HOBO Data Nodes: Advanced Technology for Wireless Energy and Environmental Monitoring

HOBO® data nodes are portable devices that record and transmit measurements wirelessly to a computer for real-time energy and indoor environmental monitoring.

Different from standalone data loggers that require manual offloading, HOBO data nodes work together in a self-healing wireless network to send logged data automatically to your computer at regular intervals. HOBO data nodes combine the portability and reliability of traditional HOBO data loggers with the flexibility of wireless technology; they are loggers and data transmitters all in one.

With HOBO data nodes, you can:

- Set up a network of up to 100 nodes in a variety of indoor monitoring applications.

- Measure temperature, relative humidity, AC voltage, AC amperage, kilowatts, kilowatt hours, gauge pressure, and more with Onset-provided sensors, or use your own third-party sensors.

- Configure alarms for both the network and individual sensors.

- View data and plots in real time using HOBOnode Manager, part of HOBOware® data logging software.

- Export logged data for additional analysis, plotting, and reporting.

- Increase data collection efficiency while reducing the costs and inconvenience associated with manual data offload.

Inside the technology

HOBO data nodes use the IEEE 802.15.4 protocol, a type of wireless technology that offers constant low-cost, low-power communication between devices, and most importantly, leverages mesh network topology. There are three components to this network.

- **HOBO data receiver.** The receiver serves as the communication hub for the network. It receives incoming logged sensor data gathered from the nodes in the network and transfers that data to the computer via USB cable. Acting as a bridge between the network and the monitoring software, the receiver also stores network information and sends commands to nodes as needed. Every HOBO data node network must have a receiver.

- **HOBO data node**. A data node records data measured by internal and external sensors on multiple channels. When a data node is powered by an AC adapter with backup batteries, it functions as a dual-purpose data/router node. If it is running on battery power only, then it has no routing capabilities.

- **HOBO data router.** A router is a node that provides connectivity to the other nodes, ensuring that the data recorded by sensors finds its way to the receiver. Routers serve as traffic directors in the mesh network; they determine the best path to deliver the sensor data to the receiver and can step in for each other if one should fail. There are two types of routers: standalone routers that only transfer data and dual-purpose data/router nodes that transfer data and also have the ability to record measurements.

HOBO data nodes communicate with each other via a 2.4 GHz radio frequency (RF) spectrum at a rate of up to 250 kbit/s. In a data node network, data nodes record packets of data, which are delivered across a spectrum of RF channels using routers. The routers relay data to a

radio housed within the receiver. The incoming data packets are then offloaded automatically via USB connection from the receiver to the computer for storage.

The power of a mesh network

Because the HOBO data node network supports the IEEE 802.15.4 wireless protocol, it uses mesh network topology. In a mesh network, router nodes are scattered throughout the network for continuous communication. This results in greater reliability and range than other types of networks, and provides redundancy, which means if one router becomes temporarily disabled due to a lack of power or a physical obstruction, another router can take its place.

This is very different from other devices that use IEEE 802.11b/g wireless protocols. Those devices typically use either a star or tree network topology, which can be less reliable. In a star network, all nodes are connected to one central hub like spokes on a wheel. If the central hub fails, then none of the data from the nodes will be transmitted. There are no other routers to step in. A tree network offers slightly more reliability because it can support routers. However, all nodes in this type of network are connected along "branches" of the tree and back to a main hub. If a router on one branch is disabled, the data at the end of that branch cannot be relayed to the hub because the data has only one path, or branch, to follow.

The self-healing capability of a mesh network with multiple dispersed routers is one of the primary benefits of the IEEE 802.15.4 wireless protocol. The HOBO data node network can dynamically rearrange itself if one router should fail, ensuring that critical data from a data node will always find a way to get to the receiver simply by following a different path.

Benefits of HOBO Data Nodes

There are several other key features in a HOBO data node network.

- Like standalone HOBO data loggers, HOBO data nodes use EEPROM, which is non-volatile memory that can retain data during a loss of power. While it is generally recommended that data nodes remain powered by an AC adapter, they also may have batteries installed for back-up purposes or when they are not being used as routers. If the batteries were to run out, 128K of data will be stored in EEPROM and available once power is restored.

- You can easily reconfigure the network, adding or removing nodes as necessary. The network can be modified to include additional sensors as your energy and environmental monitoring needs change. You can also add more routers or add routing capabilities to existing nodes to further increase data transfer reliability when signal strength is not at optimal levels or if obstructions interfere with data transmission.

- Internal buttons make HOBO data nodes virtually tamper-proof. There are no external buttons or switches that could be inadvertently pressed on nodes deployed in public locations.

- Compact HOBO data nodes have internal antennas. Wireless sensors often have external antennas, restricting deployment and mounting options. Radio modules and antennas are housed within HOBO data nodes, making it easier to deploy these nodes in numerous applications.

Advanced software for data management

While HOBO data nodes communicate wirelessly with each other, all measurement data ultimately is transferred from the receiver to the computer via USB connection and available for viewing and analysis in HOBOnode Manager.

