



Test report No:

NIE: 54505RBT.001

Test report

Bluetooth Low Energy RF-PHY Test Specification

| | |
|---|---|
| Identification of item tested..... : | SoC |
| Trademark | Nordic Semiconductor |
| Model or type reference | nRF52840 |
| Serial number | 10000012 |
| Final HW version | 73 pin AQFN package |
| Final SW version | S140 SD v6.0.0 |
| Features | Bluetooth Core Specification 5, including 2MS/s, Coded PHY and Advertising Extensions |
| Manufacturer | NORDIC SEMICONDUCTOR ASA Otto Nielsens veg 12, 7052 Trondheim, Norway |
| Test method requested..... : | Full RF-PHY testing according to Bluetooth RF-PHY Test Specification, Document Number RF-PHY.TS/5.0.2 |
| Standard..... : | RF-PHY.TS.5.0.2 |
| Test Spec Errata(s) | N/A |
| ICS | RF-PHY.ICS.5.0.0 |
| TCRL version | Core.TCRL. 2017-2 |
| Test procedure(s) | PEBT006_06 BluetoothRFConductedTesting |
| Summary | IN COMPLIANCE |
| Approved by (name / position & signature) | L. Natividad Caro García BQTF Technical Responsible |
| Date of issue | 2018-01-31 |
| Report template No | FBT039_06 |

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Competences and guarantees

DEKRA Testing and Certification S.A.U. is a BQTF competent to carry out the tests described in this report.

DEKRA Testing and Certification S.A.U. is a BQTF accredited by A2LA (The American Association for Laboratory Accreditation) to perform the test indicated in the Certificate 3350.01.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA internal document PODT000

Usage of samples

Samples undergoing test have been selected and supplied by: NORDIC SEMICONDUCTOR ASA

Sample M/01, is composed of the following elements:

| | | |
|-------------------------|------------------------------|---|
| Control N° 54505/002 | Model and/or type reference: | nRF52840 |
| | Serial number: | 10000012 |
| | Hw version: | 73 pin AQFN package |
| | Sw version: | S140 SD v6.0.0 |
| | Features supported: | Bluetooth Core Specification 5, including 2MS/s, Coded PHY and Advertising Extensions |
| | Description of test sample | SoC |
| | Date of reception | 2017-12-19 |

| | | |
|-------------------------|------------------------------|---|
| Control N° 54505/003 | Model and/or type reference: | - |
| | Serial number: | #2 |
| | Hw version: | - |
| | Sw version: | - |
| | Features supported: | - |
| | Description of test sample | FCC/ETSI and RF-PHY Qualification Motherboard |
| | Date of reception | 2018-01-23 |

The sample used for each test case is specified in the "Observations" field of the results annex.

Test sample description

The nRF52840 is an advanced multi-protocol SoC ideally suited for ultra low-power wireless applications. The nRF52840 SoC is built around a 32-bit ARM® Cortex™-M4F CPU with 1MB flash and 256kB RAM on chip. The embedded 2.4GHz transceiver supports Bluetooth® low energy (Bluetooth 5), 802.15.4, ANT and proprietary 2.4GHz protocols. It is on-air compatible with existing nRF52 Series, nRF51 Series, and nRF24 Series products from Nordic Semiconductor.

Identification of the client

| | |
|-----------------|--|
| Company name: | NORDIC SEMICONDUCTOR ASA |
| Postal Address: | Otto Nielsens veg 12, 7052 Trondheim, Norway |

Testing period

The performed test started on 2018-01-25 and finished on 2018-01-26.
The tests have been performed at DEKRA.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

| | |
|-------------------|------------------------------|
| Temperature | Min. = 18 °C Max. = 28 °C |
| Relative humidity | Min. = 20 % Max. = 75 % |

