
**Railway Signaling.**
Interlocker
Technical Manual

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# I Introduction to Axle Counting

1. **Introduction**: The Pintsch Tiefenbach Axle Counting system is quite simple to understand, once the basic concepts of operation are understood. This Technical Manual is designed to provide both an overview of system operation and architecture, as well as a general system summary of internal functions.

2. **A basic overview of axle counting**:

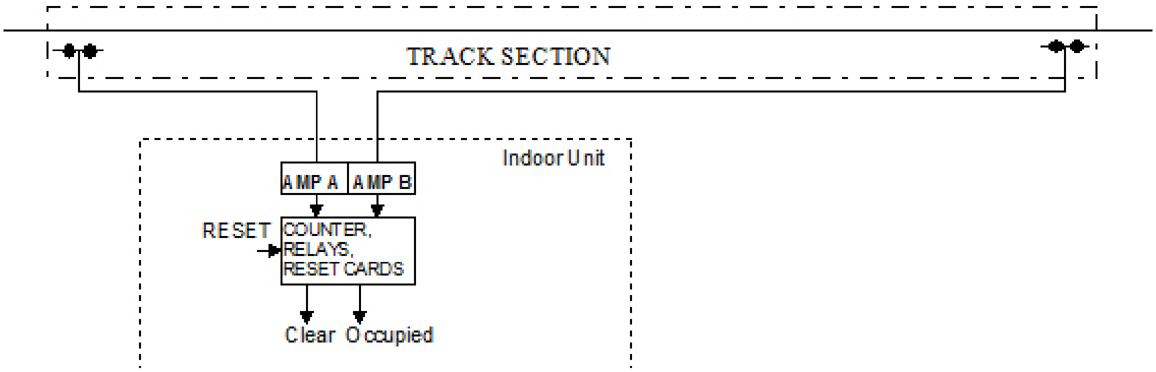


*Fig. 1: A simple axle counting circuit.*

Axle counting provides a method to detect the presence of on-track equipment located on a defined section of track. In its most basic form, the section of track to be monitored is defined by the installation of two double wheel sensors at locations, which delimit the boundaries of the monitored section or “circuit.”

As the wheel flanges of passing on-track equipment move over the double wheel sensors (hereafter “DSS”) into the protected section of track, the axle counting system detects their presence and direction of movement. This data is evaluated and utilized to increment a specially designed counter module as each wheel flange passes into the circuit. Likewise, as the wheel flanges begin passing out of the circuit at the opposite sensor, the axle counting system then decrements the counter.

When the counter module indicates one or more axles are within the circuit, a clear-contact line to the external signal equipment opens, thereby controlling external signal systems. Likewise, when the counter restores to “zero,” indicating there are no axles between the counting points, the clear-contact line to the external signal equipment is closed.

3. **A virtual track circuit**: Those familiar with railroad signal systems will quickly recognize that an axle counting circuit performs many of the same functions as a traditional “track circuit.” It might be said that axle counting creates a “virtual track circuit” using a method, which does not incorporate the rail itself into an electrical circuit. This method has many advantages, including:

   - Resistance to lightning ingress. There is no direct electrical connection to the track.
   - Immunity to shunting sensitivity problems associated with rusty rail, bad ballast conditions, and the like.
   - The elimination of insulated joints, bonds, and similar problematic components.
   - Tiefenbach axle counting systems will even work when the rail and sensors are under water!

4. **Multiple entry and exit points**: A double wheel sensor (“DSS”) may serve as a counting point for two axle counting circuits simultaneously. For example, a section of track may be broken into a series of axle counting circuits. Those DSS, which are located on the boundaries between these sections, may count axles out of one circuit, while simultaneously counting axles into an adjacent (following) circuit.

   A single axle counting circuit may be designed with up to eight counting points. For example, if one wishes to protect a switch, he may require three counting points; one on the facing point side, and one each on the normal and reverse sides.

## II The Double Wheel Sensor (DSS)

1. **The Structure of the Double Wheel Sensor ("DSS")**: The double wheel sensor, or "DSS," consists of two internal sensors within a common housing. This method simplifies installation and provides a more compact lower profile detection solution than is attainable with the installation of two single sensors. The use of a double wheel sensor allows the attached axle counting equipment to determine direction of movement into or out-of the circuit by identifying the order of pulse sequences, thereby incrementing or decrementing the axle counter.

2. **DSS Cable Pairs:** The individual internal system within the DSS requires two wires each, or one pair. Therefore, each DSS will have *two pairs* associated with it. The pairs are polarity sensitive and must be properly terminated at the junction box and equipment rack for proper sensor operation. The sensor cannot be damaged if these pairs are reversed; however, it will not function properly and the attached axle counting equipment will enter a "fail safe," occupied, condition. These pairs are color coded as follows:

   - DSS Internal System One (S-I): Brown (+)<br>Yellow (-)
   - DSS Internal System Two (S-II): Green (+)<br>White (-)

3. **Detection Method:** When a DSS is mounted to the rail and attached to an associated "Switching-Amplifier Module" the switching amplifier provides an operating voltage to the two internal wheel sensors. This voltage excites an electromagnetic field, which, in conjunction with the damping of the nearby rail, loads the circuit and maintains a consistent voltage across the sensor pair and the associated input circuit at the switching amplifier module. As a wheel flange passes over the sensor, it modifies the coefficient of coupling within the inductive circuit, resulting in a voltage change (voltage pulse), which is detected by the Switching Amplifier Module as a wheel flange. This pulse might be envisioned as a "modified square wave" pulse with a consistent rising leading edge and decaying trailing edge. The switching amplifier module then detects these signals and performs filtering, a signal processing function and analog-to-digital conversion process, which is transmitted to the remainder of the axle counting system via a series of redundant optocoupler outputs. These outputs can then be utilized to perform various axle-counting functions.

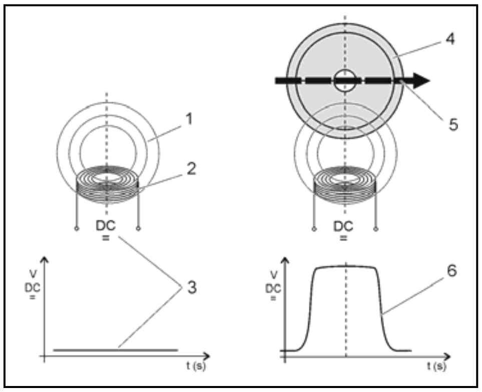


*Fig. 2: A representation of a wheel flange passing through the DSS electromagnetic field with related change in voltage.*

4. **Determining Direction**: As mentioned previously, the use of a double wheel sensor allows the associated axle counting evaluation equipment to determine the direction of movement based on the sequence of pulses generated at the sensor. Internal wiring between the switching amplifier module and the counter module logic inputs determines whether the counter module increments or decrements based on a particular pulse sequence (SI to SII or SII to SI). For example, if the DSS internal system S-I at track side faces the outside of the protected zone (axle counting circuit) and internal system S-II faces the inside of the protected zone, a wheel flange which occupies S-I first, followed by S-II will be detected as *entering* the circuit within the counter logic and will therefore *increment* the counter. Likewise, based on the same logic design, a wheel flange occupying S-II first followed by S-I will be detected as *exiting* the circuit and the counter will decrement. It should be noted that the theoretical or "design" sequence may not apply to the physical double wheel sensor installed on the web of the rail. In other words, if one looks at the DSS from within the guage of the rail, one will note that the DSS internal system S1 at the sensor is always on the left. Likewise, internals system S2 is always on the right. However, these physical designations may reverse position if a sensor is moved to the opposite rail, yet the counting logic design stays the same. *Therefore, in such situtations it becomes necessary to reconcile such a change at the sensor location with the sequence indicated on the track layout on the engineering drawings. This is typically done by simply reverseing the physical S1 and S2 sensor pairs at the terminations at the equipment rack DIN rail and not at the trackside junction box. See figure 25 for an example of the S1/S2 sequences on a track layout.*

5. **Overlapping Impulses**: The DSS and its associated switching amplifier are designed in such a manner as to require an overlapping series of pulses for an axle to be counted. For example, in a system designed so that SII is occupied first, followed by SI when a wheel flange is entering a circuit, the following pulse sequence occurs *within the system* when the double wheel sensors are wired correctly at the input terminals:

- First, DSS internal system S-II is occupied.
- Second, DSS internal system S-II remains occupied while S-I becomes occupied.
- Third, DSS internal system S-II releases while S-I remains occupied.
- Fourth, DSS internal system S-I releases and the DSS is clear.

Exit Sensor

- First, DSS internal system S-I is occupied.
- Second, DSS internal system S-I remains occupied and S-II becomes occupied.
- Third, DSS internal system S-I releases while S-II remains occupied.
- Fourth, DSS internal system S-II releases and the DSS is clear.

It is important to note that the SI or SII designation is fixed within the logic of the axle counting system, whereas the position of SI or SII may reverse when the sensor itself is moved from one track to the opposite track.

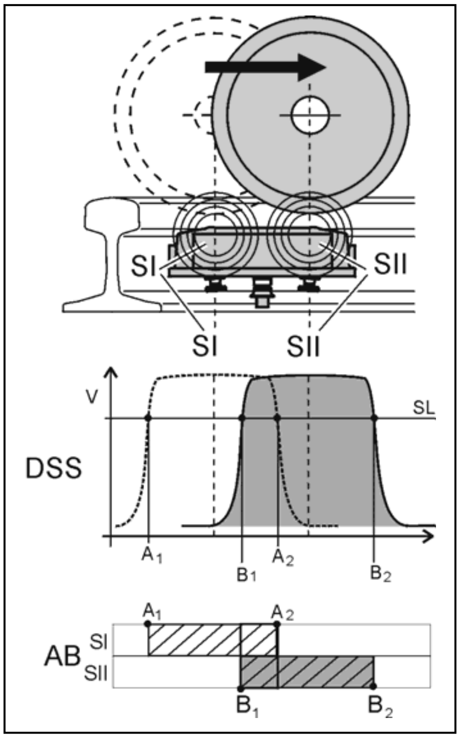


*Fig. 3: Diagram showing overlapping pulses as wheel flange passes over sensor. Pulses must properly overlap to be counted as an axle. Example shows an SI to SII sequence. This may vary depending on system design. Check the engineering drawings to deterimine if you system uses a SI to SII sequence or a SII to SI sequence. It some cases it may use both sequence in overlapping circuits.*

6. **Disassociated Impulses**: In the event that the Switching Amplifier Module does not detect the proper, overlapping pulse sequence, it can enter a fail-safe condition. Depending on the logic programming within the axle counting system, one, two, or three disassociated impulses detected at the Switching Amplifier Module may trigger a fail-safe condition, thereby releasing the relay circuit in order to place the signal system in its most restrictive condition. For example, if several wheel flanges pass over a DSS and impulses are received ONLY from S-I or S-II, but not both or should the pulses not overlap as required, this will be treated as a failure mode and the system will enter a fail-safe mode. These individual pulses must be of sufficient duration in order to fit the waveform profile of a wheel flange. Brief, short duration impulses of under 4 millisecond duration are typically classified as transient impulses and are therefore suppressed at the front end of the Switching Amplifier Module. These brief, transient impulses do not affect the fail-safe function. More details regarding this function are provided in latter sections of this manual.

7. **Permissible distances to metallic objects**: Careful design and engineering has resulted in a high-quality double wheel sensor, which is quite resistant to a wide variety of environmental influences. However, it can be influenced by nearby metallic objects or influenced by another nearby DSS. The following minimum distances apply between a DSS and nearby metalic objects or adjacent sensors:

   - From end of DSS to adjacent brackets, spacers, etc: 5.70 in.
   - From side of DSS to points, guard rail, etc: 4.33 in.
   - From end of DSS to end of adjacent sensor: 15.8 in.
   - From side of DSS to opposite sensor: 19.7 in.

   More information including visual representations may be found in the *Double Wheel Sensor Installation Manual*.

8. **Requirement for proper mounting**: Because the rail itself plays an important role in the proper functioning of the double wheel sensor, proper placement of the sensor with respect to the rail is critical to reliable performance. When properly installed, the Pintsch Tiefenbach DSS can provide incredibly accurate detection without error over a period of years! When drilling the rail, *only Pintsch Tiefenbach authorized drilling apparatus may be used*. Likewise, the use of the proper shims (spacers), if required, and the necessary mounting components are essential for proper operation. Correct rail drilling, mounting, and adjustment procedures are outlined in the document categorized in the *Double Wheel Sensor Installation Manual*.


*Fig. 4: Structure of DSS showing internal systems one and two*

9. **<u>Multi-Use Areas</u>**: Occasionally, it is necessary to install a sensor at a location at which truck and vehicular traffic cross over the rail or a location at which industrial operations regularly require heavy equipment, trucks, or similar equipment to drive along or near the right-of-way. Examples include classification yards, industrial spurs, or similar environments. The Pintsch Tiefenbach wheel sensor cannot support the weight of vehicular traffic. Therefore, it should be protected from the weight of a vehicle tire passing over the wheel sensor. One method for doing this is to “crib” the sensor.

   One can crib the sensor by installing a parallel block of wood or similar nonmetallic material parallel and adjacent to the sensor. Treated lumber, such as “wolmanized” lumber or lumber treated with copper arsenate can be built up adjacent to the sensor on the inside gauge of the rail. Lag bolts or similar hardware can secure the protective cribbing to the cross ties.

   The cribbing should be built up to the same level as the top of the sensor. Furthermore, it should be close enough to the sensor to ensure that the width of a typical vehicle tire will be supported by the cribbing, the rail, or both. If the cribbing is too far away from the sensor, a strategically placed tire may pass between the cribbing and the rail, resulting in the sensor taking the entire weight of the vehicle. The cribbing should be removable to allow for later adjustment of the wheel sensor switching distance if required or enough space between the cribbing and wheel sensor should be provided for these adjustments but still protect the sensor from damage.

**Sensors that are deformed by excessive weight are not useable. They cannot be adjusted to compensate for the deformation and they must be replaced with a new sensor.**

*Fig. 5: Two examples of sensors protected from vehicular traffic. On the left is a wheel sensor at a steel mill protected from heavy trucks making nitrogen deliveries along the right-of-way. On the right is a sensor within embedded track on a light rail system.*

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# III Overview of Basic DSS Maintenance

1. **<u>Mechanical Tolerances</u>**: It will be necessary after installation to periodically inspect sensors to ensure that mechanical tolerances remain consistent despite long-term rail wear. Once the distance between the head of the rail and the top of the DSS as measured with the *SAHL-2 gauge* drops below **38-mm**, it will be necessary to move the sensor to the upper mounting holes or "lower position." This moves the DSS lower on the web of the rail to protect it from physical damage. It is then necessary to adjust the electrical sensitivity using the *R58/117/1 test device and SSPV1 test plate*. Because the horizontal characteristics of the rail do not change, it is typically not necessary to measure the other characteristics on an existing sensor installation after its initial installation.

   Other mechanical concerns are primarily limited to damage that may be caused by maintenance-of-way activity. For example, the sensor frame should not be bent or cracked. The plastic case should be intact. No evidence of creasing, gouging or similar damage should be present. *If the sensor case is damaged, it will be necessary to replace the sensor and adjust the electrical sensitivity of the replacement (new) sensor*.

   If a sensor is removed in anticipation of maintenance-of-way activity and then replaced, it will be necessary to check and re-adjust the electrical sensitivity using the R58/117/1 test device and SSPV1 test plate after the sensor is remounted to the rail.

2. **<u>Electrical adjustment and the R58/117/1 test device</u>**: The R58 test device simulates the electrical characteristics of a standard Pintsch Tiefenbach switching amplifier module. It is used in the field to conveniently adjust the height of the active electromagnetic field generated by the internal systems of the double wheel sensor when voltage is applied.

   The R58/117/1 device is designed to be utilized with the 400-series sensor. *Be sure to use the correct R58 device for the type sensor to be adjusted. The R58/117/1 test device is always used with the 400RE-40 wheel sensors included in our axle counting systems. It is not to be confused with the R58/117 test device used with other sensors.*

   Examining the R58/117/1 device, you will note four wires color coded brown, yellow, green and white. These colors match the color coding of the sensor. As discussed earlier, the brown and yellow pair is associated with DSS internal sensor I while the green and white pair is associated with DSS internal sensor II.

On the front of the R58/117/1 panel are two LEDs, which illuminate when their respective internal systems are occupied.

When setting up the R58/117/1 device to align a sensor, simply match the four wires to the respective color coded cable coming from the sensor.  Be sure the cable leading to the equipment rack is disconnected either physically or by opening up “gold nuts” or similar test links.  Turn on the R58/117/1 device by flipping the power switch to “Aus” (On).  Check the red LED above the term “Akku Laden.”  If this LED is illuminated, the battery voltage is low and the R58 test device must be recharged before using the R58 test device.  It is recommended that the R58 be fully charged before each use, even if the low battery indicator is not illuminated.

**DO NOT replace the internal rechargeable Ni-Cad batteries with alkaline or carbon-zinc “AA” dry cells. The “per-cell” voltage is different and therefore the total voltage to the internal amplifier circuit will be different, resulting in improper adjustment of the wheel sensor, which will not match the characteristics of the Switching Amplifier Module.  The voltage applied to the sensors by the R58/117/1 test device is 10-VDC.**

The first step during adjustment is to set the SSPV-1 adjustment plate (pictured below) to 43.5-mm (this setting varies for some installations) for the 400RE-40-series sensor and place it atop the sensor.  Be careful to place the SSPV-1 plate atop the slight ridge at the center of the sensor.  The SSPV1 has a groove in its bottom foot which should align with the center of the sensor by fitting over this center ridge.  The edge of the SSPV-1 that is parallel to the rail should not significantly overlap the edge of the rail but be even with the side of the rail head.

