Home Automation, Inc.

Omni-Link II

Protocol Description

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CONTENTS

GENERAL

This document defines the Omni-Link II communications protocol. This protocol allows an external device (hereafter referred to as the "client") to communicate with an HAI automation controller using the controller's Ethernet network interface. Omni-Link II allows the client to monitor the status of the HAI controller and to control its operation.

When enabled, Omni-Link II will also automatically send to the client event notification messages upon the occurrence of various changes in the controller. This eliminates the need for the client to continually poll the controller for updated information.

Omni-Link II uses standard Ethernet, TCP (Transmission Control Protocol) and IP (Internet Protocol) protocol layers to transport Omni-Link II application-level packets across the network. The use of standard transport and routing protocols enables the HAI controller to be used in any standard network environment. The network environment may range from a small local area network (LAN) in a single residence to the worldwide Internet.

Refer to diagrams in Appendix A for related details while reading the protocol description in this document.

PROTOCOL DESCRIPTION

The HAI controller connects to the network via a standard Ethernet interface. The controller listens for all TCP/IP communications addressed to it on a specific TCP port number. The controller tracks the state of different client "sessions" by the unique combination of the source IP address (from the IP header) and the source port (from the TCP header) of the client.

The Ethernet Frame, IP Header, and TCP Header merely provide the standardized information required by the network infrastructure (routers, etc.) to transport Omni-Link II application-level packets between client and controller. The actual controller transaction requests and responses are contained in the Omni-Link II application-level packet. The structure and interpretation of the Omni-Link II application-level packet is described in the following paragraphs.

OMNI-LINK II APPLICATION-LEVEL PACKETS

The first field of the Omni-Link II application-level packet is a 16-bit message sequence number, transmitted most-significant-byte first. This field provides a mechanism for detecting duplicate packets and dynamically adjusting network timeout periods to accommodate varying network delays. If the value is set to zero, sequence tracking is disabled for the packet. If sequence tracking is used, the client increments this value each time it sends a packet to the controller. Note that since a sequence number of zero has special significance, the sequence number value rolls over from 65535 to one instead of zero. The controller replies to client requests using the same message sequence number assigned by the client.

The next field is the 8-bit "message type". This value defines the nature of the message, so that it can be processed accordingly.

The next 8-bit field is reserved for future use.

And, finally, the "message data" field is comprised of the Omni-Link II application message data (any data or message associated with the specified "message type"). This field may be empty. This is the only field that is ever encrypted.

PROTOCOL RULES

When the controller receives an Omni-Link II application-level packet, it examines the "message type" field, and takes the appropriate action as defined by the following rules.

If the controller receives a packet that is not a valid Omni-Link II application-level packet (i.e., missing or invalid "message type"), the controller quietly discards the packet without a reply.

If the message type is "Client request new session":

- If the controller cannot initiate a new session (i.e., too many sessions already open, etc.), it replies to the client with a "Controller cannot start new session" message, and no further action is taken; otherwise…
- If the controller already has a session open for this client, that session is quietly terminated (i.e., no termination message is sent to the client), and a new session is initialized as described below.
- The controller initiates a new session associated with this unique client.
- The controller uses a random number generator to produce a 40-bit "session ID". The session ID will be used by both client and controller to modify the private encryption key, which is known to both, resulting in a key that is unique for this session.
- The controller replies to the client with a "Controller acknowledge new session" message. The message data consists of a 16-bit value that indicates the HAI network protocol version being used by the controller, followed by the 40-bit session ID, both transmitted most-significant-byte first.
- The controller generates the unique encryption key for this session and initializes the encryption/decryption algorithms. The 128-bit session key is computed as follows:

    a) The 88 most significant bits of the session key are identical to the corresponding bits of the private key.

    b) The 40 least significant bits of the session key are the result of a logical XOR of the 40 least significant bits of the private key and the 40 bits of the session ID.

If the message type is "Client request secure connection":

- If the controller does not already have an active session for the client, it replies to the client with a "Controller session terminated" message, and no further action is taken; otherwise…

    a) The controller decrypts the message data, which should consist of the 40-bit session ID (transmitted MSB first).

    b) The controller compares the session ID received from the client to the session ID previously generated by the controller.

    c) If the session IDs are identical, this confirms that the client received the session ID intact, and used it to produce the correct session encryption key. The controller responds with the "Acknowledge secure connection" message, with the session ID in the data field.

    d) If the session IDs are NOT identical, the controller replies with the "Controller session terminated" message, and terminates the session.

If the message type is “Omni-Link II message”:

- If the controller does not already have an active session for the client, it replies to the client with a “Controller session terminated” message, and no further action is taken; otherwise…
    - The controller decrypts the message data and treats it as an Omni-Link II application data message.
    - If the Omni-Link II application data message requires a reply, the controller encrypts the Omni-Link II application data reply message and replies to the client with a message type of “Omni-Link II message” and the encrypted message in the data field.

If the message type is “Client session terminated”:

- The controller replies with the “Controller session terminated” message and, if a session is active, terminates the session.

ENCRYPTION

As mentioned, certain message types require encryption or decryption of the “message data” portion of the Omni-Link II application packet. This section describes the encryption/decryption methods.

Encryption and decryption of data in the Omni-Link II application packet is based on the Advanced Encryption Standard (AES) using a 128-bit cryptographic key.

The AES (sometimes referred to as the Rijndael algorithm, derived from the names of the developers) was selected by the National Institute of Standards and Technology (NIST) and approved by the U.S. Department of Commerce (in May, 2002) as a robust replacement for the widely-used, but aging and vulnerable, DES encryption standard. The AES algorithm is a symmetric block cipher that is capable of using cryptographic keys of 128, 192 or 256 bits to encrypt and decrypt data in blocks of 128 bits. Further information about the AES can be found in the Federal Information and Processing Standards (FIPS) publication FIPS-197 and at the following NIST website:

http://csrc.nist.gov/CryptoToolkit/aes

The following procedure is used to encrypt Omni-Link II application data:

1. Process data in 128-bit (16-byte) blocks. If available data does not fill a 16-byte block, the data is left-justified and padded on the right with zeros to fill the block.
2. Modify the first two bytes of the 16-byte encryption block by performing a logical XOR operation with the two bytes of the “message sequence number” in the HAI header (i.e., XOR the first byte of the encryption block with the MSB of the message sequence number, and XOR the second byte of the encryption block with the LSB of the message sequence number).
3. Encrypt the 16-byte block using the AES encryption algorithm and the 128-bit session key that was negotiated when the client and controller established the secure connection.
4. Process the next block of data until all data has been processed.

A similar procedure is used to decrypt Omni-Link II application data:

1. Process data in 128-bit (16-byte) blocks.

2. Decrypt the 16-byte block using the AES decryption algorithm and the 128-bit session key that was negotiated when the client and controller established the secure connection.

3. Modify the first two bytes of the 16-byte encryption block by performing a logical XOR operation with the two bytes of the "message sequence number" in the HAI header (i.e., XOR the first byte of the encryption block with the MSB of the message sequence number, and XOR the second byte of the encryption block with the LSB of the message sequence number).

4. Process the next block of data until all data has been processed.

5. If the number of bytes in the original message (prior to encryption) was not an exact multiple of 16, the decrypted message will have one or more trailing pad bytes. The length of the actual message (not including the pad bytes) should be determined by examining the message length field of the Omni-Link II application data message.

APPLICATION DATA MESSAGE FORMAT

The application data in the Omni-Link II protocol is binary. That is, one byte of data is sent as a single character whose hex value is 0x00 through 0xFF.

The general format of an Omni-Link II application data message is as follows:

Field	Length	Comments
Start character	1 byte	Value is always 0x21
Message length	1 byte	Value is the total number of bytes in the "message type" and "data" fields
Message type	1 byte	Value indicates the specific function of the message
Data	variable	Zero or more bytes, depending on the specific "message type"
CRC 1	1 byte	Least-significant-byte of 16-bit CRC
CRC 2	1 byte	Most-significant-byte of 16-bit CRC

The CRC-16 error detection algorithm is used to provide robust error detection in Omni-Link II application data messages. The CRC1 and CRC2 error check bytes are the 16-bit CRC-16 polynomial remainder, sent least-significant-bit first. The CRC value is calculated using all bytes of the message, except the "start character" and the CRC fields. Sample routines to calculate the CRC-16 error check bytes are provided in Appendix B.

MESSAGE TYPES

Different Omni-Link II application data message types are provided in the Omni-Link II protocol to perform different actions. These Omni-Link II application data message types can be divided into several groups:

- Acknowledgement messages
- Request messages
- Report messages
- Event log messages
- Name messages
- Voice name messages
- Command messages
- Validate security code messages
- Notifications messages

ACKNOWLEDGEMENT MESSAGES

Acknowledgement messages are sent to acknowledge the receipt of another message. An ACKNOWLEDGE message is sent in response to another message to indicate that the message was received correctly and processed.

ACKNOWLEDGE

Start character	0x21
Message length	0x01
Message type	0x01
Data	none
CRC 1	0xC0
CRC 2	0x50

A NEGATIVE ACKNOWLEDGE message is sent in response to another message to indicate that the message was received correctly, but was not processed due to an error in the message format or to an inability to successfully perform the requested action.

NEGATIVE ACKNOWLEDGE

Start character	0x21
Message length	0x01
Message type	0x02
Data	none
CRC 1	0x80
CRC 2	0x51

An END OF DATA message is sent in response to a message to indicate that the message was received correctly, but the information for the request does not exist.

END OF DATA

Start character	0x21
Message length	0x01
Message type	0x03
Data	none
CRC 1	0x41
CRC 2	0x91

REQUEST MESSAGES

Request messages are sent by the client to the HAI controller to request that the controller report configuration and status information. The following information can be requested:

- System information
- System status
- System troubles
- System features
- System formats
- Object type capacities
- Object properties
- Object status
- Audio source status
- Zone ready status
- Connected security system status

REQUEST SYSTEM INFORMATION

This message requests the HAI controller to report its model number, software version, and local phone number.

Start character	0x21
Message length	0x01
Message type	0x16
Data	none
CRC 1	0x80
CRC 2	0x5E
Expected reply	SYSTEM INFORMATION

REQUEST SYSTEM STATUS

This message requests the HAI controller to report its time, date, calculated time of sunrise and sunset, battery reading, alarm status for any area that is in alarm.

Start character	0x21
Message length	0x01
Message type	0x18
Data	none
CRC 1	0x01
CRC 2	0x9A
Expected reply	SYSTEM STATUS

REQUEST SYSTEM TROUBLES

This message requests the HAI controller to report any system troubles. The response will be variable.

Start character	0x21
Message length	0x01
Message type	0x1A
Data	none
CRC 1	0x80
CRC 2	0x5B
Expected reply	SYSTEM TROUBLES

REQUEST SYSTEM FEATURES

This message requests the HAI controller to report its enabled features.

Start character	0x21
Message length	0x01
Message type	0x1C
Data	none
CRC 1	0x00
CRC 2	0x59
Expected reply:	SYSTEM FEATURES

REQUEST SYSTEM FORMATS

This message requests the HAI controller to report the configured temperature format, time format, and date format.

Start character	0x21
Message length	0x01
Message type	0x28
Data	none
CRC 1	0x01
CRC 2	0x8E
Expected reply:	SYSTEM FORMATS

REQUEST OBJECT TYPE CAPACITIES

This message requests the HAI controller to report the number of objects of the specified type that the controller supports.

