

Installation Guide

for the model 2205 Stepping Motor Control Module

(for use with Model 2200 Automation Controllers)

This document is current as of the following revision levels:

Controller Firmware	RØ
Controller Hardware	A
Board Hardware	A

This guide is intended to assist in the proper installation and use of the model 2205 Stepping Motor Control Module. This module provides fully programmable control over stepping motor functions. It utilizes an independent on-board microprocessor, resulting in superior performance in multi-axis systems, without degrading the response of the controller's main processor.

All motion parameters for the stepping motors are programmable, providing a great amount of operating flexibility and greatly facilitating the initial set-up of the system. Direct inputs are provided for many commonly-used functions, including "jog" inputs which may be used to implement a

"self-teaching" positioning system.

This guide is divided into three sections. The first, "Installation and Connection Information", explains the proper method of making connections to the model 2205. The next section, "Specifications", provides detailed specifications for the module.

Finally, an "Applications Guide" provides ideas for the effective use of the model 2205. Included here is electrical connection information to illustrate how the model 2205 may be used in a practical system.

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Installation and Connection Information

The model 2205 Stepping Motor Control Module must be inserted into one of the five slots of a model 2200 Automation Controller. Any combination of modules may be inserted into the model 2200, and they may be inserted in any order; the controller's CPU will dynamically assign motor numbers, input numbers, output numbers, etc., each time power is reapplied to the controller. These numbers are assigned from left to right across the controller (from slot #1 to slot #5).

To install a module into the model 2200:

1. Insure that all A.C. and D.C. power to the controller has been removed. This includes any external supplies which may be connected to the controller. It is best to also remove the A.C. line cord from the side of the controller.
2. Remove the screws from the top and bottom of the cover plate in the position to be used for the

new module. Save these screws to re-install in the new module.

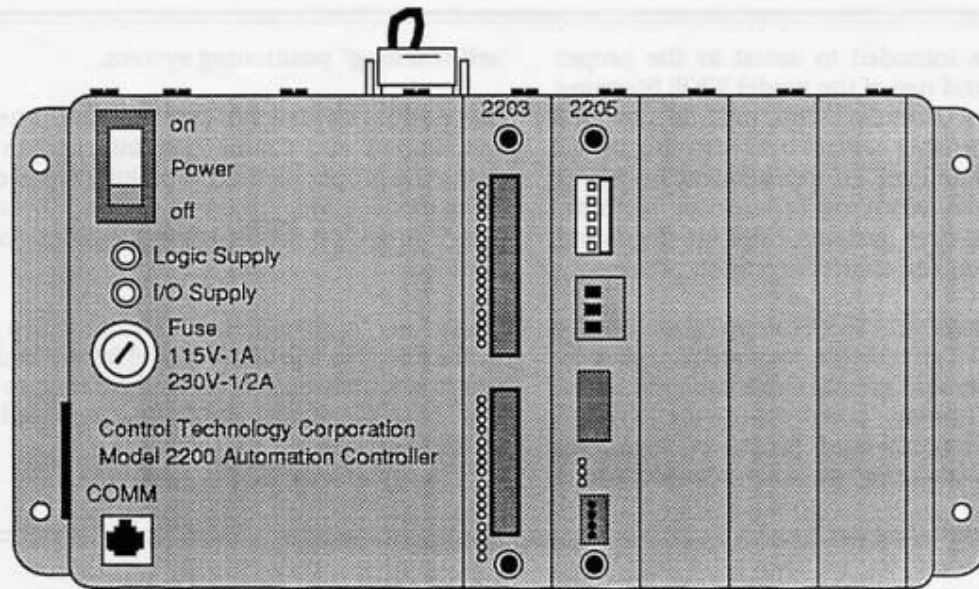
3. Slide the module into the slot, insuring that the circuit board slides into the nylon guides at top and bottom, and that the card is oriented properly (labelling should read right-side-up!).

