Report on the Radio Testing of:

RFID PROXIMITY SWITCH – safeIDS

Model(s):

1. SE1-ST1A20 (Sensor)
2. SE1-SS1A20 (Sensor)
3. SE1-AM02 (Actuator)

In accordance with
47 CFR FCC Part 15C

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Add value.
Inspire trust.

Prepared for:
SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

COMMERCIAL-IN-CONFIDENCE

Document Number: 7191331641-EEC24/02 | Issue: 01
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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Approved By	Foo Kai Maun	24 Apr 2024	
Prepared By	Quek Keng Huat	24 Apr 2024	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD PSB document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with the mentioned standard(s).

TÜV SÜD PSB

ilac-MRA

Accredited Laboratory SAC-SINGLAS

LA-2007-0380-A LA-2007-0386-C
LA-2007-0381-F LA-2010-0464-D
LA-2007-0382-B LA-2018-0702-B
LA-2007-0383-G LA-2018-0703-G
LA-2007-0384-G LA-2020-0747-L
LA-2007-0385-E

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council. Inspections/Calibrations/Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our inspection body/laboratory.

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	24 Apr 2024

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1.2 Introduction

Applicant / Manfacturer	:	SICK AG Erwin-Sick-Str. 1 79183 Waldkirch Germany
Factory	:	SICK Sdn. Bhd. No. 16, Jalan Indah Gemilang 5 Taman Perindustrian Gemilang 81800, Ulu Tiram, Johor, Malaysia
Model Number(s)	:	Sensors 1. SE1-ST1A20 2. SE1-SS1A20 Actuators 1. SE1-AM02
Serial Number(s)	:	Sensors 1. 23320012 (Part Number 1132196) 2. 23330027 (Part Number 1132197) Actuators 1. 23340004 (Part Number 1132272)
Number of Samples Tested	:	2
Test Sample(s) Condition	:	Good
Quotation Reference	:	5824642 & 5993428
Test Specification/Issue/Date	:	FCC 47 CFR Part 15C
Test Sample(s) Received Date	:	07 Sep 2023
Start of Test	:	07 Sep 2023
Finish of Test	:	03 Oct 2023

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1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with specifications as shown below.

Specification Clause	Test Description	Result	Comments/Base Standard
47 CFR FCC Part 15			
15.107(a), 15.207	Conducted Emissions	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.209(a)	Radiated Emissions (Fundamental)	Pass	ANSI C63.10: 2013
15.215	Occupied Bandwidth	Pass	ANSI C63.10: 2013

Notes

1. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.

2. The EUT was operated in continuous transmission, ie 100% duty cycle.

3. The software library stacks firmware used in the product during testing is R01.06.00. Sick Product Center Asia Pte. Ltd. has since updated their firmware to R01.06.00 → R01.07.00. Sick Product Center Asia Pte. Ltd. declares that the firmware update will not impact the RF performance and Sick Product Center Asia Pte. Ltd. had performed detailed analysis of the impact of this firmware update to the testing results. Please refer to Sick Product Center Asia Pte. Ltd. for more information.

4. The difference between variant SE1-SS1A20 and SE1-ST1A20 is the number of inductor coils (antenna) and capacitors used for impedance matching due to different sensing direction. Please refer to the following illustrations for more details.

5. Sick Product Center Asia Pte. Ltd. declares that safeIDS System comprises of a Device (Sensor) & Actuator.

Device (Sensor)
a. SE1-ST1A20 (Tested)
b. SE1-SS1A20 (Tested)

Actuator
a. SE1-AM01 (Declared)
b. SE1-AM02 (Tested)
c. SE1-AM03 to SE1-AM16 Declared)

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Notes (Continued)

SICK	SISTRAID IP-0204-PD20-801	SE1 Variant 1 and 2 comparisons E372141 Rev. 01 (2023-11-29)

Variant No	safeIDS Description	Product iden. Number P/N	TYPE of Device	Sensing Direction	Antenna placement at PCB	Hardware (RFID chipset, MCU, power supply, digital circuits)	Firmware
1	Front/TOP sensing via IO-Link Safety -- refer to Figure 1 (a) to (c)	1132196	SE1-ST1A20	TOP (Figure 1b)	Two ferrite inductor coils	IDENTICAL	IDENTICAL
2	SIDE sensing via IO-Link Safety – refer to Figure 1 (d) to (f)	1132197	SE1-SS1A20	SIDE (Figure 1e)	One ferrite inductor coil		

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Notes (Continued)

6. Sick Product Center Asia Pte. Ltd. declares that the actuators have identical electrical characteristics, material and physical dimensions.

