TECH BULLETIN

TECHNICAL SUPPORT

Installing Z-Wave with ClareHome

This document was last updated August 2nd, 2018. It will receive no further updates. To get current Z-Wave information regarding ClareHome, see *Installing Z-Wave with ClareHome*.

Introduction

This tech bulletin serves as an introduction to Z-Wave. It addresses the key specifications of ClareHome supported Z-Wave devices and their impact on installation, configuration, and maintenance. Table 3 of the document provides a list of all Z-Wave devices supported by ClareHome. A more detailed configuration process can be obtained through ClareHome training.

1. Z-Wave concepts

Wireless basics

Z-Wave is a wireless networking technology based on mesh networking devices referred to as nodes. Operating in the uncongested 900Mhz band. These nodes communicate with each other using signal, creating the mesh network between themselves and a controller device. The communication has limitations. In a home, there are obstructions that reduce the optimal range from the sender (Z-Wave device sending signals) and the receiver (Z-Wave device receiving the signal), causing attenuation. Attenuation is the weakening of the signal strength from one point to the next. A good range in the home, accounting for attenuation (decreasing signal), is 9 meters (30 feet) - however, construction materials, appliances, mirrors, and other objects may greatly affect the signal, allowing no communication. Refer to Table 1: Z-Wave attenuation for common construction materials on page 3. Z-Wave wireless networks overcome distance limitations and for the most part, obstructions, by utilizing mesh networking.

Note: The Z-Wave Alliance recommends placing Z-Wave devices every 30 feet, or closer, for maximum efficiency.

Radio interference and obstacles

Radio interference, objects/materials, and frequency angle affect the signal strength between the sending and receiving Z-Wave devices (nodes).

Radio interference

Radio interference can impede the Z-Wave device’s signal, preventing full communication between devices.

Common sources of radio interference:

- 900 MHz cordless telephones
- Wireless speaker expanders or extenders
- IR to RF remote control extenders
- Older baby monitors
- Computers
- Microwaves
- Transformers
- AV equipment
- Fluorescent lamps
- Electric motor and inductive load switch
- Defective electrical devices
- HF welding equipment
- Medical devices

Objects and materials: Anything in the way of direct line of sight shortens the length the signal can reliably travel. Objects have different impacts on the signal depending on their material. Some materials are easier to pass through – for example, plaster is easier to penetrate than metal foil.

Common objects:

- TVs, particularly plasma TVs
- Fish tanks
- Mirrors
- Appliances
- Wall hanging/pictures
- Furniture

See Table 1 below for attenuation data of construction materials:

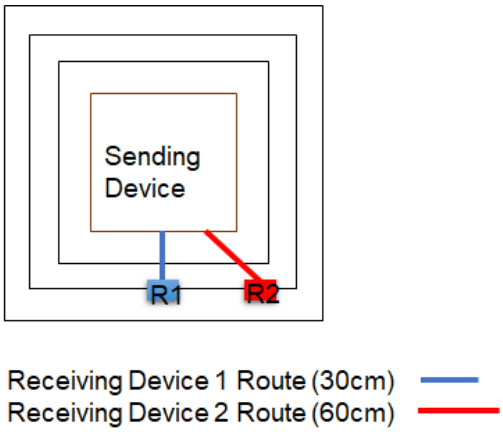
Table 1: Z-Wave attenuation for common construction materials

Material	Thickness	Attenuation
Plaster	< 10 cm	10%
Glass (excluding any metal coating – mirrors)	< 5 cm	10%
Stone	< 30 cm	30%
Pumice	< 30 cm	30%
Aerated Concrete	< 30 cm	20%
Red Brick	< 30 cm	35%
Concrete with Rebar	< 30 cm	30 – 90%
Ceilings	< 30 cm	70%
Outer Wall	< 30 cm	60%
Inner Wall	< 30 cm	40%
Metal Foil or Grid	< 1 mm	90%
Aluminum Coating	< 1 mm	100%

From *Z-Wave Basics: Remote Control in Smart Homes* by Dr. Christian Paetz (2015).

