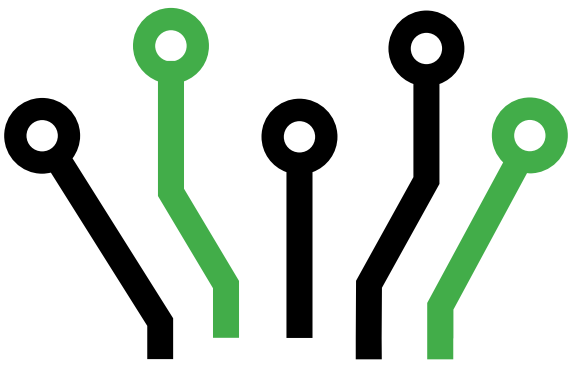
RAW DATA. REFINED RESULTS.

OPERATIONS MANUAL

DATA ACQUISITION

STS4 WIRELESS BASE STATION



Document Revision History

Document	Rev.	Date	ECO	Changes
101061	A	7/2/19	n/a	Initial release document

WARRANTY INFORMATION

BDI warrants its products to be free from defects in materials and workmanship under normal use and service for thirty-six (36) months from date of shipment. This warranty shall be void if any products have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. Batteries have no warranty.

All equipment manufactured by BDI is intended for use by a qualified professional only. Under this warranty BDI's obligation is limited to repairing, or replacing (at BDI's option), of defective products. In no event shall BDI be liable for punitive, exemplary, special, indirect, incidental, or consequential damages and the customer shall assume all costs of removing, reinstalling, and shipping of defective products. EXCEPT AS STATED HEREIN, BDI MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY.

Before returning any product, BDI technical support must be contacted at +1-303-494-3230, or by visiting BDITEST.COM/contact and submitting a request. A technician will help determine the nature of the problem and if it cannot be resolved, authorization will be given to return the item. A return merchandise authorization (RMA) will be sent to the customer to be filled out and shipped back with the equipment. BDI will not accept shipment of any product without prior authorization as provided herein.

Ship all equipment to:

BDI

ATTN: TECHNICAL SUPPORT

740 S PIERCE AVE UNIT 15

LOUISVILLE CO 80027

+1.303.494.3230

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1. INTRODUCTION

Thank you for purchasing the wireless base station designed for use with our 4th generation of the Structural Testing System (STS4). BDI has been developing and refining rugged STS's since the early 1990's and this 4th generation system includes the latest STS4 Wireless Base Station (STS4-WBS) that includes the longest lasting lithium ion battery pack, latest wireless access point technology, as well as an integrated Automatic Load Position Tracker receiver—all packaged to be used in the difficult field environments that BDI and our clients are accustomed.

This STS4-WBS can be used with any PC that has either wireless networking, or a standard Ethernet port along with the BDI manufactured hardware listed in Table 1.

Table 1: Compatible STS Hardware

STS4-4-IW3	4-Ch Intelliducer Nodes
STS4-4-TE4	4-Ch Terminal Input Nodes
STS4-16-TE4	16-Ch Terminal Input Nodes
STS4-ALPT	Load Position Tracking Hardware
STS3	3rd Gen 4-Ch Intelliducer Nodes

1.1 ABOUT THIS MANUAL

This is a comprehensive document that explains the functions and features of the STS4-WBS and includes references to other STS components such as the STS4 Node, Automatic Load Position Indicator (ALPT), and STS-LIVE software. Other STS components are supplied with their own manuals that can also be downloaded from the BDI website.

The following highlighted message blocks will periodically appear and contain important information that the user should be aware of:

INFORMATION: This symbol and corresponding message represents general information and/or tips on successfully operating/configuring the device.

WARNING: This symbol and corresponding message represents vital information and is critical for the device operation and/or the operational settings/configuration.

STOP: This symbol and corresponding message represents information regarding the device that if not followed could lead to damaging the device! Pay close attention to this message.

2. System Characteristics

2.1 About the STS4-WBS

The STS4-WBS is the central communication hub for fielded STS4 systems that generates the required communication links between all STS4 components. The STS4-WBS broadcasts the Wireless Local Area Network (WLAN) and coordinates communications between:

+ User's Personal Computer (PC)
+ Up to 128 STS4 Nodes
+ Optional Automatic Load Position Tracker (ALPT)
+ Optional Local Area Network (LAN) switches

The Control Unit's rechargeable internal battery will power the STS4-WBS unit for approximately 12 hours and allow the user to control all other STS4 components either wirelessly, wired, or through a combination of both.

2.2 Technical Specifications

Table 2: Technical Specifications

MODEL	STS4-WBS-AC000	STS4-WBS-AC900	STS4-WBS-AC024
Control Unit Communication:			
AP	10/100 Base-T, +24 Vdc Proprietary (Passive) Power-Over-Ethernet (Connection to Access Point)		
POE	10/100 Base-T, +24 Vdc Proprietary (Passive) Power-Over-Ethernet (Alternative Connection)		
PC	10/100 Base-T (Connection to PC)		
Control Unit Power:			
Li-Ion Battery	+10.8 Vdc (Nominal), 8.7Ah, 93Wh		
DC Supply	+24 Vdc @ 2.0 Amp (max for charging)		
Access Point:			
Type	Dual Band Wireless Access Point		
Model	ENS620EXT		
2.4 GHz Wireless	IEEE 802.11b/g/n, 27 dBm		
	Access Point Mode (wirelessly connect STS4 hardware and PC)		
5.0 GHz Wireless	IEEE 802.11a/n/ac, 27 dBm		
	Bridge Mode (wirelessly connect between multiple STS4-WBS)		
Antennas	Four External 5 dBi Dual-Concurrent Omni-directional, SMA Connector		
Ethernet (LAN) Interface	2 x 10/100/1000 T-Base RJ45 Ports		
Power Source	+24 Vdc Proprietary (passive) Power-Over-Ethernet		
ALPT Transceiver:			
Radio Frequency	n/a	900-928 MHz	2.400 - 2.483 GHz

Transmit Power	n/a	200 mW	10 mW
Antenna	n/a	2 dBi Omni Directional (RP-SMA Male)	5 dBi Omni Directional (SMA Male)
Range[1]	n/a	4 miles (6.5 km)	2.5 miles (4 km)
Typical Power Consumption:			
Base Consumption (no AP or ALPT)	1.5W	1.7W	1.6W
Base Consumption (AP connected)	5.1W	5.4W	5.2W
Typical Power Consumption (AP + ALPT)	5.1W	5.8W	5.4W
Estimated Operating Time[2]	18 Hours	16 Hours	17 Hours
Physical:			
Protection			
Control Unit	Waterproof		
Access Point	IP55		
Assembled Size (W x L x H)	24 x 24 x 42 in. (610 x 610 x 1220 mm)		
Assembled Weight	10.5 lbs (4.76 kg)		
Temperature:			
Operating	-20 °C to +60 °C		
Battery Charging	0 °C to +40 °C		
Storage	-20 °C to +60 °C		
Compliance & Warranty:			
Li-Ion Battery	FCC Part 15 Class B, CE		
Access Point	FCC, CE		
ALPT Transceiver	n/a	FCC, IC, CE	FCC, IC, CE
Warranty	3 Years		

[1] The stated range is based on line-of-sight. Range will be reduced with physical interference within the line-of-sight.
[2] The estimated operating time is based on a new battery operating at room temperature, time will vary slightly depending on actual conditions.

2.3 ACCESSORIES

Table 3: STS4-WBS Accessories

	**Ethernet Cables:** Industrial shielded CAT5e Ethernet cable with IP67 VS 8-pin connector on one end and RJ45 connector on the other end. Supports PoE. Maximum length of 330 ft. (100m) per cable.
	**Directional Antennas:** Enterprise-class long-range antenna
	**Power Supply (North America):** 100-240 Vac to +24 Vdc power supply with M8 connectors. 3 ft (1m) extension cable
	**Power Supply (European):** 100-240 Vac to +24 Vdc power supply with M8 connector. 3 ft. (1m) extension cable

	**Shipping Cases**: Rugged plastic travel & storage case, variable sizes

2.3.1 STS4-WBS Components

The primary components of the STS4-WBS are the Control Unit and a dual-band wireless Access Point (AP) mounted on a tripod with customized clamps.

