Vital Proximity Detection System Technical Reference Manual

BNSF

Shifted Load Detector

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*** Warnings and Cautions ***

The following technical Reference Manual is provided for reference only. Consult authorized signal staff for approved signal practice.

The VPD circuit board should be handled with care to prevent electro-static discharge (ESD) damage during the installation and wiring of the signal system.

The VPD has no field serviceable parts. Circuit board should be returned to J&A Industries for repair. Attempting to repair the circuit board will void warranty.

Most of the parts contained in the Shifted Load Detector are custom fabricated, lead times for delivery of some parts can exceed 4-6 weeks. Spares should be kept on-site to prevent train or service delays.

A typical installation schematic for the sensor and circuit board wiring is provided in this Technical Reference Manual. On-site official signal circuit plans should be used for the troubleshooting of the signal circuit.

The magnets used in the High Wide Detector are rare earth or neodymium magnets and are extremely strong, and must be handled with care to avoid personal injury and damage to the magnets. Fingers and other body parts can get pinched between two attracting magnets. Neodymium magnets are brittle, and can peel, crack or shatter if allowed to slam together. Eye protection should be worn when handling these magnets.

The strong magnetic fields of neodymium magnets can also damage magnetic media such as floppy disks, credit cards, magnetic I.D. cards, cassette tapes, video tapes or other such devices. They can also damage televisions, VCRs, computer monitors and other CRT displays. Never place neodymium magnets near electronic devices. ***USE SPECIAL CARE AROUND THE VPD CIRCUIT BOARD***

Never allow neodymium magnets near a person with a pacemaker or similar medical aid. The strong magnetic fields of the magnet can affect the operation of such devices.

Neodymium magnets will lose their magnetic properties if heated above 175°F (80°C).

Proximity Sensor Signal Detection

Operation Description:

The Proximity Sensor detection system is made up of 2 major components: inductive proximity sensors and Vital Proximity Detection (VPD) circuit board. The proximity sensors perform the position detection of critical signal components to an exact predetermined distance.

The VPD circuit board provides the validation of the proximity sensor inputs for signal indication, checking for shorts, line resistance, and proximity sensor failure. Both of these components have been designed to provide a state-of-the-art detection system and meet AREMA vital specifications.

Proximity Sensor:

The proximity sensor is an inductive component containing two basic elements; an oscillator and a coil. The oscillator creates a frequency that is emitted from the coil and out through the sensor face. If a metal object enters this radiated field, eddy currents are induced on the metal targets' surface. As the target plate moves closer to the sensor, the eddy current increases, causing greater load on the oscillator. Control output is triggered when the oscillator load reaches a predetermined level which is related to the predetermined distance.

The proximity sensor is permanently encased in a stainless steel sleeve to provide additional protection and secured in the bracket using positive retention locking fasteners. (Refer to appendix for proximity sensor technical data)

Circuit Board:

The VPD circuit board performs the logic function with input from the proximity sensors and provides vital isolated +12 V output to the signal relays. Each output is driven by two switching power supplies, powered from each of the two microprocessors, providing redundant operation. Each microprocessor must also drive the power supplies at a specific frequency or if one would "hang up" no output would be allowed to be active. The circuit board also provides an external alarm output sent out to a signal relay if any error is detected by the circuit board. (Refer to appendix for VPD circuit board technical data)

Operation Description: (continued)

The Shifted Load Detector system utilizes one (1) VPD circuit board that monitors two (2) proximity sensors per track side, that in turn monitor the vertical cable position. Each lower Shifted Load extension arm houses two adjustable proximity sensors that detect the spring actuated target plate position. When the trip wire is properly adjusted, a shifted load will break the wire at the appropriate connection point causing the sensors to loose detection and drop relay drive to appropriate signal relays. The system is designed so that the trip wire breaks at the top mast extension arm. This is accomplished by using a lower pull force magnet on the top arm than the bottom and allows a backup infrared (IR) system to be turned on as backup without interference from the broken trip wire.

Proximity sensors provide input to the VPD circuit board. The input and output circuits of the VPD unit will switch on or off dependent upon cable tension and display through the LEDs located on each circuit board. Both proximity sensors must detect the tensioned position of the target plate or the relay outputs will not indicate. Proper adjustment and set up of the proximity sensors will be covered later in this Technical Manual.

During normal operation the following LED indications (see Table 1 on Page 6) located on the circuit board will appear as depicted in the following table (refer to Figure 1 for location of the LED indication lights): This table is shown as typical.