Remove the two nylon retaining nuts from the sensor adjustment slugs underneath the sensor.  Then, place the drive end of the EW-1 (pictured below) adjustment tool into the adjustment slug and push it upward to disengage the locking mechanism cam and access the tuning slug.  It must be fully engaged to avoid damage to the sensor.

While keeping the EW-1 pushed upwards, turn the knob clockwise to increase sensitivity (EMF height) or counter-clockwise to decrease sensitivity.  *With a new sensor, just two to three turns should be sufficient to illuminate the LED*.  Once the switch-on point is located, back the sensitivity off slightly until the LED goes out. Then very gradually increase the sensitivity again until reaching just the point where the LED just illuminates. Repeat this procedure with the other internal system.

Once both sides of the sensor are properly adjusted, both LEDs should illuminate at the same time as the SSPV-1 plate is lowered to 43.5-mm. Readjust the coils if necessary until both LED’s illuminate at the same time or as close as possible to the same time. For a last check turn the SSPV-1 adjustment knob counterclockwsie until the LED's extinguish, then wait a second and then turn the knob clockwise to lower the test plate until the LED's illuminate at the same time. Check the scale on the SSPV-1 plate and see that the measured distance is 43.5-mm as required.

Some useful tips for trouble-free adjustment include:

- Be sure to fully charge the R58/117/1 device immediately before use.
- Do not replace the rechargeable NiCad batteries with AA batteries, and their total voltage output is different.
- Do not bump the SSPV-1 adjustment plate while aligning the sensor. If necessary, hold the bottom foot to the top of the wheel sensor using 2 fingers to keep it in place.
- Do not allow the SSPV-1 to overlap the rail.

If in doubt about the proper adjustment procedure, please call Pintsch Tiefenbach at the telephone number provided at the front of this document. When properly installed and adjusted, Pintsch Tiefenbach wheel sensors offer the absolute best performance in the industry.

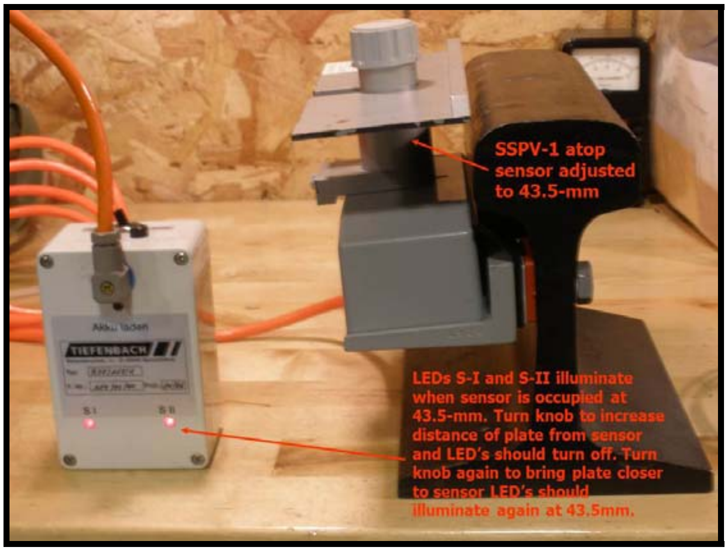



*Fig. 6: R-58/117/1 Device showing S1 and S2 LEDs illuminated when SSPV-1 Plate is at 43.5-mm.*

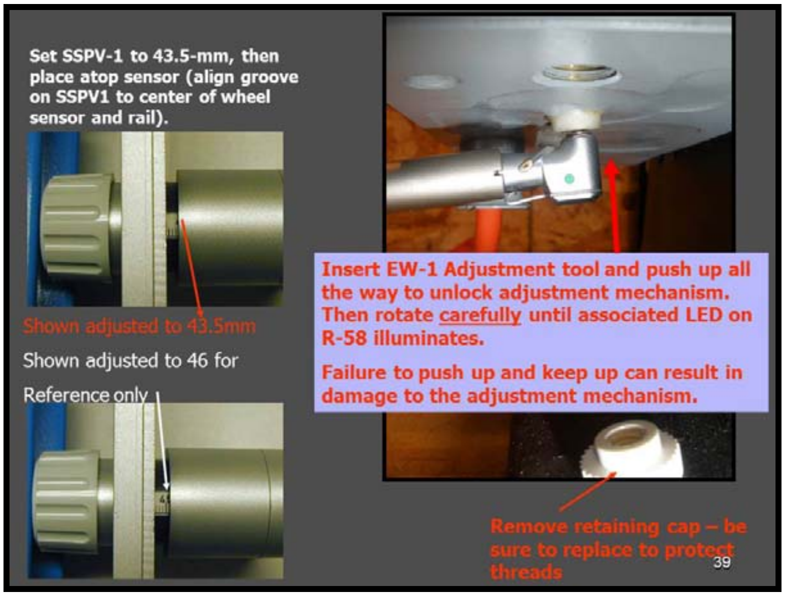



*Fig 7: Illustration showing SSPV-1 set to 43.5-mm, and EW-1.*

3. **<u>Unauthorized Tools</u>**: Authorized tools ensure the proper adjustment and maintenance of Pintsch Tiefenbach sensors for consistent, reliable operation. This is not simply a sales gimmick. “Home Brew” devices or unauthorized devices provided by some manufactures of signal equipment do not have the correct characteristics and are not recommended for use. **The customer utilizing these unauthorized test devices does so at his own risk.**

*Fig.8: An unauthorized “test” plate provided by a manufacturer of defect detectors and AEI scanners.*

4. **Adjustment and Inspection Schedule**: The Pintsch Tiefenbach Double Wheel Sensor is extremely stable. Some sensors remain in operation for years without adjustment. However, it is recommended that each sensor be visually inspected at least twice each year for potential damage or wear. An excellent policy is to inspect the sensors each quarter in much the same way one "walks bonds" at a traditional grade crossing.

5. **Seasonal Shifts**: The ideal times to check the electrical adjustment of sensors is immediately after the winter months and again after the summer season. The sensors are not particularly sensitive to temperature changes, however, we find that it is best to inspect and adjust sensors using the R58/117/1 Test Device after these major seasonal shifts.

6. **Wiring, Cable, and Junction Boxes**: When a counting or reliability problem arises, but sensor inspection and electrical adjustment checks "OK," we recommend that the underground cable, junction box, and related connections be carefully checked and tested. For example, some problems, such as a ground on one side of a sensor pair may not be readily apparent. While the sensor may appear to operate normally, a variety of problems may be introduced, which result in axle counting errors and random fail-safe activations. When a problem is not readily apparent, *always start with the "boiler plate" aspects of an installation.* Examples of such items include:

   - Ensure all physical connections are secure and tight. Terminals may be crimped on insulation instead of the conductor. Lugs may be improperly crimped.

   - Inspect wires in cable troughs and junction boxes for possible chaffing or worn insulation resulting in grounds or nonlinear connections.

   - Check cables for leakage to ground. A "megger" or similar device is not always necessary. Leakage to ground will often show up on a standard analog ohmmeter. When checking wires for grounds or leakage, be sure to first disconnect the cable from the sensor and equipment rack. Likewise, be sure not to exceed the dielectric breakdown value of the sensor wire insulation. A Simpson 260, TS-113 or similar meter are usually more than adequate. The Simpson 372-2 or 372-3 is ideal due to the moderate voltages used. *When checking leakage to ground, be sure the cables under test are disconnected from both the sensors and equipment rack to prevent damage to sensistive components.*

- Measure voltage across sensor pairs in both the unoccupied and occupied condition.  Note values and consistency between circuits. Record this data for future reference.

- Place an oscilloscope or "scope meter" across each pair.  The presence of "noise" or induced voltages on a pair is an indication of potential problems with a sensor circuit.  These problems can range from improper grounding of the shield and drain wires to a ground on one side of the pair.

- **Again, please note that nearly all equipment reliability issues are the result of basic "boiler plate" infrastructure problems, such as grounding, cable faults, submerged junction boxes, or similar issues.**

# IV Connecting the DSS to the Equipment Rack

1. **Mechanical and environmental requirements of buried cables**: The Tiefenbach Double Wheel Sensor utilizes two cable pairs (four wires) to convey the operating voltage from the equipment rack to the sensor, while conveying the return pulses to the switching amplifier module as each wheel flange passes over the DSS. The cable utilized to connect the sensor to the equipment rack is critical to ensuring a high level of reliability.

   *Mechanical rigidity*: The diameter (gauge) of the individual conductors is not critical from an electrical standpoint. However, experience has shown that a minimum diameter of 18-gauge conductor size is essential to prevent failures due to mechanical stress. Stranded conductors should be used in this application.

   *Environmental concerns*: Buried cables are subject to a wide variety of stressors, which can lead to cable failure. This includes frost heave, moisture ingress, damage from burrowing animals, and so forth. Consider these factors during cable installation:

- Cable should not be under tension nor should it be stretched. When pulling long lengths of corrugated cable from the spool or through a conduit, utilize a *hoisting grip* to prevent the corrugated outer shield from pulling apart, twisting, and cutting into the internal conductors. *Do NOT pull long lengths of corrugated cable (copper or aluminum 'heliax' type shield) without a hoisting grip!*

- Direct burial cables should lay loosely in a trench or conduit. This ensures that cable can move without stress during shifts in the underground structure, which encompasses it. Exercise care when backfilling a trench containing cable. A layer of sand atop a cable can protect it from compression until the backfill stabilizes.

- Leave a sufficient service loop at the end of cables. This allows future technicians to trim back cable in the event that faults occur near the cable end or at the point of termination.

- Document the location and depth of the cable. Place any required notes about cable location or potential conflicts related to future signal construction in the technical manual and prints. Internal as-built prints should incorporate information on buried cable location, depth, and any special considerations regarding this buried infrastructure.

2. **Electrical Requirements**: The length of a cable connecting a DSS to the equipment rack is not critical. Provided the total series resistance of the cable is less than 200-ohms, the cable should provide good service. Other electrical requirements for the cable are as follows:

   - Each pair within the cable must incorporate transpositions ("twist") to minimize or eliminate crosstalk between cable pairs.

   - Each pair must be individually shielded and incorporate a suitable "drain wire."

   - An overall shield is desirable for both shielding and lightning protection purposes.

   "Okonite" SP-OS or CLX SP-OS Instrumentation cable types at 18 gauge meet all necessary Pintsch Tiefenbach requirements.

   Customers should beware of the fact that we have recently encountered inexpensive cables manufactured overseas, which are inherently defective being used by a few customers. Some of these cables have proven unusable. Such cables appear to utilize copper conductors, but are instead manufactured using amalgams of scrap metal. In such cases the conductors exhibit high resistance, excessive corrosion, or other faults related to improper manufacturing. When ordering cable, the rule of "caveat emptor" applies. Purchase your cable from a reputable manufacturer.

3. **Grounding Requirements**: Proper grounding techniques are critical to all properly engineered railroad signal systems. Improper grounding can introduce noise, induced voltages, and ground loops to low-voltage sensor and control circuits. Additionally, improper grounding techniques can significantly increase the vulnerability of a system to lightning damage. The following guidelines should ensure a trouble-free and reliable installation, which will provide years of service without failure:

   A. *All grounding should occur at a common reference point*. This is typically the relay case or signal house. Grounds at distant points should float to prevent ground loops or current flow and induced voltages due to differences in potential.

   B. When shielded cables must pass through junction boxes or other termination points, *the shield ground should pass through*. However, there should be NO ground connection at intermediate points.

C. *Shields/grounds should float at distant sensors*. Remember, the only ground should be at the relay case/equipment rack.

D. *Ground loops will introduce noise on sensor circuits*. Ground loops occur when two or more grounds are present in a circuit at widely separated points. Ground loops will result in decreased counting accuracy and greater susceptibility to lightning damage. Sufficient noise on a sensor pair can decrease the effectiveness of the interference pulse suppression signal processing at the front end of the Switching Amplifier Module.

E. Sensor pairs can be checked with an oscilloscope or “scope meter” to identify grounding problems or other noise introduced by unintentional ground loops. A properly grounded sensor pair will show little or no noise on the pair. A quick comparison between pairs will often reveal a circuit containing excessive noise.

**Service Note: Lightning protection and Grounding:**

Most signal systems operate with a floating “neutral.” In other words, there must be no connection between the signal system and ground, regardless of potential. This is sometimes a difficult concept for those not trained in railroad signaling to comprehend. There are, of course, good reasons for this isolation, which are outside the scope of this document.

While signal circuits themselves must “float” above ground potential, grounds nonetheless exist in signal practice. Cable shields must be grounded, some types of electrical control circuits may be grounded, and the AC Mains neutral and safety ground must be properly grounded and bonded.

An excellent example of the need for a common-point reference ground involves lightning protection. For example, when a lightning strike occurs at a particular point, it discharges through the soil. As it discharges through the soil, it encounters resistance in the earth itself. This soil resistance creates a voltage gradient surrounding the point of the lightning strike.

When a component or system shares two or more grounding points, which are located within this voltage gradient, a difference in potential may exist between the grounding points. This difference in potential may measure in the range of several if not tens of kilovolts. This difference in potential will attempt to equalize between these points. Therefore, any equipment or system sharing these separate grounding points will find itself in the equalization path.  In other words, thousands of volts may flow through a circuit intended to carry only relatively low voltages and low currents.   The result is significant damage to signal and control systems.

Within short distances, such as within a relay house or communications buildings, a variety of grounding points can be “bonded” using a low impedance conductor, such as flat copper strap or a metallic building frame.  Because lightning behaves in a manner that is fairly consistent with the “skin effect” for high frequency alternating currents, any bonding conductor must offer a reasonably large *surface area.  Conductor thickness is generally not critical.  However, surface area is critical!*

Ideally, cable shields, equipment cabinet grounds, the AC mains ground, communications grounds, and arrestor/surge suppressor grounds should be *bonded* together with a low-impedance conductor at a common reference point, which is typically the relay house/case. The relay house/case is then grounded to earth ground.  When shielded cables exit the relay house to distant points, such as power switches, wheel sensors, or other wayside equipment, the distant shield on this cable should float to prevent a difference in potential between the distant equipment and control equipment at the reference ground.

Provided there is no connection between the shield and the distant control point, it is permissible to ground local equipment for local protection.  The primary requirement is to prevent a difference of potential from equalizing through a common piece of equipment.

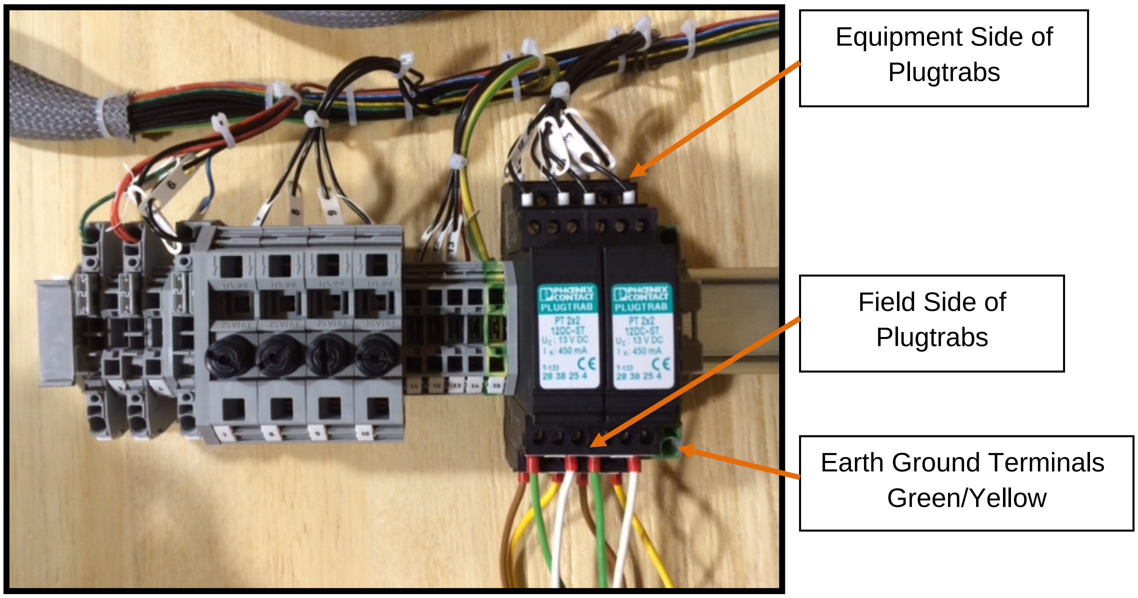
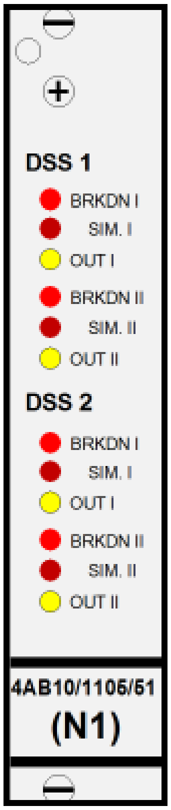



*Fig 9:  A sample Axle Counting System DIN Rail showing “plugtrab” protective devices to which external sensor lines attach to axle counting system.  Protective ground not to be confused with floating (ungrounded) signal system neutral*

# V A Brief Overview of the Axle Counting System Components

## 1. The Switching Amplifier Module (4AB10/1105/51):




The Switching Amplifier Module serves as the "front end" of the axle counting system. This device "talks" to the double wheel sensors at track side. It provides the voltage necessary to excite the electromagnetic field, which is used to detect the presence of wheel flanges. It also receives the returned voltage impulses associated with the passage of each wheel flange.

