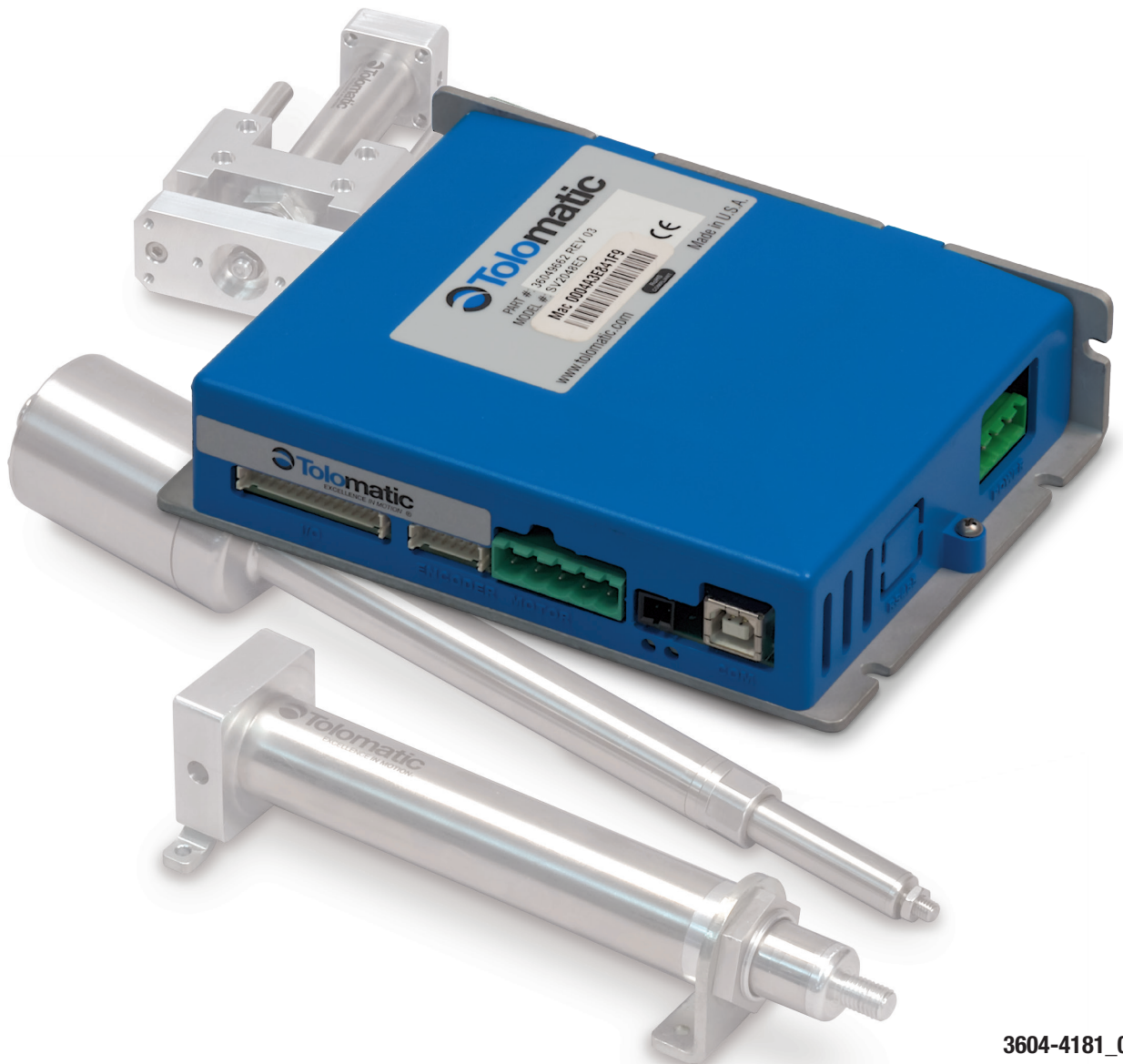


HARDWARE & INSTALLATION GUIDE

**ACS – Actuator Control Solutions
Servo Drive/Controller and Motors**



3604-4181_05

Tolomatic reserves the right to change the design or operation of the equipment described herein and any associated motion products without notice. Information in this document is subject to change without notice.

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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 Servo Drive/Controller for Actuator Control Solutions

Tolomatic's ACS Drive/Controller is a brushless DC servo motor 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).

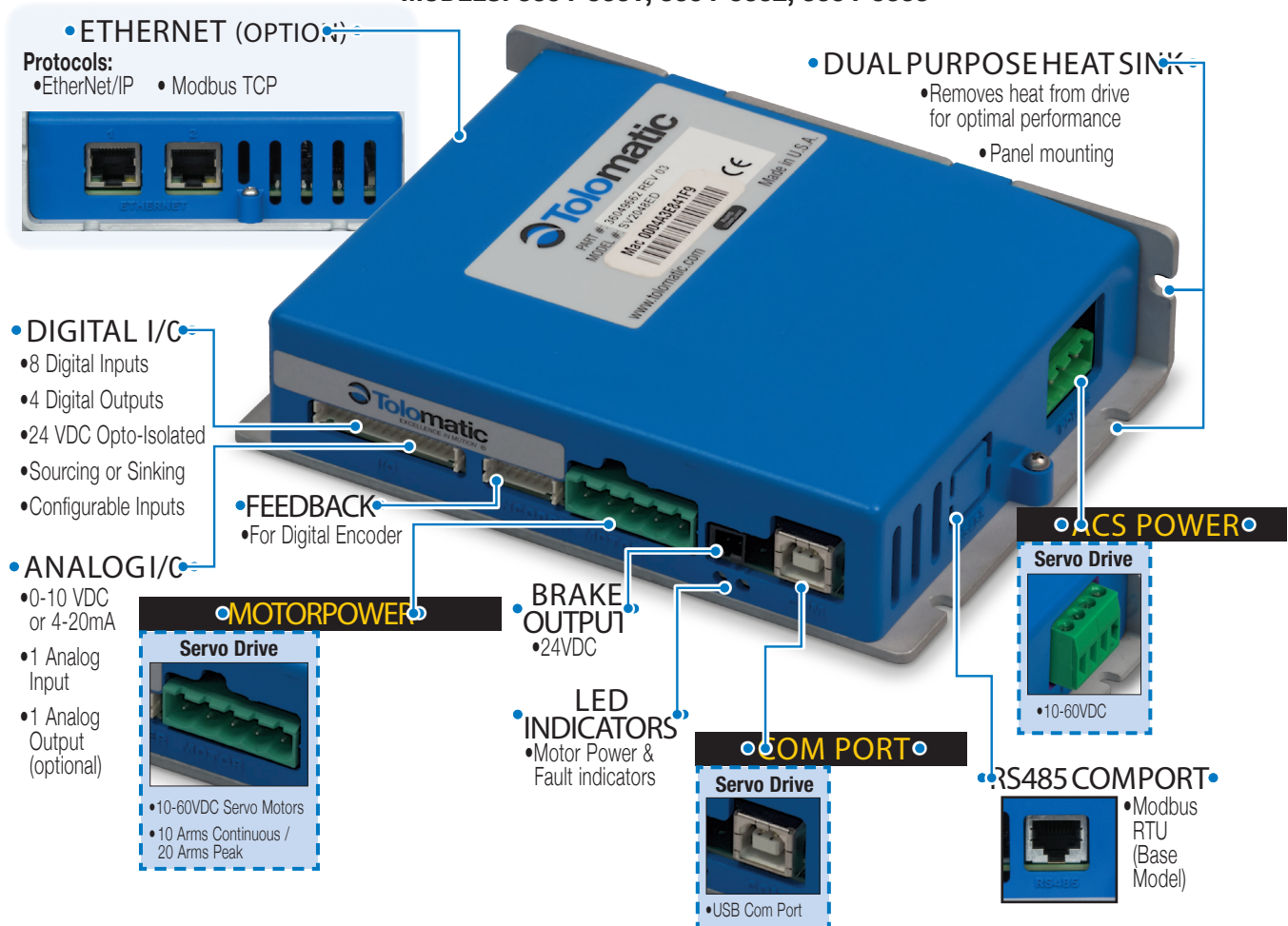
Currently there are three ACS Servo Drive/Controller choices:

- #3604-9661 - ACS Servo Drive/Controller, Modbus RTU over RS485 firmware 36043177UD.tol
- #3604-9662 - ACS Servo Drive/Controller, EtherNet/IP™ (Analog Output) firmware 36043177UD.tol
- #3604-9663 - ACS Servo Drive/Controller, Modbus TCP (Analog Output) firmware 36043177UD.tol

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

1.1.1 ACS Servo Drive/Controller — Overview

MODELS: 3604-9661, 3604-9662, 3604-9663



1: PRODUCT OVERVIEW

ACS Drive/Controller (3604-9661) Capabilities

- 4, 8, or 16 move command modes (absolute, force, incremental and jog or home)
- 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
- Zone output based on position
- Force limiting capability
- Configurable digital I/O (24 VDC Opto-Isolated) (sinking or sourcing)
- Compatible with most 24-48 VDC servo motors
- Brake output

ACS Drive/Controller (3604-9662, 3604-9663) Additional Capabilities

- EtherNet/IP™ mode provides infinite positioning using EtherNet/IP and Modbus TCP protocols
- Dual EtherNet/IP 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/encoder mating connector, combined with encoder cable with drive and motor/encoder connector. Cables are available in either 3-meter or 5-meter lengths.

