ALLEN-BRADLEY

Allen-Bradley
Stepper Positioning Assembly

(Cat. No. 1771-QA)

Product Data

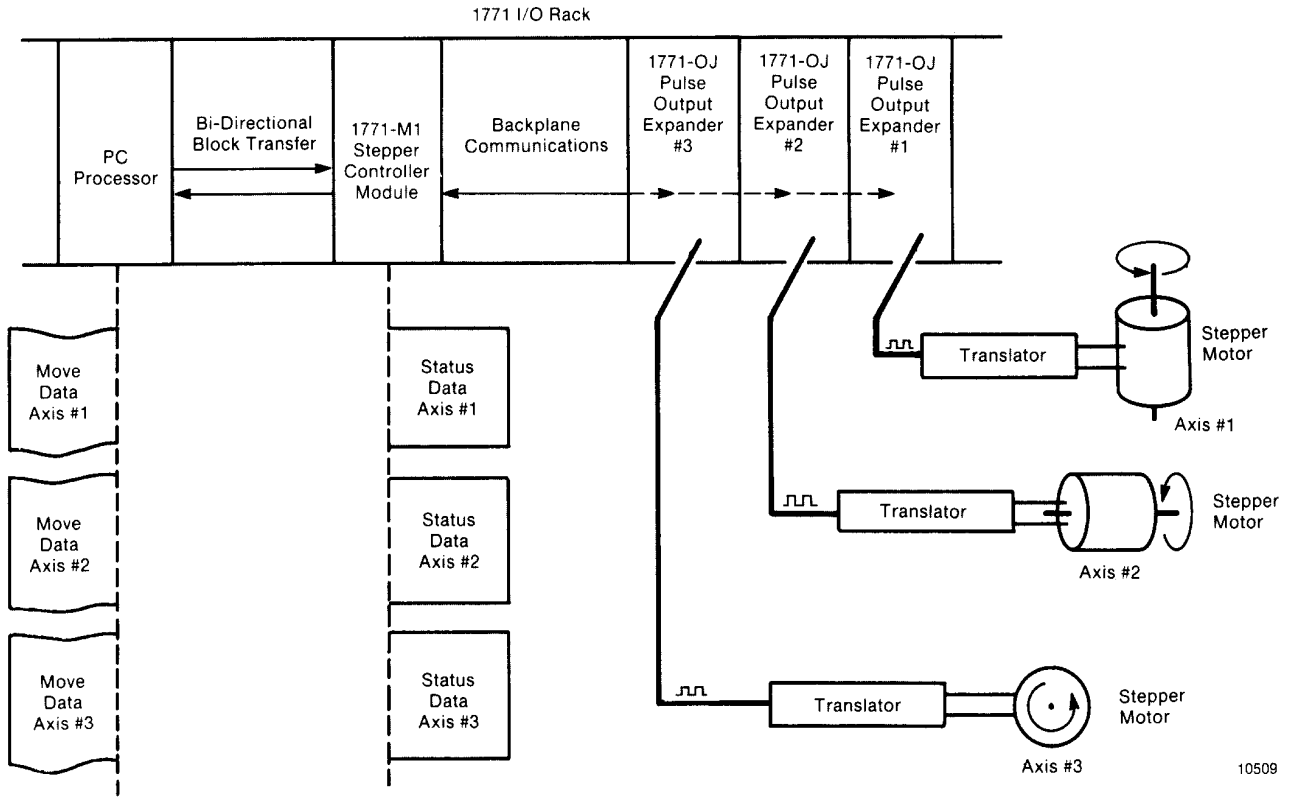
Description

The Stepper Positioning Assembly allows programmable control of stepper motors using Allen-Bradley programmable controllers. Accelerations, decelerations, constant velocities and final positions can be programmed in single moves or combinations of moves to suit a variety of motion applications. Data and commands sent to the stepper positioning assembly are converted to a pulse output for a user-supplied stepper motor translator which in turn drives the stepper motor. The stepper positioning assembly consists of one each of the following:

- Stepper Controller Module (cat. no. 1771-M1)
- Pulse Output Expander Module (cat. no. 1771-OJ) which includes Field Wiring Arm (cat. no. 1771-WB)

One stepper controller module can control up to three pulse output expander modules. Each expander module drives one stepper motor axis. The system can be expanded modularly from one to three axes per I/O chassis by placing from one to three output expander modules in the chassis (figure 1).

Figure 1
Typical System Block Diagram



Stepper positioning assemblies can be used in applications Stepper positioning assemblies can be used in applications requiring more than three axes by adding additional I/O chassis. Stepper positioning assemblies can be distributed throughout the plant using remote I/O.

The stepper positioning assembly can be used with any Allen-Bradley programmable controller that has block transfer instructions.

