



## Instruction

### How to Use Z-Wave Certified Apps

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<b>Written By:</b>	ANERDO;BSANTOK;MAMIHALI;SCBROWNI
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<b>Reviewed By:</b>	BSANTOK;JCC;MAMIHALI;SCBROWNI;ANERDO;MALEDESM
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## 1 Abbreviations

Abbreviation	Explanation
AGI	Association Group Information
AOS	Always on End device
BEA	Button Extension Adapter
FLiRS	Frequently Listening Routing End device
IDE	Integrated Development Environment
LSS	Listening Sleeping End device
RSS	Reporting Sleeping End device
S0	Security 0 Command Class
S2	Security 2 Command Class
SDK	Software Development Kit
SoC	System on Chip
WSTK	Wireless Starter Kit Mainboard
ZAF	Z-Wave Plus v2 Application Framework

## 2 Introduction

### 2.1 Purpose

The purpose of this document is to describe how to use the Z-Wave certified applications, which come as part of the Z-Wave and Z-Wave Long Range SDK 7.1x.

### 2.2 Audience and Prerequisites

The audience is Z-Wave Developers.

It is assumed that developers already have the development environment up and running, as per the instruction "INS14280 Z-Wave Getting Started for End Devices" [10].

Be aware of the user guide describing Z-Wave non-certified applications "INS14816 How to use Z-Wave Pre-Certified Apps" [11].

## 3 Software and Hardware

This section will present the hardware that comes as part of the development kit and the needed software to start developing Z-Wave devices. For a guide on how to set up and connect the hardware, refer to [10].

### 3.1 Hardware by 700 Series

The Z-Wave development kit contains the following:

- 2 pcs. BRD4001A – Wireless Starter Kit Mainboard (WSTK).
- 2 pcs. BRD4207A – Z-Wave and Z-Wave Long Range ZGM130S Radio Board intended end device development.
- 2 pcs. BRD8029A – Buttons and LEDs Expansion Board.
- 1 pc. SLUSB001A – UZB7 – Controller USB stick.
- 1 pc. UZB-S – (ACC-UZB3-S) UZB-S USB stick network sniffer.
- 2 pcs. ANT-SS900 – 868-915 MHz Compressed Whip Antenna.
- 2 pcs. ENRM002 – 1m USB A<-> USB Mini B cable.

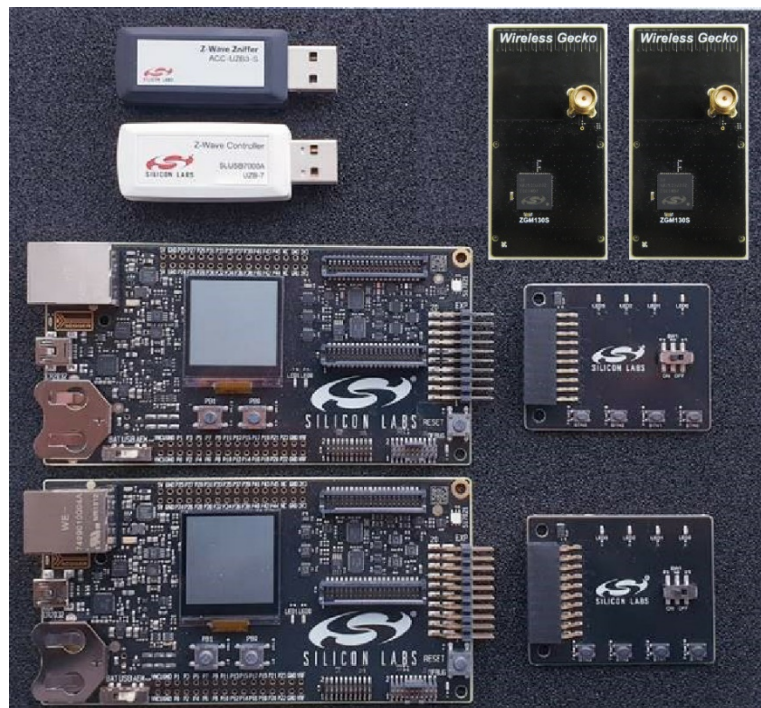


Figure 1: Content of the Z-Wave Development Kit

### 3.1.1 Main Development Board

The Main Development Board connects to the PC using USB. It features a coin cell holder, supports Advanced Energy Monitor for battery measurements and energy profiling, as well as expansion headers for easy expansion. It has an on-board SEGGER J-Link for debugging, a low-power 128x128 pixel LCD, user LEDs / pushbuttons, and breakout pads for attaching the Z-Wave development board.



