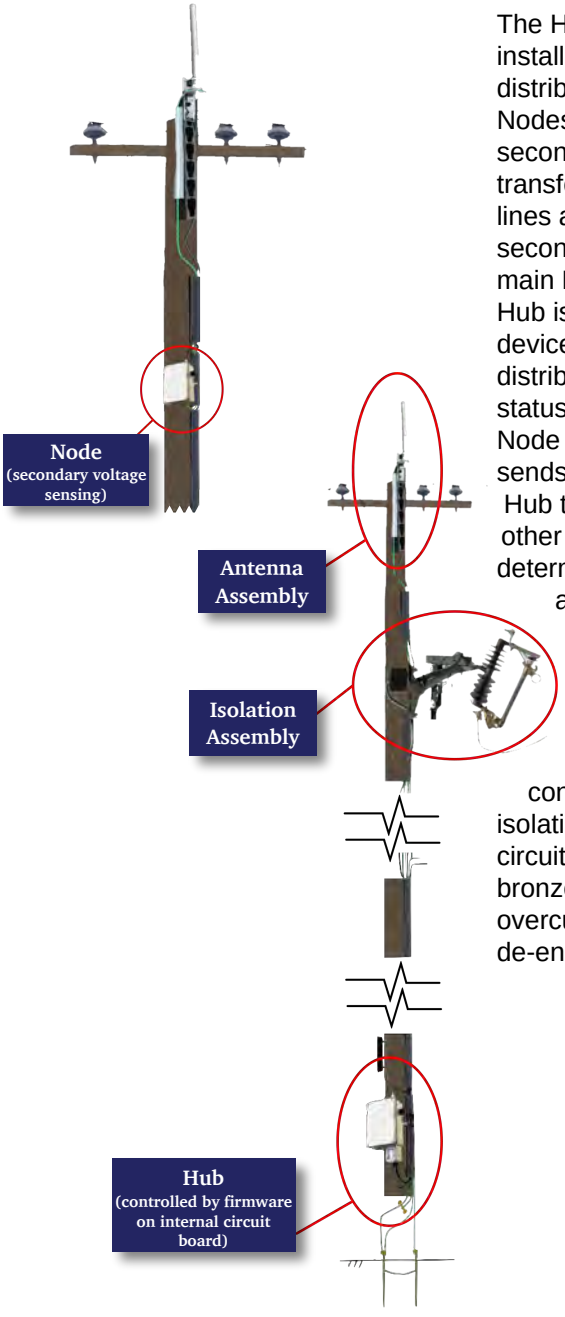
ELECTRICAL MATERIALS COMPANY

Products for the Utility Industry

Overview

Electrical Materials Company has developed the **High Impedance Fault Isolation System** (HIFIS), which is a solution to sensing and clearing high impedance faults on overhead electrical power distribution systems. The High Impedance Fault Isolator System (HIFIS) detects high impedance faults, even under zero fault current conditions, by sensing and analyzing loss of voltage at associated locations on the distribution system. Following positive analysis, HIFIS automatically de-energizes and isolates a live primary downed wire, if the overcurrent protection hasn't initially cleared the downed conductor.

Architecture & Function



The HIFIS system is built around a **Node** and **Hub** architecture. Typical installation would be located on a high voltage overhead primary distribution tap (see schematic of typical installation on page 2). The Nodes constantly monitor the voltage of the 120 volt service on the secondary side of overhead transformers on high voltage power lines and communicate their secondary voltage conditions to a main Hub through encrypted RF. The Hub is located near the overcurrent device at the beginning of the primary distribution tap. The Hub logs voltage status for each associated node. If a Node voltage status is below 85V, it sends an RF signal to the hub. The Hub then transmits RF signal to other associated Nodes to determine their status. The associated Nodes then transmit RF response signals back to the Hub. The Hub receives RF signals and then analyzes them using an EMC proprietary firmware, installed on a circuit board, for possible causes of voltage loss on the associated distribution tap. When the Hub confirms the loss in voltage, the hub microprocessor activates an isolation device. The isolation device is activated by closing 120 volt trip circuit which melts a 6K fuse link which releases a grounded coiled bronze spring. The spring applies a bolted fault to force operation of the overcurrent device, (low or no-spark fuse or recloser by others) which de-energizes the downed primary conductor.

HIFIS is a complementary backup for clearing the overcurrent protection system but it does not replace the overcurrent system.

Communication Specification

Antenna Information:	
Antenna Type	Monopole
Frequency	824 – 960 MHz
Gain	6 dBi
Vertical Beam Width	30 Degrees
Horizontal Beam Width	360 Degrees
Impedance	50 Ω
VSWR	< 1.5:1 avg
Connector	N type female

Radio Characteristics:	
Frequency Bandwidth	908 – 924MHz
Number of Channels	9
Data Rate	100 kbits/sec
Channel Spacing	2 MHz
Channel Bandwidth	529 kHz
Output Power	19 dBm
Transmitter Duty Cycle	3%
Modulation Type	FSK -2
Hop dwell time & Pseudo Random-Table	N/A
Radio Module Name	EFR32MG12 Gecko Multi-Protocol Wireless
Frequency deviation	50 ppm

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1/12/22

Electrical Materials Company
145 Elizabeth Lane
Genoa City, WI 53128

FCC ID: 2A3P5HIFIS1

Subject: FCC Statement to be included in the High Impedance Fault Isolation System's user manual

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.

