EMC TEST REPORT

TEST STANDARD(S)	:	ETSI EN 301 489-1: V2.2.3 ETSI EN 301 489-52: V1.2.1
CLIENT / APPLICANT	:	Kovco (Pty) Ltd.
CLIENT ADDRESS	:	6 Milner Road Metro industria Parden Eiland 7405
TEST SAMPLE (EUT)	:	Data Logger for Industrial Refrigeration
MODEL NUMBER	:	Data-V8 R2
VARIANTS	:	None
RESULT	:	Pass
REPORT NUMBER	:	TRE02110/23
DATE ISSUED	:	28/03/2023
REVISION	:	1.0

iSERT (Pty) Ltd. Test reports apply only to the specific sample(s) tested under stated conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to ensure that additional production units of this model are manufactured with identical electrical and mechanical components. iSERT (Pty) Ltd. Shall have no liability for any deductions, inference or generalizations drawn by the client or others from our Issued test reports. This report shall not be used to claim, constitute or imply a product endorsement from iSERT (Pty) Ltd.

This test report was prepared by: ***Name:*** *JA du Plooy*
Title: *EMC Test Engineer*

This test report was approved by: ***Name:*** *CJ Deysel*
Title: *Technical Director*

T0812

This test report is issued in accordance with SANAS accreditation requirements. SANAS is a signatory to the ILAC Mutual Recognition arrangement for the mutual recognition of the equivalence of testing and calibration reports

DOCUMENT CONTROL

Revision	Date	Author	Pages affected	Change proposal
1.0	28/03/2023	JA du Plooy	All	N/A

TEST LABORATORY INFORMATION

Established in 2017, iSERT (Pty) Ltd. Provides EMC, RF & Safety testing services by our skilled Engineers. Our services employ a wide variety of advanced cutting-edge test equipment with one of the widest ranges of accredited standards in the country.

The site and apparatus are constructed in conformance with the requirements of CISPR 16-1-4, EN 50147-1 and other equivalent standards. The laboratory is compliant with the requirements of ISO/IEC 17025

It is our definite objective to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise, and devotion to a certified value structure. Our passion is to grant our clients with the best EMC, RF & Safety services by knowledgeable and accommodating staff.

Our test site is located at 129 Khai-Apple Street, Montana, Pretoria, South Africa 0186.

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DEFINITIONS & ACRONYMS

AE – Associated Equipment. Equipment needed to exercise and/or monitor the operation of the EUT.

AM – Amplitude Modulation

Antenna Port – Port, other than a broadcast receiver tuner port, for connection of an antenna used for intentional transmission and/or reception of radiated RF energy.

Broadcast Receiver Tuner Port – Port intended for the reception of a modulated RF signal carrying terrestrial, satellite and/or cable transmissions of audio and/or video broadcast and similar services.

Class A device – A device that is marketed for use in a commercial, industrial or business environment. A 'Class A' device should not be marketed for use by the general public. A 'Class A' device should contain the following warning in its user manual: "Warning: Operation of this equipment in a residential environment could cause radio interference."

Class B device – A device that is marketed for use in a residential environment and may also be used in a commercial, business or industrial environment. NOTE: A residential environment is an environment where the use of broadcast radio and television receivers may be expected within a distance of 10m of the device concerned.

EMC – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

EMI – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

EUT – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

ITE – Information Technology Equipment. Has a primary function of entry, storage, display, retrieval, transmission, processing, switching, or control of data and/or telecommunication messages and which may be equipped with one or more ports typically for information transfer.

LISN – Line Impedance Stabilization Network

NA – Not Applicable

NCR – No Calibration Required

NSA – Normalized Site Attenuation

Optical Fiber Port – Port at which an optical fiber is connected to an equipment.

RF – Radio Frequency

Signal/Control Port – Port intended for the interconnection of components of an EUT, or between an EUT and local AE and used in accordance with relevant functional specifications (for example for the maximum length of cable connected to it). (Examples include: RS-232, USB, HDMI, Fire Wire)

Wired Network Port – Point of connection for voice, data and signaling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network. (Examples include: CATV, PSTN, ISDN, xDSL, LAN and similar networks)

TABLE OF CONTENTS

1. INTRODUCTION

This report details the results of tests performed on the Kovco Data Logger for Industrial Refrigeration with model number: Data-V8 R2. The testing was carried out on the 13/03/2023 at the iSERT laboratory. Testing was conducted by Altus du Plooy.

2. STANDARDS APPLIED

1. ETSI EN 301 489-1 V2.2.3 (2019-11) 'Electromagnetic compatibility and Radio Spectrum Matters (ERM)

2. ETSI EN 301 489-52 V1.2.1 (2021-11) 'Specific conditions for Cellular Communications Mobile and portable (UE) radio and ancillary equipment.

3. SUMMARY OF TEST RESULTS

No.	Test Standard	Description	Results
Section A - Emissions			
1.	EN 55032 / CISPR 32	Radiated emissions: 30 – 1000MHz	✓
2.	EN 55032 / CISPR 32	Radiated emissions: 1 – 6GHz	✓
3.	EN 55014-1 / CISPR 14-1	Conducted emissions input power	✓
4.	EN / IEC 61000-3-2	Harmonic current emissions	N/A (1)
5.	EN / IEC 61000-3-3	Voltage fluctuation & flicker	✓
Section B - Immunity			
6.	EN / IEC 61000-4-2	Immunity to Electrostatic discharge	✓
7.	EN / IEC 61000-4-3	Immunity to Radiated Electromagnetic Fields	✓
8.	EN / IEC 61000-4-4	Immunity to Electrical Fast Transient	✓
9.	EN / IEC 61000-4-5	Immunity to Surges	✓
10.	EN / IEC 61000-4-6	Immunity to Conducted Disturbances	✓
11.	EN / IEC 61000-4-11	Voltage dips	✓
12.	EN / IEC 61000-4-11	Voltage interruptions	✓
Note 1: This rated power of the EUT is less than 75W			

4. CONCLUSION

Based on the results of our investigation, we have concluded that the EUT (in the configuration tested) complies with the requirements of the standard(s) indicated above. The results obtained in this test report are only valid for the item(s) tested. iSERT (Pty) Ltd. does not make any claims of compliance for samples or variants which were not tested.

5. EMISSION CLASSES AND IMMUNITY CRITERIA

5.1 EMISSIONS

CISPR 32 / EN 55032 defines Class A equipment and Class B associated with two types of end-user environment.

The Class B requirements for equipment are intended to offer adequate protection to broadcast services within the residential environment.

Equipment intended primarily for use in a residential environment shall meet the Class B limits. All other equipment shall comply with the Class A limits.

Broadcast receiver equipment is class B equipment.

NOTE: Equipment meeting Class A requirements may not offer adequate protection to broadcast services within a residential environment.

Class A equipment shall have the following warning in the instructions for use, to inform the user of the risk of operating this equipment in a residential environment:

Warning:

This equipment is compliant with Class A of CISPR 32 / EN 55032. In a residential environment this equipment may cause interference

5.2 IMMUNITY

Description of performance criteria:

A: No loss of performance or function

B: Temporary loss of function or performance which is self-recoverable

C: Temporary loss of function or performance which requires operator intervention or system reset

D: Loss of function which is not recoverable

5.3 ENVIRONMENTAL CONDITIONS DURING ESD TEST:

Temperature	Relative Humidity
22.6°C	47%

5.4 CALIBRATION OF TEST EQUIPMENT

The calibration of the test equipment is performed by a SANAS accredited laboratory and is traceable to the national standards maintained by NMISA.

