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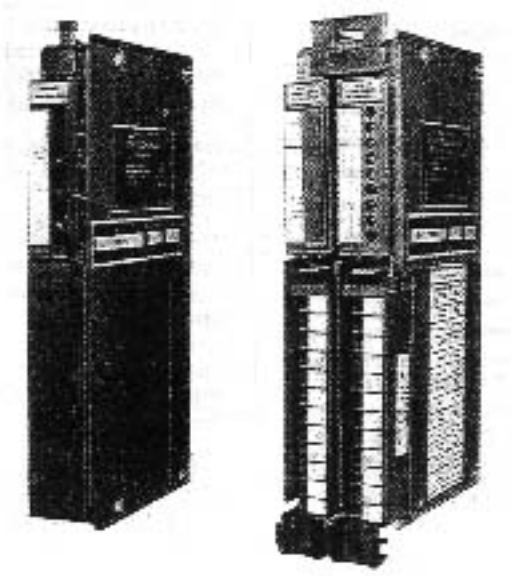
# Allen-Bradley Servo (Encoder Feedback) Positioning Assembly

(Cat. No. 1771-QC, Series B)

Product Data



## Description

A Servo Positioning Assembly consists of:

- one Servo Controller Module (cat. no. 1771-M3)
- one Servo Expander Module (cat. no. 1771-ES) which includes two Field Wiring Arms (cat. no. 1771-WB)

With a basic servo positioning assembly (plus a servo drive, motor, tachometer, and encoder) you can control the motion of one user-supplied axis. You can add a second 1771-ES expander to control a second axis and a third 1771-ES expander to control a third axis. A 1771 I/O chassis can accommodate one 1771-M3 expander and a maximum of three 1771-ES expanders.

## Applications

Typical applications for a servo positioning assembly include:

- grinders
- transfer lines
- material handling machines

## Function

Figure 1 shows a closed-loop axis servo system. The 1771-M3 controller communicates with the 1771-ES expander thru I/O chassis backplane connections.

The PC processor sends commands and user-programmed data from the data table to the 1771-M3 controller as directed by a block transfer write instruction. The 1771-M3 controller coordinates the block transfers automatically, keeping ladder diagram programming to a minimum.

Based on information it receives from the processor, the 1771-M3 controller sends axis motion commands to the 1771-ES expander.

The 1771-ES expander closes the servo positioning loop. It commands axis motion by sending an analog velocity command voltage signal to your servo drive. Every 2.4ms it updates this analog output voltage according to incremental position feedback from your encoder, discrete inputs, and axis motion commands from the 1771-M3 controller. The 1771-ES expander is able to provide this fast servo sample rate because the update is independent of the I/O scan.

A drive-disable output provides a signal to disable the servo drive in conditions such as loss of feedback or hardware stop. Discrete hardware inputs include hardware stop, jog forward, jog reverse, home limit, feedrate enable, and hardware start.

The 1771-M3 controller sends axis status and diagnostic data to the data table as directed by a block transfer read instruction. Because axis command and status data is stored in the data table, axis motion control can be interactive with other axes, discrete I/O, and report generation.

