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Installation

The information in this chapter will enable you to:

- Mount all system components properly
- Connect all electrical and non-electrical system inputs and outputs properly
- Ensure that the complete system is installed properly
- Perform basic system operations

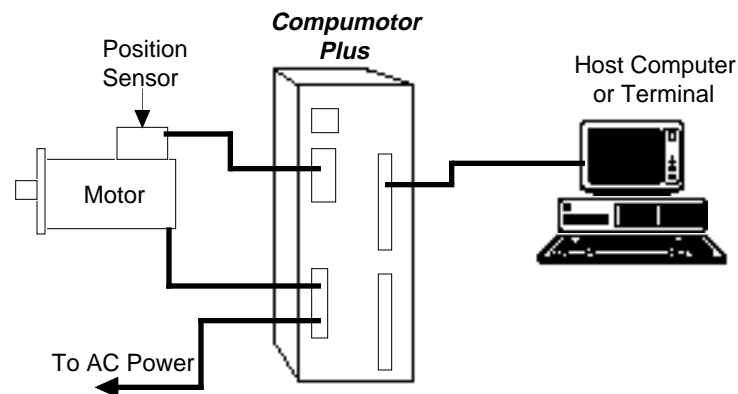
Environmental Specifications

The environmental temperature and humidity limitations for the Compumotor Plus are listed below.

Condition	Specification
Ambient (operating) temperature	0 to 50°C (32 to 122°F)
Max drive heatsink temperature	75°C (162°F) (Low Power only)
Max temperature source below drive	45°C (113°F)
Max motor case temperature	100°C (212°F)
Storage temperature	-40 - 85°C (-40 - 185°F)
Humidity	0 to 95% non-condensing

Complete System Configuration

In this section, you will go through complete set-up procedures to set the Compumotor Plus functions. The wiring requirements will be described and a check out procedure to verify the functionality of the interface is provided.



Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure the safety of personnel. You can reduce the effects of electrical noise due to electromagnetic interference (EMI) by grounding. All Compumotor equipment should be properly grounded. A good source of information on grounding requirements is the National Electrical Code published by the National Fire Protection Association of Boston, Massachusetts.

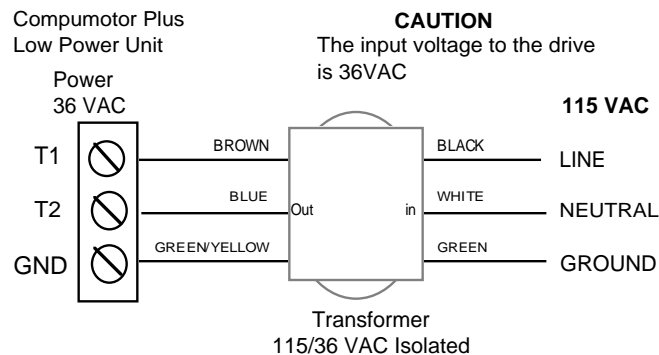
In general, all components and enclosures must be connected to earth ground through a grounding electrode conductor to provide a low impedance path for ground fault or noise-induced currents. All earth ground connections must be continuous and permanent. Compumotor recommends that you use a single-point ground.

One commonly used grounding method is to prepare components and mounting surfaces prior to installation so that good electrical contact is made between mounting surfaces of equipment and enclosure. Remove the paint from equipment surfaces where the ground contact will be bolted to a panel and use star washers to ensure solid bare metal contact. You should connect the case of the motor to the Motor Ground terminal on the Compumotor Plus Drive. (This is done for you with Compumotor supplied cables.)

For temporary installation, or when you cannot implement the grounding method described above, you must connect the Ground terminal on the AC power connector to the earth ground.

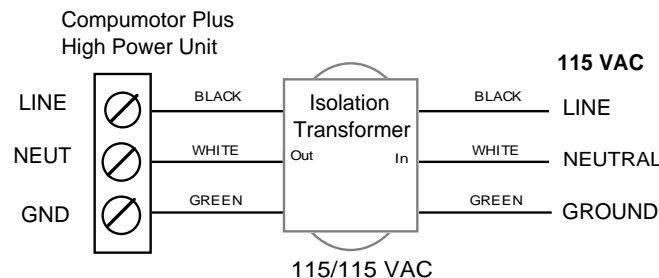
Line Power Connections

The CPLX57-120 and CPLX83-150 operate on 36VAC single-phase power. The 36VAC is supplied from a 115/36VAC isolated transformer that is provided with the unit (externally). The connections from the transformer to the indexer/drive are discussed below.



