Tolomatic
EXCELLENCE IN MOTION®

STEPPER

HARDWARE & INSTALLATION GUIDE

ACS – Actuator Control Solutions

Stepper Drive/Controller and Motors

DISCONTINUED Product Style, Size or Part no. This guide is for reference only. See 3604-4183 for current ACS Stepper Hardware & Installation Guide

3604-4173_08

LINEAR SOLUTIONS MADE EASY

201503201551

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Health and Safety Regulations

Read through the applicable sections of the manual before the equipment is unpacked, installed or operated. Pay attention to all of the dangers, warnings, cautions and notes stated in the manual.

Serious injury to persons or damage to the equipment may result if the information in the manual is not followed.

Safety Symbols

Items that are specifically marked DANGER!, WARNING!, CAUTION! or NOTE! are arranged in a hierarchical system and have the following meaning:

DANGER!

Indicates a very hazardous situation which, if not avoided, could result in ***death or serious injury***. This signal word is limited to the most extreme situations.

WARNING!

Indicates a potentially hazardous situation which, if not avoided, could result in ***death or serious injury***.

CAUTION!

Indicates a potentially hazardous situation which, if not avoided, may result in property damage, minor or moderate injury.

CAUTION!

Indicates hot surfaces. Avoid contact.

NOTE!

Information that requires special attention is stated here.

EMC Wiring Guidelines

Cable routing

It is recommended that the power and signal cables for the ACS Drive be routed as far apart as possible to minimize system noise.

NOTE! The standard cables from Tolomatic are not flex rated and have a minimum bend radii of 3.75 inches. Any repeated flexing or excessive bending can result in broken conductors and intermittent faults.

Shielding and grounding

When cabling the system, high quality braided or foil with braided shielded cables are recommended. The standard motor cables provided by Tolomatic have a braided shield with drain wires. The metal angle bracket on the drive/controller is also a case ground and should be tied to earth ground. To minimize EMI and ensure system reliability, all shield drain wires from all cables should be tied to a common earth ground.

Proper and Safe Use of Product

Protection circuits and external fuses

A fuse should be added to the input power line to protect the drive/controller and power supply from any potential over current conditions that may occur. (See Section 6: Specifications & Wiring)

WARNING!

The manufacturer takes no responsibility whatsoever if the equipment is modified or if the equipment is used in any way beyond performance specifications. Unauthorized modifications or changes to the equipment are strictly forbidden and void all warranties.

Fail Safe Emergency Stop Recommendations

A means for a fail safe e-stop is highly recommended to ensure equipment and personal safety. The e-stop should provide a means to remove main power from the actuator to cease and prevent any unwanted motion.

Device Damage Prevention

To prevent permanent damage to the device, proper care should be taken not to exceed published voltage, current, temperature, and load ratings. In addition, proper wiring should be verified and safety measures checked before applying power.

Personal Safety

During normal operation the motor can become hot. It is highly recommended to display proper safety notices and implement proper safety measures to prevent contact with hot surfaces.

CAUTION!

Proper ESD measures should be taken to avoid static electricity from contacting the signal and power lines of the drive, motor and encoder.

Handling and Unpacking

When unpacking and handling, care should be taken not to drop the drive/controller as this can damage the connectors and internal electronics.

Product Warnings

The following precautions should be observed to prevent erratic behavior or damage:

- Do not short circuit the motor power at the power connector. Doing so may damage the drive power electronics. The motor/cable is part of the current regulation circuitry. For a short occurring in a motor, the motor leads should provide enough resistance and inductance to prevent dangerous peak currents from occurring.
- Do not reverse bias the drive power.
- Do not apply voltages above the maximum rated voltage.
- Do not expose drive to conductive contaminants, moisture, or excessive temperature.
- Do not disassemble or modify the drive/controller.
- Do not plug and unplug cables while the drive is energized.

1.1 The ACS Stepper Drive/Controller for Actuator Control Solutions

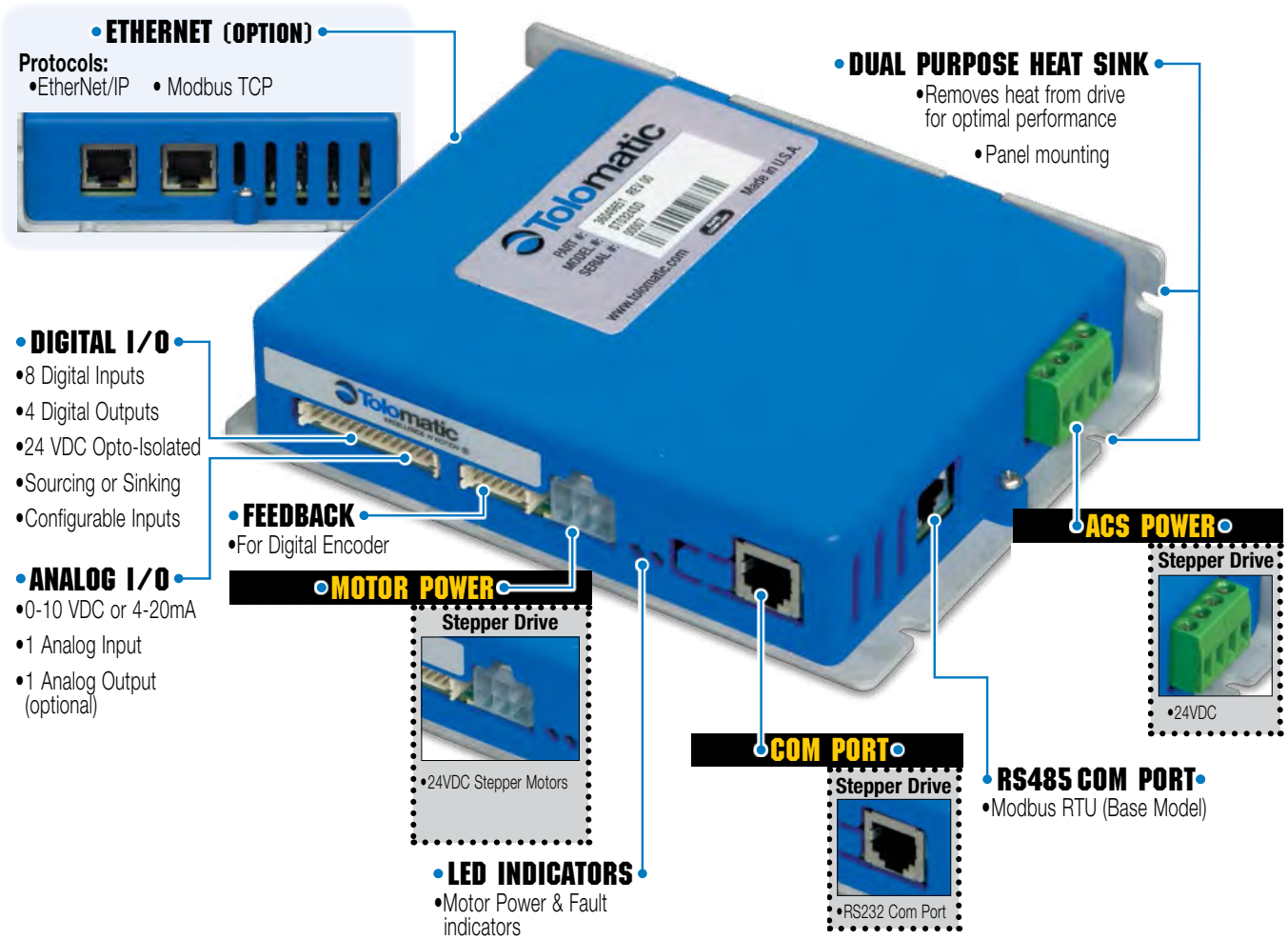
Tolomatic's ACS Drive/Controller is a stepper drive and controller intended for use with electric actuators. Tolomatic's Motion Interface software allows the user to select the compatible Tolomatic electric linear actuator of choice. The software automatically sets most of the necessary parameters to create the desired motion of the selected actuator reducing setup and programming time. (See Tolomatic Motion Interface Software Manual 3600-4167 for more information).

Currently there are three ACS Drive/Controller choices:

- #3604-9651 - ACS Stepper Drive/Controller, Modbus RTU over RS485 - firmware 36043144SD.hex
- #3604-9654 - ACS Stepper Drive/Controller, EtherNet/IP (Analog Output) - firmware 36043175ED.hex
- #3604-9655 - ACS Stepper Drive/Controller, Modbus TCP (Analog Output) -firmware 36043176MD.hex

NOTE: They will collectively be referred to as ACS Drive throughout this guide

1.1.1 ACS Stepper Drive/Controller — Overview



ACS Drive/Controller (3604-9651) Capabilities

- 4, 8, or 16 move command modes (absolute, incremental and jog or home with analog output echoing position of actuator from encoder) for infinite position capability
- Analog position mode (0-10 VDC or 4-20 mA)
- Pneumatic mode replaces pneumatic valve logic for simple motion
- ModBus RTU over RS485 provides infinite positioning
- Adjustable motion profile parameters (velocity, accel/decel, force). Parameters are independently configurable for each move
- Ability to reduce holding current for energy savings
- End point correction
- Zone output based on position
- Force limiting capability
- Configurable digital I/O (24 VDC Opto-Isolated) (sourcing or sinking)
- Compatible with most 24 VDC stepper motors

ACS Drive/Controller (3604-9654, 3604-9655) Additional Capabilities

- EtherNet mode provides infinite positioning using EtherNet/IP and Modbus TCP protocols
- Dual EtherNet port with internal switch for easy daisy chaining
- Analog output for Analog Position Mode

1.1.2 Optional Accessories

Cable Options

Tolomatic offers a motor power cable with drive and motor mating connectors, an encoder cable with drive and encoder connectors, and an I/O cable with drive mating connector to flying leads. Cables are available in either 3-meter or 5-meter lengths.

Starter Kit

Tolomatic offers a Starter Kit (Part No. 3604-9044) for use with optional USB computer connections. The kit includes:

USB to RS-232 converter

Adapter cable for RJ12 to D-sub

Tolomatic Motion Interface Software CD

2.1 Operating Environment

WARNING!

Do not expose the drive to conductive contaminants, moisture, or exceed temperature ratings.

The ACS Drive is designed to be operated in ambient conditions from 0° – 40°C (32° – 104°F), and humidity from 0 – 90% non-condensing. There is no ingress protection (IP) for the drive, so it is important to protect the drive from water and other conductive contamination. In addition, proper ESD procedures should be observed to prevent static discharge and damage to electronic components.