SE1 Actuator			
no.	Type of Device	Identification Number (1 mio#)	ShortID (Variants)
1	SE1-AM01	1132271	01
2	SE1-AM02	1132272	02
3	SE1-AM03	1132273	03
4	SE1-AM04	1132274	04
5	SE1-AM05	1132275	05
6	SE1-AM06	1132276	06
7	SE1-AM07	1132277	07
8	SE1-AM08	1132278	08
9	SE1-AM09	1132279	09
10	SE1-AM10	1132280	10
11	SE1-AM11	1132281	11
12	SE1-AM12	1132282	12
13	SE1-AM13	1132283	13
14	SE1-AM14	1132284	14
15	SE1-AM15	1132285	15
16	SE1-AM16	1132286	16

The only difference between each actuator is the digital data programmed in ShortID. Sick Product Center Asia Pte. Ltd. declares that the difference in ShortID value will not cause any interference to RF/electromagnetic or EMC. SE1-AM02 was selected as a representative model for the family.

7. This report 7191331641-EEC24/02 | Issue: 01 was reproduced from TÜV SÜD PSB issued test report 7191315763-EEC23/02 | Issue: 01 dated 17 Oct 2023 to amend Applicant to SICK AG.

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1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a **RFID PROXIMITY SWITCH.**
Microprocessor	:	STMicroelectronics STM32F303VEH6
Operating Frequency	:	125KHz (RFID)
Clock / Oscillator Frequency	:	16MHz (crystal for MCU)
Modulation	:	Amplitude Modulation (AM)
Antenna Gain	:	Not Applicable
Port / Connectors	:	M12 A-coded 4-pin Male connector
Rated Power	:	DC Supply Voltage Nominal 24Vdc Maximum 30Vdc Minimum 18Vdc
Accessories	:	Nil

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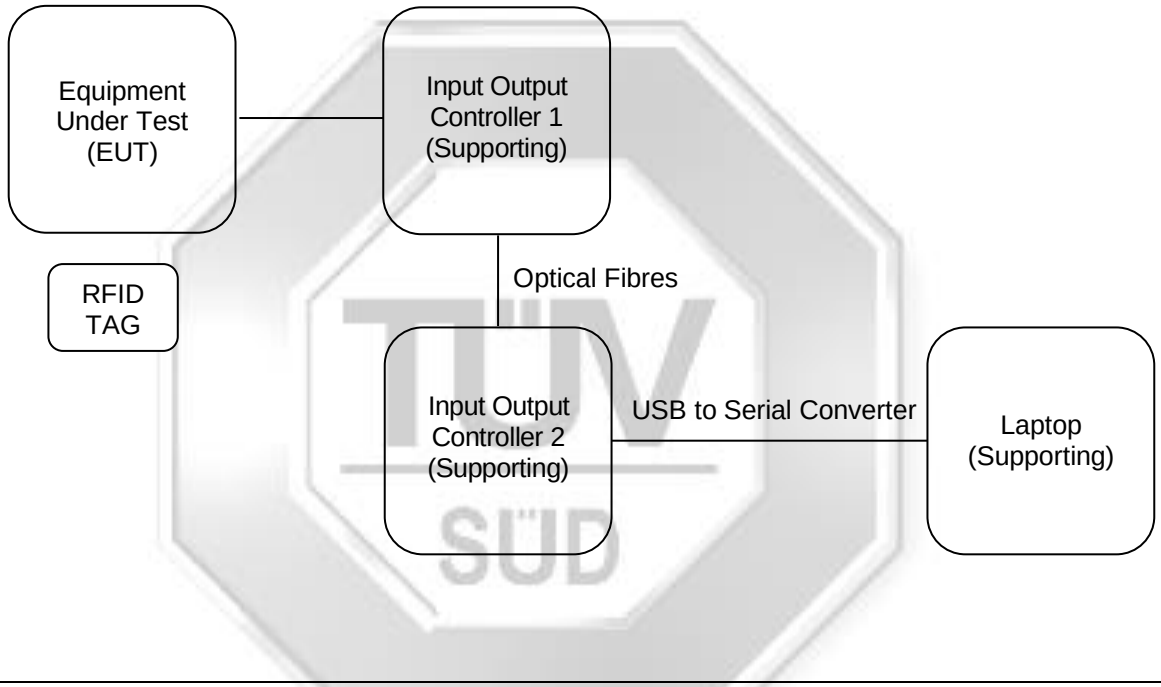
1.4.2 Test Configuration and Modes of Operation

Mode(s)	Description
Maximum RF power transmission	The EUT was transmitting and receiving continuously at 125kHz.

1.4.3 Test Setup Drawings



Test Setup Drawing

1.5 Deviations from the Standard

Nil.