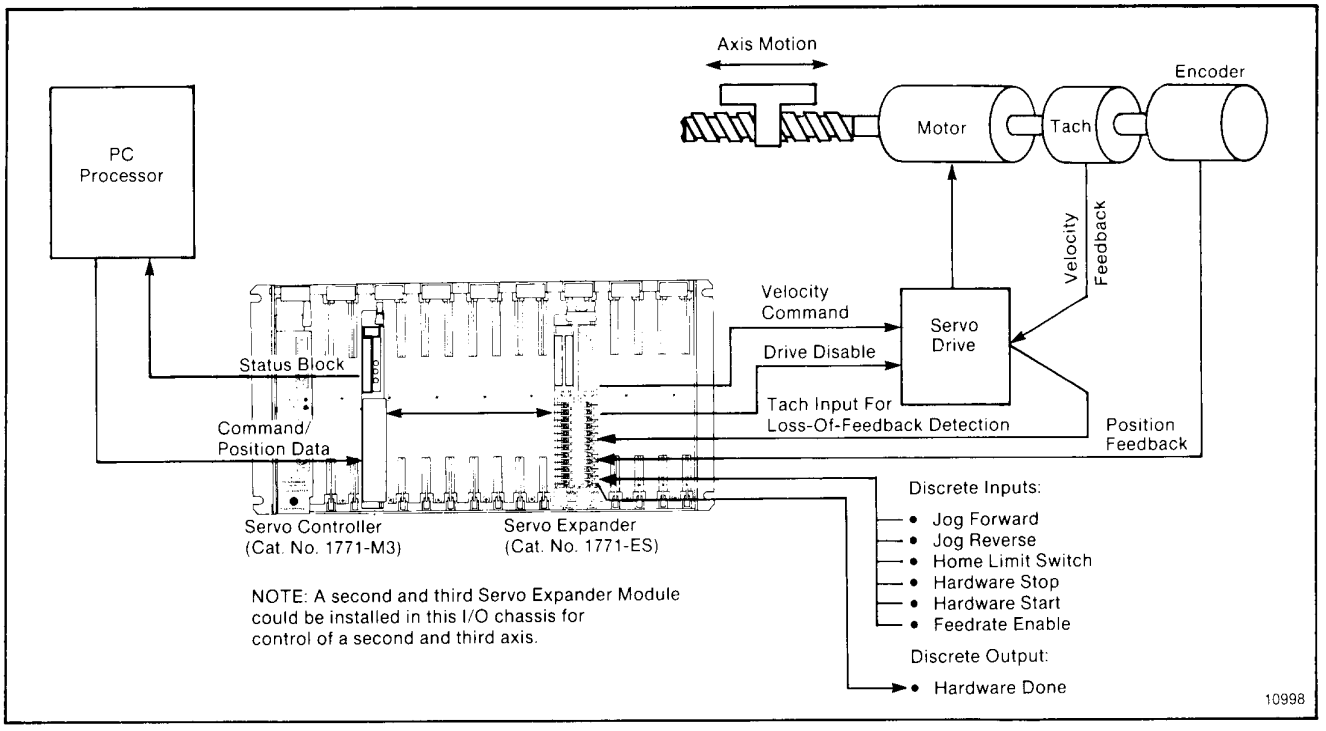
## Features

A servo positioning assembly has many features that can provide useful benefits for closed-loop positioning applications. A series B servo positioning assembly provides:

- **incremental digital encoder feedback** — for precise closed-loop positioning
- **absolute or incremental positioning commands** — for programming flexibility

- **programmable gain break** — to allow high gain for precise positioning at low speed and low gain for stability at high speed
- **programmable acceleration/deceleration** — to optimize the machine cycle time over varying loads
- **programmable in-position band** — for flexibility of positioning accuracy

**Figure 1**
**Closed Loop Axis Servo System**




- **programmable jog rates** — for flexibility of manual positioning
- **programmable dwell** — for precise dwell times
- **excess following error detection** — for automatic drive shutdown if the axis following error becomes too large
- **loss of feedback detection** — to allow automatic drive shutdown during a move if tachometer or encoder feedback is lost
- **software travel limits** — to guard against axis overtravel
- **backlash takeup** — to compensate for mechanical backlash in an axis
- **offset** — to compensate for a variation in tool length or fixture dimension
- **preset** — to allow redefinition of axis coordinates

- **optically isolated analog output** — to guard against noise entering the backplane circuits and to limit the potential for damage due to improper connection
- **external hardware start and done signals** — to synchronize moves with other axes
- **encoder inputs selectable for high-true or low** — true to allow compatibility with a wider range of encoders
- **synchronized start of feedrate override** — to allow you to activate a pre-loaded feedrate override value to change speed on several axes simultaneously
- **sensing of customer power supply loss** (dc supplies shown in figure 2) — to allow an orderly shutdown of the servo system and to provide you with this diagnostic information
- **following error reduction** — to allow you to reduce following error by up to 99.9% without increasing gain (thru feed forwarding)
- **constant velocity command** — to allow you to run an axis continuously at a selected velocity (could apply to controlling a conveyor)
- **moveset override** — to allow you to modify a moveset while it is being executed
- **diagnostic words in the status block** — to provide your ladder diagram program with access to diagnostic information for hardware and program troubleshooting

## Compatibility

You cannot use a series A 1771-M3 controller with a series B 1771-ES expander. Likewise, you cannot use a series B 1771-M3 controller with a series A 1771-ES expander.

### Compatible Encoders

The 1771-ES expander is compatible with Allen-Bradley Incremental Differential Line Driver Encoders (cat. no.845N-SJDN4-C) and with other encoders having 5V line-driver outputs, 5V totem-pole (TTL) outputs, or 5-30V open-collector outputs.

### Compatible Drives/Motors

The 1771-ES expander is compatible with a wide variety of servo drives, including Allen-Bradley Bulletin 1388 DC Servo Controllers. Allen-Bradley also offers Bulletin 1326 DC Servo Motors to match the Bulletin 1388 DC Servo Controllers.

### Compatible Processors

The servo positioning assembly can be used with PC processors that have block transfer capability and adequate data table size. Compatible processors include:

- Mini-PLC-2/05 (cat. no. 1772-LS, -LSP)
- Mini-PLC-2/15 (cat. no. 1772-LV)
- PLC-2/20 (cat. no. 1772-LP2)
- PLC-2/30 (cat. no. 1772-LP3)
- PLC-3 (cat. no. 1775-L1, -L2)

## Hardware

The 1771-M3 controller requires one I/O chassis slot. You can install it Hardware in any I/O slot in the I/O chassis. The 1771-ES expander requires two slots; install it in a pair of slots which make up an I/O module group.


