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AUTOMATION TECHNOLOGY GROUP

MOTION TECHNOLOGY DIVISION

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SC750 SERIES

Programmable, Digital Brushless Servocontroller

Installation & Hardware Reference Manual

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SC750 S

In this Chapter

This Chapter introduces the SC750 series servocontrollers. Topics covered are:

- SC750 series definition
- Functional block diagram
- Other system components
- How to use this manual
- Warranty information

1.1 SC750 Series Definition

The Pacific Scientific SC750 Series single axis servocontrollers provide digital position, velocity and torque control for brushless servomotors. There are five models in this series:

- The *SC752* with peak power output capability of 2200 Watts
- The *SC753* with peak power output capability of 4500 Watts
- The *SC754* with peak power output capability of 9000 Watts
- The *SC755* with peak power output capability of 18000 Watts
- The *SC756* with peak power output capability of 36000 Watts

All models are functionally equivalent, differing only in output capability and external size.

The servocontrollers, when used with Pacific Scientific brushless servomotors, provide continuous torque ranging from 5.4 lb-in to 451 lb-in. Peak torque ranges from 10 lb-in. to 898 lb-in.

Features

ServoBASIC *Plus*™ programming language - combines the ease of BASIC language programming in conjunction with sophisticated motion control features.

Motion Dialogue interactive programming environment - provides a powerful development environment which aids in rapid program development and testing.

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Signature commutation - insures smooth low speed torque while maintaining high performance at high speeds.

Resolver control - requires only a single resolver mounted on the motor for complete feedback information for motor commutation and for all digital velocity and position servo feedback signals.

Autotuning - provides initialization and set up based on drive selection and motor type.

Encoder emulation output - emulates an incremental encoder, converting resolver position information to incremental encoder outputs. This emulation provides selectable resolution quadrature output signals for an external use. Outputs are differential line drivers with up to 16,384 PPR (pulse per revolution).

Stand-alone design - combines stand alone, fully-enclosed construction with internal power supply and a shunt regulator.

230 volt power - powered directly from 230 volt line for high performance 320 volt dc bus operation (120 V optional).

IGBT technology - uses IGBT (Insulated Gate Bipolar Transistor) technology in the output stage.

Proprietary circuitry - uses proprietary integrated circuits for motor commutation, drive protection and resolver interfaces.

High performance microcontroller technology - features a high performance 16 bit microcontroller performing the arithmetic and logical functions required to supervise and execute motion control programs.

Multiple protection circuits - provide protection and ease of diagnosis with:

- 7-segment drive status display
- MOV-protected input
- Output short-circuit protection
- Overtemperature protection for servocontroller and motor
- IT (current-time) protection
- Low line protection
- Front panel test points
- Summary fault diagnostic output

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Options

- Standard motor power and feedback cables
- Higher accuracy R/D

Typical applications

Typical applications for SC750 servocontrollers include:

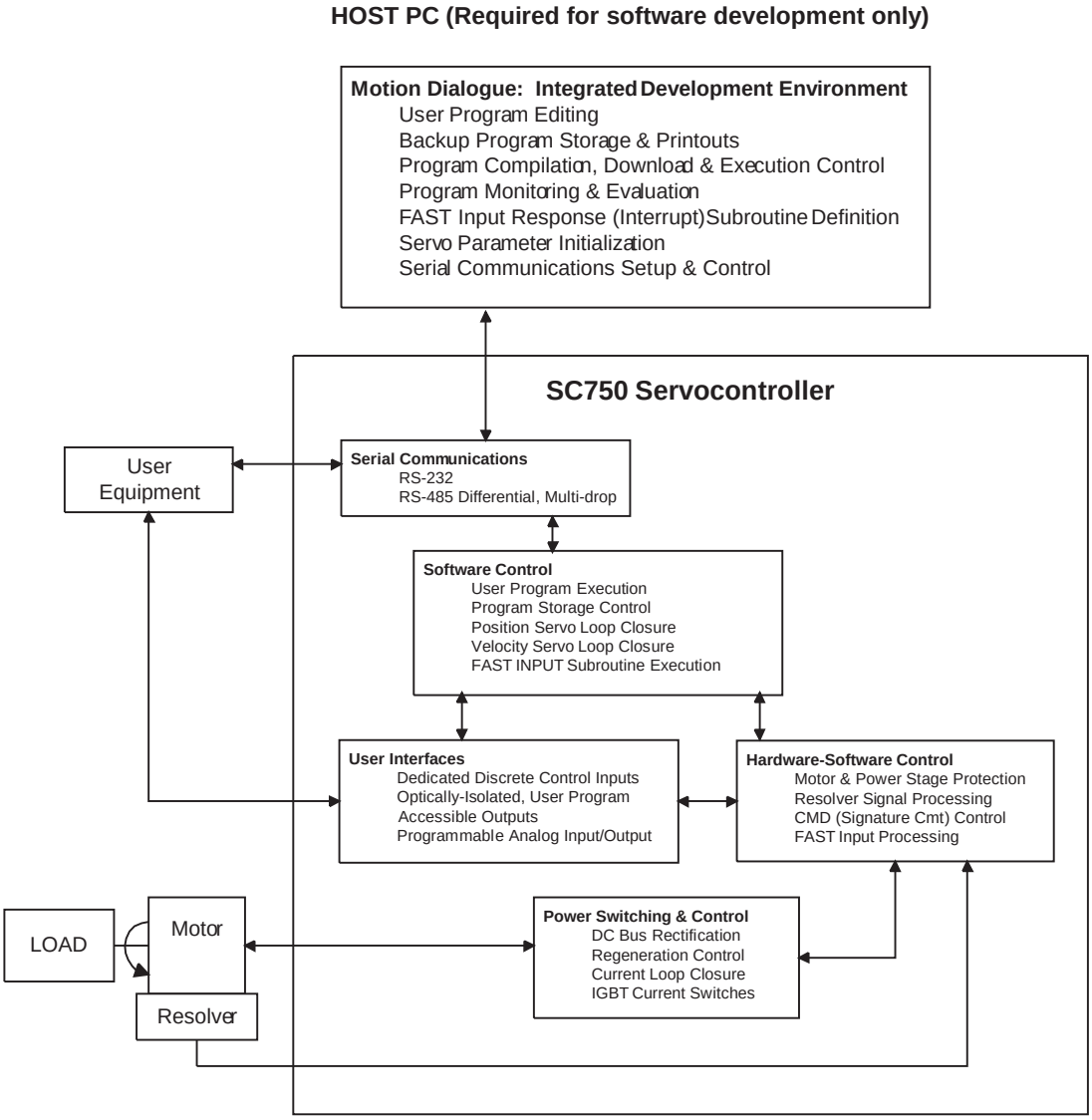
- X-Y tables & slides
- Machine tools
- Packaging machinery
- Microcircuit wafer spinners
- Robotics
- Specialty machinery
- Index feed of material
- Labeling machines

1.2 Functional Block Diagram

The diagram on the following page illustrates the configuration of the SC750 with other system components.

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Functional diagram



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1.3 How to Use this Manual

The SC750 Series servocontroller documentation is presented in three sections:

- I - Installation and Hardware Reference
- II - ServoBASIC *Plus* Programming Guide
- III - ServoBASIC *Plus* Reference

This manual, “SC750 Installation and Hardware Reference,” is intended to describe initial set up, installation, and maintenance of the SC750 servocontroller.

1.4 Warranty

The Pacific Scientific SC750 series servomotor controllers have a **two year warranty** against defects in material and assembly. Products that have been modified by the customer, physically mishandled, or otherwise abused through miswiring, incorrect switch settings, and so on, are exempt from the warranty plan.

Warning



If the continuous current rating of the drive is greater than the continuous current rating of the motor that it is being used with, then it is possible to cause significant damage to the motor. Pacific Scientific may not honor the warranty of the motor if it is run under these conditions.

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I SC750 S

In this Chapter

This Chapter explains how to install the SC750 series unit. Topics covered are:

- Unpacking and inspecting the SC750 series controller
- Installing and using the SC750 series unit safely
- Selecting other system components
- Mounting the SC750 series controller in your installation
- Connecting input/output cables
- Selecting switch functions

2.1 Unpacking and Inspecting

Unpacking procedure

1. Remove the SC750 series controller from the shipping carton. Make sure all packing materials are removed from the unit.
2. Check the items against the packing list. A label located on the side of the unit identifies the unit by model number, serial number, and date code.

Inspection procedure

Inspect the unit for any physical damage that may have been sustained during shipment.

If you find damage, either concealed or obvious, contact your buyer to make a claim with the shipper. Do this within 10 days of receipt of the unit.

Storing the unit

After inspection, store the controller in a clean, dry, place. The storage temperature must be between -25 degrees C and 85 degrees C. To prevent damage during storage, replace the unit in the original shipping carton.

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2.2 Installing and Using the SC750 Series Unit Safely

Your responsibility

As the user or person applying this unit, you are responsible for determining the suitability of this product for any application you intend. In no event will Pacific Scientific Company be responsible or liable for indirect or consequential damage resulting from the misuse of this product.

Note: *Read this manual completely to effectively and safely operate the SC750 series unit.*

Safety background

Voltage levels within this controller can exceed 400 volts dc and/or 230 volts ac.



Warning

The circuits in the SC750 series controller are a potential source of severe electrical shock. Follow the safety guidelines to avoid shock.

Safety guidelines

To avoid possible personal injury whenever you are working with the SC750 series controller:

- Do not power up the controller without the cover on and the chassis tied to earth ground.
- Do not operate the controller without the motor case tied to earth ground.
- Do not make any connections to internal circuitry.
- Do not connect or disconnect the motor with power applied to the unit. Always remove power before making any connections to the unit.
- Before removing the cover of the unit, shut off power and allow the unit to sit for 5 minutes to discharge the internal voltages.
- Be careful of the motor terminals on the drive when disconnected from the motor. With the motor disconnected and power applied to the controller, the motor terminals of the drive have high voltage present.
- Do not use the enable input as a safety shutdown. Always remove power to the controller for a safety shutdown.

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2.3 Selecting Other System Components

Introduction

Match your SC750 series unit to your other components:

Serial communications interfaces

The SC750 requires a serial communication link in order to develop ServoBASIC *Plus*™ software (using Motion Dialogue). A serial interface may be used under software control to interface the SC750 with other user-supplied equipment such as:

- Operator displays
- Host computers
- Programmable controllers (PLC)

The SC750 uses serial communication interfaces supported by the EIA RS-232B and RS-485 hardware specifications.

Single- and multi-unit control

For controlling a single SC750, use RS-232 communications and install cabling as described in section 2.5.2.5, “J58 Serial I/O Connections.”

For controlling multiple SC750s, RS-422 or RS-485 communications permit a single PC to host from 1 to 255 SC750s (each requiring a unique switch selectable address). For detailed information on set up, refer to section 2.5.2.5, “J58 Serial I/O Connections.”

The SC750 utilizes 9600 baud communications with one start bit/one stop bit and eight bit word length in either RS-232 or RS-485 format.

Analog I/O Interfaces

The SC750 provides an analog input channel, accessible to the user through software control. The analog signal must be within a ±12.5 volt range. The signal is digitized with 14 bit accuracy, at a 1000 Hz sampling rate, or full 16 bit accuracy at a 200 Hz rate.

A 12 bit ±5 volt range analog output channel is user accessible under software control.

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Digital I/O

Control inputs

Four dedicated control inputs provide controller enable, inhibit, and fault reset functions. These inputs are interfaced with switch closures or open collector transistor outputs.

General purpose inputs

The SC750 provides 16 optically isolated general purpose inputs to support logic type interfaces. The input circuitry is intended to be operated with open collector type circuitry. Each input channel must be capable of sinking 3.75 milliamperes nominally. These inputs can be polled under software control.

Note: *The user must supply an external 5 to 24 volt logic supply to power the optically isolated general purpose inputs (30 volts absolute maximum).*

Registration

Inputs

Two of the 16 input channels are dedicated high speed input channels which will support registration, latching resolver and encoder position data with a 5 microsecond response time.

Outputs

Twelve open collector discrete output channels host logic outputs under software control. Each channel permits a maximum of 100 milliamperes and is compatible with 5 to 24 volt logic interfaces.

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Encoder I/O

The external encoder I/O port permits interfacing quadrature type encoder signals for applications, such as electronic gearing. This circuit can be configured as an input or as an output under software control.

Input

When configured as an input (default) the encoder input characteristics must be defined by software parameters to determine resolution.

Note: *The encoder input characteristics can also be configured as step and direction inputs.*

Output

Software commands also configure the encoder interface as an output. The resolution capabilities of the encoder output channel range from 500 lines per revolution to 16384 lines per revolution.

Selecting a motor

The SC750 series unit is designed for use with Pacific Scientific's line of brushless servo motors including the R (rare earth) and F (ferrite) series motors. Refer to the Pacific Scientific Brushless Servosystem catalog for system torque-speed curve information.

2.4 Mounting the SC750 Series Unit

Cabinet selection

Select a standard NEMA (National Electrical Manufacturer's Association) cabinet appropriate for industrial applications.

The SC752 and SC753 require a 10 inch (25.4 cm) deep cabinet. The SC754, SC755, and SC756 require a 12 inch (30.5 cm) deep cabinet.

Caution



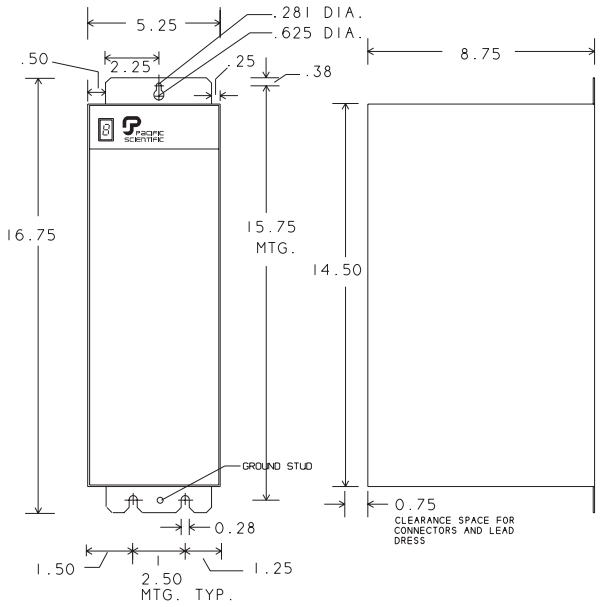
If the cabinet is ventilated, use filtered or conditioned air to prevent the accumulation of dust and dirt on the electronic components. The air should also be free of corrosive or electrically conductive contaminants.

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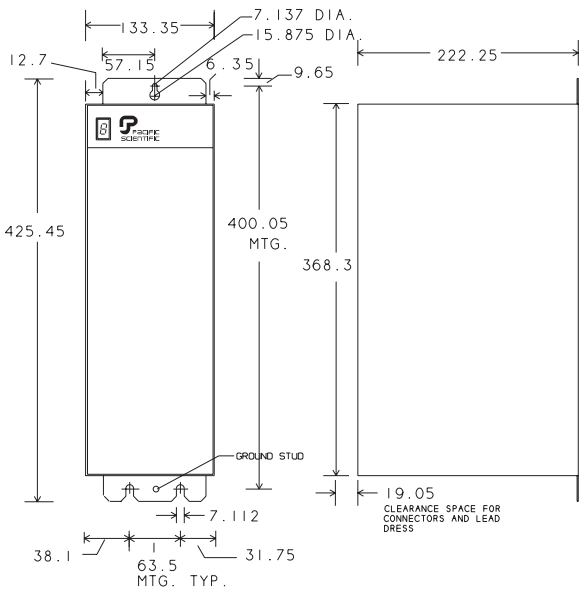
Mounting dimensions

Set up the cabinet for the SC750 series unit using the dimensions shown.

SC752/753 mounting dimensions (in inches)

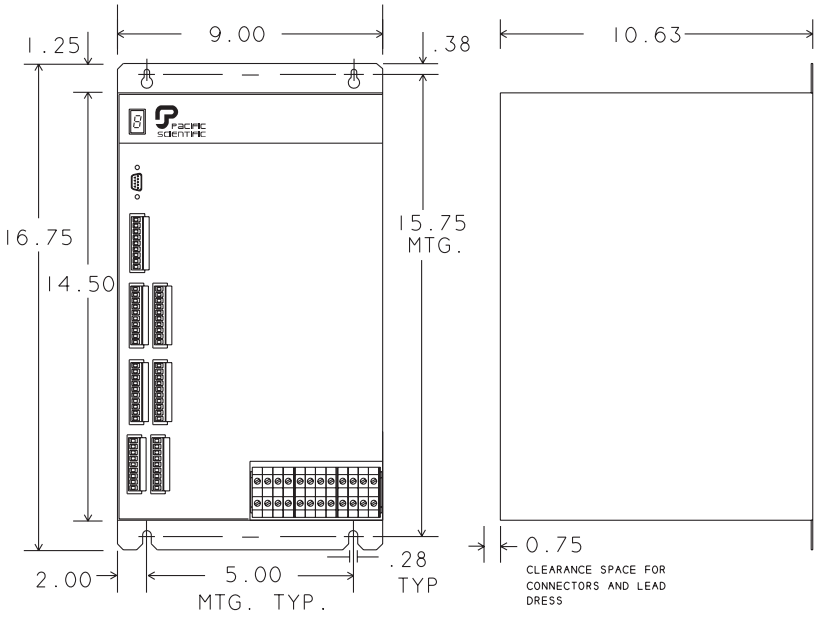


SC752/753 mounting dimensions (in millimeters)

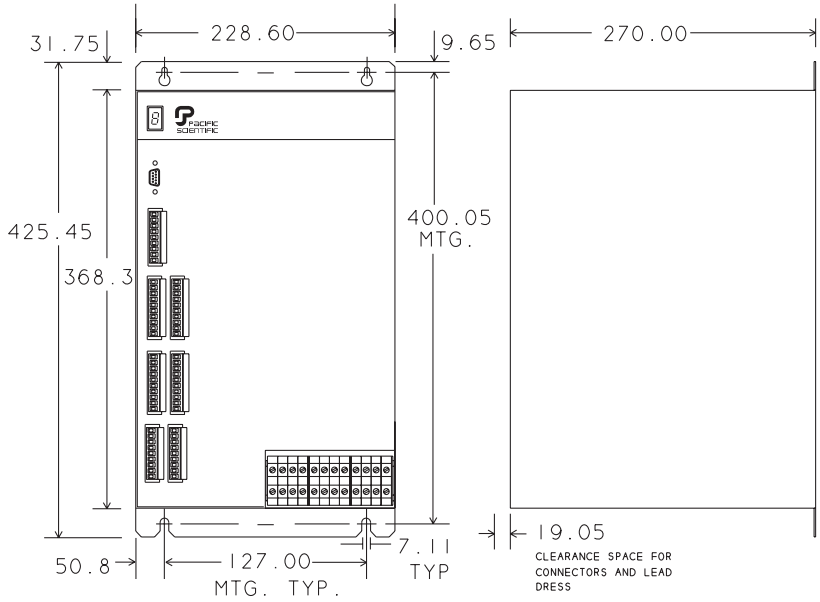


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SC754/755 mounting dimensions (in inches)

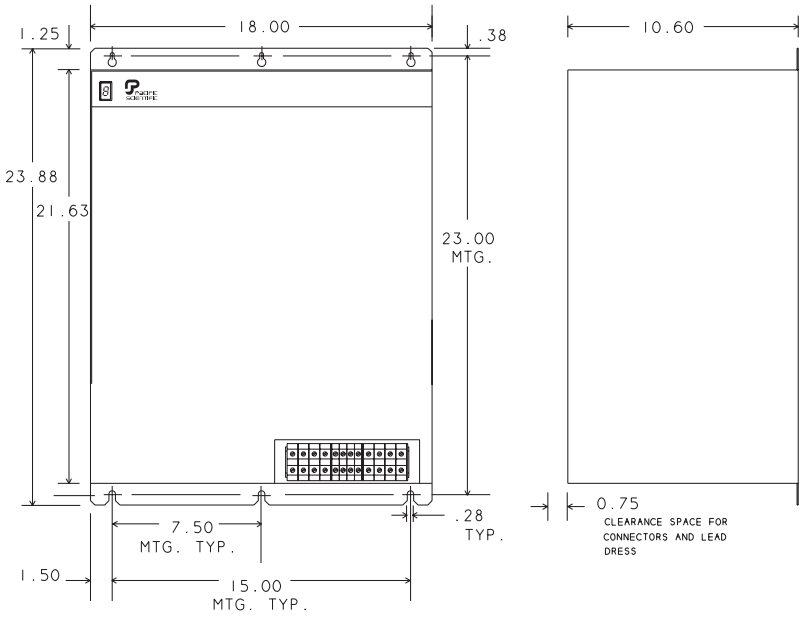


SC754/755 mounting dimensions (in millimeters)

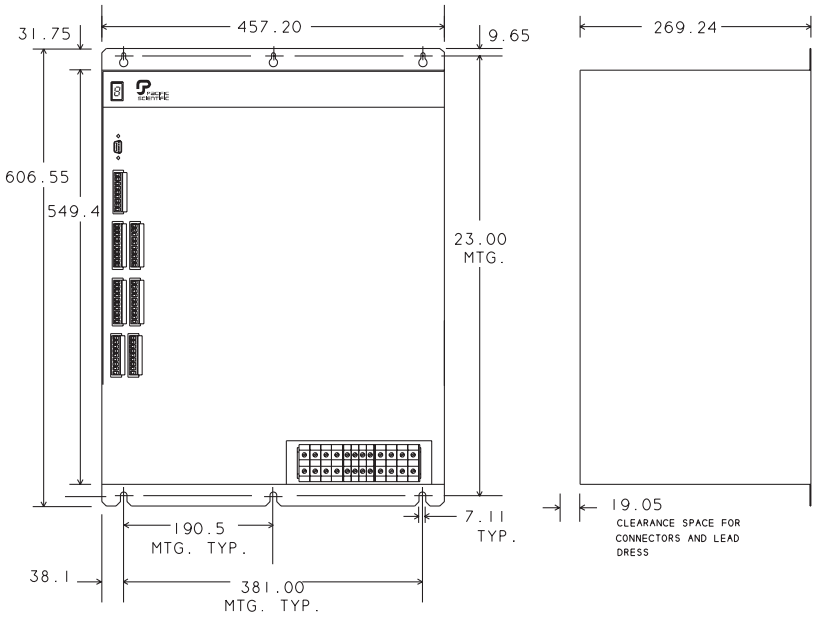


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SC756 mounting dimensions (in inches)



SC756 mounting dimensions (in millimeters)



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Mounting guidelines

The SC750 series controller is designed for installation in a cabinet. Your installation should meet the following guidelines:

- Vertical orientation for the controller
- Flat, solid surface capable of supporting the approximate weight of the units as follows:

Unit	Weight
SC752	13 lbs (5.9 kg)
SC753	16 lbs (7.26 kg)
SC754	40 lbs (18.16 kg)
SC755	40 lbs (18.16 kg)
SC756	90 lbs (40.86 kg)

- Free of excessive vibration or shock.
- On the SC752 and SC753 controllers, a minumum unobstructed space of 2 inches (5 cm) above and below the controller is required. Also, one inch (3 cm) clearance on each side of the controller should be provided. The controller is cooled by natural convection only.

  Note: *On the SC754, SC755 and SC756 the AC Switch (see Section 2.5.1.3) should be placed in the appropriate position before mounting the controller.*
- Minimum unobstructed space of 4 inches (10 cm) above and below the SC754, SC755, and SC756 controllers. These controllers are cooled by natural convection and built-in fans.
- Operating temperature of:
  - 0 to 50 degrees C at full rated output current.
  - 0 to 60 degrees C at 70% full rated output current. Derate linearly from 100% to 70% of full rating at 60 degrees C.

Mounting procedure

Bolt the unit to the cabinet using the mounting slots (refer to dimensions figure) with 1/4-20 (M6 metric equivalent) or # 10 bolts.

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Power dissipation

The SC750 series controller dissipates power that results in cabinet heating.

To estimate the power dissipation for use in calculating cabinet cooling requirements, use the values shown in the table. These numbers are approximate and do not include shunt regulator power (that is, regenerated power).

