3. PPMC-104BFP's Control Commands

The PPMC-104BFP operates according to the command codes and data provided by the host processor. These commands are roughly divided into the following four types.

(1) Initialization command

This command sets up the motor type, excitation method, and acceleration/deceleration control data. This command must be issued first after the system is turned on or reset. This command is also necessary after a software reset.

(2) Operation commands

These commands operate the stepper motor. There are nine operation commands including two different types of stop commands. Some commands require only the command code to operate the motor, and other commands require several bytes of parameter data.

(3) Internal register read commands

After an operation command is complete, these commands read the cause of termination, the output signal sent to the motor, and the status of the limit switch input, as well as the number of remaining steps.

(4) Auxiliary commands

These are the Switching Parameter Setting command, the Phase Excitation Output OFF (software reset) command, and the Auxiliary Control Output ON/OFF command.

3. PPMC-104BFP's Control Commands

3-1. Host Interface Registers

The PPMC-104BFP has the following four types of registers for input and output of command codes and data. Table 3-1 shows the access conditions for these registers.

Table 3-1 Host interface registers

Register	$\overline{CS}$	A_0	$\overline{RD}$	$\overline{WR}$	Read cycle/Write cycle
Disable	H	x	x	x	Disable
Data register	L	L	L	H	Read
Status register	L	H	L	H	Read
Data register	L	L	H	L	Write
Command register	L	H	H	L	Write

3-1-1. Status Register

The status register is a read-only register that indicates the internal conditions of the PPMC-104BFP, and can be read at any time. The bit structure of this register is shown in Diagram 3-1.

<Status Register>

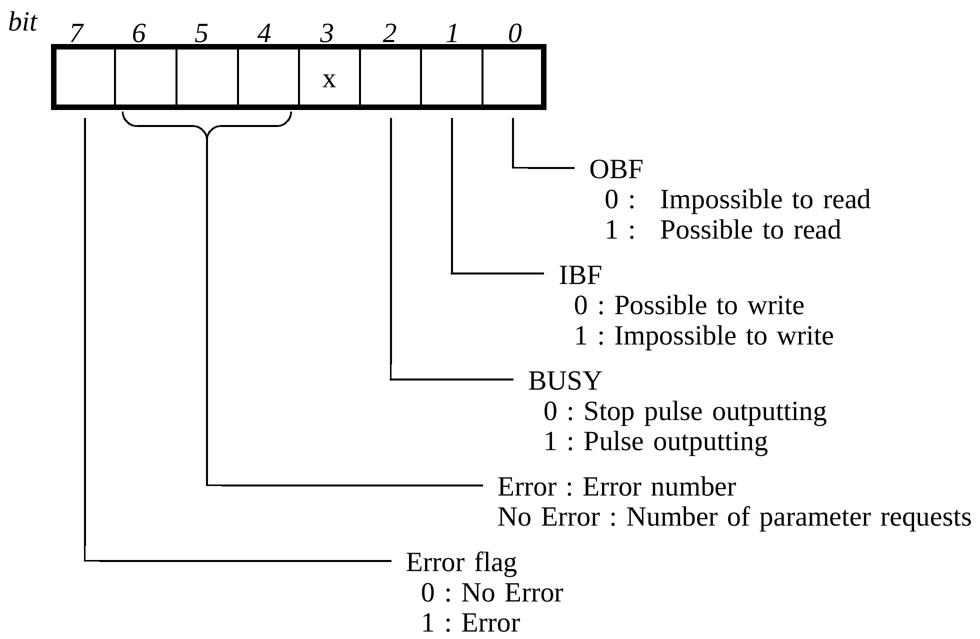


Diagram 3-1 Bit structure of status register

(1) OBF (Output Buffer Full Flag)

This bit checks whether or not data are ready to be read from the PPMC-104BFP.
When the OBF is "0," it indicates that there are no data in the buffer. Make sure that the OBF is "1" before reading data. When the OBF is "0," the data are invalid.

(2) IBF (Input Buffer Full Flag)

This bit checks whether or not a command code or data can be written into the PPMC-104BFP.
When this bit is "1," it indicates that there are data in the buffer and new data cannot be written. Make certain that the IBF bit is "0" when writing a command code or data. Entry of data when the IBF bit shows "1" deletes previously written data.

(3) BUSY (Motor Busy)

This flag reads "1" to indicate that the PPMC-104BFP is in the middle of pulse output (the motor is in operation). The only commands that can be accepted during this time are the Immediate Stop, Decelerating Stop, and the Auxiliary Control Output ON/OFF commands. Other command codes and data are not accepted. When writing other command codes, it is generally recommended to check this BUSY bit along with the IBF.

(4) Command status (bit7 - bit4)

These bits indicate a communication condition between the PPMC-104BFP and the host. Bit7 = 1 indicates that there is an error in the command code given by the host. In this case, the error number is outputted to bit6 - bit4. The meanings of the error numbers are explained in Table 3-2.
Bit7 = 0 indicates that a normal command code and parameters were given. In this case, bit6 - bit4 show the number of parameter bytes remaining to be transmitted.

Table 3-2. Error in the command code

Code	Contents of errors
0	Undefined command code was received
1	Command code that cannot be processed was received during BUSY
2	Initialization has not been executed
3	There are too many parameters (data not preceded by a command code were received)
4	The number of acceleration/deceleration steps is greater than 11,220.
5	Rate data are abnormal (RH>RL) or the number of acceleration/deceleration pulses is less than 4
6	Data were received while BUSY
7	Decelerating Stop command was received during deceleration

3-1-2. Data Register (when reading)

This register is for reading data that can be read by the Status Read command. Make certain to check the OBF bit of the status register while reading data. The details of this register will be explained in Section 3-4 [Register Read Command].

3-1-3. Command Register (when writing)

This is the register in which codes of various commands, such as Initialization command, Operation commands, Status Read commands, and Auxiliary commands, are written. Command codes can be written when the IBF bit of the status register is "0."

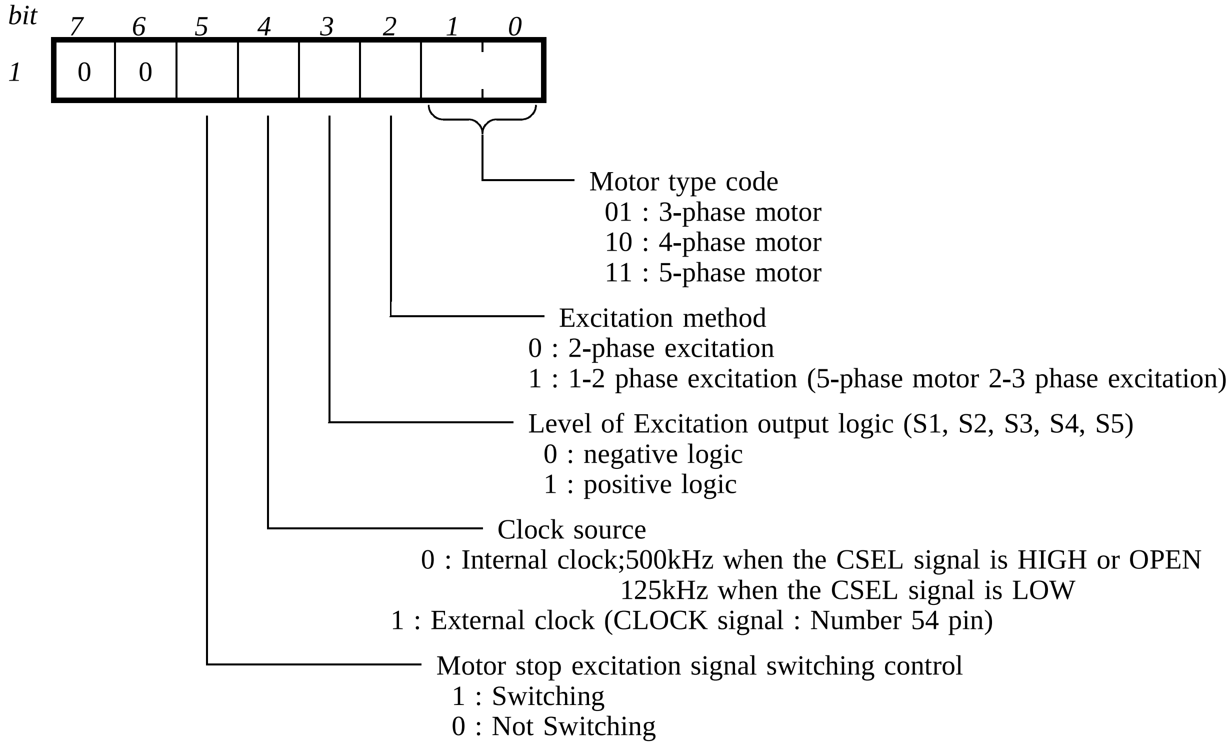
3-1-4. Data Register (when writing)

This is the register in which necessary data for each command (pulse rate, the number of operation pulses, etc.) are written after each command code is written. Data can be written when the IBF bit of the statusregister is set to "0." The order of writing will be explained in the section on each command. When data are written, the PPMC-104BFP will internally process the necessary steps to initiate the operation specified by the command.

3-2. Initialization Command

After the system is turned on, the host processor needs to first issue the initialization command to the PPMC-104BFP to set up the motor type, excitation method, and acceleration/deceleration control data. This command is also necessary after a software reset.

