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TEST REPORT

CE BT LE Test for SFM20R1

APPLICANT
SJI Co.,Ltd

REPORT NO.
HCT-RF-2208-CE002

DATE OF ISSUE
August 9, 2022

Tested by
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Additional Model
-

Applicant	**SJI Co.,Ltd** 54-33, Dongtanhana 1-gil, Gyeonggi-do Hwaseong-si South Korea
Eut Type Model Name	Sigfox Quad-mode module SFM20R1
Date of Test	July 27, 2022 ~ August 09, 2022
Test Standard Used	ETSI EN 300 328 V2.2.2 (2019-07)
Test Results	Approval for CE Temperature : (24.5 ± 3.0) °C, Relative Humidity : (55.9 ± 3.0) % R.H. Results, Measurement uncertainty : Refer to the attachment
Manufacturer Frequency alignment range	SJI Co.,Ltd 2 402 MHz ~ 2 480 MHz

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	August 09, 2022	Initial Release

Test Report Statement:

The above Test Report is not related to the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme) / A2LA(American Association for Laboratory Accreditation)(4114.01), which signed the ILAC-MRA.

If this report is required to confirmation of authenticity, please contact to www.hct.co.kr

CONTENTS

1. CLIENT INFORMATION

The EUT has been tested by request of

Company	**SJI Co.,Ltd** 54-33, Dongtanhana 1-gil, Gyeonggi-do Hwaseong-si South Korea

2. EQUIPMENT UNDER TEST (EUT)

Equipment	Sigfox Quad-mode module
Model	SFM20R1
Additional Model	-
Serial number	-
Manufacturer	SJI Co.,Ltd
Rating	DC 3.30 V

3. DESCRIPTION OF THE EQUIPMENT UNDER TEST

3.1 Manufacturers declarations

No. of units:	One (Transceiver)	
No. of deviating variants:	None	
Application:	Sigfox Quad-mode module	
Equipment category:	Short Range Device	
Model No.:	SFM20R1	
Additional Model No.:	-	
Serial No.:	-	
Type of modulation:	GFSK	
Bluetooth version	4.2	
Specification(s):	ETSI EN 300 328 V2.2.2 (2019-07)	
Receiver Category:	2	
Type of unit:	Stand-alone equipment	
Type of Equipment	☒Adaptive Equipment without the possibility to switch to a non-adaptive mode	
	☐Non-adaptive Equipment	
	☐Adaptive Equipment which can also operate in a non-adaptive mode	
Operating frequency range:	2 400 MHz ~2 483.5 MHz	
Frequency alignment range:	2 402 MHz ~ 2 480 MHz	
Channels :	40	
Version:	Hardware : 1.0	
	Software : SFM20R_V204	
Power source:	Normal voltage :	DC 3.30 V
	Extreme lower voltage :	DC 3.20 V
	Extreme upper voltage :	DC 5.00 V
Temperature range:	Normal Temperature :	+24.5°C
	Extreme lower Temperature :	-30.0°C
	Extreme upper Temperature :	+85.0°C
Antenna type:	Dipole Antenna	
Max. antenna gain:	4.44 dBi	

Note:

At the request of the customer, all test requirements were performed ETSI EN 300 328 V2.2.2 (2019-07)

3.2 Channel List

Bluetooth Low Energy					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2 402	14	2 430	28	2 458
01	2 404	15	2 432	29	2 460
02	2 406	16	2 434	30	2 462
03	2 408	17	2 436	31	2 464
04	2 410	18	2 438	32	2 466
05	2 412	19	2 440	33	2 468
06	2 414	20	2 442	34	2 470
07	2 416	21	2 444	35	2 472
08	2 418	22	2 446	36	2 474
09	2 420	23	2 448	37	2 476
10	2 422	24	2 450	38	2 478
11	2 424	25	2 452	39	2 480
12	2 426	26	2 454	-	-
13	2 428	27	2 456	-	-