Features

Motion can be programmed to conform to a variety of applications. You can control the motion of each axis using pushbutton or thumbwheel switches, or you can program motion that is controlled automatically by the PC processor. Motion control includes the following:

- Jog forward, jog reverse, or jog to a starting position
- Automatically override moves in progress
- Offset all moves of a move profile to compensate for tool wear without reprogramming
- Preset the starting position to a desired value

- Extend the range of travel beyond the 999,999 pulse limit of the stepper positioning assembly
- Select the operating mode single-step, continuous, independent, or synchronous
- Select the acceleration, final rate, deceleration, and final position values
- Skip a move or combination of moves
- Halt one axis or all three axes using a programmed stop command or an E-STOP switch

Your ladder program can monitor the status of each axis and turn on indicators or alarms. The following is a partial listing of status reported by the stepper positioning assembly.

- Display in BCD the current position between 0 and 999,999 pulses
- Indicates forward or reverse motion
- Indicate the completion of every move in the single-step mode, or the completion of an independent mode or continuous mode profile
- Indicate the current moveset in process, moveset 0 or 1
- Indicate the current move in process, move 1 thru 10
- Indicate when programmed commands such as reset, software stop, jog forward, or jog reverse are enabled

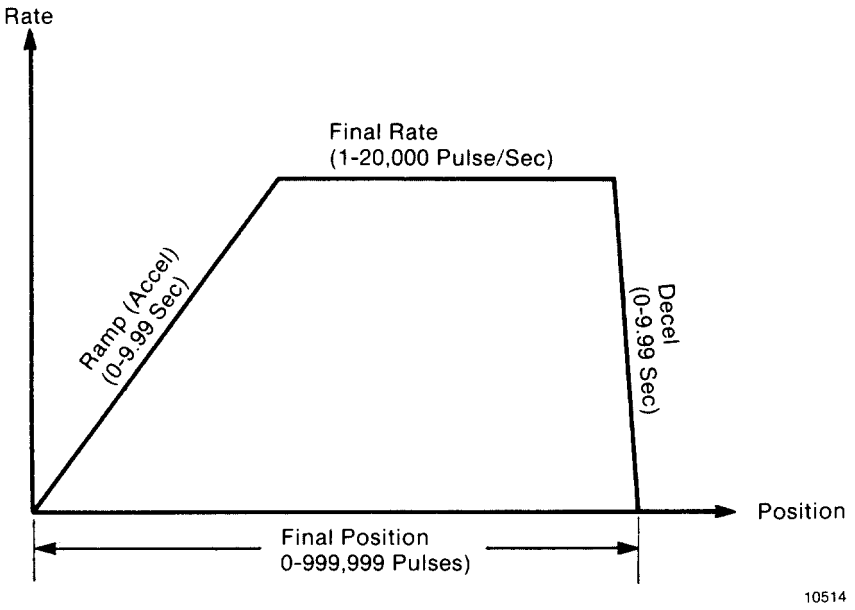
Operational Overview

The desired motion of the stepper motor can be accelerated, decelerated, or maintained at constant rate by controlling the pulse rate from the pulse output expander module. You can control three different single-axis machines with one stepper controller module and three pulse output expander modules in one I/O chassis. Terms used to describe the operation of the stepper positioning assembly are defined in the following paragraphs.

Move Definition

A move in its simplest form consists of an acceleration of the stepper motor axis, a final rate, a deceleration to zero, and a final position (figure 2). The value for an acceleration is the time required to achieve a final rate. You can choose values from 0-9.99 seconds. The final rate determines the constant speed of machine motion. You can choose final rate values from 1 to 20,000 pulses per second. The decel value is the time required to decelerate to zero pulses per second from a final rate. You can choose any value from 0-9.99 seconds.

Figure 2
Move Definition



The final position of a move is the number of pulses between 0 The final position of a move is the number of pulses between 0 and 999,999 to be achieved by the move. The physical location will depend on the resolution (pulses per degree of rotation or pulses per inch of travel) of the stepper translator/motor configuration and the specific application such as gearing threads per inch of the axis.

Moveset

A moveset refers to a data block of from one to ten moves. Sequential moves can be blended to form a continuous positioning profile or can be implemented one move at a time where motion stops between moves. Two or more movesets can be implemented sequentially as if they were a single large moveset for controlling one axis. You can use multiple movesets for controlling one axis. You can use multiple movesets to achieve long and complex positioning profiles or long sequences of single moves with little additional programming. You can control up to three axes in this manner.

