

# Zigbee Range Test user manual

## Introduction

The Enphase Zigbee Range Test allows installers to test the quality of Zigbee RF link between any two locations. If conducted in advance of installing the actual Enphase Energy System equipment, it can ensure that the Zigbee network is properly formed when the equipment is installed and has an acceptable RF link quality. If the Range Test finds that the quality of RF link with selected equipment locations is not sufficient, it prompts the user to rerun the test with a Zigbee Wireless Range Extender (ZWRE). It is a simple procedure which is guided by the Enphase Installer App step by step. An alternative range extension method based on Wired USB Extender (WUE) is also described in the user guide.

This user guide should be read along with the following supporting documents:

- [Designing an Enphase Zigbee network tech brief](#)
- [Zigbee range extension FAQ](#)
- [Zigbee Wireless Range Extender data sheet](#)
- [Zigbee Wireless Range Extender installation guide](#)
- [Zigbee Wired USB Extender installation guide](#)

The North American version of Zigbee Wireless Range Extender can be purchased [here](#).

The user guide is organized as follows:

Section I: Ordering & assembling Range Test nodes

Section II: Preparing for Range Test

Section III: Conducting Range Test

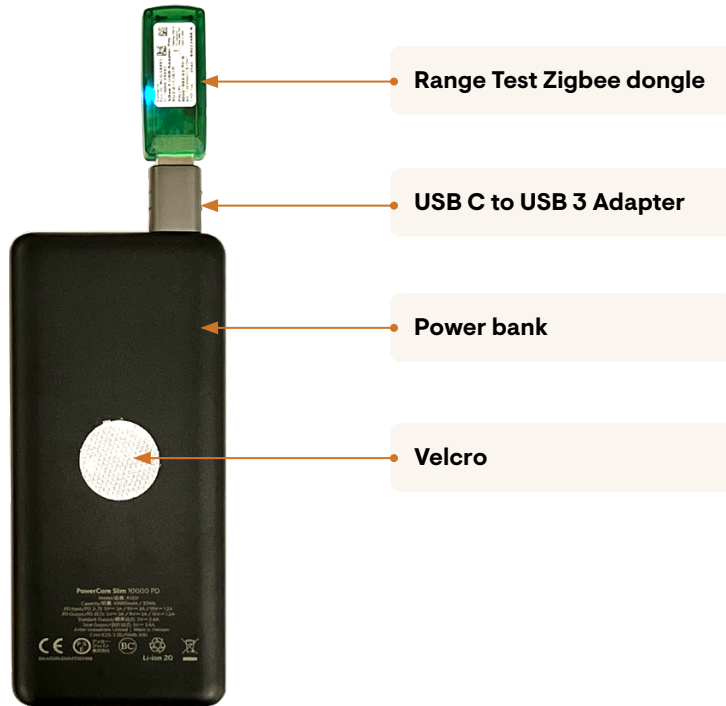
Section IV: Range Test pass criteria

Section V: Selecting the right Range Extender

Section VI: Conclusions

# Section I: Ordering and assembling Range Test nodes

Two Range Test nodes are required to conduct a Range Test. An assembled Range Test node is shown below:



## Range Test Zigbee Dongle:

The NA version of Range Test Zigbee dongle can be bought from Enphase Store: [Comms-kit-01](#). For EMEA, use COMMS-KIT-EU-01. Open the Communications kit enclosure to extract the Range Test Zigbee dongle. The barcode on the Communications kit should be peeled off and placed on the Range Test Zigbee dongle. One Communications kit each is required for each of the two nodes.



### USB Adapter, power bank, and Velcro:

Here are the links and quantities needed for two nodes:

[USB C to USB 3 Adapter](#): Quantity - 1 (there are two adapters in the package)

[Power bank](#): Quantity - 2

[Velcro](#): Quantity - 1 sheet

### Range Test node assembly:

Charge the power bank overnight in case it has low charge. Insert the USB C to USB 3 adapter in the USB C power port of the power bank. Insert the Zigbee dongle at the other end of the USB adapter. The blue light in the Zigbee dongle should light up and stay “ON”. Attach Velcro hook to the rear side of the power bank.

## Section II: Preparing for Range Test

At the site, determine the best location for IQ Gateway (either standalone or inside IQ combiner), IQ System Controller, and IQ Batteries. For good RF quality without range extension, it is recommended that all equipment be installed 40 feet within line of sight.