ACS Drive Operating Conditions	
Ambient Temperature	77° F, 25° C Nominal
Operating Temperature	32°-104° F, 0°-40° C Non Freezing
Storage Temperature	32°-158° F, 0°-70° C
Humidity	0-90% non-condensing

Table 2-1: ACS Drive Operating Conditions

2.2 ACS Drive Dimensions

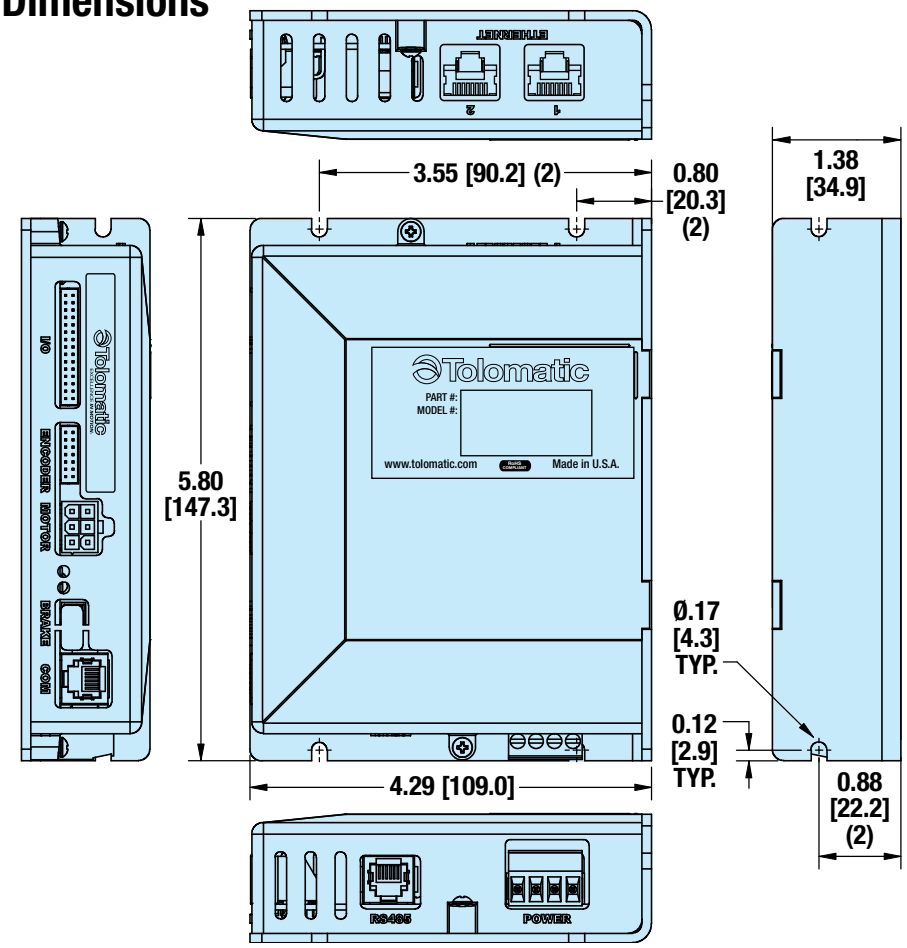


Figure 2-1: ACS Drive Dimensions

2.3 Mounting the ACS Drive

The drive/controller is intended to be mounted vertically (as shown in Figure 2-2) to provide the vents with enough clearance on the top and bottom of the drive to allow for air flow. The metal bracket should also be mounted to a metal surface for best thermal dissipation. A 2-inch head space is recommended from the drive vents to another surface to ensure the proper ambient temperature ratings are maintained.

It is recommended to have a minimum of 1-inch spacing between drives. This spacing may be relaxed provided the ambient temperature is kept within limits and the drive is mounted to a metal surface suitable enough to heat sink the drives.

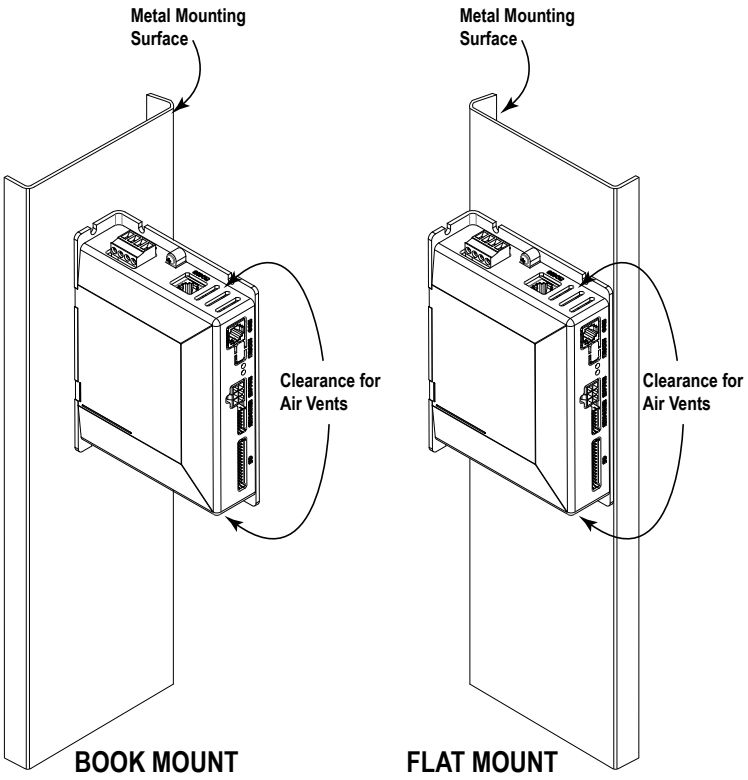


Figure 2-2 Mounting the ACS Drive

3.1 Starter Kit

Tolomatic offers a basic Starter Kit for the ACS Drive that can be used to convert a USB connection to a serial port.

The kit includes an RJ12 cable, a D-sub to RJ converter, a USB to RS232 converter and a CD with the Tolomatic Motion Interface software.

ACS Drive Starter Kit: PN 3604-9044		
ITEM	**TOLOMATIC PART NUMBER**	**MFR PART NUMBER**
RJ12 Cable	3604-1783	Assmann PN: AT-S-26-6/6/B-7/R-R
D-sub to RJ Converter	3604-1782	Assmann PN: AT-23065-R
USB to RS232 Converter	3604-1795	Keyspan PN: USA19-HS
Tolomatic Motion Interface Software CD	3604-9526	–

Table 3-1: ACS Drive Starter Kit Contents

Tolomatic also offers a Programming Cable Kit (3604-9043) which includes the RJ12 cable and D-sub to RJ12 Converter.

The D-sub to RJ12 converter should to be wired as follows:

WIRE COLOR	D-SUB
Yellow	2
Green	3
Red	4
Black	5
White	7

Table 3-2: D-Sub to RJ12 Converter Wiring

NOTE: The brown wire is not used.

NOTE: Pinout assumes RJ12 cable is reversed.

4.1 ACS Drive and Actuator Basic Setup

Figure 4-1 shows the simple setup of the ACS Drive, the Tolomatic ERD actuator and the necessary cables and power source.

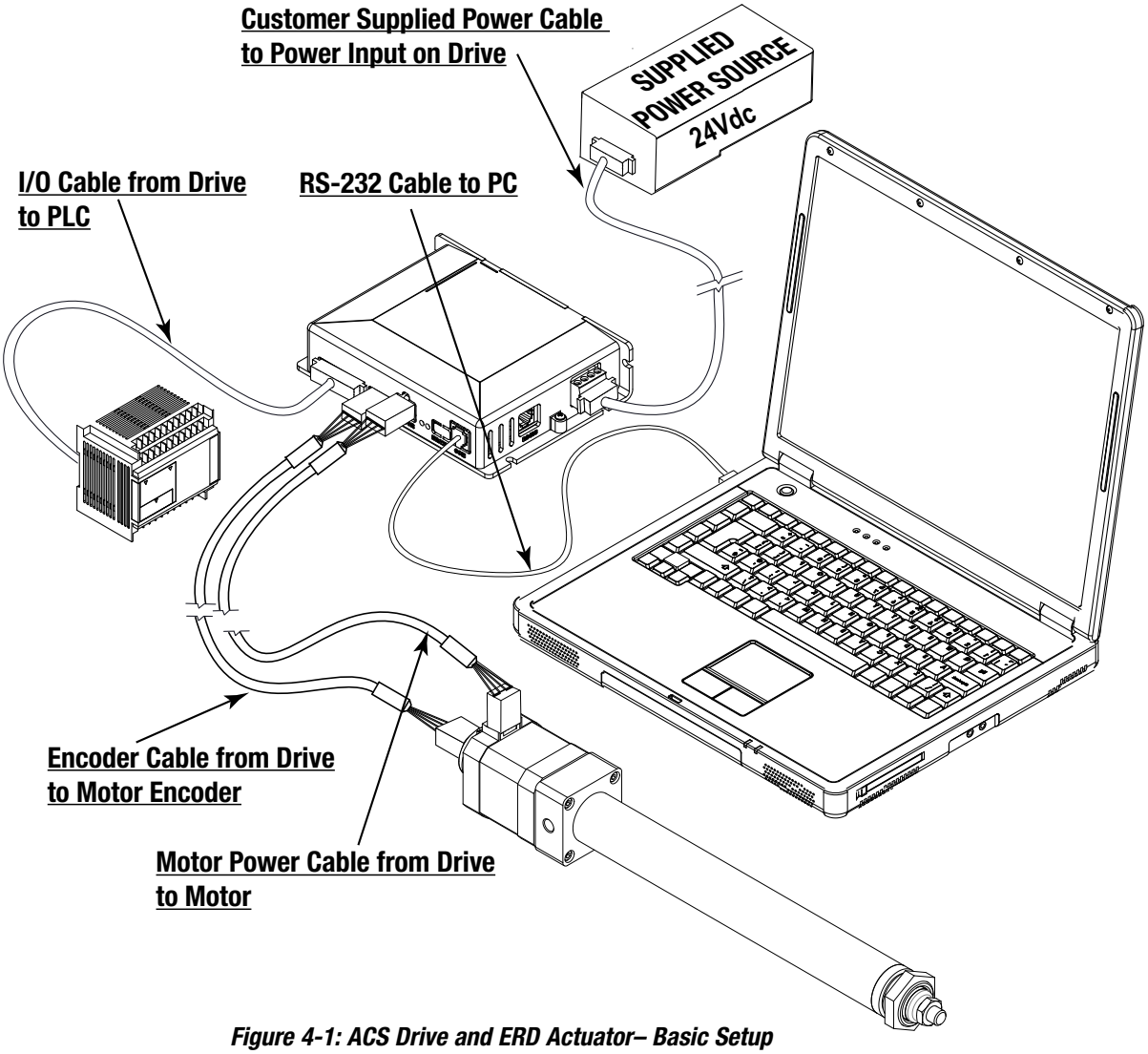


Figure 4-1: ACS Drive and ERD Actuator– Basic Setup

Please refer to the following sections and page numbers for cable part numbers and wiring specifications:

