RS-485 Communication Protocol for ROS Positioners, Cameras & Lights

Document 21-30022W

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Abstract

This document describes the communication protocol used to transmit and receive information from the controller to the ROS RS-485 controllable positioners, cameras and lights.

1 INTRODUCTION

ROS RS485 positioners, both single axis (rotators) and dual axis (pan & tilt), cameras and LED Lights can be controlled from a remote location. A controller with a 2-wire half duplex RS-485 link is used to send commands to the unit and receive status and feedback from it.

1.1 Concept of Nodes

Each axis of a positioner or a camera or a light is referred to as a node. A rotator, a camera or a light are single node unit while a pan & tilt is a dual node unit. The protocol does not recognize the difference between a pan axis or a tilt axis, they are all addressed in the same manner using a unique node identification.

1.2 Interconnection and Network Ability

The RS-485 protocol described here is designed for multipoint communication: several devices may be connected to a single cable – similar to commonly used Ethernet networks. The system uses the Master/Slave architecture where each node has its unique identification or address and responds only to messages that are addressed to that unit. The commands are generated by the Master (controller), which periodically polls all connected slave units.

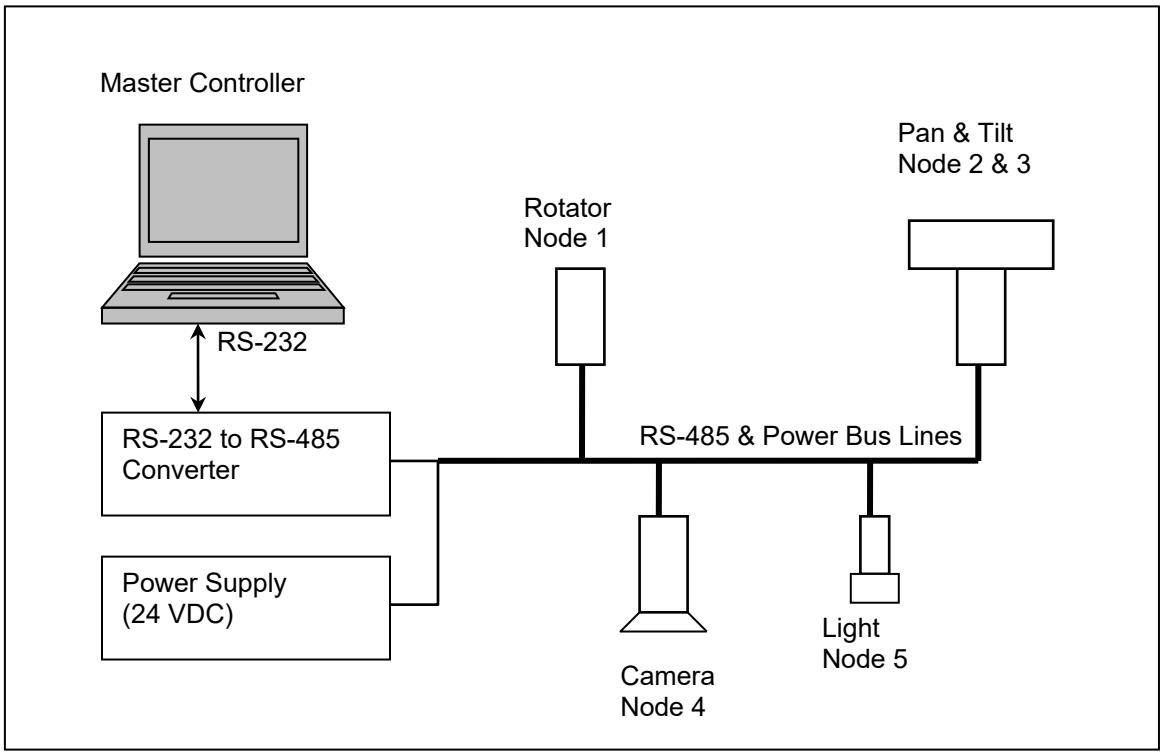


Figure 1: Master/Slave Interconnection Example with 5 nodes

Figure 1 shows how a master controller (a laptop in this example) can control 5 networked nodes. The rotator is seen by the master as a single node, the pan & tilt is seen as another 2 nodes, one for pan and another for tilt. The camera and the light add 2 more individual nodes to the system.
The protocol described in this document is designed to control up to **32 nodes** in a network. It can be, for example, 32 rotators or 16 pan & tilts, 8 sets of camera Pan & Tilt and Light or an arrangement of rotators, pan & tilts cameras and lights where the total number of nodes does not exceed 32.

1.3 Clockwise (CW) and Counterclockwise (CCW) Reference

Rotators and pan & tilt rotation directions are often referred to as up, down left and right. Unfortunately these directions are relative to how the unit is mounted; right side up or upside down. It can also depend on what hardware is mounted on the unit (camera, lights, sonar…) and where the hardware points; up, down, left or right. To avoid confusion, we will refer to clockwise and counterclockwise directions which are independent of the positioner's orientation.

The general rule is to use the conventional clockwise and counter clockwise directions when looking directly at the output shaft of the positioner. See Figure 2and Figure 3 for details.

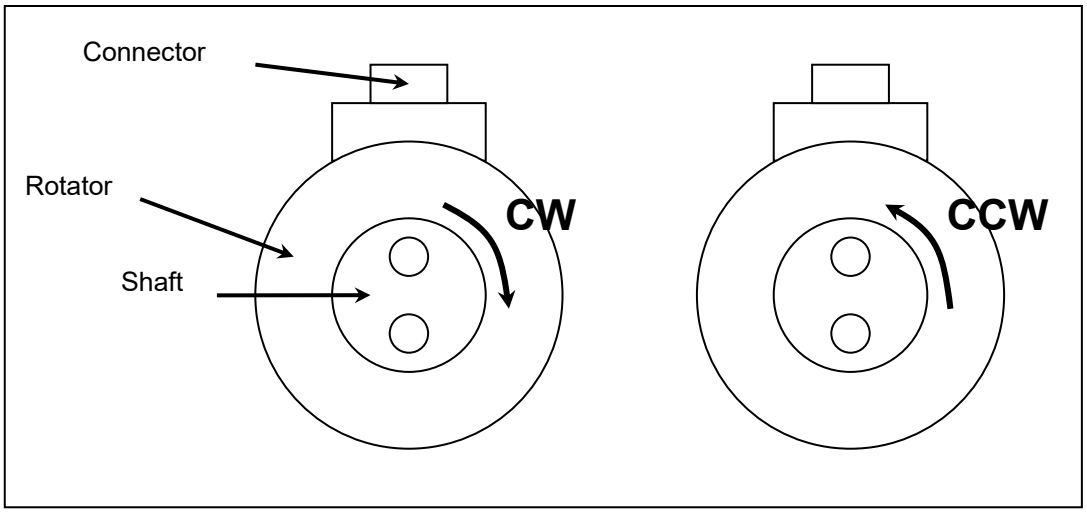


Figure 2: CW and CCW Reference for a Rotator

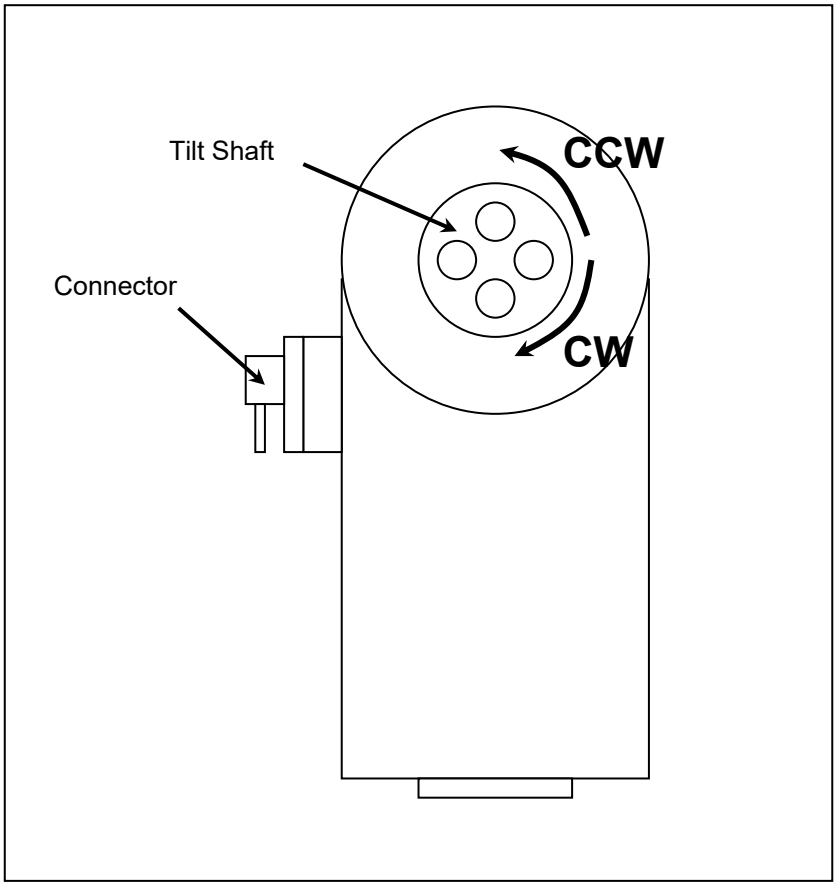


Figure 3: CW and CCW Reference for the Tilt axis of a Pan & Tilt

NOTE: On pan & tilts equipped with a yoke bracket, it is not obvious which side of the tilt axis the output shaft comes out off. When in doubt refer to the drawing on Figure 3 and use the connector as a reference.

1.4 Position Feedback Concept

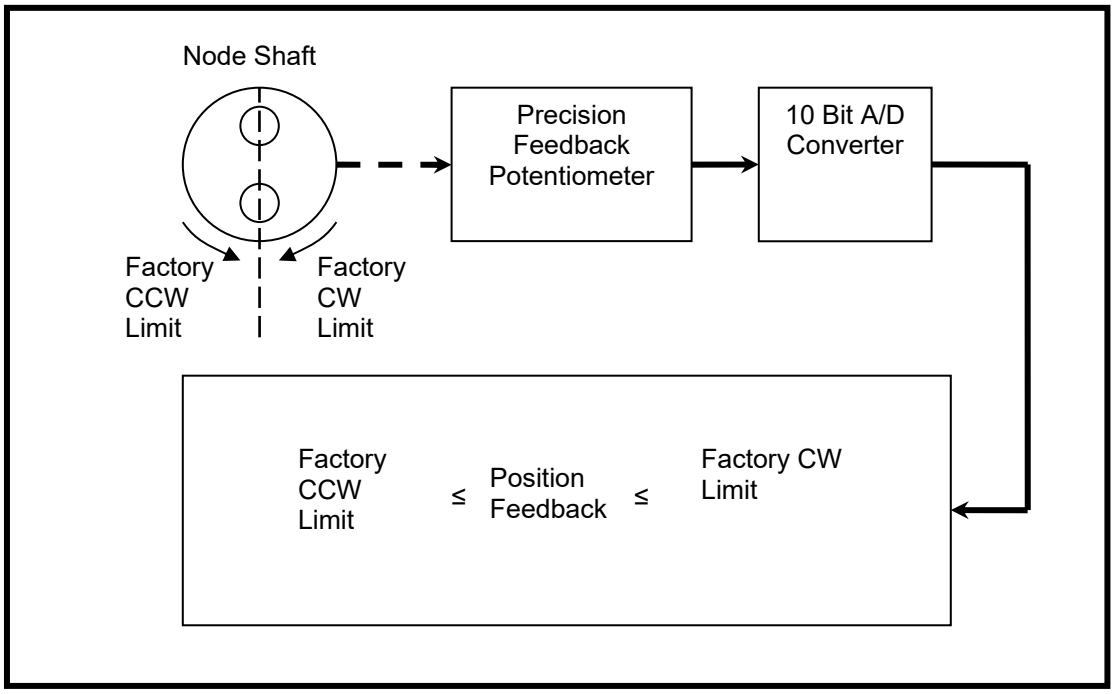


Figure 4: Position Feedback Concept Diagram

The shaft of each ROS positioner node, whether it is a rotator or a pan & tilt, is capable of rotating 360 degrees from its factory CW limit in the CCW direction and 360 degrees from its factory CCW limit in the CW direction. The use of a precision 10-turn feedback potentiometer does not allow crossing the CW/CCW limit. However, in most practical cases the ability to turn more than 360 degrees would tangle and damage cables and therefore is not beneficial. Most users using a yoke bracket on the tilt axis of a Pan and tilt unit will need to restrict the CW limit and CCW limits to half the possible travel to avoid running the yoke assembly into the pan axis housing. This is why user CW and CCW limits can be set inside the factory CW and CCW limits. In other words, the factory CW and CCW settings allow for a 360 degree travel of the output shaft while the user setting can restrict that range of motion:

Due to a combination of electronic component tolerances, as well as mechanical tolerances in the gears and potentiometer drive, the position feedback precision is < 0.5 degree on the output shaft.

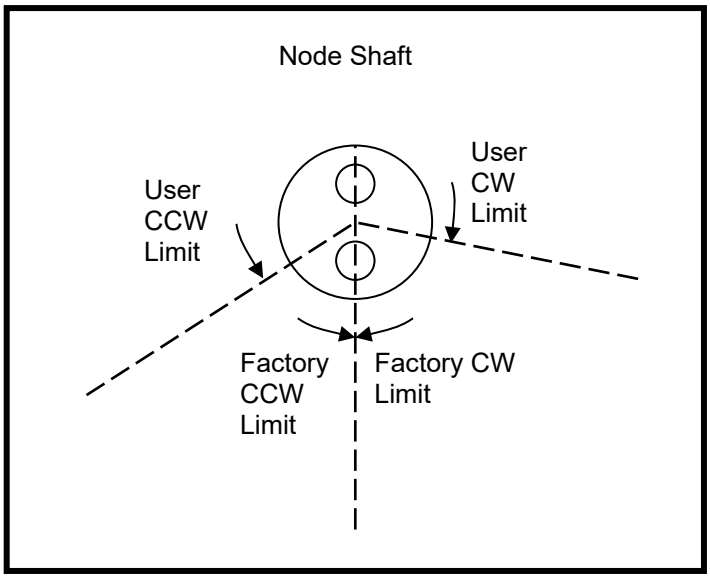


Figure 5: Factory and User CW and CCW limits

Figure 5 illustrates how the user CW and CCW limits can be set within the factory CW and CCW limits.

2 ROS UNITS COMMUNICATING WITH THIS PROTOCOL:

- RS-485 R-10 FB
- RS-485 PT-10 FB
- RS-485 R-25 FB
- RS-485 PT-25 FB
- RS-485 MV-LED II
- RS-485 Inspector
- RS-485 Inspector HD
- RS-485 CE-X 36
- RS-485 Titanium Navigator
- RS-485 Spectator
- RS-485 L300
- RS-485 P20
- RS-485 P100

3 PROTOCOL

3.1 Interface Definition

The interface definition is: asynchronous 2-wire half duplex RS-485, 8 data bits, 1 stop bit, no parity, and no hardware flow control.

3.2 Windows Operating System Hardware Configuration

When using windows operating systems, the serial port of the computer is often used via an RS-232 to RS-485 converter in order to control the ROS product. For proper work of bi-directional communication between the computer and the device, the hardware configuration needs to be set to “use the FIFO buffers”. Figure 6-Figure 11 below explain the following procedure on how to find the configuration menu with Windows 2000. Other Windows based operating systems will have similar menus.

