

# CONTROLS FOR PRECISION LINEAR ACTUATORS

*Superior*  
Electric



A Supplement to the  
Thomson Actuator Catalog

Solutions by  
**DANAHER**  
MOTION



## Mechanical and Electro-Mechanical Product Solutions by Danaher Motion

Danaher Motion engineers, manufactures and markets a select combination of the world's top brands of mechanical and electro-mechanical products. Our principal brands and products include:

- THOMSON industrial, precision and rodless actuators, linear slide tables and systems, ball and lead screws, linear bearings and guides, precision balls, molded products, shafting and integrated solutions
- THOMSON BSA lead screws and precision miniature ball screws
- MICRON gearheads
- HAROWE resolvers
- DELTRAN electromagnetic friction and wrap spring clutches and brakes
- SUPERIOR ELECTRIC stepper and servo motors and controls
- SECO AC and DC variable speed drives

Designed to help increase productivity and improve performance, our products are incorporated into new equipment designs as well as machines already in service. From semiconductor assembly, packaging, robotics and industrial automation to medical, fitness and mobile off-highway equipment, our mechanical and electro-mechanical products bring flexibility, precision, efficiency, and reliability to a wide variety of industries.

Beyond our world-class product designs, one of our greatest strengths is our commitment to the Danaher Business System (DBS), which is comprised of a unique set of robust, repeatable processes that help us constantly improve the operational efficiency of our factories. Based upon the time-tested methods of Kaizen, the DBS is a team-based mindset that continuously and aggressively eliminates waste in every facet of our business operations. Furthermore, the DBS focuses the entire organization on breakthrough objectives that culminate in maintainable, results-oriented business processes, which, in turn, create advantages for our customers in the areas of quality, delivery and performance.

At Danaher Motion, we bring together best-in-class products, unsurpassed customization expertise, and innovative solutions to significantly improve and revolutionize the way things move. We are the experts in motion control. In short, Danaher Motion offers more choices, more application expertise and more integrated solutions than anyone else in the market.

Website:  
[www.DanaherLinear.com](http://www.DanaherLinear.com)

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**Superior  
Electric**

**Seco**  
**AC/DC Drives**

**Superior  
Electric**

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## DC Controls – for TN-D and TC2-D Precision Linear Actuators

The D2403 is designed for positioning applications requiring simple linear extend and retract motion, which require variable speed control. The D2403 commands linear move profiles based on input activation. Six optically-coupled inputs and four open-collector outputs allow for a simple interface to external devices such as PLCs, I/O Cards, simple pushbutton operator stations, and "Normally Open" position sensors. I/O Programmability via DIP switches adds increased versatility and auto function capabilities.

### Power Requirements

105-125 VAC; 50/60 Hz (from factory) @ 2 Amps max or 208-245VAC; 50/60 Hz @ 1 Amp max

### Motor Output

0-28 VDC @ 10 Amps max (adjustable current trip: 0-10 Amps). Note: Motor rated for 4.5 Amps continuous; 10 Amps peak.

Operator Devices: Extend, Stop, Retract push-buttons

### Inputs

Stop, EXT, RET, LS1, LS2, SP2 Sinking Inputs (1K Pull-up to 12 VDC)

High Level (Off) 10.5 - 12.25 VDC (open circuit high)

Low Level (Activated) 0-0.8 VDC (sinking to ground) @ 12 mA max

### Outputs

EXT COMP, RTR COMP, Open Collector Sinking Output (1K pull-up COM EXT-EN, COM RTR-EN to 12 VDC)

High Level (OFF) 10.5–12 VDC (open circuit high)

Low Level (On) 0–0.5 VDC capable of sinking 100 mA

### Operational

Variable Speed Range 15:1

PWM Frequency 2000 Hz

### Environmental

Operating Temperature 32° to 122°F [0° to 50°C]

Storage Temperature -40° to 185°F [-40° to 85°C]

