



Instruction

Z-Wave PC based Controller v5 User Guide

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REVISION RECORD

Doc. Rev	Date	By	Pages affected	Brief description of changes
1	20141217	SRO;AVA;VSA	All	Initial version based on INS10240-13
1	20150226	SRO;AVA;VSA	All	Updated all screenshots, Updated Association, Command Class, Encrypt/Decrypt, Firmware Update, Backup/Restore NVM topics Added IMA, Settings Trace Capturing, Polling functionality, Setup Route functionality topic
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4	20160708	SRO	3.1.1 3.2 3.2.4 3.3 3.1, 3.2, 3.2.3 3.2.4	Updated Tab S2 Security Test Scheme topic (new test settings and CSA option) Updated screenshot Updated screenshot and added MPAN table description Updated Association view screenshot and description Added screenshots for Z/IP controller Added screenshots for Z/IP controller, Unsolicited destination description
4	20160708	SRO	4.5	Updated topic
5	20160726	AVASILEVSKY	4, 4.2.1	Added reminders to set up unsolicited destination for Z/IP Gateway
5	20160726	AVASILEVSKY	3.4	Update command classes view screenshot Added description of 'Auto increment' session id functionality for supervision encapsulation
5	20160805	AVASILEVSKY	4.14	Added clarifications on how NVM restores from zip and hex files
6	20160912	AVASILEVSKY	3.1, 3.2, 3.11, 4.2	Updated screenshots Added description for new buttons and views
6	20160913	AVASILEVSKY	4.7	Added explanations how to configure security test schema
6	20160927	JFR	1.3	Updated necessary tools for PC-based Controller build environment.
7	20161206	SRO	2.3	Updated installation steps

REVISION RECORD

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			4.12	Added S2 message encapsulation frame decrypt description
			4.14	Include mention of the wake-up settings of the Sensor PIR nodes
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			3.16	Updated screenshot and description table
			4.17	Updated section "Transmit Settings" and screenshot
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			3.16	Added section "Set Node Information View" section
			4.17	Added section "Set Node Information" section
			4.1	Updated table
16	20190923	SEROMAN1	3.1.1.1	Updated table and figure
			3.1.1.3	Added Section
			3.2, 3.4, 3.6, 3.7, 3.10, 3.15, 4.2.1, 4.12	Updated Sections and screenshots

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1. ABBREVIATIONS

Abbreviation	Explanation
API	Application Programming Interface
DLL	Dynamic Link Library
IMA	Installation and Maintenance Application
NVM	Non-volatile memory
OTA	Over-the-air
OTW	Over-the-wire
SC	Static Controller
SUC	Static Update Controller
SIS	SUC ID Server
ERTT	Enhanced Reliability Test Tool
DSK	Device-Specific Key

1 INTRODUCTION

1.1 Purpose

The Z-Wave PC-based Controller application is an example on how Static/Bridge Controller Serial API functionality can be used to implement a Z-Wave-enabled PC application.

1.2 Audience and Prerequisites

The audience is Z-Wave partners and Silicon Labs. It is assumed that the Z-Wave partner is already familiar with the current Z-Wave Developer's Kit.

1.3 Implementation

The Z-Wave PC-based Controller application requires the .NET Framework 4.6.1 or higher. It's based on the Z-Wave DLL. The solution also contains a Setup project for creating the msi setup file and xxx.UnitTest project with unit tests. Both can be excluded safely from the solution. Building the Setup project requires the following:

- The WiX toolset (<http://wixtoolset.org>) lets developers create installers for Windows Installer and the Windows installation engine. Must install specific version WiX toolset 3.10

Note: See [4] Regarding a detailed description about the Z-Wave DLL.

2 THE Z-WAVE PC-BASED CONTROLLER

The Z-Wave PC-based Controller is an application designed for the Windows platform that is capable of communicating with Z-Wave nodes like switches and sensors through a Static Controller (SC).

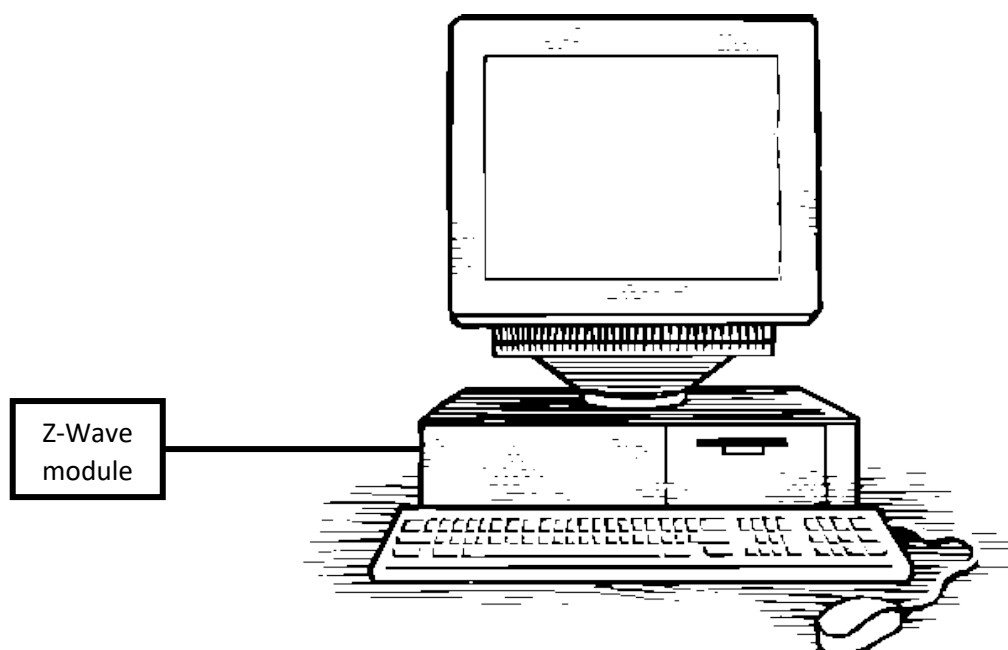


Figure 1 PC with a Z-Wave Module Connected

2.1 Check the Prerequisites

The .NET Framework 4.6.1 or later must be installed on the machine to run the Z-Wave PC-based Controller Windows application.

Limitation: Z-Wave PC Controller has been tested on Windows 10.

Important: Ensure that you have the latest service pack and critical updates for the version of Windows that you are running. To find the recent security updates, visit [Windows Update](#).

2.2 Required Z-Wave Hardware

Z-Wave PC Controller application requires a Z-Wave module programmed with a Serial API application, including next library types: Static Controller, Bridge Controller, Portable Controller, Slave Enhanced and connected to the appropriate serial or USB port.

To program the Z-Wave module, use the firmware HEX file and additional programming tool:

- For devices with ZW070x chip series use [Simplicity Studio](#) and choose needed application from latest available Z-Wave SDK demos.

- For other devices with chip series older than ZW070x use Z-Wave Programmer tool and file by next name pattern: `serialapi_<Lib_Type>_ZW050x_XX.hex` (USB version has USBVCP in its name) located in the directory
`'C:\DevKit_X_YY\SDK\ProductPlus\Bin\SerialAPI_Controller_Static\';`

Finally, connect the Z-Wave module to the COM port on the PC.

USB is the Z-Wave USB Adapter. It is a USB-based Static Controller.

As the device exports a USB CDC/ACM class-compliant interface, it appears as a serial port, reusing existing standard drivers on the most popular PC operating systems. As such, there is no vendor driver required. Over the serial port, the Z-Wave Serial API is exported.

USB.INF is provided that reuses the standard Windows `usbser.sys` or `usbser64.sys` driver. The device appears in the Device Manager under the Ports section, and is accessible through the Windows CreateFile API by applications as `"\\\\.\\COMxxx"` where `xxx` is the COM Port number assigned by the OS.

For more information on USB, see INS11850, Instruction, USB User Manual.

2.3 Install the Z-Wave PC Controller

1. Exit all programs.
2. Run the installation file of the Z-Wave PC Controller application and follow the installation wizard.
3. The actual installation procedure will pass with progress indicator and final confirmation appears.
4. Click **Finish** to complete the installation.

2.4 Remove Z-Wave PC Controller

You can uninstall Z-Wave PC Controller from your computer if you no longer use it.

1. Open **"Add or Remove Programs"** in Control Panel.
Click **"Start"**, click **"Control Panel"** (in Classical View – click **"Start"**, point to **"Settings"**, click **"Control Panel"**), and then double-click **"Add or Remove Programs"**.
2. Click the program in the list and then click the **"Remove"** button. You can sort programs by selecting different options in **"Sort by"**.
3. Standard confirmation dialog appears. Click **"Yes"** to continue the removal of the Z-Wave PC Controller software.
4. Z-Wave PC Controller and its settings will be removed without further prompting.

3 USER INTERFACE

3.1 Main Menu View

The Z-Wave PC Controller application's Main menu view consists of the following items:

- Title bar
- Content view (current view depends on selected button on Main menu view)
- Log bar

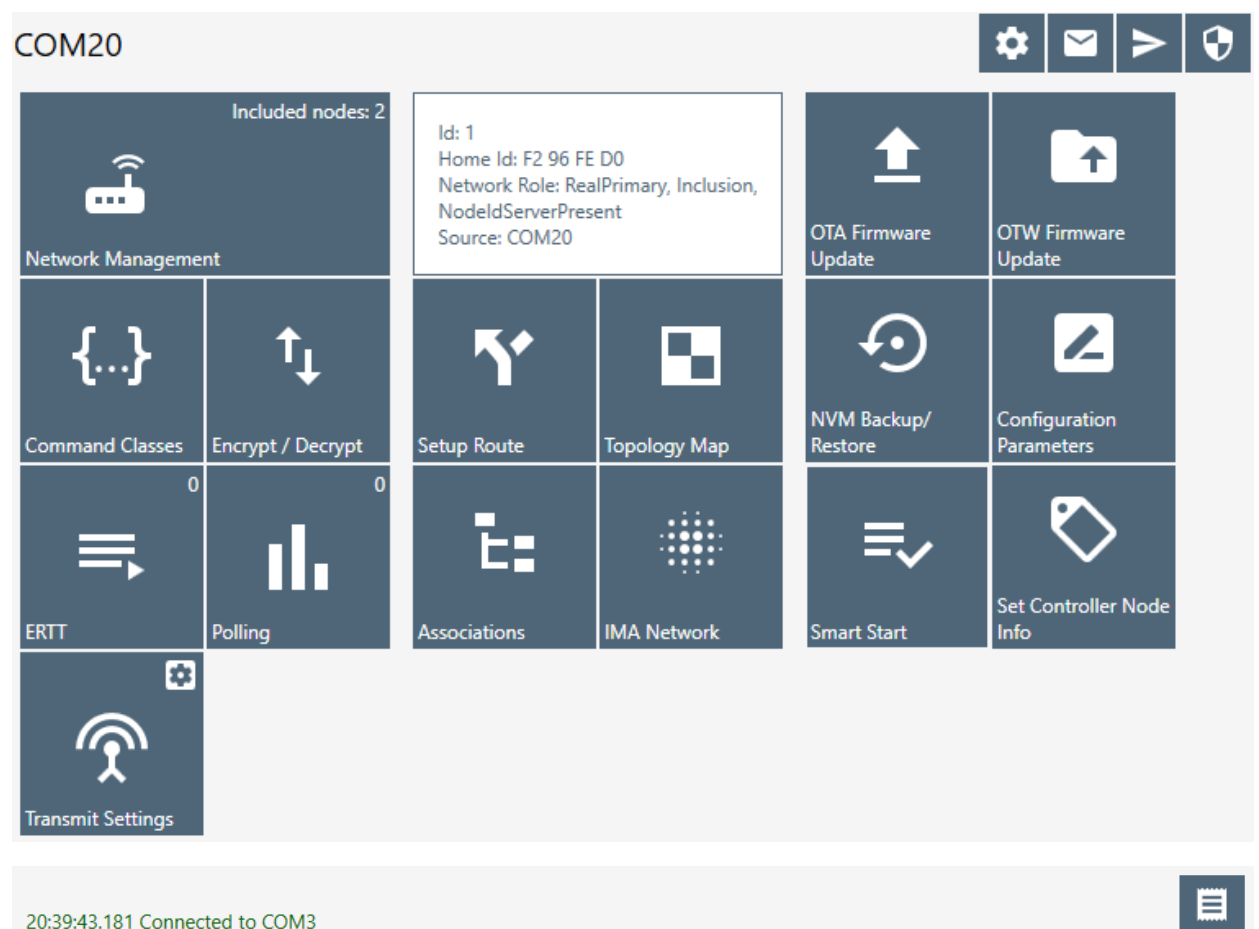


Figure 2 Main Menu View

3.1.1 Title Bar

Title bar is located on top of the Main Menu View. It is accessible from any view. It has the following items:

3.1.1.1 Settings

Pressing on Settings button opens a new window in which a controller device can be selected. Also, in this window users can set up trace capture settings.

Serial Port Data Sources:			Socket Data Sources:			
Name	Version	Description	Type	IP Address	Port	Args
COM7		MOXA Port 5	Z/IP	1.1.1.1	9999	-psk 1234567890123456789012
COM8		MOXA Port 6				
COM9	SlaveEnhancedLib 6.07	MOXA Port 7				
COM11		Silicon Labs CP210x USE				
COM12		Silicon Labs CP210x USE				
COM14		Silicon Labs CP210x USE				
COM17		Silicon Labs CP210x USE				
COM20	ControllerBridgeLib 7.12	JLink CDC UART Port				
COM23		JLink CDC UART Port				
COM30		Silicon Labs CP210x USE				
COM70		Silicon Labs CP210x USE				

☐ Enable Watchdog
☐ Capture communication trace to _____
 Capture Folder: _____
☒ Auto split by: Size, Mb: 10 Duration, min 0 Keep last files, count: 3
 OK Cancel

Figure 3 Settings View

Menu item	Description
Detect	Detects library type for available devices
Refresh	Refreshes list of connected devices
Clear All	Clears list of ZIP Gateway Data Source
Discover	Detects available ZIP Gateway
Add	Adds custom IP Address to list
Enable Watchdog	Turn On/Off Watchdog command for ZW070x devices
Capture communication trace to	Enables trace capturing
... (Browse for Folder)	Selects folder for saving files of capture

Auto split	Enables splitting files by size and/or duration and count of file parts
Ok	Selects chosen COM port as controller and closes the window and applies changes of trace capturing.
Cancel	Closes the window without changes

3.1.1.2 Commands Queue Button

Pressing the “Commands Queue” button shows the queue commands for nodes in the new window. Each node has its own group.

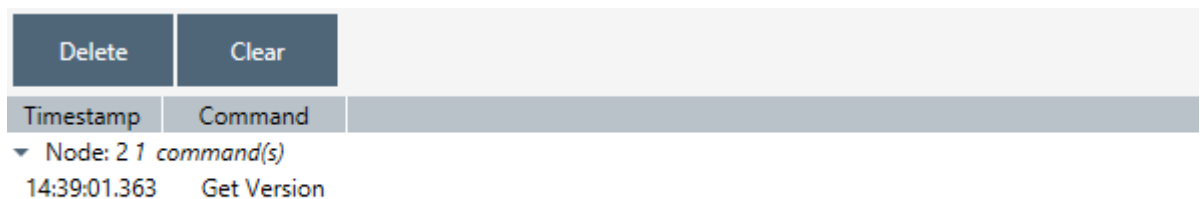


Figure 4 Commands Queue View

Menu item	Description
Delete	Deletes selected command from queue
Clear	Clears queue

3.1.1.3 Send Data Settings

Opens view with Send Data options to easy navigation and setup data from any other view

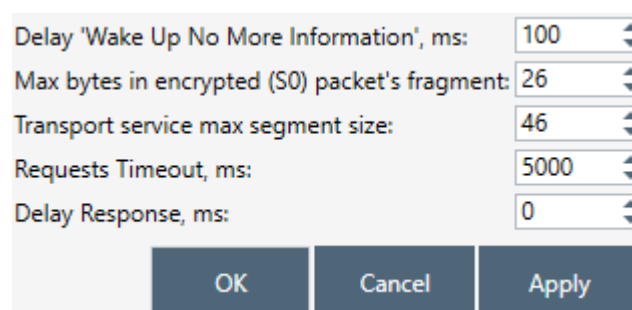


Figure 5 Send Data Settings

Menu item	Description
-----------	-------------

Delay 'Wake Up No More Information'	Sets additional delay in ms to respond with Wake Up No More after releasing commands queue for non-listening receiver
Max bytes in encrypted (S0) packet's fragment	Sets the maximum length in encrypted packet fragments
Transport service max segment size	Sets the Transport service maximum segment size. Reads max payload length from device. Default value is 46 bytes
Request Timeout	Changes wait time in ms for request commands responds
Delay Response	Sets additional delay in ms to respond on any received data
Ok	Apply options and close the dialog
Cancel	Close the dialog with changes
Apply	Applies set options without closing

3.1.1.4 Security Test Schema Button

Pressing on the Security Test Schema button opens a new window Security Settings which contains the list security of network keys and the list of test properties for Security and Security version 2.

Pause

☒ Enable S0;
 ☒ Enable S2 Unauthenticated;
 ☒ Enable S2 Authenticated;
 ☒ Enable S2 Access;
 ☐ Join with CSA

Network Key S0	<div><div style="width: 10px; height: 10px; background-color: red;"></div> 92 C9 D0 62 F4 AF AA 69 5C 3A 61 AF 3C 8C EB 72</div>		<input type="checkbox"/> override	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Unauthenticated	<div><div style="width: 10px; height: 10px; background-color: orange;"></div> 71 DD 00 DD D9 16 6A C2 63 B7 C6 73 17 38 23 F1</div>		<input type="checkbox"/> override	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Authenticated	<div><div style="width: 10px; height: 10px; background-color: blue;"></div> F2 74 8A 0D F5 42 FC 87 20 81 EA 93 90 DD 6D 70</div>		<input type="checkbox"/> override	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Access	<div><div style="width: 10px; height: 10px; background-color: green;"></div> 4D 1D 38 1E EF 6F BC FB E2 FF 0B 63 AC 09 67 A7</div>		<input type="checkbox"/> override	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Last used Temp	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00			

S0 Test Scheme
S2 Test Scheme

☐ Enable security test schema

Save

Load

Security parameters overrides

Enabled	Parameter Name	Value
	Test Span ▾	

Clear

Delete

Set / Add

Message overrides

Enabled	Frame	Delay	Multicast	Broadcast	Encrypted	Temp	Network Key	Command
	Test Frame						KEXGet ▾ 00 00 00 00	
<input type="checkbox"/>	Command:						0 ▴▾	
<input type="checkbox"/>	Delay (sec):							
<input type="checkbox"/>	Is Multicast:							
<input type="checkbox"/>	Is Broadcast:							
<input type="checkbox"/>	Is Encrypted:							

☐ Save Security Keys to Storage Folder:

OK

Cancel

Apply

Figure 6 Security Test Settings

Menu item	Description
Save	Saves the current Security S2 test schema to file
Load	Loads the Security S2 test schema from file
OK	Applies current Security settings and Security Test Settings if enabled and closes the Security Settings dialog.
Cancel	Closes the Security Settings dialog without applying changes.
Apply	Applies current Security settings and Security Test Settings if enabled without closing the Security Settings dialog.

The Security Test Schema functionality is available to test secure networks for failures if the device malfunctions.

