Trouble-Shooting Axle Counting Systems

A general outline of basic procedures and recommendations.

INTRODUCTION

Pintsch Tiefenbach axle counting systems offer unprecedented reliability when installed and maintained properly. Axle counting methods are utilized to create a “virtual track circuit,” which is immune to a variety of environmental variables that can degrade the performance of traditional track-circuit methods.

Generally, a Pintsch Tiefenbach axle counting system can be broken into two basic sub-systems, these being the evaluation equipment located in a relay case or control cabinet, and the field equipment consisting of underground cable, junction boxes and wheel sensors.

This document treats these two basic subsystems separately. It also defines a “risk analysis” designed to maximize the odds of trouble-shooting success in those failure case, which fail to provide evidence of a definitive fault condition.

RISK ANALYSIS

Over a decade of experience in field service has identified those components of the system, which are most likely to be a cause of malfunctions or reliability problems. Generally, the following components can be ranked from those with the greatest likelihood of failure to those least likely to fail. Again, this is a generalization based on empirical observation over an extended period of years across the North American installed base:

1. Improper wheel sensor installation (improper rail drilling, incorrect mounting position, improper use of shims, etc.).
2. Improper wheel sensor adjustment (improper modification of R58 device, improper use of SSPV-1 test plate), or related error.
3. Improper grounding methods at time of installation.
4. Improper crimping of sensor or underground cable terminations.
5. Defective wheel sensor due to age, lightning damage or other fault.
6. Defective underground sensor cable.
7. Failure of switching amplifier module.
8. Failure of AK19-series reset module.
9. Failure of relay release module.

It is also important to differentiate between "reliability problems" and "system failures."

In the former case, most reliability issues are a direct result of improper installation or intermittent problems on the field side of the system. For example, one will note that improper installation or adjustment of wheel sensors is ranked higher as a potential risk than component failures within the evaluation equipment.

As a general trouble-shooting rule, always follow this advice:

When a failure mode is not obvious, ALWAYS check the "boiler plate" infrastructure first!

As indicated by the risk analysis, this generally means the "field side" of the installation including sensors, terminations, and cable respectively.

In the subsequent section, we will cover some basic trouble shooting procedures designed to assist the maintainer or field service engineer.

INVESTIGATING FAILURE MODES

System Failures:

For the purposes of this section, a system failure mode is defined as "a failure condition which recurs regularly or which results in a fail-safe condition that cannot be cleared or reset. System failures are hereby differentiated from reliability problems in the form of occasional miscounts or fail-safe activations that exhibit intermittently.

Some basic steps for identifying the cause of consistent failures are as follows:

A. Problems in sensor circuits:

1. Observe the front panel of the card cage (evaluation equipment). If possible, take a photograph of the system before resetting the system or otherwise manipulating the system.

2. First, examine the switching amplifier modules (4AB10/1105/…..) carefully. Look for any RED BREAKDOWN LEDs that may be illuminated. In such cases, one should suspect a short, open, major change in electrical characteristics of cabling, or an off-rail situation. In order or priority, check the following components:

    a. Double wheel sensors (deformed, bent, or loose).
    b. Terminations and connections within track-side junction box.
    c. Terminations and connections at DIN rail.

3. A 1.5K ohm resistor (1/4-watt or higher) can be placed across a sensor pair to simulate the presence of a working sensor. This method may be used to differentiate between a sensor fault and a cable fault. Likewise, in complex systems, the resistor substitution can be used along a cable pair at intermediate terminations/junction boxes in order to isolate a cable fault condition to a particular segment. *Befor connecting the resistor, be sure to disconnect the sensor cable pair first*. **VITAL SAFETY NOTICE: The installation of 1.5K ohm resistors across sensor cable pairs is the equivalent of utilizing a jumper to take a crossing out of service. Be sure the test resistors are removed and the sensor pairs are reconnected before placing the axle counting system back in service.**

4. Examine the relay release modules (WST-8021/…..). Without on-track equipment present, all LEDs should be illuminated GREEN. If so, also note the "CL" Relay LED. If all LEDs are green, but the "CL" is not illuminated, this may indicate a failure of one internal system within a double wheel sensor or an intermittent fault on a sensor pair. If so, test the sensor using the SSPV-1 plate and R58 device to ensure both internal systems function properly. If these check OK, then proceed to examine the cable pair carefully.

5. At the switching amplifier modules (4AB10/1105/……) check the "OUT" LEDs. These should only be illuminated when a wheel flange is present. If on-track equipment is not present, inspect the wheel sensors carefully. Look for metallic material resting atop the sensor.

