



High-Performance

Pan-Tilt Unit (E Series)

(includes PTU-E46)

Command Reference Manual

Version 6.00 (09/2014)



DOCUMENT CONTROL

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12/2011	A. Hernandez	4.10	Updated E Series release
08/2012	A. Hernandez	5.00	Reformat document, GPM, other updates
09/2014	A. Hernandez	6.00	Additional serial & Pelco D updates

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E Series Pan-Tilt Command Reference Manual, version 6.00 (09/2014)

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1 - Introduction

Each Pan-Tilt Unit (PTU) from FLIR Commercial Systems, Inc. includes a comprehensive set of available commands that give you full control over all functionality. The E Series of PTUs features an expanded command set for even more control options.

This *Pan-Tilt E Series Command Reference Manual* covers the software control interface for the following E Series PTUs:

- PTU-E46 models
- PTU-D48 E Series
- PTU-D100 E Series
- PTU-D300 E Series

Each PTU also includes a *PTU User Manual* specific to that unit model (such as *PTU-D48 E Series User Manual*). The *PTU User Manual* describes the electrical and mechanical interfaces and includes general setup and use instructions.

The E Series command set described in this manual is backwards compatible with prior PTU models with the following exceptions:

- Range of motion command syntax has been updated (Section 7).
- Network commands have been added to support the Ethernet interface (Section 14).



Note: This manual is not intended for use with the PTU-D46 or PTU-D47. If you have a PTU-D46 or PTU-D47, please refer to the PTU-D46.47 Command Reference Manual.



Note: The Compatibility Mode feature allows you to switch from D Series compatibility to the slightly different E Series behavior. Please see Appendix A for details.

1.1 - Safety

Please refer to and comply with all safety warnings contained in your *PTU User Manual*.

1.2 - E Series Features



The E Series of PTUs (PTU-D48E, PTU-D100E, and PTU-D300E) include the following new features:

- Built-in Ethernet/Web IP interface for easy configuration, control, and diagnostics
- Improved power protection circuitry
- 32-pin base connector for simplified wiring
- Integrated digital encoder for more robust positioning
- Programmable ranges of motion
- Higher command rates with lower latency and jitter
- Reduced calibration movement
- Integrated geo-pointing (GPM) support
- Available stabilization (ISM) functionality
- Full backward compatibility with previous PTU models.

1.3 - PTU-E46 Features

The PTU-E46 includes the following new features (compared to the PTU-D46):

- Built-in Ethernet/Web IP interface for easy configuration, control, and diagnostics
- Pelco-D support
- Integrated geo-pointing (GPM) support
- Compatible with the PTU Software Development Kit (PTU-SDK)
- Higher command rates with lower latency and jitter

1.4 - About This Manual

This section describes the formatting conventions and information contained in this manual.

1.4.1 - Formatting Conventions

This manual uses several formatting conventions to present information of special importance.

Commands and other information that is new for the E Series PTUs include the “E” icon shown here.



Lists of items, points to consider, or procedures that do not need to be performed in a specific order appear in bullet format:

- Item 1
- Item 2

Procedures that must be followed in a specific order appear in numbered steps:

1. Perform this step first.
2. Perform this step second.

Specific keyboard keys are depicted in square brackets and are capitalized, for example: [ESC]. If more than one key should be pressed simultaneously, the notation will appear as [KEY1]+[KEY 2], for example [ALT]+[F4].

Interface elements such as document titles, fields, windows, tabs, buttons, commands, options, and icons appear in **bold** text.

Menus and submenus have the notation **Menu>Submenu**. For example, “Select **File>Save**” means that you should first open the **File** menu, and then select the **Save** option.

Specific commands appear in standard *Courier* font. Sequences of commands appear in the order in which you should execute them and include horizontal or vertical spaces between commands.

This manual also contains important safety information and instructions in specially formatted callouts with accompanying graphic symbols. These callouts and their symbols appear as follows throughout the manual:



WARNING: CAUTIONS ALERT YOU TO THE POSSIBILITY OF EQUIPMENT OR PROPERTY DAMAGE IF THESE INSTRUCTIONS ARE NOT FOLLOWED.



CAUTION: CAUTIONS ALERT YOU TO THE POSSIBILITY OF EQUIPMENT OR PROPERTY DAMAGE IF THESE INSTRUCTIONS ARE NOT FOLLOWED.



Note: Notes provide helpful information.



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2 - Web Interface



This chapter describes how to configure and program your E Series PTU using the Web interface.



Note: D Series PTUs do not support the Web interface. This chapter is for E Series PTUs and the PTU-E46 only.



Note: You may also have a simultaneous serial connection to a terminal, as described in Section 13.



ISM: The ISM Web interface includes additional command and configuration options to support the stabilization function. Please refer to the ISM User Manual for instructions on using the ISM Web interface.

Follow the instructions in your *PTU User Manual* to connect the PTU to the host computer and power it on, obtain the IP address, and launch the Web interface in a browser window. If your PTU includes the optional ISM module, please refer to the ISM documentation.



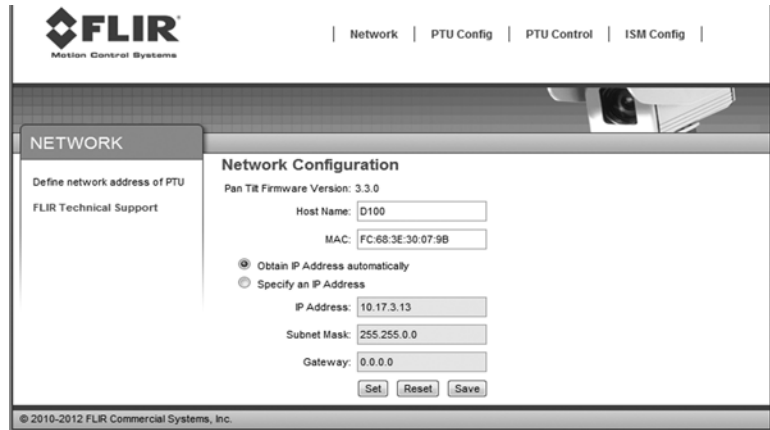
Note: Commands issued via the Web interface correspond to commands issued via the serial interface.

2.1 - Network Page

The **Network** page appears when you click the **Network** link in the top menu.

This page allows you to configure the following options for your PTU:

- **Host Name:** Name of the PTU. If you have multiple PTUs on the network, you may enter a unique name for the currently selected PTU to make reconnecting faster.
- **MAC:** Displays the unique Media Access Control (MAC) address for the PTU. You may change this address if necessary.
- **Automatic IP Address:** Checking the **Obtain IP address Automatically** radio button allows the PTU to either accept IP information from a DHCP server (such as a router) or select its own IP information (if connected directly to a host computer).
- **Manual IP Address:** Checking the **Manual IP Address** radio button lets you specify the following information:
 - **IP Address:** IP address for the PTU.
 - **Subnet Mask:** Subnet mask of the network the PTU is connected to.
 - **Gateway:** Specify the gateway to forward outgoing packets.



After changing network information, click the appropriate action button at the bottom of the page:

- **Set:** Clicking **Set** implements your changes but does not save them to the PTU. This is a global function that sets all specified parameters.
- **Reset:** Clicking **Reset** reverts the PTU to factory default settings. This is a global function that resets all specified parameters.
- **Save:** Clicking **Save** implements your changes and saves them to the PTU.

2.2 - PTU Configuration Page

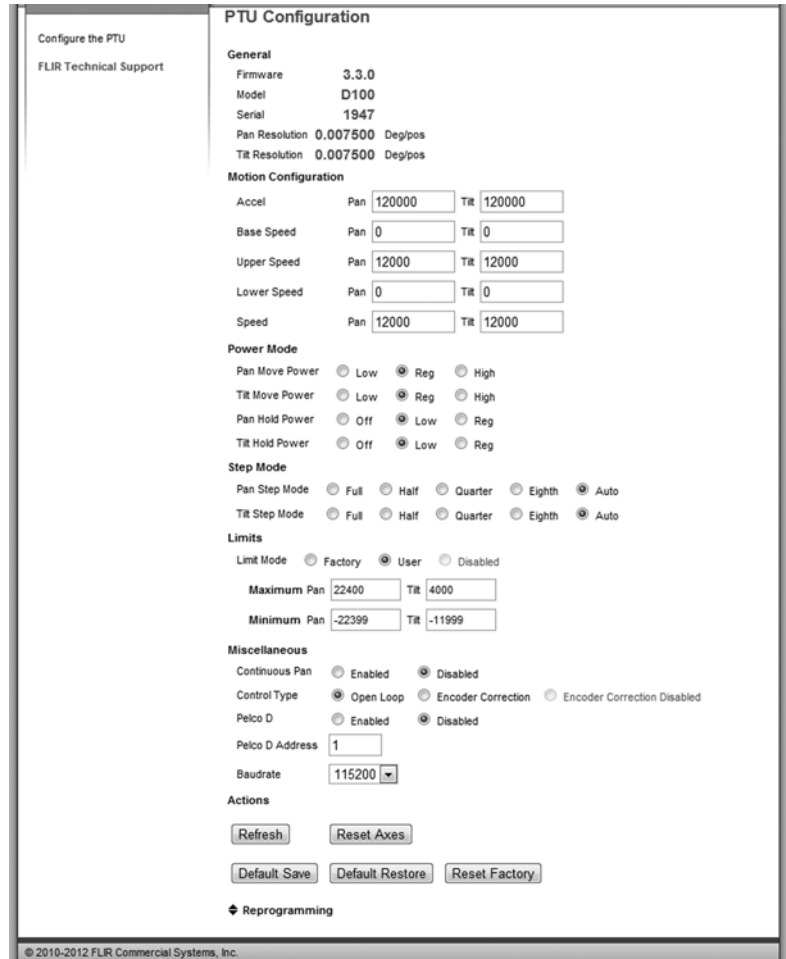
The **PTU Config** page appears when you click the **PTU Config** link in the top menu. All changes entered on this page are instantly implemented by the PTU. Entering an invalid value highlights the error in red text.

To use this page:

1. Make your desired changes.
2. Click the appropriate **Apply** button to apply certain changes (see below).
3. Click the appropriate action button at the bottom of the page.

This page allows you to view and configure the following options for your PTU:

- **General:** The **General** section of the **PTU Config** page displays the following information:
 - **Firmware:** The PTU installed firmware revision.
 - **Model:** The PTU model number.
 - **Pan Resolution:** Horizontal motion resolution in degrees. This number varies depending on your selected step mode (see below). Each unit of resolution equals one “position.”
 - **Tilt Resolution:** Vertical motion resolution in degrees. This number varies depending on your selected step mode (see below). Each unit of resolution equals one “position.”



Configure the PTU
FLIR Technical Support

PTU Configuration

General
 Firmware 3.3.0
 Model D100
 Serial 1947
 Pan Resolution 0.007500 Deg/pos
 Tilt Resolution 0.007500 Deg/pos

Motion Configuration
 Accel Pan 120000 Tilt 120000
 Base Speed Pan 0 Tilt 0
 Upper Speed Pan 12000 Tilt 12000
 Lower Speed Pan 0 Tilt 0
 Speed Pan 12000 Tilt 12000

Power Mode
 Pan Move Power Low Reg High
 Tilt Move Power Low Reg High
 Pan Hold Power Off Low Reg
 Tilt Hold Power Off Low Reg

Step Mode
 Pan Step Mode Full Half Quarter Eighth Auto
 Tilt Step Mode Full Half Quarter Eighth Auto

Limits
 Limit Mode Factory User Disabled
 Maximum Pan 22400 Tilt 4000
 Minimum Pan -22399 Tilt -11999

Miscellaneous
 Continuous Pan Enabled Disabled
 Control Type Open Loop Encoder Correction Encoder Correction Disabled
 Pelco D Enabled Disabled
 Pelco D Address 1
 Baudrate 115200

Actions
 Refresh Reset Axes
 Default Save Default Restore Reset Factory

◆ Reprogramming

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- **Motion Configuration:** The **Motion Configuration** section of the **PTU Config** page allows you to specify the following motion options for both pan and tilt in positions. One position equals one unit of resolution:
 - **Accel:** Pan and tilt acceleration and deceleration in positions per second per second. The PTU will accelerate at this rate to the selected speed, maintain this speed as long as necessary, and then slow back down at the same rate.
 - **Base Speed:** Speed the PTU instantly accelerates to.
 - **Upper Speed:** Maximum PTU speed that can be commanded.
 - **Lower Speed:** Minimum PTU speed that can be commanded.
 - **Speed:** Pan and tilt speed, in positions per second.
- **Power Mode:** The **Power Mode** section of the **PTU Config** page allows you to specify the following power options for each axis:
 - **Move Power:** Amount of power the PTU uses when moving the payload.
 - **Hold Power:** Amount of power the PTU uses in order to hold the payload in a fixed position.

The following power settings are available for pan and/or tilt power:

- **Off:** Setting the hold power to **Off** means that the PTU motor(s) are completely off when the payload is not moving in the selected axis or axes.
- **Low:** Setting the hold and/or move power to **Low** means that the PTU motors draw lower power while moving and/or holding.
- **Reg:** Setting the hold and/or move power to **Reg** means that the PTU motors draw normal power while moving and/or holding.
- **High:** Setting the move power to **High** means that the PTU motors draw maximum power while moving the payload in the pan and/or tilt axis. This power setting should be used for intermittent (<20%) duty cycles.



CAUTION: THE HIGH POWER SETTING IS INTENDED ONLY FOR INTERMITTENT DUTY CYCLES (<20%). EXTENDED HIGH POWER CYCLES CAN OVERHEAT THE PTU MOTORS.

- **Step Mode:** The **Step Mode** section of the **PTU Config** page allows you to specify the following resolution options for each axis:
 - **Full:** Low resolution.
 - **Half:** Medium resolution.
 - **Quarter:** High resolution.
 - **Eighth:** Maximum resolution. This setting provides the greatest aiming accuracy.
 - **Auto:** Internally switches between step modes for optimal movements, but all commands and accuracy are in 1/8 step mode.

Changing the step mode requires a calibration reset. Please see Section 12 for more information about steps and fractional steps.

- **Limits:** The **Limits** section of the **PTU Config** page allows you to specify the pan and tilt range of motion for your PTU. You can program limits on the PTU-E46; however, you must still perform a reset sequence after a power cycle to move through the full range of motion. Please see Section 7 for an explanation of limit types and a visual depiction of the PTU range of motion.
 - **Factory:** Checking the **Factory** radio button sets the PTU range of motion to its factory default. The range of motion appears below.
 - **User:** Checking the **User** radio button allows you to program your own range of motion. The **Minimum** and **Maximum** fields become editable, allowing you to enter your desired range for both pan and tilt.
 - **Disabled:** Enabling continuous pan mode by checking the **Disabled** radio button overrides the factory or user pan limits, allowing the PTU to pan a full 360°. Checking the **Disabled** radio button limits the PTU pan range of motion to the factory or user limits you specified above. This requires a calibration reset.
 - **Maximum:** Enter the maximum pan and tilt positions in the appropriate fields.
 - **Minimum:** Enter the minimum pan and tilt positions in the appropriate fields.
- **Miscellaneous:** The **Miscellaneous** section of the **PTU Config** page allows you control the following miscellaneous functions:
 - **Continuous Pan:** Enable or disable continuous pan mode by clicking the **Enabled** or **Disabled** radio button, as appropriate. This feature is not supported on the PTU-E46.
 - **Control Type:** Select the desired control mode by clicking the **Open Loop**, **Encoder Correction**, or **Encoder Correction Disabled** radio button, as appropriate. Please see Section 15 for more information about control modes. This feature is not supported on the PTU-E46.
 - **Pelco D:** Enable or disable the Pelco D protocol by checking the **Enabled** or **Disabled** radio button, as appropriate.
 - **Pelco D Address:** Enter the Pelco D address to use in the **Pelco D Address** field.
 - **Baudrate:** Select the desired baud rate using the **Baudrate** pull-down menu.

Please see Section 18 for more information about the Pelco D protocol.
- **Action Buttons:** The action buttons at the bottom of the **PTU Config** page allow you to perform the following actions:
 - **Refresh:** Clicking the **Refresh** button updates the **PTU Config** page with the values stored on the PTU.
 - **Reset Axes:** Clicking the **Reset Axes** button cycles the PTU through a complete calibration reset cycle.
 - **Default Save:** Clicking the **Default Save** button saves the changes you made on the **PTU Config** page as the default settings for the PTU.

- **Default Restore:** Clicking the **Default Restore** button restores the previously-saved defaults.
- **Reset Factory:** Clicking the **Reset Factory** button restores factory default speed, acceleration, power, and limit settings to the PTU. This erases any user limits.
- **Reprogramming:** The **Reprogramming** section of the **PTU Config** page allows you to upload firmware to the PTU.



