APD ENGINEERING

BHP NEWMAN TOWNSHIP ELECTRICITY SUPPLY ANNUAL COMPLIANCE REPORT 2021/2022

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REVISION HISTORY

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EXECUTIVE SUMMARY

BHP own and operate numerous iron ore mines located in the Pilbara region of Western Australia. The township of Newman has located approximately 1,200 km to the north of Perth and the town's electricity network is owned, governed, and operated by BHP Supply Authority (BHPSA).

In accordance with Western Australia Electricity Industry Code 2005 (the Code), the electrical supply authority must publish a report setting out the information described in Schedule 1 of the Code, with respect to each year ending on the 30th of June. This document, known as the A*nnual Compliance Report*, is to provide the full suite of information outlined in Schedule 1 of the Code, pertaining to Network Quality and Reliability of Supply.

The methodology adopted to examine compliance/non-compliance with the Code utilises the following sources of information:

- Power quality data measured from the Newman 0.415 kV network over a period of seven calendar days or more: and
- Outage data and other relevant information provided by the network operator (BHPSA).

The Code is written in four parts plus a reporting-requirements schedule:

- *Part 1*: Preliminary information associated with terms of reference.
- *Part 2*: Quality and reliability standards (further partitioned into 4 *divisions*).
- *Part 3*: Payment to customers for lack of regulatory adherence.
- *Part 4*: Incidental duties as a Supply Authority.
- *Schedule 1*: Information to be published in this report.

This Annual Compliance Report presents the relevant parts of the Code listed above, in particular:

- Power quality criteria pertaining to Newman's distribution network (measured across eight feeders supplying the town, four of which originating from the Township Zone Substation and the remaining four originating from the South Town Zone Substation); and
- The reportable requirements as outlined in Part 2 and Schedule 1 of the Code, for the 2021/22 Financial Year (FY).

With regards to the site measurements, the *average* values of electrical parameters were logged over a period of seven days, at 2-minute intervals. PQ indices were then calculated and found to be, in large, well within the limits stipulated by the Code. That is, the *averages* of the following parameters are proven to meet the Code's requirements:

- *Voltage Flicker (short- and long-term criteria);*
- RMS Voltage Magnitude.
- Power System Frequency; and
- *Voltage Total Harmonic Distortion (U-THD)*.

The following was noticed from results of PQ recordings:

- Voltage Flicker: A significant improvement in the number of short-term and long-term voltage fluctuation limit breaches described in AS61000:2001 was identified. No breaches were recorded compared to the logging periods for the previous five years.
- RMS Voltage Magnitude: A relatively high number of voltage level breaches (fifteen undervoltage breaches) were observed compared to the logging periods for the previous four years. However, majority of these seem to have been linked to a single network event.
- Power System Frequency: No under-frequency breaches of the limits described in the Electricity Act of 1945 Section 25(1)(d) were recorded during the logging period.
- U-THD: Zero U-THD breaches of the limits described in Part 2, Division 1, Section 7 of the Code were recorded during the logging period. There is an improvement in the breaches of U-THD compared to the previous three years.

Reportable parameters for Newman Township Electricity Supply over the 2021/2022 FY (as outlined in 'Schedule 1' of the Code) are presented below:

- >12-hour interruptions: In 2021/2022, no network interruption which exceeded 12 hours was recorded. Temporary generators were used to supply customers during the transformer T81 outage.
- No small use customers were disconnected from the network more than the maximum number of times permitted by the Code (i.e., the limit of 16 times per year).
- No power quality and reliability-related complaints were received from customers during FY 2021/2022.
- The key reliability indices are calculated as listed below:
    - *Customer Average Interruption Duration Index (CAIDI)* of 75.3 minutes – CAIDI is a measure of the average outage duration or average outage restoration time. [It is defined as "The sum of the durations of sustained[1] customer interruptions divided by the total number of sustained customer interruptions"].
    - *System Average Interruption Frequency Index (SAIFI)* of 0.95 interruptions – SAIFI is the average number of interruptions per customer served. [It is defined as "the total number of sustained customer interruptions divided by the total number of customers served"].
    - *Average Service Availability Index (ASAI)* of 99.986% – ASAI is the perceived availability of the network to the customers.
    - *System Average Interruption Duration Index (SAIDI)* of 71.41 minutes – SAIDI is the average outage duration for each customer served. [It is defined as "the sum of durations of sustained customer interruptions divided by the total number of customers served"].

[1] By "sustained" we mean only interruptions lasting 1 minute or longer. (Momentary) Outages lasting less than 1 minute are not included in the index. Planned outages and some other types of outages are also excluded from this index. This note also applies to the SAIFI and SAIDI indices.

In summary, the metering data collected from the 16 locations throughout the Newman Township network indicate that the power quality is, in large, within the limits stipulated by the Code.

While the reliability indices have improved since 2020/21, the 2021/22 performances (with possibly the exception of ASAI) have departed significantly from their best performance over the recent 5-year period. With this is in mind, it is recommended that the cause(s) of this issue is monitored with a view of seeking opportunities for improvement.

Notwithstanding this, the overall network performance is still considered to be satisfactory. The relative deterioration in reliability indices can be attributed to the forced outages and events outside of BHPSA's control. As such, this report finds the reliability and quality of the supply for Newman Township network in compliance with the Code's requirements, with further monitoring of areas of the network recommended to ensure quality and reliability is maintained in the upcoming years.

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1. INTRODUCTION

The township of Newman is located approximately 1,200 km to the north of Perth; the town's electricity network is owned, governed, and operated by BHP Supply Authority (BHPSA). The network encompasses the township of Newman, Newman Airport, Capricorn Roadhouse, town water supply bore field, Mt Whaleback iron ore mine, and several smaller satellite mines in the adjacent areas.

At present, the township of Newman includes 2,506 registered premises comprised of a mixture of residential and commercial customers.

According to Western Australia Electricity Industry (Network Quality and Reliability of Supply) Code 2005 (the Code), an electricity distributor must prepare a report setting out the information described in Schedule 1 of the Code, in respect to each year ending on the 30th of June.

This Annual Compliance Report presents all information required by "Schedule 1 – Information to be published", relating to supply of electricity, for the period of 1st July 2021 to 30th June 2022. Measurement information is based on sampled data and outlined in Section 6, whereas outage information is based on data provided by BHPSA and outlined in Section 7.

The compliance statistical analysis has focused solely on Newman Township and the key infrastructure adjacent to the township. The electrical network supplying the BHP mining operation and the surrounding mine leases have not been assessed in this report.

2. ASSUMPTIONS

The terminologies used throughout this compliance report are as defined in the Western Australia Electricity Industry (Network Quality and Reliability of Supply) Code 2005 (the Code).

The logging information gathered over the limited period is indicative of the performance of the network over the complete financial year (2021/2022 FY).

3. METHODOLOGY

The electricity supply compliance review entailed the following processes:

1. Retrieving data from permanent (SEL735) PQ loggers installed at the beginning and end of the 11 kV feeders emanating from the Town and Southtown Substations (a total of 16 loggers, 2 for each feeder were installed). Each PQ logger is on the low voltage (LV) side of pad-mounted transformers. The measuring period for each location lasted around 7 days, between Jan to May 2022. The PQ measurements were undertaken in accordance with AS 61000.4.30:2007, Annex A (Power Quality Measurements).
2. Interpretation and analysis of the logged PQ data using SEL735 PQ meters.
3. The receipt of the following information from BHPSA:
    - Network outage information for planned and forced outages for the Newman Township during the 2021/2022 FY as well as information on customer complaints.
    - Expenditure information on programs directed to improve/maintain reliability or power quality of the network.
4. Identification of any breaches of the Code's provisions and Electricity Act 1945.
5. Statistical analyses and review of network performance.
6. Preparation of a compliance report that fulfils the requirements outlined in the Code.

4. NEWMAN TOWNSHIP PQ MONITORING

4.1. PQ DEVICE SPECIFICATION

The equipment used to undertake the PQ logging was a mixture of permanently installed SEL735 PQ meters. The SEL devices can measure multiple waveforms and transient events simultaneously using 4 voltage channels and 4 current channels per device. The measurements obtained from the loggers are then extracted and analysed in csv format.

4.2. PQ DEVICE LOCATIONS AND IN-SERVICE PERIODS

A total of 16 PQ loggers were deployed across 16 locations on the Newman TC1, TC2, TC3, TC4, STS1, STS2, STS4 and STS6 feeders. The installation locations and times are as listed in **Table 1**. Figure 1 presents a colour-coded single line diagram of the eight Newman township feeders. Shaded circles indicate the locations at which the PQ loggers were temporarily located. All loggers were installed on pad-mount transformers (on the LV, or secondary side), due to the difficulty and safety issues of installing the loggers on pole-top transformers.

Table 1 | PQ Logger Locations

ZONE SUB	FEEDER NAME	START/END OF FEEDER	SUBSTATION NAME	DATE INSTALLED	DATE REMOVED
Township	TC1	Start	PS28	24/01/2022 00:00	31/01/2022 00:00
		End	PS68	24/01/2022 00:00	31/01/2022 00:00
	TC2	Start	PS10	24/01/2022 00:00	31/01/2022 00:00
		End	PS14	24/01/2022 00:00	31/01/2022 00:00
	TC3	Start	PS108	24/01/2022 00:00	31/01/2022 00:00
		End	PS69	24/01/2022 00:00	31/01/2022 00:00
	TC4	Start	PS115	24/05/2022 00:00	31/05/2022 00:00
		End	PS15	24/01/2022 00:00	31/01/2022 00:00
South Town	STS1	Start	PS94	24/01/2022 00:00	31/01/2022 00:00
		End	PS25	24/01/2022 00:00	31/01/2022 00:00
	STS2	Start	PS60	24/01/2022 00:00	31/01/2022 00:00
		End	PS70	20/04/2022 00:00	27/04/2022 00:00
	STS4	Start	PS111	24/01/2022 00:00	31/01/2022 00:00
		End	PS44	24/01/2022 00:00	31/01/2022 00:00
	STS6	Start	PS129	24/01/2022 00:00	31/01/2022 00:00
		End	PS122	24/01/2022 00:00	31/01/2022 00:00

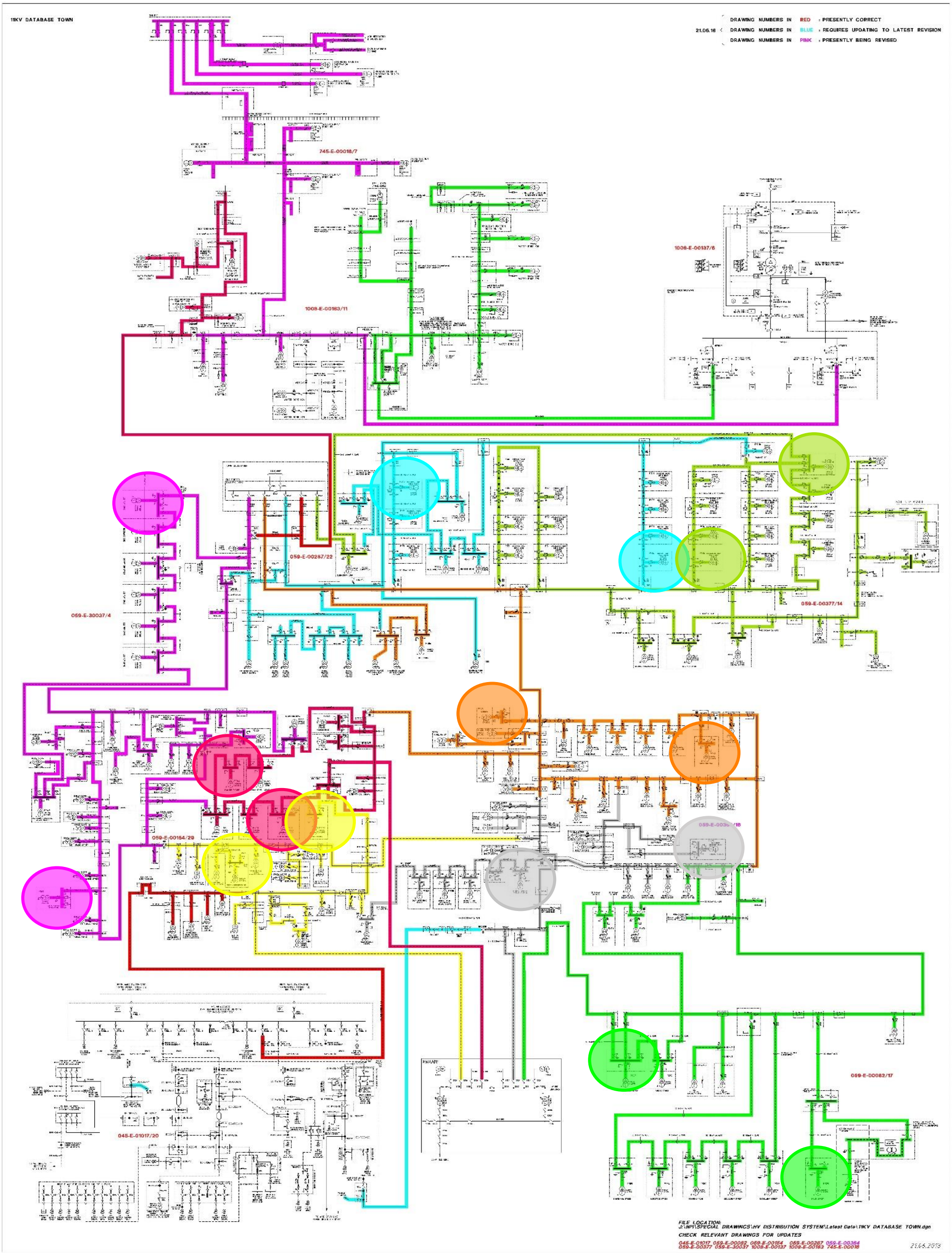


Figure 1 | Single Line Diagram of the Newman township (shaded circles indicate the location of PQ loggers)

4.3. PQ DEVICE SETUP

4.3.1. SEL735

The SEL735 PQ meters are permanently installed meters and have been setup by BHP. These were installed at 16 of 16 feeder locations.

5. COMPLIANCE REQUIREMENTS

This section summarises the *Compatibility Levels* to which a 'Distributors' electrical network is to comply, as outlined in the Code.

5.1. VOLTAGE FLUCTUATIONS

5.1.1. FLICKER

The Code specifies that flicker shall comply with long- and short-term flicker 'compatibility levels' as per AS 61000:2001. The compatibility levels are shown below in Table 2, and are a measure of the voltage quality limits over a 10-minute interval for short (P_{ST}) and long term (P_{LT}) flicker, respectively.

Table 2 | Short and long-term flicker limits

COMPATIBILITY LEVEL	VALUE
Short Term (P_{ST})	1.0
Long Term (P_{LT})	0.8

5.1.2. VOLTAGE LEVELS

In accordance with AS 3000:2018 the voltage levels of the electrical network must be maintained between +10%/-6% of the nominal 240 V single-phase supply voltage.

5.2. FREQUENCY

The Code specifies that the frequency fluctuation shall adhere to the Electricity Act 1945 with the level to be maintained at ±2.5% of 50 Hz.

5.3. VOLTAGE TOTAL HARMONIC DISTORTION

Part 2, Division 1, Section 7 of the Code specifies that the voltage total harmonic distortion (U-THD) must, as far as is reasonably practical not exceed 8%. Individual odd and even harmonic components are not to exceed the values shown below in **Table 3**.

Table 3 | Harmonic compatibility levels (in percentage of nominal voltage)

EVEN HARMONICS		ODD HARMONICS (MULTIPLES OF 3)		ODD HARMONICS (NON-MULTIPLES OF 3)	
ORDER (H)	HARMONIC VOLTAGE (%)	ORDER (H)	HARMONIC VOLTAGE (%)	ORDER (H)	HARMONIC VOLTAGE (%)
2	2	3	5	5	6
4	1	9	1.5	7	5
6	0.5	15	0.3	11	3.5
8	0.5	21	0.2	13	3
10	0.5	>21	0.2	17	2
12	0.2			19	1.5
>12	0.2			23	1.5
				25	1.5
				>25	0.2 + 1.3(25/h)

5.4. POWER INDUSTRY RELIABILITY INDICATORS

As per Schedule 1, Clause 11 (a) to (d) of the Code, a few reliability indicators (e.g., interruption durations and number of interruptions) are required to be reported. To achieve the Code's requirement, the following standard utility reliability indices have been used.

5.4.1. CUSTOMER AVERAGE INTERRUPTION DURATION INDEX (CAIDI)

Customer Average Interruption Duration Index is defined as the sum of the duration of each sustained customer interruption (in minutes) divided by the total number of sustained customer interruptions.

$$CAIDI_{Minutes} = \frac{\sum Customer\ Interruption\ Durations}{\sum Customer\ Interruptions} = \frac{SAIDI}{SAIFI}$$

5.4.2. SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

System Average Interruption Frequency Index is defined as the sum of each sustained distribution customer interruption (number of interruption events) attributable to the distribution system divided by the number of distribution customers served.

$$SAIFI_{Minutes} = \frac{\sum Number\ of\ Sustained\ Distribution\ Customer\ Interruptions}{\sum Number\ of\ Distribution\ Customers\ Served}$$

5.4.3. AVERAGE SERVICE AVAILABILITY INDEX (ASAI)

Average Service Availability Index is the percentage of time that the service is available to the network customers in a reportable year.

$$ASAI_{Percent} = 1 - \frac{SAIDI_{Hours}}{8760}$$

5.4.4. SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

System Average Interruption Duration Index is defined as the sum of the duration of each sustained distribution customer interruption (in minutes) attributable to the distribution system divided by the number of distribution customers served.

$$SAIDI_{Minutes} = \frac{\sum Sustained\ Distribution\ Customer\ Interruption\ Durations}{\sum Number\ of\ Distribution\ Customers\ Served}$$

6. SITE MEASUREMENTS (PQ LOGGER DATA)

The following sections describe the results and notable PQ events recorded during the 2021/22 logging period for each of the eight feeders included in the audit.

6.1. FEEDER TC1

The PQ logger at the start of the TC1 feeder is located at the PS28 Library substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while the PQ logger at the end of the TC1 feeder is located at the PS68 Capricorn Oval substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Orange), TC1 originates from the Town substation. The TC1 feeder supplies a few older distribution substations.

6.1.1. FLICKER

The logged flicker data for the start and end of the TC1 feeder is shown from Figure 3 to figure 4 in Appendix A.2. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.1.2. VOLTAGE

The logged voltage level data for the start and end of the TC1 feeder is shown from Figure 3 to figure 4 in Appendix A.2. **Table 4** below shows the recorded breach events during the logging period.

Table 4 | Feeder TC1 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
TC1 Start (PS28)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=222.13 V, W=222.06 V, B=218.92 V
TC1 End (PS68)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=220.74 V, W=224.19 V, B=224.09 V

6.1.3. FREQUENCY

The logged frequency data for the start and end of the TC1 feeder is shown from Figure 7 to Figure 8 in Appendix A.1. There were no recorded frequency limit events causing the frequency level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.1.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the TC1 feeder is shown from Figure 9 to Figure 10 in Appendix A.2. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.1.5. HARMONICS

The logged harmonic data for the start and end of the TC1 feeder is shown from Figure 11 to Figure 12 in Appendix A.2. No non-compliant harmonics were recorded for the recording period.

6.2. FEEDER TC2

The PQ logger at the start of the TC2 feeder is located at the PS10 McLennan Drive substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while PQ logger at the end of the TC2 feeder is located at the PS14 Bondini Drive substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Cyan), TC2 originates from the Town substation.

6.2.1. FLICKER

The logged flicker data for the start and end of the TC2 feeder is shown from Figure 13 to Figure 14 in Appendix A.2. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.2.2. VOLTAGE

The logged voltage level data for the start and end of the TC2 feeder is shown from Figure 15 to Figure 16 in Appendix A.2. Table 5 below shows the recorded breach events during the logging period.

Table 5 | Feeder TC2 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
TC2 Start (PS10)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=221.59 V, W=223.74 V, B=223.65 V
TC2 End (PS14)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=221.30 V, W=223.63 V, B=223.92 V

6.2.3. FREQUENCY

The logged frequency data for the start and end of the TC2 feeder is shown from Figure 17 to Figure 18 in Appendix A.2. There were no recorded frequency limit events causing the frequency level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.2.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the TC2 feeder is shown from Figure 19 to Figure 20 in Appendix A.2. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.2.5. HARMONICS

The logged harmonic data for the start and end of the TC2 feeder is shown from Figure 21 to Figure 22 in Appendix A.2. No non-compliant harmonics were recorded for the recording period.

6.3. FEEDER TC3

The PQ logger at the start of the TC3 feeder is located at the PS108 Les Tutt Drive substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while the PQ logger at the end of the TC3 feeder is located at the PS69 Giles Avenue substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Purple), TC3 originates from the Town substation.

6.3.1. FLICKER

The logged flicker data for the start and end of the TC3 feeder is shown from Figure 23 to Figure 24 in Appendix A.3. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.3.2. VOLTAGE

The logged voltage level data for the start and end of the TC3 feeder is shown from Figure 25 to Figure 26 in Appendix A.3. Table 6 below shows the recorded breach events during the logging period.

Table 6 | Feeder TC3 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
TC3 Start (PS108)	R, W, B	26/01/2022 19:30:00	Undervoltage limit (-6%) exceeded: R=216.27 V, W=218.69 V, B=219.30 V
TC3 End (PS69)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=219.23 V, W=221.91 V, B=222.28V

6.3.3. FREQUENCY

Figure 27 to Figure 28 in Appendix A.3. *There were no recorded frequency limit* events causing the frequency level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.3.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the TC3 feeder is shown from Figure 29 to Figure 30 in Appendix A.3. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.3.5. HARMONICS

The logged harmonic data for the start and end of the TC3 feeder is shown from Figure 31 to Figure 32 in Appendix A.3. No non-compliant harmonics were recorded for the recording period.

6.4. FEEDER TC4

The PQ logger at the start of the TC4 feeder is located at the PS115 substation and was logged between 24/05/2022 00:00:00 and 31/05/2022 00:00:00 while the PQ logger at the end of the TC4 feeder is located at the PS15 Karrawan Way substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Green), TC4 originates from the Town substation.

6.4.1. FLICKER

The logged flicker data for the start and end of the TC4 feeder is shown from Figure 33 to Figure 34 in Appendix A.4. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.4.2. VOLTAGE

The logged voltage level data for the start and end of the TC4 feeder is shown from Figure 35 to Figure 36 in Appendix A.4. **Table 7** below lists the recorded breach events during the logging period.

Table 7 | Feeder TC4 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
TC4 End (PS15)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=219.99 V, W=222.49 V, B=222.47 V

6.4.3. FREQUENCY

The logged frequency data for the start and end of the TC4 feeder is shown from Figure 37 to Figure 38 in Appendix A.4. There were no recorded frequency limit events causing the frequency level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.4.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the TC4 feeder is shown from Figure 39 to Figure 40 in Appendix A.4. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.4.5. HARMONICS

The logged harmonic data for the start and end of the TC4 feeder is shown from Figure 41 to Figure 42 in Appendix A.4. No non-compliant harmonics were recorded for the recording period.

6.5. FEEDER STS1

The PQ logger at the start of the STS1 feeder is located at the PS94 Pardoo Street substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while the PQ logger at the end of the STS1 feeder is located at the PS25 Laver Street substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Lime Green), STS1 originates from the South Town substation.

6.5.1. FLICKER

The logged flicker data for the start and end of the STS1 feeder is shown from Figure 43 to Figure 44 in Appendix A.5. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.5.2. VOLTAGE

The logged voltage level data for the start and end of the STS1 feeder is shown from Figure 45 to Figure 46 in Appendix A.5. **Table 8** below shows the recorded breach events during the logging period.

Table 8 | Feeder STS1 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
STS1 Start (PS94)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=220.61 V, W=223.48 V, B=223.34 V

STS1 End (PS25)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=222.48 V, W=225.26 V, B=224.98 V

6.5.3. FREQUENCY

The logged frequency data for the start and end of the STS1 feeder is shown from Figure 47 to Figure 48 in Appendix A.5. There were no recorded frequency limit events causing the frequency level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.5.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the STS1 feeder is shown from Figure 49 to Figure 50 in Appendix A.5. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.5.5. HARMONICS

The logged harmonic data for the start and end of the STS1 feeder is shown from Figure 51 to Figure 52 in Appendix A.5. No non-compliant harmonics were recorded for the recording period.

6.6. FEEDER STS2

The PQ logger at the start of the STS2 feeder is located at the PS60 Forrest Avenue substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while the PQ logger at the end of the STS2 feeder is located at the PS70 Jabbarup Crescent Park substation and was logged between 20/04/2022 00:00:00 and 27/04/2022 00:00:00. As shown in Figure 1 (Grey), STS2 originates from the South Town substation.

6.6.1. FLICKER

The logged flicker data for the start and end of the STS2 feeder is shown from Figure 53 to Figure 54 in Appendix A.6. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.6.2. VOLTAGE

The logged voltage level data for the start and end of the STS2 feeder is shown in Figure 55 to Figure 56 in Appendix A.6. Table 7 below lists the recorded breach events during the Logging Period:

Table 9 | Feeder STS2 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
STS2 Start (PS60)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=221.99 V, W=224.28 V, B=224.27 V

6.6.3. FREQUENCY

Figure 57 to Figure 58 in Appendix A.6. There were no recorded frequency limit events causing the frequency level to breach the code's limit. (i.e., full compliance with the Code requirements).

6.6.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the STS2 feeder is shown from Figure 59 to Figure 60 in Appendix A.6. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.6.5. HARMONICS

The logged harmonic data for the start and end of the STS2 feeder is shown from Figure 61 to Figure 62 in Appendix A.6. No non-compliant harmonics were recorded for the recording period.

6.7. FEEDER STS4

The PQ logger at the start of the STS4 feeder is located at the PS111 Hilditch Avenue substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while the PQ logger at the end of the STS4 feeder is installed at the PS44 Iron Ore Parade substation and logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Red), STS4 originates from the South Town substation.

6.7.1. FLICKER

The logged flicker data for the start and end of the STS4 feeder is shown from Figure 63 to Figure 64 in Appendix A.7. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.7.2. VOLTAGE

The logged voltage level data for the start and end of the STS4 feeder is shown from Figure 65 to Figure 66 in Appendix A.7. Table 10 below shows the recorded breach events during the logging period.

Table 10 | Feeder STS4 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
STS4 Start (PS111)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=215.35 V, W=217.76 V, B=218.10 V
STS4 End (PS44)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=219.96 V, W=222.39 V, B=222.53 V
STS4 Start (PS111)	R, W	30/01/2022 07:40:00	Undervoltage limit (-6%) exceeded: R=223.83 V, W=224.59 V

6.7.3. FREQUENCY

The logged frequency data for the start and end of the STS4 feeder is shown from Figure 67 to Figure 68 in Appendix A.7. There were no recorded frequency limit events causing the frequency level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.7.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the STS4 feeder is shown from Figure 69 to Figure 70 in Appendix A.7. There were no recorded voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.7.5. HARMONICS

The logged harmonic data for the start and end of the STS4 feeder is shown from Figure 71 to Figure 72 in Appendix A.7. A summary of non-compliant harmonics and the scale of non-compliances is shown in Figure 2.

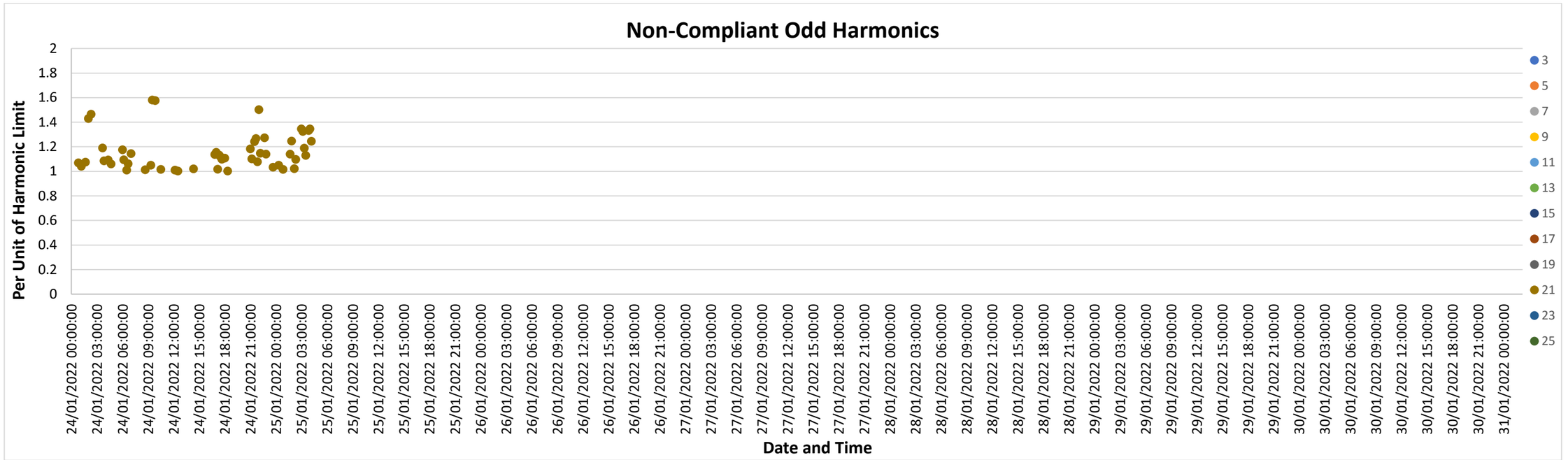


Figure 2 | Feeder STS4 (Start) - Non-Compliant Even Harmonics

6.8. FEEDER STS6

The PQ logger at the start of the STS6 feeder is located at the PS129 Moondoorow Street substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00 while the PQ logger at the end of the STS6 feeder is located at the PS122 Administration substation and was logged between 24/01/2022 00:00:00 and 31/01/2022 00:00:00. As shown in Figure 1 (Yellow), STS6 originates from the South Town substation.

6.8.1. FLICKER

The logged flicker data for the start and end of the STS6 feeder is shown from Figure 73 to Figure 74 in Appendix A.8. There were no recorded flicker limit events causing the flicker level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.8.2. VOLTAGE

The logged voltage level data for the start and end of the STS4 feeder is shown from Figure 75 to Figure 76 in Appendix A.8. **Table 11** below shows the recorded breach events during the logging period.

Table 11 | Feeder STS6 Voltage Breach Event Details

LOCATION	PHASE(S)	DATE AND TIME	VOLTAGE EVENT DETAILS/MAGNITUDE
STS6 Start (PS129)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=216.03 V, W=218.50 V, B=218.52 V
STS6 End (PS122)	R, W, B	26/01/2022 19:40:00	Undervoltage limit (-6%) exceeded: R=221.58 V, W=224.15 V, B=224.06 V

6.8.3. FREQUENCY

Figure 77 to Figure 78 in Appendix A.8. There were no recorded frequency limit events causing the frequency level to breach the code's limit. (i.e., full compliance with the Code requirements).

6.8.4. VOLTAGE THD

The logged voltage THD level data for the start and end of the STS6 feeder is shown from Figure 79 to Figure 80 in Appendix A.8. There were no noted voltage THD limit events causing the voltage THD level to breach the Code's limits (i.e., full compliance with the Code requirements).

6.8.5. HARMONICS

The logged harmonic data for the start and end of the STS6 feeder is shown from Figure 81 to Figure 82 in Appendix A.8. No non-compliant harmonics were recorded on the feeder.1

7. RESPONSE TO THE CODE REQUIREMENTS

This section contains all the information required for compliance reporting as detailed in the Code "Schedule 1 – Information to be published" and "Part 2 – Quality and reliability standards".

7.1. QUALITY AND RELIABILITY STANDARDS (PART 2)'

7.1.1. FLICKER (PART 2 DIVISION 1 QUALITY STANDARDS SECTION 6(2))

The voltage fluctuations (flicker) of electricity supplied must not exceed the compatibility levels for long-term and short-term flicker as described in Section 5.1.1. **Table 12** presents the results for the previous five reporting periods together with the 2021/2022 result.

Given the results presented, a decrease in the issues of flicker breaches is observed over the 2021/2022 FY compared to the logging periods from the previous four years.

Table 12 | Total number of flicker level breaches

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total short-term breaches P_{ST}	8	17	15	2	0
Total long-term breaches P_{LT}	0	4	36	2	0

7.1.2. VOLTAGE LEVEL (PART 2 DIVISION 2 QUALITY STANDARDS SECTION 8 NOTE(A))

The following information is not required as part of the reporting requirements of the Code. It has been included here to provide a more complete indication of the network power supply quality. In accordance with AS 3000:2018, the voltage levels of the electrical network must be maintained between +10%/-6% of the nominal 240 V single-phase supply voltage.

Table 13 presents the results for the previous five reporting periods together with the 2021/2022 result. Within the 2021/2022 FY logging period three separate voltage limit breaches were recorded, all of which were undervoltage events (below -6% of 240 V). This shows an increase in the number of voltage breaches; However, the breaches seem to have occurred across all feeders at the same time thus likely to be a result of a single event. It is recommended to investigate the breaches.

Table 13 | Total number of voltage level breaches

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total voltage limit breaches	4	8	5	3	15

7.1.3. FREQUENCY (PART 2 DIVISION 2 QUALITY STANDARDS SECTION 8 NOTE(B))

The Electricity Act of 1945 Section 25(1)(d) states that the frequency of electricity supplied must be maintained at ±2.5% of 50 cycles per second. This information is not required as part of the reporting requirements of the Code, but it has been included here to provide a more complete indication of supply PQ.

Table 14 presents the results for the previous five reporting periods together with the 2021/2022 result. Within the 2021/2022 FY logging period no frequency events were recorded. There is improvement in number of frequency level breaches.

Table 14 | Total number of frequency level breaches

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total frequency limit breaches	0	1	4	2	0

7.1.4. HARMONICS (PART 2 DIVISION 1 QUALITY STANDARDS SECTION 7)

Within the Code, there are two measures for assessing the power quality of the Newman network. The two measures are:

1. Assessment of individual harmonics and a comparison of their magnitudes against the table in Part 2 Division 1 Section 7 of the Code; and
2. Assessment of the calculated Voltage Total Harmonic Distortion (U-THD) and a comparison of its magnitude with the Code's compliance value of 8%.

7.1.4.1. INDIVIDUAL VOLTAGE HARMONICS

Individual, non-compliant harmonics for each respective feeder are presented in Section 6.

7.1.4.2. VOLTAGE TOTAL HARMONIC DISTORTIONS

The voltage harmonic distortion levels of electricity supplied must not exceed the U-THD limit of 8% stated in Part 2, Division 1, Section 7 of the Code. Table 15 presents the results for the previous four reporting periods together with the 2021/2022 result. Within the 2021/202 FY logging period, zero breaches of U-THD were recorded. The average U-THD recorded within the same logging period was consistently well below the 8% limit.

Table 15 | Total number of total harmonic distortion level breaches

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total U-THD limit breaches	0	1	3	0	0

7.2. REMEDIAL ACTIONS TAKEN FOR BREACHES (SCHEDULE 1 ITEM 4(B))

Newman BHPSA has a pro-active approach toward establishing and executing asset replacement and improvement programs to sustain and improve power quality and reliability across the Newman Township.

To ensure compliance with Australian regulations, BHPSA has undertaken annual PQ logging on the 11 KV supply feeders originating from both the South Town and Township substations during the summer/autumn period. Improvements are implemented based on the PQ logging data results and any complaints received from customers related to power quality issues.

Asset upgrades completed or in progress include:

- BHP have completed the installation of 16 permanent fixed SEL735 Advanced Power Quality and revenue meters at selected pad-mount substations to improve the logging process by providing year-round access to power quality data including harmonics.
- Replacing aging assets 'end of useful life' – transformer T7 and pad-mount substations PS61
- Closely monitoring the situation with respect to HV overhead line (main road) crossings and high/oversized loads; BHP has made budgetary provision for undergrounding the relevant sections of overhead line to address the issue and expected to finish at the end of 2022/2023 fiscal year.
- Considering the replacement of existing line interrupters with air-break switches (which have load break capability). Project is expected to complete in 2022/2023 FY.
- BHP is considering the replacement of existing line interrupters (which cannot be switched on load) with air break switches (which can be switched on load). This will provide a better reliability of supply experience for customers during the day-to-day operation of the network. This is in design phase now.
- The upgrade of the electricity supply to the town hospital as part of the overall hospital upgrade project is completed.
- Purchased a 300kVA trailer mounted (mobile) generator to help reduce transformer outage times. This wasn't used in 2021/2022 FY.
- BHP are continuing the process of changing out the existing with Advanced Metering Infrastructure (AMI) meters, as part of the same project would be appointed a suitable service provider to manage the billing section and monitoring of the AMI meters. This project still in progress. The AMI smart meters are capable of two-way communication which in turn will provide several benefits including:
    - Improved accuracy of meter readings – reducing estimated billing errors;
    - Early detection of power quality issues;
    - Improved monitoring of power outages to assist maintenance crews in reducing restoration times.

7.3. SUPPLY INTERRUPTED (SCHEDULE 1 ITEM 5)

Schedule 1 of the Code gives the information to be published within the annual compliance report. The provisions of Item 5 require that the following information be published:

> *"The number of premises of small use customers the supply of electricity to which has been interrupted:*
>
> *(a) for more than 12 hours continuously; or*
>
> *(b) more than the permitted number of times, as that expression is defined in section 12(1) *,*
>
> *and in the case of interruptions referred to in paragraph (a), the number of interruptions and the length of each interruption."*

*Section 12(1) of the Code defines 'permitted number of times' as nine times (for Perth CBD or urban areas) or 16 times (for small use customers in other areas).

7.3.1. INTERRUPTIONS EXCEEDING 12 HOURS

In 2021/22, no network interruption which exceeded 12 hours was recorded.

Table 16 | Total number of premises of small customers interrupted continuously for more than 12 hours

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total number of premises that experienced a single interruption exceeding 12 hours	0	0	1	1	0

7.3.2. INTERRUPTIONS EXCEEDING THE PERMITTED NUMBER OF TIMES

The permitted number of times that a customer connection can be disconnected from the electricity supply within the preceding year (defined as the period of 12 months ending on 30 June) is given as 16 as per Section 12(1) of the Code.

There were no customers disconnected more than 16 times as observed in the BHP outage logs.

Table 17 | Total number of premises that experienced >16 interruptions within the preceding year

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total number of premises that experienced more than 16 interruptions	0	0	0	0	0

7.4. NUMBER OF COMPLAINTS RECEIVED (SCHEDULE 1 ITEMS 6 AND 10)

Division 2, Section 25(1) of the Code defines "complaint" as a complaint that a provision of Part 2, or of an instrument made under section 14(3), has not been, or is not being, complied with. Table 18 presents the results for the previous four reporting periods together with the 2021/2022 FY result.

No complaints relating to power quality were received in 2021/2022 FY.

Table 18 | Total number of formal complaints lodged to BHPSA

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total number of formal complaints received	0	0	0	0	0

7.5. COMPLAINTS RECEIVED IN EACH DISCRETE AREA (SCHEDULE 1 ITEMS 7 AND 10)

The township of Newman is supplied from an integrated network and therefore there are no discrete areas to be reported.

7.6. TOTAL AMOUNT SPENT ADDRESSING COMPLAINTS (SCHEDULE 1 ITEMS 8 AND 10)

There have been no complaints over the 2021/22 FY that required BHP's action.

7.7. NUMBER AND TOTAL AMOUNT OF PAYMENTS MADE (SCHEDULE 1 ITEMS 9 AND 10)

Sections 18 and 19 of the Code stipulates that failure on the part of the electricity distributor to provide required notice for either a planned interruption or an interruption exceeding 12 hours to a small use customer shall result in a financial payment.

Table 20 presents the summary of payments made to small use customers over the five previous reporting periods, as well as the 2021/2022 FY period.

Table 19 | Summary of payments made under Sections 18 and 19

DESCRIPTION	REPORTABLE PERIOD				
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022
Total number of payments	0	0	0	0	0
Total amount of payouts in AUD ($)	0	0	0	0	0

7.8. RELIABILITY OF SUPPLY (SCHEDULE 1 ITEM 11)

The provisions of Schedule 1, Item 11 of the Code requires that the following information to be published:

> *"For each discrete area:*
>
> *(a) the average length of interruption of supply to customer premises expressed in minutes;*
>
> *(b) the average number of interruptions of supply to customer premises;*
>
> *(c) the average percentage of time that electricity has been supplied to customer premises; and*
>
> *(d) the average total length of all interruptions of supply to customer premises expressed in minutes."*

In the context of this report, the township of Newman is considered the *discrete area*. The BHPSA 2021/2022 FY fault outage data presented within B has been applied in determining the parameters described above and presented further in the following sub-sections.

7.8.1. AVERAGE INTERRUPTION (SCHEDULE 1 ITEMS 11(A), 12 AND 13)

Table 20 presents the average duration of a supply interruption to small use customer connections affected by a fault within the Newman township electrical network, also known as the CAIDI described in Section 5.4.1, over the five previous reporting periods including the 2021/2022 FY period. A substantial decrease in CAIDI was observed this year when compared to the previous years. The CAIDI performance in 2021/2022 is the best performance since 2018/19.

Table 20 | Summary of average interruption length to affected customers (CAIDI)

DESCRIPTION	REPORTABLE PERIOD					AVERAGE
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	
Average interruption duration – CAIDI (minutes)	33	141	99.28	182.82	75.38	106.296

7.8.2. AVERAGE NUMBER OF INTERRUPTIONS (SCHEDULE 1 ITEMS 11(B), 12 AND 13)

Table 20 presents the average number of interruptions to small use customer connections within the Newman township electrical network, also known as the SAIFI, described in Section 5.4.2, over the five previous reporting periods as well as the 2021/2022 FY period. SAIFI is improved in 2021/22 as compared to 2020/21. SAIFI in 2021/2022 is the second-best performance over the last 5 years.

Table 21 | Summary of average number of interruptions (SAIFI)

DESCRIPTION	REPORTABLE PERIOD					AVERAGE
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	
Average number of interruptions – SAIFI	1.07	2.66	0.417	1.96	0.947	1.41

7.8.3. AVERAGE TIME PERCENTAGE SUPPLIED (SCHEDULE 1 ITEMS 11(C), 12 AND 13)

Table 22 presents the average percentage of time that electricity has been supplied to small use customer connections, also known as the ASAI described in Section 5.4.3, over the five previous reporting periods as well as the 2021/2022 FY period. A slight increase in ASAI was observed this year when compared to the previous years.

Table 22 | Summary of average percentage of time supplied (ASAI)

DESCRIPTION	REPORTABLE PERIOD					AVERAGE
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	

Average percentage of time supplied – ASAI (%)	99.99	99.93	99.99	99.93	99.986	99.96

7.8.4. AVERAGE DURATION OF ALL INTERRUPTIONS (SCHEDULE 1 ITEMS 11(D), 12 AND 13)

Table 23 presents the average duration of a supply interruption to any single small use customer connection within the Newman township electrical network, also known as the SAIDI described in Section 5.4.4, over the four previous reporting periods as well as the 2021/2022 FY period. A notable decrease in SAIDI was observed this year when compared to the previous year 2020/2021. It can be noted that there is increase in SAIDI if we ignore 2020/2021 from the last four years.

Table 23 | Summary of average interruption duration to customers (SAIDI)

DESCRIPTION	REPORTABLE PERIOD					AVERAGE
	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	
Average interruption duration – SAIDI (minutes)	35	376	41.36	354.91	71.41	175.736

7.9. PERCENTILE VALUES (SCHEDULE 1 ITEMS 14 AND 15)

This section outlines the response to Schedule 1, Items 14 and 15 of the Code. An extract from the Code requirements is shown below:

> *Item 14: "For customer premises in each discrete area, an estimate of the 25th, 50th, 75th, 90th, 95th, 98th and 100th percentile values of —*
>
> *(a) the average length of interruption referred to in item 11(a).*
>
> *(b) the number of interruptions; and*
>
> *(c) the total length of interruptions."*
>
> *Item 15: "For each category of information in item 14(a), (b) and (c), a graph showing the distribution of customer premises across the range of that category."*

7.9.1. AVERAGE INTERRUPTION (CAIDI) – PERCENTILE

Table 24 presents the percentile distribution spread for the average duration of interruptions to affected small use customers (CAIDI) within the Newman Township for the 2021/2022 FY logging period.

Table 24 | CAIDI Percentile Distribution 2021/2022 FY

DESCRIPTION	PERCENTILE						
	25TH	50TH	75TH	90TH	95TH	98TH	100TH
Average Length of Interruption (CAIDI)	69	120	80	75	75	75	75

Number of Interruptions (SAIFI) – Percentile

Table 25 presents the percentile distribution spread for the average number of interruptions to small use customers (SAIFI) within the Newman Township for the 2021/2022 FY logging period.

Table 25 | SAIFI Percentile Distribution 2021/2022 FY

DESCRIPTION	PERCENTILE						
	25TH	50TH	75TH	90TH	95TH	98TH	100TH
Average Number of Interruptions (SAIFI)	0.03	0.07	0.4	0.95	0.95	0.95	0.95

7.9.2. AVERAGE DURATION OF ALL INTERRUPTIONS (SAIDI) – PERCENTILE

Table 26 presents the percentile distribution spread for the average duration of all interruptions to a small use customer (SAIDI) within the Newman Township for the 2021/2022 FY logging period.

Table 26 | SAIDI Percentile Distribution 2021/2022 FY

DESCRIPTION	PERCENTILE						
	25TH	50TH	75TH	90TH	95TH	98TH	100TH
Average Length of All Interruptions (SAIDI)	71	71	71	71	71	71	71

8. CONCLUSION

This report addresses all relevant parts pertaining to Newman's 11 kV supply network and the reportable requirements as per Part 2 and Schedule 1 of the Code.

With regards to the site measurements, the average values of electrical parameters were logged over a period of seven days, at 2-minutes intervals. PQ indices were then calculated and found, in large, within the limits stipulated by the Code. That is, the averages of the following parameters are proven to meet the Code's requirements:

- *Voltage Flicker (short- and long-term criteria);*
- RMS Voltage Magnitude;
- Power System Frequency; and
- *Voltage Total Harmonic Distortion (U-THD)*.

The following compliance issues were identified:

- Voltage Flicker: An improvement in the number of short-term and long-term voltage fluctuation limit breaches (no short-term and long-term breaches) described in AS61000:2001 was recorded compared to the logging periods for previous four years.
- RMS Voltage Magnitude: A relatively high number of voltage level breaches (fifteen undervoltage breaches) were observed compared to the logging periods for the previous four years. Given the temporary and random nature of the breaches, it is not deemed of a practical concern at this stage, but it is recommended that this parameter be monitored over the coming years.
- Power System Frequency: No under frequency breaches of the limits described in the Electricity Act of 1945 Section 25(1)(d) were recorded during the logging period.
- U-THD: Zero U-THD breaches of the limits described in Part 2, Division 1, Section 7 of the Code were recorded during the logging period. There is an improvement in the breaches of U-THD compared to the previous three years.

The recorded individual order harmonic showed a (temporary) breach on Southtown substation feeder STS4 Start (PS 111 Hilditch Avenue Substation). There were 53 incidents observed during the 2021/2022 logging period in which the 21st harmonic level exceeded the allowable limit. This is not considered of a practical concern at this stage but given that this issue also arose in the same location in 2019/20. It is recommended that the situation be monitored and addressed over the year.

Reportable parameters for Newman Township Electricity Supply over the 2021/2022 FY (as outlined in the 'Schedule 1' of the Code) are presented below:

- >12-hour interruptions: In 2021/2022, no network interruption which exceeded 12 hours was recorded.
- No small use customer was disconnected from the network more than the maximum number of times permitted by the Code (i.e., limit of 16 times per year).
- No power quality and reliability related complaints were received from customers during FY 2021/2022.
- The key reliability indices are calculated as listed below:
    - *Customer Average Interruption Duration Index (CAIDI)* of 75.38 minutes – CAIDI is a measure of the average outage duration or average outage restoration time. [It is defined as "The sum of the durations of sustained[2] customer interruptions divided by the total number of sustained customer interruptions"].
    - *System Average Interruption Frequency Index (SAIFI)* of 0.947 interruptions – SAIFI is the average number of interruptions per customer served. [It is defined as "the total number of sustained customer interruptions divided by the total number of customers served"].
    - *Average Service Availability Index (ASAI)* of 99.986% – ASAI is the perceived availability of the network to the customers.
    - *System Average Interruption Duration Index (SAIDI)* of 71.41 minutes – SAIDI is the average outage duration for each customer served. [It is defined as "the sum of durations of sustained customer interruptions divided by the total number of customers served"].

In summary, the metering data collected from the 16 locations throughout the Newman Township network indicate that the power quality is, in large, within the limits stipulated by the Code.

While the reliability indices have improved since 2020/21, the 2021/22 performance (with possibly the exception of ASAI) have departed significantly from their best performance over the recent 5- year period. With this is in mind, it is recommended that the cause(s) of this issue is monitored with a view of seeking opportunities for improvement.

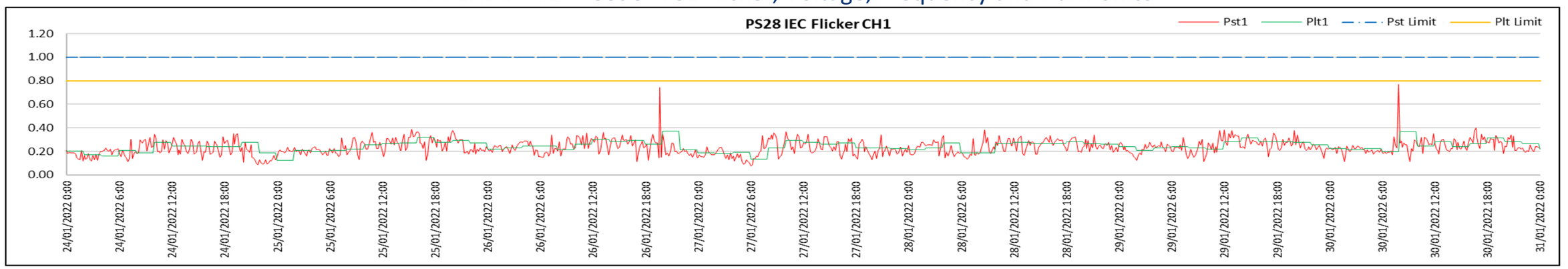
Notwithstanding this, the overall network performance is still considered to be satisfactory. The relative deterioration in reliability indices can be attributed to the forced outages and events outside of BHPSA's control. As such, this report finds the reliability and quality of the supply for Newman Township network in compliance with the Code's requirements, with further monitoring of areas of the network recommended to ensure quality and reliability is maintained in the upcoming years.

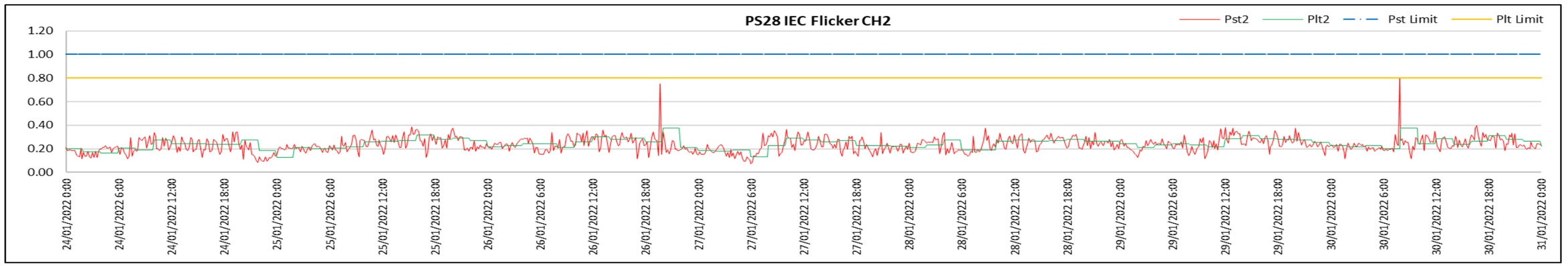
[2] By "sustained" we mean only interruptions lasting 1 minute or longer. (Momentary) Outages lasting less than 1 minute are not included in the index. Planned outages and some other types of outages are also excluded from this index. This note also applies to the SAIFI and SAIDI indices.

APPENDIX A. PQ LOGGING DATA (2021/2022 FY)

Refer to the following pages.

