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LV8048CS

ON Semiconductor®

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Bi-CMOS IC

For Digital Still Cameras

Single-chip motor driver IC for

Overview

LV8048CS is single-chip motor driver IC for digital still cameras.

Features

- The actuator driver for DSC is built into single-chip.
- Two 256-division microstep output channel, and two constant current output channels
- All actuators can be driven at the same time
- AF / ZOOM stepping motor is driven by the clock signal
- Supports PWM control of a DC zoom motor
- The constant current output reference voltage can be set to one of 16 internal reference voltage levels (motor holding current switching possible).
- Two photosensor drive transistor channels
- Two Schmitt buffer channels (the presence or absence of hysteresis can be set individually).

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_B max		6.0	V
Supply voltage 2	V_{CC} max		6.0	V
Peak output curren t	I_O peak1	OUT5 to 6, OUT9 to 10 (t ≤ 10ms, ON-duty ≤ 20%)	800	mA
	I_O peak2	OUT1 to 4, OUT7 to 8, OUT11 to 12 (t ≤ 10ms, ON-duty ≤ 20%)	600	mA
Continuous output current	I_O max1	OUT5 to 6, OUT9 to 10	600	mA
	I_O max2	OUT1 to 4, OUT7 to 8, OUT11 to 12	400	mA
	I_O max3	PI1, PI2	40	mA
Allowable power dissipation	Pd max	Mounted on a circuit board*	1100	mW
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

* Specified circuit board : 40×50×0.8mm^3 : glass epoxy four-layer board(2S-2P).

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
Supply voltage range 1	V_B	VB1, VB2 (*1) (*2)	2.7 to 5.5	V
Supply voltage range 2	V_{CC}	(*2)	2.7 to 5.5	V
Logic level input voltage	V_{IN}		0 to V_{CC}+0.3	V
Clock frequency	F_{CLK}	CLK1, CLK2/PWM, CLK3/ENA6	to 64	kHz
PWM frequency	F_{PWM}	CLK2/PWM	to 100	kHz

(*1) There are no restrictions on the magnitude relationships between the voltages applied to VB1 and VB2.

(*2) There are no restrictions on the magnitude relationships between the voltages applied to each V_B and V_{CC}.

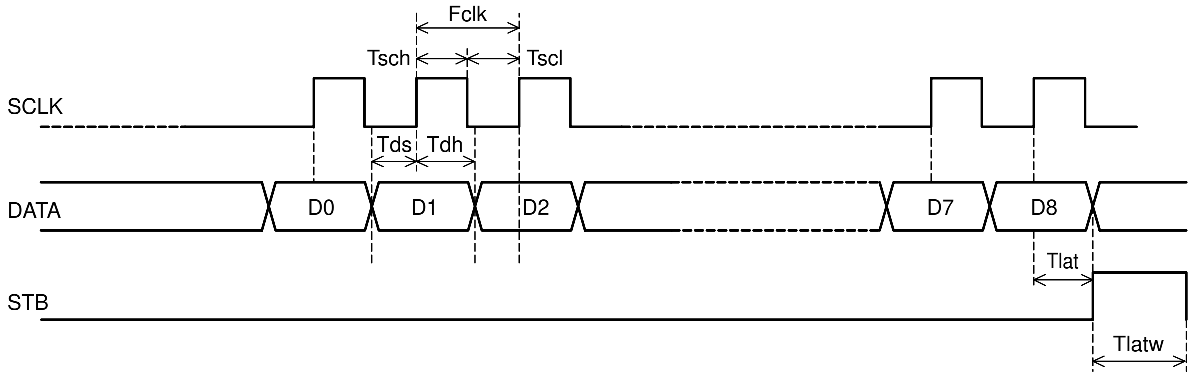
Electrical Characteristics at Ta = 25°C, V_B = 5V, V_{CC} = 3.3V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent current	I_{CCO}	ST = low, BI1, BI2 = low			1	μA
Current drain 1	I_B	ST = high, BI1, BI2 = low, With no output load		75	150	μA
Current drain 2	I_{CC}	ST = high, BI1, BI2 = low, With no output load		2.5	4	mA
V_{CC} low-voltage cutoff voltage	$V_{th}V_{CC}$		2.1	2.4	2.6	V
Low-voltage hysteresis voltage	$V_{th}HYS$		90	140	190	mV
Thermal shutdown temperature	TSD	Design target value	160	180	200	°C
Thermal hysteresis width	ΔTSD	Design target value	20	40	60	°C
AF/ZOOM Motor Drivers (OUT1-2, OUT3-4, OUT5-6, OUT7-8)						
Output on-resistance 1	Ronu1	I_O = 200mA, High side on-resistance		0.6	0.85	Ω
	Rond1	I_O = 200mA, Low side on-resistance		0.25	0.4	Ω
Output leakage current 1	$I_O$leak1				1	μA
Diode forward voltage 1	V_D1	I_D = -400mA	0.7	0.9	1.2	V
Chopping frequency	Fchop1		293	390	488	kHz
	Fchop2		146	195	244	kHz
	Fchop3		428	570	713	kHz
	Fchop4		214	285	356	kHz
Current setting reference voltage	VSEN00		0.185	0.200	0.215	V
	VSEN01		0.125	0.140	0.155	V
	VSEN10		0.085	0.100	0.115	V
	VSEN11		0.045	0.060	0.075	V
Logic pin input current	$I_{IN}L$	V_{IN} = 0V (ST, CLK1, CLK2/PWM)			1.0	μA
	$I_{IN}H$	V_{IN} = 3.3V (ST, CLK1, CLK2/PWM)		33	50	μA
High-level input voltage	$V_{IN}H$	ST, CLK1, CLK2/PWM	2.5			V
Low-level input voltage	$V_{IN}L$	ST, CLK1, CLK2/PWM			1.0	V
Motor driver for aperture, shutter (OUT9-10, OUT11-12)						
Output on-resistance 2	Ronu2	I_O = 200mA, High side on-resistance		0.6	0.85	Ω
	Rond2	I_O = 200mA, Low side on-resistance		0.25	0.4	Ω
Output leakage current 2	$I_O$leak2				1	μA
Diode forward voltage 2	V_D2	I_D = -400mA	0.7	0.9	1.2	V
Constant current output	I_O	Rf = 1Ω, (D3, D4, D5, D6) = (0, 0, 0, 0)	190	200	210	mA

Continued on next page.

Continued from preceding page.

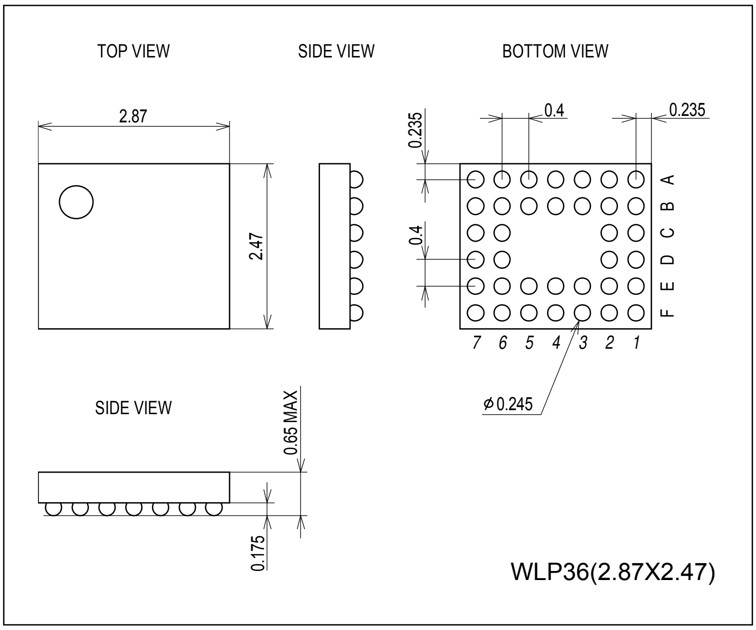
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Internal current setting reference voltages	$V_{REF}1$	(D3, D4, D5, D6) = (0, 0, 0, 0)	0.190	0.200	0.210	V
	$V_{REF}2$	(D3, D4, D5, D6) = (1, 0, 0, 0)	0.162	0.170	0.179	V
	$V_{REF}3$	(D3, D4, D5, D6) = (0, 1, 0, 0)	0.157	0.165	0.173	V
	$V_{REF}4$	(D3, D4, D5, D6) = (1, 1, 0, 0)	0.152	0.160	0.168	V
	$V_{REF}5$	(D3, D4, D5, D6) = (0, 0, 1, 0)	0.147	0.155	0.163	V
	$V_{REF}6$	(D3, D4, D5, D6) = (1, 0, 1, 0)	0.143	0.150	0.158	V
	$V_{REF}7$	(D3, D4, D5, D6) = (0, 1, 1, 0)	0.138	0.145	0.152	V
	$V_{REF}8$	(D3, D4, D5, D6) = (1, 1, 1, 0)	0.133	0.140	0.147	V
	$V_{REF}9$	(D3, D4, D5, D6) = (0, 0, 0, 1)	0.128	0.135	0.142	V
	$V_{REF}10$	(D3, D4, D5, D6) = (1, 0, 0, 1)	0.124	0.130	0.137	V
	$V_{REF}11$	(D3, D4, D5, D6) = (0, 1, 0, 1)	0.119	0.125	0.131	V
	$V_{REF}12$	(D3, D4, D5, D6) = (1, 1, 0, 1)	0.114	0.120	0.126	V
	$V_{REF}13$	(D3, D4, D5, D6) = (0, 0, 1, 1)	0.109	0.115	0.121	V
	$V_{REF}14$	(D3, D4, D5, D6) = (1, 0, 1, 1)	0.105	0.110	0.116	V
	$V_{REF}15$	(D3, D4, D5, D6) = (0, 1, 1, 1)	0.100	0.105	0.110	V
	$V_{REF}16$	(D3, D4, D5, D6) = (1, 1, 1, 1)	0.095	0.100	0.105	V
Motor holding drive switching rate	Rhold			33		%
Logic pin input current	$I_{IN}L$	V_{IN} = 0V (CLK3/ENA6)			1.0	µA
	$I_{IN}H$	V_{IN} = 3.3V (CLK3/ENA6)		33	50	µA
High-level input voltage	$V_{IN}H$	CLK3/ENA6	2.5			V
Low-level input voltage	$V_{IN}L$	CLK3/ENA6			1.0	V
Photosensor peripheral circuits (PI1, PI2, BI1, BO1, BI2, BO2)						
Output on-resistance 3	Ron3a	I_O = 20mA, PI1, PI2		2.4	5	Ω
	Ron3b	I_O = 40mA, PI1, PI2		2.4	5	Ω
Output leakage current 3	$I_O$leak3	PI1, PI2			1	µA
Schmitt buffer threshold level (hysteresis)	$V_{th}H$		1.00	1.28	1.50	V
	$V_{th}L$		0.60	0.84	1.10	V
Schmitt buffer hysteresis	V_{th}hys1		0.3	0.44	0.6	V
Schmitt buffer threshold level (no hysteresis)	V_{th}		0.90	1.20	1.40	V
Serial Data Transfer Pins						
Logic pin input current	$I_{IN}L$	V_{IN} = 0V (SCLK, DATA, STB)			1.0	µA
	$I_{IN}H$	V_{IN} = 3.3V (SCLK, DATA, STB)		33	50	µA
High-level input voltage	$V_{IN}H$	SCLK, DATA, STB	2.5			V
Low-level input voltage	$V_{IN}L$	SCLK, DATA, STB			1.0	V
Minimum SCLK high-level pulse width	Tsch		0.125			µS
Minimum SCLK low-level pulse width	Tscl		0.125			µS
Stipulated STB 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 CLK frequency	Fclk				4	MHz

