



ST630/HT630 - Z-Wave Module

DEVELOPER PACK

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1. Introduction

The Sprue Z-Wave Module resides inside the ST630 smoke alarm or HT630 heat alarm, in the compartment normally used for the WiSafe2 Radio Module. The Z-Wave Module communicates with the ST630/HT630 via the SPI interface. The protocol for this interface is defined in the SPI-Coms document.

The Z-Wave Module identifies itself as a Z-Wave Plus Sensor-Notification, with role Reporting Sleeping Slave. As such, there is no capability to receive unsolicited incoming messages. Much functionality is lost due to this restriction. The Z-Wave communications restrict functionality to reporting change in alarm state and reporting change in fault state.

The Z-Wave Module has a push button used for learning and un-learning and other operations. Pressing this button causes the Z-Wave Module to wake up briefly.

Since the Z-Wave Module can be installed in either a ST630 smoke alarm or HT630 heat alarm, it must send different messages depending on where it is installed.

2. Supported Command Classes

All Command Classes given in Table 1 are supported by the Z-Wave Module.

Command Class	Functionality	Comment
WAKEUP_V2	Set Wake Up Interval during Inclusion, Wake Up Notification for SIS	Requirement for sleeping devices
ASSOCIATION_V2	Associate Devices and setup life-line	Mandatory for all Z-Wave+ Devices
ASSOCIATION_GROUP_INFORMATION_V1	Specify group profiles	Mandatory for all Z-Wave+ Devices
ZWAVE_PLUS_INFO_V2	Z-Wave+ Information	Mandatory for Z-Wave+ Devices
MANUFACTURER_SPECIFIC_V2	Manufacturer specific information	Unique serial number for each device
NOTIFICATION_V8	Notification of Events (e.g. Smoke or Heat alarm)	
BATTERY_V1	Report Battery level of Z-Wave Module	
VERSION_V2	Report firmware version	

Command Class	Functionality	Comment
DEVICE_RESET_LOCALLY_V1	Report manual reset	Mandatory for all Z-Wave+ Devices
POWERLEVEL_V1	Adjust transmit power level	Only used during installation or test

Table 1: Supported Command Classes

3. Z-Wave Device Properties

Field	Value
Generic Product Type	General Z-Wave Plus Product
Specific Product Type	Notification Sensor
Manufacturer ID	0x026F
ProductType	0x01
ProductID	0x01 when installed in ST630; 0x02 when installed in HT630
Role Type	0x06 (ZWAVEPLUS_INFO_REPORT_ROLE_TYPE_SLAVE_SLEEPING_REPORTING)

Table 2: Z-Wave device properties

4. Notification Reports when Installed in an ST630 Smoke Alarm

The Device operates in push mode, so all events are reported by notification report commands via the lifeline association. Notification Reports have sequence numbers (these are optional in the Command Class Specification). Smoke Alarm notification type includes events up to the V8 rev level.

4.1. Notification Reports when Important Conditions Start

Important conditions are those other than the normal idle condition.

No.	Important Condition Starting	Notification Type / Event
1	Smoke Alarm	Smoke Alarm (0x01) / Smoke detected unknown location (0x02)
2	Smoke Alarm Test	Smoke Alarm (0x01) / Smoke Alarm Test (0x03)
3	ST630 Battery Low	Smoke Alarm (0x01) / Replacement required, End of Life (0x05)
4	End-of-life (after many years)	Smoke Alarm (0x01) / Replacement Required, End of Life (0x05)
5	Smoke Alarm silenced	Smoke Alarm (0x01) / Alarm Silenced (0x06)

No.	Important Condition Starting	Notification Type / Event
6	Maintenance Required (yearly basis)	Smoke Alarm (0x01) / Maintenance Required, Planned periodic inspection (0x07)
7	Maintenance required (dust in device)	Smoke Alarm (0x01) / Maintenance Required, Dust in device (0x08)
8	ST630 not responding or in fault	System (0x09) / System hardware failure (0x01)
9	Off Base	System (0x09) / Tampering (0x06)

Table 3: Start of Important Conditions notified by notification report commands

4.2. Notification Reports when Important Conditions End

The end of any given important conditions will be communicated with Event Inactive notification report of the appropriate Notification Type (i.e. Event 0x00). If there are other important conditions which are still in progress for that type, the Event Inactive message will contain a parameter indicating which important condition has just ended. This parameter has the value of the Event corresponding to that condition. If there is no such parameter, then the controller can assume there are no other active important conditions of that type.

