



Test report

Number	T251-0545/24		Project file: C20241046 Date: 2024-06-21 Pages: 43
Product:	Notecard v2 M.2 card		
Type reference:	NOTE-NBGLN, NOTE-WBEXN		
Ratings:	VIO - 1.8 V or 3.3 V; 150 mA VMODEM - 2.5 V to 5.5 V; 750 r (powered directly from a develop	mA oment board and AC	/DC power supply
Trademark:	/		
Applicant:	Blues Inc. Harbor Street 50, 01944 Mancl	hester, USA	
Manufacturer:	Blues Inc. Harbor Street 50, 01944 Manch	ester, USA	
Place of manufacture:	Blues Inc. Harbor Street 50, 01944 Manch	ester, USA	
Summary of testing			
Testing method:	EN 303 446-1 V1.2.1 in conjunc	tion with EN 301 489	9-52 V1.2.1
Testing location:	SIQ Ljubljana Mašera-Spasićeva ulica 10, SI-1	1000 Ljubljana, Slove	enia
Remarks:	Date of receipt of test items: 202 Number of items tested: 2 Date of performance of tests: 20 The test results presented in this The test items were tested in the The product complies with the re	24-05-07 24-05-23 – 2024-06 s report relate only to e condition as receive equirements of the te	-11 o the items tested. ed. ssting methods.
Tested by: Aljaž Bajeo	2	Approved by: Marja	an Mak

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1. General

Abbreviations and markings:

AC mains power port	Port used to connect to the mains supply network
DC network power port	Port, not powered by a dedicated AC/DC power converter and not supporting
	communication, that connects to a DC supply network
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
Port	Physical interface through which electromagnetic energy enters or leaves the
	EUT
Wired network port	Point of connection for voice, data and signalling transfers intended to
	interconnect widely dispersed systems by direct connection to a single-user
	or multi-user communication network (for example CATV, PSTN, ISDN,
	xDSL, LAN and similar networks).
AE associated equipment	Equipment needed to exercise and/or monitor the operation of the EUT
EUT	Equipment Under Test
Highest internal frequency (Fx)	Highest fundamental frequency generated or used within the EUT or highest
	frequency at which it operates
ESD	Electrostatic Discharge
CDN	Coupling and Decoupling Network
RF	Radio Frequency

Possible test case verdicts:

Test does not apply to the tested sample:	N/A
Tested sample passed the requirements:	P (Pass)
Tested sample failed the requirements:	F (Fail)
Test was not performed:	N/P (Not performed)

Throughout this report a comma is used as the decimal separator. Numerical data taken from IEC standards are using a comma as the decimal separator.

History sheet:

Date:	Report No.:	Change:	Revision:
2024-06-21	T251-0545/24	Initial Test Report issued.	

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2. Measurement uncertainty

The following measurement uncertainty levels have been calculated according to the SIQ internal document EN208, as specified in CISPR 16-4-2 and EN 55016-4-2. The uncertainties represent an expanded uncertainty expressed at 95% confidence level using a coverage factor k=2.

The following measurement uncertainty has been included in test results as specified in each of the basic referenced standards as applicable.

Emission:

Measurement / test method		ULAB	
Conducted emission measurement	(150 kHz to 30 MHz)	2,7 dB	3,4 dB
Radiated emission measurement (electric field strength at an OATS or in a SAC)	(30 MHz to 1000 MHz)	5,3 dB	6,3 dB
Harmonic current emission measurement	1	±0,0016 A	/
Voltage changes, fluctuations, and flicker measurement	1	2,4 %	/

Immunity:

Measurement / test method	Parameter values
Electrostatic discharge immunity measurement	All required parameters comply with requirements of standard.
Radiated, RF electromagnetic field immunity measurement	2,2 dB
Electrical fast transients/burst immunity measurement	All required parameters comply with requirements of standard.
Surge immunity measurement	All required parameters comply with requirements of standard.
Conducted disturbances, induced by RF fields immunity measurement	3,2 dB
Power frequency magnetic field immunity measurement	All required parameters comply with requirements of standard.
Voltage dips, short interruptions, and voltage variations immunity measurement	All required parameters comply with requirements of standard.



3. Decision rule

Application of decision rule and statement of conformity is defined in document TN023 Decision rule and measurement uncertainty.

As a general rule Pass/Fail decisions are based on simple acceptance rule and acceptance limits chosen based on simple acceptance (w = 0, AL = TL) except if a decision rule is governed by particular standard or guidance document.