Motor Power Cable: Section 5

Encoder Cable: Section 5

I/O Cable: Section 5

RS-232 Cable: Section 5

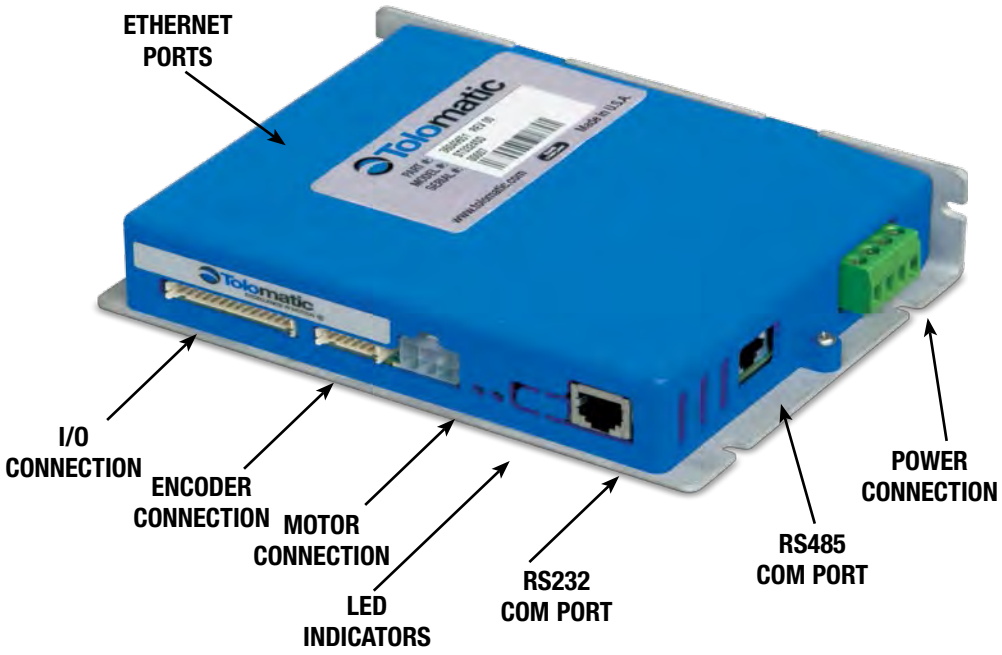
For recommended power supplies: Section 6

4.1.1 Setup Procedures

1. Install drive/controller and actuator into appropriate fixtures.
2. Wire the 24VDC power supply to the drive. See Section 6: Power Supply Selection.
3. Wire input and output signals to the desired logic device. See Section 5: Connections and Cables.
4. Attach motor and encoder cables.
5. Attach serial programming cable and install the Tolomatic Motion Interface software.
6. Configure ACS Drive.
7. Program the logic device.

5.1 Connections and Cables Overview

All cables for the ACS Drive can be ordered through Tolomatic with the exception of the power supply. When using cables other than those provided by Tolomatic, reference the cable mating connector style to ensure the proper cabling is supplied.



5.2 Motor Power Connection and Cables

WARNING!

Do not connect or disconnect motor cables while the drive is powered.

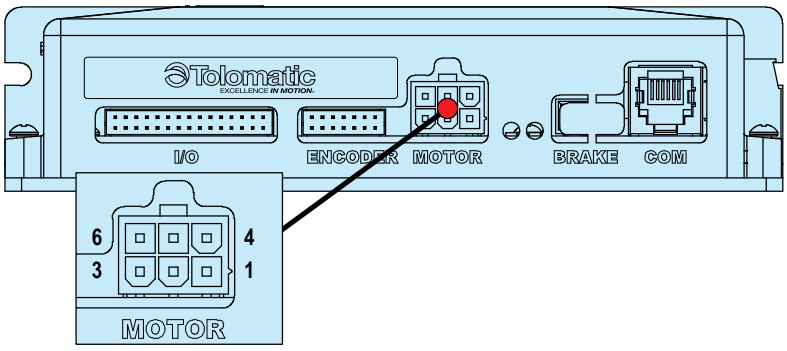


Figure 5-1: Motor Power Connection on ACS Drive

PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
1	Motor A+	Red
2	Shield	Shield
3	Motor B+	Green
4	Motor A-	White
6	Motor B-	Black

Table 5-1: Motor Power Connection pinouts

The ACS Drive has a maximum output of 2.5A peak.

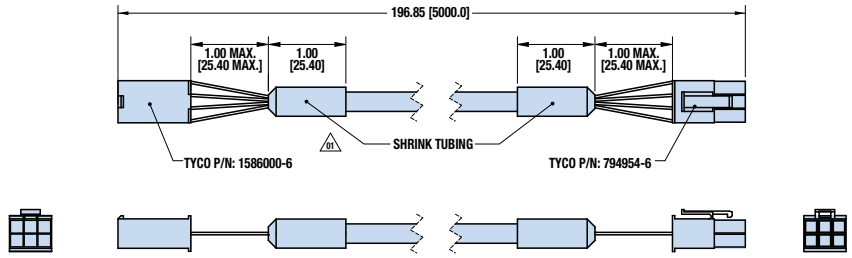


Figure 5-2: Motor Power Cable 3604-1767/1766

CABLE	TOLOMATIC PART NO.	DRIVE MATING CONNECTOR	DRIVE CONTACTS	MOTOR MATING CONNECTOR	MOTOR CONTACTS
Motor Power: 3-meter	3604-1766	Tyco PN: 794954-6	Tyco PN: 1586315-3	Tyco PN: 1586000-6	Tyco PN: 1586314-3
Motor Power: 5-meter	3604-1767	Tyco PN: 794954-6	Tyco PN: 1586315-3	Tyco PN: 1586000-6	Tyco PN: 1586314-3

Table 5-2: Motor Power Cable and Connector Parts

5.3 Encoder Connection and Cable

The ACS Drive has an encoder port that supports differential quadrature encoders. Single ended encoders may be used with additional external circuitry. It is highly recommended to use differential encoders as they are more resistant to noise issues. The drive can supply +5VDC power to the feedback device up to 100mA.

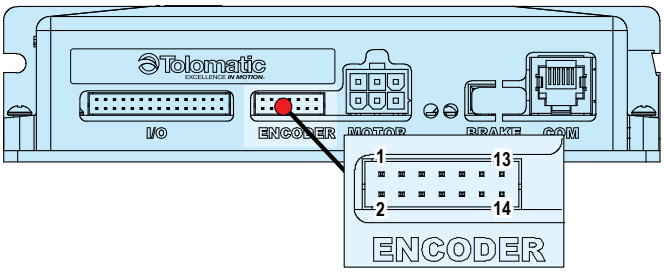


Figure 5-3: Encoder Connection on ACS Drive

PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
1	ENC A+	Blue
2	ENC A-	Orange
3	ENC B+	Yellow
4	ENC B-	Gray
5	NA	NA
6	NA	NA
9	Signal Ground	Black
12	+5VDC	Red
13	Case Ground	NA

Table 5-3: Encoder Connection pinouts

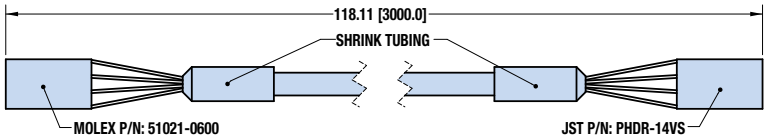


Figure 5-4: Encoder Cable 3604-1768

CABLE	TOLOMATIC PART NO.	DRIVE MATING CONNECTOR	DRIVE MATING CONTACTS	ENCODER MATING CONNECTOR	ENCODER MATING CONTACTS
Encoder: 3-meter	3604-1768	JST PN: PHDR-14VS	JST PN: SPHD-001T-P0.5	Molex PN: 51021-0600	Molex PN: 50079-8100
Encoder: 5-meter	3604-1769	JST PN: PHDR-14VS	JST PN: SPHD-001T-P0.5	Molex PN: 51021-0600	Molex PN: 50079-8100

Table 5-4: Encoder Cable and Connector Parts

5.4 I/O Connection and Cable

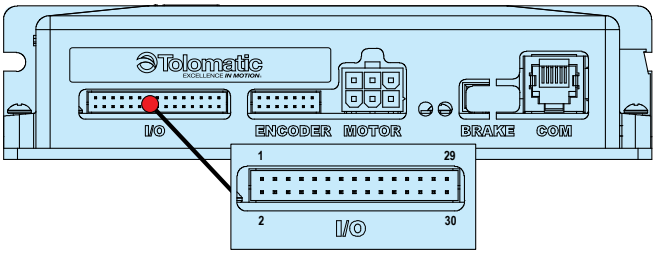


Figure 5-5: I/O Connection on ACS Drive

JST #PHDR-30VS		
PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
1	Input ISO 1	Red/Black/White
2	Input ISO 2	Orange/Green
3	Input ISO 3	Red/White
4	Input ISO 4	Green/White
5	Input ISO 5	Blue/White
6	Input ISO 6	White/Black/Red
7	Input ISO 7	White/Red
8	Input ISO 8	Orange/Red
9	Input ISO COM	Green/Black
10	Output 1 -	Red/Black
11	Output 1 +	White
12	Output 2 -	White/Black
13	Output 2 +	Blue
14	Output 3 -	Blue/Black
15	Output 3 +	Orange

16	Output 4 -	Orange/Black	
17	Output 4 +	Red	
20	Case Ground	Shield	
23	*Step Input	Blue/Red	*Not yet supported by software
24	*Direction Input	Red/Green	
25	NA	Green	
26	NA	Black/Red	
27	Analog Out	GRN/Black/White	
28	Analog In	Black/White/Red	
29	Signal Ground	Black	
30	Signal Ground	Black/White	
28	Analog In	Black/White/Red	
29	Signal Ground	Black	
30	Analog Ground	Black/White	

Table 5-5: I/O Connection pinouts

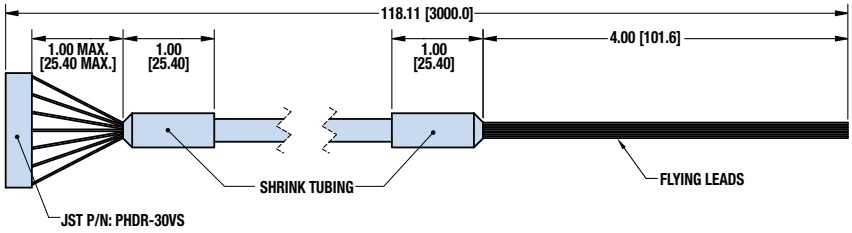


Figure 5-6: I/O Cable 3604-1770

CABLE	TOLOMATIC PART NO.	DRIVE MATING CONNECTOR	DRIVE MATING CONTACTS
I/O: 3-meter	3604-1770	JST PN: PHDR-30VS	JST PN: SPHD-001T-P0.5
I/O: 5-meter	3604-1771	JST PN: PHDR-30VS	JST PN: SPHD-001T-P0.5

Table 5-6: I/O Cable and Connector Parts

5.5 Input Power Connection

CAUTION!

