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Testing of

Electromagnetic Emissions

per

USA: CFR Title 47, Part 15.247
Canada: RSS-GEN and RSS-210

are herein reported for

Trane, Inc.
WRATS

Test Report No.: 20101029-01

Applicant:
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Measurements made by:	Joseph D. Brunett, Ph.D.	Report Reviewed by:	Joseph D. Brunett, Ph.D.
Report written by:	Joseph D. Brunett, Ph.D.	Report Date of Issue:	October 29, 2010

Results of equipment under test (EUT) testing completed before October 29, 2010 are as follows.

The transmitter fundamental emission meets the regulatory limit(s) by no less than 32.3 dB. Transmit chain spurious harmonic emissions comply by no less than 0.3 dB. Radiated spurious emissions associated with the receive chain of this device meet the regulatory limit(s) by no less than 5.8 dB. Unintentional spurious emissions from digital circuitry comply with the radiated emission limit(s) by more than 9.2 dB. AC Power Line conducted emissions comply by more than 15.1 dB.

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1 Test Specifications, General Procedures, and Location

1.1 Test Specification and General Procedures

The ultimate goal of Trane, Inc. is to demonstrate that the EUT complies with the Rules and/or Directives detailed below. Detailed in this report are the results of testing the Trane, Inc. WRATS for compliance to:

Country/Region	Rules or Directive	Referenced Section(s)
United States	Code of Federal Regulations	CFR Title 47, Part 15.247
Canada	Industry Canada	RSS-GEN and RSS-210

In association with the rules and directives outlined above, the following specifications and procedures are followed herein.

ANSI C63.4-2003	"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
FCC KDB 558074	"Measurement of Digital Transmission Systems Operating under Section 15.247"
FCC KDB 913591	"Measurement of radiated emissions at the edge of the band for a Part 15 RF Device"
Industry Canada	"The Measurement of Occupied Bandwidth"

1.2 Test Location and Equipment Used

Test Location The EUT was fully tested at **Willow Run Test Labs, LLC**, 8501 Beck Road, Building 2227, Belleville, MI 48111. The site description and attenuation characteristics of the Open Area Test Site are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: 688478) and with Industry Canada, Ottawa, ON (File Ref. No: IC 8719A-1).

Test Equipment Pertinent test equipment used for measurements at this facility is listed in Table 1. The quality system employed at Willow Run Test Labs, LLC has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

Table 1: Willow Run Test Labs, LLC Equipment List.

Description	Manufacturer/Model	SN	Quality Number	Last Cal By / Date Due
Antennas				
Shielded Loop (9 kHz - 50 MHz)	EMCO/6502	2855	UMLOOP1	UMRL / July-2011
Dipole Set (20 MHz - 1000 MHz)	EMCO/3121C	9504-1121	DIPEMC001	Liberty Labs / Sept-2011
Bicone (20 MHz - 250 MHz)	JEF	1	BICJEF001	UMRL / July-2011
Bicone (200 MHz - 1000 MHz)	JEF	1	SBICJEF001	UMRL / July-2011
Log-Periodic Array (200 MHz - 1000 MHz)	JEF/Isbell	1	LOGJEF001	UMRL / July-2011
L-Band	JEF		HRNL001	JEF / July-2011*
LS-Band Horns	JEF/NRL	001, 002	HRN15001, HRN15002	JEF / July-2011*
S-Band Horns	Scientific-Atlanta	1854	HRNSB001	JEF / July-2011*
C-Band	JEF/NRL	1	HRNC001	JEF / July-2011*
XN-Band Horns	JEF/NRL	001, 002	HRNXN001, HRNXN002	JEF / July-2011*
X-Band Horns	JEF/NRL	001, 002	HRNXB001, HRNXB002	JEF / July-2011*
Ku-Band Horns	JEF/NRL	001, 002	HRNKU001, HRNKU002	JEF / July-2011*
Ka-Band Horns	JEF/NRL	001, 002	HRNKA001, HRNKA002	JEF / July-2011*
Receiver's / Spectrum Analyzers				
Spectrum Analyzer	HP/8593E	3649A02722	HP8593E001	DTE / Sept-2011
Signal Generators				
Tracking Generator	HP/8593E	3649A02722	HP8593E001	DTE / Sept-2011
Line Impedance Stabilization Networks				
LISN	EMCO	9304-2081	LISNEM001	JEF / Jan-2011

* Verification Only - Standard Gain Horn Antennas

2 Configuration and Identification of the Equipment Under Test

2.1 Description and Declarations

The Wireless Remote Ambient Temperature Sensor (WRATS) is a 802.15.4 Zigbee wireless sensor for use with home heating and cooling systems. The equipment under test (EUT) is approximately 9.0 x 6.0 x 2.5 cm in dimension, and is depicted in Figure 1. It is powered by a 24 V AC transformer or two 'AA' batteries (3 VDC). This device is envisioned for use as a wireless home heating and cooling sensor. Table 2 outlines provider declared EUT specifications.

Figure 1: Photographs of the EUT.

Table 2: EUT Declarations

General Declarations			
Equipment Type:	Zigbee Sensor	**Country of Origin:**	USA
Nominal Supply:	24 V	**Oper. Temp Range:**	-10^o C to $+60^o$ C
Frequency Range:	2405 to 2480 MHz	**Antenna Dimension:**	2.5 cm (approx.)
Antenna Type:	Integral PCB Antenna	**Antenna Gain:**	3.0 dBi
Number of Channels:	16	**Channel Spacing:**	5 MHz
Alignment Range:	–	**Type of Modulation:**	802.15.4
United States			
FCC ID Number:	XVRZONE930TRX	**Classification:**	DSS
Canada			
IC Number:	6178D-ZONE930TRX	**Classification:**	Spread Spectrum Device

2.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

2.1.2 Modes of Operation

The EUT is capable of temperature monitoring in a residential HVAC system and sending measured data over it's ZigBee interface.

2.1.3 Variants

There is only a single variant of this device.

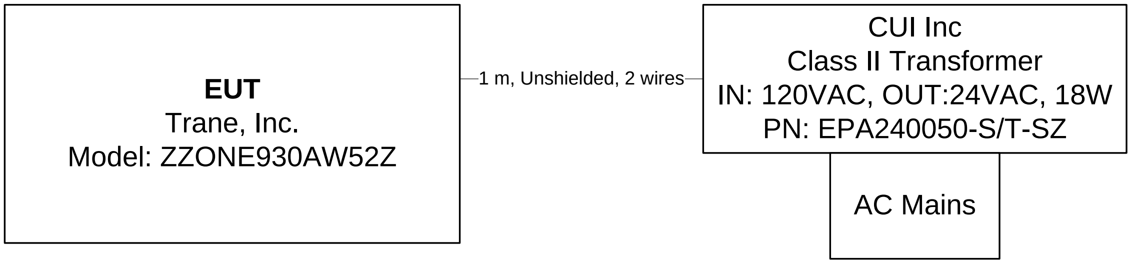

Figure 2: EUT test configuration diagram.

