Home Automation, Inc.

Omni-Link

Serial Protocol Description

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GENERAL

This document defines the Omni-Link communications protocol. This protocol allows an external device to communicate with a Home Automation, Inc. automation controller through an RS-232 or RS-485 serial interface. Omni-Link allows the external device to monitor the status of the HAI controller and to control its operation. The current status of the security system and of each security zone, control unit, temperature sensor, thermostat, and displayed text messages may be obtained. Commands may be sent to control security, units, temperature setpoints, and thermostat operation. Additionally, the controller display names may be uploaded from and downloaded to the HAI controller and the event log may be uploaded from the HAI controller.

ELECTRICAL INTERFACE

The external device connects to the HAI controller through the HAI Model 10A17-1 Serial Interface. This interface provides both an RS-232 interface and an RS-485 interface. Only one of these interfaces may be active at a time.

The RS-232 interface is provided through a standard DB-9M connector configured as DTE (data terminal equipment). This is the same configuration as provided on a typical personal computer. The serial interface may be connected to a personal computer using a readily available "null modem" or data transfer cable.

The RS-485 interface is provided through a two-position terminal block. The external device may be connected up to 1000 feet away when using standard twisted pair cabling. Since the RS-485 interface is a half-duplex bus, the external device must be capable of turning its RS-485 driver on before transmitting to the controller and turning it off after it has completed its transmission to the controller.

Data is transmitted asynchronously using standard nonreturn-to-zero (NRZ) format (one start bit, eight data bits, and a single stop bit) at up to 9600 baud.

MESSAGE TIMING

The Omni-Link protocol is a master/slave protocol. The external device is the master. The HAI controller is the slave. The master initiates all communications. The slave can only communicate when requested by the master. All communication takes place half-duplex. That is, the master will first transmit to the slave, then the slave may reply to the master.

Data transfer between the external device and the HAI controller takes place though a series of message exchanges. The external device sends a message to the controller requesting the controller to take some action or to provide some information. The controller then replies with the requested information or an acknowledgement that it has performed the desired action.

When using the RS-485 interface, the master must turn on its RS-485 driver, send its message, then disable its RS-485 driver after the last character of the message has been transmitted. The master's driver must be turned off and the master must be ready to receive the slave's reply within 1 ms after the last character has been transmitted.

The master must allow at least 250 ms for the slave to begin replying with its message. It must then allow at least 5 ms for each subsequent character to be sent. The master must wait at least 1 ms after receiving the last character from the slave before turning on its driver again to initiate a new message.

MESSAGE FORMAT

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

Each message in the Omni-Link protocol follows the same format. The first byte of the message is the start character, which is the single character 0x5A. The next byte is the message length, 0x01 through 0x41. The next byte is the message type, 0x00 through 0xFF, which identifies the specific function of the message. Next, zero or more data bytes are sent. The number of data bytes varies based on message type and is equal to the message length minus one. The final two bytes of the message are the CRC-16 error check bytes.

The CRC-16 error detection algorithm is used to provide a robust error detection capability in the Omni-Link protocol. The error check bytes are the 16-bit CRC-16 polynomial remainder sent least significant bit first. Sample routines to calculate the CRC-16 error check bytes are provided in Appendix A.

MESSAGE TYPES

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

- Acknowledgement messages
- Access control messages
- Status request messages
- Status report messages
- System event messages
- Command messages
- Name messages
- Event log 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. 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.

ACKNOWLEDGE

Start character	0x5A
Message length	0x01
Message type	0x05
Data	none
CRC 1	0xC1
CRC 2	0x93

NEGATIVE ACKNOWLEDGE

Start character	0x5A
Message length	0x01
Message type	0x06
Data	none
CRC 1	0x81
CRC 2	0x92

ACCESS CONTROL MESSAGES

Access control messages are used to insure that only authorized users may access the HAI controller through the Omni-Link interface. The external device must first "log in" using an approved security code before access is allowed to the HAI controller. It may then "log out" when the access has been completed. Once logged in, the external device has full access to the controller. Therefore, only the PC access code or a master code may be used to access the controller through Omni-Link.

