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ROS HALF-DUPLEX RS485 LIGHTS, POSITIONERS

NODE COMMUNICATION PROTOCOL

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The HDX RS485 Command Parser description of the Command Set as implemented in ROS products with extensions noted within this document. The specifics for legacy products are documented for a general ROS positioner in

RS485 Communication Protocol for ROS Positioners, Cameras & Lights
Version 1.09, Document 21-30022Q

Contents

1 General Information

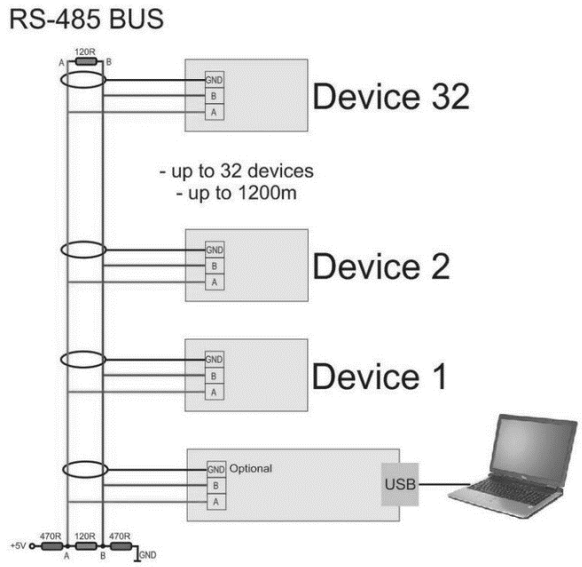
Consult the original command set guide for technical details.

1.1 Bench Wiring of a Node

The communications wiring for the node follows a standard RS485 Half Duplex wiring.

Pin	Description
Voltage	Node Power
GND	Node Ground
RS485 T/R-	Node RS485 Communications
RS485 T/R+	Node RS485 Communications

A typical RS485 network bus is illustrated. Network termination resistors may be important when the physical network wiring. An unterminated network is generally suitable for bench testing. The ROS RS485 HDX Node is an unterminated Node; the user is expected to ensure that the RS485 network is electrically sound with proper termination.



When the RS485 network is improperly cabled, this can be seen as garbled characters on an output device such as a computer. Polarity of the connections needs to be maintained throughout the network. Trouble shooting would consist starting at the terminated end of the network, isolating a node from the network, and communicate with it directly – progressively working through all the nodes until the cabling infrastructure issue can be located.

If the Node does not communicate, reverse the wiring polarity of the node onto the bus as a troubleshooting method; matching polarity is critical for successful communication.

Vendors do not always use the same labeling or terminology; vendors are usually consistent of labeling within their product offerings.

1.2 Bench Communication with a Node

There are a number of terminal emulator packages that are suitable for a bench testing environment. There is not a specific recommendation for a bench testing scenario; the end user can evaluate the need based upon the specific use case.

Realterm: http://realterm.sourceforge.net/

PuTTY: http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html

Tera Term: https://ttssh2.osdn.jp/index.html.en

1.2.1 Node Serial Settings

The RS485 Protocol is a byte oriented streaming protocol; to minimize latency, the Host Device Drivers will have to be customized for the specific application by the end user.

Default settings of the ROS RS485 HDX node for serial communications are 9600 Baud, None Parity, 8 Bit Word Length, 1 Stop Bit (9600, N, 8, 1), and all Flow Control disabled.

1.2.2 Windows Device Manager Settings

The following screen captures can be used to identify Windows Device settings that are related to communications with the node. Select the COM Port in the Device Manager.

<<FIGURE>>

Select the Default Baud Rate, Word Length, Parity, Stop Bits, and Flow Control.

<<FIGURE>>

Select Advanced Settings. The RS485 to USB adapter advanced settings may have settings that are adjusted for a specific end user application.

<<FIGURE>>

The end user is expected to perform characterization of the Host Application Driver, and optimize the Host serial port settings to accommodate the application and minimize latency. There is not one specific group of settings that are appropriate for all situations.

1.2.3 Node Addressing

RS485 half-duplex nodes are assigned an address on the network. By convention, the ROS products utilize the set of characters "A-Z[\]^_`" which are indexed starting at ASCII character 0x41.

http://www.asciitable.com/

Each axis of the node has a unique node address. This implies that all dual axis nodes are addressed by two distinct node addresses, one for each axis individually.

The node is assigned a factory default identification; in order to interoperate on a network, the correct node identification will need to be set by the user in a bench environment before being attached to the RS485 network and integrated with other nodes. Network planning and topology decisions are made by the user for the specific user application.

The RS485 network allows a maximum of 32 connected nodes. Each node is preconfigured to respond to a specific network address. ROS products allow for a range of Node Identifiers to be selected from the 32 ASCII characters beginning with the uppercase 'A' and end with '`' back-quote. The range [NODEID_RANGE] maps to hexadecimal character values of [0x41 ... 0x60] as valid node identifiers for ROS products.

NODEID_MIN = "A" = ASCII 0x41

NODEID_MAX = "`" = ASCII 0x60

NODEID_RANGE = [NODEID_MIN … NODEID_MAX]

1.2.4 Adding a Second Host to Eavesdrop

It is possible to add a second host computer to the RS485 network and use it to eavesdrop on the communications stream. The configuration can also be used by the user to facilitate Host Application Driver development.

The simple configuration of the second host is to run terminal emulation software. Configure the second host to passively eavesdrop upon activity of the RS485 network.

1.3 Coordinate Systems Descriptions

The ROS nodes utilize different coordinate systems when reporting information to the host application driver.

1.3.1 Coordinate Systems Scaling

Scaling is performed between the different coordinate systems at the node. Scaled numbers are mathematically generated through a linear scaling function. The linear transformation from range [A ... B] into the range [C ... D] can be expressed as

$$f(x) = C\left(1 - \frac{x - A}{B - A}\right) + D\left(\frac{x - A}{B - A}\right)$$

To linearly scale [40,100] to [0,100] the function works out to

$$f(x) = \frac{5}{3}(x - 40)$$

To linearly scale [8, 35] to [0, 100] the function works out to

$$f(x) = \frac{100}{27}(x - 8)$$

The math operation performed by the MCU in the node represents the data as the closest rounded integer of a floating-point result. This results in transformations between the different coordinate systems that express the same translated value.

1.3.2 Lights ILLUMINATION

Reflects a value in the range [000 … 099] of relative illumination ON. 000 is FULL OFF, and 099 is FULL ON.

1.3.3 Lights TEMPERATURE

Reflects a value in the range [000 … MAX].

