

DESCRIPTION

The PT5111 is a semiconductor integrated circuit that incorporates driver circuits suitable for the motors of digital cameras. The current consumption can be held at quite low level during standby or operation. And the active power supply voltage range for VM is from 2.7~5.5V. So the device is ideal for portable and battery powered applications. The PT5111 is available in QFN40 (5mm × 5mm) package. Performance is specified for -40°C to +85°C temperature range.

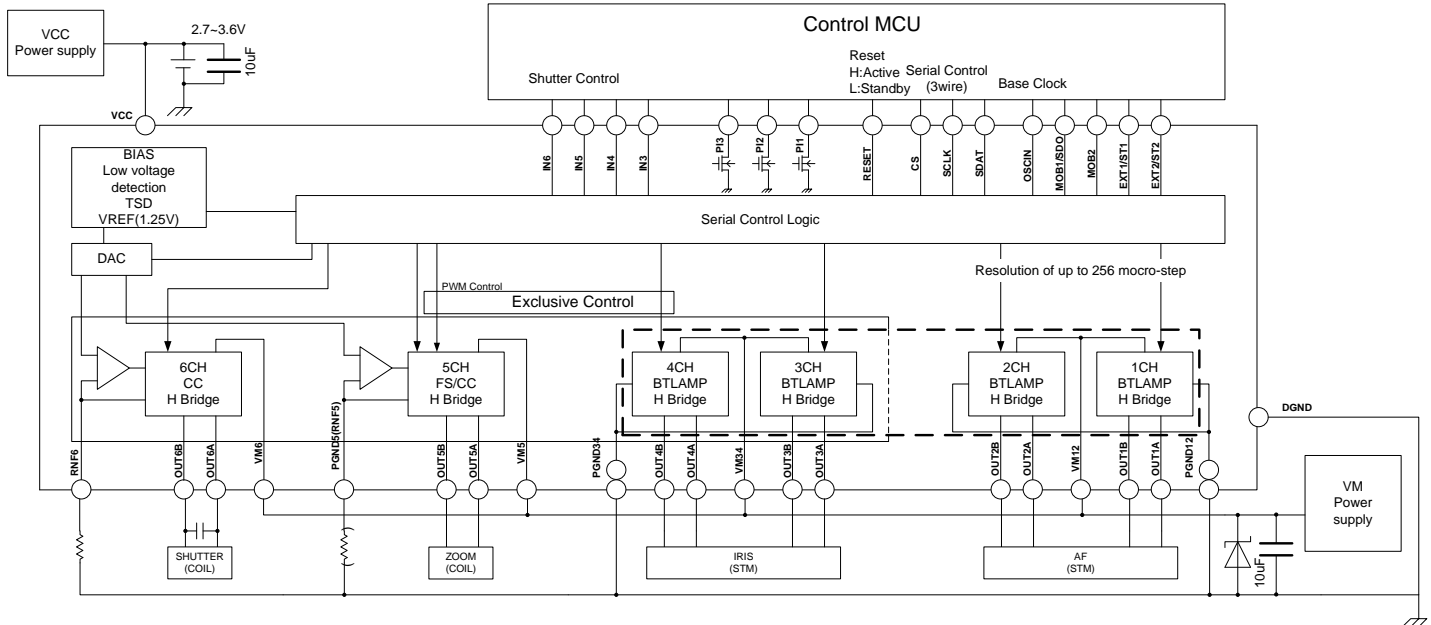
APPLICATION

- DSC/DV

FEATURES

- An ultra-fine CMOS process has been adopted for low power consumption in a design.
- A small 40-pin QFN package(5mm×5mm, lead pitch is 0.4 mm)has been adopted.
- 1ch/2ch and 3ch/4ch are capable of micro-steps mode. Possible modes are from 2-2 phase stepper drive to maximum 256 resolution micro-steps.
- Built-in autonomous drive circuit under the control of serial settings.
- Built-in 3-ch PI driver
- Under voltage lockout circuit
- Shut down the internal circuit at VCC=1.8V (Typ.)
- Thermal shut down circuit
- Shut down the internal circuit at 150°C Hysteresis 30°C
- Power supply systems are all internally isolated and include a function to prevent reverse current between power supplies.
- Built-in exclusive control mode from channel 3 to channel 6.(resemblance 7 channel motor drive application)

BLOCK DIAGRAM



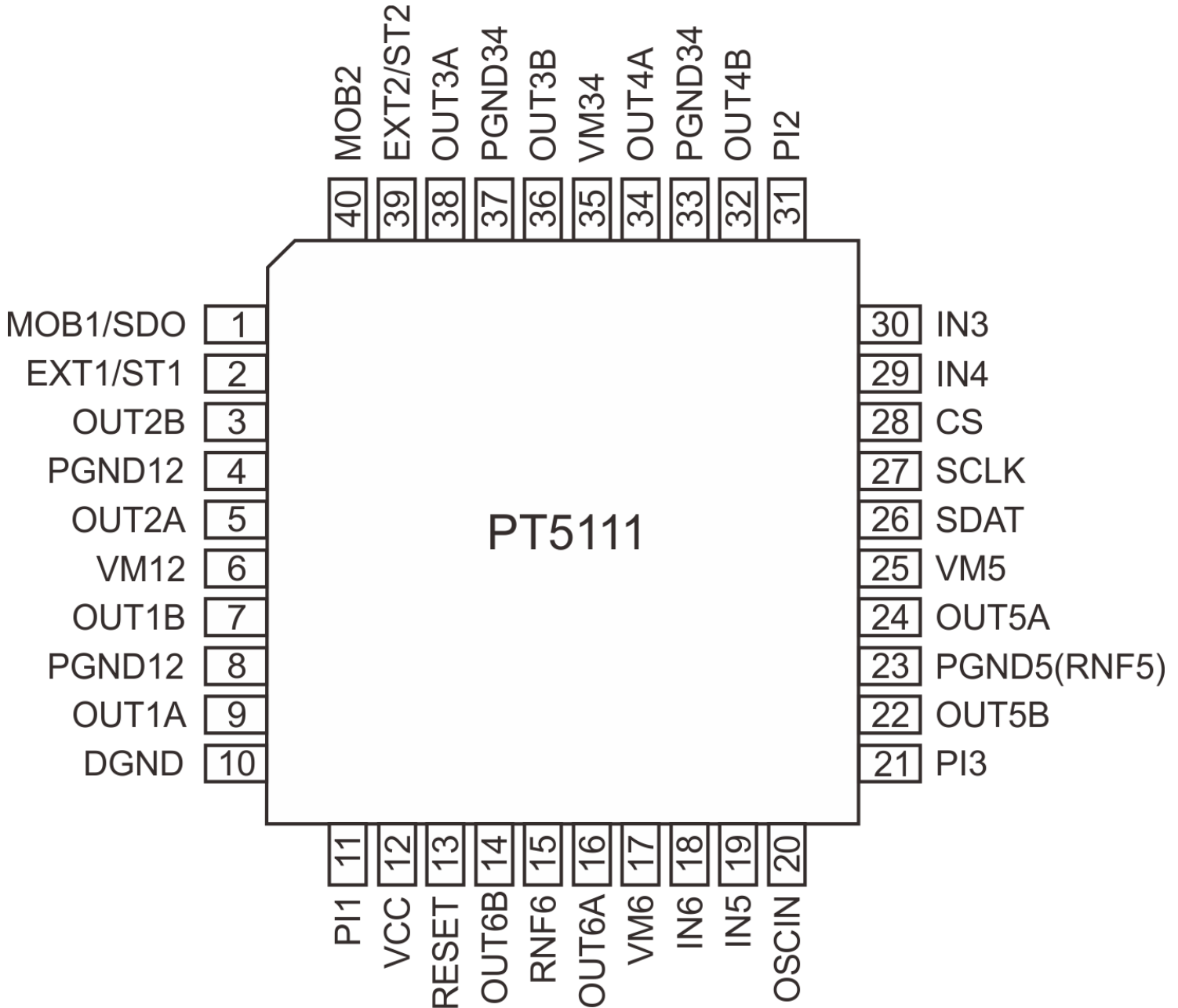
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1. ORDER INFORMATION

Valid Part Number	Package Type	Top Code
PT5111	40 Pins, QFN	PT5111

2. PIN CONFIGURATION

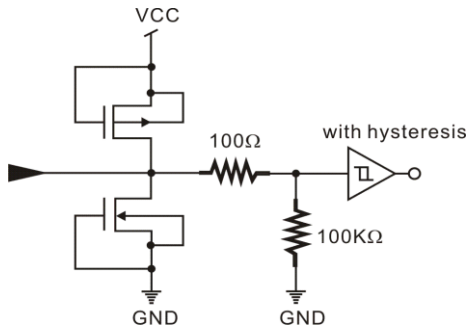


3. PIN DESCRIPTION

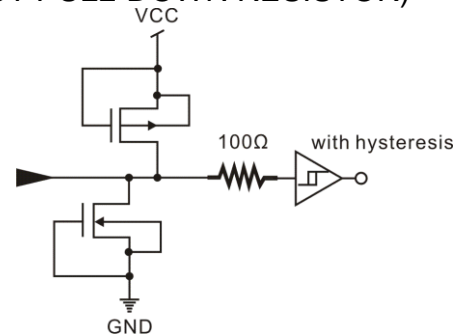
Pin Name	I/O	Description	Pin No.
MOB1/SDO	O	MOB (SDO) output	1
EXT1/ST1	O	EXT (ST) output	2
OUT2B	O	CH2 output B	3
PGND12	GND	CH1/2 power GND	4
OUT2A	O	CH2 output A	5
VM12	Power Supply	CH1/2 Power supply	6
OUT1B	O	CH1 output B	7
PGND12	GND	CH1/2 power GND	8
OUT1A	O	CH1 output A	9
DGND	GND	Control GND	10
PI1	O	PI1 output	11
VCC	Power Supply	Small signal power supply	12
RESET	I	Logic reset	13
OUT6B	O	CH6 output B	14
RNF6	GND	CH6 current sense input or power GND	15
OUT6A	O	CH6 output A	16
VM6	Power Supply	CH6 power supply	17
IN6	I	Channel 5 and 6 control	18
IN5	I	Channel 5 and 6 control	19
OSCIN	I	Clock	20
PI3	O	PI3 output	21
OUT5B	O	CH5 output B	22
PGND5(RNF5)	GND	CH5 current sense input or power GND	23
OUT5A	O	CH5 output A	24
VM5	Power Supply	CH5 Power supply	25
SDAT	I	Serial data input	26
SCLK	I	Serial clock input	27
CS	I	Serial data latch control	28
IN4	I	Channel 4, 5 and 7 control	29
IN3	I	Channel 3, 4, 5 and 7 control	30
PI2	O	PI2 output	31
OUT4B	O	CH4 output B	32
PGND34	GND	CH3/4 power GND	33
OUT4A	O	CH4 output A	34
VM34	Power Supply	CH3/4 power supply	35
OUT3B	O	CH3 output B	36
PGND34	GND	CH3/4 power GND	37
OUT3A	O	CH3 output A	38
EXT2/ST2	O	EXT (ST) output	39
MOB2	O	MOB output	40

4. INPUT/OUTPUT CONFIGURATION

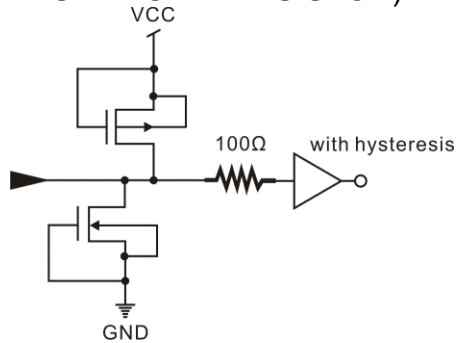
CS, RESET



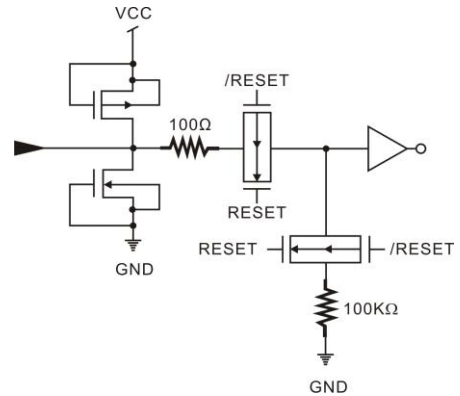
SDAT, SCLK
(WITHOUT PULL-DOWN RESISTOR)



IN3, IN4, IN5, IN6
(WITHOUT PULL-DOWN RESISTOR)

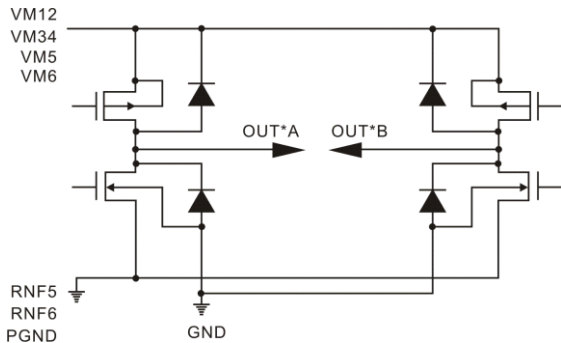


OSCIN

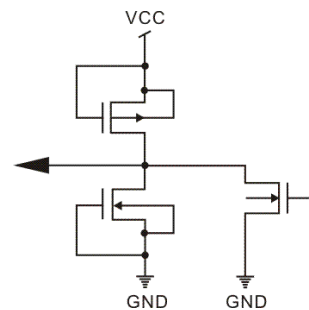


OUT*A, OUT*B

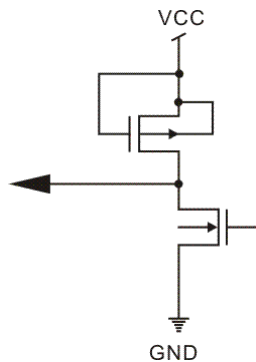
*=1, 2, 3, 4, 5, 6



EXT1(ST1), EXT2(ST2), MOB1(SDO), MOB2

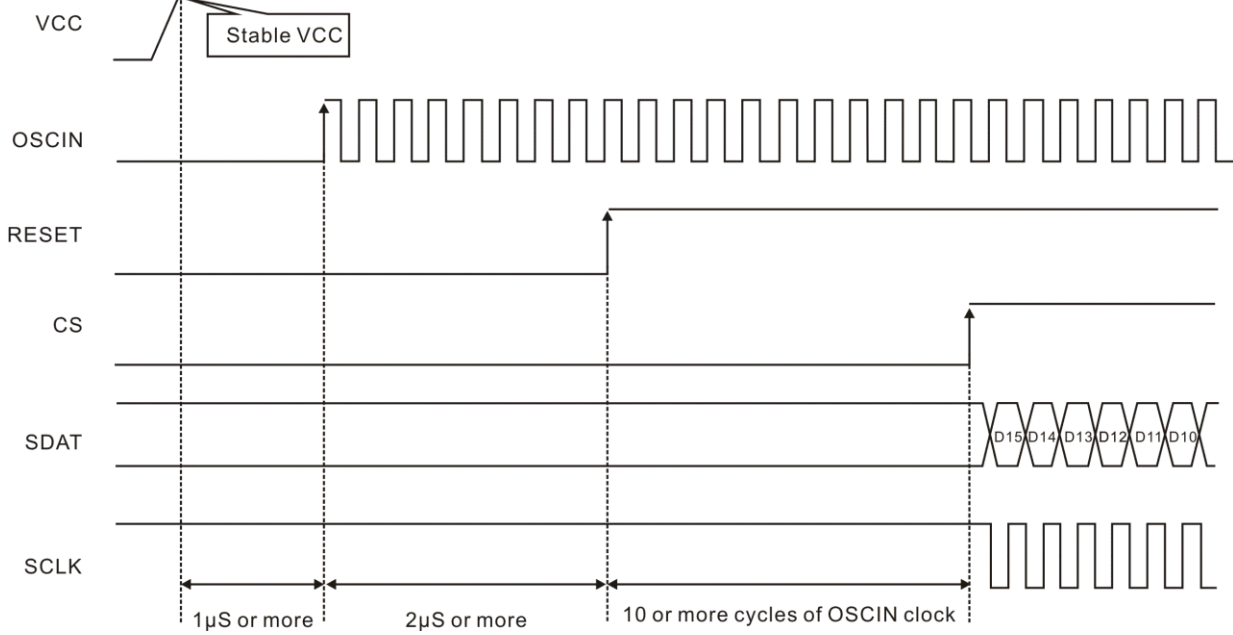


PI1, PI2, PI3

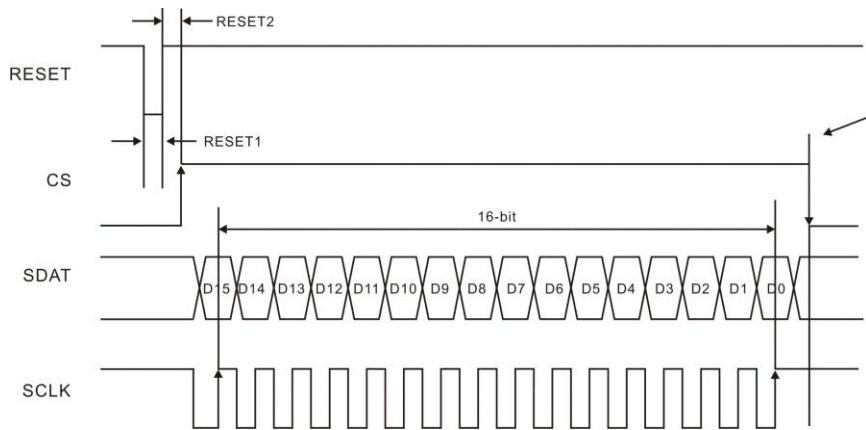


5. FUNCTION DESCRIPTION

POWER SUPPLY(VCC) STARTING & SERIAL DATA INPUT TIMING

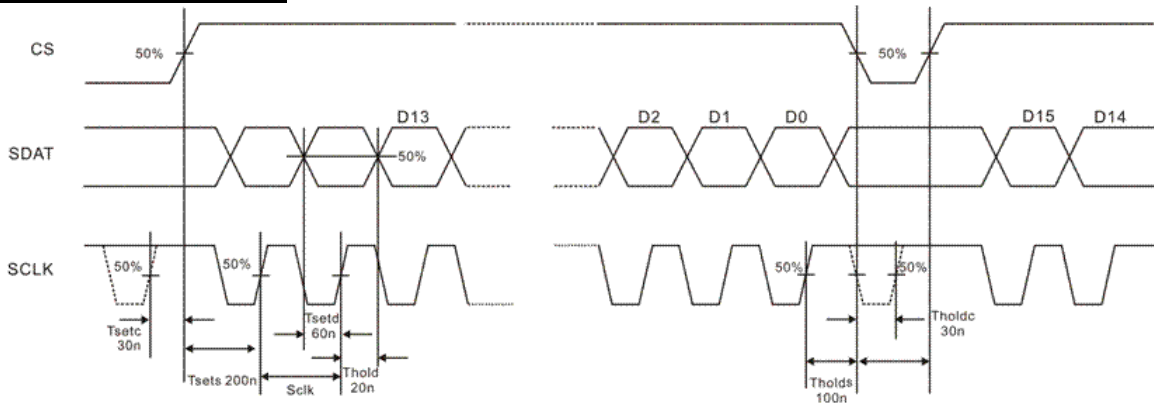


SERIAL DATA INPUT SETTING

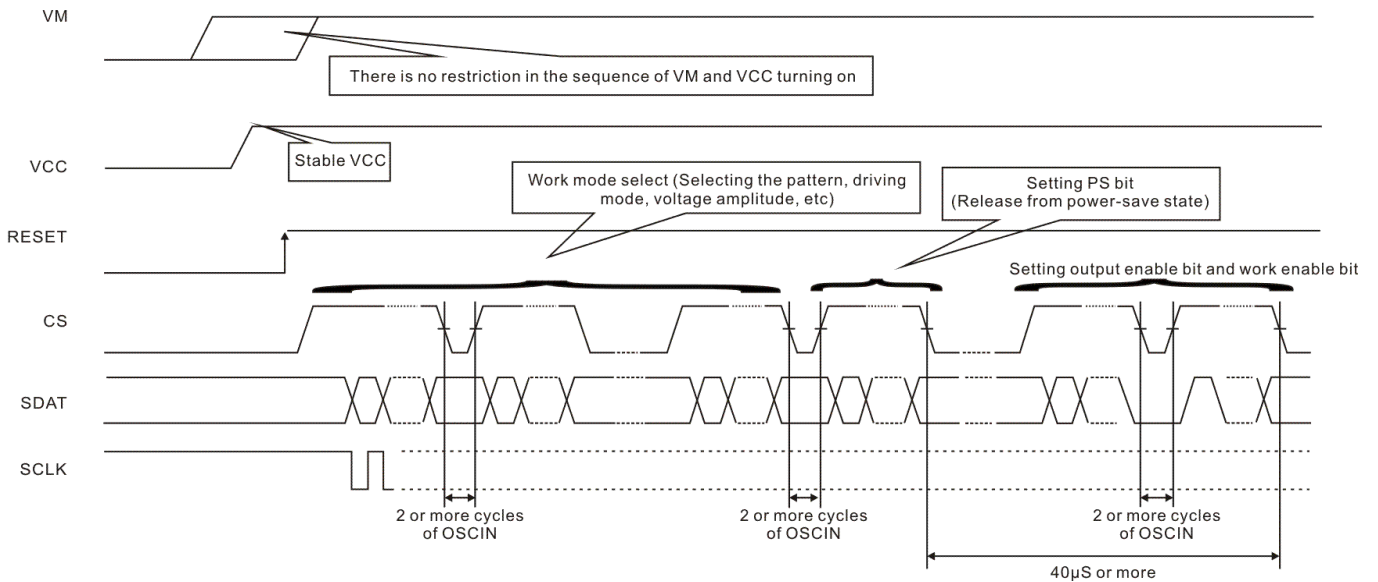


<Timing of writing internal registers>
 16-bit of data sent after a rising edge of CS will be latched and written to an internal register during the falling edge of CS.
 When fewer or more than 16 clock pulses are received while the CS signal is high, the data input of SDAT line will be invalid.
 The existing data is retained in the register.

SERIAL PORT WRITE TIMING



TIMING: RELEASE FROM THE POWER-SAVE STATE TO INPUT OF SIGNAL ENABLING OPERATION



6. STEP CONTROL

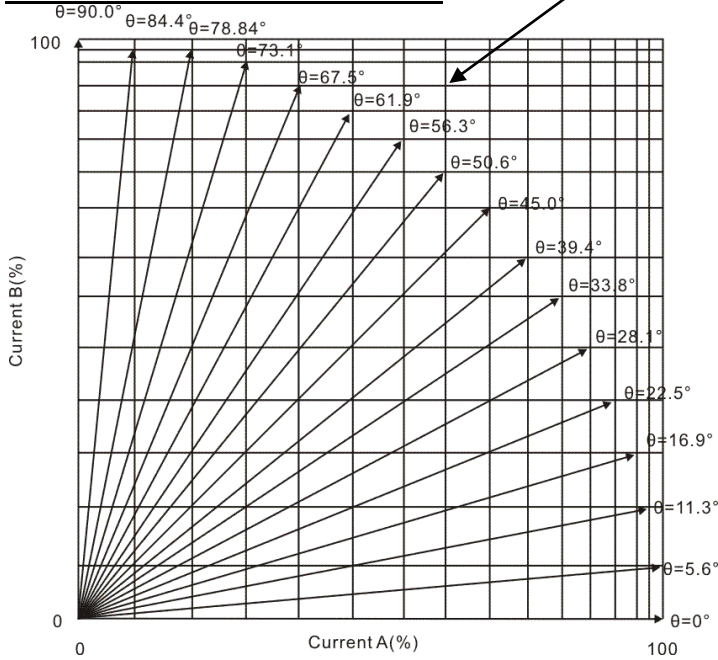
(1) MICRO STEP CONTROL 1

Any of the four resolutions are selectable: 32, 64, 128 and 256 steps

(The example given below is for 64 steps)

·When a magnetization starting position is not Specified, it will START at 45°

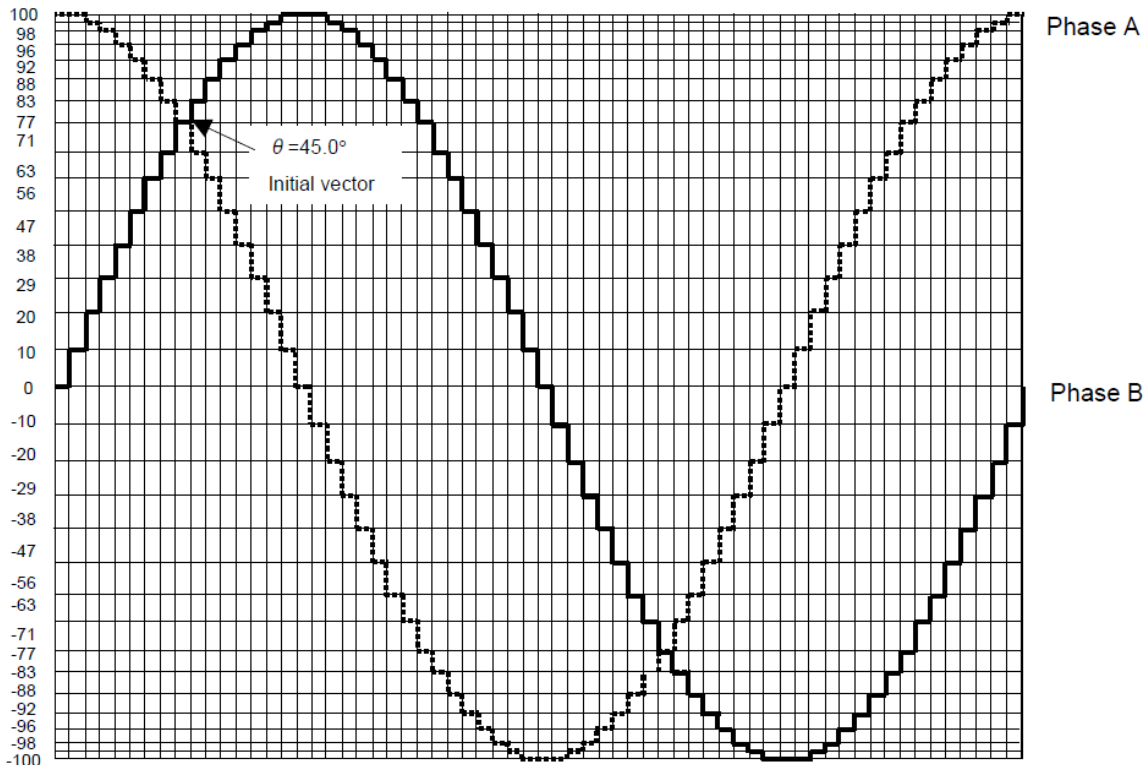
OUTPUT CURRENT VECTOR



ACH & BCH POSITION AND CURRENT

Step	Set Angle	Current B	Current A
0	0.0	0.0%	100.0%
1	5.6	9.8%	100.0%
2	11.3	19.5%	98.1%
3	16.9	29.0%	95.7%
4	22.5	38.3%	92.4%
5	28.1	47.1%	88.2%
6	33.8	55.6%	83.1%
7	39.4	63.4%	77.3%
8	45.0	70.7%	70.7%
9	50.6	77.3%	63.4%
10	56.3	83.1%	55.6%
11	61.9	88.2%	47.1%
12	67.5	92.4%	38.3%
13	73.1	95.7%	29.0%
14	78.8	98.1%	19.5%
15	84.4	100.0%	9.8%
16	90.0	100.0%	0%