Figure 2: Main Development Board

### 3.1.2 Z-Wave Development Radio Boards

Two Z-Wave Development Radio Boards targeted for end device development are included in the kit. Another radio board targeted for controller development can be purchased as an add-on to the kit.



Figure 3: Z-Wave Development Radio Boards (Left: BRD4207A, Right: BRD4206A)

The possible options are:

- BRD4207A Radio Board with ZGM130S used for Z-Wave and Z-Wave Long Range end device development (included). Added additional harmonics filtering compared to BRD4200A Radio Board.



- BRD4206A Radio Board with EFR32ZG14 used for Z-Wave and Z-Wave Long Range controller development (add-on). Added additional harmonics filtering compared to BRD4201A Radio Board.

While BRD4207A boards are intended for end devices, they can also be used for Controller development. The difference is the BRD4207 comes as a SiP module, provides I/O, and as such, has a higher cost.

The boards include a Worldwide SAW filter configuration, so the same development boards can be used to test all regions.

### 3.1.3 Recommendation on SAW Filters

For Z-Wave gateways (outside EU freq.) with LTE embedded, it is recommended that one analyze the specific need for a SAW filter in-depth. Optionally, a SAW filter bank can be added and controlled via the SAW0 and SAW1 output pins for operation in different regions. This means:

#### No SAW

- End-devices and gateways without LTE modem embedded: no SAW filter is recommended.
- Gateways on EU frequency with LTE modem embedded: no SAW filter is recommended.

#### SAW recommended

- Gateways with LTE embedded on U and H related frequencies: using a SAW filter is recommended.

### 3.1.4 EXP Board

The EXP Board is an adapter to be connected to the EXP-header of the WSTK mainboard. **The EXP Board is required by the platform to run the provided Z-Wave certified application** by expanding the available buttons and LEDs. The EXP Board offers the following features:

- 4 push buttons
- 1 slide switch
- 4 LEDs

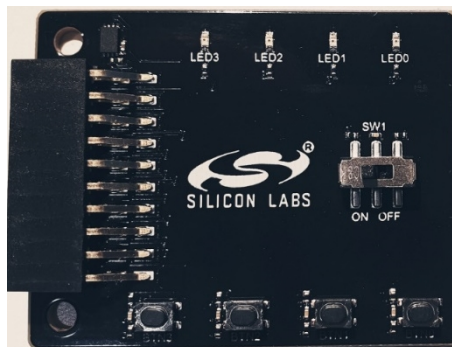


Figure 4: Expansion Board

## 3.2 Hardware by 800 Series

### 3.2.1 Z-Wave 800 Pro Kit

The Z-Wave development kit contains the following:

- 2 pcs. BRD4002A – Wireless Starter Kit Mainboard (WSTK).
- 1 pcs. BRD4204D – Z-Wave and Z-Wave Long Range EFR32ZG23 868-915 MHz 14 dBm Radio Board.
- 1 pcs. BRD4205B – Z-Wave and Z-Wave Long Range ZGM230S Radio Board.
- 2 pcs. BRD8029A – Buttons and LEDs Expansion Board.
- 1 pc. SLUSB7000A – UZB7 – Controller USB stick.
- 2x ANT-SS900 868-915MHz Compressed Whip Antenna.
- 1x 10-pin 1.27 mm IDC debug cable.

Note: the UZB-S USB stick network sniffer is not part of the Z-Wave 800 Pro Kit. A second Kit can be configured for use as a Z-Wave network sniffer. For instructions, refer to Appendix B of [10].

#### 3.2.1.1 Main development Board

The Wireless Pro Kit Mainboard is the successor to the Wireless Starter Kit Mainboard, which comes with some improvements and added features including increased AEM measurement range and sample rate, variable VMCU voltage, joystick, and a Mini Simplicity Connector. Kit features, such as the Si7021 sensor and the EXP header, are available on the same EFR32ZG23 pins regardless of the mainboard being used, but the pinout to the breakout pads differs.