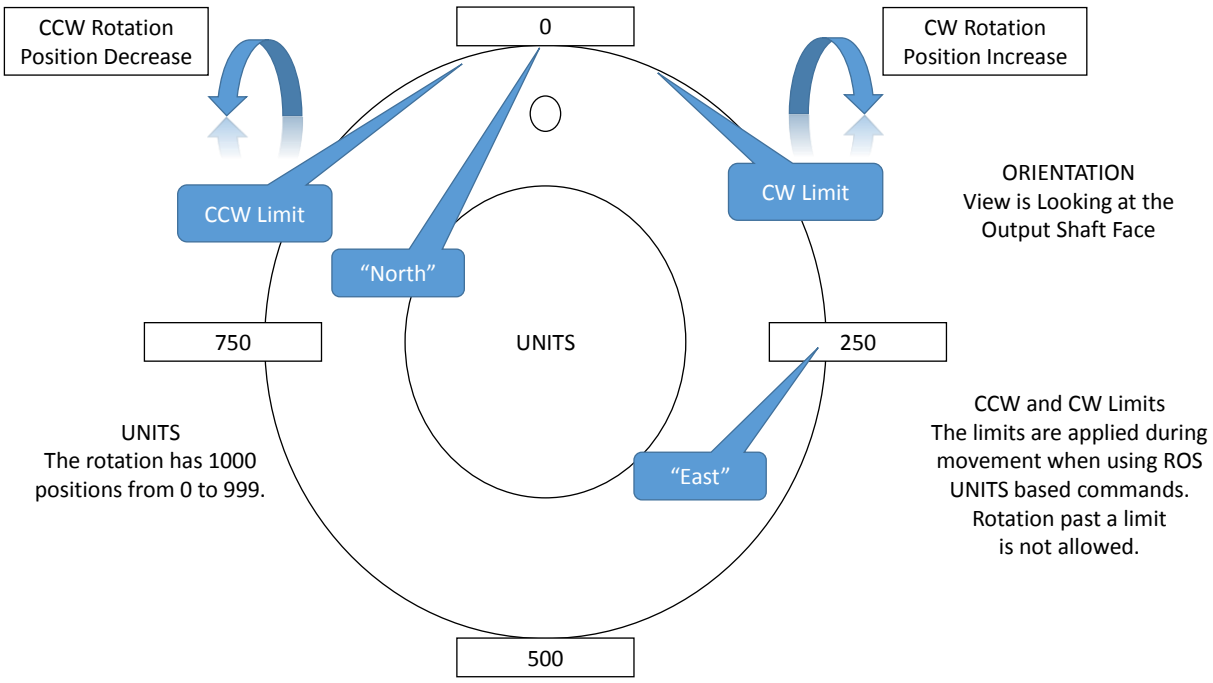
1.3.4 Positioner UNITS

UNITS is the positioning coordinate system utilized by ROS products. Use of this coordinate system will provide the user application the most flexibility in being deployed across a range of ROS positioner products. The range represented by UNITS is [000 ... 999] around one revolution of a circle.

UNITS_MIN = 0

UNITS_MAX = 999

UNITS_RANGE = [UNITS_MIN … UNITS_MAX]



1.3.5 Positioner STEPS

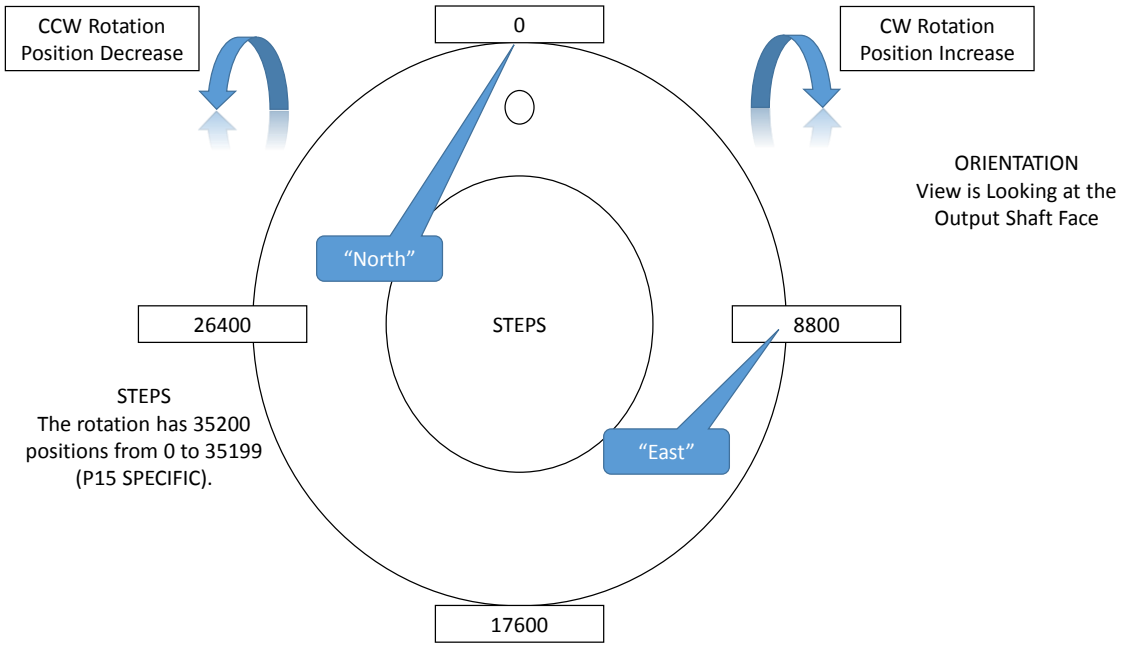
STEPS is the position coordinate system utilized internally by the positioner for open loop positioning. The range of the coordinate system can vary between products, but generally reflects the number of unique step positions that are available around one revolution of a circle. The difference between positioners occurs due to different gearing ratios and motor technologies.

For example, the range for P15 STEPS can be represented as [00000 ... STEPMAX]. A node with an internal gear shaft reduction ratio of 88:1 and a stepping motor having 200 discrete positions operating with a driver that supports half stepping would yield a STEPMAX of 35199.

STEPS_MIN = 0

STEPS_MAX = 35199

STEPS_RANGE = [STEPS_MIN … STEPS_MAX]



1.3.6 Positioner RESOLVER

RESOLVER is the position coordinate system utilized internally by the positioner for closed loop positioning. The position can also be queried by the host application driver to monitor closed loop positioning. The range can vary between products, but generally reflects the number of unique positions that can be resolved around one revolution of a circle. The difference between positioners occurs due to different resolving technologies that can be used.

The range of a 15-bit resolver solution would be represented by the range [00000 ... 16383].

RESOLV_MIN = 0

RESOLV_MAX = 16383

RESOLV_RANGE = [RESOLV_MIN … RESOLV_MAX]

1.3.7 Positioner VELOCITY

Velocity is encoded as an integer that represents 0.5 degrees/second.

VELOC_MIN = 0

VELOC_MAX = 40

VELOC_RANGE = [VELOC_MIN … VELOC_MAX]

1.3.8 Positioner ACCELERATION

Acceleration is encoded as a profile setting.