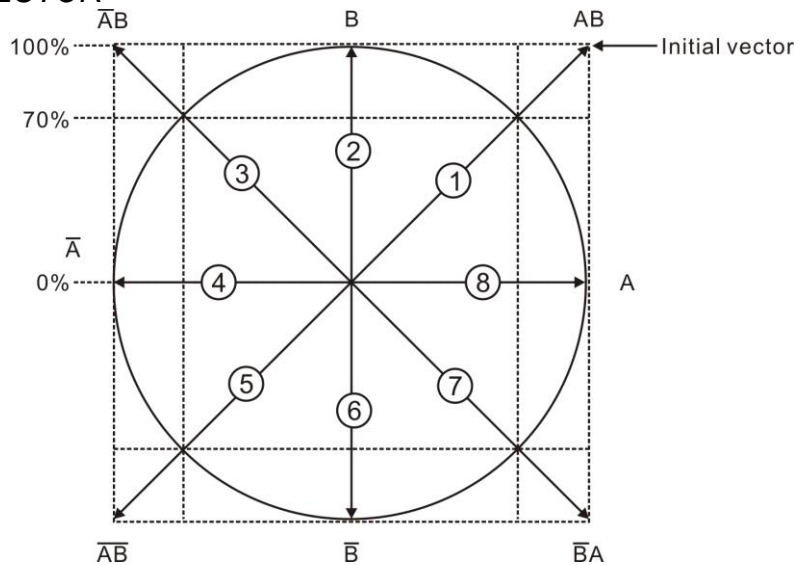
Initial vector



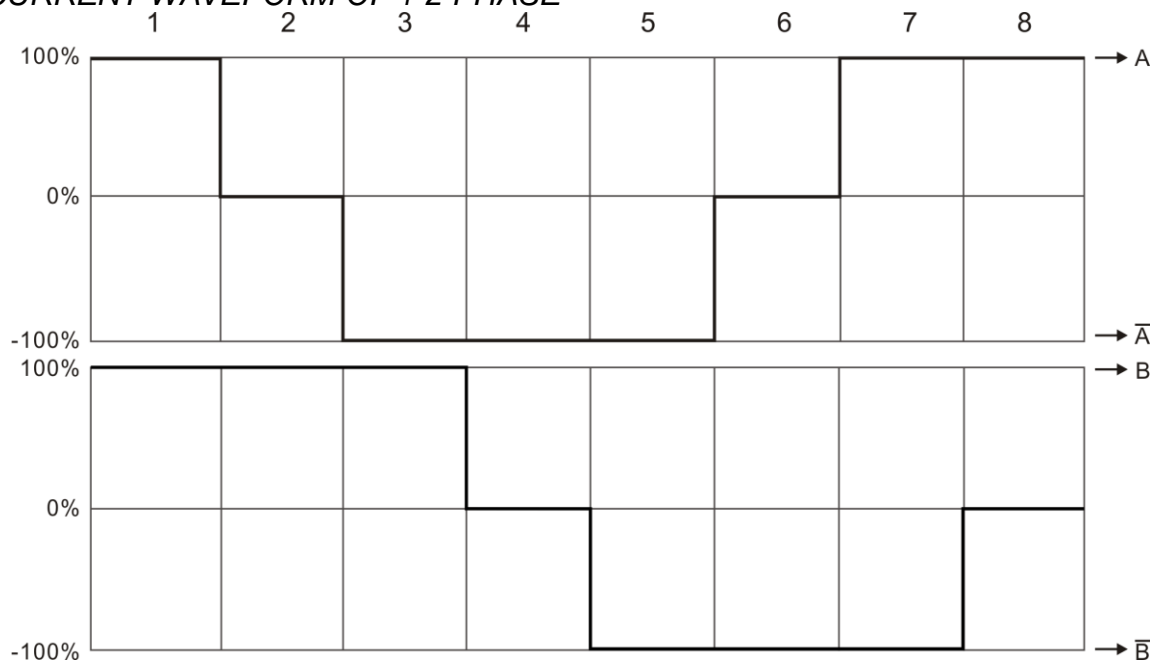
Output current waveform of pseudo sine wave

(2) 1-2 PHASE(100%)

OUTPUT CURRENT VECTOR

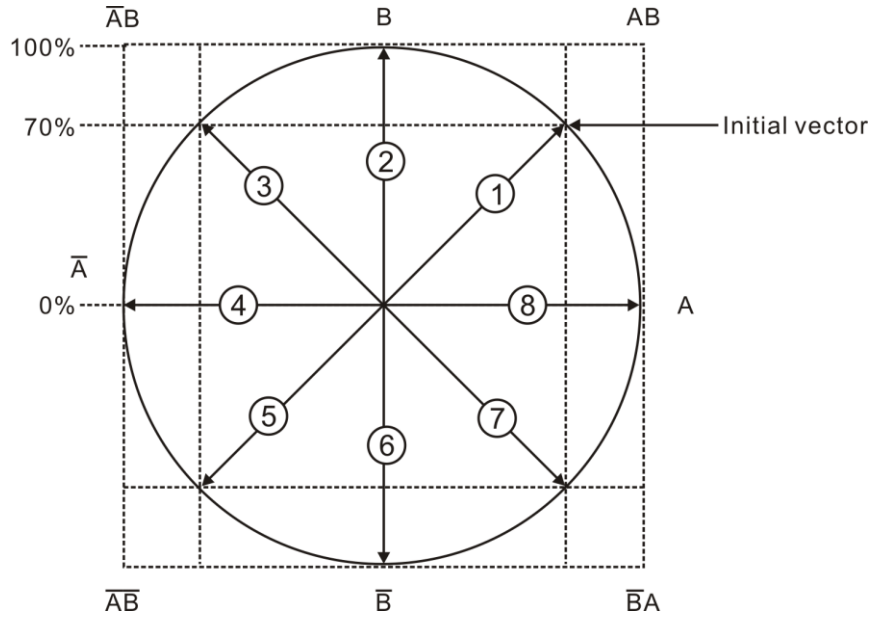


OUTPUT CURRENT WAVEFORM OF 1-2 PHASE

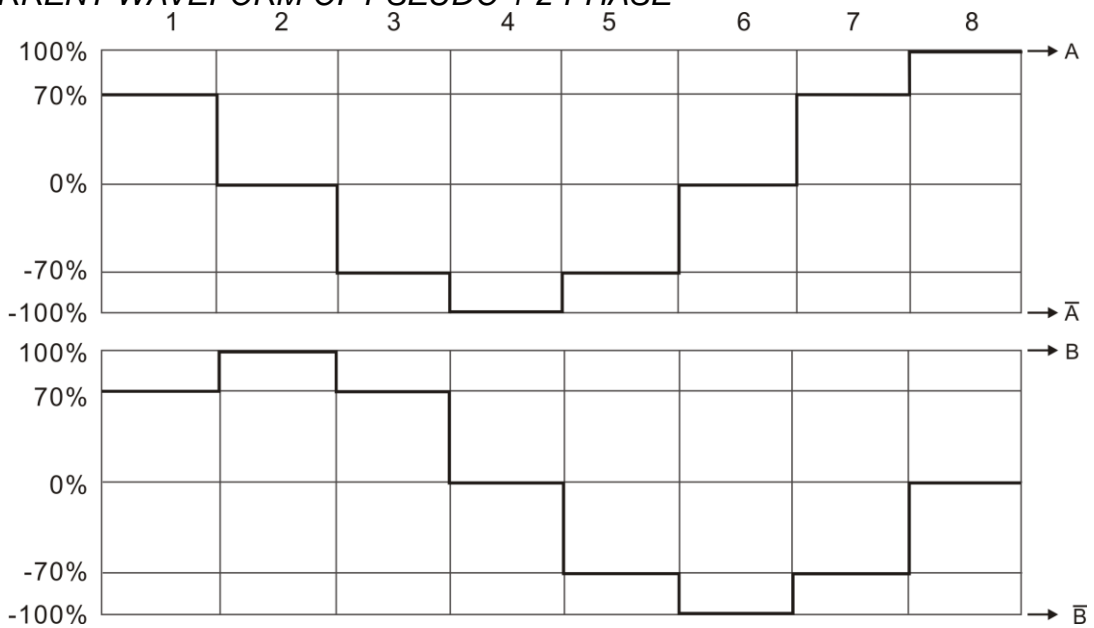


(3) 1-2 PHASE(70%)

OUTPUT CURRENT VEVTOR

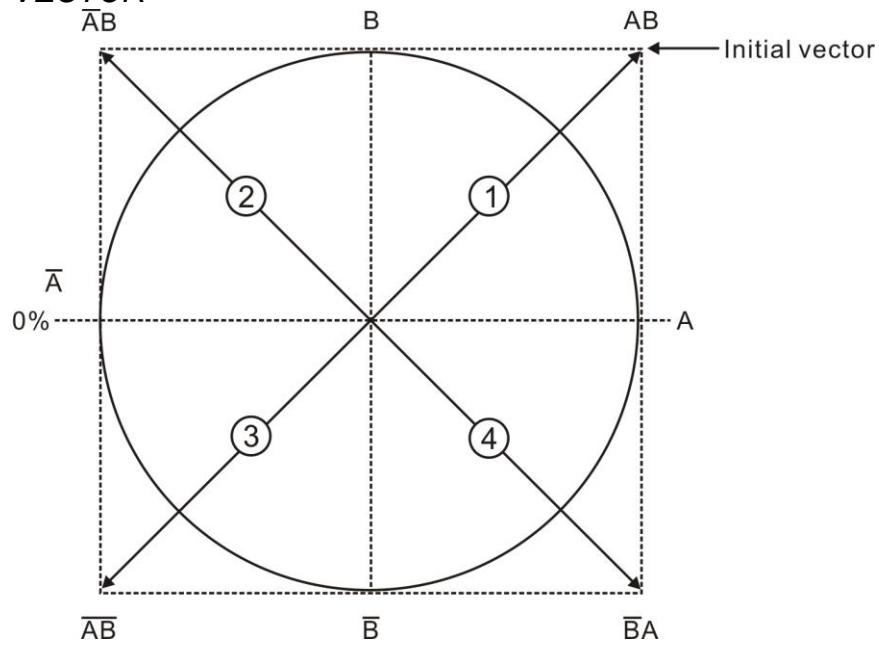


OUTPUT CURRENT WAVEFORM OF PSEUDO 1-2 PHASE

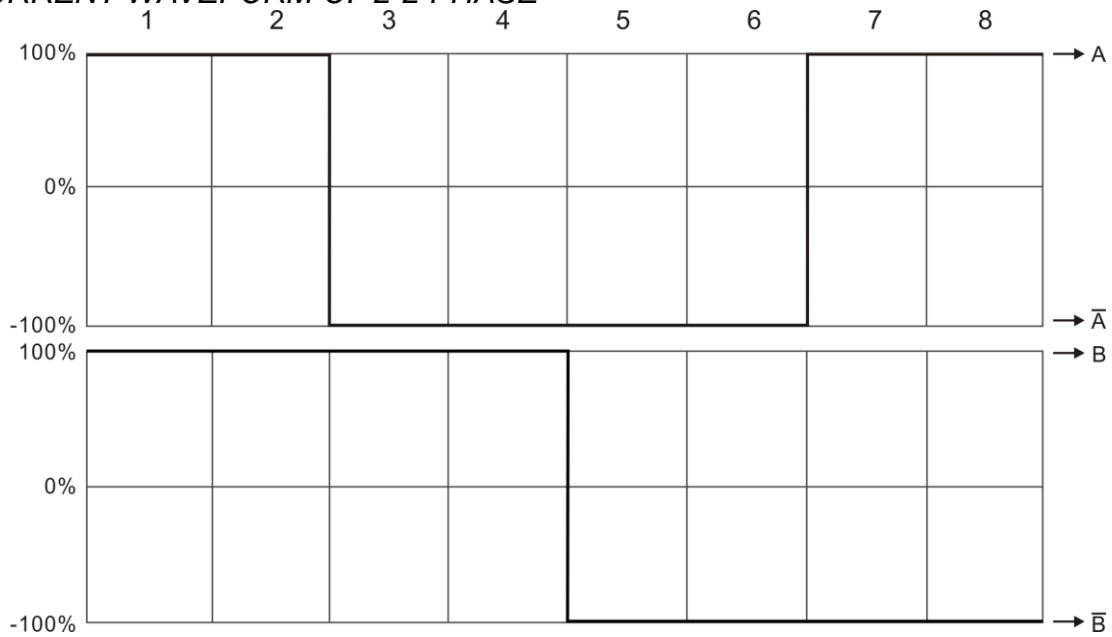


(4) 2-2 PHASE

OUTPUT CURRENT VECTOR



OUTPUT CURRENT WAVEFORM OF 2-2 PHASE



7. DC MOTOR, COIL CONTROL EXPLANATION

7.1 DRIVING MODES OF CHANNELS 5

SERIAL CONTROL ADDRESS: <10 0000>

b8	b7	b6	5ch
1	0	0	FS
1	0	1	FS(parallel drive)
1	1	0	CC

CC: Constant-current drive

FS: Full-swing PWM drive

7.2 CONTROL-PIN SELECTION OF IN3, IN4, IN5, AND IN6 FUNCTIONS

Function setting via the serial interface can be used to select control modes for INx pins.

Function setting via the exclusive bit can be used to select a part if control modes for INx pins.

Serial Control Bit			I/O Port				Remark
Exclusive	b9	b8	IN3	IN4	IN5	IN6	
0	0	0	3ch input 7ch input ¹	4ch input 7ch input ²	5ch input	6ch input	3~6ch(7ch) one-line control
0	0	1	5ch two-line control		6ch two-line control		5, 6ch each two-line control
0	1	0	-	5, 6ch three-line control			5, 6ch three-line control
1	0	0	3ch input	4ch input	345ch input	6ch input	3~6ch one-line control
1	0	1	5ch two-line control		6ch two-line control		5, 6ch each two-line control
1	1	0	47ch input	5, 6ch three-line control			47ch one-line control 5, 6ch three-line control
1	1	1	3ch input	7ch input	5ch input	6ch input	34, 5~7ch one-line control

Notes:

1. The input of channel 7 is effective when mode of channel 34 is set "110".
2. The input of channel 7 is effective when mode of channel 34 is set "101" or "110".

7.2.1 CHANNELS 3, 4, 5, AND 6 LOGIC FUNCTION FOR SHUTTER, APERTURE, AND ZOOM CONTROL

TRUTH TABLE FOR ONE-LINE CONTROL OF CHANNEL 3, 4, 5, AND 6

All mode settings are made via the serial interface. IN3, IN4, IN5 and IN6 are the controlling pins of 1line mode for each channel. And CH3 and CH5 can also be controlled with enable operation bits of serial setting.

IN3, IN4, IN5, IN6	OUTxA	OUTxB	Mode
L	Z or L	Z or L	Off or Brake*
H	H or L	L or H	Forward or Reverse Rotation

Current from OUTxA to OUTxB is positive in forward rotation.

X=3, 4, 5, 6

H=High level; L=Low level; Z=High impedance

Notes:

1. *=Brake only on channels 3 and 4.
2. Besides IN3, CH3 1line driving can also be controlled by the enable operation bit (b9_011111).
3. Besides IN5, CH5 1line driving can also be controlled by the enable operation bit (b9_101111).

TRUTH TABLE FOR TWO-LINE CONTROL OF CHANNEL 5 AND 6

<WHEN ENABLE/INPUT CONTROL HAS BEEN SELECTED>

X=5, 6

IN3, IN5(EN)	IN4, IN6(IN)	OUTxA	OUTxB	Mode
L	-	Z	Z	Off
H	L	H	L	Forward
H	H	L	H	Reverse

Current from OUTxA to OUTxB is positive in forward rotation.

H=High level; L=Low level; Z=High impedance

<WHEN INPUT CONTROL HAS BEEN SELECTED>
X=5,6

IN3, IN5	IN4, IN6	OUTxA	OUTxB	Mode
L	L	Z	Z	Off
H	L	H	L	Forward
L	H	L	H	Reverse
H	H	L	L	Brake

Current from OUTxA to OUTxB is positive in forward rotation.
 H=High level; L=Low level; Z=High impedance

TRUTH TABLE FOR THREE-LINE CONTROL OF CHANNEL 5 AND 6

IN3	IN4	IN5	OUT5A	OUT5B	OUT6A	OUT6B	Channel 5 mode	Channel 6 mode
L	-	-	Z	Z	Z	Z	Off	Off
H	L	L	H	L	H	L	Forward	Forward
H	L	H	H	L	L	H	Forward	Reverse
H	H	L	L	H	H	L	Reverse	Forward
H	H	H	L	H	L	H	Reverse	Reverse

Currents from OUT5A to OUT5B and OUT6A to OUT6B are positive in forward rotation.
 H=High level; L=Low level; Z=High impedance

7.2.2 CHANNEL 5 AND 6 DAC SETTINGS

Table 1. Channel 5 DAC settings
 Serial control address:<11_0110>

b7	b6	b5	b4	Voltage on RNF5 (mV)
0	0	0	0	310
0	0	0	1	300
0	0	1	0	290
0	0	1	1	280
0	1	0	0	270
0	1	0	1	260
0	1	1	0	250
0	1	1	1	240
1	0	0	0	230
1	0	0	1	220
1	0	1	0	210
1	0	1	1	200
1	1	0	0	190
1	1	0	1	180
1	1	1	0	170
1	1	1	1	160

The fixed current value is decided the above-mentioned setting by the resistance connected with the terminal GND5(RNF5).

Ex.) DAC setting: 310mV, PGND5(RNF5) terminal: 1Ω
 Fixed current value = 310mV/1Ω = 310mA

Table 2. Channel 6 DAC settings
 Serial control address:<11_0111>

b7	b6	b5	b4	Voltage on RNF6 (mV)
0	0	0	0	310
0	0	0	1	300
0	0	1	0	290
0	0	1	1	280
0	1	0	0	270
0	1	0	1	260
0	1	1	0	250
0	1	1	1	240
1	0	0	0	230
1	0	0	1	220
1	0	1	0	210
1	0	1	1	200
1	1	0	0	190
1	1	0	1	180
1	1	1	0	170
1	1	1	1	160

The fixed current value is decided the above-mentioned setting by the resistance connected with the terminal RNF6

Ex.) DAC setting: 310mV, RNF6 terminal: 1Ω
 Fixed current value = 310mV/1Ω = 310mA



8. SERIAL CONTROL MAP

Upper 6-Bit		Register Name	Lower 10-Bit									
b15-b14	b13-b10		b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
00	0000	Channels 1 and 2: Direction, driving mode, acceleration and deceleration, and initial position set by excitation	Direction of rotation	Driving mode			Acceleration and deceleration control		Initial position set by excitation			
	0001	Channels 1 and 2: Number of pulses 1	Number of pulses 1									
	0010	Channels 1 and 2: Number of pulses 2	Number of pulses 2									
	0011	Channels 1 and 2: Pulse rate 0	Pulse-rate 0									
	0100	Channels 1 and 2: Pulse-rate range and number of steps	Pulse-rate range				Number of steps					
	0101	Channels 1 and 2: Number of pulses per stage in acceleration and deceleration	Number of pulses per stage in acceleration and deceleration									
	0110	Channels 1 and 2: Pulse rate 1 in acceleration and deceleration	Pulse rate 1 in acceleration and deceleration									
	0111	Channels 1 and 2: Pulse rate 2 in acceleration and deceleration	Pulse rate 2 in acceleration and deceleration									
	1000	Channels 1 and 2: Pulse rate 3 in acceleration and deceleration	Pulse rate 3 in acceleration and deceleration									
	1001	Channels 1 and 2: Pulse rate 4 in acceleration and deceleration	Pulse rate 4 in acceleration and deceleration									
	1010	Pre-pulse-generation excitation time	Period of excitation before pulse generation									
	1011	Post-pulse-generation excitation time	period of excitation after pulse generation									
	1100	Setting prohibited										
	1101	Channels 1 and 2: Voltage amplitude and Gain	Value of voltage amplitude					Gain				
1110	Read of pulses position	Micro-stepping current position output										
1111	Channels 1 and 2: Operation-enabling control	Enable operation	HOLD	Excitation ON			Continuous operation					
01	0000	Channels 3 and 4: Direction, driving mode, acceleration and deceleration, and initial position set by excitation	Direction of rotation	Driving mode			Acceleration and deceleration control		Initial position set by excitation			
	0001	Channels 3 and 4: Number of pulses 1	Number of pulses 1									
	0010	Channels 3 and 4: Number of pulses 2	Number of pulses 2									
	0011	Channels 3 and 4: Pulse rate 0	Pulse-rate 0									
	0100	Channels 3 and 4: Pulse-rate range and number of steps	Pulse-rate range				Number of steps					
	0101	Channels 3 and 4: Number of pulses per stage in acceleration and deceleration	Number of pulses per stage in acceleration and deceleration									
	0110	Channels 3 and 4: Pulse rate 1 in acceleration and deceleration	Pulse rate 1 in acceleration and deceleration									
	0111	Channels 3 and 4: Pulse rate 2 in acceleration and deceleration	Pulse rate 2 in acceleration and deceleration									
	1000	Channels 3 and 4: Pulse rate 3 in acceleration and deceleration	Pulse rate 3 in acceleration and deceleration									
	1001	Channels 3 and 4: Pulse rate 4 in acceleration and deceleration	Pulse rate 4 in acceleration and deceleration									
	1010	Pre-pulse-generation excitation time	Period of excitation before pulse generation									
	1011	Post-pulse-generation excitation time	period of excitation after pulse generation									
	1100	Channels 3 and 4: DC-motor settings	Settings for DC motor 1					Settings for DC motor2				
	1101	Channels 3 and 4: Voltage-amplitude settings	Value of voltage amplitude 1					Gain		Value of voltage amplitude 2		
1110	Read of pulses position	Micro-stepping current position output										
1111	Channels 3 and 4: Operation control	Enable operation	HOLD	Excitation ON	Enable operation 2	Continuous operation						
10	0000	Channels 5 and 7: Direction, driving mode, acceleration and deceleration, and initial position set by excitation	Direction of rotation	Driving mode			Acceleration and deceleration control		Initial position set by excitation			
	0001	Channels 5 and 7: Number of pulses 1	Number of pulses 1									
	0010	Channels 5 and 7: Number of pulses 2	Number of pulses 2									
	0011	Channels 5 and 7: Pulse rate 0	Pulse-rate 0									
	0100	Channels 5 and 7: Pulse-rate range	Pulse-rate range									
	0101	Channels 5 and 7: Number of pulses per stage in acceleration and deceleration	Number of pulses per stage in acceleration and deceleration									
	0110	Channels 5 and 7: Pulse rate 1 in acceleration and deceleration	Pulse rate 1 in acceleration and deceleration									
	0111	Channels 5 and 7: Pulse rate 2 in acceleration and deceleration	Pulse rate 2 in acceleration and deceleration									
	1000	Channels 5 and 7: Pulse rate 3 in acceleration and deceleration	Pulse rate 3 in acceleration and deceleration									
	1001	Channels 5 and 7: Pulse rate 4 in acceleration and deceleration	Pulse rate 4 in acceleration and deceleration									
	1010	Pre-pulse-generation excitation time	Period of excitation before pulse generation									
	1011	Post-pulse-generation excitation time	period of excitation after pulse generation									
	1100	Channels 5 and 7: Direction of full scale PWM, stop mode, PWM driving mode, carrier frequency	Direction	Stop mode	PWM drive	Carrier frequency			Direction 2	Stop mode 2	PWM drive 2	Carrier frequency 2
	1101	Channel 5: Full-scale PWM duty cycle	Setting of duty cycle									
1110	Channel 7: Full-scale PWM duty cycle	Setting of duty cycle 2										
1111	Channels 5 and 7 Operation control	Enable operation	HOLD	Excitation ON	Enable operation 2							



Upper 6-Bit		Register Name	Lower 10-Bit									
b15-b14	b13-b10		b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0000	Setting prohibited										
	0001	EXT output control	Data selection		MOB1	EXT1		EXT2				
	0010	Control of PI Output value	PI1	PI2	PI3							
	0011	Power supply control	PS	PS12	PS34							
	0100	Setting prohibited										
	0101	Control of input pin	Control of IN		Edge	Control of input pin for channel 5		Control of input pin for channel 6				
	0110	Channel 5: Control mode and setting of constant current value	Direction	Stop mode	Setting of constant current value for channel 6							
	0111	Channel 6: Control mode, setting or constant current value, weak excitation ON, and setting of weak excitation	Direction	Stop mode	Setting of constant current value for channel 7					Weak excitation	Weak excitation current	
	1000	Software reset and deceleration to a stop	12ch	34ch	5ch	Decelerate-to -a-stop 12	Decelerate-to -a-stop 34	Decelerate-to -a-stop 56				
	1001	Exclusive control	Exclusive	5ch	6ch	7ch						
	1010	Read of status	Channel							Status output		
	1011	Setting output of status flag for channel 1 and 2	Off	Pre-pulse-generation excitation	Acceleration /Constant velocity	Deceleration	Post-pulse-generation excitation	excitation				
	1100	Setting output of status flag for channel 3 and 4	Off	Pre-pulse-Generation excitation	Acceleration /Constant velocity	Deceleration	Post-pulse-generation excitation	excitation				
	1101	Setting output of status flag for channel 5 and 7	Off	Pre-pulse-Generation excitation	Acceleration /Constant velocity	Deceleration	Post-pulse-generation excitation	excitation				
	1110	Read of pulses position						Current pulse position output				
	1111	Operation control (activation/stop)	12ch	34ch	5ch	HOLD 12	HOLD 34	HOLD 5	12 ON	34 ON	56 ON	

8.1 SERIAL CONTROL FUNCTION TABLE

8.1.1 DIRECTION OF ROTATION, MODE OF DRIVING, ACCELERATION AND DECELERATION REGISTER (B13, B12, B11, B10) = (0, 0, 0, 0) WHEN B15 AND B14 SELECT CHANNELS 1 AND 2

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
00	0000	Rotation direction	Driving mode			Acceleration and deceleration		Initial position set by excitation			
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset :b'xxxxxx00 00000000>

Bit	Bit Name	Function
9	Rotation direction	Sets the direction of rotation. (only valid when one of the stepper-motor modes is selected from among the driving modes below) 0: Forward 1: Reverse
8~6	Driving Mode Setup	Stepper motor-driving mode setup 000: Micro-stepping 001: 1-2 phase (100%) 010: 1-2 phase (70%) 011: 2-2 phase 100: Setting prohibited 101: Setting prohibited 110: Setting prohibited 111: Setting prohibited
5~4	Control of Acceleration and Deceleration	00: No acceleration/no deceleration control 01: No acceleration control/with deceleration control 10: With acceleration control/no deceleration control 11: Acceleration/deceleration control
3~1	Initial Position Set by Excitation	Specifies the initial position set by excitation of the selected channel as any the possible 1-2 phase combinations. 000: A→100% B→100% 001: A→0% B→100% 010: A→-100% B→100% 011: A→-100% B→0% 100: A→-100% B→-100% 101: A→0% B→-100% 110: A→100% B→-100% 111: A→100% B→0% If you select 2-2 phase as the driving mode, do not specify the initial position by selecting a combination that only exists in 1-2 phase driving. (i.e. the odd numbers above).
0	Enable Initial Positioning by Excitation	Disable or enable the above setting of initial position by excitation 0: Disable 1: Enable *After reset release, the default excitation start position will be at: A→100% B→100%

WHEN B15 AND B14 SELECT CHANNELS 3 AND 4

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
01	0000	Rotation direction	Driving mode			Acceleration and deceleration		Initial position set by excitation			
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset :b'xxxxxx00 00000000>

Bit	Bit Name	Function
9	Rotation Direction	Sets the function (Only valid when one of the stepper-motor modes is selected from among the driving modes below) 0: Forward 1: Reserve
8~6	Driving Mode Setup	Stepper motor-driving modes setup 000: Micro-stepping 001: 1-2 phase (100%) 010: 1-2 phase (70%) 011: 2-2 phase 100: DC motor (BTL one-channel independent drive or two-channels separate drive) 101: DC motor (PWM one-channel independent drive or two-channels separate drive) (Channel 3: BTL channel 4: PWM) 110: DC motor (PWM parallel drive by two channels) 111: Setting prohibited
5~4	Control Of Acceleration And Deceleration	00: No acceleration / no deceleration control 01: No acceleration control / with deceleration control 10: With acceleration control / no deceleration control 11: Acceleration / deceleration control
3~1	Initial Position Set By Excitation	Specifies the initial position set by excitation of the selected channel as any the possible 1-2 phase combinations 000: A→100% B→100% 001: A→0% B→100% 010: A→-100% B→100% 011: A→-100% B→0% 100: A→-100% B→-100% 101: A→0% B→-100% 110: A→100% B→-100% 111: A→100% B→0% If you selected 2-2 phase as the driving mode, do not specify the initial position by selection a combination that only exists in 1-2 phase driving (i.e. the odd numbers above)
0	Enable Initial Position By Excitation	Disable or enable the above setting of initial position by excitation 0: Disable 1: Enable *After reset release the default excitation start position will be at: A→100% B→100%

WHEN B15 AND B14 SELECT CHANNELS 5 AND 7

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
10	0000	Rotation direction	Driving mode			Acceleration and deceleration		Initial position set by excitation			
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9	Rotation Direction	Sets the direction of rotation (Only valid when one of the stepper-motor modes is selected from among the driving modes below) 0: Forward 1: Reverse
8~6	Driving Mode Setup	Sets the motor driving mode 000: Setting prohibited 001: 1-2 phase (100%)* ¹ 010: Setting prohibited 011: 2-2 phase* ¹ 100: Channels 5 and 7 are full-swing PWM (one-channel independent drive or two channels separate drive)* ² 101: Channel 5 and 7 are full-swing PWM (parallel drive by two channels)* ¹ 110: Constant current is drive on channel 5, channel 7 is full-swing PWM* ² 111: Setting prohibited
5~4	Control Of Acceleration And Deceleration	00: No acceleration / no deceleration control 01: No acceleration control / with deceleration control 10: With acceleration control / no deceleration control 11: Acceleration / deceleration control
3~1	Initial Position Set By Excitation	Specifies the initial position set by excitation of the selected channel as any of the possible 1-2 phase combinations 000: A→100% B→100% 001: A→0% B→100% 010: A→-100% B→100% 011: A→-100% B→0% 100: A→-100% B→-100% 101: A→0% B→-100% 110: A→100% B→-100% 111: A→100% B→0% If you select 2-2 phase as the driving mode, do not specify the initial position by selecting a combination that only exists in 1-2 phase driving (i.e. the odd numbers above)
0	Enable Initial Position By Excitation	Disable or enable the above setting of initial position by excitation 0: Disable 1: Enable *After reset release, the default excitation start position will be at A→100% B→100%

Notes:

1. Only exclusive control is effective.
2. Channel7: Only exclusive control is effective.

8.1.2 SETTING THE NUMBER OF PULSES

Each number of pulses setting for motor control consists of 20 bits in two fields: number of pulses 1 and number of pulses 2. This allows the setting of values in the range from 0 to 1,048,575. (When b15 and b14=xx, b15 and b14 can select channel 1 and 2(00), or select channel 3 and 4(01), or select channel 5 and 7(10)).

