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Bam-ST™

Stepper Motor Interface

for the

Bam™ Machine Controller

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BAMST-989b
Revision 1.2

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1. Introduction

The Bam-ST, Stepper Motor Interface, provides step and directional pulse output for use with most brands of stepper motors and stepper drives. A *Bam* Series-32 Machine Controller, in conjunction with the stepper motor interface, can drive stepper axes while also controlling servo axes. The Bam-ST allows you to integrate stepper and servo functions into one, efficient process.

Bam-ST, stepper motor interface, is an external module that allows you to control two axes of stepper motor. Connection to the *Bam* Series-32 and to stepper drives is simplified through use of the Bam-CA1-x, Bam-CA2-x cables and Bam-CA6 cables, respectively. The stepper interface is housed in a small, lightweight, all metal enclosure that can be easily mounted in your system.

Stepper axes may be run closed or open loop, and full, half, or micro step. The full scale step rate options available are 640 KHz for microstepping, 80 KHz for intermediate rate microstepping, 10 KHz for standard steppers, and 5 KHz for slow steppers.

The Bam-ST is connected to the *Bam* Series-32 Machine Controller via controller connector C-2. The output of the C-2 connector on the *Bam* controller is a ±10 Vdc signal that is interpreted and converted to step and direction by the Bam-ST stepper motor interface. Each Bam-ST is capable of handling two axes.

This manual provides the necessary information to interface the *Bam* Series-32 Machine Controller and the Bam-ST stepper motor interface with your stepper driven system.

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2. Hardware Information

2.1 General Description

The Bam-ST Stepper Interface has three connectors configured by function: Connectors S1 and S2 provide the stepper motor drive signals for each of two axes. Connector S3 is used to connect the Bam-ST module to the *Bam* Series-32 Machine Controller. Figure 1 gives the location of these connectors.

Connector S1 Axis-1 Stepper Motor Drive:

This connector provides outputs to the Axis-1 stepper motor drive in the form of differential RS-422 step and direction signals. The full-scale step rate is selected by jumpers at this connector. The cable from this connector goes to the stepper motor drive.

Connector S2 Axis-2 Stepper Motor Drive:

This connector provides outputs to the Axis-2 stepper motor drive in the form of differential RS-422 step and direction signals. The full-scale step rate is selected by jumpers at this connector. The cable from this connector goes to the stepper motor drive.

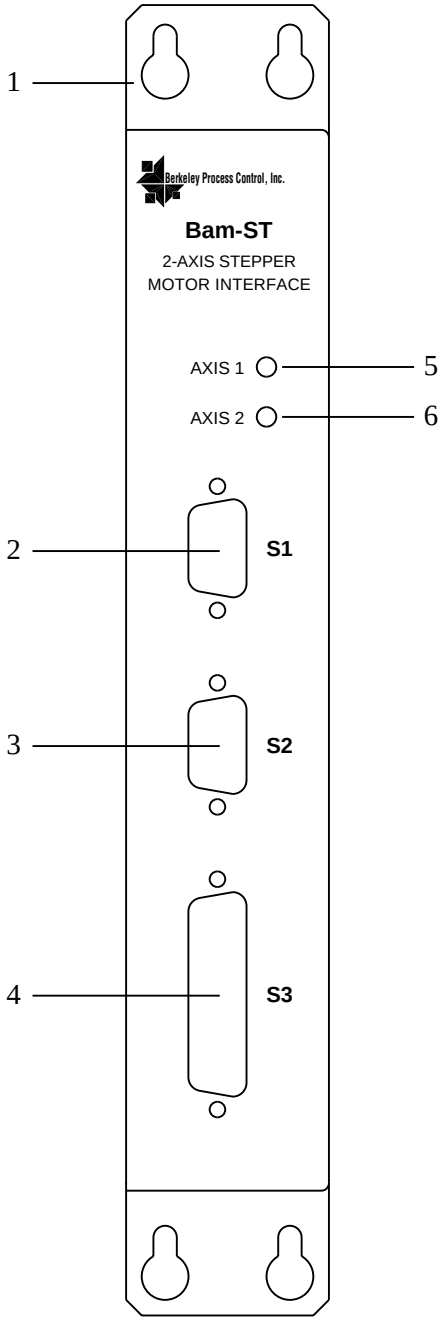
Connector S3 *Bam* Machine Controller Control and Feedback:

Outputs from the *Bam* Machine Controller enter at this connector to generate the stepper motor motion requested. These signals are industry standard ±10 Volt command signals for each axis. This connector also provides differential RS-422 phase A and phase B quadrature outputs to the *Bam* machine controller.