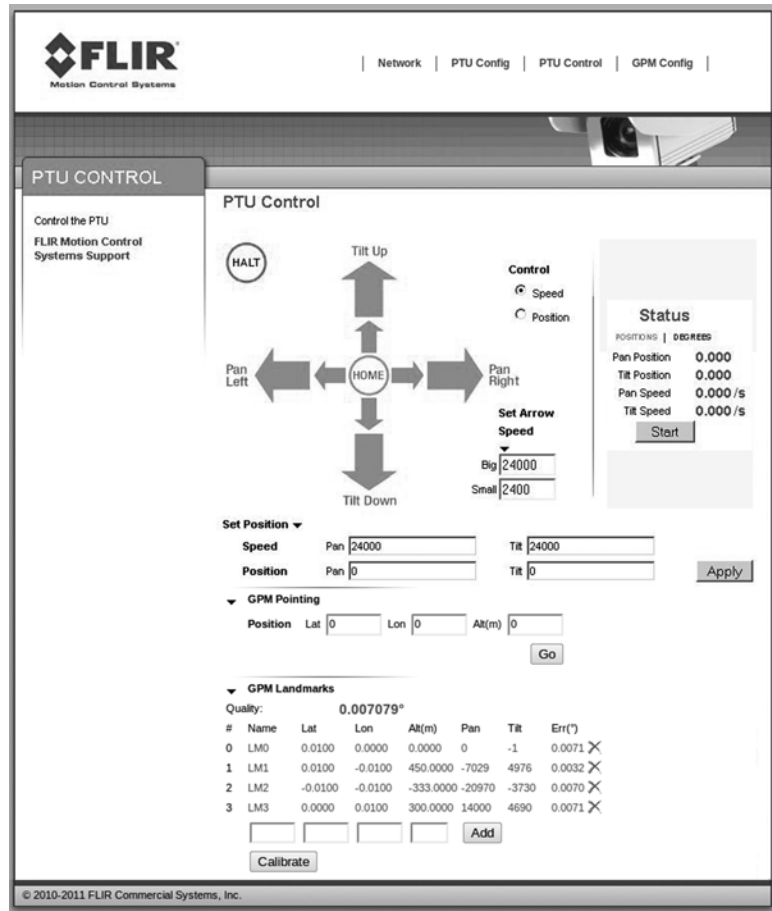
CAUTION: ONLY REPROGRAM YOUR PTU USING FIRMWARE SUPPLIED BY FLIR COMMERCIAL SYSTEMS, INC. UNDER THE DIRECT GUIDANCE OF TECHNICAL SUPPORT. FIRMWARE DOWNGRADES MAY NOT BE SUPPORTED.

2.3 - PTU Control Page

The **PTU Control** page appears when you click the **PTU Control** link in the top menu.

This page allows you to control your PTU as follows:

- **Home:** Clicking **Home** returns the PTU to its home pan and tilt positions.
- **Directional controls:** The directional controls allow you to move the PTU left and right (pan), and up and down (tilt).
 - **Halt:** Clicking Halt immediately stops the PTU in its current position.
 - **Small Arrow:** Clicking a small arrow moves the PTU by either the smaller position step size or at the lower speed (see below).
 - **Big Arrow:** Clicking a big arrow moves the PTU by either the larger position step size or at the higher speed (see below).
- **Speed/Position selection:** Check the appropriate radio button to control the PTU by **Position** (the PTU will move by the selected amount when an arrow is clicked) or **Speed** (the PTU will accelerate up to the selected speed when an arrow is clicked, and will continue moving at that speed until the arrow is released).



- **Set Arrow Step Size:** The **Set Arrow Step Size** fields allow you to specify either how many positions the PTU will move each time an arrow is clicked (if you selected **Position**), or how fast it will move (if you selected **Speed**).
 - **Big:** The **Big** number specifies either the number of positions the PTU will move each time you click a big arrow (if you selected **Position**) or the number of positions per second the PTU will move (if you selected **Speed**).
 - **Small:** The **Small** number specifies either the number of positions the PTU will move each time you click a small arrow (if you selected **Position**) or the number of positions per second the PTU will move (if you selected **Speed**).
- **Status:** The **Status** section of the **PTU Control** page displays the PTU position and speed in real time. Click the appropriate link to see this information in **Degrees** or **Positions**.
 - **Position:** Pan and tilt location of the PTU in degrees or positions.
 - **Speed:** Pan and tilt speed of the PTU in degrees or positions per second.
 - **Start/Stop:** Clicking the **Start/Stop** button toggles updating the PTU status on and off.
- **Set Position:** The **Set Position** section of the **PTU Control** page allows you to manually enter position and/or speed information. Please see Section 7 for an explanation of limit types and for a visual depiction of the PTU range of motion.
 - **Speed:** Enter your desired pan and/or tilt speeds in the **Speed** fields.
 - **Position:** Enter your desired pan and/or tilt position in the **Position** fields.

Click the **Apply** button to move the PTU to the specified position at the specified speed.

- **GPM Pointing:** The **GPM Pointing** section of the **PTU Control** page allows you to aim your PTU based on geographical location. Please see Sections 2.4 and 17 for information on configuring the Geo Pointing Module (GPM) in your PTU using the web interface and/or serial commands, respectively.
 - **Lat:** Latitude to aim the PTU in degrees.
 - **Lon:** Longitude to aim the PTU in degrees.
 - **Alt(m):** Altitude of the PTU relative to sea level in meters.

Click the **Go** button to aim the PTU at the specified geographical location.

- **GPM Landmarks:** The **GPM Landmarks** section of the **PTU Control** page displays the landmarks stored in the PTU, allows you to point the PTU at a stored landmark, and add/delete landmarks. The PTU can store up to 16 landmarks.
 - **Quality:** Displays the largest pointing error to any landmark in degrees. This does not necessarily reflect the largest error when pointing to a true location.
 - **Landmark number:** Displays the unique number for each landmark in the # column.
 - **Name:** Unique name assigned to each landmark. Names can be up to 15 characters long.
 - **Lat:** Latitude of the landmark in degrees.
 - **Lon:** Longitude of the landmark in degrees.

- **Alt(m):** Altitude of the landmark in meters relative to sea level.
- **Pan:** Pan angle of the PTU required to point at the landmark based on the currently configured position and orientation in positions.
- **Tilt:** Tilt angle of the PTU required to point at the landmark based on the currently configured position and orientation in positions.
- **Err(°):** Pointing error to the landmark in degrees.

You may aim the PTU at a landmark and add or remove a landmark as follows:

- Add a landmark by aiming the PTU at the landmark, entering its name, latitude, longitude, and altitude in the appropriate field and then clicking the **Add** button.
- Remove a landmark by clicking the **X** for the selected landmark.
- **GPM Calibration:** Click the **Calibrate** button to calculate the PTU's orientation (roll, pitch, yaw), complete a six dimensional pose (latitude, longitude, altitude, roll, pitch, yaw), and calculate the calibration error. The error can be described as how much the landmarks disagree about each other's location using the calculated pose.

2.4 - GPM Config Page

The **GPM Config** page appears when you click the **GPM Config** link in the top menu.

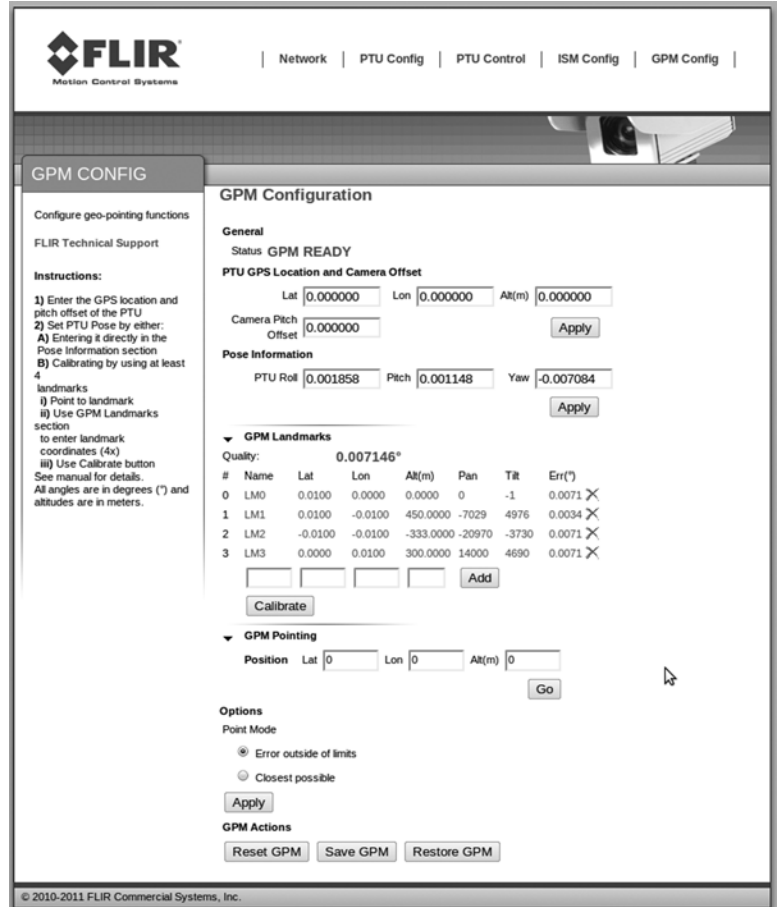
This page allows you to configure the built-in Geo Pointing Module (GPM) in your PTU as follows:

Status: Displays the current status of the GPM.

- **PTU GPS Location and Camera Offset: section:** Allows you to enter the geographical location and payload (camera) offset of the PTU.
 - **Lat:** Enter the latitude of the PTU location in degrees.
 - **Lon:** Enter the longitude of the PTU location in degrees.
 - **Alt(m):** Enter the altitude of the PTU relative to sea level in meter.
 - **Camera Pitch Offset:** Enter the difference between the payload line of sight and the PTU line of sight in degrees.

Click the **Apply** button to set the PTU location and camera (payload) offset.

- **GPM Landmarks:** The **GPM Landmarks** section of the **GPM Config** page displays the landmarks stored in the PTU, allows you to point the PTU at a stored landmark, and add/delete landmarks. The PTU can store up to 16 landmarks.
 - **Quality:** Displays the largest pointing error to any landmark in degrees. This does not necessarily reflect the largest error when pointing to a true location.
 - **Landmark number:** Displays the unique number for each landmark in the # column.
 - **Name:** Unique name assigned to each landmark. Names can be up to 15 characters long.
 - **Lat:** Latitude of the landmark in degrees.
 - **Lon:** Longitude of the landmark in degrees.
 - **Alt(m):** Altitude of the landmark in meters relative to sea level.
 - **Pan:** Pan angle of the PTU required to point at the landmark based on the currently configured position and orientation in positions.



The screenshot shows the FLIR GPM Configuration page. The top navigation bar includes links for Network, PTU Config, PTU Control, ISM Config, and GPM Config. The main content area is titled 'GPM CONFIG' and contains several sections:

- General:** Status is 'GPM READY'.
- PTU GPS Location and Camera Offset:** Fields for Lat (0.000000), Lon (0.000000), and Alt(m) (0.000000). A 'Camera Pitch Offset' field is set to 0.000000. An 'Apply' button is present.
- Pose Information:** Fields for PTU Roll (0.001858), Pitch (0.001148), and Yaw (-0.007084). An 'Apply' button is present.
- GPM Landmarks:** A table showing the quality and details of stored landmarks.

#	Name	Lat	Lon	Alt(m)	Pan	Tilt	Err(°)
0	LM0	0.0100	0.0000	0.0000	0	-1	0.0071 ✕
1	LM1	0.0100	-0.0100	450.0000	-7029	4976	0.0034 ✕
2	LM2	-0.0100	-0.0100	-333.0000	-20970	-3730	0.0071 ✕
3	LM3	0.0000	0.0100	300.0000	14000	4690	0.0071 ✕
- GPM Pointing:** Fields for Position Lat (0), Lon (0), and Alt(m) (0). A 'Go' button is present.
- Options:** Radio buttons for 'Error outside of limits' (selected) and 'Closest possible'. An 'Apply' button is present.
- GPM Actions:** Buttons for 'Reset GPM', 'Save GPM', and 'Restore GPM'.

- **Tilt:** Tilt angle of the PTU required to point at the landmark based on the currently configured position and orientation in positions.
- **Err(°):** Pointing error to the landmark in degrees.

You may aim the PTU at a landmark and add or remove a landmark as follows:

- Aim the PTU at a landmark by clicking the selected landmark.
- Remove a landmark by clicking the **X** for the selected landmark.
- Add a landmark by entering its name, latitude, longitude, and altitude in the appropriate field and then clicking the **Add** button.
- **GPM Calibration:** Click the **Calibrate** button to calculate the PTU's orientation (roll, pitch, yaw), complete a six dimensional pose (latitude, longitude, altitude, roll, pitch, yaw), and calculate the calibration error. The error can be described as how much the landmarks disagree about each other's location using the calculated pose.
- **GPM Pointing:** The **GPM Pointing** section of the **GPM Config** page allows you to aim your PTU based on geographical location.
 - **Lat:** Latitude to aim the PTU in degrees.
 - **Lon:** Longitude to aim the PTU in degrees.
 - **Alt(m):** Altitude of the PTU relative to sea level in meters.

Click the **Go** button to aim the PTU at the specified geographical location.

- **Options:** The **Options** section of the **GPM Config** page is where you specify how the PTU should respond if you command it to aim at a point beyond its range of motion.
 - **Error outside of limits:** The PTU will report an error if the desired pointing position is out of range of the PTU motion.
 - **Closest possible:** The PTU will get as close as possible to the desired pointing position without reporting an error
- **GPM Actions:** The **GPM Actions** section of the **GPM Config** page lets you reset, save, and restore GPM settings.
 - **Reset GPM:** Clicking the **Reset GPM** button resets all GPM configuration in the PTU (latitude, longitude, altitude, pitch, roll, yaw, and camera offset) to factory defaults.
 - **Save GPM:** Clicking the **Save GPM** button saves the current GPM configuration to the PTU.
 - **Restore GPM:** Clicking the **Restore GPM** button restores the previously saved GPM configuration to the PTU.

3 - ASCII Serial Commands

This chapter describes the ASCII command syntax used when controlling a PTU via a serial connection, lists the available commands, and discusses power level and acceleration considerations. Please also refer to the “Quick Start” chapter in your *PTU User Manual* for information about getting your PTU up and running quickly.

3.1 - ASCII Command Syntax

A PTU uses both commands and queries. A command tells the PTU to do something (such as pan to a specific angle). A query asks the PTU to return the requested value (such as reporting the current pan angle).

The basic ASCII command syntax is `<command><parameter><delimiter>`, where:

- `<command>` is the actual command (such as PP for pan position),
- `<parameter>` is an alphanumeric value (such as the desired pan position), and
- `<delimiter>` is a character used to denote the end of a command. Valid delimiter characters can be either [SPACE] or [ENTER].

The basic ASCII query syntax is `<command><delimiter>`, where:

- `<command>` is the actual command (such as PP for pan position),
- `<delimiter>` is a character used to denote the end of a query. Valid delimiter characters can be either [SPACE] or [ENTER].

For example:

- **Command:** PP<position><delim> sets the desired absolute pan position.
- **Query:** PP<delim> returns the current absolute pan position.

Commands and queries return results that display on the terminal screen, as follows:

- A successfully executed command displays * `<CR><N>` on the terminal screen (where `<CR>` is a carriage return and `<N>` is a new line).
- A successfully executed query displays * `<QueryResult><CR><N>` (where `<QueryResult>` is the result of the query you just executed).
- A failed command displays ! `<ErrorMessage><CR><N>` (where `<ErrorMessage>` describes the error encountered).

- A pan axis limit hit asynchronously displays !P.
- A tilt axis limit hit asynchronously displays !T.



Note: You may see one or multiple !P or !T errors. This is normal behavior.

This sample command sequence pans the PTU to the left, waits, and then pans it back to the right with queries after finishing each pan movement:

```
PP-2500 *
A *
PP * Current Pan position is -2500
PP2500 *
A *
PP * Current Pan position is 2500
```

3.2 - Serial Command List

These tables list the available serial commands. Please refer to later sections within this manual for complete information about the available commands and their usage.

3.2.1 - Position

The available position commands are:

PP	Set/query pan position	XS	Set preset	MS	Monitor status
TP	Set/query tilt position	XG	Go to preset	I	Immed. execution mode
PO	Set/query pan offset	XC	Clear preset	S	Slaved mode
TO	Set/query tilt offset	M	Monitor	H	Halt all
PR	Pan resolution	ME	Monitor auto enable	HP	Halt pan
TR	Tilt resolution	MD	Monitor auto disable	HT	Halt tilt
A	Await	MQ	Monitor auto query		

Please see Section 4 for more information about the position commands.

