Cambridge Technology

SC500
Scan Controller
User Manual

Part Number P0900-0150, Revision H

CAMBRIDGE TECHNOLOGY INC.

SC500 Scan Controller User Manual

P/N: P0900-0150
Rev: H

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Revision Notes

Revision C – July 2011

Location:	Update:
Tables and Figures	Revised and fixed with clearer images
Chapter 5 – Software	Added

Tutorial Appendix B and C	Added
Appendix A – Universal API Reference	Updated to reflect DLL changes and added functions
Entire Document	General Formatting and wording

Revision D – August 2011

Location:	**Update:**
Figure 2: Controller Layout	Laser pinout fixed
Table 3: Laser Connector – Standard Laser Configuration	Pinout fixed
Chapter 5 – Software	SyncDomain Naming conventions fixed
Entire Document	Light formatting

Revision E – September 2011

Location:	**Update:**
Chapter 2 – USB interface	Added USB protection comment
Chapter 2 – Laser and Auxiliary I/O connectors	Added ESTOP section
Chapter 5	Renamed chapter to “The SC500 SDK”
Chapter 5 – SyncDomains	Updated SyncDomain explanation
Chapter 5 – Lists	Updated List explanation
Chapter 5 – I/O	Updated I/O explanation
Appendix B	Combined tutorials in Appendix B; “Example Code
	Added Simple Input Detection example code
	Added FIFO management example code
Appendix D	Added appendix; Laser Configuration
Entire Document	Removed MOTF content
Entire Document	Spacing, minor grammar and spelling
Chapter 2 - Laser Control	Moved all laser control types to Appendix D
Chapter 3 – Theory of Operation	Removed MOTF reference
Chapter 5 – Software	Updated terminology

Revision F – October 2011

Location:	**Update:**
Chapter 2 – Figure 2: Controller Layout	Fixed laser/DB25 pinout inconsistency
Appendix E – ScanTest Application	New appendix added to detail this application
Appendix A – Universal API Command Reference	Added new error codes

Revision G – May 2012

Location:	**Update:**
General	Split Theory of Operation and all software-related sections into a separate Universal API manual

Revision H – January 2013

Location:	**Update:**
General	Updated Address

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Chapter 1

Important Information

Safety

Please read all operating instructions completely before installing and using the SC500 board.

Laser Radiation: Do not stare directly into a laser beam. Follow all system laser safety requirements during installation and operation. Cambridge Technology recommends the use of a shutter to prevent unwarranted emission of laser radiation, where practical.

Use of controls, adjustments, or procedures other than those specified in this manual without consulting a competent safety professional may result in component damage, and/or exposure to potential hazards. Always follow established industrial safety practices when operating equipment.

ESD Warning

The electronics that Cambridge Technology manufactures - including the SC500 controller - are electrostatic discharge (ESD) sensitive. Improper handling could therefore damage these electronics. Proper handling is required. The SC500 drivers and receivers for XY2-100 are rated for ESD protection to 15kV. All controller I/O pins resist ±2kV ESD per the human body model (100pF capacitor and 1500Ω resistor).

Cambridge Technology has implemented procedures and precautions for handling these devices and we encourage our customers to do the same. Upon receiving your components, you should note that it is packaged in an ESD-protected container with the appropriate ESD warning labels. The equipment should remain sealed until you are located at a proper static control station.

A proper static control station should include:

- A soft grounded conductive tabletop or grounded conductive mat on the tabletop.
- A grounded wrist strap with the appropriate (1 Mega Ohm) series resistor connected to the tabletop mat and ground.
- An adequate earth ground connection such as a water pipe or AC ground.

- Conductive bags, trays, totes, racks or other containers used for storage.
- Properly grounded power tools.
- Personnel handling ESD items should wear ESD protective garments and ground straps.

Note: Any equipment returned to the factory must be shipped in anti-static packaging.

Unpacking

Carefully unpack the contents from the box and inspect each item for damage. Check the contents of the box against the packing list to ensure reception of all parts. Contact customer service immediately if you suspect shipping damage or an incomplete shipment. Save the shipping container and packaging material in case you need to return a unit for service.

Warranty Information

The Customer shall examine each shipment within 10 days of receipt and inform Cambridge Technology of any shortage or damage. If no discrepancies are reported, we shall assume the shipment was delivered complete and defect free. Cambridge Technology warrantees products against defects up to 1 year from manufacture date, barring unauthorized modifications or misuse. Repaired product is warranted 90 days after the repair is made, or one year after manufacture date - whichever is longer.

Contact Customer Service to obtain a Return Materials Authorization (RMA) number before returning any product for repair.

All orders are subject to the Cambridge Technology Terms and Conditions and Limited Warranty. Contact your local sales office for the latest version of these documents and other useful information.

Customers assume all responsibility for maintaining a laser-safe working environment. OEM customers must assume all responsibility for CDRH (Center for Devices and Radiological Health) certification.

Customer Support

Cambridge Technology has support services to address your questions or concerns with either the product or the manual you are using. Before calling for assistance, be sure to refer to any appropriate sections in the manual that may answer your questions. Call Cambridge Technology's Customer Service Department Monday through Friday between 8 A.M. and 5 P.M. local time (GMT – 05:00 Eastern Time (US & Canada)). Customer service personnel will be able to give you direct assistance and answers to your questions. See the Copyright page for contact information.

Chapter 2

General Description

System Description

Cambridge Technology continues the advancement of scan and laser control products with the SC500 scan controller.