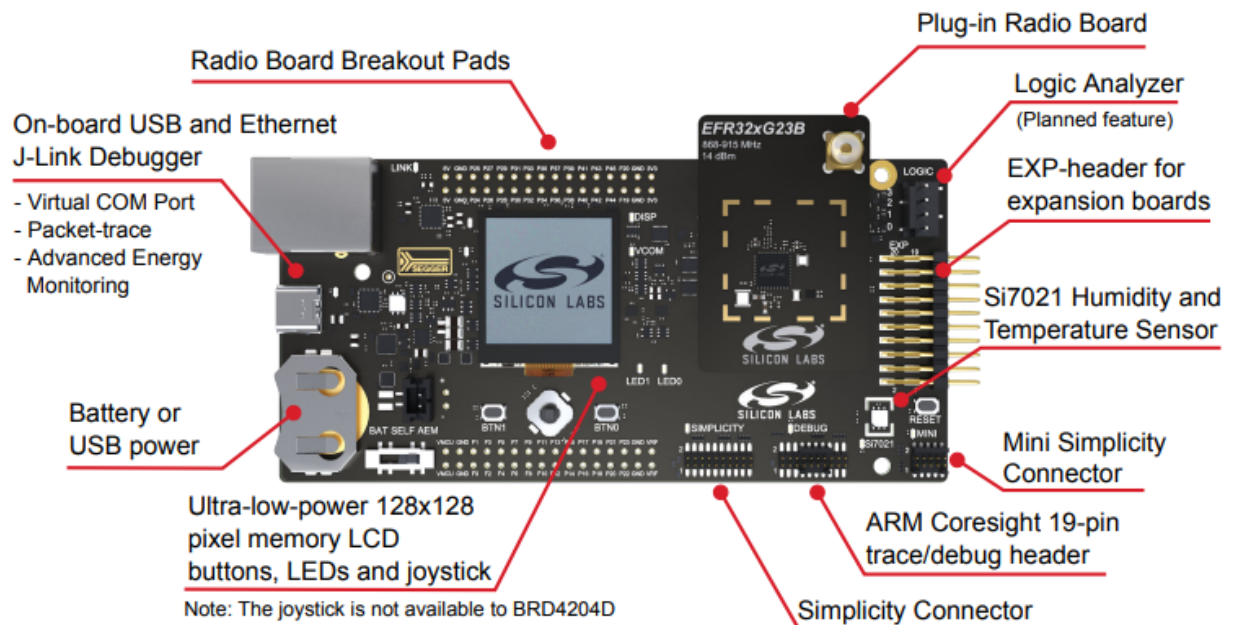


Figure 5: Main Development Board

### 3.2.1.2 Z-Wave Development Radio Boards

The EFR32ZG23 and ERF32xG28 SoCs and the ZGM230S SiP module expose the Z-Wave serial API via UART and both can be used as a gateway, controller, or end-device application. The ZGM230S SiP module combines a general-purpose SoC, crystal, supply decoupling components, and RF matching components into a single small-footprint module requiring only one or two decoupling capacitors, depending on the level of GPIO activity in the application.



Figure 6: Z-Wave Development Radio Boards (Left: BRD4204D, Right: BRD4205B)

### 3.2.1.3 Recommendation on SAW Filters

Silicon Labs recommends using a SAW filter in Z-Wave 800 gateway designs also containing GSM or LTE transceivers operating in the sub-GHz band. A SAW filter attenuates unwanted radio emissions and improves the receiver blocking performance. Three regions are defined to cover the global Z-Wave frequency range. Be aware of the user guide describing "Z-Wave 800 Series Integration Guide" [12].

### 3.2.1.4 EXP Board

The EXP Board is an adapter to be connected to the EXP-header of the WSTK mainboard.

**The EXP Board is required by the platform to run the provided Z-Wave certified application** by expanding the available buttons and LEDs. The EXP Board offers the following features:

- 4 push buttons
- 1 slide switch
- 4 LEDs



Figure 7: Expansion Board

### 3.2.2 Z-Wave Thunderboard Kits

The Z-Wave Thunderboard Kits are small form factor, cost-effective, all-in-one development platforms equipped with a USB Type-C connector.

These development boards can be configured to act as end devices, network controllers or network sniffers.

Note: some sample applications are either not available or supported only with a different or reduced set of functionalities on these development boards due to hardware limitations.