Start character	0x21
Message length	0x02
Message type	0x1E
Data 1	object type
CRC 1	varies
CRC 2	varies
Expected reply:	OBJECT TYPE CAPACITIES

The available object types and filters are as follows:

Object Type	Object Description	Filter 1	Filter 2	Filter 3
1	Zone	Name	Area	
2	Unit	Name	Area	Room
3	Button	Name	Area	
4	Code	Name	Area	
5	Area	Name		
6	Thermostat	Name	Area	
7	Message	Name	Area	
8	Auxiliary Sensor	Name	Area	
9	Audio Source	Name		
10	Audio Zone	Name		
11	Expansion Enclosure			
12	Console		Area	

REQUEST OBJECT PROPERTIES

This message requests the HAI controller to report the properties of the specified object. The object type and index number specifies what is being requested. The object type identifies whether the requested object is a zone, unit, button, code, area, thermostat, message, auxiliary sensor, audio source, audio zone, expansion, or console. The index number (0-511) identifies the specific object.

The index number is used in conjunction with the relative direction (offset) value to determine which object in the list will be sent. If the offset is 0, the controller will return the properties of the specified object (index number). If the offset is -1, the controller will return the properties of the object before the specified index number. If the offset is 1, the controller will return the properties of the object after the specified index number.

Filters are used to narrow the return to an object with specific properties.

Filter 1: allows only named objects to be returned (0=Named or Unnamed, 1=Named, 2=Unnamed).

Filter 2: allows only an object that is in specific Areas to be returned. The area statuses for eight areas are packed into one message byte. The status for Area 1 is indicated by bit 7. Lower order bits indicate the statuses of Area 2 – Area 8, respectively. The bits corresponding to specified Areas are on.

Filter 3: allows only an object that is defined as a Load in a Room, Room, or Independent Load to be returned (0=Any Load, 1-31=Load in a Room, 254=Room, 255=Independent Load).

Start character	0x21
Message length	0x08
Message type	0x20
Data 1	object type
Data 2	index number (MSB)
Data 3	index number (LSB)
Data 4	relative direction (-1, 0, 1)
Data 5	filter 1
Data 6	filter 2
Data 7	filter 3
CRC 1	varies
CRC 2	varies

Expected reply: OBJECT PROPERTIES

REQUEST OBJECT STATUS

This message is used to request the status of a group of zone, unit, area, thermostat, message, auxiliary sensor, audio zone, or expansion enclosure objects.

Zones: The status reported for each zone includes the zone number, current condition of the zone (secure, not ready, or trouble), and the current analog loop reading for the zone.

Units: The status reported for each unit includes the unit number, current condition of the unit, and any time remaining on a timed command.

Areas: The status reported for each area includes the area number, current mode of the area, alarm status of the area, and time remaining on an entry or exit timer.

Thermostats: The status reported for each thermostat includes the thermostat number, whether the thermostat is communicating with the controller, the current temperature, the heat and cool setpoints, the system mode, the fan mode, and whether the thermostat has been placed in hold mode.

Messages: The status reported for each message includes the message number, which messages are currently being displayed and what displayed messages have not been acknowledged.

Auxiliary: The status reported for each auxiliary sensor includes the sensor number, the output status for each PESM, the current temperature or humidity reading, and the low and high setpoints.

Audio Zone: The status reported for each audio zone includes the audio zone number, the on/off status of the zone, the selected source for the zone, the volume, and whether the zone is muted.

Expansion: The status reported for each expansion enclosure includes the expansion enclosure number, whether the thermostat is communicating with the controller, and the battery reading.

The request is sent using two bytes for each object.

Start character	0x21
Message length	0x06
Message type	0x22
Data 1	object type
Data 2	starting object (MSB)
Date 3	starting object (LSB)
Data 4	ending object (MSB)
Data 5	ending object (LSB)
CRC 1	varies
CRC 2	varies
Expected reply:	OBJECT STATUS

REQUEST AUDIO SOURCE STATUS

This message requests the HAI controller to report the status of an audio source. This is used to report any metadata (album, song, artist, etc.) or other feedback from the specified source.

Start character	0x21
Message length	0x05
Message type	0x30
Data 1	source number (1-8)
Data 2	position
CRC 1	varies
CRC 2	varies
Expected reply	AUDIO SOURCE STATUS

The source status is sent as a series of zero or more AUDIO SOURCE STATUS messages, followed by an END OF DATA message. Each AUDIO SOURCE STATUS message contains the data for one field position of metadata (album, song, artist, etc.) or the overall feedback from the source, such as the frequency of a tuner.

A field ID is sent as part of each AUDIO SOURCE STATUS message to identify the metadata field that is being reported. If this field ID is zero, it indicates that there is only one field of information, such as a frequency or other status information. The field IDs reported by the HAI controller are the field IDs reported by the audio system. If an END OF DATA message is sent back immediately in response to the REQUEST AUDIO SOURCE STATUS message, no source data is available.

If the source status has not yet been obtained, send a REQUEST AUDIO SOURCE STATUS message with the position number set to "0". When an AUDIO SOURCE STATUS message is received from the controller, it contains a sequence number and position number. Send a second AUDIO SOURCE STATUS message incrementing the position number contained in the AUDIO SOURCE STATUS message by one to cause the HAI controller to send the next field of information. If the AUDIO SOURCE STATUS message contains a different sequence number from the previous message, the metadata in the connected audio system has been updated. Send a REQUEST AUDIO SOURCE STATUS message with the position number set to "0" to get the updated metadata.

Sending an AUDIO SOURCE STATUS message with the same position number to the HAI controller will cause the HAI controller to resend its last message.

REQUEST ZONE READY STATUS

This message is used to report the secure/not ready status of security zones. Any burglary or 24 hour zone that is not in the secure state will be reported as not ready. Auxiliary and temperature zones are always reported as secure.

Start character	0x21
Message length	0x01
Message type	0x38
Data	none
CRC 1	0x00
CRC 2	0x42
Expected reply:	ZONE READY STATUS

REQUEST CONNECTED SECURITY SYSTEM STATUS

This message is used to report the mode and status of each partition in a security system connected to a Lumina or Lumina Pro controller.

Start character	0x21
Message length	0x01
Message type	0x2D
Data	none
CRC 1	0xC1
CRC 2	0x8D
Expected Reply:	CONNECTED SECURITY SYSTEM STATUS

REPORT MESSAGES

Report messages are sent in response to each of the request messages. The following information is reported:

- System information
- System status
- System troubles
- System features
- System formats
- Object type capacities
- Object properties
- Object status
- Audio source status
- Zone ready status
- Connected security system status

SYSTEM INFORMATION

This message is sent by the HAI controller in reply to a REQUEST SYSTEM INFORMATION message. The controller reports its model number, software version, and local phone number.

Start character	0x21
Message length	0x1E
Message type	0x17
Data 1	model number
Data 2	major version
Data 3	minor version
Data 4	revision
Data 5-29	local phone number
CRC 1	varies
CRC 2	varies

The model number identifies the controller model, such as Omni IIe, OmniPro II, Lumina, or Lumina Pro. The following model numbers are defined:

Model Number	Model
30	HAI Omni IIe
16	HAI OmniPro II
36	HAI Lumina
37	HAI Lumina Pro

The major version, minor version, and revision identify the controller software version. For example, if the software version is 2.16b, the major version would be 0x02, the minor version would be 0x10, and the revision would be 0x02. Revision 0x00 specifies no revision letter, revision 0x01 specifies revision “a”, and so on. If the revision is a 2's complement negative number, such as 0xFF, it specifies a prototype revision such as X1 or X2. Revision 0xFF specifies revision X1, revision 0xFE specifies revision X2, and so on.

The local phone number corresponds to the "MY PHONE NUMBER" setting in the controller. It is an ASCII text string up to 24 characters long, terminated with a trailing 0x00.

SYSTEM STATUS

This message is sent by the HAI controller in reply to a REQUEST SYSTEM STATUS message. The controller reports its time, date, calculated time of sunrise and sunset, battery reading, and current alarm(s) in each area.

Start character	0x21
Message length	(2 * number of alarms) + 15
Message type	0x19
Data 1	time/date valid flag (0-1)
Data 2	year (0-99)
Data 3	month (1-12)
Data 4	day (1-31)
Data 5	day of week (1-7)
Data 6	hour (0-23)
Data 7	minute (0-59)
Data 8	second (0-59)
Data 9	daylight savings time flag (0-1)
Data 10	calculated sunrise hour (0-23)
Data 11	calculated sunrise minute (0-59)
Data 12	calculated sunset hour (0-23)
Data 13	calculated sunset minute (0-59)
Data 14	battery reading
Data 15	area in alarm (1-8)
Data 16	alarm status for first alarm (0-255)
…	
Data n-1	area in alarm (1-8)
Data n	alarm status for last alarm (0-255)
CRC 1	varies
CRC 2	varies

The time/date valid flag is zero if the time and date have not been set in the controller. The daylight savings time flag is nonzero if daylight savings time is in effect. The day of the week is 1 for Monday through 7 for Sunday.

The bits in the area alarm status bytes are shown below. The corresponding bit is set if the condition is true.

Bit	Condition
0	Burglary alarm
1	Fire alarm
2	Gas alarm
3	Auxiliary alarm
4	Freeze alarm
5	Water alarm
6	Duress alarm
7	Temperature alarm

SYSTEM TROUBLES

This message is sent by the HAI controller in reply to a REQUEST SYSTEM TROUBLES message. The controller reports any system troubles. If multiple troubles exist, each trouble is reported in a separate data byte.

Start character	0x21
Message length	number of troubles + 1
Message type	0x1B
Data 1	first trouble
…	
Data n	last trouble
CRC 1	varies
CRC 2	varies

The system trouble conditions are shown below.

Trouble Byte	Condition
1	Freeze
2	Battery low
3	AC power
4	Phone line
5	Digital communicator
6	Fuse
7	Freeze
8	Battery low

SYSTEM FEATURES

This message is sent by the HAI controller in reply to a REQUEST SYSTEM FEATURES message. The controller reports any enabled features. If multiple features are enabled, each feature is reported in s separate data byte.

Start character	0x21
Message length	number of features + 1
Message type	0x1D
Data 1	first feature
….	
Data n	last feature
CRC 1	varies
CRC 2	varies

The available system features are as follows:

Feature Byte	System Feature
1	NuVo Concerto
2	NuVo Essentia/Simplese
3	NuVo Grand Concerto
4	Russound
5	HAI Hi-Fi
6	Xantech
7	Speakercraft
8	Proficient

SYSTEM FORMATS

This message is sent by the HAI controller in reply to a REQUEST SYSTEM FORMATS message. The controller reports the configured temperature format, time format, and date format.

Start character	0x21
Message length	0x04
Message type	0x29
Data 1	temperature format (1-2)
Data 2	time format (1-2)
Data 3	date format (1-2)
CRC 1	varies
CRC 2	varies

The temperature format byte is shown below.

1 = F
2 = C

The time format byte is shown below.

1 = 12 HR
2 = 24 HR

The date format byte is shown below.

1 = MMDD
2 = DDMM

OBJECT TYPE CAPACITIES

This message is sent by the HAI controller in reply to a REQUEST OBJECT TYPE CAPACITIES message. The HAI controller reports the number of objects of the specified type that the controller supports.