Reversing polarity of the input power will damage the drive electronics.

The input power is connected via pins on the drive with customer supplied cabling. The input power mating connector is supplied by Tolomatic.

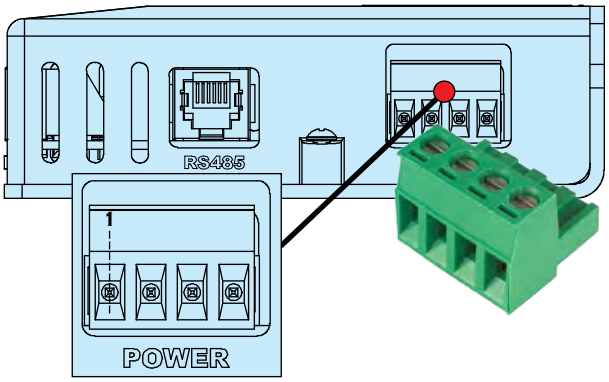


Figure 5-7: Input Power Connection

PIN NUMBERS	SIGNAL
1	Main Power +24VDC
2	Keep Alive +24VDC
3	NA
4	Ground – Power

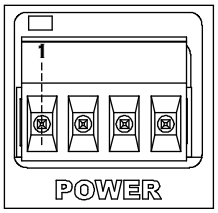


Table 5-7: Input Power pinouts

CABLE	INPUT POWER MATING CONNECTOR
Customer Supplied	OnShore PN: ED950/4 - provided

Table 5-8: Input Power Cable Parts

5.6 RS-232 Connection

The RS-232 port connector is a standard RJ12 type connector and will mate with standard RJ12 connectors and cables.

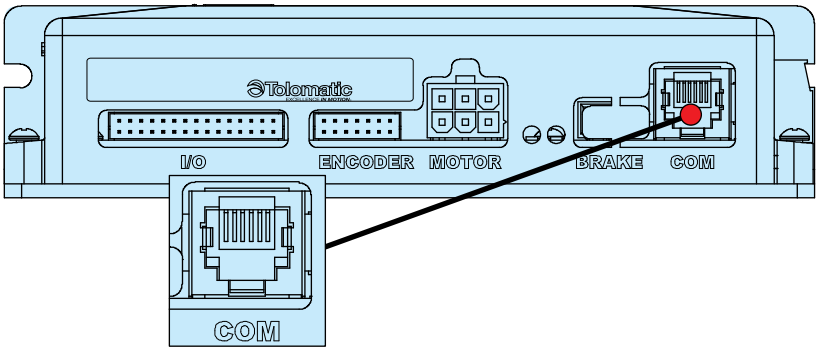
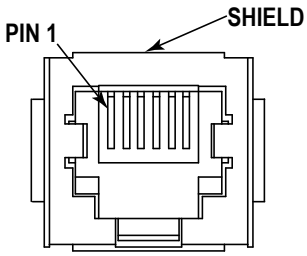


Figure 5-8: RS-232 Connection

The ACS Drive uses five signals from the RS-232 port and will need to be properly wired to the pin diagram shown below. RS-232 baud rate is set at 38400 bps, 1-stop bit, no parity and no flow control. The RS-232 cable itself is a straight through cable.



PIN NUMBERS	DESCRIPTION
2	TX
3	RX
4	Programming
5	Ground
6	Reset

Table 5-9: RS-232 pinouts and Connection

CABLE	TOLOMATIC PART NO.
RJ12	Customer Supplied or 3604-1783
D-sub to RJ12	3604-1782

Table 5-10: RS-232 Cable Parts

5.7 RS-485 Connection

The ACS RS485 connection requires an RJ45 plug with 3 conductors. The ACS controller/drive uses a two-wire configuration for RS485 connection. This requires three signals: A, B, and Common. Signals A and B are a differential pair. Signals A and B are dupliocated on pins 7 and 8. Common is used as a reference voltage. Figure 5-9 shows the pin assignment on the ACS socket.

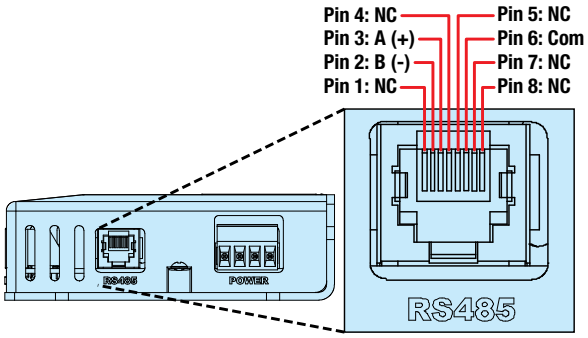


Figure 5-9: ACS 2-Wire RS485 with RJ45 Socket

5.7.1 RS-485 Cable Length

A multipoint serial line bus is made of a main cable (the trunk) which connects to a Master device, and derivation cables that tap off from the trunk to Slave devices. RS-485 transceivers have a wide (-7V to +12V) common mode range. This differential signal has good noise immunity for long distance transmission lines. The absolute maximum cable length of the trunk is 4,000 feet. If more than one Slave device is tapped from the trunk, then terminating 150 Ohm resistors must be placed across lines A and B at both ends of the trunk. The derivation cable to the Slave device must be short with a maximum cable length of 60 feet. Some factors that may reduce cable length are: the number of devices on a multi-drop application, the quality of cabling used, and the baud rate selected.

5.7.2 RS-485 Grounding

The Common wire must be connected to protective ground. This wire should only be connected at one point on the bus, preferably at the Master device. If ground potentials are too large, resistors must be placed in the Common wire at each device to limit the current and prevent damage to the circuit. This is shown in Figure 5-10.

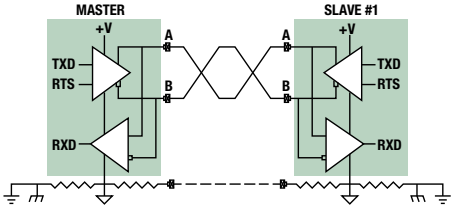


Figure 5-10: Resistors in ground wire to limit current

5.8 EtherNet Connection

The following parts have two EtherNet ports with a built-in switch to be used for daisy chaining.
3604-9654 - ACS Stepper Drive/Controller, EtherNet/IP (Analog Output)
3604-9655 - ACS Stepper Drive/Controller, Modbus TCP (Analog Output)

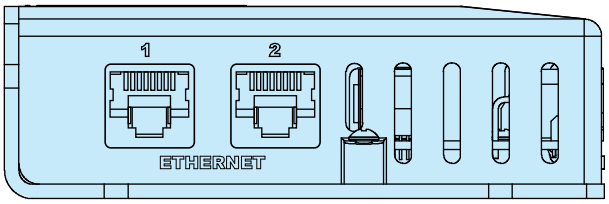
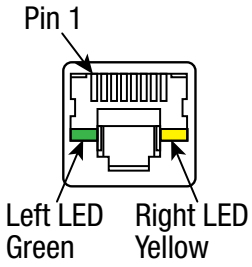


Figure 5-11: EtherNet Connection for ACS Drive Programmability



PIN NUMBER	FUNCTION
1	Transmit Port (+) Data Terminal
2	Transmit Port (-) Data Terminal
3	Receive Port (+) Data Terminal
4	NA
5	NA
6	Receive Port (-) Data Terminal
7	NA
8	NA

Table 5-11 EtherNet pinouts and Connections

5.9 Cable Routing

Over time, liquid contaminants such as oil and cleaning solutions may accumulate on the cables and in the connectors if they are an exposed type. To minimize the introduction of contaminants into the connector, route the cables so that there is a loop in the cable just prior to its attachment to the connector.

In figure 5-12 proper cable routing is shown for connectors located on the top or side of the unit. Units mounted with the connectors are the bottom surface of the actuator require no cable looping.

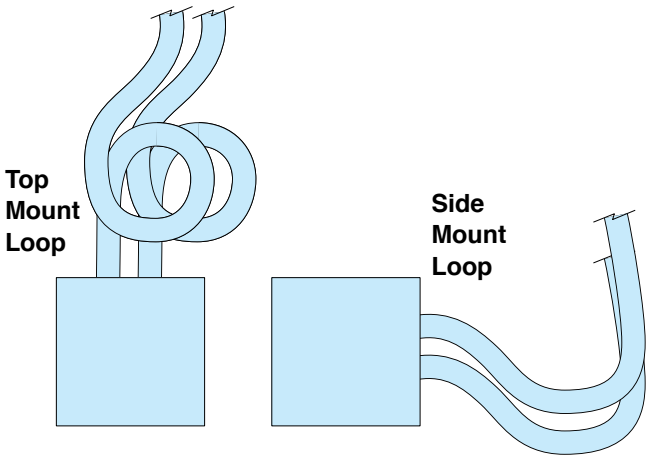


Figure 5-12 Cable Routing for Top and Side Facing Connectors

5.9.1 EtherNet Cable

The selection of cables has a profound impact on network performance and reliability. Selecting the correct cable requires an understanding of the environment where the cable is installed.

Due to high data rate and reliability considerations, at the minimum, Cat5e cables should be used with the ACS Drive. If the cables are made on site, they must be tested to meet performance criteria set according to TIA/EIA -568-B standard. This cable definition is the general cable requirements for copper and fiber cabling installations.

5.9.2 EtherNet Cable Length

The following information on cables is from the ODVA standard. Reference Section 8-9.2.3.6 of the ODVA EtherNet/IP Standard v. 1.11 for additional information.