<Initialization command code>



<Initialization data>

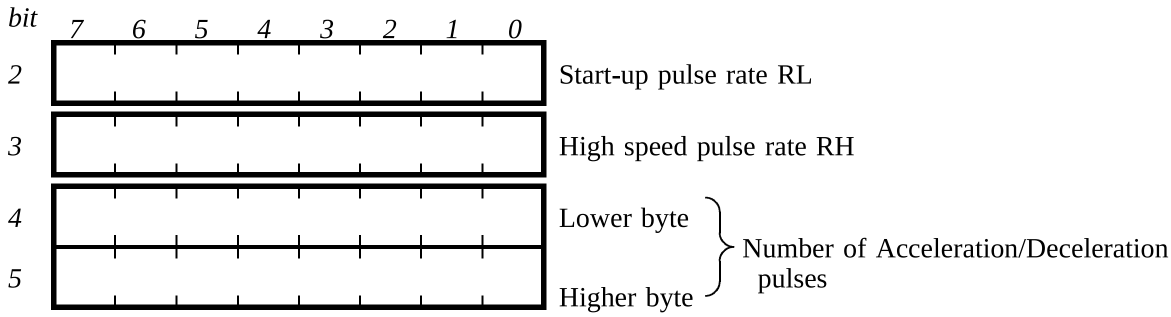


Diagram 3-2

After the system is turned on or reset, or after a software reset, the initialization command code and initialization data will be written in the order described in Diagram 3-2. A flowchart of this process is shown in
Diagram 3-3.

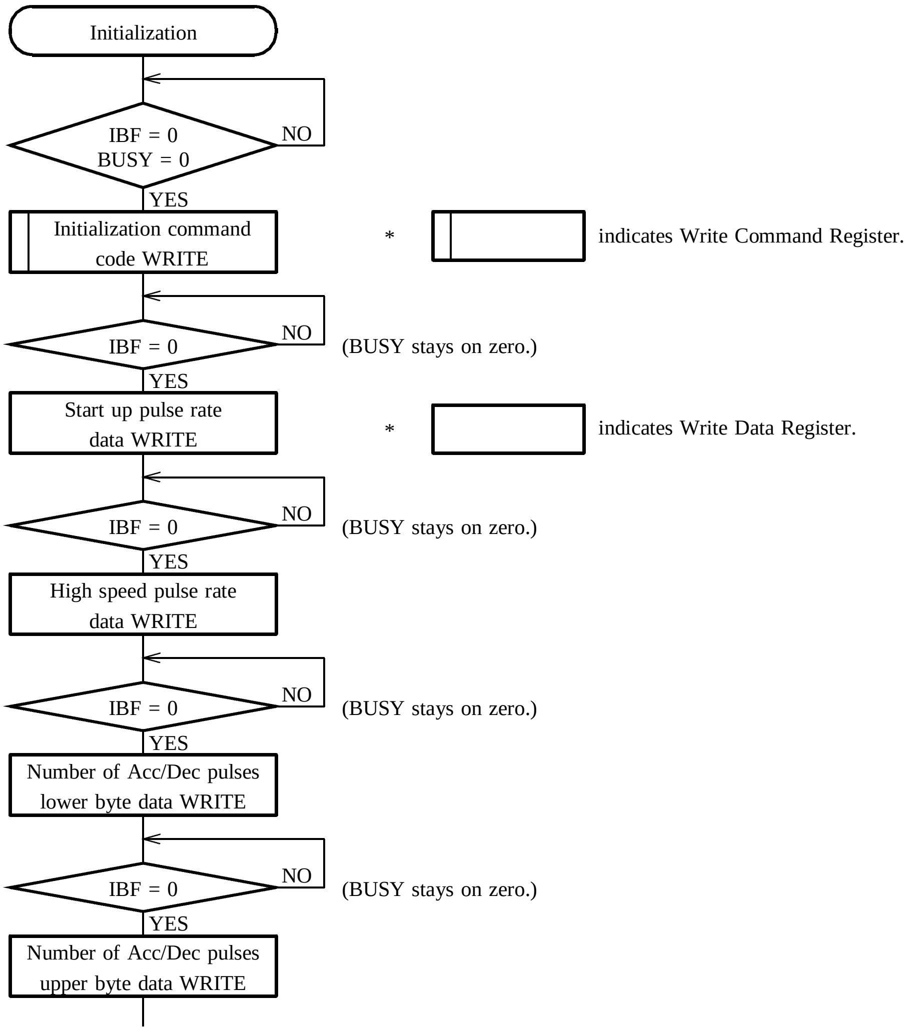
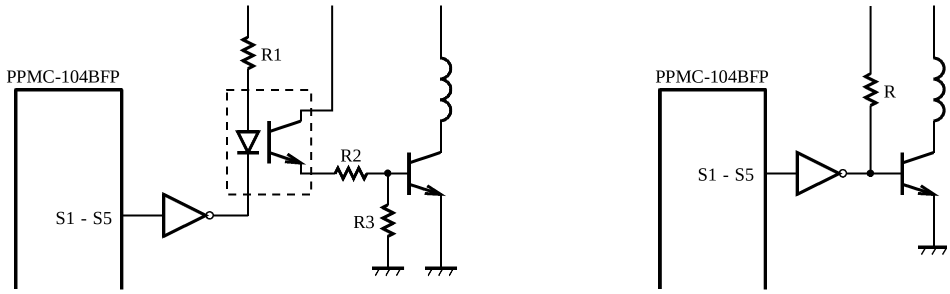


Diagram 3-3 Initialization flowchart

3-2-1. Initialization Command

The motor type code and excitation method should be chosen according to the motor and excitation method to be used. The excitation output logical level should be set according to the drive output circuit. Positive logic should be selected for the circuit that sends current to the motor coil when the PPMC-104BFP's output is at level "1," and negative logic should be selected for the circuit that sends current to the motor coil when the PPMC output is at level "0." Examples of these circuits are shown in Diagram 3-4.



positive logical output　　　　negative logical output

Diagram 3-4. Example circuits of drive output

(1) The base clock for the operation speed is specified using a clock source bit.
The PPMC-104BFP operates based on a clock internally created when the internal clock is specified, and based on clock input into the 54th pin when an external clock is specified. Either 500kHz (1/32of the system clock) or 125kHz (1/128 of the system clock) can be selected for the internal clock. High speed operation is possible up to 27kppS in phase excitation mode, and up to 40kppS possible in POUT mode. If an attempt is made to operate the motor at higher speeds, operation will reach its limit where no commands from the host CPU can be accepted during pulse output.
The external clock is used when the speed that the internal clock can control is too slow or too fast. When a frequency of the system clock is 16MHz, an external clock can be inputted up to 1MHz (the limitations described in Section 2-6 apply).

(2) Because the current does not change, the pulse motor receives a large amount current when it is stopped. This current is only used to hold the motor and most of it is unnecessary. If the heat generated is not well dissipated into the surroundings, the motor itself can heat up and may malfunction. To avoid this condition, the PPMC-104BFP executes switching of the motor's excitation outputs to reduce the excitation current while the motor is stopped. Execution of this switching function can be specified by bit 5. The switching frequency and the duty ratio can be set freely using the appropriate command (See Section 3-5 for details on the Switching Parameter Setting command). The default when a command is not given is shown in Diagram 3-5.

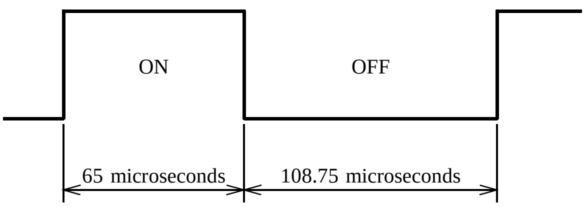


Diagram 3-5. Switching duty (16MHz default)

(3) Once the motor type code, excitation method, and excitation pulse output logical level data are set up,these three sets of data cannot be changed until the Excitation OFF command is received. This is because the excitation output logic gets corrupted if the data are changed during operation. For this reason, even if different data are entered, they will be ignored. However, specification of the clock, phase excitation switching mode, and initiation data can be changed freely, allowing more flexible speed control. The time necessary for initialization varies depending upon the data, and 460 milllseconds is maximum. Therefore, switching is not executed between reset and completion of the first initialization command.

3-2-2. Initialization Data

The 4-bytes of parameter data, following the initialization command code, determine the conditions of the acceleration/deceleration operation of the motor. The data consist of three parameters that contain the start-up pulse rate, the high speed pulse rate, and the number of acceleration/deceleration pulses (See Section 1-3-1 and 1-3-2). The start-up pulse rate and high speed pulse rate are 1 byte values. The corresponding pulse output frequency is obtained by the following equations.

When VSEL is at "H" or OPEN,

$$SH = \frac{10^6}{(RH + 1) \times Tclock} \quad (PPS) \qquad \text{(Equation 3-1)}$$

$$SL = \frac{10^6}{(RL + 1) \times Tclock} \quad (PPS) \qquad \text{(Equation 3-2)}$$

When VSEL is at "L"

$$SH = \frac{10^6}{(RH + 1) \times Tclock + 7.5} \quad (PPS) \qquad \text{(Equation 3-3)}$$

$$SL = \frac{10^6}{(RL + 1) \times Tclock + 7.5} \quad (PPS) \qquad \text{(Equation 3-4)}$$

SH, SL: Speeds for High Speed operation and for Start-up
RH, RL: Pulse rates for High Speed operation and for Start-up
Tclock : Base clock cycle (microseconds)

However, when the Tclock is greater than 9 microseconds, the value "7.5" in Equations 3-3 and 3-4 becomes "0". Therefore, even when the VSEL signal shows "L," these equations become identical to Equations 3-1 and 3-2. When the Tclock is greater than 8 microseconds and less than 9 microseconds, the pulse rate varies between Equations 3-1 and 3-2, and Equations 3-3 and 3-4.

