Controller-USB

User Manual

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General Information

About Controller-USB

Controller-USB is part of the SCORBOT robotic system. In addition to the robot arm, it can also be used to control peripheral motorized devices. A teach pendant is available for this system.

The basic robotic system is comprised of three hardware components:

- Controller-USB
- SCORBOT robot arm
- Computer

The robot, teach pendant and the controller are shown in Figure 1-1.
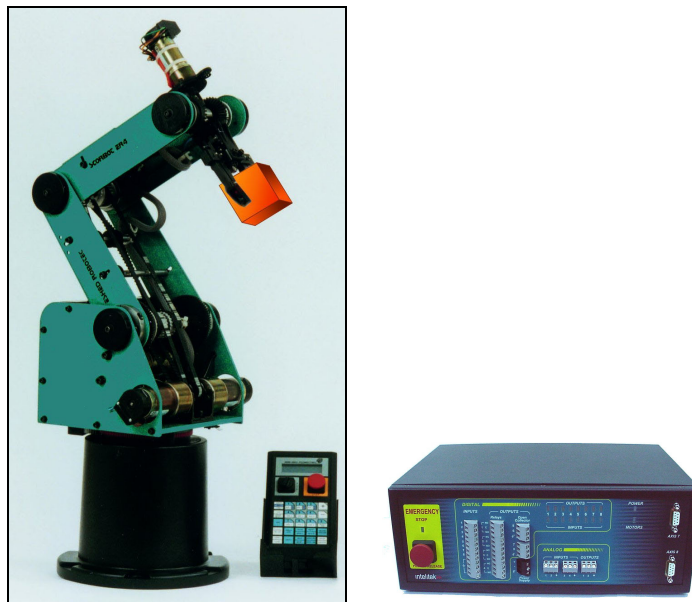
Figure 1-1: System Overview

The computer is connected to Controller-USB via a USB module. The robot is connected to Controller-USB by a proprietary interface cable. See block diagram in Figure 1-2.

Controller-USB controls the 24V power supply to six robot motors and to two motors of (optional) peripheral devices (axes 7 and 8).

Controller-USB contains the circuits that control the motors (by means of PWM signals), and reads the encoder and microswitch signals.

Analog and digital I/O devices can also be interfaced with Controller-USB via the digital and analog I/O ports.

Controller-USB can be connected to:
- Teach pendant (enables direct manual control of axes)
- Two motorized peripheral devices
- Analog and digital I/O devices
- RS232 communication port (for future use).
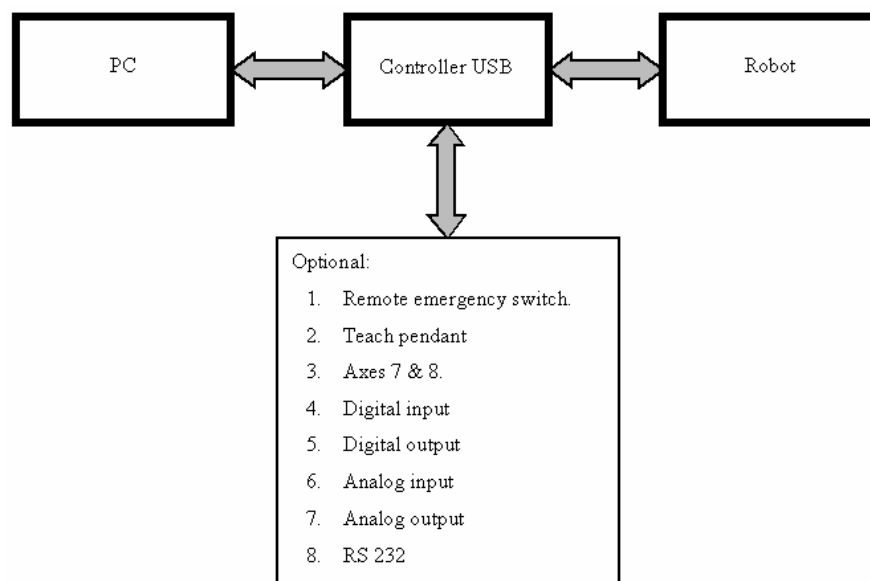
Figure 1-2: Block Diagram

Acceptance Inspection

After removing Controller-USB from the shipping carton, examine all components for signs of shipping damage. If any damage is evident, do not install or operate Controller-USB. Notify your freight carrier and begin appropriate claims procedures.

The following items are standard components in Controller-USB package.

Make sure you have received all the items listed on the shipment's packing list. If anything is missing, contact your supplier.

	Controller-USB Package packing list
1.	Controller-USB 110/220V AC
2.	Cables: Power Cable 110/220 VAC UBS Cable Remote emergency switch by pass cable.
3.	Emergency Bypass Plug (required when TP not connected)
4.	SCORBASE software - on CD.
5.	Documentation: Controller-USB User Manual SCORBASE User Manual
6.	Teach Pendant (TP) (Optional and supplied only when ordered): Teach Pendant Mounting fixture; Teach Pendant for Controller-USB User Manual

Repackaging Controller-USB

Save the packing materials and shipping carton. You may need them later for shipment or for storage of Controller-USB.