Figure 1: STS4-WBS Components

Table 4: STS4-WBS Components

Item	Component
1	2.4 GHz Antennas (x2)
2	5.0 GHz Antennas (x2)
3	Wireless Access Point (AP)
4	Wireless Access Point Tripod Mounting Bracket
5	Control Unit Tripod Mounting Bracket
6	Tripod Vertical Pole
7	Tripod Base
8	Control Unit
9	Wireless Access Point to Control Unit Ethernet Cable
10	Computer to Control Unit Ethernet Cable

11	Control Unit Power Supply
12	Optional ALPT Receiver Antenna (900 MHz or 2.4 GHz)

2.3.2 STS4-WBS Assembly Procedures

1. Attach the four Antennas (1 & 2) into Antenna Receptacles on Wireless Access Point (3). Be sure to identify the antenna frequency ranges and attach them to their matching receptacles (2.4 GHz vs. 5.0 GHz). Thread each antenna clockwise until secure, do not overtighten.

WARNING: Note that the two antenna frequency ranges connect to opposing diagonal corners of the Access Point. Follow labels on antennas and AP!

2. Slide dowel on back of Wireless Access Point (3) into Wireless Access Point Tripod Mounting Bracket (4) socket with metal slide handle and secure. Do not overtighten.
3. Slide the adjustable Control Unit Tripod Mounting Bracket (5) to the midpoint of Tripod Vertical Pole (6) and lightly tighten clamp.
4. Attach Tripod Vertical Pole (6) into Tripod Base (7) and extend the three support legs to be 120° apart. Extend the Tripod Vertical Pole (6).
5. Attach the Wireless Access Point Tripod Mounting Bracket (4) to the top of the Tripod Vertical Pole (6) and tighten. The angle of Wireless Access Point can be adjusted as required to assure best signal coverage.
6. Attach the Control Unit (8) to the Control Unit Tripod Mounting Bracket (5).
7. Using the Wireless Access Point to Control Unit Ethernet Cable (9), connect the Wireless Access Point (3) into Control Unit (8) AP receptacle.
8. If using the ALPT, attach the antenna (12) to the ALPT receptacle on the Control Unit (1).
9. If communicating with the STS network in wired mode, using the Computer to Control Unit Ethernet Cable (10), connect between the PC and the Control Unit (8).
10. If the Control Unit (8) needs to be charged, connect the Power Supply (11) to an AC source and then plug into the Control Unit (8) power input receptacle.

The completed STS4-WBS assembly is illustrated in Figure 2.

Figure 2: Wireless STS4-WBS (assembled)

2.3.3 Shipping Requirements

BDI wants to insure our that our customers are aware that the internal Lithium-Ion battery (Li-Ion) units utilized in STS4-WBS units are considered Dangerous Goods/Hazardous Materials for shipping purposes. There are certain strict rules governing the transportation of lithium ion batteries and products powered by lithium ion batteries. These rules, imposed by federal and international regulatory agencies, can be very complex and will vary depending on transport mode and battery type.

If you are uncertain on applicable Li-Ion transport rules, BDI recommends you visit the DOT's website for further information: https://www.phmsa.dot.gov/lithiumbatteries

WARNING: Safety requirements for shipping Li-Ion batteries by both ground and air are continuously updated. Anyone handling shipments that involve Li-Ion batteries should receive the appropriate Dangerous Goods/Hazardous Materials shipping training which is offered by many vendors.

STOP: Significant criminal and civil penalties may be applied to ***individuals*** who improperly ship hazardous materials.

In addition to recommended training, three primary sources for shipping guidelines are:

- **Ground:** In the United States, ground shipment regulations for L-Ion batteries are provided by the U.S. Department of Transportation. Refer to phmsa.dot.gov/lithiumbatteries for further information.
- **Air:** Air shipment requirements are provided by the International Air Transport Association (IATA) which the user should refer to at iata.org.
- **Manufacturer:** Another excellent source for shipping information is provided by the battery manufacturer, Inspired Energy, LLC at inspired-energy.com.

BDI complies with the latest hazmat delivery guidelines when shipping STS4 systems to and from our facilities and has developed recommended guidelines only for customers who are returning STS4 systems to BDI which are available at: https://bditest.com/resources/support/ under "Shipping Documents".

3. Power

3.1 Power On/Off

After the internal battery has been charged and/or the power supply is plugged in, press the power button until the red LED shown in Figure 3 turns green. When the button is released, the unit will remain on and the LED will flash green the entire time that the unit is operational. The STS4-WBS is turned off by depressing the power button until all LEDs go out.

3.2 Battery Status Test

In addition to controlling the charging parameters, an on-board "fuel gage" is provided that visually displays the five green LEDs shown in Figure 3 to indicate the battery charge level. To activate the meter, momentarily depress and release the power button and the LEDs should light up from left to right, providing the percentage charge associated with each LED lighting sequence outlined in Table 5. The LEDs will remain on for a few seconds before turning off again.

Figure 3: Power Button and Battery Status Indicator

Table 5: Battery Status LED Functions for Charging Batteries using External Supply

Battery Charge	LED 1 Red	LED 1 Green	LED 2	LED 3	LED 4	LED 5
100% - 97%	OFF	ON	ON	ON	ON	ON
96% - 81%	OFF	ON	ON	ON	ON	ON
80% - 61%	OFF	ON	ON	ON	ON	OFF
60% - 41%	OFF	ON	ON	ON	OFF	OFF
40% - 21%	OFF	ON	ON	OFF	OFF	OFF
20% - 0%	ON	OFF	OFF	OFF	OFF	OFF
Overheated	Flashing*	Flashing*	OFF	OFF	OFF	OFF

* Alternating flashing

3.3 AP POWER

When power is turned on at the Control Unit, power will automatically be provided to the AP which will be indicated by the solid orange power LED seen in Figure 4.

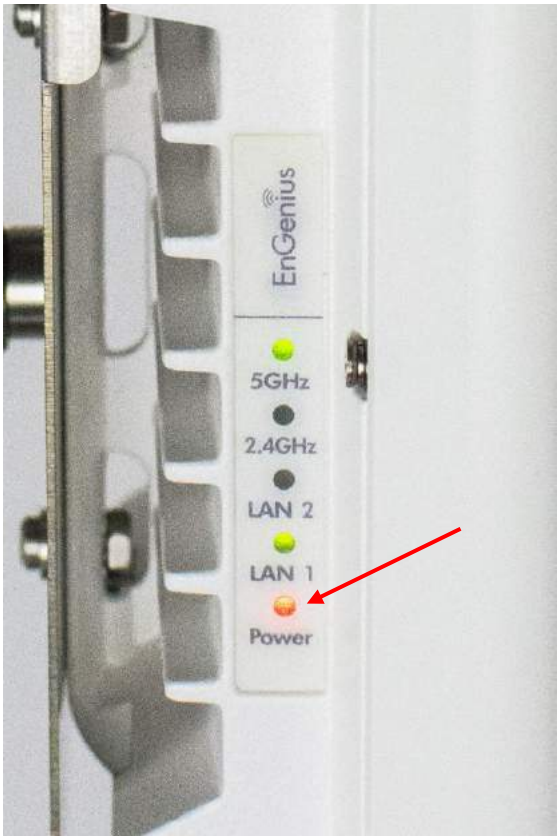

Figure 4: AP Power Indicator – Orange LED

3.4 POWER SOURCES

The STS4-WBS operates on its internal Li-Ion battery that is charged with a +24 Vdc Power Supply. When the Power Supply is connected, it will power the STS4-WBS while simultaneously charging the battery.

