0.066V) with the serial data, the output current can be set from the reference voltage and SEN resistor.

(Example) The output current as follows flows when the reference voltage is 0.2V and SEN resistance is 1Ω.

I_{OUT} = 0.2V/1Ω = 200mA

Stepping Mode (3ch · 4ch drive mode setting D7="1")

CLK Function

Input		Operation mode	Charge pump circuit
ST	CLK34		
L	*	Standby mode	Stop
H		Excitation step feed	Operating
H		Excitation step hold	

3ch · 4ch (STP) Status Setting Serial Data: (D1, D0=1, 0)

D7(OE)	D6(RST)	D5(HOLD)	D4(MS2)	D3(MS1)	D2(F/R)	Operation mode
*	*	*	*	*	0	CW (Forward)
*	*	*	*	*	1	CCW (Reverse)
*	*	*	0	0	*	2 phase excitation drive
*	*	*	0	1	*	1-2 phases full torque excitation drive
*	*	*	1	0	*	1-2 phases excitation drive
*	*	*	1	1	*	4W1-2 phase excitation drive
*	*	0	*	*	*	Step hold cancel
*	*	1	*	*	*	Step hold
*	0	*	*	*	*	Counter reset (Excitation at initial position)
*	1	*	*	*	*	Counter reset cancel
0	*	*	*	*	*	Output high-impedance
1	*	*	*	*	*	Output operation status

*: Don’t care

3ch · 4ch Reference Voltage Setting Serial Data: (D1, D0=0, 0)

D5 (VSEN2_SELECT2)	D4 (VSEN2_SELECT1)	Current setting reference voltage (at 100%)
0	0	0.2V
0	1	0.134V
1	0	0.1V
1	1	0.066V

The output current setting reference voltage can be changed in four stages by the serial data.
This is useful for power saving during hold power application to the motor.

Set Current Value Calculation Method

I_{OUT} = (reference voltage × set current ratio) /SEN resistance

Since the reference voltage can be made variable (0.2V, 0.134V, 0.1V, 0.066V) with the serial data, the output current can be set from the reference voltage and SEN resistor.

(Example) The output current as shown below flows when the reference voltage is 0.2V, the set current ratio is 100%, and SEN resistance is 1Ω.

I_{OUT} = 0.2V × 100%/1Ω = 200mA

Initial Excitation Position (Monitor output position)

Excitation mode	3ch	4ch
2 phase	100%	-100%
1-2 phases full torque	100%	0%
1-2 phases	100%	0%
4W1-2 phase	100%	0%

* For the monitor setting, refer to the description made for 1ch/2ch.

PWM Driven Motor Driver (5ch/6ch)

5ch (PWM) truth table: (D1, D0=1, 1)

Input				Output		Operation mode	Charge pump circuit
ST	PWM5	D2	D3	OUT5A	OUT5B		
L	*	*	*	OFF	OFF	Standby	Stop
H	H	0	*	H[Note]	L	CW (Forward)	Operating
H	H	1	*	L	H[Note]	CCW (Reverse)	
H	L	*	0	OFF	OFF	FAST DECAY (output OFF)	
H	L	*	1	L	L	SLOW DECAY (brake)	

6ch (PWM) truth table: (D1, D0=1, 1)

Input				Output		Operation mode	Charge pump circuit
ST	PWM6	D4	D5	OUT6A	OUT6B		
L	*	*	*	OFF	OFF	Standby	Stop
H	H	0	*	H[Note]	L	CW (Forward)	Operating
H	H	1	*	L	H[Note]	CCW (Reverse)	
H	L	*	0	OFF	OFF	FAST DECAY (output OFF)	
H	L	*	1	L	L	SLOW DECAY (brake)	