The external device "logs in" by sending a LOGIN message containing an approved security code. The controller will reply with an ACKNOWLEDGE message if the login was successful. Prior to login, the controller will send NEGATIVE ACKNOWLEDGE messages in reply to all other messages.

The ACKNOWLEDGE message can be used to determine if the external device is currently logged in. The controller will reply to an ACKNOWLEDGE message with another ACKNOWLEDGE message if the external device is logged in. The controller will reply with a NEGATIVE ACKNOWLEDGE message if the external device is not logged in.

The controller will disallow any further login attempts for one hour if three consecutive unsuccessful login attempts are made. This prevents an intruder from randomly trying all possible security codes to gain access to the controller.

The external device "logs out" by sending a LOGOUT message. This allows the Omni-Link interface to be secured when the external device has completed access to the controller. The system will automatically log the external device out if:

- No messages are sent for three minutes
- Carrier detect is lost when using a modem
- The controller is reset

LOGIN

Start character	0x5A
Message length	0x05
Message type	0x20
Data 1	first digit of code
Data 2	second digit of code
Data 3	third digit of code
Data 4	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.

LOGOUT

Start character	0x5A
Message length	0x01
Message type	0x21
Data	none
CRC 1	0xC1
CRC 2	0x88

STATUS REQUEST MESSAGES

Status request messages are sent by the external device to the HAI controller to request that the controller report certain status information. The following information can be requested:

- System information
- System status
- Zone status
- Unit status
- Auxiliary status
- Thermostat status
- Message Status

REQUEST SYSTEM INFORMATION

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

Start character	0x5A
Message length	0x01
Message type	0x11
Data	none
CRC 1	0xC1
CRC 2	0x9C
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, current security mode for each area, and the status of each expansion enclosure. The status for each expansion enclosure includes the AC power status, battery status, communications status, and battery reading.

Start character	0x5A
Message length	0x01
Message type	0x13
Data	none
CRC 1	0x40
CRC 2	0x5D
Expected reply	SYSTEM STATUS

REQUEST ZONE STATUS

This message requests the HAI controller to report the status of a group of security zones. The status reported for each zone includes the 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	0x5A
Message length	0x03
Message type	0x15
Data 1	starting zone
Data 2	ending zone
CRC 1	varies
CRC 2	varies
Expected reply	ZONE STATUS

REQUEST UNIT STATUS

This message requests the HAI controller to report the status of a group of units. The status reported for each unit includes the unit's current condition and any time remaining on a timed command.

Start character	0x5A
Message length	0x03
Message type	0x17
Data 1	starting unit
Data 2	ending unit
CRC 1	varies
CRC 2	varies
Expected reply	UNIT STATUS

REQUEST AUXILIARY STATUS

This message requests the HAI controller to report the status of a group of temperature sensors. The status reported for each temperature sensor includes: the output relay status for Programmable Energy Saver Modules (PESMs), the current temperature reading, and the low and high temperature setpoints.

Start character	0x5A
Message length	0x03
Message type	0x19
Data 1	starting temperature sensor
Data 2	ending temperature sensor
CRC 1	varies
CRC 2	varies
Expected reply	AUXILIARY STATUS

REQUEST THERMOSTAT STATUS

This message requests the HAI controller to report the status of a group of thermostats. The status reported for each thermostat includes 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	0x5A
Message length	0x03
Message type	0x1E
Data 1	starting thermostat
Data 2	ending thermostat
CRC 1	varies
CRC 2	varies
Expected reply	THERMOSTAT STATUS

REQUEST MESSAGE STATUS

This message requests the HAI controller to report the status of displayed text messages. The status reported for each message includes which messages are currently being displayed and what displayed messages have not been acknowledged. The status reported also indicates if there is a memo message that has not yet been played.

Start character	0x5A
Message length	0x01
Message type	0x24
Data	none
CRC 1	0x01
CRC 2	0x8B

STATUS REPORT MESSAGES

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

- System information
- System status
- Zone status
- Unit status
- Auxiliary status
- Thermostat status
- Message 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	0x5A
Message length	0x1E
Message type	0x12
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, OmniPro, or Aegis. The following model numbers are defined:

NUMBER	MODEL
2	HAI Omni
4	HAI OmniPro
5	Aegis

The major version, minor version, and revision identify the controller software version. For example, if the software version is 1.4G, the major version would be 0x01, the minor version would be 0x04, and the revision would be 0x07. 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, current security mode for each area, and the status of each expansion enclosure. The status for each expansion enclosure includes the AC power status, battery status, communications status, and battery reading.