REGISTER FOR SETTING THE NUMBER OF PULSES 1 (B13, B12, B11, B10) = (0, 0, 0, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	0001	Number of pulses 1									
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9~0	Number of pulses 1	The ten lower-order bits of the overall number of pulses.

REGISTER FOR SETTING THE NUMBER OF PULSES 2 (B13, B12, B11, B10) = (0, 0, 1, 0)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	0010	Number of pulses 2									
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9~0	Number of pulses 2	The ten higher-order bits of the overall number of pulses.

(Number of pulses for motor control) = (ten higher-order bits, i.e. number of pulses 2) x 2¹⁰ + (ten lower-order bits, i.e. number of pulses 1)

Examples of Setting	Number of pulses 2(10-bit)	Number of pulses 1(10-bit)	Total number of pulses
1	00,0000,0000	00,0000,0000	0 pulse
2	00,0101,0101	01,0101,0101	87,381 pulses
3	00,1010,1010	10,1010,1010	174,762 pulses
4	00,1111,1111	11,1111,1111	262,143 pulses
5	11,1111,1111	11,1111,1111	1,048,575 pulses

In example 1, neither pulse transitions nor current driving proceed. For details, see pages 53 and 56.

If either type of DC motor control is selected as the driving mode, the settings for number of pulses 1 and 2 are ignored.

8.1.3 PULSE RATE 0 SETTING REGISTER (B13, B12, B11, B10) = (0, 0, 1, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	0011	Pulse rate 0									
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9~0	Pulse Rate 0	Sets the period of a single pulse. The minimum resolution is selected according to the register value set the range of pulse rate and 1-1023 level pulse rate can be set by this register.

In this specification, the same single-pulse period setting applies regardless of the driving mode (except in driving DC motors). Therefore, correction is required to realize the same speed of rotation when the mode of driving is changed. Consult the following table for the correction factors when changing the mode. Set pulse rate 0 to a value other than 0.

Table Relationships of pulse rate settings to realize the same speed when switching between driving modes(when the 256-step setting has been selected for micro-stepping)

Basic Driving Mode	Driving Mode after Changing		
	2-2 phase	1-2 phase	Micro-stepping
2-2 phase	-	x2	x64
1-2 phase	x1/2	-	x32
Micro-stepping	x1/64	x1/32	-

Along with the register for setting the range of pulse rates, the above 10-bit setting is available. The minimum resolution is 0.2μs and the maximum resolution is 204.8μs when the operating-clock frequency is 5MHz(0.2-μs period).

Conversion formulae for obtaining pps (pulse-per-second) values from the settings for pulse rate 0 and the range of pulse rates:

2-2 phase: 1/(single-pulse period)

1-2 phase: 1/(single-pulse period x 2)

Micro-stepping: 1/(single-pulse period x 64)

Micro-stepping is not available on channels 5 and 6.

If DC-motor control is selected as the driving mode, this specification is ignored.

8.1.4 PULSE-RATE RANGE AND NUMBER OF STEPS SETTING REGISTER (B13, B12, B11, B10) = (0, 1, 0, 0)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	0100	The range of pulse rate				The number of steps					
		0	0	0	0	0	0	?	?	?	?

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 0000xxxx>

Bit	Bit Name	Function
9~6	Pulse-Rate Range	Sets range of pulse-rate settings (in μs). 0000: 204.8 0001: 102.4 0010: 51.2 0011: 25.6 0100: 12.8 0101: 6.4 0110: 3.2 0111: 1.6 1000: 0.8 1001: 0.4 1010: 0.2 1011~1111: Setting prohibited
5~4	The number of steps for(b15, b14) = (0, 0): Channels 1 and 2 (0, 1): Channels 3 and 4 (1, 0): Not defined (1, 1): Setting prohibited	Sets the number of steps when micro-stepping has been selected as the drive mode (only valid when micro-stepping has been selected by the driving mode bits). 00: 256 01: 128 10: 64 11: 32
3~0	Not defined	

The Pulse-rate range in the above table is described on OSCIN=5MHz, but it varies with OSCIN frequency. For example, when Pulse-rate range=0110, the value=3.2μs if operating on 5MHz (OSCIN), but the value=4.57μs=3.2μs × 5MHz / 3.5MHz if operating on 3.5MHz.

8.1.5 NUMBER OF PULSES PER STAGE IN ACCELERATION AND DECELERATION REGISTER (B13, B12, B11, B10) = (0, 1, 0, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	0101	Number of pulses per stage in acceleration and deceleration									
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9~0	Number Of Pulses Per Stage In Acceleration And Deceleration	1 to 1023 (00000: Setting prohibited)

Sets the number of pulses per unit (stage or rate) in acceleration and deceleration operations (setting of zero is prohibited) If neither acceleration nor deceleration control is specified, this setting is ignored.

8.1.6 PULSE RATES 1 TO 4 IN ACCELERATION AND DECELERATION SETTING REGISTER

When (b13, b12, b11, b10) = (0, 1, 1, 0), pulse rate 1 in acceleration and deceleration is selected.

When (b13, b12, b11, b10) = (0, 1, 1, 1), pulse rate 2 in acceleration and deceleration is selected.

When (b13, b12, b11, b10) = (1, 0, 0, 0), pulse rate 3 in acceleration and deceleration is selected.

When (b13, b12, b11, b10) = (1, 0, 0, 1), pulse rate 4 in acceleration and deceleration is selected.

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	xxxx	Pulse rate in acceleration and deceleration 1, 2, 3, 4									
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9~0	Pulse rate in acceleration and deceleration	Can be set to any value from 0 to 1023.

Settings of pulse rate in acceleration and deceleration are with reference to the setting for range of pulse rates, so the range of pulse rates is the same as for the pulse rate 0 setting register.

Pulse rate 1 in acceleration and deceleration is the pulse rate in the first stage of acceleration.

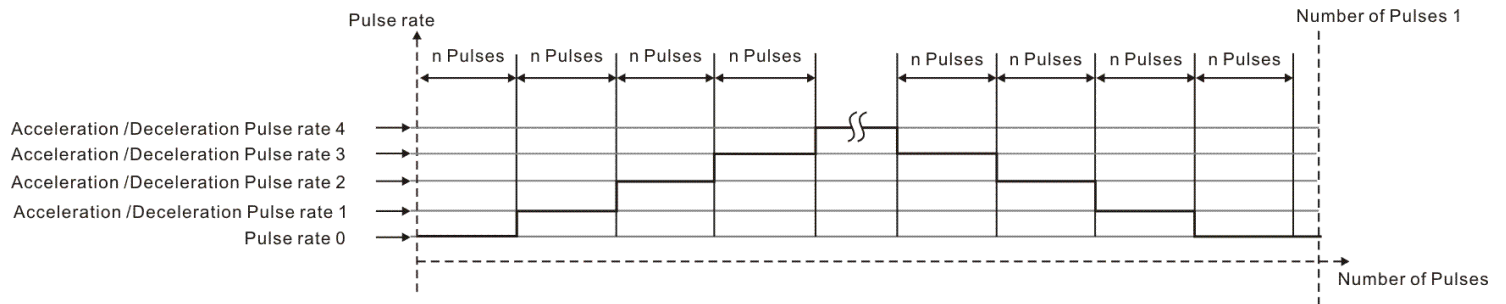
Pulse rate 2 in acceleration and deceleration is the pulse rate in the second stage of acceleration.

Pulse rate 3 in acceleration and deceleration is the pulse rate in the third stage of acceleration.

Pulse rate 4 in acceleration and deceleration is the pulse rate in the fourth stage of acceleration.

In deceleration, pulse-rate control is applied, in order, from pulse rate 4 in acceleration and deceleration to pulse rate 1 in acceleration and deceleration.

With acceleration and deceleration



8.1.7 EXCITATION TIME SETTING REGISTER

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	1010	Pre-pulse-generation excitation time						?	?	?	?
		0	0	0	0	0	0				

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 0000xxxx>

Bit	Bit Name	Function
9~4	Pre-pulse-generation excitation time	Sets the excitation time before a pulse signal occurs. In operation at 5 MHz, times up to 51.61 ms (4096*63/OSCIN) can be set in 0.82-ms (4096/OSCIN) steps.
3~0	Not defined	

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	1011	Post-pulse-generation excitation time						?	?	?	?
		0	0	0	0	0	0				

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 0000xxxx>

Bit	Bit Name	Function
9~4	Post-Pulse-Generation Excitation Time	Sets the excitation time after a pulse signal occurs. In operation at 5 MHz, times up to 50.79ms (4096*62/OSCIN) can be set in 0.82ms (4096/OSCIN) steps. When the setting is 6'b11_1111, excitation continues until the enable operation bit is changed, the system is reset, or the PS bit is reset.
3~0	Not defined	

Pre-pulse-generation excitation time sets the period of excitation prior to pulse control.

When the setting is 6'b00_0000, the period of excitation prior to pulse control is set to 0, so the pulse control starts immediately.

Post-pulse-generation excitation time is the period of driving at the final current value after generation of the number of pulse signals determined by the pulse control settings.

Output current is set to 0 after the post-pulse-generation excitation time has elapsed.

When the setting is 6'b00_0000, the current is set to 0 immediately after pulse control.

When the setting for post-pulse-generation excitation time is 6'b11_1111, excitation continues until:

- the enable operation bit is cleared (to 0),
- a hardware reset,
- a software reset, or
- the power is turned off by resetting the PS bit (blocking power to the analog portion).

This setting is ignored when DC-motor control has been selected as the method of driving.

The Pre/Post-pulse-generation excitation time varies in inverse proportion to OSCIN frequency.

8.1.8 DC MOTOR SETTING REGISTER (B13, B12, B11, B10) = (1, 1, 0, 0)

WHEN B15 AND B14 SELECT CHANNELS 3 AND 4

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
01	1100	DC motor setting 1				DC motor setting 2					
		0	0	0	0	0	0	0	0	0	0

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00000000>

Bit	Bit Name	Function
9~5	DC motor setting 1 Output voltage amplitude when DC motor setting is selected = DC motor setting x setting for voltage amplitude	0: Forward 1: Reverse The next four consecutive bits set the actual output voltages as listed below: 0000: 0% 0001: 10% 0010: 20% 0011: 29% 0100: 38% 0101: 47% 0110: 56% 0111: 63%
4~0	DC Motor Setting 2	1000: 71% 1001: 77% 1010: 83% 1011: 88% 1100: 92% 1101: 96% 1110: 98% 1111: 100%

The DC motor settings are only valid when DC motor control has been selected as the method of driving.

WHEN B15 AND B14 SELECT CHANNELS 5 AND 6

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
10	1100	Direction	Stop mode	PWM drive	Carrier frequency		Direction 2	Stop mode 2	PWM drive 2	Carrier frequency 2	
		0	0	0	0	?	0	0	0	0	?

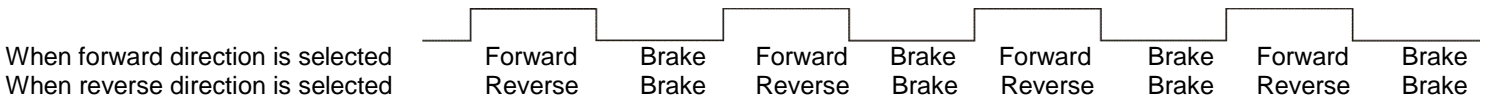
Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00x0000x>

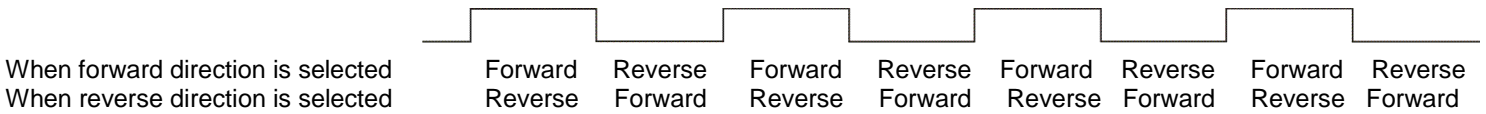
Bit	Bit Name	Function
9	Direction of DC Motor on Channel 5	Sets the direction of rotation. 0: Forward 1: Reverse
8	Stop Mode For Channel 5	Sets the state of the output when operation stops. 0: Off 1: Brake
7	PWM Drive Mode For Channel 5	Sets the control mode when the PWM driving signal is off. 0: Brake 1: Reverse <When b9 is set to 0, forward operation> 0: Forward → brake 1: Forward → reverse <When b9 is set to 1, reverse operation> 0: Reverse → brake 1: Reverse → forward
6	Carrier Frequency Setting for Channel 5	Determines the carrier frequency of the channel-5 PWM signal. Carrier frequency = 1/0.2μs/D (when OSCIN = 5 MHz) 0: D = 32 (156.25 KHz when OSCIN = 5 MHz) 1: D = 48 (104.17 KHz when OSCIN = 5 MHz)
5	Not Defined	
4	Direction of DC Motor on Channel 7	Sets the direction of rotation. 0: Forward 1: Reverse
3	Stop Mode for Channel 7	Sets the state of the output when operation stops. 0: Off 1: Brake
2	PWM Drive Mode for Channel 7	Sets the control mode when the PWM driving signal is off. 0: Brake 1: Reverse <When b4 is set to 0, forward operation> 0: Forward → brake 1: Forward → reverse <When b4 is set to 1, reverse operation> 0: Reverse → brake 1: Reverse → forward
1	Carrier Frequency Setting for Channel 7	Determines the carrier frequency of the channel-7 PWM signal. Carrier frequency = 1/0.2μs/D (when OSCIN = 5 MHz) 0: D = 32 (156.25 KHz when OSCIN = 5 MHz) 1: D = 48 (104.17 KHz when OSCIN = 5 MHz)
0	Not Defined	

When the enable operation bit is set to 0, the operation of channels 5 and 6 stops and control is applied according to the settings above; that is, the stop mode settings determine whether the state of the output is off (high impedance) or brake (low level). When operation is enabled, PWM driving is applied in according with the direction and PWM drive mode settings. The PWM drive mode setting determines the control mode when PWM driving is in the off-state. The Carrier frequency setting for channel 5 and channel 6 varies in proportion to OSCIN frequency. When D=32, the carrier frequency= OSCIN frequency / 32. When D=48, the carrier frequency= OSCIN frequency / 48.

<PWM drive mode: Braking in the off-state >



<PWM drive mode: Reversal in the off-state>



When parallel or stepping-motor drive is selected, the settings for channel 5 are valid. When stepping-motor drive mode, setting of the following 3 bits is needed, b8: Stop mode for channel 5, b7: PWM drive mode for channel 5 and b6: Carrier frequency for channel 5. When 2-wire-type-control is selected for channel 5, b9 & b8 (b4 & b3) are invalid.

8.1.9 VOLTAGE AMPLITUDE AND CARRIER FREQUENCY SETTING REGISTER (B13, B12, B11, B10) = (1, 1, 0, 1)

WHEN B15 AND B14 SELECT CHANNELS 1 AND 2

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
00	1101	Voltage amplitude value					Gain				
		0	0	0	0	?	0	?	?	?	?

Note: The lower shows Initial value at RESET.

<After reset: b'xxxxxx00 00x0xxxx>

Bit	Bit Name	Function
9~6	Voltage amplitude value	Setting values of voltage amplitude
4	Gain 0: Gain One time 1: Gain Two times (Note) The output voltage amplitude becomes a saturated condition by the VM power-supply voltage. The output voltage amplitude never exceeds the VM voltage.	'b4=0
		'b4=1
		0000 : 5.2V
		0001 : 5.0V
		0010 : 4.8V
		0011 : 4.6V
		0100 : 4.4V
		0101 : 4.2V
		0110 : 4.0V
		0111 : 3.8V
		1000 : 3.6V
		1001 : 3.4V
		1010 : 3.1V
		1011 : 2.9V
		1100 : 2.7V
		1101 : 2.4V
1110 : 2.2V		
1111 : 2.0V		
5	Not Defined	
3~0	Not Defined	

The above values apply when the output voltage amplitude settings are 100%. Since a single setting is made for channels 1 and 2, different settings for the two channels are not possible.

WHEN B15 AND B14 SELECT CHANNELS 3 AND 4

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
01	1101	Voltage amplitude value 1				Gain	Voltage amplitude value 2				
		0	0	0	0	0	0	0	0	0	?

Note: The lower shows Initial value at RESET.

<After reset : b'xxxxxx00 0000000x>

Bit	Bit Name	Function
9~6	Voltage Amplitude Value 1 (Channel 3)	Setting values of voltage amplitude 'b4=0 'b4=1 0000 : 5.2V 10.4V 0001 : 5.0V 10.0V 0010 : 4.8V 9.6V 0011 : 4.6V 9.2V 0100 : 4.4V 8.8V 0101 : 4.2V 8.4V 0110 : 4.0V 8.0V 0111 : 3.8V 7.6V 1000 : 3.6V 7.2V 1001 : 3.4V 6.8V 1010 : 3.1V 6.2V 1011 : 2.9V 5.8V 1100 : 2.7V 5.4V 1101 : 2.4V 4.8V 1110 : 2.2V 4.4V 1111 : 2.0V 4.0V
5	Gain 0: Gain One time 1: Gain Two times (Note) The output voltage amplitude becomes a saturated condition by the VM power-supply voltage. The output voltage amplitude never exceeds the VM voltage. This bit is common to 3ch and 4ch.	
4~1	Voltage Amplitude Value 2 (Channel 4)	
0	Not Defined	

The above values apply when the output voltage amplitude settings are 100%. The actual output voltage on DC motor is product of the DC motor setting (b13-b10=1100) (%) and the above voltage amplitude value (V). If the DC motor setting is set to 1001 (77%) and the voltage amplitude value is set to 0101 (4.0V), it means the actual output voltage on DC motor is 3.08V (=0.77×4.0V). The voltage amplitude value 2 (channel 4) setting is invalid when the DC motor setting (parallel drive) has been selected as the motor driving method.

WHEN B15 AND B14 SELECT CHANNELS 5 AND 7, AND (B15, B14 B13, B12, B11, B10)

= (10 1, 1, 1, 0)

(b15, b14_b13, b12, b11, b10) = (10_1, 1, 0, 1): channel 5

(b15, b14_b13, b12, b11, b10) = (10_1, 1, 1, 0): channel 7

When independent driving has been selected as the motor driving method

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	
10	xxxx	Duty cycle setting										
		0	0	0	0	0	0	?	?	?	?	

Note: The lower shows Initial value at RESET.

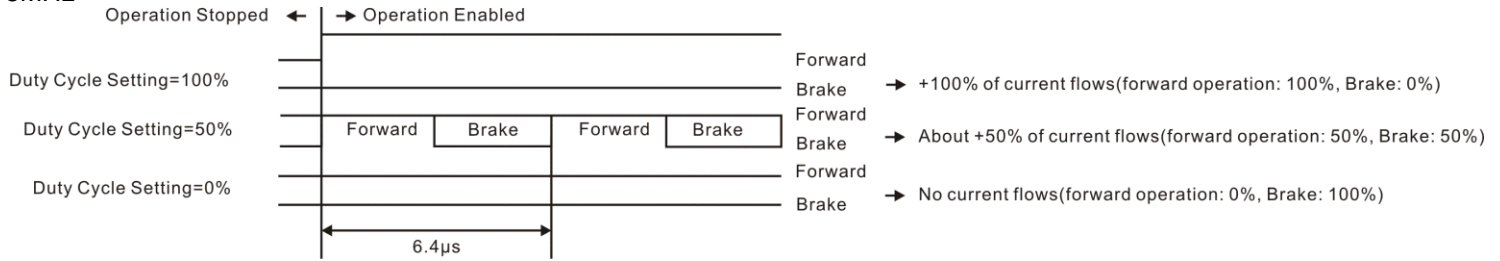
<After reset: b'xxxxxx00 0000xxxx>

Bit	Bit Name	Function
9~4	Duty Cycle Setting for Channels 5 and 7	<p>Sets the duty cycle of the output when channels 5 and 6 are set for driving DC motors. When the operating frequency = 156.25KHz (OSCIN = 5MHz), settings cover the range from 0% (6'b00_0000) to 100% (6'b10_0000) in 3.125% steps.</p> <p>*When b9 is set to 1, the duty cycle is 100%, regardless of the value in b8 to b4. When the operating frequency = 104.167KHz (OSCIN = 5MHz), settings cover the range from 0% (6'b00_0000) to 100% (6'b11_0000) in 2.083% steps.</p> <p>*When b9 and b8 are both set to 1, the duty cycle is 100%, regardless of the value in b7 to b4.</p>
3~0	Not defined	

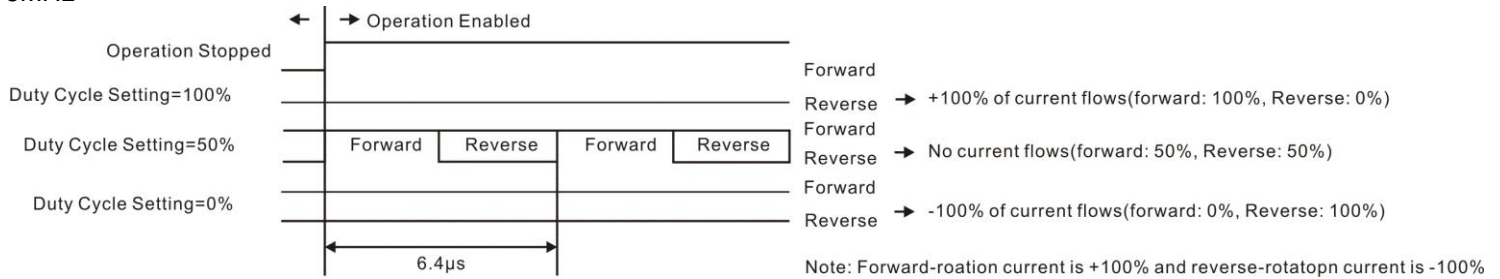
The duty-cycle setting for channels 5 and 7 operates to control the current in PWM driving and sets the output duty cycle. Setting of the output cycle by the six bits of internal data differs according to whether frequency division by 32 or 48 has been selected. At the initial value of 6'b00_0000, the duty cycle is 0%. With division by 32, the setting 6'b10_0000 corresponds to a duty cycle of 100% and the resolution is 3.125% (with division by 48, the setting for a duty cycle of 100% is 6'b11_0000 and the resolution is 2.083%). The operating frequency is set by counting cycles of the external clock up to the divisor in the carrier frequency setting register. At settings other than those for 0% and 100%, the actual duty cycle of the signals output from the H-bridge are lengthened by the turn-on and -off times, as well as the setting value above. The resolution of duty cycle setting varies with the carrier frequency (D=32 or 48), but there is no register bit only for the resolution

EXAMPLE OF OPERATION: PWM DRIVE

When the PWM drive mode setting is 0 (brake), the direction setting is 0 (forward rotation), and the OSC_CLK frequency is 5MHz



When the PWM drive mode setting is 1 (reversal), the direction setting is 0 (forward rotation), and the OSC_CLK frequency is 5MHz



The registers required to set output voltage and duty cycle in each drive mode are tabulated below.