1. Click on Start then Settings then Control Panel

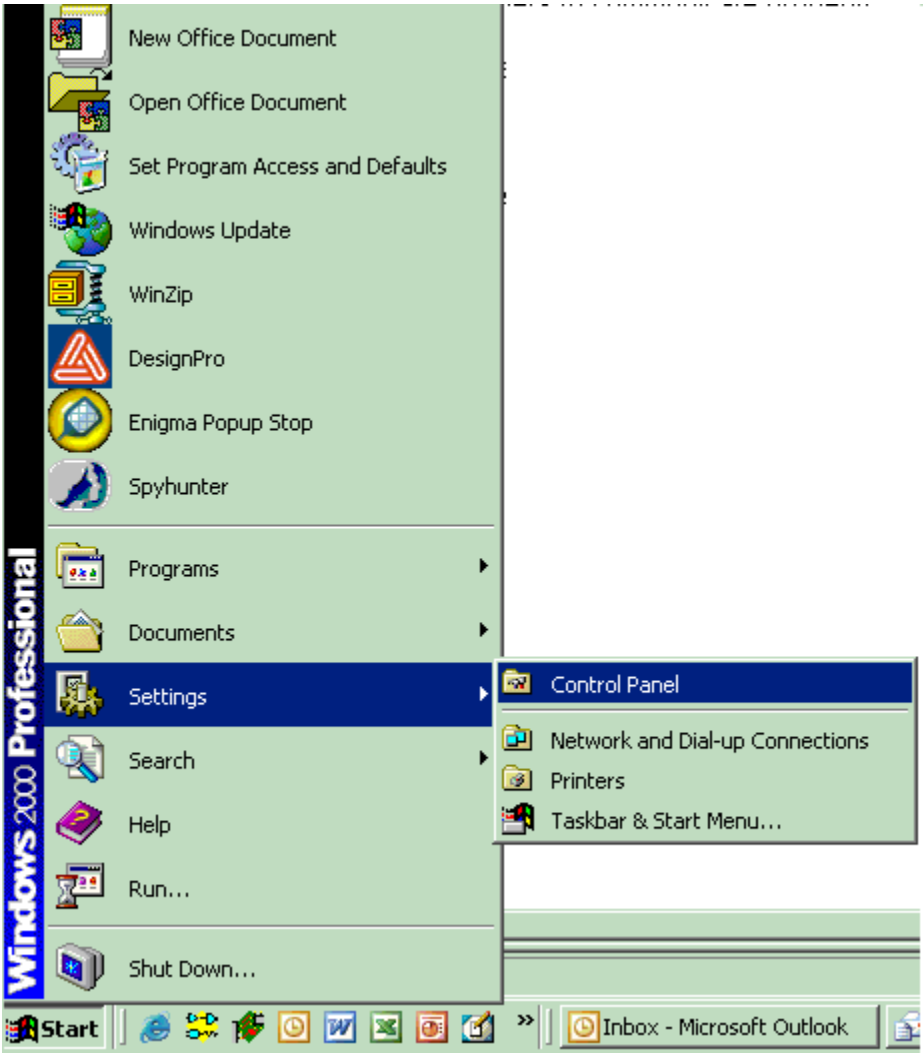


Figure 6: Step 1

2. Double click on System

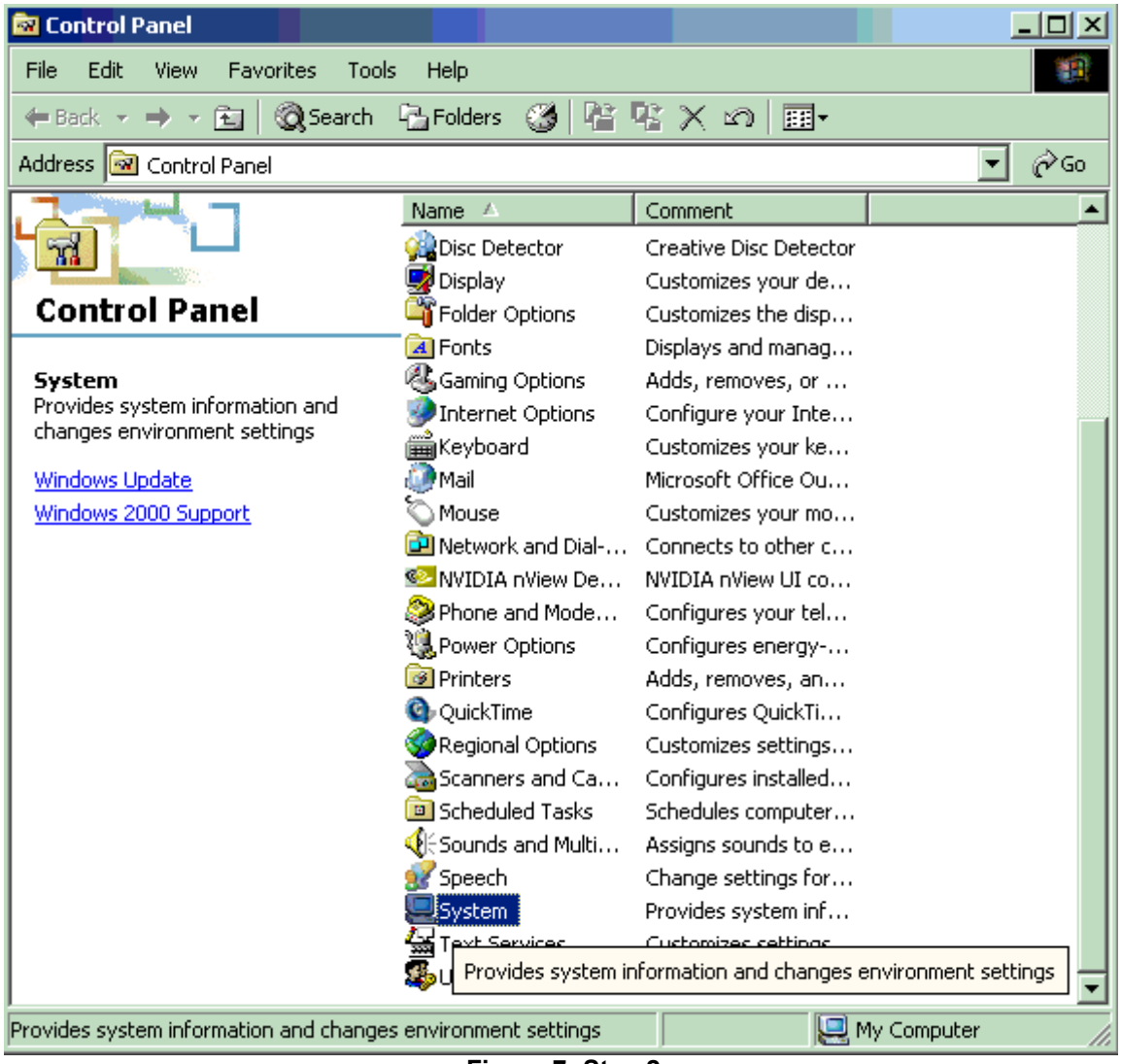


Figure 7: Step 2

3. Click on the Hardware tab then Device Manager Button

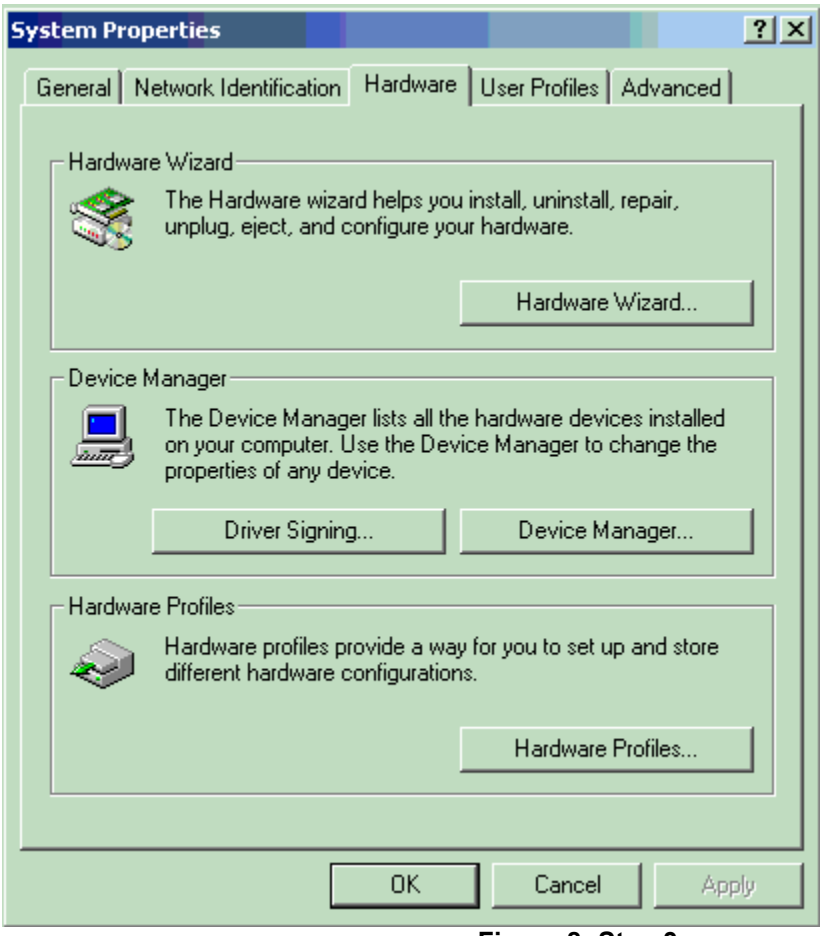


Figure 8: Step 3

4. Double click on COM port of your choice properties

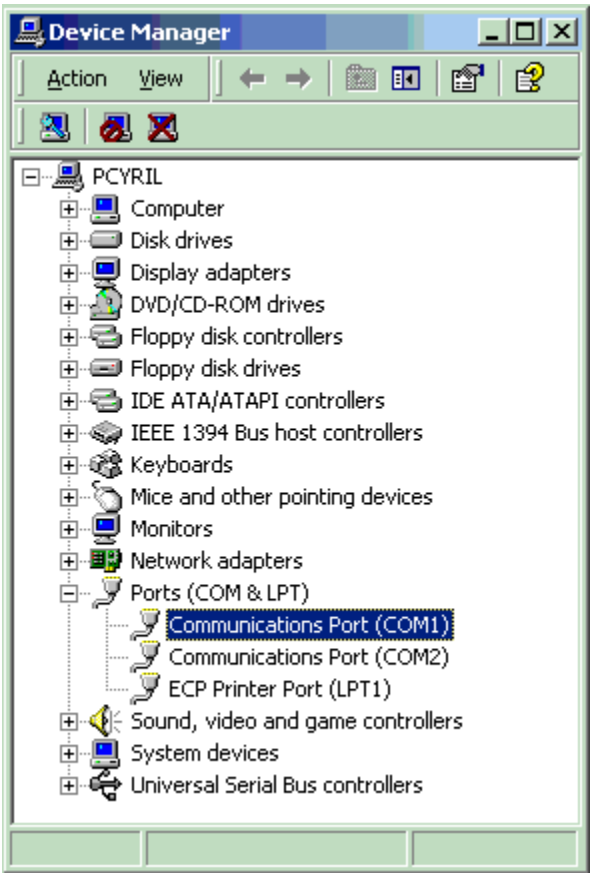


Figure 9: Step 4

5. Click on the Port Setting tab then the Advanced button

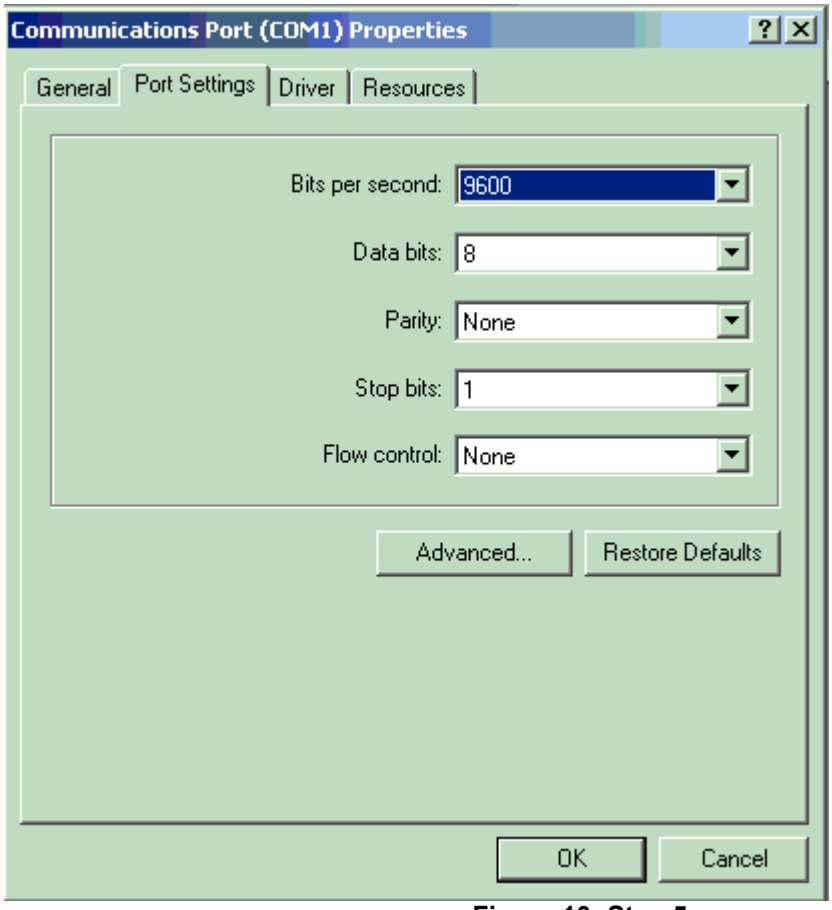


Figure 10: Step 5

6. Verify that the Use FIFO buffers is checked

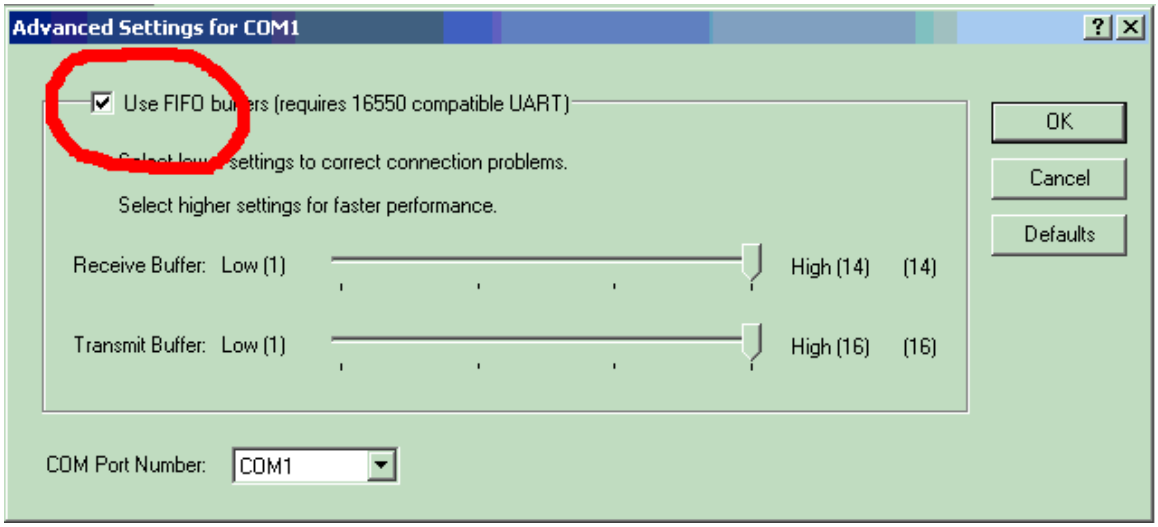


Figure 11: Step 6

The default setting for the buffer performance is fine.

3.3 Flow Control (When Enabled)

The ROS recommended method for flow control is character echo for all messages going from the master to the slaves or nodes. This is due to the absence of input buffer for each node.
For all feedback messages going from the nodes to the master, character echo is not implemented and is not necessary since the master (usually a computer) often includes a rather large input buffer.

NOTE1: To respect the flow control determined by the nodes, the controller must wait for the echoed character from the node before sending the next character.

NOTE2: As described in the "COMMAND MESSAGES" section 4, all messages always start with the Node ID character. When several nodes are networked together in the case of a pan & tilt for example, the node ID character sent by the controller will only be echoed by the node concerned and none of the other nodes.

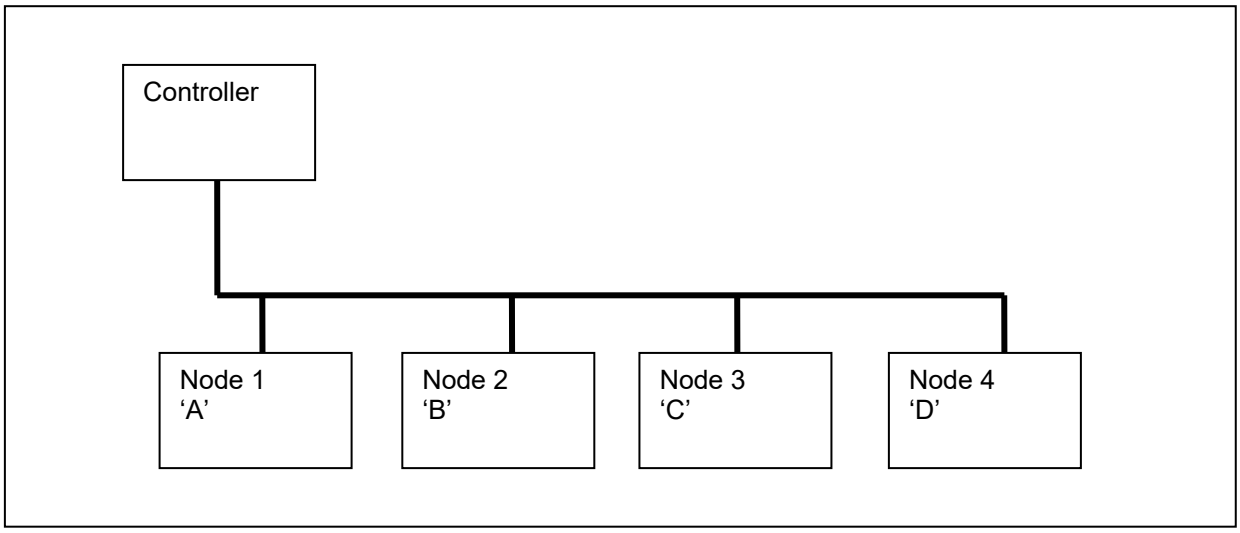


Figure 12: Example with 4 Nodes in a Network

Figure 12 shows an example of 4 nodes in a network, 2 pan & tilt units with node ID address character of 'A', 'B', 'C' and 'D'. When the controller sends a message to node 2 or 'B', only 'B' will echo the characters of the message. In this configuration, if a message is sent to node 5 or 'E' not connected in this example, the message sent by the controller will not be echoed at all.

3.4 Character Echo Timing

Messages traveling on 2-wire half duplex RS-485, are either going from the controller to the device or from the device to the controller. In this type of communication, the messages going one direction are using the same 2 wires as the messages going the other direction. Therefore the timing is sometimes critical to avoid collisions of messages going in opposite directions. The device is always listening or in receiving mode. Once it receives a character, the device will switch from receiver to transmitter, echo the character back and then switch back to a receiver. See Figure 13 and Figure 14 for the sequence of events.

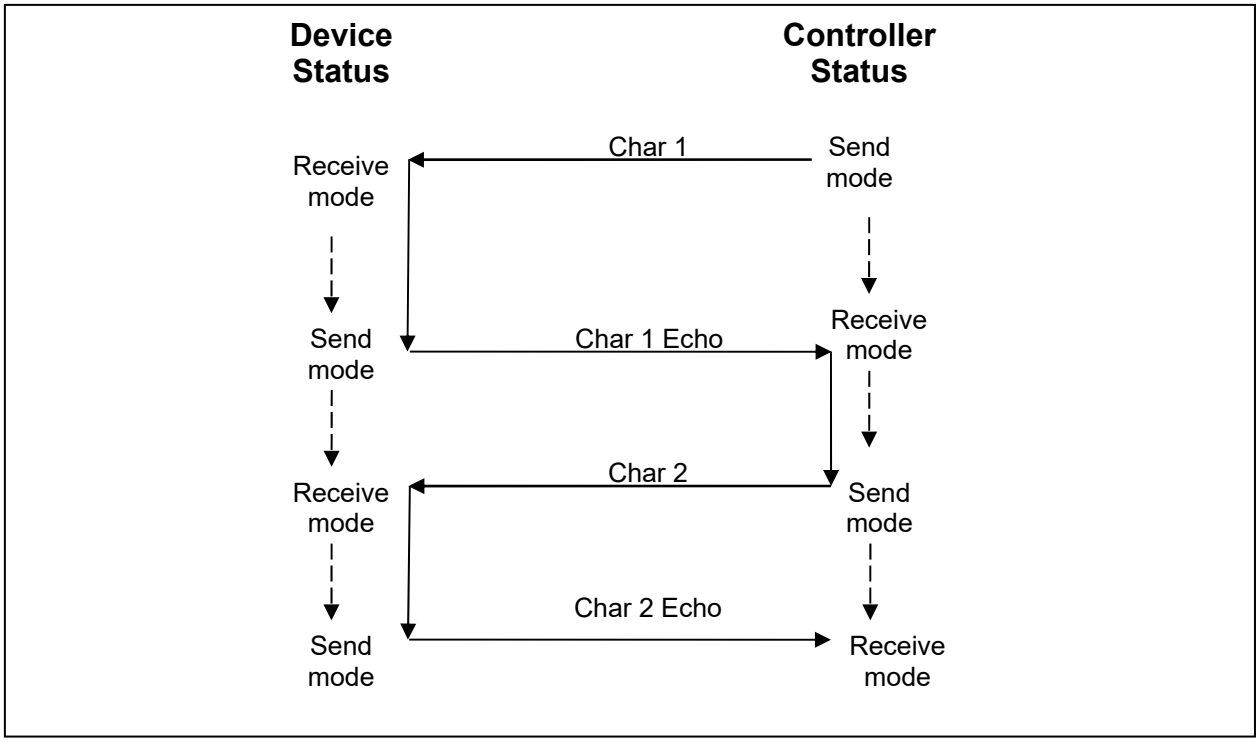


Figure 13: Half Duplex Controller/Device Communication Diagram

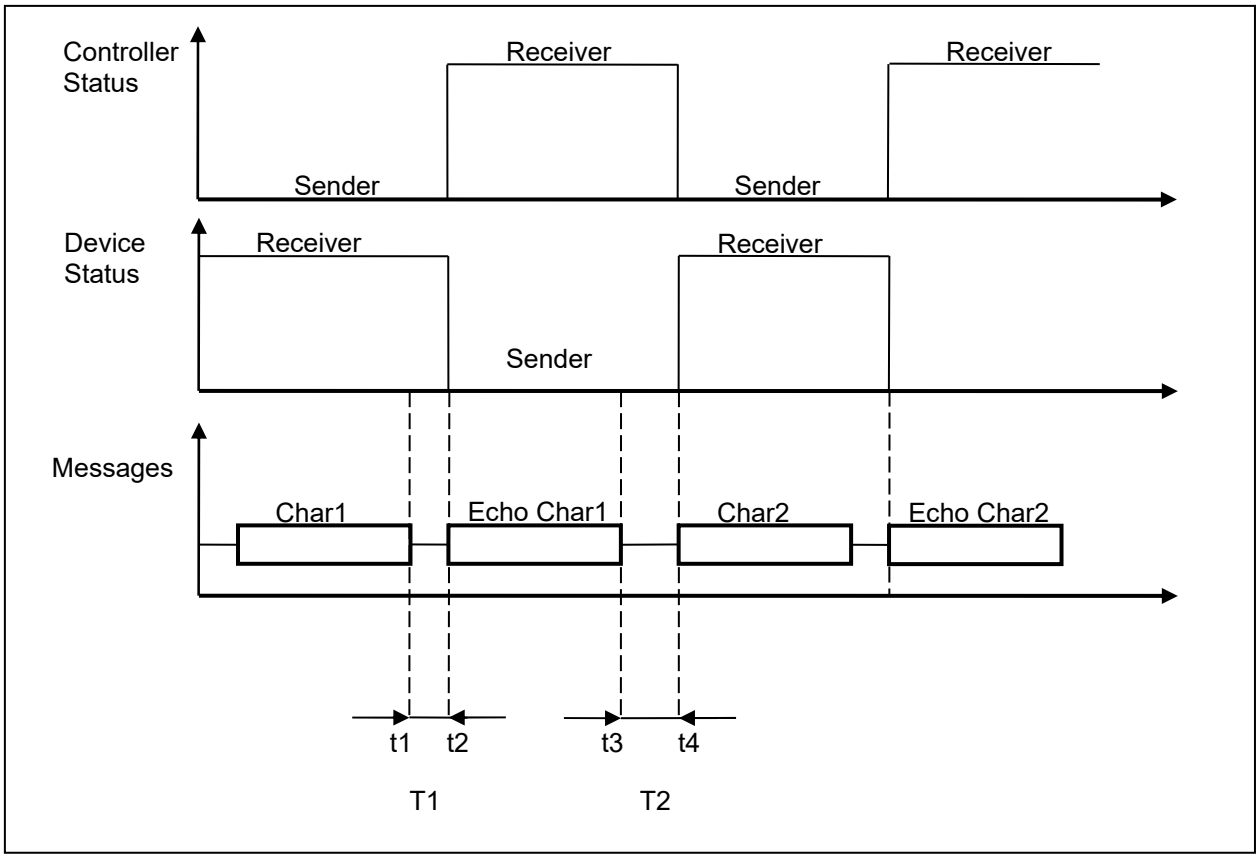


Figure 14: Half Duplex Critical Timing

Description of T1 and T2 according to Figure 14:

T1 = t2 – t1 is the typical time delay between the last bit of the byte just received by the device and the transition from receiver to sender of the device in order to send the character echo.

T2 = t4 – t3 is the typical time delay between the last bit of an echoed character by the device and the transition from sender to receiver in order for the device to be ready to receive the next byte.

Timing T1 and T2 vary slightly according to the communication baud rate:

Baud Rate	T1 in µs	T2 in µs
9600 Baud	200	100
19200 Baud	94	55
57600 Baud	120	21

Figure 15: Character Echo Timing

WARNING: Ideally the controller and the device are synchronized such that when the controller is in sending mode, the device is in receiving mode and vice versa. In reality, the device and the controller are independent and not synchronized; the timing outlined above can be critical for communication compatibility between the device and the RS-485 converter in the controller. When selecting an RS-485 converter make sure that after sending a character from the controller to the device, the converter does not stay in send mode for more than T1 specified above at a given baud rate. If the selected converter requires more time than outlined above, the communication delay command can be used to compensate for the converter and increase T1 as needed.

3.5 Feedback Message Timing

When the controller inquires the feedback from the unit, several bytes in a row are expected as opposed to the normal character echo format described in Figure 14. See Figure 16 for details:

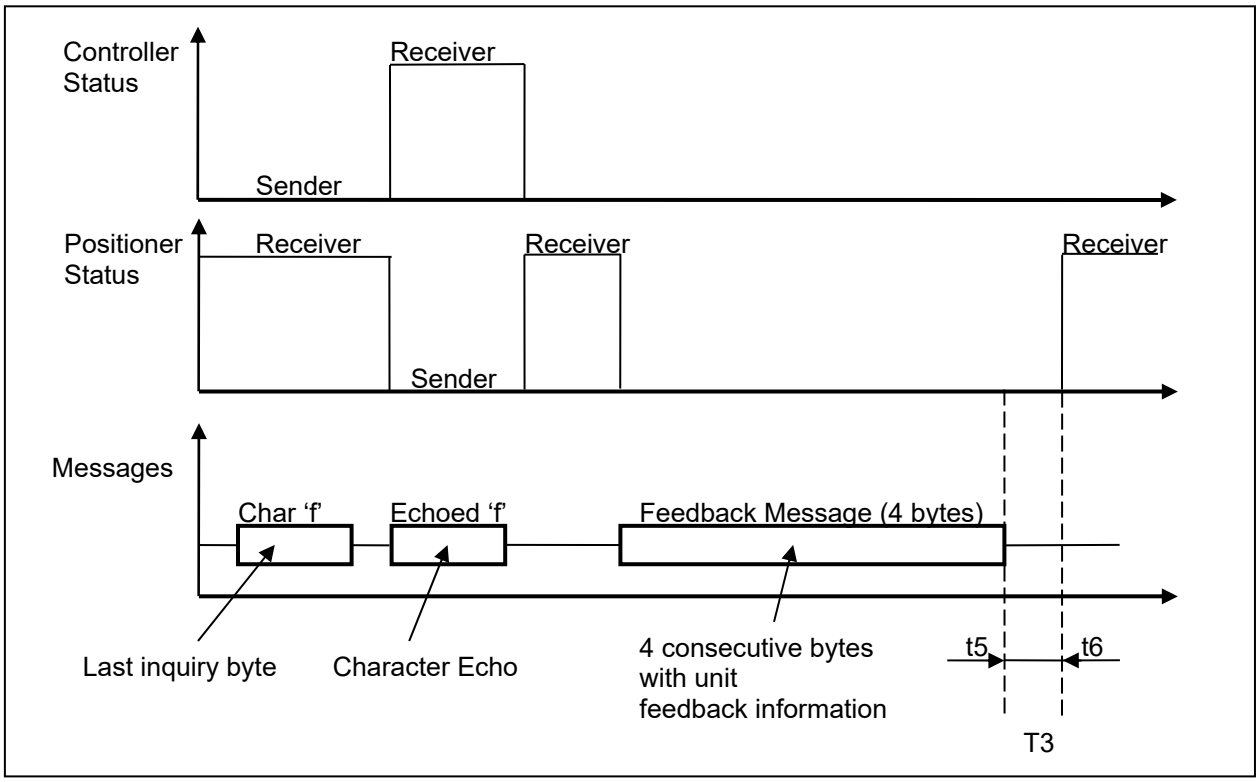


Figure 16: Feedback Message Timing

The message to inquire feedback consists of 2 characters, node ID character and the character ‘f’.