The SC500 scan controller:

- Connects to a host PC through a USB port to provide digital or analog commands to scanner sets and scan heads.
- Enables easy system integration with its laser control (interfaces including CO_2 tickle pulse and first pulse suppression) and opto-isolation of IO ports.
- Comes with a fully functional software library. In addition, Cambridge Technology offers the ScanMaster API as well as ScanMaster Designer*

**For more information see www.camtech.com*

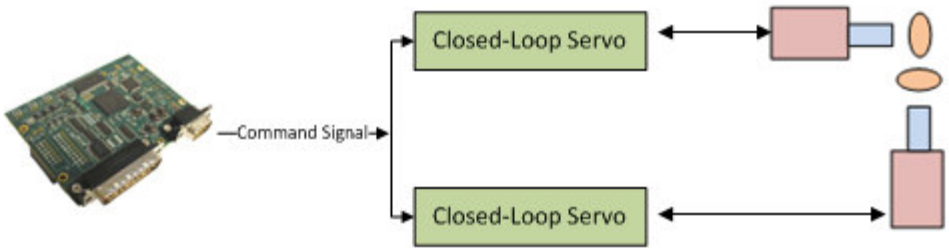


Figure 1: Typical Two-Axis Optical Scanning System

(including galvos, servos, and control electronics)

The SC500 controller and software package is intended to provide essential laser marker functionality, with a feature set adequate for most marking applications. The SC500 scan controller and software can be used for welding, laser guidance and many other applications.

The SC500 scan controller is connected to a host PC via a USB connection. This is often the same PC used as the human machine interface (HMI) in a production application.

The SC500 has mounting holes for securely fastening it to a chassis assembly and can be placed up to 3 meters from the PC. The SC500 controller is designed for ease of embedding within a scan head or the PC itself.

Hardware features

- USB 2.0 Interface
- 2 general purpose optically isolated outputs for interface to automation systems.
- 2 general purpose optically isolated inputs plus one high speed Start Mark input for interface to automation systems.
- 0-5V analog isolated Laser power control Output
- Direct cable-level interfacing with the IPG YLP type-B interface.
- Power input from a male DB9 power connector.
- Three 4-conductor Molex 3mm connectors for power connection to servos.
- Three 6-conductor Molex 2mm signal connectors for analog servo control.
  (3-axis analog command signals using 16 Bit D/A Converters to convert digital position command to +/-10V differential analog voltage).
- Generates 3-axis XY2-100 output as defined in the industry standard digital XY2-100 communication specification and accepts return of status information over the interface.
- Monitors configurable servo ready signal from servos and updates via XY2-100 data stream.
- Connectors can be populated on either the top or bottom of the board if necessary to accommodate different packaging designs.

Software Features

- Command Data Stream
- Status Data Stream
- Optional Programmable laser control and I/O connectors pinout
- Compatibility with Windows XP, Vista and 7.

Layout

The controller layout is shown below. Dimensions are shown in inches. The outer board dimensions are 3.9" (9.91 cm) by 2.9" (7.36 cm). The DB9 and DB25 connectors are in the same relative locations as most XY2-100 receiver boards.