3.3 Operating frequency range during under the test

Operating frequency	Frequency(MHz)
Bottom	2 402
Middle	2 440
Top	2 480

4. TEST SUMMARY

Clause	Parameter	Test method	Result
4.3.2.2	RF Output Power	Conducted	(See note3)
4.3.2.3	Power Spectral Density	Conducted	Pass
4.3.2.4	Duty cycle, Tx-Sequence, Tx-gap	N/A	(See note1)
4.3.2.5	Medium Utilisation	N/A	(See note1)
4.3.2.6	Adaptivity	N/A	(See note1)
4.3.2.7	Occupied Channel Bandwidth	Conducted	(See note3)
4.3.2.8	Transmitter unwanted emissions in the OOB domain	Conducted	(See note3)
4.3.2.9	Transmitter unwanted emissions in the spurious domain	Radiated	(See note3)
4.3.2.10	Receiver Spurious emissions	Radiated	(See note3)
4.3.2.11	Receiver Blocking	Conducted	Pass
4.3.2.12	Geo-location capability	N/A	(See note2)

Note:

1. These requirements do not apply for equipment with a maximum declared RF Output power of less than 10 dBm e.i.r.p or for equipment when operating in a mode where the RF Output power is less than 10 dBm e.i.r.p.
2. Geo-location capability is implemented in this product and can't be accessible to the user.
3. Standard update: ETSI EN 300 328 V2.1.1 → ETSI EN 300 328 V2.2.2
   We tested only some items (PSD, Receiver blocking) due to RED update.
   For the other test items, refer to the previous report results.
   (Previously report no.: HCT-RF-1907-CE010)

5. TEST EQUIPMENT

No.	Instrument	Model No.	Manufacture	Serial No.	Due to Calibration
☒	Signal Analyzer (20 Hz ~ 40.0 GHz)	FSV40-N	ROHDE & SCHWARZ	101068-SZ	2022-09-15
☒	Signal Analyzer (20 Hz ~ 26.5 GHz)	N9020A	AGILENT	MY50510027	2022-08-18
☒	SIGNAL GENERATOR (100kHz~40GHz)	SMB100A	Rohde&Schwarz	177633	2023-07-05
☒	Communication Tester	CMW500	Rohde&Schwarz	169839	2023-06-14
☒	Power Measurement Set	OSP 120(See note3)	Rohde&Schwarz	101231	2023-06-14
☒	High Pass Filter	WHKX10-2700-3000-18000-40SS	WAINWRIGHT INSTRUMET	3	2023-01-06
☒	Band reject filter (2 400 MHz ~ 2 483.5 MHz/DC ~ 4 GHz)	WRCJV2400/2483.5-2370/2520-60/12SS	WAINWRIGHT INSTRUMET	2	2023-01-06
☒	BI-LOG Antenna (25 MHz ~ 1 GHz)	VULB9160	Schwarzbeck	9160-3150	2023-03-03
☒	Full anechoic chamber	10m×5m×5m	EMERSON&CUMING	-	-
☒	Fixed Attenuator (10 dB, DC ~ 26.5 GHz)	56-10	WEINSCHEL	72324	2022-09-15
☒	Fixed Attenuator (30 dB, DC ~ 26.5 GHz)	8493C-030	Agilent	77640	2023-06-14
☒	DC power supply	E3632A	HP	KR94907553	2023-06-08
☒	Temp & Humidity Chamber	SU-642	ESPEC	93008124	2023-03-04
☒	POWER AMP (9 kHz ~ 1 GHz)	310N	SONOMA Instrument	320622	2022-09-08
☒	POWER AMP (0.1 GHz ~ 18 GHz)	CBLU1183540B-01	CERNEX	25539	2023-01-06
☒	Horn Antenna (1 GHz ~ 18 GHz)	BBHA9120D	Schwarzbeck	9120D-1298	2023-09-15
☒	Power Divider-2way (DC ~ 26.5 GHz)	11636B	HP	11377	2023-06-14