Disc and Cable



Tolomatic software is always available online at www.tolomatic.com. For your convenience a software CD and optional USB computer connections are available:

Tolomatic Motion Interface Software CD (3604-9526) and a USB Type B cable (3604-1852)

Brake Cable



Tolomatic offers a 5-meter brake power cable with drive and brake mating connectors

Environment, Dimensions & Mounting

2

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

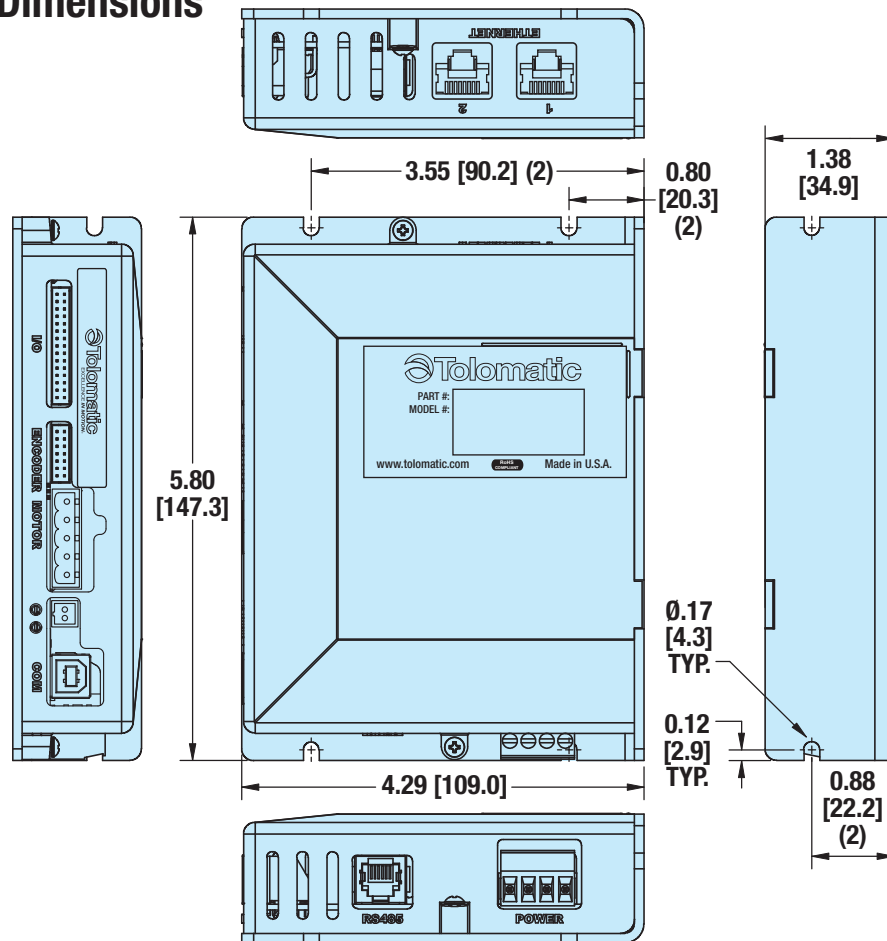


Figure 2-1: ACS Drive Dimensions

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 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.

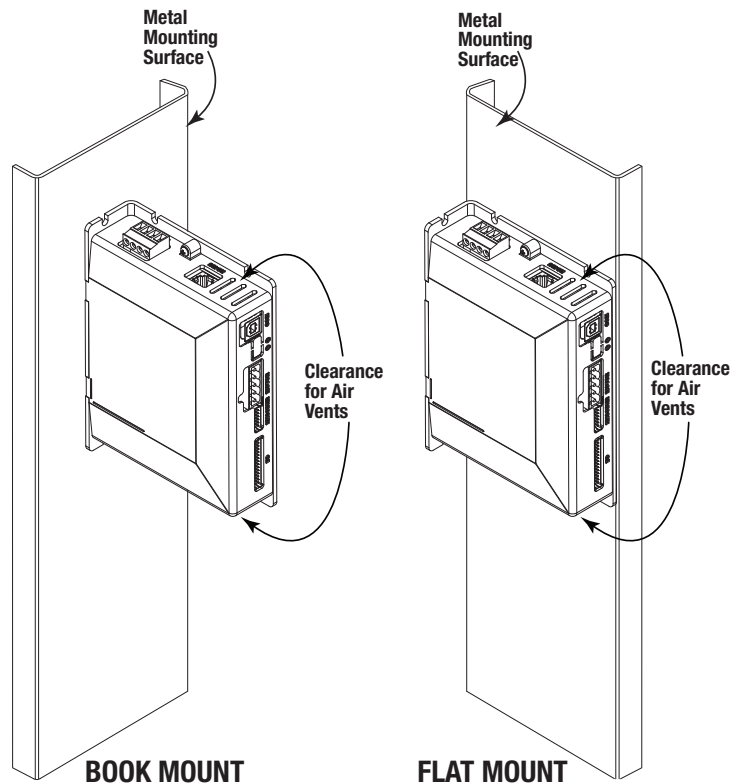



Figure 2-2 Mounting the ACS Drive

3.1 CD & USB Cable

 **NOTE:** The most current version of software and firmware is always available at www.tolomatic.com

Tolomatic offers a CD with Tolomatic Motion Interface software, drive firmware and firmware upgrade utility. A USB type B cable is also available for connecting your computer to the ACS drive.



ACS Servo Drive Accessories	
ITEM	TOLOMATIC PART NUMBER
Tolomatic Motion Interface Software CD	3604-9526
1 meter USB Cable	3604-1852

Table 3-1: It may be convenient to order the CD and USB cable.

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.