Two LEDs are located on the front panel of the Bam-ST module to indicate the status of each axis. The LEDs are on when a motion command is being received.

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1. Panel Mounting Bracket
2. Axis-1 Stepper Motor Drive Interface
3. Axis-2 Stepper Motor Drive Interface
4. Bam Machine Controller Control and Feedback Interface
5. Axis-1 Active LED
6. Axis-2 Active LED

Figure 1. Bam-ST Front Panel

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2.2 Mounting Requirements

The Bam-ST stepper interface is designed for easy mounting within your system. Figure 2 shows the dimensions required for mounting. BPC recommends #8-32 fasteners for the best mounting fit.

If the Bam-ST stepper interface is to be installed within a closed environment such as a cabinet, it is important to observe the air flow requirements. Proper operation of the Bam-ST requires good cooling.

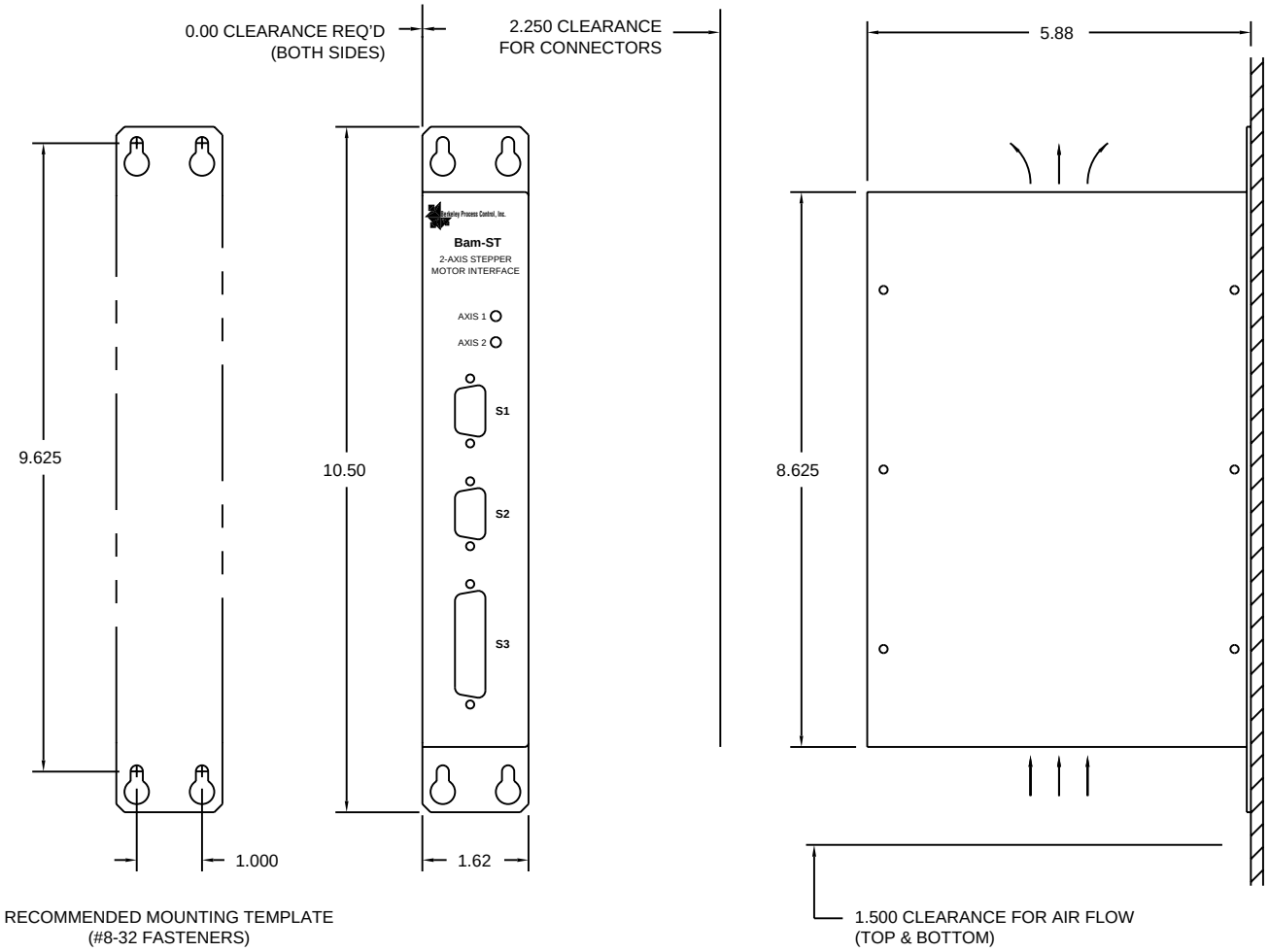


Figure 2. Mounting the Bam-ST

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3. Interfacing Specifications

3.1 Connectors S1 and S2

3.1.1 Connector S1 and S2 Pin Assignments

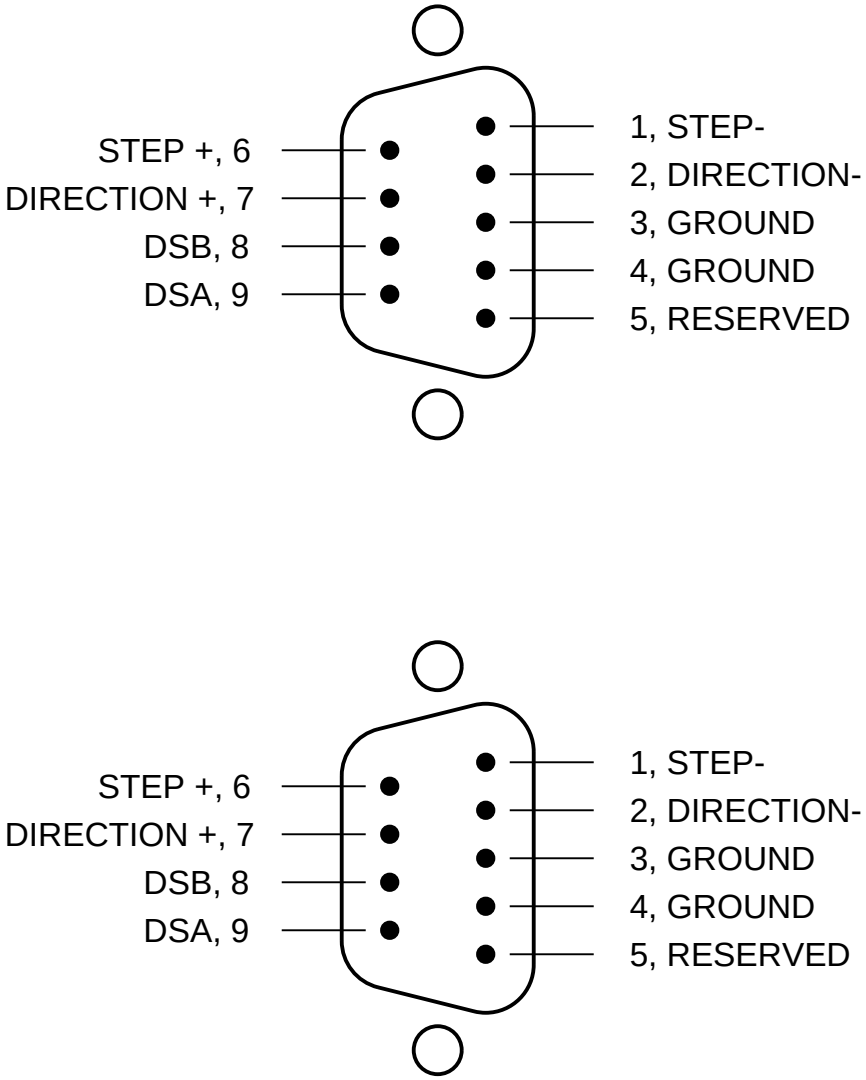


Figure 3. Connector S1, Axis-1 (top) and Connector S2, Axis-2 (bottom) Pin Assignments

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3.1.2 Connector S1 and S2 Signal Descriptions

STEP+ and STEP–

This pair of output signals differentially drive a twisted pair of wires connected to the step inputs of the stepper drive. The signal levels meet the requirements of EIA standard RS-422, and are protected against short-circuits. If the stepper drive requires a single-ended step and ground pair, use only the STEP+ signal.