*: Don’t care

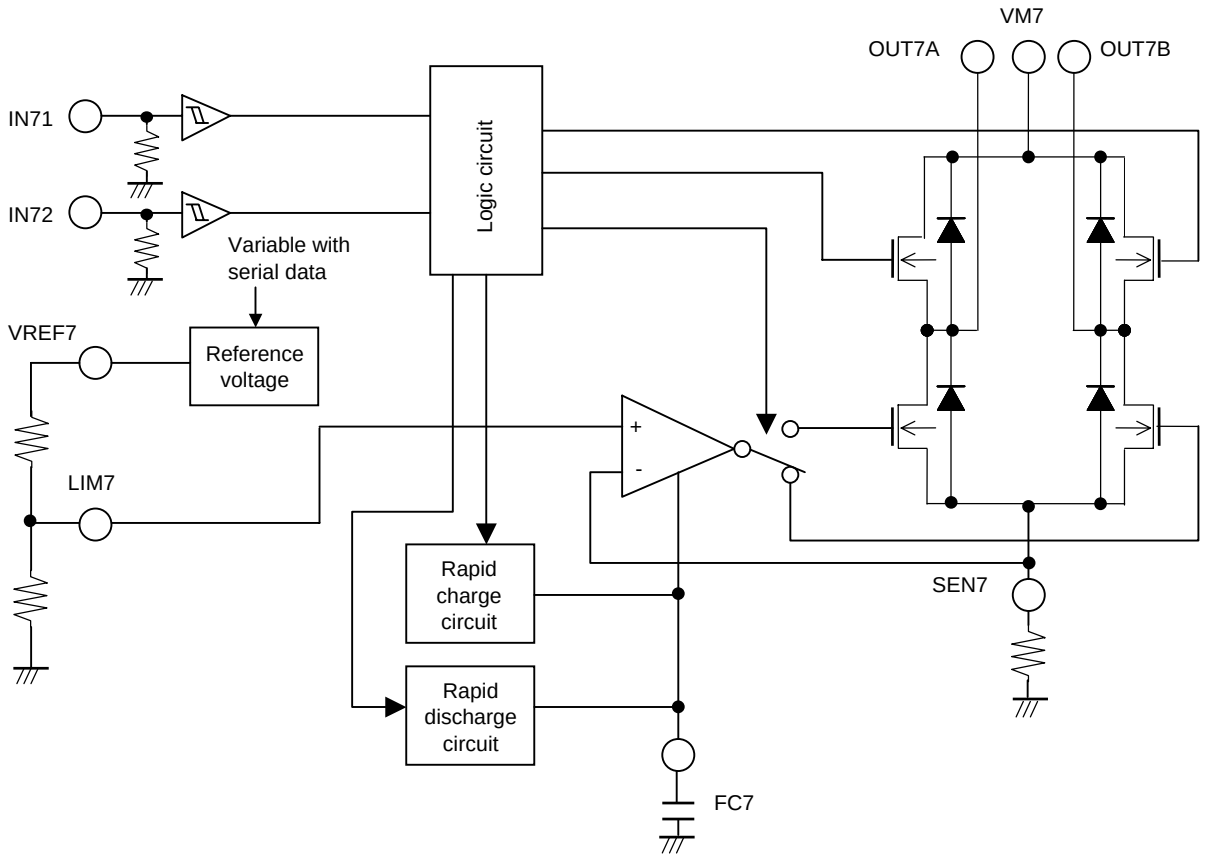
Note: Since there is no SEN pin, saturation drive is made.

Constant-Current Forward/Reverse Motor Driver (7ch)

7ch (Constant-current) Truth Table

Input			Output		Mode	Charge pump circuit
ST	IN71	IN72	OUT7A	OUT7B		
L	*	*	OFF	OFF	Standby	Stop
H	L	L	OFF	OFF	Output OFF	Operating
H	L	H	H	L	CW (Forward)	
H	H	L	L	H	CCW (Reverse)	
H	H	H	L	L	Brake	

*: Don't care



7ch Reference Voltage (VREF7 voltage) Setting Serial Data: (D1, D0=1, 1)

D7 (VSEN7_SELECT2)	D6 (VSEN7_SELECT1)	Current setting reference voltage (VREF7 voltage)
0	0	0.2V
0	1	0.134V
1	0	0.1V
1	1	0.066V

Set Current Value Calculation Method

I_{OUT} = LIM7 voltage/SEN7 resistance

Since LIM7 voltage is the external input, the reference voltage can be freely set.

