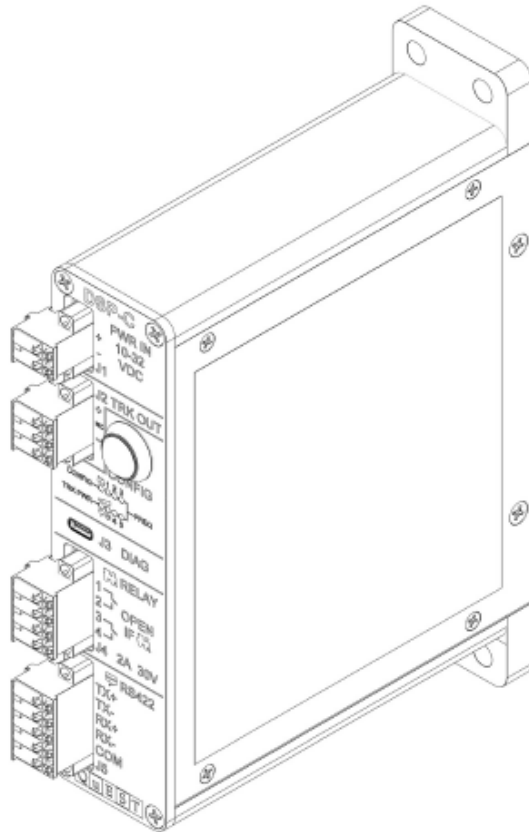


DSP-C Product Manual

Document No.: 095-190236-0000

Revision A05

Date: 29June2022



QUEST RAIL LLC

Wellington MO. 64097

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Safety Conventions

QuEST Rail LLC issues this *Document* which may provide equipment setup instructions. Read all instructions and processes thoroughly before making any adjustments or modifications to equipment.

This Document may contain safety related **DANGER**, **WARNING** and **CAUTION** alert messages with safety related **NOTICES** that are used to reduce the risk of injury and equipment damage. It is important that the reader understand the context and significance of each message.

The  symbols indicate that important personal safety information follows. Carefully read and understand each safety related text message and apply the message to the operation and maintenance of the system as defined in the safety alert message. The following are definitions associated with the different safety alert message categories.



Indicates an imminently hazardous situation, which if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.




Indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.



Indicates a potentially hazardous situation, which if not avoided, may result in minor or Moderate injury. It may be used to alert against unsafe practices.



This symbol is permitted for property-damage-only accidents. The safety alert symbol  should not be used to alert persons to property-damage-only potential hazards.



Indicates information or a company policy that relates directly or indirectly to the safety of personnel or protection of property

Personal Safety Instructions

Only qualified personnel should work on or around this equipment. To ensure the highest degree of personal safety, all who use this equipment are required to become thoroughly familiar with all safety instructions contained in this document. Successful and safe operation of this equipment depends upon proper handling, operation, maintenance, and application of associated railroad equipment.

**CAUTION**

No information in this manual supersedes or replaces your railroads operating rules. If there is a difference in instructions between this manual and the railroads operating rules, follow the most restrictive instruction.

**CAUTION**

CAUTION – Read Manual

Never install or perform maintenance on the DSP-C until after reading and understanding the installation and maintenance sections of this manual.

**CAUTION**

CAUTION – Service

This unit to be serviced by properly trained personnel only

**CAUTION**

CAUTION – Fit and Purpose

Although possessing many safety-minded functions, tests, alerts, and architecture, the DSP-C should not be used in SIL4 safety-critical applications.

**CAUTION**

CAUTION – Operation by Trained Personnel

The QuEST DSP-C shall only be operated by properly trained and authorized personnel as determined by the Railroad.

Warranty and Service Information

Each unit is assembled and tested in Wellington, MO. All boards and systems come with a 2-year warranty, which begins from the date of shipping. Please contact RMA@questrail.com, if your product requires service or repair. The 2 year warranty covers defects in materials and workmanship. This warranty does not cover misuse & abuse.

Product Support please include: '800-190236-0001 DSP-C' in the subject

Product Orders	orders@questrail.com
Technical Support	waysideproducts@questrail.com
RMA Requests	rma@questrail.com
Accounts Payable	ap@questrail.com
Accounts Receivable	ar@questrail.com
Other Inquiries	(816)-240-8425

Check the website for the latest DSP-C manual and product support information:
<http://www.questrail.com/dspc>

Return Material Authorization

Send inquiries and requests for RMAs to rma@questrail.com. Information to include with a RMA request:

QuEST Part Numbers (QPNs): 800-190236-0001 DSP-C
Serial Numbers
Problem Statement
Date of Problem Occurrence
Name and Contact Info

Scope

This Product Manual for the QuEST DSP-C part number 800-190236-0001 provides information related to Installation, Operation, Programming, and Basic Servicing. Please read carefully and thoroughly understand the instructions and processes before installing or putting into service.

Revision History

This document supersedes all previously issued versions, providing new or revised information. The most recent publication can be determined by the alphanumeric version character and the date issued found in the footer of each page.

Revision Record

Revision	Date	Description	Prepared By	Approved By
A00	Jan 2021	Initial Release	S. Mollet	NDQ
A01	Feb 2021	Updated per Review Comments	S. Mollet	NDQ
A02	Feb 2021	Updated for version 2.0.0 software.	S. Mollet	NDQ
A03	March 2021	Added BQF clarification.	S. Mollet	NDQ
A04	September 2021	Replaced TD1-A with TD-1A. Added programming and DC Current details.	S. Mollet	NDQ
A05	June 2022	Several updates per customer requests.	S. Mollet	NDQ

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Chapter 1. Introduction & Specifications

1.1. Introduction

The QuEST Rail Digital Signal Processor – Style C Track Circuit (DSP-C) is designed specifically for freight and transit rail applications.

The DSP-C is a digital version of the classic AC/DC Style C track circuit with excellent analytics and remote alarm capabilities via RS422 allowing railroads to monitor track circuit performance, so issues such as poor ballast conditions and leaky IJs can be corrected BEFORE operations suffer.

Features:

- Input battery voltage range: 10-32 VDC
- 1 Isolated Track Circuit Interface
- 1 Isolated RS-422 Communications Link
- 2 Normally Open Relay Contacts, where OCCUPIED is also the SAFE STATE and is Normally Open
- USB-C Diagnostic Port
- Adaptive Track Power
- Designed and tested to AREMA Class C wayside environmental specifications

The QuEST Digital Signal Processing AC/DC Style C Track Circuit (DSP-C) is meant to replace any AC/DC style, such as the TD-1A type of track circuit, used in non-vital (non-SIL4) applications. Through a proprietary algorithm, the DSP-C automatically adjusts its track output power to compensate for varying track conditions.

The DSP-C is a better choice when any of the following are needed:

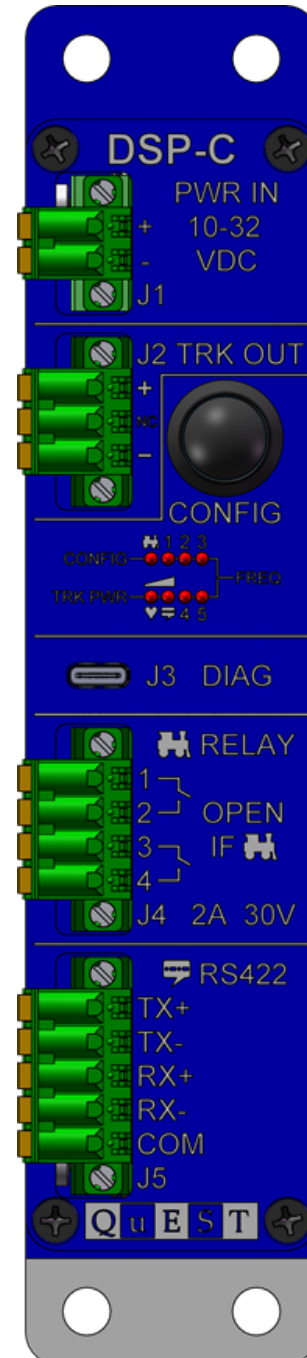
- Large Scale Yard Automation
- Trending of IJ integrity and Ballast
- Small footprint
- Ease of Installation
- Lower ongoing maintenance cost
- Remote connectivity
- Challenging ballast conditions

1.2. DSP-C Specifications

Integrated Power Supply – J1	
Voltage Range	10 to 32 VDC, < 1 Amp Typical
Internal Fuse	5 A (nano)
Reverse Polarity Protection	Yes
Connector	2-pin cage-clamp style, 1776508 (male PCB shrouded header)
Mating Connector	Phoenix 1874109 (female plug)
Connector Wire Gauge	14-22 AWG

Track Output – J2	
Outputs	1
Voltage Range	1.5 to 3.0 Vpeak
Current (max)	3 Apeak
Frequencies (5)	75, 105, 135, 165, and 195 Hz
Internal Fuse	7.5 A, Mini-Auto
Source Impedance	0.75 Ω
Connector	3-pin keyed cage-clamp style, 1776511 (male PCB shrouded header)
Mating connector	Phoenix 1874112 (female plug)
Connector Wire Gauge	14-22 AWG
Max Track Wiring (6 AWG)	1000 feet
Max Track Length	600 feet
Minimum Ballast	1 Ohm/1000 Feet

