

CG Power and Industrial Solutions Limited

Railway Transportation- Traction Electronics

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Smart solutions.
Strong relationships.

Our Ref: CLW/SW/IGBT-SR/2024/Aug 16

Date: 16-08-2024

**To,
The Dy. Chief Electrical Engineer, (C D&D)
Chittaranjan Locomotive Works
Chittaranjan.**

Kind Attention: Shri Pankaj Kumar (Dy.CEE-D&D-I /CLW)

SUB: Permission for uploading software version 30 (1E) in CGPISL make IGBT Traction Converter

Ref. – i) RPM letter no. M/RS/RPM/221/III/05/E8 dtd: 20.04.2024

ii) RPM letter no. M/RS/RPM/221/III/08/E8 dtd: 13.08.2024

Dear Sir,

This is with reference to reliability improvement of our IGBT based Traction Converter and as per the letter mentioned in reference, the issue observed during neutral section has been corrected by modifying changes in switching management of the rectifier IGBTs and this will also support for main contactor to remain in closed condition during neutral section negotiation until the DC link voltage goes below pre-charge value. This modified software is uploaded in loco 30422 on 24/7/2024 and performance found to be satisfactory and improved then existing one.

This Software also incorporate the required subset functionality for the Energy saving mode, while the actual activation and deactivation of energy saving mode depends on VCU software.

Enclosed herewith the 8D report for the issue as per ref (i) of Loco 37207.

Hence we request for the approval and permission to upload this software with our equipped IGBT Traction Converter.

Thanking you and assuring for best services to Indian Railway all the times.

Thanking You.

**With Best Regards,
Krishan Junwani
Sr. Manager – Design**

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सं/No.M/RS/RPM/221/III/05/E8

दिनांक/Date 20.04.2024

**M/s. CG power and industrial solutions limited.
Drives & automation division,
Plot no 9, phrase 2, Industrial Area,
Mandideep, Bhopal-462046.**

Sub: Issues in CGL IGBT Traction Converters – Reg

On 15.04.2024 while working with Train No. 12616, loco no.37207 failed enroute with OCR action and Both bogies also isolated due to Rectifier over current detected by all the four H-Bridges of both the Traction converters (SLG1 & SLG2). After resetting the OCR and VCU reset done by LP, both the traction converters (SLG1 & SLG2) came back to service and the train worked up to destination without any trouble. The detention/ loss of punctuality featured in Railway Board Punctuality/Asset failure.

On arrival of Loco at ELS/RPM, Loco checked and found normal with both traction converters in Service. No abnormalities found in the equipment available in HT circuit and DGA of Transformer Oil found normal. Both the converters are checked visually and functionally and found normal. MCR relay tested in test bench and found working normal @ set value of current i.e., 3.3 A.

On analysing DDS data, SR data and LP report the following were observed,

1. After Passing Neutral section LP experienced VCB not closing with Popup Fault message F0102P1 VCB stuck in OFF position (but DDS record was not available) and displayed F0108P1 (primary current above maximum).
2. It is noticed that Rectifier Line 1 & 2 over current logged from both the SR's for several times during VCB reclosing time. As per SR data at the time of OCR action, input inrush current has gone beyond 960 A (Figure 2) and rectifier over current also logged (Figure 3).
3. This is because in **CGL Traction Converter's (SR's)**, when every time VCB opens, **Line contactors get opened and DC link discharged through MUB resistor (Figure 1)**. When VCB is closed again, for immediate charging of DC link capacitor (since DC link voltage is too low) rectifier draws over current instantaneously (above 2400 A) and causing heavy inrush primary current (above 960 A). This has caused OCR action in the above failed locomotive.