APPENDIX A.2 Feeder TC1 Flicker, Voltage, Frequency and Harmonics





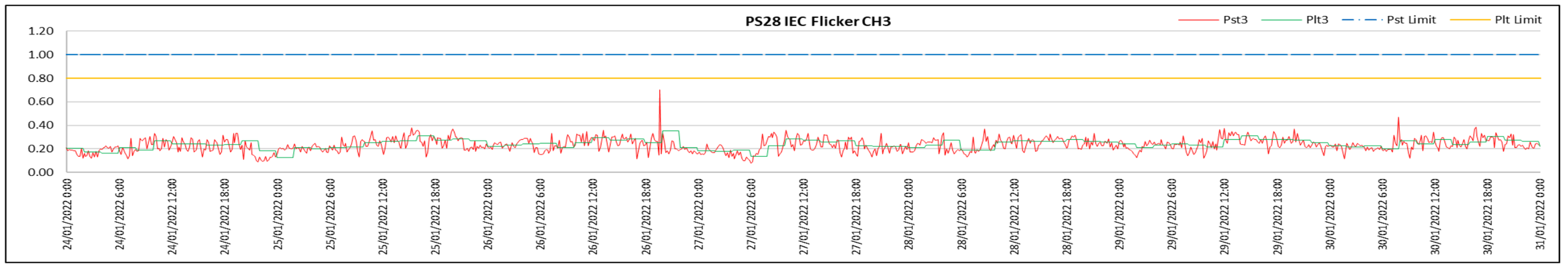
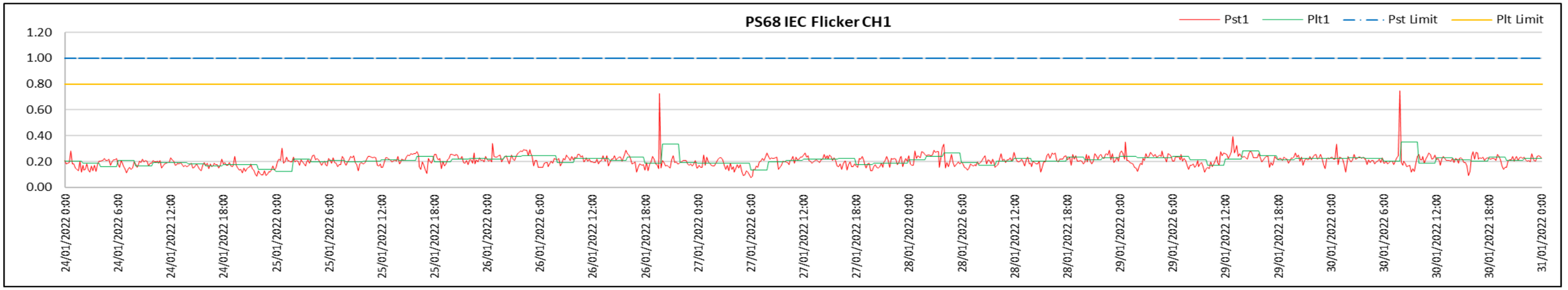
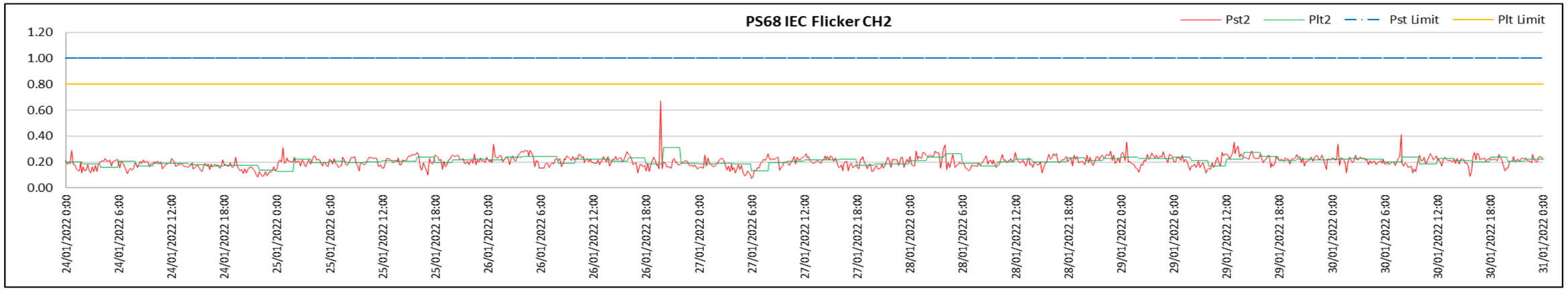


Figure 3 | TC1 Start Flicker measurements





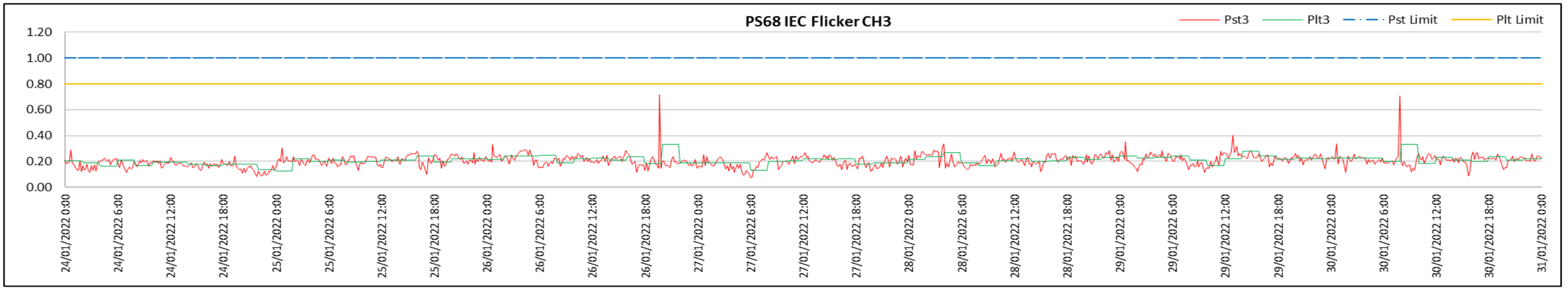
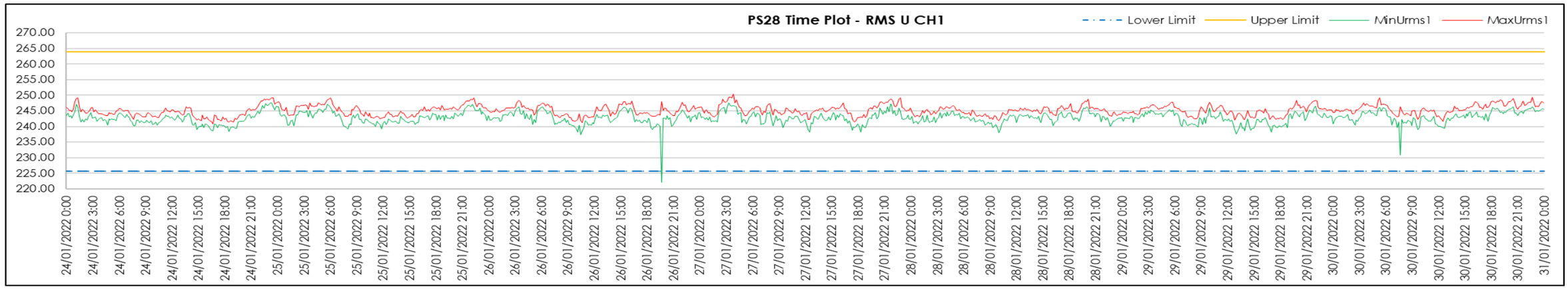
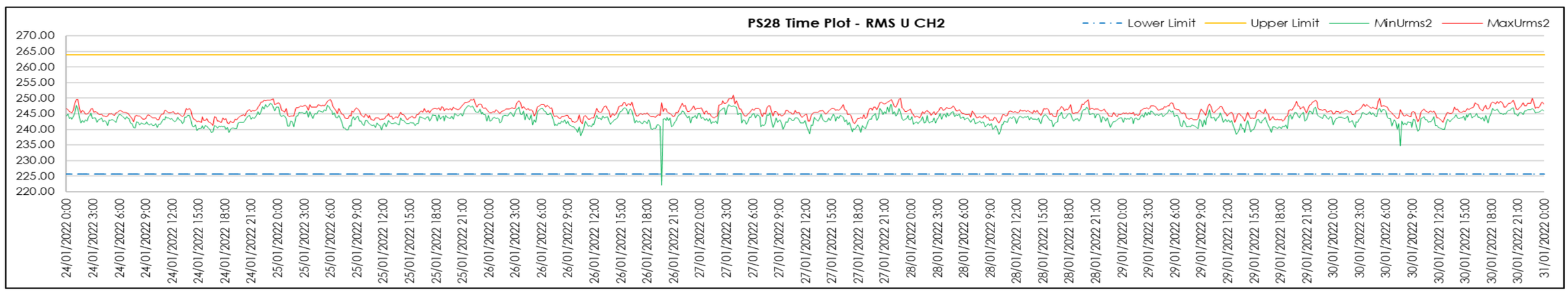


Figure 4 | TC1 End Flicker measurements





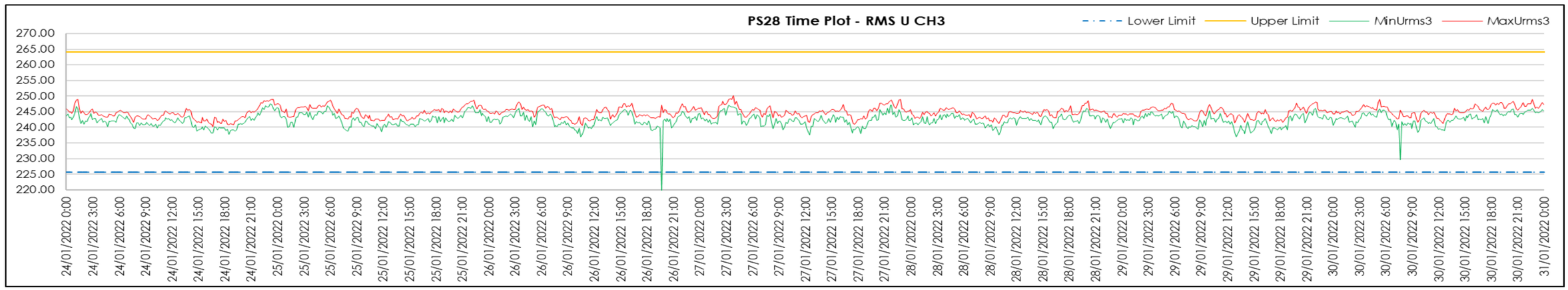


Figure 5 | TC1 Start Voltage measurements

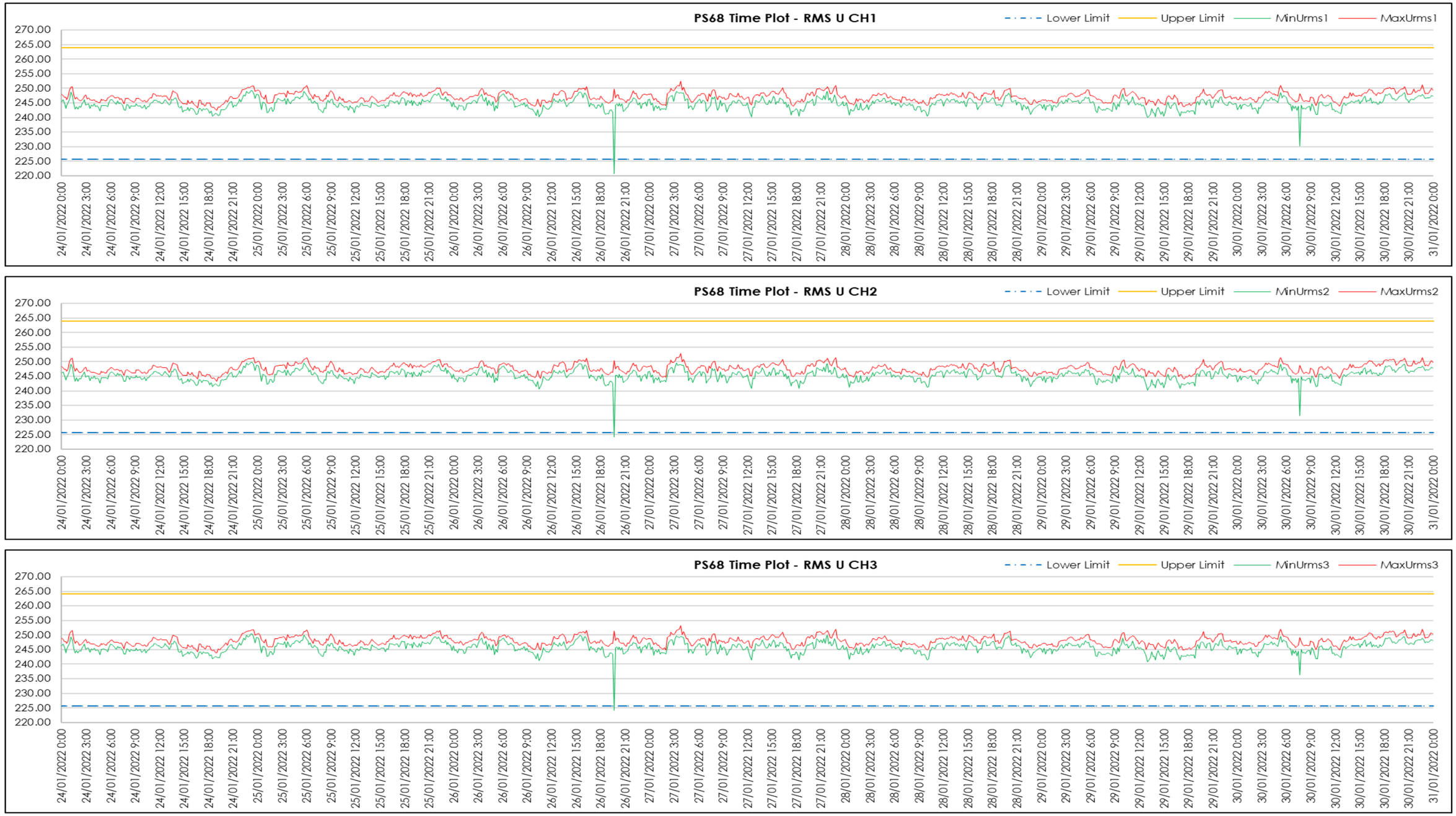


Figure 6 | TC1 End Voltage measurements

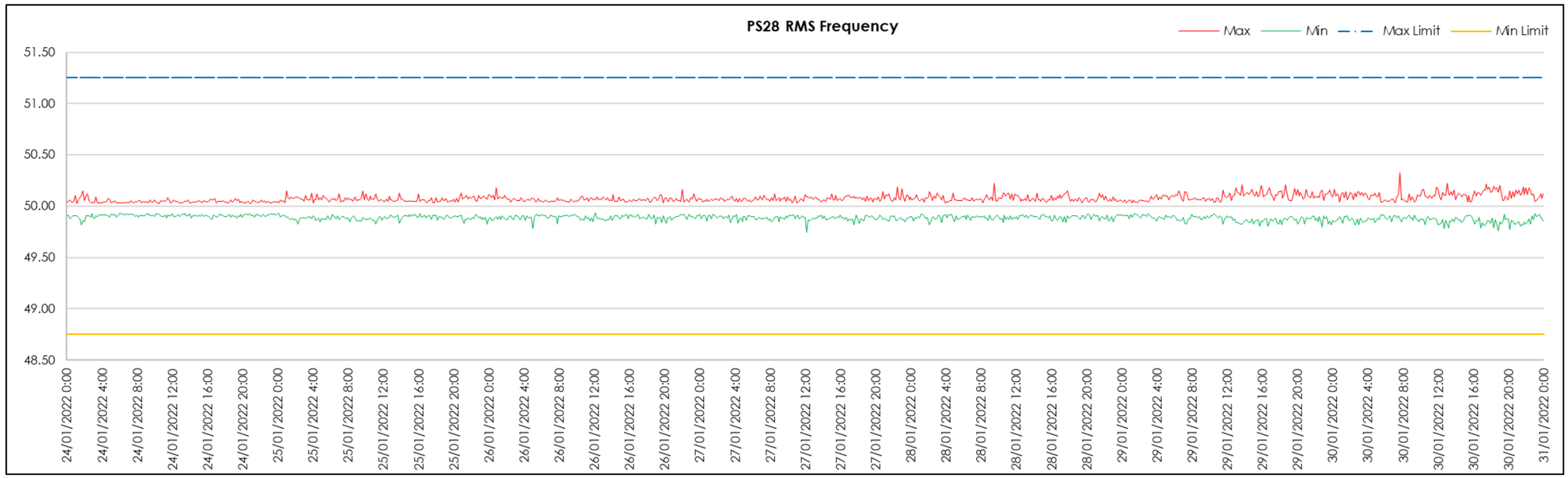


Figure 7 | TC1 Start Frequency measurements

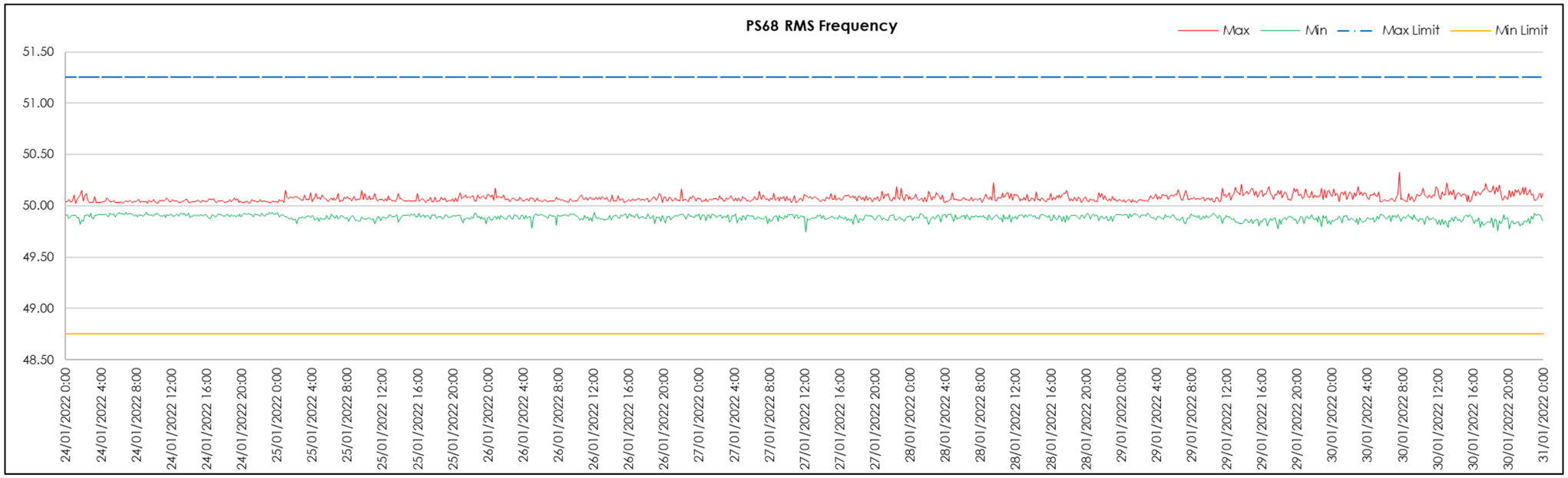
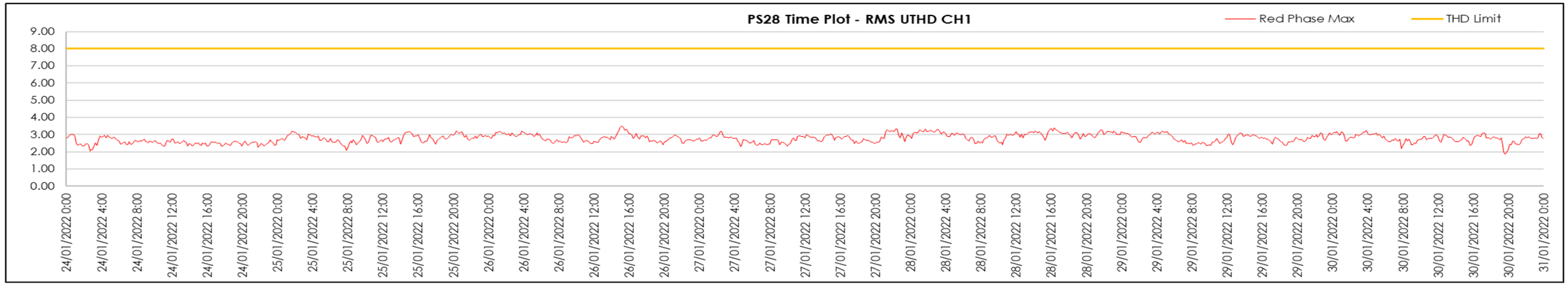
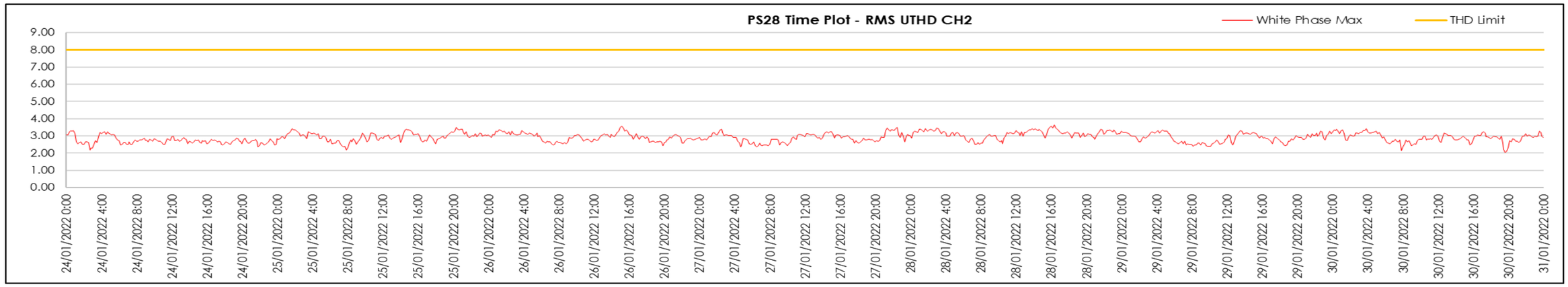


Figure 8 | TC1 End Frequency measurements





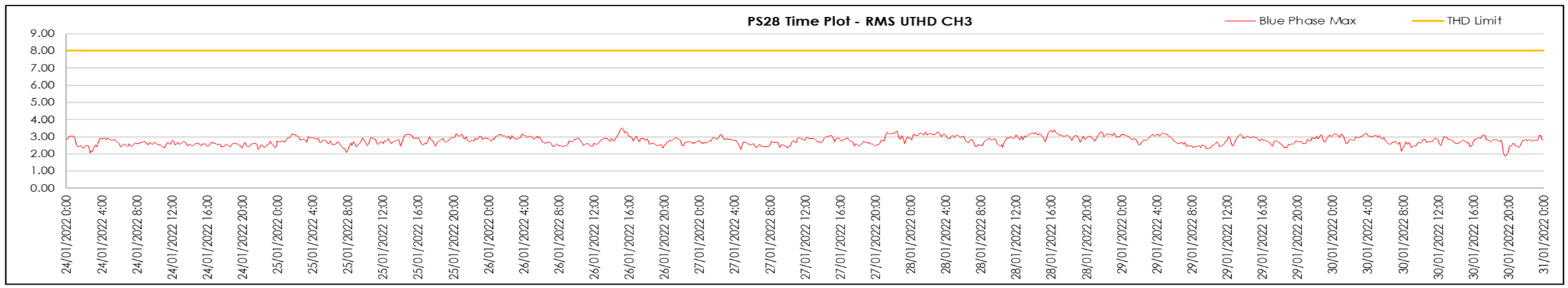
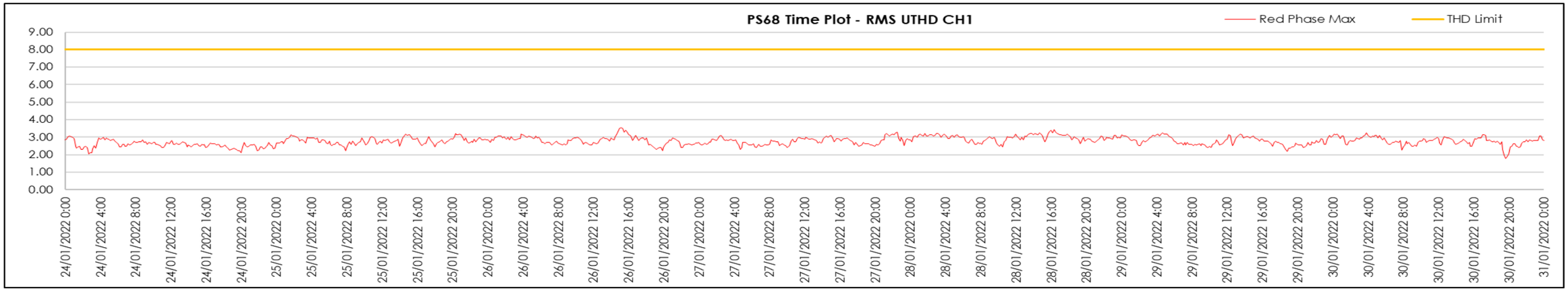
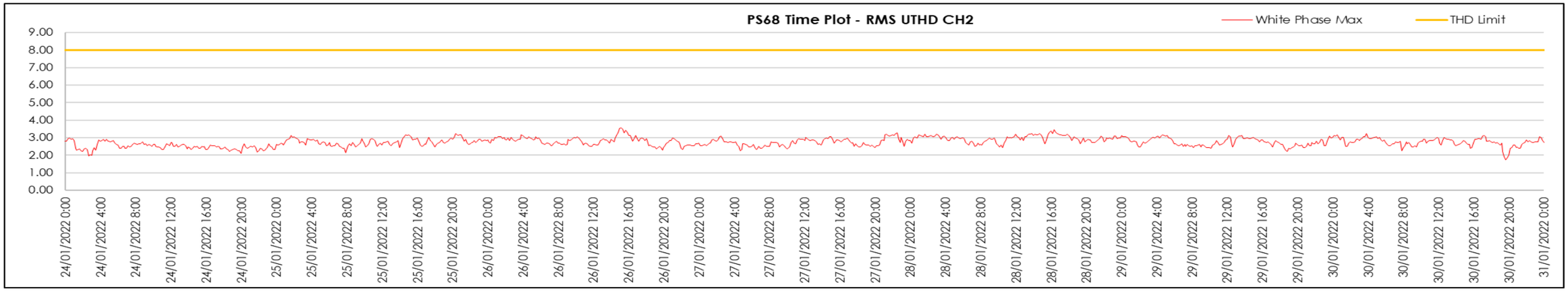


Figure 9 | TC1 Start U-THD measurements





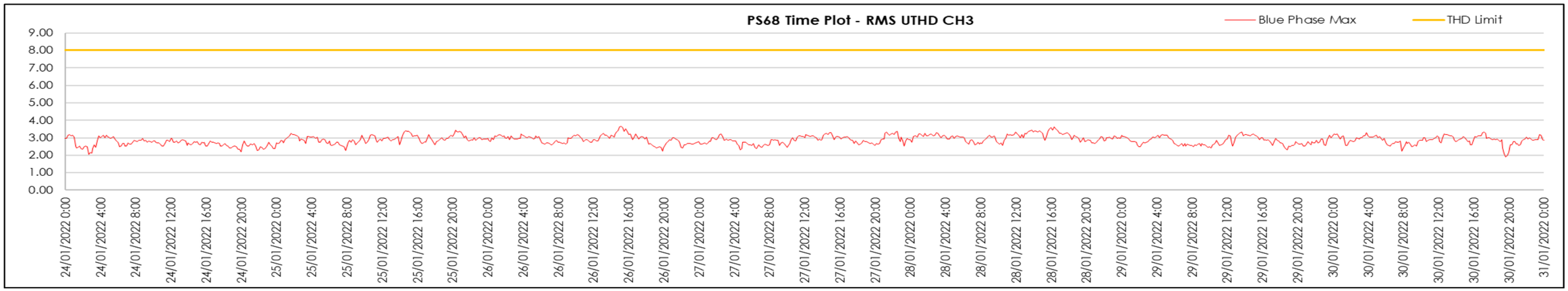
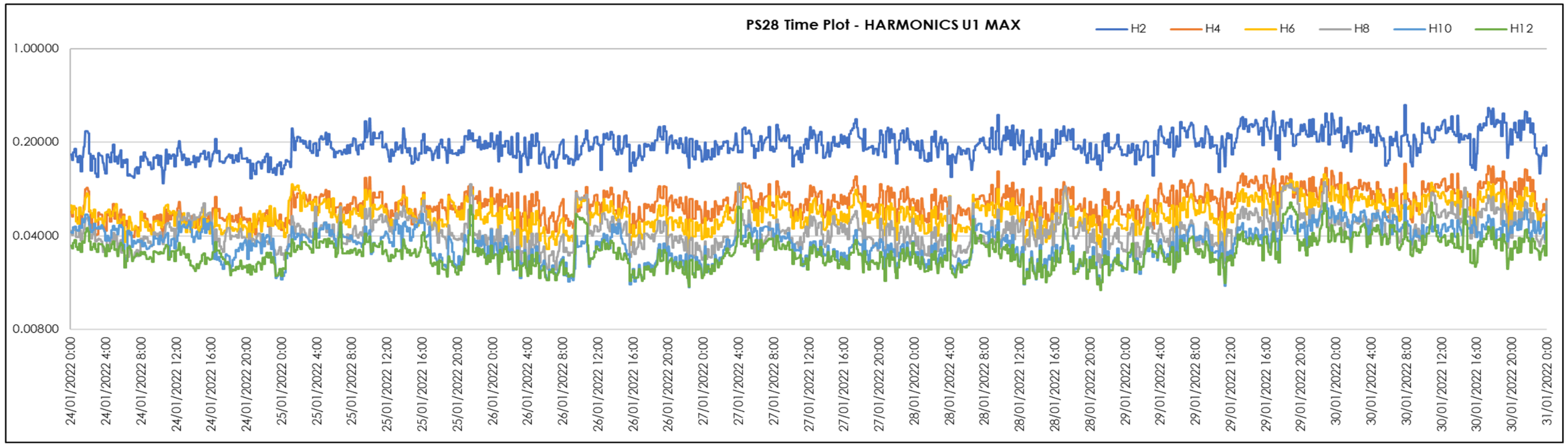


Figure 10 | TC1 End U-THD measurements


PS28 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
1.00000
0.20000
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
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26/01/2022 12:00
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27/01/2022 20:00
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30/01/2022 8:00
30/01/2022 12:00
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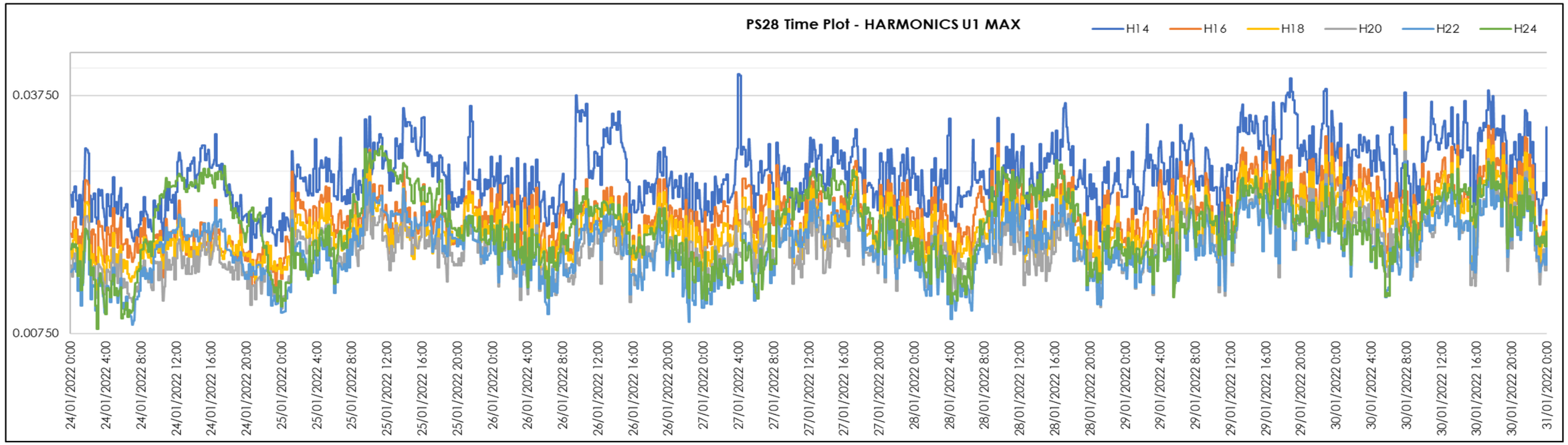
31/01/2022 0:00


PS28 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
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24/01/2022 8:00
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30/01/2022 4:00
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30/01/2022 16:00
30/01/2022 20:00
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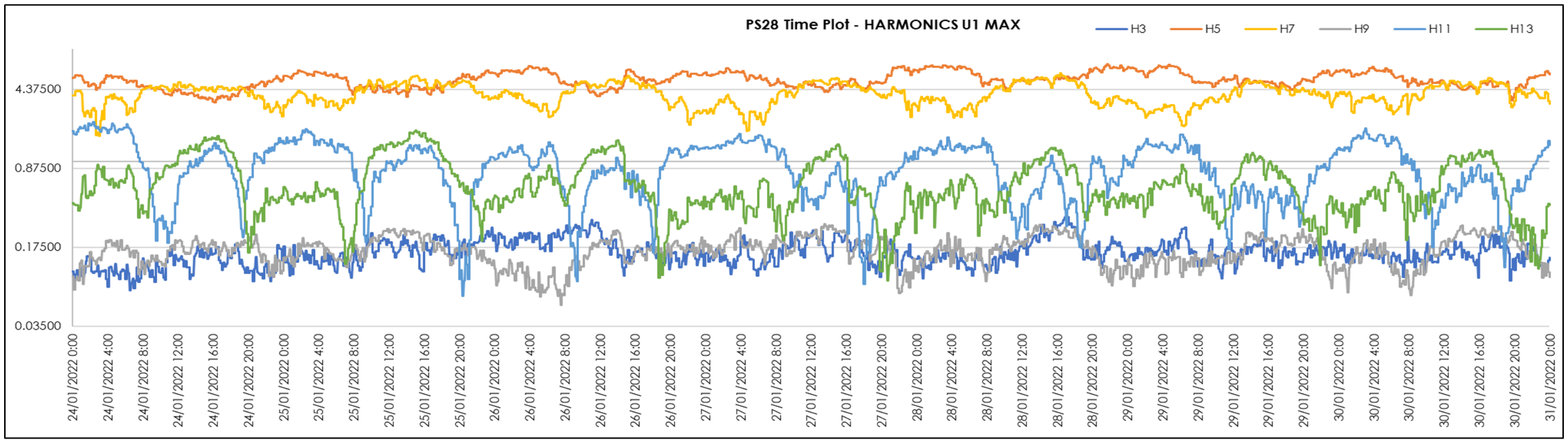


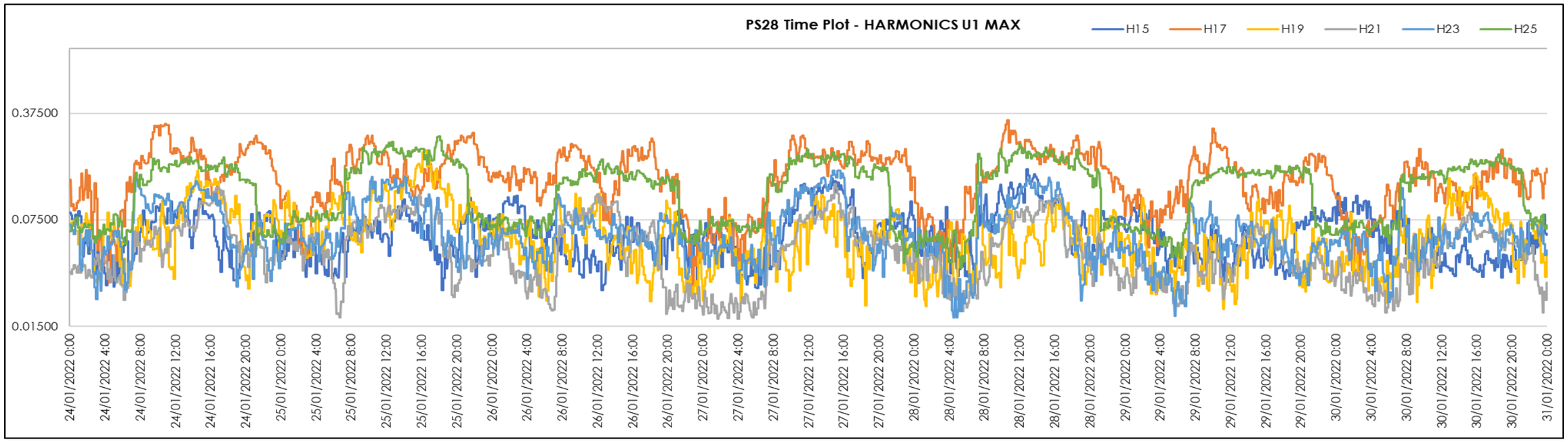
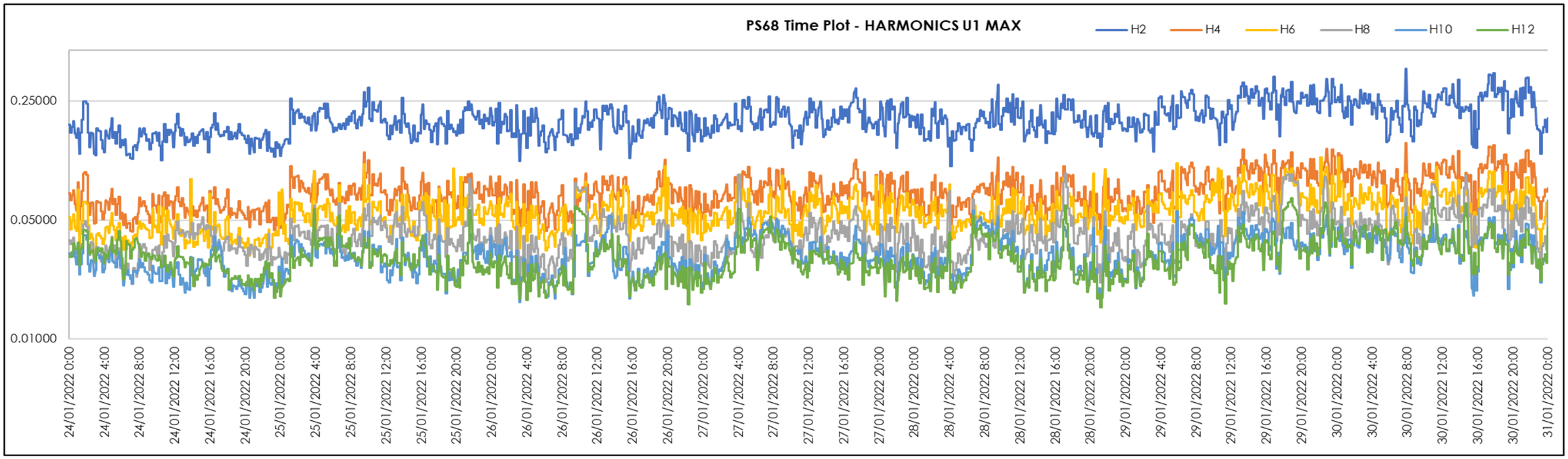


Figure 11 | TC1 Start Harmonics


PS68 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
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30/01/2022 16:00
30/01/2022 20:00
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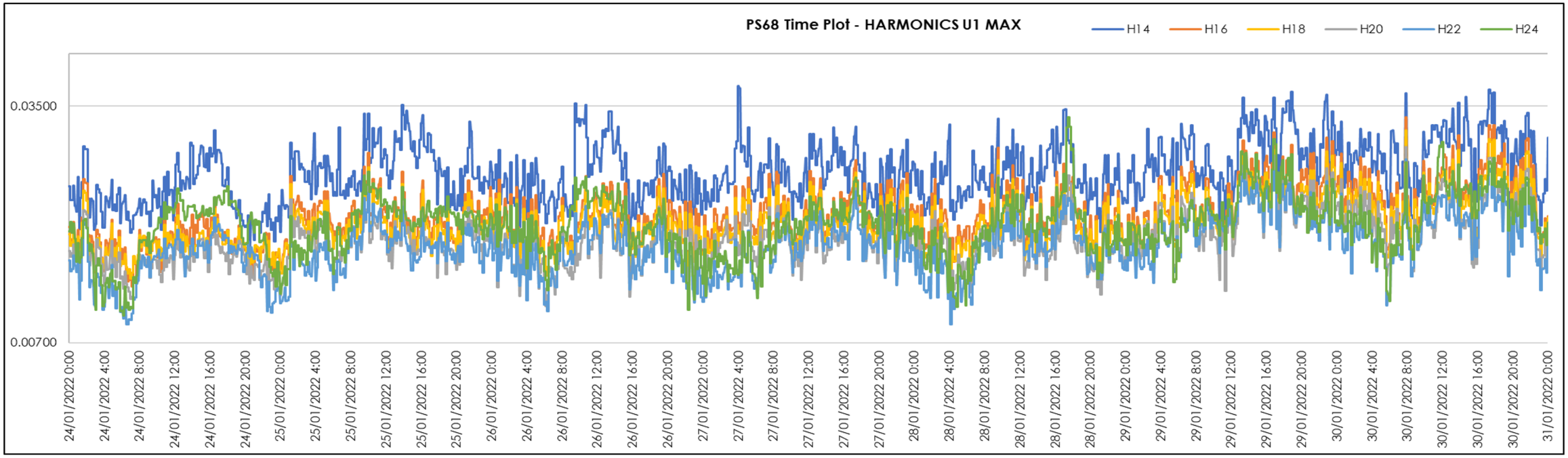
PS68 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03500
0.00700
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
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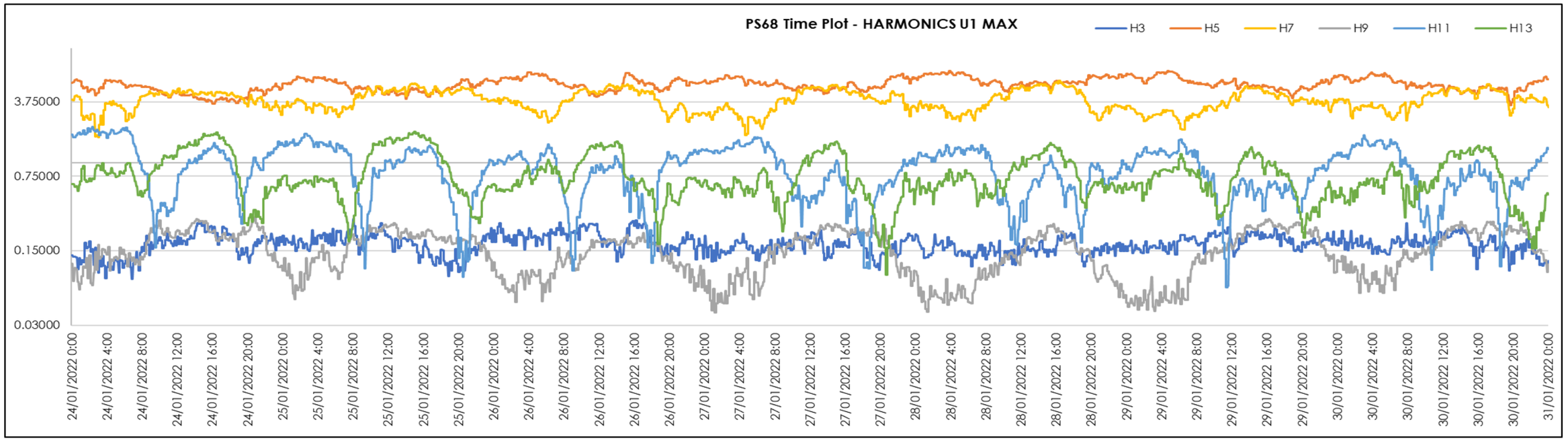


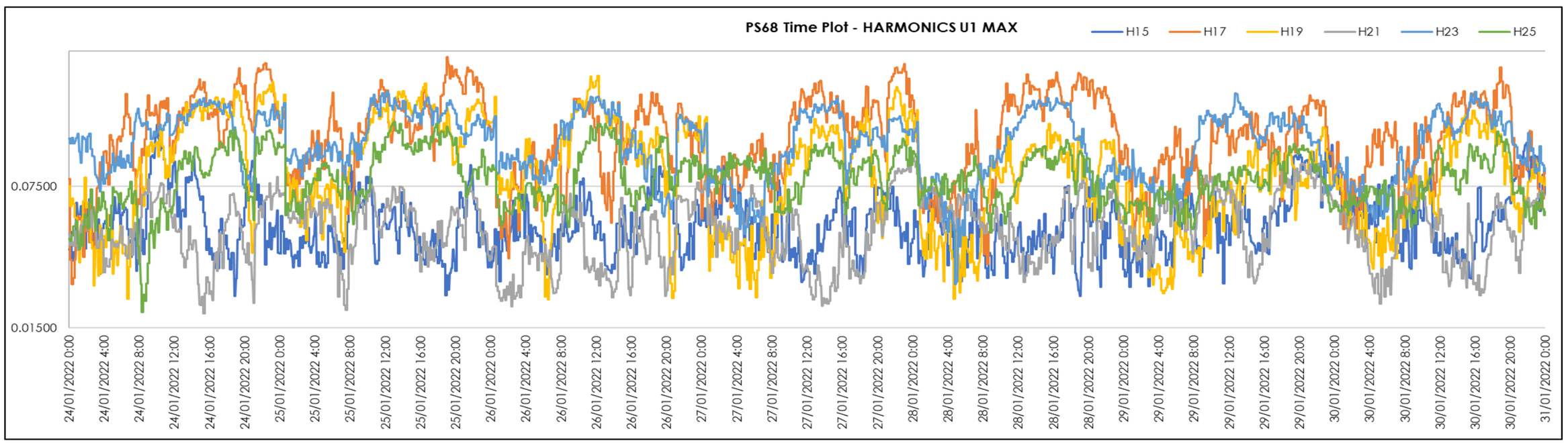
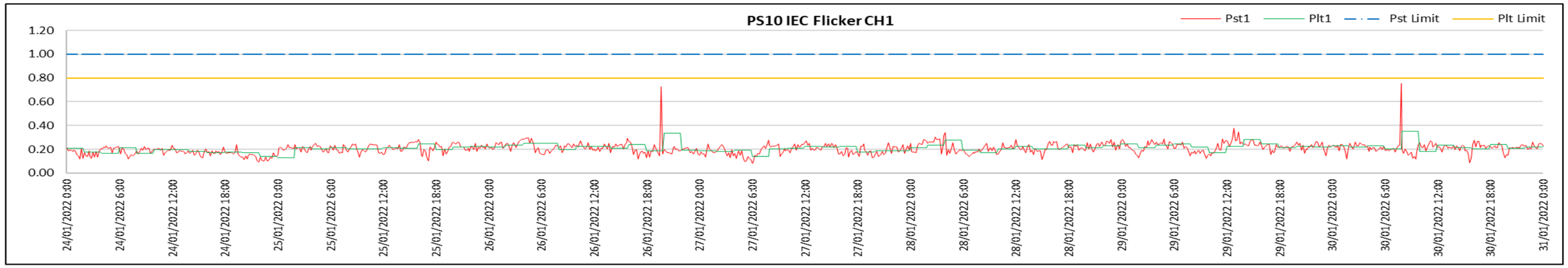
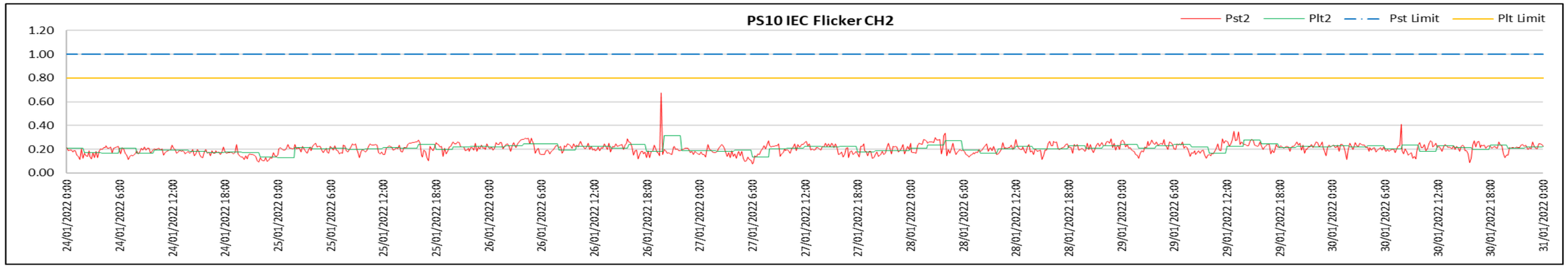