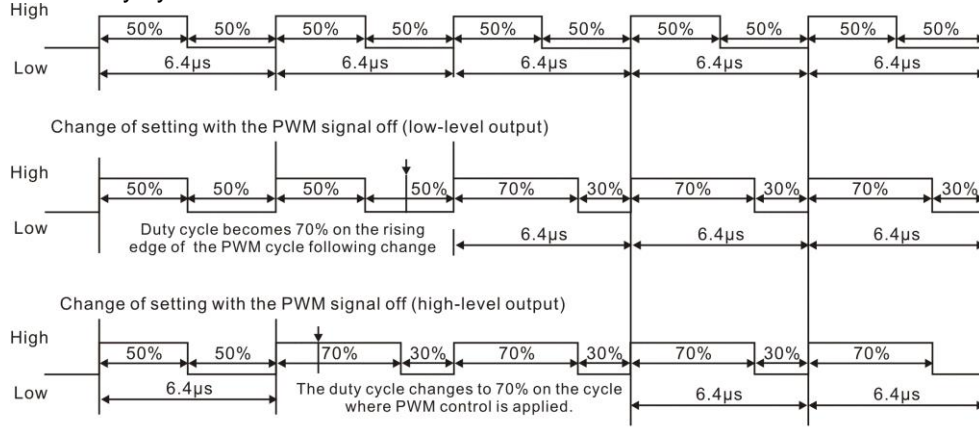
Channel	Drive Mode	Registers Required to Set Output Voltage and Duty Cycle
1ch, 2ch	Stepping-Motor	Set both 1ch & 2ch by 00_1101 Voltage amplitude value register
3ch, 4ch	Stepping-Motor	Set 3ch by 01_1101 Voltage amplitude value register 1 Set 4ch by 01_1101 Voltage amplitude value register 2
	DC (BTL Independent)	Set 3ch by 01_1100 DC motor setting 1 Set 4ch by 01_1100 DC motor setting 2 Set 3ch by 01_1101 Voltage amplitude value register 1 Set 4ch by 01_1101 Voltage amplitude value register 2
	DC(PWM Independent)	Set 5ch by 10_1101 Duty cycle setting for channel 5 Set 7ch by 10_1110 Duty cycle setting for channel 7
	DC(PWM Parallel)	Set 5ch by 10_1101 Duty cycle setting for channel 5
5ch, 7ch	Stepping-Motor (Serial Control)	Set both 5ch & 7ch by 10_1101 Duty cycle setting for channel 5
	DC (Parallel)	Set both 5ch & 7ch by 10_1101 Duty cycle setting for channel 5
	DC (Independent)	Set 5ch by 10_1101 Duty cycle setting for channels 5 Set 7ch by 10_1110 Duty cycle setting for channels 7

NOTES FOR THE TIME OF PWM DRIVE

When the duty cycle setting is changed during PWM driving, the timing of the change may vary depending on the operational state. This is because the PWM control signal and OSCIN clock are not synchronous.

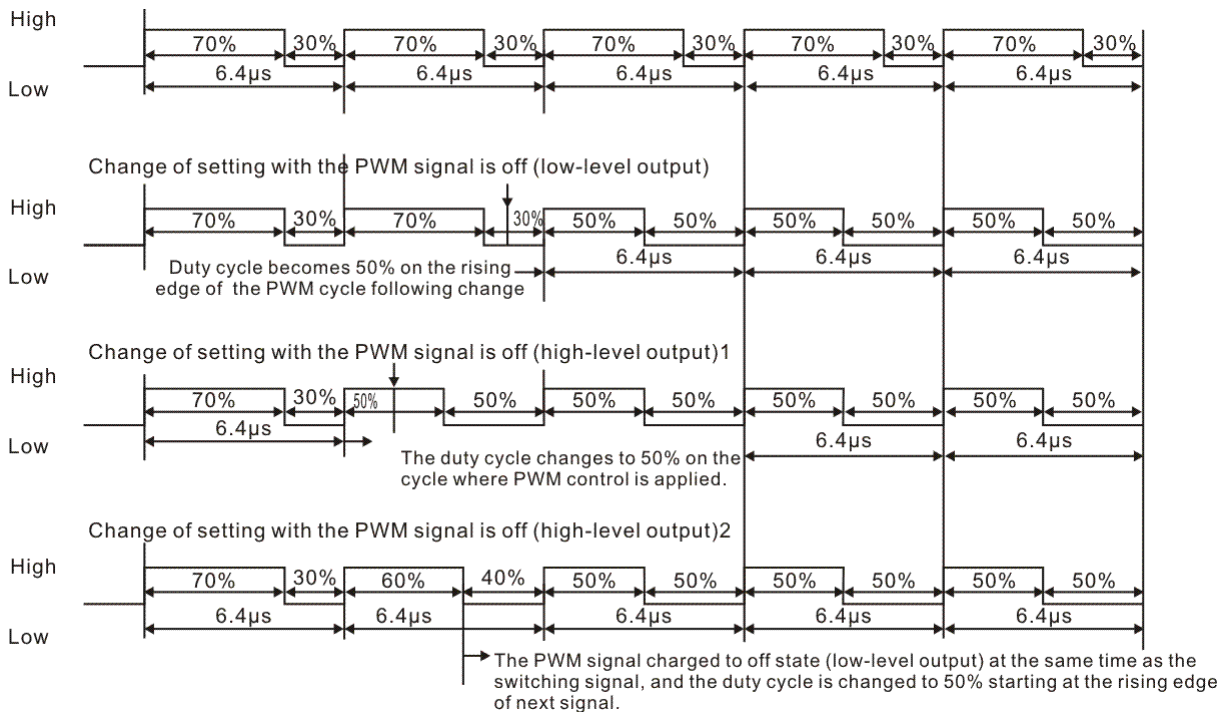
EXAMPLE1: CHANGING THE DUTY CYCLE FROM 50 TO 70% ↓ SWITCH TIMING

Output waveform with 50% duty cycle



EXAMPLE2: CHANGING THE DUTY CYCLE FROM 70 TO 50% ↓ SWITCH TIMING

Output waveform with 70% duty cycle



SETTING OF ENABLE-OPERATION CONTROL REGISTER IN CHANNEL UNITS

OPERATION SETTING REGISTER (B13, B12, B11, B10) = (1, 1, 1, 1)

b15~14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
xx	1111	Operation enabled	HOLD	Excitation on	Operation enabled 2	Continuous operation					
		0	0	0	0	0	?	?	?	?	?

Note: The bottom row indicates the initial value after a reset.

<After a reset: b'xxxxxx00 000xxxxx>

Bit	Bit Name	Function
9	Enable operation bit for ch XX(b15, b14)= (0,0): Channels 1 and 2 (0,1): Channels 3 and 4 (1,0): Channels 5 and 7	0: Operation disabled (excitation is off) 1: Operation enabled (excitation is on, and pulse transitions proceed).
8	Operating-state hold bit for ch XX(b15, b14)= (0,0): Channels 1 and 2 (0,1): Channels 3 and 4 (1,0): Channels 5 and 6	0: Release from held state. 1: Hold (excitation is on, but pulse transitions stop).
7	Excitation-on bit for ch XX(b15, b14)= (0,0): Channels 1 and 2 (0,1): Channels 3 and 4 (1,0): Channels 5 and 7	0: Operation disabled (excitation is off) 1: Operation enabled (excitation is on)
6	Enable operation bit for channels 4 and 7(b15, b14)= (0, 0): Not defined. (0,1): Channel 4 (1,0): Channel 7 (1,0): Setting prohibited	This is the enable operation bit for channel 4(or channel 7) for the case when independent driving has been selected as the motor driving method for channels 3 and 4 (channels 5 and 7). In these cases, b9 described above becomes the enable operation bit for channel 3(or channel 5) 0: Operation disabled (excitation is off) 1: Operation enabled (excitation is on)
5	Continuous operation bit for ch XX(b15, b14)= (b15,14)=(0,0) : 12ch (b15,14)=(0,1) : 34ch (b15,14)=(1,0) : 57 ch	0: Operation disabled (Continuous operation is off) 1: Operation enabled (Continuous operation is on)
4~0	Not defined	

These bits disable and enable the operation of channels or switch the excitation off. Setting the bits to 0 stops the operation of the selected channels (switches the excitation off). When the hold bit is set to 1 during operation, the state is suspended as soon as the state of the hold bit is recognized. In the held state, the excitation remains on. Subsequent operations continue on release from the held state. To do this, the hold bit must be cleared by software. Use this register for the independent control of channels in channel units. Channels do not affect channels other than the target channels for setting. When channels 5 and 7 are specified by bits 14 and 15, the enable operation bit stops or enables the PWM signals on these channels. Setting the bit to 0 stops the signals (stops motor operation). When operation is stopped, the output is either off (high impedance) or braked (low level), according to the brake mode setting. When operation is enabled, a PWM drive signal is generated in accord with the direction and PWM drive mode settings. The PWM drive mode setting determines the mode of control while the PWM signal is off. If the continuous operation bit is set in "1", the pulse progress is continued by set number of pulses and pulse rate. If the continuous operation bit is set "1" to "0", the pulse progress is stopped by set number of pulses and pulse rate.

EXAMPLE OF OPERATING CONTINUOUS OPERATION

The pulse progress is continued by the pulse rate that the number of set pulses was set to the continuous operation bit during "1" as one unit.

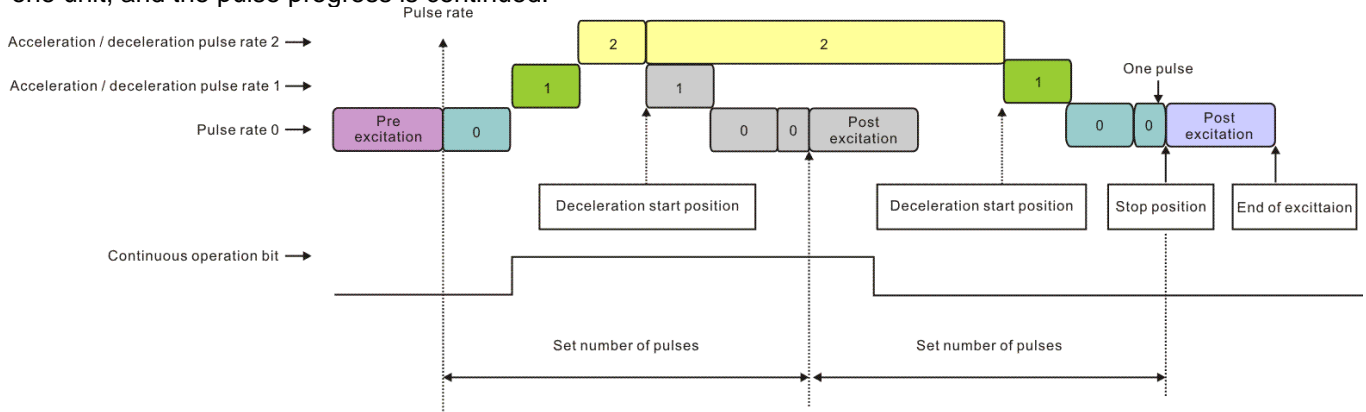
SETTING OF "1" OF CONTINUOUS OPERATION BIT

Please set "1" before it reaches the number of deceleration beginning pulses when you want to execute continuous operation. Continuous operation stops by the number of set pulses becoming invalid and continuing the deceleration operation when "1" is set after it reaches the number of deceleration start pulses.

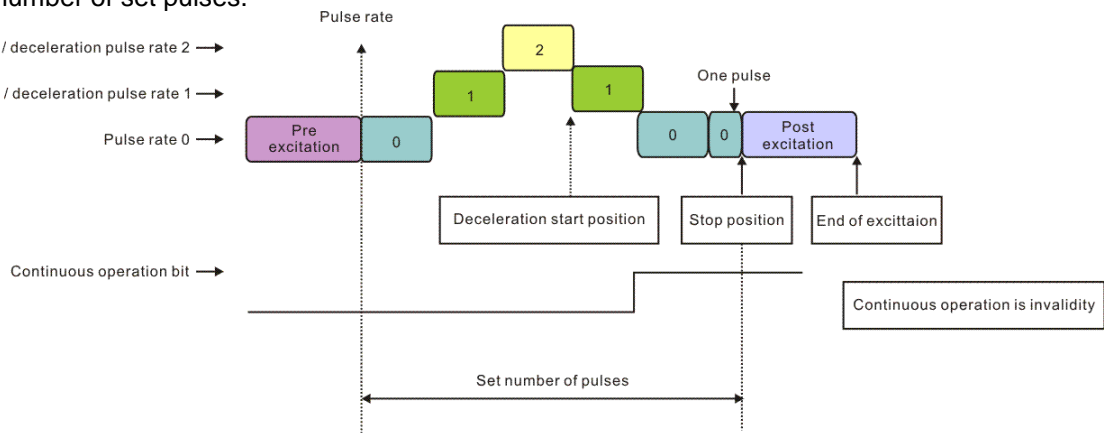
SETTING OF "0" OF CONTINUOUS OPERATION BIT

Please set "0" before it reaches the number of deceleration start pulses when you want to end by a set pulse driving now. When "0" is set after it reaches the number of deceleration start pulses, the following number of set pulses is executed continuing continuous operation and it stops.

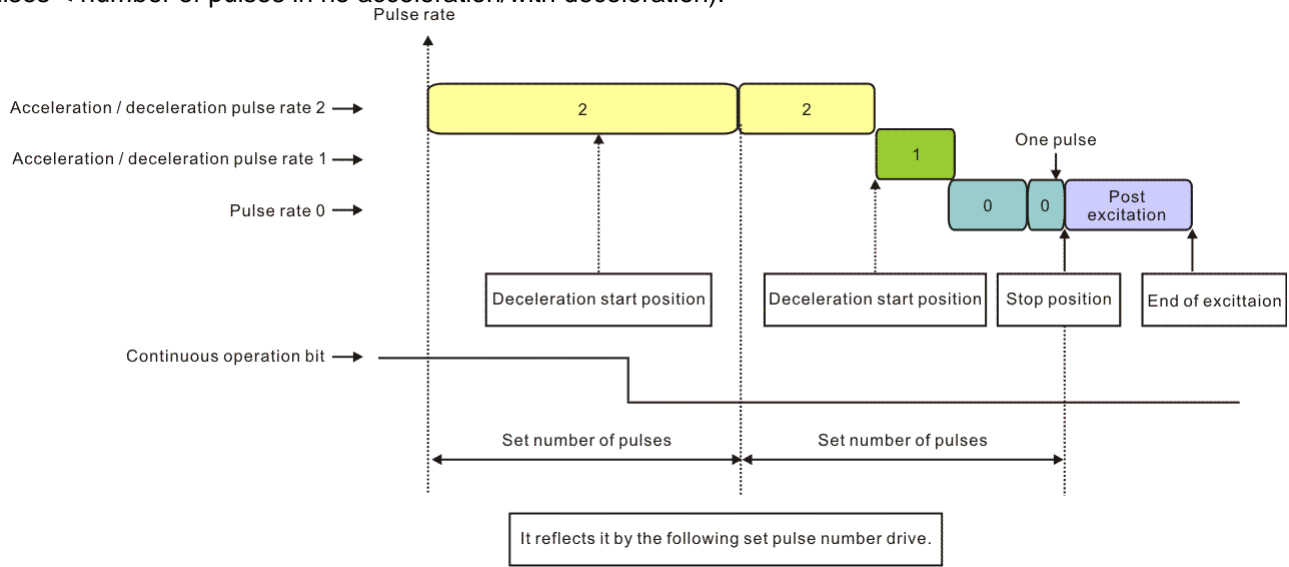
- (1) When the Continuous operation bit is set to 1 or 0 before it reaches the number of deceleration start pulses (set number of pulses < number of pulses in no acceleration/with deceleration). "0" is set before it reaches the number of deceleration start pulses: Continuous operation is released, and it stops by the number of set pulses. "1" is set before it reaches the number of deceleration start pulses: It enters the continuous operation mode, the number of set pulses is assumed to be one unit, and the pulse progress is continued.



- (2) When the Continuous operation bit is set to 1 after it reaches the number of deceleration start pulses (set number of pulses < number of pulses in no acceleration/with deceleration). The setting of the continuous operation bit is disregarded, and stops by the number of set pulses.



- (3) When the Continuous operation bit is set to 0 after it reaches the number of deceleration start pulses (set number of pulses < number of pulses in no acceleration/with deceleration).



- (4) Priority between the hold bit and decelerate-to-a-stop bit Continuous operation < decelerate-to-a-stop < hold
- When holding is set while continuously operating, it gives priority to the holding setting and continuous operation is restarted from point that accepts the holding release ("0" is set in the holding bit).
 - When the deceleration stop is set while continuously operating, it gives priority to the deceleration stop and the deceleration operation is done.

Use enable-operation bits marked with "yes" shown in the table below when DC motor driving mode has been selected. In the case of 5ch 2-wire-type-control or 56ch 3-wire-type-control, operation is not enabled by serial register bits.

DC motor driving mode (independent)

Register	Bit	3ch	4ch	5ch	7ch
[**-1111] Enable-Operation- Control Register in Channel Units	Enable operation bit for ch XX	yes		yes	
	Enable operation bit for channels 4 and 7		yes		yes
[11-1111] Operation Setting Register	Channels XX enable operation bit	yes		yes	

DC motor driving mode (parallel)

Register	Bit	34ch	57ch
[**-1111] Enable-Operation-Control Register in	Enable operation bit for ch XX	yes	yes
	Enable operation bit for channels 4 and 7		
[11-1111] Operation Setting Register	Channels XX enable operation bit	yes	yes

8.1.10 SETTING OF COMMON ITEM REGISTERS (B15, B14) = (1, 1)

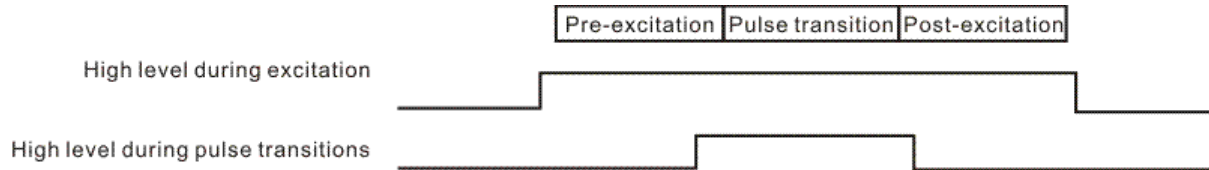
EXT SETTING REGISTER (B13, B12, B11, B10) = (0, 0, 0, 1)

b15~14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0001	Data selection		MOB1 /SDO	EXT1		EXT2				
		0	0	0	0	0	0	0	?	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 00000xxx>

bit	Bit Name	Function
9~8	EXT output data selection	00: High level is output during the excitation. 01: High level is output during pulse transitions. 10: Setting prohibited 11: Setting prohibited
7	MOB1/SDO pin output setting	0: MOB12 1: SDO
6~5	EXT1 pin output setting	00: EXT12 01: EXT34 10: ST12 11: ST34
4~3	EXT2 pin output setting	00: EXT34 01: EXT57 10: ST34 11: ST57
2~0	Not defined	



When consecutive enable operation signals are being input, a next enable operation signal should only be input after the end of the post-excitation phase for the previous enable-operation signal (indicated by the falling edge of the EXT signal).

PI SETTING REGISTER (B13, B12, B11, B10) = (0, 0, 1, 0)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0010	PI1	PI2	PI3							
		0	0	0	?	?	?	?	?	?	?

(The bottom row indicates the initial value after a reset.)

< After a reset: b'xxxxxx00 0xxxxxxx >

bit	Bit Name	Function
9	PI1	0: High-z output 1: Low-level output
8	PI2	0: High-z output 1: Low-level output
7	PI3	0: High-z output 1: Low-level output
6~0	Not defined	

Each bit sets the state of the corresponding PI pin.

PS SETTING REGISTER (B13, B12, B11, B10) = (0, 0, 1, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0011	PS	PS12	PS34							
		0	0	0		?	?	?	?	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 00xxxxxx>

Bit	Bit Name	Function
9	PS	0: Power Off 1: Power ON
8	PS12	0: Channels 1 and 2 off 1: Channels 1 and 2 on However, when b9 is 0, switching the power off, channels 1 and 2 will be off regardless of the setting of this bit.
7~6	PS34	00: Channel 3 and 4off 01: Setting prohibited 10: Setting prohibited 11: Channel 3 and 4 on However, when b9 is 0, switching the power off, channel 3 and 4 will be off regardless of the setting of this bit.
5~0	Not defined	

Clearing the PS bit to 0 stops current for the analog system.

Since the initial value after a reset is 0, current for the analog system is initially stopped.

Besides, PS bit controls CH5 and CH6 on/off, CH5 and CH6 are on when setting PS bit to 1.

INPUT PIN SETTING REGISTER (B13, B12, B11, B10) = (0, 1, 0, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0101	IN control			5-ch input pin		6-ch input pin				
		0	0	?	0	0	0	0	?	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 x0000xxx>

Bit	Bit Name	Function																									
9~8	IN input pin control	Sets the allocation of the input pins, IN3 to IN6. <table border="1"> <thead> <tr> <th></th> <th>IN3</th> <th>IN4</th> <th>IN5</th> <th>IN6</th> </tr> </thead> <tbody> <tr> <td>00(*1):</td> <td>3ch</td> <td>4ch</td> <td>5ch</td> <td>6ch</td> </tr> <tr> <td>01(*2):</td> <td>5chA</td> <td>5chB</td> <td>6chA</td> <td>6chB</td> </tr> <tr> <td>10(*3):</td> <td>47ch</td> <td>56ch</td> <td>56ch</td> <td>56ch</td> </tr> <tr> <td>11(*4):</td> <td>34ch</td> <td>7ch</td> <td>5ch</td> <td>6ch</td> </tr> </tbody> </table> (*1)The logical OR of IN3 and IN5 and the corresponding enable operation bit is taken (*2)Only effective when two-wire-type control has been selected (b6=1, b4=1) for in the registers for channels 5 and 6. (*3)IN3 is only effective when the exclusive control mode has been selected. Simultaneous three-wire-type control for channels 5 and 6 is only enabled when constant current drive for channel 5 has been selected in the driving-mode register. (*4)Only effective when the exclusive control mode has been selected.		IN3	IN4	IN5	IN6	00(*1):	3ch	4ch	5ch	6ch	01(*2):	5chA	5chB	6chA	6chB	10(*3):	47ch	56ch	56ch	56ch	11(*4):	34ch	7ch	5ch	6ch
	IN3	IN4	IN5	IN6																							
00(*1):	3ch	4ch	5ch	6ch																							
01(*2):	5chA	5chB	6chA	6chB																							
10(*3):	47ch	56ch	56ch	56ch																							
11(*4):	34ch	7ch	5ch	6ch																							
7	Not defined																										
6	Input pin control for channel 5	Sets the input pin mode for channel 5. 0: Serial or single-wire-type (IN5) control 1: Two-wire-type control (this setting can only be made when the setting of bits 9 and 8 is 01).																									
5		Valid when two-wire-type control has been selected by the bit 6. 0: Enable (IN3)/input (IN4) control 1: Input/input control																									
4	Input pin control for channel 6	Sets the input pin mode for channel 6 (the setting of this bit has no effect when simultaneous three-wire-type control has been selected for channels 5 and 6). 0: Serial or single-wire-type (IN6) control 1: Two-wire-type control (this setting can only be made when the setting of bits 9 and 8 is 01.)																									
3		Valid when two-wire-type control has been selected by the bit 4. 0: Enable (IN5)/input (IN6) control 1: Input/input control																									
2~0	Not defined																										

CHANNEL 5 SETTING REGISTER (B13, B12, B11, B10) = (0, 1, 1, 0)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0110	Direction	Stop mode	Setting of constant current value for channel 5							
		0	0	0	0	0	0	?	?	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 0000xxxx>

Bit	Bit Name	Function
9	Direction for channel 5	Sets the direction of rotation when the constant-current drive and input mode-pin settings have selected serial or single-wire control for channel 5. 0: Forward 1: Reverse
8	Stop mode for channel 5	Sets the state of the output when operation stops in serial or single-wire control for channel 5 selected by the constant-current drive and input mode-pin settings. 0: Off 1: Brake
7~4	Constant current value setting for channel 5 (RNF5 voltage) 310mV~160mV (RNF 5=1Ω) 10mV/bit	0000: 310mV 0110 : 250mV 1100 : 190mV 0001: 300mV 0111 : 240mV 1101 : 180mV 0010: 290mV 1000 : 230mV 1110 : 170mV 0011: 280mV 1001 : 220mV 1111 : 160mV 0100: 270mV 1010 : 210mV 0101: 260mV 1011 : 200mV
3~0	Not defined	

The direction and stop-mode settings for channel 5 are valid only when constant-current driving has been selected. These bits have no effect when either two-wire-type control or simultaneous 3-wire-type control for channels 5 and 6 has been selected by the IN input pins setting register. The size of the constant current (RNF5 voltage) is set by the value in bits 7 to 4.

SETTING REGISTER FOR CHANNEL 6 (B13, B12, B11, B10) = (0, 1, 1, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	0111	Direction	Stop mode	Setting of constant current value for channel 6				Weak excitation	Weak excitation current		
		0	0	0	0	0	0	0	0	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 000000xx>

Bit	Bit Name	Function
9	Direction for channel 6	Sets the direction of rotation when the constant-current drive and input mode-pin settings have selected serial or single-wire control for channel 6. 0: Forward 1: Reverse
8	Stop mode for channel 6	Sets the state of the output when operation stops in serial or single-wire control for channel 6 selected by the constant-current drive and input mode-pin settings. 0: Off 1: Brake
7~4	Constant current value setting for channel 6 (RNF6 voltage) 310mV~160mV (RNF 6=1Ω) 10mV/bit	0000: 310mV 0110: 250mV 1100: 190mV 0001: 300mV 0111: 240mV 1101: 180mV 0010: 290mV 1000: 230mV 1110: 170mV 0011: 280mV 1001: 220mV 1111: 160mV 0100: 270mV 1010: 210mV 0101: 260mV 1011: 200mV
3	Weak excitation ON for channel 6	0: Weak excitation OFF 1: Weak excitation ON
2	Weak excitation current setting for channel 6	Weak excitation current value = setting of constant current value for channel 6/D 0: D=2, 1: D=3 Only valid when weak excitation for channel 6 has been turned on.
1~0	Not defined	

SOFTWARE RESET REGISTER (B13, B12, B11, B10) =(1, 0, 0, 0)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	1000	12ch	34ch	57ch	Decelerate to stop 12	Decelerate to stop 34	Decelerate to stop 57				
		0	0	0	0	0	0	?	?	?	?

(The bottom row indicates the initial value after a reset.)

< After a reset: b'xxxxxx00 0000xxxx >

Bit	Bit Name	Function
9	Software reset bit for channels 1 and 2	0: No operation. 1: Initializes channels 1 and 2.
8	Software reset bit for channels 3 and 4	0: No operation. 1: Initializes channels 3 and 4.
7	Software reset bit for channels 5 and 7	0: No operation. 1: Initializes channels 5 and 7.
6	Decelerate to a stop for channels 1 and 2	0: No operation 1: Speed is reduced until operation stops.
5	Decelerate to a stop for channels 3 and 4	0: No operation 1: Speed is reduced until operation stops.
4	Decelerate to a stop for channels 5 and 7	0: No operation 1: Speed is reduced until operation stops.
3~0	Not defined	

Software setting of bits 7 to 9 is used to initialize the individual pairs of channels. Setting any of these bits to 1 initializes the corresponding channels. These software resets initialize the information on the phase of the channels and the register areas corresponding to each channel.

