

JNIOR Communications Protocol

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(Series 4 JANOS v1.0.6 and later)

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Contents

Revision History	4
Connection	6
Message Structure	6
Connection Maintenance (Keep Alive)	6
CRC16 Error Check	6
Character Strings	7
Numeric Formatting	7
Byte Ordering	8
Device Identification (IDs)	9
Introduction to a JNIOR protocol Connection	10
Example Messages.....	10
Message Specification	12
Monitor Message – Message Type 1	14
Extended Monitor Message – Message Type 2	15
Request – Message Type 5	16
STARTTLS – TLS Secured Communications	16
Textual Response – Message Type 3	17
Date & Time Response – Message Type 6	17
Set Clock Message – Message Type 7	17
Usage Meter Response – Message Type 8	18
Command Message – Message Type 10	19
ReadRegistryKeys – Message Type 11	21
ReadRegistryKeys Response – Message Type 12	21
WriteRegistryKeys – Message Type 13	22
WriteRegistryKeys Response – Message Type 14	22
SubscribeRegistryKeys – Message Type 15	22
ListRegistry – Message Type 16	23
ListRegistryResponse – Message Type 17	23
UnsubscribeRegistryKeys – Message Type 18	24
ReadDevices – Message Type 21	25
ReadDevicesResponse – Message Type 22	25
Read Device Block Structures	26
jr310 Digital Inputs (din1 – din8) Read Block.....	26
jr310 Relay Outputs (rout1 – rout8) Read Block.....	26
External Sensor Type 10 – Temperature Probe Read Block.....	26
External Sensor Type 12 – Dual Addressable Switch Read Block.....	27
External Sensor Type 1D – 4kbit RAM with Counter Read Block.....	27
External Sensor Type 20 – Quad A/D Converter Read Block.....	27
External Memory Type 23 – 512 Byte EEPROM Memory.....	27
External Sensor Type 26 – Smart Battery Monitor Read Block.....	28
External Sensor Type 28 – Temperature Probe Read Block.....	28
External Sensor Type 2C – Digital Potentiometer Read Block.....	29
External Device Type F9 – 3-Channel LED Dimmer.....	30
External Device Type FA – Rack Mounted User Panel (A1) Read Block.....	30
External Sensor Type FB – 4ROUT Digital Module Read Block.....	31
External Sensor Type FC – RTD Temperature Module Read Block.....	31

External Sensor Type FD – 10V Analog Module Read Block.....	32
External Sensor Type FE – 4-20ma Analog Module	32
WriteDevices – Message Type 23	33
WriteDevices Response – Message Type 24.....	33
Write Device Block Structures	34
jr310 Digital Inputs (din1 – din8) Write Block.....	34
jr310 Relay Outputs (rout1 – rout8) Write Block	34
External Sensor Type 12 – Dual Addressable Switch Write Block	34
External Memory Type 23 – 512 Byte EEPROM Memory.....	35
External Sensor Type 26 – Smart Battery Monitor Write Block	35
External Sensor Type 2C – Digital Potentiometer Write Block	36
External Device Type F9 – 3-Channel LED Dimmer.....	37
External Device Type FA – Rack Mounted User Panel (A1) Write Block.....	39
External Sensor Type FB – 4ROUT Digital Module Write Block.....	41
External Sensor Type FD – 10V Analog Module Write Block.....	42
External Sensor Type FE – 4-20ma Analog Module Write Block	43
SubscribeDevices – Message Type 25	44
EnumerateDevices – Message Type 26	45
EnumerateDevicesResponse – Message Type 27	45
UnsubscribeDevices – Message Type 28	45
GetExternalValue – Message Type 29	46
GetExternalValueResponse – Message Type 30.....	46
SetExternalValue – Message Type 31.....	47
SetExternalValueResponse – Message Type 32	47
NonceRequest – Message Type 128.....	48
NonceResponse – Message Type 127	48
LoginRequest – Message Type 126	48
Anonymous Login.....	49
Encoded Password Transfer.....	49
Login Acknowledgement – Message Type 125	49
Custom Command Response – Message Type 254.....	50
Custom Command – Message Type 255	50
CRC-16 Algorithm	51
Example Transactions	52
CRC Test Strings	54

Revision History

<u>Date</u>	<u>OS Version</u>	<u>Change Description</u>
6/3/2005	v2.01.655	Added the ability to request the Usage Meter content using the Status Request Message (Message Type 5 – Request #2), the ability to reset input and output Usage Meters using the Command Message (Message Type 10 – Commands #8 and #9), and the Usage Meter Response message (Message Type 8). The latter reporting all Usage Meters in millisecond long format.
7/18/2005	v2.02.3	Added JNIOR Protocol functions to return lists of Registry sections and keys. A ListRegistry (Message Type 16) request is used to obtain a list of the entries for any node in the Registry. Those are supplied by the ListRegistryResponse (Message Type 17). Added Reboot function to the Request (Message Type 5 – Request 3).
9/9/2005	v2.03.60	Added Read/Write/Subscribe Device protocol structure. Dropped support for the jr200. Added ability to disable/enable unsolicited Monitor Message transmission to the Request message (type 5). Added block relay controls to the Command message (type 10) allowing relays to be commanded simultaneously. Support added for external sensor types Temperature (10), Dual Addressable Switch (12), Counters (1D), Quad A/D Converter (20), Temperature (28), and Digital Potentiometer (2C).
12/6/2005	v2.03.174	Added support for external EEPROM Memory (23). This component is used to store configuration information for INTEG I/O Net modules.
12/22/2005	v2.03.225	Added login extensions to LoginRequest (message type 126) supporting anonymous and encoded login options.
5/3/2006	v2.11.261	Extended Digital Input and Relay Output device Read Blocks to include the Usage Alarm status. This extends the each by one (1) byte.
6/9/2006	v2.11.269	Added device types for the 4-20ma and 10V analog modules.
9/17/2006	v2.12.51	Support added for DS2438 Smart Battery Monitor external device.
8/8/2007	v2.13.86	Added support for the 4-channel RTD analog temperature module.
4/8/2008	v2.14.17	Added support for the 4 relay digital output module with pulse capability.
3/20/2009	v3.1.3	ROUT9 – ROUT16 using 1 or 2 relay expansion boards was added to the Command Message (type 10). Added Custom Command Support for communications from Ethernet applications using the JNIOR Protocol to external applications running on the JNIOR. Added support for external device channel assignments in messages (types 29 – 32). Up to 2 external devices total may be connected.
2/24/2011	v4.1	Added support for the JNIOR 19" Rack User/Automation Panel (Standard and Enhanced models).

<u>Date</u>	<u>OS Version</u>	<u>Change Description</u>
11/22/2-13	v4.1.1	Add support for STARTTLS (See Message Type 5).

Connection

The JNIOR protocol connection is connection oriented using the TCP/IP protocol. By default the connection is made over port 9200. This is configurable via the use of the `JniorServer/Port` registry key. Multiple connections can be made to the JNIOR. There is a performance hit for each connection made as well as the number of items subscribed to. Item subscriptions can be IO or registry keys.

Since 3.3. In addition to making a connection to the JNIOR protocol server, the JNIOR protocol server can be configured to make a connection to one remote host. This is configured through the `JniorServer/RemoteIP` and `JniorServer/RemotePort` registry keys. The connection is tried every 30 seconds until it is established. If the connection is lost then the connection attempts are resumed. This does not require a reboot.

Message Structure

Each of the following messages (regardless of its source) is transmitted with the following header. If the supplied CRC16 does not match that calculated from the included data then the message should be ignored.

Item	# of Bytes	Content	Defined Values
1	1	Start of header	0x01 (always)
2	2	Length (Short)	N - Count of data bytes in the message
3	2	CRC16 (Short)	CRC for the following message
4	N	Message as defined below	

Connection Maintenance (Keep Alive)

Connections that are not closed properly can linger. Under certain circumstances the server may not be aware that the client has improperly dropped the connection. This can happen if the client device or system is interrupted by the loss of power, reset or otherwise unplugged from the network.

The **JNIOR** continues to service such connections and if after 15 minutes there has not been any communications from the client (neither command nor acknowledgement) the connection will be dropped. This frees resources in the **JNIOR** system and readies the **JNIOR** for additional connections. At that time it is quite possible that the disconnected device or system has reconnected using a new socket.

In order to keep a quiet connection from dropping the client should transmit a single ACK byte (0x06) periodically. This is acceptable at any time when the **JNIOR** would otherwise be ready to receive a command from the client. The **JNIOR** must receive this ACK byte or some other message from the client within 15 minutes of any prior ACK or command message or the connection will be assumed dead and it will be dropped.

CRC16 Error Check

A 16-bit Circular Redundancy Check is used. This calculation is made using only the Message content (N bytes that follow the CRC16 entry).

As it is the implementer's option to ignore the CRC16 on incoming messages, it is also optional for outgoing messages. A CRC16 value of 0xFFFF (-1) will bypass the CRC verification in the **JNIOR**. This is highly useful during development where it may be desirable to first demonstrate function and latter insure accuracy by enabling the error check.

Since the **JNIOR** will happily ignore the CRC16 value if it is set to 0xFFFF (-1) the client should return the favor. A CRC16 value of 0xFFFF (-1) received from **JNIOR** should bypass the client's error check. By design this should never occur as **JNIOR** carefully provides a valid CRC16 value with all transmissions. A symmetrical implementation is recommended for possible future compatibility.

It is highly recommended that the proper Circular Redundancy Check be implemented. An example Java program to generate the CRC is supplied later in this document.

Character Strings

All character strings are encoded with a single byte prefix defining the number of characters to follow. A US_ASCII character set is used. Where Strings appear in the following messages their length is indicated as being variable. In fact the encoded string uses one byte more than the number of characters. For example the string "Hello World" will be transmitted in order from left to right as follows:

0x0B	'H'	'e'	'l'	'l'	'o'	' '	'W'	'o'	'r'	'l'	'd'
------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Numeric Formatting

The header and messages may contain multiple-byte numeric values which are generally unsigned integer values although other formats may be used. The following formats are referenced:

byte	Single byte representing 0x00 to 0xFF (hexadecimal) 0 to 255 (unsigned) -128 to -127 (signed) Used typically for string lengths.
short	2-Byte integer value representing 0x0000 to 0xFFFF (hexadecimal) 0-65535 (unsigned) -32768 to 32767 (signed). Used typically for message lengths, CRC16 error checks, integer counts and identifiers.
int	4-Byte integer value representing 0x00000000 to 0xFFFFFFFF (hexadecimal) 0 to 4294967295 (unsigned) -2147483648 to 2147483647 (signed) Used typically for long term tallies and time intervals.

long	8-Byte integer value representing 0x0000000000000000 to 0xFFFFFFFFFFFFFFFF (hexadecimal) 0 to 2 ⁶⁴ -1 (unsigned) -2 ⁶³ to 2 ⁶³ -1 (signed) Used typically for absolute time and date.
double	8-byte value in IEEE 754 64-bit double-precision binary floating-point format.