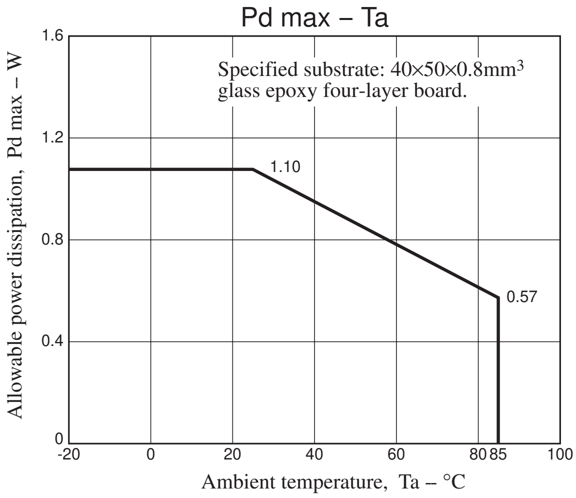


Package Dimensions

unit : mm (typ)

3389





Pin Assignment

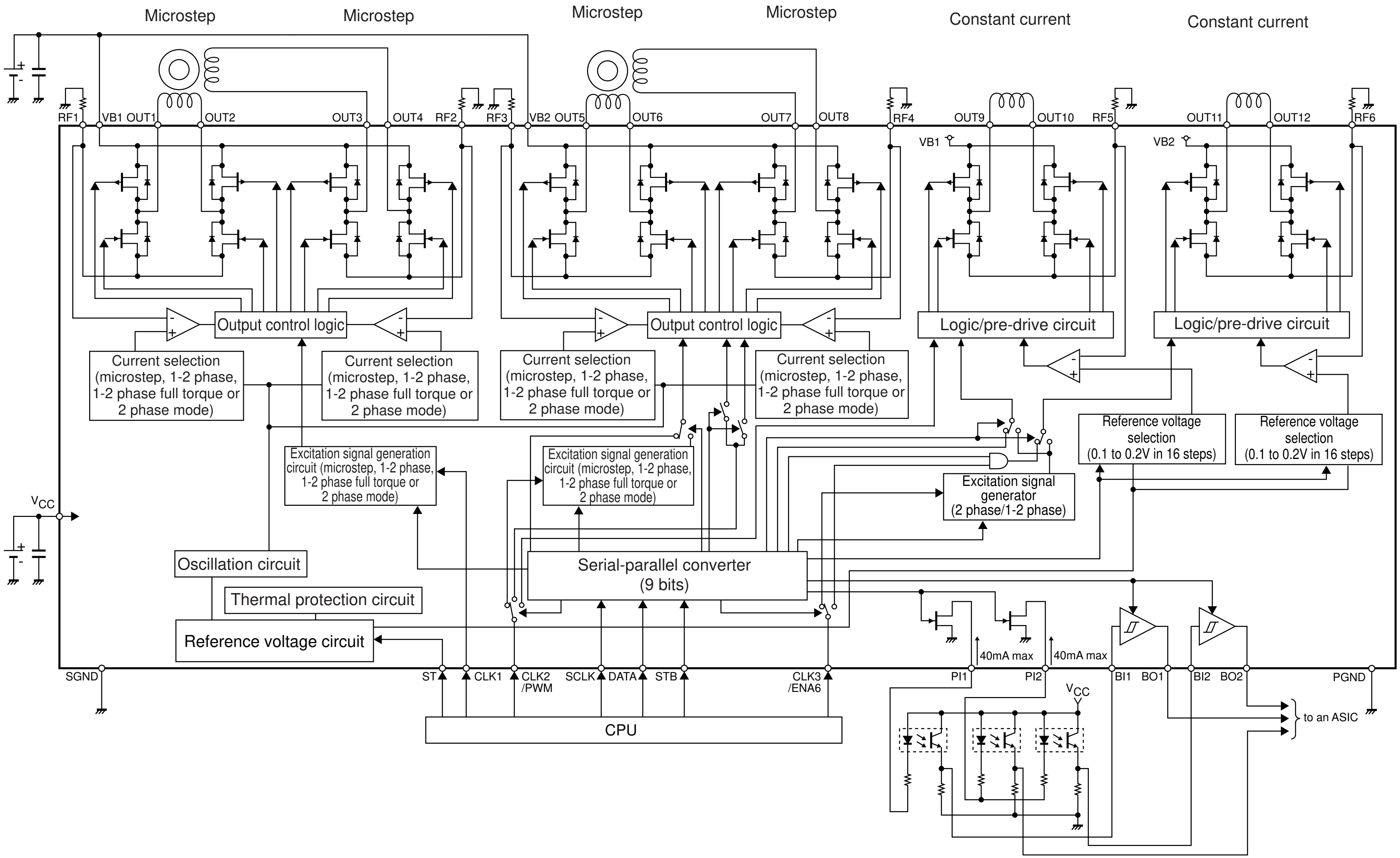
Bottom View

	1	2	3	4	5	6	7
F	RF3	OUT6	OUT7	RF4	OUT8	OUT11	RF6
E	OUT5	PI1	PI2	BO1	BI1	BI2	OUT12
D	VB2	SCLK				BO2	SGND
C	VB1	DATA				V_{CC}	PGND
B	OUT9	STB	ST	CLK1	CLK2/PWM	CLK3/ENA6	OUT2
A	RF5	OUT10	OUT3	RF2	OUT4	OUT1	RF1

Top View

7	6	5	4	3	2	1	
RF6	OUT11	OUT8	RF4	OUT7	OUT6	RF3	F
OUT12	BI2	BI1	BO1	PI2	PI1	OUT5	E
SGND	BO2				SCLK	VB2	D
PGND	V_{CC}				DATA	VB1	C
OUT2	CLK3/ENA6	CLK2/PWM	CLK1	ST	STB	OUT9	B
RF1	OUT1	OUT4	RF2	OUT3	OUT10	RF5	A

Block Diagram

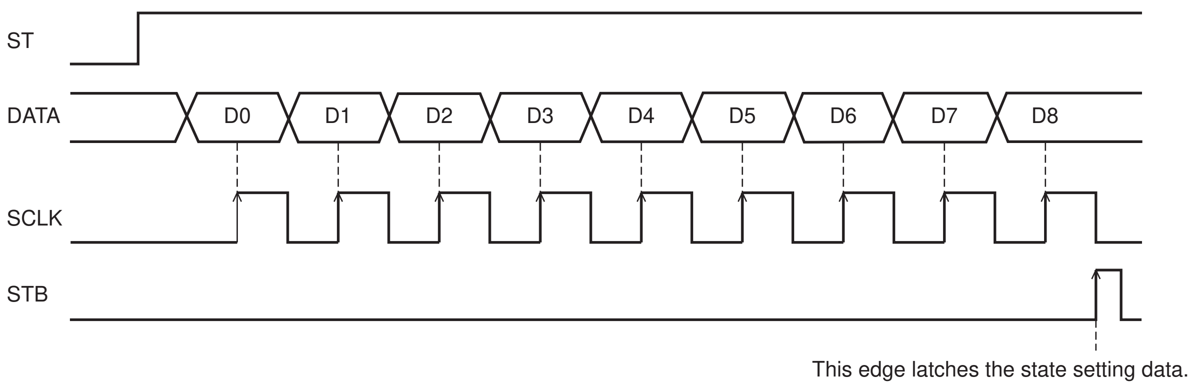


Pin Functions

Pin No.	Pin name	Description
C1	VB1	Power supply for OUT1-4, OUT9-10
D1	VB2	Power supply for OUT5-8, OUT11-12
C7	PGND	Power system ground
C6	V_{CC}	Control system power supply
D7	SGND	Control system ground
A6	OUT1	Motor driver output
B7	OUT2	Motor driver output
A3	OUT3	Motor driver output
A5	OUT4	Motor driver output
E1	OUT5	Motor driver output
F2	OUT6	Motor driver output
F3	OUT7	Motor driver output
F5	OUT8	Motor driver output
B1	OUT9	Motor driver output
A2	OUT10	Motor driver output
F6	OUT11	Motor driver output
E7	OUT12	Motor driver output
A7	RF1	Current detection connection for OUT1-2
A4	RF2	Current detection connection for OUT3-4
F1	RF3	Current detection connection for OUT5-6
F4	RF4	Current detection connection for OUT7-8
A1	RF5	Current detection connection for OUT9-10
F7	RF6	Current detection connection for OUT11-12
E2	PI1	Photosensor drive output
E3	PI2	Photosensor drive output
E5	BI1	Schmitt buffer input 1
E4	BO1	Schmitt buffer output 1
E6	BI2	Schmitt buffer input 2
D6	BO2	Schmitt buffer output 2
B3	ST	Chip enable
D2	SCLK	Serial data transfer clock
C2	DATA	Serial data
B2	STB	Serial data latch pulse input
B4	CLK1	Stepping motor clock for OUT1-4
B5	CLK2/PWM	Stepping motor clock for OUT5-8/PWM input for OUT5-8/PWM input for OUT9-10
B6	CLK3/ENA6	Stepping motor clock for OUT9-12/Enable input for OUT11-12

Serial Data Input Overview

Serial Data Input Timing Chart



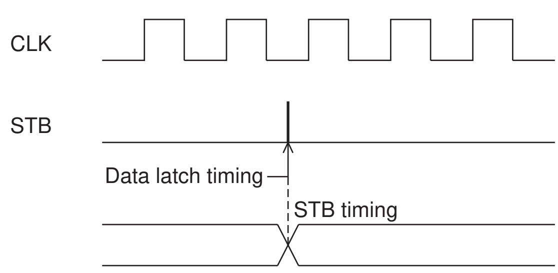
Data is input in order from D0 to D8. Data is transferred on the SCLK rising edge and, after all data has been transferred, the data is latched by the rising edge of the STB signal.
Note that the IC internal circuits will not accept the SCLK signal while the STB signal is high.