Description of T3 according to Figure 16 above:

T3 = t6 – t5 is the typical time delay between the last bit of a feedback message from the positioner and the transition from sender to receiver in order for the unit to be ready to receive the next byte.

Timing T3 varies slightly according to the communication baud rate:

Baud Rate	T3 in µs
9600 Baud	920
19200 Baud	980
57600 Baud	660

Figure 17: Character Echo Timing

NOTE: The meaning of T3 is that after receiving a feedback message, the controller must wait at least 1ms before sending the next message.

3.6 Communication Speed

ROS units can be ordered with a factory preset communication speed of:

1. 9600 Baud
2. 19200 Baud
3. 57600 Baud

3.7 Message Types

3.7.1 Command

A command is a message that is sent from the controller to a node. The message is decoded by the node interface in order to perform an action. The commands are divided into 3 groups:

3.7.1.1 Standard Control Commands

Standard Control commands are used to: rotate clockwise (CW), counterclockwise (CCW), apply braking (stop); change the zoom, focus, exposure setting, or light intensity.

3.7.1.2 Inquiry Commands

Inquiry commands are used to query each node about factory settings, user settings, position feedback (positioners only), temperature feedback (lights only), and Long Line Amplification (cameras only).

3.7.1.3 User Setting Commands

User Setting Commands are used to modify user adjustable settings such as CW or CCW rotation limits for the positioners, changing a node identification (Node ID), changing the LLA setting of the camera etc…

3.7.2 Feedback

Feedback is a message sent from the node to the controller upon request of the controller only. It provides which node the message was issued from and feedback data to the operator.

3.7.2.1 Position Feedback

Position feedback is sent from the node to the controller upon request.

3.7.2.2 Factory and User Settings

The positioner example factory and user settings are sent from the node to the controller upon request with the following information:

1. Node ID
2. Factory CCW limit
3. Factory CW limit
4. User CCW limit
5. User CW limit
6. Hardware Dash Number (Tested for air or oil filled units)
7. Feedback Enable
8. Printed Circuit Board (PCB) driver serial number
9. Baud Rate
10. Model Type
11. Firmware Revision

3.8 Printable ASCII Characters

In order to make troubleshooting and debugging as easy as possible for developers, all communications between the controller and the nodes are ASCII printable characters. This allows operation of the ROS units via standard communication software such as Windows Terminal, Hyperterminal, Procomm, et.al.

All decimal values are formatted in their ASCII representation. For example the value 39 will be represented by ASCII characters '3' and '9'.

4 COMMAND MESSAGES (FROM CONTROLLER TO NODE)

4.1 Standard Control Commands

The control command string sequence contains 5 ASCII printable characters organized in 3 sections. One character for the Node ID, one character for the action type and 3 digits value.

Character 1	Character 2	Character 3-5
Node ID	Action Type	Digit 1, 2 and 3

4.1.1 Command Message Section Description

4.1.1.1 Node ID Description

Node ID is a printable ASCII Character used to identify a node number from 1 to 32.
Node ID of 1 corresponds to the first letter of the alphabet in higher case: 'A'. Node ID of 2 is the character B and so forth following the ASCII printable character table:

Node ID Number	ASCII Printable Character	Hexadecimal Representation
1	A	0x41
2	B	0x42
3	C	0x43
4	D	0x44
5	E	0x45
6	F	0x46
7	G	0x47
8	H	0x48
9	I	0x49
10	J	0x4A
11	K	0x4B
12	L	0x4C
13	M	0x4D
14	N	0x4E
15	O	0x4F
16	P	0x50

Node ID Number	ASCII Printable Character	Hexadecimal Representation
17	Q	0x51
18	R	0x52
19	S	0x53
20	T	0x54
21	U	0x55
22	V	0x56
23	W	0x57
24	X	0x58
25	Y	0x59
16	Z	0x5A
27	[	0x5B
28	\	0x5C
29	]	0x5D
30	^	0x5E
31	_	0x5F
32	`	0x60

Figure 18: Node ID ASCII Character Correspondence

NOTE: in C language the appropriate character can be determined using the following expression:

```
int     NodeID_Number;      // Integer string the Node ID number from 1-32
Char    NodeID_Character;   // Character corresponding to the Node ID number

NodeID_Character = 'A' + NodeID_Number - 1;
```

4.1.1.2 Action Type Description

The action type is a command character that defines which action the node will perform:

Action Type Decription	ASCII Printable Character	ROS Unit
Rotate CW	>	Positioners
Rotate CCW	<	Positioners
Stop/Brake	s (lower case)	Positioners
Camera command	c (lower case)	Cameras
Light	l (lower case L)	Lights or ROVer Camera

4.1.1.3 3-Digit Description

All 3 digits value must be ASCII character 0-9. The 3 digit represent different things depending on the action type.

4.1.2 Positioner Commands

4.1.2.1 Rotate Clockwise (CW)

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	>	Speed Setting (001-080)	PT-10 40deg/sec version
Node ID	>	Speed Setting (001-040)	PT-10 with firmware Version 9.0 or later
Node ID	>	Speed Setting (001-020)	PT-25 with firmware Version 5.0 or later

The speed setting is a value between 1 and 80 that represents the desired speed of rotation. The value represents the number of times an increment of 0.5 deg/s is utilized which determines the output shaft rotation speed. *Note: All pan-and-tilts do not necessarily possess the entire speed range. Some have a max speed of 20 deg/s. Some have a max speed of 10 deg/s. Refer to the pan-and-tilt manual.*

Shaft Rotation speed (Deg/s) = Speed Setting x 0.5 Deg/s

Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)	Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)	Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)	Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)
001	0.5	*021*	10.5	*041*	20.5	*061*	30.5
002	1	*022*	11	*042*	21	*062*	31
003	1.5	*023*	11.5	*043*	21.5	*063*	31.5
004	2	*024*	12	*044*	22	*064*	32
005	2.5	*025*	12.5	*045*	22.5	*065*	32.5
006	3	*026*	13	*046*	23	*066*	33
007	3.5	*027*	13.5	*047*	23.5	*067*	33.5
008	4	*028*	14	*048*	24	*068*	34
009	4.5	*029*	14.5	*049*	24.5	*069*	34.5
010	5	*030*	15	*050*	25	*070*	35
011	5.5	*031*	15.5	*051*	25.5	*071*	35.5
012	6	*032*	16	*052*	26	*072*	36
013	6.5	*033*	16.5	*053*	26.5	*073*	36.5
014	7	*034*	17	*054*	27	*074*	37
015	7.5	*035*	17.5	*055*	27.5	*075*	37.5
016	8	*036*	18	*056*	28	*076*	38
017	8.5	*037*	18.5	*057*	28.5	*077*	38.5
018	9	*038*	19	*058*	29	*078*	39
019	9.5	*039*	19.5	*059*	29.5	*079*	39.5
020	10	*040*	20	*060*	30	*080*	40

Figure 19: Shaft Rotation Speed in Deg/s versus Speed Setting

EXAMPLE: To send a command to go clockwise at 7.5 degree/s to node number 1 the following command needs to be sent:

A>015

4.1.2.2 Rotate Clockwise (CW) with Ramping

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	+	Speed Setting (001-080)	PT-10 with 40deg/sec version
Node ID	+	Speed Setting (001-040)	PT-10 with firmware Version 9.0 or later
Node ID	+	Speed Setting (001-020)	PT-25 with firmware Version 5.0 or later

Rotate CW with Ramping uses the acceleration value to ramp up to the desired speed. The speed setting is a value between 1 and 80 that represents the desired speed of rotation. The value represents the number of times an increment of 0.5deg/s is utilized which determines the output shaft rotation speed, reference **Figure 19**. Ramping commands only work with other ramping commands. *Note: All pan-and-tilts do not necessarily possess the entire speed range. Some have a max speed of 20 deg/s. Some have a max speed of 10 deg/s. Refer to the pan-and-tilt manual.*

EXAMPLE: To send a command to ramp up to 7.5 degree/s CW to node number 1 the following command needs to be sent:

A+015

4.1.2.3 Rotate Counterclockwise (CCW)

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	<	Speed Setting (001-080)	PT-10 with 40deg/sec version
Node ID	<	Speed Setting (001-040)	All firmware versions
Node ID	<	Speed Setting (001-020)	PT-25 with firmware Version 5.0 or later

The speed setting is a value between 1 and 80 that represents the desired speed of rotation. The value represents the number of times an increment of 0.5 deg/s is utilized which determines the output shaft rotation speed. *Note: All pan-and-tilts do not necessarily possess the entire speed range. Some have a maximum speed of 20 deg/s. Some have a maximum speed of 10 deg/s. Refer to the pan-and-tilt manual.*

Shaft Rotation speed (Deg/s) = Speed Setting x 0.5 Deg/s

Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)	Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)	Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)	Speed Setting	Corresponding Shaft Rotation Speed (Deg/s)
001	0.5	*021*	10.5	*041*	20.5	*061*	30.5
002	1	*022*	11	*042*	21	*062*	31
003	1.5	*023*	11.5	*043*	21.5	*063*	31.5
004	2	*024*	12	*044*	22	*064*	32
005	2.5	*025*	12.5	*045*	22.5	*065*	32.5
006	3	*026*	13	*046*	23	*066*	33
007	3.5	*027*	13.5	*047*	23.5	*067*	33.5
008	4	*028*	14	*048*	24	*068*	34
009	4.5	*029*	14.5	*049*	24.5	*069*	34.5
010	5	*030*	15	*050*	25	*070*	35
011	5.5	*031*	15.5	*051*	25.5	*071*	35.5
012	6	*032*	16	*052*	26	*072*	36
013	6.5	*033*	16.5	*053*	26.5	*073*	36.5
014	7	*034*	17	*054*	27	*074*	37
015	7.5	*035*	17.5	*055*	27.5	*075*	37.5
016	8	*036*	18	*056*	28	*076*	38
017	8.5	*037*	18.5	*057*	28.5	*077*	38.5
018	9	*038*	19	*058*	29	*078*	39
019	9.5	*039*	19.5	*059*	29.5	*079*	39.5
020	10	*040*	20	*060*	30	*080*	40

Figure 20: Shaft Rotation Speed in Deg/s versus Speed Setting

EXAMPLE: To send a command to go counterclockwise at 12 degree/s to node number 1 the following command needs to be sent:

A<024

4.1.2.4 Rotate Counterclockwise (CCW) with Ramping

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	— "minus sign"	Speed Setting (001-080)	PT-10 with 40deg/sec version
Node ID	— "minus sign"	Speed Setting (001-040)	PT-10 with firmware Version 9.0 or later
Node ID	— "minus sign"	Speed Setting (001-020)	PT-25 with firmware Version 5.0 or later

Rotate CCW with Ramping uses the acceleration value to ramp up to the desired speed. The speed setting is a value between 1 and 80 that represents the desired speed of rotation. The value represents the number of times an increment of 0.5 deg/s is utilized which determines the output shaft rotation speed. Reference **Figure 19**. Ramping commands only work with other ramping commands. *Note: All pan-and-tilts do not necessarily possess the entire speed range. Some have a max speed of 20 deg/s. Some have a max speed of 10 deg/s. Refer to the pan-and-tilt manual*

EXAMPLE: To send a command to ramp up to 7.5 degree/s CCW to node number 1 the following command needs to be sent:

A-015

4.1.2.5 Stop/Brake

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	s (lower case)	Speed Setting (001-128)	All PT-10 firmware versions
Node ID	s (lower case)	Speed Setting (001-040)	PT-25 with firmware Version 4.0 or older
Node ID	s (lower case)	Speed Setting (001-060)	PT-25 with firmware Version 5.0 or later

The brake setting is a value between 000 and 128 that represents the desired brake setting. This command will instantaneously brake the axis without ramping down. A value of 000 represents the maximum brake setting, and a value of 127 represents the minimum brake setting. No braking is represented by the value 128.

If slip/stall detection is available on your positioner, it will use the last commanded braking value. Slip/Stall is only available on PT-25 RS485 units with firmware version 5.0 and PT-10 RS485 with firmware version 9.0 and later.
The braking value is retained through power cycles on PT-25 RS485 units with firmware version 5.0 and PT-10 RS485 with firmware version 9.0 and later.

Figure 21: Brake Effect versus Brake Setting Relationship

EXAMPLE 1: To send a command to stop with no brake current to node number 1 the following command needs to be sent:

As128

EXAMPLE 2: To send a command to stop with maximum brake current to node number 1 the following command needs to be sent:

As000

4.1.2.6 Stop/Brake with Deceleration Ramping

Character 1	Character 2	Character 3-5
Node ID	t (lower case)	Brake Setting (000-128)

The stop/brake with deceleration command can only be used with commands that use ramping. If a stop/brake with deceleration command is sent while rotating, the axis will come to a stop using the acceleration value, reference **Figure 22**. The brake setting is retained through power cycles. Slip/stall detection is uses the last commanded braking value. This is a ramping command. Ramping commands only work with other ramping commands such as (A+020) rotate CW with ramping at 10deg/s.

NOTE: *Most of PT-25 pan-and-tilts have a maximum brake value of 40 or 60 and will not respond to max brake commands of 000. Also, braking with deceleration is only available on PT-25 RS485 units with firmware version 5.0 and later and PT-10 RS485 firmware version 9.0 and later.*

EXAMPLE 1: To send a command to stop the axis with deceleration send the following:

At090

4.1.2.7 Closed loop position commands

Character 1	Character 2	Character 3-5
Node ID	p (lower case)	Position (001-999)

The closed loop position command moves the axis to the position specified according to the position speed profile, reference **Figure 22**. The axis will only accept moves to positions that are within the user CCW and CW limits. Reference Section 5.2 for details on user limits. The acceleration and maximum velocity parameters should be set according to your pan-and-tilt's torque curve. Upon completing a position move, the axis will brake at the last specified braking value. The position profile can be interrupted by new position commands, rotate commands, stop commands, or stop with deceleration commands. The profile will adjust to the new command maintaining the speed profile settings. This is a ramping command. Ramping commands only work with other ramping commands.

NOTE: Position commands are only available on PT-25 RS485 units with firmware version 5.0 and PT-10 RS485 units with firmware version 9.0 and later.
PT-10 RS-485 with firmware version 9.0 and later are accurate to +/-0.5deg when a goto position control is used.

EXAMPLE 1: To send a position move command to position 525 the following command needs to be sent:

Assume that Factory CW = 10 and Factory CCW = 969

Use the following formula to calculate the position bits equal to a specific angle with 0.5deg increments.

$$ROUNDOUP\left[\frac{ANGLE\ (1-359.5)}{\left(\frac{360}{CW-CCW}\right)}+(CCW+0.5)\right]=position\ bits$$

Note: This formula is only applicable between 1 – 359.5 angular degrees due to the required 0.5°offset:
When rotating to 0° use Factory CCW value. (i.e. **Ap010**)
When rotating to 0.5° use Factory CCW value + 1. (i.e. **Ap011**)
When rotating to 360° use Factory CW value. (i.e. **Ap969**)

Rotate to angle: **125.5deg**
ROUNDUP [**125.5** /(0.37539) + (10+0.5)] = 345

Issue the following command

NODE ID	Command ID	Value
A	p	345

The tilt axis will start rotating in a ramping fashion until it reaches 125.5 +/- 0.5deg.

Ap345

NOTE: FOR HIGHER ACCURACY IT IS RECOMMENDED TO ISSUE THE SAME GOTO COMMAND TWICE ONCE THE AXIS HAS STOPPED ROTATING. IN OTHER WORDS CONSIDER IT FINE TUNNING.

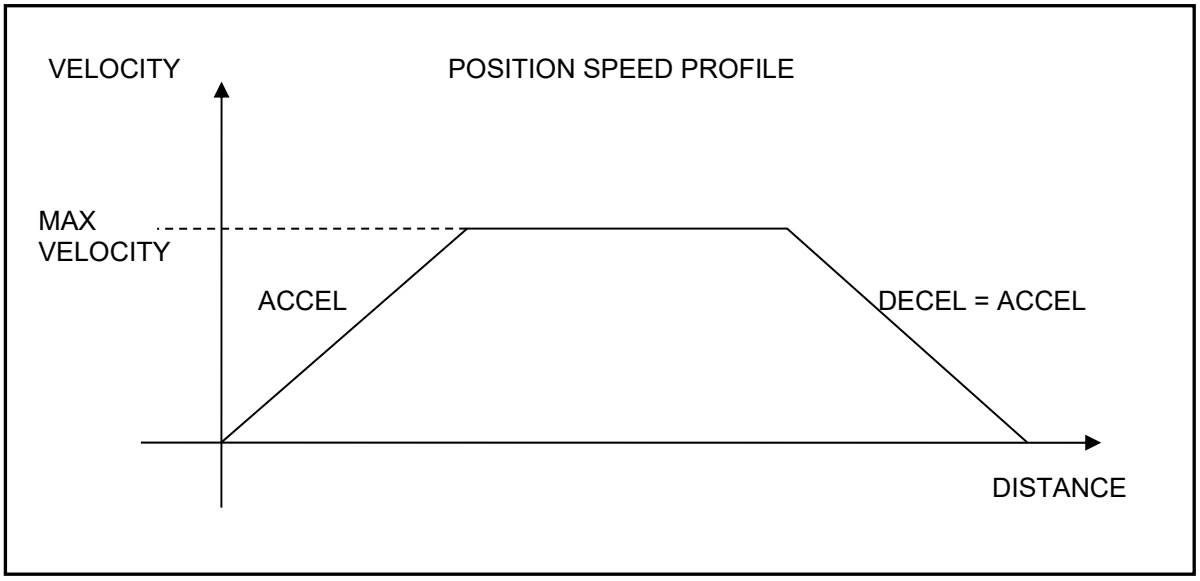


Figure 22: Position Speed Profile

4.1.2.8 Acceleration (Ramping) Setting

Character 1	Character 2	Character 3-5
Node ID	a (lower case)	Acceleration Setting (000-004)

The acceleration variable sets the acceleration (ramping) for position commands and rotate commands when ramping is enabled. The acceleration values 0 – 4 correspond to:

Acceleration Setting	Actual Acceleration
0	2 deg/s^2
1	4 deg/s^2
2	6 deg/s^2
3	8 deg/s^2
4	10 deg/s^2

The acceleration value is used for the deceleration value as well. Reference the figure below. The acceleration value is retained through power cycles.

NOTE: *The acceleration value cannot be changed while moving. Also, the acceleration setting is only available on PT-25 RS485 units with firmware version 5.0 and PT-10 RS485 with firmware version 9.0 and later.*

EXAMPLE 1: To send a command to change the acceleration value to 10 deg/s^2 the following command needs to be sent:

Aa004

4.1.2.9 Maximum Velocity Setting

Character 1	Character 2	Character 3-5
Node ID	m (lower case)	Maximum Velocity (001-080)

The maximum velocity variable sets the maximum velocity for position commands when ramping is enabled reference **Figure 22**. The maximum velocity values (0 – 80) correspond to **Figure 1.** The maximum velocity value is retained through power cycles. The maximum velocity value is only for position commands and does not limit the user on rotate commands.

NOTE: *The maximum velocity value cannot be changed while moving. All pan-and-tilts do not necessarily possess the entire velocity range. The maximum velocity setting is only available on PT-25 RS485 units with firmware version 5.0 and PT-10 RS485 with firmware version 9.0 and later.*

EXAMPLE 1: To send a command to change the maximum velocity value to 10 deg/s^2 the following command needs to be sent:

Am020

4.1.2.10 Precision rotation / single step motion

Character 1	Character 2	Character 3	Character 4 – 5	Character 6 – 10
Node ID	y (lower case)	Angular direction 1 = CW 0 = CCW	Angular Speed 01 – 40 = 0.5 – 20deg/s	Step amount 00001 - 65536

This feature gives the axis the capability to rotate CW or CCW to a specific step number from a known reference point. In other words, this feature allows the user to control the stepper driver “directly” by issuing a command that specifies the rotation speed, angular direction and amount of steps. Each step count is equal to **0.0102272727272727output shaft deg** assuming no backlash and no slip stall condition**.**

This feature is monitored by slip/stall detection and user CW-CCW limits. For example if the user wishes to rotate the axis 270 degrees CW starting at 15deg/s (Ay13026400) it is very likely that the axis will stall and stop due to the mechanical load or the instant acceleration. Also the axis will stop at the user CW limit or the desired position whichever is reached first. When slip/stall has been detected, limit or desired position has been reached the axis will stop and apply the braking value used last.