High Power Connections

The CPHX83-150 and CPHX106-220 operate on 120VAC single-phase power. AC power is connected to the screw terminal connector on the front panel. The 120VAC single-phase should be connected with 14-gauge or heavier, stranded wire. The wires should be connected to the screw terminals as shown in the figure below.



Note: The isolation transformer is provided by the user, the transformer is recommended but not required.

Isolation Transformer (CPH only)

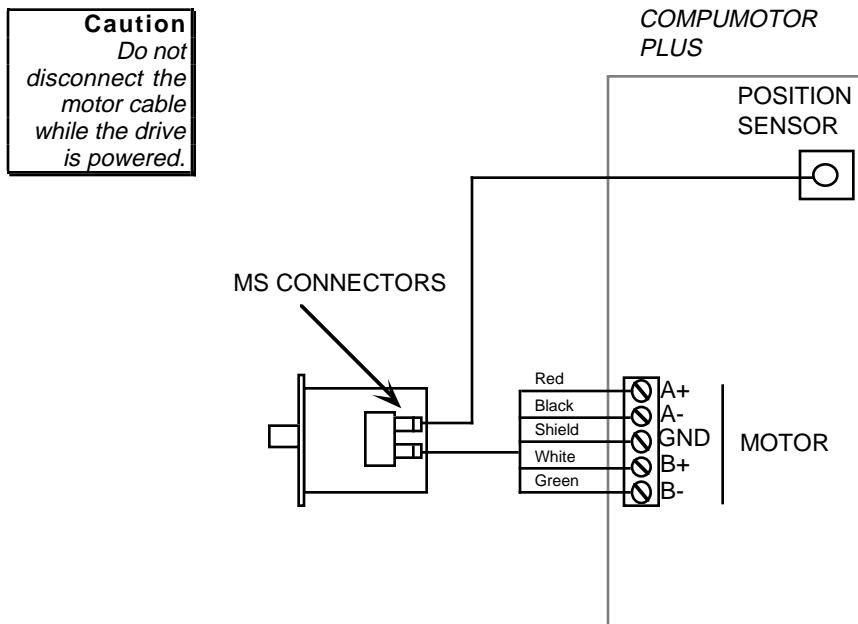
The Compumotor Plus high-power indexer/drive does not provide line isolation for the input power. If your installation requires line isolation, use an isolation transformer with a 1KVA rating.

An isolation transformer with line filtering capabilities also protects sensitive equipment on the same power line from power line noise produced by the switch-mode amplifiers in the Compumotor Plus Drive.

The Compumotor Plus low-power indexer/drives (CPLX57-120 and CPLX83-150) are supplied with step-down, isolating transformers to step down 120VAC to 36VAC.

Motor Connections

The Compumotor Plus Motor is supplied with a preassembled motor cable. The cable has an MS-type connector on the motor end, and five leads with screw terminals on the drive end. This cable should be attached to both the motor and the drive before the AC power is connected. The motor connections on the Compumotor Plus Drive are made to a screw terminal block on the front panel. The terminals are marked as shown in the figure below.



Resolver Connections

The resolver cable has an MS-style connector on the motor/resolver end and a 9-pin, D-type connector on the drive end. The cable cannot be installed on the wrong connector. Attach the MS-style connector to the motor and the D-type connector to the motor/drive.

RS-232C Connections (Serial Communications)

The RS-232C connector is a screw terminal connector and is electrically compatible with the EIA specifications for RS-232C communications. The Compumotor Plus Drive has a three-wire implementation of this interface and provides Receive Data (R_x), Transmit Data (T_x), and Ground signals on the connector.