Timing with which the Serial Data is Reflected in the Outputs

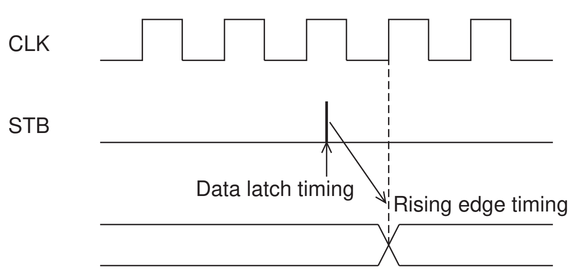
Basically, the new values are reflected in the output at the point the data is latched with the STB signal. → Pattern 1

However, the "Excitation direction" and "Excitation mode" settings used in stepping motor clock drive mode for channels 1 through 4 are an exception. In this case only, after the data is latched with the STB signal, the new values are reflected on the next rising edge of the CLK1 signal and CLK2 signal. → Pattern 2
(Similarly, the "Excitation direction" and "Excitation "mode settings used in the stepping motor clock drive mode for channels 5 to 6 are also an exception. After the data is latched with the STB signal, the new values are reflected on the next rising edge of the CLK3 signal.)

[Pattern 1]



[Pattern 2]



Detailed Description of Serial Data Input

Note: This IC's channels are assigned as follows.

OUT1/OUT2	→	Channel 1
OUT3/OUT4	→	Channel 2
OUT5/OUT6	→	Channel 3
OUT7/OUT8	→	Channel 4
OUT9/OUT10	→	Channel 5
OUT11/OUT12	→	Channel 6

Stepping motor excitation type for channels 1 through 6

This IC supports connecting stepping motors to channels 1 and 2 and 3 and 4 to channels 5 and 6. Either of these stepping motors can be controlled by a single clock signal.

When this capability is used, the clock signal input pins and the channels as associated as shown below.

CLK1 :	Controls channel 1 and 2 drive
CLK2/PWM :	Controls channel 3 and 4 drive
CLK3/ENA6 :	Controls channel 5 and 6 drive

The following state settings related to control of these stepping motors are set using the serial data. (See subsection, Serial Logic Table 1, 2, in section ,Truth Tables, for a detailed description of this data.)

[For channel 1 to 4 drive]

- Excitation mode : 2-phase, 1-2 phase (full torque), 1-2 phase or microstep
- Microstep division number : 256 or 128
- Excitation direction : CW (clockwise) or CCW (counterclockwise)
- Step/hold : Clear or Hold
- Counter reset: Clear or Reset
- Output enable : Output Off or Output On
- Chopping frequency : Selects one of four values
- Current setting reference voltage : Selects one of four values

[For channel 5, 6 drive]

- Excitation mode : 2-phase, 1-2 phase
- Excitation direction : CW (clockwise) or CCW (counterclockwise)
- Step/Hold : Clear or Hold
- Counter reset : Clear or Reset
- Output enable : Output Off or Output On

[CLK1] pin function

input		operational mode
ST	CLK1	
L	*	standby mode
H	↑	excitation step sending
H	↓	excitation step maintenance

[CLK2/PWM] possession [CLK3/ENA6] similar

Excitation mode setting : (D0 = [1], D1 = [0], D2 = [0], D3 = [0])

D4	D5	D6	excitation mode	Initial position	
				1ch	2ch
0	0	*	2-phase	100%	-100%
1	0	*	1-2 phase (full torque)	100%	0%
0	1	*	1-2 phase	100%	0%
1	1	0	microstep (256step)	100%	0%
		1	microstep (128step)		

It is an initial position in each excitation mode when the counter is reset the state in the early starting up the power supply.

The serial data for standard voltage setting : (D0 = [0], D1 = [1], D2 = [1], D3 = [0])

D6	D7	Current setting and standard voltages
0	0	0.2V
1	0	0.140V
0	1	0.1V
1	1	0.060V

A standard voltage for the current the setting and the standard voltage output current setting can be switched to four stages by the serial data.

It is effective for the power saving when the motor energizes maintenance.

(Computational method of set current value)

A standard voltage can set the output current from the RF resistance connected between standard voltage and terminal RF-GND because it is changeability can (0.2V,0.140V,0.1V,0.060V) in the serial data.

I_{OUT} = (Standard voltage x Set current ratio) / RF resistance

(example)The following output current flows in 100% and the RF resistance 1Ω compared with 0.2V in a standard voltage and set currents at times.

$I_{OUT} = 0.2V \times 100\% / 1\Omega = 200mA$

Chopping frequency setting

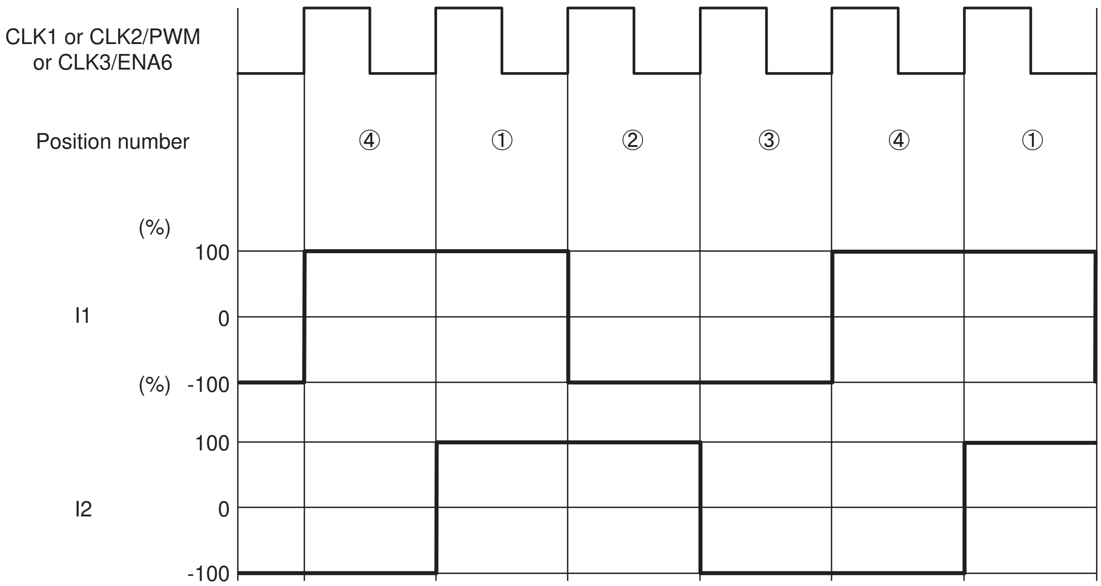
The oscillation circuit is built into in IC, and the chopping frequency of the constant current control can be switched by setting serial data 0110, D4, D5, and ***.

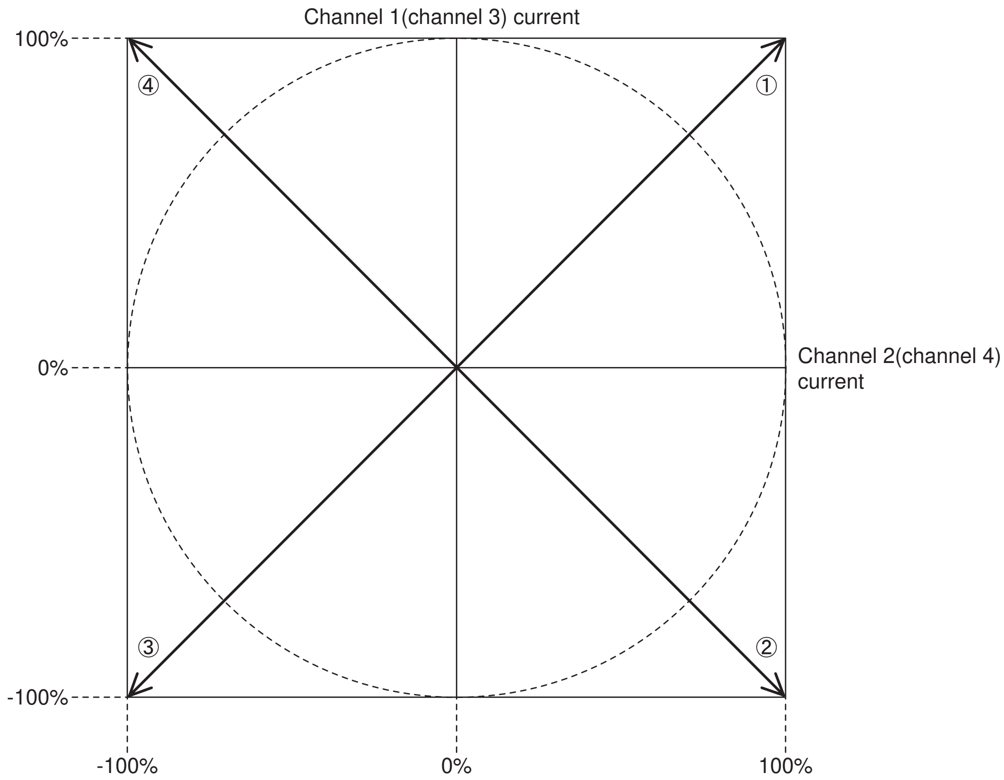
DATA[4]	DATA[5]	chopping frequency
0	0	390kHz
1	0	195kHz
0	1	570kHz
1	1	285kHz

Excitation Mode Setting

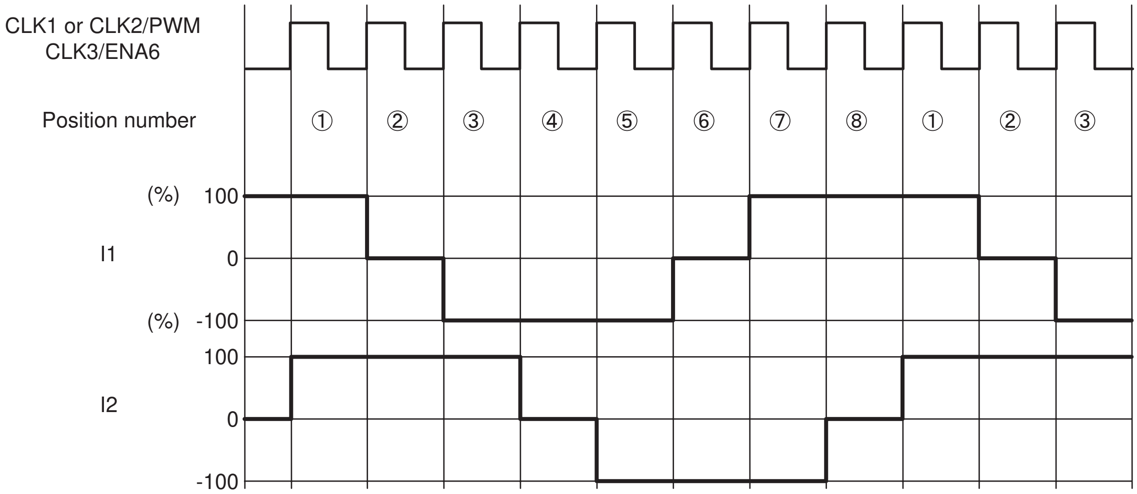
This section presents the timing charts for each excitation mode.