4.3. Smoke Alarm Condition

While smoke is present, a notification message will be sent every 2 minutes. This behavior is not required by the Z-Wave specifications, but it is not prohibited.

4.4. ST630 Battery Low

The ST630 Battery Low condition is set when the ST630 battery becomes low. This condition is cleared if the ST630 later reports its battery has recovered.

The ST630 battery voltage is temperature dependent. It is possible that during the night the ST630 can get so cold that its battery voltage becomes low. Then during the day the ST630 can get warm enough that the battery voltage is no longer low. It is probably wise to replace the ST630 at this point since its battery is near the end of its life. However, the ST630 may operate correctly for months after temperature sensitivity first occurs.

4.5. End of Life Condition

The End of Life condition starts after 10 years of operation, or after the unit is 12 years old, based on hour counts reported by the ST630. This condition never ends.

4.6. Silenced Condition

The Silenced condition starts when the ST630 Test button is pressed during an alarm. This condition typically ends when the alarm condition ends, or after a timeout.

4.7. Dust in Device Condition

The Dust in Device condition starts when the ST630 detects a contaminated chamber. This condition ends when the ST630 ceases detection of a contaminated chamber. Pressing the ST630 test button causes the chamber to be rechecked.

4.8. Maintenance Required Yearly Basis Condition

The Maintenance Required Yearly Basis condition starts once per year, based on the number of operating hours reported by the ST630. It ends when the ST630 Test button is next pressed.

4.9. ST630 Not Responding or in Fault Condition

The ST630 Fault condition corresponds to a fatal fault reported in a SPI FAULT message by the ST630.

The ST630 Not Responding condition starts if the ST630 stops responding to messages on the SPI interface. This condition ends if the ST630 resumes responding.

This will happen if the Z-Wave Module is removed and then wakes-up, or if the ST630 battery is completely dead.

Note – the Z-Wave Module cannot detect immediately if it is removed. Detection will occur during the next daily wake-up.

If the Z-Wave Module is re-installed in its original ST630 and communications resume, the condition ends. However, if the Z-Wave Module is moved to a different alarm, the condition will not end. Before transferring a module to a different alarm, it must be manually reset.

4.10. Off Base Condition

The Off Base condition is set if the ST630 remains off its base for 30 seconds. This condition ends 30 seconds after it is replaced on its base.

5. Notification reports when installed in an HT630 Heat Alarm

The Device operates in push mode, so all events are reported by notification report commands via the lifeline association. Notification Reports have sequence numbers (these are optional in the Command Class Specification). Heat Alarm notification type includes events up to the V8 rev level.

5.1. Notification Reports when Important Conditions Start

Important conditions are those other than the normal idle condition.

No.	Important Condition Starting	Notification Type / Event
1	Heat Alarm	Heat Alarm (0x04) / Overheat detected, Unknown Location (0x02)

No.	Important Condition Starting	Notification Type / Event
2	Heat Alarm Test	Heat Alarm (0x04) / Heat Alarm Test (0x07)
3	HT630 Battery Low	Heat Alarm (0x04) / Replacement required, End-of-life (0x08)
4	End-of-life (after many years)	Heat Alarm (0x04) / Replacement Required, End-of-life (0x08)
5	Heat Alarm silenced	Heat Alarm (0x04) / Alarm Silenced (0x09)
6	Maintenance Required (yearly basis)	Heat Alarm (0x04) / Maintenance Required, Planned periodic inspection (0x0B)
7	HT630 not responding or in fault	System (0x09) / System hardware failure (0x01)
8	Off Base	System (0x09) / Tampering (0x06)

Table 4: Start of Important Conditions notified by notification report commands

5.2. Notification Reports when Important Conditions End

The end of any given important conditions will be communicated with Event Inactive notification report of the appropriate Notification Type (i.e. Event 0x00). If there are other important conditions which are still in progress for that type, the Event Inactive message will contain a parameter indicating which important condition has just ended. This parameter has the value of the Event corresponding to that condition. If there is no such parameter, then the controller can assume there are no other active important conditions of that type.