Output current % of rated continuous current	Power dissipation (watts)				
	SC752	SC753	SC754	SC755	SC756
0	10	10	15	15	15
25	15	20	39	69	130
50	23	35	68	135	270
75	32	54	109	218	435
100	45	77	150	300	600

2.5 SC750 Interfaces and Connections

Introduction

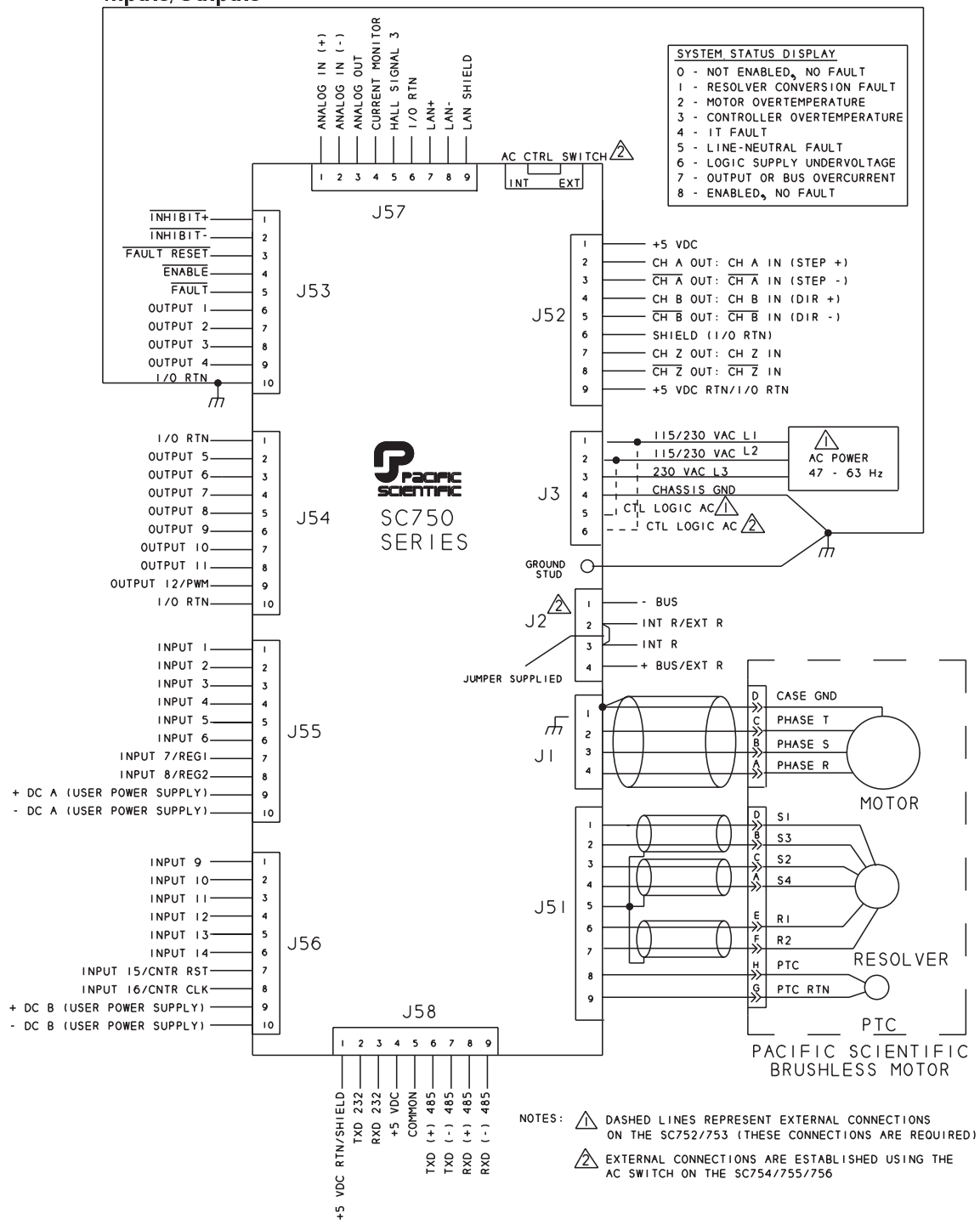
The eleven input/output connectors are:

- J1 - Motor windings
- J2 - External Shunt Regulator/Bus (Not on SC752 or SC753)
- J3 - 230 Volt AC Power
- J51 - Resolver and Overtemperature Sensor
- J52 - Encoder Input/Outputs
- J53 - Discrete Input/Output #3
- J54 - Discrete Input/Output #4
- J55 - Discrete Input/Output #1
- J56 - Discrete Input/Output #2
- J57 - Analog Input/Output
- J58 - Serial Interface Port

These inputs and outputs are shown on the following page.

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Inputs/Outputs



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2.5.1 J1 - J3 Motor, Power and Resolver Connections

Introduction

The J1 motor cable connects the controller to the motor windings.

The J2 shunt regulator connector is for use in providing additional continuous shunt regulator power capability.

The J3 230 V ac power cable connects voltage to the logic supply and the motor power supplies.

Note: *The J2 connector is located on the SC754, SC755, and SC756 units only.*

2.5.1.1 J1 Motor Connections

Introduction

The J1 motor cable connects the controller to the motor windings.

J1 - motor output table

Output	Pin	Explanation
Motor ground	J1-1	Ground for the motor case.
Motor phase T	J1-2	T output phase from controller.
Motor phase S	J1-3	S output phase from controller
Motor phase R	J1-4	R output phase from controller.

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Cable requirements

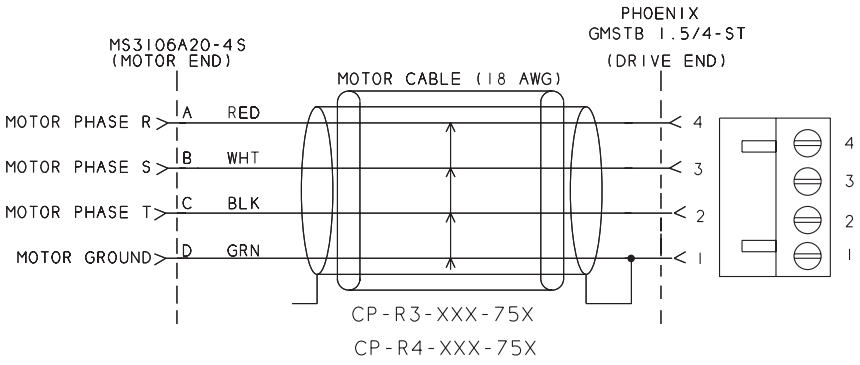
The recommended wire size shown in the table below is sufficient to handle the rated current of the drive. Wire sizes are in AWG.

Controller	Wire size range	Recommended wire size	
		Motor	Line
SC752	#18 to #14	#18	#18
SC753	#18 to #14	#18	#18
SC754	#18 to #8	#16	#16
SC755	#18 to #8	#10	#12
SC756	#16 to #6	#8 *	#10

* Use wire size #6 above 50A Continuous.

For **motor** cable, obtain cable with the four conductors twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter). As an option, the cable may be shielded to reduce radiated noise.

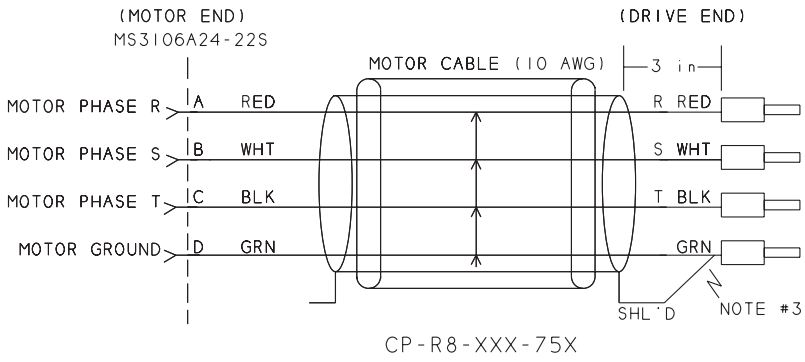
Wiring diagram - SC752/SC753



Note: *Insulate shield drain wire at motor end.*

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Wiring diagram - SC754/SC755



Note: *1. Insulate shield drain wire at motor end.*

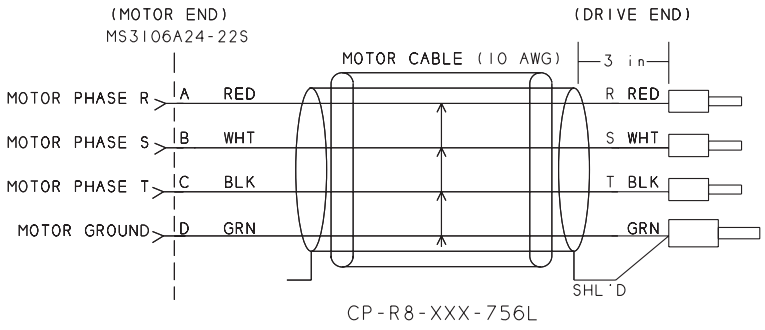
2. Drive end strip wire 15mm (.591 in)

3. Ferrules on wires at drive end.
RST wires black #10 ferrules.
Motor ground and shield tied before ferrules (#10 ferrule).

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Wiring diagram - SC756

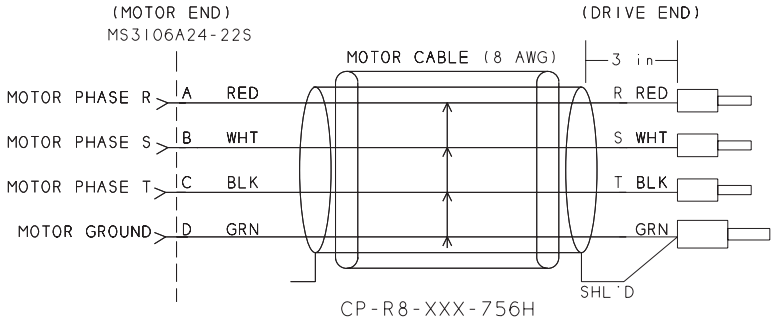
Light duty cable



Note:
1. *Insulate drain wire at motor end.*
2. *Drive end strip wire 15mm (.591 in).*
3. *Ferrules on wires at drive end.*
   R.S.T. wires black #10 ferrules.
   Motor ground and shield white # 8 ferrule.

Wiring diagram - SC756

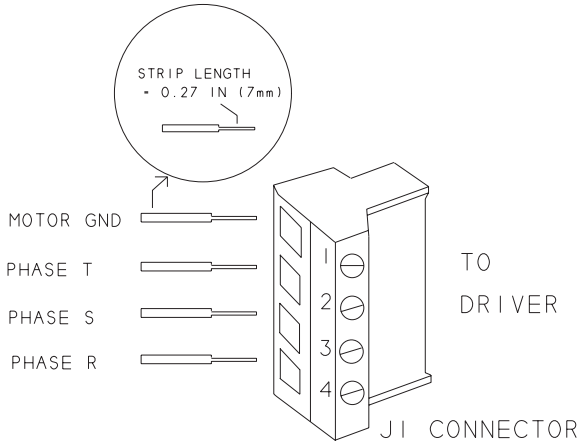
Heavy duty cable



Note:
1. *Insulate drain wire at motor end.*
2. *Drive end strip wire 15mm (.591 in).*
3. *Ferrules on wires at drive end.*
   R.S.T. wires black #10 ferrules.
   Motor ground and shield white # 8 ferrule.

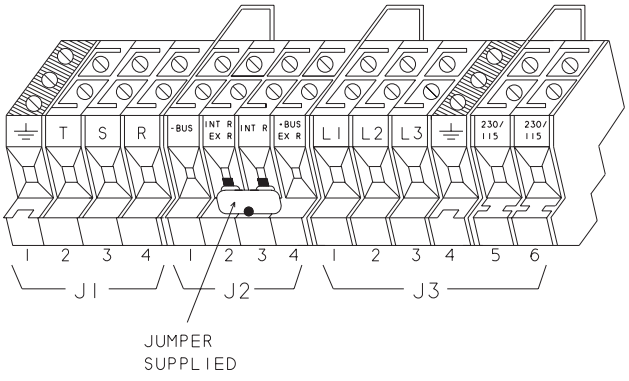
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Cabling diagram - J1 motor (SC752/753)



Note: *Mating connectors are used only on SC752 and SC753 model controllers. J1 and J2 are screw terminal for the SC754, SC755 and SC756 model controllers.*

Cabling diagram - J1 motor (SC754/755/756)



J1 CONNECTIONS	
1	GROUND
2	PHASE T
3	PHASE S
4	PHASE R

J2 CONNECTIONS	
1	-BUS
2	INT R/EXT R
3	INT R
4	+BUS/EXT R

J3 CONNECTIONS	
1	L1 (230 Vac)
2	L2 (230 Vac)
3	L3 (230 Vac)
4	GROUND
5	CTL LOGIC AC
6	CTL LOGIC AC

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Mating connectors

J1 motor - this output is for a Phoenix 4-pin screw mating connector. The connector is type GMSTB 1.5/4 ST 7.5 mm. The Phoenix order number is 1766903.

Note: *Mating connectors are used only on SC752 and SC753 model controllers. J1 and J2 are screw terminal for the SC754, SC755 and SC756 model controllers.*

Procedure

1. Attach the wires to the desired connector as indicated in the diagram.

Note: *Make sure the screws on the Phoenix connector are tightened down firmly on the wiring.*

Caution



Do not solder the tips of the cables before insertion into the connector. Solder can contract and cause a loose connection over time.

2. If connecting the motor cable, remove power from the SC750 series unit.

Warning



For motor terminal connection, disconnect the power cable before making or removing connections to the unit. The motor terminals have high voltage present when the SC750 series unit in On.

3. Plug the mating connector firmly into the SC750 series unit.

Warning



The motor case must be connected to earth ground. Failure to do this leaves the potential for severe shock hazard. Make sure the motor case is connected via J1-1 or that it connects to the ground stud on the lower mounting tab of the SC750 series unit. Ensure that J3-4 is also connected to earth ground.

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2.5.1.2 J2 Shunt Regulator

Introduction

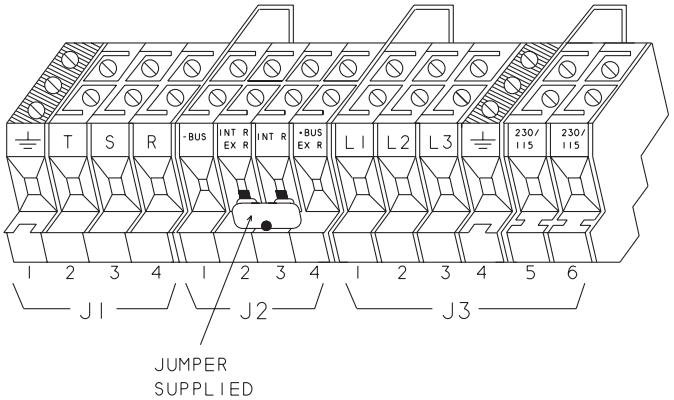
The J2 shunt regulator is enabled when the maximum bus voltage levels are exceeded.

Note: *The J2 connector is located on the SC754, SC755, and SC756 units only.*

J2 - Shunt regulator table

Input	Pin	Explanation
- Bus	J2-1	Negative 300 V dc bus
Int R/Ext R	J2-2	Shunt regulator transistor collector
Int R	J2-3	Internal shunt regulator resistor
+ Bus/Ext R	J2-4	Positive 300 V dc bus

Cable diagram - J2 shunt regulator



J1 CONNECTIONS	
1	GROUND
2	PHASE T
3	PHASE S
4	PHASE R

J2 CONNECTIONS	
1	-BUS
2	INT R/EXT R
3	INT R
4	+BUS/EXT R

J3 CONNECTIONS	
1	L1 (230 Vac)
2	L2 (230 Vac)
3	L3 (230 Vac)
4	GROUND
5	CTL LOGIC AC
6	CTL LOGIC AC

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External Regen Resistors

Introduction

To increase the continuous power dissipation of the shunt circuit, the internal drive shunt resistor is disabled and replaced with external resistors. The equivalent resistance of the external resistors must be as specified below:

Model	Equivalent Resistance
SC754, SC755	8 ohms ± 10%
SC756	4 ohms ± 10%

Configuration

A simple way to configure an external resistor array with correct resistance is shown in the table below:

Drive	Wire Size (AWG)	Resistance	PacSci Number
SC754/755	#12	8 ohm, 375W, rib, Milwaukee 18-168-8R	352-080000-00
SC756	#10	4 ohm, 550W, rib, Milwaukee 26-188-4R	352-040000-00

The resistors used within the drives, procured from Pacific Scientific, are wired in series/parallel in groups of 4, 9, or 16. (Refer to the diagram on the following page for circuitry.)

Note: *A fan can be used to further increase dissipation capability.*

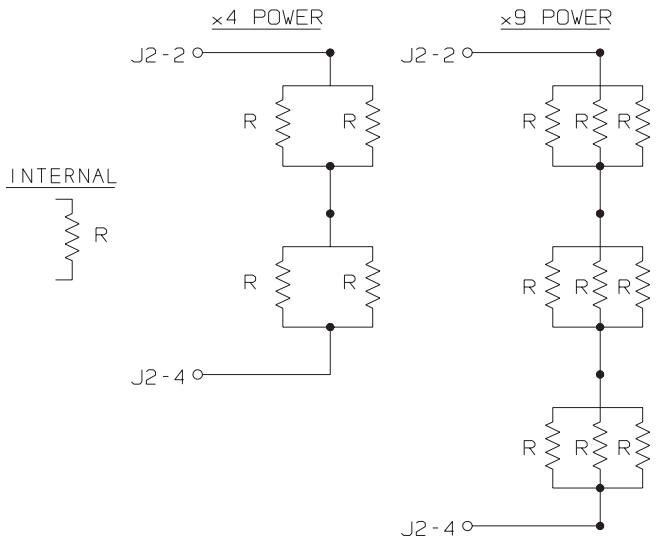


Warning

The resistors are connected to the drive bus voltage and must be shielded for safety.

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External regen wiring circuitry



Procedure

The following procedures outline the connection of the external regen resistors.

SC754/755/756

1. Remove jumper (supplied with drive) from between J2-2 and J2-3.
2. Wire external resistor array (using #12 or #10 wire) between the J2 pins marked “EXT R” (J2-2 and J2-4).

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2.5.1.3 J3 AC Power Cabling

Introduction

The J3 230 V ac power cable connects voltage to the logic supply and the motor power supplies.

J3 - 230 V ac power input table

Input	Pin	Explanation
115/230 V ac - line 1	J3-1	Fan AC power for motor supply.
115/230 V ac - line 2	J3-2	
230 V ac - line 3	J3-3	
Chassis ground	J3-4	Safety ground for controller.
Control voltage - 115/230 V ac	J3-5	Power for control circuits and fault logic (see AC switch).
Control voltage - 115/230 V ac	J3-6	

Note: *The control voltage for the SC750 controllers is input to a switching power supply. This input will accept voltages ranging from 115 to 230 Vac. These inputs are required on the SC752 and SC753 controllers. The SC754, SC755, and SC756 controller voltage can be switched from the motor supply input power using the AC switch. Having separate control and motor supply inputs permit controller electronics operation independent of high voltage motor power.*

AC switch

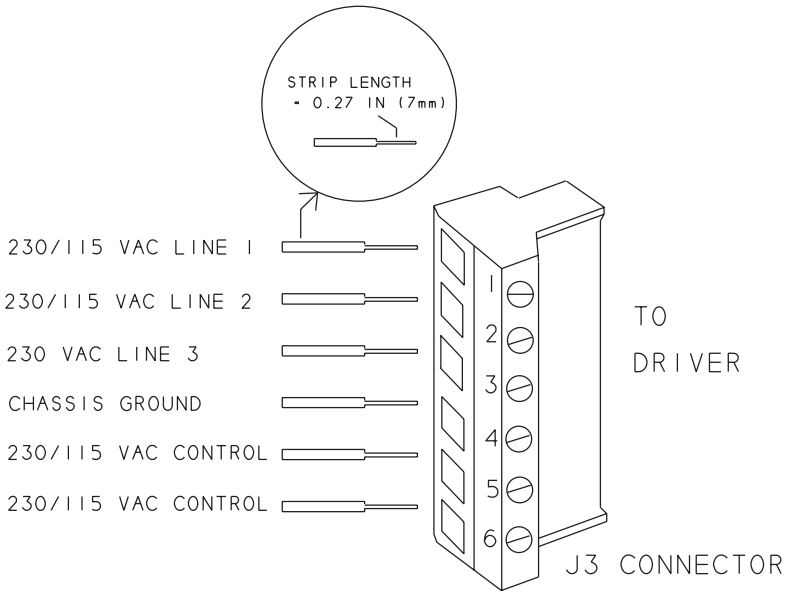
The AC switch applies to the SC754, SC755, and SC756 drivers only.

Note: *The switch is mounted on the right side of the drive.*

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Switch Position	Explanation
Ext	Control power from J3-5, J3-6
Int	Control power from J3-1, J3-2 (J3-5, J3-6 open)

Cable diagram - J3 V ac power (SC752/753)



Mating connectors

J3 230 V ac power - this input is for a Phoenix 6-pin screw terminal mating connector. The connector is type GMSTB 1.5/6ST 7.5 mm. The Phoenix order number is 1766929.

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2.5.1.4 J51 Resolver and Motor Temperature Connections

Introduction

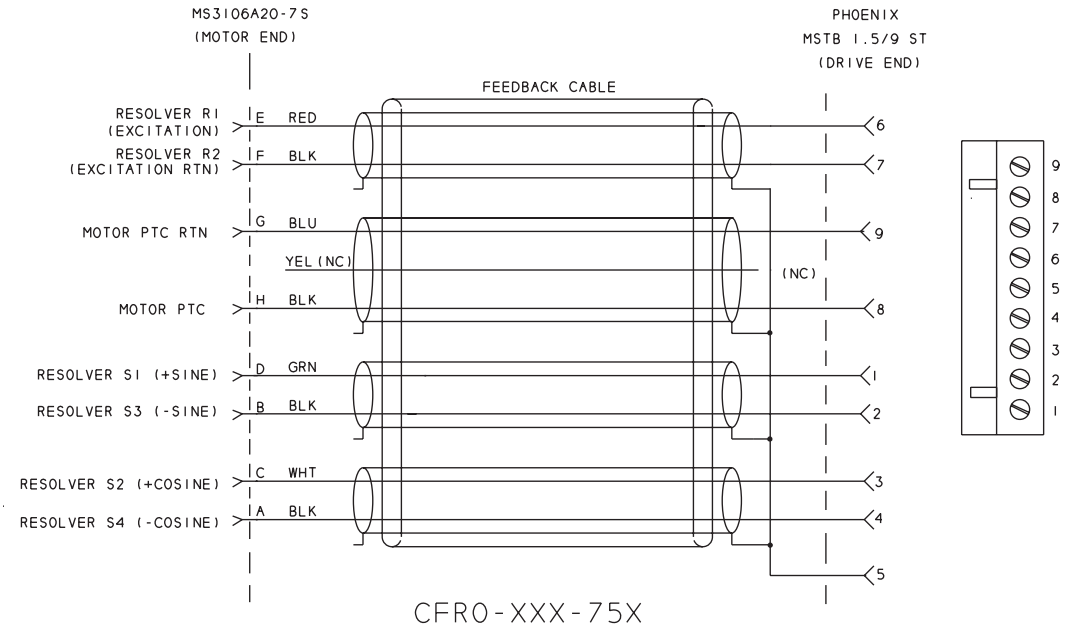
Resolver sine and cosine signals are processed to produce commutation, velocity, and position information. The PTC (positive temperature coefficient) thermistor input is also located here to provide thermal overload protection for the motor.

Input/output table

Input/Output	Pin Number	Explanation
Resolver S1+ sine (input) Resolver S3- sine (input)	J51-1, J51-2	Sine inputs (plus and minus) from resolver. These are differential inputs.
Resolver S2+ cosine (input) Resolver S4- cosine (input)	J51-3, J51-4	Cosine inputs (plus and minus) from resolver. These are differential inputs.
Shield ground	J51-5	Ground for resolver cable shield.
Resolver excitation and excitation return (output and ground)	J51-6, J51-7	Output drive for resolver excitation winding.
Motor PTC and PTC return (input and ground)	J51-8, J51-9	PTC temperature overload sensor.

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Wiring diagram



Notes: *1. Individually insulate shield drain wires at motor end.*
2. Individually insulate unused wires at motor end.
3. Individually insulate unused wires at drive end.