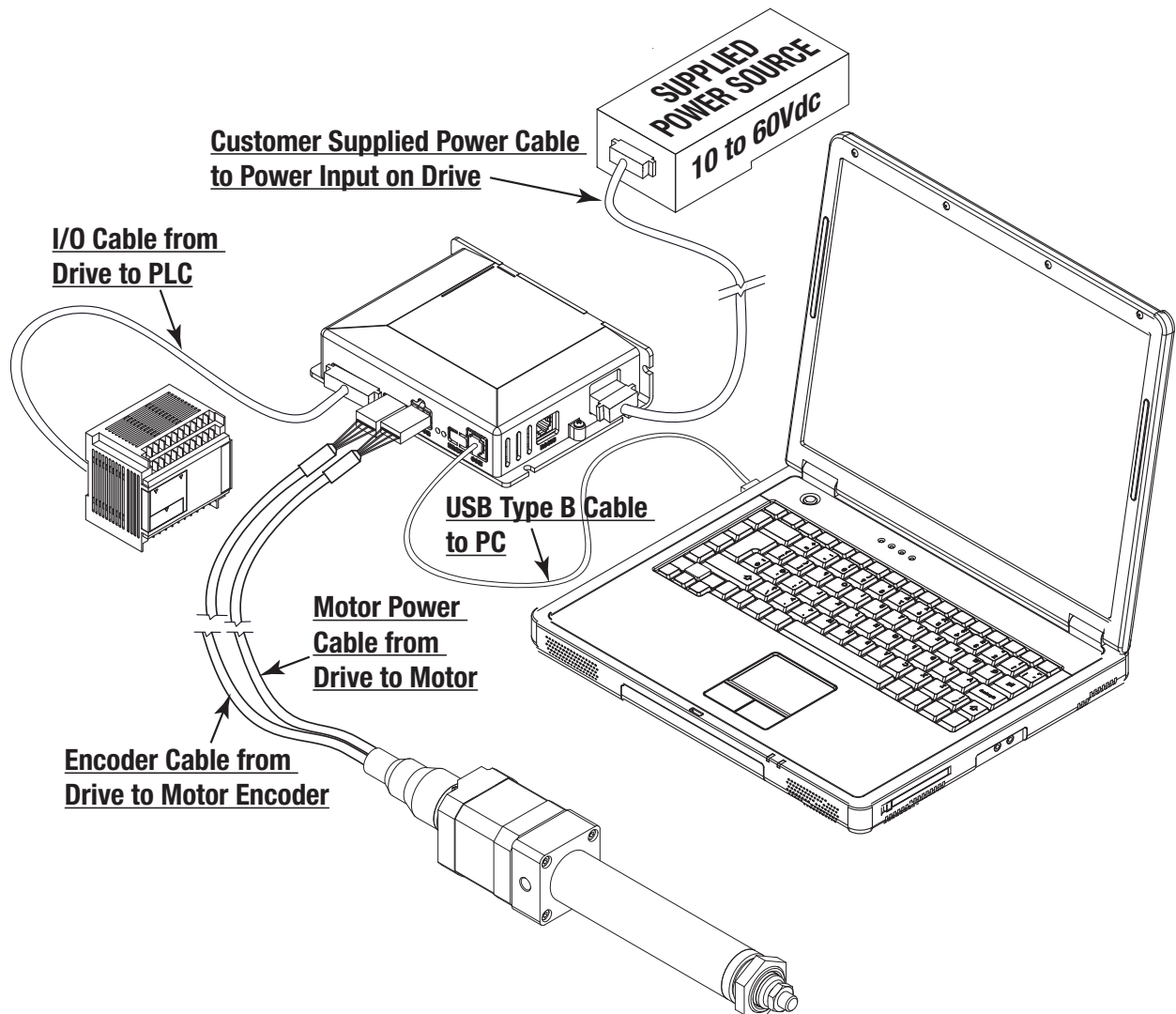


Figure 4-1: ACS Drive and ERD Actuator– Basic Setup

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

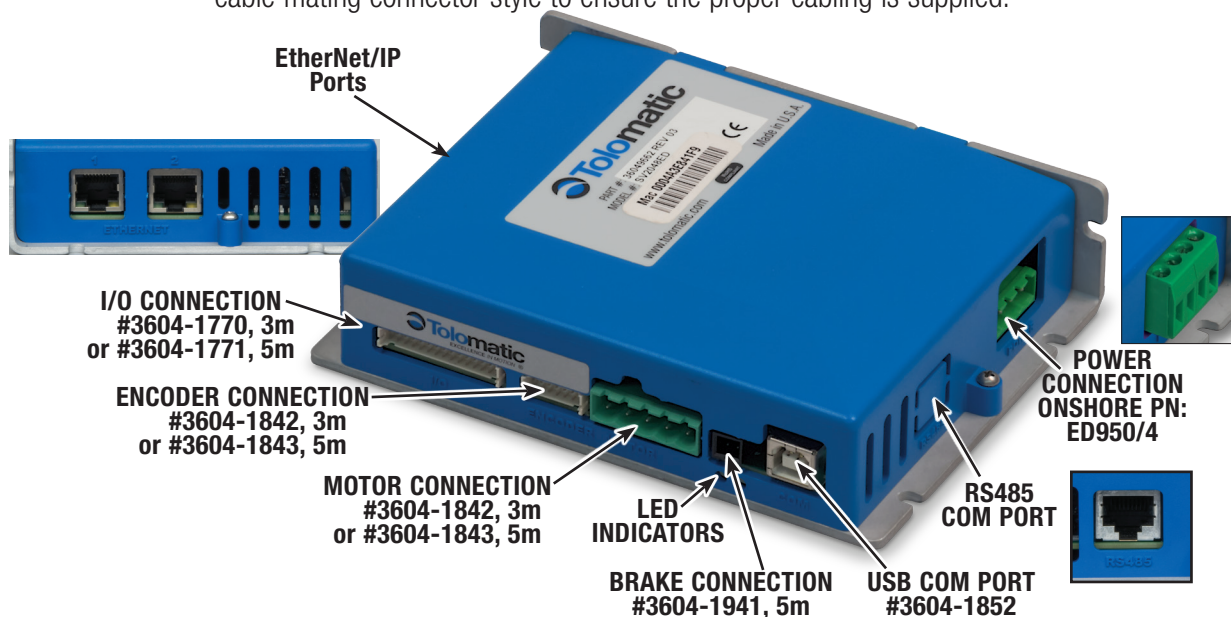
For recommended power supplies: Section 6

■ 4.1.1 Setup Procedures

1. Install drive/controller and actuator into appropriate fixtures.
2. Wire the 10 to 60VDC 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 USB 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/Encoder Connection and Cables

The ACS Drive has a maximum output of 20A peak of Sine. 10A continuous.



WARNING!

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

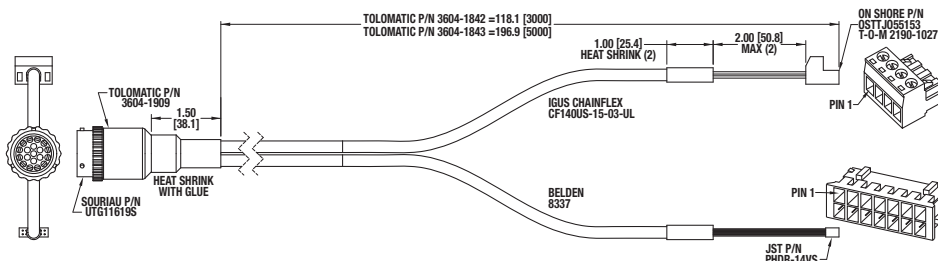


Figure 5-1: Motor Power/Encoder Cable 3604-1842, 3604-1843

CABLE	TOLOMATIC PART NO.	DRIVE MOTOR CONNECTOR	DRIVE ENCODER CONNECTOR	MOTOR MATING CONNECTOR	MOTOR CONTACTS
Motor Power / Encoder: 3-meter	3604-1842	On Shore P/N: OSTTJ055153	JST P/N: PHDR-14VS use with contacts SPHD-001T-P0.5	Souriau P/N: UTG11619S	Souriau Phase P/N: RC16M23T Signal P/N: SC24M1TK6
Motor Power / Encoder: 5-meter	3604-1843				

Table 5-1: Motor Power Cable and Connector Parts

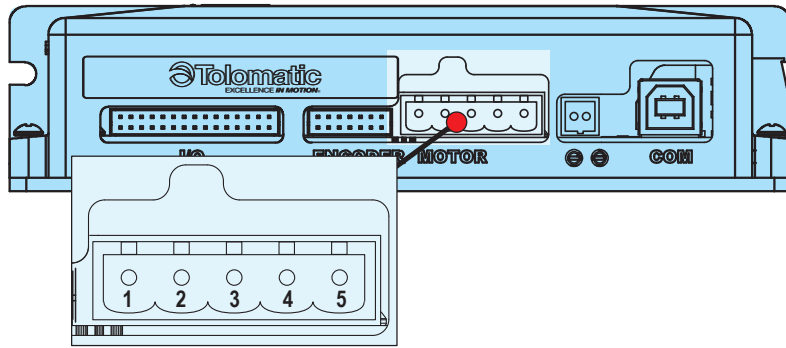


Figure 5-2: Motor Power Connection on ACS Servo Drive

SOURIAU P/N UTG11619S		ON SHORE P/N OSTTJ055153 21901027		
PIN	PIN NUMBER	COLOR	ACS SIGNAL	MOTOR SIGNAL
B	1	GRN/YEL (16AWG)	PHASE R	PHASE R
D	2	BLK #1 (16AWG)	PHASE S	PHASE T
E	3	DRAIN	DRAIN	NC
C	4	BLK #2 (16 AWG)	PHASE T	PHASE S
R		NC	NC	DRAIN

Table 5-2: Motor Power Connection pinouts

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.

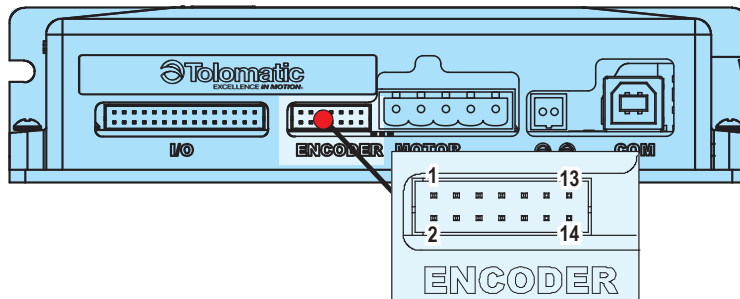


Figure 5-3: Encoder Connection on ACS Drive

SOURIAU P/N UTG11619S		JST P/N PHDR-14VS 21901028		
PIN	PIN NUMBER	COLOR	ACS SIGNAL	MOTOR SIGNAL
K	1	WHT/BLU (24 AWG)	ENC A	ENC A~
J	2	BLU/WHT (24 AWG)	ENC A~	ENC A
V	3	WHT/OR (24 AWG)	ENC B	ENC B
F	4	OR/WHT (24 AWG)	ENC B~	ENC B~
U	5	WHT/GRN (24 AWG)	ENC Z	ENC Z

5: CONNECTIONS & CABLES

SOURIAU P/N UTG11619S		JST P/N PHDR-14VS 21901028		
PIN	PIN NUMBER	COLOR	ACS SIGNAL	MOTOR SIGNAL
N	6	GRN/WHT (24 AWG)	ENC Z~	ENC Z~
T	7	RED/BLU (24 AWG)	+5VDC	+5VDC
H	8	WHT/BRN (24 AWG)	HALL U	COMM R-S
S	9	BLU/RED (24 AWG)	GROUND	GROUND
L	10	BRN/WHT (24 AWG)	HALL V	COMM T-R
P	11	ORG/RED (24 AWG)	GROUND	NA
A	12	RED/ORG (24 AWG)	+5VDC IN	NA
M	13	DRAIN	ENCODER DRAIN	DRAIN
G	14	WHT/GRY (24 AWG)	HALL W	COMM S-T

