

## HARDWARE & INSTALLATION GUIDE

**ACSI – Actuator Control Solutions  
Integrated Servo Drive/Motor**

Models: ACSI23-1Q1  
ACSI34-1Q1



Ether**CAT**® 



EtherNet/IP™  
 **ODVA**  
CONFORMANT

 **PROFI**®  
**NET**  
 **PI** CERTIFIED  
PROFIBUS • PROFINET

 **Modbus**

3604-4185\_13

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201812171222

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# Health & 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.



### **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.***

## EMC Wiring Guidelines

### Cable routing

It is recommended that the power and signal cables for the ACSI Motor/Drive/Controller 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 cables provided by Tolomatic have a braided shield with drain wires. 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)

### **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. Cables should be de-energized before plugging into the motor to prevent “hot plugging” the cables.

### **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 integrated motor.***

## **Handling and Unpacking**

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

## **Product Warnings**

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

- Do not reverse bias the drive power.
- Do not apply voltages above the maximum rated voltage.
- Do not expose drive to excessive pressure wash 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 ACSI Motor/Drive/Controller

The ACSI is an all-in-one solution (motor/drive/controller) for cost-effective servo control. Mount to a Tolomatic (or any) electric actuator for a complete motion system. The ACSI can be controlled with simple digital I/O, analog input or robust industrial ethernet.

### Features:

#### DIGITAL I/O

- 24 VDC Digital I/O control for flexible easy operating modes
- Opto-isolated

#### ANALOG IN/OUT

- 0-10VDC or
- 4-20 mA

#### DUAL ETHERNET PORTS

- Supports Star, Daisy Chain and Ring Topologies



#### ETHERNET/IP

- AOP: Add on profile
- AOI: Add on Instructions
- DLR: Device Level Ring

#### PROFINET



#### MODBUS TCP



#### INPUT SUPPLY

- 10 VDC to 60 VDC
- Logic & Drive Power

#### M12 CONNECTORS

- Industry standard connectors

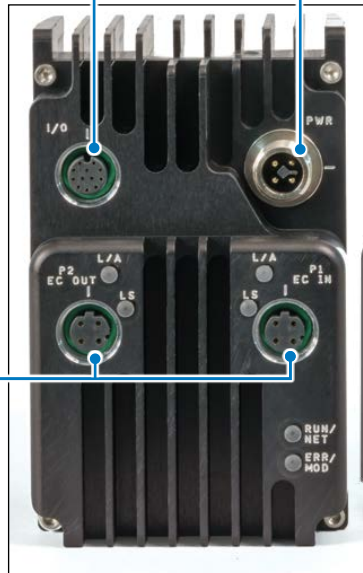
#### USB CONFIGURATION PORT

#### QUALITY TESTED

- Each ACSI is performance tested at Tolomatic before shipping
- Mounted, configured and tested on Tolomatic electric actuators

#### IP65

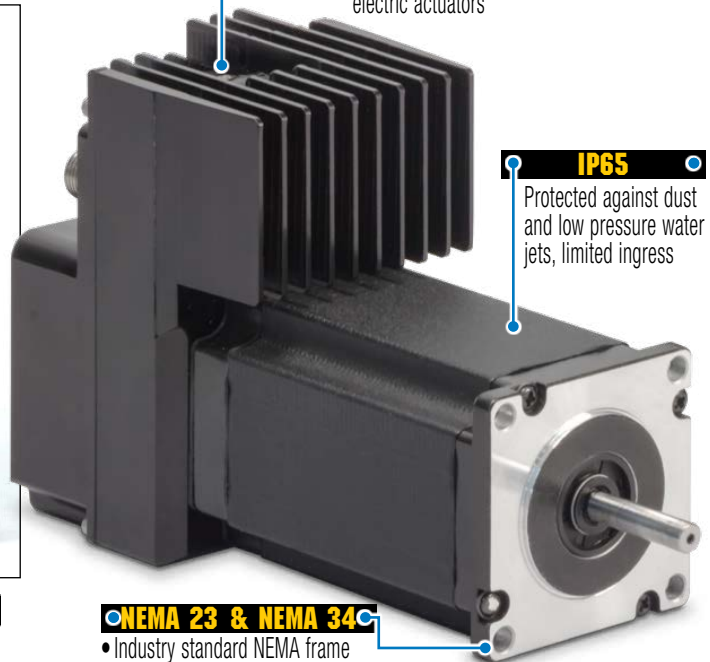
- Protected against dust and low pressure water jets, limited ingress



#### VIBRATION TESTED

- 0-500 Hz, 2 G, 3-Axis, 1-hour

#### ETHERCAT



#### NEMA 23 & NEMA 34

- Industry standard NEMA frame sizes

## 1.2 Capabilities ACSI Motor/Drive/Controller:

### Modes of Operation:

**EtherNet/IP, PROFINET, EtherCAT and ModbusTCP** – Ethernet based protocols allow controllers to command infinite positioning. Dual Ethernet ports with integral switch for daisy-chaining.

**Analog Control** – one analog input sets motion for a position or velocity move. Configurable for 0-10Vdc or 4-20mA. One analog output gives feedback for the actuator's position or velocity.

**Pneumatic** – replaces pneumatic valve logic for simple motion using 1-3 digital inputs.

**Index Move** – up to 4 moves selectable with 2 digital inputs. Absolute, force, incremental, jog, velocity, and home move types available.

# 1 : PRODUCT OVERVIEW

## 1.3 Additional Capabilities ACSI Motor/Drive/Controller:

Rotary Actuator setup allows velocity moves and infinite moves in one direction

Adjustable motion profile parameters (velocity, accel/decel, force) independently configurable for each move.

Zone digital output based on position

Force limiting capability

Configurable Digital I/O (24Vdc Opto-Isolated, sinking or sourcing)

Brake output logic - controlled by drive (low current, 20mA)

Ethernet status lights visible for network setup.

## 1.4 Optional Accessories:

### Cable Options



**Tolomatic offers power, I/O, and ethernet cables with circular M12 style connectors. Cables are available in either 3 m, 5 m or 10 meter lengths.**

### Disc and Cable



**Tolomatic software is always available online at [www.tolomatic.com](http://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 2 meter USB Type micro-B cable (3604-2145)**

### Brake Cable



**Tolomatic offers a 10 meter brake power cable with drive and brake mating connectors**

### Power Supply



**Tolomatic offers 2.5, 5 and 10 Amp 48 Vdc power supplies**

# Environment, Dimensions & Mounting 2

## 2.1 Operating Environment



### WARNING!

**Do not expose the drive to pressurized wash-downs or exceed temperature ratings.**

The ACSI Motor/Drive/Controller is designed to be operated in ambient conditions from 0° – 40°C (32° – 104°F), and humidity from 0 – 90% non-condensing.

ACSI 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
Vibration	0 - 500 Hz, 2G, 3-axis, 1-hour

IP Rating	Protection	Description	Test Method
IP65 Enclosures	Able to protect against water jets	Water projected by a nozzle (6.3 mm) against enclosure from any direction shall have no harmful effects.	Test duration: at least 15 minutes Water volume: 12.5 litres per minute Pressure: 30 kPa at distance of 3 m

Table 2-1: ACSI operating conditions

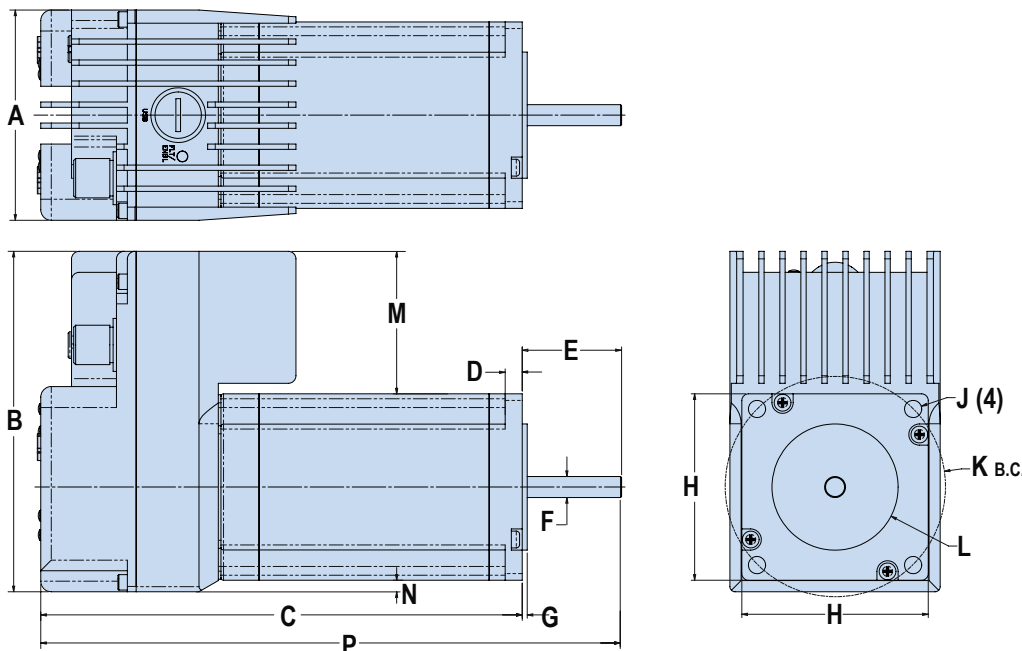
### NOTE!

