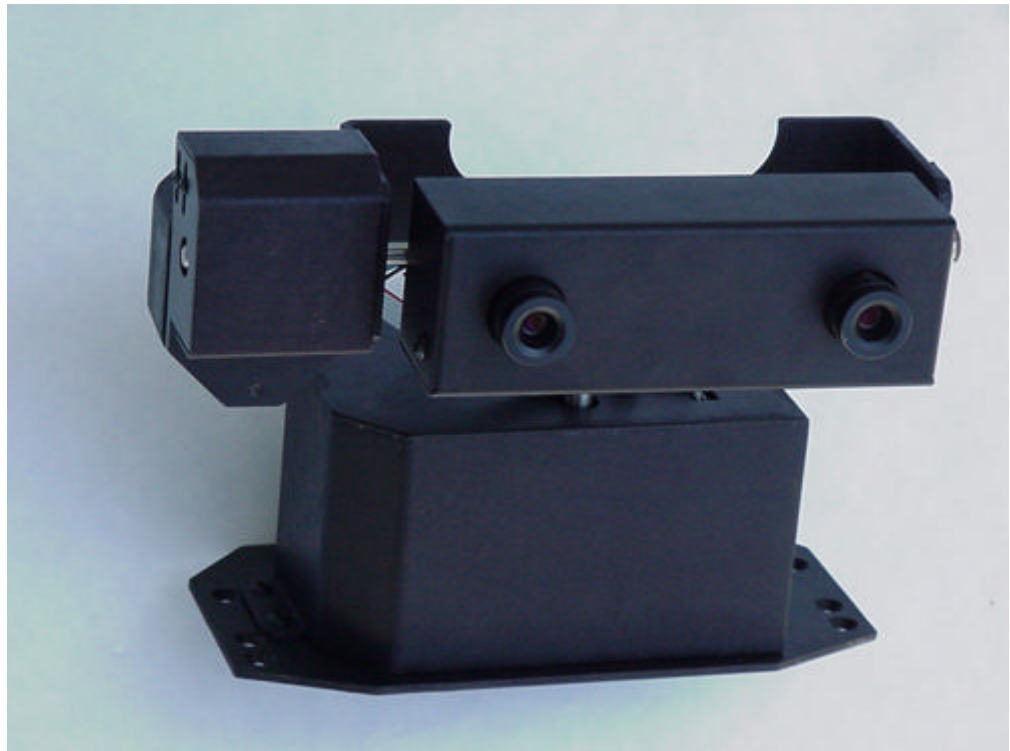


Pan Tilt Unit



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Contents

	Page
Introduction	1
AMPTU Components	1
AMPTU Accessories	1
Where to get AMPTU Software	2
Related Resources.....	2
Installation & Operation.....	3
Selecting the Unit Number	3
Free Mounting	4
Mounting on Pioneer Robots.....	4
Power/Signal Cable Installation	4
Came with Robot	4
Robot Accessory.....	4
Free Standing	6
Serial Communications	6
Power	6
Payload Signals.....	6
Testing the Connections	6
AMPTU Software	8
AMPTU Command Syntax	8
Command Execution	10
Status and Errors	10
Pioneer Software	11
PSOS/P2OS.....	11
Saphira Plugin	12
Colbert	12
Appendix A	13
Appendix B	14
Warranty & Liabilities	15

Introduction

*Activ*MEDIA ROBOTICS' Pan-Tilt Unit (AMPTU) is an economical, yet high performance, intelligent device for positioning cameras and other accessories. Developed by Paul Giacomo of Pegco Labs, Inc., the AMPTU's position head has two degrees of freedom with extraordinary ranges of motion: 300-degrees of pan and 180-degrees of tilt. The AMPTU accommodates a selection of payloads up to 125g (4.5 oz) at a 180-degrees-per-second slew speed, including *Activ*MEDIA ROBOTICS' day-night cameras and Videre Designs' stereo cameras.

The AMPTU's head position is controlled via a common RS232 serial port and a set of simple commands. Accordingly, you may operate the AMPTU connected to a laptop, deskside, or handheld computer using a simple terminal program, such as Hyperterminal or minicom. When installed on a Pioneer Mobile Robot, the AMPTU can be controlled from an onboard computer serial port or through the auxiliary (AUX) serial port on the Pioneer's microcontroller.