Frequency angle: A frequency sent through material in a straight line is stronger than a frequency being sent through material at an angle. If the signal is anything other than 90 degrees, the signal is significantly weakened. The angle through the material creates a longer line that the signal passes through from the sender and receiver device. The sending and receiving devices should be arranged to allow for a straight, short connecting line. See Figure 1: Wall thickness and angle on page 4. This figure displays the wall thickness and signal angle.

Figure 1: Wall thickness and angle



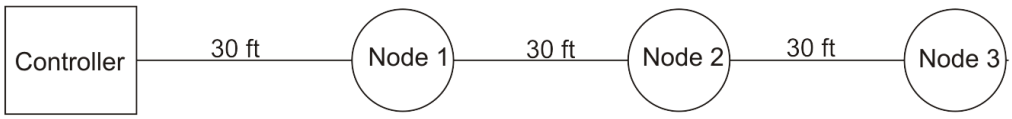
To get a reliable measurement of radio frequency travel, take the obstacle, material, and angle into consideration. See below, Table 2: Z-Wave attenuation distance work .

Table 2: Z-Wave attenuation distance work sheet

Obstacle	Distance	Type	Attenuation	New Distance
No 1	30m	Concrete	30%	21m
		Take value to next step		
No 2	21m	Glass	10%	18.9m
		Take value to next step		
No 3	18.9m	Plaster wall	10%	17m
		Take value to next step		
	17m			

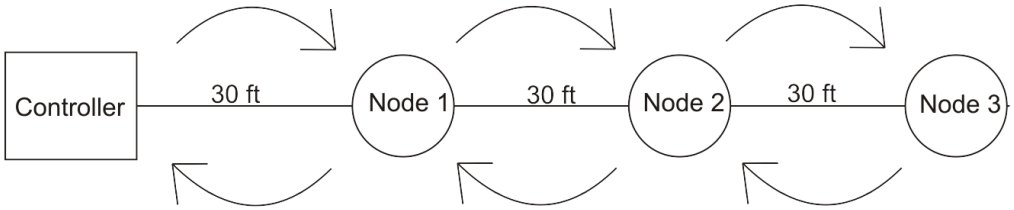
From *Z-Wave Basics: Remote Control in Smart Homes* by Dr. Christian Paetz (2015).

Figure 2: Z-Wave mesh networking



In Figure 2, three devices are connected to the controller utilizing a Z-Wave wireless network. Node 1 is in range of the controller and can communicate. Nodes 2 and 3 are out of range and cannot communicate directly with the controller.

Figure 3: Z-Wave mesh communication



Z-Wave wireless technology handles this issue through the use of mesh networking. In a mesh network, the controller communicates with Node 1, Node 1 relays the data to Node 2, Node 2 in turn relays the data to Node 3. This can also occur in reverse. This communication path is called a *route* and is the basis of all communication in a Z-Wave network.

As the mesh network is built, nodes get multiple options on relaying commands to the intended node. More options make the network faster, more efficient, and better able to cope with the loss of a node. For example, if the circuit breaker to one room is switched off.

Z-Wave commands are able to relay five times before they time-out. This accounts for the controller, four repeating devices, and the receiver. Due to this, it is best that the controller is installed in a central location in the home.

