Produkte
Products

Auftraggeber: *Client:*	**Bury GmbH & Co. KG** **Robert-Koch-Str. 1-7** **32584 Löhne** **Germany**

Gegenstand der Prüfung: *Test Item:*	**Bluetooth Carkit**

Bezeichnung: *Identification:*	**M541 Lumen CCBT**	**Serien-Nr.:** *Serial No.:*	**Engineering sample**

Wareneingangs-Nr.: *Receipt No.:*	**00111202123-004,** **00120411101-002**	**Eingangsdatum:** *Date of Receipt:*	**02.12.2011, 11.04.2012**

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of test item at delivery:*	Test samples received are sufficient for testing and not damaged.

Prüfort: *Testing Location:*	**TÜV Rheinland Hong Kong Ltd.** 8/F., First Group Centre, 14 Wang Tai Road, Kowloon Bay, Kowloon, Hong Kong **Hong Kong Productivity Council** HKPC Building, 78 Tat Chee Avenue, Kowloon, Hong Kong

Prüfgrundlage: *Test Specification:*	**FCC Part 15 Subpart C** **ANSI C63.4-2003** **CISPR 22:1997**

Prüfergebnis: *Test Results:*	**Das vorstehend beschriebene Gerät wurde geprüft und entspricht oben genannter Prüfgrundlage.** The above mentioned product was tested and **passed**.

Prüflaboratorium: *Testing Laboratory:*	**TÜV Rheinland Hong Kong Ltd.** 8 - 10/F., Goldin Financial Global Square, 7 Wang Tai Road, Kowloon Bay, Kowloon, Hong Kong

geprüft/ *tested by:*			**kontrolliert/** *reviewed by:*		
31.05.2012	Joey Leung Test Engineer	*(signature)*	31.05.2012	Sharon Li Section Manager	*(signature)*
Datum *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name/Stellung** *Name/Position*	**Unterschrift** *Signature*

Sonstiges: Other Aspects	**FCCID: QZ9-CCBT**

Table of Content

Product information

Manufacturers declarations

	Transceiver
Operating frequency range	2402 - 2480 MHz
Type of modulation	GFSK
Number of channels	79
Channel separation	1 MHz
Type of antenna	Integral
Antenna gain (dBi)	0
Power level	variable
Type of equipment	stand alone radio device
Connection to public utility power line	No
Nominal voltage	V_{nor}: 12.0V
Independent Operation Modes	Page scan Inquiry scan Connection state - ACL Link Connection state - SCO Link

Product function and intended use

The test item is a Bluetooth Carkit based on the Bluetooth technology.
Bluetooth is a short-range radio link intended to be a cable replacement between portable and/or fixed electronic devices.
Bluetooth operates in the unlicensed ISM Band at 2.4 GHz. In the US a band of 83.5 MHz width is available. In this band, 79 RF channels spaced 1 MHz apart are defined.
The channel is represented by a pseudo-random hopping sequence through the 79 channels. The channel is divided into time slots, with a nominal slot length of 625 µs, where each slot corresponds to different RF hop frequencies. The nominal hop rate is 1600 hops/s. The symbol rate on the channel is 1 Ms/s.

Submitted documents

Circuit Diagram
Block Diagram
Bill of material
User Manual
Label Artwork

Remark

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases.

Special accessories and auxiliary equipment

The product has been tested together with the following additional accessory:

Sealed lead-acid battery
Model: CB12-7.2, 12V, 7.2AH
Output: 12VDC 2160mA

List of Test and Measurement Instruments

Hong Kong Productivity Council (Registration number: 90656)