Controller-USB should be repacked in its original packaging for transport.

Specifications

The following table describes Controller-USB specifications:

Controller-USB Specifications	
Item	**Specification**
Type of Control	Real time; Multi-tasking; PID (proportional, integral, differential); PWM (pulse width modulation).
Number of Servo Axes	Maximum: 8
Groups of Control	6 robot axes and 2 peripheral axes. Axis interpolation in robot and peripherals groups.
Axis Drivers	PWM H-bridge drivers 15 kHz, 3A standard; 7A peak 12/24V (depending on input voltage and load)
Path / Trajectory Control	CP: Joint; Linear; Circular. 1.5 ms control cycle parameter. Software controlled acceleration/deceleration. PID parameters.
Speed Control	Speed or Travel time definitions. Ten speed levels are available
Control Parameters	I/O control Speed, velocity profile, smoothing Axis position error Gripper operation Thermic, impact, limit protection Homing Encoder interface Cartesian calculations
Power Requirements	110/220V AC (+15%, -10%), 50/60Hz, 180W max.
Internal Power Supplies	Servo: 24V (depending on input voltage and load) Digital: 5V, +15V, -12V
Weight	7 kg (15.4 lb)
Dimensions	L=315mm; W=223.5mm; H=117 (L=12.4"; W=8.8"; H=4.6")
Ambient Operating Temperature	10°–35°C (36°-104°F)
Microcontroller	NEC V853 on I/O card

Controller-USB Specifications	
Item	**Specification**
Communication	2 integrated RS232 channels: one for teach pendant; one for future use.
12 Volt power supply	12 volt power supply 0.1A Max
Digital Outputs	8 digital outputs, 24V max. 1.5A Max. 1 – 4: relays 5 – 8: open collectors sink/source configurable
Digital Inputs	8 Dry Contacts or 0 – 24 V 0.5A Max. PNP/NPN (high/low) configurable.
Analog Outputs	2 analog outputs: 8-bit resolution; 20mA Max. output voltage 0–10V
Analog Inputs	4 analog inputs 8-bit resolution digital signal; input voltage 0–10V
Programming and Position Teaching	SCORBASE software; RoboCell 3D simulation software (optional); Teach Pendant (optional)
Types of Positions	Absolute; Relative; Cartesian; Joint (angle); Encoder
Position Feedback	Incremental optical encoders for each axis
Coordinate Systems	XYZ coordinates; Joint coordinates

LED Indicators	Main power, alternating colors:
	  power on and communicating with PC(green);
	  power on and not communicating with PC (orange);
	8 digital inputs;
	8 digital outputs;
	Emergency

Safety Features	Emergency switches: on Controller-USB; on Teach Pendant; optional connection of remote switches.
	Short-circuit protection; On overheating, driver power shutdown; On failure, motor power shutdown; On communication failure, motor power shutdown.
	Thermal, impact and limit software protection Hardware watchdog for each axis protects against software faults.

2

Safety

Handling Controller-USB

Do not hold Controller-USB by either the front or rear panels.

Make sure that all cables are disconnected before moving Controller-USB.

Warnings

- Do not operate Controller-USB until you have studied this manual thoroughly.
- Do not install or operate Controller-USB under any of the following conditions:
  - Power supply is not grounded
  - Ambient temperature drops below or exceeds the specified limits
  - Exposed to large amounts of dust, dirt, salt, iron powder, or similar substances
  - Subject to vibrations or shocks
  - Exposed to direct sunlight
  - Subject to chemical, oil or water splashes
  - Corrosive or flammable gas is present
  - Power line contains spikes
  - Near any equipment that generates large electrical noise.
- Turn off Controller-USB before you connect any inputs or outputs.
- Do not plug Controller-USB into the AC power outlet before making sure that its voltage requirement (as marked at the rear panel of Controller-USB) matches your voltage supply.

  If the voltage setting does not match your supply, follow the instructions for changing the controller's voltage setting in the chapter "Maintenance".
- Do not connect voltage source to input terminals exceeding +24V.

- Do not connect any output device that does not meet Controller-USB specifications.
- Never connect voltage from an external power supply directly to any open collector outputs.
- Always connect the open collector outputs to a load that meets Controller-USB specifications.
- Do not drive a current higher than 1.5A through the relay outputs. Do not drive a current higher than 0.5A through the open collector outputs.
- Make sure that the voltage supply of a device connected via the relay output does not exceed 24VDC.

Emergency Button

Pressing the Emergency button disconnects the power supply to the robot, to axes 7 and 8, and halts the SCORBASE program. The digital and analog outputs freeze their status.