Table 6: Power Sources & Configurations

Source	Power State	Operation Time
+10.8 Vdc Internal Battery	STS4-WBS Power Only	Approx. 16-18 hours
+24 Vdc Power Supply	STS4-WBS Power + Charge Battery	Indefinite

3.4.1 Internal Lithium-Ion (Li-Ion) Battery

BATTERY SPECIFICATIONS

The internal battery pack consist of (9) internal Li-Ion cells assembled in a 3 series/3 parallel (3S-3P) configuration and packaged with an on-board Battery Management Module (BMM) as illustrated in Figure 5. The technical specifications are provided in Table 7.

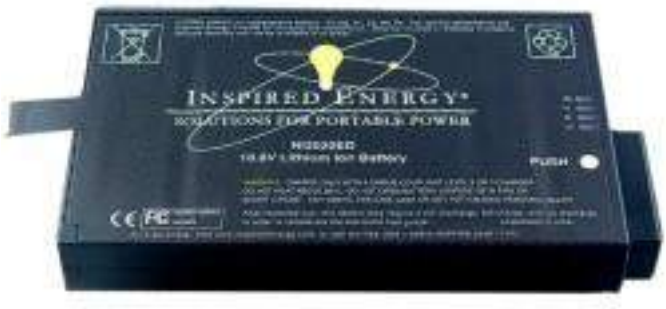

Figure 5: Lithium Ion Battery Pack w/BMM (Courtesy Inspired Energy, LLC)

Table 7: Li-Ion Battery Technical Specifications

Manufacturer	Inspired Energy, LLC
Model	Ni2020HD29
Chemistry	Lithium Ion
Equivalent Lithium Content	0.25 oz. (7.0g)
Capacity	8.7 Amp-Hours (94 Watt-Hours)
Voltage Range	7.6 to 12.6 Vdc, (10.8 Nominal)
Temperature Range	-4° F (-20° C) to 175° F (80° C)
Dimensions	5.9 x 2.4 x 0.9 in (150 x 58.9 x 22.3mm)
Weight	1.12 lbs. (0.506 Kg)

BUILT-IN BATTERY PROTECTION

To optimize the battery performance and to extend its useful life, the built-in Battery Management Module (BMM) keeps the unit within its voltage, current, and temperature tolerances. The BMM also manages the battery's Discharge and Charging Operating Limits illustrated in Figure 6 and Figure 7.

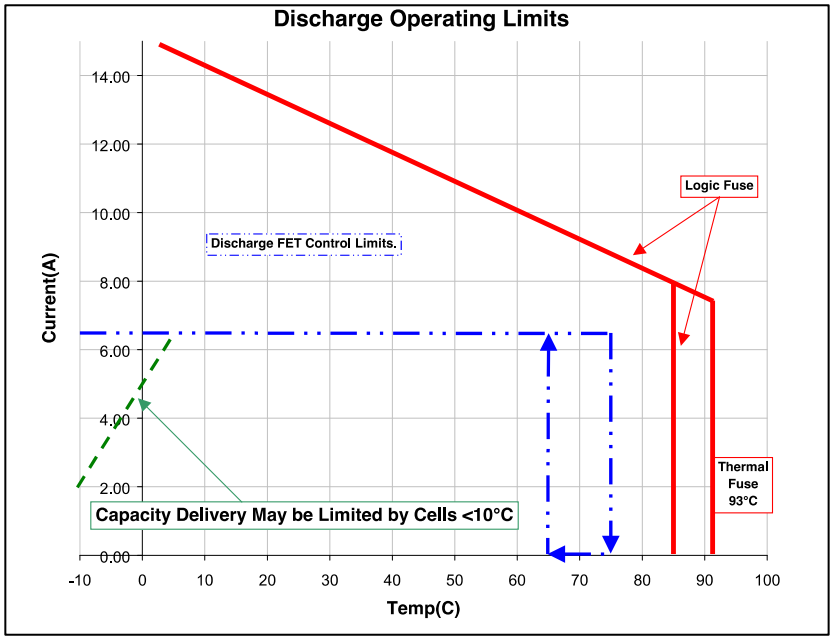

Figure 6: Battery Discharge Limits (Courtesy Inspired Energy, LLC)

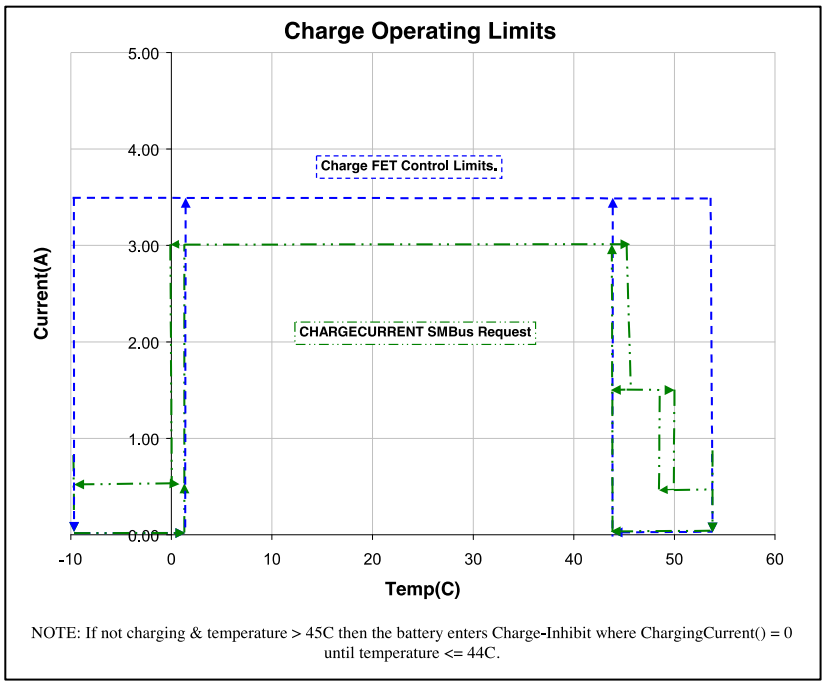

Figure 7: Battery Charging Operating Limits (Courtesy Inspired Energy, LLC)

3.4.2 +24 Vdc External Power Supply

Each STS4-WBS is supplied with an external power supply that converts 110-240 VAC to +24 Vdc as illustrated in Figure 8. This unit provides power for simultaneous STS4-WBS operation and/or battery charging. The standard Power Supply is supplied with a USA AC outlet adapter. However, a wide range of optional AC adapters are available from BDI depending on the country in which the system is being utilized.

Figure 8: Typical External 24Vdc Power Supply

Table 8: +24Vdc Typical External Power Supply Specifications (varies slightly by manufacturer)

Max Output Power	60 W
Input	90~264 VAC, 47-63 Hz, 1.5A (Specify Power Adapter)
Output	+24 Vdc, 2.7A
Leakage Current	0.25 mA
Operating Temp.	32 to 104°F (0 to 40°C)
Storage Temp.	14 to 158°F (-10 to 70°C)
Dimensions	4.5 x 1.85 x 1.28 in (114 x 47 x 32mm)
Weight	0.5 lbs. (230g)

A 3-pin power connector as shown in Figure 9 threads onto the power receptacle on the back of the STS4-WBS (Figure 10) and supplies the +24 Vdc required to operate the STS4-WBS while simultaneously charging the battery. Since this scenario requires AC power at the STS4-WBS location, it is usually reserved for charging the battery only, or in laboratory conditions where AC power is readily available.

If an alternate +24 Vdc source is to be supplied by the user, the 3-pin connector shown in Figure 9 with the pinout described in Table 9 can be supplied by BDI to allow user to fabricate custom power cables.