*The Switching Amplifier Module has the following controls and indicators:*

***OUT LEDs (Yellow):*** These LEDs illuminate whenever a wheel flange passes over a DSS. One will see these LEDs "flicker" as on-track equipment passes over a DSS. If the equipment is going very slowly, it may also be possible to determine which internal system of the DSS is occupied first. When a metallic object is placed atop (or is resting over) either internal system S1 or internal system S2 (or both) of the DSS, the respective yellow LED should stay illuminated as long as the wheel flange or metallic object is present.

***BREAKDOWN LEDs (Red):*** These LEDs illuminate when a breakdown occurs in association with a DSS. Such breakdowns may consist of a cable fault (short or open) or an off-rail condition in which the DSS is displaced from the rail by more than one millimeter.

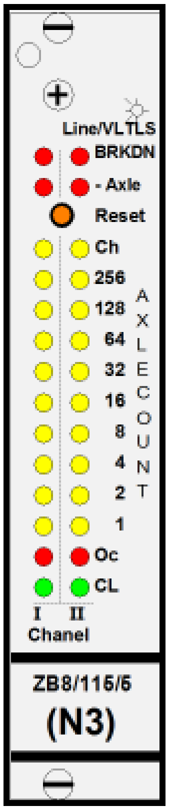
***SIM BUTTONS:*** The SIM Buttons may be used to simulate the presence of a wheel flange atop the DSS. One button represents internal system one. The second button simulates internal system two. When the button is depressed, it sends a message to the amplifier, which simulates the presence of on-track equipment passing over the double wheel sensor.

By depressing the SIM Buttons in the correct sequence (e.g. SIM I to SIM II or SIM II to SIM I), one can simulate a wheel flange moving in either direction into or out of the axle counting circuit.

***Yellow OUT LED stays illuminated*:** Should a yellow "OUT" LED remain illuminated, note the DSS with which the OUT LED is associated. Physically check the DSS at track side to determine whether any metallic objects are resting atop or immediately adjacent to the wheel sensor or if a train wheel flange is resting over the DSS, or if the DSS is loose or detached from the rail.

***Red BREAKDOWN LED stays illuminated:*** Inspect the DSS to ensure it is not displaced from the rail or possibly deformed from dragging equipment or other damage. If the DSS appears to be properly affixed to the rail and undamaged, it will be necessary to inspect and test the sensor cable pairs for a short or open condition.

## 2. The Binary Counter Module (ZB8/115/5):




The Binary Counter Module stores the axle count within two buffers (channels). The number of axles within the axle counting circuit is displayed on two vertical columns of Yellow LEDs. When two or more LEDs in any one column are illuminated, their associated values should be added together to determine the exact axle count. The sum indicates the number of axles present between the counting points.

The two columns should be equal at all times. *Should the two values not match, this indicates an internal system problem, which may most likely originate in an associated Switching Amplifier Module or within the Binary Counter Module itself*. Under such circumstances, swapping the Binary Countery Module with an adjacent module to determine if the problem stays with the "slot" or follows the card is an excellent first trouble-shooting step. It should be noted, however, that such failure modes are extremely rare.

Under normal conditions, it is impossible for more axles (wheel flanges) to pass out of a circuit than were originally counted into the circuit. Therefore, should more axles be counted out than were originally counted in, the system enters a fail-safe mode called “minus axle condition.” In such a case both columns of LEDs will flash alternately, the –Axle LED will illuminate and the system will be held in its most restrictive mode, which is occupied status. If this condition arises consult section 3 entitled Troubleshooting Procedures.

**The following indicators are present on the ZB8/115 binary counter module:**

***Line VLTLs/Breakdown LEDs:*** These RED LEDs illuminate in the event of a breakdown mode, such as a counter error, a voltage lost to the system or counter module, or a failure mode transmitted to the Counter Module from the Switching Amplifier Module such as open or shorted cable or a sensor loose or off of the rail. Should these LEDs illuminate, it is advisable to also check the switching amplifier modules for any associated failures.

***-Axle (minus axle) LEDs:*** These RED LEDs illuminate in the event of a minus axle count. A minus axle count often indicates an improperly adjusted wheel sensor, defective on-track equipment or perhaps dragging equipment.

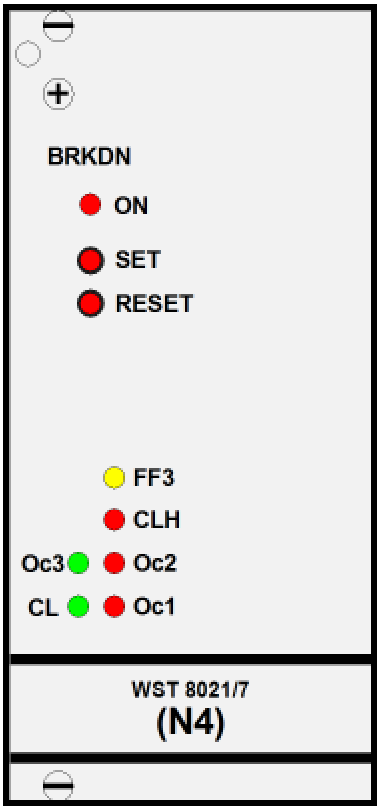
*Ch LEDs:* These YELLOW LEDs illuminate as each axle passes over the wheel sensor and the counting pulses are registered and input within the binary counter channels.

***Yellow Axle Count LEDs:*** These YELLOW LEDs display the quantity of axles present within the axle circuit. The values indicated in both columns should match. If they do NOT, maintenance personnel should be notified immediately.

***Oc LEDs:*** These RED LEDs illuminate when one or more axles are present within the axle counting circuit and also indicate the status of the Oc optocouplers outputs (energized ON, deenergized OFF). They should extinguish when the counter module restores to zero. The Oc designation stands for “occupied.”

***CL LEDs:*** These GREEN LEDs illuminate when the binary counter is at zero and the track circuit is unoccupied and also indicates the status of the CL optocouplers outputs (energized ON, deenergises OFF). They should extinguish when the counter module increments and the axle counting circuit becomes occupied. The CL designation stands for “clear.”

3. **The Clear signal relay module (WST8021/7):**




The Clear Signal Relay Module is controlled by outputs from the Switching amplifier module and the Counter Module. The Clear Signal Relay module outputs are available to control an external clear contact line. A variety of safety features are built into the Clear Signal Relay Module, which are covered in latter sections of this manual. There is one Clear Signal Relay Module for each of the ~~16~~ axle counter circuits within the Interlocking System.

**The following indicators are present on the Clear Signal Relay Module:**

***BREAKDOWN LED:*** The RED BREAKDOWN LED illuminates when a failure occurs within the Clear Signal Relay Module. Such failures may include an improper sequence during relay actuation, the failure of an antivalent contact to actuate, the activation of the BRKDN relay or the failure of a relay to restore within a specified time-constant. Should the BREAKDOWN LED illuminate, maintenance personnel should be notified immediately.

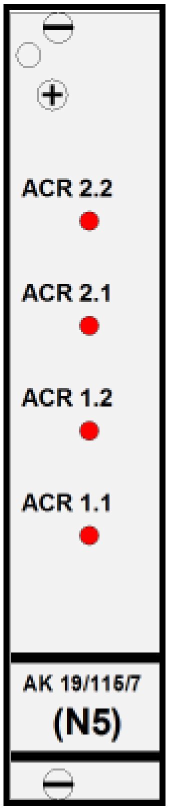
***SET push button:*** This push button manually drops the BRKDN relay, forcing an occupied condition. Under normal conditions, this push button should not be used as its only purpose is to check the function of the BRKDN relay. When this button is depressed you should also see the CL LED on the WST8021/7 extinquish.

***RESET push button:*** Resets the Clear Signal Relay Module after pressing the SET push button for the BRKDN test or after a fault condition. *The Clear signal relay module should not be reset except by qualified maintenance personnel.* When resetting the card, it is important to test the function of the system by simulating a complete train movement through the axle counting circuit upon completion of the test to ensure restoration to normal operating condition.

***CLH, Oc2, Oc1 LEDs:*** These RED LEDs should illuminate when the associated axle counting circuit is occupied. For a more detailed discussion, please refer to additional information later in this technical manual.

***Oc3, CL LEDs:*** These GREEN LEDs should illuminate when the associated axle counting circuit is clear (unoccupied). For a more detailed discussion, please refer to additional information later in this technical manual.

## 4. The Reset Module (AK19/115/7):




The Reset Module resets the axle counting system in the event of a fault or counting issue. It is actuated by the Axle Counter Reset (ACR) Key Switch. When the key switch is activated for at least 2 seconds, the Reset Module restores the Binary Counter Module and Clear Signal Relay Module to standby (unoccupied) position. It also counts two axles into and out of its associated Binary Counter Module, thereby clearing the buffers and preparing the system for subsequent train movements.

**DANGER! The ACR key should NEVER be actuated until it is ascertained that no on-track equipment is located within the track circuit.**

The following indicators are present on the front panel of the Reset Card:

***ACR 2.2,  ACR 2.1 LEDs:*** These RED LEDs illuminate when the ACR Key is actuated.  They should remain dark otherwise.

***ACR 1.2, ACR 2.2 LEDs:*** These RED LEDs illuminate when the ACR Key is actuated.  They should remain dark otherwise.

IMPORTANT NOTE: Each pair of ACR LEDs resets a single axle counter circuit.  In other words, ACR 1.1 and ACR 1.2 reset one axle counting circuit whereas ACR 2.1 and ACR 2.2 reset a second axle counting circuit.  If an actuation of the ACR key fails to reset the system, and no other breakdown LEDs are illuminated, *check to ensure the ACR LEDs illuminate in pairs*.

Depending upon design, it is not uncommon for one pair of LEDs to not illuminate (unassigned).  However, the two within a pair should always illuminate when a reset is performed (e.g. 1.1 and 1.2 and/or 2.1 and 2.2).  For example, if 1.1 illuminates whereas 1.2 does not, then it is likely the AK19/115 Reset Card is defective.

# VI Detailed Discussion of Components and System Architecture – Switching Amplifier Module:

1. **Excitation of Electromagnetic Field**: Amongst its several functions, the Switching Amplifier Module (nomenclature 4AB10/1105/51) provides the necessary quiescent voltage needed to excite the electromagnetic field at each internal system within the double wheel sensor. Under typical operating conditions in the field, the nominal quiescent voltage drop across an *unoccupied* sensor will run between 5.5-VDC and 6.5-VDC. This standby voltage can be measured with a digital multi-meter (DMM) or VOM to confirm proper operation. Please note that this voltage may vary somewhat depending upon the type of cable used, the length of cable, rail damping and other factors.

2. **Returned Pulses**: As discussed earlier, as each wheel flange passes over the double wheel sensor, it affects the electromagnetic field within the associated wheel sensor and creates a pulse. This pulse might be envisioned as a modified square wave pulse with a slightly softer rising and trailing edge. When occupied by a wheel flange (or test plate), a typical sensor circuit (pair) will show a voltage of approximately 9.4-VDC to 9.8-VDC. Again, please note that these are nominal voltages that may vary slightly.

   An oscilloscope or “scope meter” may be utilized to examine the return pulses from a Pintsch Tiefenbach wheel sensor. A good pulse should show both a fast leading edge and quick falling edge and consistent maximum voltage associated with each wheel flange with no "spikes" or other waveform anomolies. A comparison of the waveform between sensors should reveal a very consistent waveform.

3. **Signal Processing**: The switching amplifier module is designed to suppress short duration pulses, which fall below the minimum pulse duration associated with a typical passing wheel flange. This process is the first line of defense against transient impulses from nearby lightning strikes, high-voltage discharges, or other transient noise, which may be induced on the sensor line.

   Additional signal processing includes analog signal processing and an analog-to-digital conversion process within the amplifier. The analog modified square wave impulse received from the sensor is processed and converted into a perfect “on/off” momentary output via the “AZ” optocouplers at the amplifier output. These momentary optocoupler outputs can then be utilized to increment/decrement the associated counter components of the axle counting system. Further pulse extended “on/off” “AK” optocoupler outputs are provided which are utilized to control relays on the clear signal relay module.

4. **Outputs to Clear Signal Relay Module and Counter Module**: As mentioned previously, with each individual impulse that is detected at the double wheel sensor the corresponding switching amplifier module provides corresponding outputs. These momentary outputs are interfaced to the counter module via redundant "AZ" optocouplers, which increment or decrement the associated Binary Counter Module depending upon direction of movement and sequence. Axles entering into the circuit increment both counter channels within the Binary Counter Module, whereas axles exiting the circuit decrement both counter channels within the Binary Counter Module. The Binary Counter Module then, in turn, releases a clear contact line via the Relay Release Module.

   The Switching Amplifier Module also provides "AK" optocouplers to control primary and redundant outputs intended to release vital relay circuits on the Clear Signal Relay Module when axles are detected *entering* the axle counting circuit. This redundant activation path is independent of, and in addition to, the secondary and tertiary release path provided indirectly to the Clear Signal Relay Module via the Binary Counter Module. These different release paths provide additional layers of safety.

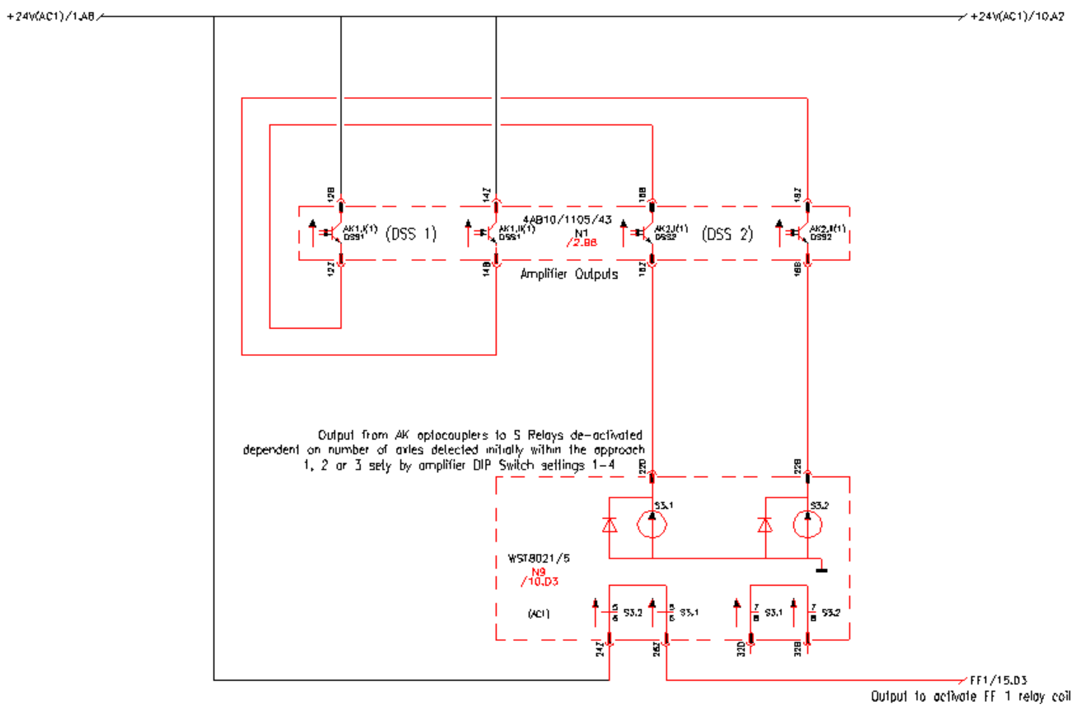



*Fig. 10 : Typical schematic showing the direct path from the redundant AK optocouplers at the output of the amplifier car to the S-Relays on the Clear Signal Relay Module.* ***Schematic for illustration purposes only.*** *Check associated engineering drawings for specific information on your system.*

**IMPORTANT: All circuit modules are keyed uniquely to their respective slots in the card cage. For example, this prevents the insertion of a /51 amplifier card in a slot designated for a /43 amplifier**

**card or the incorrect installation of a physically similar card of different function in an incorrect slot. Nonetheless, technicians should be careful to avoid placing the wrong card in a card cage slot (position).**

5. **<u>DIP Switch Cards – Amplifier</u>**: Each 4AB10/1105/51 Switching Amplifier Module incorporates a set of DIP switches on-board. The DIP switches govern a variety of specialized functions, which take place at the amplifier module. Examples include axle counter circuit activation on the first, second, or third axle entering the circuit, activation after a set number of individual pulses and other specific features. *Within the Interlocker System, these DIP switch settings are configured to disable all optional functions.*

**<u>DANGER!</u> These DIP switch settings are set at the factory and should be changed <u>only</u> after consultation with Pintsch Tiefenbach US. Because these settings program the function of the axle counter circuit, an incorrect setting can result in life-critical signaling conflicts, which may not be immediately apparent. It is recommended that the settings of these components not be changed nor adjusted in the field unless absolutely necessary and then only after obtaining approval from the Pintsch Tiefenbach US.**

**<u>B-12 Voltage Inputs</u>**: The Switching Amplifier module utilizes B-12 for all functions. Furthermore, B-12 is passed through the switching amplifier module to succeeding components. Removal of the switching amplifier module from the rack opens the 12-VDC supply buss to succeeding components to ensure the release of the relays and fail-safe activation of the crossing. If it is necessary to check for voltage at the input of an switching amplifier module, B-12 may be located at terminal 2Z and N-12 may be located at terminal 4Z.