### Timer Function

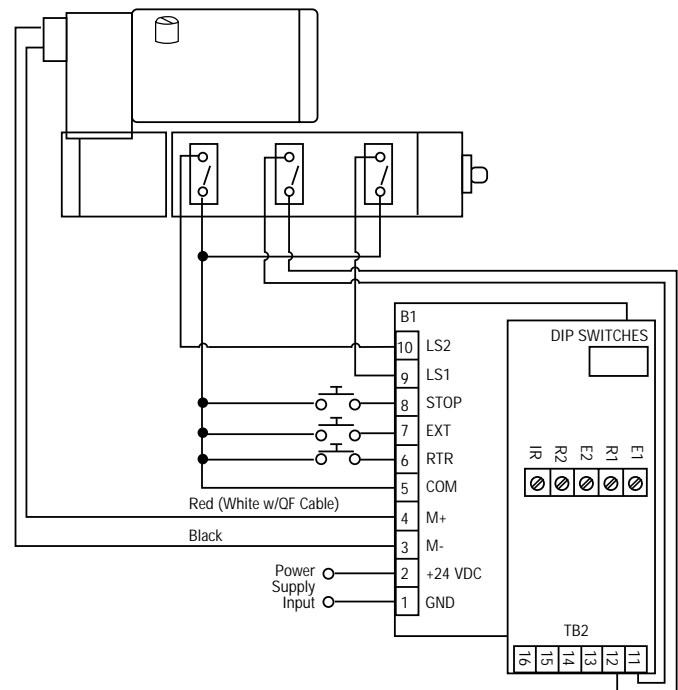
- 0 to 20 sec. adjustable time delay allows control of dwell time between cycles. DIP switches allow configuration of the time delay to begin when:
  - LS1 Limit Switch triggered
  - LS2 Limit Switch triggered
  - Motor Current Limit (Extend)
  - Motor Current Limit (Retract)

### Options

MOD300 Remote Speed Pots – 6 ft. ribbon cable with remote connections for on board speed potentiometers; E1, R1, E2, and R2. MOD300 is supplied with two 10K Ohm, 0.25 W potentiometers for E1 and R1 connections.



TYPICAL CONNECTIONS



**Terminal Functions**

**TB1 10 Pin Terminal Strip**

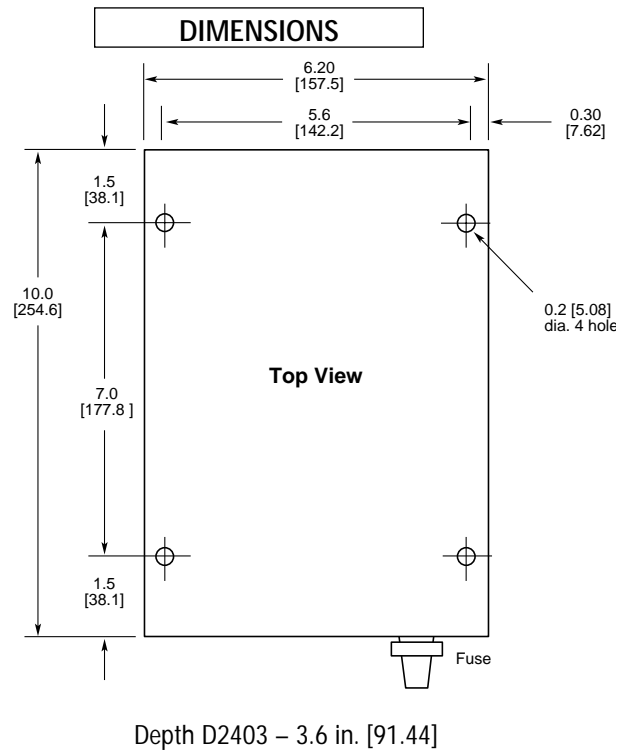
1. GND External Supply Input: DC Ground
2. +24 V External Supply Input: +24 VDC
3. M- Motor Negative Terminal
4. M+ Motor Positive Terminal
5. COM DC Ground
6. RTR Retract Input
7. EXT Extend Input
8. Stop Stop Input
9. LS1 Limit Switch Input #1
10. LS2 Limit Switch Input #2

**TB2 6 Terminal Connector**

11. SP2 Speed Change
12. COM EXT-EN Common – extend enable
13. COM RTR-EN Common – retract enable
14. EXTCOMP Extend Complete Output
15. RTRCOMP Retract Complete Output