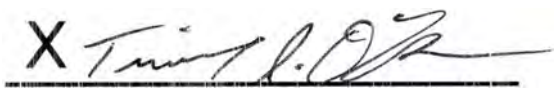
- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

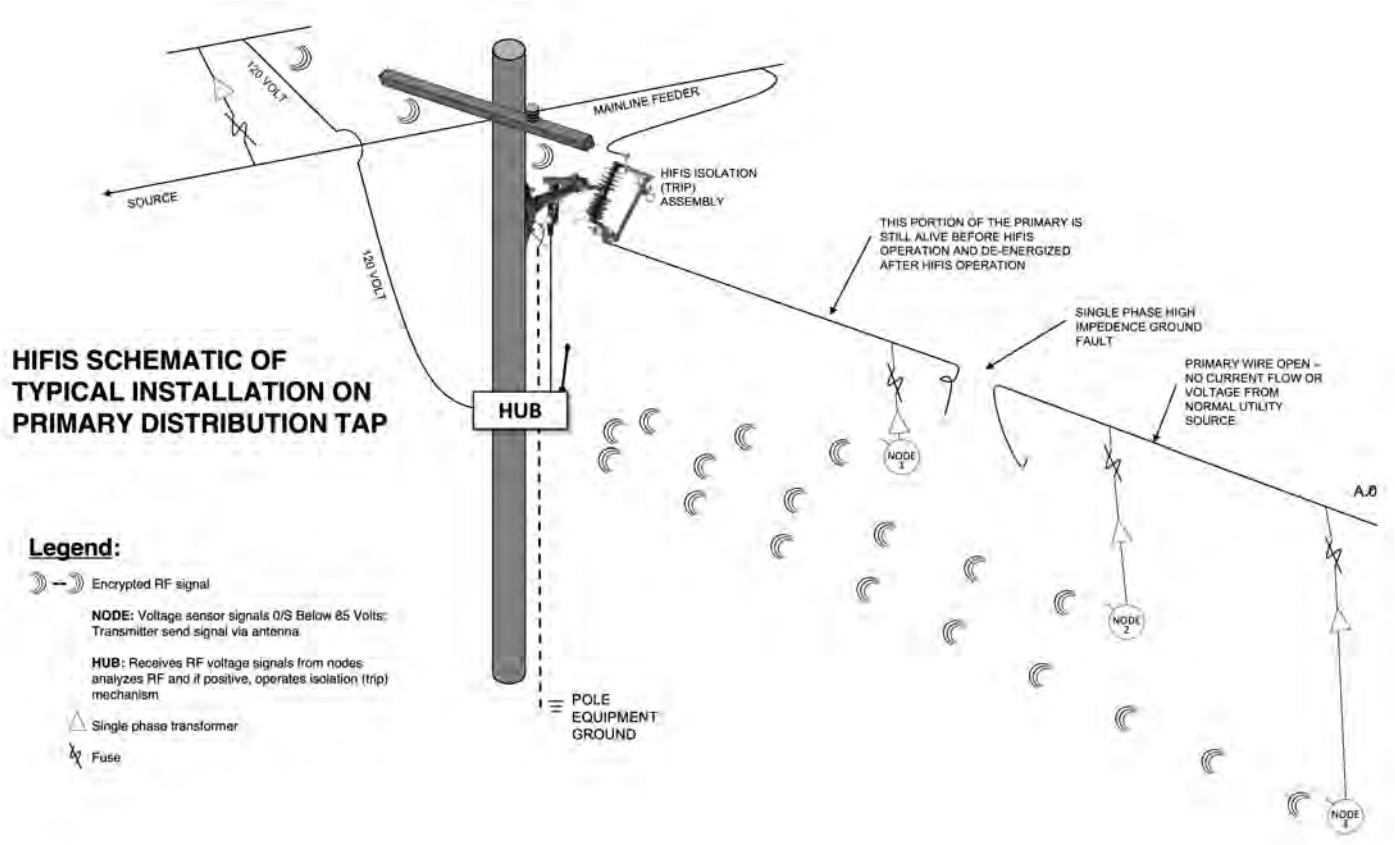
(Sign here)