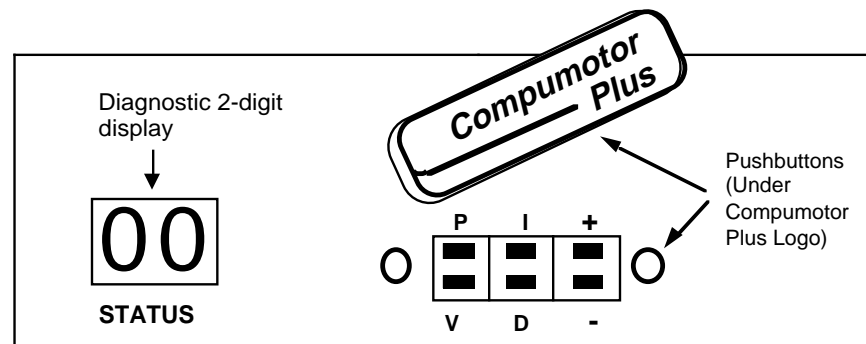
To set the baud rate, expose the front panel pushbuttons by removing the Compumotor Plus logo on the front panel. Press the V and D buttons together and hold. Press the + or - buttons to select the next and previous baud rate, respectively. Refer to the section below on Tuning for a detailed description of button locations. The available baud rates are shown in the table below.

Baud rates are selected through the front-panel push buttons

Baud rate	
300	
600	
1,200	
2,400	
4,800	
9,600	Default setting
19,200	

Using the Front-Panel Pushbuttons

The following section describes how to use the pushbuttons located under the Compumotor Plus logo on the unit's front. The pushbuttons are useful for setting gains, saving parameters, resetting the unit, setting the baud rate for RS-232 and setting the units device address.



Tuning pushbutton adjustments

Function	Show value	Adjust (press together)
Integral Gain	Press I	Press I and + or -
Velocity gain	Press V	Press V and + or -
Proportional gain	Press P	Press P and + or -
Derivative gain:	Press D	Press D and + or -

Miscellaneous pushbutton adjustments

Function	Show value	Adjust (press together)
Device address:	Press V and P	Press V, P and + or -
Baud rate	Press D and V	Press D, V and + or -

Miscellaneous pushbutton functions

Function	Keys
Return to factory settings	Press I and P
Drive reset	Press + and -
Display software revision	Press D and I

RS-232C Daisy Chain Connections

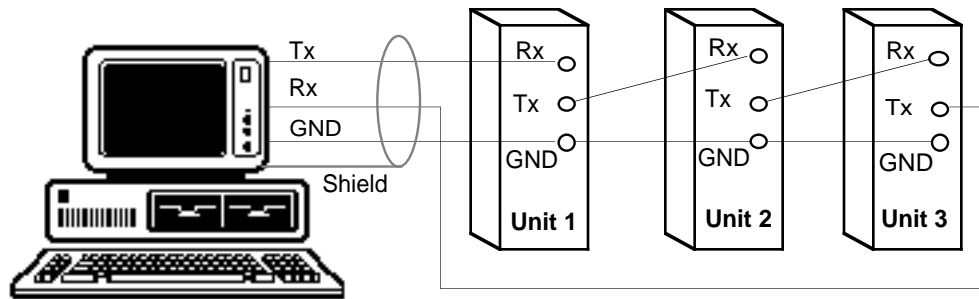
You can daisy chain up to 16 Compumotor Plus Drives to a single RS-232C port on a computer or terminal. Use the figure below as a guide for daisy chain connections. You must establish a unique device address for each Compumotor Plus so that you can distinguish them when programming. The device address is set with the front panel pushbuttons (refer to *Chapter 4, Application Design* for appropriate settings).

To set the device address follow the steps shown below.

- Remove the Compumotor Plus logo on the front of the unit.

- ❑ Press the V and P buttons together and hold. The current device address will appear in the diagnostic display.
- ❑ Press and hold the V and P keys, then press + or - to increase or decrease the device address, respectively.

RS-232C Interface



The daisy chain feature is useful when you are setting up or monitoring the motor's performance from multiple units.

Encoders

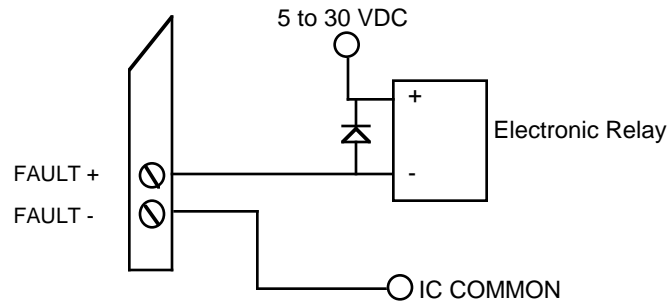
The Compumotor Plus is not capable of accepting encoder feedback. However, you can install an encoder on the back of the motor and use a separate indexer or encoder monitoring device to track motor position.