Remarks and comments

N/A

Means of testing identification

| | | | | | |
|-------------|--|---------------------------------------|------------|-------------------------|-----------------------|
| Test System | TACS4 BEST Bluetooth RF Test System | | | | |
| Control No. | 5852 | | | | |
| Hardware: | Control No. | Equipment | Serial No. | Latest Calibration Date | Next Calibration Date |
| | 5767 | LAN/GPIB/USB E5810B | MY56030024 | N/A | N/A |
| | 5398 | Power Supply Agilent 66311B | MY52002833 | 2017-12-18 | 2018-12-18 |
| | 5399 | Sweep Generator AGILENT E8257D | MY53401729 | 2017-12-20 | 2018-12-20 |
| | 5749 | R&S® CMW270 | 100651 | 2017-12-19 | 2018-12-19 |
| | 5853 | T4BCU100A | 000001 | N/A | N/A |
| Software: | 5902 | User Interface TACS4 BEST v1.10.0 | | | |
| | 5903 | Technology Package Version: v3.2.0_R1 | | | |
| Test Setup: | Conducted measurements: IUT (Item Under Test) connected directly to measuring instruments using low loss SMA cable. IUT controlled by test software. See “Test Setup” section. | | | | |

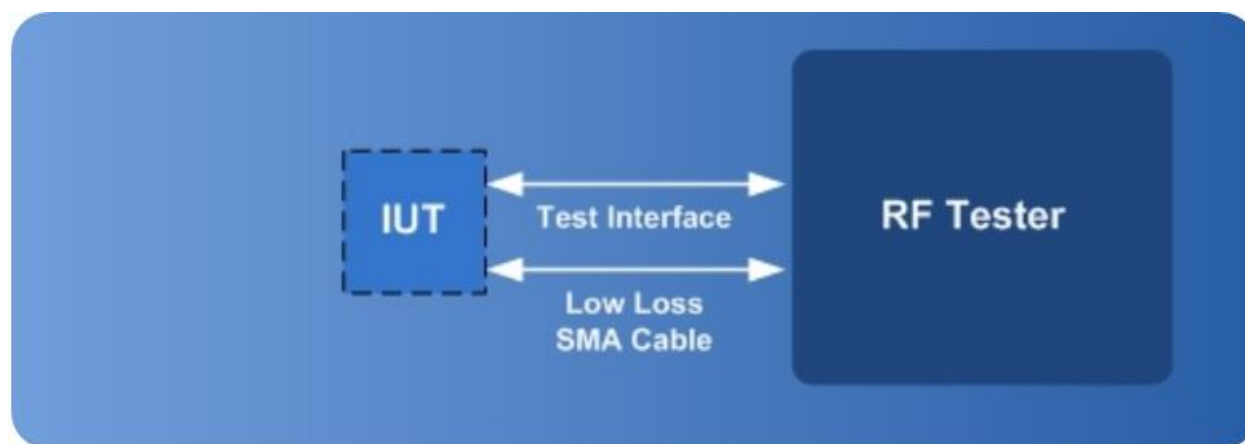
| | Control No. | Equipment | Serial No. | Latest Calibration Date | Next Calibration Date |
|-----------|-------------|------------------|------------|-------------------------|-----------------------|
| Hardware: | 3379 | Shielded Chamber | 06 825 | NA | NA |

For nominal temperature conditions, the following equipment was used:

| | Control No. | Equipment | Serial No. | Latest Calibration Date | Next Calibration Date |
|-----------|-------------|-------------------------|------------|-------------------------|-----------------------|
| Hardware: | 2624 | HUMIDIPROBE | IFY97/067 | 2017-04-17 | 2018-04-17 |
| Software: | 4762 | Control temp_Hum v2.5.1 | | | |

Test setup

The configuration used for Test Cases in nominal temperature conditions was the following one:



Measurement uncertainty

TACS4 BEST Bluetooth RF Test System uncertainty values^{1, 2} and the corresponding limits, according to the RF-PHY *Bluetooth* Test Specification, can be found below:

| Measurement uncertainty | RF Tester uncertainty | Specification limit | Test Case |
|---|-----------------------|---------------------|--|
| Absolute RF power (wanted channel) | ±0.98 dB | ±1.2dB | RF-PHY/TRM-LE/CA/BV-01-C |
| Absolute RF power (for unwanted emissions in the BT band) | ±2.46 dB | ±3dB | RF-PHY/TRM-LE/CA/BV-03-C |
| Absolute radio frequency | ±4.70 kHz | ±5 kHz | RF-PHY/TRM-LE/CA/BV-05-C RF-PHY/TRM-LE/CA/BV-06-C |
| Relative drift radio frequency | ±1.00 kHz | ±1 kHz | RF-PHY/TRM-LE/CA/BV-06-C |
| Frequency deviation | ±3.96 kHz | ±4 kHz | RF-PHY/TRM-LE/CA/BV-05-C |

Note 1: All values reflect a 95% confidence level.

Note 2: All values are valid for a temperature range of 23±5°C.

Testing verdicts

| | |
|----------------------|----|
| Not applicable | NA |
| Pass | P |
| Fail | F |
| Not measured | NM |

Appendix A – Test result

Test campaign report

The abbreviations used in the header row of the test campaign report tables are:

Test Case ID : As it can be found on the standard

Verdict: Records the verdict assigned to each Test Case run to completion. Following verdicts are possible:

Pass: If the Test Case passed.

Fail: If the Test Case failed.

NA: Not applicable.

NM: Not measured.

Date: Date of the beginning of the execution.

Observations: Provides a reference to additional information relevant to the test presented in “Test Setup” section.

| Test Case ID | Description | Verdict | Date | Observations |
|--------------------------|--|---------|------------|--------------|
| RF-PHY/TRM-LE/CA/BV-01-C | Output power | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-03-C | In-band emissions | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-05-C | Modulation characteristics | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-06-C | Carrier frequency offset and drift | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-08-C | In-band emissions at 2 Ms/s | Pass | 2018-01-26 | M/01 |
| RF-PHY/TRM-LE/CA/BV-09-C | Stable Modulation Characteristics at 1 Ms/s | NA | - | - |
| RF-PHY/TRM-LE/CA/BV-10-C | Modulation Characteristics at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-11-C | Stable Modulation Characteristics at 2 Ms/s | NA | - | - |
| RF-PHY/TRM-LE/CA/BV-12-C | Carrier frequency offset and drift at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-13-C | Modulation Characteristics, LE Coded (S=8) | Pass | 2018-01-25 | M/01 |
| RF-PHY/TRM-LE/CA/BV-14-C | Carrier frequency offset and drift, LE Coded (S=8) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-01-C | Receiver sensitivity | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-03-C | C/I and receiver selectivity performance | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-04-C | Blocking performance | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-05-C | Intermodulation performance | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-06-C | Maximum input signal level | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-07-C | PER Report Integrity | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-08-C | Receiver sensitivity at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-09-C | C/I and Receiver Selectivity Performance at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-10-C | Blocking performance at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-11-C | Intermodulation performance at 2 Ms/s | Pass | 2018-01-25 | M/01 |