Care must be taken to properly read, write, promote and calculate integers supplied through this protocol using signed or unsigned values as appropriate. The automatic sign extension that might occur when casting a *byte* value into an *int* integer value or a *short* integer value into an *int* integer value can raise havoc with protocol processing.

Byte Ordering

When acquiring a multiple-byte numeric value the byte order as transmitted across the network is important. Clearly the bytes of an integer value when taken in reverse order will result in a dramatically different value. These numeric values must be properly assembled from the data being received byte-by-byte through the network connection. The **JNIOR** Protocol uses *big-endian* byte ordering.

big-endian: adj.

Describes a computer architecture in which, within a given multi-byte numeric representation, the most significant byte has the lowest address (the word is stored 'big-end-first'). Most processors, including the IBM 370 family, the PDP-10, the Motorola microprocessor families, and most of the various RISC designs are big-endian. Big-endian byte order is also sometimes called network order.

A format for storage or transmission of binary data in which the most significant bit (or byte) comes first. The term comes from "Gulliver's Travels" by Jonathan Swift. The Lilliputians, being very small, had correspondingly small political problems. The Big-Endian and Little-Endian parties debated over whether soft-boiled eggs should be opened at the big end or the little end. [Source: The Network Working Group Internet Glossary RFC 1392]

Java data streams format these numeric values by writing the most significant byte first using big-endian as is common in the network world. Java applications and applets can easily manipulate values passed through the **JNIOR** Protocol. C/C++, Visual Basic and similar language programmers need to take extra care in constructing values as these languages use the *little-endian* byte order employed by Intel processors and the standard Personal Computer.

Device Identification (IDs)

Each JNIOR input and output can be envisioned as an independent device. This would also include any additional components connected to the external Sensor Port. Each device is assigned a permanent identification. This is an unsigned 64-bit (8 byte) value. For external devices the ID may be obtained from its labeling, documentation or through discovery using the EnumerateDevices request.

The IDs may convey additional information about the device. The least significant byte of the ID for those external devices connected through the sensor port provides an indication of the device type (one-wire devices). The internal device IDs (type FF) are assigned as follows:

jr310 Internal Devices	
Inputs	
din1	0x0000000000000001FF
din2	0x0000000000000002FF
din3	0x0000000000000003FF
din4	0x0000000000000004FF
din5	0x0000000000000005FF
din6	0x0000000000000006FF
din7	0x0000000000000007FF
din8	0x0000000000000008FF
Outputs	
rou1	0x000000000000101FF
rou2	0x000000000000102FF
rou3	0x000000000000103FF
rou4	0x000000000000104FF
rou5	0x000000000000105FF
rou6	0x000000000000106FF
rou7	0x000000000000107FF
rou8	0x000000000000108FF
rou9	0x000000000000109FF
rou10	0x00000000000010AFF
rou11	0x00000000000010BFF
rou12	0x00000000000010CFF
rou13	0x00000000000010DFF
rou14	0x00000000000010EFF
rou15	0x00000000000010FFF
rou16	0x000000000000110FF

Introduction to a JNIOR protocol Connection

This section is an introduction into the methods and logistics for communicating from an application residing on a personal computer (or other device) with the JNIOR 310 utilizing the JNIOR Protocol over an Ethernet network using TCP. This document is an introduction to the more detailed document describing the JNIOR Protocol. The JNIOR Protocol document describes the various communication messages that are sent back and forth between the JNIOR and an application over the Ethernet to read and write to the JNIOR I/O and other settings.

The JNIOR device acts as a server for the TCP communications. The default setting is for the JNIOR to listen and accept connections coming in over the Ethernet on port 9200. [NOTE: This port is a configurable setting that can be altered via the JNIOR registry. The registry key for this setting is JniorServer/Port. The registry key can be changed from the main JNIOR web page and/or via a Telnet window using the Registry editor. These are further described in the JNIOR Web Based Interface Manual and Command Line Communications Manual.] The remote application makes the initial contact with the JNIOR by creating a socket connection to the JNIOR. In order to receive a response from the JNIOR, you must either successfully login or disable login by modifying the appropriate JNIOR Registry setting. After a successful login, the JNIOR automatically sends out the Monitor message with any changes in the I/O state. The Monitor message contains the status of all the I/O and is described in the JNIOR Protocol document. The remote application can parse this message and get the desired information.

The following is a summary of what a programmer should initially expect when implementing the JNIOR protocol.

1. Establish a socket connection over port 9200 and login with a valid user name and password (**message type 126**). “jnior”, “jnior” is the default admin user name and password.
2. Based on the login user name and password, the JNIOR will reply with the login acknowledgement message (**message type 125**) alerting the application of the security level granted.
3. The JNIOR will issue a Monitor message (**message type 1**). This monitor message has information about the JNIOR and the current I/O states.

Once connected and logged in, the application can communicate with the JNIOR by following the JNIOR protocol and issuing any of the commands. The login is necessary before any commands are sent to the JNIOR with the exception of registry reads (**message type 11**).

Please note, that when you send an I/O command to the JNIOR, a Monitor message (**type 1**) does not automatically get returned. The Monitor message (**message type 1**) only gets returned after I/O commands that actually cause the I/O states to alter. The Monitor message is automatically issued with each change in I/O state unless the Monitor message was disabled.

For those requiring finer control of the Ethernet messages, the user application can issue a command to the JNIOR disabling the Monitor message using the Request message (**type 5**) for the current connection (it is not global for all connections, only for this particular connection because multiple connections can be made to the JNIOR at the same time). The user would then issue a command to Subscribe (**message type 15**) to various I/O points. The JNIOR will then notify this particular connection of the change in the subscribed to I/O points.

If you need to continuously interact with the JNIOR I/O, it is better to leave the connection open. However, the JNIOR has a 15 minute timeout such that if it doesn't see any activity on a particular connection, it will close the connection. This is a failsafe so that unused connections do not build on the JNIOR should the Ethernet link be physically broken or the other application stop. In order to keep the connection active, a “keep alive” message needs to be sent to the JNIOR approximately every 10 minutes. This is described in the JNIOR Protocol document on page 5 – Connection Maintenance (Keep Alive).

Example Messages

The following example messages were captured using WireShark, formerly Ethereal. WireShark is an exceptional tool for debugging the implementations of communication protocols. This gives you a sample of the format of the messages you will be receiving and sending.

Monitor (message type 1)

```
01 00 60 68 85 01 0e 6a 72 33 31 30 20 76 32 2e ..`h...j r310 v2.
31 34 2e 31 37 00 00 00 00 00 00 00 00 00 00 00 14.17... ..
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 01 .....
19 33 ca 9f eb .3...
```

Login Request Message (type 126)

```
01 00 0d 60 b7 7e 05 6a 6e 69 6f 72 05 6a 6e 69 ...`.~.j nior.jni
6f 72 or
```

Login Response Message (type 125)

```
01 00 02 f0 20 7d 80 .... }.
```

Read Registry Keys Message (type 11)

```
01 00 13 be 61 0b 00 01 00 de 0d 24 53 65 72 69 ....a... ..$Seri
61 6c 4e 75 6d 62 65 72 alNumber
```

Registry Response Message (type 12)

```
01 00 0f 9e d2 0c 00 01 00 de 09 31 30 35 31 30 ..... ...10510
30 33 32 38 0328
```

Message Specification

A number of messages are available as payload within the **JNIOR** Protocol. These messages will be either transmitted by the **JNIOR** or received by **JNIOR** following the Message Header. The following are available.

Message Type	Description
1	Monitor Message ¹ JNIOR sends this message when a connection is logged in and then afterwards whenever the status changes (input or output changes state).
2	External Monitor Message ¹ JNIOR sends this message when the digital expansion I/O is being used. This message is sent whenever the status of any digital I/O (internal or external) changes.
3	Textual Response JNIOR supplies a general textual message. These messages may contain one of more lines terminated with newline characters (single LF 0x0A).
5	Request ¹ Requests action from JNIOR. JNIOR replies with the appropriate response.
6	DateTime Response JNIOR sends this message in response to a DateTime Status request.
7	Set Clock Command ¹ Provides a means to set the JNIOR clock.
8	Usage Meter Response Reports the high resolution usage meter content.
10	Command Message ¹ This message is sent to the JNIOR to request various actions such as, for example, a change in output state.
11	ReadRegistryKeys A request sent to JNIOR listing the Registry Keys for which values are needed. The client assigns IDs to each key to facilitate processing the response.
12	ReadRegistryKeys Response The list of Registry Key values along with the associated ID sent by JNIOR in response to a ReadRegistryKeys request. Note that values are returned ONLY for existing keys. It is the client's responsibility to assign default values for those keys not present. This message is also sent unsolicited when Registry subscriptions are used.
13	WriteRegistryKeys ² A list sent to JNIOR containing pairs of Registry Keys and values. JNIOR updates the Registry with the new Key content.
14	WriteRegistryKeys Response JNIOR acknowledges a WriteRegistryKeys request with this message.
15	SubscribeRegistryKeys A request sent to JNIOR listing the Registry Keys of which values are needed. The format of this request is identical to the ReadRegistryKeys request and JNIOR sends the ReadRegistryKeys Response. Subsequently should the values for any of those keys change, JNIOR will send another ReadRegistryKeys Response message with the updated values. The subscriptions are cancelled when the connection is closed.
16	ListRegistry ² A request sent to JNIOR to obtain the list of Registry Sub-sections and key names present at the specified section node.
17	ListRegistryResponse JNIOR responds to a ListRegistry request with this message.
18	UnsubscribeRegistryKeys This command is used to unsubscribe from previously subscribed registry keys.
21	ReadDevices ¹ A request sent to JNIOR to obtain device status/content for one or more device IDs. Both internal and external I/O is supported.