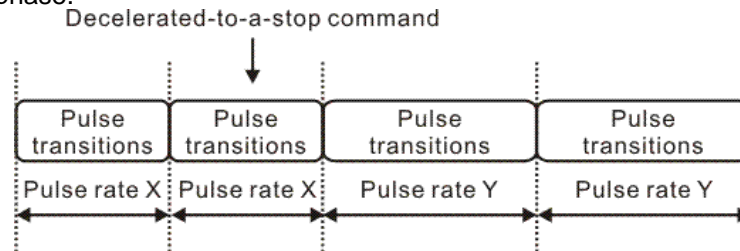
Furthermore, simultaneously resetting channels 1 and 2, 3 and 4, and 5 and 7 by software causes the resetting of registers in the common area. The effect is thus equivalent to that of a hardware reset.

Note a simultaneous reset applied in this way must be canceled by either of the means below.

- A true hardware reset (reset applied through the external RESET pin)
- Clearing of the three reset bits (b9 to b7) to 0

Setting the decelerate-to-a-stop bits for channels 1 and 2, 3 and 4, and 5 and 7 to 1 in the “no acceleration but deceleration” or “acceleration and deceleration” states, state transition occurs to deceleration operation according to the information on acceleration/deceleration pulse rate and the number of pulses. Here, the specification of the total number of pulses for controlling the motor is ignored.

Also, when no-acceleration/no-deceleration or with-acceleration/no-deceleration is selected by the acceleration and deceleration register, post-pulse-excitation is entered immediately. These bits are cleared and returned to their initial values after the end of the excitation phase.

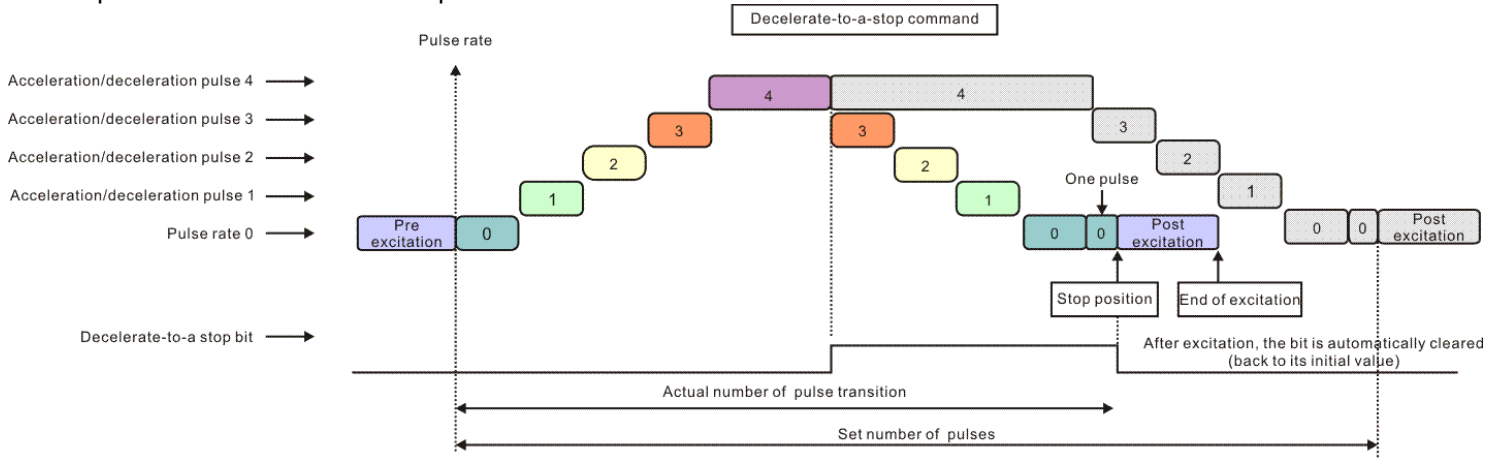


The pulse rate is maintained immediately after acceptance of the decelerate-to-a-stop command, and deceleration starts from the next set of pulse transitions.

8.2 EXAMPLE OF OPERATION IN DECELERATION TO A STOP

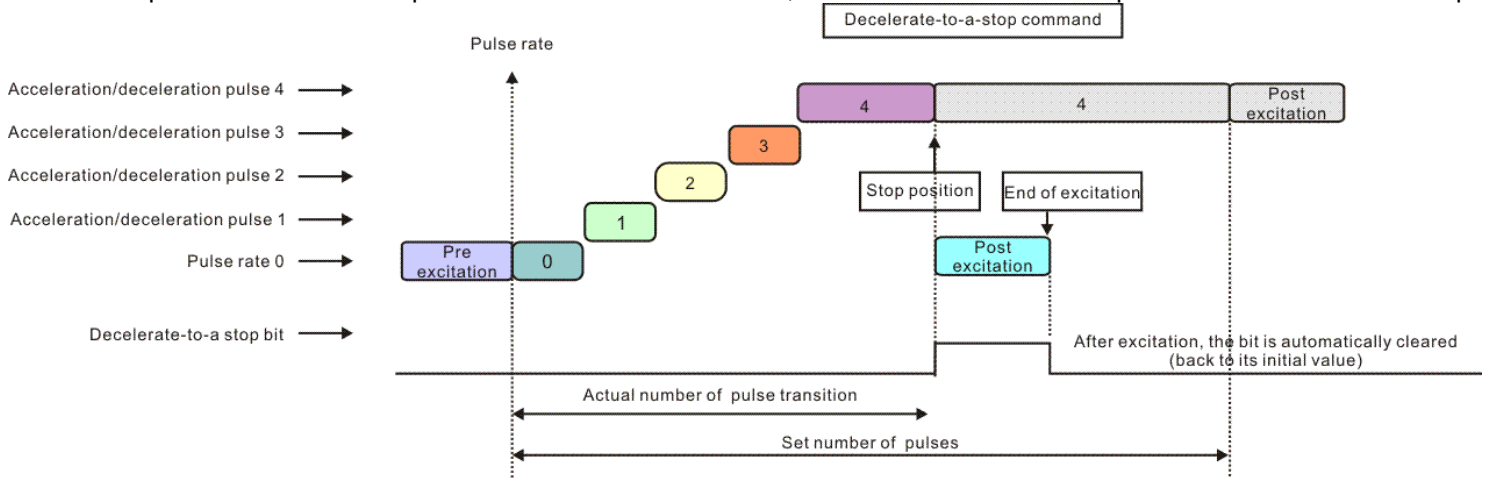
WITH OR WITHOUT ACCELERATION/WITH DECELERATION

After completion of the operation at the pulse rate at which the decelerate-to-a-stop command was accepted, deceleration proceeds and stops according to acceleration and deceleration pulse rate settings and the number of acceleration and deceleration pulses, and the state makes the transition to post-excitation. When post-excitation is not set, excitation stops at the last pulse of deceleration to a stop.



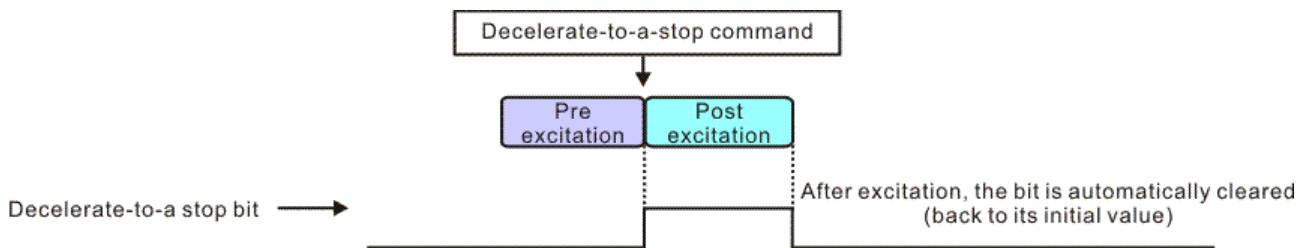
WITH ACCELERATION/WITHOUT DECELERATION

Pulse transitions end at the pulse rate at which the decelerate-to-a-stop command is accepted, and control makes the transition to post-excitation. When post-excitation has not been set, excitation ends at the final pulse of deceleration to a stop.



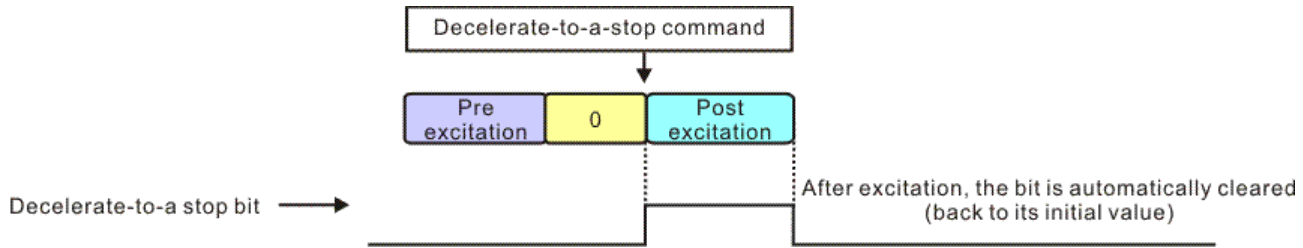
WHEN THE DECELERATE-TO-A-STOP BIT IS SET TO 1 DURING PRE-EXCITATION

Control moves to post-excitation on acceptance of the decelerate-to-a-stop command. When post-excitation is not set, excitation ends when the decelerate-to-a-stop command is accepted.



WHEN THE DECELERATE-TO-A-STOP BIT IS SET TO 1 AT ACCELERATION PULSE RATE 0

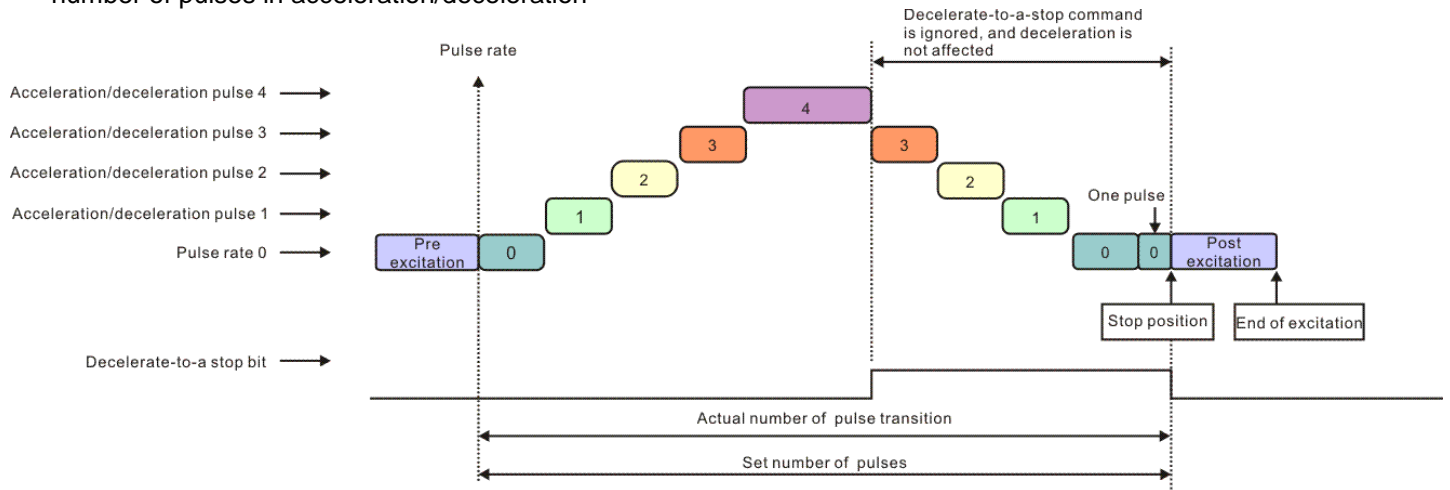
After the pulse transition at the point of acceptance of the decelerate-to-a-stop command, control makes the transition to post-excitation. When post-excitation is not set, excitation ends when operation at the pulse rate at which the decelerate-to-a-stop command was accepted is complete.



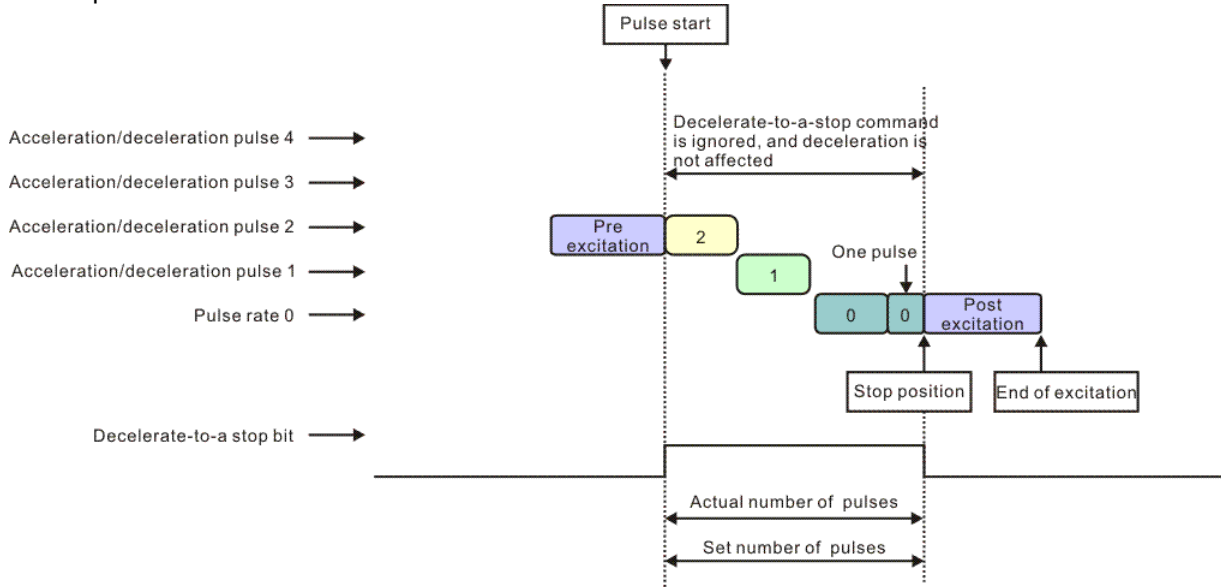
WHEN THE DECELERATE-TO-A-STOP COMMAND IS EXECUTED DURING DECELERATION

Since deceleration has already begun, the decelerate-to-a-stop command is invalid, and has no effect on the deceleration operation.

- Example of operation when acceleration and deceleration are set and the total number of pulses (set number of pulses) > number of pulses in acceleration/deceleration

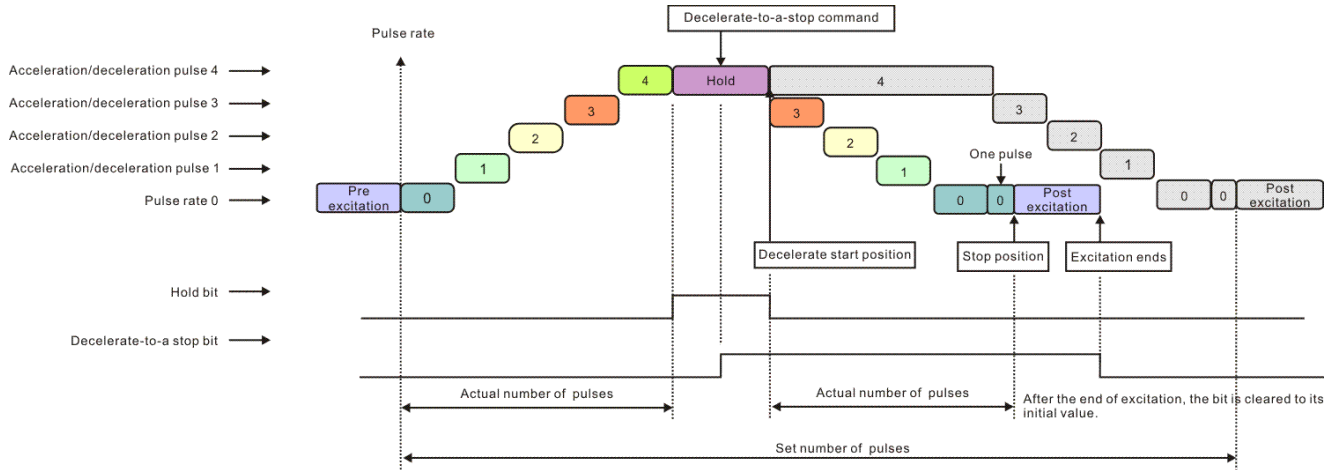


- Example of operation when acceleration without deceleration is set and the total number of pulses (set number of pulses) < number of pulses in no acceleration/with deceleration.



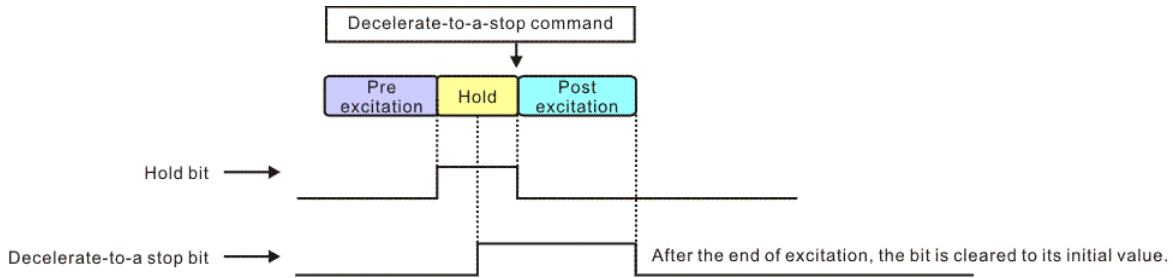
PRIORITY BETWEEN THE HOLD BIT AND DECELERATE-TO-A-STOP BIT

When decelerate-to-a-stop is set during hold, the hold setting takes priority. After the hold cancellation has been received (the hold bit has been cleared to 0), decelerate-to-a-stop operation proceeds.



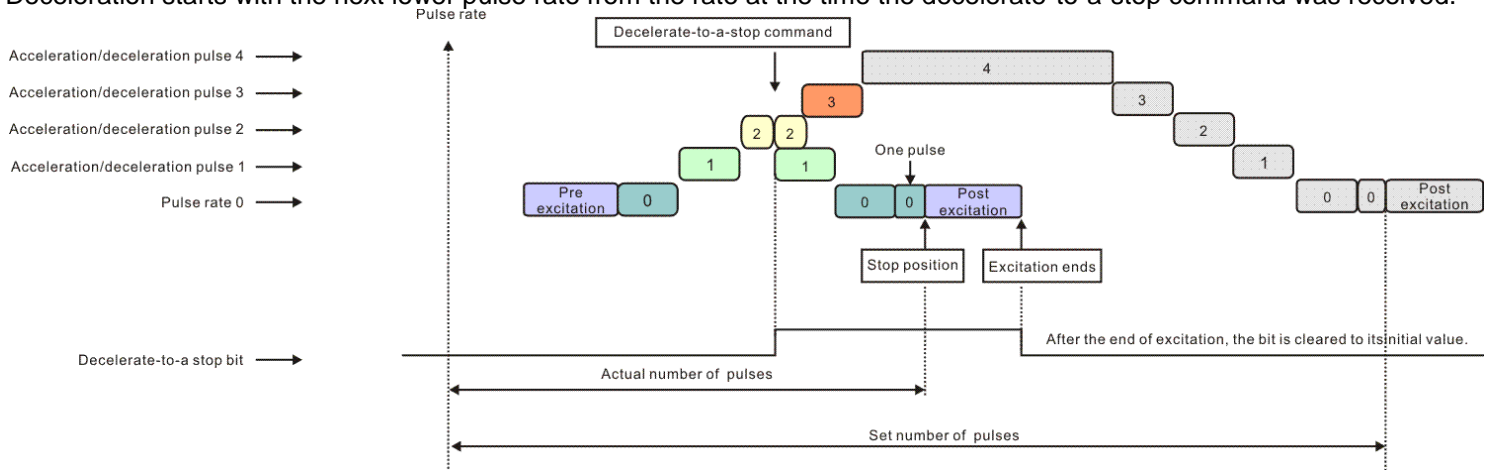
WHEN THE DECELERATE-TO-A-STOP IS SET AFTER THE HOLD SETTING HAS BEEN APPLIED DURING PRE-EXCITATION

The hold setting takes priority. Accordingly, post-excitation only proceeds after the hold cancellation has been received (the hold bit has been cleared to 0). When post-excitation has not been set, excitation terminates immediately after the hold bit has been cleared to 0 (releasing the hold state).



WHEN THE DECELERATE-TO-A-STOP COMMAND IS EXECUTED DURING ACCELERATION

Deceleration starts with the next lower pulse rate from the rate at the time the decelerate-to-a-stop command was received.



EXCLUSIVE CONTROL REGISTER (B13, B12, B11, B10) =(1, 0, 0, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	1001	Exclusive	5ch	6ch	7ch						
		0	0	0	0	?	?	?	?	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 00xxxxxx>

Bit	Bit Name	Function
9	Control of exclusive	0: Normal mode 1: Exclusive mode
8	Exclusive control of channel 5	0: Normal mode 1: Exclusive mode of channel 5
7	Exclusive control of channel 6	0: Normal mode 1: Exclusive mode of channel 6
6	Exclusive control of channel 7	0: Normal mode 1: Exclusive mode of channel 7
5~0	Not defined	

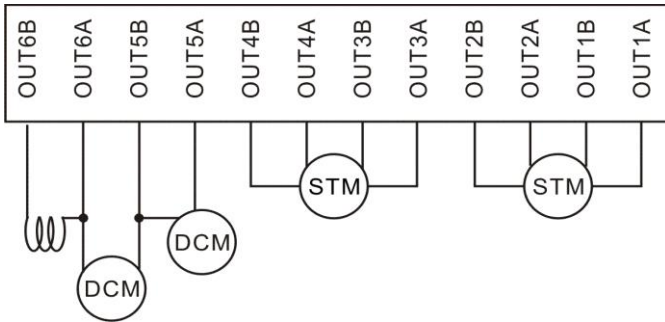
* The setting of two or more bits is prohibited.(bit 8 to 6)

It is a command that executes exclusive control.

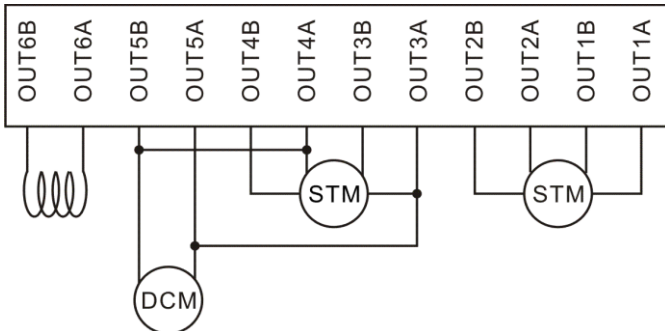
When b9 is "1", it effectively controls from ch3 to ch6 exclusively.

(When b9 is "0", the "1" setting of b8 to b6 is invalid.)

Correspondence ch control becomes effective because it makes the control bit of correspondence ch "1", the channel that exists in an exclusive relation is off.



- When 5ch control bit is made "1", OUT6A/6B is turned off.
- When 6ch control bit is made "1", OUT5A/5B is turned off.
- When 7ch control bit is made "1", OUT5A/6B is turned off.



- When 5ch control bit is made "1", OUT3B and OUT4B is turned off.
- When 5ch control bit is made "0", OUT5A/5B is turned off.

STATUS READ CONTROL REGISTER (B13, B12, B11, B10) =(1, 0, 1, 0)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	
11	1010	channel								status		
		0	0	?	?	?	?	?	-	-	-	

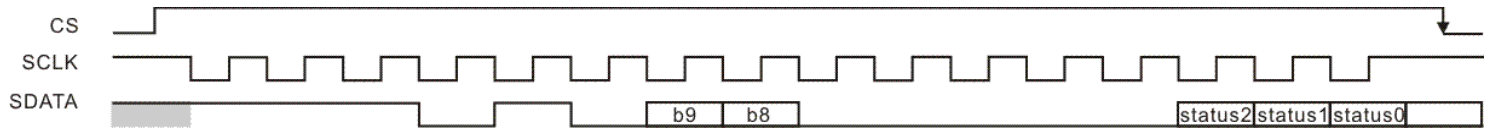
(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 xxxxx000>

Bit	Bit Name	Function
9~8	Channel select	00 : 12ch 01 : 34ch 10 : 57ch 11 : Setting prohibited
7~3	Not defined	
2~0	Output of status	It is a serial output synchronizing with SCLK as for the present status. 000: OFF 001: Pre-pulse-generation excitation 010: Acceleration and Constant velocity 011: Deceleration 100: Post-pulse-generation excitation 101: excitation(Excluding 001~100) 110: Setting prohibited 111: Setting prohibited

The channel to output the status under the drive is set.

The status of the channel set with bit9 and bit8 is output from the terminal SDO.



STATUS FLAG CONTROL REGISTER(B15, B14 B13, B12, B11, B10) = (1, 0, 1, 1): CHANNEL 12
 (B15, B14 B13, B12, B11, B10) = (1, 1, 0, 0): CHANNEL 34 (B15, B14 B13, B12, B11, B10) = (1, 1, 0, 1):
 CHANNEL 57

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	xxxx	Off	Pre-pulse-generation excitation	Acceleration and Constant velocity	Deceleration	Post-pulse-generation excitation	Excitation				
		0	0	0	0	0	0	?	?	?	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 0000xxxx>

Bit	Bit Name	Function
9	Flag output of off mode	0: No flag output 1: Flag output at the turning point to Off mode
8	Flag output of pre-pulse-generation excitation mode	0: No flag output 1: Flag output at the turning point to Pre-pulse generation excitation mode
7	Flag output of acceleration mode and constant velocity mode	0: No flag output 1: Flag output at the turning point to Acceleration and Constant velocity mode
6	Flag output of deceleration mode	0: No flag output 1: Flag output at the turning point to Deceleration mode
5	Flag output of post-pulse-generation excitation mode	0: No flag output 1: Flag output at the turning point to Post pulse-generation excitation mode
4	Flag output of excitation mode	0: No flag output 1: Flag output at the turning point to excitation mode
3~0	Not defined	

It is a register to output the one shot pulse when the mode is switched. (Two or more bits can be set.)

**PULSE POSITION READ CONTROL REGISTER (B13, B12, B11, B10) =(1, 1, 1, 0)
(WHEN B15 AND B14 SELECT CHANNELS 12 AND 34)**

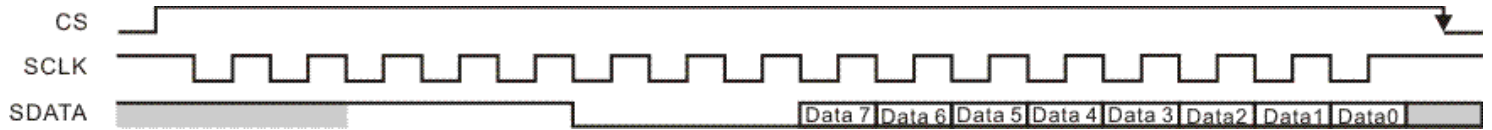
b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0x	1110	Micro-stepping current position									
		?	?	-	-	-	-	-	-	-	-

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxxxx 00000000>

Bit	Bit Name	Function
9~8	Not defined	
7~0	Micro-stepping current position	It is a serial output synchronizing with SCLK as for the present location of Micro-stepping

The channel to output a present pulse position of Micro-stepping is set.
It outputs it from the terminal SDO according to the timing shown in the figure below.



