

COMPLIANCE TESTING REPORT FOR
 REMOTE CONTROL THERMOSTAT TRANSMITTER
 MODEL NO: SEELEY FREEDOM

CLIENT:	SEELEY INTERNATIONAL PTY. LTD.
ADDRESS:	1-11 ROTHESAY AVENUE, ST. MARYS, SOUTH AUSTRALIA 5042
REPORT NUMBER:	04-811-1SA
FILE NUMBER:	04-811SA
DATE OF ISSUE:	8 TH APRIL, 2004
TEST STANDARD:	FCC PART 15.231
RESULT:	COMPLIES
TESTED AND COMPILED BY:	PAUL KAY 
APPROVED BY:	P. KAY EMC MANAGER
CHECKED BY:	E. NOWAK

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1. CLIENT INFORMATION

COMPANY: SEELEY INTERNATIONAL PTY. LTD.
1-11 ROTHESAY AVE. ST. MARYS, SOUTH AUSTRALIA 5042

NAME OF CONTACT: TRIET CHAU

2. EQUIPMENT UNDER TEST (EUT)

2.1 IDENTIFICATION OF THE EUT

EQUIPMENT: 433 MHZ TRANSMITTER AND RECEIVER
TYPE/MODEL: REMOTE CONTROL THERMOSTAT FOR EVAPORATIVE COOLER
BRAND NAME: BREEZAIR FREEDOM
SERIAL NUMBER: K02461073
MANUFACTURER: SEELEY INTERNATIONAL PTY. LTD.

RATING: 3 x 1.5V AAA ALKALINE BATTERIES

2.2 ADDITIONAL INFORMATION ABOUT THE EUT

The transmitter is designed to operate in a hand-held or wall mounted application. The receiver is mounted with the cooling plant, typically located in or on the ceiling of a building.

The system operates by the transmitter sending a data packet to the receiver once every ten minutes in automatic operation, or by edge triggered manual push-button operation (only when the control is adjusted).

2.3 PERIPHERAL EQUIPMENT

Defined as equipment needed for correct operation of the EUT, but not included as part of the testing and evaluation of the EUT.

A laboratory DC supply, Trio PR-630 was used to supply power to the receiver during receive spurious emissions tests. No other supporting equipment was required.

3. TEST SPECIFICATIONS

3.1 STANDARD SELECTION AND JUSTIFICATION

FCC Part 15.231 was chosen to demonstrate compliance with the RF requirements of 47CFR Part 15 (FCC), because the Breezair Freedom 433 MHz is a periodic operation transmitter for remote control applications, in accordance with 15.231(e).

3.2 TEST FACILITY

Results reported in this document were performed by Austest Laboratories' South Australian EMC facilities, at the following locations:

Main Laboratory:	Unit 3, No. 4 Aristotle Close, Golden Grove, SA 5125 (2.4 x 2.4 x 7.2m screened room, equipped with power and telecommunications line filters.)
Open Area Test Site:	Cnr. Fox Creek Road and Lobethal Road, Cudlee Creek SA 5232 10m OATS, equipped with 360 degree remote control turntable and 6m remote control antenna mast.

Radiated emissions tests are performed at a class C OATS, where some ambients may exceed the limit. The possibility of missing an emission is avoided by performing a pre-scan of the test item in a screened enclosure prior to final OATS measurements.

The EMC laboratory and OATS are listed with the FCC for tests against FCC parts 15 or 18. The registration number is 97015 and the last update was completed on 10th October 2003.

3.3 ADDITIONS TO, DEVIATIONS AND EXCLUSIONS FROM STANDARDS AND ACCREDITATION

No deviations from the prescribed test methods were required.