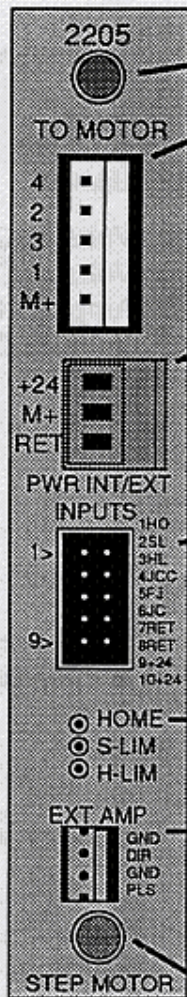
4. Press the module firmly into the controller; when properly seated, the faceplate of the module should be flush with the adjacent sheet metal surface.

5. Reinstall the retaining screws in the top and bottom of the new module.

Model 2200 Automation Controller

Shown with a model 2203 Combination I/O Module in the first position, and a model 2205 Stepping Motor Control Module in the second position.





Module Extraction Handle - do not detach!

Motor Connector - This connector allows use of the on-board drivers of the model 2205. It mates with the model 3971 Cable (for use with the model 3901 Stepping Motor), the model 3915 Resistor/Heatsink Assembly (for the model 3902), or the model 3916 Resistor/Heatsink Assembly (for the model 3903). A Molex #10-01-3056 connector shell with #08-70-1030 pins may also be used to create your own cable assembly.

Motor Power Connector - This removable 3-position screw terminal is used when the on-board drivers of the model 2205 are being utilized. It allows the motor power (M+) to be derived either from the controller's internal +24 V. supply (jumper from "+24" to "M+") or from an external supply (external supply connects to "M+" (positive) and to "RET" (common)). **Important!** - see Applications Guide for limitations!

Auxiliary Input Connector - This 10-pin connector provides access to the 6 Auxiliary Inputs of the model 2205, as well as providing +24 V. for powering external sensors. A model 2270 Pigtail Cable is available, which consists of a mating connector with 6-foot unterminated wires, or an AMP #87922-1 housing with #87523-6 contacts may be used to create your own cable.

Sensor Indicators - Three LED indicators are provided to indicate the status of the "HOME", "SOFT-LIMIT", and "HARD-LIMIT" inputs. Note that the SOFT-LIMIT indicator will flash briefly during power-up.

External Drive Connector - When using larger stepping motors, this connector allows connection to a model 3921 or 3922 Stepping Motor Drive, via a model 3973 Cable. It provides "pulse" and "direction" signals to the drive. Alternatively, a Molex #22-01-3047 housing with #08-50-0114 contacts may be used to create your own cable.

Another Module Extraction Handle - do not detach!

Front View - Model 2205 Stepping Motor Control Module

Motor Connector

Pin #	Signal
1	Motor V+
2	Phase #1
3	Phase #3
4	Phase #2
5	Phase #4

Note: Pin #1 is the bottom-most pin!

Auxiliary Input Connector

Pin #	Signal
1	Home Sensor
2	Soft-Limit
3	Hard-Limit
4	Jog CCW
5	Fast Jog
6	Jog CW
7	Return
8	Return
9	+24 Volts
10	+24 Volts

External Drive Connector

Pin #	Signal
1	Pulse Signal
2	Ground
3	Direction Signal
4	Ground

Note: Pin #1 is the bottom-most pin!

Specifications

Absolute Maximum Ratings	Min.	Max.	Units
Applied Input Voltage		27.0	Volts D.C.
Maximum Output Voltage (Driver Outputs)*		55.0	Volts D.C.
Maximum Output Current (Driver Outputs)		2.0	Amps D.C.
Maximum Output Voltage (Signal Outputs)		5.5	Volts D.C.
Temperature:			
Operating	0	+50	°C
Storage	-20	+80	°C

*may not exceed voltage applied to cathodes of protection diodes.