#### 3.2.2.1 Z-Wave 800 Series Development Kit

The contents of the **Z-Wave 800 Series Development Kit** are the following:

- 1 pc. BRD2603A – ZGM230s +14 dBm Dev Kit Board.
- 1 pc. ANT SS900 – 868-915 MHz Antenna

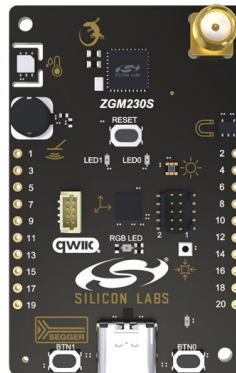


Figure 8: BRD2603A - ZGM230s +14 dBm Dev Kit Board

#### 3.2.2.2 EFR32xG28 Explorer Kit

The **EFR32xG28 Explorer Kit** contains a single xG28 Explorer board (BRD2705A).



Figure 9: EFR32xG28 Explorer Kit

### 3.3 Software Needed

All you need to start developing Z-Wave devices is Simplicity Studio.

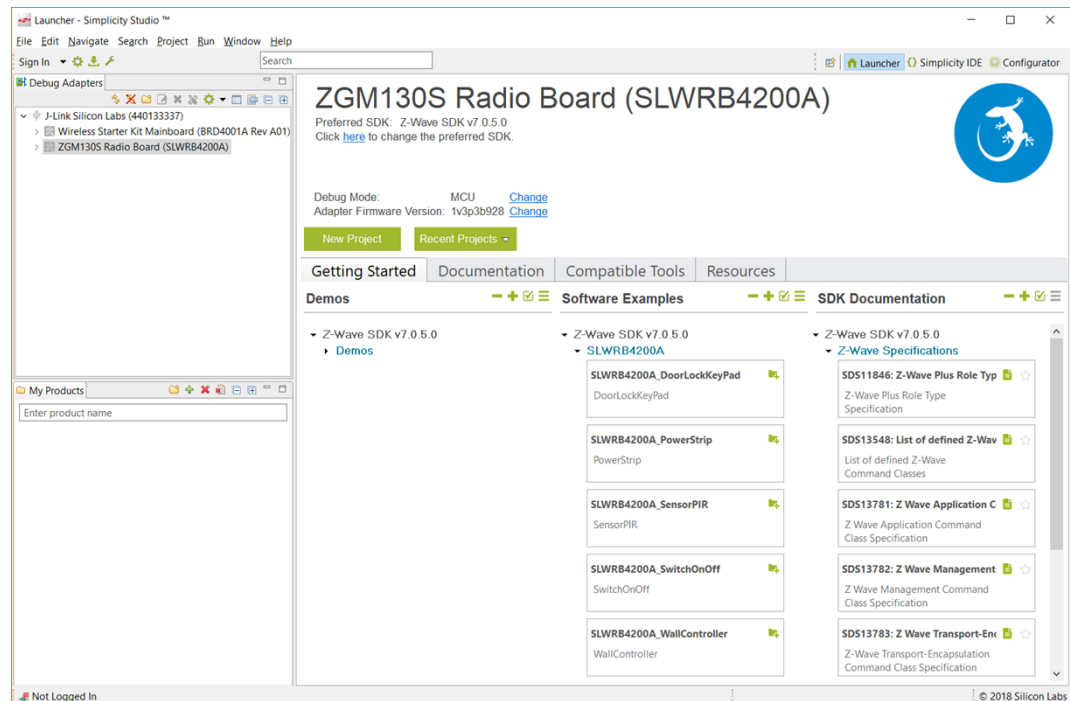


Figure 10: Simplicity Studio—IDE for Developing Z-Wave Devices

Download the installer from [silabs.com](https://www.silabs.com), where you will also find additional training material for how to develop, compile, debug, and measure energy consumption.

When connecting the development board with the Z-Wave Radio Development Board attached, the IDE will auto-discover the hardware and show the available Z-Wave certified applications.

## 4 SDK and Framework Introduction

### 4.1 SDK 7.1x Overview

Z-Wave and Z-Wave Long Range 700/800 are designed to meet the demands of the future smart home, where increasing needs for more sensors and battery-operated devices require both long range and low power. Context-aware environments are the next evolution in the smart home market, and they require technologies that have been optimized specifically for these applications.

The hardware is now based on the Silicon Labs Gecko family, a 32-bit Microcontroller based on the powerful ARM® Cortex® core. This change has resulted in power consumption being reduced by 80%, the point-to-point range has been increased to over 100 meters, and the mesh range increased to over 400 meters. With fast wake-up and back-to-sleep mode, battery-powered sensors can now last for ten years using a single coin cell.