1.6 EUT Modification Record

No modifications were made.

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1.7 Test Location(s)

TÜV SÜD PSB Pte Ltd
Electrical & Electronics Centre (EEC), Product Services,
15 International Business Park
TÜV SÜD @ IBP
Singapore 609937

1.8 Test Facilities Registrations

Requirements	Registration Numbers
FCC	994109 (Test Firm Registration Number) SG0002 (Designation Number)
ISED	SGAP01 (CAB Identifier) 2932N-1 (10m Semi-Anechoic Chamber)
VCCI	R-13324 (10m ANC), G-10203 (10mANC) R-20151 (3m RF Chamber - Lab 7), G-20149 (3m RF Chamber - Lab 7) C-14933 (C.E @ CEIBP) T-12403 (Telecom Ports @ CEIBP)
BSMI	SL2-IS-E-6001R *[CNS-13803 (ISM Equipment)]* SL2-IN-E-6001R *[CNS-13438, CNS-15936 (IT Equipment)]* SL2-R1/R2-E-6001R *[CNS-13439, CNS-15936 (Broadcast Receivers)]* SL2-A1-E-6001R *[CNS-13783-1 (Household Appliances)]* SL2-L1-E-6001R *[CNS-14115 (Lighting Equipment)]*
SABS	SABS/A-LAB/0030/2018
ASCA	TL-86

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1.9 Supporting Equipment

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Dell Latitude 7280 Laptop	M/N: P28S001 S/N: JQPRBH2 FCC ID: DoC	
Dell AC Adapter	M/N: LA130PM121 S/N: CN-0VJCH5-72438-4AS-2F47-A01 FCC ID: DoC	1.80m unshielded power cable
PowerPax AC Adapter	M/N: SW4309B S/N: AM-77717 FCC ID: DoC	1.50m unshielded power cable
PowerPax AC Adapter	M/N: SW4309B S/N: AM-77718 FCC ID: DoC	1.50m unshielded power cable
TEConcept GmbH	M/N: IO-Link Master 03 S/N: EMVT006A FCC ID: DoC	
TEConcept GmbH	M/N: IO-Link Master 03 S/N: EMVT006B FCC ID: DoC	
LINDY Electronics Limited Serial USB to Serial Converter	M/N: Nil S/N: Nil FCC ID: DoC	1.50m unshielded signal cable

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2 Test Details

2.1 Conducted Emissions

2.1.1 Test Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

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2.1.2 Test Setup

2.1.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.1.2.2 The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.

2.1.2.3 The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

2.1.2.4 All other supporting equipment were powered separately from another LISN.

2.1.3 Test Method

2.1.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.1.3.2 A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.

2.1.3.3 High peaks, relative to the limit line, were then selected.

2.1.3.4 The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.

2.1.3.5 The measurements were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz Q-P limit = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)
Therefore, Q-P margin = 60.0 - 40.0 = 20.0 i.e. 20.0 dB below Q-P limit

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2.1.4 Test Results

Operating Mode	Transmit Mode	Temperature	24°C
Test Input Power	120V 60Hz	Relative Humidity	60%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
Class	B	Tested By	Kelvin Cheng
Model	SE1-SS1A20	Test Date	29 Sep 2023

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.1682	45.1	65.0	19.9	28.0	55.0	27.0	Live
0.3444	38.1	59.1	21.0	32.6	49.1	16.5	Live
3.3093	36.0	56.0	20.0	28.7	46.0	17.3	Neutral
3.9579	36.6	56.0	19.4	28.9	46.0	17.1	Neutral
4.3766	35.7	56.0	20.3	27.1	46.0	18.9	Neutral
4.8380	35.3	56.0	20.7	26.9	46.0	19.1	Neutral

Operating Mode	Transmit Mode	Temperature	24°C
Test Input Power	120V 60Hz	Relative Humidity	60%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
Class	B	Tested By	Kelvin Cheng
Model	SE1-ST1A20	Test Date	29 Sep 2023

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.1691	46.0	65.0	19.0	29.8	55.0	25.2	Live
0.3440	38.3	59.1	20.8	32.6	49.1	16.5	Live
2.9888	35.1	56.0	20.9	27.9	46.0	18.1	Neutral
3.5700	36.8	56.0	19.2	29.2	46.0	16.8	Neutral
3.9509	36.4	56.0	19.6	28.7	46.0	17.3	Neutral
4.3395	35.7	56.0	20.3	27.2	46.0	18.8	Neutral

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Notes

1.	All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 150kHz - 30MHz RBW: 9kHz VBW: 30kHz

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2.2 Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)

2.2.1 Test Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490 *	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 – 88	40.0 @ 3m
88 – 216	43.5 @ 3m
216 – 960	46.0 @ 3m
Above 960 *	54.0 @ 3m
* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

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2.2.2 Test Setup

2.2.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.2.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.2.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.2.3 Test Method

2.2.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.2.3.2 A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.