### Indicators

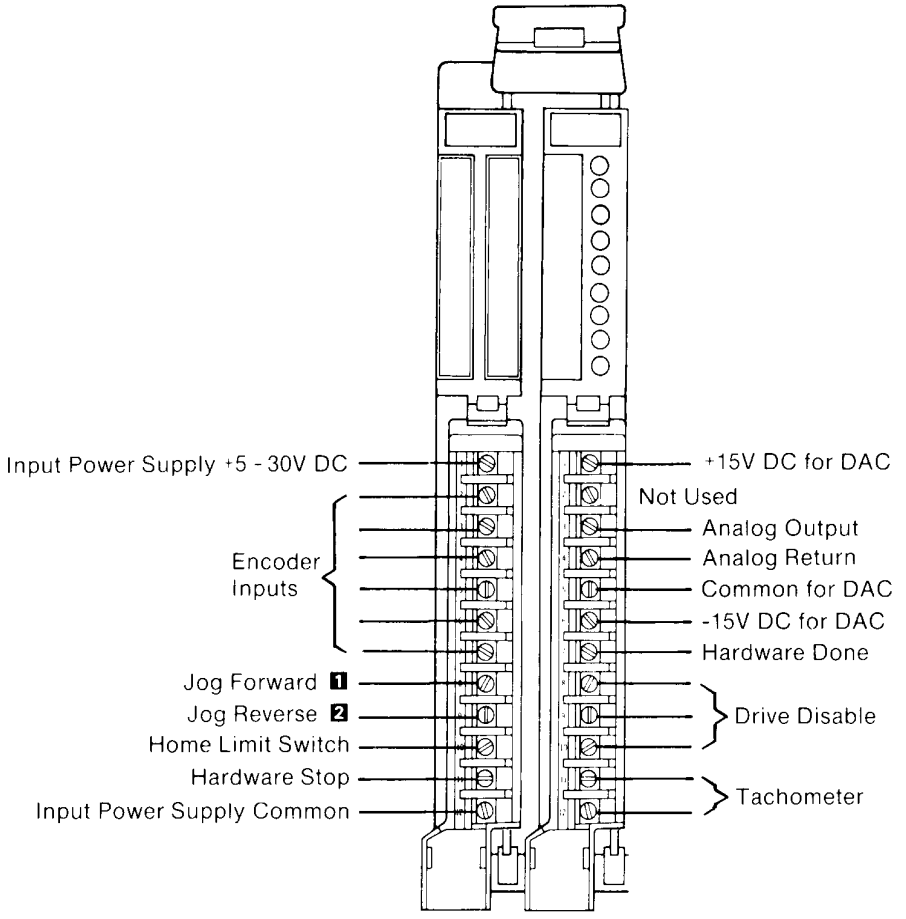
The 1771-M3 controller has three indicators. With the PC Indicators processor in the run mode, the indicators have the following functions:

- **Processor Communication Fault** — This red indicator turns on when the module detects a fault in the communication between it and the PC processor. The I/O adapter module or PC processor will not detect this as a fault.
- **Expander Communication Fault** — This red indicator turns on when the module detects a fault in the communication between it and a 1771-ES expander.
- **Active** — This green indicator is normally on. It turns off when a hardware fault is detected on a 1771ES expander. It blinks if you have not properly configured the modules.


The 1771-ES expander has six indicators. With the PC processor in the run mode, the indicators have the following functions:

- **Module Active** — This green indicator is on when the module is operating normally.
- **Marker** — This green indicator is on when the channel A, channel B, and marker signals are true simultaneously.
- **Home** — This green indicator is on when the axis is in the home position.
- **Tach Calibrate** — This green indicator is used in setting the adjustments for loss of feedback detection.
- **Hardware Stop** — This red indicator goes on when the hardware stop input opens. It stays on until the input closes and the servo expander module is reset.
- **Diagnostic** — This red indicator goes on when a fault is detected at the servo expander module.

**Figure 2**
**I/O Terminal Connections**




1 In the auto mode, the module accepts this input as the hardware start signal.

2 In the auto mode, the module accepts this input as the feedrate enable signal.

**NOTE:** All connections are limited to 50 cable-feet.

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## Module Configuration

You can install one 1771-M3 controller in an I/O chassis together with either one, two, or three 1771-ES expanders. The I/O chassis must not contain any other master/slave (expander) module combination. If the module configuration violates either of these rules, the ACTIVE indicator on the 1771-M3 controller will blink. When planning module configuration, also consider the backplane power supply load of all modules in the I/O chassis.

### Connections

You will make all connections to the 1771-ES expander terminals (figure 2).

You can connect the drive disable signal to the servo drive to provide either a current source or a current sink to enable the drive. For all connections to the terminals, limit the cable length to 50 ft. For details on how to connect to these terminals, refer to the Servo Positioning Assembly User's Manual (publication 1771-832).

### External Power Supplies

You must provide at least two external power supplies.

You'll need a supply (5V DC to 30V DC) for the input circuits. The input circuits require 500mA (max) at 30V. You could use this same supply to power the encoder. However, the supply must have enough additional current capacity for the encoder.

Unless the servo drive provides its own DC voltage source for this circuit, you'll also need a supply (5V DC to 30V DC) to provide 100mA (max) for the drive disable circuit.

A separate ±15V DC supply is needed to provide 200mA (max) for the digital/analog converter (DAC) to generate the analog output signal and for the hardware done output circuit.

## Programming and Operation

Program the PC processor to communicate with the 1771-M3 controller thru a block transfer read instruction and a block transfer write instruction.

### Data Blocks

The block transfer read instruction transfers status block data from the module to the data table. The block transfer write instruction transfers the parameter block, the moveset block, and the control block data from the data table to the module.