ACCEL_MIN = 0

ACCEL_MAX = 6

ACCEL_RANGE = [ACCEL_MIN … ACCEL_MAX]

1.3.9 User Application DEGREES

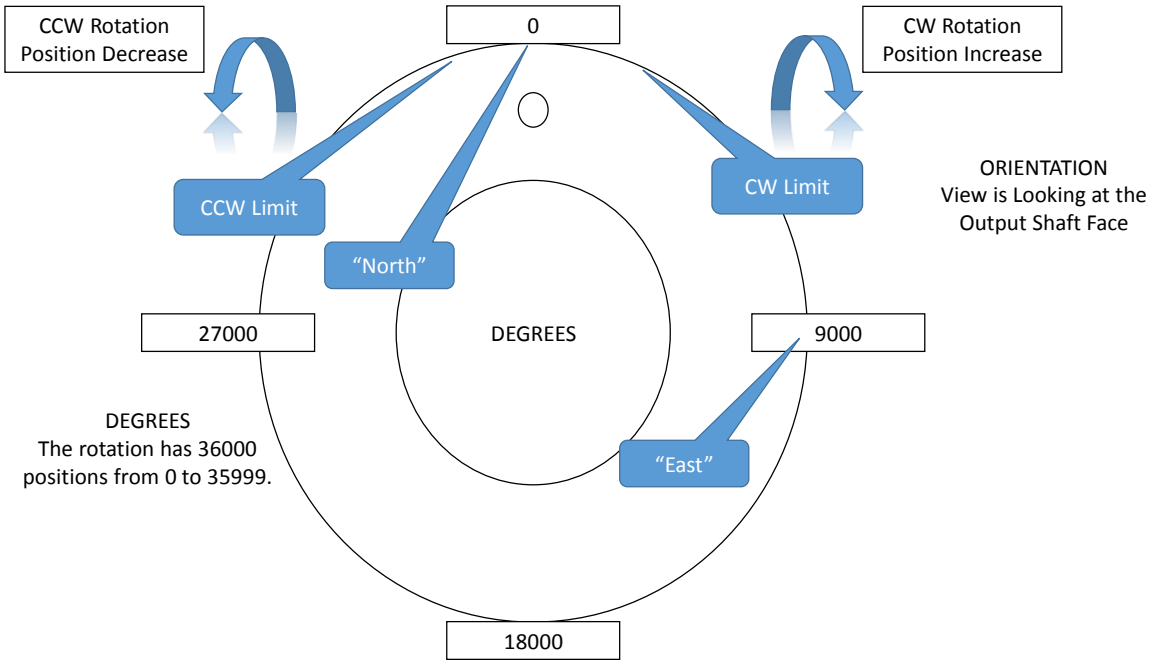
The angular measurement of DEGREES is represented as an integer. The integer reflects DEGREES multiplied by 100 with the remainder of the fractional part being dropped. The range of DEGREES is represented by [00000 ... 35999].

The positioner does not report any values using DEGREES.

DEGREES_MIN = 0

DEGREES_MAX = 35999

DEGREES_RANGE = [DEGREES_MIN … DEGREES_MAX]



1.3.10 User Application RADIANS

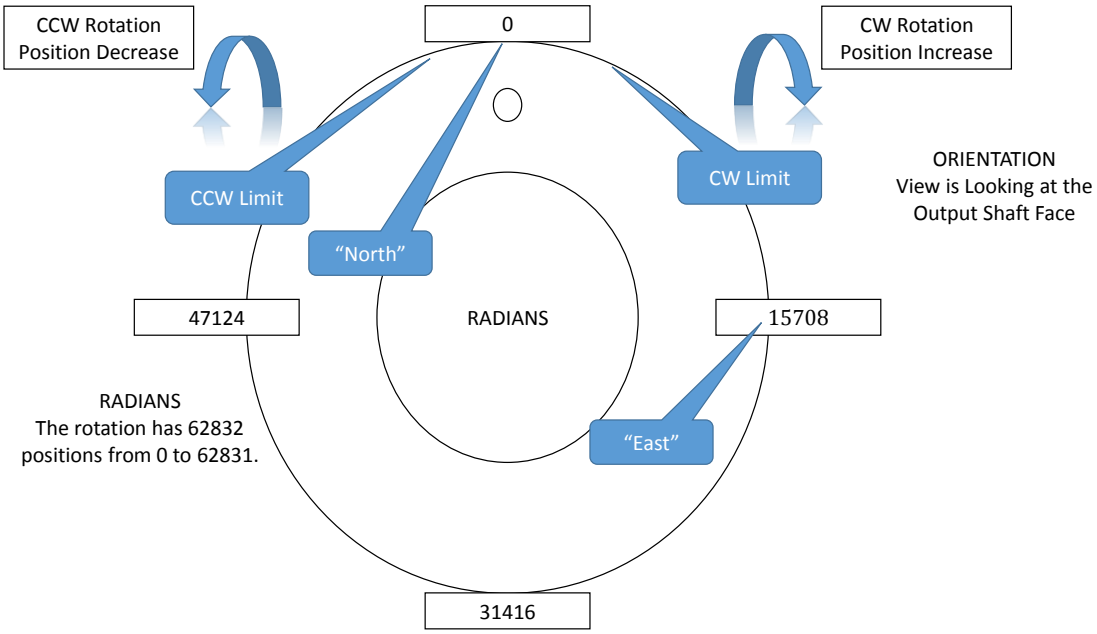
The angular measurement of RADIANS is represented as an integer. The integer reflects RADIANS multiplied by 10,000 with the remainder of the fractional part being dropped. The range of RADIANS is represented by [00000 ... 62831].

The positioner does not report any values using RADIANS.

RADIANS_MIN = 0

RADIANS_MAX = 62831

RADIANS_RANGE = [RADIANS_MIN … RADIANS_MAX]



1.4 Host Application Drivers

Various general algorithm descriptions

1.4.1 Driver Development Notes

Specialized software written for a Host computer to communicate should take into account that nodes are addressed by the first byte transmitted. It is important to allow the networked node to echo back the characters before sending the next. It is important the Host complete the entire message to a node before attempting to address a different node.

The expectation is that the Host computer will initiate all communications to the nodes on the bus and act as the communications master. A specific node will not generate asynchronous messages to the Host which contain relevant information. The Host is expected to query each node for status information at the time the Host is ready to process the status information.

Nodes do not communicate with one another.

1.4.1.1 Host Application Driver Out of Sync to Node

The host driver solution is required to manage communications with all of the nodes on the RS485 bus as the bus master. The ROS HDX communications protocol does not implement checksums or receive timeouts at the node. The ROS HDX communications protocol only implements a character transmit delay at the node. The character transmission delay is applied following each byte sent by the node. Programmatically the node is incapable to listen during the transmission delay.

The host computer will restart the command when the character echo from the node is not obtained following a character delay timeout. Character timeout at the node is only applicable to character transmission by the node. Nodes are not intended to communicate with one another; the host application driver is expected to retain control of the RS485 bus at all times.

When the host driver is losing synchronization to the nodes due to character dropouts, the best solution is to troubleshoot the cables infrastructure. Determine where characters are being lost. The BENCH WIRING and BENCH COMMUNICATIONS sections in this document contain potential troubleshooting instructions which may help locate the equipment that cause the host to get out of sync with the nodes.

A secondary solution the host application driver can implement is emitting a series of valid or invalid node identification characters. Invalid node identification characters include the SPACE ' ' (ASCII 0x20), and the AT '@' (ASCII 0x40). The host application driver will not successfully resync to a node by continuing to issue parameter characters (e.g., ZERO … NINE, '0' … '9'). The host application driver will have to be tuned specifically to use this mechanism to overcome a problematic cable infrastructure; there is not a specific number of node identification characters that can be transmitted to always resync a problematic cable infrastructure.