**<u>Fail Safe Functions</u>**: A variety of failsafe functions are incorporated into Pintsch Tiefenbach axle counting systems. These functions ensure the system provides the most restrictive output or indication in the event of component failure. The switching amplifier module monitors the sensors and their associated circuitry for faults, which must result in a restricted, fail safe condition. The following indications reflect a failsafe condition:

- <u>Sensor cable short</u>: RED breakdown and YELLOW occupied LED illuminated
- <u>Sensor cable open</u>: RED breakdown and YELLOW occupied LED illuminated
- <u>Sensor off rail</u>: RED breakdown LED and YELLOW occupied LED illuminated

**Note**: When the sensor is displaced from the rail by more than one millimeter, an off-rail condition will be detected and the system will enter fail safe mode. This function must be tested when a new or replacement sensor is installed.


*Fig. 11: Amplifier card front panel indicating DSS 1 SII shorted or open cable.Note both yellow “OUT” and red “BKN” LEDs illuminated.*


*Fig. 12: Amplifier card front panel indicating DSS off-rail condition.*
*Note both yellow “OUT” and red “BKN” LEDs illuminated.*


*Fig.13: Metallic Object or Wheel Flange Resting Atop Both Systems of the Sensor*

### *6.* Red Light Overrun Outputs:

The Interlocker System is equipped with additional outputs at the DIN rail, which provide a "Red Light Overrun" capability. These directional-dependent momentary optocoupler outputs are designed to signal a vital processor when on-track equipment moves over a sensor. These outputs are directional in nature and are used by the external signaling system to determine when a train wheel flange has crossed over a particular wheel sensor into a following circuit after a red light overrun. The provider of the external signaling system will decide how to use these outputs. These optocoupler outputs are provided by the Switching Amplifier Module and appear at the DIN rail. The method in which the directional outputs are to be used must be determined by the designer of the external signaling system based on overall requirements. The diagram below provides a view of the structure of these outputs.

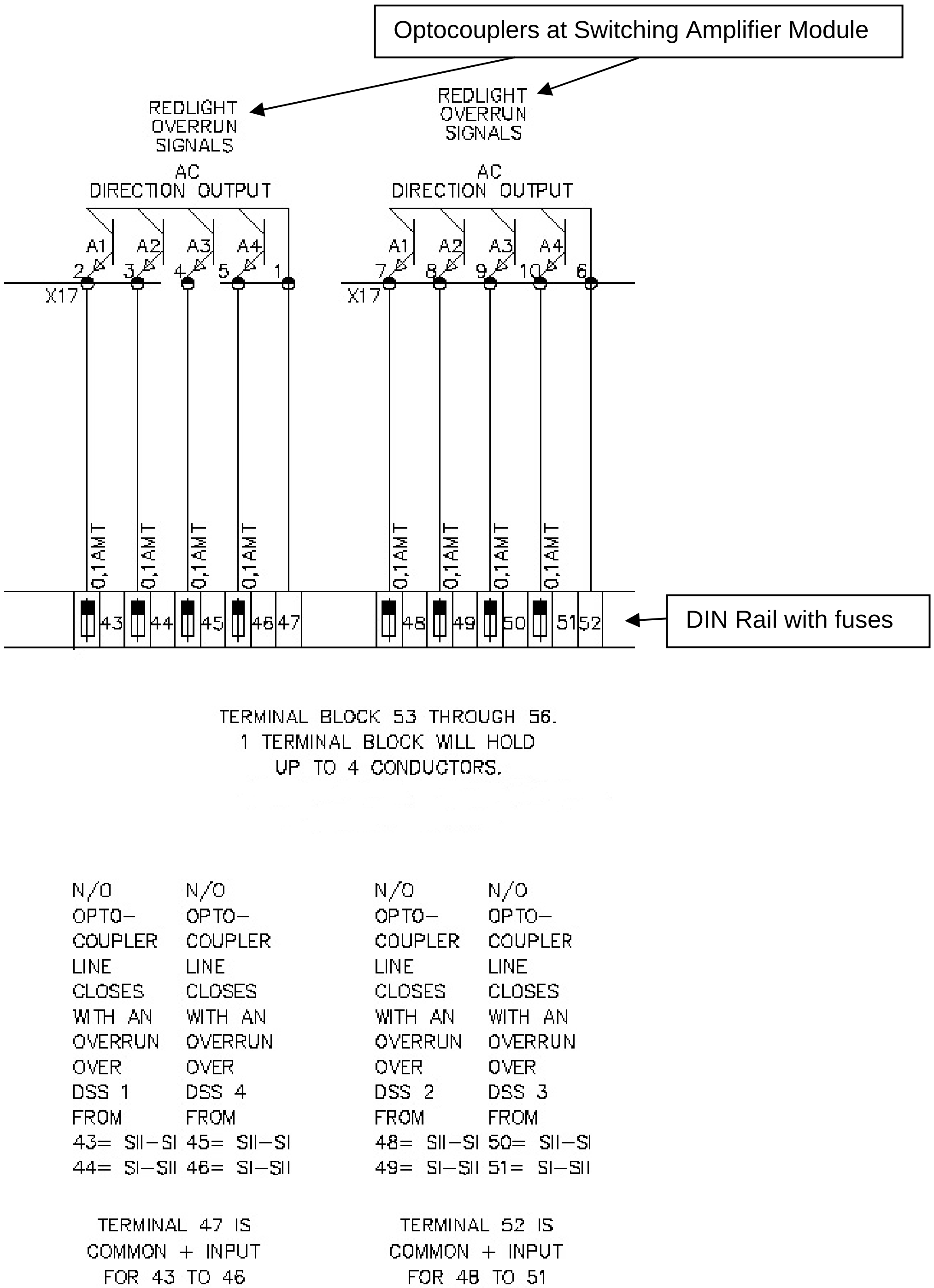



*Fig 14: Red Light Overrun Outputs from Switching Amplifier Module to DIN Rail.*

## VII Detailed Discussion - BinaryCounter Module ZB8/115/5

1. **Dual Channels**: The Binary Counter Module utilizes a dual-channel approach to provide an additional layer of safety and reliability during the axle counting process. As previously discussed, when one or more axles are detected entering the circuit, the switching amplifier module AK-optocouplers directly release the CL relay at the Clear Signal Relay Module, thereby opening the Clear Contact Line. Additionally, its momentary AZ-optocouplers provide outputs, which increment the counter as each axle enters the circuit. Likewise, the counter decrement as each axle exits the circuit.

   When one or more axles are registered at the counter module, the Oc1 and Oc2 relays on the clear signal relay module are energized via the counter module **Oc1** and **Oc2** optocouplers. Contacts from the Oc1 and Oc2-relays provides two release paths to release the Oc3 relay on the Clear Signal Relay Module in addition to the initial release of the CL relay on the Clear Signal Relay Module directly from the associated Switching Amplifier Module. The CL1 and CL2 optocouplers on the counter module are also in line with the CL-relay coil and deactivate when one or more axles are registered at the counter module serving as another path to release the CL-relay.

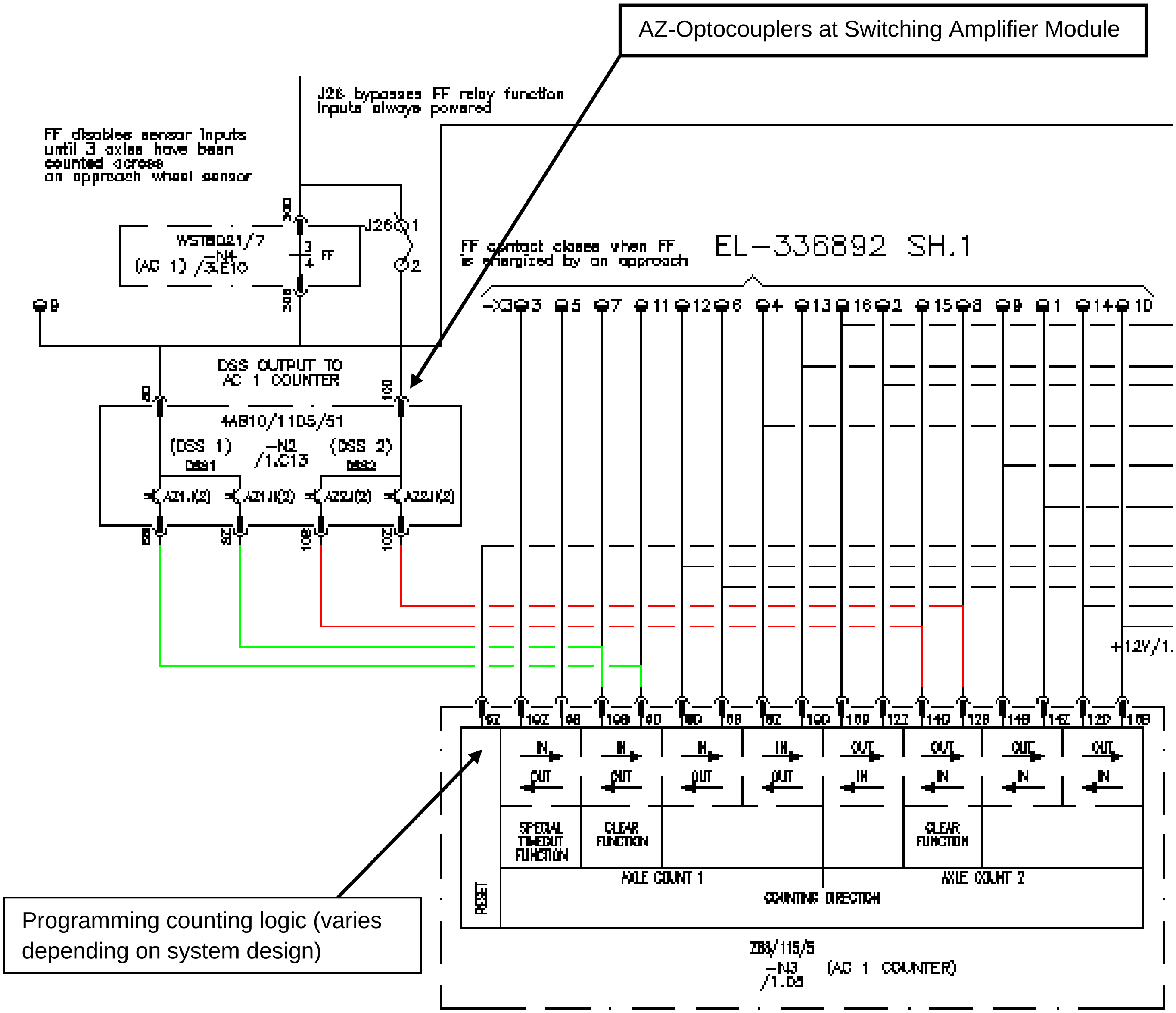



*Fig. 15: A typical switching amplifier to binary counter arrangement showing momentary AZ-optocouplers interfaced with counter logic. <u>Diagram for illustration only</u>. Such arrangements may vary from system to system.*

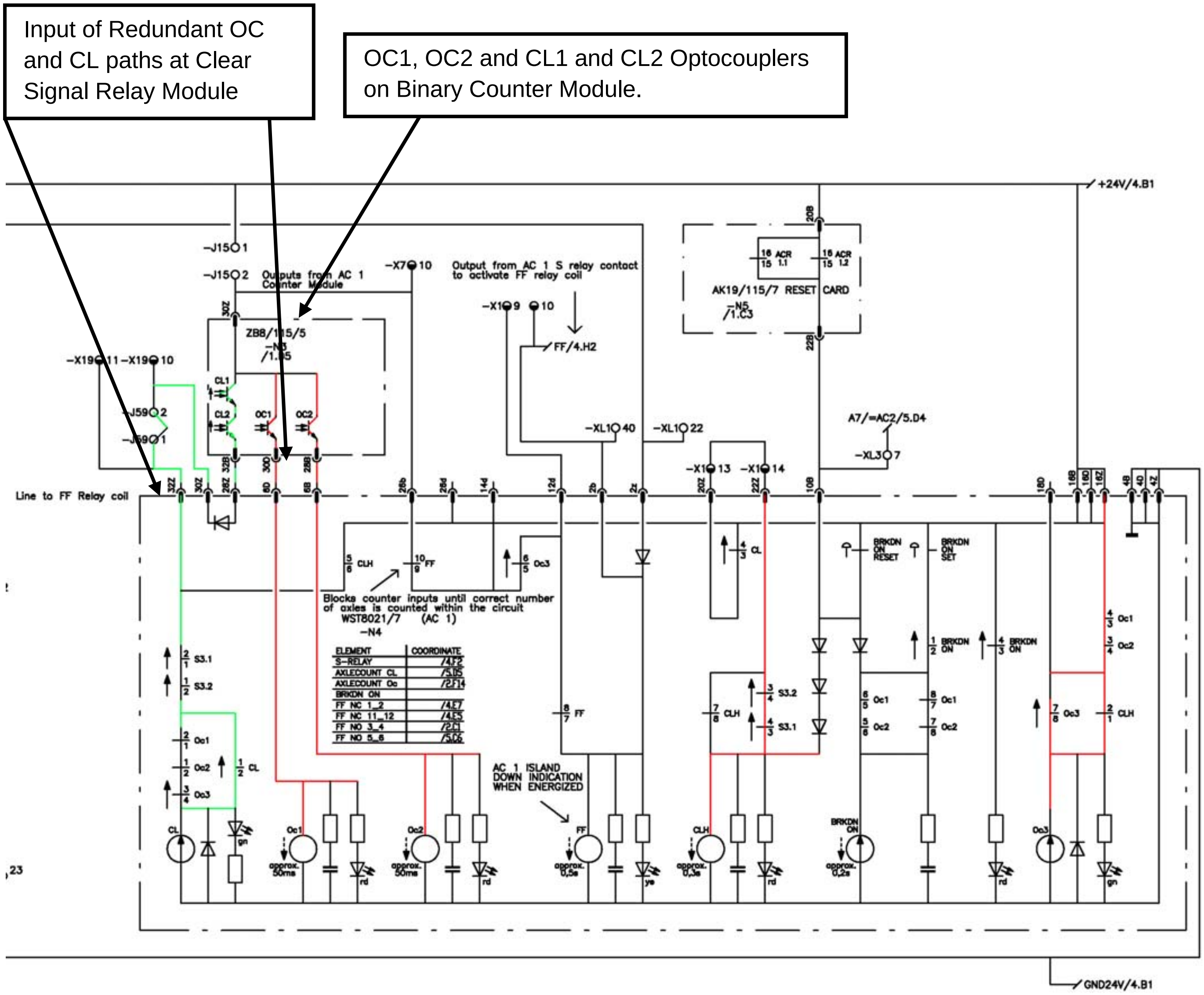



*Fig. 16: A typical diagram showing path from Oc and CL optocouplers on Binary Counter Module to Clear Signal Relay Module. Please refer to your specific engineering drawings for specific equipment details.*

2. **<u>Minus Axle Count</u>**: In the event of a "minus axle count," the counter module is blocked and the circuit will remain in an occupied, fail-safe condition. *A minus axle count is any condition in which the number of axles counted out of a circuit exceeds the number of axles counted into a circuit*. Because on-track equipment must pass through the entire axle counting circuit under normal conditions, it is assumed that a condition in which a greater number of axles (wheel flanges) exits the axle counting circuit than were counted into the circuit is typically evidence of an improperly tuned or malfunctioning wheel sensor, an intermittent condition or in rare cases possibly a switching amplifier or counter component failure.

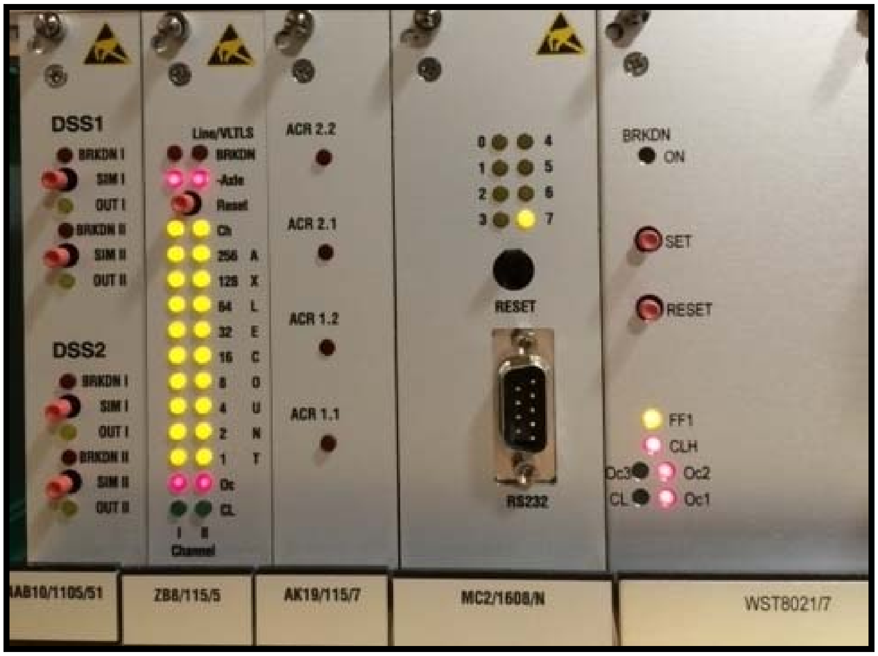



*Fig. 17: Minus axle LED status indication. Note that the vertical column of LEDs Would be flashing alternately*

3. **<u>Clearing a Minus Axle Count</u>: A minus axle count should only be cleared by manually resetting the system using the "ACR" ("axle counter reset") key switch mounted on the card cage at the equipment rack.** Counting additional axles into the circuit in an attempt to "balance" the count will not restore this fail-safe condition.

