Pioneer

Mobile Robots
with Pioneer Server Operating System Software

Pioneer 2 Gripper Manual
Contents

Introduction ................................................................................................................................. 1
P2-Gripper Package .................................................................................................................... 1
  Package Components .................................................................................................................. 1
  User Supplied Components ....................................................................................................... 1
Basic Pioneer 2 Platform ............................................................................................................ 1
The P2 Gripper ............................................................................................................................. 1
P2 Gripper Specifications ............................................................................................................ 2
Required Components ................................................................................................................ 2
Additional Resources .................................................................................................................. 3
  Pioneer Web Software Archive .................................................................................................. 3
  Pioneer and Saphira Newsgroups ............................................................................................... 3
  Support ..................................................................................................................................... 3
Installation .................................................................................................................................. 4
  Step 1: Remove Power ................................................................................................................. 4
  Step 2: Remove Nose .................................................................................................................. 4
  Step 3: Remove Top Plate .......................................................................................................... 5
  Step 4: Install Gripper Power and Control Cables ................................................................. 5
  Step 5: Remount the Top Plate and Nose .................................................................................. 5
  Step 6: Attach the Gripper ......................................................................................................... 6
  Step 7: Enabling the Gripper in P2OS ...................................................................................... 6
    If your robot's P2OS pre-dates version 1.3: .............................................................................. 6
    Now that your robot has P2OS version 1.3 or later installed: ................................................. 6
  Step 7: Test the Assembly ....................................................................................................... 6
P2 Gripper Operation and .......................................................................................................... 7
Programming .............................................................................................................................. 7
  P2 Gripper Self Test .................................................................................................................... 7
  Gripper I/O .................................................................................................................................. 7
P2 Gripper Servers ...................................................................................................................... 8
  P2OS GRIPPER and P2 Gripper Commands .......................................................................... 8
  GRIPPERVAL Gripper Values .................................................................................................... 8
  Grasping Pressure ..................................................................................................................... 9
  LIFTCarry ................................................................................................................................. 9
P2 Gripper States and Status ....................................................................................................... 9
  Saphira Convenience Functions ............................................................................................... 10
Maintenance & Repair .............................................................................................................. 15
  Drive Lubrication ...................................................................................................................... 15
  Factory Repairs ....................................................................................................................... 15
Appendix A .................................................................................................................................. 16
Index .......................................................................................................................................... 17
Introduction

Congratulations on your purchase and welcome to the rapidly growing community of researchers, developers, and enthusiasts of the Pioneer Mobile Robot.

This Pioneer 2 Gripper Manual provides the general and technical details you will need to install and operate your new P2 Gripper in your the Pioneer 2 Mobile Robot.

We also encourage you to use these companion resources that come with your Pioneer:

- Pioneer 2 Operation Manual
- Saphira, Ayllu and PAI Software Manuals
- Pioneer Registration & Account Sheet
- Personal Account for the [http://robots.activmedia.com](http://robots.activmedia.com) Internet server
- Pioneer- and Saphira-users@activmedia.com support newsgroups

P2-Gripper Package

Our experienced robotics manufacturing staff put your Pioneer 2 Gripper through a “burn-in” period and carefully tested it before we shipped the hardware and software to you. Our care extends beyond: Besides the companion resources listed above that bring the whole community of Pioneer to you, we warranty the Gripper against mechanical and electronic parts and labor defects for 90 days. All of these precautions ensure that you have many years to enjoy your new accessories for the Pioneer 2 Mobile Robot.

Even though we’ve made every effort to make your package complete, please check the components once again after you unpack it from the shipping crate.

Package Components

- Pioneer 2 Gripper complete with mounting hardware and cabling
- Pioneer 2 Gripper Manual
- P2OS update and Gripper software disk (Win32 and Linux)

User Supplied Components

- Pioneer 2 Mobile Robot
- Set of hex wrenches that accompanied your original robot
- Small, flat-bladed screwdriver

Basic Pioneer 2 Platform

Pioneers are small, intelligent mobile robots originally developed by Kurt Konolige of SRI International and Videre Designs and now available exclusively through ActivMedia ROBOTICS. The basic Pioneer 2 Mobile Robot platform contains all of the components for sensing and navigation in a real-world environment, including battery power, drive motors and wheels, position encoders, and range-finding ultrasonic sonar transducers—all managed via an onboard Siemens C166-based microcontroller board (Figure 1-1). The Pioneer 2 DX and CE models are two-wheel, differential drive mobile robots intended for indoor, albeit less than ideal surface operation (wheel-chair accessible areas, for example). The Pioneer 2-AT is a four-wheel drive, differential skid-steering version of the Pioneer 2 intended for outdoor, all-terrain (AT) operation. Otherwise, the platforms are nearly identical and share accessories, including the P2 Gripper.

All Pioneers come with onboard robotics server software (Pioneer 2 Operating System) and an open API for client software control of the robot’s systems and accessories. Users access the onboard servers from their client workstation connected wirelessly, or via a piggyback laptop or integrated onboard PC through an RS232 serial communication port.

The P2 Gripper

The Pioneer 2 Gripper is a manipulation accessory that attaches to the Pioneer 2 DX, CE, or AT’s Nose and whose signal and power are derived from the robot’s onboard (“User”) I/O ports and power systems.
Introduction

Mechanically, the P2 Gripper is a simple, yet powerful 2-degrees of freedom robotic manipulator. Independent segments—the Gripper itself and its Lift mechanism—each are driven by reversible-DC motors (Figure 1-2). Embedded limit switches act to sense the Gripper and Lift positions. And the Gripper’s paddles each contain grip sensors and IR breakbeams both front and rear to sense objects and their positions within its grasp.

