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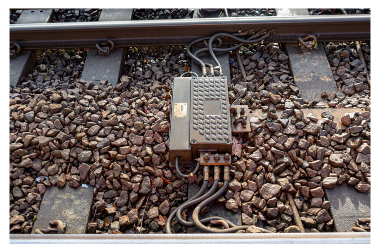
Understanding Ballast Resistance — Why It Matters and How to Measure It

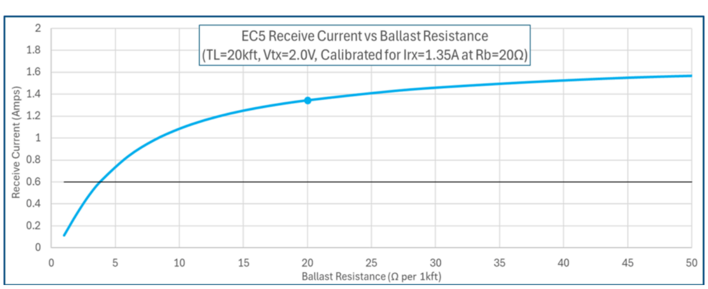


Contaminated ballast can wreak havoc on track circuits, leading to false occupancies, unreliable crossings, and unnecessary maintenance calls. But how can you measure ballast resistance if your signaling system doesn't report it? This article breaks down why ballast resistance matters, how it impacts operations, and offers practical ways to measure it - whether you have existing track circuits or are working in an area with no signaling equipment. Plus, we'll share a tool to make calculations easy.

Why Does Ballast Resistance Matter?

The ballast underneath the tracks does more than just hold everything in place — it also plays a big role in how electrical signals travel between the rails. These signals are essential for track circuits, which help detect trains and activate crossings.

The challenge? When ballast becomes wet, the electrical resistance drops. This drop in resistance can cause issues for track circuits. As ballast resistance decreases, the electrical current detected by the system can fluctuate significantly. In some cases, these fluctuations are large enough to create a false reading, making it appear as though a train is present when it is not. This is known as false occupancy and typically requires manual intervention to adjust the track circuit and restore accurate detection.



Understanding how ballast resistance changes over time gives railroads a heads-up on when adjustments might be needed. It also provides insight into when track maintenance could be due, while offering valuable feedback on whether recent maintenance efforts were effective.

Moreover, ballast resistance is an importance consideration when setting up signaling equipment. For example, when configuring Electro Code track circuits, you'll need to know whether the ballast is "wet," "normal," or "frozen" to set the right thresholds.

Table 2-10 Receiver Reference Setting

Receive Current	Wet Ballast	Normal Ballast	Frozen Ballast
<1.20A	0.60A	0.50A	0.50A
1.30A	0.65A	0.54A	0.50A
1.40A	0.70A	0.58A	0.50A
1.50A	0.75A	0.62A	0.50A
1.60A	N/A	0.66A	0.53A
1.70A	N/A	0.70A	0.56A
1.80A	N/A	0.75A	0.59A
1.90A	N/A	0.79A	0.63A
2.00A	N/A	0.85A	0.66A

There's also a practical aspect to ballast resistance: it directly influences the determination of how long a track segment can be for specific crossing approach frequencies, such as those used with ElectroLogIXS XP4.