| Test Case ID | Description | Verdict | Date | Observations |
|--------------------------|---|---------|------------|--------------|
| RF-PHY/RCV-LE/CA/BV-12-C | Maximum input signal level at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-13-C | PER Report Integrity at 2 Ms/s | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-14-C | Receiver Sensitivity at NOC, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-15-C | C/I and Receiver Selectivity Performance, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-16-C | Blocking Performance, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-17-C | Intermodulation Performance, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-18-C | Maximum input signal level, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-19-C | PER Report Integrity, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-20-C | Receiver sensitivity at 2 Ms/s, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-21-C | C/I and Receiver Selectivity Performance at 2 Ms/s, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-22-C | Blocking performance at 2 Ms/s, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-23-C | Intermodulation performance at 2 Ms/s, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-24-C | Maximum input signal level at 2 Ms/s, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-25-C | PER Report Integrity at 2 Ms/s, Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-26-C | Receiver sensitivity, LE Coded (S=2) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-27-C | Receiver sensitivity, LE Coded (S=8) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-28-C | C/I and Receiver Selectivity Performance, LE Coded (S=2) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-29-C | C/I and Receiver Selectivity Performance, LE Coded (S=8) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-30-C | PER Report Integrity, LE Coded (S=2) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-31-C | PER Report Integrity, LE Coded (S=8) | Pass | 2018-01-25 | M/01 |
| RF-PHY/RCV-LE/CA/BV-32-C | Receiver sensitivity, LE Coded (S=2), Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-33-C | Receiver sensitivity, LE Coded (S=8), Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-34-C | C/I and Receiver Selectivity Performance, LE Coded (S=2), Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-35-C | C/I and Receiver Selectivity Performance, LE Coded (S=8), Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-36-C | PER Report Integrity, LE Coded (S=2), Stable Modulation Index | NA | - | - |
| RF-PHY/RCV-LE/CA/BV-37-C | PER Report Integrity, LE Coded (S=8), Stable Modulation Index | NA | - | - |

Relevant numerical results

| Test Case ID | Parameter | Value |
|--|-----------------------|----------|
| RF-PHY/TRM-LE/CA/BV-01-C Output power measurements for each frequency. | Peak Power; f=2402 | 7.65 dBm |
| | Peak Power; f=2440 | 7.80 dBm |
| | Peak Power; f=2480 | 7.78 dBm |
| | Average Power; f=2402 | 7.62 dBm |
| | Average Power; f=2440 | 7.77 dBm |
| | Average Power; f=2480 | 7.76 dBm |

Appendix B - ICS

Static Conformance Summary

The ICS set for this IUT is consistent with the static conformance requirements in the referenced base specification. The qualified ICS and IXIT menus of the test system were defined in accordance with the client.

| Item | Capability | Reference | Status | Support: Yes or No |
|------|---|----------------|--------|-----------------------|
| 1 | LE Transmitter (Non-connectable, Broadcaster) | [2], [3] | C.1 | Yes |
| 2 | LE Receiver (Non-connectable, Observer) | [2], [4] | C.1 | Yes |
| 3 | LE Transceiver (Connectable, Peripheral/Central) | [2], [3] & [4] | C.1 | Yes |
| 4 | LE 2M PHY | [6] 3, 4 | C.2 | Yes |
| 5 | Stable Modulation Index - Transmitter | [6] 3.1.1 | C.3 | No |
| 6 | Stable Modulation Index - Receiver | [6] 3.1.1 | C.4 | No |
| 7 | LE Coded PHY | [6] 3, 4 | C.2 | Yes |

C.1: Mandatory to support at least one of these capabilities.

C.2: Optional IF SUM ICS 21/16 “Core 5.0” AND RF PHY 1/3 “LE Transceiver” are supported, otherwise Excluded.

C.3: Optional IF SUM ICS 21/16 “Core 5.0” AND (RF PHY 1/1 “LE Transmitter” OR RF PHY 1/3 “LE Transceiver”) are supported, otherwise Excluded.

C.4: Optional IF SUM ICS 21/16 “Core 5.0” AND (RF PHY 1/2 “LE Receiver” OR RF PHY 1/3 “LE Transceiver”) are supported, otherwise Excluded.

[1] Specification of the Bluetooth System, Error Codes, Volume 2, Part E, Version 4.0 or later

[2] Specification of the Bluetooth System, Physical Layer Specification (PHY) Volume 6, Part A, Version 4.0 or later

[3] Specification of the Bluetooth System, Direct Test Mode, Volume 6, Part F, Version 4.0 or later

[4] ICS Proforma for Radio (RF) System Specification [5] Summary ICS

[6] Specification of the Bluetooth System, Physical Layer Specification (PHY) Volume 6, Part A, Version 5.0 or late