Fault Output

The system provides two complimentary outputs that signal when the amplifier has shut off motor current due to a fault (e.g., excessive following error). The outputs, named **Fault+** and **Fault-**, are the collector and emitter, respectively, of a 60 mA, optically isolated transistor. A separate DC power supply is required to power the output. This assures the signal is valid even if the Compumotor Plus has not power.

☞ **Hint** If you use a mechanical relay you must use a blocking diode.

Connect the anode of the diode to the **Fault+** output and the cathode to your positive terminal of your DC power supply. Connect **Fault-** to the negative terminal of your DC power supply.



End-of-Travel Limits

The Compumotor Plus has two end-of-travel limit inputs, (named the **CW LIMIT** and the **CCW LIMIT**) they are connected to ground to allow motor movement. **Note: If your motor does not respond to motion commands over RS-232C, be sure to check the end-of-travel limit inputs.** Limits may be bypassed using the Limit Disable (**LD3**) command over the RS-232C interface. Normally closed switches, preferably electronic, must be used. These inputs draw 12 mA from the internal 12VDC supply.

The limit inputs are set up to function with normally closed contact switches in order to provide fail-safe operation. This way, if a limit switch wire is disconnected or broken, motion in the direction of the disabled limit is

inhibited. Refer to *Chapter 2, Getting Started* for a detailed description of how to disable the limits.

System Mounting

You should give special attention to the environment and location in which you will operate your Compumotor Plus Series system. Consider atmospheric contamination and excess heat before you install and operate your Compumotor Plus system. Refer to the table outlining the environmental specifications of the Compumotor Plus at the beginning of this chapter.

Drive Mounting

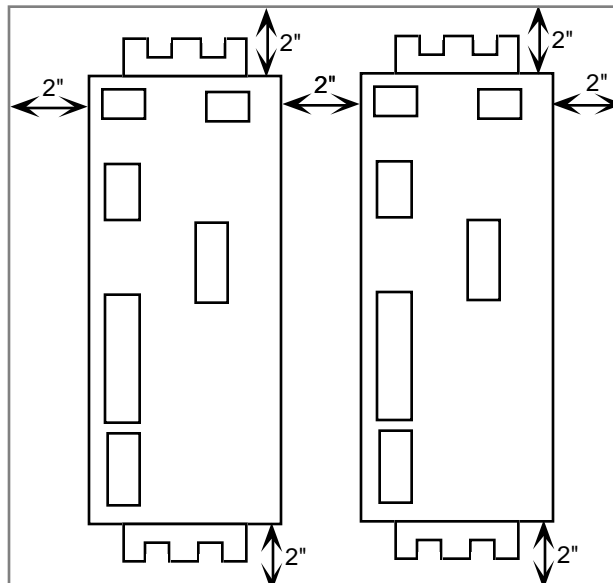
Safety is of prime importance when installing a motion-control system. This section outlines installation guidelines with the safety of the operator and the equipment in mind. You should become familiar with this section and with local and national codes that pertain to the installation of electrical equipment.

If you mount the Compumotor Plus in an enclosure, observe the following guidelines:

- ❑ The vertical clearance between the Compumotor Plus Drive and other equipment, or the top or bottom of the enclosure, should be no less than 2 inches.
- ❑ The horizontal clearance should be no less than 2 inches.
- ❑ Do not mount large, heat-producing equipment directly beneath the Compumotor Plus.
- ❑ Do not mount the Compumotor Plus Drive directly below an indexer (the Compumotor Plus produces more heat than an indexer).
- ❑ The maximum allowable ambient temperature directly below the Compumotor Plus is 45°C. Fan cooling may be necessary if adequate air flow is not provided with the low power units.

The following illustration describes suggested clearances around the Compumotor Plus upon installation.

☛ **Hint** Leave at least a 2" space around the drive to provide adequate ventilation. Do not put heat sensitive units above the drive.



Motor Mounting

The motor should be mounted using bolts through the flange and centered by the pilot on the front face. The pilot is the raised circular portion of the flange end of the motor. Refer to the *Mechanical Reference* section for motor dimensions.

CAUTION

Remember, electrical noise, a poorly designed enclosure, or improper grounding can affect system performance and safety. For more information about these factors, refer to *Chapter 7, Troubleshooting and Maintenance*.