Decision rule applicable for emission:



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Decision rule applicable for immunity:







4. Product specific data

General description of test item: Device is a notecard for various machines to be built-in with 3 different LTE modules.

Product key:

NOTE-NBGLN contains Quectel BG95-M3 wireless module; NOTE-WBEXN contains Quectel EG91-EX wireless module;

Power supply type:		Powered with AC/DC power supply and 5 V d.c. from the development			
Power suppry type.	board				
Hardware version:	2.1				
Firmware/software version:	7				
	\boxtimes	Table-top equipment	:		
		Floor-standing equipment:			
Mounting position:		Wall/ceiling mounted equipment:			
		Hand-held equipment:			
		Other:			
	Name	9:	LTE module:	Frequency:	
Highest Internal Operating	Maximum clock		MG95-M3	1980 MHz	
riequencies.	transmission frequency that of the LTE module		EG91-EX	2570 MHz	

Port(s):

No.	Port	Туре	cable length / m	cable shielded
0	Enclosure	N/E	/	/
1	DC charging input	DC	/	/
Note:	DC = DC network power port / input d.c. p N/E = Non-Electrical	ower port		

Configuration diagram:

/

NOTE: The information in this section has been provided by the applicant.

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5. Equipment under test (EUT)

Prod	uct Type	Device	Manufacturer	Model No.	Comments
	EUT	Notecard	Blues Inc.	NOTE-NBGLN	/
	EUT	Notecard	Blues Inc.	NOTE-WBEXN	/
	AE	Development board	/	NOTECARRIER – D V1.6	/
	AE	Power supply	Rigol	DP832	/
	AE	Notebook	HP	Z-book	/
Note	EUT = Equip	oment Under Test			
note.	AE = Associ	ated Equipment			

Pictures of EUT:





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Operating conditions:

Clause	Test	Connection type	Operating conditions
Conducted emission measurement9.1	Conducted emission measurement	/	N/A
9.2	Radiated emission measurement	Charged by external AC-DC adapter to development board	5 Vdc supply to development board
9.3	Harmonic current emissions measurement	/	N/A
9.4	Voltage changes, fluctuations, and flicker measurement	/	N/A
10.1	Electrostatic discharge immunity measurement	Charged by external AC-DC adapter to development board	5 Vdc supply to development board
10.2	Radiated, RF electromagnetic field immunity measurement	Charged by external AC-DC adapter to development board	5 Vdc supply to development board
10.3	Electrical fast transients/burst immunity measurement	/	N/A
10.4	Surge immunity measurement	/	N/A
10.5	Conducted disturbances, induced by RF fields immunity measurement	/	N/A
10.6	Power frequency magnetic field immunity measurement	/	N/A
10.7	Voltage dips, short interruptions, and voltage variations immunity measurement	/	N/A

Operating modes:

No.	Operating mode
1	Modem test with "burn" operating mode

Tested sample:

Sample number	Used for measurement
S202404230	All measurements
S202404231	All measurements

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6. Environmental conditions

The climatic conditions during the tests were within the following limits:

Ambient temperature: 15 °C to 35 °C Relative humidity Electrostatic Discharges (ESD): 30 % to 60 % Relative humidity all other testing except Electrostatic Discharges (ESD): 15 % to 75 % Atmospheric pressure: 860 mbar to 1060 mbar



7. Verdict summary section

STANDARDS (details on first page)	PERFORMED ¹⁾	CONCLUSION ¹⁾
EN 303 446-1 V1.2.1 Electromagnetic Compatibillity (EMC) standard for combined and/or integrated radio and non-radio equipment; Part 1: Requirements for equipment intended to be used in residential, commercial and light industry locations.	YES	Ρ
SUBSTANDARD: RADIO PART		
EN 301 489-1 V2.2.3 ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; harmonized Standard for ElectroMagnetic Compatibility	YES	Ρ
EN 301 489-52 V1.2.1 ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 52: Specific conditions for Cellular Communication User Equipment (UE) radio and ancillary equipment; Harmonised Standard for ElectroMagnetic Compatibility	YES	Ρ
EN 301 489-19 V2.2.1 ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 19: Specific conditions for Receive Only Mobile Earth Stations (ROMES) operating in the 1,5 GHz band providing data communications and GNSS receivers operating in the RNSS band providing positioning, navigation, and timing data; Harmonised Standard for ElectroMagnetic Compatibility	YES	Ρ
SUBSTANDARD: NON-RADIO PART		
EN 55032:2015 + A11:2020 Electromagnetic compatibility of multimedia equipment – Emission requirements	YES	Р
EN 61000-3-2:2014 Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	NO	N/A
EN 61000-3-3:2013 Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems for equipment with rated current ≤ 16A per phase and not subjected to conditional connection	NO	N/A
EN 55035:2017 + A11:2020 Electromagnetic compatibility of multimedia equipment – Immunity Requirements	YES	Р
¹⁾ See details in table(s) below		