Message Type	Description
22	ReadDevicesResponse Message contains the device status/content for each requested by ReadDevices. This will also be sent unsolicited when SubscribeDevices is used.
23	WriteDevices ¹ Provides new status/content for one or more devices. This is used to command outputs or to configure devices.
24	WriteDevicesResponse JNIOR acknowledges a WriteDevices request with this message.
25	SubscribeDevices ¹ A request sent to JNIOR requesting the status/content of one of more devices. The format of this request is identical to the ReadDevices request and JNIOR sends the ReadDevices Response. Subsequently should the status for any of those devices change, JNIOR will send another ReadDevicesResponse message with the updated status/content. The subscriptions are cancelled when the connection is closed.
26	EnumerateDevices ² A request sent to JNIOR for an enumeration of available devices.
27	EnumerateDevicesResponse JNIOR responds to an EnumerateDevices with a list of active device IDs present in the current hardware configuration. This contains both internal and external devices.
28	UnsubscribeDevices This will unsubscribe the given devices from the current connection
29	GetExternalValue Each connected external device can be enumerated by the JNIOR OS and assigned channel numbers. This command allows a user to request a value by channel number for a device type
30	GetExternalValueResponse JNIOR responds with the scaled value of the desired IO. The scaling information can be set in the registry or by the JNIOR Web Page. Outputs are returned on a scale of 0 – 100%
31	SetExternalValue Each connected external device can be enumerated by the JNIOR OS and assigned channel numbers. This command allows a user to set a value by channel number for a device type. Outputs are entered on a scale of 0 – 100%
32	SetExternalValueResponse JNIOR responds with the scaled value of the desired IO. The scaling information can be set in the registry or by the JNIOR Web Page. The returned value mimics the set value.
125	Login Acknowledgement Sent by JNIOR in response to a LoginRequest.
126	LoginRequest ³ Provides a username and password (clear text) for login. The user must be valid previously assigned.

¹ By default requires successful Login.

² By default requires successful Login by administrator.

³ Requirement may be disabled using the JniorServer/Login Registry key.

Monitor Message – Message Type 1

Note that the Monitor Message is NOT fixed-length. The version string is variable length and will change with software version. Therefore, the location of any particular I/O status relative to the start of the message will vary. The location of the I/O information may be calculated using the length of the version string which is always the second byte in the message. Recall that strings are sent with a preceding length byte.

Item	# of Bytes	Content	Defined Values
1	1	Message Type	(1 = Monitor message from JNIOR)
2	Variable	JNIOR Software Version (String)	"jrNNN #.##.####" where NNN indicates the Model Number and # digits in the current OS version.
Following Block (Items 3-7) Repeated For Each DIN1 – DIN8			
3	1	Present State	0 = Off, 1 = On
4	1	Alarm State	1 = alarm
5	4	Count (int)	
6	1	Count Alarm 1	1 if Count exceeds Alarm 1
7	1	Count Alarm 2	1 if Count exceeds Alarm 2
Following Item (8) Repeated For Each ROUT1 – ROUT8			
8	1	Present State	0 = Open, 1 = Closed
9	8	Date and Time (long)	Number of milliseconds since January 1, 1970 00:00:00 GMT

Extended Monitor Message – Message Type 2

The External Monitor Message is available for the Model 312/412 to report relay states for ROUT9 through ROUT12 and also when external digital expansion I/O modules (4ROUT) are used. The message is sent whenever the status of any digital I/O (internal or external) changes.

Item	# of Bytes	Content	Defined Values
1	1	Message Type	(2 = External Monitor message from JNIOR)
2	1	Count	The number of digital INPUTS on the Expansion Modules. FUTURE USE so value should be 0.
Following Item (3) Repeated For Each DIN9 – DIN16 (FUTURE Digital Inputs)			
3	1	Present State	0 = Off, 1 = On (FUTURE)
4	1	Count	The number of relay OUTPUTS on the Expansion Modules. (value will be 4 or 8)
Following Item (5) Repeated For Each ROUT9 – ROUT16 (Digital Outputs)			
5	1	Present State	0 = Open, 1 = Closed, 0xFF Inactive
6	8	Date and Time (long)	Number of milliseconds since January 1, 1970 00:00:00 GMT

The JNIOR automatically determines the number of inputs or outputs available for the specific JNIOR model and the available Expansion Modules.

The associated Relay Output number (9 through 16) is determined by the JNIOR based on the order the modules are recognized by the JNIOR on the initial boot-up (Series 3). Refer to the EXTERN command for Series 4 JANOS based units.

The Series 3 units configure the external 4ROUT assignments at boot. Here are several scenarios:

- If the user connects 1 Relay Output Expansion Module to the Sensor Port and then applies power to the JNIOR (or reboots it) the JNIOR will assign the 4 relay outputs as outputs 9 – 12.
- If the user then adds a second Relay Output Expansion Module and reboots the JNIOR, the JNIOR will assign the outputs on the second module as 13 – 16.
- If the user disconnects the first module and reboots the JNIOR, the JNIOR will continue to maintain the addresses of the second module as outputs 13 – 16.
- If the user re-connects the original first expansion module (or a different one) and reboots, the JNIOR will assign these outputs as 9 – 12.
- If the user unplugs all expansion modules and reboots, the numbering process will start over again the next time an expansion module is added.

The Series 4 units configure 4ROUT assignments as the units are first seen. You may reset the assignments using the EXTERN command at the command line or through Registry modifications.

These methods were implemented to allow the user to add new modules or change failed modules without requiring software changes.

The relay output numbering sequence being used for each expansion module is stored and displayed as a Registry Key in the JNIOR. For the Relay Output Expansion Modules, the keys are viewed in the IO/Outputs registry folder (Series 3) or the Externals/DeviceOrder registry folder (Series 4).

Request – Message Type 5

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	5 = Request message
2	2	Request (short)	0 = Date and Time 1 = Monitor Message Request 2 = Usage Meter Request 3 = Reboot Request 4 = Disable Monitor Messages 5 = Enable Monitor Messages 6 = STARTTLS
3	4	Interval (int) Required for Monitor Message Request	Defines an interval in milliseconds. 0 indicates infinity.

The Interval field is optional and may or may not be included in messages. It is used with the Monitor Message Request to specify a new interval in milliseconds at which Monitor Messages will be sent. By default a Monitor Message is transmitted upon initial login (or connection if login disabled) and whenever the states of inputs/outputs have changed.

If external digital I/O modules are being used, whenever the user sends the Monitor Message Request, the External Monitor Message will also be sent.

Request 3 is available to Administrator logins. There is no response. The JNIOR communications connection is immediately terminated and a shutdown commences. You may reconnect in about 60 seconds.

STARTTLS – TLS Secured Communications

The Model 410 provides for secured communications through Transport Layer Security (TLS). To upgrade a protocol connection to use a secured connection, issue the Request Message with Request 6. The JNIOR will respond with a “200 TLS v1.0 enabled” response using the general textual Response Message Type 3. The client may then begin the standard TLS v1.0 negotiation. There will be no response to this message if it is issued to a JNIOR that does not support TLS secured communications.

Textual Response – Message Type 3

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	3 = Textual Data
2	N	ASCII byte data	One or more lines of text terminated with a newline character (0x0A). The overall message includes a null (0x00) terminator.

Date & Time Response – Message Type 6

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	6 = DateTime response message
2	8	Date and Time (long)	Number of milliseconds since January 1, 1970 00:00:00 GMT

Set Clock Message – Message Type 7

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	7 = Set Clock Message
2	8	Date and Time (long)	Number of milliseconds since January 1, 1970 00:00:00 GMT

Usage Meter Response – Message Type 8

Usage Meters report the number of milliseconds that the corresponding input or relay output has been in the “on” or “closed” state respectively (default). This may be inverted separately for each input or output using the `UsageState` Registry key so that usage is tallied with the input in the “off” state or relay in the “open” state.

An array of 16 usage meters is returned. The values apply to inputs and outputs according to the model of Series 4 JNIO.

Item	# of Bytes	Content	Defined Values
1	1	Message Type	8 = Usage Meter Response
2	8	din1	milliseconds (long)
3	8	din2	milliseconds (long)
4	8	din3	milliseconds (long)
5	8	din4	milliseconds (long)
6	8	din5 412:rout1	milliseconds (long)
7	8	din6 412:rout2	milliseconds (long)
8	8	din7 412:rout3	milliseconds (long)
9	8	din8 412:rout4	milliseconds (long)
10	8	rout1 412:rout5 414:din9	milliseconds (long)
11	8	rout2 412:rout6 414:din10	milliseconds (long)
12	8	rout3 412:rout7 414:din11	milliseconds (long)
13	8	rout4 412:rout8 414:din12	milliseconds (long)
14	8	rout5 412:rout9 414:rout1	milliseconds (long)
15	8	rout6 412:rout10 414:rout2	milliseconds (long)
16	8	rout7 412:rout11 414:rout3	milliseconds (long)
17	8	rout8 412:rout12 414:rout4	milliseconds (long)
18	8	Date and Time (long)	Number of milliseconds since January 1, 1970 00:00:00 GMT

Command Message – Message Type 10

The Command Message structure varies depending on the parameter requirements.

Item	# of Bytes	Content	Defined Values																																																				
1	1	Message Type (byte)	10 = Command message																																																				
2	1	Action (byte)	1 = close relay output 2 = open relay output 3 = toggle relay output 4 = reset input latch 5 = clear input counter 8 = clear input usage meter 9 = clear output usage meter																																																				
3	2	Channel (short)	selected digital input or relay output as appropriate. <table border="1"> <thead> <tr> <th>Channel</th> <th>2 Bytes</th> <th>Inputs</th> <th>Outputs</th> </tr> </thead> <tbody> <tr><td>1</td><td>00 01</td><td>din1</td><td>rout1</td></tr> <tr><td>2</td><td>00 02</td><td>din2</td><td>rout2</td></tr> <tr><td>3</td><td>00 03</td><td>din3</td><td>rout3</td></tr> <tr><td>4</td><td>00 04</td><td>din4</td><td>rout4</td></tr> <tr><td>5</td><td>00 05</td><td>din5</td><td>rout5</td></tr> <tr><td>6</td><td>00 06</td><td>din6</td><td>rout6</td></tr> <tr><td>7</td><td>00 07</td><td>din7</td><td>rout7</td></tr> <tr><td>8</td><td>00 08</td><td>din8</td><td>rout8</td></tr> <tr><td>9</td><td>00 09</td><td>din9</td><td>rout9</td></tr> <tr><td>10</td><td>00 0A</td><td>din10</td><td>rout10</td></tr> <tr><td>11</td><td>00 0B</td><td>din11</td><td>rout11</td></tr> <tr><td>12</td><td>00 0C</td><td>din12</td><td>rout12</td></tr> </tbody> </table> Usage is monitored for internal inputs and relay outputs only.	Channel	2 Bytes	Inputs	Outputs	1	00 01	din1	rout1	2	00 02	din2	rout2	3	00 03	din3	rout3	4	00 04	din4	rout4	5	00 05	din5	rout5	6	00 06	din6	rout6	7	00 07	din7	rout7	8	00 08	din8	rout8	9	00 09	din9	rout9	10	00 0A	din10	rout10	11	00 0B	din11	rout11	12	00 0C	din12	rout12
Channel	2 Bytes	Inputs	Outputs																																																				
1	00 01	din1	rout1																																																				
2	00 02	din2	rout2																																																				
3	00 03	din3	rout3																																																				
4	00 04	din4	rout4																																																				
5	00 05	din5	rout5																																																				
6	00 06	din6	rout6																																																				
7	00 07	din7	rout7																																																				
8	00 08	din8	rout8																																																				
9	00 09	din9	rout9																																																				
10	00 0A	din10	rout10																																																				
11	00 0B	din11	rout11																																																				
12	00 0C	din12	rout12																																																				

The Command Message specifying a **pulse** requires an additional parameter. This command will pulse the given output high for the specified duration. Note: If you wish to pulse an output low you must use the block pulse action parameter as part of the command message.