For HAI Omni, the reply is as follows:

Start character	0x5A
Message length	0x11
Message type	0x14
Data 1	time/date valid flag
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
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 1 security mode
Data 16	area 2 security mode
CRC 1	varies
CRC 2	varies

For HAI OmniPro and HAI Aegis, the reply is as follows:

Start character	0x5A
Message length	0x1F
Message type	0x14
Data 1	time/date valid flag
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
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 1 security mode
Data 16	area 2 security mode
Data 17	area 3 security mode
Data 18	area 4 security mode
Data 19	area 5 security mode
Data 20	area 6 security mode
Data 21	area 7 security mode

Data 22	area 8 security mode
Data 23	expansion enclosure 1 status
Data 24	expansion enclosure 1 battery reading
Data 25	expansion enclosure 2 status
Data 26	expansion enclosure 2 battery reading
Data 27	expansion enclosure 3 status
Data 28	expansion enclosure 3 battery reading
Data 29	expansion enclosure 4 status
Data 30	expansion enclosure 4 battery reading
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 security mode for an area is as follows:

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

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

Bit 0	AC power off
Bit 1	Battery low
Bit 7	Communications failure

ZONE STATUS

This message is sent by the HAI controller in reply to a REQUEST ZONE STATUS message. The controller reports the status of a group of security zones. The status reported for each zone includes the 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	0x5A
Message length	(2 * number of zones) + 1
Message type	0x16
Data 1	zone status for first zone
Data 2	analog loop reading for first zone
Data 3	zone status for second zone
Data 4	analog loop reading for second zone
...	
Data n-1	zone status for last zone
Data n	analog 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 current condition of the zone:

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.

Status can be requested for the following zones in HAI Omni:

Zone 1-32	Security zone inputs
Zone 33	Freeze alarm
Zone 34	Area 1 fire emergency
Zone 35	Area 2 fire emergency
Zone 36	Area 1 police emergency
Zone 37	Area 2 police emergency
Zone 38	Area 1 auxiliary emergency
Zone 39	Area 2 auxiliary emergency
Zone 40	Area 1 duress alarm
Zone 41	Area 2 duress alarm
Zone 42	Battery low trouble
Zone 43	AC power failure trouble
Zone 44	Phone line dead trouble
Zone 45	Digital communicator trouble

Status can be requested for the following zones in HAI OmniPro and HAI Aegis:

Zone 1-96	Security zone inputs
Zone 97	Freeze alarm
Zone 98	Area 1 fire emergency
Zone 99	Area 2 fire emergency
Zone 100	Area 3 fire emergency
Zone 101	Area 4 fire emergency
Zone 102	Area 5 fire emergency

Zone 103	Area 6 fire emergency
Zone 104	Area 7 fire emergency
Zone 105	Area 8 fire emergency
Zone 106	Area 1 police emergency
Zone 107	Area 2 police emergency
Zone 108	Area 3 police emergency
Zone 109	Area 4 police emergency
Zone 110	Area 5 police emergency
Zone 111	Area 6 police emergency
Zone 112	Area 7 police emergency
Zone 113	Area 8 police emergency
Zone 114	Area 1 auxiliary emergency
Zone 115	Area 2 auxiliary emergency
Zone 116	Area 3 auxiliary emergency
Zone 117	Area 4 auxiliary emergency
Zone 118	Area 5 auxiliary emergency
Zone 119	Area 6 auxiliary emergency
Zone 120	Area 7 auxiliary emergency
Zone 121	Area 8 auxiliary emergency
Zone 122	Area 1 duress alarm
Zone 123	Area 2 duress alarm
Zone 124	Area 3 duress alarm
Zone 125	Area 4 duress alarm
Zone 126	Area 5 duress alarm
Zone 127	Area 6 duress alarm
Zone 128	Area 7 duress alarm
Zone 129	Area 8 duress alarm
Zone 130	Battery low trouble
Zone 131	AC power failure trouble
Zone 132	Phone line dead trouble
Zone 133	Digital communicator trouble

UNIT STATUS

This message is sent by the HAI controller in reply to a REQUEST UNIT STATUS message. The controller reports the status of a group of control units. The status reported for each unit includes the unit's current condition and any time remaining on a timed command.