Test (emission)	Referenced standard	Clause within the report	Class	Conclusion
Conducted emission measurement	EN 55032:2015 + A11:2020	3.1	/	N/A
Radiated emission measurement	EN 55032:2015 + A11:2020	3.2	В	Р
Harmonic current emissions measurement	EN 61000-3-2:2014	3.3	/	N/A
Voltage changes, fluctuations, and flicker measurement	EN 61000-3-3:2013	3.4	/	N/A

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Test (immunity)	Referenced standard	Required criteria	Achieved criteria	Conclusion			
Electrostatic discharge immunity measurement	EN 61000-4-2:2009	В	А	Р			
Radiated, RF electromagnetic field immunity measurement	EN 61000-4-3:2006 + A1:2008 + A2:2010	А	А	Р			
Electrical fast transients/burst immunity measurement	EN 61000-4-4:2012	/	/	N/A			
Surge immunity measurement	EN 61000-4-5:2014	/	/	N/A			
Conducted disturbances, induced by RF fields immunity measurement	EN 61000-4-6:2014	/	/	N/A			
Power frequency magnetic field immunity measurement	EN 61000-4-8:2010	/	/	N/A			
Voltage dips, short interruptions, and voltage variations immunity measurement	EN 61000-4-11:2004	/	/	N/A			
NOTE: for detailed description of achieved criteria refer to each test separately							

NOTE: no non-standard test method used



8. Performance/observation criteria

If there are no special manufacturer performance criteria defined, those below are used for evaluation.

Radio part:

EN 301 489-52:

Performance criteria for Continuous phenomena (E-UTRA, E-UTRA with LAA, inband or guard band NB-IoT, Standalone NB-IoT):

In data transfer mode, the data throughput of the EUT shall not fall below 95 % of the maximum data throughput.

Performance criteria for Transient phenomena

At the conclusion of each exposure of the transient phenomena, the EUT shall operate without loss of the

communication link.

At the conclusion of the total test comprising the series of individual exposures, the EUT shall operate as intended without loss of user control functions or critical stored data.

In addition, where the EUT supports idle mode, it should be verified that the transmitter shall not unintentionally operate when transient phenomena are applied.

EN 301 489-19:

Performance criteria for Continuous phenomena:

During the test, the equipment shall operate as intended, e.g. not unintentionally change its operating state, and not unintentionally change critical stored data.

After the test, the equipment shall operate as intended, e.g. have no loss of function, and have no loss of critical stored data.

Performance criteria for Transient phenomena:

After the test, functions shall be self-recoverable, and the equipment shall operate as intended and the equipment shall have no loss of critical stored data.

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Non-radio part:



<u>Criteria A:</u> The equipment shall continue to operate as intended without operator intervention. No degradation of performance, loss of function or change of operating state is allowed below a performance level specified by the manufacturer when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.

<u>Criteria B:</u> During the application of the disturbance, degradation of performance is allowed. However, no unintended change of actual operating state or stored data is allowed to persist after the test.

After the test, the equipment shall continue to operate as intended without operator intervention; no degradation of performance or loss of function is allowed, below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance.

If the minimum performance level (or the permissible performance loss), or recovery time, is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.

<u>Criteria C:</u> Loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions. A reboot or re-start operation is allowed.

Information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

Test	Observed function
Electrostatic discharge immunity measurement NOTE	Sent and received packets via terminal (connected to PC)
Radiated, RF electromagnetic field immunity measurement NOTE	Sent and received packets via terminal (connected to PC)
Electrical fast transients/burst immunity measurementSurge immunity measurement NOTE	/
Conducted disturbances, induced by RF fields immunity measurement NOTE	/
Power frequency magnetic field immunity measurement NOTE	/
Voltage dips, short interruptions, and voltage variations immunity measurement $^{\mbox{\scriptsize NOTE}}$	/
NOTE: see section 7, referenced standards	



9. Emission

9.1 Conducted emission measurement

9.1.1 Limits of conducted emission measurement

AC ports:

	Limit Choose an item. (dBµV)			
Frequency (MHz)				
	Quasi-peak	Average		
0,15 – 0,5	66 - 56	56 - 46		
0,5 – 5,0	56	46		
5,0-30,0	60	50		

9.1.2 Test procedure

- The EUT is placed 0,4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). LISN provide 50 Ohm / 50 μ H+5 Ohm of coupling impedance for the measuring instrument.
- EUT is checked for maximum conducted interference:
- Frequency range from 150 kHz to 30 MHz is searched.