Software accompanying the AMPTU include native Pioneer Operating System support, as well as Saphira and Ayllu robotics client integration software. ASCII-encoded commands also let you control the system from a simple terminal program, and make programming and interfacing the AMPTU to your own software easy.

AMPTU Components

The following items come in the AMPTU package. If you ordered the AMPTU with a Pioneer Robot, some items may already be attached to your robot. Power and signal cabling may vary depending on payload options.

- ✓ AMPTU
- ✓ Serial Control Cable
- ✓ Power Module or Cable
- ✓ Signal Cable
- ✓ Mounting Hardware
- ✓ Disk with WIN32 AMPTU Software

AMPTU Accessories

The AMPTU extends the capabilities of a variety of video and other sensor and manipulation systems and applications. Because of its extended envelope of operation, it's an ideal accessory for real-time video surveillance systems.

For more information about these and other options, browse our website (<http://www.activrobots.com>) and/or contact us directly (sales@activmedia.com).

- ✓ Day-Night Cameras
- ✓ Stereo Vision Systems
- ✓ Fast-Track Vision Systems
- ✓ A/V Transmitter/Receivers

Where to get AMPTU Software

The control software for operation of the AMPTU is embedded in the system and is ready to work when you apply power to the unit. Accordingly, you position the AMPTU head by sending commands and arguments to its common RS232 serial port. Details are in Chapter 3.

The Windows95/98/NT version of the AMPTU software comes on disk with every unit. Relevant software also are included with *ActivMEDIA* ROBOTICS' development systems, including Saphira and Ayllu.

Other versions of the AMPTU software, such as for Linux and Unix, as well as updates to all versions are available online from the *ActivMEDIA* ROBOTICS support website. The compressed archives contain the shared executables and accessory files you need to operate the AMPTU System and integrate it with your own software, Ayllu, or Saphira:

<http://robots.activmedia.com>

Be sure to choose the software version that matches your computer's operating environment; AMPTU.EXE for Windows95/98/NT computers or AMPTU_linux.tgz for Linux OS, for example.

Related Resources

When attached and integrated with your Pioneer Mobile Robot, you need a working knowledge of the robot and its Operating System software (PSOS for Pioneer 1 or P2OS for Pioneer 2) to use the AMPTU. Consult your *Pioneer Operation Manual* for details. Obtain copies of the latest Pioneer manuals (this document, too) from our Internet website:

<http://robots.activmedia.com/docs>

We announce Pioneer software-related updates and new versions, as well as share ideas and code, through two main email-based newsgroups:

pioneer-users@activmedia.com

saphira-users@activmedia.com

To join—and please do join—simply send an email message (substitute *saphira-users* for *pioneer-users* to access that separate group):

To: pioneer-users-request@activmedia.com
From: < <i>your return email address goes here</i> >
Subject: <choose one command>
help (returns instructions)
lists (returns list of newsgroups)
subscribe
unsubscribe

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

To: pioneer-users@activmedia.com
From: < <i>your return email address goes here</i> >
Subject: < something of interest to all members of pioneer-users >

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.

If something seems (or clearly is) broken with the software, your Pioneer robot, and/or AMPTU System, send an email message To: pioneer-support@activmedia.com and a team of experts will leap to the rescue.

Installation & Operation

The AMPTU system requires no assembly, just mounting and cabling. Before installation, however, you may choose to change its unit number from its default number 1.

Selecting the Unit Number

Each AMPTU gets a unit number—a value from one to seven which you may use to address an individual unit in a serial daisychain of units (unit number zero addresses all units.) Unless you had made special arrangements with the factory, the AMPTU unit number is one. Before installing the unit, change the unit number if you want. Do so by moving jumpers on the AMPTU Control Board.

To access the Control Board, remove the four button-head hex screws that fasten the AMPTU case to its bottom plate. Carefully lift the case to expose its contents and locate the Control Board and Unit Selector jumper block (Figure 2-1.)