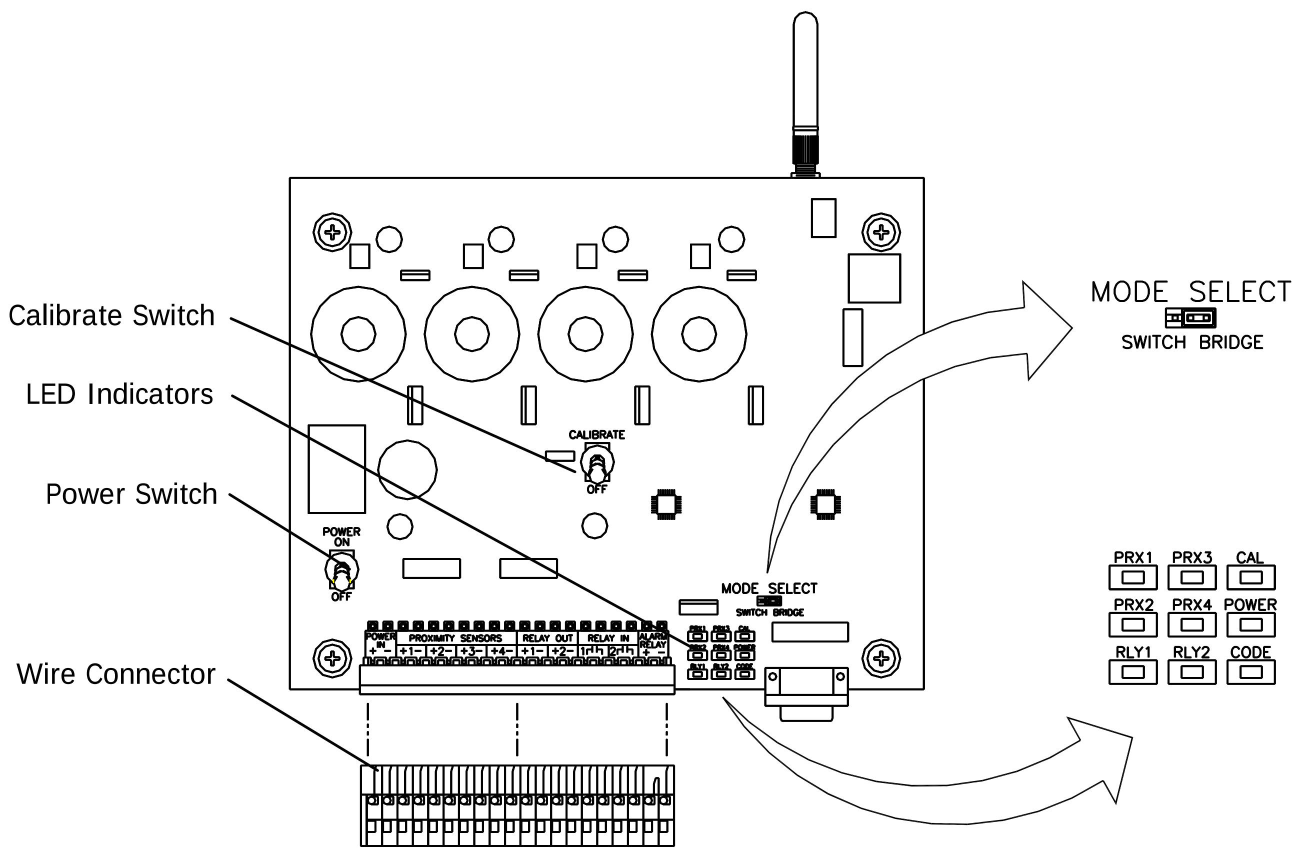


Figure 1. VPD Circuit Board Layout

Operation Description: (continued)

Table 1. Circuit Board LED Indications

Circuit Board LED Indication Label	Sensor Location		Closed Position LED (Cable in Place)	Open Position LED (Broken/Loose Cable)
PRX 1	Near Rail Detector Proximity Sensor		ON	OFF
PRX 2	Near Rail Detector Proximity Sensor		ON	OFF
RLY 1	Relay 1 Contact Feedback		ON	OFF
PRX 3	Far Rail Detector Proximity Sensor		ON	OFF
PRX 4	Far Rail Detector Proximity Sensor		ON	OFF
RLY 2	Relay 2 Contact Feedback		ON	OFF
CODE	VPD Circuit Board		OFF	OFF

Operation Description: (continued)

Remote Status Unit (RSU):

The Remote Status Unit (RSU) (see Figure 2) provides the maintainer with an instrument to determine proximity sensor and signal relay on/off status during the operation, adjustment, and setup of the VPD system. The handheld unit also provides the user with circuit board status while allowing sensor adjustment by a single individual. The RSU operates on a 9-volt battery located in the base of the unit and should be checked regularly to ensure that the unit is providing the strongest signal.