Figure 12 | TC1 End Harmonics

APPENDIX A.2 FEEDER TC2 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





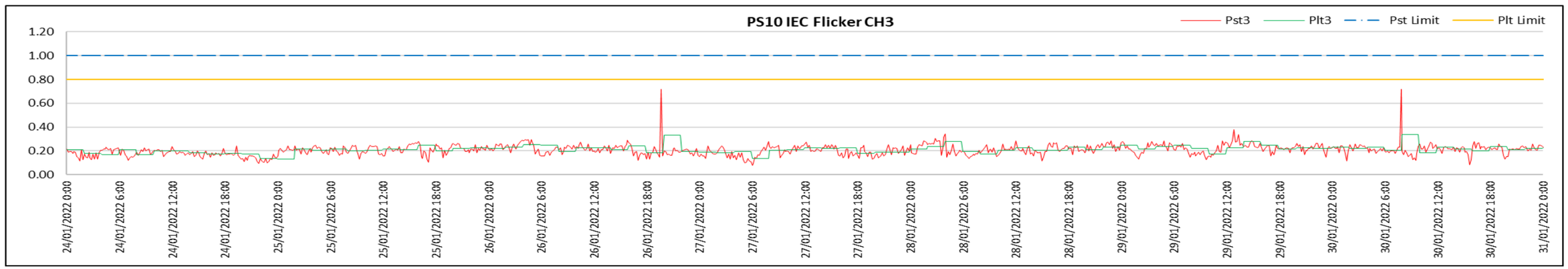


Figure 13 | TC2 Start Flicker measurements

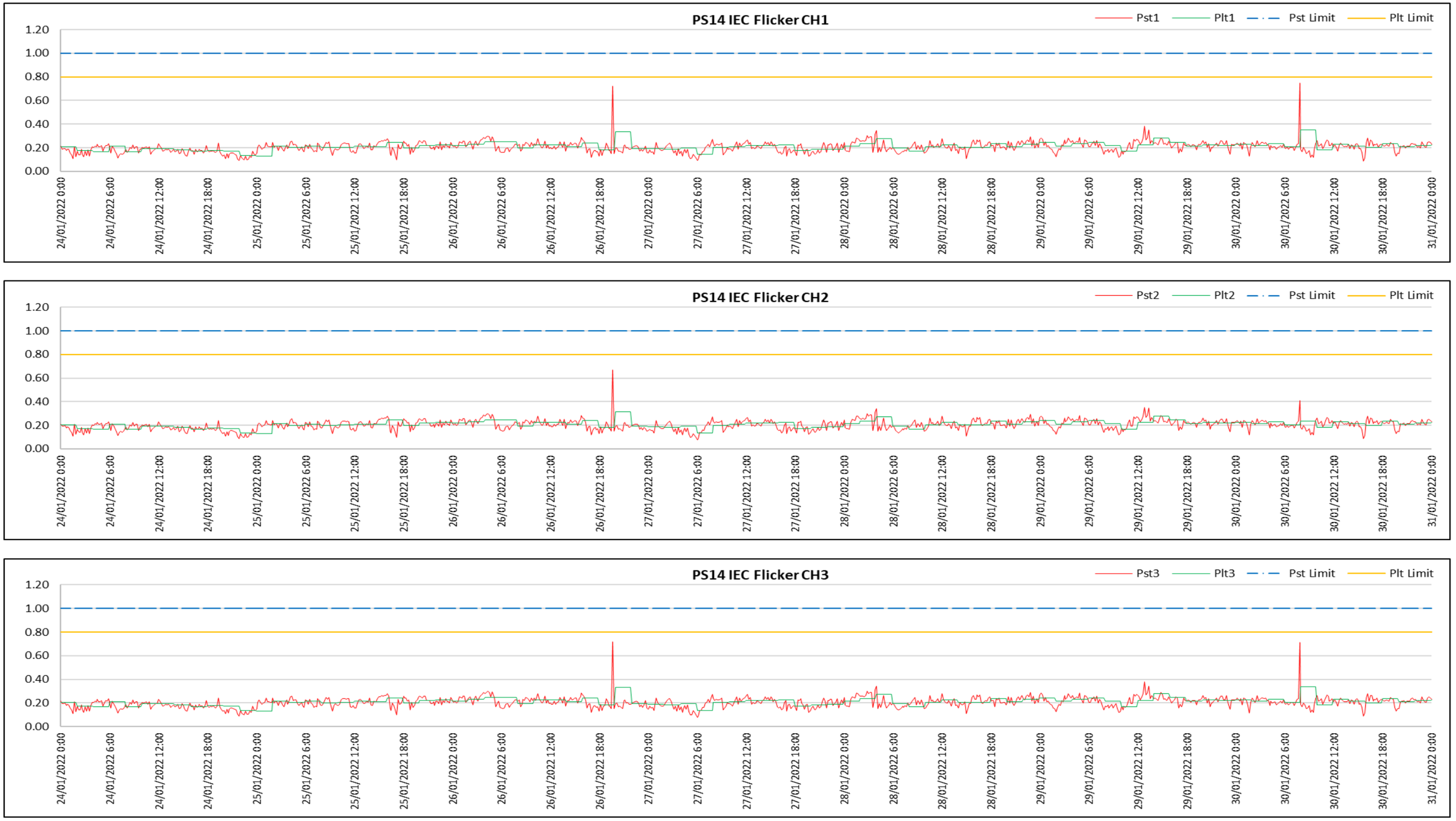


Figure 14 | TC2 End Flicker measurements

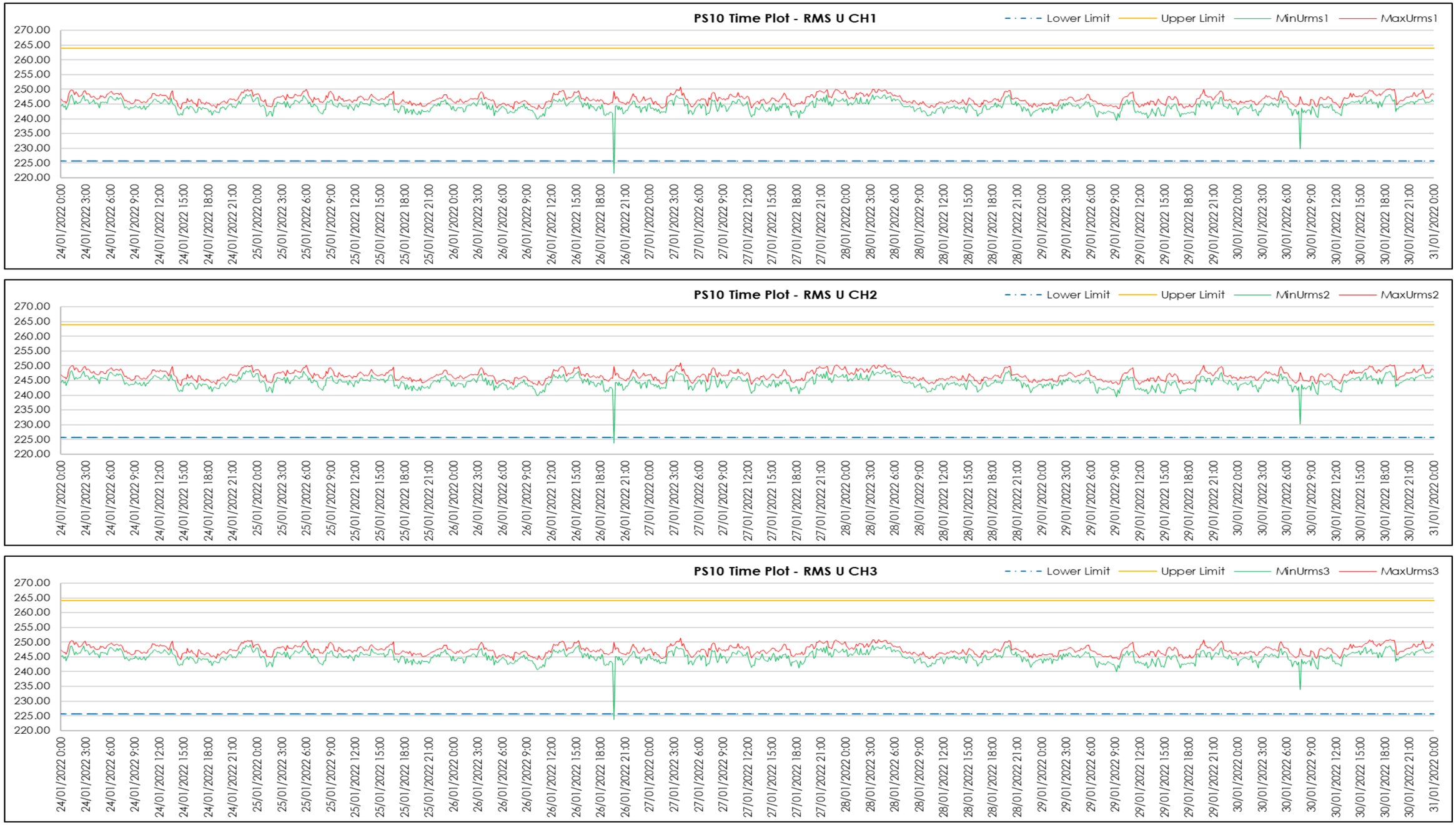


Figure 15 | TC2 Start Voltage measurements

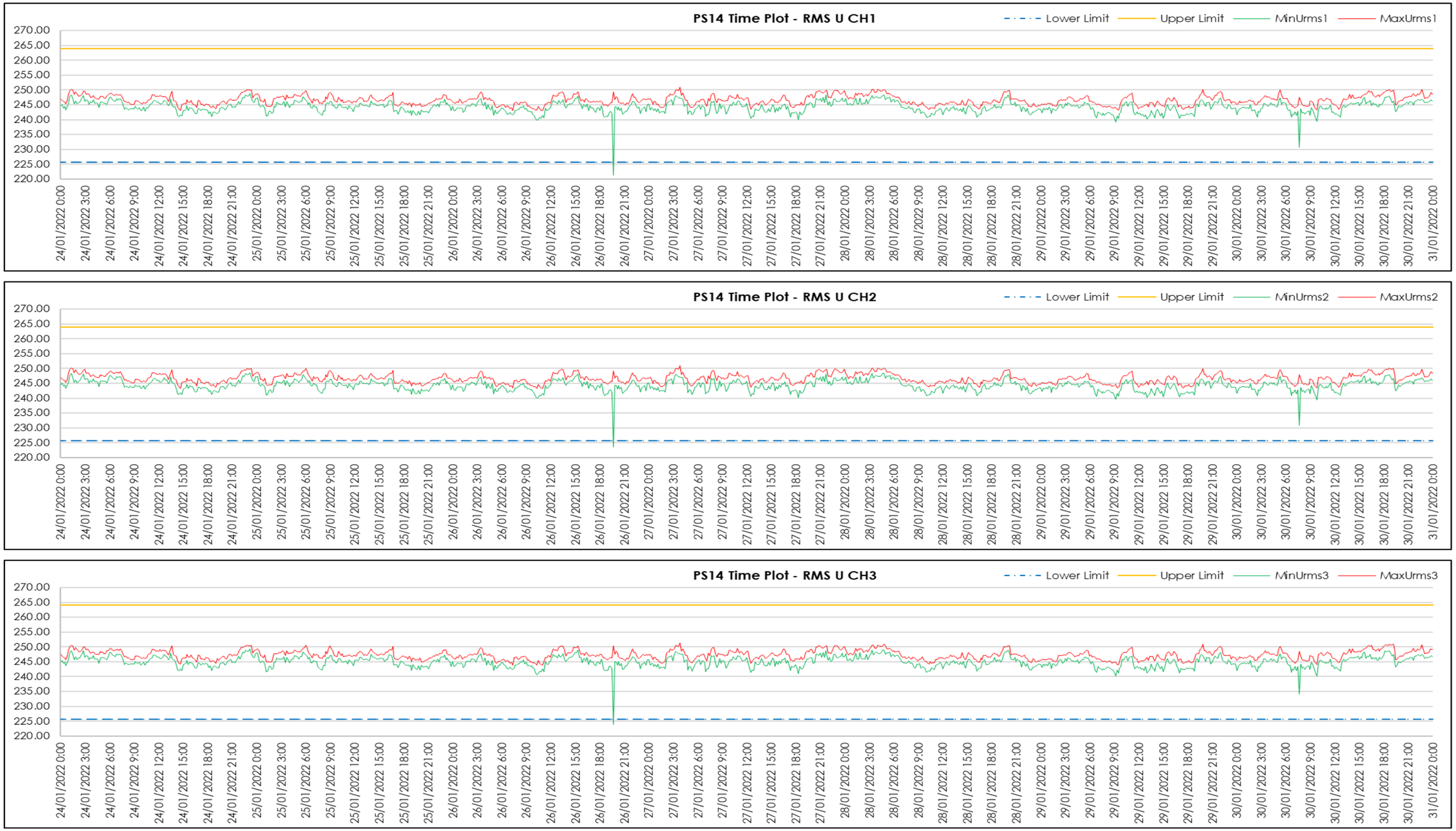


Figure 16 | TC2 End Voltage measurements

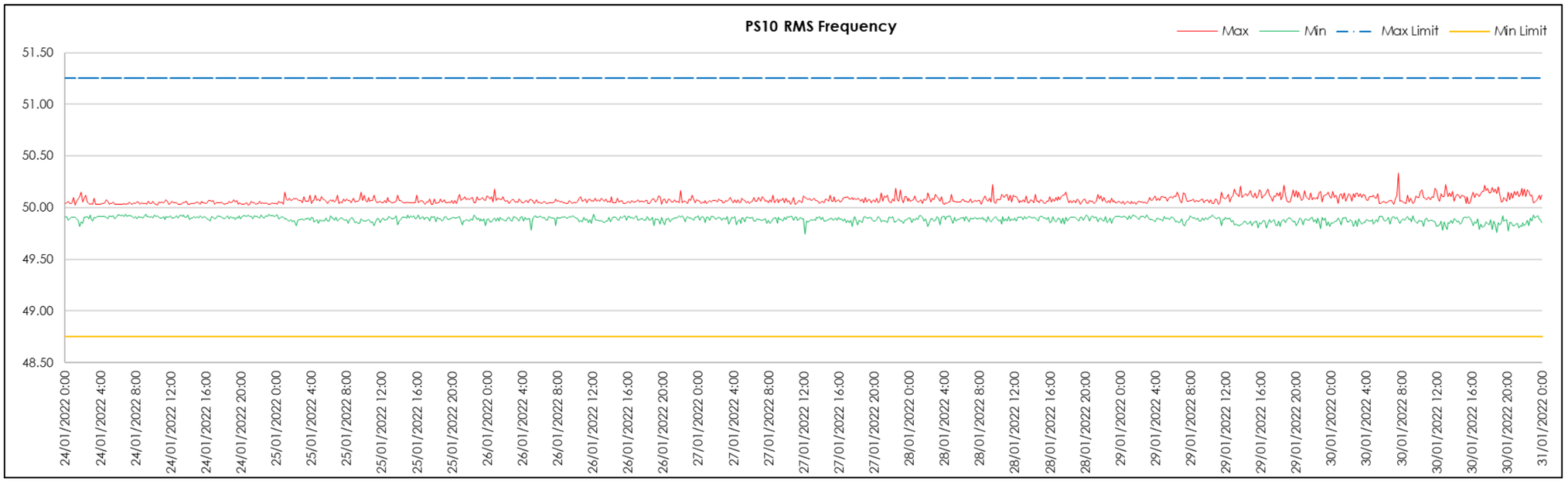


Figure 17 | TC2 Start Frequency measurements

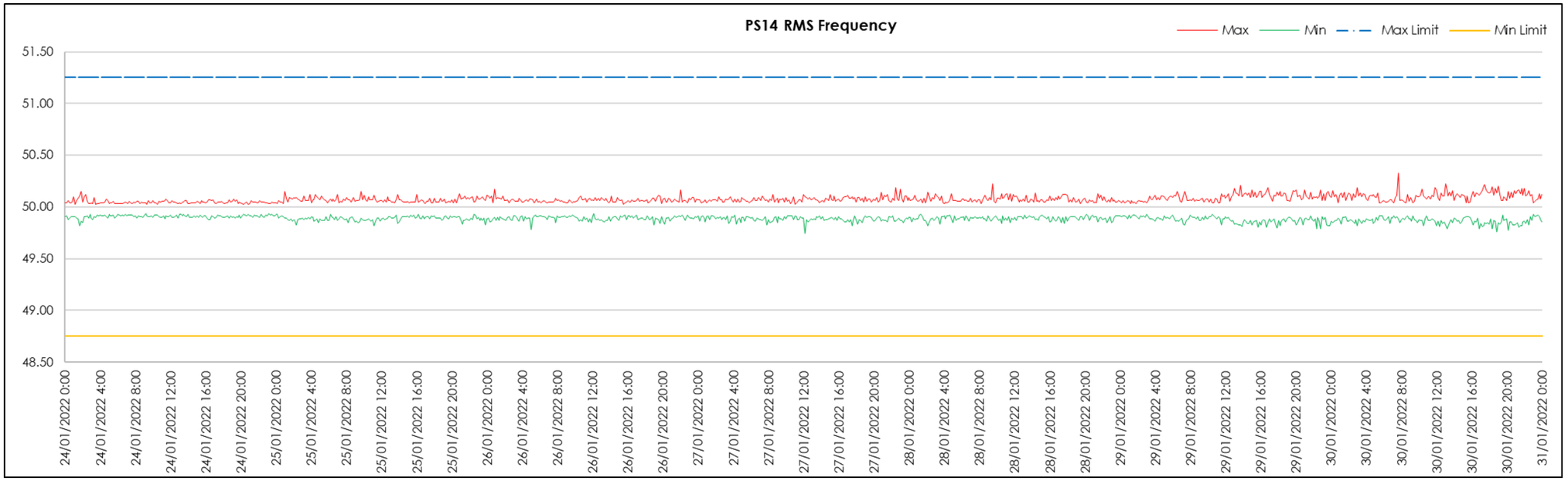
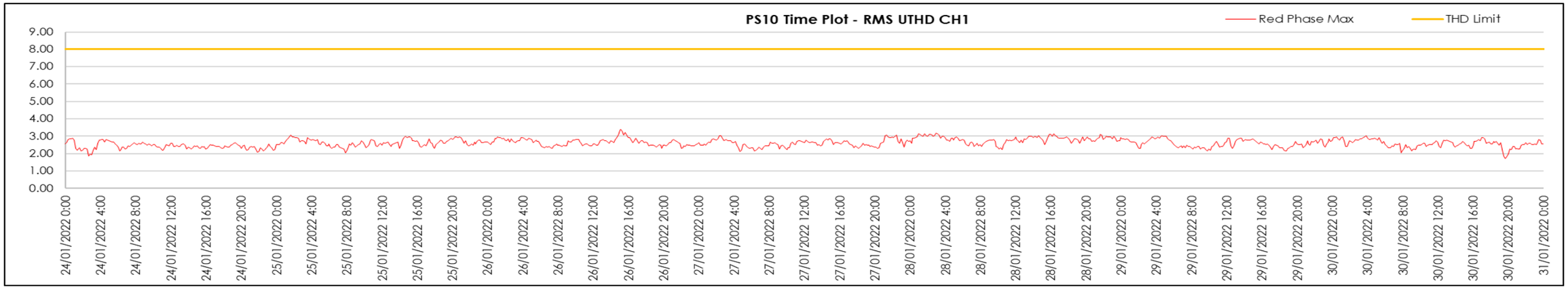
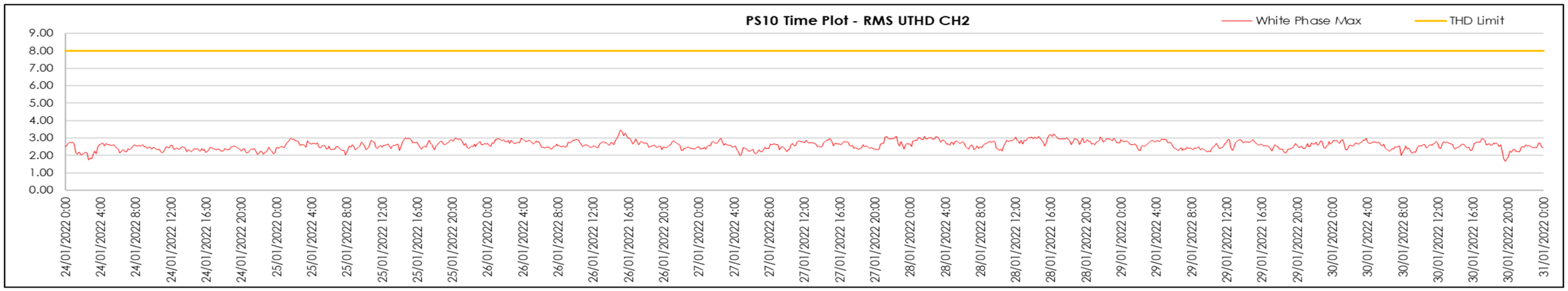


Figure 2 | TC2 End Frequency measurements





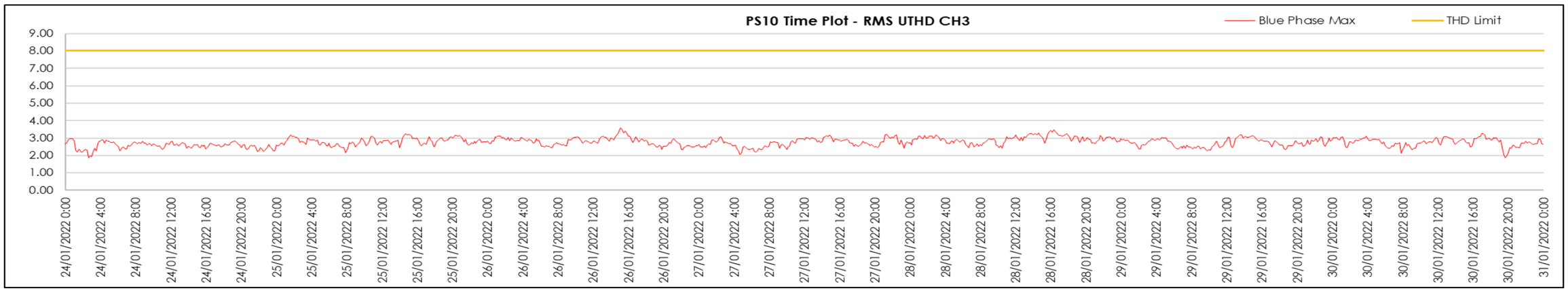
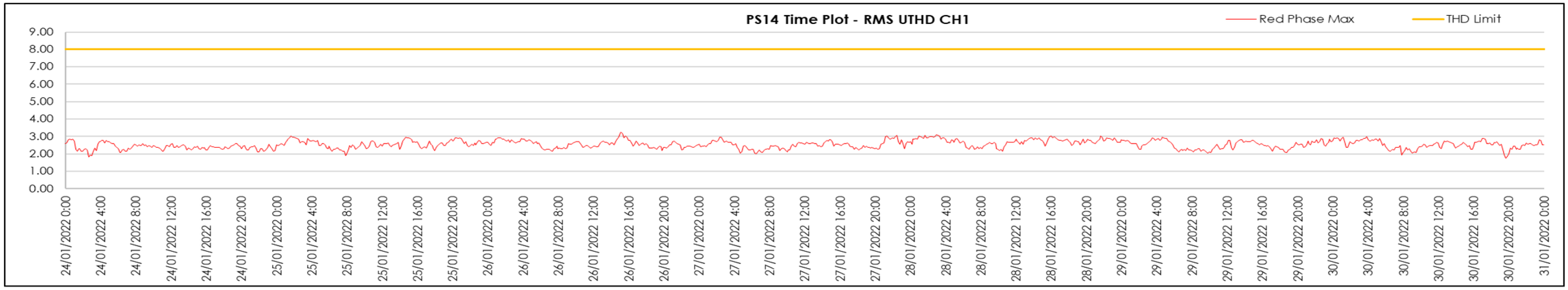
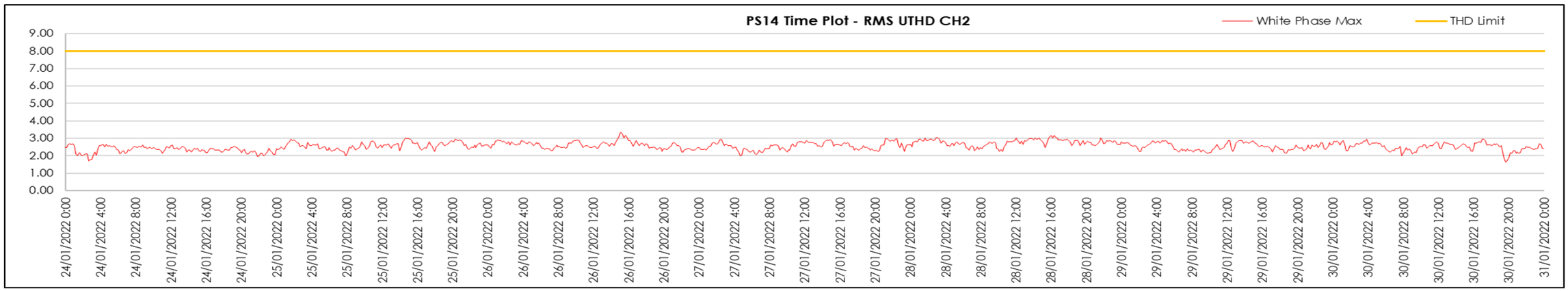


Figure 19 | TC2 Start U-THD measurements





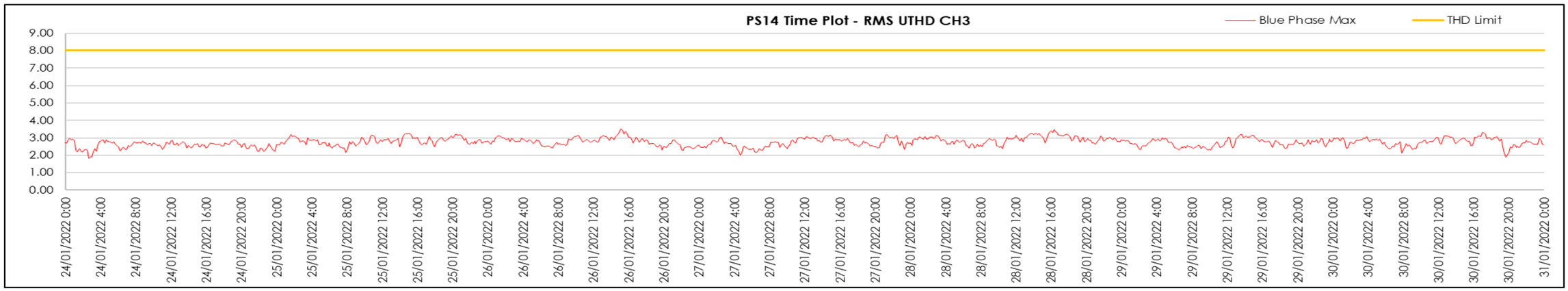
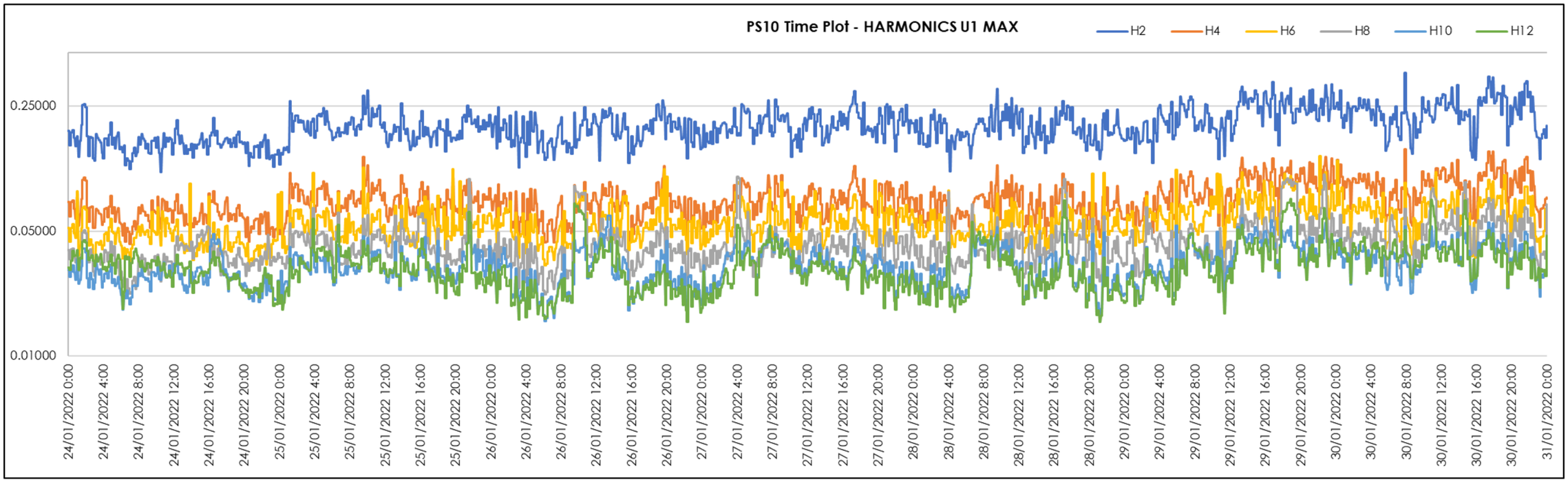


Figure 20 | TC2 End U-THD measurements


PS10 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
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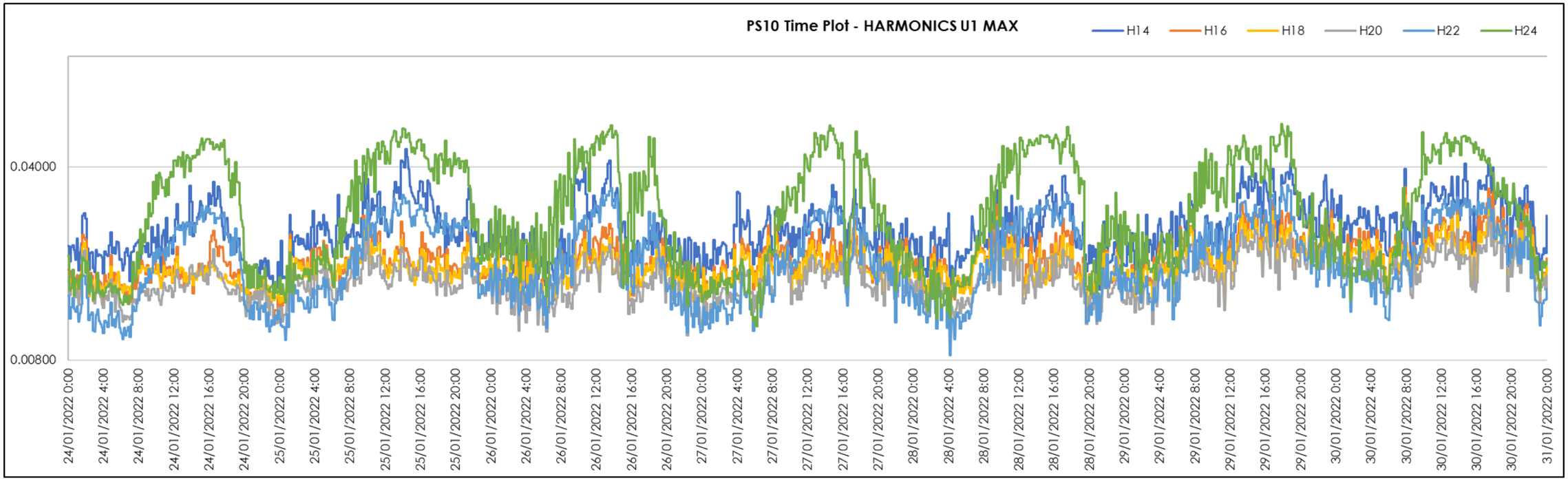
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS10 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
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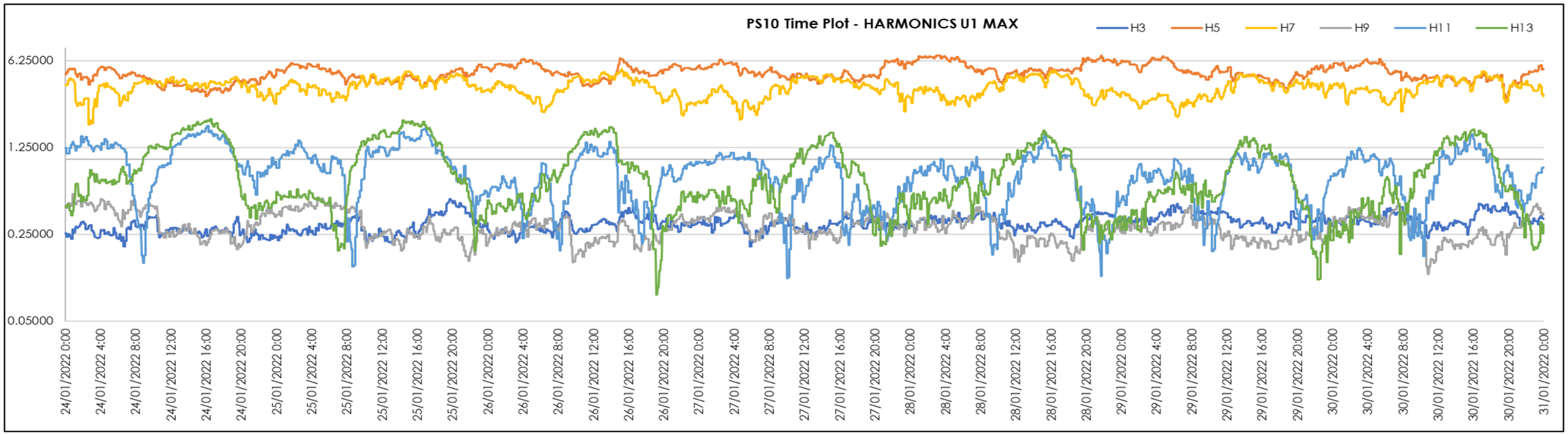
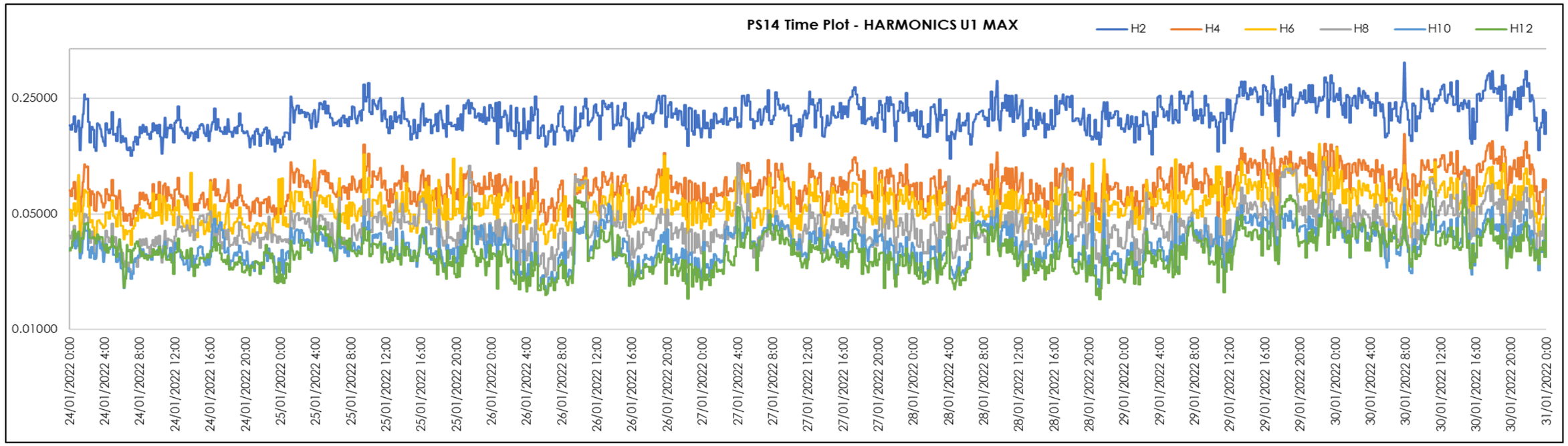


Figure 21 | TC2 Start Harmonics


PS14 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
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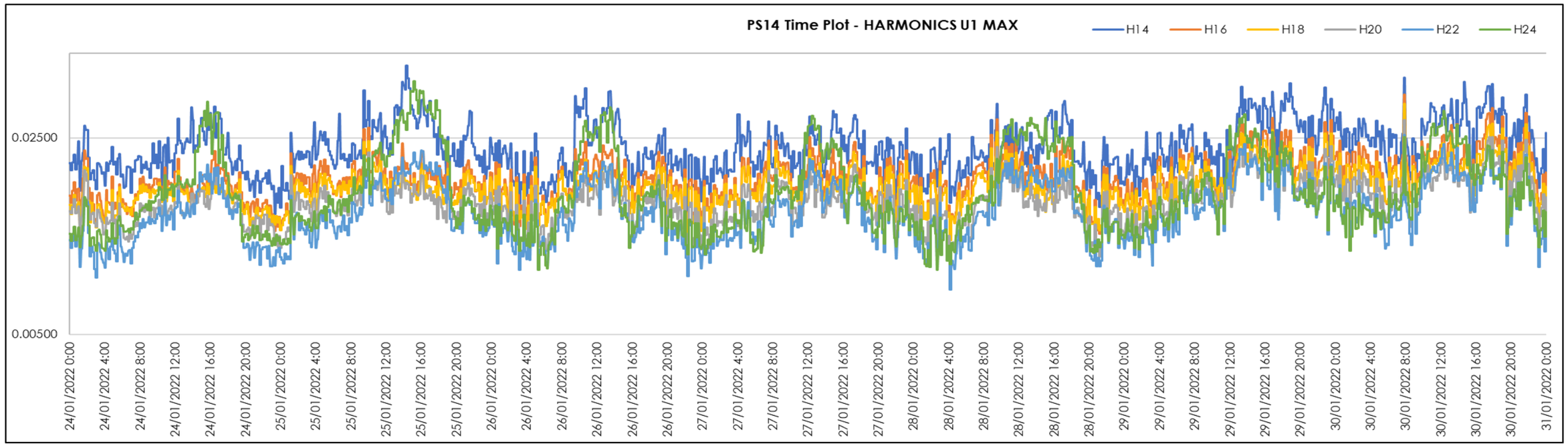
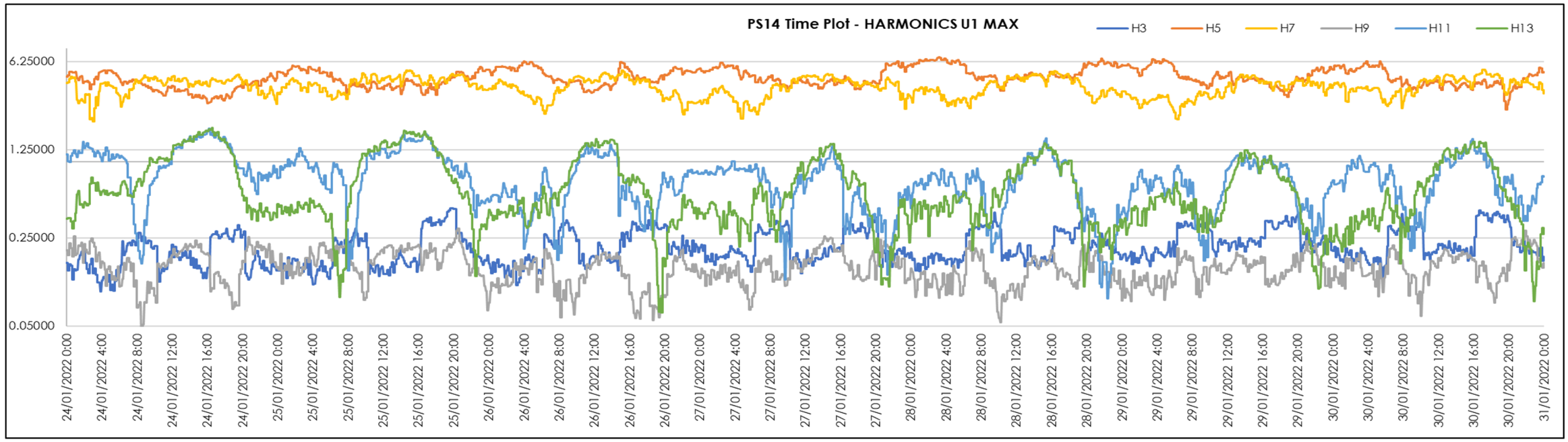
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS14 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.02500
0.00500
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



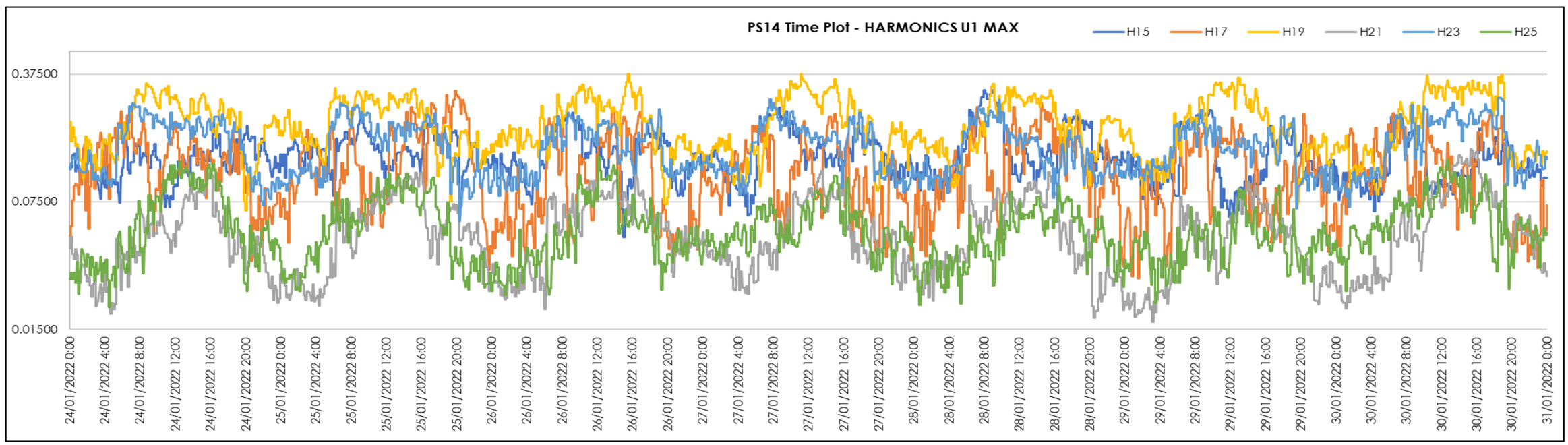
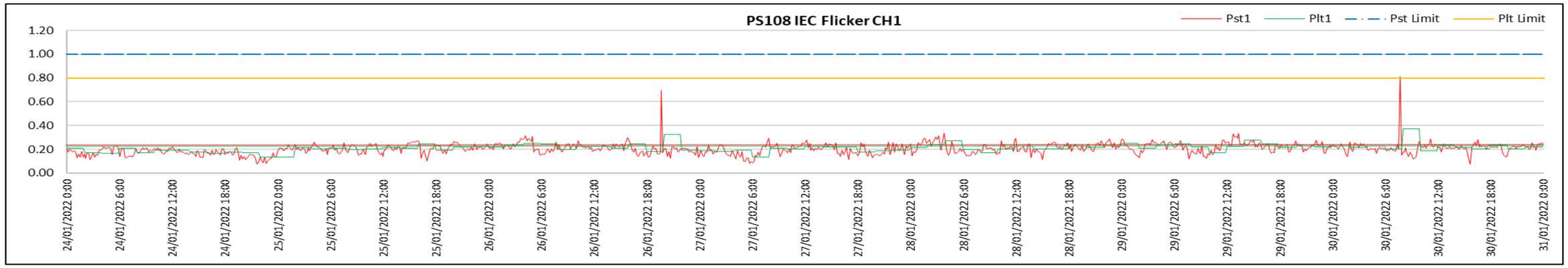
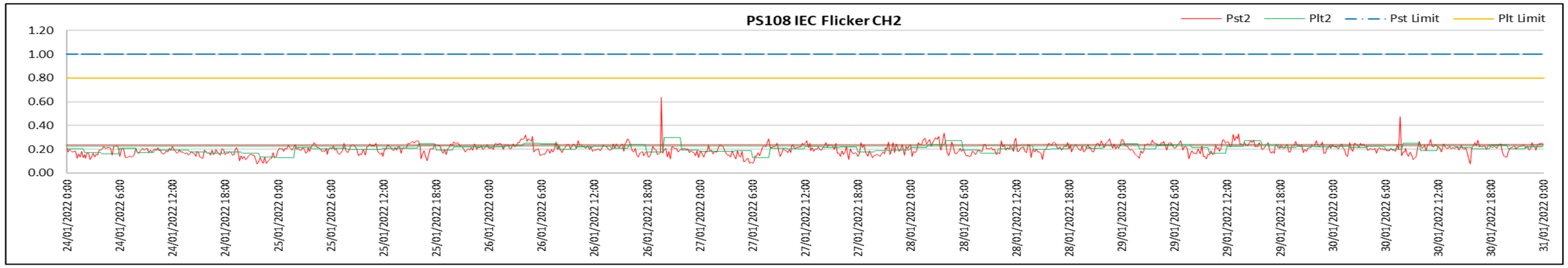