FREQUENCY SELECTION GUIDELINE BI-DIRECTIONAL

	2Ω BALLAST		4Ω BALLAST		6Ω BALLAST		8Ω BALLAST		10Ω BALLAST		15Ω BALLAST		20Ω BALLAST		30Ω BALLAST	
	MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET		MAX TRACK LENGTH IN FEET	
FREQ	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
86	720	5000	720	7500	720	8700	720	10100	720	11200	720	13800	720	15900	720	19500
114	615	4250	615	6000	615	7400	615	8500	615	9500	615	11700	615	13500	615	16500
135	584	3938	584	5546	584	6700	584	7700	584	8700	584	10600	584	12200	584	15000
151	560	3700	560	5200	560	6300	560	7300	560	8100	560	10000	560	11500	560	14100
156	550	3675	550	5150	550	6200	550	7100	550	8000	550	9800	550	11300	550	13800
172	535	3550	535	4900	535	5900	535	6800	535	7600	535	9300	535	10700	535	13100
210	485	3100	485	4400	485	5300	485	6100	485	6800	485	8300	485	9600	485	11700
211	485	3100	485	4400	485	5200	485	6100	485	6800	485	8300	485	9600	485	11700
230	470	2998	470	4264	470	5000	470	5800	470	6500	470	7900	470	9100	470	11200
267	440	2800	440	4000	440	4600	440	5300	440	6000	440	7300	440	8400	440	10300
285	425	2700	425	3850	425	4500	425	5200	425	5800	425	7100	425	8100	425	10000
326	400	2500	400	3550	400	4200	400	4800	400	5400	400	6600	400	7600	400	9300
348	380	2425	380	3450	380	4000	380	4600	380	5200	380	6300	380	7300	380	9000
392	360	2300	360	3250	360	3800	360	4400	360	4900	360	6000	360	6900	360	8400
430	340	2200	340	3100	340	3600	340	4200	340	4600	340	5700	340	6600	340	8000
452	330	2150	330	3050	330	3500	330	4000	330	4500	330	5500	330	6400	330	7800
522	315	2000	315	2850	315	3300	315	3800	315	4200	315	5100	315	5900	315	7300
525	315	2000	315	2850	315	3200	315	3700	315	4200	315	5100	315	5900	315	7200
560	305	1925	305	2700	305	3100	305	3600	305	4000	305	5000	305	5700	305	7000
630	290	1800	290	2550	290	3000	290	3400	290	3800	290	4700	290	5400	290	6600
645	290	1770	290	2500	290	2900	290	3400	290	3800	290	4600	290	5300	290	6500
686	275	1750	275	2450	275	2800	275	3300	275	3600	275	4500	275	5200	275	6300
753	265	1675	265	2350	265	2700	265	3100	265	3500	265	4300	265	4900	265	6000
790	260	1630	260	2300	260	2600	260	3000	260	3400	260	4200	260	4800	260	5900
816	255	1600	255	2250	255	2600	255	3000	255	3300	255	4100	255	4700	255	5800
881	250	1550	250	2200	250	2500	250	2900	250	3200	250	3900	250	4500	250	5500
970	240	1455	240	2050	240	2400	240	2700	240	3100	240	3700	240	4300	240	5300
979	240	1450	240	2050	240	2400	240	2700	240	3000	240	3700	240	4300	240	5200

The bottom line: Understanding ballast resistance helps keep everything running smoothly, and in many cases, is necessary for proper setup and reliable operation of signaling systems.

How Do You Figure Out Ballast Resistance?

Most traditional signaling equipment doesn't directly measure ballast resistance— it's more of an indirect factor that affects system performance. While some specialized meters can give you a general sense of ballast condition, they don't provide precise resistance values. However, there's one notable exception: Electro Code 6, which can deliver real-time ballast resistance readings.

But what if you don't have an Electro Code 6 installed? Or what if you are working somewhere with no existing signaling equipment at all? Don't worry - there are still ways to gather the data you need. Here's how you can measure ballast resistance in this situations.

Measuring Ballast Resistance — Different Scenarios and Methods

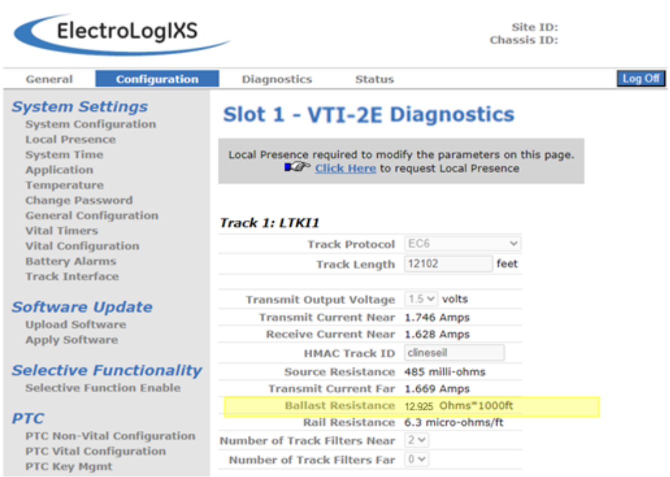
Scenario 1: Insulated Joints are in Place