To begin using the Remote Status Unit handheld, turn on the power toggle switch located on the lower portion of the remote status unit. The LED on the handheld toggle switch will light to show power "ON". Ensure that the "CALIBRATE" mode switch is turned to the "on" position on the VPD circuit board (refer to Figure 1). A corresponding "CAL" LED on the circuit board will illuminate to indicate an "ON" status.

The RSU will go through a normal startup sequence where each LED on the unit illuminates to confirm operation. The red "VALID SIGNAL" LED must be illuminated on the RSU to confirm proper reception from the VPD circuit board's RF transmitter. The LED lights on the RSU handheld unit will flash occasionally to correspond with the circuit boards intermittent broadcasting of the VPD status. A loss of signal strength or operability of the handheld unit will usually indicate battery replacement is required.

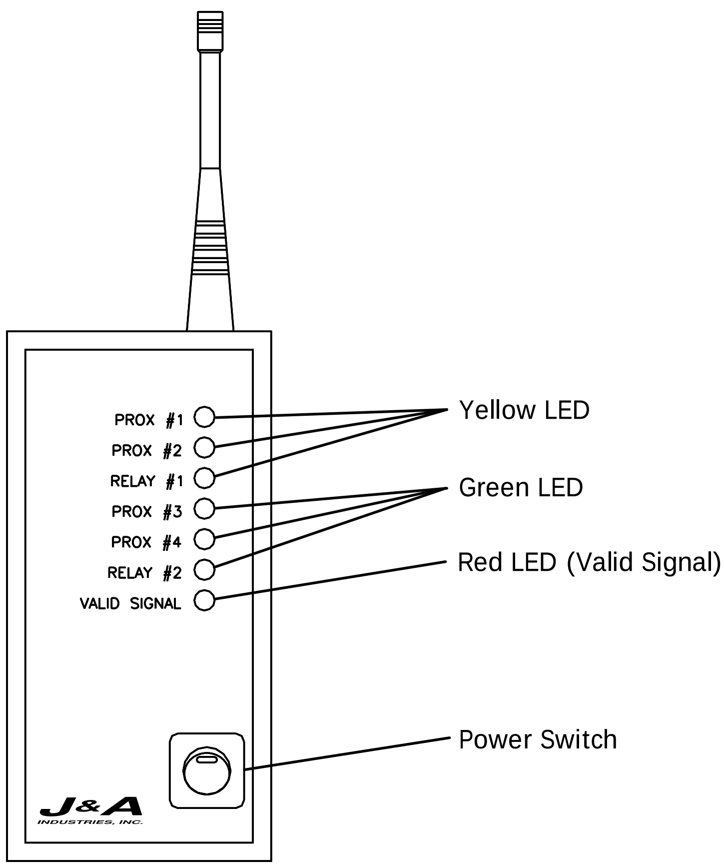


Figure 2. Remote Status Unit

Troubleshooting Information

Failure Indications:

If a proximity sensor or circuit board failure occurs, a red LED indicates an error code output on the VPD circuit board (see Figure 1, page 5 to identify the CODE LED location). The code will flash on and off to indicate the error type as depicted on the following table. (Page 9, Table 2) This VPD system feature is designed to aid the signal maintainer with most of the common troubleshooting issues.

Generally, turning the power off for 15 seconds and then on again will reset the VPD and re-energize the outputs to return to normal operation, provided the improper input which caused the failure no longer exists. If a required input is still incorrect or the circuit board has detected a failure after resetting, the VPD will simply go into failure mode again.

If one or more of the proximity sensors is out of detection range the signal relay will not pick up and will require the signal maintainer to inspect the sensor and move it back into proper adjustment. Comparing the proximity sensor and relay LEDs on the VPD circuit board or using the handheld RSU will aid with the troubleshooting. Refer to the Sensor Adjustment Procedure (see page 10) to return sensor to proper adjustment range.

When the circuit board indicates an error, it is advisable to first compare the VPD circuit board indicator LEDs using the Error Codes. There are two main possibilities for error types; sensor or circuit board related errors. The circuit board LED lights will flash short and long on/off sequence that repeats after a short pause. Troubleshooting charts for both the sensors and circuit board are located on pages 15 and 16.