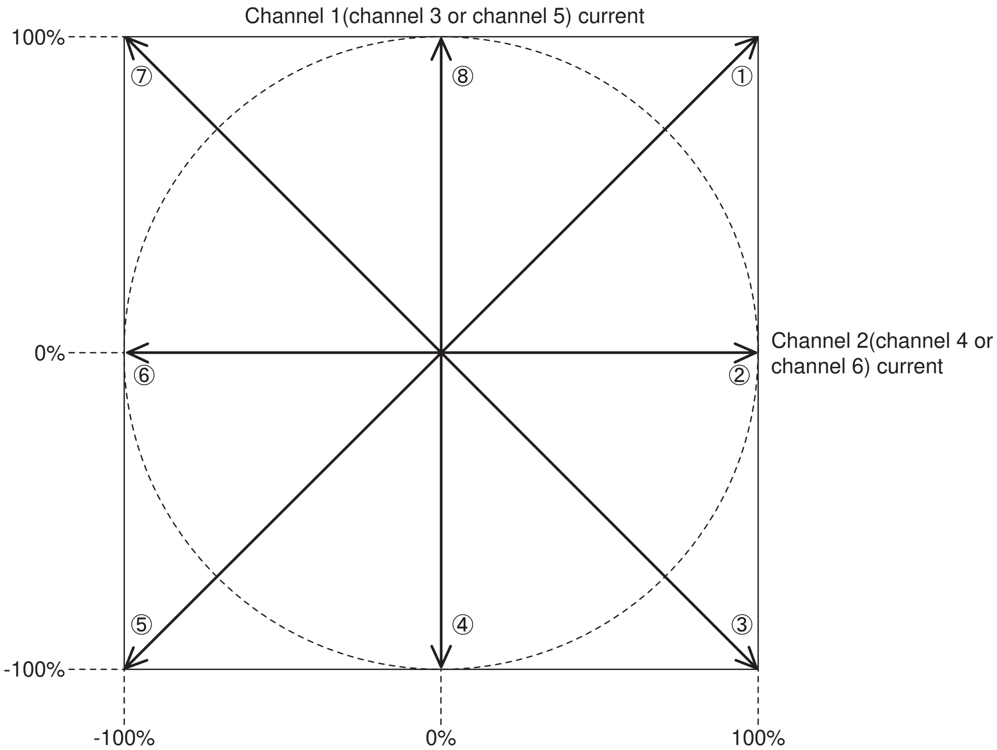
Two-Phase Excitation Timing Chart



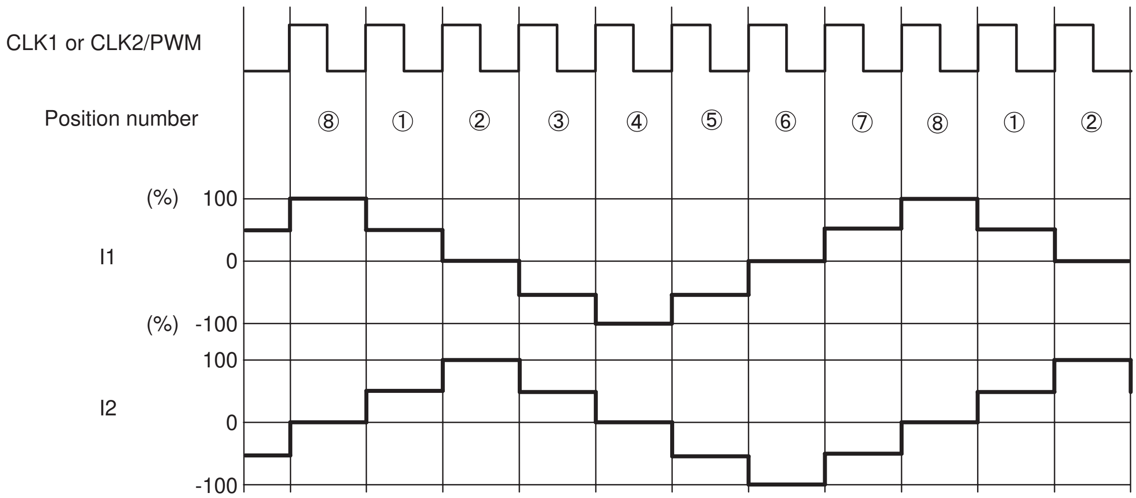


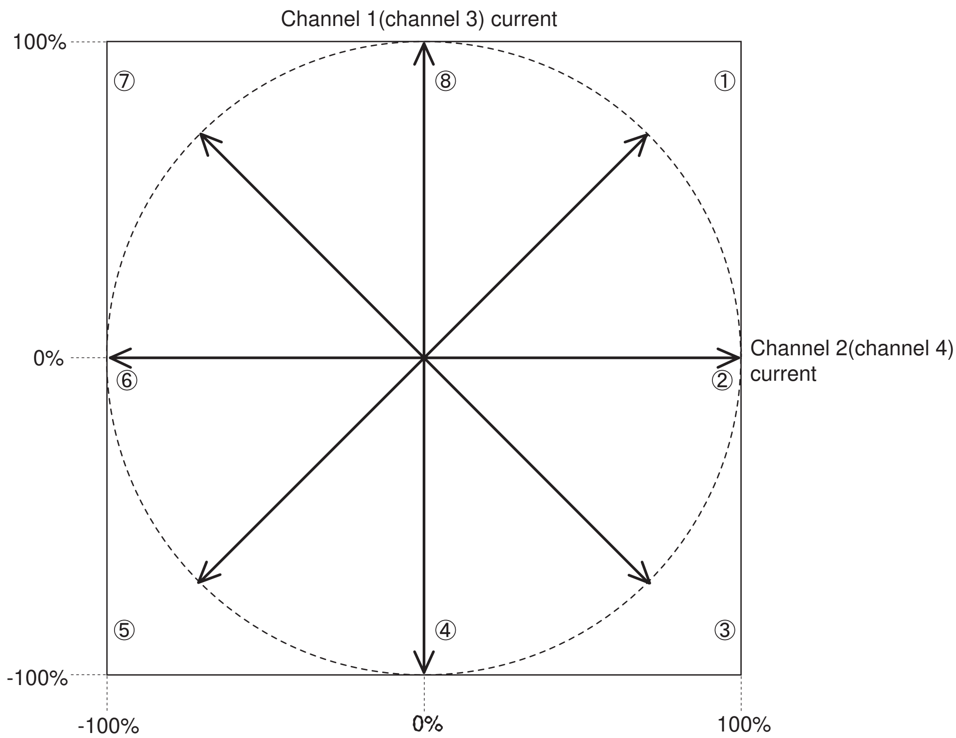
1-2 phase (full torque) Excitation Timing Chart