Table 5-3: Encoder Connection pinouts

5.4 I/O Connection and Cable

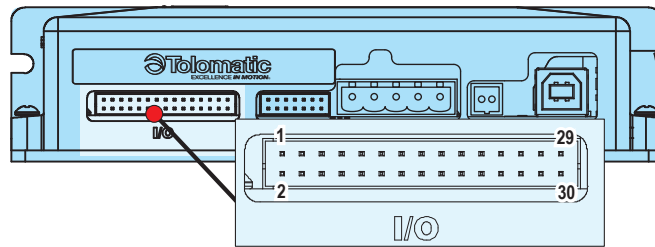


Figure 5-4: I/O Connection on ACS Drive

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

5: CONNECTIONS & CABLES

JST #PHDR-30VS		
PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
20	Case Ground	Shield
23	*Step Input	Blue/Red
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

*Not yet supported
by software

Table 5-4: I/O Connection pinouts

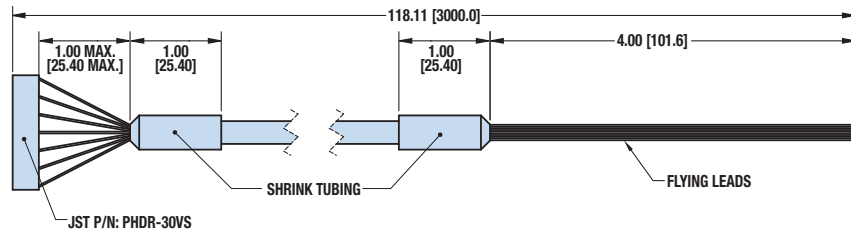


Figure 5-5: I/O Cable 3604-1770

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		

Table 5-5: 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.

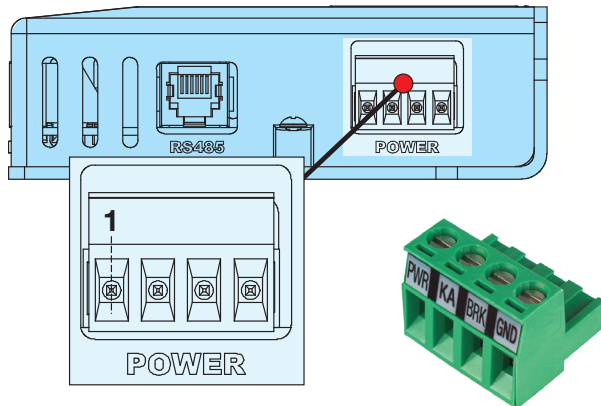
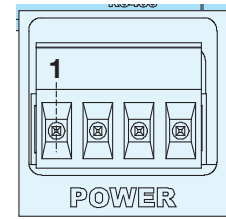


Figure 5-6: Input Power Connection

5: CONNECTIONS & CABLES

PIN NUMBERS	SIGNAL
1	Main Power 10 to 60VDC
2	Keep Alive 10 to 60VDC*
3	Brake Power 24 VDC
4	Ground – Power



*Must always be less than Main Power or drive will not function correctly

Table 5-6: Input Power pinouts

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

Table 5-7: Input Power Cable Parts

5.6 Brake Output Connection

The brake output is controlled via an onboard relay by the drive Power is supplied via the Input Power Connection and output on the Brake Output Connection.

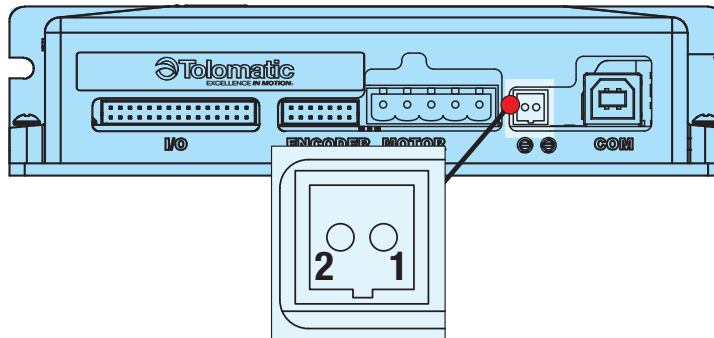
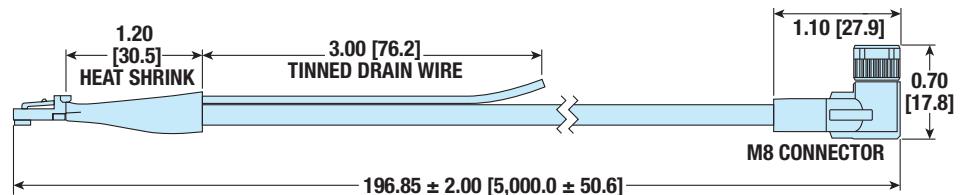


Figure 5-7: Brake Connection

MOLEX #0050579702		M8 CONNECTOR	
PIN NUMBERS	FUNCTION	PIN NUMBERS	
1	Brake -	1	
2	Brake +	2	Front View

Table 5-8: Brake Pinout



CABLE	DESCRIPTION
3604-1949 Brake Cable	ACS Brake Cable, 5m

Figure 5-8: Brake Cable

5.7 USB 2.0 Connection

The USB port connector is a standard B type connector.

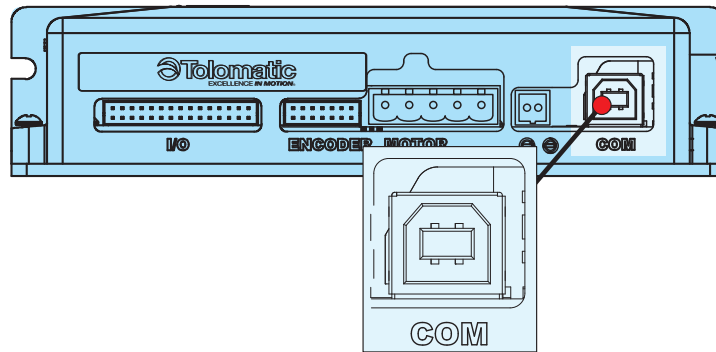


Figure 5-9: USB 2.0 Connection

5.8 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 duplicated on pins 7 and 8. Common is used as a reference voltage. Figure 5-10 shows the pin assignment on the ACS socket.

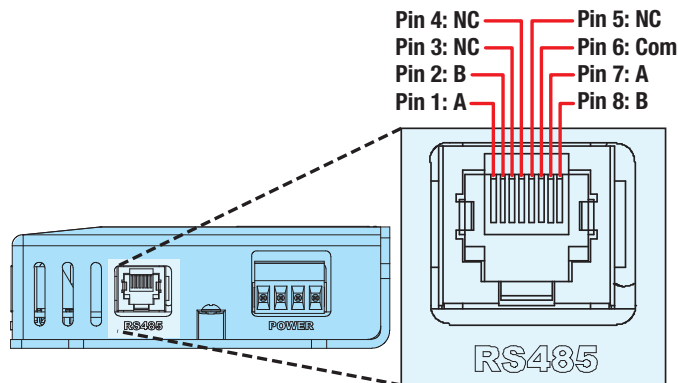


Figure 5-10: ACS 2-Wire RS485 with RJ45 Socket

5.8.1 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.

5.8.2 RS-485 Grounding

The Common wire must be connected to protective ground. This wire should only

5: CONNECTIONS & CABLES

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 5-11.

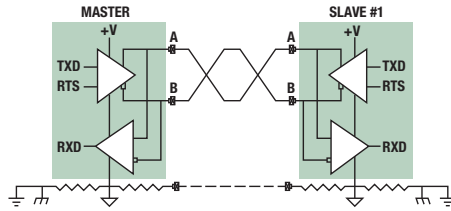


Figure 5-11: Resistors in ground wire to limit current

5.9 EtherNet Connection

The following parts have two EtherNet ports with a built-in switch to be used for daisy chaining.

3604-9662 - ACS Servo Drive/Controller, EtherNet/IP™

3604-9663 - ACS Servo Drive/Controller, Modbus TCP

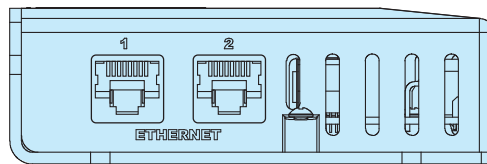
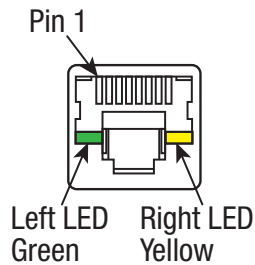


Figure 5-12: EtherNet/IP Connection for ACS Drive Programmability



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 5-9 EtherNet/IP pinouts and Connections

5.10 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 5-13 proper cable looping is shown for connectors located on the top or side of the unit. Units mounted with connectors on the bottom surface require no cable looping.