DIRECTION+ and DIRECTION–

This pair of output signals differentially drive a twisted pair of wires connected to the direction inputs of the stepper drive. The signal levels meet the requirements of EIA standard RS-422, and are protected against short circuits. If the stepper drive requires a single-ended direction and ground pair, use only the DIRECTION+ signal.

DSB and DSA

These two inputs are used to select the full-scale step rate. This is the step rate when the control command input is +10 or –10 Volts. Table 1 describes the connections necessary to select the step rate. The step rate that is chosen is dependent on the maximum speed of the motor and the number of steps per revolution of the motor.

Full-scale Step Rate	DSB	DSA
640 Khz	Connect to Pin 4	Connect to Pin 3
80 Khz	Connect to Pin 4	No Connection
10 Khz	No Connection	Connect to Pin 3
5 Khz	No Connection	No Connection

TABLE 1. Full Scale Step Rate Selection

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3.1.3 Connector S1 and S2 Specifications

Step and Direction Signals:

Connector Type:	DB9S (female)
Type:	Differential RS-422
Signal Levels:	HIGH ≥ 3.0V at 20 mA. LOW ≤ 0.5V at 20 mA.
Driver Impedance:	120 Ohm.
Cable Length:	< 4000 ft.
Minimum Direction Setup to Step:	390 ns.
Minimum Direction Hold from Step:	670 ns.
Minimum Step Pulse Width:	500 ns.

3.1.4 Interfacing Notes

- The connectors may have jumpers installed to select the appropriate step rate for your motor. Please refer to Table 1.

- Please refer to the user's manual for the stepper motor drive that you are using to determine the proper connections for the S1 and S2 connectors.