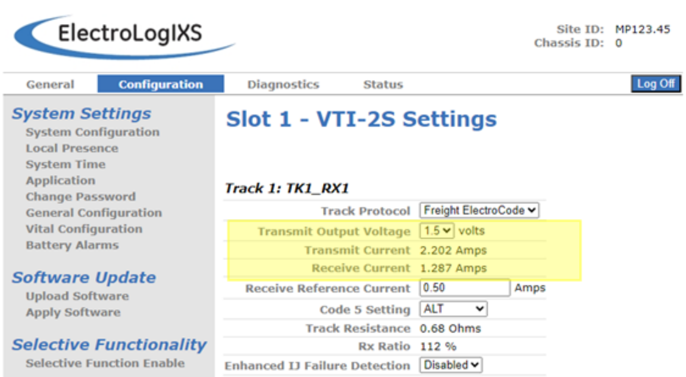
In areas where insulated joints are already part of the track, there are two ways you can determine ballast resistance:

1. Use Electro Code 6 to directly measure ballast resistance.
2. Use data from existing DC or coded DC track circuits to calculate ballast resistance.

- **Option 1 — Direct Measurement with Electro Code 6**

If you can temporarily connect an Electro Code 6 to the track, it can give you a direct ballast resistance reading almost immediately. There is no complex setup — once the system is running, you can see the real-time ballast resistance (along with minimum and maximum readings) through the ElectroLogIXS® web GUI.





If you have historical data from other track circuits, KB Signaling can also help compare Electro Code 6 readings to those older records.

- **Option 2 — Calculating Resistance from Existing Equipment**

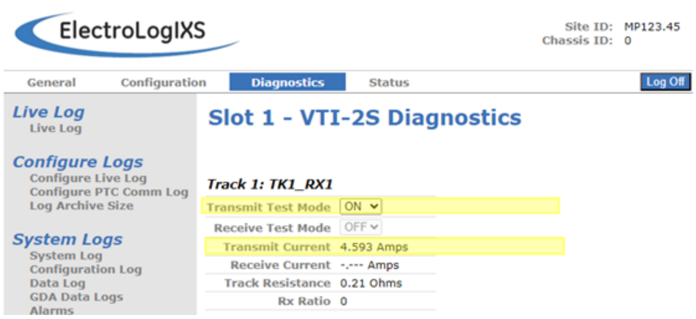
If you are working with DC or coded DC track circuits, you can calculate ballast resistance using data the equipment is already collecting. This method follows the formulas in AREMA Manual Part 8.1.10 (Recommended DC Track Circuit Test Record).

The key data points you need are:

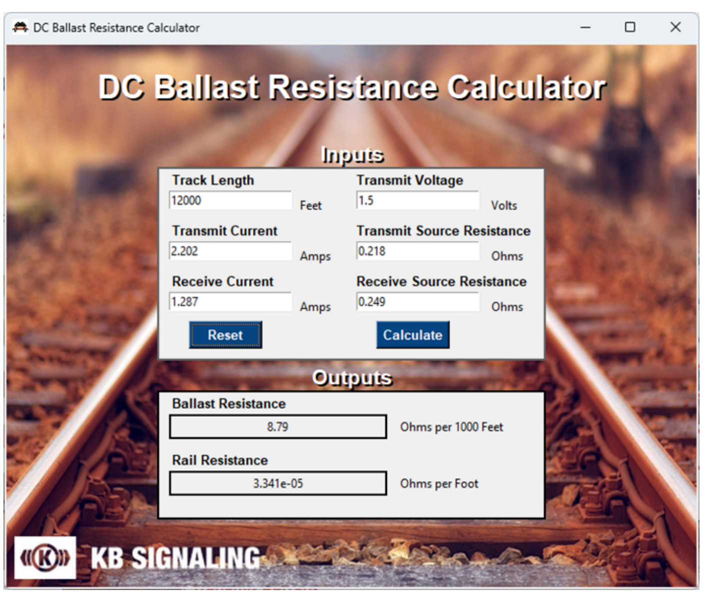
- Transmit voltage and current at one end
- Receive current at the other end
- Resistance between the track and the equipment at both ends

If your site uses VTI-2S modules, you can easily pull most of this data directly from the ElectroLogIXS web GUI.