The motors used with the Compumotor Plus Drive can produce very large torques. These motors can also produce high accelerations. This combination can shear shafts and mounting hardware if the mounting is inadequate. High accelerations can produce shocks and vibrations that require much stronger hardware than required for similar static loads. The motor can set up low-frequency vibrations in its mounting hardware.

These vibrations will cause fasteners to loosen if they are not locked. This can be prevented by using a locking nut such as an aircraft grade NyLock™ nut. These vibrations can also cause metal fatigue in structural members if harmonic resonances are induced by the move profiles. A thorough mechanical engineering analysis of the machine should be performed to ensure the mounting structure is adequate.

Coupling the Motor to the Load

The coupling you choose to link the motor to the load affects the accuracy and efficiency of your application. A bad coupling can cause a large proportion of the motor's power to be lost before it gets to the load. This can be caused by poor shaft alignment between the motor and the load and by loose and/or poor fitting hardware.

Special couplings that accommodate different types of misalignment are available. The following are the three types of misalignments; they can exist in any combination.

- ❑ Parallel Misalignment. The offset of two mating shaft center lines, although the center lines remain parallel to each other.
- ❑ Angular Misalignment. When two shaft center lines intersect at an angle other than zero degree.
- ❑ End Float. A change in the relative distance between the ends of two shafts

Special couplings are used to accommodate the above misalignments and to transmit the desired torque. The coupling manufacturer should be consulted to ensure that the coupling is being used within its specified torque capacity and alignment ranges.

Shaft couplings may be divided into three types: single-flex, double-flex, and rigid. Like a hinge, single-flex couplings accept angular misalignment only. A double-flex coupling accepts both angular and parallel misalignments. Both single-flex and double-flex, depending on their design, may or may not accept end-play. Rigid couplings do not compensate for any misalignment.

CAUTION

Do not machine the motor shaft without consulting a Compumotor Applications Engineer at (800) 358-9070. Improper shaft machining can destroy the motor's bearings.

Single-Flex Coupling

When a single-flex coupling is used, one and only one of the shafts must be free to move in the radial direction without constraint. *Do not use a double-flex coupling in this situation because it will allow too much freedom and the shaft will rotate in an eccentric fashion; this will cause large vibrations and eventual coupling failure.*

Double-Flex Coupling

Use a double-flex coupling whenever two shafts are joined that are fixed in the radial and angular direction (angular misalignment). *Do not use a single-flex coupling with a parallel misalignment; this will bend the shafts, causing excessive bearing loads and premature failure.*

Rigid Coupling

Rigid couplings are generally not recommended. They should be used only if the motor is on some form of float mounting which allows for misalignment.

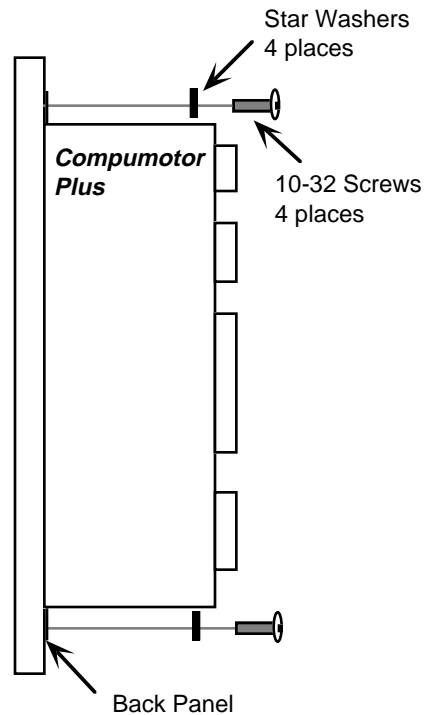
*Coupling
Manufacturers*

HELI-CAL ROCOM CORP
901 McCoy Lane 5957 Engineering Drive
P.O. Box 1460 Huntington Beach, CA 92649
Santa Maria, CA (714) 891-9922
(805) 928-3851

For unusual motor installations contact Compumotor Application Engineering for assistance.

Panel Mounting

The Compumotor Plus has L shaped mounting brackets. They are notched with slots to accept screws on either end to facilitate mounting to flat panel surfaces. Use 10-32 screws with captured nuts to mount drive. If a fan is used, it may create vibrations, so locking the screws is advisable. Since the drive is difficult to manage with one hand, it is advisable to have a power interlock that prevents the drive from being removed with the power on.