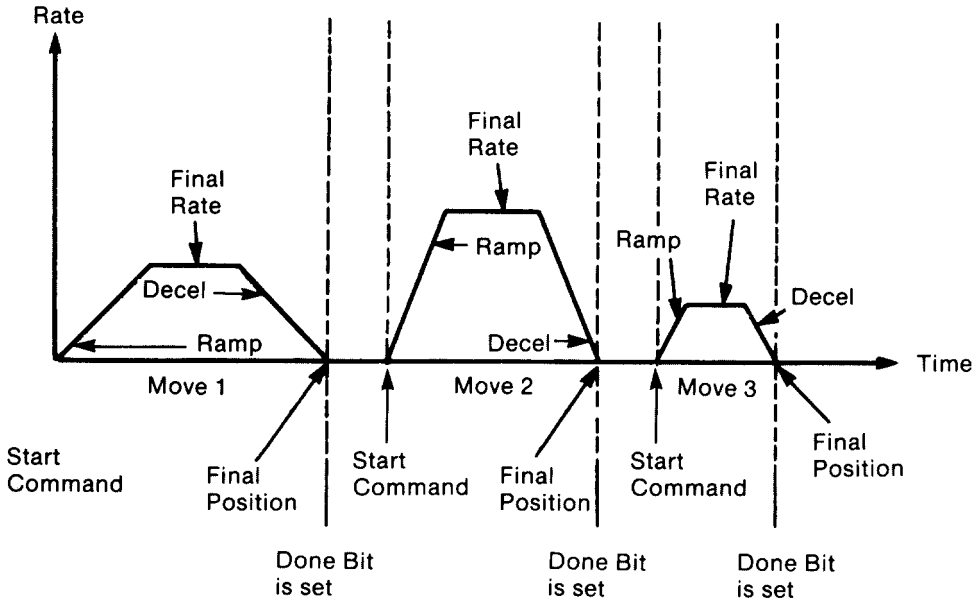
Positioning Modes

A positioning profile is the graphic or tabular representation of moves. Positioning modes refer to the modes of module operation that you can select. Positioning modes determine the type of positioning profile and the manner in which you can coordinate the axes of two or three stepper motors. You can program the stepper positioning assembly to execute positioning profiles automatically, or program it for manual operation using hardware or software jog inputs.

Single-step Mode

The single-step mode allows you to control individual moves one at a time. A start command from the PC processor starts the first move of the sequence. After the move is completed, the stepper motor axis stops and a done bit is set. In order for the next move to begin, the PC processor must transfer another start command to the stepper controller module (fig. 3).

Figure 3
Single-Step Mode



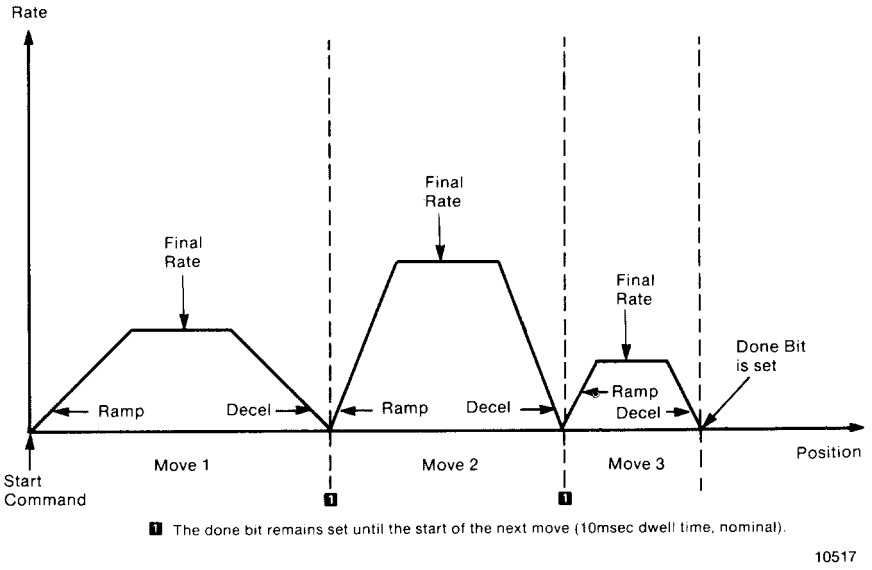
Jog

A jog is a single-step move that allows you to manually control one axis independently of other axes in the system. You can perform a jog at any time, except when a positioning profile is in process, by either a hardware or a software input to the stepper positioning assembly.

Independent Mode

The independent mode allows you to program a chain of single-step moves that are performed sequentially. Each move is defined as having a ramp, decel (to 0hz rate), and a final position (figure 4). Typically there is a pause of 10-30ms from the end of one move to the beginning of the next (dwell at 0hz rate). One start command is required for the entire positioning profile. A done bit is set at the completion of the profile.

