PINTSCH TIEFENBACH

Railway Signaling.

600 Main Street Axle Counting System.

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 explained. 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**:

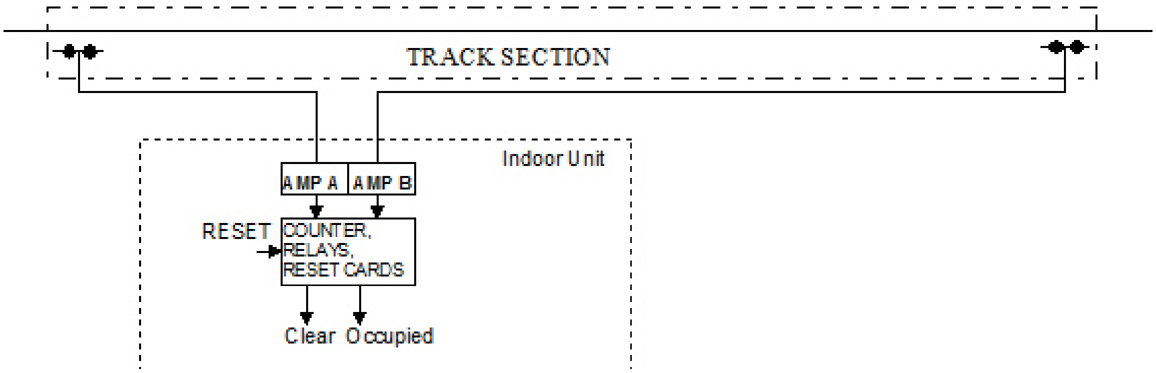


Fig. 1: A simple axle counting circuit.

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. **<u>The Structure of the Double Wheel Sensor ("DSS")</u>**: 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. **<u>DSS Cable Pairs:</u>** 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 (+)
Yellow (-)
   - DSS Internal System Two (S-II): Green (+)
White (-)

3. **<u>Detection Method:</u>** 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 and current 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.

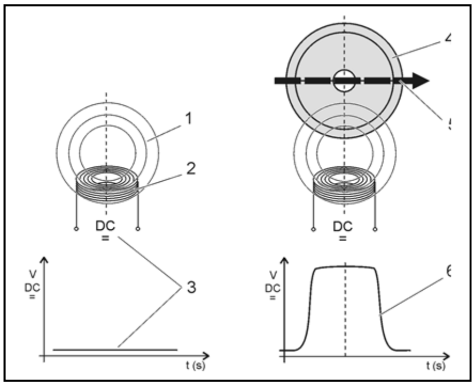


Fig. 2: A representation of a wheel flange passing through the DSS electromagnetic field with related change in voltage.

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 (SII to SI or SI to SII). 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 and will therefore *increment* the counter (providing the SI and SII cable pairs have been swapped at the input terminals), if the internal wiring to the counter module is wired for a sequence of SII to SI as entering a circuit. Likewise, based on the same logic design, a wheel flange occupying an exiting wheel sensor at S-II first followed by S-I will be detected as *exiting* the circuit and the counter will decrement, if the internal wiring to the counter module is wired for a sequence of SII to SI for an exiting wheel sensor. 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, internal 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 internal counting logic design stays the same for the particular circuit. *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. The engineering drawings will show the required sequence needed for each circuit and this must be adhered to in all cases. 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 10 for an example of the S1/S2 sequences on a track layout.*

5. **Overlapping Impulses**: The DSS and its associated switching amplifier and counter module 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 and can be seen at the amplifier OUT LED indictations for the respective DSS:

Entrance Sensor (S93 or S100 circuit)

- 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 (S93 or S100)

- First, DSS internal system S-II is occupied.
- Second, DSS internal system S-II remains occupied and 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.

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.The design sequence logic is shown on the track layout for your system.

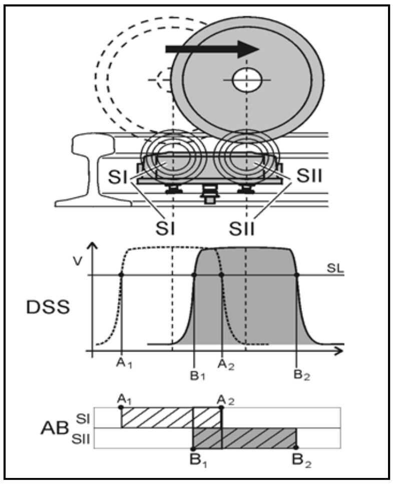


Fig. 3: Diagram showing overlapping pulses as wheel flange passes over sensor. Pulses must properly overlap to be counted as an axle. Example shows an SI to SII sequence. This may vary depending on system design. Check the engineering drawings to deterimine if you system uses a SI to SII sequence or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

6. **<u>Disassociated Impulses</u>**: 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. The axle counting systems installed at 600 Main are programmed to go active after the 3rd disassociated inpules is detected.

7. **<u>Permissible distances to metallic objects</u>**: 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. **<u>Requirement for proper mounting</u>**: Because the rail itself plays an important role in the 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*.

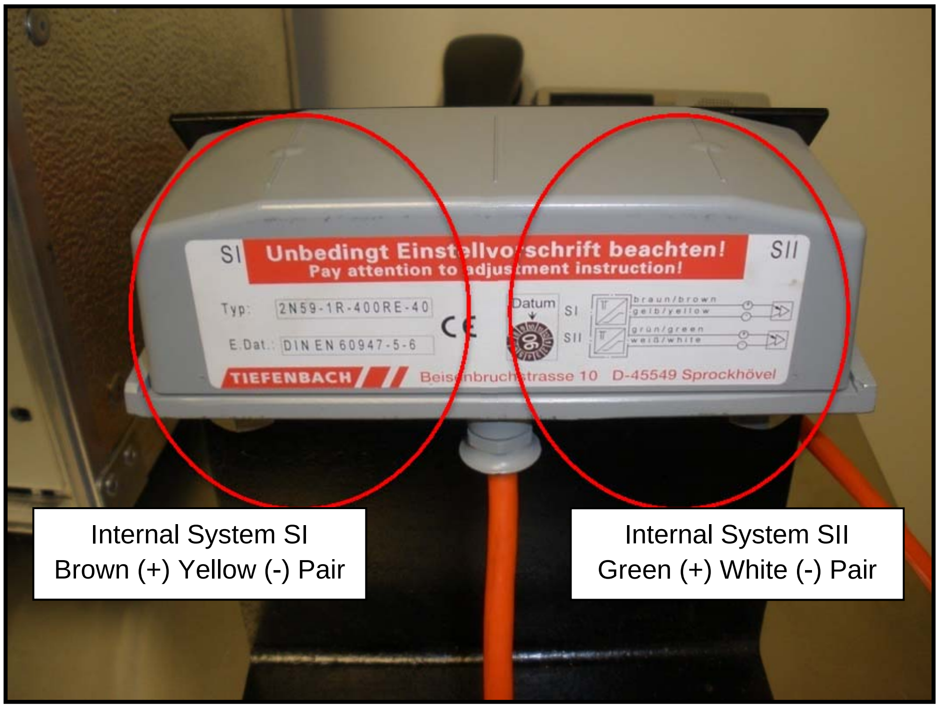


Fig. 4: Structure of DSS showing internal systems one and two

9. **Multi-Use Areas**: 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.

III Overview of Basic DSS Maintenance

1. **Mechanical Tolerances**: 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 at an existing sensor location 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 unit*.

   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. **Electrical adjustment and the R58/117/1 test device**: 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 with 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. Then 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. <u>It must be fully engaged to avoid damage to the sensor.</u>

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 the point at which 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, because their total voltage output would be 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 significantly overlap the rail.

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

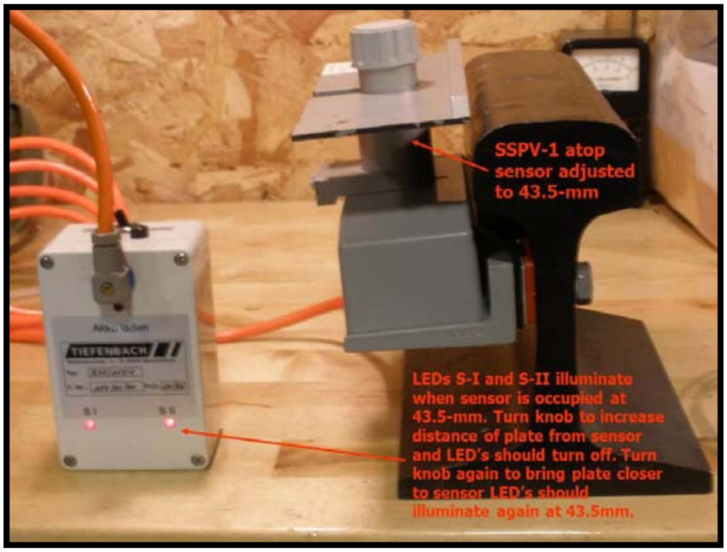


Fig. 6: R-58/117/1 Device showing S1 and S2 LEDs illuminated when SSPV-1 Plate is at 43.5-mm.

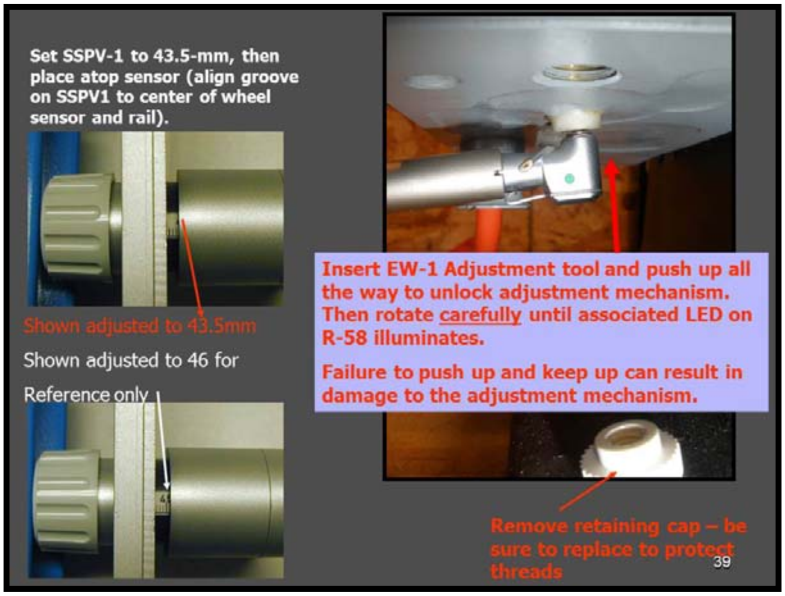


Fig 7: Illustration showing SSPV-1 set to 43.5-mm, and EW-1.

3. **Unauthorized Tools**: 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. **<u>Mechanical and environmental requirements of buried cables</u>**: 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 <u>18-gauge</u> 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 transient 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. 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. Therefore, 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.

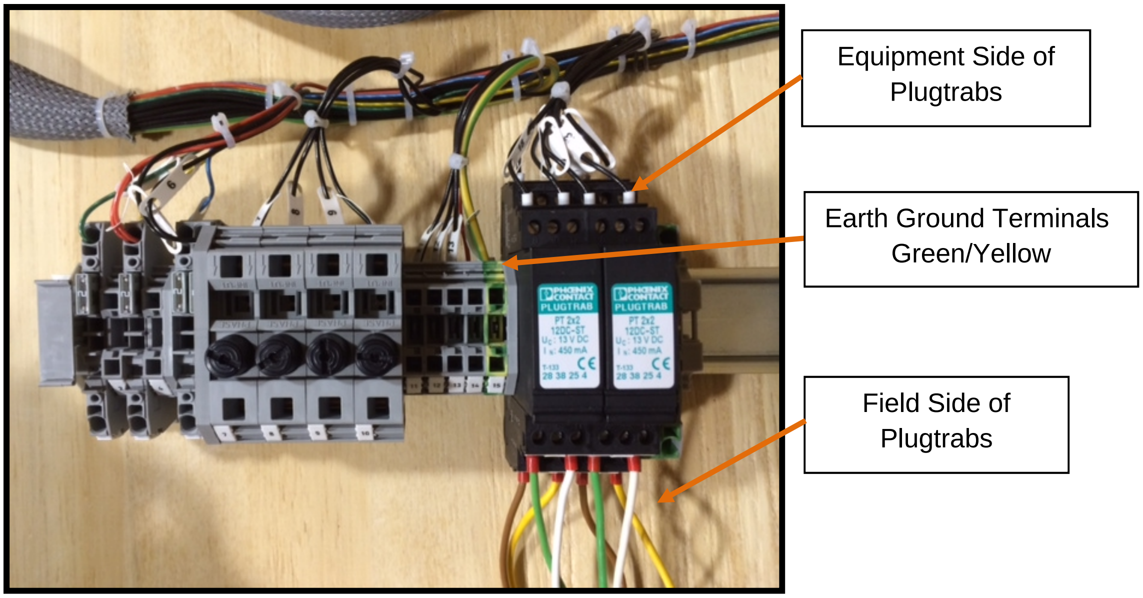


Fig 9: A sample Axle Counting System DIN Rail showing “plugtrab” protective devices to which external sensor lines attach to axle counting system. Protective ground not to be confused with floating (ungrounded) signal system neutral

V Overview of the 600 Main Axle Counting System

1. **Introduction**: At first glance, the 600 Main systems appear to be configured in the same manner as an approach-island-approach crossing system. While the layout of the axle counting circuits is physically similar to the approach-island-approach for track1 and approach-island for track 2 arrangement, each axle counting circuit operates independently of the others, with its own normally closed clear-contact line to the external signal system. Control of the signal circuit and the external signal equipment is provided by an external processor, which is controlled (signalled) by each of these clear contact lines.

2. **Card Cage and Track Layout**: The 600 Main Axle Counting System consists of two independent card cages; track 1, which supports three axle counting circuits and track 2, which supports two axle counting circuits. As such, the card cage is arranged for two tracks. Not only do these two tracks function independently, as noted above, each of the three axle counting circuits assigned to each track function independently.

3. **Summary of Axle Counting Circuits and DSS**: The 600 Main hardware based axle counter system provides a normally-closed clear-contact line output for each axle counting circuit and consists of:

   Track-1: One 19" card cage with associated components for three axle counting circuits and four wheel sensors.

   Track-2: One 19" card cage with associated components for two axle counting circuits and three wheel sensors.