3

Installation

Getting to Know Controller-USB

Before beginning the installation, it is recommended that you familiarize yourself with Controller-USB. Refer to Figures 3-1 and 3-2 and the legends that follows.
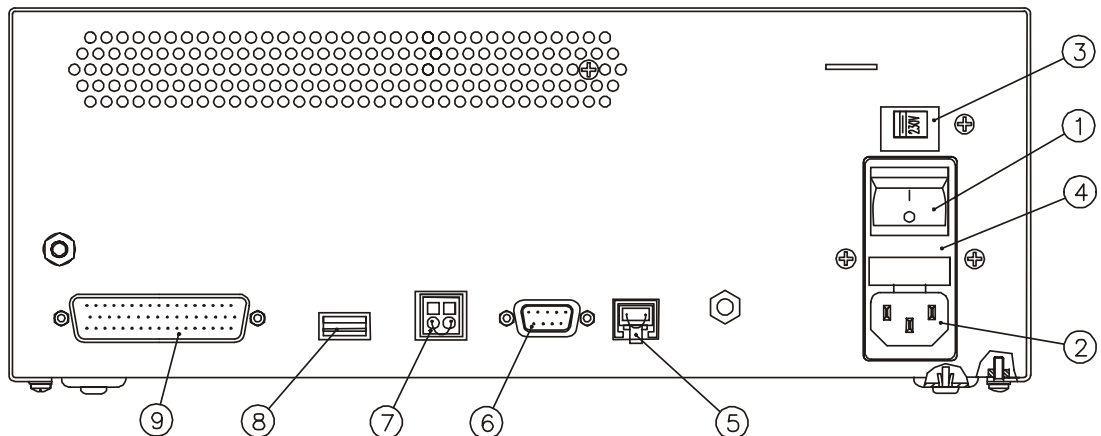
Figure 3-1: Controller-USB - Rear Panel

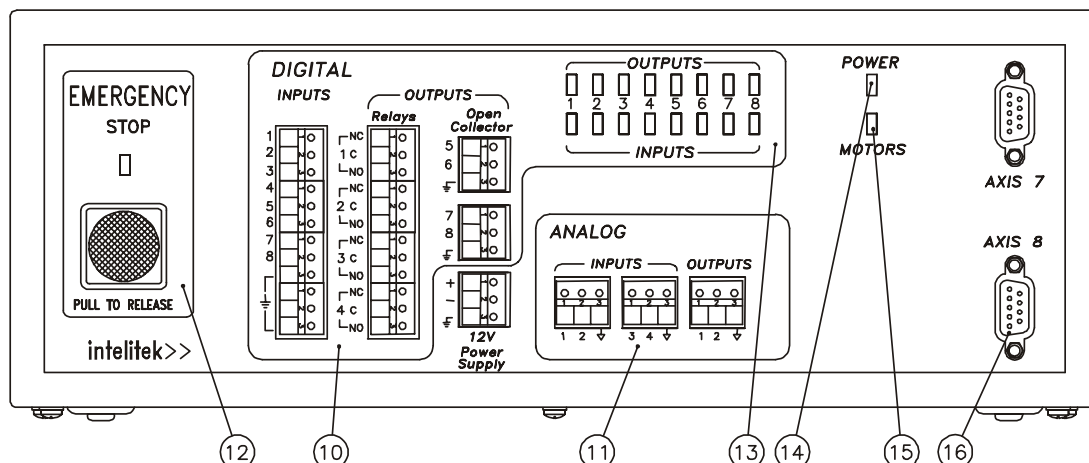| Legend: Controller Rear Panel	
1	Power On/Off Switch
2	Power Line 110/220VAC socket
3	Line Voltage Selector
4	AC Power Fuse Drawer - 110V 2A; 220V 1A
5	TEACH PENDANT connection
6	RS232 COM. port for future use
7	Remote EMERGENCY switch 2-pin connector
8	USB connector (to PC)
9	Robot 62-pin D-type high density connector

Figure 3-2: Controller-USB - Front Panel

Legend: Controller Front Panel	
10	Digital Input / Output terminals
11	Analog Input / Output terminals
12	Emergency Button and LED indicator
13	Digital Input / Output LED indicators
14	Power LED indicator). See below
15	Motors LED indicator (lit when control on). See below.
16	Axes 7 and 8 driver D9 connectors (separate for each device)
17	Auxiliary 12 V dc Supply. - 0.1 Amp max.

When Robocell is activated in online mode, the POWER LED changes color to indicate the following:

- **Green:** The controller is turned on and is currently communicating with the PC.
- **Orange:** The controller is turned on but is currently **not** communicating with the PC.

The MOTORS LED indicates whether or not power is being supplied to all connected motors. This LED lights after SCORBASE is activated and the CON (control on) command is issued.