2.1.4 Test Samples

One normal operating sample (SN: EMC1), one sample modified for RF conducted output (SN: EMC2) and one Receive-Only sample (SN: EMC3) were provided for testing.

2.1.5 Functional Exerciser

Not Applicable

2.1.6 Modifications Made

There were no modifications made to the EUT tested by this laboratory. A Trane engineer programmed the device into various operating modes for testing.

2.1.7 Production Intent

The EUT appears to be a production ready sample.

2.1.8 Additional Product Notes

None.

3 Emissions

3.1 General Test Procedures

3.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first evaluated in our shielded fully anechoic chamber. Spectrum and modulation characteristics of all emissions are recorded, and emissions above 1 GHz are fully characterized. The anechoic chamber contains a set-up similar to that of our outdoor 3-meter site, with a turntable and antenna mast. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.2 are employed. After indoor pre-scans, emission measurements up to 1 GHz are made on our outdoor 3-meter Open Area Test Site (OATS). If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All

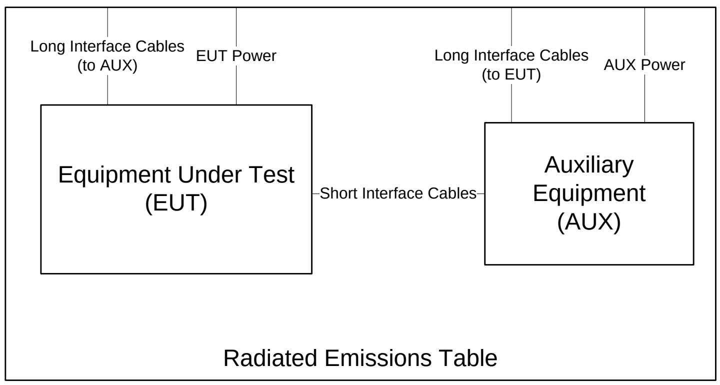

Figure 3: Radiated Emissions Diagram of the EUT.

intentionally radiating elements are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through 360^o in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded.

If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, a shielded loop antenna is used as the test antenna. It is placed at a 1 meter receive height and appropriate low frequency magnetic field extrapolation to the regulatory limit distance is employed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced.

When the regulatory limit is specified as a field strength at at a given distance, the dBm values measured on the test receiver / analyzer are converted to dBμV/m at three meters, using

$$E_{3m} = 107 + P_R + K_A - K_G + K_E - C_F$$

where P_R is the power recorded on spectrum analyzer, in dBm, K_A is the test antenna factor in dB/m, K_G is the pre-amplifier gain and cable loss in dB, K_E is duty correction factor (where applicable) in dB, and C_F is a distance conversion (employed only if limits are specified at alternate distance) in dB. This value is then compared with the regulatory limit extrapolated to the same distance. When presenting data at each frequency, the highest measured emission under all possible EUT orientations (3-axes) is reported. Photographs of the test setup employed are depicted in Figure 4.

Figure 4: Radiated Emissions Test Setup Photograph(s).

3.1.2 Conducted Test Setup and Procedures

Transmit Antenna Port Conducted Emissions At least one sample EUT supplied for testing employed a removable antenna with 50Ω port. Thus, conducted RF emissions measurements (when applicable) are made by connecting the EUT antenna port directly to the test receiver port.

AC Port Conducted Spurious For this device, AC power line conducted emissions are measured in our screen room. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 5. Conducted

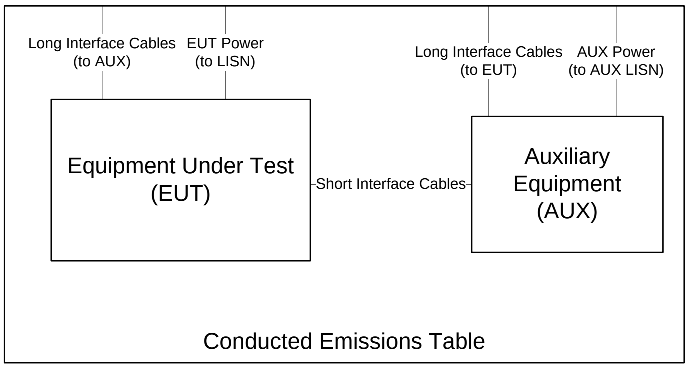

Figure 5: Conducted Emissions General Setup Diagram.

emissions are measured and recorded for each AC mains power source over the spectrum 0.15 MHz to 30 MHz for both the ungrounded (HI/PHASE) and grounded (LO/GRND) conductors with the EUT placed in its highest current draw operating mode(s). The test receiver is set to peak-hold mode in order to record the peak emissions throughout the course of functional operation. Only if an emission exceeds or is near the limit are quasi-peak and average detection applied. Photographs of the test setup employed are depicted in Figure 6.

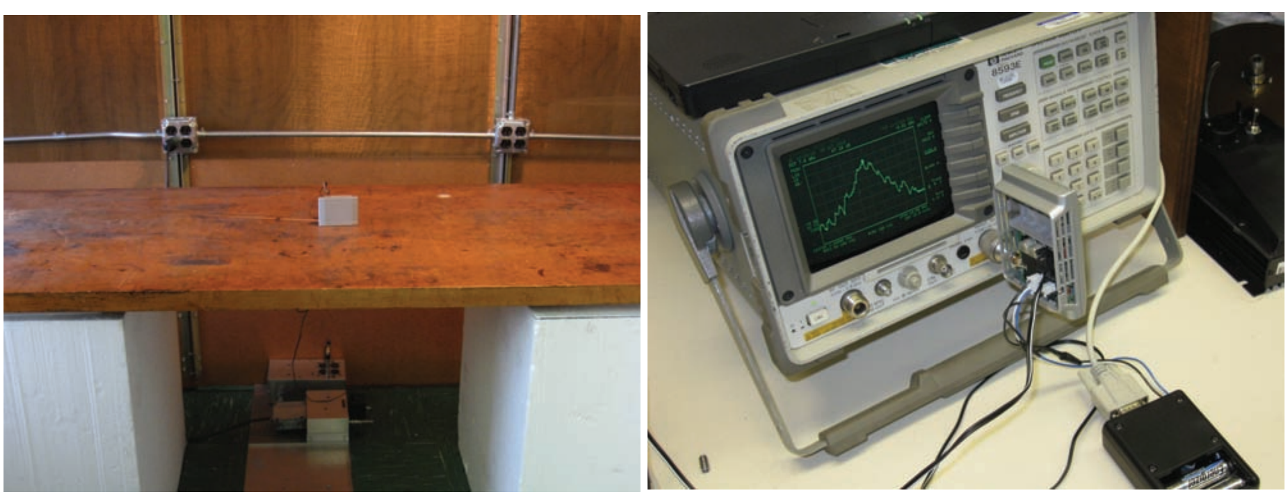

Figure 6: Conducted Emissions Test Setup Photograph(s).