To measure the resistance between the track and the equipment, simply switch the equipment into Transmit Test mode, short the track feed, and divide 1 volt by the transmit current reading. This will give you the resistance in ohms.



If you would rather not crunch the numbers yourself, KB Signaling offers a convenient calculator tool to handle the calculations for you. Scan the QR code at the end of this article to download the tool.

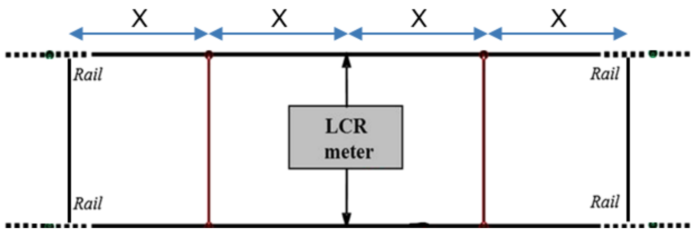


Scenario 2: No Insulated Joints or Signaling Equipment

If you are working in a location with no existing signaling equipment (or no insulated joints), there is another way to estimate ballast resistance — but it is a bit more involved.

This method requires an LCR meter (like the GW-Instek LCR-6020) to measure track impedance and phase angle at a specific frequency. The meter connects across the track, and you'll place shorts on either side of the meter — first at distance X, and then again at 2X.

There is a bit of trial and error here, so you'll want to pick a frequency and distance where the impedance at 2X is roughly double the impedance at X. If not, you may need to lower the frequency or reduce the distance between the shorts.



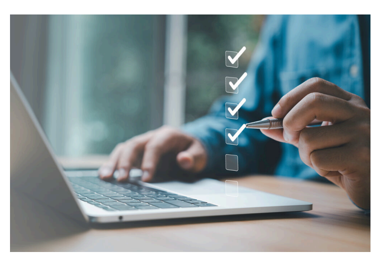
The math involved in converting these measurements into ballast resistance gets a little complex, but again, KB Signaling has a calculator tool that does the hard part for you.

Need Help?

Whether you are working with an existing track circuit, measuring ballast resistance on a new section of track, or simply seeking guidance on best practices, KB Signaling is here to assist.

If you need support, tools, or expert advice to interpret your ballast resistance data, don't hesitate to reach out. We're committed to helping you ensure smooth and reliable signaling operations every step of the way.

A Smarter, Faster Way to Validate ElectroLogIXS® Applications: The Alternative Reduced Test Validation Procedure (RTVP)



If you have worked with ElectroLogIXS® applications, you've probably encountered the challenge of making even minor modifications without triggering a full, time-consuming, and costly validation process. Enter the Reduced Test Validation Procedure (RTVP), a process designed to ensure that only the intended changes were made to an application, eliminating the need for a complete re-test. But now, there is an even better way:

Alternative RTVP, which leverages the latest software tools to streamline validation and save even more time.

Why Does RTVP Matter?

In railway signaling, safety is paramount. Traditionally, any change—no matter how small—required a full validation test to ensure system integrity. RTVP simplifies this by providing a structured method to confirm that no unintended changes were introduced.

RTVP is not new; it has been around since the days of the Vital Harmon Logic Controller (VHLC), proving its reliability and value over the years. However, with new software capabilities, the original RTVP process faced certain limitations, highlighting the need for a more modern approach.