   Track One Counting Points:
   S93 circuit is delimited by DSS 1S and DSS 2S
   S95 circuit is delimited by DSS 2S and DSS 3S
   S100 circuit is delimited by DSS 3S and DSS 4S

   Track Two Counting Points:
   N93 circuit is delimited by DSS 1N and DSS 2N
   N100 circuit is delimited by DSS 2N and DSS 3N

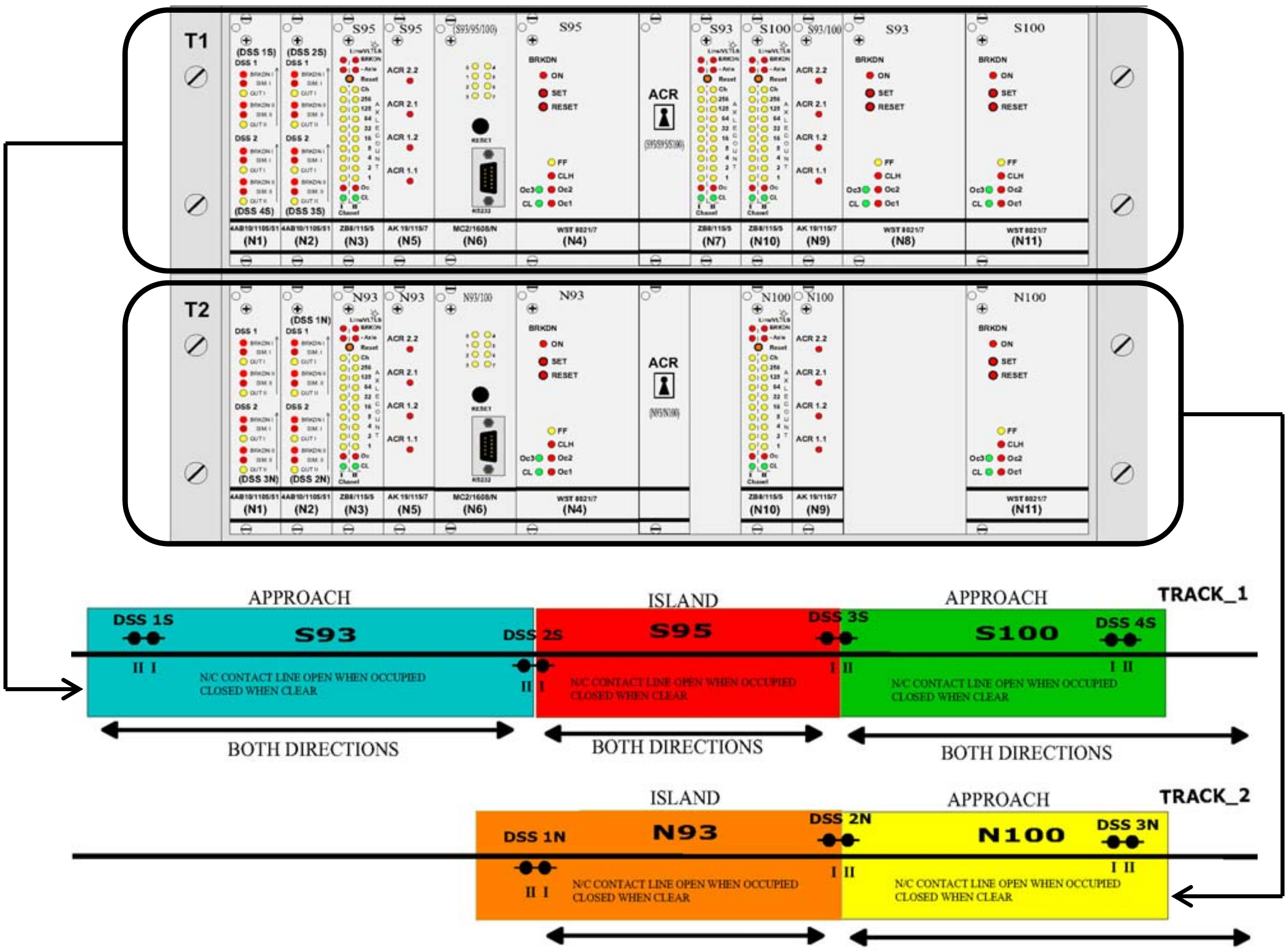


Fig. 10: Card Cage front panel view juxtaposed with track layouts.

4. **Double Wheel Sensor Assignments**: Each axle counting circuit requires two counting points provided by double-wheel sensors. Those Double Wheel Sensors, which are located at the boundary of two axle counting circuits, serve as a count-in/count-out point for both circuits. Examples include DSS-2S and DSS-3S on Track One as well as DSS-2N and DSS-3N on Track Two. These DSS are represented at the Card Cage at the two Switching Amplifier Modules. The physical relationship between the DSS and Switching Amplifiers is indicated below:

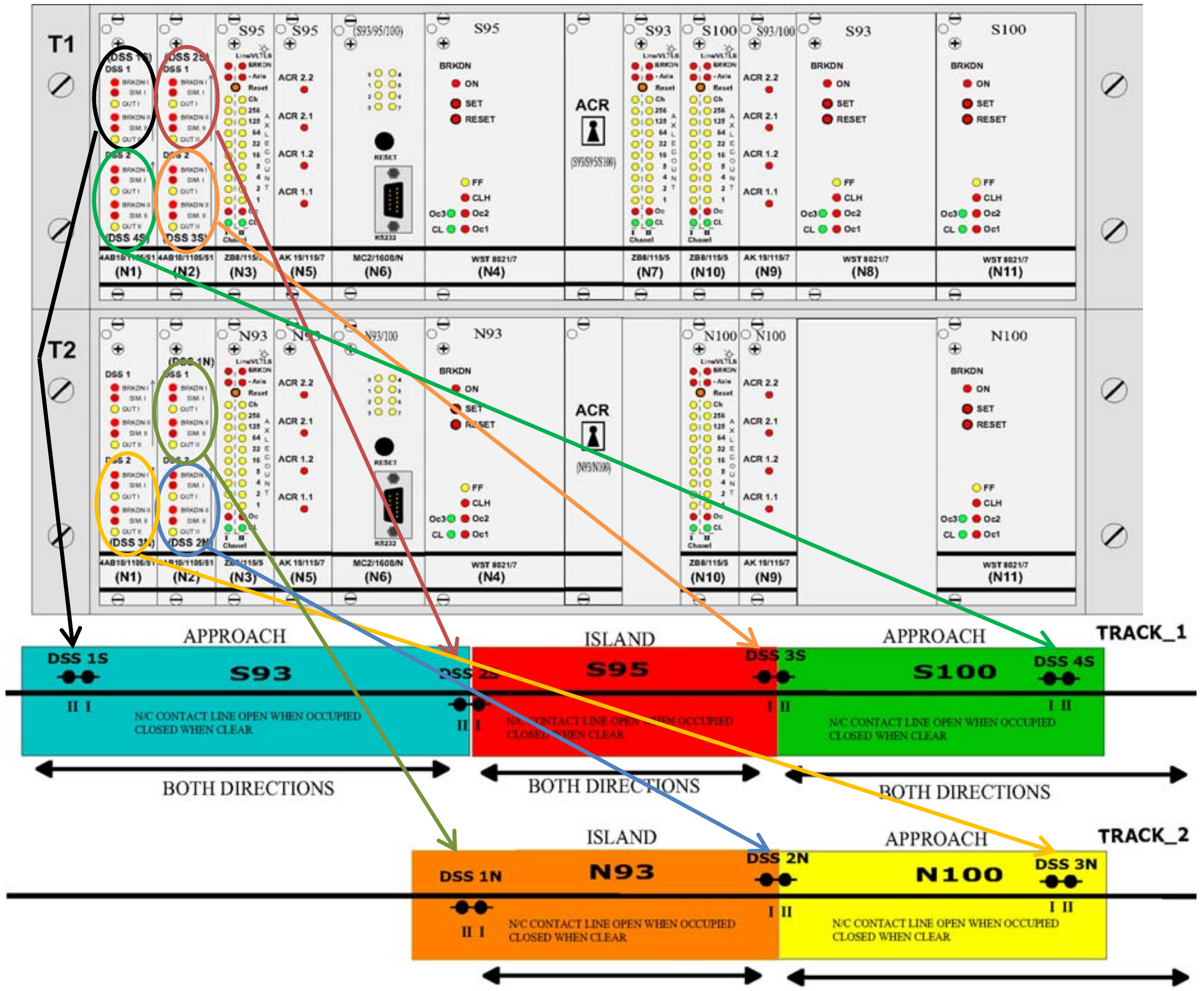


Fig. 11: DSS locations at Switching Amplifier Modules

5. **System Start Position**: In quiescent (standby) mode all axle counter circuits are clear and their respective clear-contact lines are closed. The CL-I and CL-II LEDs are illuminated green on the ZB8/115/5 counter modules and no axles are indicated on the counter channels. Likewise, the CL and Oc3 LEDs are illuminated and the CLH, Oc1, Oc2 and FF-LEDs are off on the WST-8021/7 Clear Signal Relay Modules. The system is ready to detect the movement of any on-track equipment entering an axle-counter circuit.

   The Track 1 axle counting circuit has three identical ZB8/115/5 binary counter modules which should indicate zero axles in the standby mode.as well as three identical WST-8021/7 Clear Signal Relay Modules.
   The Track 2 axle counting circuit has two identical ZB8/115/5 binary counter modules which should indicate zero axles in the standby mode.as well as three identical WST-8021/7 Clear Signal Relay Modules.

   A good rule of thumb when first surveying the front panel indications is to note that all green LEDs are illuminated when the system is in standby mode (unoccupied).

6. **Basic Function of 600 Main system (ex: Track-1 module cage and track layout S93 to S100)**:

If a train wheel flange moves across one of the double wheel sensors at either approach (DSS-1S or DSS-4S), a series of overlapping signal pulses are generated as the wheel flange influences the inductive electric fields generated at the sensor. These pulses and their sequence are then detected at the switching amplifier module, processed to determine direction and prepared for output to the various vital circuits.

If the direction of movement at DSS-1S is determined to be into the S93 circuit, the amplifier takes each individual signal impulse and feeds it to the S93 ZB8/115/5 counter module, which subsequently increments. Likewise, the switching amplifier module transmits an additional pulse directly to the S93 WST-8021/7 Clear Signal Relay Module in order to open the relay circuit as each wheel flange is detected moving into the circuit.

Additional wheel flanges detected entering the approach increment the associated binary counter channels at the S93 ZB8/115/5 counter module. When one or more axles are counted into the circuit, the CL LEDs extinguish and the Oc LEDs illuminate. Meanwhile, the axle count is displayed simultaneously on the two channels at the counter module.

Within a standard Pintsch Tiefenbach crossing system, the secondary optocoupler outputs from the ZB8/115/5 counter module to the WST-8021/7 relay module are typically suppressed by a FF-relay contact until the first three wheel flanges (axles) are detected moving in the direction into the circuit. However, the 600 main axle counting system is designed to activate (open the external control line) after the first complete wheel flange (axle) is detected moving into each circuit. Therefore, the FF-relay contact is bypassed via a jumper on the rear circuit board in this particular application to disable this function.

The first action within the system upon the detection of the 1^{st} axle moving into the circuit is the release of the relay module. This occurs when the switching amplifier module opens a series of primary and secondary "AK" optocouplers. These, in turn, de-energize two S-relays located on the WST 8021/7 clear signal relay module. This redundant path provides two vital circuits controlling the WST8021/7 relay logic, which is supported by the safety provided by the normally-closed characteristics of the relay circuit.

Contacts from the S-relays then open the circuit to the CL-relay, the contacts of which are in the line to the external control circuit. Additionally the FF-relay which can activate the secondary counter outputs and turn on counting at the S95 counter module is permanently energized at the circuit board for this application.

When the S93 axle counter track circuit is activated by the first axle, the CL1 & CL2 optocoupler outputs from the S93 binary counter module deactivate also opening the line to the CL-relay coil while the Oc1 and Oc2 optocoupler outputs from the counter module activate (energize) the Oc1, Oc2 relays whose contacts deactivate the Oc3-relay. The CLH-relay is activated in combination by the changing of the S-relay and by a contact from the CL-relay. The CLH and Oc3 contacts are also in the line to the external control circuit, providing yet additional layers of safety. Any of these redundant contacts in the S93 circuit can cause the clear-contact line to open. Only after the train has left the S93 circuit and the axle count at the S93 counter restores to zero, and there are no other trains detected within the circuit can the S93 circuit restore to standby position.

Continuing with our example; as the train passes from the S93 circuit into the S95 circuit (at DSS-2S), the associated switching amplifier module likewise releases the S95 circuit WST-8021/7 Clear Signal Relay Modules CL-relay via the AK-optocouplers in the same manner as occurred within the S93 circuit. Likewise, the momentary AZ-optocouplers at the switching amplifier module simultaneously signal the S95 counter module and increments its axle counter, which deactivates its CL1 and CL2 optocoupler outputs to open the line to its respective CL-relay coil in the S95 WST-8021/7 relay module, which is in the line to the external control circuit. Likewise, the associated Oc1 and Oc2 optocoupler outputs energize the S95 Oc1, Oc2 relays and their contacts deactivate its Oc3-relay. The S95 CLH-relay is activated in combination by the changing of the S-relay and by a contact from the CL-relay. These CLH and Oc3 contacts are also in the line to the external control circuit, providing yet additional layers of safety. Any of these contacts in the S95 track circuit can cause the clear-contact line to open, thus keeping the line to the external signal circuit open.

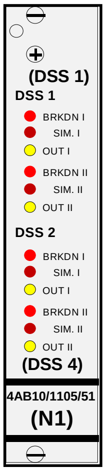
As the train passes from the S95 circuit into the S100 track circuit (at DSS-3S), the associated switching amplifier module likewise releases the S100 circuit WST-8021/7 Clear Signal Relay Modules CL-relay via the AK-optocouplers in the same manner as occurred within the S93 circuit. Likewise, the momentary AZ-optocouplers at the switching amplifier module simultaneously signal the S100 counter module and increments its axle counter, which deactivates its CL1 and CL2 optocoupler outputs to open the line to its respective CL-relay coil in the S100 WST-8021/7 relay module, which is in the line to the external control circuit. Likewise, the S100 counters associated Oc1 and Oc2 optocoupler outputs energize the Oc1, Oc2 relays and their contacts deactivate the Oc3-relay. The S100 CLH-relay is activated in combination by the changing of the S-relay and by a contact from the CL-relay. These CLH and Oc3 contacts are also in the line to the external control circuit, providing yet additional layers of safety. Any of these contacts in the S100 track circuit can cause the clear-contact line to open, thus keeping the line to the external signal circuit open.