Simply note operational lighting sequences (on/off) of the red circuit board error code LED with the following table:

Table 2. Circuit Board Error Indication Codes

Dash Sequence		Description	Location	Cause
• • • —	3 short – 1 long	Sensor 1 Error	Far rail trip wire	Most probable: Sensor disconnected, connected reverse polarity, or failed. Input opened or shorted. Other causes: Bad component in analog channel 1 on circuit board
• • — •	2 short – 1 long – 1 short	Sensor 2 Error	Far rail trip wire	Most probable: Sensor disconnected, connected reverse polarity, or failed. Input opened or shorted. Other causes: Bad component in analog channel 2 on circuit board.
• — • •	1 short – 1 long – 2 short	Sensor 3 Error	Near rail trip wire	Most probable: Sensor disconnected, connected reverse polarity, or failed. Input opened or shorted. Other causes: Bad component in analog channel 3 on circuit board.
— • • •	1 long – 3 short	Sensor 4 Error	Near rail trip wire	Most probable: Sensor disconnected, connected reverse polarity, or failed. Other causes: Bad component in analog channel 3 on circuit board
— — • •	2 long – 2 short	MODE Error	Circuit board jumper	Mode Select jumper not installed
— — • • •	2 long – 3 short	SYNC Error	Circuit board dual processor communication	CPUs not communicating – Most probable: R26 (0 ohm) open, missing, or bumped out of tolerance Other causes: CPU2 not running, open or shorted and/or clock lines Improper jumper placed on P1
— — •	2 long – 1 short	RES Error	Circuit board resistor pairs	Most Probable: Analog channel 1 – 4 resistor pairs are out of balance. Other causes: U1/U2 analog inputs are bad.
• • • • •	1 Short	SHIM Error (Switch Mode)	Circuit Board MODE Select jumper in	Most probable: Mode Select jumper is set for SWITCH mode instead of BRIDGE mode Other causes: U1/U2 analog input bad
— — • • • •	2 long – 4 short	INPUT TEST Error	Circuit Board	Most probable: Analog channel 1 – 4 problem Other causes: U1/U2 analog bad
— — — —	1 Long	Power Supply Error	Circuit Board	Most probable: Bad power supply Other causes: Bad component in the power supply feedback circuit
		Relay Error	Signal Relay	Most probable: Bad signal relay or relay feedback is disconnected from circuit board Other causes: Bad component in the relay feedback circuit

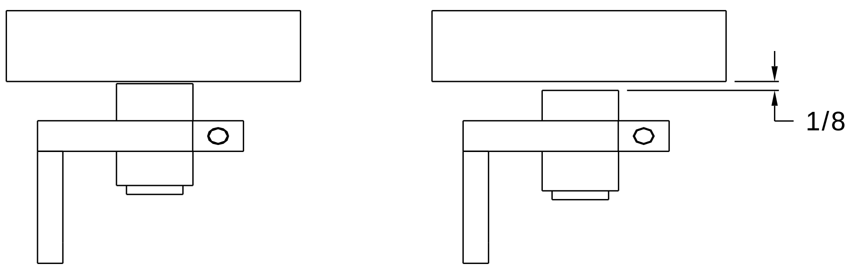
Sensor Adjustment Procedures

Dual Proximity sensors provide position indication at the lower cable end for the Shifted Load Detector. The proximity sensor mounting brackets are attached to the lower base arm. Remove lower arm cover to access the proximity sensor mounting bracket.

Adjustment Procedures:

The proximity sensor bracket has one adjustment: The proximity sensor attached in the bracket can be raised or lowered. The bracket itself cannot be raised and lowered or adjusted in any way.

The typical sensor “ON” or detection distance is 10mm, (0.3937”) or approximately 3/8”. If you want the indication to turn “OFF” when the target plate moves away from the proximity sensor 1/4” then adjustment of the sensor would require setting the sensor 1/8” away from the target. Other variables on proximity sensor detection distances may include temperature or type of metal being detected.



Proximity Sensor adjusted to turn off at 3/8 inch

Proximity Sensor adjusted to turn off at 1/4 inch

Figure 3. Proximity Sensor Setup

1. Ensure that the calibrate mode switch, located near the center of the Vital Proximity Detection (VPD) circuit board has been turned on (see Figure 1, Page 5). A red indicator LED on the circuit board will illuminate to confirm an “on” position.

2. Turn on the handheld Remote Status Unit (RSU) and wait for the unit to fully cycle through the startup procedure. The “Valid Signal” LED light on the handheld RSU will be on only if the VPD circuit board calibrate switch has been turned on.