Patch Cord Length

EtherNet/IP specifications limit the channel to 100 meters or up to 90 meters horizontal wiring with two 5-meter patch cords. Some applications will require longer patch cords. In these applications the total length of horizontal wiring must be adjusted to compensate for the added loss of each connector pair and additional patch cord length beyond 10m.

$$C = \frac{(102-H)}{(1+D)} \qquad (1)$$

Where:

C is the maximum combined length (m) of the work area cable, equipment cable, and patch cord

H is the length (m) of the horizontal cable (H + C </= 100 m)

D is a de-rating factor for the patch cord type (0.2 for 24 AWG UTP/24 AWG ScTP and 0.5 for 26 AWG ScTP). The de-rating factors are based on COMMERCIAL cables. Other constructions, such as high flex, may have different performance. Consult the manufacturer for information.

W is the maximum length (m) of the work area cable.

T is the total length of horizontal, patch and equipment cords.

The maximum stranded cable length is limited to 85mm for the channel with the standard 20% derating for standard stranded cables.

WIRE TYPE VERSUS LENGTH					
	D	H	W	C	T
PATCH CABLE GAUGE	PATCH DERATING	HORIZONTAL LENGTH (H+C<=100M)	PATCH LENGTH	TOTAL LENGTH PATCH AND EQUIPMENT	TOTAL LENGTH OF PATCH, EQUIPMENT AND HORIZONTAL
#24	0.2	100	0	0	100
#24	0.2	0	80	85	85
#24	0.2	25	59	64	89
#24	0.2	50	38	43	93
#26	0.5	0	63	68	68
#26	0.5	25	46	51	76
#26	0.5	50	30	35	85
#26	0.5	100	0	0	100

Table 5-12: Cable Wire Type versus Cable Length

6.1 Digital Inputs

6.1.1 Specifications

The ACS Drive has a total of 8 opto-isolated digital inputs. These digital inputs are opto-isolated from the controller's drive circuitry and can be wired either as sinking or sourcing. All of the digital inputs have a common return.

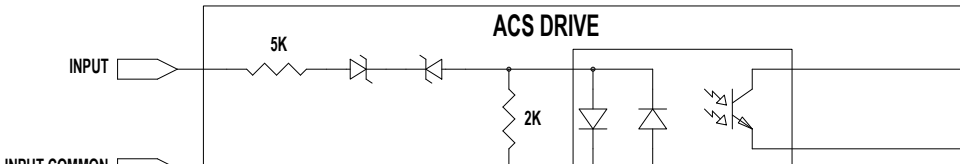


Figure 6-1: Digital Input Circuit

Opto-isolated Digital Input Specifications		
Parameter	**Value**	**Units**
Input Voltage Range	0 to 28	VDC
On State Voltage Range	16 to 28	VDC
Off State Voltage Range	0 to 5	VDC
On State Current: 16VDC (minimum) 24VDC (nominal) 28VDC (maximum)	 1.9 3.4 4.2	mA
Nominal Input Impedance (24V)	7	KΩ
Off State Current (maximum)	0.4	mA
Update Rate (maximum)	2	ms

Table 6-1: Opto-Isolated Digital Input Specifications

6.1.2 Typical Wiring Diagrams

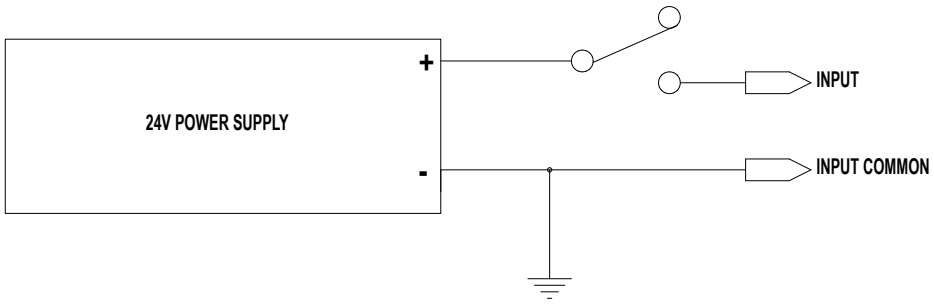


Figure 6-2: Input Source (switched) Connection

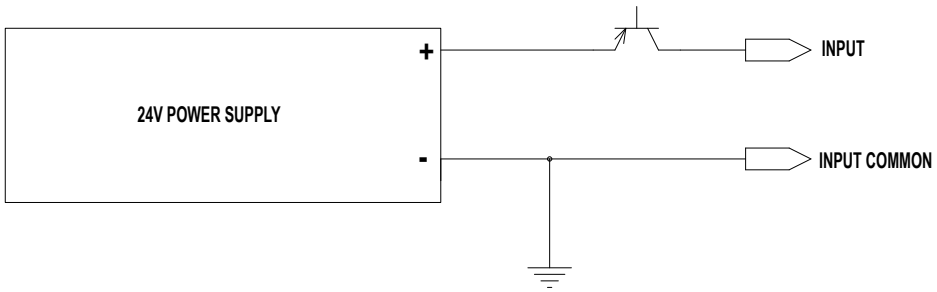


Figure 6-3: Input Source (PNP) Connection

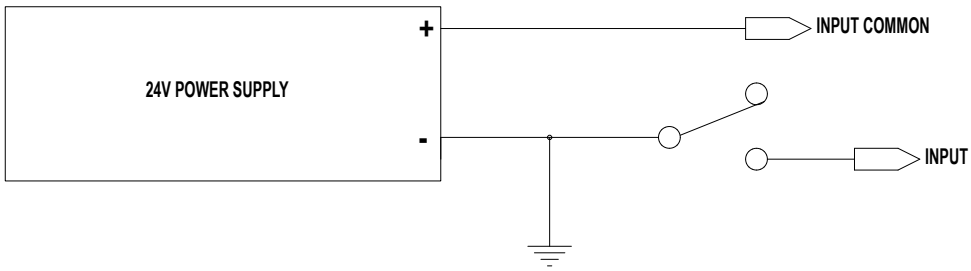


Figure 6-4: Input Sink (switched) Connection

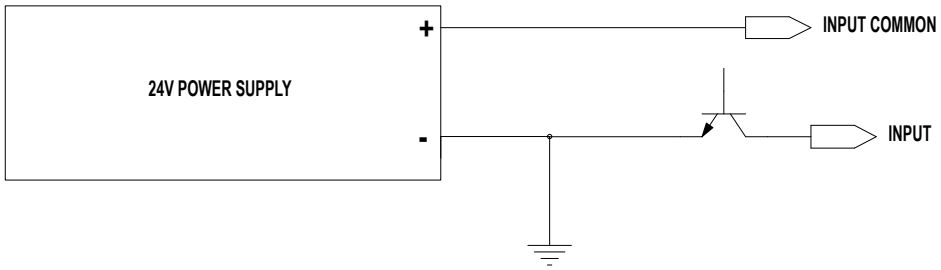


Figure 6-5: Input Sink (NPN) Connection

6.2 Digital Outputs

6.2.1 Specifications

The ACS Drive has four digital outputs. These digital outputs are opto-isolated from the drive circuitry and can be configured for sinking or sourcing. The outputs are protected against over current and short circuit conditions. If an over current condition is present, the output turns off until the load is removed.

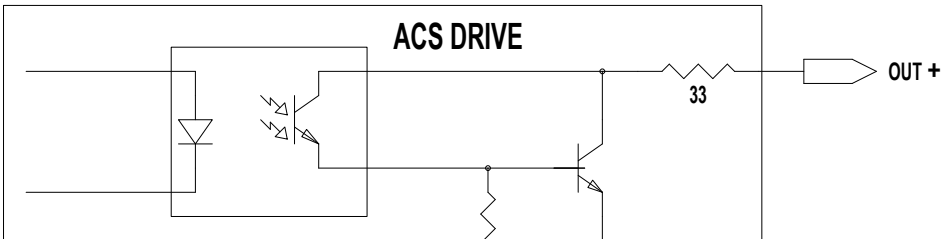


Figure 6-6: Output Circuit

Digital Output Specifications		
Parameter	**Value**	**Units**
Switched Voltage (max)	24	V
Output Voltage drop (20mA)	2	V
Continuous Current (max)	20	mA
Fold Back Current	80	mA
Update Rate (10KOhm Load)	2	ms
Output Leakage Current	30	uA

Table 6-2: Digital Output Specifications

6.2.2 Typical Wiring Diagrams

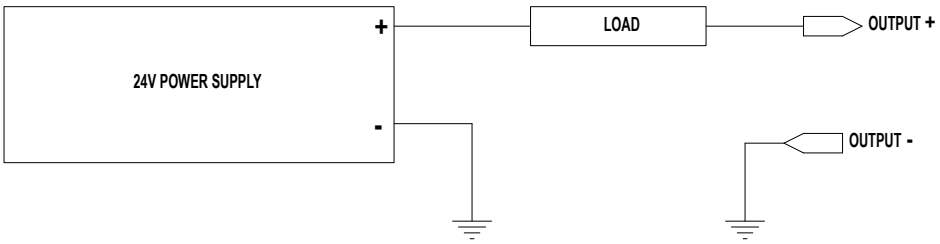


Figure 6-7: Digital Output Sinking Connection

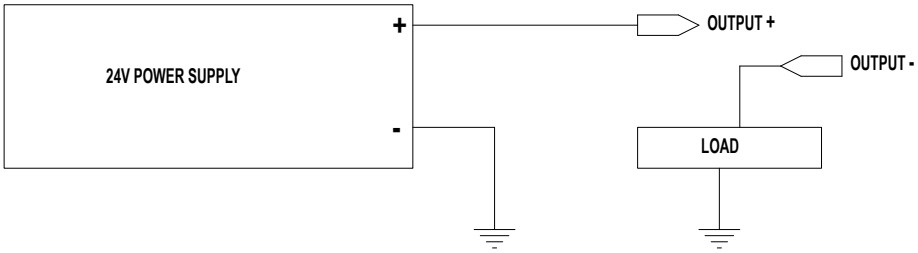


Figure 6-8: Digital Output Sourcing Connection

6.3 Analog Input

6.3.1 Specifications

The ACS Drive comes with one analog input. The input is configurable through software to be 0-10V or 0-20mA input. The analog input is referenced to the analog ground pin.