Programmable Functions	Min.	Max.	Units
Base Speed	0	(Max. Speed)	Steps/sec.
Maximum Speed	(Base Speed)	17,000	Steps/sec.
Absolute Position Range	0	65,535	Steps
Relative Position Range	0	65,535	Steps

Operating Characteristics	Min.	Typ.	Max.	Units
Control Input Signals				
Input voltage (low) - V_{IL}		1.0	2.0	Volts D.C.
Input voltage (high) - V_{IH}		20.0	25.0	Volts D.C.
Input current (low) - I_{IL}		-5.0	-17.0	mAD.C.
Input current (high) - I_{IH}		50	300	μ AD.C.
Driver Output "on" voltage			2.0	Volts D.C.
Driver Output "off" leakage			1.0	mAD.C.
Pulse and Direction Output Signals				
Output voltage (low) - V_{OL} ($I_{OL} = 40$ mA)			0.7	Volts D.C.
Output voltage (high) - V_{OH} ($I_{OH} = 0$)	5.0		5.25	Volts D.C.
Output current (low) - I_{OL}			17.0	mA
Output current (high) - I_{OH} ($V_{OH} = 2.4$ V)			9.5	mA

Applications Guide

Using the Auxiliary Inputs

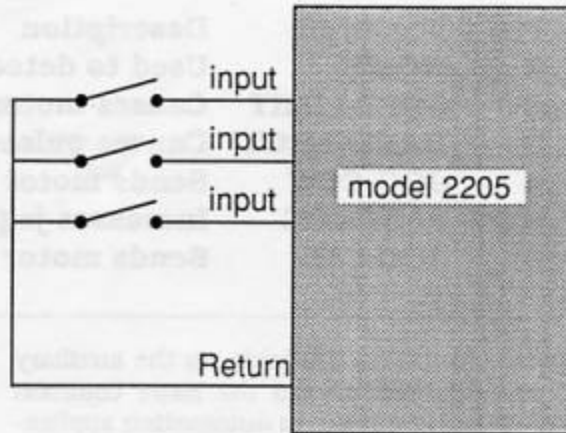
The auxiliary inputs provided by the model 2205 require only a switch closure to "Return" (the common for the controller's 24 Volt supply) to be actuated. Each input is internally self-powered from the controller's 24 Volt power supply through a current limiting resistor, and is opto-isolated from the controller's logic.

The stepping motor control microprocessor can sense when any of the inputs have been "pulled down" to ground by a switch closure, and will activate the related function in response.

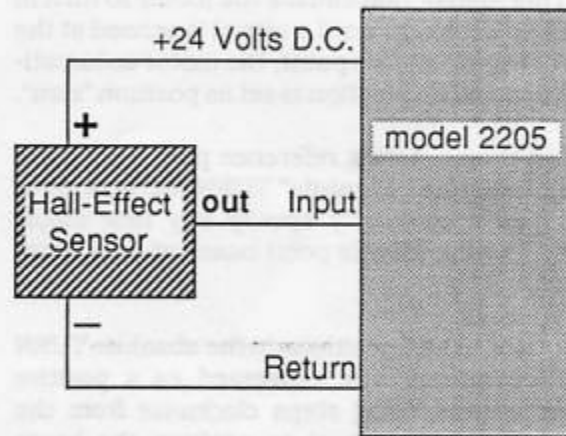
Many types of electronic sensors may be connected to these auxiliary inputs. Hall-effect sensors, proximity sensors and phototransistors may be wired to the inputs without any additional circuitry required.

Such devices should be specified as having "sinking"-type open-collector outputs, and must be capable of withstanding at least +24 Volts on their output terminals when in the "off" state. The sensor must also be able to sink the required input current (i.e.; 10 mA) when on.

Electronic sensors typically require an external power source for powering their internal circuitry. If the sensor chosen requires a power supply voltage equal to the controller's built-in auxiliary supply (i.e.; 24 Volts), it can be powered directly by the controller, eliminating the need for an additional external supply.



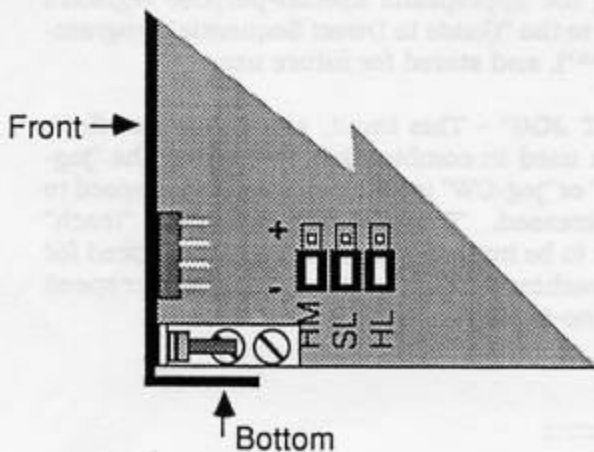
Inputs require only a switch closure to the "return" point