Figure 4: Example of a good Z-Wave mesh network

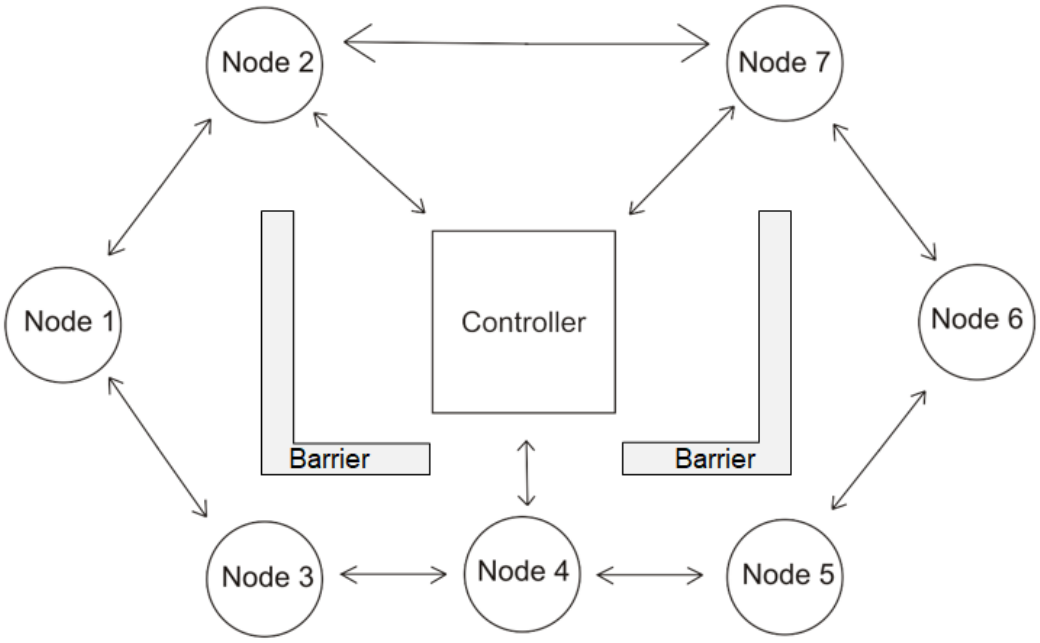


Figure 4 is an example of a Z-Wave mesh network. Note that the controller has multiple methods to communicate with each device. In this network if Node 3 fails, Nodes 1 and 5 have alternative methods to receive commands. This is also the case for failure with other nodes in the network.