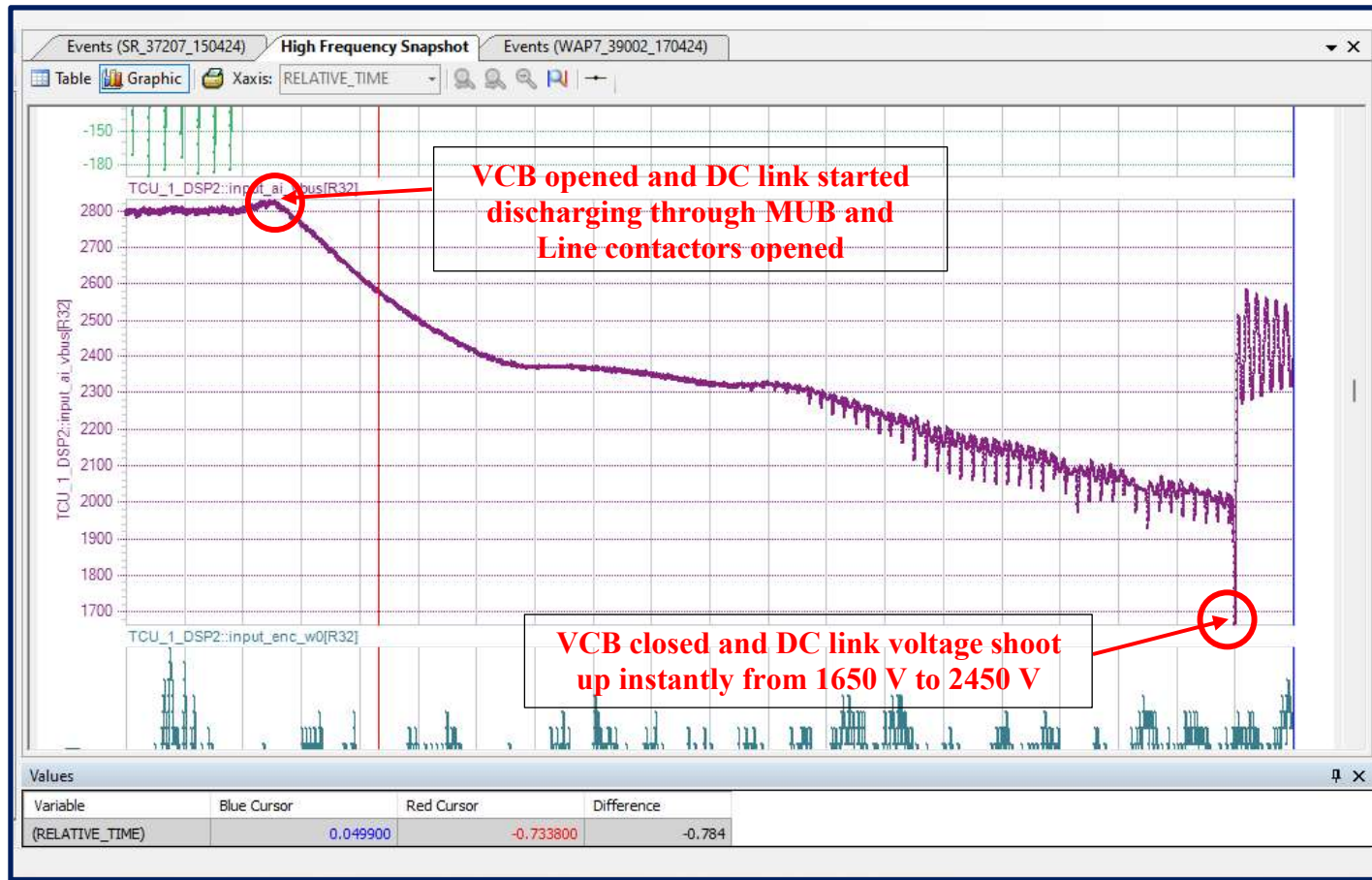


Figure 1: DC-link voltage at the time of OCR action

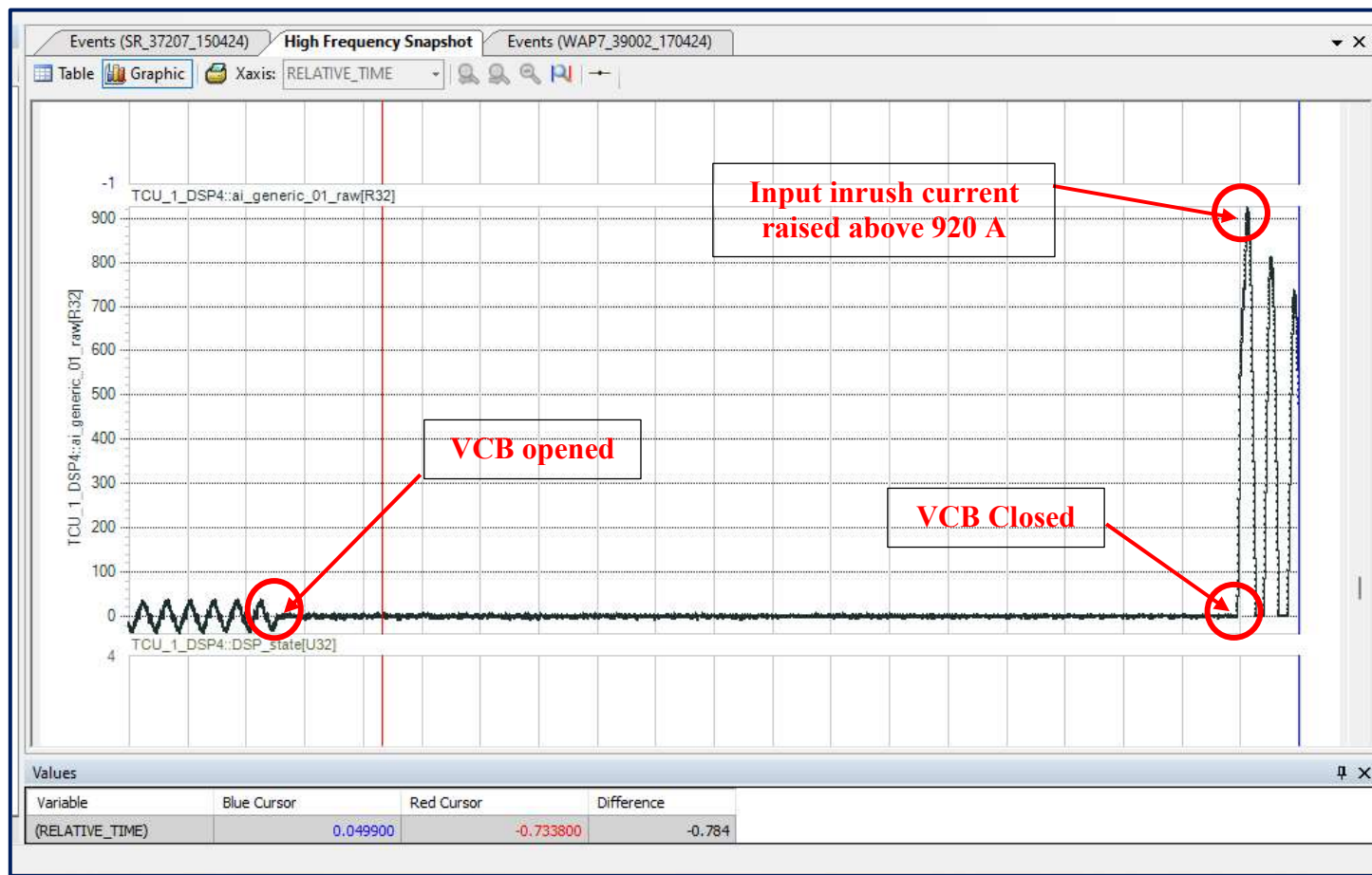


Figure 2: Input Current at the time of OCR action

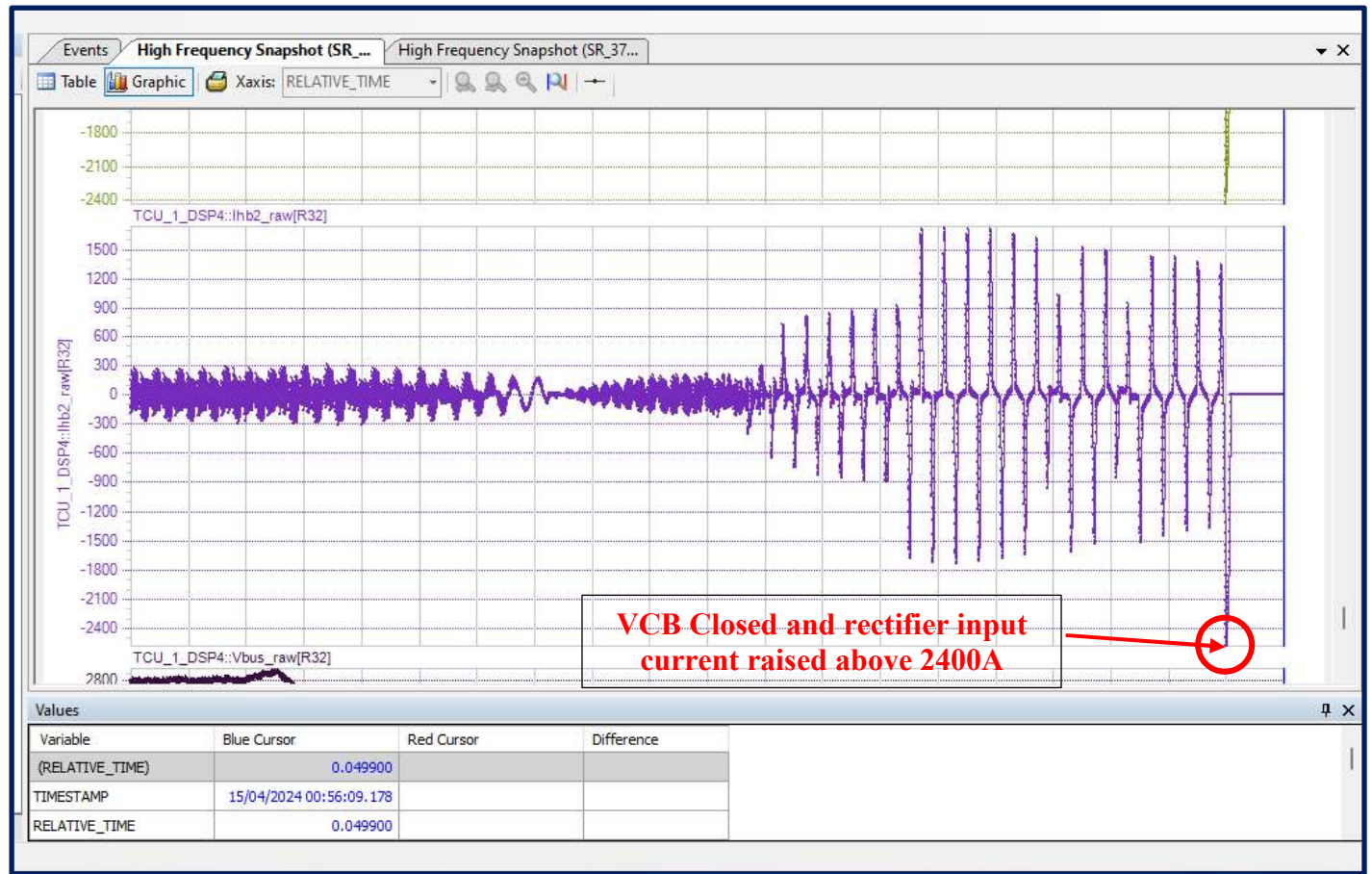


Figure 3: Rectifier Current at the time of OCR action

From the above graphs it is inferred that DC link voltage is discharging after opening the VCB and pulsing of the rectifier H-bridge immediately after closing of the VCB in such a manner that drawing of inrush current by DC link capacitors (DC link voltage set value 2450 V – actual DC voltage at the instant of VCB closed 1650 V(Figure 1)). This sudden increase in the DC link voltage causes over current to flow in the rectifiers of both the Traction converters and hence the primary circuit. In MICAS and other propulsion DC link voltage is maintained and Line contactors remain in closed condition during VCB opening and DC link voltage will be discharged only at the time of protective shutdown.

Hence it is advised to analyse the above issue in the CGL IGBT SR and come up with suitable changes in the CGL SR software.