3.4 TEST EQUIPMENT

item	model no.	cal due
Bi Log Antenna	Schaffner CBL 6141A	Feb-04
coaxial cable (4m)	Suhner RG223/U	May-04
coaxial cable (13m)	Suhner RG223/U	May-04
coaxial cable (6m)	Suhner RG223/U	May-04
RF pre-amp	HP8447E	May-04
h/d coax (25m)	Suhner FSJ4-50B	Jun-04
h/d coax (18m)	Suhner FSJ4-50B	Jun-04
OATS	Cudlee Creek 10m range	Jun-04
Attenuator 3dB DC-4GHz	Suhner 6803.17.AC	Jun-04
Digital multimeter	Fluke 111	Sep-04
Spectrum Analyser (9 kHz – 2.9 GHz)	HP8594EM	Nov-04
Spectrum Analyser (2.9-18GHz)	SD 763	Verified on use
EMI Receiver	Schaffner SCR3102	Jan-05
16 A LISN	Electro-Metrics EM7823	Feb-05
Horn antenna	AH Systems SAS571	Feb-06
Horn antenna	AH Systems SAS571	Dec-06
RF amplifier	ZHL-1042J	Verified on use

3.5 REFERENCES

DOCUMENT	NAME	ISSUE/AMENDMENTS
Test standard(s)	47CFR Part 15	Dec. 2003
Frequency allocations and radio treaty matters; general rules and regulations	47CFR Part 2	Oct. 2003
Quality Manual	Austest Laboratory Quality & Operations Manual	Quman10
Equipment and methods of measurement	CISPR 16 – 1 CISPR 16 – 2 CISPR 16 – 3 CISPR 16 – 4 ANSI C63.4	1999-10 2002-10 2000-05 2002-05 2001
Procedures and Work Instructions	RAD-WI-01	1.1, 15-10-02
	SCR-WI-01	1.5, 23-3-04

4. LABELLING REQUIREMENTS

4.1 EQUIPMENT AND DOCUMENTATION LABELS

Part 15.19 requires the following label on the device or, if space does not permit on the device, in a prominent location in the instruction manual or on the packaging.

“This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.”

The FCC identifier must be displayed on the device.

Section 2.925 and 2.926 require a label of the following form on the transmitter.

TX FCC ID XXX123.

XXX is the Grantee Code and 123 is the equipment product code.

The receiver label format is RX FCC ID XXX123.

4.2 INFORMATION TO THE USER

The user manual shall include a cautionary note to the user that changes or modifications not expressly approved by the manufacturer could void the user’s authority to operate the equipment.

5. TEST SUMMARY

Austest makes no claim regarding the consistency of production versions of the product.

The results in this report apply only to the sample tested.

RF Tests	Result	Note
Conducted emissions (mains port)	n/a	EUT has no mains port
Transmitter auto-off function 15.231a(1), a(2)	Complies	For manual operation
Radiated spurious emissions 15.231 (b)	Complies	15.205 refers to 15.209 for limits of spurious emissions in restricted bands.
Occupied Bandwidth 15.231 (c)	Complies	-
Occupied Bandwidth 15.231 (d)	n/a	EUT does not operate in the band 40.66-40.7 MHz.
Transmitter EIRP 15.231(e) automatic operation	Complies	For automatic operation only.
Transmitter automatic ON time limit 15.231 (e)	Complies	-
Receiver spurious emissions 15.209	Complies	-

The equipment complies with the relevant requirements of 47CFR Part 15 (Dec. 2003 issue).

6. MODIFICATIONS

No modifications were necessary for the equipment to comply with the requirements of the standard. The equipment was fitted with a 150Ω transmitter drive resistor, component designation R28 when submitted for final testing.

7. TEST RESULTS

7.1 15.231(A) TRANSMITTER AUTO-OFF

7.1.1 TEST CONDITIONS

Date of test	1 st April 2004
Temperature	21°C
Humidity	51%
Supply Voltage	4.6V dc (battery)
Location	Golden Grove screened room
Test Officer	Paul Kay

Tests were performed with the equipment connected to the spectrum analyser by a coupling antenna. The spectrum analyser was tuned to the centre frequency of the transmitter's emission and set to zero span mode with a sweep time of 10 seconds. The trace was captured and the analyser's marker function was used to determine the duration of transmission.