HOBOnode Manager is integrated within HOBOware® data logging software. It is a full-featured data management tool that allows you to easily set up and monitor your HOBO data node network.

The first time you connect the receiver to the computer, HOBOnode Manager will automatically detect the

receiver and then prompt you to form the rest of your network. The receiver will search for any available nodes and let them join the network one at a time. After the network is formed, you can then configure any external sensors for each node. Data logging begins automatically by default as nodes are launched upon detection. Measurements then stream into HOBOnode Manager at regular intervals. Because HOBOnode Manager maintains a live connection to the receiver, data can continue to be downloaded to the computer even if you close the software.

HOBOnode Manager provides many tools for managing the network and organizing and viewing data. You can use the software to:

- Set up a map of deployed data nodes. Using a blank HOBOnode canvas or your own custom image, such as the blueprint of your building, you can create a visual representation of all the data nodes and their network connections for quick reference.

- Monitor data live as it is downloaded by the receiver. You can check current data in a sortable table or plot data for viewing in real-time graphs.

- Configure both sensor and system alarms. With sensor alarms, you can set an alarm to trip when a sensor reading is outside a specified range (such as below 32°F). You can then receive an email or text message when an alarm trips, or set an audible or visual notification to occur on your computer. For system alarms, you can poll data nodes by sending a "heartbeat" to confirm the network is still operational. You can also set up the system to notify you when a data node goes missing.

- Label and group data nodes for easy identification. For example, let's say you are deploying 30 data nodes in a three-story office building, with 10 data nodes on each floor. You might label, or name, each data node by its location, such as "Floor 1 Utility Closet" or "Top Floor Copy Room." You could

then create three groups in HOBOnode Manager, one for each floor, allowing you to work with data grouped in a meaningful category. In this example, you could view data for all nodes in the "First Floor" group, and then compare it to data from the "Second Floor" or the "Third Floor" group.

- View logged data by exporting measurements to a Microsoft® Excel® or text file for further analysis. Or, plot data directly into HOBOware where you can create custom graphs. You can export or plot data in many ways: by date or time (for example, all data recorded in a single day or hour), by sensor (such as, all temperature readings), or even by group (all data from the "First Floor" in the previous example). Plus, you can save your settings if you want to quickly export the same type of data again.

Data nodes vs. data loggers: which is right for you?

HOBO data nodes offer many advantages, but they are not suited for every application and may not be a good substitute for traditional loggers in certain circumstances. The following questions may help you determine which device is right for your application:

1. Is this a longer term or permanent installation? HOBO data nodes are generally best suited for longer term and/or continuous monitoring applications, such as making sure a warehouse is kept at a certain temperature or monitoring the air quality in your building. If you only need to collect data from a very short time period, standalone data loggers may be a better solution.

2. Will you be deploying loggers in a physically large site? If you will be monitoring data in a space that covers a significant amount of area, vertically and/or horizontally, then the HOBO data nodes can save you a substantial amount of time normally spent downloading loggers manually. For example, if you are measuring kilowatt usage in a 10-story building, data from the entire building is downloaded automatically so that you don't have to

walk to each logger and manually retrieve data. Conversely, if you are monitoring a 500 square foot office, it may be easier to use one or two traditional loggers and download them as needed.

3. Do you have the resources to set up and maintain the network? HOBO data nodes have been carefully designed to make network setup as streamlined as possible. But the nature of a wireless system requires some unavoidable site work. Specifically, you will need to:

   – Estimate the distance between nodes to ensure they are within 300 feet (91 meters) of each other.

   – Place routers to compensate for any physical obstructions that could interfere with data transmission, and make sure routers are situated near electrical outlets.

   – Set up a computer where the receiver can remain connected and continuously transfer data via USB cable (minimum computer requirements are listed in the Frequently Asked Questions section).

   If you do not have the resources to set up and maintain the network on an ongoing basis, then you might consider using traditional data loggers instead.

4. Will you need to set up alarms for sensor readings? HOBO data nodes have built-in alarm functionality. Through HOBOnode Manager, you can configure an alarm to trip when a sensor meets certain thresholds that you specify. You can set up the alarm to sound on your computer, display a message on the computer, or send an email or text message. Plus, you can use system alarms to ensure the entire HOBO data node network is operational and that no data nodes have gone missing. While standalone data loggers do have some alarm capabilities, the ability to monitor an entire network is unique to data nodes.

5. How will you be using the logged data? HOBO data nodes offer real-time data, making them ideal for applications where you want to check conditions in your environment at any moment. Traditional data

loggers may be better suited for applications that do not require immediate access to data.

Consideration	Data Nodes	Traditional Loggers
Length of deployment	Longer term	Shorter term
Size of building/facility	Large	Small
Personnel to map out and monitor deployment	Yes	No
A computer available for storing incoming data	Yes	No
The ability to permanently install devices in building/facility	Yes	No
Built-in sensor and network alarm capabilities	Yes	Sometimes
Data gathering needs	Real-time/ immediate	Deferred

Common applications

From monitoring environmental conditions in large warehouses to tracking energy consumption in businesses, HOBO data nodes can be used in a variety of applications across a wide range of industries. Here are some common application examples:

- **Storage monitoring.** Ensure the proper temperature is being maintained in food warehouses to prevent spoilage and loss of inventory. Provide continuous environmental monitoring in museums to preserve and protect artifacts.