It is normal for the RSU LED indicator lights to flicker on the handheld unit as the circuit board broadcasts information to the handheld unit. If signal distance or strength deteriorates, replace the 9-volt battery located in the base of the RSU. When not in use ensure that both the handheld RSU and the calibrate switch located on the VPD circuit board are turned off.

3. Pull up on cable or turnbuckle to allow placement of the spacer tool under the target tabs. (See Figure 4, Page 11)

Adjustment Procedures: (continued)

4. Remove the retainer clip from the head of the locking screw located on the front of the sensor mounting bracket. Carefully remove the locking tab from the locking screw. The locking screw head should now be accessible. Using a wrench or socket loosen the screw just enough to free the sleeved proximity sensor from the bracket.

5. Slide the proximity sensor either up or down to desired position using the handheld RSU to determine when the sensor turns either on or off. The Spacer Assist Tool will allow the spring actuated Target Plate (Figure 4) to be secured to aid with proximity sensor alignment. The Spacer tool is designed so that the cover cannot be attached while tool is in place. ***DO NOT SUBSTITUTE***.

6. While keeping proximity sensor in the desired position, firmly tighten the locking screw, replace the locking tab, and retainer clip. Confirm that the proximity sensor is secure in the bracket.

7. Turn off the RSU handheld switch and the calibrate mode switch on the VPD circuit board.
REMOVE THE SPACER ASSIST TOOL and replace the cover.

Figure 4. Sensor Adjustment

Adjustment Procedures: (continued)

Cable setup and adjustment:

Cable length will be determined by each site specific setup. Spare 1/16” clear plastic coated cable wire can be preassembled as spares and kept for replacement. Each site is provided with extra cable crimps, cable end pucks, and crimp tool.

The cable length should be determined with the spacer assist tool in place and the cable base with turnbuckle pulled to the full up position. The spacer assist tool will always ensure that the cable base is in the correct position.

The cable base turnbuckle should be adjusted before determining site specific cable length. The turnbuckle has approximately four (4) inches of adjustment and should be set at around ten (10) inches overall length measured from the top of cable collar to center of 5/16” clevis pin. (See Figure 6) This will ensure the greatest amount of adjustment both ways.

Make sure that the exposed thread lengths match between the top and bottom turnbuckle screws. Use the spacer assist tool to keep the tensioned target plates in the top position.

Attach one cable end puck to the cable end using crimper and cable crimps and attach cable end to the top support arm magnet. Feed second cable end puck through cable end and attach to the bottom arm magnet. Pull slack from cable, making sure not to pull cable end from top magnet, and mark cable where the lower cable puck should be attached.

Complete cable by permanently attaching lower cable end puck with cable crimps. Attach cable to the lower magnet and adjust the turnbuckle so that the excess slack is removed from the cable. Do not over tighten the cable to prevent exceeding magnet capacity, thereby avoiding a premature tripping of the cable. Secure jam nuts on the turnbuckle to prevent loosening.

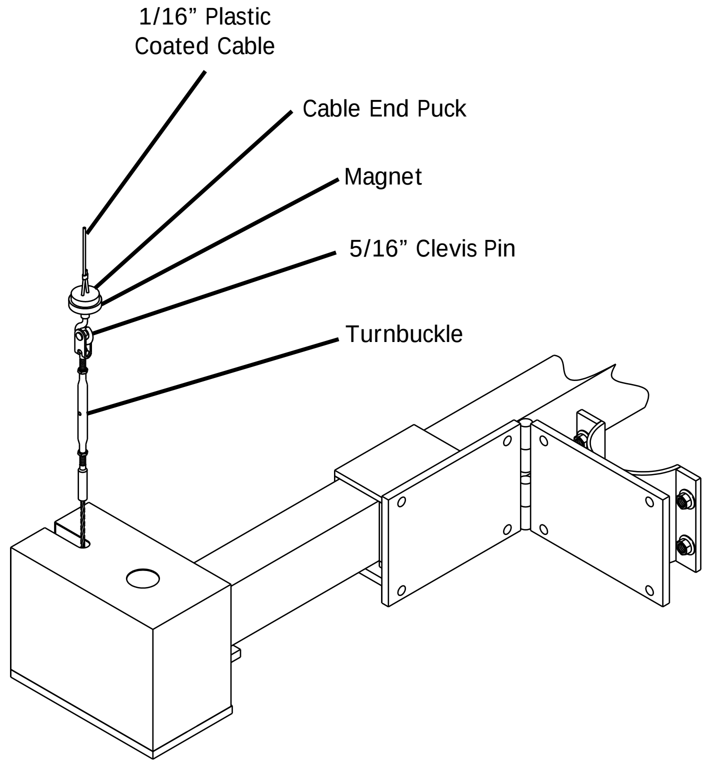


Figure 5. Cable Setup
(Shown with arm swung out)