Item	# of Bytes	Content	Defined Values				
1	1	Message Type (byte)	10 = Command message				
2	1	Action (byte)	6 = pulse relay output				
3	2	Channel (short)	selected digital input or relay output as appropriate. <table border="1"> <thead> <tr> <th>Channel</th> <th>jr310</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>routx</td> </tr> </tbody> </table> <p>Where x = 1 through 16 (see previous table)</p>	Channel	jr310	X	routx
Channel	jr310						
X	routx						
4	4	Pulse Duration (Int)	Pulse length in milliseconds				

The Command Message that is used to perform **block I/O** (changing relay states simultaneously) requires a combination of a mask byte to select the affected outputs and a byte defining the resulting state for those outputs. The changes may optionally be pulsed.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	10 = Command message
2	1	Action (byte)	7 = block pulse relay states 10 = block change relay states
3	1	Channel Select Mask	Byte indicating channels affected by this command. Bits set to 1 will be changed. LSB represents channel 1 and MSB channel 8.
4	1	Relay State	Defines the state of the relays affected. A 1 indicates closed and a 0 open. LSB represents channel 1 and MSB channel 8.
5	4	Pulse Duration (int) Required for Pulse only	Pulse length in milliseconds

A maximum of 31 pulse requests may be queued at any one time. Each pulse will complete in its entirety before the next is begun. Relays return to their original state upon completion.

The Command Message that is used with the **Relay Output Expansion Modules** to perform **block I/O** (changing relay states simultaneously) requires two bytes to implement the mask byte that selects the affected outputs and two bytes to define the resulting state for those outputs. This Command Message can thus handle the 8 internal relay outputs and up to 2 external Relay Output Expansion Modules for a total of 16 relay outputs. The changes may optionally be pulsed. The JNOR uses the message length to determine which of the two Command Messages for pulsing are being sent because of the different lengths for the channel select mask and the relay state mask.

IMPORTANT: Please make sure that the length field is correct in the message header.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	10 = Command message
2	1	Action (byte)	7 = block pulse relay states 10 = block change relay states
3	2	Channel Select Mask (short)	Byte indicating channels affected by this command. Bits set to 1 will be changed. LSB represents channel 1 and MSB channel 16.
4	2	Relay State (short)	Defines the state of the relays affected. A 1 indicates closed and a 0 open. LSB represents channel 1 and MSB channel 16.
5	4	Pulse Duration (int) Required for Pulse only	Pulse length in milliseconds

A maximum of 31 pulse requests may be queued at any one time. Each pulse request on the internal outputs will complete in its entirety before the next request is begun. The external relay outputs differ from the internal relay outputs in that the pulse duration can be changed by sending a new command and new pulse commands can be initiated on the other expansion relay outputs while one of the expansion relay outputs is already executing a pulse command. Relays return to their original state upon completion.

ReadRegistryKeys – Message Type 11

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	11 = ReadRegistryKeys message
2	2	Count (short)	The number of Registry Keys requested
Following Block (Items 3 & 4) Repeated For Each Requested Key			
3	2	Unique ID (short)	A unique integer identifying the Registry Key.
4	Variable	Registry Key (String)	The Registry Key identification.

ReadRegistryKeys Response – Message Type 12

This message will be received in response to either the ReadRegistryKeys or SubscribeRegistryKeys request. When the SubscribeRegistryKeys request has been used this response message may be subsequently returned (unsolicited) whenever a subscribed key value changes. If a requested Registry Key does not exist, or in the case of a subscribed key and the key has been removed, this message will include the key’s Unique ID followed by a null string (string of length zero). No matter how the Registry Key is requested it will be returned at least once whether or not it exists in the Registry.

The returned key value is formatted as it appears in the jnior.ini file with multiple values (if present) separated by commas with double quotation marks and escaping used as required. It is recommended that the user’s application parse the returned string to retrieve the desired value. A key that may usually contain only one value would appear properly if used directly in many cases but if a second element happens to be added to the JNIOR Registry both elements may be inappropriately used unless properly handled.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	12 = ReadRegistryKeys Response message
2	2	Count (short)	The number of Registry Key Values to follow
Following Block (Items 3 & 4) Repeated For Each Key Value			
3	2	Unique ID (short)	The unique identifier for the associated Registry Key copied from the ReadRegistryKeys request message.
4	Variable	Registry Key Value (String)	The Registry Key value as obtained from the Registry.

WriteRegistryKeys – Message Type 13

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	13 = WriteRegistryKeys message
2	2	Count (short)	The number of Registry Keys and Values to follow
Following Block (Items 3 & 4) Repeated For Each Key-Value Pair			
3	Variable	Registry Key (String)	The Registry Key Identification.
4	Variable	Registry Key Value (String)	The Registry Key value.

WriteRegistryKeys Response – Message Type 14

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	14 = WriteRegistryKeys Response message
2	2	Count (short)	The number of Registry Keys successfully written.

SubscribeRegistryKeys – Message Type 15

Note: With the exception of the Message Type byte this message is physically identical to the ReadRegistryKeys request (Message Type 11). JNIOR responds with a ReadRegistryKeys Response (Message Type 12). A subscription is entered for the connection and an additional ReadRegistryKeys Response message will be spontaneously transmitted whenever a subscribed key changes value.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	15 = SubscribeRegistryKeys message
2	2	Count (short)	The number of Registry Keys requested
Following Block (Items 3 & 4) Repeated For Each Requested Key			
3	2	Unique ID (short)	A unique integer identifying the Registry Key.
4	Variable	Registry Key (String)	The Registry Key identification.

ListRegistry – Message Type 16

Registry keys imply a structure much like the directory structure of the file system. Each *node* of the tree in the structure may contain the name of a Registry Key and the name of any sub-sections (folders). The ListRegistry request is used to obtain a list of sub-section and key names for any given node.

The Registry node is specified without leading '/' or trailing '/' and specifies the complete path to the specific Registry section from the Registry Root. The Registry Root is specified with a null or empty string (zero length).

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	16 = ListRegistry message
2	Variable	Registry Node (String)	Specifies the sub-section or node of the Registry for which the list is requested.

ListRegistryResponse – Message Type 17

JNIOR responds to a ListRegistry request with a ListRegistryResponse in all cases even if the Registry section or node is empty or does not exist. The response contains the list of local entries. If an entry represents a node with further substructure, the returned name will include a trailing '/'. Otherwise the entry represents a Registry Key and the value of that Key may be obtained with the ReadRegistryKey or SubscribeRegistryKey requests.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	17 = ListRegistryResponse message
2	2	Count (short)	The number of Registry names to follow. Zero (0) if there are no entries
Following Item 3 Repeated For Each Name Value			
3	Variable	Registry Name Value (String)	The Registry Name as it exists at the specified node. Nodes with further substructure are indicated by a trailing '/'.

The Registry names are returned in no specific order.

UnsubscribeRegistryKeys – Message Type 18

Use this command to unsubscribe from previously subscribed registry keys.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	18 = UnsubscribeRegistryKeys message
2	2	Count (short)	The number of Registry names to follow. Zero (0) if there are no entries
Following Item 3 Repeated For Each Name Value			
3	Variable	Registry Name Value (String)	The Registry Name as it exists at the specified node. Nodes with further substructure are indicated by a trailing '/

The Registry names are returned in no specific order.

ReadDevices – Message Type 21

This requests the status/content for each of the devices listed. The returned status/content is device dependent.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	21 = ReadDevices message
2	2	Count (short)	The number of Device IDs to follow.
Item #3 Repeated for the Count indicated			
3	8	Device ID (unsigned long)	

ReadDevicesResponse – Message Type 22

This message will be received in response to either the ReadDevices or SubscribeDevices request. When the SubscribeDevices request has been used this response message may be subsequently returned (unsolicited) whenever a subscribed device status changes. What actually constitutes a device status *change* is device dependent. In some cases that may be configurable.

The returned byte array contains a structure that is also device dependent. If a requested Device does not exist this message will include the Device ID followed by an empty byte array.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	22 = ReadDevicesResponse message
2	2	Count (short)	The number of Device Reports to follow.
Following Items 3 - 5 Repeated For Each Device Report			
3	8	Device ID (unsigned long)	
4	2	Length (short)	Length in bytes of the following Device Block.
5	Variable	Device Block. (byte array)	Contains device dependent structure.

The Devices are reported in no specific order.

Read Device Block Structures

The byte array returned by the ReadDevicesResponse contains a structure that is device dependent. This varies depending on the type of device and its capabilities. The following defines those structures for the internal devices and known external devices. Note that the size of the byte array returned may vary with each ReadDevicesResponse and should not be assumed to be constant for any particular device.

jr310 Digital Inputs (din1 – din8) Read Block

Item	# of Bytes	Content	Defined Values
1	1	Present State	0 = Off, 1 = On
2	1	Alarm State	1 = alarm
3	4	Count (int)	
4	1	Count Alarm 1	1 if Count >= Alarm 1 setpoint
5	1	Count Alarm 2	1 if Count >= Alarm 2 setpoint
6	8	Usage Meter (long)	milliseconds "on"
7	1	Usage Alarm	1 if Usage >= Alarm setpoint
17 bytes Total Length			

jr310 Relay Outputs (rout1 – rout8) Read Block

Item	# of Bytes	Content	Defined Values
1	1	Present State	0 = Open, 1 = Closed
2	8	Usage Meter (long)	milliseconds "on"
3	1	Usage Alarm	1 if Usage >= Alarm setpoint
10 bytes Total Length			

External Sensor Type 10 – Temperature Probe Read Block

Item	# of Bytes	Content	Defined Values
1	8	Temperature (double)	Current temperature in degrees Celsius. Conversions take from 500 to 750 milliseconds. Resolution is 0.0625 degrees Celsius.
8 bytes Total Length			

External Sensor Type 12 – Dual Addressable Switch Read Block

Item	# of Bytes	Content	Defined Values
1	1	Channel A Level (byte)	0=low, 1=high
2	1	Channel B Level (byte)	0=low, 1=high
2 bytes Total Length			

External Sensor Type 1D – 4kbit RAM with Counter Read Block

Item	# of Bytes	Content	Defined Values
1	4	Channel A Count (unsigned int)	
2	4	Channel B Count (unsigned int)	
8 bytes Total Length			

Note: RAM access not available.