3.2.2 - Speed

The available speed commands are:

PS	Set/query pan speed	TA	Tilt acceleration	TU	Tilt upper speed
TS	Set/query tilt speed	PB	Pan base speed	TL	Tilt lower speed
PD	Set/query pan speed offset	TB	Tilt base speed	C	Query control mode
TD	Set/query tilt speed offset	PU	Pan upper speed	CI	Set to position control
PA	Pan acceleration	PL	Pan lower speed	CV	Set to velocity control
B	Query/set PTU motion				

Please see Section 5 for more information about the speed commands.

3.2.3 - Continuous Axis Rotation

The available continuous axis rotation commands are:

PC	Query Pan continuous	PCD	Pan continuous disable	PCE	Pan continuous enable
----	----------------------	-----	------------------------	-----	-----------------------

Please see Section 6 for more information about the continuous axis commands.

3.2.4 - Limits

The available limit commands are:

PN	Minimum pan position	PNU	User-defined pan min.	L	Query limit status
PX	Maximum pan position	PXU	User-defined pan max.	LE	Enable limits ¹
TN	Minimum tilt position	TNU	User-defined tilt min.	LD	Disable limits ²
TX	Maximum tilt position	TXU	User-defined tilt max.	LU	User limits

NOTES

1. Factory limits.
2. This command is retained for backward compatibility. For E Series PTUs, it is best to either use continuous pan mode to exceed limits or enable user limits to reduce range of motion.

Please see Section 7 for more information about the limit commands.

3.2.5 - Unit Controls

The available unit control commands are:

R	Reset	F	Query feedback mode	DS	Default save
RD	Disable reset	FV	Enable verbose feedback	DR	Restore saved settings
RT	Reset tilt ³	FT	Enable terse feedback	DF	Restore factory defaults
RP	Reset pan ³	V	Query firmware version	EE	Enable host cmd. echo
RE	Reset both axes ⁴	E	Query echo mode	ED	Disable host cmd. echo
RPS	Query/set pan reset speed	RTS	Query/set tilt reset speed		

NOTES

- 3. Subsequent resets and any power-on reset will only affect this axis.
- 4. This also enables reset on power-up.

Please see Section 8 for more information about the unit commands.

3.2.6 - Power

The available power commands are:

PH	Query pan hold power	THL	Tilt hold power low	TM	Query tilt move power
PHR	Pan hold power regular	THO	Tilt hold power off	TMH	Tilt move power high
PHL	Pan hold power low	PM	Query pan move power	TMR	Tilt move power regular
PHO	Pan hold power off	PMH	Pan move power high	TML	Tilt move power low
TH	Query tilt hold power	PMR	Pan move power regular	O	Query VDC and temp
THR	Tilt hold power regular	PML	Pan move power low		

Please see Section 9 for more information about the power commands.

3.2.7 - Serial & Expanded I/O

The available serial and expanded I/O commands are:

@	Serial port settings	_<id>	Unit select	JE	Joystick enable
@A	Channel A	U	Query network ID	JD	Joystick disable
@B	Channel B				

Please see:

- Section 10 for more information about the host serial commands.
- Section 11 for more information about the expanded I/O commands.

3.2.8 - Step Modes

The available step mode commands are:

WP	Query pan step mode	WPE	Pan axis eighth step	WTH	Tilt axis half step
WPF	Pan axis full step	WPA	Pan axis auto-step	WTQ	Tilt axis quarter step
WPH	Pan axis half step	WT	Query tilt step mode	WTE	Tilt axis eighth step
WPQ	Pan axis quarter step	WTF	Tilt axis full step	WTA	Tilt axis auto-step

Please see Section 12 for more information about the step mode commands.

3.2.9 - IP Network

The available IP network commands are:

NA	MAC address	NMS	Network mode static	NN	Network host name
NI	IP address	NMD	Network mode dynamic	NS	Network mask
NM	Query network mode	NG	Network gateway		

Please see Section 14 for more information about the IP network commands.

E

3.2.10 - Control Mode

The available control mode commands are:

BT	Get PTU motion w/ timestamp	CNT	Timestamp	CNF	Timestamp frequency
CEC	Control encoder correction	CT	Query control type	IQ	Query immed/slave
RQ	Query reset type				

Please see Section 15 for more information about the control mode commands.

3.2.11 - Geo Pointing Module (GPM)

The available GPM commands are:

GC	Calibrate PTU	GCQ	Query calibration quality	GDF	Reset GPM to factory
GDR	Restore last-saved settings	GDS	Save all GPM settings	GT	Query/set GPM point type
GS	GPM status	GL	GPM latitude	GO	GPM longitude
GA	GPM altitude	GLLA	GPM position & altitude	GCP	GPM camera offset
GR	PTU roll	GP	PTU pitch	GY	PTU yaw
GRPY	PTU roll/pitch/yaw	GM	GPM landmarks	GMA	Add landmark
GMN	Number of landmarks	GMD	Delete newest landmark	GMC	Delete all landmarks
GG	Query/set aim landmark	GGD	Distance to aim point		

Please see Section 17 for more information about the geo pointing commands.

3.2.12 - Pelco D



The available Pelco D commands are:

QP	Query Pelco D parsing	QPE	Enable Pelco D parsing	QPD	Disable Pelco D parsing
QA	Pelco D address				

Please see Section 18 for more information about the Pelco D commands.

3.2.13 - Firewall



The available firewall commands are:

NFU	Push rule to rule list	NFO	Remove/return last rule	NFF	Remove all rules
NFI	Index	NFC	Return number of rules	NFA	Apply staging to current

Please see Appendix A for more information about the firewall commands.

3.2.14 - Compatibility Mode



The available compatibility mode commands are:

CM	Check compat. status	CME	Enable compat. mode	CMD	Disable compat. mode
----	----------------------	-----	---------------------	-----	----------------------

Please see Appendix B for more information about the compatibility mode commands.

3.2.15 - Timestamp



The available timestamp commands are:

CNT	Query timestamp count	CNF	Query counter frequency	BT	PTU speed/pos. w/ stamp
-----	-----------------------	-----	-------------------------	----	-------------------------

Please see Appendix C for more information about the timestamp commands.

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4 - Position

This chapter describes the available PTU position commands and queries.

4.1 - Absolute Position

Specify or query the absolute pan or tilt axis position. Desired positions can be changed on-the-fly without waiting for previous position commands to complete.

4.1.1 - Commands

The available absolute position commands are:

- PP
- TP

4.1.2 - Syntax

- Query current absolute pan position: `PP<delim>`
- Set desired absolute pan position: `PP<position><delim>`
- Query current absolute tilt position: `TP<delim>`
- Set desired absolute tilt position: `TP<position><delim>`

4.1.3 - Example

The following command sequence sends the pan axis to the left, waits, then sends it to the right:

```
PP-2500 *
A *
PP * Current Pan position is -2500
PP2500 *
A *
PP * Current Pan position is 2500
```

4.1.4 - See Also

Please refer to the following sections for more information:

- Position (relative offset and desired position queries): Section 4.2
- Position resolution (units): Section 4.3
- Position limits: Section 4.4
- Position limit enforcement modes: Section 4.5
- Position execution modes: Section 4.6

4.2 - Offset Position

Specify the desired pan or tilt axis position as an offset relative to the current position, or query the desired axis position. You may change desired offset positions on the fly without waiting for previous position commands to complete.

4.2.1 - Commands

The available offset position commands are:

- PO
- TO

4.2.2 - Syntax

- Query desired pan position: PO<delim>
- Set desired offset pan position: PO<position><delim>
- Query desired tilt position: TO<delim>
- Set desired offset tilt position: TO<position><delim>

4.2.3 - Example

The following command sequence sends the pan axis to position -500, then sends it 1500 positions to the left of position -500:

```
PP-500 *  
A *  
PO * Current Pan position is -500  
PO1500 *  
A *  
PP * Current Pan position is 1000
```

4.2.4 - See Also

- Position resolution (units): Section 4.3
- Position limits: Section 4.4
- Position limit enforcement modes: Section 4.5
- Position execution modes: Section 4.6

4.3 - Resolution per Position

This query returns the axis resolution per position moved in seconds of arc.



Note: A degree of arc is divided into 60 minutes of arc, and each minute of arc is further divided into 60 seconds of arc. A degree of arc therefore contains 3600 seconds of arc, and each second of arc is equal to 1/3600 of a degree or 0.0002778°.

4.3.1 - Commands

The available resolution per position queries are:

- PR
- TR

4.3.2 - Syntax

- Query pan resolution: PR<delim>
- Query tilt resolution: TR<delim>

4.3.3 - Example

To pan the PTU 21.3 degrees to the right:

```
PR * 92.5714 seconds arc per position
P0828 *
```

There are 3,600 arc-seconds per degree. Thus, to calculate the number of positions to move the PTU to obtain the desired degrees of angle change, use the formula [degrees divided by (resolution divided by 3,600)]. For example:

$$\frac{21.3}{(92.5714/3,600)} = \frac{21.3}{0.025714} \approx 828.342 \approx 828$$

In this example, each position equals 0.025714°, which is 92.5714/3600. You should therefore move the PTU 828 positions.

4.3.4 - See Also

Step Modes: Section 12

4.4 - Limit Position Queries

These queries return the axis position limits (either factory set or user limits). Please refer to your PTU User Manual for more information about limits.

4.4.1 - Commands

The available limit position queries are:

- PN
- PX
- TN
- TX

4.4.2 - Syntax

- Query minimum pan position: PN<delim>
- Query maximum pan position: PX<delim>
- Query minimum tilt position: TN<delim>
- Query maximum tilt position: TX<delim>

4.4.3 - Example

The following query sequence enables factory limits, resets the PTU, queries the pan and tilt axis limits, and then attempts to pan the PTU beyond its limits to return an error message.

```
LE *
RE * !T!T!P!P
PN * Minimum Pan position is -3090
PX * Maximum Pan position is 3090
TN * Minimum Tilt position is -907
TX * Maximum Tilt position is 604
PP3200 ! Maximum allowable Pan position is 3090
```

4.4.4 - See Also

- Position resolution (units): Section 4.3
- Achieving larger axis bounds: Section 4.5

4.5 - Position Limit Enforcement

Determines whether position commands beyond the detected pan axis limits are allowable. When limits are enabled (default), commands outside of the limits return an error message and are not executed. In this mode, the PTU only reaches limits when it has lost synchronization, a condition that requires a unit reset (see Section 7.1). The PTU displays !P on the host computer port when it reaches its pan axis limits and !T when it reaches its tilt axis limits.



Note: You may see one or multiple !P or !T errors. This is normal behavior.

4.5.1 - Commands

The available position limit enforcement commands are:

- L
- LD
- LE
- LU

4.5.2 - Syntax

- Query current pan position limit mode: L<delim>
- Enable pan position limits: LE<delim>
- Disable pan position limits: LD<delim>
- User limits: LU<delim>



Note: You can program user limits on the PTU-E46; however, you must still perform a reset sequence after a power cycle to move the unit through its full range of motion because the unit has no encoders.



CAUTION: DISABLING LIMITS MAY DAMAGE INTERNAL PTU WIRING AND IS NOT RECOMMENDED, PARTICULARLY ON PTUS WITHOUT HARD STOPS.

4.5.3 - Example

This command sequence queries the current limit status and maximum pan limit, attempts to pan the PTU beyond its pan limit to return an error message, then disables limits and repeats the pan command, which now executes successfully because of the disabled limits.

```
L * Limit bounds are ENABLED (soft limits enabled)
PX * Maximum Pan position is 3090
PP3200 ! Maximum allowable Pan position is 3090
LD *
R * !T!T!P!P
PP3200 *
A *
PP * Current Pan position is 3200
```



Note: This example demonstrates the LD command. This command is not recommended, and is not necessary for continuous pan mode. Use the PCE command instead.

4.5.4 - See Also

Position commands: Section 4.1 and Section 4.2

4.6 - Position Execution Mode

Instructs the PTU to either immediately execute positional commands (default) or execute these commands only after an Await Position Completion command is executed (slaved position execution). Slaved position execution is recommended when you need coordinated pan and tilt axis movements. Switching from slaved to immediate execution mode will execute any queued commands.

4.6.1 - Commands

The available position execution mode commands are:

- I
- S
- IQ

4.6.2 - Syntax

- Enable immediate execution mode: I<delim>
- Enable slaved execution mode: S<delim>
- Query execution mode: IQ<delim>

The IQ command returns one of the following results:

- **I**: Immediate mode.
- **S**: Slaved mode.

4.6.3 - Example

This command sequence enables immediate execution mode and then sends a pan command to the PTU, which will begin moving immediately. It then changes to slaved execution mode, commands the axes to specified positions, and adds an Await Position Completion command to start moving the PTU in both axes simultaneously.

```
I *
PP1000 *
IQ * I
S *
IQ * S
PP1500 *
TP-900 *
PP * Current Pan position is 0
TP * Current Tilt position is 0
A *
PP * Current Pan position is 1500
TP * Current Tilt position is -900
```

4.7 - Await Position Completion

Awaits the completion of the most recently issued pan and tilt axis position commands. Use this command to coordinate axis motions when the PTU is in slaved execution mode.

4.7.1 - Command

The available await position completion command is:

- A

4.7.2 - Syntax

- To command the PTU to await the completion of previous position commands: A<delim>

4.7.3 - Example

This commands sequence instructs the pan axis to move to a position, then move to another position:

```
I *
PP * Current Pan position is 0
PP2000 *
A *
PP * Current Pan position is 2000
PP0 *
A *
PP * Current Pan position is 0
```

Compare the previous example to this one, in which the PTU will begin to move to the first position and then, while still in transit, begin moving to the second position (an “on-the-fly” position change):

```
I *
PP * Current Pan position is 0
PP2000 *
PP0 *
```

4.7.4 - See Also

You may use this command with either Immediate or Slaved Position Execution modes (see Section 4.6).

4.8 - Halt

Immediately decelerates and halts PTU movement.

4.8.1 - Command

The available halt command is:

- H

4.8.2 - Syntax

- Halt all PTU movement in both axes: H<delim>
- Halt pan axis movement only: HP<delim>
- Halt tilt axis movement only: HT<delim>

4.8.3 - Example

This command sequence pans the PTU to the right and then to the left. The PTU must be in motion for you to see the H command in action.

```
PP2500 *  
A *  
PP-2500
```

Enter the following command while the PTU is moving:

```
H *  
PP * Current pan position is <pos>
```

(where <pos> is the current pan position, which will be between 2500 and -2500)

4.8.4 - See Also

You may use this command with either Immediate or Slaved Position Execution mode (see Section 4.6).

4.9 - Monitor (Auto-scan)

This command defines and initiates repetitive PTU monitoring (auto-scanning). Auto-scanning stops immediately and the PTU returns to its home position upon receiving a character from the host computer. Monitoring may also stop due to communications problems, errors, and/or PTU motor faults (Section 4.10).

4.9.1 - Commands

The available monitor (auto-scan) commands are:

- M
- ME
- MD
- MQ
- MS

4.9.2 - Syntax

- Initiate monitoring (pan axis only): `M<pan pos 1>,<pan pos 2><delim>`
- Initiate monitoring (both axes): `M<pan pos 1>,<pan pos 2>,<tilt pos 1>,<tilt pos 2><delim>`
- Initiate the last-defined monitor command: `M<delim>`



Note: The power-up monitoring default is the most recently saved auto-scan mode. The pan limits are the default monitor positions.

- Begin monitoring: `M<delim>`
- Enable monitor at power-up: `ME<delim>`
- Disable monitor at power-up: `MD<delim>`
- Query power-up monitor status: `MQ<delim>`

4.9.3 - Example

Executing the following command at power-up starts the PTU scanning between its most recently saved default limits:

`M *`

To stop scanning and return the PTU to the home position:

`<delim>`

This example enables pan axis monitoring between the specified positions:

`M-2500,100 *`

This example enables pan and tilt monitoring between the specified positions:

`M-2500,100,-800,600 *`

This example enables tilt axis monitoring between the specified positions:

`M0,0,-300,300 *`

4.9.4 - See Also

Limit Position Queries (Section 4.4)

4.10 - Monitor Status

Returns the current status or reason why the monitor command (M) stopped. Multiple values will appear if monitoring stopped for more than one reason.

4.10.1 - Command

The available monitor status command is:

- MS

4.10.2 - Syntax

- View monitor status: `MS<delim>`

This command may return one or more of the following values to indicate the current monitoring status:

- Monitor not started: `NO_START 1`
- Monitor started: `START 2`
- Monitoring stopped: `STOP 4`
- Channel I/O interrupt: `CH_INT 8`
- General error: `ERROR 16`
- Motor fault: `FAULT 21`

4.10.3 - Example

The following example reports that monitoring is already started.

```
MS * STOP 4
```

4.10.4 - See Also

Monitor (auto scan): Section 4.9

4.11 - Position Presets

E Series PTUs support 33 position presets, which allow you to command the PTU to a position using any standard motion-control commands and then store that position as a preset numbered from 0 to 32. You can then command the PTU to any previously stored preset using a “Go to” command. Presets are retained when the PTU is powered down.