**DIP switch Functions**

1. On One-shot retract triggered by LS1  
 Off One-shot stop triggered by LS1
2. On One-shot extend triggered by LS1  
 Off One-shot stop triggered by LS1
3. On One-shot retract triggered by LS2 (Term 10)  
 Off One-shot stop triggered by LS2
4. On One-shot extend triggered by LS2  
 Off One-shot stop triggered by LS2
5. Extend complete output Terminal 14 triggered by:  
 On Current overload  
 Off LS1 (Term 9)
6. Retract complete output Terminal 15 triggered by:  
 On Current overload  
 Off LS1 (Term 9)
7. On After current sensing overload auto retract  
 Off After current sensing overload stop
8. On After current sensing overload auto extend  
 Off After current sensing overload stop



## DC Controls – for TN-D and TC2-D Precision Linear Actuators

The D2502B is an analog position control which accepts an analog voltage or current command input and translates the signal into a proportional linear displacement. The control is used with electric cylinders containing a linear potentiometer (-L) option. Feedback from the linear potentiometer is proportional to distance. The control compares this feedback to the scaled command input, providing a closed loop linear positioning system.

- Closed Loop Absolute Linear Positioning System.
- Accepts three types of remote analog command signals: 0 to 5 VDC, 0 to 10 VDC, and 4-20 mA.
- Joystick Slide Pot – provided to give a 0-5 VDC command signal for initial testing and setup.
- 2 Inputs prevent cylinder motion – Stop and Disable.
- Dedicated Outputs – Stall Output, when motor current exceeds current sensing threshold.
- LED Indicators to monitor system operation. Stall Detect, In Position, and Current Sense.
- Tuning Potentiometers optimize system response and performance.
- Compatible with TN-D and TC2-D precision linear actuators with -L option.



### Power Requirements

105-125 VAC; 50/60 Hz (from factory) @ 2 Amps max or 208-245 VAC; 50/60 Hz @ 1 Amp max (Jumper Selectable)  
Motor Output 0-28 VDC, 5 Amps max (adjustable clamp: 0-5 Amps). Note: Motor rated for 4.5 Amps continuous; 10 Amps peak

### Inputs

- Stop – Sinking Input (1K Pull-up to 12 VDC)
- High Level (OFF) 10.5-12 VDC (open circuit high)
- Low Level (On) 0-0.5 VDC capable of sinking 100mA
- Disable – Optically-Isolated, Sinking or Sourcing Input 10-30 VDC at 20 mA max
- Position Command – 0-5 VDC, 0-10 VDC, or 4-20 mA

### Outputs

- Stall, IN POS – Open Collector (1K pull-up to 12 VDC) High Level (OFF) 10.5-12 VDC (open circuit high)
- Low Level (ON) 0-5 VDC capable of sinking 100 mA

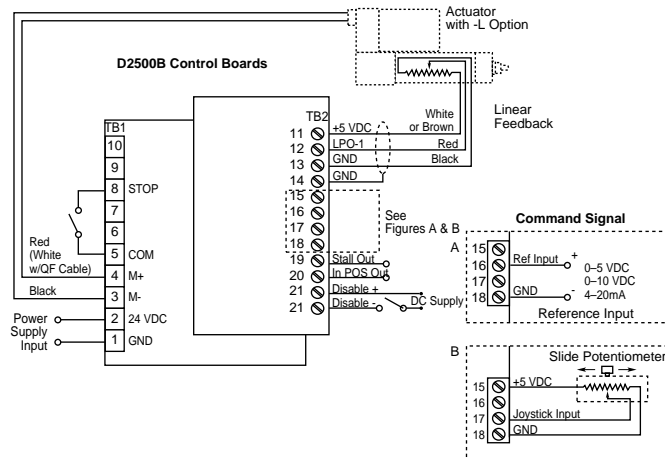
### Operational

- Variable Speed Range 15:1
- PWM Frequency 2000 Hz

### Environmental

- Operating Temperature 32° to 122°F [0° to 50°C]
- Storage Temperature -40° to 185°F [-40° to 85°C]

## TYPICAL CONNECTIONS



**Terminal Connections**

TB1 10 Pin Terminal Strip

1. (GND) External Supply Input: DC Ground
2. (+24V) External Supply Input: +24 VDC
3. (M-) Motor Negative Terminal
4. (M+) Motor Positive Terminal
5. (COM) DC Ground
8. (STOP) Stop Input