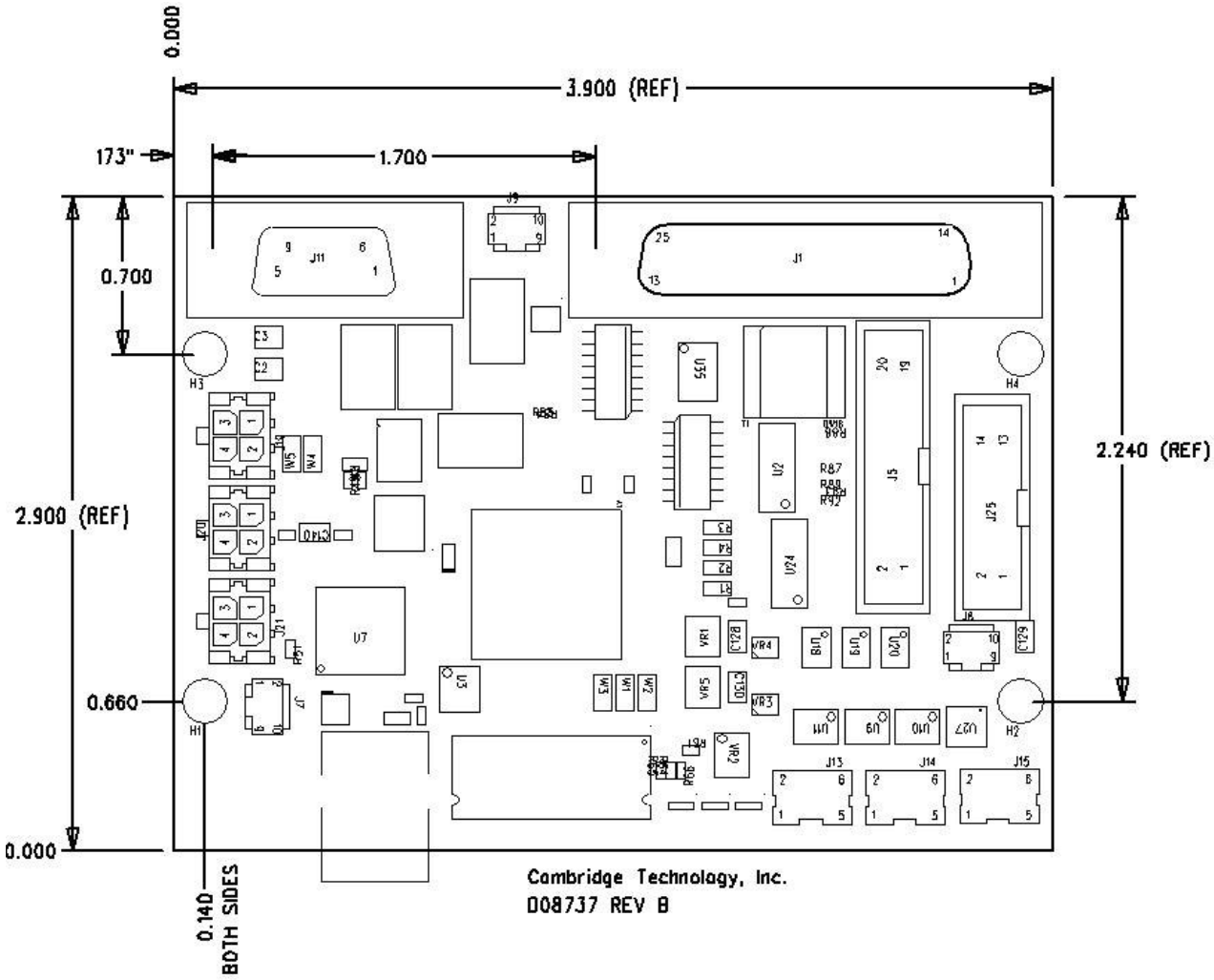


Figure 2: Controller Layout

NOTE: There are two unlisted connectors, one located below the XY2-100 port, and another located under the USB 2.0 port. These connectors are used to configure the board during manufacture ONLY and are not for customer use.

Inputs and Outputs

Connector Identification

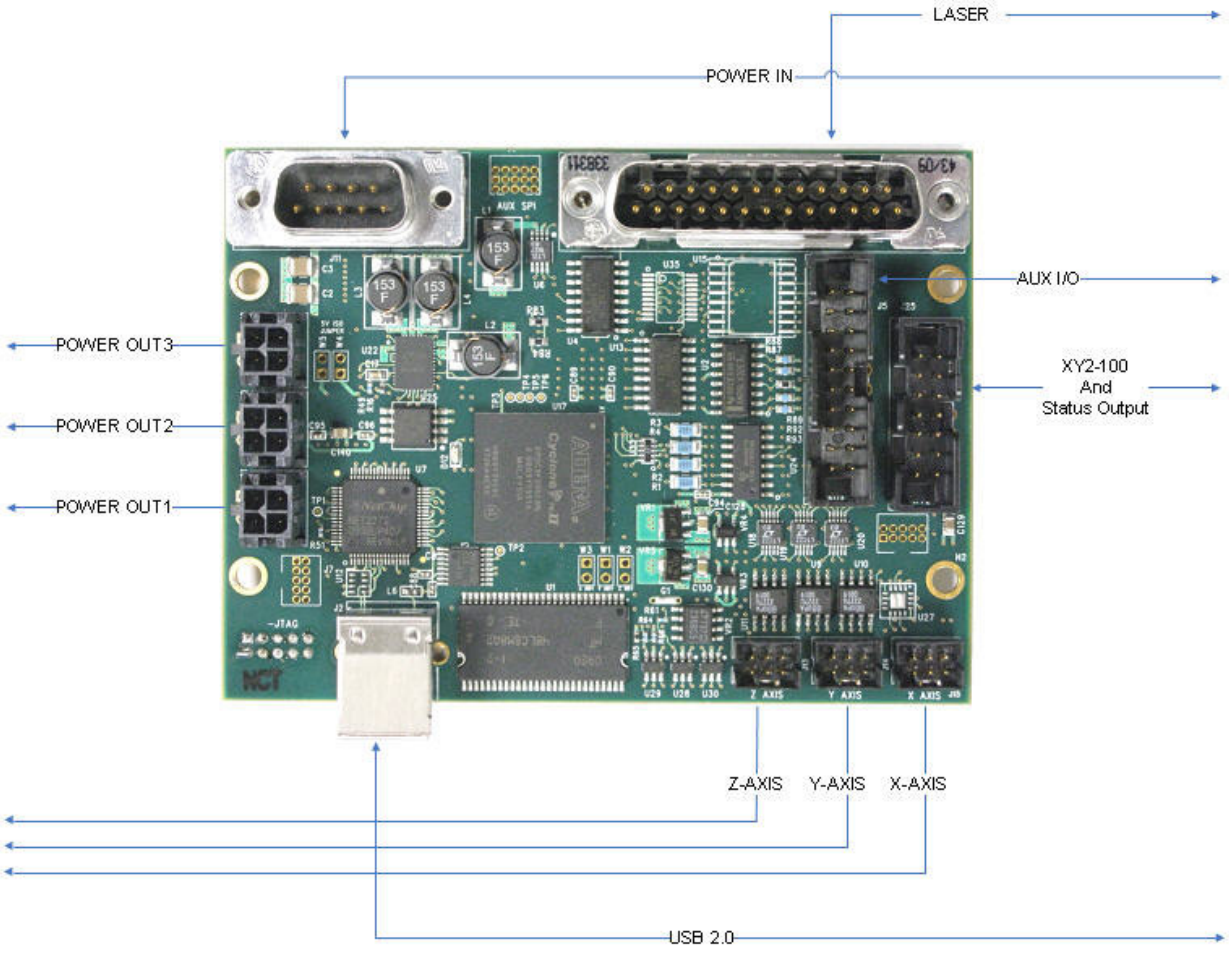


Figure 3: SC500 Connectors

Connector Options

The SC500 is provided with a standard connector configuration as depicted in the table below. The additional connector options in the table are available for qualified customers.