To leverage off the powerful hardware, the software has been redesigned. The software now uses a Real-Time Operating System to divide the Z-Wave protocol and the application into independent tasks, an event driving architecture to ensure no direct function calls between protocol and application, and a power manager to automatic power down to lowest possible power mode. While everything has been redesigned, existing customers will find the Z-Wave Framework has been kept, thereby ensuring easy development.

Specifications have been updated to the Z-Wave Plus v2 to ensure interoperability between all Z-Wave products and vendors, and backward compatibility with all existing products. Z-Wave 700/800 devices work seamlessly with the world's largest ecosystem of interoperable smart products.

### 4.2 Z-Wave Plus v2 Specification

Each product must follow the Z-Wave Plus v2 specification to be able to pass the certification program and ensure interoperability in the ecosystem of existing products. The primary focus is the ease of use for consumers, which can be summarized into the following:

- Shopping does not require intensive knowledge about which products work with which other products.
- Installation is as simple as possible and intuitive.
- Operating the products does not require any technical knowledge.
- No tricky maintenance procedures, such as exclude/include, are needed.

To accomplish this vision, several new requirements are added to the original Z-Wave Plus specification. These additions include:

- Both Security-2 (S2) and SmartStart are now mandatory to increase security while keeping the inclusion process simple.
- Each product must support Identify functionality, i.e., must feature a visible LED for identification purposes, making it easy to identify a product.

- All actuators must support the Basic command class, guaranteeing that any controller can control any actuator.
- Any state change must now be reported, making sure the controller always knows the true status of a device.
- OTA Firmware update is mandatory to support for all nodes, and dynamic capabilities are now allowed as a controller must have an option to re-interview a node to detect any new/changed capabilities.

For more information about the specifications, refer to [7] and [8].

### 4.3 Z-Wave Plus v2 Framework

The purpose of the Z-Wave Plus v2 Framework is to facilitate the implementation of robust Z-Wave Plus v2 Compliant products.

The framework is described in full detail in [9]. It is strongly recommended that you read this document before developing your own Z-Wave Application. You can read a short outline here to give you an overview.

The ZAF consists of three blocks:

- **Transport Layer:**  
This layer handles all communication with the protocol, which includes single cast, multicast, Multi-Channel encapsulation, delivery of bundled commands, etc.
- **Command Class Handlers:**  
These handlers parse and compose Command Class frames.
- **Utilities (Utils):**  
Utilities are composed of different modules. Among them, there are modules for handling I/O communication specific for the hardware bundled with the SDK. Other modules are battery monitoring and firmware updating, etc.

Figure 11 below outlines the Z-Wave Plus Framework modules.



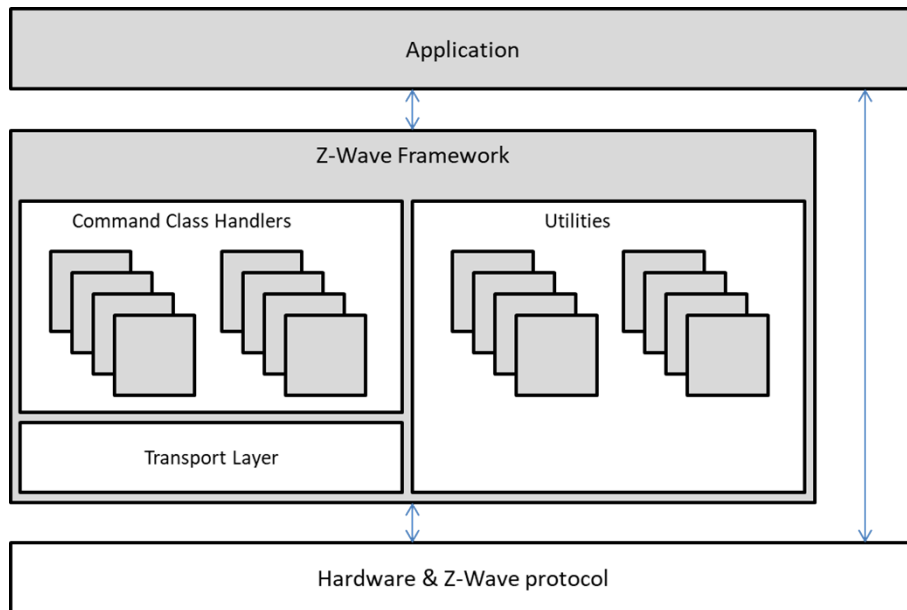


Figure 11: Z-Wave Plus v2 Application Framework

#### 4.4 Libraries

This section introduces the different libraries available in the SDK 7.1x. See [6], [9] for more information.