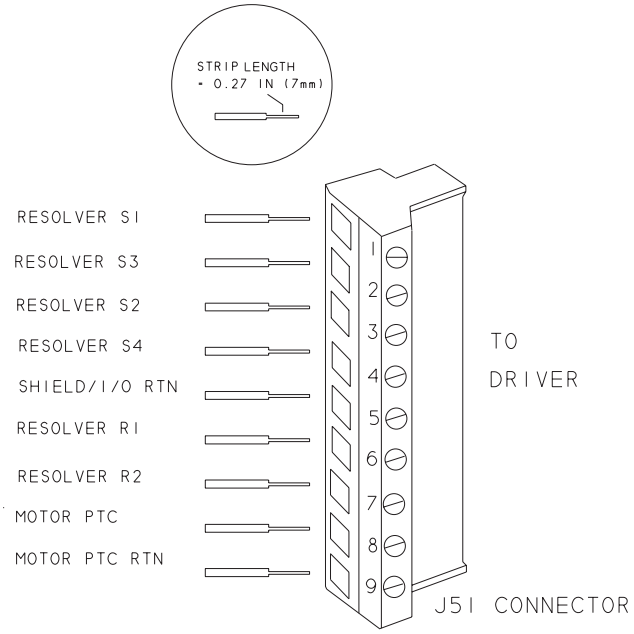
Mating connector

The J51 resolver cables are for a Phoenix 9-pin screw mating connector. The connector is type MSTB 1.5/9-ST 5 mm. The Phoenix order number is 1754588.

This connector is supplied with the drive.

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Cabling Diagram - J51 Resolver



Procedure notes

When building the resolver/PTC cable, make sure to follow these additional guidelines:



Caution

Ensure that the resolver signals are correctly oriented as shown. Incorrect orientation will lead to incorrect rotor position and/or incorrect commutation.

- Connect the resolver cable shield to J51-5. **Do not connect the resolver cable shields at the motor end.**

  For the **resolver cable**, obtain individually twisted-shielded cable for output pairs (refer to diagram, page 2-21) twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter).

  The cable must be shielded as shown in the diagram for proper operation and to reduce noise pickup.

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Procedure notes

- Connect the PTC and PTC return.

Note: *Tie the PTC and PTC return pins together if not using a PTC. The controller will not operate if these pins do not have inputs.*

2.5.2 J52 to J58 - User Interface Connections

Introduction

The seven input/output cables are:

- J52 - Encoder Input/Outputs
- J53 - Discrete Input/Output #3
- J54 - Discrete Input/Output #4
- J55 - Discrete Input/Output #1
- J56 - Discrete Input/Output #2
- J57 - Analog Input/Output
- J58 - Serial Interface Port

The cables and connectors are described in the following sections. Build the cables per the following procedure.

General cabling procedure

1. Refer to the following sections for connection information for the appropriate mating connector.
2. Use 22- to 14-gauge wire for the cabling.
3. Strip the wires to 0.27 inch (7 mm).
4. Attach the wires to the connector as indicated in the connector diagram.

Note: *Make sure the screws on the Phoenix connector are tightened down firmly on the wiring.*



Caution

Do not solder the tips of the cables before insertion into the connector. Solder can contract and cause a loose connection over time.

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Warning

The chassis ground must be tied to earth ground. Failure to do this leaves the potential for severe hazard. Make sure the ground is connected via the ground stud on the front of the SC750 controller.

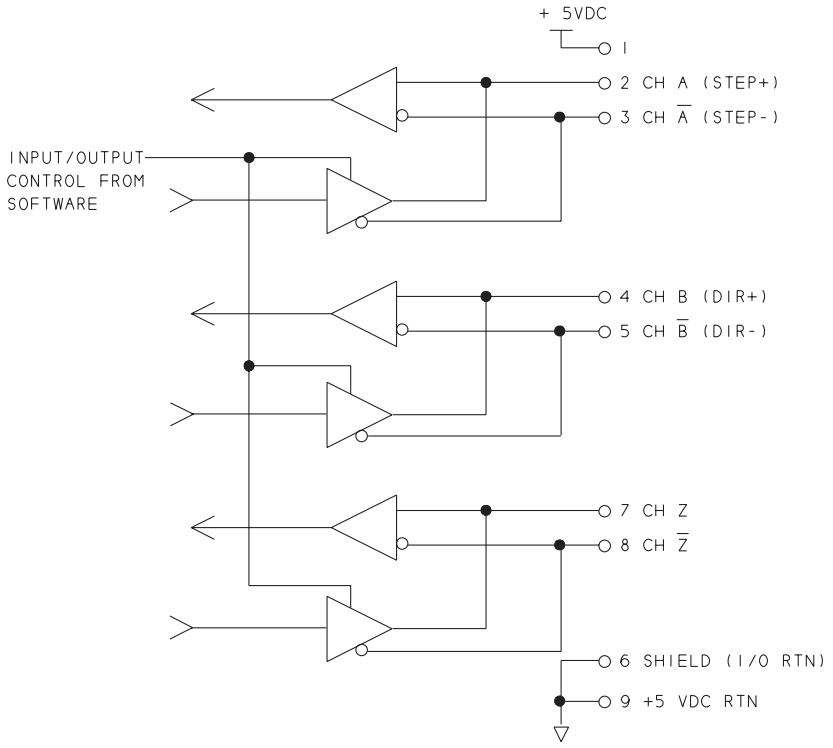
5. Plug the connector firmly into the SC750 controller.

2.5.2.1 J52 Encoder I/O Connections

Introduction

Encoder input and output signals are connected with the J52 connector. The encoder interface is configured either as an input or as an output (emulator) under software control.

Functional circuit diagram



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Input/Output table The following table lists the inputs/outputs on connector J52:

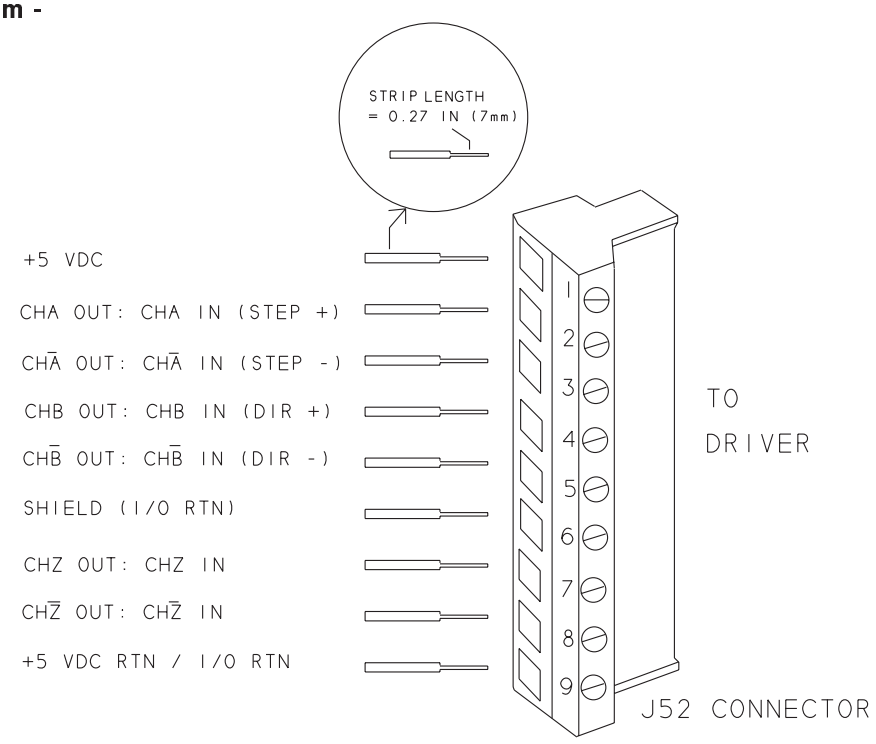
Input/Output	Pin Number	Explanation
+ 5 volts dc	J52-1	5 volt dc 250 milliampere power source for encoder electronics.
CH A (STEP+), CH $\overline{A}$ (STEP-)	J52-2, J52-3	Differential, quadrature, TTL encoder input (receiver) or emulation (transmitter) signals. Input or emulation operation is defined under software control. Defaults to input. When configured as an output, signals are indefinitely short circuit to ground proof. These signals can also be configured under software control for step and direction inputs to interface to a stepper controller's indexer.
CH B (DIR+), CH $\overline{B}$ (DIR-)	J52-4, J52-5	
Shield (I/O RTN)	J52-6	Common — Input (receiver) mode: The shield must be tied to signal common of encoder signal transmitter end only.
		Output (Transmitter) mode - Cable shield should be connected to signal ground at encoder signal transmitter only.

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Input/Output table

Input/Output	Pin Number	Explanation
Channel Z and $\overline{Z}$	J52-7, J52-8	Differential TTL marker pulse input (receiver) or output (transmitter) signals. Input or output operation defined under software control. Defaults to input. When configured as an output, a single pulse is generated per each revolution of the motor shaft. When configured as an output, signals are indefinitely short circuit to ground proof.
I/O RTN	J52-9	Common — must be connected to the common of the encoder input source or receiver electronics.

Cabling diagram - J52 Encoder



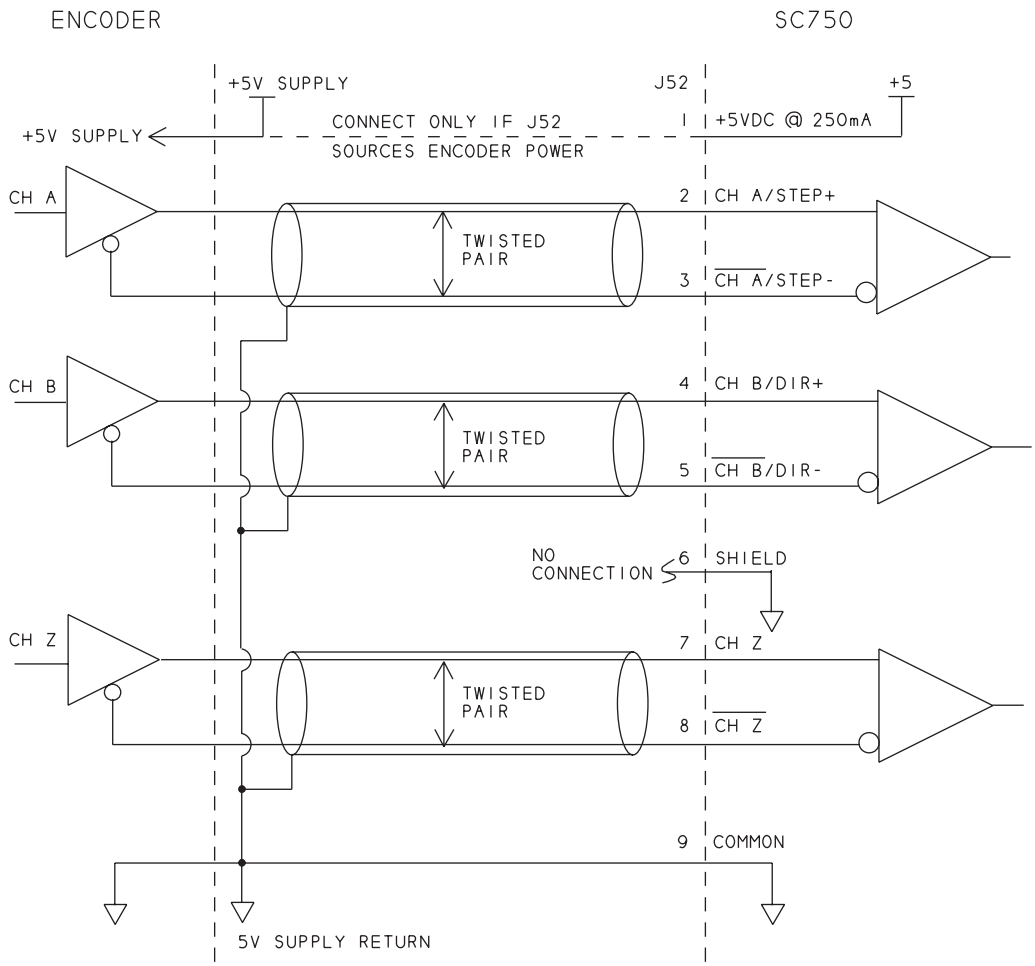
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Interfacing external encoders

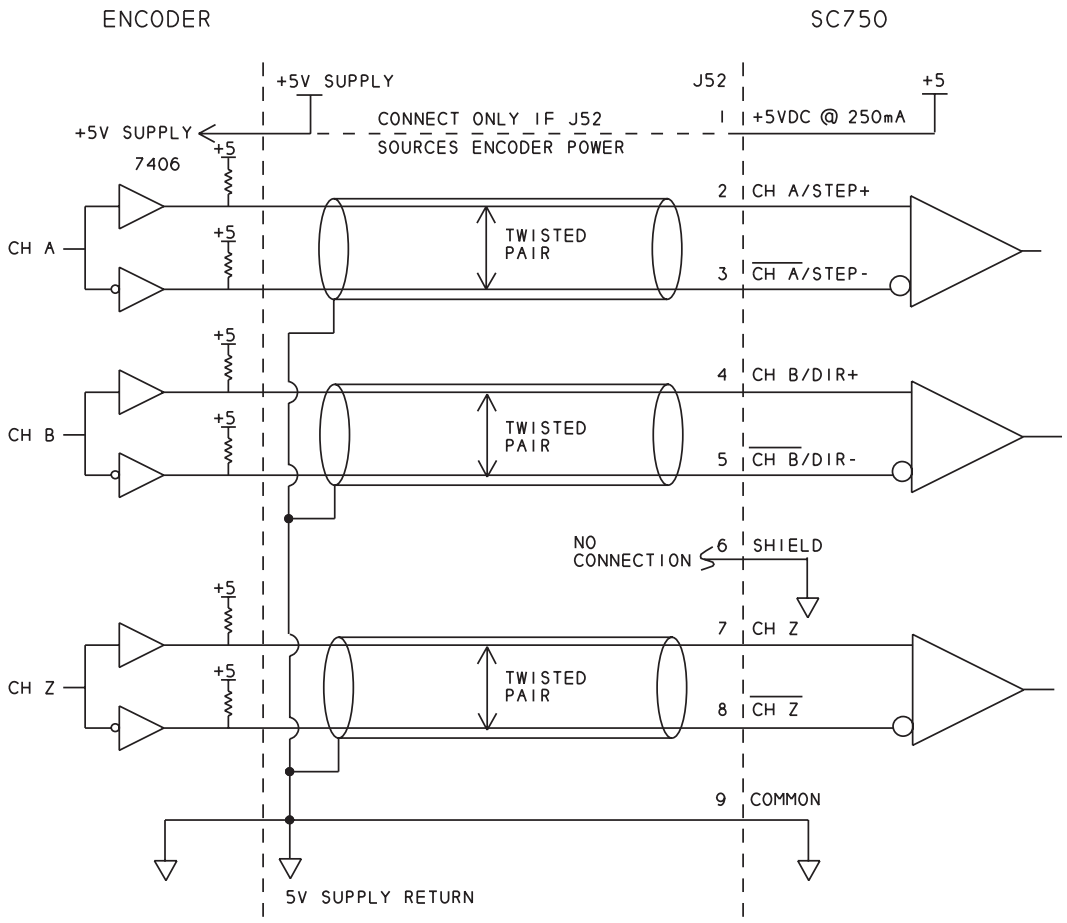
To interface an external encoder input to the SC750 encoder port, refer to the following diagrams.

Using TTL differential line drivers

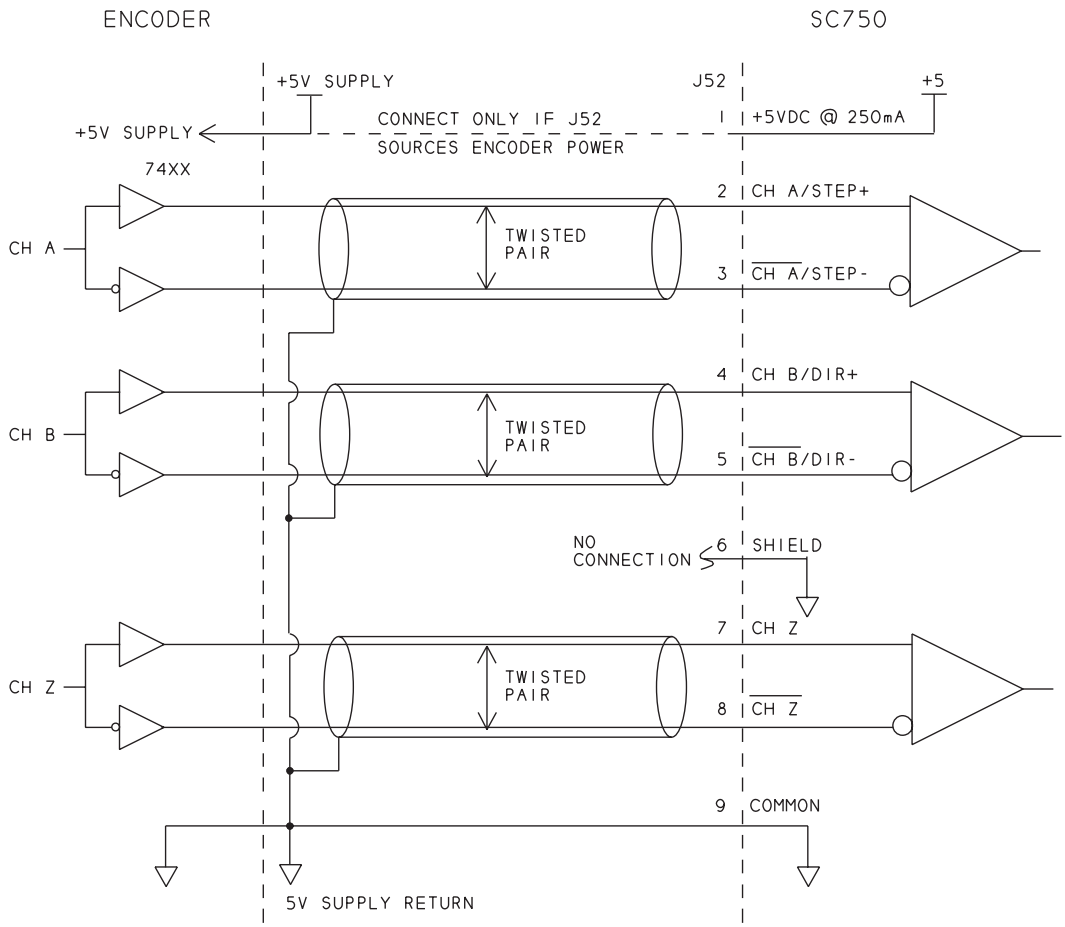
To interface for encoder outputs using TTL differential line drivers, wire as follows:



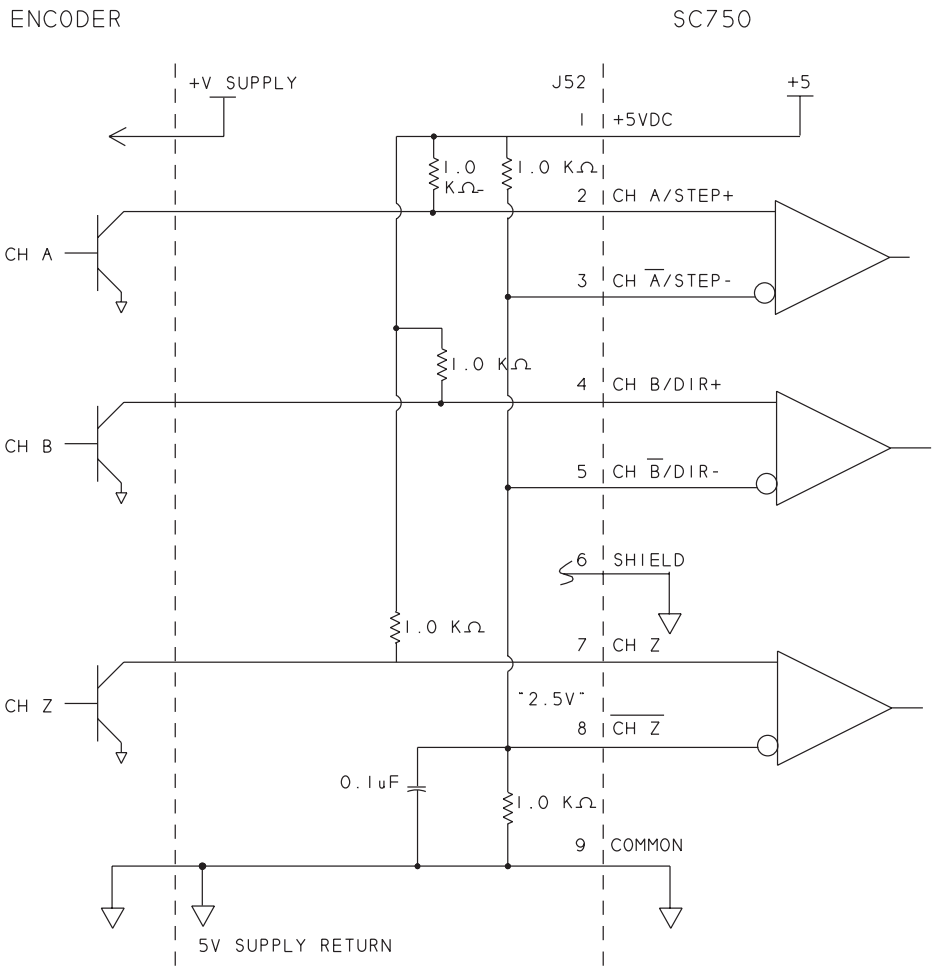
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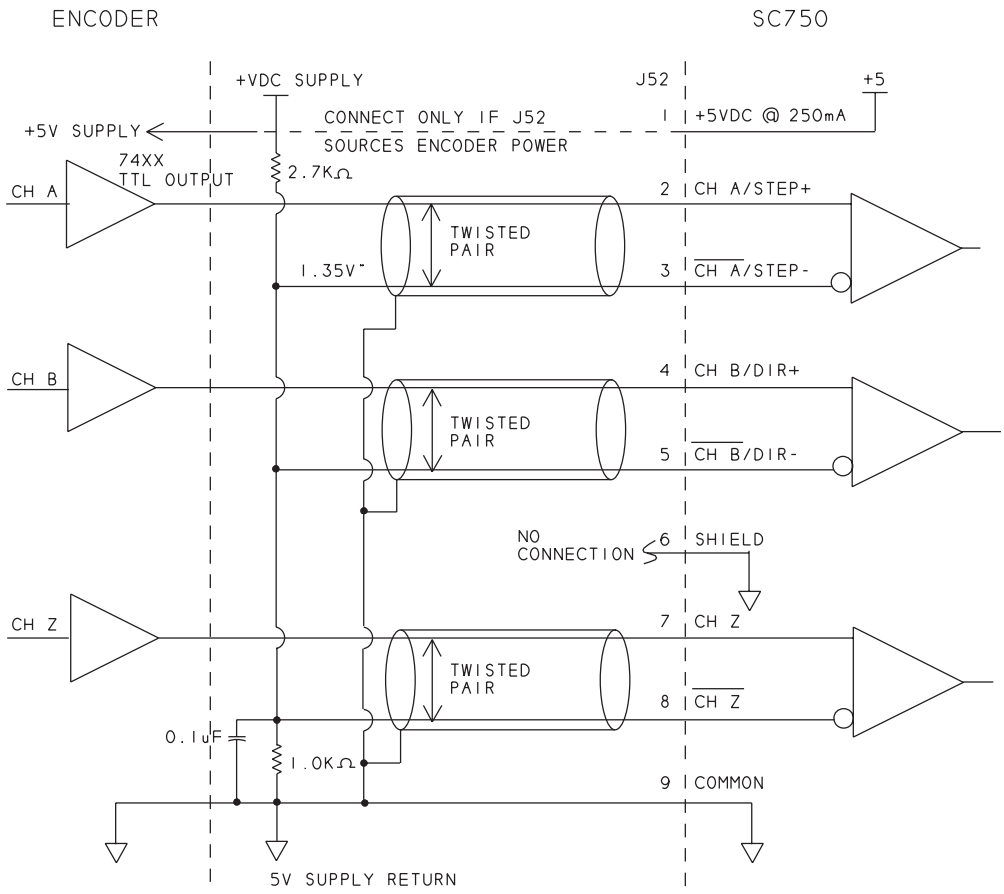
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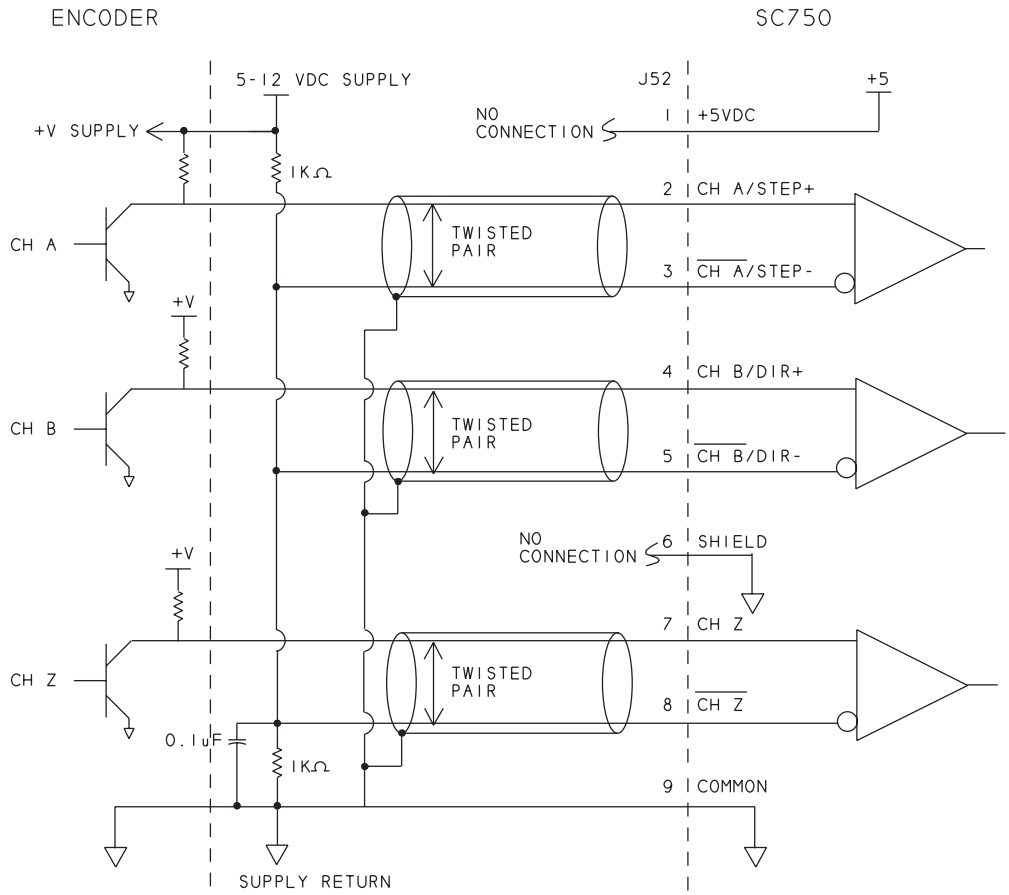
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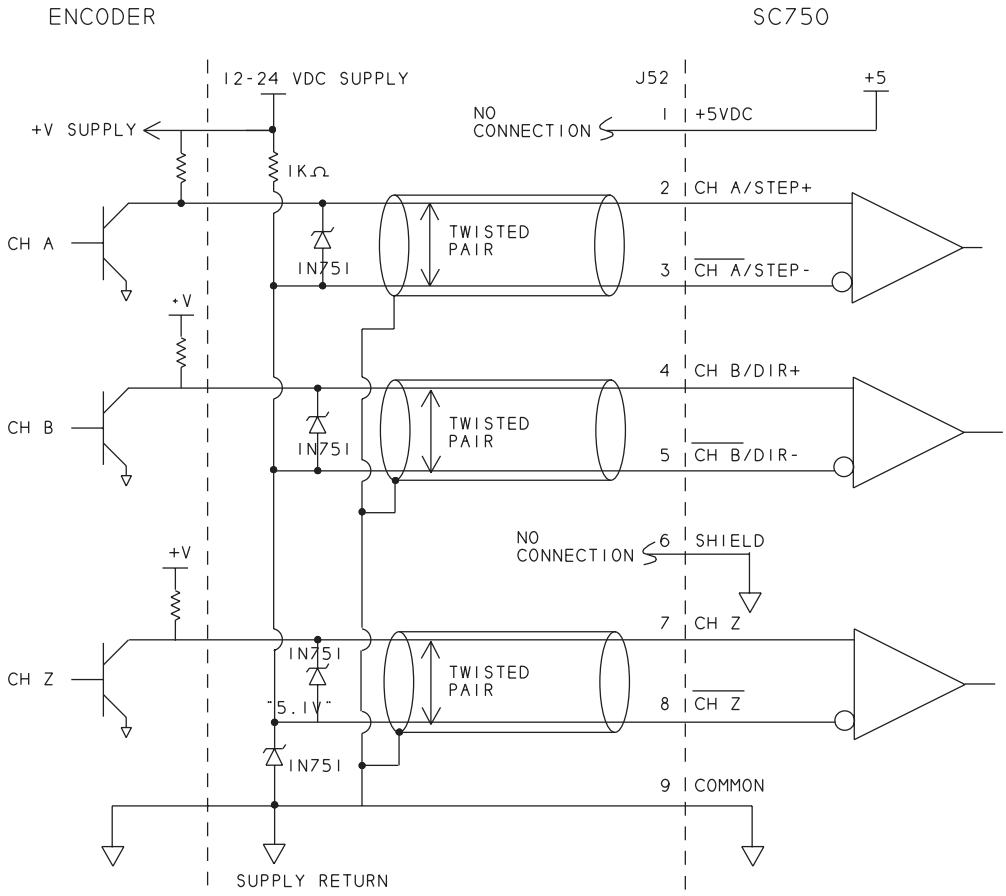
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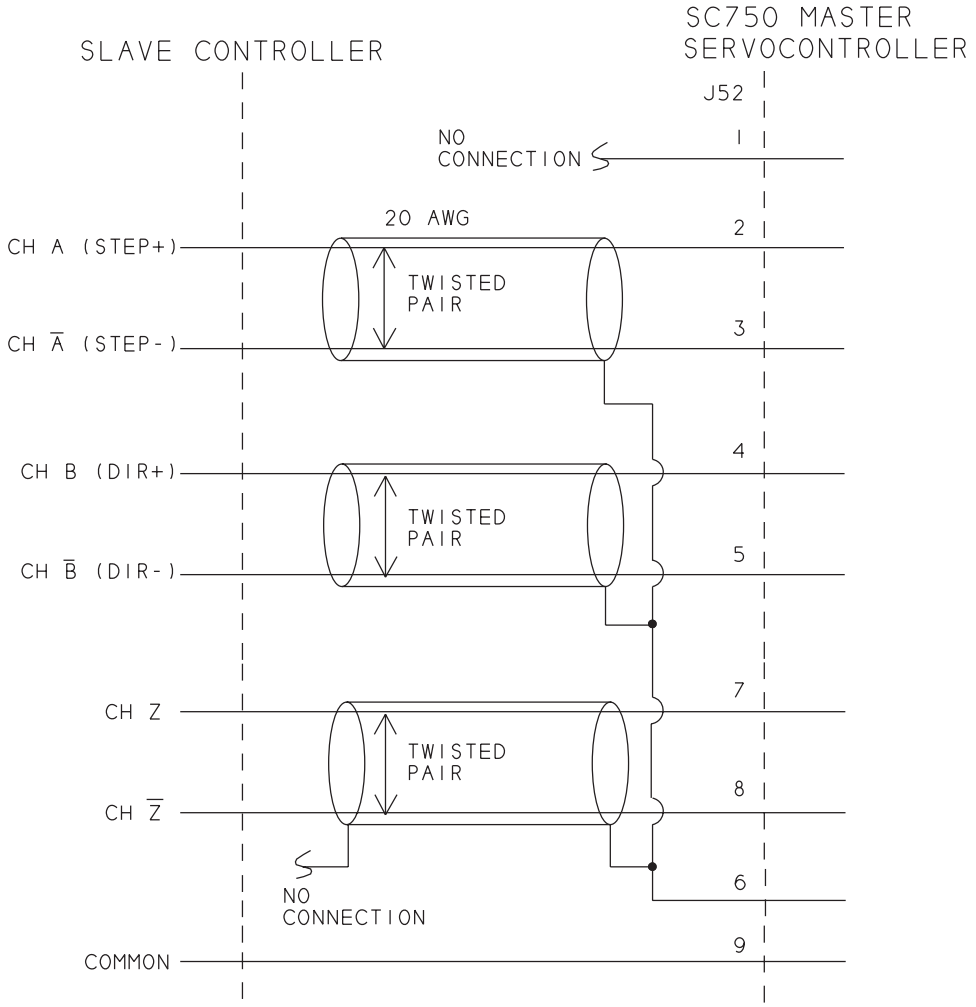
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Mating connector

The J52 encoder cables are for a Phoenix 9-pin screw mating connector. The connector is type MSTB 1.5/9-ST 5 mm. The Phoenix order number is 1754588.

This connector is supplied with the drive.

2.5.2.2 J53 and J54 Discrete Output Connections

Introduction

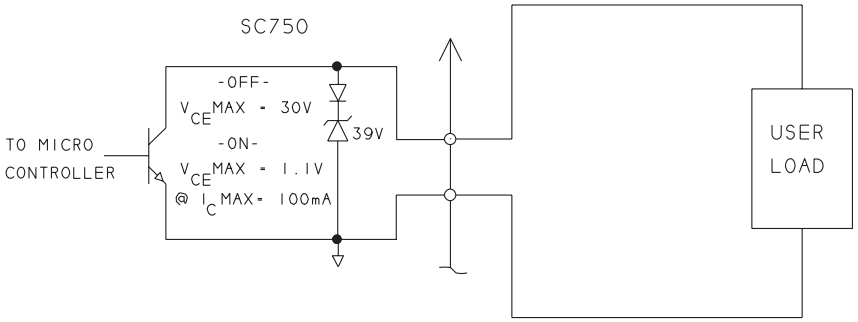
The SC750 series controllers provide discrete output signals controlled by the user through software, in addition to a dedicated summary fault output. Each output channel utilizes an open collector type transistor capable of 100 milliamperes current sink, in the ON state.

Output 12 provides a dual function output/PWM signal. This function is accessible by the user under software control. This channel provides twice the current sink capability (200 milliamperes) of a standard output. When used as a PWM signal, the output is configured as a variable duty cycle with a fixed frequency of 11.8 kilohertz.

Output circuit connections

Refer to the diagram below for a general circuit diagram. The discrete output diagrams (on page 2-32) illustrate specific discrete output circuit examples.

General output circuit



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J53 discrete output signals

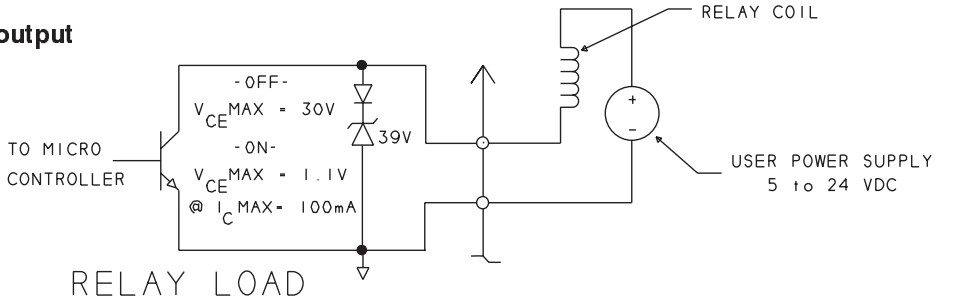
Output	Pin Number	Explanation
Fault	J53-5	Summary fault output (output low if fault detected).
Output 1	J53-6	General purpose output.
Output 2	J53-7	General purpose output.
Output 3	J53-8	General purpose output.
Output 4	J53-9	General purpose output.
I/O Return	J53-10	Output circuit common.

J54 discrete output signals

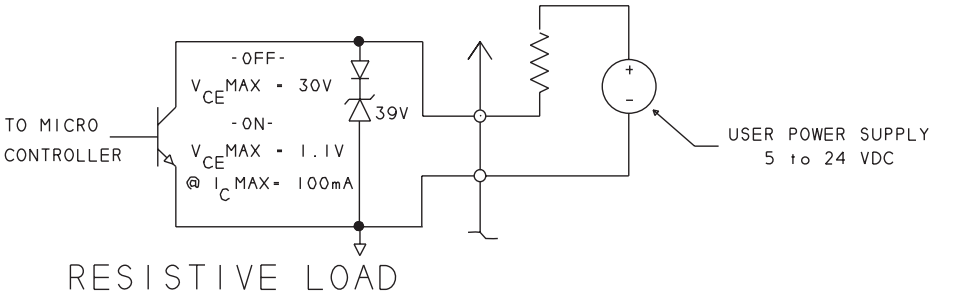
Output	Pin Number	Explanation
I/O Return	J54-1	Output circuit common.
Output 5	J54-2	General purpose output.
Output 6	J54-3	General purpose output.
Output 7	J54-4	General purpose output.
Output 8	J54-5	General purpose output.
Output 9	J54-6	General purpose output.
Output 10	J54-7	General purpose output.
Output 11	J54-8	General purpose output.
Output 12/PWM	J54-9	General purpose output/PWM signal output.
I/O Return	J54-10	Output circuit common.

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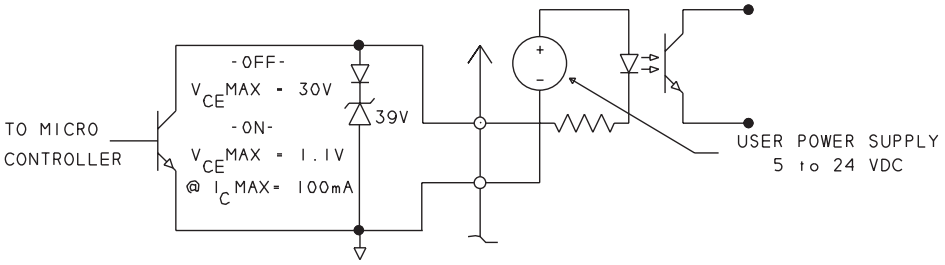
Discrete output diagrams



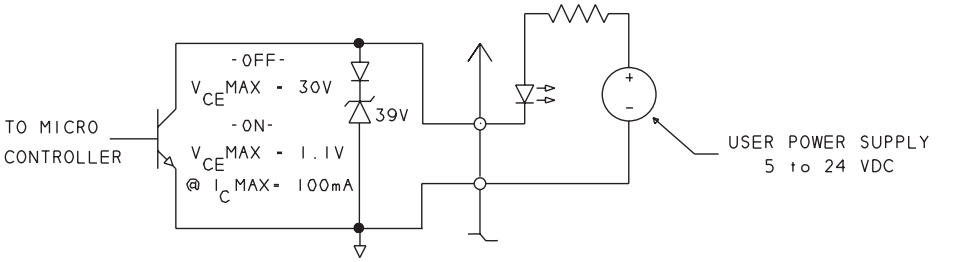
RELAY LOAD



RESISTIVE LOAD



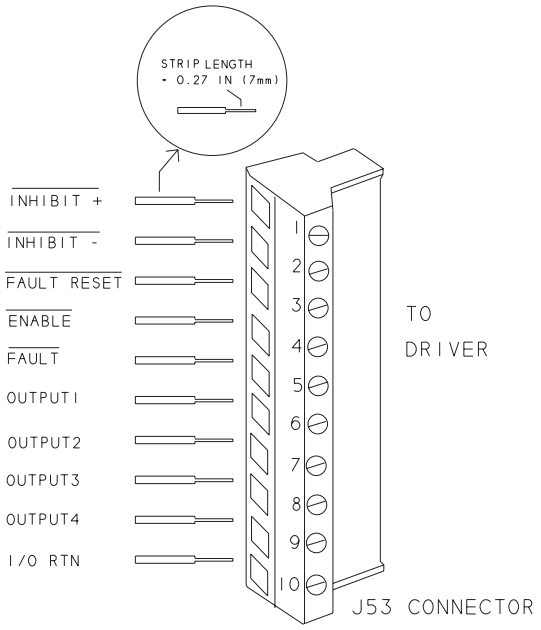
OPTO-ISOLATOR LOAD



LED INDICATOR

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Cabling diagram - J53 discrete I/O



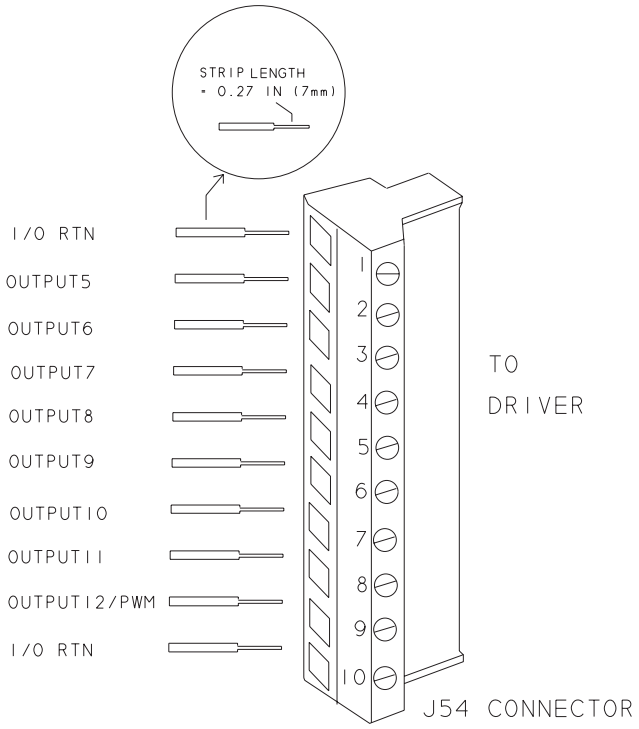
Mating connector

The J53 command cables are for a Phoenix 10-pin screw mating connector. The connector is type MSTB 1.5/10-ST 5mm. The Phoenix order number is 1754601.

This connector is supplied with the drive.

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Cabling diagram - J54 discrete I/O



Mating connector

The J54 command cables are for a Phoenix 10-pin screw mating connector. The connector is type MSTB 1.5/10-ST 5mm. The Phoenix order number is 1754601.

This connector is supplied with the drive.

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2.5.2.3 J53, J55 and J56 Discrete Input Connections

Introduction

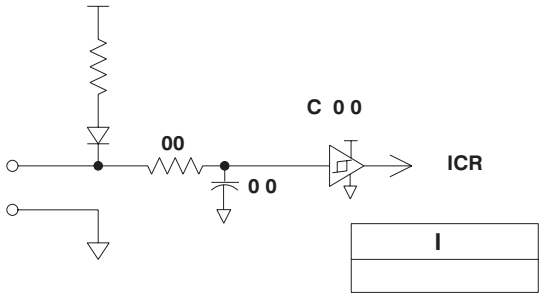
The SC750 has two basic types of discrete input circuitry:

- Dedicated control circuits - enable, fault, inhibits
- General purpose programmable circuits - input1 -input16

Dedicated control inputs

The J53 connection has four dedicated input circuits that provide control functions to the SC750. These input circuits are shown in the dedicated input functional diagram below.

Simplified functional diagram - dedicated inputs



General purpose inputs

The J55 and J56 connectors have sixteen general purpose optically isolated input channels.

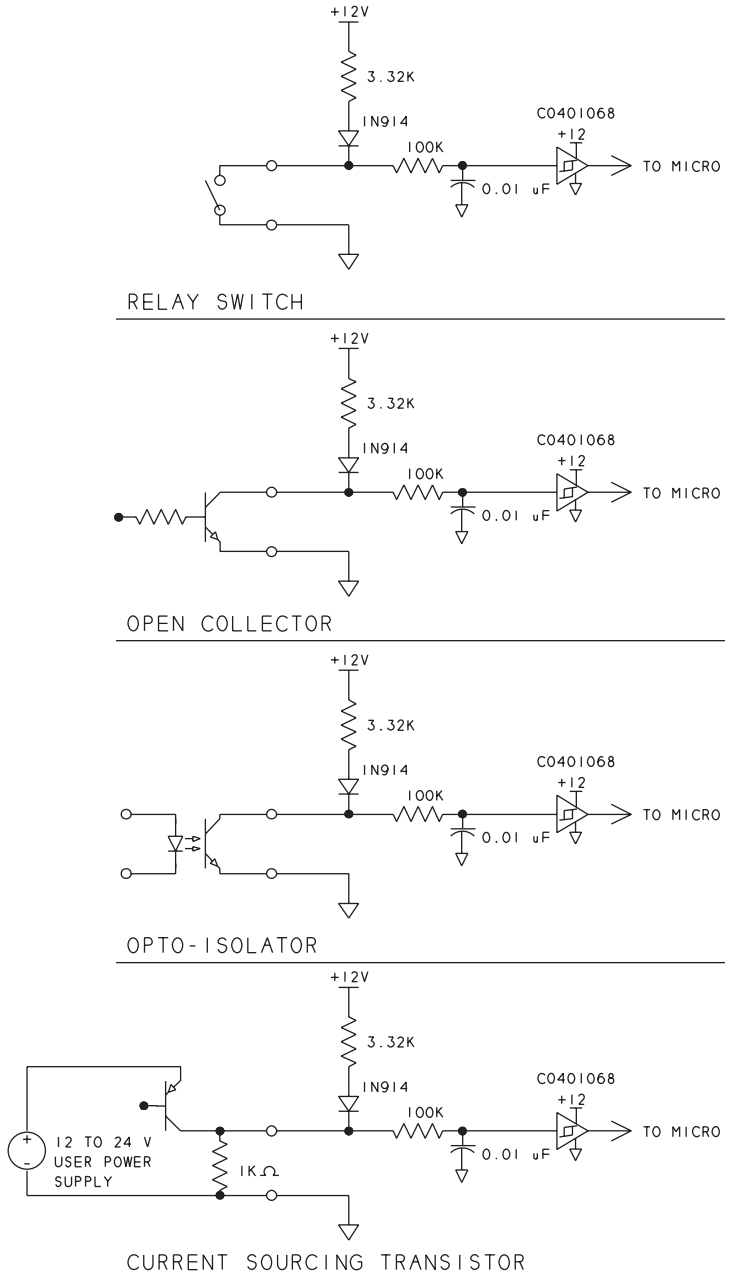
- J55 contains one bank of eight input channels (Input 1 through Input 8).
- J56 contains a separate electrically isolated bank of eight input channels (Input 9 through Input 16). Each bank requires a user supplied power source of 5 to 24 VDC rated at 50 mA.

The figures on the following page illustrate simplified circuit diagrams for each optically isolated input. The input circuit is intended for use with a current sinking driver. The input circuit consists of constant current source, current detector and noise reduction filter, comparator with hysteresis and opto-isolator. Operation of the input circuit requires the external driver to provide a current sink capability exceeding 4 milliamperes.

Note: *Additional information regarding the input circuit details can be found in Appendix E.*

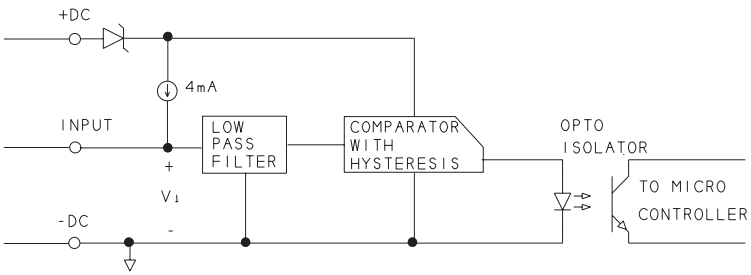
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J53 - Common input circuit dedicated control configuration



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Simplified functional diagram - General purpose inputs



Logic static Input voltage (Vi) trip points

	V_{DC}		
	24 Volt	**12 Volt**	**5.0 Volt**
V_{T-}	15.1V/63%	6.5V/54%	1.65V/33%
V_{T+}	16.6V/69%	7.9V/66%	2.95V/59%

Fast inputs

Input 7 and Input 8 provide alternate functions as fast inputs and general purpose inputs. Fast inputs provide minimal response time and are directly input to the microcontroller to trigger (as defined by user software) interrupt service routines. Fast inputs also support registration functions, permitting hardware latching of the resolver and encoder positions.

Counters

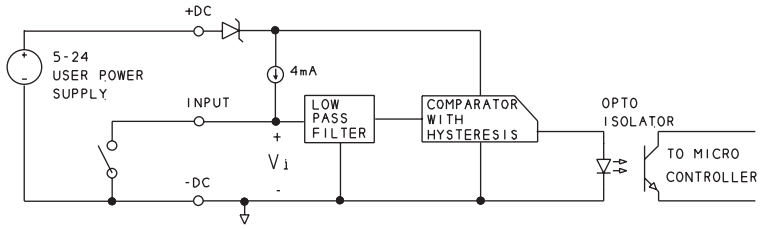
Input 15 and Input 16 perform alternate functions as user accessible event counters (resident on the microcontroller) and general purpose inputs. In the counter mode, Input 15 is used to issue a hardware reset to the counter. Input 16 is the counter's clock input, incrementing the counter once for each cycle of the input clock frequency.

The maximum clock counter input frequency is 10 KHz.