(Handwritten signature)

**Naga Sreenivasu Rongala,
Sr.DEE/RS/RPM**

Copy To:

CELE/SR	- for kind information
EDSE/RDSO	- for kind information
CEE/CLW/CRJ	- for kind information



सं/No.M/RS/RPM/221/III/08/24/E8

दिनांक/Date 13.08.2024

CELE/SR

Sub: Performance of CGL IGBT software Version 30 Beta 04 -reg

CGL has come up with a new software version 30 Beta 04 to address the issue Line contactors opening and DC link voltage discharging immediately after opening the VCB in neutral section. This software version 30 Beta 04 has been started loading in locos from date 24-07-24 onwards for trial basis and completed in 10 locos. After running for 15 days in mainline the VCU and SR data of loco no. 30422 has been analyzed and no abnormalities were noticed in the data. The performance of new software is satisfactory. However, the following Minor issues are yet to be addressed/checked in this software are,

1. Currently DC link voltage is maintained on VCB opening/closing only after loco speed reaches above 5 Kmph. Below 5 Kmph and at stand still condition if VCB opened Line contactors are opening and DC link voltage is discharging and after closing VCB DC link capacitor has to go to charging cycle which causes IGBT power modules to undergo heavy inrush current. So, during routine test at shed/trip sheds, the new software is not helping to safe guard modules. So, software has to be corrected such that DC link voltage should not discharge immediately irrespective of the running speed.
2. Locking of traction converters to be checked and verified when severe fault like IGBT error is being detected.

It is requested to advise CLW to validate the release notes and give approval for loading the software in remaining fleet of locos.

6/12/24 13.08.24
Naga Sreenivasu Rongala,
Sr.DEE/RS/RPM

Copy To:

Dy.CEE/D-II/CLW/CRJ - for kind information and necessary action

8D Report

JIRA issue CLW – 874

After-sales department

Produced

Rameshwar Goswami

Service Engineer

23-07-2024

Reviewed

Parashuram Naganur

Service Manager

23-07-2024

Approved

Ion Sagarzazu

After Sales engineering

23-07-2024

*The latest version of this document is filed in CAF Power & Automation servers. Every printed copy is an **uncontrolled copy**.*

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1. Control of Edition

Version	Reason	Date
00	First edition	2024-07-23

2. Acronyms

CAF	Construcciones Auxiliares de Ferrocarriles
CAF P&A	CAF Power & Automation
CGPISL	CG Power and Industrial Solutions Limited
CLW	Chittaranjan Locomotive Works
JIRA	Issue collection web application
SW	Software
IGBT	Insulated Gate Bipolar Transistor
SNS	Snapshot
VCB	Vacuum Circuit Brakes (HSCB)
VEGA	Vehicle Electronics for Generic Applications
SR-SLG	Traction Converter
HF	High Frequency
LF	Low Frequency

3. (D1) Define the team

Company	Department
CAF	After Sales Engineering
CGPISL	After Sales Engineering

4. (D2) Analysis and description of the issue

The issue description is taken from the JIRA application web server.

Issue title	LOCO 37207
Date and time:	27/03/2024
Unit number:	37207
Shed:	RPM - Royarpuram
Kilometers:	-
Unit type:	WAP-7
SW Version:	v29
Affects service:	2- Service Delay
Description:	Primary current above maximum and SLG1&2 rectifier over current message logged in Line 1&2.

5. (D3) Immediate containment actions

The first immediate action was to note the incident details so that it could be analyzed once the locomotive reached the nearest shed, as both SR-s showed over currents that were recovered within seconds with no loss of full power availability.

- SR 1 serial number: CGPI1920419-P142
- SR 2 serial number: CGPI1920420-P412

6. (D4) Definition and analysis of the root cause

According to the VEGA (SR) logs and driver complain, the incident occurred on March 27, 2024, where both SLG traction converters reported a rectifier line over current on the DDU apparently after leaving a neutral zone.