1.4.2 Positioners, User Step Counter

Closed Loop Positioning can be **simulated** on nodes using the following process at the Host Application software by use of the node specific stepping commands. The trade off to this method is portable Host Application Software without node model specifics vs. positioning granularity which ***is*** node model specific. **UNITS / STEPS ratio is not the same across all node models.**

1. Position the node to the Host Application Logical HOME/ORIGIN.
   1.1. Command 'pNNN' (eg p500 to position to 180deg)
   Closed Loop Positioning by Node
   1.1.1. NNN = UNITS Position
2. Reset the User Steps Counter
   2.1. Command 'z000'
3. Position the node using the steps command
   3.1. Command 'yDVVVNNNNN'
   3.1.1. D = Direction CCW/CW
   3.1.2. VVV = Stepping Velocity, Reduction in Spamming of Position Queries to Node can be timed better. The velocity is specified, the start and end of the rotation and its duration are known by Host Application.
   3.1.3. NNNNN = Step Count
4. Query User Step Counter
   4.1. Command 'q'
   4.1.1. CCW Motion Decrements User Steps Counter
   4.1.2. CW Motion Increments User Steps Counter

5. Query the Rotation Flag, Rotation in Progress
   5.1. Command '?007'
6. Check for Rotation to Complete before Reading Final Value of User Steps Counter

Caveat to this method: STEPS are Node Model Dependent (based on node technology), and should not be expected to reflect the same size of travel between different node models. Host Application software should be written in a manner that allows for different node models to be accounted for – **don't hardcode values, use a MANIFEST CONSTANT** to reflect mapping of User Steps to Degrees in the Host Application software.

1.4.3 Positioners, Sweeping Within User Set Limits

Another second method to position the node is by setting the User Rotation Limits for CCW and CW motion, and then having the node sweep CCW or CW to the user specified limit. The Host Application software then must manage the rotation limits to achieve a **simulated** closed loop positioning methodology.

Every time the user limit is set, it is also stored to non-volatile memory; it is not recommended to change the user limits before every rotation. Excessive writes will shorten the lifespan of the EEPROM that saves the non-volatile memory settings. The EEPROM parts are typically rated in number of writes cycles < 10K per datum. However, setting limits to the arc of travel infrequently is another valid method available to Host Application software as a positioning algorithm.

1. Position the node to the Host Logical HOME/ORIGIN.
   1.1. Command 'pNNN' (eg p500 to position to 180deg)
      Closed Loop Positioning by Node
      1.1.1. NNN = UNITS Position
2. Set CCW Limit
   2.1. Command 'dNNN'; **MUST BE LESS THAN CURRENT POSITION**
      2.1.1. NNN = UNITS Position
3. Set CW Limit
   3.1. Command 'uNNN'; **MUST BE GREATER THAN CURRENT POSITION**
      3.1.1. NNN = UNITS Position
4. Sweep to CCW Limit
   4.1. Command '<VVV', Node Stops at CCW Limit
      4.1.1. VVV = Velocity, Reduction in Spamming of Position Queries to Node can be timed better. The velocity is specified, the start and end of the rotation and its duration are known by Host Application.
5. Sweep to CW Limit
   5.1. Command '>VVV', Node Stops at CW Limit
      5.1.1. VVV = Velocity, Reduction in Spamming of Position Queries to Node can be timed better. The velocity is specified, the start and end of the rotation and its duration are known by Host Application.
6. Query the Current Position
   6.1. Command 'f'

7. Query the Rotation Flag, Rotation in Progress
   7.1. Command '?007'
8. Check for Rotation to Complete before Reading Final Position

2 Command Quick Reference Tables

Quick Reference Tables

2.1 Quick Reference Table Lights Commands

Command	Format	Description
l	lNNN	Light Illumination Level
w	wNNN	Light Illumination Level at Power On
i	iNNN	Set Node ID
e	eNNN	Set Serial Character Echo
b	bNNN	Set Serial Character Delay
?	?NNN	Query General Setting
	?000	Factory Settings
	?001	Character Echo
	?002	Character Transmit Delay
	?080	Firmware Specific Power On Sign On
	?081	Latest Node Reset Flags
	?082	Latest Node Operations Flags
	?083	Latest Node Error Condition

2.2 Quick Reference Table Positioner Commands

Command	Format	Description
?	?NNN	Query General Setting
	?000	Factory Settings
	?001	Character Echo
	?002	Character Transmit Delay
	?003	Node Default Acceleration
	?004	Node Default Velocity
	?005	Node Slip/Stall Flag
	?006	Node Brake Setting
	?007	Node Moving Flag
	?080	Firmware Specific Power On Sign On
	?081	Latest Node Reset Flags
	?082	Latest Node Operations Flags
	?083	Latest Node Error Condition
e	eNNN	Set Serial Character Echo
b	bNNN	Set Serial Character Delay
i	iNNN	Set Node ID
x	x….	Set Factory Parameters
f	f	Query Position
<	>NNN	Rotate Counter Clockwise
>	<NNN	Rotate Clockwise

s	sNNN	Rotate Stop
p	pNNN	Rotate to Position
-	-NNN	Acceleration Profile, Rotate Counter Clockwise
+	+NNN	Acceleration Profile, Rotate Clockwise
t	tNNN	Acceleration Profile, Rotate Stop
q	q	User Steps Counter, Query Position
z	zDNNN	User Steps Counter, Step Once
y	yDNNNXXXXX	User Steps Counter, Step Multiple
a	aNNN	Set Default Acceleration Profile
m	mNNN	Set Default Velocity
d	dNNN	Set User Counter Clockwise Limit
u	uNNN	Set User Clockwise Limit
<<	>>NNN	Rotate Counter Clockwise Free Run
>>	<<NNN	Rotate Clockwise Free Run
cf	cf	Resolver, Query Position
cr	cr	Resolver, Query Position Enhanced
cp	cpNNNNN	Resolver, Rotate to Position
ctr	ctr	Resolver, User Tare Reset
ct+	ct+NNNNN	Resolver, User Tare Add to ZERO
ct-	ct-NNNNN	Resolver, User Tare Subtract from ZERO
of	of	Stepper, Query Position
or	or	Stepper, Query Position Enhanced
op	opNNNNNNNNN	Stepper, Rotate to Position

3 Common Command Set

Details of the command set follow. These commands are implemented with all ROS nodes.

3.1 Query Settings by Address

3.1.1 Description

Command to query a current operating parameter. ***param1*** is the setting address to query. See the example output for details and descriptions.