Connector	Default	Option
Power & Laser (D-sub)	Straight (vertical)	Edge (right-angle)
Servo outputs	Top of Board (same as D-sub)	Bottom of Board
Analog circuitry	Included	Omitted
USB	B-style Socket	5-Pin Header

Table 1: Connector Options

Power Input – DB9 Straight or Edge Connector

The acceptable voltage for this input connection is ±15V to ±28V DC. The board will require no more than 200mA of current.

Make sure not to exceed the power requirement of the scanner set / scan head connected to the SC500 controller! Please refer to the scanner set or scan head hardware's documentation that you are connecting to the SC500.

Pin	Function	DB9 Mating Connector Pinout
1	- Supply	
2	- Supply	
3	Power Return (tied to Sig. Ground)	
4	+ Supply	
5	+ Supply	
6	- Supply	
7	Power Return (tied to Sig. Ground)	
8	Power Return (tied to Sig. Ground)	
9	+ Supply	

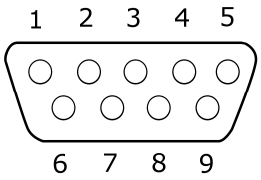


Table 2 Power Input Connector

SINGLE OR DUAL POWER SUPPLY CONFIGURATIONS

The power input can be configured either as a single or a dual power supply depending on the system configuration, as seen in the following examples.

If the servos are powered through the SC500, a single power supply is required, as shown in the following diagram.

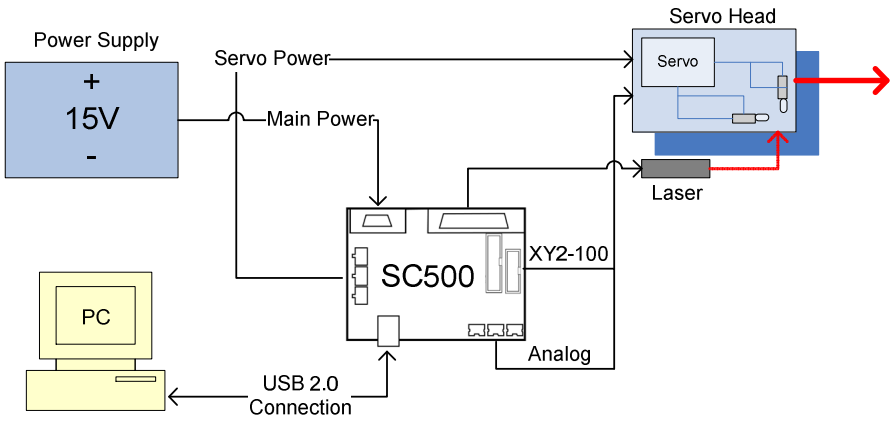


Figure 4: Servos Powered through SC500

If the servos are powered directly by a separate power supply and the SC500 is generating a digital (XY2-100) command, a dual power supply is used, as shown in the following diagram.

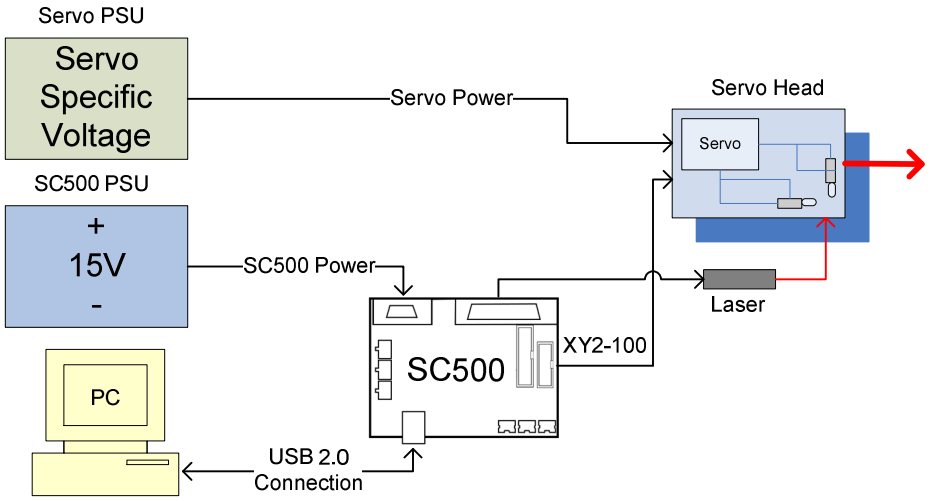


Figure 5: Servos Powered Directly - Digital Command

If the servos are powered directly by a separate power supply and the SC500 is generating an analog command, a dual power supply is used, as shown in the following diagram.