3.1.3 Power Supply Variation

Measurements of the worst-case radiated emissions are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value.

3.2 Intentional Emissions

3.2.1 Fundamental Emission Peak to Average Ratio

For the measurements presented here, the EUT was set to transmit with the shortest available packet length and minimum packet spacing (i.e. maximum on time) allowed by the radio software for each operating mode. The following modes were measured with the test receiver set to zero-span (time-domain). Plots showing the measurements made to obtain these values are provided in Figure 7.

Table 3: Computed Peak to Average Ratio.

Frequency Range	Detector	IF Bandwidth	Video Bandwidth
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz
f > 1 000 MHz	Pk	3 MHz	3 MHz
f > 1 000 MHz	Avg	3 MHz	10 kHz

Test Date: 15-Sep-10
Test Engineer: Joseph Brunett
EUT Mode: Cont. Tx.

Trane WRATS Zigbee; FCC/IC							
			Frequency	Packet Length (t)	Packet Period (T)	Duty Cycle	
Mode	Data Rate	Channel	(MHz)	(ms)	(ms)	(%)	(dB)
802.15.4	Continuous	1	2440.0	N/A	N/A	100	0

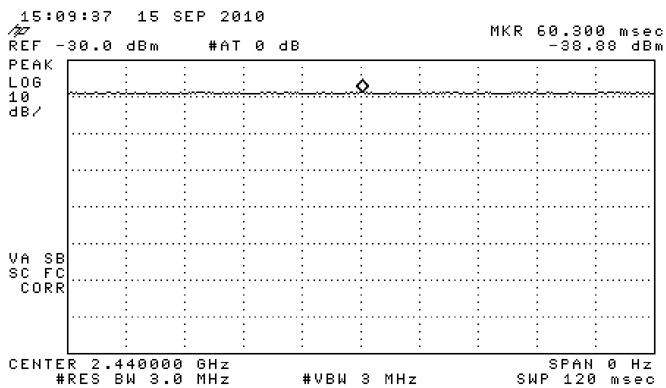

Figure 7: Intentional emission duty cycle measurements.

3.2.2 Fundamental Emission Bandwidth

Emission bandwidth of the EUT is measured with the device placed in the test mode(s) with the shortest available packet length and minimum packet spacing. Radiated emissions are recorded following the test procedures listed in Section 1.1 The 6-dB bandwidth and 26 dB EBW are measured for the lowest, middle, and highest channels available. The 99% emission bandwidth per IC test procedures is also reported.Plots showing example measurements employed obtain the emission bandwidths reported are provided in Figure 8.

Table 4: Measured emission bandwidth.

Frequency Range	**Detector**	**IF Bandwidth**	**Video Bandwidth**	**Test Date:**	15-Sep-10
f > 1 000 MHz	Pk	100 kHz	>100 kHz	**Test Engineer:**	Joseph Brunett
				EUT Mode:	Cont. Tx.

Trane WRATS Zigbee; FCC/IC						
Mode	Data Rate	Channel	Frequency (MHz)	6 dB BW (MHz)	26 dB EBW (MHz)	IC 99% PWR BW (MHz)
802.15.4	Continuous	1	2405.0	1.53	4.35	2.850
		8	2440.0	1.50	4.30	2.625
		16	2480.0	1.50	4.33	2.475

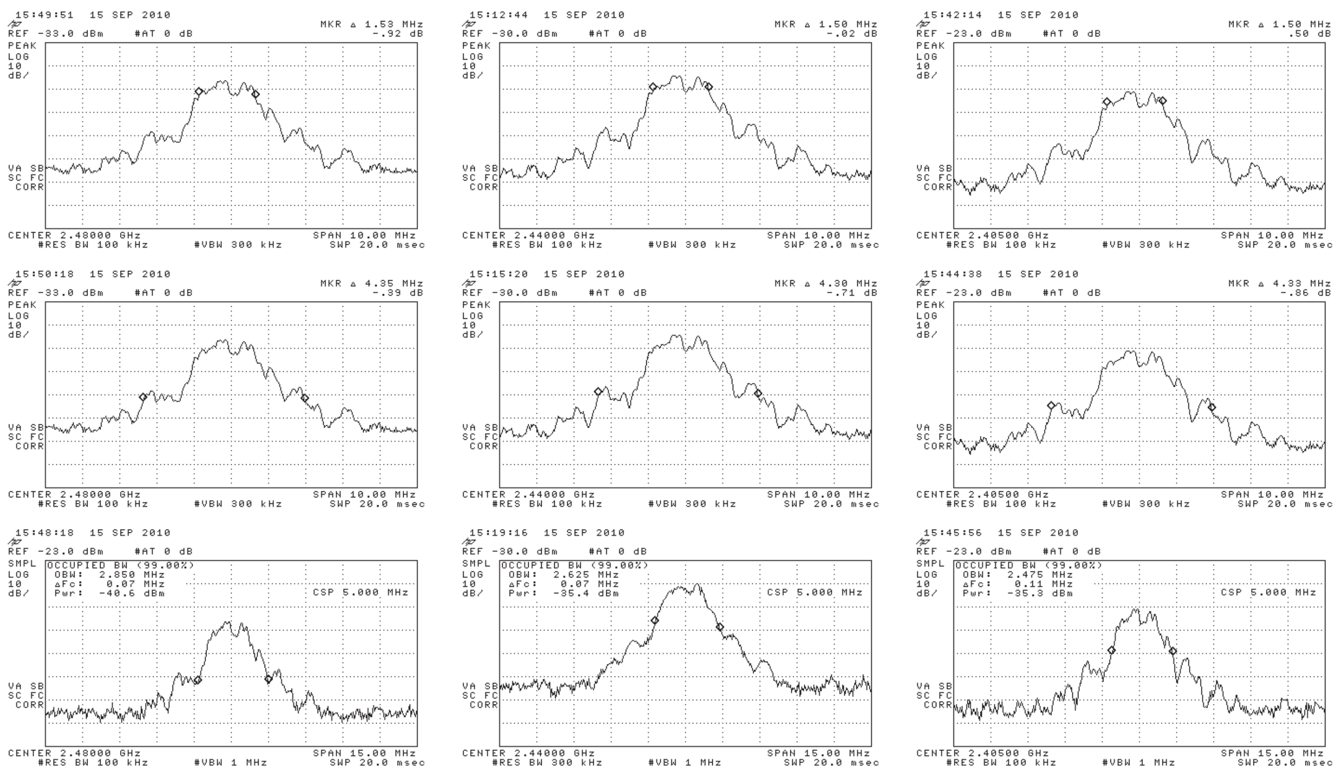

Figure 8: Intentional emissions bandwidth measurements.