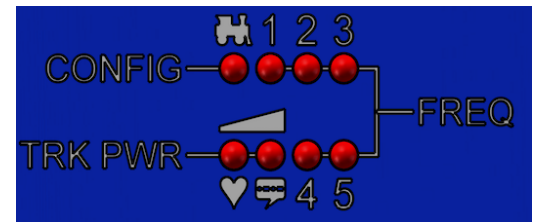
Diagnostic Port – J3	
Connector/Cable	USB Type C receptacle
Data Format	115,200 bps, 8-N-1
Protocol	Raw text over virtual serial COM port
Application	Configuration, Diagnostics, Reference DSP-C Product Manual 095-190236-0000



Relay Outputs (NO, Occupied) – J4	
Outputs	2
Voltage	32 VDC max
Current (max)	2 ADC max
Internal Fuses	5 A (nano)
Open	< 0.5 mA at 30 VDC
Closed	< 1 Ω
Connector	4-pin keyed cage-clamp style, , 1776524 (male PCB shrouded header)
Mating Connector	Phoenix 1874125 (female plug)
Connector Wire Gauge	14-22 AWG
Typical Application	Track Circuit Monitoring

Maintenance Port – J5	
Connector	5-pin cage-clamp style, Phoenix 1874138 (female plug), 1776537 (male PCB shrouded header)
Data Rate	115,200 bps
Protocols	Proprietary, over RS-422/485
Application	Office monitoring and control

Front Panel LEDs	
Occupancy 🚂	Solid – Occupied Off – Not Occupied Flashing – Not Configured
FREQ	Frequencies 1 – 5 1: 75 Hz 2: 105 Hz 3: 135 Hz 4: 165 Hz 5: 195 Hz
Health ❤️	Processor Heartbeat
Comm 🗨️	RS422 Transmitting
Track DC Current 1	1 and 2 On – Good DC Current (>90mA)
Track DC Current 2	2 only – AVG DC Current (70-90 mA)
Target: 90-125 mA	1 only – Poor DC Current (50-70 mA)



Temperature Sensor	
Type	Internal

Loss of Shunt Timer	
Fixed	2.4 s after loss of shunt

Mechanical	
Dimensions	8" x 5-15/16" x 1-3/4"
Weight	1lbs 14 oz

Environmental (AREMA Class C Compliant)	
Operating Temperature	-40 to 70° C
Operating Humidity	0 to 95% non-condensing
Isolation	2000 Vrms

Track Diode	
Compatible with all track diodes without an integrated resistor. Not compatible with Ring 10-5 type of track diodes.	

Chapter 2. System Overview

2.1. Background

Rail yards employ non-vital track circuits around their switches to ensure switch movements do not occur underneath cars. There are a variety of track circuit types that have been deployed for this purpose, but a very common track circuit type is a two-wire TD-1A. The QuEST DSP-C is being designed as a drop-in replacement for this type of track circuit.

2.2. System Functions

The track circuit diagram in Figure 2-1. DSP-C Track Circuit Diagram, configured to protect the switch area shows the intended track circuit configuration and connectivity for the DSP-C. Note that the insulated joints are required and the bonding across the switch is required in order for the track circuit to “see” into the diverging track. An alternate configuration is shown in Figure 2-2. In this case, a PD loop (or some other suitable mechanism) is used to protect the switch area, and two different DSP-C devices are connected with a shared common section of rail. In some scenarios, a Distance-to-Couple system (like the RIM) is connected directly after the Insulated Joints that demarcate the DSP-C Track circuits. Note that the diodes or the DSP-C track wires may be connected at this point, whichever results in the simplest/shortest wiring from the equipment bungalow.

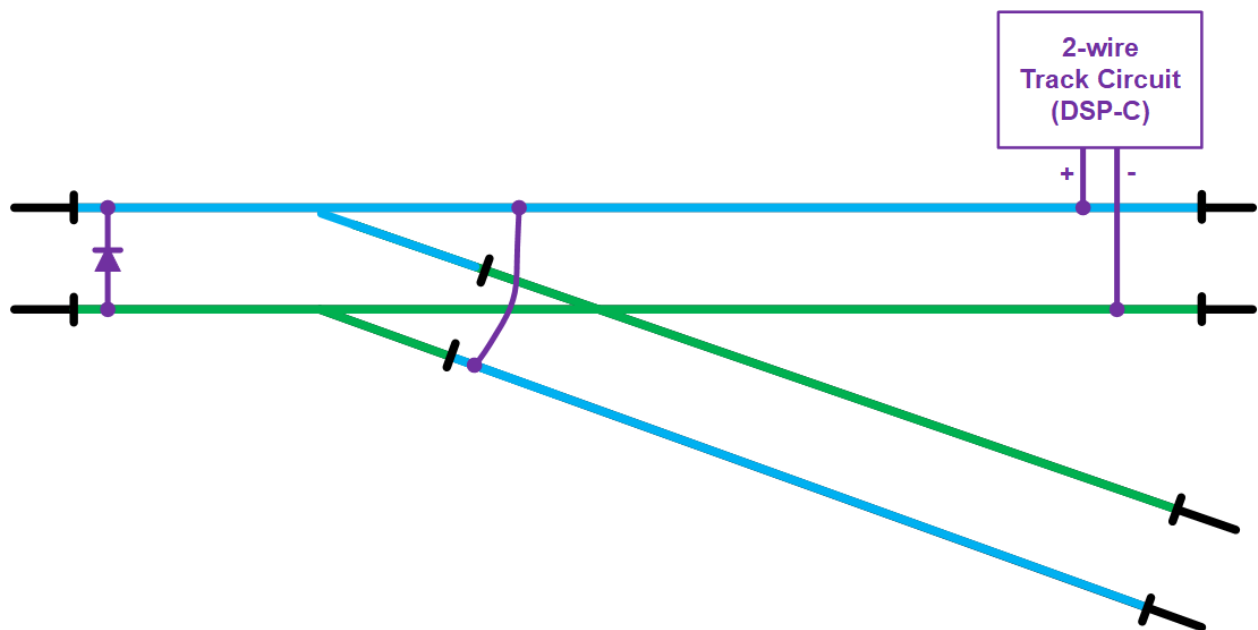


Figure 2-1. DSP-C Track Circuit Diagram, configured to protect the switch area

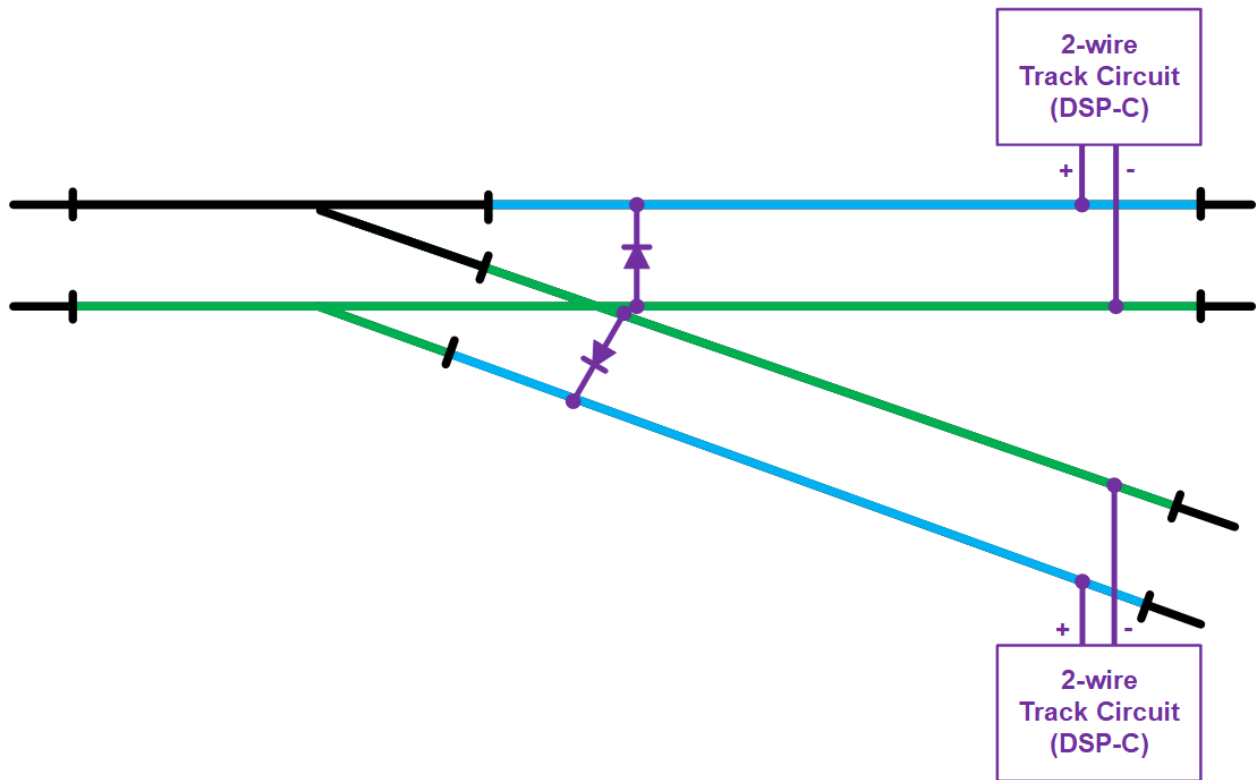


Figure 2-2. DSP-C Track Circuit Diagram, configured with common rail section.

