

EMI TEST REPORT
ON
RADIO REMOTE CONTROL SYSTEM
FOR
IRWIN TECHNOLOGY PTY. LTD.

R.F.I. INDUSTRIES TEST REPORT TL2905
May, 2000.

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FOR
IRWIN TECHNOLOGY PTY LTD.

Administrative Data

Specification : FCC Part 15 Subpart C – Intentional Radiators
EN 300 220-1 V1.2.1 (1997-11) Electromagnetic Compatibility and Radio spectrum Matters (ERM); Short range devices; Technical characteristics and Test methods for radio equipment to be used in the 25MHz to 1000MHz frequency range with power level ranging up to 500mW;
Part 1: Parameters intended for regulatory purposes.

Test Sample : Radio remote control system
Model No RCS16

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Test Dates : 8th and 9th May, 2000.

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Report Issued : May, 2000.

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R.F.I. Industries - Copy 3

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1. INTRODUCTION

Radiated and Conducted Electromagnetic Interference (EMI) tests was performed on the Radio remote control system to determine compliance with the FCC Part 15 Subpart C and EN300 220-1 requirements.

2. TEST SAMPLE DETAILS

The Equipment Under Test (EUT) was identified as:

IRWIN RADIO REMOTE CONTROL SYSTEM
Model No RCS16
(See Appendix B – EUT Description and Configuration)

3. TEST CONFIGURATION AND OPERATING CONDITIONS

- 3.1 Radiated and Conducted EMI tests were performed in accordance with customer specification.
- 3.2 Transmitter and Receiver units were tested separately.
- 3.3 To obtain the recorded values, the following modifications were performed to the EUT:

Transmitter unit:: 3.3pF and 6.8pF connected between the output to antenna and antenna to ground respectively.

Receiver unit: Software changed to “Low EMI”
(Refer to Appendix C – Photographs)

4. DESCRIPTION OF MEASUREMENT FACILITIES AND EQUIPMENT

4.1 Test Site

The Open Area Test Site and conducted measurement facility used to collect the radiated and conducted EMI data, is located at Tooborac, near Heathcote, 100km north of Melbourne.

4.2 Test Equipment

Refer to Appendix A for EMI/EMC Test and Measurement Instruments List.

5. TEST PROCEDURE - RADIATED EMISSIONS

5.1 Range 2: 30MHz – 1GHz

- 5.1.1 Radiated EMI was measured at a test distance of 3 metres at the Open Area Test Site using R.F.I. Industries EMI Measurement Software.
- 5.1.2 The measurements were performed automatically with a PC driving the analyser and plotter via the IEEE-488 BUS, to acquire, store and plot corrected field strength measurements over six frequency ranges.

Range 1	30 - 85MHz
Range 2	85 - 110MHz
Range 3	110 - 200MHz
Range 4	200 - 500MHz
Range 5	500 – 700MHz
Range 6	700 – 1000MHz

- 5.1.3 The EUT was tested in accordance with each configuration identified in Para. 3.
- 5.1.4 The EUT was slowly rotated in order to find the worst case emissions arrangement for one program loop. For both horizontal and vertical antenna polarization, the peak detector was set to MAX-HOLD and the range selected continuously scanned. The antenna height was varied from 1 to 4 metres and the turntable slowly rotated.

The accumulated measurement data for both horizontal and vertical polarization, including all calibration parameters were then stored on disk.

The six ranges were then combined and plotted onto one logarithmic graph of corrected field strength (dB μ V/m) versus frequency.

- 5.1.5 The EMI Receiver was used to measure the quasi-peak value of significant emissions and the value manually plotted onto the graph.
- 5.1.6 The Fundamental Frequency and Spurious emissions limit are specified in Section 15.231 of the FCC Part 15 Subpart C standard.
- 5.1.7 A zoom measurement was performed to obtain the Fundamental Frequency measurements in accordance with the FCC Part 15 Subpart C and the EN300 220-1 requirements.

5.2 Range 2: 1.0GHz – 5.0GHz

- 5.1.1 Radiated EMI was measured at a test distance of 3 metres at the Open Area Test Site using R.F.I. Industries EMI Measurement Software.

5.1.2 The measurements were performed automatically with a PC driving the analyser and plotter via the IEEE-488 BUS, to acquire, store and plot corrected field strength measurements over three (3) frequency ranges.