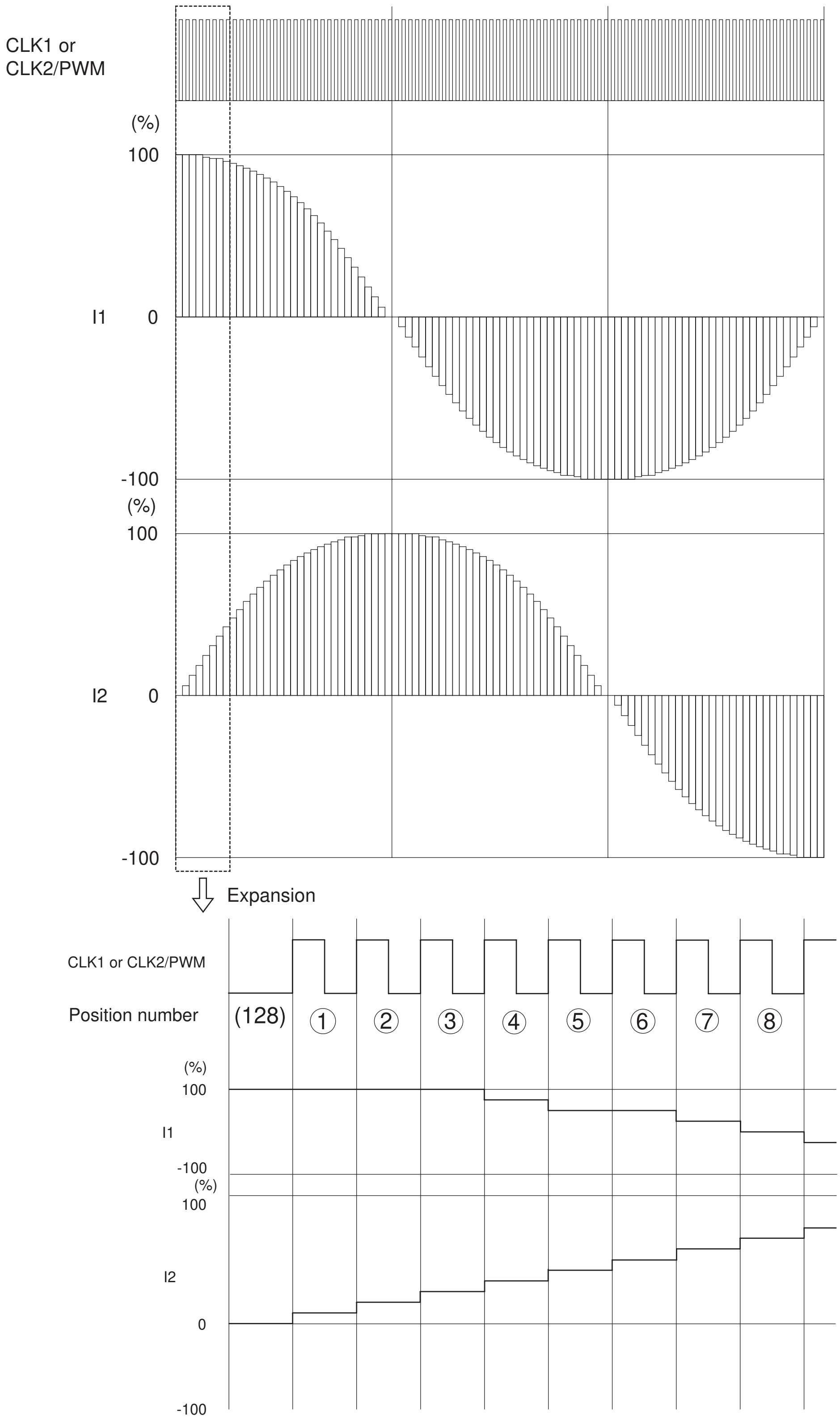
1-2 Phase Excitation Timing Chart



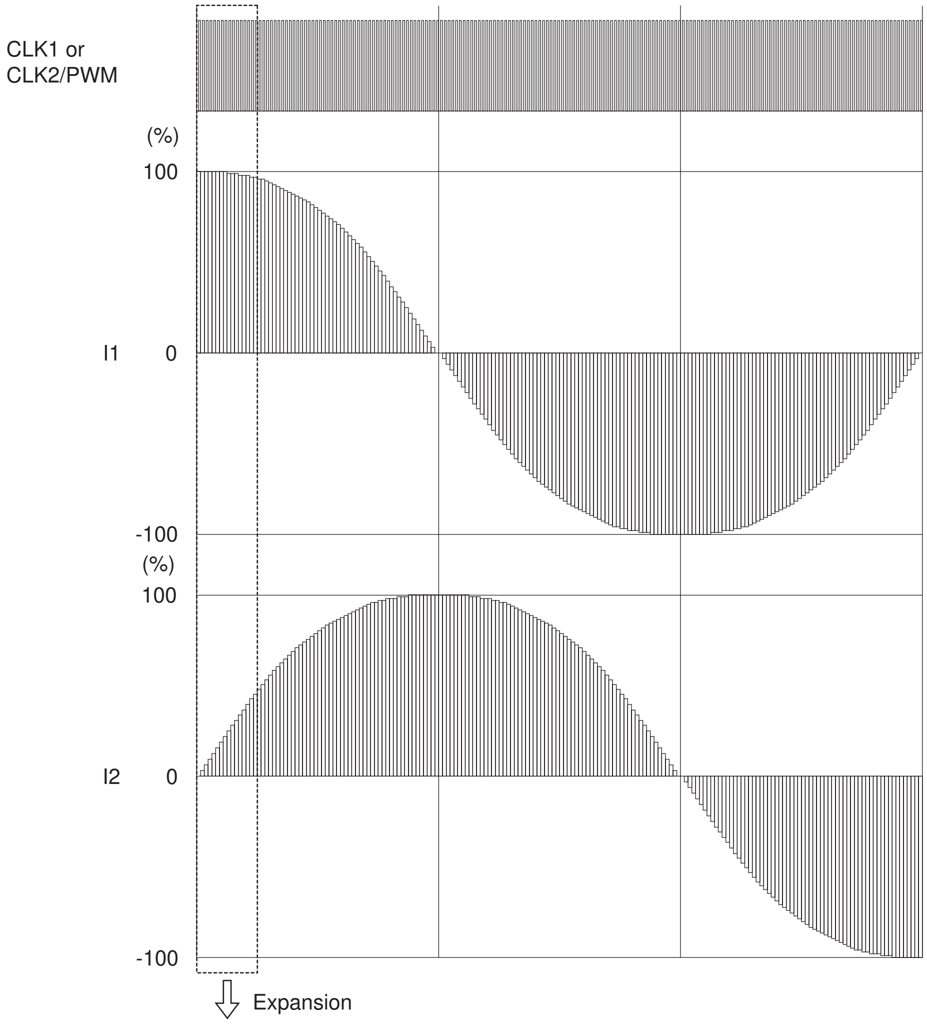


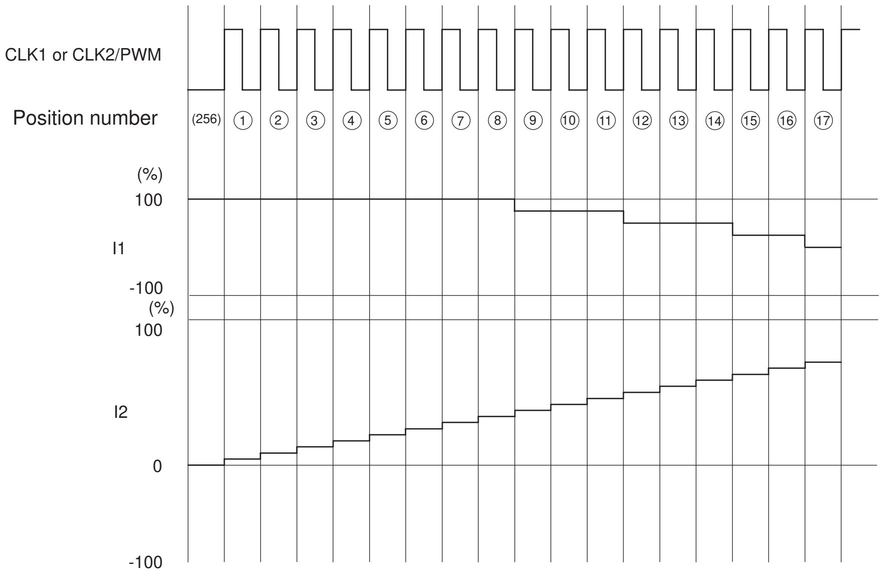
128-division microstep Timing Chart

Ichi of the motor also similarly moves 128-division microstep and 256-division microstep at the time of each standing up of CLK.



256-division microstep Timing Chart

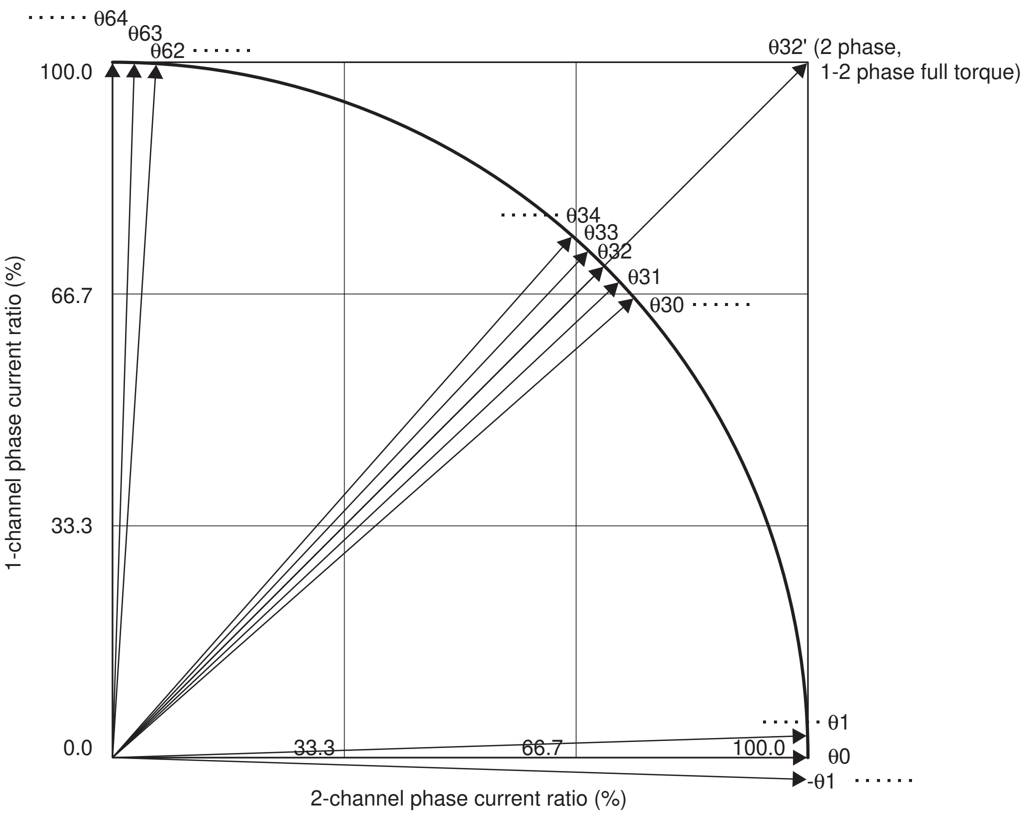




Operation when excitation mode of operation is changed

Chenge to microstep(256-division or 128-division)

After the change, it moves to the following position of microstep by the first pulse when changing to microstep(256-division or 128-division) from each excitation mode.