Note:

1. All equipment is calibrated with traceable calibrations.

2. Each calibration is traceable to the national or international standards.

3. OSP120 spec :

- RMS integration over a significant portion of signal

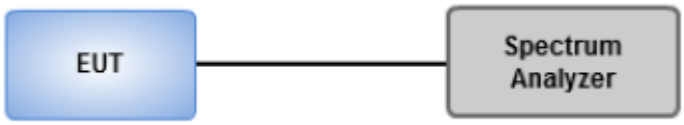
- Fast response time for accurate burst detection

- Sampling rate 1 MS/s
- Storage of max. 32 Million samples in total
- Synchronous measurement channels for 4 antenna port
- Maximum DUT output power 12 dBm linear without attenuator, with included attenuators 22 dBm linear (and 32 dBm linear optional)
- Measurement tolerances better than ETSI requirements

6. TRANSMITTER MEASUREMENTS – RESULTS

6.1 Power spectral density

6.1.1 Test Setup



6.1.2 Test Procedure

Refer to ETSI EN 300 328 V2.2.2 (2019-07) Clause 5.4.3.2

Step 1:

Connect the UUT to the spectrum analyser and use the following settings:

• Start Frequency: 2 400 MHz

• Stop Frequency: 2 483,5 MHz

• Resolution BW: 10 kHz

• Video BW: 30 kHz

• Sweep Points: > 8 350; for spectrum analysers not supporting this number of sweep points, the frequency band may be segmented

• Detector: RMS

• Trace Mode: Max Hold

• Sweep time: 2 × Channel Occupancy Time × number of sweep points

For non-continuous signals, wait for the trace to stabilize.

Save the data (trace data) set to a file.

Step 2:

For conducted measurements on smart antenna systems using either operating mode 2 or operating mode 3 (see clause 5.3.2.2), repeat the measurement for each of the transmit ports. For each sampling point (frequency domain), add up the coincident power values (in mW) for the different transmit chains and use this as the new data set.

Step 3:

Add up the values for power for all the samples in the file using the formula below.

$$P_{Sum} = \sum_{n=1}^{k} P_{sample}(n)$$

with k being the total number of samples and n the actual sample number

Step 4:

Normalize the individual values for power (in dBm) so that the sum is equal to the RF Output Power (e.i.r.p.) measured in clause 5.4.2 and save the corrected data. The following formulas can be used: with 'n' being the actual sample number

$$C_{Corr} = P_{Sum} - P_{e.i.r.p.}$$

$$P_{Samplecorr}(n) = P_{Sample}(n) - C_{Corr}$$

Step 5:

Starting from the first sample *PSamplecorr(n)* (lowest frequency), add up the power (in mW) of the following samples representing a 1 MHz segment and record the results for power and position (i.e. sample #1 to sample #100).

This is the Power Spectral Density (e.i.r.p.) for the first 1 MHz segment which shall be recorded.

Step 6:

Shift the start point of the samples added up in step 5 by one sample and repeat the procedure in step 5 (i.e. sample #2 to sample #101).

Step 7:

Repeat step 6 until the end of the data set and record the Power Spectral Density values for each of the 1 MHz segments.

From all the recorded results, the highest value is the maximum Power Spectral Density (PSD) for the UUT. This value, which shall comply with the limit given in clause 4.3.2.3.3, shall be recorded in the test report.

6.1.3 Limit

For equipment using wide band modulations other than FHSS, the maximum Power Spectral Density is limited to 10dBm per MHz.