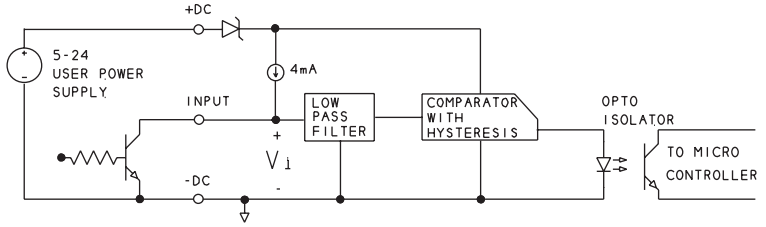
The figures on the following pages demonstrate common input circuits used with the SC750. If a current sourcing input is used, a pull-down resistor will be required.

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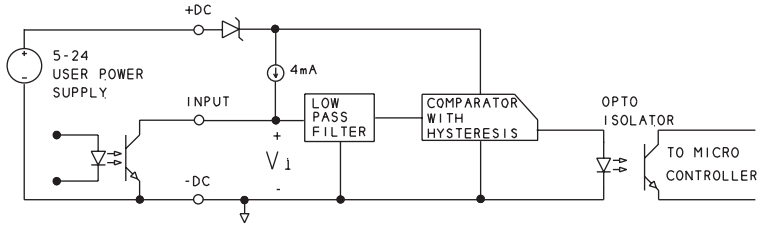
J55, J56 -common general purpose programmable input circuit configurations



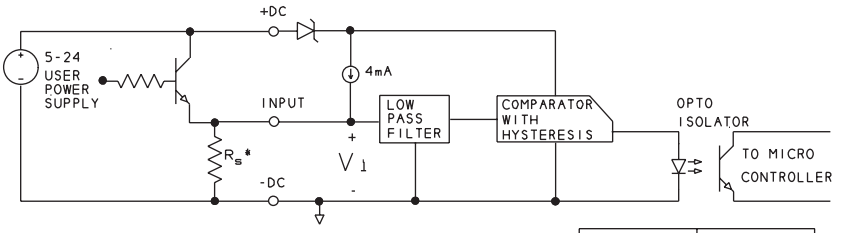
SWITCH/RELAY CONTACT



OPEN COLLECTOR



OPTO-ISOLATOR



SOURCING TRANSISTOR

USER SUPPLY	R_S
24V	2.7KΩ 1/2W
12V	1.0KΩ 1/4W
5V	330 Ω 1/4W

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J53 dedicated control input signals

Input	Pin Number	Explanation
Inhibit +	J53-1	Selects directional dynamic braking mode. If moving in the positive direction, will decelerate motor to zero velocity then disable positive torque. Will still permit operation in the negative direction. Useful for overtravel limit switch applications.
Inhibit -	J53-2	Selects directional dynamic braking mode. If moving in the negative direction, will decelerate motor to zero velocity then disable negative torque. Will still permit operation in the positive direction. Useful for overtravel limit switch applications.
Fault reset	J53-3	Resets the controller after a fault has occurred. Controller disabled when reset is applied.
Enable	J53-4	Controller enable. Must be applied to permit motor operation.
I/O Return	J53-10	Control input circuit common.

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J55 General purpose inputs - Bank A

Input	Pin Number	Explanation
Input 1	J55-1	General purpose input.
Input 2	J55-2	General purpose input.
Input 3	J55-3	General purpose input.
Input 4	J55-4	General purpose input.
Input 5	J55-5	General purpose input.
Input 6	J55-6	General purpose input.
Input 7/Reg 1	J55-7	General purpose input & fast input.
Input 8/Reg 2	J55-8	General purpose input & fast input.
+ DC A	J55-9	5 to 24 V dc @ 50 mA user source power for inputs 1 thorugh 8.
- DC A	J55-10	Return for inputs 1 through 8. Power Supply Common.

J56 General purpose inputs - Bank B

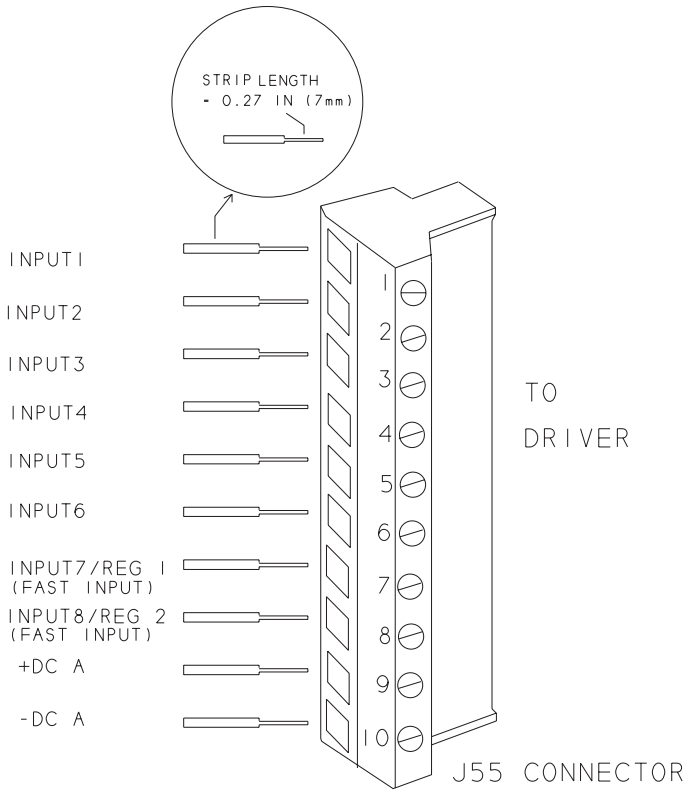
Input	Pin Number	Explanation
Input 9	J56-1	General purpose input.
Input 10	J56-2	General purpose input.
Input 11	J56-3	General purpose input.
Input 12	J56-4	General purpose input.
Input 13	J56-5	General purpose input.
Input 14	J56-6	General purpose input.
Input 15/Cntr RST	J56-7	General purpose input/counter reset.

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J56 General purpose inputs - Bank B

Input	Pin Number	Explanation
Input 16/Cntr CLK	J56-8	General purpose input/counter clock.
+ DC B	J56-9	5 to 24 V dc @ 50 mA user source power for inputs 9 through 16.
- DC B	J56-10	Return for inputs 9 through 16, Power Supply Common.

Cabling diagram - J55 discrete I/O



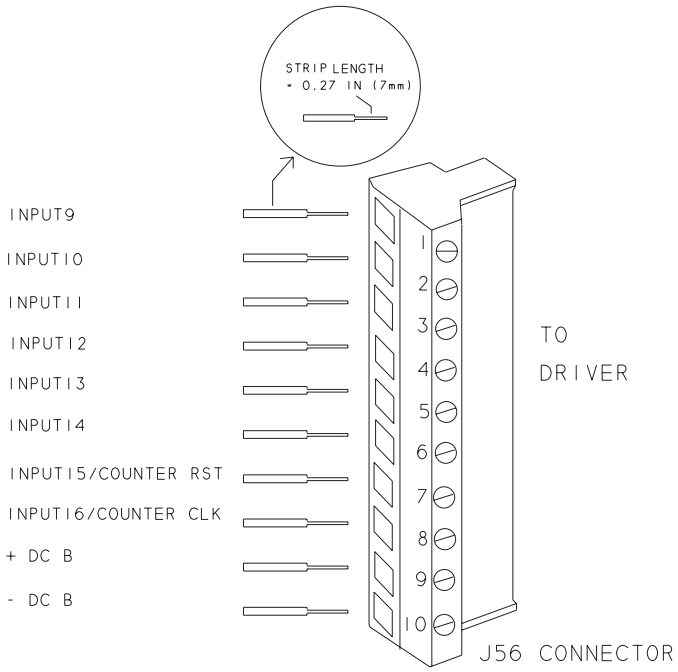
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Mating connector

The J55 command cables are for a Phoenix 10-pin screw mating connector. The connector is type MSTB 1.5/10-ST 5mm. The Phoenix order number is 1754601.

This connector is supplied with the drive.

Cabling diagram - J56 discrete I/O



Mating connector

The J56 command cables are for a Phoenix 10-pin screw mating connector. The connector is type MSTB 1.5/10-ST 5mm. The Phoenix order number is 1754601.

This connector is supplied with the drive.

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2.5.2.4 J57 Analog I/O Connections

Introduction

The SC750 features an analog input channel and an analog output channel. The analog input channel is digitized and is available to the user under software control. The analog output is controlled by a digital-to-analog converter, also set by the user's program.

The analog input channel signal accepts signals with a ±12 volt range with a differential input amplifier having 100 kilohms input impedance. The analog output channel provides a signal range of ±5 volts, with 50 ohms source impedance.

Analog input/output table - J57

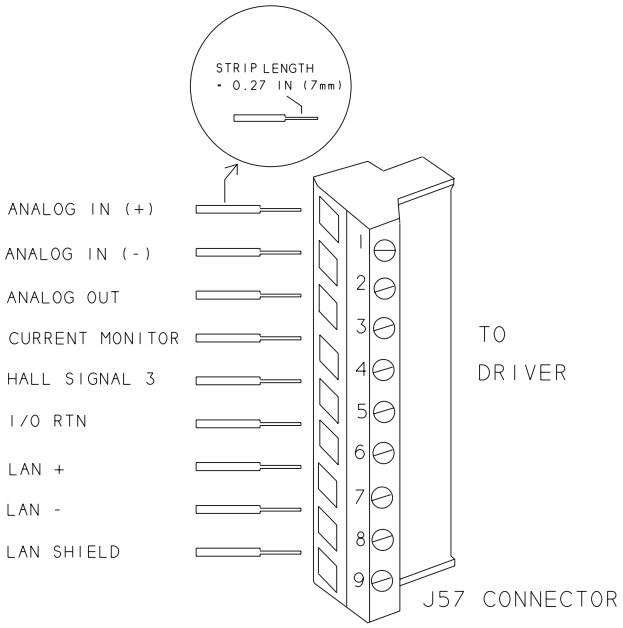
Input/Output	Pin Number	Explanation
Analog in (+)	J57-1	±12 volt analog input.
Analog in (-)	J57-2	±12 volt analog input.
Analog out	J57-3	±5 volt analog output.
Current monitor	J57-4	Output voltage proportional to peak measured motor current (shaft torque). Monitor Scale Factor SC752 0.56 V/A SC753 0.28 V/A SC754 0.14 V/A SC755 0.070 V/A SC756 0.036 V/A
Hall Signal 3	J57-5	TTL level digital motor commutation signal. At constant shaft speed, this signal is a square wave at the motor electrical frequency (60 Hz at 1800 RPM 4-pole R series motor, 120 Hz at 1800 RPM 8-pole F series motor).

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Analog input/output table - J57

Input/Output	Pin Number	Explanation
I/O Return	J57-6	Common.
LAN +	J57-7	PacLAN Blue
LAN -	J57-8	PacLAN White
LAN shield	J57-9	PacLAN Shield

Cabling diagram - J57 analog I/O



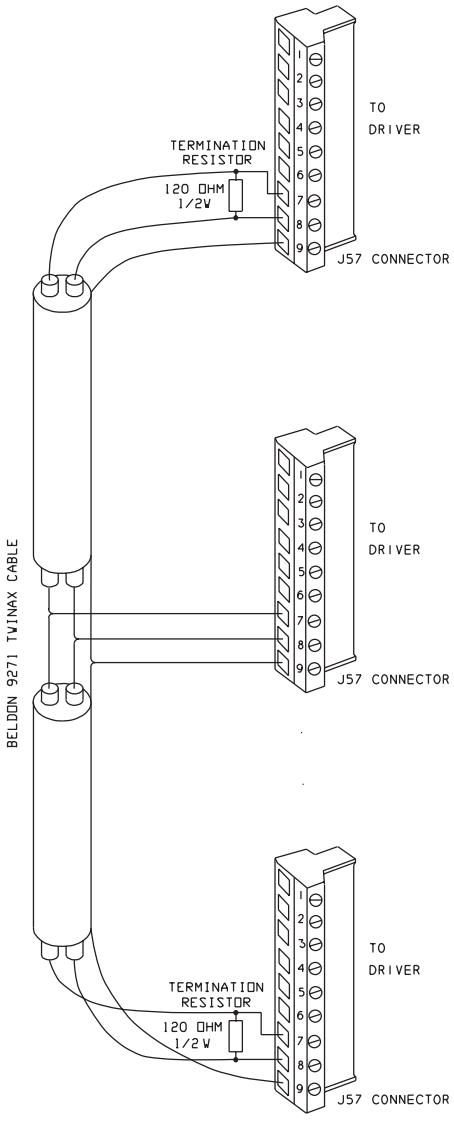
Mating connector

The J57 analog input/output cables are for a Phoenix 9-pin screw mating connector. The connector is type MSTB 1.5/9-ST 5mm. The Phoenix order number is 1754588.

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PacLAN Cabling & hardware connections

The electrical connections of the PacLAN interface between SC750 servocontrollers is illustrated in the diagram below.



LAN CABLING DIAGRAM

Cabling for the PacLAN interface must conform to the cabling specifications met by twinaxial transmission cable manufactured by Belden. The Belden part number is 9271. This cable is also available from Pacific Scientific. The Pacific Scientific part number is CL-CO-xxx, where xxx is the desired cable length.

The most distant trunks of the cable should each be terminated in 120 ohm, 1/2 watt termination resistors. These resistors can be inserted into the screw terminal connectors after the cable has been soldered on.

Note: *PacLAN operation will be supported only if the proper communications cabling is used.*

PacLAN permits direct connection of up to 32 SC750 servocontrollers. The total cable length must be limited as indicated in the table. To acheive longer cable lengths, or to connect more than 32 controllers, ARCNET compatible active hubs must be used. These devices are capable of transmission lengths of up to 2000 feet. Active hubs are available from SMC, Contempory Control Systems, Inc., and Black Box Corporation.

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LAN Cabling

Maximum PacLAN Cabling Lengths	
Number of PacLAN Nodes	**Maximum Cable Length (Feet)**
2	475
3	462
4	450
5	437
6	427
7	412
8	400
9	387
10	375
12	350
15	312
20	250
25	187
32	100

Note: *To configure communications with m ore than 32 axes, ARCNET active hubs must be used.*

PacLAN axis address setup

Each SC750 must have a unique PacLAN axis address. The PacLAN address selection is performed by configuring the S1 DIP switch. **Note:** *The switch setting is read only when power is first applied to the controller.*

Each SC750 Servocontroller axis must have a unique port address. Please refer to Section 3.1.1 for additional information on setting the address. For additional information on PacLAN, please refer to the SC750 ServoBASIC Plus Programming Manual, Section 5.

Note: *PacLAN Address 0 is reserved. DO NOT USE.*

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2.5.2.5 J58 Serial I/O Connections

Introduction

The serial port transmits and receives RS-232 or RS-485 multidrop serial communication for the user interface of your unit. You can configure installation to control single or multiple SC750s.

Single- and multi-unit control

For controlling a single SC750, use RS-232 communications.

For controlling multiple SC750s, RS-422 or RS-485 communications permits a single PC to host from 1 to 32 SC750s (each requiring a unique switch selectable address ranging from 1 to 254).

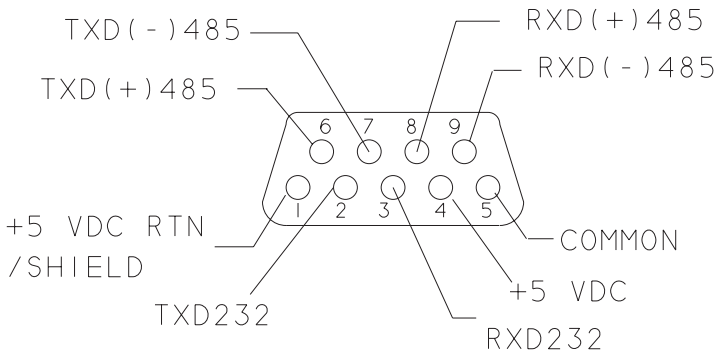
The SC750 utilizes 9600 baud communications with one start bit/one stop bit and eight bit word length in either RS-232 or multidrop format.

Serial input/output table - J58

Input/Output	Pin Number	Explanation
+5V Return/ Shield	J58-1	Common/shield - serial port interface.
Txd 232	J58-2	RS-232 transmitter output (from SC750).
Rxd 232	J58-3	RS-232 receiver input (to SC750).
+5 V dc	J58-4	5 volt dc, 250 milliampere power source for RS-232 communication devices.
+5 V Common	J58-5	Common - serial port interface.
Txd (+) 485	J58-6	RS-485 transmitter output (from SC750).
Txd (-) 485	J58-7	
Rxd (+) 485	J58-8	RS-485 transmitter input (to SC750)
Rxd (-) 485	J58-9	

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Connector pinout - J58 serial interface



Mating connector

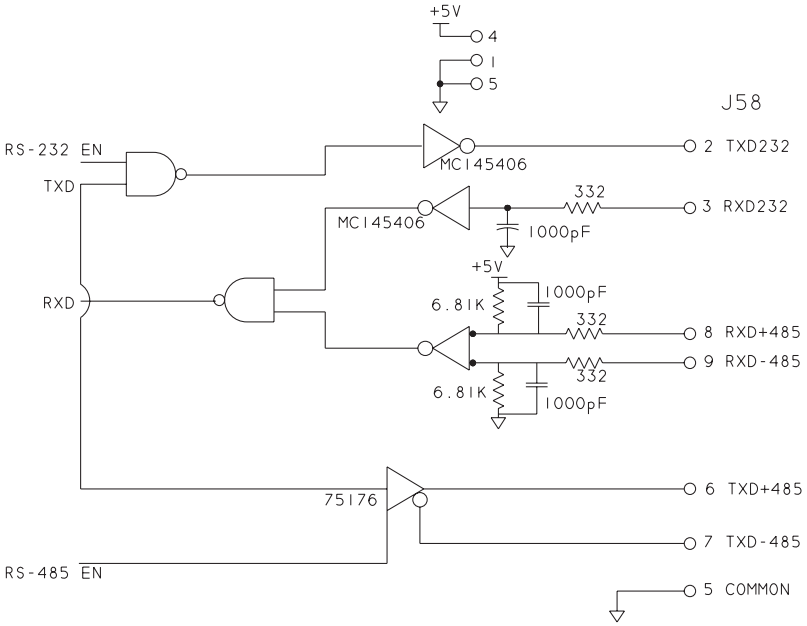
The J58 serial interface connector cables are for a standard 9-pin D connector.

The mating connector is supplied with the drive.

Note: *The J58 serial connector provides a +5 Vdc source for powering external devices up to 250 milliamperes. Be careful not to connect this to external equipment if not used.*

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J58 I/O schematic



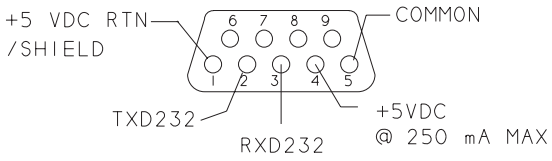
J58 Serial Port - RS-232 Connection

Introduction

Connect the SC750 to your computer or terminal (non-T10) as follows.

Procedure

1. Solder the cable leads to the 9-pin connector as shown.
2. Assemble the connector housing.



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Procedure (cont'd) 3. Build the cable to connect to your computer or terminal by referring to the documentation for the device.

Note: *Pinouts vary among computer manufacturers. Check your computer's hardware reference manual before wiring.*

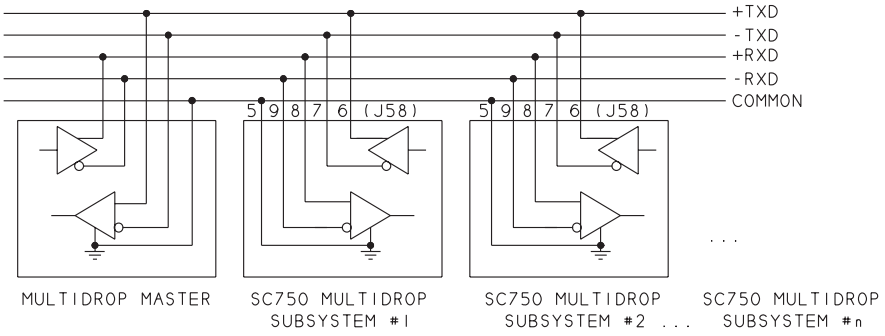
4. Plug the connector into the input and affix the connector to the unit with screws.

J58 Serial Port - Multidrop (RS-422 or RS-485) Connection

Background

SC750 controllers can be connected in parallel to a multidrop master. The SC750 controllers must each have a unique subsystem address. A maximum of 32 SC750s can be controlled from a single multidrop master.

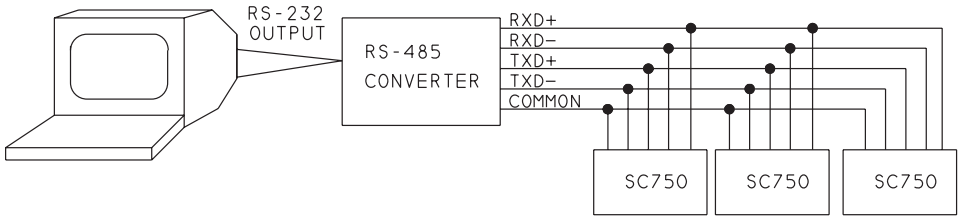
Multidrop interconnection diagram



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RS232/RS485 converter installation

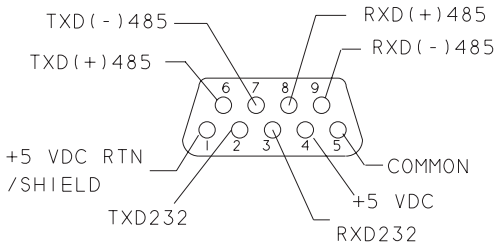
Operation of multiple SC750s can be implemented by installing an RS-422 or RS-485 converter between the PC (multidrop master) and the SC750 multidrop subsystem. If your computer does not have RS-422/RS-485 port, refer to the converter instruction manual to connect the converter to the user interface.



Note: *Flat ribbon connections are not recommended for RS-422/RS-485 connections.*

Procedure

1. Solder the leads to the connector as shown.
2. Insure RS-232 connections (pins J58-2 and J58-3) are left open.



3. Solder the leads for the other units to the corresponding leads on the preceding SC750.
4. Repeat step 3 for the other units to be controlled.

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Procedure (cont'd)

5. Connect the Common (J58-5) to the signal ground of the converter.
6. If necessary, connect pin J58-4 supplying +5 Vdc power to the converter. The maximum allowable load on this pin must be an amount that totals less than 250 mA.
7. Assemble the connector housings.
8. Plug the connectors into the ports and affix the connectors to the unit with screws.
9. Connect the units to the converter.
10. Set specific addresses for the unit as described in section 3.1.1, "Setting Up Serial Addresses Using Switch S1".

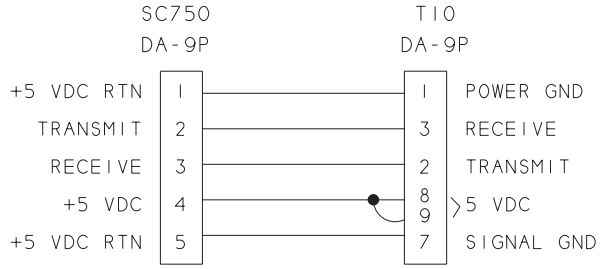
J58 Serial Port T10 Connections (RS-232)

Introduction

Connect the SC750 to your T10 terminal as follows:

The T10 terminal requires a DC-9P 9-pin plug-in male D connector.

Note: *The T10 terminal is a Burr-Brown TM2500.*



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Procedure

1. Solder the cable leads to the SC750 mating connector and the T10 connector as shown.
2. Assemble the connector housings.
3. Plug the connectors into the SC750 and T10 and affix the connectors to the units.

Parameter setup

Set up the T10 terminal as follows:

1. Enter the setup mode by pressing the "." key while power is applied to the T10 (wait until the two letter prompt appears). Refer to the terminal manual for more information.
2. Enter the following values:

VW = 4	Default	LE = 0	Local Echo OFF
TM = 0	Character Mode	EN = 1	Line Terminator (CR)
TD = 0	Turnaround Delay	KC = 2	Key Click
BR = 2	Baud Rate (9600)	KR = 1	Key Repeat
DF = 4	8 Bits, No Parity	CU = 2	Cursor
HS = 0	Default (DTR asserted)		

Note: *The SC750 is always configured for 9600 baud, 8 bit, no parity data formats.*

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SC750 S

In this Chapter

This Chapter explains how to power up the SC750 Series Servocontroller after installation. Topics covered are:

- Adjustments
- Establishing serial communications with host PC
- System status display and outputs

This section is intended to familiarize the SC750 user with the hardware adjustments and settings required to power up and operate the SC750 series servocontroller.