5.5 MEASUREMENT OF UNCERTAINTY

ISO / IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions results be included in the test report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor of k = 2)

Measurement Uncertainty		
Test Item	**Frequency**	**Uncertainty (dB)**
Conducted Emissions from the AC mains power ports	150kHz – 30MHz	3.4
Radiated Emissions - Horizontal	> 200 MHz	4.84
	< 200 MHz	4.84
Radiated Emissions - Vertical	> 200 MHz	4.96
	< 200 MHz	5.16

In cases where the measured results are below the specification limit by a margin less than the measurement uncertainty it is not possible to state outright compliance based on the 95% level of confidence. The result however indicates that compliance is more probable than non-compliance with the specification limit.

Determining compliance with the limits in this standard shall be based on the results of the compliance measurement, not considering measurement instrumentation uncertainty.

5.5.1 Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF – AG

Where: FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBµV/m.

6. TECHNICAL INFORMATION

6.1 EQUIPMENT UNDER TEST (EUT) DETAILS

EUT Description:	Data Logger for Industrial Refrigeration
EUT Model Nr:	Data-V8 R2
Radio Module (Cellular):	SIM800C
Power Ratings:	AC/DC adaptor: 12Vdc External

6.2 SUPPORT EQUIPMENT

Product Type	Manufacturer	Model number
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6.3 EUT TEST SETUP DETAIL AND OPERATING CONDITION

The specific test methodology will be discussed under each relevant test if different to the general set-up guidelines below.

6.3.1 Emissions

1. The EUT test modes were adapted accordingly in reference to the instructions for use.
2. Tests were performed while the device was fully operational.
3. The equipment under test (EUT) was configured to measure its highest possible radiation level.
4. Deviations from the above set-up will be noted in each specific case.

6.3.2 Immunity

1. The equipment under test (EUT) was configured to have its highest possible susceptibility against the tested phenomena.
2. The test modes were adapted accordingly in reference to the instructions for use
3. Different configurations were used to obtain the most susceptible setup.

6.4 EUT MODE OF OPERATION

The EUT was tested in the following mode of operation:

No.	Mode	Description
1.	Cellular (2G)	The EUT was supplied with an AC/DC adaptor and fully operational during testing. The EUT`s functionality was exercised by monitoring the measured real time data on the KovcoLabs Web interface during all tests. The LED`s were monitored for any state changes and / or error messages. A communications link was setup with a Rohde & Schwartz CMW 500 base station simulator in the variance cellular bands. The EUT was commanded in maximum transmit power. The downlink RXQUAL was closely monitored for signs of susceptibility. The EUT was closely monitored for signs of susceptibility during all immunity testing.

6.5 DEVICE IMAGES

Figure 1: Top view

Figure 2: Bottom view

Figure 3: Right view

Figure 4: Left view

6.6 TEST EQUIPMENT LIST

No.	Equipment description	Serial number	Cal Due date
1.	California Instruments Model 4503L AC Power system	HK50775	Internal verification
2.	Bulk Current Injection Probe CLCI-100	581149	Internal verification
3.	RF Current Injection Probe	561383	Internal verification
4.	M2 & M3 Coupling / de-Coupling Network CDN-M325E	521169	Internal verification
5.	Telecommunications Coupling / de-Coupling Network CDN-T8SE	511434	Internal verification
6.	Combilog Antenna AC-200	061128	July 2027
7.	TESEQ NSG 3040 EMC Immunity Test System	6074	June 2023
8.	TESEQ CDN 3425 Capacitive clamp	3082	Inter-laboratory comparison
9.	TESEQ NSG 435 ESD Gun	7184	August 2023
10.	RS Pro ICM 33II Clamp meter	74700018	June 2023
11.	Agilent 83620B Signal Generator (10MHz – 20GHz)	98091	September 2023
12.	Rohde & Schwarz Universal communication tester – CMU200	103025	September 2023
13.	Rohde & Schwarz Wideband Radio Communication Tester – CMW500	112781	September 2023
14.	Rohde & Schwarz SML02 Signal generator	100045	October 2023
15.	Rohde & Schwarz NRVD Power meter	100686	October 2023
16.	Rohde & Schwarz NRV-Z4 Power meter sensor	191130	October 2023
17.	Narda EP-600 Electric Field probe	611WX70397	Inter-laboratory comparison
18.	AFJ LISN LS16C\10	16011850466	Inter-laboratory comparison
19.	Thurlby Thandar HA1600A Power & harmonics analyzer	479560	September 2023
20.	AH Systems SAS-571	2455	March 2027
21.	Kalmus 7100LC 100 Watt Amplifier (80MHz – 1GHz)	7439-1	No calibration required
22.	Kalmus 757LC 75 Watt Amplifier (10kHz – 1GHz)	7591	No calibration required
23.	Milmega Dual Band AS0760 Series amplifier (0.7 – 6GHz)	ISQ0008	No calibration required
24.	Fluke 115 Multi-meter	3451488WS	November 2023
25.	AFJ FFT3010 EMI analyzer	301017460136	August 2023
26.	Keysight N9020A EMI Signal analyzer: ATO-8599	MY52330018	May 2023
27.	Flus Humidity and temperature meter: ET-951W	2015106449	November 2023
28.	Com-Power EM Clamp CLEM-6146	16030004	Internal verification
29.	HP EPM-441A Power meter	GB37170880	October 2023
30.	HP 8482A Power sensor	2349A10222	October 2023

7. EMISSIONS

7.1 RADIATED EMISSIONS:

Method: Measurements were made in an 8-meter fully anechoic chamber that complies to CISPR 16. Preliminary (peak) measurements were performed at an antenna to EUT separation distance of 3 meters. The limit line was adjusted accordingly. The EUT was rotated 360° about its azimuth with the receive antenna located at a fixed height in horizontal and vertical polarities. Final measurements (quasi-peak) were then performed by rotating the EUT 360°. All frequencies within 10 dB of the limit were investigated in both horizontal and vertical antenna polarity, where applicable.

7.1.1 Test set-up

a. The EUT was tested within its intended operating conditions as specified by the manufacturer.
b. Automated scans in the frequency band 30MHz to 6000MHz (radiated emissions) were done to determine compliance emission results for the EUT.
c. The EUT was tested in both horizontal and vertical polarizations.