Figure 22 | TC2 End Harmonics

APPENDIX A.3 FEEDER TC3 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





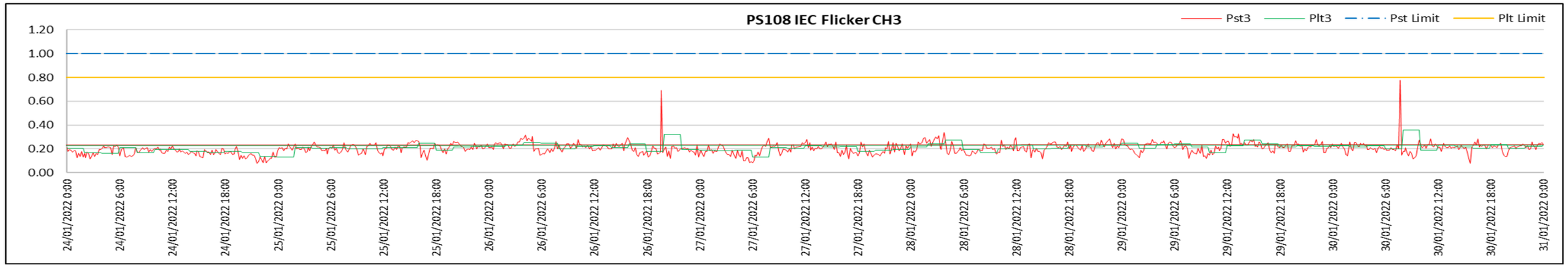


Figure 23 | TC3 Start Flicker measurements

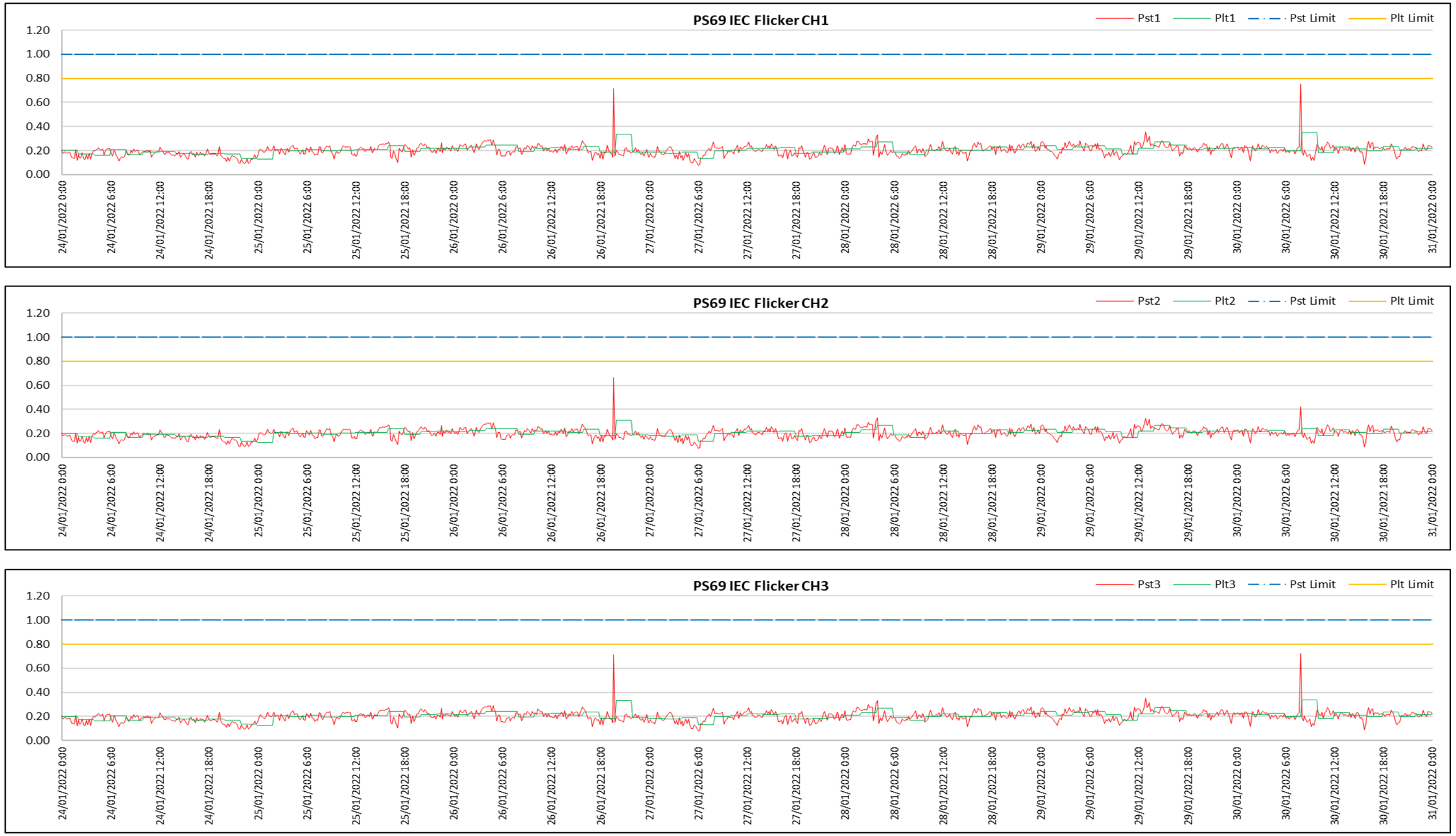


Figure 24 | TC3 End Flicker measurements

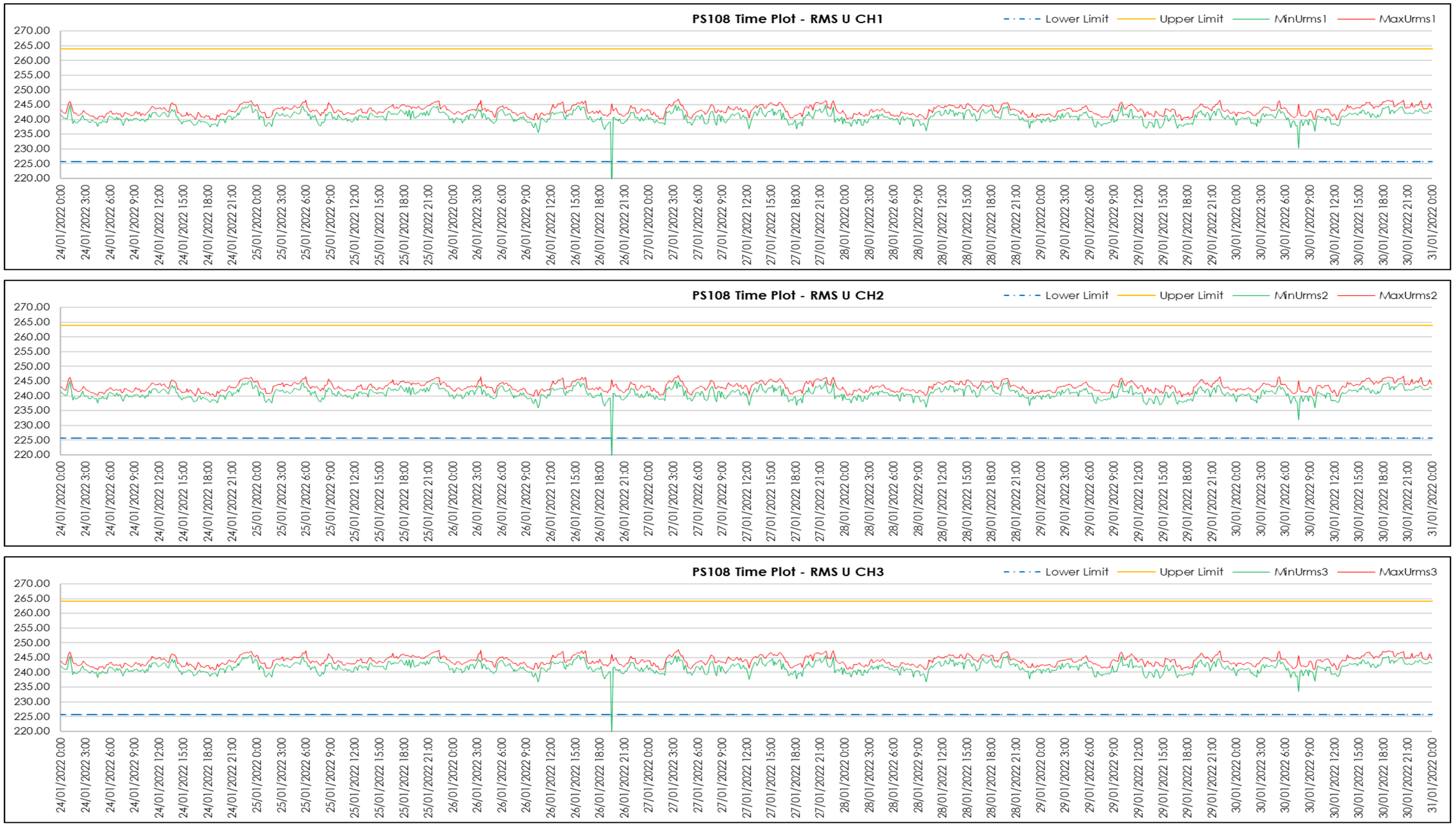


Figure 25 | TC3 Start Voltage measurements

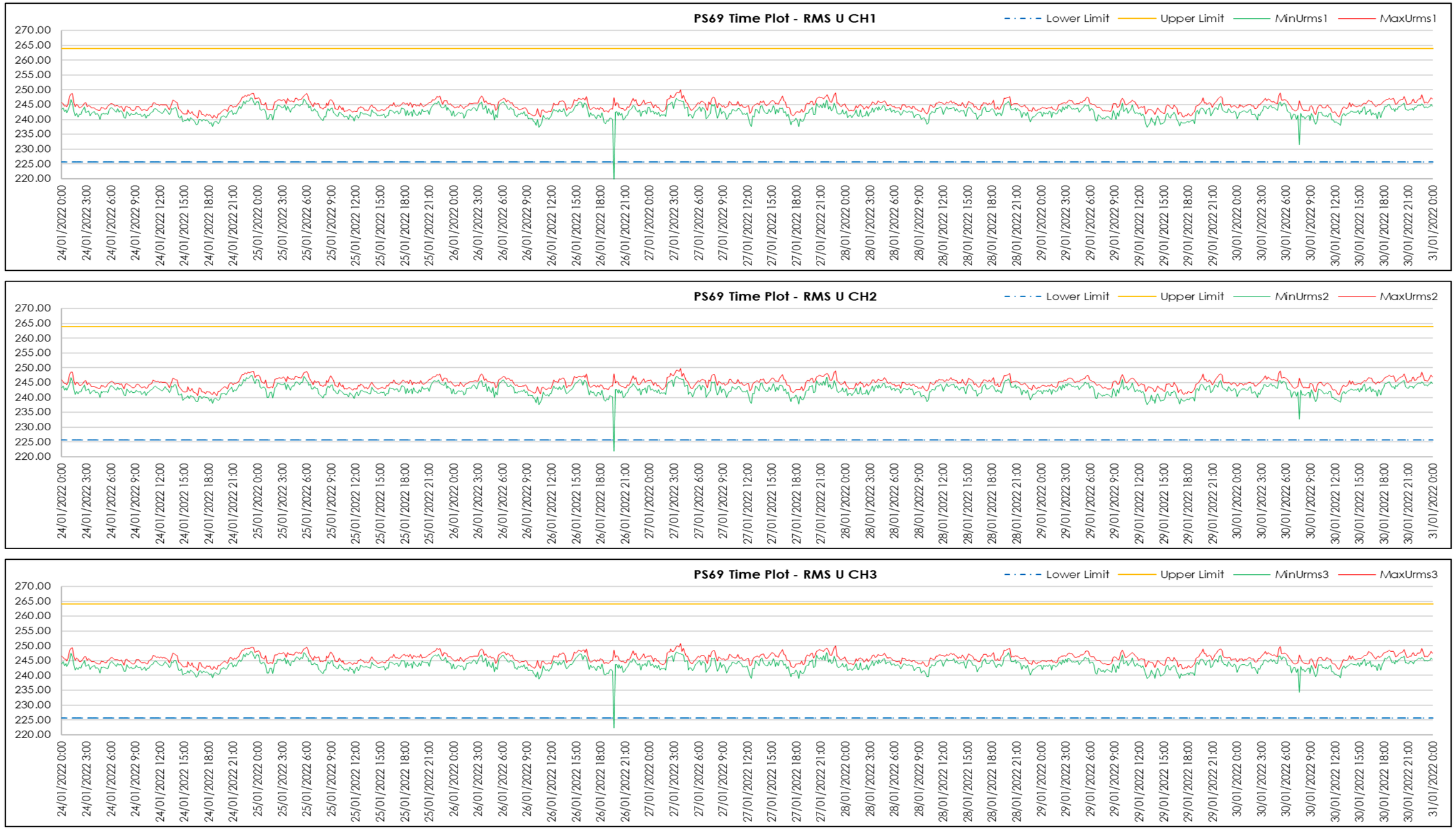


Figure 26 | TC3 End Voltage measurements

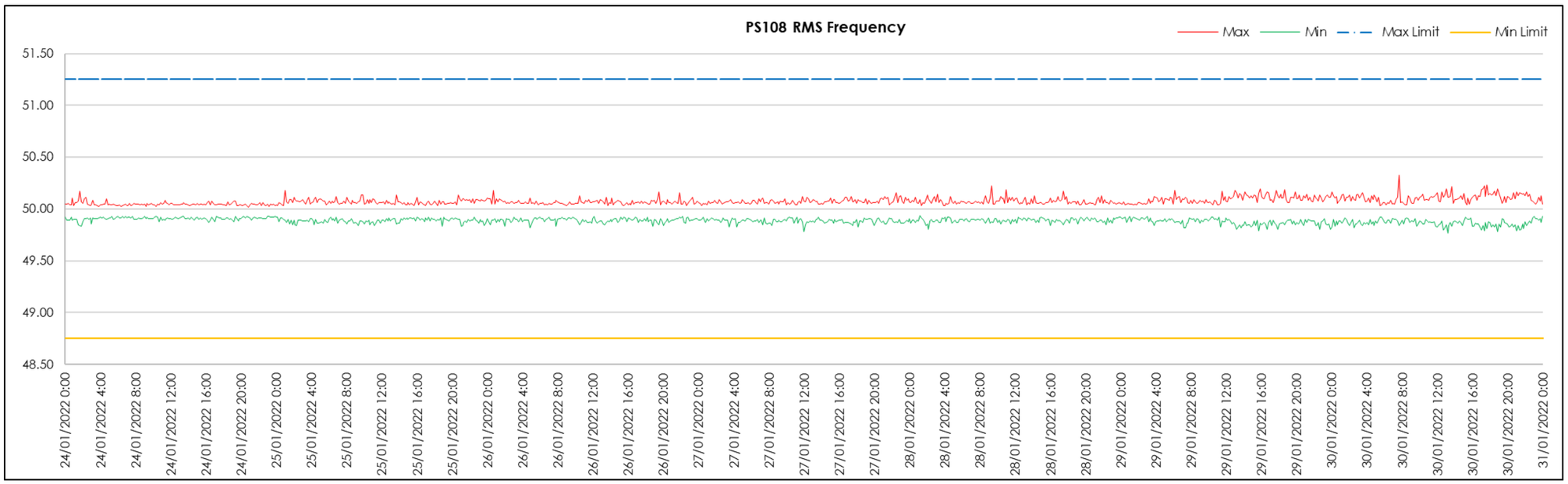


Figure 27 | TC3 Start Frequency measurements

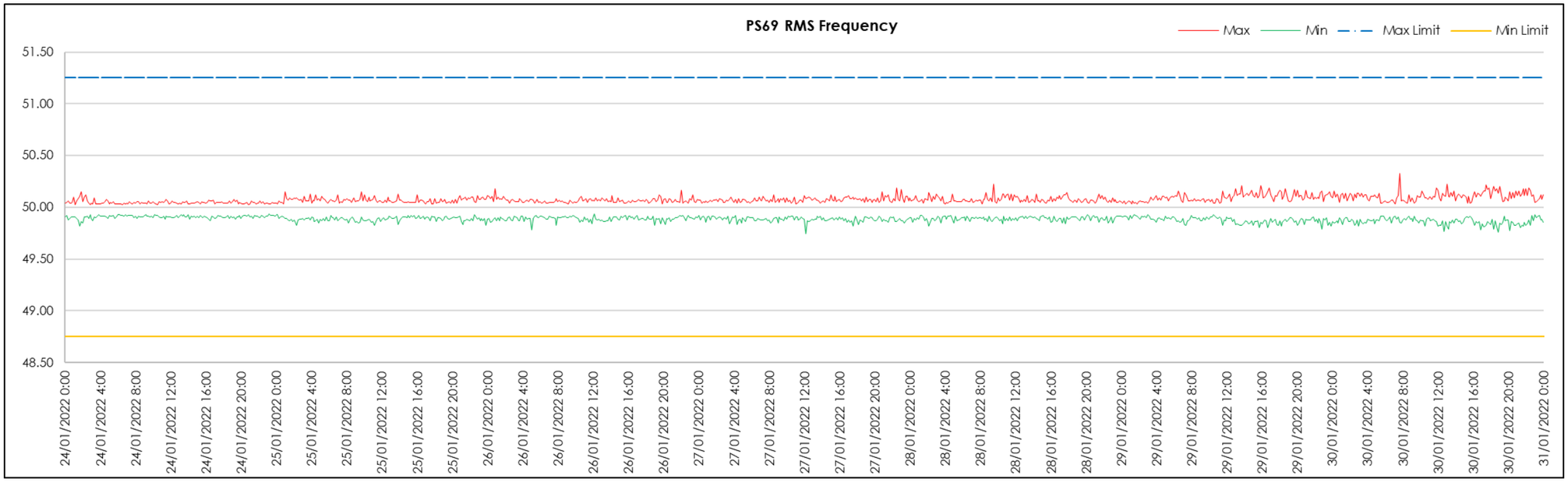
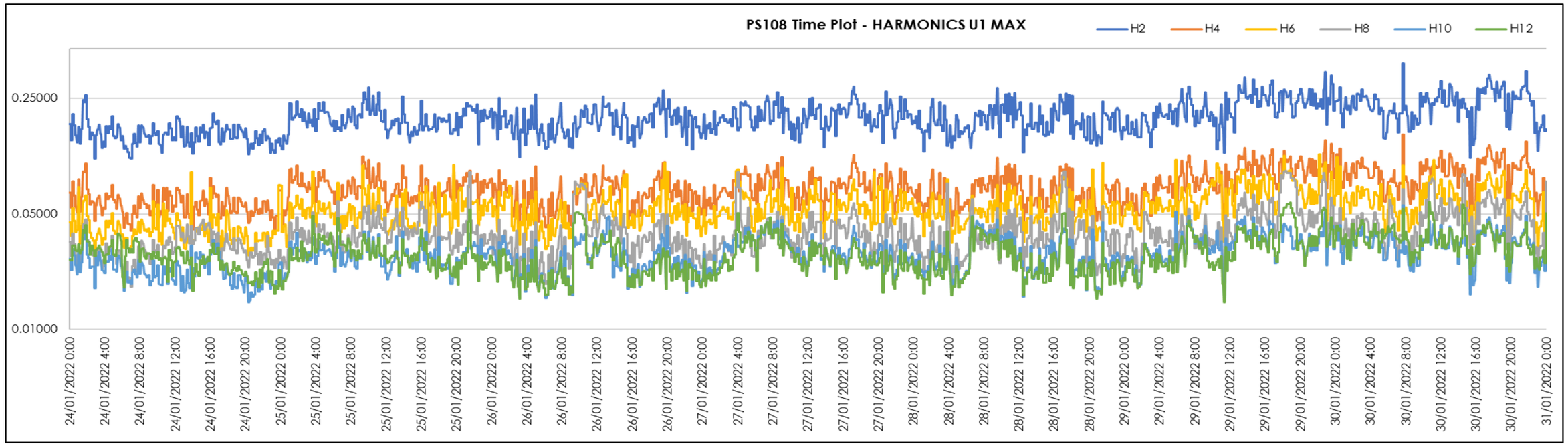
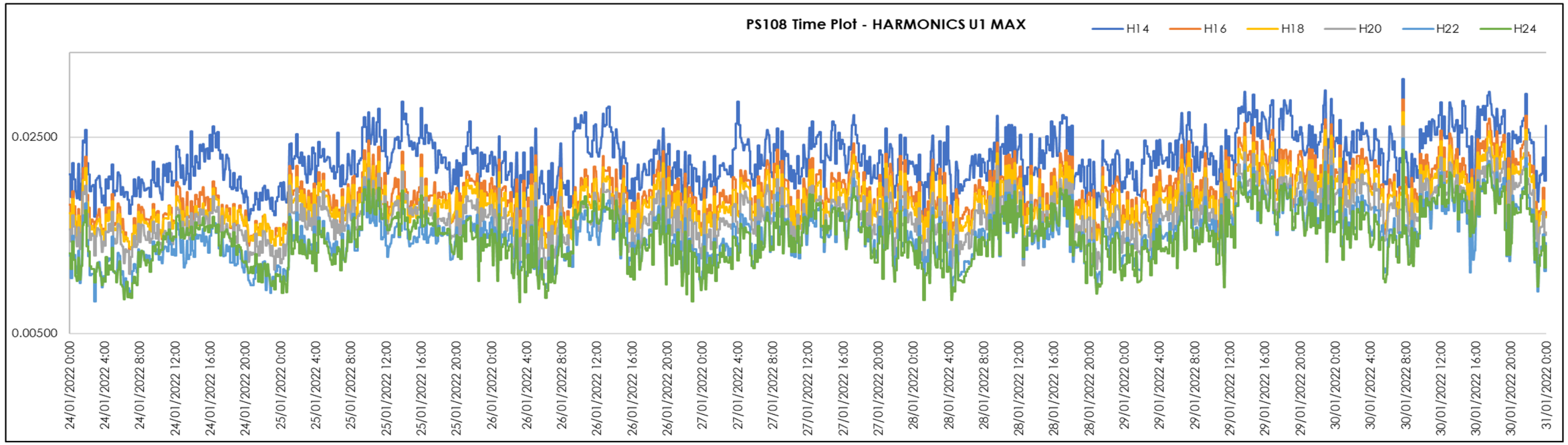


Figure 28 | TC3 End Frequency measurements

Figure 29 | TC3 Start U-THD measurements

Figure 30 | TC3 End U-THD measurements


PS108 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS108 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.02500
0.00500
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
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27/01/2022 0:00
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27/01/2022 16:00
27/01/2022 20:00
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28/01/2022 4:00
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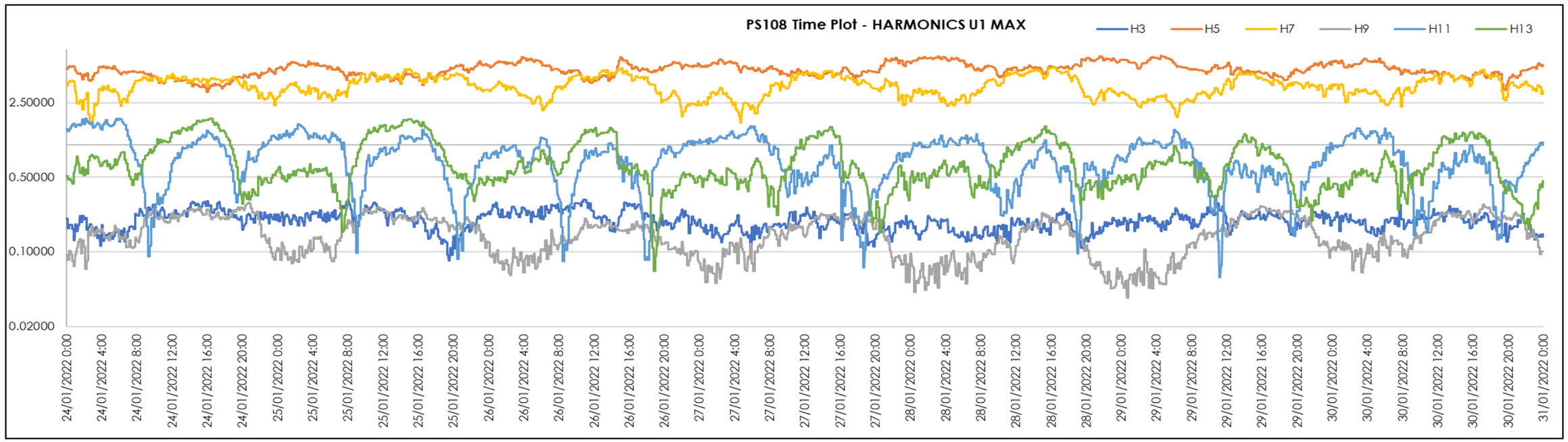
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



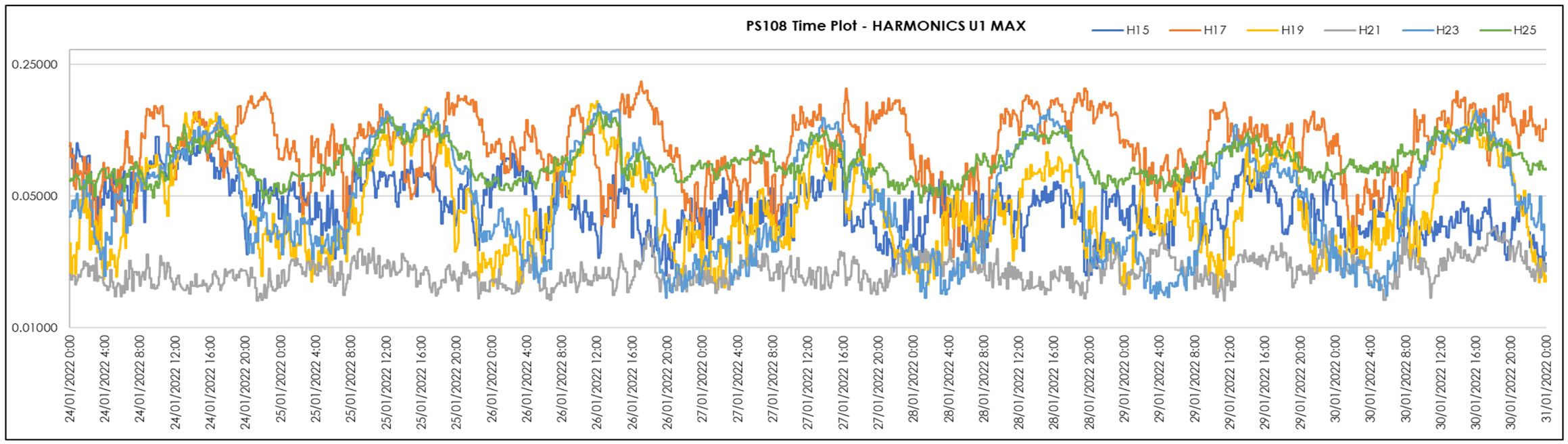
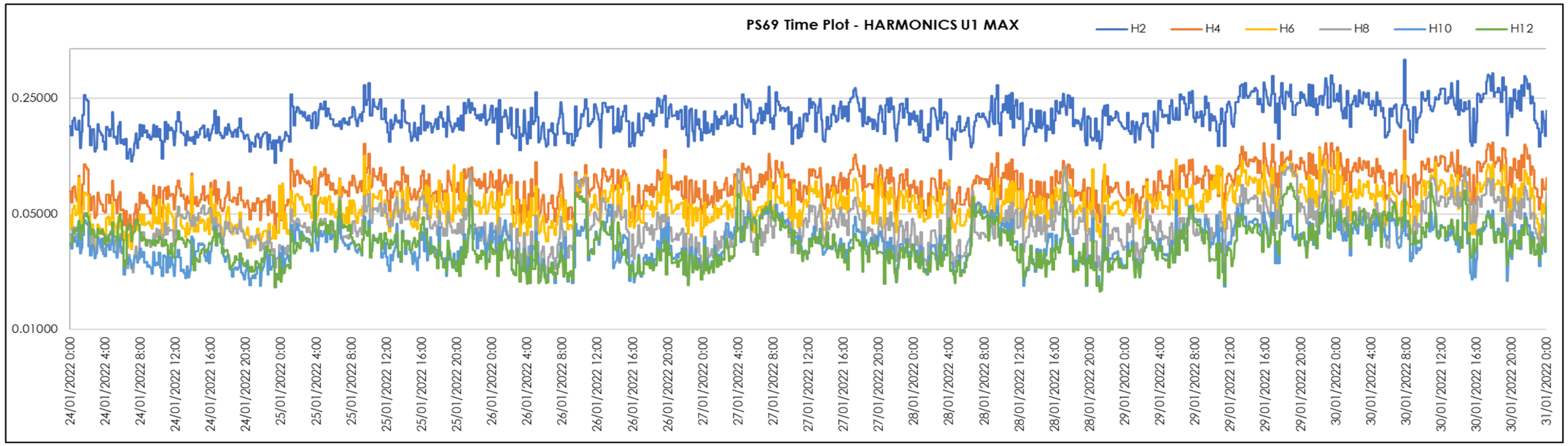


Figure 31 | TC3 Start Harmonics


PS69 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
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26/01/2022 4:00
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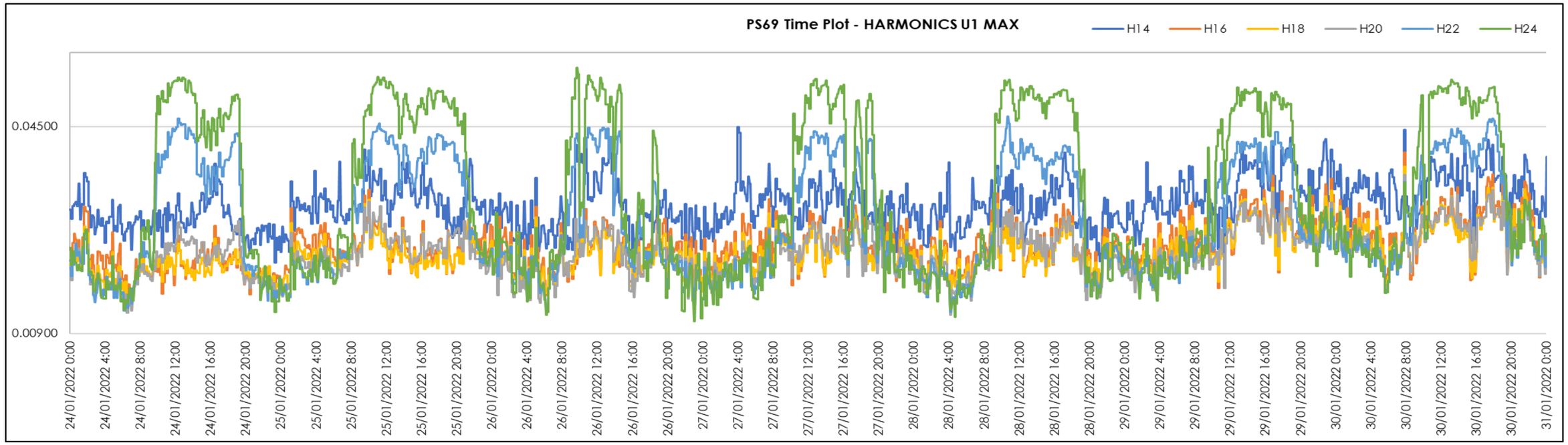
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS69 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.04500
0.00900
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
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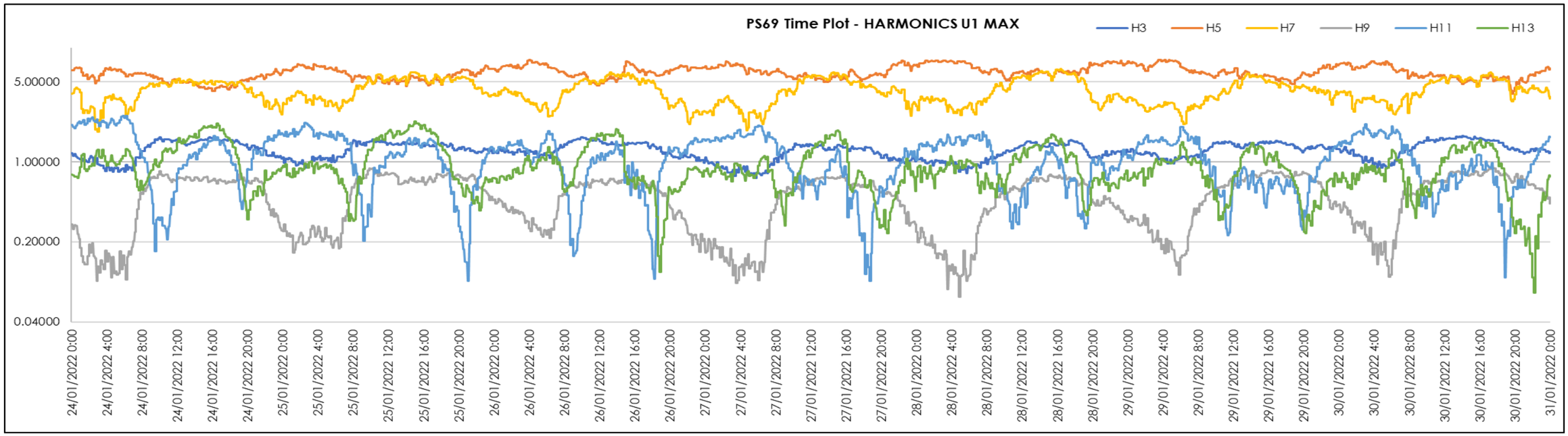
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



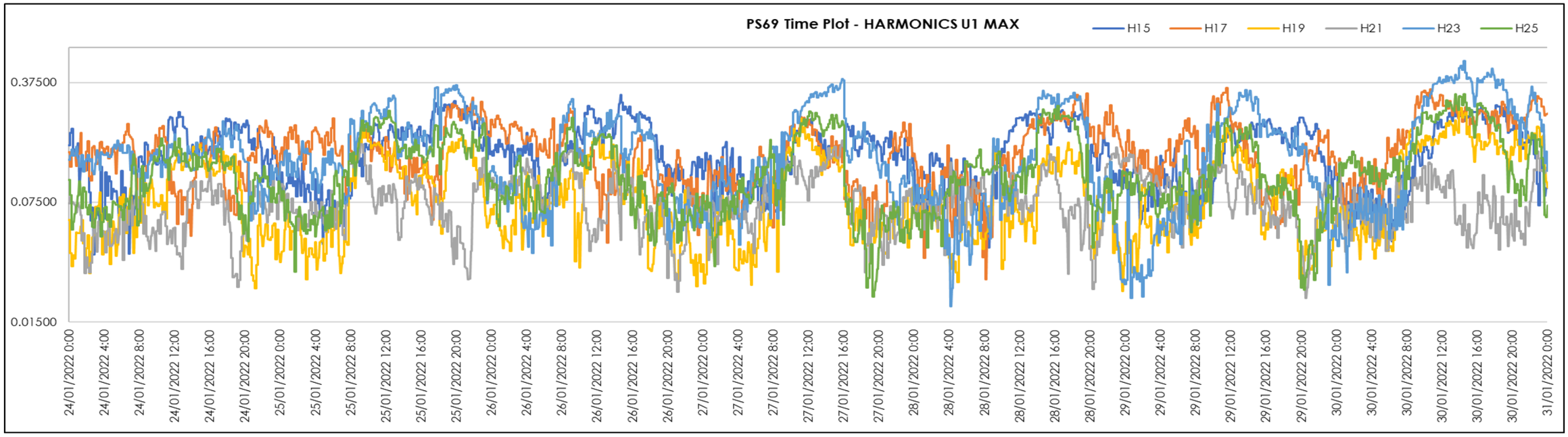
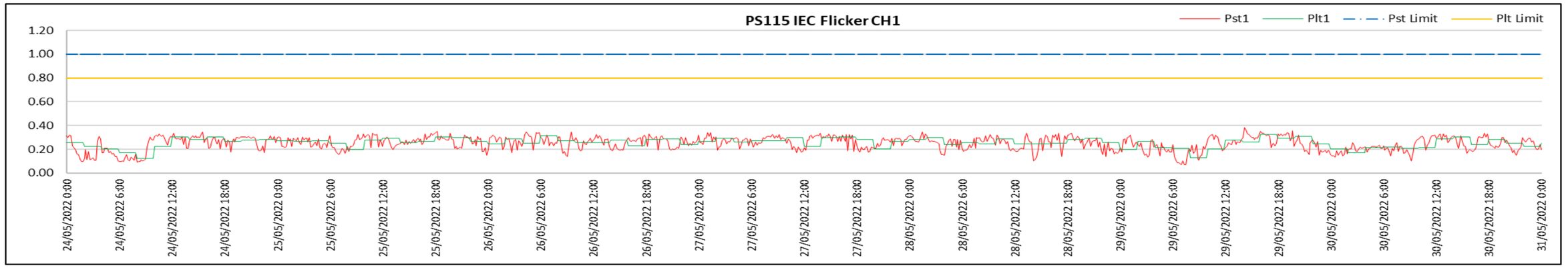
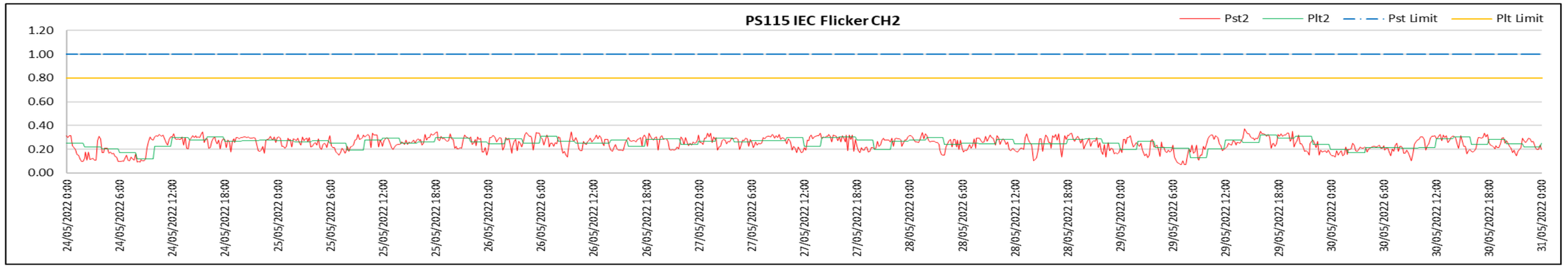


Figure 32 | TC3 End Harmonics

APPENDIX A.4 FEEDER TC4 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





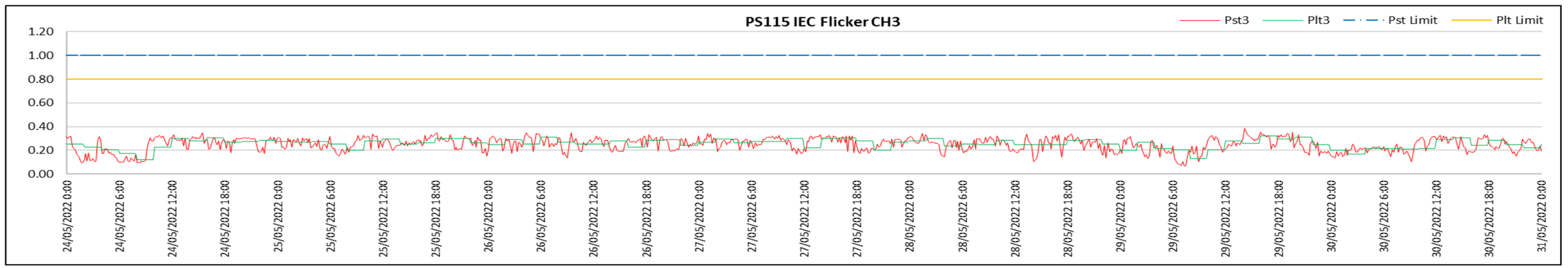
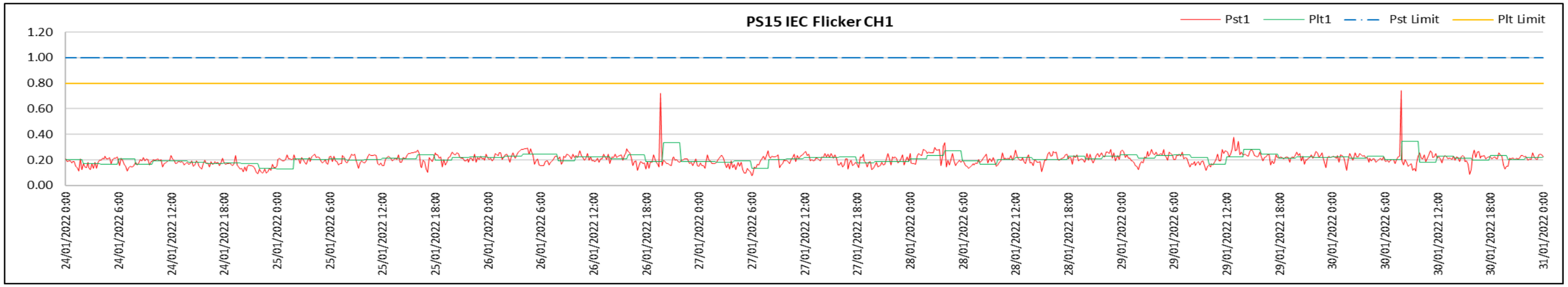
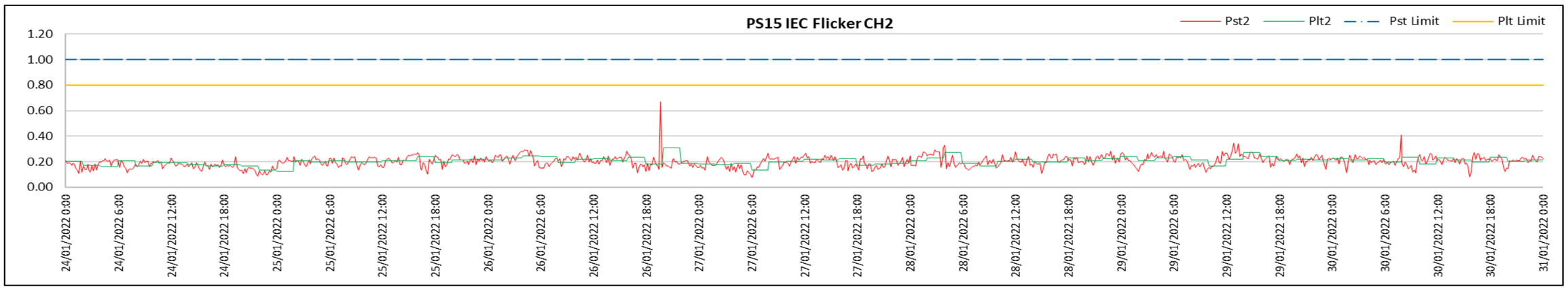


Figure 33 | TC4 Start Flicker measurements





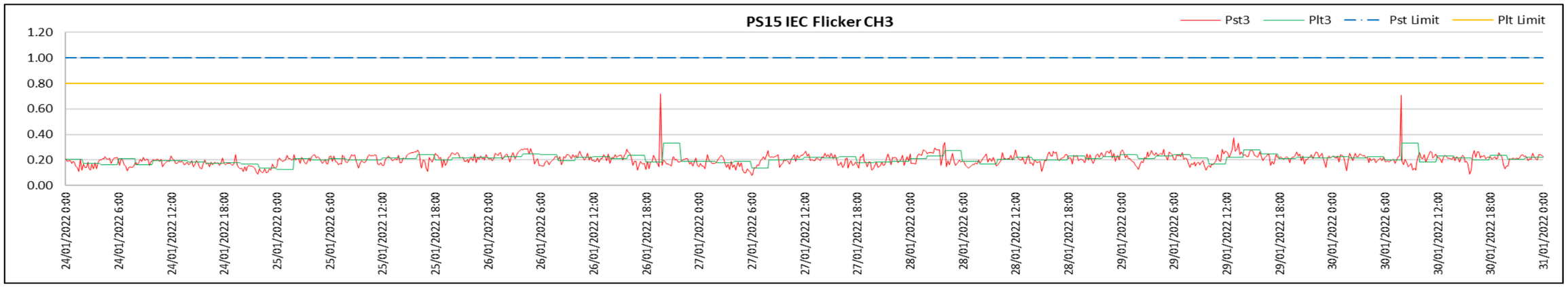


Figure 34 | TC4 End Flicker measurements

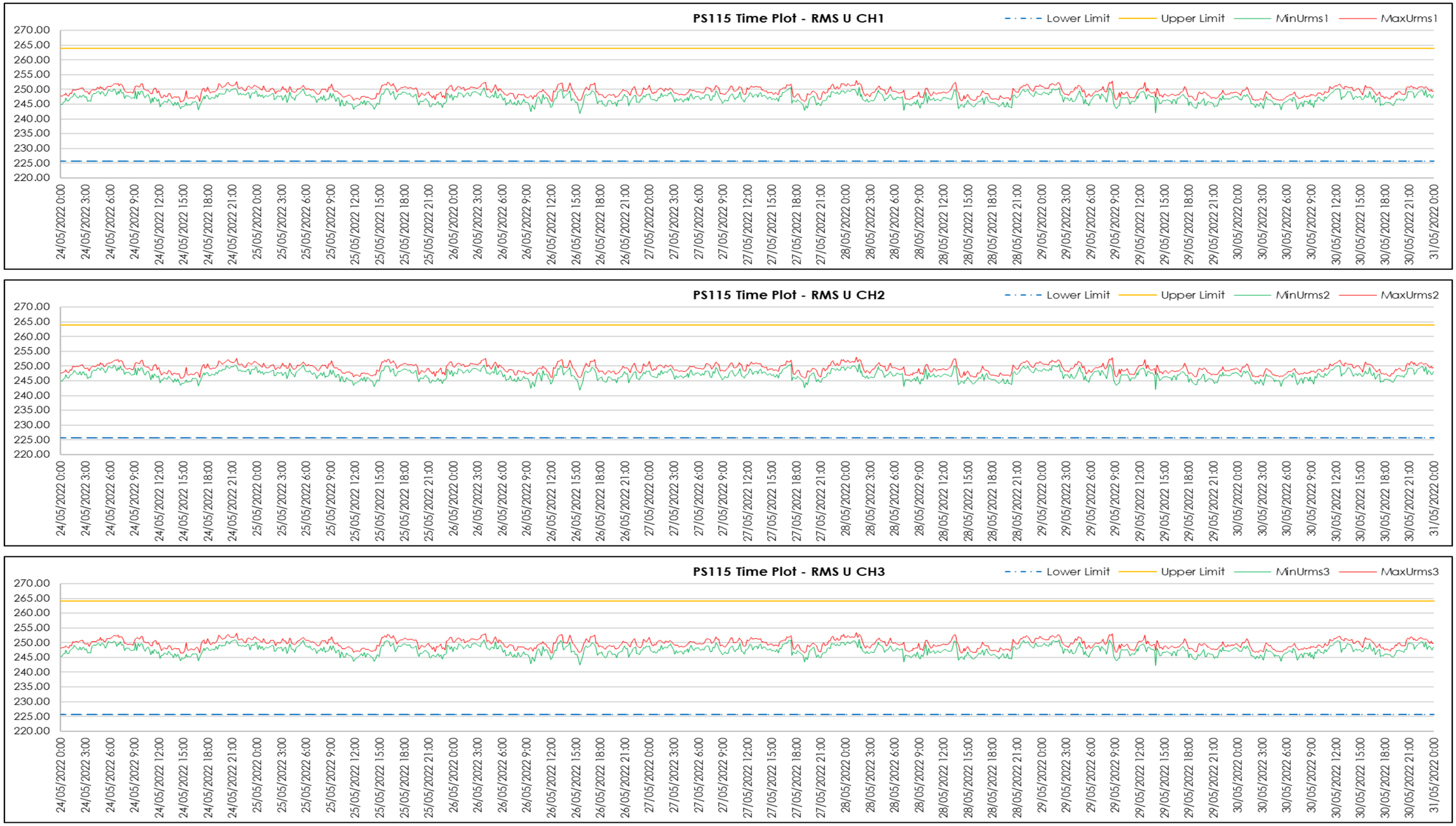
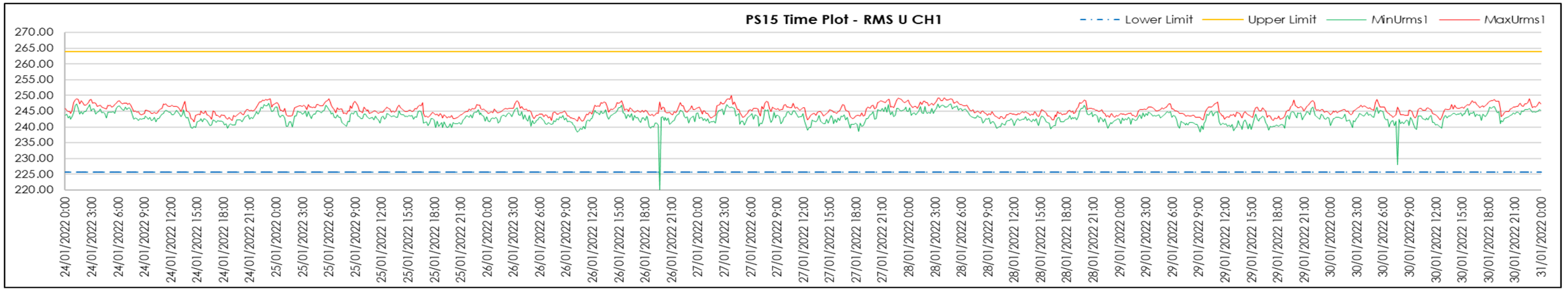
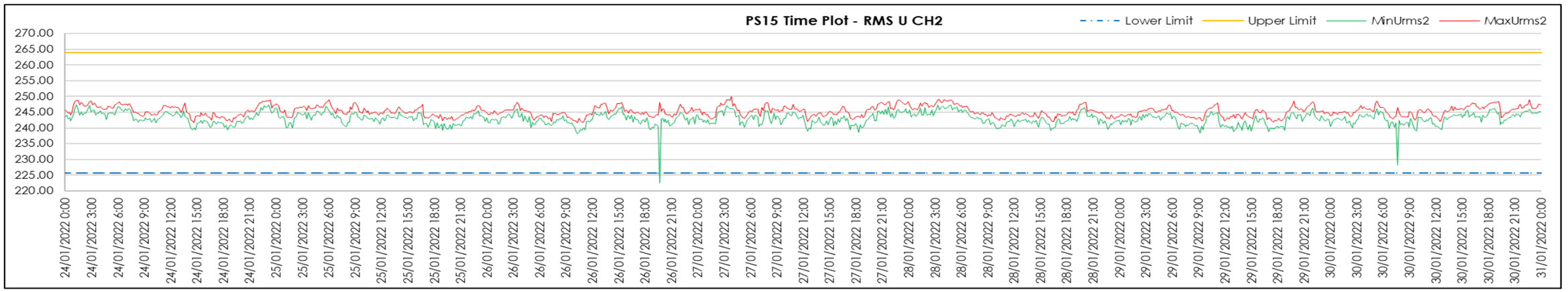


Figure 35 | TC4 Start Voltage measurements





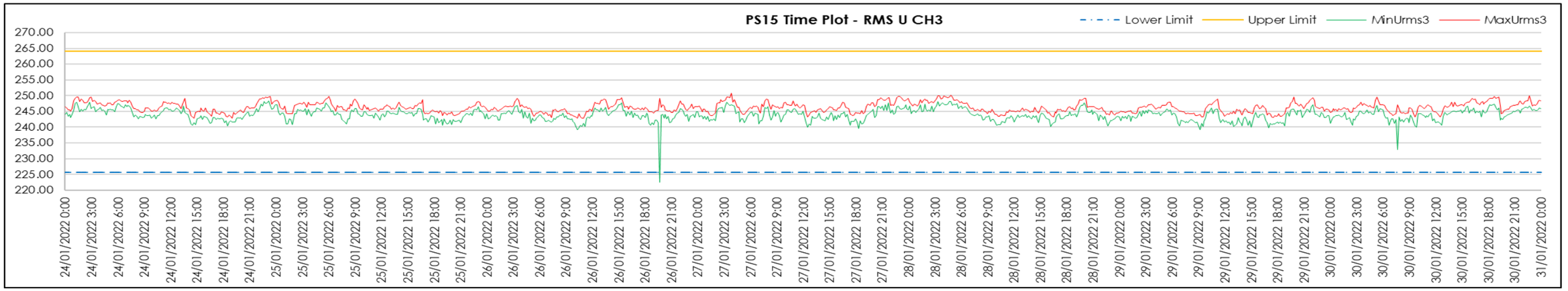


Figure 36 | TC4 End Voltage measurements

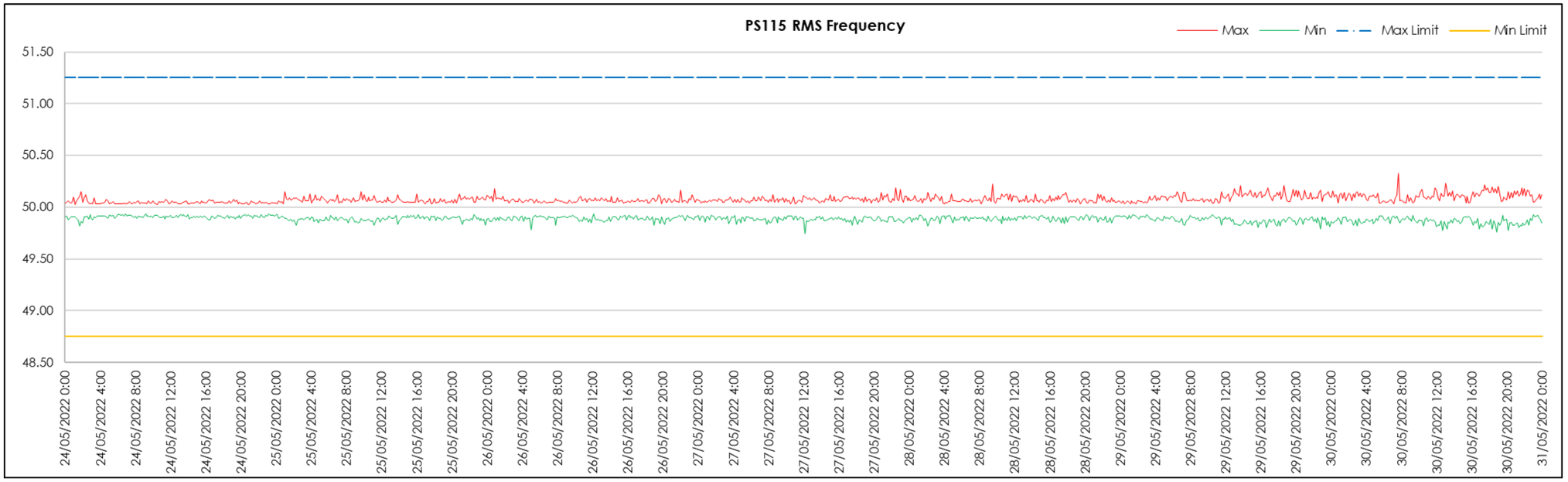


Figure 37 | TC4 Start Frequency measurements

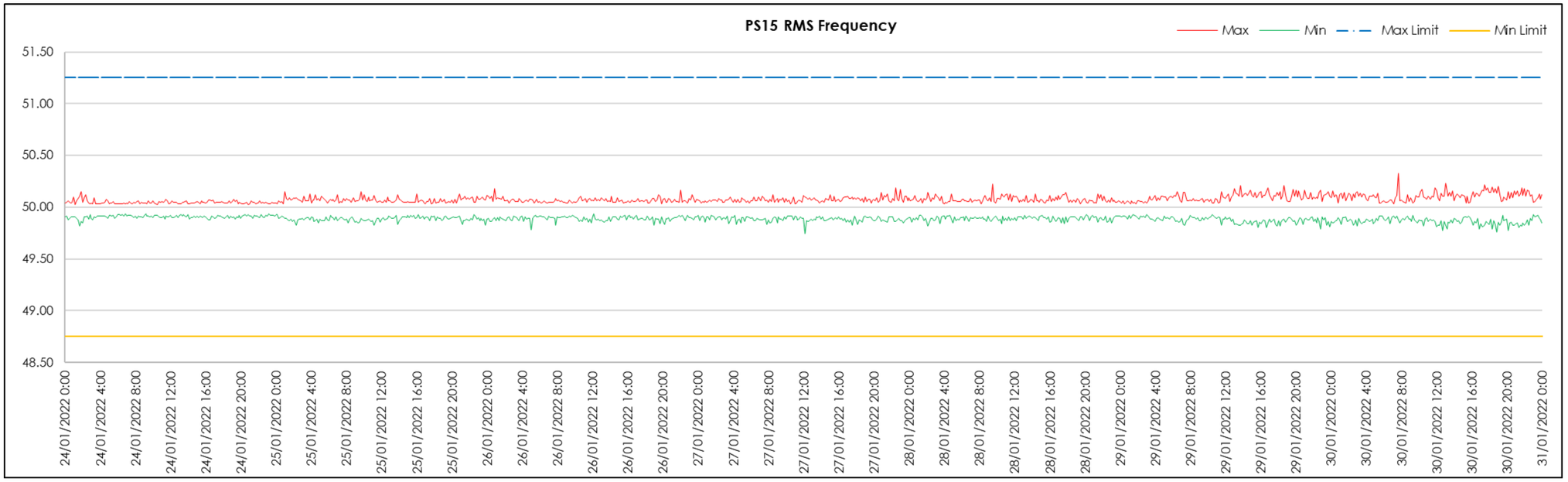
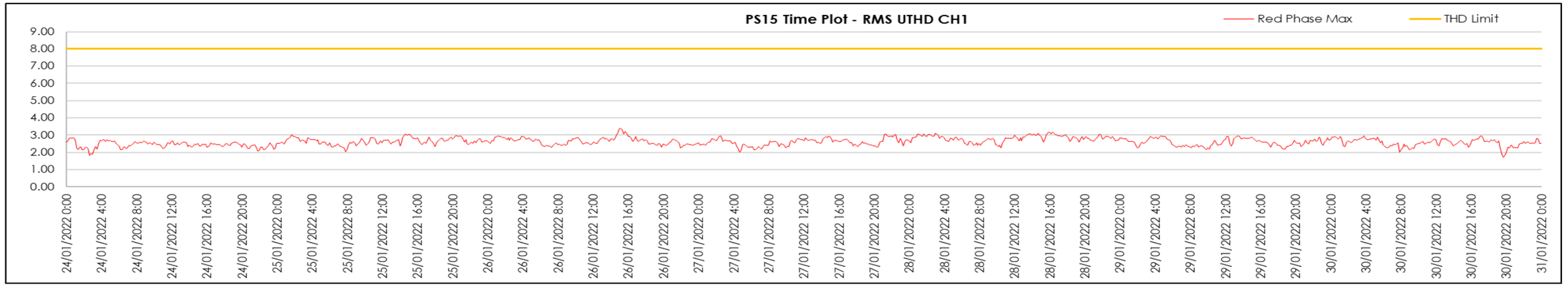
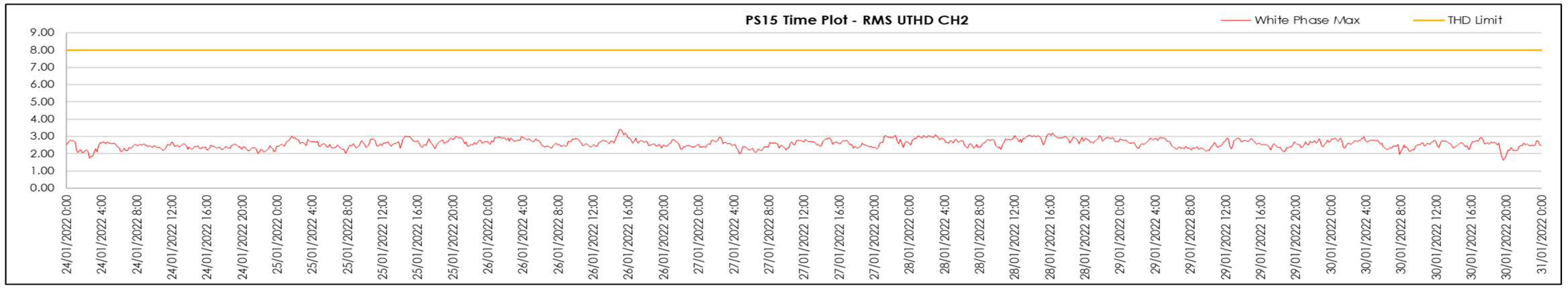


Figure 38 | TC4 End Frequency measurements





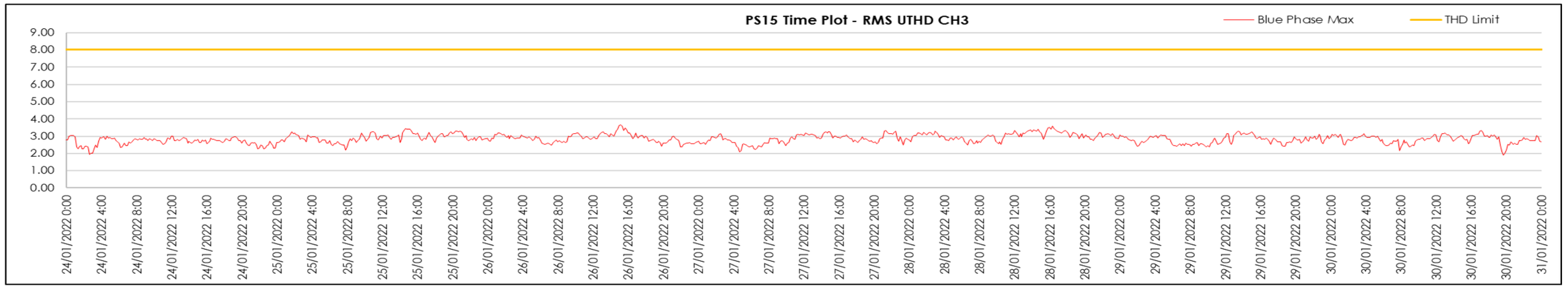
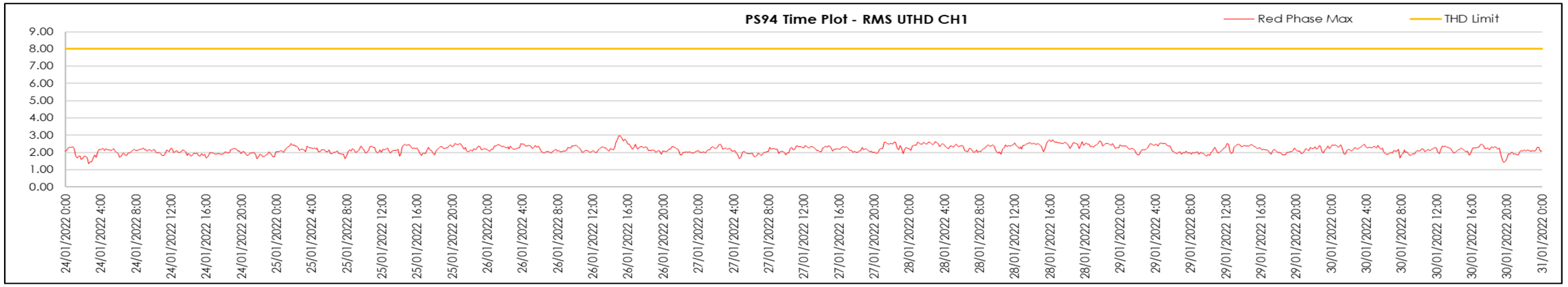
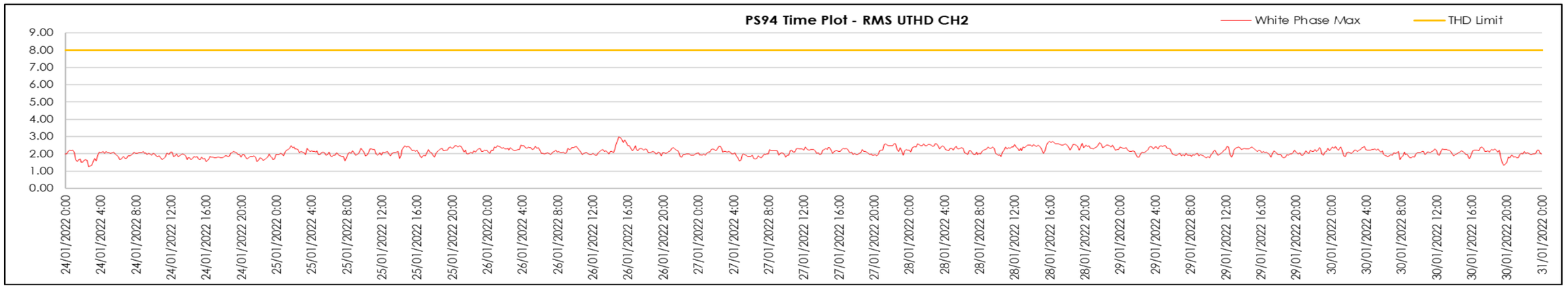


