TÜVRheinland®

Prüfbericht - Nr.: *Test Report No.:*	**14029196 001**	**Seite 1 von 14** *Page 1 of 14*

Auftraggeber: *Client:*	**JAPAN REMOTE CONTROL CO., LTD.** **2-2-12 Eiwa** **Higashi Osaka-shi, Osaka** **577-0809 JAPAN**
Gegenstand der Prüfung: *Test Item:*	**2.4GHz Receiving Module (Transceiver)**
Bezeichnung: *Identification:*	**RA01TL** **Serien-Nr.:** *Serial No.:* **Engineering sample**
Wareneingangs-Nr.: *Receipt No.:*	**00120727006-001** **Eingangsdatum:** *Date of Receipt:* **27.07.2012**
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
Zustand des Prüfgegenstandes bei Anlieferung: *Condition of test item at delivery:*	Test sample(s) is/are not damaged and suitable for testing.
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:*

Datum *Date*	Name/Stellung *Name/Position*	Unterschrift *Signature*	Datum *Date*	Name/Stellung *Name/Position*	Unterschrift *Signature*
27.09.2012	Mika Chan Senior Project Engineer		27.09.2012	Sharon Li Section Manager	

Sonstiges: Other Aspects	**FCCID: AXG-RF1RPA**

Abkürzungen:				Abbreviations:			
P(ass)	=	*entspricht Prüfgrundlage*			*P(ass)*	=	*passed*
F(ail)	=	*entspricht nicht Prüfgrundlage*			*F(ail)*	=	*failed*
N/A	=	*nicht anwendbar*			*N/A*	=	*not applicable*
N/T	=	*nicht getestet*			*N/T*	=	*not tested*

Table of Content

Product information

Manufacturers declarations

	Transceiver
Operating frequency range	2404 - 2479 MHz
Type of modulation	Hybrid System (FHSS+DSSS)
Number of channels	26
Channel separation	3 MHz
Type of antenna	Wire Antenna
Antenna gain (dBi)	1
Power level	fix
Type of equipment	plug in radio device
Connection to public utility power line	No
Nominal voltage	V_{nor}: 3.3V
Independent Operation Modes	Transmitting Receiving

Product function and intended use

The model (RA01TL) is a transceiver for the remote control (R/C) of models such as helicopters, airplane, glider and etc. It mainly used as receiver and equipped in a models. But it replies the data based on a requests from transmitter.

The model (RA01TL) use 2.4GHz signals for communication. It supports wide-band, frequency-agile 2.4GHz signal protocol to improve the reliability and efficiency.

Submitted documents

Circuit Diagram
Block Diagram
Bill of material
User manual

Remark

Special accessories and auxiliary equipment

Test together with accessories as shown below:

11 Channel 2.4GHz Receiver:
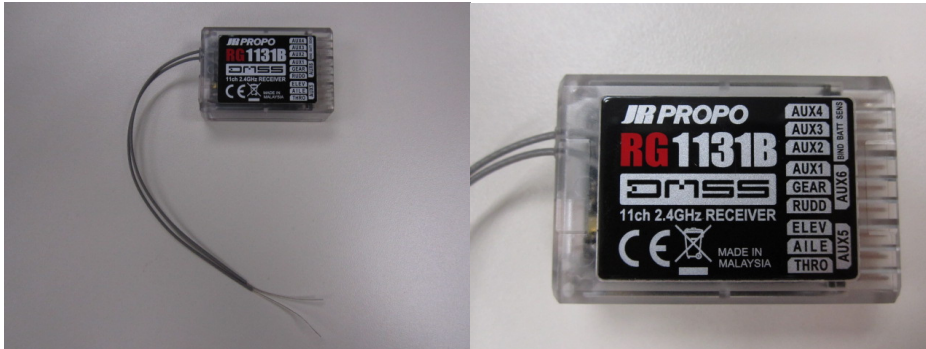
List of Test and Measurement Instruments

Hong Kong Productivity Council (Registration number: 90656)

Equipment	Manufacturer	Type	S/N	Due Date
Semi-anechoic Chamber	Frankonia	Nil	Nil	25-May-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	21-Jun-13
FSP 30 Spectrum Analyser	R & S	FSP 30	100007	17-Sep-12

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: Wire Antenna b) Manufacturer and model no: N.A. c) Gain with reference to an isotropic radiator: 1 dBi
Verdict:	Pass

Subclause 15.207 – Disturbance Voltage on AC Mains	N/A

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

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 (2404MHz, 2440MHz, 2479MHz)
Port of testing	: Temporary antenna port
Detector	: Peak
RBW/VBW	: 300 kHz / 1 MHz
Supply voltage	: 3.3VDC from Receiver
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. For test protocols refer to Appendix 1, page 2-3.