Checkboxes “Enable S0”, “Enable S2 Unauthenticated”, “Enable S2 Authenticated”, and “Enable S2 Access” turns on/off corresponding security class.

Checkbox “Join with CSA” allows the PC Controller to send KEX Report with CSA flag set to 1. This flag will only be set when the PC Controller is included in the network as a secondary controller.

Current Network Keys are shown in grey (disabled editing) textboxes according to security level: Network Key S0, Unauthenticated, Authenticated, and Access. Near each network key are buttons to copy the value to clipboard and checkboxes to use the Permanent Key from white (enabled editing) textbox.

Save Security Keys to Storage checkbox enables saving network keys to file when applying settings, resetting the controller, and when adding the controller to another network. Button “...” changes the storage folder path. Values will be added to file with the current network home ID name.

Tab S0 Security Test Scheme

Security Test Schema S0 can be configured for both Including Controller and Included Node. To enable Schema, check the “Enable security test schema” checkbox.

All changes made on this view are applied after clicking “OK” or “Apply” buttons.

Tab S2 Security Test Scheme

To enable Schema, check the “Enable security test schema” checkbox. See [5] for more details.

All changes made on this view are applied after clicking “OK” or “Apply” buttons.

Group “**Security parameters overrides**” allows changing encryption parameters:

Security parameters overrides			
Is Enabled	Parameter Name	Value	
<input checked="" type="checkbox"/>	Test Span	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
<input checked="" type="checkbox"/>	Test Sender Entropy Input S2	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
<input checked="" type="checkbox"/>	Test Secret Key S2	00 00	
<input checked="" type="checkbox"/>	Test Sequence Number S2	00	
<input checked="" type="checkbox"/>	Test Reserved field S2	00	
<div>Test Span</div>		<div>00</div>	
<div>Clear</div>		<div>Delete</div>	<div>Set / Add</div>

Figure 7 Security Parameter Overrides

- Test Span – replaces the current SPAN with a specified value during data encryption
- Test Sender Entropy Input S2 – replaces the sender Entropy Input with a specified value during data encryption
- Test Secret Key S2 – replaces the current secret key of the S2 keypair. DSK value will be calculated based on the secret key.
- Test Sequence Number S2 – replaces the current Sequence Number with a specified value during data encryption
- Test Reserved field S2 – replaces the Reserved field with a specified value during data encryption

Group “**Message overrides**” contains a set of test frames with properties: “Command”, Delay, “Is Encrypted”, “Is Multicast”, “Is Broadcast”, “Network Key”, and “Is Temp Network Key”. Click a corresponding checkbox to activate the parameter override and specify a new value. If the parameter override is not active, the PC Controller will use a valid specific frame parameter value. For example, “KEXGet” is not encrypted but KexGetEcho is encrypted if “IsEncrypted” parameter is not active.

Message overrides

Frame	Delay	Multicast	Broadcast	Encrypted	Temp	Network Key	Command
KEXGet							00 00 00 00
PublicKeyReportA	10						
NetworkKeyGet_S2Unauth				✓	✗	00 00	

Test Frame

☐ Command:

☐ Delay (sec):

☐ Is Multicast:

☐ Is Broadcast:

☒ Is Encrypted:

☒ Network Key:

☒ Is Temp Network Key:

NetworkKeyGet_S2Unauthenticated

0

☒

00 00

☐

Clear

Delete

Set / Add

Figure 8 Security Message Overrides

Test Frame types:

- KEXGet,
- KEXReport,
- KEXSet,
- PublicKeyReportB – joining node’s Public Key Report frame,
- PublicKeyReportA – including controller’s Public Key Report frame,
- KEXSetEcho,
- KEXReportEcho,
- NetworkKeyGet_S0,
- NetworkKeyReport_S0,
- NetworkKeyVerify_S0,
- NetworkKeyGet_S2Unauthenticated,
- NetworkKeyReport_S2 Unauthenticated,
- NetworkKeyVerify_S2 Unauthenticated,
- NetworkKeyGet_S2 Authenticated,
- NetworkKeyReport_S2 Authenticated,
- NetworkKeyVerify_S2 Authenticated,
- NetworkKeyGet_S2Access,
- NetworkKeyReport_S2 Access,
- NetworkKeyVerify_S2 Access,
- TransferEndA_S0 – including controller,
- TransferEndA_S2Unauthenticated– including controller,
- TransferEndA_S2Authenticated – including controller,
- TransferEndA_S2 Access – including controller,
- TransferEndB – joining node,

- NonceGet,
- NonceReport,
- MessageEncapsulation,
- CommandsSupportedReport,
- InclusionInitiate1,
- InclusionInitiate2,
- InclusionComplete1,
- InclusionComplete2.

Group “**Extension overrides**” table allows users to set custom extensions for any S2 Message encapsulation. Message type filters are as follows: “SinglecastAll”, “SinglecastWithSpan”, “SinglecastWithMpan”, “SinglecastWithMpanGrp”, “SinglecastWithMos”, and “MulticastAll”. Extension types are as follows: “Span”, “Mpan”, “MpanGrp”, “Mos”, and “Test”. Other parameters are as follows: “Is Encrypted”, “Extension Length”, “More To Follow”, “Is Critical”, and “Number of usage”. Click a corresponding checkbox to activate the parameter override and specify a new value. If the parameter override is not active, the PC Controller uses a valid specific extension parameter value. For example, Extension Length will be calculated based on the Extension value unless a specific parameter value is activated.

Extension overrides

☐ Cleanup existing extensions first

Action	Message	Counter	Extension	Encrypted	Length	MoreToFollow	Critical	Value
Add	SinglecastAll	0	Mos					00
AddOrModify	MulticastAll	0	Mpan					00

Message type:
 Extension type:
 Applied action:
☒ Extension value:
☐ Is Encrypted: ☐
☐ Extension length:
☐ More to follow: ☐
☐ Is Critical: ☐
☐ Number of usage:

Figure 9 Security Extension Overrides

Checkbox “Cleanup existing extensions first” overrides existing extensions in selected message type when applying test extensions. When this checkbox is not set, test extension will be added to default extensions.

3.1.2 Content View

The Content View consists of command buttons and one Information item:

- Network Management
- Command Classes
- Encrypt/Decrypt
- ERTT

- Polling
- Setup Route
- Topology Map
- Associations
- IMA Network
- Firmware Update (OTA)
- Firmware Update (OTW)
- Backup/Restore (NVM)
- Configuration Parameters
- UL Tool
- Controller Information (active when the controller is selected and active)

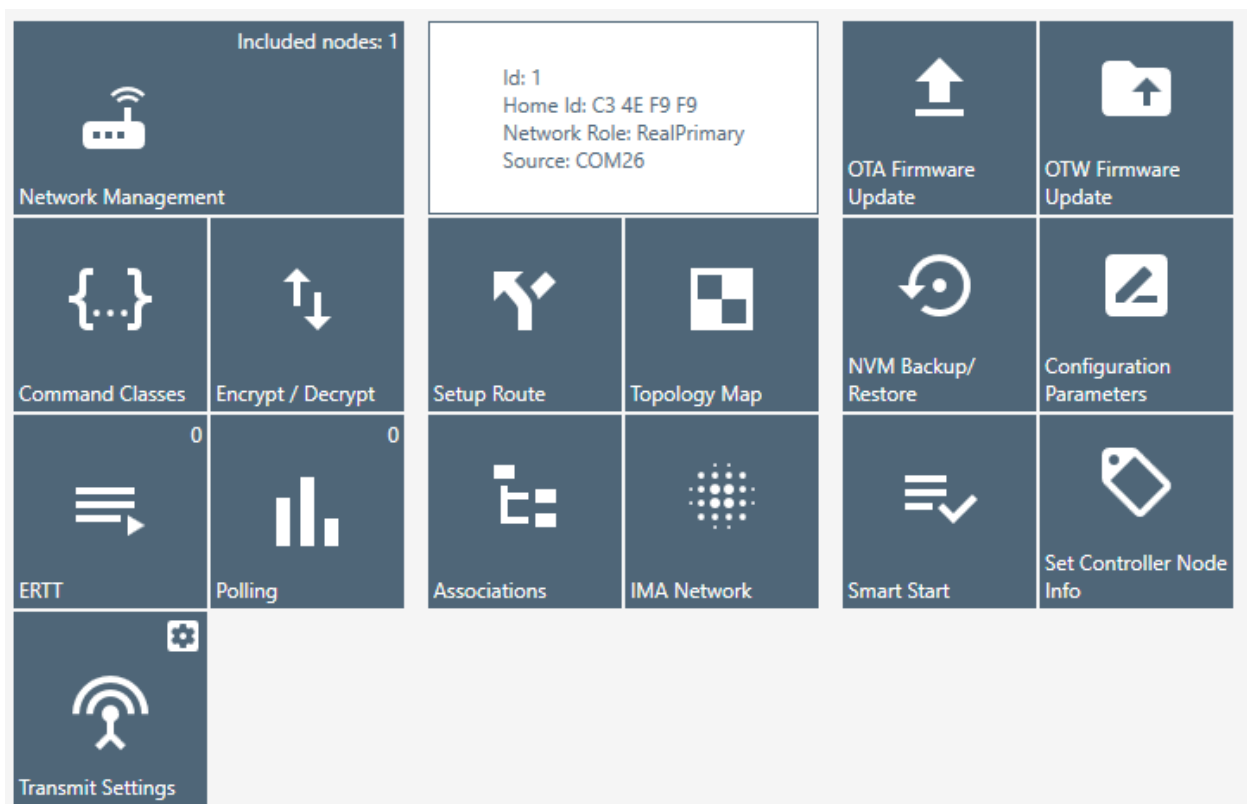


Figure 10 Content View

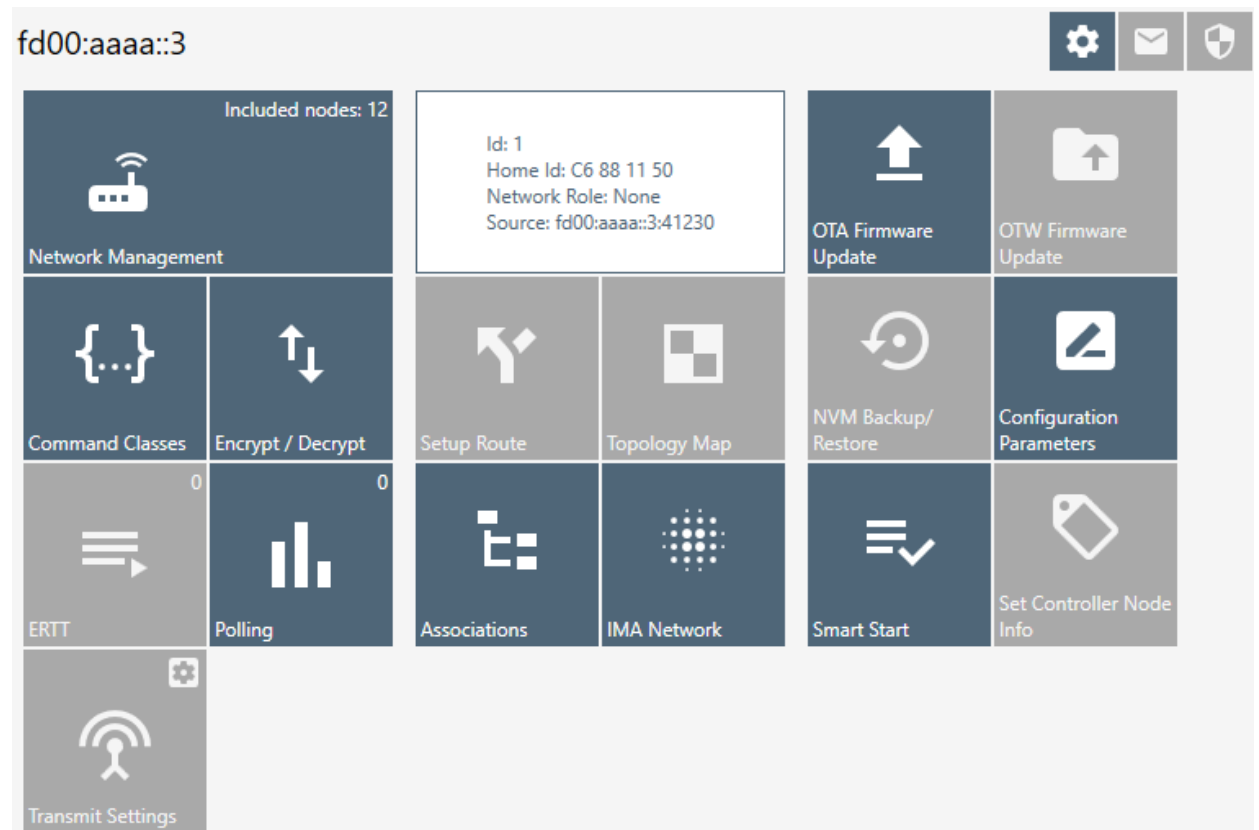


Figure 11 Content View with Z/IP Controller Connected

3.1.3 Log Bar

Log bar contains information about the last action and a **Show Log button**.

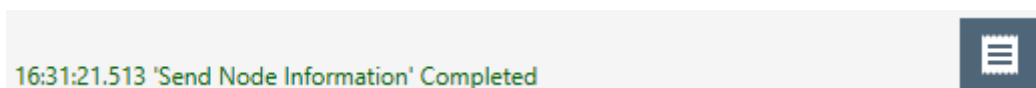


Figure 12 Log Bar View

Pressing the **Show Log button** opens a new window with brief information about the action and its time.

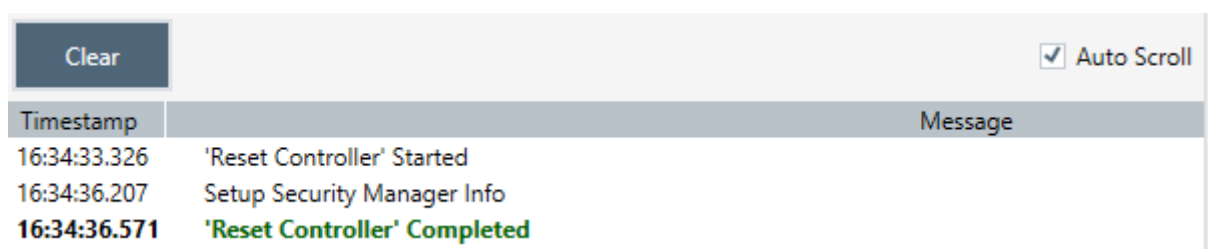


Figure 13 Log Window View

Menu item	Description
Clear	Clears log items
Auto Scroll	Enables auto scroll

3.2 Network Management View

The **Network Management View** contains *Node List* and *Node information* for the selected node, *Nodes Actions*, and *Controller Actions*.

It is used for operations with nodes and basic controller actions.

If checked, the 'Floating View' checkbox Network Management View will be shown in the other window.

COM20 - Network management

Settings, Mail, Send, Shield icons

☐ Floating View

Id	Type	Sche	Liste	Virtu
▼ Controllers (2)				
1	[S2] Pc Controller			✓
2	[S2] Pc Controller			✓

Left sidebar icons: Home, Signal, Checkmark, Brackets, Gear, Arrow, Bar chart, Up arrow, Refresh

1 [S2] Pc Controller

- Properties1: 0xD3
- Properties2: 0x96
- Properties3: 0x01
- Basic Device Class: 0x02 - STATIC_CONTRC
- Generic Device Class: 0x02 - STATIC_CONT
- Specific Device Class: 0x01 - PC_CONTROL
- Command Classes:
 - 0x5E - ZWAVEPLUS_INFO
 - 0x7A - FIRMWARE_UPDATE_MD
 - 0x70 - CONFIGURATION
 - 0x60 - MULTI_CHANNEL
 - 0x85 - ASSOCIATION
 - 0x86 - VERSION
 - 0x59 - ASSOCIATION_GRP_INFO

Buttons:

- Add, Remove (0), NWI, NWE
- Add Virtual, Remove Virtual, NOP (0), Is Failed
- Replace Failed, Remove Failed, Set as SIS, Neighbors Update
- Add Custom
- Node Info, Get Version, Basic Set ON, Basic Set OFF
- Wakeup Interval (5), Switch All ON, Switch All OFF, Identify
- Start Test 'Basic Get', Reset SPAN, Next SPAN, Security Scheme
- Classic Learn Mode, Select Learn Mode, Reset, Send Node Info
- RF Receiver Set OFF, Shift, Update, Mpan Table

Id: 1

- Home Id: F2 96 FE D0
- Network Role: RealPrimary, Inclusion, NodeldServerPresent
- DSK: 20432-01331-16333-59014-24831-32839-37483-12835
- Pu: 4FD005333FCDE68660FF8047926B32236199B2C302962F96192A6BE
- Source: COM20
- Z-Wave library: ControllerBridgeLib

13:12:26.388 Add Node completed in 00:00:19.316

Menu icon

Figure 14 Network Management View

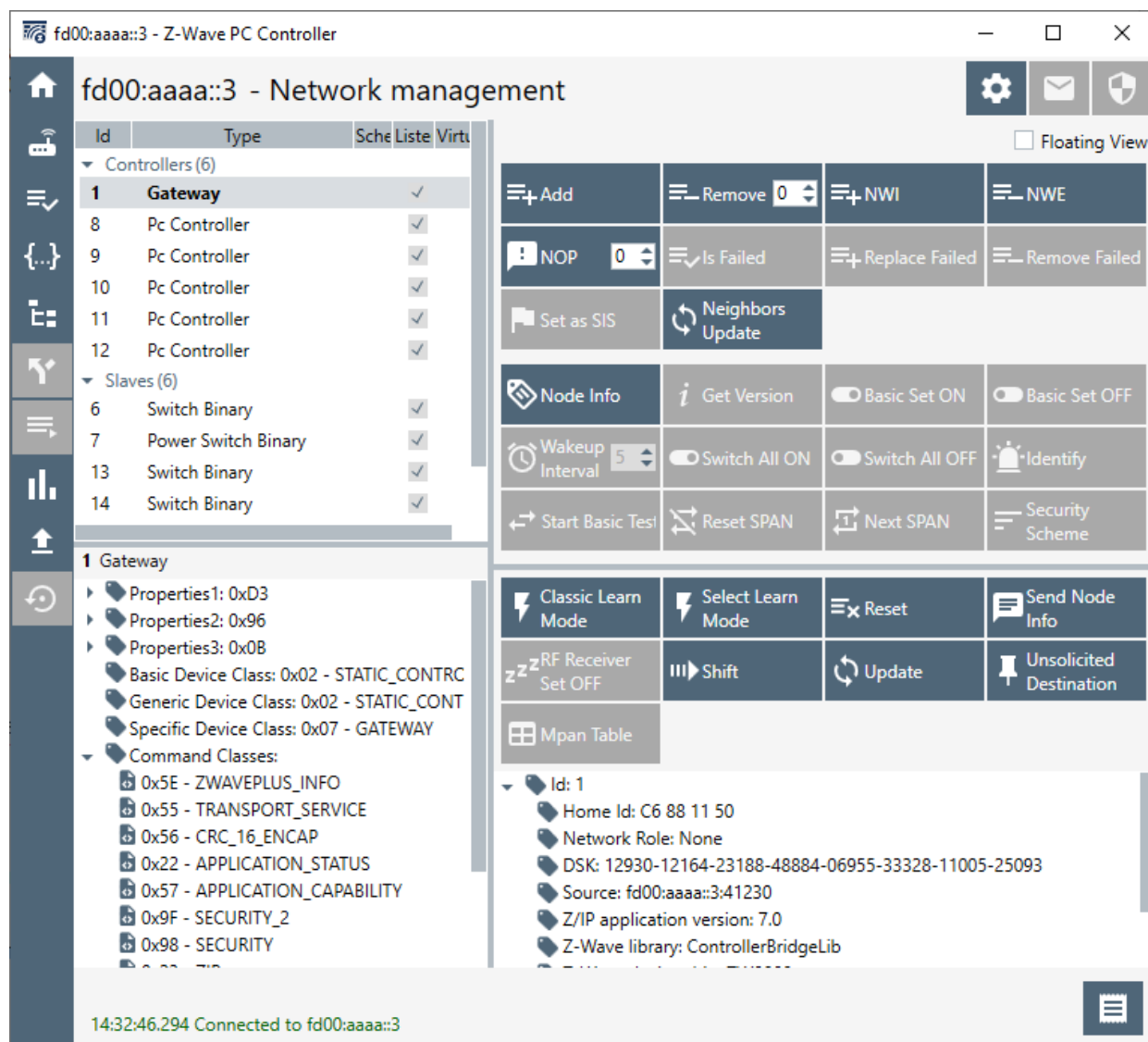


Figure 15 Network Management View with Z/IP Controller Connected

3.2.1 Node List View

Id	Type	Sche	Liste	Virtu
▼ Controllers (2)				
1	[S2] Pc Controller			✓
7	[S2] Pc Controller			✓
▼ Slaves (5)				
2	[S2] Switch Binary			✓
3	[S2] Switch Binary			✓
4	[S2] Switch Binary			✓
5	[S2] Switch Binary			✓
6	[S2] Switch Binary			✓

Figure 16 Nodes View

Uses for view and selecting *Nodes*, contains next columns:

- ID – shows the node numbers of all nodes in the network;
- Type – device type - shows description of the type of every node in the network;
- IL – checked if node is a listening node;
- QO – Queue override check box;
- IV – checked if node is a virtual node.