Setting Motor Resolution

The Compumotor Plus control hardware functions with a natural resolution of 12,800 steps/rev (12,800 = 50 poles per revolution times 256 steps/pole). To provide the most flexible system possible, the Compumotor Plus software allows user to define any motor resolution from 200 steps/rev to 25,600 steps/rev. This is called the user resolution. However, motor resolutions above 12,800 steps per revolution do not improve the accuracy of the system.

User resolutions may be better suited for your application than the natural resolution by allowing you to program in units which make sense in your application. For example, it may be desirable to specify distance in microns. By selecting appropriate mechanical components and a suitable user resolution you will be able to specify moves in increments of microns. This does not mean that each motor step will be one micron, the accuracy of the system is unchanged. It does mean that you may calculate distance using units familiar to you.

Truncation Errors

The Compumotor Plus servo algorithm converts the commanded move distance (in terms of the user resolution) into the equivalent number of steps at 12,800 steps/rev. This is done by multiplying the number of commanded motor steps by 12,800 divided by the user-resolution.

$$distance_{\text{natural steps}} = \frac{distance_{\text{user steps}} \times 12,800}{\text{user resolution}}$$

The fractional part of this product is discarded. Thus, there is a truncation error of $1/12,800$ of a revolution for user resolutions that are not sub-multiples of 12,800. A sub-multiple is any resolution which can be multiplied by a whole number to get 12,800 (e.g., 6,400; 3,200 steps/rev). This error is not cumulative, however. The truncation error is same for one revolution as it is for many revolutions. User resolutions that are sub-multiples of 12,800 do not have a truncation error.

Verifying Proper Installation

The first time you power-up the Compumotor Plus, it will send the following ready prompt from the RS-232C port:

```
*READY  
>
```

To verify that the Compumotor Plus is communicating, power up the terminal before you power up the drive. Once the drive is powered, the ready prompt shown above is sent to your terminal. If your terminal displays garbled characters, check the terminal's protocol set-up. It is likely that the baud rate is not set at 9,600. If the baud rate is set at 9,600, and nothing appears on the terminal's screen, switch the transmit and receive wires and try again.

After you receive the ready prompt, enter some characters (they should appear on your screen). If each character appears twice, your terminal is set to half-duplex and should be reset to full-duplex.

Enter the following on your terminal's keyboard.

Type This	Compumotor Plus Response
<space>E<space>	E
	>

Note: <space> represents the space bar.

If the correct response does not appear, type the commands again. If you are still unsuccessful, refer to *Chapter 6, Maintenance and Troubleshooting*.

If characters are being echoed on the screen, but no prompts (>) are being displayed, your system may not be set in Interactive mode (SSIO command). Interactive mode is the factory default mode. The Interactive mode is intended for initial testing and set-up. This mode is not generally used with applications that are controlled by a host computer.

Bypassing Limit Switch Inputs for Test

The limit switches are set-up to function with normally closed contact switches. This is a fail-safe configuration. If a wire is disconnected, motion in that direction is not allowed by the system.

If you wish to test your motor without connecting the limit switches you can defeat them by issuing the Limit Disable (LD3) command. Compumotor ships the drive from the factory with the limits enabled. This means that the motor will not move unless either the limit switches are properly connected, or the LD3 command has been issued.

Testing Limit
Switch
Operation
Example

To test the CW limit function in the Compumotor Plus Indexer/Drive, ground the CW limit input with piece of wire and enter the following commands.

Command	Description
> LD0	Enable CW and CCW Limits
> H+	Set direction CW
> MC	Set to Continuous mode
> A10	Set acceleration to 10 rps ²
> V1	Set velocity to 1 rps
> G	Execute the move (Go)

The LD0 command enables the limits so the motor will not turn unless the CW limit input is grounded. The motor begins turning in the CW direction at a constant velocity of one revolution per second.

CW limit test

To test the CW limit function, open the CW limit (remove the CW Limit wire). The motor comes to an immediate halt.

To test the CCW limit function in the Compumotor Plus Indexer/Drive, ground the CCW limit input with piece of wire and enter the following commands.

Example

Command	Description
> MC	Set to Continuous mode
> A10	Set acceleration to 10 rps ²
> V1	Set velocity to 1 rps
> H-	Set direction to CCW
> G	Execute the move (Go)

CCW limit test

The motor begins turning in the CCW direction at constant velocity of one revolution per second. To test the CCW limit function, open the CCW limit (remove the CCW Limit wire). The motor comes to an immediate halt.