9.1.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

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9.1.4 Test results

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.



9.2 Radiated emission measurement

9.2.1 Limits of radiated emission measurement

Frequency (MHz)	Limit Cla (dl	lss B (at 3 m) BμV/m)
30 – 230	40	Quasi Peak
230 – 1000	47	Quasi Peak
1000 - 2000	70	Peak
1000 – 3000	50	Average
3000 6000	74	Peak
3000 - 6000	54	Average

NOTE: • The lower limit shall apply at the transition frequencies.

• Emission level (dB μ V/m) = 20 log Emission level (μ V/m).

9.2.2 Test procedure

- The EUT is set 3 m away from the interference-receiving antenna, which was mounted on the top of variableheight antenna tower.
- The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT is arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the turn table is turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system is set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- The highest points are to be re-tested one by one using the quasi-peak method.
- CMAD has not been applied in test setup.

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9.2.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

9.2.4 Test result

Operating mode(s):	1
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NOTE-NBGLN:

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Radiated emission

EUT Information EUT: Operating condition:

BG95-M3 5 V d.c.

Full Spectrum



Comment

	count								
Frequency	QuasiPeak	Limit	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.
(MHz)	(dBµV/m)	(dBµV/m)	(dB)	Time	(kHz)	(cm)		(deg)	(dB/m)
				(ms)					
44.850000	28.23	40.00	11.77	1000.0	120.000	100.0	V	5.0	10.6
42.360000	17.26	40.00	22.74	1000.0	120.000	100.0	V	5.0	12.2
30.090000	15.68	40.00	24.32	1000.0	120.000	212.0	Н	24.0	19.7
30.270000	15.30	40.00	24.70	1000.0	120.000	104.0	Н	323.0	19.6
30.480000	14.74	40.00	25.26	1000.0	120.000	212.0	V	35.0	19.4
45.810000	13.92	40.00	26.08	1000.0	120.000	100.0	V	190.0	10.0
895.350000	15.93	47.00	31.07	1000.0	120.000	188.0	V	225.0	22.5
895.440000	15.86	47.00	31.14	1000.0	120.000	188.0	V	225.0	22.5
672 000000	14.66	47 00	32 34	1000.0	120 000	138.0	н	231.0	20.0

Final Result





Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
1836.000000		40.91	50.00	9.09	162.0	V	327.0
5980.500000		42.36	54.00	11.64	141.0	Н	351.0
4933.000000		41.92	54.00	12.08	100.0	V	357.0
5007.500000	-	41.56	54.00	12.44	138.0	V	148.0
5019.250000	-	41.54	54.00	12.46	100.0	Н	62.0
5186.250000		41.21	54.00	12.79	162.0	V	218.0
5180.500000		41.19	54.00	12.81	141.0	V	218.0
5185.000000		41.18	54.00	12.82	138.0	V	218.0
4346.500000	-	35.96	54.00	18.04	103.0	Н	54.0
4433.250000	-	35.94	54.00	18.06	162.0	V	55.0
4904.750000	55.82		74.00	18.18	138.0	Н	180.0
5203.250000	55.35		74.00	18.65	138.0	V	40.0
4933.000000	55.24		74.00	18.76	141.0	V	335.0
4956.250000	55.20		74.00	18.80	154.0	Н	188.0
5185.750000	55.14		74.00	18.86	138.0	V	218.0
5184.750000	54.79		74.00	19.21	153.0	V	218.0

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NOTE-WBEXN:

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Radiated emission

EUT Information EUT: Operating condition:

EG91-EX 5 V d.c.