(WHEN B15 AND B14 SELECT CHANNELS 57)

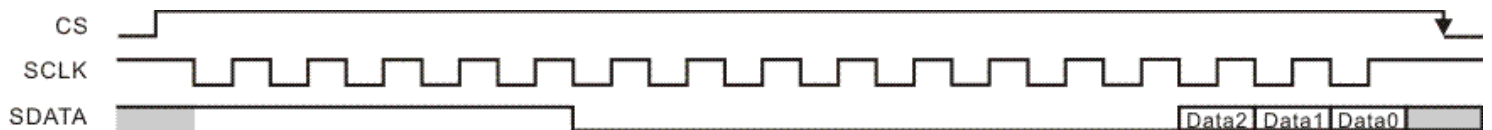
b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	1110	current pulse position							-	-	-
		?	?	?	?	?	?	?	-	-	-

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxxxx xxxxx000>

Bit	Bit Name	Function
9~3	Not defined	
2~0	Current pulse position	It is a serial output synchronizing with SCLK as for the present pulse location.

The channel to output a present pulse position of Micro-stepping is set.
It outputs it from the terminal SDO according to the timing shown in the figure below.



OPERATION SETTING REGISTER (B13, B12, B11, B10) = (1, 1, 1, 1)

b15~b14	b13~b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
11	1111	12ch	34ch	57ch	HOLD12	HOLD34	HOLD57	12 ON	34 ON	57 ON	
		0	0	0	0	0	0	0	0	0	?

(The bottom row indicates the initial value after a reset.)

<After a reset: b'xxxxxx00 0000000x>

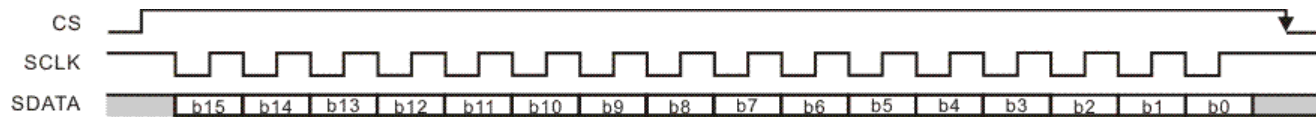
Bit	Bit Name	Function
9	Channels 1 and 2 enable operation	0: Operation stopped (no excitation) 1: Operation enabled (excitation, pulse transitions)
8	Channels 3 and 4 enable operation	0: Operation stopped (no excitation) 1: Operation enabled (excitation, pulse transitions)
7	Channels 5 and 7 enable operation	0: Operation stopped (no excitation) 1: Operation enabled (excitation, pulse transitions)
6	Channels 1 and 2 hold operating state	0: Hold cancelled 1: Held (excitation, pulse transitions stop)
5	Channels 3 and 4 hold operating state	0: Hold cancelled 1: Held (excitation, pulse transitions stop)
4	Channels 5 and 7 hold operating state	0: Hold cancelled 1: Held (excitation, pulse transitions stop)
3	Channels 1 and 2 excitation ON	0: Disabled 1: Enabled
2	Channels 3 and 4 excitation ON	0: Disabled 1: Enabled
1	Channels 5 and 7 excitation ON	0: Disabled 1: Enabled
0	Not defined	

These bits stop/enable operation on the respective channels. Clearing these bits to 0 applies control to terminate operation on the corresponding channel (excitation is also turned off).

Under the following conditions, setting the enable-operation bit to 1 is invalid.

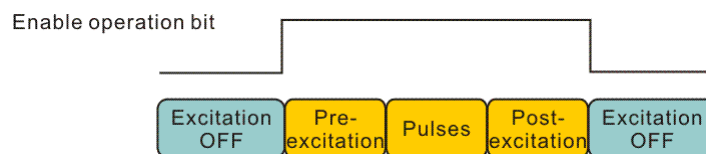
- No pre-excitation,
- The number of pulses=0,
- No post-excitation and
- Selection of stepper motor mode (the setting for driving method other than the DC motor setting)

When the hold bit is set to 1 during operation, operation is suspended at the time of recognition of the hold information. In this suspended state, excitation is turned on. When the hold state is released while operation is suspended in the held state, subsequent operations continue. The hold bit must be cleared to 0 by software.

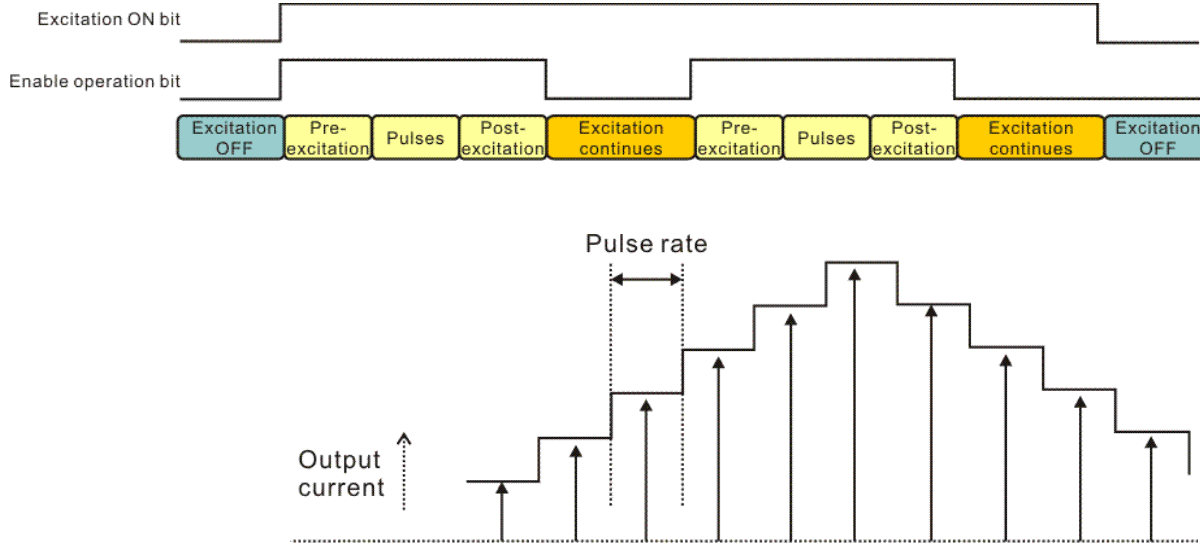


Activation of control by these bits takes place when the data is transferred to the internal registers, that is, on the falling edge of the CS signal. That is, control to enable or stop operation is applied from this point.

When the excitation ON bits for channels x and x+1 are set to 1, excitation starts regardless of the whether or not operation is enabled. Excitation continues after post-excitation subsequent to pulse transitions has been completed. When an enable operation bit is cleared (to 0), the excitation voltage value immediately beforehand continues to be applied.

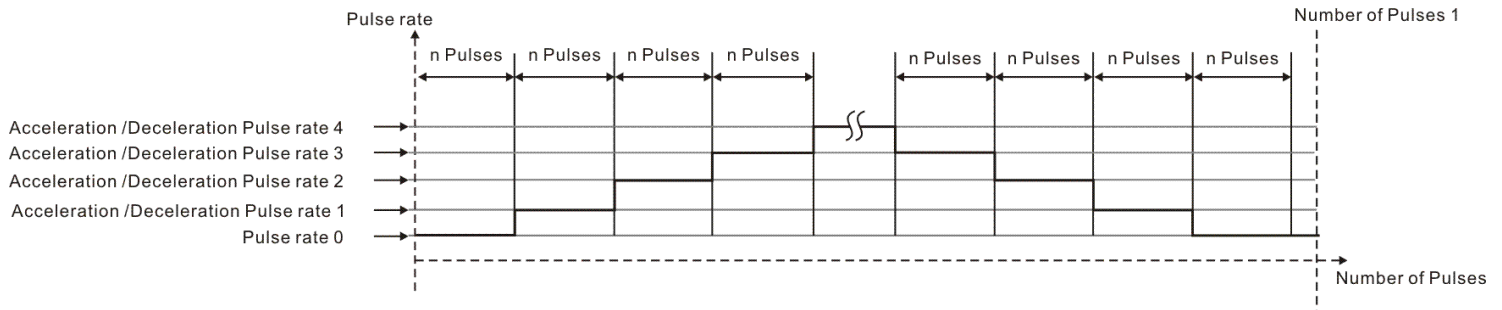


The above enable operation bit is cleared on completion of post-excitation after the end of pulse control



The pulse rate setting is the absolute length in time of one current pulse.
 When the operating frequency is 5 MHz for a period of 0.2μs, the pulse rate can be set in the range from 0.2μs (1 x 0.2μs) to 209.51ms (1023 x 204.8μs).
 Pulse rate = (Pulse rate *) x (Pulse rate range) * = 0, 1, 2, 3 or 4

With acceleration and deceleration

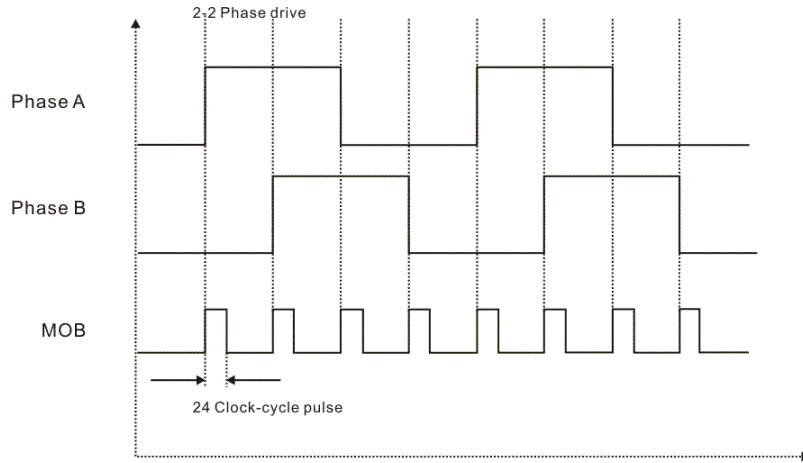


Acceleration and deceleration proceed in four stages. The pulse rate changes in units of the number of pulses in acceleration and deceleration.

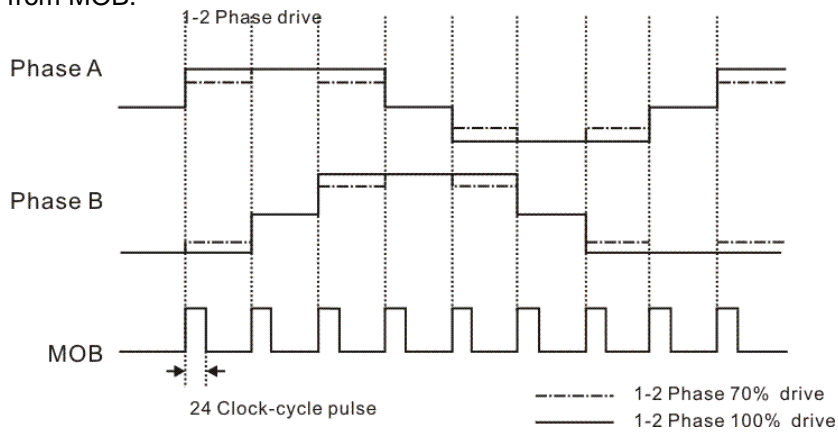
The pulse rates after the changes are in accord with the acceleration/deceleration pulse rate 1 to 4 settings.

The specified pulse rates must be within the range of possible pulse rates.

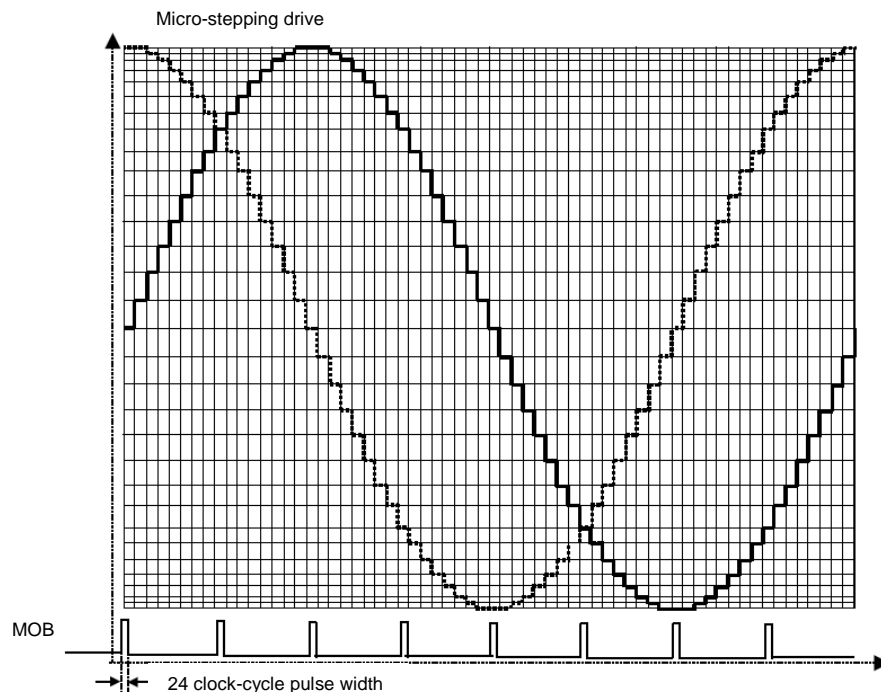
Number of pulses, n, is determined by the setting for number of pulses in acceleration and deceleration.



At the start timing when current outputs in phases A and B are +100% and -100%, respectively, a high-level pulse with a width of 24 clock cycles is output from MOB.



A high pulse of 24-clock width is output from MOB at all positions in 1-2 phase operation.



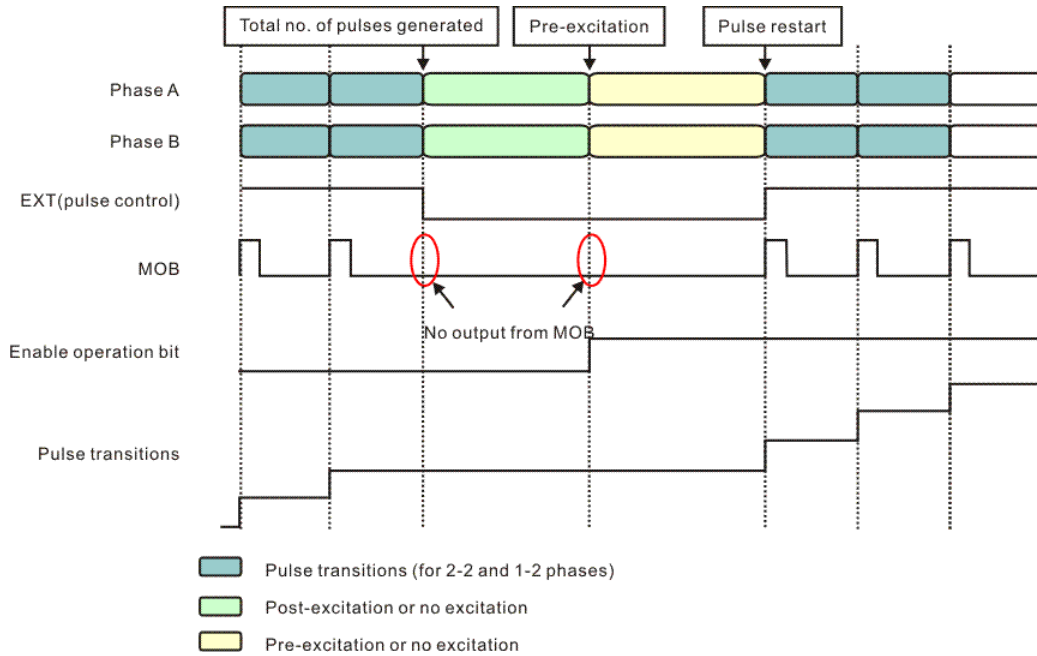
In micro-stepping drive, a high-level is output from MOB at the following positions in 1-2 phase operation. +100%, +70.7%, 0%, -70.7%, -100%.

8.3 TIMING OF MOB OUTPUT

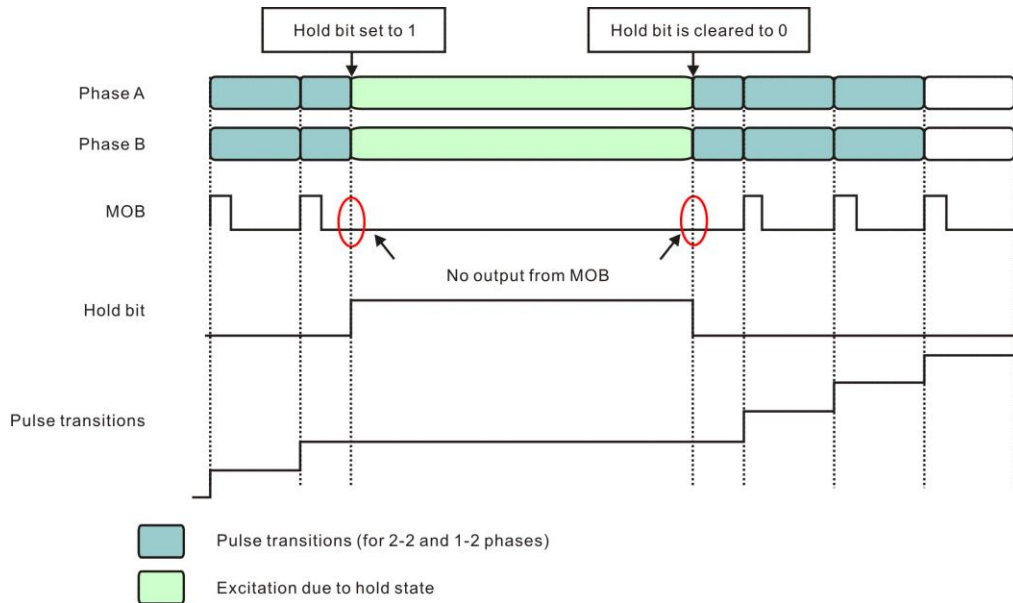
(1) WHEN PULSE TRANSITIONS RECOMMENCE AFTER COMPLETION OF TOTAL PULSE PROCEDURE

A high level is not output from MOB when post-excitation or pre-excitation is applied at the time after the completion of the full pulse sequence to restarting of pulse transitions.

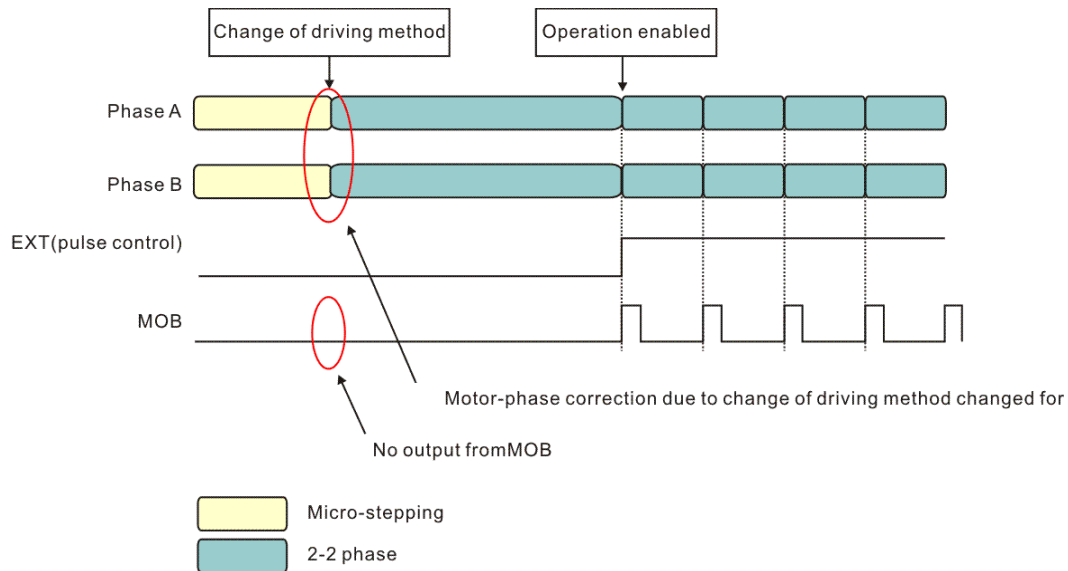
If the excitation ON bit is set to 1 during the period depicted below, the MOB output remains unchanged.



(2) WHEN THE HOLD BIT IS SET TO 1

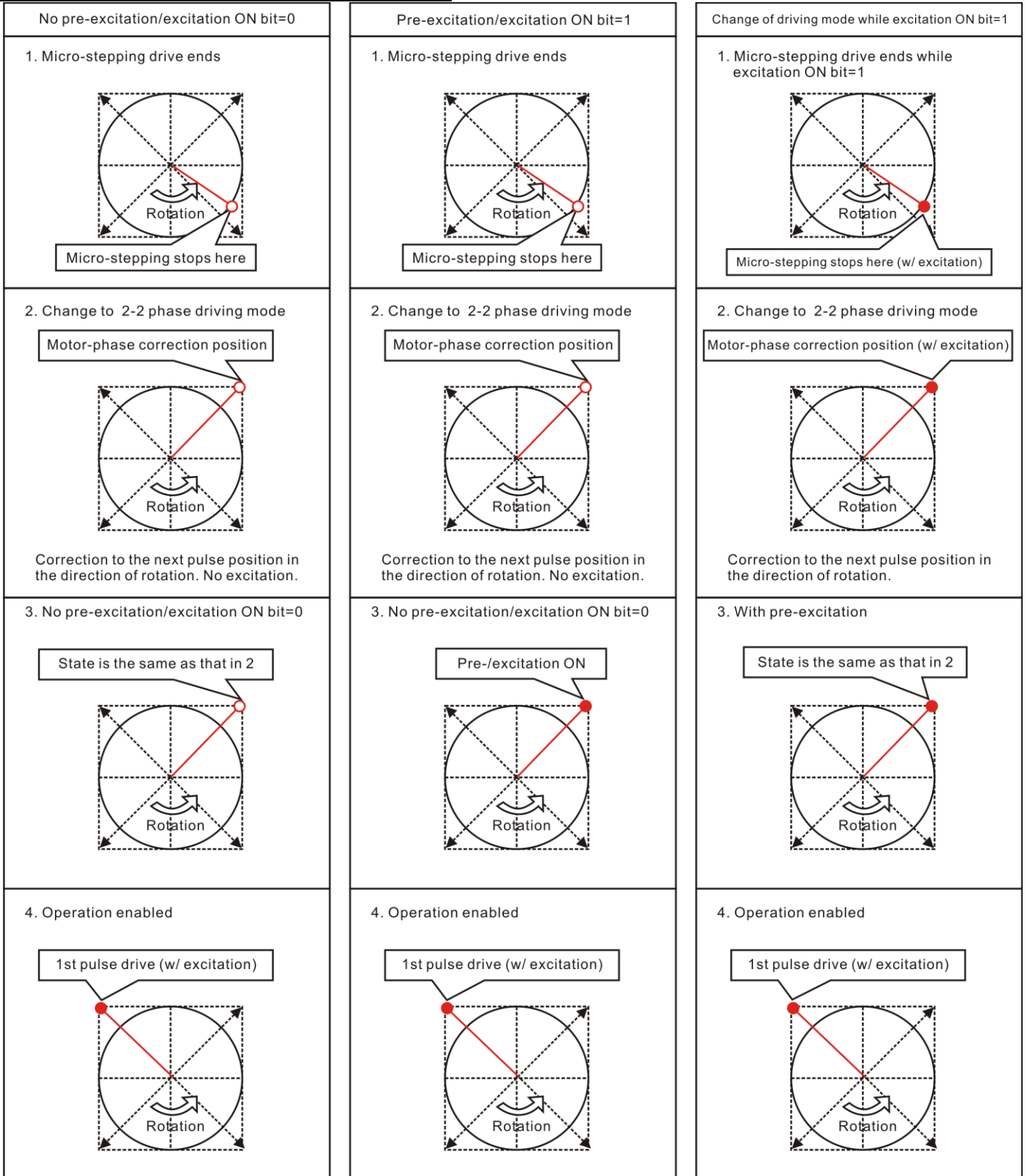


8.4 MOTOR PHASE CORRECTION FUNCTION

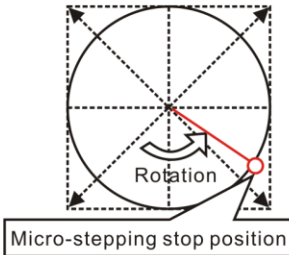
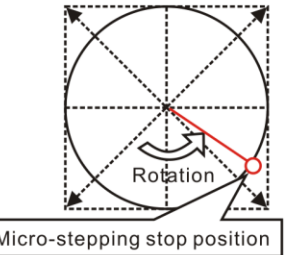
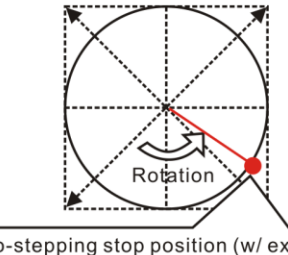
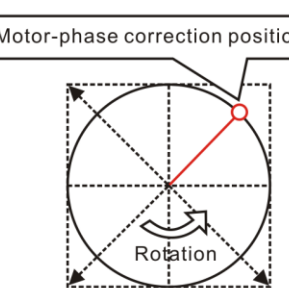
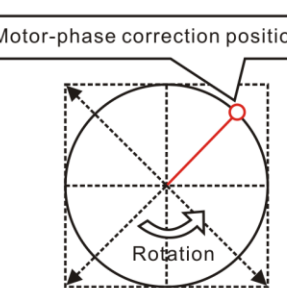
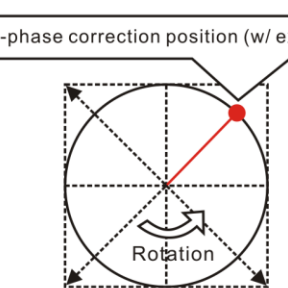
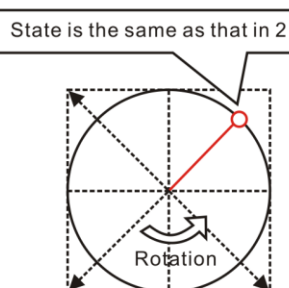
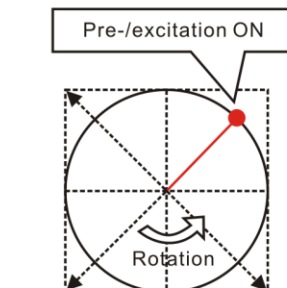
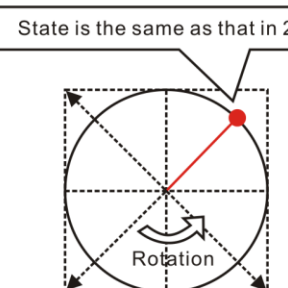
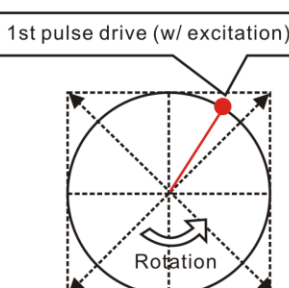
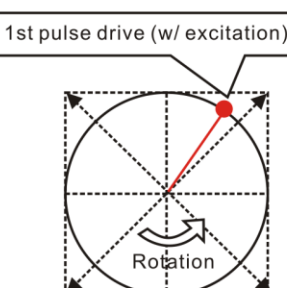
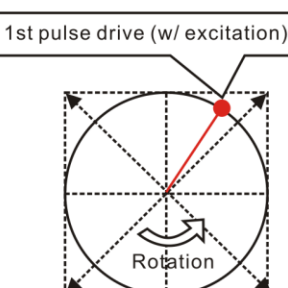


When the driving method is changed, since motor phase control differs with the driving method, the phase where the motor stops before the change of the method of driving becomes the phase of the motor control after changing the driving method. Here, correction is not performed when the stopped phase matches the motor phase after changing the driving method. When motor phase correction is applied, the correction is made to the next nearest position of the pulse in the direction of rotation. When 2-2 phase position or 1-2 phase position occurs by the phase correction, high-level is not output from MOB. That is, MOB is output when 2-2 phase position or 1-2 phase position occurs when the motor phase changes by setting the enable-operation bit to 1. Automatic phase correction is also performed when operation is forcibly terminated by an interrupt.