Range 1	1000 - 2648MHz
Range 2	2648 - 4200MHz
Range 3	2648 - 5000MHz

5.1.3 The EUT was tested in accordance with each configuration identified in Para. 3.

5.1.4 The EUT was slowly rotated in order to find the worst case emissions arrangement for one program loop. For both horizontal and vertical antenna polarization, the peak detector was set to MAX-HOLD and the range selected continuously scanned. The antenna height was positioned to 1 metres and the turntable slowly rotated.

The accumulated measurement data for both horizontal and vertical polarization, including all calibration parameters were then stored on disk.

The three ranges were then combined and plotted onto one logarithmic graph of corrected field strength (dB μ V/m) versus frequency.

6. TEST PROCEDURE - CONDUCTED SPURIOUS EMISSIONS

6.1 Conducted Spurious Emissions (CE) were measured in accordance with the requirements of the EN 300 220-1 specifications in two separate frequency ranges, identified as:

Range 1: Low Frequency (0.009 – 30MHz)

CE Segment 1	0.009 - 0.01MHz
CE Segment 2	0.01 - 0.1MHz
CE Segment 3	0.1 - 1.0MHz
CE Segment 4	1.0 – 6.0 MHz
CE Segment 5	6.0 – 30MHz

Range 2: High Frequency (30 – 5000MHz)

CE Segment 1	30 – 100MHz
CE Segment 2	100 – 200MHz
CE Segment 3	200 – 600MHz
CE Segment 4	600 – 1000MHz
CE Segment 5	1000 – 2648MHz
CE Segment 6	2648 – 5000MHz

6.2 The test for the transmitter unit was performed in two configurations identified as:

Configuration 1: Stand by mode
Configuration 2: Transmitting mode

6.3 The test for the receiver unit was performed in two configurations identified as:

Configuration 1: Stand by mode
Configuration 2: Receiving data mode

The data of each frequency range were plotted onto a single graph of amplitude versus log frequency.

6.4 The EMI Receiver was used to measure the quasi-peak value of significant emissions and the value manually plotted onto the graph.

7. RESULTS – RADIATED EMI TEST

7.1 Unit No 1: Transmitter unit

7.1.1 Range 1: 30MHz – 1000MHz

Assessment: 10dB below Fundamental Frequency Limit
10dB below Spurious Emission Limit

Graph No.	Set Up	Freq. MHz	Peak dB μ V/m	Quasi Peak dB μ V/m	Limit FCC	Comments FCC Part 15 Subpart C
1 and 5	Horizontal See Note 1	434.06	63.68	63.58	80	16dB below limit
		868.01	50.67	49.90	62	12dB below limit
2 and 6	Vertical See Note 1	434.06	69.76	69.58	80	10dB below limit
		868.02	51.95	51.90	62	10dB below limit

7.1.2 Range 2: 1.0GHz – 5.0GHz

Assessment: 5dB below Spurious Emissions Limit

Graph No.	Set Up	Freq. GHz	Peak dB μ V/m	Limit	Comments FCC Part 15 C
3	Horizontal See Note 1	1.309	50.69	62	11dB below limit
		2.178	51.19	62	11dB below limit
		2.615	54.31	62	8dB below limit
		3.020	50.87	62	11dB below limit
		3.905	45.11	62	>15dB below limit
		4.344	48.16	62	14dB below limit
4	Vertical See Note 1	1.309	55.17	62	7dB below limit
		1.741	50.05	62	12dB below limit
		2.178	50.75	62	11dB below limit
		2.615	56.62	62	5dB below limit
		3.020	54.00	62	8dB below limit
		3.462	47.87	62	14dB below limit

Note 1: Notice should be taken of the measurement uncertainty of \pm 3.5 dB.

7.2 Unit No 2: Receiver unit

7.2.1 Range 1: 30MHz – 1000MHz

Assessment: 11dB below Spurious Emission Limit

Graph No.	Set Up	Freq. MHz	Peak dB μ V/m	Quasi Peak dB μ V/m	Limit FCC	Comments FCC Part 15 Subpart C
11	Horizontal See Note 1	48.02	25.61	24.60	45	>15dB below limit
		52.00	34.00	33.02	44	11dB below limit
		116.05	26.84	26.30	42	>15dB below limit
12	Vertical See Note 1	52.06	30.02	29.02	44	15dB below limit
		116.04	21.46	21.29	42	>15dB below limit

7.2.2 Range 2: 1.0GHz – 5.0GHz

Assessment: >15dB below Spurious Emissions Limit

Graph No.	Set Up	Freq. GHz	Peak dB μ V/m	Limit	Comments FCC Part 15 C
13	Horizontal See Note 1	Emissions >15dB below limit			
14	Vertical See Note 1	Emissions >15dB below limit			

Note 1: Notice should be taken of the measurement uncertainty of \pm 3.5 dB.