27/03/2024 21:50:08.907	TCU_1_crc_log_ALAR...	Overcurrent in bridge H1	ERROR_CURRENT_BRIDGE_H1_MAX
27/03/2024 21:50:08.907	TCU_1_crc_log_ALAR...	Overcurrent in bridge H2	ERROR_CURRENT_BRIDGE_H2_MAX
27/03/2024 21:50:08.915	TCU_1_rc_log_ALAR...	Rectifier is in FAULT state	INFO_RCC_ENTER_FAULT
27/03/2024 21:50:09.058	TCU_2_crc_log_ALAR...	Overcurrent in bridge H1	ERROR_CURRENT_BRIDGE_H1_MAX
27/03/2024 21:50:09.058	TCU_2_crc_log_ALAR...	Overcurrent in bridge H2	ERROR_CURRENT_BRIDGE_H2_MAX
27/03/2024 21:50:09.066	TCU_2_rc_log_ALAR...	Rectifier is in FAULT state	INFO_RCC_ENTER_FAULT

Here is the full sequence written and graphed below:

1. The SLG received from the FLG the MVCB_OnFast = 0 signal so a FastOpen request is sent to the SLG from the FLG.
2. After a few ms, the SLG received the confirmation from the FLG that the VCB was open (MVCB_On=0).
3. Despite of receiving the OnFast request and the confirmation from the FLG that the VCB was open.

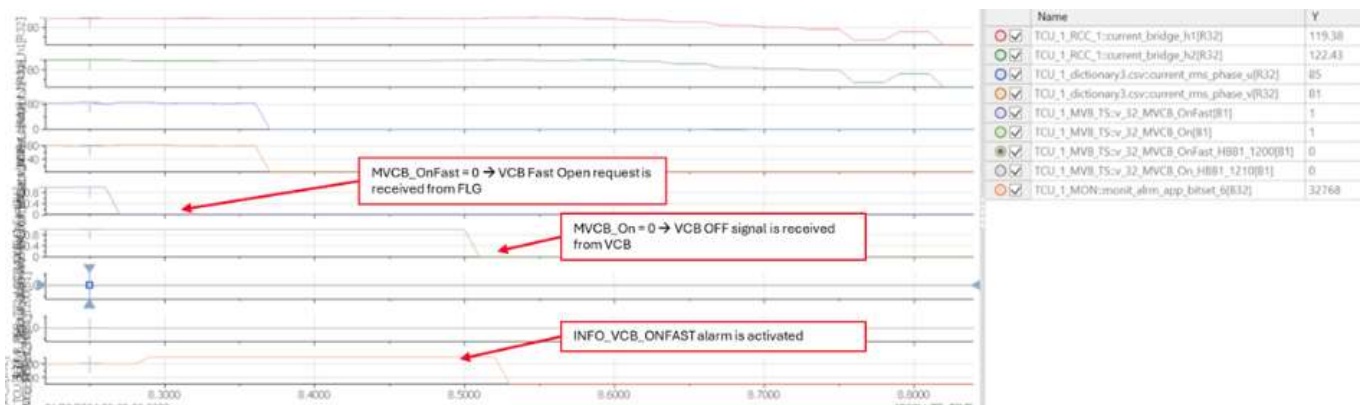


Figure 1. Over Current LF SNS background.

4. When the FLG sent to the SLG a FastOpen request the SLG prepared itself to open the VCB and started stopping all the converters starting from the inverter.
5. After 1 second from the OnFast request, a catenary/rectifier input phase overcurrent situation happened. In that moment, the SLG (TCU) detects the over-current situation and protects as expected.

From the data obtained from the high frequency SNS of the SLG, it is observed that the catenary or OHL voltage does not drop at any time as it should in a neutral zone noticed by the driver. For this reason, the RCU IGBT-s are kept switching after VCB opening. Otherwise, the motor currents are switched off as soon as the opening signal is received from the driver.

The SLG contactors are kept closed, maintaining the DC-Link voltage which is still discharging by the permanent discharge resistors (safety protection).

1s after the neutral zone notice and the VCB closure, with no OHL loss, as the rectifier IGBT-s are still switching, the unexpected current peak and instantaneous loss of both SLG-s occurs, which are then able to recover and become operational again after a few seconds.