At the selected locations for equipment, stick a Velcro loop on the wall as shown in the figure below. Range Test node can be attached to the Velcro loop. Please ensure that the Velcro loop is not attached on the surface of an existing metal enclosure as presence of a metal backplane can affect the Range Test results.

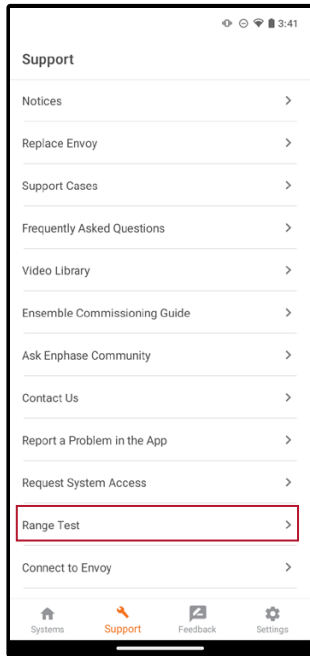


Stick Velcro on wall  
at equipment location

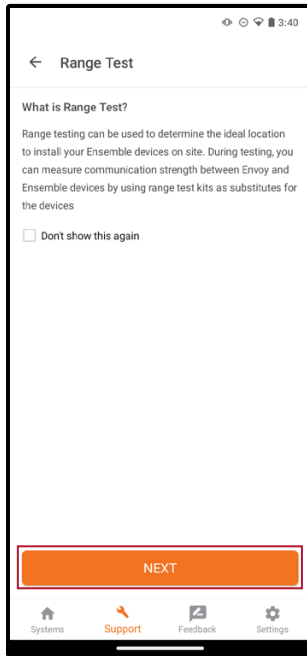


Attach Range Test node  
on wall

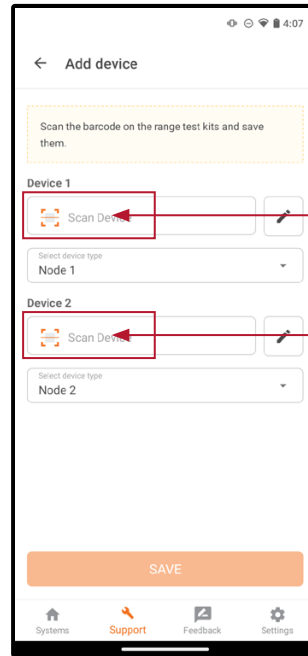
# Section III: Conducting Range Test



Select Range Test