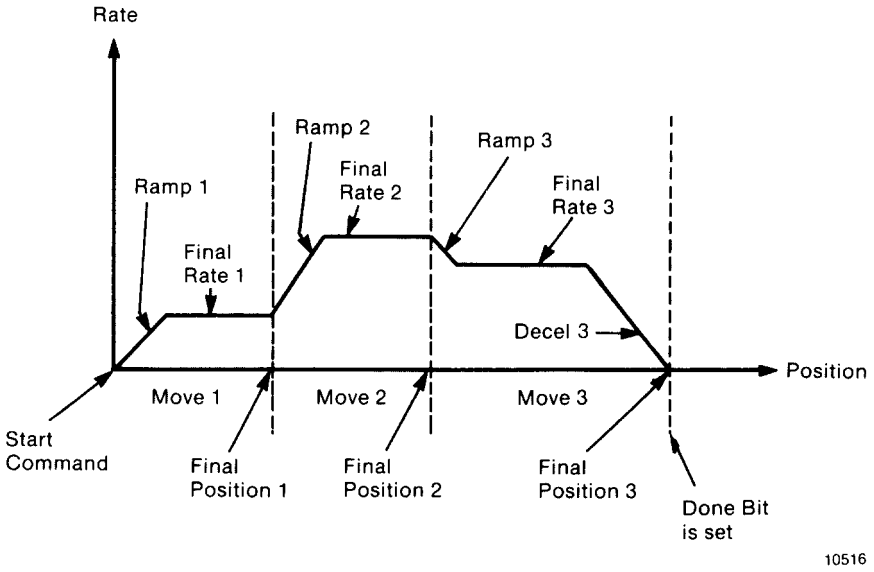
Figure 4
Independent Mode



Continuous Mode

The continuous mode allows you to blend moves continuously into a move profile with fully programmed accelerations and decelerations. Each move is defined as having a ramp, a final rate, and a final position. The last move of the profile, in addition to the ramp, final rate, and final position, contains a deceleration to zero (figure 5). Programmed decel values do not affect the positioning profile in any move except the last move. However, they can be used for a controlled emergency stop in any move.

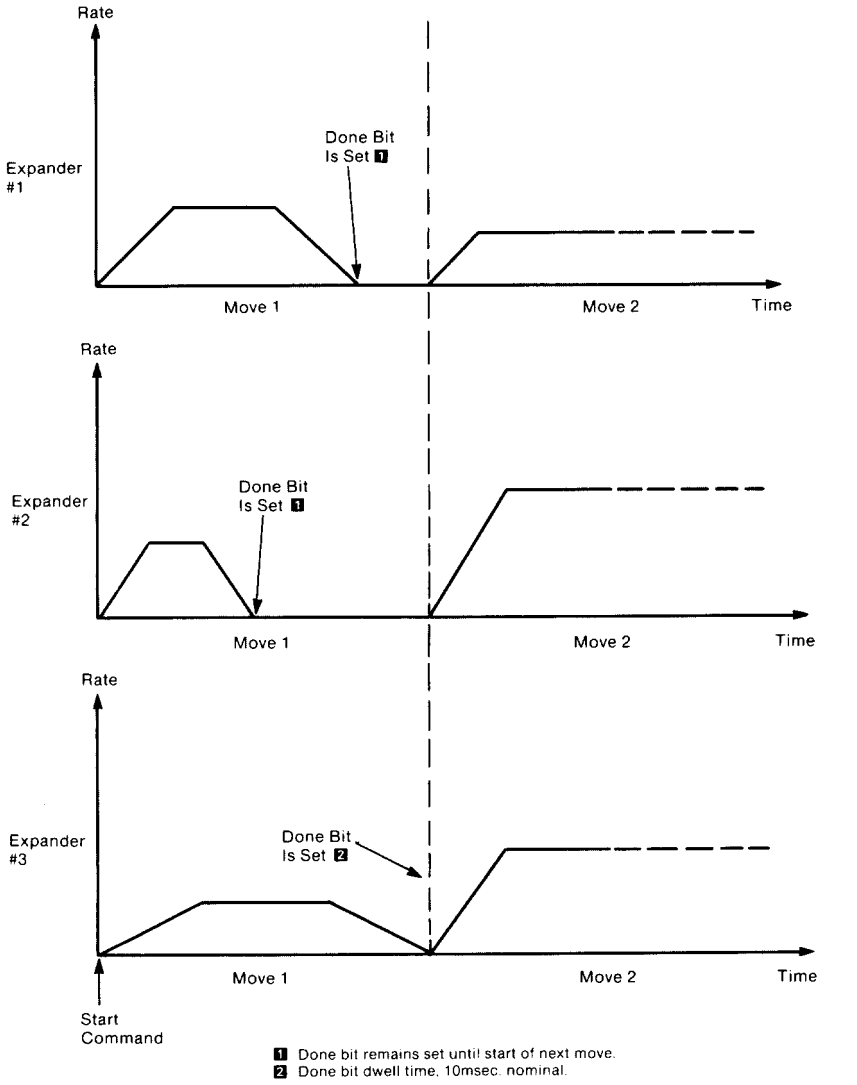
Figure 5
Continuous Mode



Syncrhonization

You can synchronize move-by-move all axes (up to three) in the single-step, and independent modes. Each axis completes its move before any of the three axes can begin the next move (figure 6). In the continuous mode, you synchronize the start of all axes in unison, and each axis completes its profile independently of the other profiles.