Figure 5: Example of attenuation and routes in a home environment

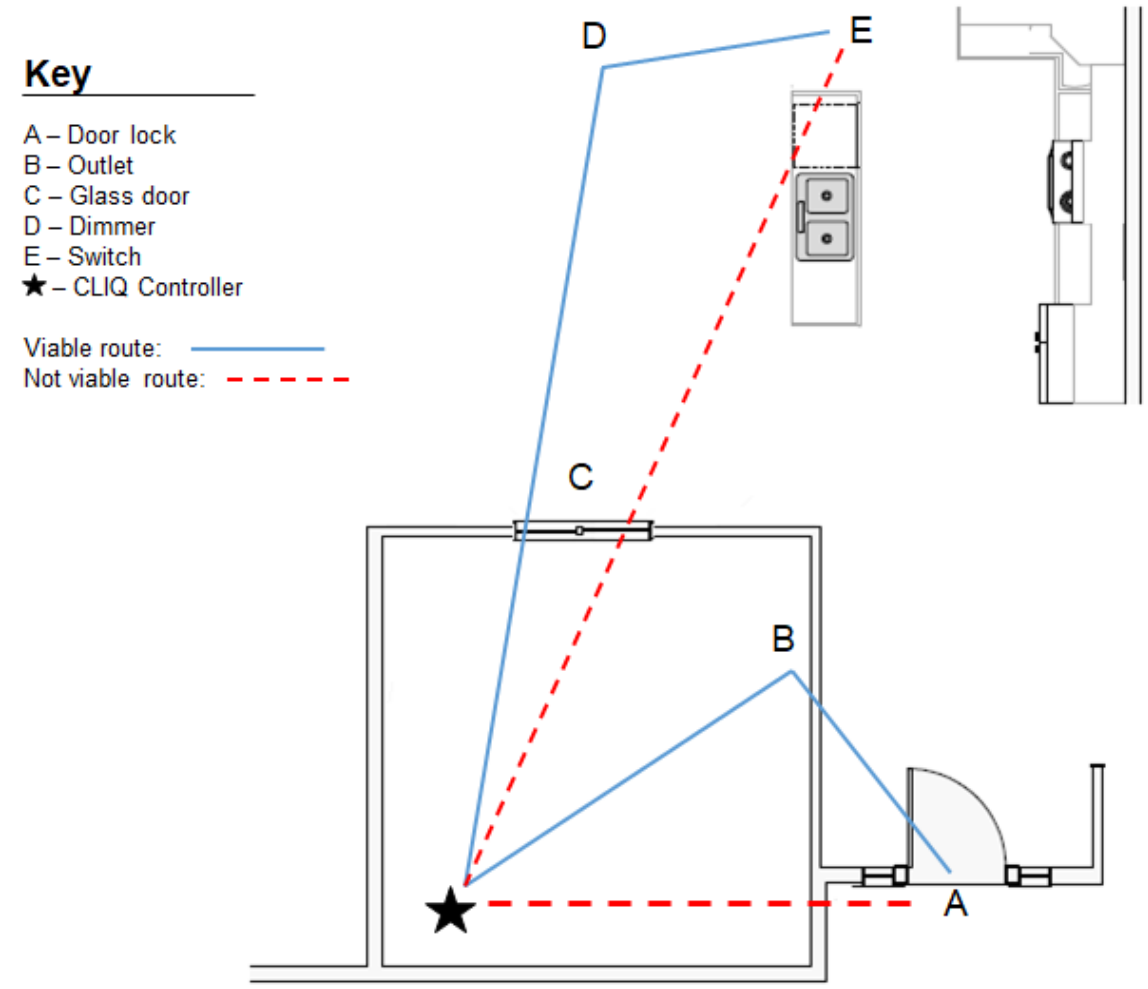


Figure 5 is an example of attenuation and Z-Wave routes in a home. The star symbol (★) is the CLIQ Controller's location in the home. The lines (both solid and dashed) show routes from the controller to individual devices. This diagram and the below attenuation worksheets walk through why certain routes are viable and others not.

Controller to A: The Controller (★) to the door lock (A) is not a viable route. It is only 10 ft away from the controller, but there is an outer wall between them. The outer wall consists of plaster and metal foil insulation, resulting in 90% attenuation. In this example the signal cannot successfully pass through the outer wall. The signal must rely on being carried to the door lock another way.

Attenuation worksheet

Using the worksheet, we can see the reliable signal distance.

Controller (★) to door lock (A)

Obstacle	Distance	Type	Attenuation	New Distance
No 1	30m	Inner wall	40%	18m
		Take value to next step		
No 2	18m	Outer wall	60%	7.2m
		Take value to next step		
No 3	7.2m	Foil insulation	90%	.72m
		Take value to next step		
	.72m			

There is very little communication between the CLIQ and the door lock with this amount of attenuation. At this point, the door lock must be within .72m (2.36 ft) of the controller to receive signal.

Note: The door lock must be paired within a few feet of the CLIQ controller, and then placed in its final location.

Controller to B and then A: The Controller (★) sends a signal to the outlet (B) 10ft away, and then the outlet sends a signal through the inner wall to the door lock (A) 5 ft away. This route is further, but it is viable because the signal only passes through an interior wall.

Attenuation worksheet

Using the worksheet, we can see the reliable signal distance.

Controller (★) to the outlet (B) and then to the door lock (A)

Obstacle	Distance	Type	Attenuation	New Distance
No 1	30m	Open air	0%	30m
		Take value to next step		
No 2	30m	Inner wall	40%	18m
		Take value to next step		
	18m			

The controller can reliably talk to the door lock with this amount of attenuation for up to 59 ft. At about 15 feet between the controller to the outlet and the outlet to the door, there is enough signal for reliable communication.

Controller to E: The Controller (★) to the switch (E) is not a variable route. It is 38 ft away from the controller, passes through a glass door (C), and then the signal is blocked by a metal refrigerator. The switch will not communicate directly with the CLIQ controller.

Attenuation worksheet

Using the worksheet, we can see the reliable signal distance.

Controller (★) to the switch (E)

Obstacle	Distance	Type	Attenuation	New Distance
No 1	30m	Glass door air	10%	27m
		Take value to next step		
No 2	27m	Refrigerator	100%	0m
		Take value to next step		
	0m			

There is no communication between the CLIQ and the switch with this amount of attenuation.

Controller to D and then to E: The Controller (★) sends a signal through the glass door (C), and then to the dimmer (D) 30 ft away. From here, the dimmer sends the signal to the Switch (E) 10 ft away. The distance is greater, but no metal or high signal blocking material lies between the devices and the controller.