Bit 4 the initialization command code selects either the internal clock (2 microseconds) or the external clock connected to the CLOCK signal is selected as the system clock. The value of the pulse rate has the following limitations, and Error #5 will be returned if these conditions are not met.

$$255 \geqq RL \geqq RH > 0$$

The number of acceleration/deceleration pulses is a 2-byte value expressed by the number of steps during the acceleration between start-up and high speed operation. This value has the following limitations, and Errors #4 or #5 will be returned if these conditions are not met.

$255 \geqq RL \geqq RH > 0$

$11{,}220 \geqq PA \geqq 4$ PA: Number of acceleration/deceleration pulses

This value varies depending upon factors such as motor type, moment of inertia of the load etc., and ultimately should be determined by experiment. In general, when the moment of inertia of the load is large, acceleration/deceleration should be slow, and when the resonance point is in the middle of acceleration/deceleration (the motor torque can become 0 at the resonance point), it is necessary to set the number of acceleration/deceleration pulses low so that the resonance point can be passed quickly.
It may also be necessary to attach a damper to the mechanical system in order to reduce the negative impact of resonance.
In order to change the acceleration/deceleration data, simply change the initialization parameters to reexecute an initialization command. In order to change the excitation method to make adjustments (e.g. changing two-phase excitation to 2-3 excitation), reexecute an initialization after a software reset.

If a high speed pulse rate is set at a faster speed than the speed limit, the PPMC-104BFP stops accepting commands from the host processor. The speed limit is obtained by the following equation.

Speed Limit = Max speed (SysClk) / 16 (kppS)
SysClk : System Clock (MHz)
Max speed: 40kppS in POUT mode
27kppS in Excitation mode

3-3. Operation commands

bit	7	6	5	4	3	2	1	0
		1	x					

Operation command code (bits 2–0)
- 000 : Immediate Stop
- 001 : Decelerating Stop
- 010 : Single Step
- 011 : Acceleration/Deceleration Operation
- 100 : Constant Speed Operation
- 101 : Continuous Constant Speed Operation
- 110 : Continuous High Speed Operation
- 111 : Constant Speed Origin Search Operation

Direction of motor rotation (bit 3)
- 0 : CW direction
- 1 : CCW direction

Termination Interrupt control (bit 4)
- 0 : Outputting interrupt signals
- 1 : Not outputting interrupt signals

Expansion command (bit 7)
- 0 : Basic Operation command
- 1 : Expansion command

Expansion command code
- 000 : Excitation FF(Init command resetting)
- 001 : AUX* ON
- 010 : AUX* OFF
- 011 : POUT mode Acceleration/Deceleration Operation
- 110 : POUT mode Continuous High Speed and Acceleration Operation

Diagram 3-6 Bit structure of operation command code

3-3-1. Immediate Stop

This command immediately stops the excitation output to stop rotation of the motor in either acceleration /deceleration operation or constant operation. During high speed operation, because the phaseexcitation output is stopped even when the motor is in operation, the inertia of the motor and the load cause advancement, resulting in a stepout and incorrect data on position. In order to restart the motor, it is necessary to return the carrier to the origin first and redo the whole process from the beginning. During constant speed operation, because the motor itself immediately stops, the number of remaining pulses can be read by the Register Read command, making it possible to restart the motor from its stopped position. The Immediate Stop command is normally used for emergency stops. The Motor Rotation Direction bit and termination interrupt mask have no effect in this command, and should be set to "0".
This command does not contain data and consists of a command code only. This command has effect only during motor operation (Busy bit =1). If this command is received while the motor is stopped, Error #0 will be returned.

<Immediate Stop command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	0	1	0	0	0	0	0	0	Immediate Stop command

Diagram 3-7

Flowchart of immediate stop command is below on Diagram 3-8

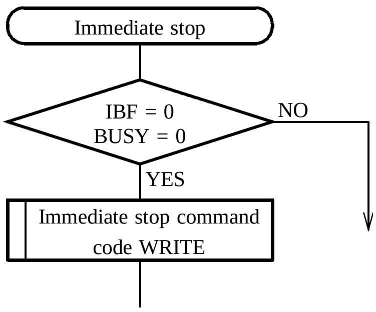


Diagram 3-8 Fowchart of Immediate Stop command

3-3-2. Decelerating Stop

If the Decelerating Stop command is given during acceleration/deceleration operation, the motor decelerates by the number of acceleration/deceleration pulses and comes to a stop. When the motor stops, the number of remaining pulses can be read by the Register Read command, making it possible for the motor to restart from that position.
The Motor Rotation Direction bit and Termination Interrupt Mask bit should all be set to "0". If a termination interrupt is specified by the original operation command, the termination interrupt is issued when the motor actually stops.
The Decelerating Stop command does not contain any data, and consists of a 1 byte command code only. As with the Immediate Stop command, Error #0 will be returned when this command is received while the motor is stopped. If this command is received during deceleration, Error #7 will be returned.

<Decelerating Stop command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	0	1	0	0	0	0	0	1	Decelerating Sstop command

Diagram 3-9

Flowchart of decelerating stop command is below on diagram 3-10

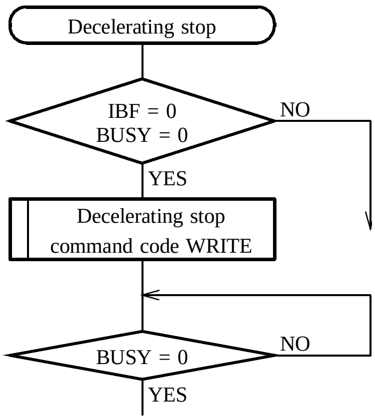


Diagram 3-10 Fowchart of Decelerating Stop command

3-3-3. Single Step

This is a command from the host processor that moves the motor by one step, and is used by the host itself to confirm the motor position. When this command is issued continuously, the time control and all other controls need to be processed by the host processor.
This command does not contain data, and operates with a command code only. Make certain that the motor is stopped (Busy bit =0) and check the IBF bit before issuing this command.
Approximately 112 microseconds are necessary to process this command.

<Single Step Operation Command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	0	1	x			0	1	0	Single Step Operation command

Bit 3: Direction of motor rotation
0 : CW direction
1 : CCW direction

Bit 4: Termination Interrupt control
0 : Outputting Interrupt signals
1 : Not outputting Interrupt signals

Diagram 3-11

Flowchart of Single step operation command is below on diagram 3-12

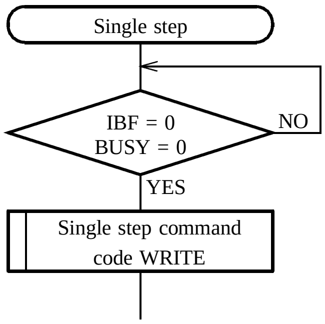


Diagram 3-12 Flowchart of Single Step Operation command

3-3-4. Acceleration/Deceleration Operation

This is a command that executes acceleration/deceleration operation according to data that is set up at initialization. Two modes of operation are possible: a mode in which a phase excitation is outputted, and a high speed mode in which only POUT is outputted. The mode is specified by bit 7 of the command code. The command has 3 bytes of data which determine the number of operation pulses, and the number of steps by which the motor moves. If a value smaller than twice the number of acceleration /deceleration pulses is specified in the data, the motor operates in triangular drive. If the Deceleration Limit signal for the same direction or the Decelerating Stop command is issued prior to initiation of deceleration at the specified number of pulses, the motor decelerates to stop regardless of the number of pulses remaining.
However, in POUT mode, the high-speed limit signals are not checked during acceleration. In this case, the cause of termination and the number of remaining pulses can be checked by the Register Read command. When the ALM* signal, Limit signal for the same direction, or Immediate Stop command is received,pulse output is terminated and the motor stops under any circumstances.
Normally, when the motor stops in this way, a stepout occurs due to the inertia of the motor load, and all data on position become meaningless.

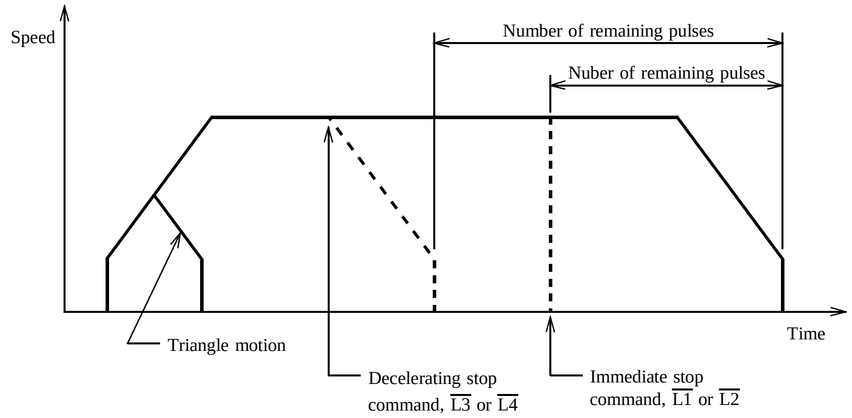


Diagram 3-13 Example of Acceleration/Deceleration operation

The number of operation pulses consists of 3 bytes, and is expressed by the value of "the number of steps the motor is required to move, minus 1." If FFFFFF (hexadecimal number) is entered, the motor moves 16,777,216 steps, and this is the maximum value the motor can move at one time.
In order to move the motor 1,000 steps, convert 1,000-1=999 into a hexadecimal number and enter 0003E7 (hexadecimal number). Data are written in order from the lower byte.