External Sensor Type 20 – Quad A/D Converter Read Block

Item	# of Bytes	Content	Defined Values
1	2	Channel A (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF full scale.
2	2	Channel B (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF full scale.
3	2	Channel C (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF full scale.
4	2	Channel D (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF full scale.
8 bytes Total Length			

External Memory Type 23 – 512 Byte EEPROM Memory

Item	# of Bytes	Content	Defined Values
1	512	Memory content (byte array)	Contains Reserved and Free memory areas configured per the application.
512 bytes Total Length			

External Sensor Type 26 – Smart Battery Monitor Read Block

Item	# of Bytes	Content	Defined Values
1	1	Status Register **	See Write Block fir detail
2	1	Temperature LSB	Degrees C Combine to Signed Integer and divide by 256.0 for reading.
3	1	Temperature MSB	
4	1	Voltage LSB	Volts Combine to Unsigned Integer and divide by 100.0 for reading.
5	1	Voltage MSB	
6	1	Current LSB	Volts ** Combine to Signed Integer and multiply by 0.002441 for reading.
7	1	Current MSB	
8	1	Threshold **	read only
8 bytes Total Length			

** Refer to Dallas/Maxim DS2438 Datasheet for details.

External Sensor Type 28 – Temperature Probe Read Block

Item	# of Bytes	Content	Defined Values
1	8	Temperature (double)	Current temperature in degrees Celsius. Conversions take from 500 to 750 milliseconds. Resolution is 0.0625 degrees Celsius.
8 bytes Total Length			

External Sensor Type 2C – Digital Potentiometer Read Block

Item	# of Bytes	Content	Defined Values
1	1	Feature Register (byte)	(see below)
2	1	Control Register (byte)	(see below)
3	1	Wiper Position (byte)	
3 bytes Total Length			

Feature Register

D7	D6	D5	D4	D3	D2	D1	D0
PR		NWP		NP		WSV	PC

PC 0: logarithmic potentiometer element(s)
1: linear potentiometer element(s)

WSV 0: wiper position(s) non-volatile
1: wiper position(s) volatile

NP 00: device contains 1 potentiometer
01: device contains 2 potentiometers
10: device contains 3 potentiometers
11: device contains 4 potentiometers

NWP 00: 5-bit (32 positions)
01: 6-bit (64 positions)
10: 7-bit (128 positions)
11: 8-bit (256 positions)

PR 00: 5K Ohm resistance
01: 10K Ohm resistance
10: 50K Ohm resistance
11: 100K Ohm resistance

Control Register

D7	D6	D5	D4	D3	D2	D1	D0
X	CPC	X	X	IWN		WN	

WN 00: select potentiometer 1
01: select potentiometer 2
10: select potentiometer 3
11: select potentiometer 4

IWN 1's complement of WN

CPC 0: charge pump OFF
1: charge pump ON

X don't care

External Device Type F9 – 3-Channel LED Dimmer

Item	# of Bytes	Content	Defined Values
1	2	Output Channel 1 (unsigned short) RED	Raw 16-bit setting 0x0000 to 0xFFFF full scale.
2	2	Output Channel 2 (unsigned short) GREEN	Raw 16-bit setting 0x0000 to 0xFFFF full scale.
3	2	Output Channel 3 (unsigned short) BLUE	Raw 16-bit setting 0x0000 to 0xFFFF full scale.
4	2	Output Channel 4 (unsigned short) WHITE	unused
5	2	Channel 1 Slew Rate (unsigned short)	Milliseconds (3000 default)
6	2	Channel 2 Slew Rate (unsigned short)	Milliseconds (3000 default)
7	2	Channel 3 Slew Rate (unsigned short)	Milliseconds (3000 default)
8	2	Channel 4 Slew Rate (unsigned short)	unused
16 bytes Total Length			

External Device Type FA – Rack Mounted User Panel (A1) Read Block

Item	# of Bytes	Content	Defined Values
1	2	Switch Function Status	Bits D0 thru D11 correspond to Switch Functions F1 thru F12. (0 = Clear, 1 = Pressed/Activated)
2	2	LED State	Bits D0 thru D11 correspond to LEDs L1 thru L12. (0 = Off, 1 = On/Flashing)
4 bytes Total Length			

External Sensor Type FB – 4ROUT Digital Module Read Block

Item	# of Bytes	Content	Defined Values
1	1	Last Used Channel Select Mask	Bits D0 thru D3 correspond to Relay Outputs A thru D. (0 = No Change, 1 = Change)
2	1	Relay State	Bits D0 thru D3 correspond to Relay Outputs A thru D. (0 = Open, 1 = Closed)
3	2	Relay A Pulse Time Remaining. (unsigned short)	1 to 65535 milliseconds. (0 = static)
4	2	Relay B Pulse Time Remaining. (unsigned short)	1 to 65535 milliseconds. (0 = static)
5	2	Relay C Pulse Time Remaining. (unsigned short)	1 to 65535 milliseconds. (0 = static)
6	2	Relay D Pulse Time Remaining. (unsigned short)	1 to 65535 milliseconds. (0 = static)
10 bytes Total Length			

External Sensor Type FC – RTD Temperature Module Read Block

Item	# of Bytes	Content	Defined Values
1	2	Input Channel 1 (signed short)	Signed integer temperature in degrees Celsius X10.
2	2	Input Channel 2 (signed short)	Signed integer temperature in degrees Celsius X10.
3	2	Input Channel 3 (signed short)	Signed integer temperature in degrees Celsius X10.
4	2	Input Channel 4 (signed short)	Signed integer temperature in degrees Celsius X10.
8 bytes Total Length			

Note: Each channel requires the connection of a 2-wire or 3-wire PT100 RTD device. The value of 32767 (0x7FFF) is returned for unwired channels.

External Sensor Type FD – 10V Analog Module Read Block

Item	# of Bytes	Content	Defined Values
1	2	Input Channel 1 (short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
2	2	Input Channel 2 (short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
3	2	Input Channel 3 (short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
4	2	Input Channel 4 (short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
5	2	Output Channel 1 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
6	2	Output Channel 2 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
12 bytes Total Length			

Note: Inputs are +/- 10 volts. 0x0000 represents a -10V input and 0xFFFF0 a +10V input. 0x8000 therefore represents the 0V input level. Outputs are 0 to 10 volts only. A setting of 0x0000 results in a 0V output and 0xFFFF0 in +10V out. Only the most significant 12 bits are used for the output channels.

External Sensor Type FE – 4-20ma Analog Module

Item	# of Bytes	Content	Defined Values
1	2	Input Channel 1 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
2	2	Input Channel 2 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
3	2	Input Channel 3 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
4	2	Input Channel 4 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
5	2	Output Channel 1 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
6	2	Output Channel 2 (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
12 bytes Total Length			

Note: 0x0000 represents a 4 milliamp loop current and 0xFFFF0 (thru 0xFFFFF) represents 20 milliamps. Scaling is linear. Only the most significant 12 bits are used for the output channels.

WriteDevices – Message Type 23

This is used to change one or more device’s status, configuration, or content. The requested change is conveyed as a byte array whose structure is device dependent.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	23 = WriteDevices message
2	2	Count (short)	The number of Devices to be written.
Following Items 3 - 5 Repeated For Each Device			
3	8	Device ID (unsigned long)	
4	2	Length (short)	Length in bytes of the following Device structure.
5	Variable	Device Block (byte array)	Contains device dependent structure.

WriteDevices Response – Message Type 24

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	14 = WriteDevices Response message
2	2	Count (short)	The number of Devices successfully written.

Write Device Block Structures

The byte array supplied with the WriteDevices message must contain the defined structure that is device dependent. This varies depending on the type of device and its capabilities. The following defines those structures for the internal devices and known external devices. Note that the *Flags* field is used to indicate which the items in the structure to be modified by the write request. The bit positions in *Flags* indicate the action and may contain any combination of bits allowing for any portion of the structure to be affected. The entire structure must be provided and those fields not being written are ignored.

jr310 Digital Inputs (din1 – din8) Write Block

Item	# of Bytes	Content	Defined Values
1	1	Flags (byte)	0x01 – Reset Count 0x02 – Write Count 0x04 – Reset Usage Meter
2	4	Count (int)	Required if Write Count flag set.
1 or 5 bytes Total Length			

jr310 Relay Outputs (rout1 – rout8) Write Block

Item	# of Bytes	Content	Defined Values
1	1	Flags (byte)	0x01 – Modify State 0x02 – Reset Usage Meter
2	1	Present State	0 = Open, 1 = Closed Required if Modify State flag set.
1 or 2 bytes Total Length			

External Sensor Type 12 – Dual Addressable Switch Write Block

Item	# of Bytes	Content	Defined Values
1	1	Channel A Level (byte)	0=low, 1=high
2	1	Channel B Level (byte)	0=low, 1=high
2 bytes Total Length			

External Memory Type 23 – 512 Byte EEPROM Memory

Item	# of Bytes	Content	Defined Values
1	2	Starting Address (short)	0 – 511
2	2	Count (short)	Count of bytes to be written. The sum of the Starting Address and the Count must not exceed 511.
3	Variable	Content to be written (byte array)	Array of Bytes to be written. Must be exactly the number of bytes defined by Count.