3.2.3 Radiated Power

The EUT's radiated power is computed from antenna port conducted power measurements and the measured gain of the EUT antenna. Where the EUT is not sold with an antenna connector, a modified product has been provided including such. Peak conducted output power is measured directly from the EUT antenna port by setting the test receiver bandwidth greater than the measured emission bandwidth of the EUT. Antenna gain is computed by comparing radiated and conducted fundamental emissions measurements with equivalent test receiver detection bandwidths. Table 5 details the results of these measurements. Plots showing the measurements made to obtain these values are provided in Figure 9.

Table 5: Radiated power test results.

Frequency Range	**Det**	**IF Bandwidth**	**Video Bandwidth**		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	12-Oct-10
f > 1 000 MHz	Pk	3 MHz	10kHz	**Test Engineer:**	Joseph Brunett
f > 1 000 MHz	Avg	3 MHz	10kHz	**EUT Mode:**	802.15.4 Continous Tx

Trane WRATS Zigbee; FCC/IC											
Mode	Channel	Freq. MHz	Ant. Used	Ant. Pol.	Pr (Pk)** dBm	Ka dB/m	Kg dB	EIRP (Pk) dBm	Pout (Pk)* dBm	Calc. Ant Gain dB	Pout Limit dBm
802.15.4	1	2405.0	Horn S	H/V	-36.1	23.5	-1.2	0.4	**- 2.3**	2.7	30.0
	8	2440.0	Horn S	H/V	-37.0	23.6	-1.2	- 0.4	- 2.3	1.9	30.0
	16	2480.0	Horn S	H/V	-36.0	23.8	-1.2	0.8	- 2.2	3.0	30.0
Mode	Channel	Freq. MHz	AC Supply Voltage		Pout (Pk)* dBm	DC Supply Voltage		Pout (Pk)* dBm			
802.15.4	8	2440.0	16.7		- 3.5	2.50		- 3.7			
		2440.0	20.2		- 3.4	2.75		- 3.6			
		2440.0	23.9		- 3.4	3.00		- 3.6			
		2440.0	26.6		- 3.5	3.25		- 3.5			
		2440.0	29.6		- 3.4	3.50		- 3.6			

* Measured conducted from EUT

** Measured radiated at 3 meter distance

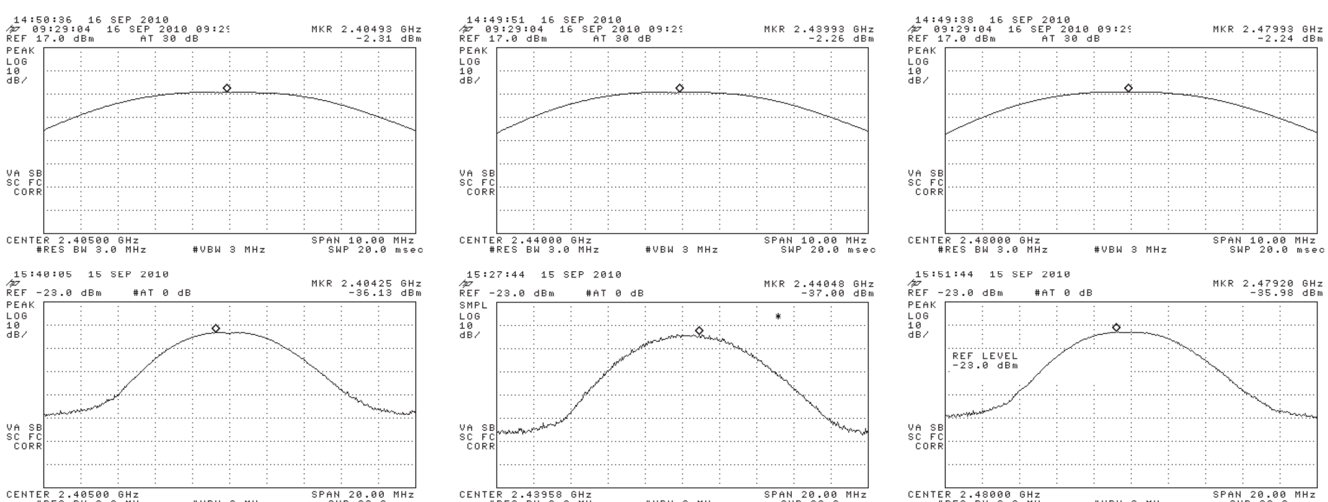

Figure 9: Fundamental power measurement plots.

3.2.4 Power Spectral Density

For this test, the EUT was set to transmit the shortest available packet length and minimum packet spacing allowed by the radio software. The EUT was attached directly to the test receiver. The emission spectrum is first scanned for maximum spectral peaks, the span and receiver bandwidth are then reduced until the power spectral density is measured in the prescribed receiver bandwidth. A sweep time of 100 seconds is maintained to ensure peak signals are captured in each frequency bin. The results are of this testing are summarized in Table 6. Example plots showning how these measurements were made are depicted in Figure 10.

Table 6: Radiated power test results.

Frequency Range	Detector	IF Bandwidth	Video Bandwidth		
2405-2480 MHz	Pk	3 kHz	300 kHz		
				Test Date:	20-Oct-10
				Test Engineer:	Joseph Brunett
				EUT Mode:	Cont. Tx.