Note: If the motor fails to stop issue a Stop (s) or Kill (κ) command over the RS-232 port (Rx and Tx connections).

Making the Motor Move

To test the CW rotation function of the Compumotor Plus, enter the following string of commands on the terminal's keyboard.

Example

Command	Description
> LD3	Enable end-of-travel limits
> A10	Set acceleration to 10 rps ²
> V10	Set velocity to 10 rps
> D10000	Set distance to 10,000 steps
> G	Execute the move (Go)

The motor shaft turns two revolutions in the CW direction. To test the CCW rotation function of the Compumotor Plus enter the following string of commands:

Example

Command	Description
> A10	Set acceleration to 10 rps ²
> V10	Set velocity to 10 rps
> D-10000	Set distance to -10,000 steps
> G	Execute the move (Go)

The motor shaft turns two revolutions in the CCW direction. If the motor moves the wrong distance, issue the Configure Motor Resolution (1CMR)<space> command (assuming a device address of 1). The response should be 5,000 steps/rev. If it is some other value, you may reset it (refer to the CMR command listing in *Chapter 5, Software Reference*).

Homing The Motor

You can initiate the Go Home function by issuing the Go Home (GH) command. When you issue the Go Home command, you must include the direction and velocity that the motor should use to search for home. The home limit input on the Compumotor Plus is optically isolated, and is normally off. A normally open, load activated switch to ground is the most common way of signifying the home position.

When you command the Compumotor Plus to go home, it begins to move in the direction and at the velocity you specify with the GH command (e.g., GH+2 causes a go home move in the CW direction at two revolutions per second).

It performs this move at the last defined acceleration rate, and looks for the home limit input to become active. If the motor encounters an end-of-travel limit while it searches for home, it will reverse direction and look for the home limit input to go active in the opposite direction. If motor encounters the other limit before it detects the home signal, the go home move is aborted and the motor stops.

To test the functionality of the home input switch, manually open the switch and type the following:

```
1IS<space>          *000_011_000_0
>
```

Assuming your end-of-travel limits are active, you should get back the response shown. Close the home switch and type the following:

```
1IS<space>          *000_111_000_0
>
```

This verifies that the limit switch is functioning properly. Refer to the IS command in *Chapter 5, Software Reference* for more information.

Example

To test the Compumotor Plus Drive's homing function you will need a short piece of wire to ground the HOME input. Then, enter the following commands:

Command	Description
> 1GA5	Set go home acceleration to 5 rps ²
> 1GH+1	Instructs the motor to go home CW at 1 rps

The following events occur as a result of this command.

- ① The motor moves in the positive direction at a constant velocity at one revolution per second.
- ② You must create a HOME input signal by grounding the HOME input.
- ③ The motor decelerates to a stop.

When the HOME input goes on after a GH command, the system recognizes the location where the input became active as home. The drive decelerates the motor at the last rate specified. The absolute position counter is automatically reset at the end of the Go Home move. More elaborate home sequences are available (refer to *Chapter 5, Software Reference*).

Testing Continuous Mode Moves

The Mode Continuous (MC) command accelerates the motor to the velocity that you last specified with the Velocity (V) command. The motor continues to move at the specified velocity until you issue the Stop (S) command or specify a velocity change.

To change velocity while the motor is moving, use the **V** command followed by the **G** command. Continuous mode is useful for applications that require constant movement of the load, when the motor must stop after a period of time has elapsed (rather than after a fixed distance), or when the motor must be synchronized to external events such as trigger input signals.

Example

Command	Description
> PS	Pause
> MC	Set to Continuous mode
> A2	Set acceleration to 2 rps ²
> V.1	Set velocity to 0.1 rps
> G	Execute the move (Go)
> T1	Wait 1 second after the motor reaches constant velocity
> V.5	Set velocity to 0.5 rev/sec
> G	Change velocity (Go)
> T1	Wait 1 second after the motor reaches constant velocity
> V0	Set velocity to 0 rps
> G	Change velocity to 0 (Stop)
> C	Continue

This series of commands sets the indexer to the Continuous mode. The motor is accelerated to 0.1 revolution per second, waits one second, changes velocity to 0.5 revolution per second, waits one second, and then stops. Note that the commands **V0 G** stops the motor (the **S** command is not a buffered command and cannot be used in this type of situation).