When each counter (S93, S95 or S100) module has switched back to the clear state; CL optocouplers energized and Oc1, Oc2 optocouplers de-energized then their associated CL, CLH and Oc3-relay contacts pick-up closing the respective line to the external control circuit.

Unlike our standard approach-island-approach crossing system, the 600 Main System does not operate in a manner similar to a “directional stick circuit.” In other words in the 600 Main System, after the train has left the S95 circuit and entered into the opposite S93 or S100 circuit (exit approach circuit), depending upon direction of movement, the exit circuit output is not suppressed. Rather, its contact line functions are the same as the previous circuits when occupied, in that the clear-contact line opens to the external control circuit. In other words, each of the three circuits within the 600 Main track 1 system may be envisioned as separate, independent “island” circuits that are simply arranged in the same overlapping layout as a standard approach-island-approach crossing would be done. Each of the two circuits within the 600 Main Track 2 System may be envisioned as separate, independent “island” circuits that are simply arranged in an overlapping circuit. Therefore, the logic for controlling the external signal equipment or logic inputs is the responsibility of the external equipment manufacturer to provide.

VI Basic Features of the 600 Main 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 resting over) either internal system S1 or internal system S2 (or both), 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 a button is depressed, it sends a message to the amplifier, which simulates the presence of on-track equipment passing over its respective 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 an axle counting circuit.

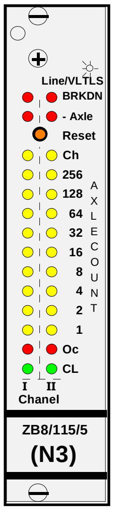
More details on the procedure for simulating axles may be found later in this manual. Generally, there should be no need to utilize the SIM buttons during routine operations. However, it is wise to be familiar with those indications associated with common failure modes:

***Yellow OUT LED stays illuminated*:** Should a yellow OUT LED remain illuminated, note the DSS with which the OUT LED is associated. Physically check that 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 a system or systems of the DSS. Refer to the track layout to determine which wheel sensor is associated with the OUT LED illuminated.

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 physical 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.

Report either of the above conditions to maintenance personnel immediately!

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



The 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, 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 ZB8/115/5 binary counter module:

Line/VLTLS / Breakdown LEDs: These RED LEDs illuminate in the event of a breakdown mode, such as a counter error, or a failure mode transmitted to the binary counter module from the Switching amplifier module. Causes include an open or shorted cable or sensor loose or off the rail. Should these LEDs illuminate, it is advisable to also check the Switching amplifier modules for any associated failure indications. These LEDs may also illuminate or flash in the event power is lost to the system and to the counter module (in the case of a power loss you will not normally see any failures indicated at the Switching Amplifier Modules.

-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.

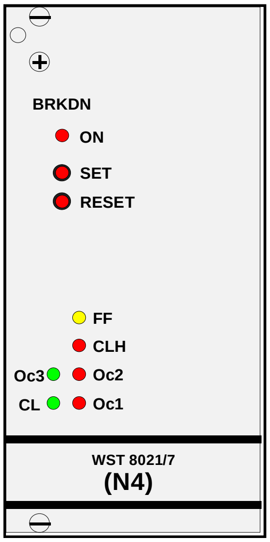
Ch LEDs: These YELLOW LEDs illuminate as each axle passes over the wheel sensor and the counting pulses are registered and input within the binary counter channels.

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 redundant outputs from both the Switching amplifier module and the Counter Module. The Clear Signal Relay module outputs then control an external control contact line. A variety of safety features are built into the Clear signal relay module, which are beyond the scope of this manual. Please refer to later in this manual for further details regarding the design philosophy and operational characteristics of the Clear Signal Relay Module.

The following indicators are present on WST 8021/7 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.

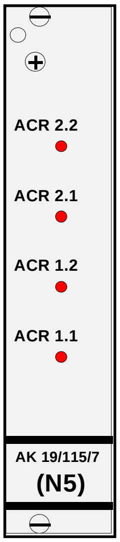
SET push button: This push button manually drops the BRKDN relay, forcing an occupied condition. Under normal conditions, this push button should not be used as its only purpose is to check the function of the BRKDN relay. When this button is depressed you should also see the CL LED on the WST8021/7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

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

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

ACR 1.1, ACR 1.2 LEDs: These RED LEDs illuminate when the ACR Key is actuated. They should remain dark otherwise.

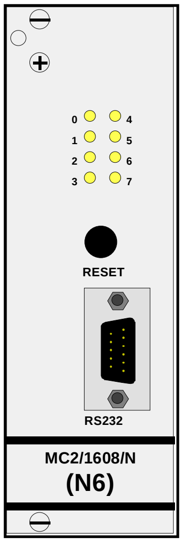
ACR 2.1, ACR 2.2 LEDs: These RED LEDs illuminate when the ACR Key is actuated. They should remain dark otherwise.

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. These are spare or unassigned pairs. However, at least one pair should always illuminate when a reset is performed (e.g. 1.1

and 1.2 and/or 2.1 and 2.2). A situation in which only half of a pair illuminates indicates a likely failure mode. For example, if 1.1 illuminates whereas 1.2 does not, then it is likely the AK19/115 Reset Module is defective.

5. MC2 Data Module:



The MC2 Data Module monitors various points within the system and provides event recording based on those event changes.

LEDs 1 to 7: LED 0 on the module should always being flashing to indicate the health status of this module. All other LED's have no functional information.

VII 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. **<u>Outputs to Clear Signal Relay Module and Counter Module</u>**: 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 Clear Signal Relay 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.

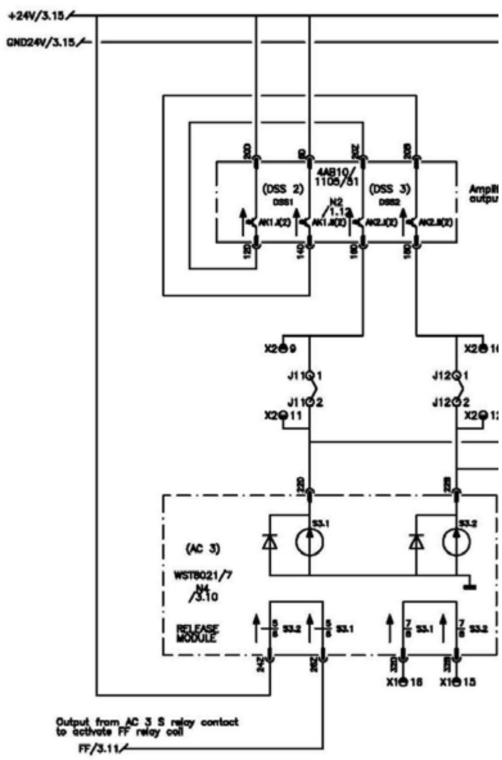


Fig. 12 : Typical schematic showing the direct path from the redundant AK optocouplers at the output of the amplifier car to the S-Relays on the Clear Signal Relay Module. ***Schematic for illustration purposes only.*** *Check associated engineering drawings for specific information on your system.*

IMPORTANT: All circuit modules are keyed uniquely to their respective slots in the module cage. For example, this prevents the insertion of a /51 amplifier module in a slot designated for a /43 amplifier module or the incorrect installation of a physically similar module of different function in an incorrect slot. Nonetheless, technicians should be careful to avoid placing the wrong module in a module cage slot (position).

5. **DIP Switches on Amplifier Module**: 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 600 Main System, these DIP switch settings are configured to disable all optional functions, except for activating on the 1st complete axle and/or 3 pulses at each DSS.*

   DANGER! These DIP switch settings are set at the factory and should be changed only 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 Pintsch Tiefenbach US.

6. **B-12 Voltage Inputs**: 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.

7. **Fail Safe Functions**: 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:
   - Sensor cable short: RED breakdown and YELLOW occupied LED illuminated
   - Sensor cable open: RED breakdown and YELLOW occupied LED illuminated
   - Sensor off rail: 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. 13: Amplifier module front panel indicating DSS 1 SII shorted or open cable.Note both yellow "OUT" and red "BKN" LEDs illuminated.

*Fig. 14: Amplifier module front panel indicating DSS off-rail condition.
Note both yellow "OUT" and red "BKN" LEDs illuminated.*

Fig.15: Metallic Object or Wheel Flange Resting Atop Both Systems of the Sensor

VIII Detailed Discussion – Binary Counter 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 WST 8021/7 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.

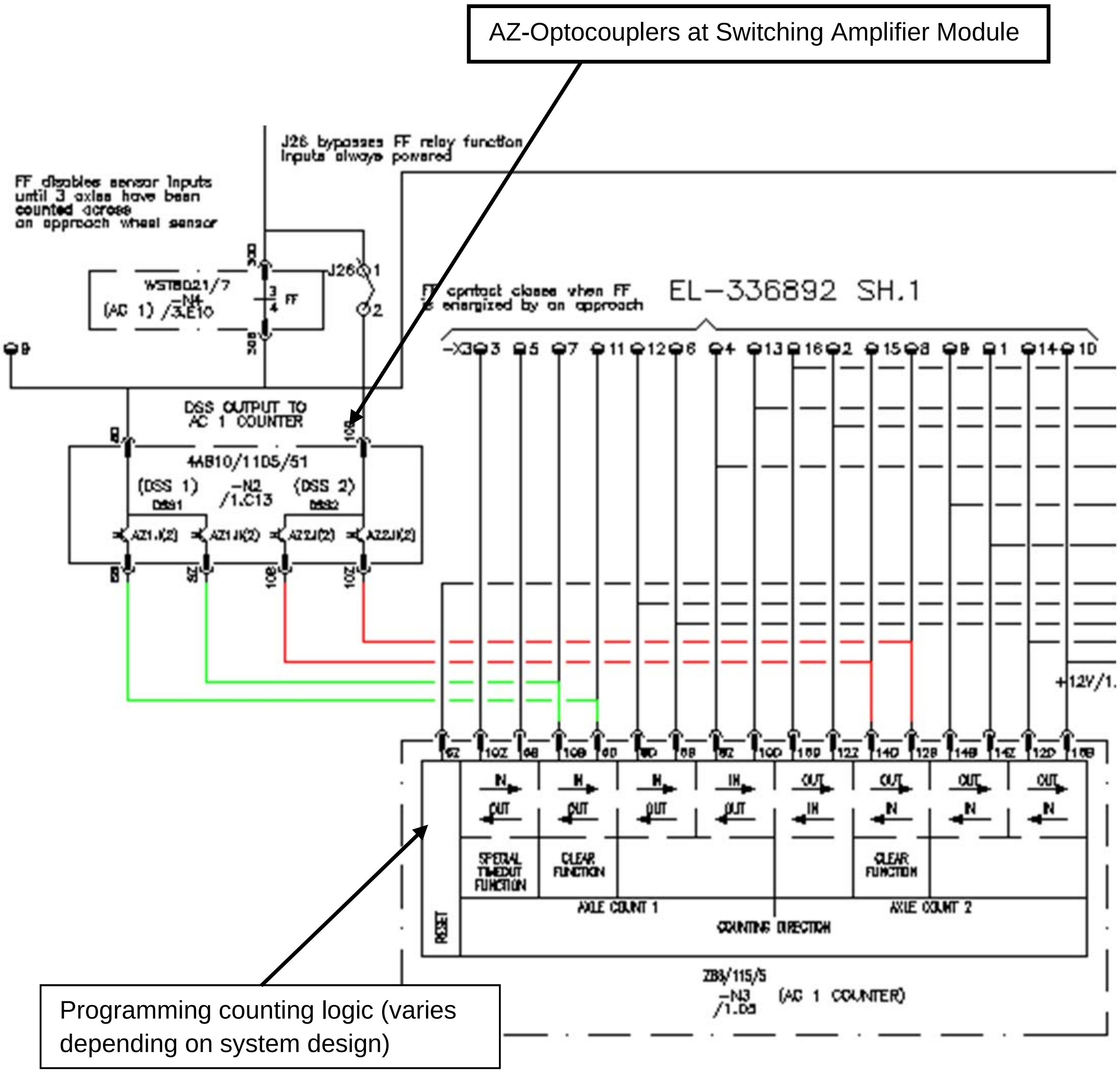


Fig. 16: A typical switching amplifier to binary counter arrangement showing momentary AZ-optocouplers interfaced with counter logic. Diagram for illustration only. Such arrangements may vary from system to system.

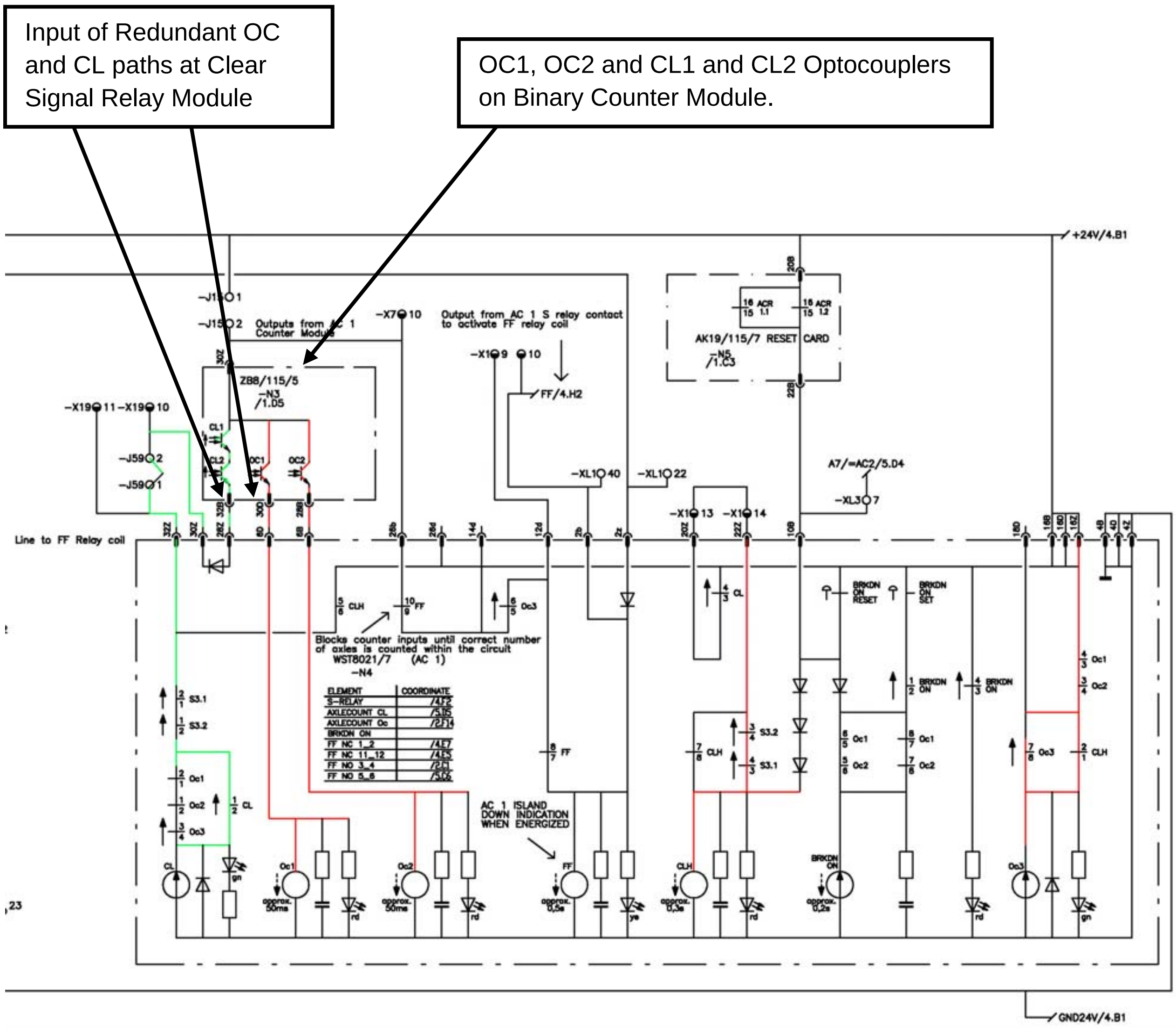


Fig. 17: A typical diagram showing path from Oc and CL optocouplers on Binary Counter Module to Clear Signal Relay Module. Please refer to your specific engineering drawings for specific equipment details.