As part of the Pioneer 2 Operating System (P2OS), onboard software servers interface with the Gripper and Lift electronics and sensors to fully manage their operations. Accordingly, the client software developer need only issue a single, simple command to actuate fundamental manipulation operations.

**P2 Gripper Specifications**

In its fully down and open state, the two 3cm (1.5 inch) tall by 9.5cm (3.5 inch) deep P2 Gripper paddles, each with 2mm soft-foam pads on the inside, are 21.5cm (8.4 inches) apart and ride 2.4cm (1.2 inches) off the floor with the Pioneer 2 DX/CE or just 1cm (0.25 inches) off the floor with the AT. The paddles extend out from the Pioneer 2’s main body 11cm (5 inches) beyond the Console edge.

The P2 Gripper paddles, close together horizontally until they grasp an object or close on themselves. The grasping pressure is under software control, and varies between 200g (0.5 lbs.) and 2kg (5 lbs.). Under independent control and drive, the Gripper's Lift mechanism reaches to the floor, rises 9cm (4 inches), and can lift objects weighing up to 2kg (5 lbs.).

**Required Components**

The P2 Gripper will fit and operate on any Pioneer 2 DX, CE, or AT Mobile Robot and work with all versions of client software. The only caveat is P2OS: You need version 1.3 or later and its related utilities to operate your new accessory and its various I/O ports and connections.

If the Gripper came attached with your new robot, you should already have the necessary software. Otherwise, use the disk that comes with the Gripper, or a version that supports your computing platform as downloaded from our support website (see *Additional Resources* below).

If still in doubt, please contact pioneer-support@activmedia.com for help in updating your robot's server software.
**Additional Resources**

Every Pioneer customer gets three additional and valuable resources: a private account on ActivMedia ROBOTICS' Internet server for downloading Pioneer software, updates, and manuals; access to private Pioneer and Saphira robotics newsgroups; and e-mail access to the Pioneer support team.

**Pioneer Web Software Archive**

We have a World Wide Web server connected continuously to the Internet where customers may obtain Pioneer software and support materials. Point your favorite Web browser to:

http://robots.ActivMedia.com

Some access areas are restricted to licensed customers, including Pioneer owners. To gain restricted access, use the username and password that are written on the Pioneer Registration and Account Sheet that accompanied your robot.

**Pioneer and Saphira Newsgroups**

ActivMedia ROBOTICS also maintains a special e-mail-based newsgroup for Pioneer owners and Saphira programmers to share ideas, software, and questions. We strongly encourage you to sign up. For details, send E-mail:

<table>
<thead>
<tr>
<th>To:</th>
<th><a href="mailto:pioneer-users-request@ActivMedia.com">pioneer-users-request@ActivMedia.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>From:</td>
<td>&lt;your return email address goes here&gt;</td>
</tr>
<tr>
<td>Subject:</td>
<td>&lt;choose one commands:&gt;)</td>
</tr>
<tr>
<td></td>
<td>help (returns instructions)</td>
</tr>
<tr>
<td></td>
<td>lists (returns list of newsgroups)</td>
</tr>
<tr>
<td></td>
<td>subscribe</td>
</tr>
<tr>
<td></td>
<td>unsubscribe</td>
</tr>
</tbody>
</table>

Our SmartList-based listserv will respond automatically. Once subscribed, send your email comments, suggestions, and questions intended for the worldwide community of Pioneer users:

<table>
<thead>
<tr>
<th>To:</th>
<th><a href="mailto:pioneer-users@ActivMedia.com">pioneer-users@ActivMedia.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>From:</td>
<td>&lt;your return email address goes here&gt;</td>
</tr>
<tr>
<td>Subject:</td>
<td>&lt;something of interest to all members of pioneer-users&gt;</td>
</tr>
</tbody>
</table>

Access to the pioneer-users newlist is limited to subscribers, so your address is safe from spam. However, the list currently is unmoderated, so please confine your comments and inquiries to that concerning Pioneer operation and programming.

**Support**

Have a problem? Can’t find the answer in this or any of the accompanying manuals? Know a way that we might improve Pioneer? Share your thoughts and questions directly with us:

pioneer-support@ActivMedia.com

Your message goes to our team of Pioneer developers who will help you directly or point you to where you may find help. Because this is a support option, not a general-interest newsgroup like pioneer-users described above, we must reserve the option to reply only to questions about bugs or problems with Pioneer and its accessories.
Installation

Please read through this chapter carefully before you attempt to attach the P2 Gripper to your Pioneer 2 Mobile Robot. If for any reason you do not wish to perform the work yourself, contact ActivMedia ROBOTICS and make arrangements to have the assembly installed at the factory.

On the other hand, skip this chapter altogether if your Pioneer 2 Mobile Robot came with the Gripper already attached.

The P2 Gripper requires P2OS version 1.3 or later. Contact pioneer-support@ActivMedia.com if you need to update P2OS.

Step 1: Remove Power

Switch Main power off. On the DX and AT models, for extra safety, you might reach in through the back door and remove the automotive spade-type fuse from its socket on top of the battery box.