How RTVP Works

At the core of RTVP is a key concept: the validation CRC (Cyclic Redundancy Check). This unique value is generated by Application Compiler Editor (ACE) and ensures that all vital data within an application is accounted for. If there is any vital change to the application, the validation CRC will change.

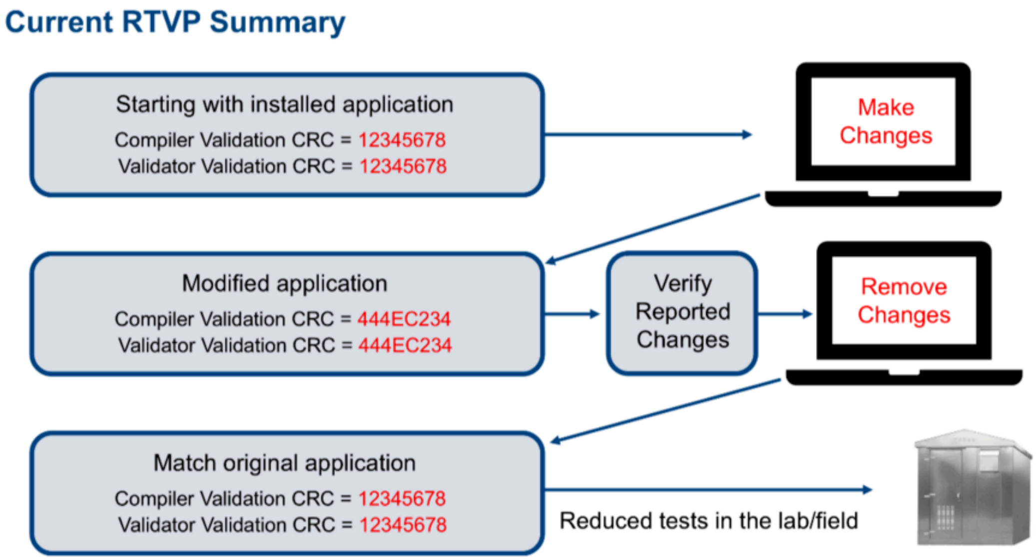
When ACE compiles an application it calculates the validation CRC and exports a binary file. This binary file is loaded into a program called Validator., which reverse-compiles the binary to calculate the validation CRC from a different perspective.

Since Windows®-based applications are non-vital, RTVP introduces an essential layer of verification. It allows for two independent calculations to confirm system integrity.

The Traditional RTVP Process

The original RTVP followed these steps:

1. Start with the current application running in the field.
2. Verify validation CRCs from both ACE and the Validator.
3. Make the desired changes.
4. Confirm that only the intended changes were made.
5. Check new validation CRCs in ACE and the Validator.
6. Revert to the original application.
7. Verify the validation CRCs match the original state.
8. Done!



The Problem?

- It's time-consuming, especially when reverting changes just to validate them.
- Newer ACE versions include additional vital components, which alter the validation CRC and prevent the old RTVP from working as intended.

Introducing the Alternative RTVP: A Faster, Smarter Approach

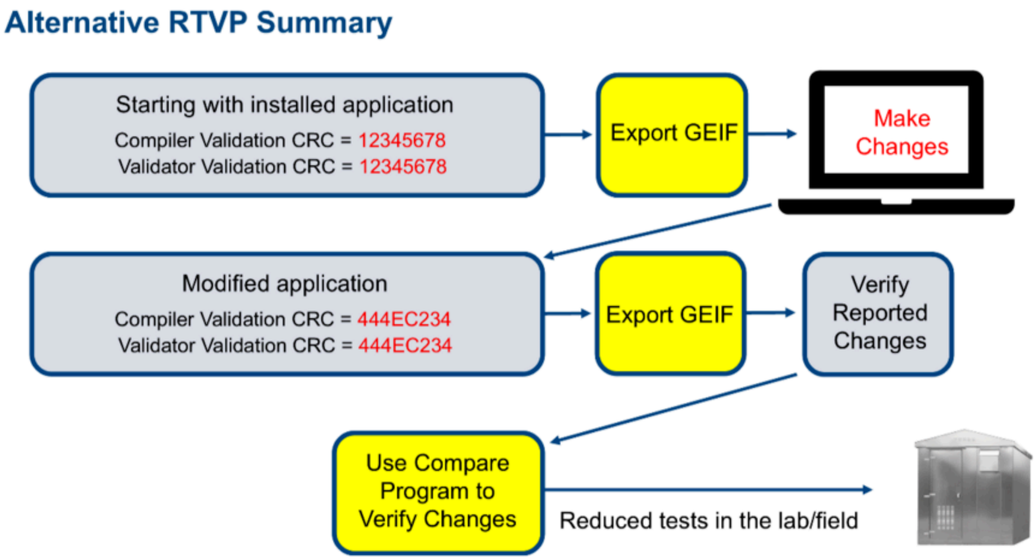
Responding to customer demand, KB Signaling now has a more efficient and modernized RTVP that integrates new validation tools.