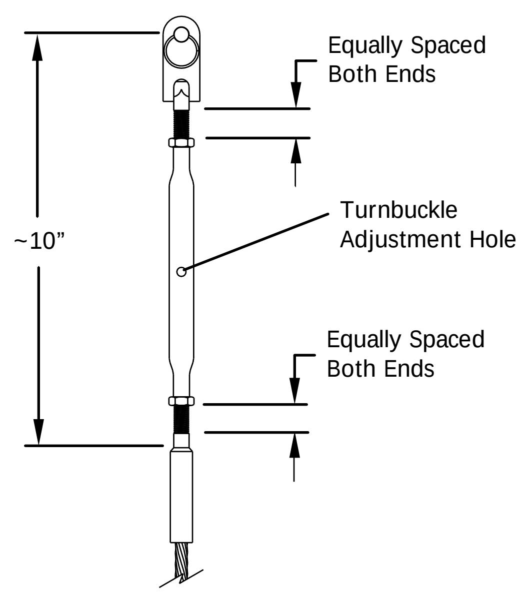


Figure 6. Turnbuckle Adjustment

Adjustment Procedures: (continued)

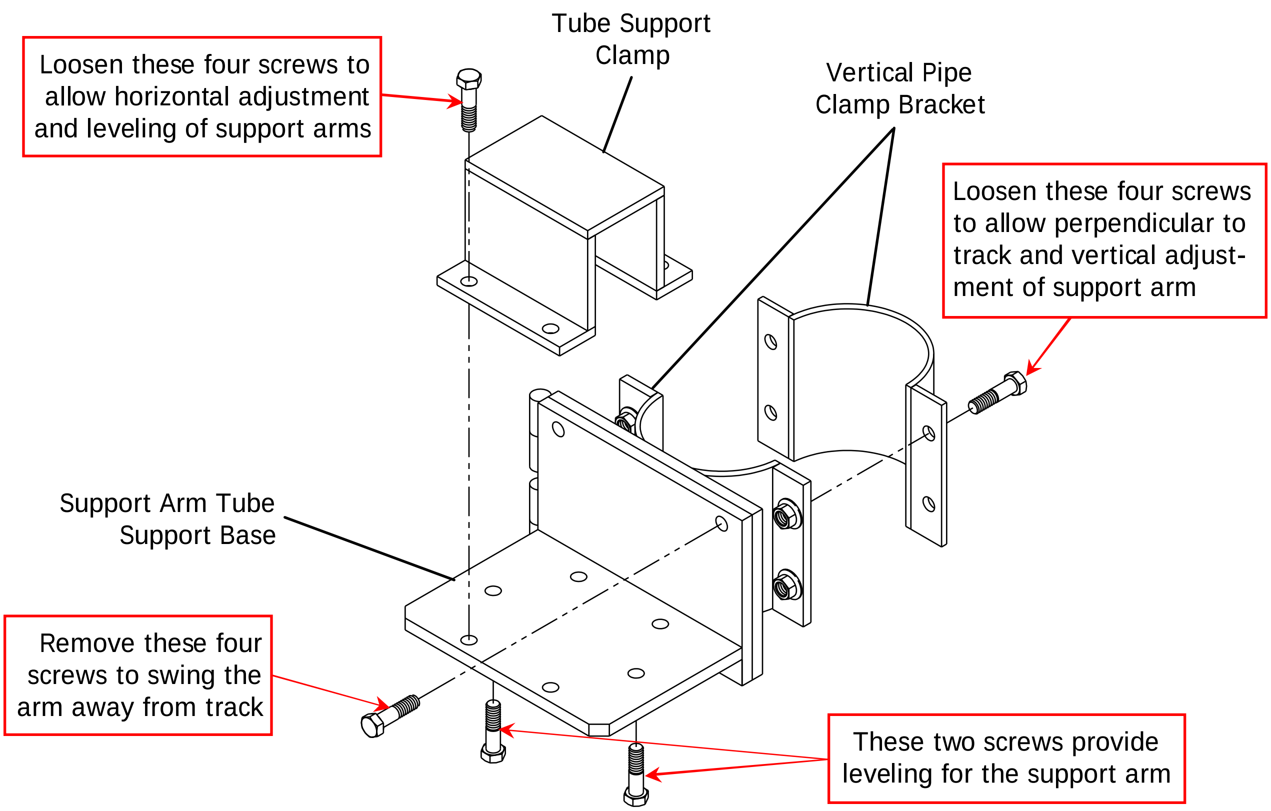


Figure 7. Clamp Adjustment Components

VPD Circuit Board Replacement

Use caution whenever handling the VPD circuit board to prevent damage from electrostatic discharge (ESD)

There are no replacement components for the Vital Proximity Detection circuit board. Tampering or attempting to replace components on the VPD circuit board will void the factory warranty.