The current controller node is highlighted in bold font.

The button on the bottom line is to return to the 'Network Management View' from other views.

3.2.2 Node Information View

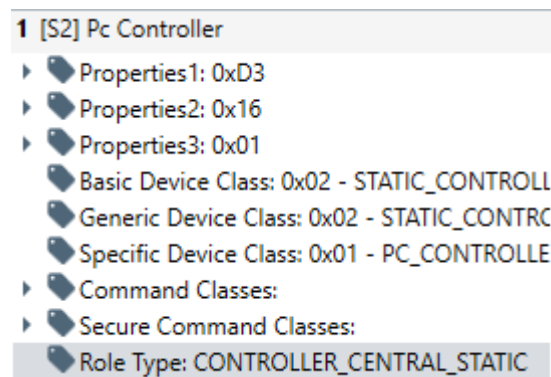


Figure 17 Node Information View

The *Node Info* section gives structured information about the selected node. For more information, see the Z-Wave Device Class Specification documentation.

Navigate to 'Command Classes View' is possible by double clicking on an item from Command Classes or Securely S0/S2 Supported Command Classes lists.

3.2.3 Nodes Actions View

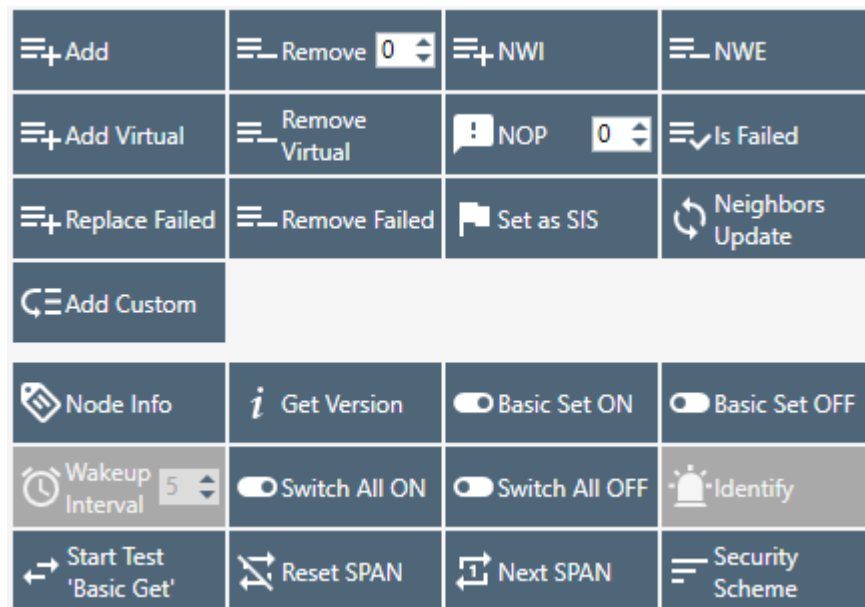


Figure 18 Nodes Actions View

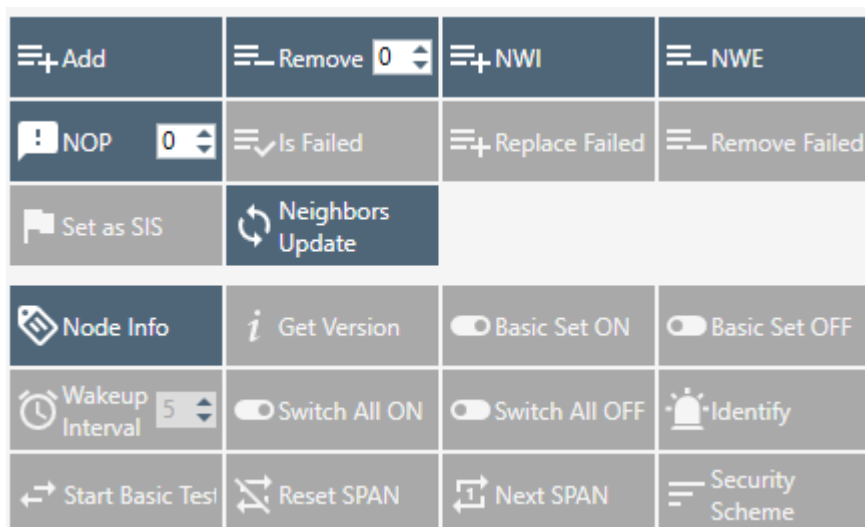


Figure 19 Nodes Actions View when Z/IP Controller Connected

This view contains all available actions for a selected node. An action button is greyed out if the current action isn't available for a selected node.

Additional buttons for the Bridge Controller:



Figure 20 Bridge Controller Additional Actions

Menu item	Description
Add	Start inclusion mode with default settings
Remove	Removes a node
NWI (Network Wide Inclusion)	Network Wide Inclusion, to include all nodes into network once they have been reset and given power
NWE (Network Wide Exclusion)	Network Wide Exclusion, to exclude all nodes from network once they have been reset and given power
Add Virtual	Adds a virtual node for the Bridge Controller
Remove Virtual	Removes a virtual node from Bridge Controller
NOP (Send NOP)	'No Operation' – to send a frame not carrying any functional info to a node
Is Failed	Sends a Failure signal to a node
Replace failed	Replaces a failed node
Remove Failed	Removes a failed node
Set SIS	Sets the "Set SIS" command to the selected Controller
Neighbor Update (Request Node Neighbor Update)	Gets the neighbors from the specified node
Add Custom	Add node using custom settings
Node Info	Requests Node information from a node
Version Get	Sends Version Get command to the selected node
Basic Set On	Sends the BASIC SET ON command to Switch a selected node(s) ON
Basic Set Off	Sends the BASIC SET OFF command to Switch a selected node(s) OFF
Wake Up Interval	Sets up the Wake-Up Interval for a non-listening node

Switch All On	Switches all nodes in the network ON
Switch All Off	Switches all nodes in the network OFF
Start Basic Test/ Stop Basic Test	Starts and stops the basic test functionality to the selected item
Node Settings	Opens a pop-up with following actions for selected node 'Reset SPAN', 'Next SPAN', 'Security Scheme'
Reset SPAN	Clears SPAN table for selected node
Next SPAN	Rolls SPAN record one time on each click for selected node
Security Scheme	Sets active security scheme for selected node

Add Node Custom dialog:

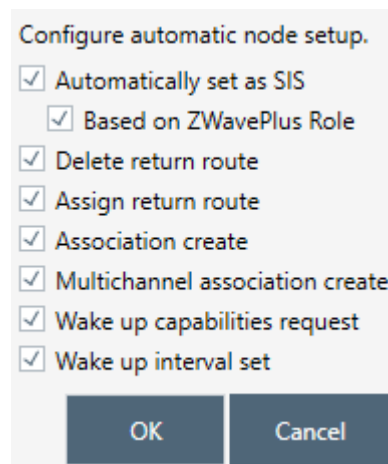


Figure 21 Add Custom

3.2.4 Controller View

The *Controller view* includes *Network Role Option*, *Controller Actions*, and *Controller Information* sections.

The **Controller view** is used for operations with controllers.

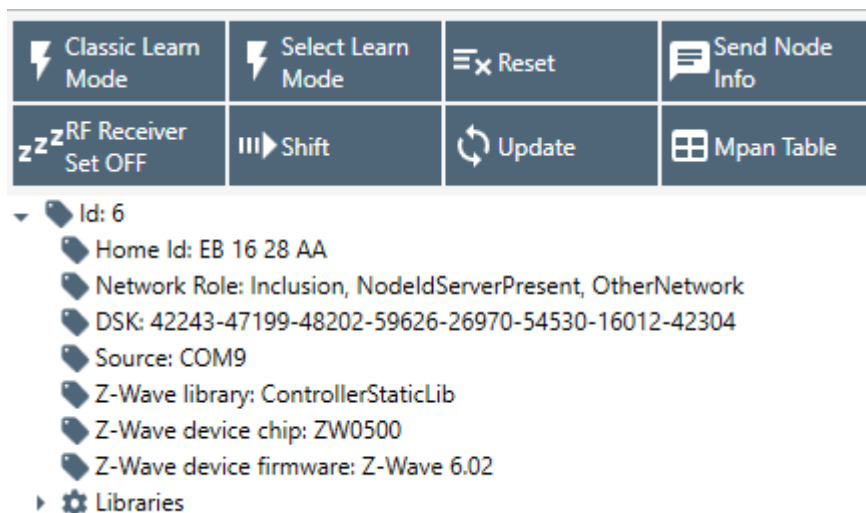


Figure 22 Controller View

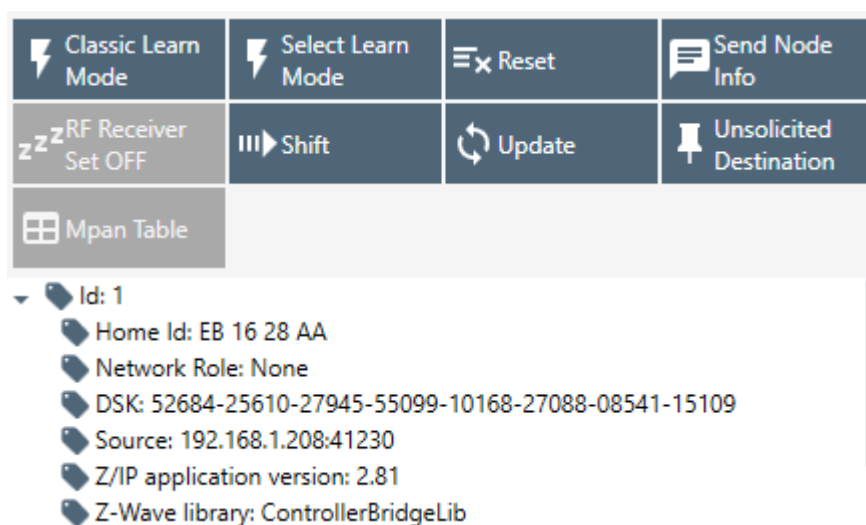


Figure 23 Z/IP Controller View

Select the Controller learn modes dialog:

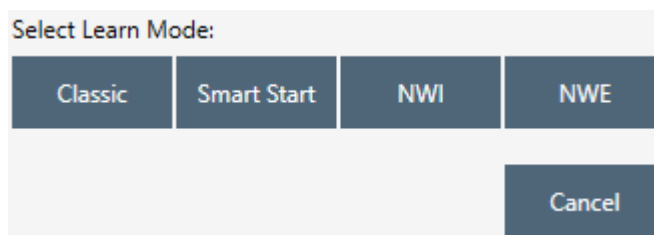
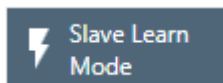


Figure 24 Select Learn Mode

Additional button for the Bridge Controller:

**Figure 25 Bridge Controller Additional Action**

The Controller view has the following actions:

Menu item	Description
Learn Mode (Start Learn Mode)	Starts classic learn mode for the controller if it is needed to include it in another controller's network
Select Learn Mode	Opens Select learn mode dialog
Reset	Resets a controller
Send Node Info	Broadcasts node info from controller
RF Receiver Set OFF	Disables radio transmission on connected device. Auto enables when send operation is initiated
Set Node Info	Changes node information for controller
Shift	Shifts the primary role to another controller in the network
Update (Request Update)	An Inclusion controller can request network updates from a SIS
MPAN Table	Modifies an existing MPAN table in PC Controller
Unsolicited Destination	Gets and sets unsolicited destination for Z/IP Gateway

The *Network Role Option* section has controls to assign the role of the SC in the network:

- SIS – Static Update Controller with ID server
- None

General information regarding the SC is displayed in the *Controller Information* section in the following items:

Section	Description
Controller ID	Displays the node ID of the PC-based SC
Controller Home ID	Displays the current Home ID of the PC-based SC
Controller Network Role	Displays the PC-based SC network role
Serial Port	Displays the serial port in use.
Source	Displays connection address (for Z/IP Controller)
DSK	Displays DSK of current controller
Z/IP application version	Displays current firmware version of Z/IP Gateway application

Mpan Table View

Call from the Controller View by clicking on 'Mpan Table' button opens a new window 'Mpan Table configurations'. Group ID, Owner ID, MOS state, MPAN, Node IDs list will be listed for each record in the table after pressing "Load MPANs" button.

Modify existing Mpan table

Load MPANs Clear

Group id	Owner id	MOS	MPAN State	SeqNo	Node ids
1	1		B3 5A B2 D8 40 CC D8 F8	17	04 02

Group Id Owner Id ☐ MOS Sequence number

MPAN

MPAN State

Node Ids

Add/Update Remove Next MPAN

Figure 26 Mpan Table View

Buttons	Description
Load MPANs	Retrieves current state of Mpan table of PC Controller
Clear	Deletes all entries in Mpan table
Add/Update	Create new or updates data in Mpan table for entered Group id and Owner ID. If data wasn't present in the table, a new record will be created
Remove	Removes the selected item from Mpan table
Next MPAN	Calculates next MPAN for selected item in table

Unsolicited destination

Call from the Controller View by clicking on 'Unsolicited Destination' button opens a new window 'Z/IP Unsolicited Destination'. Pressing the "Set" button will update the unsolicited destination address on the Z/IP Gateway and restart an unsolicited listener in the PC Controller for a selected port.

Figure 27 Unsolicited Destination View

Button	Description
Get current	Retrieves current unsolicited destination address from Z/IP Gateway
Set	Sends Unsolicited destination set command to Z/IP Gateway
Close	Closes the window

Checkbox "Select from local addresses" triggers the "Unsolicited address" view from text input to drop down list selector with list of all IP Addresses of the current machine.

3.3 Associations View

The **Associations** view has a *Nodes List View*, *Node Information View*, and *Association Actions View*. It is used to set up associations between nodes.

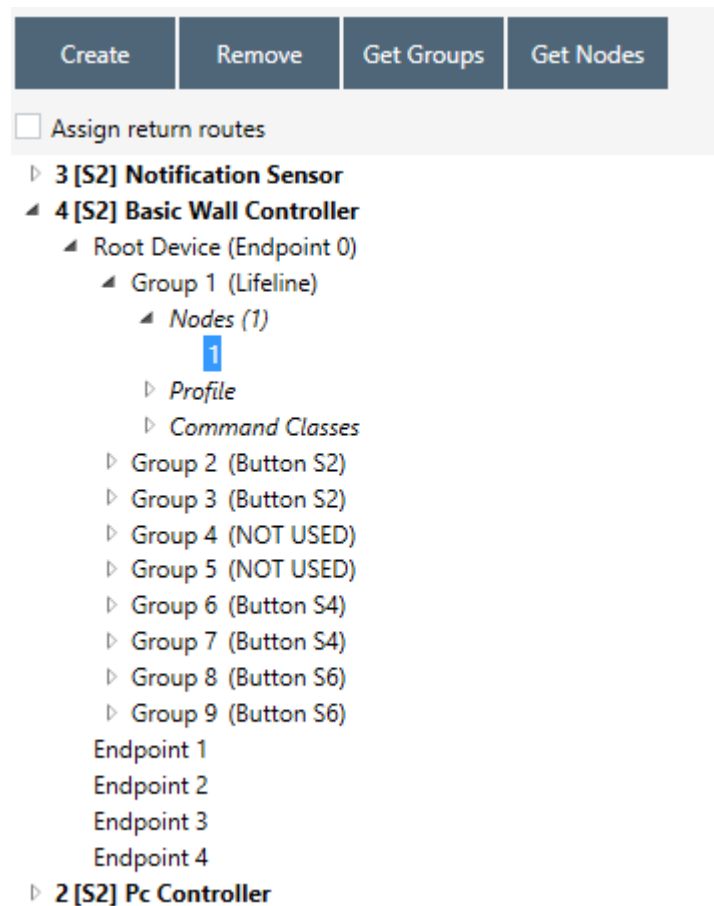


Figure 28 Associations View

The *Association Actions*:

Menu item	Description
Create	Creates an association between selected nodes
Remove	Removes a selected association
Get Groups Info	Returns groups for selected nodes in the association's tree view with information about group's Profile and group's supported command classes
Get Nodes	Return nodes for a selected group in the association's tree view

The Associations View shows a tree of available source nodes that support the Association command class, e.g., Binary sensor.

The Groups node shows the association groups that can be or have been created, information based on Association Group Info command class, and profile and supported command classes for each group.

The “Assign Return Routes” checkbox is to define whether the Controller should assign return routes together with setting the association.

3.4 Command Class View

The **Command Class view** is used to send a specified command class to a selected node with parameters.

Command Classes View can be shown in a separate window when the Floating View is checked.