The MOTORS LED goes out whenever any of the following occurs:

- COFF (control off) command is issued.
- EMERGENCY button is pressed.
- Controller-USB detects a communication time-out.
- Controller-USB detects an over-current error
- SCORBASE closes.

Computer Requirements

To operate and control the robot using SCORBASE and Controller-USB, the following requirements must be met:

- Pentium IIIPC with 350 MHz processor, or higher.
- At least 128 MB of RAM.
- Hard drive with at least 20 MB of free disk space.
- Windows 98/2000.
- Super VGA or better graphics display, minimum 256 colors.
- A mouse or other pointing device.
- USB port.

Installing Controller-USB

Do not yet connect Controller-USB to the AC power supply.

The numbers in parentheses refer to Figures 3-1 and 3-2.

1. Make sure that Controller-USB voltage setting (3) matches your power supply. If the voltage setting does not match your supply, refer to Changing the Voltage Setting in the chapter "Maintenance".

2. Make sure the controller's power switch (1) is turned off.

3. Connect the controller's USB socket (8) to the USB socket on the computer.

4. Connect the robot cable to the ROBOT port (9) on the controller. Tighten the connector screws.

5. If a teach pendant will *not* be used, connect the emergency bypass plug to the teach pendant port (5) on the controller's rear panel.

   To use a teach pendant, connect it to the TEACH PENDANT connector (5) on the controller's rear panel.

   It is recommended that you set the Teach Pendant Auto/Teach switch to AUTO before you power on the system. If the switch is set to AUTO, the robot can be controlled either from the teach pendant or via Controller-USB. For more details, refer to the teach pendant's user manual.

6. Connect the power cable to the POWER socket (2) on the controller's rear panel and to a grounded AC power source.

7. If a remote emergency switch is not in use, connect the emergency switch bypass cable to the EMERGENCY terminal (7) on the controller's rear panel.

8. To install a remote emergency switch, refer to the section, "Remote Emergency Switch Installation" below.

9. Once you have made all the required hardware connections, you can turn on Controller-USB.

10. After you turn on the controller, the power indicator LED (14) lights up. Its color indicates that the controller is communicating with the PC (green) and not communicating (orange).

Installing Peripheral Axes

The D9 connectors on the front panel of Controller-USB, marked AXIS 7 and AXIS 8, are used for connecting SCORBOT motorized devices that can be controlled by Controller-USB.

The following SCORBOT peripheral devices are supported Controller-USB:

- Conveyor belt (gray), 24V
- Linear positioning table 0.3 m, 24V
- XY positioning table, 24V
- Rotary table, 24V
- Motor kit (127:1), 24 V
- Slidebase (USB), 1.0 m, 24V
- Slidebase (USB), 1.8 m, 24V

To connect peripheral axes, do the following:

1. Turn off Controller-USB before you connect any devices.

2. Connect the peripheral device's D-type connectors to the D9 connectors on the controller's front panel.

   If you are connecting only one peripheral, use the AXIS 7 connector.

3. Tighten the cable connector screws.

4. Configure the peripheral axes using the SCORBASE software. Refer to the SCORBASE user manual.

Installing a Remote Emergency Switch

The EMERGENCY terminal at the back of Controller-USB (7) allows you to add a remote switch (such as a mushroom button) that will function exactly like the control's EMERGENCY button.

To connect a remote emergency switch, do the following:

1. Make sure the EMERGENCY terminal contacts are normally closed (NC).

2. Remove the wire that shorts the two terminals of the EMERGENCY terminal (7) on the rear panel of Controller-USB. To do so, insert a small screwdriver into the upper (square) opening of the terminal and press down to release each end of the wire.

3. Connect the two wires from the remote emergency switch terminals to the EMERGENCY terminal (7). To do so, insert a small screwdriver into the upper (square) opening of the terminal and press down while inserting each wire into the lower (round) openings of the terminal. Remove the screwdriver to clamp the wire in place.

4

Inputs and Outputs

Output Terminals and LEDs

The output terminals allow Controller-USB to control external devices in the robot's environment. Controller-USB has 12 outputs, as follows:

- 4 digital relay outputs
- 4 digital open collector outputs
- 2 analog outputs

Eight yellow LEDs, which correspond to the eight digital outputs, individually light up when any of the digital outputs are on.

Relay Outputs

Digital outputs 1 to 4 are relay outputs. The relay outputs are controlled by SCORBASE software commands.

Maximum voltage allowed: 24 V
Maximum current allowed: 1.5A

Each relay output has three contact points:

- Common (C)
- Normally Closed (NC)
- Normally Open (NO).

Normally (before the relay is energized by a SCORBASE command), the NO terminal is disconnected from the common line, and the NC terminal is connected to the COM terminal. When the relay is activated the NO terminal is connected to the COM terminal, and the NC terminal is disconnected from the COM terminal.

Figure 4-1 shows the interconnection scheme for devices via relay outputs.