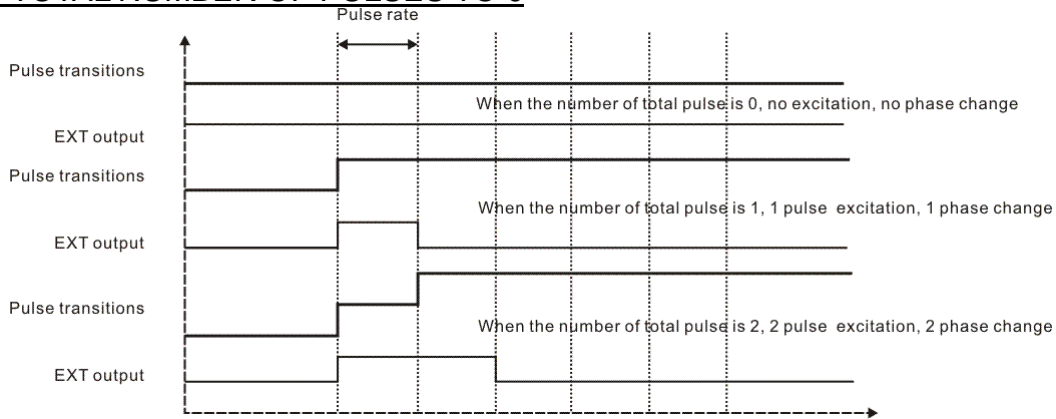
MOTOR PHASE CORRECTION WHEN THE MODE OF DRIVING IS CHANGED FROM MICRO-STEPPING TO 2-2 PHASE DRIVING



POSITION WHERE EXCITATION STARTS:

No pre-excitation/excitation ON bit=0	With pre-excitation/excitation ON bit=1	Excitation start position change while excitation ON bit=1
<p>1. End of micro-stepping drive</p>  <p>Micro-stepping stop position</p>	<p>1. End of micro-stepping drive</p>  <p>Micro-stepping stop position</p>	<p>1. End of micro-stepping drive while excitation ON bit=1</p>  <p>Micro-stepping stop position (w/ excitation)</p>
<p>2. Change excitation initial position to 100%/100%</p>  <p>Motor-phase correction position</p> <p>Corrected to pulse position of 100%/100%(70%/70%). No excitation.</p>	<p>2. Change excitation initial position to 100%/100%</p>  <p>Motor-phase correction position</p> <p>Corrected to pulse position of 100%/100%(70%/70%). No excitation.</p>	<p>2. Change excitation initial position to 100%/100%</p>  <p>Motor-phase correction position (w/ excitation)</p> <p>Corrected to pulse position of 100%/100%(70%/70%).</p>
<p>3. No pre-excitation/excitation ON bit=0</p>  <p>State is the same as that in 2</p>	<p>3. With pre-excitation/excitation ON bit=1</p>  <p>Pre-excitation ON</p>	<p>3. With pre-excitation</p>  <p>State is the same as that in 2</p>
<p>4. Operation enabled</p>  <p>1st pulse drive (w/ excitation)</p>	<p>4. Operation enabled</p>  <p>1st pulse drive (w/ excitation)</p>	<p>4. Operation enabled</p>  <p>1st pulse drive (w/ excitation)</p>

SETTING THE TOTAL NUMBER OF PULSES TO 0



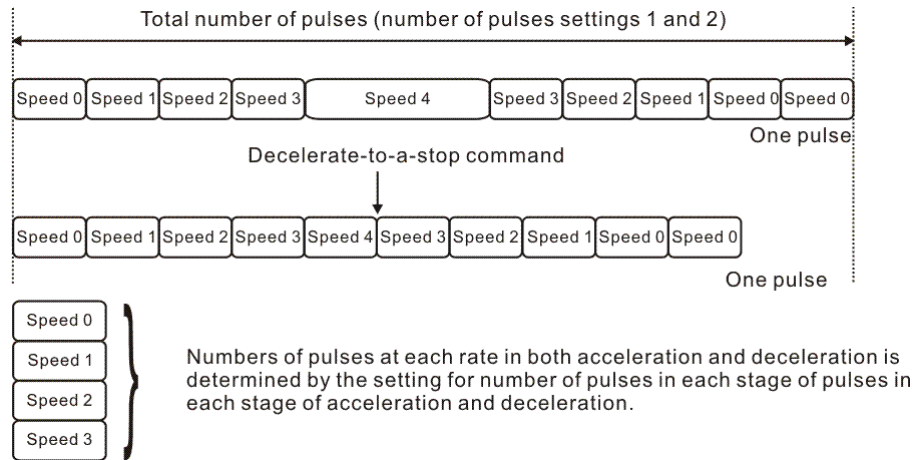
By the total number of pulses setting for the number of pulses 1 and 2
 When the total number of pulses is 0: No pulse transition, no output, no drive
 When the total number of pulses is 1: One-pulse transition, drive for one-pulse rate.
 When the total number of pulses is 2: Two-pulse transition, drive for two-pulse rate.

As shown in the above figure, when the total number of pulses is set to 0 by the number of pulses 1 and 2, pulse transitions do not proceed and no output driving is applied. Accordingly, even when the pulse-control setting is selected for EXT output, the EXT signal remains low.

When the total number of pulses is set to 0 after the method of driving has been changed, motor-phase correction is applied at the point where the change of method is accepted, but neither driving nor pulse transitions proceed. However, when the pre-excitation setting is made, excitation is applied at the position of motor phase correction.

When the total number of pulses is set to a value other than 0 (i.e. to n), the number of pulse transitions becomes n. Here, when the pulse-control setting is selected for EXT output, the EXT signal is driven high for the period of n pulses.

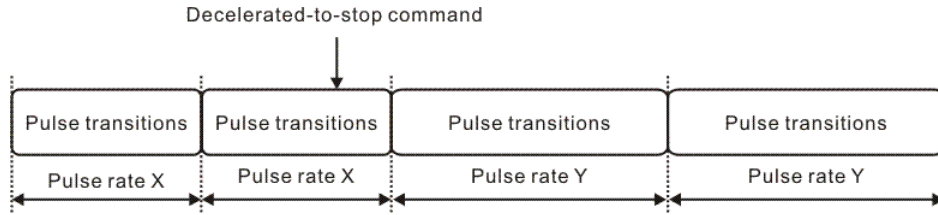
EXAMPLE OF ACCELERATION/DECELERATION OPERATION



As shown in the above figure, speeds in acceleration and deceleration follow in this order:
 Acceleration: speed 0→speed 1→speed 2→speed 3→speed 4
 Deceleration: speed 4→speed 3→speed 2→speed 1→speed 0→speed 0 (1 pulse)

Here, numbers of pulses at speeds 0 to 3 are determined by the setting for the number of pulses per stage in acceleration and deceleration. However, only one pulse is output at the last speed in deceleration, i.e. speed 0, regardless of the setting. The number of pulses at speed 4 is the total number of pulses minus the number of pulses in acceleration and deceleration (number of pulses at speeds 0 to 3).

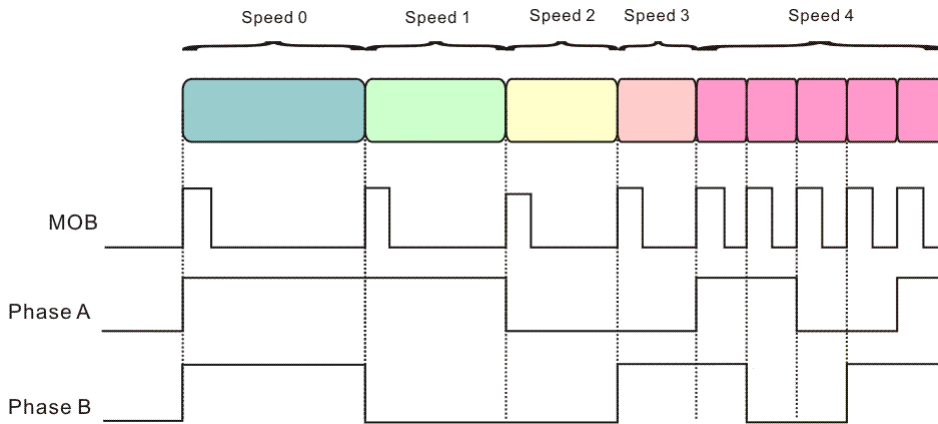
When a decelerate-to-a-stop command is issued during the period at a given speed, deceleration starts immediately after recognition of the command. In the above figure, deceleration is started from speed 4.



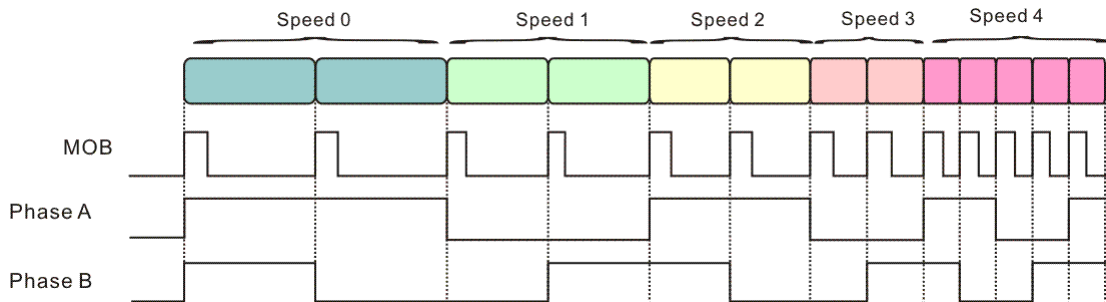
On acceptance of the decelerate-to-a-stop command, the pulse rate is maintained at the pulse rate until that set of transitions, and the pulse rate is decelerated from the next set of pulse transitions.

The figure below shows the pulse transitions when the number of pulses in acceleration/deceleration is set to 1, 2, and 4. When the total number of pulses is set to 0, even if the number of pulses in acceleration and deceleration is set to 1023, excitation is not applied.

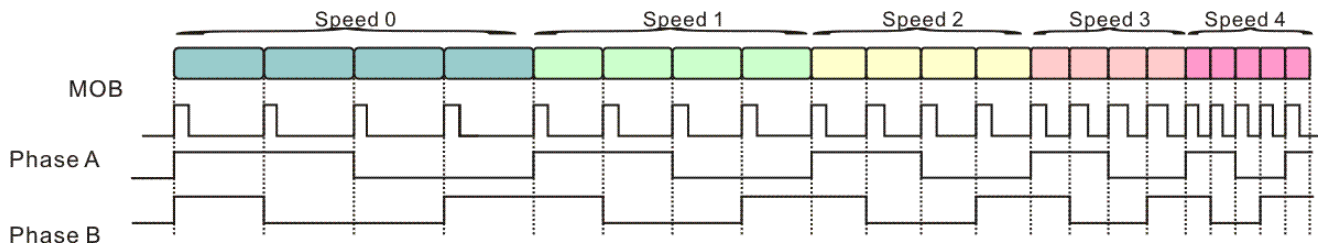
NO. OF PULSES IN ACCELERATION = 1



NO. OF PULSES IN ACCELERATION = 2

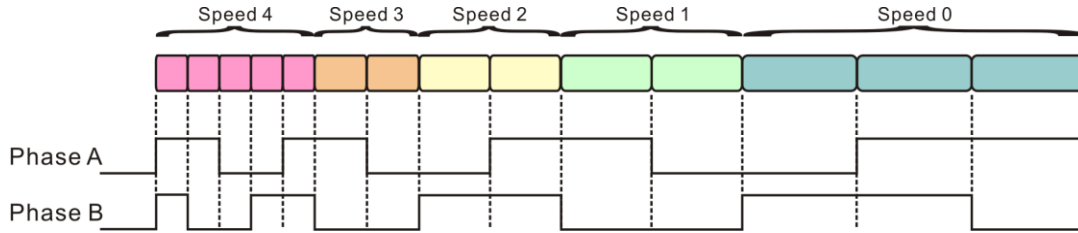


NO. OF PULSES IN ACCELERATION = 4

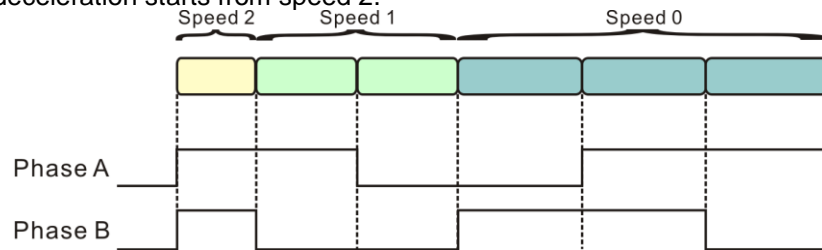


RELATION BETWEEN THE OVERALL NUMBER OF PULSES AND THE NUMBER OF PULSES IN ACCELERATION / DECELERATION WITH NO ACCELERATION BUT WITH DECELERATION

- (1) When the total number of pulses set by number of pulses setting 1 and 2 is greater than the total number of pulses in acceleration/deceleration, the number of pulses at speed 4 is calculated by subtracting number of pulses at speed 0 to 3 from the number of pulses set by number of pulses setting 1 and 2.

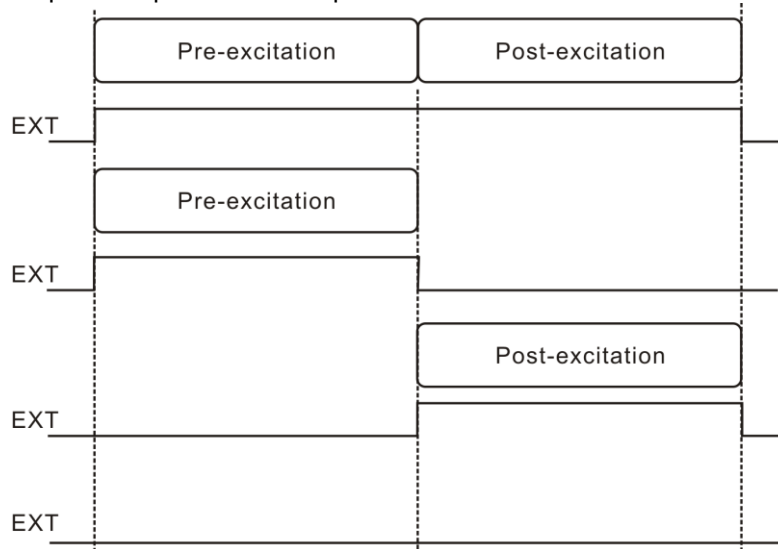


- (2) When the total number of pulses set by number of pulses setting 1 and 2 is less than the total number of pulses in acceleration/deceleration, the pulse transition starts in mid-flow of deceleration so as to end at speed 0. The figure below shows an example when deceleration starts from speed 2.



EXAMPLE OF OPERATION WHEN THE TOTAL PULSE NUMBER OF PULSES IS SET TO ZERO, AND PRE- AND POST-EXCITATION ARE APPLIED:

When total number of pulses set by number of pulses settings 1 and 2 is equal to zero, pulse transitions do not proceed and current is not driven. Accordingly, when the total number of pulses is set to zero and pre-and post-excitation are applied:
 Excitation period= pre-excitation period + post-excitation period



When the total number of pulses is set to 0, operation follows one of the above four patterns. The three higher graphs indicate the output waveform when the output of a high level during excitation is selected for EXT output. When the output of a high level during pulse control is selected, a low level is output on EXT throughout the above period.

9. IC OPERATION CONTROL

9.1 OPERATION CONTROL

Control of operations starts with the setting of items via the serial interface, and is followed by setting of the enable-operation bit (or the application of the required signals to the IN pins).

- Pulse-position (phase) information is initialized by a hardware or software reset.
- Positional information on motor control (phase information) is not initialized by setting or clearing the enable-operation bit.

9.2 OPERATION PROCEDURE

9.2.1 FOR DC MOTOR CONTROL (CHANNEL 3 AND 4)

1. These items are executed in any order.
 - Select the method of driving.
 - Set the voltage amplitude.
 - Set the voltage value of DC motor setting.
2. Select the required allocations of the IN input pins.
3. Turn the power on (setting the PS bits).
4. Set the enable-operation bit (start excitation).
5. From here, you can make DC motor settings to change the direction of rotation and the voltage value (the voltage amplitude value can also be adjusted).

<CAUTION>

- Do not change the method of driving or allocations of the IN input pins during operation.

9.2.2 FOR DC MOTOR CONTROL (CHANNEL 5 AND 7)

1. These items are executed in any order.
 - Set the method of driving.
 - Make the direction, stop mode, PWM drive, and carrier frequency settings.
 - Set the duty cycle.
2. Select the required allocations of the IN input pins.
3. Turn the power on (by setting the PS bits).
4. Set the enable-operation bit (start excitation).
5. From here, you can make settings to change the direction of rotation, PWM drive, carrier frequency, and duty cycle.

<CAUTION>

- Do not change the method of driving or allocations of the IN input pins during operation.

9.2.3 STEPPER MOTOR CONTROL WITH NO ACCELERATION OR DECELERATION: ON CHANNEL 1 AND 2, CHANNEL 3 AND 4, OR CHANNEL 5 AND 7

1 Channels 1 and 2 or Channels 3 and 4

- Set the direction of rotation and the method of driving (2–2 phase, 1–2 phase, or micro-stepping).
- Set the position obtained by initial excitation (to enable adjustment of this setting, set the enable-initial-positioning-by-excitation bit).
- Set the number of driving pulses.
- Set the pulse rate and pulse-rate range.
- Set the number of steps for micro-stepping driving.
- Set the pre- and post-excitation periods.

Channels 5 and 7

- Set the direction of rotation and the method of driving (2–2 phase, 1–2 phase).
- Set the position obtained by initial excitation (to enable adjustment of this setting, set the enable-initial-positioning-by-excitation bit).
- Set the number of driving pulses.
- Set the pulse rate and pulse - rate range.
- Set the pre - and post - excitation periods.

2 Select the required allocations of the IN input pins.

3 Channel 1 and 2, Channel 3 and 4

- Set the voltage amplification value and carrier frequency.

Channel 5 and 7

- Make the stop mode, PWM drive, and carrier frequency settings.
- Set the duty cycle.

4 Turn power on (by setting the PS bits).

5 Set the enable-operation bit (start excitation, pulse transitions)

- After completion of pulse transitions and post-excitation, settings made in steps 1 to 3 can be changed.

---State when the enable-operation bit is cleared during operation ---

- Current phase of pulse transitions is retained.
- The counter for the number of pulse transitions is cleared. Accordingly, the number of pulses can be controlled afresh by changing the number of pulses settings and again setting the enable-operation bit.
- The function of controlling the pulse rate is initialized, and operation is restarted by setting the enable operation bit. Accordingly, operation restarts with the new pulse rate and pulse-rate range.

---Hold during operation---

- The phase of pulse transitions at the time of the hold setting is maintained, and control enters the excitation state. The counter for the number of pulses is not initialized. Operation continues on the release of the held state.

<CAUTION>

- Do not change the settings made in steps 1 and 2 above, and do not make a new carrier-frequency setting during operation. Since there is no acceleration or deceleration, the settings for pulse rate and number of pulses in acceleration or deceleration are ignored and are thus not needed.
- In the held state, do not make any of the changes listed under steps 1 and 2 above, and do not make a new carrier-frequency setting.

9.2.4 STEPPER MOTOR CONTROL WITH ACCELERATION AND DECELERATION

1. Channel 1 and 2, and channel 3 and 4

- Set the direction of rotation and method of driving (2–2 phase, 1–2 phase, micro-stepping).
- Set the position obtained by initial excitation (to enable adjustment of this setting, set the enable-initial-positioning-by-excitation bit).
- Set the number of driving pulses.
- Set the pulse rate and pulse-rate range.
- Set the number of steps for micro-stepping driving.
- Set the number of pulses per stage in acceleration/deceleration.
- Set acceleration/deceleration pulse rates 1 to 4.
- Set the pre- and post-excitation periods.

Channel 5 and 7

- Set the direction of rotation and method of driving (2–2 phase, 1–2 phase).
- Set the position obtained by initial excitation (to enable adjustment of this setting, set the enable-initial-positioning-by-excitation bit).
- Set the number of driving pulses.
- Set the pulse rate and pulse-rate range.
- Set the number of pulses per stage in acceleration/deceleration.
- Set acceleration/deceleration pulse rates 1 to 4.
- Set the pre- and post-excitation periods.

2. Select the required allocations of the IN input pins.

3. Channel 1 and 2, and channel 3 and 4

- Set the voltage amplification value and carrier frequency.

Channel 5 and 6

- Make the stop mode, PWM drive, and carrier frequency settings.
- Set the duty cycle.

4. Turn on the power (by setting the PS bits).

5. Set the enable-operation bit (start excitation, and then pulse transitions)

---Pulse-rate transitions during acceleration/deceleration control ---

- In acceleration

Pulse rate 0→ Pulse rate 1→ Pulse rate 2→ Pulse rate 3→ Pulse rate 4

- In deceleration

Pulse rate 4→ Pulse rate 3→ Pulse rate 2→ Pulse rate 1→ Pulse rate 0

---Clearing the enable-operation bit during operation ---

- Operation stops regardless of whether acceleration or deceleration is in progress.
- The number of pulses and pulse rate are in the same state as with no acceleration/deceleration described previously.

---Hold during operation---

- The hold state is entered regardless of the state in terms of acceleration/deceleration.

On transition from the held state, the state prior to setting of the hold bit is resumed and operation is restarted.

Accordingly, when acceleration or deceleration is in use, note that hold control does not include control of acceleration or deceleration.

---Setting the decelerate-to-a-stop bit ---

When the decelerate-to-a-stop bit is set when acceleration or deceleration has been specified (during the pulse transitions), deceleration control is applied from the pulse rate *n* at which the decelerate-to-a-stop command was received and proceeds until pulse rate 0.

<CAUTION>

- During operation, do not change the settings made in steps 1 and 2 above, or the carrier frequency.
- Do not set the number of pulses for the stages of acceleration and deceleration to zero.

9.2.5 MEANS FOR STOPPING AND RESULTING DEVICE STATES

MEANS FOR STOPPING

The following means for stopping are available during motor control, i.e. while the enable-operation bit is set.

- (1) HARDWARE RESET
- (2) SOFTWARE RESET
- (3) CLEARING THE ENABLE-OPERATION BIT
- (4) SETTING THE HOLD BIT
- (5) SETTING THE DECELERATE-TO-A-STOP BIT

(1) HARDWARE RESET

The controller's whole state is initialized. Apply a hardware reset after power is initially supplied.

(2) SOFTWARE RESET

Allows initialization of the individual motor-driving channels.

Note that when a software reset is simultaneously applied to all three channels, the common register settings are also initialized.

(3) CLEARING THE ENABLE OPERATION BIT

When the enable operation bit is cleared during operation, operation immediately stops in that state. In this case, excitation is not applied.

(4) SETTING THE HOLD BIT

When the hold bit is set during operation, the operation is immediately suspended with the current state retained. In this case, excitation is applied. When the hold bit is cleared, subsequent operations proceed.

(5) SETTING THE DECELERATE-TO-A-STOP BIT

The decelerate-to-a-stop bit is used to halt operation while operation is in progress and acceleration and deceleration are enabled. Once this bit is set, the operation comes to a halt after deceleration control (in the end, operation stops when the pulse rate set as pulse rate 0 is reached).