The context diagram in Figure 2-3 shows the high-level interfaces for the DSP-C.

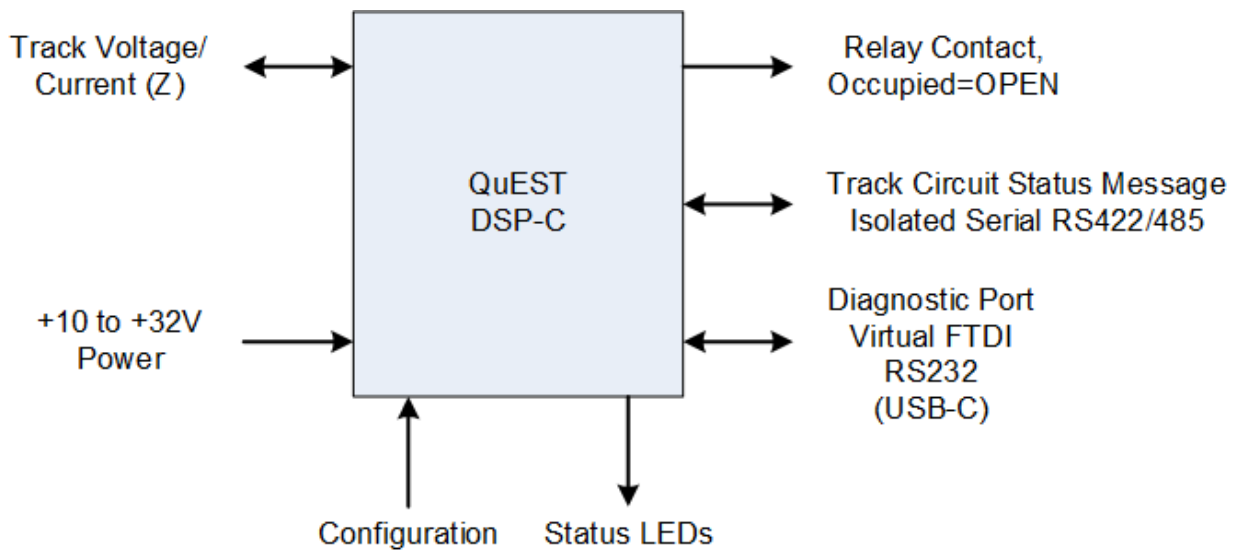


Figure 2-3. DSP-C Context Diagram

Status LEDs will provide user feedback on operational status. These LEDs will indicate power, health, track circuit occupancy, and communications activity to support factory test, installation, and troubleshooting.

The DSP-C can be supplied by 12 or 24 VDC signal battery for powering its controller board. The DSP-C power circuitry provides 2000 Vrms isolation between battery input and any other DSP-C connection and accepts an input voltage range of 10-32 VDC.

The DSP-C configuration settings are configurable through both the diagnostic port and the isolated RS422 interface.

The DSP-C will support upgrade of its firmware via the diagnostic port. In order to update the firmware, a laptop or computer with Windows XP or later is required in conjunction with programming software, Reference 3.3.

2.3. **Physical Architecture**

The DSP-C is packaged in an aluminum enclosure with a solid back plate suitable for rack or wall mounting. The mechanical requirements section provides more details about the enclosure design.

Chapter 3. Installation & Configuration

3.1. Unpacking and Inspection

When ready to install, remove the DSP-C from the packing and inspect to make sure there has been no damage to any of the connectors.

3.2. Installation

Mount the DSP-C on a rack or wall. Reference mounting hole dimensions in Figure 4-1.

Install appropriate primary line-to-line and line-to-ground surge protections on the TRK OUT and PWR IN leads. For 12V battery systems, ERICO RTB12N or equivalent recommended.



It is recommended to tie the DSP-C chassis to Bungalow Ground (Earth Ground) using a mounting screw/bolt on either of the bottom, non-painted mounting holes.

Connect TRK OUT, PWR IN and RELAY wiring per the site plans.

Connect RS422 per the site plans, if applicable.

After power is applied, verify LEDs are on and not erratic. If the LEDs do not illuminate or act erratically the unit has failed its power-up tests. Return the unit to QuEST Rail for repair. Reference 6.2 QuEST Factory Service.

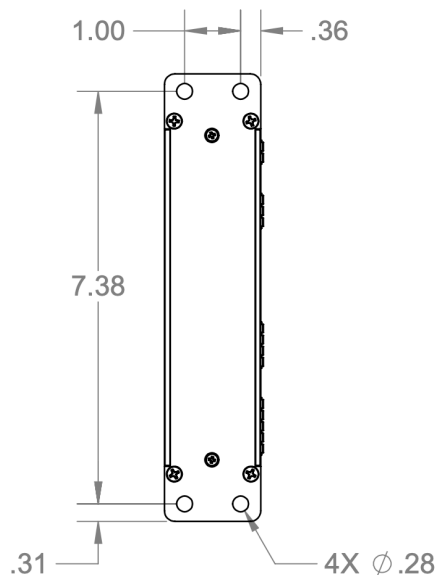







Figure 3-1. Bottom View Mounting Flange Hole Dimensions





3.3. Configuration/Verify

- Once power is applied to a new unit, the Occupancy LED  will blink at a slow rate indicating the DSP-C must be configured and a shunt verified.
- To verify a unit, the unit must be in an unverified state. See below for how to set the DSP-C to the unverified state.

To Verify Using the Front Panel Pushbutton:

- Press and hold the Configuration Button for 1 to 9 seconds. The Occupancy LED will now flash at a fast rate if the operational readiness tests pass.
- Press the Configuration Button to cycle through the frequencies. The FREQ LEDs will indicate the currently selected frequency. Press and hold the Configuration Button for 1 to 9 seconds to confirm the frequency selection.
- The Health  and Comm  LEDs will now flash indicating the DSP-C is waiting to verify a shunt.
- Place a 0.06 Ohm shunt on the DSP-C track circuit.
- Press and hold the Configuration Button for 1 to 9 seconds to perform a shunt verification. Once the shunt is verified, the DSP-C will commence normal operation.
- The Configuration / Shunt Verification must be completed in two minutes or the DSP-C will return to the unverified state. If a shunt cannot be verified, the Health  and Comm  LEDs will flash three times and the DSP-C will return to an unverified state.
- To return the DSP-C in the unverified state, e.g. to move it to another location, press and hold the Configuration Button for 10 to 15 seconds.

To Verify Using the Diagnostic Port:

- Sending '***V' or '**v' via the diagnostic port will perform an operational readiness check
- If this check fails, health and comm LEDs will alternate and flash 5 times
- If this check passes, the system will wait for a shunt check
- Sending '***X' or '**x' via the diagnostic port will perform a shunt check
- If this check fails, Health  and Comm  LEDs will alternate and flash 5 times
- If this check passes, the system will flash the Health  and Comm  LEDs and go into normal operation

Other useful Diagnostic Port commands:

- sending '***Z' or '**z' via the diagnostic port to reset the DSP-C to an unverified state
- sending '***D', '***E', '***F', '***G', or '***H' will change the output frequency.
- sending '***0' – '***9', '***A' – '***C' will temporarily change the power level.

The Diagnostic Port can also be used to update the firmware on the DSP-C.

- With the DSP-C powered up, plug in a USB-C cable to a Window’s computer running a terminal emulator program such as Tera Term and enter --+---. The DSP-C should go into reset.
- After the DSP-C is in reset and ready to be programmed, close the terminal to release the serial port.
- Open FlashMagic, 13.10 or later, program the DSP-C firmware. See screen shot below for settings. Optionally, load saved setting.
 - i. Select Device “LPC54102J512 (LPC54000)”
 - ii. Select virtual serial port number
 - iii. Set Baudrate to “115200”
 - iv. Select Firmware Hex File Path
 - v. Select Verify after Programming
 - vi. Click/Select Start to Program DSP-C (Do not remove power or the programming cable until after the DSP-C has been programmed)
 - vii. After the progress bar below the Start Button is complete and Flash Magic does not indicate any errors, the DSP-C has been programmed successfully.
 - viii. Close Flash Magic, if desired, save the FlashMagic settings
 - ix. Cycle power to reset the DSP-C
 - x. To validate the new update, you may check the firmware version using the diagnostic port (J3). See Chapter 7, Log entries for more details.
 - xi. To recover from a failed programming attempt and force the DSP-C into program mode, remove the side cover, momentarily short J8 (reference picture below) with power applied, program per the procedure above.