5.3. Heat Alarm Condition

While over-heat is present, a notification message will be sent every 2 minutes. This behavior is not required by the Z-Wave specifications, but it is not prohibited.

5.4. HT630 Battery Low

The HT630 Battery Low condition is set when the HT630 battery becomes low. This condition is cleared if the HT630 later reports its battery has recovered.

The HT630 battery voltage is temperature dependent. It is possible that during the night the HT630 can get so cold that its battery voltage becomes low. Then during the day the HT630 can get warm enough that the battery voltage is no longer low. It is probably wise to replace the HT630 at this point since its battery is near the end of its life. However, the HT630 may operate correctly for months after temperature sensitivity first occurs.

5.5. End of Life Condition

The End of Life condition starts after 10 years of operation, or after the unit is 12 years old, based on hour counts reported by the HT630. This condition never ends.

5.6. Silenced Condition

The Silenced condition starts when the HT630 Test button is pressed during an alarm. This condition typically ends when the alarm condition ends, or after a timeout.

5.7. Maintenance Required Yearly Basis Condition

The Maintenance Required Yearly Basis condition starts once per year, based on the number of operating hours reported by the HT630. It ends when the HT630 Test button is next pressed.

5.8. HT630 Not Responding or in Fault Condition

The HT630 Fault condition corresponds to a fatal fault reported in a SPI FAULT message by the HT630.

The HT630 Not Responding condition starts if the HT630 stops responding to messages on the SPI interface. This condition ends if the HT630 resumes responding.

This will happen if the Z-Wave Module is removed and then wakes-up, or if the HT630 battery is completely dead.

Note – the Z-Wave Module cannot detect immediately if it is removed. Detection will occur during the next daily wake-up.

If the Z-Wave Module is re-installed in its original HT630 and communications resume, the condition ends. However, if the Z-Wave Module is moved to a different alarm, the condition will not end. Before transferring a module to a different alarm, it must be manually reset.

5.9. Off Base Condition

The Off Base condition is set if the HT630 remains off its base for 30 seconds. This condition ends 30 seconds after it is replaced on its base.

6. Response to Notification Get and Set Commands

Notification messages are sent in push mode, when important conditions start or end. However, it is useful for the Z-Wave Controller to be able to poll the Z-Wave Module and directly ask about existing important conditions.

For pull devices, the Notification Get command gives this capability. However, for push devices the Z-Wave Command Class documentation is not clear how this works. In fact, the documentation is self-contradictory.

The Z-Wave Module is a push mode device that can also act as a pull mode device!

Notification Command Class V5 requires response to Alarm CC V1, Alarm CC V2, Notification CC V3, Notification CC V4, as well as Notification CC V5.

6.1. Response to Alarm CC V1 Alarm Get Command

This command contains a single parameter, the V1 Alarm Type. The Z-Wave Module does not support any V1 Alarm Types, so a V1 Alarm Report is sent in response with V1 Alarm Type 0x00 and Alarm Level 0x00.

6.2. Response to Alarm CC V2 Alarm Get Command

This command contains two parameters. The first is the V1 Alarm Type, and the second is the Z-Wave Alarm Type. The V1 Alarm Type is ignored.

If the Z-Wave Alarm Type is 0x01 (in the ST630 case) or is 0x04 (in the HT630 case), then a V2 Alarm Report is sent in response, but only the smoke alarm condition (in the ST630 case) or the overheat condition (in the HT630 case) are reported.

If there is no alarm condition, then the V2 Alarm Report indicates Unknown Event (0xFE). This strange behavior is required operation.

If the Z-Wave Alarm Type is 0xFF, and there is a smoke or heat alarm condition, then a V2 Alarm Report is sent in response indicating the alarm condition.

If the Z-Wave Alarm Type is 0xFF, and there is no smoke or heat alarm condition, then a V2 Alarm Report is sent indicating Z-Wave Alarm Type 0x00 and Unknown Event (0xFE). This strange behavior is required operation.

Note – V2 Alarm Report messages are similar to V3 Notification Report messages except that sequence numbers are not allowed.