In order to maintain IP65 rating on motor/drive the protective sealing cover must be used on all unused connections.

For connections that are used, the cable must be properly be torqued down to 0.6 Nm (5.31 in-lbs) to provide sealing. If the cable can be removed by hand with no tools the cable connection is not properly connected at the proper torque.

All caps must be present and properly installed for unused ports to maintain IP65 rating.

## 2.2 ACSI Motor/Drive/Controller Dimensions



	ACSI23	ACSI34
A	in 2.50	2.50
	mm 63.5	63.5
B	in 4.05	4.49
	mm 102.8	113.9
C	in 5.73	5.92
	mm 145.4	150.4
D	in 0.20	0.39
	mm 5.2	10.0
E	in 0.900	1.25
	mm 22.86	31.8
F	in 0.2500	0.5000
	mm 6.350	12.700
G	in 0.059	0.063
	mm 1.50	1.60
H	in 2.22	3.38
	mm 56.3	85.8
J	in 0.20	0.22
	mm 5.2	5.5
K	in Ø2.625	Ø3.875
	mm 66.68	98.43
L	in Ø1.500	Ø2.875
	mm 38.10	73.03
M	in 1.70	1.11
	mm 43.1	28.3
N	in 0.14	0.00
	mm 3.5	0.0
P	in 6.63	7.17
	mm 168.26	182.20

Figure 2-1: ACSI Motor/Drive/Controller Dimensions

### 2.3 Mounting the ACSI Motor/Drive/Controller

The ACSI Motor/Drive/Controller can handle mounting in any orientation. Avoid mounting multiple ACSI units with reduced motor-to-motor spacing, airflow may be reduced causing over-temperature conditions. 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 ACSI motors. This spacing may be relaxed provided the ambient temperature is kept within limits and the motor is mounted to a metal surface suitable enough to heat sink the motor.

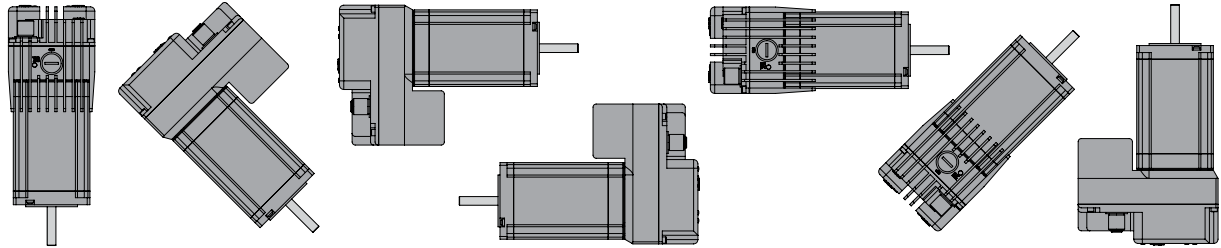


Figure 2-2: ACSI may be mounted in any orientation

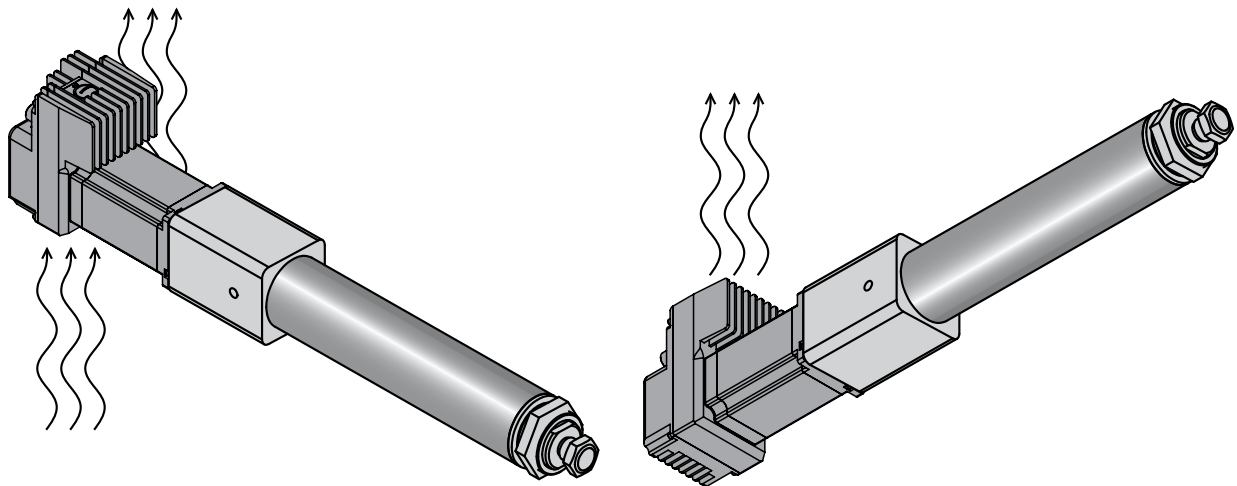


Figure 2-3: It is important that airflow to the ACSI is unrestricted

3.1 CD & USB Cable

**NOTE:** The most current version of software and firmware is always available at [www.tolomatic.com](http://www.tolomatic.com)

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



ACS Servo Drive Accessories	
ITEM	TOLOMATIC PART NUMBER
Tolomatic Motion Interface Software CD	3604-9526
2 meter USB Cable	3604-2145

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

## 4.1 ACSI Motor/Drive/Controller Basic Setup

Figure 4-1 shows the simple setup of the ACSI Drive and the necessary cables and power source.

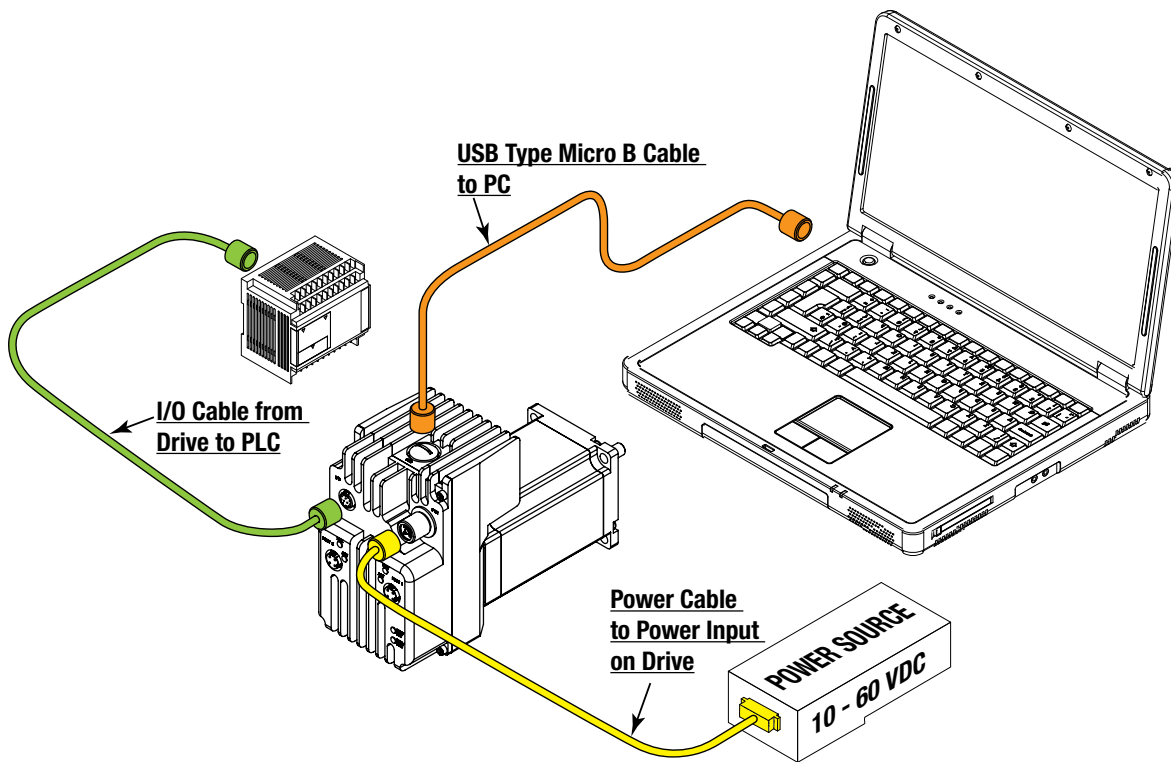


Figure 4-1: ACSI Motor/Drive/Controller – Basic Setup

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

Power Cable: Section 5

USB Cable: Section 5

I/O Cable: Section 5

Ethernet Cable: Section 5

For recommended power supplies: Section 6

### Setup Procedures

1. Install drive/controller and actuator into appropriate fixtures.
2. Wire the 10-60 VDC 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 USB programming cable and install the Tolomatic Motion Interface software.
5. Configure ACSI Drive.
6. Program the logic device.



### CAUTION!

Motor tuning is required based on the attached load, the default inertia setting is for a medium size load. Running the motor with no load attached requires tuning.