Step 2: Remove Nose

The P2 Gripper attaches to your Pioneer 2’s Nose. Use the hex wrenches that come with your robot to remove the two 3mm button-head screws that fasten it to the underside of the sonar ring and to the underside of the Body. If you do not have an onboard PC, simply loosen and remove the Nose.

If you have an onboard PC, swing the unfastened Nose towards the left side of the robot, and carefully unplug the following cables, noting the orientation of each connector:

- Fan
- Speaker
- Hard-Disk Drive

Once removed from the robot, remove the plastic plug that covers the rectangular gripper cable-access hole in the front face of the Nose.

![Figure 2-1. Screws that affix the Top Plate on the Pioneer 2 DX/CE](image-url)
**Step 3: Remove Top Plate.**

**DX and CE Models:** Using the hex wrenches that came with your robot, remove the six 3mm flat-head screws that attach the top plate of the Pioneer 2 to the sides of its Body. They are the three rear-most screws on each side. Do not remove the screws that attach the microcontroller board and the front sonar ring to the top plate (Figure 2-1).

Also remove the eight 4mm screws from the two wheel struts and remove the struts from the wheel axles.

**P2 AT Model:** Remove the sixteen 3mm flat-head screws that attach the top plate to the Body. All of the screws are to the rear of the robot, along the sides and around the Accessory door. Do not remove the screws at the front of the robot or around the Console.

**All Models:** Lift the top plate a few centimeters from the robot's body and carefully unplug the following cables after noting their position on the robot (also see Figure 2-2):

- 10-wire twisted-pair flat-cable from the rear sonar ring (if present)
- All of the cables attached to the rear of the microcontroller board, including the 20-wire ribbon cable and any 10-wire ribbon cable(s) to the serial port(s).

Lift the top plate free from the robot and set it aside.

**Step 4: Install Gripper Power and Control Cables**

At the rear of the robot, on top of the box that holds the batteries, locate the main Power Out screw terminals. Loosen those screws and add the spade terminal ends of the Gripper Power cable to that connector; black wire to similar black wire GND, and yellow wire to yellow wire Vpp (12 VDC).

Route the Gripper Power cable forward to the front of the robot.

Insert the 26-wire Gripper Control cable into the User I/O connector on the back of the Pioneer 2 microcontroller that is still attached to the Top Plate (see Figure 2-2).

![Figure 2-2. Pioneer 2 Microcontroller Connectors and Controls](image)

**Step 5: Remount the Top Plate and Nose**

Reverse the process in Steps 2 and 3. Hold the Top Plate a few centimeters above the Pioneer 2 Body and reattach the 10-wire rear sonar cable (if present) to the rear sonar controller and each of the previously unplugged cables to the rear of the microcontroller. Make sure that you insert the "host" serial cable into the HOST port, and the "aux" serial connector (if present) to the AUX port. You can damage the microcontroller and an attached accessory if you get things backwards.

Align the 3mm mounting holes and reattach the Top Plate to the Body with the 3mm hex screws. And reattach the wheel struts on the DX and CE models with the 4mm screws.
Draw the Gripper Power and Control cables through the access portal you uncovered in Step 2, and reattach the computer cable connectors and Nose hardware to the front of the Pioneer 2.

**CAREFUL!** Re-attaching the hard-disk drive cable incorrectly will permanently damage both the drive and the onboard PC.

**Step 6: Attach the Gripper**

Locate the Gripper power cable and plug it into the 2-pin latching connector on the P2 Gripper control board. Find it at the rear of the P2 Gripper's Lift mechanism.

Plug the 20-line P2 Gripper control cable into the 20-pin header also on the P2 Gripper Control board.

Place the P2 Gripper Assembly flush against the Nose of your robot, aligning the pilot pins through their respective guide holes. Now secure the P2 Gripper with the four 3mm button-head screws supplied with the assembly.

That's it. Time to switch on your Pioneer 2’s MAIN Power and sniff for blue smoke. If sparks don’t fly and smoke is absent, it's time to enable the Gripper servers.

**Step 7: Enabling the Gripper in P2OS**

You must use P2OS version 1.3 or later, which contains P2 Gripper servers, before you can properly and efficiently operate the P2 Gripper.

*If your robot's P2OS pre-dates version 1.3:*

*Do not* start up your robot until you are ready to install the software; you could damage its motors. Please use the accompanying P2OS software disk to install P2OS version 1.3 or later, according to the README instructions that come with the software. Briefly, either double-click the Win32 self-extracting icon p2osV_r.EXE (“V” and “r” are the Version and revision numbers, respectively; p2os1_3, for example) or uncompress/untar the p2osV_r.tgz Linux version that is on the disk that accompanied your P2 Gripper or a distribution that you have downloaded from the http://robot.activmedia.com support website. In either case, the extracted archive creates a p2os directory containing the necessary download and configuration utilities, as well as the new P2OS image file.

Tether your computer's serial port with the one on Pioneer's Console unless you are performing the P2OS download from an onboard integrated PC.

Power up and immediately place your Pioneer’s microcontroller into BOOT mode by holding down the white MOTORS button, pressing and releasing the red RESET button, then after about 5 seconds, releasing the MOTORS button.

Execute the p2os/p2osdl(.exe) program (p2osdl p2os1_3.hex, for example) to download the new servers, then RESET Pioneer 2.

If all goes well, the P2OS-update program automatically will install the P2OS upgrade and append a new parameter, HasGripper, to your current operating parameters.