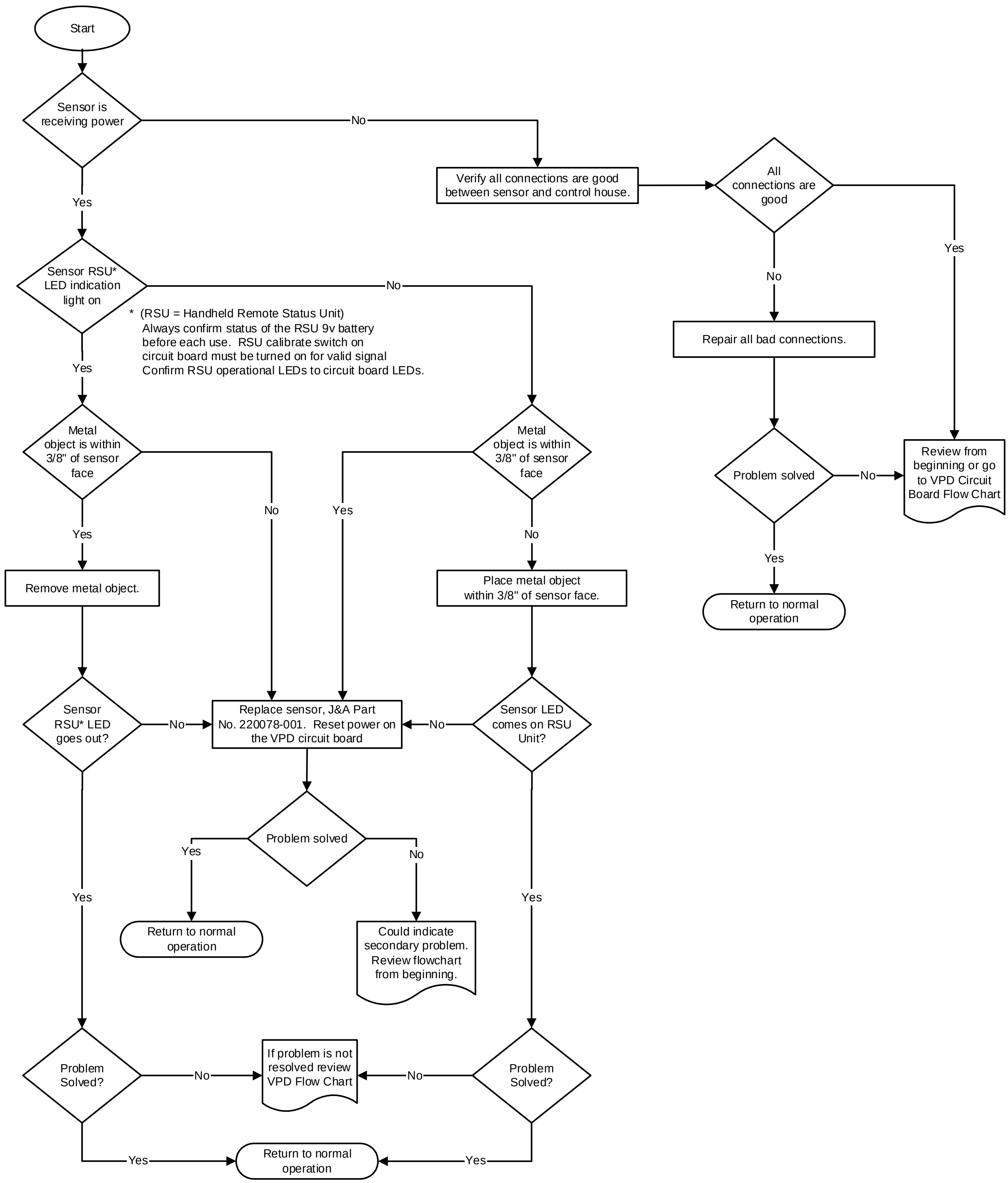
Touch a metal chassis or other metal object before handling the circuit board to mitigate any damage from static buildup and, whenever possible, handle circuit board by the edges.