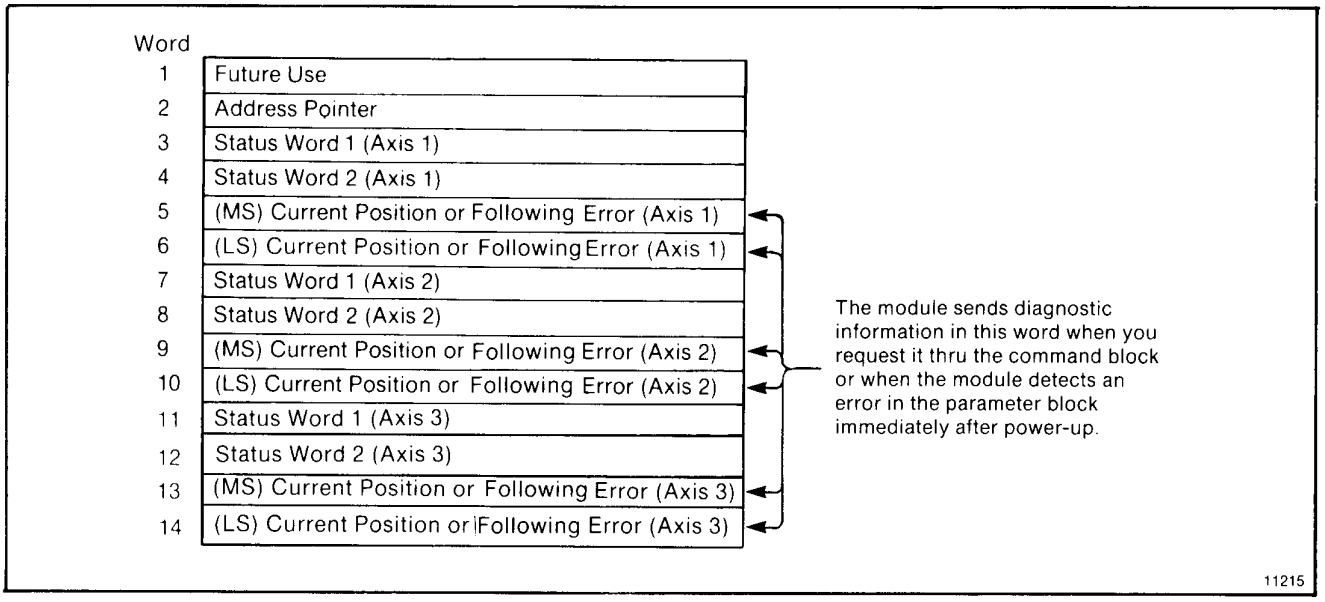
#### Status Block

The status block (figure 3) is regularly transferred to the data table to provide updated information about the current status of each axis. This status includes:

- actual axis position
- in position
- at home position

- slide stop
- emergency stop
- software travel limit exceeded
- feed reduction
- excess following error
- auto/manual mode
- diagnostic status that tells you where programming errors are in parameter, moveset, and control blocks

**Figure 3**
**Status Block**




The first block transfer after power-up writes a 6-word status block into the data table. After that, the status block consists of 6 words for a 1-axis system, 10 words for a 2-axis system, or 14 words for a 3-axis system. You establish the address of the status block thru the block transfer read instruction. Because axis command and status data is stored in the data table, axis motion control can be interactive with other axes, discrete I/O, and report generation.

### Parameter Block

The parameter block for a 1-axis system has 25 words. The parameter block for a 2-axis system has 44 words. The parameter block for a 3-axis system has 63 words (figure 4).

Parameters (such as: software travel limits, home position, servo gain, global accel/decel rate, rapid traverse rate) are specified for each axis separately.

The processor transfers the parameter block to the module thru a block transfer write. This provides axis parameter information after a power-up and after a command block commands a reset or new parameters.

### Move set Block

A moveset block describes a sequence of axis moves (figure 5).You can program axis motion to provide either single step moves (figure 6) or continuous moves (figure 7).