Figure 9: 3-Pin Power Input Connector

Figure 10: +24 Vdc Power Input Receptacle

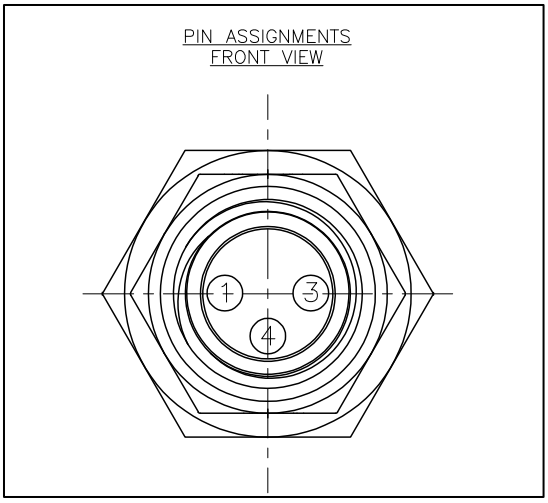

Figure 11: Pinout for +24 Vdc Adapter

Table 9: 3-Pin Power Connector Pin-Out

Pin	Signal
1	+24 Vdc
3	GND
4	n/a

4. COMMUNICATIONS

4.1 COMMUNICATION METHOD

The STS4-WBS is primarily a battery-powered TCP/IP LAN/WLAN Access Point (AP) that broadcasts the wireless networks and manages all incoming and outgoing communication traffic between the PC and all STS4 components. In addition to the WLAN capabilities required for managing STS4 Nodes, the STS4-WBS can be configured to communicate with additional STS4-WBSs well as an Automatic Load Position Tracker (ALPT). These optional connections require separate communication links and are described in below sections.

To provide maximum flexibility to adapt to a wide range of field conditions, various hardware configurations can be utilized. For example, for most short-term testing cases in which all nodes will be placed within several hundred feet of the STS4-WBS, the 100% wireless option is usually the most efficient. However, for applications where nodes are spaced significantly far apart, or a wired Ethernet mode. This option not only ensures high-quality communication over longer distances but can also provide the PoE feature that allows the system to operate indefinitely. In still other situations, it may be advantageous to use a combination of both wireless and wired configurations.

The flexibility to combine wireless and wired modes stem from the use of the two-layered Transmission Control Protocol/Internet Protocol (TCP/IP) in which the TCP handles data transmission and the IP guides it to the correct IP address. STS4 systems rely on a completely fixed IP network, meaning that all components have been preconfigured by BDI with assigned IP addresses.

One significant advantage of TCP/IP technology is that it treats the communications links as "transparent", meaning that wireless and wired links can be freely interchanged as required. To operate in this environment, the user's PC must first be configured with a fixed address as described in Section 4.2 .

4.2 Computer Requirements & Network Settings

4.2.1 Personal Computer Requirements

BDI recommends that a personal computer (PC) equipped with a minimum of a Dual Core Intel i5 processor supported with 8Gb RAM and Windows® 10 Pro be used for operating STS4 systems consisting of 100 data channels or less. For higher channel count STS4 systems, please contact BDI for recommended PC capabilities. It is also highly recommended to dedicate one PC for running the STS4 rather than having to configure the Windows® Firewall and other third-party internet security applications that often block the STS-LIVE application on various computer operating systems.

4.2.2 Configuring Network Settings

Prior to initiating communication with STS4 systems, the PC will need to be configured to act as the control point for the STS4 LAN. Due to the wide variety of available PCs and operating systems, it is not feasible to provide detailed configuration instructions for all.

PC CONFIGURATIONS FOR IP ADDRESS AND SUBNET MASK

WARNING: It is important that the computer Network Settings are correct before launching the STS-LIVE application and attempting to establish connections with STS4 components. This is often the first suspect in case a connection cannot be established. Please ensure the TCP/IPv4 settings are as follows:

IP address: 192.168.10.2

Subnet mask: 255.255.0.0

Default gateway: Blank

DNS Settings: Blank

For further assistance in configuring STS-LIVE and running tests with an assembled STS4 system, please refer to the extensive series of instructional videos available on the BDI website at:

https://bditest.com/product/training-support/video-tutorials/sts-live/

PC WINDOWS® FIREWALL AND OTHER SECURITY APPLICATIONS

We recommend that **ALL** Internet security and firewalls are simply turned off or enter STS-LIVE as a trusted program within any third-party Internet security software (i.e., Norton Internet Security) and Windows® firewall. In most cases when the STS4 system has initial communication problems (connecting to STS-LIVE), the issue is a result of the computer's firewall blocking communication. For more details regarding the disabling of security programs, please refer to the operation guide for the specific security program that is installed on the computer.

4.3 Wireless Communications

4.3.1 WLAN System Architecture

The communications capability of the STS4-WBS is provided by an internal Access Point (AP) that broadcasts the Wireless Local Area Network (WLAN) and manages all incoming and outgoing traffic between the STS4 nodes and the PC. All STS4-WBS units supplied by BDI are preconfigured with the "STS" network name (SSID) and should be visible to the computer's wireless network tool/application when configuring network settings. Figure 12 illustrates the standard STS4 wireless system configuration.

Through STS-LIVE, the STS4-WBS is capable of providing three separate wireless links as follows:

+ Standard: WLAN 2.4 GHz link for TCP/IP communication between the PC and all STS4 Nodes
+ Standard: WLAN 5.0 GHz "backhaul" link for transparent TCP/IP communication between multiple STS4-WBS units
+ Optional: 900 MHz/2.4 GHz serial link for communication between STS4-WBS and Automatic Load Position Tracker (ALPT)

When the STS4 Nodes, STS4-WBS, and PC are connected and controlled through STS-LIVE using the 2.4 GHz WLAN (specifications in Table 10), the primary IP address is linked to the STS4-WBS while each node is assigned a subdivision IP address. This configuration can support up to 128 nodes with a single STS4-WBS.

As soon as the STS4-WBS has established communications with the PC running STS-LIVE, it will establish the LAN/WLAN Service Set Identifier (SSID) network required to allow nodes to connect to STS-LIVE. The TCP/IP communication protocol directs data to each component based on its unique name and network address.

Multiple customized STS4-WBS units can communicate through the separate 5.0 GHz WLAN "backhaul" wireless link which allows expansion of the testing range as shown in Figure 13. Optional directional antennas from BDI can allow for long range communications, meaning that two instrumented areas separated by very long distances can be tested simultaneously.