**TB2 12 Pin Terminal Connector**

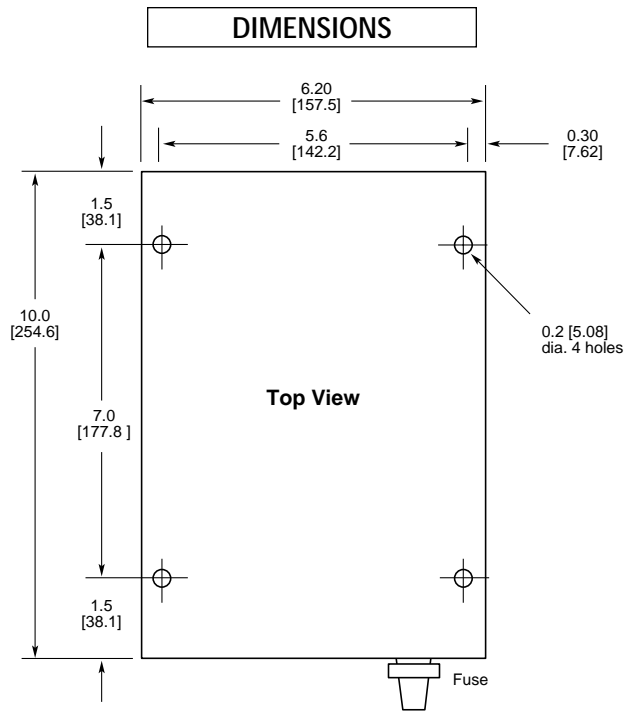
11. (+5V) Linear Pot: +5 VDC Power Supply
12. (LPO-1) Linear Pot: Wiper Input

13. (GND) Linear Pot: DC Ground
14. (GND) DC ground
15. (+5 V) +5 VDC Power Supply
16. (REF INP) External Reference Input
17. (Joystick INP) External Joystick Input
18. (GND) DC Ground
19. (Stall Out) Stall Output
20. (IN POS Out) In Position Output
21. (Disable+) Disable Input +
22. (Disable-) Disable Input -

**Potentiometer Functions**

Ten potentiometers are available to optimize system response and performance.

1. Current Sense: Sets the current draw to the motor, dictating the cylinder's thrust potential and stall threshold
2. High: Sets the main move velocity
3. Low: Sets the final creep speed prior to stopping (prevents overshoot).
4. IR: Sets the current regulation of the motor when the cylinder is traveling at low speeds with heavy loads.
5. Sens: Sets the system bandwidth, determining how close the feedback signal must be to the commanded signal before the cylinder is considered IN POSITION.
6. Decel: Sets the distance for the target position at which the cylinder decelerates to the final move speed.
7. EX-L: Sets the limit of travel in the Extend Direction.
8. RT-L: Sets the limit of travel in the Retract Direction.
9. Scale: Scales the Command Signal on the Reference Input down to 5 VDC (internally). Used with 0-10 VDC, 4-20 mA.
10. Offset: Adjusts 4 mA command signal to be equal to 0% cylinder extension.



Depth D2502B – 2.9 in. [73.66]

## Servo Controls – for TN-B and TC2, 3, 4, 5-B Precision Linear Actuators, Rodless Linear Actuators, and Linear Slide Tables/Systems

The B8961 and B8962 Brushless Servo Smart Drives are user friendly systems that offer you many compelling features and benefits. B8961 is a single axis control, while B8962 handles two axes in a single, cost-effective package. Consider these controls when your motion control application requires:

- A well integrated motion controller, digital servo drive, operator interface, power supply, 30 I/O, and built-in OPTO I/O rack
- A sophisticated servo controller capable of controlling position, velocity, and force/torque simultaneously. This capability makes the B8961/2 an ideal solution for clamping, pressing, drilling, and automated fastening applications.
- A simple Machine Controller
- Interrupts
- Configurable I/O
- Linear Interpolation, and Registration
- Coordinated motion between two axis
- Go Immediate Mode. This mode of operation allows the controller to multitask between motion control and I/O operations. Immediate Mode also allows each axis to move completely independently of the other axis.
- 1–99 axes of immediate control via host RS-232C communication
- Optional analog I/O for:
  - Reading an analog input proportional to temperature, distance, pressure, or force
  - Setting an analog output to control position of another axis of motion



### Motion Control

- 6K memory for up to 199 user programs (30K, 400 programs optional)
- User scaling of position, velocity, and acceleration
- Descriptive variables, math and conditional branching
- High Speed interrupt driven inputs–registration
- B8962–linear interpolated vector moves
- Application Developer software included.