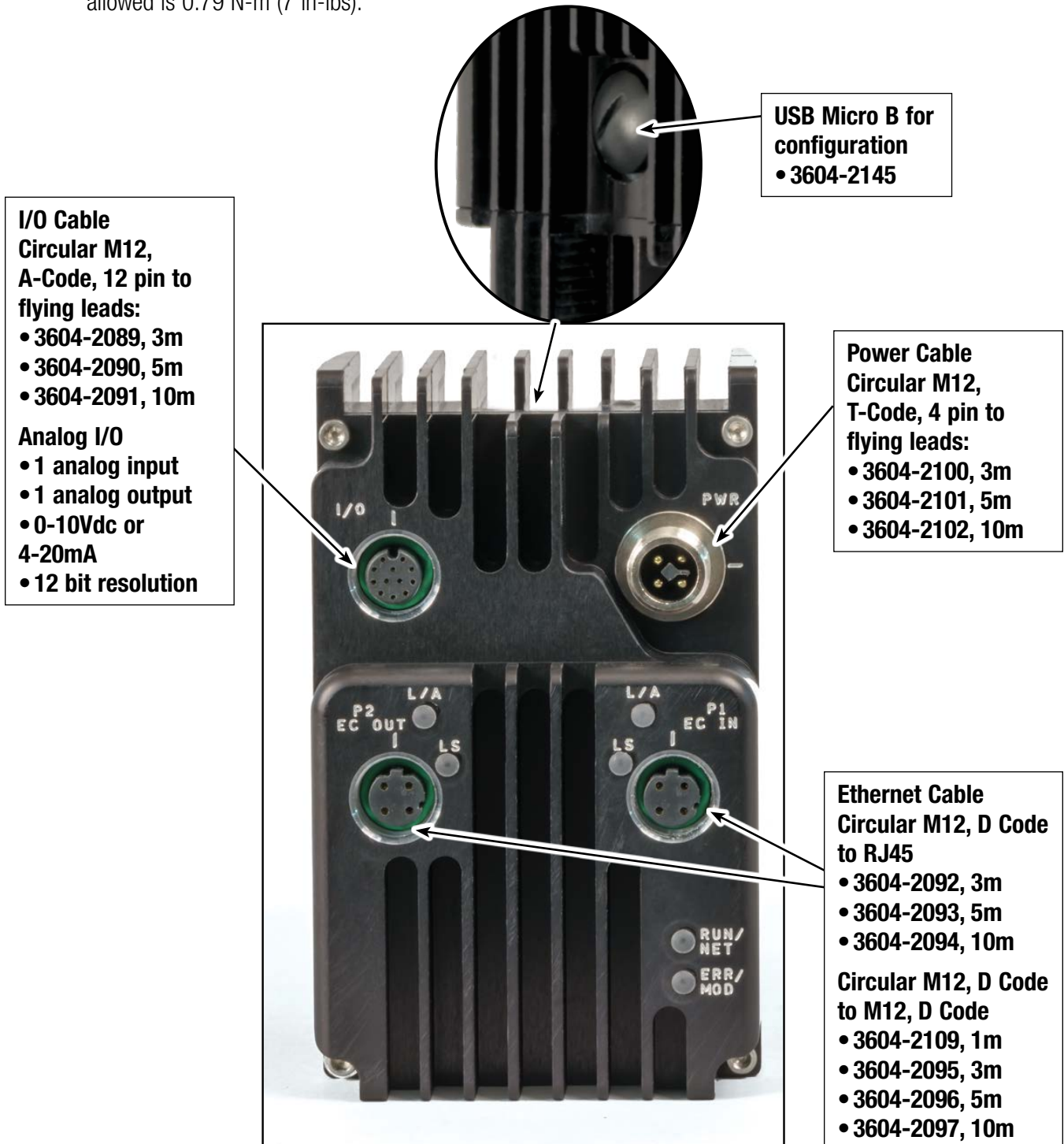


## 5.1 Connections and Cables Overview

All cables for the ACSI Motor/Drive/Controller can be ordered through Tolomatic. When using cables other than those provided by Tolomatic, reference the cable mating connector style to ensure the proper cabling is supplied.



**WARNING: Cables should be hand tightened only.** Do not use tools during installation or over torque cables to connectors. Visually align keys before inserting cable into connector. Maximum install torque allowed is 0.79 N-m (7 in-lbs).



**5.2 Connecting Cables to Motor**

When coupling the cables (Power, I/O, & Ethernet) the key must be aligned. Do not apply force and rotate to align connector to the key.



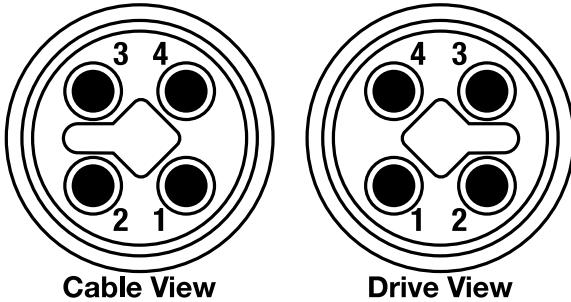
**WARNING!**

*Damage may occur to device if force is applied while rotating to align connector to key on the motor.*



**WARNING: Cables should be hand tightened only.**

Do not use tools during installation or over torque cables to connectors. Visually align keys before inserting cable into connector. Maximum install torque allowed is 0.79 N-m (7 in-lbs)



PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
1	Main Power 10 to 60 VDC	Brown
2	Keep Alive 10 to 60 VDC	White
3	NC	Blue
4	Ground	Black
Drain Wire	Earth Ground	Bare

Table 6-7: Input Power pinouts

Figure 5-1: Input Power Connection

To take advantage of Keep Alive, and not be required to re-home after power up, a second supply is required that is a minimum of 10 VDC with 200mA current capability connected between pin 2 and 4.

Mating connector type is M12, T-Code, 4 Position, Female pin

**NOTE!**

Keep Alive voltage is not required for the drive to function and may be left disconnected.

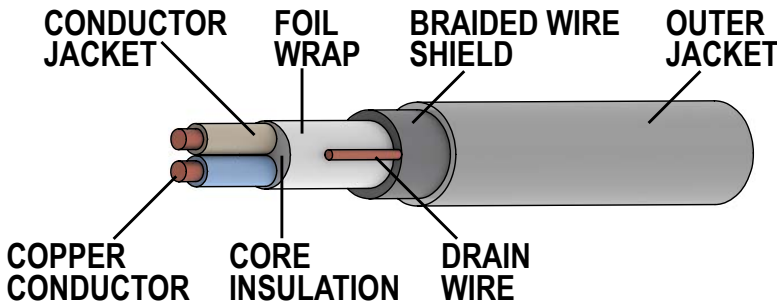


Figure 5-2: Shielded wire diagram



**CAUTION!**

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



**WARNING!**

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

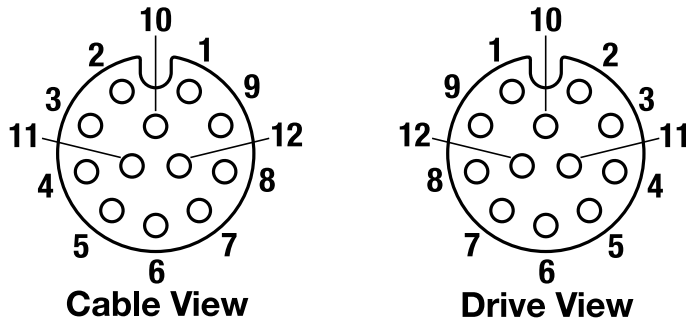


**WARNING!**

*Do not connect or disconnect power cable while drive or power supply is energized. Doing so may cause damage to the drive.*



**5.3 I/O Connections and Cables**



**WARNING: Cables should be hand tightened only.** Do not use tools during installation or over torque cables to connectors. Visually align keys before inserting cable into connector. Maximum install torque allowed is 0.79 N-m (7 in-lbs)

Figure 5-3: I/O Connection Pinout

PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
1	Input ISO 1	Blue
2	Input ISO 2	Orange
3	Input ISO 3	Green
4	Input ISO 4	Brown
5	ISO COM	Grey
6	Analog In	White
7	Analog Out	Red
8	Output 1+	Black

PIN NUMBERS	SIGNAL	CABLE WIRE COLOR
9	Output 1-	Yellow
10	Output 2+	Purple
11	Output 2-	Pink
12	*Analog GND	Light Blue
Shell	Braid	Bare

Table 5-1: I/O Connection Pinout

Mating connector type is M12, A-Code, 12 Position, Male pin

**NOTE!**

The analog GND is shared with the power cable GND internal to the ACSI, it should be connected to a high impedance or isolated source. Failing to do so will sink current from the motor driver potentially causing a noisy signal.

**5.4 USB 2.0 Connection**

The USB port connector is a standard micro B type connector.

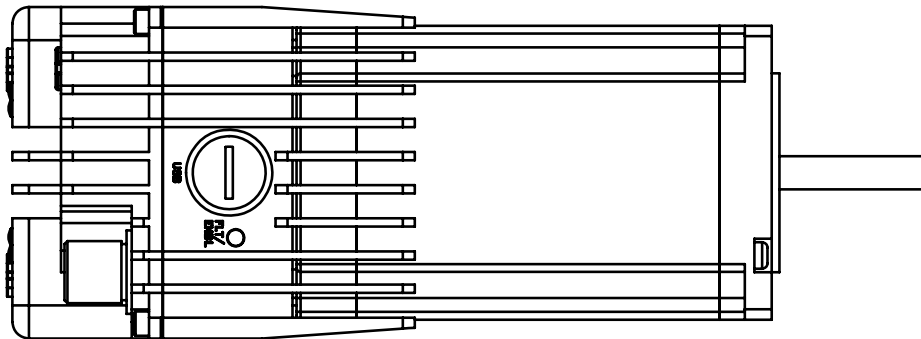


Figure 5-4: USB 2.0 Connection

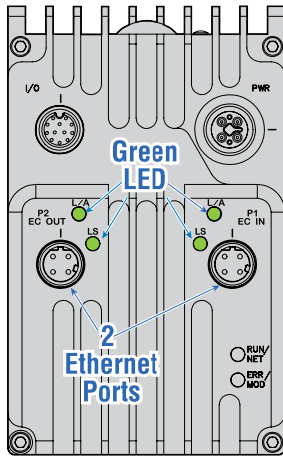
**NOTE!**

If access to this connector is limited in the application environment a 90° angle connector can be used for USB micro B.