Electronic sensors may often be powered by the controller

Three of the inputs on the model 2205 may be configured for either "normally-open" or "normally-closed" operation. These are the "HOME", "SOFT-LIMIT" and "HARD-LIMIT" inputs. This allows the use of "vane"-type sensors, or interrupter modules, as sensing devices for home and over-travel positions on a stepping-motor-driven actuator.

To change these inputs to normally-closed operation, move the corresponding jumper plug (see diagram at right) to the upper position (marked "+") by lifting the jumper off the bottom set of pins and pushing it back onto the top set of pins.



Model 2205 Jumper Locations

Chart of Auxiliary Input Functions

Pin #	Function	Description
1	HOME	Used to detect "home" reference position
2	SOFT-LIMIT	Causes motor to decelerate to a stop
3	HARD-LIMIT	Causes pulses to motor to stop instantly
4	JOG-CCW	Sends motor counter-clockwise at slow speed
5	FAST JOG	Increases jog speed, (with JOG-CW or CCW)
6	JOG-CW	Sends motor clockwise at slow speed

The specific functions available via the auxiliary inputs are oriented toward the more common usage of stepping motors in automation applications. These functions, summarized in the above chart, are further described below.

"HOME" - This input is used in conjunction with the programmable "SEARCH AND ZERO" instruction. This instruction causes the motor to turn in a specified direction until a signal is sensed at the "HOME" input. At this point, the motor automatically stops and its position is set as position "zero".

This can then act as a reference point for future moves; using an "absolute" TURN MOTOR command, you may simply specify any new motor position as a coordinate point based on this "zero" position.

NOTE: Because all positions in the absolute TURN MOTOR command are expressed as a positive number, representing steps *clockwise* from the home position, it is best to position the home sensor at the furthest counter-clockwise position.

"SOFT-LIMIT", "HARD-LIMIT" - These inputs are often used as "over-travel" sensing inputs, connected to sensors at extreme limits of an actuators motion. The main difference between these inputs is that "soft-limit" will decelerate the motor to a stop, whereas the "hard-limit" input immediately stops pulses to the motor.

IMPORTANT NOTE: Because the inertia of the motor rotor and its associated load may cause the motor to mechanically over-travel in the event of a hard-limit, the motor must be "re-homed" after

any such event to insure continued accuracy.

If more than one over-travel sensor is necessary, the sensors may simply be connected in parallel and wired to the appropriate input.

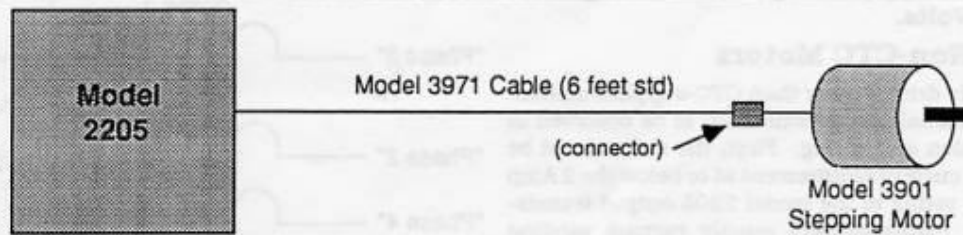
It is not recommended that these inputs be used as the sole means to implement an "Emergency Stop" function in any application where human safety or substantial economic loss is in danger. Refer to the CTC Technical Note "Thinking About Safety".

"JOG-CCW", "JOG-CW" - These inputs are often used to create a "teach" mode on a machine using stepping motors for positioning. They cause the motor to turn at a slow rate of speed in the direction indicated by the input.