<Acceleration/Deceleration Operation command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1		1	x			0	1	1	Acceleration/Deceleration Operation command

Direction of motor rotation
0 : CW direction
1 : CCW direction

Termination interrupt control
0 : Outputting Interrupt signal
1 : Not outputting Interrupt signal

Operation mode
0 : Phase excitation mode (Phase excitation output)
1 : POUT mode (Only POUT)

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*		
2	1	1	1	0	0	1	1	1	E7 Lower byte	Number of operation pulses data
3	0	0	0	0	0	0	1	1	03 Middle byte	
4	0	0	0	0	0	0	0	0	00 Higher byte	

Diagram 3-14

Flowchart of Acceleration/Deceleration Operation command is below on diagram 3-15.

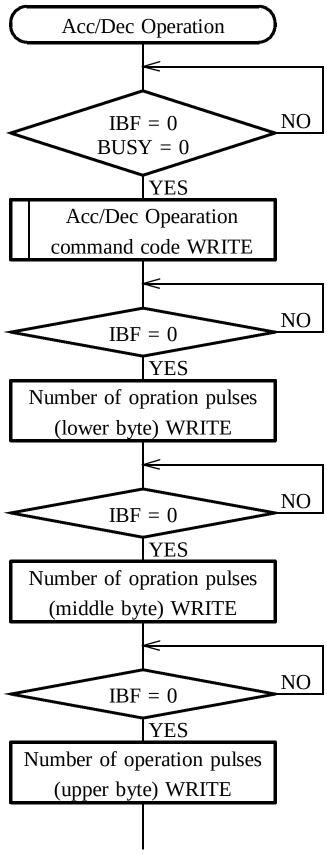


Diagram 3-15 Flowchart of Acceleration/Deceleration Operation

3-3-5. Constant Speed Operation

When constant speed pulse rate data and 3 byte data that indicates the number of operation pulses are provided following a command code, the motor moves for a specified distance at a constant speed. In this case, the speed is set by the pulse data, and the value must be within the motor's start-up frequency. When the ALM* signal, Limit signal for the same direction, or Immediate Stop command is issued, pulse output is terminated to stop the motor. The cause of the termination and the number of remaining pulses can be checked by the Register Read command.

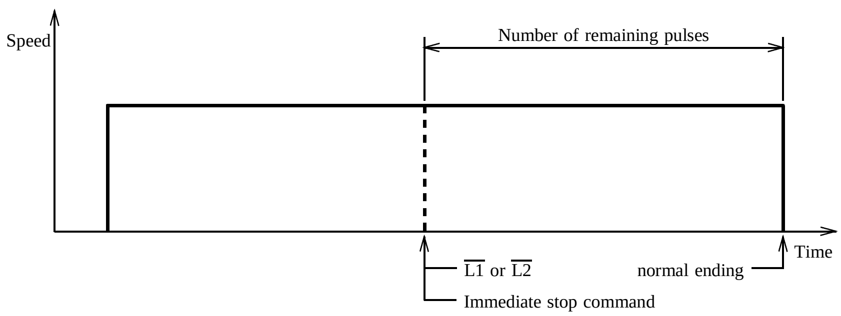


Diagram 3-16 Example of Constant Speed Operation

The constant speed pulse rate consists of 1 byte of data. The number of pulses consists of 3 bytes, and, as in the Acceleration/Deceleration Operation command, the "the number of steps the motor is required to move, minus 1" is written in order from the lower byte.

<Constant operation command>

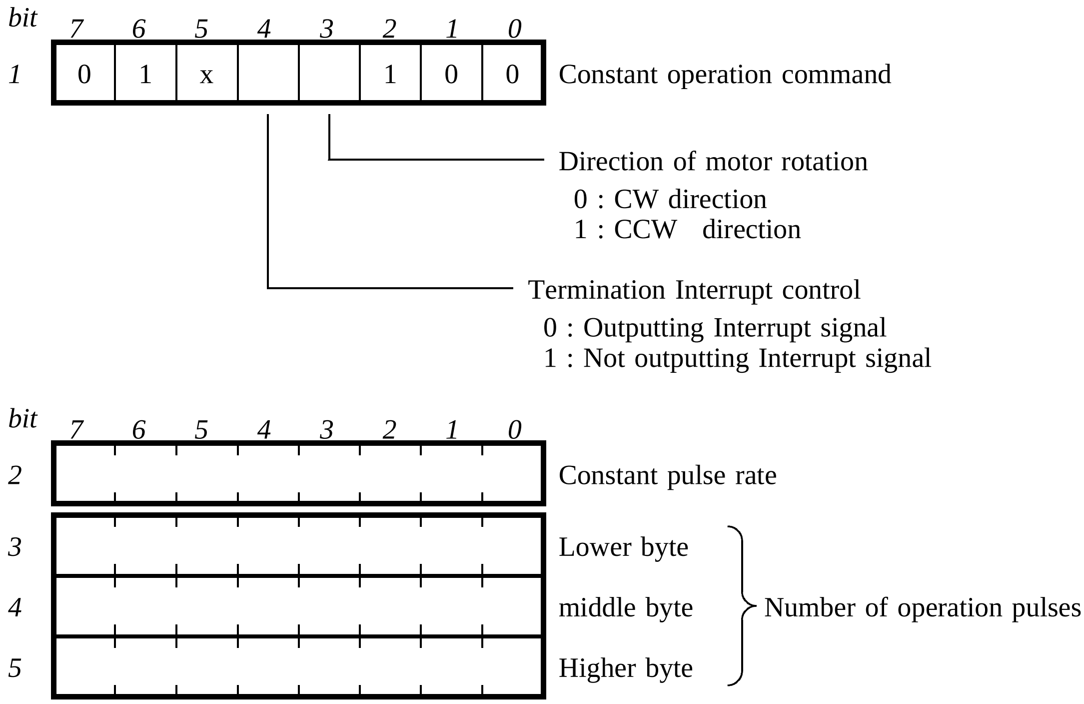


Diagram 3-17

Flowchart of Constant operation command is below on diagram 3-18

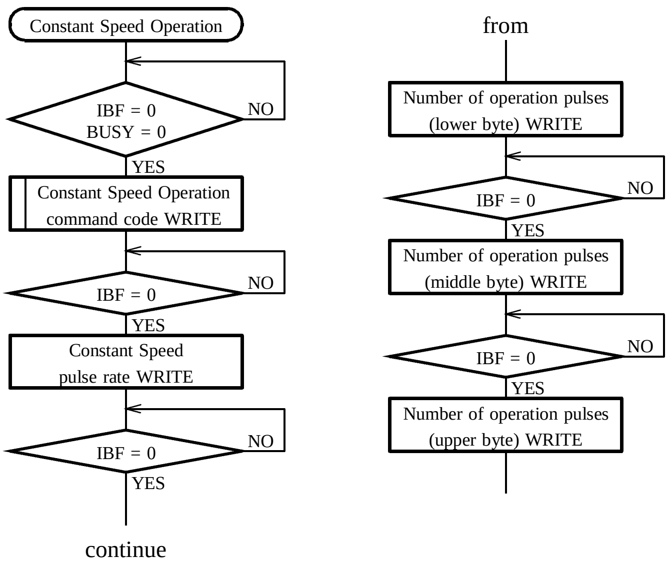


Diagram 3-18 Flowchart of Constant Operation

3-3-6. Continuous Constant Speed Operation

This command consists of a command code and 1 byte of constant speed pulse rate data, and operates the motor at a constant speed until a Limit signal is received. When an ALM* signal, Limit signal for the same direction, or Immediate Stop command is received, operation stops.

A Limit signal for the same direction means that an L1* signal is issued during clockwise operation, and an L2 signal is issued during counter-clockwise operation. L2* signals issued during clockwise operation will be ignored.

Diagram 3-19 Example of Continuous Constant Speed Operation

This command is normally used immediately after the power source is turned on, or when restarting the system after the motor has a stepout. Because the number of operation steps is set by FFFFFF (hexadecimal number), the position before operation can be determined by the number of pulses remaining.

<Continuous Constant Speed Operation command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	0	1	x			1	0	1	Continuous Constant Speed Operation command

Bit 3 — Direction of motor rotation
0 : CW direction
1 : CCW direction

Bit 4 — Termination Interrupt control
0 : Outputting Interrupt signal
1 : Not outputting Interrupt signal

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
2									Constant speed pulse rate

Diagram 3-20

Flowchart of Continuous constant speed operation command is below on diagram 3-21

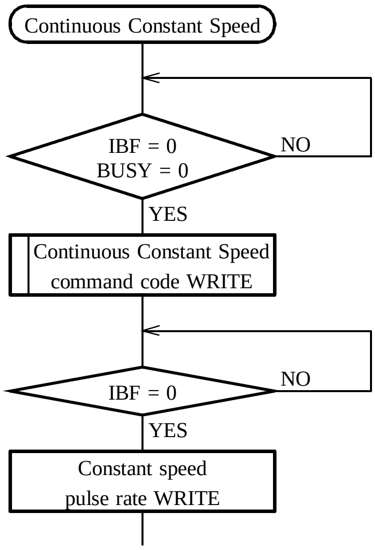


Diagram 3-21 Flowchart of Continuous Constant Speed Operation

3-3-7. Continuous High Speed Operation

This command accelerates the motor according to the acceleration/deceleration data at initialization and shifts into high speed operation. When the high speed operation limit is reached, this command decelerates to move the motor by the number of acceleration/deceleration pulses and then brings the motor to a stop. Once initiated, deceleration continues even when the Limit signal is OFF, requiring only that a limit switch be placed at the start of deceleration. Although operation stops when the ALM* signal, Limit signal for the same direction, or Immediate Stop command is given, operation might go beyond the stop point because of inertia. The High Speed Limit signal is accepted even during acceleration, causing a decelerating stop.