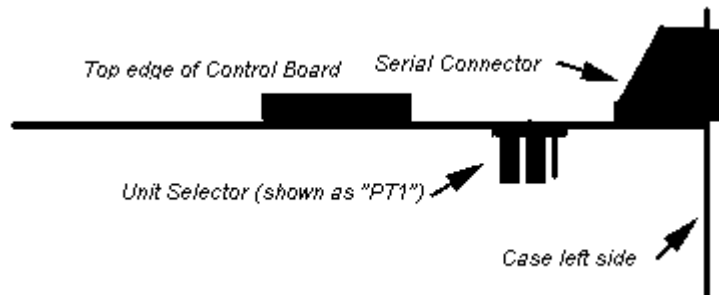


Figure 2-1. The AMPTU's unit number selector jumper block is on the bottom of the Control Board.

Three jumper pairs represent three digital addresses for up to eight unique combinations. When jumpered, it is considered off, or digital zero. When unjumpered, it is on or digital one. Reading from right-to-left when facing the board as we do in Figure 2-1, the digital units are one, two, and four. Accordingly, the default unit number one has the right pins unjumpered and the middle and left pin sets jumpered (1+0+0), as shown in the Figure 2-1).

Remove all the pins to set the unit number to seven (1+2+4); jumper just the middle pins to set the unit number to 1+0+4=5; jumper both end pins to set the unit number to 0+2+0=2.

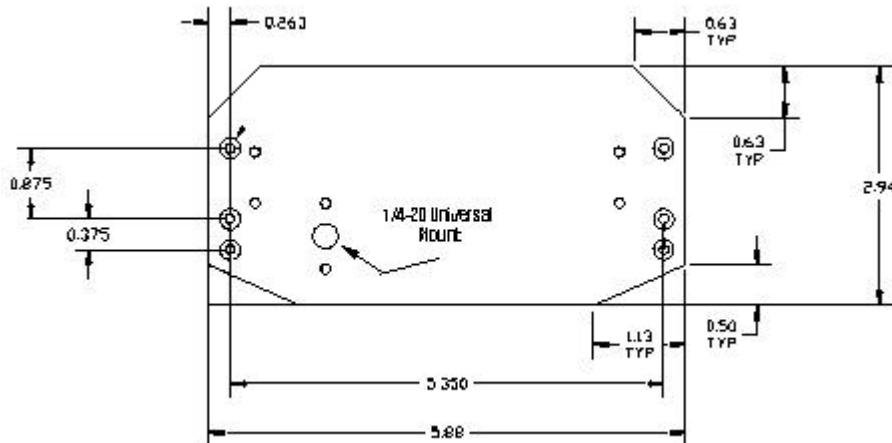


Figure 2-2. AMPTU mounting holes

Free Mounting

There are six mounting holes in the bottom plate (three holes per side) for easy installation of the AMPTU (Figure 2-2). There also is a common ¼-20 threaded mounting socket on the bottom of the unit for convenient mounting to a universal swivel or tripod.

Install the AMPTU in nearly any position—just be sure to allow the head to freely operate through its range of motion. Include head attachments in that envelope of operation.

Mounting on Pioneer Robots

Even if ordered and shipped with the robot, the AMPTU camera comes detached from Pioneer for safe shipment. Mounting screws and cabling come included with the kit and may be attached to the robot.

Although you may mount it anywhere on the robot, we recommend mounting the AMPTU to the front of the robot, centered on top of the Console. Use the 2.5mm (5/64”) hex wrench that came with your Pioneer to remove the two front-most screws that hold the front sonar array to the robot’s Console Plate. Line up the middle screw holes on the AMPTU’s mounting plate with those two front-most screw holes and insert the hex screws that come with the AMPTU. Fasten tightly.



Power/Signal Cable Installation

The AMPTU’s power and signal connectors and indicators are at the rear (Figure 2-3) of the unit. These include a power on-off switch and indicator LED, a mini-stereo socket for payload signals, such as two-channel video from the stereo camera head, a 2.5mm power socket, and a common DSUB-9 connector for RS232 serial communication with the AMPTU controller.