2.2.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
b. The EUT was then rotated to the direction that gave the maximum emission.
c. Finally, the antenna height was adjusted to the height that gave the maximum emission.

2.2.3.4 A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz.For frequency point in range of 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, both Peak and Average measurements were carried out.

2.2.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

2.2.3.6 The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10^{th} harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

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2.2.5 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	3m (30MHz – 1GHz)	Relative Humidity	60%
Mode	Transmit Mode	Atmospheric Pressure	1030mbar
Model	SE1-ST1A20	Tested By	Derrick Ng
		Test Date	03 Oct 2023

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 6

Freq (MHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m) *See Note 5	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.0100	71.0	126.7	55.7	--	106.7	35.7	120	336
0.0200	50.0	120.7	70.7	--	100.7	50.7	120	341
0.0280	41.9	117.7	75.8	--	97.7	55.8	120	213
0.0350	42.4	115.8	73.4	--	95.8	53.4	120	20
0.0690	37.1	109.9	72.8	--	89.9	52.8	120	327
0.2660	22.5	98.2	75.7	--	78.2	55.7	120	169

Spurious Emissions ranging from 9kHz – 30MHz *See Note 6

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
0.7860	16.5	29.7	13.2	120	165
2.0190	22.2	30.0	7.8	120	140
2.6150	21.7	30.0	8.3	120	227
3.0800	22.6	30.0	7.4	120	88
3.3790	22.0	30.0	8.0	120	101
3.4770	23.5	30.0	6.5	120	185

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
47.6150	30.1	40.0	9.9	100	227	V
88.0190	23.0	43.5	20.5	133	140	V
90.1790	15.8	43.5	27.7	160	101	H
168.0800	23.8	43.5	19.7	107	88	V
354.9790	22.7	46.0	23.3	120	123	V
532.3350	23.6	46.0	22.4	100	149	V

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Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	3m (30MHz – 1GHz)	Relative Humidity	60%
Mode	Transmit Mode	Atmospheric Pressure	1030mbar
Model	SE1-SS1A20	Tested By	Derrick Ng
		Test Date	03 Oct 2023

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 6

Freq (MHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m) *See Note 5	AV Margin (dB)	Height (cm)	Azimuth (Degrees)
0.0100	71.3	126.7	55.4	--	106.7	35.4	120	196
0.0200	51.3	120.7	69.4	--	100.7	49.4	120	11
0.0350	43.7	115.8	72.1	--	95.8	52.1	120	120
0.0090	69.8	127.6	57.8	--	107.6	37.8	120	2
0.0150	47.3	123.2	75.9	--	103.2	55.9	120	258
0.0250	44.5	118.7	74.2	--	98.7	54.2	120	329

Spurious Emissions ranging from 9kHz – 30MHz *See Note 6

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)
0.0710	16.2	30.6	14.4	120	337
2.0440	21.7	30.0	8.3	120	50
2.8920	21.9	30.0	8.1	120	130
3.3940	24.3	30.0	5.7	120	160
3.4770	23.4	30.0	6.6	120	332
3.5500	20.0	30.0	10	120	149

Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)
47.9850	21.4	40.0	18.6	101	226	V
87.7910	23.0	40.0	17.0	140	111	V
87.9910	17.0	40.0	23.0	159	171	H
168.1940	22.8	43.5	20.7	105	356	V
362.8120	22.4	46.0	23.6	101	128	V
711.8260	20.8	46.0	25.2	137	199	V

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Notes

1.	All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 9kHz – 150kHz RBW: 200Hz VBW: 1kHz 150kHz – 30MHz RBW: 9kHz VBW: 30kHz 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
4.	As the measured peak shows compliance to the average limit, as such no average measurement was required.
5.	The average margin indicates the margin of the measured peak value below the average limit.
6.	The measurement was done at 3m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
7.	Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
8.	The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33 (a) for intentional radiators & Section 15.33 (b) for unintentional radiators.
9.	The channel in the table refers to the transmit channel of the EUT.

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2.3 Radiated Emissions (Fundamental)

2.3.1 Test Limits

Fundamental Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490 *	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 – 88	40.0 @ 3m
88 – 216	43.5 @ 3m
216 – 960	46.0 @ 3m
Above 960 *	54.0 @ 3m

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2.3.2 Test Setup

2.3.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.3.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.3.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.3.3 Test Method

2.3.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.3.3.2 A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.

