1. Specifications and Functions

1-1. Overview

PPMC-104BFP is a motion control LSI for stepper motors. It's developed to meet the PPMC-101C, 102A and 103A/AFP customers' needs.

The PPMC-104BFP can control stepper motors by giving simple command codes and data from the host CPU.

PPMC-104BFP has eight operation commands, five internal register read commands, and four auxiliary commands. The motor's operation speed and the number of operation steps are also programmable.

Using PPMC-104BFP, you'll make the best use of the software resources for PPMC-100 Series. Because PPMC-104BFP is algorithm compatible with PPMC-101C and 102A, and it's also data compatible with PPMC-103A/AFP.

1-2. Function Specifications

Operation commands
- Immediate Stop
- Deceleration Stop
- Single Step
- Acceleration/Deceleration Operation
- Constant Speed Operation
- Continuous Constant Speed Operation
- Continuous Acceleration/High Speed Operation
- Constant Speed Origin Search Operation

Internal register read commands
- Finish Status Code Read command
- Input Signal status Read command
- Output Signal Status Read command
- Number of Remaining Pulses Read command
- Auxiliary Input Signal Status Read command

Auxiliary commands
- Switching Parameter Setting command
- Auxiliary Control Signal Output command
- Auxiliary Output command
- Software Reset (Excitation OFF) command

Excitation methods

3-phase motor	2-phase excitation
	1-2 phase excitation
4-phase motor	2-phase excitation
	1-2 phase excitation
5-phase motor	2-phase excitation
	2-3 phase excitation

Maximum number of steps
- 16,777,216 steps

Number of acceleration/deceleration pulses
- 4~11,220

Maximum speed
- In POUT mode:40kppS (system clock 16MHz)
- In phase excitation mode:27kppS (system clock 16MHz)

Power source
- +5V ±10%, maximum 50mA (16MHz)

Table 1-1 Command Codes

		Command/Data		Function
Initialization		1 2 3 4 5	0 0 (Start-up pulse rate) (High speed pulse rate) [Number of Acceleration/Deceleration pulses]	Sets up motor type, excitation method, and acceleration/deceleration constant.
	Switching frequency specification	1 2 3	10000100 (ON time) (Off time)	Specifies the frequency and duty ratio when phase excitation output switching is executed while the motor is not in operation (If this command is not executed, the frequency and duty ratio will be set at 5.8kHz and 1/3 ON.)
[Operation Commands]	Immediate Stop	1	01000000	During acceleration/deceleration operation During constant speed operation
	Decelerating Stop	1	01000001	During acceleration/deceleration operation During constant speed operation
	Single Step	1	01 010	1 pulse
	Acceleration /Deceleration Operation	1 2 3 4	01 011 (Number of operation pulses)	Trapezoidal drive Triangular drive (when fewer operation pulses are output)
	POUT mode Acceleration /Deceleration Operation	1 2 3 4	11 011 (Number of operation pulses)	Acceleration/Deceleration Operation in high-speed mode that does not control phase excitation output.
	Constant Speed Operation	1 2 3 4 5	01 100 (Constant pulse rate) [Operation pulse rate]	
	Continuous Constant Speed Operation	1 2	01 101 (Constant pulse rate)	At the point L1* or L2*
	Continuous Acceleration/ High Speed Operation	1	01 110	At the point L3* or L4*
	POUT mode Continuous Acceleration/ High Speed Operation	1	11 110	At the point L3* or L4*
	Constant Speed Origin Search Operation	1 2	01 111 (Constant pulse rate)	At the point CNP*
	AUX ON	1	11 001	Sets auxiliary control output signal to "0"
	AUX OFF	1	11 010	Sets auxiliary control output signal to "1"
	Excitation OFF	1	11 000	Sets phase excitation output to "OFF" and allows reinitialization.
	Auxiliary control output	1 2	10000110 0000(Output data)	Controls AUXO0-3.
[Register Read]	Finish satus code	1	10000000	Reads data such as termination cause. 1 byte.
	Input Signal	1	10000001	Reads data such as limit signals. 1 byte.
	Output Signal	1	10000010	Reads motor phase output and directional data. 1 byte.
	Number of Pulses Remaining	1	10000011	Reads the number of pulses remaining. 3 bytes.
	Auxiliary control input signal	1	10000101	Reads the status of AUXI0-3. 1 byte.

1-3. PPMC-104BFP's Concept and Performance

The PPMC-104BFP outputs motor control signals using its built-in timer, counter, and microprocessor. When the host CPU gives a command code and parameters, the PPMC-104BFP will internally creates control data according to the command code and parameters, and outputs a high-speed pulse train using these control data.