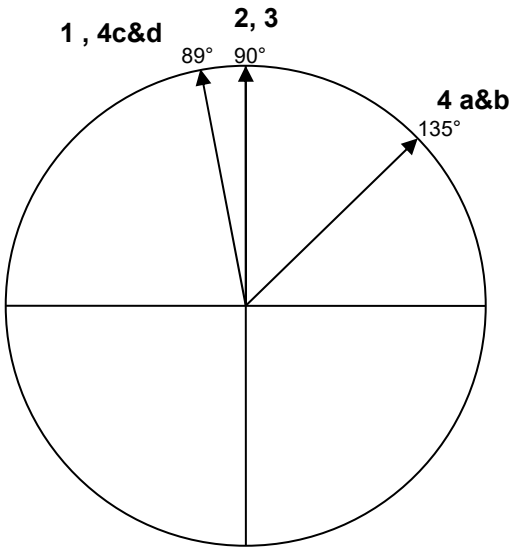
For best precision position results, the axis backlash within the gears (0.6deg) and the mechanical assembly tolerances +/-0.2deg should be minimized. In other words make sure to rotate at least 1deg in the forward direction relative to the desired position.

NOTE: This feature is only available on PT-10 RS485 with firmware version 9.0 and later and on PT-25 RS485 with firmware version 7.0 and later.

EXAMPLE 1: To send a command to rotate 5deg CW from a relative position:

Calculate the number of steps:
ROUNDUP (5deg / 0.0102272727272727deg) = 489steps
Issue the command

Ay11000489



Example for moving 45deg CW from a relative position.

1. Get rid of backlash
    a. Rotate 1deg CW, 2.5deg/s (**Ay10500098**)
2. Reset counter (**Az000**)
3. Rotate 45deg CW, 2.5deg/s relative (**Ay10504400**)
4. Return to the relative position
    a. Get counter feedback (**Aq**) = 04400
    b. Rotate 46deg CCW, 2.5deg/s Feedback + 98 = 04498 **Ay00504498**
    c. Get counter feedback (**Aq**) = 00098 (aprox)
    d. Rotate CW equal to the counter feedback amount **Ay10100098**

Figure 23 Precision angular rotation control example

4.1.2.11 Single step and step counter controls

Character 1	Character 2	Character 3-5
Node ID	z (lower case)	Single step CW 001
Node ID	z (lower case)	Single step CCW 002

This feature allows the user to control the axis in single motor steps. Each step is equal to **0.0102272727272727 output shaft deg.** Single step commands are only activated after the last stop (As100) command. Each step driving current is equivalent to the last brake value (stop command).

NOTE: This feature is only available on PT-10 RS485 with firmware version 9.0 and later and on PT-25 RS485 with firmware version 7.0 and later.

EXAMPLE 1: To send a command to rotate 0.0102272727272727deg CW:

NOTE: This function will only work while the axis is not rotating.

Az001

EXAMPLE 2: To send a command to rotate 0.0102272727272727deg CCW:

NOTE: This function will only work while the axis is not rotating.

Az002

4.1.3 Camera Commands

4.1.3.1 Standard Control Commands

Character 1	Character 2	Character 3-5
Node ID	c (lower case)	Command Number (000-200)

The command number determines which action the camera shall perform. Commands available to each camera are marked with an 'X':

Camera Command Number	Camera Action	RS-485 Navigator	RS-485 Inspector & CE-X	Inspector HD	RS-485 ROVer	Mantis HD
000	**ZOOM STOP Command**		**X**	**X**	**X**	**X**
001	**ZOOM TELE Command**		**X**	**X**	**X**	**X**
002	**ZOOM WIDE Command**		**X**	**X**	**X**	**X**
003	**FOCUS STOP Command**		**X**	**X**		**X**
004	**FOCUS NEAR Command**		**X**	**X**		**X**
005	**FOCUS FAR Command**		**X**	**X**		**X**
006	**FOCUS AUTO Command**		**X**	**X**		**X**

007	**EXP INC Command**		**X**	**X**		**X**
008	**EXP DEC Command**		**X**	**X**		**X**
009	**EXP AUTO Command**		**X**	**X**		**X**
010	**Enter LLA Command**	**X**	**X**			
011	**Exit LLA Command**	**X**	**X**			
012	**Increase LLA Command**	**X**	**X**			
013	**Decrease LLA Command**	**X**	**X**			
014	**Camera Wake**		**X**	**X**		**X**
015	**Camera Sleep Mode (saves current)**		**X**	**X**		**X**
016	**Digital Zoom ON**		**X**	**X**		**X**
017	**Digital Zoom OFF**		**X**	**X**		**X**
018	**Backlight Compensation ON**		**X**	**X**		**X**
019	**Backlight Compensation OFF**		**X**	**X**		**X**
020	**Left/Right Reverse ON**		**X**			
021	**Left/Right Reverse OFF**		**X**			
022	**Camera Freeze ON**		**X**			**X**
023	**Camera Freeze OFF**		**X**			**X**
024	**Camera Color Mode**		**X**	**X**	**X**	**X**
025	**Camera Negative Art**		**X**	**X**	**X**	**X**
026	**Camera Black & White**		**X**	**X**	**X**	**X**
027	**Image Flip ON**		**X**			
028	**Image Flip OFF**		**X**			
029	**Display ON (shows Zoom status bar…)**		**X**			
030	**Display OFF**		**X**			
031	**Zoom Speed Increment**		**X**	**X**		**X**
032	**Zoom Speed Decrement**		**X**	**X**		**X**
033	**Focus Speed Increment**		**X**			**X**
034	**Focus Speed Decrement**		**X**			**X**
035	**Telemacro ON**			**X**		
036	**Telemacro OFF**			**X**		
037	**Enter Still Image Transfer**			**X**		
038	**Exit Still Image Transfer**			**X**		
039	**4.5 Mp Image Mode**			**X**		
040	**6.0 Mp Image Mode**			**X**		
041	**IR Filter ON**			**X**		**X**

042	**IR Filter OFF**			**X**		**X**
043	**White Balance Shift INC**			**X**		
044	**White Balance Shift DEC**			**X**		
045	**White Balance Shift OFF**			**X**		
048	**Image Stabilizer ON**			**X**		
049	**Image Stabilizer OFF**			**X**		
050	**Component Video ON**			**X**		
051	**Composite Video OFF**			**X**		
052	**Photo Capture**			**X**		
053	**Positive Video**				**X**	
054	**Raster Stop**				**X**	
055	**Raster UP**				**X**	
056	**Raster DOWN**				**X**	
057	**Raster LEFT**				**X**	
058	**Raster RIGHT**				**X**	
059	**Switch to Video Format 1080i, NTSC**					**X**
060	**Switch to Video Format 1080i, PAL**					**X**
061	**Switch to Video Format 720p, NTSC**					**X**
062	**Switch to Video Format 720p, PAL**					**X**
150	**Clear Text Overlay**		**X**			
151	**Turn Text Overlay ON**		**X**			
152	**Turn Text Overlay OFF**		**X**			
153	**Display Text Overlay on upper right corner of screen**		**X**			
154	**Display Text Overlay on lower right corner of screen**		**X**			
155	**Display Text Overlay on upper left corner of screen**		**X**			
156	**Display Text Overlay on upper left corner of screen**		**X**			
157	**Set Text Overlay Characters**		**X**			
200	**Direct Zoom position**		**X**			
201	**Direct Focus position**		**X**			

Figure 24: List of Camera Commands

EXAMPLE 1: To send a command to Zoom Tele to node number 3 the following command needs to be sent:

Cc001

EXAMPLE 2: To send a command to Zoom Stop to node number 3 the following command needs to be sent:

Cs000

4.1.3.2 Direct Zoom Command

This command set is used to move the zoom lens to a specific position.

Character 1	**Character 2**	**Character 3-5**
Node ID	c (lower case)	Start Direct Zoom Command (200)
Followed by		
Character 1	**Character 2**	**Character 3-10**
Node ID	x (lower case)	00112233
		Zoom range= 0 – 16384d = 0000 – 4000h Wide = 0000h Max optical Tele = 4000h

The Direct zoom position example:

Initiate the direct zoom command mode

Cc200

Set the lens to the desired optical zoom position.
03150002 = 3F02hex = 16130decimal

Cx03150002

4.1.3.3 Direct Focus Command

This command set is used to move the focus lens to a specific position.

Character 1	**Character 2**	**Character 3-5**
Node ID	c (lower case)	Start Direct Focus Command (201)
Followed by		
Character 1	**Character 2**	**Character 3-10**
Node ID	x (lower case)	00112233
		Focus range= 0 – 49152d = 0000 – C000h Focus Far limit = 0000h Focus near limit = C000h

The Direct zoom position example:

Initiate the direct focus command mode

Cc201

Set the lens to the desired focus position.
05151304 = 5FD4hex = 24532decimal

Cx05151304

4.1.3.4 OSD (On Screen Display) Text Overlay Commands

This command set is used to move the focus lens to a specific position.

Character 1	Character 2	Character 3-5	Description
Node ID	c (lower case)	(150)	Clears any text overlay currently displayed on the screen
Node ID	c (lower case)	(151)	Turns ON the OSD feature
Node ID	c (lower case)	(152)	Turns OFF the OSD feature
Node ID	c (lower case)	(153)	Displays the text overlay on the Upper Right corner of the screen
Node ID	c (lower case)	(154)	Displays the text overlay on the Lower Right corner of the screen
Node ID	c (lower case)	(155)	Displays the text overlay on the Lower Left corner of the screen
Node ID	c (lower case)	(156)	Displays the text overlay on the Upper Left corner of the screen
Node ID	c (lower case)	(157)	Starts the text overlay feature. See example below

OSD On Screen Display setting example:

Make sure the text overlay buffer is cleared

Cc150

Turn on the OSD feature

Cc151

Set the display on the upper right corner of the screen

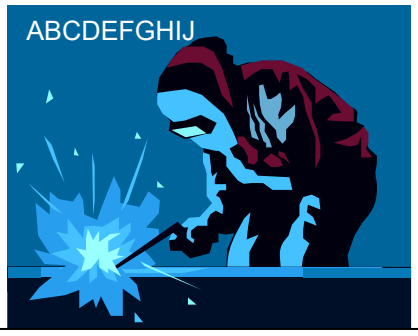
Cc153

Start the text overlay command

Cc157

Set the text to overlay on the screen **ABCDEFGHIJ** 10 characters max

Cx00112233445566778899



VIEW OF THE MONITOR SCREEN

Figure 25 Video OSD example

Start the text overlay command

Cc157

Change the overlay text to say: **TEST 123** 10 characters max

Cx19041819273032332727

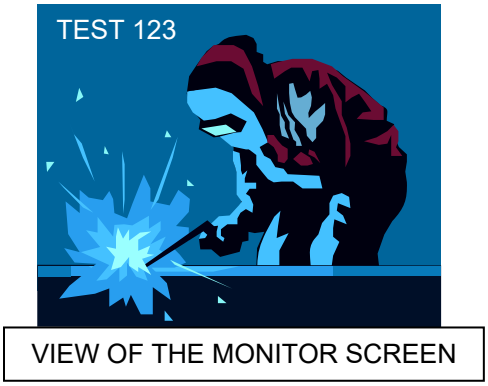


Figure 26 Video OSD example

Charter #	00	01	02	03	04	05	06	07
Character	A	B	C	D	E	F	G	H
Charter #	08	09	10	11	12	13	14	15
Character	I	J	K	L	M	N	O	P
Charter #	16	17	18	19	20	21	22	23
Character	Q	R	S	T	U	V	W	X
Charter #	24	25	26	27	28	29	30	31
Character	Y	Z	&		?	!	1	2
Charter #	32	33	34	35	36	37	38	39
Character	3	4	5	6	7	8	9	0
Charter #	40	41	42	43	44	45	46	47
Character	À	È	Ì	Ò	Ù	Á	É	Í
Charter #	48	49	50	51	52	53	54	55
Character	Ó	Ú	Â	Ê	Ô	Æ	OE	Ã
Charter #	56	57	58	59	60	61	62	63
Character	Õ	Ñ	Ç	ß	Ä	Ï	Ö	Ü
Charter #	64	65	65	67	68	69	70	71
Character	Å	$	**F**	¥	DM	£	¿	¡
Charter #	72	73	74	75	76	77	78	79
Character	ø	“	:	‘	.	,	/	-

Table 1 Video OSD character table

4.1.4 Light Commands

4.1.4.1 Light Dimming

A single light dimming command offers 100 discrete intensity levels between the OFF setting and the full ON setting. The light Intensity command is a 5 character message that consists of the node ID, a lower case 'l' character (for light) and three digits that represents the intensity level between 000 and 100:

NOTE: The light commands are applicable to cameras with integrated lights such as the ROVer.

Character 1	Character 2	Character 3-5
Node ID	l (lower case L)	000-100

EXAMPLE 1: To send a command to node number 4 to set the light to turn on at ½ intensity, the following command needs to be sent:

Dl050

EXAMPLE 2: To send a command to node number 4 to turn the light OFF, the following command needs to be sent:

Dl000

NOTE: Intensity level 000 turns the light OFF, while intensity 100 turns the light ON to full intensity

4.1.4.2 On Power Up Light Setting Command

A single light command offers 100 discrete intensity levels between the OFF setting and the full ON setting. The light Intensity on power up command is a 5 character message that consists of the node ID, a lower case 'w' character (for light) and three digits that represents the intensity level between 000 and 100. This command sets the value at which the light will set the its intensity upon power up, the value is saved in the non volatile memory.

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	w (lower case)	000-100	MV-LED-RS485 firmware version 2.0 or greater

EXAMPLE 1: To send a command to node number 4 to set the light to turn on at ½ intensity and save the value in NON volatile memory, the following command needs to be sent:

Dw050

EXAMPLE 2: To send a command to node number 4 to turn the light OFF, and save the value in NON volatile memory, the following command needs to be sent:

Dw000

NOTE: Intensity level 000 turns the light OFF, while intensity 100 turns the light ON to full intensity. The light will turn ON at full intensity for ~120ms while the firmware is booting up. The saved light intensity setting will be implemented once the firmware has booted up.

4.2 Inquiry Commands

4.2.1 General Inquiries (Positioners, Cameras and Lights)

4.2.1.1 Factory Setting Inquiry

The factory setting inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits that need to be set to 000:

Character 1	Character 2	Character 3-5
Node ID	?	000

EXAMPLE 1: To send a current setting inquiry command to node number 1 the following command needs to be sent:

A?000

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.1.2 Character Echo Status Inquiry

The character echo status inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits:

Character 1	Character 2	Character 3-5
Node ID	?	001

EXAMPLE 1: To send a character echo status inquiry command to node number 1 the following command needs to be sent:

A?001

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.2 Positioner Inquiries

4.2.2.1 Position Feedback

The feedback (or position) inquiry message is a 2 character message that consists of the node ID and the character 'f' for feedback.

NOTE: For position control purposes of a positioner this is the command that is the most often sent from the controller to the nodes and therefore it was minimized to 2 characters to optimize time response speed.

Character 1	Character 2
Node ID	f

EXAMPLE: To send a feedback inquiry command to node number 1 the following command needs to be sent:

Af

The expected response format will be something like **A512** which represents the potentiometer position in bits.
A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5.5.1) for details.

4.2.2.2 Step count / relative position feedback

The step count feedback (or relative position) inquiry message is a 2 character message that consists of the node ID and the character 'q' for feedback.

NOTE: This feature is only available on PT-10 RS485 with firmware version 9.0 and later and on PT-25 RS485 with firmware version 7.0 and later.

Character 1	Character 2
Node ID	q

EXAMPLE: To send a feedback inquiry command to node number 1 the following command needs to be sent:

Aq

The expected response format will be something like **A35200** which represents the current traveled step count from the relative position or the from what the counter was last reset.

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

Character 1	Character 2	Character 3-5
Node ID	z (lower case)	Reset counter 000

This command resets the step counter that is used for precision control. See sec 4.1.2.10. a step counter will increment its value while rotating CW and decrement its value while rotating CCW.

4.2.2.3 Communications Delay Inquiry

The communications delay inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later. And PT-10 RS485 models with firmware 8.0 or later*

Character 1	Character 2	Character 3-5
Node ID	?	002

EXAMPLE 1: To send this command to node number 1 the following command needs to be sent:

A?002

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.2.4 Acceleration Setting Inquiry

The acceleration inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

Character 1	Character 2	Character 3-5
Node ID	?	003

EXAMPLE 1: To send this command to node number 1 the following command needs to be sent:

A?003

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.2.5 Maximum Velocity Setting Inquiry

The maximum velocity setting inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

Character 1	Character 2	Character 3-5
Node ID	?	004

EXAMPLE 1: To send this command to node number 1 the following command needs to be sent:

A?004

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.2.6 Slip/Stall Flag Inquiry

The slip/stall flag inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

Character 1	Character 2	Character 3-5
Node ID	?	005

EXAMPLE 1: To send this command to node number 1 the following command needs to be sent:

A?005

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.2.7 Brake Value Inquiry

The brake value inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

Character 1	Character 2	Character 3-5
Node ID	?	006

EXAMPLE 1: To send this command to node number 1 the following command needs to be sent:

A?006

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.2.8 Moving Flag Inquiry

The moving flag inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

Character 1	Character 2	Character 3-5
Node ID	?	007

EXAMPLE 1: To send this command to node number 1 the following command needs to be sent:

A?007

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.3 Camera Inquiries

4.2.3.1 LLA Current Setting Inquiry

The LLA current setting inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits:

NOTE: This setting is available only to the CE-X and Inspector, not the Inspector HD, ROVer, or Mantis HD

Character 1	Character 2	Character 3-5
Node ID	?	002

EXAMPLE 1: To send a LLA current setting inquiry command to node number 1 the following command needs to be sent

A?002

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.3.2 Zoom Speed Setting Inquiry

The zoom speed setting inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits:

Character 1	Character 2	Character 3-5
Node ID	?	003

EXAMPLE 1: To send a zoom speed setting inquiry command to node number 1 the following command needs to be sent:

A?003

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.3.3 Focus Speed Setting Inquiry

The focus speed setting inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits:

NOTE: This setting is available only to the CE-X, Inspector and Mantis HD. It is not available to the Inspector HD or ROVer.

Character 1	Character 2	Character 3-5
Node ID	?	004

EXAMPLE 1: To send a focus speed setting inquiry command to node number 1 the following command needs to be sent:

A?004

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.3.4 Zoom Position Inquiry

The Zoom position inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits:

NOTE: This setting is available only to the CE-X, Inspector. It is not available to the Mantis HD, Inspector HD or ROVer.

Character 1	Character 2	Character 3-5
Node ID	?	100

EXAMPLE 1: To send a zoom position inquiry command to node number 1 the following command needs to be sent:

A?100

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.3.5 Focus Position Inquiry

The Focus position inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits:

NOTE: This setting is available only to the CE-X, Inspector. It is not available to the Mantis HD, Inspector HD or ROVer.

Character 1	Character 2	Character 3-5
Node ID	?	101

EXAMPLE 1: To send a focus position inquiry command to node number 1 the following command needs to be sent:

A?100

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.3.6 Additional Inspector HD Inquiries

The Inspector HD has additional inquiries not applicable to the CE-X or Inspector. These inquiries follow the 5 character format consisting of a node ID, a question mark character, and three digits.

Inquiry	Character 1	Character 2	Character 3-5
Focus Auto/Manual	Node ID	?	005
Exposure Auto/Manual	Node ID	?	006
Digital Zoom On/Off	Node ID	?	007
Backlight On/Off	Node ID	?	008
Camera Picture Mode	Node ID	?	009
Telemacro On/Off	Node ID	?	010
Mode State	Node ID	?	011
IR Filter On/Off	Node ID	?	012
White Balance Shift Off/On	Node ID	?	013
Image Stabilizer On/Off	Node ID	?	015
Component/Composite	Node ID	?	016

A string of characters is generated and sent back from the queried node upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.4 Light Inquiries

4.2.4.1 Light Temperature Inquiry

The feedback (internal light temperature) inquiry message is a 2 character message that consists of the node ID and the character ‘f’ for feedback.

Character 1	Character 2
Node ID	f

EXAMPLE: To send a feedback inquiry command to node number 4 the following command needs to be sent:

Df

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER) for details.

4.2.4.2 Light Intensity Inquiry

The light intensity inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits that need to be set to 005:

Character 1	Character 2	Character 3-5
Node ID	?	005

EXAMPLE 1: To send a light intensity inquiry command to node number 4 the following command needs to be sent:

D?005

A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.2.4.3 On Power Up Light Intensity Inquiry

The On power up light intensity inquiry message is a 5 character message that consists of the node ID, a question mark character and three digits that need to be set to 006.

Character 1	Character 2	Character 3-5	Availability on Model
Node ID	?	006	MV-LED-RS485 firmware version 2.0 or greater

EXAMPLE 1: To send an On power up light intensity inquiry command to node number 4 the following command needs to be sent:

D?006

The light will respond with a string of characters like this one **D050** which means that the light is set to output 50% of its intensity upon power up.
A string of characters is generated and sent back from the node concerned to the master controller upon reception of the above command. See section FEEDBACK MESSAGE (FROM NODE TO CONTROLLER, SECTION 5) for details.

4.3 User Setting Commands

The user setting commands are commands that allow modifying the user settings such as:

1. Assigning a different Node ID to a given Node (Positioner, Cameras, Lights)
2. Changing the User CCW limit (Positioners only)
3. Changing the User CW limit (Positioners only
4. Changing the camera long line amplification (Cameras only)
5. Enabling or disabling the character echo (Positioners, Cameras & Lights)

4.3.1 General User Settings (positioners, cameras, lights)

4.3.1.1 Change Node ID Command

The ROS RS-485 protocol allows for 32 nodes to be connected and addressed in a network. At times it might be necessary to change the node ID address of one unit to another.

WARNING: Changing a Node ID should be performed with caution and preferably using the appropriate ROS software. The ROS software implements safety measures to avoid assigning 2 nodes with the same ID that are connected on the same network.

The “Change Node ID” message is a 5 character message that consists of the current node ID, the character ‘i’ (lower case i) and three digits for the new node ID ranging from 001-032:

Character 1	Character 2	Character 3-5
Node ID	i	001-032

EXAMPLE: To send node number 1 the command to change it to node number 3 the following command needs to be sent:

Ai003

Note that in the example above. Immediately after the node ID was changed from 1 to 3 (‘A’ to ‘C’) it must be addressed from that point on using the new node ID and the system does not need to be rebooted, however it is recommended to wait a minimum of **500ms** before issuing the next command.

4.3.1.2 Character Echo Enable

NOTE: This feature is implemented on all cameras and lights. PT-10 positioners with firmware versions 1.06 or higher have this feature. Firmware version up to 1.05 do not allow disabling the character echo. PT-25 positioners with firmware revisions 3.0 or higher have this feature enabled.