Trane WRATS Zigbee; FCC/IC					
Mode	Data Rate	Channel	Frequency (MHz)	PSD (dBm/3kHz)	Line Spacing (kHz)
802.15.4	Continuous	1	2405.0	-13.89	63.0
		8	2440.0	-13.80	62.3
		16	2480.0	-13.58	61.5

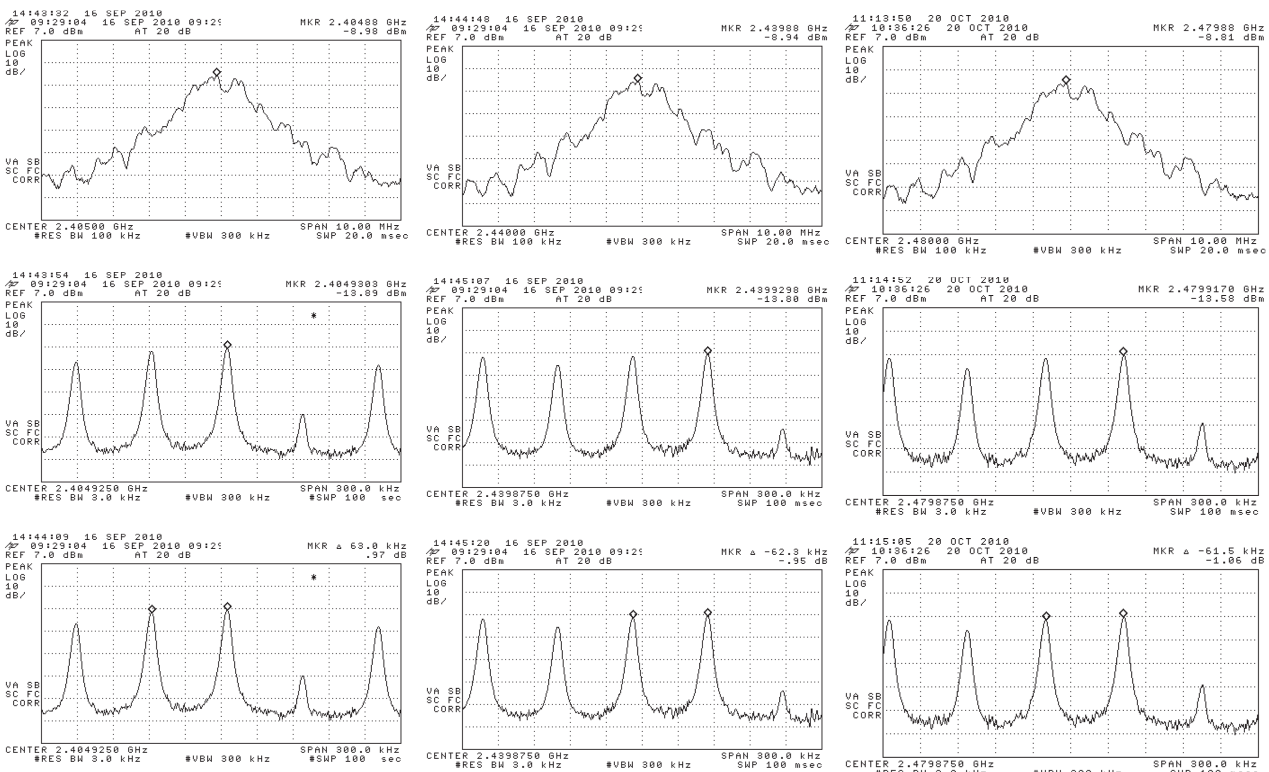

Figure 10: Conducted power spectral density measurement plots.

3.3 Unintentional Emissions

3.3.1 Transmitter Conducted Spurious

For this test, the EUT was set to transmit the shortest available packet length and minimum packet spacing allowed by the radio software. The EUT was attached directly to the test receiver. Conducted spurious emissions were recorded up to (and beyond) 10 times the highest fundamental operating frequency for each applicable operating mode. In all cases, spurious emissions are more than 30 dB below the carrier level. Plots demonstrating compliance across all channels for each operating mode and max held for low, middle, and high channels are included in Figure 11. Also included are plots demonstrating band-edge compliance at lower and upper edges of the declared operating band for each mode and max held for low, middle, and high channels.