Full Spectrum



Final Result

Frequency	QuasiPeak	Limit	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.
(MHz)	(dBµV/m)	(dBµV/m)	(dB)	Time	(kHz)	(cm)		(deg)	(dB/m)
				(ms)					
44.100000	25.15	40.00	14.85	1000.0	120.000	100.0	V	212.0	11.1
46.560000	20.72	40.00	19.28	1000.0	120.000	100.0	V	195.0	9,5
30.000000	15.95	40.00	24.05	1000.0	120.000	104.0	v	18.0	19.7
30.090000	15.65	40.00	24.35	1000.0	120.000	141.0	V	207.0	19.7
30.150000	15.62	40.00	24.38	1000.0	120.000	141.0	V	91.0	19.6
45.690000	10.23	40.00	29.77	1000.0	120.000	104.0	V	133.0	10.1
41.610000	7.04	40.00	32.96	1000.0	120.000	100.0	V	110.0	12.7
332.970000	13.62	47.00	33.38	1000.0	120.000	104.0	V	287.0	13.3
580.290000	13.28	47.00	33.72	1000.0	120.000	142.0	Η	82.0	18.9



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Full Spectrum



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
2112.000000		31.97	50.00	18.03	100.0	Н	226.0
2109.000000		31.98	50.00	18.02	100.0	Н	226.0
1836.000000		40.90	50.00	9.10	162.0	v	203.0
5180.750000	-	41.17	54.00	12.83	162.0	V	234.0
5135.000000	-	41.13	54.00	12.87	103.0	Н	37.0
5182.750000	-	41.15	54.00	12.85	142.0	v	234.0
5982.750000	-	42.33	54.00	11.67	100.0	Н	53.0
5185.250000		41.14	54.00	12.86	138.0	v	234.0
5009.000000		41.53	54.00	12.47	162.0	Н	71.0
5029.750000		41.46	54.00	12.54	104.0	V	204.0
4962.000000	54.80		74.00	19.20	104.0	v	281.0
4953.000000	56.07		74.00	17.93	100.0	Н	118.0
4954.250000	55.27		74.00	18.73	105.0	Н	149.0
5178.000000	54.91		74.00	19.09	162.0	V	234.0
5179.250000	54.66		74.00	19.34	162.0	V	234.0
5182.500000	55.27		74.00	18.73	162.0	V	234.0





Figure 1: Radiated emission measurement – sample picture for both samples



Figure 2: Radiated emission measurement – sample picture for both samples

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9.3.1 Configuration

- The EUT is placed on the top of an insulating support 0,1 (floor equipment) or 0,8 (table-top equipment) meters in height above the ground and operated to produce the maximum harmonic components under normal operating conditions for each successive harmonic component in turn.
- The correspondent test program of test instrument to measure the current harmonics emanated from EUT is chosen. The measure time shall be not less than the time necessary for the EUT to be exercised.

9.3.2 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

9.3.3 Test results

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.





9.4 Voltage changes, fluctuations, and flicker measurement

9.4.1 Configuration

- The EUT is placed on the top of an insulating support 0,1 (floor equipment) or 0,8 (table-top equipment) meters in height above the ground and operated to produce the **most unfavourable sequence of voltage changes under normal operating** conditions.
- During the flicker measurement, the measure time shall include that part of whole operating cycle in which the EUT produce the most unfavourable sequence of voltage changes. The observation period for short-term flicker indicator is 10 minutes and the observation period for long-term flicker indicator is 2 hours.

9.4.2 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

9.4.3 Test results

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.

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10. Immunity

10.1 Electrostatic discharge immunity measurement

10.1.1 Test specifications

Referenced Standard:	See clause 7.	
Discharge Impedance:	330 Ω / 150 pF	
Discharge Voltage:	Air Discharges – 8 kV (Direct) Contact Discharge- 4 kV (Indirect, Direct)	
Polarity:	Positive / Negative	
Number of Discharges:	Minimum 20 discharges (10 positive and 10 negative polarity)	
Discharge Mode:	Single Discharge	
Discharge Period:	1-second minimum	

10.1.2 Test procedure

The discharges shall be applied in two ways:

• Contact discharges to the conductive surfaces and coupling planes:

The EUT shall be exposed to at least 20 discharges, 10 each at negative and positive polarity on each accessible metal part. If no direct contact points are available, then at least 20 indirect discharges shall be applied in the indirect mode. Test shall be performed at a maximum repetition rate of one discharge per second.

• Air discharges at slots and apertures and insulating surfaces:

On those parts of the EUT where it is not possible to perform contact discharge testing, the equipment should be investigated to identify user accessible points where breakdown may occur. Such points are tested using the air discharge method. This investigation should be restricted to those area normally handled by the user.

For air discharge testing, the test starts with 2 kV and continues with value multiplied by 2 up to and including the specified test level.