**Figure 4**
**Parameter Block**

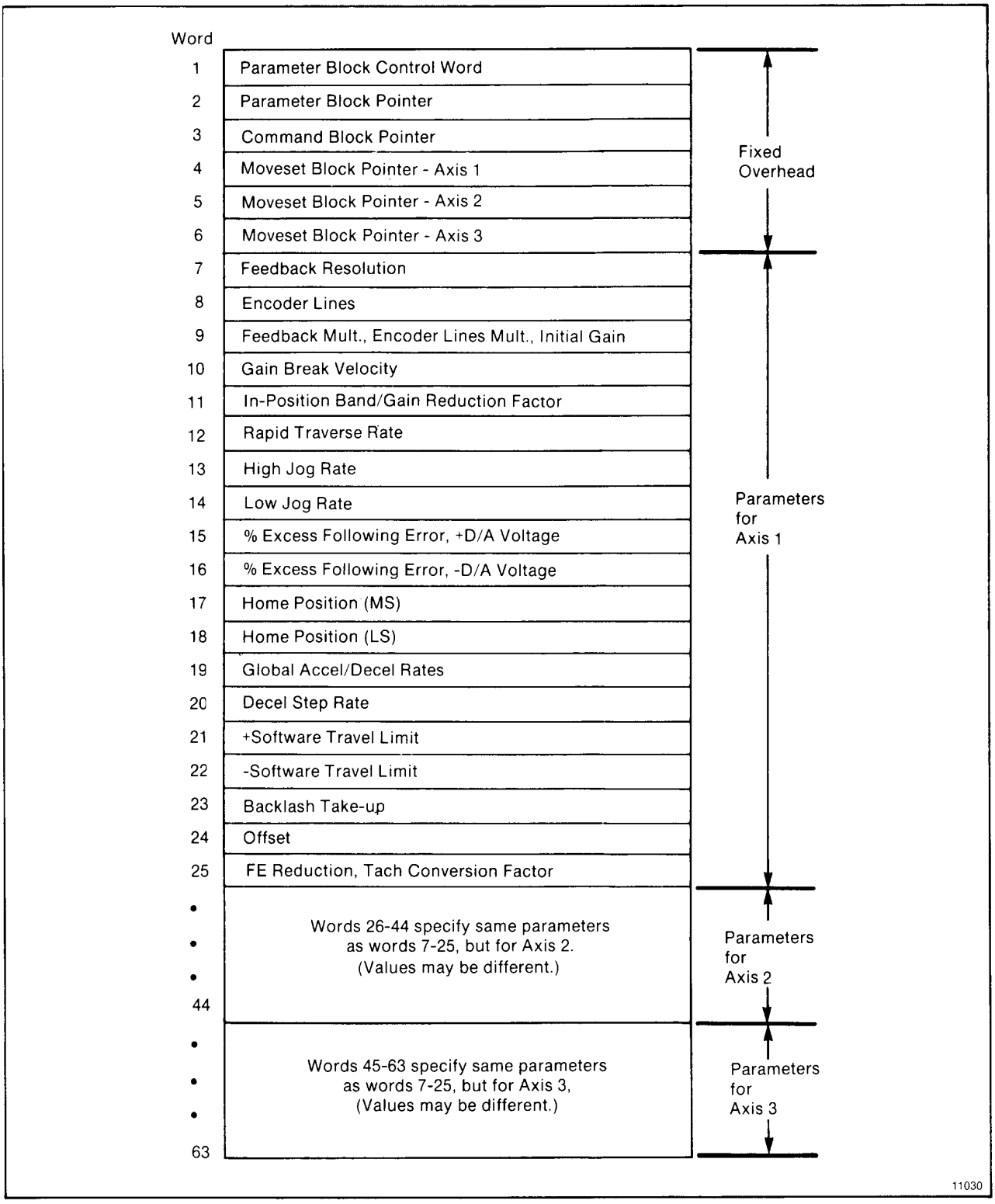


**Figure 5**
**Moveset Block**

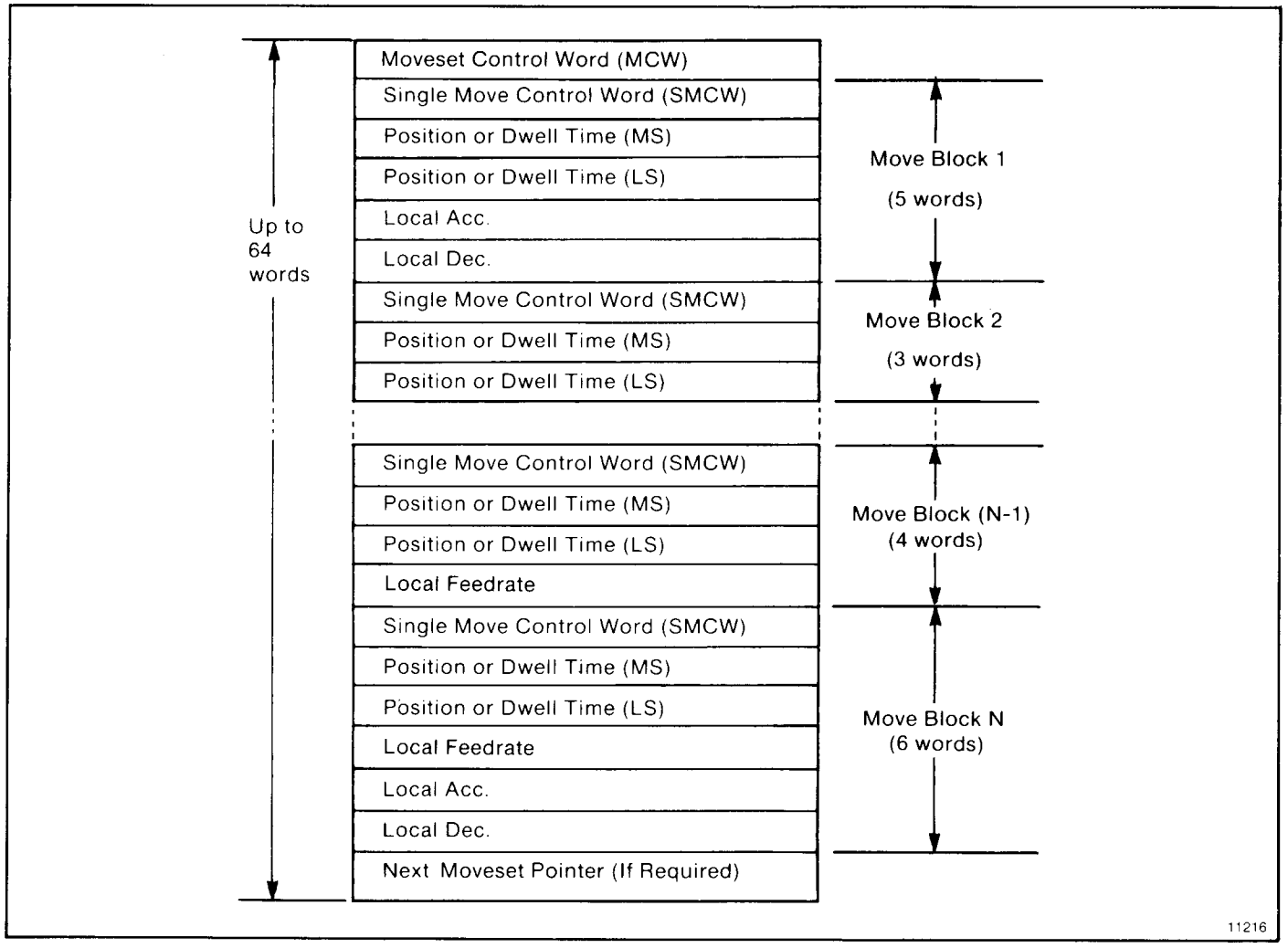