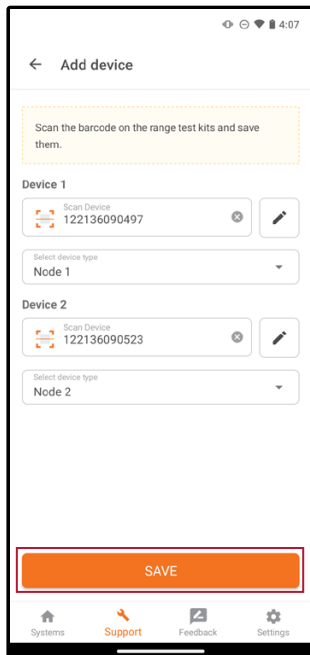


Begin Range Test

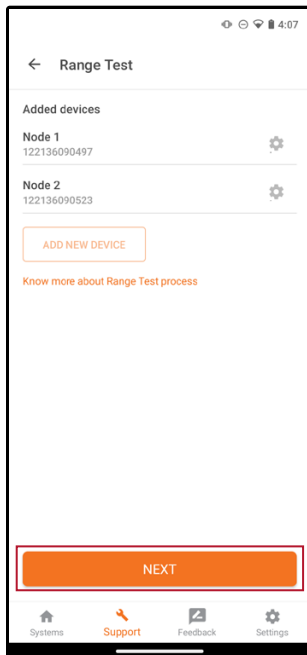


Scan Barcode. Mark respective node # on dongles for future use

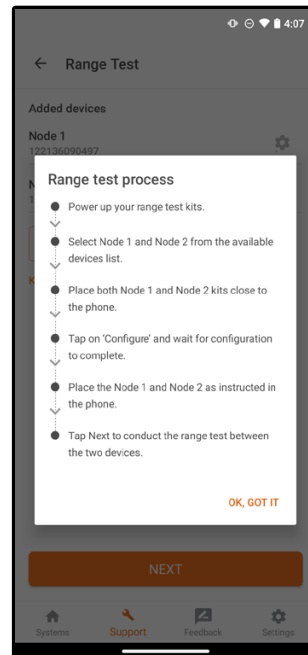
Scan Range Test dongles



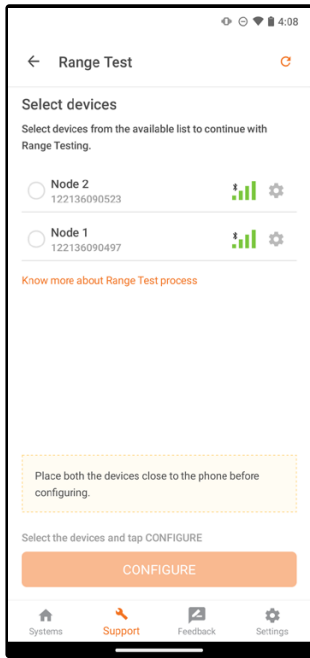
Save test dongle serial #'s in Installer App and assign to the two nodes respectively



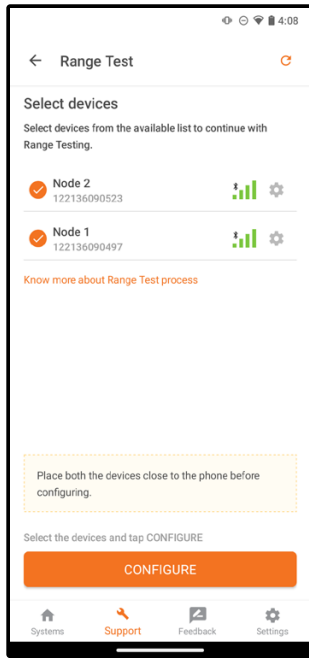
Go to next step



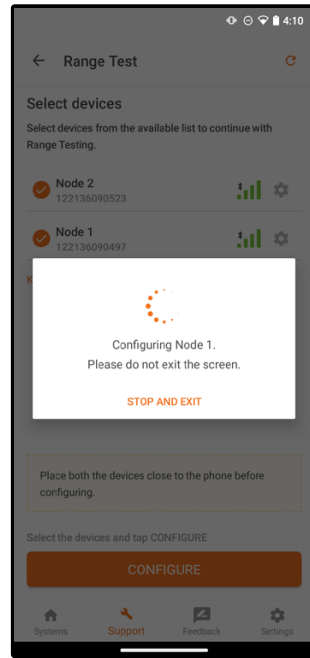
Overview of Range Test process



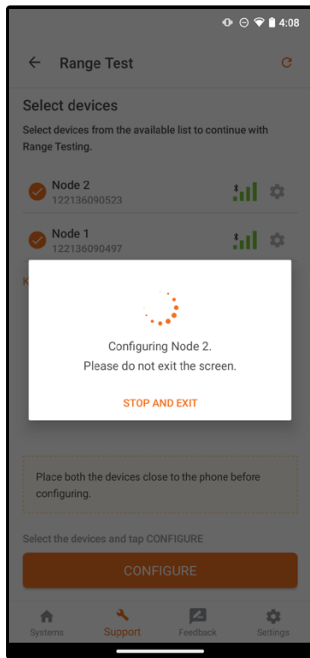
Begin comm between  
dongles and phone  
over Bluetooth



