# Conducting a Site Survey and Interpreting the Results

## Conducting a Site Survey (Gateway and Nodes)

A Site Survey, also known as a Radio Signal Strength Indication (RSSI), analyzes the radio communications link between the Gateway and any Node within the network by analyzing the radio signal strength of received data packets and reporting the number of missed packets that required a retry.

Perform a Site Survey before permanently installing the radio network to ensure reliable communication. Activate Site Survey mode from either the Gateway buttons or the Gateway Modbus holding register 15. Only the Gateway can initiate a Site Survey, and the Site Survey analyzes the radio communications link with one Node at a time.

### Conduct a Site Survey Using the Menu System

Initiate a Site Survey using the Gateway's buttons and menu system.

1. Remove the Gateway's rotary dial access cover.
2. Set the Gateway's rotary dials to the desired Node number.

   For example, to check the status of Node 1, set the Gateway's left rotary dial to 0 and the right rotary dial to 1. To check the status of Node 32, set the Gateway's left rotary dial to 3 and the right rotary dial to 2.

   The Gateway is now enabled to read the status of the selected Node. The display scrolls through the Node's I/O status.
3. Single-click button 1 to scroll across the menu levels until reaching the Site Survey (SITE) menu.
4. Single-click button 2 to enter the Site Survey menu.
5. Single-click button 2 to begin conducting a Site Survey with the Node selected in step 2.
   The Gateway analyzes the quality of the signal from the selected Node by counting the number of data packets it receives from the Node.
6. Examine reception readings (M, R, Y, G) of the Gateway at various locations.

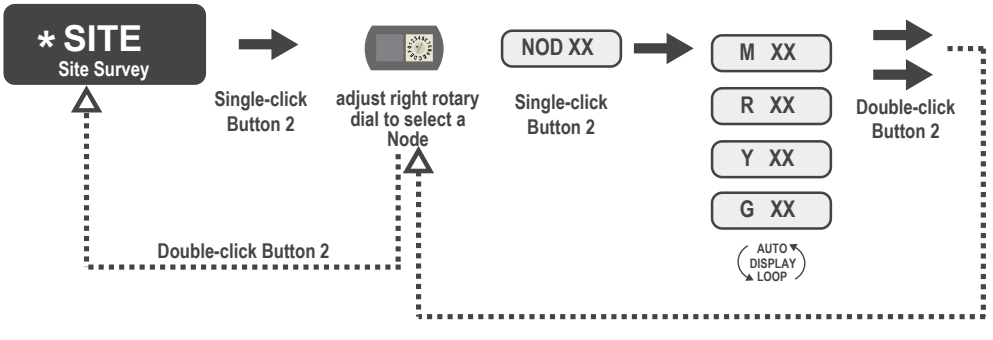
   Site survey results display as a percentage. M represents the percent of missed packets while R, Y, and G represent the percent of received packets at a given signal strength.

   M = Percent of missed packets; R = RED marginal signal; Y = YELLOW good signal; G = GREEN excellent signal. Record the results if you need troubleshooting assistance from the factory.
7. Change the Gateway's rotary dials to conduct a Site Survey with another Node and repeat steps 2 through 6.
8. To end the Site Survey, double-click the Gateway's button 2.
9. Change the Gateway's rotary dials back to 0.
   The LCD displays the device readings for the Gateway.
10. Double-click button 2 to move back to the top level menu.
11. Single-click button 1 to return to RUN mode.
12. Install the rotary dial access cover, referring to the Installation section of the manual to create an IP67 seal.

### SITE (Site Survey) Menu

The **SITE** menu displays the results of a Site Survey conducted with this Gateway.

*SITE menu*




The **SITE** menu displays the device number of the Node the Site Survey was conducted with as well as the missed, green, yellow, and red received packet count. The **SITE** menu is only available on the Gateways. To access the **SITE** menu, single-click button 1 to scroll across the menu levels until reaching the Site Survey (**SITE**) menu.

See "Conduct a Site Survey Using the Menu System" on page 1.

See "Interpreting the Site Survey Results" on page 3.

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# Conduct a Site Survey from a Gateway Board Model

Conducting a Site Survey, also known as an RSSI (Radio Signal Strength Indication), analyzes the radio communications link between the Gateway and any Node within the network by analyzing the radio signal strength of received data packets and reporting the number of missed packets that required a retry.