### Opto Compatible I/O

- Accepts OPTO–22 (G4) digital modules and Grayhill (G5) analog and temperature modules
- 100% solid state, Opto–isolation to 4000 volts
- 8 positions, all bidirectional
- Specify (Intermix) Opto I/O modules: for AC, DC, analog, and temperature signals

### Specifications

Input Power 90-240 VAC single phase, 50/60 Hz, 1150 VA Max @115 VAC, 2300 VA max @230 VAC. (Double the current and power for B8962)

#### Motor Output

Current Capability 5A continuous, 10 A peak  
Protection Protected against phase-to-phase shorts and shorts to ground. Fused.

#### Encoder Input

Type Differential quadrature incremental encoder, with or without index  
Maximum Rate 2 MHz (post-quadrature)  
Power +5V @ 200 mA power encoder

#### Diagnostic Output

Format 0 to 5 V analog signal (centered at 2.5 V)  
Variables Configurable as actual, and commanded velocity; position error; velocity error; actual, and commanded torque – programmable scaling  
Serial Interface RS-232C, 3-wire implementation (Tx, Rx, & Com), 9600 Baud, 8 data bits, 1 stop bit, no parity.

#### Environmental

Operating Temp. Shutdown occurs if heat-sink exceeds 55°C (131°). This temperature is a function of motor current, regen and ambient temperature. Some applications may require FK fan kit.  
Humidity 0% to 90% non-condensing

**Additional B8961 Specifications**

**Motion**

Position Range                    ±0-2,147,483,647 steps. Absolute and incremental.  
 Acceleration Range            0.01 to 999.99 rev/sec/sec  
 System Resolution              8,000 counts per revolution (With Danaher supplied motors)  
**OPTO-compatible I/O**        8 Positions support OPTO-22 (G4) digital, Grayhill (G5) analog and temperature modules  
 Analog Opto Module            Resolution - 12 bits, Bandwidth - 62.5 Hz

**Inputs**

Digital                                8 programmable, Limits, home - Optically isolated, 24 VDC compatible (via pull up terminal – disconnect jumper to 12 VDC), 12 mA sinking current required.  
 Incremental Encoder            Optically isolated, differential 5 VDC, 2 MHz max (post-quadrature). 5VDC, 200 mA power available.

**Outputs**

Digital                                8 Programmable Open collector, sink current 100 mA max. (Total of 350 mA for all I/O.)

**Front Panel/Keypad (Included w/B8961/B8962)**

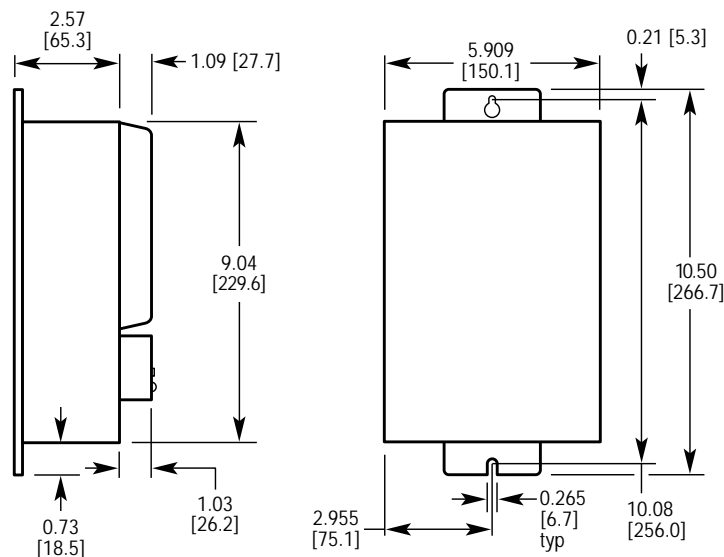
- Both a programming and an operator interface
- Menu-driven setup, Tuning, Help Function, Diagnostic Screens, Trace Mode-easy set up, troubleshooting and program debugging
- Easy-to-read 40-character display
- Keypad is protected to NEMA 4 (IP65) when panel mounted