6.3. Response to Notification CC V3 Notification Get Command

This command contains three parameters. The first is the V1 Alarm Type, the second is the Notification Type, and the third is an Event.

If the V1 Alarm Type is not 0x00, then no response is sent. Oddly, this differ from the V2 Alarm Get where the V1 Alarm Type is ignored.

If the Notification Type is 0x01 (in the ST630 case) or is 0x04 (in the HT630 case) or is 0x09 (in either case), then the command is treated as a request asking whether unsolicited notifications are enabled or disabled for that Notification Type. If the Event parameter is one of the supported events then a Notification report is sent with that event. Warning – this message looks identical to an unsolicited Notification report, but it shows the event regardless of whether the corresponding condition is present! If the Event parameter is not one of the supported events then a Notification report is sent showing Notification Event 0xFE.

If the Notification Type is 0xFF, then the Z-Wave Module responds as if it were a pull device getting polled! This is contrary to some parts of the Command Class Specification document, but consistent with other parts of this same document! In response to the first such Notification Get command, a message is queued up for each of the conditions that are active. If the queue is not empty then the message with highest priority is sent. In response to subsequent Notification Get commands with Notification Type 0xFF, the next highest priority message is sent, unless the queue is empty.

The Notification Reports sent when getting polled show Notification Status 0x00 if the message contains an active condition, or 0xFE if the queue is empty. Warning – the Notification Status field does not have the same values that unsolicited Notification Reports show!

The Z-Wave controller must use great care when analyzing Notification Reports that are not unsolicited! If handled the same way as unsolicited reports, incorrect conclusions will be drawn!

6.4. Response to Notification Set Command

Because the Z-Wave Module is a push device, this command is interpreted as a command to disable (if Notification Status = 0x00) or enable (if Notification Status = 0xFF) unsolicited notifications.

Even though the Z-Wave Module can also operate as a pull device, the alternate pull-device interpretation is not used.

7. WakeUp

As the default, the Z-Wave Module wakes up once each 12 hours. The wake-up period can be changed using Wake Up Command Class messages. The minimum wake-up interval is 1 hour, the maximum wake-up interval is 24 hours, and the wake-up interval can be any multiple of 1 hour from ranging from 1 to 24.

The minimum recommended wake-up interval is 6 hours. If the wake-up interval is reduced below this, the 3-year battery life will be reduced. If the wake-up interval is more than 12 hours the battery might last 4 years or more. If the wake-up interval is 1 hour the battery will likely last only 1 year.

On WakeUp the following reports are sent to the nodes associated via the lifeline association

- Send Battery Report to lifeline associated nodes
- Send unsolicited Notification Report for each condition that is active

8. Instructions for Inclusion

Step 1 Do not attempt to include your Z-Wave Module unless you are familiar with the operation of your Z-Wave Controller. Special configuration of your Z-Wave Controller is required for successful operation. It is best to leave installation to a professional.

Step 2 Read the instructions for your Z-Wave Controller regarding adding new devices. Then initiate the inclusion from your Z-Wave Controller.

Step 3 Triple-press the button on the Z-Wave Module. The LED will show a quick blink once per second while the inclusion is pending. This process may take as long as 30 seconds, but typically is much quicker. If you triple-press too quickly or too slowly, inclusion will not start. In this case you must try to triple-press again after waiting a few seconds.

Step 4 Upon successful inclusion, the Z-Wave Module LED will flash 3 times (half-second on, half-second off). If learn-in fails, the LED will simply stop its "pending inclusion" blink pattern.

Step 5 If inclusion does not succeed, restart at Step 1. Do not be surprised if this occurs.

Step 6 After the Z-Wave Module is included, you may define association groups or perform other configuration operations from the Z-Wave Controller. Be sure to study the list of unique messages documented

in this functional spec and program your Z-Wave Controller to respond appropriately for each such message.