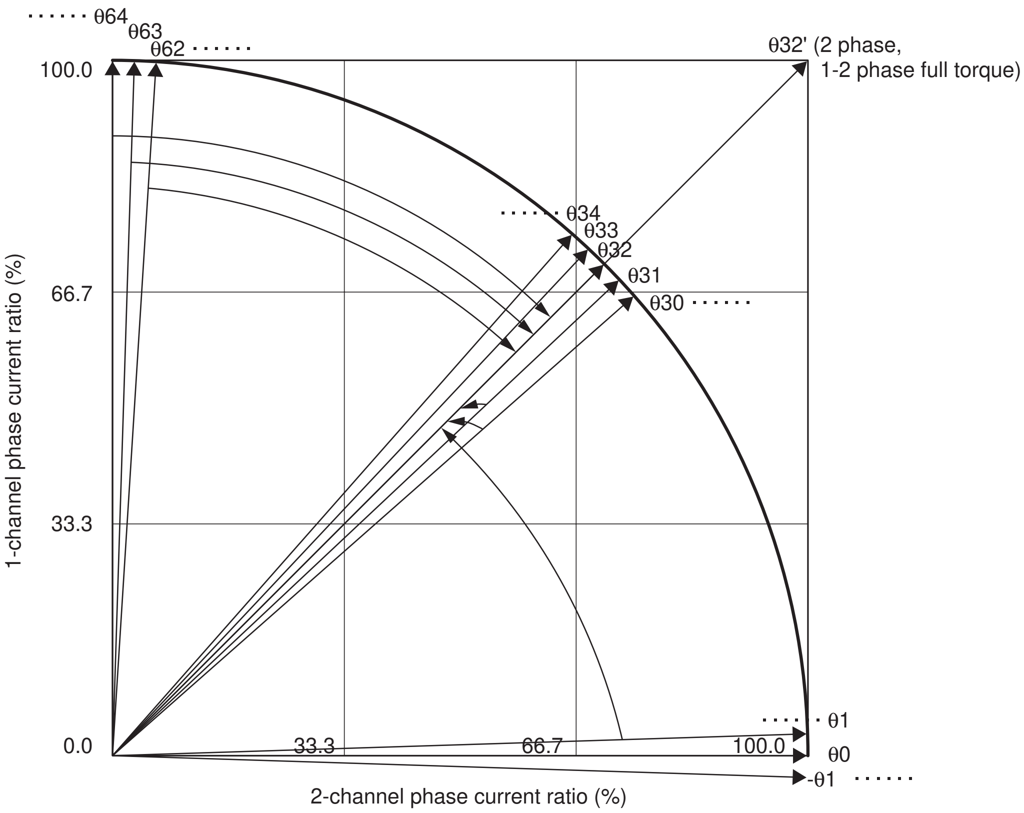
Before the change of the excitation mode		Step position of excitation mode	
excitation mode	position	256-division microstep	128-division microstep
256-division microstep	θ64		θ62
	θ63 to θ33		θ62 to θ32
	θ32		θ30
	θ31 to θ1		θ30 to θ0
	θ0		-θ2
128-division microstep	θ64	θ63	
	θ63 to θ33	θ62 to θ32	
	θ32	θ31	
	θ31 to θ1	θ30 to θ0	
	θ0	-θ1	
1-2 phase	θ64	θ63	θ62
	θ32	θ31	θ30
	θ0	-θ1	-θ2
1-2 phase full torque	θ64	θ63	θ62
	θ32’	θ31	θ30
	θ0	-θ1	-θ2
two phase	θ32’	θ31	θ30

Change to 1-2 aspect excitation (1-2 aspect excitation full torque)

It moves to θ32(θ32') by the first pulse after the change when changing to 1-2 aspect excitation (1-2 aspect exciting full torque) from each excitation mode, and it shifts to 1-2 aspect excitation (1-2 aspect exciting full torque) afterwards. However, after the change, it moves to the following position of 1-2 aspect excitation (1-2 aspect exciting full torque) by the first pulse when the position of the previous state of the change is θ32(θ32').

Change to two aspect excitation

It moves to θ32 'by the first pulse after the change when changing from 1ch to two aspect excitation from each excitation mode for 4ch, and it moves to the following position of two aspect excitation afterwards. However, after the change, it moves to the following position by the first pulse for 5ch and 6ch.

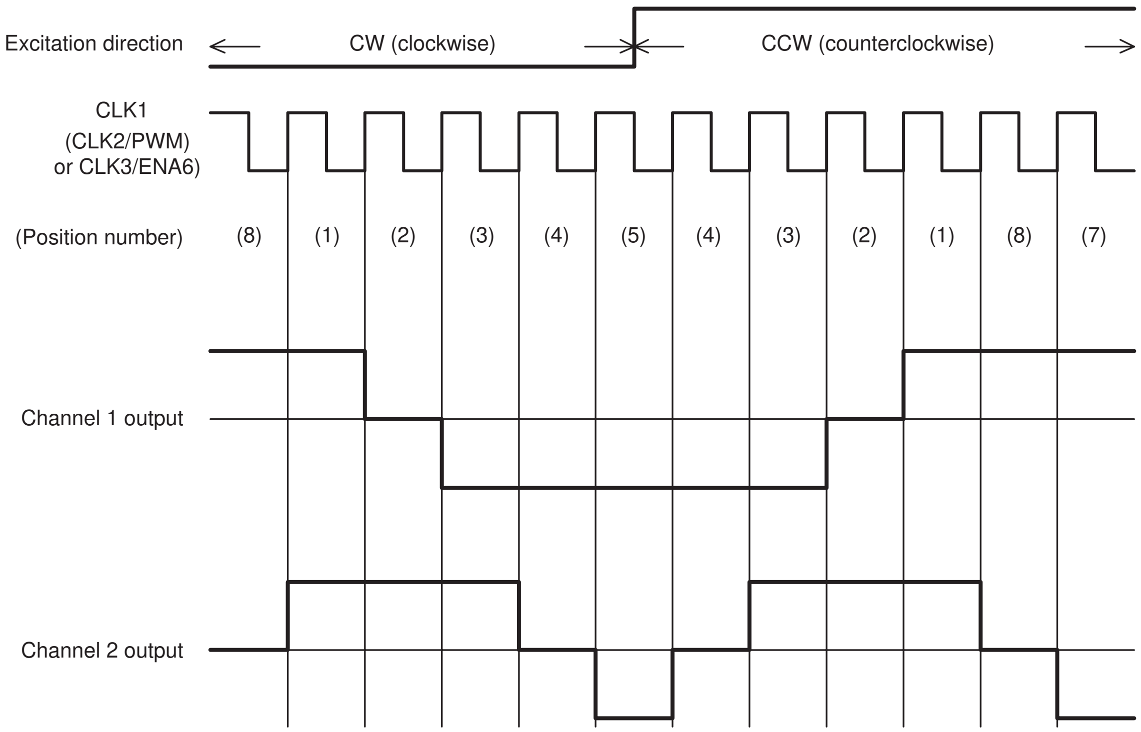


Before the change of the excitation mode		Step position of excitation mode		
excitation mode	position	1-2 phase	1-2 phase full torque	two phase
256-division microstep	θ64	θ32	θ32'	θ32'
	θ63 to θ33	θ32	θ32'	θ32'
	θ32	θ0	θ0	θ32'
	θ31 to θ1	θ32	θ32'	θ32'
	θ0	-θ32	-θ32'	-θ32'
128-division microstep	θ64	θ32	θ32'	θ32'
	θ63 to θ33	θ32	θ32'	θ32'
	θ32	θ0	θ0	θ32'
	θ31 to θ1	θ32	θ32'	θ32'
	θ0	-θ32	-θ32'	-θ32'
1-2 phase	θ64		θ32'	θ32'
	θ32		θ0	θ32'
	θ0		-θ32'	-θ32'
1-2 phase full torque	θ64	θ32		θ32'(θ32')
	θ32'	θ0		θ32'(-θ32')
	θ0	-θ32		-θ32' (-θ32')
two phase	θ32'	θ0	θ0(θ0)	

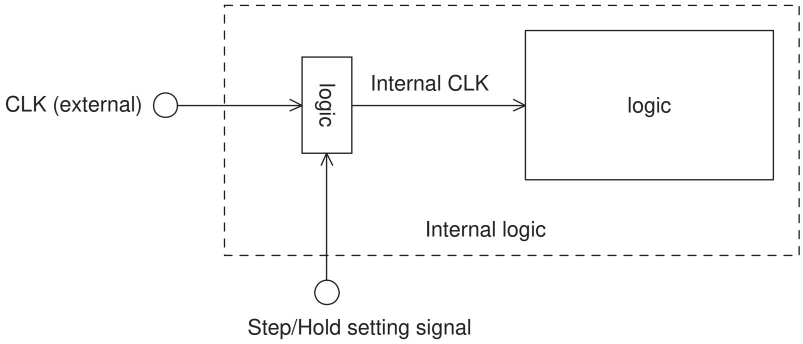
*()In the inside, for 5ch and 6ch

Sample Timing Chart for the Excitation Direction Setting

The excitation direction setting sets the excitation (rotation) direction of the stepping motor.
With the CW (clockwise) setting, the phase of the channel 2 current is delayed from that of the channel 1 current by 90°.
With the CCW (counterclockwise) setting, the phase of the channel 2 current leads that of the channel 1 current by 90°.
The same applies for channel 3, 4, 5 and 6 drive.



Step/Hold Operation Overview

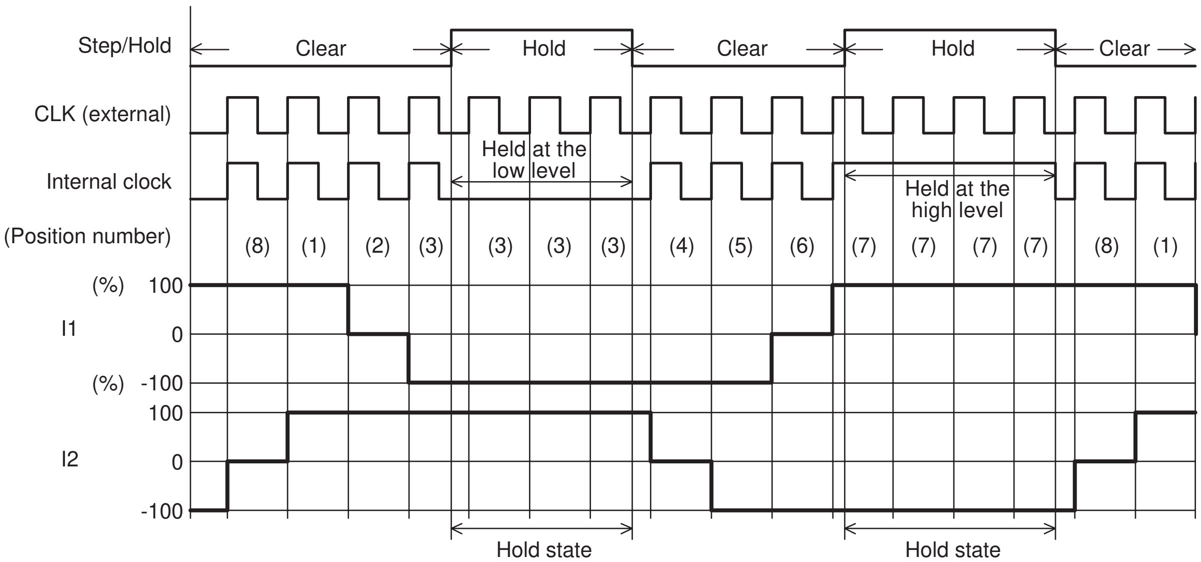


Sample Timing Chart for the Step/Hold Setting

When the Step/Hold data is set to the Hold state, the state of the external clock signal (CLK) at that time is latched and held as the internal clock signal.