Figure 39 | TC4 Start U-THD measurements





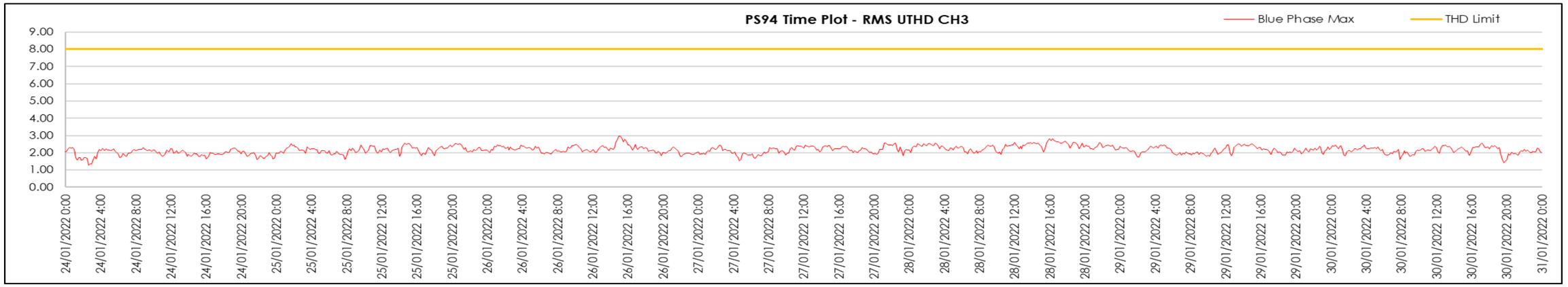
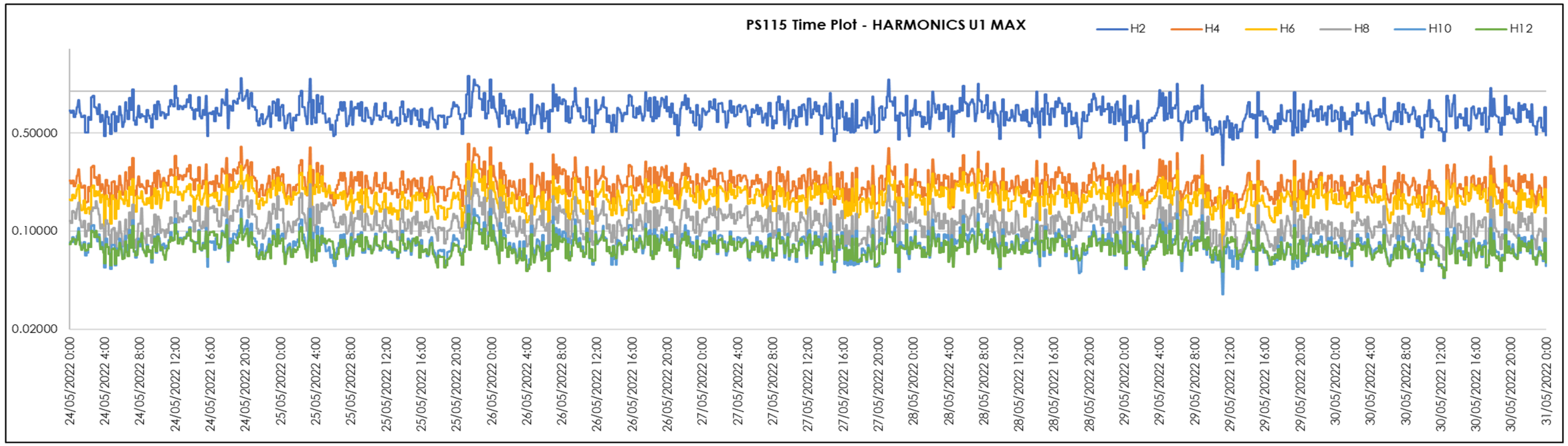
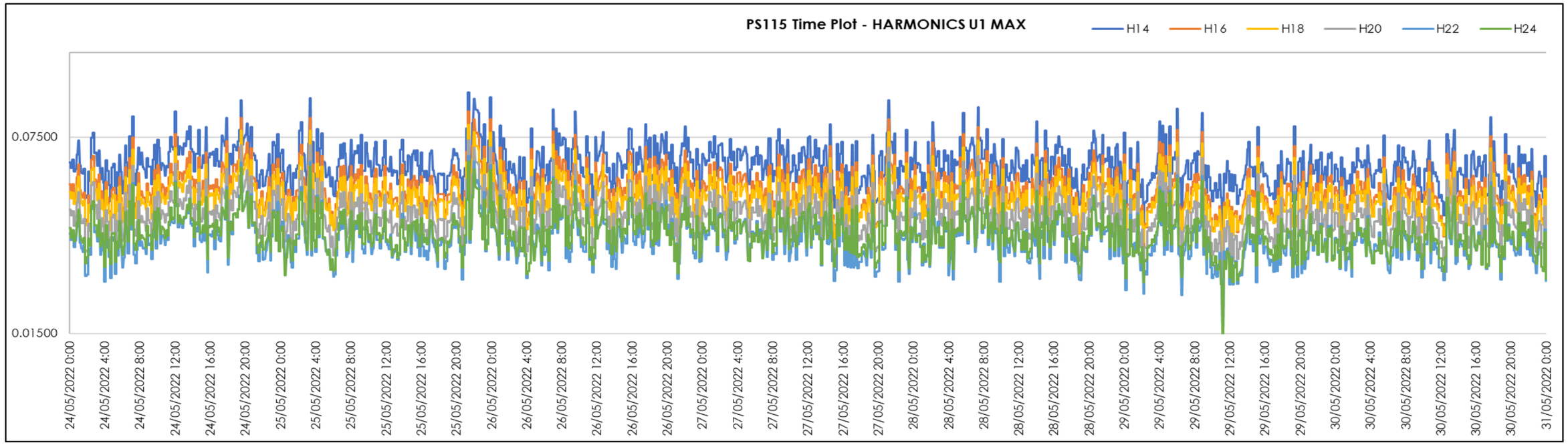


Figure 40 | TC4 End U-THD measurements


PS115 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.50000
0.10000
0.02000
24/05/2022 0:00
24/05/2022 4:00
24/05/2022 8:00
24/05/2022 12:00
24/05/2022 16:00
24/05/2022 20:00
25/05/2022 0:00
25/05/2022 4:00
25/05/2022 8:00
25/05/2022 12:00
25/05/2022 16:00
25/05/2022 20:00
26/05/2022 0:00
26/05/2022 4:00
26/05/2022 8:00
26/05/2022 12:00
26/05/2022 16:00
26/05/2022 20:00
27/05/2022 0:00
27/05/2022 4:00
27/05/2022 8:00
27/05/2022 12:00
27/05/2022 16:00
27/05/2022 20:00
28/05/2022 0:00
28/05/2022 4:00
28/05/2022 8:00
28/05/2022 12:00
28/05/2022 16:00
28/05/2022 20:00
29/05/2022 0:00
29/05/2022 4:00
29/05/2022 8:00
29/05/2022 12:00
29/05/2022 16:00
29/05/2022 20:00
30/05/2022 0:00
30/05/2022 4:00
30/05/2022 8:00
30/05/2022 12:00
30/05/2022 16:00
30/05/2022 20:00
31/05/2022 0:00


PS115 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.07500
0.01500
24/05/2022 0:00
24/05/2022 4:00
24/05/2022 8:00
24/05/2022 12:00
24/05/2022 16:00
24/05/2022 20:00
25/05/2022 0:00
25/05/2022 4:00
25/05/2022 8:00
25/05/2022 12:00
25/05/2022 16:00
25/05/2022 20:00
26/05/2022 0:00
26/05/2022 4:00
26/05/2022 8:00
26/05/2022 12:00
26/05/2022 16:00
26/05/2022 20:00
27/05/2022 0:00
27/05/2022 4:00
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27/05/2022 12:00
27/05/2022 16:00
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28/05/2022 4:00
28/05/2022 8:00
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29/05/2022 4:00
29/05/2022 8:00
29/05/2022 12:00
29/05/2022 16:00
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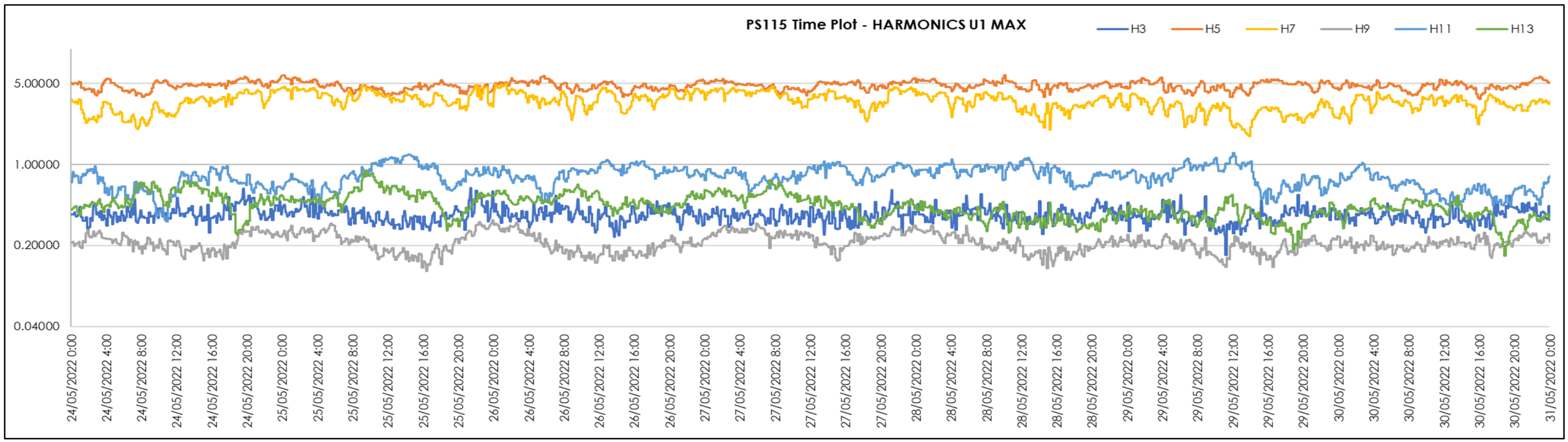
30/05/2022 4:00
30/05/2022 8:00
30/05/2022 12:00
30/05/2022 16:00
30/05/2022 20:00
31/05/2022 0:00



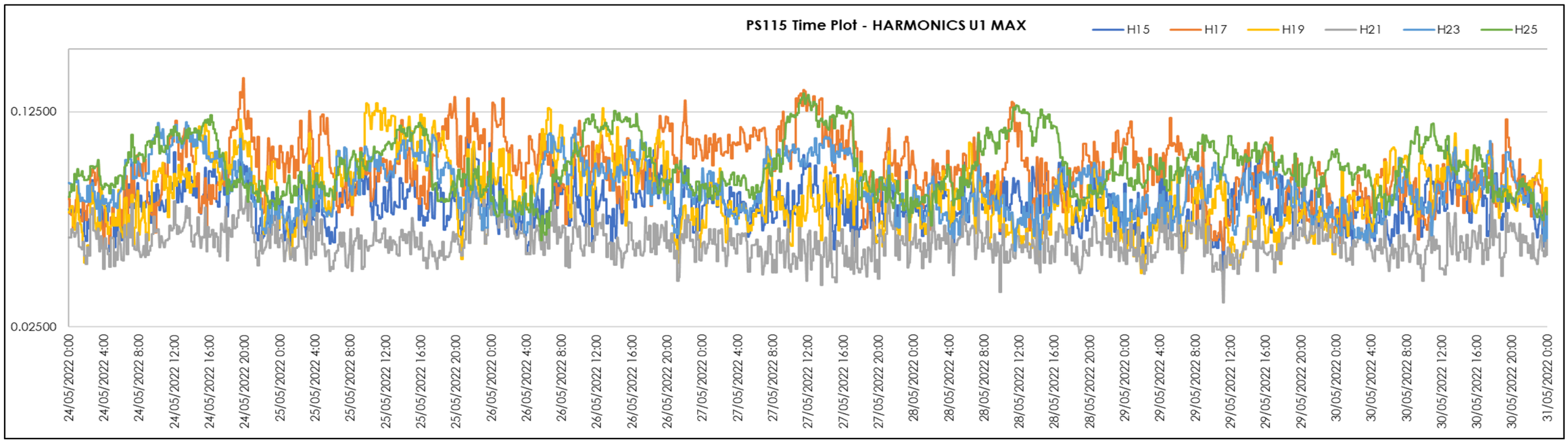
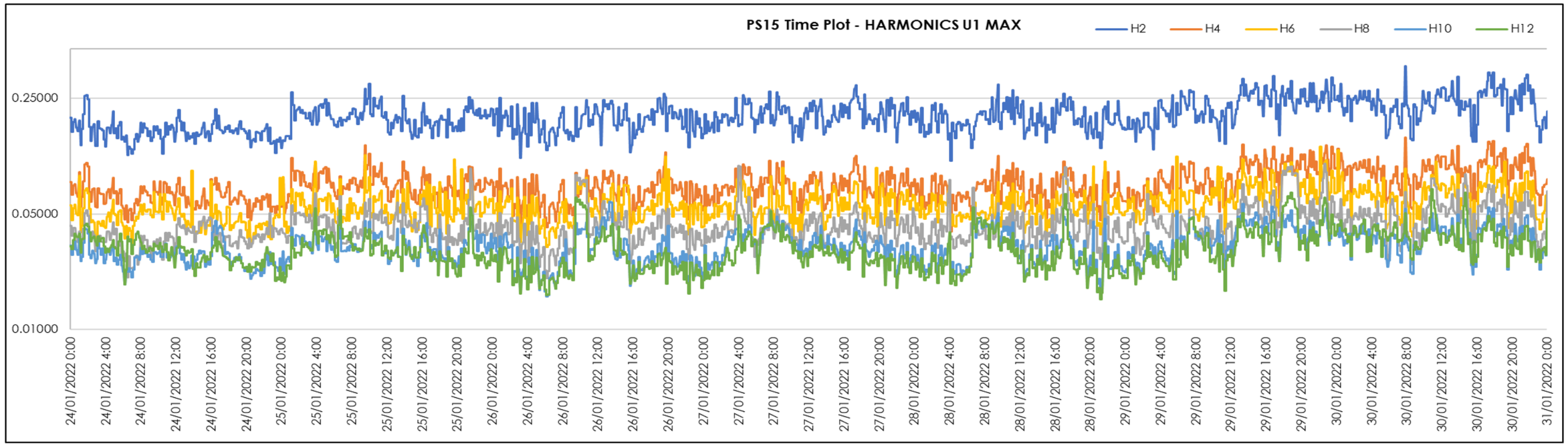
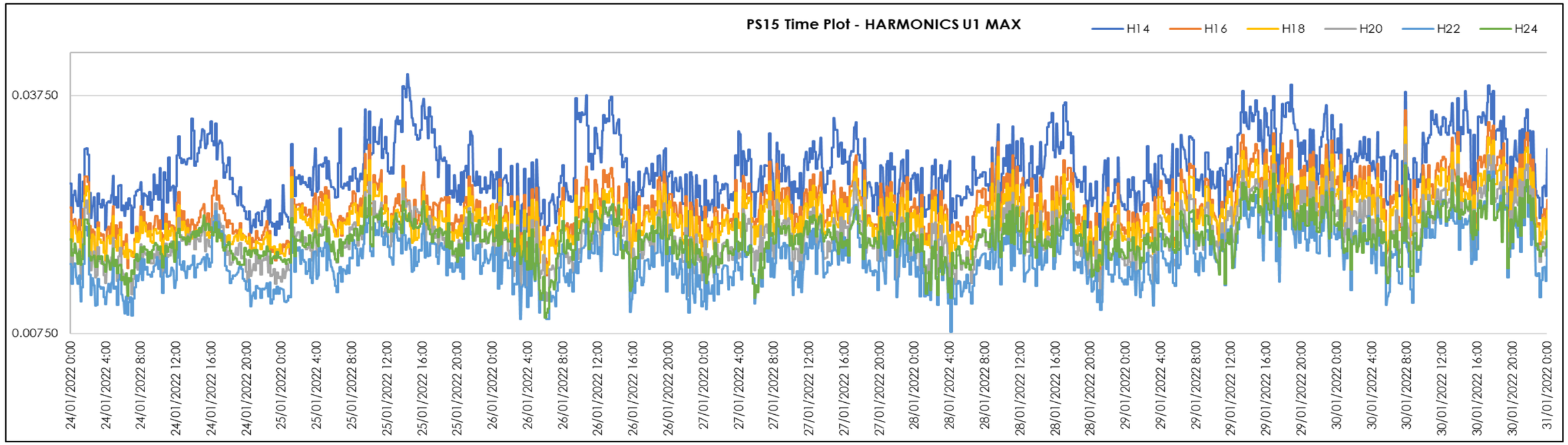


Figure 41 | TC4 Start Harmonics


PS15 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS15 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
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28/01/2022 4:00
28/01/2022 8:00
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30/01/2022 4:00
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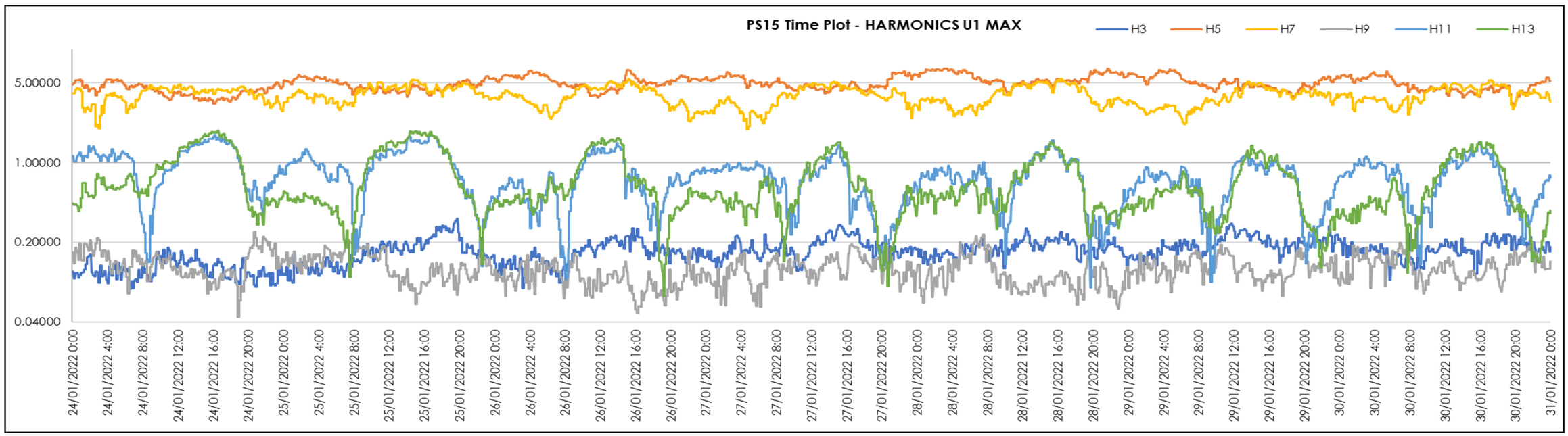
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



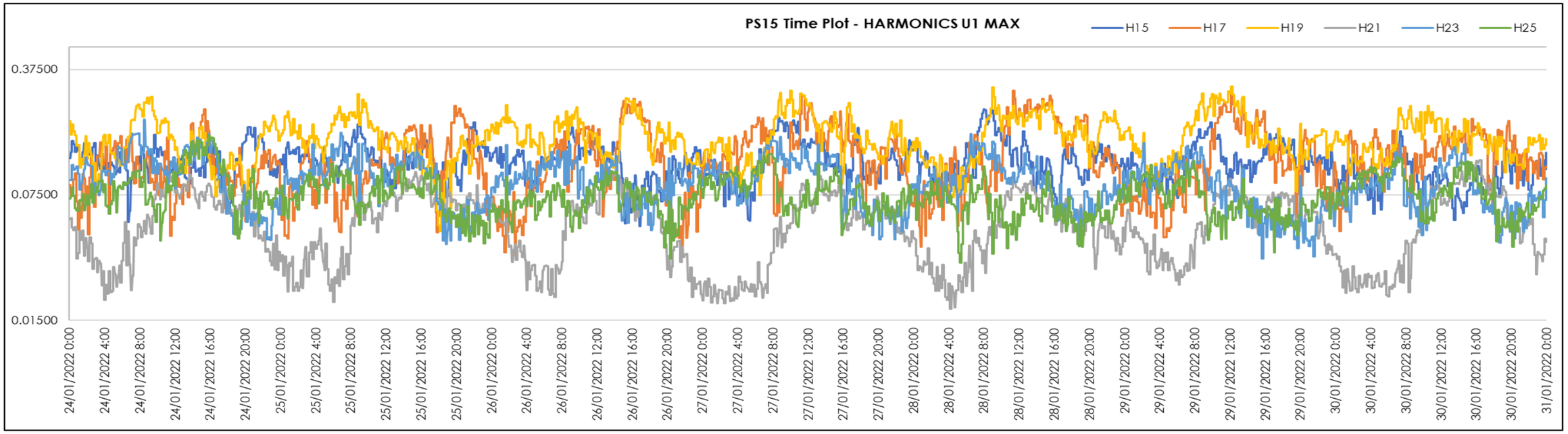
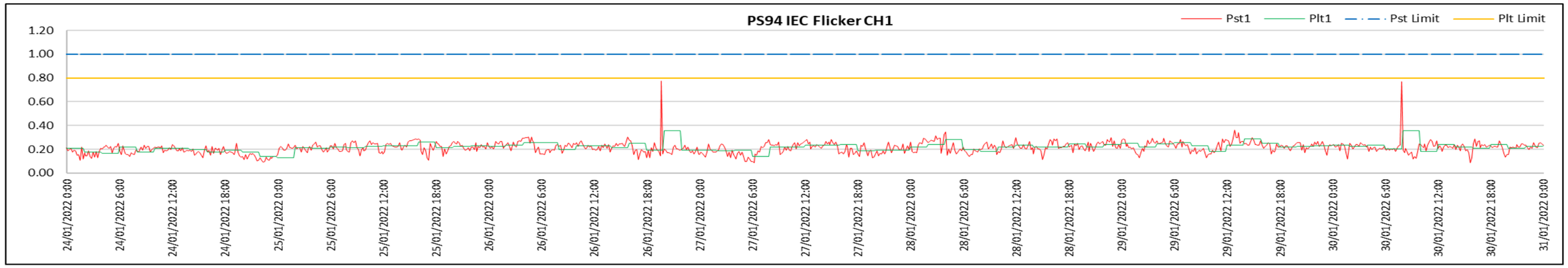
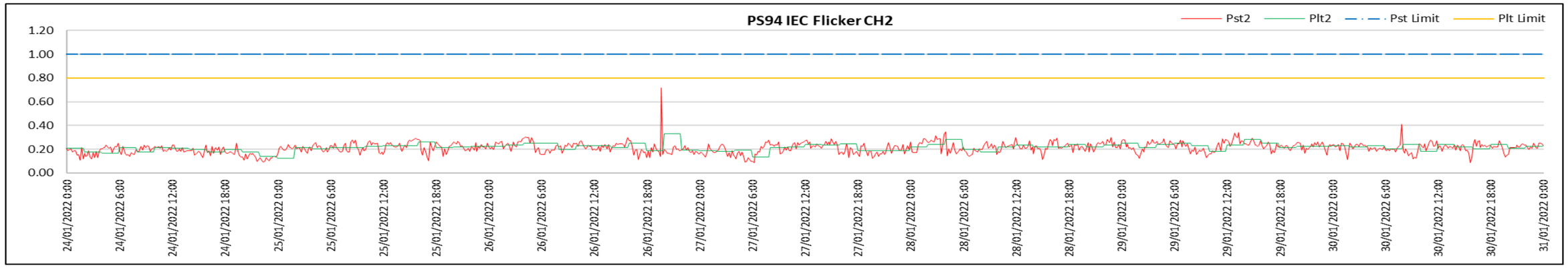


Figure 42 | TC4 End Harmonics

APPENDIX A.5 FEEDER STS1 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





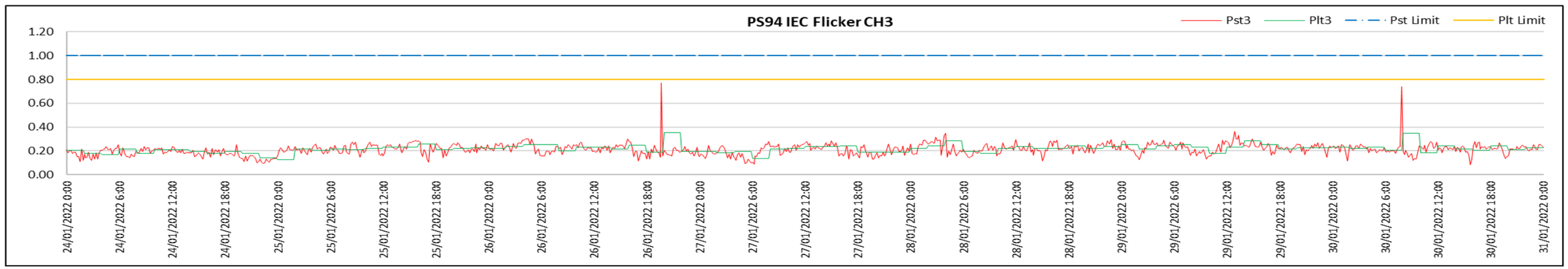


Figure 43 | STS1 Start Flicker measurements

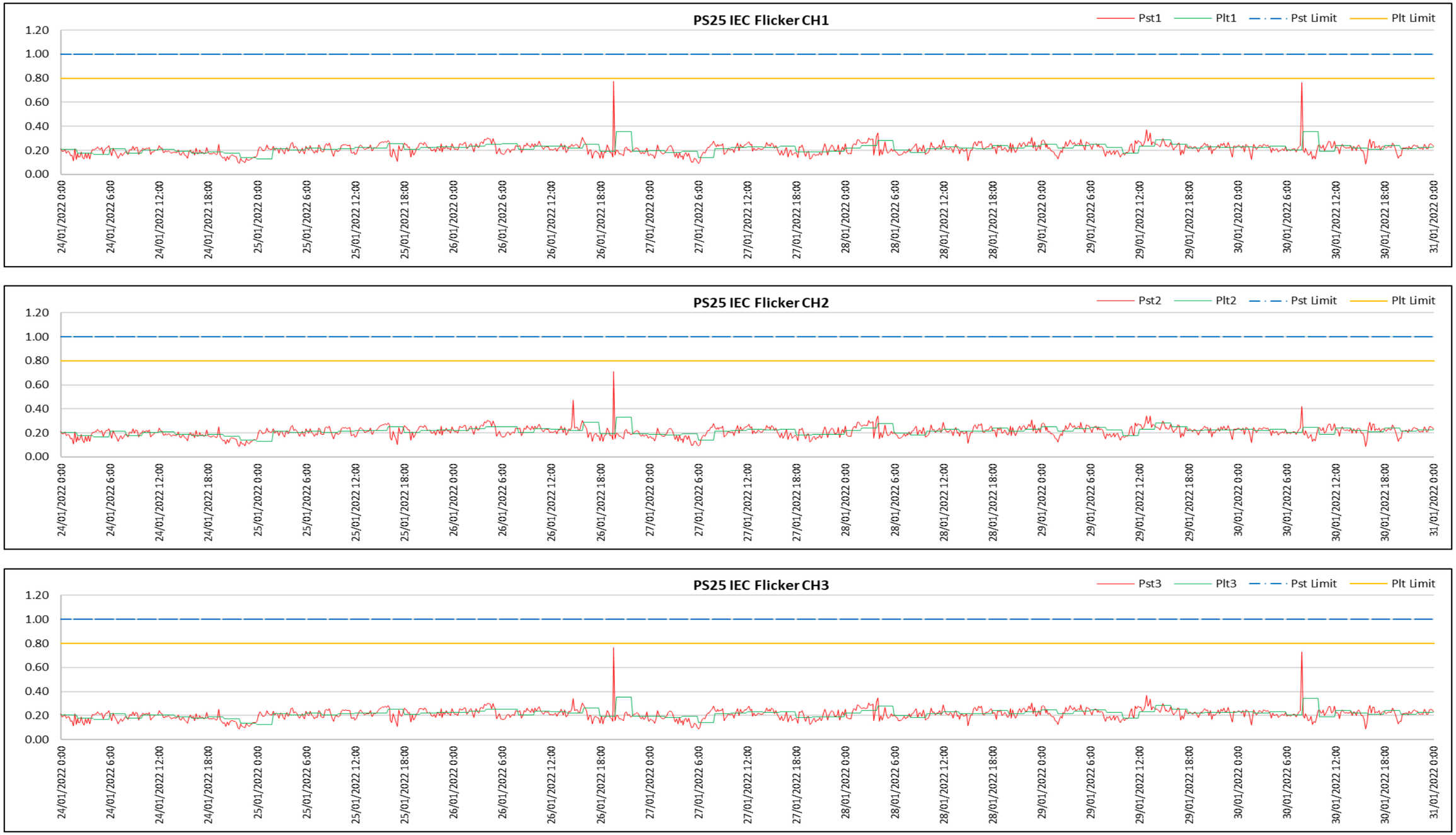


Figure 44 | STS1 End Flicker measurements

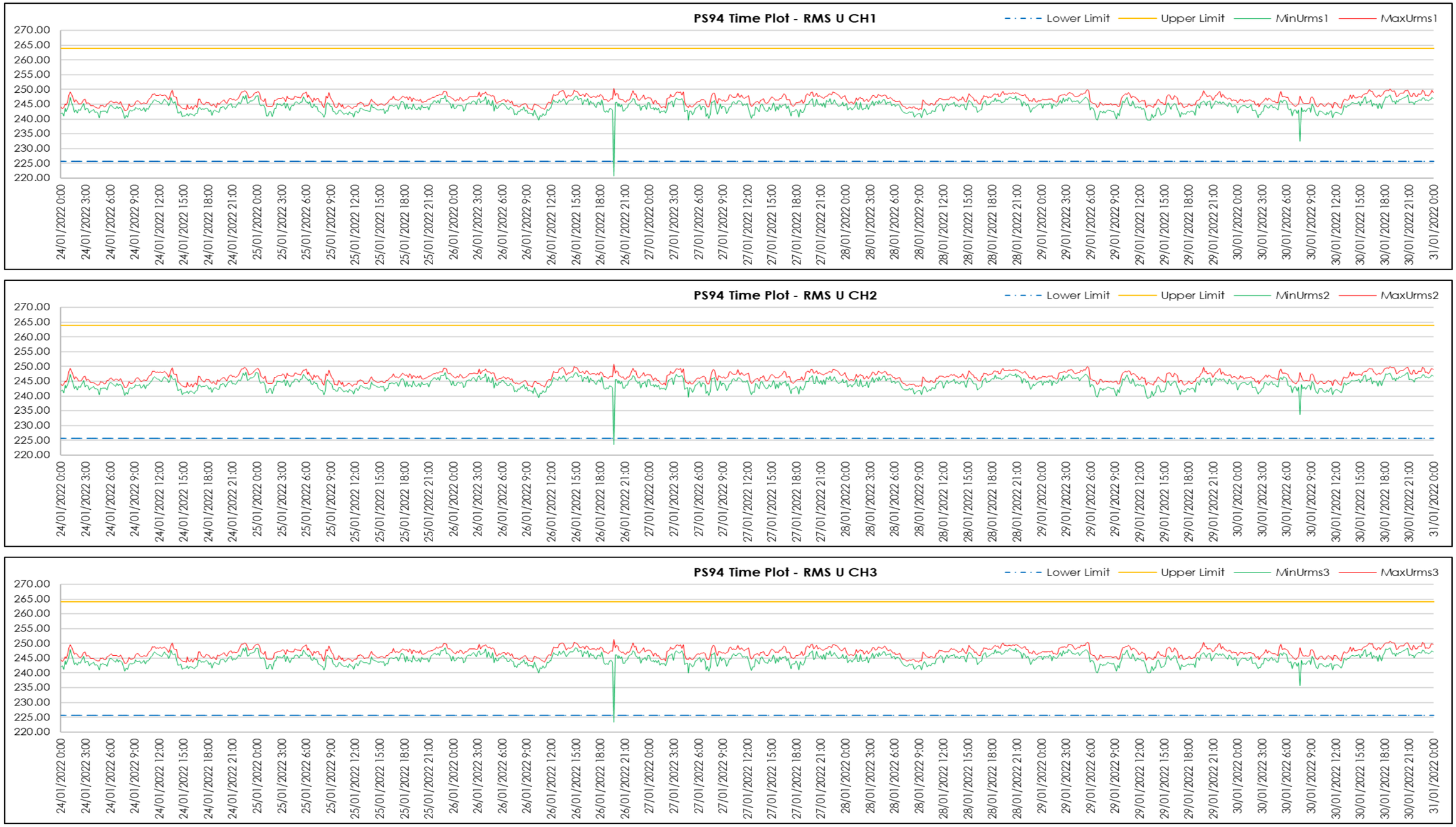


Figure 45 | STS1 Start Voltage measurements

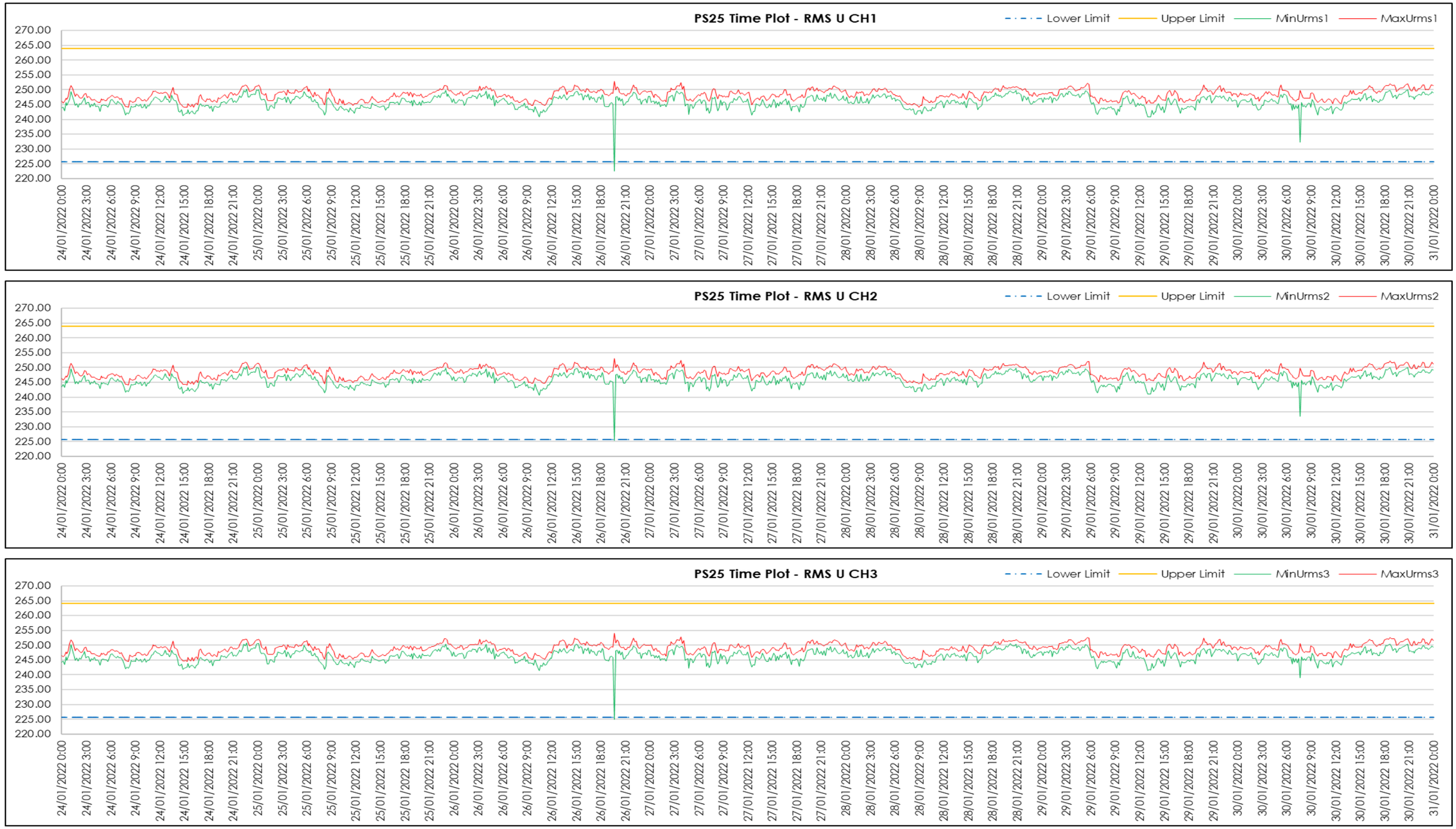


Figure 46 | STS1 End Voltage measurements

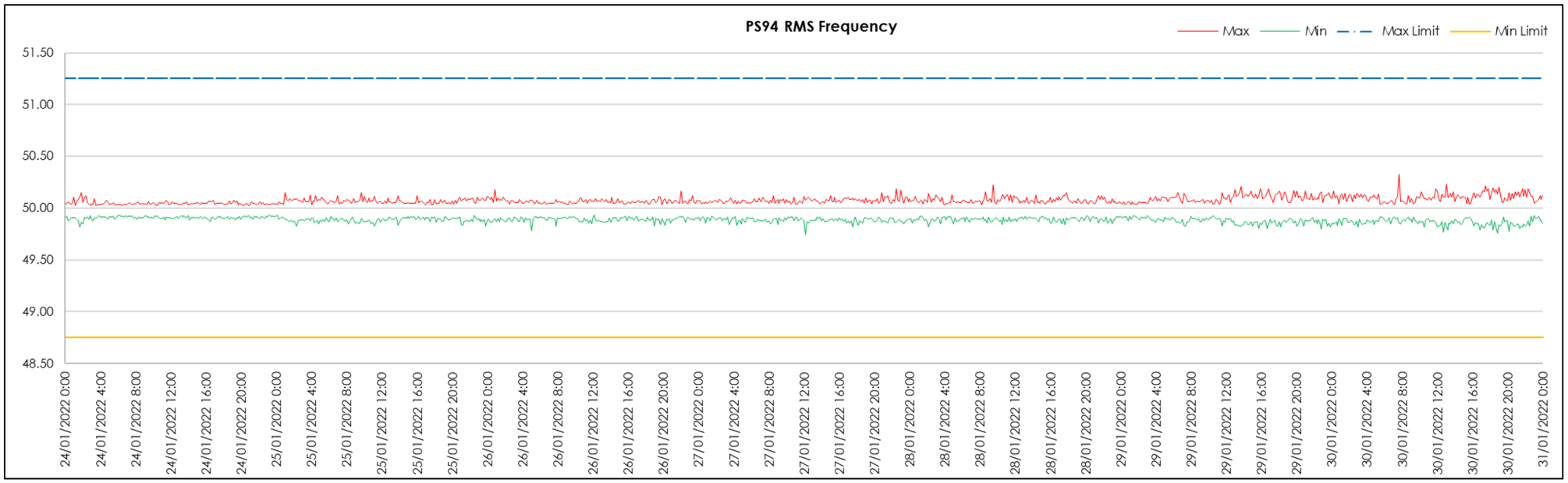


Figure 47 | STS1 Start Frequency measurements

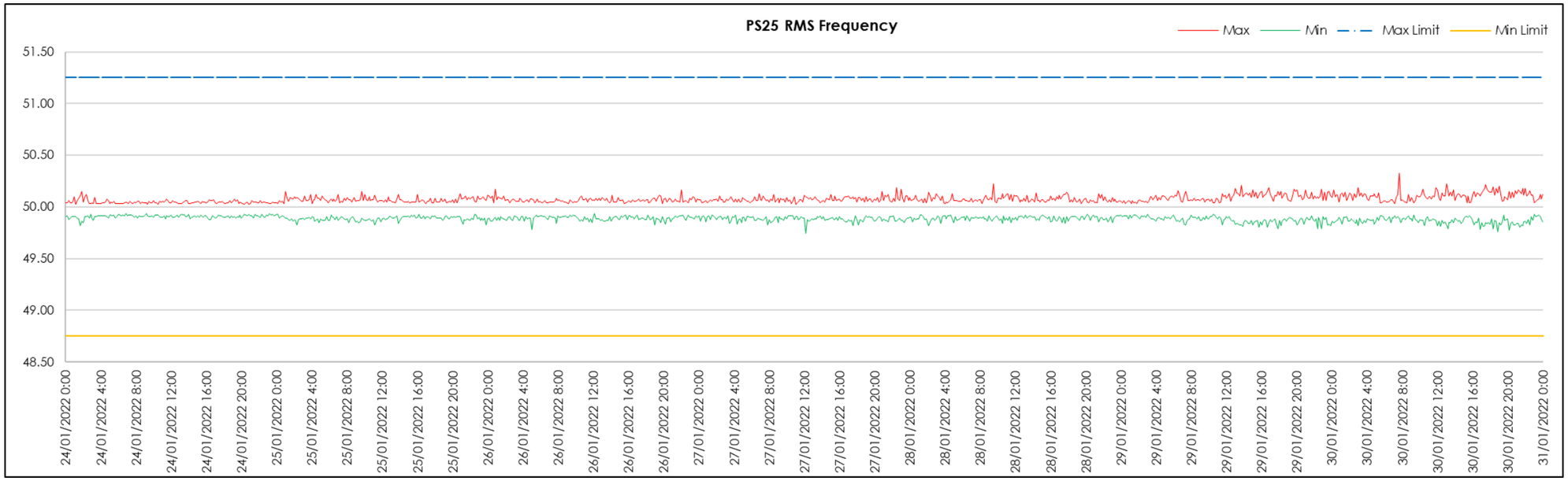


Figure 483 | STS1 End Frequency measurements

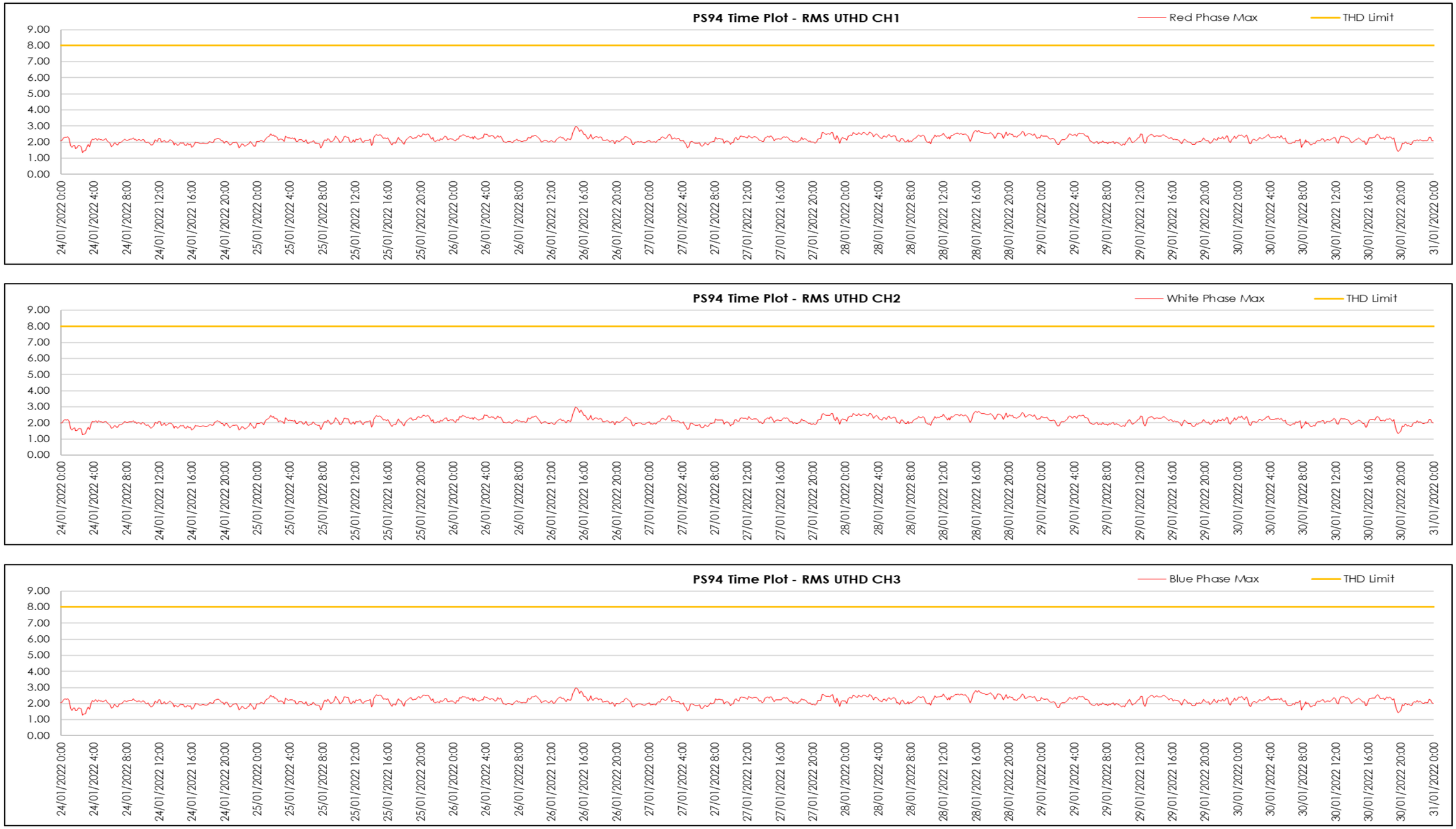
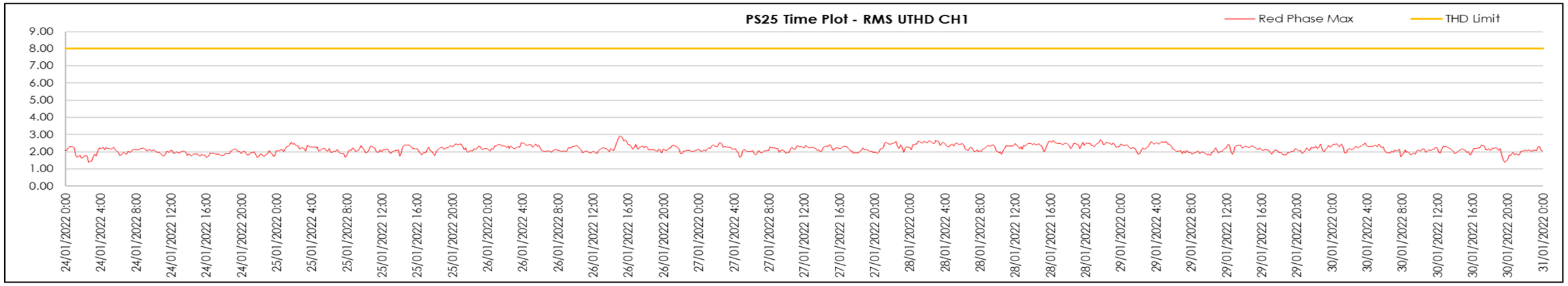
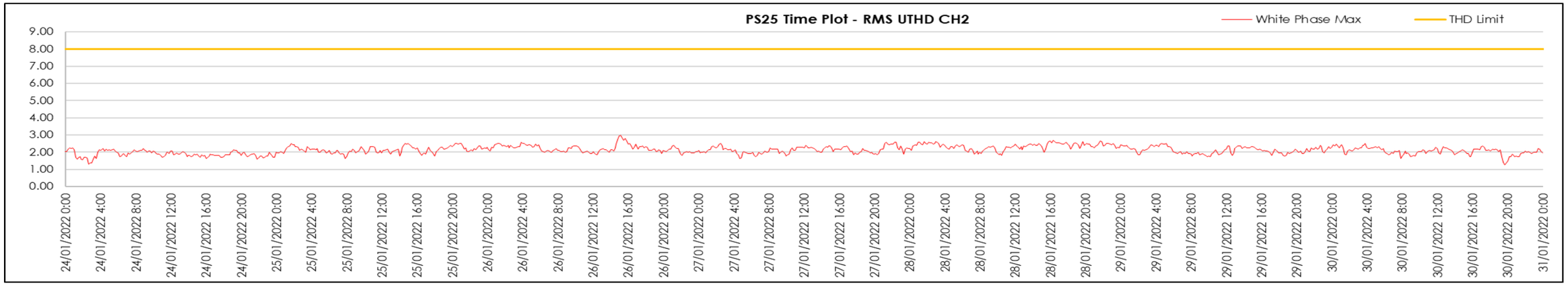


Figure 49 | STS1 Start U-THD measurements





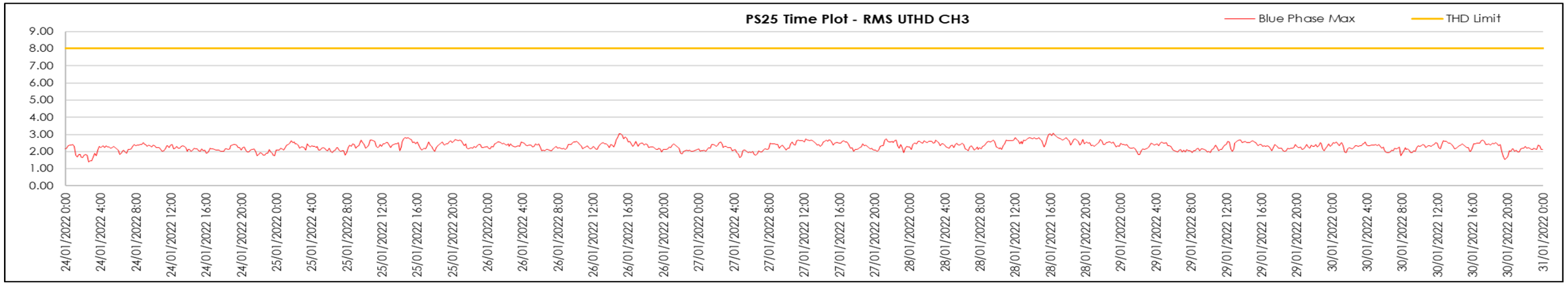
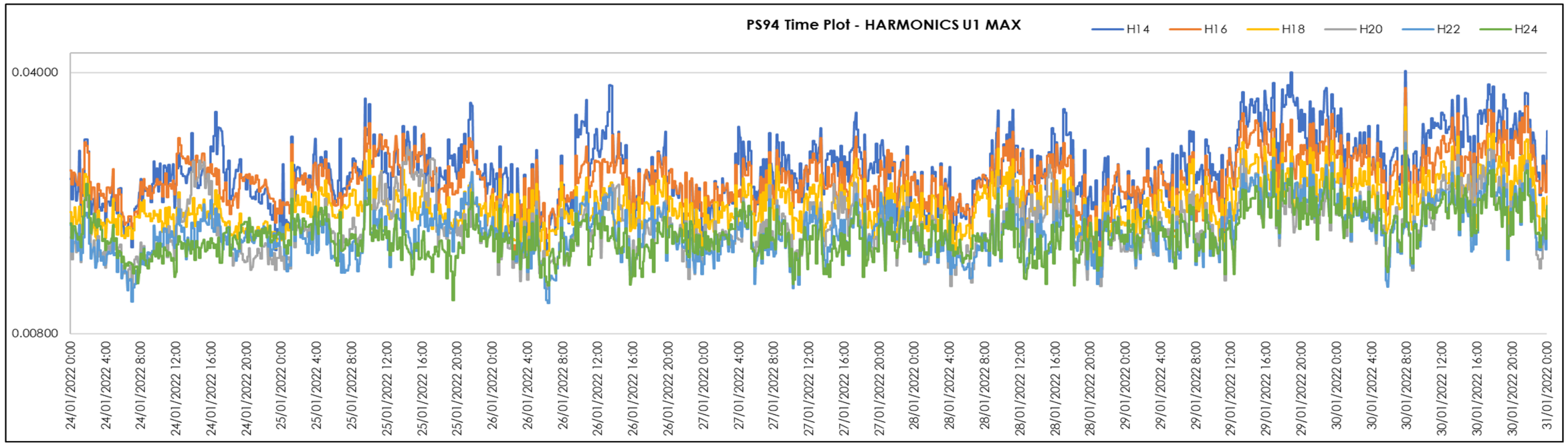
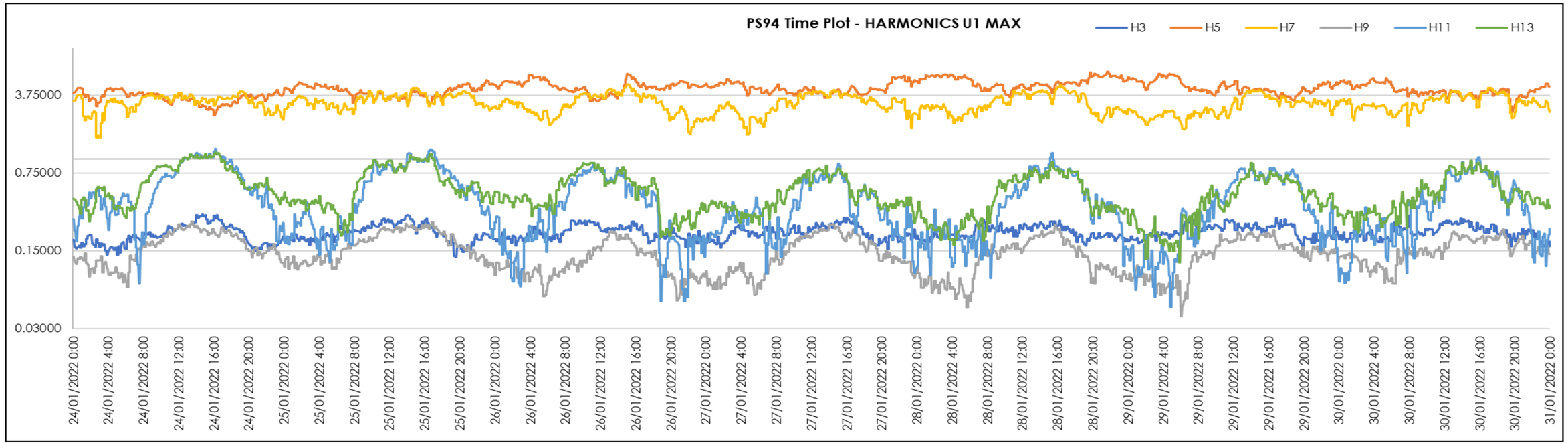