X 

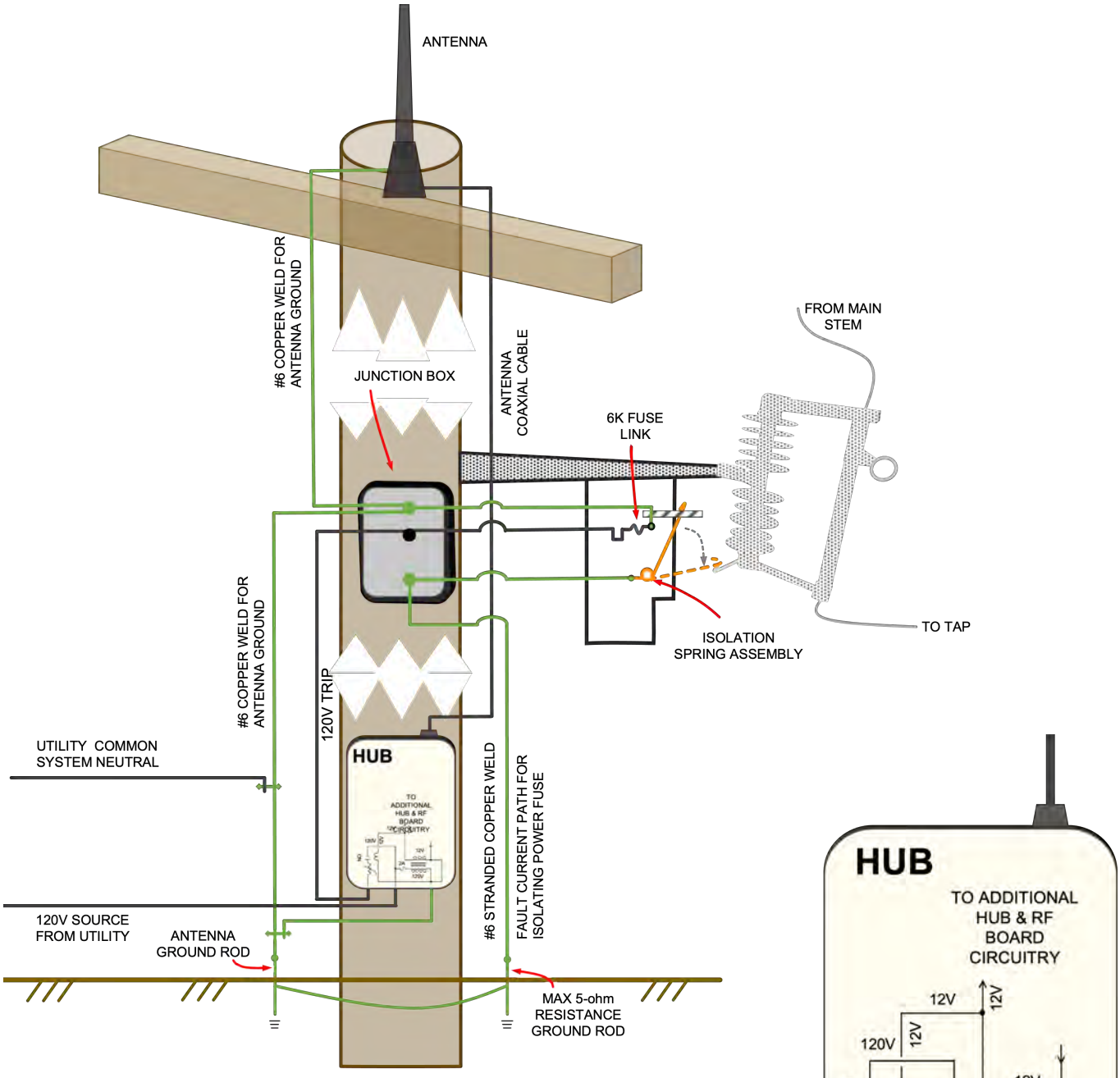
Title: President

Email: tim@rvpedestal.com

SCHEMATICS: System overview

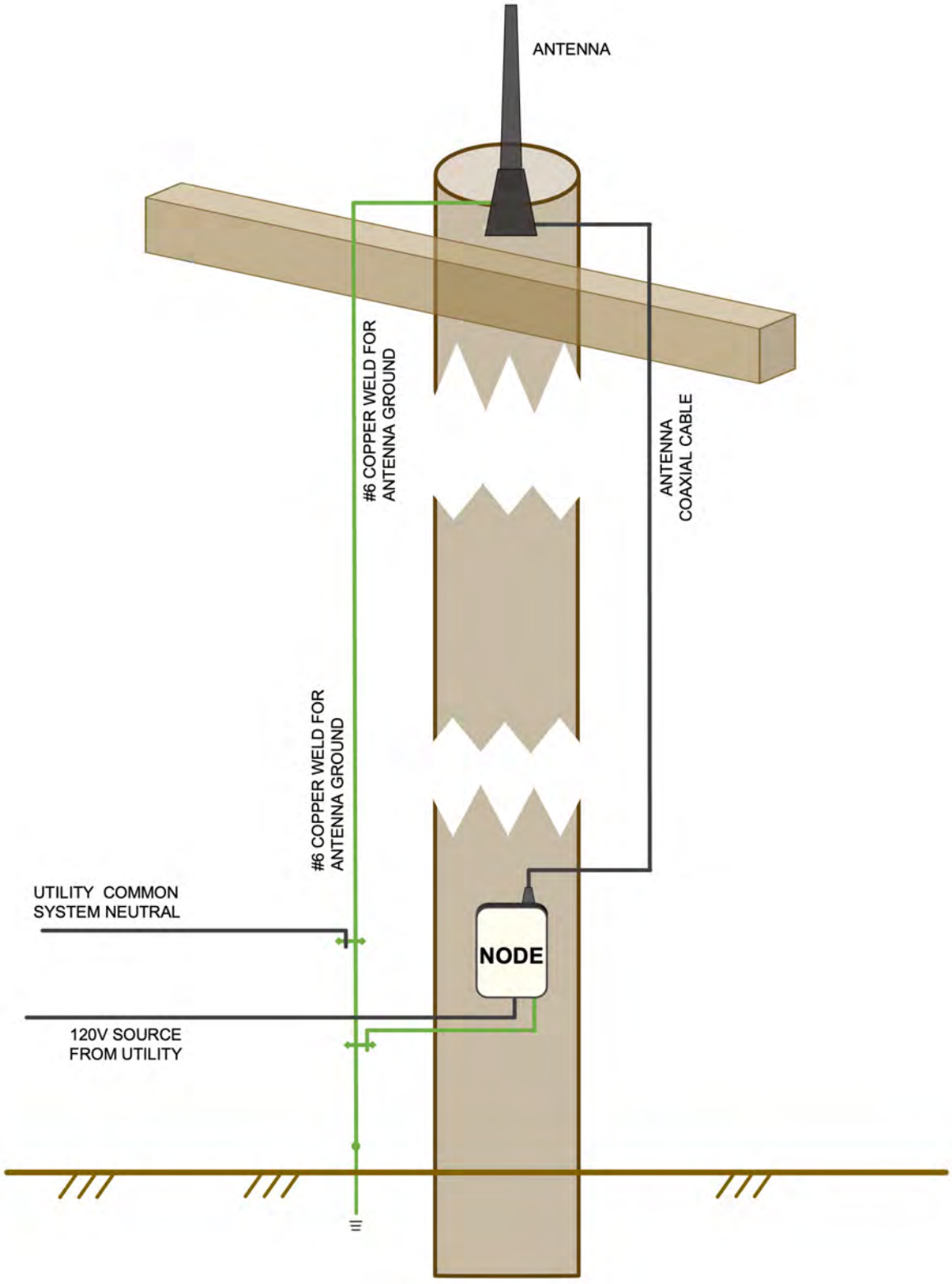


SCHEMATICS: HUB Schematic Wiring Diagram



Close up of Hub wiring

SCHEMATICS: NODE Schematic Wiring Diagram



HIFIS Hub & Node Installation & Commissioning

SECTION I: Hub and Isolation Device Installation

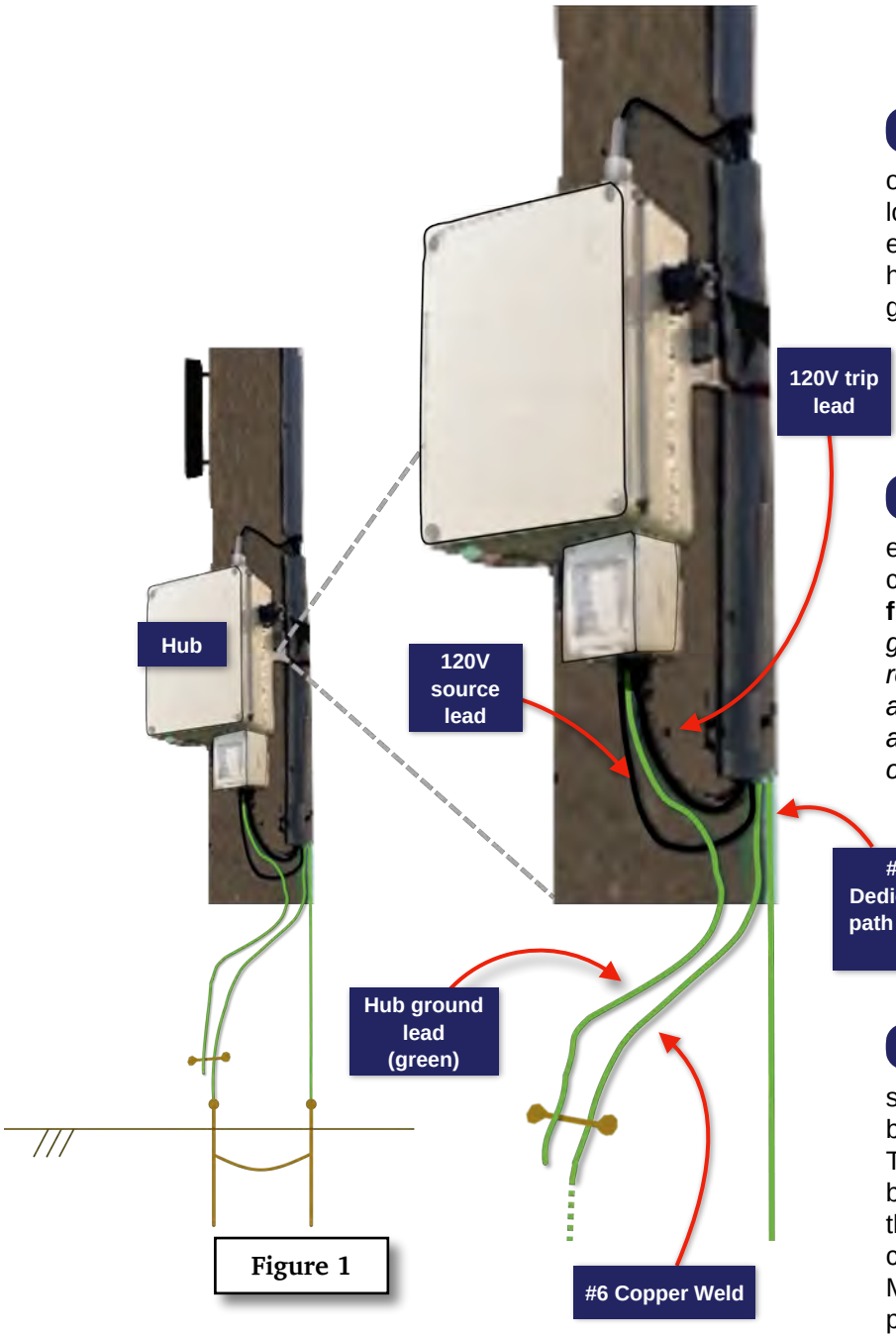


Figure 1

Figure 2
(close up of Hub)

1 Mount Hub enclosure on pole at overhead tap location, where overhead overcurrent isolation device is located. Mount Hub to pole with enclosed pole mounting brackets and hardware, at least 10' 6" above the ground.

2 Connect ground wire lead on bottom of switch on bottom of Hub enclosure to #6 Copper weld that is then connected to pole ground rod **(See figures 1 & 2)**. *Note: resistance on ground rod should be 5 ohms or less. If resistance is greater than 5 ohms, drive additional ground rod or use other approved means to obtain a ground of 5 ohms.*

3 Connect 120 volt utility source power to the Hub via the 120 volt source lead on the bottom of the switch box on the bottom of the Hub enclosure. The 120 volt utility power source should be obtained from the secondary side of the overhead transformer and connected to the 120 volt lead. Note: Make sure the switch is in the OFF position, so that the Hub is not powered on at this time.