3.1.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	?	Command Code
In	***param1***	3	ADDR	Address

3.1.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	VARIABLE		Values

3.1.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Positioner		
A?000	Characters Echo when Enabled A,000,999,001,996,3,y,0000,1,1,09	Factory Settings Factory CCW Limit Factory CW Limit User CCW Limit User CW Limit Dash Number Position Feedback Node Identification Node Baud Rate Node Device Type Firmware Features Code

A?001	Characters Echo when Enabled A111	Character Echo
A?002	Characters Echo when Enabled A000	Character Transmit Delay
A?003	Characters Echo when Enabled A000	Node Default Acceleration Profile
A?004	Characters Echo when Enabled A000	Node Default Velocity
A?005	Characters Echo when Enabled A000	Node Slip/Stall Flag
A?006	Characters Echo when Enabled A000	Node Brake Setting
A?007	Characters Echo when Enabled A000	Node Rotating Flag
A?020	Characters Echo when Enabled A000	Node UNITS Position
A?021	Characters Echo when Enabled A000	Node UNITS Position Adjusted
A?022	Characters Echo when Enabled A000	Node UNITS Position Minimum
A?023	Characters Echo when Enabled A000	Node UNITS Position Maximum
A?030	Characters Echo when Enabled A00000	Node ENCODER Position
A?032	Characters Echo when Enabled A00000	Node ENCODER Position Minimum
A?033	Characters Echo when Enabled A00000	Node ENCODER Position Maximum
~~A?040~~	~~Characters Echo when Enabled A000000000~~	~~Node STEPS Position~~
~~A?042~~	~~Characters Echo when Enabled A000000000~~	~~Node STEPS Position Minimum~~
~~A?043~~	~~Characters Echo when Enabled A000000000~~	~~Node STEPS Position Maximum~~
~~A?050~~	~~Characters Echo when Enabled A+00000~~	~~Node USER Scaled Position~~
~~A?051~~	~~Characters Echo when Enabled A+00000~~	~~Node USER Scaled Position Adjusted~~
~~A?052~~	~~Characters Echo when Enabled A+00000~~	~~Node USER Scaled Minimum~~
~~A?053~~	~~Characters Echo when Enabled A+00000~~	~~Node USER Scaled Position Maximum~~
A?080	Characters Echo when Enabled A061b300421030428ff020105ffffffff	Firmware Specific Power On Sign On 061b3004 MCU DEVID

		21030428 Firmware ID ff020105 Firmware VER ffffffff MCU FUID
A?081	Characters Echo when Enabled A0040	Latest Node Reset Flags
A?082	Characters Echo when Enabled A00000000	Latest Node Operations Flags
A?083	Characters Echo when Enabled A00000000	Latest Node Error Condition
Lamp		
A?000	Characters Echo when Enabled A,000,000,000,000,0,y,0000,0,0,00	Factory Settings Light Type Dim Control Type Input Power Type 000 Dash Number y Node Identification Node Baud Rate Node Device Type Firmware Features Code
A?001	Characters Echo when Enabled A111	Character Echo
A?002	Characters Echo when Enabled A000	Character Transmit Delay
A?005	Characters Echo when Enabled A000	Light Intensity
A?006	Characters Echo when Enabled A000	Power Up Light Intensity
A?080	Characters Echo when Enabled A061b300421030428ff020105ffffffff	Firmware Specific Power On Sign On 061b3004 MCU DEVID 21030428 Firmware ID ff020105 Firmware VER ffffffff MCU FUID
A?081	Characters Echo when Enabled A0040	Latest Node Reset Flags
A?082	Characters Echo when Enabled A00000000	Latest Node Operations Flags
	Characters Echo when Enabled A00000000	Latest Node Error Condition

3.2 Set Serial Character Echo

3.2.1 Description

Positioner command to enable or disable echo of serial characters by the node. ***param1*** indicates if characters are echoed from the positioner. "110" indicates to disable character echo. "111" indicates to enable character echo.

The value is stored to non-volatile memory.

3.2.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	e	Command Code
In	***param1***	3	MIN ... MAX	Echo Setting

3.2.3 Output

There is no output generated from this command.

3.2.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Ae111	Characters Echo when Enabled No Command Response	Character Echo Enable

3.3 Set Serial Character Delay

3.3.1 Description

Command to set the delay between characters transmitted by the node.

param1 represents the delay programmatically inserted between transmitted characters in 0.25ms increments. Programmatically, the Node is not expected to be capable of receiving on the RS485 Half Duplex bus until the character delay has elapsed following the last character transmission.

The value is stored to non-volatile memory. The MAX useable value is 50.

Highest throughput will be achieved by the host application driver waiting for character echo and delay to elapse before sending the next character. The host application driver should utilize a similar delay between character transmissions to the nodes.

3.3.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID

In	***code***	1	b	Command Code
In	***param1***	3	MIN ... MAX	Character Delay

3.3.3 Output
There is no output generated from this command.

3.3.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Ab000	Characters Echo when Enabled No Command Response	No Additional Character Delay

3.4 Set Node ID
3.4.1 Description
Command to set the node identifier.

param1 represents the new ***node*** identification in decimal.

The value is stored to non-volatile memory.

3.4.2 Command Format
Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	i (verbal 'eye')	Command Code
In	***param1***	3	MIN ... MAX	*Node* ID

3.4.3 Output
There is no output generated from this command.

3.4.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Ai005	Characters Echo when Enabled No Command Response	Node Change to ID 'E'

3.5 Device Diagnostic Bits List (Extension)

3.5.1 Description

Command to query various device diagnostic bits.

3.5.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	ddbl	Command Code

The bitmask output represents the status of the following diagnostic capabilities

Mask	Name	Description
0x0001	BITS_LINETERM	Node Output CRLF Termination when Cleared
0x0002	BITS_SIGNON_MESSAGE	Node Sign on Message Generation at Startup when Cleared

3.5.3 Output

Output is generated from this command.

3.5.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Addbl	Characters Echo when Enabled Affff	Node Device Diagnostic Bits List

3.6 Device Diagnostic Bits Set (Extension)

3.6.1 Description

Command to set various device diagnostic bits.

3.6.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	4	ddbs	Command Code
In	***param1***	4	HEX Mask	Bitmask

The bitmask output represents the status of the following diagnostic capabilities. Unused bits must be set to '1' when creating the mask.

3.6.3 Output

There is no output generated from this command.

3.6.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Addbl	Characters Echo when Enabled Affff	Node Device Diagnostic Bits List

3.7 Device Diagnostic Bits Clear (Extension)

3.7.1 Description

Command to clear various device diagnostic bits.

3.7.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	4	ddbc	Command Code
In	***param1***	4	HEX Mask	Bitmask

The bitmask output represents the status of the following diagnostic capabilities. Unused bits must be set to '1' when creating the mask.

3.7.3 Output

Output is generated from this command.

3.7.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Addbcffff	Characters Echo when Enabled No Command Response	Node Device Diagnostic Bits Clear

3.8 Device Diagnostic Power on Reset (Extension)

3.8.1 Description

Command to programmatically reset the device as if powered on.

3.8.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	4	ddrp	Command Code

3.8.3 Output

There is no output generated from this command.

3.8.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Addrp	Characters Echo when Enabled No Command Response	Node Device Diagnostic Power on Reset

4 Lights Command Set

Details of the command set follow.

4.1 Query Temperature

4.1.1 Description

Light command to query onboard temperature sensor.

4.1.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	f	Command Code

4.1.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	3	MIN ... MAX	Temperature

4.1.4 Example

None

4.2 Illumination Level

4.2.1 Description

Light command to set current illumination.

param1 represents the illumination value applied to the light immediately. "000" represents full off and "099" represents node supported full on.

4.2.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	l (verbal 'ell')	Command Code
In	***param1***	3	MIN ... MAX	Illumination

4.2.3 Output

There is no output generated from this command.

4.2.4 Example

None

4.3 Illumination Level at Power On

4.3.1 Description

Light command to set power on illumination.

param1 represents the illumination value applied to the light when power is applied. "000" represents full off and "099" represents full on.

The value does not impact the current illumination state.

The value is stored to non-volatile memory.

4.3.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	w	Command Code
In	***param1***	3	MIN ... MAX	Illumination

4.3.3 Output

There is no output generated from this command.

4.3.4 Example

None

4.4

5 Positioners Command Set

Details of the command set follow.