Note: When moving to a preset, the PTU will follow the currently set motion parameters such as acceleration, base rate, etc.

4.11.1 - Commands

The available position preset commands are:

- XS
- XG
- XC

4.11.2 - Syntax

- Set preset: XS<index><delim>
- Go to preset: XG<index><delim>
- Clear Preset: XC<index><delim>

In the above examples, <index> is the number of the stored preset position. Valid index numbers are integers between 0 and 32.

4.11.3 - Example

The following command sequence sets the PTU to position 500/400, store that position as preset 0, move the PTU to position 600/800, and then return it to the previously stored preset 0 position.

```
PP500 *
TP400 *
A *
XS0 *
PP600 *
TP800 *
A *
XG0 * (PTU moves to 500/400)
```

4.12 - Query/Set PTU Speed/Position

You may query the PTU's current speed and/or position and command the PTU to a specified speed and/or position.

4.12.1 - Command

The available PTU speed/position command is:

- B

4.12.2 - Syntax

- Query PTU position and speed: B<delim>
- Set PTU position and speed: B<pan pos>,<tilt pos>,<pan speed>,<tilt speed>

4.12.3 - Example

The following command queries the PTU position and speed and then sends new position and speed parameters to the PTU.

```
B *
B *P(256,-23) S(0,0) (PTU is at position 256/-23 and moving at speed 0.)
B256,-400,300,250 * (Commands the PTU to position 256/-400 at pan speed 300 and tilt speed 250)
```

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5 - Speed Control

Each PTU combines precise position control with precise speed and acceleration control. This allows you to quickly and accurately predict any given PTU position at any given time.

- The base (start-up) speed is the instantaneous velocity that the PTU axis can achieve without losing synchronization when starting from a full stop. Base speed capabilities are more a function of the motors rather than load characteristics.
- The upper speed limit is the maximum speed that the PTU axis can achieve.
- Motors lose torque as speed increases and acceleration is therefore necessary to achieve speeds above the base rate. The PTU uses trapezoidal acceleration and deceleration for speeds between the base and maximum speed, meaning that acceleration and deceleration occur at the same rate. Acceleration is measured in positions per second per second. For example, a PTU accelerating from 500 positions per second at a rate of 150 positions per second per second will be moving at 650 positions per second after one second, 800 positions per second after two seconds, etc.

Figure 1 displays the relationships between lower (base) speed limits, upper speed limits, and velocity changes (acceleration) under three scenarios from left to right:

- In the first scenario, a PTU axis starts at the base speed and accelerates to a desired constant speed (slew rate) which it holds for some time before decelerating to the base rate.
- In the second scenario, additional speed changes are required that are below the base speed. The PTU instantaneously changes speed.
- In the third scenario, the PTU does not have enough time to accelerate to the desired slew speed before having to decelerate to stop at the desired position.

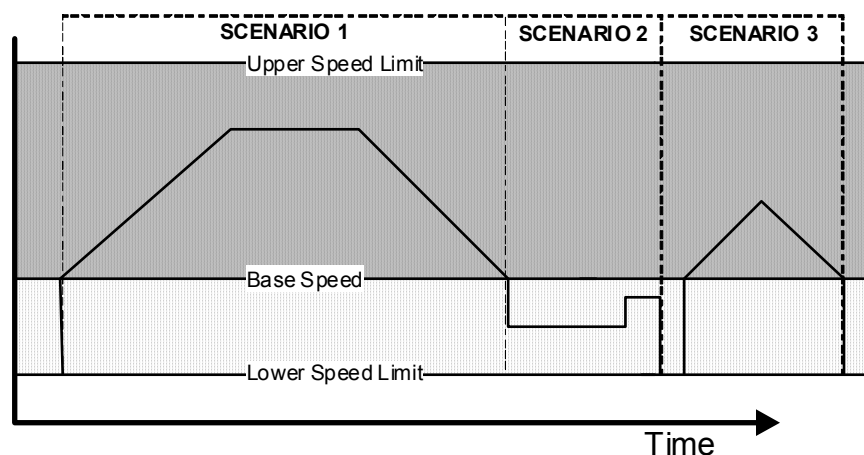


Figure 1: Axis speed during on-the-fly desired speed and position changes

The upper speed, base speed, and acceleration parameters are interrelated. Depending on how one or more of these parameters are set, attempting to set another parameter may return an error. If you receive an error while setting an acceleration, try lowering the upper speed limit. If you receive an error while setting an upper speed limits, try increasing the acceleration.

The PTU allows on-the-fly position, speed, and directional changes. When changing direction on-the-fly, the PTU manages all deceleration, direction reversal, and acceleration to achieve the most recently specified target speed and acceleration rates.

5.1 - Absolute Speed

Specify the desired axis speed in positions per second, or query the desired speed for the selected axis. Speed is the rate at which the PTU moves to execute movement commands. You can change speeds on-the-fly. Speed commands outside the speed bounds return an error and are not executed.

5.1.1 - Commands

The available absolute speed commands are:

- PS
- TS

5.1.2 - Syntax

- Query desired pan speed: PS<delim>
- Set desired pan speed: PS<position><delim>
- Query desired tilt speed: TS<delim>
- Set desired tilt speed: TS<position><delim>

5.1.3 - Example

The following command sequence instructs the pan axis to move to the far left, then slowly move right and speed up on-the-fly:

```
PS1900 *
PP2600 *
A *
PS600 *
PP-2600 *
PS1900 *
```


5.1.4 - See Also

- Position commands: Section 4.1 and Section 4.2
- Position resolution (units): Section 4.3
- Speed bounds: Section 5.5

5.2 - Relative Speed

Specify desired axis speed in positions per second relative to the current speed, or query the current axis speed. The relative speed (change or delta) is measured in positions per second relative to the speed before the command is issued. For example, if the PTU is moving at 1,000 positions per second, adding a delta of 300 using a relative speed command will increase the speed to 1,300 positions per second. You can change speeds on-the-fly. Speed changes that will result in a speed outside the speed bounds return an error and are not executed.

5.2.1 - Commands

The available relative speed commands are:

- PD
- TD

5.2.2 - Syntax

- | | |
|--|---------------------|
| • Query current pan speed: | PD<delim> |
| • Set desired delta (offset) pan speed: | PD<position><delim> |
| • Query current tilt speed: | TD<delim> |
| • Set desired delta (offset) tilt speed: | TD<position><delim> |

5.2.3 - Example

The following command sequence instructs the pan axis to move to the far left, then slowly move right, decrease speed on-the-fly by -150 positions/ second, and then query the current speed:

```
I *
PS1900 *
PP2600 *
A *
PS600 *
PP-2600 *
PD-150 *
PD * Current Pan speed is 450 positions/sec
```

5.2.4 - See Also

- Position commands: Section 4.1 and Section 4.2
- Position resolution (units): Section 4.5
- Speed bounds: Section 5.5

5.3 - Acceleration

Specify or query axis acceleration and deceleration for speeds above the base speed. Acceleration is specified in positions per second per second.



Note: The PTU requires a brief period to re-compute the internal tables used to rapidly execute speed ramping when calculating acceleration and deceleration. Acceleration therefore cannot be changed on-the-fly. If the PTU is moving and you attempt to change the acceleration, the PTU will immediately slow to a halt.

5.3.1 - Commands

The available acceleration commands are:

- PA
- TA

5.3.2 - Syntax

- Query current pan acceleration: PA<delim>
- Set desired pan acceleration: PA<position><delim>
- Query current tilt acceleration: TA<delim>
- Set desired tilt acceleration: TA<position><delim>

5.3.3 - Example

The following command sequence illustrates different rates of acceleration:

```
PA * Pan acceleration is 2000 positions/sec/sec
PB * Current Pan base speed is 1000 positions/sec
PU * Maximum Pan speed is 2902 positions/sec
A *
PP0 *
PS1900 *
PP2600 *
A *
PA1500 *
```

PP0 *
A *

5.3.4 - See Also

Position resolution (units): Section 4.3

5.4 - Base (Start-Up) Speed

Specify or query the axis base (start-up) speed, in positions per second. The default base speed is 0 positions per second.



Note: The PTU requires several seconds to re-compute the internal tables used to rapidly execute speed ramping when calculating speeds. The base speed therefore cannot be changed on-the-fly. If the PTU is moving and you attempt to change the base speed, the PTU will immediately slow to a halt.

5.4.1 - Commands

The available base speed commands are:

- PB
- TB

5.4.2 - Syntax

- Query current pan base speed: PB<delim>
- Set desired pan base speed: PB<position><delim>
- Query current tilt base speed: TB<delim>
- Set desired tilt base speed: TB<position><delim>

5.4.3 - Example

The following command sequence homes the pan axis, moves it far left, changes the base rate, then moves back to home:

```
I *
PP0 *
PB * Current Pan base speed is 0 positions/sec
PP2600 *
A *
PB1000 *
PP0 *
A *
```

5.4.4 - See Also

- Position resolution (units): Section 4.3
- Acceleration: Section 5.3
- Speed bounds: Section 5.5

5.5 - Speed Bounds

Set and query the upper and lower speed bounds for desired speed commands.



Note: The PTU requires several seconds to re-compute the internal tables used to rapidly execute speed ramping when calculating speeds. The upper speed bound therefore cannot be changed on-the-fly. If the PTU is moving and you attempt to change the upper speed, the PTU will immediately slow to a halt.

5.5.1 - Commands

The available speed bound commands are:

- PU
- PL
- TU
- TL

5.5.2 - Syntax

- | | |
|---------------------------------|---------------------|
| • Query upper pan speed limit: | PU<delim> |
| • Set upper pan speed limit: | PU<position><delim> |
| • Query lower pan speed limit: | PL<delim> |
| • Set lower pan speed limit: | PL<position><delim> |
| • Query upper tilt speed limit: | TU<delim> |
| • Set upper tilt speed limit: | TU<position><delim> |
| • Query lower tilt speed limit: | TL<delim> |
| • Set lower tilt speed limit: | TL<position><delim> |

5.5.3 - Example

This command sequence queries the upper and lower pan speeds and attempts to exceed those limits in order to return an error message.

```
PU * Maximum Pan speed is 1985 positions/sec
PS3300 ! Pan speed cannot exceed 1985 positions/sec
PS1985 *
PL * Minimum Pan speed is 31 positions/sec
PL20 ! Motor speed cannot be less than 31 pos/sec
PL40 *
```

5.5.4 - See Also

Position resolution (units): Section 4.3

5.6 - Speed Control Modes

PTU position and speed control are independently controlled by default. In this mode, speed commands represent unsigned magnitudes that determine how fast the PTU travels between independently commanded positions while not affecting the commanded positions themselves. This mode is appropriate for both

- pure position control methods (when pan-tilt control is affected solely by commanding pan-tilt position), and
- hybrid position-velocity control methods (when both pan-tilt positions and the rate at which the PTU travels between them are controlled).

Your PTU also supports controlling pan and tilt via a “pure” velocity-control mode that uses signed changes in the commanded axis speed. In this mode, the speed command is a signed value where the sign determines the direction of movement and the value determines the speed of movement in that direction, as follows:

- If the commanded speed is negative, the axis is automatically commanded to the minimum axis position.
- If the commanded speed is positive, the axis is automatically commanded to the maximum axis position.
- If the commanded speed is 0, axis movement is halted.
- If the axis supports continuous movement, the PTU will continue to move until commanded to stop.

In “pure” velocity control mode, issuing a speed command for a given axis effectively overrides any position commands that are currently being executed. By default, the PTU defaults to the independent control mode on power-up; the speed control mode is not saved when the PTU powers down.

5.6.1 - Commands

The available speed control mode commands are:

- C
- CI
- CV

5.6.2 - Syntax

- Query the current speed control mode: C<delim>
- Set to independent control mode (default): CI<delim>
- Set to “pure” velocity control mode: CV<delim>

5.6.3 - Example

This command sequence places the PTU into the default independent control mode and pans to position -3000 at a rate of 1,000 positions per second. When placed into the “pure” velocity control mode, the PTU will finish on the opposite pan side. The factory restore (DF) command restores independent control mode.

```
CI *  
PS1000 *  
PP-3000 *  
A *  
CV *  
PP-3000 *  
PS1000 * (PTU begins panning in positive direction)  
A *  
PP * Current pan position is <pos>  
DF *  
C * PTU is in Independent Mode
```

(where <pos> is the current pan position)



*Note: When the PTU commanded to CV mode, the axis will not move until the next velocity command is issued. For example, PS1000 * CV * will still show a speed of 1000 even though the axis is not moving.*



Note: Speed control mode is intentionally not saved with other settings.

5.6.4 - See Also

- Position commands: Section 4.1 and Section 4.2
- Speed commands: Section 5.1 and Section 5.2

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6 - Continuous Axis Rotation

The PTU-D300, PTU-D100, and PTU-D48 (with optional slip-ring) support continuous rotation in both of the control modes described in Section 5.6. This section describes the command syntax and semantics that support continuous axis rotation.

You do not need to disable limits in order to enable continuous rotation.



Note: The PTU-E46 does not support continuous rotation.

6.1 - Continuous Rotation



These commands allow you to enable or disable continuous (360-degree) pan rotation.

Commands

The available continuous rotation commands are:

- PC
- PCE
- PCD



Note: These commands supersede the previous %%1CPT command. Executing this command on an E Series PTU will return an error message.



Note: You must reset the PTU after issuing a PCE or PCD command.

6.1.1 - Syntax

- Query continuous pan mode PC<delim>
- Enable continuous pan rotation: PCE<delim>
- Disable continuous pan rotation: PCD<delim>

The PC command returns one of the following values to indicate the current continuous rotation mode status:

- Continuous pan enabled: ENABLED
- Continuous pan disabled: DISABLED

6.1.2 - Example

This command sequence disables continuous panning, resets the pan axis, queries the pan minimum and maximum limits, then enables continuous panning and starts continuous rotation at a speed of 1,000 positions per second.

```
PCD *  
RP *  
!P!P *  
PN * Minimum Pan position is - 6533  
PX * Maximum Pan position is 6533  
PCE *  
CV *  
RP !P!P *  
PS1000 *
```

7 - User-Defined Limits

E Series PTUs allow user-defined limits on commanded positions. The PTU must perform a power up calibration to establish its axis coordinates, after which the user-defined limits restrict all subsequent movement commands for that axis to the specified allowable range of motion. When user limits are activated, movements commanded outside those limits will return an error message.

Factory limits define the possible range of motion allowed for an axis when limits are enabled, and that axis cannot travel beyond those limits. User-defined limits are a subset of factory limits that can be defined by issuing commands to the PTU. You can store user limits and have the PTU restore them on power-up. User limits must contain an origin (0), which means that you cannot set a minimum position above 0 or a maximum position below 0.

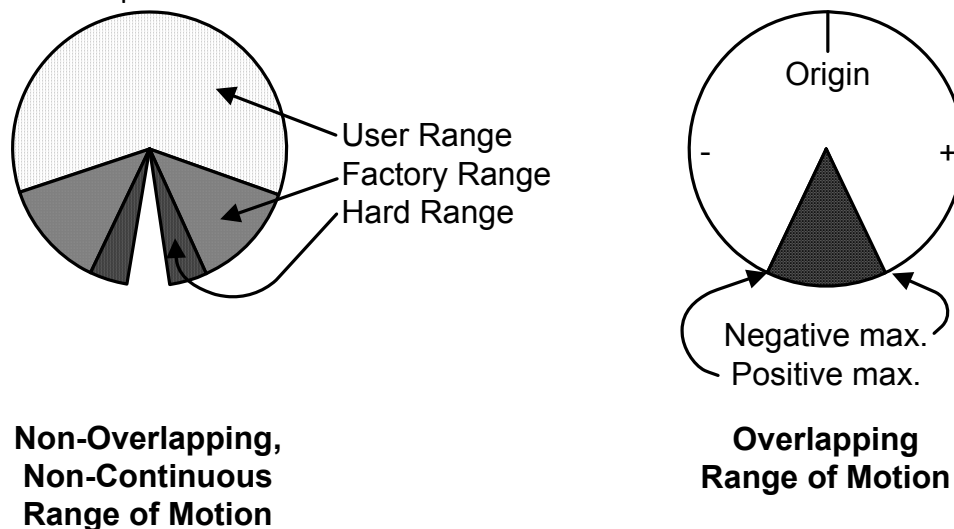


Figure 2: Range of motion and limits



Note: If your PTU has an internal slip-ring, it is capable of full 360-degree pan motion.