The message to enable the character echo is 5 character message that consists of the current node ID, the character ‘e’ (lower case e for echo) and three digits with the value 001:

Character 1	Character 2	Character 3-5
Node ID	e	001

To check if the command was successfully accepted, a character echo status inquiry commands can be sent. See inquiry section 4.2.1.2.

EXAMPLE: To send the node number 3 the command enable character echo:

Ce001

Note that in the example above. Immediately after the command was sent, the setting takes effect and the system does not need to be rebooted, however it is recommended to wait a minimum of **500ms** before issuing the next command. The setting is stored in the non-volatile memory and will be preserved even after a power cycle.

4.3.1.3 Character Echo Disable

The message to disable the character echo is 5 character message that consists of the current node ID, the character ‘e’ (lower case e for echo) and three digits with the value 000:

Character 1	Character 2	Character 3-5
Node ID	e	000

To check if the command was successfully accepted, a character echo status inquiry commands can be sent. See inquiry section 4.2.1.2

EXAMPLE: To send the node number 3 the command disable character echo:

Ce000

Note that in the example above. Immediately after the command was sent, the setting takes effect and the system does not need to be rebooted, however it is recommended to wait a minimum of **500ms** before issuing the next command. The setting is stored in the non-volatile memory and will be preserved even after a power cycle.

4.3.2 Positioner User Settings

4.3.2.1 Modify User CCW Limit Command

The User CCW limit can be modified to prevent the positioner node to cross a given limit as long as:

User CCW limit ≥ Factory CCW limit

The message to modify the User CCW limit is a 5 character message that consists of the current node ID, the character 'd' (lower case d for down limit) and three digits for the limit ranging from 000-999:

Character 1	Character 2	Character 3-5
Node ID	d	000-999

EXAMPLE: To send the node number 1 the command set the User CCW limit to a value of 127the following command needs to be sent:

Ad127

Note that in the previous example. Immediately after the command was sent, the setting takes effect and the system does not need to be rebooted, however it is recommended to wait a minimum of **500ms** before issuing the next command

NOTE: In order to prevent damage to the positioner feedback mechanism, if the User CCW Limit sent is not greater or equal to the Factory CCW limit, then the User CCW limit will be disregarded and set to default value of the Factory CCW limit.

4.3.2.2 Modify User CW Limit Command

The User CW limit can be modified to prevent the positioner node to cross a given limit as long as:

User CW limit ≤ Factory CW limit

The message to modify the User CW limit is a 5 character message that consists of the current node ID, the character 'u' (lower case u for Up limit) and three digits for the limit ranging from 000-999:

Character 1	Character 2	Character 3-5
Node ID	u	000-999

EXAMPLE: To send the node number 1 the command set the User CW limit to a value of 648 the following command needs to be sent:

Au648

Note that in the example above. Immediately after the command was sent, the setting takes effect and the system does not need to be rebooted, however it is recommended to wait a minimum of **500ms** before issuing the next command.

NOTE: In order to prevent damage to the positioner feedback mechanism, if the User CW Limit sent is not lesser or equal to the Factory CW limit, then the User CW limit will be disregarded and set to default value of the Factory CW limit.

4.3.2.3 Communication Delay

Character 1	Character 2	Character 3-5
Node ID	b (lower case)	Com Delay (000-999)

PT-10 RS485 parameter range for firmware versions 8.0 only

Character 1	Character 2	Character 3-5
Node ID	b (lower case)	Com Delay (000-260)

The communication delay is useful when integrating your pan-and-tilt with multiplexers and other devices that create a lag in communication. The delay occurs on character echo and inquiry responses. Each input value corresponds to 0.25ms. The communication delay is retained through power cycles.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

EXAMPLE 1: To create a communication delay of 20ms the user would send the following command (20/0.25 = 80):

Ab080

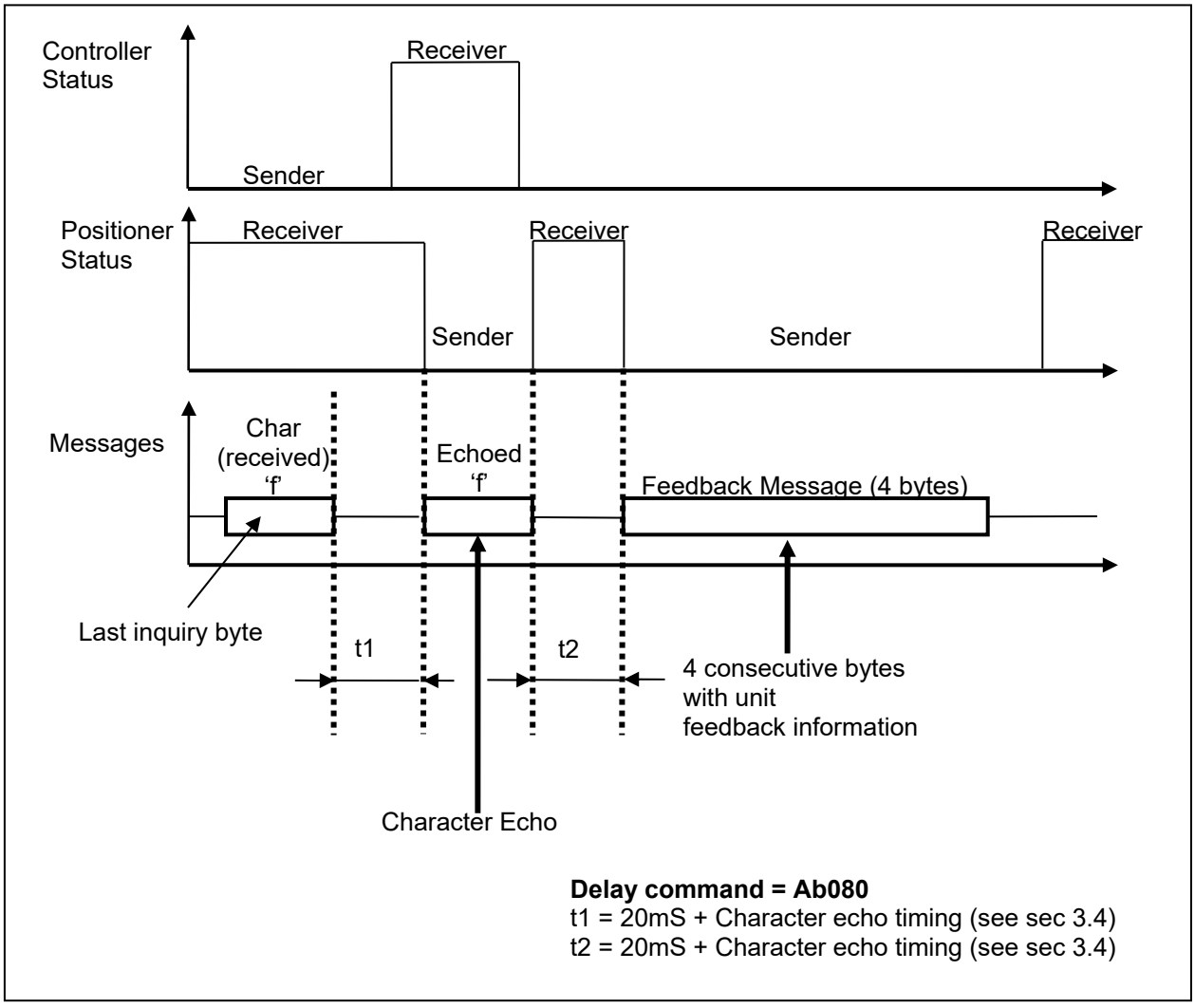


Figure 27 Programmable Character Delay Timing Example

4.3.3 Camera User Settings

Camera user settings are feature that are saved in the non-volatile memory and retained upon power cycles.

4.3.3.1 Long Line Amplifier (LLA) Commands

The long line amplification level can be adjusted depending on the length and quality of the cable used for the video transmission (usually a coaxial cable).
NOTE: This feature is not available with the ROVer, Inspector HD, or Mantis HD cameras.

Adjusting the LLA level is a three step process:

1. Enter the LLA adjust mode
2. Increase or Decrease the level as required
3. Exit the LLA adjust mode

The message to enter the LLA adjust mode is a 5 character message that consists of the current node ID, the character 'c' (lower case c for Camera command) and three digits for the limit ranging from 000-999:

Character 1	Character 2	Character 3-5
Node ID	c	010-013

Character 3-5	Command Description
010	Enter LLA Adjust Mode
011	Exit LLA Adjust Mode
012	Increase LLA setting
013	Decrease LLA setting

Figure 28: LLA Commands

When entering the LLA Adjust mode (command 010) the current setting is automatically displayed on the video. The current LLA setting can also be inquired (see camera inquiry section).

Once in LLA Adjust mode, Increase and Decrease (command 012 and 013) commands can be sent in order to adjust the LLA level.

Finally, when the LLA level is adjusted, the exit LLA adjust mode can be sent in order to save the current setting. When exiting the LLA adjust mode, the current setting video overlay is automatically removed.

EXAMPLE: To send the node number 4 the command to enter the LLA adjust mode:

Dc010

To send the node number 4 the command to increase the LLA setting:

Dc012

To send the node number 4 the command to exit the LLA adjust mode:

Dc011

The LLA should be adjusted by looking at the video quality on a video monitor. If need be the current setting can be inquired using the RS-485 protocol. See section 4.2.3. on camera inquiries for details.

NOTE: Each time an increase or decrease command is sent, the video current setting is incremented or decremented by one unit. There are 100 different settings, from 0 to 99 that represent an approximate percentage of the LLA amplification level, with 0 representing no amplification and 99 maximum amplification.

4.3.3.2 Zoom Speed User Setting

The CE-X, Inspector, and Inspector HD cameras offer 8 discrete speed levels for the zoom speed from slow (0) to fast (7). Two commands are available one to increase and the other to decrease the speed level.
NOTE: For the Inspector HD, this feature is volatile, meaning the setting is not remembered upon restart.

The message to increase or decrease the zoom speed is a 5 character message that consists of the current node ID, the character 'c' (lower case c for Camera command) and three digits for the increase or decrease command, respectively '031' and '032':

Character 1	Character 2	Character 3-5
Node ID	c	031-032

Character 3-5	Command Description
031	Zoom Speed Increment
032	Zoom Speed Decrement

The current zoom speed setting can be inquired using the RS-485 protocol. See section 4.2.3. for camera details.

EXAMPLE: To send the node number 4 the command to increase the zoom speed setting the following message needs to be sent:

Dc031

4.3.3.3 Focus Speed User Setting

The CE-X and Inspector cameras **(not applicable to the Inspector HD)** offer 8 discrete speed levels for the focus speed from slow (0) to fast (7). Two commands are available one to increase and the other to decrease the speed level.
The message to increase or decrease the focus speed is a 5 character message that consists of the current node ID, the character 'c' (lower case c for Camera command) and three digits for the increase or decrease command, respectively '033' and '034':

Character 1	Character 2	Character 3-5
Node ID	c	033-034

Character 3-5	Command Description
033	Focus Speed Increment
034	Focus Speed Decrement

The current zoom speed setting can be inquired using the RS-485 protocol. See section on camera inquiries for details.

EXAMPLE: To send the node number 4 the command to increase the focus speed setting the following message needs to be sent:

Dc033

4.3.4 Light User Settings

There are no light user settings implemented at this point others than the ones described under the section "General User Settings 4.3.1. (positioners, cameras, lights)".

5 FEEDBACK MESSAGES (FROM NODE TO CONTROLLER)

NOTE: The current setting string was originally designed for ROS positioners. Later on cameras and lights inherited the same string format for consistency. However some of the fields have different meanings depending if it is a camera, a positioner or a light. When a system includes several node, for example, a camera, a Pan & Tilt and a light, inquiring the current setting string for each node is useful to determine exactly what hardware is in the network.

5.1 Character Echo Status Feedback (Positioners, Cameras, and Lights)

A character echo status feedback string is a response to a character echo status feedback inquiry Node ID number followed by ASCII character '?' and three digits set to '001', message of type "A?001". The 5 character feedback string contains information in printable ASCII characters that determines if the character echo feature is enabled or disabled:

Char 0	Char 1	Char 2-4
Node ID	e (lower case E)	Threes digits: 110 = Character Echo Disabled 111 = Character Echo Enabled

EXAMPLE: To send the node number 1 the command to inquire about the character echo status the following message needs to be sent:

A?001

One example answer to this message is:

Ae110

The feedback message above means that the character echo is currently disabled.

5.2 Positioner Factory Settings Feedback String

A current settings feedback string is a response to a current setting feedback inquiry Node ID number followed by ASCII character '?' and 3 zeros, message of type "A?000". The 33 character string contains information in printable ASCII characters that is comma separated:

Char 0	Char 2-4	Char 6-8	Char 10-12	Char 14-16	Char 18	Char 20	Char 22-25	Char 27	Char 29	Char 31-32
Node ID	Factory CCW Limit	Factory CW Limit	User CCW Limit	User CW Limit	PCB Dash Number	Position Feedback Status	PCB Serial Number	Baud Rate	Device Type	Firmware Revision

A total of 33 characters is received containing 10 commas, one separating each field. Assuming that the first character received is the character number 0, commas can be found at the following locations:

Char 1, 5, 9, 13, 17, 19, 21, 26, 28 and 30 are commas

5.2.1 Node ID

Node ID is a printable ASCII Character used to identify a node number from 1 to 32.
Node ID of 1 corresponds to the first letter of the alphabet in higher case: 'A'. Node ID of 2 is the character B and so forth following the ASCII printable character table:

Node ID Number	ASCII Printable Character	Hexadecimal Representation
1	A	0x41
2	B	0x42
3	C	0x43
4	D	0x44
5	E	0x45

6	F	0x46
7	G	0x47
8	H	0x48
9	I	0x49
10	J	0x4A
11	K	0x4B
12	L	0x4C
13	M	0x4D
14	N	0x4E
15	O	0x4F
16	P	0x50
17	Q	0x51
18	R	0x52
19	S	0x53
20	T	0x54
21	U	0x55
22	V	0x56
23	W	0x57
24	X	0x58
25	Y	0x59
16	Z	0x5A
27	[	0x5B
28	\	0x5C
29	]	0x5D
30	^	0x5E
31	_	0x5F
32	`	0x60

Node ID Number	ASCII Printable Character	Hexadecimal Representation

Figure 29: Node ID ASCII Character Correspondence

NOTE: in C language the appropriate ID number can be determined from the ASCII character received using the following expression:

```
int     NodeID_Number;      // Integer string the Node ID number from 1-32
Char    NodeID_Character;   // Character corresponding to the Node ID number

NodeID_Number = NodeID_Character – ‘A’ +1;
```

5.2.2 Factory CCW Limit

Factory CCW limit is represented by 3 ASCII digits ranging from 000-499. It is an ASCII representation of the limit the axis will not be able to cross while rotating in the CCW direction. Each node is programmed to stop motion if that limit is reached to prevent hardware damage.

Typically it is a value between 010 and 050.

NOTE: The factory CCW Limit is unique to a given axis and may vary slightly from node to node due to mechanical and component tolerances.

5.2.3 Factory CW Limit

Factory CW limit is represented by 3 ASCII digits ranging from 500-999. It is an ASCII representation of the limit the axis will not be able to cross while rotating in the CW direction. Each node is programmed to stop motion if that limit is reached to prevent hardware damage.

Typically it is a value between 950 and 999.

NOTE: The factory CCW Limit is unique to a given axis and may vary slightly from node to node due to mechanical and component tolerances.

5.2.4 User CCW Limit

User CCW limit is represented by 3 ASCII digits ranging from. It is an ASCII representation of the limit the axis will not be able to cross while rotating in the CCW direction. Each node is programmed to stop motion if that limit is reached to prevent any damage. The limit is set by the user and must be greater or equal to the Factory CCW Limit. See Figure 5 for details.

User CCW Limit ≥ Factory CCW Limit

5.2.5 User CW Limit

User CW limit is represented by 3 ASCII digits ranging from. It is an ASCII representation of the limit the axis will not be able to cross while rotating in the CW direction. Each node is programmed to stop motion if that limit is reached to prevent any damage. The limit is set by the user and must be lesser or equal to the Factory CW Limit. See Figure 5 for details.

User CW Limit ≤ Factory CW Limit

5.2.6 PCB Dash Number

PCB Dash number is a single digit that ranges from 0-4. It designates if the PCB was intended to be used inside a pressure compensated housing or non pressure compensated housing. The only difference is the pressure test performed if the PCB is intended to be used in a pressure compensated housing. Also the dash number designates if the PCB was intended to be used for a Pan axis (or rotator) or a tilt axis of a pan & tilt unit.

PCB Dash Number	Intended Housing	Intended Axis
1	Air filled Housing (not pressure compensated)	Single rotator or Pan Axis
2	Air filled Housing (not pressure compensated)	Tilt axis
3	Oil filled Housing (pressure compensated)	Single rotator or Pan Axis
4	Oil filled Housing (pressure compensated)	Tilt axis
5	Air filled Housing (not pressure compensated)	Single rotator or Pan Axis
6	Air filled Housing (not pressure compensated)	Tilt axis
7	Oil filled Housing (pressure compensated)	Single rotator or Pan Axis
8	Oil filled Housing (pressure compensated)	Tilt axis
9	Air filled Housing (not pressure compensated)	Single rotator or Pan Axis High Speed

Figure 30: PCB Dash Number Designation

5.2.7 Position Feedback Status

Position feedback status is a single character that can only have two different values, ‘y’ or ‘n’. Character ‘y’ for YES means that the position feedback is enabled. Character ‘n’ for NO means that the position feedback is disabled.

Position Feedback Status Character	Description
y	YES Position feedback is Enabled
n	NO Position feedback is Disabled

Figure 31: Position Feedback Status Designation

5.2.8 PCB Serial Number

Each PCB used to drive a node is assembled and manually engraved with a unique 4 digit serial number during the ROS production process. The engraved serial number can be read on the PCB but can also be read using the RS-485 protocol without having to open the positioner housing. This information is useful for tracking purposes. The serial number for this circuitry ranges from 0000 - 9999

5.2.9 Baud Rate

The Baud rate is single digit that is used to determine the current Baud rate. Character ‘1’ for 9600 Baud, ‘2’ for 19200 Baud, and ‘3’ for 57600 Baud.

Baud Rate Character	Current Baud Rate
1	9600 Baud
2	19200 Baud
3	57600 Baud

Figure 32: Baud Rate Designation

5.2.10 Device Type (Determines if positioner, camera, or light)

The device type is a single digit that determines what type of device the PCB is intended on driving. The four types supported at this point are, character '1' for R-10 and PT-10 with 88:1 reduction gears, character '2' for R-25 and PT-25 with 160:1 reduction gears, character '3' for cameras (Inspector, CE-X or navigator) and character 4 for the RS485 Light.

Device Type Character	Description
1	R-10, PT-10 with 88:1 reduction gears
2	R-25, PT-25 with 160:1 reduction gears
3	Camera
4	Light
5	R-10, PT-10 with 50:1 reduction gears

Figure 33: Device Type Designation

NOTE: Should be set to character 1 or 2 or a positioner.

5.2.11 Firmware Revision

The Firmware Revision is a two-digit value from 00 – 99 that determines the Firmware revision that the PCB was programmed with. Should be interpreted as 1.xx where xx are the 2 digits described above. See example below for details.

5.2.12 Positioner Current Settings Feedback String Examples

Inquiry sent to node number 1:

Inquiry: "A?000"

Response: A,010,989,015,975,2,y,0007,2,1,03
See Figure 34 for detailed interpretation of each field.

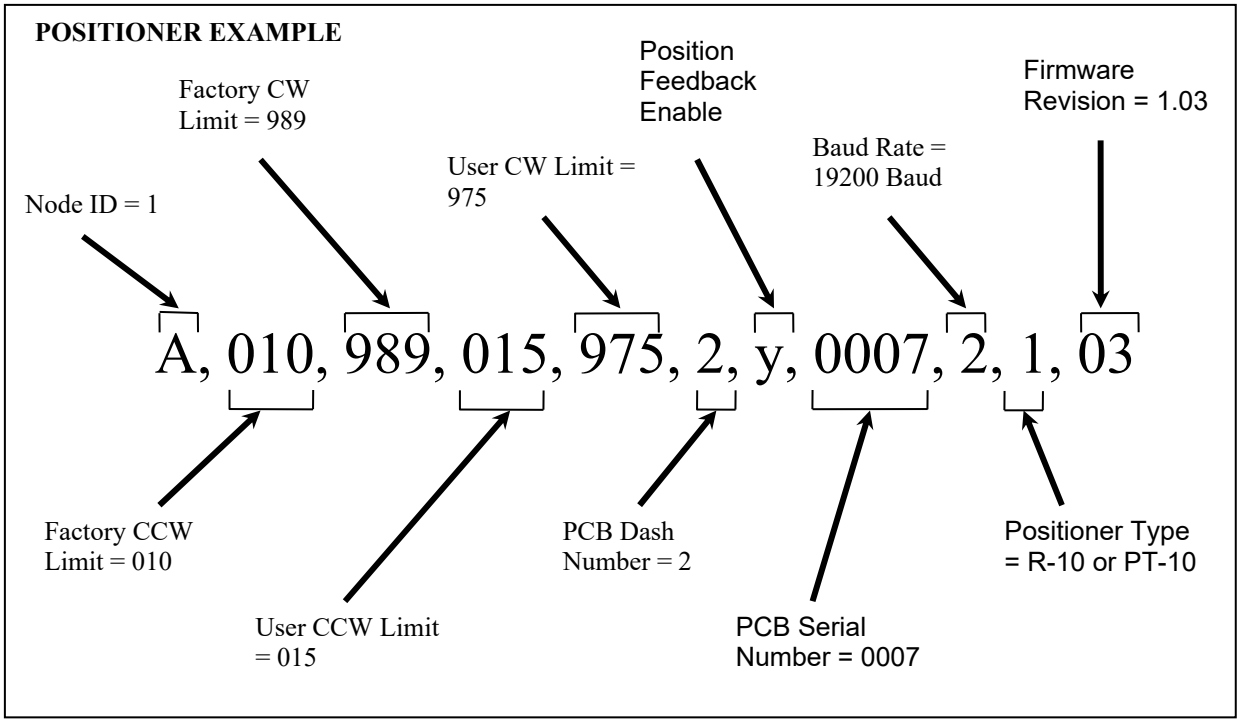


Figure 34: Sample Current Settings Feedback String (Positioner)

5.3 Camera Factory Settings Feedback String

A current settings feedback string is a response to a current setting feedback inquiry Node ID number followed by ASCII character '?' and 3 zeros, message of type "A?000". The 33 character string contains information in printable ASCII characters that is comma separated:

Char 0	Char 2-4	Char 6-8	Char 10-12	Char 14-16	Char 18	Char 20	Char 22-25	Char 27	Char 29	Char 31-32
Node ID	Camera Model	TV Video Format Type	000	000	PCB Dash Number	y	PCB Serial Number	Baud Rate	Device Type	Firmware Revision

A total of 33 characters is received containing 10 commas, one separating each field. Assuming that the first character received is the character number 0, commas can be found at the following locations:

Char 1, 5, 9, 13, 17, 19, 21, 26, 28 and 30 are commas

NOTE: The fields filled with 000 in the table above are irrelevant for a camera.