Steps in the New Alternative RTVP

1. Start with the original application running in the field.
2. Verify validation CRCs from ACE and the Validator.
3. **NEW:** Output a GEIF file in ACE. (GEIF is a text file containing all application details.)
4. Make the desired changes.
5. Check new validation CRCs in ACE and the Validator.
6. **NEW:** Output another GEIF file for the modified application.
7. **NEW:** Use a text comparison tool to compare the original and new GEIF files to ensure that only the intended changes were made.
8. **NEW:** Compare the Ladder Logic Equation Report (LER) files between the original and modified applications to confirm changes at a functional level.
9. Done!

Why The New RTVP is Better

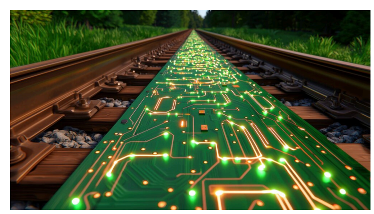
- **Faster execution** – No need to manually revert changes just for validation.
- **More precise validation** – New comparison tools ensure only the expected changes are present.
- **Compatible with new ACE versions** – Avoids issues caused by additional vital components.



Alternative RTVP gives rail professionals a more efficient, cost-effective way to validate changes, keeping operations running smoothly while maintaining the highest safety standards.

It’s a win-win for efficiency, accuracy, and safety.

New VIO-88 and VI-16 Modules Simplify Replacement of VHLC



KB Signaling's VHLC (Vital Harmon Logic Controller) has been discontinued after 33 years of service in railway signaling. The recommended replacement is the ElectroLogIXS® VLC, KB Signaling’s next-generation interlocking controller. While ElectroLogIXS offers far more capabilities than VHLC, a key consideration for replacement is the difference in I/O density per chassis. To address this, KB Signaling is developing new ElectroLogIXS modules, (VIO-88 and VI-16) to improve I/O density and simplify the replacement of VHLC.

For over 30 years, the V**HLC** has been a key player in railway signaling, ensuring safe and efficient train movement. However, with the official discontinuation of VHLC, railroads are now transitioning to a modern replacement. Enter ElectroLogIXS® VLC—KB Signaling’s next-generation interlocking controller designed to redefine trackside technology.

While ElectroLogIXS offers far more capabilities than VHLC, a key consideration for replacement is the difference in I/O density per chassis. To address this, KB Signaling is developing new ElectroLogIXS modules (VIO-88 and VI-16), designed to improve I/O density and simplify the replacement of VHLC.

Why Was VHLC Discontinued?

As technology advances, so must railway systems. The VHLC was introduced in 1992, and has been a reliable solution, with more than 10,000 locations still in revenue service today. However. in December 2024, the VHLC was officially discontinued, as outlined in PUB 22-016. The discontinuation includes all pre-configured VHLC systems, chassis, modules, cables, the PTC Site Specific Module, and generic HLC LCPs.

Since electronics inevitably become obsolete, finding a replacement is crucial. ElectroLogIXS isn't just a substitute - it's an upgrade in every way, offering enhanced capabilities and more advanced features to meet the evolving needs of the railway industry.

What Sets ElectroLogIXS Apart?