7.1 - Position Limit Queries

Query both factory and user axis position limits, and set user limits.

7.1.1 - Commands

The available position limit commands are:

- PN
- PX
- TN
- TX
- PNU
- PXU
- TNU
- TXU

7.1.2 - Syntax

- | | |
|---|-------------------|
| • Query minimum pan factory/user limit position: | PN<delim> |
| • Query maximum pan factory/user limit position: | PX<delim> |
| • Query minimum tilt factory/user limit position: | TN<delim> |
| • Query maximum tilt factory/user limit position: | TX<delim> |
| • Query minimum pan user defined limit position: | PNU<delim> |
| • Query maximum pan user defined limit position: | PXU<delim> |
| • Query minimum tilt user defined limit position: | TNU<delim> |
| • Query maximum tilt user defined limit position: | TXU<delim> |
| • Set minimum pan user defined limit position: | PNU<value><delim> |
| • Set maximum pan user defined limit position: | PXU<value><delim> |
| • Set minimum tilt user defined limit position: | TNU<value><delim> |
| • Set maximum tilt user defined limit position: | TXU<value><delim> |



Note: The PN, PX, TN, and TX commands return either factory limits (if user limits are not enabled) or user limits (if user limits are enabled).

7.1.3 - Example

This command sequence resets the PTU to factory defaults, queries the limits for each axis, then commands a movement beyond the specified limits to return an error message and queries the user-defined minimum pan position.

```
R *
PN * Minimum Pan position is -3090
PX * Maximum Pan position is 3090
TN * Minimum Tilt position is -907
TX * Maximum Tilt position is 604
LE *
PP3200 ! Maximum allowable Pan position is 3090
PNU * Minimum Pan user defined position is -1000
```

7.1.4 - See Also

- Position resolution (units): Section 4.3
- Achieving larger axis bounds: Section 4.5

7.2 - Position Limit Enforcement

These commands specify whether position commands beyond the factory or user-defined limits are allowable.



Note: Factory limits are enabled and enforced by default.

When limits are enabled, commands beyond those limits return an error message and are not executed.

When factory limits are enabled, the PTU will only reach those limits when it has lost synchronization. This error condition requires a unit reset, as described in Section 8.1. A PTU that reaches a factory limit sends !P or !T to the serial port to indicate that the specified limit was hit.



Note: You may see one or multiple !P or !T errors. This is normal behavior.

You may disable limit enforcement when larger operational pan ranges are required, as described in Section 5. The PTU accepts positional commands beyond the specified limits when limits are disabled.

Enabling user-defined limits triggers an error message when the PTU is commanded to positions beyond those limits. The PTU respects user limits in both independent and “pure” velocity modes, as described in Section 4.6.



Note: Enabling continuous pan overrides user limits.

7.2.1 - Commands

The available position limit enforcement commands are:

- L
- LE
- LU
- LD

7.2.2 - Syntax

- Query current limit enforcement: L<delim>
- Enable factory limits: LE<delim>
- Enable user defined limits: LU<delim>
- Disable limit enforcement: LD<delim>

7.2.3 - Example

This command sequence resets the PTU, queries the pan axis limits, sets user pan axis limits, enables limit enforcement, commands the PTU beyond pan limits to return an error message, enables user limit enforcement, and queries the pan position after the PTU finishes panning to come within the user limits.



Note: In this example, the PTU pan position is beyond the specified user limit. The PTU therefore automatically pans to the appropriate user limit when user limit enforcement is enabled.

```
R *
PN * Minimum Pan position is -3090
PX * Maximum Pan position is 3090
PNU-1000 *
PNU * Minimum user defined Pan Position is -1000
PXU1500 *
PXU * Maximum user defined Pan Position is 1500
LE *
L * Limit bounds are ENABLED
R * !T!T!P!P
```

```
PP-3000 *  
A *  
PP * Current Pan position is -3000  
PP3200 ! Maximum allowable Pan position is 3090  
LU *  
L * Limit user defined bounds are enabled  
R * !T!T!P!P  
PN * Minimum Pan position is -1000  
PX * Maximum Pan position is 1500
```



Note: Perform a reset after enabling limits, as shown in this example.

7.2.4 - See Also

Position commands: Section 5.1 and Section 5.2

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8 - Unit Commands

The commands and queries listed in this chapter allow you to issue “housekeeping” commands and queries to the PTU.

8.1 - Reset PTU

This command controls PTU calibration. By default, the PTU resets both axes automatically upon power-up. You may also issue a reset mode command to control how the PTU resets on power-up and allow you to reset individual axes.

A reset calibration allows the PTU to determine the home position and should therefore occur before you issue any axis position commands. A non-calibrated PTU has axis minimum and maximum positions set to 0, meaning that any position commands issued when limits are enabled (see Section 6.2) will return an error message.

Payloads beyond the PTU’s handling capacity may cause the reset to fail. Always test load-handling ability as described in your *PTU User Manual*. Also, E Series PTUs have a region at 180° (+/- 5°) called a lockout region. Powering down a PTU in this area means that it will not know which way to turn to return home when you power it back on. PTUs with firmware version 3.4.0 or later include a specific error message if you attempt a reset when the PTU is in the lockout region. Previous firmware versions display a more generic “axis error” message. Contact FLIR Technical Support as directed in your *PTU User Manual* for assistance if you see this lockout region error message.

8.1.1 - Commands

The available reset commands are:

- R
- RD
- RT
- RP
- RE
- RQ
- RPS
- RTS

8.1.2 - Syntax

- Perform Reset calibration: `R<delim>`



*Note: Issuing an `R` command executes the last reset mode only. For example, `RP * R` * executes a pan axis reset followed by another pan axis reset.*

The PTU saves the following reset modes for power-up reset control:

- Disable reset upon power-up: `RD<delim>`
- Reset tilt axis only: `RT<delim>`
- Reset pan axis only: `RP<delim>`
- Reset both pan and tilt axes upon power up: `RE<delim>`
- Query current reset type: `RQ<delim>`
- Query Reset Pan Speed: `RPS<delim>`
- Query Reset Tilt Speed: `RTS<delim>`
- Set Reset Pan Speed: `RPS<speed><delim>`
- Set Reset Tilt Speed: `RTS<speed><delim>`



Note: Issuing an `RE` command followed by a `DS` command (see Section 7.2) restores the default of calibrating both axes at power-up.

The `RQ` command returns one of the following results:

- **E**: Reset both axes on PTU boot.
- **P**: Reset pan axis on PTU boot.
- **T**: Reset tilt axis on PTU boot.
- **D**: No reset on boot, both axes on command.

8.1.3 - Example

This command sequence switches reset modes and performs a reset calibration between each mode change. It then queries the pan and tilt reset speeds and sets new values (1,000 positions per second for the pan axis and .

```
RT *  
!T!T *  
R *  
!T!T *  
RP *
```

```
!P!P *
R *
!P!P *
RD *
R *
!T!T!P!P *
RE *
!T!T!P!P *
R *
!T!P!P *
RPS * 2000
RTS * 1500
RPS1000 *
RTS750 *
```

8.2 - Default Save/Restore

Save current axis settings as defaults that are preserved when the PTU is powered up, and/or restore factory defaults.

The PTU can save and restore the following settings:

- Serial port settings (Host, CHA, CHB)
- Maximum speed
- Desired speed
- Base speed
- Acceleration
- Hold power
- Move power
- Monitor positions
- Continuous rotation mode
- Step mode
- User limits
- Echo mode



CAUTION: THE PTU SAVES DEFAULTS TO EEPROM, WHICH HAS A LIFETIME MAXIMUM NUMBER OF WRITES BEFORE MEMORY FAILURE OCCURS. WHILE IT IS VERY UNLIKELY THAT YOU WILL REACH THESE LIMITS, YOU SHOULD AVOID EXCESSIVE SAVING OF CURRENT DEFAULTS DURING THE PTU LIFE.

8.2.1 - Commands

The available default save/restore commands are:

- DS
- DR
- DF

8.2.2 - Syntax

- Save current settings as defaults: DS<delim>
- Restore stored defaults: DR<delim>
- Restore factory defaults: DF<delim>



Note: You will probably need to perform a reset after executing a DR or DF command because motor parameters and limits may have changed.

8.3 - Echo

Specify or query whether the PTU will echo incoming commands from the host.



Note: Disable echoing for fastest command throughput.

8.3.1 - Commands

The available echo commands are:

- E
- EE
- ED

8.3.2 - Syntax

- Query current echo mode: `E<delim>`
- Enable host command echoing: `EE<position><delim>`
- Disable host command echoing: `ED<delim>`

8.3.3 - Example

This command sequence queries the pan position, disables echoing, and reattempts the query to demonstrate that echoing is disabled.

```
PP * Current pan position is 22
ED *
PP * Current pan position is 22
```

8.4 - Feedback

Command and query the ASCII feedback returned by PTU commands.



Note: Enable terse mode for fastest command throughput.

8.4.1 - Commands

The available feedback commands are:

- FV
- FT
- F

8.4.2 - Syntax

- Enable verbose ASCII feedback: `FV<delim>`
- Enable terse ASCII feedback: `FT<delim>`
- Query ASCII feedback mode: `F<delim>`

8.4.3 - Example

This command sequence demonstrates verbose and terse feedback, then queries the current feedback mode.

```
FV *  
PP * Current pan position is 0  
FT *  
PP * 0  
F * ASCII terse mode
```

8.5 - Controller Version

Query the PTU firmware version and copyrights, PTU model number, and PTU serial number

8.5.1 - Commands

The available controller firmware version commands are:

- V
- VV
- VM
- VS

8.5.2 - Syntax

- Query PTU firmware version: V<delim>
- Query PTU short firmware version: VV<position><delim>
- Query PTU model number: VM<delim>
- Query PTU serial number: VS<position><delim>

8.5.3 - Example

This series of commands queries the PTU firmware version, short firmware version, PTU model number, and PTU serial number.

```
V * Pan-Tilt Controller v3.2.0, (C)2010 FLIR Commercial Systems, Inc.,  
All Rights Reserved  
VV * 3.2.0  
VM * D48  
VS * 1271
```

8.6 - Voltage and Temperature Query

The PTU includes sensors for both input voltage (to 0.5V) and internal and motor temperatures.



Note: Reported voltage is accurate to approximately 0.5V.

8.6.1 - Command

The available voltage and temperature query is:

- 0

8.6.2 - Syntax

- Query PTU voltage and internal/motor temperatures: 0<delim>

8.6.3 - Example

This command queries the PTU input voltage and temperature:

```
0 * Input 29.7 VDC @ 106 degF, motors: pan 96 degF, tilt 96 degF
```

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9 - Power Control

The constant-current motors used in FLIR PTUs allow you to control power consumption using simple commands. This is useful for battery-powered operation, reducing internal temperatures, and extending motor life.

9.1 - Hold Power Mode

Set and query the current power level applied to axis motors when holding position (stationary).

Regular Power is the highest amount of hold power available because stepper motors generate significantly more holding torque than dynamic torque. This allows you to use the Low Power hold mode in most situations. If needed, you may use Regular Power hold mode for brief periods when maximum holding torque is required.



CAUTION: THE REGULAR HOLD POWER SETTING IS INTENDED ONLY FOR INTERMITTENT DUTY CYCLES (<20%). EXTENDED HIGH POWER CYCLES CAN OVERHEAT THE PTU MOTORS.

If your payload is light enough and/or suitably positioned, you may be able to shut power off completely when holding. Before doing this, verify that your payload will not back-drive the PTU when holding under all expected conditions. Back-driving causes the PTU to lose track of pan and tilt position, which requires a unit reset (See Section 7.1).



Note: Back-driving usually occurs on the tilt axis because of the higher torque loads applied by the payload in high-vibration environments.



Note: If you set hold power to off, there will be a 2-second delay from the time the axis stops moving to when hold power shuts off. This allows the payload to come to a complete stop.



Note: If you change the hold power setting, the PTU must move before the new setting takes effect.

9.1.1 - Commands

The available hold power mode commands are:

- PH
- PHR
- PHL
- PHO
- TH
- THR
- THL
- THO

9.1.2 - Syntax

- Query pan hold power mode: PH<delim>
- Regular pan hold power mode: PHR<delim>
- Low pan hold power mode: PHL<delim>
- Off pan hold power mode: PHO<delim>
- Query tilt hold power mode: TH<delim>
- Regular tilt hold power mode: THR<delim>
- Low tilt hold power mode: THL<delim>
- Off tilt hold power mode: THO<delim>

9.1.3 - Example

The following command sequence queries the pan hold power mode, sets the mode to LOW, and then verifies the change.

```
PH * Pan in REGULAR hold power mode
PHL *
PH * Pan in LOW hold power mode
```

9.2 - In-Motion Power Mode

Set and query the current power level applied to axis motors when in motion (transiting).



CAUTION: THE HIGH MOVE POWER SETTING IS INTENDED ONLY FOR INTERMITTENT DUTY CYCLES (<20%). EXTENDED HIGH POWER CYCLES CAN OVERHEAT THE PTU MOTORS.

9.2.1 - Commands

The available move power mode commands are:

- PM
- PMH
- PMR
- PML
- TM
- TMH
- TMR
- TML

9.2.2 - Syntax

- Query pan move power mode: PM<delim>
- High pan move power mode: PMH<delim>
- Regular move power mode: PMR<delim>
- Low pan move power mode: PML<delim>
- Query tilt move power mode: TM<delim>
- High tilt move power mode: TMH<delim>
- Regular tilt move power mode: TMR<delim>
- Low tilt move power mode: TML<delim>

9.2.3 - Example

The following command sequence queries the pan move power mode, sets the mode to LOW, and then verifies the change

```
PM * Pan in REGULAR move power mode
PML *
PM * Pan in LOW move power mode
```

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10 - Host Serial Port

Serial PTU communications always use the following settings:

- **Start bits:** 1
- **Stop bits:** 1
- **Data bits:** 8
- **Handshaking:** None
- **Parity:** None

In addition, you may specify the following serial communications settings:

- **Baud rate:** Up to 115200 baud (default is 9600)

10.1 - Baud Rate

This command specifies the baud rate for the RS-232/RS-485 serial communications between the PTU and the host computer.



Note: Serially networked PTUs automatically use the default communications settings described above.



Note: E Series PTUs do not support host byte delays but the command syntax has been preserved to ensure backward compatibility with previous PTU models. Add a 0 in the byte delay segment of the command as shown below.



10.1.1 - Command

The available baud rate command is:

- @

10.1.2 - Syntax

- Specify baud and default: @(<baud>,0,<startup default>)<delim>
- Set desired absolute pan position: PP<position><delim>
- Query current absolute tilt position: TP<delim>
- Set desired absolute tilt position: TP<position><delim>

where:

- <baud> may be 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bits per second.
- <startup default> may be either T (to apply your specified baud at power-up) or F to use the default 9600 baud. The T and F arguments are only effective when the PTU is in Compatibility mode (see Appendix B).

10.1.3 - Example

The following command sets the host serial port RS-232/RS-485 to 19200 baud with 8 data bits per byte, no parity, no handshaking, and keeps the power-up baud rate at the default 9600.

```
@(19200,0,F) *
```

The following command sets the host serial port RS-232/RS-485 to 19200 baud with 8 data bits per byte, no parity, no handshaking, and changes the power-up baud to 19200.

```
@(19200,0,T) *
```

10.1.4 - See Also

Setting the PTU controller unit ID: Section 13.1

11 - Expanded I/O

Many usage scenarios require additional serial units that are attached to or located near the PTU. These devices can be connected directly to the host computer, which requires additional serial ports on the host plus additional serial cabling.



Note: The PTU-E46 does not support Expanded I/O.

Some E Series PTU configurations offer an optional Expanded Input/Output (EIO) option that adds CHA/CHB/TTL lines through the payload interface. Please refer to your *PTU User Manual* for more information about available lines and wiring.

The PTU controls serial port expansion channels. You may configure CHA and CHB RS-232 communications for expanded port baud rates, data bits, parity, and handshaking. Each channel operates independently, and the PTU fully buffers bidirectional data flow to allow for communications rate mismatch. Point-to-point communications between the PTU serial port and an expansion channel (e.g., CHB) is initiated by the host computer. Point-to-point communications is broken upon command from the host computer.

Communications from a serial device attached to an expansion serial channel is buffered by at least 200 characters. This buffer can overflow when hardware handshaking is not used; verify that attached devices do not exceed the buffer size before the host computer can read their serial data.

11.1 - Serial Communications Target

These commands establish point-to-point communications between the host computer connected to the PTU serial port and either the expanded serial port (CHA/CHB) or PTU. Selecting an expansion port channel switches the host computer communications from the PTU to the external device connected to the selected port. To resume communications with the PTU, the host computer issues another command that selects the PTU as the desired communication target.