Parameter	Value	Units
Voltage Mode Input Voltage (min)	0	V
Voltage Mode Input Voltage (max)	10	V
Current Mode Input Current (min)	0	mA
Current Mode Input Current (max)	25	mA
Current Mode Input impedance (nom)	500	Ohm
Resolution	12	Bits

Table 6-3: Analog Input Specifications

6.3.2 Equivalent Circuit

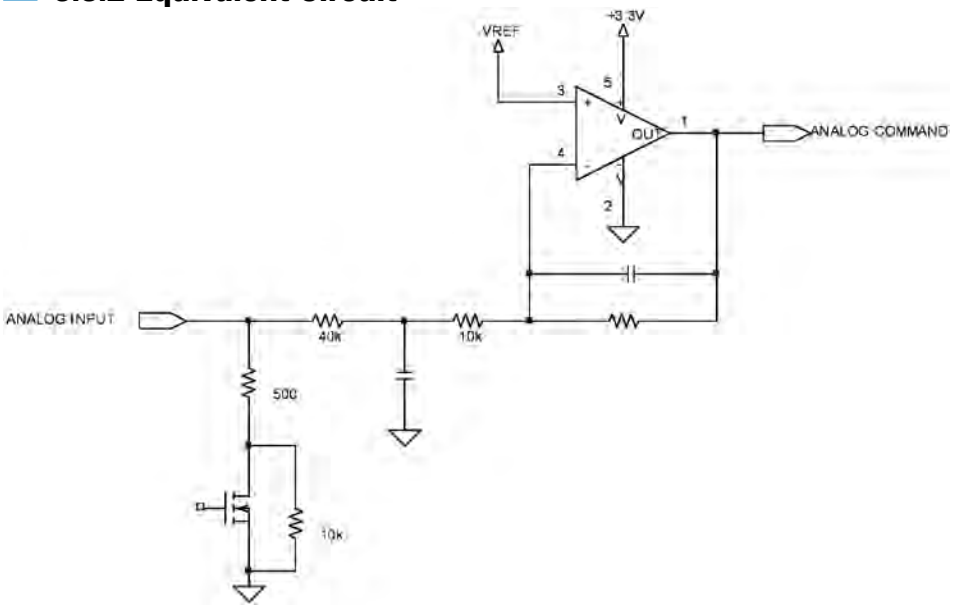


Figure 6-9: Analog Input Equivalent Circuit

IMPORTANT!

Devices sharing analog inputs and outputs must have their grounds connected together for proper and reliable operation.

6.4 Analog Output

6.4.1 Specifications

The ACS Drive can have one analog output capable of 0-10V or 0-20mA operation (on selected models). The analog output is referenced to the analog output ground pin.

Parameter	Value	Units
Output Voltage (min)	0	V
Output Voltage (max)	10	V
Output Current (min)	0	mA
Output Current (max)	20	mA
Resolution	12	Bits

Table 6-4: Analog Output Specifications

6.4.2 Equivalent Circuit

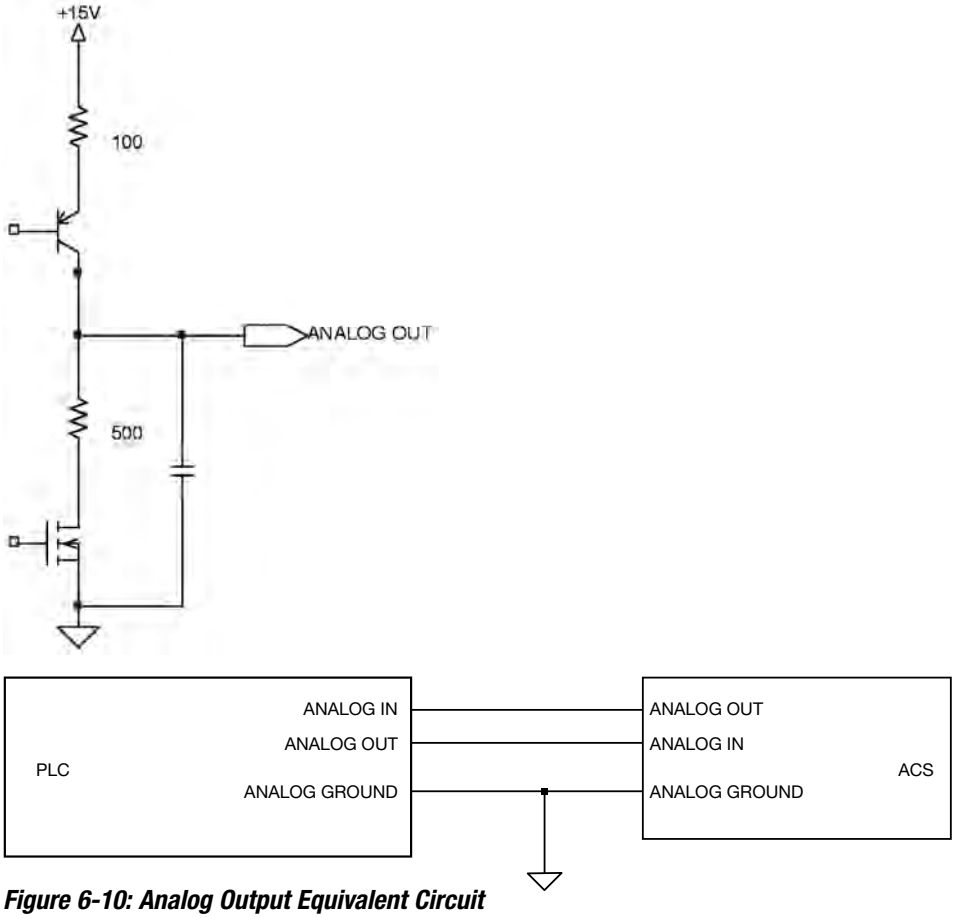


Figure 6-10: Analog Output Equivalent Circuit

IMPORTANT!

Devices sharing analog inputs and outputs must have their grounds connected together for proper and reliable operation.

6.5 Input Power

6.5.1 Drive Specifications

CAUTION!

Voltage above the absolute maximum can result in permanent damage to the ACS internal drive components.

WARNING!

Do not reverse bias the power inputs. Doing so will result in permanent damage to the drive.

WARNING!

Do not short circuit the motor power at the power connector. Doing so may damage the drive power electronics. The motor/ cable is part of the current regulation circuitry. For a short occurring in a motor, the motor leads should provide enough resistance and inductance to prevent dangerous peak currents from occurring.

ACS Internal Drive Specifications		
Parameter	**Value**	**Units**
Current - Maximum	4	A
Voltage - Nominal	20-28	V
Over Voltage[1]	30	V
Under Voltage[2]	18	V
Absolute Maximum Voltage	35	V
Logic Current Draw Maximum (24V)	100	mA

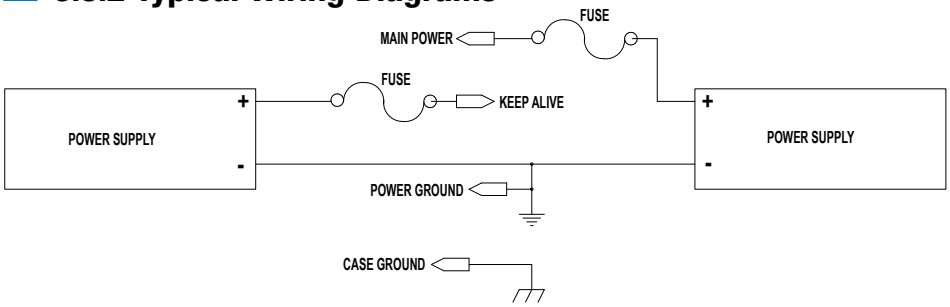
Table 6-5: ACS Internal Drive Specifications

[1] Drive will shut down at 30V; any voltage above the absolute max voltage can result in permanent damage.

[2] Drive will turn off below 18V.

The drive and logic (keep alive) power share the same ground. Drive logic circuitry can be powered from the keep alive input or the main drive power. **Keep Alive voltage must always be less than Main Power or drive will not function correctly.**

6.5.2 Typical Wiring Diagrams



LOGIC AND MAIN POWER SUPPLIES

Figure 6-11: ACS Drive Logic and Main Power Supplies

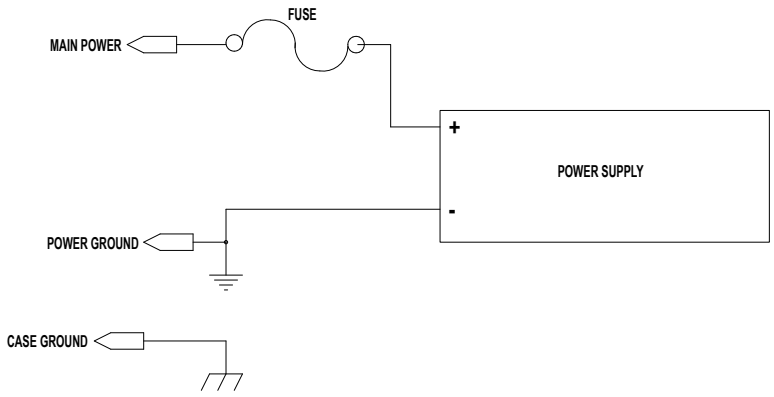


Figure 6-12: ACS Drive Single Supply – Main Power

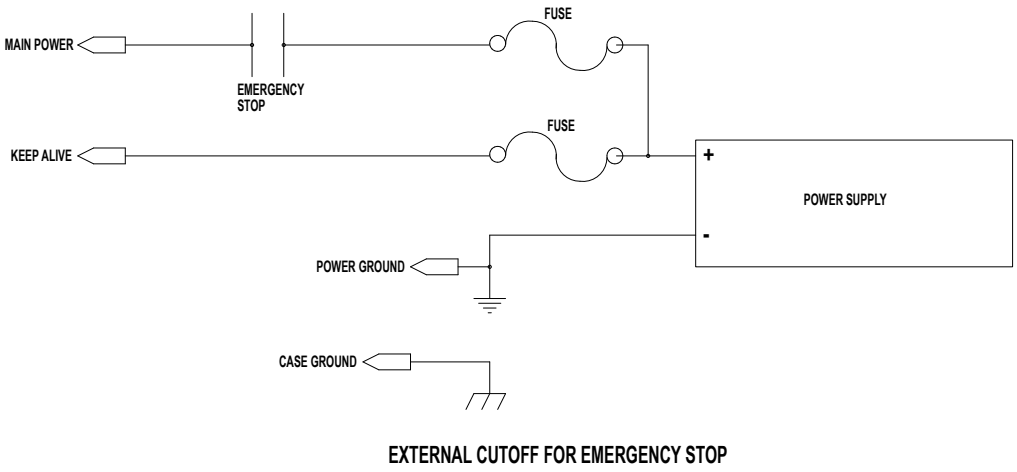


Figure 6-13: ACS Drive External Cutoff Switch for Emergency Stop

WARNING!