**NOTE!**

To maintain IP65 rating, always replace the protective cover when the micro USB connector is not in use.

## 5.5 Ethernet Connection



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

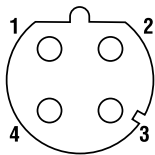
- ACSI Servo Drive/Controller, EtherNet/IP (AMI3)
- ACSI Servo Drive/Controller, Modbus TCP (AMI4)
- ACSI Servo Drive/Controller, PROFINET (AMI6)
- ACSI Servo Drive/Controller, EtherCAT (AMI5)

Figure 5-5: Ethernet Connection for ACSI

**NOTE!**

LED functions are described in section 9.1 LED codes and also in the EtherNet/IP guide (3600-4168), PROFINET guide (3600-4196) and Modbus TCP guide (3600-4169).

**DRIVE VIEW**



PIN NUMBER	FUNCTION
1	Transmit Port (+) Data Terminal
2	RX (+)
3	Data Terminal TX (-)
4	RX (-)

Figure 5-6: Ethernet cable pinouts and connections

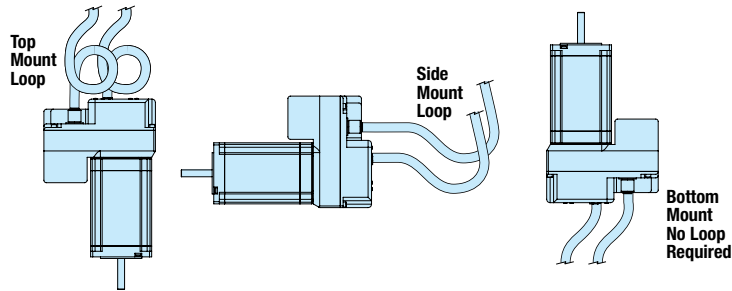
Mating connector type is M12, D-Code, 4 Position, Male pin

NOTE: Internal testing has shown that unmanaged switches are unreliable in PROFINET topologies. Tolomatic recommends only using managed switches when required.

## 5.6 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 5-7 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 5-7 Cable routing loops for top and side facing connectors**

### **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 ACSI 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.

### **Ethernet Cable Length**

The following information regarding cable length is from commercial building telecommunications cabling standard ANSI/TIA/EIA-568-B.1. The maximum length of a cable segment is 100 meters (328 ft). Category 5e cable is capable of transmitting data at speeds up to 1000 Mbps – 1Gbps (ACSI has a maximum speed of 100 Mbps). The specifications for 10BASE-T networking specify a 100-meter length between active devices. This allows for 90 meters of fixed cabling, two connectors, and two patch leads of 5 meters, one at each end.

<b>MOTOR CONTROL SECTION</b>	
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
<b>ENCODER SECTION</b>	
Type	Magnetic
Counts	4096
<b>COMMUNICATION SECTION</b>	

Communication ports	USB
	Ethernet
USB Type	USB device only
USB Speed	USB Full Speed
Ethernet Speed	10/100M (Auto Negotiate)
Ethernet Duplex	Full/Half-Duplex (Auto Negotiate)

Table 6-1: Controller specifications

## 6.1 Digital Inputs

### Specifications

The ACSI Motor/Drive/Controller has a total of 4 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.

NOTE: ACSI supports configuration of a digital input as a limit switch. This configuration requires the use of 'Normally Open' switches

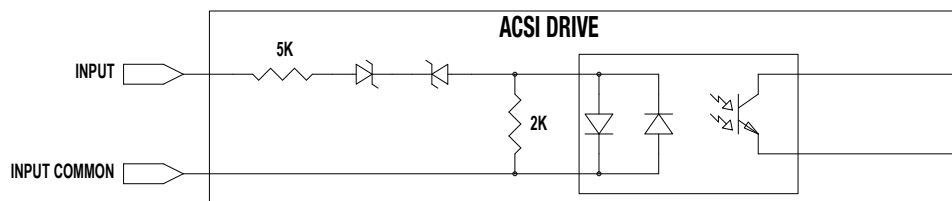


Figure 6-1: Digital Input Circuit

<b>Opto-isolated Digital Input Specifications</b>		
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	KΩ
Off State Current (maximum)	0.4	mA
Update Rate (maximum)	2	ms

Table 6-2: Opto-Isolated digital input specifications

## Typical Wiring Diagrams

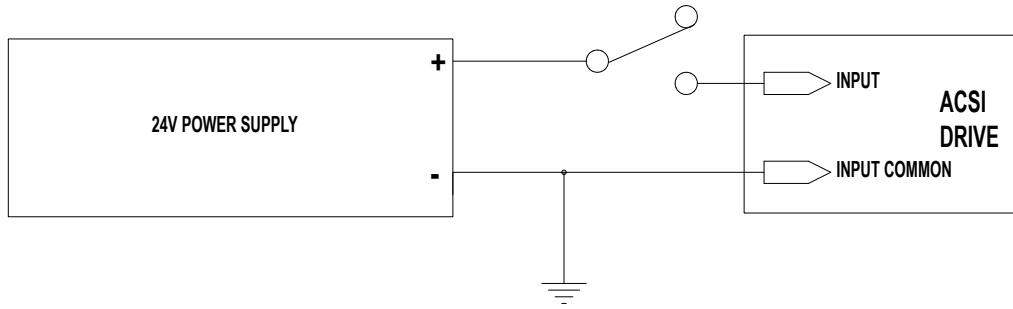


Figure 6-2: Input Source (switched) Connection

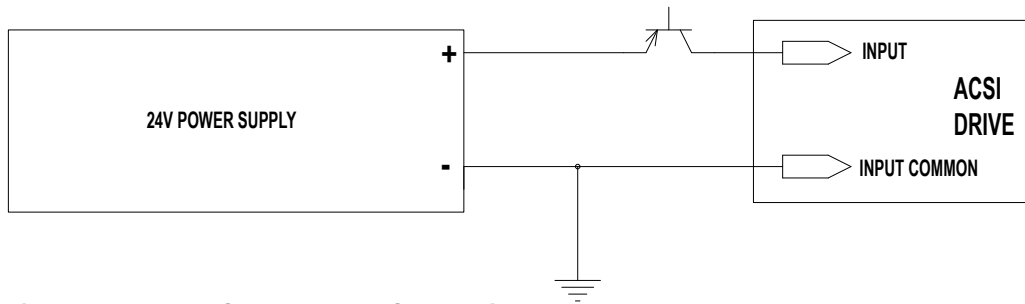


Figure 6-3: Input Source (PNP) Connection

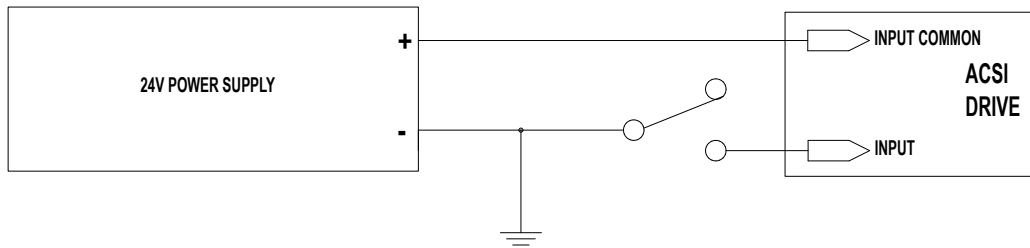


Figure 6-4: Input Sink (switched) Connection

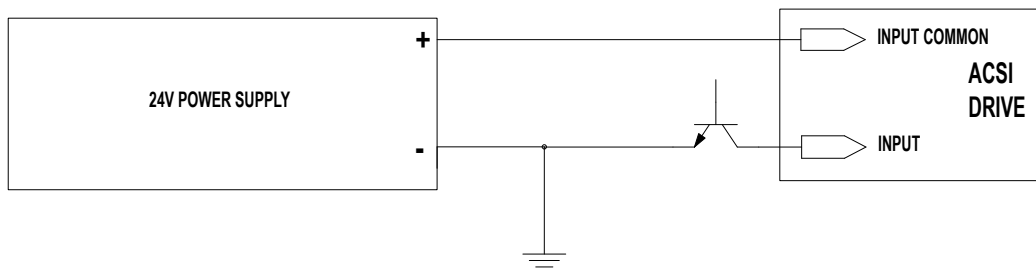


Figure 6-5: Input Sink (NPN) Connection

## 6.2 Digital Outputs

### 6.2.1 Specifications

The ACSI Drive has two 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 current is limited to 80 mA.