6.1.4 Test Result

TEST CONDITIONS:		Power Spectral Density(dBm/MHz)		
		2 402 MHz	2 440 MHz	2 480 MHz
T nom	V nom	7.76	7.72	7.65
Measurement Uncertainty : 1.03 dB (Confidence level about 95 %, k = 2)				

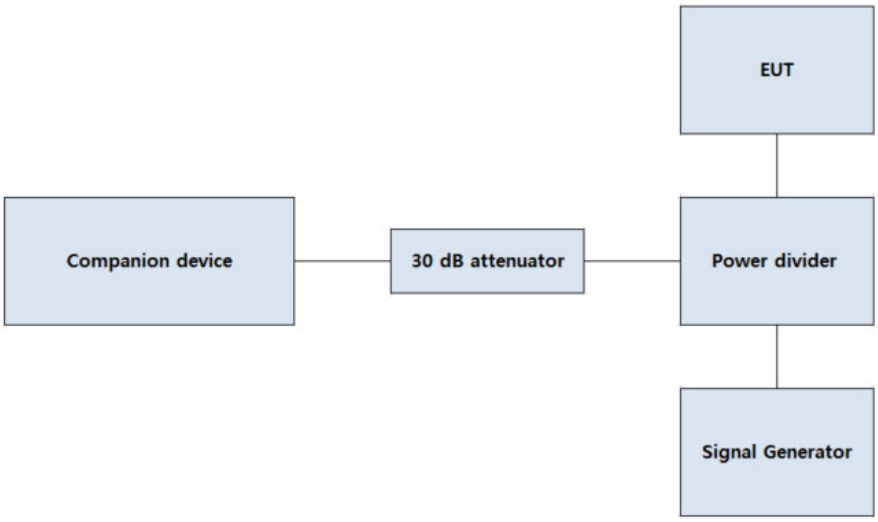
Note:

1. Modulation type : GFSK

7. RECEIVER MEASUREMENTS – RESULTS

7.1 Receiver Blocking

7.1.1 Test Setup



7.1.2 Test Procedure

Step 1:

• For non-FHSS equipment, the UUT shall be set to the lowest operating channel on which the blocking test has to be performed (see clause 5.4.11.1).

Step 2:

• The blocking signal generator is set to the first frequency as defined in the appropriate table corresponding to the receiver category and type of equipment.

Step 3:

• With the blocking signal generator switched off, a communication link is established between the UUT and the associated companion device using the test setup shown in figure 6.

• Unless the option provided in note 2 of the applicable table referred to in clause 5.4.11.2.1 is used, the level of the wanted signal shall be set to the value provided in the table corresponding to the receiver category and type of equipment. The test procedure defined in clause 5.4.2, and more in particular clause

5.4.2.2.1.2, can be used to measure the (conducted) level of the wanted signal however no correction shall be made for antenna gain of the companion device (step 6 in clause 5.4.2.2.1.2 shall be ignored). This level may be measured directly at the output of the companion device and a correction is made for the coupling loss into the UUT. The actual level for the wanted signal shall be recorded in the test report.

• When the option provided in note 2 of the applicable table referred to in clause 5.4.11.2.1 is used, the attenuation of the variable attenuator shall be increased in 1 dB steps to a value at which the minimum performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still met. The resulting level for the wanted signal at the input of the UUT is Pmin. This signal level (Pmin) is increased by the value provided in note 2 of the applicable table corresponding to the receiver category and type of equipment.

Step 4:

• The blocking signal at the UUT is set to the level provided in the table corresponding to the receiver category and type of equipment.

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 are met then proceed to step 6.

Step 5:

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is not met, step 3 and step 4 shall be repeated after that the frequency of the blocking signal set in step 2 has been increased with a value equal to the Occupied Channel Bandwidth except:

- For the blocking frequency 2 380 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be increased by 3 dB.

- For the blocking frequency 2 503,5 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be decreased by 3 dB.

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still not met, step 3 and step 4 shall be repeated after that the frequency of the blocking signal set in step 2 has been decreased with a value equal to the Occupied Channel Bandwidth except:

- For the blocking frequency 2 380 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be decreased by 3 dB.