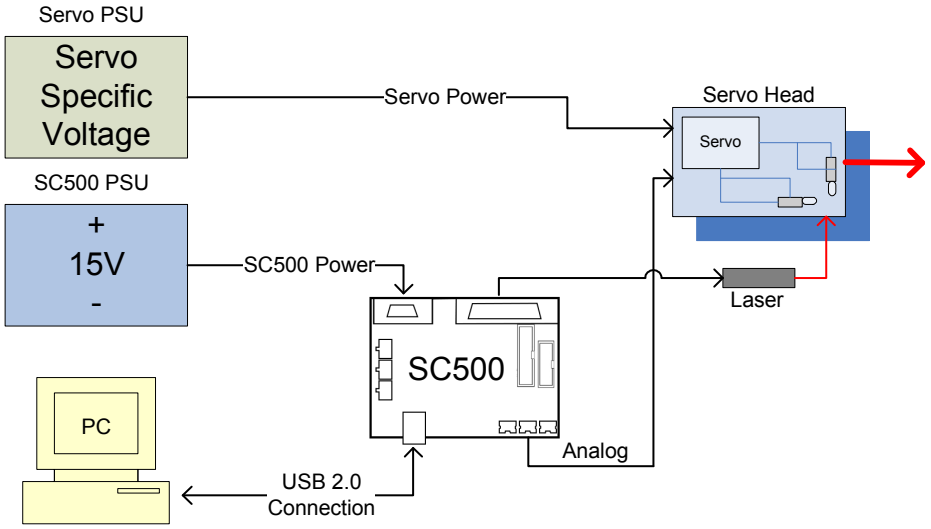


Figure 6: Servos Powered Directly – Analog Command

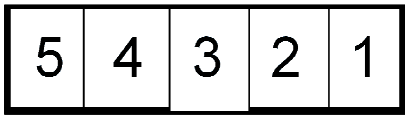
USB Interface

A USB 2.0 connection is used to stream data to and from the PC through a right-angle USB edge connector on the side edge of the board.

For implementation inside a scan head, a 5-pin 0.1" inline header is available for cabling to a bulkhead USB connector, such as the Bulgin P/N PX0443.

The controller buffers the data on both sides of the USB connection, to prevent any disruptions in the command data. The board does not draw any power from the USB connector.

To prevent a ground loop from damaging the PC, we suggest using a USB hub for the SC500 connection.

Pin	Function	J12 USB Board Connector Pinout
1	VCC	
2	D-	
3	D+	
4	GND	
5	Shield	

Laser Control – DB25 Edge or Straight Connector

The SC500 Utilizes a DB25 connector for laser control. The pinouts can be found in Appendix A – Laser Configurations. Appendix A also shows the pin functions for lasers commonly used with the SC500.

Servo Power Output – Molex 43045-0414 connector

Mate: Molex 43025-0400 (contacts 43030-0006 for 26-30AWG).

Each of these 3 connectors sends power and ground to one servo driver. The pinout matches the CTI ASD and 677 Servo board power connectors to simplify cabling.

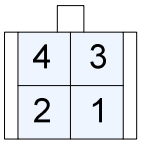
Pin	Function	Molex Mating Connector Pinout
1	Signal Ground	
2	Chassis Ground	
3	-VDRV	
4	+VDRV	

Table 3: Servo Power Connector

Analog Servo Command - Molex 87831-0620 connector

Mate: Molex 51110-0660 (contacts 50394-8200 for 26-30AWG).

These connectors are used to send the ±10V differential analog command voltage to the X, Y, and Z servo drivers. They also return digital servo ready signal to the board, as well as a probe signal feedback. The board provides a pull-up for the active low servo ready signal if available.

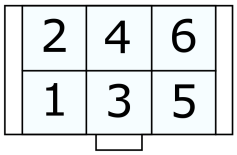
Pin	Function	Molex Mating Connector Pinout
1	-Command Out	
2	+Command Out	
3	~Ready*	
4	Chassis Ground	
5	Probe In	
6	Signal Ground	

Table 4*:* Servo Analog Connector

**Ready signal input from the servo. Servo Ready can be connected to the signal ground if a signal is not required from the servo.*

Servo XY2-100 Command – 14 pin IDC Header

This interface is used to generate 3-axis digital position commands and to report servo status.

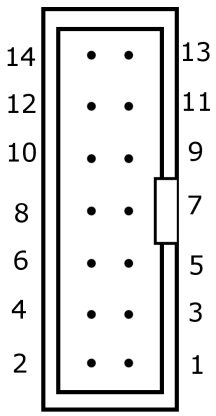
Pin	Name	XY2-100 Serial Link	XY2-100 Board Pinout
1	CLK-	Clock, 1.875MHz nominal	
2	CLK+		
3	SYNC-	Indicates start of 20-bit data word	
4	SYNC+		
5	XDATA-	20-bit X-axis data send	
6	XDATA+		
7	YDATA-	20-bit Y-axis data send	
8	YDATA+		
9	ZDATA-	20-bit Z-axis data send	
10	ZDATA+		
11	STAT-	20-bit status return	
12	STAT+		
13	NC		
14	NC		

Table 5*:* Servo XY2-100 Connector

All XY2-100 output differential pairs are driven to EIA-422 standard.

STAT differential inputs are terminated by 150Ω plus 680Ω bias (input + 680Ω to 3.3V, input -

Status Channel Data

2-axis status data is generated from Status Channels per the following table:

Bit	XY2-100 definition	Value
C2	0	0
C1	1	1
C0	1	1
S15	Power Status	XReady & YReady
S14	Temperature Status	1
S13	In-field	1
S12	1	1
S11	1	1
S10	1	1
S9	x	0
S8	x	1
S7	Power Status	XReady & YReady
S6	Temperature Status	1
S5	In-field	1
S4	1	1
S3	1	1
S2	1	1
S1	x	0
S0	x	1
Par	x (no parity)	even parity

Table 6: XY2-100 Status

Auxiliary I/O

A 20-pin IDC header is provided for auxiliary I/O. Many of the signals on the Auxiliary I/O pins also occur on the Laser Connector as seen in the following table.