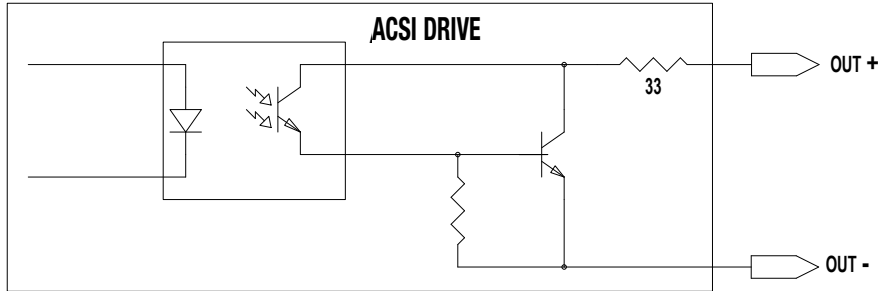


Figure 6-6: Output Circuit

Digital Output Specifications		
Parameter	Value	Units
Switched Voltage (nominal)	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

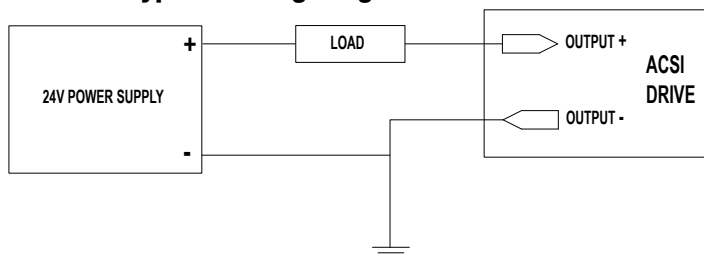


Figure 6-7: Digital Output Sinking Connection

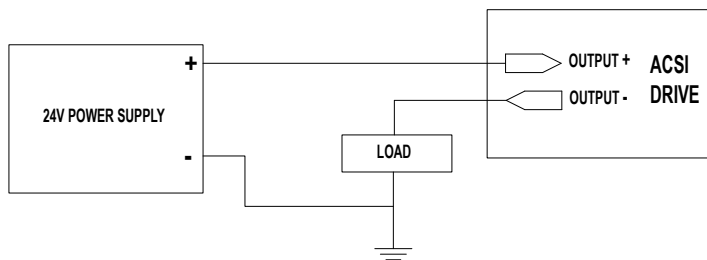


Figure 6-8: Digital Output Sourcing Connections

## 6.3 Analog Input Specifications

The ACSI Drive comes with one analog input. The input is configurable through software to be 0-10V or 4-20mA 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

### Equivalent Circuit

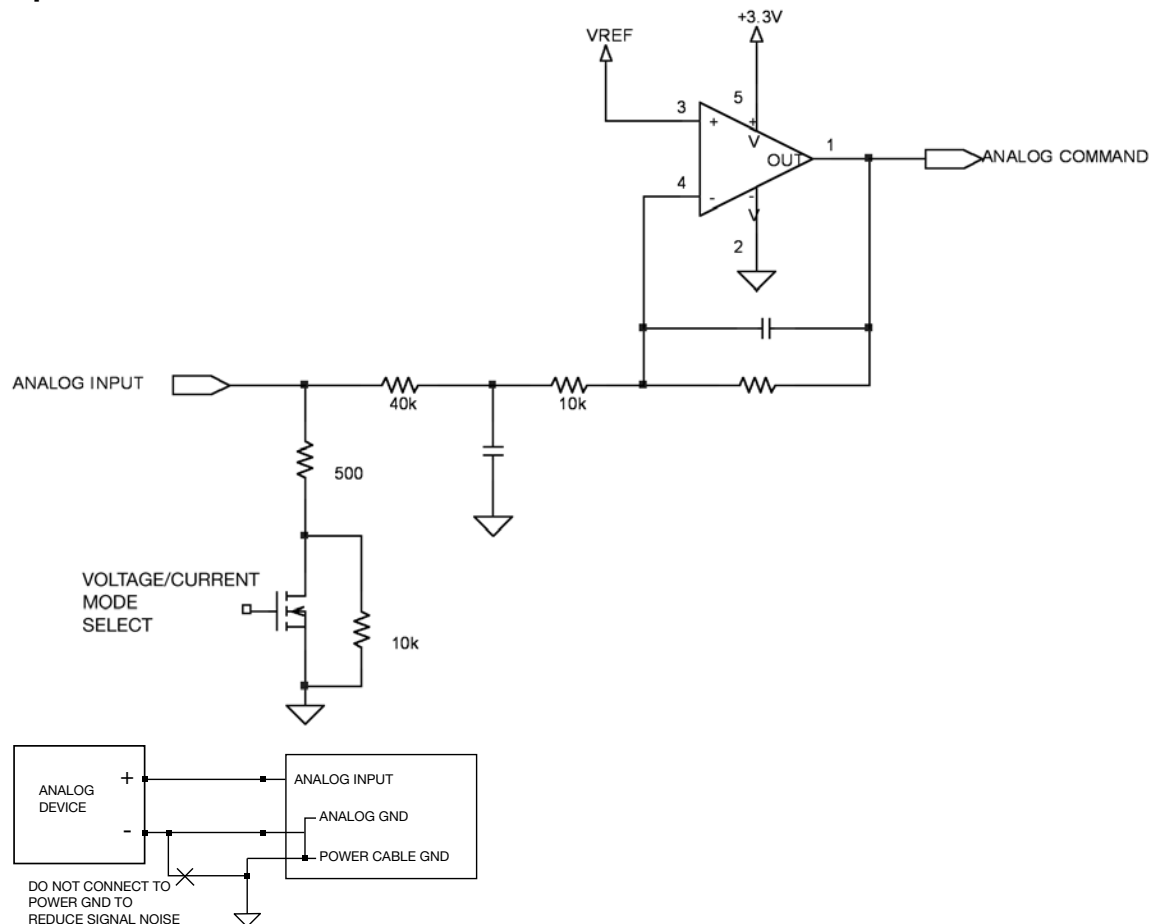


Figure 6-9: Analog Input Equivalent Circuit



### IMPORTANT!

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

### 6.4 Analog Output Specifications

The ACS Drive can have one analog output capable of 0-10V or 4-20mA operation (on selected models). The analog output is referenced to the analog 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

#### Equivalent Circuit

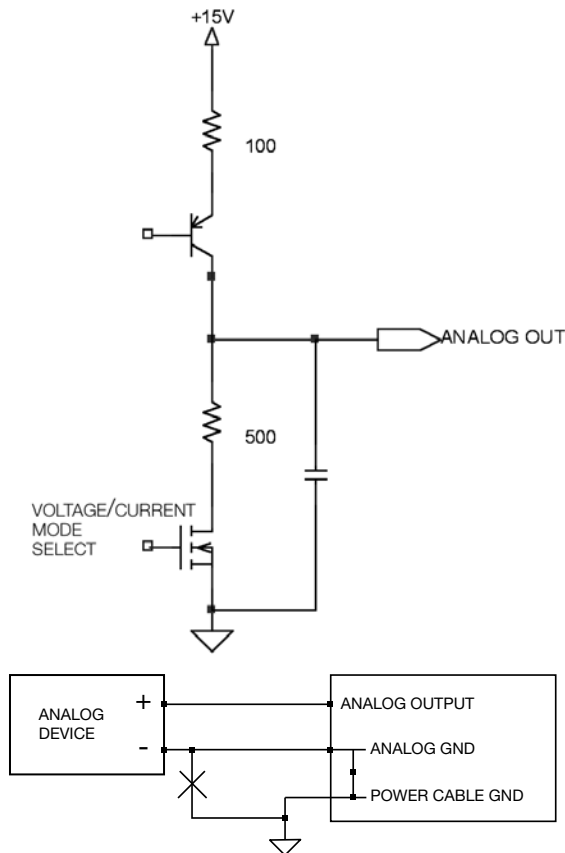


Figure 6-10: Analog Output Equivalent Circuit



#### **IMPORTANT!**

*Devices sharing analog inputs and outputs must be referenced to the analog GND pin for proper and reliable operation.*



#### **IMPORTANT!**

*The analog GND is shared with the power cable GND internal to ACSi it should be connected to a high impedance or isolated source or else it will sink current from the motor driver potentially causing a noisy signal.*



### 6.5 Brake Output

The brake output is a 20mA low current output with braking logic controlled by the drive. It obeys the timing configured using Tolomatic Motion Interface Software. The brake output requires hardware to interface it to the higher currents required to operate a brake.