5.1 Query Position

5.1.1 Description

Positioner command to query current position in UNITS.

5.1.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	f	Command Code

5.1.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	3	UNITS_RANGE	UNITS Position

5.1.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Af	Characters Echo when Enabled A000	UNITS Position

5.2 Rotate Counter Clockwise

5.2.1 Description

Positioner command to rotate counter clockwise.

param1 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity.

Rotation is suspended at the user or factory specific limit based upon direction of travel.

5.2.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID

In	***code***	1	<	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.2.3 Output
There is no output generated from this command.

5.2.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
A<012	Characters Echo when Enabled No Command Response	Counter Clockwise Rotation at 6.0d/s

5.3 Rotate Clockwise
5.3.1 Description
Positioner command to rotate clockwise.

param1 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity.

Rotation is suspended at the user or factory specific limit based upon direction of travel.

5.3.2 Command Format
Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	>	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.3.3 Output
There is no output generated from this command.

5.3.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
A>012	Characters Echo when Enabled No Command Response	Clockwise Rotation at 6.0d/s

5.4 Rotate Stop

5.4.1 Description

Positioner command to cease rotation. This command only impacts rotation that has been commanded without a specific destination parameter.

param1 brake setting represents the desired break setting; when the hardware does not support braking all values are treated logically as MAX.

5.4.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	s	Command Code
In	***param1***	3	MIN ... MAX	Brake

5.4.3 Output

There is no output generated from this command.

5.4.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
As000	Characters Echo when Enabled No Command Response	Suspend Rotation

5.5 Rotate to Position

5.5.1 Description

Positioner command to rotate in appropriate direction with a simple acceleration profile used at the start and termination of rotation.

param1 reflects the UNITS coordinate system for positioning. the axis suspends rotation upon arrival to the destination.

Rotation is not allowed when it would exceed a user or factory specific limit based upon direction of travel.

5.5.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	p	Command Code
In	***param1***	3	UNITS_RANGE	UNITS

5.5.3 Output
There is no output generated from this command.

5.5.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Ap500	Characters Echo when Enabled No Command Response	Rotation to UNITS position 500 at User Velocity

5.6 Acceleration Profile, Rotate Counter Clockwise
5.6.1 Description
Positioner command to rotate counter clockwise with a simple acceleration profile used at the start of rotation.

param1 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity.

The axis specific user setting for Acceleration Profile is used to ramp up to the desired velocity.

Rotation is suspended at the user or factory specific limit based upon direction of travel.

5.6.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	-	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.6.3 Output
There is no output generated from this command.

5.6.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
A-012	Characters Echo when Enabled No Command Response	Counter Clockwise Rotation at 6.0d/s

5.7 Acceleration Profile, Rotate Clockwise

5.7.1 Description

Positioner command to rotate clockwise with a simple acceleration profile used at the start of rotation.

param1 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity. The axis specific user setting for Acceleration Profile is used to ramp up to the desired velocity.

Rotation is suspended at the user or factory specific limit based upon direction of travel.

5.7.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	+	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.7.3 Output

There is no output generated from this command.

5.7.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
A+012	Characters Echo when Enabled No Command Response	Clockwise Rotation at 6.0d/s

5.8 Acceleration Profile, Rotate Stop

5.8.1 Description

Positioner command to cease rotation with a simple acceleration profile used at the termination of rotation.

param1 brake setting represents the desired break setting; when the hardware does not support braking all values are treated logically as MAX. The axis specific user setting for Acceleration Profile is used to ramp down before stopping.

5.8.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	t	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.8.3 Output

There is no output generated from this command.

5.8.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
At000	Characters Echo when Enabled No Command Response	Suspend Rotation

5.9 User Steps Counter, Query Position

5.9.1 Description

Positioner command to query current position in steps from the steps counter. The user application can manage fine positioning by monitoring and resetting the steps counter.

5.9.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	q	Command Code

5.9.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	5	STEPS_RANGE	User Steps Position

5.9.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Aq	Characters Echo when Enabled A00000	User STEPS Position

5.10 User Steps Counter, Step Once

5.10.1 Description

Positioner command to rotate in specific direction by one step. Programmatically, the steps counter is incremented or decremented on specific rotation. The host application driver is expected to query the step counter after use of this command. This command is used to implement a simulated 'closed loop' scenario by the host application driver.

param1 represents the direction of the single step. "000" clears the reported step counter. "001" indicates clockwise single step. "002" indicates single counter clockwise step.

Rotation is not impacted by a user or factory specific limit.

5.10.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	z	Command Code
In	***param1***	3	MIN ... MAX	Direction

5.10.3 Output

There is no output generated from this command.

5.10.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Az001	Characters Echo when Enabled No Command Response	Single Clockwise Step

5.11 User Steps Counter, Step Multiple

5.11.1 Description

Positioner command to rotate in specific direction with a simple acceleration profile used at the start and termination of rotation.

param1 reflects the direction of travel. 0 indicates clockwise, 1 indicates counter clockwise.

param2 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity.

param3 reflects the stepper coordinate system for positioning. The axis suspends rotation upon arrival to the destination. The coordinate system MIN ... MAX is expected to vary between products.

Rotation is not impacted by a user or factory specific limit.

5.11.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	y	Command Code
In	***param1***	1	0 ... 1	Direction 1 = CCW 0 = CW
In	***param2***	3	VELOC_RANGE	Velocity
In	***param3***	5	STEPS_RANGE	Steps

5.11.3 Output

There is no output generated from this command.

5.11.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Ay001200100	Characters Echo when Enabled No Command Response	Clockwise Rotation at 6.0d/s for 100 Steps

5.12 Set Default Acceleration Profile

5.12.1 Description

Positioner command to set the time component for the simple acceleration profile used at the start and termination of rotation.

param1 reflects the Acceleration Profile value for a simple ramped acceleration profile.

The value is stored to non-volatile memory.

5.12.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	a	Command Code
In	***param1***	3	ACCEL_RANGE	Acceleration Profile

5.12.3 Output
There is no output generated from this command.

5.12.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Aa000	Characters Echo when Enabled No Command Response	Acceleration Profile

5.13 Set Default Velocity
5.13.1 Description
Positioner command to set the velocity component for the other commands which do not supply a velocity parameter.

param1 reflects the maximum velocity value for positioning commands not to exceed.

The value is stored to non-volatile memory.

5.13.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	m	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.13.3 Output
There is no output generated from this command.

5.13.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Am012	Characters Echo when Enabled No Command Response	Rotation at 6.0d/s

5.14 Set User Counter Clockwise Limit
5.14.1 Description
Positioner command to set the counter clockwise limit on rotation. The specific parameter impacts positioner commands that work with UNITS.

param1 represents the UNITS position that stops rotation in the counter clockwise rotation. the rotation is stopped when the limit is met.

The value is stored to non-volatile memory.

5.14.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	d	Command Code
In	***param1***	3	UNITS_RANGE	CCW Limit

5.14.3 Output

There is no output generated from this command.

5.14.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Ad002	Characters Echo when Enabled No Command Response	Counter Clockwise User Limit at 002 UNITS

5.15 Set User Clockwise Limit

5.15.1 Description

Positioner command to set the clockwise limit on rotation. The specific parameter impacts positioner commands that work with UNITS.

param1 represents the UNITS position that stops rotation in the clockwise rotation. the rotation is stopped when the limit is met.