B. Miscount due to defective sensor:

1. Examine the “ZB8/115/……” binary counter module. After on-track equipment has passed through, look for either axle retained in the counter (e.g. one or more axles still indicated on the counter) or a “minus axle count” indicated by the vertical row of LEDs alternately flashing and indicated by “-axle” LEDs at the top of the counter module.

2. Such problems are often the result of an incorrectly adjusted sensor or an unstable/failed sensor. While Pintsch Tiefenbach sensors are incredibly reliable and often remain in service for a decade or more, they are exposed to extensive vibration and environmental variations.

3. Some systems have multiple, adjacent axle counting circuits (e.g. an “Approach-Island-Approach” grade crossing system). Determine whether the miscount affects two axle counting circuits. If so, focus your attention on the wheel sensor that serves as a count-in/count-out point for both axle counting circuits.

   Example:

   An Approach-Island-Approach grade crossing system has four sensors, two of which are at the limits of the approach circuits, and two of which are at the limits of the island circuit. In such a case, the island sensors will serve as count-in/count-out points for both the island circuit and an adjacent approach circuit. Miscounting that affect both the island and its adjacent approach circuit are often evidence of a defective sensor.

C. Binary Counter Module Failures:

1. Examine the binary counter module (ZB8/115/….). When axles are present in the circuit (axle count of greater than or equal to one), the two counter channels should match. Any failure to match is an indication of a serious internal problem. Try swapping out the binary counter module FIRST to see if the problem clears. If the problem moves with the card, replace it with a spare.

2. If the problem remains with the slot, suspect an associated switching amplifier module.

3. Examine the OC and CL LED indicators at the bottom of the binary counter module. When the axle counting circuit is occupied (on-track equipment present and the axle count is greater than or equal to one), the Oc LEDs should illuminate RED and the CL LEDs should extinguish. Likewise, when the axle counting circuit restores to zero (i.e. on-track equipment NOT present), the Oc LEDs should extinguish and the CL LEDs should illuminate GREEN.

   Note: Binary counter module failures are quite rare.

D. Relay Release Module Failures:

1. The Relay Release Module (WST-8021/…..) has a low likelihood of failure. However, it is a complex device with multiple safety layers in the form of back-checking, interlaced anti-valent contacts and back-checking functions. If a relay release module is suspected, swap the unit with a spare to determine if the fault is associated with the card or the slot.

2. If the fault is associated with the “slot,” the fault likely originates within another component, such as the switching amplifier module or the binary counter module.

3. Special Case: Rare failures of the relay release module have been traced to aging electrolytic capacitors on the circuit board. This failure mode will often exhibit as a RED Breakdown LED illuminated on the front panel of the relay release module. These cases, when they do occur, are often associated with aging cards, which have been in service for a decade or more.

   Note: The module is a single-sided circuit board, making it possible to replace a defective electrolytic capacitor. However, note that this is a vital, life-critical component. Such a repair should only be entrusted to a skilled technician. The customer is fully responsible for ensuring the repair has been done correctly and should verify that all vital functions perform properly after the card is returned to service.

Reliability Problems:

Nearly all intermittent failures or reliability issues can be traced to the field. Technicians should concentrate on the inspection and testing of sensors, cable and terminations.

A. **Sensor failures**

1. The double wheel sensor is a very reliable device. The technician should start by ensuring the sensors are installed properly, beginning with the mechanical installation.

2. Was the rail drilled properly? A failure to use the correct, approved drilling apparatus or the proper templates will result in improper sensor placement and degrade performance, particularly under extreme environmental conditions.

3. Are the correct shims in place? Depending on rail size and wear, shims may be required between the reduction plate and rail web. See the Sensor Installation Manual for more details.

4. Are the sensors adjusted properly? Examine….

- The proper use of the SSPV-1 reduction plate: Ensure it is set to the correct switching height for your rail operations. Typical heights are 47, 45 or 43.5 millimeters.

- When placing the SSPV-1 atop the sensor, ensure the plate does not touch the rail or significantly overlap the rail. The back edge of the SSPV-1 plate should be parallel with the side of the rail head.

- Ensure the R58/117/….test device is fully charged. Note: DO NOT replace the rechargeable Ni-Cad batteries with alkaline dry cells, which have a different nominal voltage.

5. If the above appear correct, additional tests will be required….

Check voltages:

1. An unoccupied 400-RE sensor (i.e. no wheel flange or test device present) should exhibit a measured voltage across each sensor pair (brown/yellow or green/white) of approximately 5.5. to 6.5 volts.