Start Character	0x21
Message Length	0x04
Message Type	0x1F
Data 1	capacity type
Data 2	capacity (MSB)
Data 3	capacity (LSB)
CRC 1	varies
CRC 2	varies

OBJECT PROPERTIES

This message is sent by the HAI controller in reply to a REQUEST OBJECT PROPERTIES message. The HAI controller reports the properties of the specified object.

Start character	0x21
Message length	number of data bytes + 1
Message type	0x21
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
….	
Data n	last property
CRC 1	varies
CRC 2	varies

The object type identifies whether the returned properties are for a zone, unit, button, code, area, thermostat, message, auxiliary sensor, audio zone, or audio source object. The object number identifies the specific object (zone, unit, button, code, area, thermostat, message, auxiliary sensor, audio zone, or audio source object).

The object name data specifies the name for the respective object. Each name consists of one or more printable ASCII characters, followed by a terminating zero. Zone and message names can be up to 15 characters long, exclusive of the terminating zero. All other names may be up to 12 characters long. Names are always transferred with a fixed number of data bytes for each name type, as shown in the table below. The terminating zero indicates the actual end of the name. Data bytes following the terminating zero may be filled with any value. If the first character received is zero, the object is not named in the controller.

Listed below are the available object types and maximum name length for each object type:

Object Type	Object Description	Maximum Name Length
1	Zone	15
2	Unit	12
3	Button	12
4	Code	12
5	Area	12
6	Thermostat	12
7	Message	15
8	Auxiliary Sensor	15
9	Audio Source	12
10	Audio Zone	12

See NAME DATA for additional information.

ZONE PROPERTIES

Data 4	zone status
Data 5	zone loop reading
Data 6	zone type (0-87)
Data 7	zone area (1-8)
Data 8	zone options (0-7)
Data 9	zone name
…	
Data 24	zone name

For description of zone status, see ZONE STATUS in this document.

The available zone types are as follows:

Zone Type	Description
0	Entry/Exit
1	Perimeter
2	Night Interior
3	Away Interior
4	Double Entry Delay
5	Quadruple Entry Delay
6	Latching Perimeter
7	Latching Night Interior
8	Latching Away Interior
16	Panic
17	Police Emergency
18	Duress
19	Tamper
20	Latching Tamper
32	Fire
33	Fire Emergency
34	Gas Alarm
48	Auxiliary Emergency
49	Trouble
54	Freeze
55	Water
56	Fire Tamper
64	Auxiliary
65	Keyswitch Input
80	Programmable Energy Saver Module
81	Outdoor Temperature
82	Temperature
83	Temperature Alarm
84	Humidity
85	Extended Range Outdoor Temperature
86	Extended Range Temperature
87	Extended Range Temperature Alarm

The available zone options are as follows:

Zone Options	0	1	2	3	4	5	6	7
Cross Zoning	No	Yes	No	Yes	No	Yes	No	Yes
Swinger Shutdown	No	No	Yes	Yes	No	No	Yes	Yes
Dial Out Delay	No	No	No	No	Yes	Yes	Yes	Yes

UNIT PROPERTIES

Data 4	unit state
Data 5	unit time (MSB)
Data 6	unit time (LSB)
Data 7	unit type (0-255)
Data 8	unit name
…	
Data 20	unit name

For description of unit status, see UNIT STATUS in this document.

The unit time is the number of seconds remaining for the last command.

The available unit types are as follows:

Unit Type	Description
1	Standard
2	Extended
3	Compose
4	UPB
5	HLC Room
6	HLC Load
7	Lumina Mode
8	RadioRA
9	CentraLite
10	ViziaRF Room
11	ViziaRF Load
12	Flag
13	Output
14	Audio Zone
15	Audio Source

BUTTON PROPERTIES

Data 4	button name
…	
Data 16	button name

CODE PROPERTIES

Data 4	code name
…	
Data 16	code name

AREA PROPERTIES

Data 4	area mode (0-255)
Data 5	area alarms (0-255)
Data 6	entry timer
Data 7	exit timer
Data 8	enabled (0-1)
Data 9	exit delay (0-255)
Data 10	entry delay (0-255)
Data 11	area name
…	
Data 23	area name

For description of area mode and area alarms, see AREA STATUS in this document.

The entry timer and exit timer is the number of seconds remaining for the respective timer. The exit delay and entry delay is the configuration setting for the respective delay.

If AREA PROPERTIES are requested for an area that is configured in the HAI controller, the enabled byte will be set to 1; if an area is not configured in the HAI controller, the enabled byte will be set to 0.

THERMOSTAT PROPERTIES

Data 4	communicating (0-1)
Data 5	temperature
Data 6	heat setpoint
Data 7	cool setpoint
Data 8	mode
Data 9	fan (0-1)
Data 10	hold (0-1)
Data 11	thermostat type
Data 12	thermostat name
…	
Data 24	thermostat name

For description of communicating, temperature, heat and cool setpoints, mode, fan and hold status, see THERMOSTAT STATUS in this document.

The temperatures are reported in the Omni temperature format (see Appendix C).

The available thermostat types are as follows:

Thermostat Type	Description
0	Not Used
1	Auto Heat/Cool
2	Heat/Cool
3	Heat Only
4	Cool Only
5	Setpoint Only

MESSAGE PROPERTIES

Data 4	message name
…	
Data 19	message name

AUXILIARY SENSOR PROPERTIES

Data 4	output status
Data 5	current temperature or humidity
Data 6	low setpoint
Data 7	high setpoint
Data 8	sensor type
Data 9	sensor name
…	
Data 24	sensor name

The temperatures are reported in the Omni temperature format (see Appendix C).

The available sensor types are as follows:

Sensor Type	Description
80	Programmable Energy Saver Module
81	Outdoor Temperature
82	Temperature
83	Temperature Alarm
84	Humidity
85	Extended Range Outdoor Temperature
86	Extended Range Temperature
87	Extended Range Temperature Alarm

AUDIO SOURCE PROPERTIES

Data 4	source name
…	
Data 16	source name

AUDIO ZONE PROPERTIES

Data 4	on/off (0-1)
Data 5	source (1-n)
Data 6	volume (0-100)
Data 7	mute (0-1)
Data 8	zone name
…	
Data 20	zone name

OBJECT STATUS

This message is sent by the HAI controller in reply to an OBJECT STATUS message. The HAI controller reports the status for the specified object(s).

ZONE STATUS

The controller reports the status of a zone object or group of zone objects. The status reported for each zone includes the zone number, current condition of the zone (secure, not ready, or trouble), the latched alarm status for the zone, whether the zone is armed, whether the zone has had any trouble, and the current analog loop reading for the zone.

Start character	0x21
Message length	(4 * number of zone) + 2
Message type	0x23
Data 1	0x01
Data 2	zone number for first zone (MSB)
Data 3	zone number for first zone (LSB)
Data 4	zone status for first zone
Data 5	zone loop reading for first zone
Data 6	zone number for second zone (MSB)
Data 7	zone number for second zone (LSB)
Data 8	zone status for second zone
Data 9	zone loop reading for second zone
…	
Data n-3	zone number for last zone (MSB)
Data n-2	zone number for last zone (LSB)
Data n-1	zone status for last zone
Data n	zone loop reading for last zone
CRC 1	varies
CRC 2	varies

The zone status for a zone is packed into a single byte. Bits 0 and 1 indicate the zone's current condition:

Bit 1	Bit 0	Current Condition
0	0	Secure
0	1	Not ready
1	0	Trouble

Bits 2 and 3 indicate the latched alarm status for the zone:

Bit 3	Bit 2	Latched Alarm Status
0	0	Secure
0	1	Tripped
1	0	Reset, but previously tripped

Bits 4 and 5 indicate the arming status for the zone:

Bit 5	Bit 4	Arming Status
0	0	Disarmed
0	1	Armed
1	0	Bypassed by user
1	1	Bypassed by system

Bit 6 is set if a trouble condition has occurred that has not been acknowledged by the user. The current condition of the zone will indicate whether the zone currently has a trouble condition. If the zone does not currently have a trouble condition, but bit 6 is set, it indicates that the zone has previously had a trouble condition that has not yet been acknowledged.

UNIT STATUS

The controller reports the status of a control unit object or group of control unit objects. The status reported for each unit includes the unit number, the unit's current condition, and any time remaining (specified in seconds) on a timed command.

Start character	0x21
Message length	(5 * number of units) + 2
Message type	0x23
Data 1	0x02
Data 2	unit number for first unit (MSB)
Data 3	unit number for first unit (LSB)
Data 4	unit status for first unit
Data 5	high byte of time for first unit
Data 6	low byte of time for first unit
Data 7	unit number for second unit (MSB)
Data 8	unit number for second unit (LSB)
Data 9	unit status for second unit
Data 10	high byte of time for second unit
Data 11	low byte of time for second unit
…	
Data n-4	unit number for last unit (MSB)
Data n-3	unit number for last unit (LSB)
Data n-2	unit status for last unit
Data n-1	high byte of time for last unit
Data n	low byte of time for last unit
CRC 1	varies
CRC 2	varies

The current condition of the unit depends on the type of the unit.

For X-10 units, the possible conditions are:

0	Last commanded off
1	Last commanded on
17-25	Last commanded dim 1-9, respectively
33-41	Last commanded brighten 1-9, respectively
100-200	Last commanded level 0%-100%, respectively

For Lightolier Compose PLC units:

0	Off
1	On
2-13	Scene A-L, respectively
17-25	Last commanded dim 1-9, respectively
33-41	Last commanded brighten 1-9, respectively

For Advanced Lighting Control (ALC) relay modules:

0	Off
1	On

For Advanced Lighting Control (ALC) dimmer modules:

0	Off
1	On
100-200	Level 0%-100%, respectively

For Universal Powerline Bus (UPB) units:

0	Off
1	On
100-200	Level 0%-100%, respectively

For voltage outputs:

0	Off
1	On

For flags:

0	Off
Non-zero	On

For counters:

0-255	Counter value

AREA STATUS

The controller reports the status of an area object or group of area objects. The status reported for each area includes the area number, mode, alarms, entry timer, and exit timer.

Start character	0x21
Message length	(6 * number of areas) + 2
Message type	0x23
Data 1	0x05
Data 2	area number for first area (MSB)
Data 3	area number for first area (LSB)
Data 4	area mode for first area
Data 5	area alarms for first area
Data 6	entry timer for first area
Data 7	exit timer for first area
Data 8	area number for second area (MSB)
Data 9	area number for second area (LSB)
Data 10	area mode for second area
Data 11	area alarms for first area
Data 12	entry timer for second area
Data 13	exit timer for second area
…	
Data n-5	area number for last area (MSB)
Data n-4	area number for last area (LSB)
Data n-3	area mode for last area
Data n-2	area alarms for last area
Data n-1	entry timer for last area
Data n	exit timer for last area
CRC 1	varies
CRC 2	varies

For HAI Omni series controllers, the security mode for an area is as follows:

0	Off
1	Day
2	Night
3	Away
4	Vacation
5	Day instant
6	Night delayed

Bit 3 of the security mode byte will be set during the arming exit delay, resulting in the following additional security modes:

9	Arming day
10	Arming night
11	Arming away
12	Arming vacation
13	Arming day instant
14	Arming night delayed

The bits in the area alarm status bytes are shown below. The corresponding bit is set if the condition is true.