Perform a Site Survey before permanently installing the radio network to ensure reliable communication. Only the Gateway can initiate a Site Survey, and the Site Survey analyzes the radio communications link with one Node at a time. Follow these steps to conduct a Site Survey from the board module Gateway.

1. Set the Gateway's rotary dials to the Node address you'd like to conduct a Site Survey with.

   For example, to analyze the signal strength between this Gateway and Node 02, rotate the left rotary dial to 0 and the right rotary dial to 2.

   The Site Survey automatically begins running. If there is no device at address 02, the LED is solid red. If there is a device at address 02, the LED flashes amber.
2. Evaluate the signal strength. The amber LED flashes at specific rates to indicate the Site Survey results. Each signal strength represents the majority of the data packets being received at that signal strength. For example, a strong signal strength indicates the majority of the data packets were received at a strong signal, but a few may have been received at a good or weak signal strength.
   - Eight flashes per second: Very strong signal strength
   - Four flashes per second: Strong signal strength
   - Two flashes per second: Good signal strength
   - One flash per second: Weak signal strength
   - Solid amber LED: No radio communication detected
3. To exit the Site Survey, set the Gateway's rotary dials to 00. Otherwise, after 15 minutes the Gateway automatically exits Site Survey mode.
   The LED flashes green to indicate the Gateway is in standard operating mode.

# Conduct a Site Survey Using Modbus Commands

Use Modbus commands sent from the host system to start a Site Survey.

To start a Site Survey using a Modbus write holding register command, send a control code of 32 (0x20) and the Node number 1 through 47 (0x01 to 0x2F) to the Gateway Modbus holding register for I/O 15.

*Modbus commands for I/O 15*

| | Modbus Register | |
|---|---|---|
| | [15:8] | [7:0] |
| I/O 15 | Control Code | Data Field |

*I/O 15 control messages*

| I/O 15 Control Messages | | | |
|---|---|---|---|
| **Control Code** | **Data Field** | **Restrictions** | **Description** |
| 32 | Node # 1–15 | Gateway only | Enable Site Survey between Gateway and Node defined by the data field. All error messages from the Gateway are ignored when running Site Survey.<br>Only one Node can participate in Site Survey at a time. To disable the Site Survey, use control code 0x20 with Node 0. A Node must be enabled to run the Site Survey, then disabled before selecting the next Node. |

## Example Command

*Example Modbus command for I/O 15*

| | Modbus Register | |
|---|---|---|
| I/O 15 | 32 | 02 |

When Site Survey runs, the accumulated results are stored in the Gateway's I/O 7 and I/O 8 holding registers. The LEDs on the both the Gateway and the Node's front panel display the signal strength for the wireless RF link. The quality of the communications link is indicated by:

Green LED = excellent signal strength
Amber LED = good signal strength
Red LED = poor signal strength

The signal strength is the transmitted signal strength relative to the ambient RF signal present in a specific location, or noise floor.

The Gateway also displays the Site Survey results on the LCD (for models with an LCD). For one transmit and receive interval, the Gateway saves the lowest signal strength. The LCD and Modbus registers contain the results of the last 100 samples. The totals are a running tally of the last 100 samples and are continuously updated. Four categories are displayed:

G (green) = excellent signal strength


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Y (yellow) = good signal strength
R (red) = poor signal strength
M = Missed packet

To disable Site Survey, send control code 32 (0x20) and Node number 0 (0x0), which is represented as 8192 (0x2000).

### Site Survey Data Holding

With Site Survey active, registers I/O 7 and 8 are Site Survey data holding registers that store the accumulated Site Survey results. Error collections in holding register 8 are saved when Site Survey runs and restored after Site Survey is disabled.

*Site survey registers and example results*

| | Register | | Example Results | |
|---|---|---|---|---|
| | [15:8] | [7:0] | [15:8] | [7:0] |
| I/O 7 | Red Total | Missed Total | 10 | 0 |
| I/O 8 | Green Total | Yellow Total | 80 | 10 |

**NOTE:** This is the current register arrangement when using Modbus/TCP or Modbus RTU. In some older models, the Modbus/TCP registers are reversed (missed and yellow totals are in [8:15], red and green totals are in [0:7]).