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.

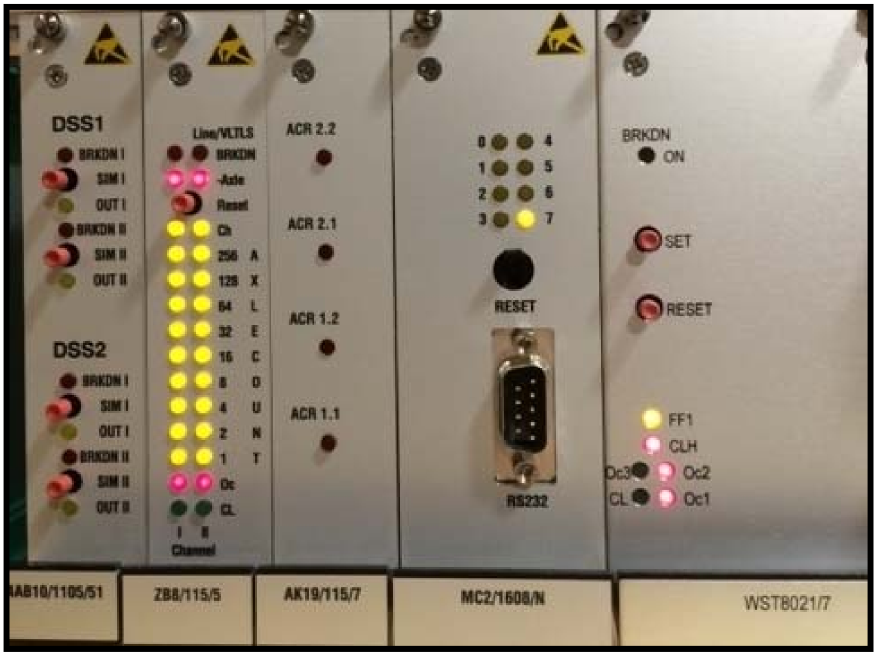


Fig. 18: Minus axle LED status indication. Note that the vertical column of LEDs would be flashing alternately

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 module 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.

IX 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 (SII and SI or 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 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 de-energize and open the line to the CL-relay and it's Oc1 and Oc2 energize 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.

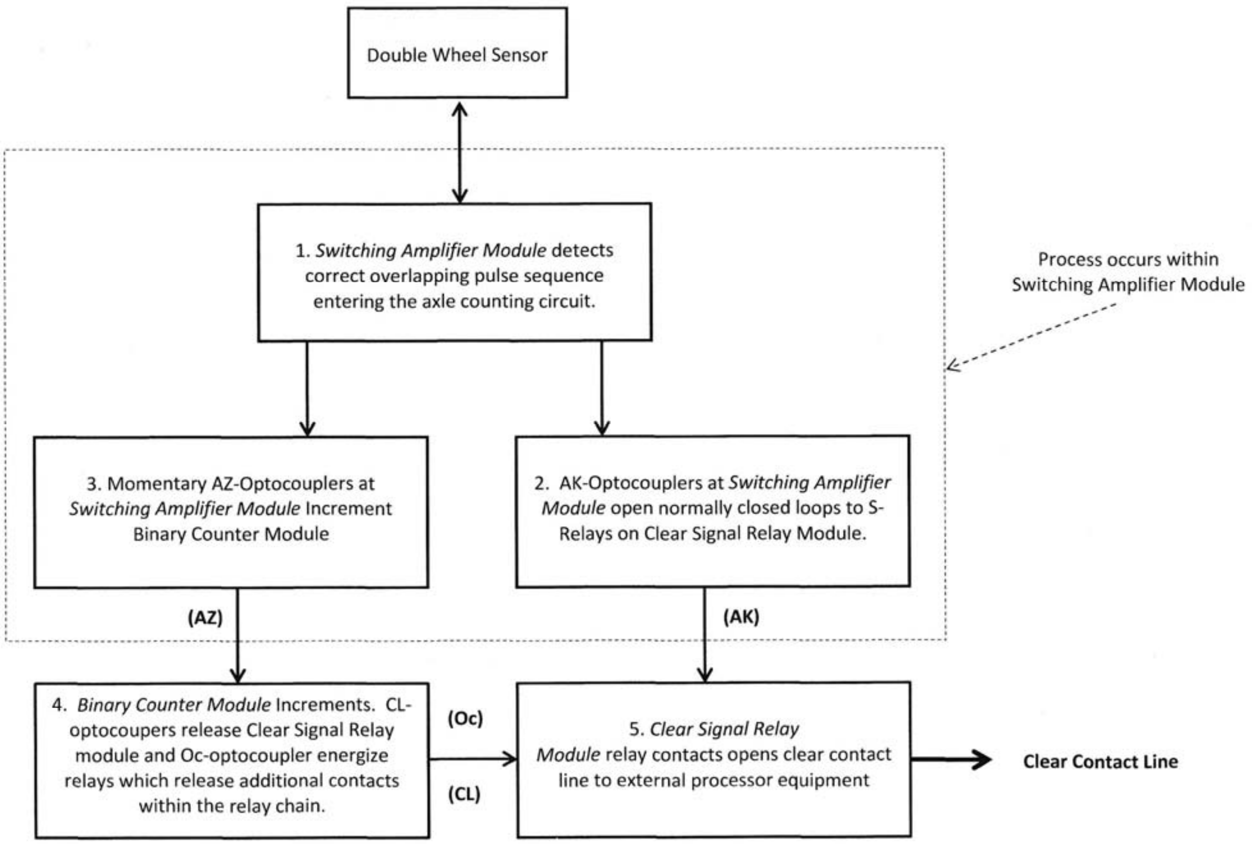


Fig. 19: Flow Chart showing signal process control between Switching Amplifier Module, Binary Counter Module and Cear Signal Relay Module.

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>Clear Signal Relay Module Indications:</u>** As a general rule, the Clear Signal Relay 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 Clear Signal Relay 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

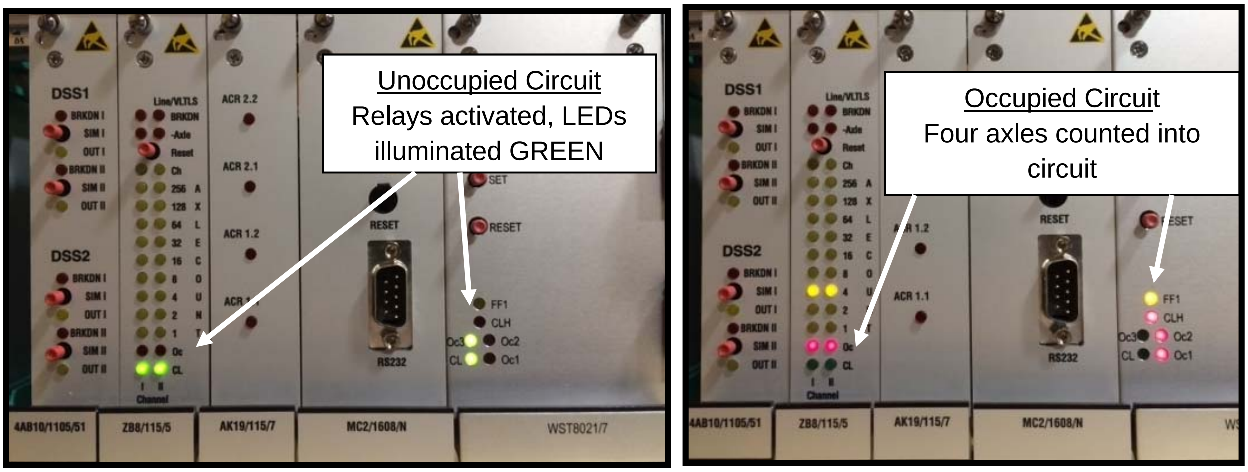


Fig. 20: LED indications (counter module and clear signal relay module) for clear and occupied axle counter circuit status

6. **Safety Relays:** 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.

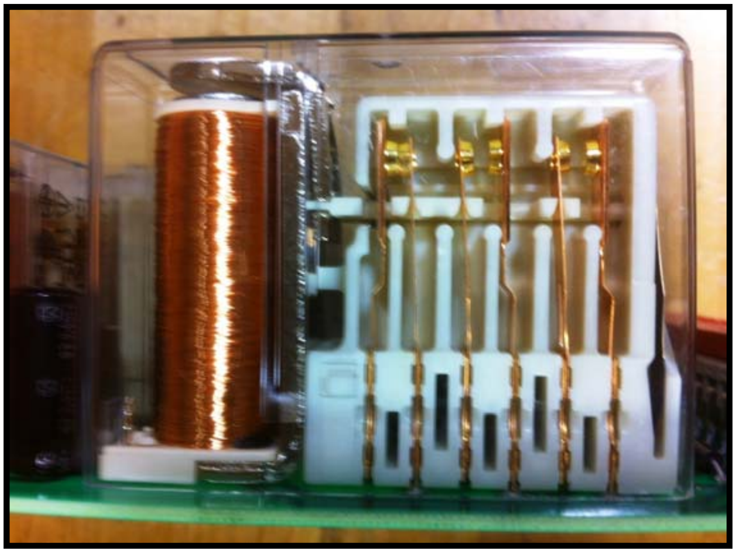


Fig. 21: Safety Relay showing coupled, force-guided contacts

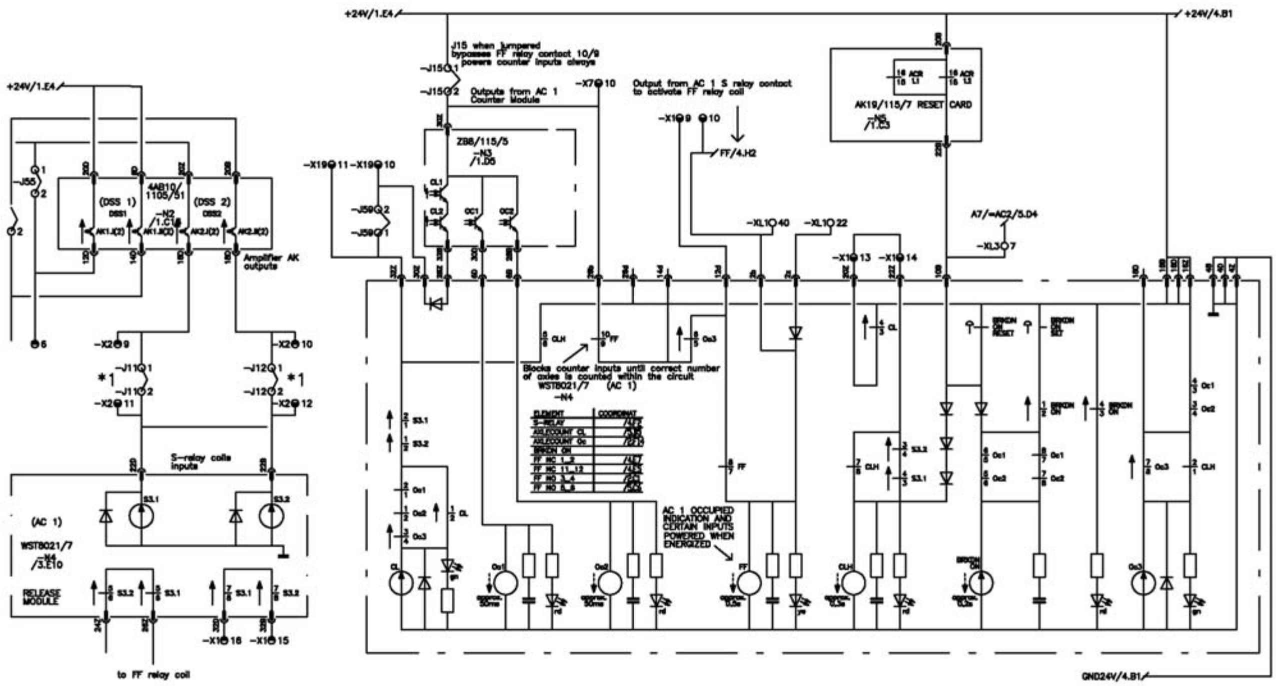


Fig. 22: Typical configurations of a clear signal relay module circuit showing optocouplers interface to S-Relays and Counter optocouplers interface to CL and Oc Relays. ***Exact S-relay wiring arrangement may vary slightly.*** *Consult your engineering drawings for specific information.*

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.

X Detailed Discussion - AK19/115/7 Reset Module

<u>ACR Key Switch Function:</u> 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. **<u>Simulation Function:</u>** When the ACR key is actuated 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 module when the ACR-key is actuated.

