DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

DEKRA

Test report No:

NIE: 61320RBT.001

Test Lab
Cert 3350.01

Test report
Bluetooth Low Energy RF-PHY Test Specification

Identification of item tested	CC2650MODA SimpleLink™ Bluetooth® Low Energy Wireless MCU Module
Trademark	CC2650MODA
Model and /or type reference	CC2650MODA
Other identification of the product	Final HW version: 1.0 Final SW version: 2.2.2
Features	Bluetooth 5.1 LE, 1Mbps
Manufacturer	TEXAS INSTRUMENTS Hoffsveien 70 c, 0377 Oslo, Norway
Test method requested, standard	Full RF-PHY testing according to Bluetooth RF-PHY Test Specification, Document Number RF-PHY.TS/5.1.0
Standard .... :	RF-PHY.TS.5.1.0
Test Spec Errata(s) .... :	N/A
ICS .... :	RF-PHY.ICS.5.1.0
TCRL version .... :	Core.TCRL.2018-2
Test procedure(s)................................... :	PEBT006_07 BluetoothRFConductedTesting
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Juan Manuel Gómez BQTF Technical Responsible
Date of issue	2019-06-06
Report template No	FBT039_08

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Competences and guarantees

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

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Uncertainty

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

Data provided by the client

The ICS and IXIT provided by the customer and used for testing are indicated in Annex B and C.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

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Usage of sample

Samples undergoing test have been selected by: TEXAS INSTRUMENTS NORWAY

Sample M/01 is composed of the following elements:

Control Nº 61320/001	Model and/or type reference:	CC2650MODA
	Serial number:	Not provided
	Hw version:	1.0
	Sw version:	2.2.2
	Features supported:	Bluetooth 4.2 LE
	Description of test sample	Test Board
	Date of reception	2019-05-23

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

Test sample description

Bluetooth Low Energy CC2650 Module with antenna.

Identification of the client

TEXAS INSTRUMENTS
Hoffsveien 70 c, 0377 Oslo, Norway

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2019-05-27
Date (finish)	2019-05-27

Document history

Report number	Date	Description
61320RBT.001	2019-06-06	First release

Environmental conditions

The following limits were not exceeded during the test:

Temperature	Min= 18 ºC
	Max= 28 ºC
Relative humidity	Min= 20 %
	Max= 75 %

Remarks and comments

NA

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	2018-12-17	2019-12-17
	5399	Sweep Generator AGILENT E8257D	MY53401729	2018-12-20	2019-12-20
	5749	R&S® CMW270	100651	2019-02-01	2020-02-01
	5853	T4BCU100A	000001	N/A	N/A
Software:	5902	User Interface TACS4 BEST v1.11.0			
	5903	Technology Package Version: v3.4.0_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	06825	N/A	N/A

Hardware:	Control No.	Equipment	Serial No.	Latest Calibration Date	Next Calibration Date
	2624	HUMIDIPROBE	IFY97/067	2019-04-24	2020-04-24
Software:	4762	Control temp_Hum v2.5.1			

Test setup

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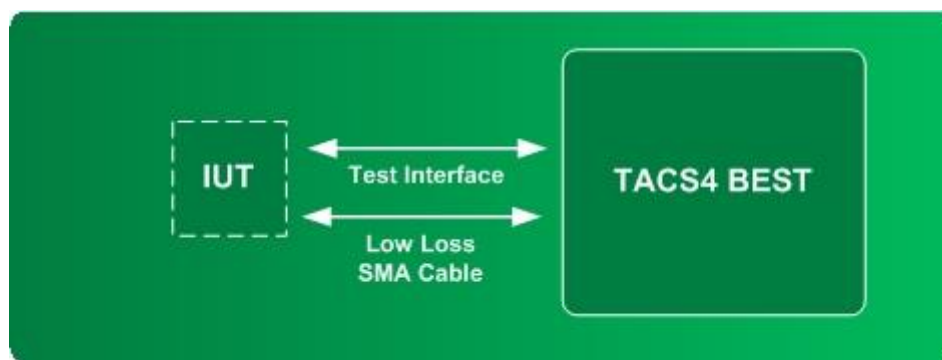
Measurement uncertainty

TACS4 BEST Bluetooth RF Test System uncertainty values1, 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/BV-01-C
Absolute RF power (for unwanted emissions in the BT band)	±2.46 dB	±3dB	RF-PHY/TRM/BV-03-C
Absolute radio frequency	±4.70 kHz	±5 kHz	RF-PHY/TRM/BV-05-C RF-PHY/TRM/BV-06-C
Relative drift radio frequency	±1.00 kHz	±1 kHz	RF-PHY/TRM/BV-06-C
Frequency deviation	±3.96 kHz	±4 kHz	RF-PHY/TRM/BV-05-C

Note 1: All values reflect a 95% confidence level.
Note 2: All values are valid for a temperature range of 23±5ºC

Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

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Appendix A: Test results

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 (Testing verdicts)