2.3.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
b. The EUT was then rotated to the direction that gave the maximum emission.
c. Finally, the antenna height was adjusted to the height that gave the maximum emission.

2.3.3.4 A Quasi-peak measurement was made for that frequency point using the loop antenna.

2.3.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

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2.3.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	3m *see Note 4	Relative Humidity	60%
Mode	Transmit Mode	Atmospheric Pressure	1030mbar
Model	SE1-SS1A20	Tested By	Derrick Ng
		Test Date	03 Oct 2023

Freq (MHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Height (cm)	Azimuth (Degrees)
0.125	53.0	105.7	52.7	80	260

Test Input Power	120V 60Hz	Temperature	24°C
Test Distance	3m *see Note 4	Relative Humidity	60%
Mode	Transmit Mode	Atmospheric Pressure	1030mbar
Model	SE1-ST1A20	Tested By	Derrick Ng
		Test Date	03 Oct 2023

Freq (MHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Height (cm)	Azimuth (Degrees)
0.125	55.6	105.7	50.1	80	324

Notes

1.	All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 9kHz – 150kHz RBW: 200Hz VBW: 1kHz 150kHz – 30MHz RBW: 9kHz VBW: 30kHz 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
4.	The measurement was done at 3m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.

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2.4 Occupied Bandwidth Measurement

2.4.1 Test Limits

The EUT must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

2.4.2 Test Setup

2.4.2.1 The EUT and supporting equipment were set up as shown in the set up photo.

2.4.2.2 The power supply for the EUT was connected to a filtered mains.

2.4.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.4.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 3 times of RBW.

2.4.2.5 All other supporting equipment were powered separately from another filtered mains.

2.4.3 Test Method

2.4.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.4.3.2 The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 6dB bandwidth of the transmitting frequency.

2.4.3.3 The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.

2.4.3.4 The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The frequencies below the 20dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser. For 99% bandwidth measurement, the spectrum analyser power measurement was activated with bandwidth measurement as 99%.

2.4.3.5 The 20dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$. For 99% bandwidth measurement, the measured 99% bandwidth shown on the spectrum analyser was recorded.

2.4.3.6 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.4.3.7 The measurements were repeated with the transmitting frequency was set to middle and upper channels respectively.

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2.4.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	1 – 2	Relative Humidity	60%
Model	SE1-SS1A20	Atmospheric Pressure	1030mbar
		Tested By	Derrick Ng
		Test Date	03 Oct 2023

Channel Frequency (MHz)	**20dB Bandwidth (MHz)** *See Note 1	**99% Bandwidth (MHz)** *See Note 1
0.125	49.330	31.240

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	3 – 4	Relative Humidity	60%
Model	SE1-ST1A20	Atmospheric Pressure	1030mbar
		Tested By	Derrick Ng
		Test Date	03 Oct 2023

Channel Frequency (MHz)	**20dB Bandwidth (MHz)** *See Note 1	**99% Bandwidth (MHz)** *See Note 1
0.125	46.500	44.240