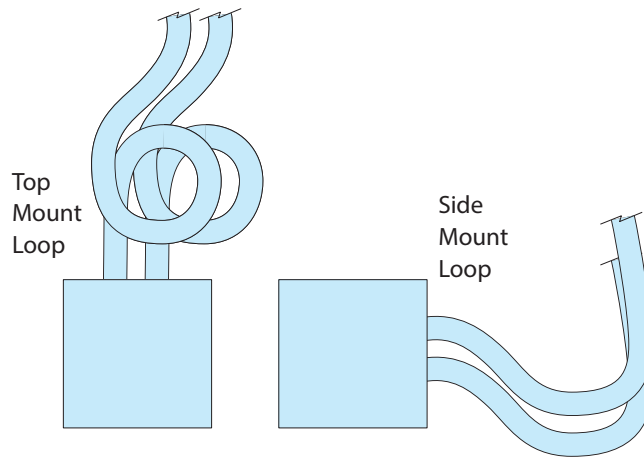


Figure 5-13 Cable Routing for Top and Side Facing Connectors

■ 5.10.1 EtherNet/IP™ 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.

■ 5.10.2 EtherNet/IP 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.

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

Where:

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

5: CONNECTIONS & CABLES

H is the length (m) of the horizontal cable ($H + C \leq 100$ 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 85m for the channel with the standard 20% derating for standard stranded cables.

WIRE TYPE VERSUS LENGTH					
PATCH CABLE GAUGE	D	H	W	C	T
	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 5-10: Cable Wire Type versus Cable Length

MOTOR CONTROL SECTION	
Commutation Method	Field Oriented Commutation
PWM Mode	Centered
PWM Efficiency	>90%
PWM Switching Frequency	12 KHz
PWM Ripple Frequency	24 KHz
Minimum PWM pulse duration	4.16uS
Dead Band	50ns - 500ns
Velocity Loop Frequency	1.2 KHz
ENCODER SECTION	
Maximum encoder rate	800 kHz
Index pulse	Required
Halls	Required
Electrical Pinout	A+/A-/B+/B-/Z+/(Z- optional)
COMMUNICATION SECTION	
Communication ports	USB
	Ethernet
	RS485,
USB Type	USB device only
USB Speed	USB Full Speed
Ethernet Speed	10/100M (Auto Negotiate)
Ethernet Duplex	Full/Half-Duplex (Auto Negotiate)
RS485 Baud Rate	19200
	38400
	115200

Table 6-1: Controller Specifications

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.

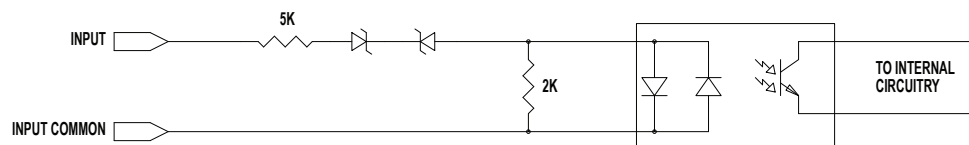


Figure 6-1: Digital Input Circuit

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)	1.9	mA
24VDC (nominal)	3.4	
28VDC (maximum)	4.2	
Nominal Input Impedance (24V)	7	K Ω
Off State Current (maximum)	0.4	mA
Update Rate (maximum)	2	ms

Table 6-2: Opto-Isolated Digital Input Specifications

6.1.2 Typical Wiring Diagrams

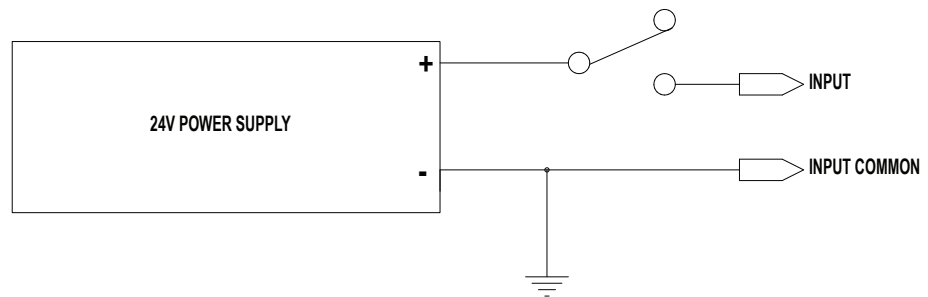


Figure 6-2: Input Source (switched) Connection

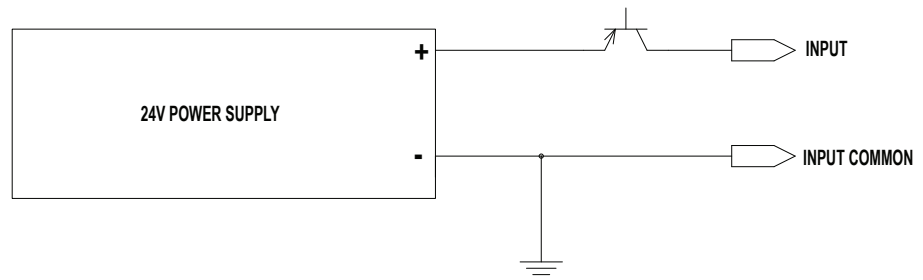


Figure 6-3: Input Source (PNP) Connection

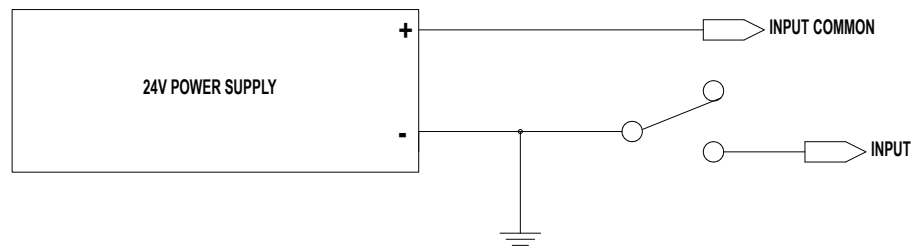


Figure 6-4: Input Sink (switched) Connection

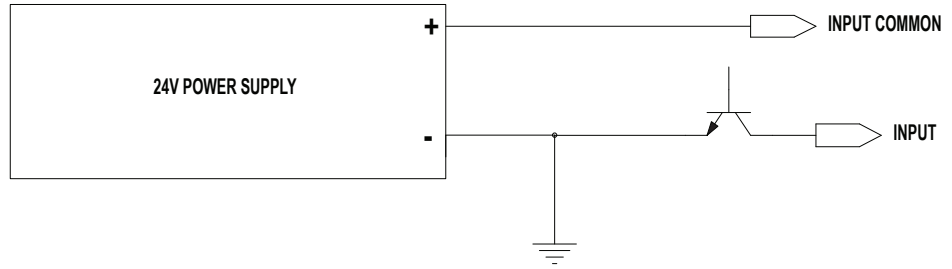


Figure 6-5: Input Sink (NPN) Connection

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.

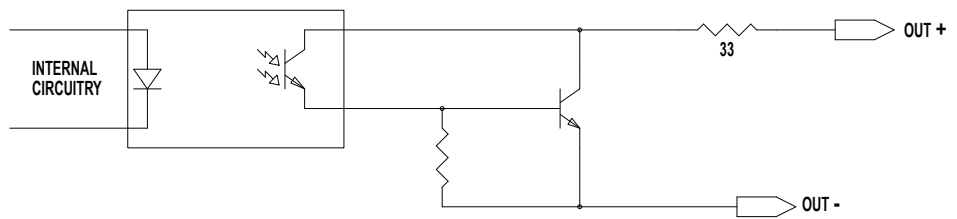


Figure 6-6: Output Circuit

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 6-3: Digital Output Specifications

6.2.2 Typical Wiring Diagrams

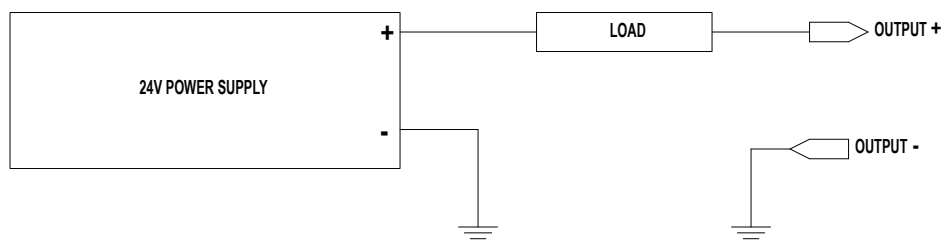


Figure 6-7: Digital Output Sinking Connection

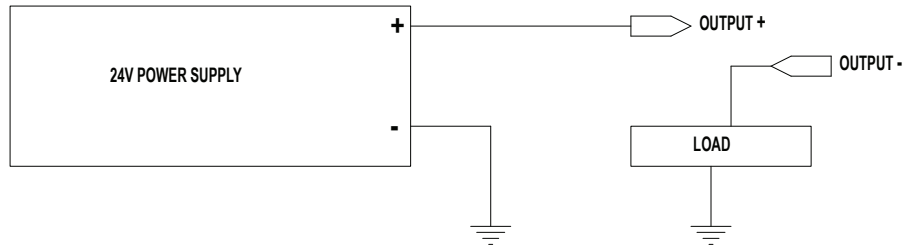


Figure 6-8: Digital Output Sourcing Connection

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 6-4: Analog Input Specifications