   The ACR key switch must be activated for at least 2 seconds, to allow for the complete reset sequence to occur. The reset module clears the counter buffers, counts 1 axle in and out of the counter module and restores the clear signal relay module to standby (unoccupied) position.

# VIII Detailed Discussion - Clear Signal Relay Module WST-8021/7

The Clear Signal Relay Module, WST-8021/7 integrates the outputs of the associated Switching Amplifier Module and Binary Counter Module to provide a highly reliable, fail-safe output to external signal equipment. Included within this module are a variety of processes, which confirm the proper function of critical internal components. The functions of the Clear Signal Relay Module are summarized below:

1. **Primary Release Path**: The primary release path utilized to de-energize the CL-relay originates within the Switching Amplifier Module and S-Relays. When a wheel flange is detected completely crossing both internal systems (S-I and S-II) of the double wheel sensor into the axle counting circuit, the aforementioned AK-optocoupler output loop opens at the switching amplifier module. This normally closed loop is interfaced with the two S-Relays on the Clear Signal Relay Module. The S-Relays S3.1 and S3.2 have normally closed contacts in series with the CL relay, which open allowing it to drop down and open the clear line to the external signal circuit.

2. **Secondary Release Path**: Upon detection of the complete wheel flange across the DSS, additional N/O contacts from both the S3.1 and S3.2-Relays that are in series with the control line to the CLH-relay close causing the CLH-relay to energize. A contact from the CLH-relay, which is also in the clear contact line opens to the associated signal equipment. This provides a a redundant release method.

3. **Tertiary Release Path**: As axles are detected entering the axle counting circuit by the switching amplifier module, associated momentary optocoupler outputs are generated via the AZ-optocouplers. These optocouplers increment or decrement the Binary Counter Module depending upon direction of movement. When the Counter Module is occupied with one or more axles, it's CL1 and CL2 outputs open the line to the CL-relay and it's Oc1 and Oc2 outputs control the Oc1 and Oc2 relays, energizing them. Contacts from the Oc1 and Oc2 relays in series with the Oc3-relay cause it to de-energize. A contact from the Oc3-relay is in the clear contact line to the external signal equipment, providing yet another redundant release method.

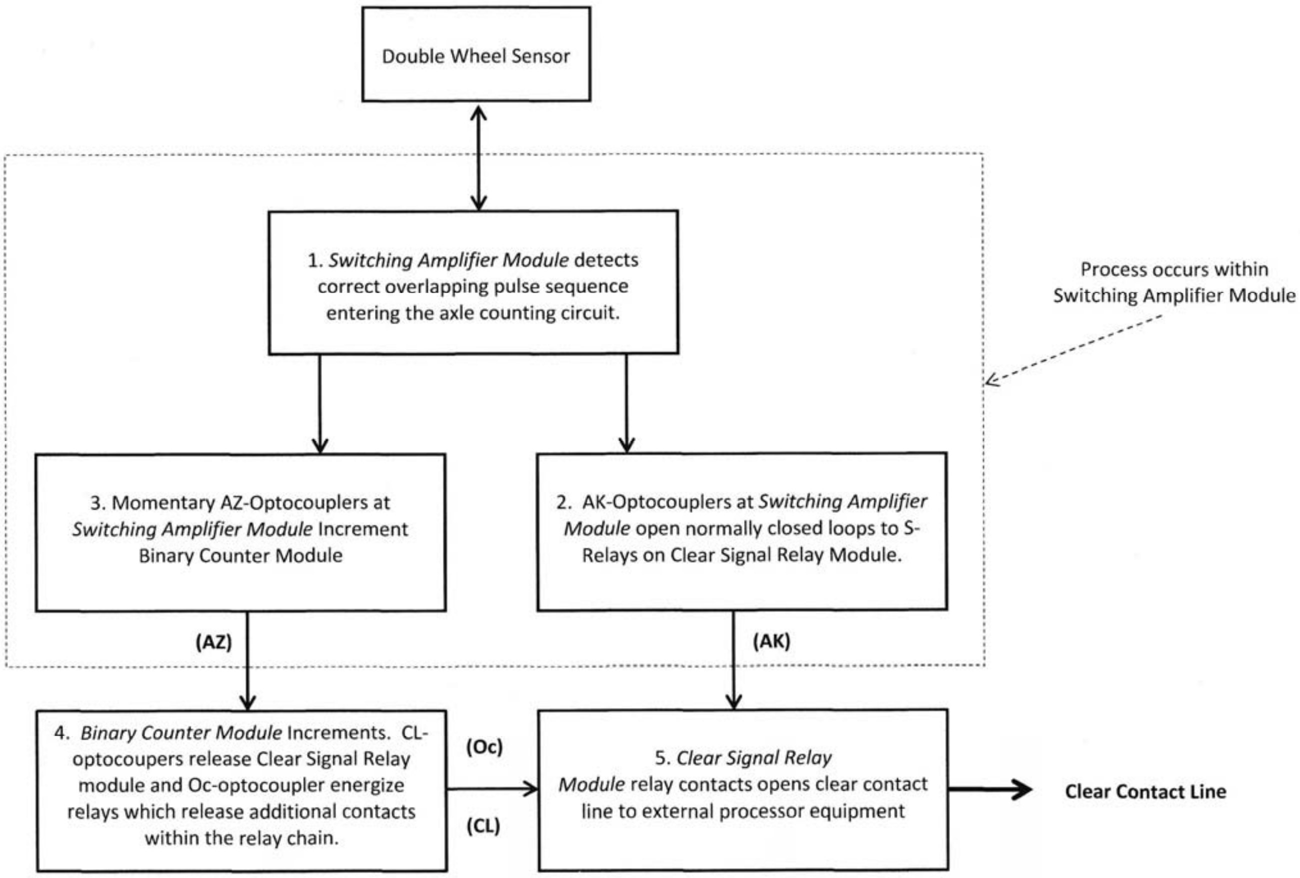



*Fig. 18: Flow Chart showing signal process control between Switching Amplifier Module, Binary Counter Module and Cear Signal Relay Module.*

4. **<u>LED Indications at the Binary Counter Module:</u>** When the Binary Counter signals the Relay Relase Module that the axle counter circuit is *occupied*, the following indications are present:

OC1 and OC2 LEDs ILLUMINATE
CL1 and CL2 LEDs EXTINGUISH

These indications reverse when the axle counter circuit clears and returns to the standby position.

OC1 and OC2 LEDs EXTINGUISH
CL1 and CL2 LEDs ILLUMINATE

5. **<u>Relay Release Module Indications:</u>** As a general rule, the Relay Release Module LEDs associated with an unoccupied (clear) condition will all Illuminate GREEN when no axles are present within the axle counter circuit. Likewise, the LEDs associated with an occupied condition will illuminate Red. This provides a quick and easy way to determine the status of the Relay Release Module. A more detailed outline of the status of the LEDs is provided below.

**Unoccupied Circuit:**

CL LED Illuminated Green
Oc3 LED Illuminated Green

CLH LED Dark
Oc1 LED Dark
OC2 LED Dark

**Occupied Circuit:**

CLH LED Illuminated Red
Oc1 LED Illuminated Red
Oc2 LED Illuminated Red
Oc3 LED Dark
CL LED Dark

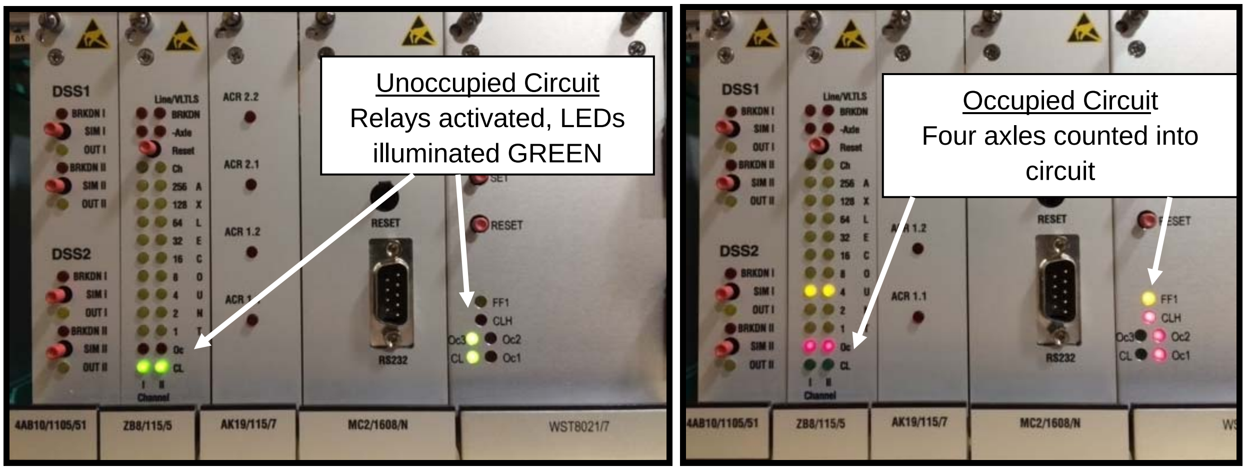



*Fig. 19: LED indications (counter module and clear signal relay module) for clear and occupied axle counter circuit status*

6. **<u>Safety Relays:</u>** The Clear Signal Relay Module incorporates a number of safety features, which ensure an extremely high level of reliability. This includes antivalent contacts incorporated into the clear signal relay circuits. Time constant analysis is also incorporated to ensure the relay restores to its correct in-position status within a set time constant. Forcibly-guided contacts are incorporated into the relay mechanical design to prevent any pair of contacts from operating independently, as in the case of a mechanical fault. Special contacts are incorporated to minimize wear and to prevent contacts from being “frozen” through a high-voltage discharge.

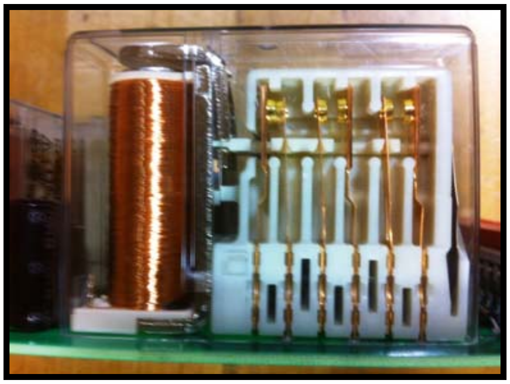


*Fig. 20: Safety Relay showing coupled, force-guided contacts*

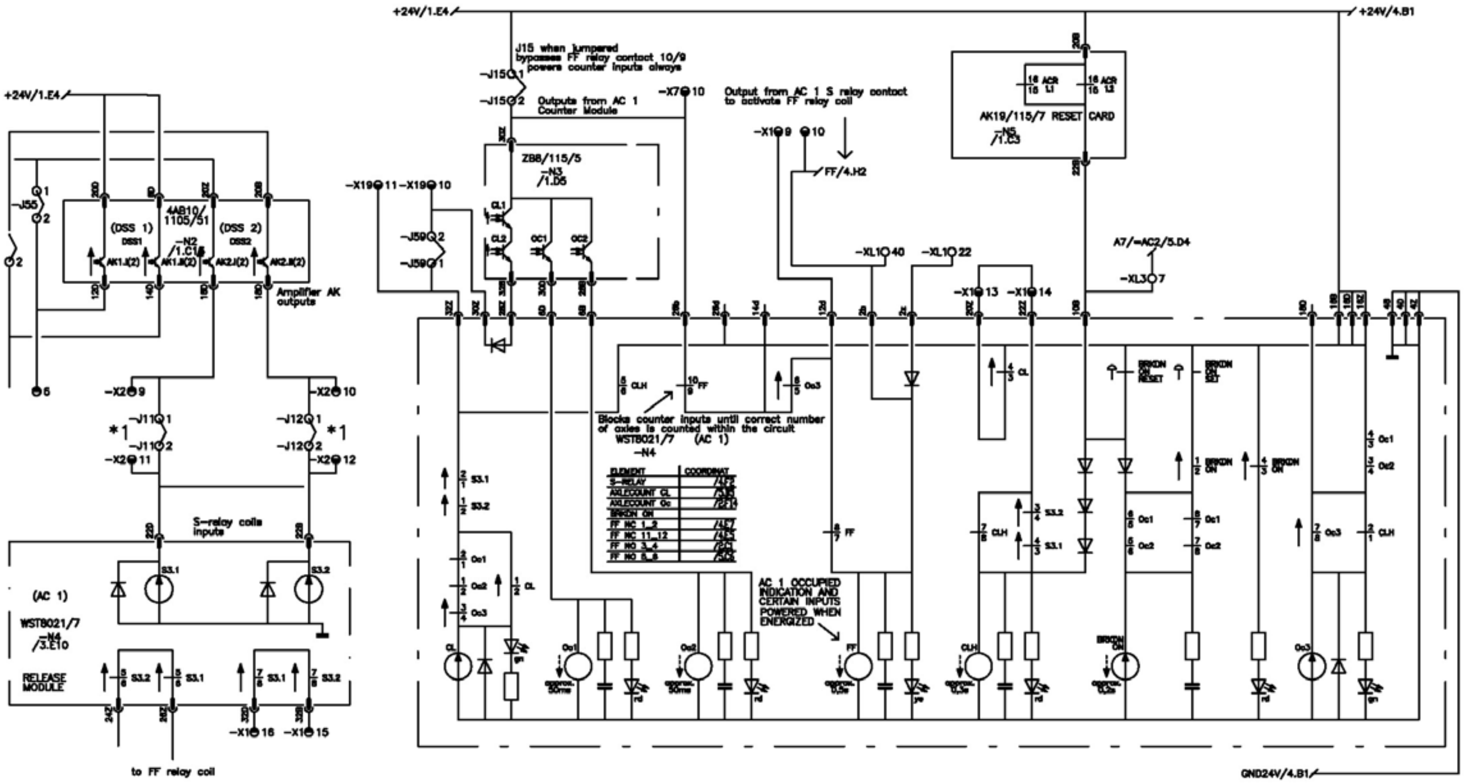



*Fig. 21: Typical configurations of a clear signal relay module circuit showing optocouplers interface to S-Relays and Counter optocouplers interface to CL and Oc Relays.* ***Exact S-relay wiring arrangement may vary slightly.*** *Consult your engineering drawings for specific information.*

**Important Note**:

US Federal Railroad Administration (FRA) Relay Testing requirements DO NOT apply to the relays utilized in the Pintsch Tiefenbach System. The nature of the relay, the back-checking process, and the time-constant analysis, which occurs with each actuation, combined with the structure of the relay and circuit design is such that each relay is tested within the circuit as part of normal functions.

It is not necessary to isolate the relay from the circuit and test its various functions as is typically done with shelf relays or type B vital relays.

# IX Detailed Discussion - AK19/115/7 Reset Module

**ACR Key Switch Function:** The AK-19 Reset Module is activated by the "Axle Counter Reset" ("ACR") Key. Its purpose is to restore the system to standard position in the event of a fail-safe condition, miscount, or similar fault.

**It should be noted that the system can NOT be reset unless a fail-safe fault has been corrected.**

The basic functions are as follows:

1. **Simulation Function:** When the ACR key is actuated ~~(providing the conditional reset has been met),~~ the AK-19 module resets the counter module, clears the Binary Counter Module buffers and then counts an axle in and out of the counter module. It also applies 24-VDC to the CL-relay to restore the system to standard position. This activation can be seen on the front panel of the AK-19 card when the ACR-key is actuated.

2. **Two or Four Channels:** Activation of the reset function results in outputs at four channels, which are labeled 1.1, 1.2, 2.1, and 2.2 respectively. One will note that each pair correspondeds to the pair (two) of channels in a Binary Counter Module. Therefore, these channels are activated in pairs. This allows a single AK-19 to clear two axle counting circuits simultaneously. In some cases only one set of channels (e.g. 1.1 and 1.2 *or* 2.1 and 2.2) will be utilized because the AK19/115/7 card is assigned to only a single Binary Counter Module. The LEDs associated with each of these channels should illuminate when the ACR key is actuated.

   On rare occasions, an AK-19 can be damaged by lightning or other failure modes. **Should only one LED within a pair illuminate when the ACR key is actuated, this is a strong indication that the module is defective.** Likewise, a failure of any LEDs to illuminate likely indicates a serious problem within the AK-19 module, the ACR-key circuit, or a similar failure. In such cases, the AK-19 module should be replaced with a spare. To further assist in troubleshooting the AK-19 module may be swapped to see if the problem follows the module.

3. **IMPORTANT NOTE**: When actuating the ACR key, be sure to hold it to the momentary right (clockwise) position for a **minimum of 2 seconds**. All faults must be cleared before the system can be reset.