The vast majority of SC750 servo adjustments are performed in conjunction with Motion Dialogue, the integrated development environment, and the ServoBASIC *Plus* programming language. These are discussed in detail in the SC750 programming guide.

3.1 Adjustments

Background

This section explains how to adjust the SC750 series controller to your operating parameters.

3.1.1 Setting Up Serial Addresses Using Switch S1

Definition

The S1 switch:

- determines if you are using RS-232 or multidrop communications
- sets the address required for each SC750 on the multidrop bus

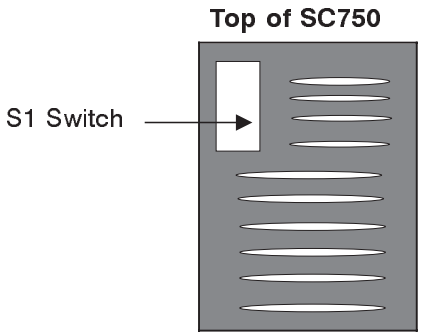
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Procedure

The following diagram shows the location of switch S1. The view shows the location of the S1 switch looking down at the top of the SC750.

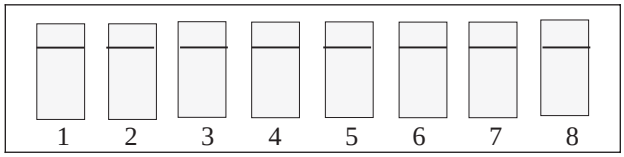
Note: *Each SC750 subsystem connected to the multidrop master must have a unique serial address.*

Switch location



The diagram below shows the S1 switch settings.

Switch S1



The switches are:

- On in the down position (toward number)
- Off in the up position (away from number)

Note: *RS-232 requires that all switches are in the UP position.*

1. Remove power from the SC750 servocontroller.
2. Refer to the table on the next page to set the SC750 to the appropriate address.

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S1 address table

Address	1	2	3	4	5	6	7	8
0	On	On	On	On	On	On	On	On
1	Off	On	On	On	On	On	On	On
2	On	Off	On	On	On	On	On	On
3	Off	Off	On	On	On	On	On	On
4	On	On	Off	On	On	On	On	On
5	Off	On	Off	On	On	On	On	On
6	On	Off	Off	On	On	On	On	On
7	Off	Off	Off	On	On	On	On	On
8	On	On	On	Off	On	On	On	On
9	Off	On	On	Off	On	On	On	On
10	On	Off	On	Off	On	On	On	On
11	Off	Off	On	Off	On	On	On	On
12	On	On	Off	Off	On	On	On	On
13	Off	On	Off	Off	On	On	On	On
14	On	Off	Off	Off	On	On	On	On
15	Off	Off	Off	Off	On	On	On	On
16	On	On	On	On	Off	On	On	On
17	Off	On	On	On	Off	On	On	On
18	On	Off	On	On	Off	On	On	On
19	Off	Off	On	On	Off	On	On	On
20	On	On	Off	On	Off	On	On	On

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S1 address table (cont'd)

Address	1	2	3	4	5	6	7	8
21	Off	On	Off	On	Off	On	On	On
22	On	Off	Off	On	Off	On	On	On
23	Off	Off	Off	On	Off	On	On	On
24	On	On	On	Off	Off	On	On	On
25	Off	On	On	Off	Off	On	On	On
26	On	Off	On	Off	Off	On	On	On
27	Off	Off	On	Off	Off	On	On	On
28	On	On	Off	Off	Off	On	On	On
29	Off	On	Off	Off	Off	On	On	On
30	On	Off	Off	Off	Off	On	On	On
31	Off	Off	Off	Off	Off	On	On	On
32	On	On	On	On	On	Off	On	On
33	Off	On	On	On	On	Off	On	On
34	On	Off	On	On	On	Off	On	On
35	Off	Off	On	On	On	Off	On	On
36	On	On	Off	On	On	Off	On	On
37	Off	On	Off	On	On	Off	On	On
38	On	Off	Off	On	On	Off	On	On
39	Off	Off	Off	On	On	Off	On	On
40	On	On	On	Off	On	Off	On	On

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S1 address table (cont'd)

Address	1	2	3	4	5	6	7	8
240	On	On	On	On	Off	Off	Off	Off
241	Off	On	On	On	Off	Off	Off	Off
242	On	Off	On	On	Off	Off	Off	Off
243	Off	Off	On	On	Off	Off	Off	Off
244	On	On	Off	On	Off	Off	Off	Off
245	Off	On	Off	On	Off	Off	Off	Off
246	On	Off	Off	On	Off	Off	Off	Off
247	Off	Off	Off	On	Off	Off	Off	Off
248	On	On	On	Off	Off	Off	Off	Off
249	Off	On	On	Off	Off	Off	Off	Off
250	On	Off	On	Off	Off	Off	Off	Off
251	Off	Off	On	Off	Off	Off	Off	Off
252	On	On	Off	Off	Off	Off	Off	Off
253	Off	On	Off	Off	Off	Off	Off	Off
254	On	Off	Off	Off	Off	Off	Off	Off
255*	Off	Off	Off	Off	Off	Off	Off	Off

* For RS-232 operation (factory default)

3. Re-connect power to the SC750 servocontroller.

4. Repeat steps 1 through 4 for other SC750 units on the bus. Make sure to give the other units unique addresses.

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3.1.2 Jumper Block Set Up

There are no user accessible jumper block settings on the SC750.

3.1.3 Potentiometers

There are no potentiometer settings on the SC750.

3.2 Establishing Serial Communications with Host PC

Background

The SC750 utilizes both RS-232 and RS-485 electrical specifications for its serial communications interfaces. Cabling the host PC to the SC750 is described in section 2.5.2.

Procedure

Once cabled up to the SC750:

1. Power up the SC750 with the drive disabled.
2. Set the serial interface position to one of the following:
   - Address 255 for RS-232 operation
   - Appropriate address for RS-422/485 operation

Note: *The SC750 always assumes 9600 baud, no parity, 1 start bit and 1 stop bit. Motion Dialogue assumes the same.*

3. Once communications have been established, the integrated programming environment will supervise program development and execution.

Warning



Upon initial power up of the SC750, Motion Dialogue will require entry of the part number of the motor connected to the drive, this is the user's responsibility.

Note: *This parameter is only entered the first time the unit is turned on.*

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3.3 System Status Display and Outputs

Introduction

The system status codes are displayed on the seven-segment display on the front panel. These codes are also available as outputs on connector J53. Refer to the following table for the meaning of these codes.

To troubleshoot codes that indicate faults, refer to Section 4.2, "Troubleshooting the SC750 Series Servocontroller." To use the J53 outputs, refer to Section 2.5.2, "J51 to J58 - Input/Output Cabling."

System status tables

Below are the system status tables for the SC750 units.

SC752/SC753

Status Display	FAULTCODE	Description
0	0	No fault, disabled
1	1	Software resolver overspeed
2	2	Motor overtemperature
3	3	Servocontroller overtemperature
4	4	Servocontroller IT
5	5	Motor Line-Neutral fault
6	6	Analog control undervoltage
7	7	Bus OV/OC (highest priority)
8	0	No fault, enabled
9	9	Estimated shunt regulator IT fault
b	11	Encoder +5V low
C	12	Terminal +5V low
E	14	Microprocessor fault

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Status Display	FAULTCODE	Description
F 1	241	Following error overflow
F 2	242	Program memory fault
F 3	243	Parameter memory fault
F 4	244	Run time error
F 5	245	PacLAN error
F 6	246	Incompatible motion dialogue
U C		Unconfigured controller

SC754/SC755/ SC756

Status Display	FAULTCODE	Description
0	0	No fault, disabled
1	1	Software resolver overspeed
2	2	Motor overtemperature
3	3	Servocontroller overtemperature
4	4	Servocontroller IT
5	5	Bus overcurrent (BOC)
6	6	Analog control undervoltage
7	7	Output overcurrent
8	0	No fault, enabled
9	9	Measured shunt regulator IT fault
A	10	Bus overvoltage or Hot control undervoltage
b	11	Encoder +5V low
C	12	Terminal +5V low

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Status Display	FAULTCODE	Description
d	13	Power stage control undervoltage
E	14	Microprocessor fault
F 1	241	Following error overflow
F 2	242	Program memory fault
F 3	243	Parameter memory fault
F 4	244	Run time error
F 5	245	PacLAN error
F 6	246	Incompatible motion dialogue
U C		Unconfigured controller

Note: *Status displays F1, F2, F3, F4, F5, F6 and UC alternately flash between the two values.*

Note: *There is no faultcode 8 - No faults, enabled. For status display* 8 *, the faultcode indicates 0. The variable ENABLED will indicate whether the controller is enabled.*

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In this Chapter This chapter covers maintenance and troubleshooting of the SC750 servocontroller.

4.1 Maintaining the SC750 Servocontroller

Introduction The SC750 series servocontrollers are designed for minimum maintenance. The following cleaning procedures performed as needed will minimize problems due to dust and dirt build-up.

Procedures Remove superficial dust and dirt from the unit using clean, dry, low-pressure air.

Warning



Use the procedure given in the fuse replacement section (see Section 4.2 "Troubleshooting the SC750 Series Servocontroller") to avoid personal injury or damage to the unit when removing the cover.

4.2 Troubleshooting the SC750 Series Servocontroller

Introduction The system status display located on the front panel indicates unit status and is useful for troubleshooting. The SC752 and SC753 have a BUS ACTIVE LED which signifies the unit is connected to line voltage.

A table of problems, causes, and appropriate actions are on the pages that follow.

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Troubleshooting table

Problem (and system status numbers)	Possible cause	Action
System status display not lit.	No control power.	Check that SC754, SC755, and SC756 have AC switch set to INT **or** SC752, SC753 and SC754, SC755, and SC756 have 115 V ac or 230 V ac applied to J3 pins 5,6.
	Blown control power fuse.	Replacement of fuses within the drive is not recommended and rarely useful. A blown fuse is a strong indication that the drive is defective and should be returned to the factory for repair.
Bus active LED not lit (SC752, SC753).	No Bus power.	Apply power.
	Blown Bus fuses.	Replacement of fuses within the drive is not recommended and rarely useful. A blown fuse is a strong indication that the drive is defective and should be returned to the factory for repair.

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Troubleshooting table (cont'd)

Problem (and system status numbers)	Possible cause	Action
Resolver conversion overspeed (1).	Incorrect resolver phasing.	Verify proper phasing.
	Open or intermittent resolver connection.	Check connector and cable.
Motor overtemperature (2).	Motor PTC pins open.	Connect PTC pins (J51-8 and J51-9).
	Temperature overload due to high motor ambient temperature or excessive RMS torque.	Lower ambient temperature. Operate within continuous torque rating.
Controller overtemperature (3).	Temperature overload due to:	
	High ambient temperature.	Lower ambient temperature to below 50 degrees (60 degrees, if derated).
	Restriction of cooling air due to insufficient space around unit.	Provide sufficient cooling space.
	Operation above continuous power rating.	Operate within continuous power rating.
	Fan inoperative.	Return to factory for fan replacement.
IT Fault (4).	Excessive time at peak current.	Check time spent at peak current. If excessive, change profile or load. (Use larger motor/drive.)
Controller unconfigured (U/C).	New controller.	Perform controller setup.

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Troubleshooting table (cont'd)

Problem (and system status numbers)	Possible cause	Action
Line-neutral fault (5).	Motor cable short to ground.	Check motor cable.
	Internal failure.	Contact distributor.
Servocontroller logic supply undervoltage (6).	External short on signal connectors.	Remove connectors and reapply power.
	Insufficient voltage on J3-5 and J3-6.	Check voltage with meter (> 90 V).
	Internal failure.	Contact distributor.
Output overcurrent, or bus overvoltage (7).	Excessive ac input voltage.	Reduce ac input voltage to below 264 V ac.
	Output short circuit.	Check for short.
	Motor cabling wires shorted together.	Check for short.
	Motor cabling shorted to ground.	Check for short.
	Internal motor winding short circuit.	Check for short.
	Insufficient motor inductance.	Check current loop compensation parameters in software. Replace motor with motor of correct inductance.
Unit will not enable (does not display 8 when enable applied).	External enable not applied.	Apply enable input to pin J53-4.
	Internal fault.	Contact distributor.
	Software enable not on.	Set Enable variable to 1.

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Troubleshooting table (cont'd)

Problem (and system status numbers)	Possible cause	Action
Unit is enabled, BUS ACTIVE LED On (SC752, SC753) no system status faults (status code 8), but motor does not respond.	Seized load or excessive load friction.	Reduce load.
	Reset command on J53-3.	Remove reset from J53-3.
	Open motor connections.	Connect motor.
Motor oscillates or runs erratically.	Improper shielding and grounding.	Shield cabling correctly per Section 2.5.1 or Section 2.5.2.
	Improper drive set up.	Review set up procedure.

If problems continue to exist, please contact your local distributor for further assistance.

If the servocontroller is defective

If you cannot correct the servocontroller problem, or if it is defective, return it to Pacific Scientific for repair or replacement.

Return procedure

1. Call Pacific Scientific at (978) 988-9800 from 8 am to 6 pm Eastern Standard Time to get a Returned Materials Authorization Number (RMA#).

   Note: *Do not attempt to return the servocontroller or any other equipment without a valid RMA#. Returns received without a valid RMA# will not be accepted and will be returned to the sender.*

2. Pack the controller in its original shipping carton. Pacific Scientific is not responsible or liable for damage resulting from improper packaging or shipment.

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Procedure (cont'd)

3. Ship the servocontroller to:

Pacific Scientific
Motion Technology Division
110 Fordham Road
Wilmington, MA 01887
Attn: Repair Department, RMA #_____

Note: *Do not ship Pacific Scientific motors to the above address. The correct address for motors is:*

Pacific Scientific
Motor Products Division
4301 Kishwaukee Street
Rockford, IL 61105
Attn: Brushless Repair Department, RMA#_____

Shipment of your controller or motor to Pacific Scientific constitutes authorization to repair the unit. Refer to Pacific Scientific's repair policy for standard repair charges. Your repaired unit will be shipped via UPS Ground delivery. If another means of shipping is desired, please specify this at the time of receiving an RMA#.

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S

Resolver Feedback Interface

Position

Resolution	2^{-16} Rev = 0.3 arc min
Noise	< 2^{-16} Rev rms
Repeatability	< 2^{-16} Rev
Accuracy	
standard, drive only	± 22 arc min
standard with 15 arc min resolver	± 37 arc min
optional, drive only	± 4 arc min

Velocity

Resolution	0.67 rpm
Max tracking rate	13,733 rpm
Accuracy	
worst case	± 0.05%
typical	± 0.01% @ 25°C
Offset	< 0.021 rpm
Noise	< 1.5 rpm rms
Ripple	
standard, drive only	3% p-p at 1000 rpm
standard with 15 arc min resolver	5% p-p at 1000 rpm
optional, drive only	0.75% p-p at 1000 rpm

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Excitation Frequency	5859.375 Hz
Sample Update Period	85.33 µsec
-3 dB Bandwidth	> 900 Hz
-60° Phase Lag	> 550 Hz
Position Control Command	
Range	0 to ± 100,000,000 steps
Resolution	4096 steps per rev (5.3 arcmin/step)
Speed Control Command	
Range	0 to ± 12,000 rpm (actual maximum speed depends upon motor/controller combination used)
Resolution	0.01 rpm
Acceleration/ Deceleration Command	
Range	3 to 16,000,000 rpm/second
Resolution	3 rpm/second
Torque (current)	
Limit control range	0% to 100% of peak rating (software control)
Position loop update period	1.28 milliseconds

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Velocity loop update	427 microseconds
Serial interface	
Type	RS-232/RS-485/422 (address selectable)
Baud rate	9600
Parity	none
Data word	10 bit (8 data, 1 start/1 stop)
Efficiency (50 % output voltage, rated cont. current)	> 95%
Form factor	< 1.01
Current loop bandwidth	1500 to 3000 Hz
Output ripple frequency (± 15%)	20 KHz
Analog input	± 12.5 Vdc range, 0.25% linearity, 50 µV/°C drift, fully monotonic, 60 mV offset, 100 Kohm input impedance

16 bit S/N Ratio @ ADF0 = 2.5 Hz
14 bit S/N Ratio @ ADF0 = 50 Hz
12 bit S/N Ratio @ ADF0 = 1000 Hz

Analog output	± 5 Vdc range, 12 bit, updated at velocity loop update rate, fully monotonic, 30 mV offset, 50 ohm source impedance, 30 mA maximum output current.

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Control inputs	Enable, Fault reset, Inhibit +, Inhibit -
Program Memory Data Retention	10 years
Control outputs	Fault, Current monitor, Commutation signal Two +5 V @ 250 mA max.
Programmable inputs	12 general purpose 2 general purpose/fast 2 general purpose/counter Optically isolated, 5 to 24 Vdc logic, sourcing; fast inputs have 5 µS max. capture time Each bank of 8 optical inputs requires nominally 50 mA of current from its supply
Programmable outputs	11 general purpose 1 general purpose/PWM (up to 200 mA) 5 to 24 Vdc logic, open collector sinking, up to 100 mA
Encoder Input/Output	
Encoder emulation output	Quadrature with marker pulse, differential TTL line driver, software selectable resolution 500, 512, 1000, 1024, 2000, 2048, 4096, 16,384 PPR, 750 KHz max.
Encoder input	Quadrature with marker pulse, differential TTL line receivers, 750 KHz max.
Step/Dir input	Differential TTL line receivers, 750 KHz max.

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Registration Response time

Registration Trigger Input	Response Time (microseconds)
Input 7/Reg 1 or Input 8/Reg2	5.0
Z Reference Channel	1.0

	SC752	SC753	SC754	SC755	SC756
Input voltage					
Control logic power	90 to 264 V ac, 47 to 63 Hz, 1 phase or 130 to 370 Vdc				
Bus power	115 Vac (+10%, -15%)/ 230 Vac (+10%, -15%) 47 to 63 Hz, 1 or 3 phase			230 Vac (+10%, -15%) 47 to 63 Hz, 3 phase	
Bus voltage			320 Vdc		

Input current	SC752	SC753	SC754	SC755	SC756
Control logic power	500 mA max. @ 115 V ac, 250 mA max. @ 230 V ac				
Bus Power (RMS) 230 Vac/3 phase	4.5 A	9 A	18 A	29 A (@ 6kW)	38 A (@ 12 kW)

Output current	SC752	SC753	SC754	SC755	SC756
Peak (5 seconds)	7.5 A	15 A	30 A	60 A	120 A
Continuous	3.8 A	7.5 A	15 A	30 A	60 A

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Output power (min @ 50°C)	SC752	SC753	SC754	SC755	SC756
Peak (5 second)					
230 V ac, 3-phase	2.2 kW	4.5 kW	9 kW	18 kW	36 kW
230 V ac, 1-phase	2.0 kW	4.0 kW	N/A	N/A	N/A
Continuous					
230 V ac, 3-phase	1.1 kW	2.2 kW	4.5 kW	9 kW	18 kW
230 V ac, 1-phase	0.8 kW	1.6 kW	N/A	N/A	N/A

Shunt regulator	SC752	SC753	SC754	SC755	SC756
Peak power	3 kW	6 kW	20 kW	20 kW	40 kW
Continuous power	20 W	40 W	200 W	200 W	500 W
Bus capacitance	20 J	20 J	25 J	50 J	180 J
(From 330V Bus)					
energy absorption					

Motor l-l inductance requirement	SC752	SC753	SC754	SC755	SC756
Min L_{l-l}	4 mH	2 mH	1 mH	0.5 mH	0.25 mH
MaxL_{l-l}	1000 mH	500 mH	200 mH	130 mH	63 mH

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Full ratings	0° to 50°C
Derated (linearly derate the continuous current and power ratings to 70% at 60°C)	50°C to 60°C
Humidity	10 % to 90%, non-condensing
Altitude	5000 ft (1500 meters)
Storage temperature	-55°C to 70°C

Weight	SC752	SC753	SC754	SC755	SC756
	13 lbs	16 lbs	40 lbs	40 lbs	90 lbs
	(5.9 kg)	(7.26 kg)	(18.16 kg)	(18.16 kg)	(40.86 kg)
Dimensions	Refer to Section 2.4				

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B

Background

This appendix gives the model number for the SC750 number series lists of accessories for:

- Servocontrollers
- Cables
- Recommended motors

SC750 part number table

Part	Order Number	Comment
Connector Kit (SC752/SC753)	106-075001-01	Assorted Phoenix and D connectors
Connector Kit (SC754/55/56)	106-075002-01	Assorted Phoenix and D connectors
Installation Manual	903-075100-00	
Programming Manual	903-075200-00	
ServoBASIC Plus Reference Manual	903-075300-00	
Motion Dialogue diskette	904-075100-00	3 1/2 inch
	904-075200-00	5 1/4 inch (Prog.)
	904-075300-00	5 1/4 inch (Help)

How to order

Contact Pacific Scientific to order these parts:

Call: 978-988-9800 from 8 am to 6 pm Eastern Standard Time

Write:
Pacific Scientific
Motion Technology Division
110 Fordham Road
Wilmington, MA 01887

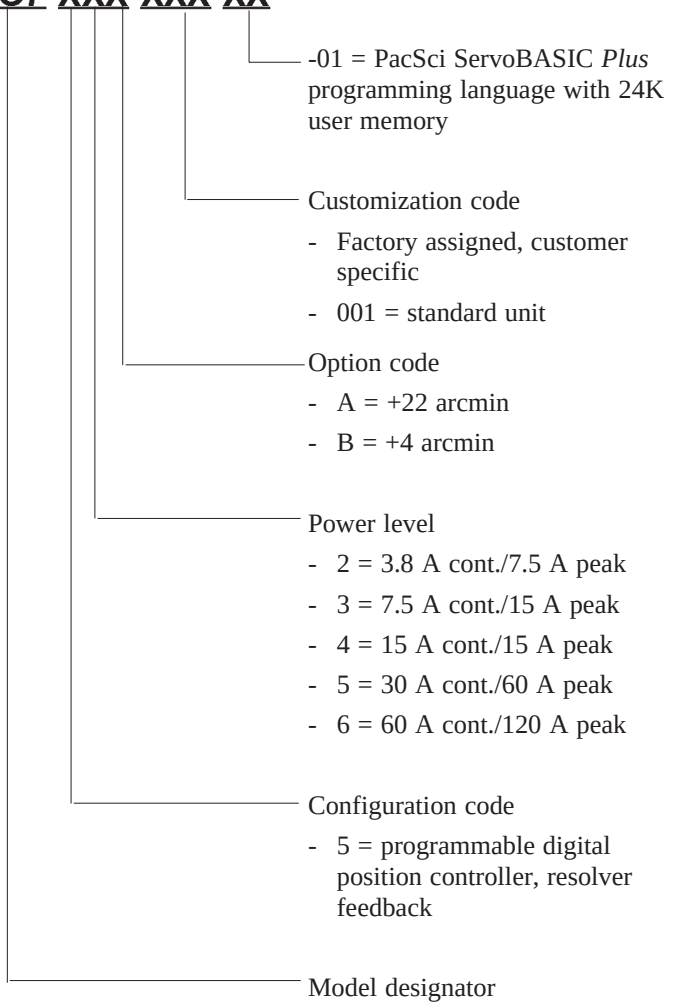
Fax: (978) 988-9940

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Servocontroller Ordering Codes

Servocontroller only

SC7 XXX-XXX-XX



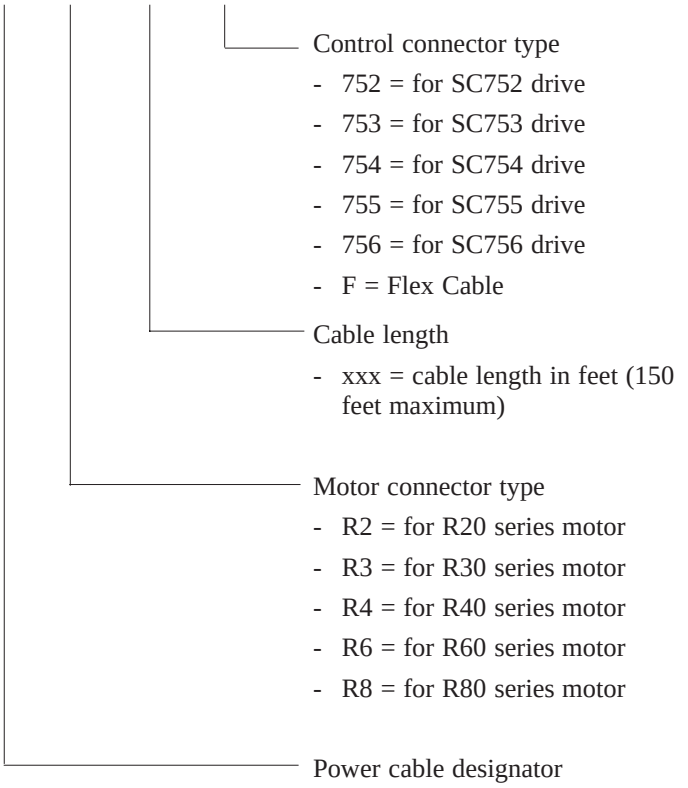
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Cable ordering codes

Each system requires one power cable and one feedback cable.