☐ Floating View

☐ CRC16, ☐ Suppress Multicast Follow up, ☐ Force Multicast,

☐ Supervision Get (☐ Status Updates; Session ID ☐ Auto Increment)

☐ Multi Channel (Src. End Point Dest. End Point ☐ Bit Address)

Command class

Command

Last Used:

Basic Set

Version Get

Z-Wave+ Info Get

Send Data:

☒ Expect command

☒ Default
 ☐ Secure
 ☐ Non-Secure

☐ Broadcast
 ☐ Serial API

Figure 29 Command Classes View

Command Classes View consists of the following items:

- 1) Nodes and Node Info views (on the left)
- 2) Group of checkboxes for wrapping selected command with another (on the top)
- 3) Command selection view (in the middle, includes command class selection and send data text box)
- 4) Send Data section: Last used commands list, Send Data field – current payload and Drop-down list of expected commands (if enabled)
- 5) Sending mode radio buttons and control buttons (on the bottom)
- 6) Security commands references

Item	Description
CRC16	Wraps the selected command with a CRC16 command
Suppress Multicast Follow up	Disables follow up Singlecast frames after a multicast frame
Force Multicast	Uses multicast even if only one frame is selected
Supervision Get	Wraps the selected command with a Supervision command
Session ID	Session ID will be present in the Supervision encapsulated command. Can be set manually or auto incremented by enabling the 'Auto increment' checkbox
Multi-Channel	Enables multi-channel wrapping
End Point (SRC)	Sets the Source End Point when a wrapping multi-channel is enabled
End Point (DST)	Sets the Destination End Point when a wrapping multi-channel is enabled
Bit Address	Sets the Bit Address flag for a Multi-Channel Command
Command class	Shows the selected command class
Command	Selects a command from the selected Command Class and shows selected command from the 'Select Command View'
Select	Open the 'Select command' view (fig. 26) to choose a command.
Last Used	List of recently sent commands. A click on item automatically inserts data in Send Data control.
Send data	List of recently sent commands. A click on item automatically inserts data in Send Data control.
Expect command	Shows a list of commands that is filtered by currently selected Command Class control. PC Controller will wait for a node to respond with selected command. Timeout for this expect defined in 'Send Data Settings' view. When enabled 'Send' button changes its label to 'Request'.
Default	Radio button to set security mode to default (Secure for securely included nodes, non-secure for normally included)

	nodes)
Secure	Radio button to enable force secure command sending
Non-secure	Radio button to enable force non-secure command sending
Broadcast	Radio button to enable force broadcast sending
Serial API	Radio button to send bytes directly to Serial API of connected controller device.
Reload XML	Reloads XML from the local machine if changes were made in it
Repeat List	Sends all commands from Last Used list in order that they were added to it.
Send/Request	Button to send a command or request if enabled 'Expect command' to a selected node
Node Info	Gets the node information from a selected node
Reset SPAN	Clears the SPAN table for a selected node
Next SPAN	Rolls the SPAN record one time on each click for a selected node
Security Scheme	Sets the active security scheme for a selected node
MPAN Table	Opens the MPAN settings dialog

The **Select Command view** is used to show and select all available commands with information about a selected node. Consist of:

- List of Command classes and commands (on the left);
- Information about a selected command (on the right).

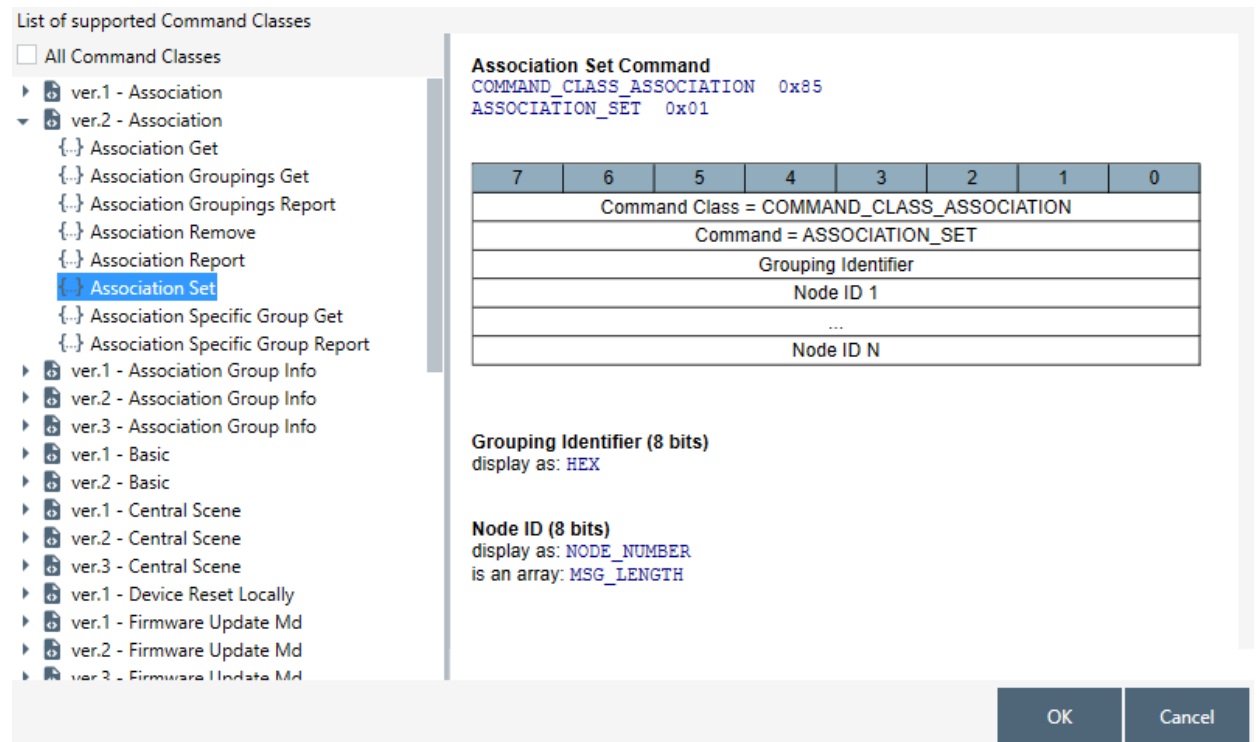


Figure 22 Select Command View

Item	Description
All Command Classes	Allows choosing all command classes and not only supported by device
Ok	Confirms a selection
Cancel	Closes a window without selection

3.5 Setup Route View

Setup Route View allows assigning or deleting routes between nodes.

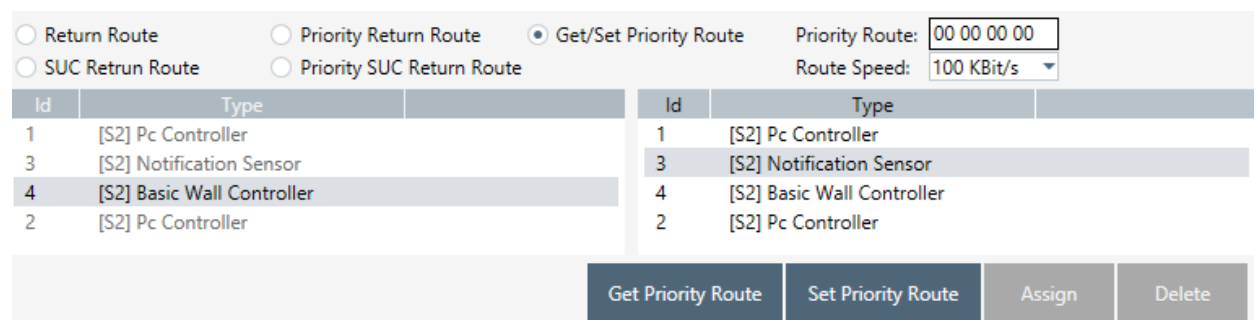


Figure 30 Setup Route View

Setups in the top of the view are change modes for assigning a route.

Source Node list(left) and *Destination Node list(right)* shows lists of source and destination nodes in a routed network respectively.

Item	Description
Return Route	Enables 'Return Route' mode
Priority Return Route	Enables 'Priority Return Route' mode
SUC Return Route	Enables 'SUC Return Route' mode
Priority SUC Return Route	Enables 'Priority SUC Return Route' mode
Get/Set Priority Route	Enables 'Get/Set Priority Route' mode
Priority Route	Repeaters array from route
Route Speed	Selects Route Speed
Get Priority Route	Gets a priority route for selected node
Set Priority Route	Sets a priority route for selected node
Assign	Assigns routes via selected nodes
Delete	Deletes assigned routes for selected node

3.6 ERTT View

ERTT (Enhanced Reliability Test Tool) View allows configuring the test scenario and shows status of the test running.

Test Iterations: 1

☐ Run forever

☐ Stop on Error

Tx Delay, ms: 100

☒ Basic Set, Value 0

☐ Basic Set, Value 255

☐ Basic Set, Value 0/255

Transmit Options

☐ Low power

☒ Retransmission

☐ Custom (hex value) 00

TX Controlled by Module

Mode: sendData with Basic Set toggle ON/OFF between rou

Tx Delay (1/100 sec.): 1

Payload Length: 2

Start/Stop

Packets Sent: 1

Route Tries: 1

Packets Received: 1

UART Errors: 0

Id	Type	Status	Elapsed, ms	Errors
2	[S2] Pc Controller	CompleteOk	29	0

Figure 31 ERTT View

ERTT View itself consists of following items:

- 1) Nodes and Node Info views (on the left)
- 2) ERTT configuration view (in the middle)

Item	Description
Test Iterations	Repeats the test selected number of times

Run forever	Repeats the test infinite times with 100 ms delay between requests
Low power	Send frames with low power when selected
Test Mode	Sends basic set with a selected value by radio buttons
TX Controlled by Module	Enable TX mode to start test from device, only for supported devices
Stop on Error	Stops the test if error occurs
Start/Stop	Starts or stops running test
Retransmission	When checked, enables frame retransmission

3.7 Polling View

Polling View allows enabling polling for all available nodes in the network.

Poll	Node	Type	Interval, sec	Timeout, sec	Requests	Failures	Missing	Avg Poll, ms	Max Poll, ms
<input checked="" type="checkbox"/>	2	[S2] Pc Controller	0	1	21	0	0	57	68

Figure 32 Polling View

Item	Description
Start button	Runs the Polling for all nodes in the list

Stop button	Stops the process
Edit buttons	On list items allows setting Poll Time, sec. and Report Time, sec parameters for polling
Done button	Used to finish editing parameters and exit Edit mode

3.8 Topology Map View

This view shows a graphical representation of the node network and access between.

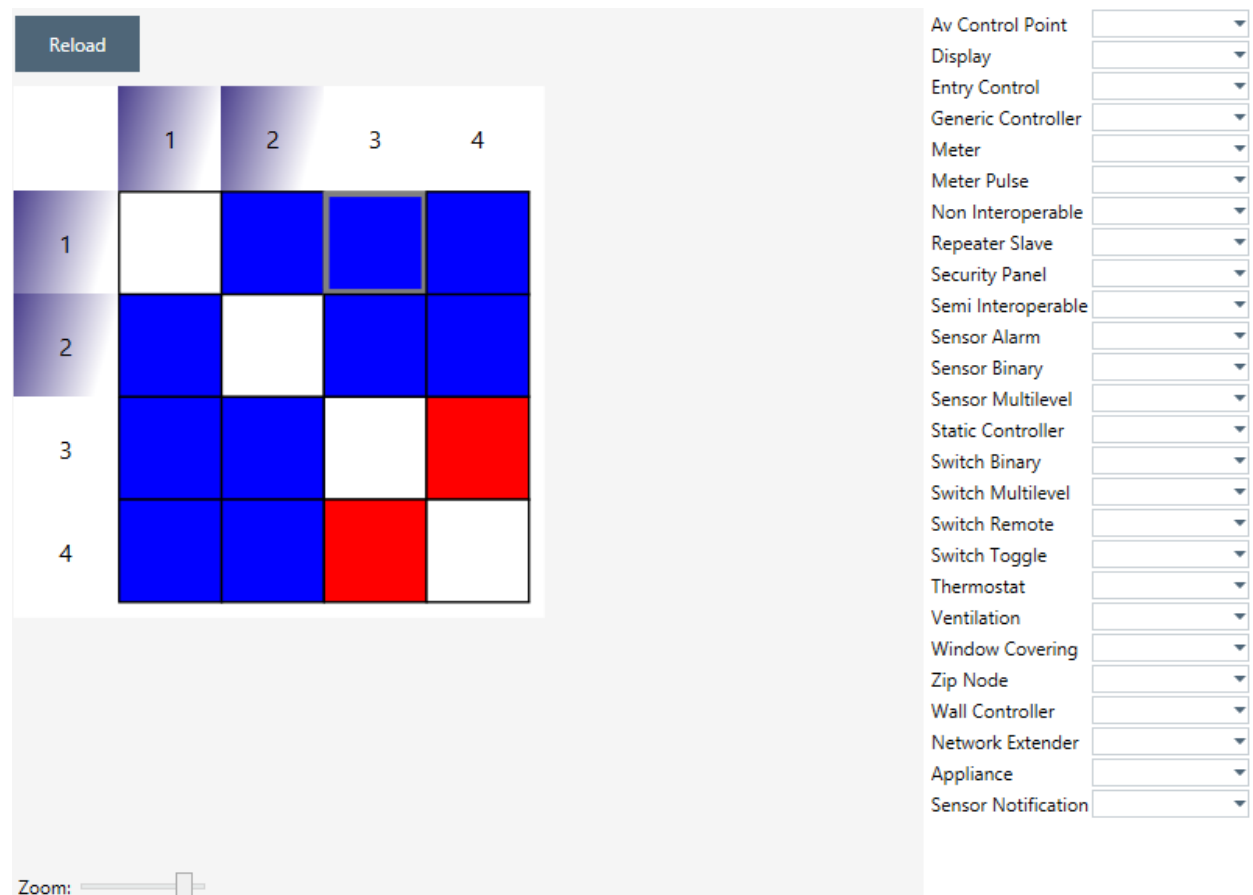


Figure 33 Topology Map

The Topology Map view consists of:

- The Graphical topology scheme itself
- Node Type Colors section

The Map

Item	Description
Graphical topology scheme	Graphically represents the network scheme, showing the nodes of all types differentiated through colorization, and the link statuses between the Installer controller and slave nodes.
Reload Topology	Reloads the topology

Node Type Colors

Node Type Colors is a list of node types with colors assigned for graphical representation on the Topology Scheme. It is possible to select a special color for each node type.

3.9 IMA Network View

The **IMA Network** view has a *Network Actions View Nodes*, *Nodes View*, *IMA Details View*, and *Network Layout Properties View*. Installation and Maintenance Application (IMA) is designed to perform analysis of network health.

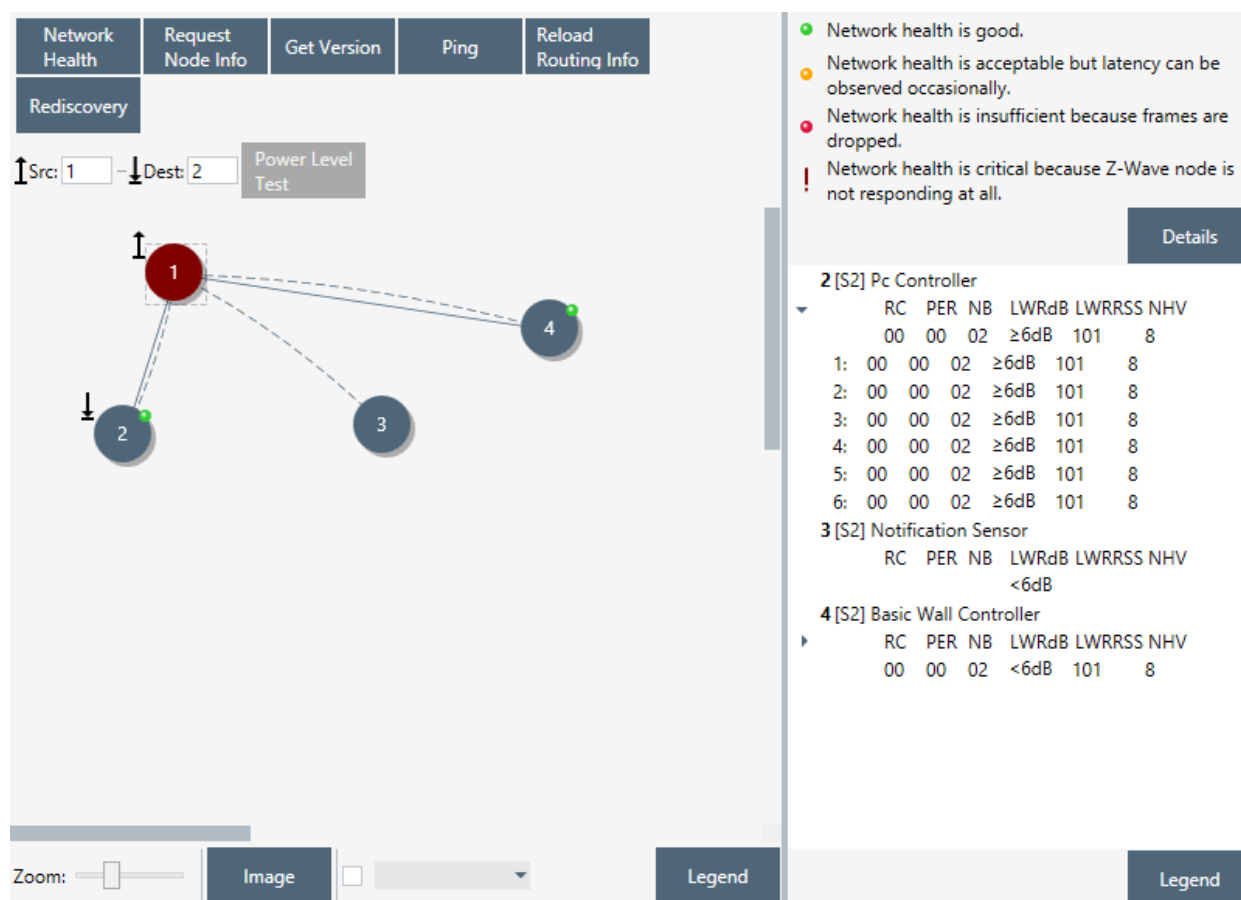


Figure 34 IMA Network View

The *Network Actions*:

Menu item	Description
Network Health	Performs an algorithm for gathering measurements to calculate the Network Health Value. These measurements are: RC, PER, NB, LWRdB, and LWRRSSI
Request Node Info	Sends the Node information get command
Get Version	Sends the Version get command
Ping Node(s)	Sends the NOP command and waits for Ack from the node
Reload Routing Info	Executes the Get routing information command and rebuilds the neighbors list
Rediscovery	Sends Get Nodes In Range command
Src / Dest	Specifies the source and destination node for commands with source and destination arguments
Power Level Test	Performs a power level test (only for selected nodes Src and Dest)

The *Nodes View* shows the nodes in the network and controller. Also, neighbor's connections of selected node and, after the Network health completed the connections between nodes. Each node can be moved on canvas. Multiple nodes can be selected.

To move the canvas use ALT + drag.

To zoom in/out the canvas use CTRL + scroll.

The *IMA Details View* contains detailed information about each step of the Network Health algorithm. Empty entries show that this measurement can't be calculated for a selected node.

Menu item	Description
Details	Shows the list of recommended actions according to the Network Health status. See figure 20.
Legend	Opens a popup window with information about the measurements. See figure 21.

- Network health is good.

ACTIONS: No actions are needed. The installation leverages on route resolution mechanisms to assure a robust and reliable Z-Wave network. This mechanism is handled solely by the Z-Wave protocol when using the TRANSMIT_OPTION_EXPLORE flag.
- Network health is acceptable but latency can be observed occasionally.

ACTIONS:

Installation: The installer MUST move nodes or install repeater nodes to achieve green traffic lights on all nodes.

Maintenance: No immediate actions are needed and the installation leverages on route resolution mechanisms to assure a robust and reliable Z-Wave network. Nodes with potential problems are flagged for rediscovery. Rediscovery of flagged nodes MUST be performed once a day to rebuild the routing information and resolve the potential problems. Assignment of return routes MUST be done after a rediscovery.
- Network health is insufficient because frames are dropped.

ACTIONS:

Installation: The installer MUST move nodes or install the necessary repeaters to achieve green traffic lights on all devices.