Attenuation worksheet

Using the worksheet, we can see the reliable signal distance.

Controller (★) to the dimmer (D) and then to the switch (E)

Obstacle	Distance	Type	Attenuation	New Distance
No 1	30m	Glass door	10%	27m
		Take value to next step		
No 2	27m	Open air	0%	27
		Take value to next step		
	27m			

The controller can reliably talk to the dimmer, which then talks to the switch, within 27m (88.58 ft). The controller is 30 ft from the dimmer, and the dimmer is another 10 ft away from the switch. This is well within the 88 ft reliable signal strength distance.

2. Device types

Controllers

A Z-Wave controller is responsible for including and excluding devices from the Z-Wave network and updating them with the best routes. The term including is also referred to as pairing or adding. Excluding is also referred to as un-pairing or removing. Controllers are either static or portable, and primary or secondary. Controllers can also be scene controllers.

Note: A device being included receives the Network ID from the controller and is assigned a Node ID. The controller stores all of the properties and capabilities of the device. This lets the controller know the device type, what it can do, and how to control it.

- A portable controller is powered by batteries and can move. For example, a remote control.
- A static controller is stationary. For example, a ClareHome CLIQ Controller.
- A primary controller is responsible for assigning the Network ID and Node ID to each new device. The Node IDs are each device's identifiers in the network. In a ClareHome system, the CLIQ is always the primary controller.
- There is only one primary controller in a Z-Wave network, other controllers are secondary controllers. Secondary controllers defer to the primary controller when including devices, but they can generate commands.
- A scene controller cannot include or exclude devices. Instead it works with the primary controller to execute scenes that control devices – for example, a ClareVue 5-Button Keypad. It executes preset scenes from ClareHome, but does not directly send commands to other Z-Wave devices.

Slaves

Any non-controller node on the Z-Wave network is a slave. Instead, the device sends or receives data to and from the controller – for example, a Yale door lock.

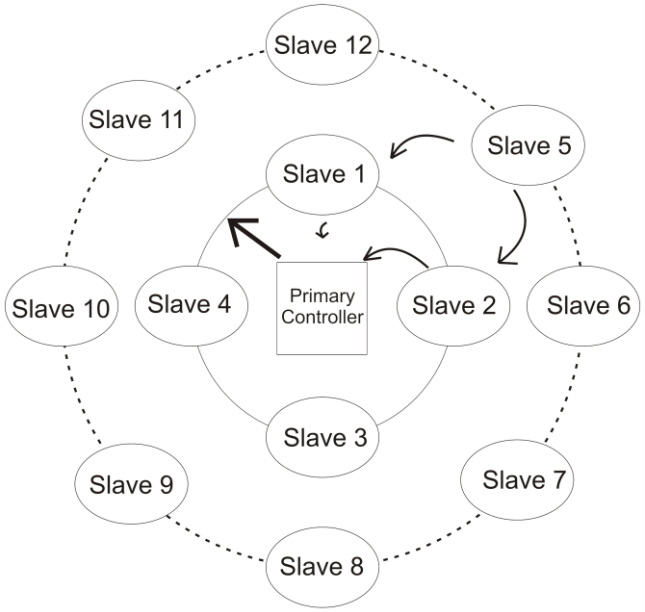
Routing slaves

A Z-Wave routing slave is a slave device that has the ability to relay commands across the network. Routing slaves are critical to the mesh network. For example, a ClareVue accessory or master dimmer.

3. Network Wide Inclusion (NWI)

In order to be included into a Z-Wave network, a device must either be in range of the controller or support Network Wide Inclusion. Network Wide Inclusion relays inclusion data for a device through one or more routing slaves in the Z-Wave network, if the device being included is out of range of the controller.

Figure 6: Network Wide Inclusion diagram



In Figure 6, the controller connects to the inner circle of devices because they are in this initial range. The outer circle of devices is too far from the controller to receive direct communication. Slave 5 is the first device added to the outer circle. Slave 5 is not in range of the controller, but it is in range of Slave 1 and 2. Both slaves 1 and 2 support NWI and can relay the data to the ClareHome controller.