Figure 50| STS1 End U-THD measurements


PS94 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS94 Time Plot - HARMONICS U1 MAX
H3
H5
H7
H9
H11
H13
3.75000
0.75000
0.15000
0.03000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
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27/01/2022 20:00
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28/01/2022 4:00
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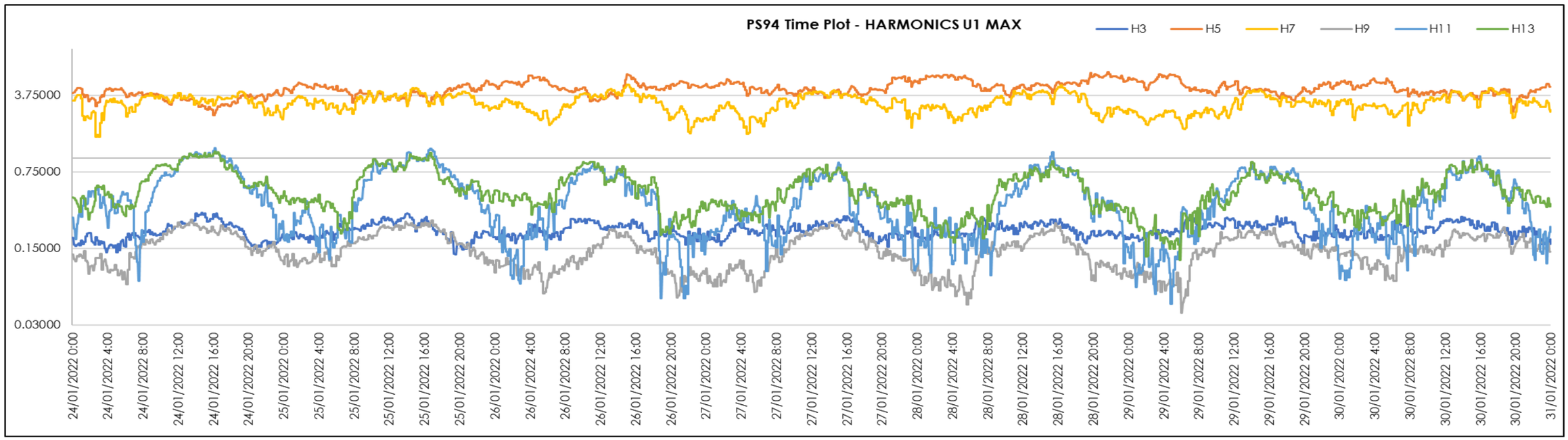
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



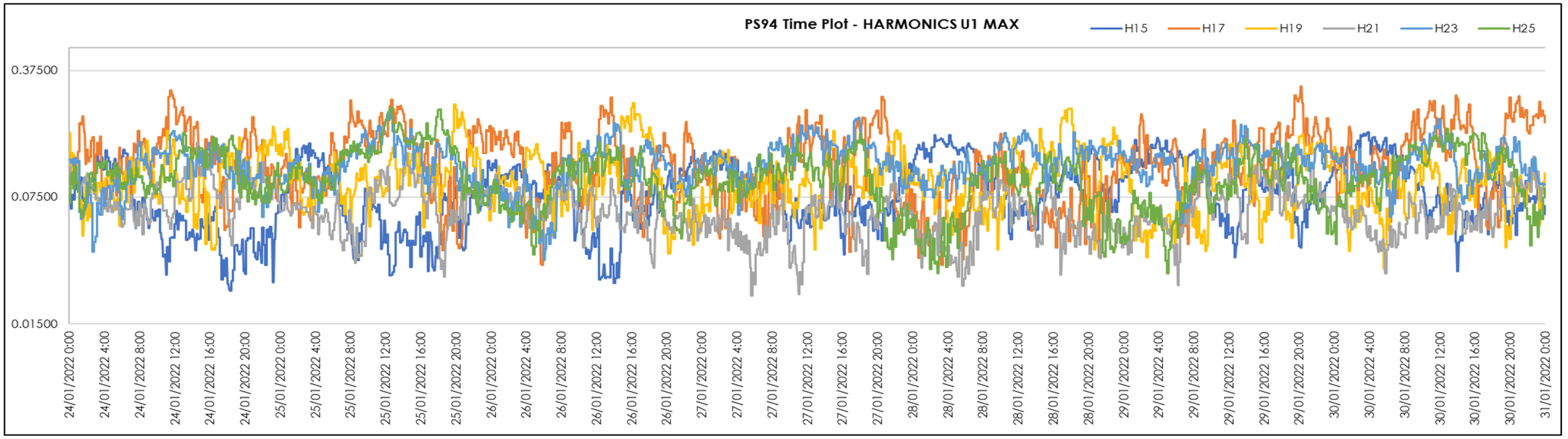
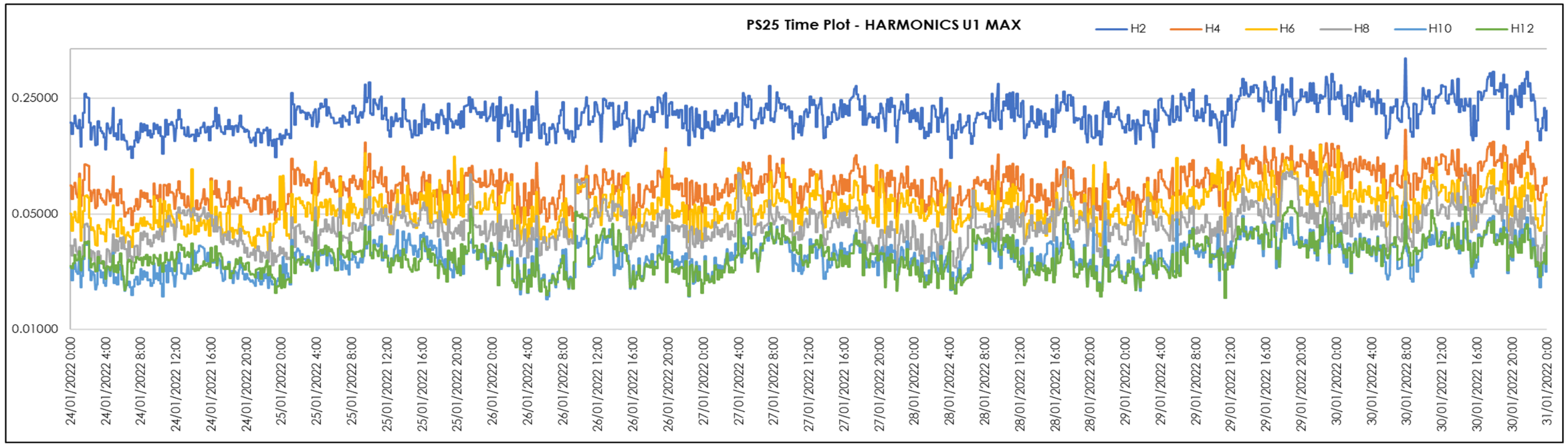


Figure 51 | STS1 Start Harmonics


PS25 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
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27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
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29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
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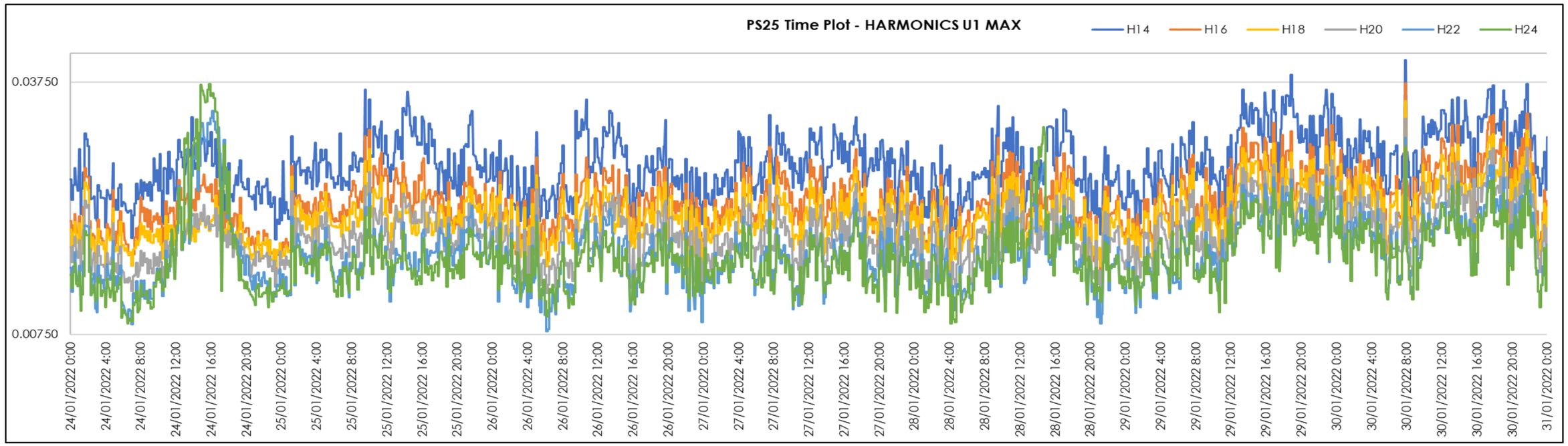
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS25 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
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28/01/2022 12:00
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28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
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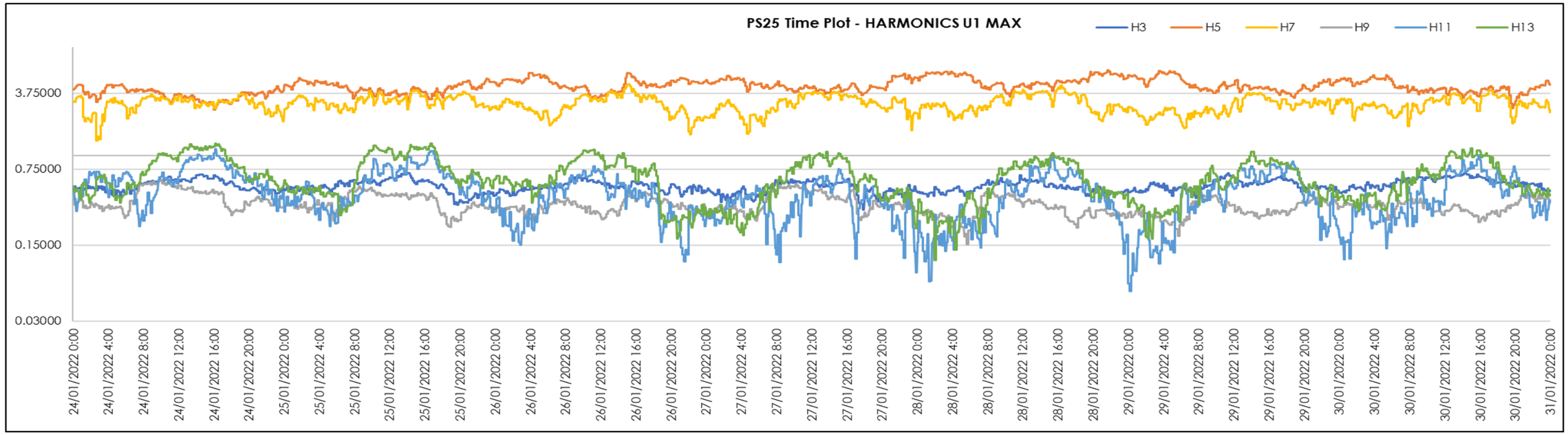


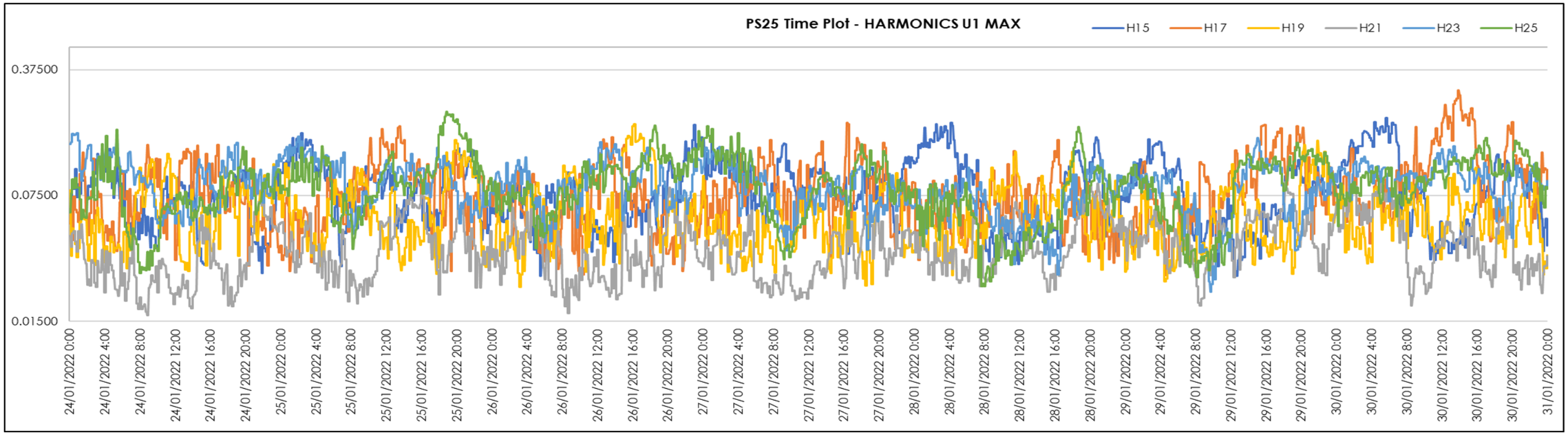
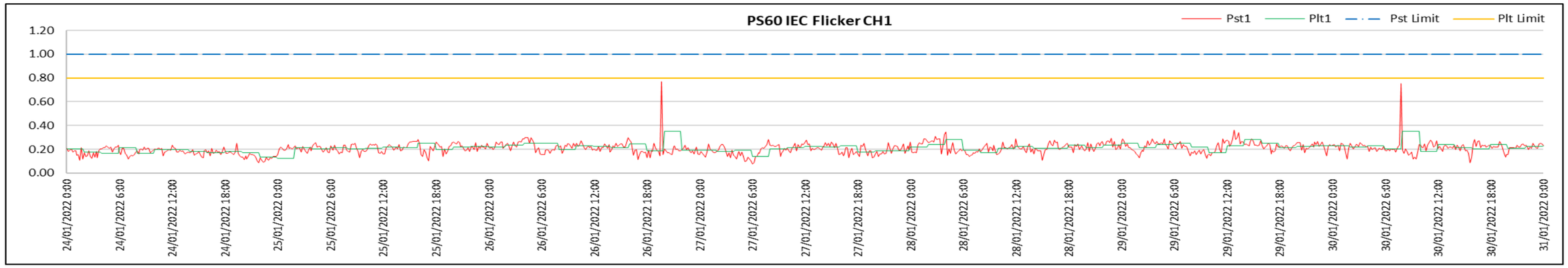
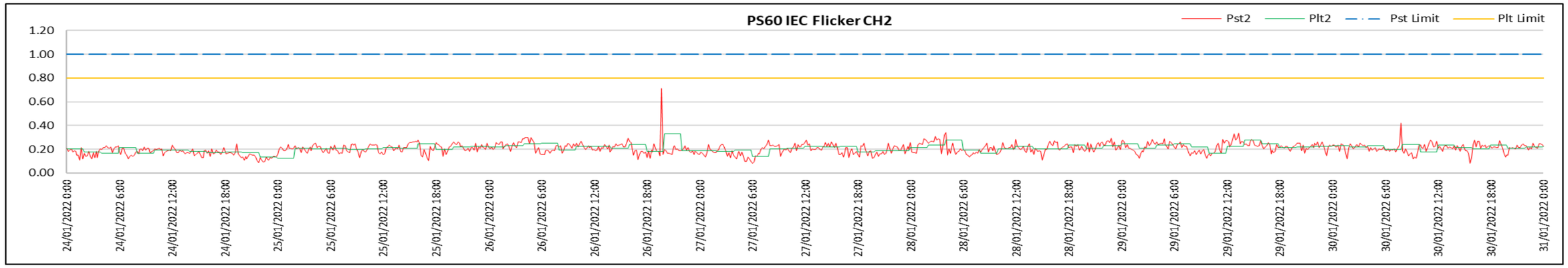


Figure 52 | STS1 End Harmonics

APPENDIX A.6 FEEDER STS2 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





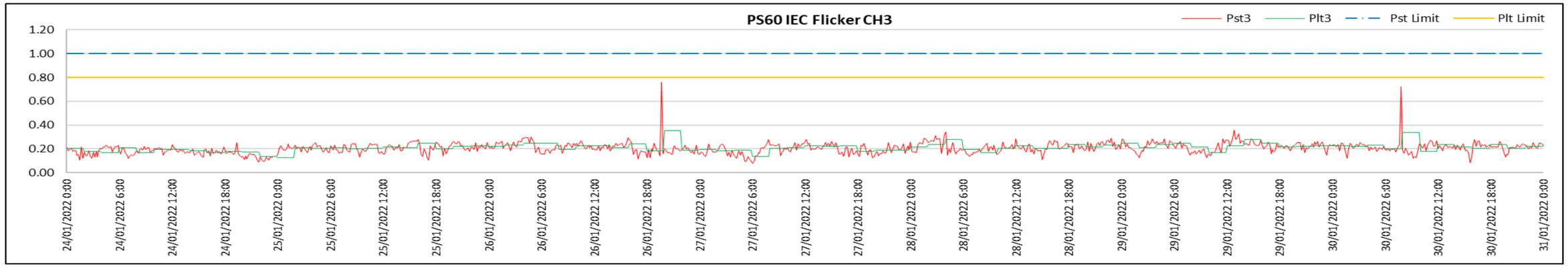
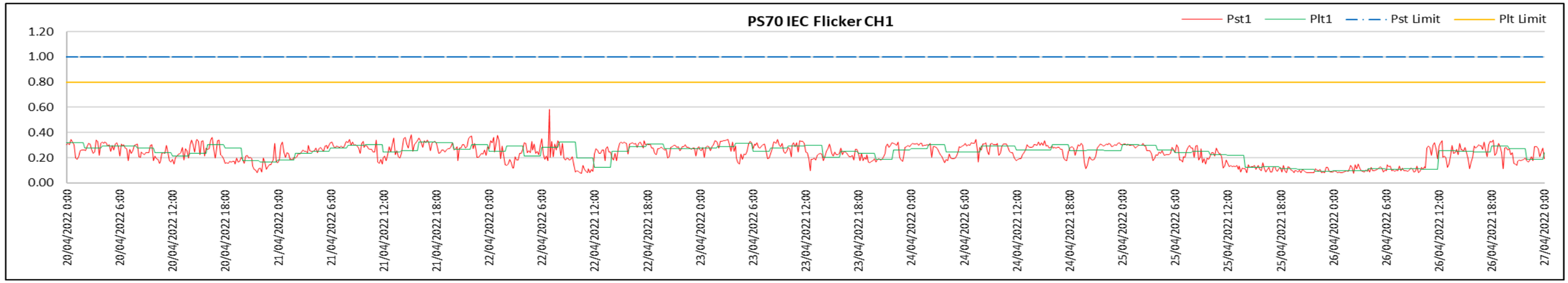
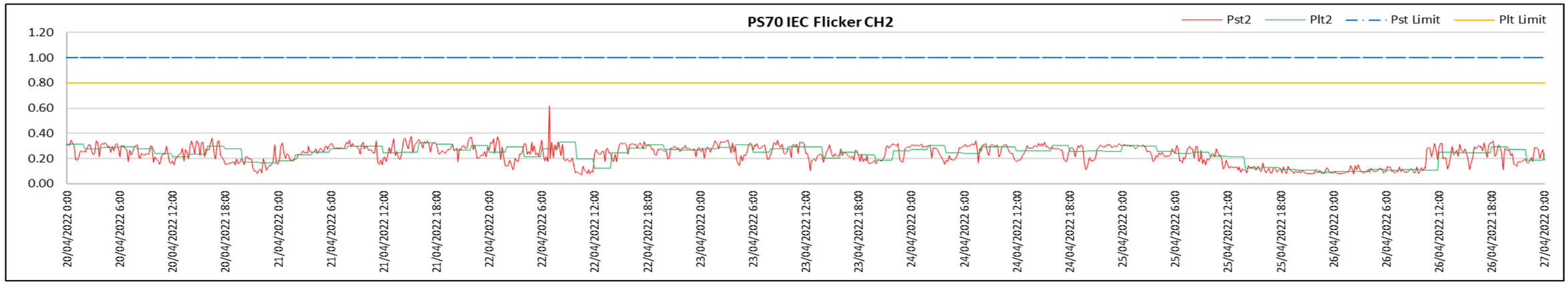


Figure 53 | STS2 Start Flicker measurements





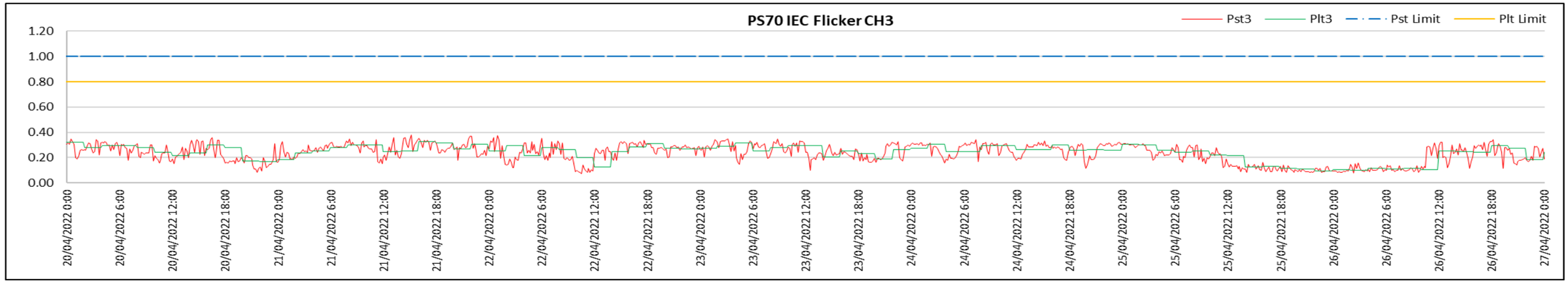
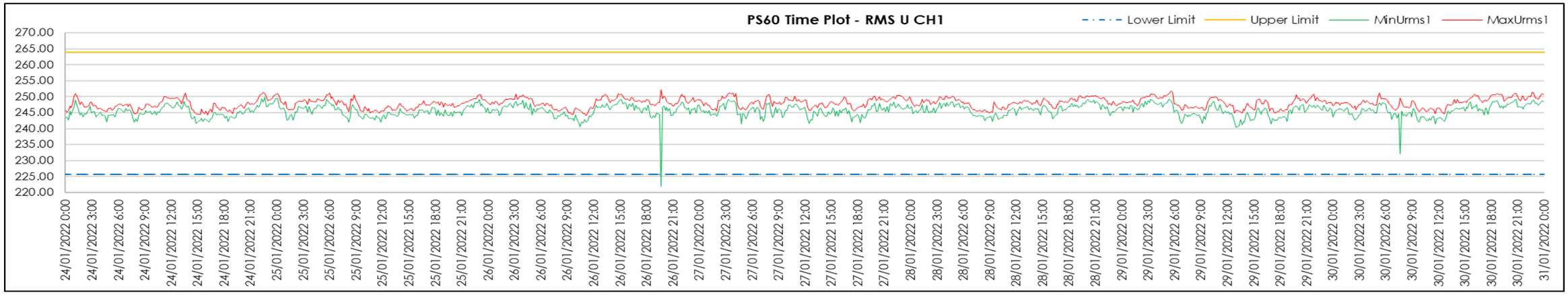
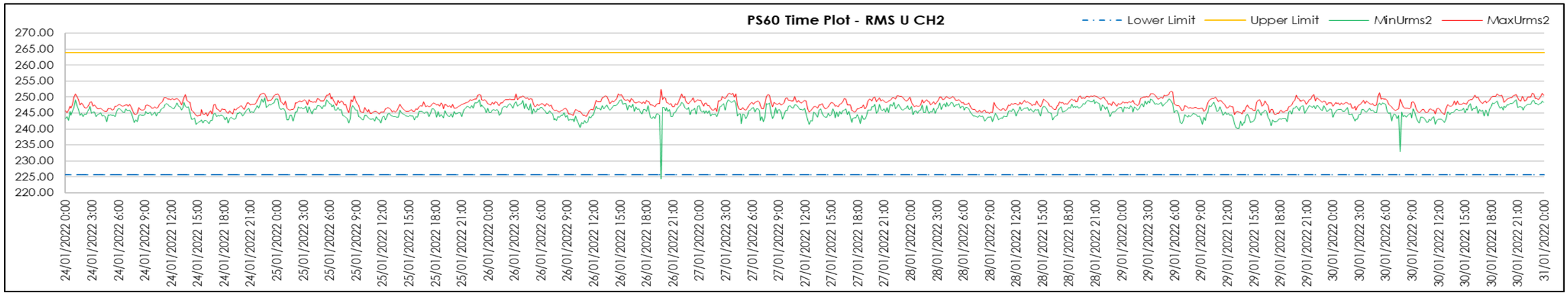


Figure 4 | STS2 End Flicker measurements





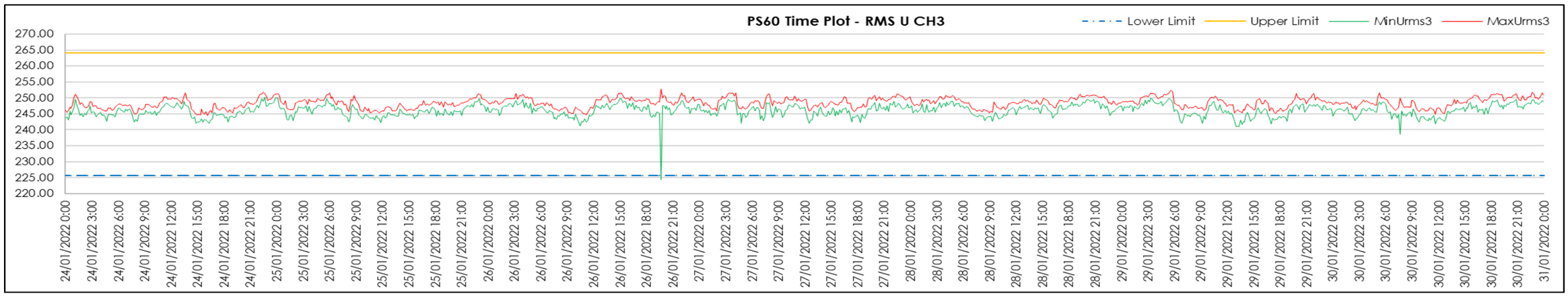
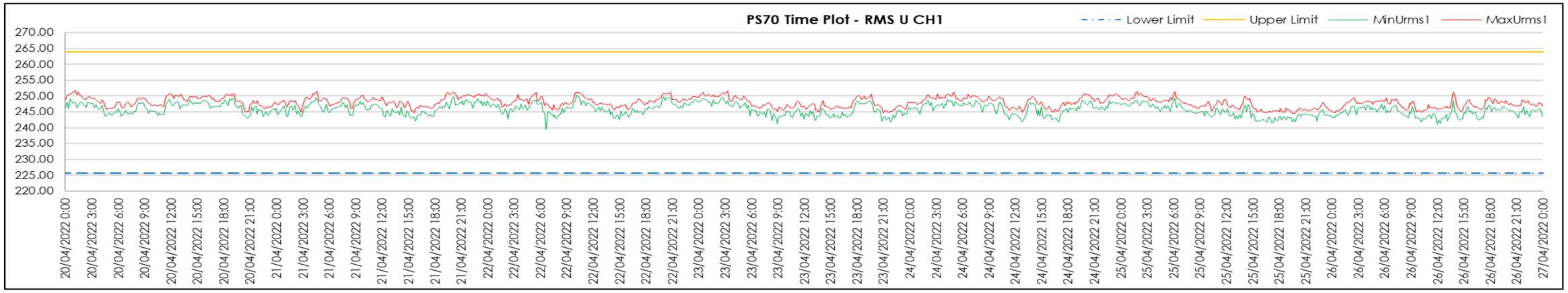
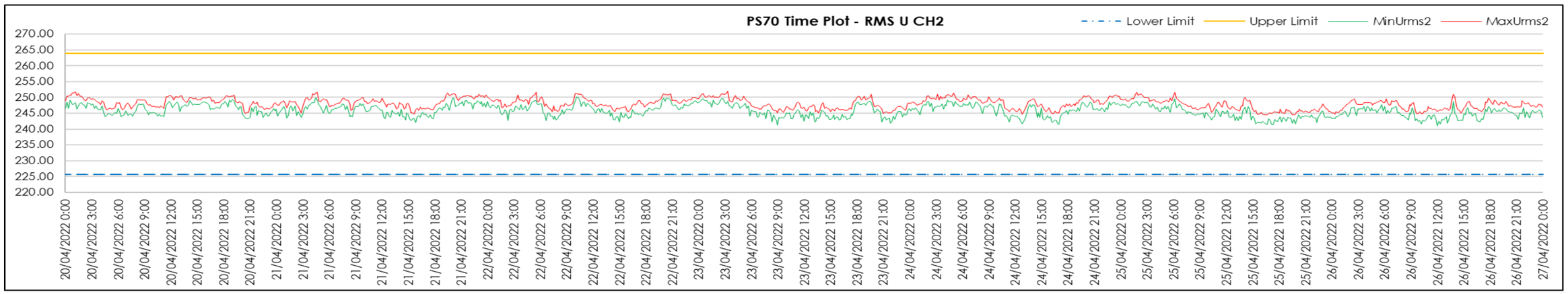


Figure 55 | STS2 Start Voltage measurements





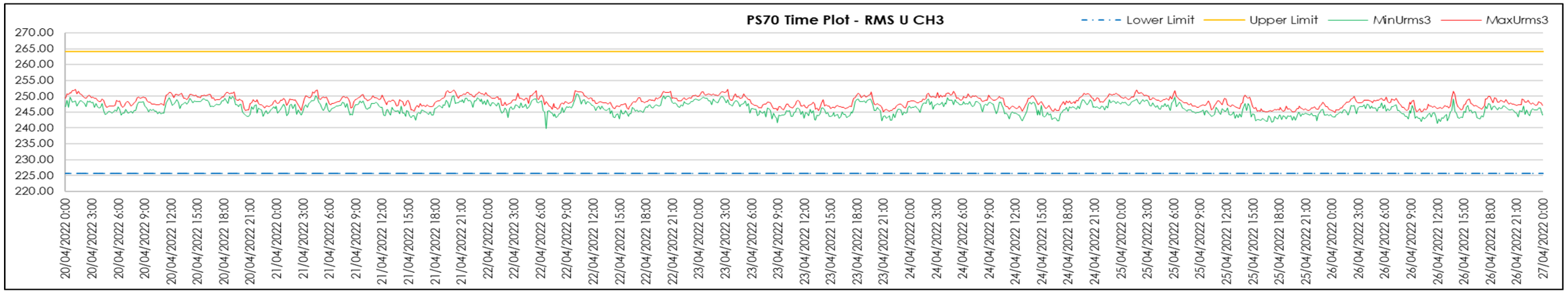


Figure 56 | STS2 End Voltage measurements

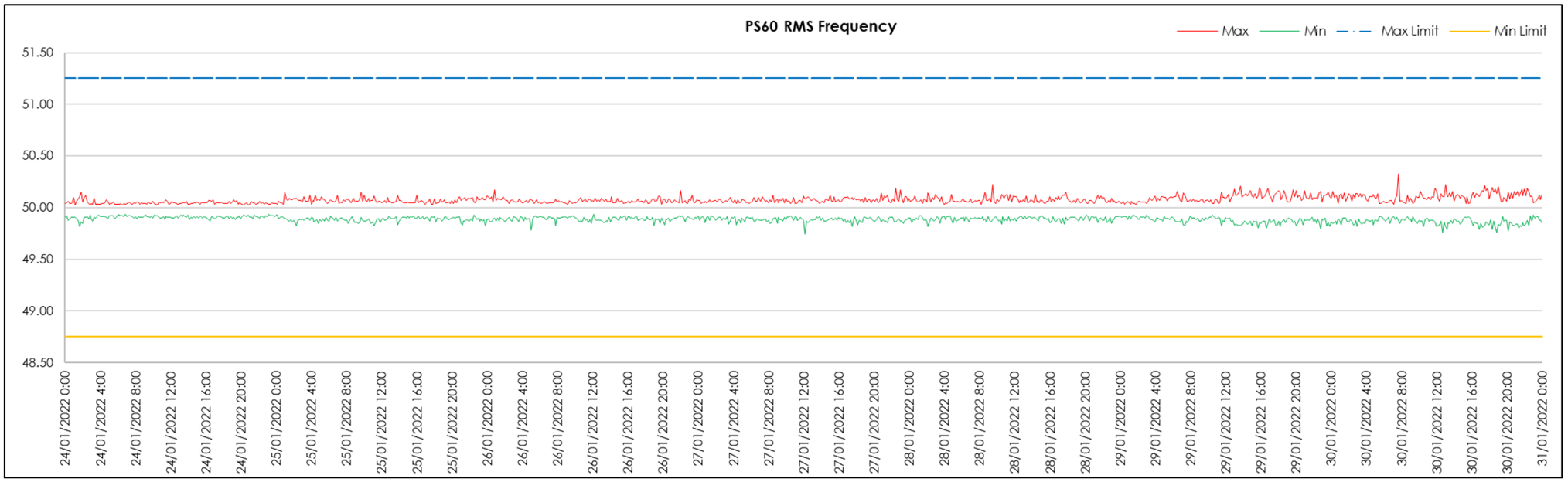


Figure 57 | STS2 Start Frequency measurements

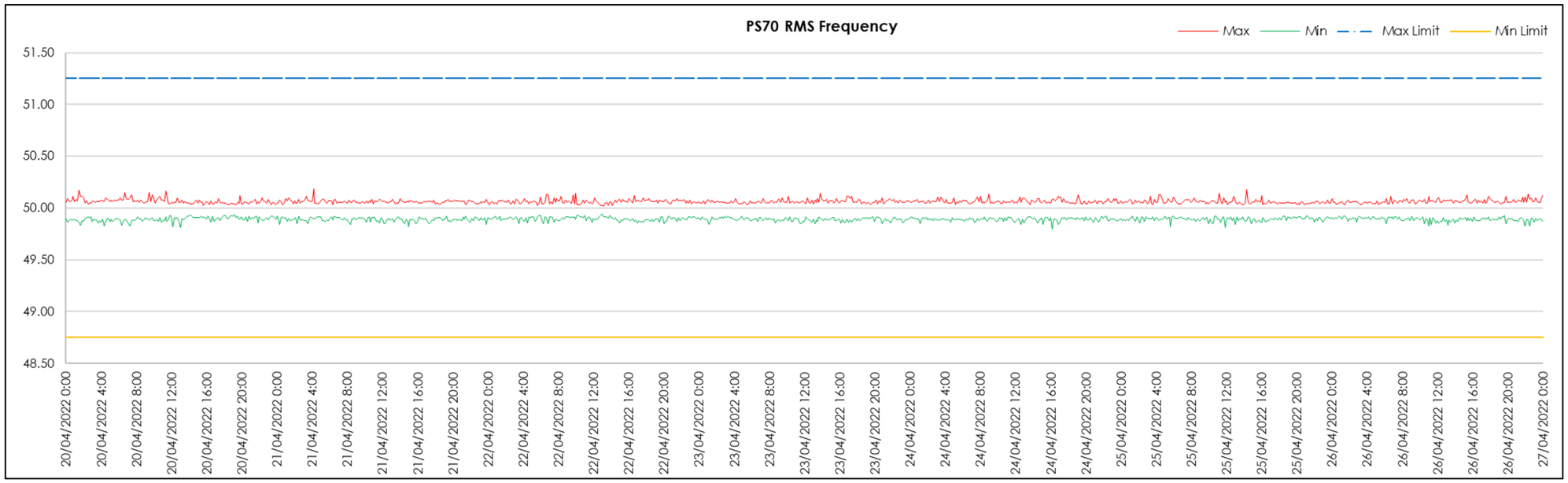
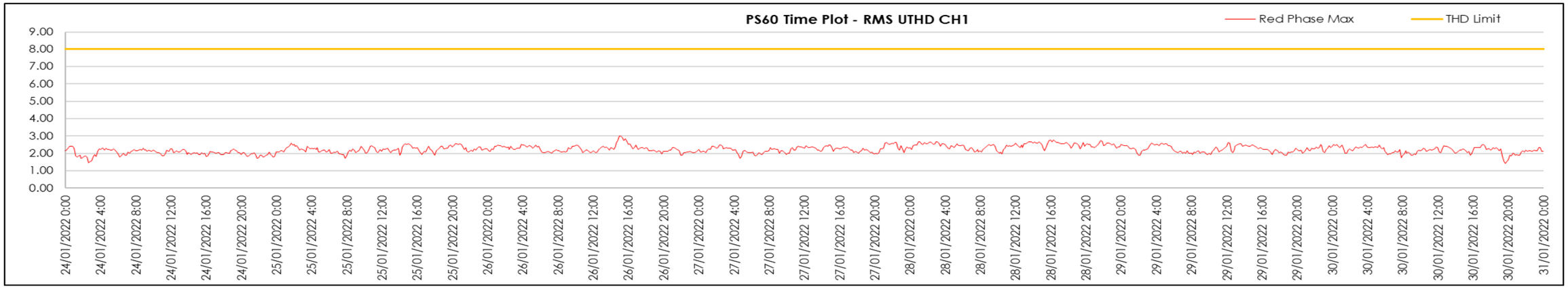
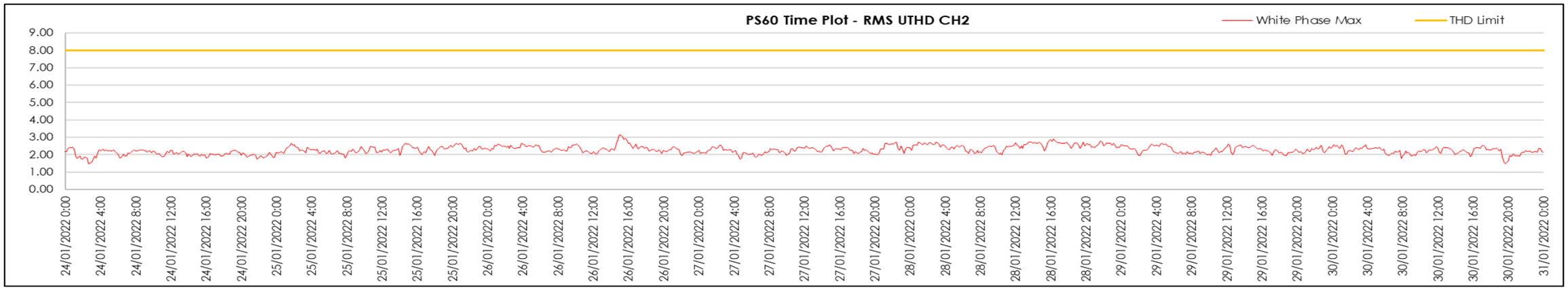


Figure 58 | STS2 End Frequency measurements





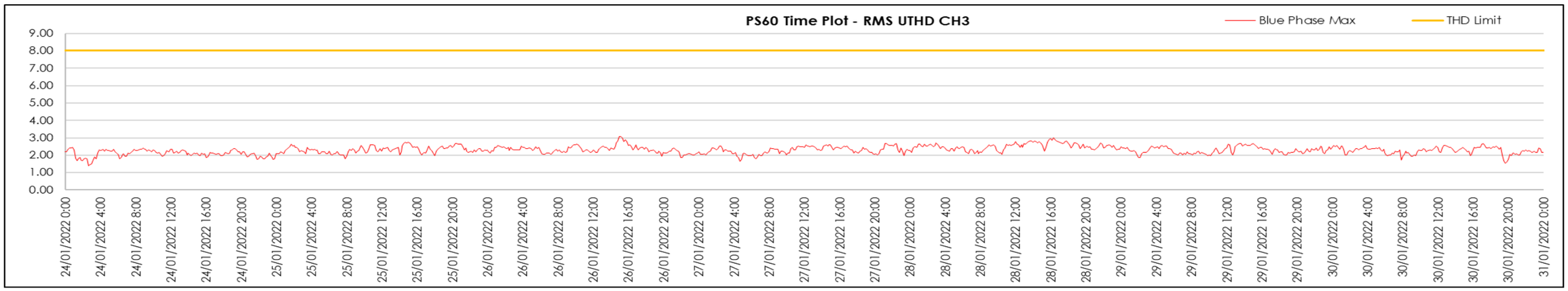
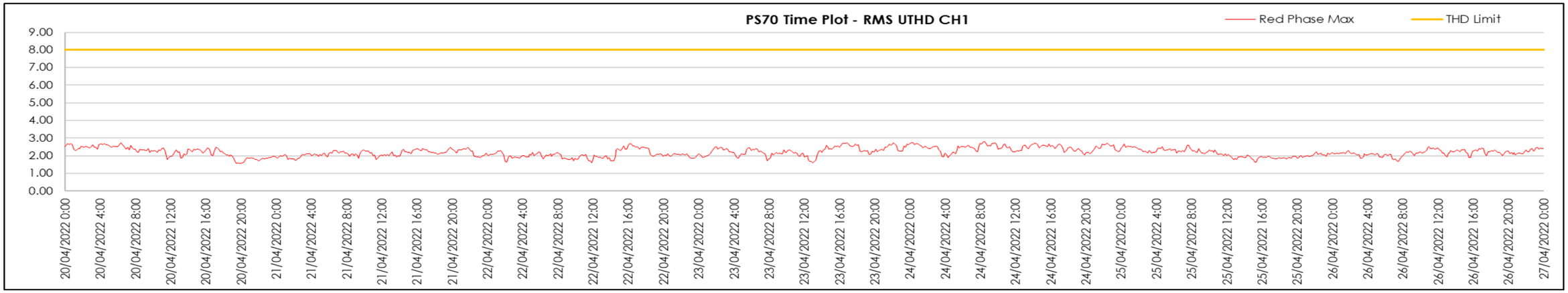
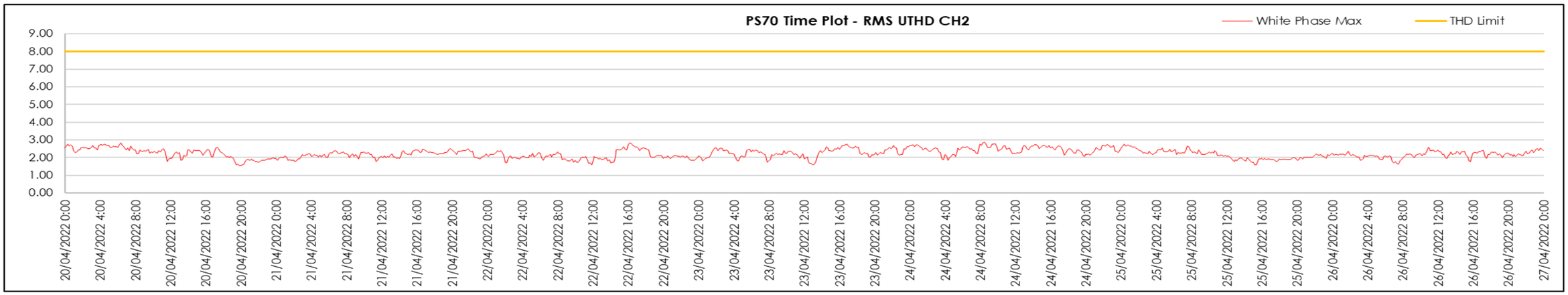


Figure 59 | STS2 Start U-THD measurements





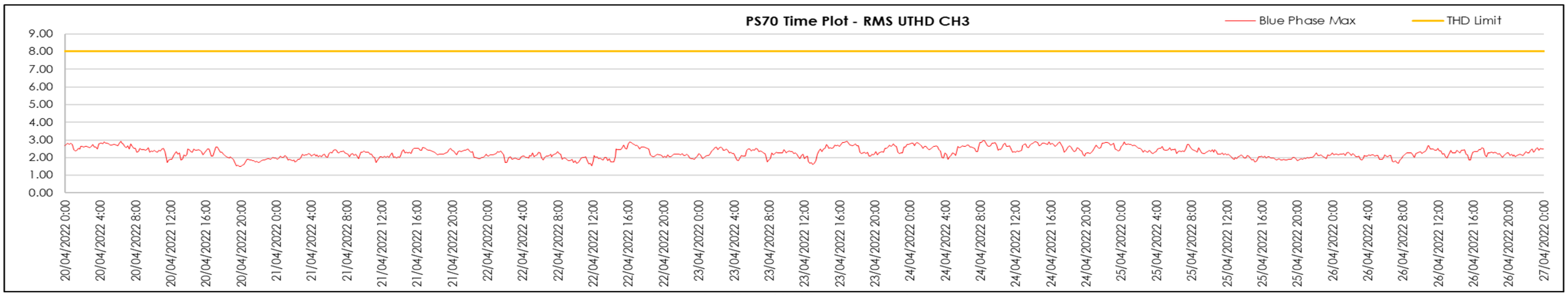
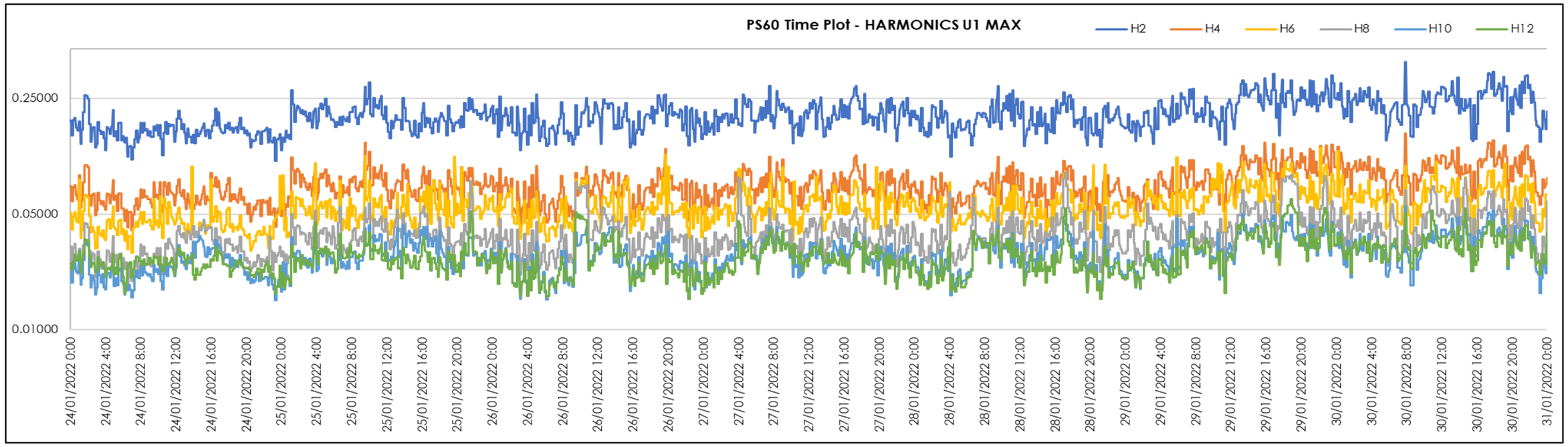


Figure 60 | STS2 End U-THD measurements


PS60 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.25000
0.05000
0.01000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
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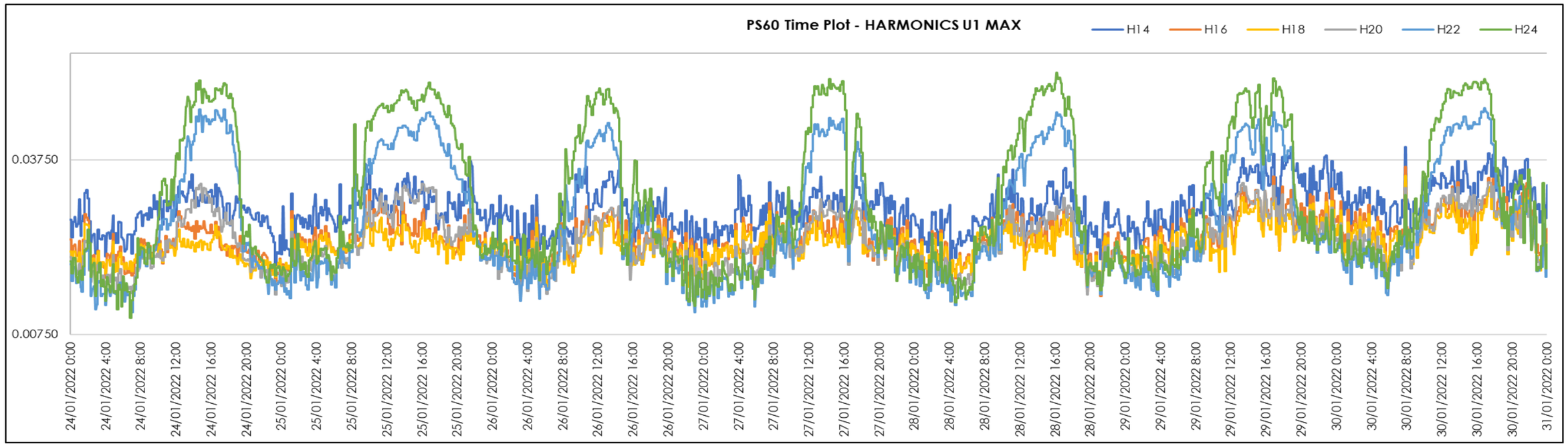
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS60 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
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24/01/2022 16:00
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30/01/2022 20:00
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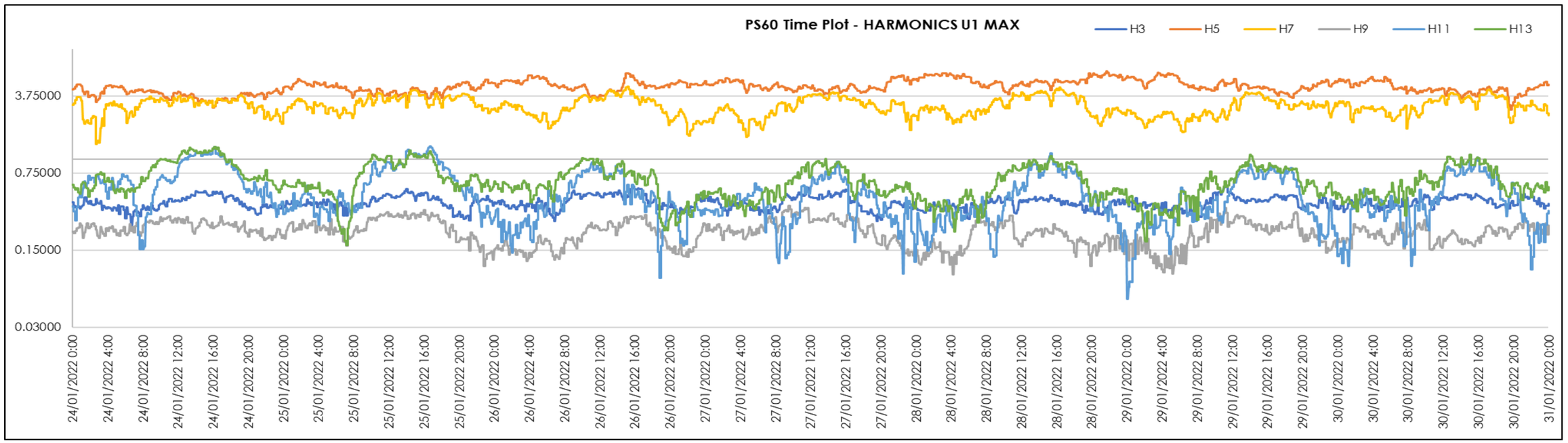