All installations should provide a means for a hardware emergency stop that removes power from the drive in an emergency condition. The drive emergency stop function should not be relied on when safety is required. It is recommended to disconnect only the + bus power and keep the power ground line connected.

6.5.3 Power Supply Selection

Both unregulated and regulated power supplies can be used to power the ACS Drive. Unregulated supplies can be a better choice depending on the application as they have a larger output capacitance, which can make them better at supplying peak current without faulting out.

The ACS Drive is intended to run off of an isolated DC power source. The power supply current that will be required will depend on the motor power needed in the installation. If operating more than one drive on the same power supply, add the required power supply rating for each actuator. Maximum power supply current for Tolomatic motors are shown below.

Maximum Power Supply Requirements for Tolomatic Motors		
MOTOR	**MAXIMUM AMPERAGE**	**MAXIMUM WATTS @ 24 VDC**
NEMA 11	2.3 A	55.2
NEMA 17	3.4 A	81.6
NEMA 23	4 A	96

Table 6-6: Maximum Power Supply Current for Tolomatic Motors

To size the power supply, the following formula can also be used to estimate maximum current required:

Motor Current (amps rms) * 2.2 + 0.1

For example, if the motor is rated at 1 Arms, the calculation would look like:

1 Arms * 2.2 + 0.1 = 2.3A

The drive can supply a maximum of 2.5A peak (1.77 Arms), so the drive will not use more than 4 Amps.

Supply power = current x 24V

Example: If 2.3A is needed, 2.3A x 24V = 55.2W.

6.5.4 Suggested Power Supplies

Switching Power Supplies	Power Output
CUI PN: VGS-25-24	25W
CUI PN: VGS-50-24	50W
CUI PN: VGS-75-24	75W
TDK-Lambda PN: LS150-24	150W

Table 6-7: Recommended Switching Power Supplies

Linear Regulated Power Supplies	Power Output
Power One PN: HB24-1.2-AG	28W
Power One PN: HN24-3.6-AG	80W
Power One PN: HD24-4.8-AG	115W

Table 6-8: Recommended Linear Regulated Power Supplies

Linear Unregulated Power Supplies	Power Output
Acopian PN: U24Y500	120W
Acopian PN: U24Y350	84W

Table 6-9: Recommended Linear Unregulated Power Supplies

Fuses (Slow Blow Type)
Bus Fuse: 4A
Logic Power Fuse: 1A

Table 6-10: Fuses

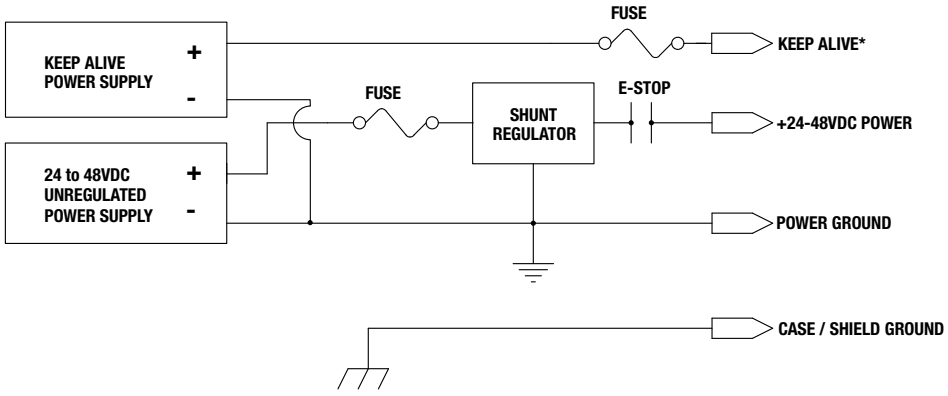


Figure 6-14: Unregulated Power Supply Configuration with Shunt Regulator

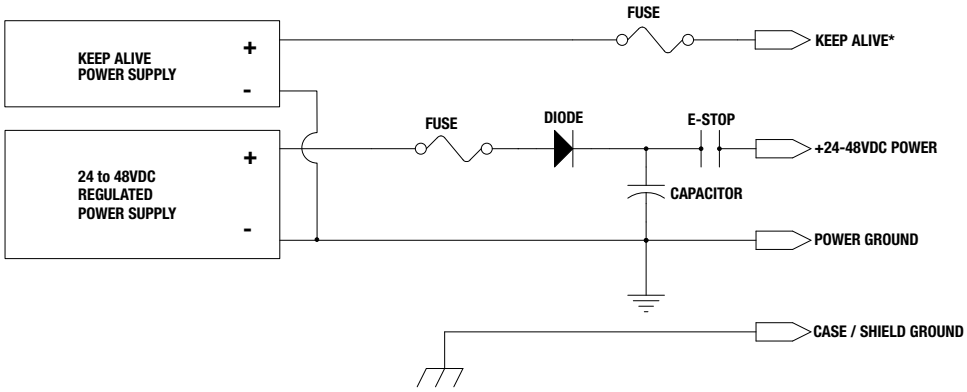


Figure 6-15: Regulated Power Supply Configuration with Blocking Diode and Added Capacitance

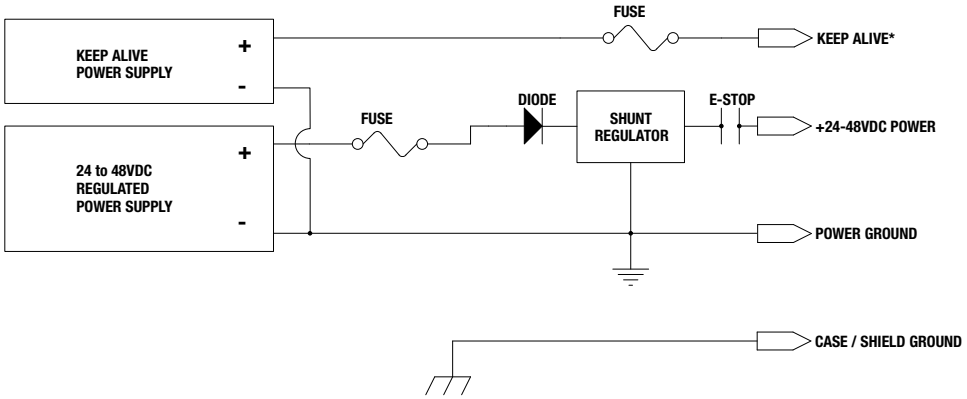


Figure 6-16: Regulated Power Supply with Blocking Diode and Shunt Regulator

7.1 I/O Timing Diagrams

The opto-isolated digital inputs require a minimum of 2ms of time to guarantee that the input signal is registered by the drive. This is an important consideration to take into account, especially if limit switches are used. If limit switches are used, careful consideration should be used to prevent missed triggering due to high velocities. Output timing assumes 10K Ω load. Additional software filtering of digital inputs by TMI will increase response time.

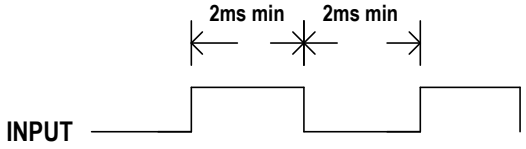


Figure 7-1 Input Requirement

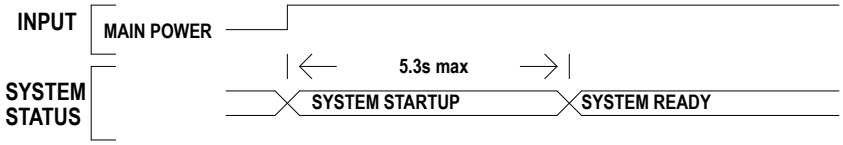


Figure 7-2 System Startup Timing

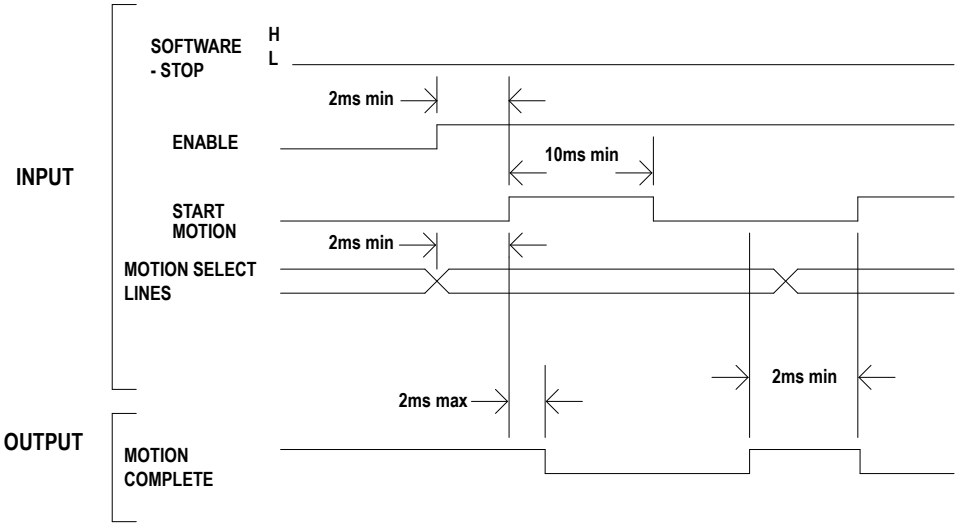


Figure 7-3 Jog Move Timing

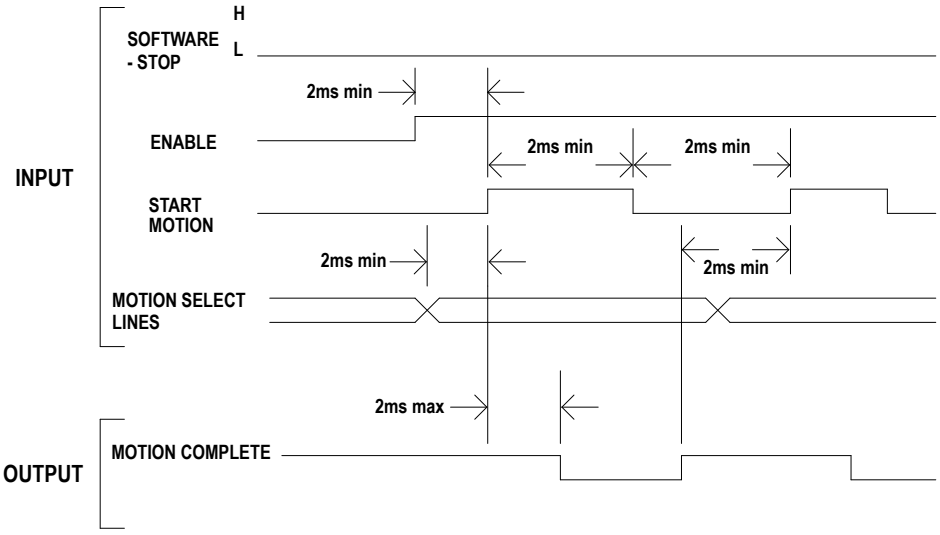


Figure 7-4 Absolute & Incremental Move Timing

7.1.1 Move Timing Rules

1. While the Motion Complete signal is low, the drive will ignore Start Motion pulses and Motion Selection lines.
2. If the enable signal is low or Software Stop signal is high, the drive will ignore start motion pulses.