External Sensor Type 26 – Smart Battery Monitor Write Block

Item	# of Bytes	Content	Defined Values
1	1	Configuration Register **	See below
1 bytes Total Length			

** Refer to Dallas/Maxim DS2438 Datasheet for details.

Configuration Register

D7	D6	D5	D4	D3	D2	D1	D0
X	ADB	NVB	TB	AD	EE	CA	IAD

- IAD 0: current A/D disabled
1: current A/D enabled
- CA 0: CCA/DCA disabled (inaccessible)
1: CCA/DCA disabled
- EE 0: CCA/DCA not shadowed
1: CCA/DCA shadowed
- AD 0: Voltage reports general purpose input
1: Voltage reports supply voltage
- TB 0: Temperature conversion complete
1: Temperature conversion in-process
- NVB 0: Non-volatile memory not busy
1: Non-volatile memory busy
- ADB 0: A/D conversion complete
1: A/D conversion in-process
- X Don't care

External Sensor Type 2C – Digital Potentiometer Write Block

Item	# of Bytes	Content	Defined Values
1	1	Control Register (byte)	(see below)
2	1	Wiper Position (byte)	
2 bytes Total Length			

Control Register

D7	D6	D5	D4	D3	D2	D1	D0
X	CPC	X	X	IWN		WN	

WN 00: select potentiometer 1
 01: select potentiometer 2
 10: select potentiometer 3
 11: select potentiometer 4

IWN 1's complement of WN

CPC 0: charge pump OFF
 1: charge pump ON

X don't care

External Device Type F9 – 3-Channel LED Dimmer

Item	# of Bytes	Content	Defined Values
1	2	Channel 1 Setting (plus 1) RED (unsigned short)	16-bit value. 0x0000 leaves channel unchanged. 0x0001 is OFF. 0xFFFF sets maximum brightness.
2	2	Channel 2 Setting (plus 1) GREEN (unsigned short)	16-bit value. 0x0000 leaves channel unchanged. 0x0001 is OFF. 0xFFFF sets maximum brightness.
3	2	Channel 3 Setting (plus 1) BLUE (unsigned short)	16-bit value. 0x0000 leaves channel unchanged. 0x0001 is OFF. 0xFFFF sets maximum brightness.
4	2	Channel 4 Setting (plus 1) WHITE (unsigned short)	unused
5	2	Channel 1 Slew Rate (plus 1) (unsigned short)	Milliseconds. 16-bit value. 0x0000 leaves setting unchanged. 0x0001 is immediate – slew disabled.
6	2	Channel 2 Slew Rate (plus 1) (unsigned short)	Milliseconds. 16-bit value. 0x0000 leaves setting unchanged. 0x0001 is immediate – slew disabled.
7	2	Channel 3 Slew Rate (plus 1) (unsigned short)	Milliseconds. 16-bit value. 0x0000 leaves setting unchanged. 0x0001 is immediate – slew disabled.
8	2	Channel 4 Slew Rate (plus 1) (unsigned short)	unused
9	128	64 Curve Points (unsigned short)	16-bit values 0x0000 to 0xFFFF. OPTIONAL AS NEEDED
144 bytes maximum Total Length			

The LED Dimmer Write Block allows you to independently set brightness and slew rates for specific channels without affecting the other channels. A non-zero value will change the associated setting others will be left unchanged.

Add 1 to the Channel and Slew values that you intend to set. A value of 0x0000 leaves the setting unchanged. To turn a channel OFF set the field to 0x0001. This will read back as 0x0000. To set a channel to maximum brightness set the field to 0xFFFF. This will read back as 0xFFFF as the dimmer will see 0xFFFE and 0xFFFF as being equivalent.

Similarly you must add 1 to the Slew rate as a field value of 0x0000 will leave the setting unchanged. To set a Slew Rate of precisely 5 seconds enter the value 5001 (0x1389) in the field. The value will read back as 5000. To disable slewing and have brightness values take effect immediately enter the value 0x0001 in the appropriate Slew Rate field.

Since we are more sensitive to changes in low brightness levels than we are to changes in high-intensity light the LED Dimmer employs a curve. This is intended to provide seemingly linear and smooth transitions. The appropriate curve can be dependent upon the actual LED lighting used and can also be a matter of personal preference. A default curve is supplied but it may be optionally reprogrammed. The curve array is typically omitted from the Write Block. Only the channel brightness and slew rate fields need be supplied.

If the curve is to be reprogrammed a full 144 byte block must be written and all 64 points of the curve supplied. The first point represents the brightness level for a setting of 0x0000. A 65th point is required for interpolation and it is assumed to be 0xFFFF. The 64 points are equally spaced in the range 0x0000 to 0xFFFF. A linear curve would have values 0x0000, 0x0400, 0x0800, ... 0xFF00 as the 64 points correspond to the upper 6 bits of the channel setting. When brightness is calculated a point is selected using the upper 6-bits of the channel setting and the value is determined by interpolation using the remaining 10 bits and the next point in the table. This is where the 65th point (maximum) is used.

NOTE

When reprogrammed the curve is permanently saved. You need only transmit a new curve to a dimmer once. The curve applies to all channels in the device. Once all 64 points have been successfully received the entire curve is committed to flash memory. This can take several seconds during which time the dimmer will not respond. The curve **MUST** be sent only when reprogramming is intended. To restore the LED dimmer curve to factory default, program all 64 points to 0xFFFF.

External Device Type FA – Rack Mounted User Panel (A1) Write Block

Item	# of Bytes	Content	Defined Values
1	2	LED Select Mask	Bits D0 thru D11 correspond to LEDs L1 thru L12. (0 = No Change, 1 = Change)
2	2	LED States	Bits D0 thru D11 correspond to LEDs L1 thru L12. Only those selected in the LED Select Mask are affected. (0 = Off, 1 = On)
3	1	Flash Rate	Applied to the selected LEDs in the ON state. 0 = static on/no flash 1 = slow 2 = medium 3 = fast
4	1	Flash Count	1-255. Applied to the selected LEDs in the ON state. LED goes to OFF state upon completion. (0 = continuous)
5	2	Switch Acknowledge	Bits D0 thru D11 correspond to Switch functions F1 thru F12. Acknowledges the current switch activation. (0 = no change, 1 = acknowledge)
6	2	Switch Reset	Bits D0 thru D11 correspond to Switch functions F1 thru F12. Resets function status and clears all pending activations. (0 = no change, 1 = reset)
7	1	Command	Enumeration, 0 = no command 1 = global reset 2 = set panel brightness ¹ 3 = play sound ^{1 2} 4 = set audio volume ^{1 2} 5 = sound alarm ⁴ 6 = silence alarm
8	1	Command Parameter	Brightness (Command 2) 0-255 dim thru full brightness setting is non-volatile ³ Play Sound (command 3) 0-255 Sound ID Volume (Command 4) 0-255 min thru max setting is non-volatile ³ Sound Alarm (Command 5) 1-255 volume level for alarm 0 use default volume
9	8	Parameter Block	See below.
20 bytes Total Length			

¹ Requires Parameter.

² Enhanced panels with audio feature only.

³ Default is 255.

⁴ Requires Parameter Block as defined below. Overrides any ongoing alarm.

Parameter Block – Alarm Descriptors for Sound Alarm Command 5

Item	# of Bytes	Content	Defined Values
9-1	1	Tone Frequency	1-96 selecting the frequency of the associated piano key (1-88) including an extension to the keyboard (89-96) ¹
9-2	1	Tone Count	0-255 Optional count of tones to issue ²
9-3	2	Tone Length	Tone duration in milliseconds
9-4	2	Period	Time from the beginning of one tone to the beginning of the next in milliseconds ³
9-5	2	Alarm Duration	Total overall duration of the alarm in seconds ²
8 bytes Parameter Block Length			

¹ Frequency range from 275 Hz to 6.27 KHz. Selections below 30 are not audible with small speaker. Volume increases with frequency and selections from 80 to 96 are recommended for alarms. Select 40 for Middle C. Twelve (12) steps per octave.

² The duration of an alarm may be defined either by the count of tones or the duration in seconds or both. If both the count and duration are defined the alarm continues until both are satisfied. With both count and duration of 0 a single beep is issued.

³ If the Period does not exceed the specified Tone Length only a single tone will be issued.

External Sensor Type FB – 4ROUT Digital Module Write Block

Item	# of Bytes	Content	Defined Values
1	1	Channel Select Mask	Bits D0 thru D3 correspond to Relay Outputs A thru D. (0 = No Change, 1 = Change)
2	1	Relay States	Bits D0 thru D3 correspond to Relay Outputs A thru D. Only those relays selected in the Channel Select Mask are affected. (0 = Open, 1 = Closed)
3	2	Relay A Pulse Duration. (unsigned short)	1-65535 milliseconds. Enabled only if relay selected by the Channel Select mask. (0 = static/no pulse)
4	2	Relay B Pulse Duration. (unsigned short)	1-65535 milliseconds. Enabled only if relay selected by the Channel Select mask. (0 = static/no pulse)
5	2	Relay C Pulse Duration. (unsigned short)	1-65535 milliseconds. Enabled only if relay selected by the Channel Select mask. (0 = static/no pulse)
6	2	Relay D Pulse Duration. (unsigned short)	1-65535 milliseconds. Enabled only if relay selected by the Channel Select mask. (0 = static/no pulse)
10 bytes Total Length			

Note: Add 1-2 milliseconds to offset the mechanical response time of relays. Relays return to their prior state upon completion of a pulse except if a pulse is interrupted. In that case the new duration is started and the relay will return to its state prior to the original interrupted pulse.

External Sensor Type FD – 10V Analog Module Write Block

Item	# of Bytes	Content	Defined Values
1	2	Channel 1 Setting (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
2	2	Channel 2 Setting (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
4 bytes Total Length			

Note: 0x0000 results in a 0 volt output and 0xFFFF0 in 10 volts out. Only the most significant 12 bits are used. Scaling is linear.

10V analog modules built after March 2014 have firmware version v1.11 or later. This firmware provides the option to specify a slew rate for each channel. This defines the time in milliseconds for the channel to ramp from the current setting to the new setting. The D-to-A outputs are adjusted each millisecond to linearly change from the level at the time the command is received to the specified output level. To specify the slew rates, the additional parameters are passed using the following block format.

Item	# of Bytes	Content	Defined Values
1	2	Channel 1 Setting (unsigned short)	Raw 16-bit D/A setting 0x0000 to 0xFFFF0 full scale.
2	2	Channel 2 Setting (unsigned short)	Raw 16-bit D/A setting 0x0000 to 0xFFFF0 full scale.
3	2	Channel 1 Slew (unsigned short)	0 to 65535 milliseconds
4	2	Channel 2 Slew (unsigned short)	0 to 65535 milliseconds
8 bytes Total Length			

A slew rate value of 0 milliseconds signifies an immediate change and is equivalent to not specifying the slew rate at all. If you are specifying a slew rate for channel 1 you may omit the channel 2 field from the block entirely. Note that both channels are set by this block and this occurs simultaneously. Care must be taken if you are slewing independent signals on both channels.