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3.2 Connector S3

3.2.1 Connector S3 Pin Assignments

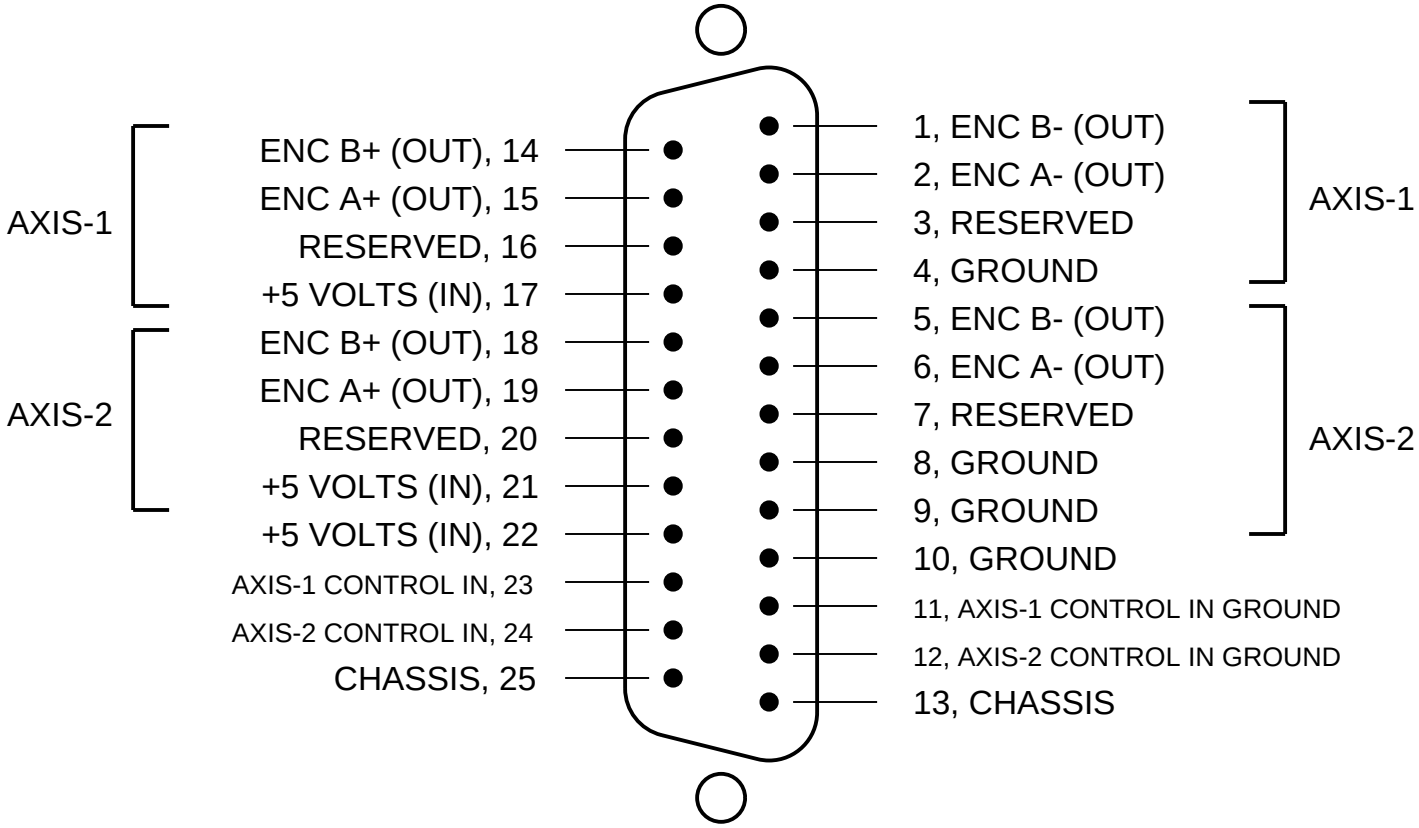


Figure 4. Connector S3 Pin Assignments

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3.2.2 Connector S3 Signal Descriptions

Axis-1	B+, B– A+, A–	These four output signals comprise the differential quadrature feedback to C-1a or C1-b of the *Bam* Machine Controller for the stepper Axis-1. The axis output signals A+, A–, B+, and B– should be shielded separately and this shield should connect to the shield pin on *Bam* connector C-1a or C-1b.
Axis-2	B+, B– A+, A–	These four output signals comprise the differential quadrature feedback to C-1a or C1-b of the *Bam* Machine Controller for the stepper Axis-2. The axis output signals A+, A–, B+, and B– should be shielded separately and this shield should connect to the shield pin on *Bam* connector C-1a or C-1b.
Axis-1	Control In Control Gnd	This pair of analog input signals is driven by the Axis-1 command voltage from C-2a or C2-b of the *Bam* Machine Controller. The command voltage ranges from -10 Volts to +10 Volts.
Axis-2	Control In Control Gnd	This pair of analog input signals is driven by the Axis-2 command voltage from C-2a or C2-b of the *Bam* Machine Controller. The command voltage ranges from –10 Volts to +10 Volts.
+5 and GROUND		These inputs provide power for the Bam-ST.
CHASSIS		This pin is connected to the enclosure of the Bam-ST. The Control In and Control Gnd wires connecting the signals from the *Bam* Machine Controller to the Bam-ST should be shielded twisted pairs with the shields connected to this pin.

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3.2.3 Connector S3 Specifications

Quadrature Output Signals:

Connector Type:	DB37S (female)
Signal Type:	Differential RS-422
Signal Levels:	HIGH ≥ 3.0V at 20 mA. LOW ≤ 0.5V at 20 mA.
Driver Impedance:	120 Ohm.
Cable Length:	< 4000 ft.
Maximum Count Rate:	640 KHz.

Command Inputs:

Type:	Differential Analog:
Signal Levels:	+10 Volts = Full Speed Clockwise –10 Volts = Full Speed Counter-clockwise
Input Impedance:	10K Ohms
Common-Mode Input Range:	–14.5 Volts to +13.5 Volts

Power Inputs:

Voltage:	4.5 to 5.5 Volts
Current:	580 mA maximum.

3.2.4 Interfacing Notes

- The Bam-ST stepper motor interface module permits combining servo and stepper motors in a system operated by one central controller and programmed in one language. Berkeley Process Control sells a connector kit with solder cup connectors to provide flexibility in configuring an S3 compatible cable.

- Standard BPC Bam-CA1-x, encoder cables and Bam-CA2-x controller output cables should be used to configure the cable required for the Bam-ST S3 connector for your system. The -x indicates the number of axes supported by the cable. Please see Figures 6 and 7.

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- For open-loop stepper operation, +5 Volt power is provided from the *Bam* connector C-1a or C-1b via the Bam-CA1-x cable.

- For closed-loop stepper operation, the Bam-CA6 cable may be used to provide +5 Volt power to the Bam-ST.