Frequency (MHz)	20 dB left (MHz)	20 dB right (MHz)	20dB bandwidth (MHz)
2404	2.052	1.080	3.132
2440	1.026	2.088	3.114
2479	1.116	2.034	3.150

Subclause 15.247 (a) – Hopping Sequence **Pass**

Requirement: The hopping sequence is generated and provided with an example.

Hopping sequence

Transmitter will determine the hopping sequence as below.

  - Check around RF environment

  - Check chip around temperature (and this information will be used as a part of rnd seed.)

  - RF module CPU will combine these information and generate appropriate hopping sequence..

Example data:

where as:
 rand() is a typical random generator function defined in ANSI C.
 mt_rand() is a mersenne twister random generator function.

```
example:
do
 {
   seed1 = temperature * rand() * 128392733U * (rand() * mt_rand() >>
30) + 3;
   seed2 = (the detected RF signal around the RF modules when the TX
powered on) * rand() * 33234 * (mt_rand() >> 3) + 34;
   ch_map_temp = (seed1 * seed2) & 26;
   ....
   (It repeats the above equation until the map completion.)
   ....
 } while (i < 26);   /* '26' is a channel hopping number */
```

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

In a fixed period, the probability for each available channel to be chosen is equal.

Subclause 15.247 (a) – Receiver Input Bandwidth **Pass**

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

Receiver input bandwidth

The receiver bandwidth is equal to the transmitter bandwidth in the 26 hopping channel mode, which is 2MHz. The receiver bandwidth was verified during 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 receiver is waiting the signal from TX with dedicated packet address (8bytes).

Once the receiver received the signal from TX, RX starts to parse the packet and fetch the 2 kinds of data.

The former data describes the timing data, and the latter is random seeds to generate the hopping pattern.

Then RX starts generating hopping patter at first, and wait the TX signal again to sync the hopping.

After the above procedure, RX can easily sync the hopping pattern.

Subclause 15.247 (a)(1) – Carrier Frequency Separation	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 (hopping on)
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 300 KHz / 1 MHz
Supply voltage : 3.3VDC from Receiver
Temperature : 23ºC
Humidity : 50%

Results:	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 4.
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)
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 1 MHz / 3 MHz
Supply voltage : 3.3VDC from Receiver
Temperature : 23ºC
Humidity : 50%

Results:	The total number of hopping frequencies is more than 15. For test Results plots refer to Appendix 1, page 5.
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),
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 1 MHz / 3 MHz
Supply voltage : 3.3VDC from Receiver
Temperature : 23ºC
Humidity : 50%

Results: Time period calculation = 0.4 x 26 = 10.4s
Dwell time = $31 \times 1.096 \times 10^{-3} = 33.976 \times 10^{-3}$ s
$<= 400 \times 10^{-3}$ s

For test protocols please refer to Appendix 1, page 6.

Verdict: Pass

Subclause 15.247 (a)(2) – 6dB Bandwidth Measurement	N/A
Requirement:	Systems using digital modulation techniques may operate in the 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz bands. The minimum 6dB bandwidth shall be at least 500kHz. There is no requirement for hybrid system to comply with the 500 KHz minimum bandwidth normally associated with a DTS transmission. In addition, the EBW is required information for subsequent band power measurement.

EBW

Test Specification : FCC Part 15 Subpart A – Subclause 15.31
Mode of operation : Tx mode, DSSS, hopping off
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 1-5% of EBW / >=3xRBW
Supply voltage : 3.3VDC from Receiver
Temperature : 23ºC
Humidity : 50%

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

Channel	Channel frequency (MHz)	Emission Bandwidth (MHz)	Limit (MHz)	Verdict
1	2404	1.832	-	-
13	2440	1.824	-	-
26	2479	1.832	-	-

Subclause 15.247 (b)(3) – Maximum Peak Output Power				Pass	
Requirement:	For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850MHz bands: 1 Watt (30dBm)				
Test Specification : FCC Part 15 Subpart A – Subclause 15.31 Mode of operation : Tx mode, DSSS, hopping off Port of testing : Temporary antenna port Detector : Peak RBW/VBW : >=EBW / >=3xRBW Span : zero Supply voltage : 3.3VDC from Receiver Temperature : 23ºC Humidity : 50%					
Results:	For test protocols please refer to Appendix 1, page 9-10.				