Pin	Pin Name	Special Use	Laser Connector (See Table 3)	SMD Pin Name*	Description	Auxiliary I/O Board Pinout
1	GPO0	fifo_underrun			Data can't be delivered to SC500 fast enough	
2	GPO1	not_busy			SC500 in idle state	
3	GPO2	Laser Master Oscillator	Pin 18			
4	GPO3	Guide Laser	Pin 22			
5	GPO4	Free for user	Pin 1	UserOut 3	User Out Data	
6	GPO5	Free for user	Pin 2	UserOut 4	User Out Data	
7	GPO6	Laser Data 2	Pin 3			
8	GPO7	Laser Data 3	Pin 4			
9	GPI0	(Encoder In)				
10	GPI1	(MOTF Event)		Start Mark	Start marking process	
11	GPI2	Laser Status 0	Pin 21			
12	GPI3	Laser Status 1	Pin 16			
13	GPI4	Free for user		UserIn3	User In Data	
14	GPI5	Free for user		UserIn4	User In Data	
15	GPO15	LSR_PWR_PWM_OUT			PWM signal**	
16	ESTOP	Configured to 5V pull-down	Pin 23		Pin is *only* for laser use	
17	+5.0_ISO					
18	GND_ISO					
19	LSR_PWR_ANALOG				0 – 5 V signal 300 KHz BW**	
20	GND_ISO					

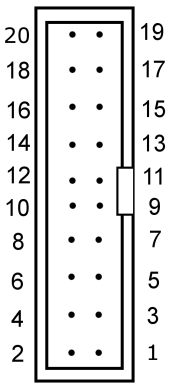


Table 7*:* Auxiliary I/O Connector

**ScanMaster Designer software ScanScript scripting language.*
For more information about ScanMaster Designer software and ScanScript see www.camtech.com

*** Signal proportional to the 8-bit laser digital power command.*

The Auxiliary I/O Connection is intended to allow the SC500 board system level integration.

The I/O Ports are accessed via the physical pins described in the table above and are managed using the Universal API Software Development Kit provided.

NOTE: The pinout and accessibility described is only applicable to a standard configuration of the board and can change as per your configuration.

ESTOP PIN

The ESTOP pin listed in the Auxiliary I/O connector (pin 16) is routed directly to the ESTOP pin listed in the Laser Control connector (pin 23). This pin is only for the IPG laser, but can be used for other laser configurations (see Appendix D – Laser Configurations). The two pins (Auxiliary I/O pin 16 and Laser Control connector pin 25) are tied to a resistor which pulls both to a logic high state (5V), and does nothing else.

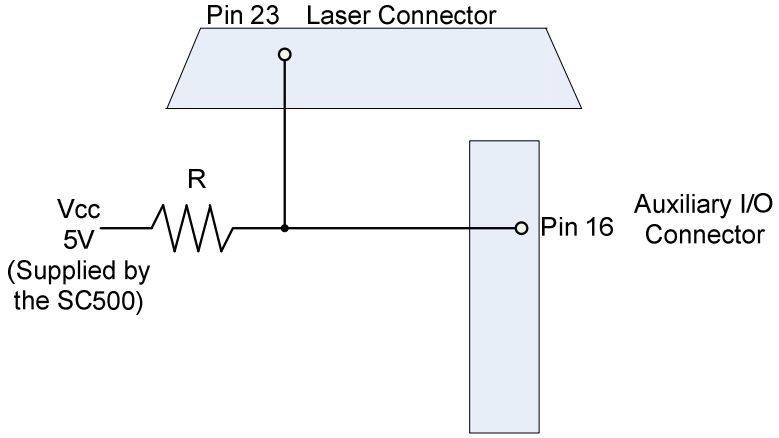


Figure 7: user ESTOP

The intended use of these pins is to have the Laser Control connector's ESTOP pin be plugged into the IPG laser, and the Auxiliary I/O connector's ESTOP pin be connected to some external switch/failsafe solution. The switch should pull the ESTOP pin state to a logic low by grounding it, when this happens the Laser Control connector ESTOP pin will also be grounded and the laser will be forced to turn off via its own failsafe mechanism.

Grounding the ESTOP pin will have no effect on the SC500, and is NOT a hardware failsafe solution for the SC500.

If you are not using an IPG laser, you are still free to utilize the functionality offered from these pins to implement your own failsafe solution or use it for some other implementation of your choosing.

User Output Signal Conditioning

The user output signal conditioning for pins GPO 0 – GPO11 is illustrated in the following figure. See Table 7 for corresponding pin numbers on the Auxiliary I/O connector.