Notes

1.	Only the largest measured bandwidths were reported. Refer to plots for all measured bandwidth.

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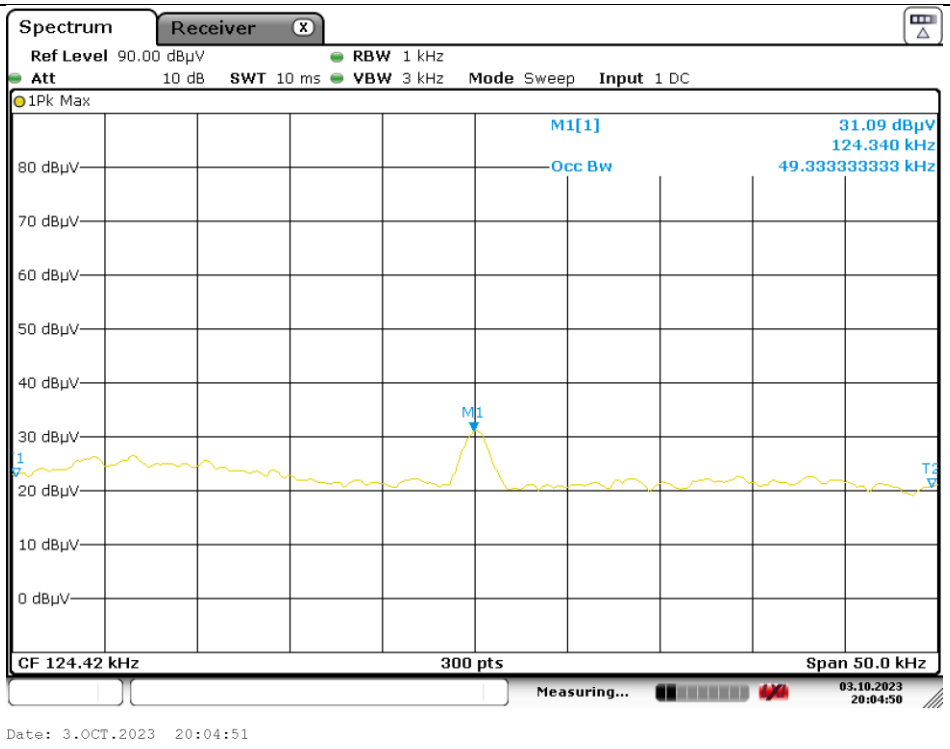
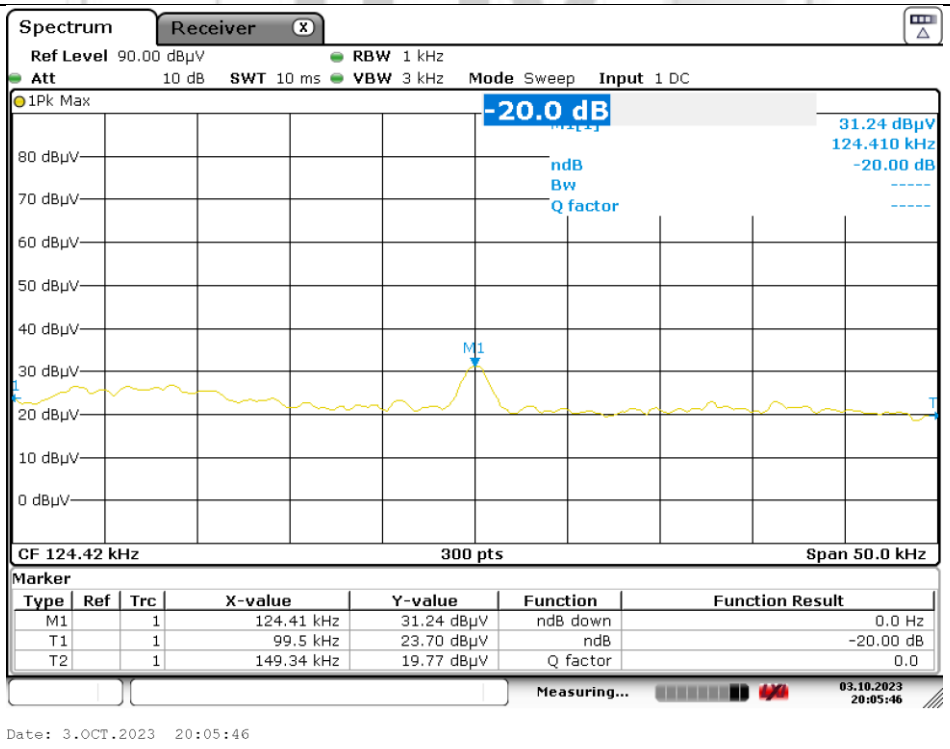
Spectrum Bandwidth (6dB Bandwidth Measurement) Plots – SE1-SS1A20