The value is stored to non-volatile memory.

5.15.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	1	u	Command Code
In	***param1***	3	UNITS_RANGE	CW Limit

5.15.3 Output

There is no output generated from this command.

5.15.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Au998	Characters Echo when Enabled No Command Response	Clockwise User Limit at 998 UNITS

5.16 Rotate Clockwise Free Run (Extension)

5.16.1 Description

Positioner command to rotate clockwise. The command is to facilitate bench testing; it is not expected to have host driver application use.

param1 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity.

Rotation is not impacted by a user or factory specific limit.

5.16.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	>>	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.16.3 Output

There is no output generated from this command.

5.16.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
A>>012	Characters Echo when Enabled No Command Response	Clockwise Rotation at 6.0d/s

5.17 Rotate Counter Clockwise Free Run (Extension)

5.17.1 Description

Positioner command to rotate counter clockwise. The command is to facilitate bench testing; it is not expected to have host driver application use.

param1 velocity setting represents the number of times an increment of 0.5d/s is utilized at the output shaft for rotation velocity.

Rotation is not impacted by a user or factory specific limit.

5.17.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	<<	Command Code
In	***param1***	3	VELOC_RANGE	Velocity

5.17.3 Output

There is no output generated from this command.

5.17.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
A<<012	Characters Echo when Enabled No Command Response	Counter Clockwise Rotation at 6.0d/s

5.18 Resolver, Query Position (Extension)

5.18.1 Description

Positioner command to query current position from the resolver. The reported value is in RESOLVER coordinates.

5.18.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	cf	Command Code

5.18.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	5	RESOLV_RANGE	Resolver Position

5.18.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description

Acf	Characters Echo when Enabled A00000	Resolver Position

5.19 Resolver, Query Position Enhanced (Extension)

5.19.1 Description

Positioner command to query current position from the resolver. The reported value is in RESOLVER coordinates.

5.19.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	cr	Command Code

5.19.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	5	RESOLV_RANGE	Resolver Position
Out	***output2***	5	RESOLV_MIN	Resolver Position Minimum
Out	***output3***	5	RESOLV_MAX	Resolver Position Maximum
Out	***output4***	6	RESOLV_RANGE	Resolver Tare

5.19.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Acr	Characters Echo when Enabled A00000,00000,00000,+00000	Resolver Position

5.20 Resolver, Rotate to Position (Extension)

5.20.1 Description

Positioner command to rotate in appropriate direction.

param1 reflects the RESOLVER coordinate system for positioning. The axis suspends rotation upon arrival to the destination.

Rotation is not allowed when it would exceed factory specific limit based upon direction of travel.

5.20.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	cp	Command Code
In	***param1***	5	RESOLV_RANGE	Resolver Position

5.20.3 Output

There is no output generated from this command.

5.20.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Acp00000	Characters Echo when Enabled No Command Response	Rotation to Position

5.21 Resolver, User Tare Reset (Extension)

5.21.1 Description

Reset User Tare to Match Factory Shipped Tare. The value is saved to non-volatile memory, and utilized on the next power cycle initialization.

5.21.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	3	ct=	Command Code

5.21.3 Output

There is no output generated from this command.

5.21.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Act=	Characters Echo when	User TARE Reset

	Enabled No Command Response	

5.22 Resolver, User Tare Add to ZERO (Extension)

5.22.1 Description

Resolver tare is adjusted by addition. The value is saved to non-volatile memory, and utilized on the next power cycle initialization.

param1 is added to ZERO.

5.22.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	3	ct+	Command Code
In	***param1***	5	RESOLV_RANGE	Resolver TARE

5.22.3 Output

There is no output generated from this command.

5.22.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Act+00000	Characters Echo when Enabled No Command Response	User TARE Addition

5.23 Resolver, User Tare Subtract from ZERO (Extension)

5.23.1 Description

Resolver tare is adjusted by subtraction. The value is saved to non-volatile memory, and utilized on the next power cycle initialization.

param1 is subtracted from ZERO.

5.23.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	3	ct-	Command Code
In	***param1***	5	RESOLV_RANGE	Resolver TARE

5.23.3 Output
There is no output generated from this command.

5.23.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Act-00000	Characters Echo when Enabled No Command Response	User TARE Subtraction

5.24 Stepper, Query Position (Extension)
5.24.1 Description
Positioner command to query current position from the stepper. The reported value is in STEPPER coordinates.

5.24.2 Command Format
Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	of	Command Code

5.24.3 Output
Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	9	STEPS_RANGE	Stepper Position

5.24.4 Example
Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Aof	Characters Echo when Enabled A000000000	Stepper Position

5.25 Stepper, Query Position Enhanced (Extension)
5.25.1 Description
Positioner command to query current position from the stepper. The reported value is in STEPPER coordinates.

5.25.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	or	Command Code

5.25.3 Output

Output is generated from this command.

Parameter	Name	Length	Range	Description
Out	***node***	1	NODEID_RANGE	ASCII Node ID
Out	***output1***	9	STEPS_RANGE	Stepper Position
Out	***output2***	9	STEPS_MIN	Stepper Position Minimum
Out	***output3***	9	STEPS_MAX	Stepper Position Maximum

5.25.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Aor	Characters Echo when Enabled A000000000,000000000,000000000	Resolver Position

5.26 Stepper, Rotate to Position (Extension)

5.26.1 Description

Positioner command to rotate in appropriate direction.

param1 reflects the STEPPER coordinate system for positioning. The axis suspends rotation upon arrival to the destination.

Rotation is not allowed when it would exceed factory specific limit based upon direction of travel.

5.26.2 Command Format

Parameter	Name	Length	Range	Description
In	***node***	1	NODEID_RANGE	ASCII Node ID
In	***code***	2	op	Command Code
In	***param1***	9	STEPS_RANGE	Stepper

				Position

5.26.3 Output

There is no output generated from this command.

5.26.4 Example

Examples Matrix, Examples Addressed to Node A

Command	Output	Description
Aop000000000	Characters Echo when Enabled No Command Response	Rotation to Position

6 Positioner User Tare Information

Nodes are supplied with a calibrated tare from the factory; in certain circumstances, it may be suggested that an end user readjust a tare for a specific application to overcome certain physical application environment variables.

The initial tare supplied with the node has been performed with calibrated measurement equipment at the factory. The end user may not have access to similar equipment, and when the tare is redone, the factory calibrated tare is superseded.