*Now that your robot has P2OS version 1.3 or later installed:*

Use the p2oscf(.exe) program that accompanied your P2OS distribution to reset the HasGripper parameter. Set it to 1 (> hasgripper 1) to enable the P2 Gripper servers and support software. And save it to your robot's FLASH, if not also to a current configuration file that you store on disk.

Details for operation of the P2OS utility programs are given in the Pioneer 2 Operations Manual.

**Step 7: Test the Assembly**

Time to test your new P2 Gripper. Run its self-test, which is described in detail in the next chapter.
P2 Gripper Operation and Programming

The Pioneer 2 Gripper comes fully integrated with the Pioneer 2’s systems and software. The latest versions of Pioneer 2’s operating servers, P2OS (version 1.3 and later), contain support for direct control of the Pioneer’s onboard I/O that run the P2 Gripper functions, as well as state-based software control routines that manage the P2 Gripper functions for you.

In turn, these P2OS servers are supported in all versions of Pioneer 2-related client software that support P2OS, including Saphira and Ayllu. We supply simple Saphira-based examples for programming the P2 Gripper in this manual. Please consult the various Pioneer-related Operation and Software Manuals for more details about P2OS, Saphira, Ayllu, PAI, and P-LOGO.

P2 Gripper Self Test

P2OS comes with test routines for all of the main functions of the robot. This section describes the P2 Gripper’s self-test. Consult the Pioneer 2 Operation Manual for a detailed description of the location and operation of the various Console function buttons and switches and for how to test the drive, I/O, and sonar subsystems.

Do not perform Pioneer 2 Mobile Robot self-tests on a tabletop.

The P2 Gripper self-test is the last in the series of Pioneer 2 self-tests, just after the Analog tests. And it happens in lieu of the User PWM self-test described in the Pioneer 2 Operations Manual if you have properly configured your robot to recognize the P2 Gripper accessory (HasGripper; see Chapter 2).

The Gripper self-test simply exercises the mechanism, first lowering and opening the paddles. Then, after a short delay, the Gripper closes (perhaps on an object you have placed inside), and rises to the top of its Lift.

Press the white MOTORS button to end the Analog #5 test and start the P2 Gripper self-test. Press the white MOTORS button or the red RESET button on the Console to prematurely halt the test. Otherwise, it will run to completion and return the robot to its client-connect wait state.

Gripper I/O

The P2 Gripper’s drives and sensors are attached electronically to the User I/O port on the Pioneer 2 microcontroller (see Appendix A in the Pioneer 2 Operation Manual for diagrams and port specifications). Table 3-1 summarizes the P2 Gripper/User I/O port connections.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
<th>when high</th>
<th>when low</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OD0</td>
<td>Gripper enable</td>
<td>off</td>
<td>on</td>
</tr>
<tr>
<td>3</td>
<td>OD1</td>
<td>Gripper direction</td>
<td>open</td>
<td>close</td>
</tr>
<tr>
<td>5</td>
<td>OD2</td>
<td>Lift enable</td>
<td>off</td>
<td>on</td>
</tr>
<tr>
<td>7</td>
<td>OD3</td>
<td>Lift direction</td>
<td>up</td>
<td>down</td>
</tr>
<tr>
<td>2</td>
<td>ID0</td>
<td>Paddles open limit</td>
<td>between</td>
<td>fully open</td>
</tr>
<tr>
<td>4</td>
<td>ID1</td>
<td>Lift limit</td>
<td>between</td>
<td>top or bottom</td>
</tr>
<tr>
<td>6</td>
<td>ID2</td>
<td>Inner breakbeam</td>
<td>clear</td>
<td>obstructed</td>
</tr>
<tr>
<td>8</td>
<td>ID3</td>
<td>Outer breakbeam</td>
<td>clear</td>
<td>obstructed</td>
</tr>
<tr>
<td>9</td>
<td>ID4</td>
<td>Left paddle contact</td>
<td>clear</td>
<td>grasping</td>
</tr>
<tr>
<td>11</td>
<td>ID5</td>
<td>Right paddle contact</td>
<td>clear</td>
<td>grasping</td>
</tr>
</tbody>
</table>
You may directly control the various P2 Gripper functions and read its sensors using native P2OS commands that manage the User I/O digital input and output ports that were introduced in version 1.2. For example to lift the P2 Gripper, you may set the appropriate control output bits on the digital I/O ports with the P2OS DIGOUT command number 30. This can be dangerous, however. Left unattended and running, you could damage the P2 Gripper's drive electronics.

**P2 Gripper Servers**

For safety and convenience, use the set of P2 Gripper servers that come with P2OS version 1.3 or later to manage the accessory. These servers automatically drive the P2 Gripper so to achieve some fundamental state, such as up or down, open or closed. When used by client software, P2OS' Gripper servers monitor and report its progress towards and achievement (or lack) of a state, saving you coding time and effort. And the servers include a timeout feature to protect against unfortunate stalls or hang-ups.

**P2OS GRIPPER and P2 Gripper Commands**

Table 3-2 summarizes the P2 Gripper's P2OS-based command set. From the client, issue the P2OS GRIPPER command (number 33), followed by its required unsigned integer argument which is the Gripper command number.