5.3.1 Node ID

Node ID is a printable ASCII Character used to identify a node number from 1 to 32.
Node ID of 1 corresponds to the first letter of the alphabet in higher case: 'A'. Node ID of 2 is the character B and so forth following the ASCII printable character table:

Node ID Number	ASCII Printable Character	Hexadecimal Representation
1	A	0x41
2	B	0x42
3	C	0x43
4	D	0x44
5	E	0x45

6	F	0x46
7	G	0x47
8	H	0x48
9	I	0x49
10	J	0x4A
11	K	0x4B
12	L	0x4C
13	M	0x4D
14	N	0x4E
15	O	0x4F
16	P	0x50
17	Q	0x51
18	R	0x52
19	S	0x53
20	T	0x54
21	U	0x55
22	V	0x56
23	W	0x57
24	X	0x58
25	Y	0x59
16	Z	0x5A
27	[	0x5B
28	\	0x5C
29	]	0x5D
30	^	0x5E
31	_	0x5F
32	`	0x60

Node ID Number	ASCII Printable Character	Hexadecimal Representation

Figure 35: Node ID ASCII Character Correspondence

NOTE: in C language the appropriate ID number can be determined from the ASCII character received using the following expression:

```
int     NodeID_Number;      // Integer string the Node ID number from 1-32
Char    NodeID_Character;   // Character corresponding to the Node ID number

NodeID_Number = NodeID_Character – ‘A’ +1;
```

5.3.2 Camera Model

Camera is represented by 3 ASCII digits ranging from 000-999. It is an ASCII representation of the code outlined in the table below:

Camera Model	Description
000	Inspector
001	CE-X
002	Navigator
003	ROVer
004	Inspector HD
005	Mantis HD

5.3.3 Television System Type

Television Video format Type is represented by 3 ASCII digits ranging from 000-999. It is an ASCII representation of the code outlined in the table below:

Television System Type ID	Description	Description for Mantis HD
000	NTSC (*lights always OFF)	1080i NTSC
001	PAL(*lights always OFF)	1080i PAL
002	NTSC (*lights always ON)	720p NTSC
003	PAL (*lights always ON)	720p PAL
004	NTSC (*analog light dimming controls)	N/A
005	PAL (*analog light dimming controls)	N/A

*Note: Light settings applicable to ROVer only.

5.3.4 PCB Dash Number

PCB Dash number is a single digit that ranges from 0-9. It is mainly used for ROS tracking and quality control process.

5.3.5 PCB Serial Number

Each PCB used to drive a node is assembled and manually engraved with a unique 4 digit serial number during the ROS production process. The engraved serial number can be read on the PCB but can also be read using the RS-485 protocol without having to open the positioner housing. This information is useful for tracking purposes. The serial number for this circuitry ranges from 0000 - 9999

5.3.6 Baud Rate

The Baud rate is single digit that is used to determine the current Baud rate. Character '1' for 9600 Baud, '2' for 19200 Baud, and '3' for 57600 Baud.

Baud Rate Character	Current Baud Rate
1	9600 Baud
2	19200 Baud
3	57600 Baud

Figure 36: Baud Rate Designation

5.3.7 Device Type (Determines if positioner, camera, or light)

The device type is a single digit that determines what type of device the PCB is intended on driving. The four types supported at this point are, character '1' for R-10 and PT-10 with 88:1 reduction gears, character '2' for R-25 and PT-25 with 160:1 reduction gears, character '3' for cameras (Inspector, CE-X or navigator) and character 4 for the RS485 Light.

Device Type Character	Description
1	R-10, PT-10 with 88:1 reduction gears
2	R-25, PT-25 with 160:1 reduction gears
3	Camera
4	Light
5	R-10, PT-10 with 50:1 reduction gears

Figure 37: Device Type Designation

NOTE: Should be set to character 3 for a camera.

5.3.8 Firmware Revision

The Firmware Revision is a two-digit value from 00 – 99 that determines the Firmware revision that the PCB was programmed with. Should be interpreted as 1.xx where xx are the 2 digits described above. See example below for details.

5.3.9 Camera Current Settings Feedback String Example

Inquiry sent to node number 3:

Inquiry: "C?000"

Response: C,001,000,000,000,1,y,0015,1,3,05

See Figure 38 for detailed interpretation of each field.

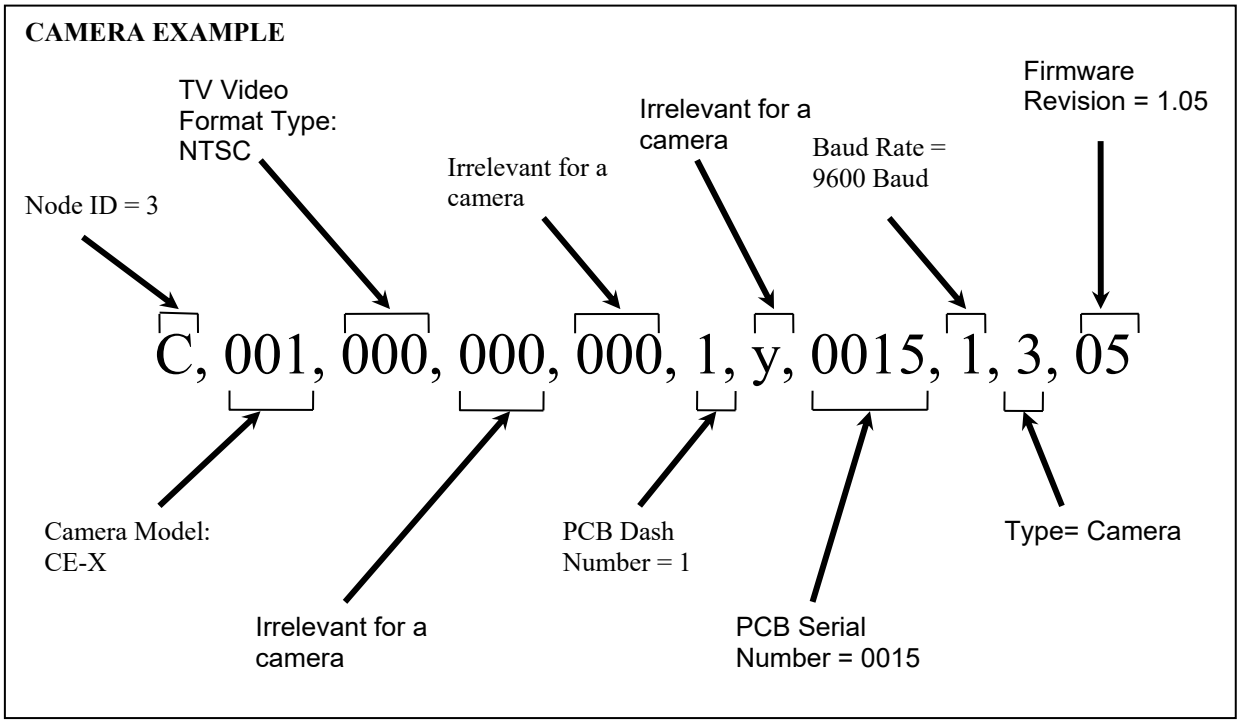


Figure 38: Sample Current Settings Feedback String (Camera)

5.4 Light Factory Settings Feedback String

A current settings feedback string is a response to a current setting feedback inquiry Node ID number followed by ASCII character '?' and 3 zeros, message of type "A?000". The 33 character string contains information in printable ASCII characters that is comma separated:

Char 0	Char 2-4	Char 6-8	Char 10-12	Char 14-16	Char 18	Char 20	Char 22-25	Char 27	Char 29	Char 31-32
Node ID	Light Type	Dimming Control	Input Power	000	PCB Dash Number	y	PCB Serial Number	Baud Rate	Device Type	Firmware Revision

A total of 33 characters is received containing 10 commas, one separating each field. Assuming that the first character received is the character number 0, commas can be found at the following locations:

Char 1, 5, 9, 13, 17, 19, 21, 26, 28 and 30 are commas

5.4.1 Node ID

Node ID is a printable ASCII Character used to identify a node number from 1 to 32.
Node ID of 1 corresponds to the first letter of the alphabet in higher case: 'A'. Node ID of 2 is the character B and so forth following the ASCII printable character table:

Node ID Number	ASCII Printable Character	Hexadecimal Representation
1	A	0x41
2	B	0x42
3	C	0x43

4	D	0x44
5	E	0x45
6	F	0x46
7	G	0x47
8	H	0x48
9	I	0x49
10	J	0x4A
11	K	0x4B
12	L	0x4C
13	M	0x4D
14	N	0x4E
15	O	0x4F
16	P	0x50

17	Q	0x51
18	R	0x52
19	S	0x53
20	T	0x54
21	U	0x55
22	V	0x56
23	W	0x57
24	X	0x58
25	Y	0x59
16	Z	0x5A
27	[	0x5B
28	\	0x5C
29	]	0x5D
30	^	0x5E
31	_	0x5F
32	`	0x60

Node ID Number	**ASCII Printable Character**	**Hexadecimal Representation**

Figure 39: Node ID ASCII Character Correspondence

NOTE: in C language the appropriate ID number can be determined from the ASCII character received using the following expression:

```
int     NodeID_Number;      // Integer string the Node ID number from 1-32
Char    NodeID_Character;   // Character corresponding to the Node ID number

NodeID_Number = NodeID_Character – 'A' +1;
```

5.4.2 Light Type

Light type is represented by 3 ASCII digits ranging from 000-999. It is an ASCII representation of the code outlined in the table below:

Light Type	Description
000	MV-LED
001	Lightning

5.4.3 Dimming Control

Dimming Control type is represented by 3 ASCII digits ranging from 000-999. It is an ASCII representation of the code outlined in the table below:

Dimming Control	Description
000	RS-485
001	0-5 VDC Analog Input
002	0-10 VDC Analog Input
003	Phase Control (Reverse or Forward)
004	None(Full On)

5.4.4 Input Power

Dimming Control type is represented by 3 ASCII digits ranging from 000-999. It is an ASCII representation of the code outlined in the table below:

Dimming Control	Description
000	N/A

001	24VDC
002	120VAC
003	220VAC

5.4.5 PCB Dash Number

PCB Dash number is a single digit that ranges from 0-9. It is mainly used for ROS tracking and quality control process.

5.4.6 PCB Serial Number

Each PCB used to drive a node is assembled and manually engraved with a unique 4 digit serial number during the ROS production process. The engraved serial number can be read on the PCB but can also be read using the RS-485 protocol without having to open the positioner housing. This information is useful for tracking purposes. The serial number for this circuitry ranges from 0000 - 9999

5.4.7 Baud Rate

The Baud rate is single digit that is used to determine the current Baud rate. Character '1' for 9600 Baud, '2' for 19200 Baud, and '3' for 57600 Baud.

Baud Rate Character	Current Baud Rate
1	9600 Baud
2	19200 Baud
3	57600 Baud

Figure 40: Baud Rate Designation

5.4.8 Device Type (Determines if positioner, camera, or, light)

The device type is a single digit that determines what type of device the PCB is intended on driving.

Device Type Character	Description
1	R-10, PT-10 with 88:1 reduction gears
2	R-25, PT-25 with 160:1 reduction gears
3	Camera
4	Light
5	R-10, PT-10 with 50:1 reduction gears

Figure 41: Device Type Designation

NOTE: Should be set to character 4 for a light.

5.4.9 Firmware Revision

The Firmware Revision is a two-digit value from 00 – 99 that determines the Firmware revision that the PCB was programmed with. Should be interpreted as 1.xx where xx are the 2 digits described above. See Figure 42 for details.

5.4.10 Light Current Settings Feedback String Example

Inquiry sent to node number 4:

Inquiry: "D?000"

Response: D,000,000,000,000,2,y,0017,1,4,06
See Figure 42 below for detailed interpretation of each field:

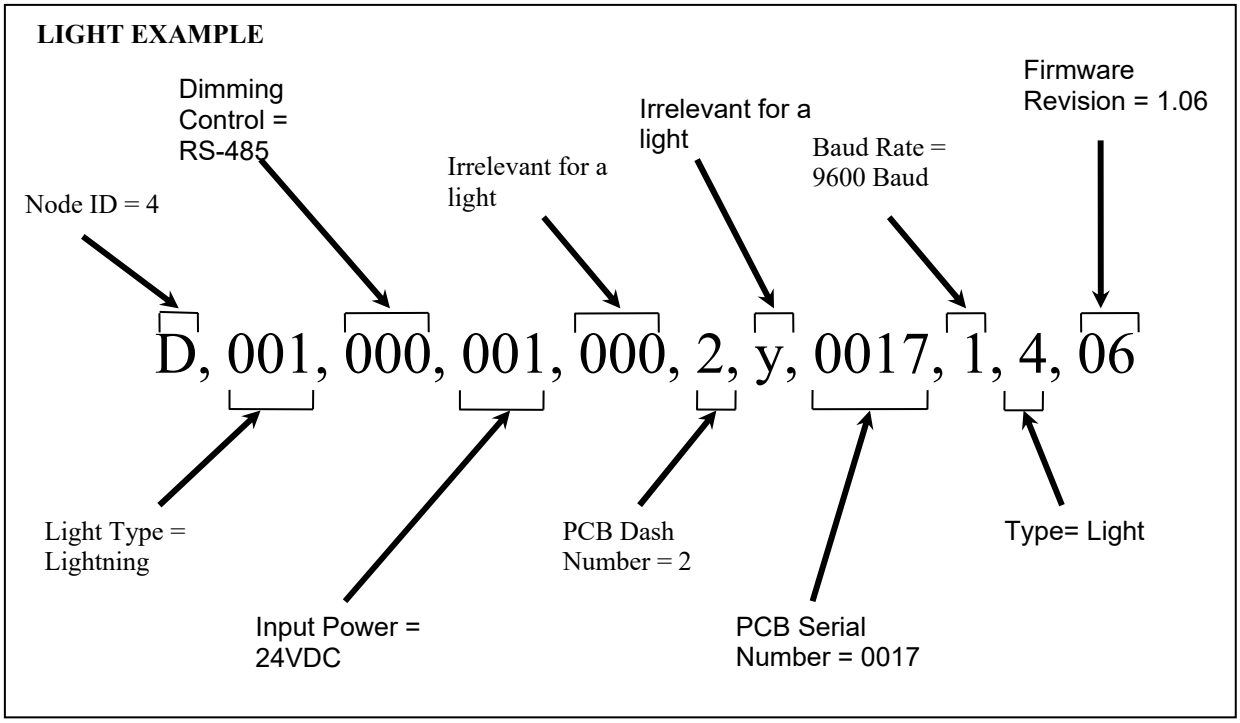


Figure 42: Sample Current Settings Feedback String (Light)

5.4.11 Light intensity feedback string

Light intensity percentage can be acquired using the light intensity feedback inquiry. Node ID number followed by ASCII character '?006', example "A?006". The 4 character string contains information in printable ASCII characters formatted as follow. First the Node ID of the inquired node is sent then a 3-digit value ranging from 000-100.

Char 0	Char 1-3
Node ID	Feedback 000-100

5.5 Positioner Feedback

5.5.1 Position Feedback String Description

The position feedback string comes as a response to a position feedback inquiry. Node ID number followed by ASCII character 'f', example "Af". The 4 character string contains information in printable ASCII characters formatted as follow. First the Node ID of the inquired node is sent then a 3-digit value ranging from 000-999 or more exactly from Factory CCW limit to Factory CW Limit.

Char 0	Char 1-3
Node ID	Position Feedback 000-999

Factory CCW Limit ≤ User CCW Limit **≤ Position Feedback ≤** User CW Limit ≤ Factory CW Limit

If position feedback is not within the range specified above, it means that the axis has been rotated slightly past the theoretical limits via external forces. This should be avoided to prevent damaging the feedback potentiometer that only has limited travel.

5.5.1.1 Position Feedback String Example

Inquiry sent to node number 1:

Inquiry: "Af"

Response: "A086"

5.5.1.2 Position Feedback Conversion to Degrees

The feedback string gives positional information about a given node that may need to be converted into degrees of rotation of the output shaft with respect to a zero position. There are many different ways to reference angular positions, mostly depending on the orientation of the unit; upright or inverted or how the moving hardware is mounted. We will present here an absolute 0-360 degrees reference used to determine the position of the shaft with respect to the housing connector. Developer integrating and writing control software/firmware for ROS positioners may decide to convert the feedback to a different referential that makes more sense considering their application. In most cases the absolute referential presented here can be converted to any chosen referential using one multiplication by -1 for direction change if necessary and an addition for offset.

Accurate conversion of the position feedback information to a number of degrees of rotation of the output shaft is performed using the Factory CCW and CW limit as calibration points. Factory CCW and CW limits are carefully calibrated by ROS for each positioner after the assembly is complete. The factory CCW and CW limits will be slightly different from one node to the other.

5.5.2 Corrected Position Feedback String Description

All PT-10-RS485 with firmware version 9.0 and greater have an embedded feedback correction curve. The received feedback string is equal to an angular shaft degree with a tolerance of +/-0.5deg (see sec 5.5.2.2). Node ID number followed by ASCII character 'g', example "Ag". The 4 character string contains information in printable ASCII characters formatted as follow. First the Node ID of the inquired node is sent then a 3-digit value ranging from 000-999 or more exactly from Factory CCW limit to Factory CW Limit.

Char 0	Char 1-3
Node ID	Position Feedback 000-999

Factory CCW Limit ≤ User CCW Limit **≤ Position Feedback ≤** User CW Limit ≤ Factory CW Limit

If position feedback is not within the range specified above, it means that the axis has been rotated slightly past the theoretical limits via external forces. This should be avoided to prevent damaging the feedback potentiometer that only has limited travel.

5.5.2.1 Corrected Position Feedback String Example

Inquiry sent to node number 1:

Inquiry: "Ag"

Response: "A086"

5.5.2.2 Corrected Position Feedback Conversion to Degrees Formula

The feedback string gives positional information about a given node that may need to be converted into degrees of rotation of the output shaft with respect to a zero position. There are many different ways to reference angular positions, mostly depending on the orientation of the unit; upright or inverted or how the moving hardware is mounted. We will present here an absolute 0-360 degrees reference used to determine the position of the shaft with respect to the housing connector. Developer integrating and writing control software/firmware for ROS positioners may decide to convert the feedback to a different referential that makes more sense considering their application.