Maintenance: No immediate actions are needed and the installation relies on route resolution mechanism to assure a robust and reliable Z-Wave network. Nodes with potential problems are flagged for needing rediscovery. Rediscovery of flagged nodes MUST be performed once a day to rebuild the routing information and resolve the potential problems. Assignment of return routes MUST be done after a rediscovery.

REMOTE ACTIONS: Customer interaction can be conducted to understand what potential change has caused the problem to find a solution. An additional node rediscovery can be initiated. Assignment of return routes MUST follow rediscovery.

ON-SITE ACTIONS: If the problem couldn't be solved remotely, a technician may have to be dispatched. The Z-Wave node in question must either be moved closer to the gateway or a repeater node must be inserted between the Z-Wave node and the gateway.
- Network health is critical because Z-Wave node is not responding at all.

ON-SITE ACTIONS:

 - Alert the user about the problem and instruct him to check that all Z-Wave nodes are powered.
 - In case the Z-Wave node is powered, instruct the user to check local operation of the device.
 - Perform a new network health check after the user has checked Z-Wave nodes.
 - In case network health is not green, perform a full rediscovery.
 - If network health is still critical notify call center about the problem, and initiate replacement of the node or installation of a repeater node.

Network health is good.

Network health is acceptable but latency can be observed occasionally.

Network health is insufficient because frames are dropped.

Network health is critical because Z-Wave node is not responding at all.

Details

2 [S2] Pc Controller

	RC	PER	NB	LWRdB	LWRRSS	NHV
	00	00	02	≥6dB	101	8
1:	00	00	02	≥6dB	101	8
2:	00	00	02	≥6dB	101	8
3:	00	00	02	≥6dB	101	8
4:	00	00	02	≥6dB	101	8
5:	00	00	02	≥6dB	101	8
6:	00	00	02	≥6dB	101	8

3 [S2] Notification Sensor

	RC	PER	NB	LWRdB	LWRRSS	NHV
	00	00	02	≥6dB	101	8

4 [S2] Basic Wall Controller

	RC	PER	NB	LWRdB	LWRRSS	NHV
	00	00	02	<6dB	101	8

Figure 35 IMA Network Health Status Description (Details)

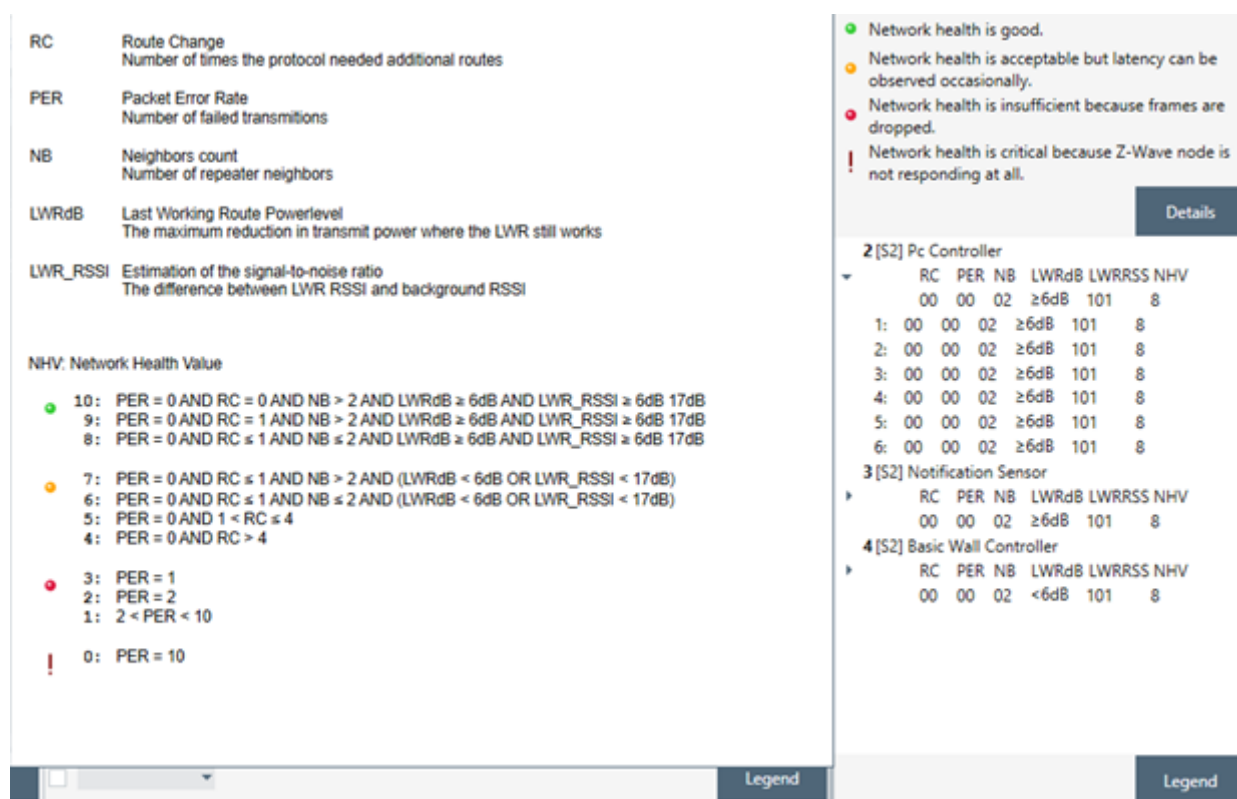


Figure 36 IMA Network Health Value Description (Legend)

The *Network Layout Properties View* allows changing the view of the Nodes, its scale, and background.

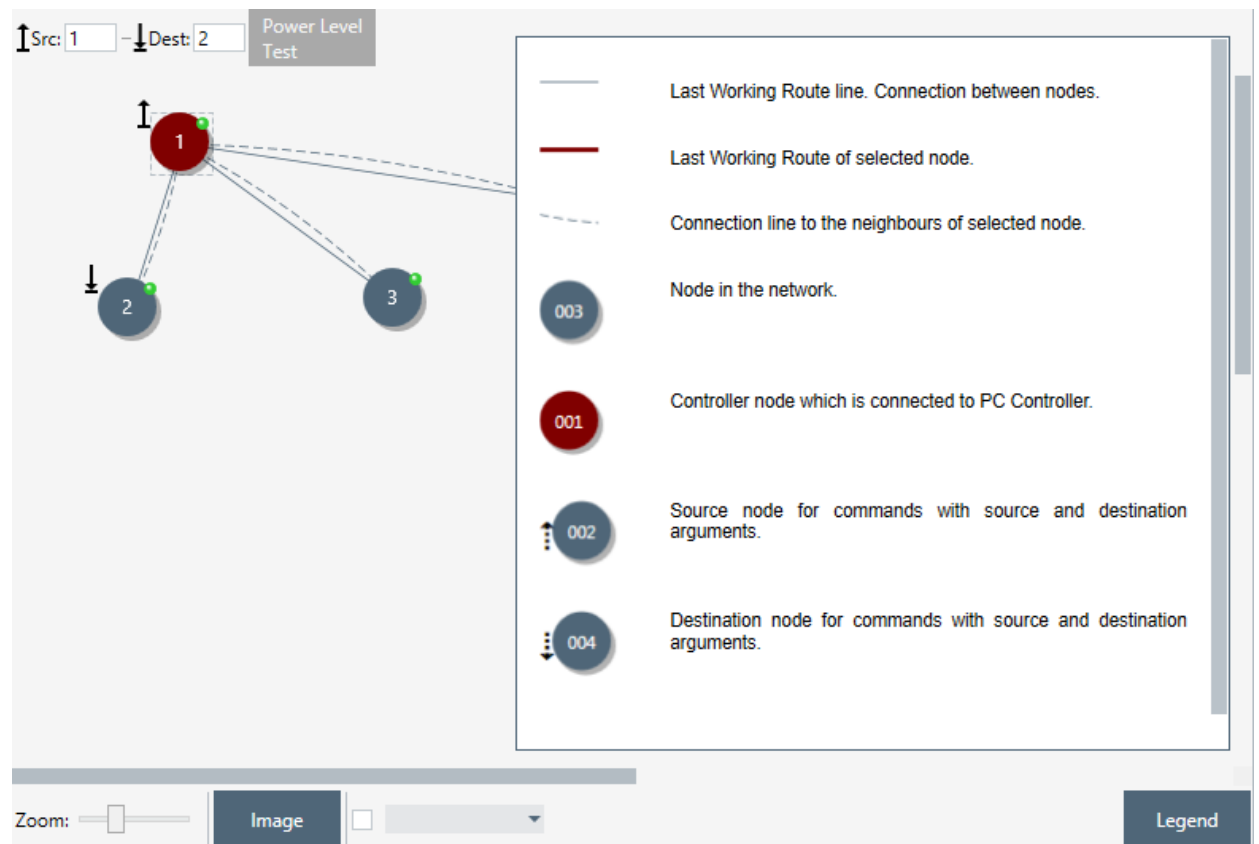


Figure 37 IMA Nodes View Description (Legend)

Menu item	Description
Zoom	Changes the scale of the canvas
Image	Opens a dialog window to choose the picture background for the canvas
Fill	A color of filling can be chosen when the checkbox is activated
Legend	Opens a popup window with information about the elements shown on <i>Nodes View</i> . See figure 21.

3.10 Encrypt/Decrypt View

Encrypt/Decrypt Message View allows to either Encrypt or Decrypt message.

S0 Tab to use Security S0 encrypt algorithms

S0	S2
External Nonce:	01 01 01 01 01 01 01 01
Internal Nonce:	01 01 01 01 01 01 01 01
Security Key:	73 CB 5E 85 BF B7 78 1E D5 C7 3E 97 31 6D B4 77
	<input type="button" value="Use Current"/>
Encrypted message:	20 02
	<input type="button" value="Decrypt"/>
Decrypted message:	C4 65
	<input type="button" value="Encrypt"/>

Figure 38 Encrypt/Decrypt View S0 Tab

Item	Description
Use Current	Inserts the current network key to a field from the security scheme
Decrypt	Decrypts the message set in the Encrypted message with parameters from input fields
Encrypt	Encrypts the message set in the Decrypted message with parameters from input fields

S2 Tab to use Security S2 encrypt algorithms

S0	S2
Home Id:	01 01 01 01
Sender Id:	1
Receiver Id:	2
Sequence Number:	00
Generations, from:	1
Generations, to:	1
Receiver Nonce:	00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
Sender Nonce:	00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
Security Key:	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Key extract algorithm:	<input checked="" type="radio"/> Normal <input type="radio"/> Temp
Encrypted message: (9F 03 xx ... xx)	
	<input type="button" value="Decrypt"/>
Decrypted message:	
	<input type="button" value="Encrypt"/>

Figure 39 Encrypt/Decrypt View S2 Tab

Item	Description
Decrypt	Decrypts the message set in the Encrypted message with parameters from input fields
Encrypt	Encrypts the message set in the Decrypted message with parameters from input fields

3.11 Firmware Update (OTA) View

Firmware Update (Over the Air) View provides functionality to update devices over the air.

— Current Firmware —

Command Class Version: 4

Manufacturer ID: 00 00

Firmware ID: 03 0C

Firmware Version: 5.01

Hardware Version:

Checksum: EC 21

Get

— Firmware Update —

File: D:\DevKits\ToTest\WallController_slave_enhanced_232_OTA_ZW050x_JP.otz

☐ Add padding to firmware update file (.ota and .hex files only), StartAddress: 0x00

Firmware Targets:

Target: 0 - Firmware Id: 03 0C

Firmware ID: 03 0C

Fragment Size: 40

Checksum: 5F BB

Activation: ☐

Update Activate Download

Status: successfully=0xFF

Figure 40 Firmware Update (OTA) View

Firmware Update View consists of the following items:

- Nodes and Node Info views (on the left)
- Firmware configuration view (in the middle)

Item	Description
Get	Gets the information about the current firmware of a selected node
File selection	Allows selecting a file with *.hex or any other extension
Update	Starts the update process on a selected node
Activate	Sends Firmware Update Activation Set command to start the delayed activation process. Button available only for Firmware Update MD Command Class version 4.

3.12 Firmware Update (OTW) View

Firmware Update (Over the Wire) View provides functionality to update devices that are connected to the PC. It opens file dialog window to choose the update file.

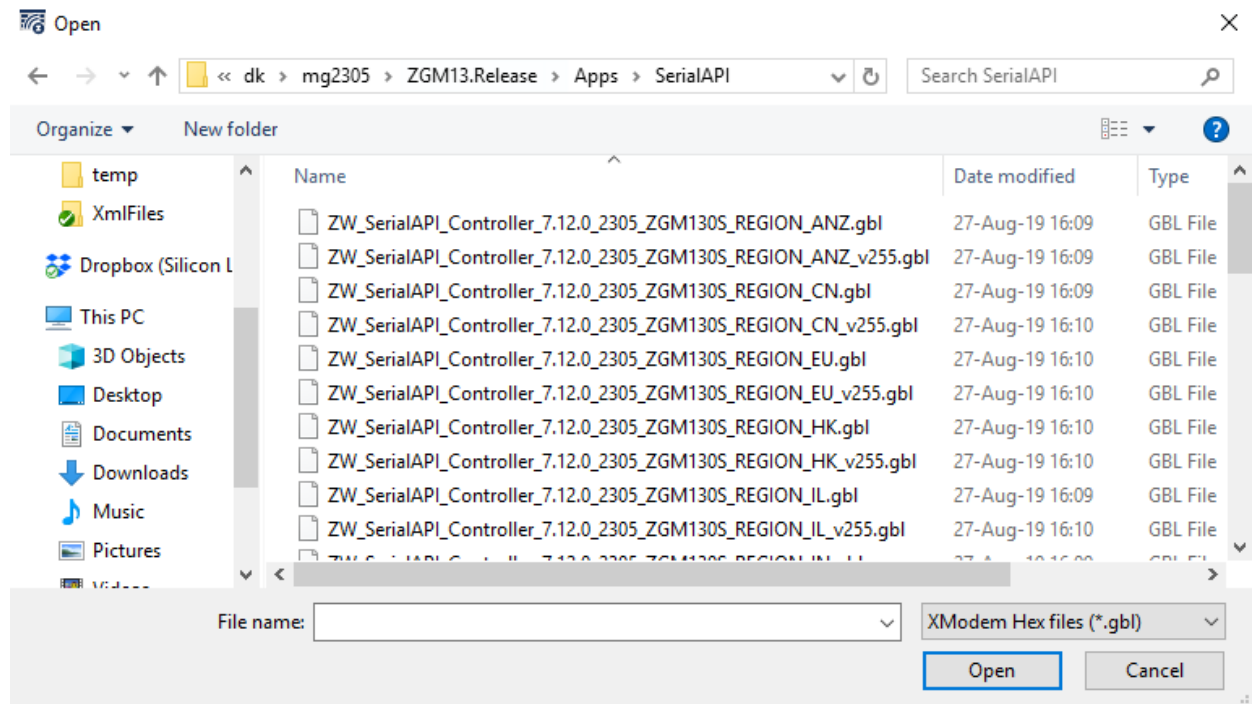


Figure 41 File Dialog View

3.13 Backup/Restore NVM

NVM (Non-volatile Memory) Backup/Restore View provides functionality to save and upload non-volatile memory content of the device.

Backup file path:	D:\nvm - backups\test.zip		Backup
Restore file path:			Restore

Figure 29 NVM Backup/Restore View

Item	Description
... (Save As)	Selects a destination file to save data
Backup	Starts backup to file
... (Open)	Selects a source file of NMV
Restore	Starts a restore file to device

3.14 Configuration Parameters

Configuration Parameters View to manage node settings using the Configuration Command Class

The screenshot displays the 'Configuration Parameters View' interface. At the top, there are two tabs: 'Get List' and 'Set'. Below the tabs, the following parameters are listed:

- Signed Int Test Param**: A numeric input field showing '1' and a range '(0 .. 32767)'.
- Signed Int Test Param Information**: A link to view more details.
- Unsigned Int Test Param**: A numeric input field showing '16777216' and a range '0 .. 32767'.
- Unsigned Int Test Param Information**: A link to view more details.
- Radio Buttons Test Param**: A group of radio buttons labeled 1, 2, 3, 4, and 5.
- Radio Buttons Test Param Information**: A link to view more details.
- Check Boxes Test Param**: A group of checkboxes labeled 1, 2, 3, and 4.
- Check Boxes Test Param Information**: A link to view more details.

Figure 42 Configuration Parameters View

Item	Description
Get List	Gets list of configuration parameters for a selected controller
Set	Sets configuration parameters

3.15 Smart Start View

Smart Start View contains provisioning list of DSKs provided by the PC Controller and enables managing it.

Provisioning List:

DSK: 11171-41043-20863-47628-30995-11652-62353-43561

DSK: 20432-01331-16333-59014-24831-32839-37483-12835

Refresh List Scan DSK Import DSKs Export DSKs

DSK Value: 20432-01331-16333-59014-24831-32839-37483-12835

Grant Schemes: ☒ S0; ☒ S2 Unauthenticated; ☒ S2 Authenticated; ☒ S2 Access;

☐ Auto remove DSK on Device Reset Locally Notification

Add Remove Remove All

Figure 43 Smart Start View

☐ Floating View

Provisioning List:

▶ DSK: 61362-24400-02773-06411-09941-56087-19794-48359

▼ DSK: 34080-61449-35120-42836-29835-32220-46142-63322

test

Refresh List

DSK:

34080-61449-35120-42836-29835-32220-46142-63322

Add Remove Remove All

Metadata Type - Name: test

Metadata Type - Location:

Figure 44 Z/IP Controller Connected Smart Start View

Item	Description
Refresh List	Reloads the provisioning list
Scan DSK	Open dialog which give opportunity to scan QR-Code using special scanner or connected camera
Import DSKs	Load provisioning list from special XML file
Export DSKs	Save provisioning list to file
Auto remove DSK on Device Reset Locally Notification	Option to enable/disable removing node included to network using DSK from the provisioning list on receiving 'Device Reset Locally' notification from it.
Add	Adds a new DSK to the provisioning list
Remove	Removes the selected DSK from a provisioning list
Remove All	Clears the provisioning list

3.16 Set Node Information View

Set Node Information view allows to change PC Controller list of command classes for node information, setup device options and Z-Wave Plus Info Report.