Plot 1 – 99% Bandwidth



Plot 2 – 20dB Bandwidth

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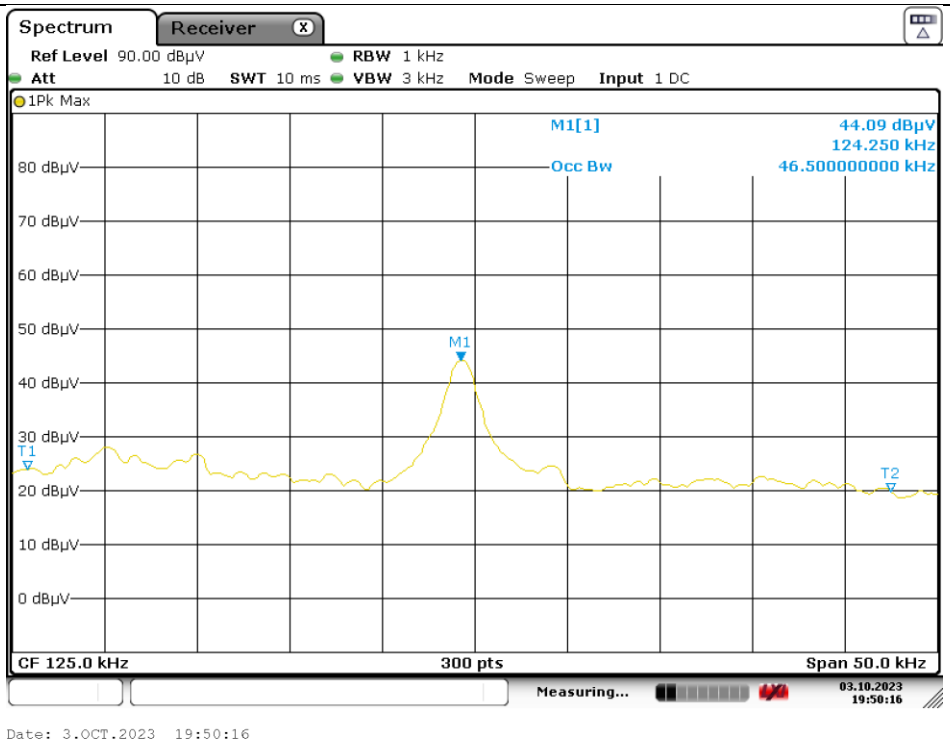
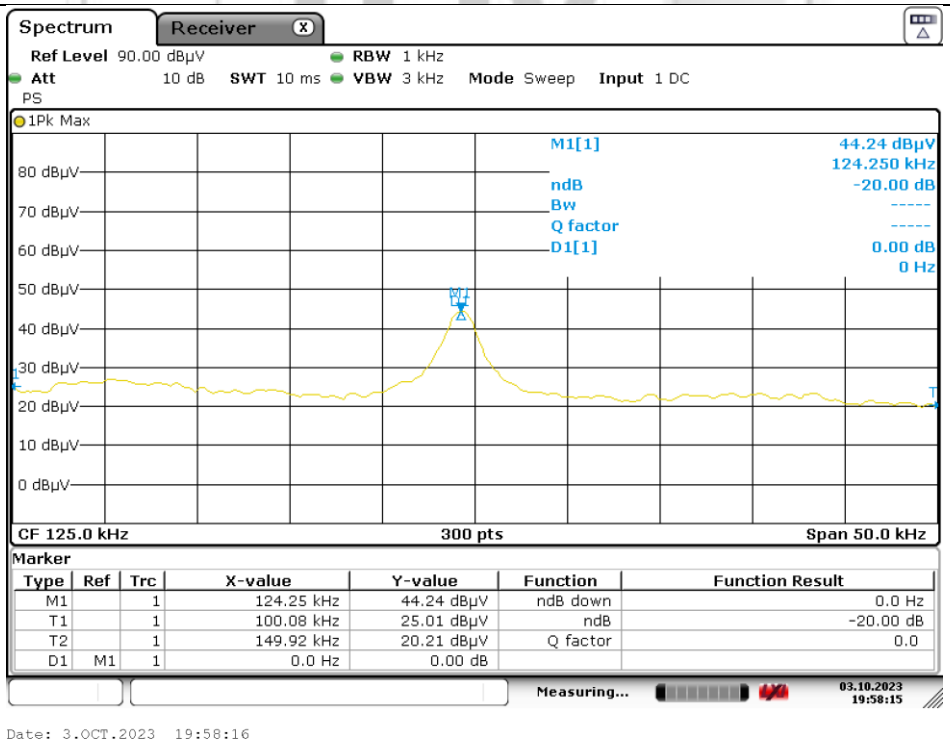
Spectrum Bandwidth (6dB Bandwidth Measurement) Plots – SE1-ST1A20



Plot 3 – 99% Bandwidth



Plot 4 – 30dB Bandwidth

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3 Test Equipment

Instrument	Model	S/No	Cal Due Date
Conducted Emissions			
R&S EMI Test Receiver (9kHz - 3GHz)	ESPI3	100349	09 May 2024
AFJ LISN	AFJ LT32C/10	32031929295	13 Apr 2024
Schaffner LISN	NNB42	04/10055	08 Aug 2024
EMCO LISN (supporting)	3825/2	9309-2127	08 Aug 2024
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) and Radiated Emissions (Fundamental)			
R&S EMI Test Receiver (9kHz - 26.5GHz)	ESR26	101714	14 Sep 2024
EMCO Loop Antenna (10kHz – 30MHz)	6502	134413	03 Jul 2024
Com-Power Preamplifier (1MHz - 1GHz)	PAM-103	441056	11 Sep 2024
Schaffner Bilog Antenna (30MHz - 2GHz)	CBL6112B	2593	11 Dec 2023
Spectrum Bandwidth			
R&S EMI Test Receiver (9kHz - 26.5GHz)	ESR26	101714	14 Sep 2024
EMCO Loop Antenna (10kHz – 30MHz)	6502	134413	03 Jul 2024

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4 Measurement Uncertainty

All measured results are traceable to the SI units. The uncertainty of the measurement is at a confidence level of approximately 95%, with a coverage factor of 2.