Equipment used	Manufacturer	Model No.	S/N	Due Date
Semi-anechoic Chamber	Frankonia	Nil	Nil	12-Apr-13
Test Receiver	R & S	ESU40	100190	26-May-13
Bi-conical Antenna	R & S	HK116	100242	05-May-13
Log Periodic Antenna	R & S	HL223	841516/020	06-May-13
Coaxial cable 50ohm	Rosenberger	RTK081-05S-05S-10m	LA2-001-10M / 001	15-Nov-13
Microwave amplifer 0.5-26.5GHz, 25dB gain	HP	83017A	3950M00241	03-Oct-13
High Pass Filter (cutoff freq. =1000MHz)	Trilithic	23042	9829213	28-Oct-13
Horn Antenna	EMCO	3115	9002-3351	11-May-13
Active Loop Antenna	EMCO	6502	9107-2651	19-Apr-13

Results FCC Part 15 – Subpart C

Subclause 15.203 – Antenna Information	Pass

Requirement:	No antenna other than that furnished by the responsible party shall be used with the device
Results:	Permanent attached antenna
Verdict:	Pass

Subclause 15.204 – Antenna Information	Pass

Requirement:	Provide information for every antenna proposed for the use with the EUT	
Results:	a) Antenna type:	Integral
	b) Manufacturer and model no:	N.A.
	c) Gain with reference to an isotropic radiator:	0 dBi
Verdict:	Pass	

Subclause 15.207 – Disturbance Voltage on AC Mains	N/A

Applicable only to equipment designed to be connected to the public utiliy power line.

Subclause 15.247 (a)(1) – Carrier Frequency Separation	Pass

Requirement: is	Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 2/3*20dB bandwidth of the hopping channel, whichever greater.

Test Specification : FCC Part 15 Subpart A – Subclause 15.31
Mode of operation : Tx mode (hopping on), GFSK
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 1 MHz / 3 MHz
Supply voltage : 12VDC from DC power supply
Temperature : 23ºC
Humidity : 50%

Results:	Pre-scan has been conduced to determine the worst-case mode from all possible combinations between available modulations and packet types. The centre frequencies of the hopping channels are separated by more than the 2/3*20dB bandwidth. For test Results plots refer to Appendix 1, page 2.
Verdict:	Pass

Subclause 15.247 (a)(1)(iii) – Number of hopping channels	Pass
Requirement:	Frequency hopping systems operating in the 2400MHz-2483.5MHz bands shall use at least 15 hopping frequencies.
Test Specification : FCC Part 15 Subpart A – Subclause 15.31 Mode of operation : Tx mode (hopping on), GFSK Port of testing : Temporary antenna port Detector : Peak RBW/VBW : 1 MHz / 3 MHz Supply voltage : 12VDC from DC power supply Temperature : 23ºC Humidity : 50%	
Results:	The total number of hopping frequencies is more than 15. For test Results plots refer to Appendix 1, page 3.
Verdict:	Pass

Subclause 15.247 (a)(1)(iii) – Time of Occupancy (Dwell Time)	Pass
Requirement:	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.
Test Specification : FCC Part 15 Subpart A – Subclause 15.31 Mode of operation : Tx mode (hopping on), DH5 packet Port of testing : Temporary antenna port Detector : Peak RBW/VBW : 1 MHz / 3 MHz Supply voltage : 12VDC from DC power supply Temperature : 23ºC Humidity : 50%	

Results: Time period calculation = 0.4 x 79 = 31.6s

$$\text{Dwell time} = 64 \times 2.936 \times 10^{-3} = 187.904 \times 10^{-3} \text{ s}$$
$$<= 400 \times 10^{-3} \text{ s}$$

For test protocols please refer to Appendix 1, page 4.

Verdict: Pass

Subclause 15.247 (a) – 20 dB Bandwidth	Pass
Requirement: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 2/3*20dB bandwidth of the hopping channel, whichever is greater.	

Test Specification : FCC Part 15 Subpart A – Subclause 15.31
Mode of operation : Tx mode (2402MHz, 2441MHz, 2480MHz)
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 30 kHz / 100 kHz
Supply voltage : 12VDC from DC power supply
Temperature : 23ºC
Humidity : 50%

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

For test protocols refer to Appendix 1, page 5-6.