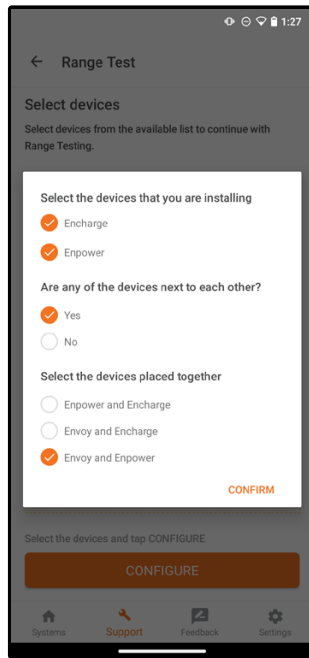
Begin configuration of  
nodes 1 and 2



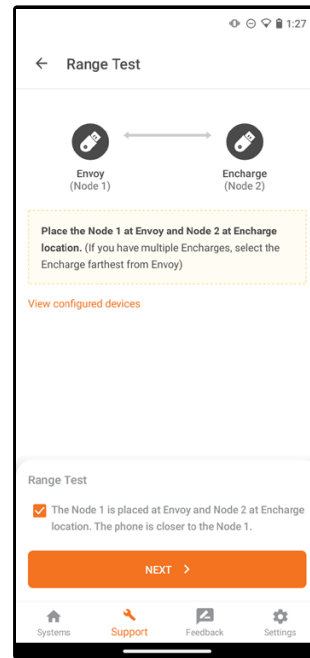
Node 1 being configured



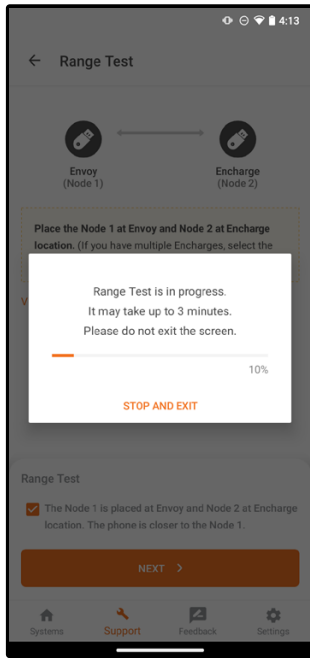
Node 2 being configured



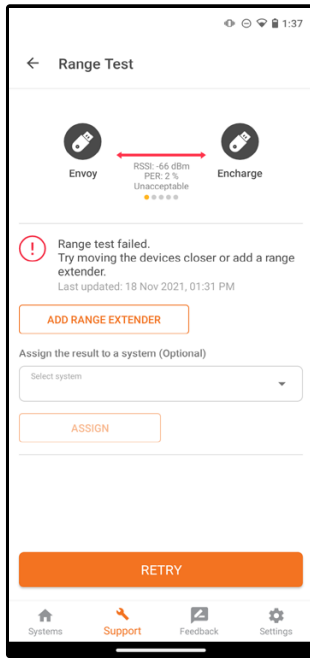
Select options based on  
site specifics



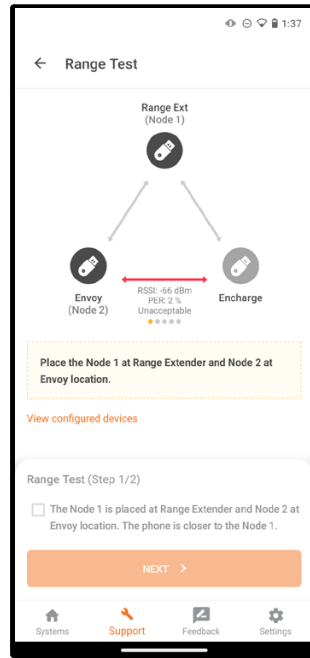
Begin Range Test



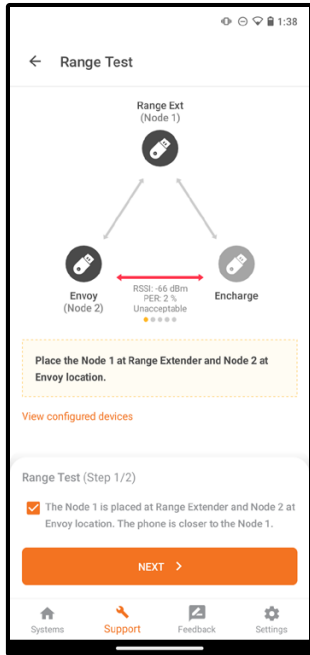
Range Test ongoing



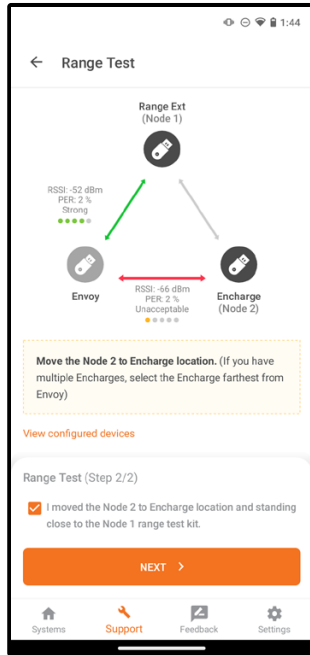
Range Test failed. Retry if test results marginal, otherwise go to next step with ZWRE