Figure 2-3. AMPTU connectors, switches and indicators (unit rear view)

Came with Robot

If the AMPTU was shipped along with your new Pioneer 2 Mobile Robot, the signal, power, and serial communication cabling came installed, attached to the robot. All you need to do is mount the unit and insert the power, signal, and serial-communication plugs that emerge from the Pioneer’s access port at the center of the Console into their respective sockets on the AMPTU.

Robot Accessory

If you have to install the AMPTU’s serial and power cables into a Pioneer 2, you will need to access the robot’s AUX control port on the microcontroller and the User Power port on the Motor/Power board. To do that, you must remove the robot’s Top Plate.

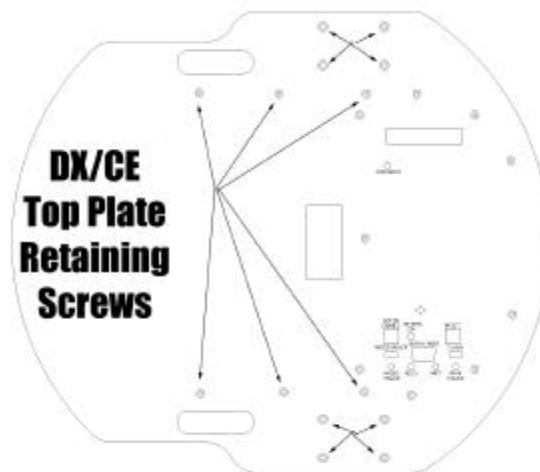


Figure 2-4. DX/CE Top Plate retaining

screws

For the Pioneer 2 DX and CE models, use the hex wrenches that came with your robot to 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 2-4). Also remove the eight 4mm screws from the two wheel struts and remove the struts from the wheel axles.

For the Pioneer 2 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.

Lift the Top Plate a few centimeters from the robot's body and carefully insert the AMPTU's 10-pin IDC cable into the AUX port on the Pioneer 2's microcontroller. AUX is the 10-position IDC connector nearest the center of the board (Figure 2-5).

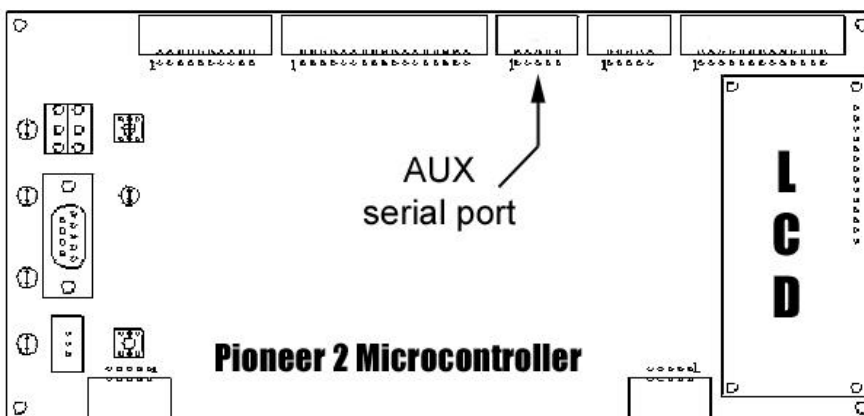


Figure 2-5. Pioneer 2 AUX serial port on the microcontroller

Insert the AMPTU's 12-pin latch-lock power connector into the User Power header on the Pioneer 2's Motor/Power board (Figure 2-6).