#### Specifications

Parameter	Value	Units
Input Voltage	24	V
Continuous Current (max.)	20	mA
Output Voltage Drop (20 mA)	2	V

Table 6-6: Brake Output Specifications

#### Brake Output Wiring Diagram

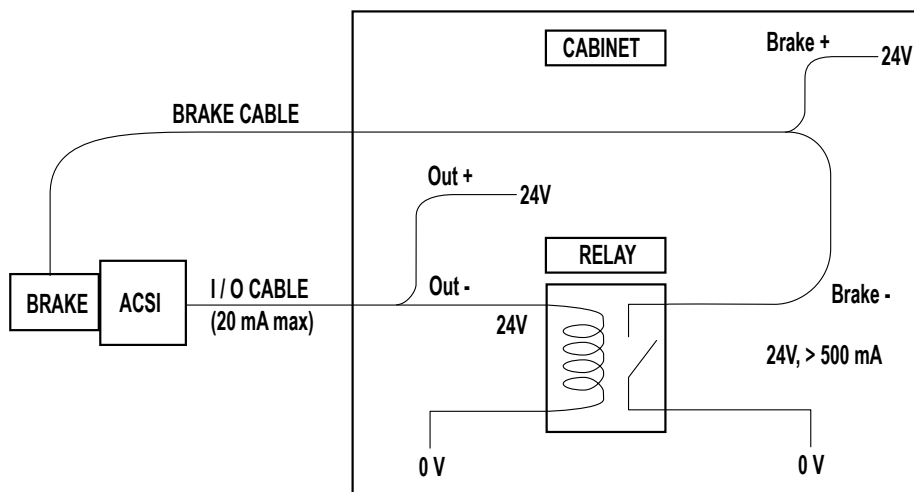


Figure 6-11: Brake output wiring diagram

### 6.6 Input Power

#### Drive Specifications

ACSI Internal Drive Specifications		
Parameter	Value	Units
Current - Continuous (max)	10	A <sub>PK</sub>
Current - Peak (max)	20	A <sub>PK</sub>
Over Voltage <sup>1</sup>	65	V
Under Voltage <sup>2</sup>	9	V
Maximum Operating Voltage <sup>1</sup>	60	V
Logic Current Draw Maximum (24V)	200	mA

Table 6-8: ACSI Internal Drive Specifications

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

<sup>2</sup> Drive will fault below 9V.

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Software Fault - Overvoltage and Undervoltage Trigger Values		
Configured Motor Voltage	Undervoltage Trigger Value	Overvoltage Trigger Value
12	*10	18
24	14.4	36
36	21.6	54
48	28.8	*65

\*NOTE: The absolute minimum/maximum voltage will over-ride the calculated voltage threshold of 0.6x for undervoltage and 1.5 for overvoltage

Table 6-9: Software Faults Trigger Values



### Keep Alive not required

**Providing 10 to 60Vdc to keep alive maintains the drive logic memory when main power is de-energized; which stops all motion; the drive keeps all control logic active and position information.**

### Keep Alive Wiring Diagram

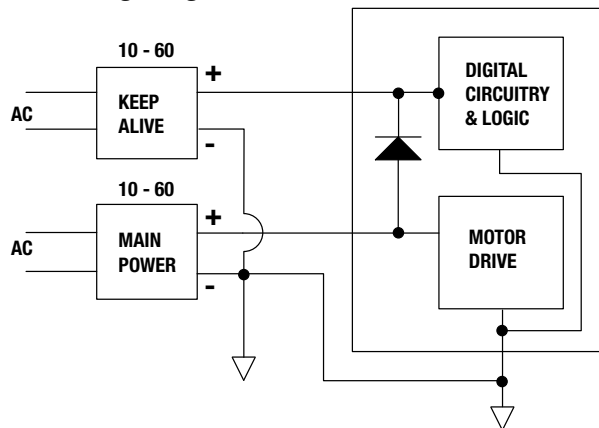


Figure 6-13: Keep Alive wiring diagram

### Power Supply Sizing Guidelines

Both unregulated and regulated power supply can be used to power the ACSI 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 ACSI 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 ACSI 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

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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. Use the following tables to find the required power for a supply. These are measured values, please add 15 - 25% margin for implementation.

ACSI Nema 23 - Input Power Supply WATTS								
SPEED (RPM)	TORQUE (in-lb)							
	1.7	3.5	5.2	6.9	8.6	10.4	12.1	13.8
200	11	20	36	58	77	106	137	173
400	15	29	49	72	96	125	168	202
600	23	42	66	93	125	158	206	250
800	26	49	77	108	144	182	230	288
1000	31	58	91	126	168	206	262	322
1200	37	69	106	145	189	235	293	341
1400	42	77	118	163	211	264	326	384
1600	46	86	132	180	233	293	355	418
1800	54	99	149	197	259	312	389	456
2000	60	108	163	221	284	348	418	490
2200	62	115	173	235	300	370	451	528
2400	69	127	192	255	326	403	490	566
2600	76	134	197	269	346	427	514	600
2800	80	144	216	293	374	456	552	634
3000	90	157	230	307	389	480	590	
3200	100	165	240	331	418	514		
3400	102	173	254	360				
3600	108	197	269					
3800	130							
SPEED (RPM)	0.19	0.40	0.59	0.78	0.97	1.18	1.37	1.56
	TORQUE (N-m)							

ACSI Nema 34 - Input Power Supply WATTS								
SPEED (RPM)	TORQUE (in-lb)							
	3	6	9	12	15	18	21	24
200	19	29	48	67	82	110	139	182
400	26	48	72	101	120	158	197	254
600	38	62	96	139	163	211	259	322
800	48	82	120	163	206	254	312	374
1000	58	96	149	202	250	302	374	446
1200	72	120	182	235	293	370	437	542
1400	82	139	206	274	348	427	504	590
1600	96	154	230	307	394	451		
1800	110	173	269					
SPEED (RPM)	0.34	0.68	1.02	1.36	1.69	2.03	2.37	2.71
	TORQUE (N-m)							

### Calculating Wattage of Power Supply

$$\text{Watts} = I(\text{amps-rms}) \times V(\text{volts}) / \text{Motor Efficiency}$$

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Where

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

And

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

Motor Efficiency  $\sim = 0.7$

Watts = (Peak Application Torque /  $K_t$ ) x ( $K_e$  x Peak Application Speed) / (1000 x 0.7)

Tolomatic Part Number	Motor Config. Code	Max Speed	Peak Torque	Kt	Ke	Max Peak Supply Power*
		RPM	in-lbs	in-lb/amp-rms	Vp/krpm	
3604-9740 3604-9746 3604-9752	AMI2C1A1 AMI3C1A1 AMI4C1A1	3850	13.8	0.836	10	825
3604-9770 3604-9776 3604-9782	AMI2D1A1 AMI3D1A1 AMI4D1A1	2050	25.0	1.39	16.55	744

\*Calculation uses peak torque and rated speed

Table 6-10: ACSI Internal Drive Specifications

**Example:** If we size a power supply for an AMI2C1A1 motor where the max application speed is 2000rpm and max torque reached in the application is 7 in-lbs, we can calculate the power supply watts needed:

$$\text{Watts} = (7/0.836) \times (10 \times 2000) / (1000 \times 0.7) = 239W$$

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



### 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.**

### Suggested Power Supplies:

Switching Power Supply:		
Manufacturer	Tolomatic Part No.	Specs
Meanwell	3604-2147	48V, 2.5A, 120 W
	3604-2148	48V, 5A, 240 W
	3604-2149	48V, 10A, 480 W

Unregulated Power Supply: International Power IP500U48

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

Logic Power Fuse: 2 Amp, 125V or equivalent

## 6 : SPECIFICATIONS & WIRING

A shunt regulator (#2180-1163) may be needed to dissipate excess energy.

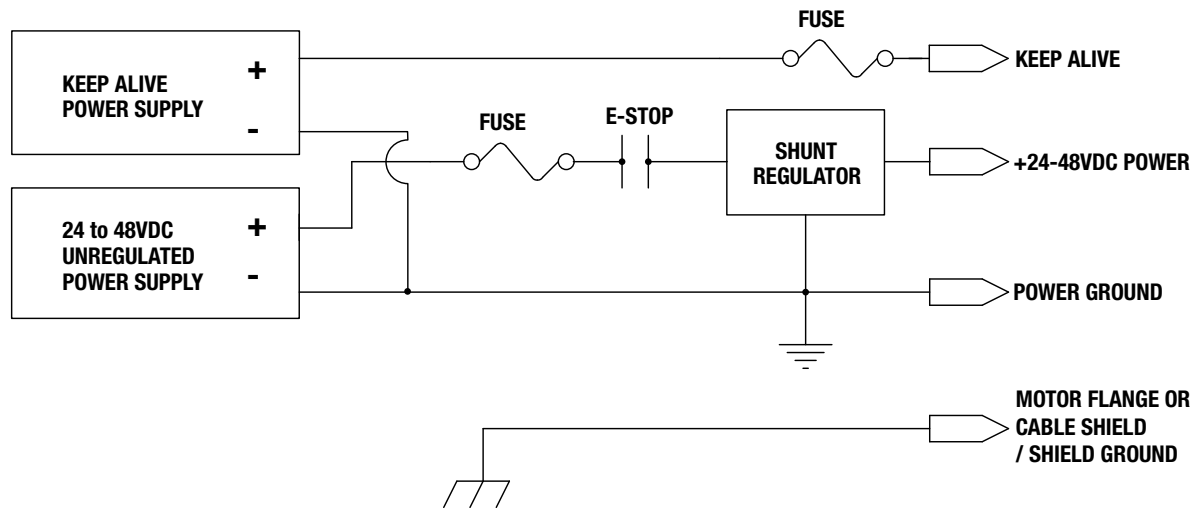


Figure 6-14: Unregulated Power Supply Configuration with Shunt Regulator

## 6: SPECIFICATIONS & WIRING

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## 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  $\Omega$  load. Additional software filtering of digital inputs as configured by TMI will increase response time.