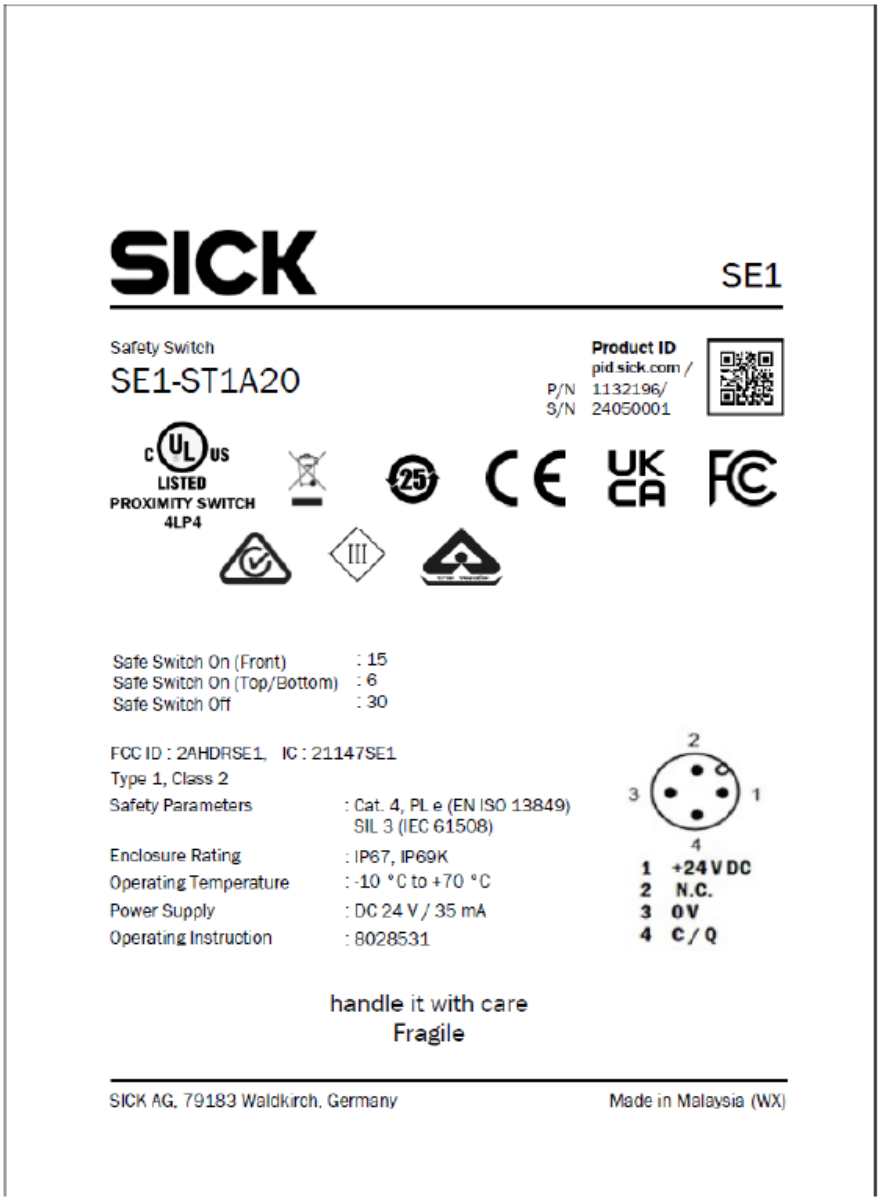
Test Name	Measurement Uncertainty
Conducted Emissions at Mains Terminals	1.1dB (9kHz to 30MHz)
Radiated Emissions	10m Anechoic Chamber (Lab 4) 2.2dB (9kHz to 30MHz @ 10m) 3.1dB (30MHz to 1GHz @ 10m) 3.7dB (30MHz to 1GHz @ 3m) 4.7dB (>1GHz to 40GHz @ 3m) 3m RF Chamber (Lab7) 3.6dB (30MHz to 1GHz @ 3m) 4.7dB (>1GHz to 40GHz @ 3m)
Maximum Permissible Exposure	2.53% (0.01kHz to 400kHz) – H-field 1.3dB (0.3MHz to 18GHz) - E-field 2.3dB (1MHz to 40GHz) - E-field

5 Annex A – FCC Label and PositionS

Labelling requirements per Section 2.925 & 15.19

The label shown will be permanently affixed at a conspicuous location on the device and be readily visible to the user at the time of purchase.

- Sensor



Sample Label Print on Packaging Bag

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Effective 26 January 2021

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End of the Test Report