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3.3 Cabling Requirements

3.3.1 Open Loop Connections

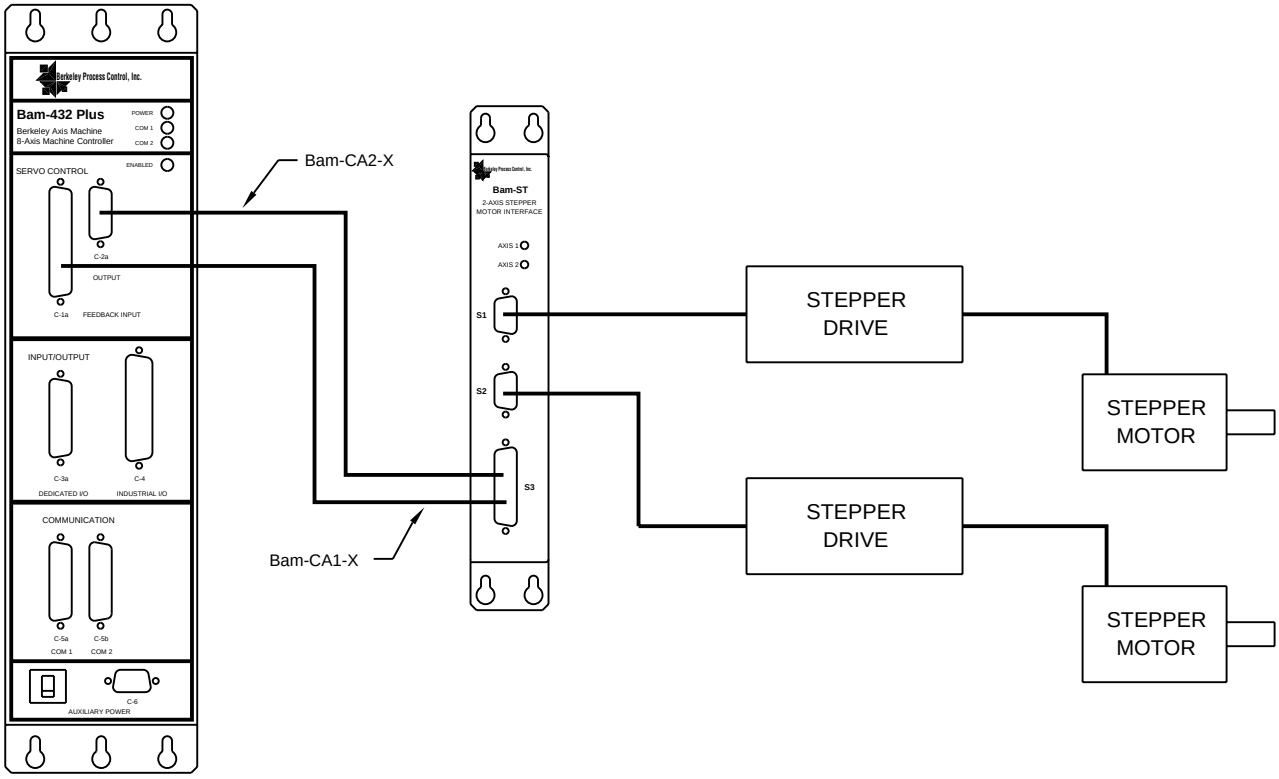


Figure 5. Cabling Diagram — Open Loop Connections

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3.3.2 Closed Loop Connections