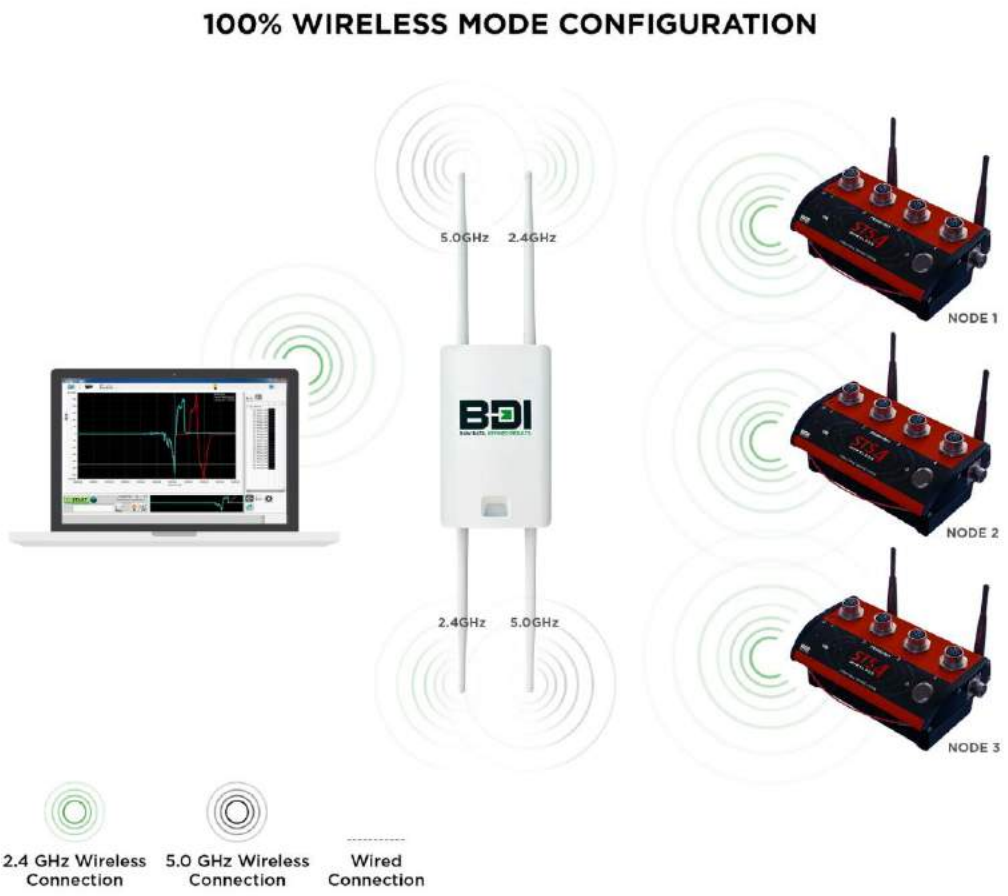

Figure 12: 100% Wireless single STS4-WBS

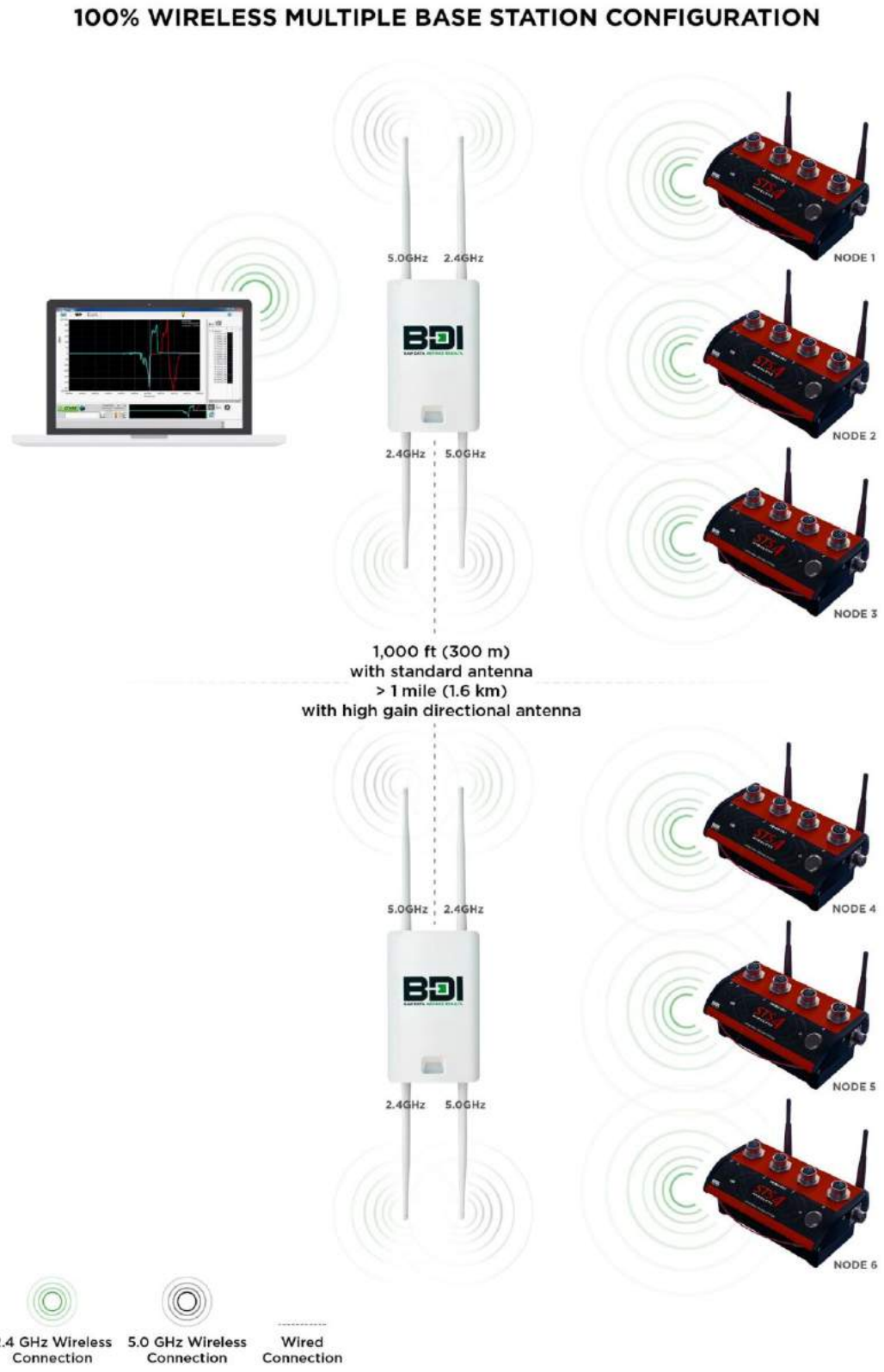

Figure 13: 100% Wireless Multiple STS4-WBS here

4.3.2 WLAN Communication Protocols

The STS4-WBS broadcasts two WLAN, one at 2.4 GHz and the other at 5.0 GHz. Each WLAN controls the components listed in Table 10 and Table 11.

2.4 GHZ WLAN NETWORK LINKS

Table 10: 2.4 GHz WLAN Communication Link Specifications

Feature	Description
Components Linked	PC, STS4-WBS, and STS4 Nodes
TCP/IP Protocol	IEEE 802.11b/g/n
Frequency Bands	2.400 – 2.500 GHz
Transmit Power	27 dBm
Transmission Range	~500ft (150m), line of sight (approx. 3,000 sq. ft.)

5.0 GHZ WLAN NETWORK LINKS

The 5.0 GHz STS4-WBS communication backhaul links as illustrated in Figure 13 are broadcast through the standard AP unit is typically configured by BDI when the STS4-WBS is purchased; however, if a second STS4-WBS is purchased after the first unit is purchased, the 5.0 GHz link must be setup by the user. Since the model and features change frequently with the AP's, please contact BDI directly to get the procedures for setting up the 5.0 GHz link. Table 11 provides the 5.0 GHz communication link specifications. Note that Long Range communications between STS4-WBS units can be accomplished with directional antennas, please contact BDI for further information.

Table 11: 5.0 GHz WLAN Communication Link Specifications

Feature	Description
Components Linked	Multiple STS4-WBS units
TCP/IP Protocol	IEEE 802.11a/n/ac
Frequency Bands	5.15-5.25 GHz, 5.25–5.35 GHz, 5.47-5.725 GHz, 5.725-5.850 GHz
Transmit Power	27 dBm (adjustable)
Transmission Range	~500ft (150m), line of sight (approx. 3,000 sq. ft.) Up to 6,000 ft (1,800m) Directional Antennas

WLAN ANTENNA POSITIONING

All STS4 components antennas should be oriented such that the wireless radiation pattern between the STS4-WBS and the STS4 nodes and PC overlap. Figure 14 shows the typical radiation pattern for the omni direction antenna types that are used in the STS4-WBS and STS4 nodes. What this typical radiation pattern shows is that the primary direction of the wireless signal radiates outward from the antenna in a "donut" pattern meaning that the antenna positions should always be parallel to each other and aligned so that the radiation pattern overlaps. Figure 15 illustrates correct and incorrect antenna positioning.