0	Burglary alarm
1	Fire alarm
2	Gas alarm
3	Auxiliary alarm
4	Freeze alarm
5	Water alarm
6	Duress alarm
7	Temperature alarm

For HAI Lumina series controllers, the mode is as follows:

1	Home
2	Sleep
3	Away
4	Vacation
5	Party
6	Special

Bit 3 of the security mode byte will be set during the mode change delay, resulting in the following additional security modes:

9	Setting home
10	Setting Sleep
11	Setting away
12	Setting vacation
13	Setting party
14	Setting special

The bits in the area alarm status bytes are shown below. The corresponding bit is set if the condition is true.

4	Freeze alarm
5	Water alarm
7	Temperature alarm

THERMOSTAT STATUS

The controller reports the status of a thermostat object or group of thermostat objects. The status reported for each thermostat includes the thermostat number, whether the thermostat is communicating with the controller, whether a freeze condition has been detected by the thermostat, the current temperature, the heat and cool setpoints, the system mode, the fan mode, and whether the thermostat has been placed in hold mode.

Start character	0x21
Message length	(9 * number of thermostats) + 2
Message type	0x23
Data 1	0x06
Data 2	thermostat number for first thermostat (MSB)
Data 3	thermostat number for first thermostat (LSB)
Data 4	status byte for first thermostat
Data 5	current temperature for first thermostat
Data 6	heat setpoint for first thermostat
Data 7	cool setpoint for first thermostat
Data 8	system mode for first thermostat
Data 9	fan mode for first thermostat
Data 10	hold status for first thermostat
Data 11	thermostat number for second thermostat (MSB)
Data 12	thermostat number for second thermostat (LSB)
Data 13	status byte for second thermostat
Data 14	current temperature for second thermostat
Data 15	heat setpoint for second thermostat
Data 16	cool setpoint for second thermostat
Data 17	system mode for second thermostat
Data 18	fan mode for second thermostat
Data 19	hold status for second thermostat
…	
Data n-8	thermostat number for last thermostat (MSB)
Data n-7	thermostat number for last thermostat (LSB)
Data n-6	status byte for last thermostat
Data n-5	current temperature for last thermostat
Data n-4	heat setpoint for last thermostat
Data n-3	cool setpoint for last thermostat
Data n-2	system mode for last thermostat
Data n-1	fan mode for last thermostat
Data n	hold status for last thermostat
CRC 1	varies
CRC 2	varies

The bits in the thermostat status byte are shown below. The corresponding bit is set if the condition is true.

Bit 0	Communications failure
Bit 1	Freeze alarm

The temperatures are reported in the Omni temperature format (see Appendix C).

The system mode is as follows:

0	Off
1	Heat
2	Cool
3	Auto
4	Emergency heat

The fan mode is as follows:

0	Auto
1	On

The hold status is non-zero if the thermostat is in hold mode.

MESSAGE STATUS

The controller reports the status of a displayed text message object or a group of displayed text message objects. The status reported for each message includes the message number, whether the message is currently being displayed, and whether the displayed message has not been acknowledged.

Start character	0x21
Message length	(3 * number of messages) + 2
Message type	0x23
Data 1	0x07
Data 2	message number for first message (MSB)
Data 3	message number for first message (LSB)
Data 4	status byte for first message
Data 5	message number for second message (MSB)
Data 6	message number for second message (LSB)
Data 7	status byte for second message
…	
Data n-2	message number for last message (MSB)
Data n-1	message number for last message (LSB)
Data n	status byte for last message
CRC 1	varies
CRC 2	varies

The status bytes are defined as follows:

0	Off (message in not being displayed)
1	Displayed (the message is currently being displayed)
2	Not acknowledged (the displayed message has not been acknowledged)

AUXILIARY SENSOR STATUS

The controller reports the status of an auxiliary sensor object or a group of auxiliary sensor objects. The status reported for each auxiliary sensor includes the auxiliary sensor number, the output status for each Programmable Energy Saver Module (PESM), the current temperature or humidity reading, and the low and high setpoints.

Start character	0x21
Message length	(6 * number of auxiliary sensors) + 2
Message type	0x23
Data 1	0x08
Data 2	auxiliary sensor number for first auxiliary sensor (MSB)
Data 3	auxiliary sensor number for first auxiliary sensor (LSB)
Data 4	output status for first auxiliary sensor
Data 5	current temperature or humidity for first auxiliary sensor
Data 6	low/heat setpoint for first auxiliary sensor
Data 7	high/cool setpoint for first auxiliary sensor
Data 8	auxiliary sensor number for second auxiliary sensor (MSB)
Data 9	auxiliary sensor number for second auxiliary sensor (LSB)
Data 10	output status for second auxiliary sensor
Data 11	current temperature or humidity for second auxiliary sensor
Data 12	low/heat setpoint for second auxiliary sensor
Data 13	high/cool setpoint for second auxiliary sensor
…	
Data n-5	auxiliary sensor number for last auxiliary sensor (MSB)
Data n-4	auxiliary sensor number for last auxiliary sensor (LSB)
Data n-3	output status for last auxiliary sensor
Data n-2	current temperature or humidity for last auxiliary sensor
Data n-1	low/heat setpoint for last auxiliary sensor
Data n	high/cool setpoint for last auxiliary sensor
CRC 1	varies
CRC 2	varies

The output status is non-zero if the output is energized.

The temperatures are reported in the Omni temperature format (see Appendix C).

AUDIO ZONE STATUS

The controller reports the status of an audio zone object or a group of audio zone objects. The status reported for each audio zone includes the audio zone number, on/off status of the zone, the selected source for the zone, the volume, and whether the zone is muted.

Start character	0x21
Message length	(6 * number of audio zones) + 2
Message type	0x23
Data 1	0x0A
Data 2	audio zone number for first audio zone (MSB)
Data 3	audio zone number for first audio zone (LSB)
Data 4	power on/off for first audio zone (0-1)
Data 5	selected source for first audio zone (1-n)
Data 6	volume for first audio zone (0-100)
Data 7	mute status for first audio zone (0-1)
Data 8	audio zone number for second audio zone (MSB)
Data 9	audio zone number for second audio zone (LSB)
Data 10	power on/off for second audio zone (0-1)
Data 11	selected source for second audio zone (1-n)
Data 12	volume for second audio zone (0-100)
Data 13	mute status for second audio zone (0-1)
...	
Data n-5	audio zone number for last audio zone (MSB)
Data n-4	audio zone number for last audio zone (LSB)
Data n-3	power on/off for last audio zone (0-1)
Data n-2	selected source for last audio zone (1-n)
Data n-1	volume for last audio zone (0-100)
Data n	mute status for last audio zone (0-1)
CRC 1	varies
CRC 2	varies

EXPANSION ENCLOSURE STATUS

The controller reports the status of an expansion enclosure object or a group of expansion enclosure objects. The status reported for each expansion enclosure includes the expansion enclosure number, whether the thermostat is communicating with the controller, and the battery reading.

Start character	0x21
Message length	(4 * number of expansion enclosures) + 2
Message type	0x23
Data 1	0x0B
Data 2	address number for first expansion enclosure (MSB)
Data 3	address number for first expansion enclosure (LSB)
Data 4	communications status for first expansion enclosure (0-1)
Data 5	battery reading for first expansion enclosure (0-255)
Data 6	address number for second expansion enclosure (MSB)
Data 7	address number for second expansion enclosure (LSB)
Data 8	communications status for second expansion enclosure (0-1)
Data 9	battery reading for second expansion enclosure (0-255)
...	
Data n-3	address number for last expansion enclosure (MSB)
Data n-2	address number for last expansion enclosure (LSB)
Data n-1	communications status for last expansion enclosure (0-1)
Data n	battery reading for last expansion enclosure (0-255)
CRC 1	varies
CRC 2	varies

AUDIO SOURCE STATUS

This message is sent by the HAI controller in response to a REQUEST AUDIO SOURCE STATUS message.

Start character	0x21
Message length	source data length (exclusive of terminating zero) + 7
Message type	0x31
Data 1	source number (MSB)
Data 1	source number (LSB)
Data 2	sequence number (0-255)
Data 3	position (1-6)
Data 4	field ID
Data 5	first byte of source data
Data 6	second byte of source data
...	
Data n-1	last byte of source data
Data n	terminating zero
CRC 1	varies
CRC 2	varies

ZONE READY STATUS

This message is sent in response to a REQUEST ZONE READY STATUS message. The secure/not ready statuses for eight zones are packed into one message byte. The status of the lower numbered zone is indicated by bit 7. Lower order bits indicate the statuses of the higher numbered zones. The bit corresponding to a zone is set if that zone is not ready.

Start character	0x21
Message length	number of data bytes + 1
Message Type	0x39
Data 1	status of first 8 zones
Data 2	status of second 8 zones
…	
Data n	status of last 8 zones
CRC 1	varies
CRC 2	varies

CONNECTED SECURITY SYSTEM STATUS

This message is sent in response to a REQUEST CONNECTED SECURITY SYSTEM STATUS message.

Start character	0x21
Message length	number of data bytes + 1
Message Type	0x2E
Data 1	mode in partition 1
Data 2	status of partition 1
Data 3	mode in partition 2
Data 4	status of partition 2
…	
Data 15	mode in partition 8
Data 16	status of partition 8
CRC 1	varies
CRC 2	varies

EVENT LOG MESSAGES

The HAI controller maintains an event log that records a time stamped listing of significant controller events, such as when the security system is armed/disarmed, alarm activations, and trouble conditions. The event log can store a fixed number of events. Once the event log is full, logging a new event will cause the oldest event to be lost.

- Upload event record
- Event log data

UPLOAD EVENT RECORD

The event number specifies the event record that is being requested (0-65535). The event number is used in conjunction with the relative direction (offset) value to determine which event in the list will be sent. A special case event number of 0 is used to receive the most recent or oldest event. If the event number is 0 and the relative direction is -1, the controller will return the most recent event (along with the event number). The returned event number along with the relative direction of -1 can be used to request the next most recent event. If the event number is 0 and the relative direction is 1, the controller will return the oldest event. The returned event number along with the relative direction of 1 can be used to request the second oldest event.

If the offset is 0, the controller will return the specified event record. If the offset is -1, the controller will return the event record before the specified event number. If the offset is 1, the controller will return the event record after the specified event number.

Start character	0x21
Message length	0x04
Message type	0x24
Data 1	event number (MSB)
Data 2	event number (LSB)
Data 3	relative direction (-1, 0, 1)
CRC 1	varies
CRC 2	varies

EVENT LOG DATA

Start character	0x21
Message length	0x0C
Message type	0x25
Data 1	event number (MSB)
Data 2	event number (LSB)
Data 3	time/date valid
Data 4	month (1-12)
Data 5	day (1-31)
Data 6	hour (0-23)
Data 7	minute (0-59)
Data 8	event type
Data 9	parameter 1
Data 10	high byte of parameter 2
Data 11	low byte of parameter 2
CRC 1	varies
CRC 2	varies

The highest numbered event is the most recent event. When the event number counter (Data 1 and Data 2) reaches 65535, when the next event occurs, the counter rolls over to 1.

The month, day, hour, and minute specify the time that the event occurred. The time/date valid flag is zero if the controller time was not set when the event occurred. In this case, the month, day, hour, and minute fields do not contain valid data and should not be used. The time/date valid flag is non-zero when the time has been properly set in the controller.