Final System Configuration

You should now have tested all of your interfaces and should be prepared to install the Compumotor Plus using your final configuration.

Inputs & Outputs

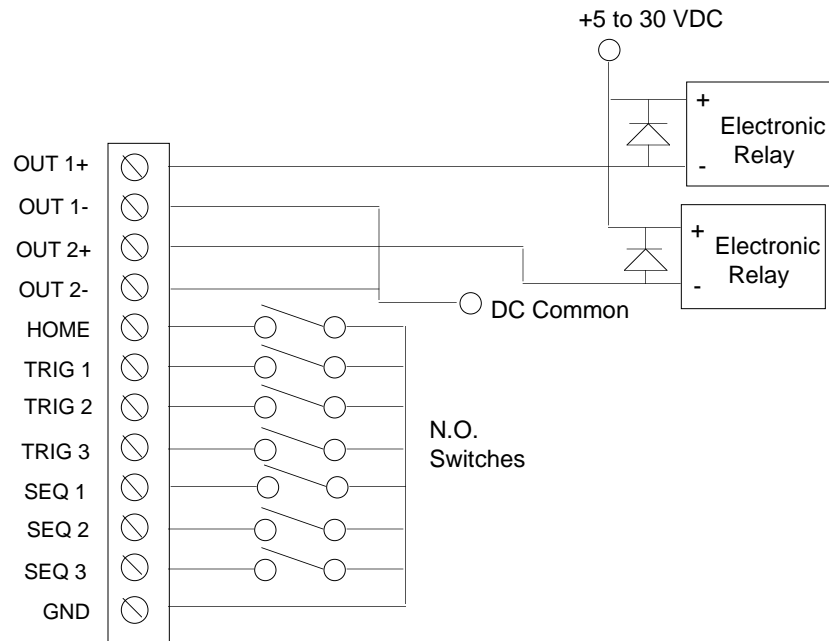
This section presents information about the Compumotor Plus Drive's inputs and outputs. The following inputs and outputs are addressed:

- Programmable Inputs
- Programmable Outputs and/or Faults

<u>Input Functions</u>	<u>Output Functions</u>
End-of-travel limits	Moving/Not moving
Home	Programmable outputs
Jog	Registration failed
Programmable trigger inputs	Registration occurred
Registration	Slip fault
Sequence select	
Start and stop	

Dedicated Inputs

End-of-Travel limits (CW & CCW limits) and the Home inputs are limited to those functions.



Sequence Inputs

Six inputs may be user defined to provide different functions. Use the **IM** command to specify the different functions.

Sequence inputs are grounded (closed) to make them active. They may be left open if they are not used. This input draws 12 mA through the internal 12VDC supply.

Trigger Inputs

Trigger inputs are grounded (closed) to make them active. They may be left open if they are not used. This input draws 12 mA through the internal 12VDC supply.

Verifying Proper Trigger Input Wiring

Use the following steps to verify that you have wired the trigger inputs properly. You will need a short piece of wire to ground the trigger inputs.

Step ①

Check the state of the trigger inputs. Note: The **1TS** command reports the state of the inputs only for the instant that the command is entered. Make sure you have a good connection between the input and ground before issuing the command.

Command	Response
1TS<space>	*000000
	>

Step ②

Ground TRIG 1 input to activate it.

Step ③

Check the state of the trigger inputs.

Command	Response
1TS<space>	*100000
	>

This verifies that TRIG 1 input is turned on.

Step ④

Repeat this process for each input.

Verifying Proper Trigger Function

If the above test was successful you are ready to use the trigger inputs in a simple program. You will require a short piece of wire to ground the TRIG1 input as in the above examples. To verify that the Trigger function is operating properly enter the following commands. Be sure to type a space or carriage return after each command.

Example

Command	Description
> PS	Pause
> LD3	Disable the limit function on trigger 3
> A2	Set acceleration to 2 rev/sec ²
> V.5	Set velocity to 0.5 rev/sec
> D10000	Set distance to 10,000 steps
> TR1XXXXX	Wait for Trigger Input 1 to turn on
> G	Execute the move (Go)
> C	Continue

The above example defines a move and then waits for a trigger input to occur. When you ground TRIG1 the motor makes a move of two revolutions.

Note: The Compumotor Plus will wait forever for the trigger input, so if it does not respond to the trigger you will need to issue a STOP (S) command or a KILL (K) command to allow it to respond to further buffered commands.