Start character	0x5A
Message length	(3 * number of units) + 1
Message type	0x18
Data 1	current condition of first unit
Data 2	high byte of time for first unit
Data 3	low byte of time for first unit
Data 4	current condition of second unit
Data 5	high byte of time for second unit
Data 6	low byte of time for second unit
...	
Data n-2	current condition of 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 AMP Lighting Control (ALC) relay modules:

0	Off
1	On

For AMP Lighting Control (ALC) dimmer modules:

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

The time remaining for the last command is specified in seconds.

AUXILIARY STATUS

This message is sent by the HAI controller in reply to a REQUEST AUXILIARY STATUS message. The controller reports the status of a group of temperature sensors. The status reported for each temperature sensor includes: the output relay status for Programmable Energy Saver Modules (PESMs), the current temperature reading, and the low and high temperature setpoints.

Start character	0x5A
Message length	(4 * number of temperature sensors) + 1
Message type	0x1A
Data 1	Relay status for first temperature sensor
Data 2	Current temperature for first temperature sensor
Data 3	Low/heat temperature setpoint for first temperature sensor
Data 4	High/cool temperature setpoint for first temperature sensor
Data 5	Relay status for second temperature sensor
Data 6	Current temperature for second temperature sensor
Data 7	Low/heat temperature setpoint for second temperature sensor
Data 8	High/cool temperature setpoint for second temperature sensor
...	

Data n-3	Relay status for last temperature sensor
Data n-2	Current temperature for last temperature sensor
Data n-1	Low/heat temperature setpoint for last temperature sensor
Data n	High/cool temperature setpoint for last temperature sensor
CRC 1	varies
CRC 2	varies

The relay status is non-zero if the relay is energized. The temperatures are reported in the Omni temperature format (see Appendix B).

THERMOSTAT STATUS

This message is sent by the HAI controller in reply to a REQUEST THERMOSTAT STATUS message. The controller reports the status of a group of thermostats. The status reported for each thermostat includes 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	0x5A
Message length	(7 * number of thermostats) + 1
Message type	0x1F
Data 1	Status byte for first thermostat
Data 2	Current temperature for first thermostat
Data 3	Heat setpoint for first thermostat
Data 4	Cool setpoint for first thermostat
Data 5	System mode for first thermostat
Data 6	Fan mode for first thermostat
Data 7	Hold status for first thermostat
Data 8	Status byte for second thermostat
Data 9	Current temperature for second thermostat
Data 10	Heat setpoint for second thermostat
Data 11	Cool setpoint for second thermostat
Data 12	System mode for second thermostat
Data 13	Fan mode for second thermostat
Data 14	Hold status for second thermostat
...	
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 B).

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

This message is sent by the HAI controller in reply to a REQUEST MESSAGE STATUS message. The controller reports the status of displayed text messages. The status reported for each message includes which messages are currently being displayed and what displayed messages have not been acknowledged. The status reported also indicates if there is a memo message that has not yet been played.

The status of each text message is indicated by two bits. The low order bit is set if the message is currently being displayed on the system console. The high order bit is set if the message has not been acknowledged. The statuses for four messages are packed into one Omni-Link message byte. The status of the lower numbered message is packed into the two high order bits, and the status for the higher numbered messages are packed into the lower order bits. Thirty-two data bytes are used to report the status of the 128 text messages in an Aegis or OmniPro system.