# X Detailed Discussion - Axle Counter Reset ("ACR") Key

1. **Dual Contacts:** The ACR key, located on the card cage front panel, applies the necessary voltage (B-24) to activate the AK19 reset module. The ACR key consists of two pairs of contacts, both pairs normally open. 24-VDC is applied to these two contact lines simultaneously to properly reset the system.

2. **Remote ACR Keys:** In some cases, it may be necessary to install remote ACR keys. Examples include locations at which high-rail equipment must normally enter or exit a right-of-way at a highway grade crossing. In such cases, two axles may be counted into a circuit, but none will be counted out, resulting in either false occupancy or a miscount when on-track equipment passes through the axle counter circuit at a later time. In such cases, it may be necessary to have reset keys located at the relay house/case to allow maintenance vehciles exiting the track at a crossing to reset the system, as well as at track-side locations past the limit of the approaches, so that the system can be reset AFTER a maintenance vehicle that has been placed on the track at a crossing has exited the approach axle counting circuit enrout to other locations.

   Remote ACR functions can be provided by a key switch or a good quality DPST industrial push button. In either case, the key switch should be protected from tampering within a strong steel or aluminum enclosure. Furthermore, any associated cable utilized to interconnect the remote ACR key with the equipment should be of good quality and designed to meet the necessary environmental criteria (conduit, direct burial, armoring, etc.).

   Remote ACR keys should be tested periodically to ensure the integrity of any associated underground cable or other inter connect wiring. **Do not cut corners by running a single 24-VDC line through a remote switch to the two ACR terminals. Instead, run two lines to a remote SPDT ACR switch and then back to the equipment rack to ensure maximum safety and in compliance with Pintsch Tiefenbach's system safety requirements.**

   When implementing a remote ACR function, a few criteria are strongly recommended:

   - Incorporate the ACR function into operating rules.
   - Ensure that all high-rail operators fully understand the function of the key and the hazards associated with its use.

- The remote reset key shall be at a location in full view of the track and at which suitable site distance allows the operator to observe the entire set of axle counting circuits to ensure no trains are present in the approaches when a reset is performed.  If site distance falls below that required by maximum authorized speed for on-track equipment, then it is best to prohibit the use of the location for hi-rail entry or exit.

- With the exception of facilitating the entry or exit of a specialized on-track equipment within a track circuit, the ACR function should be limited exclusively to trained and qualified signal department or operations personnel.

Refer to the associated engineering drawings for details covering the connection of a remote ACR key to the equipment rack.


*Fig. 22:  AK19 Module assigned to two Binary Counter Modules with four channels in use.  Red LEDs should illuminate when the ACR key is actuated.*


*Fig. 23:  AK19 module assigned to one Binary Counter Module with channels 1.1 and 1.2 activated.  Both LEDs within the pair should illuminate when the ACR key is actuated.*

# XI Detailed Discussion - MC2/1608 Data Reporting Module

1. **Non-Vital:** The MC-2 Data Reporting Module is NOT associated with any vital functions within the Pintsch Tiefenbach Axle Counting System. This device records events on a first-in, first-out basis. Information recorded by the module includes:


- Time at which an axle counting circuit was occupied and unoccupied
- Total number of axles (wheel flanges) counted into and out-of each axle counting circuit (in some cases not all DSS counts are available)
- Reset functions
- Power reset
- Approach detected at DSS
- Circuit (AC1, etc.) occupied or clear

The MC2 Module serves as an excellent trouble-shooting or investigative tool. It is often helpful to download the stored data to be saved as a text file for subsequent review and analysis. In the event of difficult to solve counting problems, this file can then be transmitted via e-mail to Pintsch Tiefenbach US for additional analysis.

2. **Computer Requirements:** In order to access the MC-2 Data Reporting Module, the following equipment is required:

- A laptop computer or similar device (cellular or dial-tone modem gateway) to access the MC-2 RS-232 serial port.
- A serial cable
- A null-modem-adapter
- A gender changer (may be required)

3. **Terminal Settings:** Any terminal emulator, such as "ProComm" or the standard Microsoft Accessory Hyperterminal emulator is typically sufficient. When opening the terminal emulator program, set the communications port to the following settings:

- 9600-baud
- 8 bits
- Even parity
- 1 stop bit
- No flow control

**4. IMPORTANT: CAPS LOCK and Menu: In order to transmit a command to the MC-2 module, the "CAPS LOCK" must be enabled. All commands must be in capital letters.**

***Menu***:

The Menu can be obtained by typing "H" and the return function. This will provide a menu of commands, which are very intuitive. A list of these commands as they typically display is shown below. Please note that this command architecture may change with subsequent equipment upgrades:

Menu

| | |
|---|---|
| C | : CRC-output |
| H | : Help text |
| M | : Clear protocol memory |
| O | : Online printout toggle |
| P [MMDD[-MMDD]] | : Print memory with optional filter |
| T MMDDYYHHMMSS | : Date and time set |

CRC Output: Generates a code, which indicates if the correct software is installed in the MC-2 module. This command will be used only rarely.

Help Text: Displays the Menu structure as indicated above.

Clear Protocol Memory: Clears all 999-lines of stored events. This is most often used after installation or an extended period of troubleshooting and testing.

Online Printout Toggle: This command turns on the real-time output of the MC-2 module so that each line is displayed during commissioning, testing, or actual operations.

Print Memory: Prints out all of the events to the screen in Hyperterminal or other terminal program.

Date Time Set: Allows one to enter the date. All values are the two digit equivalent (e.g. last two digits of the year, month, etc.). For example, June 10, 2012 at 1:00-PM would be: 061012130000

Note: Some older MC-2 modules require the insertion of a digit indicating the number of years remaining to "leap year." If the menu includes the letter "L" inserted ahead of the date-time group key, it will be necessary to insert a digit indicating the leap year sequence.

**A Sample of Stored Data:**

Movement from DSS1 to DSS2 with 4 Axles and DSS3 to DSS4 with 4 axles

Date: 03.05.12 15:15:43

Online printout on

Menu
C : CRC-output
H : Help text
M : Clear protocol memory
O : Online printout toggle
P [MMDD[-MMDD]]: Print memory with optional filter
T MMDDYYHHMMSS : Date and time set

********** Pintsch Tiefenbach GmbH - Verkehrstechnik **********
A ###### Interlocker Axle Counting System
********** PRINTER OUTPUT: 05/03/12 15:15:22 **********
05/03 15:14:50 AC1 - Approach over AC1 DSS1 detected
05/03 15:14:50 AC1 occupied - Counting Circuit down
05/03 15:14:50 AC1 FF-relay activated
05/03 15:14:59 AC1 clear - Counting Circuit up
05/03 15:14:59 Axle count AC1 DSS1 POS NEG 4 0
05/03 15:15:00 Axle count AC1 DSS2 POS NEG 0 4
05/03 15:15:00 AC1 FF-relay deactivated
05/03 15:15:05 AC2 - Approach over AC2 DSS3 detected
05/03 15:15:05 AC2 occupied - Counting Circuit down
05/03 15:15:05 AC2 FF-relay activated
05/03 15:15:14 AC2 clear - Counting Circuit up
05/03 15:15:14 Axle count AC2 DSS3 POS NEG 4 0
05/03 15:15:14 Axle count AC2 DSS4 POS NEG 0 4
05/03 15:15:14 AC2 FF-relay deactivated

************************ END **************************

# XII System Power Requirements

1. **<u>Operating Voltages:</u>** The Pintsch Tiefenbach Axle Counting System requires two operating voltages to properly function. The voltage necessary to operate the axle counting components (switching amplifier, counter and MC2 modules) is 12-VDC. The voltage necessary to operate the AK19 reset module and WST8021/7 clear signal relay module is 24-VDC.

2. **<u>Battery Bank:</u>** A single 12-VDC battery bank of 105-Ah or greater capacity is typically sufficient to operate a system. This will provide 24 to 48 hours of operation in a standby (standard position) situation for a typical Interlocking system.

3. **<u>DC-to-DC Converters:</u>** DC-to-DC converters are provided to supply both the B-12 and B-24 outputs to the axle counter system. These also isolate the system from the battery bank and associated electrical environment.

4. **<u>Fuses:</u>** The Pintsch Tiefenbach equipment is equipped with fuses for the protection of the axle counting system components. **The DC-to-DC converters are not fused on the DC line (primary) side**. Therefore, good engineering practice recommends a suitable fuse be installed between the battery bank and the B-12 line to the DC-to-DC converter input. Fuse size is specified on the front panel of the converter as 20 amp.

It is beyond the scope of this manual to outline the requirements of a battery bank and charger for railroad signaling applications. The engineer and installer are referred to those recommended practices promulgated by the American Association of Railroad Engineering and Maintenance of Way Association (AREMA) as well as the rules and regulations promulgated by the Federal Railroad Administration under CFR-49, Part 234 or the regulatory authority under which the system is installed.

**<u>IMPORTANT</u>: Please refer to the engineering drawings provided with your system for specific information regarding the DC power input connections.**



*Fig. 24: Type of DC-to-DC Converter used with Interlocker Axle Counter Equipment.*
*Two types are used, one of which provides isolated 12-VDC output and the other of which provides isolated 24-VDC outputs*

## XIII Putting it all together: The Story of a Train Movement in 9 Acts

1. It was a dark and stormy night....The axle counting system has remain unaffected by the heavy rain, lightning and other environmental influences affecting nearby track circuits. No on-track equipment is present within the boundaries of the axle counting circuit. The Switching Amplifier Module exciting the electromagnetic field above each sensor, which couples into the unoccupied track. This damping action loads the sensor ciruits and each sensor pair is seeing a nominal voltage drop of about 6.5 volts.

2. With the system In standby mode, the S-relays at the Clear Signal Relay Module are energized via the redundant AK-optocouplers at the Switching Amplifier Module. The Binary Counter Module also shows an axle count of zero. Therefore, its CL-optocouplers are energized and the Oc-optocouplers are de-energized.

3. The Clear Signal Relay Module Oc3 and CL relays are energized and the Oc1 and Oc2 Relays are de-energized, the contacts of which are associated with control of the external clear signal contact line to the external signal system. The maintainer knows at a glance that the system is un-occupied because only the GREEN "CL" LEDs on the Binary Counter Module and the GREEN "Oc3" and "CL" LEDs are energized on the Clear Signal Relay Module.

4. As a train approaches the axle counting circuit, the first wheel flange (axle) reaches the entry DSS. As this wheel flange passes over the DSS, it creates a sequence of overlapping impulses. First internal system SII is occupied; then both internal system SII and SI are occuiped; this is followed by internal system SII releasing (unoccupied) and, finally, system SI releasing. This creates an overlapping pulse sequence, which is detected by the Switching Amplifier Module as a wheel flange entering the circuit. The Switching Amplifier Module de-energizes its AK optocouplers, which in turn release the S3.1 and S3.2 relays at the Clear Signal Relay Module. This in turn de-energizes the CL relay at the Clear Signal Relay Module, thereby opening the normally closed clear signal contact line to the external signal system. This process repeats as each wheel flange is detected entering the circuit, however once the CL-relay de-energized with the first axle counted it remains de-energized.

5. At the same time, the Switching Amplifier Module is "talking" to the Binary Counter Module via its momentary AZ-optocouplers. Each overlapping pulse detected at the DSS as entering the axle counting circuit is processed by the Switching Amplifier Module and converted to redundant fast acting momentary outputs, which are connected to the counter logic circuit within the Binary Counter Module. This logic circuit determines that the sequence represents axles entering the circuit and begins incrementing the two Binary Counter Module channels as each wheel flange is detected entering the circuit.

6. With the first axle having entered the circuit, the two Binary Counter Module channels had incremented to one and this in turn de-energized its two CL optocoupler outputs to the Clear Signal Relay Modules S3.1 and 3.2 relays while energizing its two Oc-optocoupler outputs to the Clear Signal Relay Modules Oc1 and Oc2 relays. This antivalent action has in turn signaled the Clear Signal Relay Module, providing a secondary and terteriary release path to control the external signal equipment.

7. The Oc3 and CL relays at the Clear Signal Relay Module are now de-energized, whereas the CLH, Oc1 and Oc2 relays are energized. The contacts of these relays change state accordingly. The contacts of the Oc3 and CLH relays are wired in series with the clear contact line to the external signal equipment. This relay interaction ensures that the failure of any one relay in the operation will not cause the clear signal line to the external signal equpment to stay closed.

8. Eventually, the train reaches the exit sensor at the opposite (exit) side of the axle counting circuit. As each wheel flange passes over the DSS, the Switching Amplifier Module converts these overlapping analog impulses into processed digital outputs via its AZ-optocouplers. These AZ-optocouplers in turn transmit these momentary pulses to the Binary Counter Module logic circuit. The logic circuit notes the pulse sequence and interprets this sequence as axles exiting the circuit. It therefore begins decrementing the counter with each passing wheel flange.

9. Eventually, the end of the train exits the DSS and the counter restores to zero. The two Binary Counter Module CL-optocouplers energize and the two Oc-optocouplers de-energize. These in turn energize the S-relays and the Oc3 and CL relays at the Clear Signal Relay Module energize. Meanwhile, the CLH, Oc1 and Oc-2 relays de-energize at the Clear Signal Relay Module. These changes in state are back-checked through a series of anti-valent functions provided by both electrically interlaced contacts and mechanically (force-guided) contacts on the Clear Signal Relay Module board. A final "time constant" analysis is performed and with everything restoring in the proper sequence, the interlaced normally closed clear contact line to the external signal equipment is restored. The system is once again in standby mode (standard position) awaiting its next train movement.

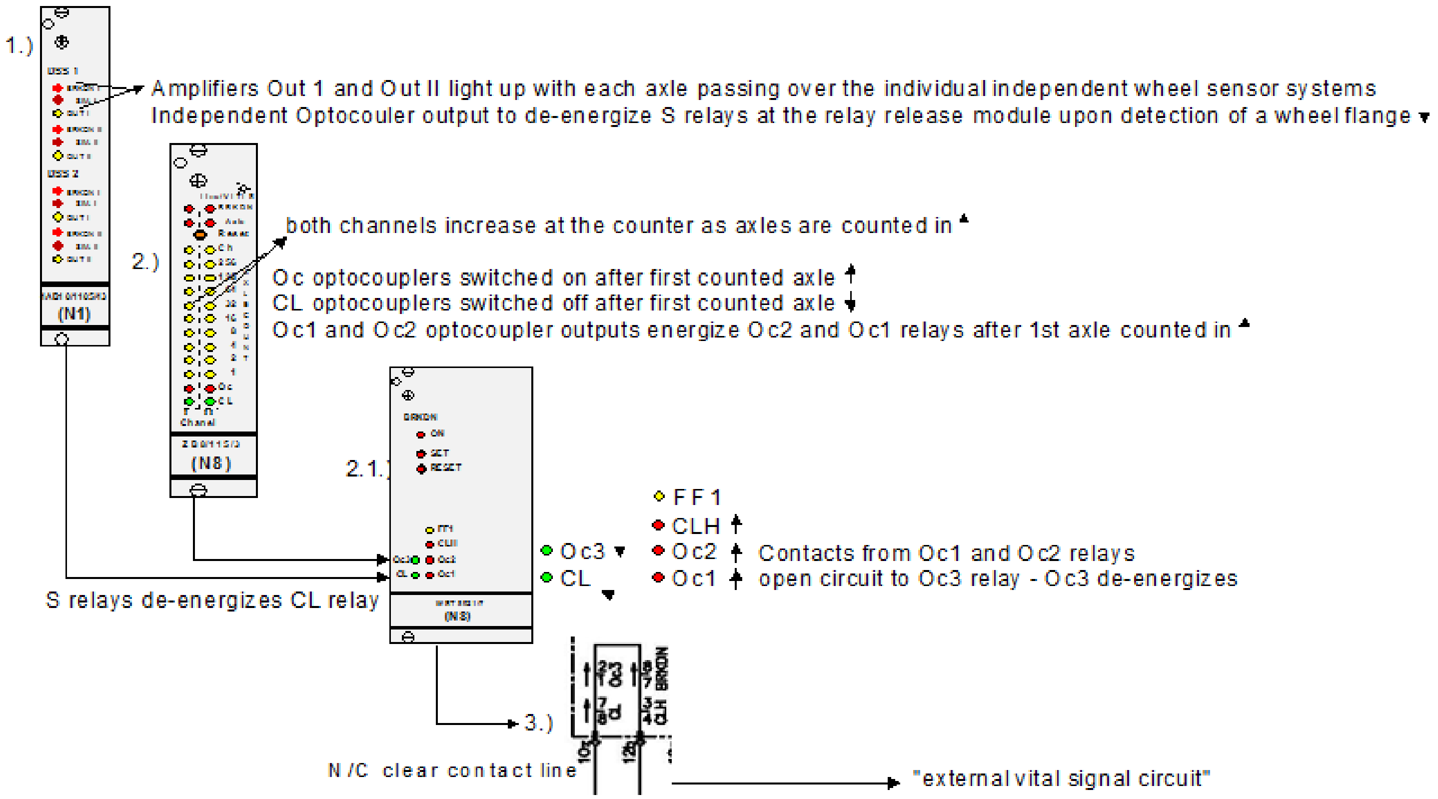



*Fig. 25: A simple flow chart showing the basic sequence, which controls the external vital signal system circuit via the clear contact line.*

# XIV An Overview of a sample Interlocker

The example below is that of a Interlocker Axle Counter System. It should be seen as a sample and not as representative of the exact layout of every Interlocker. Each system is designed for a specific track layout and specific conditions, yet the basic functions remain the same. Please refer to the specific engineering drawings for more detail.