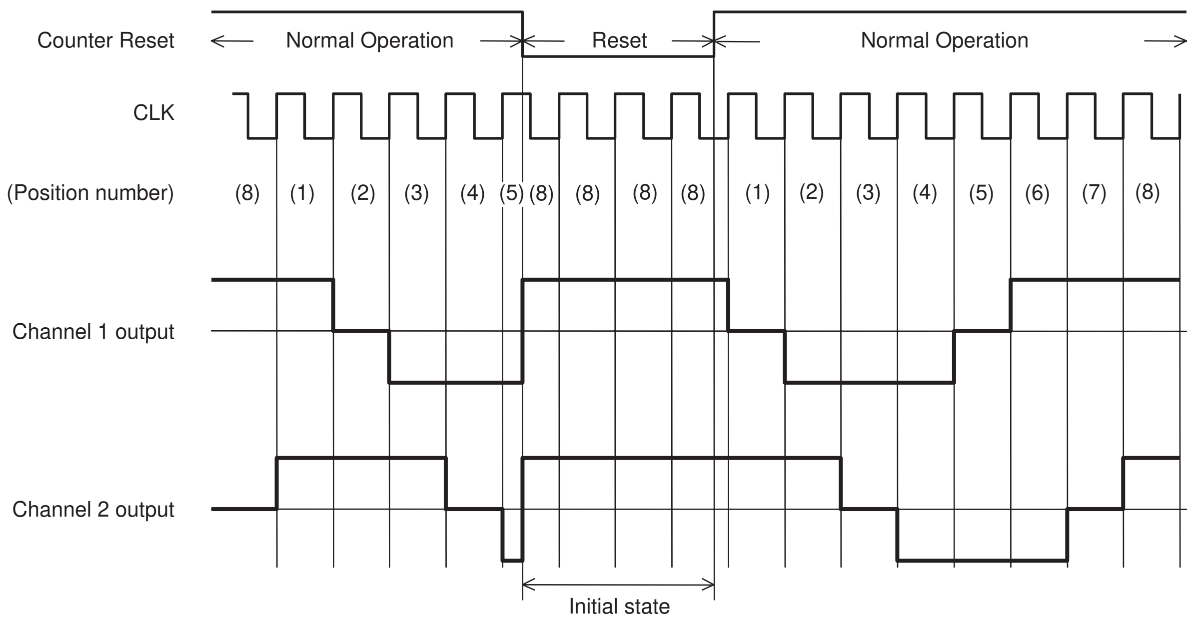
At the timing with which Step/Hold is set to the Hold state for the first time in the figure below, the internal clock signal will be held at the low level because the external clock (CLK) was at the low level. In contrast, at the timing with which Step/Hold is set to the Hold state for the second time, the internal clock signal will be held at the high level because the external clock (CLK) was at the high level.

When Step/Hold is set to the Clear state, the internal clock is synchronized with the external clock (CLK). The output holds the state it was in at the point Step/Hold is set to the Hold state, and advances on the next clock signal rising edge after Step/Hold is set to the Clear state.
As long as Step/Hold is in the Hold state, the position number does not advance even if an external clock (CLK) signal is applied.



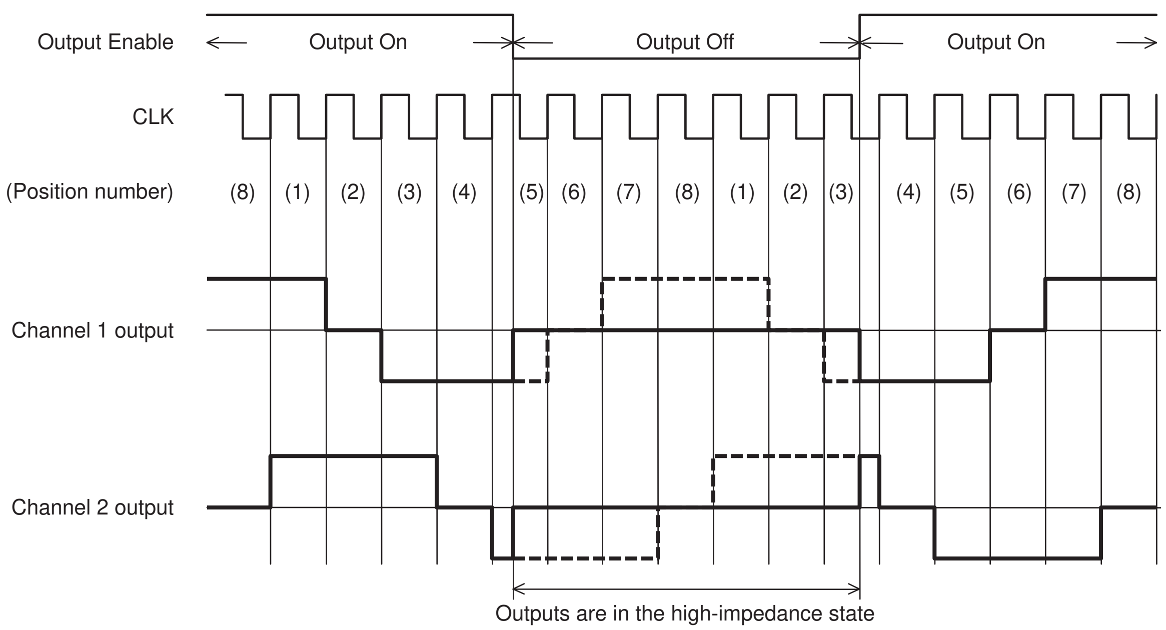
Sample Timing Chart for the Counter Reset Setting

When the Counter Reset setting is set to the Reset state, the output goes to the initial state on the rising edge of the STB signal. Then, when the Counter Reset setting is set to the Normal Operation (cleared) state, the output begins to advance the position number on the rising edge of the CLK signal following the rise of the STB signal.



Sample Timing Chart for the Output Enable Setting

When the Output Enable setting is set to the Output Off state, the outputs are turned off and set to the high-impedance state on the rising edge of the STB signal.
Note, however, that since the internal clock continues to operate, the position number advances as long as a clock signal (CLK) is input. Therefore, when the Output Enable setting is next set to the Output On (cleared) state, the output is turned on at the STB signal rising edge and the output levels at that time will be those for the position number to which the state has advanced due to the CLK signal input.



DC Motor and Voice Coil Motor Drive Methods (Channel 3, 4)

When channel 3 or channel 4 is used to drive a DC or voice coil motor, the drive polarity is set with the serial data.

Setting Procedure

(1) Set PWM signal input(channel 3 to 4) to CLK2/PWM select with the serial data.
→This sets up the signal input from the CLK2/PWM pin to be accepted as a PWM signal for channel 3 or channel 4. (It doesn't accept as CLK signal.)
(2) If the output is to be controlled by PWM control, set up PWM mode and PWM signal allocation with the serial data.
(3) Set the drive polarity for each channel with the serial data.
(4) If the output is to be controlled by PWM control, input the CLK2/PWM signal to the PWM pin.
The following tables describe the correspondence between the PWM signal and the output logic.

Operation in Slow Decay Mode (forward/reverse ↔ brake)

Serial input				PWM input	Output				Mode
D4	D5	D6	D7	CLK2/PWM	OUT5	OUT6	OUT7	OUT8	
0	0			L	OFF	OFF			Standby mode
1	0				H	L			OUT5 → OUT6
0	1				L	H			OUT6 → OUT5
1	1				L	L			Brake mode
		0	0				OFF	OFF	Standby mode
		1	0				H	L	OUT7 → OUT8
		0	1				L	H	OUT8 → OUT7
		1	1				L	L	Brake mode
0	0			H	L	L			Brake mode
1	0				L	L			Brake mode
0	1				L	L			Brake mode
1	1				L	L			Brake mode
		0	0				L	L	Brake mode
		1	0				L	L	Brake mode
		0	1				L	L	Brake mode
		1	1				L	L	Brake mode

Operation in Fast Decay Mode (forward/reverse ↔ standby mode)

Serial input				PWM input	Output				Mode
D4	D5	D6	D7	CLK2/PWM	OUT5	OUT6	OUT7	OUT8	
0	0			L	OFF	OFF			Standby mode
1	0				H	L			OUT5 → OUT6
0	1				L	H			OUT6 → OUT5
1	1				L	L			Brake mode
		0	0				OFF	OFF	Standby mode
		1	0				H	L	OUT7 → OUT8
		0	1				L	H	OUT8 → OUT7
		1	1				L	L	Brake mode
0	0			H	OFF	OFF			Standby mode
1	0				OFF	OFF			Standby mode
0	1				OFF	OFF			Standby mode
1	1				OFF	OFF			Standby mode
		0	0				OFF	OFF	Standby mode
		1	0				OFF	OFF	Standby mode
		0	1				OFF	OFF	Standby mode
		1	1				OFF	OFF	Standby mode

Voice Coil Motor Drive Methods (channels 5 and 6)

When channel 5 or 6 is used to drive a motor, such as a voice coil motor, the drive polarity is set using the serial data. The setting procedure for each channel is shown below.

[When channel 5 is used]
Set the drive polarity using the serial data.
→The signal is output between OUT9 and OUT10 when the serial data is set.

Setup steps
The direction where each channel is drive polarity to the serial data.

serial input		output		mode
D4	D5	OUT9	OUT10	
0	0	OFF	OFF	standby mode
1	0	H	L	OUT9 → OUT10
0	1	L	H	OUT10 → OUT9
1	1	L	L	Brake mode

Channel 5 when you control PWM.

(1) Set CLK2/PWM selection to "PWM signal input(channel 5)" with the serial data.
→This sets up the signal input from the CLK2/PWM pin to be accepted as a PWM signal for channel 5.
(2) Set CLK3/ENA6 selection to "ENA6 signal input" with the serial data.
→This sets up the signal input from the CLK3/ENA6 pin to be accepted as a ENA signal for channel 6.
→It comes to be able to set the direction where channel 5 and channel 6 are drive polarity to the serial data.
(3) Set the drive polarity using the serial data..
→ The signal is output between OUT9 and OUT10 when the serial data is set.