- **Air quality studies.** Identify and prevent indoor air problems in office buildings, schools, apartment buildings, and more. Check whether your facility is threatened by conditions suitable for mold growth. Monitor heating, cooling, and ventilation systems to make sure they are running efficiently. Determine optimal environmental conditions to address occupant comfort complaints, and

maintain those conditions to make sure employees are comfortable and productive.

- **Building energy/power monitoring.** Monitor the AC Voltage, power demand (kW), and energy consumption (kWh) in your facility to identify peak usage times and areas for energy savings. Conduct energy audits and track energy usage throughout a building or for individual pieces of equipment.

Frequently asked questions

Q. What is involved in setting up a HOBO data node network?

A. To set up a wireless HOBO data node network, you will need to identify where the data nodes and routers are going to be installed, locate any potential obstructions that would interfere with the data nodes "talking" to one another, and compensate for those physical obstructions with routers. Sometimes this will require creativity, such as placing a data node close to the floor to reach a router in the room below it, or finding a location where you can drill through a wall. A HOBOnode setup guide will walk you through the steps of forming a network and making sure the receiver has located each of the data nodes.

Q. Do I need a dedicated computer to operate a data node network?

A. The receiver needs to be connected to a computer running HOBOware/HOBOnode Manager. The receiver transfers any data gathered from the network to the computer via a USB connection. Note: All power saving modes on your computer should be turned off.

The receiver has 3.7 MB of buffer memory. If the computer shuts down or loses power, or if the receiver needs to be unplugged from the computer, the receiver will store any incoming sensor data until its memory is full.

Q. When will I need to use a router?

A. Use a router when the distance between data nodes is approaching 300 feet (91 meters), when there is a physical obstruction that is causing interference in

communication between data nodes, or when a fully powered data node is missing from your network. For example, if you're finding that communications become unreliable for data nodes that are 250 feet (76 meters) apart due to conditions within your facility, but they work well when they are 150 feet (46 meters) apart, then consider adding a router at 200 feet (61 feet).

Q. How many data nodes can a router handle?

A. One router can accommodate and transmit sensor data from 12 data nodes.

Q. Can I add more data nodes or routers to the network once it has been formed and deployed?

A. Yes, you can easily add or remove data nodes and routers at any time.

Q. What happens if the data node signal is temporally blocked and there isn't a router in the network to get the transmission back to the receiver?

A. Each node has an onboard buffer memory of 128K to store sensor data. Once the obstruction is removed, the data node will be able to transmit the collected data to the receiver.

Q. What is an obstruction?

A. An obstruction is any element that interferes with the wireless communication between data nodes. It could be a thick wall, a large piece of equipment, or a metal door. Any time there is not a direct line of sight between data nodes, then that obstruction could interfere with the radio communications between the devices and a router should be installed.

Q. Should I use a standalone router or a dual-purpose data/router node?

A. It depends on whether you want to record sensor data at the exact location where you will be using the router. If you need to gather measurement data at the location, then use a dual-purpose data/router node. If you do not need any measurement data at that location and simply want to relay data from other nodes, then a standalone router will suffice. A data node can easily be converted to a dual-purpose data/router node by

plugging it into an electrical outlet with an AC adapter. Data nodes running on battery power only do not have routing capabilities.

Q. Is there an alarm function available?

A. Yes. Within HOBOware/HOBOnode Manager, there are both system alarms and sensor, or measurement, alarms. The system alarm lets you know when a data node has missed a connection after a specified amount of time and also sends a "heartbeat" confirming the network is still operational. The sensor alarm trips when a sensor goes out of a range that you configure. You can receive notifications via email or text message, or by an audible or visual alarm on the computer.

Q. How long will the batteries last in my sensor node?

A. Battery life varies depending on how frequently it is recording data (logging interval) and how often it sends data to the receiver (connection interval). With a logging interval of 15 minutes and connection interval of 1 hour, battery life is estimated to be 1 year.

Q. Can I use HOBO data nodes in locations where there are other wireless networks?

A. Yes. HOBO data nodes operate on different RF bands than most other wireless networks so there should not be a conflict between the HOBO data node network and existing wireless networks.

About Onset

Onset is the world's leading supplier of data loggers. The company's HOBO data logger and weather station products are used around the world in a broad range of monitoring applications, from verifying the performance of green buildings and renewable energy systems to agricultural and coastal research. Based on Cape Cod, Massachusetts, Onset has sold more than 1.5 million data loggers since the company's founding in 1981.

Onset Computer Corporation
http://www.onsetcomp.com
1-800-564-4377 / 508-759-9500
Fax: 508-759-9100
sales@onsetcomp.com