Both VHLC and ElectroLogIXS are solid-state, programmable interlocking controllers, offering a variety of specialized I/O options. They are highly configurable and modular systems, providing the core capabilities required for interlocking and signaling applications. At the heart of each system is a vital two-out-of-two (2oo2) processor, along with an additional non-vital communications processor.

So, what sets ElectroLogIXS apart from VHLC? ElectroLogIXS has integrated Ethernet communication interfaces that support up to 32 vital remote links, a web-based user interface, systems management, integrated WIU, and data streaming for analytics. ElectroLogIXS also gracefully degrades (or shuts down) functionality under fault conditions, instead of resetting the entire system, and allows for hot swap of I/O modules. Other improvements of ElectroLogIXS over VHLC are its mounting options (rack, wall, or shelf), plastic protective module enclosures, and various configurable chassis options (1, 4, or 9 slots for I/O modules).

Features and Functions Comparison

Features/Functions	VHLC	ElectroLogIXS
Vital 2oo2 processor with programmable logic	● (green)	● (green)
Non-vital/comms processor with programmable logic	● (green)	● (green)
General-purpose vital discrete I/O	● (green)	● (green)
Lamp drivers (DC & AC)	● (green)	● (green)
EC track circuits	● (yellow)	● (green)
Cab rate outputs	● (green)	● (green)
Non-vital I/O	● (green)	● (yellow)
Serial communications	● (green)	● (green)
Ethernet communications / IP enabled	● (red)	● (green)
Vital remote links	● (yellow)	● (green)
User interface for configuration and diagnostics	● (yellow)	● (green)
Data for analytics	● (red)	● (green)
Systems management and SSH	● (red)	● (green)
Integrated WIU	● (yellow)	● (green)
Graceful degradation and hot-swappable modules	● (yellow)	● (green)

VS

We should also highlight that the new ElectroLogIXS Electro Code 6 (EC6) track circuit offers several advantages over the legacy Electro Code technology supported by VHLC. With EC6, customers can avoid train delays caused by track circuit issues due to poor ballast conditions. Additionally, EC6 eliminates the need for wayside equipment by supporting longer track circuits - up to 40,000 feet – significantly improving efficiency.

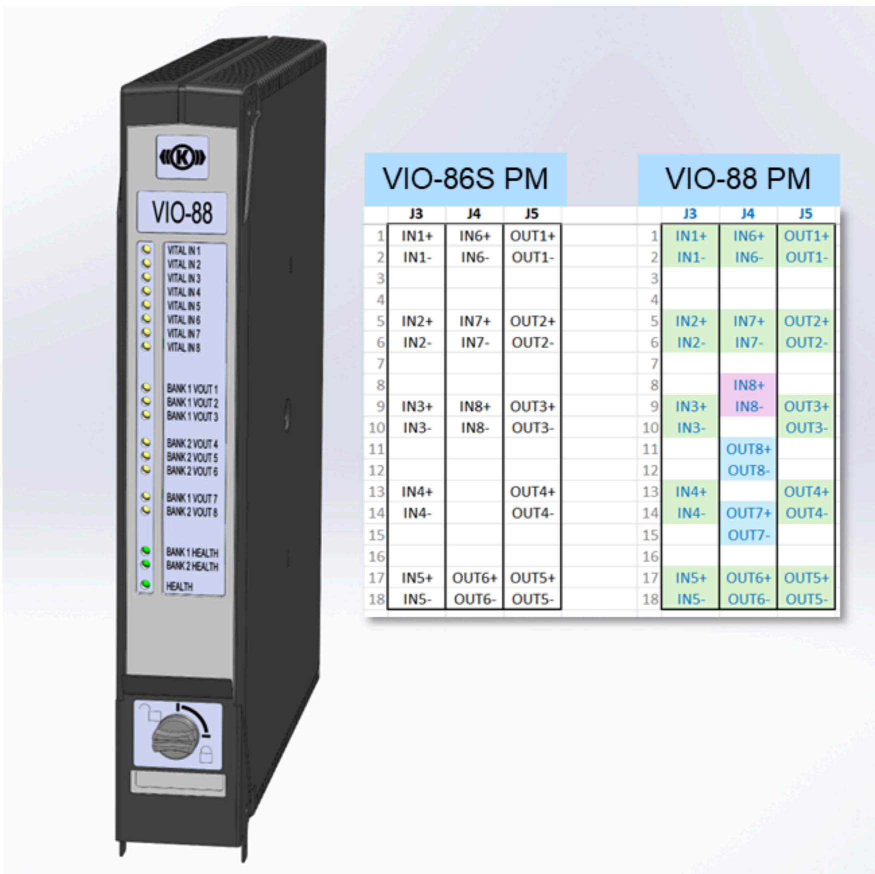
So, what are the cons? While ElectroLogIXS brings numerous improvements, there are a few considerations. In certain application scenarios, the I/O density of an ElectroLogIXS chassis might pose a challenge, particularly when replacing the VHLC in an existing application. VHLC offers the VGPIO module with 8 inputs and 8 outputs, as well as the 16VGPI module with 16 inputs. In comparison, ElectroLogIXS offers the VIO-86S module with 8 inputs and 6 outputs, and a 16-input module is not yet available.