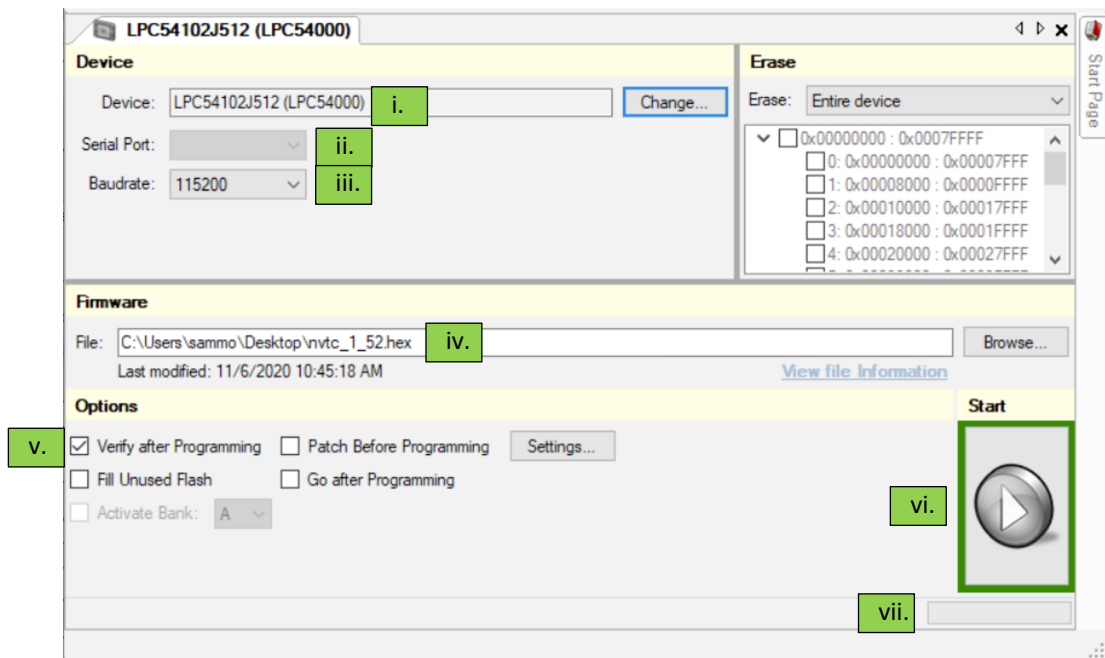


Figure 3-2. FlashMagic Screenshot



Figure 3-3. Location of J8

3.4. Track Shunt Test

Verify the DSP-C does not indicate an occupancy when the track is clear of a shunt. Using a 0.06 Ohm Track Shunt, verify the DSP indicates an occupancy at various locations along the track circuit. If the DSP-C fails the track shunt test, reference Chapter 5 DSP-C Troubleshooting.

Chapter 4. DSP-C Electrical Interface and Technical Overview

The interface signals are contained in four (4) Phoenix Contact 5.08mm cage clamp style connectors J1, J2, J3 & J4. Each connector has a different number of pins. This combination minimizes the chance of inadvertent disarrangement of track circuit wiring.

4.1. PWR IN (J1)

The Power In connector provides a DC power input to the DSP-C. The Phoenix connector is clearly marked for polarity. The top pin is positive, the bottom pin is negative. The Phoenix mating connector part number is 1874109. The voltage range is 10-32 Vdc with allowance of 7V input for up to 100 ms on an unoccupied, nominal track. The Power In port is isolated from all other DSP-C electrical interfaces. The Power In port meets AREMA specifications for surge, EMC, and isolation.

4.2. TRK OUT (J2)

The Track Output connector provides the AC signal to tracks at one of five frequencies. The five DSP-C frequencies are 75 Hz, 105 Hz, 135 Hz, 165 Hz, and 195 Hz. The source impedance is ~ 0.75 Ohms. The output signal has 13 levels at 0.125 Vpeak steps between 1.5 Vpeak and 3.0 Vpeak. The output voltage level is automatically adjusted to account for changing track conditions to maintain an unoccupied track DC current of $\pm 90 - \pm 125$ mA. The threshold for an occupied track is a DC track current below 50 mA. Typical occupied track DC current values are less than 10 mA. The Track Output port is isolated from all other DSP-C electrical interfaces. The Track Output port meets AREMA specifications for surge, EMC, and isolation.

Typical Occupied and Unoccupied track current plots for both good ballast and poor ballast are shown below in Figure 4-1 and Figure 4-2. The red trace is occupied current and the green trace is the unoccupied current. In both cases the DC Track current is about 100 mA.

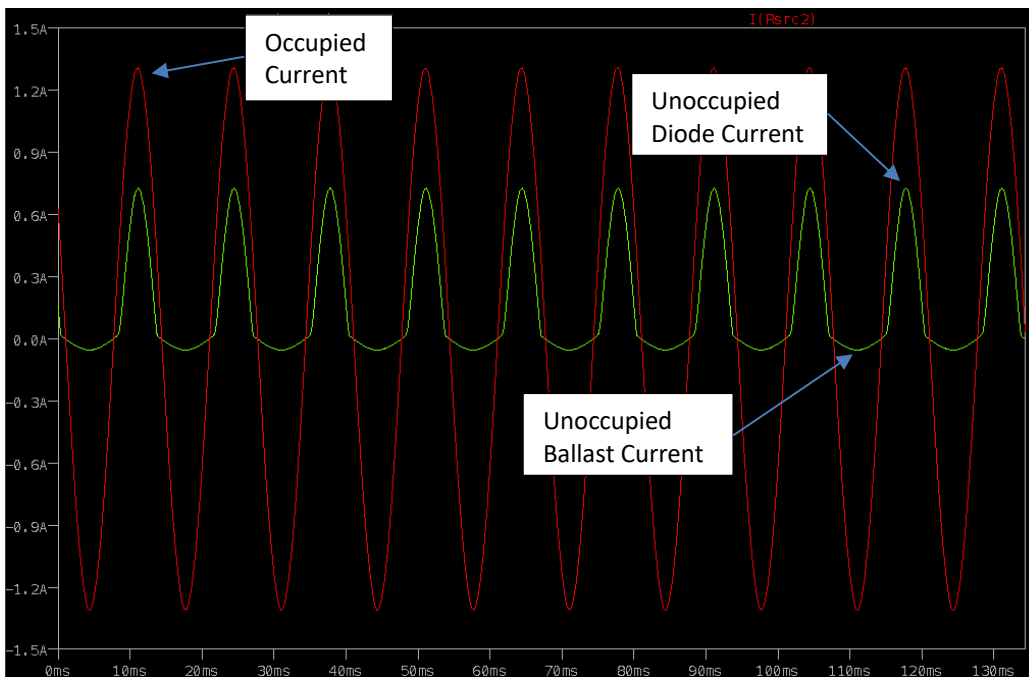


Figure 4-1. Track Current for good ballast, 8 Ohms per 1000 feet

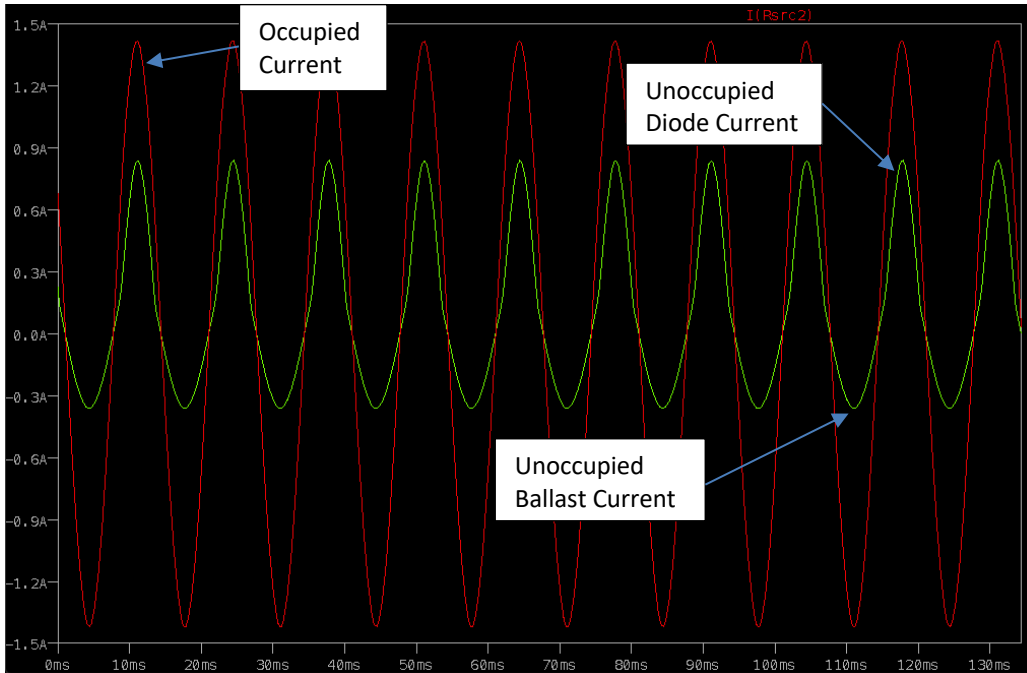


Figure 4-2. Track Current for poor ballast, 1 Ohms per 1000 feet

4.3. DIAG (J3)

The Diagnostic port provides a USB-C connector and a virtual serial port running at 115.2 kbps,8,N,1. Reference Chapter 7 DSP-C Diagnostic Log Key for a key to the DSP-C runtime log. The Diagnostic port is isolated from all other DSP-C electrical interfaces. The Diagnostic port meets AREMA specifications for surge, EMC, and isolation. When attached to most laptops, the DSP-C Diagnostic Port will enumerate as a standard serial port. A terminal emulator such as Tera Term can be used to display and capture the DSP-C diagnostic log.