The event, parameter 1, and parameter 2 identify the specific event that has occurred. The possible events are shown in the "Event Log Event Types" tables. When a security code is specified, the value is the user code number rather than the actual four-digit security code.

In addition to the user codes, the following security codes can be reported:

251 Duress code
252 Keyswitch
253 Quick arm
254 PC Access
255 Programmed

LUMINA SERIES EVENT LOG EVENT TYPES

Event Type	Parameter 1 P1	Parameter 2 P2	Description
48+m	1-n	0-n	set mode m with code P1 m = mode: 1 = home mode 2 = sleep mode 3 = away mode 4 = vacation mode 5 = party mode 6 = special mode
128		1-n	Zone P2 tripped
129		1-n	zone P2 trouble
130	1-n		remote phone access with code P1
131			remote phone lockout
133		1-n	zone P2 trouble cleared
134	1-n		PC access with code P1
135	1-n	1	alarm P1 activated 5 = freeze 6 = water 8 = temperature
136	1-n	1	alarm P1 reset 5 = freeze 6 = water 8 = temperature
137			system reset
138		1-n	message P2 logged

OMNI SERIES EVENT LOG EVENT TYPES

Event Type	Parameter 1 P1	Parameter 2 P2	Description
4	1-n	1-n	zone P2 bypassed with code P1
5	1-n	1-n	zone P2 restored with code P1
6	1-n	0-n	all area P2 zones restored with code P1 P2 = 0 means all areas/zones
48+m	1-n	0-n	area P2 armed in mode m with code P1 P2 = 0 means all areas m = security mode: 0 = disarm 1 = day mode 2 = night mode 3 = away mode 4 = vacation mode 5 = day instant mode 6 = night delayed mode
128		1-n	zone P2 tripped
129		1-n	zone P2 trouble
130	1-n		remote phone access with code P1
131			remote phone lockout
132		1-n	zone P2 auto bypassed
133		1-n	zone P2 trouble cleared
134	1-n		PC access with code P1
135	1-n	1-n	alarm P1 activated in area P2 1 = burglary 2 = fire 3 = gas 4 = auxiliary 5 = freeze 6 = water 7 = duress 8 = temperature
136	1-n	1-n	alarm P1 reset in area P2 1 = burglary 2 = fire 3 = gas 4 = auxiliary 5 = freeze 6 = water 7 = duress 8 = temperature
137			system reset
138		1-n	message P2 logged

NAME MESSAGES

Display names for controller objects (zones, units, buttons, codes, areas, thermostats, messages, auxiliary sensors, audio zones, or audio sources) may be uploaded from and downloaded to the HAI controller.

- Upload names
- Name data
- Clear names
- Download names

UPLOAD NAMES

To upload names from the HAI controller, send an UPLOAD NAMES message with the object type and object number to the HAI controller. The controller will then send a NAME DATA message.

Each NAME DATA message contains the name of a single object. If no name has been entered in the controller for the specified object, the controller will respond with an END OF DATA message rather than a NAME DATA message in reply to the UPLOAD NAMES message.

Start character	0x21
Message length	0x04
Message type	0x0D
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
CRC 1	varies
CRC 2	varies

NAME DATA

Start character	0x21
Message length	(maximum name length) + 5
Message type	0x0E
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
Data 4	first byte of name data
Data 5	second byte of name data
…	
Data n	last byte of name data
CRC 1	varies
CRC 2	varies

The object name data specifies the name for the respective object. Each name consists of one or more printable ASCII characters, followed by a terminating zero. Zone and message names can be up to 15 characters long, exclusive of the terminating zero. All other names may be up to 12 characters long. Names are always transferred with a fixed number of data bytes for each name type. Thus, a zone name will always be sent as 16 bytes, no matter how long the name really is. The terminating zero indicates the actual end of the name. Data bytes following the terminating zero may be filled with any value.

The object type and object number specify what is being named. The object type identifies whether the name is for a zone, unit, button, code, area, thermostat, message, auxiliary sensor, audio zone, or audio source. The object number identifies the specific object to be named.

Listed below are the object type, maximum name length, and maximum number of each object type:

OBJECT	TYPE	LENGTH	NUMBER (Omni IIe)	NUMBER (OmniPro II)	NUMBER (Lumina)	NUMBER (Lumina Pro)
Zone	1	15	48	176	48	176
Unit	2	12	128	511	128	511
Button	3	12	64	128	64	128
Code	4	12	16	99	16	99
Area	5	12	2	8	1	1
Thermostat	6	12	4	64	4	64
Message	7	15	64	128	64	128
Auxiliary Sensor	8	15	48	176	48	176
Audio Source	9	12	6	8	6	8
Audio Zone	10	12	8	36	8	36

CLEAR NAMES

If a group of names will be downloaded to the HAI controller, first send the CLEAR NAMES message to the controller. This instructs the controller to clear the names of all objects. This is essential to ensure that object names that have been removed, are cleared from the controller's memory.

Start character	0x21
Message length	0x01
Message type	0x0B
Data	none
CRC 1	0x40
CRC 2	0x57

DOWNLOAD NAMES

To download names from the HAI controller, send a DOWNLOAD NAMES message with the object type, object name, and the name data. Each DOWNLOAD NAMES message contains the name of a single object.

Start character	0x21
Message length	(maximum name length) + 5
Message type	0x0C
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
Data 4	first byte of name data
Data 5	second byte of name data
…	
Data n	last byte of name data
CRC 1	varies
CRC 2	varies

VOICE NAME MESSAGES

Voice names for controller objects (a zone, unit, button, code, area, thermostat, or message) may be uploaded from and downloaded to the HAI controller.

- Upload voice names
- Voice name data
- Clear Voice names
- Download voice names

UPLOAD VOICE NAMES

To upload voice names from the HAI controller, send an UPLOAD VOICE NAMES message with the object type and object number to the HAI controller. The controller will then send a VOICE NAME DATA message.

Each VOICE NAME DATA message contains the voice name of a single object. If no voice name has been entered in the controller for the specified object, the controller will respond with an END OF DATA message rather than a VOICE NAME DATA message in reply to the UPLOAD NAMES message.

Start character	0x21
Message Length	0x04
Message Type	0x11
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
CRC 1	varies
CRC 2	varies

VOICE NAME DATA

Start character	0x21
Message length	((phrases per name + 1)*(size of each phrase)) + 4
Message type	0x12
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
Data 4	high byte of first phrase number
Data 5	low byte of first phrase number or second phrase number
...	
Data n	last byte of name
CRC 1	varies
CRC 2	varies

The VOICE NAME DATA message specifies the voice name for a single item. Each voice name consists of one or more phrase numbers, followed by a terminating phrase number of zero. Voice names for Omni IIe, OmniPro II, Lumina, and Lumina Pro can consist of six phrase numbers, exclusive of the terminating phrase. Phrase numbers for Omni IIe, OmniPro II, Lumina, and Lumina Pro are two bytes long. Voice names are always transferred with a fixed number of data bytes for each voice name type. Thus, a voice name for an OmniPro II will always be sent as 14 bytes, no matter how long the voice name really is. The terminating phrase number of zero indicates the actual end of the name. Data bytes following the terminating zero may be filled with any value.

The object type and object number specify what is being named. The object type identifies whether the voice name is for a zone, unit, button, code, area, thermostat, or message. The object number identifies the specific zone, unit, button, code, area, thermostat, or message.

Listed below are the object type, number of phrases, size of each phrase number, and maximum number of each type of voice name:

NAME	TYPE	PHRASES	SIZE	NUMBER (Omni IIe)	NUMBER (OmniPro II)	NUMBER (Lumina)	NUMBER (Lumina Pro)
Zone	1	6	2	48	176	48	176
Unit	2	6	2	128	511	128	511
Button	3	6	2	64	128	64	128
Code	4	6	2	16	99	16	99
Area	5	6	2	2	8	0	0
Thermostat	6	6	2	4	64	4	64
Message	7	6	2	64	128	64	128

CLEAR VOICE NAMES

If a group of voice names will be downloaded to the HAI controller, first send the CLEAR VOICE NAMES message to the controller. This instructs the controller to clear the voice names of all objects. This is essential to ensure that object voice names that have been removed, are cleared from the controller's memory.

Start Character	0x21
Message Length	0x01
Message Type	0x0F
Data	none
CRC 1	0x41
CRC 2	0x94

DOWNLOAD VOICE NAMES

To download voice names from the HAI controller, send a DOWNLOAD VOICE NAMES message with the object type, object name, and the voice name data. Each DOWNLOAD VOICE NAMES message contains the voice name of a single object.

Start character	0x21
Message length	((phrases per name + 1)*(size of each phrase)) + 4
Message type	0x10
Data 1	object type
Data 2	object number (MSB)
Data 3	object number (LSB)
Data 4	high byte of first phrase number
Data 5	low byte of first phrase number or second phrase number
...	
Data n	last byte of name
CRC 1	varies
CRC 2	varies

COMMAND MESSAGES

Command message are used to send immediate control commands to an HAI controller or connected security system.

- Controller commands
- Connected security system commands
- Set time command
- Activate keypad emergency

CONTROLLER COMMAND

The CONTROLLER COMMAND message is used to send an immediate control command to the HAI controller. Commands are provided to control lights, appliances, temperatures, security, messaging, and audio. Each command follows the same format: a single byte command, followed by a single byte parameter, and then a two byte secondary parameter. The command message is formatted as follows:

Start character	0x21
Message length	0x05
Message type	0x14
Data 1	command (0-255)
Data 2	parameter 1 (0-255)
Data 3	parameter 2 (MSB)
Data 4	parameter 2 (LSB)
CRC 1	varies
CRC 2	varies
Expected reply	ACKNOWLEDGE

Command	Parameter 1 P1	Parameter 2 P2	Description
0	0	1-n	unit P2 off
0	1-99	1-n	unit P2 off for P1 seconds
0	101-199	1-n	unit P2 off for P1-100 minutes
0	201-218	1-n	unit P2 off for P1-200 hours
1	0	1-n	unit P2 on
1	1-99	1-n	unit P2 on for P1 seconds
1	101-199	1-n	unit P2 on for P1-100 minutes
1	201-218	1-n	unit P2 on for P1-200 hours
2		0-n	area P2 all off (0=all areas)
3		0-n	area P2 all on (0=all areas)
9	0-100	1-n	unit P2 lighting level to P1 percent
101	2-99	1-n	unit Lo9(P2) level Hi7(P2) for P1 seconds
101	101-199	1-n	unit Lo9(P2) level Hi7(P2) for P1-100 minutes
101	201-218	1-n	unit Lo9(P2) level Hi7(P2) for P1-200 hours
10		1-n	decrement counter P2
11		1-n	increment counter P2
12	0-255	1-n	set counter P2 to P1

Note: For ALC extended ramp commands, the unit is stored in the low 9 bits of P2. The level to ramp to (0-100%) is stored in the high 7 bits of P2. The rate specifies the full excursion (0% to 100% or 100% to 0%) ramp rate. Smaller excursions will reach the desired level in less time.