The P2 Gripper's commands are, for the most part, self-explanatory. For example, to make the P2 Gripper close its paddles, issue the following Saphira/Colbert command:

```c
sfRobotComInt(33, 2);
```

<table>
<thead>
<tr>
<th>P2OS Command</th>
<th>Argument (Gripper Command or Value)</th>
<th>Label</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GRIPopen</td>
<td>Open</td>
<td>Gripper paddles</td>
</tr>
<tr>
<td>2</td>
<td>GRIPclose</td>
<td>Close</td>
<td>Gripper paddles; grasp pressure regulated by command #16</td>
</tr>
<tr>
<td>3</td>
<td>GRIPstop</td>
<td>Stop</td>
<td>Gripper paddles</td>
</tr>
<tr>
<td>4</td>
<td>LIFTup</td>
<td>Raise</td>
<td>Lift</td>
</tr>
<tr>
<td>5</td>
<td>LIFTdown</td>
<td>Lower</td>
<td>Lift</td>
</tr>
<tr>
<td>6</td>
<td>LIFTstop</td>
<td>Stop</td>
<td>Lift</td>
</tr>
<tr>
<td>7</td>
<td>GRIPstore</td>
<td>Simultaneously closes paddles and raises Lift. For storage; not for grasping/carrying an object</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>GRIPdeploy</td>
<td>Simultaneously lowers Lift and opens paddles. Not useful for object drops, but for getting ready to grasp an object.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>GRIPhalt</td>
<td>Halts both Gripper paddles and Lift</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>GRIPpress</td>
<td>Sets gripper grasping pressure; must follow immediately with P2OS command 36 and grasp time value.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>LIFTcarry</td>
<td>Intermediate Lift position; must follow immediately with P2OS command 36 and carry_time value</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>1-100 grasp_time</td>
<td>Time delay in 20 millisecond increments after Gripper paddles first grasp an object and before they stop moving. Regulates grasp pressure.</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>±1-255 carry_time</td>
<td>Time in 20 millisecond increments to raise (+) or lower (-) the Gripper lift; allows for a &quot;carry&quot; position</td>
<td></td>
</tr>
</tbody>
</table>

**GRIPPERVAL Gripper Values**

In some cases, the Gripper command requires an operating value. Use another P2OS command to set that operating value: Immediately follow the P2OS GRIPPER command (33) that contains the P2 Gripper...
Grasping Pressure

To set how hard the P2 Gripper paddles will grasp an object, set a `grasp_time` delay, in 20 millisecond increments, for when the paddle contacts trigger (about 0.2kgs pressure) to when the Gripper motor stops. The default is 10 (200 milliseconds) which provides a grasping pressure of around 0.5kgs. Incrementally, the grasping pressure is roughly 0.5kgs per 200 milliseconds, to a maximum grasping pressure of around 2kgs (grasp_time of 2 seconds).

For example, to very lightly grasp an object:

```plaintext
sfRobotComInt(33,1);  /* Open the paddles */
.... place object between paddles
sfRobotComInt(33,16); /* GRIPpress */
sfRobotComInt(36,1); /* Grasp lightly -- about 0.5 lbs. pressure */
sfRobotComInt(33,2); /* Close the paddles to that pressure */
```

LIFTCarry

The LIFTcarry command and required `carry_time` operating parameter lets you use the P2 Gripper to lift or lower an object some distance between the top and bottom of the Gripper's limits. The `grip_carry` distance is time-based, since there are no travel-encoders attached. Accordingly, the actual Lift distance will be imprecise, depending on load, battery voltage, and a variety of other factors. Under no-load and otherwise normal conditions, assume approximately two centimeters per second of travel.

For example, to lower the Lift approximately three centimeters,

```plaintext
sfRobotComInt(33,17);  /* Carry command */
sfRobotComInt(36,-75); /* Travel 1.5 sec = roughly 3cm */
```

P2 Gripper States and Status

Salient P2 Gripper information gets included in the standard Server Information Packet (SIP) that P2OS regularly sends to a connected client. Appendix A contains the standard SIP details.

Included in the standard P2OS SIP is a P2 Gripper state byte, comprising the most-significant-byte portion of the User I/O Timer portion of the SIP. It is the P2 server's best guess of current Gripper status (Table 3-3).

<table>
<thead>
<tr>
<th>Bit</th>
<th>Meaning when set (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>Paddles open</td>
</tr>
<tr>
<td>R</td>
<td>Paddles close</td>
</tr>
<tr>
<td>I</td>
<td>Paddles moving</td>
</tr>
<tr>
<td>P</td>
<td>Gripper error</td>
</tr>
<tr>
<td>L</td>
<td>Lift up</td>
</tr>
<tr>
<td>I</td>
<td>Lift down</td>
</tr>
<tr>
<td>F</td>
<td>Lift moving</td>
</tr>
<tr>
<td>T</td>
<td>Lift error</td>
</tr>
</tbody>
</table>

1 If both set or clear, position is unknown.

The diginput and digoutput bytes of the SIP reflect the actual states of the User I/O digital input and output ports, respectively, that interface with the Gripper electronics. Accordingly, their values are more reliable than the Gripper state byte. Refer to Table 3-1 for digital input and output values and connections with the Gripper electronics.
Saphira Convenience Functions