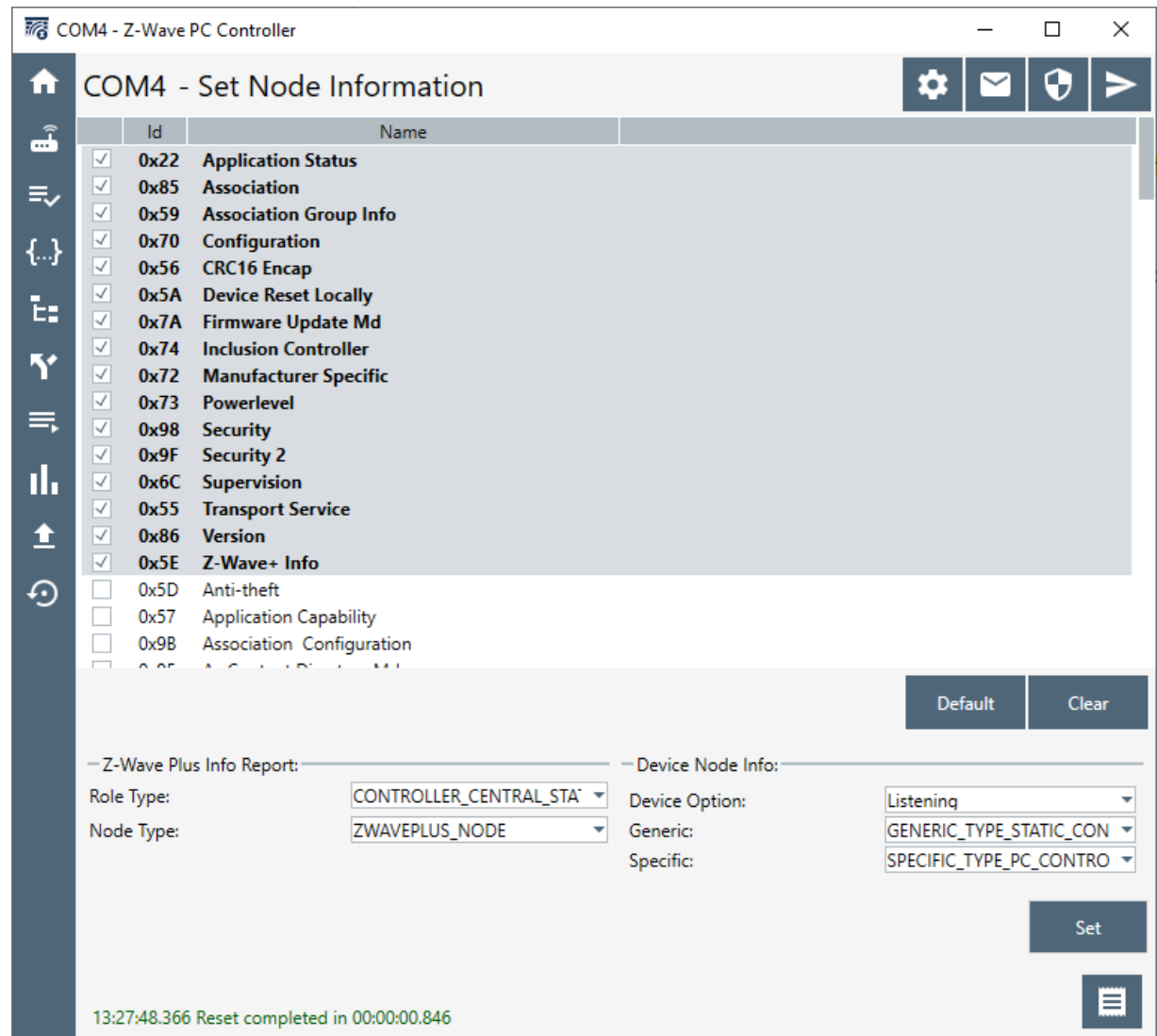


Figure 45 Set Node Info View

Item	Description
Command Classes list	Select supported command classes for connected device, bold fold highlights supported/controlled classes by application.
Default	Automatically set checkbox only for default command classes
Clear	Clear selected items in the list
Role Type	Select value for Z-Wave Plus Info Report Role Type
Node Type	Select value for Z-Wave Plus Info Report Node Type
Device Option	Select value for Basic Device Class in Application Node Info
Generic	Select value for Generic Device Class in Application Node Info
Specific	Select value for Specific Device Class in Application Node Info
Set	Apply changes

3.17 Transmit Settings View

Transmit Settings View provides functionality to adjust the TX power on Z-Wave 700 Controller devices.

Figure 46 Transmit Settings View

Item	Description
Set 'Tx Power Level'	Configure of default Tx Power level settings in deci dBm in range from -100 to +130, where value 100 equal to 10 dBm, and values greater than 100 are for test purposes
Set 'RF Region'	Configure of RF Region settings with selected item from the "Region" combo box

4 FUNCTIONALITY

For each SC in the network, a separate instance of the PC-based Controller application must be started.

Note: for correct behavior of the Z/IP Gateway as SIS in network and for support of the Inclusion controller command class, set up unsolicited destination. For more information, see section 3.2.4.

The SC can be configured to one of the following controller types:

- **Primary SC**
- **Secondary SC**
- **Primary SC with SUC and node ID Server functionality (SIS)**
- **Inclusion SC**

Primary SC

When configured as primary, the SC can be used to include/exclude nodes in the Z-Wave network. The primary SC will automatically update an SUC if present in the Z-Wave network. Only one primary controller is allowed in the Z-Wave network.

Secondary SC

When configured as secondary, the SC cannot include/exclude nodes in the Z-Wave network. Several secondary controllers are allowed in the Z-Wave network.

Primary SC with SUC and node ID Server functionality (SIS)

The SIS enables other controllers to include/exclude nodes in the network on its behalf. The SIS is the primary controller in the network because it has the latest update of the network topology and capability to include/exclude nodes in the network. When including additional controllers to the network, they become inclusion controllers because they have can include/exclude nodes in the network on behalf of the SIS. The SIS cannot shift its primary role to other controllers in the network.

To read more about SIS functionality, see reference [3].

Inclusion SC

The inclusion SC can include/exclude nodes in the network on behalf of the SIS. The inclusion SC's network topology is dated from the last time a node was included or it requested a network update from the SIS and therefore it can't be classified as a primary controller.

4.1 The SC Properties

Depending on the functionality required in the network, the PC-based Controller (SC and BC) can shift roles to obtain the desired functionality.

Primary

If the SC is the first node in a network, it will automatically be configured to act as a primary controller.

Secondary

If the SC is not the first node in a network, it will automatically be configured to act as a secondary controller.

SIS

It is possible to set the Network Role Option by clicking Set as SIS command.

The table below shows which functionality is available for the PC-based SC depending on the configuration on the controller.

Table 1 Overview of the Static Controller Properties

	Primary	Inclusion	SIS	Secondary
Node:				
Add Node	X	X	X	-
Add Node with DSK	X	X	X	-
Remove Node	X	X	X	-
Network Wide Inclusion	X	X	X	-
Network Wide Exclusion	X	X	X	-
NOP	X	X	X	X
Mark Node as Failed	X	X	X	X
Replace Failed Node	X	X	X	-
Remove Failed Node	X	X	X	-
Set as SIS	X	X	X	-
Neighbors Update	X	X	X	X
Request Node Info	X	X	X	X
Basic Set On	X	X	X	X
Basic Set Off	X	X	X	X
Set wake Up Interval	X	-	-	-
Switch All On	X	X	X	X
Switch All Off	X	X	X	X
Identify	X	X	X	X
Start Test 'Basic Get'	X	X	X	X
Change Security Scheme	X	X	X	X
Reset SPAN	X	X	X	X
Controller:				
Receive Information	X	X	-	X
Send Information	X	X	X	-
Create New Primary	-	-	-	-
Controller Shift	X	-	-	-
Reset Controller	X	X	X	X
Request Update	-	X	-	X
Command Class:				
Send	X	X	X	X
Association:				
Create Association	X	X	X	X

Remove Association	X	X	X	X
Get Associations	X	X	X	X
Setup Route:				
Assign Route	X	X	X	X
Delete Route	X	X	X	X
Get Priority Route	X	X	X	X
Set Priority Route	X	X	X	X
General:				
All On	X	X	X	X
All Off	X	X	X	X
Abort	X	X	X	X
OTA Firmware Update	X	X	X	X
OTA Firmware Update	X	X	X	X
IMA Network	X	X	X	X
NWM Backup/Restore	X	X	X	X
Configure Parameters	X	X	X	X
Smart Start	X	X	X	-
Set Node Information (Reset State)	X	X	X	-
Transmit Settings (ZW070x only)	X	X	X	X

4.2 Node View

4.2.1 How to Add a Node

PC-based SC is Primary / Inclusion / SIS

To add a node to the Z-Wave network, activate the button 'Add' in the 'Network Management' view. When activating this button, the Status popup message will display 'Press shortly the pushbutton on the node to be included in the network'. Select the node that should be added to the Z-Wave network by activating the node's button. During the inclusion process, the node must be located at its final position, so that it can obtain the correct neighbors within its range. If the operation was successful, information regarding the node type will be displayed in the node list. The PC-based controller reduces the RF output power during the inclusion process, which can cause range problems because it is static, i.e., located in a fixed position. It is, therefore, recommended to use a portable controller as primary for adding new nodes to the Z-Wave network.

Default Inclusion process in Add Node command combines inside protocol inclusion part, auto setup SIS in a network according with Role Type specifications, security bootstrap and setup default lifeline

(route, association and wakeup if supported by joining node). To manage inclusion process, use: Add Node Custom.

Note: for the correct behavior of Z/IP Gateway as SIS in network and for support of the Inclusion controller command class, set up unsolicited destination. For more information, see section 3.2.4.

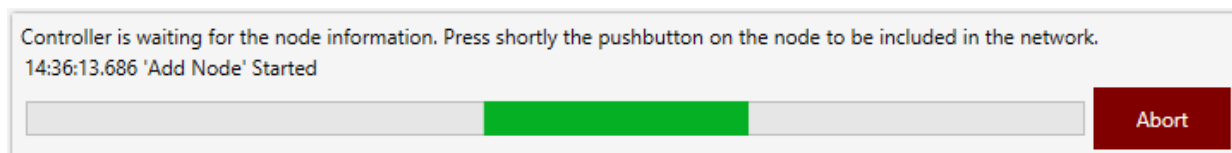


Figure 47 Popup Message After Pressing 'Add' Button

A secure S2 node asks for network keys during inclusion. PC Controller application shows the following dialog:

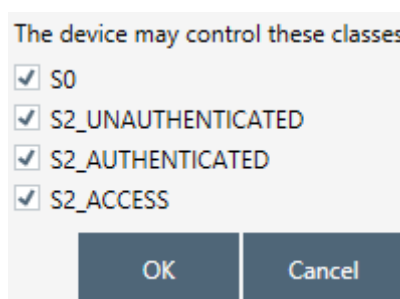


Figure 48 Network Keys Request

The secure inclusion flow will be cancelled if the user presses the Cancel button. As a result, the node will be included non-securely.

The Device-Specific Key (DSK) may be required during a secure S2 node inclusion. The PC Controller application shows the next dialog where user may input text as decimal or hex value using check box or scan it from QR Code – button “QR Code”:

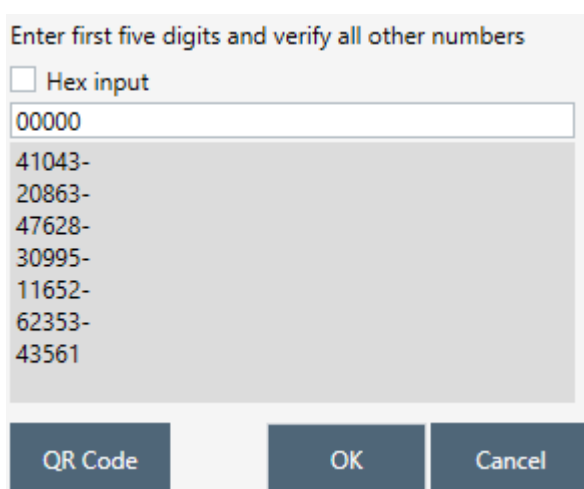


Figure 49 Enter DSK Dialog

The secure inclusion flow will be cancelled if the user presses the Cancel button. As a result, the node will be included non-securely.

PC-based Controller is Secondary

It is not possible to add nodes to the Z-Wave network.

4.2.2 How to Add Multichannel Node with EndPoints

The process of inclusion a Multichannel node is the same as for other nodes. When adding the node with supported command class Multi Channel PC Controller will additionally ask End Points list and capability for each.

4	[S2] Basic Wall Controller	✓	<input type="checkbox"/>
4.1	↳ Basic Wall Controller	✓	<input type="checkbox"/>
4.2	↳ Basic Wall Controller	✓	<input type="checkbox"/>
4.3	↳ Basic Wall Controller	✓	<input type="checkbox"/>
4.4	↳ Basic Wall Controller	✓	<input type="checkbox"/>

Figure 50 Multi Channel Node with End Points View

4.2.3 How to Remove a Node

PC-based SC is Primary / Inclusion / SIS

To remove a node from the Z-Wave network, select the node in the node list and activate the button 'Remove'. After activating the button, the Status popup message will display 'Press shortly the pushbutton on the node to be excluded from the network'. If this operation was completed successfully, the node and its information will be removed from the node list. The PC-based Controller reduces the RF output power during the exclusion process, which can cause range problems because it is static, i.e., located in a fixed position. It is, therefore, recommended to use a portable controller as primary to remove a node when having range problems.

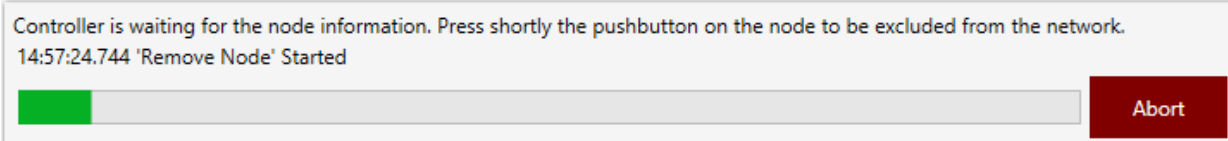


Figure 51 Popup Message After Pressing 'Remove' Button

PC-based Controller is Secondary

It is not possible to remove nodes from the Z-Wave network.

4.2.4 Network Wide Inclusion

The NWI button on the PC Controller results in the PC Controller calling AddNodeToNetwork and, after a successful inclusion, the AddNodeToNetwork is called again.

To start mass inclusion of nodes, press the Network Wide Inclusion button. The dialog will appear with the text: "Controller is waiting for the node information... Press shortly the pushbutton on the node to be included in the network."

Once all nodes have been included, press the 'Abort Operation' button to stop the NWI.

4.2.5 Network Wide Exclusion

Pressing the NWE button on the PC Controller calls `RemoveNodeFormNetwork` and, after a successful exclusion, the `RemoveNodeFormNetwork` is called again.

To start the Network Wide Exclusion nodes from the controller, press the NEW button and press the pushbutton on each node to exclude it.

4.2.6 Send NOP

This button is used to send a NOP frame to a selected node. Enter the Node ID of the target node in the text box and press the 'NOP' button.

4.2.7 How to Send a Failure Signal to a Node

If a node is corrupt and does not respond to commands, it can be marked as failed, and either replaced or removed.

Push "Is Failed" button for the selected node. The node will be marked in the list as failed (in red font).

4.2.8 How to Replace a Failed Node

PC-based SC is Primary / Inclusion / SIS

A non-responding node can be replaced by another node from the node list in the Z-Wave network by activating the button 'Replace Failed'. The following message will appear: "Replacing the non-responding node... Press shortly the pushbutton on the replacement node to be used instead of the failed one". If the operation was successful, the failed node is removed, and the other node will take the node ID of the failed node. Association setup in the failed node will be lost and must be reprogrammed.

PC-based SC is Secondary

It is not possible to replace a failing node.

4.2.9 How to Remove a Failing Node

PC-based SC is Primary / Inclusion / SIS

A non-responding node can be removed from the Z-Wave network by activating the button 'Remove Failed'. If the operation was successful, the node and its information will be removed from the node list. Responding nodes cannot be removed.

PC-based SC is Secondary

It is not possible to remove a failed node.

4.2.10 Set SIS

It is possible to assign a SIS network role to the selected controller by sending the CmdZWaveSetSucNodeId to it. To perform this operation, press on 'Set as SIS' button on the 'Network Management View'.

It is possible to set only one SIS in the network. If trying to set more than one SIS, the PC Controller will show the following warning.

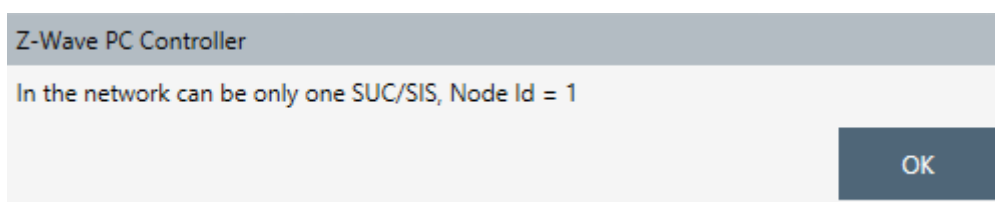


Figure 52 Set SIS Warning Message

4.2.11 Request Node Neighbors Update

It is possible to send the Find Nodes in Range command to the selected node.

4.2.12 Node Info

When the Node Info button is pressed, the PC Controller application sends a REQUEST NODE INFO command to the selected node.

For Multichannel nodes, the application will update End Points list and capability for each.

4.2.13 Version Get

Send Version Get command to the selected node(s).

4.2.14 Switching a Node or a Subset of Nodes on and off

Basic Set On

Activate the button 'On' to send the 'On' command to the selected node(s).

Basic Set Off

Activate the button 'Off' to send the 'Off' command to the selected node(s).

4.2.15 Set Wake-Up Interval

It is possible to set the wake-up interval for a non-listening node. Enter the desired wake up interval (in minutes) into the textbox and press the 'Set Wake Up Interval' button. The WAKE_UP_INTERVAL_SET command will be queued in the application memory and sent to the non-listening node the next time it wakes up.

4.2.16 'Switch All On' Command

To send an 'All on' command to all nodes in the Z-Wave network, press the button 'Switch All On'.

4.2.17 'Switch All Off' Command

To send an 'All off' command to all nodes in the Z-Wave network, press the button 'Switch All Off'.

4.2.18 'Identify' Command

To send an "Indicator Set" command to selected node if it supports this command class.

4.2.19 Start/Stop Basic Test

This option is for stress test purposes. When the 'Start Basic Test' button is pressed, the PC Controller sends a BASIC GET command to the selected node(s). After a BASIC REPORT is received from the node in the queue, the next BASIC GET command is sent either to the same node (if it is the only node selected for operation), or to the next node in the list. If the node does not respond, the controller sends the next command or moves to the next node after a timeout of 10 seconds.

Security settings contains following actions:

4.2.20 Reset SPAN

To clear Singlecast Pre-Agreed Nonce table for selected node.

4.2.21 Next SPAN

To roll Singlecast Pre-Agreed Nonce entry for selected node.

4.2.22 Security Scheme

The controller can change the security scheme for communication with a selected node.

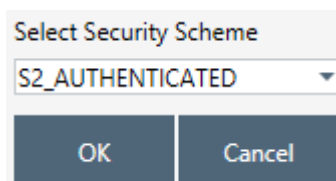


Figure 53 Select Security Scheme Dialog

4.3 Controller View

When including a PC-based SC to a network, activate the 'Add' button on the primary controller, then activate the 'Learn Mode' button on the second PC-based SC (the sequence of these two steps is not vital). This will include the SC into the Z-Wave network and transfer the complete network topology. Furthermore, it is possible to update the network topology in an existing secondary controller.

If the replication went successfully, the second PC-based SC's functionality depends on the selected option button:

If 'SIS' is chosen, and one does not already exist in the network, the SC will become the SIS in the network. If a SIS is already present, the SC will become an Inclusion controller.

If 'None' is chosen, then SC will become a secondary or inclusion controller.

PC-based SC is Inclusion / SIS / Secondary

It is not possible to shift the primary role from the PC-based SC.

4.3.1 Reset Controller

To reset the PC-based SC, activate the 'Reset' button. See also paragraph 4.2.3 to learn how to exclude nodes from the network.

4.3.2 Send Node Info

Send the broadcast node information from the controller.

4.3.3 Controller Shift

PC-based SC is Primary

To shift the primary role from the PC-based SC to another controller in the network, activate the 'Learn Mode' button within the controller to be made primary, and the 'Shift' button within the second controller interface. The second PC-based SC will now become Secondary and the first one will become Primary.