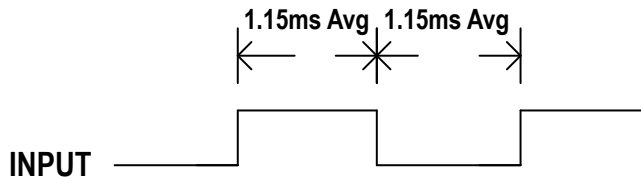


Figure 7-1: Input Requirement

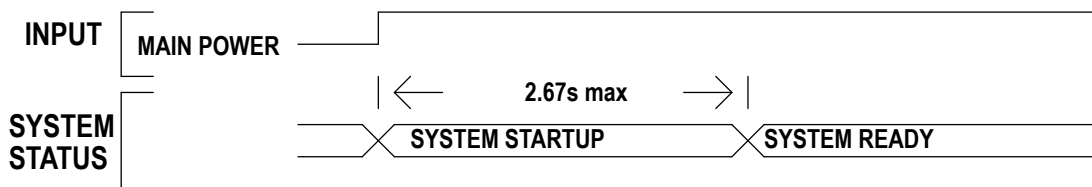


Figure 7-2: System Startup Timing

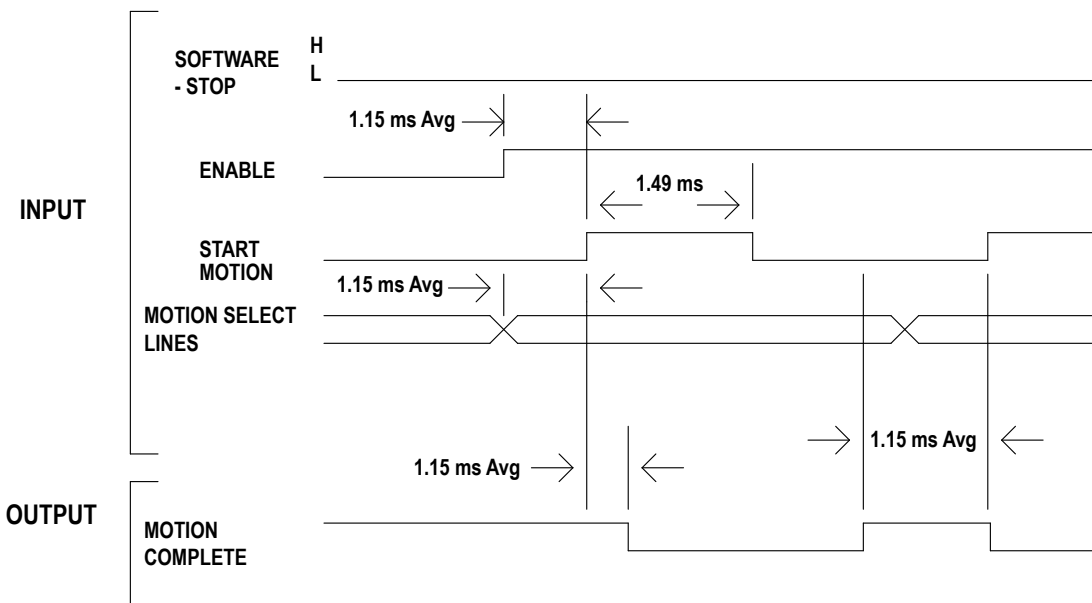


Figure 7-3: Jog Move Timing

## 7: I / O TIMING DIAGRAMS

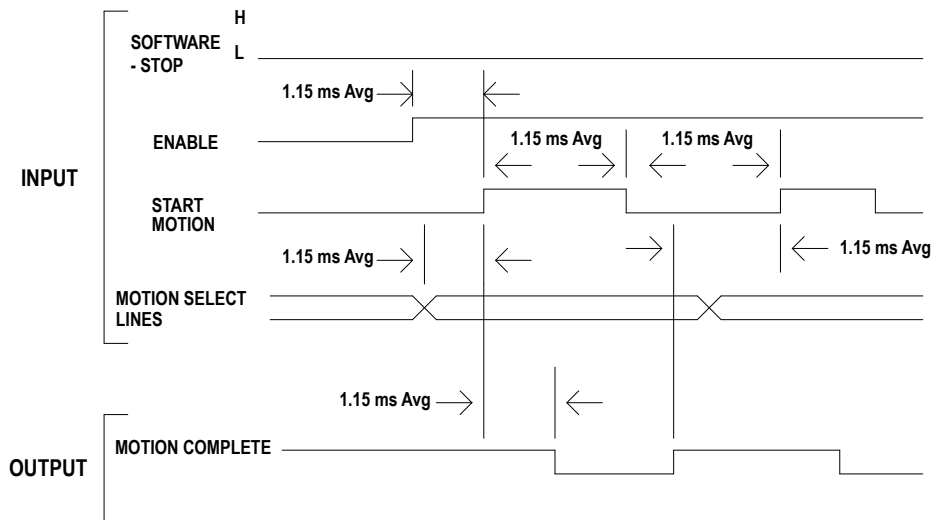


Figure 7-4: Absolute & Incremental Move Timing

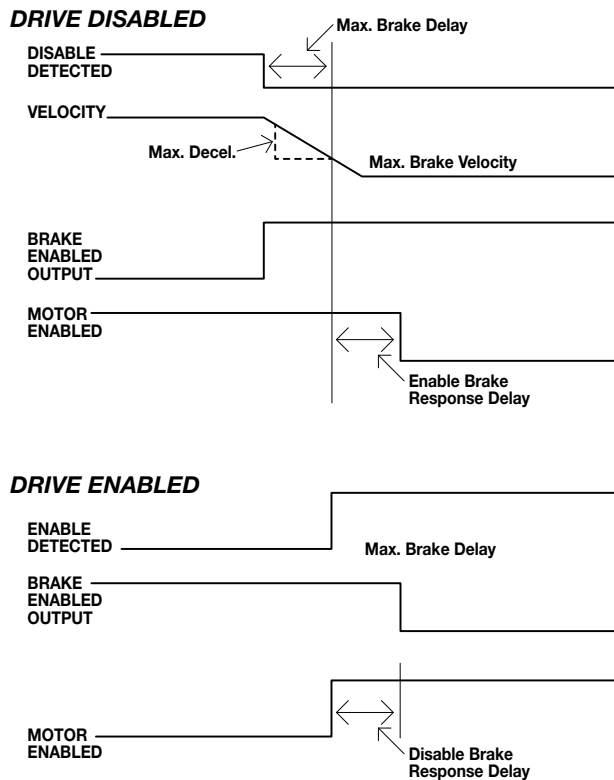


Figure 7-5: Brake Subsystem Timing

### 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 require digital inputs to select the desired move for execution. The digital inputs are called Move Select 1 and Move Select 2 in the digital input map. To select the desired move command refer to the logic table below.

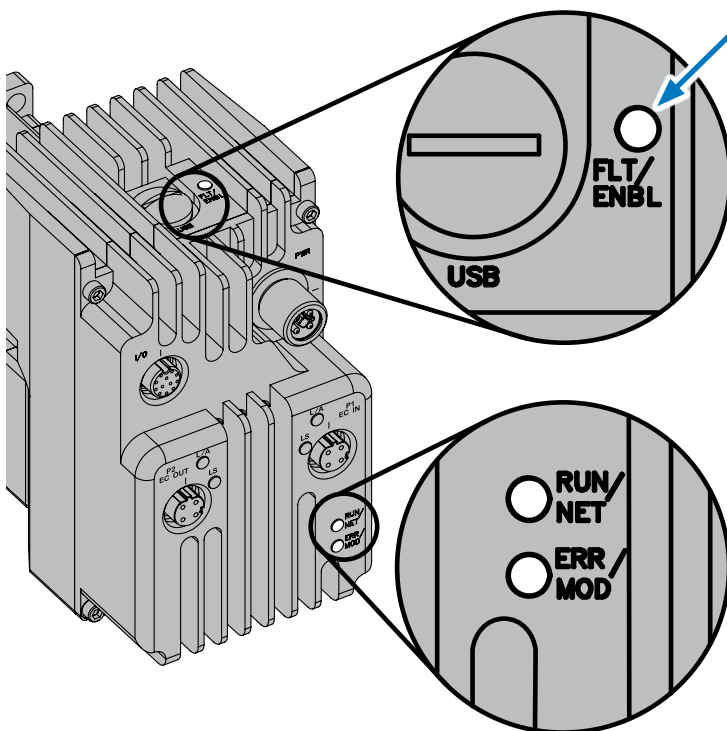
**NOTE 1:** MS# stands for Move Select #

**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*

## 9.1 LED Codes



**LED Indicators**

<b>Off</b>	Motor is not powered
<b>Green, On</b>	Motor is powered
<b>Red, On and Solid</b>	A critical fault has occurred
<b>Red, On and Blinking</b>	A safety fault has occurred
<b>Green / Red toggling</b>	Firmware Upgrade Mode

Table 9-1: LED Indicators

<b>RUN / NET</b>	Protocol Specific. Information can be found in protocol user guides
<b>ERR / MOD</b>	

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

Faults are divided into Safety Faults and Critical Faults.