9.3 RESTRICTIONS ON REGISTER SETTING DURING MOTOR CONTROL

9.3.1 CHANNEL 1 AND 2

b15~b14 = 00		Stepping Motor Control				
Registers b13, b12, b11, b10	Bit Name	Pre- Excitation	Pulses in Progress	Post- Excitation	Hold	Operation OFF
0h	Direction	NO	NO	NO	NO	YES
	Driving mode	NO	NO	NO	NO	YES
	Acceleration/deceleration control	NO	NO	NO	NO	YES
	Initial position set by excitation	NO	NO	NO	NO	YES
1h	Number of pulses 1	NO	NO	NO	NO	YES
2h	Number of pulses 2	NO	NO	NO	NO	YES
3h	Pulse rate 0	NO	NO	NO	NO	YES
4h	Pulse-rate range	NO	NO	NO	NO	YES
	Number of steps	NO	NO	NO	NO	YES
5h	Number of pulses per stage in acceleration/deceleration	NO	NO	NO	NO	YES
6~9h	Pulse rates in acceleration /deceleration 1~4	NO	NO	NO	NO	YES
Ah	Pre-pulse-generation excitation period	NO	NO	NO	NO	YES
Bh	Post-pulse-generation excitation period	NO	NO	NO	NO	YES
Ch	Setting prohibited	NO	NO	NO	NO	NO
Dh	Voltage amplitude setting	YES	YES	YES	YES	YES
	Gain	YES	YES	YES	YES	YES
Eh	Read of pulses position	NO	NO	NO	NO	YES

9.3.2 CHANNEL 3 AND 4

b15~b14 = 01		DC Motor		Stepping Motor Control				
Registers b13, b12, b11, b10	Bit Name	Drive	Operation OFF	Pre- Excitation	Pulses in Progress	Post- Excitation	Hold	Operation OFF
0h	Direction	-	-	NO	NO	NO	NO	YES
	Driving mode	NO	YES	NO	NO	NO	NO	YES
	Acceleration/deceleration control	-	-	NO	NO	NO	NO	YES
	Initial position set by excitation	-	-	NO	NO	NO	NO	YES
1h	Number of pulses 1	-	-	NO	NO	NO	NO	YES
2h	Number of pulses 2	-	-	NO	NO	NO	NO	YES
3h	Pulse rate 0	-	-	NO	NO	NO	NO	YES
4h	Pulse-rate range	-	-	NO	NO	NO	NO	YES
	Number of steps	-	-	NO	NO	NO	NO	YES
5h	Number of pulses per stage in acceleration/deceleration	-	-	NO	NO	NO	NO	YES
6~9h	Pulse rates in acceleration/deceleration1~4	-	-	NO	NO	NO	NO	YES
Ah	Pre-pulse-generation excitation period	-	-	NO	NO	NO	NO	YES
Bh	Post-pulse-generation excitation period	-	-	NO	NO	NO	NO	YES
Ch	DC motor setting 1	YES	YES	-	-	-	-	-
	DC motor setting 2	YES	YES	-	-	-	-	-
Dh	Voltage amplification setting 1, Gain	YES	YES	YES	YES	YES	YES	YES
	Voltage amplification setting 2, Gain	YES	YES	YES	YES	YES	YES	YES
Eh	Read of pulses position	NO	NO	NO	NO	NO	NO	○

9.3.3 CHANNELS 5 AND 7

b15~b14 = 10		DC Motor		Stepping Motor Control				
Registers b13, b12, b11, b10	Bit Name	Drive	Operation OFF	Pre- Excitation	Pulses in Progress	Post- Excitation	Hold	Operation OFF
0h	Direction	-	-	NO	NO	NO	NO	YES
	Driving mode	NO	YES	NO	NO	NO	NO	YES
	Acceleration/deceleration control	-	-	NO	NO	NO	NO	YES
	Initial position set by excitation	-	-	NO	NO	NO	NO	YES
1h	Number of pulses 1	-	-	NO	NO	NO	NO	YES
2h	Number of pulses 2	-	-	NO	NO	NO	NO	YES
3h	Pulse rate 0	-	-	NO	NO	NO	NO	YES
4h	Pulse-rate range	-	-	NO	NO	NO	NO	YES
5h	Number of pulses per stage in acceleration/deceleration	-	-	NO	NO	NO	NO	YES
6~9h	Pulse rates in acceleration/deceleration1~4	-	-	NO	NO	NO	NO	YES
Ah	Pre-pulse-generation excitation period	-	-	NO	NO	NO	NO	YES
Bh	Post-pulse-generation excitation period	-	-	NO	NO	NO	NO	YES
Ch	Direction 1	YES	YES	-	-	-	-	-
	Stop mode 1	-	YES	-	-	-	-	YES
	PWM drive 1	YES	YES	-	-	-	-	YES
	Carrier frequency 1	YES	YES	NO	NO	NO	NO	YES
	Direction 2	YES	YES	-	-	-	-	-
	Stop mode 2	-	YES	-	-	-	-	-
	PWM drive 2	YES	YES	-	-	-	-	-
Carrier frequency 2	YES	YES	-	-	-	-	-	
Dh	Duty cycle	YES	YES	YES	YES	YES	YES	YES
Eh	Duty cycle 2	YES	YES	-	-	-	-	-

9.3.4 COMMON ITEMS, CHANNEL 5, 6 AND 7

b15~b14 = 11		DC Motor		Stepping Motor Control				
Registers b13, b12, b11, b10	Bit Name	Drive	Operation OFF	Pre- Excitation	Pulses in Progress	Post- Excitation	Hold	Operation OFF
1h	EXT output	YES	YES	YES	YES	YES	YES	YES
2h	PI output	YES	YES	YES	YES	YES	YES	YES
3h	PS control	YES	YES	YES	YES	YES	YES	YES
4h	Setting prohibited	NO	NO	NO	NO	NO	NO	NO
5h	IN input pin control	NO	YES	NO	NO	NO	NO	YES
	Edge selection	NO	YES	NO	NO	NO	NO	YES
	Channel 5 input pin control	NO	YES	NO	NO	NO	NO	YES
	Channel 6 input pin control	NO	YES	NO	NO	NO	NO	YES
6h	Channel 5 direction	YES	YES	-	-	-	-	-
	Channel 5 stop mode	-	YES	-	-	-	-	-
	Channel 5 constant current value setting	YES	YES	-	-	-	-	-
7h	Channel 6 direction	YES	YES	-	-	-	-	-
	Channel 6 stop mode	-	YES	-	-	-	-	-
	Channel 6 constant current value setting	YES	YES	-	-	-	-	-
	Channel 6 weak excitation ON	YES	YES	-	-	-	-	-
	Channel 6 weak excitation current value	YES	YES	-	-	-	-	-
8h	Software reset	YES	YES	YES	YES	YES	YES	YES
	Decelerate-to-a-stop	-	X	YES	YES	-	YES	X
9h	Exclusive control	NO	YES	NO	NO	NO	NO	YES
Ah	Read of status	YES	YES	YES	YES	YES	YES	YES
Bh	Setting output of status flag for channel 1 and 2	-	-	NO	NO	NO	NO	YES
Ch	Setting output of status flag for channel 3 and 4	-	-	NO	NO	NO	NO	YES
Dh	Setting output of status flag for channel 5 and 7	-	-	NO	NO	NO	NO	YES
Eh	Read of pulses position	-	-	NO	NO	NO	NO	YES
Fh	Hold	-	NO	YES	YES	YES	YES	NO
	Operation-enabling control	YES	YES	YES	YES	YES	YES	YES

Notes:

1. Yes: Setting Possible
2. -: Setting possible but operation not affected
3. No: Setting prohibited

Pre-excitation	Excitation applied before pulse generation when the enable operation bit is 1
Pulses in progress	Sequence of pulse transitions while the operation enable bit is 1
Post excitation	Excitation applied after pulse generation when the operation enable bit is 1
Hold	Periods when the hold bit is ON, regardless of whether the state was held during acceleration, deceleration, or deceleration to a stop.
Operation OFF	Enable operation bit is 0
Drive	DC-motor driving

10. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Ratings	Unit
Power supply voltage	VCC	4.5	V
Power supply of motor block	VM*(*=12, 34, 5, 6)	5.5	V
DC output current	Iod	±600	mA/ch
Instantaneous output current	Iop	±800	mA/ch
PI-driver output current	Iopi	35	mA/ch
Power dissipation	Pd	1250	mW
Heat gradient rate	Kθ	-10	mW/°C
Maximum junction temperature	Tj	150	°C
Input pin voltage	VIn	-0.5 ~ VCC+0.5	V
Operating temperature	Topr	-40 ~ +85	°C
Storage temperature	Tstg	-40 ~ +150	°C

11. RECOMMENDED OPERATING CONDITIONS

(Ta=25°C)

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	+2.7 ~ +3.6	V
Supply voltage	VM	+2.7 ~ +5.5	V
Control input voltage	VIN	0 ~ VCC	V
H Bridge output current	Iout	-400 ~ +400	mA

12. ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, Ta=25°C, VM=5.0V, VCC=3.3V)

Parameter	Symbol	Conditions	Rated Value			Unit	Remark
			Min.	Typ.	Max.		
Power Supply Current							
While STAND BY consuming current(VCC)	ICC0	RESET=L CLK=stop	-	0	5	μA	In the reset state
While STAND BY consuming current(VCC)	ICCS	RESET=H CLK=IN	-	0	5	μA	In stand-by mode
While STAND BY consuming current 1 (VM)	IM01	RESET=L CLK=stop	-	0	5	μA	Sum for all VM pins
While STAND BY consuming current 2 (VM)	IM02	VCC=OV RESET=L	-	0	5	μA	Sum for all VM pins
Usual consuming current when driver operate (VCC)	ICC1	VCC=3.3V VM=5V All ch Driver operate: ON No Load	-	0.5	2	mA	Sum for all VM pins
Usual consuming current when driver operate (VM)	IM1	VCC=3.3V VM=5V All ch Driver operate: ON No Load	-	6	10	mA	Sum for all VM pins
Input Pins							
Hi level input current	IIH	VIN=VCC=3.3V	-1	0	1	μA	SCLK and SDAT, IN3, IN4, IN5, and IN6
Low level input current	IIL	-	-1	0	1	μA	
Hi level input current	IIH	VIN=VCC=3.3V	17	30	45	μA	RESET,CS
Low level input current	IIL	-	-1	0	-	μA	
Input pull down resistance	RIND	-	50	100	200	KΩ	
Input Pins							
Hi level input voltage	VIH	VCC=2.7~3.6V	0.7× VCC	-	VCC	V	
Low level input voltage	VIL	VCC=2.7~3.6V	0	-	0.3× VCC	V	
Hysteresis voltage	VHYS	VCC=2.7~3.6V	0.2	-	1.2	V	Note 2
OSCIN Pin							
Hi level input current	IIH	VIN=VCC=3.3V	17	30	45	μA	
Low level input current	IIL	-	-1	0	1	μA	
Hi level input voltage	VIH	VCC=2.7~3.6V	0.7× VCC	-	VCC	V	
Low level input voltage	VIL	VCC=2.7~3.6V	0	-	0.3× VCC	V	
OSC CLK operating frequency	OSCIN		1	5	6.2	MHz	
UVLO							
Low voltage detection voltage (VCC)	UVLO	VM=5V	1.0	1.8	2.4	V	Note 3
BTL Amps (1~4ch)							
ON Resistance 1	RON 1	At VM=5V, Io=100mA	-	2.0	2.2	Ω	Note 4
ON Resistance 2	RON 2	At VM=3V, Io=100mA	-	2.5	2.7	Ω	Note 4
Voltage accuracy between differential output pins	Vout	When setting of Vout is 2.0V	-7.0		+7.0	%	
Turn on time	Ton	Io=100mA Figure.1, Refer to switching characteristic wave shape.	-	7.0	14.0	μs	
Turn off time	Toff		-	5.5	9.5	μs	
Output rise time	Tr		-	1.3	2.0	μs	
Output fall time	Tf		-	1.1	1.5	μs	

Parameter	Symbol	Conditions	Rated Value			Unit	Remark
			Min.	Typ.	Max.		
Constant Current Driver (5, 6ch)							
ON Resistance 1	RON 1	At VM=5V, RNF=0V, Io=100mA	-	2.0	2.2	Ω	Note 4 Note 5
ON Resistance 2	RON 2	At VM=5V, RNF=0.2V, Io=100mA	-	2.03	2.25	Ω	
ON Resistance 3	RON 3	At VM=5V, RNF=0.3V, Io=100mA	-	2.05	2.28	Ω	
ON Resistance 4	RON 4	At VM=3V, RNF=0V, Io=100mA	-	2.5	2.7	Ω	
Turn on time	Ton	Io=100mA DAC=200mV RNF=2Ω, RM=5Ω; Figure.1, Refer to switching characteristic wave shape.	-	5.0	10.0	μs	
Turn off time	Tof		-	0.05	2.0	μs	
Output rise time	Tr		-	4	8	μs	
Output fall time	Tff		-	0.05	1	μs	
Constant-current accuracy (200mA)	Iout	RNF=1Ω, RM=5Ω, DAC: 200mV	186	200	214	mA	
RNF voltage	VRNF	DAC:200mV, RNF=1Ω	0.186	0.200	0.214	V	
Full-Swing Driver (5ch)							
ON Resistance 1	RON 1	At VM=5V, Io=100mA	-	2.0	2.2	Ω	Note 4
ON Resistance 2	RON 2	At VM=3V, Io=100mA	-	2.5	2.7	Ω	
Turn on time	Ton	Io=100mA Figure.1, Refer to switching characteristic wave shape.	-	0.5	2.0	μs	
Turn off time	Toff		-	0.1	0.5	μs	
Output rise time	Tr		0.1	0.3	1.0	μs	
Output fall time	Tf		-	0.05	0.2	μs	
PI-Driver							
On voltage	VPION	Io=20mA	-	0.2	0.3	V	Note 6
Leak current at the time of OFF	Ioffpi	VCC ≥ PIOUT	-2.0	0	2.0	μA	
Turn on time	Tonpi	RL=150Ω (Between VCC and outputs); Figure.2, Refer to Response Characteristic	-	0.1	1	μs	
Turn off time	Toffpi		-	0.1	1	μs	
MOB EXT							
High-output voltage	Vhout	When Iout=-1mA	VCC-0.3		-	V	
Low-output voltage	Vlout	When Iout=1mA	-		0.3	V	
TSD							
Thermal shut down temperature	TTSD	Chip temperature in case H bridge output turns OFF	130	150	170	°C	Note 7
Thermal return on temperature	TTSDL	Chip temperature in case H bridge output return ON	100	120	140	°C	
Serial Control Terminal							
SCL frequency	fsclk		-	4	6.2	MHz	Example of user set condition Note 8
CS setup time	Tsets		200	-	-	ns	
CS hold time	Tholds		100	-	-	ns	
CS negate time	Tnegs	When OSCIN is at 5MHz	400	-	-	ns	
SDA setup time	Tsetd		60	-	-	ns	
SDA hold time	Thold		20	-	-	ns	
SCLK setup time	Tsetc		30	-	-	ns	
SCLK hold time	Tholdc		30	-	-	ns	
RESET							
Reset time 1	Rset 1		1	-	-	μs	
Reset time 2	Rset 2		1	-	-	μs	

Notes

- Sequence of operations for supplying power
The separate VCC-and VM-type power supplies of this IC can be turned on and off independently. The order in which the various power supply voltages are applied will not cause leakages of power between VCC and VM supply systems, erroneous operation of outputs, and breakdown of the IC. However, ensure that the control input pins are either grounded or open-circuit (disconnected) while power is being supplied. Supply the same voltage as VM34, VM5 and VM6 by the exclusive control use.
- CS, RESET, SDA, SCL pins.(with Hysteresis)
- For VCC falling from higher to lower level, this defines the VCC voltage at which driver outputs are turned off.
- a) On-resistance is the sum of the on-resistances of the upper and lower transistors.
b) On-resistance varies with the VM voltage.
- On-resistance of the driver increases with the voltage on the RNF pin.
- Voltages on the PI outputs follow VCC ≥ PIOUT. When VCC is at the "off" level, power cannot be supplied to PIOUT.
- Operation of the thermal shutdown circuit has been tested at room temperature. However, the values for operating temperature are calculated on the basis of theory. Pre-shipping tests are not conducted.
- SCLK Frequency ≤ OSCIN Frequency

12.1 SWITCHING CHARACTERISTICS WAVEFORMS

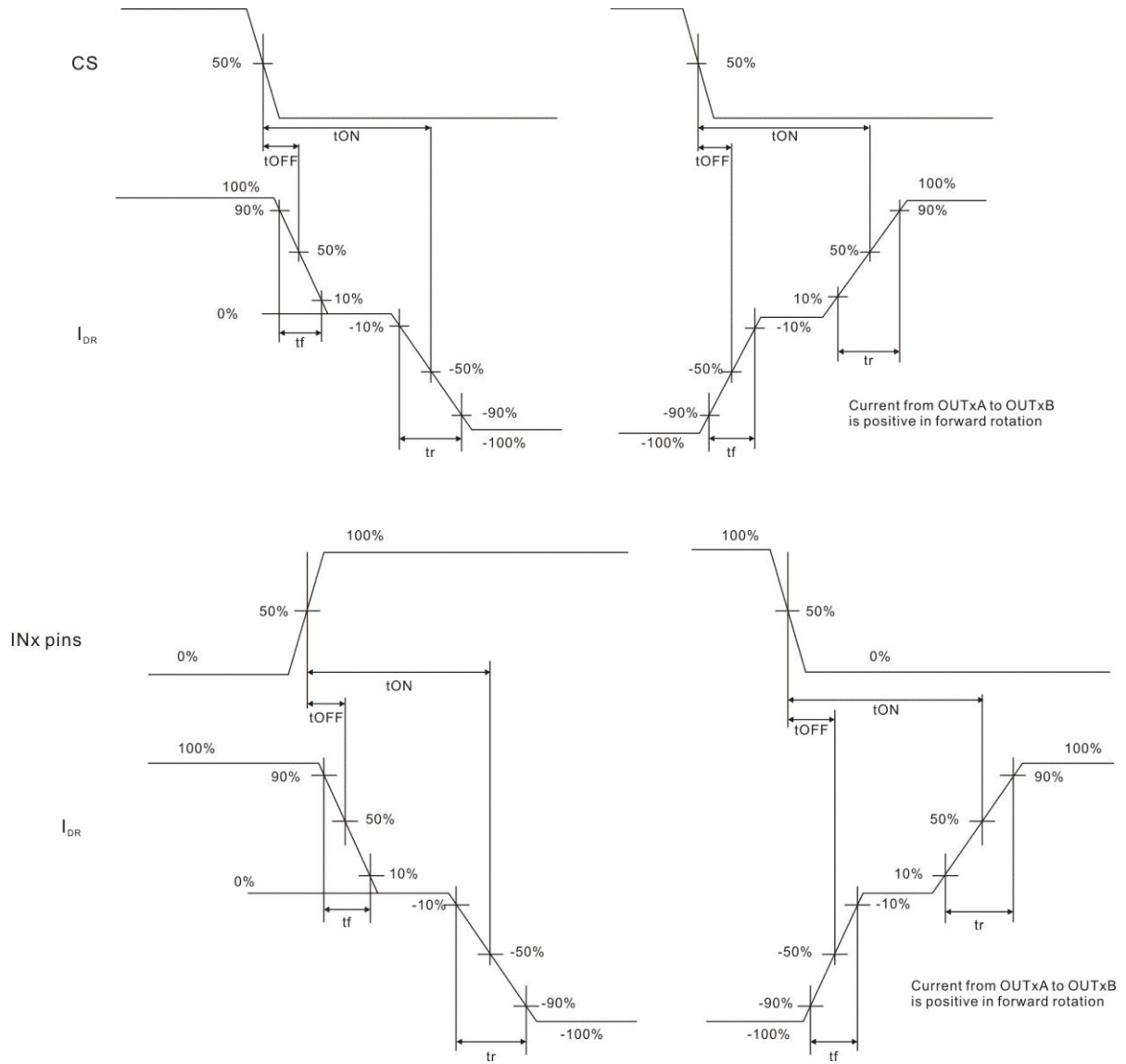


Figure 1. Waveforms of Switching Characteristics

12.2 PI RESPONSE CHARACTERISTIC

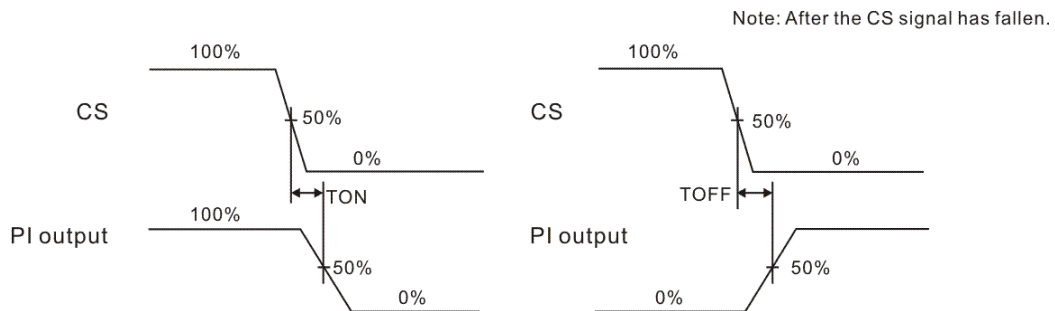
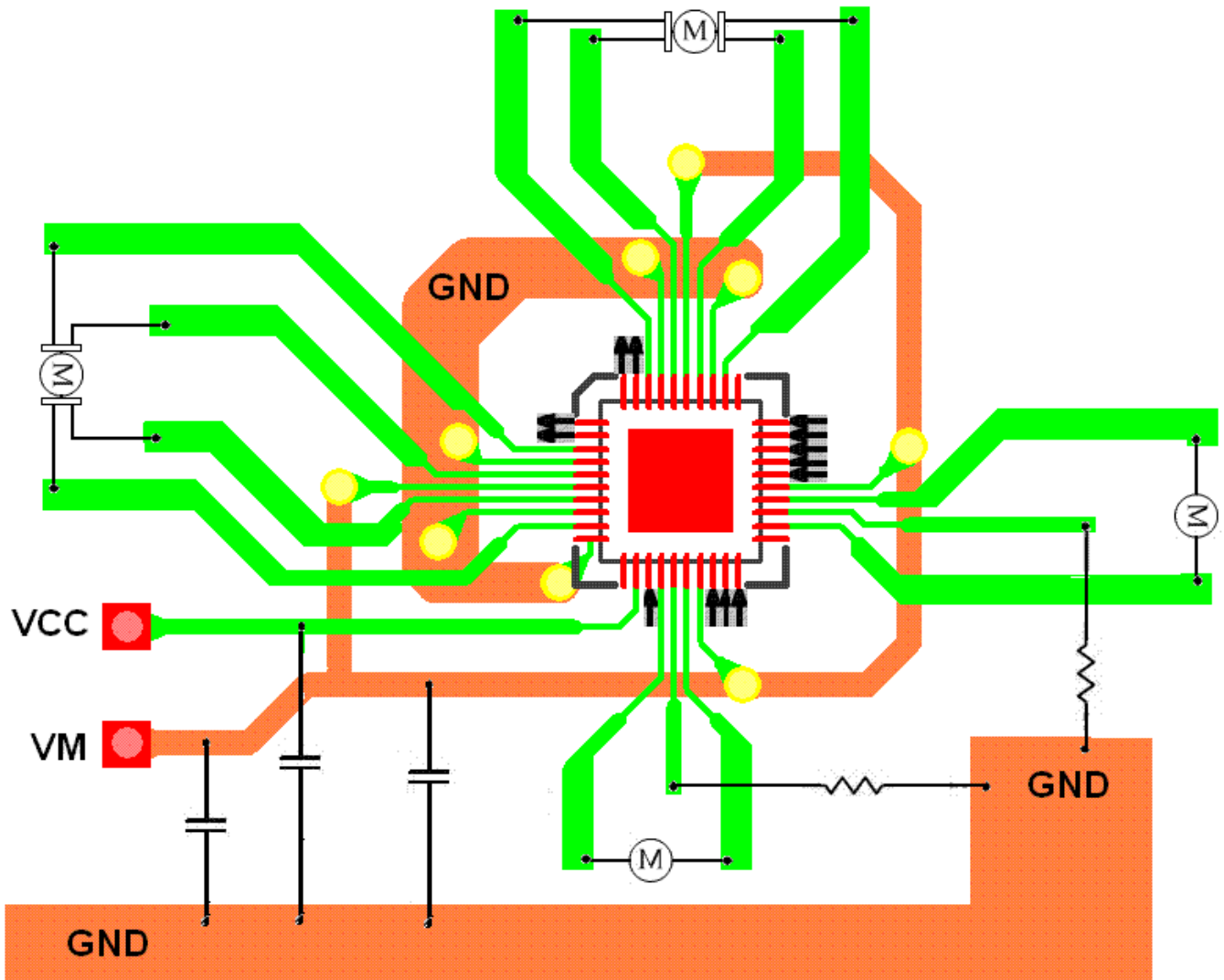
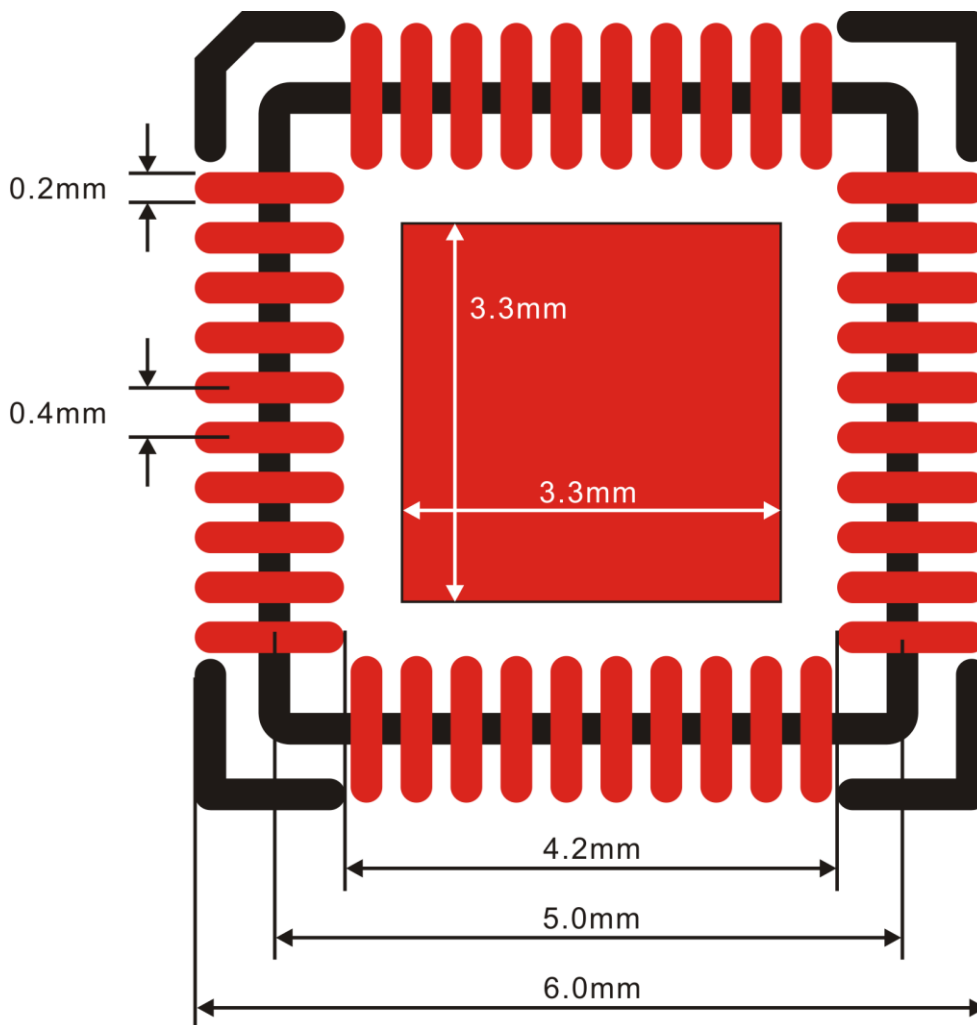


Figure 2. PI Response Characteristics

13. LAYOUT GUIDE

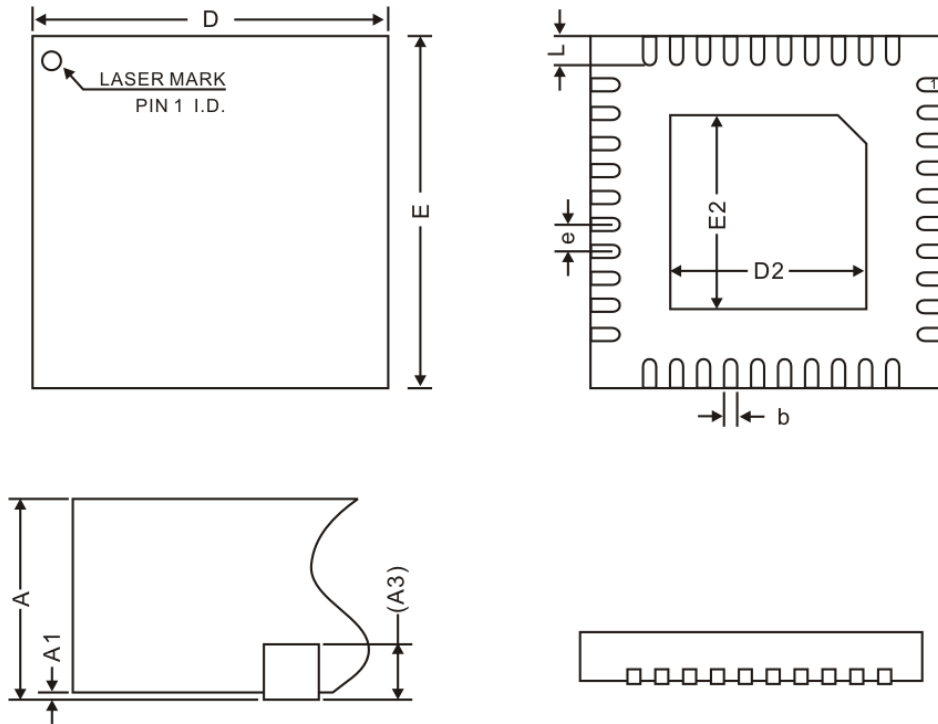


14. SOLDERING FOOTPRINT



15. PACKAGE INFORMATION

40 PINS, QFN (BODY SIZE: 5 X 5MM, LEAD PITCH: 0.4MM)



Symbol	Dimensions		
	Min.	Nom.	Max.
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.203 REF.		
b	0.15	0.20	0.25
D	5.00 BSC.		
E	5.00 BSC.		
D2	3.25	3.40	3.50
E2	3.25	3.40	3.50
e	0.40 BSC		
L	0.35	0.40	0.45

Notes:

1. All dimensions refer to JEDEC Standard MO-220 WHHE-1
2. All dimensions are in millimeter.

IMPORTANT NOTICE

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