Command	Parameter 1 P1	Parameter 2 P2	Description
13	2-99	1-n	unit Lo9(P2) ramp to Hi7(P2) at P1 seconds
13	101-199	1-n	unit Lo9(P2) ramp to Hi7(P2) at P1-100 minutes
13	201-210	1-n	unit Lo9(P2) ramp to Hi7(P2) at P1-200 hours
14	0	1-n	Lightolier Compose unit P2 off
14	1	1-n	Lightolier Compose unit P2 on
14	2-13	1-n	Lightolier Compose unit P2 scene A-L, respectively
15		1-n	send request status message to UPB unit P2
16+s	0	1-n	unit P2 dim s steps (s=1-9)
16+s	1-99	1-n	unit P2 dim s steps (s=1-9) for P1 seconds
16+s	101-199	1-n	unit P2 dim s steps (s=1-9) for P1-100 minutes
16+s	201-218	1-n	unit P2 dim s steps (s=1-9) for P1-200 hours
32+s	0	1-n	unit P2 brighten s steps (s=1-9)
32+s	1-99	1-n	unit P2 brighten s steps (s=1-9) for P1 sec
32+s	101-199	1-n	unit P2 brighten s steps (s=1-9) for P1-100 minutes
32+s	201-218	1-n	unit P2 brighten s steps (s=1-9) for P1-200 hours
26	0	1-n	UPB unit Lo9(P2) blink at Hi7(P2)
26	2-99	1-n	UPB unit Lo9(P2) blink at Hi7(P2) for P1 seconds
26	101-199	1-n	UPB unit Lo9(P2) blink at Hi7(P2) for P1-100 minutes
26	201-210	1-n	UPB unit Lo9(P2) blink at Hi7(P2) for P1-200 hours Hi7(P2) = blink rate: 0 = 0.25 s 1 = 0.50 s 2 = 1.00 s 3 = 2.00 s
27	0	1-n	stop blinking UPB unit P2
28		1-n	UPB link P2 off (deactivate)
29		1-n	UPB link P2 on (activate)
30		1-n	UPB link P2 set (store preset)
42		1-n	CentraLite Scene off
43		1-n	CentraLite Scene on
44	1-8	1-n	UPB unit P2 LED P1 off
45	1-8	1-n	UPB unit P2 LED P1 on
46		1-n	RadioRA Phantom Button off
47		1-n	RadioRA Phantom Button on
60		1-n	scene P2 off (Leviton Scene off command)
61		1-n	scene P2 on (Leviton Scene on command)
62		1-n	scene P2 set (Leviton Scene set command)

For security commands, the code specified must be the user code number rather than the actual four digit security code. That is, send a 0x05 as the code if user code 5 is being used.

Command	Parameter 1 P1	Parameter 2 P2	Description
48+m	1-n	0-n	arm area P2 in mode m with code P1 P2 = 0 means all areas m = security mode: 0 = disarm 1 = day mode 2 = night mode 3 = away mode 4 = vacation mode 5 = day instant mode 6 = night delayed mode
4	1-n	1-n	bypass zone P2 with code P1
5	1-n	1-n	restore zone P2 with code P1
6	1-n	0-n	restore all area P2 zones with code P1 P2 = 0 means all areas/zones

For Lumina mode commands, the code specified must be the user code number rather than the actual four digit code. That is, send a 0x05 as the code if user code 5 is being used.

Command	Parameter 1 P1	Parameter 2 P2	Description
48+m	1-n	1	set mode m with code P1 m = mode: 1 = home mode 2 = sleep mode 3 = away mode 4 = vacation mode 5 = party mode 6 = special mode
7		1-n	execute macro button P2
8	0-3		set energy cost to P1 0 = low 1 = mid 2 = high 3 = critical
64	0	1-n	energy saver P2 off
64	1-99	1-n	energy saver P2 off for P1 seconds
64	101-199	1-n	energy saver P2 off for P1-100 minutes
64	201-218	1-n	energy saver P2 off for P1-200 hours
65	0	1-n	energy saver P2 on
65	1-99	1-n	energy saver P2 on for P1 seconds
65	101-199	1-n	energy saver P2 on for P1-100 minutes
65	201-218	1-n	energy saver P2 on for P1-200 hours

For commands 66-70, P2 may be set to zero to indicate "all thermostats" in those controllers that support this capability.

For the following two commands, temperatures are stored in the Omni temperature format (see Appendix C) where 0 = -40 degC and 255 = 87.5 degC. Thus, 44-180 corresponds to 0 to 122 degF or -18 to 50 degC.

Command	Parameter 1 P1	Parameter 2 P2	Description
66	44-180	0-n	set temp zone P2 low/heat setpoint to P1
67	44-180	0-n	set temp zone P2 high/cool setpoint to P1
68	0-3	0-n	set thermostat P2 system mode to P1 0 = off 1 = heat 2 = cool 3 = auto
69	0-1	0-n	set thermostat P2 fan mode to P1 0 = auto 1 = on

For the following two commands, temperatures are stored in the Omni temperature format (see Appendix C).

Command	Parameter 1 P1	Parameter 2 P2	Description
71	-50 to 50	0-n	raise/lower temp P2 low/heat setting by P1 P2 = 0 means all thermostats
72	-50 to 50	0-n	raise/lower temp P2 high/cool setting by P1 P2 = 0 means all thermostats
70	0/255	0-n	set thermostat P2 hold mode to P1 0 = off 255 = hold
80		1-n	show message P2 (with beep and LED)
86	0-2	1-n	show message P2 P1 = mode 1 = no beep 2 = no beep or LED
81		1-n	log message P2
82	0-n	0-n	clear message P2 (0=all) if clear all messages, P1 = area (0=all)
83		1-n	say message P2
84	1-n	1-n	phone number P1 and say message P2
85	1-n	1-n	send message P2 out serial port P1

Command	Parameter 1 P1	Parameter 2 P2	Description
102	0-255	0-16	enable/disable console beeper P2 P2 = 0 means all consoles P1 = mode 0 = disabled 1 = enabled
103	0-6	0-16	console P2 (0=all consoles) beep P1 0 = off 1 = indefinitely 2 = 1 time 3 = 2 times 4 = 3 times 5 = 4 times 6 = 5 times
112	0-3	0-n	set audio zone P2 (0=all zones) to P1 0 = off 1 = on 2 = mute off 3 = mute on
113	0-100	1-n	set audio zone P2 volume to P1 percent
114	1-n	1-n	set audio zone P2 to audio source P1
115	1-40	1-n	audio zone P2 select key P1 (see audio key codes table)

Audio Key Codes

Code	HAI Hi-Fi	Russound [1]	NuVo [2]	NuVo Grand Concerto	Xantech [3]	Speakercraft [4]
1	Power	Power	Power	Power	Power	Source select 1
2	Source step	Source step	Source step	Source step	Source select 1	Source select 2
3	Vol up	Vol up	Vol up	Vol up	Source select 2	Source select 3
4	Vol down	Vol down	Vol down	Vol down	Source select 3	Source select 4
5	Mute	Mute	Mute	Mute	Source select 4	Source select 5
6		Play	Play	Play / Pause	Source select 5	Source select 6
7		Stop	Stop	Stop (not used)	Source select 6	Source select 7
8		Pause	Pause	Pause (not used)	Source select 7	Source select 8
9		Minus	Rewind	Previous	Source select 8	
10		Plus	Forward	Next	Channel up	Mute
11		Previous	Fast rewind	Favorite 1	Channel down	Vol Up
12		Next	Fast forward	Favorite 2	Mute	Power
13		Record	Continuous	Favorite 3	Play	Vol Down
14		Channel up	Shuffle	Favorite 4	Stop	
15		Channel down	Group	Favorite 5	Pause	
16		Zero	Disc	Favorite 6	Rewind	
17		One	Zero	Favorite 7	Forward	One
18		Two	One	Favorite 8	Vol up	Two
19		Three	Two	Favorite 9	Vol down	Three
20		Four	Three	Favorite 10	Tier 2 power	Four
21		Five	Four	Favorite 11	Tier 2 source select 1	Five
22		Six	Five	Favorite 12	Tier 2 source select 2	Six
23		Seven	Six	Ok button down	Tier 2 source select 3	Seven
24		Eight	Seven	Ok button up	Tier 2 source select 4	Eight
25		Nine	Eight	Play / Pause button down	Tier 2 source select 5	Nine
26		Plus ten	Nine	Play / Pause button up	Tier 2 source select 6	Track
27		Enter	Plus ten	Previous button down	Tier 2 source select 7	Zero
28		Last	Enter	Previous button up	Tier 2 source select 8	Disc
29		Sleep	Hotkey zero	Next button down	Tier 2 channel up	Random
30		Guide	Hotkey one	Next button up	Tier 2 channel down	Repeat
31		Exit	Hotkey two	Power / Mute button down	Tier 2 mute	Bass
32		Info	Hotkey three	Power / Mute button up	Tier 2 play	Treble
33		Menu	Hotkey four	Menu button down	Tier 2 stop	Guide
34		Menu up	Hotkey five	Menu button up	Tier 2 pause	Menu
35		Menu right	Hotkey six	Up button down	Tier 2 rewind	Up
36		Menu down	Hotkey seven	Up button up	Tier 2 forward	Left
37		Menu left	Hotkey eight	Down button down		Select
38		Select	Hotkey nine	Down button up		Right
39		Favorite 1				Down
40		Favorite 2				Escape
41						Info
42						Rewind
43						Forward
44						Pause
45						Play
46						Stop

1: applies to Russound CAM and CAV audio systems.
2: applies to NuVo Concerto, Essentia, and Simplese audio systems (Essentia and Simplese responds to Key Codes 1-5 only).
3: applies to Xantech MRC-88 audio system.
4: applies to Speakercraft MZC and Proficient M4 and M6 audio systems.

CONNECTED SECURITY SYSTEM COMMAND

This message is used to send commands to a connected security system.

Start character	0x21
Message length	0x09
Message type	0x2F
Data 1	command
Data 2	partition number (1-8)
Data 3	digit 1 (0-9)
Data 4	digit 2 (0-9)
Data 5	digit 3 (0-9)
Data 6	digit 4 (0-9)
Data 7	digit 5 (0-9)
Data 8	digit 6 (0-9)
CRC 1	varies
CRC 2	varies

SET TIME COMMAND

This message is used to set the time, date, and daylight savings time flag in an HAI controller.

Start character	0x21
Message length	0x08
Message type	0x13
Data 1	year (0-99)
Data 2	month (1-12)
Data 3	day (1-31)
Data 4	day of week (1-7)
Data 5	hour (0-23)
Data 6	minute (0-59)
Data 7	daylight savings time flag (0-1)
CRC 1	varies
CRC 2	varies
Expected reply	ACKNOWLEDGE

ACTIVATE KEYPAD EMERGENCY

This message is used to activate a burglary, fire, or auxiliary keypad emergency alarm in an area on an Omni IIe or OmniPro II system.

Start character	0x21
Message length	0x03
Message type	0x2C
Data 1	area (1-8)
Data 2	emergency type (1=burglary, 2=fire, 3=auxiliary)
CRC 1	varies
CRC 2	varies
Expected reply	ACKNOWLEDGE

VALIDATE SECURITY CODE MESSAGES

These messages instruct the controller to confirm that the specified four-digit security code is valid in the specified area. The code is only valid if it matches a four-digit user code in the area, and that code is currently time-enabled. The controller will return the user code number and authority level for the code. The controller will also check to see if the duress code was specified. If so, it will return the duress code number (251) as the user code number and set the authority level to user.