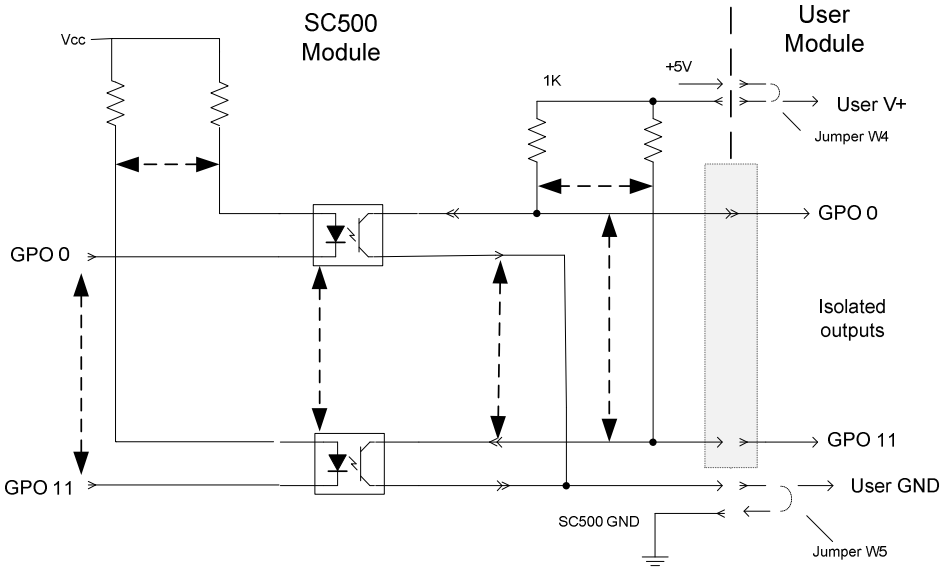


Figure 8: User Output Signal Conditioning

NOTE: User Output on pins GPO 12 – GPO 15 (the Fast lines) are driven by a high speed isolator interface component (ISO7240).

User Input Signal Conditioning

The user input signal conditioning for pins GPI 0 – GPI 5 is illustrated in the following figure. See Table 7 for corresponding pin numbers on the Auxiliary I/O connector.

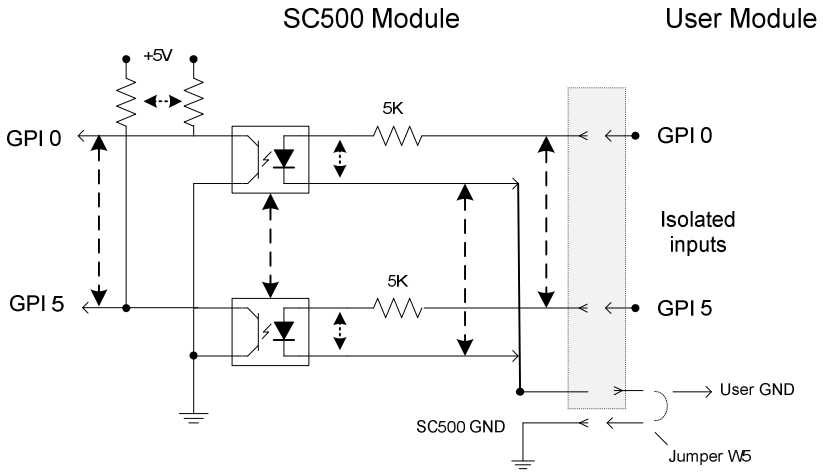


Figure 9: User Input Signal Condition

Jumper W4 and W5

Jumpers W4 and W5 give the option to isolate the outputs and voltage from the SC500 and allow them to be user-supplied.

Leaving the jumpers in place will keep the outputs and voltage supplied by the SC500.

Removing the jumpers will allow the outputs to be isolated and user-specified.

Jumper W4 – jumps Voltage

Jumper W5 – jumps Ground

It is recommended to either leave both jumpers in place or remove both, leaving only jumper W4 in may potentially cause damage to the board.

Environmental Requirements

- Operating temperature: +10 to +60ºC
- Storage temperature: -20 to +100ºC
- Humidity: 10% to 85% RH non-condensing
- Shock: 500G (0.5ms half sine-wave)
- Vibration: 10G (55Hz to 2kHz) operating

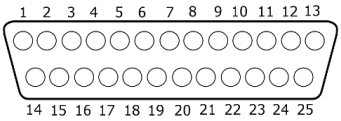
Appendix

A

Laser Configurations

This appendix shows the pin functions for lasers commonly used with the SC500. Below is an image of the DB25 straight or edge board connector and its pin numbers for reference (looking towards the connector on the SC500):

DB25 Pinout:



Also shown is how the guide laser should be connected and controlled.

Pin	Pin Definitions for Common Laser Types see Note 1			Access through the Universal API		Level
	IPG YLP Type "B"	CO2	Lasers with FPS	UAPI Designations	UAPI Commands	
1	Laser Power, Bit 0, LSB			DIGITAL_OUTPUTS (Bit 4)	see Note 2	TTL/CMOS
2	Laser Power, Bit 1			DIGITAL_OUTPUTS (Bit 5)	see Note 2	TTL/CMOS
3-8	Laser Power, Bits 2-7			n/a	UA_set_laser_power UAL_set_laser_power	TTL/CMOS
				DIGITAL_LASER_POWER	UA_write_io_port UAL_write_io_port	
9	Laser Power Latch Control		Laser Modulation	n/a	see Note 3	TTL/CMOS
10-15	Ground	Ground	Ground	n/a	n/a	Ground
16	Laser Alarms Status, Line 1			DIGITAL_INPUTS (Bit 2)	UA_read_digital_port	TTL/CMOS
17	Guide Laser DC Power	Guide Laser DC Power	Guide Laser DC Power	n/a	n/a	5±0.25VDC
18	Master Oscillator On/Off			DIGITAL_OUTPUTS (Bit 12)	see Note 2	TTL/CMOS
19	Power Amplifier On/Off		Laser Modulation Gate	n/a	see Note 3	TTL/CMOS
20	Pulse Synchronization	Laser Modulation	First Pulse Suppression	n/a	see Note 3	TTL/CMOS
21	Laser Alarms Status, Line 2			DIGITAL_INPUTS (Bit 3)	UA_read_digital_port	TTL/CMOS
22	Guide Laser On/Off	Guide Laser On/Off	Guide Laser On/Off	DIGITAL_OUTPUTS (Bit 13)	see Note 2	TTL/CMOS
23	Emergency Stop	Emergency Stop	Emergency Stop	n/a	see Note 4	TTL/CMOS
24	Ground	Ground	Ground	n/a	n/a	Ground
25	Laser Power Output Monitor			n/a	n/a	NC