(continued)

HIFIS Hub & Node Installation & Commissioning:

SECTION I: Hub and Isolation Device Installation

4 Install spring loaded isolation hardware device on the utility pole in the vicinity of the overhead overcurrent device (low or no spark fuse or recloser), on the same pole as the Hub enclosure. Install phosphor bronze contact arm on load side of expulsion fuse. **(See figure 3 and 4)**. Isolation device hardware shall be installed so that when phosphor bronze spring is fully extended, spring can make contact with load-side contact point (aka: grounding spring catcher) on overcurrent device. **(See figure 4)**.

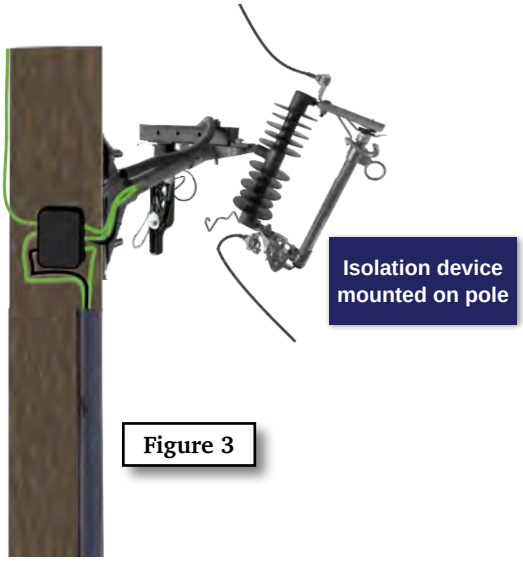


Figure 3

5 Connect green #10 trip ground lead from Isolation Device to #6 copper weld pole ground in junction box. **Note:** The green trip ground lead is in series with 6 K fuse element, immediately following the 6 K fuse control element that holds the phosphor bronze spring in tension. **(See Schematic Hub wiring diagram on page 3 in addition to Figure 4)**.