**Options**

- 30K – Memory expansion
- CL – Torque control hardware
- FK1 – 120 volt fan kit
- FK2 – 240 volt fan kit
- FP220 – Front panel/keypad
- PCS-4852 – Screw terminal to 9-pin
- D RS232 cable
- RPACK1 – External regen module, 120 volt
- RPACK2 – External regen module, 240 volt

**DIMENSIONS**





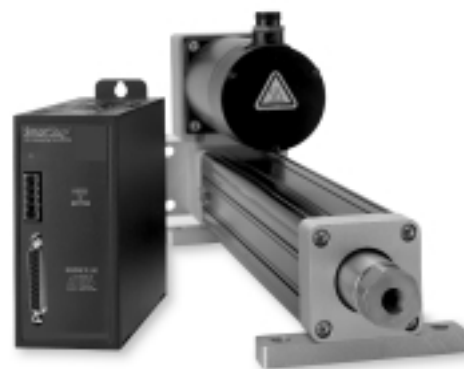
## Stepper Controls – for TN-S/P and TC2, 3, 4, 5-S/P Precision Linear Actuators, Rodless Linear Actuators, and Linear Slide Tables/Systems

The **SmartStep** is a complete, packaged microstepping drive/control that provides a user friendly system, as well as many compelling features and benefits. Consider a SmartStep when your application requires:

- **High Throughput.** The SmartStep has outstanding dynamic performance and incorporates the latest in Anti-Resonance technology to maximize the torque, and optimize the performance of step motors.
- **Ease of Integration.** The SmartStep uses IDeal™ programming language, and Application Developer software package which simplifies system set-up and integration. Or, with the optional Front Panel, program the SmartStep WITHOUT the use of a PC!
- **Small Panel Space.** The SmartStep has an internal heatsink and fan which keeps the panel space required for each unit small, and allows multiple units to be stacked together in multi-axis applications.
- **Smoother performance** across the entire motion profile.
- **Up to 8 Amps of motor current.** The SmartStep is compatible with both standard and enhanced 17 frame to 42 frame step motors.

### Additional SmartStep Features

- CE rated
- Flash memory allows the SmartStep to be completely reconfigured from a file obtained via the Internet for easy upgrades of both hardware and firmware
- 60K memory, up to 400 programs standard
- RS-232 communications standard, RS-485 optional
- Operates from 120 VAC standard, or 240 VAC optional
- All system configuration and drive settings are software configurable, which means there are no switches to set
- High Speed Registration input
- Faster microprocessor and data bus improves the SmartStep's computational horsepower
- Go Immediate Mode. This mode of operation allows the controller to multitask between motion control and I/O operations
- User scaling of position, velocity, and acceleration
- Descriptive variables, math and conditional branching
- Accepts encoder feedback for Stall Detection, Closed Loop Operation, and Position Maintenance
- 1-99 Axis of immediate control via host RS-232C communication
- Compatible Application Developer Software
- Sixteen configurable I/O (8 inputs, 8 outputs) 1 dedicated home and 2 dedicated end of travel inputs
- Optically isolated I/O, 12/24 VDC compatible
- A handful of accessories simplify integration.