**Note:**

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

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**

<b>Positive Limit Switch</b>	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.
------------------------------	--

## 9: LED INDICATORS & FAULTS

<b>Safety Faults Table</b>	
<b>Negative Limit Switch</b>	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.
<b>Position Error</b>	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.
<b>Software Stop</b>	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.
<b>I2T Limit</b>	Drive power usage greater than max allowed

Table 9-2: Safety Faults

<b>Critical Faults Table</b>	
<b>Feedback Error</b>	Feedback device is malfunctioning.
<b>Over Current</b>	If a short circuit occurs from output to ground, this fault will be triggered.
<b>Drive Over Temp</b>	Drive temperature is greater than the maximum allowed temperature (75°C).
<b>Drive Over Voltage</b>	Main power voltage exceeds the threshold defined in hardware manual: "Input Power" section..
<b>Drive Under Voltage</b>	Main power voltage below the threshold defined in hardware manual: "Input Power" section.
<b>Flash Error</b>	Flash memory checksum error or firmware version mismatch
<b>Short Circuit</b>	Short circuit to ground condition on motor
<b>Watchdog Timeout</b>	Firmware did not respond in time

Table 9-3: Critical Faults

## 10.1 Troubleshooting

### Troubleshooting the ACSI Motor / Drive / Controller

<b>Troubleshooting Table</b>	
<b>SYMPTOM / TROUBLE</b>	<b>POSSIBLE CAUSE / RESOLUTION</b>
No communication to drive	<ol style="list-style-type: none"> <li>1. Check power connection.</li> <li>2. Verify that the communication cable is plugged in securely.</li> <li>3. Verify that USB drivers are up-to-date. (TMI → Help → Install Drivers)</li> <li>4. Try a different computer.</li> <li>5. If communication fails when enabling the motor, then the motor tuning needs to be adjusted.</li> </ol>
Actuator cannot move load	<ol style="list-style-type: none"> <li>1. The load is too large.</li> <li>2. There is too much friction.</li> <li>3. Side load is excessive.</li> <li>4. Power supply does not have enough current capability.</li> <li>5. Current limits are set too low.</li> </ol>
Drive is overheating	<ol style="list-style-type: none"> <li>1. Ambient temperature is too high.</li> <li>2. Cooling is insufficient.</li> <li>3. Operating point is above where it was sized in Tolomatic sizing software.</li> </ol>
I2T Fault	<ol style="list-style-type: none"> <li>1. Graph I2T accumulator value using the TMI scoping tool.</li> <li>2. Graph actual current using TMI scoping tool.</li> <li>3. Adjust acceleration, deceleration and velocity of move curing spikes in I2T accumulator and actual current.</li> <li>4. Adjust dwells between moves to allow for I2T accumulator to reset to 0.</li> </ol>
Actuator is operating erratically	<ol style="list-style-type: none"> <li>1. Determine if power supply has enough current.</li> <li>2. Check to see if any faults are being generated, controller logic may be powering through faults.</li> <li>3. Verify that the drive has been configured properly for the actuator.</li> <li>4. Adjust tuning (bus voltage and inertia slider bar).</li> </ol>
No response from drive in I/O mode	<ol style="list-style-type: none"> <li>1. Verify the enable signal is on.</li> <li>2. Verify that all of the I/O are configured properly.</li> <li>3. Verify wiring to the actuator and drive.</li> <li>4. Disconnect from software or select digital input controlled radio button on mode setup tab.</li> </ol>
Red and Green LEDs blink alternately	<ol style="list-style-type: none"> <li>1. Cycle power to drive.</li> <li>2. Verify Firmware Upgrade completed without interruption.</li> </ol>
No Network Communication	<ol style="list-style-type: none"> <li>1. Check Network cables.</li> <li>2. Verify Network cable is plugged in securely.</li> <li>3. Incorrect combination of IP address, subnet mask &amp; gateway. Check with your network administrator.</li> </ol>

## 10 : TROUBLESHOOTING

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<b>Troubleshooting Table</b>	
<b>SYMPTOM / TROUBLE</b>	<b>POSSIBLE CAUSE / RESOLUTION</b>
Audible noise from motor when TMI is connected over USB	<ol style="list-style-type: none"><li>1. Running TMI and connecting using a virtual server has been known to cause USB connection issues. It is not recommended to control ACS drives using a virtual machine</li><li>2. Check different USB ports.</li><li>3. Check different computers.</li><li>4. Check different USB cables.</li></ol>
Drive fails to connect to PLC	<ol style="list-style-type: none"><li>1. Verify no unmanaged switch in topology.</li><li>2. Try daisy-chaining drives instead of star topology.</li><li>3. Switch Ethernet ports on drive that is failing to connect.</li></ol>

*Table 10-1: Troubleshooting Descriptions*

# Appendix 1

## Motor Specs

There are currently 2 different motor frame sizes (Nema 23, and Nema 34) available from Tolomatic for the ACSI Motor / Drive / Controller, each available in 2 torque ratings. Each motor has an integrated 1024 line (4096 count) encoder with A/B, index and hall signals.

Tolomatic Motor Specifications					
		ACSI N23	ACSI N23	ACSI N34	ACSI N34
Description		Ethernet	Basic	Ethernet	Basic
Motor Codes		AMI3C1A1		AMI3D1A1	
		AMI4C1A1	AMI2C1A1	AMI4D1A1	AMI2D1A1
<b>Holding Torque</b>	in-lbs	6.5	7.8	15.6	17.9
<b>Peak Torque</b>	in-lbs	13.8	13.8	25.0	25.0
<b>No Load Speed, 48V</b>	RPM	3850	3850	2050	2050
<b>Rated Torque</b>	in-lbs	4.9	5.4	12.0	13.6
<b>Rated Speed</b>	RPM	3500	3500	1750	1750
<b>KT</b>	in-lbs/A	0.836	0.836	1.39	1.39
<b>KE</b>	V/kRPM	10	10	16.55	16.55
<b>Rotor inertia</b>	lb-in <sup>2</sup>	0.075	0.075	0.546	0.546
<b>Motor poles</b>		8	8	8	8

Table A-1: Tolomatic ACSI Motor Specifications

## Accessory Parts

Tolomatic ACSI Cables					
PART NUMBER	DESCRIPTION	LENGTH	CONNECTOR 1	CONNECTOR 2	
3604-2089	CABLE, 3M, M12 A Code 12P/M, Digital I/O	3 Meter	M12, 12 Pin	Flying leads	
3604-2090	CABLE, 5M, M12 A Code 12P/M, Digital I/O	5 Meter	M12, 12 Pin	Flying leads	
3604-2091	CABLE, 10M, M12 A Code 12P/M, Digital I/O	10 Meter	M12, 12 Pin	Flying leads	
3604-2092	CABLE, 3M, M12 D Code 4P/M TO ETHERNET RJ45	3 Meter	M12, Ethernet	RJ45, Ethernet	
3604-2093	CABLE, 5M, M12 D Code 4P/M TO ETHERNET RJ45	5 Meter	M12, Ethernet	RJ45, Ethernet	
3604-2094	CABLE, 10M, M12 D Code 4P/M TO ETHERNET RJ45	10 Meter	M12, Ethernet	RJ45, Ethernet	
3604-2109	CABLE, 1M, M12 D Code 4P/M TO ETHERNET M12	1 Meter	M12, Ethernet	M12, Ethernet	
3604-2095	CABLE, 3M, M12 D Code 4P/M TO ETHERNET M12	3 Meter	M12, Ethernet	M12, Ethernet	
3604-2096	CABLE, 5M, M12 D Code 4P/M TO ETHERNET M12	5 Meter	M12, Ethernet	M12, Ethernet	
3604-2097	CABLE, 10M, M12 D Code 4P/M TO ETHERNET M12	10 Meter	M12, Ethernet	M12, Ethernet	
3604-2100	CABLE, 3M, M12 T Code 4P/F, POWER	3 Meter	M12, 4 Pin	Flying leads	
3604-2101	CABLE, 5M, M12 T Code 4P/F, POWER	5 Meter	M12, 4 Pin	Flying leads	
3604-2102	CABLE, 10M, M12 T Code 4P/F, POWER	10 Meter	M12, 4 Pin	Flying leads	

Table A-2: Tolomatic ACSI Cables

# Appendix 1

ACSI Power Supplies		
PART NUMBER	DESCRIPTION	VOLTAGE
3604-2147	POWER SUPPLY,48VDC,120W,2.5A	48VDC
3604-2148	POWER SUPPLY,48VDC,240W,5A	48VDC
3604-2149	POWER SUPPLY,48VDC,480W,10A	48VDC

Table A-3: Tolomatic ACSI Power Supplies

ACSI Accessories	
PART NUMBER	DESCRIPTION
2180-1163	SHUNT REGULATOR 50W, 24-80VDC
3604-2157	10 M BRAKE CABLE
3604-2145	CABLE,USB,2M,A MALE-MICRO B MALE

Table A-4: Tolomatic ACSI Accessories

CODE	TOLOMATIC MOTOR		PROTOCOL					FRAME SIZE		ENCODER / BRAKE		GEARHEAD						
	AM	I	2	3	4	5	6	C1	D1	A	B	1	2	3	4	5	6	7
DESCRIPTION	Drive / Controller	Integrated Servo	Basic (I/O only)	EtherNet/IP DLR	Modbus/TCP	EtherCAT	Profinet I/O	Nema 23	Nema 34	Incremental encoder	Incremental encoder, inline brake	No reduction	5:1 Gearhead	10:1 Gearhead	5:1 Gearhead, 23 frame output	10:1 Gearhead, 23 frame output	3:1 Gearhead	3:1 Gearhead, 23 frame output

Table A-5: Tolomatic ACSI motors with brakes & gearboxes

## Appendix 2

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### Product Warranty

Tolomatic, Inc. warrants all products manufactured by Tolomatic 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 discretion.

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 ACSI Motor/Drive/Controller is certified to meet CE emission standard

#### **EN 55011:2009/A1:2010**

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

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 personnel familiar with sound industrial wiring techniques perform the installation. If the ACSI Motor/Drive/Controller 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 ACSI Motor/Drive/Controller.



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