6.3.2 Equivalent Circuit

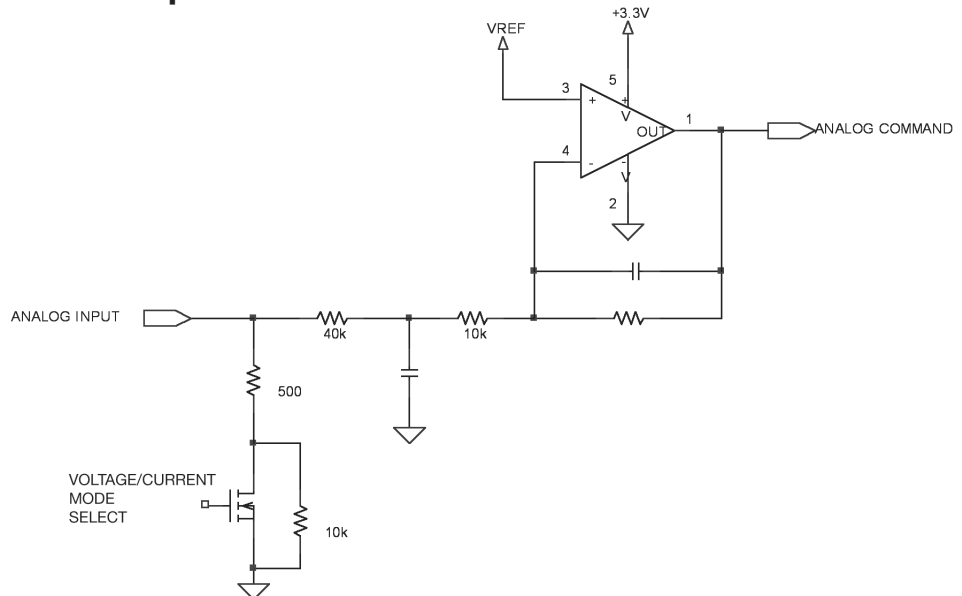


Figure 6-9: Analog Input Equivalent Circuit



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 6-5: Analog Output Specifications

6.4.2 Equivalent Circuit

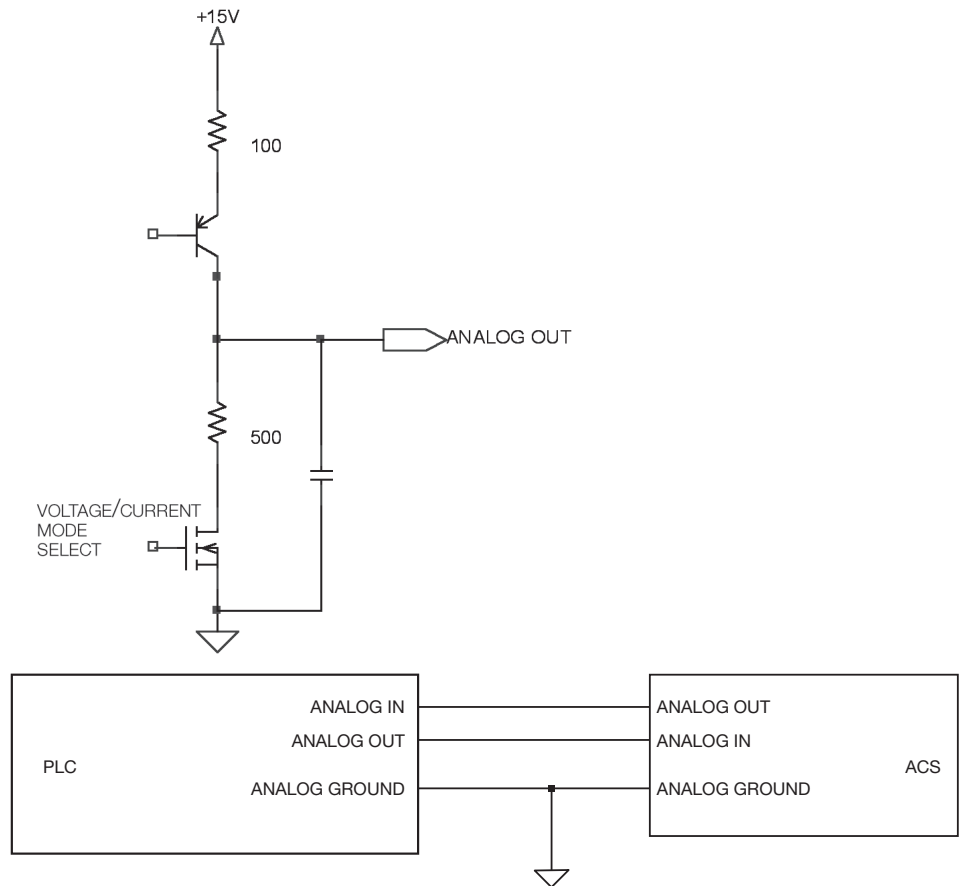


Figure 6-10: Analog Output Equivalent Circuit



IMPORTANT!

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

6.5 Brake Output

6.5.1 Specifications

Parameter	Value	Units
Input Voltage	24	V
Absolute Maximum Voltage	70	V
Output Current	0 - 500	mA

Table 6-6: Brake Output Specifications

6.5.2 Equivalent Circuit

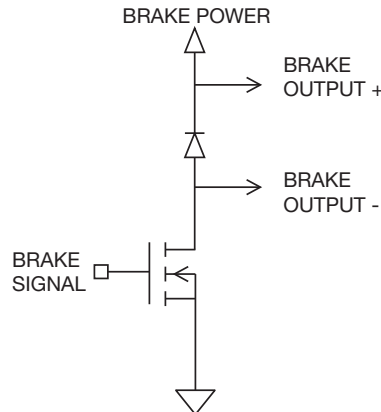


Figure 6-11: Brake Output Equivalent Circuit

6.6 Input Power



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.

6.6.1 Drive Specifications

ACS Internal Drive Specifications		
Parameter	Value	Units
Current - Continuous (max)	10	A
Current - Peak (max)	20	A
Over Voltage ¹	65	V
Under Voltage ²	9	V
Absolute Maximum Voltage	70	V
Logic Current Draw Maximum (24V)	200	mA

Table 6-7: ACS Internal Drive Specifications

¹ Drive will fault at 65V; any voltage above the absolute max voltage can result in permanent damage.

² Drive will fault below 9V.

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.**



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.

6.6.2 Power Supply Sizing Guidelines

Both unregulated and regulated power supply can be used to power the ACS Drive.

Unregulated supply can be a better choice depending on the application as they have a larger output capacitance. This characteristic makes an unregulated power supply a better energy absorption source. Unregulated power supply is a good choice for applications that require aggressive acceleration it can provide peak currents without faulting and will not trip on high voltage. **However, unregulated power supply does not have over voltage protection and care must be taken not to exceed the maximum voltage of the actuator by using a shunt regulator and proper fusing to prevent excessive loading of the supply.**

Regulated supply can be used to power the ACS drive, but additional measures may need to be taken. **To prevent regenerative energy from reaching the supply, a blocking diode and capacitor, appropriately sized for the application, should be installed. In addition, a shunt regulator may be needed to dissipate excess energy.** A shunt regulator is available Part Number 2180-1163.

The ACS Drive is intended to run off of an isolated DC power source. The power supply required will depend on the application. A 48V supply will allow the actuator to operate at maximum speed. A 24V supply will result in approximately half the rated velocity. Input current will depend on the actuator power needed in the installation. If operating more than one actuator on the same power supply, add the required power supply rating for each actuator.

6.6.3 Calculating Wattage of Power Supply

$$\text{Watts} = I \text{ (amps)} \times V \text{ (volts)}$$

Where

$$I = \text{Torque Peak (in-lbs)} / K_t \text{ (in-lb/amp-peak)}$$

And

$$V = K_e \text{ (Vp / krpm)} \times \text{Speed Peak (rpm)} / 1000$$

We get

$$\text{Watts} = (\text{Torque Peak} / K_t) \times (K_e \times \text{Speed Peak}) / 1000$$

Use the following table to help determine the proper power source voltage for an application or call Tolomatic at 1-800-328-2174 or 763-478-8000 for assistance.