Operation in Slow Decay Mode (forward/reverse ↔ brake)

Serial input		PWM input	Output		Mode
D4	D5	CLK2/PWM	OUT9	OUT10	
0	0	L	OFF	OFF	Standby mode
1	0		H	L	OUT9 → OUT10
0	1		L	H	OUT10 → OUT9
1	1		L	L	Brake mode
0	0	H	OFF	OFF	Standby mode
1	0		L	L	Brake mode
0	1		L	L	Brake mode
1	1		L	L	Brake mode

Operation in Fast Decay Mode (forward/reverse ↔ standby mode)

Serial input		PWM input	Output		Mode
D4	D5	CLK2/PWM	OUT9	OUT10	
0	0	L	OFF	OFF	Standby mode
1	0		H	L	OUT9 → OUT10
0	1		L	H	OUT10 → OUT9
1	1		L	L	Brake mode
0	0	H	OFF	OFF	Standby mode
1	0		OFF	OFF	Standby mode
0	1		OFF	OFF	Standby mode
1	1		L	L	Brake mode

[When channel 6 is used]
(1) Set CLK3/ENA6 selection to "ENA6 signal input" with the serial data.
→This sets up the signal input from the CLK3/ENA6 pin to be accepted as a ENA signal for channel 6.
→It comes to be able to set the direction where channel 5 and channel 6 are drive polarity to the serial data.
(3) Set the drive polarity using the serial data.
→The signal is output between OUT11 and OUT12 only when ENA6 is set to high.
(When ENA6 is low, the signal output between OUT11 and OUT12 is set to OFF.)

ENA6 input truth table

Serial input		Parallel input	Output		Mode
D6	D7	ENA5	OUT11	OUT12	
*	*	L	OFF	OFF	Standby mode
0	0	H	OFF	OFF	Standby mode
1	0		H	L	OUT11 → OUT12
0	1		L	H	OUT12 → OUT11
1	1		L	L	Brake mode

Constant Current Control Settings (channels 5 and 6)

The constant current levels for channels 5 and 6 are set as shown below.

The output constant current is set by the constant current reference voltage set with the serial data and the resistor (RF) connected between the RF5 and RF6 pins.
The following formula can be used to calculate the output constant current.

(output constant current) = (constant current reference voltage) / (value of the resistor RF)

reference voltage setting: channel 5 setting(D0 = [0], D1 = [0], D2 = [0], D3 = [1])
channel 6 setting(D0 = [1], D1 = [0], D2 = [0], D3 = [1])

D4	D5	D6	D7	constant current reference voltage
0	0	0	0	0.200V
1	0	0	0	0.170V
0	1	0	0	0.165V
1	1	0	0	0.160V
0	0	1	0	0.155V
1	0	1	0	0.150V
0	1	1	0	0.145V
1	1	1	0	0.140V
0	0	0	1	0.135V
1	0	0	1	0.130V
0	1	0	1	0.125V
1	1	0	1	0.120V
0	0	1	1	0.115V
1	0	1	1	0.110V
0	1	1	1	0.105V
1	1	1	1	0.100V

[Motor holding current mode]
The constant current reference voltages for channels 5 and 6 are switched to one-third levels when the motor holding current is set to ON by the serial data.

PI1, PI2 Output Drive Method

When the PI1 or PI2 output is used to drive a photosensor, the drive on/off state is set using the serial data.

Hysteresis settings of Schmitt buffer

The presence or absence of hysteresis in the Schmitt buffer outputs B01 and B02 can be set individually with the serial data.

Truth Tables **Serial Logic Table 1**

Input									Setting mode	Content set	Notes	Channels set						PI	Serial data activation timing			
D0	D1	D2	D3	D4	D5	D6	D7	D8				OUT1-2	OUT3-4	OUT5-6	OUT7-8	OUT9-10	OUT11-12		CLK1	CLK2	CLK3	STB
0	0	0	0	0	*	*	*	*	AF Excitation Direction	CW (clockwise)		○	○						○			
				1	*	*	*	*		CCW (counterclockwise)												
				*	0	*	*	*	AF Step/Hold	Clear												○
				*	1	*	*	*		Hold												
				*	*	0	*	*	AF Counter Reset	Reset												
				*	*	1	*	*		Clear												
				*	*	*	0	*	AF Output Enable	Output Off												
				*	*	*	1	*		Output On												
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														
1	0	0	0	0	0	*	*	*	AF Excitation mode	2-phase excitation		○	○						○			
				1	0	*	*	*		1-2 phase excitation (full torque)												
				0	1	*	*	*		1-2 phase excitation												
				1	1	*	*	*		Microstep												
				*	*	0	*	*	Microstep division number	256 divisions												
				*	*	1	*	*		128 divisions												
				*	*	*	0	*	(Dummy data)													
				*	*	*	1	*														
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														
0	1	0	0	0	*	*	*	*	CLK2/PWM select	CLK2 signal input	↓*1			○	○	○						○
				1	*	*	*	*		PWM signal input	↓*2											
				*	0	*	*	*	PWM mode	Slow Decay (Forward/reverse ⇔ brake)	*2											
				*	1	*	*	*		Fast Decay (Forward/reverse ⇔ standby mode)												
				*	*	0	0	0	PWM signal allocation	OFF												
				*	*		1	0		Channel 3 only												
				*	*		0	1		Channel 4 only												
				*	*		1	1		Channel 3 and 4												
				*	*	1	*	*		Channel 5 only												
1	1	0	0	0	*	*	*	*	Zoom Excitation Direction	CW (clockwise)	*1			○	○					○		
				1	*	*	*	*		CCW (counterclockwise)												
				*	1	*	*	*	Zoom step hold	Clear												
				*	1	*	*	*		Hold												
				*	*	0	*	*	Zoom counter reset	Reset												○
				*	*	1	*	*		Clear												
				*	*	*	0	*	Zoom output enable	Output Off												
				*	*	*	1	*		Output On												
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														
				0	0	*	*	*	OUT5-6 drive polarity	OFF	*2			○								○
				1	0	*	*	*		OUT5→OUT6												
				0	1	*	*	*		OUT6→OUT5												
				1	1	*	*	*		Brake												
				*	*	0	0	*	OUT7-8 drive polarity	OFF					○							
				*	*	1	0	*		OUT7→OUT8												
				*	*	0	1	*		OUT8→OUT7												
				*	*	1	1	*		Brake												
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														

Serial Logic Table 2

Input									Setting mode	Content set	Notes	Channels set						PI	Serial data activation timing			
D0	D1	D2	D3	D4	D5	D6	D7	D8				OUT1-2	OUT3-4	OUT5-6	OUT7-8	OUT9-10	OUT11-12		CLK1	CLK2	CLK3	STB
				0	*	*	*	*	SH Excitation Direction	CW (clockwise)												
				1	*	*	*	*		CCW (counterclockwise)											○	
				*	0	*	*	*	SH Excitation mode	2-phase excitation												
				*	1	*	*	*		1-2 phase excitation												
				*	*	0	*	*	SH Step/Hold	Clear	*3					○	○					
				*	*	1	*	*		Hold												
				*	*	*	0	*	SH Counter Reset	Reset												○
				*	*	*	1	*		Clear												
1	0	1	0	*	*	*	*	0	SH Output Enable	Output Off												
				*	*	*	*	1		Output On												
				0	0	*	*	*	OUT9-10 drive polarity	OFF												
				1	0	*	*	*		OUT9→OUT10						○						
				0	1	*	*	*		OUT10→OUT9												
				1	1	*	*	*		Brake	*4											○
				*	*	0	0	*	OUT11-12 drive polarity	OFF												
				*	*	1	0	*		OUT11→OUT12							○					
				*	*	0	1	*		OUT12→OUT11												
				*	*	1	1	*		Brake												
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														
				0	0	*	*	*	Chopping frequency setting	390KHz												
				1	0	*	*	*		195KHz												
				0	1	*	*	*		570KHz												
				1	1	*	*	*		285KHz												
0	1	1	0	*	*	0	0	*	Chopping current standard voltage select	100%(0.2V)		○	○	○	○							○
				*	*	1	0	*		70%(0.140V)												
				*	*	0	1	*		50%(0.1V)												
				*	*	1	1	*		30%(0.060V)												
				*	*	*	*	0	CLK3/ENA6 select	CLK3 signal input	↑*3					○	○					
				*	*	*	*	1		ENA6 signal input	↑*4											
				0	0	*	*	*	Zoom Excitation mode	2-phase excitation												
				1	0	*	*	*		1-2 phase excitation (full torque)												
				0	1	*	*	*		1-2 phase excitation				○	○					○		
1	1	1	0	1	1	*	*	*		microstep												
				*	*	0	*	*	Number of partitions to microstep	256 divisions												
				*	*	1	*	*		128 divisions												
				*	*	*	0	*	(Dummy data)													
				*	*	*	1	*														
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														

Serial Logic Table 3

Input									Setting mode	Content set	Notes	Channels set						PI	Serial data activation timing			
D0	D1	D2	D3	D4	D5	D6	D7	D8				OUT1-2	OUT3-4	OUT5-6	OUT7-8	OUT9-10	OUT11-12		CLK1	CLK2	CLK3	STB
				0	0	0	0	*		0.200V												
				1	0	0	0	*		0.170V												
				0	1	0	0	*		0.165V												
				1	1	0	0	*		0.160V												
				0	0	1	0	*		0.155V												
				1	0	1	0	*		0.150V												
				0	1	1	0	*		0.145V												
				1	1	1	0	*	OUT9-10 constant current reference voltage	0.140V						○						○
				0	0	0	1	*		0.135V												
0	0	0	1	1	0	0	1	*		0.130V												
				0	1	0	1	*		0.125V												
				1	1	0	1	*		0.120V												
				0	0	1	1	*		0.115V												
				1	0	1	1	*		0.110V												
				0	1	1	1	*		0.105V												
				1	1	1	1	*		0.100V												
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														
				0	0	0	0	*		0.200V												
				1	0	0	0	*		0.170V												
				0	1	0	0	*		0.165V												
				1	1	0	0	*		0.160V												
				0	0	1	0	*		0.155V												
				1	0	1	0	*		0.150V												
				0	1	1	0	*		0.145V												
				1	1	1	0	*	OUT11-12 constant current reference voltage	0.140V							○					
				0	0	0	1	*		0.135V												
1	0	0	1	1	0	0	1	*		0.130V												○
				0	1	0	1	*		0.125V												
				1	1	0	1	*		0.120V												
				0	0	1	1	*		0.115V												
				1	0	1	1	*		0.110V												
				0	1	1	1	*		0.105V												
				1	1	1	1	*		0.100V												
				*	*	*	*	0	Maintenance voltage (OUT9-10/11-12)	OFF(100%)												
				*	*	*	*	1		ON(33%)						○	○					
				0	*	*	*	*	Photo senser1 drive	OFF												
				1	*	*	*	*		ON								○				
				*	0	*	*	*	Photo senser2 drive	OFF												
				*	1	*	*	*		ON												○
				*	*	0	*	*	Buffer hysteresis (BI1/BO1)	NOT												
0	1	0	1	*	*	1	*	*		Having												
				*	*	*	0	*	Buffer hysteresis (BI2/BO2)	NOT												
				*	*	*	1	*		Having												
				*	*	*	*	0	(Dummy data)													
				*	*	*	*	1														