The test procedure is in accordance with referenced standard:

- Electrostatic discharges are applied only to those points and surfaces of the EUT that are accessible to users during normal operation.
- The test is performed with at least ten single discharges on the pre-selected points in the most sensitive polarity.
- The time interval between two successive single discharges is at least 1 second.
- The ESD generator is held perpendicularly to the surface to which the discharge is applied, and the return cable is at least 0,2 meters from the EUT.
- Contact discharges are applied to the non-insulating coating, with the pointed tip of the generator penetrating the coating and contacting the conducting substrate.
- Air discharges are applied with the round discharge tip of the discharge electrode approaching the EUT as fast as possible (without causing mechanical damage) to touch the EUT. After each discharge, the ESD generator is removed from the EUT and re-triggered for a new single discharge. The test is repeated until all discharges are complete.
- At least ten single discharges (in the most sensitive polarity) are applied to the Horizontal Coupling Plane at points on each side of the EUT. The ESD generator is positioned vertically at 0,1 meters from the EUT with the discharge electrode touching the Horizontal Coupling Plane.



• At least ten single discharges (in the most sensitive polarity) were applied to the centre of one vertical edge of the Vertical Coupling Plane in sufficiently different positions that the four faces of the EUT were completely illuminated. The Vertical Coupling Plane (dimensions 0,5 m x 0,5 m) was placed vertically to and 0,1 meters from the EUT.

10.1.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

The **GRP** is of a sheet of aluminium at least 0,25 mm thick, and it projects beyond the EUT by at least 0,5 meters and is connected to the protective grounding system. A Horizontal Coupling Plane (1,6 m x 0,8 m) is placed on the table and attached to the **GRP** by means of a cable with 940 k Ω total impedance. The equipment under test, is installed in a representative system as described in referenced standard on an insulating support 0,1 (floor equipment) or 0,8 (table-top equipment) meters in height, and its cables are placed on the **HCP** and isolated by an insulating support of 0,5 mm thickness. A distance of 0,8-meter minimum is provided between the EUT and the walls of the laboratory and any other metallic structure.

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10.1.4 Test results

Operating mode(s):	1

Discharge Level (kV)	Polarity	Test Point	Contact Discharge	Air Discharge	Required criteria	Achieved criteria
2	+/-			Х	/	/
4	+/-			Х	/	/
8	+/-			Х	/	/
4	+/-		Х		В	A
Changes in operation observed during testing:						
There is no accessible point on the EUT, since it is built-in to a device, hence test is not applicable.						
No changes observed.						

Legend:

- contact discharge points (HCP and VCP only) air discharge points

NOTE-NBGLN:



Figure 3: Electrostatic discharge immunity measurement





Figure 4: Electrostatic discharge immunity measurement

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NOTE-WBEXN:





Figure 5: Electrostatic discharge immunity measurement



Figure 6: Electrostatic discharge immunity measurement



10.2 Radiated, RF electromagnetic field immunity measurement

10.2.1 Test specification

Referenced Standard:	See clause 7.	
Frequency Range:	80 – 6000 MHz	
Field Strength:	3 V/m	
Modulation:	1 kHz Sine Wave, 80 %, AM Modulation	
Frequency Step:	1 % of fundamental	
Spot frequencies:	1800 MHz, 2600 MHz, 3500 MHz, 5000 MHz	
Field Strength:	3 V/m	
Modulation:	1 kHz Sine Wave, 80 %, AM Modulation	
Polarity of Antenna:	Horizontal and Vertical	
Illumination sides:	Front, Rear, Left and Right side	
Test Distance:	2,5 m	
Antenna Height:	1,55 m	

10.2.2 Test procedure

The test procedure was in accordance with referenced standard.

- The testing is performed in an anechoic chamber. The transmit antenna is located at 2,5 meters from the EUT.
- The frequency range is swept from 80 MHz to 6000 MHz and at spot frequencies 1800 MHz, 2600 MHz, 3500 MHz, 5000 MHz, with the signal 80 % amplitude modulated with 1 kHz sine wave. The rate of sweep does not exceed 1,5 x 10⁻³ decade/s. Where the frequency range is swept incrementally, the step size is 1% of fundamental.
- The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.
- The field strength level is 3 V/m.
- The test is performed with the EUT exposed to both vertically and horizontally polarized fields on each of the four sides.

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10.2.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

The EUT shall be installed in a representative system as described in referenced standard on an insulating support 0,1 (floor equipment) or 0,8 (table-top equipment) meters in height. The system under test is connected to the power and signal wire according to relevant installation instructions.