4.3.4 Request Update of PC-based SC

PC-based SC is Primary / SIS / Secondary

It is not possible to request the network topology update from another controller.

PC-based SC is Inclusion

The PC-based SC can request network topology updates from a SIS by pressing the 'Update' button.

4.4 Command Class View

Open the 'Command Class ' view to send specific command classes to nodes.

Select the node ID to receive the command from the node list.

To select a command class and command, click on the button 'Select'. 'Select Command' view will only contain those commands that are supported by the selected nodes, however it is possible to show all command classes by enabling of 'All Command Classes' check-box. Some commands require setting a value, e.g., Value. In this case, additional value fields will appear below with their names. All selected and entered values will be shown in HEX string in the Send Data text block. This text block allows changing manually Send data to send.

Finally, send the frame by activating the button 'Send'.

4.5 Association View

Open the 'Associations' view to configure associations between nodes.

Add any nodes that support the Association command class, e.g., Binary sensor.

To view the current association groups of a selected node, press the button 'Get Groups Info'. To get all nodes in the selected group, press 'Get Nodes' button.

4.5.1 Create Association

Select the to associate with the node that supports the Association command class, Select Group, and push the 'Create' button. The node ID will appear in the appropriate group.

4.5.2 Remove Association

Select the node to be removed from the association in the Groups list and press 'Remove'.

4.6 Setup Route View

Open the 'Setup Route' view to assign return routes between the two nodes in the network.

4.6.1 Assign a Route

The PC-based SC supports assigning a route between e.g., a Binary Sensor and any other node. Assigning a route specifies how the binary sensor can communicate with the node. To assign a route, select first a source and a destination node. The source node can be any node based on the routing slave library while destination node can be any node that is always in listening mode. Activate 'Assign' button to generate a route between the two nodes. For a binary battery sensor, the route assignment will be executed next time it wakes up. Until then, the request is queued in the PC-based Controller.

4.6.2 Delete a R0oute

To delete routes in a node, press the 'Delete' button. All routes assigned to the source node will be deleted. The new routing can be built either automatically or manually.

For a binary battery sensor, the route deletion will be executed next time it wakes up. Until then, the request is queued in the PC-based Controller.

4.7 Security Test Schema View

In Z-Wave Security PC Controller, Security Test Schema functionality is available to test secure networks for failures in case of device malfunctioning with using Security or Security version 2 Command Classes.

With this feature, it is possible to simulate different malfunctions of a Security PC Controller. This is needed to test the proper functioning of other devices in the network.

To use this feature, the "Enable Security Test Schema" checkbox must be checked.

'Use Permanent Network Key' checkbox allows overriding generated by the controller Network Key. It will use a specified Network Key for all operations after pressing "OK" or "Apply" buttons.

The testing Controller in Security version 0 can be configured either as the Including Controller, or as the Included Node. The corresponding options for an Including Controller or Included Node are present dependent on the selection. All changes will be applied after pressing "OK" or "Apply" buttons.

The testing Controller in Security version 2 can be configured by using security parameters, messages, and extensions overrides. All changes will be applied after pressing "OK" or "Apply" buttons.

Save Security Keys to Storage is used to generate file with network keys to load it from Zniffer Application.

4.7.1 Test S2 Parameters Overrides

The "Test Span S2" field is used to encrypt S2 Message Encapsulation with a specific SPAN. It will ignore Receivers Entropy input that is sent with the S2 Nonce Report.

The "Test Sender Entropy Input S2" field is used to substitute the SPAN extension value in the S2 Message Encapsulation in response to the S2 Nonce Report.

"Test Secret Key S2" – replaces current secret key of the S2 keypair. The DSK value will be calculated based on the secret key.

The "Test Sequence Number S2" is used to override the S2 Message Encapsulation's Sequence Number property with a specific value.

The "Test Reserved field S2" is used to override the S2 Message Encapsulation's Reserved property with a specific value.

4.7.2 Test S2 Messages Overrides

The “Test Frame” list contains all frames that are normally sent during the S2 inclusion. Therefore, the user is allowed to interfere with the inclusion process with custom frames. Click the corresponding checkbox to activate the parameter override and specify a new value. If the parameter override is not active, the PC Controller will use a valid specific frame parameter value.

“Command” field is used to substitute the selected “Test Frame” with any command that is entered.

When enabled, the “Delay” field will postpone sending the selected “Test Frame” for a specified amount of time.

“Is Multicast” field allows sending the “Test Frame” as multicast or singlecast.

“Is Broadcast” field allows sending the “Test Frame” as broadcast or singlecast.

“Is Encrypted” checkbox allows force sending the frame encrypted or force sending the message unencrypted.

“Network Key” field is used to encrypt the selected “Test Frame” with specified bytes. It will only be used if the ‘Is Encrypted’ checkbox is enabled and set.

“Is Temp Network Key” field is used to encrypt the selected “Test Frame” using a temporary expansion algorithm. It will only be used if the ‘Is Encrypted’ checkbox is enabled and set. It will also use the “Network Key” value as a security key to obtain the temporary key.

Example 1: The user wants to substitute the KEX Report (Echo) with the KEX Report frame that is unencrypted, delayed for 2 seconds and with Echo flag set to 0.

KEX Report (Echo) test frame should be configured on the *including* controller. The following screenshot shows all necessary properties that should be set.

The screenshot shows a window titled "Message overrides" with a table of test frames. The first frame is "KEXReportEcho" with a delay of 2 seconds. Below the table, there are checkboxes for "Command", "Delay (sec)", "Is Multicast", "Is Broadcast", "Is Encrypted", "Network Key", and "Is Temp Network Key". The "Is Encrypted" and "Is Temp Network Key" checkboxes are checked. The "Command" field is set to "9F 05 00 02 01 87".

Frame	Delay	Multicast	Broadcast	Encrypted	Temp	Network Key	Command
KEXReportEcho	2			X	X		9F 05 00 02 01 87

Test Frame: KEXReportEcho

☒ Command: 9F 05 00 02 01 87

☒ Delay (sec): 2

☐ Is Multicast:

☐ Is Broadcast:

☒ Is Encrypted:

☐ Network Key:

☒ Is Temp Network Key:

Buttons: Clear, Delete, Set / Add

Figure 54 Test Frame Configuration for Example 1

Example 2: The user wants to substitute the “Network Key Verify S2 Unauthenticated” frame which will not be delayed, command will be used default but should be encrypted with the custom temporary key. The Network Key Verify test frame should be configured on the *joining* controller. The following screenshot shows all necessary properties that should be set.

Message overrides

Frame	Delay	Multicast	Broadcast	Encrypted	Temp	Network Key	Command
NetworkKeyVerify_S2Unautl				✗	✓	11 00 00 00 00 00 00 00	

Test Frame

☐ Command:

☐ Delay (sec):

☐ Is Multicast:

☐ Is Broadcast:

☒ Is Encrypted:

☒ Network Key:

☒ Is Temp Network Key:

NetworkKeyVerify_S2Unauthenticated

0

11 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

Clear Delete Set / Add

Figure 55 Test Frame Configuration for Example 2

4.7.3 Test S2 Message Encapsulation Extensions Overrides

“Clean up existing extensions first” checkbox is used to delete all default extensions that should be added in a normal flow. Note that this will take effect even if no test extension is specified deleting all extensions of S2 messages.

Message type allows filtering which extensions will be changed within the S2 message encapsulation frame:

- Type “Singlecast All” means all S2 message encapsulation singlecast frames.
- Type “Singlecast with SPAN” means all S2 message encapsulation singlecast frames containing SPAN extension.
- Type “Singlecast with MPAN” means all S2 message encapsulation singlecast frames containing MPAN extension.
- Type “Singlecast with MPAN Group” means all S2 message encapsulation singlecast frames containing MGRP extension.
- Type “Singlecast with MOS” means all S2 message encapsulation singlecast frames containing MOS extension.
- Type “Multicast All” means all S2 message encapsulation multicast frames.

Extension type allows selecting a specific extension to add to the filtered S2 message encapsulation frame:

- SPAN,
- MPAN,
- MGRP (MPAN Group),
- Test (value=FF).

Applied Action value enables applying a set test extension to the next message encapsulation and contains next:

- “Add” – add predefined extension, even if extension was not added by application;
- “Add or Modify” – remove extension filtered by extension type if it was added by the application, add predefined extension;
- “Modify If Exists” – replace extension filtered by extension type with predefined only if it was added by application;

- “Delete” – remove extensions which are matches to filter item if it was added by application.

Extension length is an auto-calculated field.

Extension value allows specifying the extension data.

Click the corresponding checkbox to activate a parameter override and specify a new value. If the parameter override is not active, the PC Controller will use valid specific extension parameter value.

Extension parameters:

“Is Encrypted” option allows overriding the selected extension encryption.

“More to follow” option allows changing “more to follow” parameter of the selected extension if activated.

“Is Critical” option allows changing the “Critical” parameter of the selected extension if activated.

“Number of usage” option allows limiting a number of filtered S2 message encapsulation frames. After adding the extension with several usages, the active counter will be “0 of N”. To reset the counter, select the frame and click the button “Set”. Remember to click “OK” or “Apply” to make the new test settings active.

Examples:

1. Filter the message with a SPAN extension by message type <Singlecast with SPAN>
 - a. Put override <Add>, extension type, <NEWSPAN> value – Resulting message with SPAN and <NEWSPAN>;
 - b. Put override <Add Or Modify>, extension type, <NEWSPAN> value – Resulting message with <NEWSPAN>
 - c. Put override <Modify If Exists>, extension type, <NEWSPAN> value – Resulting message with <NEWSPAN>, if needed SPAN synchronization;
 - d. Put override <Delete>, extension type – Resulting message without any extension, extension added by the application can exist
2. Filter message with MPAN by message type <Singlecast with MPAN> and that message doesn't have SPAN
 - a. Put override <Add>, <MPAN> extension type, <NEWMPAN> value – Resulting message with MPAN and <NEWSPAN>;
 - b. Put override <Add Or Modify>, <MPAN> extension type, <NEWMPAN> value – Resulting message with MPAN and <NEWSPAN>;
 - c. Put override <Modify If Exists>, <MPAN> extension type, <NEWMPAN> value – Resulting message with NEWMPAN;
 - d. Put override <Delete>, extension type – Resulting message without any MPAN extension, extension added by the application can exist

4.8 ERTT View

The ERTT (Enhanced Reliability Test Tool) is used to test the reliability of an RF link by sending a defined number of frames and performing a simple count on how many frames were not received correctly.

A DUT node must be included in the network first. Then, select the DUT in the node list of the PC Controller, and configure the ERTT.

The following controls are available:

Test Iterations – enter the required number of iterations.

Run forever – check this box for the test to run until stopped.

Test Mode – select the data format to be used in the test (Basic Set, value 0; Basic Set, value 255; Basic Set, value 0/255).

Stop on error – check this box for the test to stop on an error.

Low Power – check this box to use low power RF transmission.

TX Control – an optional group of controls which is active only if SerialAPI reports support for (#define FUNC_ID_SERIAL_API_TEST 0x95):

- **TX is Controlled by the module** – If ticked, ZW_Test is used instead of SendData, and the module is informed to send the specified command the defined amount of times. If checked, the following fields must become available:
 - **TX Delay Field:** Define delay between each transmitted frame
 - **Payload length field**

Retransmission - if not ticked, send data will be called with TRANSMIT_OPTION_NO_RETRANSMIT = 0x40.

Packets sent: shows the numbers of sent packets.

Packets received: shows the number of reply packets received from the node.

UART Errors: shows the number of UART errors. These errors are logged when the Serial API returns transmit completion status TRANSMIT_COMPLETE_FAIL (0x06).

The UART error is a count of packages not sent to the other Z-Wave device on air traffic. Z-Wave does listen before talking to avoid interference with an ongoing communication. So, if the Z-Wave protocol "is listening" to Z-Wave air traffic, it will not send the package. Normally the Z-Wave protocol will automatically do a random back off and re-try communication. But the ERTT is a special version and will not do the random back-off. The ERTT will therefore have a higher count of non-transmitted packages.

When calculating the Frame Error Rate (FER), the UART error must be subtracted from the Packets sent to obtain the number of Packets transmitted:

Packets transmitted = Packets sent – UART Errors

$$FER = (Errors/Packets\ transmitted) * 100\ (\%)$$

Node list grid: displays information about the nodes which ERTT communicates with:

- **Node ID**

- **Device type**
- **Status** – current transmit completion status for the node. 0 stands for TRANSMIT_COMPLETE_OK. For other transmit statuses, see [2].
- **Errors** – the total number of errors (all transmit completion statuses different from TRANSMIT_COMPLETE_OK).

4.9 Polling View

Polling is an infinite process for sending Basic Get command to each node in the list with the interval 'Poll Time, sec' after the last polling command was sent and 'Report Time, sec' before Ack received and before sending to the next node. To perform Polling the 'Poll Time, sec' should be set for the needed nodes and the button 'Start' should be pressed to start. To stop the process, press the button 'Stop'.

'Requests' column shows the number of iterations for a specific node.

'Failure' shows the number of failed transmits.

'Missing Report' shows the number of requests without reports.

'Max Command Time, ms' shows the maximum delay in sending the Basic Get command and receiving a callback.

4.10 Topology Map View

The small squares on the sides of the graphic map use the color codes shown in the Node type Colors area.

The larger squares indicate the state of link between two units. Blue squares indicate that the link between two nodes exists, red squares indicate that the link does not exist, and white squares indicate that no link can exist. Note that the table is always symmetrical around the white line.

The "Reload" button loads the Topology map from the Z-Wave module. This is not done during startup because of the time it takes when the Z-Wave module holds a large network setup.

4.11 IMA Network View

Open the 'IMA Network' view to perform analysis of the network health. Add any listening node to start executing the algorithm.

The selection works as follows:

If no node selected:

- 1) Nodes range = all nodes except non-listening and controller itself.
- 2) If nodes range is empty, do nothing

If one or many nodes selected:

- 1) Nodes range = selected nodes except non-listening and controller itself.
- 2) If nodes range is empty, range = all nodes except non-listening and controller itself.
- 3) If nodes range is empty, do nothing.

For Non-listening nodes, it is possible to set “Queue overridden” check mark in the node list view, which indicates that the node is a listening node.

4.11.1 Network Health

Starts network health algorithm. This is a time-consuming process and can be aborted. After the process is finished, the Last Working Route for each node will be shown and Network Health Status will be displayed on each node. The iteration information is shown on the right side of the view.

4.11.2 Power Level Test

To perform the test, make sure that the selected nodes, marked as Source (Src) and Destination (Dest), support the power level command class. The test will be started from -9 dB reduction and continue to lower reduction until the report is received with an OK status.

4.12 Security Encrypt/Decrypt

In case of Security (tab S0), enter External Nonce, Internal Nonce, and Security Key. Then, put the encrypted message and click the “Decrypt” button or enter the decrypted message and press the Encrypt button. The outcome will be presented in the corresponding field.

For Security version 2 (tab S2), fill all fields including the network key entered manually. Select the key extract algorithm. Then, enter a message in the corresponding field and click ‘Decrypt’ or ‘Encrypt’.

Example of the S2 encapsulated message decryption using the temp key:

After including node PC Controller displays last used temp key at the Security Settings view:






Network Key S0	CB F6 8C DD F9 7B E2 68 0F 23 B8 4E 5C 67 5F 6A	
Unauthenticated	F2 B7 74 EE D0 C0 D8 53 04 D3 73 6A C8 C8 9D 6F	
Authenticated	E8 66 EA 62 48 43 E0 7F 86 B9 F4 79 16 B1 8E 2D	
Access	F5 CD 47 54 7A 7C CE 10 2D 21 6F F2 C9 EE 5F 90	
Last used Temp	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	

Figure 56 Last Used Temp Key

Choose S2 Message encapsulation frame from the Z-Wave PC Ziffer:

004	001	EC 2E CF D0	Singlecast	Public Key Report	EC 2E CF D0 04 41 0B 1
001	004	EC 2E CF D0	Ack		EC 2E CF D0 01 03 0B 1
001	004	EC 2E CF D0	Singlecast	Public Key Report	EC 2E CF D0 01 41 0D 1
004	001	EC 2E CF D0	Ack		EC 2E CF D0 04 03 0D 1
004	001	EC 2E CF D0	Singlecast	S2 Nonce Get	EC 2E CF D0 04 41 0C 1
001	004	EC 2E CF D0	Ack		EC 2E CF D0 01 03 0C 1
001	004	EC 2E CF D0	Singlecast	S2 Nonce Report	EC 2E CF D0 01 41 0E 1
004	001	EC 2E CF D0	Ack		EC 2E CF D0 04 03 0E 1
004	001	EC 2E CF D0	Singlecast	S2 Message Encapsulation	EC 2E CF D0 04 41 0D 1

Figure 57 S2 Message Encapsulation Frame

Fill all fields in the S2 Encrypt/Decrypt tab

- Home ID = EC 2E CF D0
- Sender ID = 04
- Receiver ID = 01
- Sequence Number = 6D (look in the frame details of the selected S2 Message Encapsulation frame)
- Generations = 1 (first frame after S2 synchronization, you may specify range 1...N)
- Receiver Nonce = 45 D7 23 53 64 1E 5D 76 76 92 29 AF F4 65 B0 CD (look NonceReport frame from receiver to source which was used for S2 synchronization)
- Sender Nonce = 73 35 2F 2C 32 B0 3E 93 84 EC 37 C7 85 1C 02 40 (look in the frame details of the first S2 Message Encapsulation frame after synchronization with SPAN extension, this is the selected frame in this example)
- Security Key - 08 7A B4 94 18 E3 B9 2C 69 67 3A 33 D0 9C 92 8F (last used temp key after node inclusion)
- Key Extract algorithm – Temp
- Encrypted message - 9F 03 6D 01 12 41 73 35 2F 2C 32 B0 3E 93 84 EC 37 C7 85 1C 02 40 9B B4 52 12 38 43 76 3F A4 13 0B 68 DD 9E (look in the hex data of the selected frame, starting from 9F 03 to end of frame without checksum bytes. Selected frame has 2 bytes checksum).

EC 2E CF D0 04 41 0D 2F 01	9F 03 6D 01 12 41 73 35 2F 2C 32 B0 3E 93 84 EC 37 C7 85 1C 02 40 9B B4 52 12 38 43 76 3F A4 13 0B 68 DD 9E 9C C8
----------------------------	---

Figure 58 S2 Message Encapsulation Frame Hex Data

Then, enter a message to the corresponding field and click 'Decrypt'.

Original message command - 9F 06 01 02 01 81

S0	S2
Home Id:	01 01 01 01
Sender Id:	1
Receiver Id:	2
Sequence Number:	00
Generations, from:	1
Generations, to:	1
Receiver Nonce:	00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
Sender Nonce:	00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
Security Key:	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Key extract algorithm:	<input checked="" type="radio"/> Normal <input type="radio"/> Temp
Encrypted message: (9F 03 xx ... xx)	9F 03 00 00 54 A0 45 BC 34 C2 EB 88 5A F0 72 5E 6E 87
	<input type="button" value="Decrypt"/>
Decrypted message:	9F 06 01 02 01 81
	<input type="button" value="Encrypt"/>

Figure 59 S2 Message Encapsulation Frame Decrypt

4.13 Firmware Update

If the device supports the Firmware Update Meta Data command class, it is possible to use this feature to update its firmware over the air.