7.1.2 FAR Radiated Emissions limits below 1GHz

Frequency (MHz)	Detector type	Class A (dBµV/m)	Class B (dBµV/m)
30 - 230	Quasi Peak	52 to 45	42 to 35
230 - 1000	Quasi Peak	52	42

7.1.3 FAR Radiated Emissions limits above 1GHz

Frequency (MHz)	Detector type	Class A (dBµV/m)	Class B (dBµV/m)
1000 - 3000	Peak	76	70
3000 - 6000	Peak	80	74
1000 - 3000	Average	56	50
3000 - 6000	Average	60	54

Note: The lower limit shall apply at the transition frequency

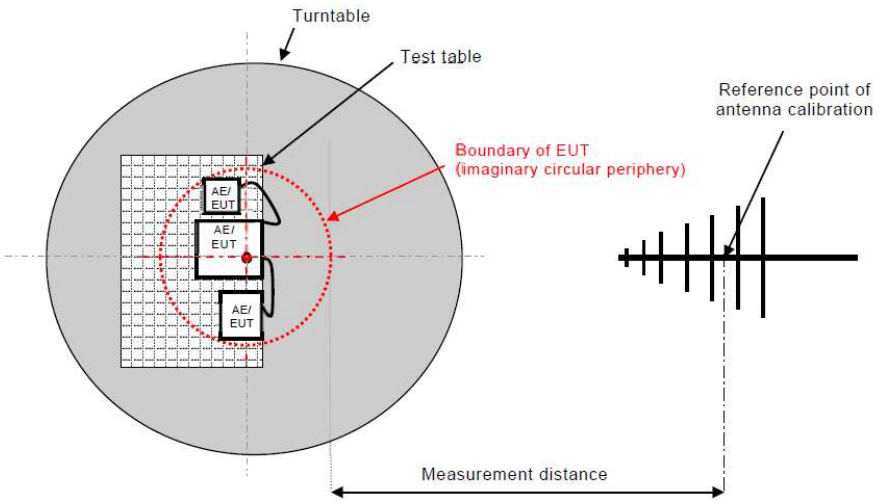
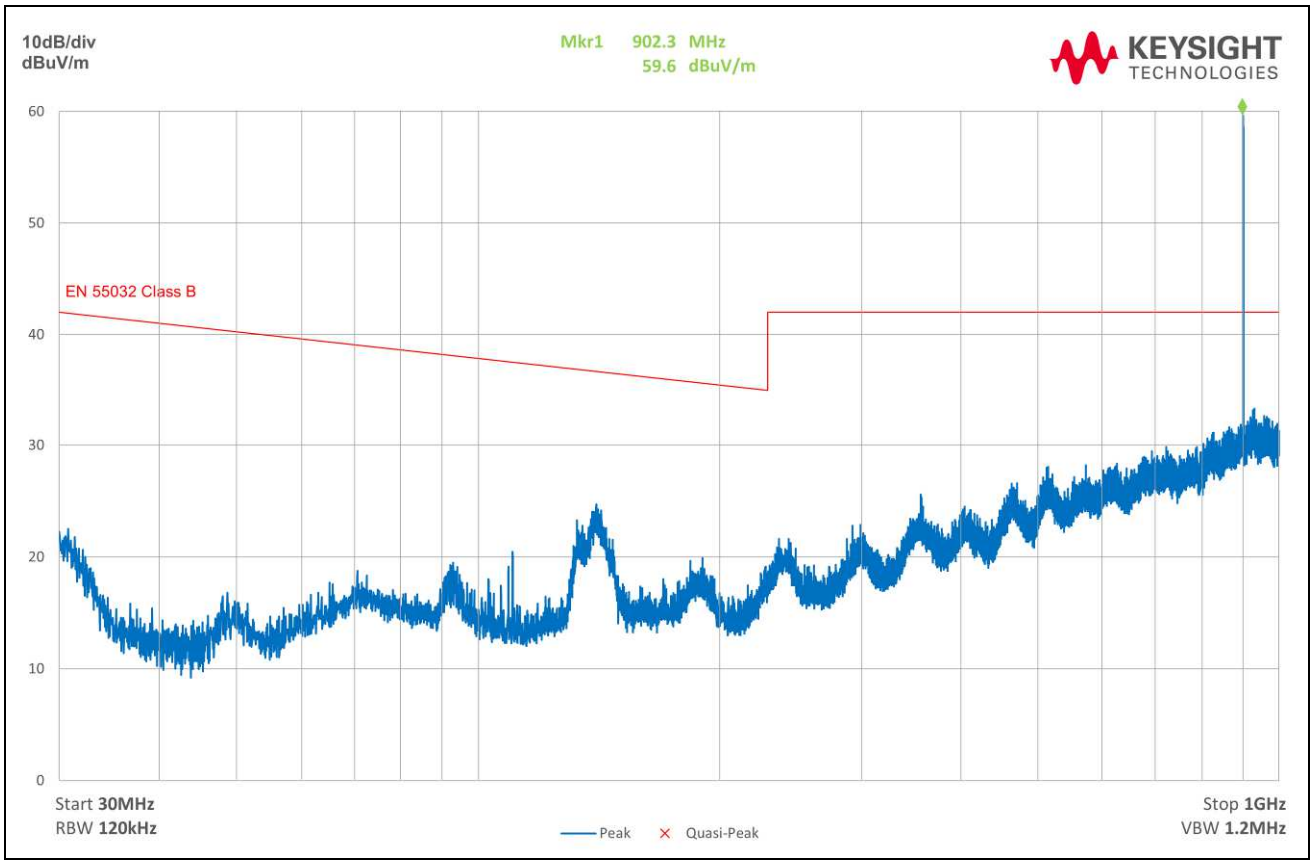


Figure 5: Typical Radiated emissions setup

7.1.4 Radiated Emission: 30MHz – 1000MHz

Graph 1: Represents radiated emissions measured from the EUT in the horizontal polarization.

Power supply: 12Vdc adaptor
Test Condition: Cellular (2G)



