EMISSIONS TEST REPORT FOR A LOW POWER TRANSMITTER

I. GENERAL INFORMATION

Requirement:	Federal Communications Commissions (Industry Canada)
Test Requirements:	15.205, 15.207, 15.209, 15.247 (RSS-210)
Submission Requirement:	Class 2 Permissive Change
Applicant:	Robertshaw Controls Company d/b/a Invensys Home Control Systems
Product ID:	FCC ID: **QI2-EMSM-101**

II. DESCRIPTION OF EQUIPMENT UNDER TEST (EUT)

The Invensys **FCC ID: QI2-EMSM-101** is a frequency hopping spread spectrum (FHSS) transceiver. The Invensys "vCon RF Meter" unit is a single phase electricity meter that utilizes an iCon Electric Meter transceiver module to communicate accumulated electricity readings to the RF Gateway unit.

The Electric Meter Transceiver Module operates in the U.S. ISM band between 902 and 928 MHz. The module incorporates a microcontroller and an r.f. integrated circuit that form a frequency hopping spread spectrum transceiver operating under FCC part 15.247.
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Transmitter Specification

TX Power	12dBm nominal
Frequency Deviation (FSK)	+/- 20 kHz
Frequency of operation	905 – 924.6 MHz
Data Rate	19.2 kbps
Number of channels	50
Channel Separation	400 kHz
Typical 20dB occupied bandwidth	150 kHz

III. TEST LOCATION

All tests were performed at:

Compliance Certification Services
561F Monterey Road
Morgan Hill, CA 95037

T.N. Cokenias 7 February 2004
EMC Consultant/Agent for Invensys

1. Antenna connector requirement

The antenna is permanently attached to the product.

15.204 Antenna description

The electric meter transceiver module uses a permanently attached built-in antenna:

Antenna description	Gain	MFR name
electric meter antenna	-1.08 dBi max	Invensys HCS

15.247(a) Frequency hopping spread spectrum definition

Pseudorandom frequency hopping sequence:

The transmitter cannot coordinate its hopping sequence with the hopping sequence of other transmitters, or vice versa, for the purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters

Each access unit has an individual ID number and there is no link or association between two access units so there is no simultaneous occupancy of individual hopping frequency transmission of two or more access units.

Equal hopping frequency use:

The EUT utilizes 50 hopping channels. Hopset is 50 channels long, then repeats. On average all channels are used equally.

System receiver input bandwidth and receiver hopping capability:

Receiver 26 dB bandwidth is 200 kHz, approximately equal to 26 dB bandwidth of TX. Receiver channel hops are synchronized to transmitter operating frequency.

NATURE OF CLASS 2 CHANGE

Some portions of the circuit boards have been laid out differently for ease of manufacture. Some passive components have been replaced with equivalent parts from different vendors.

Minor changes were made to the basic radio circuitry but L.O. chain, output power, channel occupied bandwidth, number of hopping channels, channel occupancy time, etc., all remain unchanged.

The nature of the changes are such that only transmitter radiated emissions are likely to be affected. Transmitter radiated emissions tests were performed to 10fo.

TEST DATA and TEST PROCEDURES - CCS Laboratory

Radiated Emissions
Test Requirement: 15.205, 15.247

Out of Band Measurements
Test Requirement: 15.247

Measurement Equipment Used:

Agilent E4446A Spectrum Analyzer
Miteq 924341 Pre-amplifier
EMCO 3115 Double Ridged Horn antenna

Radiated emissions generated by the transmitter portion of the EUT were measured.

1. The EUT was placed on a wooden table resting on a turntable on the open air test site. The search antenna was placed 3m from the EUT. The EUT antenna was mounted vertically as per normal installation.

2. The turntable was slowly rotated to locate the direction of maximum emission at each emission falling in the restricted bands of 15.205.

3. Radiated emissions were investigated for a LOW channel, a MID channel, and HIGH channel. Emissions were investigated to the 10^{th} harmonic.

4. Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

Test Results: Worst case results are presented. Refer to data sheets below. Restricted band emissions meet 54 dBuV/m. Other undesired emissions from the transmitter meet the -20 dBc requirement in 15.247(c).

02/11/04 **High Frequency Measurement**

Compliance Certification Services, Morgan Hill Open Field Site

Test Engr:Chin Pang
Project #:04U2484-1
Company:Invensys Viginia
EUT Descrip.: Electric Meter 902 MHz
EUT M/N:EMSM100
Test Target:FCC Class B
Mode Oper:Tx

Test Equipment:

EMCO Horn 1-18GHz	Pre-amplifer 1-26GHz	Spectrum Analyzer	Horn > 18GHz
T73; S/N: 6717 @3m	T86 Miteq 924341	Agilent E4446A Analyzer	

Hi Frequency Cables

☐ (2 ft) ☑ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☑ (12 ft)