7.1.2 OPERATION MODES

Exploratory tests were performed with the equipment operating in the following modes:

- (i) Code dip switches 1111 1111 (top row) 0111 1011 (bottom row)
- (ii) Code dip switches 1111 1111 (top row) 1111 1111 (bottom row)
- (iii) Code dip switches 1111 0000 (top row) 0111 1011 (bottom row)

Final tests were performed with the equipment operating in mode (ii), to maximise the Tx on-time.

7.1.3 TRANSMITTER ON-TIME TEST DATA

Parameter	Results	Notes
Periodic transmission frequency	Once every ten minutes	Only when remote control is on
Transmission duration	625 msec	For periodic transmissions only
Maximum manual transmission duration	5.575 sec. (6 pulses is the maximum number of pulses that can be produced by the transmitter)	Worst case manual operation (adjusting fan from minimum to maximum speed) Tx automatically turns off even if button is held down
Manual on time	625 msec	With DIP code switches set for max duty cycle
Manual off time (between pulses)	325 msec	
Duty cycle (worst case manual operation)	65.8%	

Parameter	Results	Notes
Pulse repetition frequency (worst case manual operation)	1.053 Hz (950msec total period)	Applicable for manual operation only, relates to a train of 6 pulses
Periodic on time (automatic operation)	625 msec	Automatic operation (i.e. normal thermostatic control, when operator is not adjusting controls)
Periodic off time (automatic operation)	600 seconds (10 minutes)	
Duty cycle (automatic operation)	0.104%	

7.1.4 SUMMARY

The equipment complies with the requirements of 15.231 (a), when operated in manual mode.

When operated in automatic (normal) mode, the equipment transmits a 625 msec pulse (maximum) to the receiver once every ten minutes. This operation is not allowed under 15.231(a) but is allowed under 15.231(e) if tighter field strength limits are met. Section 7.4 demonstrates that these limits are met.

In particular,

- (1) manual de-activation of the transmitter occurs within 5 seconds of releasing any switch on the remote control. (Actual on-air time is less than 625msec, depending on when the switch is released.)
- (2) Automatic transmissions are limited to 625msec, once every 10 minutes.

7.2 15.231 (B) RADIATED SPURIOUS EMISSIONS

7.2.1 TEST CONDITIONS

Date of test	12 th March 2004
Temperature	16°C
Humidity	64%
Supply Voltage	4.7V dc (battery)
Location	Cudlee Creek OATS (10m)
Test Officer	Paul Kay

Radiated emissions tests were performed in accordance with ANSI C63.4, on a 10m reflective-ground plane OATS (below 1000 MHz). At frequencies above 1000 MHz, closer ranges were used to ensure the measurement system had sufficient sensitivity to determine compliance. A spectrum analyser with peak detection and a 1MHz bandwidth was used to capture spurious emissions in this range.

7.2.2 OPERATION MODES

Exploratory tests were performed with the equipment operating in the following modes:

- (i) tabletop orientation
- (ii) wall mount orientation
- (iii) edge-on hand-held operation

Final tests were performed with the equipment operating in mode (iii). Internal modulation was used and peak readings were recorded. The high duty cycle of the transmitter during each 625msec packet causes the CISPR QP detector to produce the same result as the peak detector.