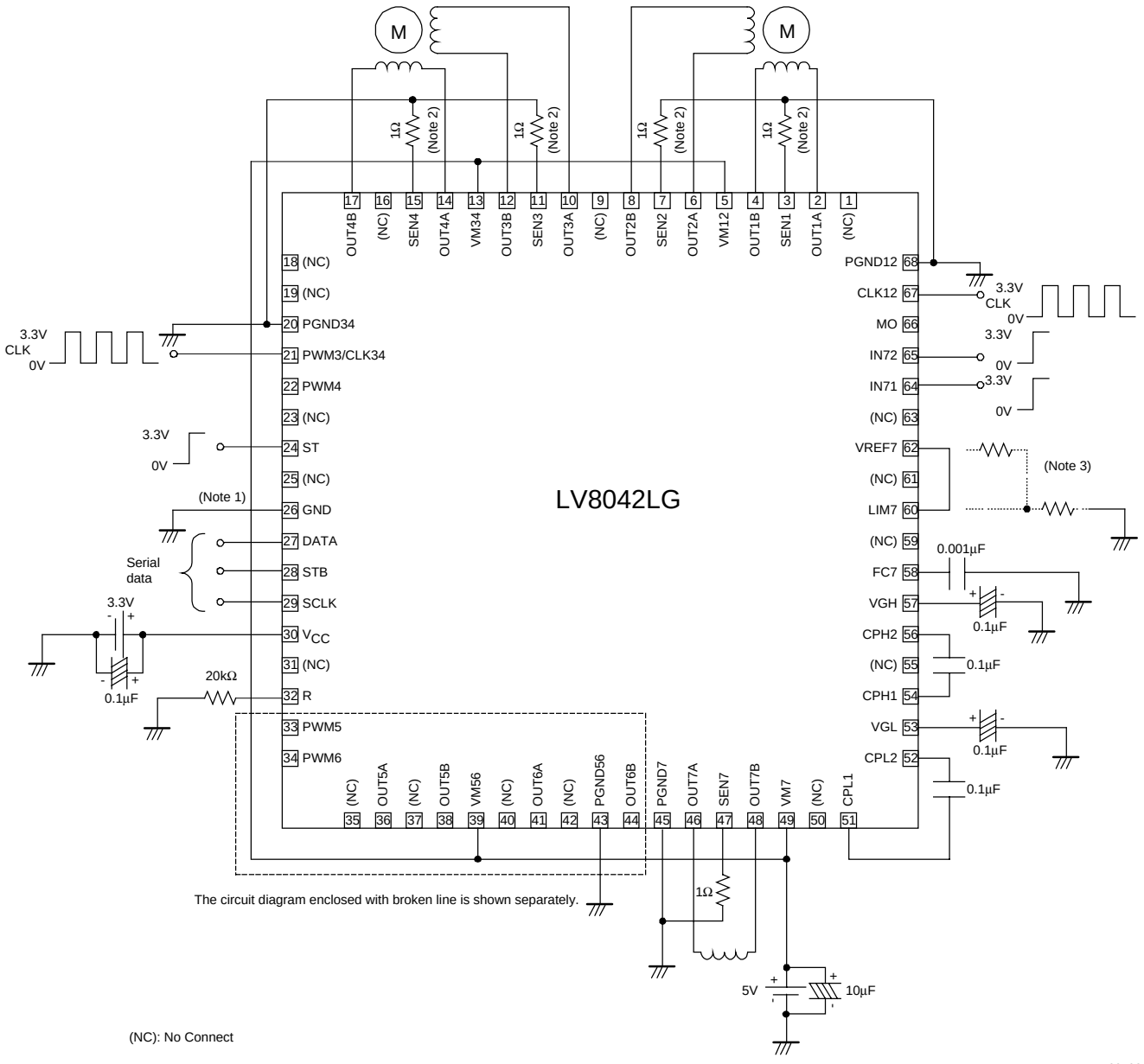
Since the VREF7 voltage can be made variable (0.2V, 0.134V, 0.1V, 0.066V) with the serial data, short-circuiting the VREF7 pin with the LIM7 pin enables varying the reference voltage.