2. **<u>Two or Four Channels:</u>** 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 module 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 <u>within a pair</u> 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. **<u>IMPORTANT NOTE</u>**: 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.

XI Detailed Discussion - Axle Counter Reset ("ACR") Key

1. **Dual Contacts:** The ACR key, located on the module 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 when the system is setup to activate on the 1st detected axle, 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 vehicles 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. 23: AK19 Module assigned to two Binary Counter Modules with four channels in use. Red LEDs should illuminate when the ACR key is actuated.

Fig. 24: 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.

XII 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, AC2, AC3, 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. **<u>IMPORTANT: CAPS LOCK and Menu:</u> In order to transmit a command to the MC-2 module, the "CAPS LOCK" must be enabled. All commands must be in capital letters.**

<u>Menu</u>:

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

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

<u>Help Text</u>: Displays the Menu structure as indicated above.

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

<u>Online Printout Toggle</u>: 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.

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

<u>Date Time Set</u>: 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

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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 (Actual report may look slightly different dependent on the system):

Movement from DSS1 to DSS2 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 ###### 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 15:14:53 AC3 FF-relay activated

05/03 15:14:56 AC3 occupied - Counting Circuit down

05/03 15:14:56 AC3 - Approach over AC3 DSS2 detected

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 15:15:08 AC3 clear - Counting Circuit up

05/03 15:15:09 Axle count AC3 DSS2 POS NEG   4   0
05/03 15:15:09 Axle count AC3 DSS3 POS NEG   0   4
05/03 15:15:12 AC3 FF-relay deactivated
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 **************************

XIII System Power Requirements

1. **Operating Voltages:** 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. **Battery Bank:** 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. **DC-to-DC Converters:** 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. **Fuses:** 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.

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

Fig. 25: Type of DC-to-DC Converter used with the 600 Main Axle Counter Equipment.
The dual voltage supply provides isolated 12-VDC output and isolated 24-VDC outputs

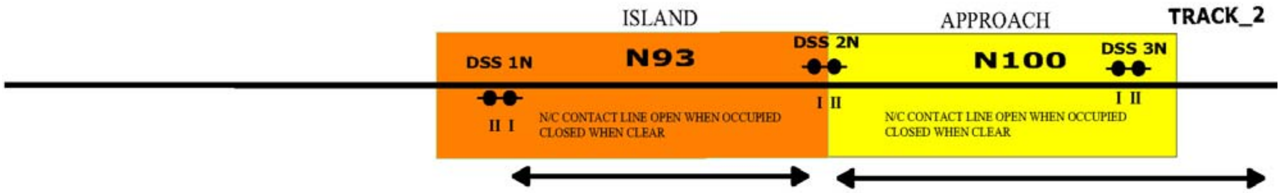
XIV A Review of System Structure and Example of Train Movements

1. **Three overlapping circuits**: The 600 Main Axle Counting System Track 1 module card cage consists of three overlapping axle counting circuits arranged in a manner similar to an approach-island-approach circuit layout. These axle counting circuits are identified as S93, S95 and S100 respectively for the T1 module card cage, and N93 and N100 respectively for the Track 2 T2 module card cage.

   The Track-1, S93 Axle Counting Circuit consists of DSS-1S and DSS-2S as seen below in the blue section; the S95 circuit consists of DSS-2S and DSS-3S as seen below in the red section; and the S100 circuit consists of DSS-3S and DSS-4S as seen in the green section:

2. **Dual Purpose Sensors**: Note that in the case of DSS-2S and DSS-3S, the double wheel sensors serve a dual purpose. DSS-2S serves as a counting point for both S93 and S95 while DSS-3S serves as a counting point for both S95 and S100 *Remember. A double wheel sensor can serve as a counting point for two axle counting circuits simultaneously.*

   The Track-2 configuration consists of two axle counting circuit, with DSS-1N and DSS-2N serving as counting points for the N93 circuit (orange section), DSS-2N and DSS-3N serving as counting points for the S100 (yellow section):

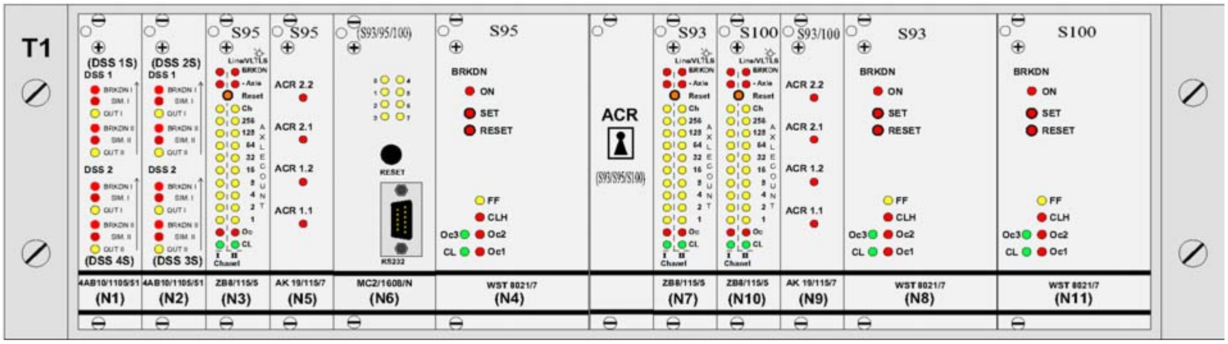


   Note that in the case of DSS-2N, the double wheel sensor serves a dual purpose. DSS-2N serves as a counting point for both N93 and N100. Remember. A double wheel sensor can serve as a simultaneous counting point for two adjacent axle counting circuits.

3. **Review of Card Cages**: The components for the three axle counting circuits serving a single track are contained within a “Euro-module” cage designed to mount in a standard 19-inch open-frame relay rack. Of primary importance from an operational standpoint are the *Switching Amplifier modules,* the *Counter modules*, the *Reset module* and the *WST Clear Signal Relay module*.

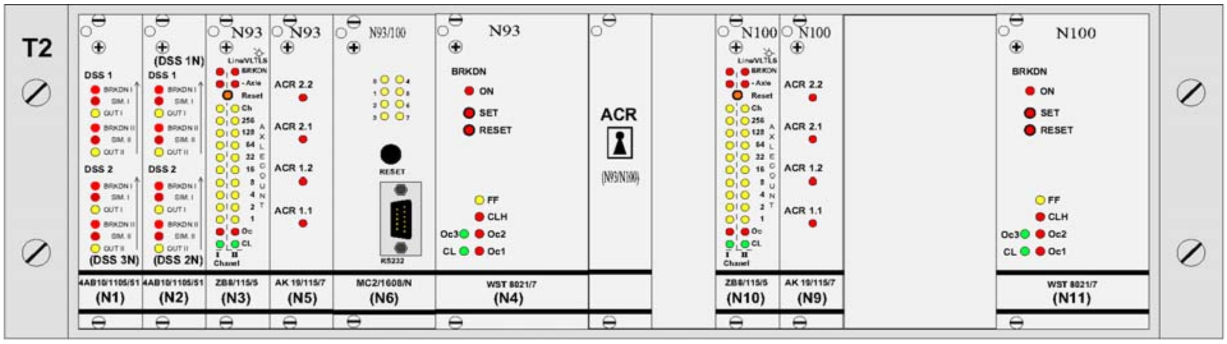
Module cage R1 (for Track-1) consists of the following components:

- Position N1: Switching Amplifier Module for DSS-1S and DSS-4S.
- Position N2: Switching Amplifier Module for DSS-2S and DSS-3S.
- Position N3: Binary Counter Module for the S95 circuit.
- Position N5: AK19/115/7 reset module for S95 circuit.
- Position N6: MC2 data recording module records all events for Track-1
- Position N4: WST8021/7 relay module for S95.
- Reset Key: WARNING! Resets all three axle counter circuits simultaneously.
- Position N7: S93 Binary Counter Module.
- Position N10: S100 Binary Counter Module.
- Position N9: AK19/115/7 Reset Module for S93, S100 circuits.
- Position N8: WST8021/7 relay module for S93
- Position N11: WST8021/7 relay module for S100



Module cage R2 (Track-2) consists of the following components:

- Position N1: Switching Amplifier Module (Module) for DSS-3N.
- Position N2: Switching Amplifier Module for DSS-1N and DSS-2N.
- Position N3: Binary Counter Module for the N93 circuit.
- Position N5: AK19/115/7 reset module for N93 circuit.
- Position N6: MC2 data recording module records all events for Track-2
- Position N4: WST8021/7 relay module for N93.
- Reset Key: WARNING! Resets all three axle counter circuits simultaneously.
- Position N10: N100 Binary Counter Module.
- Position N9: AK19/115/7 Reset Module for N100 circuit.
- Position N11: WST8021/7 relay module for N100 circuit.



4. **Manually entering axles via the switching amplifier modules**: Please see the switching amplifier module description located in Section 2.1 of this document for further details. A maintainer may simulate axles entering or exiting an axle counter circuit by manipulating the "SIM" buttons located on each of the switching amplifier modules. 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 of the require overlapping pulse sequence 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 engineering drawings to determine the appropriate sequence (e.g. S1 to S2 or S2 to S1).

5. **Counting Sequence (Track-1)**:

   Example One:

   In this example, we outline the operational sequences associated with the movement of a train from the S93 (entry) axle counting circuit through the S95 (middle) axle counting circuit and out the opposite S100 (exit) axle counting circuit. Please see the track layout diagram above to review the location of the axle counter circuits and their associated wheel sensors.

   S93 Counter Circuit at DSS 1S and DSS 2S:

   Moving in the direction towards the S93 circuit, the initial wheel flange associated with the on-track equipment is detected at DSS-1S. As soon as the first wheel flange is detected in the sequence SII to SI, the system becomes occupied and the S93 clear-contact line to the external signal system is opened. Likewise, this initial wheel flange and each subsequent wheel flange moving *into* the entry approach causes the S93 binary counter module to increment.

As the train continues moving toward the S95 circuit, it eventually crosses DSS-2S. In this direction the internal sequence is SII to SI. This sensor is shared between the S93 and the S95 circuits. Therefore, as each wheel flange continues to pass over this sensor, the S93 counter begins to decrement while the S95 counter increments. As soon as the first wheel flange is detected at DSS-2S, the S95 circuit becomes occupied and the S95 clear-contact line to the external signal equipment is opened.

Eventually, the S93 counter returns to zero, closing the clear-contact line from S93; however, because the wheel flanges are counting into the S95 circuit, the S95 clear-contact line to the external signal system should remain open.

S95 Counter Circuit at DSS 3S:

As the train continues through the S95 circuit, the leading wheel flange eventually crosses DSS-3S. This sensor is shared by both the S95 and the opposite S100 exit circuit. The sequence at DSS-3S when moving across in this direction will be SI to SII. This initial wheel flange and the subsequent wheel flanges moving out of the S95 circuit begin to decrement the S95 counter module while simultaneously counting into the S100 exit circuit counter. As soon as the first wheel flange is detected at DSS-3S, the S100 circuit becomes occupied and the S100 clear-contact line to the external signal system is opened. Once the last wheel flange has crossed DSS-3S, the S95 circuit restores to standby position and closes the S95 clear-contact line; however, because axles remain in the S100 exit circuit, this latter line to the external control circuit should remain open.

S100 Counter Circuit at DSS 4S:

As the train proceeds out of the exit circuit at DSS-4S, the S100 counter module begins to decrement. In this direction of movement the sequence will be SI to SII. Once all wheel flanges are counted out of the circuit and the counter returns to zero, the S100 axle counter circuit restores to standby position and closes the S100 clear-contact line to the external signal system and all three counter circuits should be back in the clear, standby mode.

Example Two:

In this example, we outline the operational sequences associated with the movement of a train from the S100 (entry) axle counting circuit through the S95 axle counter circuit and out the opposite S93 (exit) axle counter circuit. This is essentially the reverse movement of that described above. Please see the track layout diagram above to review the location of the axle counter circuits and their associated wheel sensors.

S100 Counter circuit using DSS 4S and DSS 3S:

Moving in the direction towards the S100 circuit, the initial wheel flange associated with the on-track equipment is detected at DSS-4S. As soon as the first wheel flange is detected in the sequence SII to SI, the system becomes occupied and the S100 clear-contact line to the external signal system is opened. Likewise, the initial wheel flange and each subsequent wheel flange moving into the entry approach causes the S100 binary counter module to increment.

As the train continues moving toward the S95 circuit, it eventually crosses DSS-3S. In this direction the internal sequence is SII to SI. This sensor is shared between the S100 and the S95 circuits. Therefore, as each wheel flange continues to pass over this sensor, the S100 counter begins to decrement while the S95 counter simultaneously increments. As soon as the first wheel flange is detected at DSS-3S, S95 circuit becomes occupied and the S95 clear-contact line to the external signal system is opened.

Eventually, the S100 counter returns to zero, closing the clear-contact line from S100 to the external signal system. However, because the wheel flanges are counting into the S95 circuit, the S95 clear-contact line to the external system remains open.

S95 Counter Circuit at DSS 2:

As the train continues through the S95 circuit, the leading wheel flange eventually crosses DSS-2S. This sensor is shared by both the S95 and the opposite S93 exit circuit. The sequence at DSS-2S when moving across in this direction will be SI to SII. This initial wheel flange and the subsequent wheel flanges moving out of the S95 circuit begin to decrement the S95 counter module while simultaneously counting into the S93 exit circuit. As soon as the first wheel flange is detected at DSS-2S, the S93 circuit becomes occupied and the S93 clear-contact line to the external signal system is opened. Once the last wheel flange has crossed DSS-2S, the S95 circuit restores to standby position and closes the S95 clear-contact line to the external signal system. However, because axles remain in the S93 exit circuit, this line to the external system remains open.

S93 Counter Circuit at DSS 1S:

As the train proceeds out of the exit circuit at DSS-1S, the S93 counter module begins to decrement. In this direction of movement the sequence will be SI to SII. Once all wheel flanges are counted out of the circuit and the counter returns to zero, the S93 axle counter circuit restores to standby position and closes the S93 clear-contact line to the external signal system and all three counter circuits should be back in the clear standby mode.

6. **Counting Sequence (Track-2)**:

Example One:

In this example, we outline the operational sequences associated with the movement of a train from the N93 (entry) axle counting circuit through the N100 axle counting circuit and out the N100 (exit) axle counting circuit. Please see the track layout diagram above to review the location of the axle counter circuits and their associated wheel sensors.