## SPECIFICATIONS

	SmartStep	SmartStep-240
AC Power Input	90-120 VAC Single Phase 50/60 Hz, 500 VA max @ 7.9 Amp setting	100-240 VAC Single Phase, 50/60 Hz, 500 VA max, @ 3.9 Amp setting
Motor Current	0-7.9 Amps, 0.1 Amp increments	0-3.9 Amps, 0.1 Amp increments
Bus Voltage	160 VDC nominal	320 VDC nominal
System Resolution	36,000 steps/motor rev	
<b>Motor Compatibility</b>		
Type	2-phase, hybrid permanent magnet; 0.9°, 1.8° or 7.2° full step	
Inductance	2-60 mH	8-240 mH
<b>Amplifier</b>		
Switching Frequency	20 kHz	20 kHz
<b>Protection</b>		
Short Circuit	Amp disabled if phase to phase, or phase to ground short detected	
Brownout (Under Voltage)	Amp disabled if supply drops below 90 VAC (100 VAC for -240 version)	
Over Temperature	Amp disabled if heat sink exceeds 70° C	
Interlock	Amp disabled if interlock connection is broken on motor connector	
Regen/Over Voltage	Amp disabled if regen condition causes bus voltage to exceed 220 VDC for 120 VAC input voltage, or 440 VDC for 240 VAC input voltage	
<b>Current Settings</b>		
Rest	Software selectable. If selected, will reduce motor current to 1 Amp after no motion has occurred for 20 minutes. Full current level will resume upon receipt of next motion command. Reduces drive and motor temperature	
Idle	Software selectable. If selected will reduce current to 75% of drive setting if no motion is commanded for 10 ms. Full current level will resume when motion is commanded. Reduces drive and motor temperature.	
Waveform	Software selectable. Configures the shape of the current waveform. Default is pure sinusoid. Selecting On changes waveform to -4% 3rd harmonic. Optimizes smoothness and step-to-step accuracy.	
<b>I/O and Diagnostics</b>		
Inputs	12 VDC or 24 VDC compatible, optically isolated, as little as 3.0 mA sinking current required. 8 Programmable, Limits, Home	
Incremental Encoder	Optically isolated, differential line driven 5 VDC signal, 2 mHz max frequency (post quadrature); 5 VDC, 200 mA available on SmartStep to power encoder	
Outputs	Open collector, 12 VDC or 24 VDC compatible, optically isolated, 100 mA max 8 Programmable sink current per output. 350 mA total sink current	
LED Indications	Green – functioning normally; Red – Fault; Amber – FLASH fault	
<b>Environment</b>		
Operating Ambient Temp.	Max. ambient temperature of 50°C (122°F) @ 6 Amps current setting	
Storage Temperature	-40°C to 80°C (-40°F to 176°F)	
Humidity	0% to 90% non-condensing	

### Optional Keypad – FP220

- Both a programming tool and an operator interface
- Menu-driven set up, On line help function, diagnostic screens, and trace mode provide straightforward setup, troubleshooting, and program debugging
- Easy to read back-lit 40 character display
- Connects to control or mounts remotely
- Scratch proof, large keys
- Displays current position and I/O status
- Keypad is protected to NEMA 4 (IP65) when panel mounted



## OPTO44 Board – OPTO44

OPTO rack that accepts up to 8 OPTO modules (up to 4 OPTO inputs and 4 OPTO outputs). OPTO I/O is useful when your application needs to switch on and off large voltages or currents (i.e., turning on a solenoid, switching on and off a 230 VAC brake, etc.). OPTO44 racks parallel all 16 I/O points to a second set of screw terminals so unconditioned I/O may still be used.



## OPTO88 Board – OPTO88

OPTO rack that accepts up to 16 OPTO modules (up to 8 OPTO inputs and 8 OPTO outputs). OPTO I/O is useful when your application needs to switch on and off large voltages or currents (i.e., turning on a solenoid, switching on and off a 230 VAC brake, etc.). OPTO44 racks parallel all 16 I/O points to a second set of screw terminals so unconditioned I/O may still be used.

## Other Options

### Breakout Board – DB25BO

This accessory converts the DB25 I/O connector on the SmartStep to screw terminals.

### SS-IO and SS-IO-6 Cables

I/O cables that connect SmartStep to other devices or PLC. SS-IO cable is 2 ft. SS-IO-6 cable is 6 ft.

### SS-RS232 Cable

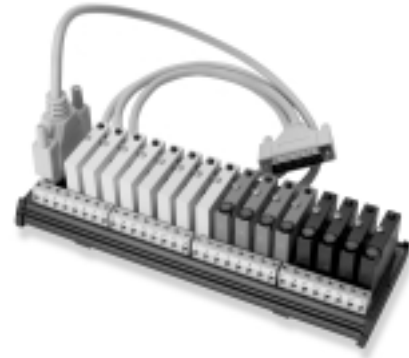
Cable for connecting SmartStep to PC (9-pin comm. port).