GFSK Modulation

Frequency (MHz)	20 dB left (MHz)	20 dB right (MHz)	20dB bandwidth (MHz)
2402	0.462	0.414	0.876
2441	0.468	0.414	0.882
2480	0.468	0.420	0.888

Subclause 15.247 (a) – Hopping Sequence	Pass
Requirement: The hopping sequence is generated and provided with an example.	

Hopping sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master. The X input determines the phase in the 32-hop segment, whereas Y1 and Y2 selects between master-to-slave and slave-to-master transmission. The inputs A to D determine the ordering within the segment, the inputs E and F determine the mapping onto the hop frequencies.
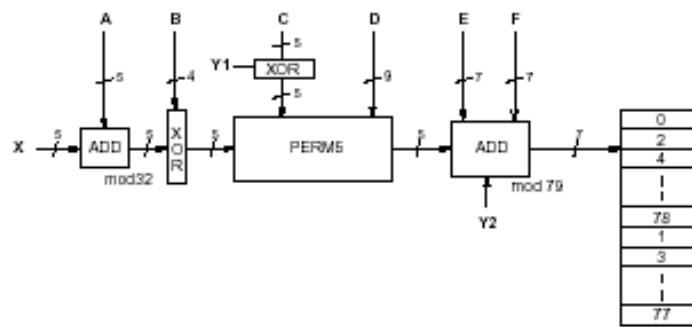
Example data:

Hop sequence {k} for CONNECTION STATE:
CLK start: 0x0000010
ULAP: 0x00000000

```
#ticks:     00 02 | 04 06 | 08 0a | 0c 0e | 10 12 | 14 16 | 18 1a | 1c 1e |
-------------------------------------------------------------------------------
0x0000010:  08 66 | 10 70 | 12 19 | 14 23 | 16 01 | 18 05 | 20 33 | 22 37 |
0x0000030:  24 03 | 26 07 | 28 35 | 30 39 | 32 72 | 34 76 | 36 25 | 38 29 |
0x0000050:  40 74 | 42 78 | 44 27 | 46 31 | 48 09 | 50 13 | 52 41 | 54 45 |
0x0000070:  56 11 | 58 15 | 60 43 | 62 47 | 32 17 | 36 19 | 34 49 | 38 51 |
0x0000090:  40 21 | 44 23 | 42 53 | 46 55 | 48 33 | 52 35 | 50 65 | 54 67 |
0x00000b0:  56 37 | 60 39 | 58 69 | 62 71 | 64 25 | 68 27 | 66 57 | 70 59 |
0x00000d0:  72 29 | 76 31 | 74 61 | 78 63 | 01 41 | 05 43 | 03 73 | 07 75 |
0x00000f0:  09 45 | 13 47 | 11 77 | 15 00 | 64 49 | 66 53 | 68 02 | 70 06 |
0x0000110:  01 51 | 03 55 | 05 04 | 07 08 | 72 57 | 74 61 | 76 10 | 78 14 |
0x0000130:  09 59 | 11 63 | 13 12 | 15 16 | 17 65 | 19 69 | 21 18 | 23 22 |
0x0000150:  33 67 | 35 71 | 37 20 | 39 24 | 25 73 | 27 77 | 29 26 | 31 30 |
0x0000170:  41 75 | 43 00 | 45 28 | 47 32 | 17 02 | 21 04 | 19 34 | 23 36 |
0x0000190:  33 06 | 37 08 | 35 38 | 39 40 | 25 10 | 29 12 | 27 42 | 31 44 |
0x00001b0:  41 14 | 45 16 | 43 46 | 47 48 | 49 18 | 53 20 | 51 50 | 55 52 |
0x00001d0:  65 22 | 69 24 | 67 54 | 71 56 | 57 26 | 61 28 | 59 58 | 63 60 |
0x00001f0:  73 30 | 77 32 | 75 62 | 00 64 | 49 34 | 51 42 | 57 66 | 59 74 |
0x0000210:  53 36 | 55 44 | 61 68 | 63 76 | 65 50 | 67 58 | 73 03 | 75 11 |
0x0000230:  69 52 | 71 60 | 77 05 | 00 13 | 02 38 | 04 46 | 10 70 | 12 78 |
0x0000250:  06 40 | 08 48 | 14 72 | 16 01 | 18 54 | 20 62 | 26 07 | 28 15 |
0x0000270:  22 56 | 24 64 | 30 09 | 32 17 | 02 66 | 06 74 | 10 19 | 14 27 |
0x0000290:  04 70 | 08 78 | 12 23 | 16 31 | 18 03 | 22 11 | 26 35 | 30 43 |
0x00002b0:  20 07 | 24 15 | 28 39 | 32 47 | 34 68 | 38 76 | 42 21 | 46 29 |
0x00002d0:  36 72 | 40 01 | 44 25 | 48 33 | 50 05 | 54 13 | 58 37 | 62 45 |
0x00002f0:  52 09 | 56 17 | 60 41 | 64 49 | 34 19 | 36 35 | 50 51 | 52 67 |
0x0000310:  38 21 | 40 37 | 54 53 | 56 69 | 42 27 | 44 43 | 58 59 | 60 75 |
0x0000330:  46 29 | 48 45 | 62 61 | 64 77 | 66 23 | 68 39 | 03 55 | 05 71 |
0x0000350:  70 25 | 72 41 | 07 57 | 09 73 | 74 31 | 76 47 | 11 63 | 13 00 |
0x0000370:  78 33 | 01 49 | 15 65 | 17 02 | 66 51 | 70 67 | 03 04 | 07 20 |
0x0000390:  68 55 | 72 71 | 05 08 | 09 24 | 74 59 | 78 75 | 11 12 | 15 28 |
0x00003b0:  76 63 | 01 00 | 13 16 | 17 32 | 19 53 | 23 69 | 35 06 | 39 22 |
0x00003d0:  21 57 | 25 73 | 37 10 | 41 26 | 27 61 | 31 77 | 43 14 | 47 30 |
0x00003f0:  29 65 | 33 02 | 45 18 | 49 34 | 19 04 | 21 08 | 23 20 | 25 24 |
```