10.2.4 Test results

Operating mode(s):	1
	•

Frequency	Level	Dwell time	Illuminated side	Required criteria	Achieved criteria
	3 V/m	1 s	Front	A	A
			Rear	A	A
80 MHZ – 1000 MHZ			Left	A	A
			Right	A	A
		1 s	Front	A	A
1800 MU-	2 \//m		Rear	A	A
	3 V/III		Left	A	A
			Right	A	A
			Front	A	A
2600 MH-	3 V/m	1 s	Rear	A	A
			Left	A	A
			Right	A	A
	3 V/m		Front	A	A
2500 MH-		1.0	Rear	A	A
3500 MIHZ		1 S	Left	A	A
			Right	A	A
	3 V/m	1 s	Front	А	A
5000 MH-			Rear	A	A
5000 MHZ			Left	A	A
			Right	А	A
	3 V/m	1 s	Front	А	A
			Rear	A	A
			Left	A	A
			Right	A	A
Changes in operation observed during testing: No changes observed.					





Figure 7: Radiated, RF electromagnetic field immunity measurement – sample picture for both samples



10.3 Electrical fast transients/burst immunity measurement

10.3.1 Test specification

Referenced Standard:	See clause 7.		
Test Voltage:	AC power Line – 1 kV		
Polarity:	Positive/Negative		
Impulse Frequency:	5 kHz		
Impulse Waveshape:	5/50 ns		
Burst Duration:	15 ms		
Burst Period:	300 ms		
Test Duration:	not less than 1 min.		

10.3.2 Test procedure

- The EUT is tested with 1000 Volt discharges to the AC power input leads.
- Both positive and negative polarity discharges are applied.
- The cable length between the EUT and the coupling device shall be as intended for installation.
- The duration time of each test sequential is 1 minute.
- The transient/burst waveform is in accordance with referenced standard, 5/50 ns.
- Artificial hand is not applied.

10.3.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

The EUT is installed in a representative system as described in referenced standard on an insulating support 0,1 meters in height and its cables are isolated from the Ground Reference Plane. The GRP consists of a sheet of aluminium (at least 0,25 mm thick and 2,5 m square) connected to the protective grounding system.

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10.3.4 Test results

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.



10.4 Surge immunity measurement

10.4.1 Test specification

Referenced Standard:	See clause 7.		
Wave-Shape:	Combination Wave		
Test Voltage:	±2 kV unsymmetrical – Common mode, ±1 kV symmetrical – Differential mode, 1,2/50 us Open Circuit Voltage		
Generator Source:	2 ohm between networks 12 ohm between network and ground		
Polarity:	Positive/Negative		
Phase Angle:	90 ° / 270 °		
Pulse Repetition rate:	10 s – 60 s		
Number of Tests:	5 positive and 5 negative at selected points		

10.4.2 Test procedure

For EUT power supply:

The surge is to be applied to the EUT power supply terminals via the capacitive coupling network. Decoupling networks are required in order to avoid possible adverse effects on equipment not under test that may be powered by the same lines, and to provide sufficient decoupling impedance to the surge wave. The power cord between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

The test shall be started with low voltage 0,5 kV and continued with level, which is higher for 0,5 kV.

10.4.3 Test setup



For the actual test configuration, please refer to the related item - Photographs of the Test Configuration.

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10.4.4 Test results

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.



10.5 Conducted disturbances, induced by RF fields immunity measurement

Referenced Standard:	See clause 7.
Frequency Range:	0,15 MHz – 10 MHz
Field Strength:	3 V rms
Frequency Range:	10 MHz – 30 MHz
Field Strength:	3 V rms – 1 V rms
Frequency Range:	30 MHz – 80 MHz
Field Strength:	1 V rms
Modulation:	1 kHz Sine Wave, 80 %, AM Modulation
Frequency Step:	1 % of fundamental
Coupled Cable:	Power Mains

10.5.1 Test specification

10.5.2 Test procedure

- The EUT shall be tested within its intended operating and climatic conditions.
- The test shall be performed with the test generator connected to each of the coupling and decoupling devices in turn, while the other non-excited RF input ports of the coupling devices are terminated by a 50 Ω load resistor.
- The frequency range is swept from 150 kHz to 80 MHz, using the signal level established during the setting process and with a disturbance signal of 80 % amplitude. The signal is modulated with a 1 kHz sine wave, pausing to adjust the RF signal level or the switch coupling devices as necessary. The sweep rate shall not exceed 1,5 x 10⁻³ decades/s. The step size shall not exceed 1 % of the start and thereafter 1 % of the preceding frequency value where the frequency is swept incrementally.
- The dwell time at each frequency shall not be less than the time necessary for the EUT to be exercised, and able to respond. Sensitive frequencies such as clock frequency(ies) and harmonics or frequencies of dominant interest, shall be analysed separately.
- Attempts should be made to fully exercise the EUT during testing, and to fully interrogate all exercise modes selected for susceptibility.
- Artificial hand is not applied.