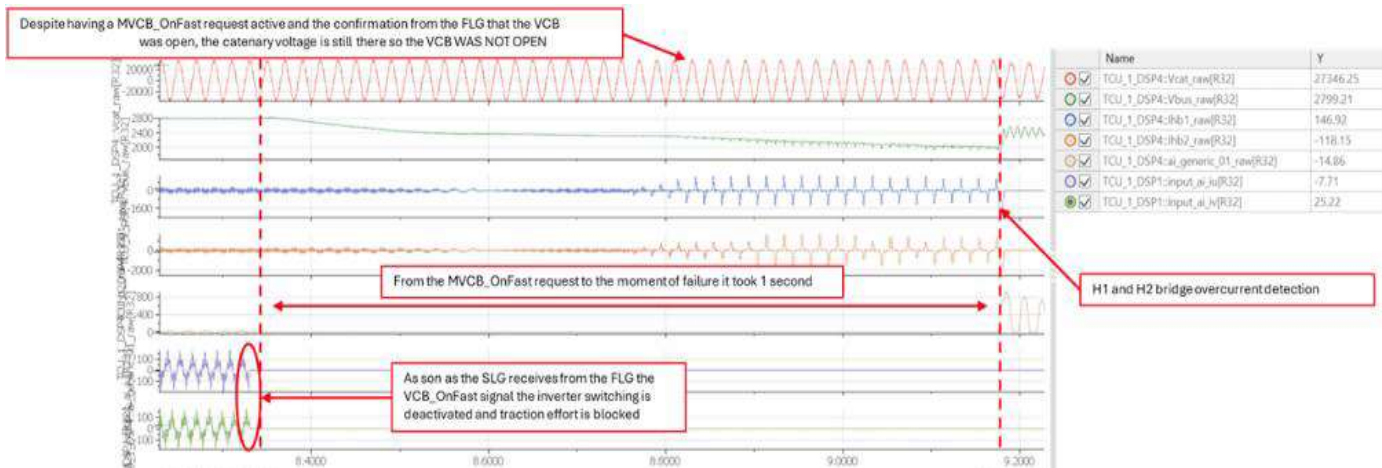


Figure 2. Over Current HF SNS background.

Variables	Description
1. vcat_raw	OHL voltage
2. vbus_raw	DC Link voltage
3. ihb1_raw	H1 bridge current
4. ihb2_raw	H2 bridge current
5. ai_generic_01_raw	Primary Current
6. input_ai_iu	Phase U Current
7. input_ai_iv	Phase V current

Table 1. Figure 2 variable description.

7. (D5) Identify corrective action

I. New SLG SW version 30 in progress.

- In a noticed neutral zone, the switching management of the rectifier IGBT-s has been modified, stopping them as soon as the neutral zone signal is received.
- The SLG main contactor will remain closed until the DC-Link voltage drops below 1700V. In case of leaving the neutral zone before the voltage drops below 1700V, the SLG will be recovered by starting to switch with the main contactor still closed.
- If due to the neutral zone the DC-Link voltage drops below 1700V, the SLG will open contactors, completely discharging the DC-Link and requiring the normal bus charging sequence to be done.

8. (D6) Implement corrective action

I. Validate the new SLG SW version 30 to be uploaded on fleet.

The upgrade to this SW version 30 will improve the management of the DC-link, avoiding rectifier line over currents after a real or unexpected neutral zone.

9. (D7) Actions to prevent recurrence

The proposed **Corrective Actions prevent the recurrence** of the problem.

10. (D8) Close the issue

8D PHASE	STATUS
D1: DEFINE THE TEAM	✓ completed
D2: ANALYSIS AND DESCRIPTION OF THE ISSUE	✓ completed
D3: IMMEDIATE CONTAINMENT ACTIONS	✓ completed
D4: DEFINITION AND ANALYSIS OF THE ROOT CAUSE	✓ completed
D5: IDENTIFY CORRECTIVE ACTION	✓ completed
D6: IMPLEMENT CORRECTIVE ACTION	✓ ongoing
D7: ACTIONS TO PREVENT RECURRENCE	✓ ongoing

- The **Analysis** and **Action Plan** will be **reviewed** and closed **together with CG**.