### SS-PNP-BO Breakout Board

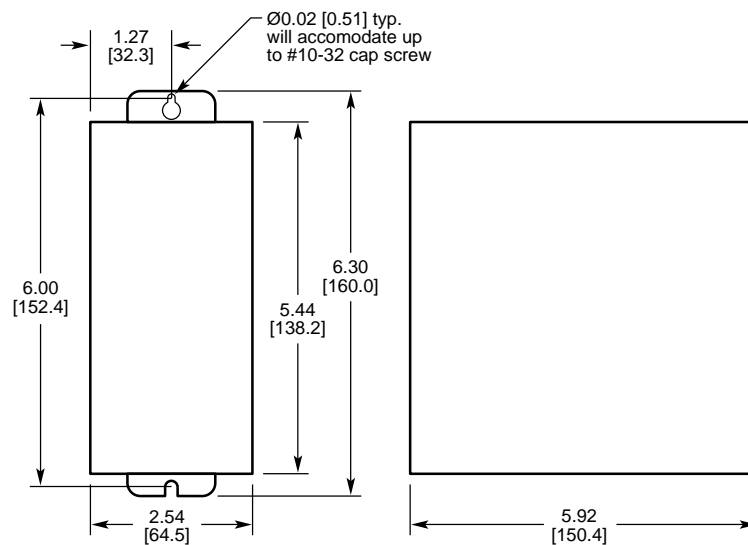
Screw terminal breakout board that converts the SmartStep's sinking outputs to sourcing outputs.

### PCS-5004 Cable

PC-keypad cable for copying programs between keypad and PC (5 VDC power supply not included).



## DIMENSIONS



### DC Controls – for TN-D, TC2-D

Part Number	Description
D2403	24 volt DC control
D2502B	24 volt DC control with analog input, for TN-D, TC2-D with "-L" option

### Servo Controls – for TN-B and TC2, 3, 4, 5-B

Part Number	Description
B8961	Servo drive/control with programming keypad, single axis
B8962	Servo drive/control with programming keypad, two axis

#### Options (Add as suffix to part number)

-30K	Memory expansion
-CL	Torque control hardware
-FK1	120 volt fan kit
-FK2	240 volt fan kit

#### Accessories

FP220	Front panel/keypad (Included with B8961, B8962)
PCS-4852	Screw terminal to 9-pin D RS232 cable
RPACK1	External regeneration module, 120 volt
RPACK2	External regeneration module, 240 volt
EMC-B8-1	EMC compatibility kit for B8961
EMC-B8-2	EMC compatibility kit for B8962
OPTO22 modules	Consult factory

### Stepper Controls – for TN-S/P and TC2, 3, 4, 5-S/P

Part Number	Description
SmartStep	Stepper drive/control, single axis, 120 volt
SmartStep-240	Stepper drive/control, single axis, 240 volt

#### Options (Add as suffix to part number)

-RS485	RS 485 communications interface
-MD	Minimum depth mounting (factory installed only)
-FP	Programming Keypad/Operator Interface Display
-DB25	Breakout Board to convert DB25 I/O connector to terminals

#### Accessories

FP220	Optional Programming Keypad/Operator Interface Display
OPTO44	I/O Module rack for up to 8 "OPTO22" modules, 4 input/4 output
OPTO88	I/O Module rack for up to 16 "OPTO22" modules, 8 input/8 output
DB25BO	Breakout Board to convert DB25 I/O connector to terminals
SS-IO	I/O cable to connect SmartStep to PLC or other devices, 2 ft.
SS-IO-6	I/O cable to connect SmartStep to PLC or other devices, 6 ft.
SS-RS232	Serial cable to connect SmartStep to 9-pin comm. port on PC
SS-PNP-BO	Breakout Board to convert sinking outputs to sourcing outputs
EMC-S6-1	EMC compatibility kit

### Ordering Information

Danaher Motion also offers motor and control packages for rodless actuators, linear slide tables, and systems. Please contact application engineering at (704) 588-5693 for more details, e-mail sales2@danahermotion.com or visit our website www.linearactuators.com

# Danaher Motion Linear Motion Systems

As part of the Danaher Motion family, our mechanical and electro-mechanical product offerings include standard and custom linear bearings, shafting, linear guides, ball and lead screws, gearheads, linear actuators, slide tables and systems, precision balls, molded products, resolvers, brakes and clutches, AC and DC adjustable speed drives, stepper and servo motors. Our products are applied worldwide throughout a variety of motion applications in the machine tool, medical, automotive, robotics, industrial, aerospace, office equipment and mobile off-highway markets. Our highly recognized brand names include: Thomson™, Thomson BSA™, Micron™, Harowe™, Deltran PT™, Superior Electric™ and SECO™.



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