Some preliminary notes may prove helpful before proceeding with this overview of Interlocker functions:

- Each axle counting circuit functions independently of the others. A separate, normally closed, clear-contact line is provided from *each* axle counting circuit to the vital processor controlling overall Interlocking Plant functions. As discussed earlier, some DSS and their associated switching amplifier are shared between axle counting circuits.

- Each sensor location has two direction-dependent associated "Red Light Over-run" outputs (one for each direction). These are normally open, momentary, optocoupler outputs to the associated processor equipment.

**Over-view of a Sample Interlocker**

1. The sample Interlocker Axle Counting System consists of sixteen (16) axle counting circuits arranged to accommodate all patterns of train movement. These axle counting circuits are identified as AC-1 through AC-16. Twenty (20) double wheel sensors are utilized to develop these axle counting circuits.

2. A color coded diagram of the Interlocker may be seen below:

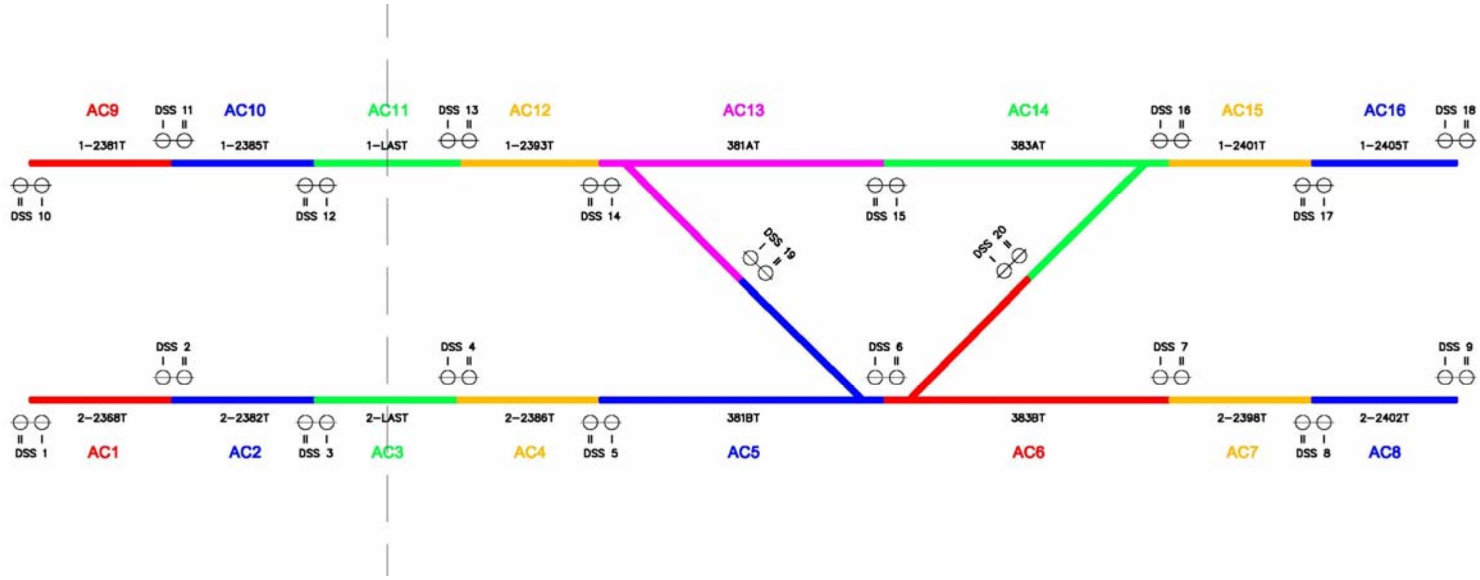



*Fig. 26: Sample Interlocker Track Layout Example.*

3. Note that in the case of those double wheel sensors (DSS) located at the boundary of two axle counting circuits, the same DSS serve as a counting point for two circuits simultaneously. For example,viewing the above track layout, DSS-2 serves as a counting point for both axle counting circuit AC1 and AC2. Because of this, any fault associated with DSS-2 or its associated infrastructure (wiring, cable, etc.) will result in a fail safe condition in both the AC1 and AC2 axle counting circuits simultaneously.

4. Should a breakdown fault occur in association with a sensor at the boundary of two axle counting circuits, *it will be necessary to reset BOTH circuits after the fault has been corrected*. Please review the previous safety instructions before resetting the system.

5. The sixteen axle counting circuits are represented at the evaluation component system consisting of eight “Euro-card” cages designed to mount in a standard 19-inch open-frame relay rack. Of primary importance from an operational standpoint on each of these card cages, are the *Axle Counter Reset Key Switches* (ACR), the *Binary Counter Modules*, the *Clear Signal Relay Modules* and the *Switching Amplifier Modules*.

6. Each Card Cage contains the necessary hardware for two axle counting circuits. These circuits are identical in layout and function, that is, the left half of each card cage is one axle counting circuit whereas the right half is a second axle counting circuit. Between these two semi-independent systems are the associated Axle Counter Reset Keys. The AK19 and MC2 modules are shared between the two axle counting circuits.

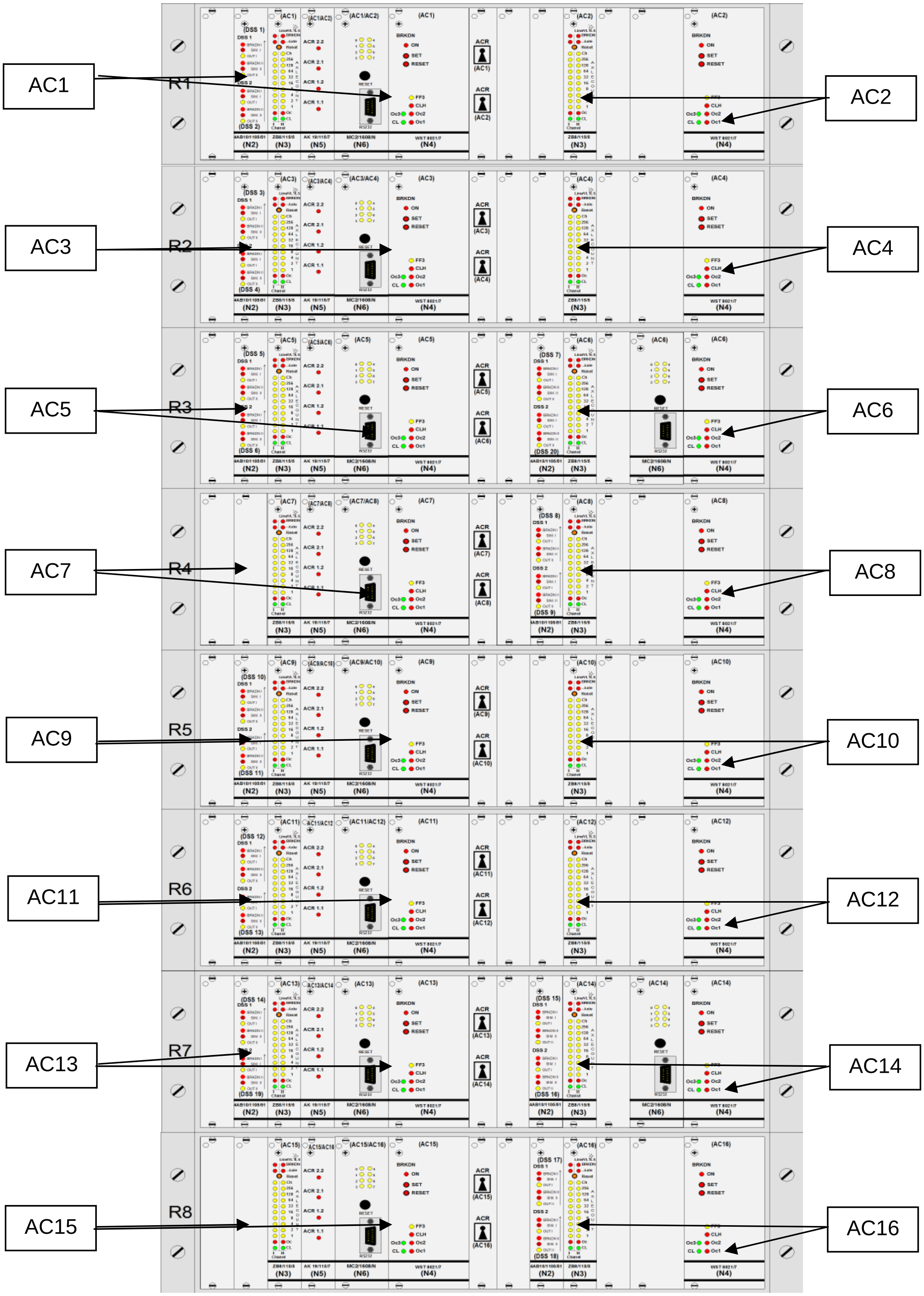



*Fig. 27: Sample Interlocker Frontpanel Layout Example.*

7. One will note that the components are arranged intuitively, from left to right; each representing its respective axle counter circuit sequentially from AC-1 to AC-16. In a sense, the axle counting circuits are laid out like one might read a book, from left to right and from the top to the bottom of the page. For example, Card Cage R1 contains the components for Axle Counter Circuit AC1 on the left and Axle Counter Circuit AC2 on the right. Located at the center of each card cage are the ACR Reset Key Switches, which are likewise arranged intuitively, with the ACR Key for the system on the left (in this example, AC1) on top, and the ACR Key for the system on the right (in this example, AC2) below.

8. Examining the front panel layout,one will note that the location of the Binary Countery Modules and the Clear Signal Relay Modules are consistent between card cages, yet, some locations lack other shared components, such as Switching Amplifier and AK19 Modules. This is due to the fact that some double wheel sensors are shared between axle counting circuits and each AK19 is designed to handle two axle counting circuits.

9. When problems occure, or when one is simply checking the status of the system, he will observe the status of the LEDs on the various modules. Please see the detailed module descriptions located earlier in this document for further details. During testing, a maintainer may simulate axles entering or exiting an axle counter circuit by manipulating the “SIM” buttons located on each of these cards. By depressing a SIM button, one simulates a wheel flange (axle) passing over the internal system of a DSS. For example, if the DSS is arranged so that a movement from internal system S2 to S1 increments a counter as on-track equipment enters the axle counting circuit, one would perform a simulation as follows:

   a. Depress SIM-2 and hold it.
   b. Depress SIM-1 and hold it.
   c. Release SIM-2 while still holding SIM-1
   d. Release SIM-1.

   *Note: This simulates the overlapping impulses needed to properly increment or decrement a counter. By reversing the direction of movement, one can count-out axles as appropriate. Please see the detailed track layout engineering drawings to determine the appropriate sequence for each DSS (e.g. S1 to S2 or S2 to S1).*

10. The diagram below shows the DIN Rail containing the various terminations for interconnection with external signal equipment. Here, one will find the DC power inputs for each Card Cage along with the terminations for the Clear Contact Line and the Red Light Over-run outputs. Detailed information covering these terminations are available in the specific engineering drawings for each system.

**Back Plane Diagram Showing Terminations**.

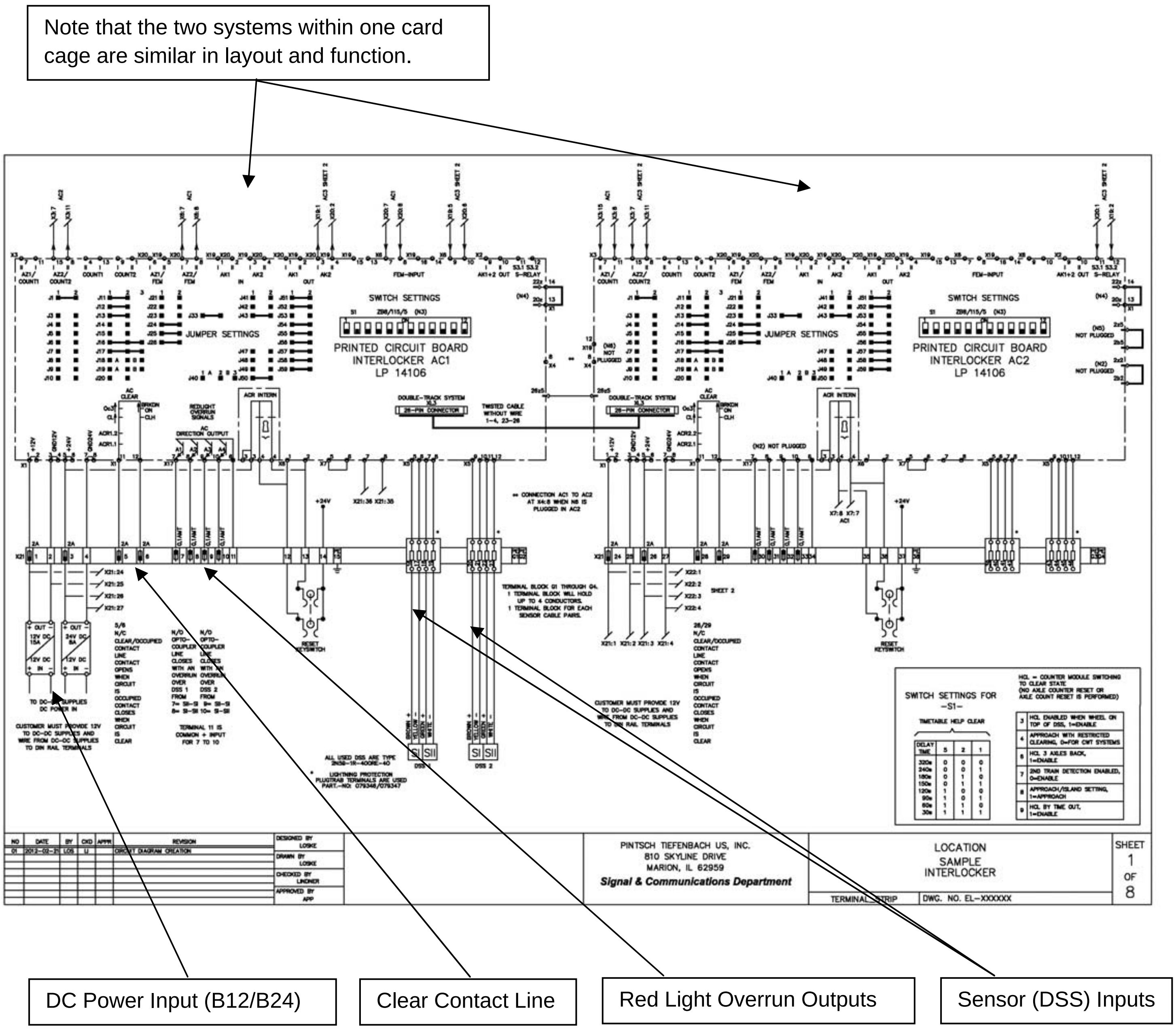



*Fig. 28: Overview of important DIN-Rail and Back Plane connections.*

# XV Juxtaposition of Interlocker Components

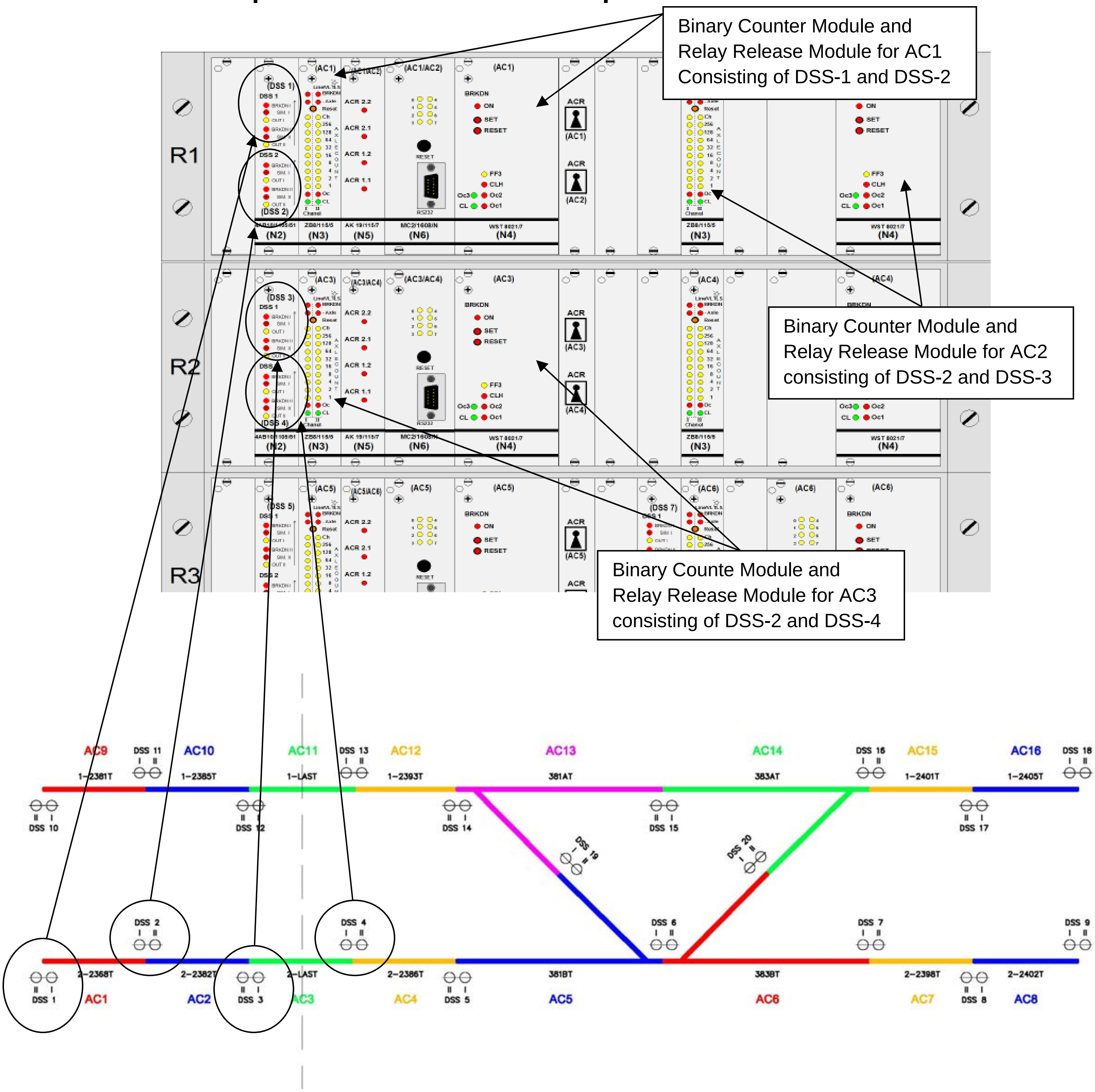



*Fig. 29: Juxtaposition of Track Layout DSS Locations with Card Cage R1 and R2 Switching Amplifier Modules. Note that some components are shared, such as the AK19 Reset Module, MC2 Data Reporting Module, etc.*