Table 8: Connection relationships between UAPI, SC500, and various laser types.

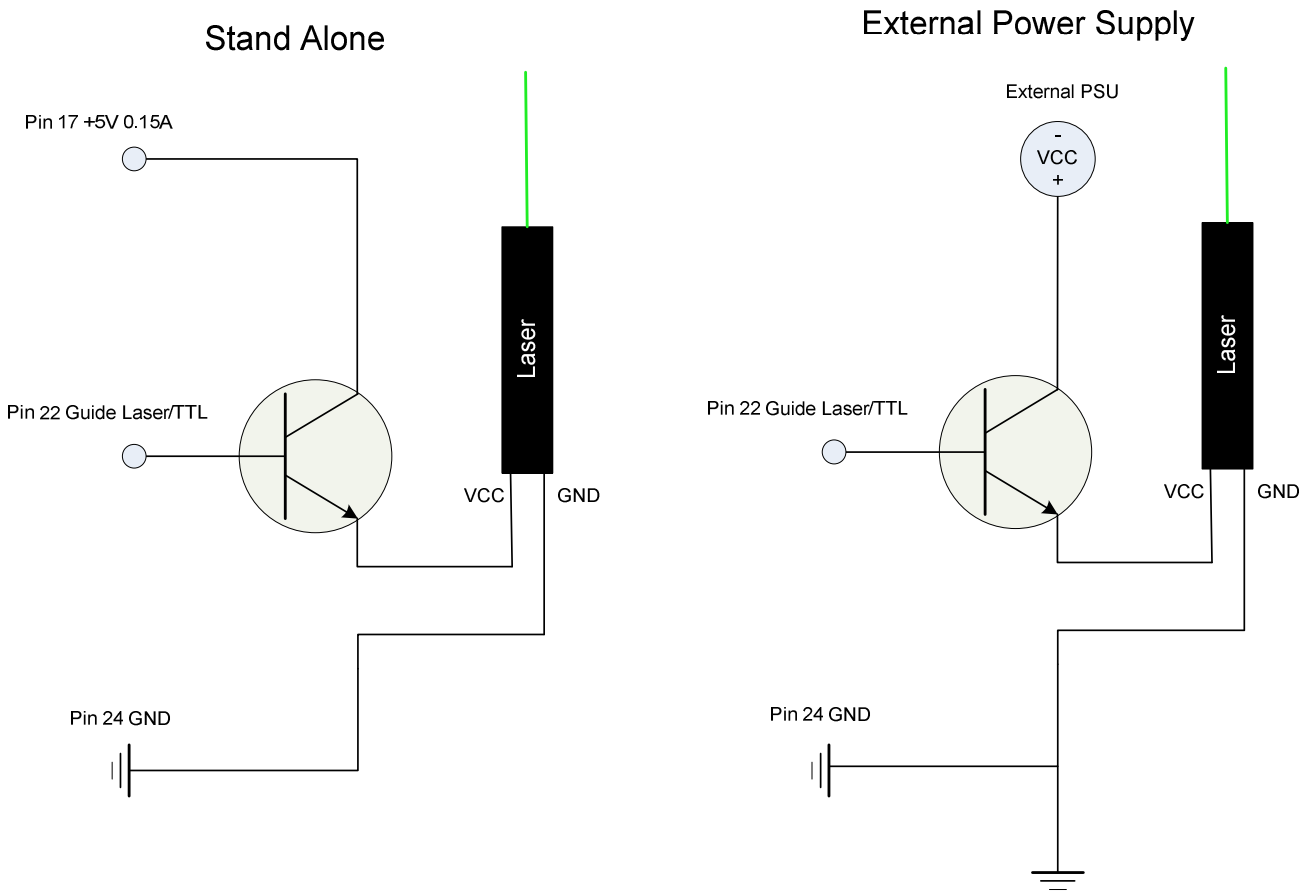
Notes:

1. These pin definitions are for differing factory configurations. Entries for the IPG laser and the CO2 laser refer to the standard SC500 configuration. Lasers needing FPS (First Pulse Suppression) require a special factory configuration.

2. All commands for writing to digital ports can be used. These are as follows: UA_write_io_port, UA_assert_io_port, UA_clear_io_port, UAL_write_io_port, UAL_assert_io_port, UAL_clear_io_port.

3. These pins are not directly controllable via UAPI commands, but are driven by the SC500 when necessary as the result of issued UAPI commands.

4. Pin 23 is routed to pin 16 on the SC500's auxiliary IO header connector, and is pulled up to 5V. The UAPI has no control over this pin.



For guide lasers that require < 150mA of current

For guide lasers that require ≥ 150mA of current

Figure 10: Guide Laser Setup

End of Document