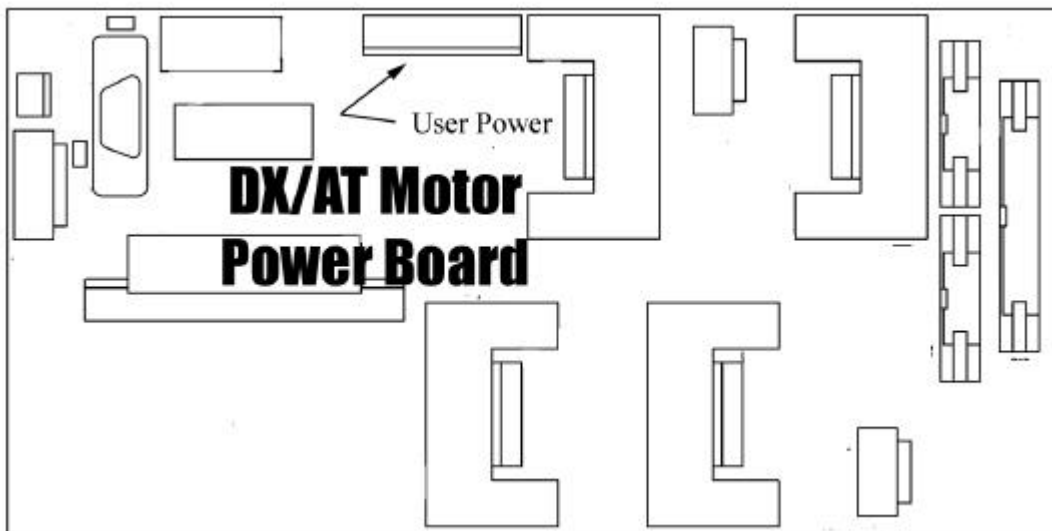


Figure 2-6. Pioneer 2 User power connector on the Motor/Power board

Feed the AMPTU cables through the access port on the robot's Top Plate and then carefully reattach the Top Plate. Mount the AMPTU and insert the power and serial cables.

Free Standing

If you purchased it for use other than with Pioneer, the AMPTU and camera head come with an external power supply, a "pass-through" serial cable for connection to the serial port on a common PC, and a mini-stereo to RCA cable adapter. Install these as you would any other computer accessory.

Serial Communications

External control of the AMPTU occurs through its serial port. Port settings are common RS232 at 9,600 baud, eight bits data, one stop bit, no parity, and no handshaking. Normally, when connected to a Pioneer Mobile Robot, use the 10-position IDC connector AUX serial communication port on its microcontroller to send control commands through PSOS or P2OS to the AMPTU.

You may also connect the AMPTU to another serial port for external control by the onboard computer on the Pioneer, by laptop or handheld computer, perhaps riding piggyback on the robot, or by any deskside or for instance. Pinouts and signal descriptions are given in Table 2-1.

Table 2-1. AMPTU serial port connections

Signal	RJ11 Connector Pin	DSUB-9 Female Connector Pin	P2 AUX IDC pin
Transmit	1	2	5
Signal Ground	2	5	1 or 9
Unit Ready	3	6	-
Receive	4	3	3

Power

The AMPTU gets its power through the 2.5mm power socket on its rear panel. The provided cabling for attachment to a Pioneer Robot or the external power module deliver 12 VDC to the unit—center positive, body ground.

Payload Signals

When wired through the "payload" connectors at the top of the AMPTU, attached cameras or other accessories derive operating 12VDC power and deliver signals, such as video, to the mini-stereo socket on the rear of the unit. We install power and signal cabling to the Stereo and Day/Night Camera attachments to the AMPTU. To attach other payloads, consult Appendix A for connector specifications.

The mini-stereo socket on the rear of the AMPTU provides two I/O channels and signal ground through the payload connectors for interface with attachments. A mating plug's tip and center are the signal channels; its body is ground.

We also provide a mini-stereo to RCA adapter. When inserted, the RCA socket centers are the signal channel and the bodies are signal ground.

Testing the Connections

Connect power and switch on the AMPTU's power. The unit's red LED power indicator should light. More telling—the unit should perform its initialization routine by swinging its head through its full envelope of operation and ending in a pan- and tilt-centered home position.

If you have the Day/Night or Stereo Camera option with the AMPTU, either plug a signal cable directly into the signal port (mini-stereo socket) or into the RCA socket of the adapter. Plug the other end of the cable into a monitor. With the day camera, you should see a full-color image; the night-vision and interlaced stereo

cameras should display in black and white, and perhaps fuzzy, depending on lighting conditions.

The AMPTU software also comes with a demonstration Colbert activity for use with Saphira. When executed, it exercises the camera via an AMPTU plugin (dll or so shared library of commands). See the next chapter for details.

AMPTU Software

The AMPTU comes with an onboard microcontroller and embedded software for controlling the pan and tilt positions of the unit's head. It requires connection to a host serial device through which you manually send positioning commands with a simple terminal program like Hyperterminal or minicom, or programmatically through your own custom software.