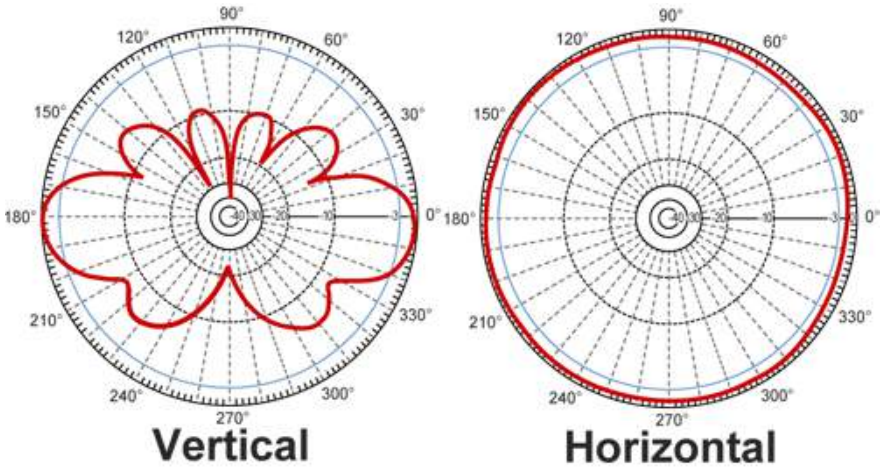

Figure 14: Wireless radiation pattern for typical omni direction antennas

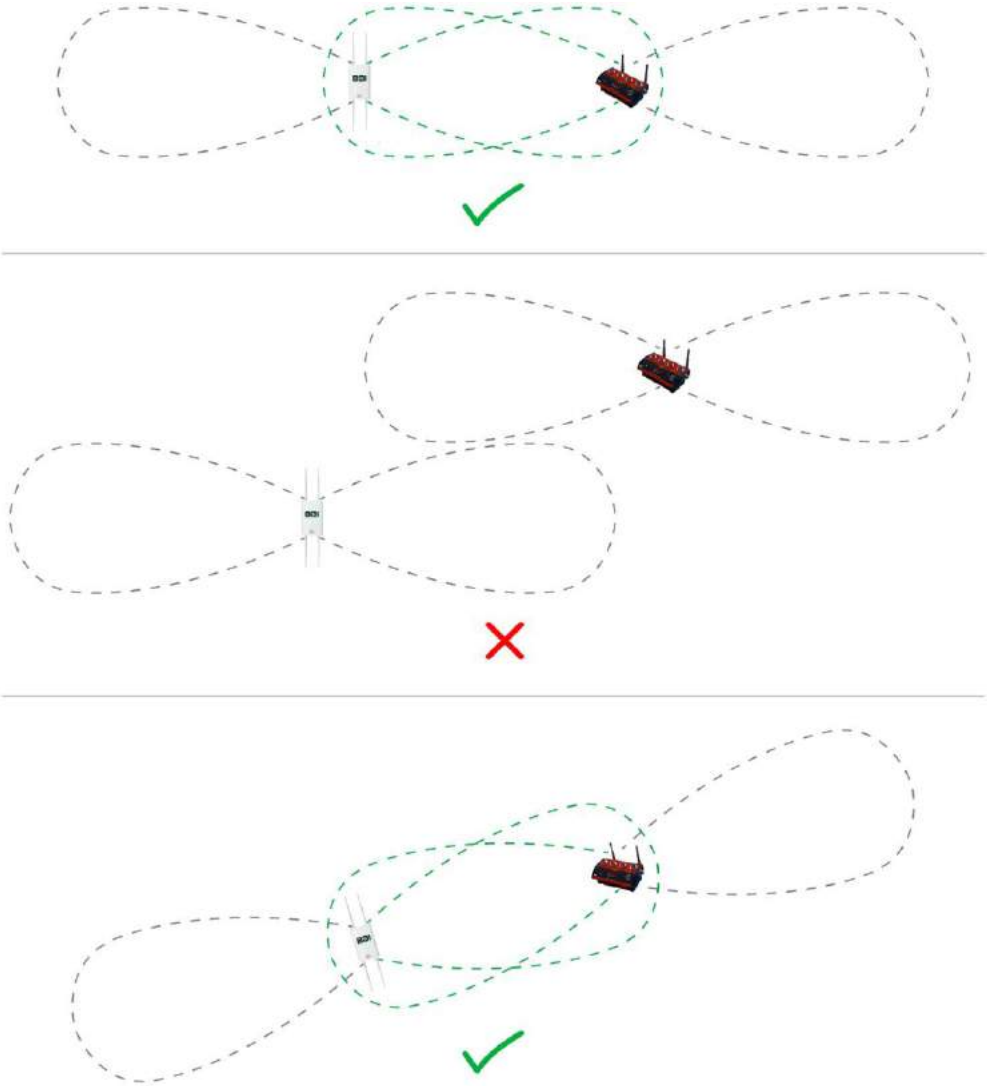

Figure 15: Correct and incorrect antenna positioning

4.3.3 ALPT Wireless Link

If an Automatic Load Position Tracker (ALPT) is in use, it connects to either the 900 MHz or 2.4 GHz link according to the geographic location as outlined in Table 12.

Table 12: ALPT & STS4-WBS Models - Compatibility

Geographic Location	ALPT Model	STS4-WBS Model	Frequency
All	No ALPT	STS4-WBS-AC000	N/A
U.S. & North America	STS-ALPT-01	STS4-WBS-AC900	900 MHz
World, excluding North America	STS-ALPT-02	STS4-WBS-AC024	2.4 GHz

900 MHZ LINK

Table 13: 900 MHz ALPT Communication Link Specifications

Feature	Description
Components Linked	STS4-WBS-AC900 to STS4-ALPT-01 (U.S. & North America)
Output Power	200mW
Frequency Bands	900 - 928 MHz
Transmission Range	Up to 4 miles (6.5 km) Line-of-Sight

2.4 GHZ LINK

Table 14: 2.4 GHz ALPT Communication Link Specifications

Feature	Description
Components Linked	STS4-WBS-AC024 to STS4-ALPT-02 (All except North America)
Output Power	10mW
Frequency Bands	2.400 – 2.483 GHz
Transmission Range	2.5 Miles (4 km) Line-of-Sight

4.3.4 Establishing Wireless Communications

When the power switch is activated and the communication link between the Control Unit and AP is fully established, the STS4-WBS will immediately broadcast the 2.4 GHz WLAN and, if applicable, the ALPT radio link and attempt to connect to the user's PC and STS4 Nodes in the vicinity. The Ethernet LED indicator illustrated in Figure 16 and the AP LED's shown in Figure 17 will flash intermittently during the entire time that the STS4-WBS is operational.

When the STS4-WBS has established a successful wireless connection to STS-LIVE running on the PC, the LED adjacent to the PC Ethernet port shown in Figure 18 will continuously flash blue.

If an Automatic Load Position Tracker (ALPT) is present, the blue ALPT LED shown in Figure 16 will indicate when a successful wireless link has been established.

INFORMATION: The STS4-WBS may require up to two minutes to boot up and establish the Wireless Local Area Network (WLAN) before it can be detected by the PC.

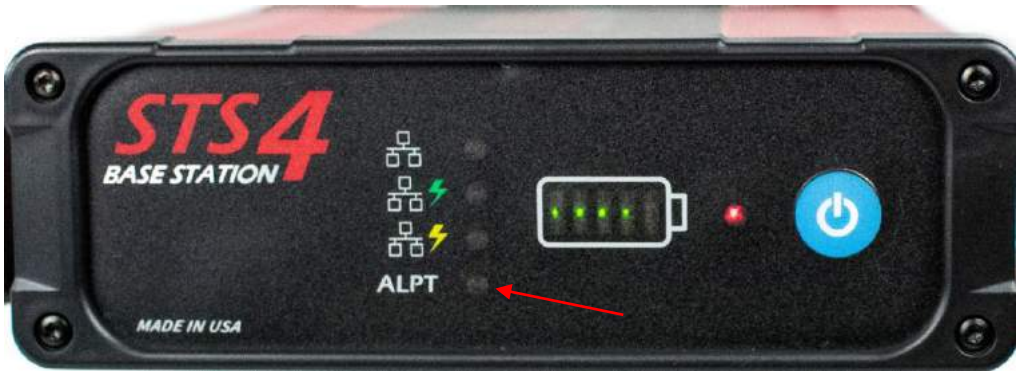

Figure 16: ALPT Connection Status LED

Figure 17: AP Communication LEDs

Figure 18: PC Connection Status LED

4.4 WIRED (LAN) CONNECTIONS

In some scenarios (either because of power or communication issues), it is advantageous to use STS4 Nodes in a "wired" mode, meaning that communication is facilitated through the standard Ethernet protocols described in Table 15 and connected as outlined in sections 4.4.1 and 4.4.2 . Note that all LAN cables require specialized circular connectors that mate with the STS4-WBS receptacles on the rear of the unit illustrated in Figure 19. The LAN icons below each connector match the LAN data traffic indicator LEDs on the front of the unit shown in Figure 20.