Note: If slaves 1, 2, or 5 did not support NWI, the inclusion would fail.

4. Secure Z-Wave devices

All Z-Wave devices use data encryption by default. However, devices classified as Secure Z-Wave devices operate using the more secure 128-bit Advanced Encryption Standard (AES-128). This encryption cannot be used until the pairing process is completed. To continue to provide greater security, Secure Z-Wave devices use a low-power inclusion (transmission) mode, requiring them to be included within six feet of the controller. Examples of Secure Z-Wave devices are a Linear garage door controller and Schlage door lock.

5. Battery powered devices

Battery powered Z-Wave devices have three possible modes they can operate in to reduce power consumption and expand operating life. Battery-powered Z-Wave devices do not relay (route) data in a Z-Wave network. This would result in frequent battery changing. Z-Wave devices not powered by batteries are referred to as mains powered devices.

Manual wakeup

These devices only wake-up when used and only communicate with the controller while being used. They have the longest battery life. For example, a remote control.

Wake-Up Interval (Interval Reception Mode)

Devices operating in Interval Reception Mode sleep for a specified period, varied by device, and process new commands when they wake-up or when they detect they need to send data to the controller. Typically the interval is several minutes to a few days. For example, a water sensor and freeze alarm.

Interval Reception Mode conserves battery life in devices that do not need to be controlled. The Clare Controls Water Sensor and Freeze Alarm operates in Z-Wave Interval Reception mode because it does not need to receive data, only send data to the controller.

Frequently Listening Routing Slaves (FLiRS)

Frequently Listening Routing Slaves (FLiRS) are similar to Wake-Up Interval devices, but wake-up every second or 250 ms to process commands. To ensure a command is received by a FLiRS device in this short period, it must be preceded by a wake-up beam. Devices that can create this wake-up beam are considered capable of **beaming**. A good Z-Wave network design ensures a beaming Z-Wave device is always near a FLiRS device. All ClareHome supported door locks are FLiRS devices. All ClareVue dimmers, switches, modules, and receptacles support beaming.

6. Z-Wave associations

Z-Wave devices can create associations so that when an action happens to one device, it triggers another device. This must first be configured in the controller, but is then capable of network independent performance. This is important in three-way Z-Wave lighting solutions. An association must be created between a master switch and accessory switch (or a master dimmer and accessory dimmer). For example, a water sensor and water valve: when the sensor detects water, close the valve.

Table 3: ClareHome supported Z-Wave devices and key specifications

Devices	Part Numbers	Routes Data (Relays)	NWI	Reception Mode	Secure Z-Wave	Supports Beaming
Clare Controls Z-Wave Repeater	CH-Z-RPTR	Yes	No	Always On	No	Yes
Clare Controls Z-Wave Thermostat – Humidistat	CH-THSTAT-Z	Yes	Yes	Always On	No	Yes
Clare Controls Water Sensor and Freeze Alarm	CH-WWA-02-W	No	No	Interval	No	No
Clare Controls Water Valve	CH-WV01-X-LF	Yes	Yes	Always On	No	Yes
ClareVue Lighting 5-Scene Keypad	CL-5KP-X	No	No	Always On	No	No
ClareVue Lighting Appliance Module	CL-APS-10	Yes	Yes	Always On	No	Yes
ClareVue Lighting Dimmer Module	CL-LDM-10	Yes	Yes	Always On	No	Yes
ClareVue Lighting Accessory Neutral Dimmer	CL-AND-X	Yes	Yes	Always On	No	Yes
ClareVue Lighting Accessory Neutral Switch	CL-ANS-X	Yes	Yes	Always On	No	Yes
ClareVue Lighting Master Incandescent Dimmer	CL-MDI-X	Yes	Yes	Always On	No	Yes
ClareVue Lighting Master Neutral Dimmer	CL-MND-X	Yes	Yes	Always On	No	Yes
ClareVue Lighting Master Neutral Switch	CL-MNS-X	Yes	Yes	Always On	No	Yes
ClareVue Lighting Tamper Resistant Receptacle	CL-TRR-X	Yes	Yes	Always On	No	Yes
Honeywell Vision PRO Touchscreen Thermostat	TH8320ZW	Yes	Yes	Always On	No	Yes
Fibaro Door/Window Sensors	FGK-101, 102, 103, 104, 105, 106, 107	Yes	Yes	Always On	No	Yes
Fibaro Flood Detection Sensor	FGFS-101	Yes	Yes	Always On	No	Yes