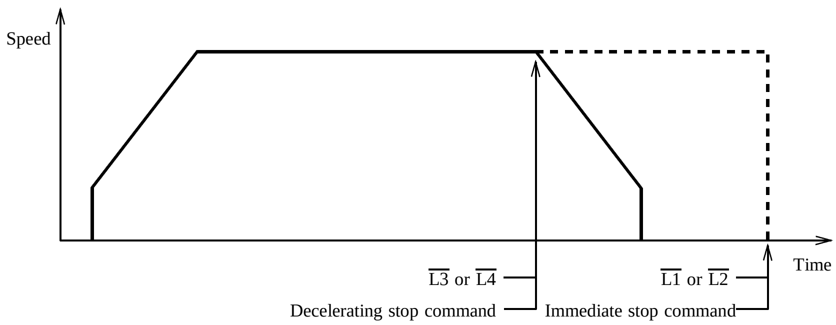


Diagram 3-22 Example of Continuous High Speed Operation

As with the Continuous Constant Speed Operation command, this command is also used normally after the power source is turned on, or when restarting the motor after a stepout occurs. Determination of which command should be used depends upon the distance, time and required positioning accuracy.
As with the Continuous Constant Speed Operation command, the actual operation of the Acceleration/Deceleration Operation command is defined by the number of operation pulses converted into FFFFFF (hexadecimal number). If bit 7 of this command is set to "1," operation shifts into POUT mode and high speed operation is possible just as with the Acceleration/Deceleration Operation command.

<Continuous High Speed Operation>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1		1	x			1	1	0	Continuous High Speed Operation command

Direction of motor rotation (bit 3)
0 : CW direction
1 : CCW direction

Termination Interrupt control (bit 4)
0 : Outputting Interrupt signals
1 : Not outputting Interrupt signals

Operation mode (bit 7)
0: Phase excitation mode (Phase excitation output)
1 : POUT mode (Only POUT)

Diagram 3-23

Flowchart of Continuous high speed operation command is below on diagram 3-24

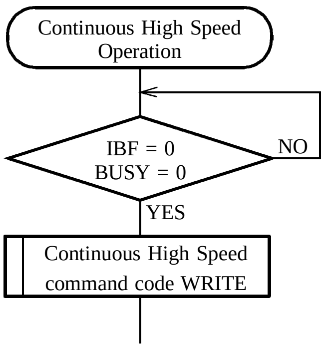


Diagram 3-24 Flowchart of Continuous High Speed Operation

3-3-8. Constant Speed Origin Search Operation

This command has a command code and constant pulse rate data, and moves the motor at a constant speed until the Origin signal (CNP*) is received. In addition to the Origin signal, an ALM* signal, Limit signal for the same direction, or Immediate Stop command also stops the operation of this command.

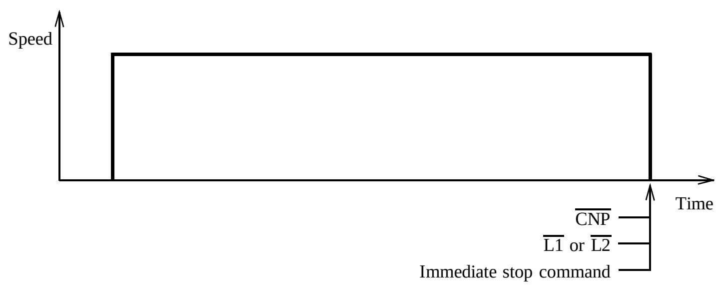


Diagram 3-25 Example of Constant speed origin search operation

<Constant Speed Origin Search Operation Command>

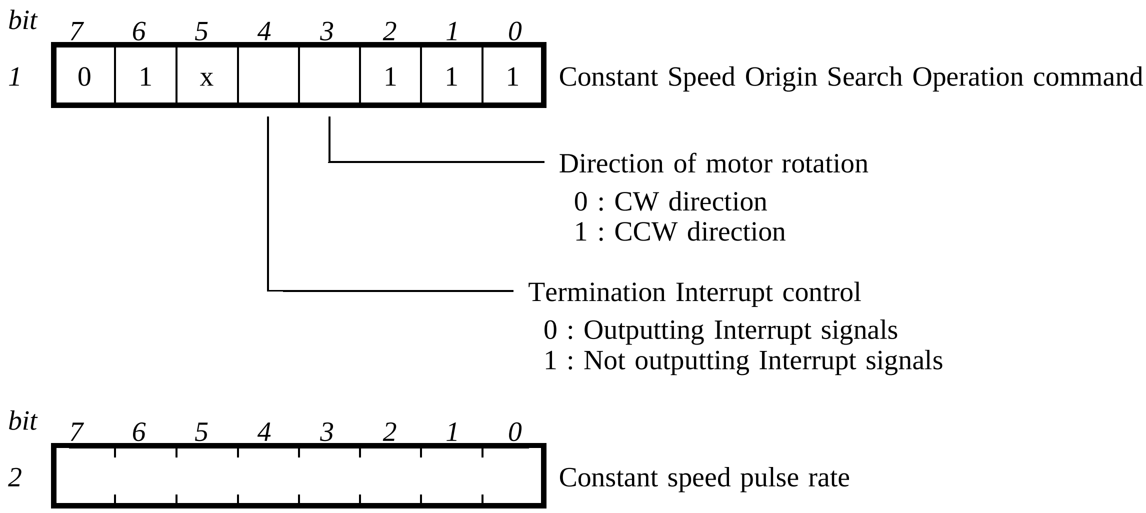


Diagram 3-26

Flowchart of Constant speed origin search operation command is below on diagram 3-27.

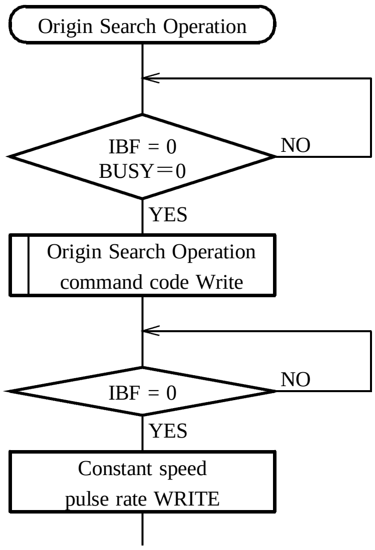


Diagram 3-27 Flowchart of Constant speed origin search operation

As with the Continuous Constant Speed Operation command, the actual operation of the Constant Speed Operation command is defined by the number of operation pulses converted into FFFFFF (hexadecimal number), and the position prior to operation can be determined by the number of pulses remaining.

3-4. Internal Register Read Command

This command is used to check the PPMC-104BFP's internal conditions and external inputs. As shown in Diagram 3-28, this command can read four types of internal data. Data can be read only when the motor is stopped.

<Internal Register Read Command>

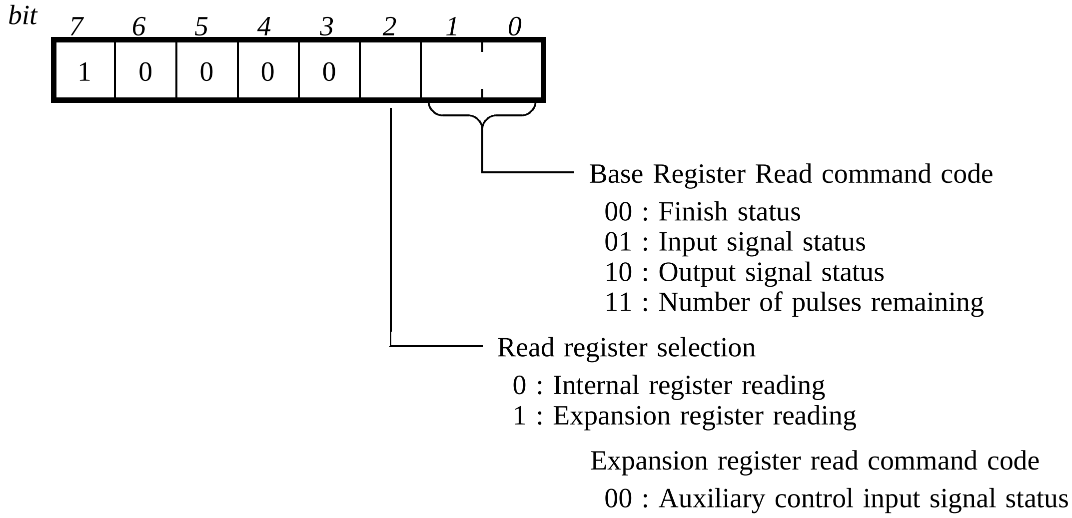


Diagram 3-28 Bit structure of Internal register read command

3-4-1. Finish Status Code Read Command

This command reads the cause of termination of pulse output. This command contains a command code only, and reads a 1 byte finish status code after the command code is written.