Subclause 15.247 (a) – Equal Hopping Frequency Use	Pass

Requirement:	Each of the transmitter's hopping channels is used equally on average.

Equal hopping frequency use

The EUT complies with the Bluetooth RF specifications. For details refer to the Bluetooth standard.

Subclause 15.247 (a) – Receiver Input Bandwidth	Pass

Requirement: matches	The associated receiver(s) complies with the requirement that its input bandwidth the bandwidth of the transmitted signal.

Receiver input bandwidth

The receiver bandwidth is equal to the receiver bandwidth in the 79 hopping channel mode, which is 1 MHz. The receiver bandwidth was verified during Bluetooth RF conformance testing.

Subclause 15.247 (a) – Receiver Hopping Capability	Pass

Requirement:	The associated receiver has the ability to shift frequencies in synchronisation with the transmitted signals.

Receiver hopping Capability

The EUT complies with the Bluetooth RF specifications. For details refer to the Bluetooth standard.

Subclause 15.247 (b)(1) – Peak Output Power	Pass

Test Specification : FCC Part 15 Subpart A – Subclause 15.31
Mode of operation : Tx mode (2402MHz, 2441MHz, 2480MHz)
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 3 MHz / 10 MHz
Supply voltage : 12VDC from DC power supply
Temperature : 23ºC
Humidity : 50%

Requirement:	For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 Watt. For all other frequency hopping systems in the 2400 – 2483.5 MHz band: 0.125 Watts.

Results:	For test protocols please refer to Appendix 1, page 7-8.