Each LAN port is dedicated to a specific "branch" of the STS4 testing system as follows:

- **Access Point:** This LAN port is permanently connected directly to the on-board AP to provide wireless capabilities. Note that this link also provides +24 Vdc passive PoE for powering the AP.
- **PC:** Provides a hardwired communication link to a PC—no PoE on this port.
- **PoE:** Utilized for a +24 Vdc passive PoE LAN-powered external device or for directly communicating and powering the STS4-4-TE4 and STS4-16-TE4 nodes.

WARNING: Note that the STS4-WBS does NOT connect directly to STS4 Nodes, an intermediate network switch must be utilized.

Figure 19: LAN Port Connections

Figure 20: LED Indicators for Wired LAN Ports

Note that BDI does not manufacture the network hardware since it is available off-the-shelf from many commercial sources. It is recommended that high-quality shielded CAT5e or better cable be utilized to reduce potential communication degradation in "noisy" environments.

Table 15: Specifications for STS4-WBS LAN and Passive Power over Ethernet (PoE) Support

Ethernet Standard	IEEE 802.3
Power Over Ethernet	Proprietary passive +24 Vdc
Power Draw from STS4-WBS	24 W Max (Combined between PoE port and AP port)
Supported cabling	Cat5e (or better)
Max Cable	100m (330 ft.)

Table 16: Ethernet Cable Standards for Passive Power over Ethernet

RJ45 Connector	T568B Color (BDI Standard)	Description
Pin 1		+ Data Transmit
Pin 2		- Data Transmit
Pin 3		+ Data Receive
Pin 4		+ Vdc (+24Vdc)
Pin 5		+ Vdc (+24Vdc)
Pin 6		- Data Receive
Pin 7		- Vdc (GND)
Pin 8		- Vdc (GND)

4.4.1 Fully Wired Configuration

If field conditions warrant that the system be operated in a fully wired configuration, the STS4-WBS is not necessary unless an ALPT is in use. As illustrated in Figure 21, an "off-the-shelf" network switch is utilized. The network can be supported by any switch or combinations of switches that support the IEEE 802.3af protocol. BDI does not manufacture or support the Ethernet switching components. If additional support is required for configuring switching components, contact your IT Support Department.

INFORMATION: The STS4-WBS is NOT required in the wired only scenario unless an ALPT is in use. Off-the shelf network switches may be utilized in its place as the central LAN interface.

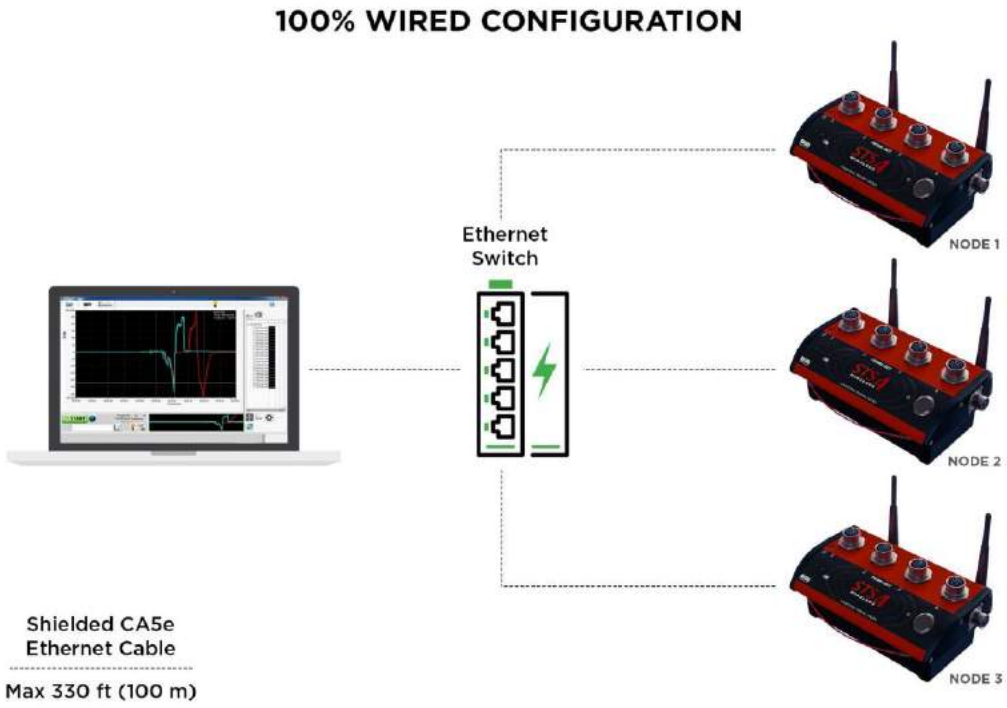

Figure 21: Wired Ethernet System Configuration using LAN Switch

4.4.2 Wired-Wireless (Mixed-Mode) Communications

The wired TCP/IP LAN protocol dovetails with the wireless TCP/IP network protocol, meaning that both communication links are essentially "transparent" to all STS4 components. This design feature allows full interchangeability between wired and wireless links as illustrated in Figure 22.