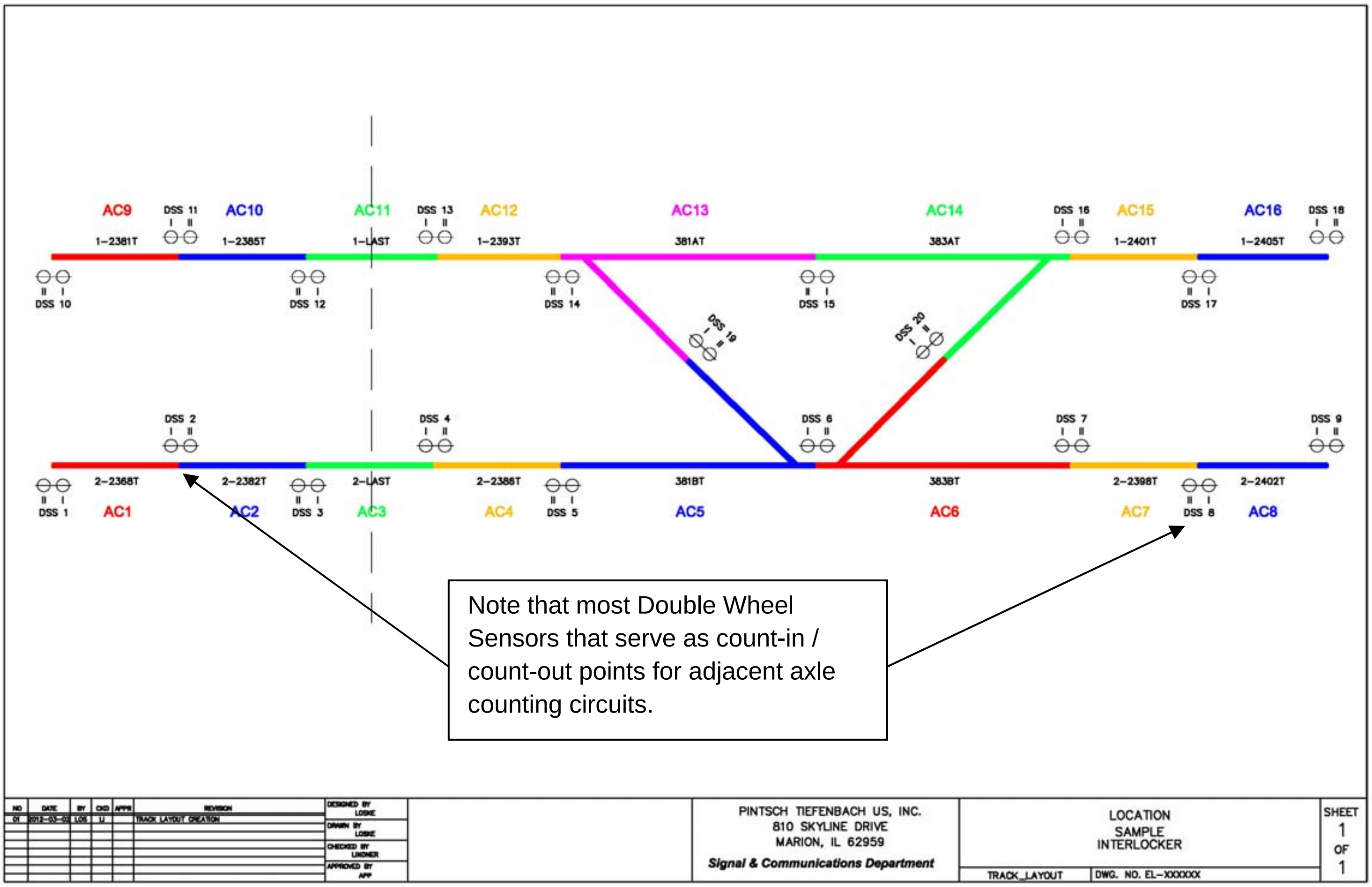



*Fig. 30: Track layout blueprint points out sensor that serve two axle counting circuits.*

**Notes:**

- Only DSS-1, DSS-10, DSS-9 and DSS-18 are associated with a single axle counting circuit. All other DSS serve two circuits.
- When a fault occurs in association with a DSS that is on the boundary of two axle counting circuits, a fail-safe conditions will be triggered for both axle counting circuits. For example, if DSS-2 is displaced from the rail, both axle counting circuit AC1 and AC2 will enter fail-safe mode. It will therefore be necessary to reset both AC1 and AC2 after the problem is corrected.

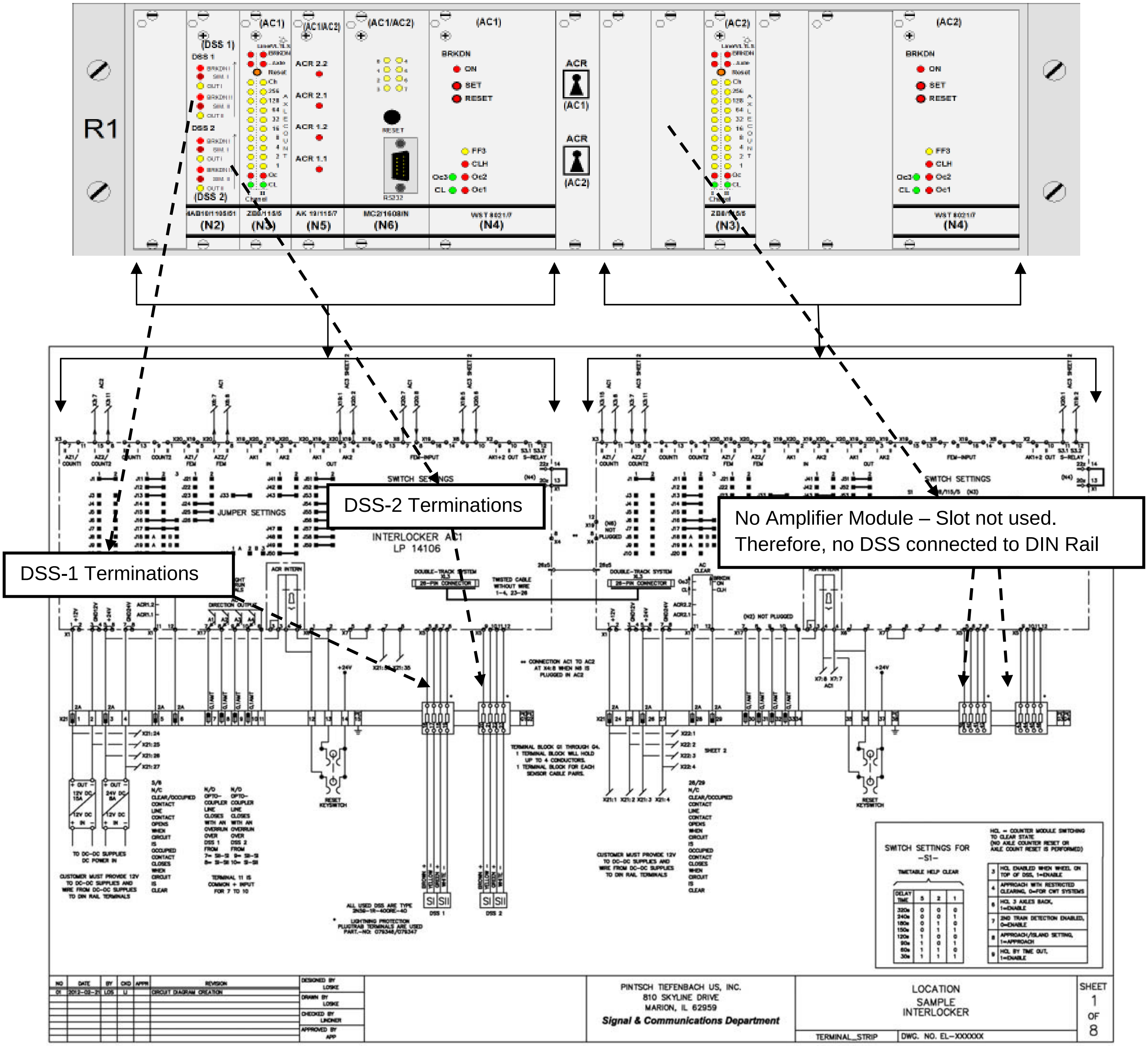



*Fig. 31: Juxtaposition of R-1 Card Cage with DSS Terminations at DIN Rail*

# XVI Trouble Shooting Procedures

Because Pintsch Tiefenbach axle counting systems are extremely reliable, a significant component failure is very rare. A more likely cause of a problem will be associated with an occasional miscount due to defective on-track equipment, maintenance of way activity, an incorrectly adjusted wheel sensor or a similar intermittent cause.

The following trouble shooting guide is intended for maintenance personnel when they first arrive on-site. Of primary importance is collecting relevant data, which may provide clues to specific module and component level failures. Technicians should be careful to collect this data BEFORE resetting the system. Sometimes, a photograph of the affected cards on the front-panel of the system will provide a record of the failure mode useful for subsequent troubleshooting.

## 1. Trouble Shooting Steps for Various Failure Modes:

*A. One or more axles left in a circuit after on-track equipment exits:*

1. If only one axle remains after on-track equipment exits an axle counting circuit, it may be a fault caused by dragging equipment, a defective brake, or defective wheel flange or incorrectly adjusted or ~~a~~ defective wheel sensor.
2. Note condition and reset the system.
3. Should condition recur regularly, check electrical adjustment of double wheel sensors associated with the problematic axle counting circuit using the R58/117/1 test device and SSPV-1 alignment tool.
4. If the associated double wheel sensors check OK, then check individual pairs for leakage to ground (disconnect from equipment rack and DSS first!). This can be done with a standard Analog VOM. However, a Simpson 372-2 or 372-3 megaohm meter may prove preferable due to the moderate voltages used.
5. Inspect all electrical connections for corrosion, intermittent connections, improperly crimped lugs, or similar faults.

6. Typically, if multiple axles are left in the axle counting circuit, this may be the result of a defective double wheel sensor.  If the infrastructure (wiring, cable, junction boxes, etc) check OK, one can temporarily swap the Switching Amplifier Module to determine if the problem follows the module.  If it does NOT (stays with "slot"), then the next course of action should be the replacement of the Double Wheel Sensor.

B. *All yellow LEDs flashing on counter module.*

1. This condition may be a fault caused by a voltage loss to the system or a minus axle count.

2. Note condition and reset the system.

3. Should condition recur regularly, check electrical adjustment of double wheel sensors associated with the problematic axle counting circuit using the R58/117/1 test device and SSPV-1 alignment tool and check voltage to the system.

4. If associated double wheel sensors check OK, check individual pairs for leakage to ground (disconnect from equipment rack and DSS first!).  This can be done with a standard Analog VOM. However, a Simpson 372-2 or 372-3 megaohm meter may prove preferable due to the moderate voltages used.

5. Inspect all electrical connections for corrosion, intermittent connections, improperly crimped lugs, or similar faults.

.

C. *Red Breakdown LED present at Input Amplifier Card.*

1. Note the DSS number with which the “breakdown” LED is associated.

2. Identify the location of the DSS on the track layout diagram.

3. Visually inspect the DSS for evidence of an off-rail condition or evidence of physical deformation of the wheel sensor bracket.

4. If rail is properly affixed to the rail, carefully inspect all electrical connections/terminations.

5. If connections/terminations are OK, check the two sensor pairs between the equipment rack and the DSS for continuity or shorts.

6. If cable, terminations, and all connections check OK, and problem does not clear, swap the Switching Amplifier Module to see if the problem follows the module. If so, replace the Switching Amplifier Module with a spare.

D. *Yellow "OUT Light" at Input Amplifier Card remains illuminated.*

1. Inspect the associated DSS at track side to ensure on-track equipment is not standing atop the sensor.

2. Inspect the associated DSS at track side to ensure no metallic debris is resting atop the DSS.

3. Check the sensor bracket to see if is bent down or deformed.

E. *Axle Counting Circuit will NOT RESET:*

1. Ensure that no BRKDN or OUT LEDs are present at the Switching amplifier modules. If so, inspect the associated DSS and cable pairs (see above).

2. Ensure that no BRKDN LEDs are present at the Counter module. If BRKDN LEDs remain on with no BRKDN indication at an associated switching amplifier module, swap the counter card with an adjacent card to see if problem moves to an alternate circuit (follows the card). Check for an intermittent short or open at the DSS which are associated to the counter module and circuit the problem is present at. The BRKDN monitoring at the Counter Module latches when an amplifier has detected a DSS breakdown (open, short or off-rail condition) in case the breakdown is intermittent.

3. As the ACR key switch is actuated, ensure both LEDs within the operational pairs at the AK19/115/7 card illuminate and the counter module switches from occupied to clear during this process.

4. If the AK19 is inoperative, try swapping it with an adjacent reset module. If problem follows the module, replace the module with a spare.

5. If problem does not follow the module, check to ensure that the proper 24-VDC (B-24) is being switched on BOTH lines coming from the ACR Key.

*F. Intermittent Conditions:*

1. A momentary failure within some circuits can force the system into a fail-safe (occupied) condition. In the event of a suspected intermittent, download the data from the MC2 data-recording module as described in the associated technical manual. This data may be helpful when determining where the intermittent failure may be.

2. When necessary, MC2 data may be saved as a “text file” and transmitted to Pintsch Tiefenbach for subsequent review and diagnosis.

3. **Always check the “boiler plate” fundamental systems first. We have found that most axle counting problems are traced to defective wire and cable, improper installation practices or wheel sensor misadjustment.**

*G. Red Light Overrun Outputs*

1. Red Light Overrun outputs should be extremely reliable. However, in the event of a suspected failure, it may be necessary to test these optocouler outputs.

2. In order to test an output, an analog ohmmeter is recommended. A Simpson 260 series or TS-113 or equivalent is recommended. These meters provide sufficient loading and voltage to the optocoupler circuit.

3. Note that the optocouplers are polarity sensitive. The switching direction can be seen in the associated engineering drawings.

4. While connected to each output, simulate one axle passing over the wheel sensor by generating the proper, simulated pulse at the Switching Amplifier Module. This can be done using the "SIM" buttons. More information regarding the proper method of simulating wheel flanges may be found elsewhere in this manual.

5. If it is determined that a Red Light Overrun Output is not working, first check the fuse. If the fuse is OK and all terminations are tight with good continuity, it will be necessary to replace the Switching Amplifier Module with a spare.

2. Sometimes, in the event that an entering DSS is not detecting wheel flanges (axles) properly, one may observe a condition in which more axles are counted out of a circuit than were originally counted into the circuit. This will result in a minus axle count. In such cases, both vertical columns of LEDs will flash alternately. In order to clear a minus axle count fail safe condition, it will be necessary to reset the associated axle counting circuit using the appropriate ACR key switch. In the event an exiting DSS is not detecting wheel flanges properly, one may observe a condition in which axles remain in the circuit, therefore the circuit remains in the occupied state.

3. A repeated problem with minus axle counts or additional axles remaining in a circuit after a train has exited the area typically indicates a DSS adjustment problem. The double wheel sensors within the axle counter circuits should be checked using the R58/117/1 device and the SSPV-1 adjustment plate as described in the detailed technical manual. In rare cases the wheel sensor may be defective and will have to be replaced if correct readjustment of the DSS does not fix the issue.

4. Technical Questions: If a technical question can not be answered by maintenance personnel, please feel free to contact Pintsch Tiefenbach at our Marion, Illinois office. We will be pleased to work with you to answer any questions.

**Pintsch Tiefenbach US, Inc.**
**810 Skyline Drive,**
**Marion, IL. 62959**
**618-993-8513**