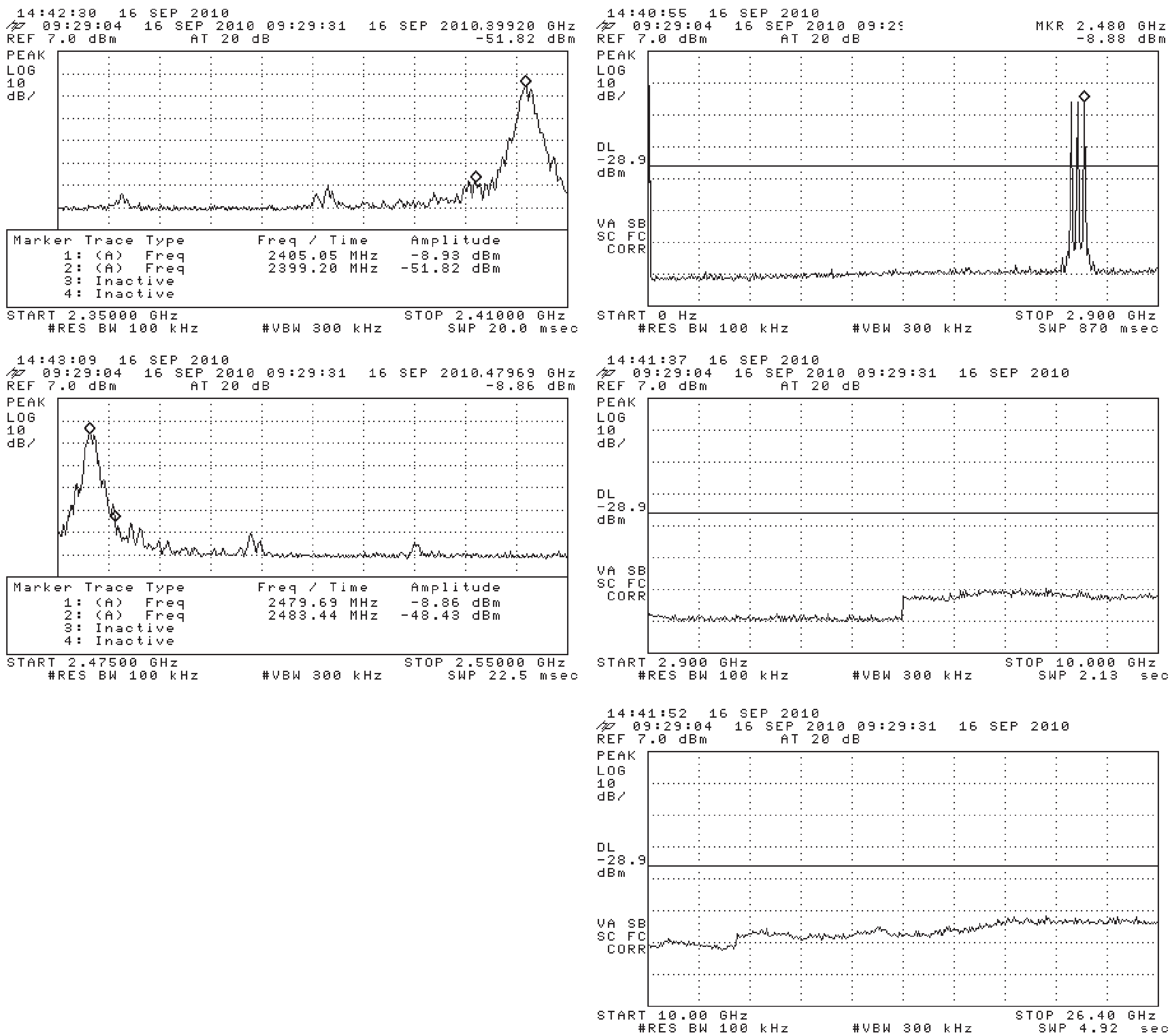

Figure 11: Transmitter Conducted Spurious Emissions (low+middle+high channels).

3.3.2 Radiated Transmitter Spurious

Transmit Chain Spurious Emissions ≥ 30 MHz The results for the measurement of transmitter chain spurious emissions above 30 MHz at the nominal voltage and temperature are provided in Table 7. Measurements are performed to 10 times the highest fundamental operating frequency.

Table 7: Transmit Chain Spurious Emissions ≥ 30 MHz.

Frequency Range	Det	IF Bandwidth	Video Bandwidth		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	23-Sep-10
f > 1 000 MHz	Pk	1 MHz	3 MHz	**Test Engineer:**	Joseph Brunett
f > 1 000 MHz	Avg	1 MHz	10kHz	**EUT Mode:**	802.15.4 Continous Tx

Tx Spurious Emissions												Trane WRATS Zigbee; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.***	Pr (Pk) dBm	Pr (Avg) dBm	Ka dB/m	Kg dB	E3(Pk) dBμV/m	E3(Avg) dBμV/m	E3 Avg Lim dBμV/m	Pass dB	Comments
1	**Fundamental Restricted Band Edge (Low Side)**											
2	2381.8	Horn S	V	-71.5	-82.0	23.5	-1.2		49.7	54.0	4.3	CH1, 2405 MHz; max all
3	2390.0	Horn S	V	-79.4	-89.5	23.5	-1.2		42.2	54.0	11.8	CH8, 2440 MHz; max all
4	2390.0	Horn S	V	-77.8	-88.1	23.5	-1.2		43.6	54.0	10.4	CH16, 2480 MHz; max all
5	**Fundamental Restricted Band Edge High Side)**											
6	2483.5	Horn S	V	-73.7	-84.4	23.8	-1.2		47.6	54.0	6.4	CH1, 2405 MHz; max all
7	2483.5	Horn S	V	-77.3	-87.7	23.8	-1.2		44.3	54.0	9.7	CH8, 2440 MHz; max all
8	2498.9	Horn S	V	-76.9	-87.8	23.8	-1.2		44.2	54.0	9.8	CH15, 2475 MHz; max all
9	2483.5	Horn S	V	-83.4	** See Line 10	23.8	-1.2		48.6	54.0	5.4	CH15, 2475 MHz; max all
10	** "Delta Method", Pr(Pk) = -36.1 dBm in (3MHz/3MHz), band-edge delta = (-45.1 dBm - -92.4 dBm) in (30 kHz / 3MHz). Key: (RBW/VBW)											
11	2483.5	Horn S	V	-78.3	** See Line 12	23.8	-1.2		53.7	54.0	**0.3**	CH16, 2480 MHz; max all
12	**"Delta Method", Pr(Pk) = -37.45 dBm in (3MHz/3MHz), band-edge delta = (-46.4 dBm - -87.2 dBm) in (30 kHz / 3MHz). Key: (RBW/VBW)											
13	**Harmonic Emissions**											
14	4810.0	Horn C	V	-62.5	-78.0	24.6	21.1	48.0	32.5	54.0	21.5	Low; max all
15	4880.0	Horn C	V	-62.3	-73.9	24.6	20.9	48.4	36.8	54.0	17.2	Mid; max all
16	4960.0	Horn C	V	-60.4	-73.5	24.6	20.7	50.6	37.5	54.0	16.5	High; max all
17	7215.0	Horn XN	V	-63.7	-73.6	25.1	21.7	46.7	36.8	54.0	17.2	Low, noise; max all
18	7320.0	Horn XN	V	-61.4	-75.0	25.2	21.9	48.9	35.3	54.0	18.7	Mid, noise; max all
19	7440.0	Horn XN	V	-62.5	-74.6	25.3	22.1	47.7	35.6	54.0	18.4	High, noise; max all
20	9620.0	Horn X	V	-63.9	-72.0	27.8	18.0	52.9	44.8	54.0	9.2	Low, noise; max all
21	9760.0	Horn X	V	-64.1	-71.9	27.9	17.9	52.9	45.1	54.0	8.9	Mid, noise; max all
22	9920.0	Horn X	V	-63.8	-72.9	28.0	17.9	53.2	44.1	54.0	9.9	High, noise; max all
23	12025.0	Horn X	V	-64.6	-73.3	31.7	17.0	57.2	48.5	54.0	5.5	Low, noise; max all
24	12200.0	Horn X	V	-65.5	-74.2	31.8	16.6	56.7	48.0	54.0	6.0	Mid, noise; max all
25	12400.0	Horn X	V	-65.4	-73.8	32.0	16.2	57.3	48.9	54.0	5.1	High, noise; max all
26	14430.0	Horn Ku	V	-63.6	-71.3	33.2	20.7	55.9	48.2	54.0	5.8	Low, noise; max all
27	14640.0	Horn Ku	V	-63.4	-71.7	33.3	20.9	56.0	47.7	54.0	6.3	Mid, noise; max all
28	14880.0	Horn Ku	V	-63.1	-71.7	33.4	21.1	56.2	47.6	54.0	6.4	High, noise; max all
29	16835.0	Horn Ku	V	-61.6	-71.5	34.6	21.9	58.1	48.2	54.0	5.8	Low, noise; max all
30	17080.0	Horn Ku	V	-62.6	-71.7	34.8	22.0	57.2	48.1	54.0	5.9	Mid, noise; max all
31	17360.0	Horn Ku	V	-60.5	-71.3	35.0	22.2	59.3	48.5	54.0	5.5	High, noise; max all
32	19240.0	Horn K	V	-60.7	-70.3	32.2	21.5	57.0	47.4	54.0	6.6	Low, noise; max all
33	19520.0	Horn K	V	-62.0	-70.5	32.3	20.2	57.1	48.6	54.0	5.4	Mid, noise; max all
34	19840.0	Horn K	V	-61.8	-70.7	32.3	17.8	59.7	50.8	54.0	**3.2**	High, noise; max all
35	21645.0	Horn K	V	-58.1	-66.7	32.7	40.0	41.6	33.0	54.0	21.0	Low, noise; max all
36	21960.0	Horn K	V	-59.9	-67.9	32.8	40.0	39.9	31.9	54.0	22.1	Mid, noise; max all
37	22320.0	Horn K	V	-59.2	-68.0	32.8	40.0	40.6	31.8	54.0	22.2	High, noise; max all
38	24050.0	Horn K	V	-58.8	-67.3	33.2	40.0	41.4	32.9	54.0	21.1	Low, noise; max all
39	24400.0	Horn K	V	-59.3	-67.9	33.2	40.0	40.9	32.3	54.0	21.7	Mid, noise; max all
40	24800.0	Horn K	V	-59.1	-67.9	33.3	40.0	41.2	32.4	54.0	21.6	High, noise; max all