6 Connect 120 V trip lead from Isolation Device to 120V trip lead from Hub: Note that the black 120 V trip lead on Isolation Device is connected in series with 6 K fuse element and is connected to the common bus bar. Connect Isolation Device black 120V trip lead to Hub Black 120V trip lead inside junction box installed on pole in the vicinity of Isolation Device **(See Figures 4)**.

7 Connect Isolation Device phosphor bronze spring grounded lead: Note that Isolation Device phosphor bronze spring grounded lead is green #6 copper stranded wire connected to spring coil. **!WARNING! This ground wire carries fault current from the overcurrent device (either low spark or no spark fuse or recloser) and therefore, is required to have its own dedicated ground conductor that is connected to its own designated ground rod.**

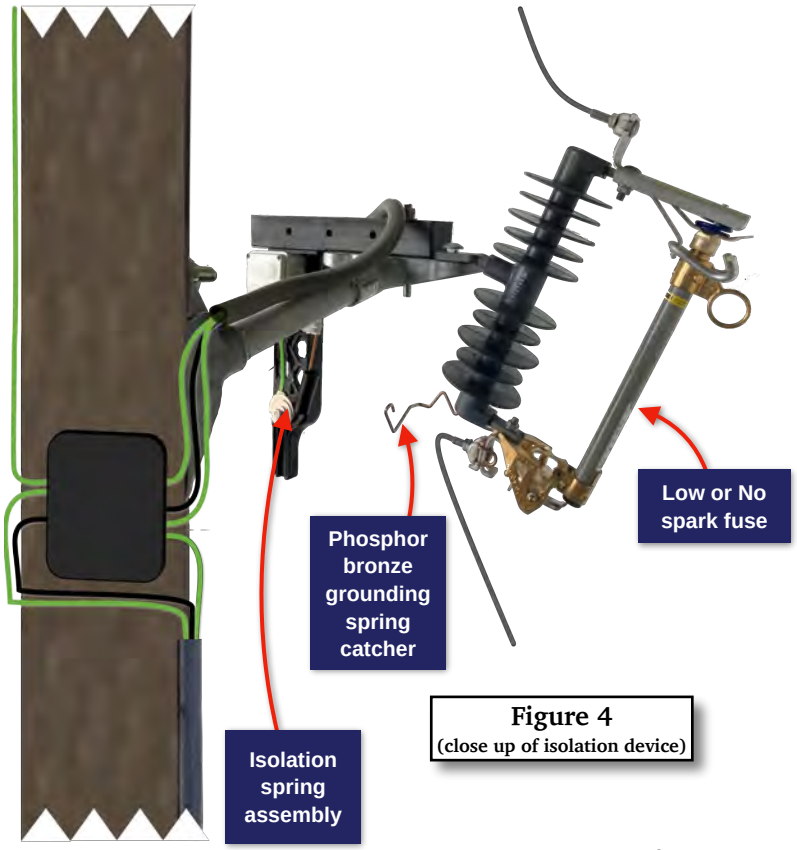
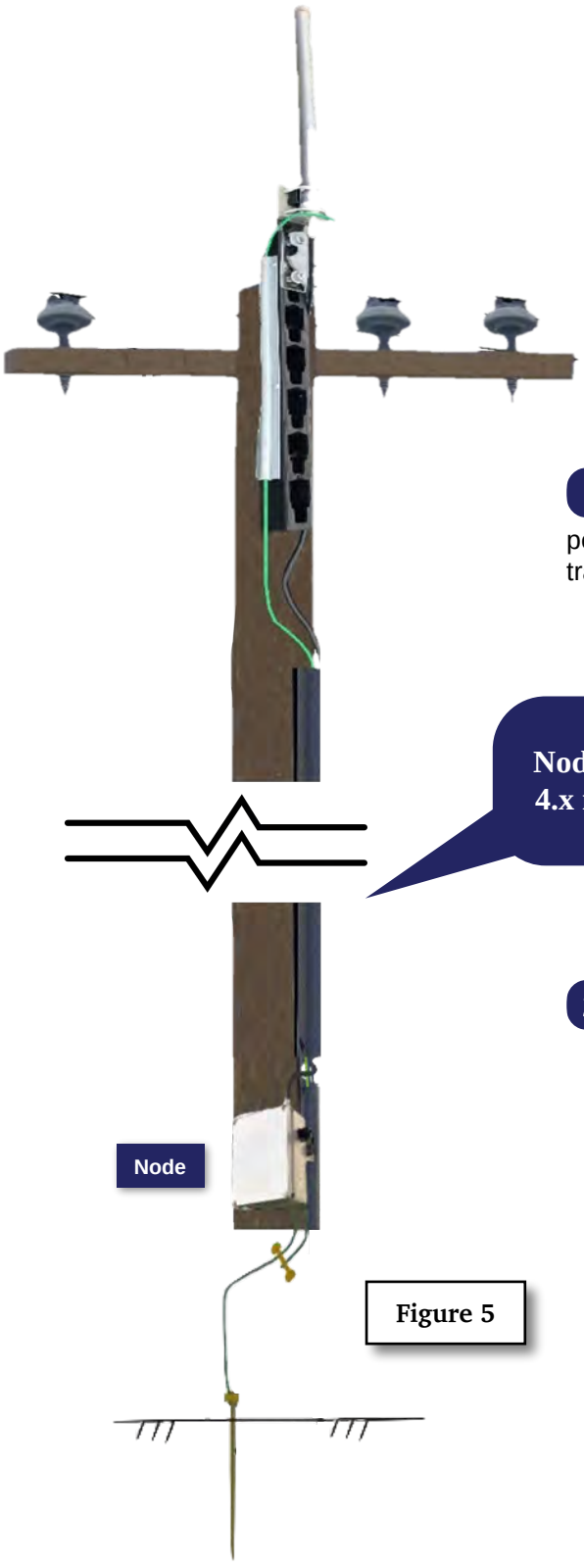


Figure 4
(close up of isolation device)

SECTION II: Node Installation



1 Mount Node enclosures on poles on the same primary overhead tap as the Hub, where it has been determined by utility personnel, where secondary voltage should be monitored at transformer locations.