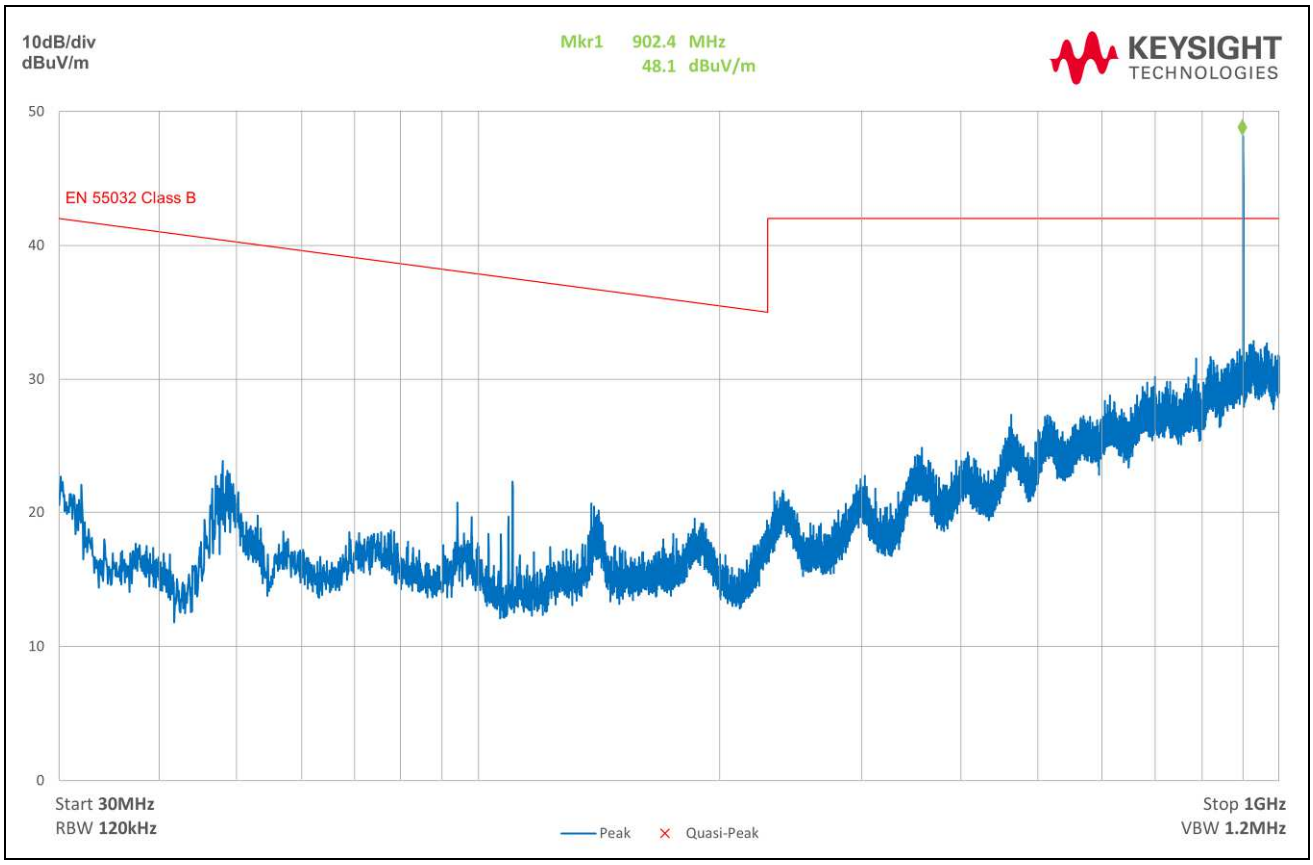
Graph 1: Radiated emissions results

Note: The 902.3MHz (2G) peak that exceeds the limit line is the uplink of the device and should be ignored.

7.1.5 Radiated Emission: 30MHz – 1000MHz

Graph 2: Represents radiated emissions measured from the EUT in the vertical polarization.

Power supply: 12Vdc adaptor
Test Condition: Cellular (2G)



Graph 2: Radiated emissions results

Note: The 902.4MHz (2G) peak that exceeds the limit line is the uplink of the device and should be ignored.

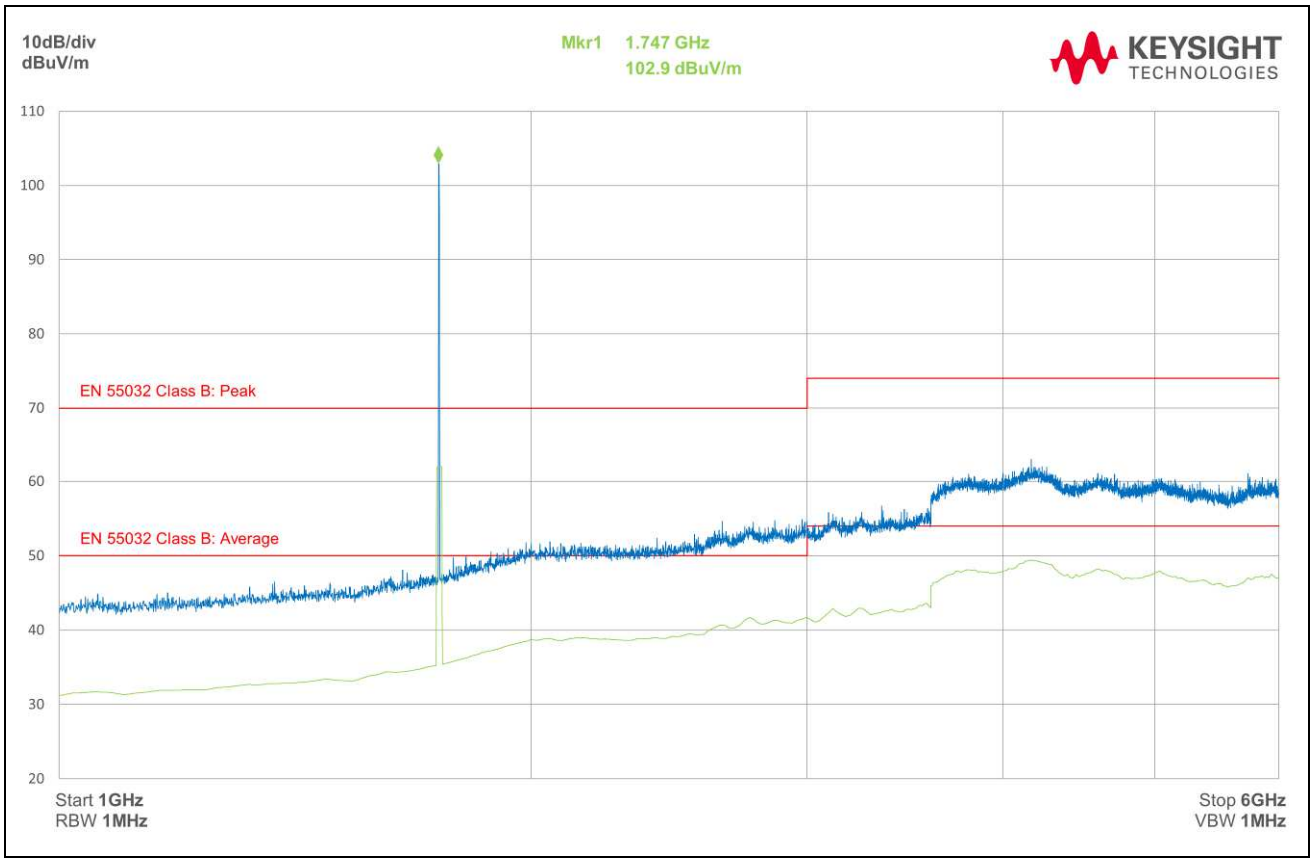
7.1.6 Conclusion

- The EUT complies with the radiated emissions requirements of EN 55032 / CISPR 32 for Class B devices.

7.1.7 Radiated Emission: 1000MHz – 6000MHz

Graph 3: Represents peak and average radiated emissions measured from the EUT in the Horizontal polarization.

Power supply: 12Vdc adaptor
Test Condition: Cellular (2G)