Input of the voltage obtained by dividing VREF7 with the resistor can produce any arbitrary reference voltage (0.2V or less).

Recommended Application Circuit

The value at each element is the recommended one.
For each input condition numerical value, confirm the previous allowable operation range.

1ch/2ch micro-step drive
3ch/4ch micro-step drive (changeover to PWM drive possible: See 5ch/6ch recommended circuit)
5ch/6ch saturation drive (described separately)
7ch constant current drive

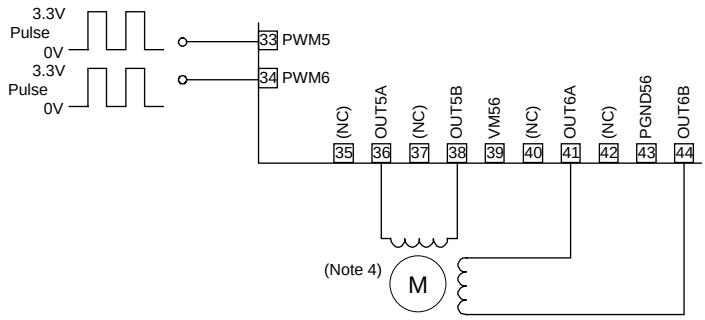


Note 1: GND wiring should be made with one-point grounding as much as possible.
Note 2: A 1Ω resistor is attached for each of the SEN pin registers. This sets an output of 200mA when the current ratio is 100%.
Note 3: Set the LIM7 reference voltage by short-circuiting VREF7 (or dividing with resistance) before input or by applying the voltage from the outside.

5ch/6ch Recommended Circuit

For 5ch/6ch, STM and DCM (VCM) can be driven by using two H-bridge circuits.
(For 3ch/4ch, the following application is possible when the mode is set to the PWM drive mode.)

Application (1) · · · STM



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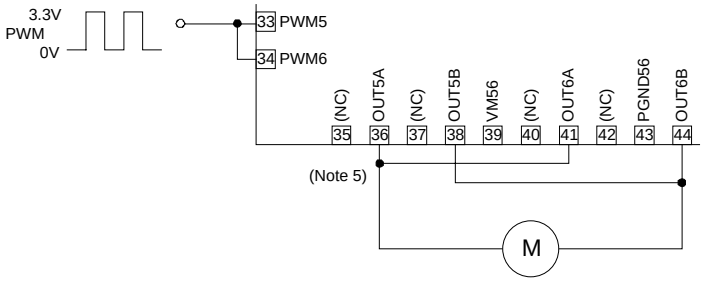
Note 4: To drive STM, serial data must be input for each excitation (phase changeover)

Application (2) · · · DCM (Double output capacity)



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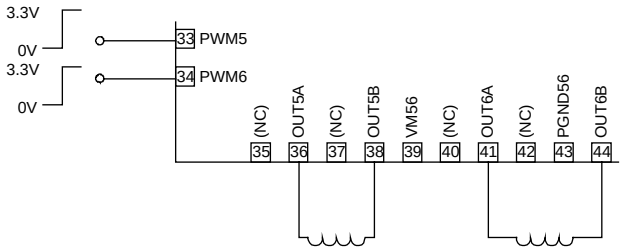
Note 5: Short-circuit each input/output.
(When short-circuiting, be sure to connect OUT5A and OUT6A, OUT5B and OUT6B correctly.)

Application (3) · · · VCM



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