- For the blocking frequency 2 503,5 MHz, where this frequency offset shall be less than or equal to 10 MHz. If this frequency offset is more than 7 MHz, the level of the wanted signal shall be increased by 3 dB.

• If the performance criteria as specified in clause 4.3.1.12.3 or clause 4.3.2.11.3 is still not met, the UUT fails to comply with the Receiver Blocking requirement and step 6 and step 7 are no longer required.

• It shall be recorded in the test report whether the shift of blocking frequencies as described in the present step was used.

Step 6:

• Repeat step 4 and step 5 for each remaining combination of frequency and level for the blocking signal as provided in the table corresponding to the receiver category and type of equipment.

Step 7:

• For non-FHSS equipment, repeat step 2 to step 6 with the UUT operating at the highest operating channel on which the blocking test has to be performed (see clause 5.4.11.1).

Step 8:

• It shall be assessed and recorded in the test report whether the UUT complies with the Receiver Blocking requirement.

7.1.3 Limit

For equipment that supports a PER or FER test to be performed, the minimum performance criterion shall be a PER or FER less than or equal to 10 %.

For equipment that does not support a PER or a FER test to be performed, the minimum performance criterion shall be no loss of the wireless transmission function needed for the intended use of the equipment.

▪ Receiver Category 1

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm)	Type of blocking signal
(-133 dBm + 10 × log10(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW
(-139 dBm + 10 × log10(OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674		

▪ Receiver Category 2

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm)	Type of blocking signal
(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW

▪ Receiver Category 3

Wanted signal mean power from companion device (dBm)	Blocking signal frequency (MHz)	Blocking signal power (dBm)	Type of blocking signal
(-139 dBm + 10 × log10(OCBW) + 20 dB) or (-74 dBm + 20 dB) whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW

7.1.4 Test Result

Wanted signal mean power from companion device (dBm)	Blocking signal power (dBm)	Blocking signal frequency (MHz)	Packets Transmitted	Packets Received	Performance criterion (%)
(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less	-34	2 380	1000	994	0.60
		2 504	1000	994	0.60
		2 300	1000	988	1.20
		2 584	1000	994	0.60

Note:

1. Receiver Category : 2
2. Type of blocking signal : CW
3. Wanted signal mean power from companion device
= -69.00 dBm ((-139 dBm + 10 × log10(OCBW) + 10 dB))
4. Minimum performance criterion : PER less than or equal to 10 %.
5. Test Frequency : 2 402 MHz

Wanted signal mean power from companion device (dBm)	Blocking signal power (dBm)	Blocking signal frequency (MHz)	Packets Transmitted	Packets Received	Performance criterion (%)
(-139 dBm + 10 × log10(OCBW) + 10 dB) or (-74 dBm + 10 dB) whichever is less	-34	2 380	1000	990	1.00
		2 504	1000	988	1.20
		2 300	1000	989	1.10
		2 584	1000	989	1.10

Note:

1. Receiver Category : 2
2. Type of blocking signal : CW
3. Wanted signal mean power from companion device
= -69.00 dBm ((-139 dBm + 10 × log10(OCBW) + 10 dB))
4. Minimum performance criterion : PER less than or equal to 10 %.
5. Test Frequency : 2 480 MHz

8. GEO-LOCATION CAPABILITY

8.1 Definition

Geo-location capability is a feature of the equipment to determine its geographical location with the purpose to configure itself according to the regulatory requirements applicable at the geographical location where it operates.

The geo-location capability may be present in the equipment or in an external device (temporary) associated with the equipment operating at the same geographical location during the initial power up of the equipment. The geographical location may also be available in equipment already installed and operating at the same geographical location.

8.2 Requirements

The geographical location determined by the equipment as defined in clause 8.1 shall not be accessible to the user.

8.3 Declaration by the Manufacturer

Geo-location capability is implemented in this product and can’t be accessible to the user.