The Diagnostic port can also be used to make adjustments and reprogram the DSP-C firmware. Reference 3.3 Configuration/Verify.

4.4. RELAY (J4)

The Relay port provides two, normally open, relay contacts to indicate an occupancy. The relay contacts are rated for 30 Volts, 2 Amps. For reliability, each contact output is a series combination of a normally open electromechanical relay contact and a normally open solid-state relay contact. To declare an UNOCCUPIED state, both internal contacts must be closed. The relay port is isolated from all other DSP-C electrical interfaces. The Relay port meets AREMA specifications for surge, EMC, and isolation.

CAUTION OUTPUT FAILURE TEST: During the Loss of Shunt timer, each contact is independently turned on. The end user can monitor the Relay Output(s) for a “bobble” after an occupancy to determine if a latent failure has developed in one of the output relay contacts. When the behavior is observed, the unit can be replaced before both contacts become permanently closed, indicating falsely an unoccupied track. If either the mechanical relay or the solid-state relay contact is shorted, two 100 ms bobbles will be observed at the relay output connector. Reference Figure 4-3 and Figure 4-4 below.

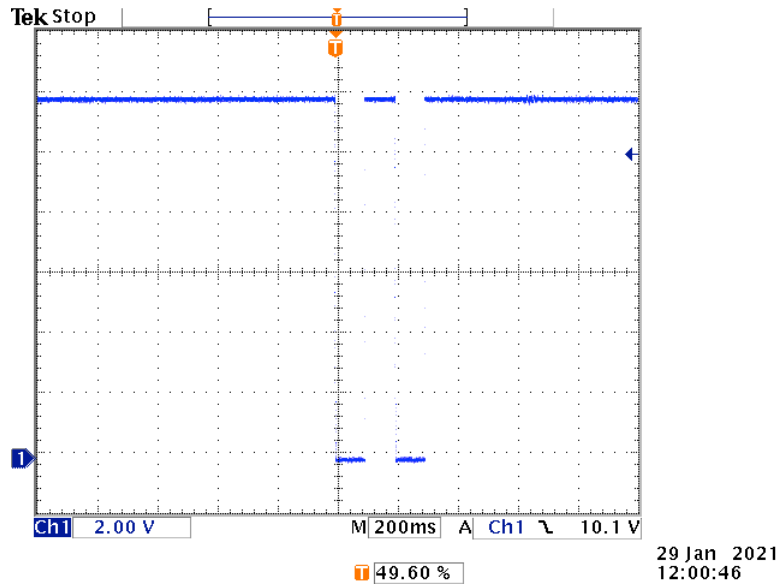


Figure 4-3. Relay Output During LOS (active low) with shorted mechanical relay contact

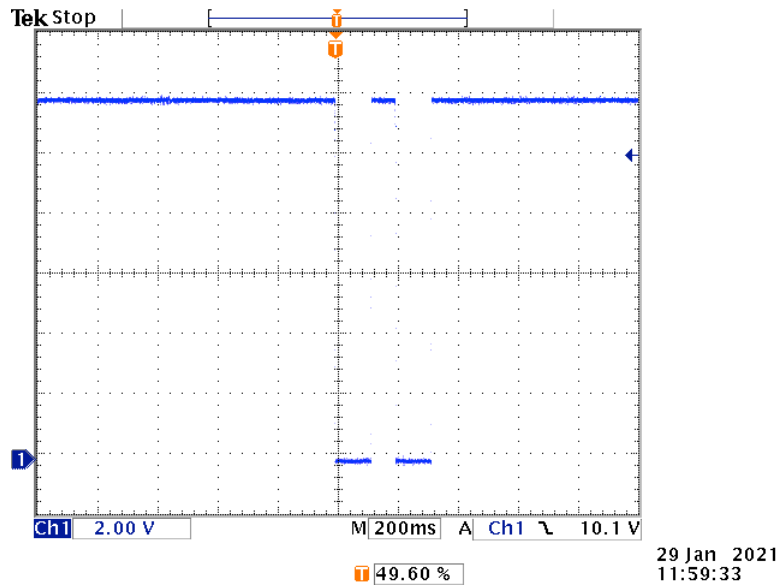


Figure 4-4. Relay Output During LOS (active low) with shorted solid-state relay contact

4.5. RS422 (J5)

The Diagnostic port provides a 5-pin, RS422 full duplex connector running at 115.2k baud. The RS422 protocol is documented in 090-190236-0422 DSP-C Management Protocol Interface Control Document.

NOTICE Note that the COM pin on this connector is the 422/485 signal reference and should not be tied to a cable shield or any other common/ground.

Chapter 5. DSP-C Troubleshooting

The following section covers the basic installation test procedure and troubleshooting guide that is recommended when installing the DSP-C for the first time or during routine operating inspections. Reference 5.4 Troubleshooting Flowchart.

- Before proceeding double check the DSP-C installation with instructions found in Chapter 3 of this manual.
- Verify the unit will power up and blink it LEDs, otherwise return the unit for service.

Recommended Troubleshooting Equipment

- Laptop to attach to the Diagnostic Port
- DMM, Fluke 87V or equivalent
- QuEST Rail DSP-C TRACK TEST PLUG, PN 808-190236-0001
- Rail Shunt, 0.25 Ohm or less

5.1. Troubleshooting Occupancy Issues

A DSP-C TRACK TEST PLUG can be used to simulate a track circuit. The test plug has a switch to simulate a shunt as well. The test plug can be used to troubleshoot verification issue, reference 3.3 Configuration/Verify, or track shunting issues, reference 0 Figure 3-2. FlashMagic Screenshot

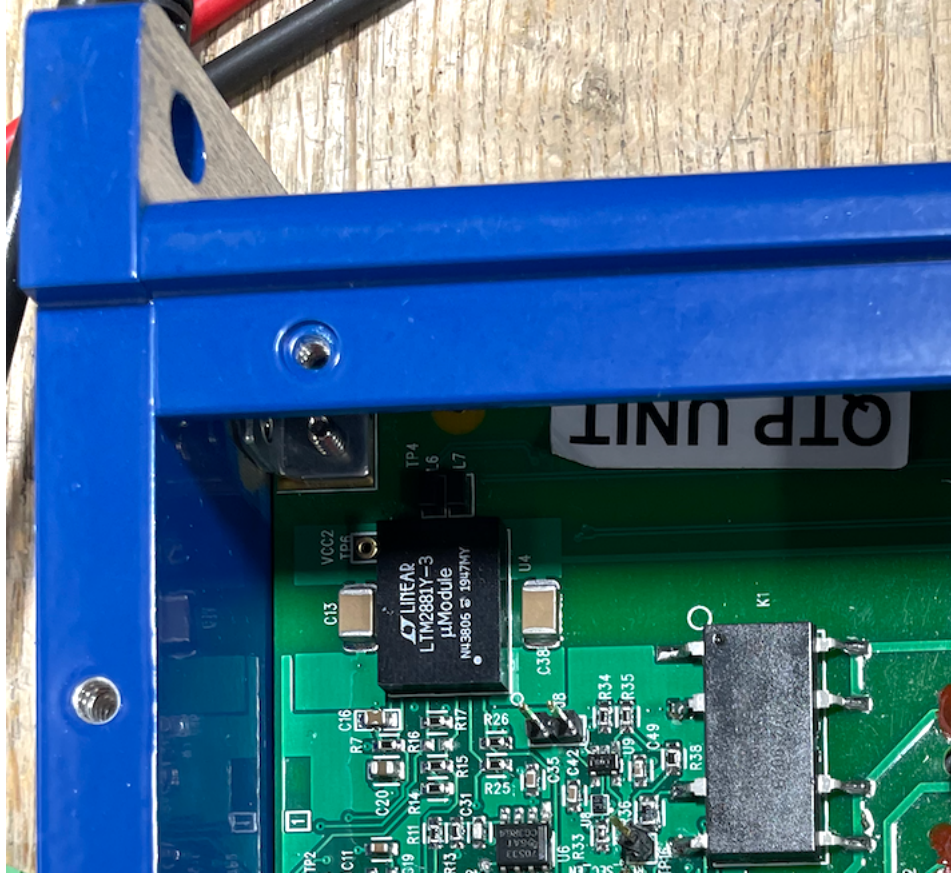
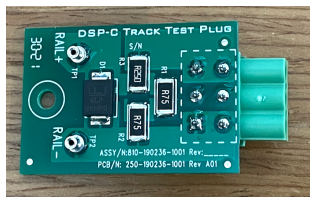


Figure 3-3. Location of J8

Track Shunt Test. In addition, the DSP-C runtime log can be used to troubleshoot common issues with the track.

If the DSP-C fails to verify or an occupancy cannot be detected when connected to the track perform the following troubleshooting steps.

- Remove the TRK OUT plug, install the DSP-C TRACK TEST PLUG, PN 808-190236-0001.