Also included with the AMPTU is plugin software that lets you program your AMPTU when attached to a Pioneer Mobile Robot through Saphira, a popular client-application development environment for Pioneer Mobile Robots. The popular Ayllu Robotics Application Development Software also has explicit support for the AMPTU. And, with the robot, you may communicate directly with the camera through the Pioneer Operating System.

AMPTU Command Syntax

All commands to the AMPTU must be comprised in a simple format (Table 3-1): a two-byte header—ASCII “PT”; 0x50 and 0x54 hexadecimal bytes, respectively—which signals the AMPTU that a command follows, a one-byte unit address—ASCII “0” for all units or “1” through “7” (0x30 through 0x37; unit 1 is the factory default) to target an individual unit, followed by a one-byte command number or ASCII command word, and ending with the requisite number of argument bytes. A terminating RETURN character (0x13) also is required to end interactive commands. Command numbers and arguments are detailed in Table 3-2.

Table 3-1 AMPTU command packet

Byte	Value	Description
1,2	“PT” (0x50, 0x54)	Header signals AMPTU command follows
3	“0” – “7” (0x30 – 0x37)	AMPTU address; “0” = all units
4	Command	See Table 3-2
5,...	Argument	Required command argument bytes
N	0x0D	Required terminal for interactive commands

The AMPTU head will pan a maximum 300 degrees and tilt a maximum of 180 degrees. Its coordinate system's origin (0 pan, 0 tilt) is when the head is in its fully down and maximum counterclockwise position. Accordingly, its 299, 179 position is pan fully clockwise and tilt facing up.

Table 3-2 AMPTU commands and arguments

Instruction	Direct Command (ASCII/hex)	Interactive Command (ASCII)	Argument (range)	Description
Pan Absolute	1 0x31	PANAB	int degrees (0-299)	Pans head to an absolute angle in degrees relative to the maximum counterclockwise head position. Integer argument order is most- followed by least-significant byte.
Pan Relative Clockwise	2 0x32	PANCW	int degrees (0-299)	Pans head clockwise (CW) relative to current position. Overruns go to maximum (299) pan position.
Pan Relative Counterclockwise	3 0x33	PANCC	int degrees (0-299)	Pan CCW from current position. Overruns go to minimum pan position (0).
Pan Slew Rate	4 0x34	PANSL	byte degrees/sec (15-120)	Sets the pan slew speed according to the equation: Slew=256 - (3840 / degrees/sec) Accordingly, the command argument 0 corresponds to a pan slew rate of about 15 degrees/sec. The maximum argument value of 0xEC produces slew of 200 degrees/second. Default rate is 90 degrees/sec.
Tilt Absolute	5 0x35	TLTAB	byte degrees (0-179)	Tilts head to the absolute angle relative to the minimum (0) position (fully down).
Tilt Relative Up	6 0x36	TLTUP	byte degrees (0-179)	Tilts head up from the present position. Overruns to the maximum tilt position(179; fully up).
Tilt Relative Down	7 0x37	TLTDN	byte degrees (0-179)	Tilts head down from the present position. Overruns to the minimum tilt position (0; fully down).
Tilt Slew Rate	8 0x38	TLTSL	byte degrees/sec (15-200)	Sets tilt slew rate. See Pan Slew Rate for equation. Default rate is 90 degrees/sec.
Pause	9 0x39	PAUSE	-	Stops the head immediately. Disables subsequent motion commands, too. Resume current motion command and command processing with Continue. Purge re-enables motion commands, too.
Continue	: 0x3a	CONT	-	Continue motion and processing motion commands after Pause. Otherwise, ignored.
Purge	; 0x3b	PURGE	-	Stops current motion command and flushes the command queue. Use Status to located head position.
Status	< 0x3c	STAT	-	Only when response mode is enabled (not default; see RESP below), theAMPTU responds to the status request with the following packet over the serial interface: A three-byte header ("PT" and the unit number), 0x3c (echoes Status command), the most recent or current motion command, the tilt position (byte), pan position (int; msbyte, lsbyte), pan slew rate (byte), tilt slew rate (byte), and zoom (byte).
Initialize	= 0x3d	INIT	-	Exercises the head, then centers it. System defaults get restored.
Response	> 0x3e	RESP	byte (0 or 1)	Have (1) or don't have (0; default) the AMPTU tell you when it has completed a command or if it encountered an error. Response packet contains three-byte header ("PT" and unit number), followed by the completed command number and