Figure 6
Synchronized Axes



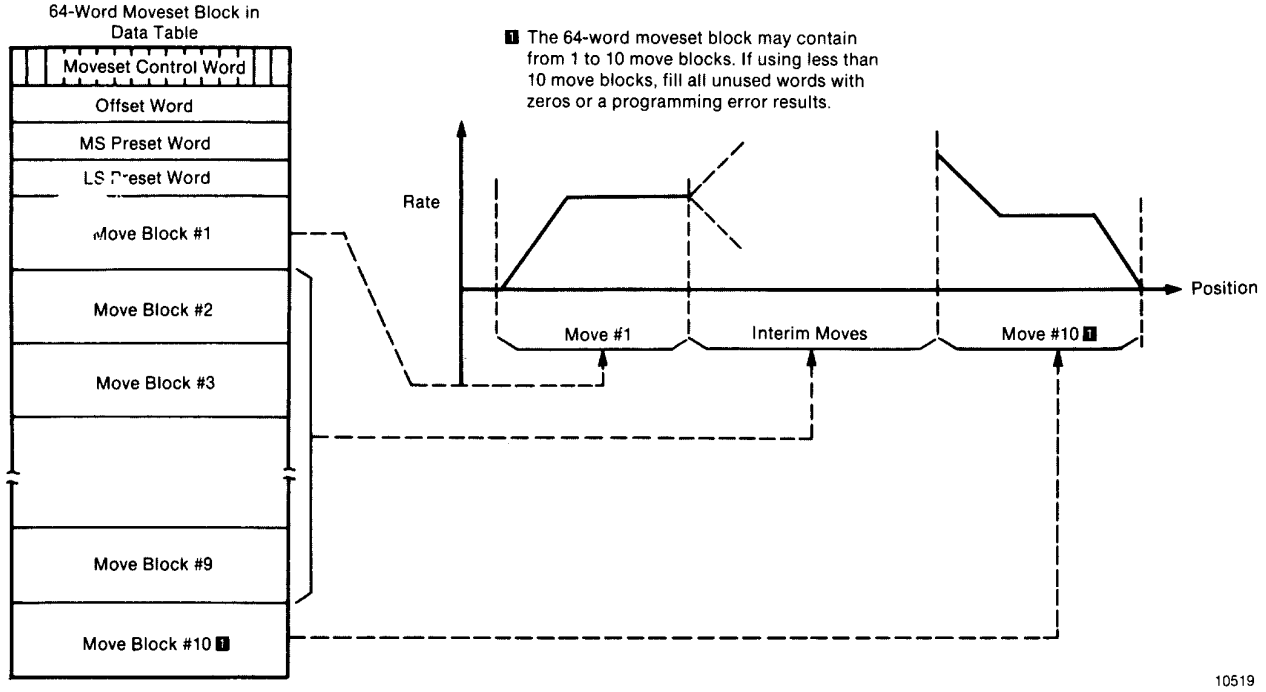
If the motion of two axes is synchronized, then you must If the motion of two axes is synchronized, then you must synchronize the third axis, if you use it. Synchronized axes only operate in the same positioning mode. Synchronized is independent of PC processor scan time.

Programming Overview

All communication between the stepper controller module and the PC processor data table is controlled by program logic. Write your ladder diagram program to manipulate blocks of data using block transfer and file move instructions.

Words that control the motion of stepper motor axes, report axis position, or monitor axis diagnostics are stored in the PC processor data table. A block of data used to control motion is the moveset block. It controls the acceleration, deceleration, final rate and final position of the axis (figure 7). Moveset blocks are transferred to the stepper controller module using write block transfer instructions.

Figure 7
Moveset Block and Positioning Profile



Another block of data is used to indicate that commands were Another block of data is used to indicate that commands were received and desired motion was implemented (status block). A status block contains position data and diagnostic bits set by the stepper positioning assembly. Status blocks are transferred to the PC processor using read block transfer instructions. Moveset and status blocks are communicated bidirectionally between the PC processor and stepper controller module.

Block Length

The block length of read or write block transfer instructions can be set to default value, 00, causing the default mode of the stepper controller module to automatically perform block transfer handshaking. The stepper controller module then toggles from a write operation (64 words) to a read operation of 4, 7, or 10 words depending on the number of axes.

Programming Strategy

You can transfer move commands and moveset blocks containing data of different block lengths to the stepper controller module by programming one unconditional write block transfer instruction containing a write block transfer file. Program a file-to-file move instruction to transfer data blocks from their storage location in the data table to the write block transfer file. When a transfer is needed, program logic enables the file-to-file move instruction.