GFSK Modulation

Frequency (MHz)	Maximum peak output power (dBm)	Cable attenuation (dB)	Output power (dBm)	Limit (W/dBm)	Verdict
2402	3.65	0.00	3.650	1 / 30.0	Pass
2441	2.74	0.00	2.740	1 / 30.0	Pass
2480	1.58	0.00	1.580	1 / 30.0	Pass

Subclause 15.247 (d) – Band edge compliance of conducted emissions	Pass
Test Specification : FCC Part 15 Subpart A – Subclause 15.31 Mode of operation : Tx mode (2402MHz, 2480MHz), GFSK Port of testing : Temporary antenna port Detector : Peak RBW/VBW : 100 kHz / 300 kHz Supply voltage : 12VDC from DC power supply Temperature : 23ºC Humidity : 50%	
Requirement:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Results:	Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types. There is no peak found outside any 100 kHz bandwidth of the operating frequency band. For test protocols refer to Appendix 1, page 9-10.

Subclause 15.205 – Band edge compliance of radiated emissions	Pass
Test Specification : FCC Part 15 Subpart A – Subclause 15.31 Mode of operation : Tx mode (2402MHz, 2480MHz), GFSK Port of testing : Temporary antenna port Detector : Peak RBW/VBW : 1 MHz / 3 MHz Supply voltage : 12VDC from DC power supply Temperature : 23ºC Humidity : 50%	
Requirement:	Radiated emissions which fall in the restricted bans, as defined in 15.205 (a), must also comply with the radiated emission limits specified in 15.209(a).
Results:	There is no peak found in the restricted bands. For test protocols refer to Appendix 1, page 11-18.

Subclause 15.247 (d) – Spurious Conducted Emissions	Pass

Test Specification : FCC Part 15 Subpart A – Subclause 15.31	
Mode of operation : Tx mode (2402MHz, 2441MHz, 2480MHz), GFSK	
Port of testing : Temporary antenna port	
Detector : Peak	
RBW/VBW : 100 kHz / 300 kHz	
Supply voltage : 12VDC from DC power supply	
Temperature : 23 ºC	
Humidity : 50 %	

Requirement:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

Results:

 Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

There is no peak found outside any 100kHz bandwidth of the operating frequency band in the three transmit frequency. All three transmit frequency modes comply with the limit stated in subclause 15.247(d). For test protocols refer to Appendix 1, page 19-20.

Operating frequency (MHz)	Spurious frequency (MHz)	Spurious Level (dBm)	Reference value (dBm)	Delta (dB)	Verdict
2402	4800.00	-43.42	3.60	-47.02	Pass
2441	4850.00	-46.51	2.54	-49.05	Pass
2480	4950.00	-42.11	1.68	-43.79	Pass

Subclause 15.247 (c) – Spurious Radiated Emissions	Pass

Test Specification : ANSI C63.4 – 2003
Mode of operation : Tx mode (2402MHz, 2441MHz, 2480MHz), GFSK
Port of testing : Enclosure
Detector : Peak
RBW/VBW : 100 kHz / 300 kHz for f < 1 GHz
                     1 MHz / 3 MHz for f > 1 GHz
Supply voltage : 12VDC from DC power supply
Temperature : 23ºC
Humidity : 50%

Requirement: In any 100kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in section15.205(a), must also comply with the radiated emission limits specified in section 15.205(c).

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

All three transmit frequency modes comply with the field strength within the restricted bands. There is no spurious found below 30MHz.

Tx frequency 2402MHz   Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4804.059	55.38	74.0 / PK
4803.979	37.92	54.0 / AV

Tx frequency 2402MHz   Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
159.999	23.40	46.0 / QP
4803.660	53.65	74.0 / PK
4804.009	38.22	54.0 / AV

Tx frequency 2441MHz   Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4881.987	55.56	74.0 / PK
4882.003	38.85	54.0 / AV

Tx frequency 2441MHz   Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
168.060	21.90	46.0 / QP
4882.115	53.26	74.0 / PK
4881.987	37.95	54.0 / AV

Tx frequency 2480MHz   Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4960.016	55.95	74.0 / PK

4960.016	39.31	54.0 / AV

Tx frequency 2480MHz	Horizontal Polarization	
Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
168.090	21.50	46.0 / QP
4960.096	55.21	74.0 / PK
4960.032	38.98	54.0 / AV