8. RESULTS - CONDUCTED SPURIOUS EMI TEST

8.1 Unit No 1: Transmitter unit

8.1.1 Range 1: 0.009 – 30MHz

Assessment: Complies with the EN300 220-1 standard.

Graph No.	Set Up	Freq. MHz	Peak mW	Limit Peak mW	Comments
Conducted					
7	Config. 1 See Note 2				No Spurious emission recorded
8	Config. 2 See Note 2				No spurious emission recorded

Note 2: Notice should be taken of the measurement uncertainty of ± 1.9 dB

8.1.2 Range 2: 30 – 5000MHz

Assessment: Complies with the EN300 220-1 standard.

Graph No.	Set Up	Freq. MHz	Peak value	Limit Peak	Comments
Conducted					
9	Config. 1 See Note 2	67.28	30pW	2.0	Complies
10	Config. 2 See Note 2	434.04	38uW	250mW	Fundamental
		870.0	48nW	250nW	Complies
		1309	599nW	1uW	Complies
		2178	378nW	1uW	Complies
		2615	475nW	1uW	Complies
		3018	238nW	1uW	Complies

Note 2: Notice should be taken of the measurement uncertainty of ± 1.9 dB

8.2 Unit No 2: Receiver unit

8.2.1 Range 1: 0.009 – 30MHz

Assessment: Complies with the EN300 220-1 standard.

Graph No.	Set Up	Freq. MHz	Peak mW	Limit Peak mW	Comments
Conducted					
15	Config. 1 See Note 2				No Spurious emission recorded
17	Config. 2 See Note 2				No spurious emission recorded

Note 2: Notice should be taken of the measurement uncertainty of ± 1.9 dB

8.2.2 Range 2: 30 – 5000MHz

Assessment: Complies with the EN300 220-1 standard.

Graph No.	Set Up	Freq. MHz	Peak value	Limit Peak	Comments
Conducted					
16	Config. 1 See Note 2				No Spurious emissions recorded
18	Config. 2 See Note 2				No spurious emissions recorded

Note 2: Notice should be taken of the measurement uncertainty of ± 1.9 dB

9. CONCLUSION

The IRWIN RADIO REMOTE CONTROL SYSTEM, Model RCS16, configured as described in clause 3, complies with the FCC Part 15 Subpart C requirements for radiated EMI test with the following margins for each configuration:

Transmitter unit: Complies by 10dB below Fundamental frequency limit
Complies by 5dB below spurious emissions limit

Receiver unit: Complies by 11dB below spurious emissions limit

9. Continued.

The IRWIN RADIO REMOTE CONTROL SYSTEM, Model RCS16, configured as described in clause 3, complies with the EN300 220-1 requirements for Conducted Spurious EMI test and Transmitter Effective Radiated Power with the following margins for each configuration:

Transmitter unit:

Fundamental Frequency:

Horizontal Polarization: 67.79dBuV = 1.9nW

Vertical Polarization: 73.16dBuV = 6.0uW

Limit: 10mW

Comment: Complies by 10mW below Fundamental Frequency limit
Complies with the spurious emissions limit