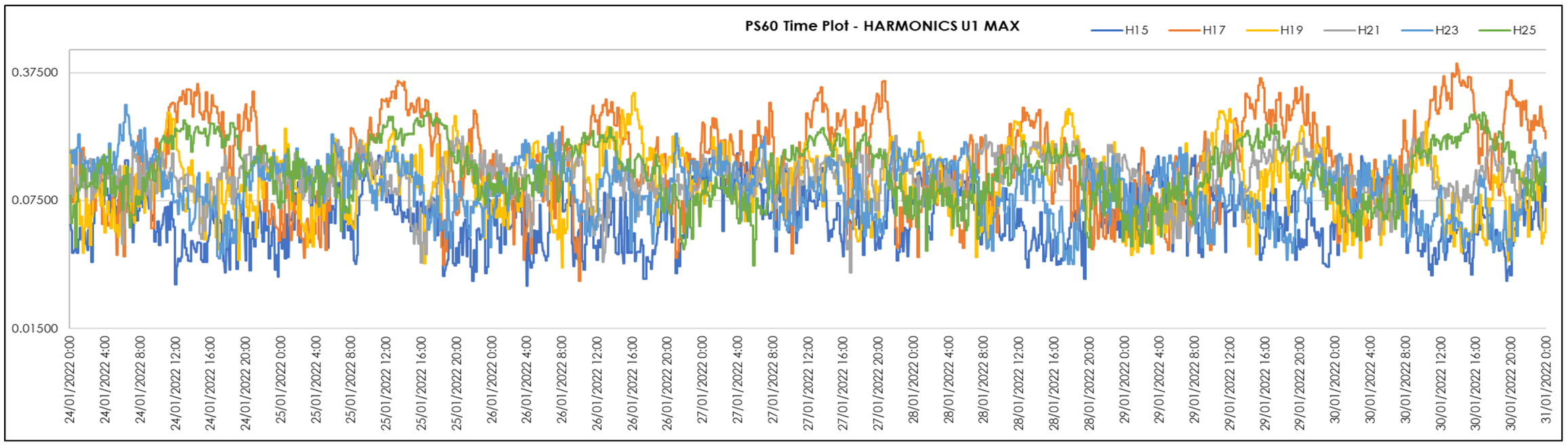
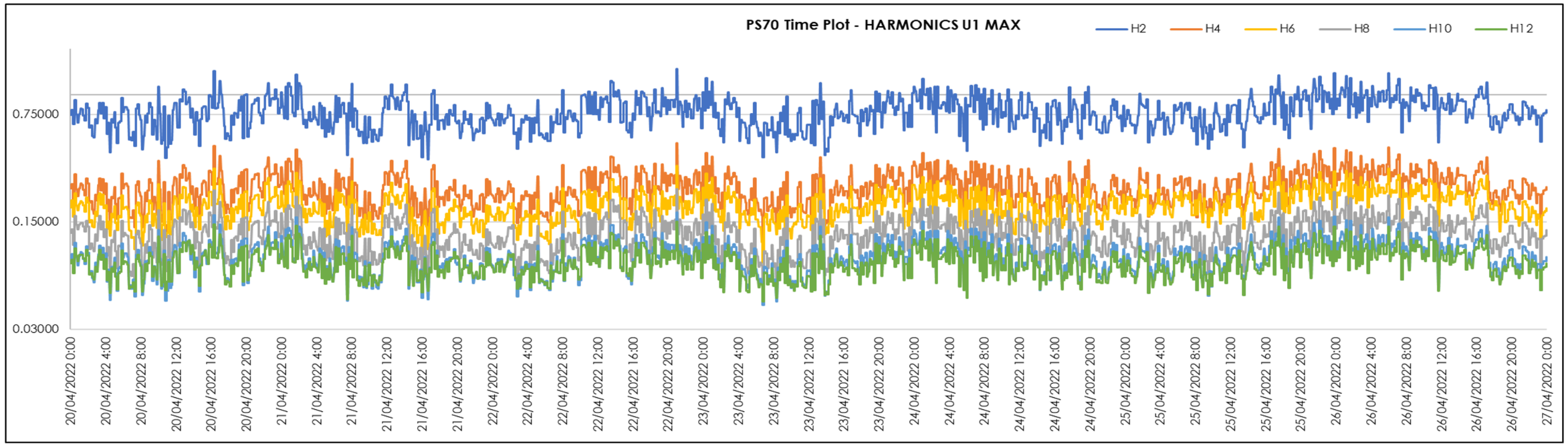


Figure 61 | STS2 Start Harmonics


PS70 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
0.75000
0.15000
0.03000
20/04/2022 0:00
20/04/2022 4:00
20/04/2022 8:00
20/04/2022 12:00
20/04/2022 16:00
20/04/2022 20:00
21/04/2022 0:00
21/04/2022 4:00
21/04/2022 8:00
21/04/2022 12:00
21/04/2022 16:00
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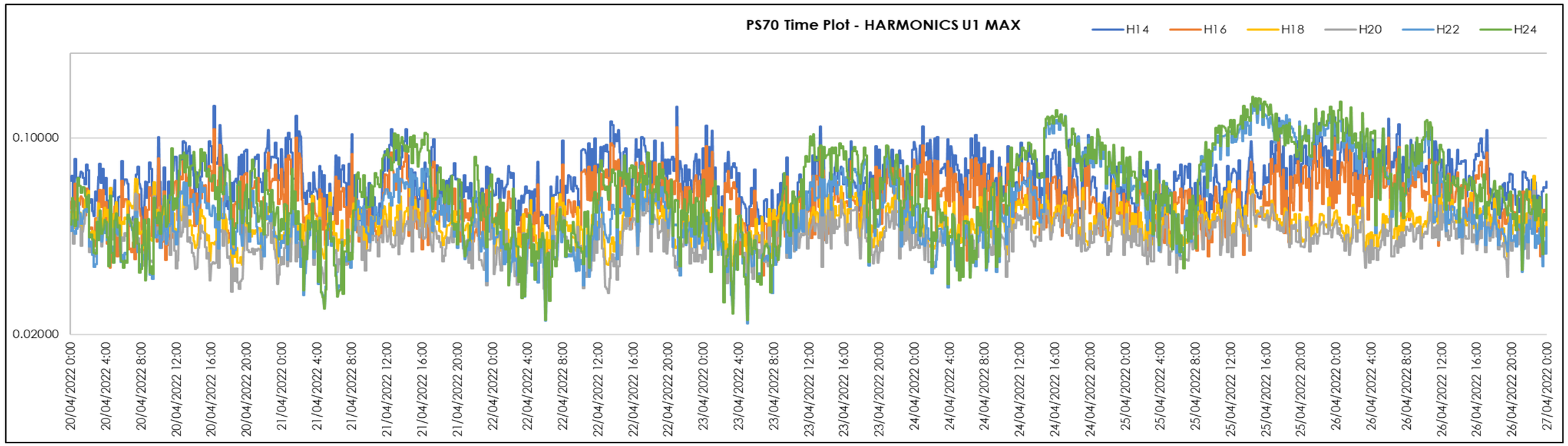
26/04/2022 4:00
26/04/2022 8:00
26/04/2022 12:00
26/04/2022 16:00
26/04/2022 20:00
27/04/2022 0:00


PS70 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.10000
0.02000
20/04/2022 0:00
20/04/2022 4:00
20/04/2022 8:00
20/04/2022 12:00
20/04/2022 16:00
20/04/2022 20:00
21/04/2022 0:00
21/04/2022 4:00
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26/04/2022 4:00
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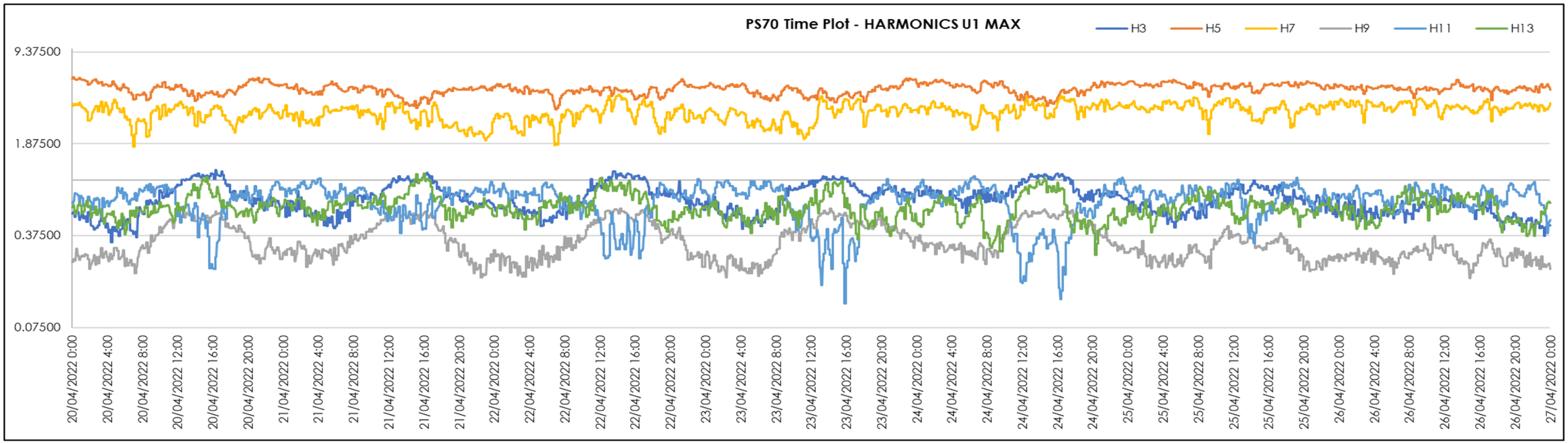


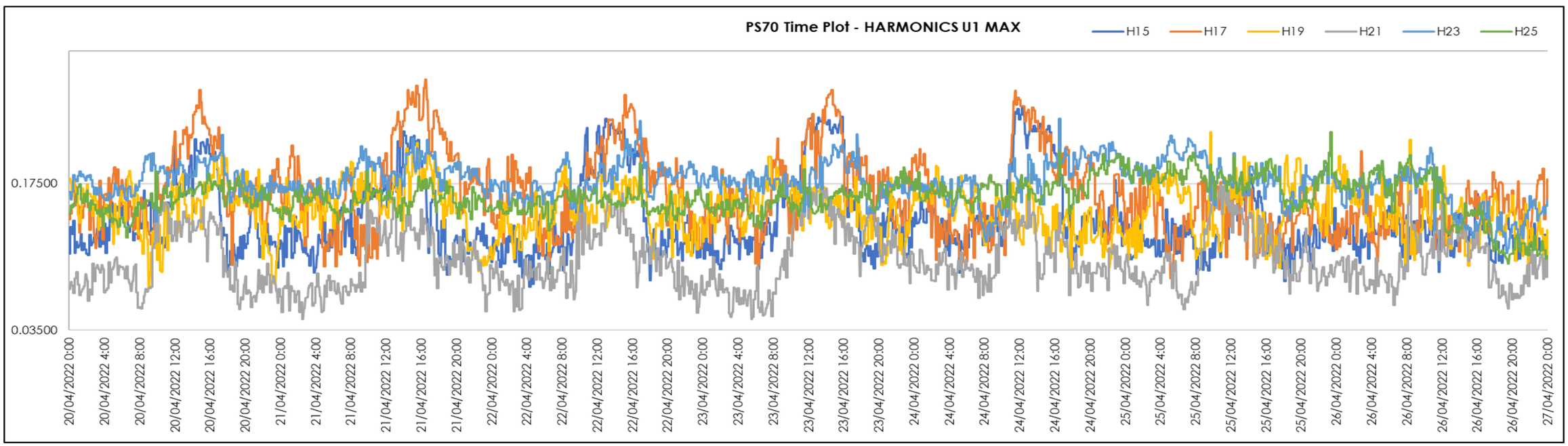
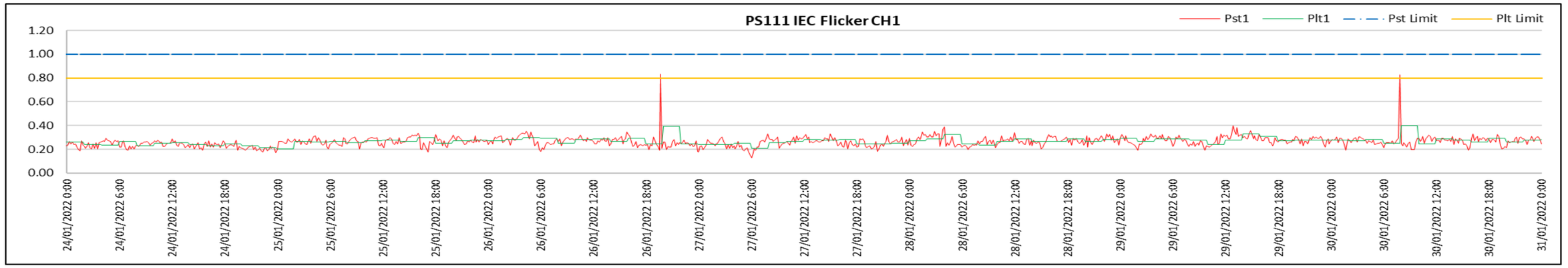
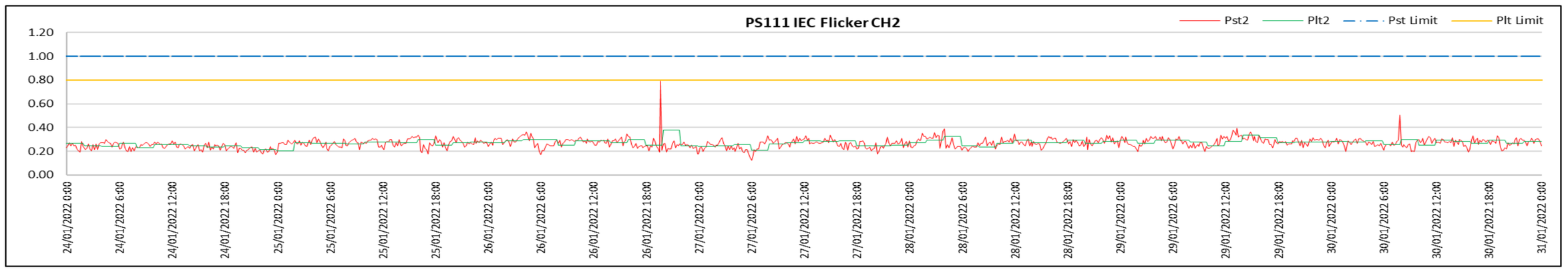


Figure 62 | STS2 End Harmonics

APPENDIX A.7 FEEDER STS4 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





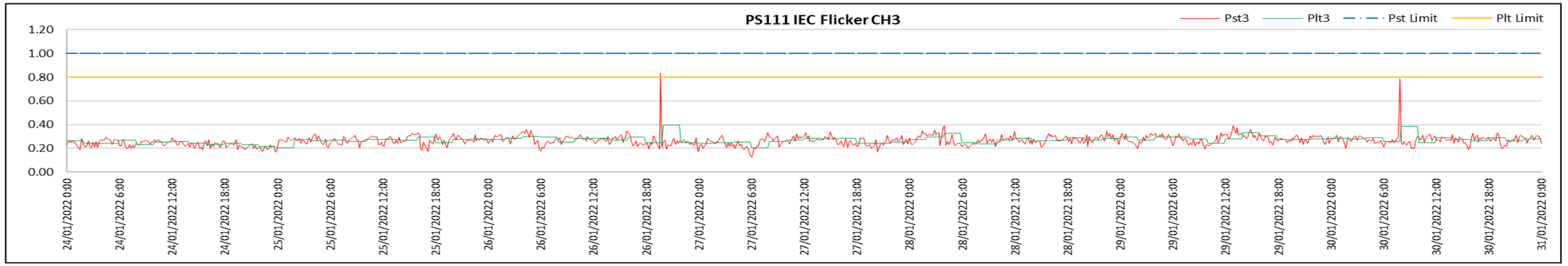
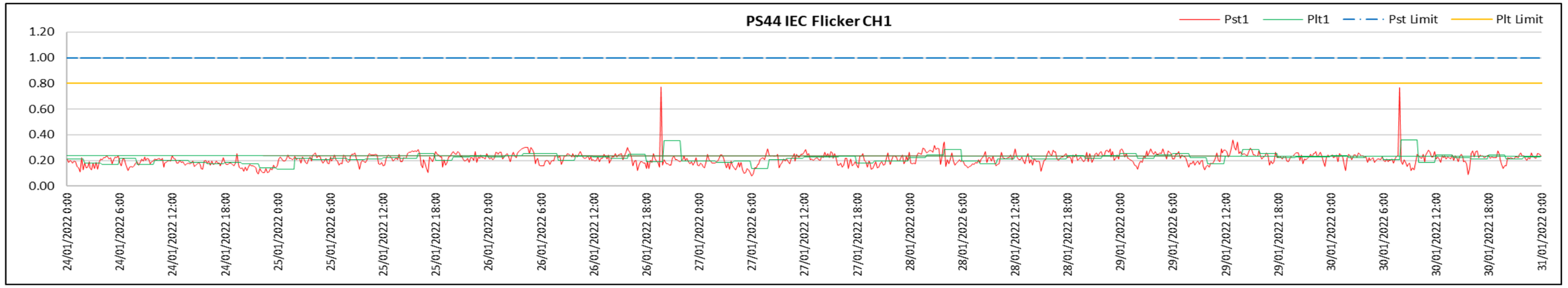
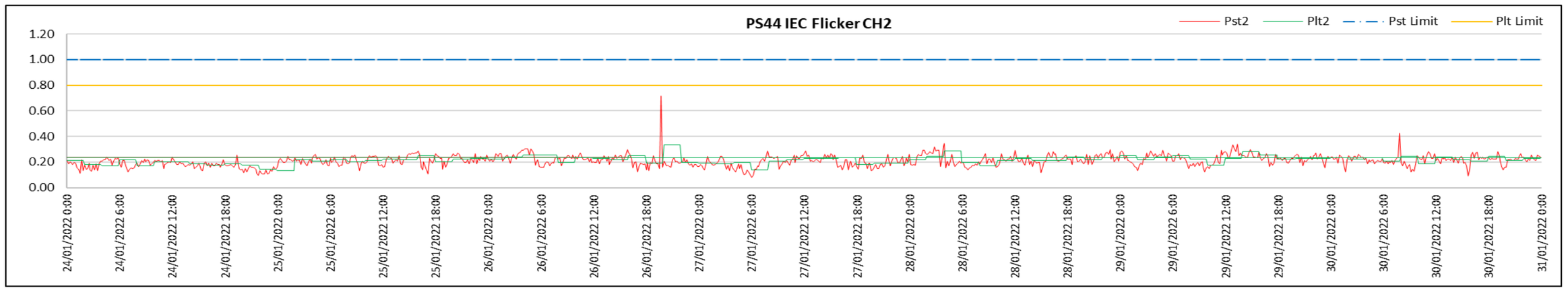


Figure 63 | STS4 Start Flicker measurements





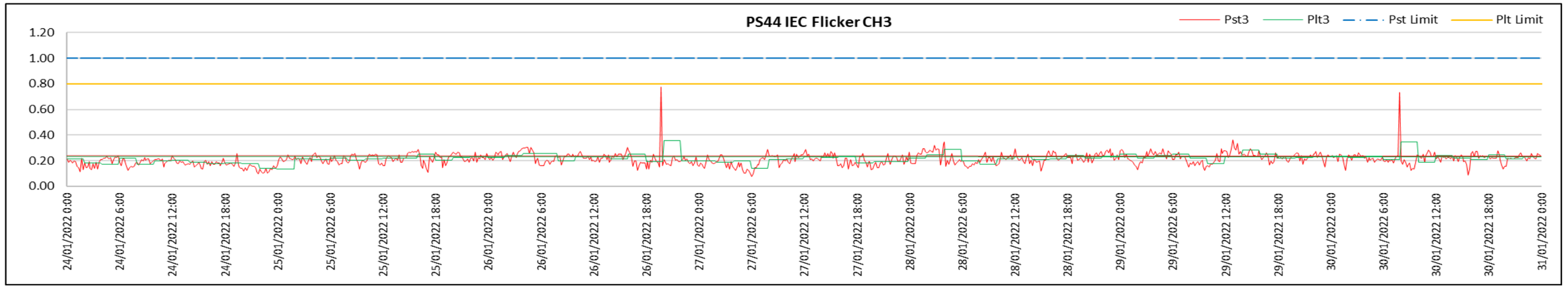


Figure 64 | STS4 End Flicker measurements

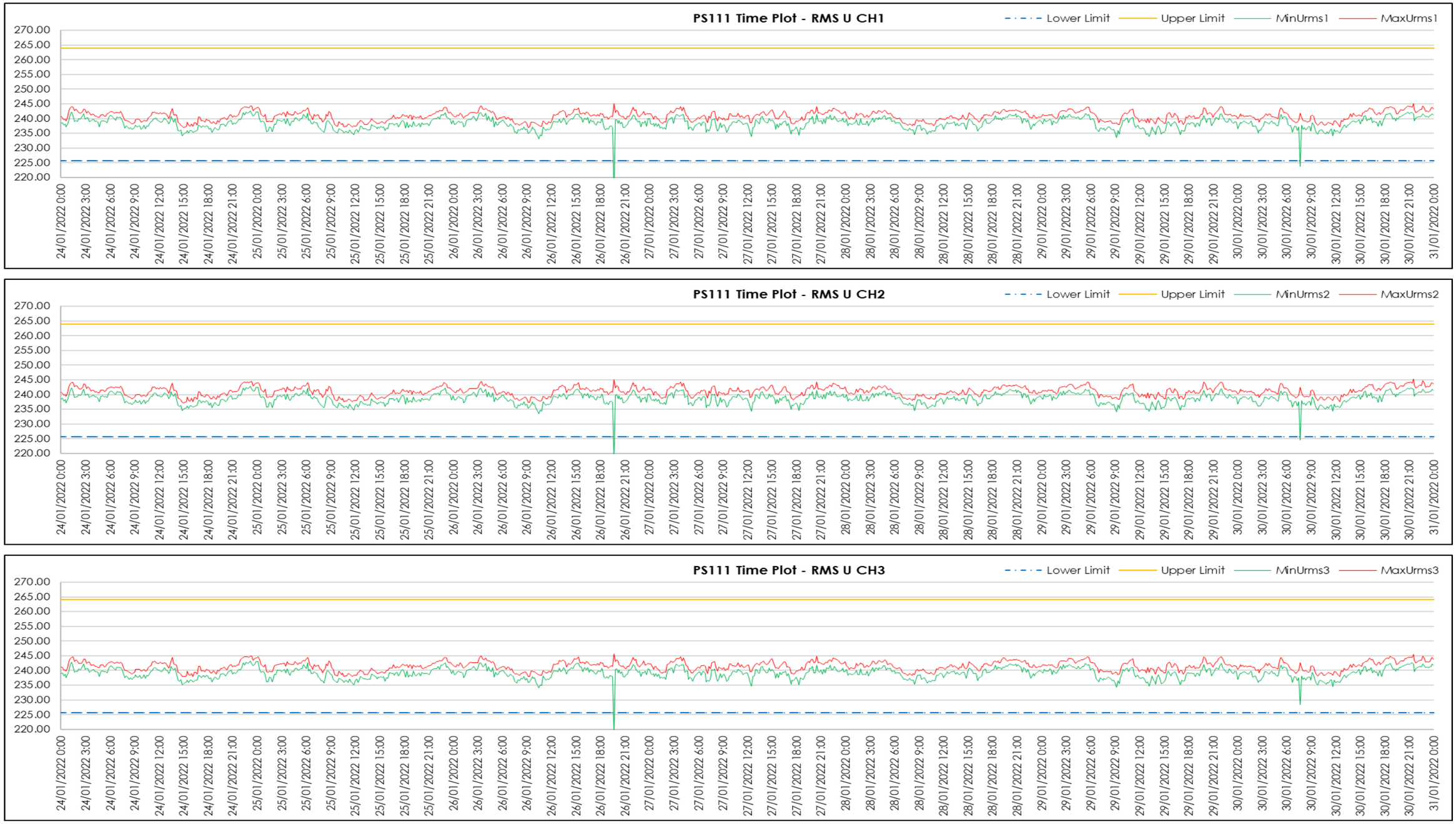


Figure 65 | STS4 Start Voltage measurements

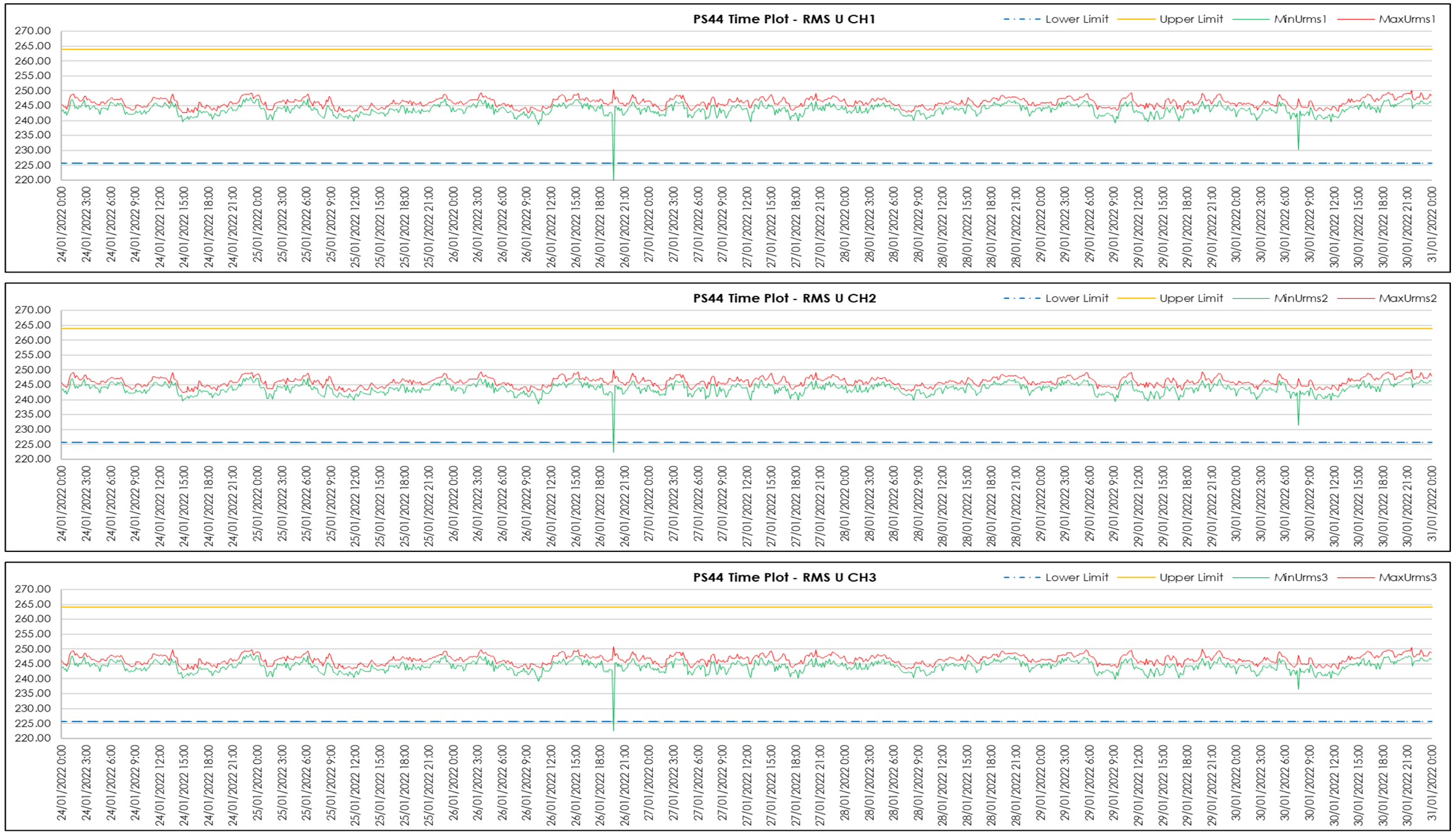


Figure 66 | STS4 End Voltage measurements

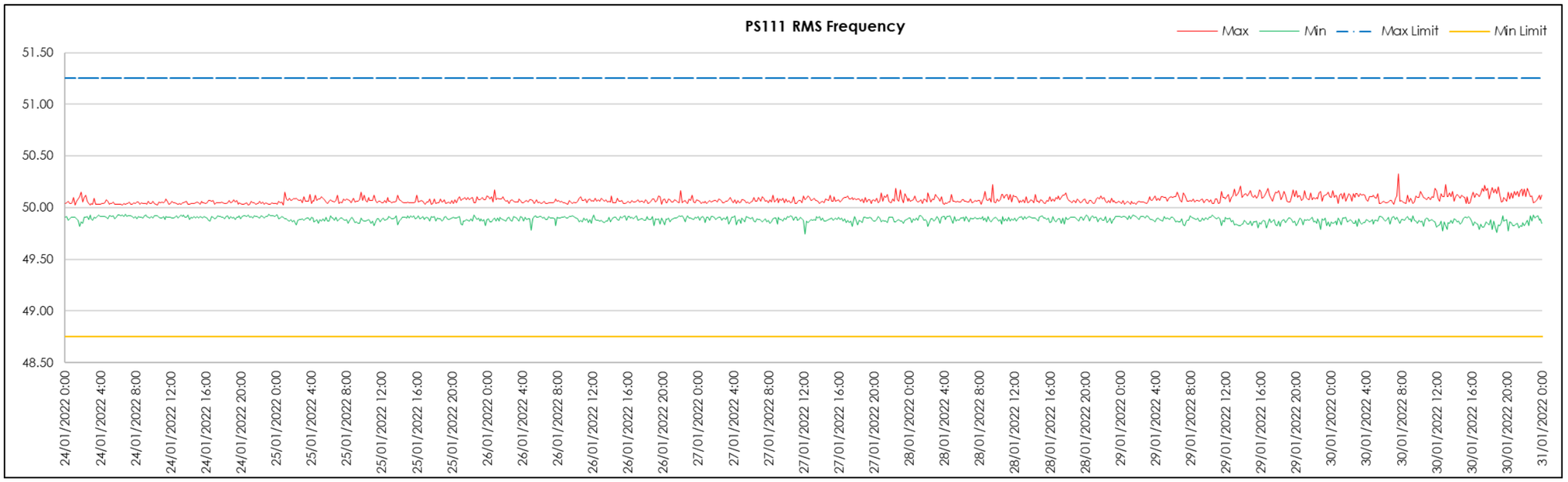


Figure 67 | STS4 Start Frequency measurements

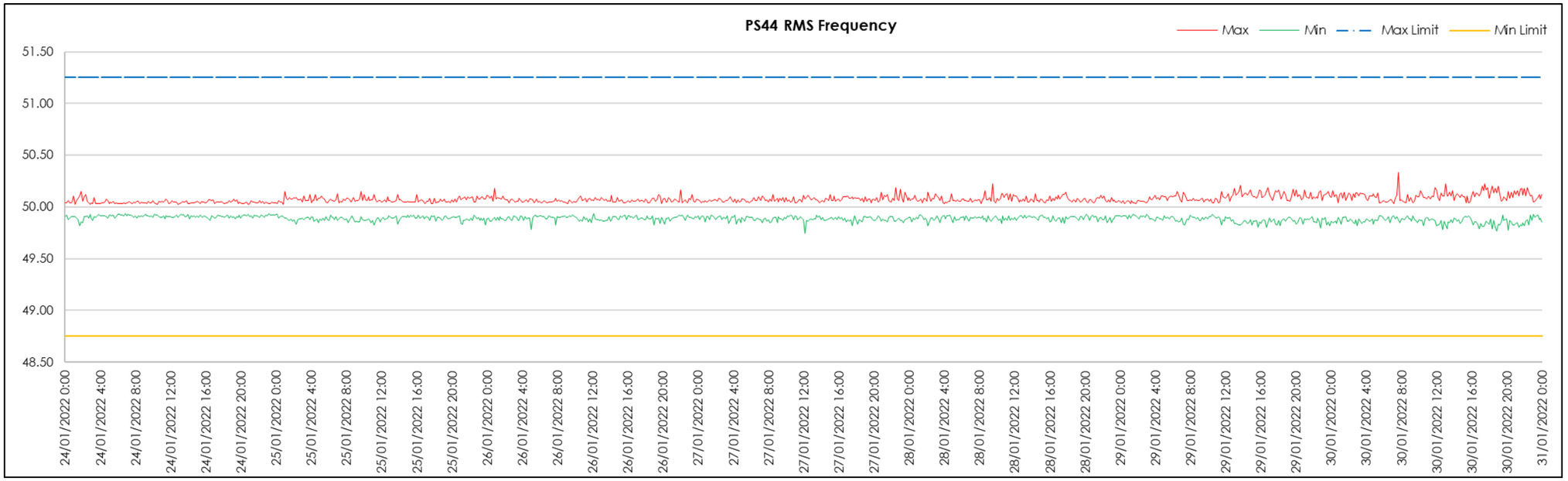
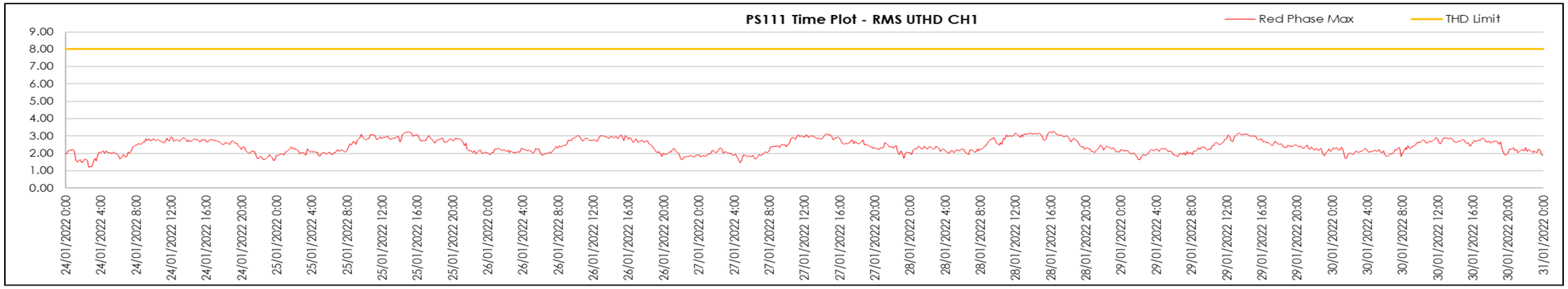
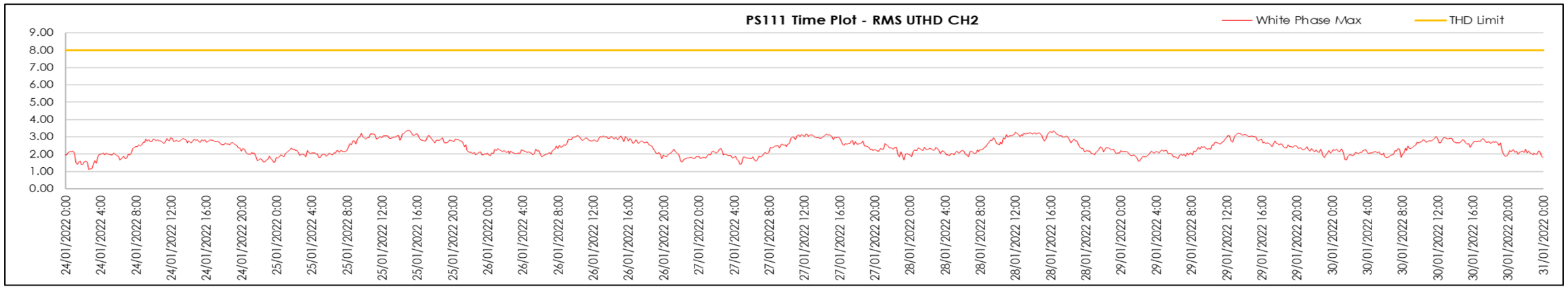


Figure 68 | STS4 End Frequency measurements





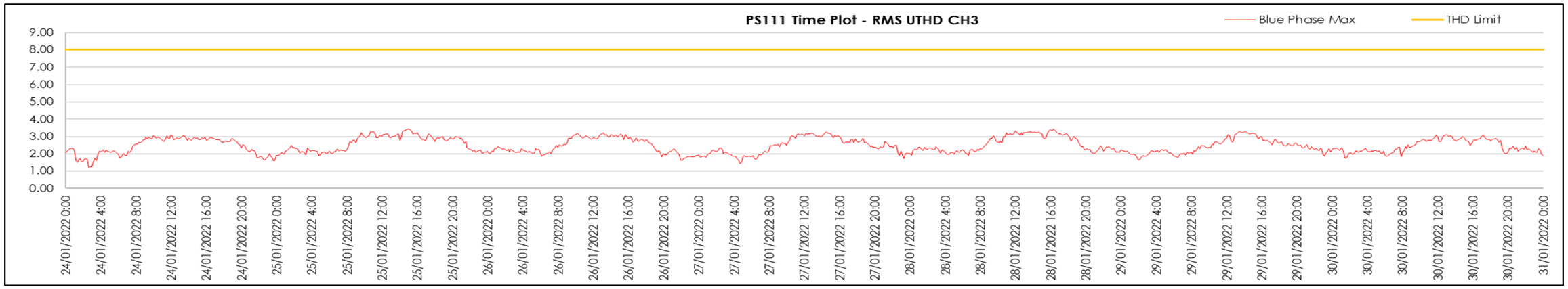
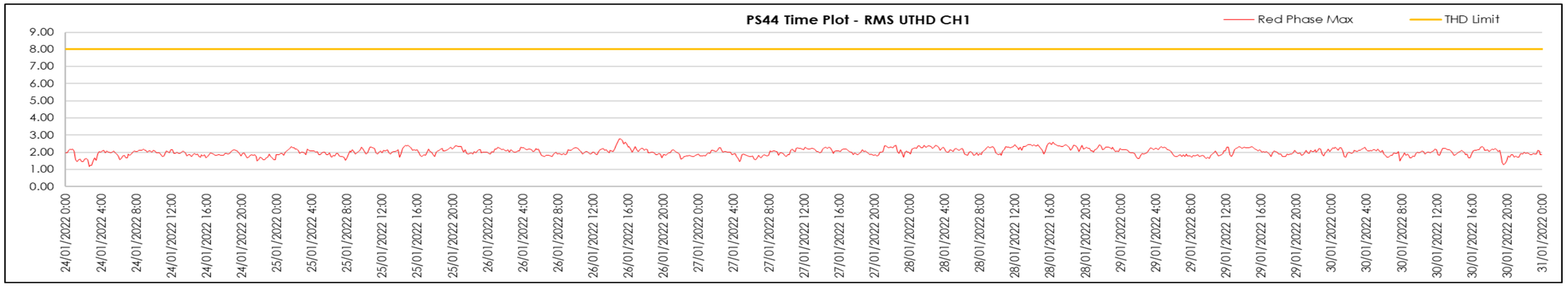
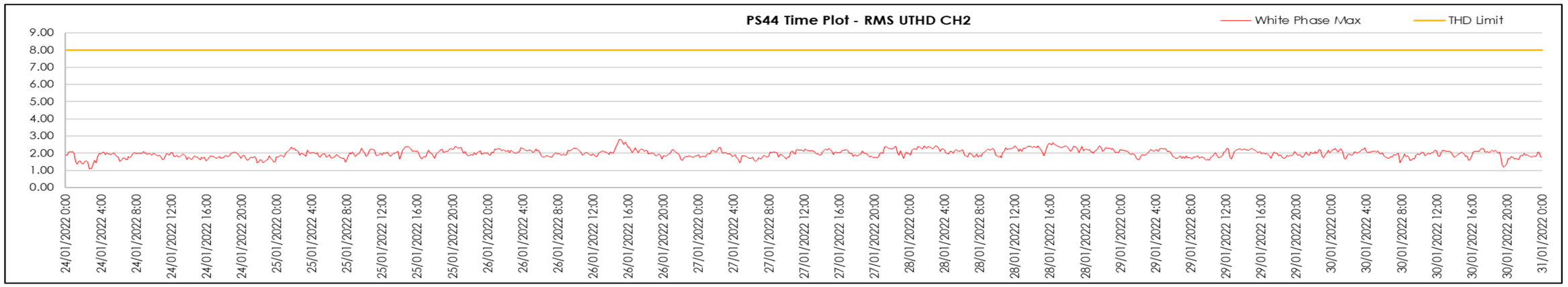


Figure 69 | STS4 Start U-THD measurements





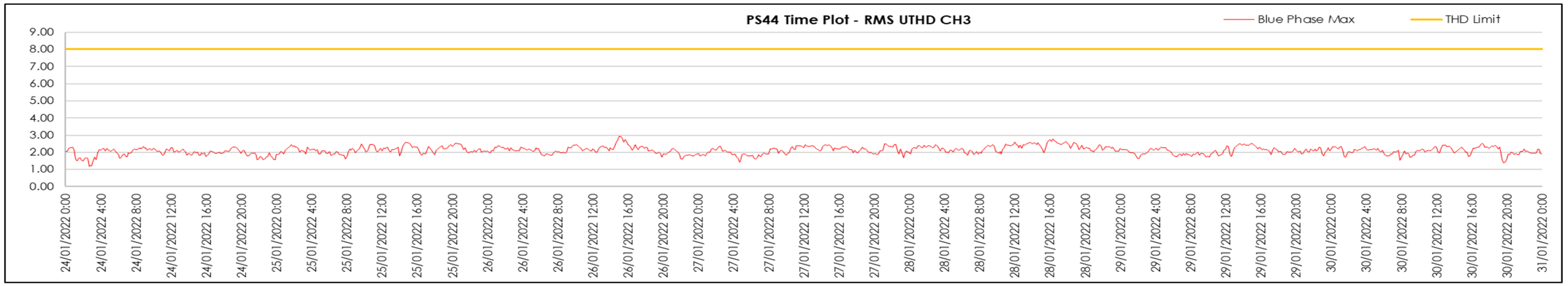
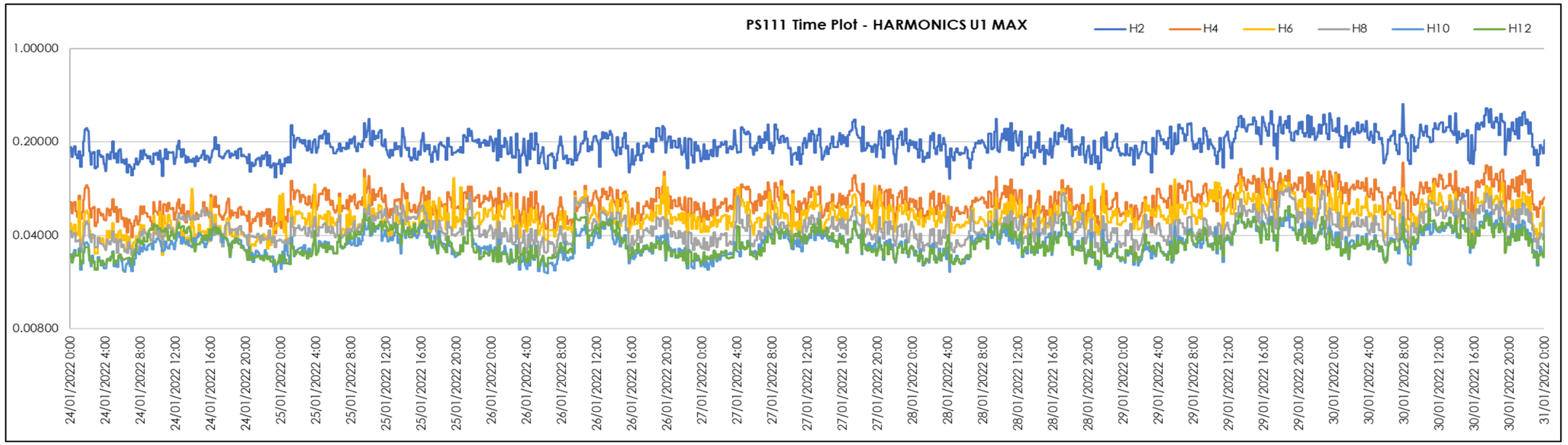


Figure 70 | STS4 End U-THD measurements


PS111 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
1.00000
0.20000
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
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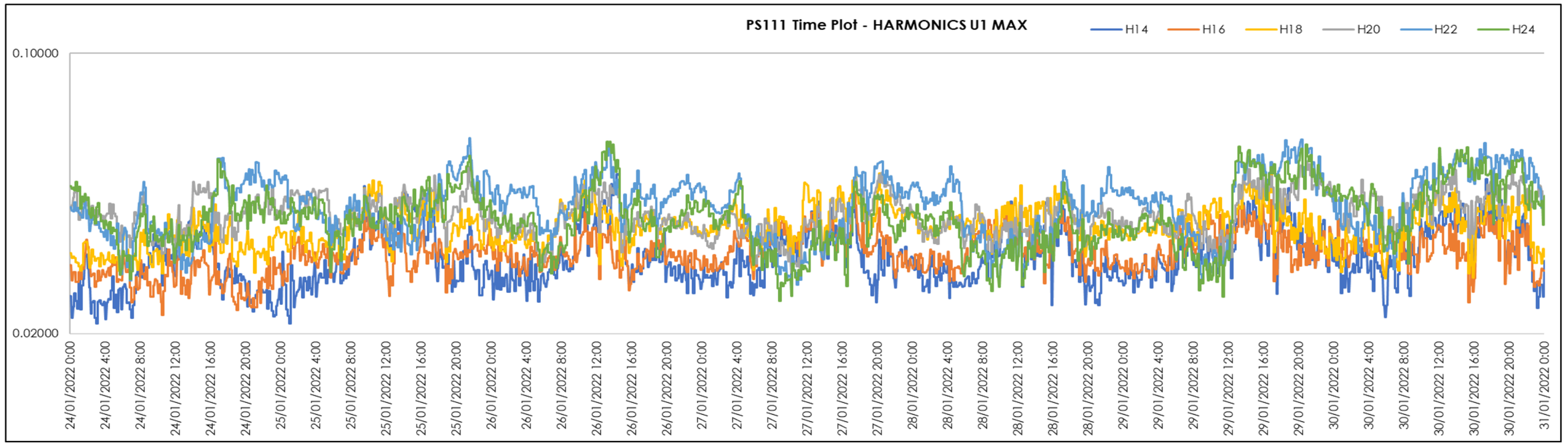
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS111 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.10000
0.02000
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
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28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00

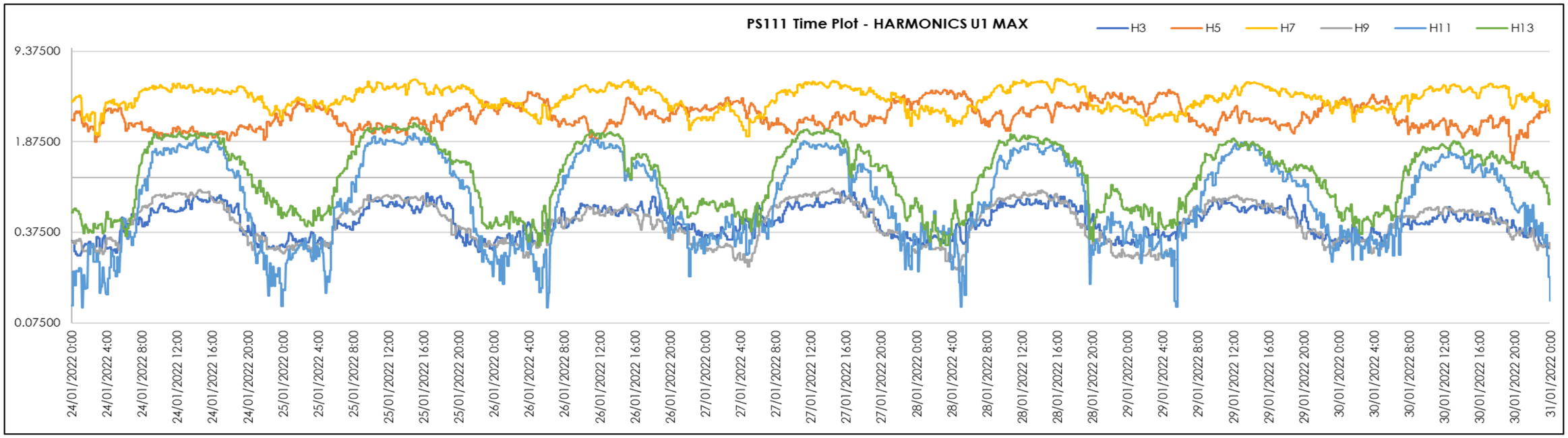
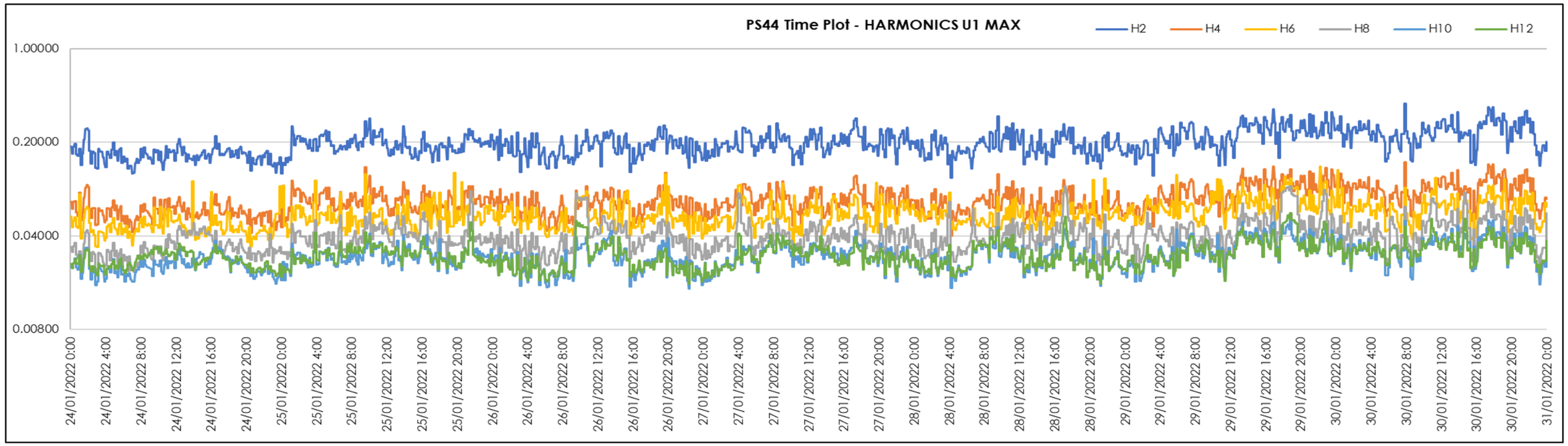


Figure 71 | STS4 Start Harmonics


PS44 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
1.00000
0.20000
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
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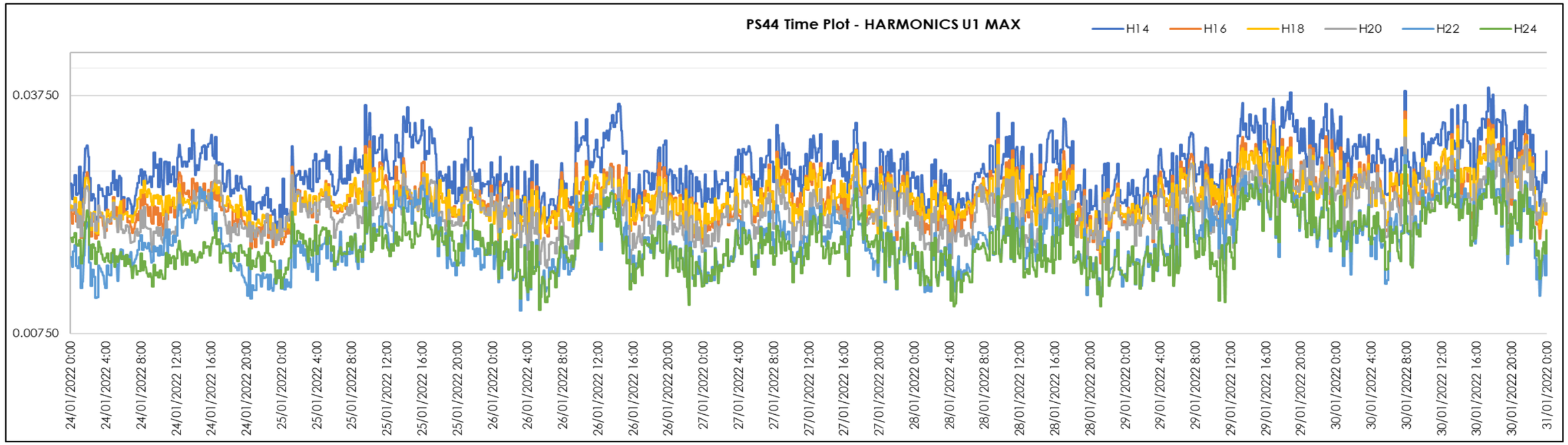
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS44 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
27/01/2022 0:00
27/01/2022 4:00
27/01/2022 8:00
27/01/2022 12:00
27/01/2022 16:00
27/01/2022 20:00
28/01/2022 0:00
28/01/2022 4:00
28/01/2022 8:00
28/01/2022 12:00
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28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
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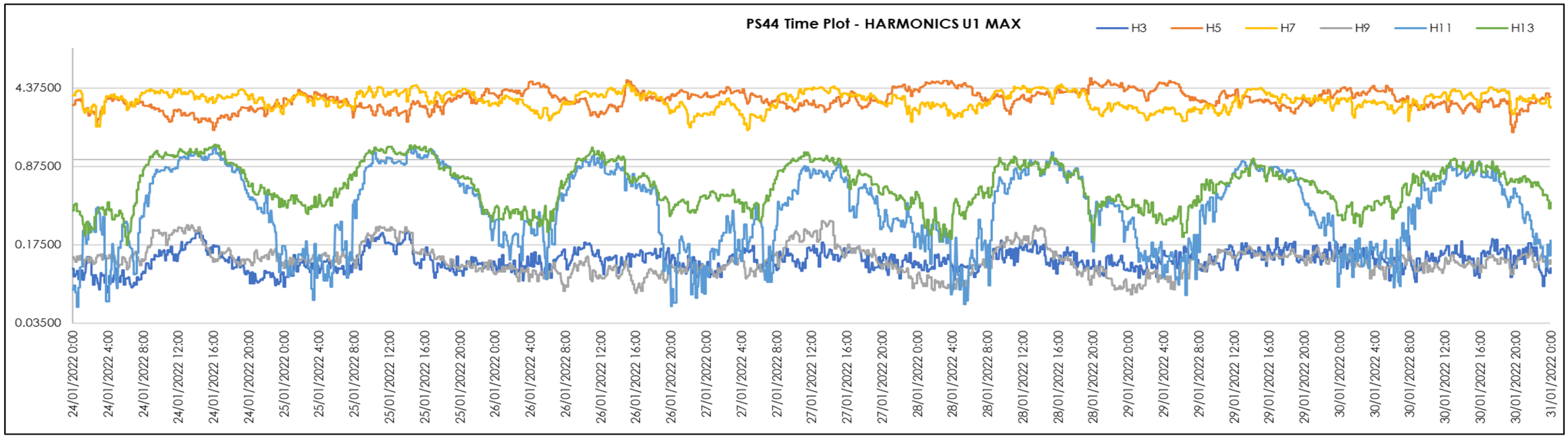
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