- Request security code validation
- Security code validation

REQUEST SECURITY CODE VALIDATION

Start character	0x21
Message length	0x06
Message type	0x26
Data 1	area number (1-8)
Data 2	first digit of code
Data 3	second digit of code
Data 4	third digit of code
Data 5	fourth digit of code
CRC 1	varies
CRC 2	varies

Each of the digits of the security code must be sent as the numeric value of the digit, 0x00 through 0x09.

SECURITY CODE VALIDATION

Start character	0x21
Message length	0x03
Message type	0x27
Data 1	user code number (1-99, 251 for duress, 0 if invalid)
Data 2	authority level (0-3)
CRC 1	varies
CRC 2	varies

The authority level is as follows:

0	Invalid code
1	Master
2	Manager
3	User

NOTIFICATION MESSAGES

HAI controllers generate event notifications upon the occurrence of various changes in the controller. When the ENABLE NOTIFICATIONS feature is enabled and a change or event occurs in the controller, the event is automatically sent to the client. When the ENABLE NOTIFICATIONS feature is enabled, the system does not need to be polled, the notifications are automatically sent to the client.

- Enable notifications
- Object event notifications
- Other event notifications

ENABLE NOTIFICATIONS

The ENABLE NOTIFICATIONS message requests the HAI controller to send event notifications as they occur. If the ENABLE NOTIFICATIONS feature is disabled, the HAI controller will not send event data.

Start character	0x21
Message length	0x02
Message type	0x15
Data 1	enable byte (0=disable, 1=enable)
CRC 1	varies
CRC 2	varies
Expected reply	ACKNOWLEDGE

OBJECT EVENT NOTIFICATIONS

When a zone, unit, thermostat, and auxiliary sensor events occurs, the HAI controller will send the respective OBJECT STATUS report message to the client.

ZONE NOTIFICATIONS:

When an event occurs with a zone (e.g. a zone becomes not ready, secure, bypassed, or restored), the HAI controller will automatically send the ZONE STATUS message for the respective zone. See ZONE STATUS for message details.

UNIT NOTIFICATIONS:

When an event occurs with a control unit (e.g. a unit is turned on or off, the light level of a unit changes, the value of a flag changes, etc.), the HAI controller will automatically send the UNIT STATUS message for the respective control unit. See UNIT STATUS for message details

THERMOSTAT NOTIFICATIONS:

When an event occurs with a thermostat (e.g. the current temperature changes, heat or cool setting changes, mode changes, hold or fan changes, etc.), the HAI controller will automatically send the THERMOSTAT STATUS message for the respective thermostat. See THERMOSTAT STATUS for message details.

AUXILIARY SENSOR NOTIFICATIONS:

When an event occurs with an auxiliary sensor (e.g. current temperature or humidity changes, low/heat or high/cool setting changes, output changes state, etc.) the HAI controller will automatically send the AUXILIARY SENSOR STATUS message for the respective auxiliary sensor. See AUXILIARY SENSOR STATUS for message details.

OTHER EVENT NOTIFICATIONS

When other system events occur, the HAI controller will send the respective event notification messages. Other event notifications are sent when:

- The security system is armed/disarmed
- The Lumina mode changes
- An alarm is activated
- X-10 / UPB / RadioRA signals are received
- Certain trouble conditions are detected
- The phone line changes state
- The cost of energy changes
- The user activates a macro button
- Pro-Link message received
- CentraLite switch is pressed

When these other event notifications are sent, they are sent in the following format:

Start character	0x21
Message length	(2 * number of system events) + 1
Message type	0x37
Data 1	High byte of oldest system event
Data 2	Low byte of oldest system event
Data 3	High byte of next oldest system event
Data 4	Low byte of next oldest system event
...	
Data n-1	High byte of most recent event
Data n	Low byte of most recent event
CRC 1	varies
CRC 2	varies

Each event notification is identified by a unique 16-bit event number. The encoding of these events is shown below. The encoding is shown in binary, with the most-significant bit to the left.

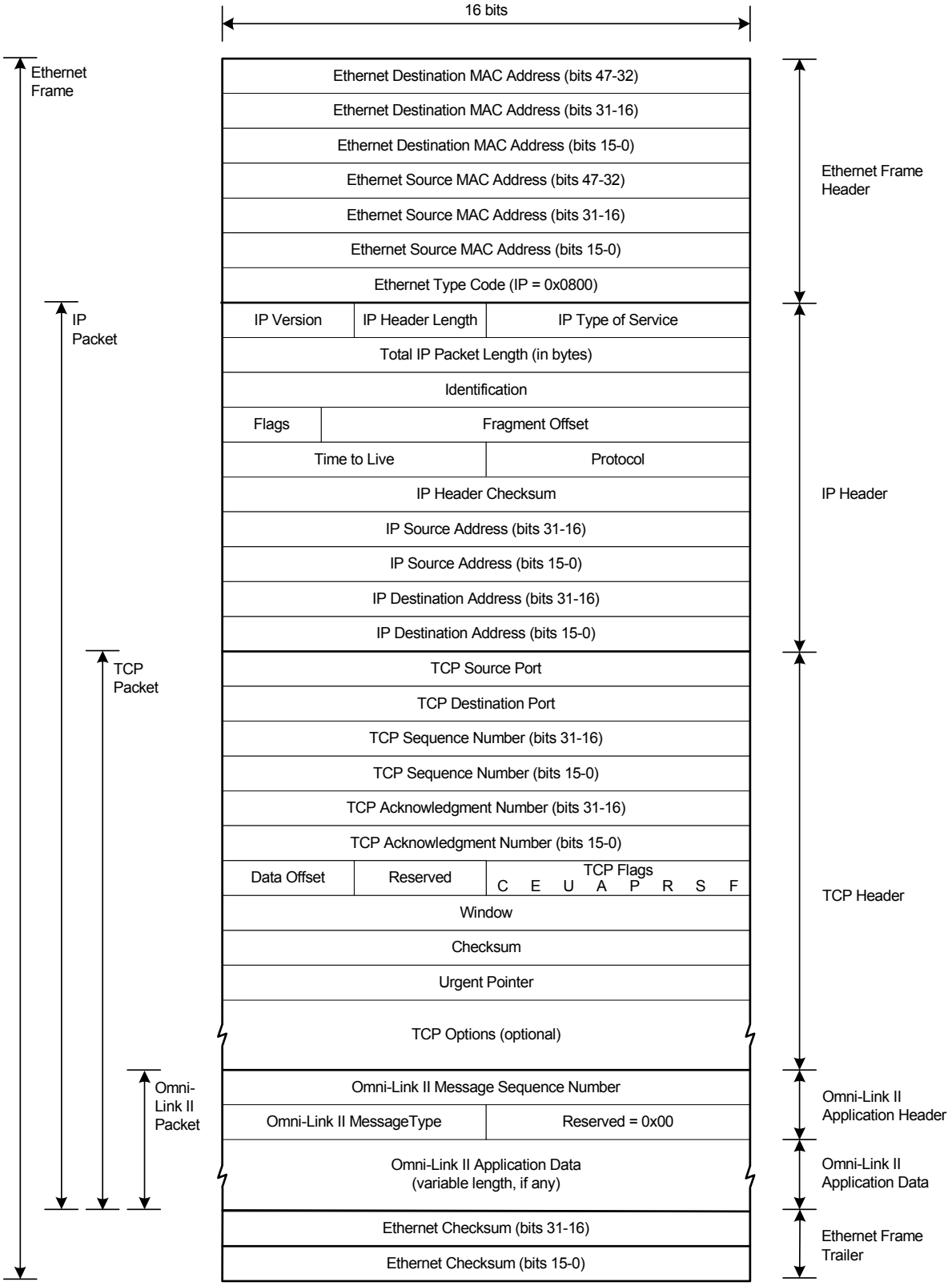
```
USER MACRO BUTTON        0000 0000 bbbb bbbb     b = button number

PRO-LINK MESSAGE         0000 0001 0mmm mmmm     m = message number

CENTRALITE SWITCH        0000 0001 1sss ssss     s = switch number

ALARM (OMNI FAMILY)      0000 0010 tttt aaaa     t = alarm type
                                                     1 = burglary
                                                     2 = fire
                                                     3 = gas
                                                     4 = auxiliary
                                                     5 = freeze
                                                     6 = water
                                                     7 = duress
                                                     8 = temperature
                                                 a = area

ALARM (LUMINA FAMILY)    0000 0010 tttt 0001     t = alarm type
                                                     5 = freeze
                                                     6 = water
                                                     8 = temperature
```

COMPOSE CODE RECEIVED	0111 ssss hhhh uuuu	s = state 0 = off 1 = on 2-13 = scene A-L h = Compose house code 0-15 = A-P u = Compose unit number 0-15 = 1-16
X-10 CODE RECEIVED	0000 11sa hhhh uuuu	s = state 0 = off 1 = on a = all units flag 0 = one unit only 1 = all on/off h = X-10 house code 0-15 = A-P u = X-10 unit number 0-15 = 1-16
SECURITY ARMING	dmmm aaaa cccc cccc	d = exit delay flag 0 = end of delay 1 = start of delay must be 1 for off m = security mode 0 = off 1 = day 2 = night 3 = away 4 = vacation 5 = day instant 6 = night delayed a = area c = code
LUMINA MODE CHANGE	dmmm 0001 cccc cccc	d = mode change delay flag 0 = end of delay 1 = start of delay m = mode 1 = home 2 = sleep 3 = away 4 = vacation 5 = party 6 = special c = code
ALC, UPB, RADIO RA, OR STARLITE SWITCH PRESS	1111 ssss uuuu uuuu	s = switch 0 = off 1 = on 2-11 = switch 1-10 u = unit number
UPB LINK	1111 11cc nnnn nnnn	c = link command 0 = off (deactivate) 1 = on (activate) 2 = set (store preset) 3 = fade stop n = link number
ALL ON/OFF	0000 0011 111s aaaa	s = state 0 = off 1 = on a = area

PHONE LINE DEAD	0000 0011 0000 0000
PHONE LINE RING	0000 0011 0000 0001
PHONE LINE OFF HOOK	0000 0011 0000 0010
PHONE LINE ON HOOK	0000 0011 0000 0011
AC POWER OFF	0000 0011 0000 0100
AC POWER RESTORED	0000 0011 0000 0101
BATTERY LOW	0000 0011 0000 0110
BATTERY OK	0000 0011 0000 0111
DCM TROUBLE	0000 0011 0000 1000
DCM OK	0000 0011 0000 1001
ENERGY COST LOW	0000 0011 0000 1010
ENERGY COST MID	0000 0011 0000 1011
ENERGY COST HIGH	0000 0011 0000 1100
ENERGY COST CRITICAL	0000 0011 0000 1101

APPENDIX A - NETWORK DIAGRAMS

TYPICAL ETHERNET FRAME WITH EMBEDDED IP, TCP, AND OMNI-LINK II APPLICATION PACKETS



HAI APPLICATION PACKET FORMAT

The following table describes the format of the Omni-Link II application data that is transmitted within the user data (payload) area of a TCP/IP packet.