<Finish Status Code Read command>

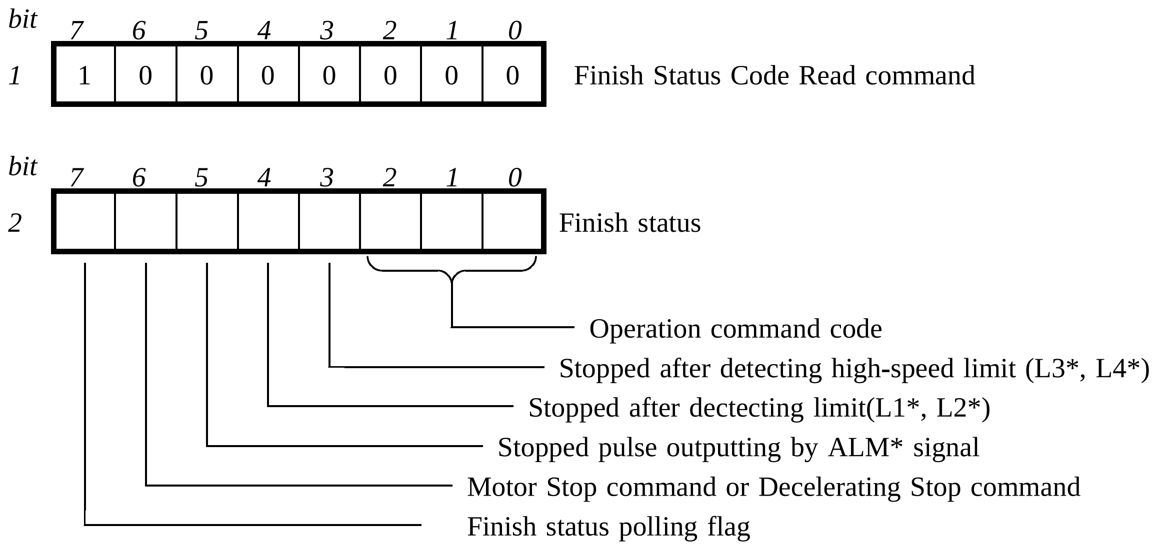


Diagram3-29

The operation command code is expressed by the three lower bits of the operation command code that was in execution before this command was issued. However, in case of Immediate Stop and Decelerating Stop commands, the previously issued operation command code remains. Bits 3 and 4 become "1" when the high-speed limits (L3 and L4) or Limits (L1 and L2) are issued and operation stops.
Bit 5 becomes "1" when ALM signall is set to "L."
Bit 6 becomes "1" when operation stops with an Immediate Stop command or Decelerating Stop command.
When operation stops after all pulses specified by Acceleration/Deceleration Operation and Constant Speed Operation are outputedt, bits 3 to 6 all become "0".
When operating with no termination interrupt mask, the INT* signal is issued when operation is complete. This becomes a termination interrupt for the host processor. When the finish status is read, the INT* signal becomes "1".
Bit 7 becomes "1" immediately after operation stops. It becomes "0" when the finish status is read, and can be used to check polling of the termination interrupt.
Diagram 3-30 is a flowchart of the Finish Status Read command.

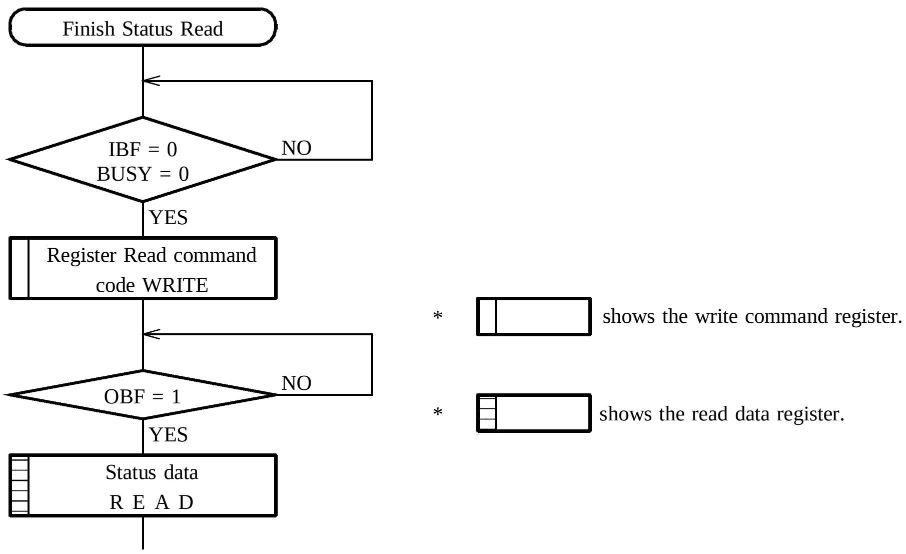


Diagram 3-30 Flowchart of Finish status read

3-4-2. Input Signal Status Read Command

This command reads input signals, such as each of the PPMC-104BFP's limit input signals, the Alarm signal, and the Origin signal. At the time the read command is issued, each input signal is read as is. For this reason, when operation decelerates and stops with a high-speed limit signal, operation has passed the limit switch position, and bits 0, 1, and etc. of this command do not become "0".