Tolomatic Part Number	Motor Config. Code	Max Speed	Torque Peak	Kt	Ke
		rpm	in-lbs	in-lb/amp-pk	Vp/krpm
3604-1844*	AMV2C4A1*	6000	9.056	0.5228	6.19
3604-1845	AMV2C1A1	6000	5.225	0.3015	3.57
3604-1846	AMV2C3A1	6000	15.36	0.8868	10.50
3604-1847	AMV2C2A1	6000	8.8625	0.5118	6.06
3604-1848*	AMV2D3A1*	5000	20.73	1.1976	14.18
3604-1849	AMV2D1A1	5000	11.98	0.6918	8.19
3604-1850*	AMV2D4A1*	5000	34.2	1.974	23.38

(continued)



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.

(continued)

Tolomatic Part Number	Motor Config. Code	Max Speed	Torque Peak	Kt	Ke
		rpm	in-lbs	in-lb/amp-pk	Vp/krpm
3604-1851	AMV2D2A1	5000	19.75	1.1401	13.50

*Not available with standard 15 day Built-To-Order delivery

Table 6-8: ACS Internal Drive Specifications

EXAMPLE: If we size a power supply for an AMV2C4A1 motor where the max speed will be 800rpm and the peak torque will be 6 in-lbs we can calculate the watts used.

$$\text{Watts} = (6/0.5228) \times (6.19 \times 800) / 1000 = 56.83 \text{ Watts}$$

It is never a good idea to buy a power supply that just meets the drive's wattage requirements. To avoid nuisance overcurrent shut downs a power supply power rating should be at least 25% greater than the calculated value.

6.6.4 Suggested Power Supplies:

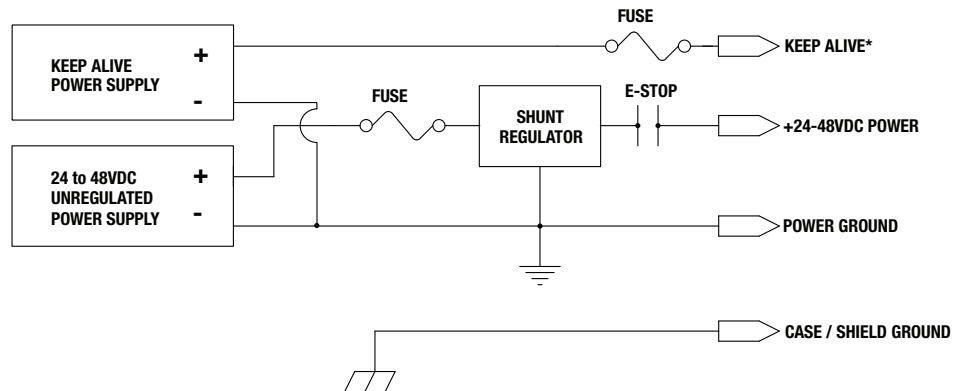
Switching Power Supply: Lambda SWS600-48

Unregulated Power Supply: International Power IP500U36

Bus Fuse: 15 Amp, 125V or equivalent or sized for application

Logic Power Fuse: 2 Amp, 125V or equivalent

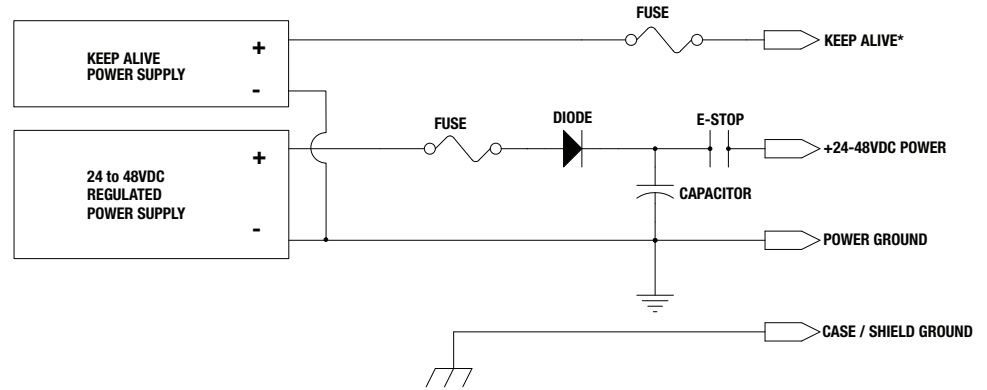
A shunt regulator may be needed to dissipate excess energy.



*The KEEP ALIVE voltage must always be less than the main power voltage or the drive may not operate properly.

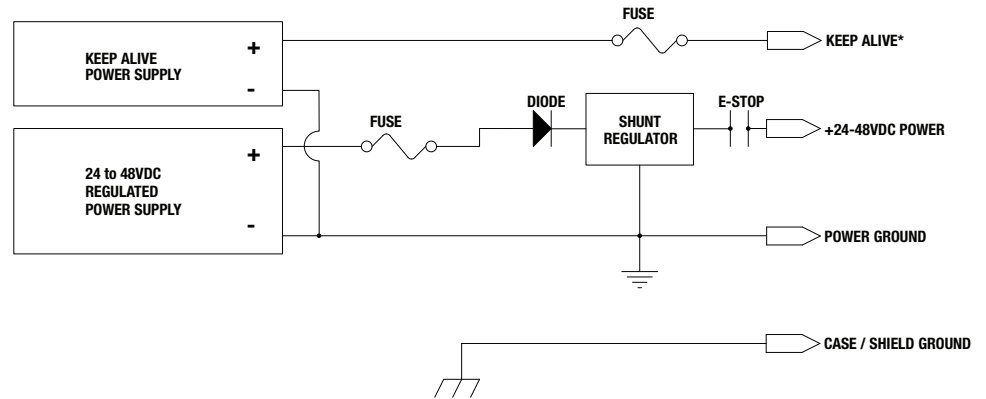
Figure 6-12: Unregulated Power Supply Configuration with Shunt Regulator

6: SPECIFICATIONS & WIRING



*The KEEP ALIVE voltage must always be less than the main power voltage or the drive may not operate properly.

Figure 6-13: Regulated Power Supply Configuration with Blocking Diode and Added Capacitance



*The KEEP ALIVE voltage must always be less than the main power voltage or the drive may not operate properly.

Figure 6-14: 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 as configured by TMI will increase response time.