Accurate conversion of the position feedback information to a number of degrees of rotation of the output shaft is performed using the Factory CCW and CW limit as calibration points. Factory CCW and CW limits are carefully calibrated by ROS for each positioner after the assembly is complete. The factory CCW and CW limits will be slightly different from one node to the other.

$$\theta\ 0 - 360 \pm 0.5^{\circ} = Feedback\ Position - (CCW\ Factory\ limit + 0.5) \times \left(\frac{360}{CW\ Factory\ limit - CCW\ Factory\ limit}\right)$$

5.5.2.2.1 Position Feedback Conversion with 0-360 degrees Absolute ROS Referential

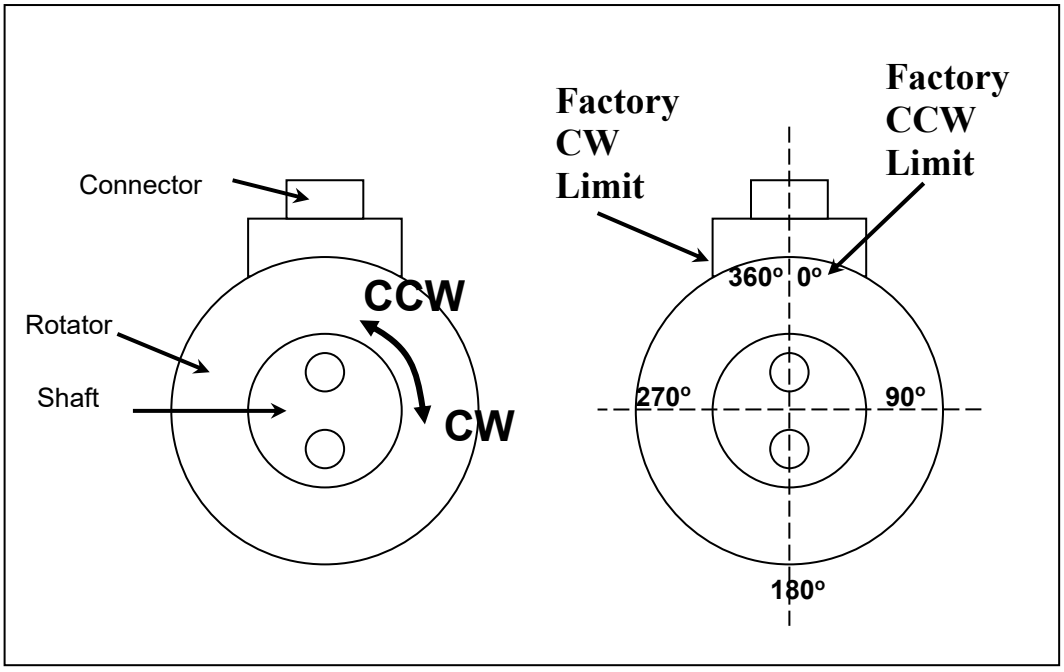


Figure 43: 0-360 degrees Referential for Rotator or Pan Axis

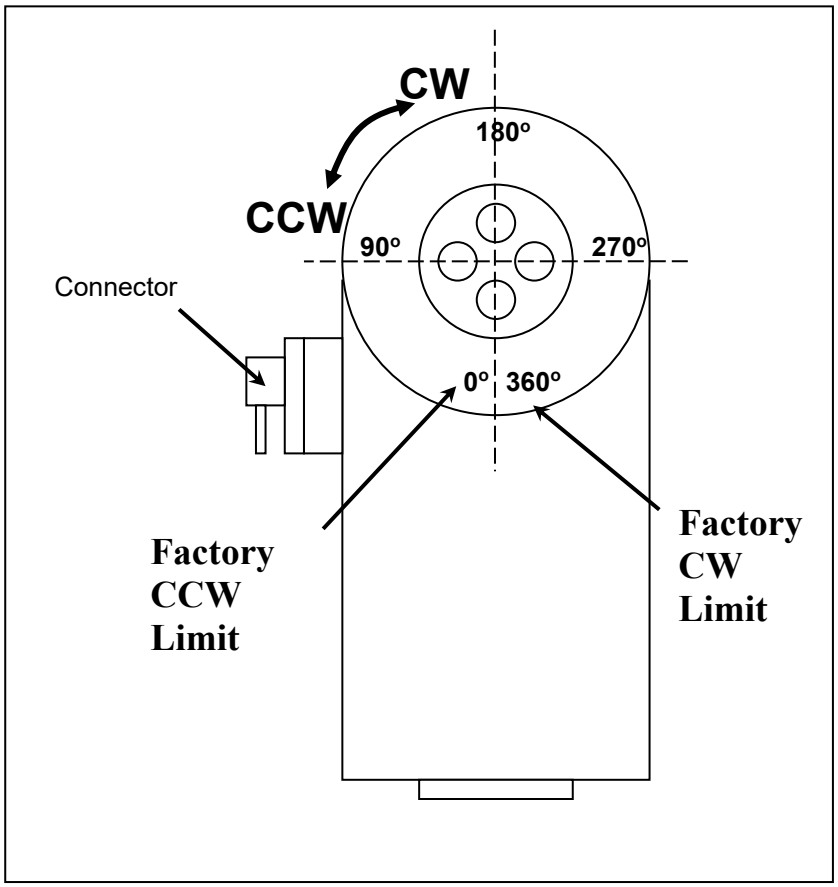


Figure 44: 0-360 degrees Referential for Tilt Axis

Figure 43 & Figure 44 show that the Factory CCW and CW limits correspond to the 0 and 360 degree positions. The limit settings can be used to convert the feedback information into a position in degrees using the following equation:

$$\theta_{0-360^0 \pm 1^0} = \frac{(Feedback\ Position - CCW_{Factory\ Limit})}{CW_{Factory\ Limit} - CCW_{Factory\ Limit}} \times 360$$

With:

θ_{0-360^0} is the converted shaft feedback position in degrees in the 0-360° Absolute referential

$Feedback\ Position$ is the "raw" feedback position extracted from the feedback string in integer format

$CCW_{Factory\ Limit}$ is the Factory CCW limit extracted from the current setting string in integer format

$CW_{Factory\ Limit}$ is the Factory CW limit extracted from the current setting string in integer format

Numerical Example:

$Feedback\,Position$ = 712

$CCW_{Factory\ Limit}$ = 22

$CW_{Factory\ Limit}$ = 956

$$\alpha_{0-360^0} = \frac{(712 - 22)}{956 - 22} \times 360 = 265.95^0$$

5.5.2.3 Relative position step count feedback string example

Inquiry sent to node number 1:

Inquiry: "Aq"

Response: "A25012"

5.5.2.4 Relative position step count feedback string description

The relative position feedback string comes as a response to a relative position feedback inquiry. Node ID number followed by ASCII character 'q', example "Aq". The 6 character string contains information in printable ASCII characters formatted as follow. First the Node ID of the inquired node is sent then a 5-digit value ranging from 00000-65535.

Char 0	Char 1-3
Node ID	Relative Position Feedback 00000-65535

5.5.2.5 Relative position step count feedback conversion to degrees

The relative step count feedback string gives positional information about a given node that may need to be converted into degrees of rotation of the output shaft with respect to a relative position. There are many different ways to reference angular positions, mostly depending on the orientation of the unit; upright or inverted or how the moving hardware is mounted. The referential chosen by ROS is outlined on "Figure 43: 0-360 degrees Referential for Rotator or Pan Axis" and "Figure 44: 0-360 degrees Referential for Tilt Axis"

Accurate conversion of the position step count feedback information to a number of degrees of rotation of the output shaft is performed as follows:

Example1:

***NOTE**: This feature is only available on PT-10 RS485 units with firmware version 9.0 and later.*

Get the current step count:
txAq ➔ rxA25040➔ Relative position step count feedback = 25040

Angular degrees per step = 0.0102272727272727

Calculate the angle:
0.0102272727272727 x 25040 = 256.09°

NOTE: THE CALCULATED ANGLE IS ONLY TRUE WHEN THE AXIS HAS MET THE CONDITIONS LISTED BELOW.

1. The feedback is relative to an operator or software chosen arbitrary starting point
2. The feedback is accurate only if slip and stall conditions do not occur. Major slip/stall conditions can be detected easily by the potentiometer feedback, but a small stall condition could not
3. The feedback is accurate only when rotating in the same direction which is the condition to avoid the error due to gear backlash
4. As long as the unit remains powered up and a point is approached from the same direction, the accuracy will remain with respect to the operator/software chosen starting point; however the starting point must be established every time the unit is powered up

5.5.3 Communications Delay Feedback

The communications delay feedback string is a 4 character feedback string containing information in printable ASCII characters that determines what the communication delay is:

Char 0	Char 1-3
Node ID	Three digits: 000 ≤ Com Delay ≤ 999

EXAMPLE: Send the following inquiry.

A?002

One example answer to this message is:

A075

Each value of the response corresponds to 0.25 ms. The example feedback would mean node A had a communication delay of 75*0.25ms = 18.75ms.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 8.0 and later.*

5.5.4 Acceleration/Deceleration Feedback

The acceleration/deceleration feedback string is a 4 character feedback string containing information in printable ASCII characters that determines what the acceleration/deceleration is:

Char 0	Char 1-3
Node ID	Three digits: 000 ≤ Accel/Decel ≤ 004

EXAMPLE: Send the following inquiry.

A?003

One example answer to this message is:

A002

There are five different settings for the acceleration value of the speed profile.

Acceleration Setting	Actual Acceleration
0	2 deg/s^2

1	4 deg/s^2
2	6 deg/s^2
3	8 deg/s^2
4	10 deg/s^2

The example feedback value would then correspond to a 6 deg/s^2 acceleration value.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

5.5.5 Maximum Velocity Feedback

The maximum velocity feedback string is a 4 character feedback string containing information in printable ASCII characters that determines what the position speed profile maximum velocity is:

Char 0	Char 1-3
Node ID	Three digits: 000 ≤ MaxVelocity ≤ 020

EXAMPLE: Send the following inquiry.

A?004

One example answer to this message is:

A010

This value would correspond to a 5 deg/s (response/2) maximum velocity.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

5.5.6 Slip/Stall Flag Feedback

The slip/stall flag feedback string is a 4 character feedback string containing information in printable ASCII characters that determines if there is a slip/stall condition:

Char 0	Char 1-3
Node ID	Three digits: 000 ≤ Slip/Stall Flag ≤ 001

EXAMPLE: Send the following inquiry.

A?005

One example answer to this message is:

A001

This value would mean that a slip/stall condition has occurred. A stall condition occurs when the axis attempts to accelerate or slew too quickly for the load. A slip condition occurs when the load is too heavy and slips faster than the speed of the axis. In either of these situations the axis will automatically attempt to brake at the last commanded braking value.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

5.5.7 Brake Value Feedback

The brake value feedback string is a 4 character feedback string containing information in printable ASCII characters that determines what the current braking setting is:

Char 0	Char 1-3
Node ID	Three digits: 000 ≤ Braking ≤ 128

EXAMPLE: Send the following inquiry.

A?006

One example answer to this message is:

A090

This corresponds to a braking value of 90.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

5.5.8 Moving Flag Feedback

The moving flag feedback string is a 4 character string containing information in printable ASCII characters that determines if the axis is moving:

Char 0	Char 1-3
Node ID	Three digits: 000 ≤ Moving Flag ≤ 001

EXAMPLE: Send the following inquiry.

A?007

One example answer to this message is:

A001

This would mean that the axis is moving. If the response was zero, then the axis would be in a stopped condition.

NOTE: *This command is only available on PT-25 RS485 units with firmware version 5.0, PT-10 RS485 units with firmware version 9.0 and later.*

5.6 Camera Feedback

5.6.1 LLA Setting Feedback

The LLA setting feedback string is a response to an LLA setting inquiry; Node ID number followed by ASCII character '?' and three digits set to '002', example "C?002". **(This feature is not available for the ROVer, Inspector HD, or Mantis HD)**. The 5 character feedback string contains information in printable ASCII characters that determines what the LLA setting is:

Char 0	Char 1	Char 2-4
Node ID	a (lower case)	Three digits: 000 ≤ LLA Setting ≤ 099

EXAMPLE: Send the following inquiry.

C?002

One example answer to this message is:

Ca075

The feedback message above means that the current setting of the LLA is set to 75%.

5.6.2 Zoom Speed Setting Feedback

The zoom speed feedback string is a response to a zoom speed inquiry; Node ID number followed by ASCII character '?' and three digits set to '003', example "C?003". The 5 character feedback string contains information in printable ASCII characters that determines what the zoom speed setting is:

Char 0	Char 1	Char 2-4
Node ID	z (lower case)	Three digits: 000 ≤ Zoom Speed ≤ 007

EXAMPLE: Send the following inquiry.

C?003

One example answer to this message is:

Cz005

The feedback message above means that the current zoom speed setting is 5 out of 7.

5.6.3 Zoom Position Setting Feedback

The zoom position feedback string is a response to a zoom position inquiry; Node ID number followed by ASCII character '?' and three digits set to '100', example "C?100".
This feature is only available for the Inspector and CE-X camera models with firmware version 1.04 or greater.

Char 0	Char 8-1				Char 9
Node ID	Eight digits followed by' #' sign:				
	Digit 8-7	Digit 6-5	Digit 4-3	Digit 2-1	Message end
	10d	01d	12d	03d	'#'
	0x0Ah	0x01h	0x0Ch	0x03h	
	String = A1C3h = Actual zoom position is 41,411				
	0000h ≥ Camera optical zoom Range is ≤ 4000h Wide Max Tele				

EXAMPLE: Send the following inquiry.

C?100

One example answer to this message is:

C01101503# = zoom position is at 1AF3h

5.6.4 Focus Position Setting Feedback

The Focus position feedback string is a response to a focus position inquiry; Node ID number followed by ASCII character '?' and three digits set to '101', example "C?101".
This feature is only available for the Inspector and CE-X camera models with firmware version 1.04 or greater.

Char 0	Char 8-1				Char 9
Node ID	Eight digits followed by' #' sign:				
	Digit 8-7	Digit 6-5	Digit 4-3	Digit 2-1	Message end
	02d	15d	10d	05d	'#'
	0x02h	0x0Fh	0x0Ah	0x05h	
	String = 2FA5h = Actual focus position is 12197d				
	0000h ≥ Camera optical focus Range is ≤ C000h Far Near				

EXAMPLE: Send the following inquiry.

C?101

One example answer to this message is:

C02151005# = focus position is at 2FA5h

5.6.5 Focus Speed Setting Feedback

The focus speed feedback string is a response to a focus speed inquiry; Node ID number followed by ASCII character '?' and three digits set to '004', example "C?004". **This feature is not available for the Inspector HD**. The 5 character feedback string contains information in printable ASCII characters that determines what the focus speed setting is:

Char 0	Char 1	Char 2-4
Node ID	z (lower case)	Three digits: 000 ≤ Focus Speed ≤ 004

EXAMPLE: Send the following inquiry.

C?004

One example answer to this message is:

Cf002

The feedback message above means that the current focus speed setting is 2 out of 7.

5.6.6 Focus State Feedback

The focus state feedback is available only for the Inspector HD. This feedback string is a response to a focus state inquiry; Node ID number followed by ASCII character '?' and three digits set to '005', example "C?005". The 5 character feedback string contains information in printable ASCII characters that determines what the focus state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = AUTO, 001 = MANUAL

EXAMPLE: Send the following inquiry.

C?005

One example answer to this message is:

Cr001

The feedback message above means that manual focus is on.

5.6.7 Exposure State Feedback

The exposure state feedback is available only for the Inspector HD. This feedback string is a response to an exposure state inquiry; Node ID number followed by ASCII character '?' and three digits set to '006', example "C?006". The 5 character feedback string contains information in printable ASCII characters that determines what the exposure state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = AUTO, 001 = MANUAL

EXAMPLE: Send the following inquiry.

C?006

One example answer to this message is:

Cr001

The feedback message above means that manual exposure is on.

5.6.8 Digital Zoom State Feedback

The digital zoom state feedback is available only for the Inspector HD. This feedback string is a response to a digital zoom state inquiry; Node ID number followed by ASCII character '?' and three digits set to '007', example "C?007". The 5 character feedback string contains information in printable ASCII characters that determines what the digital zoom state is:

Char 0	Char 1	Char 2-4

Node ID	r (lower case)	Three digits: 000 = OFF, 001 = ON

EXAMPLE: Send the following inquiry.

C?007

One example answer to this message is:

Cr000

The feedback message above means that digital zoom is off.

5.6.9 Backlight State Feedback

The backlight state feedback is available only for the Inspector HD. This feedback string is a response to a backlight state inquiry; Node ID number followed by ASCII character '?' and three digits set to '008', example "C?008". The 5 character feedback string contains information in printable ASCII characters that determines what the backlight state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = OFF, 001 = ON

EXAMPLE: Send the following inquiry.

C?008

One example answer to this message is:

Cr001

The feedback message above means that backlight is on.

5.6.10 Camera Picture State Feedback

The camera picture state feedback is available only for the Inspector HD. This feedback string is a response to a camera picture state inquiry; Node ID number followed by ASCII character '?' and three digits set to '009', example "C?009". The 5 character feedback string contains information in printable ASCII characters that determines what the camera picture state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = Color, 001 = Negative Art, 002 = Black and White

EXAMPLE: Send the following inquiry.

C?009

One example answer to this message is:

Cr001

The feedback message above means that the camera is in negative art picture mode.

5.6.11 Telemacro State Feedback

The telemacro state feedback is available only for the Inspector HD. This feedback string is a response to a telemacro state inquiry; Node ID number followed by ASCII character '?' and three digits set to '010', example "C?010". The 5 character feedback string contains information in printable ASCII characters that determines what the telemacro state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = OFF, 001 = ON

EXAMPLE: Send the following inquiry.

C?010

One example answer to this message is:

Cr001

The feedback message above means that the telemacro function is on.

5.6.12 Mode Feedback

The mode feedback is available only for the Inspector HD. This feedback string is a response to a mode inquiry; Node ID number followed by ASCII character '?' and three digits set to '011', example "C?011". The 5 character feedback string contains information in printable ASCII characters that determines what the mode is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 001 = 4.5Mp mode, 002 = 6.0Mp mode, 003 = Play/Edit mode

EXAMPLE: Send the following inquiry.

C?011

One example answer to this message is:

Cr002

The feedback message above means that the camera is in Play/Edit mode.

5.6.13 IR Filter State Feedback

The IR Filter state feedback is available only for the Inspector HD. This feedback string is a response to an IR Filter state inquiry; Node ID number followed by ASCII character '?' and three digits set to '012', example "C?012". The 5 character feedback string contains information in printable ASCII characters that determines what the IR Filter state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = OFF, 001 = ON

EXAMPLE: Send the following inquiry.

C?012

One example answer to this message is:

Cr001

The feedback message above means that the IR Filter function is on.

5.6.14 White Balance Shift State Feedback

The White Balance Shift state feedback is available only for the Inspector HD. This feedback string is a response to a White Balance Shift state inquiry; Node ID number followed by ASCII character '?' and three digits set to '013', example "C?013". The 5 character feedback string contains information in printable ASCII characters that determines what the White Balance Shift state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = OFF, 001 = ON

EXAMPLE: Send the following inquiry.

C?013

One example answer to this message is:

Cr000

The feedback message above means that the White Balance Shift is off.

5.6.15 Image Stabilizer State Feedback

The Image Stabilizer state feedback is available only for the Inspector HD. This feedback string is a response to an Image Stabilizer state inquiry; Node ID number followed by ASCII character '?' and three digits set to '015', example "C?015". The 5 character feedback string contains information in printable ASCII characters that determines what the Image Stabilizer state is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = OFF, 001 = ON

EXAMPLE: Send the following inquiry.

C?015

One example answer to this message is:

Cr001

The feedback message above means that Image Stabilizer is on.

5.6.16 Video Output Type Feedback

The Video Output type feedback is available only for the Inspector HD. This feedback string is a response to a Video Output type inquiry; Node ID number followed by ASCII character '?' and three digits set to '016', example "C?016". The 5 character feedback string contains information in printable ASCII characters that determines what the Video Output type is:

Char 0	Char 1	Char 2-4
Node ID	r (lower case)	Three digits: 000 = Composite, 001 = Component

EXAMPLE: Send the following inquiry.

C?016

One example answer to this message is:

Cr001

The feedback message above means that the video output type is component.

5.7 Light Feedback

5.7.1 Light Intensity Feedback

The light intensity feedback string comes as a response to a light intensity feedback inquiry. Node ID number followed by ASCII character '?', then 3 character string set to '005'. First the Node ID of the inquired node is sent back followed by the character 'p', then a 3-digit value ranging from 000-100.

Char 0	Char 1	Char 2-4
Node ID	p (lower case P)	Three digits: 000 ≤ Light Intensity ≤ 100

EXAMPLE: To send the node number 4 the command to inquire about the current light intensity, the following message needs to be sent:

D?005

One example answer to this message is:

Dp075

The feedback message above means that the current light intensity setting is 75 out of 100.

5.7.2 Temperature Feedback

5.7.2.1 Temperature Feedback String Description

The MV-LED internal electronics constantly monitors the LED array temperature in order to protect it from overheating. This feature allows the underwater light to be operated in-air without any risks of damage. When the temperature is too hot the light will eventually shutdown to protect itself. When used underwater, the water surrounding the housing is sufficient to cool the light down and the safety feature should not turn off the light. Because the temperature is monitored internally, the user can inquire it for monitoring purposes.

The temperature feedback string comes as a response to a temperature feedback inquiry. Node ID number followed by ASCII character 'f', example "Df". The 4 character string contains information in printable ASCII characters formatted as follow. First the Node ID of the inquired node is sent then a 3-digit value ranging from 000-999.

Char 0	Char 1-3
Node ID	Temperature Feedback 000-999

5.7.2.2 Temperature Feedback String Example

Inquiry sent to node number 4:

Inquiry: "Df"

Response: "D470"

5.7.2.3 Temperature Feedback Conversion to Degrees Celsius (MV-LED)

The temperature is monitored via a non-linear temperature sensor (thermistor) and a 10-bit analog to digital converter. In order to convert the 10 bit A/D feedback value into degrees Celsius, the following 2 equations need to be implemented:

$$R_{Therm} = \frac{10.24E^{6}}{Feedback} - 10000 \qquad \text{(Equation 1)}$$

With:

R_{Therm} is the thermistor resistance in Ω

Feedback is the Temperature feedback returned by the light

$$T^{\circ}_{Celsius} = \frac{1}{A + B\ln(R_{Therm}) + C(\ln(R_{Therm}))^{2} + D(\ln(R_{Therm}))^{3}} - 273.15 \qquad \text{(Equation 2)}$$

With:

R_{Therm} is the thermistor resistance in Ω

$T^{\circ}_{Celsius}$ is the light internal temperature in degrees Celsius

A, B, C, D are the thermistor Steinhart-Hart coefficients

A = 1.1164014655E-03
B = 2.3798297321E-04
C = -3.72283234E-07
D = 9.9063233E-08

NOTE: The temperature data provided by the light is meant to give the user an indication of the LED array heat sink temperature. The feature is not indented to be used as a calibrated temperature probe.

Numerical Example:

Feedback = 470

$$R_{Therm} = \frac{10.24E^6}{470} - 10000 = 11787.23\Omega$$

$$T°_{Celsius} = \frac{1}{1.1164014655E-03 + 2.3798297321E-04\ln(11787) + -3.72283234E-07(\ln(11787))^2 + 9.9063233E-08(\ln(11787))^3} - 273.15$$
$$= 21.3°C$$

Quick reference lookup table:

Feedback	Degrees Celsius
156	-10
195	-5
240	0
290	5
343	10
399	15
456	20
513	25
568	30
620	35
669	40
713	45
753	50
789	55
821	60
848	65

Figure 45: Temperature in Degrees C versus feedback value (lookup table)

5.7.2.4 Temperature Feedback Conversion to Degrees Celsius (Lightning)

A response of "D*nnn*" equates to "*nnn*" x 10^{-1} °C. For example, a response of "D436" should be interpreted as an LED array temperature of 43.6 °C.

6 POWER UP SPECIFICATIONS

6.1 Positioners

6.1.1 Positioners Default Factory Settings

Default factory settings should be expected when the positioner is shipped from the manufacturer.

DESCRIPTION	FACTORY DEFAULT
Baud Rate	Set per Sales order, 9600 Baud unless specified otherwise
Node ID	A for Rotators or Pan axis B for Tilt axis
Character Echo	Enabled

User CCW Limits	15 degrees for Rotators or Pan Axis 90 degrees for Tilt Axis
User CW Limits	345 degrees for Rotators or Pan Axis 270 degrees for Tilt Axis

Figure 46: Positioners Default Factory Settings

6.1.2 Positioners Default Power Up Configuration

The default configuration on power up for each node is as follow:

1. Axis is stopped in the position it was turned on
2. Braking
    a. For PT-25-RS485 with firmware version 5.0 and greater, brake is applied according to the last brake setting before the unit was powered off.
    b. For PT-25-RS485 with firmware version 4.0 and alder, brake is not applied.
    c. For PT-10-RS485 with firmware version 9.0 and greater, brake is applied according to the last brake setting before the unit was powered off.
    d. For PT-25-RS485 with firmware version 8.0 and alder, brake is not applied.
3. System is listening on the RS-485 lines for an incoming message
4. Absolute feedback position is ready to be sent from a given node to the controller without requiring any movements

6.1.3 Positioners Boot Up Delay

Allow a minimum of **200 ms** after the power supply has stabilized to its nominal voltage before attempting communication with a node.