<Input Signal Status Read Command>

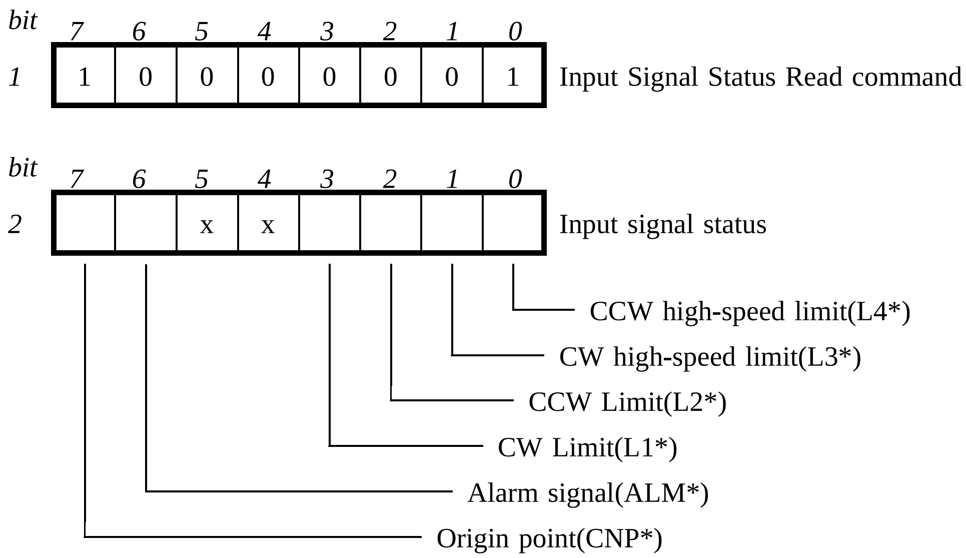


Diagram 3-31

Flowchart of Input Signal Status Read Command is below on diagram 3-32

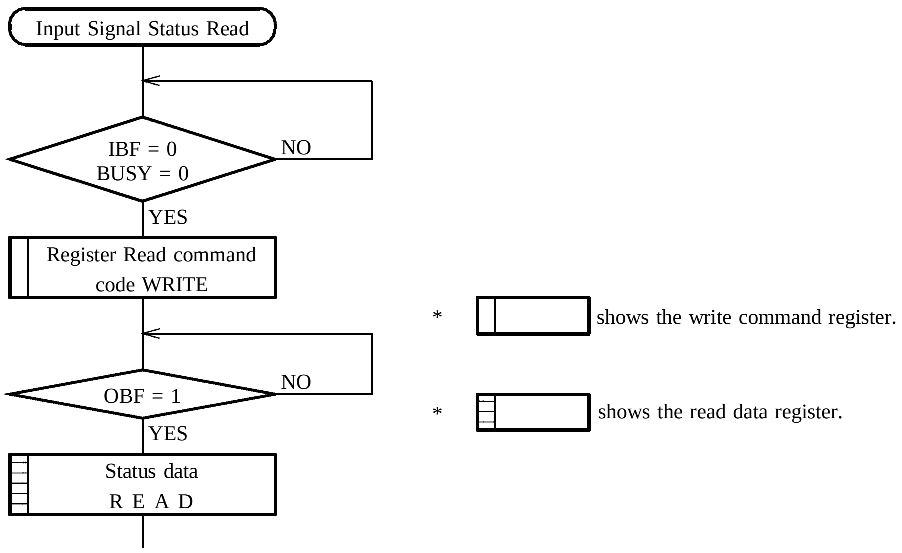


Diagram 3-32 Flowchart of Input Signal Status Read

3-4-3. Output Signal Status Read Command

<Output signal status read command>

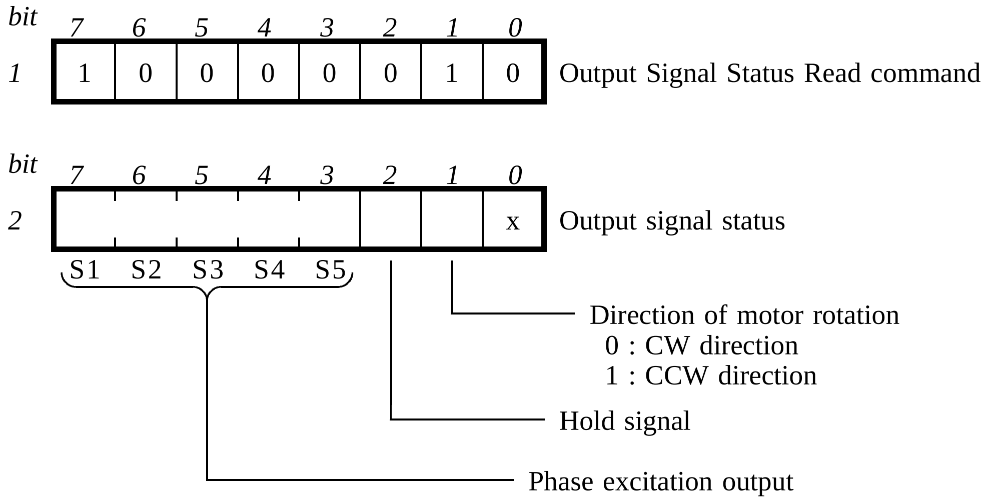


Diagram 3-33

The direction of rotation of the previous operation can be checked in bit 1.
Each of the stepper motor phase outputs is checked in bits 3 to 7.

Flowchart of output signal status read command is below on diagram 3-34.

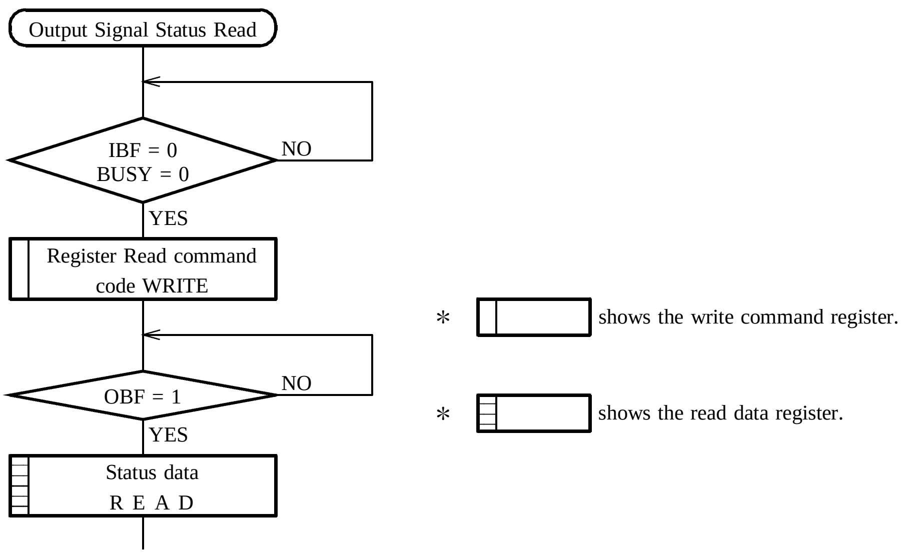


Diagram 3-34 Flowchart of Output Signal Status Read

3-4-4. Remaining Pulses Read command

While processing an Acceleration/Deceleration Operation command or Constant Speed Operation command, if operation is stopped in the middle with a limit signal or stop command, this command can read the number of remaining pulses. If problems, such as a stepout do not occur when operation stops, thesse data can be rewritten and the anticipated operation can be continued. In this case, because the data to be read is smaller than the actual number of remaining pulses by "1," the data can be resetup as it stands.

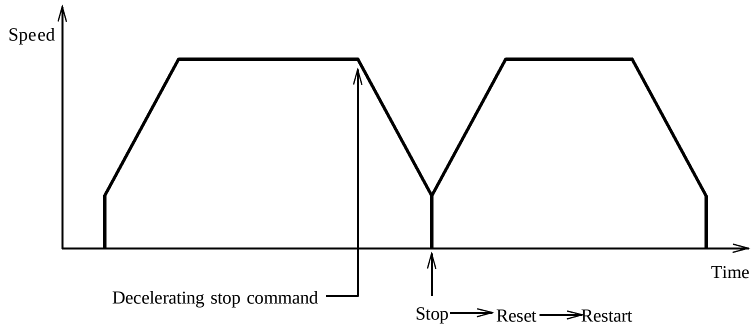


Diagram 3-35

When operation is complete after all pulses specified by the Acceleration/Deceleration Operation command or Constant Speed Operation command are outputted, the value of this command becomes "0". When the number of remaining pulses is "1" pulse, the remaining pulse data also becomes "0." However, whether the number of remaining pulses is "1" or "0" can be checked by bits 3 to 6 of the Finish Status data. In other words, if any of these bits is set to "1," it means that operation did not stop normally, and the actual value becomes "1" even if the remaining pulse data indicates "0."
The number of remaining pulses is read from the lower byte as shown in Diagram 3-36.

<Remaining Pulses Read Command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	0	0	0	0	0	1	1	Remaining pulses read command

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*		
2									Lower byte	Number of remaining pulses
									Middle byte	
									Higher byte	

Diagram 3-36

Flowchart of remaining pulses read command is below on diagram 3-37.

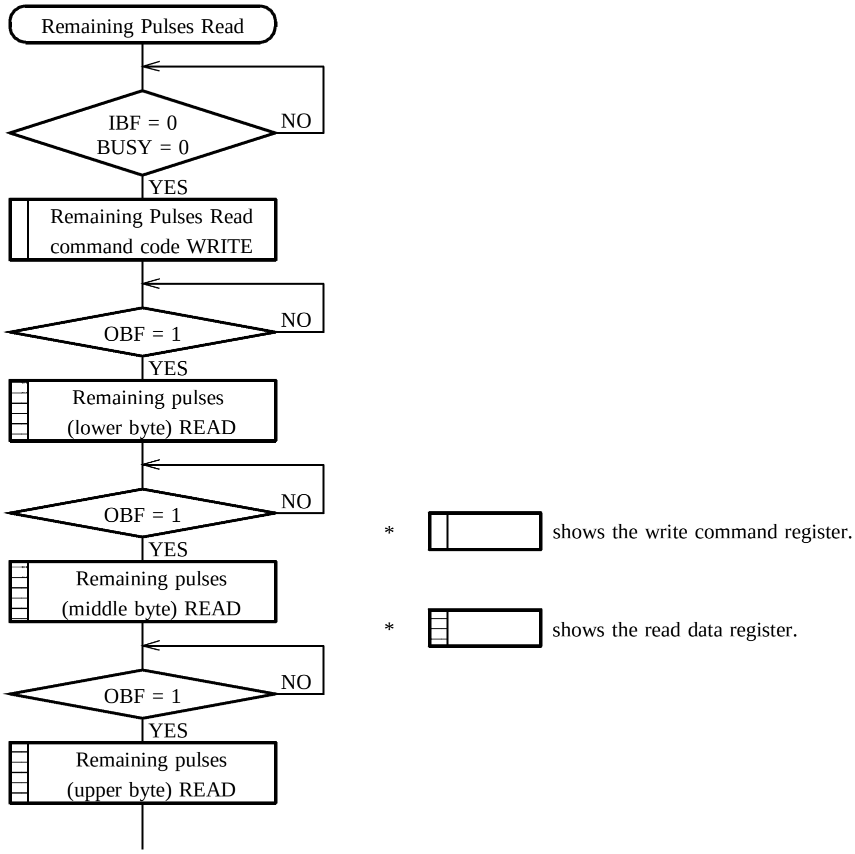


Diagram 3-37 Flowchart of Remaining Pulses Read

3-4-5. Auxiliary Input Signal Status Read Command

This command reads the status of auxiliary input signals (AUXI0~AUXI3). After the command code is written, 1 byte of auxiliary input signal status data is read.

<Auxiliary Input Signal Status Read Command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	0	0	0	0	1	0	1	Auxiliary Input Signal Status Read command code

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
2	0	0	0	0					Auxiliary Input Signal status

- bit 0: AUXI0 Auxiliary input bit0
- bit 1: AUXI1 Auxiliary input bit1
- bit 2: AUXI2 Auxiliary input bit2
- bit 3: AUXI3 Auxiliary input bit3