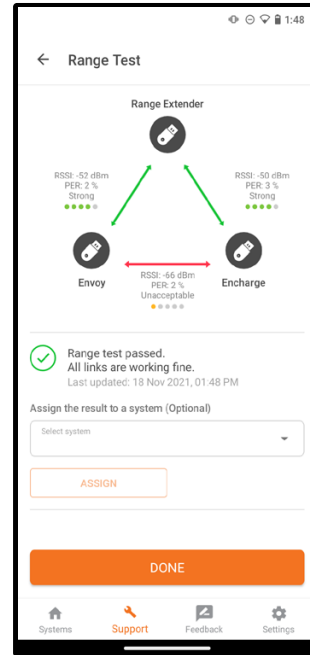
Find location of ZWRE



Place node 1 at ZWRE location and node 2 at IQ Gateway location



Run Range Test between ZWRE and IQ Gateway



Run Range Test between ZWRE and IQ Battery. If test fails consider a different ZWRE location, or a Wired USB Extender

## Section IV: Range Test pass criteria

Range Test measures Zigbee RF quality using two metrics. Received Signal Strength Indicator (RSSI) and Packet Error Rate (PER). The Transmitter (TX) in each Zigbee device has an ability to transmit RF power at +19dBm or 79mW in North America and +8dBm or 6.3mW in Europe. All devices have a Receiver (RX) sensitivity of -102dBm. The total RF budget is the difference in TX power and RX sensitivity.

RF signals attenuate as one goes further from the TX location or if there are any kind of obstruction between the TX and RX. Besides distance and obstructions, there are other sources of errors that affect RF link quality. This includes noise and interference from any transmitter that is emitting RF power close to the same frequency band, people walking by or obstructing objects such as cars, environmental conditions, as well as multipath effects.

To account for these sources of errors, the Range Test pass/fail criteria is more stringent than implied by the RX sensitivity of -102dBm. The table below shows the criteria used for passing/failing Range Test.

ITK DISPLAY	RSSI THRESHOLD	PER THRESHOLD	RANGE TEST PASS/FAIL
Excellent	<b>-50dBm</b>	<b>1%</b>	<b>Pass</b>
Strong	<b>-55dBm</b>	<b>2%</b>	<b>Pass</b>
Average	<b>-60dBm</b>	<b>3%</b>	<b>Pass</b>
Weak	<b>-65dBm</b>	<b>4%</b>	<b>Fail</b>
Unacceptable	<b>&lt; -65dBm</b>	<b>&gt; 4%</b>	<b>Fail</b>

## Section V: Selecting the right Range Extender

Range extension is recommended whenever the Range Test fails. It is very important to select the right Range Extender based on the results of Range Test and specific details of location of equipment at a site. Enphase has considered two types of range extension.

Zigbee Wireless Range Extender (ZWRE)

Wired USB Extender (WUE)

The ZWRE works as a repeater and provides a path for a “hop” between the equipment. Since the “hop” can reduce the effective distance between Zigbee nodes by a factor of 2, ZWRE can be expected to have a theoretical RSSI improvement of ~6dBm. More than one ZWREs is not recommended as there is diminishing return in tradeoff between RSSI improvement and increase in latency.

The ZWRE can also be very effective if the direct path between Zigbee nodes has obstructions such as walls, but the ZWRE can provide an alternative path without these obstructions. One example could be sites where the equipment is located on perpendicular walls and do not have line of sight. In these cases, if an appropriate location of ZWRE can be found, then the ZWRE can have a direct line of sight with all the equipment, thereby providing a “hop” with a significantly better RF link quality.

In sites where the IQ Gateway is located far from the IQ Batteries and IQ System Controller, the WUE can be very effective. In WUE, a USB over ethernet receive/transmit pair is used to relocate the Communications kit close to location of IQ Batteries.

The following steps are recommended during Range Test:

Step 1: Perform Range Test during planning/design phase or before installation. If all the equipment is co-located and is within line of sight, range extension is not needed.

Step 2: If Step 1 fails, continue Range Test to check suitability of ZWRE.

Step 3: If Step 2 fails, repeat Range Test to check suitability of WUE. Use of WUE is recommended if the IQ System Controller and the IQ Batteries are co-located and the IQ Gateway is far from them.

Step 4: If Steps 1-3 fail, choose a different equipment location and repeat Range Test

## Section VI: Conclusions

Enphase Energy System communication between the IQ Gateway, IQ System Controller, and IQ Batteries is based on a high performing Zigbee mesh network. However often extraneous factors such as environmental conditions, other sources of RF noise and changes in sites conditions due to human or vehicular movements are not considered.

The Enphase Range Test provides a tool to installers to ensure that equipment is installed with the right method of range extension while accounting for unpredictable site conditions. By ensuring adequate RF link quality, a robust RF network will be formed under all conditions.