Appendix C - IXIT

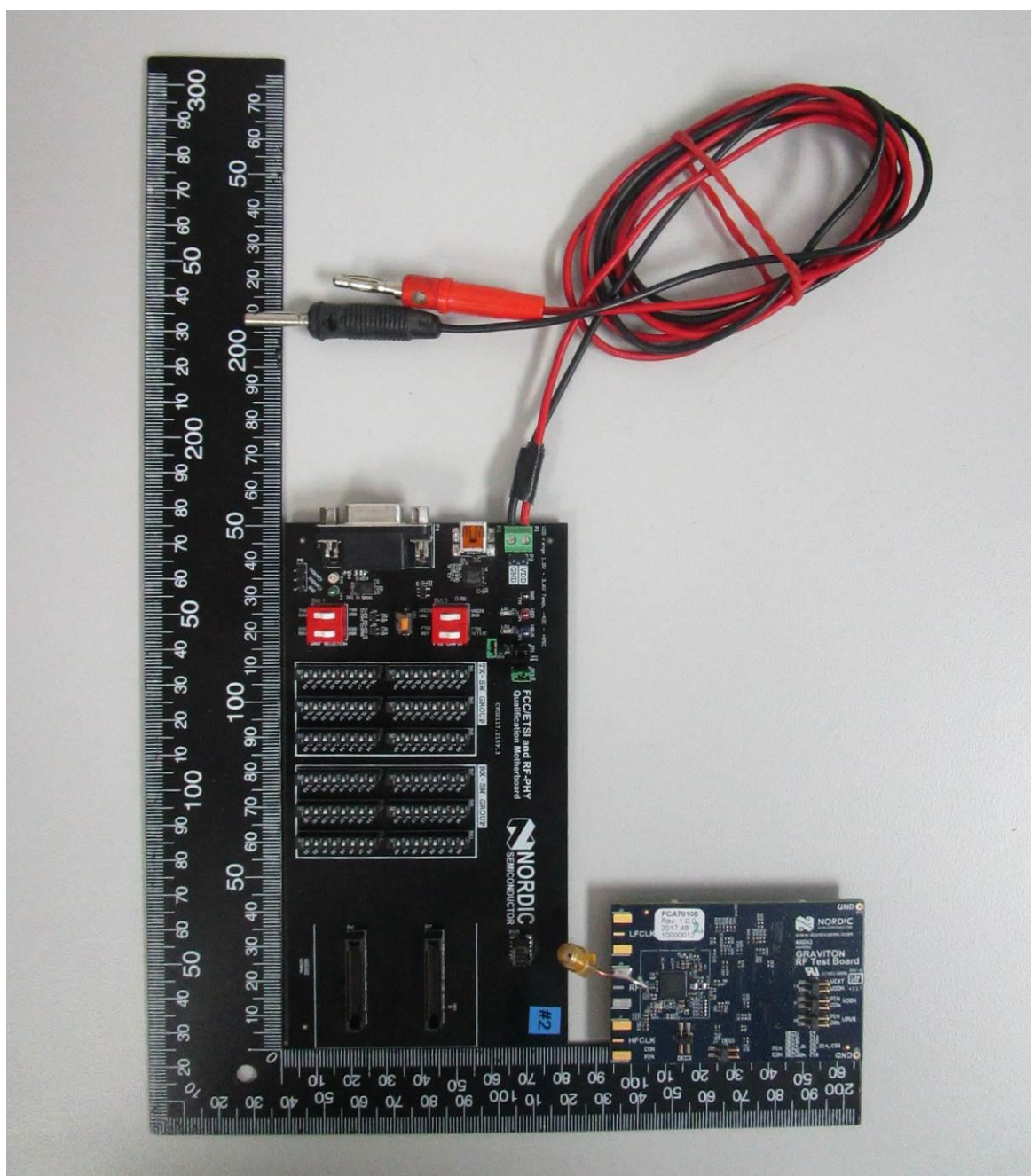
IXIT Proforma

The IXIT set for this IUT is consistent with the static conformance requirements in the referenced base specification.
The qualified ICS and IXIT menus of the test system were defined in accordance with the client