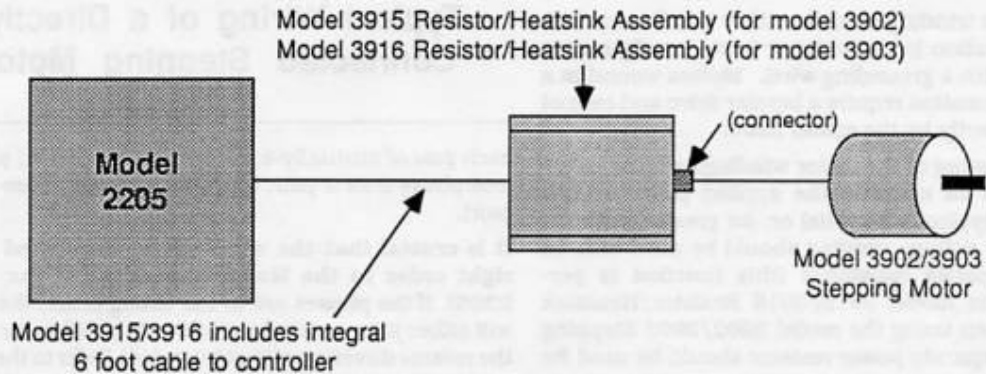
The jog inputs may be connected to manual push-button switches, or may be triggered by a joystick assembly which creates internal switch closures in response to movement of the joystick. Once a desired position has been reached, the absolute motor position may be sensed by your program using the appropriate special-purpose registers (refer to the "Guide to Direct Sequential Programming™"), and stored for future use.

"FAST JOG" - This input, alone, has no effect. When used in combination with either the "jog-CCW" or "jog-CW" input, it causes the jog speed to be increased. This allows a two-speed "teach" mode to be implemented, with a higher speed for approaching a rough position, and a slower speed for "fine-tuning".

Motor Connection



Direct Connection of the Model 3901 Stepping Motor



Note: a model 3972 Extension Cable (6 feet, std) may be used between the motor and the Resistor/Heatsink Assembly, if desired

Connection of the Models 3902/3903 using a Resistor/Heatsink Assembly

The model 2205 Stepping Motor Control Module may be used in one of three ways to drive stepping motors:

1. Motors with 24 Volt ratings may be directly connected to the Motor Connector.
2. Motors with lower voltage ratings may be connected to the Motor Connector via external power resistors.
3. Higher power motors may be driven via an external motor drive connected to the External Drive Connector of the model 2205.

CTC provides a standard series of Stepping Motors, with plug-compatible cables and accessories which eliminate any electrical compatibility issues. The diagrams above and on the next page illustrate the connection of these motors to the model 2205.

Using the On-board Drivers

IMPORTANT! - When using the on-board drivers on the model 2205, power for the motor is derived from the Motor Connector. You must insure that there is adequate power available to this connector for the motor being used. The typical current requirements for the CTC Stepping Motors which are usually direct-driven are:

Model 3901	0.4	Amp
Model 3902	2.0	Amps
Model 3903	3.6	Amps

The wiring of the Motor Power Connector determines the source of the motor's power (see page 3). Note that the internal +24 Volt power supply of the model 2200 is capable of a maximum of 1 Amp; therefore, any motor other than the model 3901 requires the use of an external power supply. An external supply may also be necessary if a great amount of current is being drawn from the controller for other purposes (solenoid valves, etc.).

This external supply may be connected in one of two ways:

1. The common (-) and positive (+) outputs of the power supply may be wired to the model 2205 Motor Power Connector, to the "RET" and "M+" terminals respectively.
2. The power supply may be wired to the external supply connector on the model 2200 Controller (refer to the model 2200 Installation Guide).

IMPORTANT! - When using an external supply, the following limitations must be respected:

1. When using the External Supply Connector on the model 2200, the voltage rating of the supply must be +24 Volts, and the current capacity of the supply should be no greater than 10 Amps.

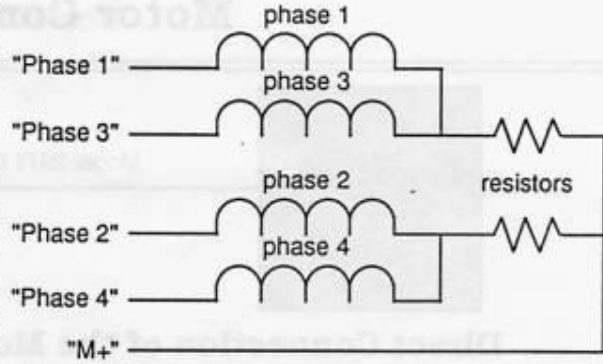
2. When using the Motor Power Connector of the model 2205 Module to connect an external supply, the supply voltage must be no greater than +24 Volts.