6.1 Commands Utilized in Tare Process

Command	Parameter	Description
cf	NONE	Node Position
cr	NONE	Node Position & Tare
ct+NNNNN	Adjustment Add	Tare Add to ZERO
ct-NNNNN	Adjustment Subtract	Tare Subtract from ZERO

6.2 General Tare Process Outline

1. Rotation Commands to HOME/ORIGIN on Specific Axis
    a. Measured and Displayed on a Calibrated Angular Measurement Tool
2. Tare List Commanded to Specific Axis
    a. Make Note of All Information Returned
    b. Command 'cr'
3. Tare Add ZERO Commanded to Specific Axis
    a. Removes All Tare Information from Non-volatile Memory
    b. Command 'ct+00000'
4. Determine if Tare Adjustment will be Additive or Subtractive
    a. Query Axis Resolver Determined Position
    b. When Overshooting HOME/ORIGIN Tare Manipulation will be Subtractive
    c. When Undershooting HOME/ORIGIN Tare Manipulation will be Additive
5. Power Cycle Node
    a. Query Axis Resolver Determined Position
    b. Position Axis to Various Locations and Query Resolver Position
    c. Determine if Further Adjustment for Application is Necessary

6. Regardless of Resolver Technology and Design
    a. The Resolver IS NOT Expected to Report Exactly the Same Between Power Cycles; Technology and Designs DO Impact the Variance of the Readings and they will occasionally fluctuate. Host Application Driver software should account for minor variance.
    b. The Scaled UNITS value of the Resolver Position IS Expected to Fluctuate by ONE UNIT when the Resolver Position is on the CUSP of the Translated Resolver Value to UNITS; Mathematical Rounding and Truncation Contribute to This Property

7 Python Scripting Information

Python is utilized for scripting in the bench test environment. The long-term support (LTS) version of Python is utilized.

Python allows for minor differences in the scripting environment to deploy a test framework to different Host Operating Systems: Linux, macOS, and Windows. Portability and testing in different environments lends itself to a better end user experience.

7.1 Installation (Linux, macOS, Windows)

The host bench test environment should be equipped with Python LTS. (e.g., v2.7.x)

Python: https://www.python.org/downloads/

Follow the supplied install instructions; add the following additional packages upon installation of Python. The following commands are issued from a command line prompt.

$ python -m pip install –upgrade pip

$ python -m pip install numpy

$ python -m pip install pyserial

$ python -m pip install parse

7.1.1 Linux Specifics

TBD

7.1.2 macOS Specifics

TBD

7.1.3 Windows Specifics

During the original installation, it is suggested to select adding Python to the PATH; the default leaves the PATH alone.

7.2 Execution of Unit Tests

Individual unit tests can be executed from a command line prompt.

$ python UnitTest.py

8 Firmware Update

Firmware update is possible with specific ROS peripherals. The process is relatively straight forward, but the process should be handled by an advanced end user that is familiar with RS485 cabling, power supply cabling, and bench testing of units.

As the ROS peripherals are environmentally sealed, the process to update firmware uses a cold power on of the unit to trigger the update process. There are no external buttons or switches available to the end user to trigger the update process of a powered-on unit. The end user must be capable to control the power on sequence with a bench power supply.

As the ROS peripherals are required to have a clean wired connection over an RS485 HDX bus, the end user must validate that communications can be established. A poor cable will result in excessive retries to flash update the firmware in the unit. It is prudent to establish that the serial connection to the unit is functional and does not exhibit any garbled or stalling communications with the unit, before firmware update process is started.

8.1 Bench Configuration

The environment for flashing a firmware update is controlled and very specific. The firmware of a node may not be updated in-situ; the firmware of a node can only be updated with the node attached as the only and exclusive unit on an RS485 HDX bus. And as the only unit attached to a bench power supply.

8.1.1 Cabling

The nominal cable will consist of an USB/RS485 HDX adapter dongle, the appropriate whip cable which is then directly attached to the unit receiving firmware update. **Power supplied through the whip should be provided by a bench power supply that can be controlled by the end user.** The end user will be prompted to power on the unit as part of the firmware update process.

The end user must verify that the cabling is connected properly, and that communications can be established with the unit before the firmware update process is attempted. The unit must be the only node on the RS485 HDX bus. It is not possible or supported to upgrade multiple nodes in a batch, or to trigger the firmware update to a single node of a multi-node RS485 HDX bus.

8.2 Flash Firmware Updater

The application is supplied to flash firmware updates to the connected node. Non-volatile parameters may be superseded with defaults depending upon the feature set offered by the firmware. Record all host application non-volatile settings before performing a flash firmware update. The application prerequisites are:

- The node does not carry a payload on any output shaft.
- The node is cabled and attached to the host serial interface as the only; the node is the only and exclusive device on the RS485 bus. The node is attached to a bench power supply that can be controlled manually by the end user.
- The node has previously been setup using a terminal emulator to verify that initial communications is possible. Defaults are set to serial interface for 9600,N,8,1 and ECHO enabled at node.
- The node is powered off before beginning the firmware update process; instructions during the process will be presented to the end user to power on the node.

D:\> **flash-21-30428 --help**

usage: flash-21-30428 [-h] **[-i INTERFACE]** [-b BAUD] [-t TIMEOUT] [--devid DEVID] [--bootaddr BOOTADDR] [--nobootaddr] **hexfile**

The two parameters to be utilized in flashing of the firmware update on the node will specify the interface, and the hexfile. All other parameters should be used as the default; the other parameters are utilized for factory testing.

8.2.1 Positional Arguments

8.2.1.1 hexfile

MCU Firmware hexfile

8.2.2 Optional Arguments

8.2.2.1 -h, --help

Show the help message and exit.

8.2.2.2 -i INTERFACE, --interface INTERFACE

Host serial port interface (defaults to COM3)

8.2.2.3 -b BAUD, --baud BAUD

Serial interface baud rate (defaults to 115200). This parameter is only utilized for factory testing and the end user should not manipulate the baud rate.

8.2.2.4 -t TIMEOUT, --timeout TIMEOUT

RX timeout (defaults to 120). This parameter is only utilized for factory testing and the end user should not manipulate the RX timeout.

8.2.2.5 --devid DEVID

MCU devid (defaults to 1563). This parameter is only utilized for factory testing and the end user should not manipulate the MCU devid.

8.2.2.6 --bootaddr BOOTADDR

MCU bootaddr (defaults to 1024). This parameter is only utilized for factory testing and the end user should not manipulate the MCU bootaddr.

8.2.2.7 *--nobootaddr*

MCU bootaddr used from hexfile. This parameter is only utilized for factory testing and the end user should not manipulate the MCU bootaddr.

8.3 Command Line Firmware Update

The initial state of the unit should be powered off after successful verification of communications with the unit has been established. It is important that the end user verify the cables have been set up properly where communications can be established, and where the bench power supply can be operated by the end user as instructed during the firmware update process.

8.3.1 Linux Specifics

TBD

8.3.2 macOS Specifics

TBD

8.3.3 Windows Specifics

TBD

9 Known Issues

Known issues during operation of the product operation.

9.1 P15 Positioner Resolver

There are known issues with the resolver design in use. A characteristic is described as an intermittent loss of accurate position during rotation. The resolved position remains stable while the node has not been commanded to perform a rotation.

A possible work around is to implement a host application driver solution which only performs a closed loop position query ‘g’ command following a motion command. The axis rotation flag can be queried with the ‘?007’ query command, and then position can be queried once commanded motion has completed.

9.2 Light Current and Temperature Parameters

The light is expected to enter a safety mode upon consumption of 4A of power. The light is expected to DIM. Turn off the Light and allow it to cool down; it is operating outside of design parameters. The nominal operating environment for the Light is submerged in fluid to supply appropriate cooling.

The light is expected to enter a safety mode upon reaching a temperature in excess of ~75 degrees Celsius. The light is expected to DIM. Turn off the Light and allow it to cool down; it is operating outside of design parameters. The nominal operating environment for the Light is submerged in fluid to supply appropriate cooling.