Receiver unit: Complies with spurious emissions limit

APPENDIX A

EMI/EMC Test and Measurement Instrument List

Inv. No.	Equipment	Manufacturer	Model	Serial No.	Calibration Due
REFERENCE EQUIPMENT					
81	Spectrum Analyser	Hewlett Packard	HP8593A	3009A00398	Aug, 2000
MAJOR TESTING EQUIPMENT					
17	EMI Receiver	Electro Metrics	EMC-30 MKIV	350	Aug, 2000
359	Transient Limiter	Hewlett Packard	HP11947A	3107A01833	On use
312	Pre Amplifier	Amplifier Research	LN1000	16565	Jan., 2001
355	High Pass Filter	Solar Electronics	7801-100	947214	On use
43	LISN	EMCO	3825/2R	1179	Aug. 2000
47	LISN	EMCO	3850/2	1005	On use
525	Signal Generator	Hewlett Packard	HP8648A	3642U01815	On use
66	Power Splitter	Hewlett Packard	11667A	A16126	On use
209	Double Ridge Guide Horn	EMCO	3115	3945	Mar. 2001
163	Biconical Antenna	Electro Metrics	BIA-30C	3110	Jan., 2001
187	Log Periodic Antenna	EMCO	3146	2630	Jan., 2001
ANCILLARY EQUIPMENT					
23	Antenna Tower	EMCO	1070-1	1569	On use
68	Position Controller	EMCO	1090	1005	On use
87	Turntable	EMCO	1081	1520	On use
406	Desktop Computer	Fujikama	Gold	-	On use
452	Notebook Computer	Toshiba 110CS	PA1224EA	09616750	On use
295	Laptop Computer	Toshiba	T3200	-	On use
148	IEEE Expansion Card	Hewlett Packard	822990A	2801A00102	On use
18	Adj. Dipole Set	EMCO	3121C	671	On use
19	Adj. Dipole Set	EMCO	3121C	672	On use
67	Plotter	Hewlett Packard	7475	2641V23300	On use
370	Printer	Hewlett Packard	Deskjet 850C	SG63T36155	On use
192	TV Camera	ELMO	SP-362	868761	On use
194	Television	Toshiba	140E7A	0487801276	On use
195	PABX	Imagineering	Ultra	A8-1280	On use
133	High Pass Filter	Radio Technology	FEH-10K	8-307	On use
235	T Network	Radio Technology	CISPR22	-	On use
164	Coaxial Termination	Welz	CT-150	Dummy Load	On use
190	Multi Voltage DC Pack	Micron			
191	Multi Voltage DC Pack	Micron			
175	RF Shielded Enclosure	RFI Industries	S100	653	

APPENDIX B

EUT DESCRIPTION AND CONFIGURATION

APPENDIX C

PHOTOGRAPHS

- Photograph 1: Radiated EMI Test Set up – Transmitter unit
- Photograph 2: Radiated EMI Test Set up – Receiver unit
- Photograph 3: Conducted Spurious emissions – Transmitter unit
- Photograph 4: Conducted Spurious emissions – Receiver unit
- Photograph 5: Transmitter unit – Front View
- Photograph 6: Transmitter unit – Internal View
- Photograph 7: Transmitter unit – Internal Board, Components Side
- Photograph 8: Transmitter unit – Modification
- Photograph 9: Receiver unit - Front View
- Photograph 10: Receiver unit – Internal View
- Photograph 11: Receiver unit – Internal Board, Components Side
- Photograph 12: Receiver unit - Modification

Photograph 1: Radiated EMI Test Set up – Transmitter unit

Photograph 2: Radiated EMI Test Set up – Receiver unit

Photograph 3: Conducted Spurious emissions – Transmitter unit

Photograph 4: Conducted Spurious emissions – Receiver unit

Photograph 5: Transmitter unit – Front View

Photograph 6: Transmitter unit – Internal View

Photograph 7: Transmitter unit – Internal Board, Components Side

Photograph 8: Transmitter unit – Modification

Photograph 9: Receiver unit - Front View

Photograph 10: Receiver unit – Internal View

Photograph 11: Receiver unit – Internal Board, Components Side

Photograph 12: Receiver unit - Modification

APPENDIX C

GRAPHS OF EMI MEASUREMENTS

Transmitter unit

- Graph 1: Radiated EMI Test – Range 1, Horizontal Polarization
- Graph 2: Radiated EMI Test – Range 1, Vertical Polarization
- Graph 3: Radiated EMI Test – Range 2, Horizontal Polarization
- Graph 4: Radiated EMI Test – Range 2, Vertical Polarization
- Graph 5: Zoom Fundamental Frequency - Horizontal Polarization
- Graph 6: Zoom Fundamental Frequency - Vertical Polarization
- Graph 7: Conducted Spurious Emissions – Range 1, Configuration 1
- Graph 8: Conducted Spurious Emissions – Range 1, Configuration 2
- Graph 9: Conducted Spurious Emissions – Range 2, Configuration 1
- Graph 10: Conducted Spurious Emissions – Range 2, Configuration 2

Receiver unit

- Graph 11: Radiated EMI Test – Range 1, Horizontal Polarization
- Graph 12: Radiated EMI Test – Range 1, Vertical Polarization
- Graph 13: Radiated EMI Test – Range 2, Horizontal Polarization
- Graph 14: Radiated EMI Test – Range 2, Vertical Polarization
- Graph 15: Conducted Spurious Emissions – Range 1, Configuration 1
- Graph 16: Conducted Spurious Emissions – Range 2, Configuration 1
- Graph 17: Conducted Spurious Emissions – Range 1, Configuration 2
- Graph 18: Conducted Spurious Emissions – Range 2, Configuration 2