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/BV-01-C	Output power	P	2019-05-27	M/01
RF-PHY/TRM/BV-03-C	In-band emissions	P	2019-05-27	M/01
RF-PHY/TRM/BV-05-C	Modulation characteristics	P	2019-05-27	M/01
RF-PHY/TRM/BV-06-C	Carrier frequency offset and drift	P	2019-05-27	M/01
RF-PHY/TRM/BV-08-C	In-band emissions at 2 Ms/s	N/A	-	-
RF-PHY/TRM/BV-09-C	Stable Modulation Characteristics at 1 Ms/s	N/A	-	-
RF-PHY/TRM/BV-10-C	Modulation Characteristics at 2 Ms/s	N/A	-	-
RF-PHY/TRM/BV-11-C	Stable Modulation Characteristics at 2 Ms/s	N/A	-	-
RF-PHY/TRM/BV-12-C	Carrier frequency offset and drift at 2 Ms/s	N/A	-	-
RF-PHY/TRM/BV-13-C	Modulation Characteristics, LE Coded (S=8)	N/A	-	-
RF-PHY/TRM/BV-14-C	Carrier frequency offset and drift, LE Coded (S=8)	N/A	-	-
RF-PHY/RCV/BV-01-C	Receiver sensitivity	P	2019-05-27	M/01
RF-PHY/RCV/BV-03-C	C/I and receiver selectivity performance	P	2019-05-27	M/01
RF-PHY/RCV/BV-04-C	Blocking performance	P	2019-05-27	M/01
RF-PHY/RCV/BV-05-C	Intermodulation performance	P	2019-05-27	M/01
RF-PHY/RCV/BV-06-C	Maximum input signal level	P	2019-05-27	M/01
RF-PHY/RCV/BV-07-C	PER Report Integrity	P	2019-05-27	M/01
RF-PHY/RCV/BV-08-C	Receiver sensitivity at 2 Ms/s	N/A	-	-
RF-PHY/RCV/BV-09-C	C/I and Receiver Selectivity Performance at 2 Ms/s	N/A	-	-
RF-PHY/RCV/BV-10-C	Blocking performance at 2 Ms/s	N/A	-	-
RF-PHY/RCV/BV-11-C	Intermodulation performance at 2 Ms/s	N/A	-	-

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

Relevant numerical results

Test Case ID	Parameter	Value
RF-PHY/TRM/BV-01-C Output power measurements for each frequency.	Peak Power; f=2402	4.04 dBm
	Peak Power; f=2440	4.00 dBm
	Peak Power; f=2480	3.88 dBm
	Average Power; f=2402	3.87 dBm
	Average Power; f=2440	3.76 dBm
	Average Power; f=2480	3.58 dBm

Appendix B: ICS

Implementation Conformance Statement (ICS)

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.

Bluetooth LE RF Capabilities

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	No
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	No

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.

References:
[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 later

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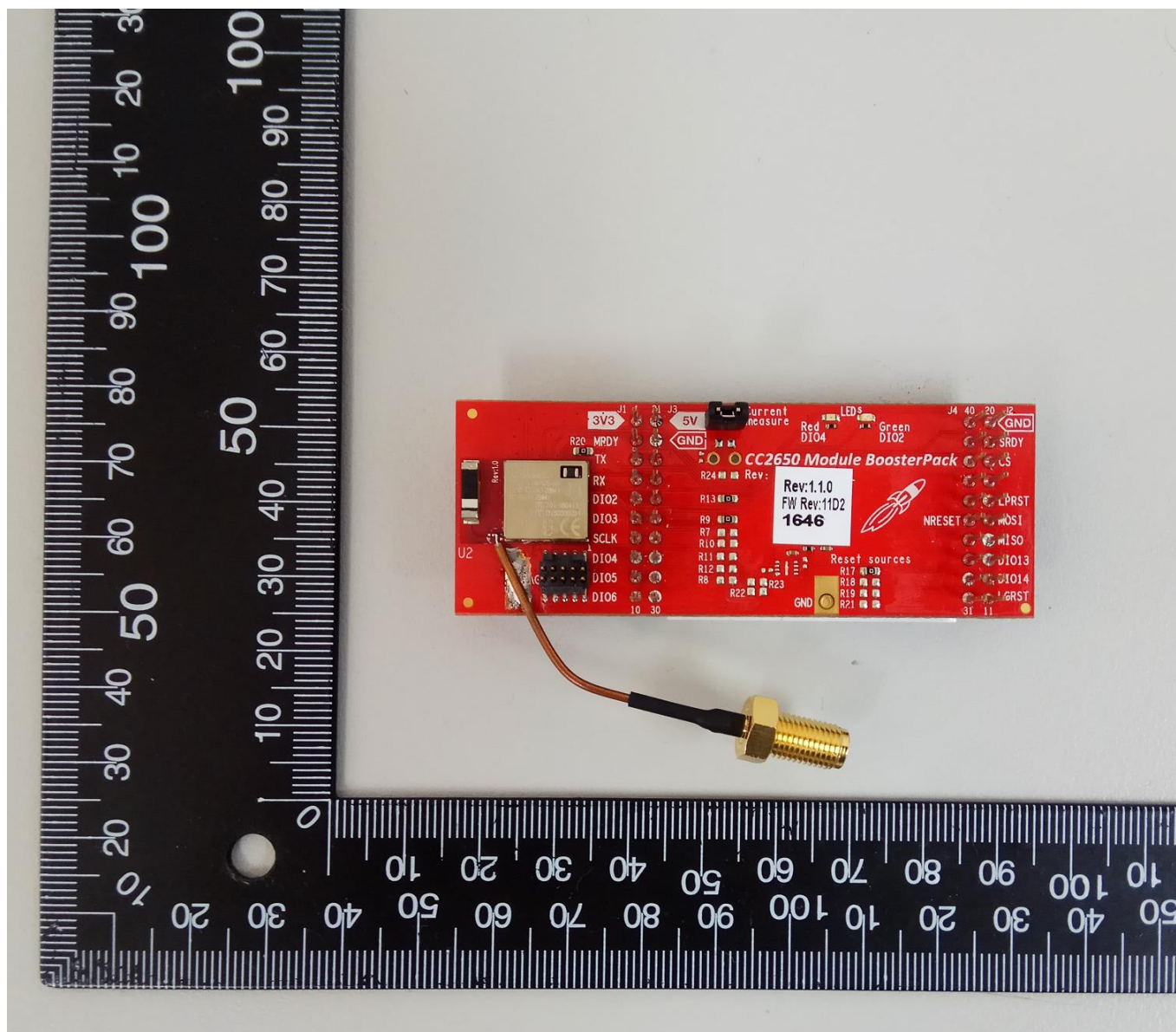C.I.F. A29 507 456