10V Voltage Transfer Function

The user may also specify a custom voltage transfer function which is applied to both channels. By default a 1-to-1 transfer function is used where the output voltage is as specified by the channel setting. In some cases where non-linear operation is desired a module may be programmed with a custom transfer function.

$$V_{out} = F_n(V_{set})$$

The table consists of 65 points defining V_{out} for each V_{set} from 0x0000 through 0xFC00 in steps of 0x0400 plus a point for maximum V_{set} (required for contiguous interpolation). The voltage transfer function is non-volatile. The table is programmed using the following write block.

Item	# of Bytes	Content	Defined Values
1	2	Channel 1 Setting (unsigned short)	ignored
2	2	Channel 2 Setting (unsigned short)	ignored
3	2	Channel 1 Slew (unsigned short)	ignored
4	2	Channel 2 Slew (unsigned short)	ignored
5	2	Voltage Output (unsigned short)	Raw 16-bit D/A value for 0x0000
6	2	Voltage Output (unsigned short)	Raw 16-bit D/A value for 0x0400
...	2	Voltage Output (unsigned short)	Raw 16-bit D/A values for 0x0800 thru 0xF000
67	2	Voltage Output (unsigned short)	Raw 16-bit D/A value for 0xF800
68	2	Voltage Output (unsigned short)	Raw 16-bit D/A value for 0xFC00
69	2	Voltage Output (unsigned short)	Raw 16-bit D/A value for 0xFFFF (essentially for 0x10000)
138 bytes Total Length			

The table will be programmed and will take effect with the next output setting once the entire write block has been successfully transferred. The process will take a few seconds during which time the module will not be accessible. It is recommended that software either wait an estimated time (5 seconds) for programming to complete or otherwise retry communications until the module is returned to service. Note that the table may be removed by writing 0xFFFF for each of the 65 points.

External Sensor Type FE – 4-20ma Analog Module Write Block

Item	# of Bytes	Content	Defined Values
1	2	Channel 1 Setting (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
2	2	Channel 2 Setting (unsigned short)	Raw 16-bit A/D reading 0x0000 to 0xFFFF0 full scale.
4 bytes Total Length			

Note: 0x0000 results in a 4 milliamp loop current and 0xFFFF0 in 20 milliamps. Only the most significant 12 bits are used. Scaling is linear.

SubscribeDevices – Message Type 25

Note: With the exception of the Message Type byte this message is physically identical to the ReadDevices request (Message Type 21). JNIO responds with a ReadDevices Response (Message Type 22). A subscription is entered for the connection and an additional ReadDevices Response message will be spontaneously transmitted whenever a subscribed device's status changes. What constitutes a status *change* is device dependent and in some cases may be configurable. A device subscription remains in place until the connection is closed.

Note that a subscription typically returns the Read Device Block for a device when any content changes. The one exception being the A/D devices wherein noise levels guarantee that every sampling results in some change. The Type 20 Quad A/D Converter reports changes only when the delta exceeds a value roughly equivalent to 8 bits of resolution.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	25 = SubscribeDevices message
2	2	Count (short)	The number of Device IDs to follow.
Item #3 Repeated for the Count indicated			
3	8	Device ID (unsigned long)	

EnumerateDevices – Message Type 26

Each JNIOR will contain internal I/O devices and possibly external I/O devices if the Sensor Port is available and additional devices are connected there. This request is used to obtain a list of active devices.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	26 = EnumerateDevices message
2	1	Flags (byte)	0x01 – enumerate internal 0x02 – enumerate external 0x03 – enumerate all

EnumerateDevicesResponse – Message Type 27

JNIOR responds to an EnumerateDevices request with a EnumerateDevicesResponse. The response contains the list of the Device IDs available either internally, externally or both depending on the setting of the associated Flags bits. Note that JNIOR is prompted to scan its I/O device structures and physical networks and several seconds may pass before the response is returned.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	27 = EnumerateDevicesResponse message
2	1	Flags (byte)	Flags provided in request.
3	2	Count (short)	The number of Devices found.
Following Item 4 Repeated For Each Device			
4	8	Device ID (unsigned long)	

The Device IDs are returned in no specific order.

UnsubscribeDevices – Message Type 28

This will unsubscribe the given devices from the current connection.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	28 = UnsubscribeDevices message
2	2	Count (short)	The number of Device IDs to follow.
Item #3 Repeated for the Count indicated			
3	8	Device ID (unsigned long)	

GetExternalValue – Message Type 29

Each connected external device can be enumerated by the JNIOR OS and assigned channel numbers. This command allows a user to request a value by channel number for a device type.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	29 = GetExternalValue message
2	1	Device Type (byte)	0x10 – Temperature Sensor 0x28 – Temperature Sensor 0xFB – 4 Relay Out Module 0xFC – RTD Module 0xFD – 10 Volt Module 0xFE – 4 – 20 ma Module
3	1	Input / Output (byte)	01 – Input Channel 02 – Output Channel
4	1	Channel Number (byte)	This can be device dependent. For example an RTD module has no outputs and temperature Sensors have 1 input.

GetExternalValueResponse – Message Type 30

JNIOR responds with the scaled value of the desired IO. The scaling information can be set in the registry or by the JNIOR Web Page. Outputs are returned on a scale of 0 – 100%.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	30 = GetExternalValueResponse message
2	1	Device Type (byte)	The device type passed in
3	1	Input / Output (byte)	The IO selection passed in
4	1	Channel Number (byte)	The channel number passed in
5	8	Value (double)	The value of the selected channel on the desired device.

SetExternalValue – Message Type 31

Each connected external device can be enumerated by the JNIOR OS and assigned channel numbers. This command allows a user to set a value by channel number for a device type. Outputs are entered on a scale of 0% - 100%.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	31 = SetExternalValue message
2	1	Device Type (byte)	0xFB – 4 Relay Out Module 0xFD – 10 Volt Module 0xFE – 4 – 20 ma Module
3	1	Channel Number (byte)	This can be device dependent. For example an RTD module has no outputs and temperature Sensors have 1 input.
4	8	Value (double)	The value to assign to the given devices channel

SetExternalValueResponse – Message Type 32

JNIOR responds with the scaled value of the desired IO. The scaling information can be set in the registry or by the JNIOR Web Page. The returned value mimics the set value.

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	32 = SetExternalValueResponse message
2	1	Device Type (byte)	The device type passed in
3	1	Channel Number (byte)	The channel number passed in
4	8	Value (double)	The value of the selected channel on the desired device.

NonceRequest – Message Type 128

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	128 = NonceRequest message

Login may be accomplished without the need to pass a password in clear text across the network. The encoded password option is not sufficiently secure in that it is a very simple matter to retrieve the password from the encoding. As an alternative the password may be encrypted as a message digest using MD5 and provided in the encoded password transfer. To do so you need to obtain a unique string from the JNIOR called the “nonce” string. This nonce string will be valid for several minutes and is used in combination with the user’s credentials to calculate the encoded password for transfer.

NonceResponse – Message Type 127

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	127 = NonceResponse message
2	Variable	Nonce (String)	

This response supplies a temporary “nonce” string that is to be used to encrypt the user’s password use the MD5 hash function. To encode the password the ‘username’, ‘nonce’ and ‘password’ are concatenated into single string with colon ‘:’ as a separator and the MD5 hash is calculated. The double quotes shown below are not included in the calculation. There is no white space added on either side of the separator.

hash = MD5 (“username” : “nonce” : “password”)

The calculated hash is a 16-byte binary value. This must be converted to a 32-character hexadecimal case-insensitive string representation. This hexadecimal string is then combined with the username as follows. Again the quotes and white space are not included.

encoded password = “username” : “hash string”

The result can then be supplied as the encoded password in the Login Request detailed below.

LoginRequest – Message Type 126

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	126 = LoginRequest message
2	Variable	Username (String)	A valid username
3	Variable	Password (String)	The valid password for this user.

By default a successful login will be required to enable protocol operation. This requirement may be removed by setting JniorServer/Login to ‘disabled’ in the JNIOR Registry. In this case the protocol proceeds as if an administrator has logged in. Note that if login has been disabled a LoginRequest may still be used to effect a login if appropriate.

Anonymous Login

If the JniorServer/Anonymous key has been defined in the Registry an anonymous login will be allowed. An anonymous login request contains both blank (zero length) Username and blank Password strings. The anonymous login must be successfully performed to enable protocol operation. The Registry key defines the integer (0-254) User ID to be used for anonymous access. A value of 0 (zero) is recommended. User IDs of 128 or greater are equivalent to an administrator login. To disable anonymous usage the JniorServer/Anonymous key must not appear in the Registry (valid content or not).

Encoded Password Transfer

The UserName and Password in the above transactions are transferred in clear text. This means that someone able to monitor network traffic may view message content and will be able to see your login information. This may be of concern when communicating with JNIOR over public networks.

Optionally one may encode the combined username:password string (for instance "jdoe:mypass") using Base64 encoding as defined by IEC RFC 1521. This renders the login information in a format that is not easily read by humans. The base64 encoded login string is transferred as the Password and its use is signified by supplying a blank (zero length) Username string. Note that this a minimal step and by no means represents true security. It will however minimize the temptation associated with accidentally discovering a user's password.

A more secure transfer is possible if a "nonce" value is obtained and the username and password are encoded using the MD5 hash as previously discussed (message types 128 and 127). The encoded hash (actually username:hash) is supplied as the Password. Its use is signified by a blank Username string and is differentiated from the Base64 encoding by the presence of the separating ':' colon.

Login Acknowledgement – Message Type 125

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	125 = Login Acknowledgement response message
2	1	User Permissions (byte)	The permissions assigned to the user or -1 if login failed. Bit7 - is Administrator Bit1 - can Control:

The following custom commands allow an application on the Ethernet that is talking to the Jnior via the Jnior protocol to talk directly to an external application running on the Jnior.

Custom Command Response – Message Type 254

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	254 = Custom Command response message
2	1	Return Status (byte)	-1 = error. Other status codes will be external application defined.
3	2	Payload size (short)	This is the length of the payload that follows.
4	Variable	Payload (byte[])	This is an array of bytes that is the payload.