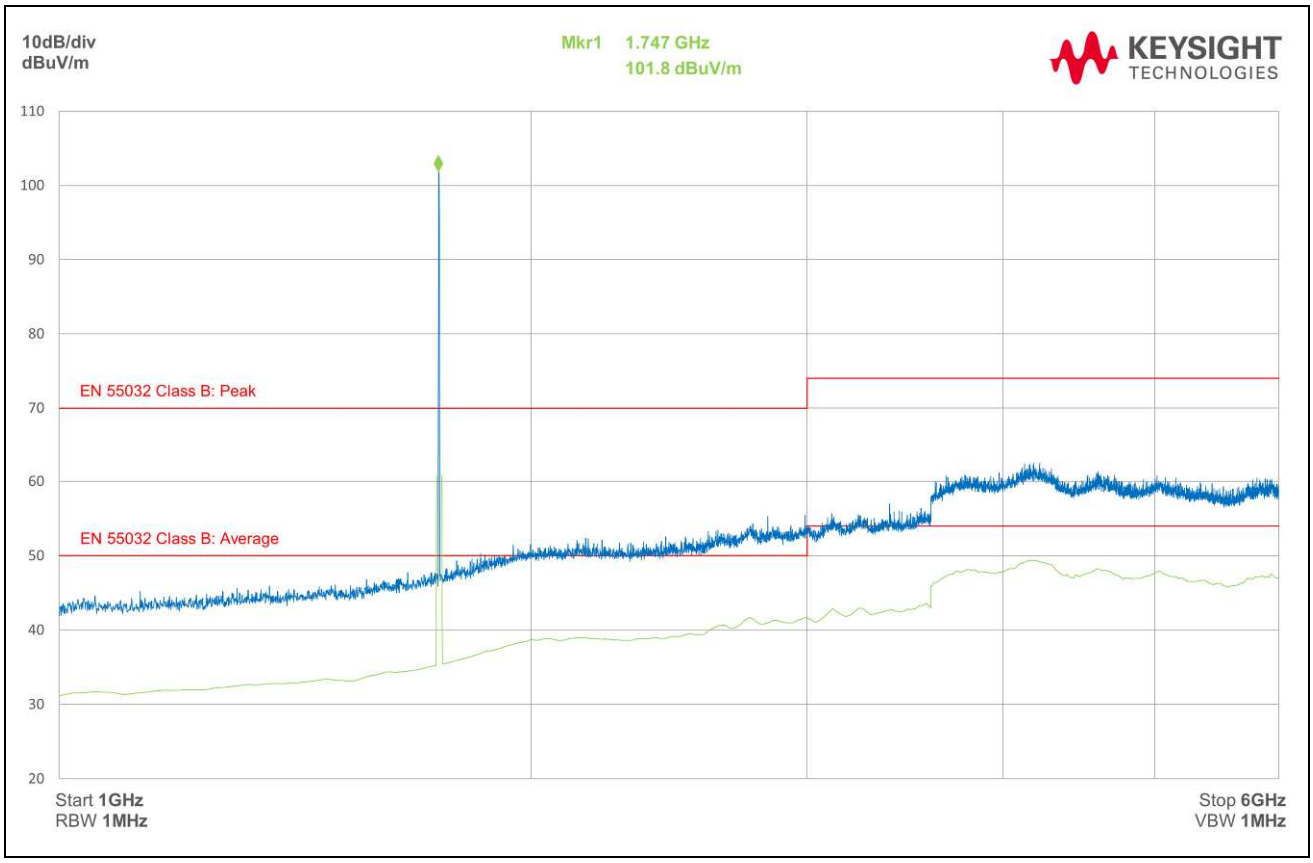
Graph 3: Radiated emissions results

Note: The 1.75GHz (2G) peak that exceed the limit line is the uplink of the device and should be ignored.

7.1.8 Radiated Emission: 1000MHz – 6000MHz

Graph 4: Represents peak and average radiated emissions measured from the EUT in the vertical polarization.

Power supply: 12Vdc adaptor
Test Condition: Cellular (2G)



Graph 4: Radiated emissions results

Note: The 1.75GHz (2G) peak that exceed the limit line is the uplink of the device and should be ignored.

7.1.9 Conclusion

- The EUT complies with the radiated emissions requirements of EN 55032 / CISPR 32 for Class B devices.

7.2 CONDUCTED EMISSIONS:

Method: The LISN was placed 0.8m from the boundary of the unit under test and bonded to a ground reference plane. This distance was the closest points of the LISN and the EUT. All other parts of the EUT and associated equipment were at least 0.8m from the LISN. The input power of the EUT was connected to the system through a LISN. Conducted voltage measurements on the mains lines were made at the output of the LISN. If the average limit is met when using a quasi-peak detector, the EUT shall be deemed to meet both limits and measurements with the average detector is unnecessary.

7.2.1 Test set-up

a. The EUT was tested within its intended operating conditions as specified by the manufacturer.
b. Automated scans in the frequency band between 150kHz to 30MHz were done in order to determine compliance emissions results for the EUT.
c. Both side of the power line were checked for maximum conducted interference.

7.2.2 Conducted Emissions limits between 150kHz to 30MHz

Frequency (MHz)	Class A (dBµV)		Class B (dBµV)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15 – 0.5	79	66	66 – 56 *	56 – 46 *
0.50 – 5.0	73	60	56	46
5.0 – 30.0	73	60	60	50

7.2.3 Conducted Emissions limits between 150kHz to 30MHz (LAN port)

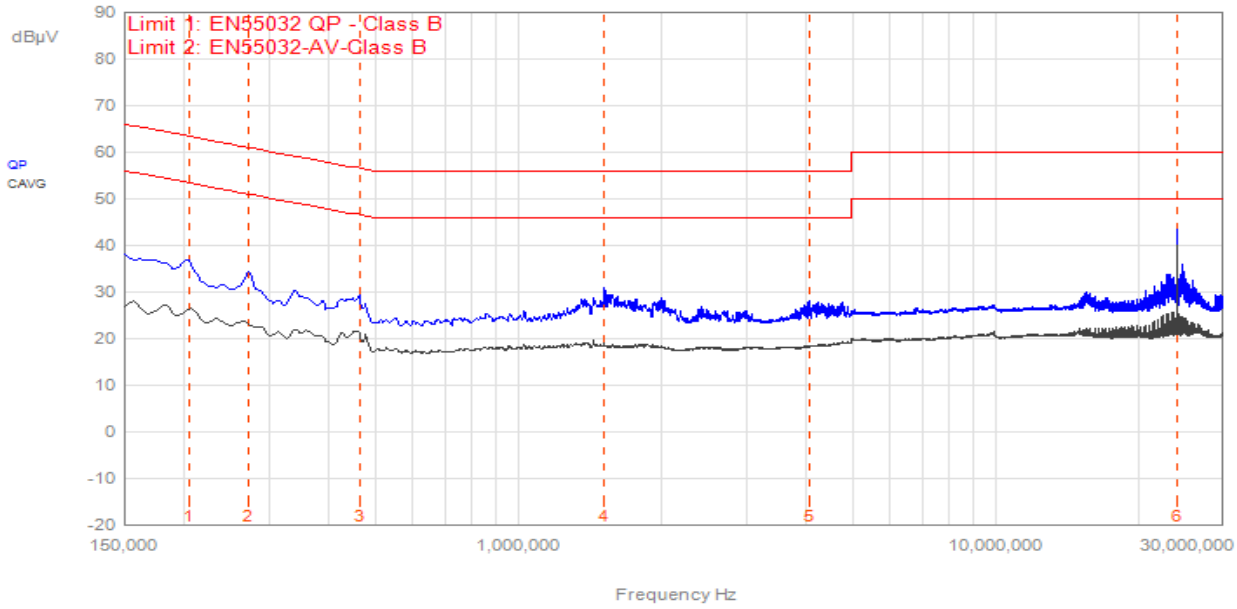
Frequency (MHz)	Class A (dBµV)		Class B (dBµV)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15 – 0.5	97 to 87	84 to 74	84 to 74	74 to 64
5.0 – 30.0	87	74	74	64

Note: The tighter limit applies at the band edges.

7.2.4 AC Input – Live

Graph CE1: Quasi Peak and Average Conducted emissions measured on the Live lead of the EUT was below the Class B Quasi Peak and Average limit.