Overall the SDK has 2 libraries: controller library and end device library. The controller library is used for controllers running the Z/IP Gateway and will not be used by end devices. The end device library is used by all the Z-Wave certified applications for end devices.

The end device library can be configured for always on (mains powered) devices or for battery devices.

- Always on End device (AOS): End devices that are main powered. They are always listening and act as repeaters in the network. Example usages are on/off switches.
- Reporting Sleeping End device (RSS): Battery-operated devices that remain in sleep mode until they are triggered; example usages are door/windows sensors and motion sensors.
- Listening Sleeping End device (LSS): Also known as a Frequently Listening Routing End device (FLiRS). A special variant of battery-operated devices, which provide a mechanism to wake up the device within one second, with the battery drain very close to that of a fully asleep device. The FLiRS device alternates between sleep mode and a partially awake mode in which it is listening for a special wakeup beam signal at the rate of once per second. When the FLiRS device receives this beam, it immediately fully wakes up. If the device does not hear a beam, it goes back to full sleep for another period until it partially awakes again and listens for a beam. It is this partially awake mode combined with the special beam that provides for battery lives on par with fully sleeping devices while providing communications latencies of around one second. Example uses are door locks.

## 4.5 Association Groups and Endpoints

An association is the creation of a logical connection between nodes. It provides the ability to instruct a end device to control other end device(s) upon activation directly. A device must support at least one association group (group 1), which is designated for "Lifeline Reporting" (as defined by the Z-Wave Plus v2 Device Type, see [8]). Each group is responsible for controlling and/or reporting specific commands, e.g., a temperature measurement. One group can hold multiple commands if needed.

Association Group Information (AGI) enables Machine-to-Machine interfacing as well as human user interpretation of available association groups, thus eliminating the need for paper-based documentation.

All device-centric events are mapped to the Lifeline group; this includes events such as Battery Low, Tamper Alarm, and Device Reset Locally. The Lifeline concept allows a gateway to set up just one association from a device to get all it needs.

In the example of a motion sensor, the sensor reading is mapped to the Lifeline group. In contrast, another association group targets local application functionality, such as turning on a lamp based on movement.

Endpoints are the ability for a device to support multiple controllable endpoints within one device. Each endpoint specifies device and command classes supported and can be controlled individually.

Z-Wave Long Range do not support a mesh network resulting in an easier configuration of associations. A Z-Wave Long Range node must only support the Lifeline group and it is only allowed to define one node ID, typically configured to the gateway destination. All the home application logic is situated on the gateway in a typically Z-Wave Long Range network.

## 4.6 Security

Security 0 was the first version of security. This command class provides a framework for establishing encrypted communications within a Z-Wave network. However, the key exchange at inclusion is vulnerable to interception.

Security 2 is the latest Security Command Class and is required for all Z-Wave devices. S2 defines three types of security layers:

- S2 Access Control
- S2 Authenticated
- S2 Unauthenticated

S2 security operates with the concept of a network key. All nodes may use this key to communicate with each other. S2 divides the logical Z-Wave network into three dedicated security classes, with each one having a unique network key. A given S2 security class not only identifies the network key to use but also dictates the rules applying to authentication of a new node during inclusion. The "S2 Access Control" class is the most trusted class, intended for access control devices like door locks and garage

doors. The “S2 Authenticated” class is used for all normal household devices such as sensors and light dimmers. The “S2 Unauthenticated” class is the least trusted class. It is only intended for the most constrained controllers that, due to a limited user interface, are not capable of authenticating a node joining the network.

In a wireless environment, there is a real risk that a foreign node is included accidentally or due to malicious intent. The S2 authentication process allows an including controller to verify that a joining node is indeed the physical device that it claims to be. Depending on the UI, an including controller may allow the user to enter a Device-Specific Key (DSK) string of decimal digits that can be read visually or scanned as a QR code.

Giving that SmartStart is mandatory for Z-Wave devices, all Z-Wave based devices must request either S2 Access Control or S2 Authenticated. If requesting S2 Authenticated, a node must also request S2 Unauthenticated for backward compatibility. All Z-Wave Long Range devices only support SmartStart as inclusion method and S2 Authenticated is the lowest class key allowed.