7.2.3 EMISSIONS DATA

Table 3: Radiated spurious emissions (transmitter) (10m range)

Frequency (MHz)	Polarisation	Measured Field Strength dBµV/m at 10m (peak)	Equivalent (µV/m at 3m) (peak)	FCC 15.231 (e) Limit (µV/m at 3m) (average)	Pass Margin (µV/m)
867.32	V	36.7	227.8	439.4	211.6
1300.98	V	<38.9	293.4	439.4	146

Table 4: Radiated spurious emissions (transmitter) (0.3m range)

Frequency (MHz)	Polarisation	Measured Field Strength dB μ V/m at 0.3m (peak)	Equivalent (μ V/m at 3m) (peak)	FCC 15.231 (e) Limit (μ V/m at 3m) (average)	Pass Margin (μ V/m)
1732	V	51.7	38.4	439.4	401
2165	V	37.6	7.6	439.4	431.8
2598	V	39	8.9	439.4	430.5
3031	V	31.8	3.9	439.4	435.5
3464	V	31	3.5	439.4	435.9
3897	V	54.5	53.1	439.4	386.3
4330	V	55.3	58.2	439.4	381.2

All emissions were lower when measured in horizontal polarisation.

7.2.4 SUMMARY

The equipment complies with the radiated spurious limits of 15.231 (b), substituted by the tighter limits of 15.231 (e), or the general radiated spurious limits of 15.209 as referenced by 15.231(b) (2) via 15.205, for all frequencies in the range 30-5000MHz.

7.3 15.231 (C) OCCUPIED BANDWIDTH

7.3.1 TEST CONDITIONS

Date of test	1 st April 2004
Temperature	21°C
Humidity	51%
Supply Voltage	4.5V dc (battery)
Location	Golden Grove Laboratory
Test Officer	Paul Kay

Occupied bandwidth emissions tests were performed in accordance with ANSIC63.4, clause 13.1.7. The spectrum analyser resolution bandwidth was 100 kHz (3dB bandwidth), which exceeds the C63.4 requirement. The trace was set to maximum hold and allowed to build up over several manual transmission actions. The transmitter was manually activated and coupled to the spectrum analyser via a coupling antenna for this test.

7.3.2 OPERATION MODES

Final tests were performed with the equipment operating in manual transmit mode using internal modulation with code switches set to all ones.

7.3.3 BANDWIDTH DATA

The allowed bandwidth under 15.231(c) is $\leq 0.25\%$ of the centre frequency, f_o .

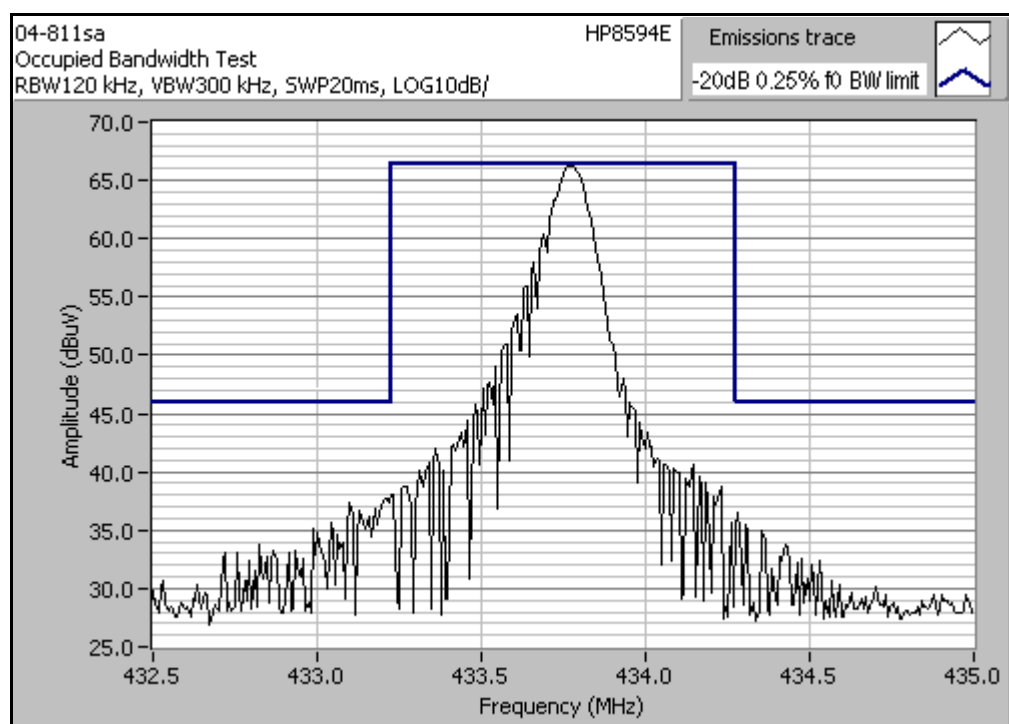
$$f_o = 433.778 \text{ MHz (central peak of emitted spectrum)}$$