Nodes in the HIFIS system have an RF range of 4.x miles from the Hub.

2 Mount Node to pole with enclosed pole mounting brackets and hardware, at least 10’ 6” above the ground.

Figure 5

(continued)
SECTION II: Node Installation

3 Connect ground wire lead from bottom of Node enclosure to same pole grounding wire #6 copper weld that is bonded to pole ground rod. **(See figure 6).** *Note: Resistance on ground rod should be 5 ohms or less. If resistance is greater than 5 ohms, drive additional ground rod or use other approved means to reduce ground resistance to 5 ohms.*

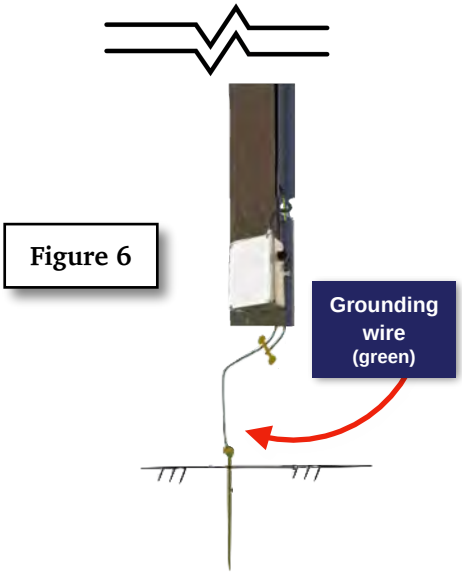


Figure 6

4 Connect 120 volt source power to Node via black 120 volt source lead on the bottom of the Node. 120 volt source power to be obtained from secondary side of overhead transformer **(See figure 7).**
*Note: Node is livened at this stage. Green LED light (**see figure 8**) on the side of Node should be illuminated when the Node PC Board is livened.*

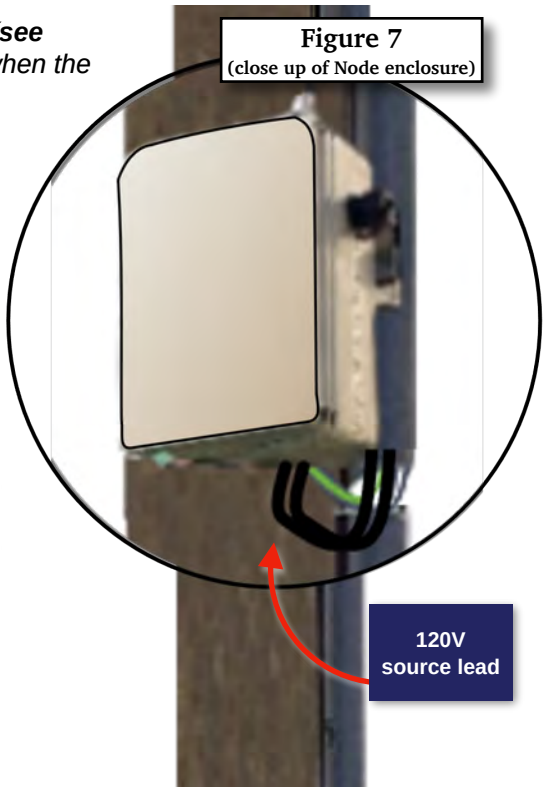


Figure 7
(close up of Node enclosure)

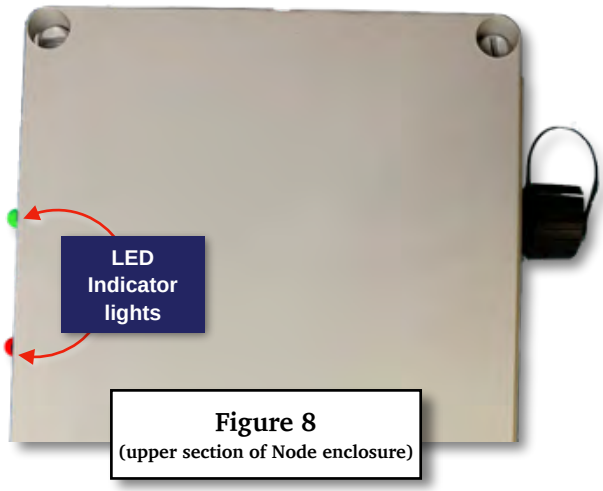


Figure 8
(upper section of Node enclosure)

(continued)

SECTION II: Antenna Installation

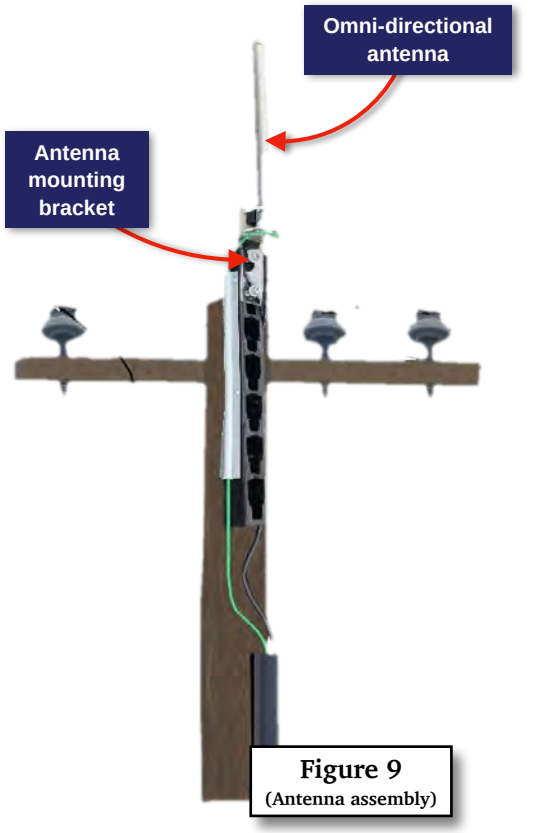


Figure 9
(Antenna assembly)