Diagram 3-46

Flowchart of Auxiliary input signal status read command is below on diagram 3-47

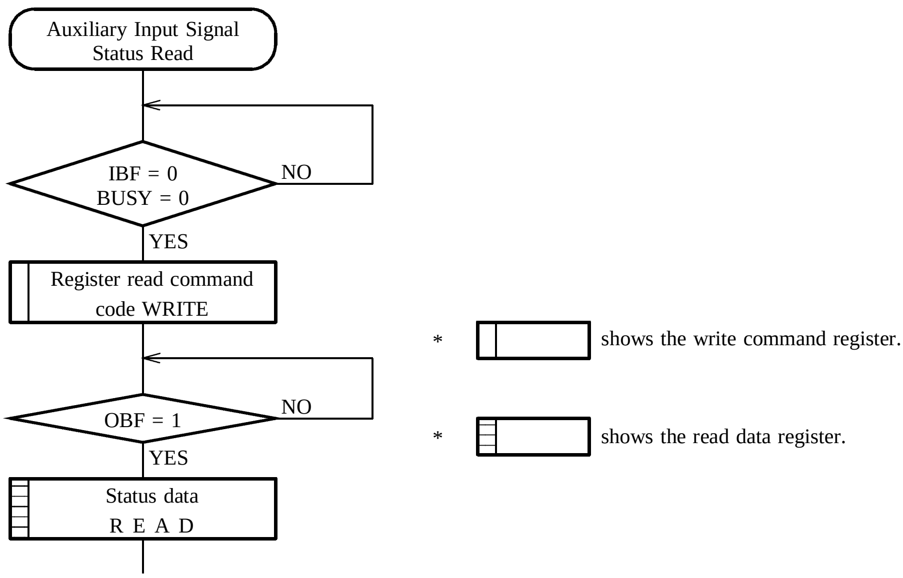


Diagram 3-47 Flowchart of Auxiliary Input Signal Status Read command

3-5. Auxiliary Commands

3-5-1. Switching Parameter Setting Command

This Command sets up the phase excitation output's chopper control parameters when the motor is stopped. If the "switching during stop mode" is specified at initialization, the PPMC-104BFP turns the excitation signal either ON or OFF according to the ON or OFF time setup by this command, reducing thephase current while the motor is stopped. Parameters for this command need to be determined experimentally in order to accommodate a conflicting request for assuring that torque is maintained and heat buildup of the motor is reduced, as well as to reduce resonance while the motor is stopped. If this command is not issued, the default value set by the PPMC-104BFP is approximately 5.s8kHz, at a 37% duty ratio.

<Switching Parameter Setting Command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	0	0	0	0	1	0	0	Switching Parameter Setting command

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
2									ON time Pon
3									OFF time Poff

Diagram 3-38

The ON and OFF time durations are defined by 1 byte of parameter data. This parameter and the actual time duration are calculated by the following equations.

When VSEL is at "H"

Ton = Pon x × 3.0 + 27 (microseconds) (Equation 3-5)

Toff = Poff x 3.0 + 33 (microseconds) (Equation 3-6)

When VSEL is at "L"

Ton = Pon x 3.0 + 25 (microseconds) (Equation 3-7)

Toff = Poff x 3.0 + 28.75 (microseconds) (Equation 3-8)

Flowchart of Switching parameter setting command is below on diagram 3-39

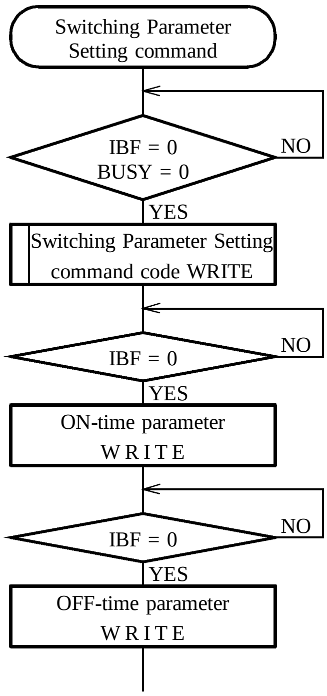


Diagram 3-39 Flowchart of Switching Parameter Setting command

3-5-2. Auxiliary Control Signal Output command

This command turns the auxiliary control signal output (AUX*) ON or OFF. This command is effective even before the initialization command is issued. This command contains no parameters and operates with a command code only.

AUX* becomes "H" at initialization and becomes "L" via the ON command. This command can be used when the motor is in operation, independent from motor control.

Auxiliary Control Signal Output command

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	1	0	0	0	0	0	1	AUX ON command code

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	1	0	0	0	0	1	0	AUX OFF command code

Diagram 3-40

Flowchart of Auxiliary Control Signal Output command is below on diagram 3-41

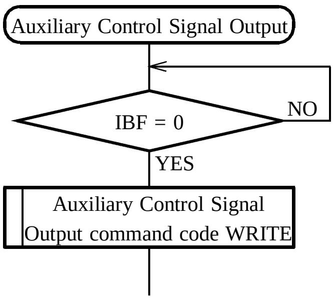


Diagram 3-41 Flowchart of Auxiliary Control Signal Output command

3-5-3. Auxiliary Output Command

This command controls the auxiliary output signals (AUXO0 - AUXO3).
1 byte of data must be specified following the command code. A bit where "1" is given will be at "L."
The lower 4 bits(bit0 -bit3) given following the command code correspond 4 auxiliary output signals (AUXO0 - AUXO3). Auxiliary output signal will be at "L" when "1" is given as an auxiliary output datum, and it will be at "H" when "0" is given.
After a reset, all signals of AUXO0 - AUXO3 become "H."
This command can be executed during pulse output.

<Auxiliary Output Command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	0	0	0	0	1	1	0	Auxiliary Output Command code

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
2	0	0	0	0					Auxiliary Output Data

AUXO0 Auxiliary output bit0
AUXO1 Auxiliary output bit1
AUXO2 Auxiliary output bit2
AUXO3 Auxiliary output bit3

Diagram 3-44

Flowchart of Auxiliary output command is below on diagram 3-45.

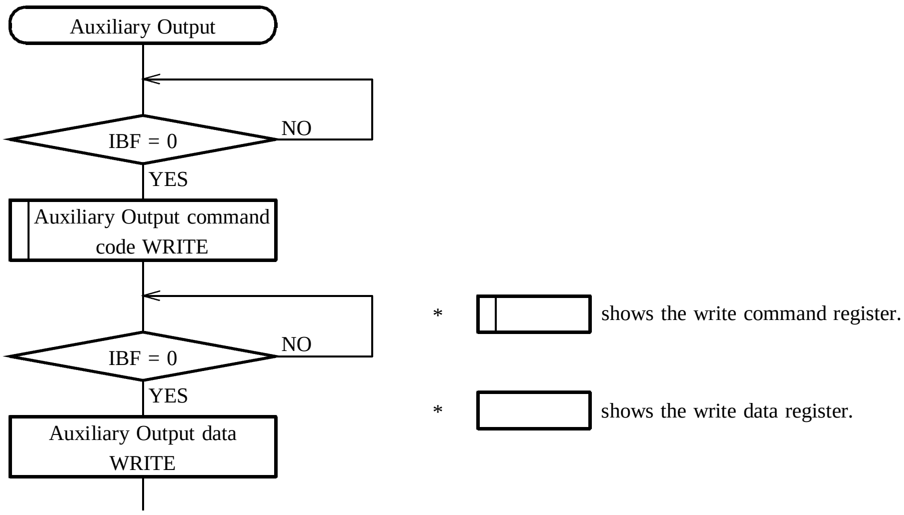


Diagram 3-45 Flowchart of Auxiliary Output command

3-5-4. Software Reset Command

This Command has 2 functions. The first one is to free up the motor by turning the phase excitation output off. The second function is to cancel out all initialization data and accept a new initialization command. Therefore, even if the system is not reset at the time of system adjustment, it is possible to change from 2-phase excitation to 1-2 phase excitation. This command contains no parameters and operates with a command code only, and is effective only when the motor is stopped. If this command is issued during motor operation, the command will be mistaken for the AUX* ON command.

<Software Reset command>

bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*	
1	1	1	0	0	0	0	0	0	Software Reset command

Diagram 3-42

Flowchart of Software reset command is below on diagram 3-43.

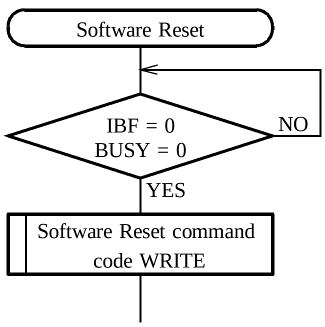


Diagram 3-43 Flowchart of Software Reset command

3-6. Command Process Time

The time required by the PPMC-104BFP to process a host command varies depending upon the command type, parameter value, and the status of the PPMC-104BFP. In this section, the process time required under some typical conditions, as well as the maximum and minimum time required under specific conditions will be explained for use as a reference in designing a system.

Table 3-3 Time required for processing commands

Command process	Conditions or tendency		MIN	TYP	MAX	unit
Initialization	The more acceleration/deceleration pulses there are, the more time required. 44 microseconds are required from the time the final data is written to the time the phase excitation signals, etc. are determined.		16.5		162.8	milli-seconds
Acceleration /Deceleration Operation (Calculation of the deceleration start point)	From the completion of command data writing to the first P-OUT. Minimum value in trapezoidal drive. In triangular drive, the more operation steps there are, the more time required.		0.2		1.1	milli-seconds
Abnormal termination (calculation of pulses remaining)	Stop by a stop command or stop by a Limit signal detection During Acceleration/Deceleration Operation only.			0.2		milli-seconds
Decelerating Stop	Time required to process a Decelerating Stop command			17		micro-seconds
	High-speed limit signal detection	During acceleration		12		
		During high speed operation		17		
Auxiliary Output Control	AUX*	ON		14		micro-seconds
		OFF		14		
Single Step	From command writing to the completion of all command processes.			112		micro-seconds
Constant Speed Operation	From command data writing to the first P-OUT			194		micro-seconds
Normal Termination	From the final P-OUT to acceptance of the next command			156		micro-seconds
	From the final P-OUT to Interrupt output			26		
	From the final P-OUT to HOLD ON			3.4		milli-seconds
Excitation OFF				18		micro-seconds
Busy Status	From final command writing to status becoming "1."		27		112	micro-seconds

* The time required for processing commands is obtained using an emulator, and there may be an error of 1% compared to the actual processing time.