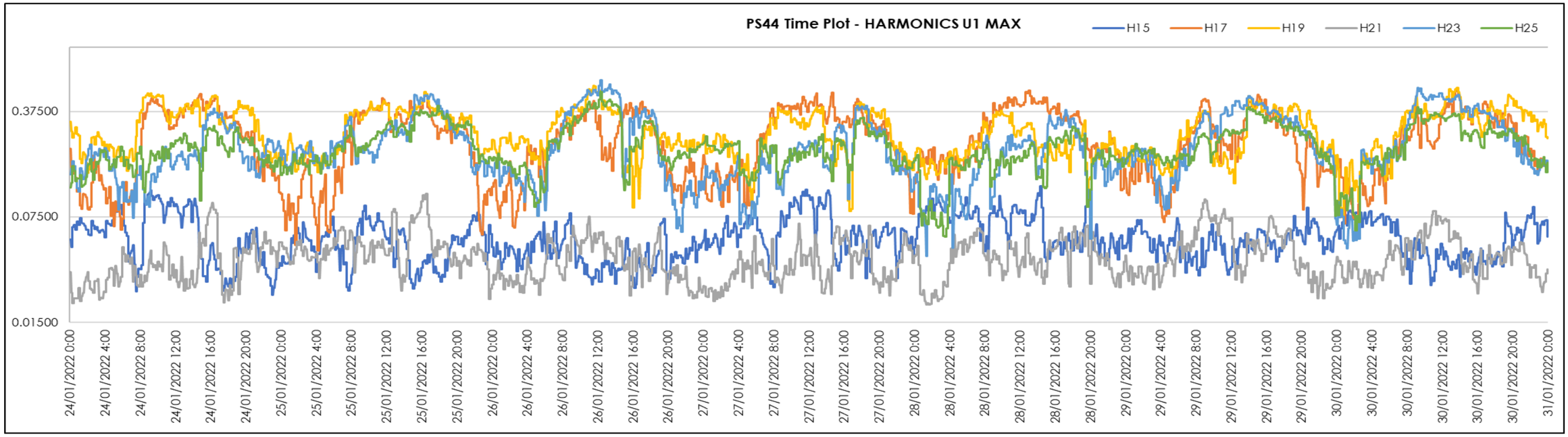
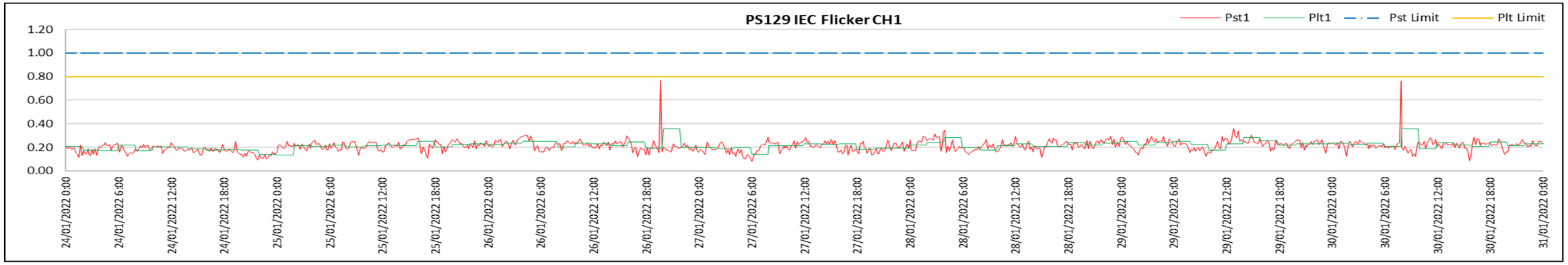
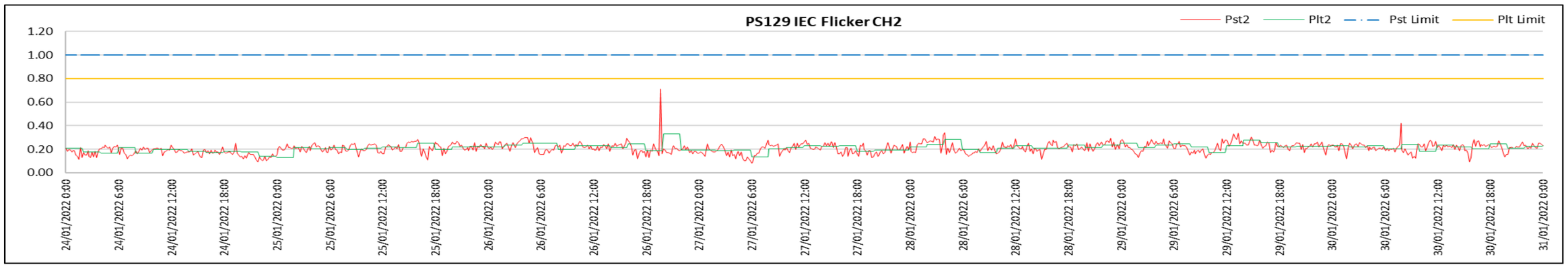


Figure 72 | STS4 End Harmonics

APPENDIX A.8 FEEDER STS6 FLICKER, VOLTAGE, FREQUENCY AND HARMONICS





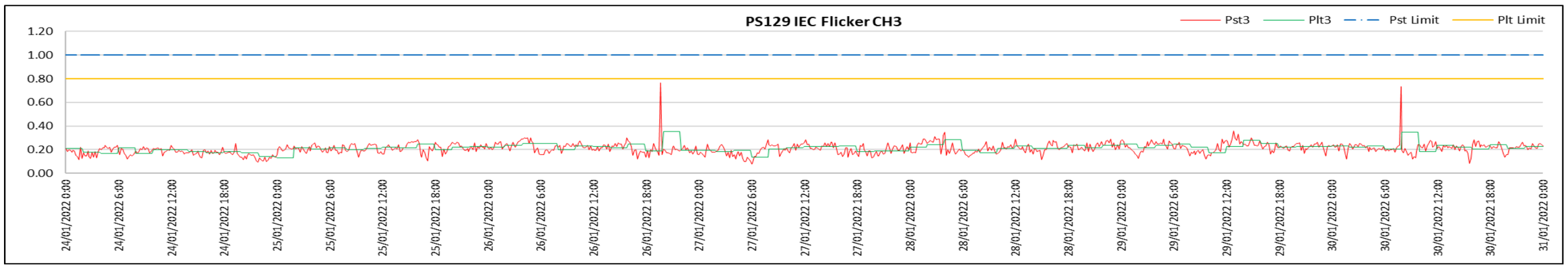


Figure 73 | STS6 Start Flicker measurements

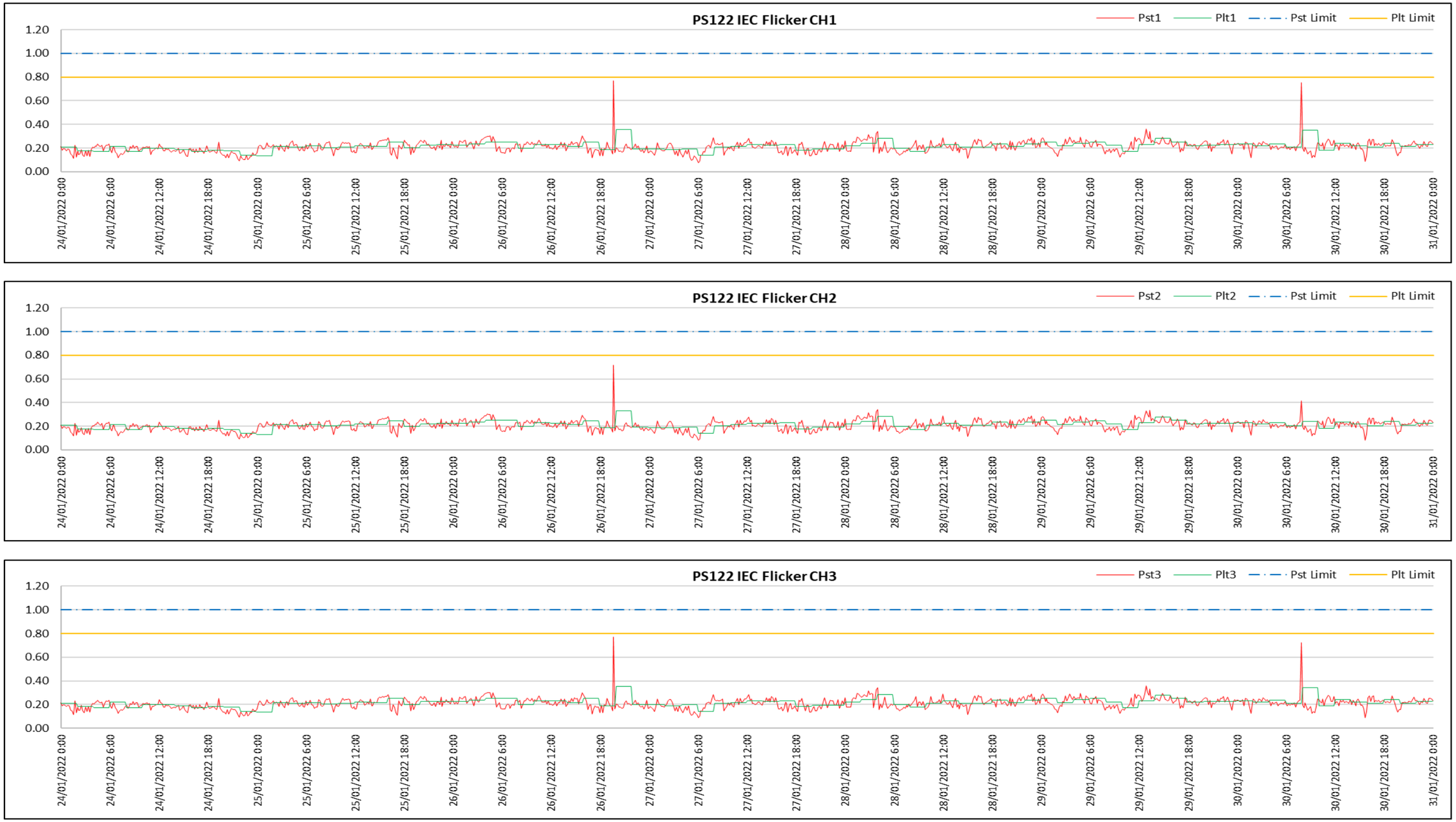


Figure 74 | STS6 End Flicker measurements

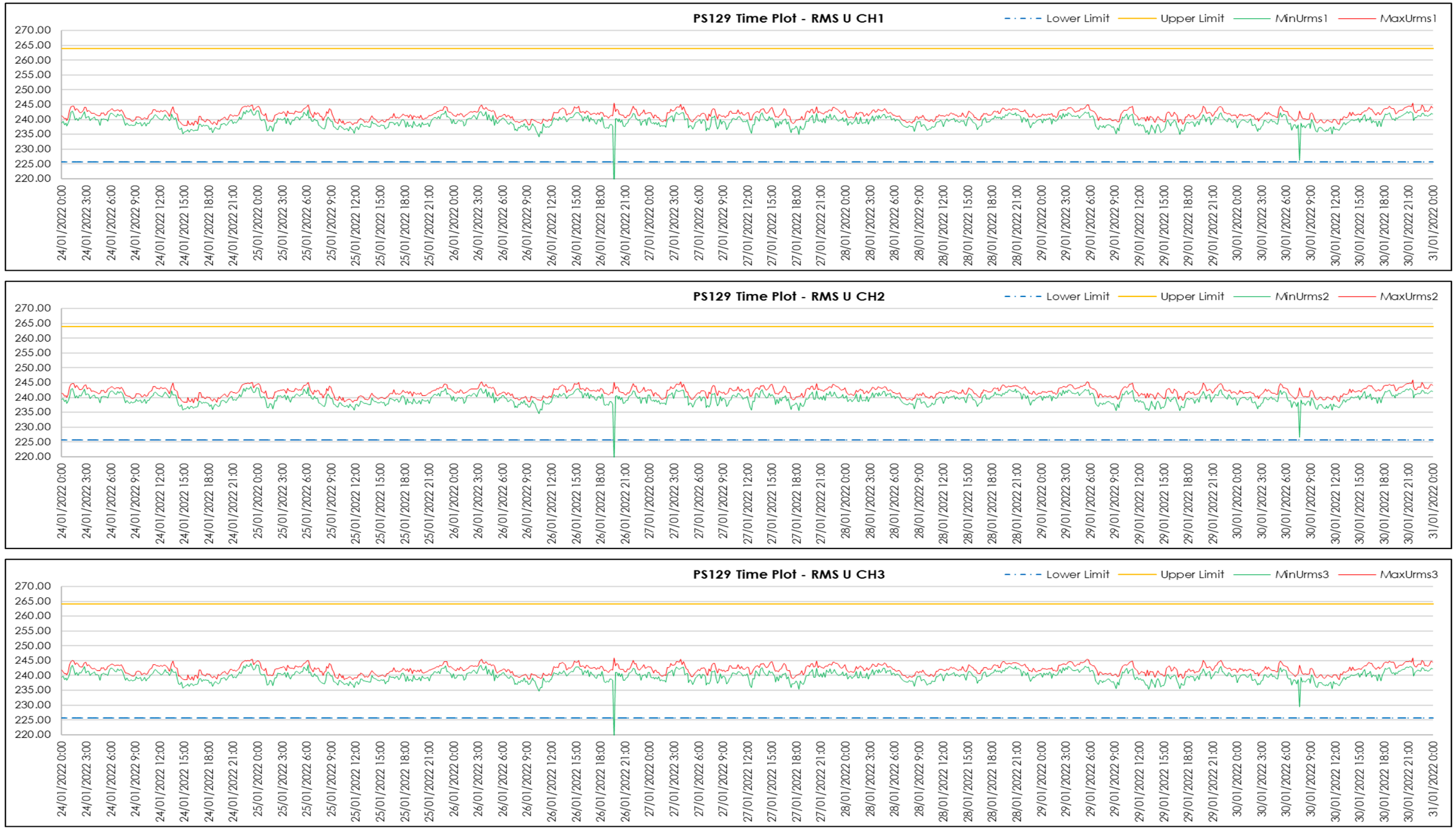


Figure 75 | STS6 Start Voltage measurements

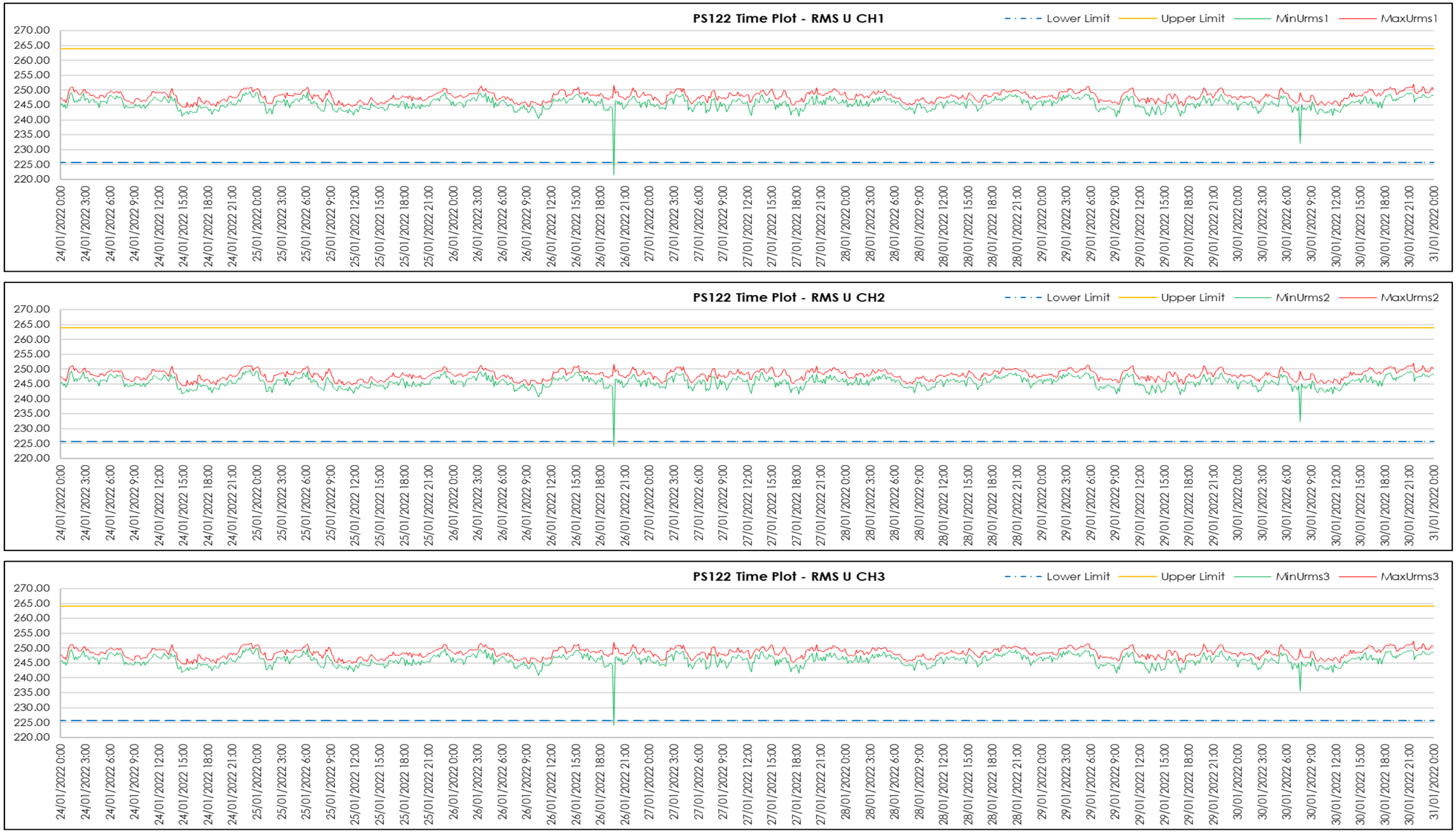


Figure 76 | STS6 End Voltage measurements

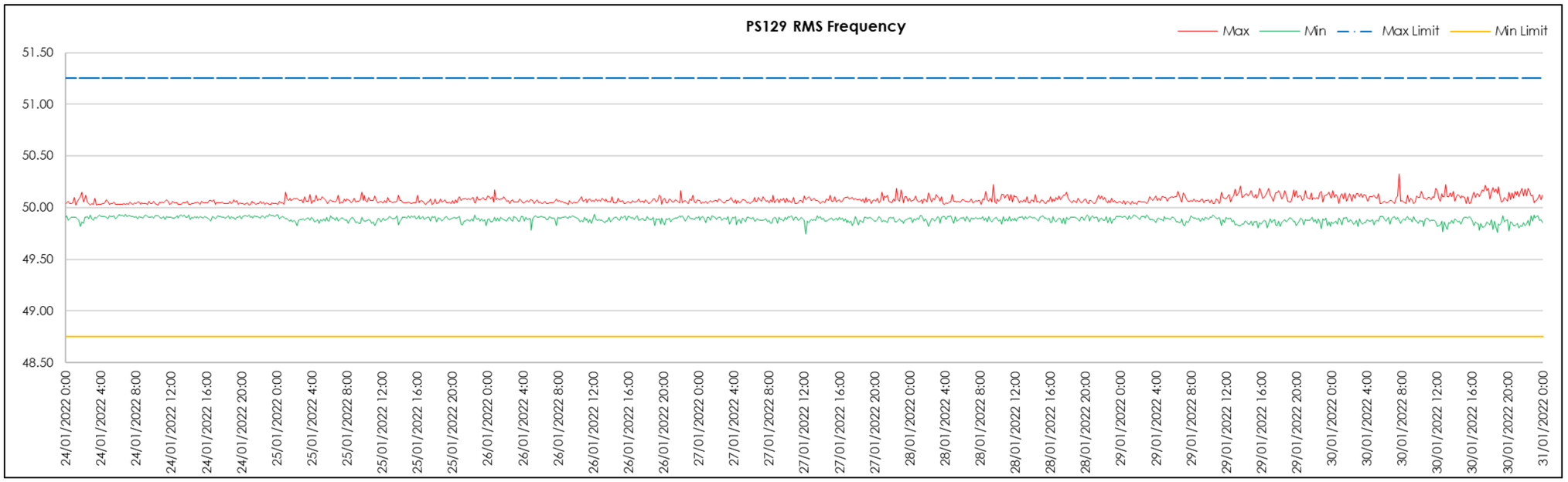


Figure 77 | STS6 Start Frequency measurements

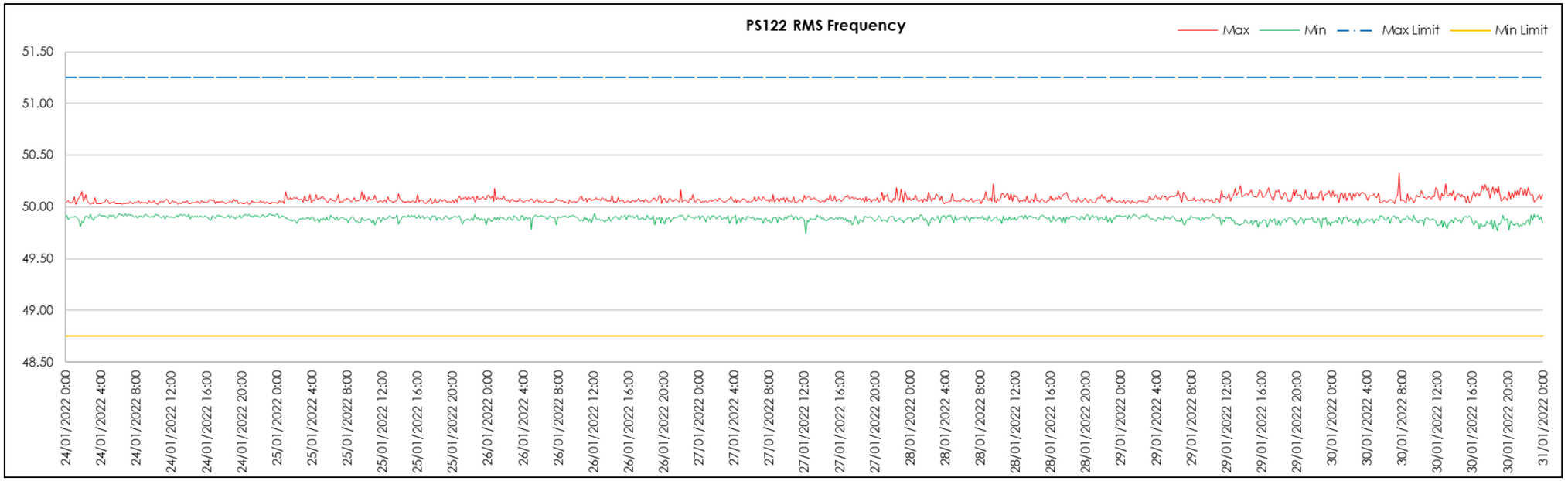
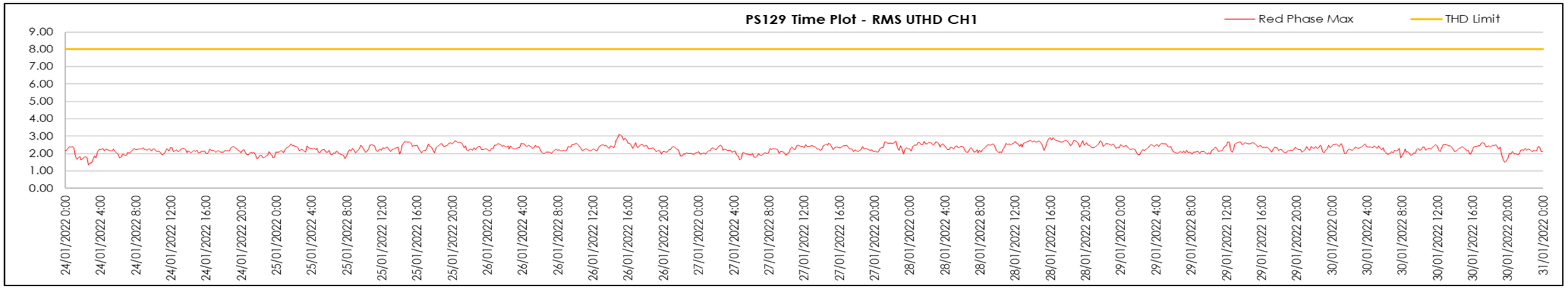
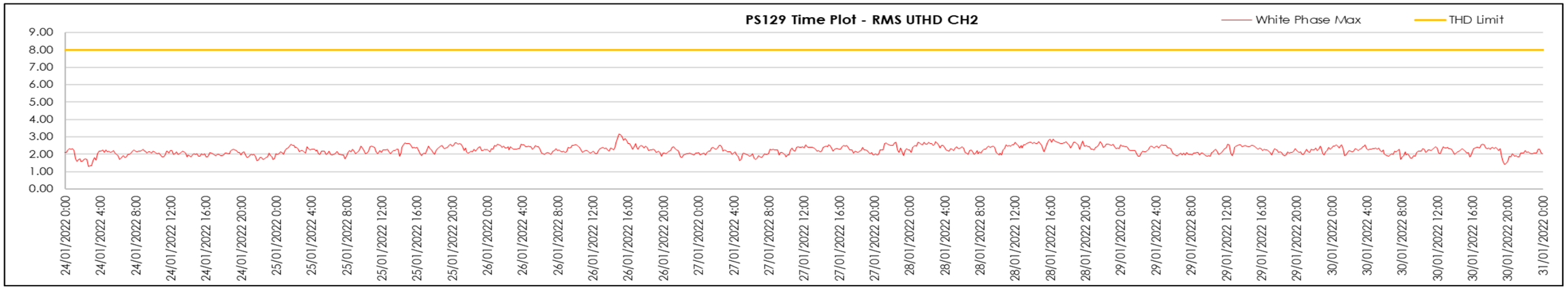


Figure 78 | STS6 End Frequency measurements





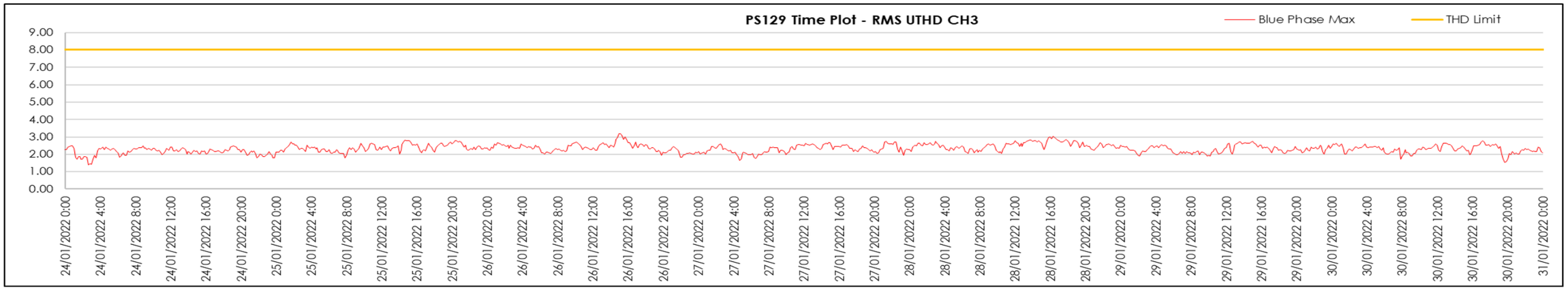


Figure 79 | STS6 Start U-THD measurements

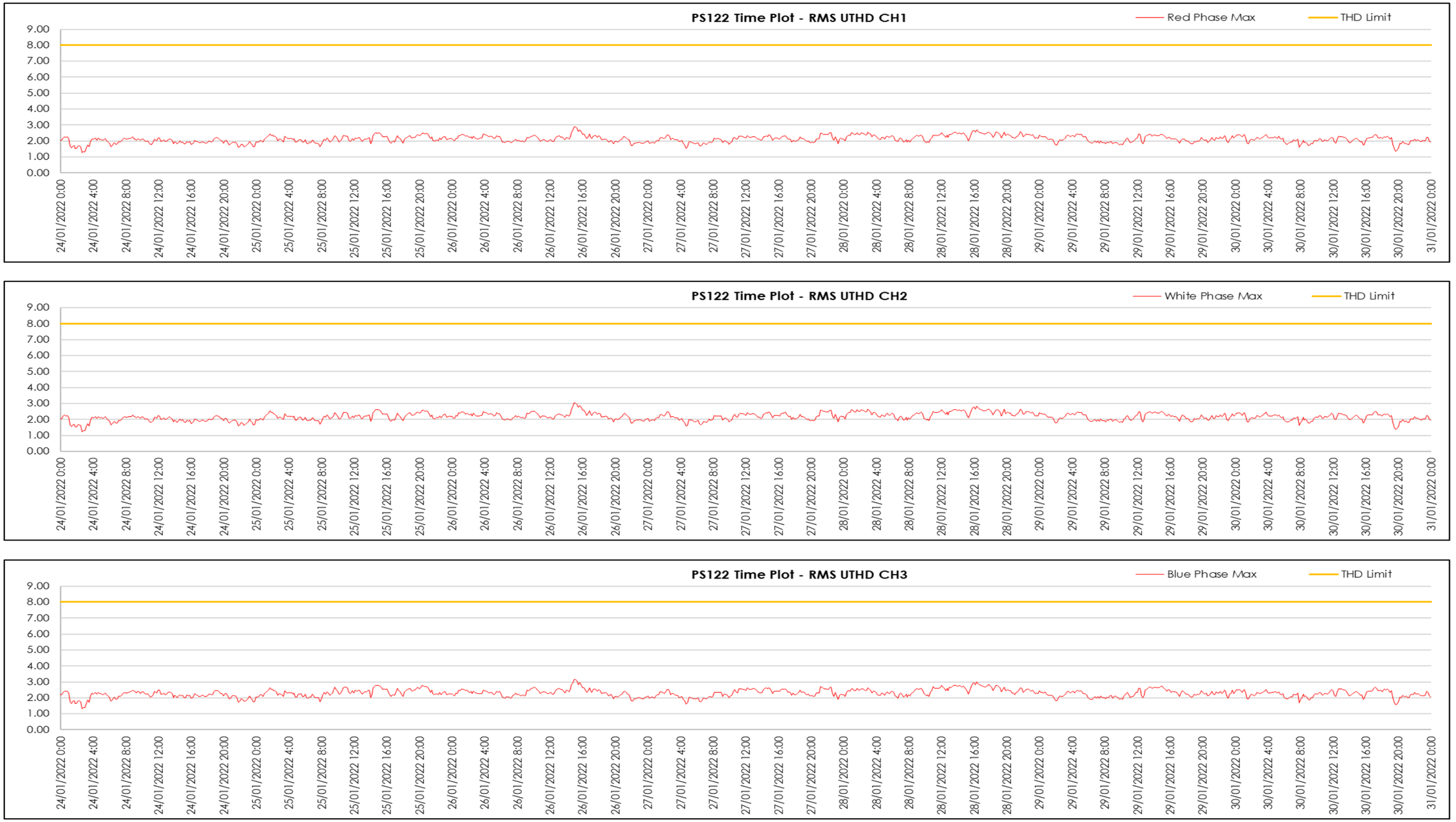
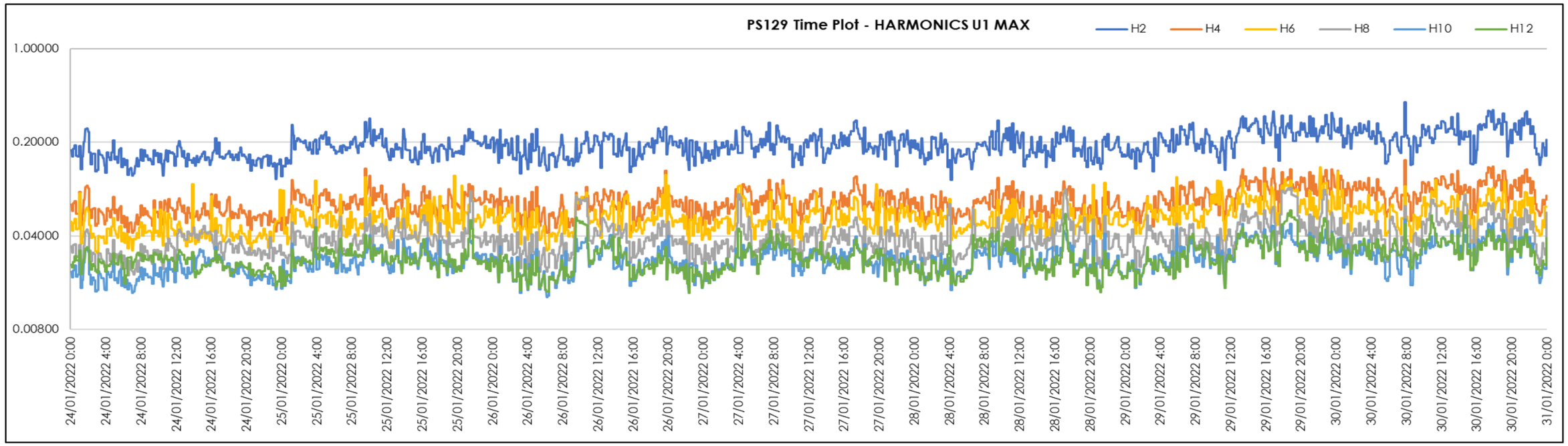


Figure 80 | STS6 End U-THD measurements


PS129 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
1.00000
0.20000
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
26/01/2022 16:00
26/01/2022 20:00
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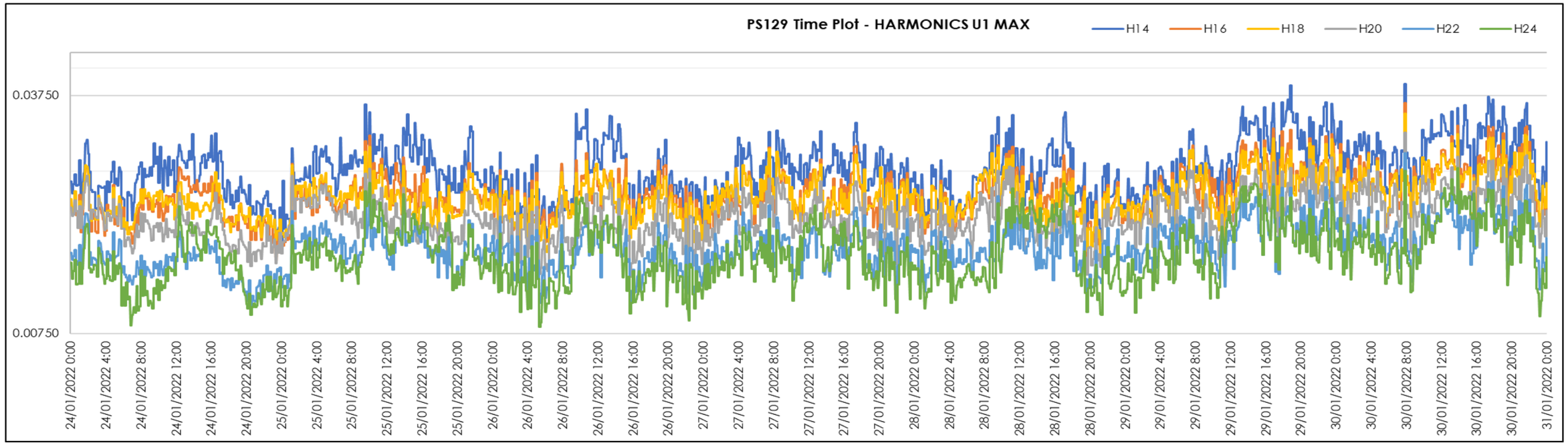
28/01/2022 8:00
28/01/2022 12:00
28/01/2022 16:00
28/01/2022 20:00
29/01/2022 0:00
29/01/2022 4:00
29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS129 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
26/01/2022 12:00
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27/01/2022 4:00
27/01/2022 8:00
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28/01/2022 4:00
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29/01/2022 8:00
29/01/2022 12:00
29/01/2022 16:00
29/01/2022 20:00
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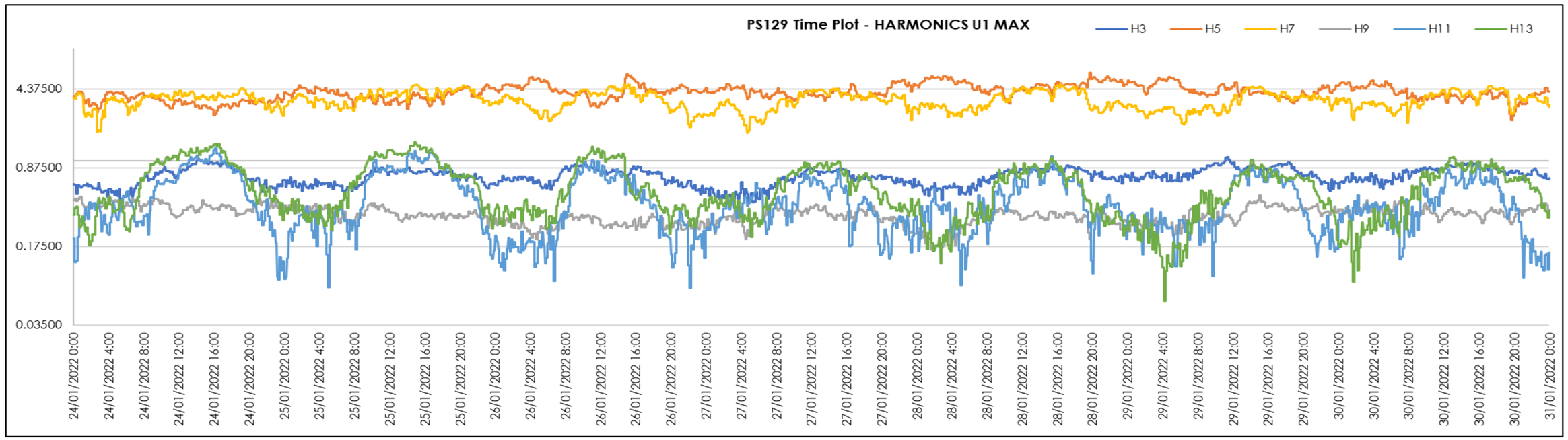
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00



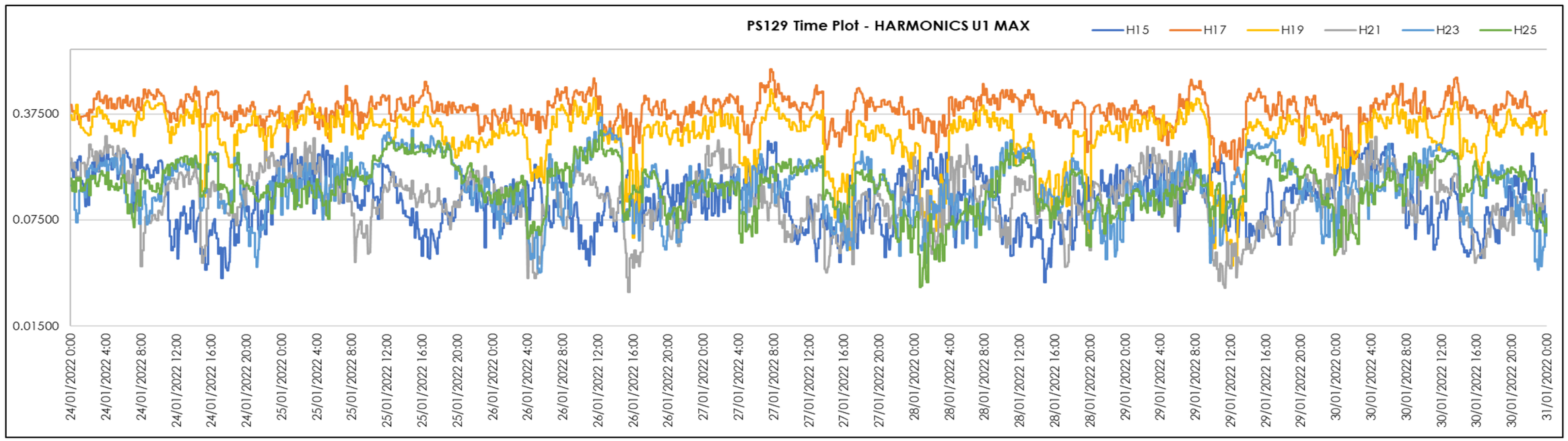
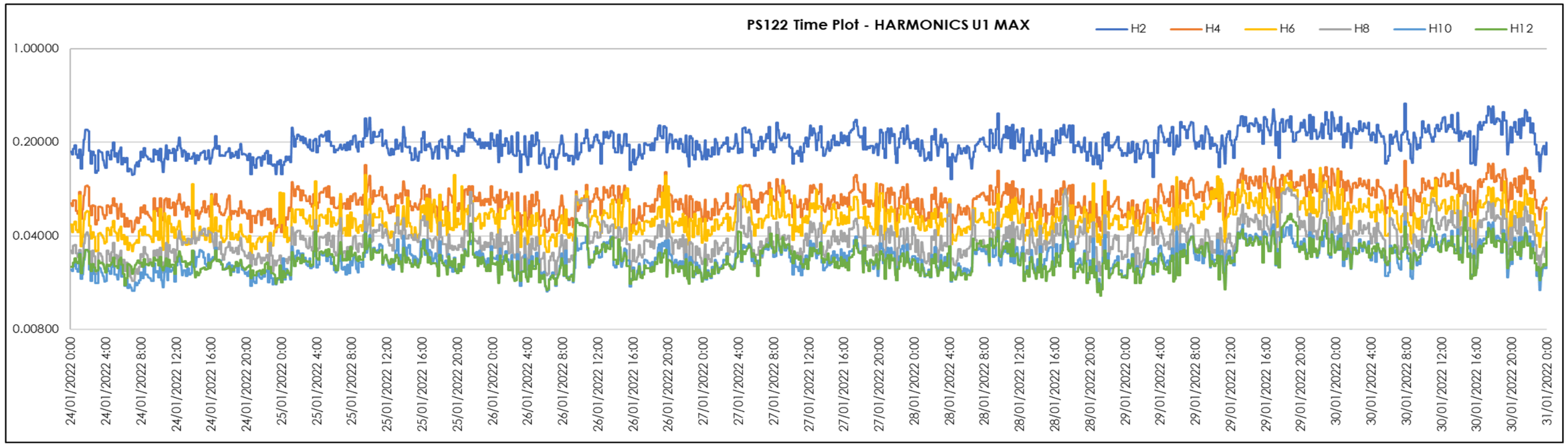


Figure 81 | STS6 Start Harmonics


PS122 Time Plot - HARMONICS U1 MAX
H2
H4
H6
H8
H10
H12
1.00000
0.20000
0.04000
0.00800
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
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27/01/2022 8:00
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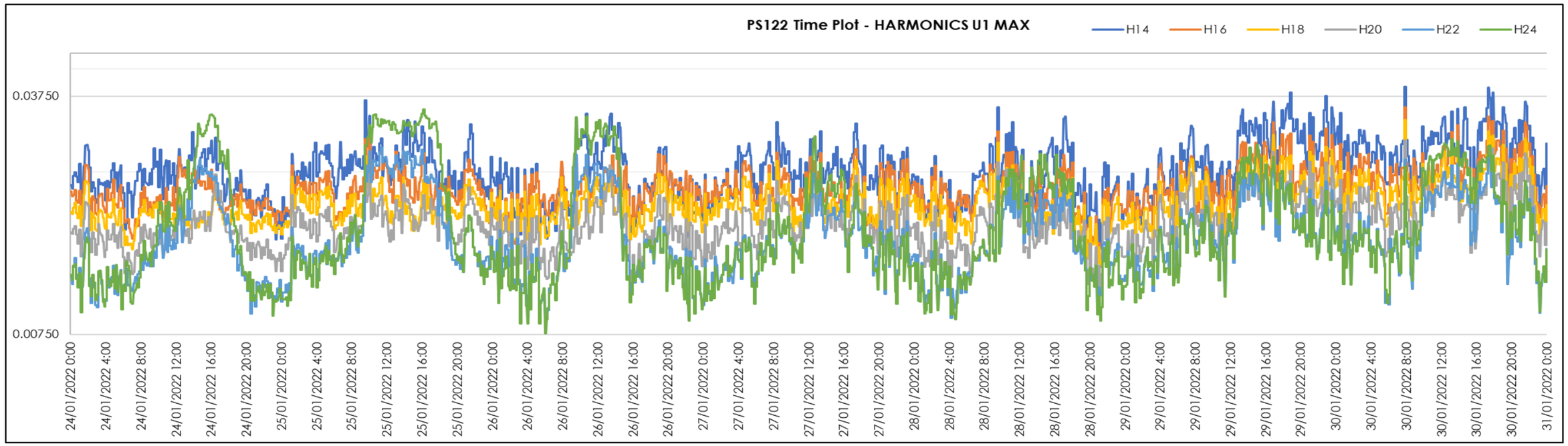
30/01/2022 0:00
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00


PS122 Time Plot - HARMONICS U1 MAX
H14
H16
H18
H20
H22
H24
0.03750
0.00750
24/01/2022 0:00
24/01/2022 4:00
24/01/2022 8:00
24/01/2022 12:00
24/01/2022 16:00
24/01/2022 20:00
25/01/2022 0:00
25/01/2022 4:00
25/01/2022 8:00
25/01/2022 12:00
25/01/2022 16:00
25/01/2022 20:00
26/01/2022 0:00
26/01/2022 4:00
26/01/2022 8:00
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26/01/2022 16:00
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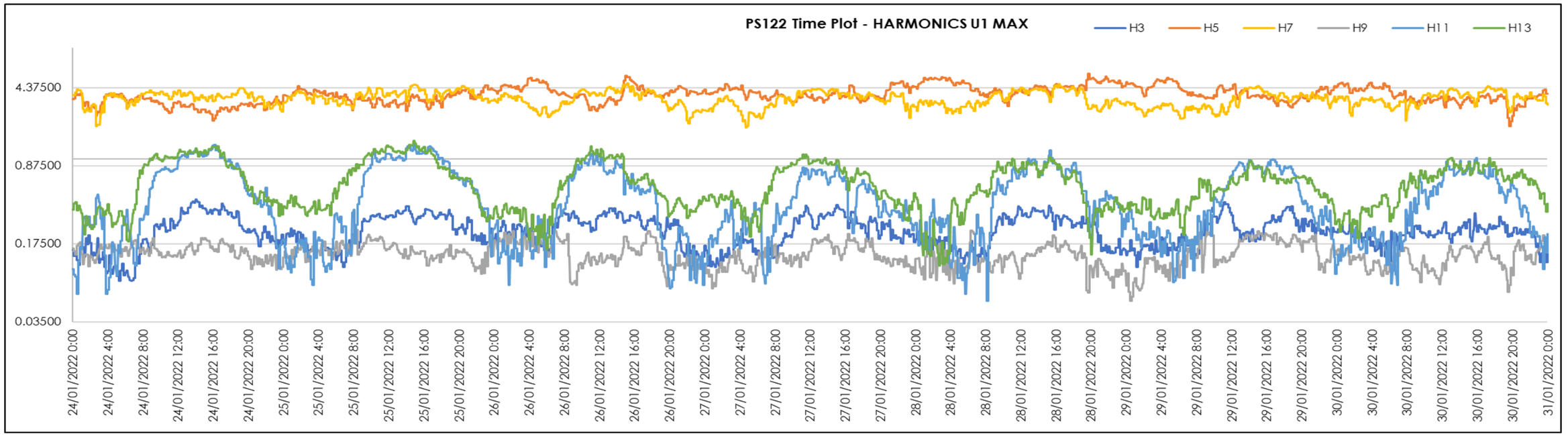
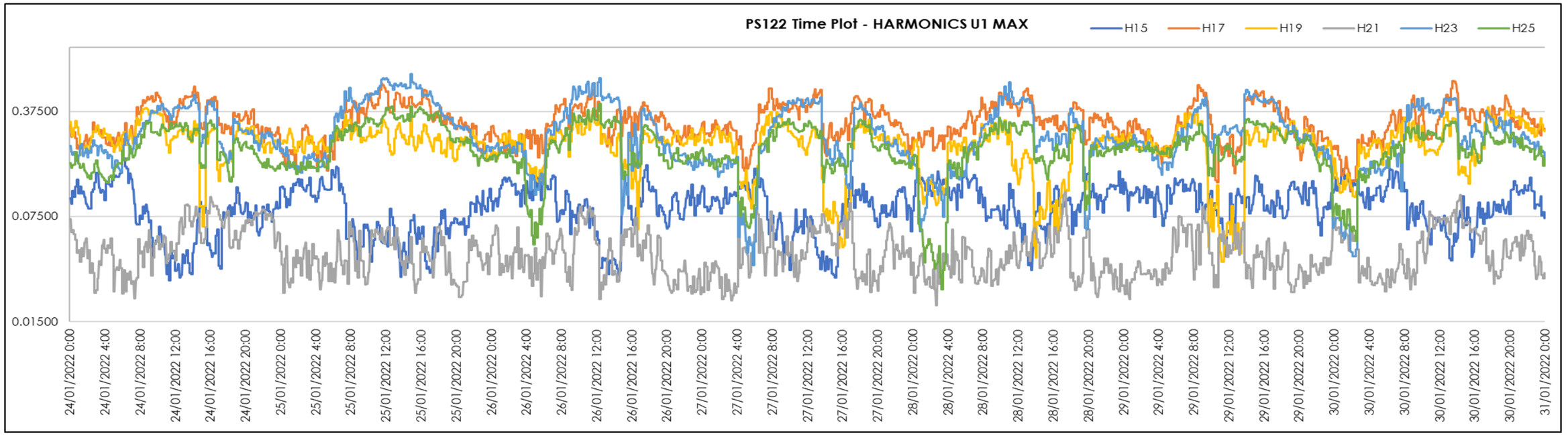
30/01/2022 4:00
30/01/2022 8:00
30/01/2022 12:00
30/01/2022 16:00
30/01/2022 20:00
31/01/2022 0:00





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APPENDIX B. ELEC. FAULT LOGS (2021/2022 FY)

Event	Date	Outage Duration (mins)	Affected Generation/Fdr/Distribution Description	System Voltage kV	Circuit-Breaker/Fuse that cleared the fault	Fault Current (Amps)	Fault Duration (Seconds)	Effect on operations	Total Number of Customer Affected
515	2022-05-18	323.00	North Newman Town	11	Town STS1	731	267	Loss of supply to LIA	43
514	2022-05-07	111.00	TC1 Feeder	11	Town Fdr TC1	0.795kA	317ms	Loss to most of South Newman	400
513	2022-05-04	54.00	Newman Airport Line	11	Town REC 34/64 Gun Club Road	0.795kA	96ms	Loss of supply to the Airport line, Corner B, Capricorn Roadhouse the Gun club region	26
509	2022-04-18	94.00	North Newman Town	11	Town RMU001	N/A	N/A	Loss of supply to North Newman region, including hospital.	457
505	2022-03-29	20	Newman Airport Feeder	11	Town REC 34/64 Gun Club Road	N/A	N/A	Loss of supply to the Airport line, Corner B, Capricorn Roadhouse the Gun club region	26
486	2022-01-17	70.00	PS128	0.415		N/A	N/A	Loss of power to art gallery	3
485	2022-01-16	34.00	East Newman	11	Town Fdr TC2	4000	100ms	Phase-Phase fault - Loss of supply to North Newman	353
479	2022-01-08	36.00	East Newman Region to Airport line	11	Reclose 34/37	N/A	N/A	Loss of supply to Corner B and Newman Airport	2
474	2021-12-16	60.00	North Newman	11	Town RMU001	580	0.125	Loss of supply to North Newman region, including hospital.	457
469	2021-12-12	11.00	Newman Hotel, Yandorah St, Ross Ave	11	ABS 31/56	N/A	N/A	Loss of supply to Newman Hotel, Yandorah St and Ross Ave	41
468	2021-12-01	135	#21 Mclennan Dr	0.415	PS8 LV Incomer / Fdr CB-DB1891	N/A	N/A	Loss of supply to residences on #21McLennan	26
466	2021-11-24	63.00	Town TC3	11	RMU01-35/14 Earth Fault	N/A	N/A	Loss of supply to North Newman region, including hospital.	457
461	2021-08-29	40.00	South Newman PadSubs62 & 59 to 56	11	Town RMU062	N/A	N/A	Power loss to customers supplied from PS62 & 59 to 56	83