Channel	Channel frequency (MHz)	Peak Power Output (dBm)	Limit (dBm)	Verdict
1	2404	-13.69	30	Pass
13	2440	-15.19	30	Pass
26	2479	-14.94	30	Pass

Verdict: Pass

Subclause 15.247 (d) – Spurious Conducted Emissions				Pass	
Test Specification : FCC Part 15 Subpart A – Subclause 15.31 Mode of operation : Tx mode (2412MHz, 2437MHz, 2462MHz), DSSS, hopping off Port of testing : Temporary antenna port Detector : Peak RBW/VBW : 100 kHz / 300 kHz Supply voltage : 3.3VDC from Receiver 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:	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 11-12.				

Operating frequency (MHz)	Spurious frequency (MHz)	Spurious Level (dBm)	Reference value (dBm)	Delta (dB)	Verdict
2404	4800	-74.18	-16.64	57.54	Pass
2440	No Peak Found	-	-16.36	-	Pass
2479	4950	-73.35	-18.27	55.08	Pass

Subclause 15.247 (d) – Spurious Radiated Emissions	Pass

Test Specification : ANSI C63.4 – 2003
Mode of operation : Tx mode (2404MHz, 2440MHz, 2479MHz), DSSS, hopping off
Port of testing : Enclosure
Detector : Peak
RBW/VBW : 100 kHz / 300 kHz for f < 1 GHz
1 MHz / 1 MHz for f > 1 GHz
Supply voltage : 3.3VDC from Receiver
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 15.209(a).

Results:	Pre-scan has been conduced 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 2404MHz   Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4808.256	48.73	74.0 / P
4807.967	41.39	54.0 / A

Tx frequency 2404MHz   Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
183.999	33.0	43.5 / QP
479.994	32.0	46 / QP
4807.823	48.83	74.0 / P
4808.016	42.13	54.0 / A

Tx frequency 2440MHz   Vertical Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
4879.903	54.12	74.0 / P
4879.951	47.90	54.0 / A

Tx frequency 2440MHz   Horizontal Polarization

Freq MHz	Level dBuV/m	Limit/ Detector dBuV/m
183.999	33.0	43.5 / QP
479.994	31.9	46/ QP
4879.938	54.09	74.0 / P
4880.304	41.08	54.0 / A

Tx frequency 2479MHz   Vertical Polarization

Freq	Level	Limit/ Detector

MHz	dBuV/m	dBuV/m
4957.852	57.98	74.0 / P
4957.964	46.58	54.0 / A

Tx frequency 2479MHz	Horizontal Polarization	
Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
183.999	33.1	43.5 / QP
479.994	32.1	46/ QP
4957.836	57.84	74.0 / P
4957.932	40.95	54.0 / A

Subclause 15.247 (d) – Band Edge Emissions   **Pass**

Test Specification	: FCC Part 15 Subpart A – Subclause 15.31
Mode of operation	: Tx mode (2404MHz, 2479MHz), DSSS, hopping off
Port of testing	: Temporary antenna port
Detector	: Peak
RBW/VBW	: 100 kHz / 300 kHz
Supply voltage	: 3.3VDC from Receiver
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:	There is no peak found outside any 100 kHz bandwidth of the operating frequency band. For test protocols refer to Appendix 1, page 13-14.

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 (2404MHz, 2479MHz)
Port of testing	: Temporary antenna port
Detector	: Peak
RBW/VBW	: 1 MHz / 1 MHz
Supply voltage	: 3.3VDC from Receiver
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 15-22.

Subclause 15.247 (e) – Power Spectral Density	Pass

Requirement:	For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Specification : FCC Part 15 Subpart A – Subclause 15.31
Mode of operation : Tx mode (hopping on), DSSS, hopping off
Port of testing : Temporary antenna port
Detector : Peak
RBW/VBW : 100 KHz / 300 KHz
Supply voltage : 3.3VDC from Receiver
Temperature : 23ºC
Humidity : 50%
BWCF : -15.2dB

Results: For test protocols please refer to Appendix 1, page 28-33.

Operating frequency (MHz)	Reading (dBm)	Power density (dBm)	Limit (dBm)	Verdict
2404	-16.14	-31.34	8.0	Pass
2440	-16.62	-31.82	8.0	Pass
2479	-17.54	-32.74	8.0	Pass

Verdict:	Pass