*QPk detection below 1 GHz, Avg detection at or above 1 GHz with receiver bandwidth as specified at top of table.

**Measured employing the "delta method", with PEAK emission measured in a 3MHz IF bandwidth followed by band-edge delta in a 30kHz IF bandwidth.

*** Both test antenna polarizations are tested. Only worst case polarization is reported.

3.3.3 Radiated Receiver Spurious

The results for the measurement of radiated receiver spurious emissions (emissions from the receiver chain, e.g. LO or VCO) at the nominal voltage and temperature are provided in Table 8. Receive chain emissions are measured to 5 times the highest receive chain frequency employed or 4 GHz, whichever is higher.

Table 8: Receiver Chain Spurious Emissions ≥ 30 MHz.

Frequency Range	Det	IF Bandwidth	Video Bandwidth		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	10-Oct-10
f > 1 000 MHz	Pk	1 MHz	3 MHz	**Test Engineer:**	Joseph Brunett
f > 1 000 MHz	Avg	1 MHz	10kHz	**EUT Mode:**	Tx & Rx Off

Receive Chain Spurious Emissions — Trane WRATS Zigbee; FCC/IC/CISPR

#	Freq. MHz	Ant. Used	Ant. Pol.***	Pr (Pk) dBm	Pr (QPk/Avg) dBm*	Ka dB/m	Kg dB	E3(Pk) dBμV/m	E3(Avg) dBμV/m	FCC/IC E3lim dBμV/m	CE E3lim dBμV/m	Pass dB	Comments
1	2381.0	SL-Horn	V	-53.5		23.5	30.4	46.6		54.0		7.4	max all, noise
2	2429.0	SL-Horn	V	-52.3		23.6	30.2	48.1		54.0		5.9	max all, noise
3	2416.0	S-Horn	V	-52.8		23.6	30.2	47.5		54.0		6.5	max all, noise
4	2464.0	S-Horn	V	-52.4		23.7	30.1	48.2		54.0		5.8	max all, noise
5	2456.0	S-Horn	V	-52.8		23.7	30.1	47.8		54.0		6.2	max all, noise
6	2504.0	S-Horn	V	-52.7		23.8	29.9	48.2		54.0		**5.8**	max all, noise
7													
8	NOTE: VCO/LO is 24 MHz offset from Rx Channel per IC datasheet. Low, Middle and High Channels tested.												
9													
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*QPk detection below 1 GHz, Avg detection at or above 1 GHz with receiver bandwidth as specified at top of table.

*** Both test antenna polarizations are tested. Only worst case polarization is reported.

3.3.4 Radiated Digital Spurious

The results for the measurement of digital spurious emissions (emissions arising from digital circuitry) at the nominal voltage and temperature are provided in Table 9. Radiation from digital components has been measured to 4 GHz, or to five times the maximum digital component operating frequency, whichever is greater.

Table 9: Digital electromagnetic emissions.

Frequency Range	Det	IF Bandwidth	Video Bandwidth		
25 MHz ≤ f ≤ 1 000 MHz	Pk/QPk	120 kHz	300 kHz	**Test Date:**	25-Sep-10
f > 1 000 MHz	Pk	1 MHz	3 MHz	**Test Engineer:**	Joseph Brunett
f > 1 000 MHz	Avg	1 MHz	10kHz	**EUT Mode:**	Tx & Rx Off