For convenience, we supply a Saphira 6.x plugin that packages the various P2OS-based P2 Gripper commands, states, and variables into a collection of convenient functions. Simply load the dynamic link library `p2grip.so` (Linux/Unix) or `p2grip.dll` (WIN32) into a Saphira 6.x running Colbert. Type "help p2grip" in the Colbert interaction window to review the list of implemented functions.

```c
#include "saphira.h"
#include "p2grip.h"

EXPORT void
sfP2GripOpen(void) /* opens the gripper paddles */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2GRIPOPEN);
}

EXPORT void
sfP2GripClose(void) /* Closes the gripper paddles */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2GRIPCLOSE);
}

EXPORT void
sfP2GripStop(void) /* stops gripper paddles */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2GRIPSTOP);
}

EXPORT void
sfP2LiftUp(void) /* raise the lift */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2LIFTUP);
}

EXPORT void
sfP2LiftDown(void) /* lowers the lift */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2LIFTDOWN);
}
```
EXPORT void
sfP2LiftStop(void)  /* stops the lift */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2LIFTSTOP);
}

EXPORT void
sfP2GripDeploy(void) /* lowers lift and opens paddles simult. */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2GRIPDEPLOY);
}

EXPORT void
sfP2GripStore(void) /* raises lift and closes paddles simult. */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2GRIPSTORE);
}

EXPORT void
sfP2LiftCarry(int carry_time) /* Gripper close and raise or lower to
carry position */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2LIFTCARRY);
    sfRobotComInt(sfCOMP2GRIPTIME, carry_time);
}

EXPORT void
sfP2GripSetPress(int grasp_time) /* time to wait after encountering
object before stopping paddles */
{
    sfRobotComInt(sfCOMP2GRIP, sfP2GRIPPRESS);
    sfRobotComInt(sfCOMP2GRIPTIME, grasp_time);
}

EXPORT int
sfP2GripMoving(void) /* returns 1 if paddles moving, 0 otherwise */
{
    int d;
    d = sfRobot.timer >> 8;
    if (d & BIT2)
        return 1;
    else
        return 0;
}

EXPORT int
sfP2LiftMoving(void) /* returns 1 if paddles moving, 0 otherwise */
{
    int d;
    d = sfRobot.timer >> 8;
    if (d & BIT6)
        return 1;
    else
        return 0;
}

EXPORT int
sfP2GripState(void) /* 0 if between, 1 if open, 2 if closed, -1 if error */
{
    int d;
d = sfRobot.timer >> 8;
if (d & BIT3) /* error */
    return -1;
else if (((d & BIT0) && (d & BIT1))
    return 0;
else if (d & BIT0) /* open */
    return 1;
else if (d & BIT1) /* closed */
    return 2;
else /* must be between if none of above */
    return 0;
}

EXPORT int
sfP2LiftState(void) /* 0 if between, 1 if up, 2 if down, -1 if error */
{
int d;
  d = sfRobot.timer >> 8;
  if ((d & BIT7) /* error */
    return -1;
  else if (((d & BIT4) && (d & BIT5))
    return 0;
  else if (d & BIT4) /* up */
    return 1;
  else if (d & BIT5) /* down */
    return 2;
  else /* must be between if none of above */
    return 0;
}

EXPORT int
sfP2GripBeam(void) /* for the breakbeams, 0 if none, 1 if inner, 2 if outter, 3 if both */
{
int d;
  d = sfRobot.diginput;
  if (((d & BIT2) && (d & BIT3)) /* both */
    return 3;
  else if (d & BIT2) /* inner */
    return 1;
  else if (d & BIT3) /* outter */
    return 2;
  else /* must be neither */
    return 0;
}