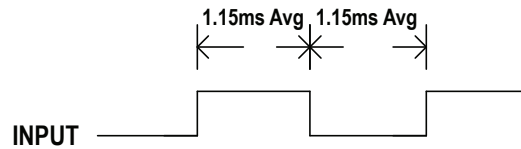


Figure 7-1 Input Requirement

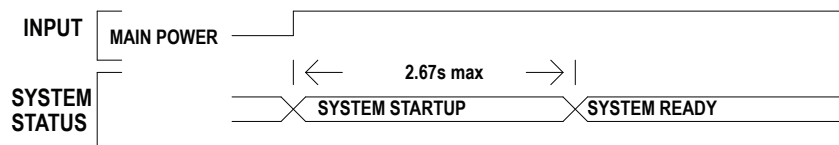


Figure 7-2 System Startup Timing

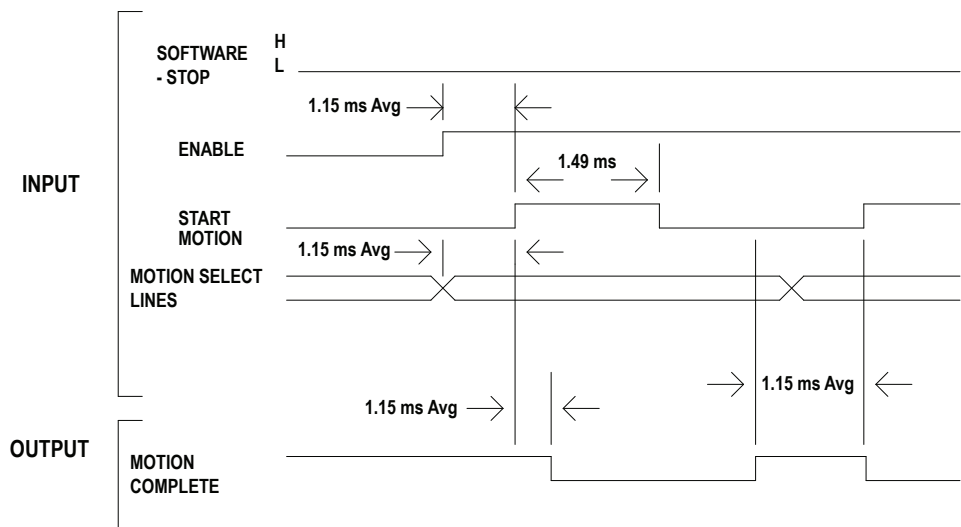


Figure 7-3 Jog Move Timing

7: I/O TIMING DIAGRAMS

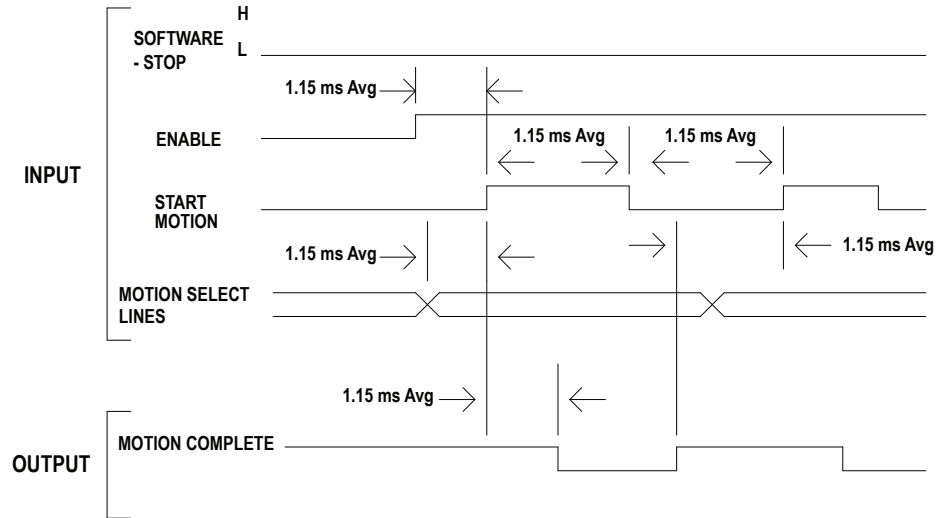


Figure 7-4 Absolute & Incremental Move Timing

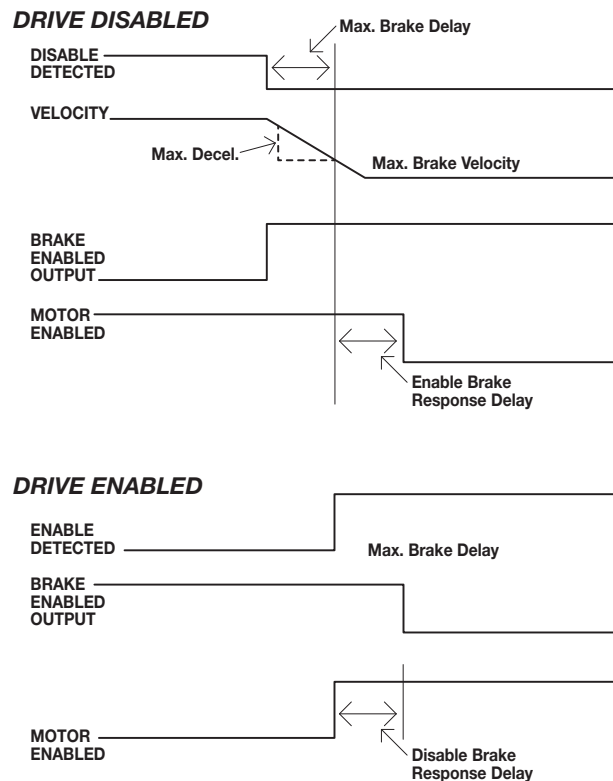


Figure 7-5 Brake Subsystem Timing

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

8: MOVE SELECT 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
Green, On and Blinking Red, On and Blinking	Firmware Upgrade Mode

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.
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
I2T Limit	Drive power usage greater than max allowed
Short Circuit	Short circuit to ground condition on motor
Watchdog Timeout	Firmware did not respond in time

Table 9-3: Critical Faults

10.1 Troubleshooting

10.1.1 Troubleshooting the ACS Servo Drive

Troubleshooting Table	
SYMPTOM / TROUBLE	POSSIBLE CAUSE / RESOLUTION
No communication to drive	<ol style="list-style-type: none"> 1. Check power connection. 2. Verify that the communication cable is plugged in securely. 3. Verify that USB drivers are up-to-date. 4. Try a different computer. 5. If communication fails when enabling the motor, then the motor tuning needs to be adjusted.
Actuator cannot move load	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. Ambient temperature is too high. 2. Cooling is insufficient.
Actuator is operating erratically	<ol style="list-style-type: none"> 1. Motor encoder is not aligned to Tolomatic spec. 2. Motor encoder signals disconnected, damaged or wired incorrectly. 3. Determine if power supply has enough current. 4. Check to see if any faults are being generated. 5. Verify that the drive has been configured properly for the actuator.
No response from drive in I/O mode	<ol style="list-style-type: none"> 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. 4. Disconnect from software or select digital input controlled radio button on mode setup tab
Red and Green LEDs blink alternately	<ol style="list-style-type: none"> 1. Cycle power to drive 2. Verify Firmware Upgrade completed without interruption
No EtherNet/IP™ Communication	<ol style="list-style-type: none"> 1. Check EtherNet/IP cables. 2. Verify EtherNet/IP cable is plugged in securely. 3. Incorrect combination of IP address, subnet mask & gateway. Check with your network administrator.

Table 10-1: Troubleshooting Descriptions

Appendix 1

Motors

There are currently 5 different motor selections available from Tolomatic for the ACS Servo drive - three NEMA 23, and two NEMA 34. Each motor has an integrated 500 line (2000 count) encoder with differential A/B, single-ended index and hall signals. A 12 inch pigtail with circular connector is standard on each motor.

Tolomatic Motor Specifications			
SPEC	AMV2C1A1	AMV2C2A1	AMV2C3A1
NEMA	NEMA 23	NEMA 23	NEMA 23
Continuous Torque	2.63 in-lbs	4.25 in-lbs	4.29 in-lbs
Peak Torque	5.25 in-lbs	8.5 in-lbs	13 in-lbs
Resistance	0.23 Ohms	0.205 Ohms	0.616 Ohms
Inductance	0.244 mH	0.305 mH	0.915 mH
Torque Constant (Kt)	4.824 oz-in/A	8.189 oz-in/A	14.189 oz-in/A
Back EMF Constant (Ke)	3.570 V/kRPM	6.06 V/kRPM	10.5 V/kRPM
Max. Continuous Current	10 Amps	10 Amps	3.5 Amps
Max. RPM	6,000 RPM	6,000 RPM	6,000 RPM
Rotor Inertia	0.001 oz-in-s ²	0.002 oz-in-s ²	0.002 oz-in-s ²
Motor Poles	8	8	8
Max Case Temp	85C	85C	85C

Tolomatic Motor Specifications		
SPEC	AMV2D1A1	AMV2D2A1
NEMA	34	34
Continuous Torque	5.9 in-lbs	9.87 in-lbs
Peak Torque	11.9 in-lbs	21.46 in-lbs
Resistance	0.250 Ohms	0.208 Ohms
Inductance	0.325 mH	0.399 mH
Torque Constant (Kt)	11.068 oz-in/A	18.243 oz-in/A
Back EMF Constant (Ke)	8.190 V/kRPM	13.5 V/kRPM
Max. Continuous Current	10 Amps	10 Amps
Max. RPM	5,000 RPM	5,000 RPM
Rotor Inertia	0.01 oz-in-s ²	0.02 oz-in-s ²
Motor Poles	8	8
Max Case Temp	85C	85C

Table A-1: Tolomatic Servo Motor Specifications

Appendix 1

Tolomatic Motor Part Numbers		
NEMA	CONFIGURATOR CODE	PART NUMBER
Nema 23	AMV2C1A1	3604-1845
Nema 23	AMV2C2A1	3604-1847
Nema 23	AMV2C3A1	3604-1846
Nema 34	AMV2D1A1	3604-1849
Nema 34	AMV2D2A1	3604-1851

Table A-2: Tolomatic Motor Part Numbers

Motor Connector Pinout					
Pin	Color	Motor Signal	Pin	Color	Motor Signal
R	DRAIN x3 (16 AWG)	P DRAIN	L	GRY/WHT	COMM T-R
C	WHT/RED (16 AWG)	PHASE S	U	BRN	ENC I
D	WHT (16 AWG)	PHASE T	G	GRN	COMM S-T
B	WHT/BLK (16 AWG)	PHASE R	T	RED	+5VDC IN
J	BLU	ENC A	F*	ORN/WHT	ENC B-
K*	BLU/WHT	ENC A~	V	ORN	ENC B
H	GRN/WHT	COMM R-S	M	DRAIN x1	E DRAIN
S	BLK	GND			

Table A-3: Motor Connector pinout

Appendix 2

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.

CE COMPLIANCE

The ACS Servo Drive is certified to be meet CE emission standard

EN 55011:2009/A1:2010

Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement.

And CE immunity standard

EN 61000-6-1:2007

Electromagnetic compatibility (EMC) -- Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments.

The above emission and immunity standards can only be guaranteed if high quality shielded cables are used and proper grounding techniques are applied to the installation. Tolomatic recommends that only trained and qualified personal familiar with sound industrial wiring techniques perform the installation. If the ACS Servo Drive is to be included in a system that intends to have emissions and immunity certification Tolomatic recommends that ferrite suppression cores such the Fair-Rite 0431164281 (or similar) be attached to all cables leading to and from the ACS Drive.

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3800 County Road 116, Hamel, MN 55340

Phone: 763.478.8000

Toll Free: 1.800.328.2174

Fax: 763.478.8080

Email: help@tolomatic.com

www.tolomatic.com