N93 Counter Circuit at DSS 1N and DSS 2N:

Moving in the direction towards the N93 circuit, the initial wheel flange associated with the on-track equipment is detected at DSS-1N. As soon as the first wheel flange is detected in the sequence SII to SI, the system becomes occupied and the N93 clear-contact line to the external signal system is opened. Likewise, this initial wheel flange and each subsequent wheel flange moving into the entry approach causes the N93 binary counter module to increment.

As the train continues moving toward the N100 circuit, it eventually crosses DSS-2N. In this direction the internal sequence is SI to SII. This sensor is shared between the N93 and the N100 circuits. Therefore, as each wheel flange continues to pass over this sensor, the N93 counter begins to decrement while the N100 counter increments. As soon as the first wheel flange is detected at DSS-2N, the N100 circuit becomes occupied and the N100 clear-contact line to the external signal equipment is opened.

Eventually, the N93 counter returns to zero, closing the clear-contact line from N93; however, because the wheel flanges are counting into the N100 circuit, the N100 clear-contact line to the external signal system should remain open.

N100 Counter Circuit at DSS 3N:

As the train proceeds out of the exit circuit at DSS-3N, the N100 counter module begins to decrement. In this direction of movement the sequence will be SI to SII. Once all wheel flanges are counted out of the circuit and the counter returns to zero, the N100 axle counter circuit restores to standby position and closes the N100 clear-contact line to the external signal system and both counter circuits should be back in the clear, standby mode.

Example Two:

In this example, we outline the operational sequences associated with the movement of a train from the N100 (entry) axle counting circuit through the N100 axle counter circuit and out the N100 (exit) axle counter circuit. This is essentially the reverse movement of that described above. Please see the track layout diagram above to review the location of the axle counter circuits and their associated wheel sensors.

<u>N100 Counter circuit using DSS 3N and DSS 2N:</u>

Moving in the direction into the N100 circuit, the initial wheel flange associated with the on-track equipment is detected at DSS-3N. As soon as the first wheel flange is detected in the sequence SII to SI, the system becomes occupied and the N100 clear-contact line to the external signal system is opened. Likewise, the initial wheel flange and each subsequent wheel flange moving into the entry approach causes the N100 binary counter module to increment.

As the train continues moving toward the N93 circuit, it eventually crosses DSS-2N. This sensor is shared between the N100 and the N93 circuits. In this direction of movement the sequence will be SII to SI. Therefore, as each wheel flange continues to pass over this sensor, the N100 counter begins to decrement while the N93 counter simultaneously increments. As soon as the first wheel flange is detected at DSS-2N, N93 circuit becomes occupied and the N93 clear-contact line to the external signal system is opened.

Eventually, the N100 counter returns to zero, closing the clear-contact line from N100 to the external signal system. However, because the wheel flanges are counting into the N93 circuit, the N93 clear-contact line to the external system remains open.

<u>N93 Counter Circuit at DSS 1N:</u>

As the train proceeds out of the exit circuit at DSS-1N, the N93 counter module begins to decrement. In this direction of movement the sequence will be SI to SII. Once all wheel flanges are counted out of the circuit and the counter returns to zero, the N93 axle counter circuit restores to standby position and closes the N93 clear-contact line to the external signal system and both counter circuits should be back in the clear standby mode.

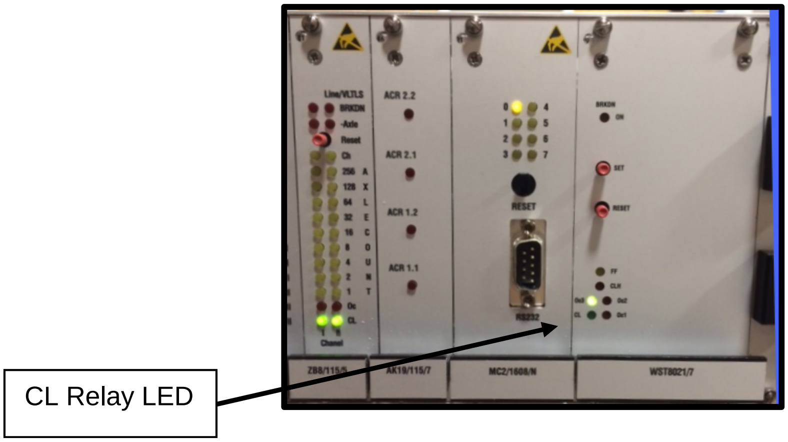
7. **<u>Sequence of activation upon detection of an axle entering circuit:</u>**

- When the first axle (wheel flange) enters the axle counting circuit at DSS-1S, it is first detected at the entrance of the 1st system of the wheel sensor and an output pulse is generated. This pulse is detected at the switching amplifier module and is shown by SII OUT II LED illuminating at the DSS-1S amplifier . The pulse is subjected to signal processing and, provided it meets the profile of a legitimate wheel flange, it is subjected to appropriate Analog to Digital Conversion after which the presence of the wheel flange is transmitted to the counter module logic via the AZ-optocouplers. Next, the axle moves within the detection zone of the second internal system at DSS-1S and its output pulse is likewise detected and processed by the switching amplifier and is shown by SI OUT I LED illuminating at the DSS-1S amplifier . Next, the axle moves out of the detection zone of the 1st system of DSS-1S and its output pulse turns off and is shown as SII OUT II LED turning off and the axle now only occupies only the 2nd system of the DSS-1S and continues to generate a pulse indicated by internal system SI OUT I LED remaining on. Finally the axle moves out of the internal SI detection zone and its output pulse turns off. This sequence of SII system occupied, followed by both SII and SI occupied, then subsequently SII unoccupied then SI unoccupied indicates that the initial axle has moved completely over the wheel sensor. Again, it should be noted that this sequence is mirrored by the AZ-optocouplers, which transmit this smoothed and processed information to the logic on the Binary Counter Module.

- At the Switching Amplifier Module these signal pulses from sensor SII and SI of DSS-1S are then processed for sequence and direction *within* the switching amplifier module's internal counter. After the first complete axle has moved over the wheel sensor the switching amplifier module AK1.1 and AK1.2 optocouplers de-activate the S3.1 and S3.2 relay coils located at the WST8012/7 Clear Signal Relay Module.

- A normally-closed contact (2/1) from the S3.1 relay opens the 24V line to the CL-relay coil allowing the CL-relay to de-energize as well, indicated by the CL LED extinguishing at the front panel of the clear signal relay module.

- A normally-closed contact (1/2) from the S3.2 relay also opens the 24V line to the CL-relay coil. This is a redundant S-relay path designed to ensure the CL-relay opens.



Upon detection of the first axle at the amplifier and counter modules the next sequences happen basically simultaneously.

- The CL-relay opens the N/C contact (7/8) of the clear signal relay chain, thereby opening the clear contact line to the external equipment.

- The normally open contact (3/4) of the S3.1 and N/O contact (4/3) of the S3.2-relays close applying 24-VDC to energize the CLH-relay. The CLH LED at the Clear Signal Relay Module will illuminate to indicate the CLH-relay has energized.

- The normally-closed contact (3/4) of the CLH-relay in the clear signal relay chain opens to the loop to the external signal equipment. This antivalent function provides an additional layer of safety.

- The Binary Counter Module switches from the clear state to the occupied state as indicated by the CL1 and CL2 LEDs (GREEN) extinguishing and Oc1 and Oc2 LEDs illuminating (RED), representing the Binary Counter Module OcI and OcII optocouplers switching on and the CLI and CLII optocoupler switching off.

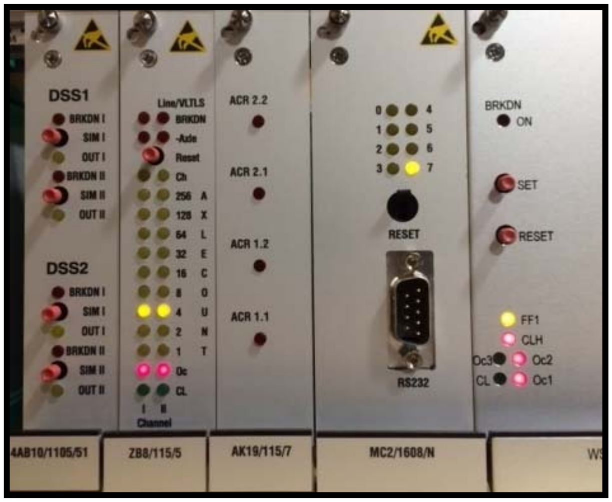
  Note: The Binary Counter OcI and OcII optocouplers control the Oc1 and Oc2-relay coils and the CLI and CLII optocouplers control the CL-relay coil and are in series to the S-relays contacts to the CL-relay.

- Simultaneously, the CLI and CLII optocouplers remove 24-VDC from the CL-relay (yet another path to release the CL-relay) and the OcI and OcII optocouplers apply 24-VDC to the respective Oc1 and Oc2-relay coils energizing them. The Oc1 and Oc2 LED on the clear signal relay module illuminate to indicate the respective Oc1 and Oc2-relay has energized.

- N/C contact (4/3) of the Oc1-relay and contact (3/4) of the Oc2-relay in series to the Oc3-relay coil open allowing the Oc-3 relay coil to de-energize.

- The Oc3-relay contact (2/1) which is in the clear signal relay chain also opens to the external circuit providing another path to the open the line to the external circuit to indicate occupancy of the axle counter circuit.

- The Clear Signal Relay Module now has all relays in their correct states indicating the switch on sequences have completed fully and all circuits have performed properly.



<u>Note:</u> When watching the WST 8021/7 clear signal relay module you will see after the first axle detected the CL, Oc3 LEDs extinquish and the CLH, Oc1 and Oc2 LEDs illuminate visually at the same time.The ZB8/115/5 counter module will be in the occupied state with the Oc1, OcII LED's illuminated and the CL1, CLII LED's extinquished.

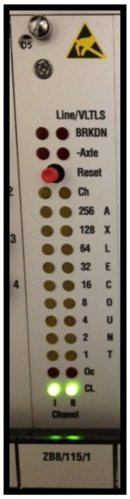
- The counter module continues counting each and every axle that passes over the entrance wheel sensor incrementing the counts with each successive axle passing over the entrance wheel sensor. Once the train reaches the exit wheel sensor and axles begin passing over this DSS in the sequence SII to SI the counting module begins decrementing in accordance with each axle that passes over the exiting DSS-2S.
  <u>NOTE</u>: The counter module can handle simultaneous counting in at the entrance DSS and out at the exit DSS.

- Once the axle counting circuit has become occupied the circuit will not restore to standard position again as long as axles are inside of the circuit and the counter has not been signaled occupied and then clear and all axles are counted back to zero.

8. **<u>Sequence of deactivation after all axles exit the circuit (counter restores to zero)</u>:**

- After the train has left the exiting DSS-2S within the axle counter circuit and all axles are counted back to zero, and there are no further axles detected within the circuit, the counting system will begin its clear status sequence.

- The ZB8/115/5 Binary Counter Module gives the clear signal once the counter has counted all axles back to zero. The counter switches from the occupied state to the clear state. Its OcI and OcII optocouplers immediately switch off indicated by the OcI and OcII LEDs extinguishing, and the counters CL I and CL II optocouplers switch back on indicated by the CL I and CL II LEDs illuminating.



- The counter module CL I and CL II optocouplers energize now allowing 24V access to the CL-relay coil.

- The S3.1-relay contact (2/1) and S3.2-relay contact (1/2) in series with the CL-relay restore to closed position.

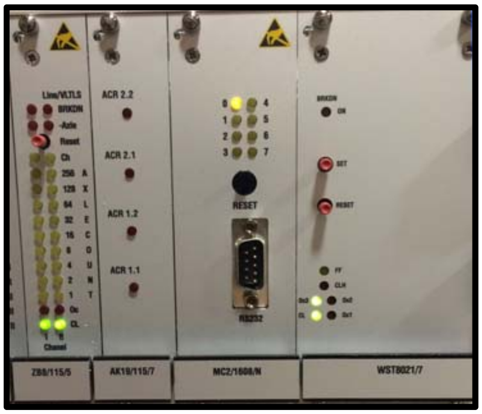
- The counter module Oc1 optocoupler removes the 24V line to the Oc1-relay coil and the Oc2 optocoupler removes the 24V line to the Oc2 relay coil allowing them to de-energize indicated by the Oc1 and Oc2 LED's extinguishing at the clear signal relay module.

- Contacts (3/4) and (4/3) from the S-relays and contact (4/3) of the CL-relay simultaneously open the circuit to the CLH-relay allowing it to de-energize. CLH contact 5/6 closes in the 24V line to the CL-relay coil and contact 2/1 remains briefly closed in the line to the Oc3-relay coil. When the CLH-relay de-energized contact (3/4) of the CLH which is in the line to the external circuit then closes.

- Contacts (2/1) of the Oc1-relay and contact (1/2) of the Oc2-relay remain closed for a few milliseconds to allow the 24V line to the CL relay coil to re-energize the CL relay and CL-relay contact (1/2) then keeps the CL-relay energized. Once the CL-relay has energized then CL-relay contact (7/8) in the line to the external circuit closes.

- When Oc1 and Oc2 relays de-energized their contacts (3/4) closed the 24V line to the Oc3 relay coil to re-energize it and Oc3 contact (1/2) in the line to the external circuit closes and the WST8021/7 module is switched back to the clear state.

- When the CL, CLH and Oc3 contacts have all switched back to their standard unoccupied positions the clear contact line has closed to the external circuit. Visual indication is shown at the WST8021/7 clear signal relay module by the CL and Oc3 LED’s illuminating and the CLH, Oc1 and Oc2 LED’s remaining dark.



- The counter circuit is now back to its standard start position and ready for the next train movement.

All axle counting circuits activation and deactivation sequence works in the same manner as above. The only difference is the DSS which is part of the respective circuit and the pulse sequence required for counting in or out of the circuit.
DSS-1S sequence SII to SI when moving into the S95 circuit. DSS-2S sequence SII to SI when entering the S95 circuit from the S93 circuit and DSS-3S sequence SI to SII when entering the S100 circuit from the S95 circuit. DSS-4S sequence SI to SII when leaving the S100 circuit.
DSS-4S sequence SII to SI when moving into the S100 circuit. DSS-3S sequence SII to SI when entering the S95 circuit from the S100 circuit and DSS-2S sequence SI to SII when entering the S93 circuit from the S95 circuit. DSS-1S sequence SI to SII when leaving the S93 circuit.