Power supply: 12Vdc adaptor
Test Condition: Cellular (2G)

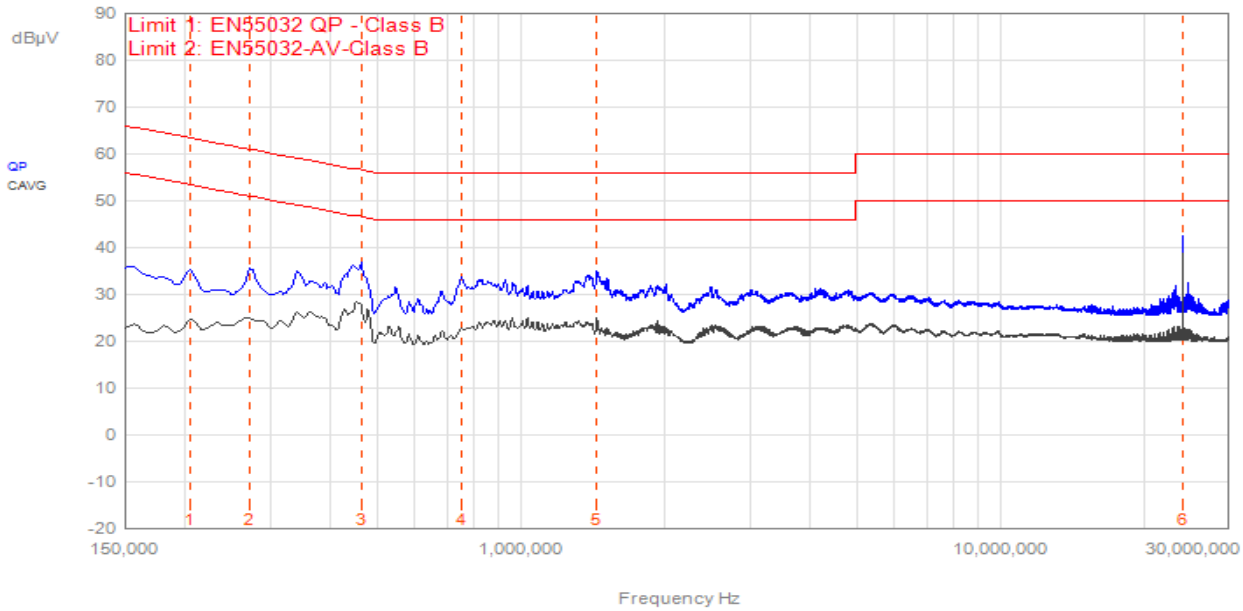


ID.	Frequency (MHz)	Detector	Measured Level (dBµV)	Limit (dBµV)	Δ Limit (dB)
1	204kHz	QPeak	36.9	Lim1 63.4 Lim2 53.4	Lim1 -26.6 Lim2 -16.6
2	273kHz	QPeak	34.2	Lim1 61.0 Lim2 51.0	Lim1 -26.8 Lim2 -16.8
3	465kHz	QPeak	29.4	Lim1 56.6 Lim2 46.6	Lim1 -27.2 Lim2 -17.2
4	1.521MHz	QPeak	30.8	Lim1 56.0 Lim2 46.0	Lim1 -25.2 Lim2 -15.2
5	4.071MHz	QPeak	28.2	Lim1 56.0 Lim2 46.0	Lim1 -27.8 Lim2 -17.8
6	24.033MHz	QPeak	43.2	Lim1 60.0 Lim2 50.0	Lim1 -16.8 Lim2 -6.8
1	204kHz	C_AVG	26.3	Lim1 63.4 Lim2 53.4	Lim1 -37.1 Lim2 -27.1
2	273kHz	C_AVG	23.2	Lim1 61.0 Lim2 51.0	Lim1 -37.8 Lim2 -27.8
3	465kHz	C_AVG	21.1	Lim1 56.6 Lim2 46.6	Lim1 -35.5 Lim2 -25.5
4	1.521MHz	C_AVG	18.9	Lim1 56.0 Lim2 46.0	Lim1 -37.1 Lim2 -27.1
5	4.071MHz	C_AVG	18.2	Lim1 56.0 Lim2 46.0	Lim1 -37.8 Lim2 -27.8
6	24.033MHz	C_AVG	39.5	Lim1 60.0 Lim2 50.0	Lim1 -20.5 Lim2 -10.5

7.2.5 AC Input - Neutral

Graph CE2: Quasi Peak and Average Conducted emissions measured on the Neutral lead of the EUT was below the Class B Quasi Peak and Average limit.

Power supply: 12Vdc adaptor
Test Condition: Cellular (2G)



ID.	Frequency (MHz)	Detector	Measured Level (dBµV)	Limit (dBµV)	Δ Limit (dB)
1	204kHz	QPeak	35.4	Lim1 63.4 Lim2 53.4	Lim1 -28.1 Lim2 -18.1
2	273kHz	QPeak	35.6	Lim1 61.0 Lim2 51.0	Lim1 -25.4 Lim2 -15.4
3	465kHz	QPeak	37.0	Lim1 56.6 Lim2 46.6	Lim1 -19.6 Lim2 -9.6
4	753kHz	QPeak	33.7	Lim1 56.0 Lim2 46.0	Lim1 -22.3 Lim2 -12.3
5	1.446MHz	QPeak	35.2	Lim1 56.0 Lim2 46.0	Lim1 -20.8 Lim2 -10.8
6	24.036MHz	QPeak	42.4	Lim1 60.0 Lim2 50.0	Lim1 -17.6 Lim2 -7.6
1	204kHz	C_AVG	24.6	Lim1 63.4 Lim2 53.4	Lim1 -38.9 Lim2 -28.9
2	273kHz	C_AVG	25.0	Lim1 61.0 Lim2 51.0	Lim1 -36.0 Lim2 -26.0
3	465kHz	C_AVG	27.6	Lim1 56.6 Lim2 46.6	Lim1 -29.0 Lim2 -19.0
4	753kHz	C_AVG	22.7	Lim1 56.0 Lim2 46.0	Lim1 -33.3 Lim2 -23.3
5	1.446MHz	C_AVG	25.0	Lim1 56.0 Lim2 46.0	Lim1 -31.0 Lim2 -21.0
6	24.036MHz	C_AVG	38.6	Lim1 60.0 Lim2 50.0	Lim1 -21.4 Lim2 -11.4

7.2.6 Conclusion

- The EUT complies with all the conducted emissions requirements of the standard.

7.3 VOLTAGE FLUCTUATIONS & FLICKER

Method: The test circuit consists of a test supply voltage, reference impedance, the equipment under test and a flicker meter compliant with IEC-60868. The equipment was tested in the condition in which the manufacturer supplied it.