Devices	Part Numbers	Routes Data (Relays)	NWI	Reception Mode	Secure Z-Wave	Supports Beaming
Fibaro Motion Detection Sensor	FGMS-001	Yes	Yes	Always On	No	Yes
Kwikset SmartCode Deadbolt/Lever with Home Connect	910, 912, 914, 916	No	No	FLiRS	Yes	No
Linear Z-Wave Garage Door Opener Remote Controller Accessory	GD00Z-4	No	No	Always On	Yes	Yes
Schlage Automated Door Locks	BE369, BE468, BE469, FE599	No	No	FLiRS	Yes	No
Yale Deadbolts	YRD-110, 120, 220, 240	No	No	FLiRS	Yes	No

Notes

- Always read the Clare Controls integration note for any device with which you are not familiar.
- An X in a part number indicates that any value of that part number is supported.

7. Z-Wave network design

Figure 7: Example of a small Z-Wave network in a home

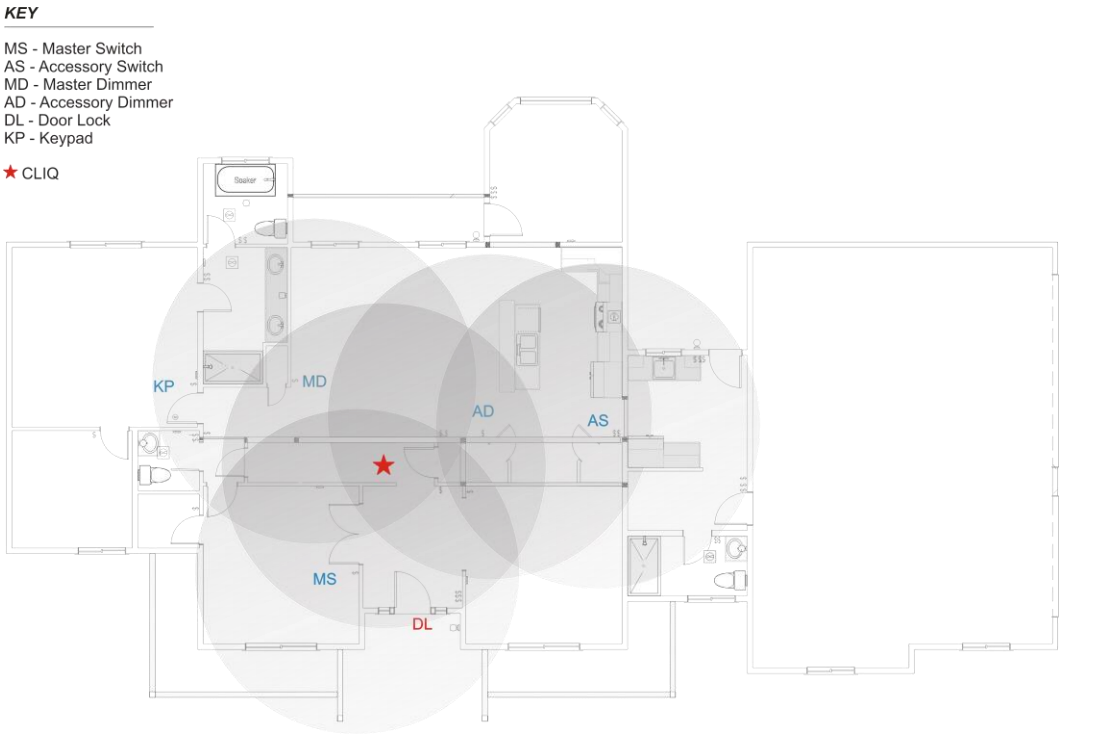


Figure 7 is a floor plan of a home with several Z-Wave devices to be included in the network.