9. Instructions for Exclusion

- Step 1 Read the instructions on your Z-Wave Controller regarding excluding devices. Note that a device can be excluded using any Z-Wave Controller, not just the Controller that was used to include the Module. Initiate the exclusion process at your Controller.
- Step 2 Triple-press the button on the Z-Wave Module. The LED will show a quick double-blink once per second while the exclusion is pending. This process may take as long as 30 seconds, but typically is much quicker. If you triple-press too quickly or too slowly, exclusion will not start. In this case you must try to triple-press again after waiting a few seconds.
- Step 3 Upon successful exclusion, the Z-Wave Module LED will flash 5 times (half-second on, half-second off). If exclusion fails, the LED will simply stop its "pending exclusion" blink pattern.
- Step 4 If the exclusion operation does not succeed, restart at Step 1. Do not be surprised if this occurs.
- Step 5 After exclusion, either a) include the Z-Wave Module into a different Z-Wave Controller, or b) remove the battery from the Z-Wave Module.

10. Button Press Operation

Certain button press sequences are documented in the user manual and are used in normal operation. In addition, there are additional "secret" button press sequences used for testing and maintenance. These should not be documented in the user manual.

While the button is pressed the LED lights up. After the button is released the LED goes off. The LED changes about 50msec after the button to account for de-bouncing.

10.1. Single Button Press

If the module has already been included into a Z-Wave mesh, a single press of the button causes the module to wake up and send a Wakeup Notification to the controller.

If the module has been included into a Z-Wave mesh the LED will flash three times in confirmation.

If the module has not been included into a Z-Wave mesh, no messages are sent and the LED does not light.

A single press can thus be used to determine whether the module is in a mesh or not.

When sending a configuration command from the Z-Wave Controller, it is recommended to wake up the module with a single button press. If this is not done, the configuration command may remain pending until the module next wakes up, which might not occur for 24 hours.

10.2. Triple Button Press

Triple press is used for inclusion or exclusion as described above.

If the module has not been included into a Z-Wave mesh, a triple press of the button causes the module to start the inclusion process. The LED flashes once per second while waiting for the Z-Wave Controller to start the inclusion process. Upon successful inclusion, the LED will flash 3 times (half-second on, half-second off). If inclusion fails, the LED will simply stop flashing once per second.

If the module has not been included into a Z-Wave mesh, a triple press of the button causes the module to start the inclusion process. The LED flashes once per second while waiting for the Z-Wave Controller to start the inclusion process. Upon successful inclusion, the LED will flash 3 times (half-second on, half-second off). If inclusion fails, the LED will simply stop flashing once per second.

10.3. Button Held for Ten Seconds

Pressing and holding the button for ten seconds will reset the Z-Wave Module. After the tenth second the LED light goes off and stays off until the button is released. The reset occurs after the button is released.

This operation should only be performed if the Z-Wave Module is to be removed and if the Z-Wave Controller is also being reset or removed.

After resetting, either a) learn the Z-Wave Module into a different Z-Wave Controller, or b) remove the battery from the Z-Wave Module.

10.4. Secret Button Press Menu

To activate the “secret” button-press mode, press and button 5 times and keep the button pressed on the fifth time. After the button is held for ten seconds the LED will go off indicating the button can be released. After the button is released, the LED will flash 4 times per second to indicate a “secret” button-press can now be performed. If no valid “secret” button-press sequence is pressed within the next 10 seconds, the LED will stop flashing and the Z-Wave Module will exit “secret” button-press mode and return to normal operation.

The various “secret” operations are detailed below.

10.4.1. One Press

Pressing the button once while in “secret” button-press mode simulates a smoke/heat alarm condition.

10.4.2. Two Presses

Pressing the button twice while in “secret” button-press mode simulates the end of a smoke/heat alarm condition.

10.4.3. Three Presses

Pressing the button three times while in “secret” button-press mode causes the Z-Wave Module to remain awake and receptive to incoming messages for 6 minutes. This is long enough to perform a Z-Wave Compliance Test Tool test suite.

10.4.4. Four Presses

Pressing the button four times while in “secret” button-press mode enables simulated rapid aging. One year will pass each hour. After each hour, a new Maintenance Required Yearly Basis condition will occur. After the tenth hour, an End-of-Life condition will occur. Rapid aging stops when the unit is reset or power-cycled.

Simulated aging can be sped up further by re-entering the “secret” button-press menu and pressing four times again.

The second time four presses are made (assuming there is not already a Maintenance Required yearly basis condition) a Maintenance Required Planned periodic inspection message is triggered immediately.