Size (bytes)	Description	Comments
2	Message sequence number	= Sequence tracking disabled 1..65535 = Sequence number of this packet (byte order is MSB..LSB)
1	Message type	0 = No message 1 = Client request new session 2 = Controller acknowledge new session 3 = Client request secure connection 4 = Controller acknowledge secure connection 5 = Client session terminated 6 = Controller session terminated 7 = Controller cannot start new session 32 = Omni-Link II application data message
1	Reserved	0 = unused
variable	Message data	May be empty, depending on message type

TYPICAL MESSAGE SEQUENCE

Sequence Number	Encrypted	Client	Direction	Controller
1	No	Request new session	→	
1	No		←	Acknowledge new session protocol version session ID (40-bit random data generated by controller)
2	Yes	Request secure connection - session ID	→	
2	Yes		←	Acknowledge secure connection - session ID
	Yes	Omni-Link message	→	
	Yes		←	Omni-Link II application data reply message
		• • •		• • •
	No	Client session terminated	→	
	No		←	Controller session terminated (timed out, terminated by client, etc.)

APPENDIX B - CRC-16 ERROR DETECTION ROUTINES

Turbo Pascal

This routine is written in Turbo Pascal. First initialize CRC to 0. Then, starting with the message length byte, call Update_CRC for each byte of the message passing the message byte in Data. The low byte of CRC will contain the low byte of the CRC-16 remainder and should be sent first. The high byte of CRC will contain the high byte of the CRC-16 remainder and should be sent last.

```
var
  CRC: Word;

procedure Update_CRC(Data: Byte);
const
  Poly = $A001;          {CRC-16 polynomial}
var
  I: Integer;
  Flag: Boolean;
begin
  CRC := CRC xor Data;
  for I := 1 to 8 do
  begin
    Flag := (CRC and 1) <> 0;
    CRC := CRC shr 1;
    if Flag then CRC := CRC xor Poly;
  end;
end {Update_CRC};
```

Motorola MC68HC11 Assembly Language

This routine is written in Motorola MC68HC11 assembly language. First initialize CRC+0 and CRC+1 to 0. Then, starting with the message length byte, call UPDCRC for each byte of the message with the B accumulator containing the message byte. CRC+1 will contain the low byte of the CRC-16 remainder and should be sent first. CRC+0 will contain the high byte of the CRC-16 remainder and should be sent last.

```
POLY  EQU   $A001       CRC-16 polynomial

UPDCRC

      PSHB              save registers
      PSHA
      EORB  CRC+1       add in new byte
      LDAA  #8          get shift count
      STAA  CRC+1       use low byte of CRC for counter
      LDAA  CRC+0       get high byte of CRC
10$
      LSRA              shift CRC
      RORB
      BCC   20$         branch if we didn't shift out a 1
      EORA  #>POLY      add in CRC polynomial
      EORB  #<POLY
20$
      DEC   CRC+1       count the shift
      BNE   10$         branch back if more to do
      STD   CRC         save updated CRC
      PULA              restore registers
      PULB
      RTS
```

C/C++

This routine is written in the C/C++ language.

```
//---------------------------------------------------------------------
void UpdateCRC(unsigned short int *CRC, unsigned char x)
{
  // This function uses the initial CRC value passed in the first
  // argument, then modifies it using the single character passed
  // as the second argument, according to a CRC-16 polynomial
  // calculation used for HAI communication protocol.

  // Arguments:
  //   CRC -- pointer to starting CRC value
  //   x   -- new character to be processed

  // Returns:
  // The function does not return any values, but updates the variable
  // pointed to by CRC

  static int const Poly = 0xA001;    // CRC-16 polynomial
  int i;
  bool flag;

  *CRC ^= x;
  for (i=0; i<8; i++)
  {
    flag = ((*CRC & 1) == 1);
    *CRC = (unsigned short int)(*CRC >> 1);
    if (flag)
      *CRC ^= Poly;
  }
  return;
}
```

APPENDIX C - OMNI TEMPERATURE FORMAT

Temperatures in HAI controllers are specified in the Omni temperature format. This format allows a temperature span of -40.0 to +87.5 degC (-40.0 to +189.5 degF) to be specified with 0.5 degC resolution in a single byte. Each Omni temperature "degree" is 0.5 degC, with 0 corresponding to -40 degC (-40 degF) and 255 corresponding to +87.5 degC (+189.5 degF).

The following chart shows the relationship between Omni, Celsius, and Fahrenheit temperatures.

Omni	Deg. C	Deg. F		Omni	Deg. C	Deg. F		Omni	Deg. C	Deg. F
0	- 40.0	- 40.0		44	- 18.0	- 00.4		88	04.0	39.2
1	- 39.5	- 39.1		45	- 17.5	00.5		89	04.5	40.1
2	- 39.0	- 38.2		46	- 17.0	01.4		90	05.0	41.0
3	- 38.5	- 37.3		47	- 16.5	02.3		91	05.5	41.9
4	- 38.0	- 36.4		48	- 16.0	03.2		92	06.0	42.8
5	- 37.5	- 35.5		49	- 15.5	04.1		93	06.5	43.7
6	- 37.0	- 34.6		50	- 15.0	05.0		94	07.0	44.6
7	- 36.5	- 33.7		51	- 14.5	05.9		95	07.5	45.5
8	- 36.0	- 32.8		52	- 14.0	06.8		96	08.0	46.4
9	- 35.5	- 31.9		53	- 13.5	07.7		97	08.5	47.3
10	- 35.0	- 31.0		54	- 13.0	08.6		98	09.0	48.2
11	- 34.5	- 30.1		55	- 12.5	09.5		99	09.5	49.1
12	- 34.0	- 29.2		56	- 12.0	10.4		100	10.0	50.0
13	- 33.5	- 28.3		57	- 11.5	11.3		101	10.5	50.9
14	- 33.0	- 27.4		58	- 11.0	12.2		102	11.0	51.8
15	- 32.5	- 26.5		59	- 10.5	13.1		103	11.5	52.7
16	- 32.0	- 25.6		60	- 10.0	14.0		104	12.0	53.6
17	- 31.5	- 24.7		61	- 09.5	14.9		105	12.5	54.5
18	- 31.0	- 23.8		62	- 09.0	15.8		106	13.0	55.4
19	- 30.5	- 22.9		63	- 08.5	16.7		107	13.5	56.3
20	- 30.0	- 22.0		64	- 08.0	17.6		108	14.0	57.2
21	- 29.5	- 21.1		65	- 07.5	18.5		109	14.5	58.1
22	- 29.0	- 20.2		66	- 07.0	19.4		110	15.0	59.0
23	- 28.5	- 19.3		67	- 06.5	20.3		111	15.5	59.9
24	- 28.0	- 18.4		68	- 06.0	21.2		112	16.0	60.8
25	- 27.5	- 17.5		69	- 05.5	22.1		113	16.5	61.7
26	- 27.0	- 16.6		70	- 05.0	23.0		114	17.0	62.6
27	- 26.5	- 15.7		71	- 04.5	23.9		115	17.5	63.5
28	- 26.0	- 14.4		72	- 04.0	24.8		116	18.0	64.4
29	- 25.5	- 13.9		73	- 03.5	25.7		117	18.5	65.3
30	- 25.0	- 13.0		74	- 03.0	26.6		118	19.0	66.2
31	- 24.5	- 12.1		75	- 02.5	27.5		119	19.5	67.1
32	- 24.0	- 11.2		76	- 02.0	28.4		120	20.0	68.0
33	- 23.5	- 10.3		77	- 01.5	29.3		121	20.5	68.9
34	- 23.0	- 09.4		78	- 01.0	30.2		122	21.0	69.8
35	- 22.5	- 08.5		79	- 00.5	31.1		123	21.5	70.7
36	- 22.0	- 07.6		80	0	32.0		124	22.0	71.6
37	- 21.5	- 06.7		81	00.5	32.9		125	22.5	72.5
38	- 21.0	- 05.8		82	01.0	33.8		126	23.0	73.4
39	- 20.5	- 04.9		83	01.5	34.7		127	23.5	74.3
40	- 20.0	- 04.0		84	02.0	35.6		128	24.0	75.2
41	- 19.5	- 03.1		85	02.5	36.5		129	24.5	76.1
42	- 19.0	- 02.2		86	03.0	37.4		130	25.0	77.0
43	- 18.5	- 01.3		87	03.5	38.3		131	25.5	77.9

Omni	Deg. C	Deg. F		Omni	Deg. C	Deg. F		Omni	Deg. C	Deg. F
132	26.0	78.8		176	48.0	118.4		220	70.0	158.0
133	26.5	79.7		177	48.5	119.3		221	70.5	158.9
134	27.0	80.6		178	49.0	120.2		222	71.0	159.8
135	27.5	81.5		179	49.5	121.1		223	71.5	160.7
136	28.0	82.4		180	50.0	122.0		224	72.0	161.6
137	28.5	83.3		181	50.5	122.9		225	72.5	162.5
138	29.0	84.2		182	51.0	123.8		226	73.0	163.4
139	29.5	85.1		183	51.5	124.7		227	73.5	164.3
140	30.0	86.0		184	52.0	125.6		228	74.0	165.2
141	30.5	86.9		185	52.5	126.5		229	74.5	166.1
142	31.0	87.8		186	53.0	127.4		230	75.0	167.0
143	31.5	88.7		187	53.5	127.3		231	75.5	167.9
144	32.0	89.6		188	54.0	129.2		232	76.0	168.8
145	32.5	90.5		189	54.5	130.1		233	76.5	169.7
146	33.0	91.4		190	55.0	131.0		234	77.0	170.6
147	33.5	92.3		191	55.5	131.9		235	77.5	171.5
148	34.0	93.2		192	56.0	132.8		236	78.0	172.4
149	34.5	94.1		193	56.5	133.7		237	78.5	173.3
150	35.0	95.0		194	57.0	134.6		238	79.0	174.2
151	35.5	95.9		195	57.5	135.5		239	79.5	175.1
152	36.0	96.8		196	58.0	136.4		240	80.0	176.0
153	36.5	97.7		197	58.5	137.3		241	80.5	176.9
154	37.0	98.6		198	59.0	138.2		242	81.0	177.8
155	37.5	99.5		199	59.5	139.1		243	81.5	178.7
156	38.0	100.4		200	60.0	140.0		244	82.0	179.6
157	38.5	101.3		201	60.5	140.9		245	82.5	180.5
158	39.0	102.2		202	61.0	141.8		246	83.0	181.4
159	39.5	103.1		203	61.5	142.7		247	83.5	182.3
160	40.0	104.0		204	62.0	143.6		248	84.0	183.2
161	40.5	104.9		205	62.5	144.5		249	84.5	184.1
162	41.0	105.8		206	63.0	145.4		250	85.0	185.0
163	41.5	106.7		207	63.5	146.3		251	85.5	185.9
164	42.0	107.6		208	64.0	147.2		252	86.0	186.8
165	42.5	108.5		209	64.5	148.1		253	86.5	187.7
166	43.0	109.4		210	65.0	149.0		254	87.0	188.6
167	43.5	110.3		211	65.5	149.9		255	87.5	189.5
168	44.0	111.2		212	66.0	150.8				
169	44.5	112.1		213	66.5	151.7				
170	45.0	113.0		214	67.0	152.6				
171	45.5	113.9		215	67.5	153.5				
172	46.0	114.8		216	68.0	154.4				
173	46.5	115.7		217	68.5	155.3				
174	47.0	116.6		218	69.0	156.2				
175	47.5	117.5		219	69.5	157.1				

APPENDIX D - REVISION HISTORY

Revision 2.16 - Released (3/3/08)

- Initial release of Omni-Link II Protocol.