Power cable

CP-XX-XXX-XXXF

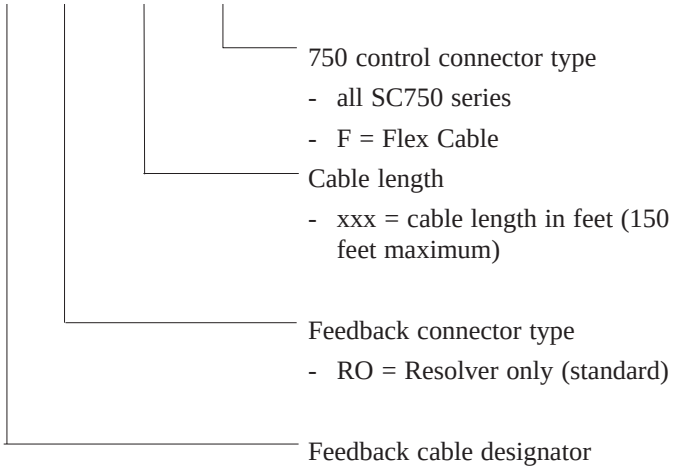


Note: *Flexible Cable is now an option that is available with all Pacific Scientific cables. Please contact customer service for additional information.*

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Feedback cable

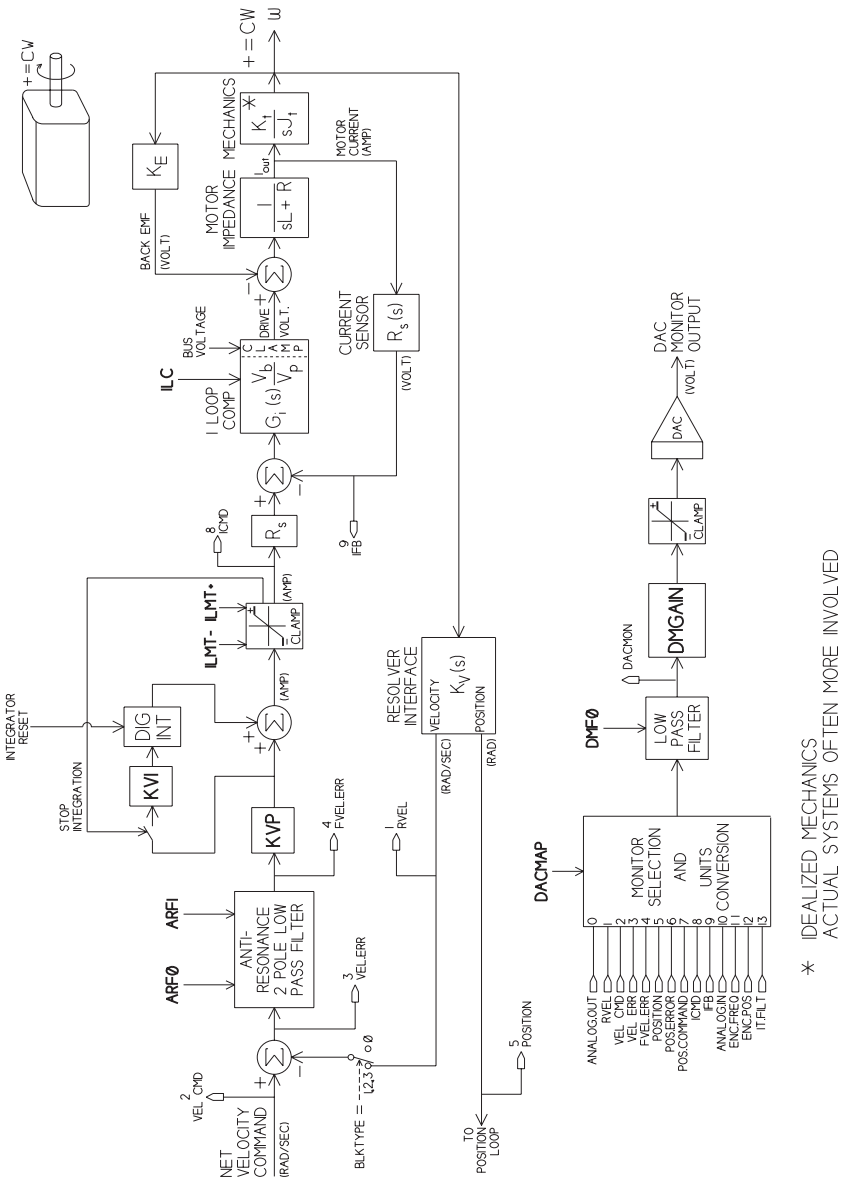
CF-XX-XXX-XXXF



Note: *Flexible Cable is now an option that is available with all Pacific Scientific cables. Please contact customer support for additional information.*

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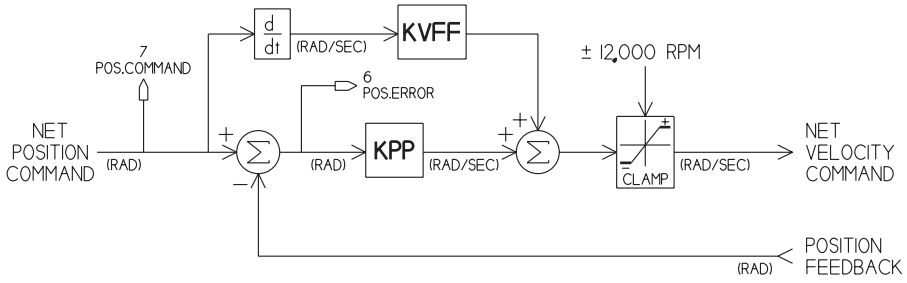
C S



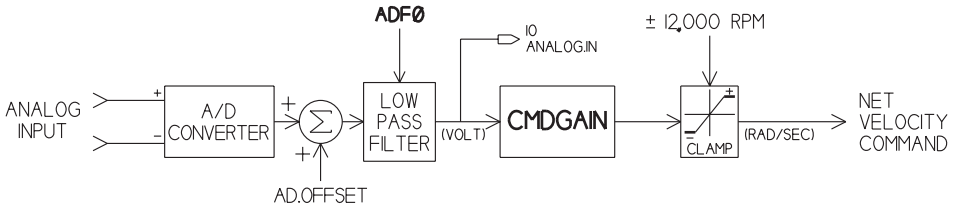
S

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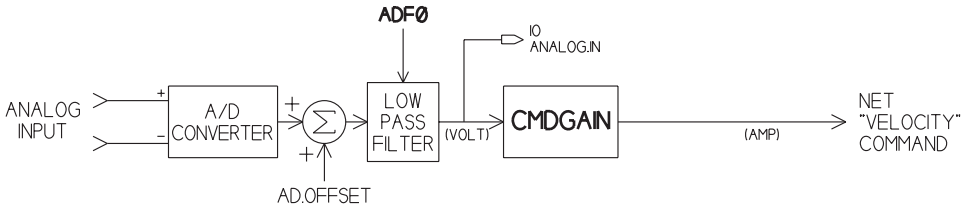
BLOCKTYPE 2: SERVO BASIC POSITION



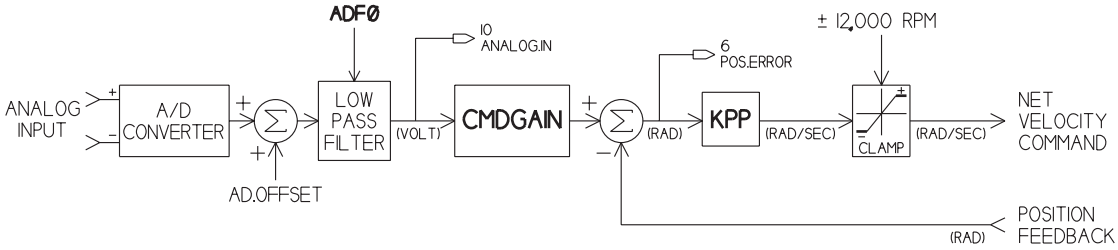
BLOCKTYPE 1: ANALOG VELOCITY



BLOCKTYPE 0: ANALOG CURRENT



BLOCKTYPE 3: ANALOG POSITION



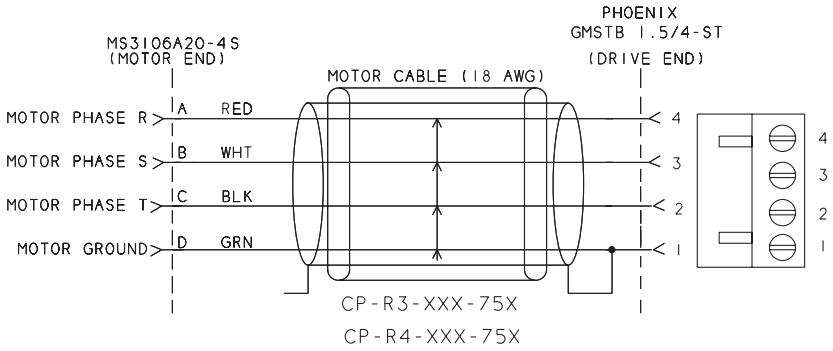
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C

Introduction This appendix contains power and feedback cabling information for all SC750 Servocontrollers.

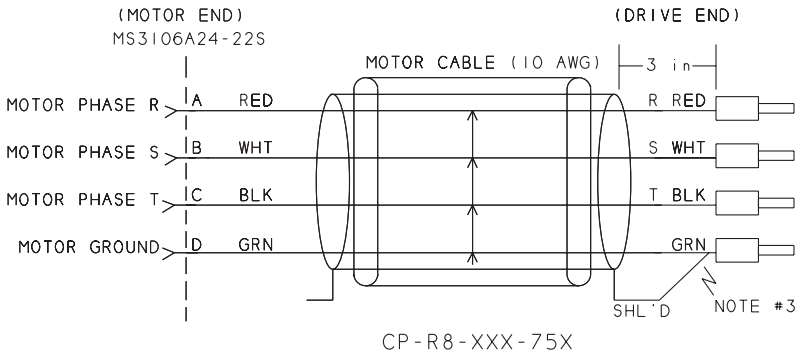
Power Cables

SC752/SC753



Note: *Insulate shield drain wire at motor end.*

SC754/SC755

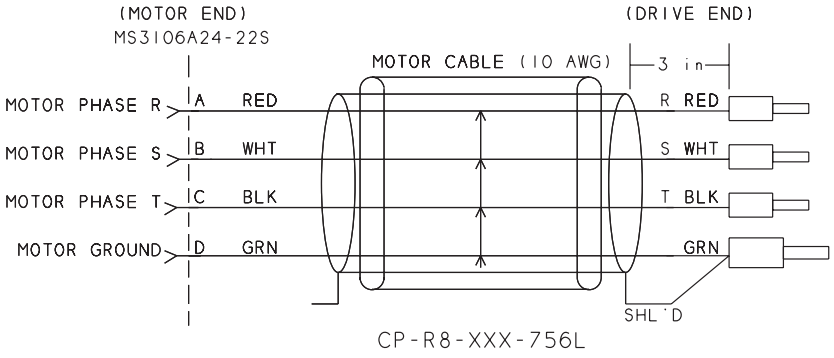


Note: *1. Insulate drain wire at motor end.*
2. Drive end strip wire 15 mm (.591 in).
3. Ferrules on wires at drive end.
R.S.T. wires black #10 ferrules.
Motor Gnd & shield tied before ferrule.

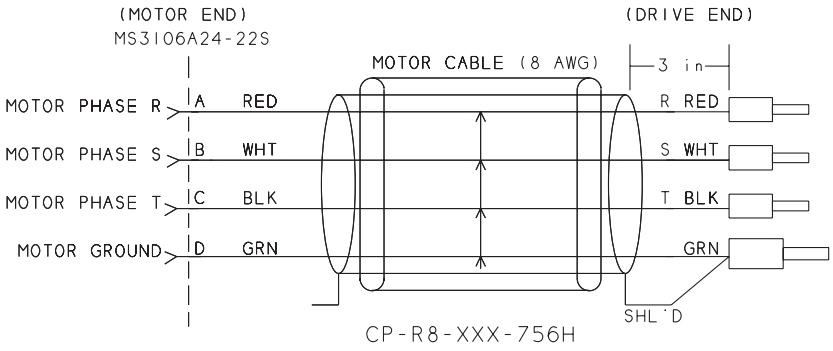
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SC756

Light duty cable



Heavy duty cable



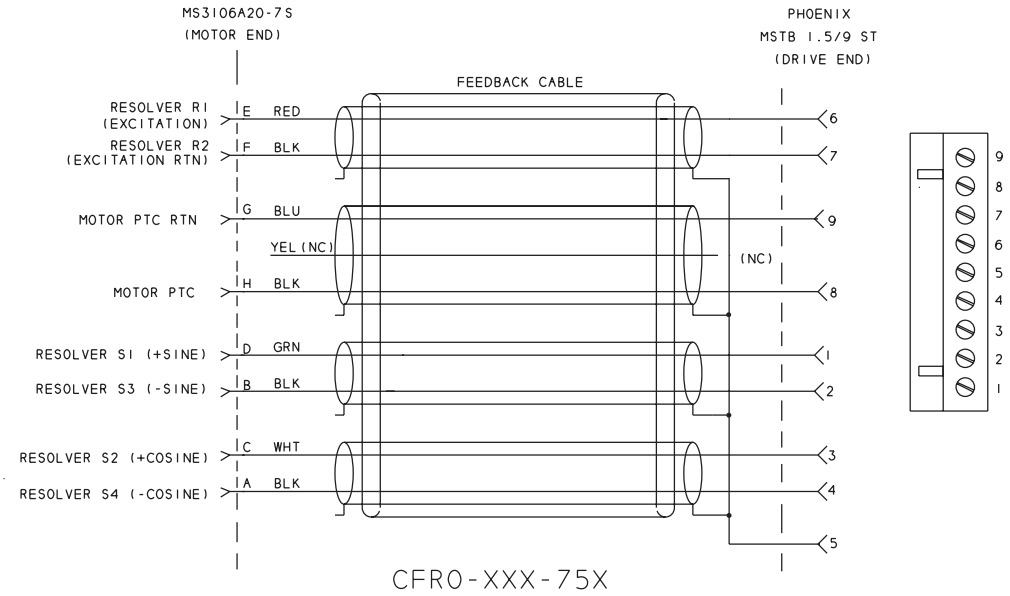
The following notes apply to both of the cable diagrams shown above:

Notes: *1. Insulate drain wire at motor end.*
2. Drive end strip wire 15mm (.591 in).
3. Ferrules on wires at drive end.
R.S.T. wires black #10 ferrules
Motor Gnd & shield white #8 ferrules.

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Feedback Cables

The feedback cable is the same for all models of the SC750.



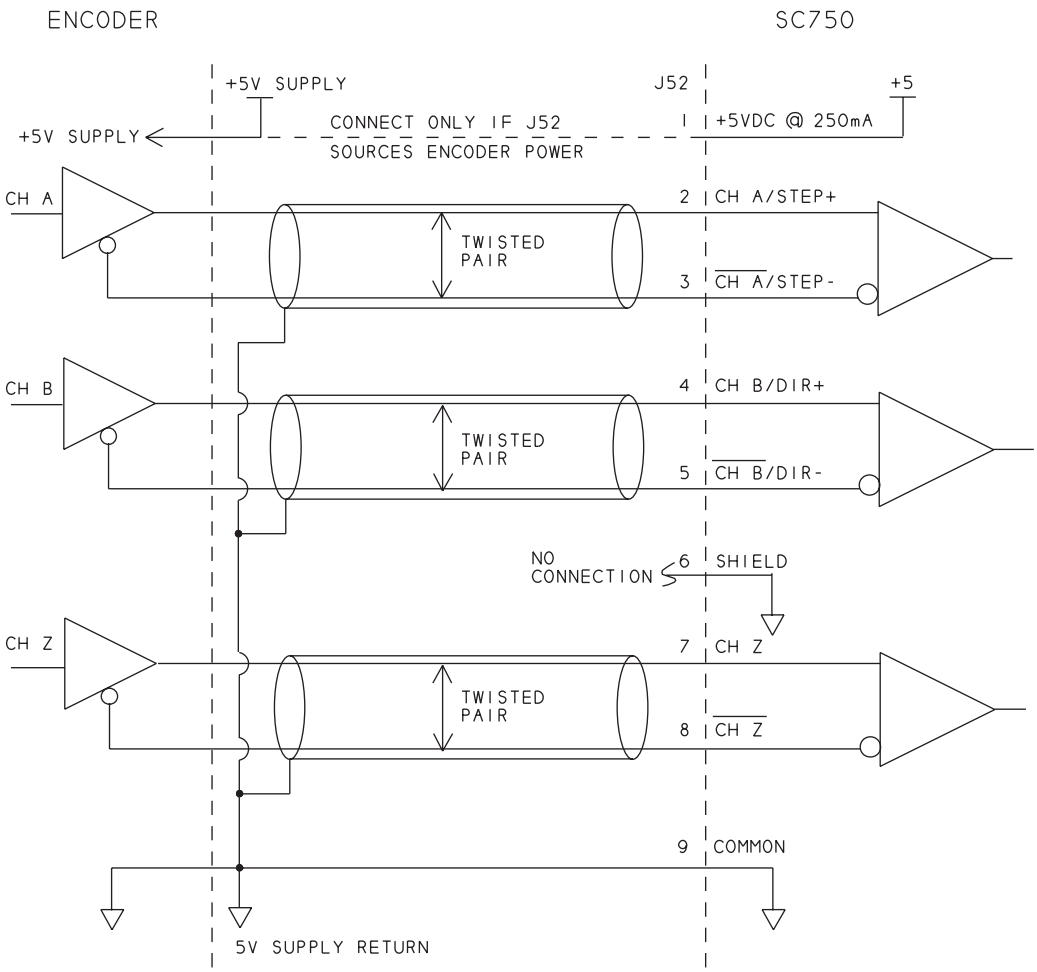
Notes: *1. Insulate shield drain wires at motor end.*
2. Insulate unused wires at motor end.
3. Insulate unused wires at drive end.

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External Encoder Cabling

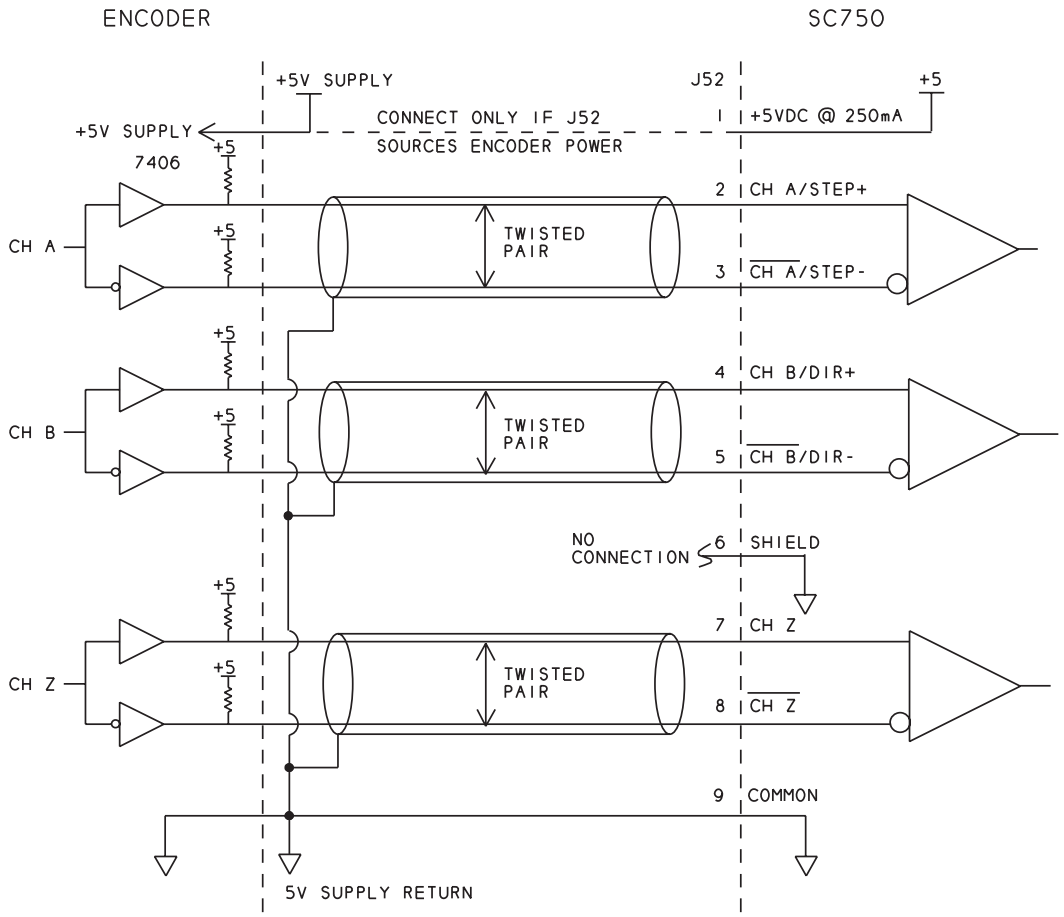
For information pertaining to interfacing an external encoder input to the SC750 encoder port, refer to the diagrams below.