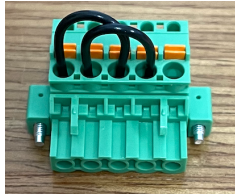
- Connect a jumper across the test points for Occupied and disconnect for Not Occupied as needed for troubleshooting track occupancy issues.
- If the DSP-C operates normally with the test plug, replace the TRK OUT plug and reference 5.3 Troubleshooting Track Issue.

- If the DSP-C fails to operating normally with the test plug, return the unit to Quest Rail. Reference 6.2 QuEST Factory Service.

5.2. Troubleshooting RS422 Communication Issues

If RS422 communication issues are suspected perform the following steps to verify that the RS422 port is operating correctly.

- Connect a laptop to the diagnostic port, reference 4.3 DIAG (J3).
- Remove the RS422 plug (if installed), install the RS422 loop-back plug, PN 808-190236-0002.



- Type ****L** to perform a RS422 loop-back test. The DSP-C log will display “Management Port Loopback Test Passed” if the test passes.
- If the DSP-C passes the RS422 test, replace the RS422 plug.
- If the DSP-C fails the RS422 test, return the unit to Quest Rail. Reference 6.2 QuEST Factory Service.

5.3. Troubleshooting Track Issue

5.3.1. Low Track DC Current with High Power Level

A low track DC Current condition can be determined by placing a DMM in series with one of the track wires via a gold nut or other means. With the DMM set to Amps mode (not mA) the meter should read between ± 0.09 and ± 0.125 Amps with an unoccupied track. Common problems with low DC current are:

- Open or bad Track Diode
- Open track wire or track wire bond
- Open or blown track fuse (internal to DSP-C)

The DSP-C diagnostic log can also be used to troubleshoot low track DC current. Reference Chapter 7 DSP-C Diagnostic Log Key.

For example, the following data from the diagnostic log for an unoccupied track indicates a high power level (12) and a low DC current (45mA).

```
1001 12 195 300 112 1 1 0 0 1 1 2 2977 33 1 123 45 45 0 0 0 0 138 33 0 49 12.7 0 1 1 00000008...
```

5.3.2. Low DC Current with Low Power Level

If the ballast resistance changes significantly during an occupancy the DSP-C may not determine the track is unoccupied after the track is cleared due to the low ballast condition. This false occupancy can be cleared in several ways. Power cycle the DSP-C or temporarily force a higher power level either using the diagnostic port (****C**) or the RS422 maintenance port.

5.3.3. Bad Insulated Joint(s)

A failed insulated joint, or IJ, will often cause a false occupancy due to excessive interference and lowering the effective track DC current. The DSP-C diagnostic log can be used to diagnose failed insulated joints. A common signature of a failed insulated joint is excessive noise in the off-frequency current FFT bins. Reference Chapter 7 DSP-C Diagnostic Log Key.

For example, the following track current data from a diagnostic log for an unoccupied track are normal:

98 98 0 0 0 0 445 33 0 163

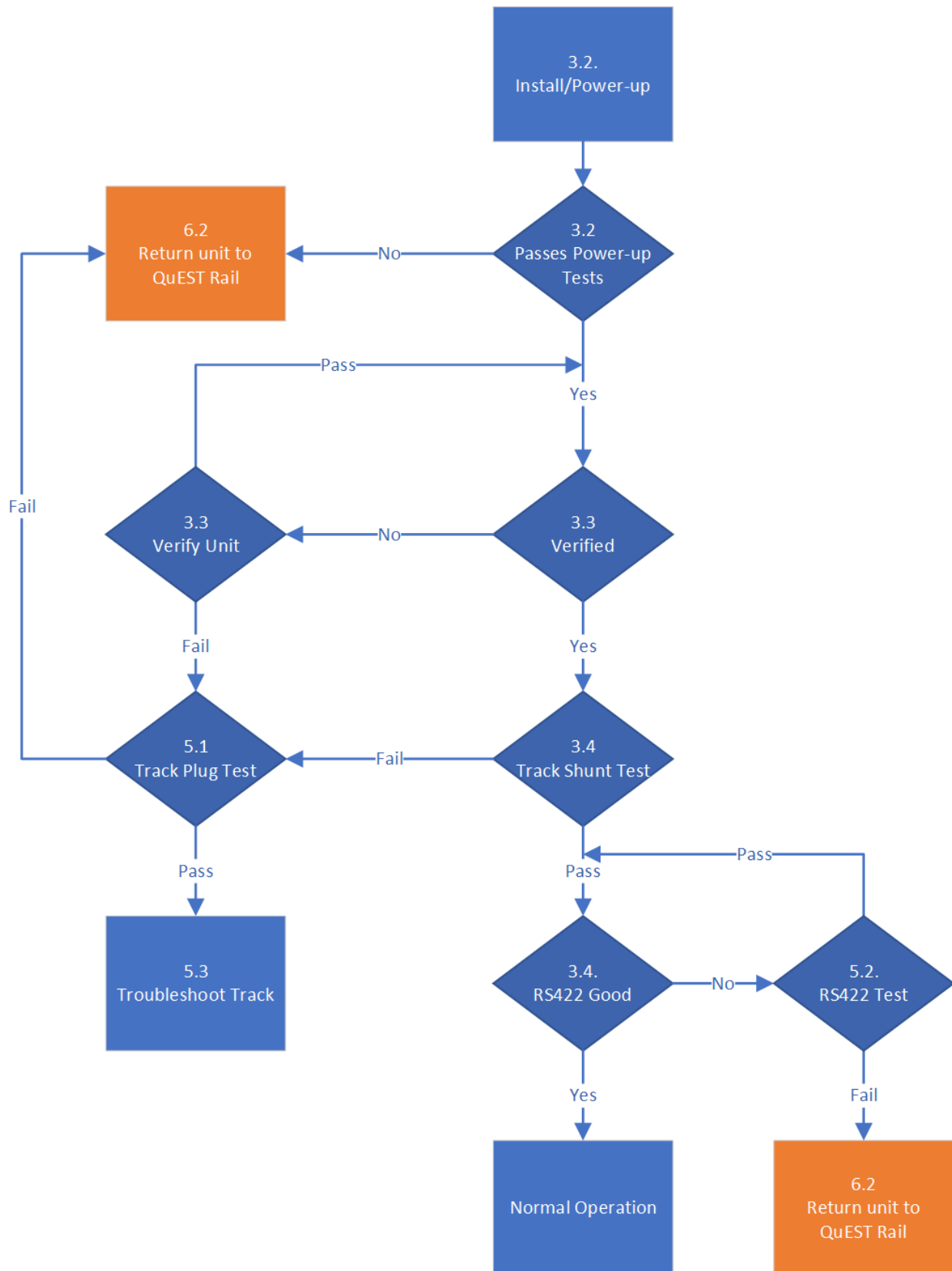
A failing IJ may look something like this:

35 34 10 20 19 26 445 33 0 205, note "noise" is present in the other DSP-C frequency bins and in this case, the DC current has dropped below the 50 mA threshold.

A ground fault looks similar to a failing IJ except 60Hz interference is often higher than a failing IJ:

35 34 10 20 19 26 445 33 40 205, note the DC current has dropped below the 50 mA threshold

5.4. Troubleshooting Flowchart



Chapter 6. DSP-C Maintenance and Service Information

This section covers the service options and information for repairing a defective DSP-C after being pulled from service.

6.1. Routine Inspection and Maintenance

6.1.1. Inspection

The DSP-C independently toggles the series relay contacts during the LOS timer. Reference 4.4 RELAY (J4). It is recommended the relay output is monitored for “bobbles” (relay output contact picks and drops) after an occupancy is cleared. If a bobble is NOT detected, the DSP-C should be replaced.

6.1.2. Maintenance

The Installation test described in the preceding section should be performed at the following times or conditions:

- Routine track circuit inspection as per FRA guidelines or railroad practices
- Whenever any of the following track components are changed out including:
 - Track Wiring
 - Track Diode
 - Insulated Joint
 - Bungalow or equipment house repair due to lightning

6.2. QuEST Factory Service

It is highly recommended that all major servicing of the DSP-C be done at the QuEST Rail factory. This can be easily accomplished by contacting QuEST and obtaining an RMA number and instructions on where to ship the unit to be repaired or serviced. QuEST has all the necessary equipment and procedures to ensure the DSP-C is returned in proper working order.

If the DSP-C Main Board has failed or has been damaged the DSP-C must be returned to QuEST if the unit is to be repaired.

For return and service instructions, refer to the Warranty and Service Information section at the start of this manual.