Devices are activated via SCORBASE according to the following truth table:

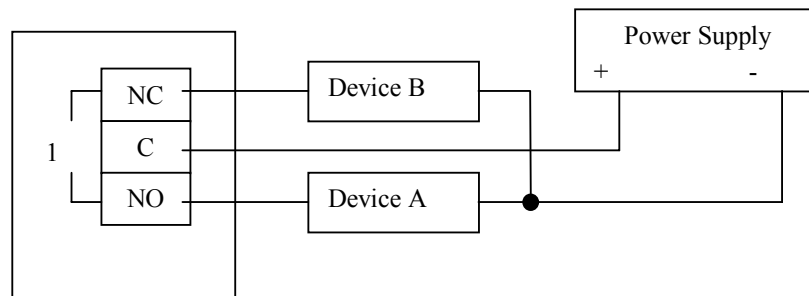| Output state	Device A (NO)	Device B (NC)
Off	Off	On
On	On	Off

Figure 4-1: Output Relay (1 - 4) Interconnection Scheme

Open Collector Outputs

Digital outputs 5 to 8 include a transistor with an open collector in its final stage. These outputs must be connected to a load, such as a-resistor, solenoid, relay or motor. When using an inductive load, such as a solenoid or a relay, connect a reversed biased protection diode across the load.

You may directly connect a Controller-USB open collector output to a Controller-USB digital input.

Output voltage: 24V
Maximum current: 0.5A.

Never connect voltage from a power supply directly to any open collector outputs (terminals 5-8). The open collector outputs must always be connected to a load of the above rating.

The interconnection scheme is illustrated in Figure 4-2.

Device B will be energized when SCORBASE turns ON output 5. Device A will be energized when output 6 is turned ON by SCORBASE

Note:
The open collector output is factory preset to SOURCE. To change setting, refer to Figure 6-2: I/O Jumpers.
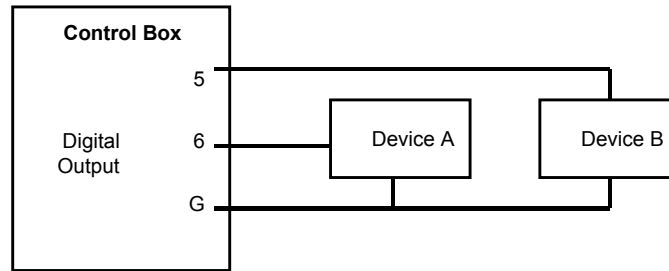
Figure 4-2: Open Collector Output - Interconnection Scheme

Analog Outputs

Analog outputs 1 and 2 allow you to control devices that operate in accordance with an analog input voltage, such as an LED or a motor driver.

The analog outputs have 8-bit resolution A/D converter and an output voltage of 0–10V. The voltage is controlled via SCORBASE (output word $0–255 \Leftrightarrow 0–10V$)

The analog output current is limited to 20mA. Use a hardware driver (booster) to energize a device requiring higher power.

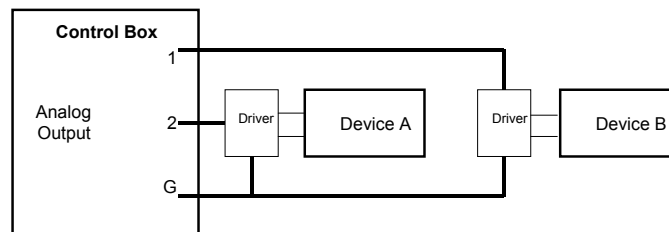Figure 4-3 shows the interconnection scheme to analog outputs.

Figure 4-1: Analog Outputs Interconnection Scheme

Input Terminals and LEDs

Controller-USB has 8 digital inputs and 4 analog inputs. Eight green LEDs, which correspond to the eight digital input status, individually light up when any of the digital inputs are on.

Controller-USB digital inputs are factory pre-set as SOURCE. For proper I/O operation, a paired source/sink connection is required. When connecting a Controller-USB input to an external device, be sure the external device output is SINK (NPN) type. To change the input setting to sink refer to Figure 6-2: I/O Jumpers.

The input states are read by software commands.

Digital Inputs

Two types of devices can be connected to digital inputs 1–8:

- A *dry-contact* switch or sensor.

  Connect the device to a controller input terminal and to a controller input ground. Closing the switch or sensor contacts turns the output ON.

  The interconnection scheme is shown in Figure 4-4.
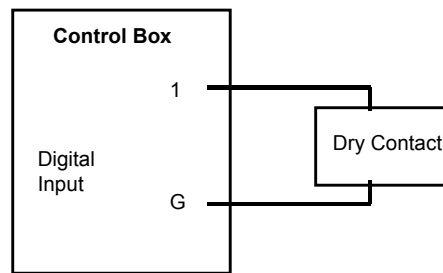

Figure 4-4: Digital Input dry-contact switch or sensor
is connected to a Controller-USB input

- *NPN sensing devices*.