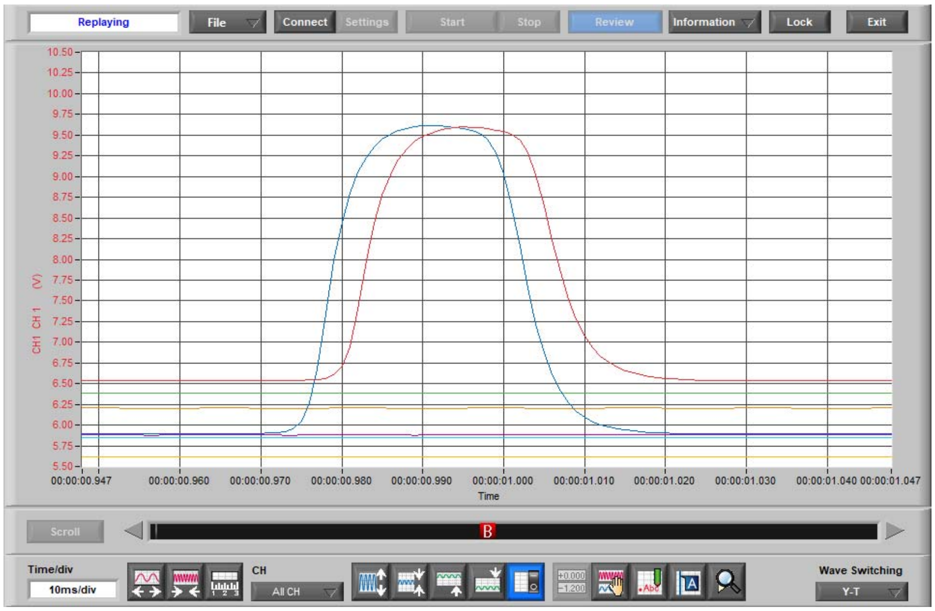
2. A fully occupied 400-RE sensor exhibit a voltage close to 10-volts. This can be tested in the field by placing a heavy tool (e.g. have wrench, trowel (hawk), or the head of a large 5-pound hammer) longitudinally across the top of the wheel sensor and then measuring the voltage. The length of the tool should be at least the length of the sensor itself.

Check waveforms:

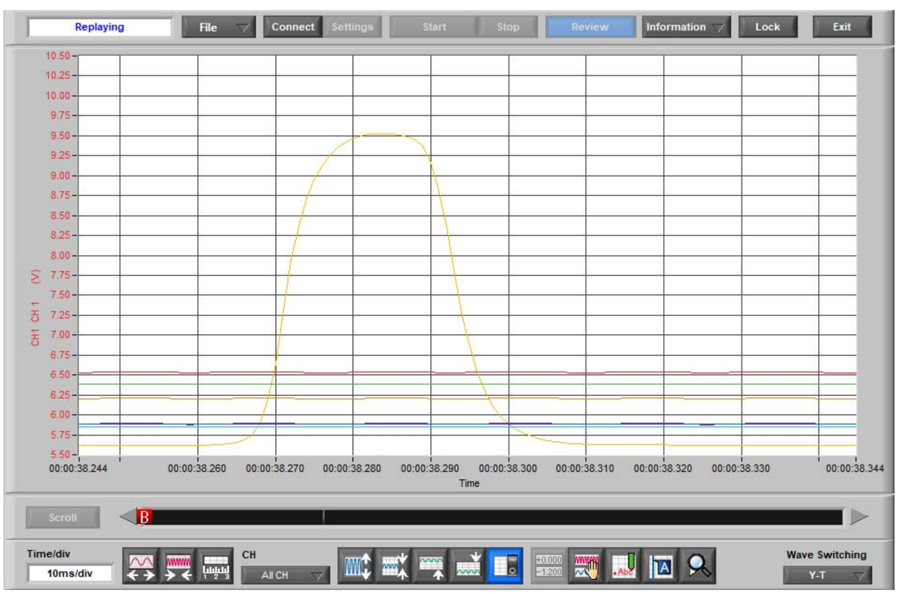
1. Utilizing an oscilloscope or equivalent device, monitor the analog impulses generated by passing on-track equipment. The waveforms should resemble a square wave, with a slightly softer rising and trailing edge.

2. Examine the DC waveform of unoccupied sensors. Look for evidence of induced noise. This may indicate an unintentional ground loop or leakage to ground.

Note: Distorted waveforms may indicate improper sensor installation, whereas noise on the waveform is typically associated with a cable failure.



Normal waveforms associated with passing freight wheel flange.