You can program the transfer of status data from the stepper controller module to the PC processor using one unconditional read block transfer instruction. Data transferred into the read block transfer file is held temporarily until the PC processor can verify that the transfer and data are valid. Then using a file-to-file move instruction, you can move valid data to a storage file where it can be manipulated by program logic.

Memory Requirements

Data table files that are used to store and transfer data to and from the stepper controller module are typically as follows:

- One or more moveset files per axis (control block): four words of control, offset, and preset data plus six words per move (64 words maximum per 10-move moveset)
- One jog file per axis (control block): four words of control, offset, and preset data plus six jog move words to store jog data
- One write block transfer file: 64 words for the storage of control data to be write block transferred to the stepper positioning assembly
- One read block transfer file: up to ten words for the temporary storage of status data read block transferred from the stepper positioning assembly

Block Transfer Timing

The time required for a block transfer read or write operation for PLC-2 family or PLC-3 processors depends on the system scan time(s), the number of words transferred, and the configuration of block transfer modules in the system. Block transfer times for a PLC-2 family local system using 1771-AL adapter modules are faster than the block transfer times in a remote system using 1771-ASB adapter modules. Also note that PLC-3 is a remote system that uses 1771-ASB adapter modules.

Refer to the Stepper Positioning Assembly User's Manual (publication 1771-815) for additional information on block transfer timing for PLC-2 family processors. For the PLC-3 processor, refer to the I/O Scanner – Programmer Interface Module User's Manual (publication 1775-6.5.2).

Hardware Overview

The stepper controller and pulse output expander modules are single-slot modules. Their front panels contain LED diagnostic indicators. The pulse output expander module contains internal switch assemblies used to match the module to a variety of input switches and stepper motor translators.

Input Considerations

You can control the pulse output expander module manually by the use of switch inputs for stop, jog forward, and jog reverse. The stop switch causes output pulses to the corresponding axis to cease instantly. You can use jog switches to start motion only when the corresponding axis is at rest.

You can select either low=true or high=true logic for manual control of hardware inputs to the pulse output expander module.

Output Format

The output format that determines forward or reverse motion differs between translators. Therefore, you can select the output terminals of the pulse output expander module to match the required pulse input configuration of the translator. There are two translator input configurations.

In one configuration, the pulse rate is applied to the PULSE terminal, and the direction (forward or reverse) signal is applied to the DIRECTION terminal. In the other configuration, a pulse rate is applied to either one of two PULSE terminals, one PULSE terminal for forward, the other for reverse.

During installation, you can select the expander module's output logic level for stopped motion as either high, low, or last state.

Expander Module Output

You can select either push-pull, current source (open emitter), or current sink (open collector) to match the input characteristics of the stepper translator.

The push-pull output is compatible with many stepper translators.

When you use the pulse output expander module as a current source or sink for output pulses, you may need to use a pulldown or pull-up resistor, respectively in the translator input circuit.

Power Requirements

The stepper controller module and a pulse output expander module draw 1.75A and 0.80A respectively from the I/O chassis backplane power supply. These amounts (4.15A maximum for a 3-axis system) should be totalled with the current requirements of all other modules in the chassis so as not to exceed the maximum output current of the I/O chassis and power supply.

Auxiliary Power Supply

Pulse output expander modules require an additional power source for switch inputs to the module and for pulse outputs to the stepper translator. Each input switch draws 11mA maximum when closed. The maximum output current that the pulse output expander module can source or sink is 100mA.

The supply voltage can be any value between 5V DC and 30V DC required by the stepper translator and/or switch input circuits.

The variation in the DC voltage level due to ripple should not exceed the input specification for the stepper translator because the supply voltage ripple appears at the output terminals of the pulse output expander module. You can use power supplies with 15mV peak-to-peak ripple. However, check the translator input specifications to ensure that the power supply specifications meet translator input requirements.

Stepper Translator and Power Supply

The stepper translator and power supply convert digital information from the pulse output expander module into the proper voltage and current for the precise control of a stepper motor. For compatibility with the pulse output expander module, the translator must accept low=true logic. The programmed maximum pulse rate from the pulse output expander module to the translator can be any integer value up to 20,000 pulses per second.