Peak Measurements:
1 MHz Resolution Bandwidth
1MHz Video Bandwidth

Average Measurements:
1 MHz Resolution Bandwidth
10Hz Video Bandwidth

f GHz	Dist feet	Read Pk dBuV	Read Avg. dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	HPF	Peak dBuV/m	Avg dBuV/m	Pk Lim dBuV/m	Avg Lim dBuV/m	Pk Mar dB	Avg Mar dB	Notes
low ch 905MHz, EUT Standup															
1.810	9.8	67.9	66.2	27.3	1.4	-44.1	0.0	1.0	53.4	51.8	74.0	54.0	-20.6	-2.2	V
2.714	9.8	53.2	44.0	29.9	1.9	-44.0	0.0	1.0	42.1	32.9	74.0	54.0	-31.9	-21.1	V
3.620	9.8	52.5	43.5	31.8	2.3	-44.5	0.0	1.0	43.1	34.1	74.0	54.0	-30.9	-19.9	V
1.810	9.8	62.2	58.6	27.3	1.4	-44.1	0.0	1.0	47.8	44.2	74.0	54.0	-26.2	-9.8	H
2.714	9.8	56.8	52.1	29.9	1.9	-44.0	0.0	1.0	45.6	41.0	74.0	54.0	-28.4	-13.0	H
3.620	9.8	53.4	46.1	31.8	2.3	-44.5	0.0	1.0	44.0	36.7	74.0	54.0	-30.0	-17.3	H
4.525	9.8	53.4	45.6	33.1	2.6	-45.3	0.0	1.0	44.8	37.0	74.0	54.0	-29.2	-17.0	H
5.430	9.8	53.3	44.0	33.9	3.0	-46.0	0.0	1.0	45.2	35.9	74.0	54.0	-28.8	-18.1	H
6.334	9.8	54.4	44.9	34.6	3.3	-46.4	0.0	1.0	46.9	37.4	74.0	54.0	-27.1	-16.6	H
low ch 905MHz, EUT Laydown position															
1.810	9.8	60.2	58.0	27.3	1.4	-44.1	0.0	1.0	45.8	43.6	74.0	54.0	-28.2	-10.4	V
2.714	9.8	53.8	46.6	29.9	1.9	-44.0	0.0	1.0	42.7	35.5	74.0	54.0	-31.3	-18.5	V
3.620	9.8	50.0	39.8	31.8	2.3	-44.5	0.0	1.0	40.6	30.4	74.0	54.0	-33.4	-23.6	V
1.810	9.8	63.5	61.9	27.3	1.4	-44.1	0.0	1.0	49.1	47.5	74.0	54.0	-24.9	-6.5	H
2.714	9.8	51.7	41.6	29.9	1.9	-44.0	0.0	1.0	40.6	30.5	74.0	54.0	-33.4	-23.5	H
3.620	9.8	49.0	38.2	31.8	2.3	-44.5	0.0	1.0	39.6	28.8	74.0	54.0	-34.4	-25.2	H
Mid ch 915MHz, EUT Standup															
1.830	9.8	66.2	64.6	27.4	1.4	-44.1	0.0	1.0	51.8	50.3	74.0	54.0	-22.2	-3.7	V
2.745	9.8	51.5	42.6	30.0	2.0	-44.0	0.0	1.0	40.5	31.6	74.0	54.0	-33.5	-22.4	V
3.660	9.8	51.2	40.0	31.9	2.3	-44.5	0.0	1.0	41.9	30.7	74.0	54.0	-32.1	-23.3	V
1.830	9.8	51.0	58.4	27.4	1.4	-44.1	0.0	1.0	36.7	44.1	74.0	54.0	-37.3	-9.9	H
2.745	9.8	58.0	55.6	30.0	2.0	-44.0	0.0	1.0	47.0	44.6	74.0	54.0	-27.0	-9.4	H
3.660	9.8	51.4	41.2	31.9	2.3	-44.5	0.0	1.0	42.1	31.9	74.0	54.0	-31.9	-22.1	H
4.575	9.8	52.0	41.8	33.1	2.7	-45.4	0.0	1.0	43.4	33.2	74.0	54.0	-30.6	-20.8	H
5.490	9.8	54.5	47.4	33.9	3.0	-46.0	0.0	1.0	46.4	39.3	74.0	54.0	-27.6	-14.7	H
6.405	9.8	51.3	40.5	34.7	3.3	-46.4	0.0	1.0	43.8	33.0	74.0	54.0	-30.2	-21.0	H
Mid ch 915MHz, EUT Laydown															
1.830	9.8	58.5	54.7	27.4	1.4	-44.1	0.0	1.0	44.2	40.4	74.0	54.0	-29.8	-13.6	V
2.745	9.8	53.6	48.0	30.0	2.0	-44.0	0.0	1.0	42.6	37.0	74.0	54.0	-31.4	-17.0	V
3.660	9.8	51.0	39.0	31.9	2.3	-44.5	0.0	1.0	41.7	29.7	74.0	54.0	-32.3	-24.3	V
1.830	9.8	64.0	62.0	27.4	1.4	-44.1	0.0	1.0	49.7	47.7	74.0	54.0	-24.3	-6.3	H
2.745	9.8	53.0	43.4	30.0	2.0	-44.0	0.0	1.0	42.0	32.4	74.0	54.0	-32.0	-21.6	H
3.660	9.8	48.0	37.6	31.9	2.3	-44.5	0.0	1.0	38.7	28.3	74.0	54.0	-35.3	-25.7	H
High ch 924.6MHz, EUT Standup															
1.848	9.8	67.5	66.7	27.5	1.4	-44.1	0.0	1.0	53.3	52.5	74.0	54.0	-20.7	-1.5	V
2.774	9.8	52.4	42.0	30.1	2.0	-44.0	0.0	1.0	41.5	31.1	74.0	54.0	-32.5	-22.9	V
3.698	9.8	50.0	40.0	32.0	2.3	-44.6	0.0	1.0	40.7	30.7	74.0	54.0	-33.3	-23.3	V
1.848	9.8	63.0	60.8	27.5	1.4	-44.1	0.0	1.0	48.8	46.6	74.0	54.0	-25.2	-7.4	H
2.774	9.8	58.6	55.8	30.1	2.0	-44.0	0.0	1.0	47.7	44.9	74.0	54.0	-26.3	-9.1	H
3.698	9.8	52.0	43.7	32.0	2.3	-44.6	0.0	1.0	42.7	34.4	74.0	54.0	-31.3	-19.6	H
4.622	9.8	57.5	53.2	33.2	2.7	-45.4	0.0	1.0	48.9	44.6	74.0	54.0	-25.1	-9.4	H
5.547	9.8	54.6	43.6	34.0	3.0	-46.0	0.0	1.0	46.5	35.5	74.0	54.0	-27.5	-18.5	H
6.471	9.8	53.0	40.5	34.8	3.3	-46.5	0.0	1.0	45.6	33.1	74.0	54.0	-28.4	-20.9	H
High c6h 924.MHz, EUT Laydown															
1.848	9.8	61.3	59.2	27.5	1.4	-44.1	0.0	1.0	47.1	45.0	74.0	54.0	-26.9	-9.0	V
2.774	9.8	55.0	48.7	30.1	2.0	-44.0	0.0	1.0	44.1	37.8	74.0	54.0	-29.9	-16.2	V
3.698	9.8	49.2	39.8	32.0	2.3	-44.6	0.0	1.0	39.9	30.5	74.0	54.0	-34.1	-23.5	V
1.848	9.8	64.9	63.6	27.5	1.4	-44.1	0.0	1.0	50.7	49.4	74.0	54.0	-23.3	-4.6	H
2.774	9.8	52.0	44.0	30.1	2.0	-44.0	0.0	1.0	41.1	33.1	74.0	54.0	-32.9	-20.9	H
3.698	9.8	50.0	39.7	32.0	2.3	-44.6	0.0	1.0	40.7	30.4	74.0	54.0	-33.3	-23.6	H