Figure 6-1. DSP-C Exploded View

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	810-190236-0001	DSP-C - PCB ASSY	1
2	261-190236-0000	DSP-C - MOUNTING BLOCK	1
3	261-190236-0002	DSP-C - SIDE EXTRUSION - 5.000"	2
4	259-190236-0001	DSP-C - FRONT PANEL	1
5	257-190236-0001	DSP-C - SIDE PANEL	2
6	152-004011-0209	WASHER #4 SPLIT-LOCK .209 OD SS	2
7	151-005501-0013	SCREW - 6-32 X 3/4" PFHMS SSBO - MCM 96640A120	4
8	151-005501-0007	SCREW - 6-32 X 3/8" PFHMS 82 DEG SSBO - MCM 96640A115	8
9	151-003501-0005	SCREW - #4-40 X 1/4" 82 DEG PFHMS SSBO - MCM 96640A054	8
10	151-003100-0006	SCREW 4-40 X 5/16LG PPHMS SS - MCM 91772A107	2
11	143-043005-1874	CON-1X5-PLUG-SR-200D-WT-1874138	1
12	143-043004-1874	CON-1X5-PLUG-SR-200D-WT-1874125	1
13	143-043003-1874	CON-1X3-PLUG-SR-200D-WT-1874112	1
14	143-043002-1874	CON-1X2-PLUG-SR-200D-WT-1874109	1
15	141-020092-0200	SWITCH PUSH SPST-NO 0.125A 125V	1

Figure 6-2. DSP-C Parts List

Chapter 7. DSP-C Diagnostic Log Key

Log Entries (Occupied) with Time Stamp

[Thu Feb 23 08:58:34.471 2022] 4913 0 195 300 112 1 0 0 0 0 1 1483 33 0 70 0 0 0 0 0 1178 33 0 54 1.2 0 1 1 00000008 25 29 0 0 V2.03.0-c0 21010001 00000001 "3RW"

Log Entries (Occupied) without Time Stamp

Sequence Number	Power Level	Frequency	Track Length	Track Wire Length	Power Good	TRK OUT mVdc	TRK OUT Frequency Bin AC Voltage (mVpeak)	TRK OUT mAdc	TRK OUT Frequency Bin AC Current (mApeak)	Diagnostic Information	SW Version	Serial Number	Unit Address	Location
-----------------	-------------	-----------	--------------	-------------------	------------	--------------	---	--------------	---	------------------------	------------	---------------	--------------	----------

4913 0 195 300 112 1 0 0 0 0 1 1483 33 0 70 0 0 0 0 0 1178 33 0 54 1.2 0 1 1 00000008 25 29 0 0 V2.03.0-c0 21010001 00000001 "3RW"

Configuration Information:

4913: Sequence Number. 0000 – 9999, entry every ~342 ms

0: Power Level. 0 – 12, 0 = 1.5 Vpeak, 12 = 3.0 Vpeak

195: AC Output Frequency (Hz)

300: Track Length (ft), default is 300 ft

112: Track Wire Length (ft), default is 112 ft

1: Power Good Indication. 1 = Good. 0 = Amplifier Error. Diagnostic Information.

TRK OUT Voltage Measurements:

0: DC Offset in mVdc. Normally between -5 to 5.

0: Compensated DC Offset of the D2A and the Amplifier in mV. Diagnostic Information.

0: TRK OUT 75Hz Voltage in mVpeak, 0 Vpeak in this example.

0: TRK OUT 105Hz Voltage in mVpeak, 0 Vpeak in this example.

0: TRK OUT 135Hz Voltage in mVpeak, 0 Vpeak in this example.

1: TRK OUT 165Hz Voltage in mVpeak, 1 mVpeak in this example.

1483: TRK OUT 195Hz Voltage in mVpeak, 1483 mVpeak or 1.483 Vpeak in this example.

33: Maximum Voltage Frequency FFT Bin. Diagnostic Information

0: 60Hz Frequency Voltage Level. Normally < 5.

70: Sum of other Voltage FFT Bins. Diagnostic Information

Log Entries (Occupied) without Time Stamp Continued

Sequence Number Power Level Frequency Track Length Track Wire Length Power Good	TRK OUT mVdc	TRK OUT Frequency Bin AC Voltage (mVpeak)	TRK OUT mAdc	TRK OUT Frequency Bin AC Current (mApeak)	Diagnostic Information	SW Version Serial Number Unit Address Location
--	--------------	--	--------------	--	---------------------------	---

4913 0 195 300 112 1 0 0 0 0 1 1483 33 0 70 0 0 0 0 0 1178 33 0 54 1.2 0 1 1 00000008 25 29 0 0 V2.03.0-c0 21010001 00000001 "3RW"

Track Current Measurements:

- 0: DC or Average DC Current in mAdc. Less than 50 mAdc indicates an Occupied circuit. Normally, an Unoccupied circuit will range between (±) 90 –120 mAdc* and an occupied track will have less than 10 mAdc.
- 0: Filtered DC or Average DC Current in mAdc.
- 0: TRK OUT 75Hz Current in mApeak, 0 mApeak in this example.
- 0: TRK OUT 105Hz Current in mApeak, 0 mApeak in this example.
- 0: TRK OUT 135Hz Current in mApeak, 0 mApeak in this example.
- 0: TRK OUT 165Hz Current in mApeak, 0 mApeak in this example.
- 1178: TRK OUT 195Hz Current in mApeak, 1178 mApeak or 1.178 Apeak in this example.
- 33: Maximum Current Frequency FFT Bin. Diagnostic Information
- 0: 60Hz Frequency Current Level. Normally < 5.
- 70: Sum of other Current FFT Bins. Diagnostic Information

*** An unoccupied track current can exceed 200 mAdc if the track wires are shorter than 100 feet.**

Diagnostics:

- 1.2: Ballast Quality Factor (BQF), 1.200 ohm/1000ft in this case, Note the BQF is only valid during an unoccupied track.
- 0: Output Relay Enable Current in mA, ~0 when occupied, ~28 when unoccupied
- 1: Output Relay Enable1, active low, 1 when occupied, 0 when unoccupied
- 1: Output Relay Enable2, active low, 1 when occupied, 0 when unoccupied
- 00000008: Integrity Bits, indicates why output relay is deenergized / Diagnostic Information

Other:

- 25: Ambient Temperature in degrees Celsius
- 29: Onboard Temperature Sensor in degrees Celsius
- 0 0: Clipping Bits, should always be 0 0
- V2.03.0-c0 21010001 00000001: Firmware version, serial number, and Unit Address in hex (32 bits)
- "3RW": Location

Log Entries (Unoccupied) without Time Stamp

4834 0 195 300 112 1 0 0 0 0 1 1487 33 0 71 98 98 0 0 0 0 445 33 0 163 1.3 28 0 0 00000000 25 29 0 0 V2.03.0-c0 21010001 00000001 "3RW"

Note the Track DC current increased from approximately 0 mA to approximately 98 mA (reference highlighted numbers above) while the Track AC peak current reduced from 1178 mA_{peak} to 445 mA_{peak}.

Integrity Bits

The integrity bits in the log indicate why the DSP-C has declared a track circuit occupied. Under normal operation, a track will be declared occupied due to the track DC current is too low (00000008), i.e. the track DC current is below the DC_CURRENT_SHUNT_THRESHOLD (50 mA).

NOT_OPERATIONAL	= 0x00000001
DC_VOLTAGE_EXCESSIVE	= 0x00000002
DC_CURRENT_EXCESSIVE	= 0x00000004
DC_CURRENT_SHUNT_THRESHOLD	= 0x00000008
AC_VOLTAGE_FREQ_D_EXCESSIVE	= 0x00000010
AC_VOLTAGE_FREQ_E_EXCESSIVE	= 0x00000020
AC_VOLTAGE_FREQ_F_EXCESSIVE	= 0x00000040
AC_VOLTAGE_FREQ_G_EXCESSIVE	= 0x00000080
AC_VOLTAGE_FREQ_H_EXCESSIVE	= 0x00000100
AC_CURRENT_FUNDAMENTAL_EXCESSIVE	= 0x00000200
AC_CURRENT_FUNDAMENTAL_TOO_LOW	= 0x00000400
AC_VOLTAGE_FUNDAMENTAL_TOO_HIGH	= 0x00000800
AC_VOLTAGE_FUNDAMENTAL_TOO_LOW	= 0x00001000
AC_CURRENT_OFF_FREQ_EXCESSIVE	= 0x00002000

5V_RAIL_TOO_LOW	= 0x00004000
5V_RAIL_TOO_HIG	= 0x00008000
3_3V_RAIL_TOO_LOW	= 0x00010000
3_3V_RAIL_TOO_HIGH	= 0x00020000
1_8V_RAIL_TOO_LOW	= 0x00040000
1_8V_RAIL_TOO_HIGH	= 0x00080000
VOLTAGE_CLIPPED	= 0x00100000
CURRENT_CLIPPED	= 0x00200000
SW_WATCHDOG_TEST_FAILURE	= 0x00400000
SSR_CORRESPONDENCE_FAILURE	= 0x00800000
CP_CURRENT_DECAY_FAILURE	= 0x01000000
CP_CURRENT_RISE_FAILURE	= 0x02000000
OSCILLATOR_FAILURE	= 0x04000000
FIRMWARE_INTEGRITY_FAILURE	= 0x08000000

Chapter 8. DSP-C Diagnostic Dashboard (Preliminary)