## Conduct a Site Survey from the DXM

Conduct a Site Survey to verify the wireless communication between the radios within your wireless network.

Conduct the site survey when the Nodes and DXM Controller are at the proposed installation sites to determine each radio's signal strength with the DXM.

For a DX80 network, the Gateway controls the site survey and the results display on the LCD. Running a site survey on a DX80 network does not affect the throughput of the DX80 network. The DX80 Gateway-Node system can run a site survey analysis while the network is operational. For a MulitHop network, the client device passes the site survey request to the intended Modbus server device. The Site Survey runs and the results display on the LCD. Running a site survey on a MultiHop network stops all network traffic to that device.

1. On the DXM: Use the arrow buttons to select the **ISM Radio** menu and press **ENTER**.
2. Select the **Site Survey** menu and press **ENTER**.
3. Use the Up or Down arrows to select the device ID number and press **ENTER** to run the site survey with that radio.
   The site survey results display as green, yellow, red, and missed packets. Green indicates the highest signal strength, then yellow, and red. Missed packets were not received.
4. When you are finished running the Site Survey, press **Back** twice to return to the main menu and exit site survey mode.

If the Site Survey fails (100 missed packets), verify the radios are at least 10 feet from the DXM and/or rerun the binding procedure. If you find poor signal quality, common solutions include moving the DXM to a more central location relative to the Nodes or using higher-gain antennas on the DXM. Contact your local Banner Engineering representative for assistance.

## Interpreting the Site Survey Results

Site Survey results are listed as a percentage of data packets received and indicate the signal strength of the received signal.

*Site survey results*

| | Result | Description |
|---|---|---|
|  | Green | Packets received at a strong signal strength. A strong signal strength is greater than −90 dBm at the receiver. |
|  | Yellow | Packets received at a good signal strength. A good signal is between −90 and −100 dBm at the receiver. |
|  | Red | Packets received at a weak signal strength. A weak signal is less than −100 dBm at the receiver. |
|  | Missed | Packets not received on the first transmission and requiring a retry. |

Judging if the reliability of a network's signal meets the needs of the application is not just a matter of green, yellow, and red packets received. In normal operating mode, when data packets are not received, the transmitter re-sends the packet until all data is received.

For slow monitoring applications such as a tank farm, where data is required in terms of seconds or minutes, receiving most of the data in the 'red' range, indicating a weak but reliable signal, transmits enough data for accurate monitoring. Nodes positioned near the outside range of the radio signal may have 90% of the data packets received in the red zone, again indicating a weak, but reliable signal.


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# Improving Your Site Survey Results

Refer to the Sure Cross Installation Guide (p/n 151514) for installation details and tips and tricks for improving your radio network's performance.

If your Site Survey results have more yellow than green, consider replacing the Node's antenna with one the following:

- Use a 2 dBi Omni dome antenna (model BWA-9O2-D) or a 5 dBi Omni antenna (model BWA-9O5-C)
- Use a 6 dBi Yagi (directional) antenna (model BWA-9Y6-A)

If the distance between devices is greater than 5,000 meters (3 miles) line-of-sight or objects, such as trees or man-made obstructions, interfere with the path, and the MISSED packet count exceeds 25 per 100 packets, consider the following steps:

- Install the antenna(s) remotely at a higher position (requires an antenna extension cable);
- Use a higher gain antenna;
- Decrease the distance between devices; or
- Use data radios to extend the position of the Gateway relative to the host system.

# Performance Levels

Referenced omni-directional and directional antennas are listed at the end of this section.

**Very strong signal strength** is 100 green signals (displayed on the LCD) or eight flashes per second (models without LCDs). If the included 2 dBi OMNI antenna does not achieve this signal strength, use a different omni antenna, such as the 2 dBi dome antenna (same gain, different form factor) or 5 dBi antenna (higher gain). You may also use a low-gain directional antenna, such as the 6.5 dBd Yagi antenna.