Start character	0x5A
Message length	0x22
Message type	0x25
Data 1	memo message status (bit 0 set if memo message not played)
Data 2	status of messages 1-4
Data 3	status of messages 5-8
Data 4	status of messages 9-12
…	
Data 32	status of message 113-120
Data 33	status of messages 121-128
CRC 1	varies
CRC 2	varies

SYSTEM EVENT MESSAGES

HAI controllers generate system events upon the occurrence of various changes in the controller (see Appendix C). These messages allow the external device to monitor changes in the HAI controller and to react to these changes. By periodically polling for system events the external device can quickly detect and operate on changes in the HAI controller.

The REQUEST SYSTEM EVENTS message requests the HAI controller to send a list of system events that have occurred since the controller last reported system events. The controller responds with a SYSTEM EVENTS message that reports each of the system events in the order of occurrence.

REQUEST SYSTEM EVENTS

Start character	0x5A
Message length	0x01
Message type	0x22
Data	none
CRC 1	0x81
CRC 2	0x89
Expected reply	SYSTEM EVENTS

SYSTEM EVENTS

Start character	0x5A
Message length	(2 * number of system events) + 1
Message type	0x23
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

COMMAND MESSAGE

The COMMAND message is used to send an immediate control command to the HAI controller. Commands are provided to control lights, appliances, temperatures, security, and messaging. 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	0x5A
Message length	0x05
Message type	0x0F
Data 1	Command
Data 2	Parameter 1
Data 3	High byte of parameter 2
Data 4	Low byte of parameter 2

CRC 1	varies
CRC 2	varies
Expected reply	ACKNOWLEDGE

Each of the commands is shown below:

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
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.

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
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

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.

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

The execute macro button command can be used to activate the user operable macro buttons as well as system event macros (see Appendix C).

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

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

69	0-1	1-n	set thermostat P2 fan mode to P1 0 = auto 1 = on
70	0/255	1-n	set thermostat P2 hold mode to P1 0 = off 255 = hold
80		1-n	show message P2
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

NAME MESSAGES

Display names for zones, units, buttons, codes, areas, thermostats, and messages may be uploaded from and downloaded to the HAI controller through the Omni-Link protocol. Names for all items must be transferred as part of the same upload/download sequence. It is not possible to upload/download the name of a single item without uploading/downloading the names of all items.

To upload names from the HAI controller, first send an UPLOAD NAMES message to the HAI controller. The controller will then send a series of NAME DATA messages, followed by a single END OF DATA message. Each NAME DATA message contains the name of a single item. NAME DATA messages are only sent for those items that have a name entered for them. The external device must acknowledge receipt of each NAME DATA message by sending an ACKNOWLEDGE message after each NAME DATA message is received. This informs the HAI controller that the NAME DATA message was received correctly and that the controller may send the next NAME DATA message. If for some reason the NAME DATA message is not received, the external device should send a NEGATIVE ACKNOWLEDGE message to the controller. This instructs the controller to resend the NAME DATA message that was missed. Once all names have been sent, the controller will send an END OF DATA message rather than a NAME DATA message, indicating the end of the name data transfer. If no names have been entered in the controller, the controller will respond with an END OF DATA message rather than a NAME DATA message in reply to the UPLOAD NAMES message.

To download names to the HAI controller, first send a DOWNLOAD NAMES message to the HAI controller. This instructs the controller to clear the names of all items and to enter the download names sequence. The controller will reply with an ACKNOWLEDGE message. The external device should then send a series of NAME DATA messages, followed by a single END OF DATA message. Each NAME DATA message contains the name of a single item. NAME DATA messages should only be sent for those items that have a name entered for them. The controller will acknowledge receipt of each NAME DATA message by send an ACKNOWLEDGE message after each NAME DATA message is received. This informs the external device that the NAME DATA message was received correctly and that the external device may send the next NAME DATA message. If the ACKNOWLEDGE message is not received from the controller, the external device should resend the NAME DATA message that was missed. Once all names have been sent, the external device should send an END OF DATA message rather than a NAME DATA message, indicating the end of the name data transfer. The HAI controller will send an ACKNOWLEDGE message in reply to the END OF DATA message.