The third time four presses are made (assuming the Maintenance Required yearly basis condition has not been cleared with a press of the alarm Test button) a Replacement Required End-of-life message is triggered immediately.

The fourth time four presses are made, both conditions are cleared.

10.4.5. Five Presses

Pressing the button five times while in “secret” button-press mode toggles the ST630/HT630 fault status. This causes a ST630/HT630 Not Responding or in Fault condition to start or end.

10.4.6. Six Presses

Pressing the button six times while in “secret” button-press mode simulates an ALARM SPI message from the ST630/HT630 with the silenced bit set.

10.4.7. Seven Presses

Pressing the button seven times while in “secret” button-press mode toggles the state of the Maintenance Required Dust in Device condition.

10.4.8. Eight Presses

Pressing the button eight times while in “secret” button-press mode starts (or stops if already running) a ping-pong packet exchange test.

To use this test mode, include two units to the same Z-Wave Controller. Put both units into ping-pong packet exchange test mode. Each unit will send one packet per second in broadcast mode (9600 baud RF modulation). The LED flashes briefly (50msec) when a packet is sent and flashes longer (200msec) when a packet is received. If the units are with RF range, they will each flash two times per second.

This test mode terminates automatically after 10 minutes.

11. Serial Number

Each Z-Wave Module has a unique 5-byte serial number created during manufacture. This serial number is reported in the Device Specific Report response to a Manufacturer Specific Command Class / Device Specific Get command.

The 3-byte serial number of the ST630/HT630 host alarm is also included in this report. The full 8-byte Device ID Data is the Z-Wave Module serial number followed by the 3-byte alarm serial number.

12. Host Alarm Detection

The Z-Wave Module will refuse to be learned-in to a Z-Wave mesh unless it is installed in either an ST630 or an HT630. After it is installed, it sends messages specific to either Smoke Alarm or Heat Alarm.

The Z-Wave Module checks once per day to verify the host alarm is still present and is the same type and has the same serial number.

If the host alarm is no longer present or is the wrong type or has the wrong serial number, an Unknown Event notification is sent with the ST630/HT630 Not Responding bit set.

Note – the Z-Wave Module does not wake automatically when it is removed from its host alarm or plugged into another alarm. If you want to move a Z-Wave Module from one alarm to the another, it must be reset after it is removed from its host alarm before it is plugged into the other alarm.

13. Association Groups

There are three association groups as specified in Table 7:

Group Number	Group Name	Max Size	Usage
1	Lifeline	1	Battery reports and Notification reports
2	Sensor Basic Rep	5	Not used
3	Sensor Notifi Rep	5	Notification reports

Table 7: Association Groups

14. Battery Report

The Z-Wave Battery Command Class messages are supposed to report percentage of battery capacity remaining. However, it is impossible to measure this meaningfully. Instead, the Battery Report message Battery Level will be 0xFF (i.e. low) if the measured voltage Vbat is $\leq 2.5V$ for three consecutive measurements (typically once each 24 hours), or 100 if $Vbat \geq 3.2V$, or some value X between 16 and 100 where the battery voltage can be computed with the formula:

$$Vbat = 960 / (400 - X)$$

For example: X = 100 means Vbat = 3.2V (battery quite new), X = 75 means Vbat = 2.95V, X = 50 means Vbat = 2.74V, X = 25 means Vbat = 2.56V, X = 16 means Vbat = 2.5V (battery low), X = 0 means Vbat = 2.4V.

Note – Battery Levels less than 16 are possible for two consecutive reports. But the third and following reports will show 0xFF instead to indicate the battery is low.

Note - the measurements can be off by 5% or more due to the limitations of the ADC. The ADC will not be factory calibrated during manufacture.

Note – the battery voltage can vary significantly depending on temperature. It is possible that a Battery Report early in the chilly night indicates low battery, but a Battery Report later in the heat of the day indicates battery is no longer low.

15. Response to Basic Get Command

The Z-Wave Module does not send unsolicited Basic CC Basic Report messages. However, in response to a Basic CC Basic Get message, it will send a Basic CC V1 Basic Report. This message has a single byte parameter. This parameter will be 0 if there is no smoke/heat currently detected, or 0xFF if there is smoke/heat currently detected.