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10.5.3 Test setup



Ground Reference Plane

For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

The equipment to be tested is placed on an insulating support 0,1 meters in height on a ground reference plane. All relevant cables shall be provided with the appropriate coupling and decoupling devices at a distance between 0,1 meters and 0,3 meters from the projected geometry of the EUT on the ground reference plane.

10.5.4 Test results

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.



10.6 Power frequency magnetic field immunity measurement

10.6.1 Test specification

Referenced Standard:	See clause 7.
Frequency Range:	50 or 60 Hz
Field Strength:	1 A/m

10.6.2 Test procedure

- The test procedure is in accordance with referenced standard.
- The EUT is tested with magnetic field antenna.
- The frequency is set to 50 or 60 Hz.
- The field strength level is 1 A/m.
- The test is performed with the EUT exposed to all three directions (X, Y, Z).

10.6.3 Test setup

The EUT installed in a representative system as described in referenced standard is placed on non-conductive table 0,1 (floor equipment) or 0,8 (table-top equipment) meters in height. The system under test is connected to the power and signal wire according to relevant installation instructions.

10.6.4 Test results

Test is not applicable due to device under test has no parts that would be susceptible to magnetic field.

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10.7 Voltage dips, short interruptions, and voltage variations immunity measurement

10.7.1 Test specification

Referenced Standard:	See clause 7.	
Test Duration Time:	Minimum three test events in sequence	
Interval between Event:	Minimum ten seconds	
Phase Angle:	0 °	
Test Cycle:	3 times	

10.7.2 Test procedure

The EUT shall be tested for each selected combination of test levels and duration with a sequence of tree dips/interruptions with intervals of 10s minimum (between each test event). Each representative mode of operation shall be tested. Abrupt changes in supply voltage shall occur at zero crossings of the voltage waveform.

10.7.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the Test Configuration.

10.7.4 Test result

Test is not applicable due to device under test is a DC powered device, powered via development board which is then connected to AC/DC power supply.



11. Used test equipment

9.2 Radiated emission measurement

Equipment	Manufacturer	Туре	ID number	Last calibration date	Last due date
SAC 1	Comtest Engineering	SAC 3m	EM0145	2022-04-14	2025-04-14
Ultra Broadband Antrenna (SAC1)	Rohde & Schwarz	HL562E	EM0140	2023-07-05	2025-07-05
SAC 2	Comtest Engineering	SAC 3m	EM0146	2023-09-26	2026-09-26
Ultra Broadband Antrenna (SAC2)	Rohde & Schwarz	HL562E	EM0130	2023-07-05	2025-07-05
EMI test receiver	Rohde & Schwarz	ESR7	EM0208	2023-06-14	2024-12-14
Horn antenna (SAC2)	Rohde & Schwarz	HF907	EM0129	2023-08-22	2026-08-22
EMI test receiver	Rohde & Schwarz	ESW 44	EM0291	2023-03-09	2024-09-09
Turn table (2 m diameter)	Maturo	TT 2.0 SI	/	N/A	N/A
Bore-sight antenna mast	Maturo	BAM-4.0-P	/	N/A	N/A
Multi-channel positioning equipment	Maturo	Maturo NCD	/	N/A	N/A

10.1 Electrostatic discharge immunity measurement

Equipment	Manufacturer	Туре	ID number	Last calibration date	Last due date
ESD Generator	EM TEST	Dito P18	EM0023	2024-02-23	2025-02-23

10.2 Radiated, RF electromagnetic field immunity measurement

Equipment	Manufacturer	Туре	ID number	Last calibration date	Last due date
SAC 1	Comtest Engineering	SAC 3m	EM0145	N/A	N/A
RF and Microwave Signal Generator (SAC1-A2)	Rohde & Schwarz	SMB100A03	EM0232	2024-02-16	2025-08-16
Average power sensor (SAC1-A2)	Rohde & Schwarz	NRP18AN	EM0233	2024-02-16	2025-08-16
Average power sensor (SAC1-A2)	Rohde & Schwarz	NRP18AN	EM0234	2024-02-16	2025-08-16
Ultra Broadband Antenna (SAC1)	Rohde & Schwarz	HL562E	EM0140	N/A	N/A
Field Uniformity (SAC1 - A2, HL562E)	SIQ	UFA	EM0229	2022-08-19	2025-08-19

-----END OF TEST REPORT------