| PIXIT Reference | Identifier | Sub-Identifier (Optional) | Value | Units |
|-----------------|---|--|--------|---------|
| RF-PHY:P1:1 | Inband Image frequency | Low frequency | -2 | MHz |
| RF-PHY:P1:2 | | Middle frequency | -2 | MHz |
| RF-PHY:P1:3 | | High frequency | -2 | MHz |
| RF-PHY:P2:1 | Value n for Intermodulation test | Low frequency | 5 | Integer |
| RF-PHY:P2:2 | | Middle frequency | 5 | Integer |
| RF-PHY:P2:3 | | High frequency | 5 | Integer |
| RF-PHY:P4 | Power source voltage Nominal (NOC) | | 3 | V |
| RF-PHY:P5 | Normal operating temperature Nominal (NOC) | | 25 | °C |
| RF-PHY:P6:1 | Air humidity range (relative) | Maximum (EOC) | - | % |
| RF-PHY:P6:2 | | Minimum (EOC) | - | % |
| RF-PHY:P6:3 | | Air humidity level for NOC/EOC tests | - | % |
| RF-PHY:P7:1 | Test interface implementation | HCI or 2-wire UART | 2-wire | - |
| RF-PHY:P7:2 | | Datarate | 19200 | bps |
| RF-PHY:P9:1 | Maximum TX packet length (MAX_TX_LENGTH) | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:2 | Maximum RX packet length (MAX_RX_LENGTH) | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:3 | Maximum TX packet length (MAX_TX_LENGTH) 2M | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:4 | Maximum TX packet length (MAX_TX_LENGTH) S=2 | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:5 | Maximum TX packet length (MAX_TX_LENGTH) S=8 | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:6 | Maximum RX packet length (MAX_RX_LENGTH) 2M | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:7 | Maximum RX packet length (MAX_RX_LENGTH) S=2 | 37 to 255 | 255 | Bytes |
| RF-PHY:P9:8 | Maximum RX packet length (MAX_RX_LENGTH) S=8 | 37 to 255 | 255 | Bytes |
| RF-PHY:P10:1 | Maximum TX mode output power | -20 to 10 (CSA5 unsupported) -20 to 20 (CSA5 supported) | 8 | dBm |
| RF-PHY:P11:1 | Inband Image Frequency (2Ms/s) | Low frequency | -4 | MHz |
| RF-PHY:P11:2 | | Middle frequency | -4 | MHz |
| RF-PHY:P11:3 | | High frequency | -4 | MHz |
| RF-PHY:P12:1 | Value n for Intermodulation test (2Ms/s) | Low frequency | 5 | Integer |
| RF-PHY:P12:2 | | Middle frequency | 5 | Integer |
| RF-PHY:P12:3 | | High frequency | 5 | Integer |
| RF-PHY:P13:1 | Inband Image Frequency (Stable Modulation Receiver) | Low frequency | NA | MHz |
| RF-PHY:P13:2 | | Middle frequency | NA | MHz |
| RF-PHY:P13:3 | | High frequency | NA | MHz |
| RF-PHY:P14:1 | Value n for Intermodulation test (Stable Modulation Receiver) | Low frequency | NA | Integer |
| RF-PHY:P14:2 | | Middle frequency | NA | Integer |
| RF-PHY:P14:3 | | High frequency | NA | Integer |
| RF-PHY:P15:1 | Inband Image Frequency (Stable Modulation Receiver, 2Ms/s) | Low frequency | NA | MHz |
| RF-PHY:P15:2 | | Middle frequency | NA | MHz |
| RF-PHY:P15:3 | | High frequency | NA | MHz |
| RF-PHY:P16:1 | Value n for Intermodulation test (Stable Modulation Receiver, 2Ms/s) | Low frequency | NA | Integer |
| RF-PHY:P16:2 | | Middle frequency | NA | Integer |
| RF-PHY:P16:3 | | High frequency | NA | Integer |