EXPORT void
sfLoadInit(void) /* this should be evaluated on open */
{
  sfMessage("Loading P2 Gripper control functions, type help p2grip for details.");
  sfAddEvalFn("sfP2GripOpen", sfP2GripOpen, sfVOID, 0);
  sfAddEvalFn("sfP2GripClose", sfP2GripClose, sfVOID, 0);
  sfAddEvalFn("sfP2GripStop", sfP2GripStop, sfVOID, 0);
  sfAddEvalFn("sfP2LiftUp", sfP2LiftUp, sfVOID, 0);
  sfAddEvalFn("sfP2LiftDown", sfP2LiftDown, sfVOID, 0);
  sfAddEvalFn("sfP2LiftStop", sfP2LiftStop, sfVOID, 0);
  sfAddEvalFn("sfP2GripStore", sfP2GripStore, sfVOID, 0);
  sfAddEvalFn("sfP2GripDeploy", sfP2GripDeploy, sfVOID, 0);
  sfAddEvalFn("sfP2LiftCarry", sfP2LiftCarry, sfVOID, 0);
  sfAddEvalFn("sfP2GripSetPress", sfP2GripSetPress, sfVOID, 0);
  sfAddEvalFn("sfP2GripMoving", sfP2GripMoving, sfINT, 0);
Pioneer 2 Gripper

```c
sfAddEvalFn("sfP2LiftMoving", sfP2LiftMoving, sfINT, 0);
sfAddEvalFn("sfP2GripState", sfP2GripState, sfINT, 0);
sfAddEvalFn("sfP2LiftState", sfP2LiftState, sfINT, 0);
sfAddEvalFn("sfP2GripBeam", sfP2GripBeam, sfINT, 0);
sfAddHelp("sfP2GripOpen",
    "void sfP2GripOpen(void) opens the gripper paddles.");
sfAddHelp("sfP2GripClose",
    "void sfP2GripClose(void) closes the gripper paddles.");
sfAddHelp("sfP2GripStop",
    "void sfP2GripStop(void) stops the gripper paddles.");
sfAddHelp("sfP2LiftUp",
    "void sfP2LiftUp(void) raises the lift.");
sfAddHelp("sfP2LiftDown",
    "void sfP2LiftDown(void) lowers the lift.");
sfAddHelp("sfP2LiftStop",
    "void sfP2LiftStop(void) stops the lift.");
sfAddHelp("sfP2GripStore",
    "void sfP2GripStore(void) closes paddles and raises lift simultaneously. For storage: not for grasping/carrying an object.");
sfAddHelp("sfP2GripDeploy",
    "void sfP2GripDeploy(void) opens paddles and lowers lift simultaneously, For getting ready to grasp an object: not for object drops.");
sfAddHelp("sfP2LiftCarry",
    "void sfP2LiftCarry(int) raises or lowers the lift, the argument is the number of 20 msec increments to raise or lower the lift. Positive argument for raise, negative for lower.");
sfAddHelp("sfP2GripSetPress",
    "void sfP2GripSetPress(int) sets the time delay in 20 msec increments after gripper paddles first grasp an object and before they stop moving. Regulates grasp pressure.");
sfAddHelp("sfP2GripMoving",
    "int sfP2GripMoving(void) returns 1 if the paddles are moving, 0 otherwise.");
sfAddHelp("sfP2LiftMoving",
    "int sfP2LiftMoving(void) returns 1 if the lift is moving, 0 otherwise.");
sfAddHelp("sfP2GripState",
    "int sfP2GripState(void) returns the state of gripper paddles, returns 1 if paddles open, 2 if paddles closed, 0 if it is between open and closed, and -1 if there is an error.");
sfAddHelp("sfP2LiftState",
    "int sfP2LiftState(void) returns the state of the lift, returns 1 if lift up, 2 if lift down, 0 if it is between up and down, and -1 if there is an error.");
sfAddHelp("sfP2GripBeam",
    "int sfP2GripBeam(void) returns the state of the gripper paddle breakbeams, returns 0 if neither is blocked, 1 if inner is blocked, 2 if outer is blocked, and 3 if both are blocked.");
sfAddHelp("gripper",
    "The following are the functions created for using the gripper, there is help on each one. sfP2GripOpen sfP2GripClose sfP2GripStop sfP2LiftUp sfP2LiftDown sfP2LiftStop sfP2GripStore sfP2GripDeploy sfP2LiftCarry sfP2GripSetPress sfP2GripMoving sfP2LiftMoving sfP2GripState sfP2LiftState sfP2GripBeam");
sfAddHelp("p2grip",
    "The following are the functions created for using the gripper, there is help on each one. sfP2GripOpen sfP2GripClose sfP2GripStop sfP2LiftUp sfP2LiftDown sfP2LiftStop sfP2GripStore sfP2GripDeploy sfP2LiftCarry sfP2GripSetPress sfP2GripMoving sfP2LiftMoving sfP2GripState sfP2LiftState sfP2GripBeam");
```

10
/* p2grip.h */
#define sfCOMP2GRIP 33
#define sfCOMP2GRIPTIME 36
#define sfP2GRIPOPEN 1
#define sfP2GRIPCLOSE 2
#define sfP2GRIPSTOP 3
#define sfP2LIFTUP 4
#define sfP2LIFTDOWN 5
#define sfP2LIFTSTOP 6
#define sfP2GRIPSTORE 7
#define sfP2GRIPDEPLOY 8
#define sfP2GRIPHALT 15
#define sfP2GRIPPRESS 16
#define sfP2LIFTCARRY 17
#define BIT0 1
#define BIT1 2
#define BIT2 4
#define BIT3 8
#define BIT4 16
#define BIT5 32
#define BIT6 64
#define BIT7 128
Maintenance & Repair

The Pioneer 2 Gripper is built to last a lifetime and requires little maintenance.

Drive Lubrication

An occasional drop or two of oil on the guide rails is a very good idea. Place some thin, household oil on a Q-Tip or similar applicator, and rub along the rails. Then start up the Pioneer to exercise the Gripper and spread the lubricant.

Factory Repairs

If you are having hardware problems with your Pioneer and, after reading this manual, you are satisfied that it needs repair, here’s who to contact:

<table>
<thead>
<tr>
<th><a href="mailto:pioneer-support@ActivMedia.com">pioneer-support@ActivMedia.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>(603) 924-2184 fax</td>
</tr>
</tbody>
</table>

In the body of your E-mail or fax message, give your Pioneer 2’s serial number, so we can look up its configuration, and describe the problem in as much detail as possible. Also include your name, e-mail and mail addresses, as well as phone and fax numbers, and when and how we can best contact you (we will assume e-mail is the best manner, unless otherwise notified).