Note: The expansion port baud rate does not affect communications with the serial port connecting the host computer to the PTU. The default PTU serial communications baud rate is 9600.

11.1.1 - Commands

The available serial communications target commands are:

- @A
- @B

11.1.2 - Syntax

- Establish communications with CHA: @A<delim>
- Establish communications with CHB: @B<delim>
- Resume communications with the PTU controller: @<delim>

The following modified commands ensure that <# raw bytes> bytes will pass directly from the host computer to the expanded serial port without any attempt to change the communications target. This allows strings like @B to be embedded in communications between the host computer and the expanded serial port device without inadvertently breaking communications in mid-stream.

- Establish protected communications with CHA: @A<# raw bytes><delim>
- Establish protected communications with CHB: @B<# raw bytes><delim>

where <# raw bytes> is the number of bytes to follow that will be received from the host computer without being scanned for changes in the serial communications target.

11.1.3 - Example

The following command sequence establishes communications with the PTU, switches communications channels, then resumes communications with the PTU.

```
@ *
PP * Current pan position is 0
@A *
This text is sent directly to the serial device on CHA
@B *
This text is sent directly to the serial device on CHB
@A20 *
This @B text is sent to CHA without choosing CHB
@ *
PP * Current pan position is 0
```

11.1.4 - See Also

To set expanded serial port communications parameters: Section 11.2

11.2 - Expanded Serial Port

These commands specify the communications parameters for the selected expanded serial port. They do not affect communications between the PTU and the host computer.



Note: You may also access Channel A (CHA) and Channel B (CHB) via TCP, as described in Section 16.

11.2.1 - Commands

The available expanded serial port commands are:

- @A
- @B

11.2.2 - Syntax

- Specify CHA parameters: @A(<baud> , <databits> , <parity> , <handshaking>) <delim>
- Specify CHB parameters: @B(<baud> , <databits> , <parity> , <handshaking>) <delim>

Where:

- A and B indicate RS232C expansion port CHA and CHB
- <baud> may be 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bits per second
- <databits> may be 7 or 8 data bits per byte
- <parity> is not case sensitive and may be N (none), E (even), or O (odd)
- <handshaking> is not case sensitive and may be:
 - **N:** (none)
 - **H:** (hardware handshaking)
 - **X:** (XON/XOFF software handshaking)
 - **F:** (both hardware/software handshaking)

11.2.3 - Example

The following command sets the expansion serial port channel CHA to a baud rate of 9,600 bits/second with 8 data bits per byte, no parity, and no handshaking:

```
@A(9600,8,N,n) *
```

The following command sets the expansion serial port channel CHB to a baud rate of 19,200 bits/second with 8 data bits per byte, no parity, and hardware handshaking:

```
@B(19200,8,n,H) *
```

11.2.4 - See Also

To communicate with an expansion serial port channel: Section 11.

11.3 - ASCII TTL Control



TTL control, seen in the payload connector as OP2, OP3, and OP4, has only been accessible with binary control. E Series PTU firmware versions 3.1.4 and later support TTL control with new ASCII commands. When working with TTL commands:

- The default OP level is low.
- Levels are undefined and may change while the PTU boots. This can take a few seconds after applying power to the PTU.
- PTUs do not have a high-impedance setting and do not support tri-state.
- E Series PTUs have buffers on the TTL lines and can source or sink 10 milliamps for every OP.



CAUTION: D SERIES PTUS CANNOT SOURCE/SINK 10 MILLIAMPS OF CURRENT. PLEASE REFER TO YOUR PTU MANUAL FOR MORE INFORMATION.

- It is good design practice to use a buffer between the PTU and your hardware for isolation and ESD protection



Note: This section does not apply to D-Series PTUs. Please refer to your PTU documentation if you have a D-Series unit.

11.3.1 - Commands

The available ASCII TTL control commands are:

- OOH
- OOL

11.3.2 - Syntax

- TTL high: OOH<n>
- TTL low: OOL<n>

(where <n> defines which TTL output to change such as 2 for OP2, 3 for OP3, etc.)

11.3.3 - Example

This example sets TTL output OP2 to low and TTL output OP3 to high.

OOL2*
OOH3*

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12 - Step Modes

E Series PTUs support various step modes for precise resolution control.

12.1 - Configuring Step Mode

You may configure separate step modes for the pan and tilt axes, including automatic stepping. When automatic stepping is enabled, the controller will automatically select the correct step mode based on the PTU's current speed and process all units as though the unit were in eighth-step mode while allowing the PTU to move at the higher speeds allowed by the half-step setting.



Note: You must perform an axis reset after changing the step mode for the new mode to take effect.

12.1.1 - Command

The available step mode command is:

- W

12.1.2 - Syntax

- Query step mode: `W<axis><resolution>`

where:

- `<axis>` can be either T (Tilt axis) or P (Pan axis)
- `<resolution>` can be either F | H | Q | E | A (for Full, Half, Quarter, Eighth and Auto-step resolution)

12.1.3 - Example

The following command sets the Tilt axis to eighth-step resolution and recalibrates the tilt axis.

```
WTE *  
RT * !T!T
```

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13 - PTU Serial Networks

This section describes the commands used to configure, set, and query the PTU serial network configuration.

13.1 - Unit Network ID

Specify or query the PTU controller network unit ID number. The default PTU unit ID is 0 when the PTU is not networked and is in the default interactive communications mode. Be sure to assign a unique unit ID number to each PTU on the network. Assigning a unit ID of 0 to a PTU places the PTU back in the default interactive (non-networked) communication mode.

13.1.1 - Command

The available PTU network ID command is:

- U

13.1.2 - Syntax

- Query current PTU network unit ID: U<delim>
- Set PTU to interactive mode (non-networked): U0<delim>
- Set PTU network unit ID: U<unit_ID><delim>

where <unit_ID> is between 1 and 127.

13.1.3 - Example

The following queries a PTU unit ID, then sets and stores the unit ID configuration so that the PTU will use the new ID number when it powers up.

```
U * Unit ID is 0
U1 *
U * Unit ID is 1
U1 *
DS *
```

13.1.4 - See Also

Unit Select/Deselect: Section 13.2

13.2 - Unit Select/Deselect

This command selects the PTU to be controlled. A PTU will execute incoming host computer commands only when the preceding `unit_ID` selected by the host is equal to either:

- The PTU's assigned unit ID
- 0



Note: A host computer can issue commands for simultaneous execution by all networked PTUs by using unit ID 0; however, only one PTU can provide feedback to the host computer at a time. A PTU only provides feedback to the host computer when its ID is selected by the computer, and buffers outgoing data until polled up to about 100 bytes.

13.2.1 - Commands

The available unit select/deselect command is:

- `_<unit_ID>`

13.2.2 - Syntax

- Select a PTU for bidirectional data: `__<unit_ID><delim>`
- Broadcast to all networked PTUs: `__0<delim>`

where `<unit_ID>` is between 1 and 127.

13.2.3 - Example

The following command sequence selects PTU #1, sets its pan position to 300, then selects all networked PTUs and simultaneously sets their pan positions to 500. It then selects PTU#1 again to receive its response

```
_1
PP300 *
_0
PP500
_1
*
```




13.2.4 - See Also

Unit Network ID: Section 13.1

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14 - IP Network

The commands in this chapter support the Ethernet connectivity included with E Series PTUs.



Note: D series PTUs and earlier do not support Ethernet connections or the commands described in this chapter.



Note: Please refer to Appendix A for information about setting up the built-in firewall when using TCP/IP to communicate with your PTU.

E Series PTUs are designed to accept an IP address assigned by a DHCP server by default. If this fails, the PTU will attempt a direct connection with the host computer. You may determine the PTU IP address using the **PTU Finder** utility included on the CD that shipped with your PTU. Please refer to your *PTU User Manual* for more information.

14.1 - MAC Address



Queries or sets the PTU Media Access Control (MAC) address.

14.1.1 - Command

The available MAC address command is:

- NA

14.1.2 - Syntax

- Query current PTU MAC address: `NA<delim>`
- Specify PTU MAC address: `NA<mac_address><delim>`

Where `<mac_address>` is the desired MAC address. A MAC address consists of 6 pairs of hexadecimal numbers separated by colons. For example, 34:A0:CB:25:12:3E.

14.1.3 - Example

The following code sequence queries the PTU MAC address, changes that address, and verifies that the change has occurred.

```
NA * MAC address is D9:38:E8:21:94:AF
NA34:A0:CB:25:12:3E *
NA * MAC address is 34:A0:CB:25:12:3E
```

14.2 - IP Address



Queries or sets the PTU Internet Protocol (IP) address.

14.2.1 - Command

The available PTU IP address command is:

- NI

14.2.2 - Syntax

- Query current PTU IP address: NI<delim>
- Specify PTU IP address: NI<ip_address><delim>

Where <ip_address> is the desired IP address. An IP address consists of 4 groups of 1-3 decimal numbers separated by periods, such as 192.168.1.1. The PTU must be in static IP mode for this command to work (see Section 14.3).

14.2.3 - Example

The following code sequence queries the PTU IP address, changes that address, and verifies that the change has occurred.

```
NI * IP address is 192.168.1.1
NI10.0.0.3 *
NI * IP address is 10.0.0.3
```

14.3 - Network Mode



Queries or sets the network IP addressing mode. In static mode, the PTU has a fixed IP address that can be specified using the NI command. In dynamic mode, the PTU accepts an IP address assigned by a Dynamic Host Control Protocol (DHCP) server. Many Ethernet routers contain DHCP servers.

14.3.1 - Commands

The available network mode commands are:

- NM
- NMD
- NMS

14.3.2 - Syntax

- Query current PTU network mode: NM<delim>
- Specify dynamic network mode: NMD<delim>
- Specify static network mode: NMS<delim>

14.3.3 - Example

The following code sequence queries the network mode, queries the PTU IP address, switches the network mode to dynamic, and then queries the PTU IP address again.

```
NM * Network mode is static
NI * IP address is 192.168.1.1
NMD *
NI * IP address is 10.0.0.3
```

14.4 - Redirect Port



Redirects the HTTP (Port 80) or UDP (Port 4000) services to a different port.

14.4.1 - Command

The available redirect port command is:

- NR

14.4.2 - Syntax

- Query default port for [T]CP or [U]DP service: `NR[T|U]<port>`
- Set new port for [T]CP or [U]DP services: `NR[T|U]<oldport><newport>`

14.4.3 - Example

This example queries the current HTTP port, resets the HTTP port to 9090, and then resets the HTTP port again to 8080.

```
NRT80 * 80
NRT80,9090
NRT80 * 9090
NRT80,8080
NRT80 * 8080
```

14.5 - Network Gateway



Sets the default gateway. Any IP host that doesn't match route to the local configuration specified by the NI (Section 14.2) and NS (Section 14.7) commands will be routed to the gateway. This command is required for static IP assignments when communication must cross a router.

14.5.1 - Command

The available network gateway command is:

- NG

14.5.2 - Syntax

- Query current PTU network gateway: `NG<delim>`
- Specify PTU network gateway: `NG<ip_address><delim>`

14.5.3 - Example

This example queries the current PTU network gateway and then specifies a new gateway with IP address 10.0.0.1.

```
NG * 192.168.1.1
NG10.0.0.1
```

14.6 - Network Host Name



Query or specify a network host name for the PTU

14.6.1 - Commands

- NN

14.6.2 - Syntax

- Query the PTU host name: `NN<delim>`
- Specify the PTU host name: `NN<hostname><delim>`

Where `<hostname>` is the name of the PTU (such as D48). The host name may contain letters, numbers, dashes (-), and periods (.).

14.6.3 - Example

The following command sequence queries the PT host name, specifies a new name, and then verifies the change.

```

NN * Current host name is D48
NN UNIT1 *
NN* Current host name is UNIT1

```

14.7 - Network Mask



Query or specify a PTU network (subnet) mask. A subnet mask determines the subnet an IP address belongs to.

14.7.1 - Command

The available network mask command is:

- NS

14.7.2 - Syntax

- Query PTU network mask: `NS<delim>`
- Specify PTU network mask: `NS<subnet><delim>`

Where `<subnet>` is the desired network mask. A network mask consists of 4 groups of 1-3 decimal numbers separated by periods. For example, 255.255.255.0.

14.7.3 - Example

This command sequence queries the PTU network mask, specifies a new network mask, and then verifies the change.

```
NS * The network mask is 255.255.0.0
NS255.255.255.0 *
NS * The network mask is 255.255.255.0
```


15 - Control Modes



E Series PTUs (except the PTU-E46, which has no encoders) support multiple control modes to meet a range of application requirements.

- **Open loop control:** PTU stepper motors can be driven to commanded positions based on the number of steps. This method of control is adequate for most applications provided that payloads are properly mounted on a suitable PTU with sufficient torque to reliably move the payload under all intended conditions. If a slip occurs, the internal position will become out of sync with the true position. Position queries will therefore return incorrect values and the PTU will move based on its internal position counter. Correctly sized and configured PTUs should only experience slip events during extreme circumstances such as wind-loading or a transient obstacle.
- **Encoder correction control:** Applying external forces such as a strong wind gust may exceed available torque and cause the PTU to fail to move. This may result in the commanded step count not matching the actual step position. If a slip is detected, the PTU automatically halts to regain control of the payload, resets its internal counters, and then begins moving again using the normal acceleration settings. This process ensures that the PTU reports and achieves the correct position.

Enabling encoder correction control on an E Series PTU allow the controller to read the true position of each motor using encoders on the output shafts and keep the internal PTU position counters accurate. Figure 3 illustrates a situation where the commanded position does not match the actual position because of to a slip event with encoder correction disabled.

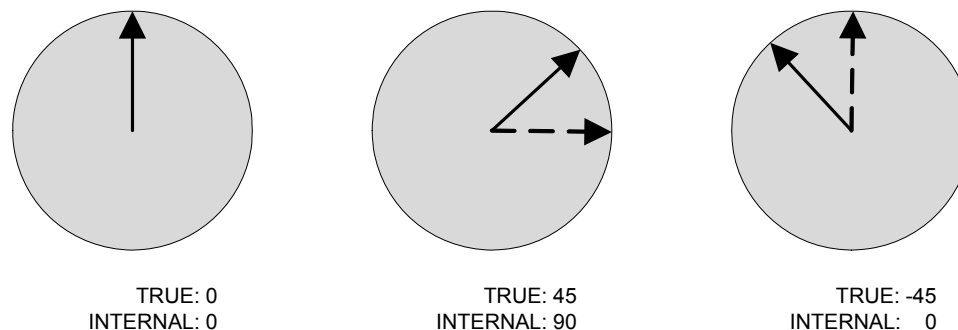


Figure 3: Slip event causes true and internal positions to de-synchronize.

In this example:

1. The PTU starts out at position 0 with the true position and the internal counter in sync.
2. The PTU is commanded to position 90 but a slip event occurs during the move. The controller continues commanding and counting step commands. At the end of the move, the controller believes the PTU is at position 90 but the true position is 45.

3. The PTU is then commanded back to position 0. The controller sends enough steps to move back to 0 based on the assumption that the PTU started at position 90. The PTU therefore ends up moving to position -45.

Enabling encoder correction mode before this slip event would have caused the PTU to immediately correct its position after the event as described above.

The CPEC and CTEC commands query the number of times that the encoder correction control mode has had to correct slips in the pan and tilt axes, respectively. Use these commands during development to validate PTU settings. Excessive slips can be caused by excessive acceleration or upper speed limits for the current payload. To remedy this:

- Lower the speed and/or acceleration.
- Adjust the payload to reduce the required torque.
- Increase the move power level.

These counters are zeroed when a reset (R) is commanded and on power-up.



Note: Resetting the PTU with the R command or power-cycling the PTU resets the pan and tilt slip counters to 0.

15.1 - Commands

The available control mode commands are:

- CT
- COL
- CEC
- CPEC
- CTEC

15.2 - Syntax

- Query current control mode: CT<delim>
- Set open loop control mode: COL<delim>
- Set encoder correction mode: CEC<delim>
- Query the number of pan axis corrections: CPEC<delim>
- Query the number of tilt axis corrections: CTEC<delim>

15.3 - Example

This command sets encoder correction control, queries the current control mode, and then sets and queries open loop control. The same control mode is used for both axes.

```
CEC *  
CT * CEC  
COL *  
CT * COL
```



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16 - E Series TCP/IP Control

E Series PTUs include industry-standard Ethernet connectivity that allow quick and reliable connections using off-the-shelf equipment. Two basic services are available:

- **Web:** The web service is intended for basic configuration and control using only a web browser. No prior experience with D or E series PTUs is necessary to get started using the web interface. Please refer to your PTU User Manual for instructions on using the built-in web interface.
- **TCP sockets:** The TCP socket service is a TCP/IP interface on port 4000 that behaves as if it were a serial port. It uses the same protocol that experienced D and E Series users are familiar with. A splash screen and initialization status (asterisk if successful) appear upon establishing a TCP connection to the PTU.