Digital Spurious Emissions — Trane WRATS Zigbee; FCC/IC/CISPR

#	Freq. MHz	Ant. Used	Ant. Pol.	Pr (Pk) dBm	Pr (QPk/Avg) dBm*	Ka dB/m	Kg dB	E3(Pk) dBμV/m	E3(Avg) dBμV/m	FCC/IC E3lim dBμV/m	CE E3lim dBμV/m	Pass dB	Comments
1	39.0	Bic	V	-80.7		11.0	25.2	12.1		40.0	47.5	27.9	
2	48.0	Bic	H	-82.5		9.4	25.1	8.8		40.0	47.5	31.2	
3	50.0	Bic	H	-79.3		9.1	25.0	11.8		40.0	47.5	28.2	
4	72.0	Bic	H	-77.9		7.6	24.7	11.9		40.0	47.5	28.1	
5	72.0	Bic	V	-78.2		7.6	24.7	11.6		40.0	47.5	28.4	
6	86.7	Bic	V	-82.9		7.8	24.5	7.3		40.0	47.5	32.7	
7	139.5	Bic	H	-82.9		11.6	23.8	11.9		43.5	47.5	31.6	
8	144.9	Bic	H	-82.4		12.1	23.7	12.9		43.5	47.5	30.6	
9	225.2	Bic	H	-82.1		14.7	22.7	16.9		46.0	47.5	29.1	
10	232.5	Bic	V	-83.9		14.7	22.6	15.2		46.0	47.5	30.8	
11	270.9	SBic	H	-84.3		16.6	22.1	17.2		46.0	47.5	28.8	noise
12	270.9	SBic	V	-84.1		16.6	22.1	17.4		46.0	47.5	28.6	noise
13	294.4	SBic	H	-85.0		17.7	21.9	17.8		46.0	47.5	28.2	noise
14	294.4	SBic	V	-84.0		17.7	21.9	18.8		46.0	47.5	27.2	noise
15	371.1	SBic	H	-85.6		20.3	21.0	20.7		46.0	47.5	25.3	noise
16	371.1	SBic	V	-84.8		20.3	21.0	21.5		46.0	47.5	24.5	noise
17	752.3	SBic	H	-82.1		26.7	17.6	34.0		46.0	47.5	12.0	noise
18	752.3	SBic	V	-82.6		26.7	17.6	33.5		46.0	47.5	12.5	noise
19	790.9	SBic	H	-83.4		27.3	17.4	33.5		46.0	47.5	12.5	noise
20	790.9	SBic	V	-81.8		27.3	17.4	35.1		46.0	47.5	10.9	noise
21	1078.8	L-Horn	H	-65.2		16.8	14.7	43.9		54.0		10.1	noise
22	1148.1	L-Horn	H	-64.5		16.9	18.0	41.4		54.0		12.6	noise
23	1212.6	L-Horn	V	-61.1		17.0	20.7	42.2		54.0		11.8	noise
24	1245.7	L-Horn	H	-62.3		17.1	21.9	39.8		54.0		14.2	noise
25	1379.6	L-Horn	H	-58.6		17.3	25.8	39.9		54.0		14.1	noise
26	1538.7	L-Horn	H	-57.0		17.6	28.8	38.8		54.0		15.2	noise
27	1552.8	L-Horn	H	-57.1		17.6	28.9	38.6		54.0		15.4	noise
28	1661.0	SL-Horn	V	-55.6		21.4	30.1	42.7		54.0		11.3	noise
29	1955.0	SL-Horn	H	-52.2		20.6	31.3	44.1		54.0		9.9	noise
30	1988.0	SL-Horn	H	-52.7		20.6	31.3	43.5		54.0		10.5	noise
31	2092.0	SL-Horn	H	-54.0		20.6	31.2	42.4		54.0		11.6	noise
32	2422.0	SL-Horn	H	-53.4		21.4	30.2	44.8		54.0		**9.2**	noise
33	2590.0	S-Horn	H/V	-58.7		21.5	21.5	29.6		54.0		24.4	noise
34	3340.0	S-Horn	H/V	-59.5		21.5	21.5	26.8		54.0		27.2	noise
35	3980.0	S-Horn	H/V	-58.3		21.5	21.5	24.5		54.0		29.5	noise
36													
37													

*QPk detection below 1 GHz, Avg detection at or above 1 GHz with receiver bandwidth as specified at top of table.

3.3.5 Conducted Emissions Test Results - AC Power Port(s)

The results of emissions from the EUT's AC mains power port(s) are reported in Table 10.

Table 10: AC mains conducted emissions results.

Frequency Range	**Det**	**IF Bandwidth**	**Video Bandwidth**		
150kHz ≤ f ≤ 30 MHz	Pk/QPk/Avg	9 kHz	30 kHz	**Test Date:**	20-Sep-10
				Test Engineer:	Joseph Brunett
				EUT Mode:	Max Current Draw

Trane WRATS Zigbee On; FCC/IC/CISPR

	Freq.	Line	Peak Det., dBμV		Pass	QP Det., dBμV		Pass	Ave. Det., dBμV		Pass	
#	MHz	Side	Vtest	Vlim*	dB*	Vtest	Vlim	dB	Vtest	Vlim	dB	Comments
1	0.18	Lo	31.6	54.6	23.0		64.6			54.6		
2	0.40	Lo	28.6	47.8	19.2		57.9			47.8		
3	0.57	Lo	27.8	46.0	18.2		56.0			46.0		
4	0.67	Lo	28.3	46.0	17.7		56.0			46.0		
5	0.76	Lo	27.8	46.0	18.2		56.0			46.0		
6	1.14	Lo	29.3	46.0	16.7		56.0			46.0		
7	1.21	Lo	27.8	46.0	18.2		56.0			46.0		
8	1.44	Lo	28.8	46.0	17.2		56.0			46.0		
9	1.50	Lo	30.3	46.0	15.7		56.0			46.0		
10	1.52	Lo	27.8	46.0	18.2		56.0			46.0		
11	3.65	Lo	30.9	46.0	**15.1**		56.0			46.0		
12	5.37	Lo	27.6	50.0	22.4		60.0			50.0		
13	7.23	Lo	29.9	50.0	20.1		60.0			50.0		
14	11.49	Lo	25.1	50.0	25.0		60.0			50.0		
15	13.05	Lo	24.8	50.0	25.3		60.0			50.0		
16	17.38	Lo	25.4	50.0	24.6		60.0			50.0		
17	20.00	Lo	24.3	50.0	25.7		60.0			50.0		
18	22.01	Lo	24.6	50.0	25.4		60.0			50.0		
19	26.19	Lo	24.7	50.0	25.3		60.0			50.0		
20												
21												
22	0.49	Hi	27.3	46.1	18.9		56.2			46.1		
23	0.64	Hi	27.3	46.0	18.7		56.0			46.0		
24	0.77	Hi	27.0	46.0	19.0		56.0			46.0		
25	0.82	Hi	16.7	46.0	29.3		56.0			46.0		
26	1.05	Hi	27.0	46.0	19.0		56.0			46.0		
27	1.08	Hi	27.6	46.0	18.4		56.0			46.0		
28	1.50	Hi	29.6	46.0	16.4		56.0			46.0		
29	1.64	Hi	27.4	46.0	18.6		56.0			46.0		
30	1.85	Hi	27.4	46.0	18.7		56.0			46.0		
31	1.95	Hi	27.7	46.0	18.3		56.0			46.0		
32	3.65	Hi	30.2	46.0	15.8		56.0			46.0		
33	4.56	Hi	27.5	46.0	18.5		56.0			46.0		
34	4.69	Hi	26.3	46.0	19.8		56.0			46.0		
35	7.23	Hi	28.1	50.0	21.9		60.0			50.0		
36	9.47	Hi	24.9	50.0	25.1		60.0			50.0		
37	10.96	Hi	25.0	50.0	25.0		60.0			50.0		
38	14.77	Hi	25.6	50.0	24.4		60.0			50.0		
39	17.46	Hi	24.7	50.0	25.3		60.0			50.0		
40	23.21	Hi	25.5	50.0	24.5		60.0			50.0		
41	27.01	Hi	26.1	50.0	23.9		60.0			50.0		
42												
43												