Using TTL differential line drivers



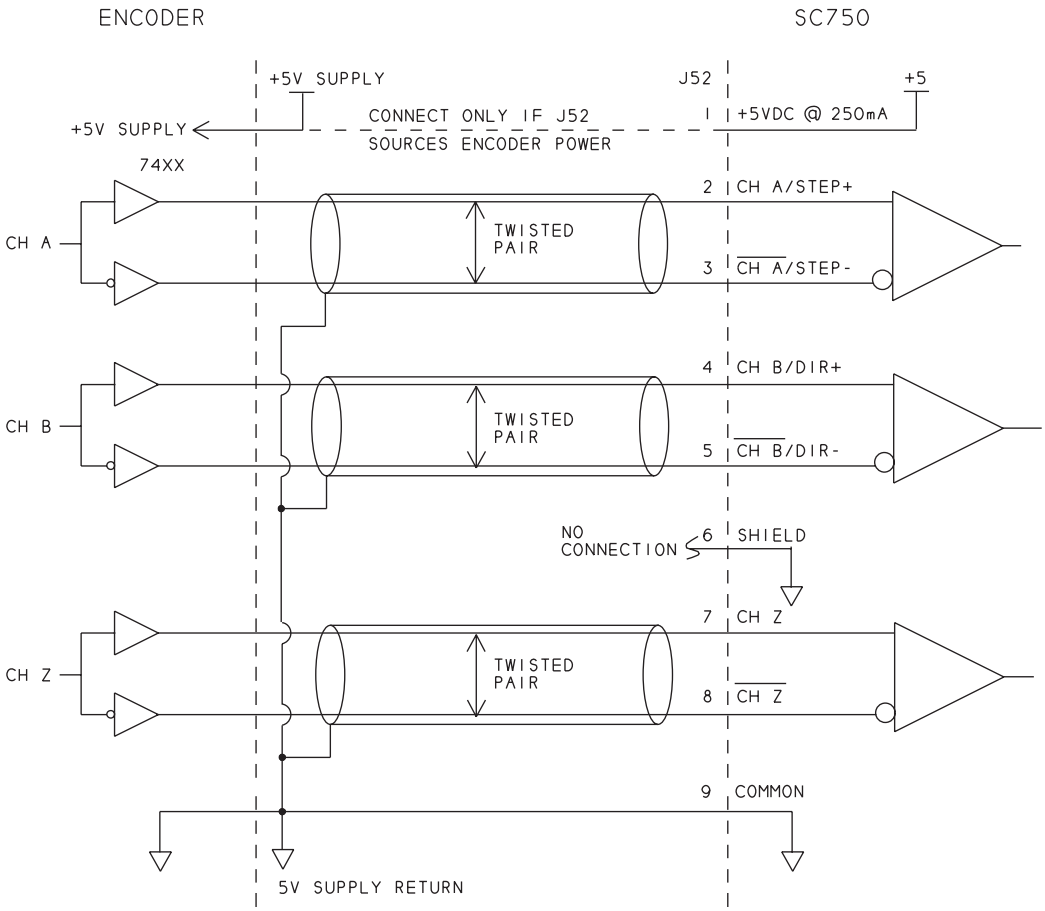
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Complementary encoder output driven by 7406 with pullup resistor



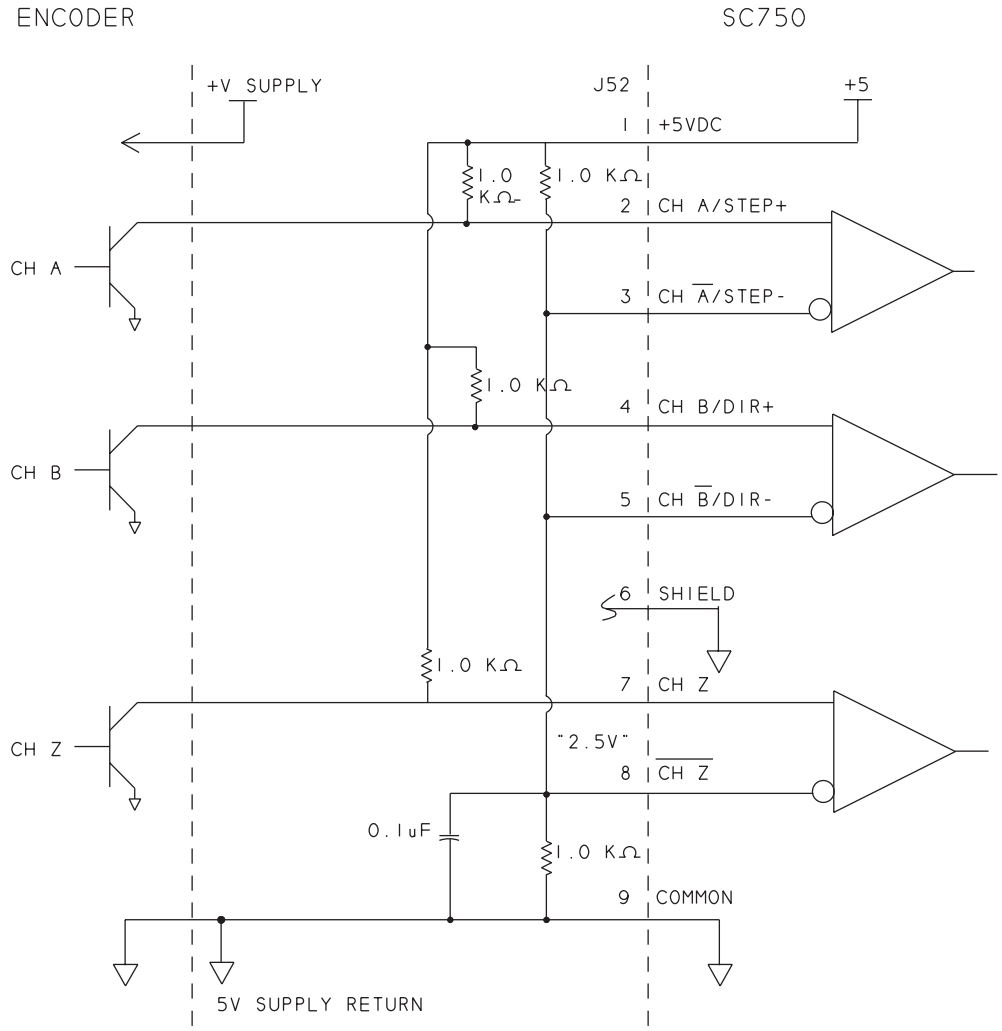
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Complementary encoder output driven by standard TTL logic



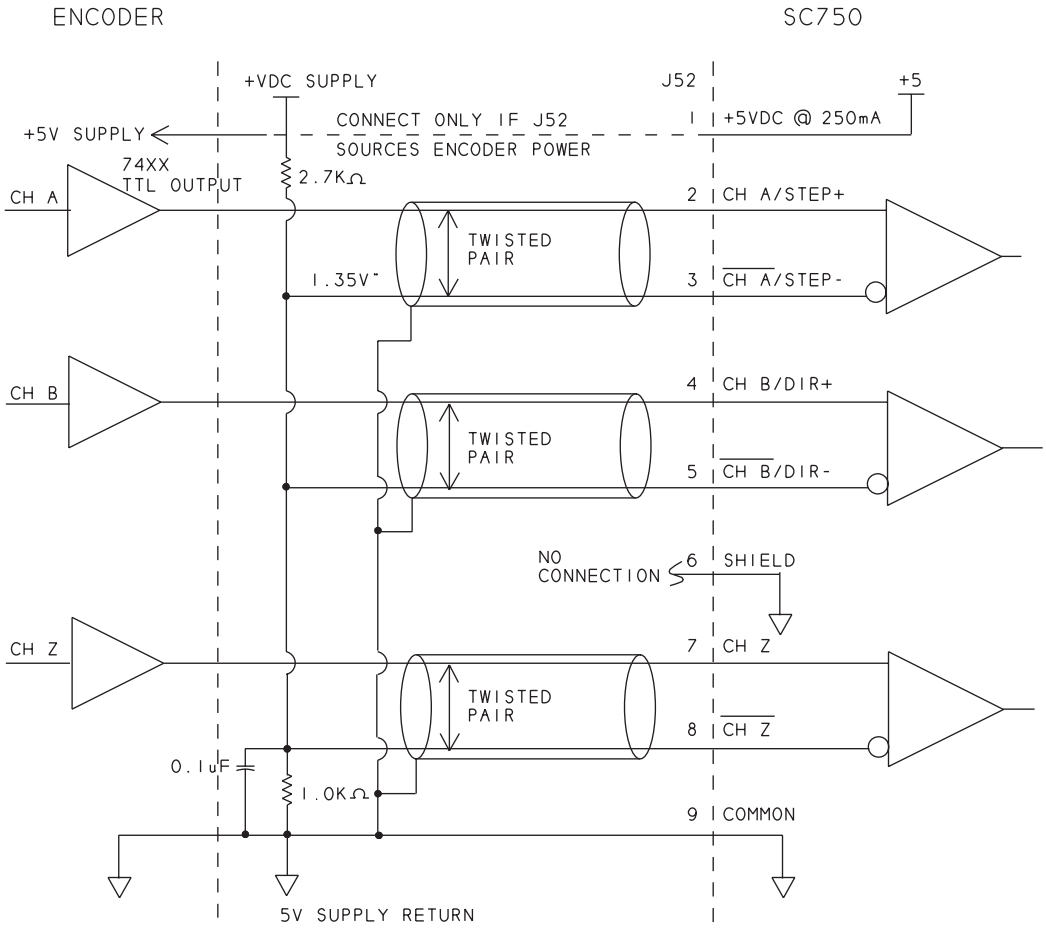
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Single-ended encoder output - open collector, no pullup



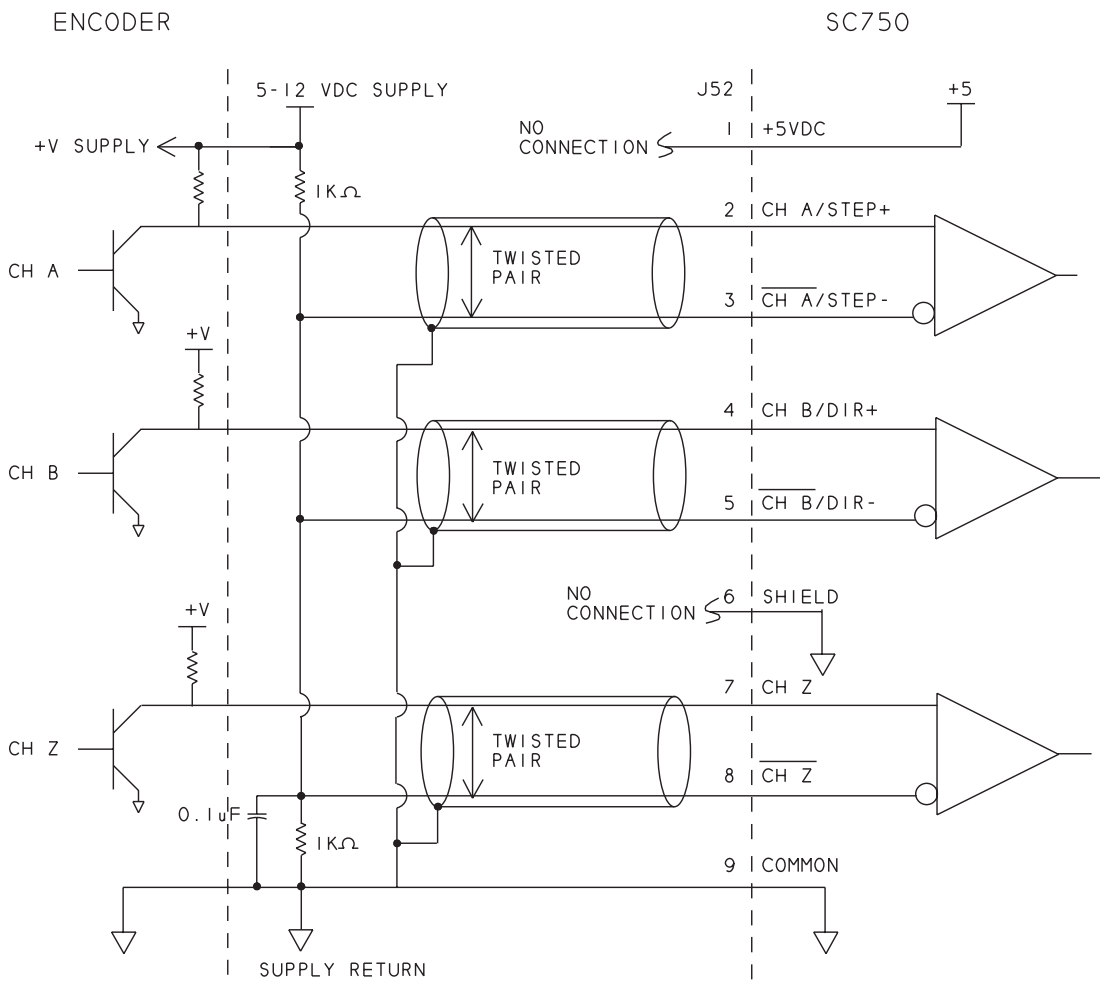
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Single-ended encoder output using standard TTL signals



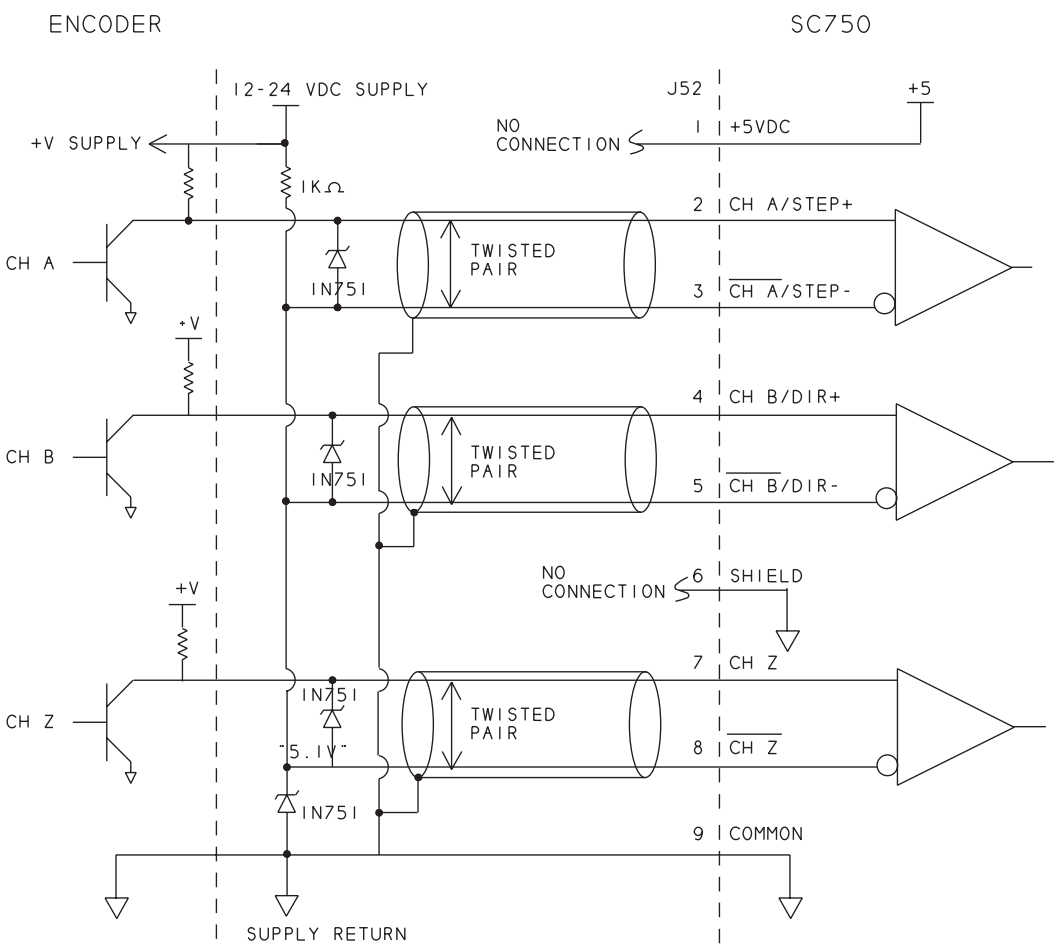
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Single-ended encoder output - open collector pull up to 5-12 Vdc



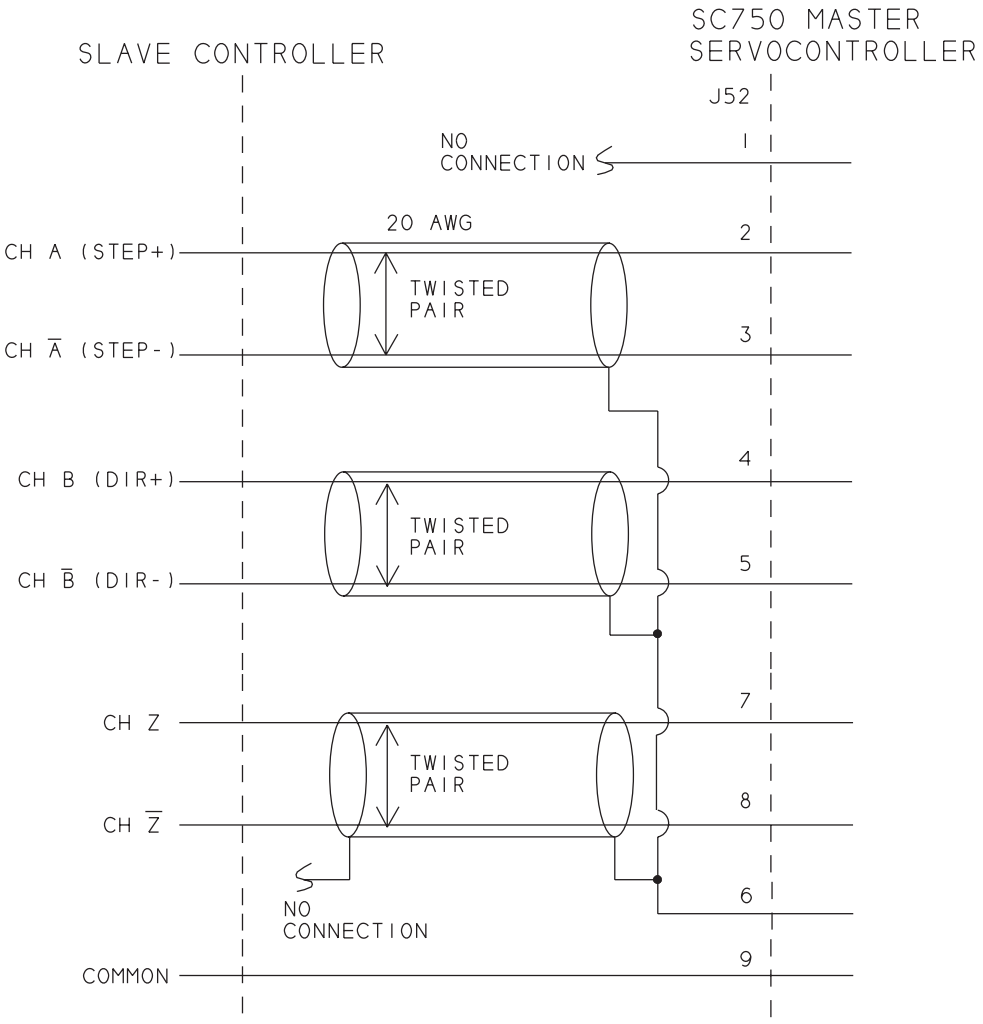
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Single-ended encoder output - open collector pull up to 12-24 Vdc



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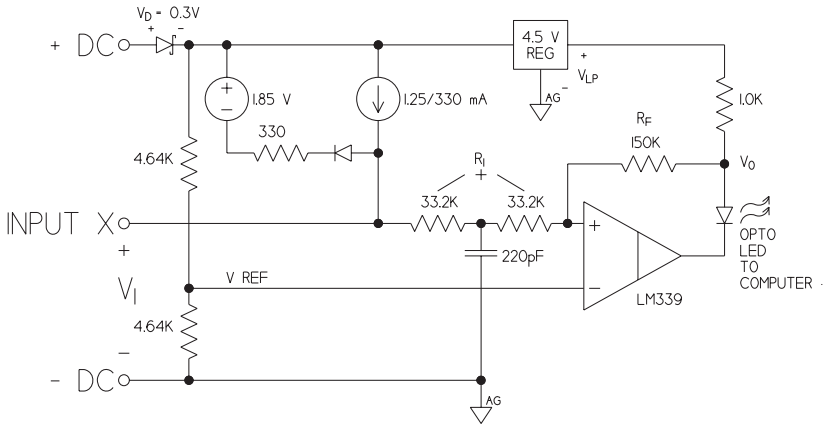
Interfacing to master servocontroller



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E I

Detailed input schematic



AT LOGIC STATIC TRIP POINTS:

$$V_I = \frac{R_I + R_F}{2R_F}(V_{DC} - V_D) - \frac{R_I}{R_F}V_O$$

V_O = 1.2V or 4.5 @ V_{DC} > 6.2 V
1.1V or 4.0 @ V_{DC} = 5.0 V

Input characteristics

	Filter Time Constant	Propagation Delay	Minimum Pulse Width
Normal Inputs	6 µsec	30 µsec	75 µsec
Fast Inputs	0 µsec	1 µsec	1 µsec

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Voltage trip percentage charts

The table below shows logic voltage thresholds and their percentages as a fraction of the DC supply voltage.

	24 Volt	12 Volt	5.0 Volt
V_{T-}	15.1V/63%	6.5V/54%	1.65V/33%
V_{T+}	16.6V/69%	7.9V/66%	2.95V/59%

- Minimum pulse width = 75 µsec for hardware through optos

Note: *The software scan rate > 75 µsec*

- Must sink ≥ 4mA
  - 3.75 mA nominal
  - 3.5 - 4.0 mA range

Outputs

Standard	< 100 mA
Out 12/PWM	< 200 mA

Internal flyback diode to 39V clamp handles up to max I_{out} ratings.

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S

SC750 drives do not require an isolation transformer. If a transformer is to be used, the table below lists recommended sizes. The smaller size is adequate for most servo applications. The larger size provides an additional safety factor for applications that require minimum bus voltage sag to accelerate the motor to high speed in minimum time, and for applications with high continuous power.

Drive	Recommended Transformer Rating
SC752/SC753	3 KVA
SC754	3 to 5 KVA
SC755	5 to 7.5 KVA
SC756	10 to 15 KVA

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S C

Note: *The default serial communications format for the SC750 is RS-232. The address value is AXIS 255 (all S1 switches in the UP or OFF position). Multidrop protocol does not apply to RS-232 communications.*

SC750 Multidrop Protocol

A multidrop system consists of a multidrop master and 1 to 32 multidrop subsystems. Each subsystem has a unique address ranging from 0 to 254. The address of a subsystem is configured using the dip switch S1, as described in Section 3.1.1 of the "SC750 Installation and Hardware Reference Manual". The subsystem address is indicated in the software variable AXIS.ADDR.

Note: *Only one multidrop subsystem can transmit data back to the multidrop master at any given time.*

Configuring a multidrop subsystem to transmit data to the multidrop master requires the multidrop master to transmit a message which selects the multidrop subsystem as the unique logged on system. A variable indicating the logon status (LOGGEDON) will be set appropriately in all the multidrop subsystems connected on the multidrop interface.

A logged on multidrop subsystem can input received data during program execution using the INKEY$ function or INPUT statement. If subsystems are not logged on, they cannot access data transmitted by the multidrop master. Also, an INPUT statement program execution will effectively be suspended until the subsystem has been issued a logon message and receives valid input data terminated with the carriage return character. The INKEY$ statement will return a null string, with a value of 0, if a subsystem is not logged on.

A logged on subsystem can transmit data to the multidrop master using the PRINT statement while the program is executing. If a subsystem is not currently logged on, its multidrop transmitter is disabled and program execution will not halt at the PRINT statement.

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Subsystem selection

A subsystem's address is configured using the S1 dip switch located underneath the small panel on top of the controller. Setting up this switch for a particular address is described in Section 3.1.1 of the "SC750 Installation and Hardware Reference Manual". The subsystem address is indicated in the software variable AXIS.ADDR.

Note: *The subsystem address S1 switch setting is polled only when power is applied to the controller. If the switch setting is modified, then power must be cycled to the controller for the new address to take effect.*

When a multidrop subsystem is logged on, its' multidrop transmitter can be enabled whenever data is to be transmitted. If a unit has not been logged on (since AC power was applied) or if a valid logon command has been issued to another SC750 multidrop subsystem, the subsystem's transmitter is disabled.

The multidrop master must transmit a multidrop subsystem selection, or logon command, message using the format:

/nnn,

This permits the multidrop subsystem's transmitter to be enabled. "nnn" is a valid SC750 subsystem address, ranging from 0 (all switches ON) to 254.

Note: *Address 255, all switches OFF, indicates the unit is configured for RS232 serial communications.*

Once the "/" (slash) has been transmitted, the subsystem address is defined by the three digit numeric code. If there are less than three numeric digits, the address is terminated by the first non-numeric character.

When a multidrop subsystem that is currently logged on recognizes selection of another subsystem, it will disable its multidrop transmitter.

A logon variable (LOGGEDON) indicates that a multidrop subsystem has been selected to transmit to the multidrop master. This variable will be updated in all multidrop subsystems after the multidrop master has issued the logon message. This variable can be used to determine the status of a multidrop subsystem.

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Change of Subsystem Address

If a multidrop master changes the subsystem address by issuing a new logon command, then a subsystem that was previously logged on will suspend its multidrop transmit and receive functions as follows:

- The INKEY$ function will not indicate data characters received by the multidrop interface and will always return a null string (value of zero).
- If an INPUT statement is encountered after the address is changed, the subsystem will effectively suspend program execution until it has been re-selected as the multidrop subsystem and the INPUT statement receives valid data terminated with a carriage return. If a logon command is received while an INPUT data message is being received (embedded within the data), the INPUT statement will ignore the data transmitted prior to the logon command, await its subsystem to be addressed with a new logon command, re-prompt with a “Redo from Start” message, and wait for valid data to be input terminated with a carriage return.
- The PRINT statement will complete transmission of the most recent (single) character being output to the multidrop transmitter, prior to issuing the change of the subsystem address. The subsystem’s multidrop transmitter will be disabled when subsequent characters are output, however the PRINT statement(s) will continue execution regardless of the logon state.

Due to the potential suspension, or hanging, of program execution if the selected subsystem address is changed while a subsystem is receiving input data, proper synchronization of the master and multidrop subsystems should be carefully developed. You may want to perform software handshaking to support the communications between the multidrop master and subsystems.

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RS-232 Notes

Serial data from the RS-232 RXD input is wire “or”-ed with the multidrop (RS-485) RXD input channel. Multidrop input communcations are not intended to be used simultaneously with RS-232 input sources.

Executing a PRINT statement when a multidrop subsystem is logged off will result in serial data being transmitted on the RS-232 channel only. When the subsystem is enabled, data will be transmitted on both the RS-232 and multidrop (RS-485) output channels.

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