1-3-1. Pulse Rate and Motor Speed

The PPMC-104BFP utilizes a value called a pulse rate as a parameter to determine the speed of the stepper motor. The pulse rate is expressed by the value of the base clock necessary to move the motor 1 step. When the VSEL pin equals "H" or OPEN, Schematic Equation 1-1 applies to the relationship between the pulse rate and the motor, and the PPMC-104BFP becomes data-compatible with the PPMC-104AFP. When the VSEL pin are at "L", Schematic Equation 1-2 applies and the PPMC-104BFP becomes data-compatible with the PPMC-103A/AFP.

When VSEL is at "H" or OPEN,

$$\text{Speed} = \frac{10^6}{(\text{Rate} + 1) \times \text{Tclock}} \ (\text{ppS}) \quad (\text{Eequation 1-1})$$

When VSEL is at "L",

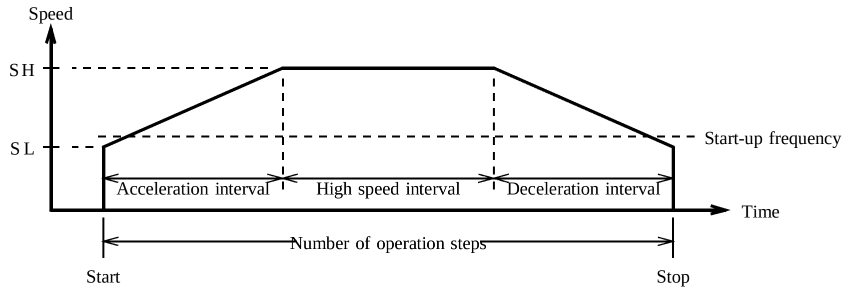
$$\text{Speed} = \frac{10^6}{(\text{Rate} + 1) \times \text{Tclock} + 7.5} \ (\text{ppS}) \quad (\text{Equation1-2})$$

Speed : Motor speed (pulses/second)
Tclock : Base clock frequency (microseconds)
Rate : Pulse rate

However, even when the VSEL equals "H" or OPEN, if Tclock is equal to or less than 8 microseconds, Equation 1-2 applies. If Tclock is equal to or greater than 9 microseconds, Equation 1-1 applies. If Tclock is greater than 8 microseconds and less than 9 microseconds, the pulse output interval varies between Equations 1-1 and 1-2.
Either the 500kHz clock or the 125kHz clock created internally in the PPMC-104BFP, or an external clock connected to the CLOCK pin (pin number 54) can be used as a base clock. The pulse rate can be expressed by any 1 byte of data other than "0". However, depending on the system clock frequency and load conditions, it is recommended that the pulse rate be set in a range where pulse interval fluctuations will not be a problem.
This concept is the same for both acceleration/deceleration operation and constant speed operation.

1-3-2. Acceleration/Deceleration Control

Because stepper motors were originally designed with an emphasis on their stepper and positioning functions, these motors cannot operate at high speeds as easily as regular motors can. Due to the kind of mechanism used and changes in drive current, the torque may fluctuate, and resonance may be created resulting in a step-out. Generally, appropriate acceleration/deceleration control is necessary to prevent these phenomena. The PPMC-104BFP was designed to digitally handle acceleration/deceleration control using simple parameters provided by the host



SH: Speed relative to RH (high speed pulse rate) during high speed operation

SL: Speed relative to RL (startup pulse rate) at startup

SL =≦ start-up frequency <SH

Diagram 1-1

In other words, the PPMC-104BFP begins operation at a speed slower than the start-up frequency, gradually accelerates, and shifts into high speed operation as shown in Diagram 1-1. Likewise, the PPMC-104BFP first decelerates to the start-up frequency, then stops motor operation. In this way, the motor can operate at high speed without a step-out even under a heavy load.

For mechanisms that tend to have resonance even under a light load, a step-out caused by resonance can also be prevented by reducing the acceleration/deceleration interval.

When the number of operation steps is fewer than the number of pulses in the acceleration and deceleration intervals, the acceleration/deceleration curve changes from trapezoidal to triangular. The former is called a trapezoidal drive, and latter is called a triangular drive. When high-speed operation is not necessary or during origin alignment, constant speed operation is carried out at a speed slower than the start-up frequency

1-3-3. PPMC-104BFP's Performance

As mentioned previously, there is a limit to the PPMC-104BFP's internal processing speed and the capacity of its built-in counter, and these factors determine its output performance.

(Conditions) PPMC system clock 16MHz
External clock 266.667kHz

(1). P-OUT mode acceleration/deceleration operation

T = Tclock x (RH + 1) ≧ 25 (microS) (expression1-3)

(2). Phase excitation output mode acceleration/deceleration operation

T = Tclock x (RH + 1) ≧ 37 (microS) (expression1-4)

T : pulses interval (microS)
RH : High speed pulse rate when Initialization Sets up
Tclock : External clock (= 3.75 microS)

(3). Operations when a High Speed Limit signal is checked and when a Decelerating Stop command is received

In P-OUT mode, high speed limit signals are checked only during high speed operation. In phase excitation output mode, high speed limits are checked during acceleration and high speed operation. When a Decelerating Stop command is received during constant speed operation or during deceleration, operation does not stop immediately and an error status is returned.