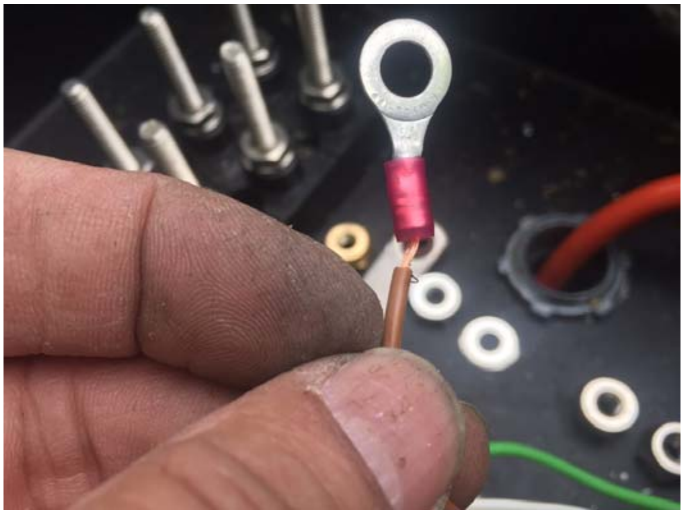


Normal waveform associated with an Amtrak passenger train at 60-mph

Cable Faults:

1. *Inspect grounding methods*. Ensure the grounding/bonding approach meets the following criteria:
   a. All shields/drain wires should be grounded to the common-point reference ground at the relay case.
   b. Shields/drain wires should be passed through intermediate junction boxes but NOT grounded at intermediate points.
   c. Shields/drain wires should follow the entire length of each sensor pair, but FLOAT at the sensor junction box.

2. *Inspect all crimps*: A double wheel sensor is a high-impedance device. Because little current is drawn, weak or corroded connections that might be acceptable in other signal applications will degrade the performance of the sensor/switching amplifier combination.



One of many defective crimps found in constant warning systems installed for shared freight/passenger rail service. A thorough inspection and re-crimping process resulted in 100-percent reliability.

3. *Test the cable pairs for leakage to ground*:
    a. New cable may be tested utilizing a 500-volt megger. This is not recommended for cable that has been in service for more than a year.
    b. A standard analog ohmmeter capable of measuring into the megaohm range at voltages ranging from 22 to 45 volts will reveal any significant leakage to ground or between conductors in a pair. A Simpson 372 ohmmeter or telecommunications “kick-meter” (loop tester) will serve this purpose nicely.
    c. Do not use a digital multimeter. The high-impedance / low voltage nature of the device will not accurately reveal some cable faults.

Simpson 372 ohmmeter (45-VDC) showing 1.2 mohms leakage to ground on a sensor cable.

ON-TRACK EQUIPMENT

On extremely rare occasions, problems arise with on-track equipment. This can be dragging equipment, a damaged wheel flange on a car that regularly runs a route, or problematic friction brake apparatus. If the prior investigative techniques do not reveal a problem with the evaluation equipment or field installations, it may be wise to inspect rolling stock, particularly if the fault occurs in the light-rail environment or within a closed intra-plant loop, such as those used at steel mills or power plants.

1. In some cases, wheel flanges present on equipment used in closed loops (power plants/steel mils) may be extremely worn. One steel mill had operating cars with wheel flanges as narrow as a quarter inch! Such situations typically require an upward adjustment of the sensor switching sensitivity.

2. Some light rail systems use mechanical brakes within axle counting circuits. In such cases, it may be necessary to adjust the sensor switching sensitivity downward to accommodate such appliances.

3. The 400-RE wheel sensor can be sensitive to some maintenance vehicle wheel sets. The small diameter of these wheel sets is often at the edge of the design parameters of the sensor. In most cases, this is not a problem, but there are reported cases of worn hy-rail wheel flanges failing to count correctly.

USEFUL TEST EQUIPMENT

Depending on the situation, various tools and test equipment are required. This equipment does not necessarily need to be new or highly advanced. The above example shows some of the typical items of various vintage commonly used in field service:

- **500-VDC Megger** – Primarily used to test cable at new installations before commissioning.
- **Oscilloscope** – Used to investigate intermittent problems of difficult provenance.
- **Digital multimeter or VOM** – Used to measure power supply voltages, sensor pair voltage drop, or digital outputs at various internal points within an axle counting system.

- **Simpson 372-series ohmmeter** - Depending on vintage, tests cable for leakage at either 21 or 45-VDC. Used on existing systems.

- **R58/117 test device** – Should be fully charged. Used to check switching height (sensitivity) of wheel sensors and for adjustment in the field.

- **SSPV-1 plate and EW-1 tool** – Used to check/adjust sensors in the field.

- **Decade resistance box set to 1.5K ohms**. A handful of small ½ watt resistors and clip leads also works nicely. Can be used at various points along a cable pair to simulate the presence of a working sensor. Ideal isolating fault conditions in complex infrastructure.