1. Mount auxiliary antenna to pole mounting bracket with enclosed hardware and mount bracket to pole top area with enclosed lag screws **(See Figure 9)**.

2. *Note: antenna is omni-directional, so no specific positioning is required for antenna installation.*

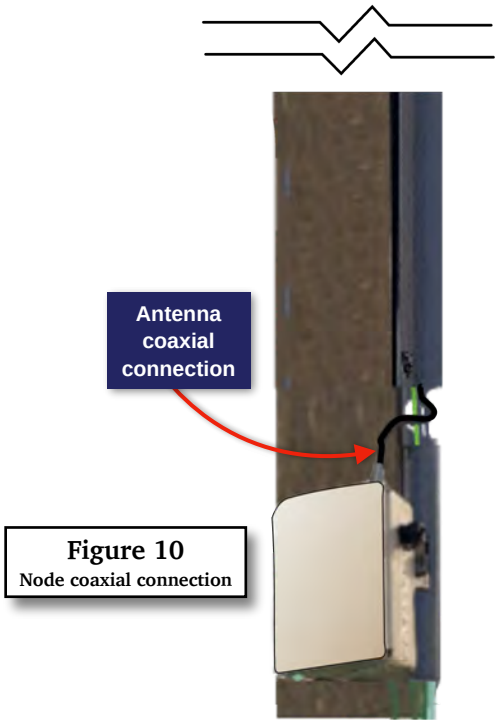


Figure 10
Node coaxial connection

3. Connect antenna coaxial cable to antenna connector on top of either Hub or Node (**See Figure 10).**

SECTION III: Hub & Node Commissioning

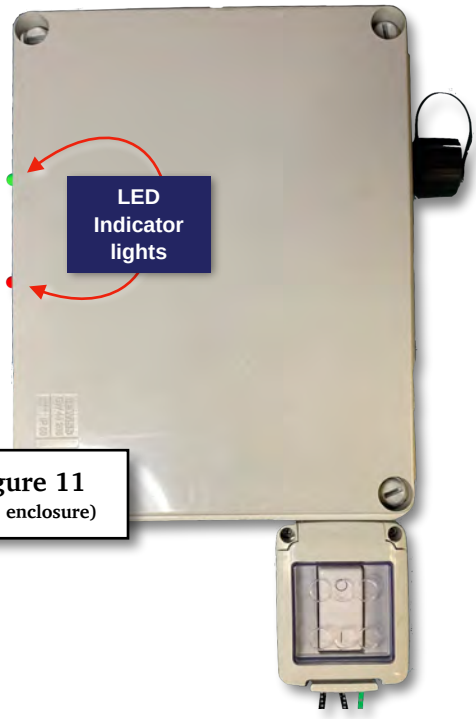


Figure 11
(Hub enclosure)

1. Once the Hub and associated Nodes are installed according to SECTIONS I & II, turn Hub switch to energized position. A green LED light on side of Hub should be illuminated at this stage **(See Figures 11 & 12 for location of LED indicator lights).**

2. Once Hub and associated Nodes are under power, firmware will automatically instruct Hub 900 MHz RF transmitter to send encrypted signals **only** to the associated Nodes on the tap. Each associated Node on the tap will verify that the Hub signal is correct, return an encrypted RF signal back to the Hub to confirm proper RF communication between the devices on the tap.

3. Hub and Nodes are now commissioned. *Note: Green LED lights on exterior of Hub enclosure and all associated Node enclosures shall be illuminated.* **The HIFIS system is now operational.**

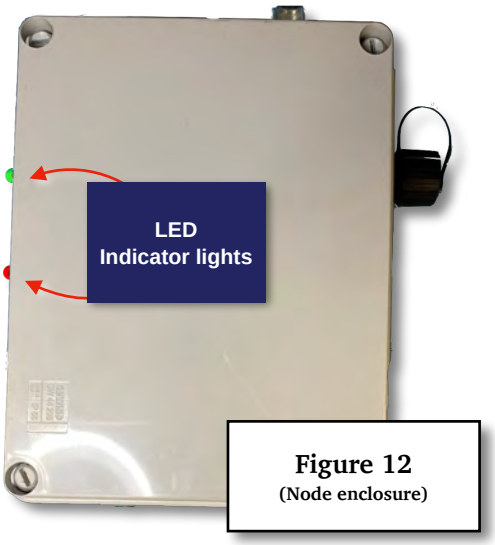


Figure 12
(Node enclosure)

4. **Under operational mode:** Nodes will automatically monitor 120 volt source voltage at a regular interval (every 3 seconds) and report status to Hub with encrypted RF signal. In addition, if any Node detects voltage below 85 volts, an encrypted RF signal will be transmitted to the Hub.
   - The Hub will then transmit encrypted RF signals to other associated Nodes on the tap to request voltage status at their location on the feeder tap. Nodes will then transmit encrypted RF voltage status signal back to Hub.
   - If Hub analysis is **negative** for a High Impedance Fault, no action is taken by the Hub.
   - If Hub analysis is **POSITIVE** for a High Impedance Fault, Hub closes 120 volt trip circuit that controls 6K fuse element on spring loaded isolation device, which causes 6K fuse link to operate, releasing the phosphor bronze spring to strike the contact arm on the overcurrent device causing the overhead overcurrent device to operate, which de-energizes downed live primary line.