Note: D-series GPM and ISM users should continue to use the modules for interfaces because the TCP socket service is different from the modules' HTTP method. Custom applications for use with the new TCP socket service require a PTU software update.



Note: Real-time behavior over TCP/IP/Ethernet depends on many factors. Applications that require real-time behavior should use point-to-point RS-232 or RS-485 serial connections.

16.1 - Using TCP/IP Control

Refer to your E Series *PTU User Manual* for instructions on how to connect and power your PTU. The *PTU User Manual* also describes how to identify a PTU on the network and how to use the web interface.



Note: New E Series users should connect to the PTU using the web interface first to verify operation before attempting to connect to the TCP socket service.

The only requirement for using the TCP socket service is opening a TCP/IP socket to the PTU on port 4000. The TCP socket service contains an application layer protocol that uses the same ASCII and binary protocols supported by existing D and E Series PTUs via RS-232/RS-485 serial connections.



Note: All protocols supported by serial communications (ASCII, Pelco-D, CPI, SDK) should work over TCP/IP port 4000.

16.2 - Legacy Applications

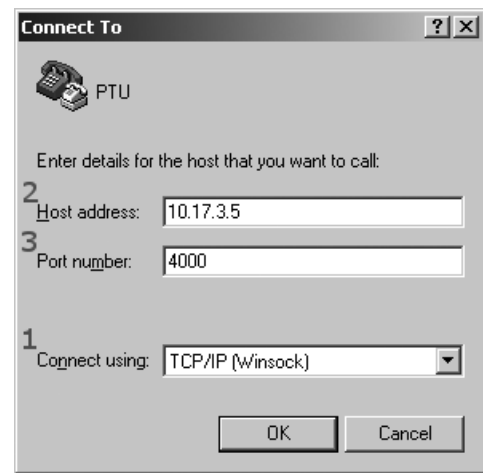
The TCP socket service supports legacy applications through a COM port redirector. The following COM port redirectors have been successfully tested with FLIR PTUs:

- TALtech TCP-Com (Microsoft® Windows®)
- Tactical Software Serial/IP (Windows)
- EterLogic Virtual Serial Port Emulator (Windows)
- Socat (Linux; links a pseudo terminal to a TCP connection.)

16.2.1 - Using HyperTerminal

To establish a TCP socket connection to the PTU using HyperTerminal:

1. Launch HyperTerminal and create a new connection as if opening a standard COM port.
2. In the **Connect To** dialog, select **TCP/IP** instead of a **COM** port using the **Connect using** pull-down menu.
3. Enter the PTU's IP address in the **Host address** field.
4. Enter 4000 in the **Port number** field.
5. Click **OK** to connect to the PTU.



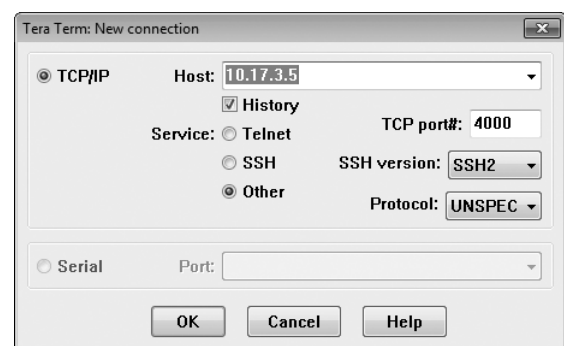
16.2.2 - Using Tera Term

Newer versions of Tera Term enable local line buffering and echoing by default on TCP connections. This is not compatible with the PTUs TCP socket service and must be disabled by editing the Tera Term configuration file. To do this:

1. Use a text editor to open the default configuration TERATERM.INI file located in the install directory (typically C:\Program Files\teraterm).
2. Locate or add the option `EnableLineMode` and set it to `False`.
3. Restart Tera Term to reload the configuration.

To connect to a PTU:

1. Launch Tera Term.
2. Open the **New connection** window.
3. Check the **TCP/IP** radio button.
4. Enter the PTU's IP address in the **Host** field
5. Check the **Other** radio button in the **Service** area.



6. Enter 4000 in the **TCP port#** field.
7. Set the protocol to **UNSPEC** using the **Protocol** pull-down menu.

16.2.3 - Using Putty

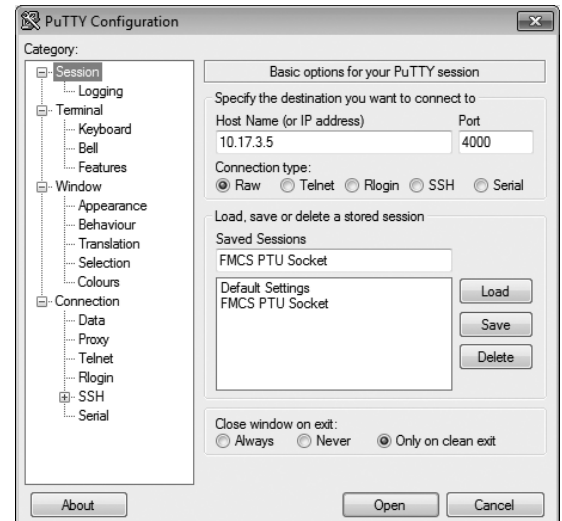
Putty is a terminal program that is available for both Windows and many versions of Linux. The Windows version does not require installation and may therefore be desirable for use on computers with limited user rights.

To configure Putty:

1. Open Putty.
2. Click the **Terminal** entry in the **Category** tree on the left side.
3. Check the **Force off** radio button in the **Local echo** section.
4. Check the **Force off** radio button in the **Local line editing** section.
5. Click the **Connection** entry in the **Category** tree on the left side.
6. Clear the **Disable Nagle's algorithm** checkbox.
7. Click the **Session** entry in the **Category** section on the left side.
8. Check the **Raw** radio button in the **Connection type** section.
9. Enter 4000 in the **Port** field.
10. Enter `FMCS PTU Socket` in the **Saved sessions** field.
11. Click the **Save** button and verify that **FMCS PTU Socket** appears in the list of sessions.

To use Putty:

1. Open Putty
2. Click the **FMCS PTU Socket** session and then click the **Load** button.
3. Enter the IP address of the PTU in the **Host Name** field.
4. Click **Open**.



16.3 - Channel A/B

You may access expansion serial channels A/B over TCP using ports 4001/4002 respectively. Opening the port will allow direct stream access to the serial port until it is closed. To connect, follow the instructions in Section 10, being sure to substitute the appropriate port. You may access the channels via TCP or one of the host channels, but not both. See Section 11 for instructions on setting the hardware characteristics for Channels A and B.

17 - Geo Pointing Module

The Geo Pointing Module (GPM) add GPS pointing capability to your PTU (with firmware version 3.2.0 or later) using the WGS84 model of the Earth. This allows you to point the PTU at landmarks based on geographic location and let the PTU do the work of determining the correct pan and tilt angles relative to both its current geographical position and orientation relative to the horizon. You may use GPM functions directly alongside normal PTU commands.



ISM: GPM functionality is not intended for use on ISM-equipped PTUs.



Note: All GPM commands are in degrees or meters unless otherwise specified.



Note: PTUs do not contain built-in GPS or orientation sensors. You must use external sensors to determine position and orientation values and configure the PTU accordingly. Once the PTU has been properly configured, you may point it at landmarks using geographical information in addition to pan/tilt commands.

To use the GPM functions in your PTU:

1. Set the PTU position (latitude, longitude, and altitude relative to sea level). See Section 17.3.
2. Set the camera offset, which is the difference between the payload line of sight and the PTU line of sight. See Section 17.4.
3. Set the PTU orientation (roll/pitch/yaw) using either of the following methods:
 - landmarks
 - directly



Note: Accuracy is paramount when setting the PTU orientation because errors here will translate into pointing errors when the PTU is in use. The easiest way to orient the PTU is to set the PTU on a perfectly flat and level mounting, and then enter a yaw angle. Yaw angles are measured from true (not magnetic) north.

PTU roll/pitch/yaw angles are extrinsic Euler angles (see Section 17.1).

4. Aim the PTU using geographical information (latitude, longitude, altitude) either directly using the GG serial command (see Section 17.5) or the **PTU Control** page (see Section 2.3).

17.1 - Setting PTU Orientation

You may set the PTU orientation either directly or by using landmarks.

17.1.1 - Direct Orientation:

Enter the PTU roll, pitch, and yaw using either the GR, GP, GY, or GRPY serial commands (see Section 17.4) or the **GPM Config** page (see Section 2.4). Roll, pitch, and yaw are extrinsic Euler angles.



Note: Yaw position is relative to true north.

17.1.2 - Landmark Orientation

To set the PTU orientation using landmarks:

1. Point the payload line (called the camera offset) of sight directly at the desired landmark.



Note: Precision is very important to obtain the best possible calibration quality and subsequent pointing accuracy. If you are aiming a camera, use a high-zoom lens and a large monitor or TV to point the PTU.

2. Enter the location of the landmark using either the GMA serial command (see Section 17.5) or the **GPM Config** page (see Section 2.4).



Note: For best results, use landmarks that are as far away and widespread as possible.



Note: Remember that latitude and longitude are expressed in degrees, while altitude is expressed in meters relative to sea level.

3. Repeat Steps 1 and 2 at least three more times to obtain at least four landmarks before proceeding to Step 4.
4. Calibrate the PTU using either the GC serial command (see Section 17.2) or the **PTU Control** page (see Section 2.3).

The PTU orientation is now set. Looking at the landmarks using either the GM command (see Section 17.5) or **PTU Control** page (see 2.3) will list the pointing error to each landmark. The GCQ command (see

Section 17.2) or **Quality** display on the **PTU Control** page displays the largest pointing error to any landmark in degrees.



*Note: The **Quality** error does not necessarily reflect the largest error when pointing to a true location.*

17.1.3 - Euler Angles and Singularities

PTU roll, pitch, and yaw are extrinsic Euler angles applied in Yaw (Z axis)-Pitch (X axis)-Roll (Y axis) order, where the axes that rotations are applied against do not move. Positive or negative angles are determined as follows:

- **Yaw (Z):** From above, positive angles are to the right, with 0 pointed to true north.
- **Pitch(X):** Positive angles are forward.
- **Roll (Y):** When facing forward, positive angles tilt left.

The PTU tracks movements during singularities but does not act on them. To avoid singularities when using GPM pointing, do not mount the PTU facing directly up or down. Please contact FLIR Technical Support if you need to mount your PTU in this manner.



Note: The direct angles are extrinsic Euler angles in Z-Y-X order. This means the axes of rotation do not change with the frame as it is rotated.

17.2 - General GPM Settings

Calibrate the PTU and perform various miscellaneous GPM functions.

17.2.1 - Commands

The available general GPM setting commands are:

- GC
- GCQ
- GDF
- GDR
- GDS
- GS
- GPT

17.2.2 - Syntax

- Calibrate the PTU: GC<delim>
- Query PTU calibration quality: GCQ<delim>
- Reset all GPM settings to factory default: GDF<delim>
- Restore all GPM settings to last-saved settings: GDR<delim>
- Save all GPM settings: GDS<delim>
- Query GPM pointing type: GPT<delim>
- Set GPM pointing type: GPT<type><delim>
- Return status of GPM system GS<delim>

where:

- PTU calibration quality is the maximum error to any single landmark point in degrees.
- <type> is the GPM pointing type. Valid types are:
 - **0 (Error outside of limits):** The PTU will report an error if the desired pointing position is out of range of the PTU motion.
 - **1 (Closest possible):** The PTU will get as close as possible to the desired pointing position without reporting an error

17.2.3 - Example

This example shows an attempt to calibrate a PTU with no landmarks, which returns an error message. After entering landmarks, the calibration quality is queried, followed by querying and changing the pointing type, saving, and showing the resulting PTU status.

Before entering landmarks:

```
GC! Not Enough Landmarks
GMN * 0
```

After entering landmarks:

```
GMN * 4
GC *
GCQ * 6.547675
GPT * 0
GPT1 *
GPT * 1
GDS *
GS * GPM READY
GDF *
GMN * 0
```

GDR *
GMN *

17.2.4 - See Also

GPM Config page: Section 2.4

17.3 - Position and Altitude

Set or query the geographical PTU position in degrees of latitude and longitude, and altitude relative to sea level in meters.

17.3.1 - Commands

The available GPM latitude, longitude, and altitude commands are:

- GL
- GO
- GA
- GLLA

17.3.2 - Syntax

- | | |
|------------------------------------|-----------------------|
| • Query PTU latitude: | GL<delim> |
| • Set PTU latitude: | GL<lat><delim> |
| • Query PTU longitude: | GO<delim> |
| • Set PTU longitude: | GO<lon><delim> |
| • Query PTU altitude: | GA<delim> |
| • Set PTU altitude: | GA<altitude><delim> |
| • Query PTU position and altitude: | GLLA<delim> |
| • Set PTU position and altitude: | GLLA<position><delim> |

where:

- <lat> is the PTU latitude in degrees.
- <long> is the PTU longitude in degrees.
- <altitude> is the PTU altitude in meters relative to sea level.
- <position> is the PTU latitude and longitude in degrees plus the PTU altitude in meters relative to sea level.

17.3.3 - Example

This example queries the PTU position and altitude, sets a new PTU position and altitude, and then confirms the new position.

```
GLLA * 37.48,-122.39,11
GLLA37.4739,-122.39393,14 *
GLLA * 37.4739,-122.39393,14
```

17.3.4 - See Also

- Euler angles and singularities: Section 17.2
- **PTU Control** page: Section 2.3
- **GPM Config** page: Section 2.4

17.4 - Roll/Pitch/Yaw

Set or query the PTU camera (payload) pitch offset, and the PTU roll, pitch, yaw angles. Roll, pitch, and yaw angles are extrinsic Euler angles.

17.4.1 - Commands

The available roll/pitch/yaw commands are:

- GCP
- GR
- GP
- GY
- GRPY

17.4.2 - Syntax

- Query camera pitch offset: GCP<delim>
- Set camera pitch offset: GCP<offset><delim>
- Query PTU roll: GR<delim>
- Set PTU roll: GR<roll><delim>
- Query PTU pitch: GP<delim>
- Set PTU pitch: GP<pitch><delim>
- Query PTU yaw: GY<delim>
- Set PTU yaw: GY<yaw><delim>
- Query PTU roll/pitch/yaw: GRPY<delim>
- Set PTU roll/pitch/yaw: GRPY<orientation><delim>

where:

- <offset> is the camera pitch offset (difference between the payload line of sight and the PTU line of sight) in degrees.
- <roll> is the PTU roll angle in degrees.
- <pitch> is the PTU pitch angle in degrees.
- <yaw> is the PTU yaw angle in degrees.
- <orientation> is the PTU roll, pitch, and yaw angle in degrees.

17.4.3 - Example

This example queries and then sets roll, pitch, and yaw values, followed by querying and setting the camera pitch angle.

```
GR * -1.459233
GP * 3.103816
GY * 50.042890
GRPY * -1.459233,3.103816,50.042890
GP3.2 *
GRPY * -1.459233,3.200000,50.042890
GR-1.5 *
GY20 *
GRPY * -1.500000,3.200000,20.000000
GCP * 0.000000
GCP10.3 *
GCP * 10.300000
```

17.4.4 - See Also

- Euler angles and singularities: Section 17.2
- **PTU Control** page: Section 2.3
- **GPM Config** page: Section 2.4

17.5 - Landmarks

The PTU can store up to 16 landmarks. Storing landmarks eliminates the need to keep entering location and altitude information for frequently aimed-at locations.

17.5.1 - Commands

The available landmark commands are:

- GM
- GMN
- GMA
- GMD
- GMC
- GG
- GGD

17.5.2 - Syntax

- List all landmarks stored on the PTU: GM<delim>
- List information for specified landmark: GM<index><delim>
- List number of landmarks stored on the PTU: GMN<delim>
- Add a landmark: GMA<name>,<lat>,<lon>,<alt><delim>
- Delete the most recently saved landmark: GMD<delim>
- Delete the specified landmark: GMD<index><delim>
- Delete all landmarks: GMC<delim>
- Query last pointed position: GG<delim>
- Point PTU at the specified landmark: GG<index><delim>
- Point PTU at position: GG<lat>,<lon>,<alt><delim>
- Distance to current aim point in meters: GGD<delim>
- Distance to specified point in meters GGD<lat>,<lon>,<alt><delim>

where:

- The GM command returns a list of all landmarks stored on the PTU delimited by semicolon in the format <index>,<name>,<lat>,<lon>,<alt>,<pan pos>,<tilt pos>,<error>;.
- <index> is the integer number of the landmark stored on the PTU (starting with 0).
- <lat> is the latitude in degrees.
- <lon> is the longitude in degrees.
- <alt> is the altitude relative to sea level in meters.
- <error> is the aiming error to the specified landmark in degrees.