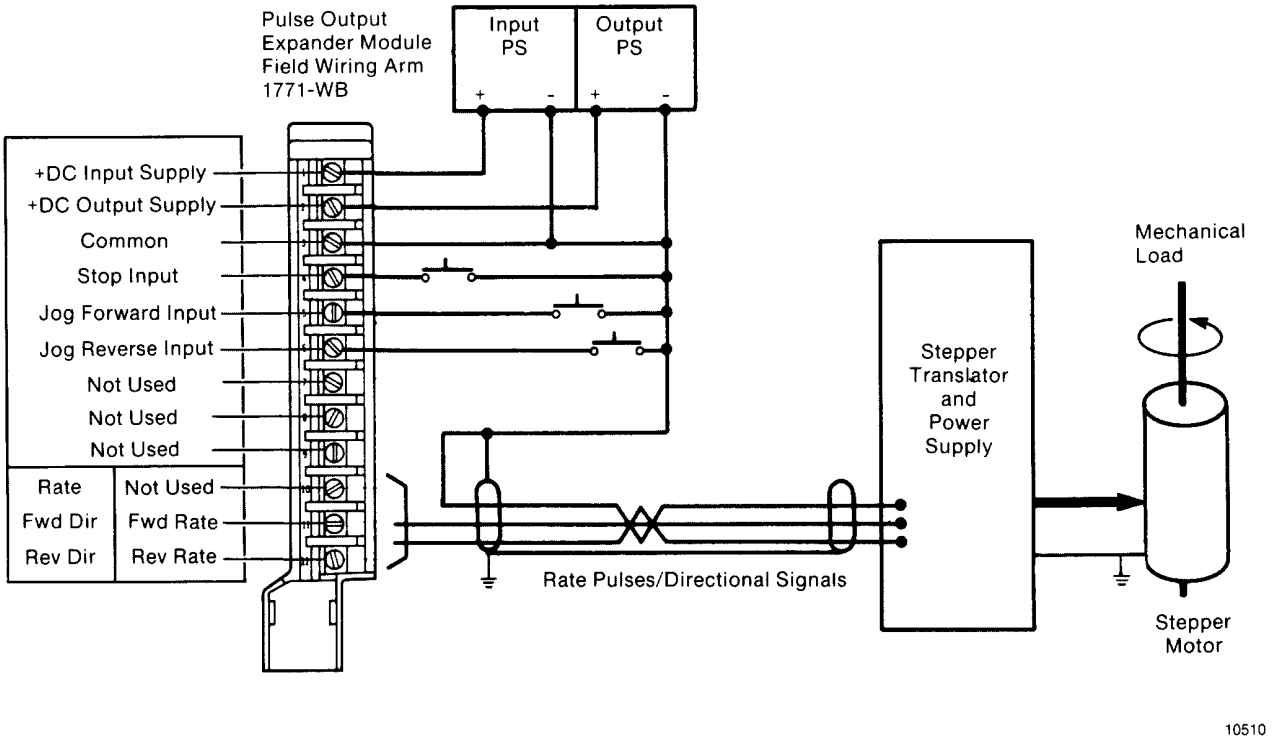
Wiring Considerations

Terminal identification and typical connections to the pulse output expander module for one axis are shown in figure 8.

The stepper positioning system is susceptible to electrical noise unless the equipment is properly grounded, the cabling is properly shielded, and the power supply is properly filtered. If not, electrical noise could adversely affect the number of position pulses output by the translator.

The stepper translator, power supply, and motor should be grounded in accordance with the manufacturer's instructions.

Figure 8
Typical 1-Axis Connection Diagram



Wire the stepper translator to the module field wiring arm Wire the stepper translator to the module field wiring arm using a twisted 3-conductor shielded cable such as Belden 8771 or equivalent. The cable distance between the pulse output expander module and the stepper translator generally should not exceed 40 feet.

Indicators

Front panel LED indicators allow you to observe the operating condition of the stepper controller and pulse output expander modules (figure 9). The indicators will be on, off, or flashing.

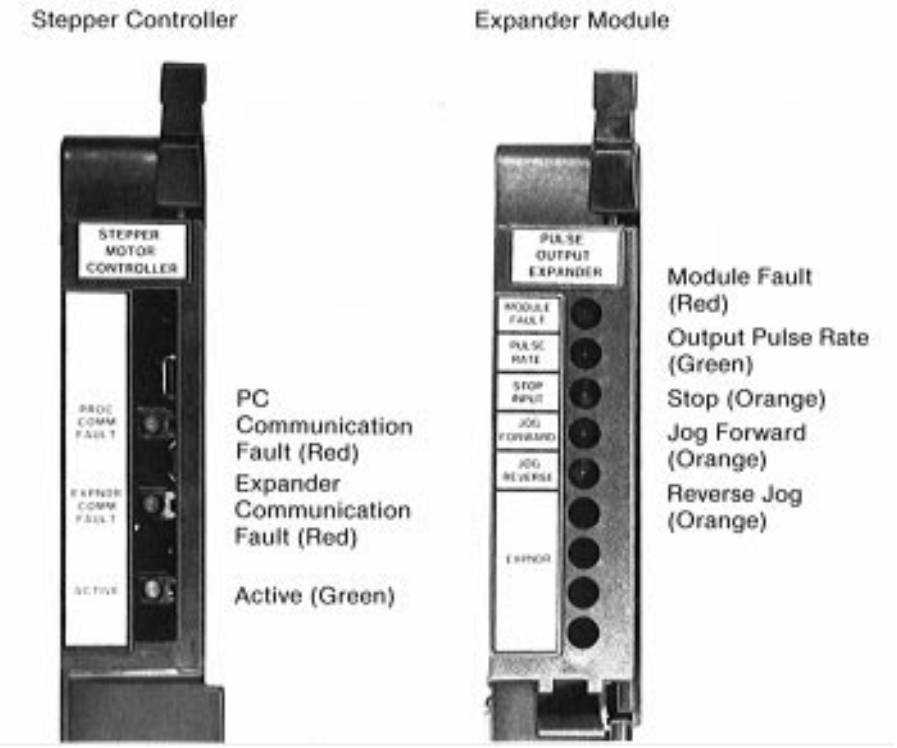
Stepper controller module indicators are:

- PC Communication Fault — Lights when a communication fault between the stepper controller module and the PC processor is detected, or when a stepper controller hardware fault is detected.
- Expander Communication Fault — Lights when a communication fault between the stepper controller module and any one of the pulse output expander modules is detected, or when a pulse output expander module hardware fault is detected.
- Active — Lights unless a hardware fault in the stepper controlled module is detected. This indicator will flash on/off, if after power-up, an invalid expander address is detected, no expander module is present, and/or another stepper controller module is detected in the same I/O chassis.

Pulse output expander indicators are:

- Module Fault — Lights if an expander module hardware fault is detected.
- Output Pulse Rate — Flashes at the output pulse rate
- Stop Input — Lights when a hardware stop input is asserted.
- Jog Forward — Lights when a hardware jog forward input is asserted.
- Jog Reverse — Lights when a hardware jog reverse input is asserted.

Figure 9
Diagnostic Indicators



Installation

Install no more than one stepper controller and three expander modules in the same I/O chassis. The modules can be located anywhere in the chassis except the left-most slot. An address switch assembly setting identifies each of the three expander modules for communications with the PC processor.

An I/O chassis that contains a stepper positioning assembly may not contain another master/expander combination. However, you may place other master modules operating in standalone mode in the same I/O chassis.

Keying

Use keying bands to guard against placing another type of module in the slots reserved for the stepper controller and expander modules. Keying positions are:

Stepper controller module

- Between 2 and 4 .
- Between 8 and 10

Pulse output expander module

- Between 8 and 10
- Between 22 and 24

Specifications

Pulse Output Expander Module (cat. no. 1771-OJ)

- Backplane Power Requirement: 800mA
- Auxiliary Power: 5-30V DC (fixed) @ 340mA max
- Input Delay: Jog @ 35-120ms, STOP @ 250us
- Input Voltage Range
  min high: +V supply –1.0V DC
  max low: 0.8V DC
- On-state Current per 5V DC Input: 8.8mA typical, 11.0mA max
- Output Voltage Range @ 10mA
  min high: +V supply –1.8V DC
  max low: +0.4V DC
- Output Voltage Range @ 100mA min high: +V supply -4.2V DC max low: +1.0V DC
- Output Current: 100mA max
- Rise/Fall Time @ 100mA 0.6us max
- Duty Cycle of Pulses: 50%
- Location: one module slot, 1771 I/O chassis
- Keying: between 8 and 10, 22 and 24

Stepper Controller Module (cat. no. 1771-M1)

- Backplane Power Requirement 1.75A max
- Number of Axes: one expander module/axis, 3 max
- Location: one module slot, 1771 I/O chassis
- Keying: between 2 and 4, 8 and 10
- Temperature Range (both modules):
  operating: 05 to 605 C (+325 to 1405 F)
  storage: –405 to 855 C (-405 to 1855 F)
- Humidity Rating (both modules): 5% to 95% (no condensation)

WORLD HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel: (1) 414 382-2000
Telex: 43 11 016
FAX: (1) 414 382-4444

EUROPE/MIDDLE EAST/AFRICA HEADQUARTERS
Allen-Bradley Europe B.V.
Amsterdamseweg 15
1422 AC Uithoorn
The Netherlands
Tel: (31) 2975/43500
Telex: (844) 18042
FAX: (31) 2975/60222

ASIA/PACIFIC HEADQUARTERS
Allen-Bradley (Hong Kong) Limited
Room 1006, Block B, Sea View Estate
28 Watson Road
Hong Kong
Tel: (852) 887-4788
Telex: (780) 64347
FAX: (852) 510-9436

CANADA HEADQUARTERS
Allen-Bradley Canada Limited
135 Dundas Street
Cambridge, Ontario N1R 5X1
Canada
Tel: (1) 519 623-1810
FAX: (1) 519 623-8930

LATIN AMERICA HEADQUARTERS
Allen-Bradley
1201 South Second Street
Milwaukee, WI 53204 USA
Tel: (1) 414 382-2000
Telex: 43 11 016
FAX: (1) 414 382-2400

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