				its arguments, as originally sent. Error packet contains common three-byte header, “U” (0x55), and an error byte. See Table 3-3 for error byte decoding.
Zoom	? 0x3f	ZOOM	byte (0-255)	Set the zoom control voltage ; 0 = 0 VDC; 0xFF = +10VDC.
Pan/ Tilt Absolute	((0x28)	PTABS	int, byte (0-299, 0-179)	Combines commands 1 and 5 for simultaneous pan and tilt to absolute positions.
Pan CW, Tilt Up) 0x29	PTCWU	int, byte (0-299, 0-179)	Combines commands 2 and 6 for simultaneous pan and tilt to relative positions.
Pan CW, Tilt Down	* 0x2a	PTCWD	int, byte (0-299, 0-179)	Combines commands 2 and 7 for simultaneous pan and tilt to relative positions.
Pan CCW, Tilt Up	+ 0x2b	PTCCU	int, byte (0-299, 0-179)	Combines commands 3 and 6 for simultaneous pan and tilt to relative positions.
Pan CCW, Tilt Down	· 0x2c	PTCCD	int, byte (0-299, 0-179)	Combines commands 3 and 7 for simultaneous pan and tilt to relative positions.

Command Execution

The AMPTU operates in two command modes simultaneously: direct and interactive. In direct mode, the AMPTU responds to commands as they arrive. In interactive mode, the AMPTU does not respond until it receives a terminating RETURN character (0x0D), such as which is sent by common terminal programs.

In both modes, the AMPTU firmware ignores any sequence that does not begin with the requisite “PT” header byte sequence, if the subsequent unit number byte is not 0 (all units) or does not match its own unit number (normally 1), or if the command is malformed.

If the AMPTU receives a proper header and unit number, it processes direct commands immediately (command values 0x28 through 0x3F). Interactive commands—the unique sequences of ASCII characters as well as ASCII-encoded command parameters, as described in Table 3-2—get processed when the AMPTU receives the RETURN (0x0D) character. This lets you edit the command line before the unit will take action. Separate requisite command parameters with spaces or a comma.

Motion commands get put in a FIFO queue and get processed in the order they are received, each after the previous command is completed, unless the queue gets Purged.

Here are two example commands that you may type in from a common terminal program attached to the AMPTU:

```
PT0 INIT
PT6 PTABS 150,90
```

The first example initializes all units connected to the serial communication line. The second command speaks only to unit number 6 and tells it to pan and tilt to its centered position (150 degrees pan, 90 degrees tilt). Notice that the command arguments also may have been separated by a space character instead of the comma.

Status and Errors

If response mode is enabled (not default), the AMPTU will echo back each motion command packet when it has completed execution from the queue. Also, if in response mode, command errors get reported. The error response packet includes the common “PT” plus unit number three-byte header, followed by the ASCII character “U” and another byte, which decoded by Table 3, describes the source of the error.

Table 3-3. Error byte encoding; meaning if bit is set (1):

Condition	Bits	Description
Not defined	7 - 5	Bits not currently used.
Buffer Overflow	4	Too many bytes queued in the command buffer. The last command sent has been ignored.
Bad Command	3	Unrecognizable command.
Zoom error	2	Zoom value is out of range.
Tilt error	1	Tilt command value is out of range; limit value substituted.
Pan error	0	Pan command value is out of range; limit value substituted.

Retrieve current position data, albeit transient if a motion command is executing, with the Status command (ASCII "<"; 0x3c). Table 3-4 summarizes the response packet the AMPTU sends back in response.