8.1. Diagnostic Dashboard – Normal Unoccupied

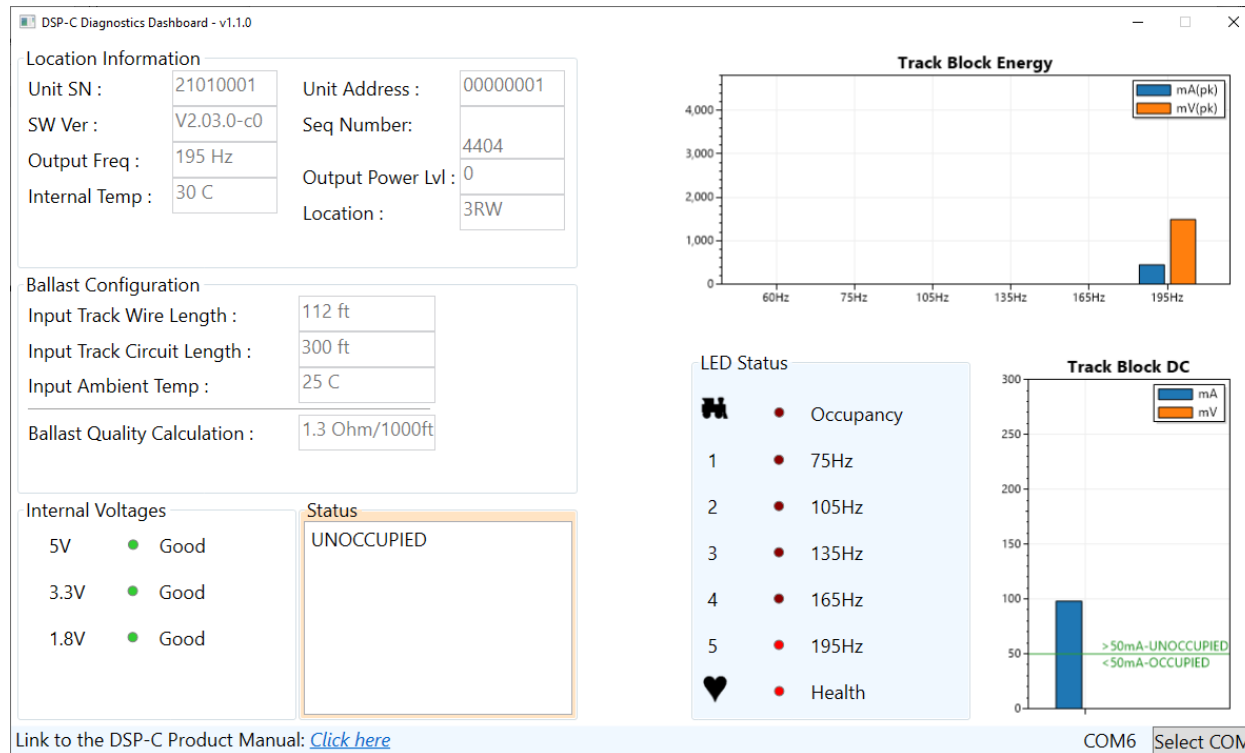


Figure 8-1. Screenshot – Normal Unoccupied

8.2. Diagnostic Dashboard – Normal Occupied



Figure 8-2. Screenshot – Normal Occupied

8.3. Diagnostic Dashboard – Unoccupied, Simulated Bad IJ between a 105 Hz DSP-C and a 195 Hz DSP-C

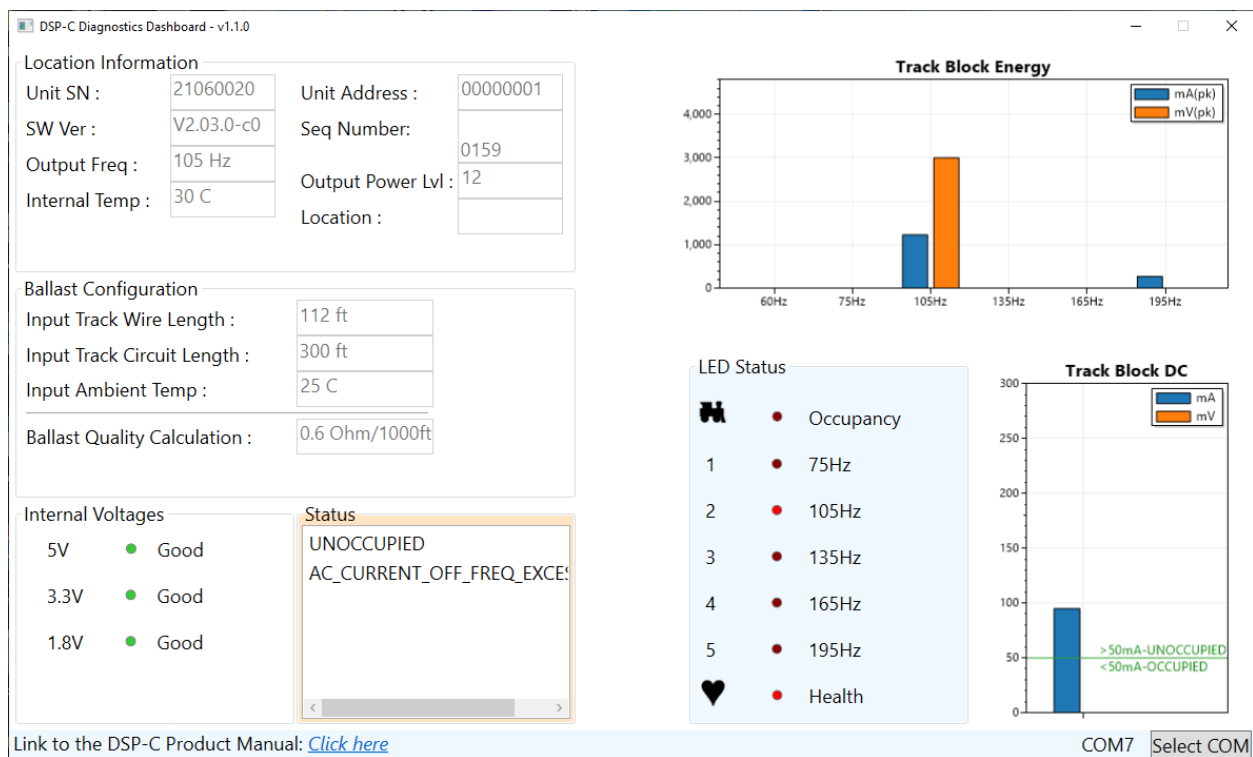


Figure 8-3. Screenshot – Simulated Bad IJ between a 105 Hz DSP-C and a 195 Hz DSP-C

8.4. Diagnostic Dashboard – Unoccupied, Grounded DSP-Cs (Corwith)

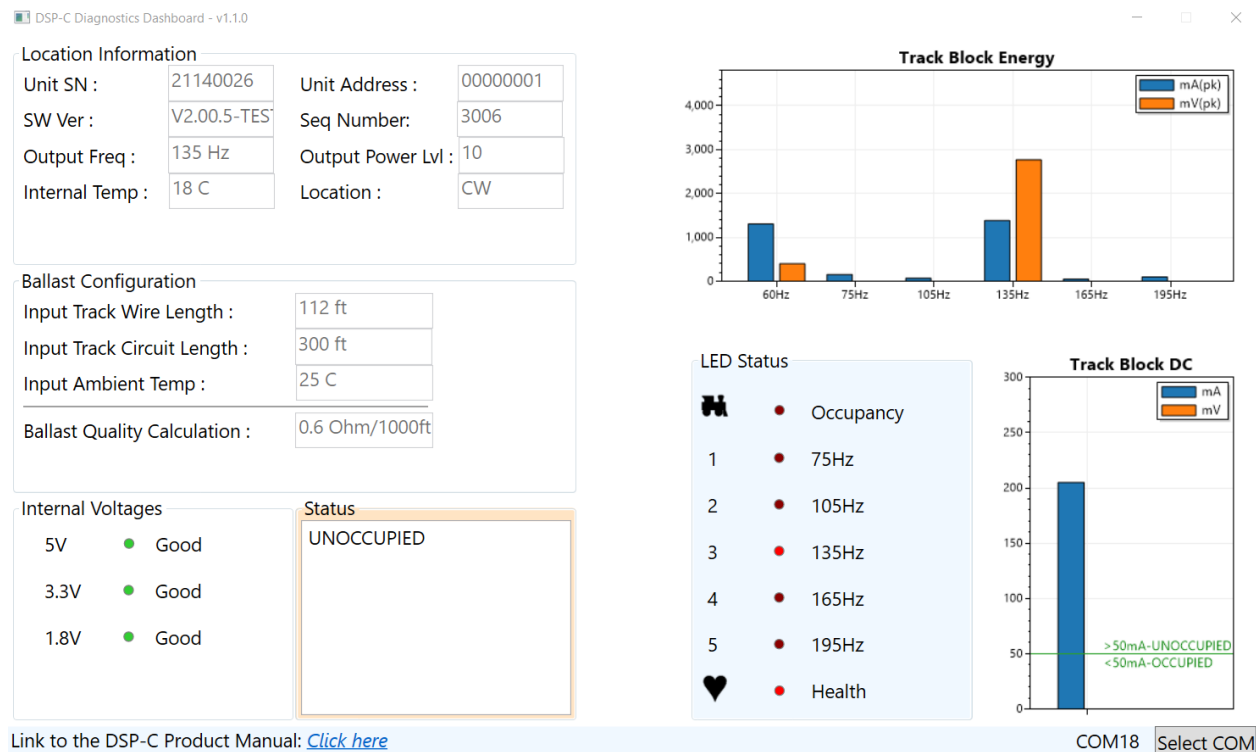


Figure 8-4. Screenshot – Unoccupied, Grounded DSP-Cs (Corwith)