**Figure 6**
**Moveset Profile with All Single Step Moves**

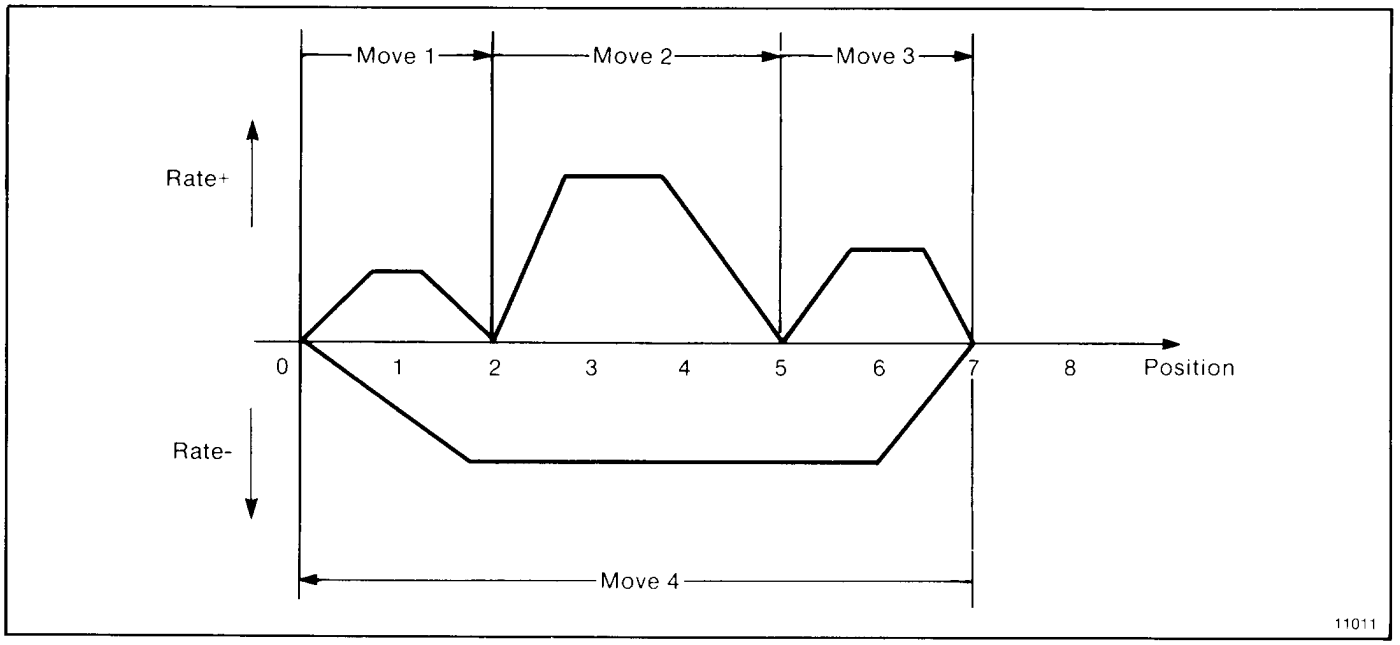
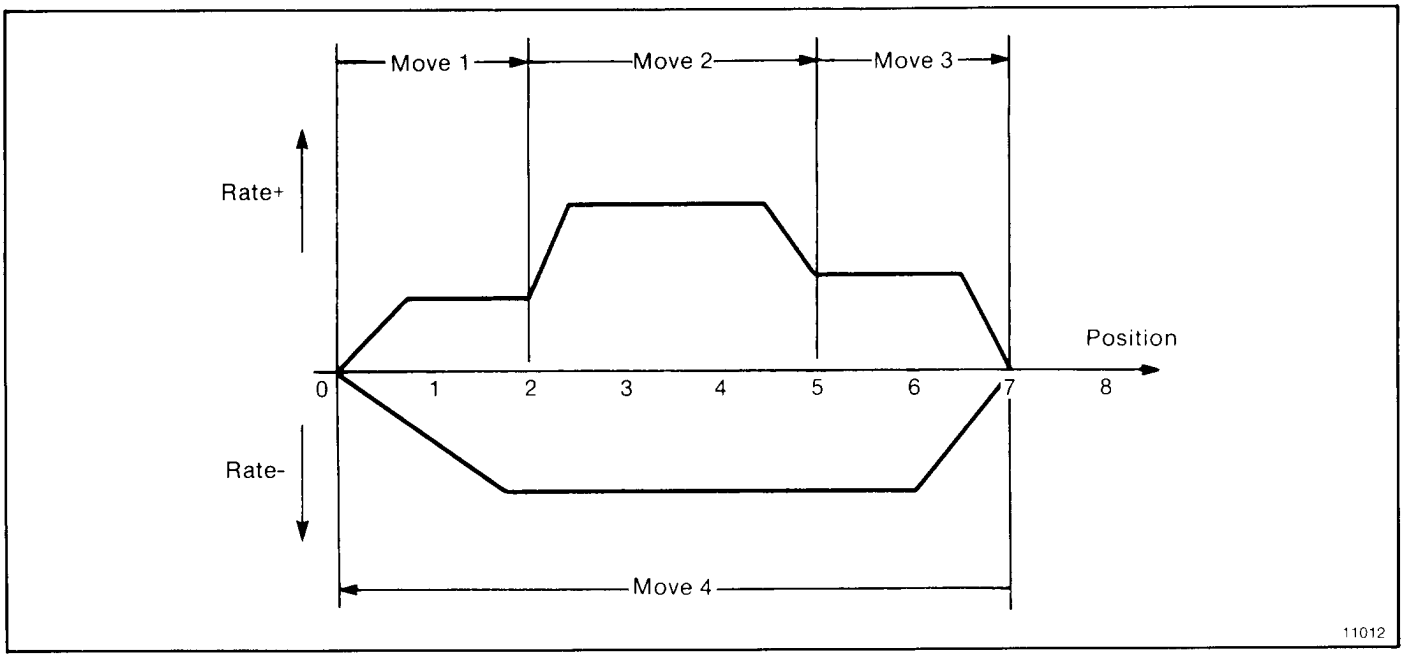