Table 3-4. Status response packet

Label	Bytes	Value(s)	Description
Header	1,2	"PT"	Header bytes
Unit #	3	1-7	Unit number responding
Echo	4	50 (0x3c)	Status command byte
Command	5	byte	The most recent or current motion command
Tilt	6	byte; 0-179	Head's current tilt position
Pan	7,8	int; 0-299	Head's current pan position
Pan slew	9	byte; 15-120	Pan slew rate
Tilt slew	10	byte; 15-200	Tilt slew rate
zoom	11	byte; 0-255	Zoom position

Pioneer Software

When attached to a Pioneer Mobile Robot, the AMPTU gets support at many software levels, including at the server level in PSOS/P2OS, and at the client level with Colbert/Saphira and Ayllu.

PSOS/P2OS

At the lowest level, integrated control of the AMPTU happens through a single PSOS/P2OS client command (number 42) with a string argument containing the AMPTU command packet. Upon receipt through the HOST serial port, as with all client communications, PSOS/P2OS repackages the string and sends it out through the AUX serial port on the Pioneer 2 microcontroller to the serial port on the AMPTU.

With P2OS, AMPTU response and status packets emerging from its serial port get processed by the Pioneer microcontroller and can be retrieved using the P2OS command number 43 and related auxiliary server packet type 176.

See the *Pioneer Operation Manual* for command and packet details.

Saphira Plugin

The Saphira robotics client application development and control environment among many other things manages client/server communications with Pioneer Mobile Robots. We have developed a Saphira plugin (dynamically loadable library) that lets you interactively and programmatically operate the AMPTU through Saphira and its related Colbert language.

The AMPTU.EXE for Windows 95/98/NT comes on disk with the unit. It, upgrades, and versions for other systems, including Linux, may also be retrieved from the <http://robots.activmedia.com> support website.

Please read the README file for installation and operation details. The source code is included, so it makes a great template for writing your own AMPTU control programs.

NOTE BENE:

Unlike the native AMPTU software, the Saphira plugin places the head origin in the center of its envelope, so that pan and tilt take positive and negative value arguments.

Colbert

To use the AMPTU plugin software with your Saphira clients and interactively through the Colbert command window, load the shared AMPTU object library into the Colbert interpreter that comes with Saphira versions 6.1 and later. With Linux/Unix systems, the shared library is called `amptu.so`; it's called `amptu.dll` for use with Windows95/98 and WindowsNT. They are kept in the `colbert` directory of Saphira.

To use the AMPTU Saphira commands from the Colbert interactive command line or from within a Saphira client program, first start up the Saphira client. Then, either draw down the Saphira File menu and select to load the shared library, or give the Colbert direct command:

```
> load amptu
```

Thereafter, invoke the many different AMPTU commands directly from the Colbert interactive window, from within a running Saphira client, or from a Colbert activity. Load and examine the `ptu_demo.act` Colbert activity from the Saphira `colbert` directory for more details.

Appendix A

Video Connector Specifications

The day/night and stereo camera heads available for the AMPTU come pre-wired and installed. Table A-1 contains the pinouts for the payload connector that sits atop the Case and available for your own payloads.

Table A-1. Payload connector pinouts

Pin	Description
1	ZOOM 0-10VDC control; not available on all units
2	GND
3	+12VDC power
4	Video connector tip (left camera for stereo head)
5	Video connector center
6	GND

Appendix B

AMPTU Specifications

Pan Angle	± 300 degrees
Pan Slew	15 to 120 degrees per second
Tilt Angle	± 180 degrees
Tilt Slew	15 - 200 degrees per second
Operating Voltage	12V DC
Interface	Standard RS232 via RJ11 connector
Programming	Direct and interactive command set
Maximum payload	125g (4.5 oz) @ 180 degrees-per-second slew
Weight (base unit)	1.75 lbs (0.8 Kg)
Controls	On-Off switch with red LED indicator
Connector power	2.5mm power socket
Connector video	Mini-stereo phone jack; tip and center signal; barrel gnd.

Warranty & Liabilities

ActivMEDIA ROBOTICS' Pan Tilt Unit (AMPTU) is fully warranted against defective parts or assembly for one year after it is shipped to you from the factory. This warranty explicitly *does not include* damage from shipping or from abuse or inappropriate operation.

The developers, marketers, and manufacturers of the AMPTU shall bear no liabilities for operation and use of the unit or any accompanying software and accessories 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 a Pioneer Mobile Robot or its accessories 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 AMPTU take responsibility for support of any special or custom modification to it or its software.



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