We will try and resolve the problem through communication. If the robot must be returned to the factory for repair, obtain a shipping and repair authorization code and shipping details from us first. We are not responsible for shipping damage or loss.
# Appendix A

## P2OS Standard Server Information Packet

<table>
<thead>
<tr>
<th>Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
<td>integer</td>
<td>Exactly 0xFA, 0xFB</td>
</tr>
<tr>
<td>Byte Count</td>
<td>byte</td>
<td>Number of data bytes + 2; must be less than 201 (0xC9)</td>
</tr>
<tr>
<td>Status</td>
<td>byte = 0x3S; where S =</td>
<td>Motors status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sfSTATUSNOPOWER (0) Motors power off</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sfSTATUSSTOPPED (1) Motors stopped</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sfSTATUSMOVING (2) Robot moving</td>
</tr>
<tr>
<td>Xpos</td>
<td>unsigned int (15 ls-bits)</td>
<td>Wheel-encoder integrated coordinates; platform-dependent units; multiply by DistConvFactor in the parameter file to convert to millimeters</td>
</tr>
<tr>
<td>Ypos</td>
<td>unsigned int (15 ls-bits)</td>
<td>DistConvFactor in the parameter file to convert to millimeters</td>
</tr>
<tr>
<td>Th pos</td>
<td>signed int</td>
<td>Orientation in platform-dependent units—multiply by AngleConvFactor for degrees.</td>
</tr>
<tr>
<td>L vel</td>
<td>signed int</td>
<td>Wheel velocities (respective Left and Right) in platform-dependent units—</td>
</tr>
<tr>
<td>R vel</td>
<td>signed int</td>
<td>Multiply by VelConvFactor to convert to millimeters per second</td>
</tr>
<tr>
<td>Battery</td>
<td>byte</td>
<td>Battery charge in tenths of volts</td>
</tr>
<tr>
<td>Bumpers</td>
<td>integer</td>
<td>Motor stall indicators; left = msb</td>
</tr>
<tr>
<td>Control</td>
<td>signed int</td>
<td>Setpoint of the server’s angular position servo—multiply by AngleConvFactor for degrees</td>
</tr>
<tr>
<td>PTU</td>
<td>unsigned int</td>
<td>Pulse width of selected servo #1</td>
</tr>
<tr>
<td>Compass</td>
<td>byte</td>
<td>Compass heading in 2-degree units</td>
</tr>
<tr>
<td>Sonar readings</td>
<td>byte</td>
<td>Number of new sonar readings included in information packet; readings follow:</td>
</tr>
<tr>
<td>Sonar number</td>
<td>byte</td>
<td>Sonar number</td>
</tr>
<tr>
<td>Sonar range</td>
<td>unsigned int</td>
<td>Sonar reading—multiply by RangeConvFactor for mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...rest of the sonar readings...</td>
</tr>
<tr>
<td>User I/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timer</td>
<td>unsigned int</td>
<td>MSB = P2 Gripper status; LSB = currently selected analog port number 1-5 (default is 5)</td>
</tr>
<tr>
<td>Analog</td>
<td>byte</td>
<td>User analog input reading (0-255) on selected port #1-5</td>
</tr>
<tr>
<td>Diginput</td>
<td>byte</td>
<td>Digital input port values</td>
</tr>
<tr>
<td>Digitsoutput</td>
<td>byte</td>
<td>Digital output ports</td>
</tr>
<tr>
<td>Checksum</td>
<td>signed int</td>
<td>Checksum</td>
</tr>
</tbody>
</table>
Index

A
- ActivMedia ROBOTICS, Inc., 1
- Additional Resources, 3
- Ayllu, 7

B

C
- Components
  - Package, 1
  - Required, 2
  - User-supplied, 1
- Control Cable, 5

D
- Description, 2
- DIGINPUT, 9
- DIGOUT, 7
- DIGOUTPUT, 9

E

G
- Grasp pressure, 9
- GRIPOFF, 10
- Operating range, 2
- operation, 7
- Gripper commands, 8
- Gripper I/O, 7
- Gripper servers, 8
- Gripper States, 9
- Gripperval, 9

I
- Installation, 4
  - Cabling, 5
  - Enabling Gripper servers, 6
  - Top Plate, 5

K
- Konolige, Kurt, 1

L
- Licenses, 3
- Lift, 2
- Lift carry, 9
- Lubrication, 15

M
- Maintenance, 15

N
- Newsgroups, 3

O

P
- P2Grip.dll, 10
- P2Grip.so, 10
- P2OS, 1, 7
- Paddles, 2
- Pioneer 2, 1
- Pioneer 2
  - AT, 1
  - DX, 1
  - Gripper, 2
  - Operating System, 1
- Pioneer Operations and Software Manual, 1
- Pioneer-users, 3
- Power Cable, 5

R
- Repairs, 15

S
- Saphira, 7
- Saphira plugin, 10
- Saphira Software Manual, 1
- Serial ports, 5
- Siemens C166, 1
- Specifications, 2
- SRI International, 1
- Self-test, 7
- Support, 3

U
- User I/O, 2, 7

V
- Videre, 1

W
- Website, 3
- Warranty, 1, 18
Warranty & Liabilities

Your Pioneer Mobile Robot and its accessories are fully warranted against defective parts or assembly for one year after it is shipped from the factory. This warranty explicitly does not include damage from shipping or from abuse or inappropriate operation, such as if the robot is allowed to tumble or fall off a ledge, or if it is overloaded with heavy objects.

The developers, marketers, and manufacturers of Pioneer shall bear no liabilities for operation and use of the robot or any accompanying software except that covered by the warranty and period. The developers, marketers, or manufacturers shall not be held responsible for any injury to persons or property involving the Pioneer Mobile Robot in any way. They shall bear no responsibilities or liabilities for any operation or application of the robot, or for support of any of those activities. And under no circumstances will the developers, marketers, or manufacturers of Pioneer take responsibility for or support any special or custom modification to Pioneer.

Notes
44 Concord Street
Peterborough, NH 03458
(603) 924-9100
(603) 924-2184 fax
http://www.ActivRobots.com