$$0.25\% f_o = 1.084445 \text{ MHz}$$

The measured -20dBc frequencies were 433.2357775 MHz and 434.3202225 MHz; the bandwidth was calculated as:

$$434.3202225 - 433.2357775 \text{ MHz} = 0.451 \text{ MHz.}$$

Figure 1: Breezair Freedom emitted spectrum (max hold)



7.3.4 SUMMARY

The equipment complies with the occupied bandwidth requirement of the standard.

7.4 15.231(E) TRANSMITTER FUNDAMENTAL FIELD STRENGTH (AUTOMATIC OPERATION LIMITS)

7.4.1 TEST CONDITIONS

Date of test	12 th March 2004
Temperature	26°C
Humidity	65%
Supply Voltage	4.6V dc (fresh batteries)
Location	Cudlee Creek OATS 10m
Test Officer	Paul Kay

Radiated emissions tests for EIRP and spurious emissions were performed in accordance with ANSI C63.4 clause 13.1, on a 10m reflective-ground plane OATS (below 1000 MHz). At frequencies above 1000 MHz, closer ranges were used to ensure the measurement system had sufficient sensitivity to determine compliance.

The limits are expressed in terms of average values. Unless otherwise stated, peak detector measurements were performed and reported. This was done to detect the worst case ASK modulation, with the code dip-switches set to all ones. Exploratory tests confirmed that the CISPR QP detector produced the same results as the peak detector during a 625msec transmission under these conditions.

7.4.2 OPERATION MODES

Exploratory tests were performed with the equipment operating in the following modes:

- (i) Code dip switches 1111 1111 (top row) 0111 1011 (bottom row)
- (ii) Code dip switches 1111 1111 (top row) 1111 1111 (bottom row)
- (iii) Code dip switches 1111 0000 (top row) 0111 1011 (bottom row)

Final tests were performed with the equipment operating in mode (ii)

7.4.3 EMISSIONS DATA

Table 5: Fundamental maximum field strength (10m range).

Frequency (MHz)	Polarisation	Measured Field Strength dB μ V/m at 10m (peak)	Equivalent (μ V/m at 3m) (peak)	FCC 15.231 (e) Limit (μ V/m at 3m) (average)	Pass Margin (μ V/m)
433.66	V	60.3	3447.5	4394.3	946.8
433.66	H	55.1	1894.5	4394.3	2499.8

7.4.4 SUMMARY

The Breezair Freedom transmitter complies with the maximum power requirements for part 15 transmitters described in 15.231 (e). Refer to section 7.2 for Tx spurious data.

7.5 15.209 RECEIVER SPURIOUS EMISSIONS

7.5.1 TEST CONDITIONS

Date of test	12 th March 2004
Temperature	25°C
Humidity	39%
Supply Voltage	4.8V dc supply
Location	Cudlee Creek OATS 10m
Test Officer	Paul Kay

Radiated emissions tests for EIRP and spurious emissions were performed in accordance with ANSI C63.4 clause 13.1, on a 10m reflective-ground plane OATS (below 1000 MHz). At frequencies above 1000 MHz, closer ranges were used to ensure the measurement system had sufficient sensitivity to determine compliance. As discussed in section 3.2, OATS measurements where applicable, were performed after an initial scan in a screened room at close range.