7.3.1 Test set-up

- The EUT was switched on and operated in accordance with the manufacturer instructions.
- The EUT was observed for 600 seconds while operating continuously. One power cycle was performed.
- The following test parameters were observed:

7.3.2 Results

```
Load Power           : 0.001 kW   0.003 kVA Power Factor  0.333
Load Current         : 0.0 Arms  0.0 Apk Crest Factor  2.000

EN 61000-3-3:2013 - Voltage reduction is positive

Voltage Variations
           Nominal Voltage: 230 Vrms
  Highest Half-cycle level:  -3.85%
   Lowest Half-cycle level:  -0.66%

                  d(max):  +2.72%          Limit: 4%     PASS
                  t(max):   0.00seconds    Limit: 500ms  PASS

   Steady State definition: >1000ms within +/- 0.2%
  Largest d(c) change down:   0.00%
    Largest d(c) change up:   0.00%
       Largest d(c) change:   0.00%          Limit: 3.3%   PASS

Flicker
    Short Term Flicker Pst:   0.93           Limit: 1.00   PASS


          Pst Classifier            Plt Calculation
       Duration    Flicker          Interval      Pst
        0.1%         5.56
        0.7%         2.19
        1.0%         2.06
        1.5%         1.94
        2.2%         1.88
          3%         1.81
          4%         1.75
          6%         1.69
          8%         1.56
         10%         1.50
         13%         1.38
         17%         1.31
         30%         1.06
         50%         0.69
         80%         0.25
```

7.3.3 Conclusion

- The EUT complies with the voltage fluctuations and flicker requirements of EN / IEC 61000-3-3.

8. IMMUNITY

8.1 EN / IEC 61000-4-2: ESD IMMUNITY

Method: The test is intended to demonstrate the immunity of equipment subjected to static electricity discharges from operators directly and to adjacent objects. The tabletop equipment under test is placed on a wooden table, 0.8 m high, standing on the ground reference plane. A horizontal coupling plane (HCP), 1.6 x 0.8 m, is placed on the table. The EUT and the cables are isolated from the coupling plane by an insulating support 0.5 mm thick. The floor standing equipment is isolated from the ground reference plane by an insulating support about 0.1 m thick. The vertical coupling plane (VCP) of dimensions 0.5 m x 0.5 m is placed parallel to, and positioned at 0.1 m from, the EUT.

8.1.1 Set-up

a. The EUT was tested within its intended operating conditions as specified by the manufacturer.
b. The EUT was tested as tabletop equipment.
c. Electrostatic discharges are applied only to those points and surfaces of the EUT that will be accessible to users during normal operation.
d. The time interval between two successive single discharges was at least 1 second.

8.1.2 ESD Test points

Figure 6: Top view

Figure 7: Bottom view

Figure 8: Right view

Figure 9: Left view

8.1.3 Results

Discharge Point	Contact discharge voltage	Discharges	Result	Criteria
HCP	± 4kV	10	Pass (1)	A
VCP	± 4kV	10	Pass (1)	A
C1 & C2	± 4kV	10	Pass (1)	A
C3	± 4kV	10	Pass (1)	A
Discharge Point	**Air discharge voltage**	**Discharges**	**Result**	**Criteria**
A1 – A6	± 8kV	10	Pass (1)	A
A7 – A9	± 8kV	10	Pass (1)	A
A10 – A13	± 8kV	10	Pass (1)	A
Note 1: The EUT was unaffected by the applied ESD pulses.				

8.1.4 Performance criteria

A: No loss of performance or function
B: Temporary loss of function or performance which is self-recoverable
C: Temporary loss of function or performance which requires operator intervention or system reset

8.1.5 Conclusion

- The EUT complies with the Electrostatic Immunity requirements of the standard.

8.2 EN / IEC 61000-4-3: RADIATED IMMUNITY

Method: The test allows estimating of the radiated immunity of electrical and electronic equipment to electromagnetic disturbances coming from intended radiofrequency (RF) transmitters in the frequency range 80MHz to 6000MHz. The interference is applied on the enclosure of the equipment by using transmitting antennas that was placed 3m from the front of the EUT and support system.

8.2.1 Set-up

a. The EUT was tested within its intended operating conditions as specified by the manufacturer.
b. The signal source was stepped through the applicable frequency range at a rate of 1% of the fundamental. The dwell time was set to 1 second.
c. The EUT was placed in the center of a non-metallic turntable.
d. The distance between the antenna and equipment was set to 3 meters.
e. The 1kHz sine wave was amplitude modulated to a depth of 80% over the entire frequency band.

8.2.2 Results

Polarization	Frequency (MHz)	EUT Position	Level (V/m)	Result	Criterion
Horizontal	80 – 1000	All Sides	3	Pass (1)	A
Vertical	80 – 1000	All Sides	3	Pass (1)	A
Note 1: The EUT was unaffected by the applied RF between 80 – 1000MHz					

Polarization	Frequency (GHz)	EUT Position	Level (V/m)	Result	Criterion
Horizontal	1 - 6	All Sides	3	Pass (2)	A
Vertical	1 - 6	All Sides	3	Pass (2)	A
Note 2: The EUT was unaffected by the applied RF between 1 – 6GHz					

8.2.3 Performance criterion

A: No loss of performance or function
B: Temporary loss of function or performance which is self-recoverable
C: Temporary loss of function or performance which requires operator intervention or system reset

8.2.4 Conclusion

- The EUT complies with the Radiated Immunity requirements of the standard.

8.3 EN / IEC 61000-4-4 FAST TRANSIENT IMMUNITY

Method: Measurements were made on a ground plane that extends 1-meter minimum beyond all sides of the system under test. Mains power tests were conducted with the product connected to a Coupling/Decoupling Network (CDN). I/O lines were tested in a Capacitive Coupling Clamp. One of each unique interface was tested for a period of one (1) minute per polarity.

8.3.1 Set-up and levels

a. The EUT was tested within its intended operating conditions as specified by the manufacturer.
b. The EUT was supplied with the required voltage and subjected to a direct injected 5 kHz repetition rate 5/50nS wave interference signal.
c. The EUT was tested as floor standing equipment.

8.3.2 Results

Injection Method	Voltage	Repetition rate	Result	Criterion
Live to Neutral	+1kV	5 / 100kHz	Pass (1)	A
	-1kV	5 / 100kHz	Pass (1)	A
Live and Neutral to Ground reference	+1kV	5 / 100kHz	Pass (1)	A
	-1kV	5 / 100kHz	Pass (1)	A
Note 1: The EUT was unaffected by the fast transients applied to the input port.				

Injection Method	Voltage	Repetition rate	Result	Criterion
Sensor Cables	+0.5kV	5 / 100kHz	Pass (2)	A
	-0.5kV	5 / 100kHz	Pass (2)	A
I/O Cables	+0.5kV	5 / 100kHz	Pass (2)	A
	-0.5kV	5 / 100kHz	Pass (2)	A
Note 2: The EUT was unaffected by the fast transients applied to the signal & I/O port(s).				

8.3.3 Performance criterion

A: No loss of performance or function
B: Temporary loss of function or performance which is self-recoverable
C: Temporary loss of function or performance which requires operator intervention or system reset

8.3.4 Conclusion

- The EUT complies with the Fast Transient / Burst Immunity requirements of the standard.

8.4 EN / IEC 61000-4-5 SURGES

Method: Mains power tests were conducted with the product connected to a Coupling/ Decoupling Network (CDN). The test voltage was increased from the lowest indicated level up to the maximum level. Five (5) positive surges and five (5) negative surges were applied at each of phases of the AC waveform: 0°, 90°, 180° and 270°. Each surge was applied 60 seconds after the previous surge. Where applicable signal and telecommunications ports were subject to five (5) positive and five (negative) surges applied through the appropriate Coupling/Decoupling Network (CDN).