**Strong signal strength** is represented by some green signals and some yellow signals (very few red signals and very few missed signals) or four flashes per second. To improve your radio performance, consider using a different omni antenna, such as the 2 dBi dome antenna, 5 dBi antenna, 6 dBi antenna, or 8 dBi antenna. You may also use a low-gain directional antenna, such as the 6.5 dBd Yagi antenna. We also recommend installing the antenna(s) remotely at a higher position. Additional antenna cables are available from Banner Engineering if needed.

**Good or weak signal strength** equals some yellow signals and a majority of red signals (very few green signals, a small number of yellow signals, and a small to medium number of missed signals) or one to two flashes per second. To improve your radio performance, consider using one of the 6 dBi or 8 dBi omni-directional antennas or the 10 dBd directional antenna. We also recommend installing the antenna(s) remotely at a higher position. Additional antenna cables are available from Banner Engineering if needed.

**No radio communication** is when more than 50% of the radio signals are missed or a solid amber LED. To improve radio performance, use a 8 dBi omni-direction antenna or a 10 dBd directional antenna and elevate the antenna above any obstructions. The lack of signals may also be due to the distance between the Gateway (parent/client radio) and Nodes (remote radio). If this is the case, please contact Banner Engineering for further assistance. We also recommend installing the antenna(s) remotely at a higher position. Additional antenna cables are available from Banner Engineering if needed.

# Omni-Directional (Omni) Antennas

**BWA-9O2-D** (2 dBi OMNI antenna, dome style)—For applications where a durable antenna is needed external to the radio enclosure.

**BWA-9O5-C** (5 dBi OMNI antenna with RP-SMA connector)—Antenna for medium antenna performance increase or to elevate the antenna above obstacles such as buildings or tall crops. We recommend using one of the following LMR200 extension cables (RP-SMA to RP-SMA):

- BWC-2MRSFRS3 (3 meters long)
- BWC-2MRSFRS6 (6 meters long)
- BWC-2MRSFRS9 (9 meters long)
- BWC-2MRSFRS12 (12 meters long)

**BWA-9O6-AS** (6 dBi OMNI antenna with Type N cable connector)— Antenna for strong antenna performance increase. Requires a RP-SMA to Type N converter cable (BWC-1MRSMN05). May require one of the following antenna extension cables:

- BWC-4MNFN3 (3 meters long)
- BWC-4MNFN6 (6 meters long)
- BWC-4MNFN15 (15 meters long)
- BWC-4MNFN30 (30 meters long)

Requires a surge suppression device (model BWC-PRC827-DC) if the antenna is external to a building, connected to other electronics, or elevated.

**BWA-9O8-AS** (8 dBi OMNI antenna with Type N cable connector)—Antenna for very strong antenna performance increase. Requires a RP-SMA to Type N converter cable (model BWC-1MRSMN05). May require one of the following antenna extension cables:

- BWC-4MNFN3 (3 meters long)
- BWC-4MNFN6 (6 meters long)
- BWC-4MNFN15 (15 meters long)
- BWC-4MNFN30 (30 meters long)

Requires a surge suppression device (model BWC-PRC827-DC) if the antenna is external to a building, connected to other electronics, or elevated.


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# Directional (Yagi) Antennas

**BWA-9Y6-A** (6.5 dBd YAGI antenna with Type N cable connector)—Antenna for strong, directional antenna performance. Requires a RP-SMA to Type N converter cable (model BWC-1MRSMN05). May require one of the following antenna extension cables:

- BWC-4MNFN3 (3 meters long)
- BWC-4MNFN6 (6 meters long)
- BWC-4MNFN15 (15 meters long)
- BWC-4MNFN30 (30 meters long)

Requires a surge suppression device (model BWC-PRC827-DC) if the antenna is external to a building, connected to other electronics, or elevated.

**BWA-9Y10-A** (10 dBd YAGI antenna with Type N cable connector)—Antenna for very strong, directional antenna performance increase. Requires a RP-SMA to Type N converter cable (model BWC-1MRSMN05). May requires one of the following antenna extension cables:

- BWC-4MNFN3 (3 meters long)
- BWC-4MNFN6 (6 meters long)
- BWC-4MNFN15 (15 meters long)
- BWC-4MNFN30 (30 meters long)

Requires a surge suppression device (model BWC-PRC827-DC) if the antenna is external to a building, connected to other electronics, or elevated.


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