**Figure 7**
**Moveset Profile with All Continuous Moves**



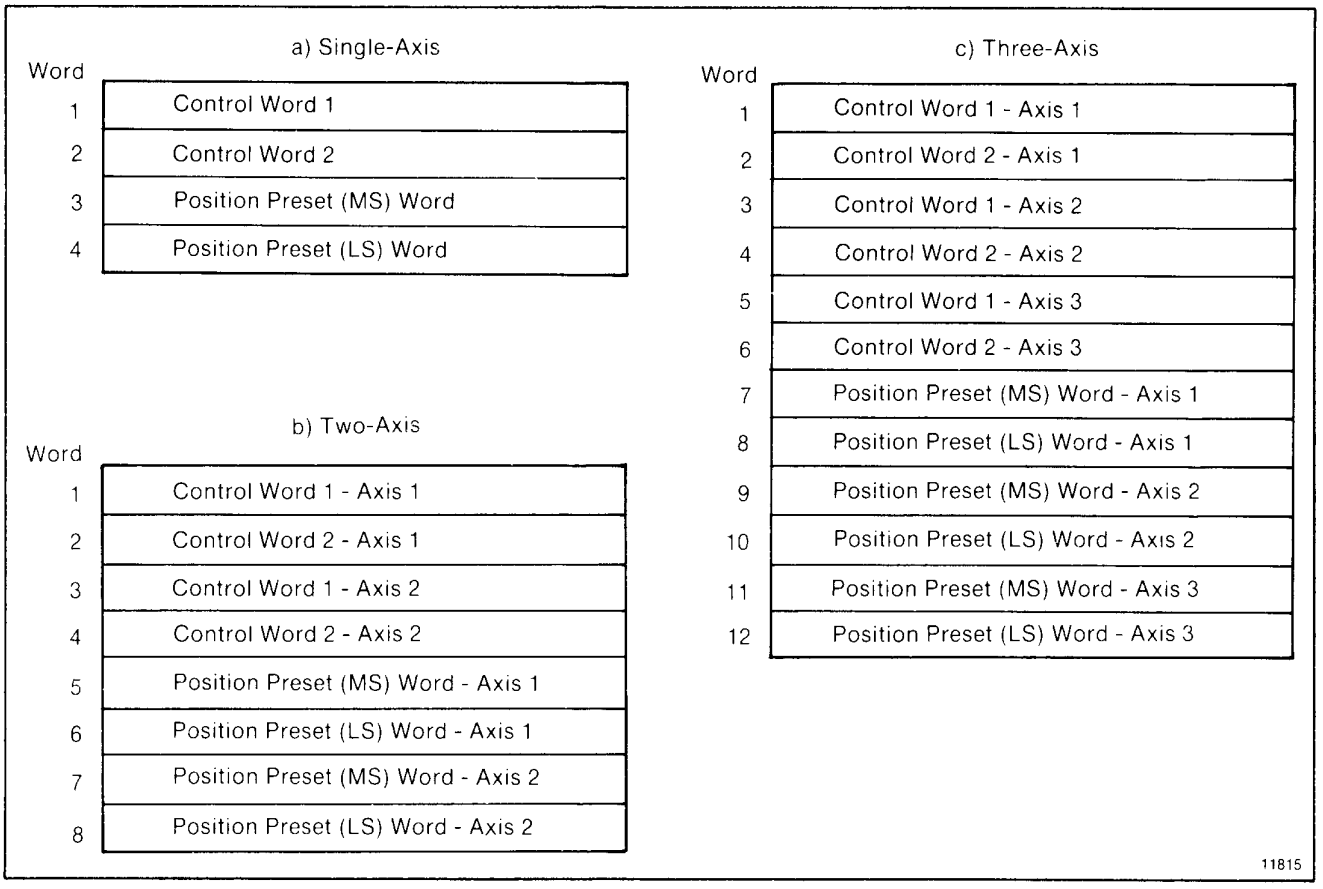
Each move requires a minimum of three words (a single move control word and two words to define position or dwell time) and can include three optional words (a rate word, an accel word, and a decel word) for a total of six. A moveset control word applies to the entire block. A next moveset pointer word is also required if additional moveset blocks are needed. A moveset block can be 64 words long maximum and describe 21 moves maximum. To describe 21 moves in a single moveset block, all 21 moves would have to use the global accel/decel and final rate values from the parameter block.