7.5.2 OPERATION MODES

Exploratory tests were performed with the equipment operating in the following modes:

- (i) Receive ON, awaiting incoming signal
- (ii) Receive ON, in presence of signal from Tx

Final tests were performed with the equipment operating in mode (i) because tests in mode (ii) showed no spurious emissions that could not be attributed to the transmitter. It was deduced that the receiver (local oscillator in particular) was not producing spurious emissions whilst receiving a signal.

7.5.3 EMISSIONS DATA

The receiver did not produce any emissions within 10 dB of the applicable limits. Preliminary measurements at 0.5m in a shielded enclosure detected no emissions above the measurement system noise floor.

7.5.4 SUMMARY

The Breezair Freedom receiver complies with the spurious emissions requirements of part 15.

8. MEASUREMENT UNCERTAINTY:

Measurement uncertainties for emission tests have been calculated in accordance with CISPR16-4.

Uncertainties quoted in this report are 95% confidence intervals, calculated with coverage factor $k=2$ and 30 degrees of freedom.

Radiated emission measurement uncertainty in the range 30 – 1000 MHz is estimated as better than ± 5.2 dB.

Transmitter on-time resolution was 25msec.

Occupied bandwidth frequency resolution was 7.5 kHz.

9. PHOTOGRAPHS

Photo 1: EUT identification (front)



Photo 2: EUT identification (rear)

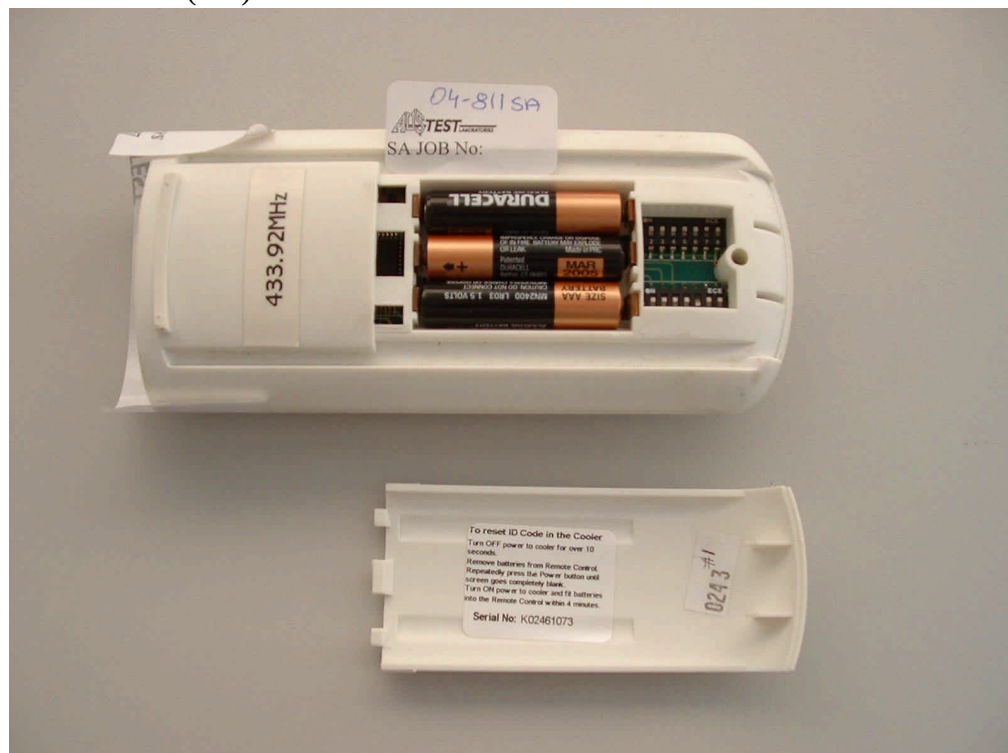


Photo 3: EUT OATS test (Tx)



Photo 4: EUT OATS test (Rx)