  Connect the sensor output to a controller input, and the sensor ground to a controller input ground, as shown in Figure 4-5.
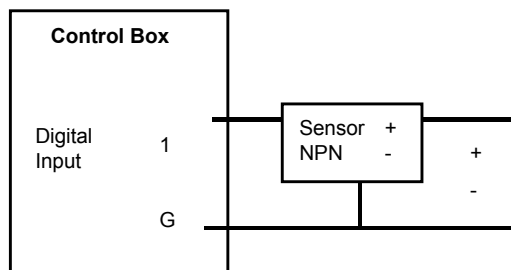
Figure 4-5: Digital Input voltage from external sensing devices
is connected to a Controller-USB input

Notes

- You can use the 12 Vdc power supply to power the sensor.
- The controller inputs are factory pre-set to NPN sensors.
  To change to PNP sensors change the input jumpers setting.
- For NPN sensors the voltage and input states are as follows:
- Voltage of 0–1.5 Vdc from NPN turns the input ON.
- Voltage of 2.5–24 Vdc turns the input OFF.
- Do not connect voltage exceeding +24 Vdc to the digital inputs.

Analog Inputs

Analog Inputs 1–4 allow Controller-USB to receive data from analog sensors.

The analog inputs have 8-bit resolution and input voltage range of 0-10V.DC. The analog inputs are read by software commands

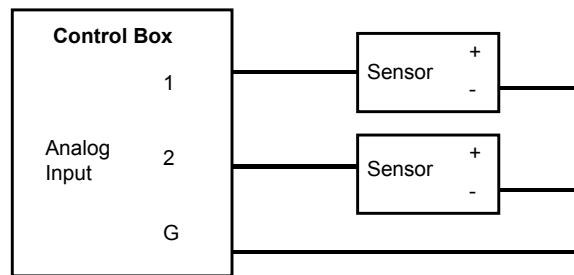Figure 4-6 shows the interconnection scheme.

Figure 4-6*: Analog Input Interconnection Scheme*

Notes:

- Before connecting an analog sensor, make sure Controller-USB is switched off.
- You may use the 12 Vdc power supply to power the sensors.
- Do not connect voltage exceeding +10 Vdc to the analog inputs.

5

Emergency Switches

EMERGENCY Button and LED

When the red EMERGENCY button on the front panel or a remote EMERGENCY stop switch is pressed, the following occurs:

- Motor power is disconnected; all motor movement stops and the MOTORS led turns off.
- COFF (control off) state is activated.
- Emergency LED lights up.
- An emergency message is displayed on the teach pendant and in SCORBASE.
- Program is aborted.
- Controller-USB outputs freeze in their current state.
- All SCORBASE commands, including HOME and CON cannot be activated.

Note:
Pressing the Emergency button will not stop the operation of an output device. To stop the output device use the device's Emergency stop button.

When the EMERGENCY button on the front panel is pulled out or a remote EMERGENCY switch is released, the following occurs:

- The red emergency LED turns off.
- A message appears on the SCORBASE screen, prompting you select CON (control on) or to remain in COFF (control off) state.
  If you select CON, the green MOTORS LED turns on.

Remote Emergency Switch

When a remote emergency switch is connected to Controller-USB (7), it functions exactly like the EMERGENCY button located on the front panel of Controller-USB.

6

Maintenance and Repairs

To ensure continued optimum performance of Controller-USB, follow all safety guidelines and warnings and regularly perform the inspection procedure.

Inspection

Perform a routine inspection of your system at the start of every working session, in the following order:

1. Before you power on the system, check the following items:
   - The installation meets all safety standards.
   - The robot is properly secured to the work surface.
   - All cables are properly and securely connected.
     Cable connector screws are fastened.
   - Replace any cables that show signs of abrasion or wear.
   - No output is connected directly to a power supply.
   - No people are within the robot's working area.

2. After you have switched on the PC and Controller-USB, check the following items:
   - The power LED is orange.
   - Motor LEDs on after SCORBASE starts and control on is selected.
   - No unusual noises are heard.
   - No unusual vibrations are observed in any of the robot axes.
   - There are no obstacles in the robot's working area.

3. Bring the robot to a position near home, and activate the homing procedure. Check the following items:
   - Robot movement is normal.
   - No unusual noise is heard when robot joins move.
   - Robot reaches home position in all five axes, gripper (axes 7 and 8 if connected), and Homing Complete message appears.

Troubleshooting

Whenever you encounter a malfunction, try to locate source of the trouble by replacing the suspected faulty component – for example, the controller, the robot arm, cables – with an identical component from a working system.

Do not open Controller-USB (*except to change jumper setting*)**.**

There are no user-serviceable parts inside. Do not attempt internal repair procedures. Contact your agent or dealer**.**

The following guidelines outline common symptoms and possible remedy.