Custom Command – Message Type 255

Item	# of Bytes	Content	Defined Values
1	1	Message Type (byte)	255 = Custom Command message
2	Variable	Command name (string)	This is the command that the external application running on the JNIOR would have registered with the OS.
3	1	Command Type (byte)	This is a byte that will be passed to the external application describing the payload to follow.
4	2	Payload size (short)	This is the length of the payload that follows.
5	Variable	Payload (byte[])	This is an array of bytes that is the payload.

CRC-16 Algorithm

A standard implementation of the CRC-16 (16-bit Cyclic Redundancy Check) is used. If a library function is not available for use the following algorithm will provide the calculation. This is a table look-up implementation and the table can either be used as supplied or generated on the fly at the programmer's option.

A Java implementation follows. This is readily adapted for use with C/C++, etc.

```

/* Static CRC16 lookup table. This table can be used as supplied or
 * generated on the fly.
 */

// Omit if dynamically generated table used
private int[] crctab = /* CRC lookup table */
{
    0x0000, 0xC0C1, 0xC181, 0x0140, 0xC301, 0x03C0, 0x0280, 0xC241,
    0xC601, 0x06C0, 0x0780, 0xC741, 0x0500, 0xC5C1, 0xC481, 0x0440,
    0xCC01, 0x0CC0, 0x0D80, 0xCD41, 0x0F00, 0xCF01, 0xCE81, 0x0E40,
    0x0A00, 0xCAC1, 0xCB81, 0x0B40, 0xC901, 0x09C0, 0x0880, 0xC841,
    0xD801, 0x18C0, 0x1980, 0xD941, 0x1B00, 0xDB01, 0xDA81, 0x1A40,
    0x1E00, 0xDEC1, 0xDF81, 0x1F40, 0xDD01, 0x1DC0, 0x1C80, 0xDC41,
    0x1400, 0xD4C1, 0xD581, 0x1540, 0xD701, 0x17C0, 0x1680, 0xD641,
    0xD201, 0x12C0, 0x1380, 0xD341, 0x1100, 0xD101, 0xD081, 0x1040,
    0xF001, 0x30C0, 0x3180, 0xF141, 0x3300, 0xF301, 0xF281, 0x3240,
    0x3600, 0xF6C1, 0xF781, 0x3740, 0xF501, 0x35C0, 0x3480, 0xF441,
    0x3C00, 0xFCC1, 0xFD81, 0x3D40, 0xFF01, 0x3FC0, 0x3E80, 0xFE41,
    0xFA01, 0x3AC0, 0x3B80, 0xFB41, 0x3900, 0xF901, 0xF881, 0x3840,
    0x2800, 0xE8C1, 0xE981, 0x2940, 0xEB01, 0x2BC0, 0x2A80, 0xEA41,
    0xEE01, 0x2EC0, 0x2F80, 0xEF41, 0x2D00, 0xEDC1, 0xEC81, 0x2C40,
    0xE401, 0x24C0, 0x2580, 0xE541, 0x2700, 0xE701, 0xE681, 0x2640,
    0x2200, 0xE2C1, 0xE381, 0x2340, 0xE101, 0x21C0, 0x2080, 0xE041,
    0xA001, 0x60C0, 0x6180, 0xA141, 0x6300, 0xA301, 0xA281, 0x6240,
    0x6600, 0xA6C1, 0xA781, 0x6740, 0xA501, 0x65C0, 0x6480, 0xA441,
    0x6C00, 0xACC1, 0xAD81, 0x6D40, 0xAF01, 0x6FC0, 0x6E80, 0xAE41,
    0xAA01, 0x6AC0, 0x6B80, 0xAB41, 0x6900, 0xA901, 0xA881, 0x6840,
    0x7800, 0xB8C1, 0xB981, 0x7940, 0xBB01, 0x7BC0, 0x7A80, 0xBA41,
    0xBE01, 0x7EC0, 0x7F80, 0xBF41, 0x7D00, 0xBDC1, 0xBC81, 0x7C40,
    0xB401, 0x74C0, 0x7580, 0xB541, 0x7700, 0xB701, 0xB681, 0x7640,
    0x7200, 0xB2C1, 0xB381, 0x7340, 0xB101, 0x71C0, 0x7080, 0xB041,
    0x5000, 0x90C1, 0x9181, 0x5140, 0x9301, 0x53C0, 0x5280, 0x9241,
    0x9601, 0x56C0, 0x5780, 0x9741, 0x5500, 0x95C1, 0x9481, 0x5440,
    0x9C01, 0x5CC0, 0x5D80, 0x9D41, 0x5F00, 0x9FC1, 0x9E81, 0x5E40,
    0x5A00, 0x9AC1, 0x9B81, 0x5B40, 0x9901, 0x59C0, 0x5880, 0x9841,
    0x8801, 0x48C0, 0x4980, 0x8941, 0x4B00, 0x8BC1, 0x8A81, 0x4A40,
    0x4E00, 0x8EC1, 0x8F81, 0x4F40, 0x8D01, 0x4DC0, 0x4C80, 0x8C41,
    0x4400, 0x84C1, 0x8581, 0x4540, 0x8701, 0x47C0, 0x4680, 0x8641,
    0x8201, 0x42C0, 0x4380, 0x8341, 0x4100, 0x8101, 0x8081, 0x4040
};

// Omit if static table used
private int[] crc_table = null; // dynamically generated table

```

```

/** Generates the CRC16 for the supplied byte array. Note that this
 * will generate the lookup table on the fly the first time it is
 * used. You may optionally use the static table. The initial CRC
 * value should be 0.
 *
 * Note: '>>>' is an unsigned right shift.
 */
public int crc16(byte[] data, int crc) {

    /* Omit this conditional block if the static version of the
     * look-up table is to be used.
     */
    if (crc_table == null) { /* generate table */
        crc_table = new int[256];

        int n, i, c, d;
        for (n = 0; n < 256; n++) {
            c = 0;
            d = n;
            for (i = 0; i < 8; i++) {
                if (((c ^ d) & 1) != 0) c = (c >>> 1) ^ 0xA001;
                else c = c >>> 1;
                d = d >>> 1;
            }
            crc_table[n] = c;
        }
    } /* generate table */

    // Calculate the CRC16 of the data byte array.
    int i;
    for (i=0; i<data.length; i++)
        crc = ((crc >>> 8) & 0xff) ^ crc_table[(crc ^ data[i]) & 0xff];
    return crc;
}

```

Example Transactions

Here is an example login transaction for programming reference. This shows two complete messages byte-by-byte. The first is a Login Request and the second the Login Acknowledgement from **JNIOR**.

```

Msg Received by JNIOR:
  01 00 0d 60 b7 7e 05 6a 6e 69 6f 72 05 6a 6e 69 6f 72

Msg Sent by JNIOR:
  01 00 02 f0 20 7d 80

```

In the above the first 5 bytes of each transmission is the Message Header these are shown using **bold** characters. Each header starts with 0x01. This is always the case and all other byte values should be ignored. **JNIOR** may send the ACK 0x06 byte periodically in an attempt to demonstrate activity and to keep a connection alive. These should be ignored with the exception of the fact that they indicate that the **JNIOR** is still connected.

Following the Start of Header 0x01 byte the next two bytes form the *short* integer message length as transmitted used big-endian byte order. This would be 13 (0x000d) and 2 (0x0002) bytes respectively. This denotes the exact length of the message payload that follows the header. The message length may be zero (0x0000). Such a message could also be used as a keep-alive indication. The message should otherwise be ignored.

The last two bytes of the header represent the CRC16 and are 0x60b7 and 0xf020 respectively in this example. With one exception, messages in which the calculated CRC16 from the message payload does not match that reported in the header will be ignored by **JNIOR** and should be ignored by the user's application. The CRC16 calculation routine has been provided in a prior section.

The programmer may be anxious to demonstrate function prior to CRC implementation. This is understandable. It is for this purpose that the **JNIOR** will ignore the CRC16 check should the supplied value be exactly 0xFFFF. Although it will likely never happen, the programmer should return the favor and not perform the check upon reception of a message from the **JNIOR** with a 0xFFFF CRC value. So, for example, the following form of the above transaction is equally functional. Note where the 0xFFFF CRC has been used.

```
Msg Received by JNIOR:
  01 00 0d ff ff 7e 05 6a 6e 69 6f 72 05 6a 6e 69 6f 72

Msg Sent by JNIOR:
  01 00 02 f0 20 7d 80
```

In the above the messages the payload is shown in **bold** characters. The first payload is 13 bytes and the second just two bytes. Both are the proper length as defined by the length field in the header.

Each message serves a purpose and the very first byte defines the message type. The first message is Type 126 (0x7e) representing the LoginRequest and the second Type 125 being the associated LoginAcknowledgement. The login request message contains two strings of 5 character length. Note the string length appears first and the following characters represent 'jnior' the default username and also the default password (both being the same as shipped from the factory).

The acknowledgement returns the User ID which is 128 (0x80) in this case. The **JNIOR** would return 255 (0xFF) if the login failed. Note that User IDs in the range 128 (0x80) to 254 (0xFE) represent Administrative users and have rights to modify configuration and perform other functions.

The following transaction demonstrates a Registry key Subscription.

```
Msg Received by JNIOR:
  01 00 2c 2c 04 0f 00 03 00 00 0b 44 65 76 69 63 65
  2f 44 65 73 63 00 01 08 24 56 65 72 73 69 6f 6e 00
  02 0d 24 53 65 72 69 61 6c 4e 75 6d 62 65 72

Msg Sent by JNIOR:
  01 00 31 98 9a 0c 00 03 00 00 16 6a 72 33 31 30 20
  44 65 76 65 6c 6f 70 6d 65 6e 74 20 55 6e 69 74 00
  01 08 32 2e 30 31 2e 33 34 36 00 02 07 34 39 30 34
  30 30 34
```

This particular exchange requests the current value and notice of all future changes to the following three keys:

```
Device/Desc
$Version
$SerialNumber
```

And the appropriate values are returned in the response:

```
"jr 310 Development Unit"
"2.01.346"
"4904004"
```

Of these three Registry Keys only the first happens to be subject to change. If it were changed now through the Registry Editor an additional message would be sent by JNIOR containing the new value. This would be referenced against the key's Unique ID of 0 (0x0000). This *subscription* would be valid until

the connection is closed. The detailed parsing of these two example transmissions will be left to the programmer.

CRC Test Strings

The following strings may be used to test the CRC16 algorithm. For each string the value should be returned as shown.

Text String	CRC16 Value
"0123456789"	0x443d
"ABCDEFGH"	0x9e6c
"" (empty string – 0 bytes)	0x0000

Proper CRC16 values for more complex arrangements can be found in the example transmissions of the prior section.