DSS-1N sequence SII to SI when moving into the N93 circuit. DSS-2N sequence SI to SII when entering the N100 circuit from the N93 circuit and DSS-3N sequence SI to SII when leaving the N100 circuit. DSS-3N sequence SII to SI when moving into the N100 circuit. DSS-2N sequence SII to SI when entering the N93 circuit from the N100 circuit and DSS-1N sequence SI to SII leaving the N93 circuit.

XV Terminations at the DIN Rail

1. **Introduction**: The "DIN Rail" consists of Wago and Phoenix Type connectors providing the necessary terminations to all external systems. Included on the DIN rail are the plug-trab surge suppression devices for the cables to the double wheel sensors, the DC (B-12 and B-24) input voltages, as well as the output lines for the interfacing with the external signal equipment.

2. **DSS Terminations**: Each DSS cable pair terminates at a surge suppression device. These devices utilize three terminals. However, the center terminal is NOT used. Ground is provided through a spring-loaded contact that makes direct, permanent connection to the DIN rail itself. Therefore, the DIN rail is always at ground potential. During installation, maintainers should be careful to dress all leads in such a way that long-term chaffing or wear will not result in an unintentional ground to the DIN Rail.

3. **Plug Trab Device**: The plug trab device operates as a self-restoring device, which "clamps" to ground when transient voltages excees a pre-defined threshold. Normally, these devices do NOT require replacement unless a significant event causes catastrpohic failure.

4. **Shield Grounds**: The shields and/or drain wires from the DSS cable pairs may be tied together and then grounded to a common buss. This provides a permanent, stable ground to the common-point referene ground at the relay house or case. As stated earlier, the ground for the surge suppressors and DIN rail may be found at a special terminal, which is striped green and yellow in color. Be certain to run a reasonably large conductor from this terminal to the same reference or common-point groud. A minimum of 12-gauge is recommended. The path to the reference ground should also be as short as possible to minimize impedance. Larger surface areas and the use of stranded wire will likewise provide a better path for any transients clamped to ground by the surge suppressors.

5. **Trouble-shooting cable problems**: Although trouble-shooting procedurs are covered in the subsequent chapters, it should be noted that one can "dummy out" a sensor circuit by placing a 1.5 k-ohm resistor across the plug trab device associated with a circuit in failure mode. It this eliminates a breakdown fault at the associated Switching Amplifier Module, then the fault is most likely in the field. One can then move the sensor to the junction box adjacent to the respective DSS to either confirm or eliminate the

underground cable as a suspect in the failure mode. If the breakdown fault indication disappears when the resistor is substituted at both the plug-trab device and then later at the junction box, this provides excellent evidence that the problem is associated with a defective double wheel sensor.

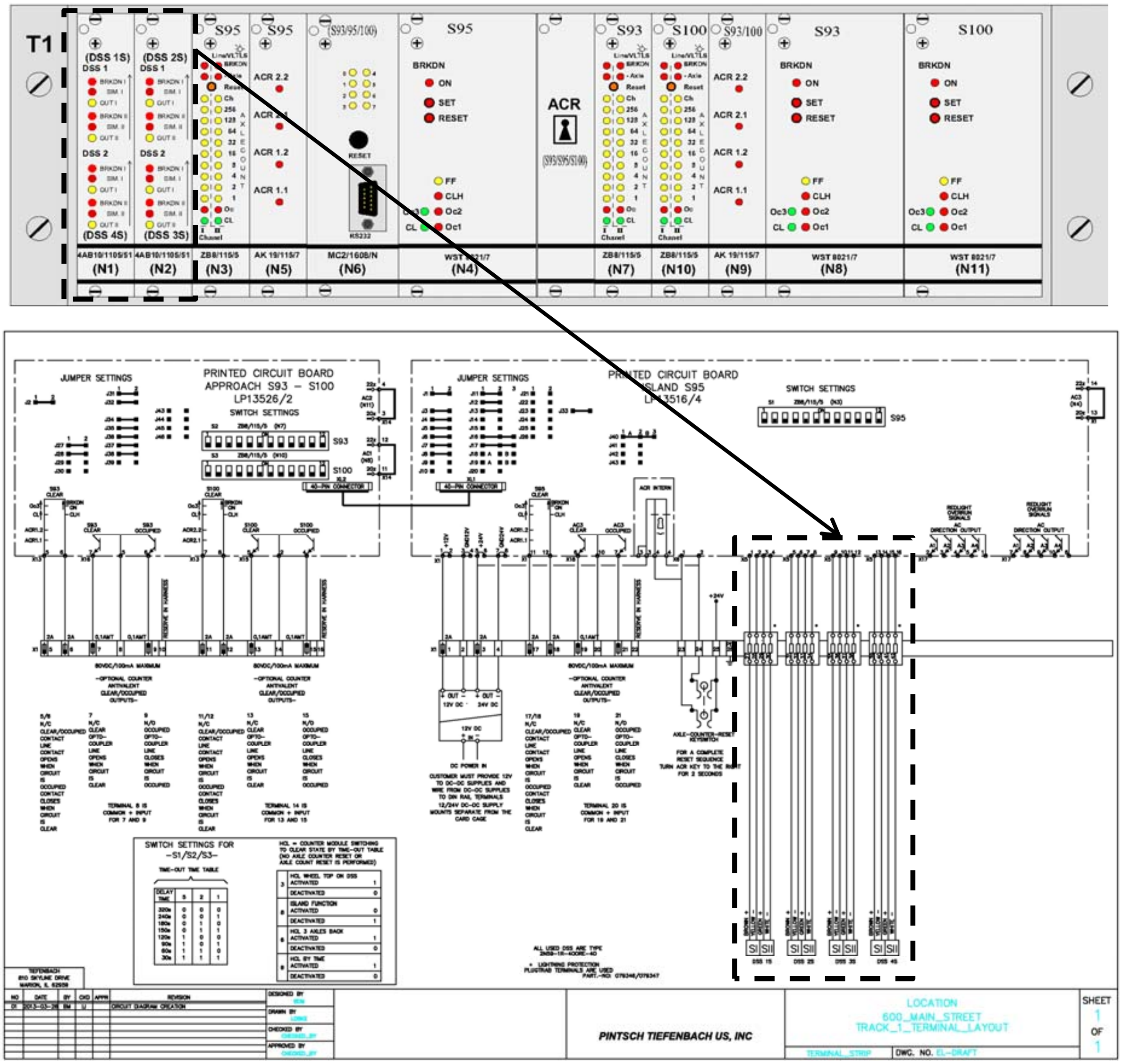


Fig. 26: Track 1 DIN Rail juxtaposed with front panel. The plug trab devices connect the "front end" of the system (Switching Amplifier Modules) with the sensors at track side.

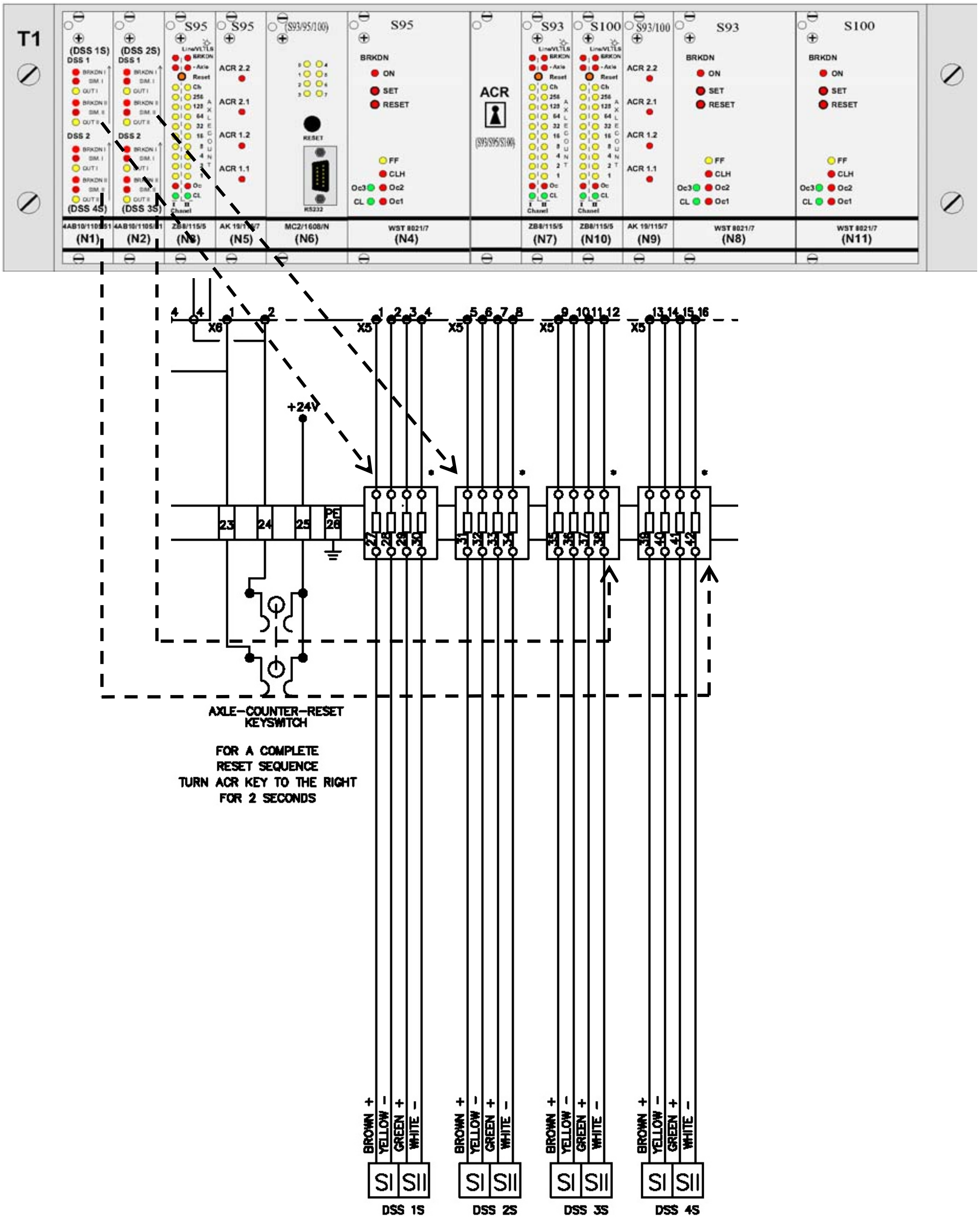


Fig. 27: Track 1 juxtaposition between Switching Amplfier Modules, plug-trab devices on DIN rail and DSS at track-side

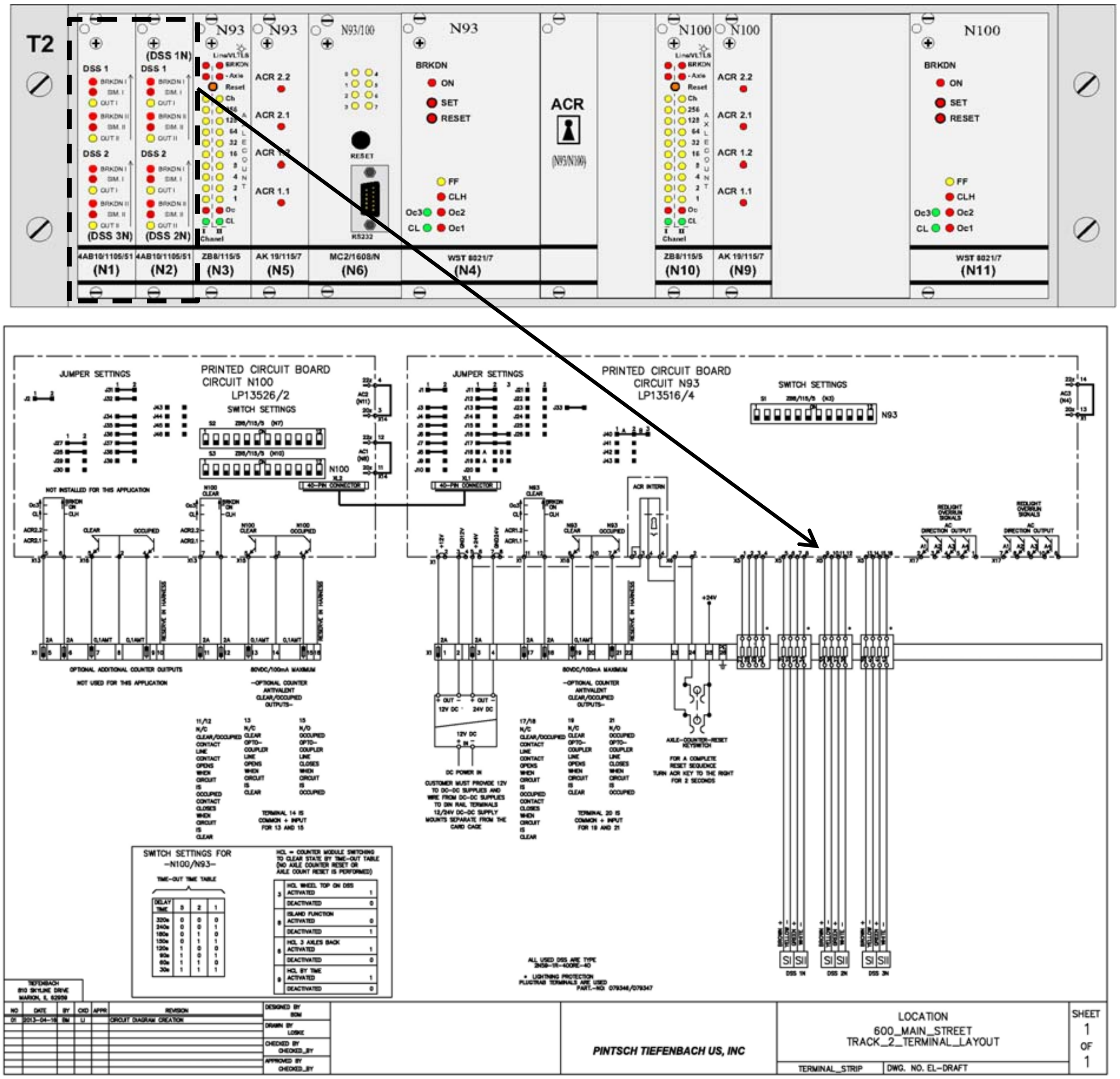


Fig. 28: Track 2 DIN Rail juxtaposed with front panel. The plug trab devices connect the "front end" of the system (Switching Amplifier Modules) with the sensors at track side.