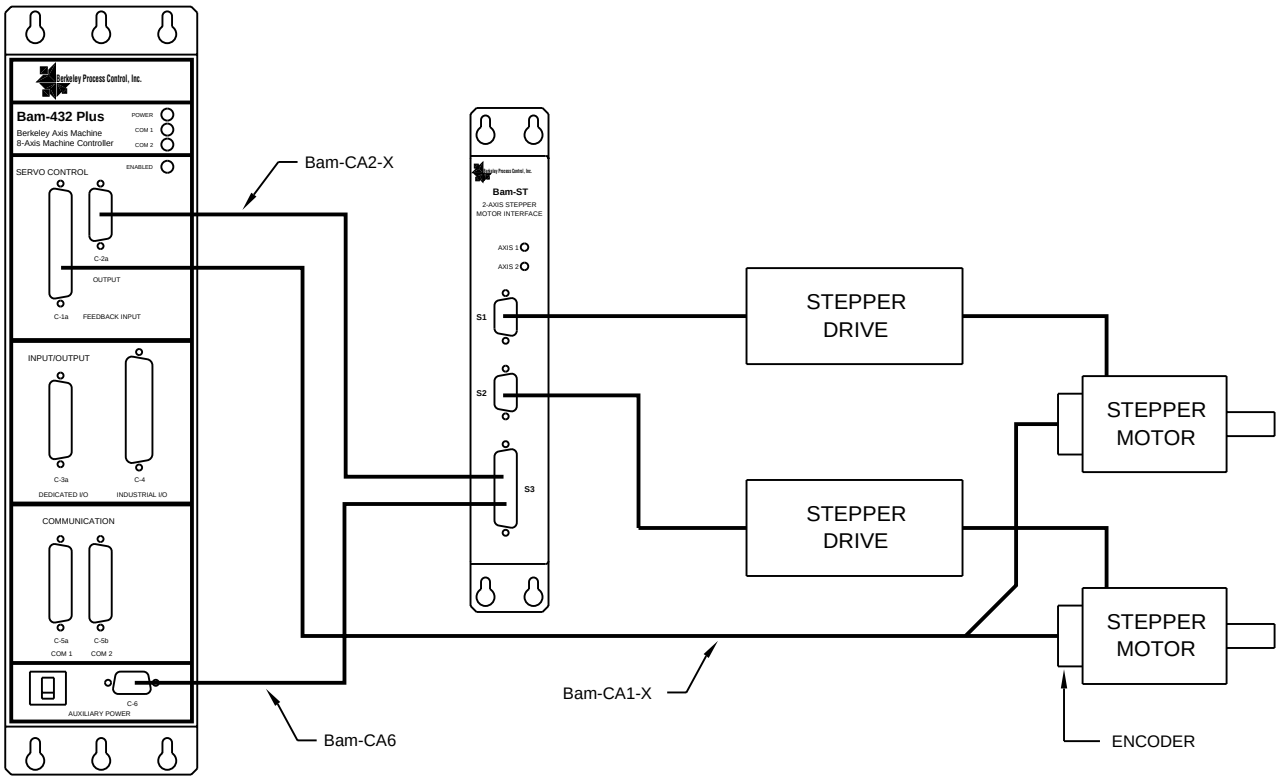


Figure 6. Cabling Diagram — Closed Loop Connections

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4. Bam-ST Operation

The first step in making the Bam-ST operational is to determine whether it will operate *open loop* or *closed loop*. Most systems run open loop: they do not have a feedback device on the motor. Cable the Bam-ST and *Bam* machine controller and then read the appropriate open or closed loop section.

4.1 Open Loop Operation

Making the Bam-ST operational in the open loop mode is really quite simple. We recommend that you disconnect both S1 and S2. Leave only Bam-ST connector S3 attached.

When operating the stepper motor in the open loop configuration, you need to use the 1008 controller. We have supplied a gain set which you can use.

Begin by loading the supplied gainset file called `step_op.g` using Bamcom. You should first select the *Bam* axis into which you wish to load the stepper gains. For example, if you have connected the Bam-ST to the x-axis and y-axis, start by selecting the x-axis by typing `Xaxis`. Then load the file `step_op.g`.

All you need do now is check the amplifier scaling factor. To do this, enable the *Bam* controller by typing `Enable`. Now type

```
1 Dac Axd.
```

You will now see three columns of numbers. The second column displays the velocity. The average value of this column can be used for the amplifier scaling factor. Type any character to stop the listing. Update the amplifier scaling factor by typing `Cpar`. Please refer to your manual *Tuning the Bam Machine Controller* for more information on the `Cpar` and other tuning commands.

Now simply connect your stepper drive and issue motion commands.

4.2 Closed Loop Operation

Once you have cabled your system, we recommend that you tune the axis just as you would a servo axis. When operating the stepper motor in the closed loop configuration, you need to use the 1008 controller. We have supplied a gain set which you can use for initial tests.

To get you started, you may load the file `step_cl.g` which is provided with your Bam-ST.

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You should first select the Bam axis into which you wish to load the stepper gains. For example, if you have connected the Bam-ST to the x-axis and y-axis, start by selecting the x-axis by typing `Xaxis`. Then load the file `step_cl.g`.

You can go through the tuning procedure that is outlined in the manual *Tuning the Bam Machine Controller*.

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