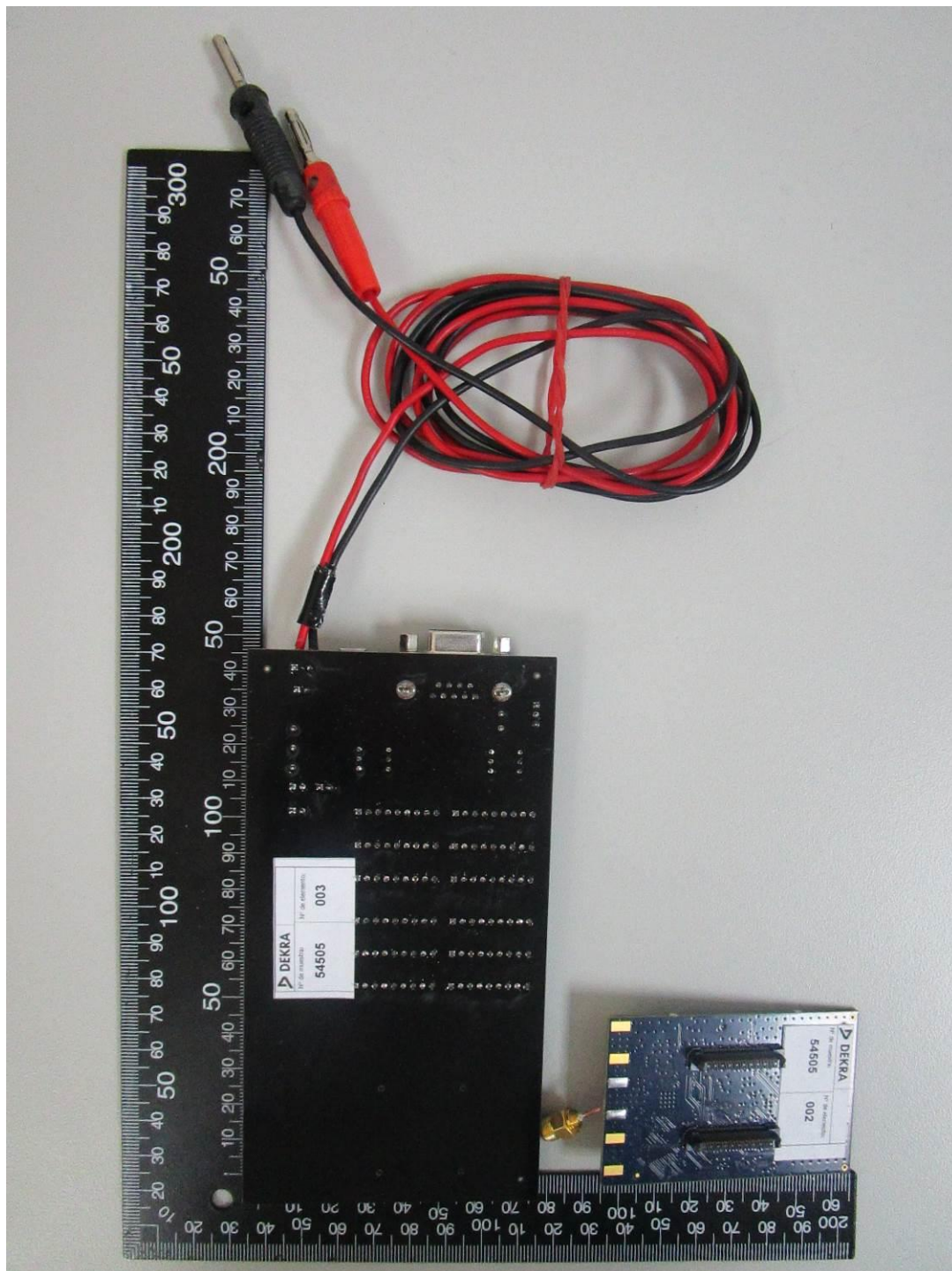
Appendix D - Photographs

FRONT VIEW



Sample M/01

REAR VIEW



Sample M/01