(continued)

SECTION III: Hub & Node Commissioning

5 Once downed power line is de-energized, 120 volt source sensing power to Nodes is then also de-energized as a result. At this time, no action is needed to be taken regarding the source power to the Nodes. Note: Hub and Nodes have supercapacitors that will provide 4 minutes of backup power for communication purposes, when the 120 volt source power is de-energized. Note: If the Hub 120 volt source power is lost, then entire tap is already de-energized upstream of the Hub and the Hub firmware recognizes the condition and Hub takes no action. The downed overhead primary line shall be the focus at this point and that primary overhead line shall be re-connected. Overhead overcurrent system (low or no spark power fuse) shall be replaced and re-loaded for normal operation. Power to Hub and Nodes shall be restored now and Green LED lights on enclosure exteriors shall be illuminated. HIFIS isolation device support bracket arm should be replaced with new pre-loaded isolating spring device which is located on the support bracket arm. This replacement bracket with pre-loaded shorting spring is stored in a storage compartment on the side of the utility pole. **(See Figure 13)**.

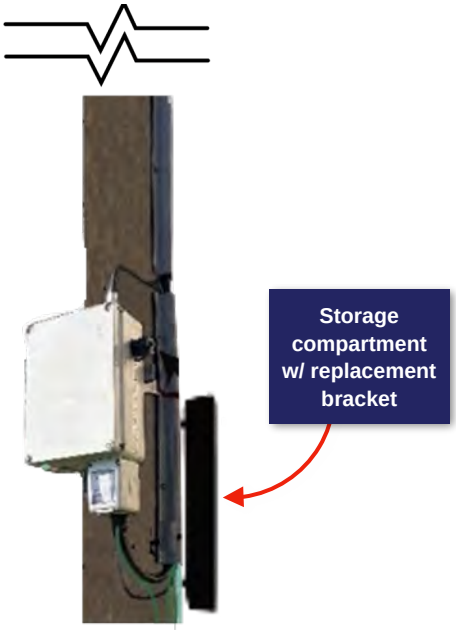


Figure 13
(Hub enclosure w/ storage compartment)

6 Note: If the Hub 120 volt source power is de-energized then the entire tap is already de-energized due to main stem outage and the Hub firmware recognizes the condition and the hub takes no action. In this case, troubleshooting the cause of the primary outage and re-energizing the primary line, shall be the focus at this point by utility personnel. Tap and Hub are restored following re-energization.

7 If Hub or Nodes lose power under the above scenarios 5 and 6, once Hub and Nodes are reenergized commissioning step 2 above will automatically be recommenced between the Hub and associated Nodes to reestablish communication links.

System is now fully operational after communication has been re-established…

SECTION IV: Troubleshooting

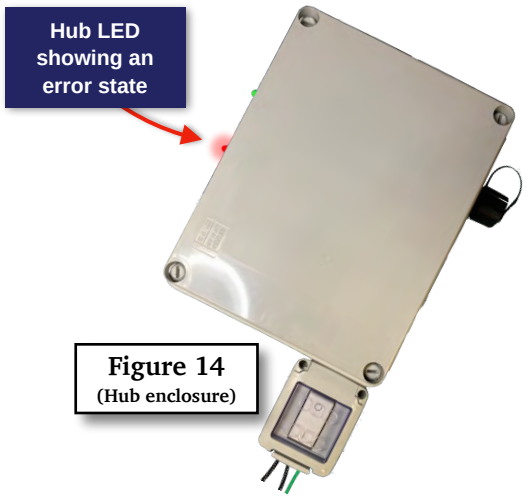


Figure 14
(Hub enclosure)

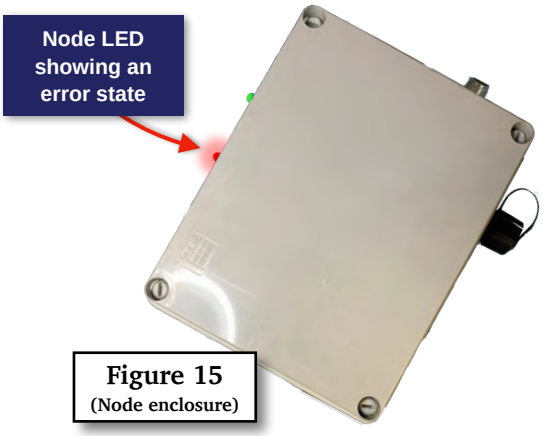


Figure 15
(Node enclosure)

1 *Note: at any time following installation of the HIFIS system, if any Hub or Node enclosure has its Red LED illuminated on the side of the enclosure, this is a notification that the device is malfunctioning.*

2 If Hub has Red LED illuminated, **(See Figure 14)** turn switch power to "OFF" and wait 5 minutes for super capacitors to discharge. Then, turn power back to "ON" position. If Green light is now illuminated, no further action is required. If Red LED is still illuminated, remove Hub enclosure from pole and replace Hub enclosure. The replacement Hub enclosure must be pre-programmed to recognize associated Nodes when 120 volt source power is connected to it. Hub and associated Nodes will follow commissioning step number 2 until system is operational. ***If Hub is still not operational at this time, please call (262) 279-3812, and a technician will further assist you.***

3 If Node has Red LED illuminated, **(See Figure 15)** disconnect 120 volt power lead on PC Board and wait 5 minutes for super capacitors to discharge. Then re-install 120 volt power lead to connector on PC Board. If Green LED is now illuminated, no further action is required. If Red LED is still illuminated, remove Node enclosure from pole and replace with a replacement Node enclosure. Replacement Node enclosure must be pre-programmed to recognize associated Hub and Nodes when 120 volt source power is connected to it. Hub and associated Nodes will follow commissioning step number 2 until system is operational. ***If Node is still not operational at this time, please call (262) 279-3812, and a technician will further assist you.***