Refer to [3] and [8] for more information.

## 5 Z-Wave Plus v2 Applications

Because starting application development from scratch is difficult, the Z-Wave and Z-Wave Long Range SDK comes with several Z-Wave certified applications covering the most frequent use cases.

The **Switch On/Off** application is a good starting point for new Z-Wave developers who wish to familiarize themselves with the protocol.

The Z-Wave and Z-Wave Long Range SDK 7 includes Z-Wave Plus v2 end device applications which are implemented according to the Z-Wave Plus v2 specifications [1], [2], [3], [4], [5], [6], [7] and [8]. All the Z-Wave specifications can be found on the Z-Wave Alliance website (Member login - Select 'Specifications' under the 'Home' tab).

### 5.1 Overview of Z-Wave Certified Applications

The SDK comes with the following Z-Wave certified applications:

- **Door Lock** (Can be found under the name of `zwave_soc_door_lock_key_pad`)  
Shows an implementation of a door lock. It supports user codes and, thereby, eliminates the need for traditional keys. It is possible to both lock and unlock the door remotely through Z-Wave.
- **Power Strip** (Can be found under the name of `zwave_soc_power_strip`)  
Shows an extension block implementation to turn on a number of devices that are connected to power. Examples include lights, appliances, etc.
- **Sensor PIR** (Can be found under the name of `zwave_soc_sensor_pir`)  
Shows a presence/movement detector implementation for controlling other devices and for sending notifications.
- **Switch On/Off** (Can be found under the name of `zwave_soc_switch_on_off`)  
Shows a switch implementation to turn on any device that is connected to power. Examples include lights, appliances, etc.
- **Wall Controller** (Can be found under the name of `zwave_soc_wal_controller`)  
Shows a push-button switch panel implementation to control devices in the Z-Wave network from push buttons (physical or virtual) on a device that is meant to be mounted on a wall. Examples include scene and zone controller and wall-mounted AV controllers.

The detailed description of the application can be found in their own README files. The README file can be found under the created Simplicity Studio project, or in the Silicon Labs GSDK [GitHub repository](#), in the related application folder under `protocol/z-wave/Apps`.

All applications are built on the Z-Wave Plus v2 Framework [9].

All Z-Wave certified applications can be operated in any Z-Wave network with other Z-Wave certified devices from other manufacturers. All main operated nodes within the network will act as repeaters, regardless of vendor, to increase the reliability of the network.

Notice that SoC on radio boards must be completely erase before downloading a new app. Data from a previous app may jeopardize operation of a new app.

Refer to Table 1 for an overview of the functionality covered by the applications.

**Table 1. Functionality Covered by the Z-Wave Plus v2 Applications**

Functionality	Door Lock	Power Strip	Sensor PIR	Switch On/Off	Wall Controller
<b>Role Type</b>					
Always On End device		✓		✓	✓
Reporting Sleeping End device			✓		
Listening Sleeping End device	✓				
<b>Multi-channel</b>					
Endpoints		✓			
<b>Security (see Note 1)</b>					
S2 Access	✓				
S2 Authenticated		✓	✓	✓	✓
S2 Unauthenticated		✓	✓	✓	✓
S0	✓	✓		✓	✓
<b>Main functionality</b>					
Binary Switch		✓		✓	
Central Scene					✓
Door Lock	✓				
Firmware Update	✓	✓	✓	✓	✓
Multilevel Switch		✓			
Notification		✓	✓		
User Code	✓				
Color Switch					

Note 1: S2 Authenticated is the lowest key class allowed for Z-Wave Long Range based devices. A node requesting the S0 key during Z-Wave inclusion will not request that key during Z-Wave Long Range inclusion. In addition, if the node is included as a Z-Wave Long Range node, Command Class Security S0 will not be listed in the NIF.

### 5.1.1 General User Interface

The following user interface applies to all the Z-Wave Plus v2 certified applications.

**Table 2. General User Interface**

Button/LED	Action	Description
RST	Press	Resets the firmware of an application (like losing power). All volatile memory will be cleared.
BTN1	Press	Enter “learn mode” (sending node info frame) to add/remove the device. Removing the device from a network will reset it.
	Hold for at least 5 seconds and release	Perform a reset to factory default operation of the device, and a Device Reset Locally Notification Command is sent via Lifeline.
LED1	n/a	Blinks with 1 Hz when learn mode is active. Used for Indicator Command Class.