No other emisssions were detected above system noise floor up to 10GHz

f	Measurement Frequency	Amp	Preamp Gain	Avg Lim	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Pk Lim	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Avg Mar	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Pk Mar	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter		

RF Power Output
Test Requirement: 15.247

Measurement Equipment Used:

HP 8542E EMI Receiver
Sunol Sciences Bilog Antenna JB1, 30MHz – 2 GHz

Test Procedures

Because the EUT antenna is permanently attached, RF output power was calculated from radiated emissions data taken at 3m. The relationship between transmitter power, antenna gain, and field strength at 3m is

E V/m = (˚(30*PW*G))/3 meters (E in volts/m, P in watts, G numeric gain over isotropic)

Converting to logarithms and combining terms,

E@3m, dBuV/m = (95.1 dB + PdBm + GdBi) dBuV/m

Re-arranging terms:

PdBm = E@3m, dBuV/m - 95.1dB - GdBi

1. The EUT was placed on a wooden table resting on a turntable on the test site. The search antenna was placed 3m from the EUT. The EUT antenna was mounted vertically as per normal installation.

2. Radiated emissions at the fundamental frequency were investigated for a LOW channel, a MID channel, and HIGH channel.

3 Once maximum direction was determined, the search antenna was raised and lowered in both vertical and horizontal polarizations. The maximum readings so obtained are recorded in the data listed below.

Test Results

Radiated field level readings converted to power in dBm shown below:

Channel No.	Frequency	E@3m, dBuV/m	Gain, dBi	Pcalc., dBm
1	905	103.93	-1.08	9.91
26	915	102.93	-1.08	8.84
50	924.6	102.45	-1.08	8.43

RF Exposure Information
MPE Calculations

Invensys HCS Electric Meter
Model vCon II
FCC ID: QI2-EMSM-101
Class 2 change
RF Hazard Distance Calculation

mW/cm2 from Table1: 0.60

Max RF Power P, dBm	TX Antenna G, dBi	MPE Safe Distance, cm
9.91	-1.1	1.0

Basis of Calculations:

E^2/3770 = S, mW/cm2
E, V/m = (Pwatts*Ggain*30)^.5/d, meters
d = ((Pwatts*G*30)/3770*S))^0.5 Pwatts*Ggain = 10^(PdBm-30+GdBi)/10)

NOTE: For mobile or fixed location transmitters, minimum separation distance is 20 cm, even if calculations indicate MPE distance is less