UPLOAD NAMES

Start character	0x5A
Message length	0x01
Message type	0x0C
Data	none
CRC 1	0x01
CRC 2	0x95

DOWNLOAD NAMES

Start character	0x5A
Message length	0x01
Message type	0x0A
Data	none
CRC 1	0x81
CRC 2	0x97

END OF DATA

Start character	0x5A
Message length	0x01
Message type	0x03
Data	none
CRC 1	0x41
CRC 2	0x91

NAME DATA

Start character	0x5A
Message length	(maximum name length, exclusive of terminating zero) + 3
Message type	0x0B
Data 1	item type
Data 2	item number
Data 3	first byte of name
...	
Data n	last byte of name
CRC 1	varies
CRC 2	varies

The NAME DATA message specifies the name for a single item. 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 item type and item number specifies what is being named. The item type identifies whether the name is for a zone, unit, button, code, area, thermostat, or message. The item number identifies the specific zone, unit, button, code, area, thermostat, or message.

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

NAME	TYPE	LENGTH	NUMBER (Omni)	NUMBER (OmniPro/Aegis)
Zone	1	15	32	96
Unit	2	12	64	255
Button	3	12	32	64
Code	4	12	16	99
Area	5	12	2	8
Thermostat	6	12	4	64
Message	7	15	0	128

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. Omni systems can store 100 events in the event log. OmniPro and Aegis systems can store 250 events in the event log. Once the event log is full, logging a new event will cause the oldest event to be lost.

The event log may be uploaded from the HAI controller through the Omni-Link protocol. To upload the event log, first send an UPLOAD EVENT LOG message to the HAI controller. The controller will then send a series of EVENT LOG DATA messages followed by a single END OF DATA message. Each EVENT LOG DATA message contains the data for a single event. The most recent event is sent first. The external device must acknowledge receipt of each EVENT LOG DATA message by sending an ACKNOWLEDGE message after each EVENT LOG DATA message is received. This informs the HAI controller that the EVENT LOG DATA message was received correctly and that the controller may send the next EVENT LOG DATA message. If for some reason the EVENT LOG DATA message is not received, the external device should send a NEGATIVE ACKNOWLEDGE message to the controller. This instructs the controller to resend the EVENT LOG DATA message that was missed. Once the complete event log has been sent, the controller will send an END OF DATA message rather than a EVENT LOG DATA message, indicating the end of the event log transfer. If no events have been logged yet, the controller will respond with an END OF DATA message rather than an EVENT LOG DATA message in reply to the UPLOAD EVENT LOG message.

UPLOAD EVENT LOG

Start character	0x5A
Message length	0x01
Message type	0x0D
Data	none
CRC 1	0xC0
CRC 2	0x55

EVENT LOG DATA

Start character	0x5A
Message length	0x0A
Message type	0x0E
Data 1	event number (1-n, with 1 being most recent)
Data 2	time/date valid
Data 3	month (1-12)
Data 4	day (1-31)
Data 5	hour (0-23)
Data 6	minute (0-59)
Data 7	event type
Data 8	parameter 1
Data 9	high byte of parameter 2
Data 10	low byte of parameter 2
CRC 1	varies
CRC 2	varies

The event number is a simple index that is incremented by 1 for each event log data message. Event 1 is the most recent event. The highest numbered event would be the oldest event.

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 table below. 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 99 user codes (32 for Omni), the following security codes can be reported:

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

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

APPENDIX A - CRC-16 ERROR DETECTION ROUTINES

This first 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};
```

This next 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
```

APPENDIX B - 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

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 C - SYSTEM EVENTS

HAI controllers generate system events when various changes occur in the controller. System events are generated when:

- A security sensor changes state
- A control unit changes state
- The security system is armed/disarmed
- An alarm is activated
- X-10 signals are received
- Certain trouble conditions are detected
- The phone line changes state
- The cost of energy changes
- The user activates a macro button.

HAI controllers can be programmed to perform various actions in response to the generation of these events. Similarly, these system events can be monitored through the Omni-Link protocol to allow external controllers to react to these events.

Each system event 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

ALARM ACTIVATION        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

ZONE STATE CHANGE       0000 01sz zzzz zzzz     s = state
                                                    0 = off
                                                    1 = on
                                                z = zone number

UNIT STATE CHANGE       0000 10su uuuu uuuu     s = state
                                                    0 = off
                                                    1 = on
                                                u = unit number
```

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
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