Upon request from the status block, the PC processor sends a moveset block to the 1771-M3 controller, which transfers each move description to the 1771-ES expander one at a time. The 1771-ES expander generates the analog voltage to command axis motion as programmed.

### Command Block

The command block for a 1-axis system has up to four words. The command block for a 2-axis system has up to eight words. The command block for a 3-axis system has up to 12 words. This block is regularly transferred from the data table to provide control commands (such as start, slide stop, search home, jog, reset, and offset) for each axis unless a parameter or moveset block is needed. You must include the command block address in the parameter block (figure 8).

**Figure 8**
**Command Block**




## Data Table Allocation

You must allocate a sufficiently large data table area for the data blocks needed in the block transfer communication. Furthermore, the parameter block must start at least 63 words before the end of a contiguous data table area. Also, each moveset block (regardless of size) must start at least 64 words before the end of a contiguous data table area.

## Timing Considerations

To properly apply the servo positioning assembly, you must consider the time it takes for block transfer between your PC processor and the servo controller module.

For detailed information on timing considerations, refer to the Servo Positioning Assembly User's Manual (publication 1771-832).

**Product Data**
Servo (encoder Feedback)
Positioning Assembly

## Specifications

**Servo Output Voltage**
- ±10V DC max (isolated)

**D/A Converter (DAC)**
- Signed 12 bit res

**Encoder Input**
- High: < 1.6V
- Low: > 1.0V

**Sinking 1mA Encoder Input Rate**
- Differential: 250kHz max
- Single-Ended: 20kHz max
- Jumper selection of differential or single-ended

**Encoder Multiplier**
- x1, x2, or x4, programmable

**Tachometer Input**
- Full Scale Voltage: 3V min, 50V max
- Input Impedance: 20k ohms

**Discrete Input**
- Resistance: 11.2k or 1.2k, switch selectable for each input
- High: > 40% of supply voltage
- Low: < 20% of supply voltage
  With 1.2k, Sink 4mA @ 5V, 25mA @ 30V
  With 11.2k, Sink 0.5mA @ 5V, 2.7mA @ 30V

**Hardware Done Output**
- On: +15V source thru 1k ohms
- Off: 5.0mA sink

**Drive Disable Output**
- Current: 100mA max, source or sink
- Voltage: 30V DC max

**Backplane Current**
- 1771-M3 Controller: 1.75A
- 1771-ES Expander: 1.70A

**Max Programmable Position**
- ±999.9999 in (res 0.0001 in)
- ±19999.999 mm (res 0.001 mm)

**Programmable Speed**
- 0.0001 – 9990 ipm (res 0.0001 ipm )
- 0.001 – 199900 mmpm (res 0.001 mmpm)

**Accel/Decel**
- 9999 ipm/s max (res 1 ipm/s )
- 99.99 mpm/s max (res 0.01 mpm/s)

**Initial Servo Gain (Programmable)**
- 0.01 – 9.99 ipm/mil following erro r
- 0.0 1
- 9.99 mmpm/mil following error

**Servo Sample Period**
- 2.4ms

**Environmental Conditions**
- Operational Temperature:
  0° to 60°C (32° to 140°F )
- Storage Temperature:
  -40° to 85° (-40° to 185°F )
- Relative Humidity:
  5% to 95% (without condensation)

**Keying**
- Servo controller slot:
  between 2 and 4, 8 and 1 0
- Left servo expander slot:
  between 2 and 4,14 and 1 6
- Right servo expander slot:
  between 4 and 6, 32 and 34

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