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Appendix C: IXIT

Implementation eXtra Information for Test, IXIT

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	3	Integer
RF-PHY:P2:2		Middle frequency	3	Integer
RF-PHY:P2:3		High frequency	3	Integer
RF-PHY:P4	Power source voltage		3.0	V
RF-PHY:P5	Normal operating temperature		25	°C
RF-PHY:P6:1	Air humidity range (relative)	Maximum (EOC)	75	%
RF-PHY:P6:2		Minimum (EOC)	20	%
RF-PHY:P6:3		Air humidity level for NOC/EOC tests	-	%
RF-PHY:P7:1 RF-PHY:P7:2	Direct Test Mode	Method	USB/UART	-
		Interface	HCI	-
		Data rate	115200	bps
		Additional configuration	-	-
RF-PHY:P9:1	Maximum TX packet length (MAX_TX_LENGTH) – LE1M		37	Bytes
RF-PHY:P9:2	Maximum RX packet length (MAX_RX_LENGTH) – LE1M		37	Bytes
RF-PHY:P9:3	Maximum TX packet length (MAX_TX_LENGTH) – LE2M		N/A	Bytes
RF-PHY:P9:6	Maximum RX packet length (MAX_RX_LENGTH) – LE2M		N/A	Bytes
RF-PHY:P9:4	Maximum TX packet length (MAX_TX_LENGTH) – LE Coded (S=2)		N/A	Bytes
RF-PHY:P9:7	Maximum RX packet length (MAX_RX_LENGTH) – LE Coded (S=2)		N/A	Bytes
RF-PHY:P9:5	Maximum TX packet length (MAX_TX_LENGTH) – LE Coded (S=8)		N/A	Bytes
RF-PHY:P9:8	Maximum RX packet length (MAX_RX_LENGTH) – LE Coded (S=8)		N/A	Bytes
RF-PHY:P10:1	Maximum TX mode output power		5	dBm
RF-PHY:P11:1	Inband Image Frequency (2Ms/s)	Low frequency	N/A	MHz
RF-PHY:P11:2		Middle frequency	N/A	MHz
RF-PHY:P11:3		High frequency	N/A	MHz
RF-PHY:P12:1	Value n for Intermodulation test (2Ms/s)	Low frequency	N/A	Integer
RF-PHY:P12:2		Middle frequency	N/A	Integer
RF-PHY:P12:3		High frequency	N/A	Integer
RF-PHY:P13:1	Inband Image Frequency (Stable Modulation Receiver)	Low frequency	N/A	MHz
RF-PHY:P13:2		Middle frequency	N/A	MHz
RF-PHY:P13:3		High frequency	N/A	MHz
RF-PHY:P14:1	Value n for Intermodulation test (Stable Modulation Receiver)	Low frequency	N/A	Integer
RF-PHY:P14:2		Middle frequency	N/A	Integer
RF-PHY:P14:3		High frequency	N/A	Integer
RF-PHY:P15:1	Inband Image Frequency (Stable Modulation Receiver, 2Ms/s)	Low frequency	N/A	MHz
RF-PHY:P15:2		Middle frequency	N/A	MHz
RF-PHY:P15:3		High frequency	N/A	MHz
RF-PHY:P16:1	Value n for Intermodulation test (Stable Modulation Receiver, 2Ms/s)	Low frequency	N/A	Integer
RF-PHY:P16:2		Middle frequency	N/A	Integer
RF-PHY:P16:3		High frequency	N/A	Integer

Appendix D: Photographs

Front view – Sample M/01

Rear view – Sample M/01