8.4.1 Set-up and Test Levels

- The EUT was supplied with the required voltage.
- A 1.2µs/50µs Voltage & 8µs/20µs Current wave was applied in the following sequence:

8.4.2 Results

Injection Method	Voltage	Phase	Result	Criterion
Live to Neutral	+ 1kV	0°, 90°, 180° and 270°	Pass (1)	A
	- 1kV	0°, 90°, 180° and 270°	Pass (1)	A
Note 1: The EUT was unaffected by the surges applied to the input port				

8.4.3 Performance criteria

A: No loss of performance or function
B: Temporary loss of function or performance which is self-recoverable
C: Temporary loss of function or performance which requires operator intervention or system reset

8.4.4 Conclusion

- The EUT complies with the Surge Immunity requirements of the standard.

8.5 EN / IEC 61000-4-6 CONDUCTED IMMUNITY

Method: Measurements were made on a ground plane that extends at least 0.5-meter minimum beyond all sides of the system under test. The EUT was located 10cm above the reference ground plane and any associated I/O cables attached to the EUT were located between 30mm and 50mm above the ground plane. The indicated field was pre-calibrated prior to placement of the system under test.

8.5.1 Set-up and Test Levels

a. The EUT was tested within its intended operating conditions as specified by the manufacturer.
b. The signal source was stepped through 150kHz to 80MHz at a rate of 1% of the fundamental.
c. The 1kHz sine wave was amplitude modulated to a depth of 80% over the entire frequency band.
d. The EUT was closely monitored for signs of susceptibility during testing.

8.5.2 Results

Injection line	Coupling method	Voltage (Vrms)	Dwell time (s)	Result	Criterion
AC Input Port	M2 CDN	3	1.5	Pass (1)	A
Sensor Cables	EM Clamp	3	1.5	Pass (1)	A
I/O Cables	EM Clamp	3	1.5	Pass (1)	A
Note 1: The EUT was unaffected by the interfering signal.					

8.5.3 Performance criteria

A: No loss of performance or function
B: Temporary loss of function or performance which is self-recoverable
C: Temporary loss of function or performance which requires operator intervention or system reset

8.5.4 Conclusion

- The EUT complies with the Conducted Immunity requirements of the standard.

8.6 EN / IEC 61000-4-11 VOLTAGE DIPS AND INTERRUPTIONS

Method: The product was subjected to voltage dips and interruptions. Testing was performed with the product connected directly to a generator capable of simulating the voltage drops and interrupts as described.

8.6.1 Set-up and Test Levels

- The EUT was switched on and operated in accordance with the manufacturer instructions.
- The EUT was subjected to the following voltage dips and interruptions applied to the AC power port of the EUT:

8.6.2 Results

Test Level (% Ut)	Test Duration (cycles)	Result	Criterion
100	0.5	Pass (1)	A
40	10	Pass (1)	A
70	25	Pass (1)	A
100	250	Pass (2)	B

Note 1: The EUT was unaffected by the applied test.
Note 2: The EUT switched off but resumed normal operation after completion of the test.

8.6.3 Performance criteria

A: No loss of performance or function
B: Temporary loss of function or performance which is self-recoverable
C: Temporary loss of function or performance which requires operator intervention or system reset

8.6.4 Conclusion

- The EUT complies with the Voltage dips and Interruption's requirements of the standard.

9. APPENDIX A: Normative references

1. ETSI EN 301 489-1 V2.2.3 (2019-11) ‘Electromagnetic compatibility and Radio Spectrum Matters (ERM)

2. ETSI EN 301 489-52 V1.2.1 (2021-11) 'Specific conditions for Cellular Communications Mobile and portable (UE) radio and ancillary equipment.

3. EN 55032 (2015 +A11:2020) / CISPR 32 (2015+A1:2019): ‘Electromagnetic compatibility of multimedia equipment – Emissions requirements

4. EN 61000-3-3 (2013+A1:2019) / IEC 61000-3-3 (2013+A1:2017): Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤16 A per phase

5. EN 61000-4-2 (2009) / IEC 61000-4-2 (2012): Testing and measurement techniques – Electrostatic discharge immunity test

6. EN 61000-4-3 (2006+A2:2010) / IEC 61000-4-3 (2006+A1:2007+A2:2010): Testing and measurement techniques –Radiated, radiofrequency, electromagnetic field immunity test

7. EN 61000-4-4 (2012) / IEC 61000-4-4 (2012): Testing and measurement techniques – Electrical Fast Transient / Burst

8. EN 61000-4-5 (2014+A1:2017) / IEC 61000-4-5 (2014+A1:2017): Testing and measurement techniques – Surge immunity test

9. EN 61000-4-6 (2014) / IEC 61000-4-6 (2013): Testing and measurement techniques – Immunity to conducted disturbances, induced by radiofrequency fields.

10. EN 61000-4-11(2020) / IEC 61000-4-11(2004+AMD1:2017): Testing and measurement techniques – Voltage Dips, Short Interruptions, and voltage variations immunity test.

10. APPENDIX B: Test images

Figure 10: Radiated Emissions (30 – 1000MHz)

Figure 11: Radiated Emissions (1 – 6GHz)

Figure 12: Electrostatic Discharge Immunity

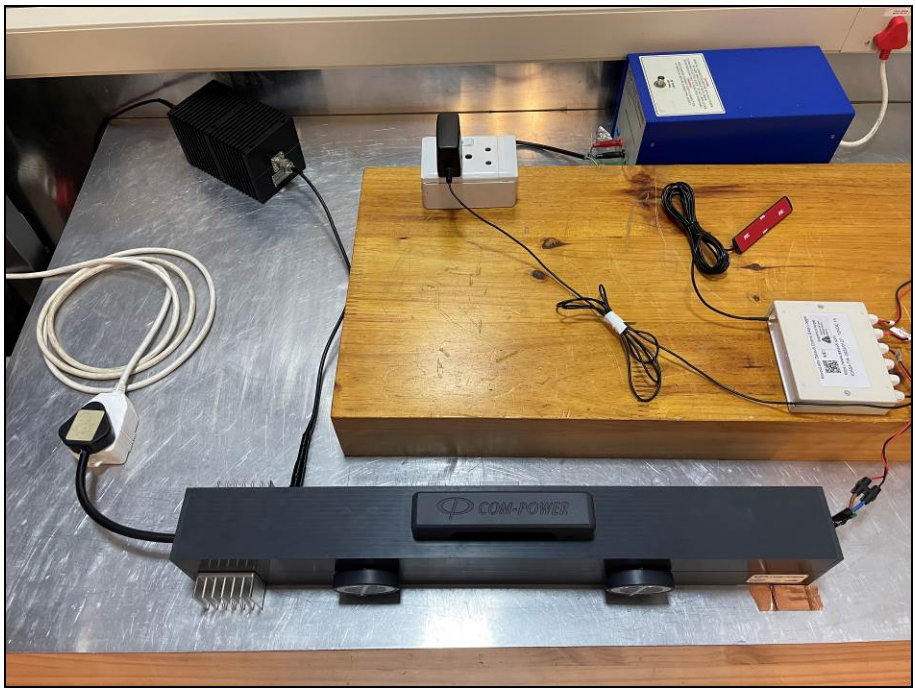


Figure 13: Electrical Fast Transient / Burst

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