To begin the removal, turn off the power switch on the circuit board. Remove the orange Wago wiring harness connector from the circuit board then remove the four mounting screws from each corner of the circuit board.

Carefully pull the circuit board assembly from the junction box enclosure. Place in the old circuit board into the replacement board's plastic shipping bag for return to J&A Industries and install new circuit board. Ensure that the new circuit board power switch is in the off position before reinstalling the orange Wago connector. Ensure that the orange Wago connector has been fully seated before turning on power to the new board.

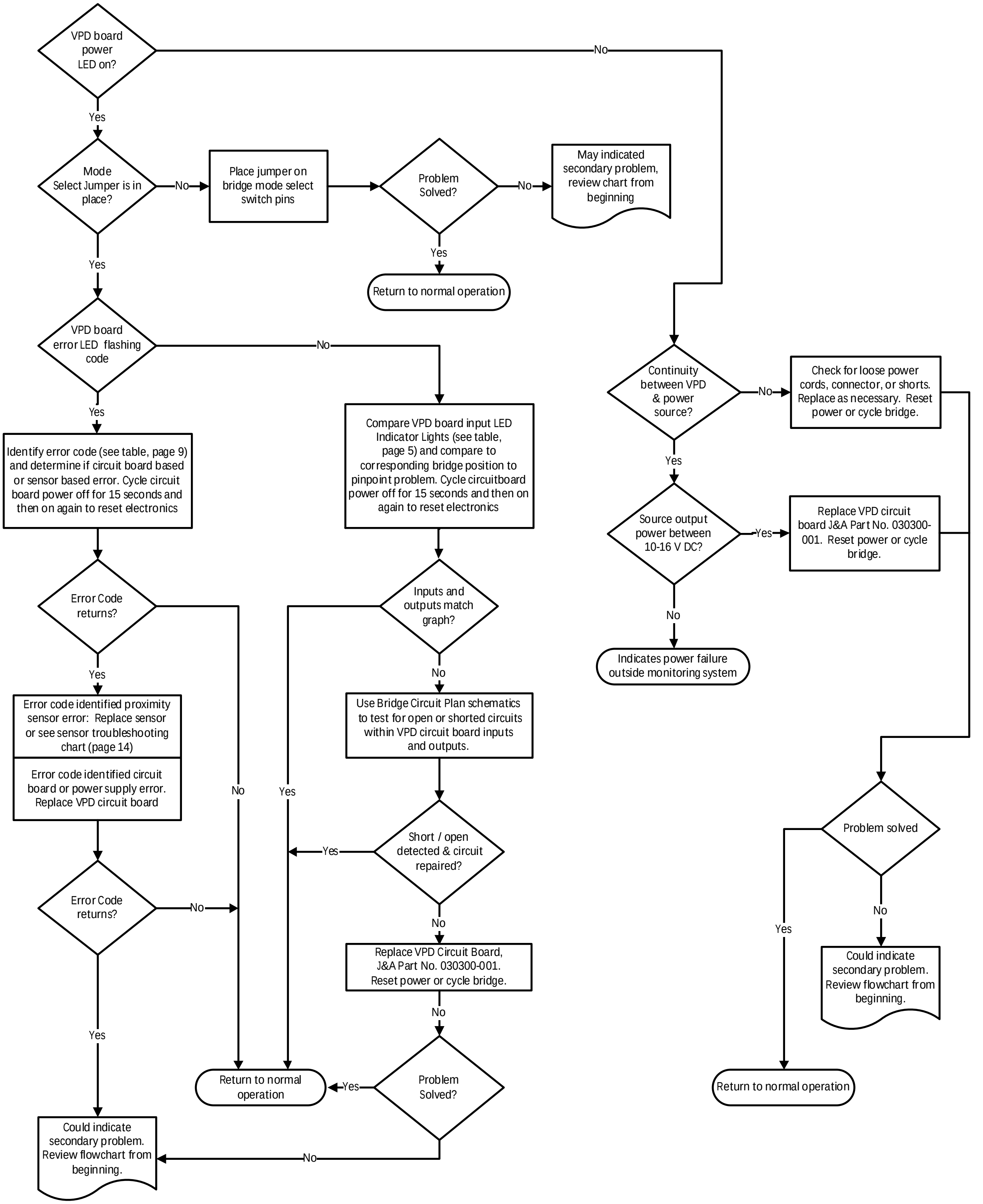
Shifted Load Detector

Sensor Troubleshooting Diagram



Shifted Load Detector

Circuit Board Troubleshooting Diagram



Shifted Load Detector

Typical Test Site Schematic