In analyzing the floor plan, a central location that is ideal to locate the controller is indicated with the star (★). Most ClareVue devices are installed before the CLIQ in a new home construction. If this was a retrofit, the order would not matter. Ensure the master devices work with their lighting loads to verify correct wiring, and verify that the thermostat is functioning properly. Do this before inclusion to save time.

Next, the controller would be installed, away from metal or using the Z-Wave antenna extender cable to move the antenna away from metal.

Notes

- The controller also counts as a device in the network and has a Node ID.
- ClareVue devices should using the ClareHome or Clare Install Assist apps. App addition is fast and simple.
- All ClareVue switches and dimmers should be paired from the final location in the walls.
- Keypads must be included within range of the controller, and then installed.
- Door locks are Secure Z-Wave devices and must be paired within six feet of the controller.
- As noted in Table , the ClareVue keypad does not support Network Wide Inclusion. Therefore, the keypad needs to be included within the range of the controller. The ClareVue keypad does not route commands

Inclusion begins using either the master dimmer, master switch, or accessory dimmer. Figure 7 displays the range, indicated by the grey circles, of the controller, devices.

Next the accessory switch is included (because it is the next closest, full-featured, mains powered device), and then the door lock (because it is a battery-powered, Secure Z-Wave device). After each device is included, install it in its final location.

After the door lock, include the keypad in range of the controller before installation.

8. Z-Wave troubleshooting and maintenance

Adding a ClareVue device after installation

To add another ClareVue device, simply access the ClareHome or Install Assist apps, and then proceed as normal.

Adding a Z-Wave device after installation

To add another non-ClareVue Z-Wave device, launch the ClareHome or Clare Controls Install Assist app and access the device addition section.

Removing a failed Z-Wave device

When a Z-Wave device is failed, it can only be removed.

To exclude (remove) the device using the Clare Controls apps:

1. Access the Clare Controls Install Assist app, and then tap **Add Devices**.

   – or –

   Access the ClareHome menu, and then tap **Add/Edit Devices**.
2. Tap the Z-Wave device's category, and then tap the 3 dots next to the desired device.
3. Tap **Remove**.

   The device is removed from the project.

The device is not responsive or appears offline

Common reasons:

1. The ClareHome controller is offline. Check if other devices can be controlled. If yes, then see option 2 or 3 below. If not, call Technical Support.
2. The device is out of range. Make sure to follow the earlier installation best practices. Check that the device is not near any large metal objects or that an object was not moved between the device and the controller. This could be furniture, electronics, mirrors, fish tanks, etc.
3. The batteries need to be changed. Some devices, have two sets of batteries. A door lock, for example, may use one set for the keypad, and another set for the Z-Wave antenna.
4. If it is a Secure Z-Wave device, it may not have paired all of its functions correctly. This is likely because it was moved shortly after the pairing process was performed. Exclude it and include it again. Over time, you will learn the pattern of child devices for each device you use.
5. If it is an Accessory ClareVue device, it may not have an association created. Check the association in the ClareHome or Clare Controls Install Assist app.

The device will not include

When a device will not include from the apps, follow the below steps below:

1. The device may be out of range. Make sure to follow the earlier installation best practices. Check that the device is not near large metal objects or that an object was placed between the device and the controller. This includes furniture, electronics, fish tanks, etc.
2. The device may not have been excluded from a previous controller. Place the ClareHome controller in Removing Mode and follow the device's instruction for exclusion. This process is completed when the controller switches itself from Removing Mode to Normal Mode. Include the device again.
3. The batteries need to be changed. Some devices, have two sets of batteries. For example, a door lock may use one set for the keypad, and another set for the Z-Wave antenna.
4. Older models of Schlage door locks require a Factory Reset. Refer to the device's installation instructions.

Contact information

Clare Controls, LLC.
7519 Pennsylvania Ave, Suite 104
Sarasota, FL 34243

General: 941.328.3991
Fax: 941.870.9646
www.clarecontrols.com

Integrator/Dealer Support: 941.404.1072
claresupport@clarecontrols.com

Homeowner Support (ClareCare): 941.315.2273 (CARE)
help@clarecontrols.com