1-4. System Structure

Diagram 1-2 shows the structure of a stepper motor control system utilizing the PPMC-104BFP. The PPMC-104BFP is placed between the host processor and the motor driver. It receives simple command codes and parameters from the host, creates data necessary to control the motor, and outputs the data to the motor driver. During motor operation, the PPMC-104BFP monitors five limit signals and four commands from the host CPU, and responds by decelerating or stopping motor operation. When an operation is complete, the PPMC-104BFP notifies the host by sending an interrupt signal and responds to status read requests from the host.

In this way, the PPMC-104BFP substantially reduces the burden of the host processor in controlling the stepper motor and helps implement a high throughput system. The PPMC-104BFP is also capable of supplying phase excitation output directly to the driver, and can control small motors with an extremely simple add-on circuit (See Diagram 1-3).

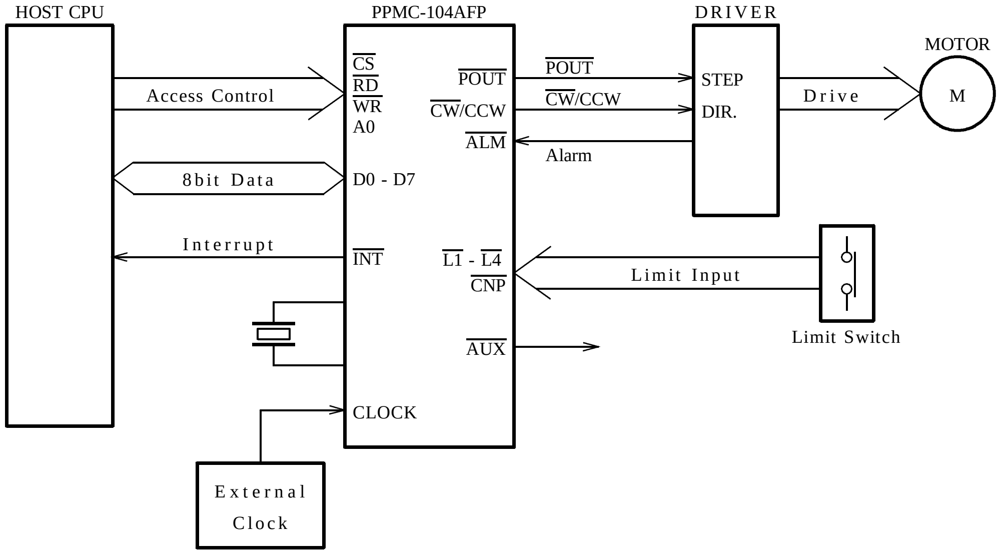


Diagram 1-5 Example of system structure

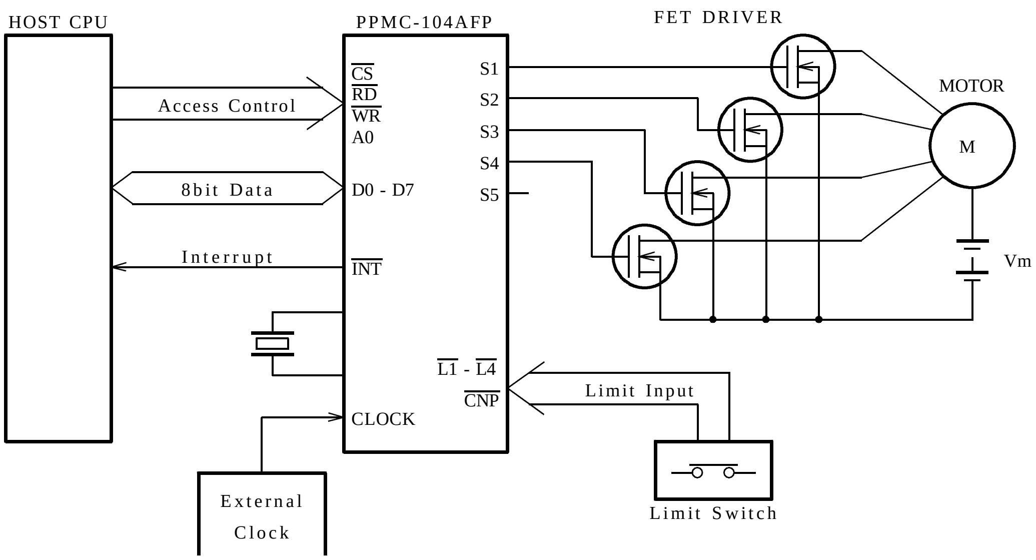


Diagram 1-6 Direct drive of small motors