Current firmware ID and manufacturer ID of the device can be checked. Press the 'Get' button to send Firmware MD Get command to the device.

New firmware file can be uploaded through selecting the file and pressing the 'Update' button.

If the update needs to be delayed, the 'Activation' checkbox should be checked before pressing the 'Update' button. After the process is finished, the 'Activate' button should be pressed to send Firmware Update Activation Set command and start the local update process on the device. This functionality is available only for Firmware Update MD Command Class version 4.

4.14 NVM Backup/Restore

This functionality saves and uploads the non-volatile memory content of the device.

Buttons with the label '...' are used to create or select a hex-file for the device data.

Press 'Backup' to copy the content of device non-volatile memory to a selected file. The file will be auto generated if it does not exist. The backup file can be either saved in the '*.zip' format or '*.hex' format. The compressed '.zip' file contains additional information from PC Controller, such as Security keys.

'Restore' will write data from file to device.

Note: When restoring from backup file, which is '*.hex' format, it will only restore device's memory. To back up Security keys and other additional information including all non-listening nodes (for example Sensor PIR) Wake Up interval settings, use the '.zip' format file.

4.15 Configuration Parameters

The Devices Configurations view realizes the Configuration Command Class which allows product-specific configuration parameters to be changed. One example could be the default dimming rate of a light dimmer.

Configuration parameters MUST be specified in the product documentation. Configuration parameters accessed via this command class MUST NOT replace similar commands provided by other existing Command Classes.

A device MUST be able to operate with default factory configuration parameter values.

4.16 Smart Start

PC Controller provides the Z-Wave Smart Start functionality which ensures that the S2 network keys are not handed out to an attacker. In the 'Smart Start' view, it is possible to add new or view existing DSK to allow inclusion of devices with Security S2 without the user's participation.

Smart Start contains Device-Specific Key (DSK) list – the Provisioning List. During inclusion with Security S2, the PC Controller selects required key. In case of successful security inclusion, the used item from the list will be marked with an included Node ID and never used again until the device is reset or removed from the network. Items can be removed from the list, but if the selected DSK corresponds to the added node, the user will be notified that device will stay in the network and needs to be removed manually by the next popup:

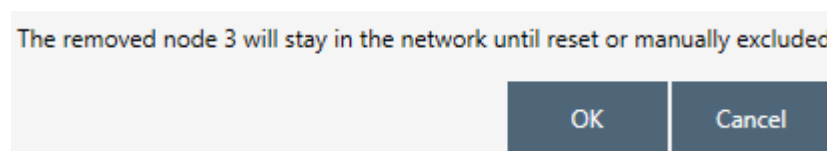


Figure 60 Provisioning List Item Delete Popup

The PC Controller reacts on the device reset event, removes the node from nodes list, and drops the link with the current DSK in the provisioning list. Users may choose whether to delete the item from the list or not:

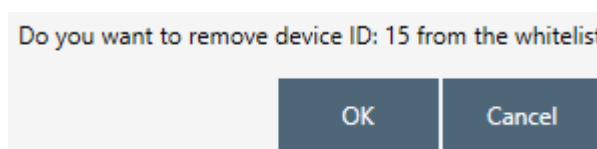


Figure 61 Smart Start Added Device Locally Reset Popup

4.17 Set Controller Node Information

The PC Controller provides possibility to generate the Node Information frame and save information about node capabilities by settings Application Node Info and changing Z-Wave Plus Info Report.

Lists of supported and securely supported classes will be applied automatically according with security settings. Apply settings possible only connected device doesn't included in any network.

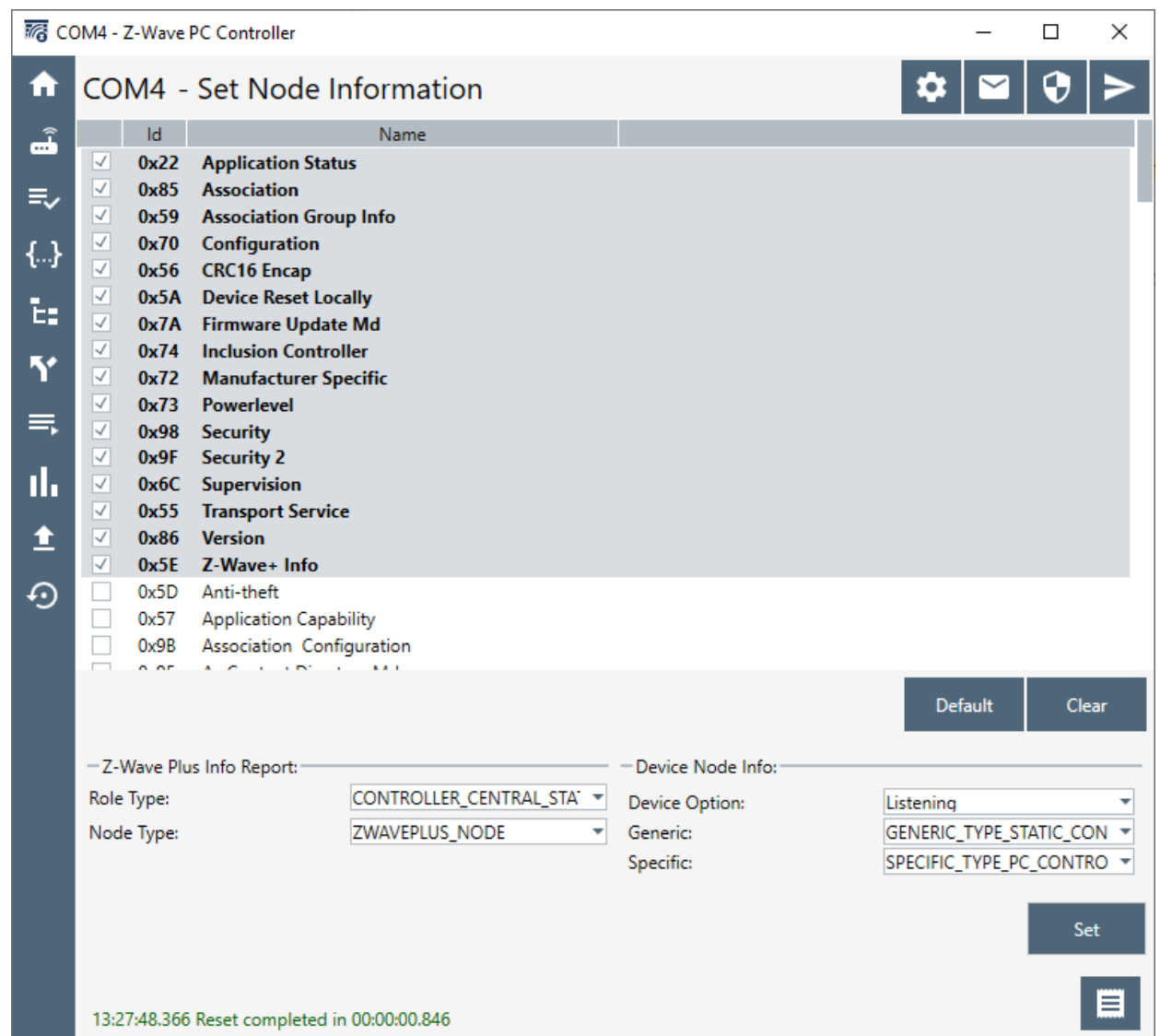


Figure 62 Set Node Information view

Application Node Info contains from list of command classes and Device Node Info fields which can be selected from appropriate drop-down lists:

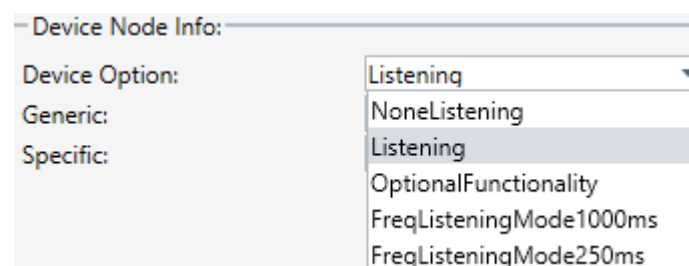


Figure 63 Device options

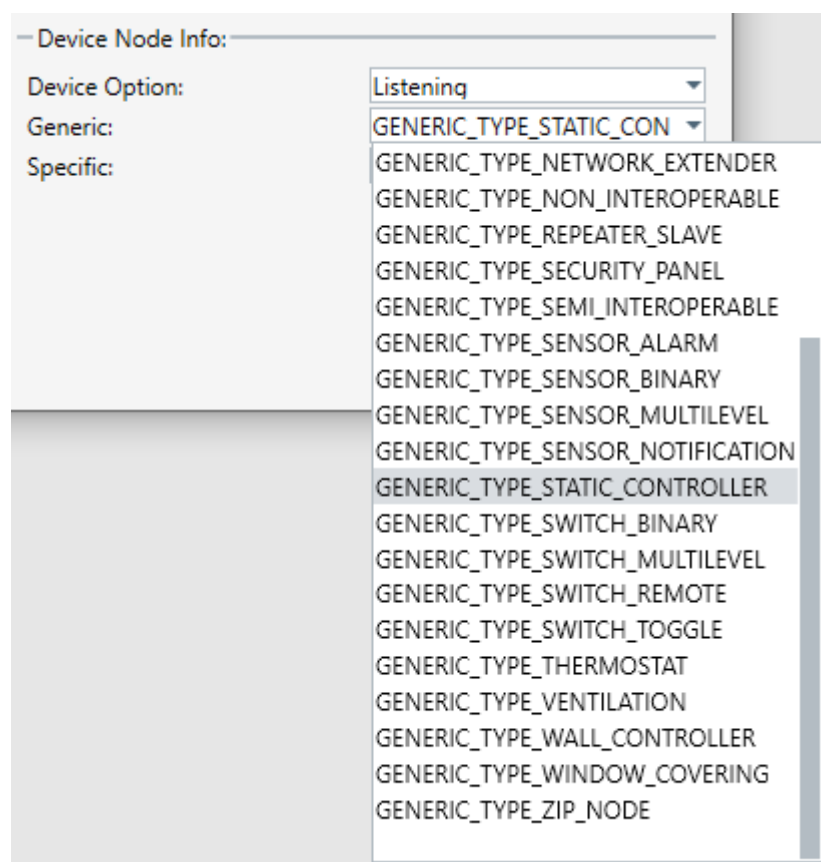


Figure 64 Generic options

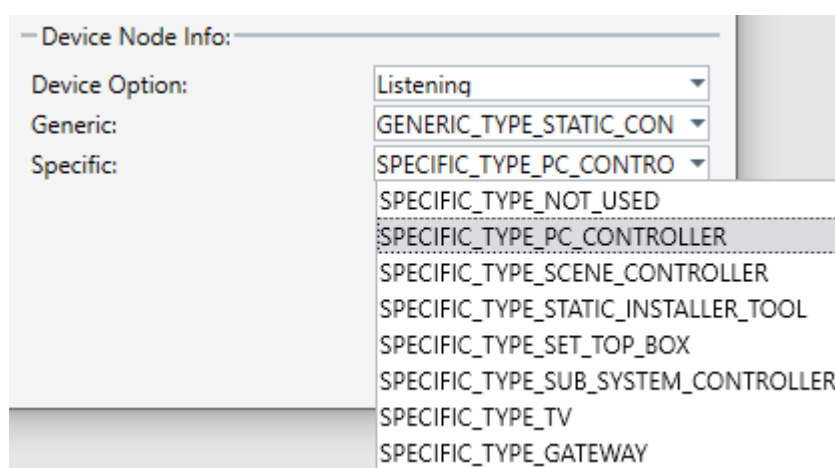


Figure 65 Specific options

Z-wave Plus Info Report section allows setup report for Z-wave Plus Info Command Class requests which use to differentiate between Z-wave Plus, Z-Wave for P and Z-wave devices.

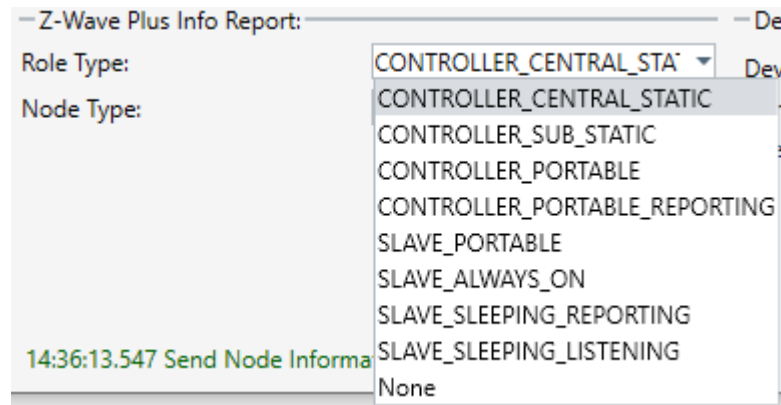


Figure 66 Role Types

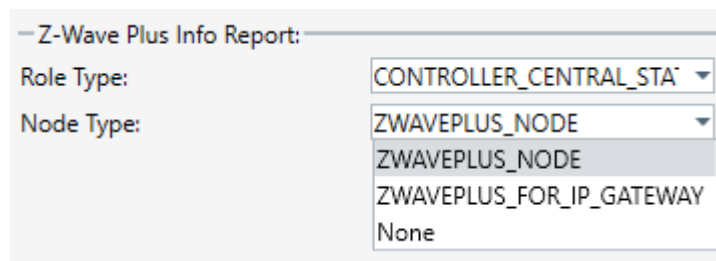


Figure 67 Node Types

4.18 Transmit Settings

The Transmit power and RF Region settings can be configured through Serial API by using PC Controller Transmit Settings View. These fields are filling from a device on connection automatically.

Normal (dBm) - The power level used when transmitting frames at normal power. The power level is in deci dBm, for example 1 dBm output power will be 10 in NormalTxPower and -2 dBm will be -20 in NormalTxPower.

Measured (dBm) - The output power measured from the antenna when NormalTxPower is set to 0 dBm. The power level is in deci dBm, for example 1d Bm output power will be 10 in Measured0dBmPower and -2 dBm will be -20 in Measured0dBmPower.

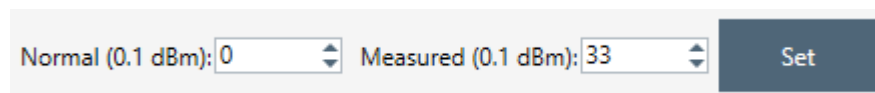


Figure 68 Transmit Settings Tx Power Level

The RF Region setting can be configured through select Region from list box:

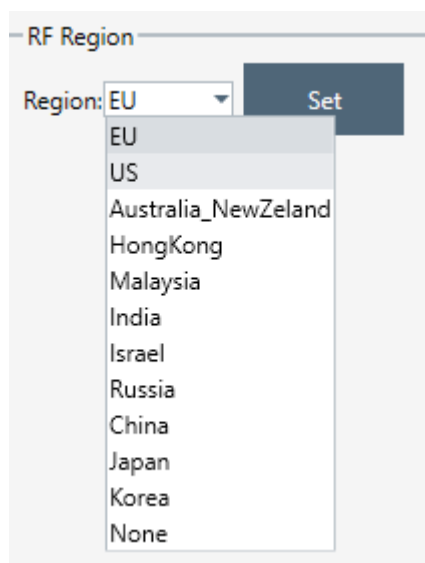


Figure 69 Select RF Region setting

4.19 Z-Wave PC Controller Log

Allows showing an application action log in the single view. The log contains all received and requested messages in the controller in the readable for user form. Also, the log writes information about application work e.g., successful connection or errors in settings. To clear the log window, press the button Clear, and auto scroll to enable scrolling of the log items list.

4.20 Settings Trace Capturing

It is possible to enable capturing of communication trace in the settings view. This functionality allows saving sent and received messages of the device to file in the capture folder. The path to the folder can be changed by users, but name of file will be auto-generated by the app and consists of ZWaveControllerDump, com port name and '.zwlw' extension, e.g., ZWaveControllerDump_COM1.zwlw.

The Auto split possibility will separate the capture file on parts by size or/and duration. The name of these will be the same as the main system file of trace plus date time of saving. Keep the last files controls count of temp files (parts) in a system. All separated parts are saved in the capture folder.

4.20.1 Open Saved Capture Trace File

The saved capture trace file can be converted to a readable format using any external script.

Example of Powershell script:

```
#####
#
# Script for reading zwlf trace capture file
#
#####

#take trace file from arguments
```

```

$FILENAME=$args
$pos=0

function ReadHeader([IO.BinaryReader] $bReader)
{
    $header = $bReader.ReadBytes(2048)
    $i = 0
    While ($i -lt 64)
    {
        $j = 0
        $outStr = ""
        While ($j -lt 32)
        {
            $outStr += "{0:X2} " -f $header[$i * 32 + $j]
            $j ++
        }
        $i ++
        $outStr
    }
}

function ReadDataChunk([IO.BinaryReader] $bReader)
{
    $outStr = ""
    $tmpBuffer = $bReader.ReadBytes(8);
    $TimeStamp = [DateTime]::FromBinary([BitConverter]::ToInt64($tmpBuffer, 0));
    $outStr += "{0:HH:mm:ss.fff}" -f $TimeStamp
    $tmpBuffer = $bReader.ReadBytes(1);
    $IsOutcome = $tmpBuffer[0] -ge 0x80
    if($IsOutcome)
    {
        $outStr += " >> "
    }
    else
    {
        $outStr += " << "
    }
    $SessionId = $tmpBuffer[0] -band 0x7F
    $outStr += "[{0:00}" -f $SessionId
    $tmpBuffer = $bReader.ReadBytes(4)
    $DataBufferLength = [BitConverter]::ToInt32($tmpBuffer, 0);
    $Data = $bReader.ReadBytes($DataBufferLength);
    $tmpBuffer = $bReader.ReadBytes(1);
    $outStr += ":{0:X2}" -f $tmpBuffer[0]
    foreach ($i in $Data)
    {
        $outStr += "{0:X2} " -f $i
    }

    $outStr
}

$scriptPath = split-path -parent $MyInvocation.MyCommand.Definition
if(Test-Path ($FILENAME))
{
    $FILENAME = (Get-Item $FILENAME).FullName
}
else
{
    $FILENAME = Join-Path($scriptPath,$FILENAME)
}

"Opening "+$FILENAME

$stream = New-Object -TypeName IO.FileStream -ArgumentList $FILENAME, Open, Read, ReadWrite
"Stream opened"
$binStream = New-Object -TypeName IO.BinaryReader -ArgumentList $stream

```

```
"Binany wrapper set"
$done = $false
"HEADER:"
""
ReadHeader $binStream
""
"CONTENT:"
""

while (!( $done))
{
    if($binStream.BaseStream.Position -lt $binStream.BaseStream.Length)
    {
        ReadDataChunk $binStream
    }
    else
    {
        {
            $done=$true
        }
    }
}

$binStream.Close()
$stream.Close()
```

5 REFERENCES

- [1] Silicon Labs, INS10236, Instruction, Development Controller User Guide.
- [2] Silicon Labs, INS13954, Instruction, Z-Wave 500 Series Appl. Programmers Guide v6.81.0x.
- [3] Silicon Labs, INS10244, Instruction, Z-Wave Node Type Overview and Network Installation Guide.
- [4] Silicon Labs, INS13113, Instruction, Z-Wave DLL v5 User Guide.
- [5] Silicon Labs, SDS11274, Specification, Security 2 Command Class.

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