While this difference may be a limitation in some cases, its important to note that ElectroLogIXS modules are designed to meet modern requirements with higher overall capabilities and flexibility.

Addressing the I/O Density Challenge: New ElectroLogIXS Modules from KB Signaling

KB Signaling is actively tackling the ElectroLogIXS I/O density challenge by introducing two new I/O modules.

The new VIO-88 (available in mid-2025), will provide two additional outputs while remaining fully compatible with existing VIO-86S applications. There will be no need to change the personality module, wiring, or application software if using the VIO-88 as a replacement or spare for VIO-86S. A new VIO-88 personality module will provide access to the additional VIO-88 outputs.



VIO-86S PM

	J3	J4	J5
1	IN1+	IN6+	OUT1+
2	IN1-	IN6-	OUT1-
3			
4			
5	IN2+	IN7+	OUT2+
6	IN2-	IN7-	OUT2-
7			
8			
9	IN3+	IN8+	OUT3+
10	IN3-	IN8-	OUT3-
11			
12			
13	IN4+		OUT4+
14	IN4-		OUT4-
15			
16			
17	IN5+	OUT6+	OUT5+
18	IN5-	OUT6-	OUT5-

VIO-88 PM

	J3	J4	J5
1	IN1+	IN6+	OUT1+
2	IN1-	IN6-	OUT1-
3			
4			
5	IN2+	IN7+	OUT2+
6	IN2-	IN7-	OUT2-
7			
8		IN8+	
9	IN3+	IN8-	OUT3+
10	IN3-		OUT3-
11		OUT8+	
12		OUT8-	
13	IN4+		OUT4+
14	IN4-	OUT7+	OUT4-
15		OUT7-	
16			
17	IN5+	OUT6+	OUT5+
18	IN5-	OUT6-	OUT5-

The new VI-16 (expected late-2026) will significantly expand ElectroLogIXS input capacity.

With these new modules, ElectroLogIXS will match VHLC's I/O density per chassis, depending on the mix of other I/O types, making the transition from VHLC to ElectroLogIXS far more practical and cost-effective

With the I/O density issue resolved by KB Signaling's new modules, replacing VHLC with ElectroLogIXS becomes a straightforward upgrade. ElectroLogIXS will maintain the same I/O mapping as VHLC, meaning:

- No extra chassis costs
- Fewer design changes
- Lower labor and material costs
- More streamlined wiring modifications

The Bottom Line

The transition from VHLC to ElectroLogIXS is not just necessary—it's an opportunity for railroads to modernize their signaling infrastructure. With KB Signaling's new modules, such as VIO-88 and VI-16, ElectroLogIXS will seamlessly replace VHLC while delivering more advanced, reliable, and scalable technology.

So, is ElectroLogIXS ready for the job? Absolutely. With the upcoming module enhancements, it is not just ready—it's the future of railway signaling.

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