17.5.3 - Example

This example lists the landmarks currently stored on the PTU.

```
GM * 0,HOTEL,37.5918,-122.3475,40.0000,0.0000;OFFICE,37.5941,-
122.3656,42.0000,0.0000;STATION,37.6010,-122.3858,18.0000,0.0000
```

This example displays the most recently aimed-at location.

```
GG * 38.60138,-122.37686,6.00000
```

This example commands the PTU to point at the specified location.

```
GG38.60138,-122.37686,6.0000 *
```

This example commands the PTU to point at the specified landmark.

```
GG1
```

This example returns the distance from the PTU to the specified location in meters.

GGD38.60138,-122.37686,300 * 1820.203

17.5.4 - See Also

GPM Config page: Section 2.4

18 - Pelco D Protocol



Pelco products use the proprietary Pelco D-Protocol (also known as Pelco D). E Series PTUs with firmware version 3.1.1 and newer support the standard pan/tilt portions of Pelco D. Camera control commands are not currently implemented.



Note: This chapter assumes that you are already familiar with Pelco D framing and specifications. Please refer to the appropriate Pelco documentation for more information about Pelco D.

18.1 - Configuration



The PTU must be configured for Pelco D. The web interface includes Pelco configuration and there are new ASCII configuration commands.

18.1.1 - Commands

The following Pelco D commands are available:

- QP
- QPD
- QPE
- QA

18.1.2 - Syntax

- Query Pelco D parsing status: QP<delim>
- Enable Pelco D parsing: QPE<delim>
- Disable Pelco D parsing: QPD<delim>
- Query Pelco D address: QA<delim>
- Set Pelco D address: QA<n><delim>

18.1.3 - Example

A common configuration enables Pelco D parsing, sets the Pelco D address to 1, the baud rate to the standard Pelco rate of 2400 baud, and then saves those settings to the PTU.

```
QPE*
QA1*
@(2400,0,T)
DS*
```

18.2 - Standard Pelco D Commands ⓔ

A standard command consists of a bit vector that describes basic pan, tilt, and camera control. E Series PTUs implement the shaded fields shown here.

Bit	15	14	13	12	11	10	9	8
Value	1	0	0	-	-	-	-	-
	Standard Command	Reserved	Reserved	Auto Scan	Camera Enable	Iris Close	Iris Open	Focus Near
Bit	7	6	5	4	3	2	1	0
Value	-	-	-	-	-	-	-	0
	Focus Far	Zoom Wide	Zoom Tele	Down	Up	Left	Right	Reserved

18.3 - Extended Pelco D Commands ⓔ

Extended commands allow for querying or changing single values instead of taking several actions simultaneously as seen in standard commands. The Pelco D protocol includes many extended commands for basic functions and advanced functions. E Series PTUs support the commands listed in the following table.

Command	Opcode	Data	Notes
Set Preset	0x03	ID number	
Clear Preset	0x05	ID number	
Go To Preset	0x07	ID number	No special indexes supported (zero pan, 180 flip, etc).
Set (ON) Auxiliary	0x09	AUX number	
Clear (OFF) Auxiliary	0x0B	AUX number	

Command	Opcode	Data	Notes
Set Pan Absolute Position	0x4B	Position in 1/100ths of a degree.	
Set Tilt Absolute Position	0x4D	Position in 1/100ths of a degree.	
Get Pan Absolute Position	0x51	N/A	Generates extended response.
Get Tilt Absolute Position	0x53	N/A	Generates extended response.
Get Pan Absolute Position Response	0x59	Position in 1/100ths of a degree.	This is an extended response, not a command.
Get Tilt Absolute Position Response	0x5B	Position in 1/100ths of a degree.	This is an extended response, not a command.

18.4- Auxiliary Pelco D IDs



Auxiliary commands function as a simple switch interface. The following table describes the auxiliary IDs implemented in E Series PTUs.

AUX Name	AUX ID	AUX Command	Notes
Inverted Pan	3	ON	
Standard Pan	3	OFF	
Inverted Tilt	4	ON	No special indexes supported (zero pan, 180 flip, etc).
Standard Tilt	4	OFF	
ISM Start	8	ON	
ISM Stop	8	OFF	
Reset	9	ON	Reinitialize Pelco module and executes a reset sequence. Both axes are reset.

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A - TCP/IP Firewall



E Series PTUs introduced Ethernet connectivity, which provides easy and reliable communication on all standard PTUs. Ethernet is a multi-layered technology that allows many different uses and protocols. E Series PTUs take full advantage of this by offering different services over a single Ethernet connection; however, not all services are required or desirable in a production installation.

Firmware version 3.1.4 and later includes lightweight firewall functionality that lets you control or restrict access to E Series services at both the Ethernet and IP layers.



Note: Dedicated firewall equipment is recommended for situations that require complex source/destination/flags/state specifications, deep packet inspection, or egress filtering.

A.1 - Rules

Rules specify how to identify and process incoming packets of data and form the core of any firewall. All rules use the same basic format:

```
Pass or Block | From (source) | All or TCP or UDP or Both | If TCP/UDP,
then Port Number
```

Rules work as follows:

- A `Pass` rule accepts packets that match the specified criteria.
- A `Block` rule rejects packets that match the specified criteria.
- `From` specifies a matching parameter, which can be all packets, a MAC address, a single IP address, or network in CIDR notation.
- Packets are further matched by the particular protocol if matching an IP packet. All IP packets can be matched. TCP or UDP packets can also be matched by additionally specifying the destination port number.

A.1.1 - Rule Syntax

The rule syntax is simple to specify and understand. The destination always matches the PTU and the PTU will not forward packets because it is not a router or a NAT device. The basic firewall rule syntax is:

```
Rule:      = Action From (Proto Port) *
Action:    = Pass | Block
Pass:      = 'P'
```

```
Block: = 'B'  
From: = All | MAC | Host | Net  
All: = 'A'  
MAC: = 'M' HB ':' HB ':' HB ':' HB ':' HB ':' HB  
HB: = HexadecimalCharacter HexadecimalCharacter  
Host: = 'H' DotQuad  
Net: = 'N' DotQuad '/' Number  
DotQuad:= Number '.' Number '.' Number '.' Number  
Proto: = TCP | UDP | Both  
TCP: = 'T'  
UDP: = 'U'  
Both: = 'B'  
Port: = Number
```

A.1.2 - Examples

Pass all TCP packets to port 80.

```
PAT80
```

Pass TCP port 4000 packets from MAC 00:11:22:33:44:55.

```
PM00:11:22:33:44:55T4000
```

Pass TCP port 80 packets from the 192.168.1.0/24 (255.255.255.0) subnet.

```
PN192.168.1.0/24T80
```

Block all TCP port 4000 packets.

```
BAT4000
```

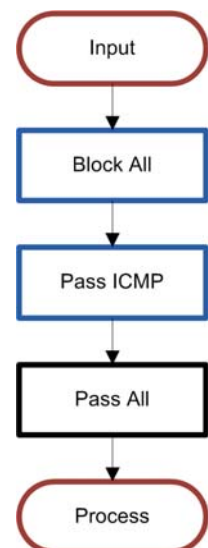
A.2 - Management

Firewall rule management uses a list format with last-match-applies processing. The default list contains one entry: pass-all. All packets except ICMP are blocked before processing the rule list. This means that the default firewall configuration marks all packets blocked, marks all ICMP packets as pass, and then marks all packets as pass. This default configuration will pass all packets because of the last-match-applies processing. Figure 4 on the right shows the order of filtering in the default configuration.

A.2.1 - Rule Lists

Rule lists are managed as two different sets:

- Staging set
- Current set

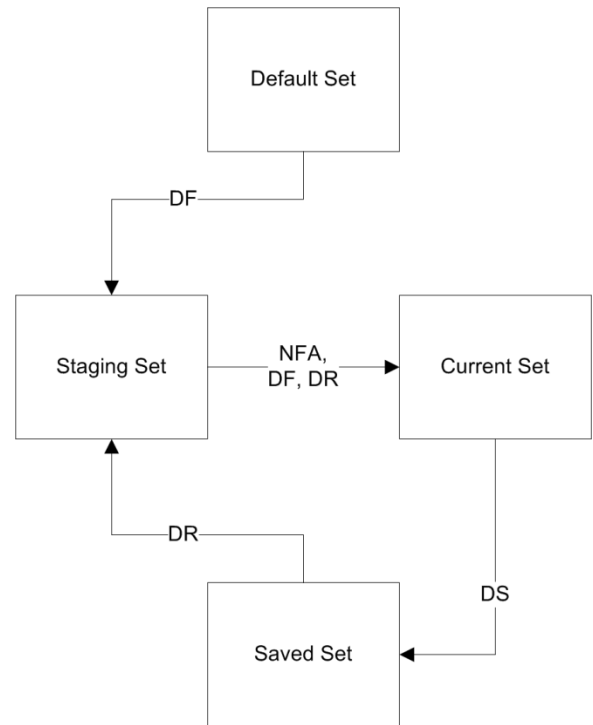


Separating the firewall into two sets where only the current set saves to non-volatile memory allows you to edit and test the firewall while reducing the risk of accidentally locking yourself out of the PTU because of a typo, accidental rule, DS command, or reboot.

The staging set is user-edited until ready for processing.

- The `NFA` (firewall apply) command applies the staging set to the current set and the firewall starts filtering with the new rules.
- `DS` (default save) saves the current set to non-volatile memory, which is loaded when the PTU boots up.
- Both the `DR` (default restore) and `DF` (default factory) commands implicitly update both the staging and current firewall sets.

Figure 5 on the right shows how these commands modify the current and working sets.



A.2.2 - Managing Rule Lists

The E Series protocols do not include a list data type. Simple commands on the staging set handle list management.

A.3 - Using the Firewall

The firewall can be controlled using several command.

A.3.1 - Commands

The available firewall commands are:

- `NFU`
- `NFO`
- `NFF`
- `NFI`
- `NFC`
- `NFA`

A.3.2 - Syntax

- Push a rule onto the end of the rule list: `NFU<rule>`
- Remove (return) the last rule: `NFO`
- Remove (flush) all rules: `NFF`
- Index: `NFI<n>`
- Read or replace a rule by its index number: `NFI<n><rule>`
- Return (count) the total number of rules: `NFC`
- Copy (apply) the staging set to the current set: `NFA`



Note: The `NFU` command is the same as the `NFI` command where the index is the maximum index plus one.

A.4 - Precautions

Network services can be complex in nature and hence difficult to describe in a firewall rule set. This section describes some network services that you should be aware of when editing the PTUs firewall.

A.4.1 - HTTP

HTTP runs on TCP port 80. No web access is possible without allowing incoming connections on this port. An “allow HTTP” rule would be `PAT80`.

A.4.2 - DHCP

DHCP uses broadcast and unicast UDP packets to assign network addresses. DHCP functionality requires incoming UDP packets on port 68. You must configure a static IP address if these packets are blocked. Use the command `PAU68` to allow DHCP requests. You may also use a more restrictive rule for greater security, such as passing only UDP port 68 packets from a specific DHCP server by MAC address.

A.4.3 - TCP Control

E Series ASCII and binary protocols are available on TCP port 4000. Blocking port 4000 will prevent access to this service. This can be desirable or undesirable, depending on your specific requirements. Be careful when editing firewall rules over the network. Failure to provide a TCP port 4000 allow rule will cause the `NFA` command to block the currently open TCP stream and all further access to the PTU will be denied until the PTU is power cycled or reconfigured via the serial interface.

A.5 - Example Configurations

Here are some sample firewall configurations.

A.5.1 - Block Everything

```
NFF *  
NFA *  
DS *
```

A.5.2 - Block Everything Except DHCP

```
NFF *  
NFUPAU68 *  
NFA *  
DS *
```

A.5.3 - HTTP Only

```
NFF *  
NFUPAT80 *  
NFA *  
DS *
```

A.5.4 - TCP/IP Control

This example is for a local network (10.0.0.0/24) and HTTP Access for a gateway (10.0.0.23).

```
NFF *  
NFUPN10.0.0.0/24T4000 *  
NFUPH10.0.0.23T80 *  
NFA *  
DS *
```

A.5.5 - Listing Rules

```
NFC * 2  
NFI0 * PAT80  
NFI1 * PN10.0.0.0/24T4000  
NFI2 ! Illegal argument
```

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B - Compatibility Mode



Both E Series PTUs and the PTU-E46 include a compatibility mode switch to ensure backward compatibility with previous models. This gives users the flexibility to either maintain backward compatibility when required or take advantage of the E Series enhancements. Enabling compatibility mode makes the PTU operate as a Series D unit. Disabling compatibility mode enables E Series behavior.

- PTUs with firmware versions earlier than 3.1.4 have compatibility mode enabled by default.
- PTUs with ISM or with firmware version 3.1.4 and later have compatibility mode disabled by default. This is the recommended setting for newer PTUs.



Note: Enabling stabilization on an ISM-equipped E Series PTU automatically disables compatibility mode.

B.1 - Commands

The available compatibility mode commands are:

- CM
- CME
- CMD

B.2 - Syntax

- Query compatibility mode status: `CM<delim>`
- Enable compatibility mode: `CME<delim>`
- Disable compatibility mode: `CMD<delim>`

B.3 - Effects

This section compares PTU behavior when compatibility mode is enabled or disabled.

B.3.1 - Firmware Version 3.0.0

- **Velocity Mode Speed 0**
 - **CME:** In velocity mode (CV), setting the desired speed to 0 does not return a response until the PTU stops completely. All other commands are postponed until the PTU stops. The desired position is reset to the current position.
 - **CMD:** Setting the desired speed to zero is a non-blocking operation where the response returns before the PTU achieves the desired speed. The desired position does not change.
- **Setting Unit ID**
 - **CME:** Setting a unit ID with the U command automatically changes the host COM port baud rate to 9600 baud.
 - **CMD:** The baud rate remains the same.
- **Limits Reported**
 - **CME:** When limits are disabled, querying the maximum and minimum position returns factory minimum and maximum values.
 - **CMD:** When limits are disabled, queries return accurate enforced limits.

B.3.2 - Firmware Version 3.1.4 and Later

- **Voltage and Temperature Report**
 - **CME:** The O command reports input voltage in whole numbers (integer).
 - **CMD:** The O command reports input voltage with 1 decimal precision. Terse mode (FT) reduces the verbosity of the report.
- **Carriage-Return Behavior**
 - **CME:** Received carriage-returns <\r> echo as-is. Using carriage returns as a delimited caused terminals to overwrite the command printed on the screen. This is standard D-Series behavior.
 - **CMD:** Carriage-returns <\r> convert to newline characters <\n> before processing. When used as a delimiter, this causes a new line (\r\n) to form before printing the response on a terminal.



Note: Changing the mode will only affect the current stream and new streams until the PTU is reset. For example, sending this command over a TCP stream will not affect the serial port until the PTU is reset. New TCP streams will inherit the most recent mode. Sending this command over the web interface will not change settings for any existing streams until the PTU is reset.



- **Await Completion**

- **CME:** The `A` command never returns an error, even if the command timed-out.
- **CMD:** The `A` command will return an error code if necessary because of situations such as internal errors, impossible-to-achieve conditions, time-outs, and more.

- **Host Serial Port Settings**

D-Series PTUs required a secondary confirmation when configuring host port settings. E-Series PTUs do not require this.

- **CME:** Entering `T` as the last argument prompts the user to confirm that they want to save the settings. A `Y` reply has the same effect as a `DS` command. An `N` reply does not change or save settings.
- **CMD:** The double conformation sequence is not used. No save is performed.

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C - Timestamps

Some commands may contain timestamp information. The timestamp is currently implemented by a free-running 32-bit counter running at 90 MHz.



Note: Future PTU hardware or software may use different frequencies. You should include a timestamp frequency query in your software as part of initialization.

C.1 - Commands

The available timestamp commands are:

- CNT
- CNF

C.2 - Syntax

- Query current timestamp count: CNT<delim>
- Query timestamp counter frequency: CNF<delim>
- Query current PTU speed/position with timestamp: BT<delim>



Note: The CNT command always returns a fixed-width timestamp count with 0s added on the front as needed to obtain the correct width. The BT command is not fixed-width and does not add 0s to the timestamp.

C.3 - Example

This example queries the current timestamp count, the current counter frequency, and the PTU speed/position with timestamp.

CNT – Current timestamp count, in fixed size format. If the value is too small, it will be prepended with 0s to full width.

```
CNT * 0000009275
CNF * 90000000
BT * P(-2300,550) S(600,200) 9278
```

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