1. *Controller-USB power does not turn on.*
   The power LED on Controller-USB front panel does not light up.
   - Verify that Controller-USB power switch in on.
   - Make sure the AC power supply matches Controller-USB voltage requirement, as seen on the tag at the back of Controller-USB.
   - If the voltage supply and Controller-USB voltage setting do not match, disconnect immediately, and change the voltage setting, as described later in this chapter.
   - Make sure AC power is being supplied to the power outlet.
   - Make sure the power cable is connected to both the proper power source and Controller-USB.
   - Check the 220V 1A / 110V 2A fuse.

2. *No communication between Controller-USB and computer.*
   Communication error message while operating robot from computer power LED is RED.
   - Select On-line mode.
   - Make sure the connecting cable is properly connected to Controller-USB and to the computer.
   - If problem persists, replace USB cable.
   - Reinstall the USB driver. Refer to the section "USB Driver Installation" below.

3. *Controller-USB is on, but robot arm cannot be activated; or one axis fails to respond and an error message is displayed.*
   - Verify that Motors LED is lit.
   - Make sure an obstacle is not blocking the robot.
   - Make sure none of the axes has reached its mechanical limit.
   - Make sure the robot cable is properly connected to Controller-USB.
   - Reinstall the USB driver. Refer to the section "USB Driver Installation" below.

4. *The gripper does not respond to open or close commands, or responds incorrectly.*

   - Make sure the robot cable is properly connected to Controller-USB.
   - Turn Controller-USB off, then turn it on again and select on-line mode.
   - If problem persists, contact your agent.

5. *Motor turns constantly in one direction, or responds incorrectly.*

   - Make sure the robot cable is properly connected to Controller-USB.
   - Turn Controller-USB off. Then turn it on again and select on-line mode.
   - If problem persists, contact your agent.

6. *Errors in the accuracy of the robot*

   - A faulty encoder may cause position deviations in one or more of the axes during the running of a program.
   - Contact your agent.

7. *Controller-USB does not receive an input signal.*

   - Check the input wiring.

8. *Controller-USB does not issue output signals.*

   - Check the output wiring.
   - Check whether a load has been connected properly.

9. *The Home position suddenly changes, and the robot continues operation in relation to the new Home.*

   - This fault may occur continually or occasionally, due to noisy electrical systems.
   - Execute the Home routine, and reload the program you want to run.
   - If the fault occurs frequently, use filtering equipment on your power line.
   - If problem persists, contact your agent.

Opening the Controller

There are no user-serviceable parts inside. Do not attempt internal repair procedures. Contact your agent or dealer**.**

*You may open Controller-USB **only when you need to change I/O jumper setting***:

1. Disconnect the power supply cable.

2. Release the screws at the bottom of Controller-USB.

3. Slide the cover gently to the rear.

Changing I/O Jumper Settings

To change the digital input setting (high/low) or to change the open collector output setting (sink/source), you must open the controller and access the I/O card.

1. Open the controller, as instructed above.

2. Gently extract the I/O card.

3. Locate the jumpers on the upper left corner of the I/O card as shown in Figure 6-1.

4. Change the jumper settings. Refer to the diagram in Figure 6-2.
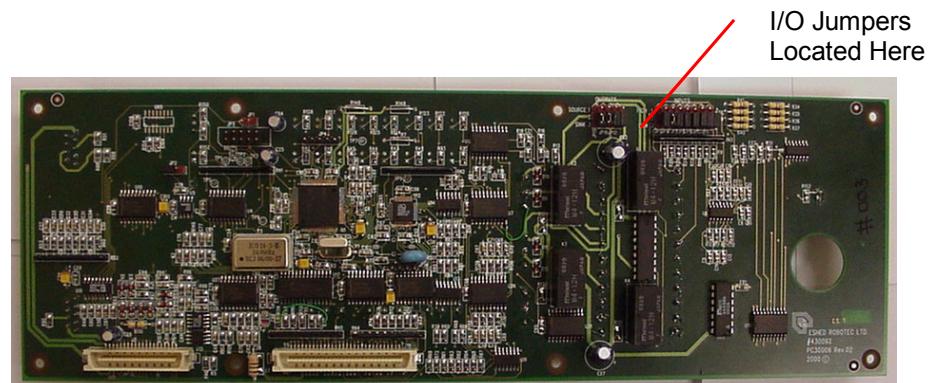
I/O Jumpers
Located Here