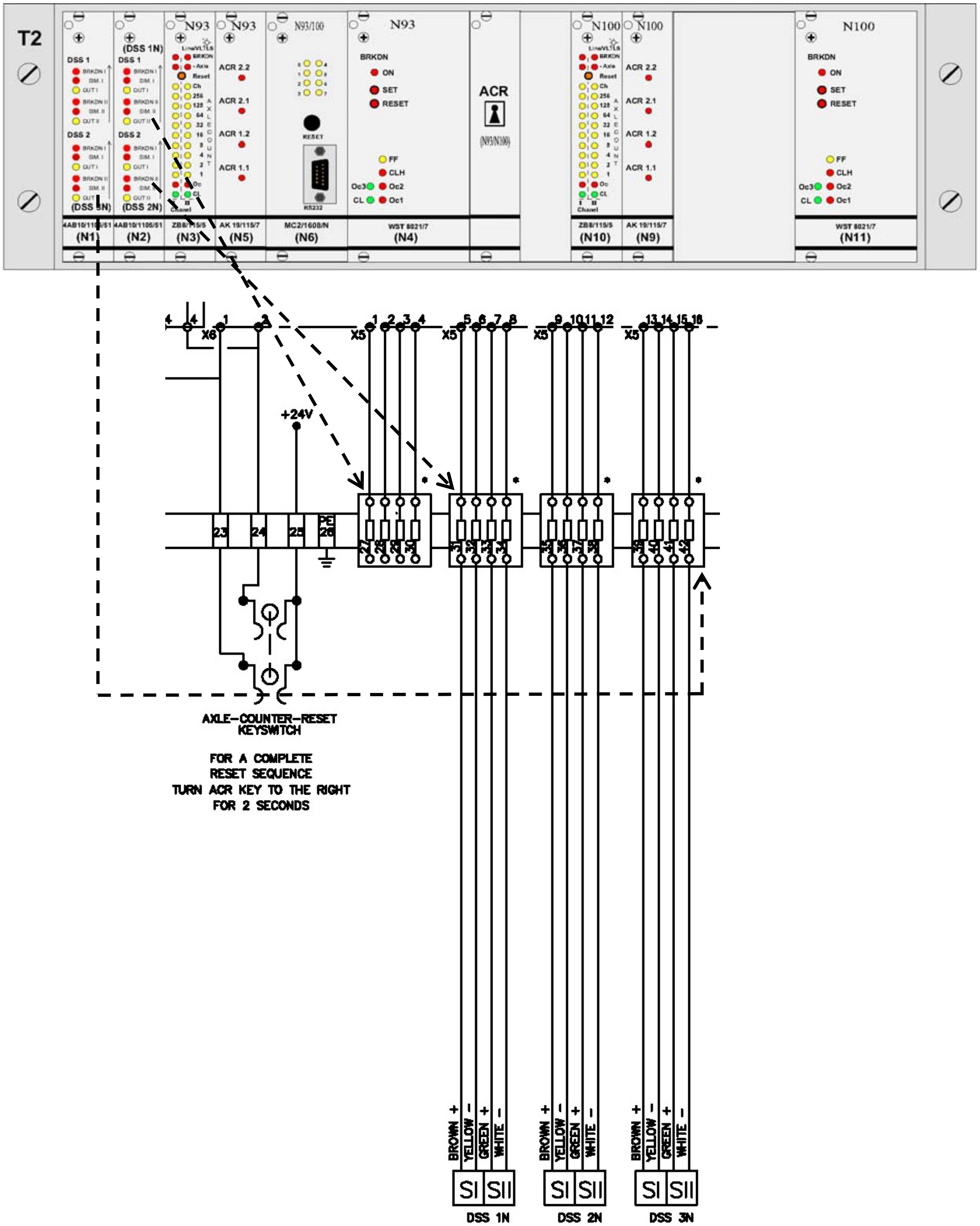


Fig. 29: Track 2 juxtaposition between Switching Amplfier Modules, plug-trab devices on DIN rail and DSS at track-side

6. **Identical Pattern**: The layout of the DIN-rail and its relationship to the card cage components is identical between the track one and track two systems. While this consistency is helpful from a design and trouble-shooting standpoint, maintainers should be careful not to disarrange terminations on both DIN rails simultaneously to prevent possible confusion between wire assignments. This is in keeping with good technical practices in any signaling environment.

7. **DC Power Inputs**: The voltage inputs appear at the left side of the DIN rail. These inputs are intended for the isolated, regulated B-12 and B-24 voltage *from* the DC-to-DC converter units. A 2-amp fuse is provided in both the B-12 and B-24 line. Remember that the B-12 voltage controls the train detection portions of the card cage (Switching Amplifiers, Binary Counter Modules, etc.), while the B-24 is used primary for the reset function and relays. This information may prove helpful when determining whether a blown fuse is likely. In other words, if the train detection portions of the rack are "dark," check the B-12 fuse first. Likewise, if the Clear Signal Relay Module is "dark" and non-responsive, check the B-24 fuse first.

8. **Clear Contact Lines**: As discussed earlier, the clear contact is a series circuit consisting of several layers of interlaced relay contacts present on the Clear Signal Relay Module. This series circuit within the Clear Signal Relay Module is then brought out to the DIN rail where it is terminated in conjunction with the external signal line. There are three clear signal lines for track 1, one each for the S93, S95 and S100 axle counting circuits respectively. There are two clear signal lines for track 2, one each for the N93 and N100 axle counting circuits respectively. Each of these normally-closed loops is protected by a 2-amp fuse at th DIN-rail terminations. See figure 30 and 31 for greater detail.

9. **Clear/Occupied Optocoupler Outputs**: These outputs also appear at the DIN rail and are available for a variety of uses. Each of these optocoupler outputs is protected by a 100-mA fuse, which is designed to protect the optocoupler from damage in the event of a wiring error or other external fault condition. DO NOT substitute a fuse of higher current rating in these locations at the DIN rail. See figure 30 and 31 for greater detail.

10. **Remote Reset Terminations**: As discussed earlier, three terminals are available for the remote reseting of the card cage axle counting system. The 24-VDC line is directly tied to the 24-VDC buss. This line is not independently fused, so exercise caution when wiring, repairing, or testing remote reset ACR key switches.

11. **Dip Switches on Backplane**: One will note in the engineering drawings a set of Dip Switches located on the backplane of the card cage. These switches control a variety of counter module special features. **These DIP switches are all set in the OFF (0) position and should NOT be changed without prior**

consultation with engineering staff at Pintsch Tiefenbach. Changing these DIP switches can result in unwanted functions not used in the 600 Main systems.

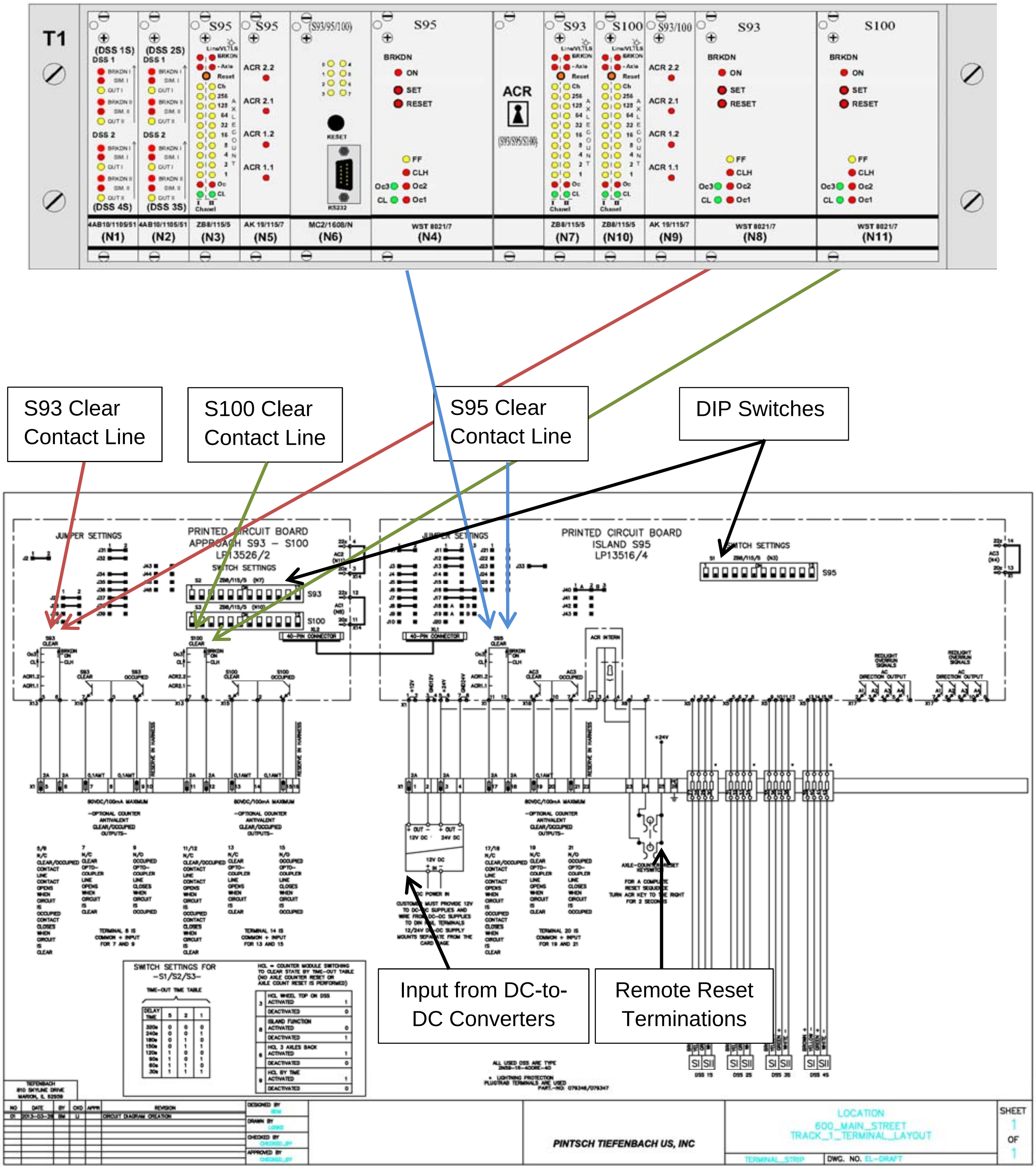


Fig. 30: Track 1 DIN rail engineering drawing showing major features. See summay in Section XV for more details

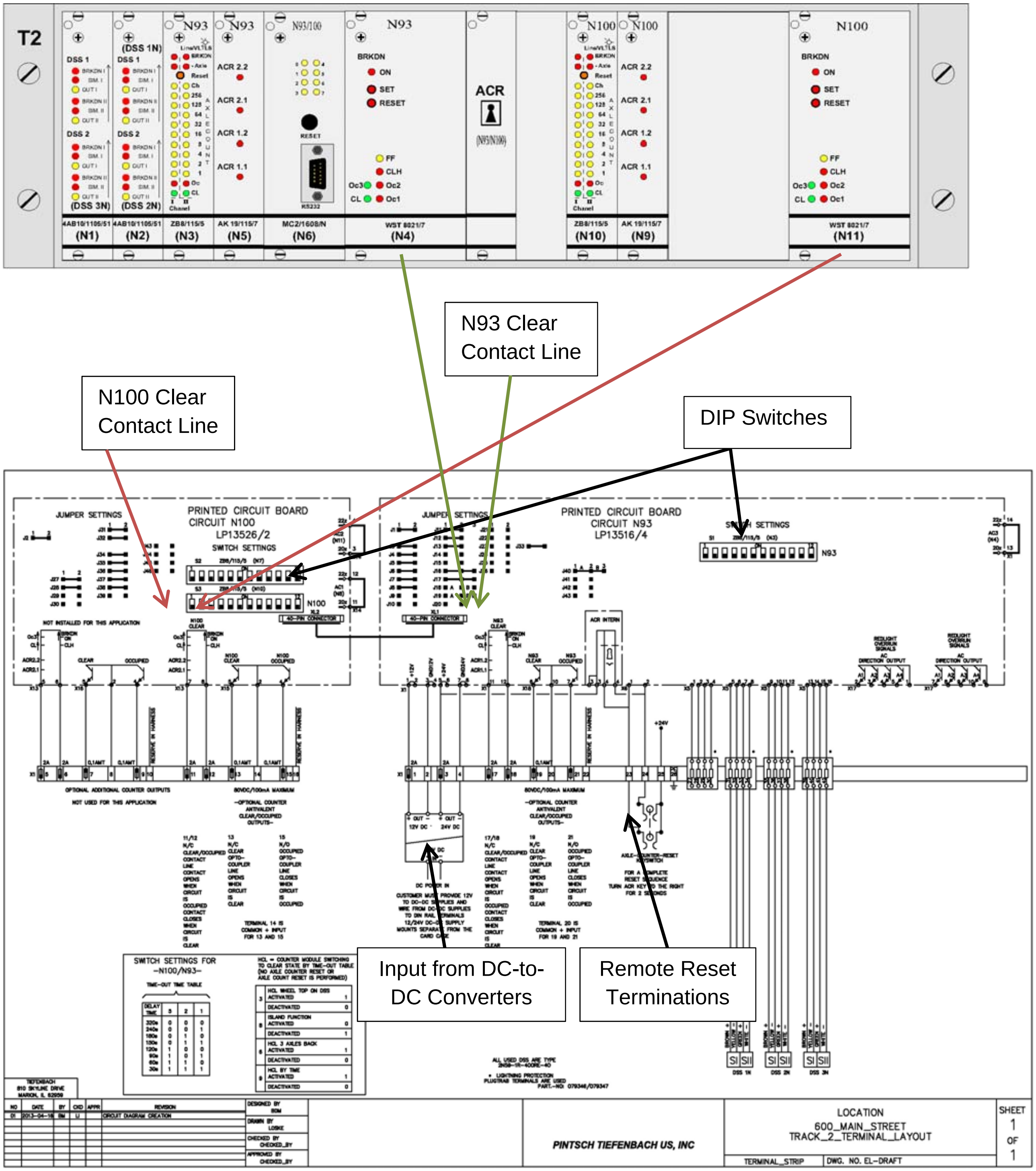


Fig. 31: Track 2 DIN rail engineering drawing showing major features.
See summay in Section XV for more details

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 modules 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 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 Module.*

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 Module 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 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. If no intermittent short or open has been found, swap the counter module with an adjacent module to see if problem moves to an alternate circuit (follows the module).

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

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

6. 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.**

2. **Minus Axle Count**: 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. **Repeated Miscounts**: 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 or Michigan office. We will be pleased to work with you to answer any questions.

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