Driving Non-CTC Motors

When directly driving other than CTC-supplied motors, several additional precautions need to be observed in motor selection and wiring. First, the motor must be chosen for a current requirement at or below the 2 Amp per winding rating of the model 2205 output transistors. Most manufacturers supply various winding configurations within the same motor case size; size of the motor alone is therefore not a good indicator of its current requirement.

Secondly, the winding must be either in a 6-wire or 8-wire configuration (or, a 7-wire or 9-wire configuration if supplied with a grounding wire). Motors wound in a 4-wire configuration require a bipolar drive and cannot be driven directly by the model 2205.

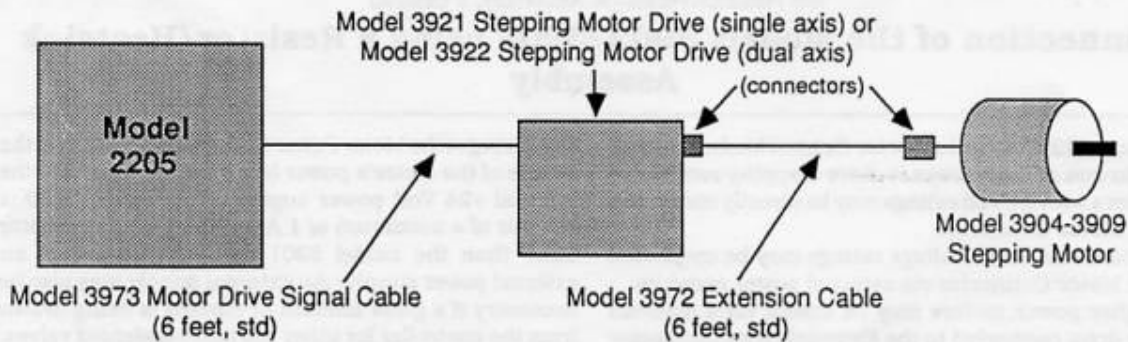
The voltage rating of the motor windings should either be chosen to be equal to the applied power supply voltage (i.e.; typically 24 volts) or, for greater performance, a lower voltage winding should be used with an appropriate series resistance (this function is performed by the model 3915/3916 Resistor/Heatsink Assembly when using the model 3902/3903 Stepping Motors). A separate power resistor should be used for



Typical Wiring of a Directly-Connected Stepping Motor

each pair of mutually-exclusive windings (i.e.; phase 1 and phase 3 as a pair, and phase 2 and phase 4 as a pair).

It is crucial that the windings be connected in the right order to the Motor Connector of the model 2205! If the phases are in the wrong order, the motor will either jitter around a stationary position, or run in the reverse direction of that intended! Refer to the motor



Connection of the Models 3904-3909 via an External Drive

manufacturer's literature for the correct wiring; note that every manufacturer uses a different color code.

Using an External Motor Drive

When using an external drive to power motors which are larger than can be directly driven by the model 2205, two signals must be provided to the drive from the control module. These logic-level (low voltage, low power) signals are the "pulse" and "direction" signals.

When using the CTC model 3921/3922 Stepping Motor Drives, a single cable assembly (model 3973) may be used to make this connection. If a drive from another manufacturer is being used, electrical compatibility must be determined prior to connection.

The electrical characteristics of the pulse and direction signals from the model 2205 are shown in the "Specifications" section of this Installation Guide. Each of these outputs consists of an industry standard type 7407 open-collector buffer, with a 220 ohm resistor connecting to +5 Volts. These outputs are not opto-isolated from the controller's logic, so caution should be used in interfacing to foreign (non-CTC) devices.

When using an external drive, there is no need to supply motor power to the model 2205 Module; therefore neither the Motor Power Connector or the Motor Connector are used.