Figure 6-1: Location of Jumpers on I/O Card

Note:
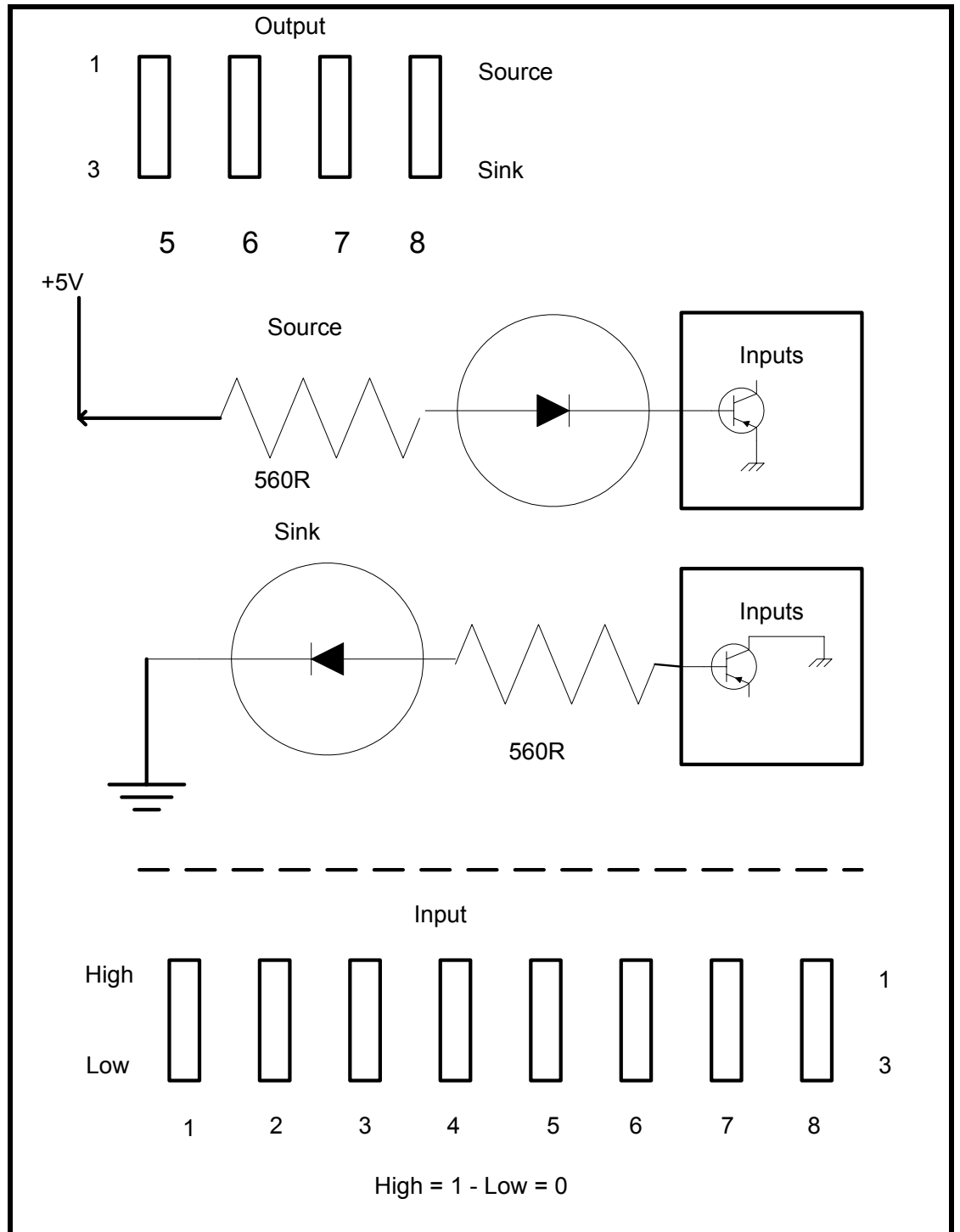The input is factory preset to High.
The output is factory preset to Source.

Figure 6-2: I/O Jumpers

Changing the Voltage Setting

If Controller-USB voltage setting does not match your AC power supply, you must change the controller's voltage setting.

Make sure Controller-USB is not connected to an AC outlet during voltage setting.

1. Using a pen or screwdriver, push the voltage selector to the opposite side, so that the proper voltage selection is visible.

2. Again, using a pen or screwdriver, pull out the fuse drawer. Remove the fuse from its holder.

3. Replace the fuse with the appropriate fuse for your power supply:
    - 110V AC requires 2A fuse.
    - 220V AC requires 1A fuse.

4. Reinsert the fuse drawer, and push until it snaps into place.

Fuse Replacement

If Controller-USB voltage setting does not match your AC power supply, you must change the controller's AC power fuse.

1. Use a small screwdriver to open the fuse drawer at the rear panel of the controller.

2. For replacement, use 110V 2A or 220V 1A.

3. Push the fuse drawer back to its normal position.

USB Driver Installation

During software installation, SCORBASE automatically installs a USB driver named **ERUSBClass** in the computer. If another application has changed the driver, or if the driver has been corrupted, reinstall the **ERUSBClass** driver as follows:

1. Select My Computer.

2. Right click and select Properties (or press Alt+Enter).
    - Click Device Manager
    - Select the ERUSBClass driver and remove it.

3. Reinstall SCORBASE. The correct USB driver will be reinstalled.