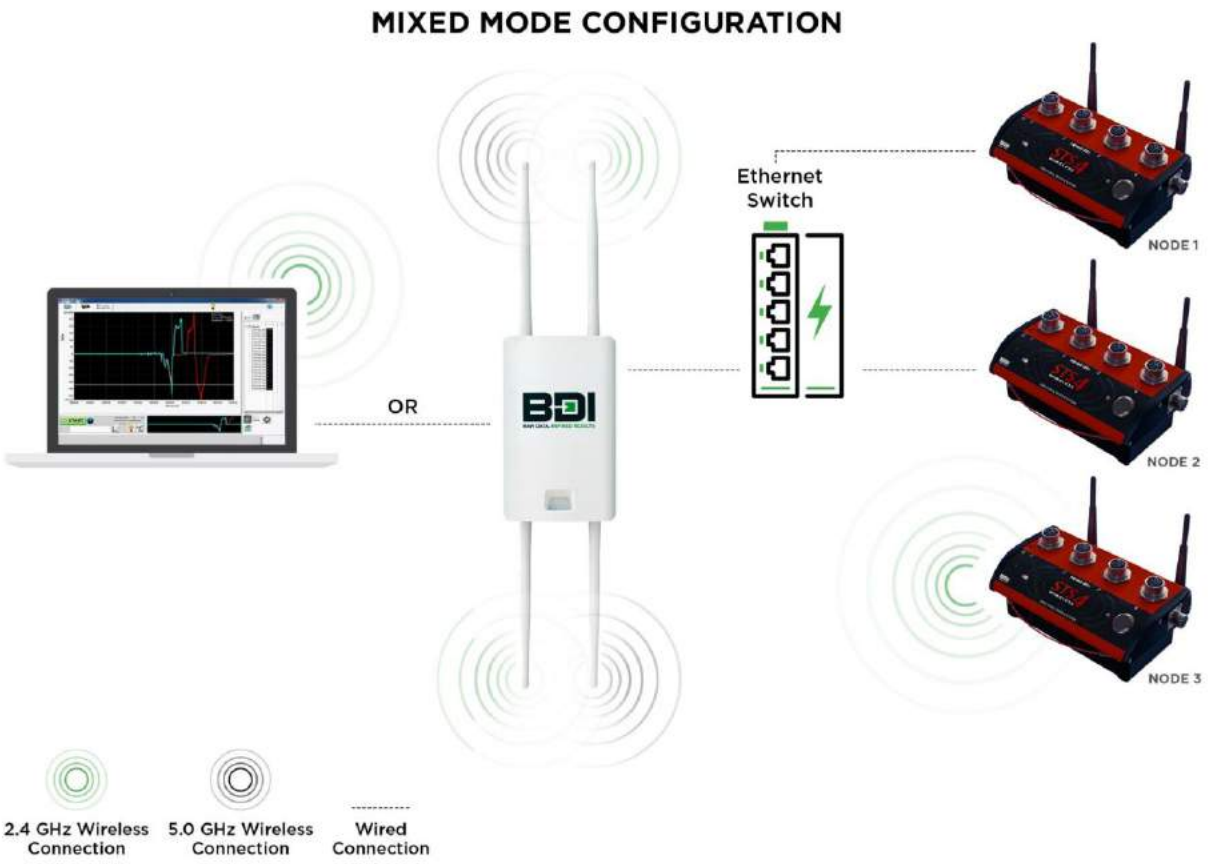

Figure 22: Mixed-Mode (Wired + Wireless) Communications using STS4-WBS and LAN Switch

5. TROUBLESHOOTING

The best way to avoid equipment-related field delays is to thoroughly test out the fully-assembled system in the office/laboratory prior to mobilization. Typical problems that may be encountered in the field usually involve communication and/or power issues. The sections below are some basic troubleshooting tips for common problems and is not intended as an exhaustive guide, if the problem cannot be addressed by the common troubleshooting items outlined in this section, please contact BDI directly for additional support.

5.1 WIRELESS CONNECTIVITY ISSUES

BDI has made every attempt to mitigate wireless interference while designing and developing STS4 systems. However, all wireless connection links can be susceptible to interference from nearby sources operating the 2.4GHz, 5.0GHz, or 900MHz frequency ranges such as:

+ Microwave towers
+ Microwave ovens
+ Cell phones
+ Bluetooth devices
+ Wireless speakers
+ High voltage power lines
+ Energized third-rails for railroads
+ Power generation facilities

Some solutions to mitigate interference include:

- Relocate PC closer to the STS4-WBS to improve signal strength.
- Connect PC directly to STS4-WBS with Cat5e cable.
- If possible, relocate STS4 hardware and STS4-WBS further away from the source of interference.
- Create physical barrier between the interference source and STS4 hardware such as metal or concrete barriers. Less-effective barriers are wood, plastic, or glass barriers.
- Eliminate wireless links by reconfiguring system into wired mode as described in Section 4.4 .
- If possible, relocate STS4 hardware to be within line of sight of STS4-WBS.
- Connect STS4 nodes directly (or through an Ethernet switch) to STS4-WBS with Cat5e cable. If multiple nodes are experiencing issues, a network switch will be required since the STS4-WBS has only one cable receptacle.

5.2 Wired Connectivity Issues

Very little can go wrong with a wired connection with the STS4 hardware. If a connection to the hardware cannot be established, even after rebooting the hardware, there are only a few items that could potentially cause the problem:

- **Damaged Ethernet cable**: Inspect the length of the cable for any damage and inspect all RJ45 connectors for integrity. Swapping suspected CAT5e cables with new cables can assist in verifying damaged units.
- **Poor quality Ethernet cable**: High quality shielded CAT5e should be used as lower quality cable is more susceptible to signal interference.
- **Verify cable connections:** Double check that the Ethernet connectors are properly plugged into the STS4-WBS hardware and the PC, AP, or alternate device (Ethernet Switch).
- **Component Damage:** It is always possible that a component of the STS4-WBS could be damaged through use or shipping. Inspect all components carefully for signs of damage, particularly around the Ethernet cable connections.

5.3 Power-Related Issues

The following represents the most common issues that can occur with the Li-Ion battery packs if they have already been determined to have sufficient charge:

- **Overheated Battery:** Battery LED's will flash alternating yellow/red when the battery is overheated. The STS4-4 node should be taken to a location where it can cool down sufficiently before attempting to power up or charge the node again.
- **Damaged Battery:** If the battery circuitry is damaged the battery status LED will simply flash red. Damage can occur if the battery overheats too much or if simply one of the internal components is damaged. The STS4-4 node will need to be returned to BDI for replacement.
- **Loss in Capacity:** After many (>300) battery charge/discharge cycles the capacity of the battery will begin to diminish. If the charge to the battery has lost significant capacity after a full charge, then it is likely time to replace the battery. The STS4-4 node will need to be returned to BDI for replacement.

5.4 Temperature-Related Issues

STS4-WBS units contain internal temperature sensors that monitor the circuitry and battery. If either sensor exceeds the over-temperature threshold, the STS4-WBS will automatically power down to prevent component damage. The shutdown limit of the Li-Ion battery pack is approximately +85°C when it is in the discharge mode and approximately +55°C when charging. It is possible to reach either of these limits if the system is operating at full capacity outdoors in direct sunlight. If this occurs, the charging will shut down along with the power supply to the STS4-4 hardware. Depressing the power button momentarily to check the battery status, the battery LED's simply show the first LED blinking, alternating between yellow and red.

It is good practice to locate STS4 components in shaded areas whenever possible. If that is not possible and the temperature is reaching the operating limit, then an alternate solution can be to cover the hardware with a cloth, or similar, to protect against direct sunlight. The STS-LIVE application will warn the user when the operating limit is close to being reached.

5.5 Moisture-Related Issues

STS4-WBS units have been designed to be used in outdoor harsh environments, meaning they are dust tight and able to withstand water spray (e.g. rain) without moisture intrusion. All dust caps must be secured to maintain a water seal to the Control Unit.

The STS4-WBS cannot be submerged under water. If this occurs, the unit should be powered down as soon as possible and then contact BDI for evaluation.

6. Maintenance & Storage

With careful handling and storage, STS4-WBS units should provide many years of use with the only limitations being battery life and potential changes in future IEEE network communication protocols.

- Periodically inspect housing and all connector receptacles.
- Keep unit clean.
- Store STS4-WBS units with a minimum of 20-40% battery charge.
- Store in cool, dry, and ventilated area.
- Store units in rugged transit cases similar to those supplied by BDI.
- If any maintenance is required, the STS4-WBS must be returned to BDI for repairs. Please refer to Warranty information at the beginning of this manual for further information.

7. Additional Help

Refer to Contact Us page at www.bditest.com, and/or call with questions at +1.303.494.3230.

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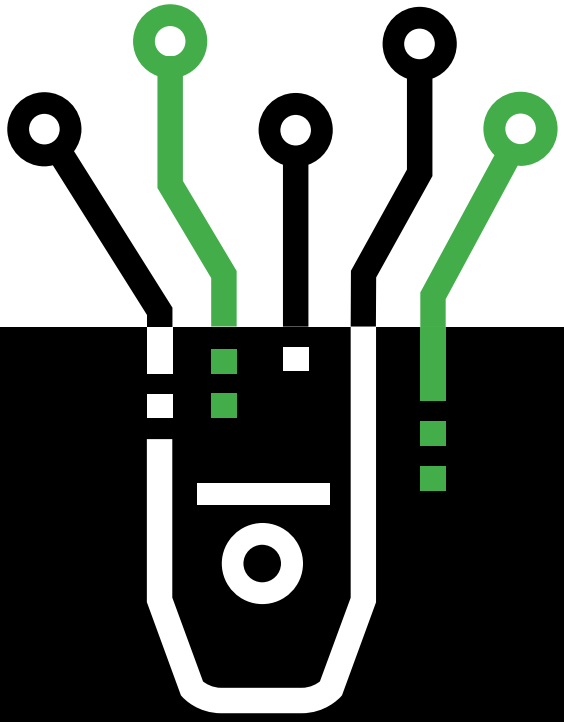

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