6.2 Cameras

6.2.1 Camera Default Factory Settings

Default factory settings should be expected when the camera is shipped from the manufacture.

DESCRIPTION	FACTORY DEFAULT
Baud Rate	Set per Sales order, 9600 Baud unless specified otherwise
Node ID	C
Character Echo	Enabled
Long Line Amplification	LLA= 00/100
Zoom Speed	Setting number 4
Focus Speed	Setting number 4

Figure 47: Camera Default Factory Settings

6.2.2 Camera Default Power Up Configuration

Here are the default settings for the CE-X/Inspector and the Inspector HD:

Command Number	Command Description	Default on Power up CE-X and	Default on Power up Inspector HD	Default on Mantis HD

		Inspector		
0	Zoom STOP Command	***Zoom Full Wide***	***Zoom Full Wide***	***Zoom Full Wide***
1	Zoom Tele Command			
2	Zoom Wide Command			
3	FOCUS STOP Command	***Auto-Focus***	***Auto-Focus***	***Auto-Focus***
4	FOCUS NEAR Command			
5	FOCUS FAR Command			
6	FOCUS AUTO Command			
7	EXP INC Command	***Auto-Exposure***	***Auto-Exposure***	***Auto-Exposure***
8	EXP DEC Command			
9	EXP AUTO Command			
10	Enter LLA Command	***0***	***N/A***	***N/A***
11	Exit LLA Command			
12	Increase LLA Command			
13	Decrease LLA Command			
14	Camera Power ON	***Power ON***	***Power ON***	***Power ON***
15	Camera Power OFF (saves current)			
16	Digital Zoom ON	***Digital Zoom ON***	***Digital Zoom OFF***	***Digital Zoom ON***
17	Digital Zoom OFF			
18	Backlight Compensation ON	***Backlight OFF***	***Backlight OFF***	***Backlight OFF***
19	Backlight Compensation OFF			
20	Left/Right Reverse ON	***Reverse OFF***	***N/A***	***N/A***
21	Left/Right Reverse OFF			
22	Camera Freeze ON	***Freeze OFF***	***N/A***	***Freeze OFF***
23	Camera Freeze OFF			
24	Camera Color Mode	***Color Mode***	***Color Mode***	***Color Mode***
25	Camera Negative Art			
26	Camera Black & White			
27	Image Flip ON	***Image Flip OFF***	***N/A***	***N/A***
28	Image Flip OFF			
29	Display ON (shows Zoom status bar…)	***Display OFF***	***N/A***	***N/A***
30	Display OFF			
31	Zoom Speed Increment	***4***	***4***	***4***
32	Zoom Speed Decrement			
33	Focus Speed Increment	***4***	***N/A***	***4***
34	Focus Speed Decrement			
35	Telemacro ON	***N/A***	***Telemacro OFF***	***N/A***
36	Telemacro OFF			
37	Enter Still Image Transfer	***N/A***	***Still Image Transfer OFF***	***N/A***
38	Exit Still Image Transfer			
39	4.5 Mp Image Mode	***N/A***	***4.5 Mp mode ON***	***N/A***
40	6.1 Mp Image Mode			
41	IR Filter ON	***N/A***	***IR Filter OFF***	***IR Filter OFF***
42	IR Filter OFF			

43	White Balance Shift INC	***N/A***	***White Balance Shift OFF***	***N/A***
44	White Balance Shift DEC			
45	White Balance Shift OFF			
48	Image Stabilizer ON	***N/A***	***Image Stabilizer ON***	***N/A***
49	Image Stabilizer OFF			
50	Component Video ON	***N/A***	***Component Video ON***	***N/A***
51	Composite Video ON			

Figure 48: Camera Default Power Configuration

6.2.3 Camera Boot-Up Sequence

6.2.3.1 CE-X/Inspector ONLY

When the camera is energized, the video signal consists of a blue screen for 5 to 7 seconds. Then the video as seen by the camera is displayed. The video overlay will automatically display the following messages for 1-2 seconds each:

1. Camera Firmware Revision:
   Overlay: ROS VER 1.XX
   In this example, 1.XX is the revision number.

2. RS-485
   Overlay: RS-485
   This is a reminder that the camera is RS-485 controlled, it helps differentiate this model from externally identical ROS cameras that are controlled differently.

3. Long Line Amplifier Setting:
   Overlay: LLA YY/100
   In this example, YY is the current Long Line Amplification setting.

NOTE: While the camera is booting up, all RS-485 commands will be ignored. Only after the last overlay message disappears will RS-485 commands be accepted.

6.2.3.2 Inspector HD

When the camera is energized, the component video signal is activated in approximately 4 seconds. The actual camera boot-up sequence takes approximately 18 seconds. To know when the camera is ready to accept commands, the user should send the node ID. When the camera is ready, the node ID will be echoed.

6.2.3.3 Mantis HD

When the camera is energized, the HDSDI video will appear in about 4 seconds and will be ready to accept commands.

6.3 Lights

6.3.1 Light Default Factory Settings

Default factory settings should be expected when the light is shipped from the manufacture.

DESCRIPTION	FACTORY DEFAULT
Baud Rate	Set per Sales order, 9600 Baud unless specified

	otherwise
Node ID	D
Character Echo	Disabled

Figure 49: Positioners Default Factory Settings

6.3.2 Light Default Power Up Configuration

For MVLED with firmware version 2.0 or greater the light will turn on to full intensity (<0.5s) during the boot up sequence, then it will change to the light intensity according to the last saved setting. See sec 4.1.4.2. The default light intensity setting is set to 2% as the light is used for the first time.

For all other light models:
When the light is energized, a short boot-up sequence (<0.5s) occurs and the light turns on to full light Intensity.

7 R10, PT10 SERIES ADDENDUM

7.1 Safety Measures

7.1.1 Power Reverse Polarity

The PT10, R10 series is equipped with power reverse polarity safety circuitry. If -24 VDC is applied to the unit instead of +24 VDC for any reason, the unit will NOT be damaged.

7.1.2 RS-485 Reverse Polarity

Reversing the polarity on the RS-485 lines (connecting A to B and B to A instead of A to A and B to B) will not damage the communication circuitry. The communication will NOT function but no damage will result.

WARNING: Damage may incur to the positioner internal circuitry if 24 VDC is applied to the any of the RS-485 lines. DO NOT APPLY 24VDC to any of the RS-485 lines.

7.2 Speed Profile

To extend the lifetime of the harmonic gears and motor, it is always recommended to implement ramping up to speed and ramping down to a stop. This applies especially when using the unit with a high torque load. The R10 and PT10 series are robust enough to start and stop a 10 lb.ft load directly at 0.5-4 degrees per seconds, however, in an effort to decrease the wear of the unit and increase its lifetime, it is recommended to apply a ramping speed profile as shown on Figure 50:

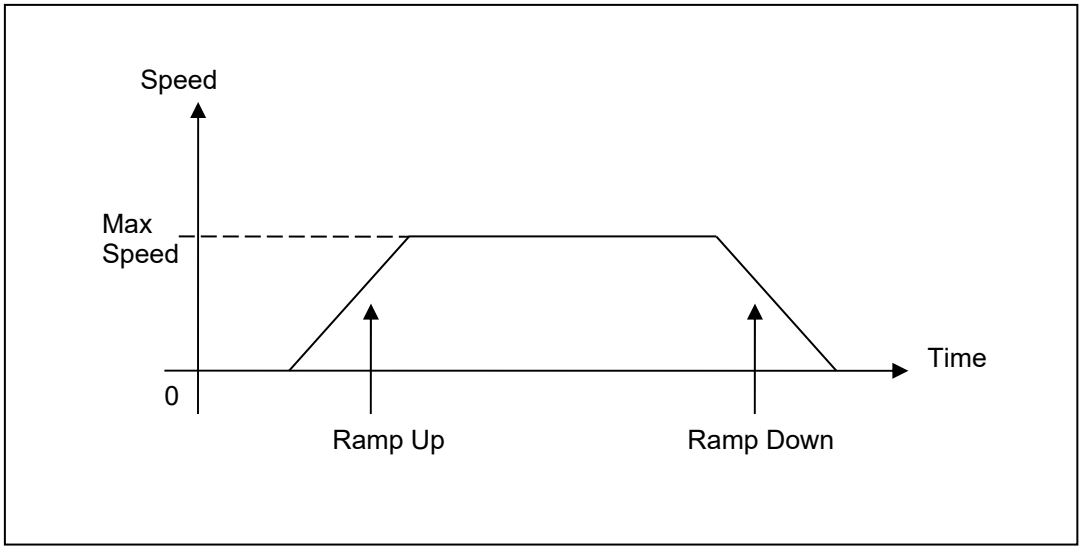


Figure 50: Recommended Speed Profile

The ramp up and down speed slopes should be determined empirically with the pan & tilt and rotator under load, using the following guidelines:

1. The lower the max speed is, the steeper the slopes can be
2. The higher the load, the shallower the slopes should be
3. The higher the inertia of the load, the shallower the slopes should be
4. The Ramp down slope can generally be steeper than the ramp up slope

7.3 Braking

Braking provides a holding torque when the motor is not turning. The higher the brake current through the higher the holding torque is.

The RS-485 interface allows the user to vary the braking current for a single axis between 0.25 A to 1.5 A. A low current value (0.25 A) is sufficient to hold a 10 lb.ft load in place. However stopping a moving load induces a momentary peak torque that a low brake current would not be able to stop. In order to stop a moving load a higher brake current can be used momentarily to provide stronger braking for a short duration. Also ramping down the speed to a stop with a slow deceleration will help stopping a load with a reduced brake current.

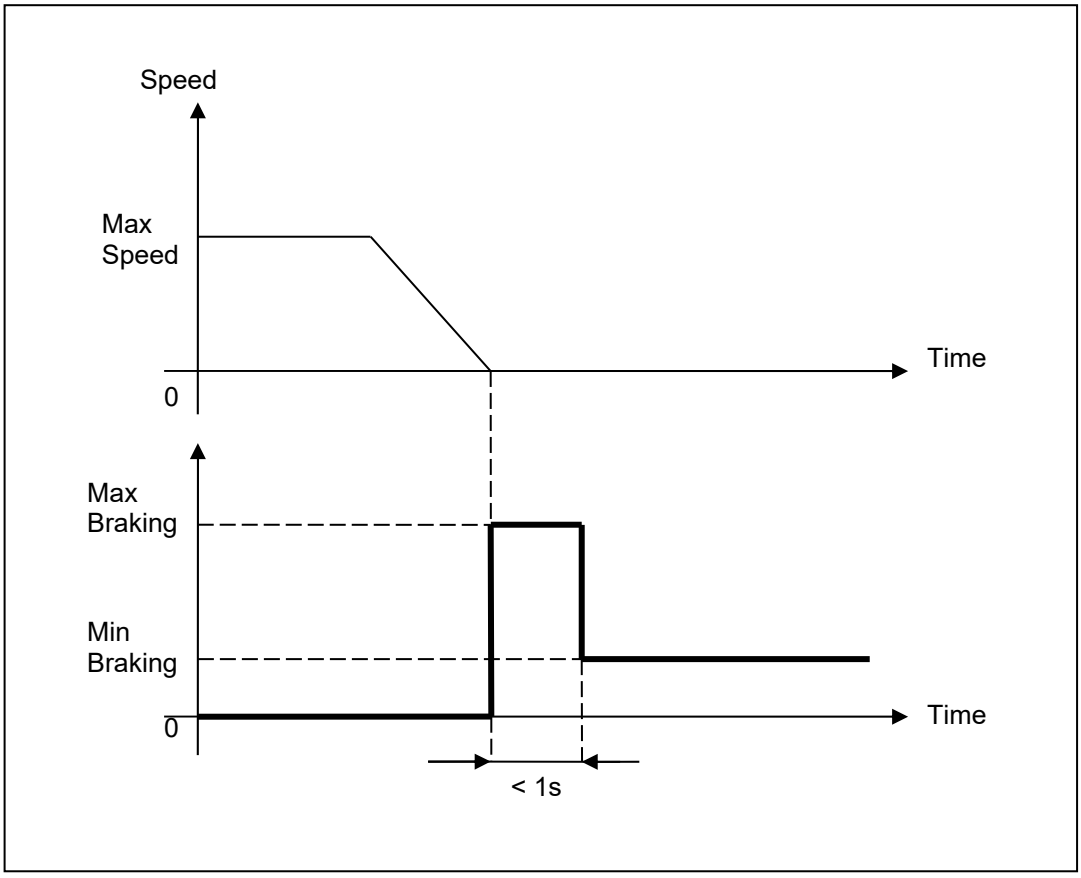


Figure 51: Braking Profile

Using a high brake current for a short duration (<1s) in order to stop a moving load as shown on Figure 51 above is appropriate, however it is not recommended to use a high brake current continuously because the high current will eventually cause heat buildup inside the housing.

WARNING: The maximum continuous brake current recommended for the R-10, PT-10 series is 750 mA. In most cases a lower value will be sufficient and will help reduce heat build up inside the housing. Any brake value > 750 mA should be used for a short duration only.

7.4 Power Input Range

The PT10, R10 series is designed to operate with a power input of 24 VDC nominal supplied to the positioner's connector. It is safe to operate the positioner within the range below, however the performance may be different from the specifications, see Figure 52 below for details:

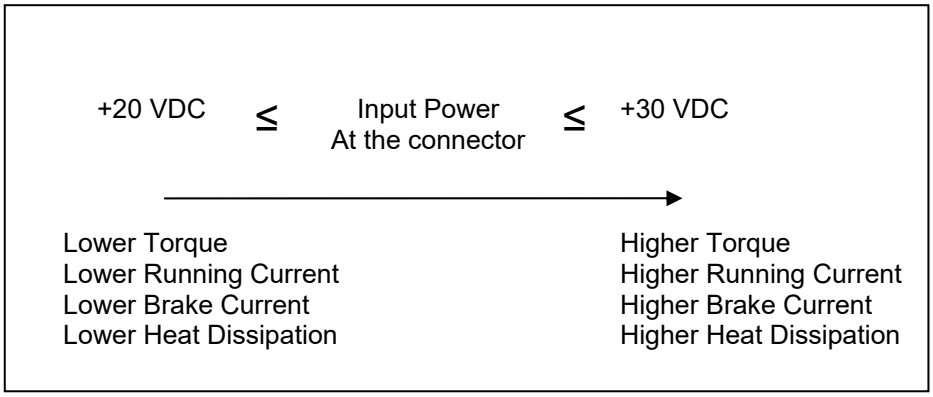


Figure 52: Power Input Range and Side Effects

The cable providing 24 VDC to the connector must be carefully selected in order to have 24 VDC delivered to the connector while the positioner is running. On long cables, there is significant voltage drop along the cable that reduces the voltage received by the positioner which in turns will reduce the torque. This needs to be taken into account carefully when selecting a cable. Please contact ROS personnel for more information.

8 PT-25FB HIGH TORQUE SERIES ADDENDUM

For safety reasons the brake current of the PT-25-FB High Torque was limited to 1.8 A maximum. The firmware V4.0 simply ignores any command that is not within the following range:

Character 1	Character 2	Character 3-5
Node ID	s (lower case)	Brake Setting (107-128)

The brake setting is a value between 107 and 128 that represents the desired brake setting. A value of 107 represents the maximum brake setting, and a value of 127 represents the minimum brake setting. No braking is represented by the value 128.

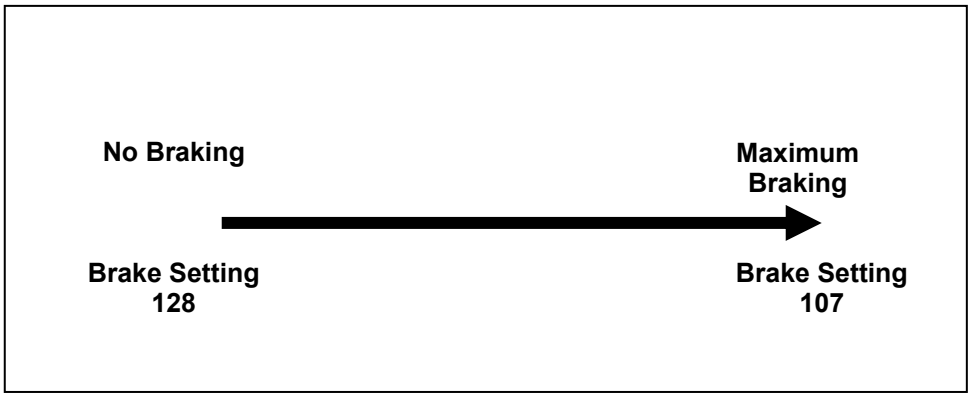


Figure 53: Brake Effect versus Brake Setting Relationship

If a value lower than 107 is sent, such as “As100” for example, the stop command will be ignored.

9 PT-25FB 160:1 GEARS SERIES ADDENDUM

For safety reasons the brake current of the PT-25-FB 160:1 GEARS was limited to 1.2A maximum per axis. The firmware 20-02239V1.0 simply ignores any command that is not within the following range:

Character 1	Character 2	Character 3-5
Node ID	s (lower case)	Brake Setting (060-128)

The brake setting is a value between 060 and 128 that represents the desired brake setting. A value of 050 represents the maximum brake setting, and a value of 127 represents the minimum brake setting. No braking is represented by the value 128.

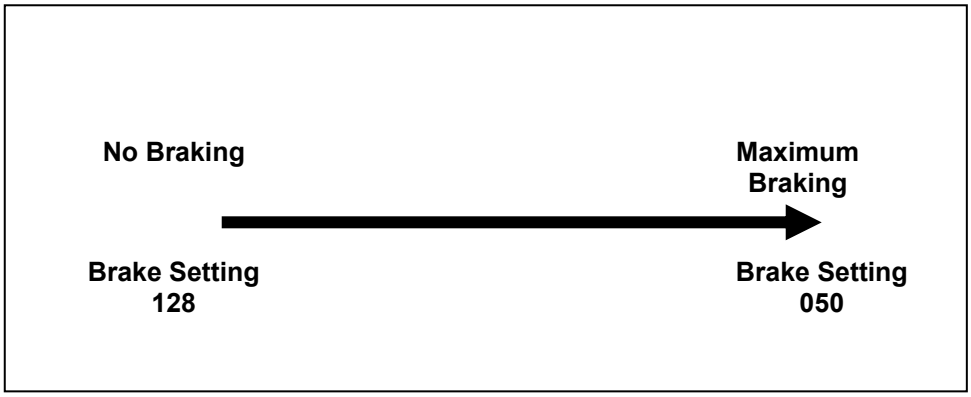


Figure 23: Brake Effect versus Brake Setting Relationship

If a value lower than 050 is sent, such as “As049” for example, the stop command will be ignored.

10 SHAFT MIN AND MAX SPEEDS FOR PT-25-FB WITH 160:1 GEARS

All 3 digits must be ASCII character 0-9. The 3 digit represent different things depending on the action type.

Rotate Clockwise (CW)

Character 1	Character 2	Character 3-5
Node ID	>	Speed Setting (001-020)

Rotate Clockwise (CCW)

Character 1	Character 2	Character 3-5
Node ID	<	Speed Setting (001-020)

The speed setting is a value between 1 and 20 that represents the desired speed of rotation. The value represents the number of times an increment of 0.5 deg/s is utilized which determines the output shaft rotation speed:

Shaft Rotation speed (Deg/s) = Speed Setting x 0.5 Deg/s

Speed Setting	Corresponding Shaft Rotation Speed in Deg/s
001	0.5
002	1.0
003	1.5
004	2.0
005	2.5
006	3.0
007	3.5
008	4.0
009	4.5
010	5.0
011	5.5
012	6.0
013	6.5
014	7.0
015	7.5

016	8.0
017	8.5
018	9.0
019	9.5
020	10.0

Figure 24: Shaft Rotation Speed in Deg/s versus Speed Setting

EXAMPLE: To send a command to go clockwise at 7.5 degree/s to node number 1 the following command needs to be sent:

A>015

11 PT-25FB 80:1 GEARS SERIES ADDENDUM

For safety reasons the brake current of the PT-25-FB 80:1 GEARS was limited to 1.1A maximum per axis. The firmware 20-30023V5.0 simply ignores any command that is not within the following range:

Character 1	Character 2	Character 3-5
Node ID	s (lower case)	Brake Setting (060-128)

The brake setting is a value between 060 and 128 that represents the desired brake setting. A value of 060 represents the maximum brake setting, and a value of 127 represents the minimum brake setting. No braking is represented by the value 128.

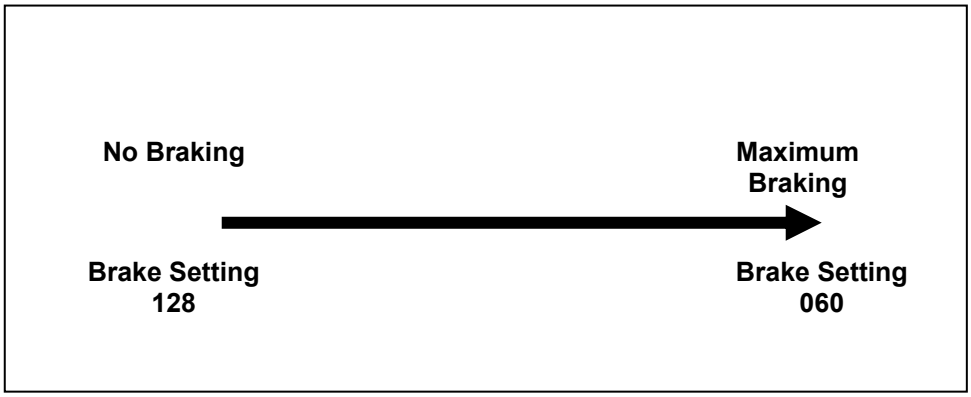


Figure 25: Brake Effect versus Brake Setting Relationship

If a value lower than 060 is sent, such as “As059” for example, the stop command will be ignored.