8.1 Move Select Logic Table

The Index Move Mode (4/8/16 move commands), require digital inputs to select the desired move for execution. The digital inputs are called Move Select 1 through 4 (MS1-MS4) in the digital input map. To select the desired move command refer to the three logic tables below.

***NOTE 1*:** MS# stands for Move Select #

NOTE 2: 1 = On; 0 = Off

4 Move Commands Mode Logic Table		
MOVE	**MS1**	**MS2**
1	0	0
2	1	0
3	0	1
4	1	1

Table 8-1: 4 Move Commands Mode Logic

8 Move Commands Mode Logic Table			
MOVE	**MS1**	**MS2**	**MS3**
1	0	0	0
2	1	0	0
3	0	1	0
4	1	1	0
5	0	0	1
6	1	0	1
7	0	1	1
8	1	1	1

Table 8-2: 8 Move Commands Mode Logic

16 Move Commands Mode Logic Table				
MOVE	**MS1**	**MS2**	**MS3**	**MS4**
1	0	0	0	0
2	1	0	0	0
3	0	1	0	0
4	1	1	0	0
5	0	0	1	0
6	1	0	1	0
7	0	1	1	0
8	1	1	1	0
9	0	0	0	1
10	1	0	0	1
11	0	1	0	1
12	1	1	0	1
13	0	0	1	1
14	1	0	1	1
15	0	1	1	1
16	1	1	1	1

Table 8-3: 16 Move Commands Mode Logic

9.1 LED Codes

LED Indicators	
Green, Off	Motor is not powered
Green, On	Motor is powered
Red, On and Solid	A critical fault has occurred
Red, On and Blinking	A safety fault has occurred

Table 9-1: LED Indicators

To clear a fault, the enable input needs to be lowered, and then raised. Faults can also be cleared by the PC software. Faults that result in a blinking red LED indicator, are cleared automatically once the fault condition is no longer present.

9.2 Fault Descriptions and Recovery

NOTE: To clear faults; PLC needs to lower/raise the enable digital input or TMI user must press the Enable button on the motion manager

Faults are divided into Safety Faults and Critical Faults.

Safety Faults are configurable. If the fault is configured as a stop motion, the fault will be cleared automatically once the fault condition is no longer present. If a safety fault is enabled and configured for disable motor, the fault will be latched until it is cleared in the same manner as the critical faults described at left.

All Critical Faults will disable the motor when they occur. To clear these faults, the fault condition cannot be present and the enable input line must be lowered and then raised to proceed with motion.

Safety Faults Table	
Positive Limit Switch	Positive limit switch has been reached. If configured to stop motion, motion will be allowed in the reverse direction. The fault will be cleared once the positive limit switch input is no longer active and there is motion in the negative direction.
Negative Limit Switch	The negative limit switch has been reached. If configured as stop motion, motion will be allowed in the positive direction. The fault will be cleared once the negative limit switch input is no longer active and there is motion in the positive direction.

Safety Faults Table	
Position Error	If an encoder is present, the position error fault can be enabled. If encoder position and commanded position differ by a larger magnitude than the defined position error, the position error fault will be activated. If fault is configured as a stop motion, fault will be cleared on next move command. NOTE: If force is less than 100%, a position error fault will not be triggered. It will stop and hold position (push mode).
Software Stop	If an input is configured as an Software Stop and fault is enabled, this fault will be activated when the signal level on the pin is high. This fault is configured as a stop motion, it will be cleared once the Software Stop input is lowered. Motion will not be allowed until Software Stop has been cleared.

Table 9-2: Safety Faults

Critical Faults Table	
Feedback Error	Feedback device is malfunctioning.
Over Current	If a short circuit occurs from output to ground, this fault will be triggered.
Drive Over Temp	Drive temperature is greater than the maximum allowed temperature (75˚C).
Drive Over Voltage	Main power voltage exceeds the maximum voltage.
Drive Under Voltage	Main power voltage below the minimum voltage.
Flash Error	Flash memory checksum error or firmware version mismatch.

Table 9-3: Critical Faults

10.1 Troubleshooting

10.1.1 Troubleshooting the ACS Stepper Drive

Troubleshooting Table	
SYMPTOM / TROUBLE	**POSSIBLE CAUSE / RESOLUTION**
No communication to drive	1. Check power connection. 2. Verify the wiring of the communication cable. 3. Verify baud rate and serial port number. 4. Verify that the communication cable is plugged in securely. 5. Verify that all drivers are up-to-date. 6. Try a different computer.
Actuator cannot move load	1. The load is too large. 2. There is too much friction. 3. Side load is excessive. 4. Power supply does not have enough current capability. 5. Current limits are set too low.
Drive is overheating	1. Ambient temperature is too high. 2. Cooling is insufficient.
Actuator is operating erratically	1. Motor encoder signals disconnected, damaged or wired incorrectly. 2. Determine if power supply has enough current. 3. Check to see if any faults are being generated. 4. Verify that the drive has been configured properly for the actuator.
No response from drive in I/O mode	1. Verify the enable signal is on. 2. Verify that all of the I/O are configured properly. 3. Verify wiring to the actuator and drive. 3. Disconnect from software or select digital input controlled radio button on mode setup tab.
Red and Green LEDs on, both solid and no communication	1. Verify serial programming cable and cycle power to drive. 2. Cycle power to drive. 3. Verify firmware upgrade completed without interuption.
No EtherNet Communication	1. Check EtherNet cables. 2. Verify EtherNet cable is plugged in securely. 3. Incorrect combination of IP address, subnet mask & gateway. Check with your network administrator.

Table 10-1: Troubleshooting Descriptions

Motors

There are currently three different motor selections available from Tolomatic–a NEMA 11, NEMA 17 and NEMA 23–available for operation with the ACS Drive. Each motor is available with an optional differential incremental encoder. All motors come with a short 150mm cable and connector on the motor body.

Tolomatic Motor Specifications			
SPEC	**NEMA 11**	**NEMA 17**	**NEMA 23**
Resistance	3.5 Ω	2.4 Ω	1.5 Ω
Inductance	2.3 mH	4.5 mH	3.7 mH
Rated Current	1 Arms	1.5 Arms	2 Arms
Maximum Torque	0.813 in-lbs	4.4 in-lbs	6.25 in-lbs
Maximum RPM	1500 RPM	900 RPM	1050 RPM
Degree per Step	1.8°	1.8°	1.8°
Rotor Inertia	0.006 lb-in^2	0.028 lb-in^2	0.075 lb-in^2

Table A-1: Tolomatic Stepper Motor Specifications

Tolomatic Motor Part Numbers	
MOTOR	**TOLOMATIC PART NUMBER**
NEMA 11 with Encoder	3604-1780
NEMA 11 without Encoder	3604-1779
NEMA 17 with Encoder	3604-1776
NEMA 17 without Encoder	3604-1775
NEMA 23 with Encoder	3604-1778
NEMA 23 without Encoder	3604-1777

Table A-2: Tolomatic Stepper Motor Part Numbers

Encoder Specifications			
MOTOR TYPE	**ENCODER**	**CABLE CONNECTOR PART NUMBER**	**CABLE TERMINAL PART NUMBER**
Bipolar Stepper, 1.8˚ per Step	Differential; 500 line (2000 count post quad)	794954-6	50212-8000

Table A-3: Encoder Specifications

NEMA11 Motor Connections TYCO Mating Connector: 51065-0600; Molex Terminals: 50212-8000			
WIRE COLOR	**TYCO PIN**	**MOLEX PIN**	**SIGNAL**
Black	6	6	B -
Green	3	4	B +
Red	1	3	A +
Blue	4	1	A -

Table A-4: NEMA11 Motor Connection pinouts

NEMA17 Motor Connections TYCO Mating Connector: PHR-6; JST Terminals: SPH-002T-P0.5S			
WIRE COLOR	**TYCO PIN**	**JST PIN**	**SIGNAL**
Black	6	1	B -
Green	3	3	B +
Red	1	4	A +
Blue	4	6	A -

Table A-5: NEMA17 Motor Connection pinouts

NEMA23 Motor Connections TYCO Mating Connector: XHP-6; JST Terminals: SXH-001T-P0.5			
WIRE COLOR	**TYCO PIN**	**JST PIN**	**SIGNAL**
Black	6	1	B -
Green	3	3	B +
Red	1	4	A +
Blue	4	6	A -

Table A-6: NEMA23 Motor Connection pinouts

ENCODER Connections: US Digital PN E8P-500-197-D-D-M-B Molex Mating Connector: 510221-0600; Molex Contacts: 50079-8100		
WIRE COLOR	**MOLEX PIN**	**SIGNAL**
Blue	2	ENC A+
Orange	3	ENC A-
Yellow	5	ENC B+
Gray	6	ENC B-
Black	1	Signal Ground
Red	4	+5VDC

Table A-7: Encoder Connections and Connector pinouts

Product Warranty

Tolomatic, Inc. warrants all products manufactured by it to be free from defects in material and workmanship for a period of one year from date of shipment by Tolomatic. If, within this period, any product is proven to be defective by Tolomatic, the product will either be repaired or replaced at Tolomatic's option.

This warranty shall not apply to:

1. Products not manufactured by Tolomatic. Warranty of these products will conform and be limited to the warranty actually extended to Tolomatic by its supplier.
2. Damage to the product caused by circumstances beyond the control of Tolomatic, such as negligence, improper maintenance, or storage.
3. This warranty shall be void in the case of: any repairs or alterations made to the product by parties other than Tolomatic.

The foregoing warranties are exclusive and in lieu of all other express and implied warranties. Tolomatic is not subject to any other obligations or liabilities for consequential damages.

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