#### 5.1.1.1 How to trigger indicator LED

The indicator LED will flash when using indicator ID 0x50 (Identify).

### 5.1.2 SmartStart

SmartStart-enabled products can be added into a Z-Wave network by scanning the Z-Wave QR Code present on the product with a controller providing SmartStart inclusion. No further action is required, and the SmartStart product will be added automatically within 10 minutes of being switched on in the network vicinity. The Z-Wave certified applications are not labeled with a QR Code. However, QR Codes are generated internally in the SoC and can be retrieved via Simplicity Studio. Right-click on your connected hardware in the 'Debug Adapters' section in Simplicity Studio, then right-click and select 'Device Configuration' from this menu, select 'Z-Wave Device Settings.'

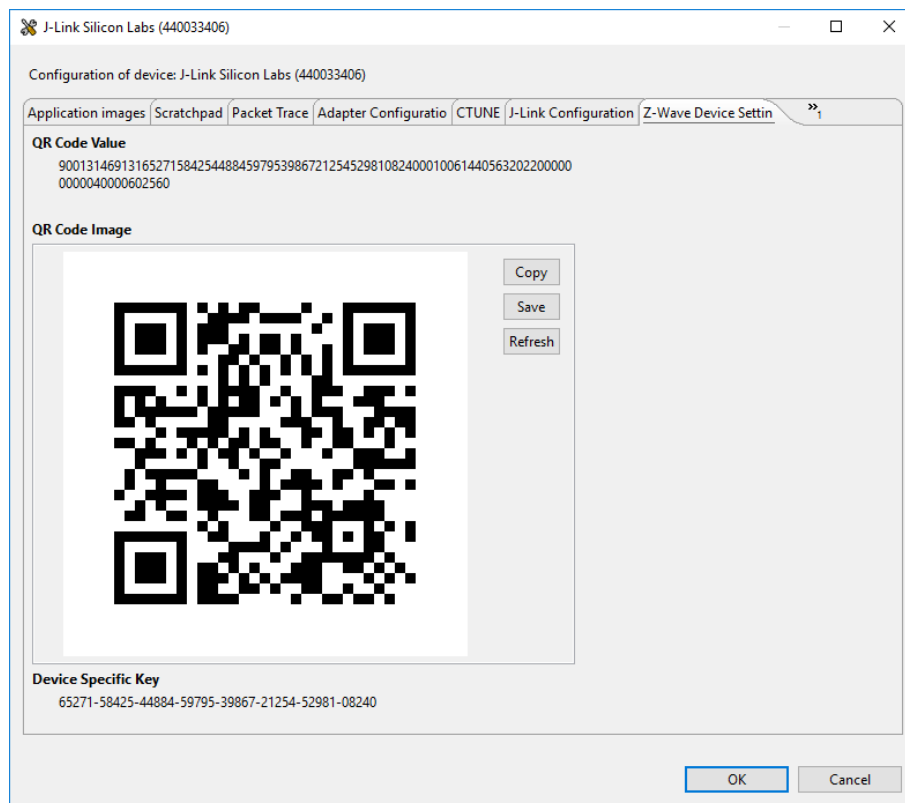


Figure 12. QR Code image and value.

In this view, the entire QR Code Value and the corresponding QR Code Image is shown. In addition, the Device Specific Key (DSK) is shown.

This DSK can be compared against the Z-Wave UI, PC Controller dialog box, or other Controller UI. If needed, the first decimal group of the DSK can be typed in for S2 secure inclusion.

## References

- [1] Z-Wave Alliance, Software Design Specification, Z-Wave Application Command Class Specification.
- [2] Z-Wave Alliance, Software Design Specification, Z-Wave Management Command Class Specification.
- [3] Z-Wave Alliance, Software Design Specification, Z-Wave Transport-Encapsulation Command Class Specification.
- [4] Z-Wave Alliance, Software Design Specification, Z-Wave Network-Protocol Command Class Specification.
- [5] Z-Wave Alliance, Software Design Specification, List of Defined Z-Wave Command Classes.
- [6] Z-Wave Alliance, Software Design Specification, Z-Wave Plus Role Type Specification.
- [7] Z-Wave Alliance, Software Design Specification, Z-Wave Command Class Control Specification.
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- [12] Silicon Labs, UG517: Z-Wave 800 Series Integration Guide